COMBIVERT

F5

7,5...630 kW

2

GB INSTRUCTION MANUAL **Water-cooled Power Circuits**

00.F5.0EW-K001

STOP **Read Instruction manual part 1 first!**

KEB

04/2006

GB

This Instruction Manual describes the control circuit of the KEB COMBIVERT F5 series. It is only valid together with the Instruction Manuals Part 1 and Part 2. Both Instruction Manuals must be made available to the user. Prior to performing any work on the unit the user must familiarize himself with the unit. This includes especially the knowledge and observance of the **safety and warning directions of Part 1**. The pictographs used in this Instruction Manual have following meaning:

Danger
Warning
Caution

Attention, observe at all costs

Information
Help
Tip

1. General

1.1 Product Description

In selecting the KEB COMBIVERT you have acquired a frequency inverter with the highest demands on quality and dynamic.

It serves exclusively for a stepless speed regulation of a three-phase a.c. motor.

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

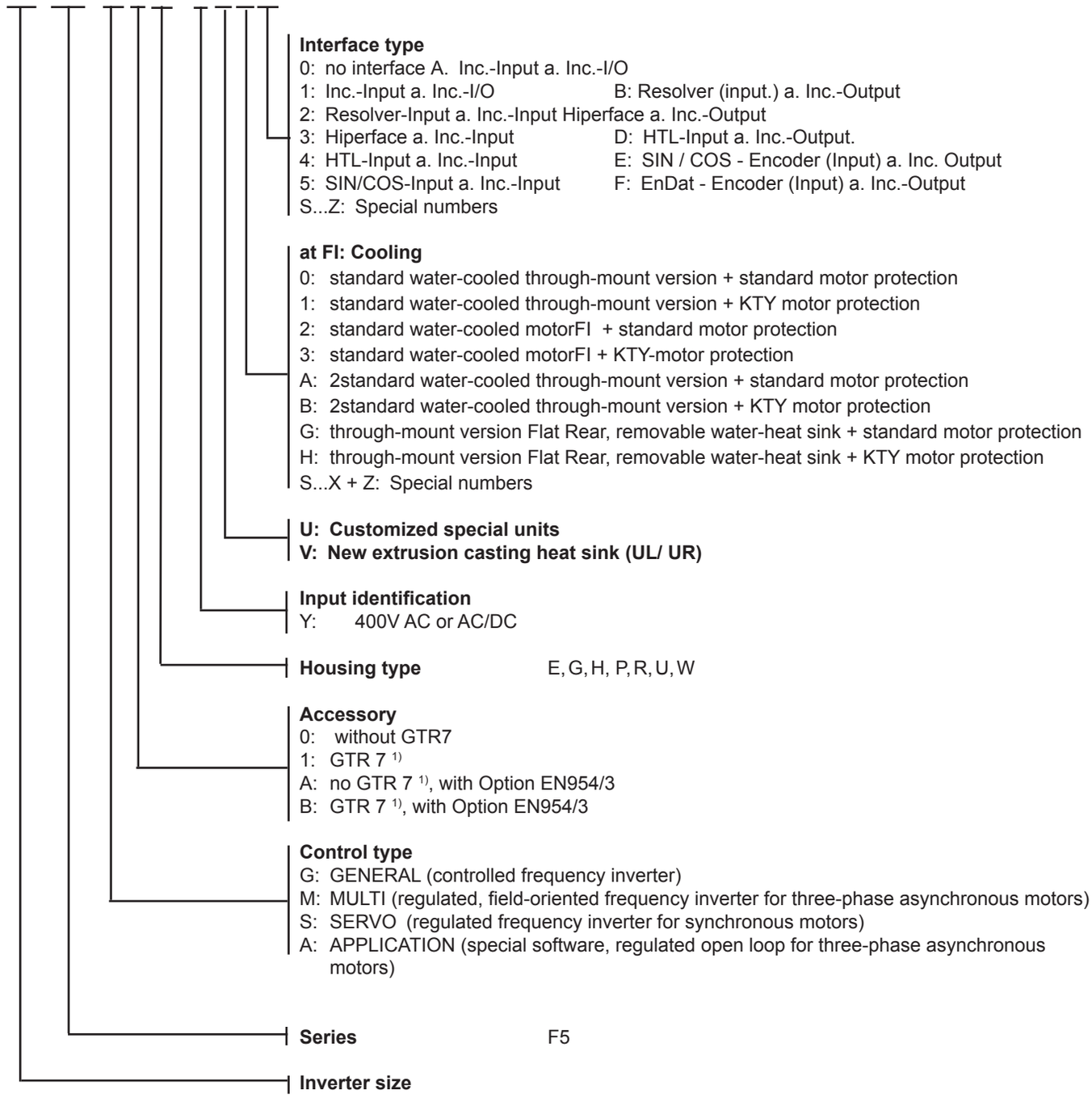
This manual describes the water-cooled power circuits for **KEB COMBIVERT F5-G and F5-M** frequency inverters in the range of **7,5 kW...355 kW / 400V class.**

Not only is this unit small in size and price, it also has the following features:

- only slight switching losses due to IGBT
- low noise development due to high switching frequency
- extensive safety device for current, voltage and temperature
- voltage and current monitoring in static and dynamic operation
- conditionally short circuit proof and earth-fault proof
- noise immunity in accordance with IEC1000
- hardware current regulation
- integrated cooling fan
- uniform mounting grid
- mountable side by side through rack design

1.2 Unit Identification

27.F5.MBU–YV12



Interface type
0: no interface A. Inc.-Input a. Inc.-I/O
1: Inc.-Input a. Inc.-I/O B: Resolver (input.) a. Inc.-Output
2: Resolver-Input a. Inc.-Input Hiperface a. Inc.-Output
3: Hiperface a. Inc.-Input D: HTL-Input a. Inc.-Output.
4: HTL-Input a. Inc.-Input E: SIN / COS - Encoder (Input) a. Inc. Output
5: SIN/COS-Input a. Inc.-Input F: EnDat - Encoder (Input) a. Inc.-Output
S...Z: Special numbers

at FI: Cooling
0: standard water-cooled through-mount version + standard motor protection
1: standard water-cooled through-mount version + KTY motor protection
2: standard water-cooled motorFI + standard motor protection
3: standard water-cooled motorFI + KTY-motor protection
A: 2standard water-cooled through-mount version + standard motor protection
B: 2standard water-cooled through-mount version + KTY motor protection
G: through-mount version Flat Rear, removable water-heat sink + standard motor protection
H: through-mount version Flat Rear, removable water-heat sink + KTY motor protection
S...X + Z: Special numbers

U: Customized special units
V: New extrusion casting heat sink (UL/ UR)

Input identification
Y: 400V AC or AC/DC

Housing type E, G, H, P, R, U, W

Accessory
0: without GTR7
1: GTR 7 [1)]
A: no GTR 7 [1)], with Option EN954/3
B: GTR 7 [1)], with Option EN954/3

Control type
G: GENERAL (controlled frequency inverter)
M: MULTI (regulated, field-oriented frequency inverter for three-phase asynchronous motors)
S: SERVO (regulated frequency inverter for synchronous motors)
A: APPLICATION (special software, regulated open loop for three-phase asynchronous motors)

Series F5

Inverter size

1) GTR 7: braking transistor
2) PFC: Power Factor Control

1.3 Installation and Operating Instructions

1.3.1 General Instructions

- Install KEB COMBIVERT stationary and ground it.
- Take into consideration the minimum distance to surrounding elements when positioning the inverter. (see control cabinet installation)
- Rack units are designed for vertical installation and can be mounted side by side. Maintain a distance of at least 50mm to preceding elements. Make sure cooling is sufficient.
- No mist or water may get into the KEB COMBIVERT.
- Prevent dust from getting into the KEB COMBIVERT. When installing a dust-proof housing make sure it has enough heat dissipation.
- Do not operate KEB COMBIVERT in an explosion-protected room!
  In explosion-protected rooms the KEB COMBIVERT must be installed in an explosion-protected housing, in observance of the local regulations.
- Protect the KEB COMBIVERT against conductive and aggressive gases and liquids.
- Consumers, which produce electrical or magnetic fields or have an influence on the voltage supply, must be placed as far away as possible and measures must be taken to suppress the influences.
- Regarding applications, that require cyclic switching off and on of the static frequency inverter, a minimum time-out of at least 5 minutes must be kept after power-off. If shorter cycle times are needed, please contact KEB.
- The life span of the KEB COMBIVERT, an inverter with voltage link, depends on the current load of the electrolytic capacitors in the intermediate circuit. By using line reactors the life span of the capacitors can be substantial increased, in particular when connecting to a „hard“ network or in case of continuous load (S1 operation) on the drive.
  For drives in continuous operation (S1) with an average load of >60% KEB recommends the use of line reactors with Uk=4%.
  The term „hard“ network can be defined as follows (as assistance):
  The rated power of the inverter (Sn) is very small in comparison to the nodal point rating (Smains) of the mains.
  k = Smains / Sn >> 200 e.g. Sn = 6,6 kVA 12.F5
  Smains = 2 MVA Supply transformer
  —> k = 303
  —> line reactor necessary

