The Drive & Control Company

Rexroth IndraDrive ML

Drive Systems with HMU05

Project Planning Manual
R911344279

Edition 02

Title Rexroth IndraDrive ML
Drive Systems with HMU05

Type of Documentation Project Planning Manual

Document Typecode DOK-INDRV*-HXX05******-PR02-EN-P

Internal File Reference RS-bdff4382be37d8ef0a6846a5002ff107-2-en-US-3

Purpose of Documentation

- Overview of the Rexroth IndraDrive Hxx05 system
- Description of the allowed system component combinations
- Selection of the drive system components
- Specification applying to all components (ambient and operating conditions)
- Application description of system characteristics

Record of Revision

Edition	Release Date	Notes
02	2016-09	Revised edition
01	2014-10	First edition

Table of Contents

Page

Table of Contents

Page

Table of Contents

Page

Table of Contents

Table of Contents

Page

Table of Contents

Page

1 System presentation

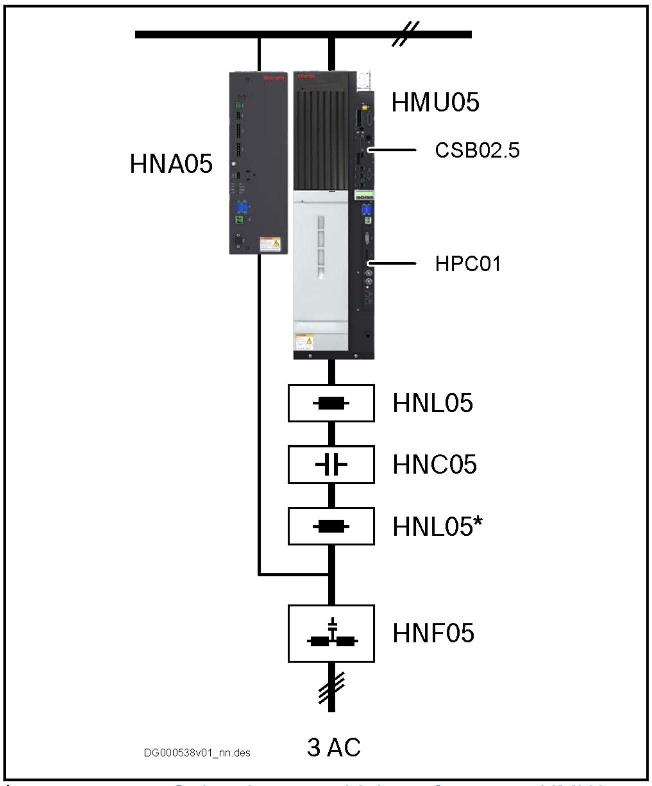
1.1 Rexroth IndraDrive ML range

1.1.1 Overview – Rexroth IndraDrive ML

Rexroth IndraDrive ML
HMU05
 DG000573v01_nn.tif

Tab. 1-1: HMU05 universal inverter of the Rexroth IndraDrive ML product range

System presentation

<table>
<tr><th>Supply unit</th><th>Drive controller</th></tr>
<tr><td>


* Only relevant to high-performance HMU05

HNA05 Mains connection module

HMU05 Universal inverter

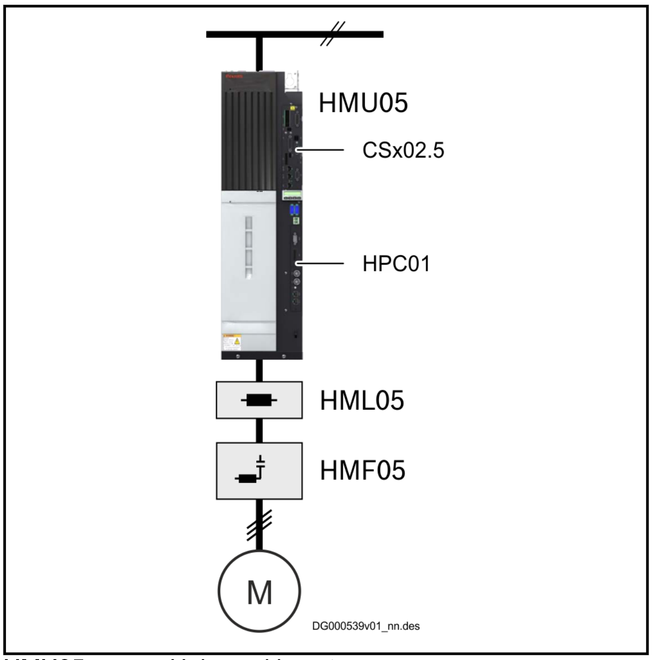
CSB02.5 Control section with firmware for supply units (FWA-INDRV*-**PSB**-…)

HPC01 Motor/mains module

HNC05 Mains capacitor

HNL05 Choke

HNF05 Mains filter

Fig. 1-1: Supply unit components
</td><td>


HMU05 Universal inverter

CSx02.5 Control section with firmware for drive controllers (FWA-INDRV*-**MPx**-…)

HPC01 Motor/mains module

HML05 Motor choke (optional)

HMF05 Motor filter (optional)

Fig. 1-2: Drive controller components
</td></tr>
</table>

Tab. 1-2: Supply unit, drive controller

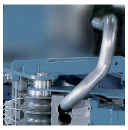
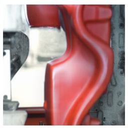
HMV05 HMV05 is the designation for a **supply unit** consisting of an HNA05 mains connecting module, HMU05 universal inverter and CSB02.5 control section with firmware for supply units (FWA-INDRV*-**PSB**-...).

HMV05 is not an official product designation and is used solely for documentation purposes.

HMS05 HMS05 is the designation for a **drive controller** consisting of an HMU05 universal inverter and CSx02.5 control section with firmware for drive controllers (FWA-INDRV*-**MPx**-...).

HMS05 is not an official product designation and is used solely for documentation purposes.

1.1.2 Target applications

	Metal forming • Servo press main drive • Winders • Straightener drives • Profiler drives
	Plastics • Extruders • Kneaders • Pumps • Injector and profiling axis drives
	Marine/offshore technology • Fishing winches • Anchor handling winches • Nautical winches • Shiplifts
	Metallurgy • Roller conveyors • Transfer lifters
	Others • Paper manufacturing (pumps, rollers) • Printing machines (winding computation, cross cutters, rollers) • General automation (pumps, cranes, testing stations)

Tab. 1-3: Target applications

1.1.3 Features

Functional features

- Universal power sections for inverters and regenerative supply units
- Power sections with the same output can be connected in parallel
- Compact type of construction
- Degree of protection of device: IP20; degree of protection of connections: IP00
- CSx02.5 control section
- Control panel with programming module function
- Scalable signal processing and firmware
- Multi-encoder interface for all standard encoders
- DC bus connection
- Analog input (14 bit, ±10 V)
- Cooling type: Liquid cooling

Performance features

Inverter

HMU05.1N-… →		0140-0350	0170-0430	0220-0510	0270-0660	0340-0820	0430-1040	0540-1300	0680-1690
Continuous current	A	254	306	392	490	616	771	1002	1185
Maximum current	A	357	427	515	660	825	1037	1297	1686
Typical motor power 1)	kW	132 | 110	160 | 132	200 | 160	250 | 200	315 | 250	400 | 315	500 | 400	630 | 500

1) x **|** y; **x** = basic load for 540 s, **10% overload** for 60 s; **y** = basic load for 540 s, **50% overload** for 60 s

Tab. 1-4: HMU05.1N, inverter performance features

Supply unit

HMU05.1N-… →		0140-0350	0170-0430	0220-0510	0270-0660	0340-0820	0430-1040	0540-1300	0680-1690
Mains connection voltage U_{LN}	V	3 AC 380 … 500; -15%, +10%							
Mains input current (basic power) 1)	A	216 | 180	260 | 216	324 | 260	405 | 324	509 | 405	645 | 509	803 | 645	1009 | 803
Basic DC bus power 1)	kW	144 | 120	173 | 144	216 | 173	270 | 216	339 | 270	430 | 339	535 | 430	672 | 535
DC bus overload capacity 1) P_{DC_max}	kW	158 | 180	190 | 216	238 | 260	297 | 324	373 | 405	473 | 509	589 | 645	739 | 803
Continuous DC bus power P_{DC_cont}	kW	145	174	219	273	342	435	540	679

1) x **|** y; **x** = basic load for 540 s, **10% overload** for 60 s; **y** = basic load for 540 s, **50% overload** for 60 s

Tab. 1-5: HMU05.1N, supply unit performance features

Interfaces

Overview

- Compatible with IndraDrive platform
- Ethernet-based communication with the following supported protocols:
  - sercos **III**
  - PROFINET IO
  - EtherNet/IP
  - EtherNet POWERLINK
  - EtherCAT
- Alternative communication:
  - PROFIBUS
  - CANopen

- Optional safety technology
- Optional multi-encoder interface
- Optional encoder emulation
- Analog input
- Freely configurable digital inputs/outputs
- Optional I/O extension digital/analog

Supported encoder systems

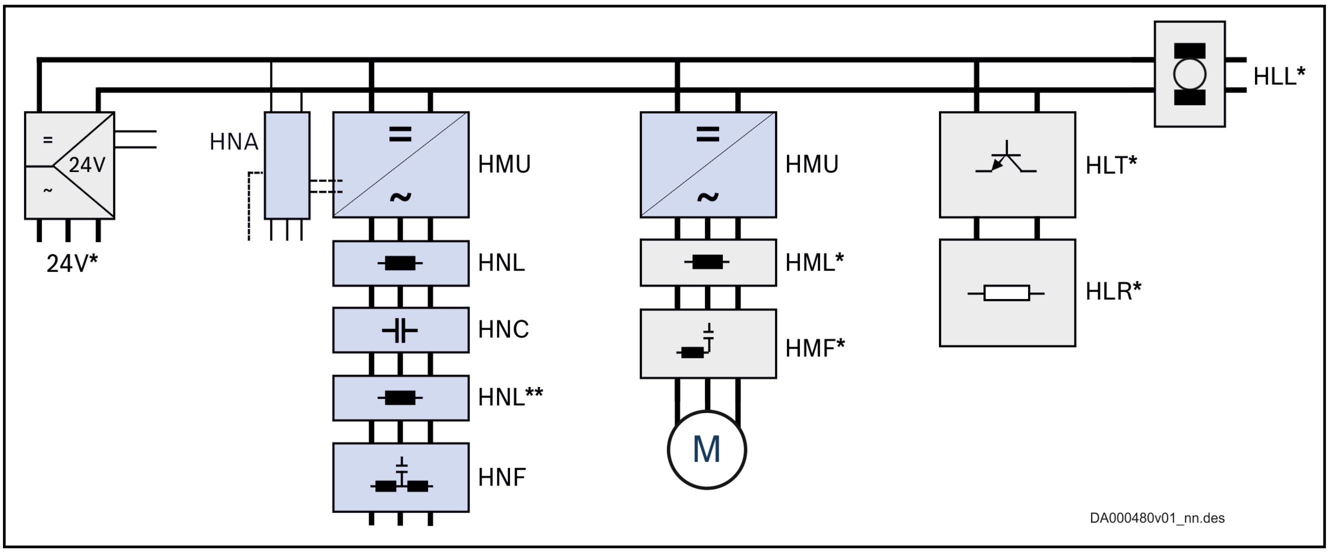
Supported encoder systems

Encoder systems with a supply voltage of 5 and 12 V:

- IndraDyn encoder
- $1V_{pp}$ sin-cos encoder; HIPERFACE®
- $1V_{pp}$ sin-cos encoder; EnDat 2.1; EnDat 2.2
- $1V_{pp}$ sin-cos encoder; with reference track
- 5V TTL square-wave encoder; with reference track
- SSI
- Combined encoder for SSI (combination of SSI and $1V_{pp}$ sin-cos encoder)
- Resolver

1.2 System configuration

1.2.1 System structure



*	Optional
**	Only relevant to high-performance HMU05
24V	24V power supply unit (AC/DC power supply unit; optional DC/DC power supply unit for redundancy in the case of mains failure)
HLL	DC bus choke
HLR	Braking resistor
HLT	Braking unit
HMF	Motor filter
HML	Motor choke
HMU	Universal inverter
HNA	Mains connection module
HNC	Mains capacitor
HNF	Mains filter
HNL	Choke
M	Motor

Fig. 1-3: Rexroth IndraDrive ML drive system

1.2.2 System components

HMU05 universal inverter

HMU05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	M	U	0	5	.	1	N	-	F	0	2	7	0	-	0	6	6	0	-	N	-	A	4	-	D	7	-	N	1	N	-	N	N	N	N				
	①			②			③	④		⑤	⑥										⑦		⑧						⑨	⑩	⑪		⑫							

①	**Product:** HMU = Universal inverter
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Application:** N = Standard
⑤	**Cooling type:** F = Liquid cooling W = Air, internal
⑥	**DC bus continuous power / maximum current [4)]:** 0140-0210 = 140 kW / 210 A 0140-0350 = 140 kW / 350 A 0170-0250 = 170 kW / 250 A 0170-0430 = 170 kW / 430 A 0220-0300 = 220 kW / 300 A 0220-0510 = 220 kW / 510 A 0270-0370 = 270 kW / 370 A 0270-0660 = 270 kW / 660 A 0340-0820 = 340 kW / 820 A 0400-0600 = 400 kW / 600 A 0430-1040 = 430 kW / 1040 A 0540-0750 = 540 kW / 750 A 0540-1300 = 540 kW / 1300 A 0680-0980 = 680 kW / 980 A 0680-1690 = 680 kW / 1690 A
⑦	**Degree of protection:** N = IP00
⑧	**Mains connection voltage / Nominal DC bus voltage:** A4-D7 = supply unit: 3 x AC 380 V -15% ... 500V +10%; inverter: DC 750 V A5-11 = supply unit: 3 x AC 525 V -15% ... 690V +10%; inverter: DC 1100 V

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	M	U	0	5	.	1	N	-	F	0	2	7	0	-	0	6	6	0	-	N	-	A	4	-	D	7	-	N	1	N	-	N	N	N	N				
	①			②			③	④		⑤	⑥										⑦		⑧						⑨	⑩	⑪		⑫							

⑨	**Parallel operation** [1]**:** N = Parallel operation is not possible P = Parallel operation is possible
⑩	**Motor/mains module connection** [2]**:** B = Not equipped (with blank cover at motor/mains module connection and control section connection) 1 = Equipped
⑪	**Parallel module connection** [3]**:** B = Not equipped, with blank cover 1 = Equipped N = Without
⑫	**Other design:** NNNN = None

1) Parallel operation = N only possible with DC bus continuous power / maximum current = 0140-0350, 0170-0430, 0220-0510 and 0270-0660

2) Motor/mains module connection = B only possible if parallel operation = P

3) Parallel module connection = B or 1 only possible if parallel operation = P

4) DC bus continuous power / maximum current = 0140-0210 or = 0170-0250 or = 0220-0300 or = 0270-0370 or = 0400-0600 or = 0540-0750 or = 0680-0980 only with cooling type = F and mains connection voltage / nominal DC bus voltage = **A5-11**; DC bus continuous power / maximum current = 0140-0350 or = 0170-0430 or = 0220-0510 or = 0270-0660 or = 0340-0820 or = 0430-1040 or = 0540-1300 or = 0680-1690 only with cooling type = F and mains connection voltage / nominal DC bus voltage = **A4-D7**

Tab. 1-6: HMU05, type code

☞ The figure illustrates the basic structure of the type code. Our sales representative will assist you with the versions available.

Control sections

Short type designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	C	S	B	0	2	.	5	B	-	E	T	-	E	C	-	P	B	-	L	3	-	E	C	-	N	N	-	F	W											
	①			②			③	④		⑤			⑥			⑦			⑧			⑨			⑩			⑪												

①	**Product:** CSB = Single-axis control section BASIC
②	**Series:** 02 = 02
③	**Design:** 5 = For Hxx05
④	**Interface equipment:** B = Extended scope
⑤	**Communication:** ET = Multi-Ethernet
⑥	**Interface 1:** EC = Multi-encoder interface
⑦	**Interface 2:** NN = Not equipped PB = PROFIBUS CN = CANopen EC = Multi-encoder interface EM = Encoder emulation EP = Engineering port
⑧	**Interface 3 (safety technology)** [1)]**:** NN = Not equipped L3 = STO (Safe Torque Off) S4 = Safe Motion S5 = Safe Motion SB = Safe Motion Bus
⑨	**Interface 4:** NN = Not equipped EC = Multi-encoder interface [2)] EM = Encoder emulation [3)] DA = Digital/analog I/O extension

									1										2										3										4
Short type designation	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	C	S	B	0	2	.	5	B	-	E	T	-	E	C	-	P	B	-	L	3	-	E	C	-	N	N	-	F	W											
	①			②			③	④		⑤			⑥			⑦			⑧			⑨			⑩			⑪											

⑩	**Other design:** NN = None
⑪	**Firmware:** FW = Firmware has to be ordered as a separate subposition NW = Without control panel, without firmware

1) The L3, S4, S5 and SB interfaces guarantee both the function and the certification
2) Only if interface 2 = PB or CN
3) Only if interface 2 = PB, CN or EC

Tab. 1-7: CSB02.5 type code

									1										2										3										4
Short type designation	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	C	S	H	0	2	.	5	B	-	C	C	-	E	C	-	E	T	-	N	N	-	D	A	-	N	N	-	F	W											
	①			②			③	④		⑤			⑥			⑦			⑧			⑨			⑩			⑪											

①	**Product:** CSH = Single-axis control section ADVANCED
②	**Series:** 02 = 02
③	**Design:** 5 = For Hxx05
④	**Interface equipment:** B = Extended scope
⑤	**Communication:** CC = sercos III master ET = Multi-Ethernet
⑥	**Interface 1:** EC = Multi-encoder interface
⑦	**Interface 2:** NN = Not equipped ET = Multi-Ethernet 1) PB = PROFIBUS 1) CN = CANopen 1) EC = Multi-encoder interface EM = Encoder emulation

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	C	S	H	0	2	.	5	B	-	C	C	-	E	C	-	E	T	-	N	N	-	D	A	-	N	N	-	F	W											
	①			②			③	④		⑤			⑥			⑦			⑧			⑨			⑩			⑪												

⑧	**Interface 3 (safety technology)** [2]**:** NN = Not equipped L3 = STO (Safe Torque Off) S4 = Safe Motion S5 = Safe Motion SB = Safe Motion Bus
⑨	**Interface 4:** NN = Not equipped EC = Multi-encoder interface [3] EM = Encoder emulation [3] DA = Digital/analog I/O extension
⑩	**Other design:** NN = None
⑪	**Firmware:** FW = Firmware must be ordered as a separate subposition NW = Without control panel, without firmware

1) Only if communication = CC
2) The L3, S4, S5 and SB interfaces guarantee both the function and the certification
3) Only if interface 2 = ET, PB, CN or EC

Tab. 1-8: CSH02.5 type code

CSB02.5 control section vs. CSH02.5 control section

Functional equipment	CSB02.5B-ET (BASIC)	CSH02.5B-CC/ET (ADVANCED)
Communication	Multi-Ethernet (incl. sercos III)	CC: sercos III master ET: Multi-Ethernet
	Alternative interface1) (PROFIBUS, CANopen)2)	Alternative interface1) (Multi-Ethernet, PROFIBUS, CANopen)
Encoder evaluation	Multi-encoder interface	Multi-encoder interface
	Optional multi-encoder interface1)	Optional multi-encoder interface1)
Encoder emulation	✓	✓
Integrated safety technology	L3 (Safe Torque Off) S4 (Safe Motion) S5 (Safe Motion) SB (Safe Motion Bus)	L3 (Safe Torque Off) S4 (Safe Motion) S5 (Safe Motion) SB (Safe Motion Bus)
IndraMotion	MLD-S3)	MLD-S3) MLD-M3)
Freely configurable digital inputs/outputs (incl. probe)	✓	✓
Analog input	✓	✓
Control panel		
• With programming module function	✓	✓
• With slot for microSD memory card	–	✓
Optional I/O extension digital/analog	✓	✓

1) **One** additional interface per converter for communication **or** encoder evaluation
2) If you use "PROFIBUS" or "CANopen" communication, the Multi-Ethernet function is no longer available. However, you can still use the connection points X24 and X25 as Engineering interfaces.
3) Firmware version MPx-19 or higher

Tab. 1-9: BASIC vs. ADVANCED

Optional cards

Short type designation										1										2										3										4
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	H	P	C	0	1	.	1	-	P	0	0	1	-	N	N																									
	①			②			③		④					⑤																										

①	**Product:** HPC = HPC
②	**Series:** 01 = 01
③	**Design:** 1 = 1
④	**Function:** P001 = Standard MN01 = Motor/mains module (for devices that cannot be connected in parallel) MN02 = Motor/mains module (for devices that can be connected in parallel)
⑤	**Other design:** NN = None

Tab. 1-10: HPC01, type code

Optional card	Function
HPC01.1-MN01	Motor/mains module (built-in) for devices that cannot be connected in parallel. Devices can only be operated individually. • Motor: temperature sensor, brake control • HNA05 mains connection module: Communication
HPC01.1-MN02	Motor/mains module for devices that can be connected in parallel; individual and parallel operation possible; when running multiple HMU05s in parallel, HMU05 with this optional card is master. • Motor: temperature sensor, brake control • HNA05 mains connection module: Communication
HPC01.1-P001	Parallel connection module; when running multiple HMU05s in parallel, the HMU05s with only this optional card are slaves. • Controlling/synchronizing HMU05s • Transmitting safety signals

Tab. 1-11: Optional cards

Installing and removing control sections and optional cards

Training

NOTICE **Risk of damage from improper handling.**

Only those trained by Rexroth for installing and removing control sections and optional cards are allowed to perform these actions.

