



# COMBIVERT F6

INSTRUCTIONS FOR USE | INSTALLATION F6 HOUSING 4

Translation of the original manual  
Document 20116235 EN 08






# Preface

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

## Signal words and symbols

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

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

### RESTRICTION

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



Used for informational messages or recommended procedures.

## More symbols

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



Note to further documentation.  
<https://www.keb-automation.com/search>



## Laws and guidelines

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

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

## Warranty and liability

The warranty and liability on design, material or workmanship for the acquired device is given in the general sales conditions.



Here you will find our general sales conditions.  
<https://www.keb-automation.com/terms-conditions>



Further agreements or specifications require a written confirmation.

## Support

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

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

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

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

## Copyright

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

This KEB product or parts thereof may contain third-party software, including free and/or open source software. If applicable, the license terms of this software are contained in the instructions for use. The instructions for use are already available to you, can be downloaded free of charge from the KEB website or can be requested from the respective KEB contact person.

Other wordmarks or/and logos are trademarks (™) or registered trademarks (®) of their respective owners.

## Table of Contents

<b>Preface</b> .....	<b>3</b>
Signal words and symbols .....	3
More symbols.....	3
Laws and guidelines.....	4
Warranty and liability.....	4
Support .....	4
Copyright.....	4
<b>Table of Contents</b> .....	<b>5</b>
<b>List of Figures</b> .....	<b>9</b>
<b>List of Tables</b> .....	<b>10</b>
<b>Glossary</b> .....	<b>12</b>
<b>Standards for drive controllers</b> .....	<b>14</b>
Product standards that apply directly to the drive controller .....	14
Basic standards to which drive controller standards refer directly .....	14
Standards that are used in the environment of the drive controller.....	15
<b>1 Basic Safety Instructions</b> .....	<b>16</b>
<b>1.1 Target group</b> .....	<b>16</b>
<b>1.2 Transport, storage and proper use</b> .....	<b>16</b>
<b>1.3 Installation</b> .....	<b>17</b>
<b>1.4 Electrical connection</b> .....	<b>18</b>
1.4.1 EMC-compatible installation.....	19
1.4.2 Voltage test.....	19
1.4.3 Insulation measurement.....	19
<b>1.5 Start-up and operation</b> .....	<b>20</b>
<b>1.6 Maintenance</b> .....	<b>21</b>
<b>1.7 Repair</b> .....	<b>22</b>
<b>1.8 Disposal</b> .....	<b>23</b>
<b>2 Product Description</b> .....	<b>24</b>
<b>2.1 Specified application</b> .....	<b>24</b>
2.1.1 Residual risks .....	24
<b>2.2 Unintended use</b> .....	<b>24</b>
<b>2.3 Product features</b> .....	<b>25</b>
<b>2.4 Part code</b> .....	<b>26</b>
<b>2.5 Nameplate</b> .....	<b>28</b>
2.5.1 Configurable options .....	29
<b>3 Technical data</b> .....	<b>30</b>
<b>3.1 Operating conditions</b> .....	<b>30</b>
3.1.1 Climatic environmental conditions.....	30
3.1.2 Mechanical environmental conditions .....	31

3.1.3	Chemical / mechanical active substances.....	31
3.1.4	Electrical operating conditions.....	32
3.1.4.1	Device classification.....	32
3.1.4.2	Electromagnetic compatibility.....	32
<b>3.2</b>	<b>Device data of the 230 V devices .....</b>	<b>33</b>
3.2.1	Overview of the 230 V devices.....	33
3.2.2	Voltage and frequencies for 230V devices.....	34
3.2.2.1	Example of the calculation of the possible motor voltage 230V:.....	35
3.2.3	Input and output currents / overload for 230 V devices.....	35
3.2.3.1	Overload characteristic (OL) for 230 V devices.....	36
3.2.3.2	Frequency-dependent maximum current (OL2) for 230V devices .....	38
3.2.4	Power dissipation at rated operation for 230V devices.....	40
3.2.5	Fusing of the 230V devices .....	41
<b>3.3</b>	<b>Device data of the 400 V devices .....</b>	<b>42</b>
3.3.1	Overview of the 400 V devices.....	42
3.3.2	Voltage and frequencies for 400V devices.....	43
3.3.3	Input and output currents / overload for 400 V devices.....	44
3.3.2.1	Example of the calculation of the possible motor voltage:.....	44
3.3.3.1	Overload characteristic (OL) for 400 V devices.....	45
3.3.3.2	Frequency-dependent maximum current (OL2) 400V devices.....	47
3.3.4	Overview of rectifiers for 400 V devices.....	50
3.3.5	Power dissipation at rated operation for 400 V devices .....	51
3.3.6	Fusing of the 400V devices .....	51
3.3.6.1	Fuse protection for AC supply .....	51
3.3.6.2	Fuse protection for DC supply.....	52
<b>3.4</b>	<b>General electrical data .....</b>	<b>53</b>
3.4.1	Switching frequency and temperature.....	53
3.4.1.1	Switching frequency and temperature of the 230 V devices .....	53
3.4.1.2	Switching frequency and temperature of the 400 V devices .....	53
3.4.2	DC link / braking transistor.....	54
3.4.2.1	DC link / braking transistor function of the 230 V devices .....	55
3.4.2.2	DC link / braking transistor function of the 400V devices .....	56
3.4.3	Fan .....	57
3.4.3.1	Switching behaviour of the fans .....	58
3.4.3.2	Switching points of the fans.....	58
<b>4</b>	<b>Installation.....</b>	<b>59</b>
<b>4.1</b>	<b>Dimensions and weights .....</b>	<b>59</b>
4.1.1	Built-in version air cooler.....	59
4.1.2	Built-in version fluid cooler (water).....	60
4.1.3	Push-through version air cooler IP20, IP54-ready .....	61
4.1.4	Push-through version fluid cooler (water) IP20, IP54-ready.....	62

4.1.5 Push-through version fluid cooler (oil) IP54-ready .....	63
<b>4.2 Control cabinet installation .....</b>	<b>64</b>
4.2.1 Mounting instructions .....	64
4.2.2 Mounting distances .....	65
4.2.3 Installation of IP54-ready devices .....	66
4.2.4 Control cabinet ventilation .....	67
4.2.5 Airflow of the drive converter .....	67

## **5 Installation and connection ..... 68**

<b>5.1 Overview of the COMBIVERT F6 .....</b>	<b>68</b>
<b>5.2 Connection of the power unit.....</b>	<b>71</b>
5.2.1 Connection of the voltage supply .....	71
5.2.1.1 Terminal block X1A.....	72
5.2.2 Protective earth and functional earth.....	73
5.2.2.1 Protective earth .....	73
5.2.2.2 Functional earthing.....	73
<b>5.3 Mains connection .....</b>	<b>74</b>
5.3.1 Supply cable.....	74
5.3.2 AC mains connection.....	74
5.3.2.1 AC supply 3-phase .....	74
5.3.2.2 Note on hard power systems.....	75
5.3.3 DC mains connection .....	76
5.3.3.1 Terminal block X1A DC connection .....	76
5.3.3.2 Connection at DC voltage supply .....	77
5.3.4 Connection of the motor.....	78
5.3.4.1 Wiring of the motor .....	78
5.3.4.2 Terminal block X1A motor connection .....	79
5.3.4.3 Wiring of the motor .....	80
5.3.4.4 Motor cable length and conducted interferences at AC supply .....	80
5.3.4.5 Motor cable length for parallel operation of motors .....	81
5.3.4.6 Motor cable cross-section .....	81
5.3.4.7 Interconnection of the motor.....	81
5.3.4.8 Connection of the temperature monitoring and brake control (X1C).....	82
5.3.5 Connection and use of a braking resistor.....	84
5.3.5.1 Terminal block X1A connection braking resistor .....	85
5.3.5.2 Use of intrinsically safe braking resistors .....	86
5.3.5.3 Using a non-intrinsically safe braking resistor .....	86
5.3.6 DC-bus connection.....	87
<b>5.4 Accessories .....</b>	<b>89</b>
5.4.1 Filters and chokes .....	89
5.4.2 Shield connection bracket mounting kit.....	89
5.4.3 Seal IP54-ready devices .....	89
5.4.4 Side-mounted braking resistors.....	90

<b>6</b>	<b>Operation of Liquid-Cooled Devices.....</b>	<b>91</b>
6.1	<b>Water-cooled devices.....</b>	<b>91</b>
6.1.1	Heat sink and operating pressure .....	91
6.1.2	Materials in the cooling circuit .....	91
6.1.3	Requirements for the coolant .....	92
6.1.4	Connection of the cooling system .....	94
6.1.5	Coolant temperature and moisture condensation .....	95
6.1.5.1	Condensation .....	95
6.1.5.2	Supply of temper coolant.....	95
6.1.6	Permissible volume flow with water cooling .....	96
6.1.7	Coolant heating .....	97
6.1.8	Typical pressure drop of the heat sink.....	98
6.2	<b>Oil-cooled devices.....</b>	<b>99</b>
6.2.1	Heat sink and operating pressure for oil-cooled devices.....	99
6.2.2	Oil requirements .....	99
6.2.3	Connection of the oil cooling system.....	100
6.2.4	Permissible volume flow with oil.....	100
6.2.5	Coolant temperature and condensation with oil .....	101
6.2.5.1	Moisture condensation .....	101
6.2.5.2	Supply of temper oil.....	102
<b>7</b>	<b>Certification.....</b>	<b>103</b>
7.1	CE-Marking.....	103
7.2	UL certification .....	104
7.3	Further informations and documentation.....	105
<b>8</b>	<b>Revision history.....</b>	<b>106</b>



## List of Figures

Figure 1:	Nameplate.....	28
Figure 2:	Configurable options .....	29
Figure 3:	Switch-off time $t$ depending on the overload $I/IN$ at OC level 180 % (OL).....	37
Figure 4:	Typical overload characteristic in the lower output frequencies (OL2) example device size 18 .....	39
Figure 5:	Switch-off time $t$ depending on the overload $I/IN$ at OC level 180 % (OL).....	46
Figure 6:	Typical overload characteristic in the lower output frequencies (OL2) example device size 19 .....	47
Figure 7:	Block diagram of the energy flow.....	54
Figure 8:	Switching behaviour of the fans example heat sink fan.....	58
Figure 9:	Dimensions built-in version air cooler .....	59
Figure 10:	Dimensions built-in version fluid cooler (water) .....	60
Figure 11:	Dimensions push-through version air cooler IP20, IP54-ready .....	61
Figure 12:	Dimensions push-through version fluid cooler (water) IP20, IP54-ready.....	62
Figure 13:	Dimensions push-through version fluid cooler (oil) IP54-ready .....	63
Figure 14:	Mounting distances .....	65
Figure 15:	Installation of IP54-ready devices .....	66
Figure 16:	Control cabinet ventilation.....	67
Figure 17:	Airflow of the drive converter .....	67
Figure 18:	F6 housing 4 top view .....	68
Figure 19:	F6 housing 4 front view.....	69
Figure 20:	F6 housing 4 rear view with control board COMPACT .....	70
Figure 21:	Input circuit.....	71
Figure 22:	Terminal block X1A .....	72
Figure 23:	Connection for protective earth.....	73
Figure 24:	Connection of the mains supply 3-phase.....	74
Figure 25:	Terminal block X1A DC connection.....	76
Figure 26:	Connection at DC voltage supply.....	77
Figure 27:	Wiring of the motor.....	78
Figure 28:	Terminal block X1A motor connection.....	79
Figure 29:	Wiring of the motor.....	80
Figure 30:	Terminal block X1C for control board APPLICATION and COMPACT.....	82
Figure 31:	Terminal block X1C for control board PRO .....	82
Figure 32:	Connection of the brake control.....	83
Figure 33:	Connection of a KTY sensor .....	83
Figure 34:	Terminal block X1A connection braking resistor .....	85
Figure 35:	Use of intrinsically safe braking resistors.....	86
Figure 36:	DC-bus connection .....	88
Figure 37:	Open pipe ends for the connection of the water cooling system .....	94
Figure 38:	Volume flow depending on the total power dissipation and temperature difference with water-glycol mixture.....	97
Figure 39:	Typical pressure drop depending on the volume flow.....	98
Figure 40:	Connection of the oil cooling system .....	100

## List of Tables

Table 1:	Part code.....	27
Table 2:	Climatic environmental conditions .....	30
Table 3:	Mechanical environmental conditions .....	31
Table 4:	Chemical / mechanical active substances .....	31
Table 5:	Device classification.....	32
Table 6:	Electromagnetic compatibility .....	32
Table 7:	Overview of the 230 V device data .....	34
Table 8:	Input voltages and frequencies of the 230V devices .....	34
Table 9:	DC link voltage for 230V devices .....	34
Table 10:	Output voltages and frequencies of the 230V devices .....	35
Table 11:	Example of the calculation of the possible motor voltage 230V:.....	35
Table 12:	Input and output currents of the 230 V devices .....	35
Table 13:	Frequency-dependent maximum current for device size 18 .....	40
Table 14:	Power dissipation of the 230 V devices .....	40
Table 15:	Fusing of the 230 V / 240 V devices .....	41
Table 16:	Overview of the 400 V device data .....	43
Table 17:	Input voltages and frequencies of the 400V devices .....	43
Table 18:	DC link voltage for 400V devices.....	43
Table 19:	Output voltages and frequencies of the 400V devices .....	44
Table 20:	Example of the calculation of the possible motor voltage:.....	44
Table 21:	Input and output currents of the 400 V devices .....	44
Table 22:	Frequency-dependent maximum current for device size 18 .....	48
Table 23:	Frequency-dependent maximum current for device size 19 .....	48
Table 24:	Frequency-dependent maximum current for device size 20 .....	49
Table 25:	Frequency-dependent maximum current for device size 21 .....	49
Table 26:	Frequency-dependent maximum current for device size 22 .....	50
Table 27:	Overview of rectifier data for 400 V devices .....	50
Table 28:	Power dissipation of the 400 V devices .....	51
Table 29:	Fusing of the 400V / 480V devices .....	51
Table 30:	Fusing of the 400 V / 480V devices .....	52
Table 31:	Switching frequency and temperature of the 230 V devices.....	53
Table 32:	Switching frequency and temperature of the 400 V devices.....	53
Table 33:	DC link / braking transistor function of the 230V devices .....	55
Table 34:	DC link / braking transistor function of the 400V devices .....	56
Table 35:	Fan.....	57
Table 36:	Switching points of the fans .....	58
Table 37:	Mounting instructions for built-in version.....	64
Table 38:	Mounting instructions for push-through version .....	64
Table 39:	Filters and chokes for 230V devices .....	89
Table 40:	Filters and chokes for 400V devices .....	89
Table 41:	Shield connection bracket mounting kit .....	89
Table 42:	Seal for IP54-ready devices.....	89
Table 43:	Electrochemical series / standard potentials against hydrogen.....	92

Table 44:	Requirements for the coolant.....	92
Table 45:	Special requirements for open and half-open cooling systems .....	93
Table 46:	Dew point table .....	95
Table 47:	Permissible volume flow with water cooling.....	96
Table 48:	Oil requirements.....	99
Table 49:	Special requirements for open and semi-open cooling systems for oil coolers .....	99
Table 50:	Permissible volume flow with oil cooler.....	100
Table 51:	Dew point table .....	102

## Glossary

0V	Earth-potential-free common point	Encoder emulation	Software-generated encoder output
1ph	1-phase mains	End customer	The end customer is the user of the customer product
3ph	3-phase mains	Endat	Bidirectional encoder interface of the company Heidenhain
AC	AC current or voltage	EtherCAT	Real-time Ethernet bus system of the company Beckhoff
AFE	From 07/2019 AIC replaces the previous name AFE	Ethernet	Real-time bus system - defines protocols, plugs, types of cables
AFE filter	From 07/2019 AIC filter replaces the previous name AFE filter	FE	Functional earth
AIC	Active Infeed Converter	FSoE	Functional Safety over Ethernet
AIC filter	Filter for Active Infeed Converter	FU	Drive controller
Application	The application is the intended use of the KEB product	GND	Reference potential, ground
ASCL	Asynchronous sensorless closed loop	GTR7	Braking transistor
Auto motor ident.	Automatically motor identification; calibration of resistance and inductance	HF filter	KEB specific term for an EMC filter (for description see EMC filter).
AWG	American wire gauge	Hiperface	Bidirectional encoder interface of the company Sick-Stegmann
B2B	Business-to-business	HMI	Human machine interface (touch screen)
BiSS	Open source real-time interface for sensors and actuators (DIN 5008)	HSP5	Fast, serial protocol
CAN	Fieldbus system	HTL	Incremental signal with an output voltage (up to 30V) -> TTL
c.d.f.	Cyclic duration factor	IEC	IEC xxxxx stands for an international standard of the International Electrotechnical Commission
CDM	Complete drive module including auxiliary equipment (control cabinet)	IPxx	Protection class (xx for class)
COMBIVERT	KEB drive controller	KEB product	The KEB product is subject of this manual
COMBIVIS	KEB start-up and parameterizing software	KTY	Silicium temperature sensor (polarized)
Customer	The customer has purchased a KEB product from KEB and integrates the KEB product into his product (customer product) or resells the KEB product (dealer)	Manufacturer	The manufacturer is KEB, unless otherwise specified (e.g. as manufacturer of machines, engines, vehicles or adhesives)
DC	DC current or voltage	MCM	American unit for large wire cross sections
DI	Demineralized water, also referred to as deionized (DI) water	Modulation	Means in drive technology that the power semiconductors are controlled
DIN	German Institut for standardization	MTTF	Mean service life to failure
DS 402	CiA DS 402 - CAN device profile for drives	NHN	Standard elevation zero; based on the specified height definition in Germany (DHHN2016). The international data generally deviate from this by only a few cm to dm, so that the specified value can be applied to the regionally applicable definition.
ELV	Extra-low voltage	OC	Overcurrent
EMC filter	EMC filters are used to suppress conducted interferences in both directions between the drive controller and the mains	OH	Overheat
Emergency stop	Shutdown of a drive in emergency case (not de-energized)	OL	Overload
Emergency switching off	Switching off the voltage supply in emergency case		
EMS	Energy Management System		
EN	European standard		

OSSD	Output signal switching device; - an output signal that is checked in regular intervals on its shutdown. (safety technology)
PDS	Power drive system incl. motor and measuring probe
PE	Protective earth
PELV	Protective Extra Low Voltage
PFH	Term used in the safety technology (EN 61508-1...7) for the size of error probability
PFH	Term used in the safety technology (EN 61508-1...7) for the size of error probability per hour
PLC	Programmable logic controller
Pt100	Temperature sensor with $R_0=100\Omega$
Pt1000	Temperature sensor with $R_0=1000\Omega$
PTC	PTC-resistor for temperature detection
PWM	Pulse width modulation
RJ45	Modular connector with 8 lines
SCL	Synchronous sensorless closed loop
SELV	Safe extra-low voltage, unearthed
SIL	The safety integrity level is a measure for quantifying the risk reduction. Term used in the safety technology (EN 61508 -1...7)
SS1	Safety function „Safe stop 1“ in accordance with IEC 61800-5-2
SSI	Synchronous serial interface for encoder
STO	Safety function „Safe Torque Off“ in accordance with IEC 61800-5-2
TTL	Logic with 5 V operating voltage
USB	Universal serial bus
VARAN	Real-time Ethernet bus system

## Standards for drive controllers

### Product standards that apply directly to the drive controller

EN61800-2	Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable frequency a.c. power drive systems (VDE 0160-102, IEC 61800-2)
EN61800-3	Speed-adjustable electrical drives. Part 3: EMC requirements and specific test methods (VDE 0160-103, IEC 61800-3)
EN61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy (IEC 61800-5-1); German version EN 61800-5-1
EN61800-5-2	Adjustable speed electrical power drive systems - Part 5-2: Safety Requirements - Functional (IEC 22G/264/CD)
UL61800-5-1	American version of the IEC 61800-5-1 with „National Deviations“ for USA and Canada
EN61800-9-2	Adjustable speed electrical power drive systems - Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications - Energy efficiency indicators for power drive systems and motor starters

### Basic standards to which drive controller standards refer directly

EN55011	Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement (IEC 55011/CISPR 11); German version EN 55011
EN60529	Degrees of protection provided by enclosures (IP Code) (IEC 60529)
EN60664-1	Insulation coordination for equipment within low-voltage systems Part 1: Principles, requirements and tests (IEC 60664-1)
EN60721-3-1	Classification of environmental conditions - Part 3-1: Classification of groups of environmental parameters and their severities - Section 1: Storage (IEC 60721-3-1); German version EN 60721-3-1
EN60721-3-2	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transportation and handling (IEC 104/670/CD)
EN60721-3-3	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities; section 3: Stationary use at weatherprotected locations; Amendment A2 (IEC 60721-3-3); German version EN 60721-3-3   1994)
EN61000-2-1	Electromagnetic compatibility (EMC) - Part 2: Environment - Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems (IEC 61000-2-1)
EN61000-2-4	Electromagnetic compatibility (EMC) - Part 2-4: Environment; Compatibility levels in industrial plants for low-frequency conducted disturbances (IEC 61000-2-4); German version EN 61000-2-4
EN61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (IEC 61000-4-2); German version EN 61000-4-2
EN61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3); German version EN 61000-4-3
EN61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test (IEC 61000-4-4); German version EN 61000-4-4

EN61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test (IEC 61000-4-5); German version EN 61000-4-5
EN61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6); German version EN 61000-4-6
EN61000-4-34	Electromagnetic compatibility (EMC) - Part 4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase (IEC 61000-4-34); German version EN 61000-4-34
EN61508-1...7	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1...7 (VDE 0803-1...7, IEC 61508-1...7)
EN62061	Safety of machinery - functional safety of electrical, electronic and programmable electronic safety-related systems (VDE 0113-50, IEC 62061)
EN ISO 13849-1	Safety of machinery - safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1); German version EN ISO 13849-1

### Standards that are used in the environment of the drive controller

DGUV regulation 3	Electrical installations and equipment
DNVGL-CG-0339	Environmental test specification for electrical, electronic and programmable equipment and systems
EN 1037	Safety of machinery - Prevention of unexpected start-up; German version EN 1037
EN 12502-1...5	Protection of metallic materials against corrosion - Part 1...5
EN60204-1	Safety of machinery - electrical equipment of machines Part 1: General requirements (VDE 0113-1, IEC 44/709/CDV)
EN60439-1	Low-voltage switchgear and controlgear assemblies - Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1); German version EN 60439-1
EN 60947-7-1	Low-voltage switchgear and controlgear - Part 7-1: Ancillary equipment - Terminal blocks for copper conductors (IEC 60947-7-1:2009); German version EN 60947-7-1:2009
EN 60947-8	Low-voltage switchgear and controlgear - Part 8: Control units for built-in thermal protection (PTC) for rotating electrical machines (IEC 60947-8:2003 + A1:2006 + A2:2011)
EN61373	Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373); German version EN 61373
EN61439-1	Low-voltage switchgear and controlgear assemblies - Part 1: General rules (IEC 121B/40/CDV); German version FprEN 61439-1
VGB S 455 P	Water treatment and use of materials in cooling systems
VDE 0100	Erection of low-voltage systems – Compliance with all parts (IEC 60364-x-x)
DIN EN 60939-1	Passive filter units for electromagnetic interference suppression - Part 1: Generic specification (IEC 60939-1:2010); German version EN 60939-1:2010

# 1 Basic Safety Instructions

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

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

## NOTICE



### Hazards and risks through ignorance!

- ▶ Read the instructions for use!
- ▶ Observe the safety and warning instructions!
- ▶ If anything is unclear, please contact KEB Automation KG!

## 1.1 Target group

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

- Knowledge and understanding of the safety instructions.
- Skills for installation and assembly.
- Start-up and operation of the product.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of *VDE 0100*
- Knowledge of national safety regulations.

## 1.2 Transport, storage and proper use

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



### Transport of drive controllers with an edge length >75 cm

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

- ▶ Transport of drive controllers on suitable pallets.
- ▶ Do not stack drive controllers or burden them with other heavy objects.

## NOTICE

### Damage to the coolant connections

#### Bending of the tubes!

- ▶ Never place the device on the coolant connections






---

**Drive controllers contain electrostatic sensitive components.**

- ▶ Avoid contact.
  - ▶ Wear ESD-protective clothing.
- 

Do not store drive controllers

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

### 1.3 Installation

**⚠ DANGER**

**Do not operate in an explosive environment!**

- ▶ The product is not intended for the use in potentially explosive environment.
- 

**⚠ CAUTION**

**Design-related edges and high weight!**
**Contusions and bruises!**

- ▶ Never stand under suspended loads.
  - ▶ Wear safety shoes.
  - ▶ Secure drive controller accordingly when using lifting gear.
- 

To prevent damages to the device:

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

## 1.4 Electrical connection

**⚠ DANGER**



**Voltage at the terminals and in the device !**

**Danger to life due to electric shock !**

- ▶ Never work on the open device or never touch exposed parts.
- ▶ For any work on the unit switch off the supply voltage, secure it against switching on and check absence of voltage by measuring at the input terminals.
- ▶ Wait until all drives has been stopped in order that no regenerative energy can be generated.
- ▶ Await capacitor discharge time (5 minutes). Check absence of voltage by measuring at the DC terminals.
- ▶ If personal protection is required, install suitable protective devices for drive converters.
- ▶ Never bridge upstream protective devices (even for testing purposes).
- ▶ Connect the protective earth conductor always to drive converter and motor.
- ▶ Install all required covers and protective devices for operation.
- ▶ The control cabinet shall be kept closed during operation.
- ▶ Residual current: This product may cause a dc current in the protective earth conductor. When a residual current protective device (RCD) or a residual current monitoring device (RCM) is used for the protection against direct or indirect contact, only a RCD or RCM type B is permitted on the power supply side of this product.
- ▶ Drive converters with a leakage current > 3.5mA AC current (10mA DC current) are intended for a stationary connection. Protective earth conductors must be designed in accordance with the local regulations for equipment with high leakage currents according to *EN 61800-5-1*, *EN 60204-1* or *VDE 0100*.