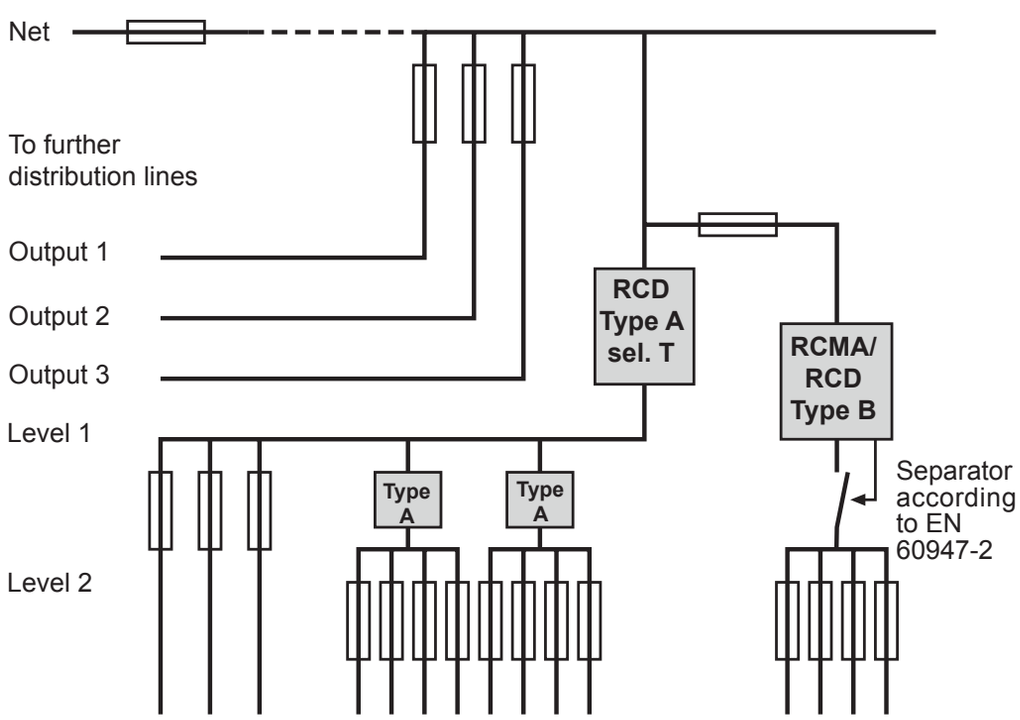
1.3.2 RCD (FI Protective Switch)

If the protection of individuals is required during the setup of systems the frequency inverter must be secured in accordance with EN 50178 (VDE 0160) as follows:

- 1-phase inverters by RCD type A (pulse-current sensitive FI´s) or type B (all-current sensitive FI's)
- 3-phase inverters (with B6 bridge-connected rectifier) by RCMA's with separator (to use with preference) or RCD's type B (all-current sensitive FI's)

The tripping current of the RCD should be 300mA or more, in order to avoid premature triggering of the inverter through discharge currents of the frequency inverter (about 200mA). Dependent on the load, the length of the motor cable and the use of a radio interference filter, substantially higher leakage currents can occur. The connection instructions from the manufacturer and the valid local requirements must be observed.
Dependent on the available network configuration (TN, IT, TT) further protective measures are necessary in accordance with VDE 0100 Part 410 (Part 4; Chapter 41). With TN networks this e.g. protection by overcurrent devices, with IT networks isolation monitoring with pulse-code measuring procedures. A protective separation can be used with all network configurations as long as the required power and

Diagram of a low-voltage distribution board (principle of protective elements)



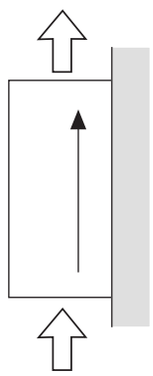
The KEB COMBIVERT can be connected at outer conductor grounded systems (e.g. delta systems) with the following restrictions:

- the classification of the control as „save separated circuit" are to be executed
- the specified measures of „basic insulation" are to be executed
- the max. voltage phase/earth may not exceed absolutely 500 V with this network configuration

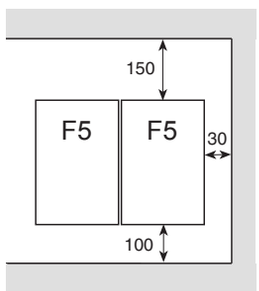
1.3.3 Cooling System

In the following the water-cooled through-mount version is described. At this design the heat sink is moved through a cutout in the control cabinet to the outside and is designed for the connection to an existing cooling system. The dissipation of the power loss must be ensured by the machine builder.

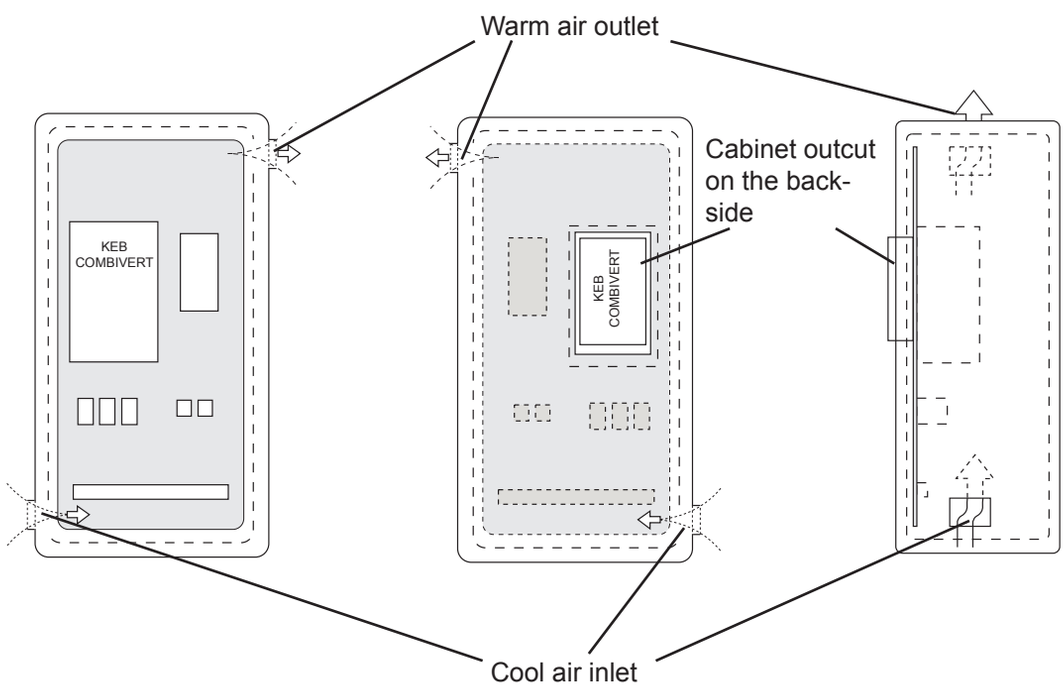
1.3.4 Control Cabinet Installation



Direction of cooling



Minimum distances



1.4 DC Supply

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

400V Class:

$$\frac{\sqrt{3} \times \text{rated motor voltage} \times \text{rated motor current} \times \text{motor cos } \varphi}{540\text{V}}$$

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

- if you accelerate on the hardware current limit, the short-time current limit of the inverter must be used in the formula above (instead of the rated motor current.
- if the motor in normal operation is never stressed with rated torque, it can be calculated with the real motor current.
- a good practice value corresponds approx. to 1,5-times of the rated motor current (from 90kW 1,25-times)

2. Technical Data

2.1 Technical Data

Inverter Size		**15**	**16**		**17**		**18**		**19**	
Housing size		**E**	**E**	**G**	**G**	**H**	**G**	**H**	**H**	**R**
Phases		3	3		3		3		3	
Output nominal power	[kVA]	17	23		29		35		42	
Max. rated motor power	[kW]	11	15		18,5		22		30	
Output nominal current	[A]	24	33		42		50		60	
Max. short time current [1)]	[A]	36	49,5		63		75		90	
OC-tripping current	[A]	43	59		75		90		108	
Nominal input current	[A]	31	43		55		65		66	
Max. permissible mains fuse (inert)	[A]	35	50		50	63	80		80	
Rated switching frequency	[kHz]	4	2	8	4	8	2	8	4	8
Max. switching frequency	[kHz]	16	16		16		16		16	
Power loss at nominal operating	[W]	350	330	500	360	470	430	610	540	750
Stall current at 4kHz [2)]	[A]	24	33		42		45	50	60	
Stall current at 8kHz [2)]	[A]	16	-	33	21,4	30	30	45	39	60
Stall current at 16kHz [2)]	[A]	10	-	20	-	13,5	20		18	27
Max. heat sink temperature TOH	[°C]	90								
Motor line cross section [3)]	[mm²]	6	10		10	16	25		25	
Min. braking resistor [4)]	[Ohm]	39	25		25	22	13		13	9
Typ. braking resistor [4)]	[Ohm]	56	42		30		22		15	
Max. braking current	[A]	21	32	30	30	37	63		63	88
Overload curve (page appendex)		1								
Tightening torque for terminals	[Nm]	1,2	1,2		1,2	2,5	4		2,5	6
Mains voltage [5)]	[V]	305...500 ±0 (400 V Nominal voltage)								
Mains frequency	[Hz]	50 / 60 +/- 2								
Output voltage	[V]	3 x 0...U Mains								
Output frequency	[Hz]	see Control board								
Max. shielded motor line length	[m]	100								
Storage temperature	[°C]	-25...70 °C								
Operating temperature	[°C]	-10...45 °C								
Model / protective system		IP20								
Relative humidity		max. 95% without condensation								
EMC tested according to		EN 61800-3								
Climatic category		3K3 in accordance with EN 50178								

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

Site altitude max. 2000 m. With site altitudes over 1000 m a power reduction of 1% per 100m must be taken into consideration.