ESD protection

NOTICE **Risk of damage and impairment to reliability from electrostatic discharge.**

Exposed conductive parts coming into contact with control sections and optional cards must be discharged beforehand through grounding.

Such exposed conductive parts include:

- The human body (grounding by touching a conductive, grounded object)
- Parts and tools (place them on a conductive surface)

Control sections and optional cards may only be stored or shipped in conductive packaging.

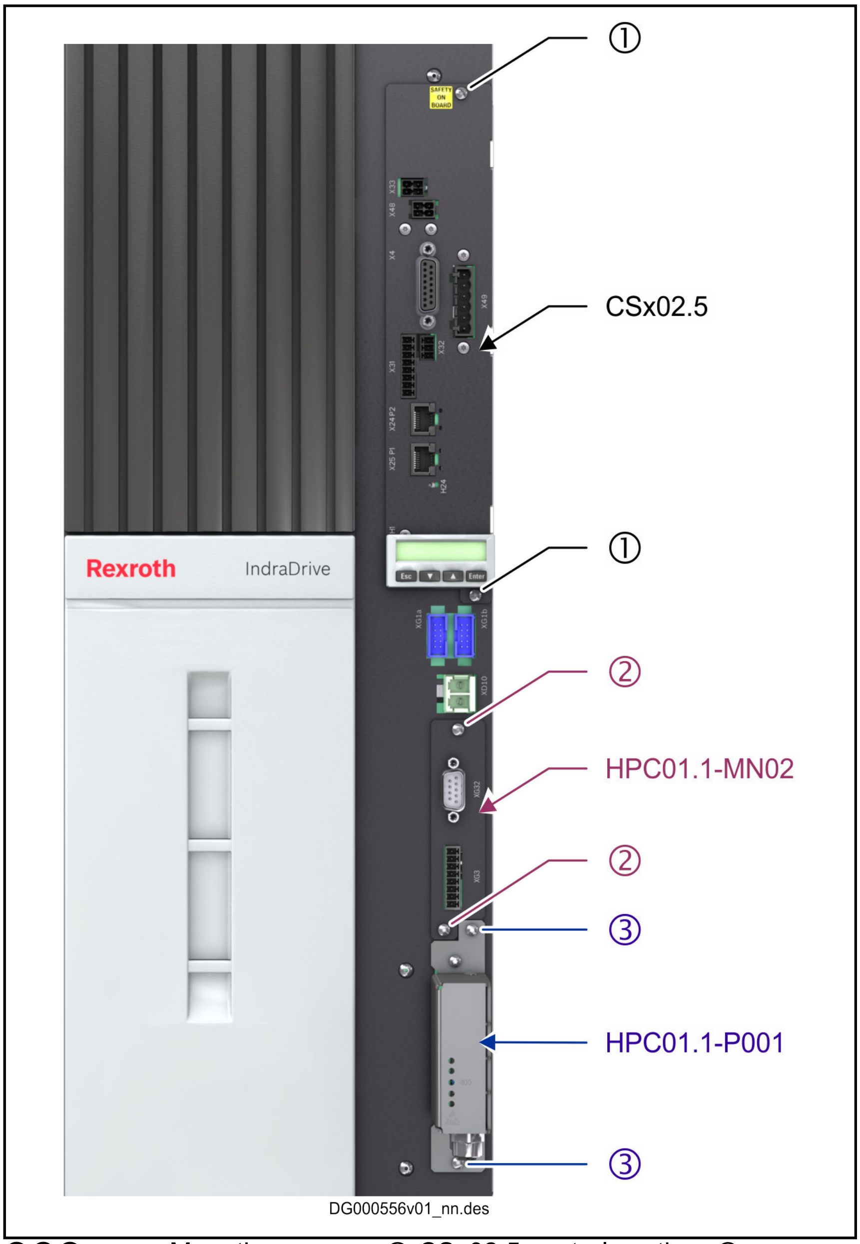
Limited number of insertions and removals

NOTICE **Risk of damage from frequent installation and removal.**

A control section/optional card may only be installed and removed a maximum of **20 times.**

Instructions

1. Loosen the mounting screws for the control section, optional card or blank cover.



①②③ Mounting screws: ① CSx02.5 control section, ② HPC01.1-MN02, ③ HPC01.1-P001

Fig. 1-4: HMU05 with control section (CSx02.5) and optional card (HPC01)

2. Carefully remove the control section or optional card from the slot.
3. Installation is the reverse of removal.

Firmware

Firmware for drive controllers	Assigned device type
FWA-INDRV*-MP**B**-**20**VRS-D5-x-NNN-NN or higher	CSB02.5 control section (BASIC)
FWA-INDRV*-MP**C**-**20**VRS-D5-x-xxx-xx or higher	CSH02.5 control section (ADVANCED)

Tab. 1-12: Drive firmware

Firmware for supply units	Assigned device type
FWA-INDRV*-PS**B**-**20**VRS-D5-x-NNN-NN or higher	CSB02.5 control section (BASIC)

Tab. 1-13: Supply unit firmware

📖 For detailed information, see the Functional Description of the firmware used (index entry "Overview of functions/functional packages").

1.2.3 About this documentation

Purpose

⚠ WARNING **Personal injury and property damage caused by improper project planning for applications, machines and installations!**

Observe the contents of the documentation relevant to your drive system (see chapter "Documentations" on page 28).

This documentation contains the following:

- Overview of the Rexroth IndraDrive ML system
- Description of the allowed combinations of Rexroth IndraDrive ML system components
- Selection of the system components of the Rexroth IndraDrive ML system
- Specification applying to all components (ambient and operating conditions)
- Application description of system characteristics

Documentations

Drive systems, system components

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-...	Material number de (en)
ML, Drive Systems with HMU05	Project Planning Manual	HXX05******-PRxx-EN-P	R911344278 (R911344279)
Control Sections CBS02, CSE02, CSH02, CDB02	Project Planning Manual	CXX02******-PRxx-EN-P	R911338961 (R911338962)

1) In the document typecodes, "xx" is a placeholder for the current edition of the documentation (e.g.: PR01 is the first edition of a Project Planning Manual)

Tab. 1-14: Documentations – drive systems, system components

Firmware

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-...	Material number de (en)
Power Supply Basic PSB-20 Version Notes	Release Notes	PSB-20VRS**-RNxx-EN-P	R911345611 (R911345612)
Power Supply Basic PSB-20 Functions	Application Manual	PSB-20VRS**-APxx-EN-P	R911345609 (R911345610)
MPx-20 Version Notes	Release Notes	MP*-20VRS**-RNxx-EN-P	R911345605 (R911345606)
MPx-20 Functions	Application Manual	MP*-20VRS**-APxx-EN-P	R911345607 (R911345608)

Title Rexroth IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-…	Material number de (en)
MPx-16 to MPx-20 and PSB Parameters	Reference Book	GEN1-PARA**-RExx-EN-P	R911328650 (R911328651)
MPx-16 to MPx-20 and PSB Diagnostic Messages	Reference Book	GEN1-DIAG**-RExx-EN-P	R911326539 (R911326738)
Integrated Safety Technology "Safe Torque Off" (as of MPx-16)	Application Manual	SI3-**VRS**-APxx-EN-P	R911332633 (R911332634)
Integrated Safety Technology "Safe Motion" (as of MPx-18)	Application Manual	SI3*SMO-VRS-APxx-EN-P	R911338919 (R911338920)
Rexroth IndraMotion MLD Libraries as of MPx-18	Reference Book	MLD-SYSLIB3-RExx-EN-P	R911338915 (R911338916)
Rexroth IndraMotion MLD as of MPx-18	Application Manual	MLD3-**VRS*-APxx-EN-P	R911338913 (R911338914)

1) In the document typecodes, "xx" is a placeholder for the current edition of the documentation (e.g.: RE02 is the second edition of a Reference Book)

Tab. 1-15: Documentations – firmware

Your feedback

☞ Your experience is important for our improvement processes of products and documentations.

Inform us about mistakes you discovered in this documentation and changes you suggest; we would be grateful for your feedback.

Please send your remarks to:

Address for your feedback

Bosch Rexroth AG
Dept. DC-IA/EDY1
Buergermeister-Dr.-Nebel-Str. 2
97816 Lohr, Germany
E-mail: dokusupport@boschrexroth.de

2 Important directions for use

2.1 Appropriate use

2.1.1 Introduction

Rexroth products are developed and manufactured to the state-of-the-art. They are tested before delivery to ensure operational safety and reliability.

⚠ WARNING **Personal injury and property damage by using products incorrectly!**

The products have been designed for use in an industrial environment and may only be used in the appropriate way. Failure to use them in the appropriate way may cause situations resulting in property damage and personal injury.

☞ Rexroth as the manufacturer cannot honor any warranty, liability or compensatory claims for damages resulting from inappropriate use. The user alone bears the risks of inappropriate use of the products.

Before using Rexroth products, make sure that all the pre-requisites for an appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with their appropriate use.
- Leave hardware products in their original state, i.e., do not make any structural modifications. Do not decompile software products or alter their source codes.
- Do not install damaged or faulty products or put them into operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

2.1.2 Areas of use and application

Drive controllers made by Rexroth are designed to control electric motors and monitor their operation.

Controlling and monitoring the drive controllers may require additional sensors and actuators.

☞ The drive controllers may only be used with the accessories and attachments specified in this documentation. If a component has not been specifically named, then it may neither be mounted nor connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant Functional Descriptions.

Drive controllers have to be programmed before commissioning to ensure that the motor executes the specific functions of an application.

Drive controllers of the Rexroth IndraDrive ML series have been developed for use in single- and multi-axis drive and control tasks.

Drive controllers may only be operated under the assembly and installation conditions described in this documentation, in the specified mounting position and under the ambient conditions as described (temperature, degree of protection, humidity, EMC, etc.).