If personnel protection is required during installation of the system, suitable protective devices must be used for drive controllers.

[www.keb.de/fileadmin/media/Techinfo/dr/tn/ti\\_dr\\_tn-rcd-00008\\_en.pdf](http://www.keb.de/fileadmin/media/Techinfo/dr/tn/ti_dr_tn-rcd-00008_en.pdf)



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

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

- The electrical installation shall be carried out in accordance with the relevant requirements.
- Cable cross-sections and fuses must be dimensioned by the user according to the specified minimum/maximum values for the application.
- Connection of the drive converter is only permissible on symmetrical networks with a maximum line voltage (L1, L2, L3) with respect to earth (N/PE) of max. 300 V, USA UL: 480 / 277 V. An isolating transformer must be used for supply networks which exceed this value! In case of non-compliance the control is not longer considered to be a PELV circuit.
- With existing or newly wired circuits the person installing the units or machines must ensure that the PELV requirements are met.
- For drive converters that are not isolated from the supply circuit (in accordance with [EN 60721-3-2](#)) all control lines must be included in other protective measures (e.g. double insulation or shielded, earthed and insulated).
- When using components without isolated inputs/outputs, it is necessary that equipotential bonding exists between the components to be connected (e.g. by the equipotential line). Disregard can cause destruction of the components by equalizing currents.

#### 1.4.1 EMC-compatible installation

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



Notes on EMC-compatible installation can be found here.  
[www.keb.de/fileadmin/media/Manuals/dr/emv/0000neb0000.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/emv/0000neb0000.pdf)



#### 1.4.2 Voltage test

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



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



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

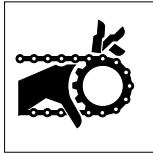
#### 1.4.3 Insulation measurement

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

## 1.5 Start-up and operation

The start-up (i.e. for the specified application) is forbidden until it is determined that the installation complies with the machine directive; account is to be taken of *EN 60204-1*.

### ⚠ WARNING



#### Software protection and programming!

##### Hazards caused by unintentional behavior of the drive!

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

### ⚠ CAUTION



#### High temperatures at heat sink and coolant!

##### Burning of the skin!

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

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

### ⚠ CAUTION



#### High sound level during operation!

##### Hearing damage possible!

- ▶ Wear hearing protection!

### NOTICE

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

##### Premature ageing of the electrolytic capacitors!

- ▶ Mains choke with  $U_k = 4\%$  absolutely necessary.



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

[www.keb.de/fileadmin/media/Techinfo/dr/tn/ti\\_dr\\_tn-format-capacitors-00009\\_en.pdf](http://www.keb.de/fileadmin/media/Techinfo/dr/tn/ti_dr_tn-format-capacitors-00009_en.pdf)



**Switching at the output**

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

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

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

**Switching at the input**

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

**Short-circuit resistance**

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

Exceptions:

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

## 1.6 Maintenance

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

- ▶ Check system for loose screws and plugs and tighten if necessary.
- ▶ Clean drive controller from dirt and dust deposits. Pay attention especially to cooling fins and protective grid of the fans.
- ▶ Examine and clean extracted air filter and cooling air filter of the control cabinet.
- ▶ Check the function of the fans of the drive controller. The fan must be replaced in case of audible vibrations or squeak.
- ▶ In the case of liquid-cooled drive controllers a visual test of the cooling circuit for leaks and corrosion must be carried out. The cooling circuit must be completely empty if a unit shall be switched off for a longer period. The cooling circuit must be blown out additionally with compressed air at temperatures below 0°C.

## 1.7 Repair

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

### **DANGER**



#### **Unauthorized exchange, repair and modifications!**

##### **Unpredictable malfunctions!**

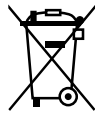
- ▶ The function of the drive controller is dependent on its parameterization. Never replace without knowledge of the application.
- ▶ Modification or repair is permitted only by KEB Automation KG authorized personnel.
- ▶ Only use original manufacturer parts.
- ▶ Infringement will annul the liability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

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

## 1.8 Disposal

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

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



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

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

Withdrawal by	WEEE-Reg.-No.	Keyword
<b>Austria</b>		
KEB Automation GmbH	ERA: 51976	Stichwort „Rücknahme WEEE“
<b>France</b>		
RÉCYLUM - Recycle point	ADEME: FR021806	Mots clés „KEB DEEE“
<b>Germany</b>		
KEB Automation KG	EAR: DE12653519	Stichwort „Rücknahme WEEE“
<b>Italy</b>		
COBAT	AEE: (IT) 19030000011216	Parola chiave „Ritiro RAEE“
<b>Spain</b>		
KEB Automation KG	RII-AEE 7427	Palabra clave „Retirada RAEE“
<b>Česko</b>		
KEB Automation KG	RETELA 09281/20 ECZ	Klíčové slovo: Zpětný odběr OEEZ
<b>Slowakei</b>		
KEB Automation KG	ASEKOL: RV22EEZ0000421	Klíčové slovo: "Spätný odber OEEZ"

The packaging must be feed to paper and cardboard recycling.

## 2 Product Description

The device series COMBIVERT F6 concerns to drive controllers, which are optimized for operation at synchronous and asynchronous motors.

The COMBIVERT can be extended with a safety module for the use in safety-oriented applications. The COMBIVERT F6 series are drive converters with functional safety, optimized for operation at synchronous and asynchronous motors.

Various safety functions are available for different applications. It can be operated with a fieldbus module at different fieldbus systems. The control board has a system comprehensive operating concept.

The COMBIVERT complies with the requirements of the Machinery Directive. The possible functions are certified via a type test.

The COMBIVERT is a product of limited availability in accordance with [EN 61800-3](#). This product may cause radio interference in residential areas. In this case the operator may need to take corresponding measures.

The Machinery Directive, EMC Directive, Low Voltage Directive and other directives and regulations must be observed

### 2.1 Specified application

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

Technical data and information for connection conditions shall be taken from the nameplate and from the instructions for use and must be strictly observed.

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

#### **Restriction**

If the product is used in machines, which work under exceptional conditions or if essential functions, life-supporting measures or an extraordinary safety step must be fulfilled, the necessary reliability and security must be ensured by the machine builder.

#### 2.1.1 Residual risks

Despite intended use, the drive converter can reach unexpected operating conditions in case of error, with wrong parameterization, by faulty connection or unprofessional interventions and repairs. This can be:

- wrong direction of rotation
- motor speed too high
- motor is running into limitation
- motor can be under voltage even in standstill
- automatic start

### 2.2 Unintended use

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



## 2.3 Product features

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

Device type:	Drive controller
Series:	COMBIVERT F6
Power range:	22 kW / 230 V 22...55 kW / 400 V
Housing:	4

The COMBIVERT F6 is characterized by the following features:

- Operation of three-phase asynchronous motors and three-phase synchronous motors, in operating modes open-loop or closed-loop with and without speed feedback
- Following fieldbus systems are supported:  
EtherCAT, VARAN, PROFINET, POWERLINK or CAN
- System-overlapping operating concept
- Wide operating temperature range
- Low switching losses by IGBT power unit
- Low noise development due to high switching frequencies
- Different heat sink concepts
- Temperature-controlled fan, easily replaceable
- Torque limits and s-curves are adjustable to protect gearboxes
- General protection functions of the COMBIVERT series against overcurrent, over-voltage, ground fault and overtemperature
- Analog inputs and outputs, digital inputs and outputs, relay output (potential-free), brake control and -supply, motor protection by I<sup>2</sup>t, KTY- or PTC input, two encoder interfaces, diagnostic interface, fieldbus interface (depending on the control board)
- Integrated safety function according to [EN 61800-5-2](#)

2.4 Part code

xx F6 xx-x-xx-xx

Heat sink version

1: Air-cooler, mounted version
2: Liquid cooler (water), mounted version
3: Air-cooler, through-mount version IP54-ready
4: Liquid cooler (water), through-mount version IP54-ready
5: Air-cooler, through-mount version IP20
6: Liquid cooler (water), trough-mount version IP54-ready, sub-mounted braking resistors
7: Liquid cooler (oil), through-mount version IP54-ready
9: Liquid cooler (water), mounted version, sub-mounted braking resistors
A: Liquid cooler (water), mounted version, High Performance, sub-mounted braking resistors
B: Liquid cooler (water), through-mount version, IP54-ready, High Performance, sub-mounted braking resistors
C: Air-cooler, mounted version, Version 2
D: Air-cooler, mounted version, High-Performance
E: Liquid cooler (water), mounted version, High-Performance
F: Air-cooler, through-mount version IP54-ready, High-Performance
G: Liquid cooler (water), trough-mount version IP54-ready, High-Performance
H: Air-cooler,, Convektion, trough-mount version IP54-ready

Control board variant

<b>APPLIKATION</b>
1: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet-busmodule <sup>3)</sup>
B Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet-busmodule <sup>3)</sup> , Alternative connector
<b>KOMPAKT</b>
1: Multi Encoder Interface, CAN <sup>® 2)</sup> , STO, EtherCAT <sup>® 1)</sup>
2: Multi Encoder Interface, CAN <sup>® 2)</sup> , STO, VARAN
<b>PRO</b>
0: No Encoder, CAN <sup>® 2)</sup> , Real-Time Ethernetinterface <sup>3)</sup>
1: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup>
3: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup> , RS485-potential free
4: No Encoder, CAN <sup>® 2)</sup> , Real-Time Ethernetinterface <sup>3)</sup> , safe relay
5: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup> , safety relay
B: Multi Encoder Interface, CAN <sup>® 2)</sup> , Real-Time Ethernet interface <sup>3)</sup> , alternative connector

*continued on the next page*

<b>x x</b>	<b>F 6</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>-x</b>	<b>x</b>	<b>x</b>	<b>x</b>
		Switching frequency, Software current limit, Turn-off current		0: 2 kHz / 125% / 150%	8: 2 kHz / 180% / 216%			
				1: 4 kHz / 125% / 150%	9: 4 kHz / 180% / 216%			
				2: 8 kHz / 125% / 150%	A: 8 kHz / 180% / 216%			
				3: 16 kHz / 125% / 150%	B: 8 kHz / HSD			
				4: 2 kHz / 150% / 180%	C: 6 kHz / HSD			
				5: 4 kHz / 150% / 180%	Non standard switching		D: frequency / Overload characteristic	
				6: 8 kHz / 150% / 180%	E: Special Device			
				7: 16 kHz / 150% / 180%				
		Voltage / Connection type		1: 3ph 230 V AC/DC with braking transistor				
				2: 3ph 230 V AC/DC without braking transistor				
				3: 3ph 400 V AC/DC with braking transistor				
				4: 3ph 400 V AC/DC without braking transistor				
				A: 3ph 400 V AC/DC incl. GTR7 / max. rectifier / max. pre-charging				
				B: 3ph 400 V AC/DC without GTR7 / max. rectifier / max. pre-charging				
				C: 3ph 400 V AC/DC. GTR7-variant 2				
				D: 3ph 400 V AC/DC GTR7-variant 2 / max. rectifier / max. pre-charging				
		Housing		2...9				
		Equipment		1: Safety module type 1 /STO at control type K				
				3: Safety module type 3				
				4: Safety module type 4				
				5: Safety module type 5				
		Control type		A: APPLICATION				
				K: COMPACT				
				P: PRO				
		Series		COMBIVERT F6				
		Inverter size		10...33				

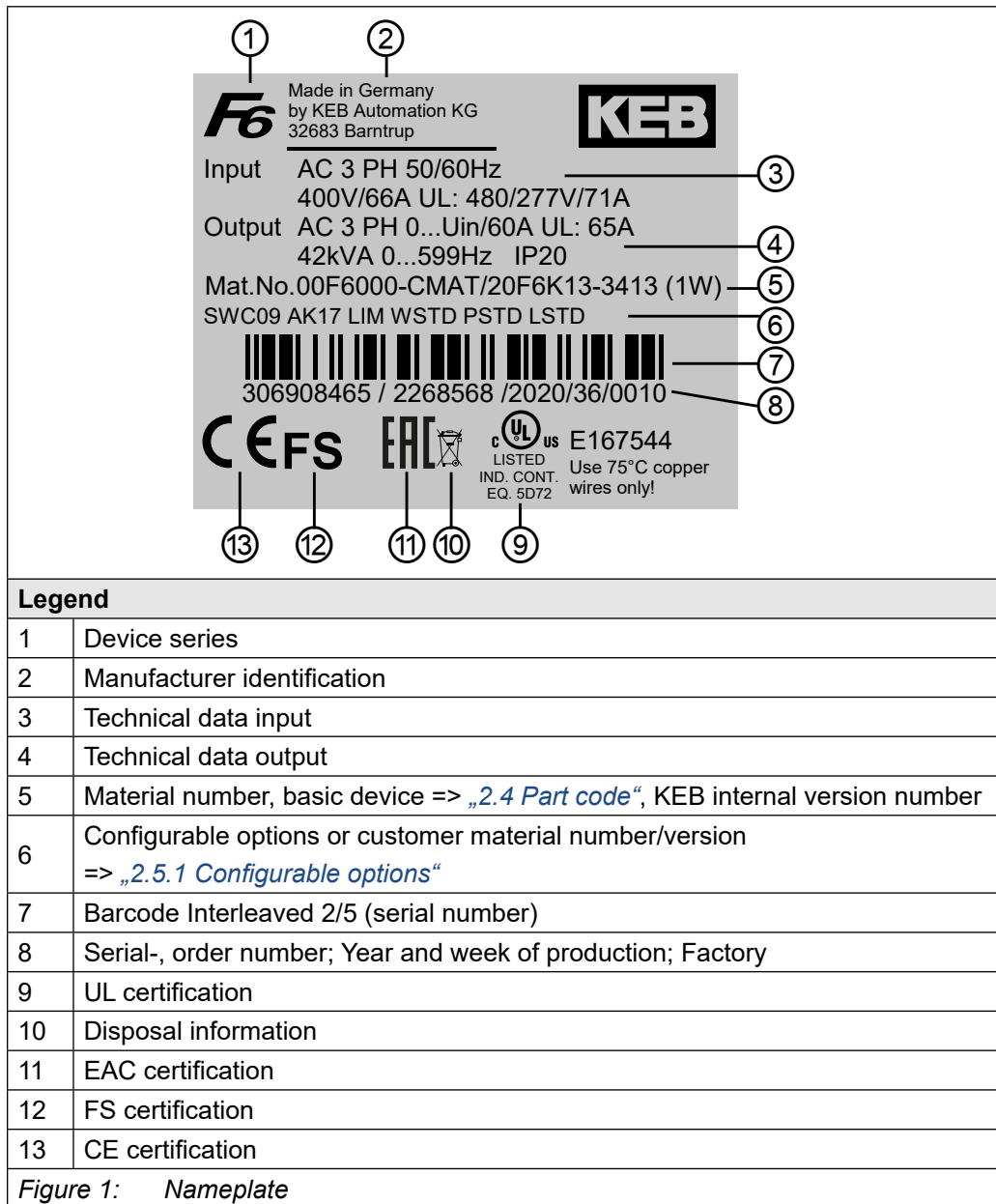
Table 1: Part code

- 1) EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany
- 2) CANopen® is registered trademark of CAN in AUTOMATION - International Users and Manufacturers Group e.V.
- 3) The Real-Time Ethernetbusmodul / Real-Time Ethernet interface contains various fieldbus control types which can be adjusted by software (parameter fb68)



The part code may not be used as order code, but only for identification!

2.5 Nameplate



2.5.1 Configurable options

Features	Feature values	Description
Software	SWxxx <sup>1)</sup>	Software status of the drive converter
Accessories	Axxx <sup>1)</sup>	Selected accessories
	NAK	No accessories
Output frequency activation	LIM	Limitation to 599 Hz
	ULO	> 599 Hz activated
Warranty	WSTD	Warranty - Standard
	Wxxx <sup>1)</sup>	Warranty extension
Parameterization	PSTD	Parameterization - Standard
	Pxxx <sup>1)</sup>	Parameterization - Customer-specific
Nameplate logo	LSTD	Logo - Standard
	Lxxx <sup>1)</sup>	Logo - Customer-specific
<i>Figure 2: Configurable options</i>		

<sup>1)</sup> „x“ indicates a variable value

## 3 Technical data

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

### 3.1 Operating conditions

#### 3.1.1 Climatic environmental conditions

Storage		Standard	Class	Descriptions
Ambient temperature		EN 60721-3-1	1K4	-25...55 °C
Relative humidity		EN 60721-3-1	1K3	5...95 % (without condensation)
Storage height		–	–	Max. 3000 m above sea level
Transport		Standard	Class	Descriptions
Ambient temperature		EN 60721-3-2	2K3	-25...70 °C
Relative humidity		EN 60721-3-2	2K3	95 % at 40 °C (without condensation)
Operation		Standard	Class	Descriptions
Ambient temperature		EN 60721-3-3	3K3	5...40 °C (extended to -10...45 °C)
Coolant inlet temperature	Air	–	–	5...40 °C (extended to -10...45 °C)
	Water <sup>1)</sup>	–	–	5...40 °C
	Oil	–	–	40...55 °C
Relative humidity		EN 60721-3-3	3K3	5...85 % (without condensation)
Version and degree of protection		EN 60529	IP20	Protection against foreign material > ø12.5 mm No protection against water Non-conductive pollution, occasional condensation when PDS is out of service. Drive controller, except power connections and fan unit (IPxxA)
Site altitude		–	–	Max. 2000 m above sea level <ul style="list-style-type: none"> <li>With site altitudes over 1000 m a derating of 1 % per 100 m must be taken into consideration.</li> <li>With site altitudes over 2000 m, the control board to the mains has only basic isolation. Additional measures must be taken when wiring the control.</li> </ul>

Table 2: Climatic environmental conditions

<sup>1)</sup> Observe the instructions for the coolant => „6.1.3 Requirements for the coolant“

### 3.1.2 Mechanical environmental conditions

Storage		Standard	Class	Descriptions
Vibration limits		<a href="#">EN 60721-3-1</a>	1M2	Vibration amplitude 1.5 mm (2...9 Hz) Acceleration amplitude 5 m/s <sup>2</sup> (9...200 Hz)
Shock limit values		<a href="#">EN 60721-3-1</a>	1M2	40 m/s <sup>2</sup> ; 22 ms
Transport		Standard	Class	Descriptions
Vibration limits		<a href="#">EN 60721-3-2</a>	2M1	Vibration amplitude 3.5 mm (2...9 Hz) Acceleration amplitude 10 m/s <sup>2</sup> (9...200 Hz) (Acceleration amplitude 15 m/s <sup>2</sup> (200...500 Hz)) <sup>1)</sup>
Shock limit values		<a href="#">EN 60721-3-2</a>	2M1	100 m/s <sup>2</sup> ; 11 ms
Operation		Standard	Class	Descriptions
Vibration limits		<a href="#">EN 60721-3-3</a>	3M4	Vibration amplitude 3.0 mm (2...9 Hz) Acceleration amplitude 10 m/s <sup>2</sup> (9...200 Hz)
		<a href="#">EN 61800-5-1</a>	–	Vibration amplitude 0.075 mm (10...57 Hz) Acceleration amplitude 10 m/s <sup>2</sup> (57...150 Hz)
Shock limit values		<a href="#">EN 60721-3-3</a>	3M4	100 m/s <sup>2</sup> ; 11 ms
Pressure in the water cooler		–	–	Rated operating pressure: 10 bar Max. operating pressure: 10 bar

Table 3: Mechanical environmental conditions

<sup>1)</sup> Not tested

### 3.1.3 Chemical / mechanical active substances

Storage		Standard	Class	Descriptions
Contamination	Gases	<a href="#">EN 60721-3-1</a>	1C2	–
	Solids		1S2	–
Transport		Standard	Class	Descriptions
Contamination	Gases	<a href="#">EN 60721-3-2</a>	2C2	–
	Solids		2S2	–
Operation		Standard	Class	Descriptions
Contamination	Gases	<a href="#">EN 60721-3-3</a>	3C2	–
	Solids		3S2	–

Table 4: Chemical / mechanical active substances

### 3.1.4 Electrical operating conditions

#### 3.1.4.1 Device classification

Requirement	Standard	Class	Descriptions
Overtoltage category	<a href="#">EN 61800-5-1</a>	III	–
Pollution degree	<a href="#">EN 60664-1</a>	2	Non-conductive pollution, occasional condensation when PDS is out of service

Table 5: Device classification

#### 3.1.4.2 Electromagnetic compatibility

For devices without an internal filter, an external filter is required to comply with the following limits.

EMC emitted interference	Standard	Class	Descriptions
Conducted interference emission	<a href="#">EN 61800-3</a>	C2 / C3	The specified value is only maintained in connection with a filter. Information on interference suppression (rated switching frequency, max. motor cable length) can be found in the corresponding filter instructions.
Radiated emitted interference	<a href="#">EN 61800-3</a>	C2	–
Immunity	Standard	Level	Descriptions
Static discharges	<a href="#">EN 61000-4-2</a>	8 kV 4 kV	AD (air discharge) CD (contact discharge)
Burst - Ports for process measurement control lines and signal interfaces	<a href="#">EN 61000-4-4</a>	2 kV	–
Burst - AC - power ports	<a href="#">EN 61000-4-4</a>	4 kV	–
Surge - Power ports	<a href="#">EN 61000-4-5</a>	1 kV 2 kV	Phase-phase Phase-ground
Conducted immunity, induced by high-frequency fields	<a href="#">EN 61000-4-6</a>	10 V	0.15...80 MHz
Electromagnetic fields	<a href="#">EN 61000-4-3</a>	10 V/m 3 V/m 1 V/m	80 MHz...1 GHz 1.4...2 GHz 2...2.7 GHz
Voltage fluctuations/ voltage dips	<a href="#">EN 61000-2-1</a> <a href="#">EN 61000-4-34</a>	–	-15 %...+10 % Class 3
Frequency changes	<a href="#">EN 61000-2-4</a>	–	≤ 2 %
Voltage deviations	<a href="#">EN 61000-2-4</a>	–	±10 %
Voltage unbalances	<a href="#">EN 61000-2-4</a>	–	≤ 3 %

Table 6: Electromagnetic compatibility



### 3.2 Device data of the 230 V devices

#### 3.2.1 Overview of the 230 V devices

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

<b>Device size</b>		<b>18</b>
<b>Housing</b>		<b>4</b>
Rated apparent output power	$S_{out}$ / kVA	34
Max. rated motor power	<sup>1)</sup> $P_{mot}$ / kW	22
Rated input voltage	$U_N$ / V	230 (UL: 240)
Input voltage range	$U_{in}$ / V	170...264
Mains phases		3
Mains frequency	$f_N$ / Hz	50 / 60 ±2
Rated input current @ $U_N = 230$ V	$I_{in}$ / A	93
Rated input current @ $U_N = 240$ V	$I_{in\_UL}$ / A	93
Insulation resistance @ $U_{dc} = 500$ V	$R_{iso}$ / MΩ	> 20
Output voltage	$U_{out}$ / V	0... $U_{in}$
Output frequency	<sup>2)</sup> $f_{out}$ / Hz	0...599
Output phases		3
Rated output current @ $U_N = 230$ V	$I_N$ / A	85
Rated output current @ $U_N = 240$ V	$I_{N\_UL}$ / A	85
Rated output overload (60 s)	<sup>3) 4)</sup> $I_{60s}$ / %	150
Software current limit	<sup>3)</sup> $I_{lim}$ / %	150
Overcurrent	<sup>3)</sup> $I_{OC}$ / %	180
Rated switching frequency	$f_{SN}$ / kHz	4
Max. switching frequency	<sup>5)</sup> $f_{S\_max}$ / kHz	16
Power dissipation at rated operation	<sup>1)</sup> $P_D$ / W	776
Overload current over time	<sup>3)</sup> $I_{OL}$ / %	=> „3.2.3.1 Overload characteristic (OL) for 230 V devices“
Maximum current 0Hz/50Hz at $f_s=2$ kHz	$I_{out\_max}$ / %	175 / 180
Maximum current 0Hz/50Hz at $f_s=4$ kHz	$I_{out\_max}$ / %	147 / 180
Maximum current 0Hz/50Hz at $f_s=8$ kHz	$I_{out\_max}$ / %	110 / 180
Maximum current 0Hz/50Hz at $f_s=16$ kHz	$I_{out\_max}$ / %	73 / 128
<i>continued on the next page</i>		

<b>Device size</b>		<b>18</b>
<b>Housing</b>		<b>4</b>
Max. braking current	$I_{B\_max} / A$	105
Min. braking resistor value	$R_{B\_min} / \Omega$	4
Braking transistor	<sup>6)</sup>	Max. cycle time: 120 s; Max c.d.f.: 50 %
Protective function for braking transistor		Short-circuit monitoring
Protective function braking resistor (Error GTR7 always on)	<sup>7)</sup>	Feedback signal evaluation and current shutdown
Max. motor cable length shielded	<sup>8)</sup> // m	50

Table 7: Overview of the 230 V device data

- <sup>1)</sup> Rated operation corresponds  $U_N = 230 V$ , rated switching frequency, output frequency = 50 Hz (4-pole standard asynchronous motor).
- <sup>2)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Notice! Devices with a maximum output frequency higher than 599 Hz are subject to export restrictions..
- <sup>3)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>4)</sup> Observe limitations => „3.2.3.1 Overload characteristic (OL) for 230 V devices“.
- <sup>5)</sup> A detailed description of the Derating => „3.4.1 Switching frequency and temperature“.
- <sup>6)</sup> The cyclic duration factor is additionally limited by the used braking resistor.
- <sup>7)</sup> The feedback signal evaluation monitors the functionality of the braking transistor. Power off occurs via the internal mains input bridge of the AC supply.
- <sup>8)</sup> The maximum cable length depends on various factors. Further information can be found in the corresponding filter instructions.