1) With the regulated systems F5-M as well as F5-S 5% are to be subtracted as control reserve
2) Max. current before response of the OL-function (F5-M, FS-S)
3) Recommended minimum cross section of the motor wire for rated power and a cable length of upto 100m (copper)
4) This data is only valid for units with internal brake transistor GTR 7 (see „unit identification“)
5) At rated voltages ≥460V multiply the rated current with factor 0.86

Inverter Size		**20**		**21**		**22**		**23**		**24**		
Housing size		**H**	**R**	**R**		**R**		**R**	**U**	**R**	**U**	
Phases		3		3		3		3		3		
Output nominal power	[kVA]	52		62		80		104		125		
Max. rated motor power	[kW]	37		45		55		75		90		
Output nominal current	[A]	75		90		115		150		180		
Max. short time current [1)]	[A]	112		135		172		225		270		
OC-tripping current	[A]	135		162		207		270		324		
Nominal input current	[A]	83		100		127		165		198		
Max. permissible mains fuse (inert)	[A]	100		160		160		200		315		
Rated switching frequency	[kHz]	2	8	4	8	4	8	2	8	2	4	8
Max. switching frequency	[kHz]	8	16	16		16		12	8	8		
Power loss at nominal operating	[W]	900		1000	1100	1200	1500	1300	1900	1700	2000	2400
Stall current at 4kHz [2)]	[A]	67,5	75	90		115	115	127,5	150	144	180	
Stall current at 8kHz [2)]	[A]	52,5	75	63	90	80	115	90	150	108	180	
Stall current at 16kHz [2)]	[A]	-	34	45	54	46	51	-	-	-	-	
Max. heat sink temperature TOH	[°C]	90										
Motor line cross section [3)]	[mm²]	35		50		50		95		95		
Min. braking resistor [4)]	[Ohm]	9		9		8		6	5	5		
Typ. braking resistor [4)]	[Ohm]	12		10		8,6		6,7		5		
Max. braking current	[A]	88		88		100		133	160	200		
Overload curve (page appendex)		1										
Tightening torque for terminals	[Nm]	4	6	6		6		15		15		
Mains voltage [5)]	[V]	305...500 ±0 (400 V Nominal voltage)										
Mains frequency	[Hz]	50 / 60 +/- 2										
Output voltage	[V]	3 x 0...U Mains										
Output frequency	[Hz]	see Control board										
Max. shielded motor line length	[m]	50										
Storage temperature		-25...70 °C (-13...158 °F)										
Operating temperature		-10...45 °C (14...113 °F)								-10...40 °C		
Model / protective system (EN 60529)		IP20										
Environment (IEC 664-1)		Pollution degree 2										
EMC tested according to		EN 61800-3										
Vibration/Jolt according to		Germanischer Lloyd; EN 50155										
Climatic category (EN 60721-3-3)		3K3										

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

Site altitude max. 2000 m. With site altitudes over 1000 m a power reduction of 1% per 100m must be taken into consideration.

An input choke is necessary from size 23.

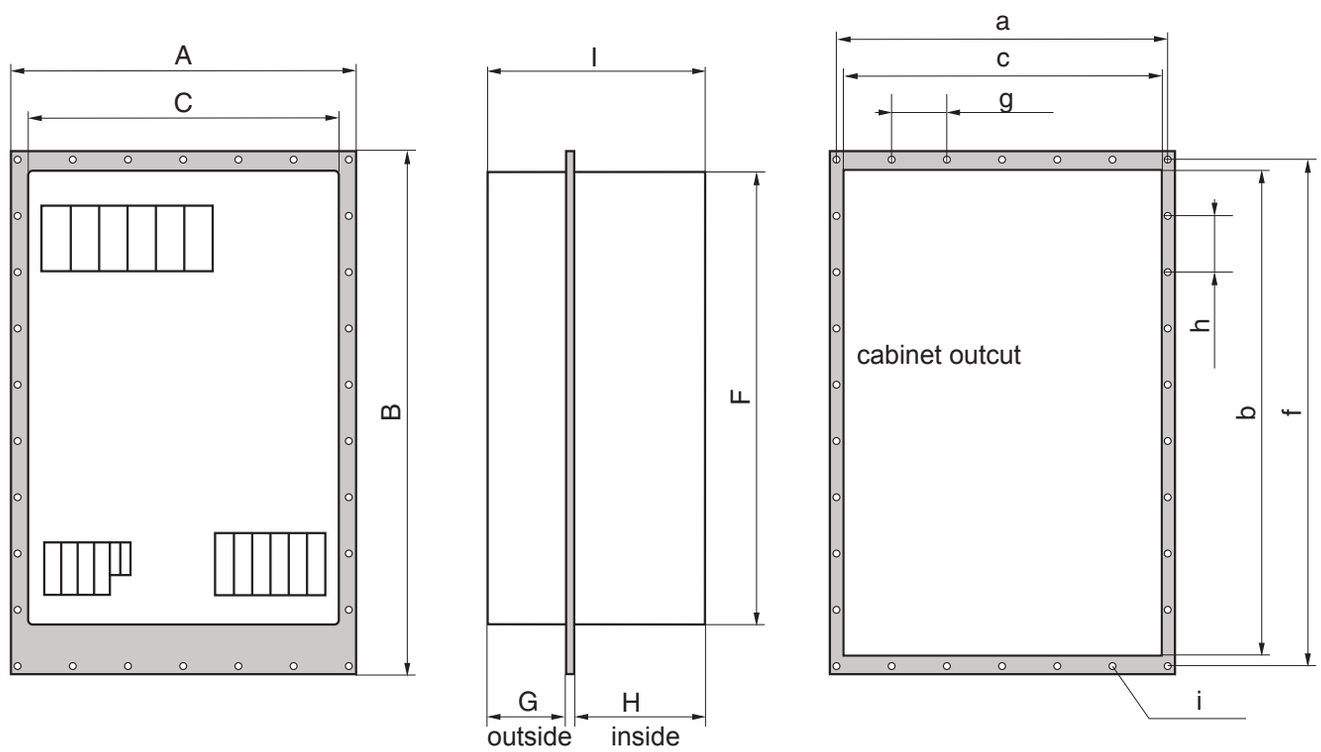
Inverter Size		**25**	**26**	**27**
Housing size		**U**	**U**	**U**
Phases		3	3	3
Output nominal power	[kVA]	145	173	208
Max. rated motor power	[kW]	110	132	160
Output nominal current	[A]	210	250	300
Max. short time current [1)]	[A]	263	313	375
OC-tripping current	[A]	315	375	450
Nominal input current	[A]	231	275	330
Max. permissible mains fuse (inert)	[A]	315	400	450
Rated operating frequency	[kHz]	4	4	2
Max. operating frequency	[kHz]	8	8	8
Power loss at nominal operating	[W]	2300	2800	3100
Stall current at 4kHz [2)]	[A]	210	250	240
Max. heat sink temperature TOH	[°C]	90		
Motor line cross section [3)]	[mm²]	95	120	150
Min. braking resistor [4)]	[Ohm]	2,5	2,5	2,5
Typ. braking resistor [4)]	[Ohm]	4	3,8	3,3
Max. braking current	[A]	200	200	200
Overload curve (page appendex)		2		
Tightening torque for terminals	[Nm]	25		
Mains voltage	[V]	305...500 ±0 (400 V Nominal voltage [4)])		
Mains frequency	[Hz]	50 / 60 +/- 2		
Output voltage	[V]	3 x 0...U Mains		
Output frequency	[Hz]	see Control board		
Max. shielded motor line length	[m]	50		
Storage temperature	[°C]	-25...70 °C		
Operating temperature	[°C]	-10...45 °C		
Model / protective system		IP20		
Relative humidity		max. 95% without condensation		
EMC tested according to product standard		EN 61800-3		
Climatic category		3K3 in accordance with EN 50178		

1) With the regulated systems F5-M as well as F5-S 5% are to be subtracted as control reserve
2) Max. current before response of the OL-function (F5-M, FS-S)
3) Recommended minimum cross section of the motor wire for rated power and a cable length of upto 100m (copper)
4) This data is only valid for units with internal brake transistor GTR 7 (see „unit identification“)
5) At rated voltages ≥460V multiply the rated current with factor 0.86