2.2 Inappropriate use

Using the drive controllers outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "inappropriate use".

Drive controllers may not be used, if …

- they are exposed to operating conditions that do not meet the prescribed ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extreme maximum temperatures.
- Furthermore, drive controllers may not be used in applications which have not been explicitly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

☞ Components of the Rexroth IndraDrive ML system with a mains input current **< 400 A** are **products of Category C3** (with restricted distribution) in accordance with IEC 61800-3. The Category C3 comprises EMC limit values for line-based and radiated noise emission.

Components of the Rexroth IndraDrive ML system with a mains input current **> 400 A** are **products of Category C4** (with restricted distribution) in accordance with IEC 61800-3. The Category C4 comprises an EMC plan developed by manufacturers and users.

Compliance with these Categories requires the appropriate measures of interference suppression (e.g., mains filters, shielding measures) to be used in the drive system.

These components are not provided for use in a public low-voltage mains supplying residential areas. If these components are used in such a mains, high-frequency interference is to be expected. This can require additional measures of interference suppression.

The components are not provided for use in a mains with grounded outer conductor (corner-grounded delta mains).

The component source shall be derived from a non-corner grounded type TN AC source not exceeding 289 V phase to earth.

---

3 Safety instructions for electric drives and controls

3.1 Definitions of terms

Installation An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Electric drive system An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

User A user is a person installing, commissioning or using a product which has been placed on the market.

Application documentation Application documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, installing, mounting, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Commissioning Manual, Instruction Manual, Project Planning Manual, Application Description, etc.

Electrical equipment Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Device A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Vendor The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Component A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Machine A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Product Examples of a product: Device, component, part, system, software, firmware, among other things.

Project Planning Manual A Project Planning Manual is part of the application documentation used to support the sizing and planning of systems, machines or installations.

Qualified persons In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work requires. To comply with these qualifications, it is necessary, among other things,

1) to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them

2) to be trained or instructed to maintain and use adequate safety equipment

3) to attend a course of instruction in first aid

Control system

A control system comprises several interconnected control components placed on the market as a single functional unit.

3.2 General information

3.2.1 Using the Safety instructions and passing them on to others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

3.2.2 Requirements for safe use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.
- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technolo-

gy". If this is not the case, they are excluded. Functional safety is a safety concept in which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,
  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user has to comply with

- European countries: In accordance with European EN standards
- United States of America (USA):
  – National Electrical Code (NEC)
  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  – Regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  – International Organization for Standardization (ISO)
  – International Electrotechnical Commission (IEC)

3.2.3 Hazards by improper use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!

- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of batteries!
- Risk of injury by improper handling of pressurized lines!

3.3 Instructions with regard to specific dangers

3.3.1 Protection against contact with electrical parts and housings

☞ This section concerns components of the electric drive and control system with voltages of **more than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.

- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Establish an equipment grounding connection with a minimum cross section according to the table below. With an outer conductor cross section smaller than 10 mm² (8 AWG), the alternative connection of two equipment grounding conductors is allowed, each having the same cross section as the outer conductors.

Cross section outer conductor	Minimum cross section equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
1.5 mm² (16 AWG)	10 mm² (8 AWG)	2 × 1.5 mm² (16 AWG)
2.5 mm² (14 AWG)		2 × 2.5 mm² (14 AWG)
4 mm² (12 AWG)		2 × 4 mm² (12 AWG)
6 mm² (10 AWG)		2 × 6 mm² (10 AWG)
10 mm² (8 AWG)		-
16 mm² (6 AWG)	16 mm² (6 AWG)	-
25 mm² (4 AWG)		-
35 mm² (2 AWG)		-
50 mm² (1/0 AWG)	25 mm² (4 AWG)	-
70 mm² (2/0 AWG)	35 mm² (2 AWG)	-
X mm²	(X × 0.5) mm² (applies to X ≥ 50)	-

Tab. 3-1: Minimum cross section of the equipment grounding connection

3.3.2 Protective extra-low voltage as protection against electric shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Rexroth, all connections and terminals with voltages up to 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g., the mains connection) are connected to Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

3.3.3 Protection against dangerous movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine’s range of motion and moving machine parts. Prevent personnel from accidentally entering the machine’s range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches/OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.

- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
  - mechanically securing the vertical axes,
  - adding an external braking/arrester/clamping mechanism or
  - ensuring sufficient counterbalancing of the vertical axes.
- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

3.3.4 Protection against electromagnetic and magnetic fields during operation and mounting

Electromagnetic and magnetic fields!

Health hazard for persons with active implantable medical devices (AIMD) such as pacemakers or passive metallic implants.

- Hazards for the above-mentioned groups of persons by electromagnetic and magnetic fields in the immediate vicinity of drive controllers and the associated current-carrying conductors.
- Entering these areas can pose an increased risk to the above-mentioned groups of persons. They should seek advice from their physician.
- If overcome by possible effects on above-mentioned persons during operation of drive controllers and accessories, remove the exposed persons from the vicinity of conductors and devices.

3.3.5 Protection against contact with hot parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140**

minutes! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.

- Before touching chokes after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**!
- After switching off supply units and drive controllers, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

3.3.6 Protection during handling and mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

3.3.7 Battery safety

Batteries consist of active chemicals in a solid housing. Therefore, improper handling can cause injury or property damage.

Risk of injury by improper handling!

- Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).
- Do not attempt to recharge the batteries as this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not dismantle batteries.
- When replacing the battery/batteries, do not damage the electrical parts installed in the devices.
- Only use the battery types specified for the product.

☞ Environmental protection and disposal! The batteries contained in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separately from other waste. Observe the national regulations of your country.

3.3.8 Protection against pressurized systems

According to the information given in the Project Planning Manuals, motors and components cooled with liquids and compressed air can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids and cooling lubricants. Improper handling of the connected supply systems, supply lines or connections can cause injuries or property damage.

Risk of injury by improper handling of pressurized lines!

- Do not attempt to disconnect, open or cut pressurized lines (risk of explosion).
- Observe the respective manufacturer's operating instructions.
- Before dismounting lines, relieve pressure and empty medium.
- Use suitable protective equipment (safety goggles, safety shoes, safety gloves, for example).
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

☞ Environmental protection and disposal! The agents (e.g., fluids) used to operate the product might not be environmentally friendly. Dispose of agents harmful to the environment separately from other waste. Observe the national regulations of your country.

3.4 Explanation of signal words and the Safety alert symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury could occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damage could occur.

4 Combining the individual components

4.1 Documentations

See chapter "Documentations" on page 28

4.2 Brief description of individual components

4.2.1 HMU05 - brief description and design

Brief description

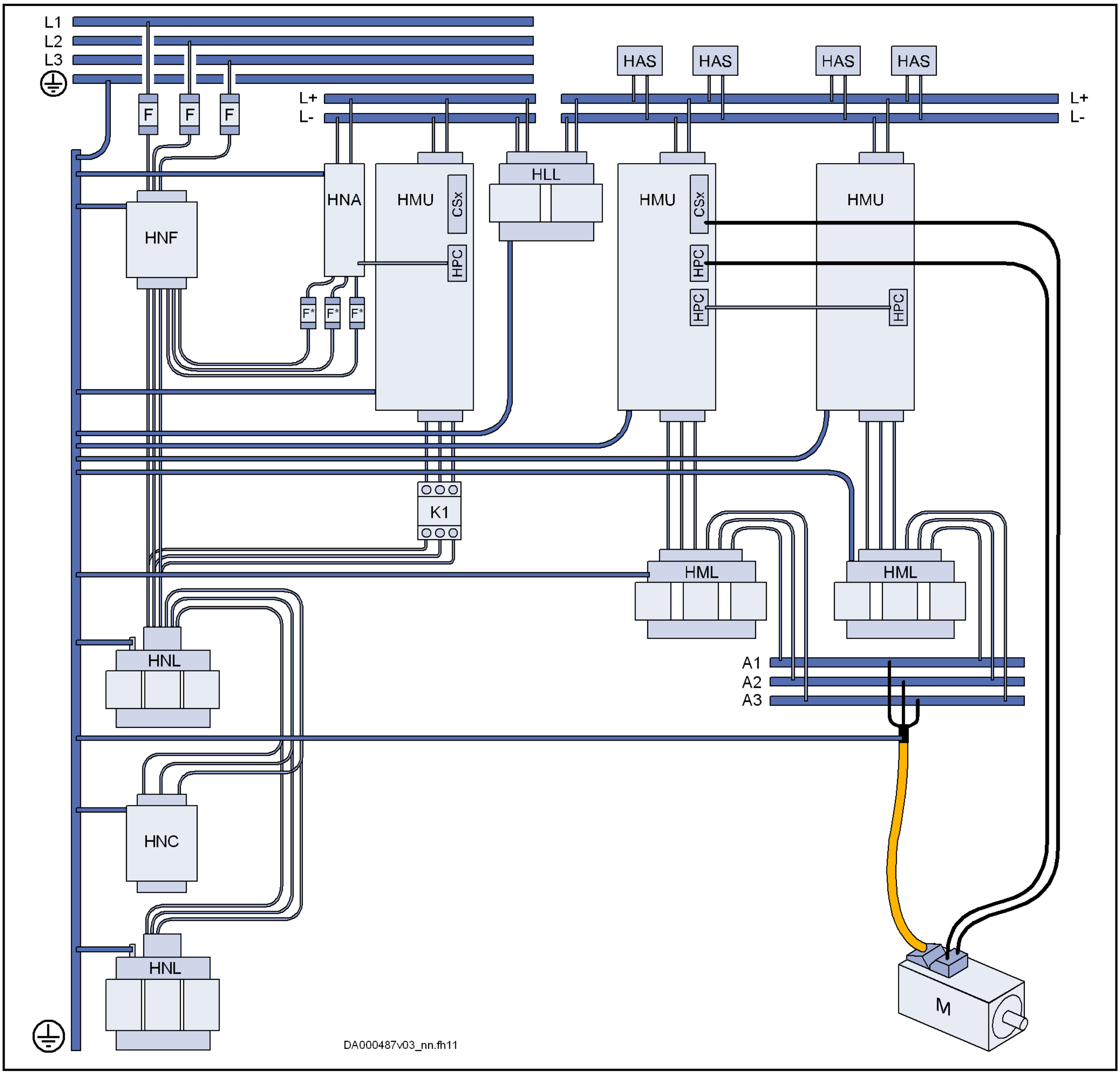
HMU05 components belong to the Rexroth IndraDrive ML product range and are used as:

- **Drive controller (HMU05 + firmware for drive controllers):**

  DC bus voltage: 450 … 800 V DC; nominal: 750 V DC
- **Supply unit (HMU05 + HNA05 + firmware for supply units):**

  Mains connection voltage: 3 AC 380 … 500 V

Combining the individual components



CSx	Control section
F	Fuse
HAS	Y capacitor pair (HAS04.1-003)
HLL	DC bus choke
HML	Motor choke
HMU	Universal inverter
HNA	Mains connection module
HNC	Mains capacitor
HNF	Mains filter
HNL	Mains choke
HPC	Plug-in module for power section
K1	External mains contactor
M	Motor

Fig. 4-1: Design of a drive system

4.3 Configuring the drive system

4.3.1 Firmware

Firmware and device types

See chapter "Firmware" on page 27.