**3.2.2 Voltage and frequencies for 230V devices**

Input voltages and frequencies		
Rated input voltage	$U_N / V$	230
Rated mains voltage (USA)	$U_{N\_UL} / V$	240
Input voltage range	$U_{IN} / V$	170...264
Input phases		3
Mains frequency	$f_N / Hz$	50/60
Mains frequency tolerance	$\pm f_N / Hz$	2

Table 8: Input voltages and frequencies of the 230V devices

DC link voltage		
DC link rated voltage @ $U_N = 400V$	$U_{N\_dc} / V$	325
DC link rated voltage @ $U_{N\_UL} = 480V$	$U_{N\_UL\_dc} / V$	339
DC link voltage working voltage range	$U_{IN\_dc} / V$	240...373

Table 9: DC link voltage for 230V devices

Output voltages and frequencies		
Output voltage at AC supply	<sup>1)</sup> $U_{out} / V$	0... $U_{in}$
Output frequency	<sup>2)</sup> $f_{out} / Hz$	0...599
Output phase		3

Table 10: Output voltages and frequencies of the 230V devices

- <sup>1)</sup> The voltage to the motor is dependent on the actual input voltage and the control method („Example of the calculation of the possible motor voltage 230V:“).
- <sup>2)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with a maximum output frequency higher than 599Hz are restricted for exportt.

3.2.2.1 Example of the calculation of the possible motor voltage 230V:

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

Component	Reduction / %	Example
Mains choke $U_k$	4	Example: open-loop drive converter with mains- and motor choke at non-rigid supply system: 230 V mains voltage - 11 % = 204,7 V motor voltage
Drive converter open-loop	4	
Drive converter closed-loop	8	
Motor choke $U_k$	1	
Non-rigid supply system	2	

Table 11: Example of the calculation of the possible motor voltage 230V:

3.2.3 Input and output currents / overload for 230 V devices

Device size		18
Rated input current @ $U_N = 230 V$	<sup>1)</sup> $I_{in} / A$	101
Rated input current @ $U_{N\_UL} = 240 V$	<sup>1)</sup> $I_{in\_UL} / A$	101
Rated output current @ $U_N = 230 V$	$I_N / A$	85
Rated output current @ $U_{N\_UL} = 240 V$	$I_{N\_UL} / A$	85
Rated output overload (60 s)	<sup>2)</sup> $I_{60s} / \%$	150
Overload current	<sup>2)</sup> $I_{OL} / \%$	=> „3.2.3.1 Overload characteristic (OL) for 230 V devices“
Software current limit	<sup>2)3)</sup> $I_{lim} / \%$	150
Overcurrent	<sup>2)</sup> $I_{OC} / \%$	180

Table 12: Input and output currents of the 230 V devices

- <sup>1)</sup> The values result from rated operation with B6 rectifier circuit and mains choke 4%  $U_k$ .
- <sup>2)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>3)</sup> Limitation of the current setpoint in closed-loop operation. This setpoint limit is not active in v/f operation.

### 3.2.3.1 Overload characteristic (OL) for 230 V devices

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

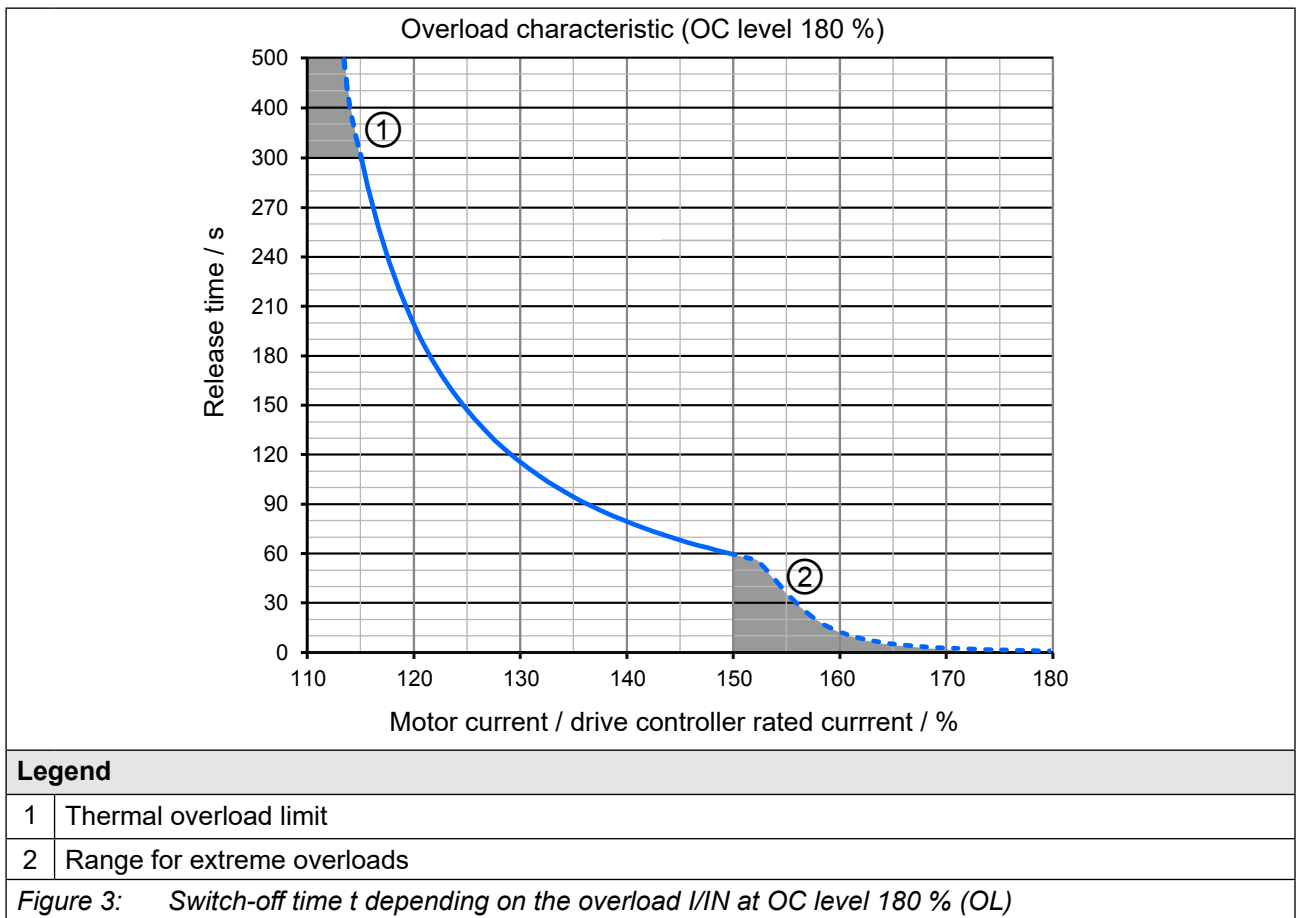
The OL overload function is a root mean square (RMS) function.

The greater the difference between the overload and underload phases, the greater the deviation of the RMS from the arithmetic mean value.

For extreme overloads (=> „[Figure 3: Switch-off time  \$t\$  depending on the overload  \$I/I\_N\$  at OC level 180 % \(OL\)](#)“) the load is weighted more heavily. This means the load is provided with a factor for the calculation of the RMS value, by way that the overload protection function triggers, even if the RMS value does not reach 100%.

#### **Restrictions:**

- The thermal design of the heat sink is based on the rated operation. The following values are taken into account: Rated output current, ambient temperature, rated switching frequency, rated voltage.
- At high ambient temperatures and/or high heat sink temperatures (for example, by preceding utilisation nearby 100%) the drive controller can change to overtemperature error before triggering the protective function OL.
- At low output frequencies or switching frequencies higher than the rated switching frequency, the frequency-dependent maximum current can be exceeded before and error OL2 can be triggered  
=> „[3.2.3.2 Frequency-dependent maximum current \(OL2\) for 230V devices](#)“.



- On exceeding a load of 105 % the overload integrator starts.
- When falling below the integrator counts backwards.
- If the integrator reaches the overload characteristic "Error! Overload (OL)" is triggered.

After a cooling down period, the integrator can be reset now. The drive controller must remain switched on during the cooling down phase.

**Operation in the range of the thermal overload limit**

Due to the high slope of the overload characteristic, the duration of a permissible overload in range ① cannot be determined exactly. Therefore, the design of the drive controller should be assumed to have a maximum overload time of 300s.

3.2.3.2 Frequency-dependent maximum current (OL2) for 230V devices

The characteristics of the maximum currents for a switching frequency which are depending on the output frequency are different for each drive controller, but the following rules are generally applicable:

- Applies for the rated switching frequency: at 0 Hz output frequency the drive controller can provide at least the rated output current.
- Lower maximum currents apply for switching frequencies > rated switching frequency.

If error (OL2) shall be triggered on exceeding the maximum currents or if the switching frequency is automatically reduced (derating) can be adjusted in the drive controller parameters.

The following characteristic curves indicate the permissible maximum current for the output frequency values 0Hz, 3Hz, 6Hz, 10Hz, 25Hz and 50Hz. Device size 18 is shown as an example.

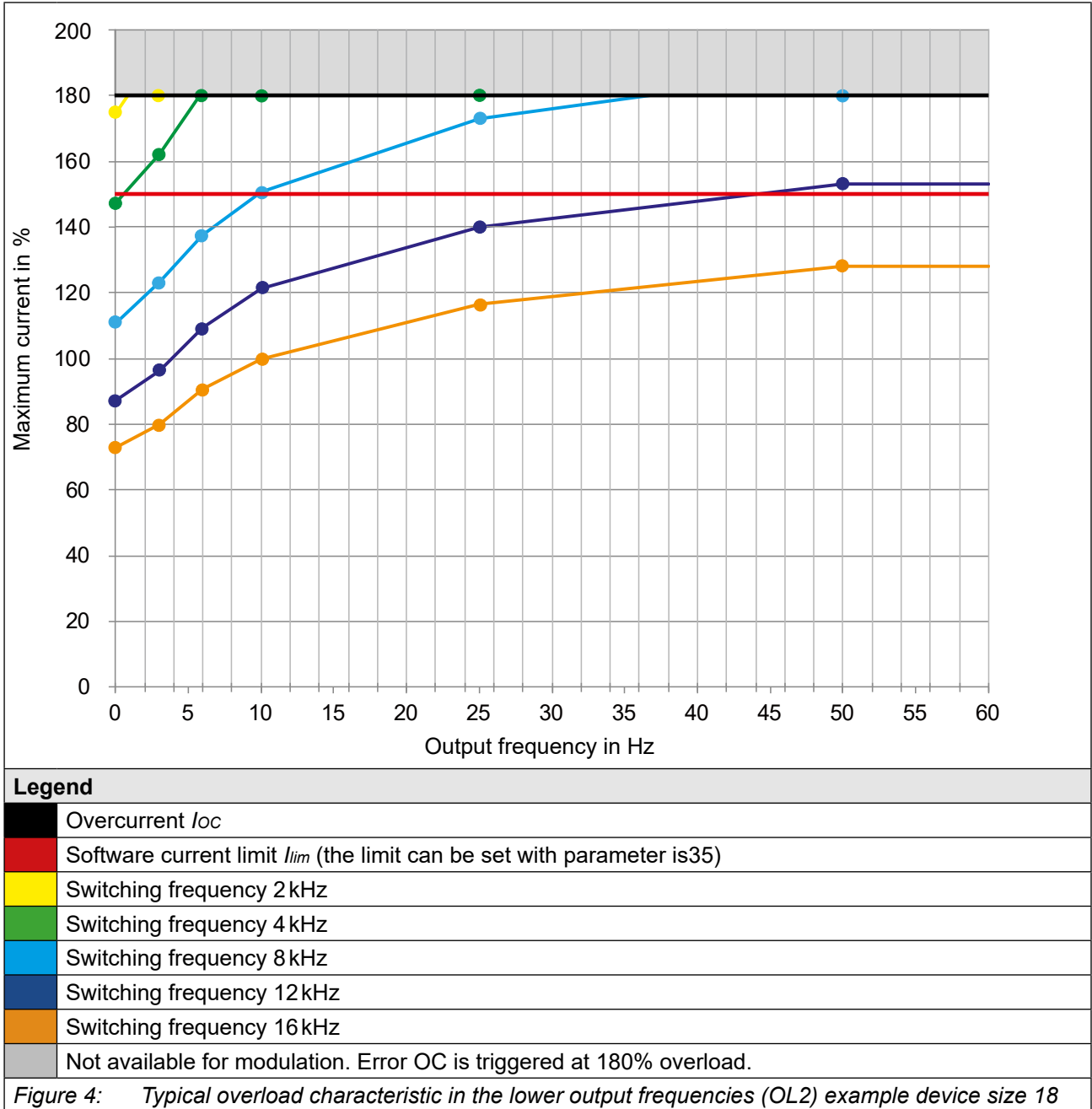


Figure 4: Typical overload characteristic in the lower output frequencies (OL2) example device size 18



The frequency-dependent maximum current  $I_{out\_max}$  refers in % to the rated output current  $I_N$ .

The current remains constant from the last specified output frequency value.



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

***Frequency-dependent maximum current***

Device size		18					
Rated switching frequency		4 kHz					
Output frequency	$f_{out}$ / Hz	0	3	6	10	25	50
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i>	2 kHz	175	180	180	180	180	180
	4 kHz	147	162	180	180	180	180
	8 kHz	111	124	138	151	173	180
	16 kHz	73	80	91	100	117	128
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i>	1.75 kHz	175	180	180	180	180	180
	3.5 kHz	154	171	180	180	180	180
	7 kHz	120	133	149	162	180	180
	14 kHz	80	88	100	111	128	141
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i>	1.5 kHz	175	180	180	180	180	180
	3 kHz	161	179	180	180	180	180
	6 kHz	129	143	159	174	180	180
	12 kHz	87	96	109	121	140	153
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>	1.25 kHz	175	180	180	180	180	180
	2.5 kHz	168	180	180	180	180	180
	5 kHz	138	153	170	180	180	180
	10 kHz	99	110	124	136	157	171

Table 13: Frequency-dependent maximum current for device size 18

**3.2.4 Power dissipation at rated operation for 230V devices**

Device size	18
Power dissipation at rated operation <sup>1)</sup> $P_D$ / W	776

Table 14: Power dissipation of the 230 V devices

<sup>1)</sup> Rated operation corresponds to  $U_N = 230$  V;  $f_{SN}$ ;  $I_N$ ;  $f_N = 50$  Hz (typically value)



3.2.5 Fusing of the 230V devices

Device size	Max. size of the fuse / A			
	$U_N = 230V$ gG (IEC)	$U_N = 240V$ Class "J"	$U_N = 240V$	
	SCCR 30 kA	SCCR 5 kA	SCCR 30 kA	Type
18	125	110	125	SIBA 20 189 20.125 EATON 170M1368

Table 15: Fusing of the 230 V / 240 V devices



**Short-circuit capacity**

After requests from [EN 60439-1](#) and [EN 61800-5-1](#) the following is valid for the connection to a network: The devices are suitable for use in a circuit capable of delivering not more than 30 kA eff. unaffected symmetrical short-circuit current.

### 3.3 Device data of the 400 V devices

#### 3.3.1 Overview of the 400 V devices

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

Device size		18 <sup>8)</sup>	19	20	21	22
<b>Housing</b>		<b>4</b>				
Rated apparent output power	$S_{out}$ / kVA	35	42	52	62	76
Max. rated motor power	<sup>1)</sup> $P_{mot}$ / kW	22	30	37	45	55
Rated input voltage	$U_N$ / V	400 (UL: 480)				
Input voltage range	$U_{in}$ / V	280...550				
Mains phases		3				
Mains frequency	$f_N$ / Hz	50 / 60 ±2				
Rated input current @ $U_N = 400$ V	$I_{in}$ / A	59	66	82	99	121
Rated input current @ $U_N = 480$ V	$I_{in\_UL}$ / A	48	57	71	85	106
Insulation resistance @ $U_{dc} = 500$ V	$R_{iso}$ / MΩ	> 20				
Output voltage	$U_{out}$ / V	0... $U_{in}$				
Output frequency	<sup>2)</sup> $f_{out}$ / Hz	0...599				
Output phases		3				
Rated output current @ $U_N = 400$ V	$I_N$ / A	50	60	75	90	110
Rated output current @ $U_N = 480$ V	$I_{N\_UL}$ / A	40	52	65	77	96
Rated output overload (60 s)	<sup>3) 4)</sup> $I_{60s}$ / %	150				
Software current limit	<sup>3)</sup> $I_{lim}$ / %	150				
Overcurrent	<sup>3)</sup> $I_{OC}$ / %	180				
Rated switching frequency	$f_{SN}$ / kHz	4	4	4	2	2
Max. switching frequency	<sup>5)</sup> $f_{S\_max}$ / kHz	16				
Power dissipation at rated operation	<sup>1)</sup> $P_D$ / W	513	698	896	895	1082
Overload current over time	<sup>3)</sup> $I_{OL}$ / %	=> „3.3.3.1 Overload characteristic (OL) for 400 V devices“				
Maximum current 0Hz/50Hz at $f_s=2$ kHz	$I_{out\_max}$ / %	180/180	176/180	141/180	117/180	111/180
Maximum current 0Hz/50Hz at $f_s=4$ kHz	$I_{out\_max}$ / %	162/180	135/180	108/180	90/153	82/138
Maximum current 0Hz/50Hz at $f_s=8$ kHz	$I_{out\_max}$ / %	106/180	88/156	70/125	58/104	51/93
Maximum current 0Hz/50Hz at $f_s=16$ kHz	$I_{out\_max}$ / %	56/104	46/86	37/69	31/57	24/47
<i>continued on the next page</i>						

Device size	18 <sup>8)</sup>	19	20	21	22
<b>Housing</b>	<b>4</b>				
Max. braking current	$I_{B\_max} / A$	93			105
Min. braking resistor value	$R_{B\_min} / \Omega$	9			8
Braking transistor	<sup>6)</sup>	Max. cycle time: 120s; Max c.d.f.: 50 %			
Protective function for braking transistor		Short-circuit monitoring			
Protective function braking resistor (Error GTR7 always on)	<sup>7)</sup>	Feedback signal evaluation and current switch-off (only for AC mains connection)			
Max. motor cable length shielded	<sup>9)</sup> $l / m$	50			

Table 16: Overview of the 400 V device data

- <sup>1)</sup> Rated operation corresponds  $U_N = 230 V$ , rated switching frequency, output frequency = 50 Hz (4-pole standard asynchronous motor).
- <sup>2)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Notice! Devices with a maximum output frequency higher than 599Hz are subject to export restrictions.
- <sup>3)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>4)</sup> Observe limitations => „3.3.3.1 Overload characteristic (OL) for 400 V devices“.
- <sup>5)</sup> A detailed description of the Derating => „3.4.1 Switching frequency and temperature“.
- <sup>6)</sup> The cyclic duration factor is additionally limited by the used braking resistor.
- <sup>7)</sup> The feedback signal evaluation monitors the functionality of the braking transistor. Power off occurs via the internal mains input bridge of the AC supply. There is no current switch-off with DC power supply.
- <sup>8)</sup> Only available as oil-cooled device.
- <sup>9)</sup> The maximum cable length depends on various factors. Further information can be found in the corresponding filter instructions.

### 3.3.2 Voltage and frequencies for 400V devices

Input voltages and frequencies		
Rated input voltage	$U_N / V$	400
Rated mains voltage (USA)	$U_{N\_UL} / V$	480
Input voltage range	$U_{IN} / V$	280...550
Input phases		3
Mains frequency	$f_N / Hz$	50/60
Mains frequency tolerance	$\pm f_N / Hz$	2

Table 17: Input voltages and frequencies of the 400V devices

DC link voltage		
DC link rated voltage @ $U_N = 400V$	$U_{N\_dc} / V$	565
DC link rated voltage @ $U_{N\_UL} = 480V$	$U_{N\_UL\_dc} / V$	680
DC link voltage working voltage range	$U_{IN\_dc} / V$	390...780

Table 18: DC link voltage for 400V devices

Output voltages and frequencies		
Output voltage at AC supply	<sup>1)</sup> $U_{out} / V$	0... $U_{N\_ac}$
Output frequency	<sup>2)</sup> $f_{out} / Hz$	0...599
Output phase		3

Table 19: Output voltages and frequencies of the 400V devices

- <sup>1)</sup> The voltage to the motor is dependent on the actual input voltage and the control method („3.3.2.1 Example of the calculation of the possible motor voltage:“).
- <sup>2)</sup> The output frequency is to be limited in such a way that it does not exceed 1/10 of the switching frequency. Devices with a maximum output frequency higher than 599Hz are restricted for export.

### 3.3.2.1 Example of the calculation of the possible motor voltage:

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

Component	Reduction / %	Example
Mains choke $U_k$	4	Open-loop drive converter with mains- and motor choke at non-rigid supply system: 400 V mains voltage (100%) - 36 V reduced voltage (11%) = 356 V motor voltage
Drive converter open-loop	4	
Drive converter closed-loop	8	
Motor choke $U_k$	1	
Non-rigid supply system	2	

Table 20: Example of the calculation of the possible motor voltage:

### 3.3.3 Input and output currents / overload for 400 V devices

Device size		18	19	20	21	22
Rated input current @ $U_N = 400V$	<sup>1)</sup> $I_{in} / A$	59	66	82	99	121
Rated input current @ $U_{N\_UL} = 480V$	<sup>1)</sup> $I_{in\_UL} / A$	48	57	71	85	106
Rated input current DC @ $U_{N\_dc} = 565V$	$I_{in\_dc} / A$	73	81	101	121	148
Rated input current DC @ $U_{N\_UL\_dc} = 680V$	$I_{in\_UL\_dc} / A$	58	70	88	104	129
Rated output current @ $U_N = 400V$	$I_N / A$	50	60	75	90	110
Rated output current @ $U_{N\_UL} = 480V$	$I_{N\_UL} / A$	40	52	65	77	96
Rated output overload (60 s)	<sup>2)</sup> $I_{60s} / \%$	150				
Overload current	<sup>2)</sup> $I_{OL} / \%$	=> „3.3.3.1 Overload characteristic (OL) for 400 V devices“				
Software current limit	<sup>2)3)</sup> $I_{lim} / \%$	150				
Overcurrent	<sup>2)</sup> $I_{oc} / \%$	180				

Table 21: Input and output currents of the 400 V devices

- <sup>1)</sup> The values result from rated operation with B6 rectifier circuit and mains choke 4%  $U_k$ .
- <sup>1)</sup> The values refer in % to the rated output current  $I_N$ .
- <sup>2)</sup> Limitation of the current setpoint in closed-loop operation. This setpoint limit is not active in v/f operation.

### 3.3.3.1 Overload characteristic (OL) for 400 V devices

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

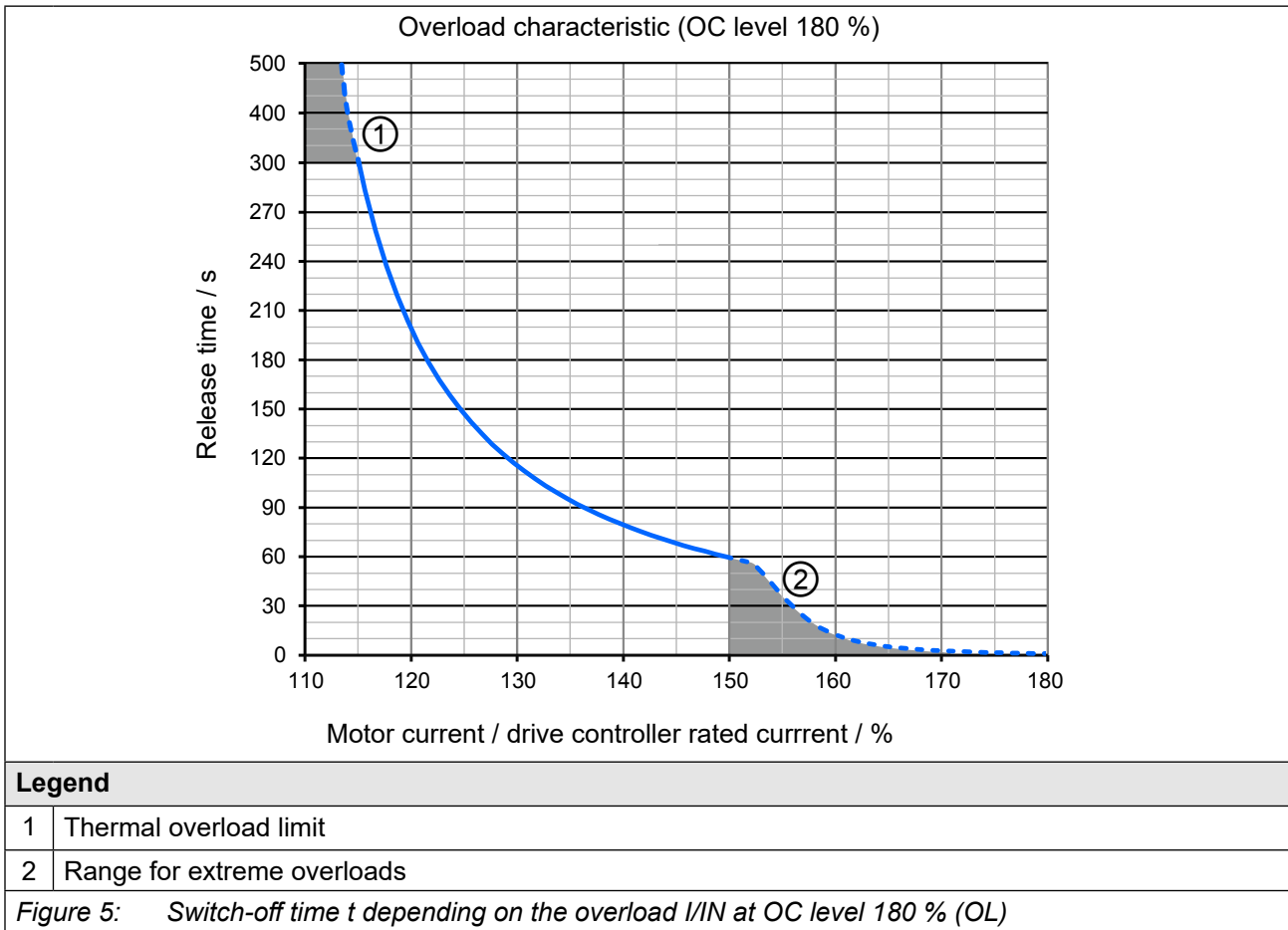
The OL overload function is a root mean square (RMS) function.