Inverter Size		**28**			**29**			**30**	**31**	**32**	**33**	**34**	**35**	**36**
Housing Size		**P**	**W**		**P**	**W**		**W**		**P**				
Phases		3	2 x 3		3	2 x 3		2 x 3						
Output nominal power	[kVA]	256			319			395	436	492	554	616	692	796
Max. rated motor power	[kW]	200			250			315	355	400	450	500	560	630
Output nominal current	[A]	370			460			570	630	710	800	890	1000	1150
Max. short time current [1]	[A]	462	463		575			713	787	887	1000	1112	1250	1437
OC-tripping current	[A]	554	555		690			855	945	1065	1200	1335	1500	1725
Nominal input current	[A]	410	2x205		483	510	2x255	2x315	2x350	746	840	935	1050	1208
Max. permissible mains fuse (inert) [2]	[A]	550	315		700	400		450	550	2x550	2x700		–	
Rated operating frequency	[kHz]	2			2			2	2					
Max. operating frequency	[kHz]	4			2			2	2	4				
Power loss at nominal operating	[W]	3500			4200			5100	5600	6800	7600	8500	9500	10700
Stall current at 4kHz [3]		370			–			–						
Max. heat sink temperature TOH	[°C]	90			90			90	60	90				
Motor line cross section [4]	[mm²]	2x95			2x150			2x185	2x185					
Min. braking resistor [5]	[Ohm]	2,4	1,2		2,4	1,2		1,2	1,2	2x2,4	3x2,4			
Typ. braking resistor [5]	[Ohm]	–	2,2		–	1,7		1,3	–					
Max. braking current	[A]	330	660		330	660		660	660	2x330	3x330			
Overload curve (page appendex)		2												
Tightening torque for terminals	[Nm]	25...30												
Mains voltage	[V]	305...500 ±0												
Mains frequency	[Hz]	50 / 60 +/- 2												
Output voltage	[V]	3 x 0...U mains												
Output frequency	[Hz]	see control card												
Shielded motor line length	[m]	100	50		100	50				100				
Storage temperature	[°C]	-25...70 °C												
Operating temperature	[°C]	-10...45 °C												
Model / protective system		IP20												
Relative humidity		max. 95% without condensation												
EMC tested in accordance with ...		EN 61800-3												
Climatic category		3K3 according EN 50178												

1) With the regulated systems F5-M as well as F5-S 5% are to be subtracted as control reserve.
2) Max. current before response of the OL-function (F5-M, FS-S)
3) Recommended minimum cross section of the motor wire for rated power and a cable length of upto 100m (copper)
4) This data is only valid for units with internal brake transistor GTR 7 (see „unit identification“)
5) Rated voltage 400V
   At rated voltage ≥460V multiply the output rated current with factor 0.86
6) The temperature range is only valid for the power and control circuit. The temperature range for the power circuit is dependent on the control cabinet installation and the cooling system.
7) 31.F5. only water-cooled version

2.2 Dimensions and Weight



Housing	A	B	C	F	G	H	I	Weight
E	192	335	128	273	34,5	131	165,5	5,1 kg
G	200	370	188	338	32	160	192	9 kg
H	325	435	288	338	34	162	196	20 kg
P	340	920	283	885	46	251,5	297,5	91 kg
R	385	595	305	395	57	199	258	52 kg
U	373	862	339	640	48,5	187	235,5	62 kg
W	720	1020	670	940	153,5	209,5	365	167 kg

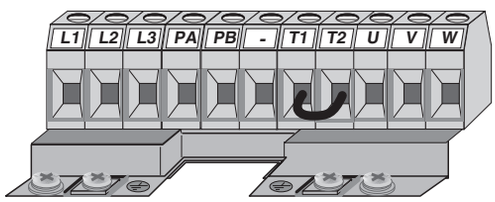
Dimensions of the cabinet outcut

Housing	a	b	c	f	g	h	i
E	177			320	4x80	2x88,5	12xØ6,5
G	120	328	197	230	2x120	4x115	10xØ6,6
H	115	328	297	345	2x115	6x115	12xØ6,6
P	325			905	1x125	6x125	12xØ9
R	365	525	309	575	8x115	10x115	18xØ7
U	355	730	310	840	6x110	14x120	20xØ9
W	700	970	674	1000	7x100	10x100	34xØ9

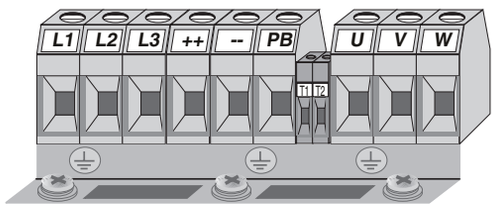
2.3 Summary of the Power Circuit Connections

⚠ **Note input voltage, since 230V and 400V class (3-phase) are possible**

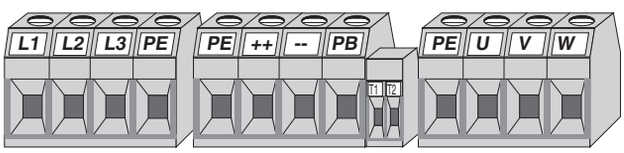
Housing size E



Housing size G

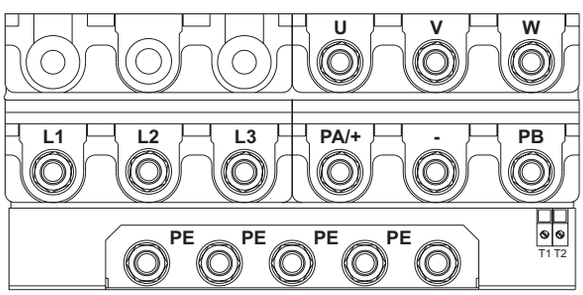


Housing size H



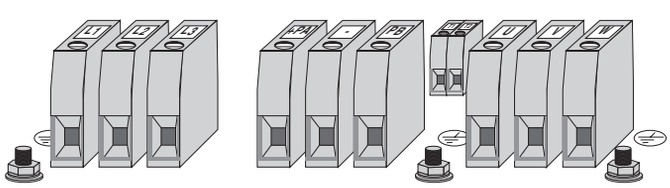
L1, L2, L3	3-phase mains connection
U, V, W	Motor connection
++, PB	Connection for braking resistor
++, --	Connection for braking module, feedback and supply unit or as DC voltage input 250...370 VDC (230V class) 420...720 VDC (400V class)
T1, T2	Connection for temperature sensor
PE, ⏚	Connection for shielding / earthing

Housing size P



L1, L2, L3	3-phase mains connection
U, V, W	Motor connection
+PA, PB	Connection for braking resistor
+PA, -	Connection for feedback unit (DC link voltage output)
T1, T2	Connection for temperature sensor
⏚	Connection for shielding / earthing

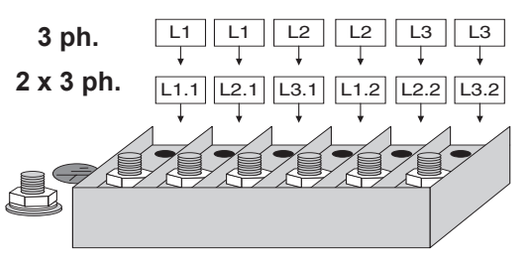
Housing size R and U



Housing size W

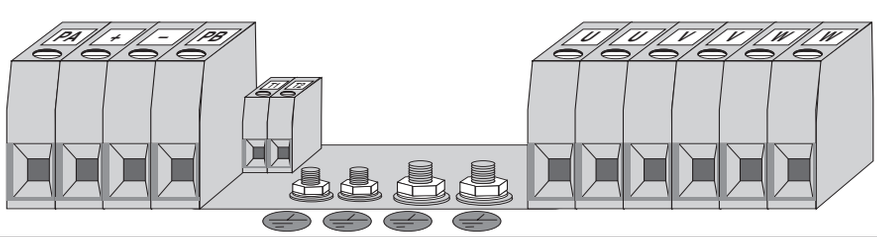
3 ph.

2 x 3 ph.



Supply side

Motor side

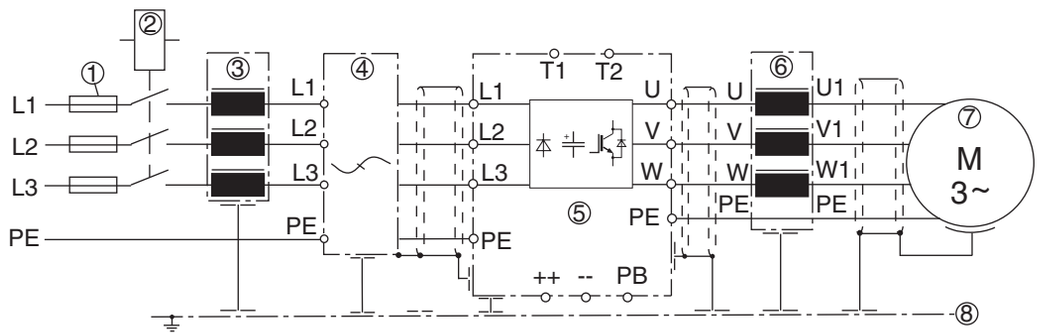


2.4 Connection of the Power Circuit

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

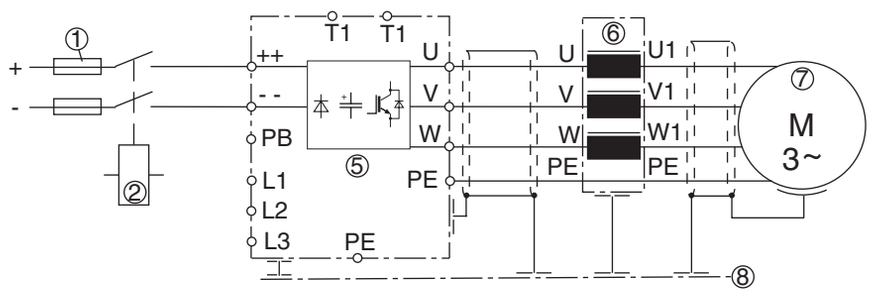
Pay attention to the supply voltage and the correct polarity of the motor !