4.3.2 Motors

Third-party motors

General information on third-party motors

Why use third-party motors on Rexroth IndraDrive ML drive controllers?

Today, machine axes are mainly moved with electric drives. Standard motors are used in most cases, as this is the most cost-efficient solution.

Special requirements

Due to special requirements on machine axes, design or safety-related aspects, it may be necessary for the machine manufacturer to use a motor design diverging from the standard.

Motor designs not included in product range

In these cases, the drive suppliers are required to also create drives with motors not in their own inventory due to their special design.

Checking before use

Third-party motors can be used on drive controllers from the Rexroth IndraDrive ML device range. Check whether or not the third-party motor meets the requirements for use.

The functional description of the firmware contains motor data forms. Obtain the completed form for testing the suitability of a third-party motor.

Which directives are important?

In accordance with the legal regulations (EU Directive EMC 89/336/EEC and the German EMC laws), installations and machines must be designed and built in accordance with the present state-of-the-art of standardization.

In order to comply with the machine directives regarding "electromagnetic compatibility (EMC)", a conformity test must be carried out on the drive system (motor with controller and connection design). The machine manufacturer has to guarantee the test of the drive system and compliance with the directives.

Controllable third-party motors

Motor types

The following motor types can be controlled:

- Asynchronous motors, rotary
- Asynchronous motors, linear
- Synchronous motors, rotary
- Synchronous motors, linear

These motors can be operated within the scope of the technical data of the selected Rexroth IndraDrive ML drive controller. If motors come with a holding brake, it should be controlled by the drive controller. Make sure that the relevant technical data for the motor holding brake complies with that of the holding brake output.

For third-party motors, Rexroth usually does not guarantee the performance data of the motor shaft.

Synchronous motors

For synchronous motors with motor encoder, the commutation offset must be set during commissioning. The drive firmware provides several methods for determining this offset so that it is possible to determine the value for different motor characteristics.

☞ Observe the restrictions when using synchronous motors in conjunction with determining commutation offset. See firmware documentation, chapter "Drive control", "Commutation setting".

Any reluctance property cannot be used for synchronous third-party motors! For third-party motors, it is impossible to determine fail-safe motor parameter values for using the reluctance property. For this reason, the corresponding bit for "P-0-4014, Motor type" cannot be set.

Requirements on third-party motors

General information

Check the following for successfully and reliably using a third-party motor:

- Third-party motor being controlled can handle the voltage loads
- Which drive controller is suitable based on the motor torques being delivered
- Third-party motor has the required minimum inductance
- Motor can be protected against inadmissible temperature rise in the case of overload (temperature evaluation)
- Mounted position measuring system can be evaluated by the drive controller or which position measuring system can be selected for kit motors

Third-party motor voltage load

The voltage load of the insulation system of a motor that occurs in practice is mainly influenced by the following characteristics:

- The output variables of the drive controller used (feed the transmission distance)
- Cable parameters depending on cable design and length (determine the properties of the transmission distance, such as attenuation)
- The motor design regarding capacitive and inductive properties (form the end of the transmission distance)

As a result of these variables, the insulation system of the third-party motor is loaded by the following voltage values:

- Periodic peak voltage U_{pp} and
- Voltage change dv/dt

The periodic peak voltages occurring on the motor terminals are caused by reflections at the motor cable end. This loads the motor insulation with a higher peak voltage than the one occurring at the output of the power section.

☞ Determine the load occurring at the **terminals** of the third-party motor in the application with all involved components.

Using the HMF motor filter

Use voltage-reducing components (e.g., HMF motor filter) if one of the following criteria applies:

- Allowed voltage change (dv/dt) of third-party motor: **< 5 kV/s**
- **With mains voltage 3 AC 380 V … 500 V:**

Allowed periodic peak voltage (peak value) of third-party motor between phase-phase and phase-housing: **< 1500 V**

- The voltage change (dv/dt) and periodic peak voltage (V_{pp}) at the motor terminals are influenced by the length and electrical properties of the motor cable:
  - The longer the motor cable, the higher the degree of voltage overshoot (periodic peak voltage) at the motor-side end of the cable. For cables 25 m and longer, the maximum periodic peak voltage occurs. Further voltage increase is not expected even with longer cables.
  - With cable lengths of less than 15 m, the periodic peak voltage is reduced to the DC bus voltage value depending on the length and compared to the specified maximum value.

☞ Apart from the nominal current I_N, observe in particular the maximum allowed switching frequency of the power output stage (f_s) with which the HMF motor filter may be operated.

Verify the success of the voltage-reducing measures by measuring the voltage at the motor terminals. Use an isolated measuring device.

Minimum inductance of third-party motor

Depending on the drive controller used, the motor has to have a minimum value for inductance. The actual inductance of a motor can be measured directly between two motor terminals with an inductance measuring bridge. The measurement has to be made for a complete motor wired for normal operation but not yet connected. One motor terminal remains open. For asynchronous motors, the measured value can only be used if the rotor does not have any closed slots!

Drive controller	Minimum required motor inductance [mH]
HMU05 with 3 × 400 V AC	$L_{U\text{-}V} = 80 \times 4 \div (\sqrt{2} \times I_{Type} \times f_s)$
HMU05 with 3 × 480 V AC	$L_{U\text{-}V} = 116 \times 4 / (\sqrt{2} \times I_{Type} \times f_s)$
HMU05 with 3x 500 V AC	$L_{U\text{-}V} = 160 \times 4 / (\sqrt{2} \times I_{Type} \times f_s)$

I_{Type} Maximum current of drive controller according to type code (rms value)

f_s Desired switching frequency in kHz

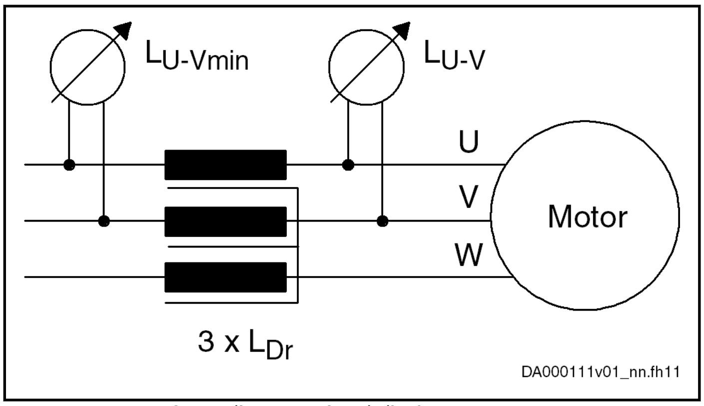
Tab. 4-1: Minimum inductances depending on drive controller data, supply units and supply voltage

Install a three-phase choke in the motor feed wire if the inductance of the third-party motor is smaller than indicated in the table above. This choke has to increase the inductance that can be measured between two motor terminals to the minimum value.

☞ When the inductance is measured, different inductance values can be determined at different rotor positions within one pole pair distance of the motor. The average value is relevant for checking the minimum value.

Correct values can only be determined when the motor is at a **standstill.**

Combining the individual components

<table>
<tr><th>Available third-party motor</th><th>Planned third-party motor</th></tr>
<tr><td>

L_{Dr} = 0.5 × ($L_{U\text{-}Vmin}$ - $L_{U\text{-}V}$) (inductance measurement with 1 kHz)
Fig. 4-2: Mounting 3x L_{Dr} (three-phase choke)</td><td>Calculate the leakage inductance (asynchronous motor) or inductance (synchronous motor) of the third-party motor using the single-phase equivalent circuit diagram (manufacturer's specification).
Calculate the choke, if necessary.
It is recommended to contact Rexroth.</td></tr>
<tr><td colspan="2">Choke requirements:
• $I_{n\_Dr} \geq I_{n\_Mot}$
The rated current of the choke has to be greater than or equal to the rated motor current.
• Depending on the maximum speed, the choke is loaded with the appropriate output frequency and the PWM frequency of the drive controller.
• The insulation class has to correspond at least to that of the motor or has to be sized for higher temperatures.
• The voltage load of the choke depends on the drive controller used.</td></tr>
</table>

Tab. 4-2: Data for any required choke

Third-party motor temperature evaluation

Only operate motors with a built-in temperature sensor on Rexroth IndraDrive ML drive controllers so that the motor can be thermally monitored by the drive controller and protected from being damaged from excess temperature increase (see "P-0-0512, Temperature sensor").

If you want to operate third-party motors without a temperature sensor on Rexroth IndraDrive ML drive controllers in exceptional instances, you have to determine the thermal time constants of the motor housing (P-0-4035) and motor winding (P-0-4034, P-0-4037). The firmware can correctly reflect the cooling situation of the motor using its temperature model.

☞ A dirty motor housing or fan impairs the cooling situation of the motor and the motor is not sufficiently protected against thermal overload.

Third-party motor encoder requirements

Third-party asynchronous motor encoder

Asynchronous motors can also be controlled by Rexroth IndraDrive ML drive controllers in "open-loop" operation (without motor encoder). In "closed-loop" operation (with motor encoder), a relative measuring system is sufficient for asynchronous motors.

Third-party synchronous motor encoder

For fail-safe drives with synchronous third-party motors on Rexroth IndraDrive ML drive controllers, the following potential combinations or restrictions have to be considered when selecting the measuring system:

Drive range	Motor measuring system	Third-party synchronous motor
Rexroth IndraDrive ML	Absolute	■
	Relative	□

■ Advantageous combination
□ Combination is possible (restrictions specific to application), commissioning may be more complicated.

Tab. 4-3: Potential combinations of third-party synchronous motor and motor measuring system

> ☞ The drive controller can evaluate measuring systems as motor encoders when they are listed in "P-0-0074, Encoder type 1 (motor encoder)".
>
> For information on absolute and relative measuring systems, see section "Measuring systems" in the firmware documentation.