The greater the difference between the overload and underload phases, the greater the deviation of the RMS from the arithmetic mean value.

For extreme overloads (=> „[Figure 5: Switch-off time  \$t\$  depending on the overload  \$I/I\_N\$  at OC level 180 % \(OL\)](#)“) the load is weighted more heavily. This means the load is provided with a factor for the calculation of the RMS value, by way that the overload protection function triggers, even if the RMS value does not reach 100%.

#### **Restrictions:**

- The thermal design of the heat sink is based on the rated operation. The following values are taken into account: Rated output current, ambient temperature, rated switching frequency, rated voltage.
- At high ambient temperatures and/or high heat sink temperatures (for example, by preceding utilisation nearby 100%) the drive controller can change to overtemperature error before triggering the protective function OL.
- At low output frequencies or switching frequencies higher than the rated switching frequency, the frequency-dependent maximum current can be exceeded before and error OL2 can be triggered  
=> „[3.3.3.2 Frequency-dependent maximum current \(OL2\) 400V devices](#)“.



- On exceeding a load of 105 % the overload integrator starts.
- When falling below the integrator counts backwards.
- If the integrator reaches the overload characteristic "Error! Overload (OL)" is triggered.

After a cooling down period, the integrator can be reset now. The drive controller must remain switched on during the cooling down phase.

**Operation in the range of the thermal overload limit**

Due to the high slope of the overload characteristic, the duration of a permissible overload in this range ① cannot be determined exactly. Therefore, the design of the drive controller should be assumed to have a maximum overload time of 300s.

3.3.3.2 Frequency-dependent maximum current (OL2) 400V devices

The characteristics of the maximum currents for a switching frequency which are depending on the output frequency are different for each drive controller, but the following rules are generally applicable:

- Applies for the rated switching frequency: at 0 Hz output frequency the drive controller can provide at least the rated output current.
- Lower maximum currents apply for switching frequencies > rated switching frequency.

If error (OL2) shall be triggered on exceeding the maximum currents or if the switching frequency is automatically reduced (derating) can be adjusted in the drive controller parameters.

The following characteristic curves indicate the permissible maximum current for the output frequency values 0 Hz, 3 Hz, 6 Hz, 10 Hz, 25 Hz and 50 Hz. Device size 19 is represented exemplary.

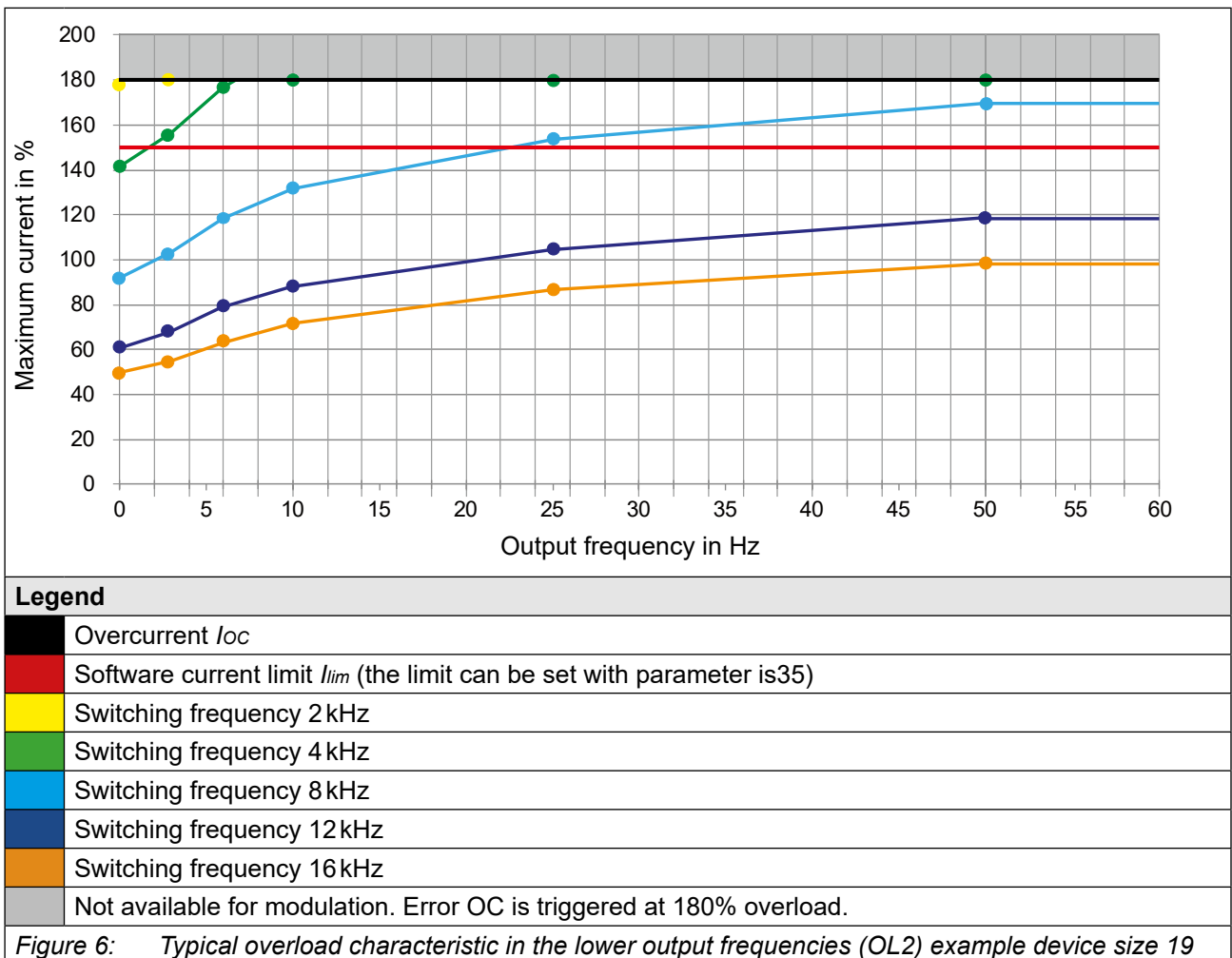


Figure 6: Typical overload characteristic in the lower output frequencies (OL2) example device size 19



The frequency-dependent maximum current  $I_{out\_max}$  refers in % to the rated output current  $I_N$ .

The current remains constant from the last specified output frequency value.



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

***Frequency-dependent maximum current***

Device size		18					
Rated switching frequency		4 kHz					
Output frequency	$f_{out}$ / Hz	0	3	6	10	25	50
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i>	2 kHz	180	180	180	180	180	180
	4 kHz	162	180	180	180	180	180
	8 kHz	106	118	134	148	172	180
	16 kHz	56	64	72	78	94	104
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i>	1.75 kHz	180	180	180	180	180	180
	3.5 kHz	175	180	180	180	180	180
	7 kHz	120	134	151	166	180	180
	14 kHz	66	75	84	92	110	121
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i>	1.5 kHz	180	180	180	180	180	180
	3 kHz	180	180	180	180	180	180
	6 kHz	134	149	168	180	180	180
	12 kHz	76	86	96	106	126	138
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>	1.25 kHz	180	180	180	180	180	180
	2.5 kHz	180	180	180	180	180	180
	5 kHz	148	165	180	180	180	180
	10 kHz	91	102	115	127	149	163

Table 22: Frequency-dependent maximum current for device size 18

Device size		19					
Rated switching frequency		4 kHz					
Output frequency	$f_{out}$ / Hz	0	3	6	10	25	50
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i>	2 kHz	176	180	180	180	180	180
	4 kHz	135	150	168	180	180	180
	8 kHz	88	98	111	123	143	156
	16 kHz	46	53	60	65	78	86
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i>	1.75 kHz	176	180	180	180	180	180
	3.5 kHz	145	161	180	180	180	180
	7 kHz	100	111	125	138	160	175
	14 kHz	55	62	70	76	91	100
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i>	1.5 kHz	176	180	180	180	180	180
	3 kHz	155	172	180	180	180	180
	6 kHz	111	124	140	153	176	180
	12 kHz	63	72	80	88	105	115
Frequency-dependent maximum current @ $f_s$ $I_{out\_max}$ / % <i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>	1.25 kHz	176	180	180	180	180	180
	2.5 kHz	166	180	180	180	180	180
	5 kHz	123	137	154	168	180	180
	10 kHz	75	85	95	105	124	135

Table 23: Frequency-dependent maximum current for device size 19



Device size		20					
Rated switching frequency		4 kHz					
Output frequency	$f_{out}$ / Hz	0	3	6	10	25	50
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i>	2 kHz	141	156	174	180	180	180
	4 kHz	108	120	134	146	168	180
	8 kHz	70	78	89	98	114	125
	16 kHz	37	42	48	52	62	69
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i>	1.75 kHz	141	156	174	180	180	180
	3.5 kHz	116	129	144	157	180	180
	7 kHz	80	89	100	110	128	140
	14 kHz	44	50	56	61	73	80
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i>	1.5 kHz	141	156	174	180	180	180
	3 kHz	124	138	154	168	180	180
	6 kHz	89	99	112	122	141	154
	12 kHz	50	57	64	70	84	92
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>	1.25 kHz	141	156	174	180	180	180
	2.5 kHz	133	147	164	179	180	180
	5 kHz	98	109	123	134	154	169
	10 kHz	60	68	76	84	99	108

Table 24: Frequency-dependent maximum current for device size 20

Device size		21					
Rated switching frequency		2 kHz					
Output frequency	$f_{out}$ / Hz	0	3	6	10	25	50
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 62.5 <math>\mu</math>s (Parameter is22=0)</i>	2 kHz	117	130	145	158	180	180
	4 kHz	90	100	112	122	140	153
	8 kHz	58	65	74	82	95	104
	16 kHz	31	35	40	43	52	57
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 71.4 <math>\mu</math>s (Parameter is22=1)</i>	1.75 kHz	117	130	145	158	180	180
	3.5 kHz	96	107	120	131	150	163
	7 kHz	66	74	83	92	106	116
	14 kHz	36	41	46	51	61	67
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 83.3 <math>\mu</math>s (Parameter is22=2)</i>	1.5 kHz	117	130	145	158	180	180
	3 kHz	103	115	128	140	160	173
	6 kHz	74	82	93	102	117	128
	12 kHz	42	47	53	58	70	76
<b>Frequency-dependent maximum current @ <math>f_s</math></b> $I_{out\_max}$ / % <i>Basic Time Period = 100 <math>\mu</math>s (Parameter is22=3)</i>	1.25 kHz	117	130	145	158	180	180
	2.5 kHz	110	122	137	149	170	180
	5 kHz	82	91	102	112	128	141
	10 kHz	50	56	63	70	82	90

Table 25: Frequency-dependent maximum current for device size 21

Device size		22					
Rated switching frequency		2 kHz					
Output frequency	$f_{out} / \text{Hz}$	0	3	6	10	25	50
<b>Frequency-dependent maximum current @ <math>f_s</math></b> <i>Basic Time Period = 62.5 <math>\mu\text{s}</math> (Parameter is22=0)</i>	2 kHz	111	123	136	146	165	180
	4 kHz	82	92	104	112	127	138
	8 kHz	51	59	66	71	84	93
	16 kHz	24	28	31	35	42	47
<b>Frequency-dependent maximum current @ <math>f_s</math></b> <i>Basic Time Period = 71.4 <math>\mu\text{s}</math> (Parameter is22=1)</i>	1.75 kHz	111	123	136	146	165	180
	3.5 kHz	90	100	112	112	127	138
	7 kHz	59	67	75	71	84	93
	14 kHz	29	34	38	35	42	47
<b>Frequency-dependent maximum current @ <math>f_s</math></b> <i>Basic Time Period = 83.3 <math>\mu\text{s}</math> (Parameter is22=2)</i>	1.5 kHz	111	123	136	146	165	180
	3 kHz	97	108	120	129	146	159
	6 kHz	67	75	85	92	105	115
	12 kHz	34	40	44	49	58	64
<b>Frequency-dependent maximum current @ <math>f_s</math></b> <i>Basic Time Period = 100 <math>\mu\text{s}</math> (Parameter is22=3)</i>	1.25 kHz	111	123	136	146	165	180
	2.5 kHz	104	115	128	138	155	169
	5 kHz	75	84	95	102	116	127
	10 kHz	43	49	55	60	71	79

Table 26: Frequency-dependent maximum current for device size 22

3.3.4 Overview of rectifiers for 400 V devices

Device size		18	19	20	21	22
Rectifier rated power	$P_{rect} / \text{kW}$	25	34	41	50	61
Rectifier continuous power	<sup>1)</sup> $P_{rect\_cont} / \text{kW}$	61	61	61	61	61
Continuous input current @ $U_N = 400 \text{V}$	<sup>1)</sup> $i_{in\_cont} / \text{A}$	121	121	121	121	121
Continuous input current @ $U_{N\_UL} = 480 \text{V}$	<sup>1)</sup> $i_{in\_UL\_cont} / \text{A}$	106	106	106	106	106
Rated output current DC @ $U_{N\_dc} = 565 \text{V}$	$i_{out\_dc} / \text{A}$	73	81	101	121	148
Continuous output current DC @ $U_{N\_dc} = 565 \text{V}$	<sup>1)</sup> $i_{out\_dc\_cont} / \text{A}$	148	148	148	148	148
Rated output current DC @ $U_{N\_UL\_dc} = 680 \text{V}$	$i_{out\_UL\_dc} / \text{A}$	58	70	88	104	129
Continuous output current DC @ $U_{N\_UL\_dc} = 680 \text{V}$	<sup>1)</sup> $i_{out\_UL\_dc\_cont} / \text{A}$	129	129	129	129	129

Table 27: Overview of rectifier data for 400 V devices

<sup>1)</sup> Continuous operation is a load that exceeds the rated operation. Continuous operation only occurs if the internal rectifier is used to supply additional drive controllers via the DC terminals => „5.3.6 DC-bus connection“. In continuous operation, the OH error can be triggered depending on the operating conditions of the internal inverter.

### 3.3.5 Power dissipation at rated operation for 400 V devices

Device size		18	19	20	21	22
Power dissipation at rated operation	<sup>1)</sup> $P_D / W$	513	698	896	895	1082
Power dissipation at rated operation DC	<sup>2)</sup> $P_{D\_dc} / W$	465	560	725	685	850

Table 28: Power dissipation of the 400 V devices

<sup>1)</sup> Rated operation corresponds to  $U_N = 400 V$ ;  $f_{SN}$ ;  $I_N$ ;  $f_N = 50 Hz$  (typically value)

<sup>2)</sup> Rated operation DC corresponds to  $U_{N\_dc} = 565 V$ ;  $I_N$ ;  $f_N = 50 Hz$  (typically value)

### 3.3.6 Fusing of the 400 V devices

#### 3.3.6.1 Fuse protection for AC supply

Device size	Max. size of the fuse / A				
	$U_N = 400V$ gG (IEC)	$U_N = 480V$ Class "J"		$U_N = 480V$	
	SCCR 30 kA	SCCR		SCCR 30 kA	Type
		5 kA	10 kA		
18	80	60	–	50	SIBA 20 189 20.50 COOPER BUSSMANN 170M1364 LITTELFUSE L70QS050
19	80	70	–	80	SIBA 20 189 20.80 EATON 170M1366
20	100	90	–	100	SIBA 20 189 20.100 EATON 170M1367
21	125	110	–	125	SIBA 20 189 20.125 EATON 170M1368
22	160	–	125	125	SIBA 20 189 20.125 EATON 170M1368

Table 29: Fusing of the 400 V / 480 V devices



#### Short-circuit capacity

After requests from [EN 60439-1](#) and [EN 61800-5-1](#) the following is valid for the connection to a network: The devices are suitable for use in a circuit capable of delivering not more than 30 kA eff. unaffected symmetrical short-circuit current.

3.3.6.2 Fuse protection for DC supply

Device size	Recommended size of the fuse / A		Permissible fuses <sup>1)</sup>
	$U_{N\_dc} = 565V$	$U_{N\_UL\_dc} = 680V$	
	SCCR 50 kA	SCCR 50 kA	
18	100	80	<ul style="list-style-type: none"> <li>•SIBA 50 250 06.80 <sup>2)</sup></li> <li>•SIBA 50 280 06.100</li> <li>SIBA 20 209 37.100 <sup>2)</sup></li> <li>SIBA 50 268 06.125</li> <li>SIBA 20 557 34.250 <sup>2)</sup></li> <li>SIBA 20 031 34.250</li> <li>Bussmann FWP-100A22F</li> <li>Bussmann 170M1422</li> <li>Littelfuse L70QS500</li> </ul>
19	125	100	
20	150	125	
21	160	150	
22	200	175	
Table 30: Fusing of the 400 V / 480 V devices			

<sup>1)</sup> Fuses of the same type with lower rated currents can be used if they are suitable for the application.

<sup>2)</sup> Fuse without UL certification.

**NOTICE**

**Observe the rated voltage of the fuse!**

- ▶ The rated voltage of the fuse must be at least equal to the maximum DC supply voltage of the drive controller.

### 3.4 General electrical data

#### 3.4.1 Switching frequency and temperature

The drive controller cooling is designed by way that the heat sink overtemperature threshold is not exceeded at rated conditions. A switching frequency higher than the rated switching frequency also produces higher losses and thus a higher heat sink heating. If the heat sink temperature reaches a critical threshold ( $T_{DR}$ ), the switching frequency can be reduced automatically step by step. This prevents that the drive controller switches off due to overheating of the heat sink. If the heat sink temperature falls below the threshold  $T_{UR}$ , the switching frequency is increased back to the setpoint. At temperature  $T_{EM}$  the switching frequency is immediately reduced to rated switching frequency. „Derating“ must be activated, for this function to work.

##### 3.4.1.1 Switching frequency and temperature of the 230 V devices

Device size		18
Rated switching frequency	<sup>1)</sup> $f_{SN}$ / kHz	4
Max. switching frequency	<sup>1)</sup> $f_{S\_max}$ / kHz	16
Min. switching frequency	<sup>1)</sup> $f_{S\_min}$ / kHz	1,25
Max. heat sink temperature	$T_{HS}$ / °C	95
Temperature for derating the switching frequency	$T_{DR}$ / °C	80
Temperature for uprating the switching frequency	$T_{UR}$ / °C	70
Temperature for switching to rated switching frequency	$T_{EM}$ / °C	85

Table 31: Switching frequency and temperature of the 230 V devices

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

##### 3.4.1.2 Switching frequency and temperature of the 400 V devices

Device size		18	19	20	21	22
Rated switching frequency	<sup>1)</sup> $f_{SN}$ / kHz	4			2	
Max. switching frequency	<sup>1)</sup> $f_{S\_max}$ / kHz	16				
Min. switching frequency	<sup>1)</sup> $f_{S\_min}$ / kHz	1,25				
Max. heat sink temperature	$T_{HS}$ / °C	95	90	95		
Temperature for derating the switching frequency	$T_{DR}$ / °C	80				
Temperature for uprating the switching frequency	$T_{UR}$ / °C	70				
Temperature for switching to rated switching frequency	$T_{EM}$ / °C	85				

Table 32: Switching frequency and temperature of the 400 V devices

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

3.4.2 DC link / braking transistor function



**Activation of the braking transistor function**

To be able to use the braking transistor, the function must be activated with parameter "is30 braking transistor function".

For more information => [F6 Programming manual](#).

**NOTICE**

**Falling below the minimum braking resistor value!**

**Destruction of the drive controller**

- ▶ The minimum brake resistance value must not fall below!

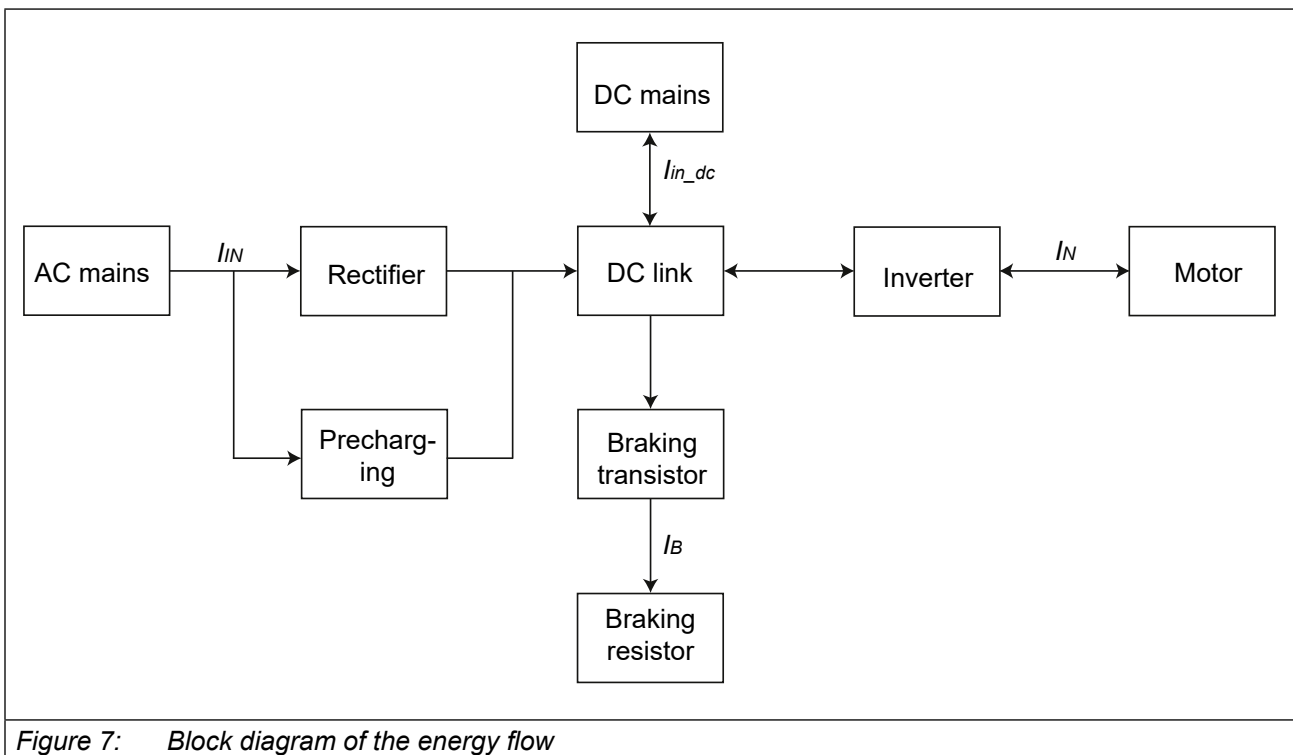


Figure 7: Block diagram of the energy flow

**NOTICE**

**Destruction of the drive controller!**

If the error "ERROR GTR7 always ON" occurs, the current consumption is switched off internally via the mains input bridge of the AC supply.

- ▶ If the error "ERROR GTR7 always ON" occurs, the drive controller is defective and must be disconnected from the power supply no later than 16 hours!
- ▶ With DC mains connection and the use of non-intrinsically safe braking resistors or sub-mounted braking resistors, the drive converter must be de-energised after 1 second at the latest.

## 3.4.2.1 DC link / braking transistor function of the 230 V devices

Device size		18
Rated DC link voltage @ $U_N = 230\text{ V}$	$U_{N\_dc} / \text{V}$	325
Rated DC link voltage @ $U_{N\_UL} = 240\text{ V}$	$U_{N\_dc\_UL} / \text{V}$	339
DC link voltage working voltage range	$U_{in\_dc} / \text{V}$	240...373
DC switch-off level "ERROR Underpotential"	$U_{UP} / \text{V}$	216
DC switch-off level "ERROR Overpotential"	$U_{OP} / \text{V}$	400
DC switch-off level braking resistor	<sup>1)</sup> $U_B / \text{V}$	380
Max. braking current	$I_{B\_max} / \text{A}$	105
Braking transistor	<sup>2)</sup>	Max. cycle time: 120 s; Max c.d.f.: 50 %
Min. braking resistor value	$R_{B\_min} / \Omega$	4
Protective function for braking transistor		Short-circuit monitoring
Protective function braking resistor (Error GTR7 always on)	<sup>3)</sup>	Feedback signal evaluation and current shutdown
DC link capacity	$C / \mu\text{F}$	6800

Table 33: DC link / braking transistor function of the 230 V devices

- <sup>1)</sup> The DC switching level for the braking transistor is adjustable. The default value is the value specified in the table.
- <sup>2)</sup> The cyclic duration factor is additionally limited by the used braking resistor.
- <sup>3)</sup> The feedback signal evaluation monitors the functionality of the braking transistor. Power off occurs via the internal mains input bridge of the AC supply.