3-ph. connection



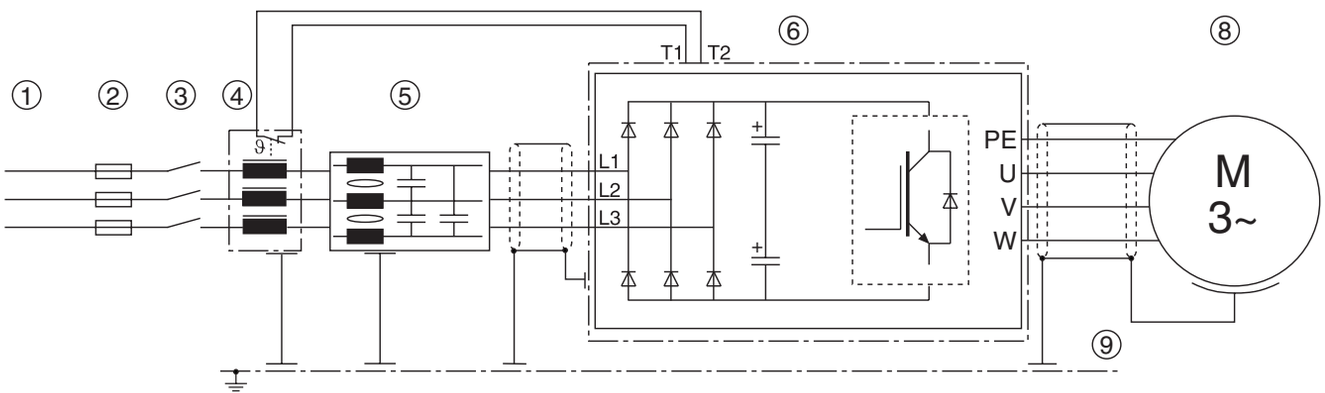
DC supply

420...720V DC (400V class)

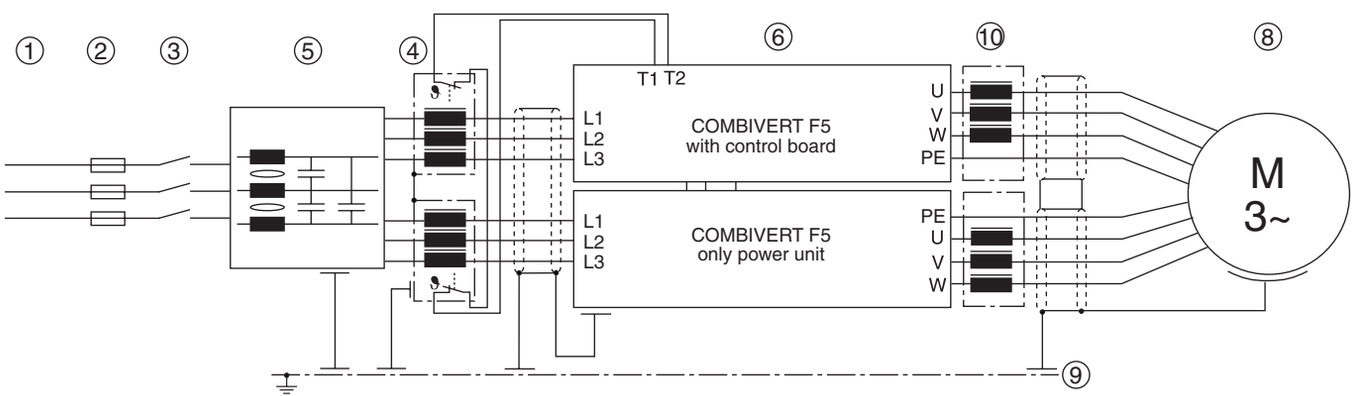


①	**Mains fuse**	⑤	**KEB COMBIVERT**
②	**Mains contactor**	⑥	**Motor choke or output filter (not for F5-M or F5-S)**
③	**Mains choke**	⑦	**Motor**
④	**Interference suppression filter**	⑧	**Mounting plate**