Motor encoder resolver – notes on selection

Resolvers first have to be checked to see if they are suited for motor encoders. The following resolver data are required to check if they can be evaluated by the drive controllers:

- Data of resolver system being compared have to be available at 8 kHz
- Gear ratio
- Current consumption
- DC resistance of stator
- Number of poles
- Phase shift

Using the resolver data, check if the supply voltage of the encoder interface and the signal levels of the encoder tracks are sufficient.

Notes on selection and commissioning

Selecting the drive controller in regard to continuous current

The drive controller required for the each motor is determined by comparing the motor data to the device data.

> ☞ The continuous current of the drive controller should be greater than the continuous current of the motor.
>
> The continuous power of the drive controller has to be greater than the required average power.

Selecting the connection technique

For the available power cables and encoder cables, see the "Rexroth IndraDrive and IndraDyn connection cables" documentation.

Notes on commissioning

> ☞ For further information, notes on commissioning and supporting documents (e.g., forms for entering the required data) see firmware documentation.

4.3.3 Cables

Motor power cable

When selecting the motor power cable, observe the following:

- **Cross section:** The minimum size depends on the type current and routing method of the motor power cable.
- **Leakage capacitance:** Without HLL DC bus choke, maximum **500 nF** per phase is permitted (phase: HMU + HNL + HNC + HNL + HNF).

  When connecting multiple HMUs in parallel, the allowed leakage capacitance drops to 450 nF per phase. Reason: balancing HNF mains filter.

  The overall leakage capacitance for n parallel HMUs is therefore n x 450 nF.

Encoder cables

Encoder	Allowed cable length
Encoder evaluation in CSx02 control section	75 m

Tab. 4-4: Cable length

4.3.4 Leakage capacitances

Allowed leakage capacitances

Capacitive leakage currents arise due to the clocked operation of an inverter in conjunction with the leakage capacitances of the motor power cables and the leakage capacitances of the motors.

In order for the drive system to run in accordance with its intended use, the values of the capacitive leakage currents have to be limited.

When sizing drive systems with HMU05 take the maximum allowed leakage capacitances into account.

Comply with the allowed cable capacitance for motor chokes or balancing chokes.

See also chapter 11.5 "Determining the leakage capacitance" on page 383.

HMU05 systems for medium leakage capacitances

HMU05 systems with a single supply unit

At a single HMU05 supply unit, it is possible to connect cables and motors with a **total leakage capacitance of 500 nF**.

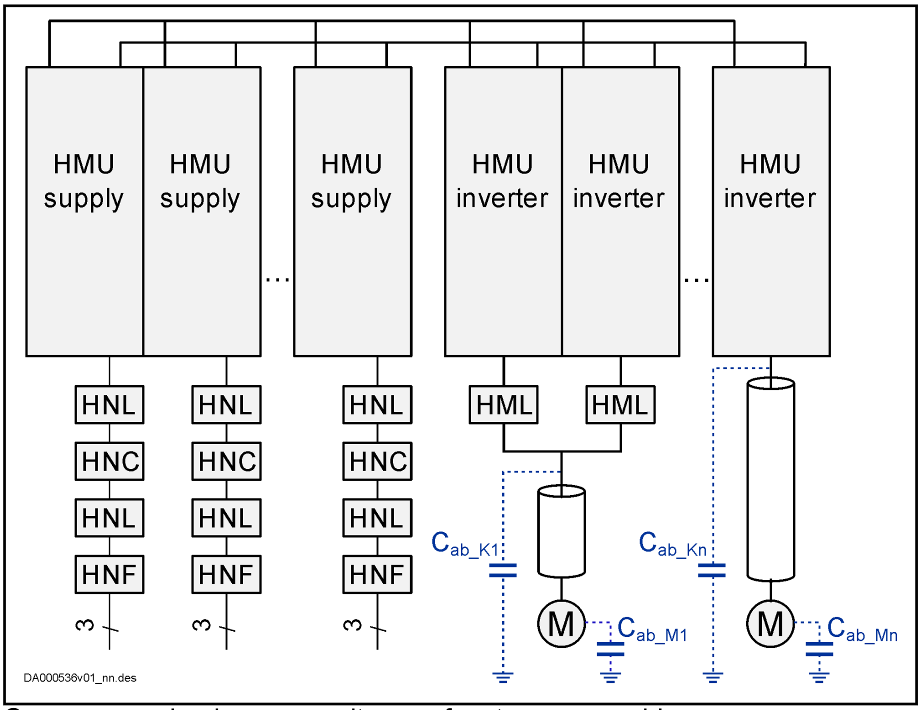
The number and operation mode (individual or parallel operation) of the HMU05 inverters are irrelevant.

HMU05 systems with supply units connected in parallel

For supply units connected in parallel, **the maximum allowed leakage capacitance increases by 500 nF with each additional supply unit.**

A **derating factor** of **0.95** applies to the allowed total leakage capacitance.

The number and operation mode (individual or parallel operation) of the HMU05 inverters are irrelevant.



C_{ab_Kx} Leakage capacitance of motor power cable
C_{ab_Mx} Leakage capacitance of motor

Fig. 4-3: HMU05 systems with supply units connected in parallel

HMU05 systems for high leakage capacitances

DC bus choke, Y capacitor pairs

In drive systems with many axes, big motors and/or long motor power cables, a DC bus choke (HLL05) can be used to increase the maximum allowed total leakage capacitance of the drive system.

4 Y capacitor pairs (HAS04.1-003) are assigned to each DC bus choke. The Y capacitor pairs have to be distributed evenly in accordance with the leakage capacitances connected to the inverters.

NOTICE	**Damage to the Y capacitor pairs!**

If the leakage current is distributed unevenly, Y capacitor pairs risk getting overloaded and damaged!

Evenly distribute Y capacitor pairs in accordance with the leakage capacitances connected to the inverters.

Example: 2 inverters at the DC bus with the same connected leakage capacitance. Consequently: 2 Y capacitor pairs are connected at the DC bus of each inverter.

Mounting the Y capacitor pairs:

- Mount them as near as possible to the DC bus bars of the inverters.
- Mount the housing directly to the grounded back panel of the control cabinet. Make sure the connection is highly conductive.
- Use the shortest possible cables (cross section: 25 mm^2) to connect Y capacitor pairs to L+ and L- of the DC bus bar.
- Always mount 4 Y capacitor pairs per DC bus choke.

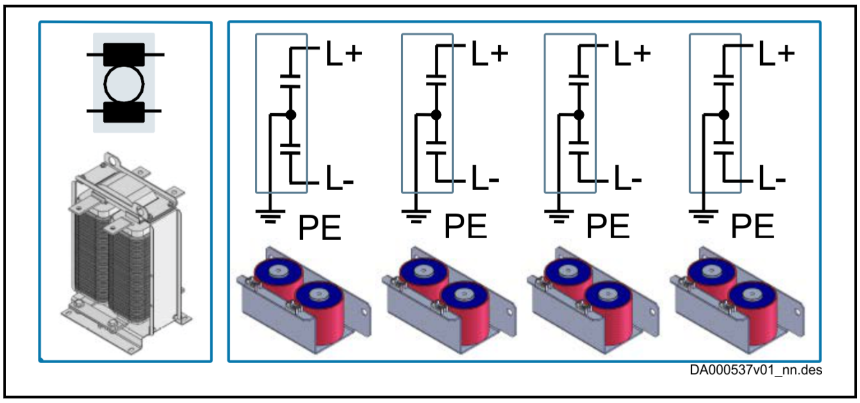


Fig. 4-4: HLL DC bus choke (left) and 4 Y capacitor pairs (right)

HMU05 systems with a single supply unit

For HMU05 systems with a single HMU05 supply unit, **the maximum allowed leakage capacitance increases to 1200 nF if the DC bus choke and the Y capacitor pairs are used.**

The number and operation mode (individual or parallel operation) of the HMU05 inverters are irrelevant.

HMU05 systems with supply units connected in parallel

For supply units connected in parallel, **the maximum allowed leakage capacitance increases by 1200 nF with each additional supply unit with a DC bus choke and 4 Y capacitor pairs**.

A **derating factor** of **0.95** applies to the allowed total leakage capacitance.

The number and operation mode (individual or parallel operation) of the HMU05 inverters are irrelevant.

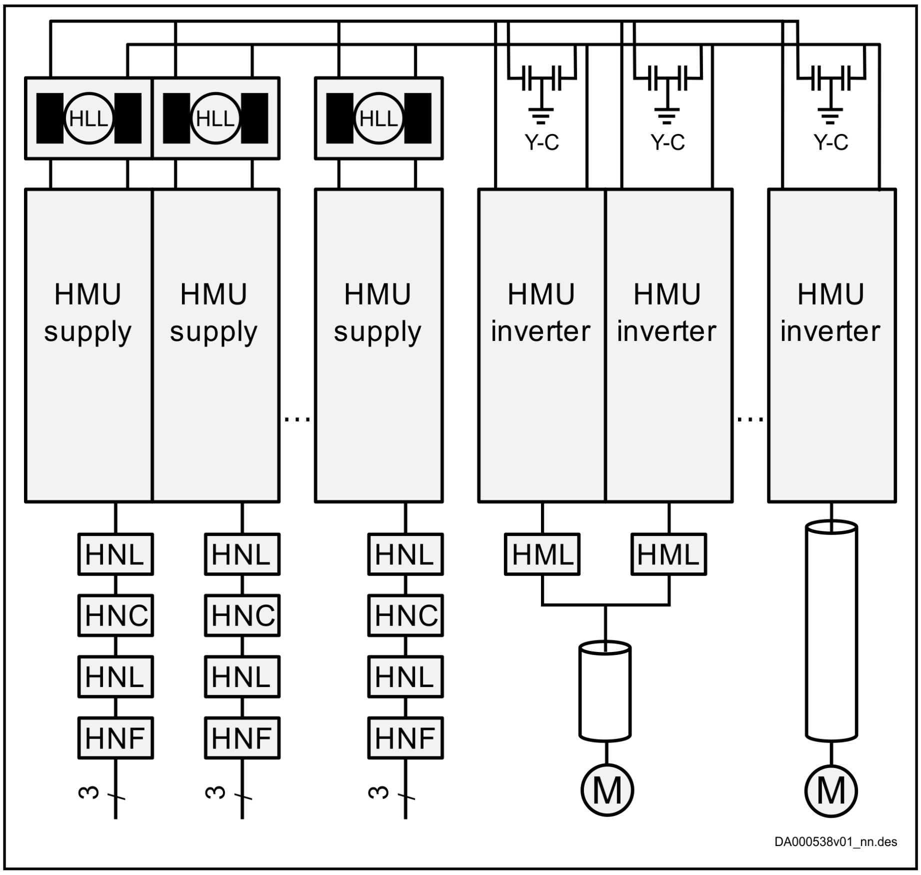


Fig. 4-5: HMU05 systems with supply units connected in parallel

Operating HMU05 together with HMS01/HMD01

Topologies

HMS01 or HMD01 drive controllers of the IndraDrive M product range may only be operated at HMU05 supply units, if at least one **HLL DC bus choke** with the corresponding **Y capacitor pairs** is used (regarding Y capacitor pairs, see also chapter "HMU05 systems for high leakage capacitances" on page 54).