## GENERAL ELECTRICAL DATA

### 3.4.2.2 DC link / braking transistor function of the 400V devices

Device size		18	19	20	21	22
Rated DC link voltage @ $U_N = 400\text{V}$	$U_{N\_dc} / \text{V}$	565				
Rated DC link voltage @ $U_{N\_UL} = 480\text{V}$	$U_{N\_dc\_UL} / \text{V}$	680				
DC link voltage working voltage range	$U_{in\_dc} / \text{V}$	390...780				
DC switch-off level "ERROR Underpotential"	$U_{UP} / \text{V}$	240				
DC switch-off level "ERROR Overpotential"	$U_{OP} / \text{V}$	840				
DC switch-off level braking resistor	<sup>1)</sup> $U_B / \text{V}$	780				
Max. braking current	$I_{B\_max} / \text{A}$	93				105
Braking transistor	<sup>2)</sup>	Max. cycle time: 120 s; Max c.d.f.: 50 %				
Min. braking resistor value	$R_{B\_min} / \Omega$	9				8
Protective function braking resistor (Error GTR7 always on)	<sup>3)</sup>	Feedback signal evaluation and current shutdown				
Protective function for braking transistor		Short-circuit monitoring				
DC link capacity	$C / \mu\text{F}$	2380	2380	2720	3400	4080
Max. prechargeable total capacity @ $U_N = 400\text{V}$	$C_{pc\_max} / \mu\text{F}$	5700	5700	9500	9500	9500
Max. prechargeable total capacity @ $U_{N\_UL} = 480\text{V}$	$C_{pc\_max\_UL} / \mu\text{F}$	3900	3900	6600	6600	6600

Table 34: DC link / braking transistor function of the 400 V devices

- <sup>1)</sup> The DC switching level for the braking transistor is adjustable. The default value is the value specified in the table.
- <sup>2)</sup> The cyclic duration factor is additionally limited by the used braking resistor.
- <sup>3)</sup> The feedback signal evaluation monitors the functionality of the braking transistor. Power off occurs via the internal mains input bridge of the AC supply. There is no current switch-off with DC power supply.



## 3.4.3 Fan

Device size		18	19	20	21	22
Interior fan	Number	1				
	Speed-variable	Yes				
Heat sink fan	Number	2				
	Speed-variable	Yes				

Table 35: Fan



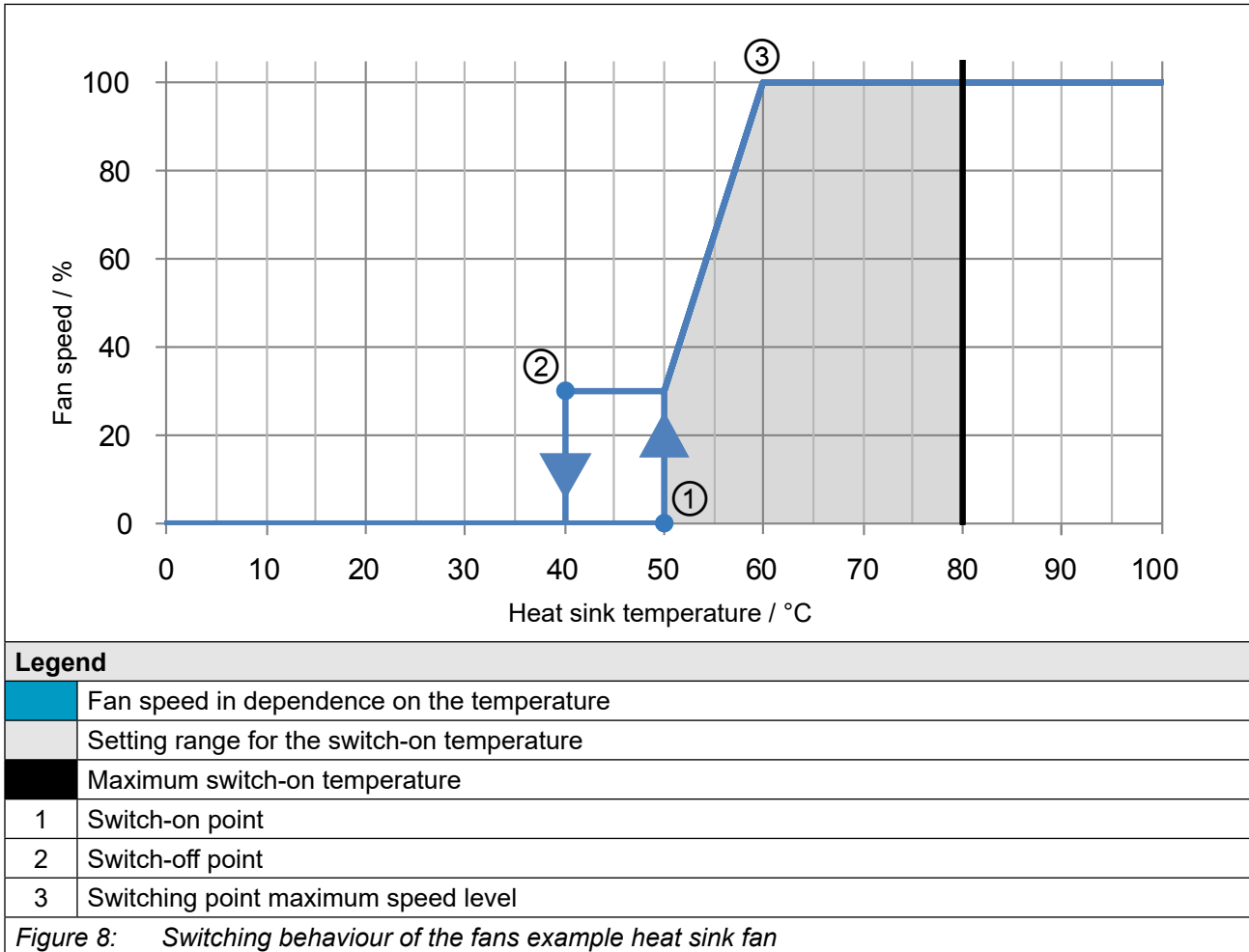
The fans are speed variable. They are automatically controlled to high or low speed depending on the setting of the temperature limits in the software.

**NOTICE****Destruction of the fan!**

- ▶ Take care that no foreign substances drop into the fan!

3.4.3.1 Switching behaviour of the fans

The temperature monitoring of the heat sinks controls the fans with different switching on and off points.



3.4.3.2 Switching points of the fans

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

Fan		Heat sink	Interior
Switch-on temperature	$t / ^\circ\text{C}$	50	45
Maximum speed level	$t / ^\circ\text{C}$	60	55

Table 36: Switching points of the fans

## 4 Installation

### 4.1 Dimensions and weights

#### 4.1.1 Built-in version air cooler

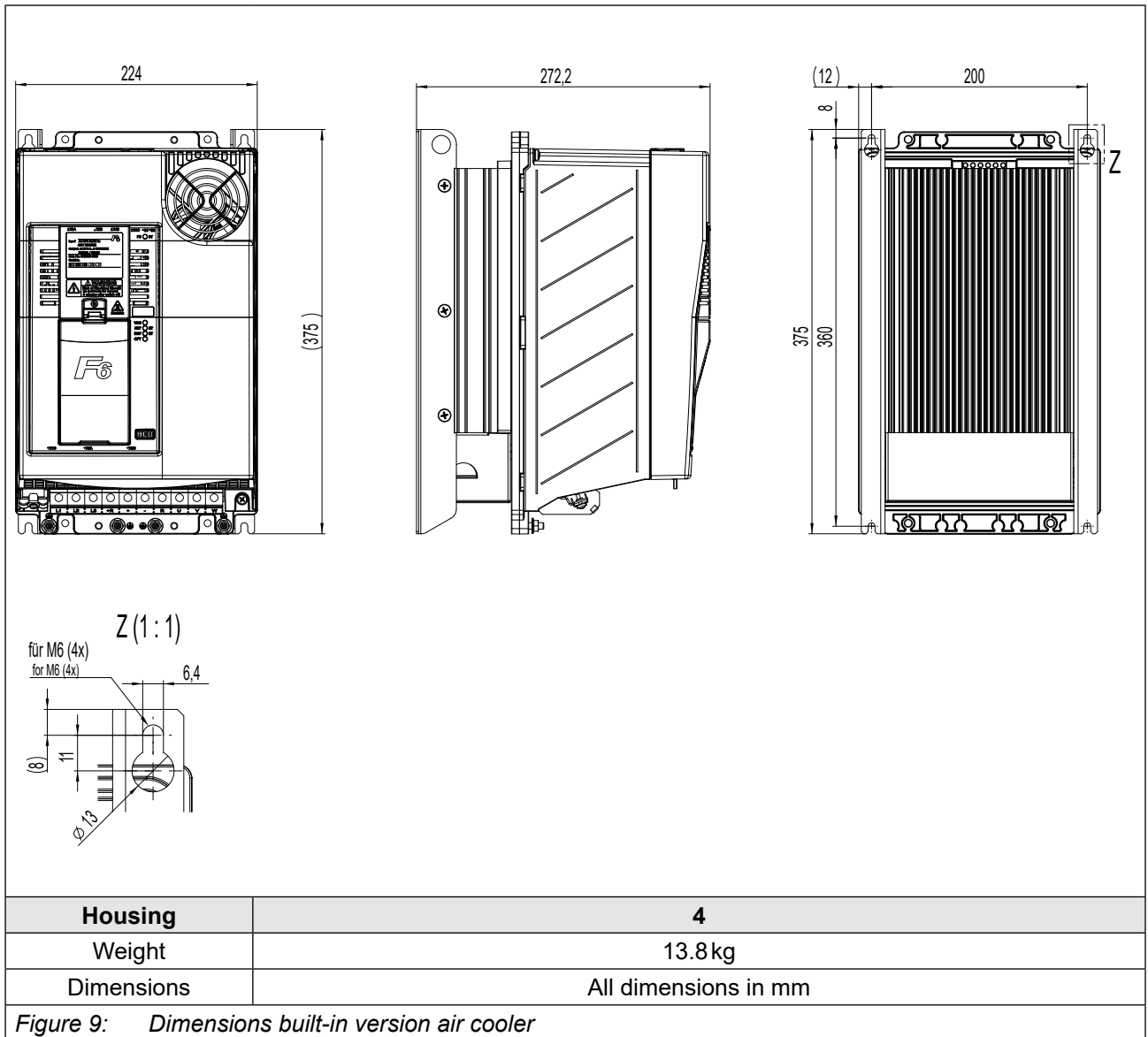
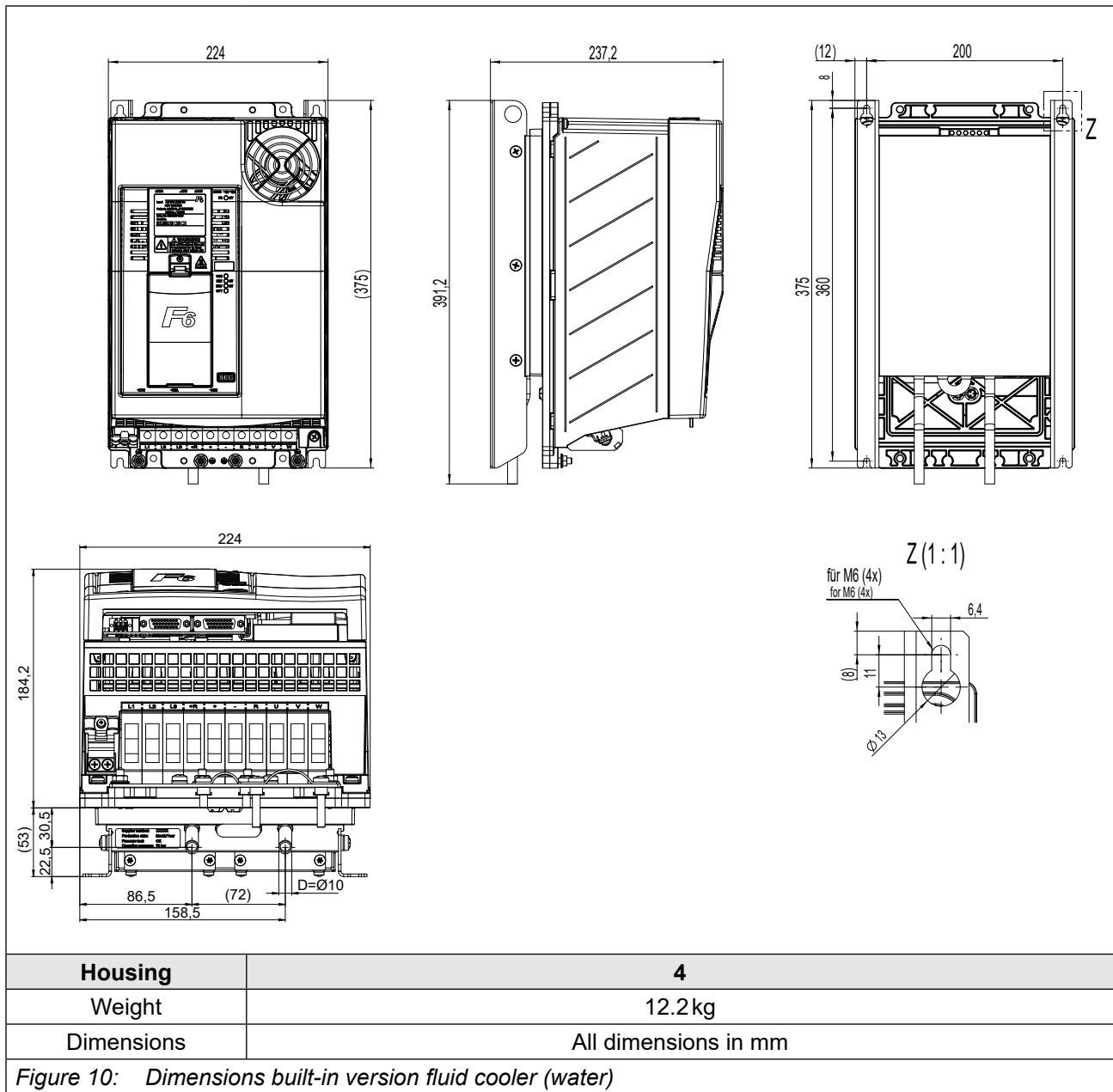


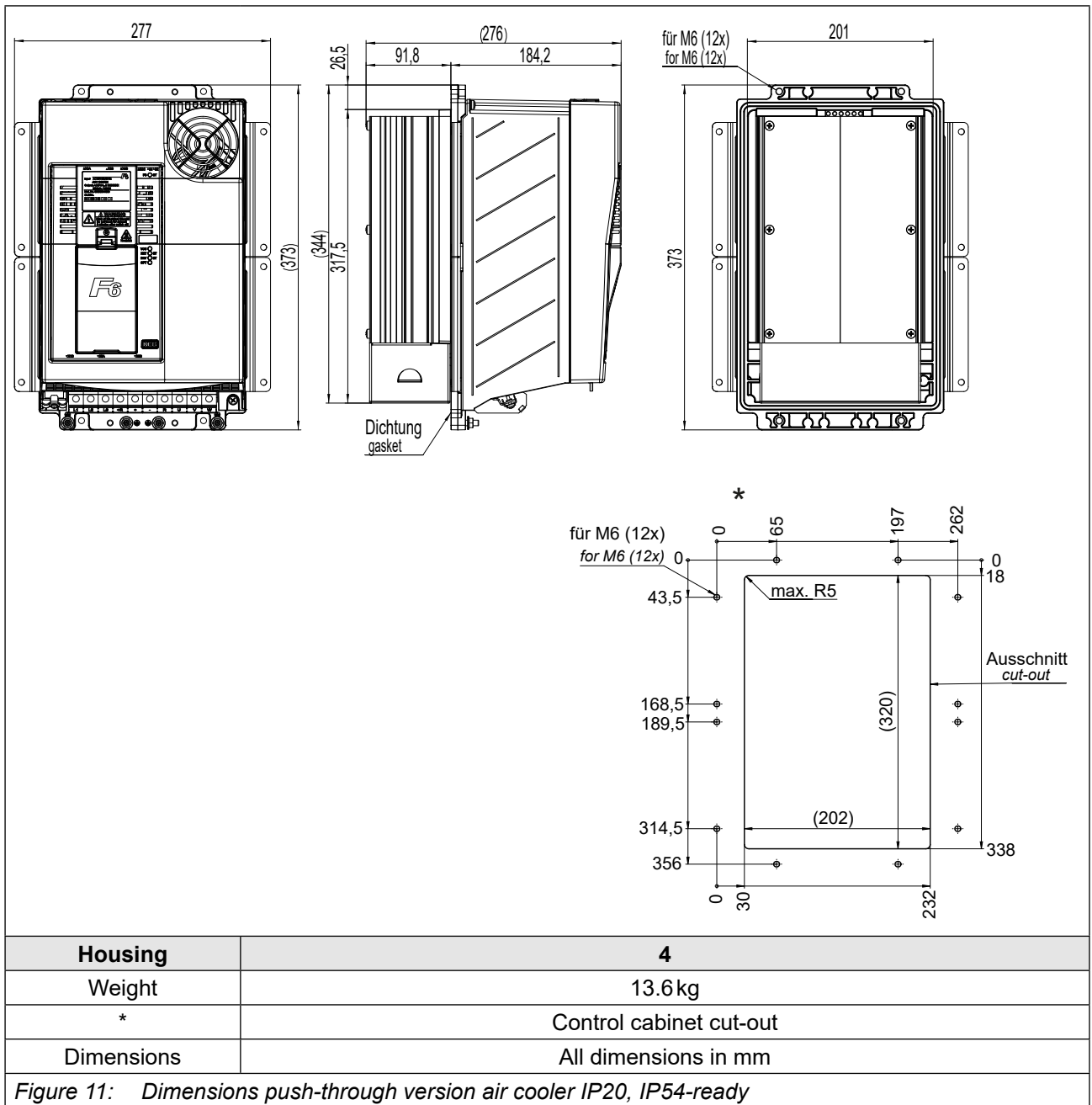
Figure 9: Dimensions built-in version air cooler

## DIMENSIONS AND WEIGHTS

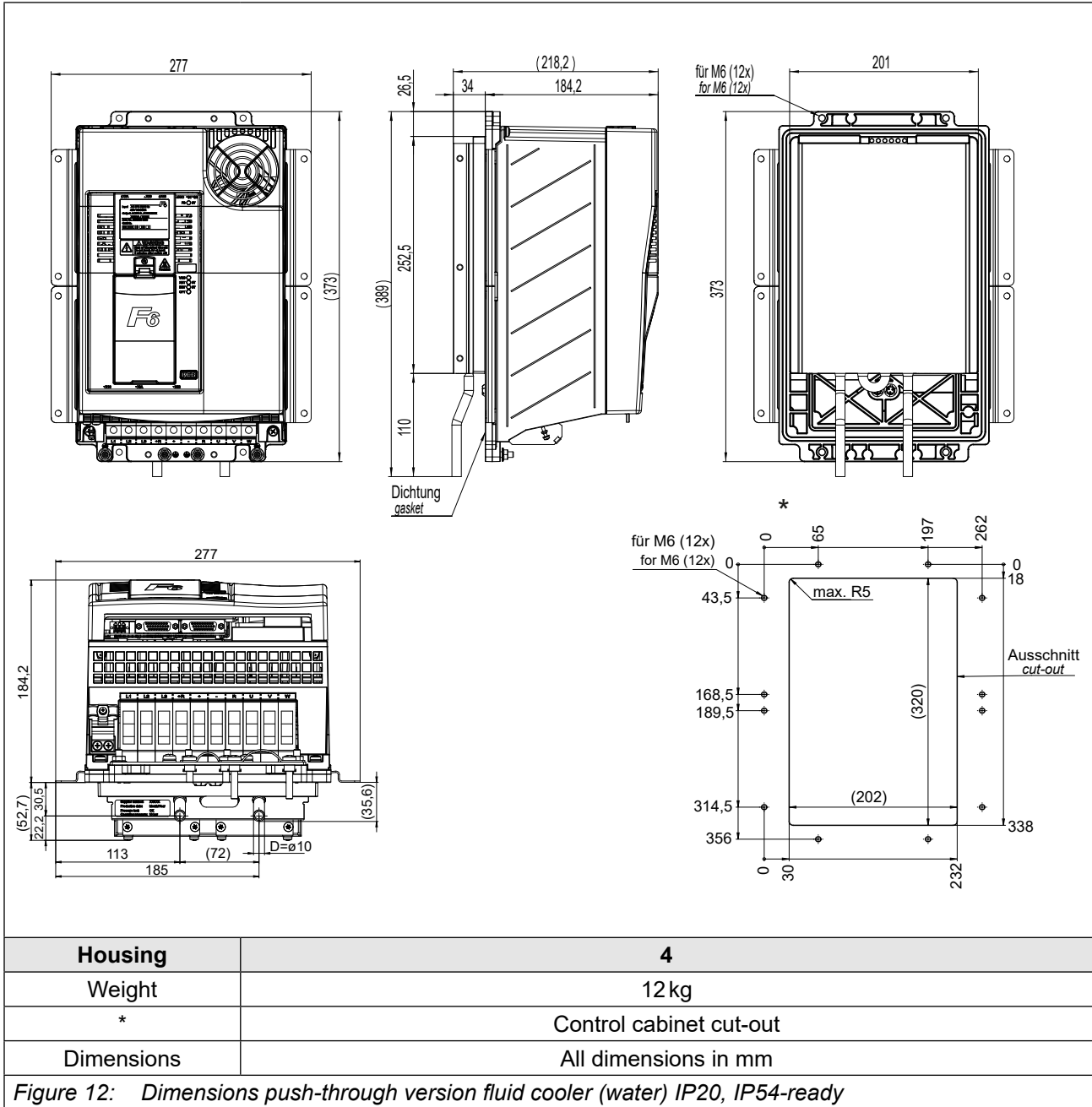
### 4.1.2 Built-in version fluid cooler (water)



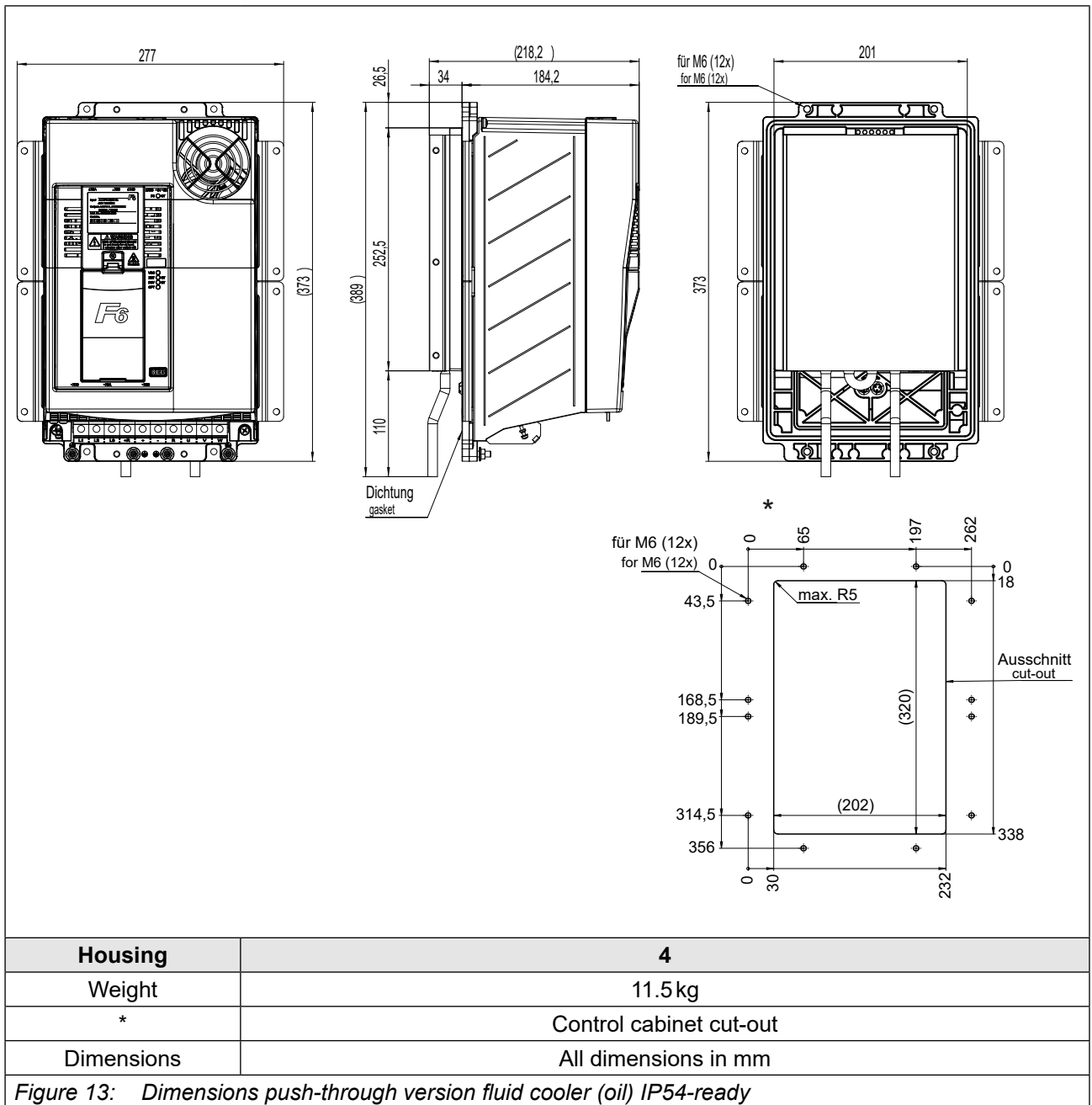
4.1.3 Push-through version air cooler IP20, IP54-ready



**4.1.4 Push-through version fluid cooler (water) IP20, IP54-ready**



4.1.5 Push-through version fluid cooler (oil) IP54-ready



## 4.2 Control cabinet installation

### 4.2.1 Mounting instructions

For mounting the drive controllers, the following mounting materials with the appropriate quality were tested by KEB.