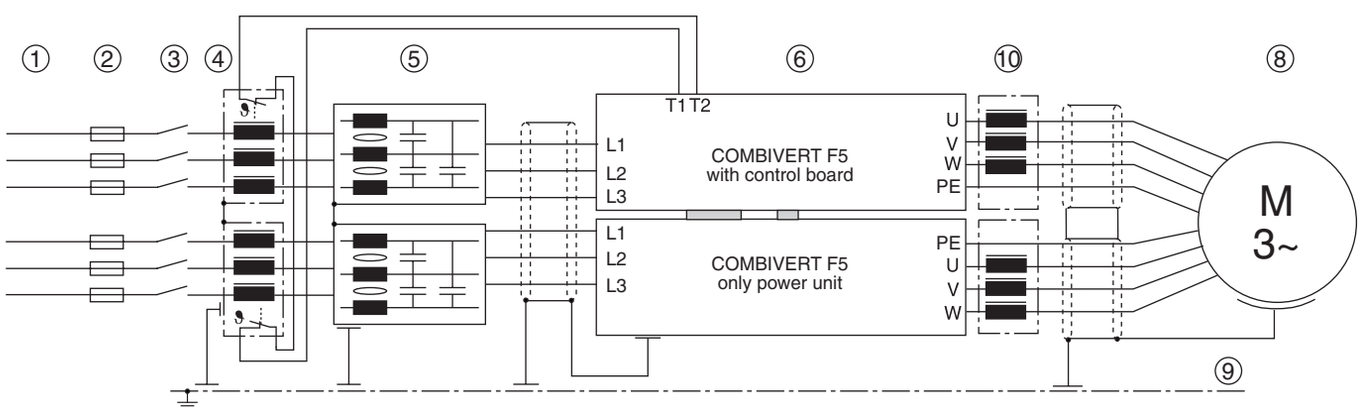
Connection P-Housing / Connection 1



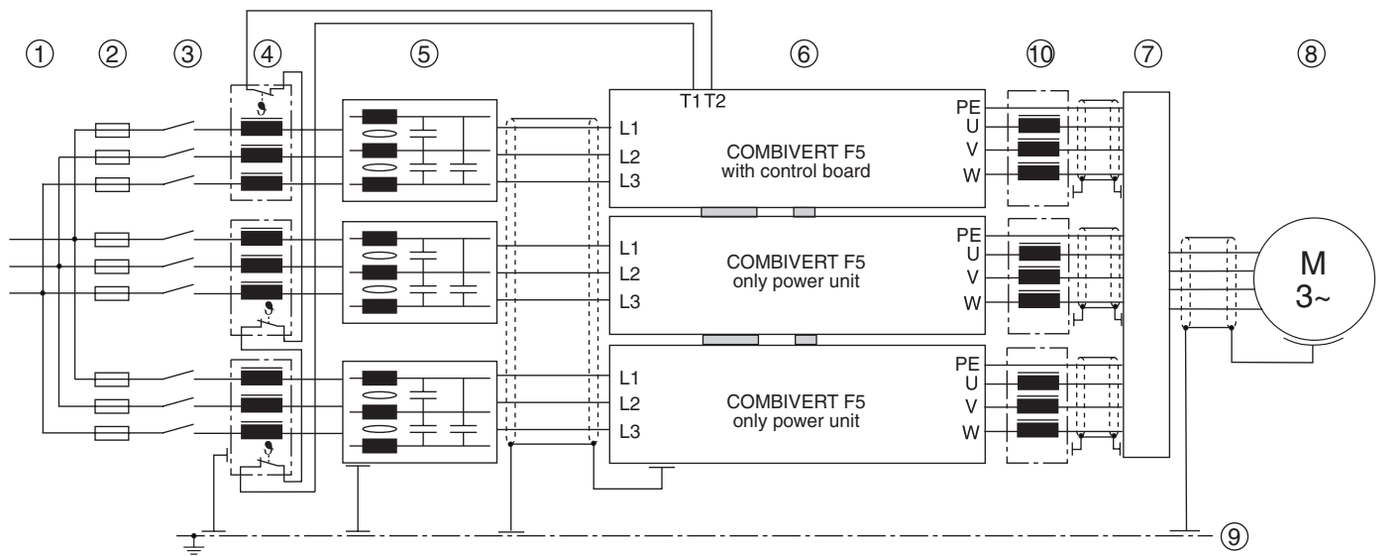
Connection P-Housing / Connection 2



Connection P-Housing / Connection 3



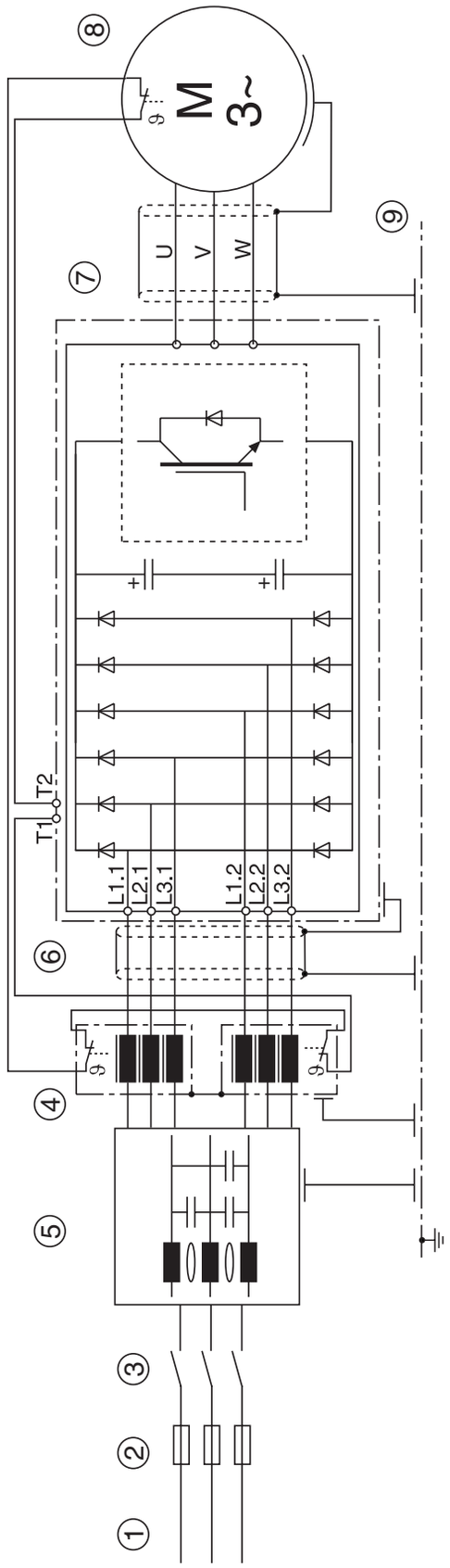
Connection P-Housing / Connection 4



1	Feed cable
2	Main protection
3	Main contactor
4	Line reactor with temperature detection
5	HF-Filter
6	KEB COMBIVERT
7	Terminal block
8	Motor
9	Mounting plate
10	Balancing choke at parallel connection of several frequency inverters

2 x 3 ph. Connection / P- and W-Housing

At the connection the temperature sensors of the line reactors must be switched in series, since otherwise these are destroyed in the case of an error by overheating.
The temperature switch for the motor is optionally.

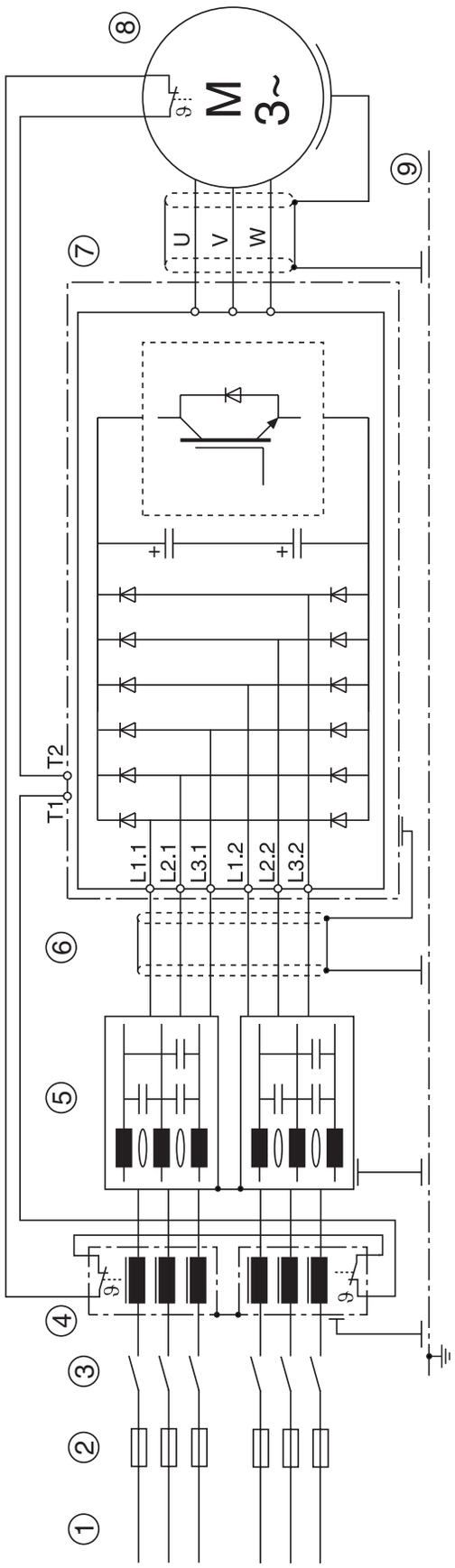


1 Feed cable
2 Main protection
3 Main contactor
4 Line reactor with temperature detection
5 HF-Filter
6 Connection line
7 KEB COMBIVERT
8 Motor
9 Mounting plate

2 x 3 ph. connection / W-units

Supply: 2 x 3 x 305 - 500 V
60° electrically shifted

At the connection the temperature sensors of the line reactors must be switched in series, since otherwise these are destroyed in the case of an error by overheating.
The temperature switch for the motor is optionally.



1 Feed cable
2 Main protection
3 Main contactor
4 Line reactor with temperature detection
5 HF-Filter
6 Connection line
7 KEB COMBIVERT
8 Motor
9 Mounting plate

Note to connection 2 x 3 ph

Supply: 2 x 3 x 305 - 500 V
60° electrically shifted

⚠ The monitoring switch of the main protection must be connected to the power-off chain or disconnect the control release!

The B12 rectifier wiring effects a reduction of the network reactions in case of large power ratings. General information for the generation of a network, to which a B 12 rectifier wiring can be connected, is specified in the following.
The voltages of the two subnetworks (basic reference is in each case the phase L1) are electrically shifted by 60 degrees. For the set up of such a network (with one or several inverters) following transformers are used:

One transformer with 2 secundary systems:
Vector group D d0 y11
Two transformers with one system each:
Vector group Y y0
Vector group Y d11
The primary-side star connection is selected for direct medium voltage supply, at 690V or 400V feed-in it also operated with D y0 and D d11.

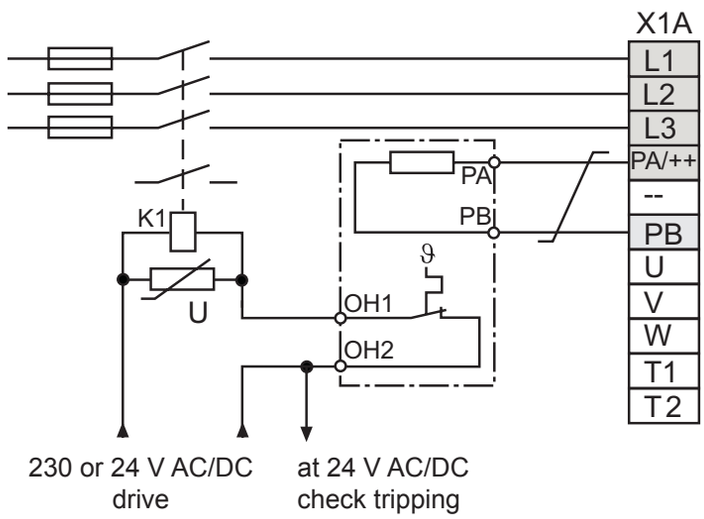
2.5 Connection Braking Resistor

In order to detect the overheating of a braking resistor it is absolutely necessary to monitor the temperature switch. The overheating can have following causes:

- ramps too short or the operation-time too long
- incorrect dimension of the braking resistor
- input voltage too high
- defect of braking transistor in the inverter or the braking module

The connection of the mains voltage offers the only protection in the case of a defective braking transistor (see diagram). The connection of the auxiliary contacts of mains contactor K1 immediately switches off the modulation through fault release (dependent on Pn.12).

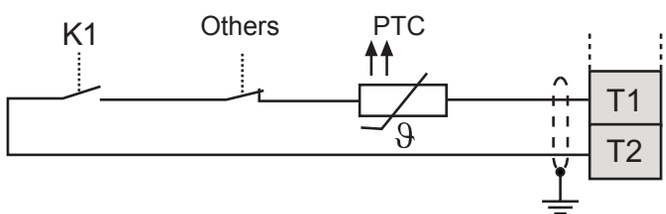
Braking resistors can develop very high surface temperatures, therefore attach as contact-proof and as far away as possible from inflammable materials!



2.6 Connection Temperature Monitoring

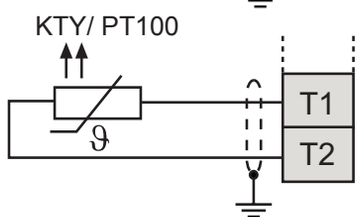
- Terminals T1, T2
- Tripping resistance 1,65...4 kOhm
- Reset resistance 0,75...1,65 kOhm
- Design in accordance with VDE 0660 Part 302
- This function can be activated by the machine builder by software
- Do not lay connecting cable together with control cable
- Permissible in the motor cable only with double shielding

a.) Example with PTC (without temperature control function)



b.) Example with KTY or PT100 (with temperature control function)

KTY- or PT100 sensor may not be integrated in the temperature monitoring, otherwise the contact of the main contactor or other switching units will be simmered!



3. Temperature Control

Note: This instruction contains not all parameters for temperature control. Start-up is only possible by using the application manual F5-M starting from version 2.7. The corresponding parameters can be found in chapters 6.8 and 8.1.
Please contact KEB to acquire this instruction manual.

3.1 General

Water-cooled frequency inverters contain the entire experiences with the air-cooled frequency inverters. In continuous operation water-cooled inverters are operated with lower temperature than air-cooled inverters. That has positive effects on lifetime-relevant components such as fan and intermediate circuit capacitors and power modules (IGBT). Also the temperature dependent switching losses are positively effected.
The use of water-cooled power circuits is offered in the drive technology, because there are process-caused coolants available with some applications.

3.2 Cooling System and Operating Pressure

Two types of heat sinks are available:

- 2-plates heat sink, consisting of milled aluminium, max. operating pressure 6 bar,
- extrusion casting heat sink, max. operating pressure 8 bar.

The heat sinks are sealed with sealing rings and posses a surface protection (anodized) even in the ducts. The heat sinks are generally maintenance-free! In order to avoid a deformation of the heat sink and the damages involved, the indicated max. operating pressure may not be exceeded briefly also by pressure peaks.
Pay attention to the guidelines 97/23/EG of pressure units.

3.3 Quality of Cooling Liquid

The cooling liquid must be free from acids, abrasive substances and solids. The material may not be corroded. A pH value of 7 is recommended. Measures against pollution and calcination must be done externally, if necessary with a filter.

The main impurities and most usual procedures for eliminating them are:

Pollution of the water	Process
Mechanical impurities	Filtration of water via - sieving filter - sand filter - cartridge filter - precoated filter
Excessive hardness	Softening of the water by ion exchange
Moderate content of mechanical impurities and hardness formers	Injection of stabilisers or dispersants into the water
Moderate content of chemical impurities	Injection of passivators and/or inhibitors into the water
Biological impurities myxobacteria and algae	Injection of biocides into the water

3.4 Temperature, Moisture Condensation and Carriage

The inlet temperature may amount to maximally 40°C. Due to high air humidity and high temperatures it can lead to moisture condensation. Moisture condensation is dangerous for the inverter, because the inverter can be destroyed by possible occuring short-circuits.

The user guarantees that any moisture condensation is avoided!

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

- Supply of temper coolant

This is possible by using heatings in the cooling circuit for the control of the coolant temperature. Select a long cycle time in An.46 or An.52 (see programming example on page 25).
There is a dew point table in the annex available.

Temperature Control

This function serves only for the temperature control of water-cooled inverters. The cooling system can be connected by means of pneumatic or magnetic valves. A relay is frontend. To avoid pressure surges, the valves for a temperature control must be inserted before the cooling circuit. All usual valves can be used. Pay attention that the valves are faultless and do not clamp. If possible, the switching states of the valves should be monitored in the machine control. The relais must be made available on the customer dependent on the assigned valve and with attention to the current carrying capacity of the digital outputs of the frequency inverters. The control is made by the analog outputs 3 + 4 and markers as pulse-width modulation signal, which are assigned to digital outputs. Two functions must be programmed, because the temperature ranges of the inverter and the motor are different.

Attention! Do not use the relay output, use the transistor outputs 1, 2!

During transport of storage below the freezing point, the heat sink must be completely drained with air pressure.

Hints to the temperature control of the motor

Attention! Only possible with KTY- or PT100 sensors in the motor and appropriate factory-installed evaluation!
This option is available starting from housing size G. A KTY- or PT100 sensor acquires the temperature exclusive at one point. Should a complete protection of the windings be claimed, then it may be realised in consulation with the producer of the motor, for example with 3 PTC´s and an external analysis unit.

3.5 Parameter Description

Function (An.41, An.47)

The respective functions are adjusted with these parameters (temperature control of the power controller or the motor).

Period (An.46, An.52)

The period determines the cycle time in which the output is switched. The period can be adjusted in a range from 1,0...240,0 s.

Offset X (An.44, An.50)

The heat sink temperature which shall be controlled is entered with Offset. The temperature is in a range from 30 °C...50°C for inverters (heat sink temperature / see power unit data) and in a range from 40°C ...80°C for motors. The adjustment occurs in percentual values (1% = 1°C).

Gain (An.43, An.49)

The gain determines the max. temperature. The adjustment occurs via a factor and is calculated as follows.

Max. temperature [°C] = An.44 + (100% / An.43)

Example

Adjustments for the controller

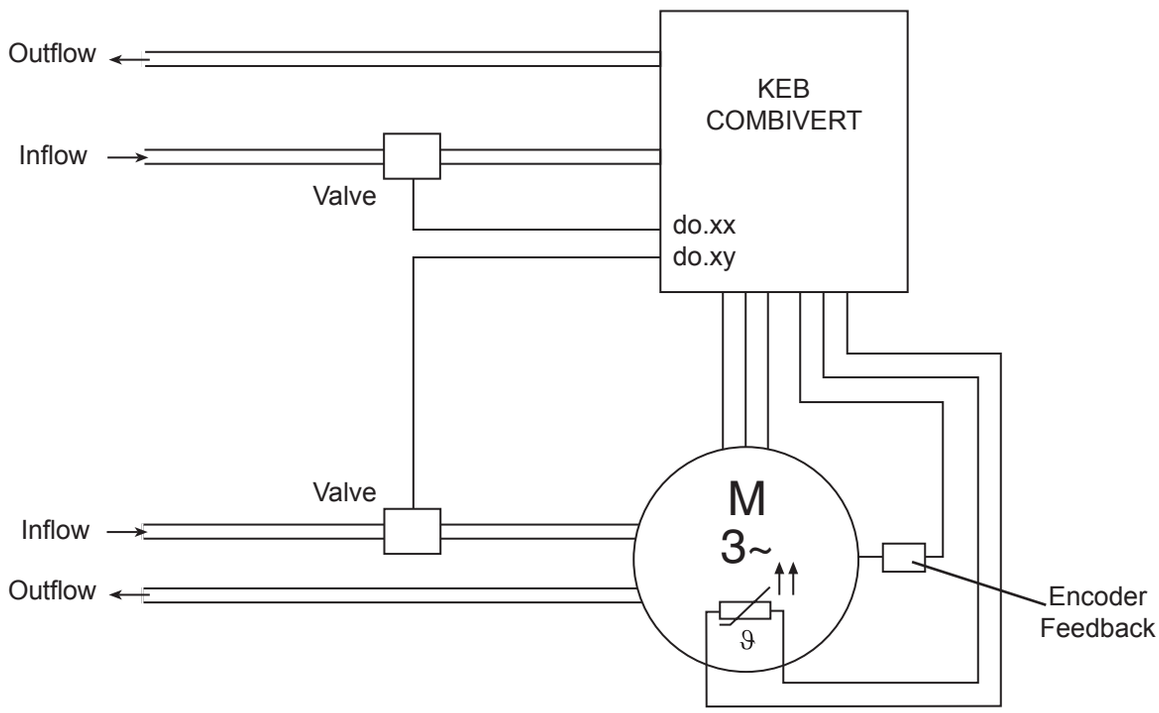
An.41	= 12 :	Power stage temperature
An.44	= 35 %	Beginning of the temperature control (35°C)
An.43	= 14	Gain for the max. temperature
An.46	= 20 s	Period (cycle time)
do.06	= 42 :	ANOUT3 PWM, switching condition 6
do.22	= 64 :	Selection for flag 6
do.33	= 64 :	Selection and assignment of the output terminal

Possibilities for a Temperature Control

There are two possibilities for a temperature control:
a.) with temperature monitoring in the motor
b.) without temperature monitoring in the motor

a.) with temperature monitoring in the motor

In this case inverter and motor possess independent cooling circuits. Two programmable outputs of the control card are required for a control of the valve. (see the following fig.).



b.) Temperature control without temperature monitoring in the motor

In this case the motor is without temperature monitoring. The motor can be permanently supplied with coolant or the motor can be integrated in the cooling circuit of the inverter.

3.6 Connection to the Cooling System

The cooling water connection is to be carried out with elastic pressure-resistant hoses and to be secured with clamps (observe the direction of flow and test for leaks!) For the connection to the cooling system the delivered connecting adapter with 1/2-inch-gland 00.00.650-G012 has to be used (Whitworth-pipe thread DIN ISO 228-1). 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 electromotive series with the heat sink to avoid contact corrosion and/or pitting corrosion (electro-chemical voltage series, see annex). A ZnNi coated steel screw connection is recommended. Other materials is before the employment to be examinated in each case. 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 PVC hoses and seals take care that halogen-free materials are used.