Required material	Tightening torque
Hexagon head screw <i>ISO 4017</i> - M6 - 8.8	9Nm 79lb inch
Flat washer <i>ISO 7090</i> - 6 - 200 HV	–
<i>Table 37: Mounting instructions for built-in version</i>	

Required material	Tightening torque
Hexagon head screw <i>ISO 4017</i> - M6 - 8.8	9Nm 79lb inch
Flat washer <i>ISO 7090</i> - 6 - 200 HV	–
<i>Table 38: Mounting instructions for push-through version</i>	

### NOTICE

#### Use of other fixing material

- The alternatively selected fixing material must meet the above material characteristics (quality) and tightening torques!

The use of other fixing materials is beyond the control of KEB and is therefore the sole responsibility of the customer.



## 4.2.2 Mounting distances

Power dissipation for the control cabinet dimension => „3.3.5 Power dissipation at rated operation for 400 V devices“. A lower value can be used here depending on the operating mode/load.



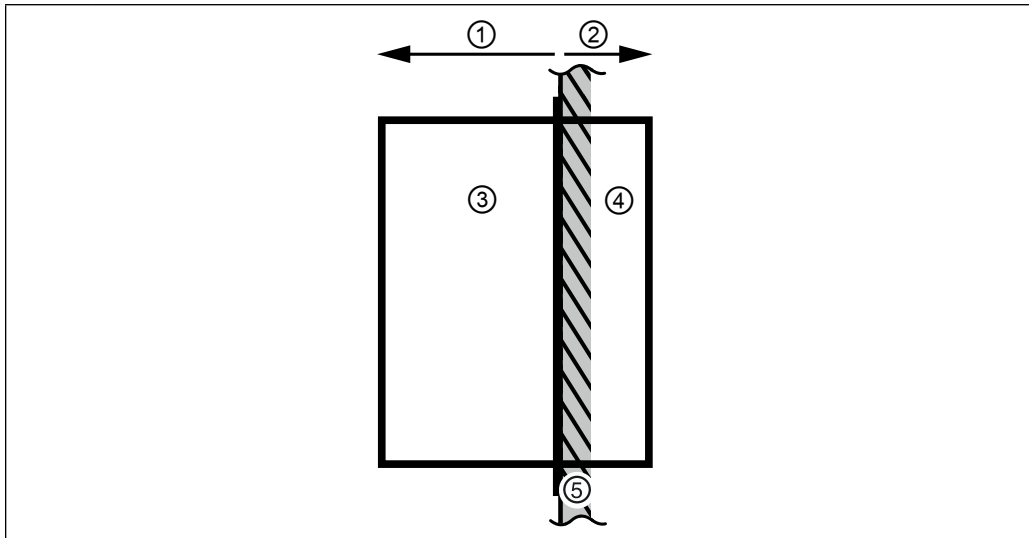
### Mounting the drive controller

For reliable operation, the drive controller must be mounted without any distance on a smooth, closed, metallicly bright mounting plate.

Mounting distances	Dimension	Distance in mm	Distance in inch
	A	150	6
	B	100	4
	C	30	1,2
	D	0	0
	E	0	0
	F <sup>1)</sup>	50	2
	<sup>1)</sup> Distance to preceding elements in the control cabinet door.		

Figure 14: Mounting distances

4.2.3 Installation of IP54-ready devices



Legend	
1	IP20 zone inside the housing
2	IP54 zone outside the housing
3	Drive controller (power unit and control unit)
4	Drive controller (heat sink)
5	Housing (e.g. Control cabinet wall)

Figure 15: Installation of IP54-ready devices



**IP54 zone: Heat sink outside the housing**

The protection class IP54 can only be achieved when the device is properly installed.

For proper installation, a suitable IP54 seal (=> „5.4.3 Seal IP54-ready devices“) must be installed between heat sink and housing (e.g. control cabinet wall).

The tightness must be checked after the installation. If properly installed, the separation to the housing corresponds to degree of protection IP54.

In the case of fan-cooled units, the fans must be protected from negative environmental influences.

These include combustible, oily or dangerous fumes or gases, corrosive chemicals, coarse foreign bodies and excessive dust. This applies especially to the access of the heatsink from the top (air outlet). Icing is inadmissible.

UL: Device heat sink is classified as NEMA type 1

**IP20 zone: Device inside the housing**

This part is intended for the installation in a suitable housing for the required degree of protection (e.g. control cabinet).

The power connections are excluded => „3.1.1 Climatic environmental conditions“.

**NOTICE**

**Defect due to continuous splash water !**

- ▶ Never expose the device to continuous splashing water (e.g. direct exposure to rain)!

4.2.4 Control cabinet ventilation

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

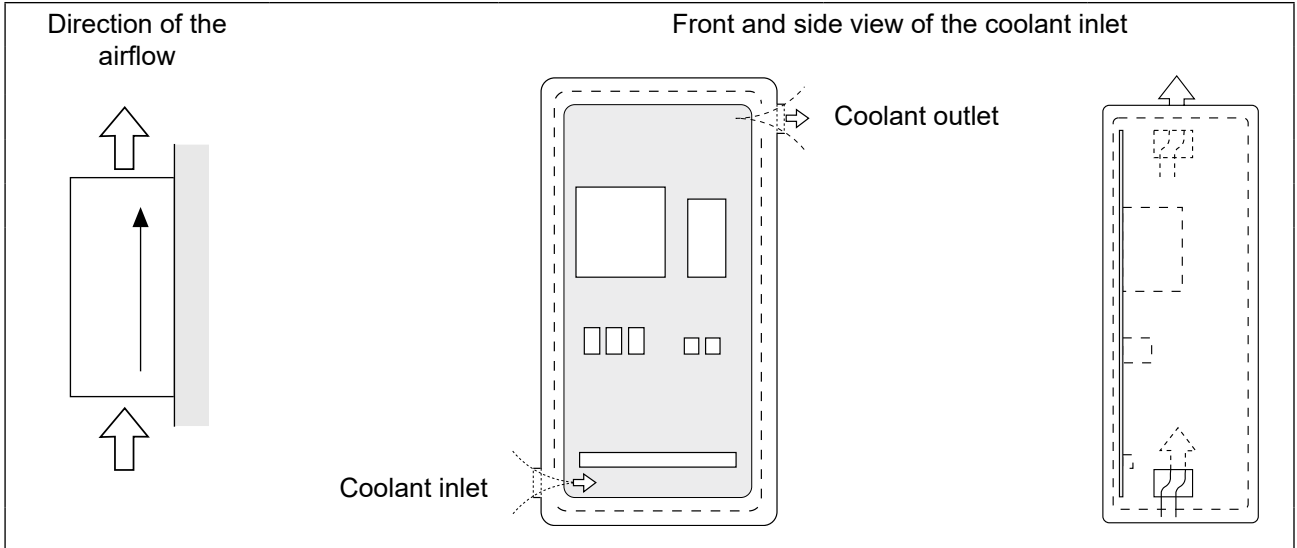
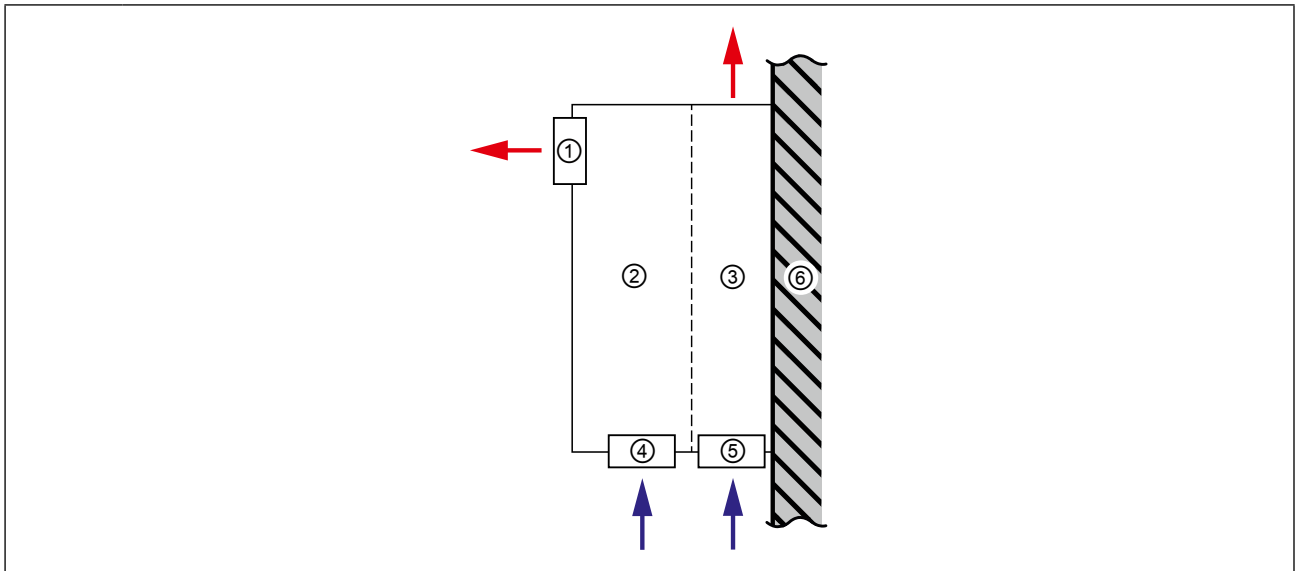


Figure 16: Control cabinet ventilation

4.2.5 Airflow of the drive converter



Legend

	Airflow direction
1	Interior fan (from housing 4)
2	Drive converter (power unit and control)
3	Drive converter (heat sink)
4	Interior fan for (housing 2 and 3)
5	Heatsink fan
6	Housing (e.g. Control cabinet rear)

Figure 17: Airflow of the drive converter

## 5 Installation and connection

### 5.1 Overview of the COMBIVERT F6

Housing 4		No.	Name	Description
<p>The image shows the top view of the F6 housing 4. Callout 1 points to the leftmost terminal. Callout 2 points to the second terminal from the left. Callout 3 points to the third terminal from the left. Callout 4 points to the fan. Callout 5 points to the nameplate. Callout 6 points to the rightmost terminal. Callout 7 points to the terminal labeled 'W'.</p>	1	–	Shield clamps for shielded control cables.	
	2	–	Fixing points for optional shield connection bracket. The shielding, e.g. of the motor cable, is placed on the base plate in the control cabinet or on the optionally available shield connection bracket 00F6V80-4001.	
	3	–	LEDs (=> manual for control unit chapter "Overview") <ul style="list-style-type: none"> <li>• For control board COMPACT: FS without function.</li> <li>• For control card APPLICATION and PRO: Status indication of the safety module</li> </ul>	
	4	–	Interior fan	
	5	–	Nameplates	
	6	PE	Protective earth; at connection to protective earth each terminal may be assigned only once.	
	7	X1A	Power circuit terminals for: <ul style="list-style-type: none"> <li>• Mains input</li> <li>• Braking resistor</li> <li>• DC supply</li> <li>• Motor connection</li> </ul>	

Figure 18: F6 housing 4 top view

Housing 4		No.	Name	Description			
	1	–	Shield clamps for shielded control cables.				
	6	PE	Protective earth; at connection to protective earth each terminal may be assigned only once.				
	7	X1A	Power circuit terminals for: <ul style="list-style-type: none"> <li>• Mains input</li> <li>• Braking resistor</li> <li>• DC supply</li> <li>• Motor connection</li> </ul>				
	8	X1C	Terminal for: <ul style="list-style-type: none"> <li>• Motor temperature monitoring</li> <li>• Brake control</li> </ul>				
	9	X3A	Encoder interface channel A				
	10	X3B	Encoder interface channel B				
	11	–	Heat sink fan				
	1	6	11	6	6	11	6
	1	6	11	6	6	11	6
	1	6	11	6	6	11	6

Figure 19: F6 housing 4 front view

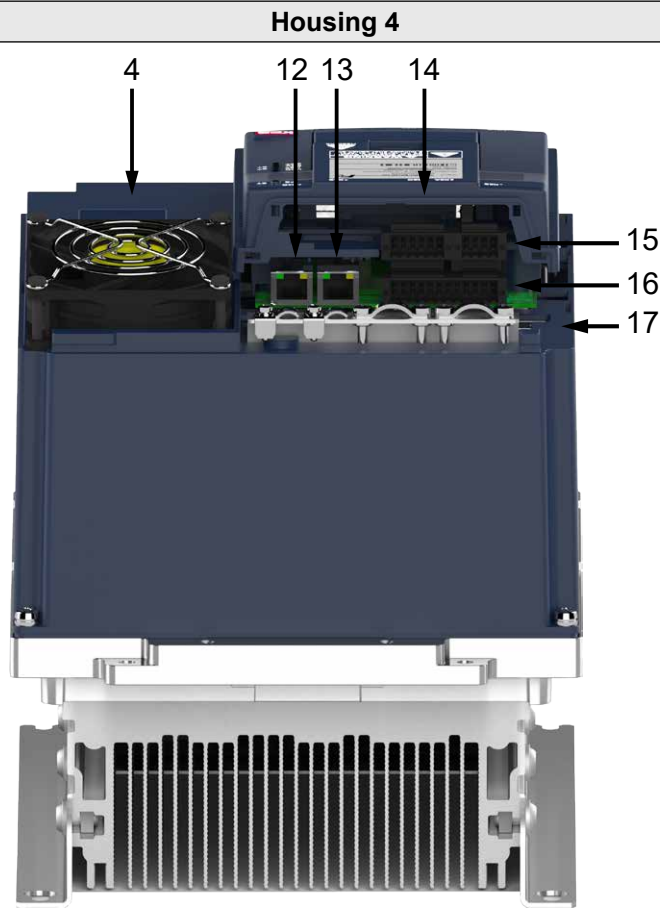
Housing 4		No.	Name	Description
	4	–	Interior fan	
	12	X4C	Fieldbus interface (out)	
	13	X4B	Fieldbus interface (in)	
	14	X2C	Control terminal block for <ul style="list-style-type: none"> <li>• CAN bus</li> <li>• Analog inputs and analog output</li> </ul>	
	15	X2B	Safety functions / 24 V DC voltage supply / 2 digital outputs	
	16	X2A	Control terminal block for digital inputs and outputs.	
	17	–	Shield clamps for shielded control cables.	

Figure 20: F6 housing 4 rear view with control board COMPACT



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



Instructions for use COMBIVERT F6 control board COMPACT  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_f6-cu-k-inst-20144795\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-k-inst-20144795_en.pdf)



Instructions for use COMBIVERT F6 control board APPLICATION  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_f6-cu-a-inst-20118593\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-a-inst-20118593_en.pdf)



Instructions for use COMBIVERT F6 control board PRO  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_f6-cu-p-inst-20182705\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_f6-cu-p-inst-20182705_en.pdf)



## 5.2 Connection of the power unit

### NOTICE

#### Destruction of the drive controller!

- ▶ Never exchange mains input and motor output!

### 5.2.1 Connection of the voltage supply

The COMBIVERT F6 can be supplied via terminals L1, L2 and L3 (AC power supply) or via terminals + and - (DC power supply with inrush current limitation)

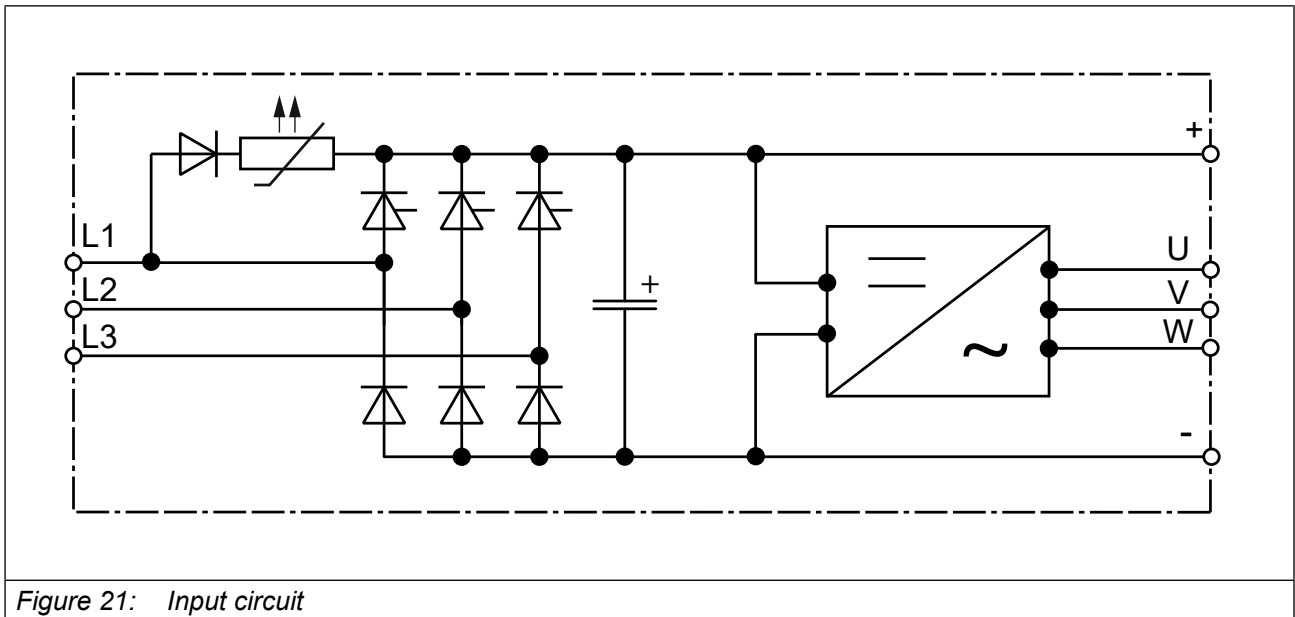


Figure 21: Input circuit

### NOTICE

With AC power supply, observe the minimum waiting time between two switch-on procedures!

Cyclical switching off and on of the drive converter leads to temporary high impedance of the PTC precharging resistor. After the PTC precharging resistor has cooled down, it can be restarted without restrictions. The waiting time between two switch-on processes depends on the external capacitance, the AC mains voltage and the ambient temperature.

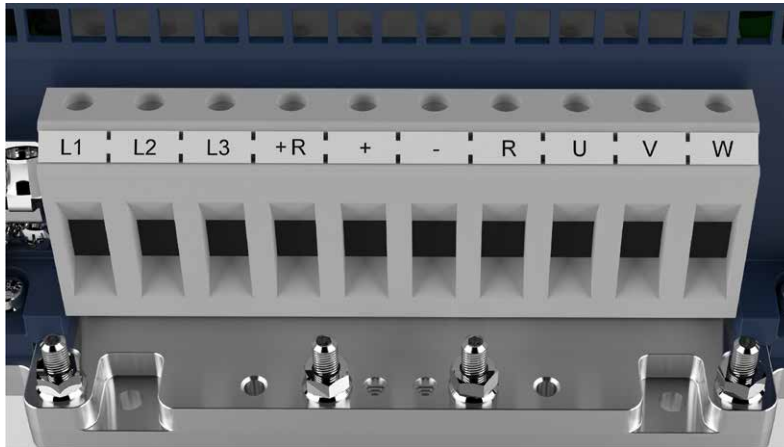
- ▶ Without external capacity: 5 min
- ▶ With external capacity (additional drive converters): 20 min

### NOTICE

No inrush current limitation with DC power supply!

- ▶ An external inrush current limiter must be provided for DC power supplies.

5.2.1.1 Terminal block X1A



Name	Function	Cross-section for terminal connection	Tightening torque	Max. number of conductors
L1	Mains connection 3-phase	Flexible cable with wire-end ferrule 1.5...35 mm <sup>2</sup> (without wire-end ferrule up to max. 50 mm <sup>2</sup> ) With 2 cables max. 16 mm <sup>2</sup>  UL: Flexible cable without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch	For IEC: 2  For UL: 1
L2				
L3				
+R	Connection for braking resistor (between +R and R)			
+	DC terminals			
-				
R	Connection for braking resistor (between +R and R)			
U	Motor connection			
V				
W				

Figure 22: Terminal block X1A



5.2.2 Protective earth and functional earth



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

5.2.2.1 Protective earth

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



**Electric shock due to incorrect dimensioning!**



► Cross-section wire to ground should be selected according to *VDE 0100!*

Name	Function	Connection type	Tightening torque
PE,	Connection for protective earth	M6 threaded pin with nut for 6.5 mm crimp connectors	6.1...12 Nm 54...106 lb inch

*Figure 23: Connection for protective earth*



**Incorrect installation of the PE connection**

Only M6 threaded pins with nut may be used as connection for protective earth!

5.2.2.2 Functional earthing

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



The use of the functional earth (FE) is not required if the frequency inverter is EMC-technically wired.

The functional earth may not be wired green/yellow!



Notes on EMC-compatible installation can be found here.  
[www.keb.de/fileadmin/media/Manuals/emv/0000neb0000.pdf](http://www.keb.de/fileadmin/media/Manuals/emv/0000neb0000.pdf)



### 5.3 Mains connection

#### 5.3.1 Supply cable

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

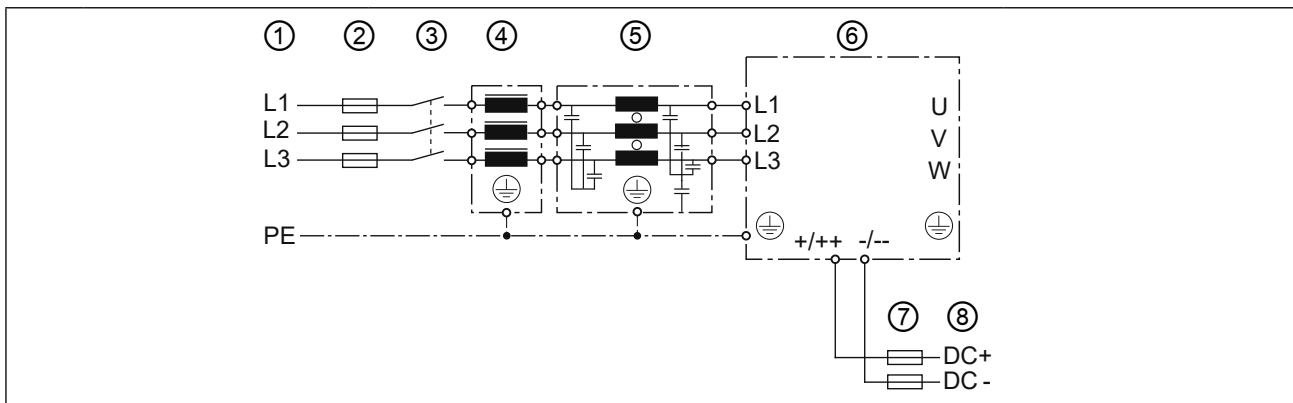
- Input current of the drive controller
- Used line type
- Installation and ambient temperatures
- The locally valid electrical regulations



The application engineer is responsible for the design!

#### 5.3.2 AC mains connection

##### 5.3.2.1 AC supply 3-phase



No.	Type	Description
1	Mains phase	3-phase
	Mains form	TN, TT
		IT
The rated voltage between one phase conductor and earth potential (or the neutral point in the IT system) must not exceed 300V, USA UL: 480 / 277V. (For the IT system, a short-term disconnection must be ensured).		
	Personal protection	RCMA with separator or RCD type B      Insulation monitors
2	Mains fuses	see chapter "Protection of the drive controllers"
3	Mains contactor	-
4	Mains choke	see notes in chapter "Filters and chokes"
5	HF filter for TN-, TT systems	Required for compliance with the limit values in accordance with <a href="#">EN 61800-3</a> .
	HF filter for IT systems	
6	Drive controller	COMBIVERT F6
7	DC-fuses	See note in chapter „Fusing of the devices“.
8	DC-supply	DC supply generated by the drive controller for connecting further drive controllers => „5.3.6 DC-bus connection“

Figure 24: Connection of the mains supply 3-phase

## 5.3.2.2 Note on hard power systems

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

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

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



A listing of filters and chokes => „5.4.1 Filters and chokes“

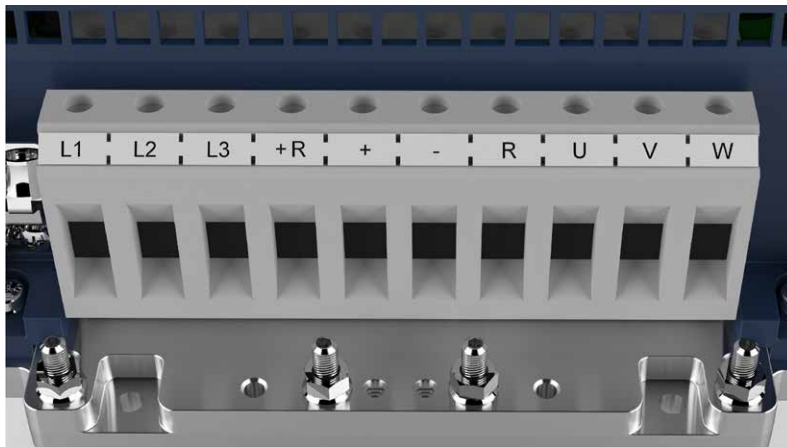
**5.3.3 DC mains connection**

**NOTICE**

**DC operation**

► The DC power supply of 230V devices is only permitted after consultation with KEB!