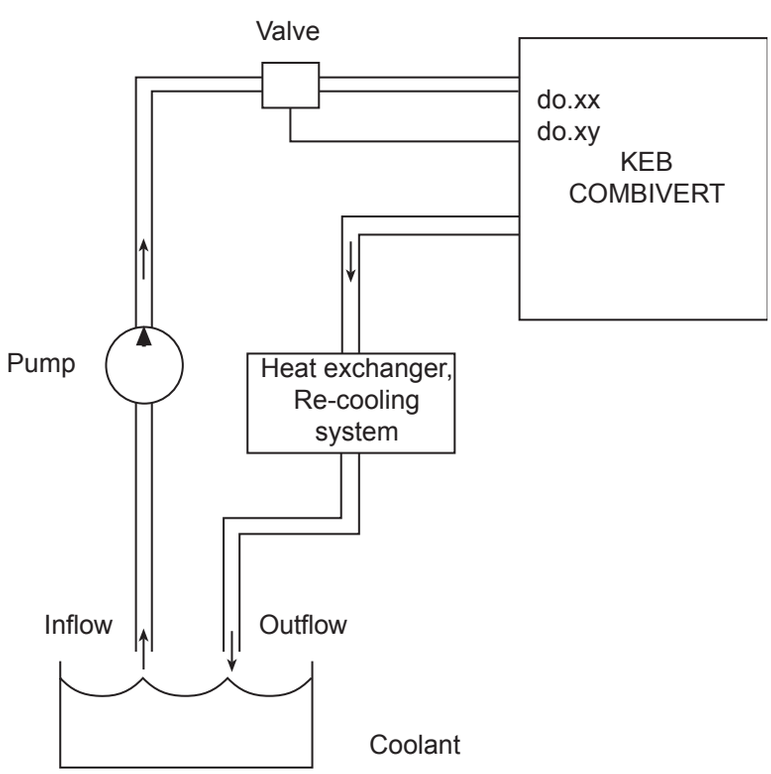
A liability for occuring damages by wrongly used materials and from this resulting corrosion cannot be taken over!

The connection to the cooling system can be executed as closed or opened cooling circuit, but it depends on the local circumstances. The connection to the closed cooling circuit is recommended, since the danger of contamination of the coolant is very small. Preferably also a monitoring of the pH value of the coolant should be installed.

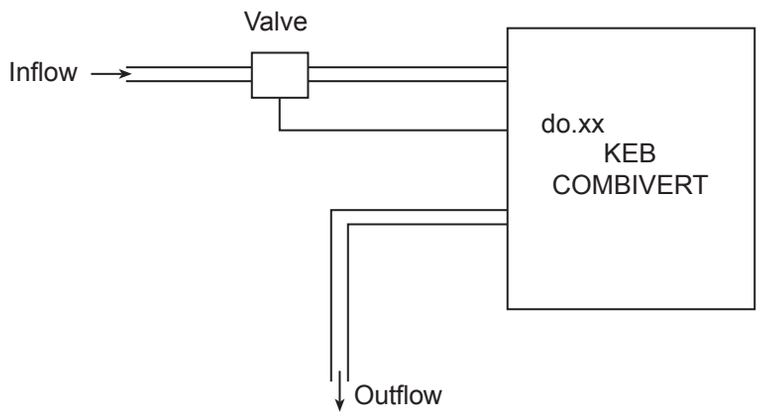
Pay attention to an appropriate conductor cross section of the copper bars at required equipotential bonding that a prevention of electro-chemical procedures is given.

closed cooling circuit

In case of a closed cooling circuit the outflow coolant is cooled down by a heat exchanger or by a re-cooling system and refeed back into the cooling circuit.



open cooling circuit In this case new coolant is constant given in and directly given out. The coolant can be contaminated very easily with this kind of water cooling, consequently the open cooling circuit is not recommended.



3.7 Inverter Protective Function „Overheat“

Dependent on the power unit and overload capacity the inverter Off-temperatures are 60° C and 90° C. To ensure a safe operation the coolant output temperature must be 10 K under „Overheat“- function.

3.8 Safety Stop Category 3 EN954-1

With the function „safety stop“ one of the following conditions must be fulfilled:
- the power supply to the drive must be interrupted (double security).
- no torque at the drive

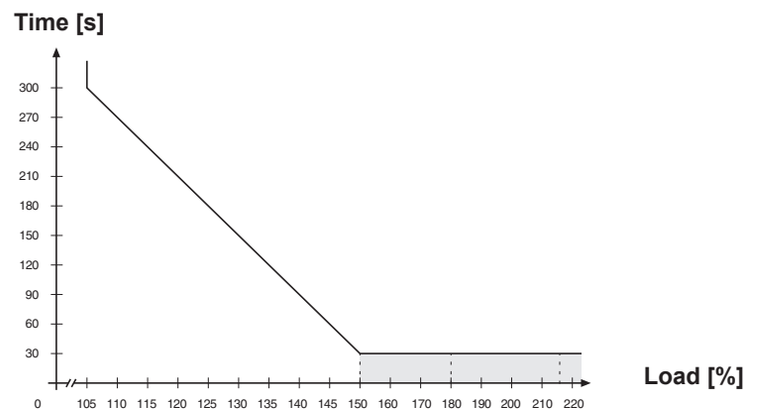
The KEB COMBIVERT fulfills the condition no torque with a safe disconnection for the phase sequence formation necessary driver signals of the power modules (IGBT). No voltage disconnection takes place.
This is guaranteed by a two-channel processing holding signal. On of the two channels is developed in programmed electronics. The second channel consists of an electro-mechanical relay. The function of the relay is cyclically monitored by programmed electronics.

Through the safety no further measure is needed for the KEB COMBIVERT (e.g. feedback via relay contact) since an individual error in the control does not lead to the loss of the stop function.

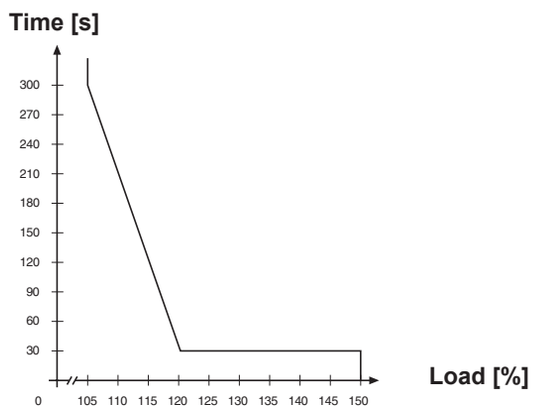
4. Annex

4.1 Overload Characteristic

Curve 1



Curve 2

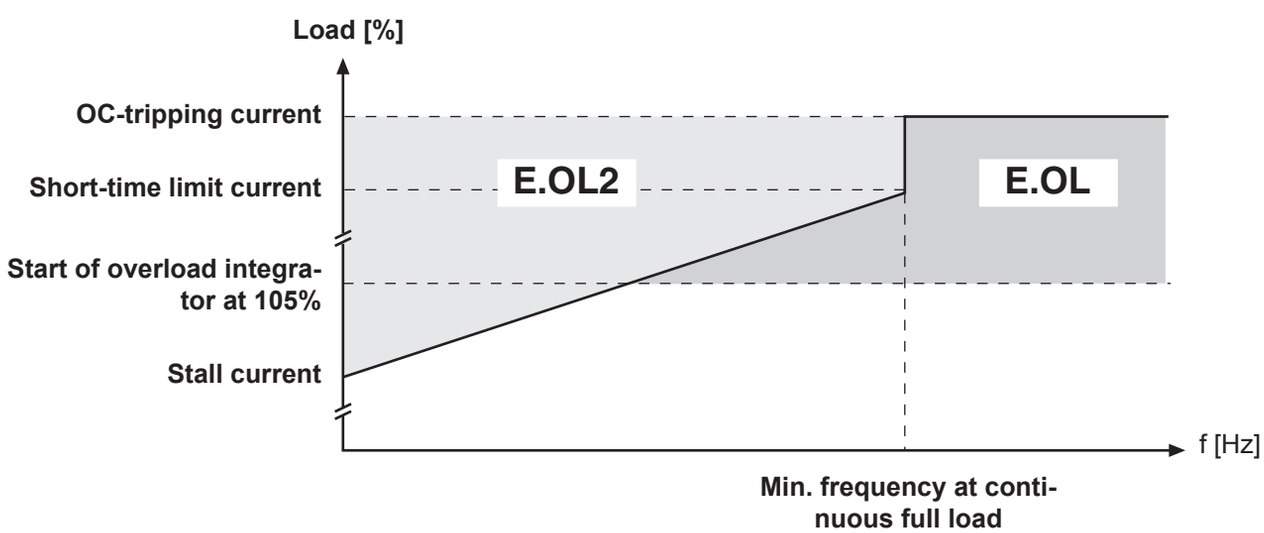


The characteristic declines device-dependently in this range (see unit identification).

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

4.2 Overload Protection in the lower Speed Range

(only valid for F5-M and F5-S, stall current see technical data)



If the permissible current is exceeded a PT1-element (τ=280ms) starts, after its sequence of operation the error E.OL2 is triggered.

4.3 Dew Points

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

4.4 Electrochemical Series

Metal	Normal Potential [V] at 25 °C
Li(lithium)	-3,01
K(potassium)	-2,92
Ca(calcium)	-2,84
Na(sodium)	-2,71
Mg(magnesium)	-2,38
Al(aluminium)	-2,34
Mn(manganese)	-1,05
Zn(zinc)	-0,76
Fe(iron)	-0,44
Cd(cadmium)	-0,4
Co(cobalt)	-0,28
Ni(nickel)	-0,23
Sn(stannous)	-0,14
Pb(lead)	-0,13
H2(hydrogen)	0
Cu(copper)	0,34
Ag(silver)	0,8
Hg(mercury)	0,8
Au(gold)	1,36
Pt(platinum)	1,6

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