5.3.3.1 Terminal block X1A DC connection



Name	Function	Cross-section for terminal connection	Tightening torque	Max. number of conductors
+	DC terminals	Flexible cable with wire-end ferrule 1.5...35 mm <sup>2</sup> (without wire-end ferrule up to max. 50 mm <sup>2</sup> )	3.2...3.7 Nm 28...32 lb inch	For IEC: 2  For UL: 1
-		With 2 cables max. 16 mm <sup>2</sup>  UL: Flexible cable without wire-end ferrule AWG 16...1		

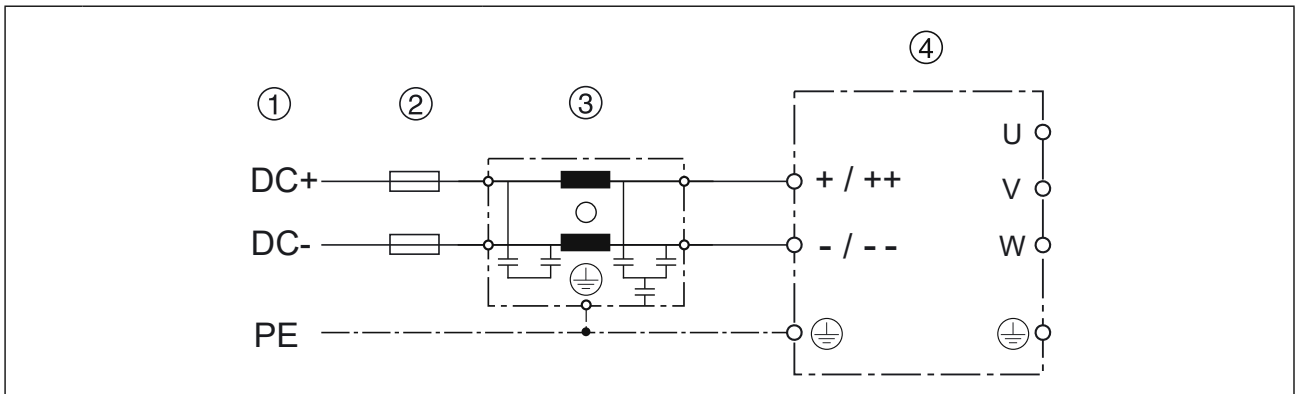
Figure 25: Terminal block X1A DC connection

5.3.3.2 Connection at DC voltage supply

**NOTICE**

**Destruction of the drive controller!**

▶ Never exchange “+ / ++” and “- / --”!



No.	Type	Description
1	Mains connection	2-phase
2	DC mains fuses	See note in chapter “Fuse protection for DC-supply”
3	HF-Filter	Type aR
4	Drive controller	COMBIVERT F6

Figure 26: Connection at DC voltage supply

5.3.4 Connection of the motor

5.3.4.1 Wiring of the motor

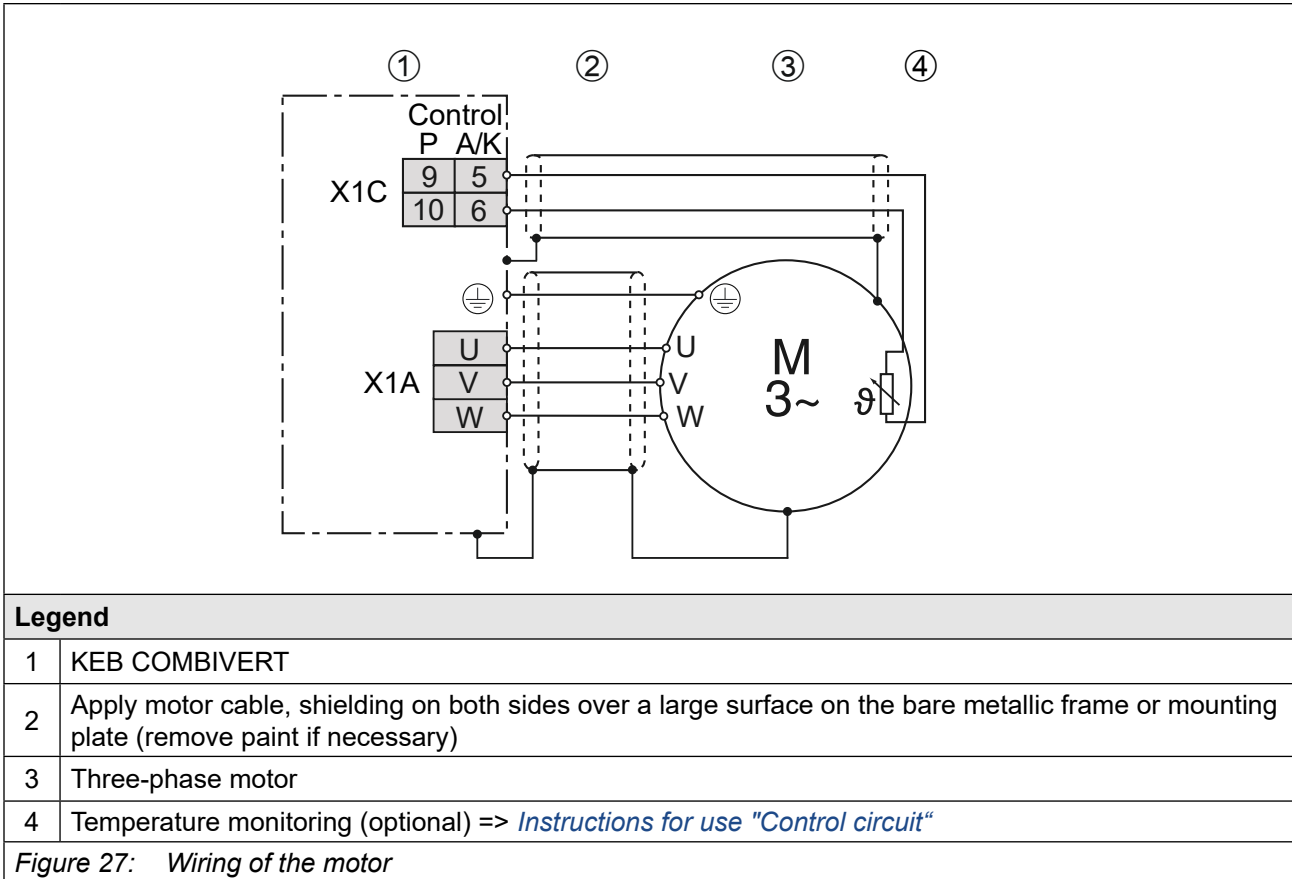
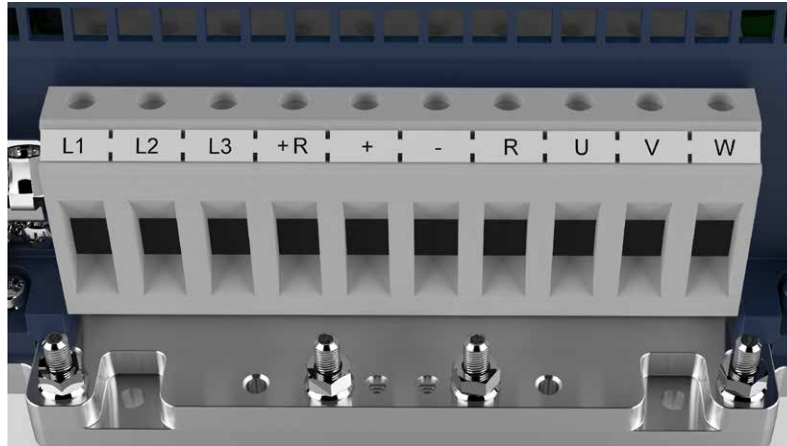


Figure 27: Wiring of the motor

5.3.4.2 Terminal block X1A motor connection



Name	Function	Cross-section for terminal connection	Tightening torque	Max. number of conductors
U	Motor connection	Flexible cable with wire-end ferrule 1.5...35 mm <sup>2</sup> (without wire-end ferrule up to max. 50 mm <sup>2</sup> ) With 2 cables max. 16 mm <sup>2</sup>  UL: Flexible cable without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch	For IEC: 2  For UL: 1
V				
W				

Figure 28: Terminal block X1A motor connection

5.3.4.3 Selection of the motor line

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

- allow major motor line lengths („5.3.4.4 Motor cable length and conducted interferences at AC supply“)
- better EMC properties (reduction of the common-mode output currents to earth)

	<p>The use of shielded motor lines with symmetrical structure is required for higher motor power (from 30 kW). In these lines the protective earth conductor is tripartite and evenly arranged between the phase lines. A cable without protective earth conductor can be used if local regulations so permit. Then the protective earth conductor must be laid externally. Certain lines also permit the shield for the use as protective earth conductor. For this, observe the details of the line manufacturer!</p>
<p>Figure 29: Symmetrical motor line</p>	

5.3.4.4 Motor cable length and conducted interferences at AC supply

The maximum motor cable length is depending on the capacity of the motor cable as well as on the EMC emitted interference. External measures must be taken here (e.g. the use of a line filter).

---

**i** The cable length can be increased significantly by using motor chokes or motor filters. KEB recommends the use of motor chokes or filters for a cable length upto 25m.

---

**i** Further information on the motor cable length can be found in the corresponding filter instructions.

---



#### 5.3.4.5 Motor cable length for parallel operation of motors

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

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

#### 5.3.4.6 Motor cable cross-section

The motor cable cross-section is dependent

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

#### 5.3.4.7 Interconnection of the motor

### NOTICE

#### Incorrect behavior of the motor!

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

### NOTICE

#### Protect motor against voltage peaks !

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

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

A switchable temperature evaluation is implemented in the COMBIVERT.

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

The desired operating mode can be adjusted via software (dr33). If the evaluation is not required, it must be deactivated via software (parameter pn12 = 7) => *Programming manual*

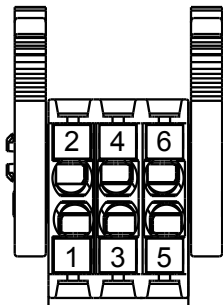
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	reserved	–
	4	reserved	–
	5	TA1	Temperature detection / output +
	6	TA2	Temperature detection / output -

Figure 30: Terminal block X1C for control board APPLICATION and COMPACT

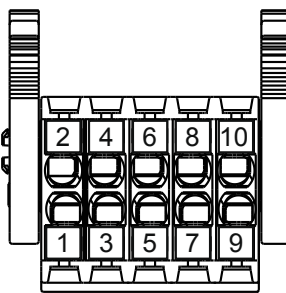
X1C	PIN	Name	Description
	1	BR+	Brake control / output +
	2	BR-	Brake control / output -
	3	0V	For supply of the checkback inputs
	4	24Vout	
	5	DIBR1	Checkback input 1 for brake and relay
	6	DIBR2	Checkback input 2 for brake and relay
	7	reserved	–
	8	reserved	–
	9	TA1	Temperature detection / output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

Figure 31: Terminal block X1C for control board PRO

**NOTICE**

**Malfunctions due to incorrect line or laying!**

**Malfunctions of the control due to capacitive or inductive coupling.**

- ▶ Do not route cables from the motor temperature sensor (also shielded) together with control cables.
- ▶ Cables from the motor temperature sensor within the motor cables may only be used with double shielding!
- ▶ The input of the temperature detection has basic isolation.

		<p>For control board APPLICATION and COMPACT. The voltage to the control of a brake is decoupled from the internal voltage supply. The brake works only with external voltage supply.</p> <p>For control board PRO The brake can be supplied with both, internal and external voltage. Voltage tolerances and output currents vary for internal and external voltage supply..</p>
1	COMBIVERT	<p>Respect the specifications =&gt; <a href="#">instruction manual „control board“</a></p>
4	Brake	
<p>Figure 32: Connection of the brake control</p>		

		<p>KTY sensors are polarized semiconductors and must be operated in forward direction! To this connect the anode to TA1 and the cathode to TA2! Non-observance leads to incorrect measurements in the upper temperature range. A protection of the motor winding is then no longer guaranteed.</p>
1	Connection via shield plate (if not available, place on the mounting plate).	
<p>Figure 33: Connection of a KTY sensor</p>		

**NOTICE**

**No protection of the motor winding in case of wrong connection.**

- ▶ Operate KTY sensors in forward direction.
- ▶ KTY sensors may not be combined with other detections.



Further information about the wiring of the temperature monitoring and the brake control have to be observed in the respective control unit manual.

### 5.3.5 Connection and use of a braking resistor

**⚠ CAUTION**



**Fire risk by using brake resistors!**

- ▶ The risk of fire can be significantly reduced by using „intrinsically safe braking resistors“ or by using suitable monitoring functions / circuits.

**NOTICE**

**Destruction of the frequency inverter if the value has fallen below the minimum brake resistance value!**

- ▶ The minimum brake resistance value must not fall below!  
*„3.3 Device data of the 400 V devices“*

**⚠ CAUTION**

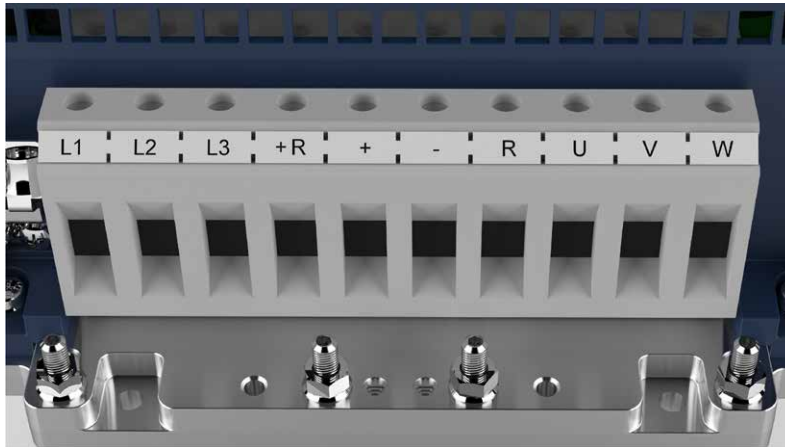


**Hot surfaces caused by load of the braking resistor!**

**Burning of the skin!**

- ▶ Cover hot surfaces safe-to-touch.
- ▶ Before touching, check the surface.
- ▶ If necessary, attach warning signs on the system.

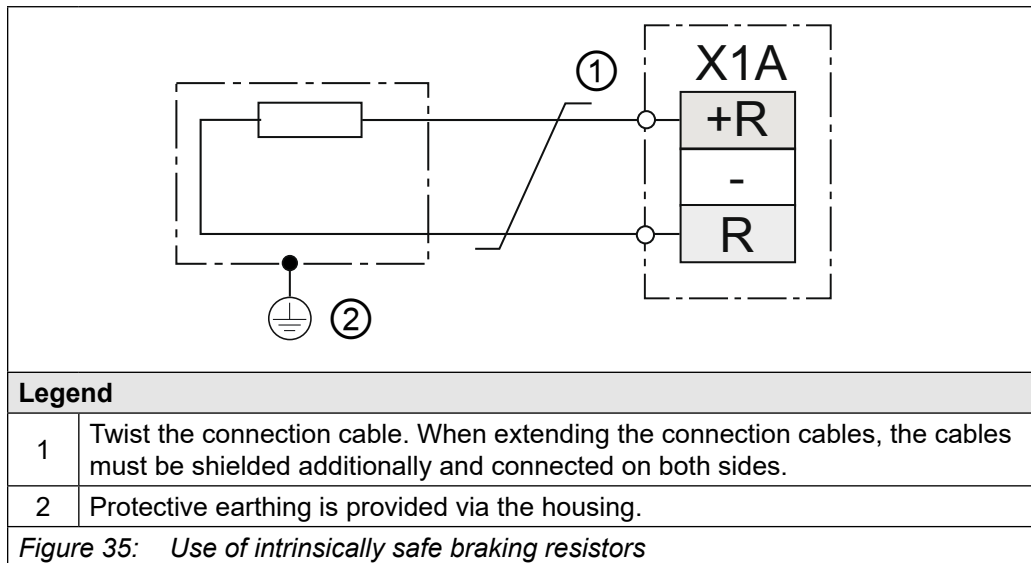
5.3.5.1 Terminal block X1A connection braking resistor



Name	Function	Cross-section for terminal connection	Tightening torque	Max. number of conductors
+R	Connection for braking resistor (between +R and R)	Flexible cable with wire-end ferrule 1.5...35 mm <sup>2</sup> (without wire-end ferrule up to max. 50 mm <sup>2</sup> ) With 2 cables max. 16 mm <sup>2</sup>  UL: Flexible cable without wire-end ferrule AWG 16...1	3.2...3.7 Nm 28...32 lb inch	For IEC: 2  For UL: 1
R				

Figure 34: Terminal block X1A connection braking resistor

5.3.5.2 Use of intrinsically safe braking resistors



Intrinsically safe braking resistors behave in error case such as a safety fuse. They interrupt themselves without fire risk.

More information about intrinsically safe braking resistors  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_safe-braking-resistors-20106652\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safe-braking-resistors-20106652_en.pdf)



5.3.5.3 Using a non-intrinsically safe braking resistor

**⚠ WARNING**



**Use of non-intrinsically safe braking resistors**

**Fire or smoke in case of overload or fault !**

- ▶ Only use braking resistors with temperature sensor.
- ▶ Evaluate temperature sensor.
- ▶ Trigger a fault on the drive controller (e.g. external input).
- ▶ Switching off input voltage (e.g. input contactor).
- ▶ Connection examples for non-intrinsically safe braking resistors
- ▶ => *Instructions for use "Installation braking resistors"*



Instructions for use "Installation braking resistors"  
[www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_braking-resistors-20116737\\_en.pdf](http://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf)



### 5.3.6 DC-bus connection

The DC link of several drive controllers are coupled in a DC-bus connection. This enables energy to be exchanged between the devices and increases the energy efficiency of the application.

As part of a DC-bus connection, this drive controller can either be supplied via the DC terminals => „5.3.3 DC mains connection“ or supply other drive controllers via the DC terminals => „5.3.2 AC mains connection“.



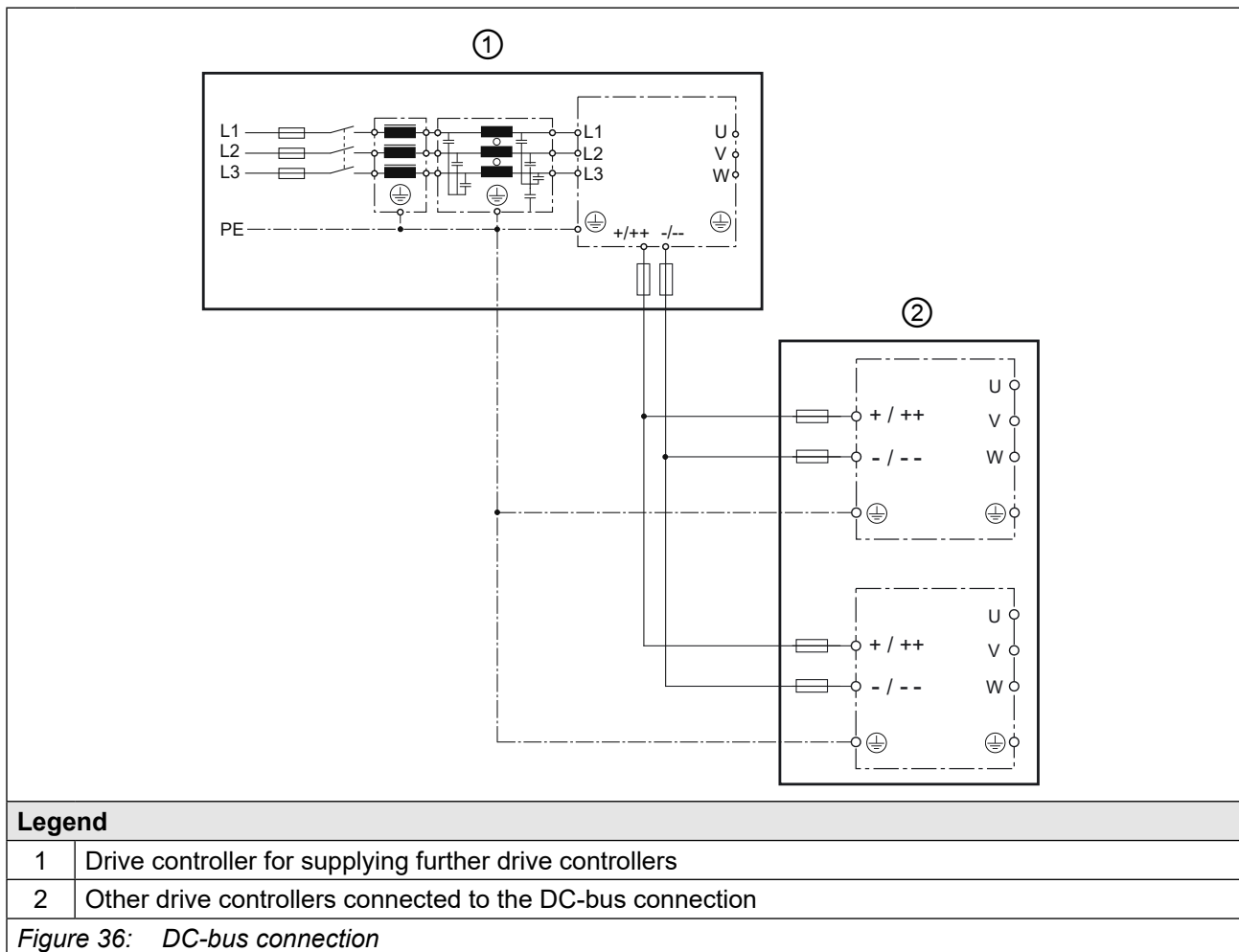
---

KEB has not tested the large number of possible DC connections against the EMC product standard DIN EN IEC 61800-3. CE conformity of the DC-bus connection is the responsibility of the user.

---

**The following additional safety instructions must be observed when using this drive controller in a DC-bus connection:**

- This drive controller may only be operated together with other F6 and S6 drive controllers of the 400V class in a DC-bus connection.
- This drive controller must be installed in an enclosure.
- This drive controller must be protected with fuses at the DC terminals => „3.3.6.2 Fuse protection for DC supply“.
- If one fuse in the DC-bus connection blows as a result of a short circuit, all fuses in the DC-bus connection should be replaced due to the risk of prior damage.
- The parameterisation of the input phase failure detection must be adapted => F6 Programming manual.



**① When using this drive controller to supply other drive controllers via the DC terminals, the following must also be observed:**

- The maximum prechargeable total capacity (internal capacity + external capacity) must not be exceeded => „Table 34: DC link / braking transistor function of the 400 V devices“.
- The minimum waiting time between two precharging procedures must be observed => „5.2.1 Connection of the voltage supply“.
- Drive controllers supplied via the DC terminals must not be loaded during precharging.
- Overloading of the rectifier must be prevented by the user => „3.3.4 Overview of rectifiers for 400 V devices“.

**② When supplying this drive controller via the DC terminals, the following must also be observed:**

- The drive controller must be pre-charged by the supplying drive controller or an external pre-charging module.



## 5.4 Accessories

### 5.4.1 Filters and chokes

Voltage class	Drive controller size	HF filter	Mains choke 50 Hz / 4% $U_k$
230V	18	20E6T60-3000	18Z1B03-1000

Table 39: Filters and chokes for 230V devices

Voltage class	Drive controller size	HF filter	Mains choke 50 Hz / 4% $U_k$
400V	19	20E6T60-3000	19Z1B04-1000
		20E6T60-3050	
		22E6T60-1050	
	20	20E6T60-3000	20Z1B04-1000
		20E6T60-3050	
		22E6T60-1050	
	21	22E6T60-1050	21Z1B04-1000
		22E6T60-3000	
		22E6T60-5150	–
	22	22E6T60-1050	22Z1B04-1000
		22E6T60-3000	
		22E6T60-5150	–

Table 40: Filters and chokes for 400V devices



The specified filters and chokes are designed for rated operation.

### 5.4.2 Shield connection bracket mounting kit

Name	Material number
Shield connection bracket mounting kit	00F6V80-4001

Table 41: Shield connection bracket mounting kit

### 5.4.3 Seal IP54-ready devices

Name	Material number
Seal IP54	40F6T45-0004

Table 42: Seal for IP54-ready devices

#### 5.4.4 Side-mounted braking resistors



Technical data and design about intrinsically safe braking resistors => [https://www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_safe-braking-resistors-20106652\\_en.pdf](https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_safe-braking-resistors-20106652_en.pdf)



Technical data and design about non-intrinsically safe braking resistors => [https://www.keb.de/fileadmin/media/Manuals/dr/ma\\_dr\\_braking-resistors-20116737\\_en.pdf](https://www.keb.de/fileadmin/media/Manuals/dr/ma_dr_braking-resistors-20116737_en.pdf)



## 6 Operation of Liquid-Cooled Devices

### 6.1 Water-cooled devices

The use of water-cooled KEB COMBIVERT drive converters is offered, because there are process-caused coolants available with some applications. However, the following instructions must be observed.

#### 6.1.1 Heat sink and operating pressure

Design system	Material	max. operating pressure	Connection
Aluminium heat sink with stainless steel tubes	Stainless steel 1.4404	10 bar	=> „6.1.4 Connection of the cooling system“

#### NOTICE

#### Deformation of the heat sink!

- ▶ In order to avoid a deformation of the heat sink and the damages thereby, the indicated maximum operating pressure may not be exceeded briefly also by pressure peaks.
- ▶ Observe the Pressure Equipment Directive 2014/68/EU!

#### 6.1.2 Materials in the cooling circuit

For the screw connections and also for the metallic articles in the cooling circuit which are in contact with the coolant (electrolyte) a material is to be selected, which forms a small voltage difference to the heat sink in order to avoid contact corrosion and/or pitting corrosion (electro-chemical voltage series, see the following table). The specific case of application must be checked by the customer in tuning of the complete cooling circuit and must be classified according to the used materials. With hoses and seals take care that halogen-free materials are used.

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

Material	formed ion	Standard potential	Material	formed ion	Standard potential
Lithium	Li+	-3.04 V	Nickel	Ni <sup>2+</sup>	-0.25 V
Potassium	K+	-2.93 V	Tin	Sn <sup>2+</sup>	-0.14 V
Calcium	Ca <sup>2+</sup>	-2.87 V	Lead	Pb <sup>3+</sup>	-0.13 V
Sodium	Na+	-2.71 V	Iron	Fe <sup>3+</sup>	-0.037 V
Magnesium	Mg <sup>2+</sup>	-2.38 V	Hydrogen	2H+	0.00 V
Titan	Ti <sup>2+</sup>	-1.75 V	<b>Stainless steel (1.4404)</b>	<b>various</b>	<b>0.2...0.4 V</b>
Aluminium	Al <sup>3+</sup>	-1.67 V	Copper	Cu <sup>2+</sup>	0.34 V

*continued on the next page*

Material	formed ion	Standard potential	Material	formed ion	Standard potential
Manganese	Mn <sup>2+</sup>	-1.05 V	Carbon	C <sup>2+</sup>	0.74 V
Zinc	Zn <sup>2+</sup>	-0.76 V	Silver	Ag <sup>+</sup>	0.80 V
Chrome	Cr <sup>3+</sup>	-0.71 V	Platinum	Pt <sup>2+</sup>	1.20 V
Iron	Fe <sup>2+</sup>	-0.44 V	Gold	Au <sup>3+</sup>	1.42 V
Cadmium	Cd <sup>2+</sup>	-0.40 V	Gold	Au <sup>+</sup>	1.69 V
Cobald	Co <sup>2+</sup>	-0.28 V			

Table 43: Electrochemical series / standard potentials against hydrogen

### 6.1.3 Requirements for the coolant

The requirements for the coolant depend on the ambient conditions as well as the used cooling system.

General requirements for the coolant:

Requirement	Description
Standards	Corrosion protection according to <i>EN 12502-1...5</i> , water treatment and use of materials in cooling systems according to <i>VGB S 455 P</i> .
VGB Cooling water directive	The VGB cooling water directive ( <i>VGB S 455 P</i> ) contains instructions about common process technology of the cooling. Particularly the interactions between cooling water and components of the cooling system are described.
Abrasive substances	Abrasive substances as used in abrasive (quartz sand), clogging the cooling circuit.
Hard water	Cooling water may not cause scale deposits or loose excretions. The total hardness should be between 7...20 °dH, the carbon hardness at 3...10 °dH.
Soft water	Soft water (<7°dH) corrodes the material.
Frost protection	An appropriate antifreeze must be used for applications when the heat sink or the coolant is exposed temperatures below zero. Use only products of one manufacturer for a better compatibility with other additives. KEB recommends the antifreeze Antifrogen N from Clariant with a maximum volume content of 52 %.
Corrosion protection	Additives can be used as corrosion protection. In connection with frost protection the antifreeze must have a concentration of 20...25Vol %, in order to avoid a change of the additives. Alternatively, an antifreeze / glycol with a concentration of 20% ... max. vol 52% can be used. If antifreeze is used, the water does not need to be provided with additional additives.

Table 44: Requirements for the coolant

Special requirements for open and half-open cooling systems:

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

Table 45: Special requirements for open and half-open cooling systems



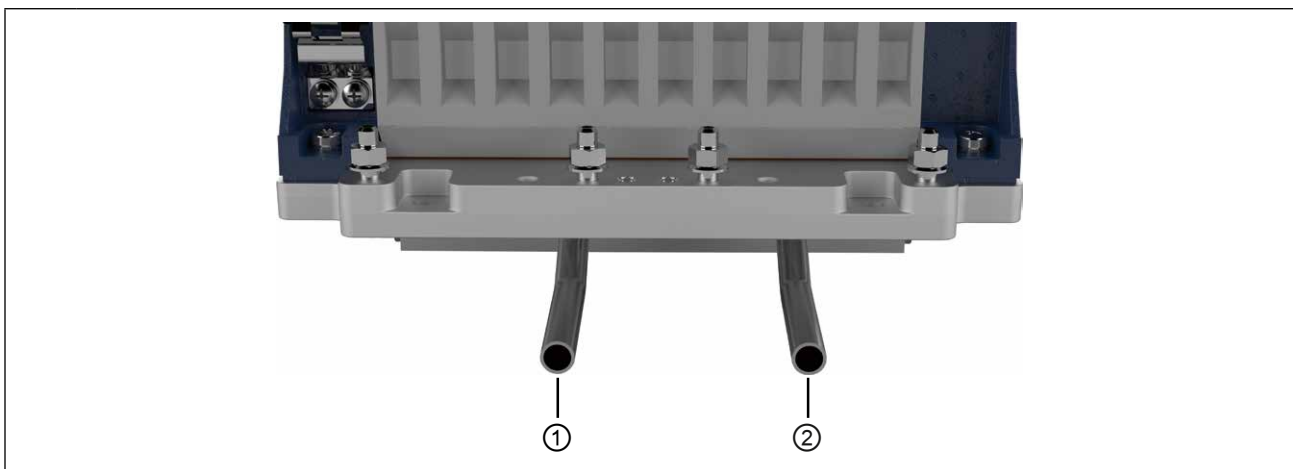
Damages at the device which are caused by clogged, corroded heat sinks or other obvious operating errors, leads to the loss of the warranty claims.

### 6.1.4 Connection of the cooling system

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

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

Other elements in the cooling circuit such as pumps, shut-off valves, ventilation etc. must be attached according to the cooling system and the local conditions.



No.	Connection	Type
1	Forward flow	Open pipe ends for the connection of the cooling system Pipe diameter outside: 10 mm
2	Return flow	

Figure 37: Open pipe ends for the connection of the water cooling system



For the connection of the cooling system KEB recommends the use of functional nuts, e.g. from the manufacturer "Parker", type FMxxL71 (xx = pipe diameter).



KEB recommends the use of a volume flow switch in order to monitor the volume flow in the cooling system.

### 6.1.5 Coolant temperature and moisture condensation

The flow temperature should be selected depending on the volume flow so that the heat sink temperature is always 10 K below the overtemperature level (OH) during rated operation. This avoids sporadic shutdown.

The maximum heat sink temperature can be found in chapter => „3.4.1 Switching frequency and temperature“.

#### 6.1.5.1 Condensation

A temperature difference between drive converter and ambient temperature can lead to condensation at high humidity.

Moisture condensation is dangerous for the drive converter. The drive converter can be destroyed through occurring short-circuits.

### NOTICE

#### Destruction of the drive converter due to short circuit!

- The user must guarantee that any moisture condensation is avoided!

#### 6.1.5.2 Supply of temper coolant

- The supply of optimally tempered coolant is possible by using heaters in the cooling circuit to control the coolant temperature.
- The following dew point table shows the coolant inlet temperature depending on the ambient temperature and air humidity.

Ambient temperature / °C \ Air humidity / %	10	20	30	40	50	60	70	80	90
-10	-34	-26	-22	-19	-17	-15	-13	-11	-11
-5	-29	-22	-18	-15	-13	-11	-8	-7	-6
0	-26	-19	-14	-11	-8	-6	-4	-3	-2
5	-23	-15	-11	-7	-5	-2	0	2	3
10	-19	-11	-7	-3	0	1	4	6	8
15	-18	-7	-3	1	4	7	9	11	13
20	-12	-4	1	5	9	12	14	16	18
25	-8	0	5	10	13	16	19	21	23
30	-6	3	10	14	18	21	24	26	28
35	-2	8	14	18	22	25	28	31	33
40	1	11	18	22	27	31	33	36	38
45	4	15	22	27	32	36	38	41	43
<b>Coolant inlet temperature / °C</b>									

Table 46: Dew point table



Information on coolant management is given in the following document

[www.keb.de/fileadmin/media/Techinfo/dr/an/ti\\_dr\\_an-liquid-cooling-00004\\_en.pdf](http://www.keb.de/fileadmin/media/Techinfo/dr/an/ti_dr_an-liquid-cooling-00004_en.pdf)



**NOTICE**

**Destruction of the heat sink at storage / transport of water-cooled devices!**

Observe the following points when storing water-cooled devices:

- ▶ Completely empty the cooling circuit
- ▶ Blow out the cooling circuit with compressed air

**NOTICE**

**Destruction of the drive converter due to condensation!**

- ▶ Use only NC valves!

**6.1.6 Permissible volume flow with water cooling**

The volume flow of the following table must be observed.

Permissible volume flow		
Min. volume flow	$Q_{min}$ / l/min	5
Max. volume flow	$Q_{max}$ / l/min	15
<i>Table 47: Permissible volume flow with water cooling</i>		



The volume flow depends on the total power dissipation.

=> „6.1.7 Coolant heating“

**NOTICE**

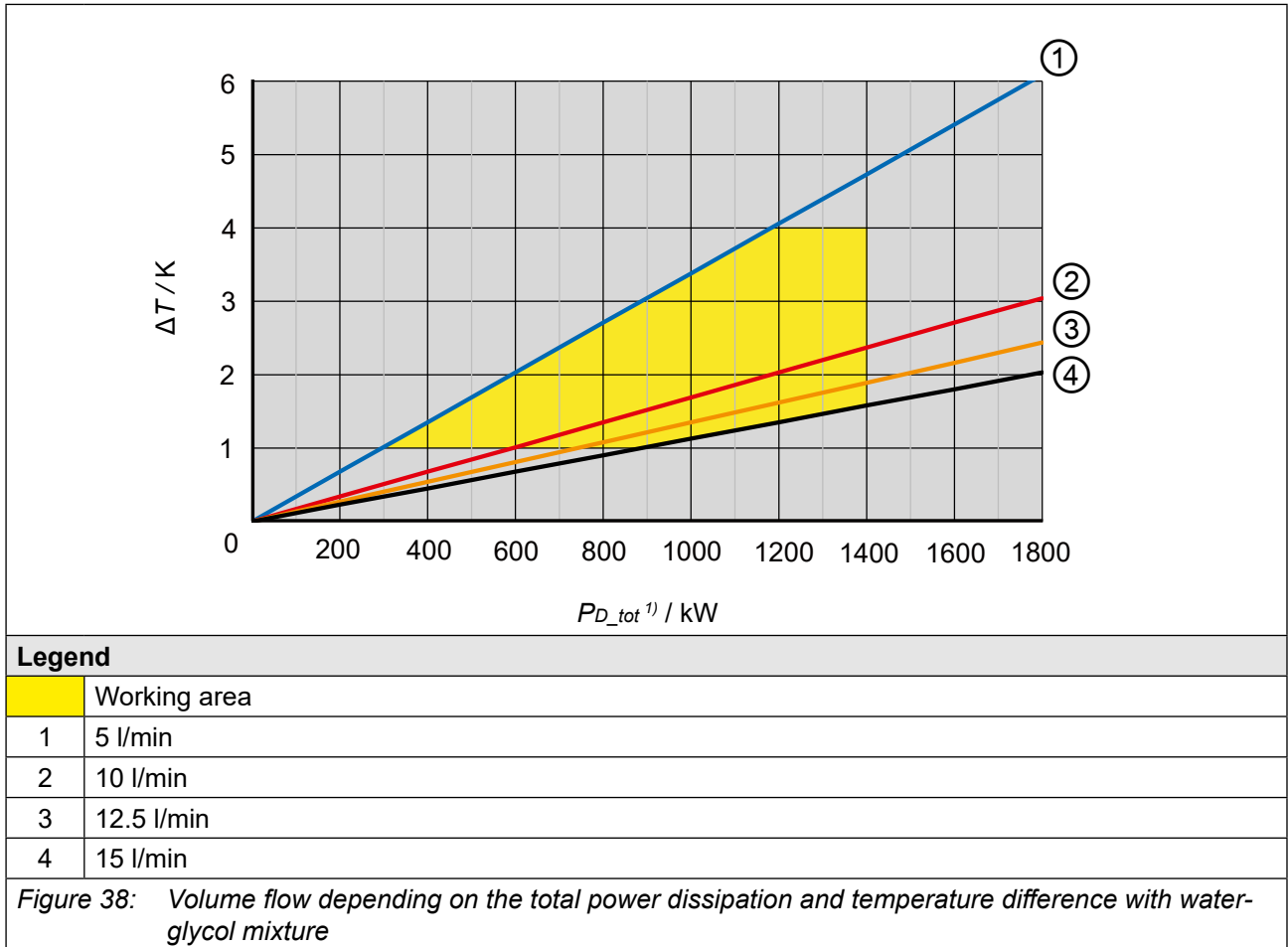
**Destruction of the heat sink due to erosion!**

- ▶ The maximum permissible volume flow must not be exceeded.



6.1.7 Coolant heating

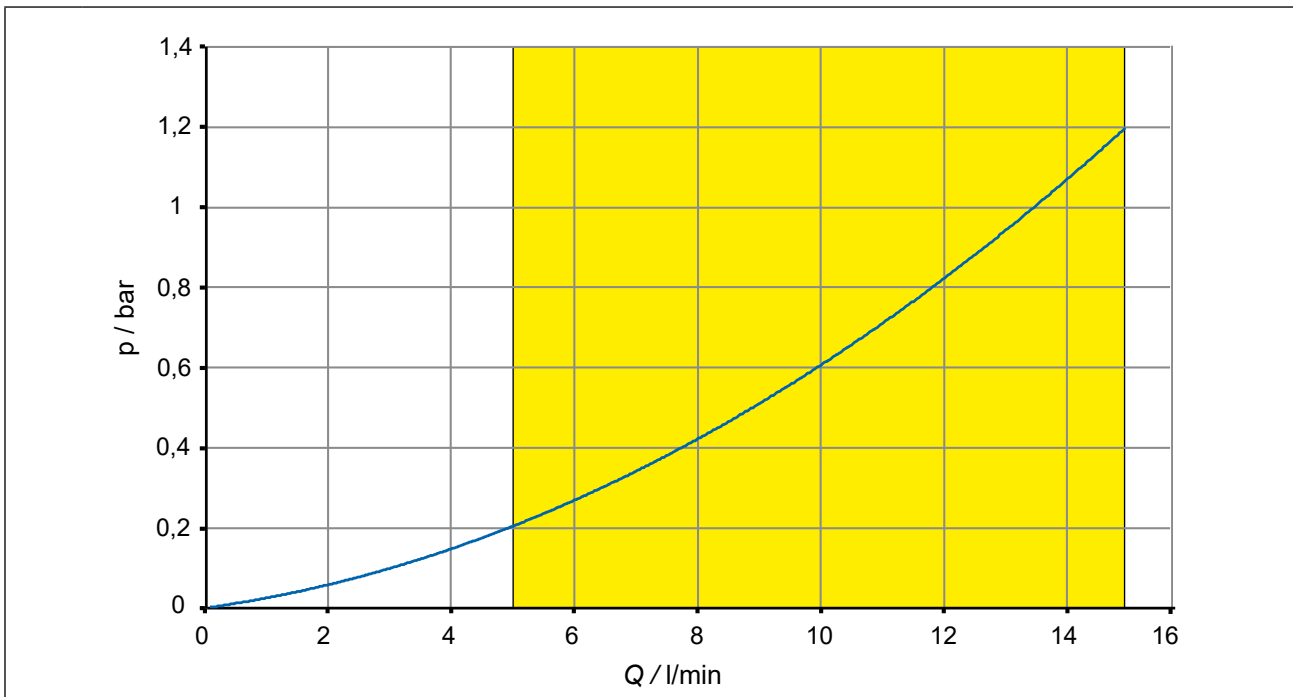
Volume flow depending on the total power dissipation and temperature difference between forward flow and return flow.



<sup>1)</sup>  $P_{D\_tot}$  can be higher than the power dissipation  $P_D$  at rated operation due to overload, higher switching frequency or sub-mounted braking resistors.

6.1.8 Typical pressure drop of the heat sink

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



**Legend**

Working area

Figure 39: Typical pressure drop depending on the volume flow

## 6.2 Oil-cooled devices

The following instructions must be observed when using the device.

### 6.2.1 Heat sink and operating pressure for oil-cooled devices

Design system	Material	max. operating pressure	Connection
Aluminium heat sink	Aluminium 3.3206	10 bar	=> „6.2.3 Connection of the oil cooling system“

#### NOTICE

#### Deformation of the heat sink!

- ▶ In order to avoid a deformation of the heat sink and the damages thereby, the indicated maximum operating pressure may not be exceeded briefly also by pressure peaks.
- ▶ The pressure equipment directive 2014/68/EU must be observed!

### 6.2.2 Oil requirements

General requirements for the oil:

Requirement	Description
Characteristic of the oil	Hydraulic oil HLP 46 (ISO VG 46)
Oils with appropriate properties	<ul style="list-style-type: none"> <li>• Mobil DTE 25</li> <li>• Shell Tellus Oil 46</li> <li>• Castrol Hyspin ZZ 46</li> </ul> Or similar oils

Table 48: Oil requirements

Special requirements for open and half-open cooling systems:

Requirement	Description
Impurities	Mechanical impurities in half-open cooling systems can be counteracted by using appropriate filters.
Organic materials	The contamination with organic materials must be kept as small as possible, because separate slime can be caused by this.

Table 49: Special requirements for open and semi-open cooling systems for oil coolers

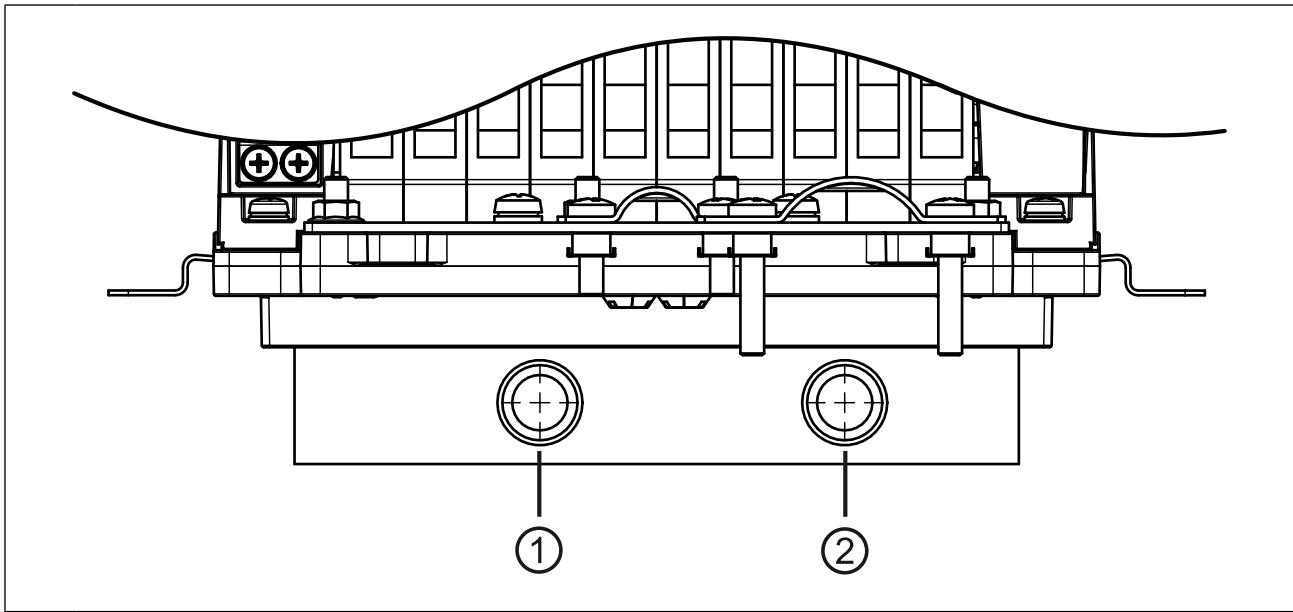


Damage to the device resulting from clogged heat sinks or other obvious usage failures leads to the loss of warranty claims.

6.2.3 Connection of the oil cooling system

The connection to the oil cooling system can occur as closed or open cooling circuit. Connection to a closed cooling circuit is recommended, because the risk of oil contamination is very low.

Other elements in the cooling circuit such as pumps, shut-off valves, ventilation etc. must be attached according to the cooling system and the local conditions.



No.	Connection	Type
1	Forward flow	G 1/2 internal thread for connection of the cooling system
2	Return flow	

Figure 40: Connection of the oil cooling system



KEB recommends the use of a volume flow switch in order to monitor the volume flow in the cooling system.

6.2.4 Permissible volume flow with oil

The volume flow of the following table must be observed.

Permissible volume flow		
Min. volume flow	$Q_{min}$ / l/min	15
Max. volume flow	$Q_{max}$ / l/min	25

Table 50: Permissible volume flow with oil cooler

### 6.2.5 Coolant temperature and condensation with oil

The flow temperature should be selected depending on the volume flow that the heat sink temperature is always 10 K below the overtemperature level (OH) at rated operation. This avoids a sporadic shutdown.

The maximum heat sink temperature can be found in chapter => „3.4.1 *Switching frequency and temperature*“.

#### 6.2.5.1 Moisture condensation

A temperature difference between drive controller and ambient temperature can lead to condensation at high humidity.

Moisture condensation is dangerous for the drive controller. The drive controller can be destroyed by occurring short-circuits.

#### **NOTICE**

#### **Destruction of the drive controller due to short circuit!**

- ▶ The user must guarantee that any moisture condensation is avoided!

6.2.5.2 Supply of temper oil

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

The following table shows the coolant inlet temperature as a function of ambient temperature and air humidity.

Ambient temperature / °C \ Air humidity / %	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
	<b>Coolant inlet temperature / C°</b>									

*Table 51: Dew point table*

## 7 Certification

### 7.1 CE-Marking

The drive controllers marked with a CE logo comply with the requirements of the Machine Directive as well as the EMC and Rohs Directives and energy efficiency regulations.




---

For more information about the CE Declarations of Conformity .  
=> *„7.3 Further informations and documentation“*

---

7.2 UL certification

	<p>Acceptance according to UL is marked at KEB drive controllers with the adjacent logo on the nameplate.</p>
---	---

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

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

Models 21F6 and 22F6: Suitable For Use On A Circuit Capable Of Delivering Not More Than 10000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Class J Fuses, see instruction manual for Branch Circuit Protection details.

All Models: Suitable For Use On A Circuit Capable Of Delivering Not More Than 30000 rms Symmetrical Amperes, 480 Volts Maximum when protected by Semiconductor Fuses by SIBA, Type 20 189 20, or by EATON, Type 170M1368, see instruction manual for Branch Circuit Protection details.

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

Details of the prescribed Branch Circuit Protection as specified in the below section 'Branch Circuit Protection' of this Report need to be marked in the instruction manual.

- Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacturer Instructions, National Electrical Code and any additional local codes.

CSA: For Canada: Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Canadian Electrical Code, Part I"

- For installations according to Canadian National Standard C22.2 No. 274-13: For use in Pollution Degree 2 and Overvoltage Category III environments only.
- Control Circuit Overcurrent Protection Required or equivalent.
- WARNING – The opening of the branch circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electrical shock, current-carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.
- Internal Overload Protection Operates prior to reaching the 130% of the Motor Full Load Current, see manual for adjustment instructions or equivalent wording.



### 7.3 Further informations and documentation

You find supplementary manuals and instructions for the download under [www.keb.de/de/service/downloads](http://www.keb.de/de/service/downloads)

#### General instructions

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

#### Instruction and information for construction and development

- Input fuses in accordance with UL
- Programming manual for control and power unit
- Motor configurator to select the appropriate drive converter and to create downloads for parameterizing the drive converter

#### Approvals and approbations

- Declaration of conformity CE
- TÜV certificate
- FS certification

#### Others

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

## 8 Revision history

Version	Date	Description
00	2016-09	Pre-series
01	2017-02	Pre-series, inclusion of device size 22, new CI
02	2017-07	Series, inclusion of UL certification, water cooling
03	2018-09	Corrections of technical data. Figures of the overload characteristics adapted.
04	2019-12	Editorial changes, inclusion of the 230V devices
05	2020-10	Inclusion of the oil-cooled devices
06	2022-01	Inclusion of the lift devices
07	2024-03	Type codes, standards, drawings updated, editorial changes, data on lift device removed, description of 400 V DC-ready devices added
08	2025-02	Editorial changes, DC-Ready connection corrected, glossary, standards updated.



**MORE KEB PARTNERS WORLDWIDE:**

[www.keb-automation.com/contact](http://www.keb-automation.com/contact)





**Automation with Drive**

**[www.keb-automation.com](http://www.keb-automation.com)**

KEB Automation KG Suedstrasse 38 D-32683 Barntrop Tel. +49 5263 401-0 E-Mail: [info@keb.de](mailto:info@keb.de)