There are two different topologies:

- HMU05 systems **without** a central DC bus choke
- HMU05 systems **with** a central DC bus choke

Concerning the tapered cross sections of the DC bus bars, please observe the information on DC bus fuses: See chapter 11.3 "DC bus fuses" on page 380.

With the drive firmware you can configure an inverter as a **module bus master**. Integrate the relay contact of the module bus master configured as a **Bb contact** in the power supply control circuit in such a way that opening the relay contact causes the power to be disconnected.

HMU05 systems without a central DC bus choke

HMU05 systems without a central DC bus choke require an HLL DC bus choke before the HMS/HMD drive lines, as well as HLC DC bus capacitor units in the HMS/HMD drive lines.

DC bus choke:

Size the DC bus choke in accordance with the continuous current and peak current. (The DC bus current is calculated from the DC bus power and DC bus voltage).

DC bus capacitor unit:

Dimension the minimum size of the DC bus capacitor unit in accordance with the planned continuous power of the respective drive system:

47 µF per kilowatt [kW] of continuous power

Mount **Y capacitor pairs** close to the HMS/HMD drive controllers.

In the case of multiple drive lines, the Y capacitor pairs are distributed proportionately in accordance with the sum of leakage capacitances.

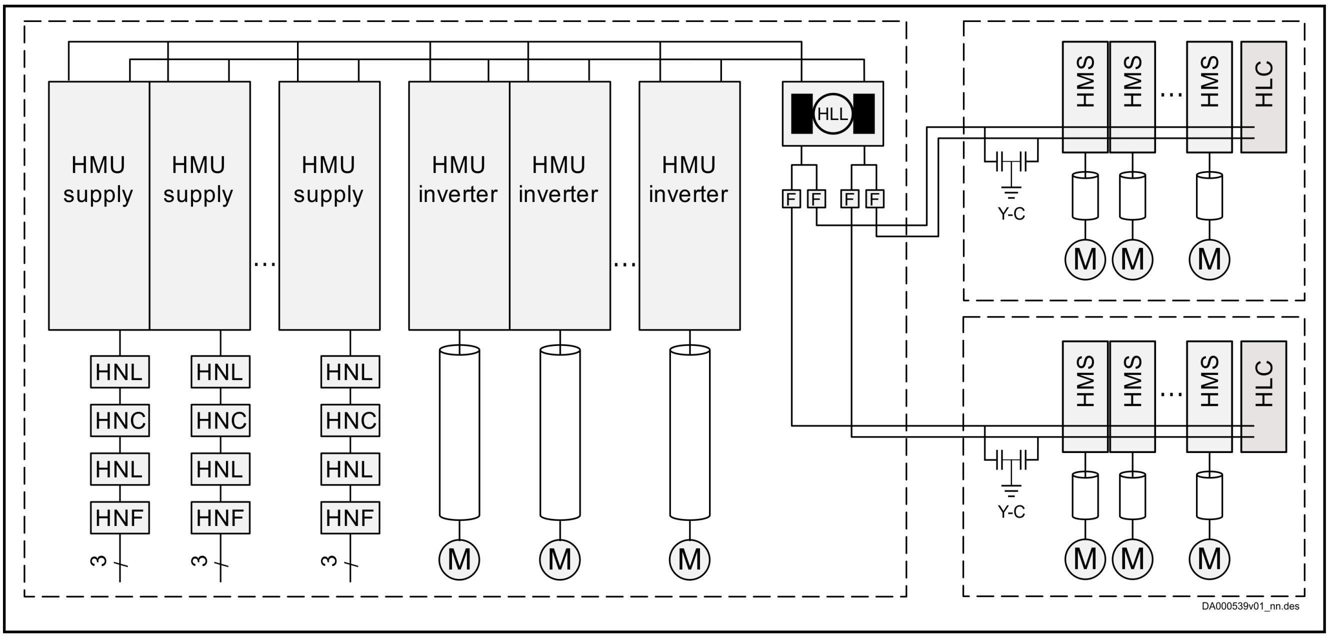


Fig. 4-6: HMU05 systems without a central DC bus choke

Combining the individual components

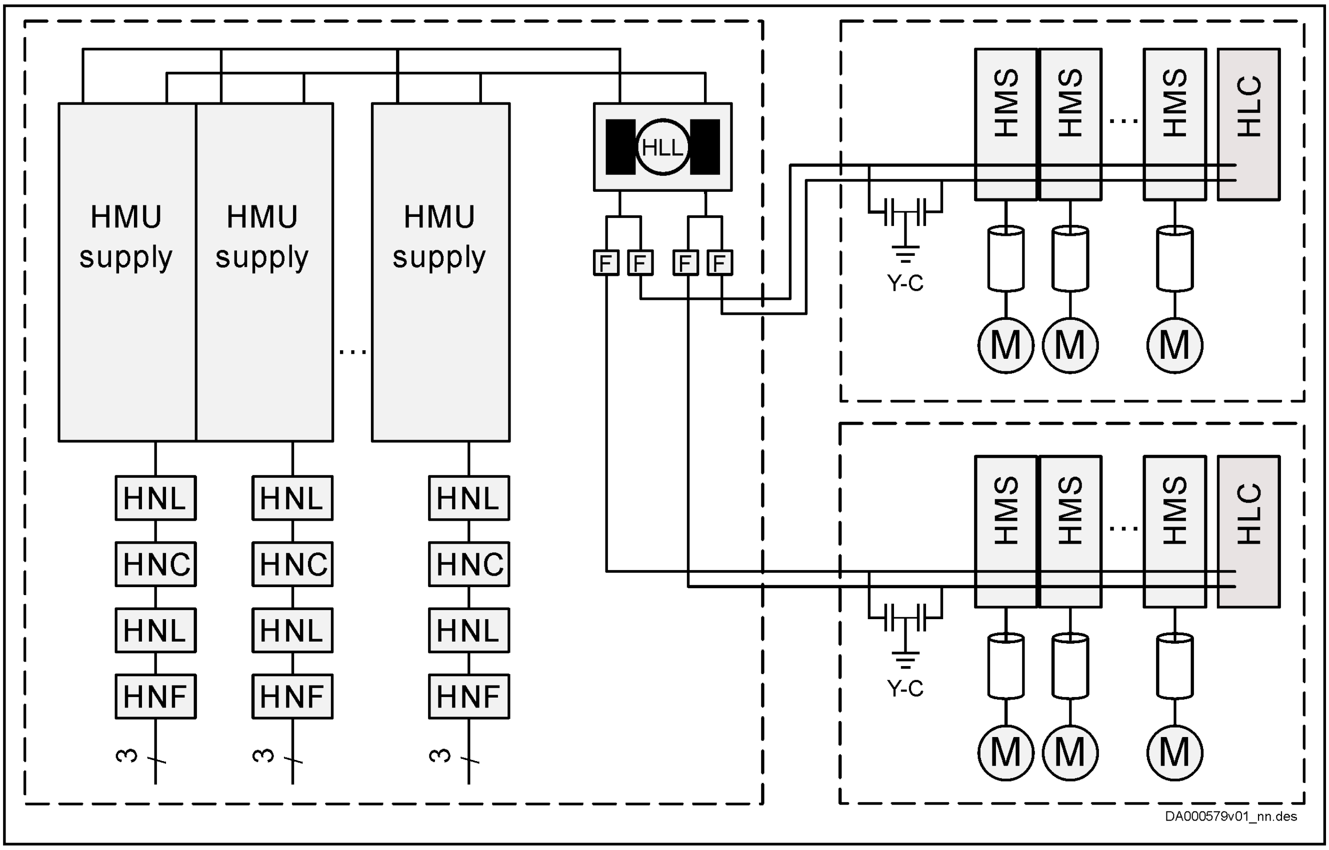


Fig. 4-7: HMU05 systems without a central DC bus choke and without an HMU05 inverter

HMU05 systems with a central DC bus choke

HMS drive lines may be connected directly to the DC bus, if a DC bus choke has been assigned to each HMU05 supply unit.

The Y capacitor pairs are distributed proportionately in accordance with the sum of leakage capacitances.

HLC DC bus capacitor units have to be installed in the HMS/HMD drive lines. Dimension the minimum size of the HLC DC bus capacitor unit in accordance with the planned continuous power of the respective drive system:

47 μF per kilowatt [kW] of continuous power

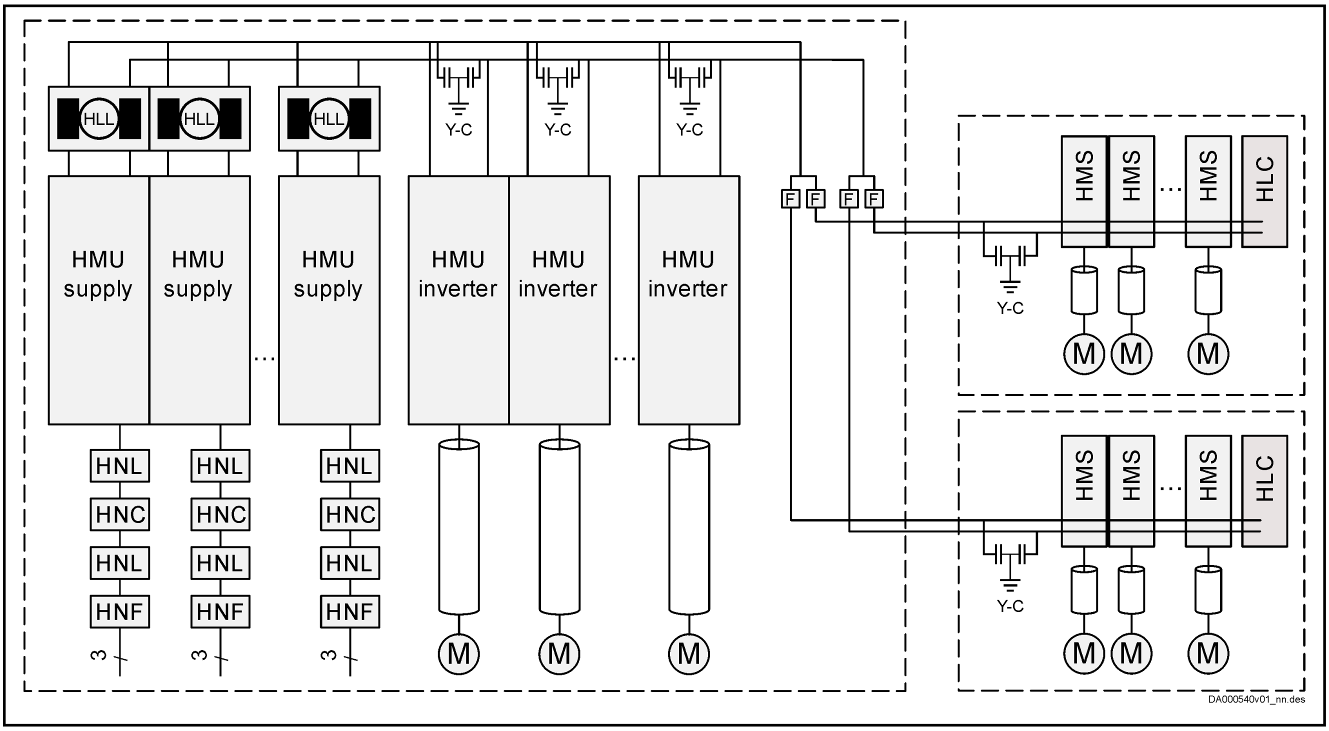


Fig. 4-8: HMU05 systems with a central DC bus choke

4.4 Installation conditions

4.4.1 Ambient and operating conditions

⚠ WARNING **Lethal electric shock by live parts with more than 50 V!**

Exclusively operate the device

- with plugged on connectors (even if there haven't been any lines connected to the connectors) and
- with connected equipment grounding conductor!

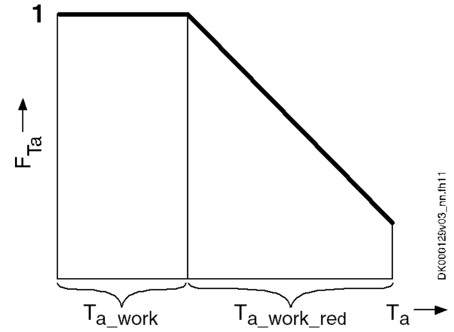
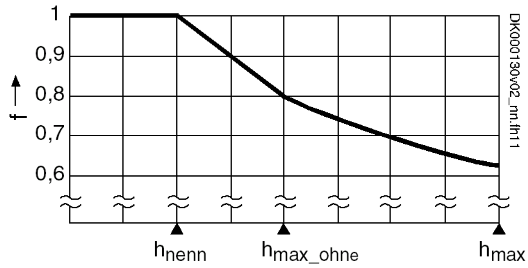
Control cabinet

The devices in the Rexroth IndraDrive ML product range, as well as their additional components (except for some braking resistors), have to be mounted **in control cabinets.**

Check that the ambient and operating conditions, in particular the control cabinet temperature, are observed by calculating the heat levels in the control cabinet. Afterwards, make the corresponding measurements to confirm that ambient and operating conditions have actually been observed. The power dissipation is indicated in the technical data of the individual components as an important input value for calculating the heat levels.

Ambient and operating conditions

Description	Symbol	Unit	Value
Conductive dirt contamination			Not allowed (You can protect the devices against conductive dirt contamination, e.g., by mounting them in control cabinets with a degree of protection of IP54 in accordance with IEC529.)
Degree of protection (IEC529)			IP00
Use within scope of CSA / UL			For use in NFPA 79 Applications only!
Temperature during storage			see chapter 5.4 "Storing components" on page 121
Temperature during transport			see chapter 5.3 "Transporting components" on page 120
Allowed mounting position			G1
Installation altitude	h_{nenn}	m	1000
Ambient temperature range	T_{a_work}	°C	0 … 40

Description	Symbol	Unit	Value
Derating vs. ambient temperature: The performance data are reduced by the factor F_{Ta} in the ambient temperature range $T_{a\_work\_red}$: $F_{TA} = 1 - [(T_a - 40) \times f_{Ta}]$ Example: With an ambient temperature $T_a = 50$ °C and a capacity utilization factor $f_{Ta} = 2\%$, the rated power is reduced to $P_{DC\_cont\_red} = P_{DC\_cont} \times F_{Ta} =$ $P_{DC\_cont} \times (1 - [(50 - 40) \times 0.02]) = P_{DC\_cont} \times 0.8$ Operation at ambient temperatures outside of T_{a_work} and $T_{a\_work\_red}$ is not allowed!	 		
	$T_{a\_work\_red}$	°C	40 … 55
	f_{Ta}	%/K	Load factor: see technical data for each component (data for cooling and power dissipation → derating of P_{DC_cont}, P_{BD}, I_{out_cont} at $T_{a\_work} < T_a < T_{a\_work\_red}$)
Derating vs. installation altitude: At an installation altitude h > h_{nenn}, the performance data reduced by factor f[2)] are available. At an installation altitude in the range h_{max_ohne} to h_{max}, an isolating transformer has to be installed at the drive system mains connection. Use above h_{max} is not allowed!	 		
	h_{max_ohne}	m	2000
	h_{max}	m	4000
Simultaneous derating for ambient temperature **and** installation altitude	Allowed; reduce with factors f and f_{Ta}		
Relative humidity		%	5 … 95
Absolute humidity		g/m^3	1 … 29
Moisture condensation			Not allowed
Climatic category (IEC 60731-3-3)			3K3
Allowed pollution degree (IEC 60664-1)			2
Resistance to chemically active substances			IEC 60721-3-3, class 3C1
Vibration sine: Amplitude (peak-peak) at 10 … 57 Hz [1)]		mm	0.15
Vibration sine: Acceleration at 57 … 150 Hz [1)]		g	1
Overvoltage category			III (according to IEC 60664-1)

1) According to EN 60068-2-6
2) Reduced performance data for drive controllers: allowed DC bus continuous power, allowed mains voltage, braking resistor continuous power, continuous current

Tab. 4-5: Ambient and operating conditions

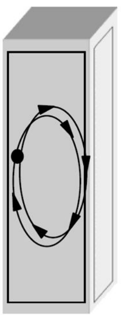
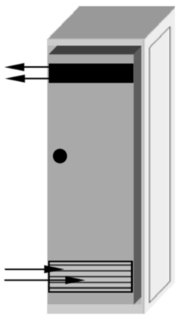
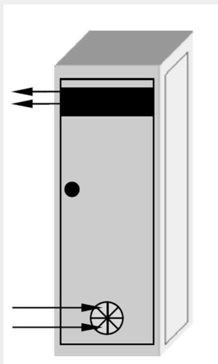
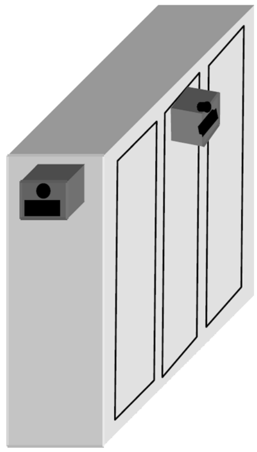
4.4.2 Control cabinet

Air cooling

Control cabinet design and cooling

☞ The only mounting position allowed for supply units and drive controllers to be installed in control cabinets is G1.

Possibilities of heat dissipation

Closed control cabinet with air circulation	Closed control cabinet with heat exchanger	Control cabinet with fan	Closed control cabinet with air conditioning unit
 DF000644v01_nn.tif	 DF000645v01_nn.tif	 DF000646v01_nn.tif	 DF000647v01_nn.tif
P_Q ~ 400 W	P_Q ~ 1700 W	P_Q ~ 2700 W	P_Q ~ 4000 W

P_Q Dissipated heat output

Tab. 4-6: Possibilities of heat dissipation

The section below describes the "control cabinet with fan".

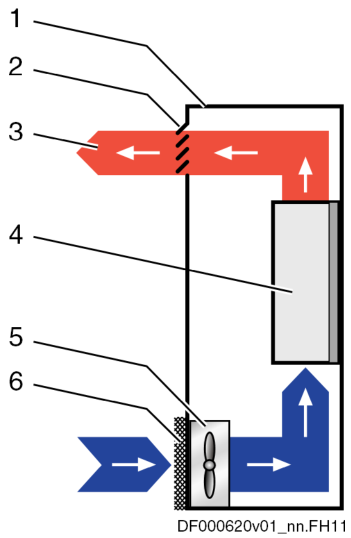
Requirements for control cabinets with fan

NOTICE **Risk of damage by unclean air in the control cabinet!**

Operating a control cabinet with a fan, but without the corresponding filters, can damage the devices or cause malfunction.

- Install filters at the air intake opening of the control cabinet so that unclean air cannot get into the control cabinet.
- Service the filters at regular intervals according to the dust loading in the environment.
- Only replace the filters when the fan has been switched off, because otherwise the fan sucks in the dirt coming off the filter and the dirt gets into the control cabinet.

Control cabinet ventilation (schematic diagram)



1	Control cabinet
2	Air outlet opening
3	Heat discharge
4	Device in control cabinet
5	Control cabinet fan
6	Filter at air intake opening

Fig. 4-9: Control cabinet ventilation (schematic diagram)

Only clean air gets into the control cabinet through the filter at the air intake opening. The control cabinet fan behind the air intake opening conveys the air into the control cabinet and generates overpressure in the control cabinet. The overpressure prevents unclean air from getting into the control cabinet through possibly existing leaky points (leaky cable ducts, damaged seals, etc.).

Liquid cooling

General information

Cooling devices

There are three types of cooling devices for liquid cooling:

- Air-liquid cooling unit
- Liquid-liquid cooling unit
- Refrigerating unit

Power dissipation in control cabinet

Liquid-cooled drive components dissipate power in the control cabinet in the form of heat. It may be necessary to include the control cabinet in the liquid-cooled circuit.

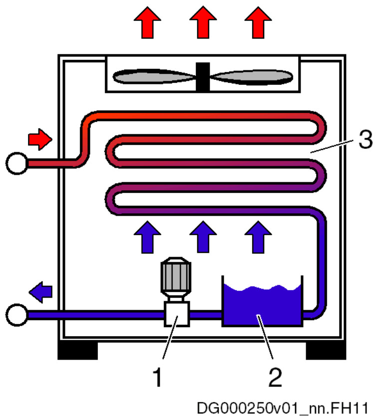
Cooling devices

The cooling device dissipates the sum of all heat output discharged in the cooling liquid to a higher-level cooling medium. The cooling device provides a cooling medium with a required temperature and thereby maintains a required temperature level in the components being cooled.

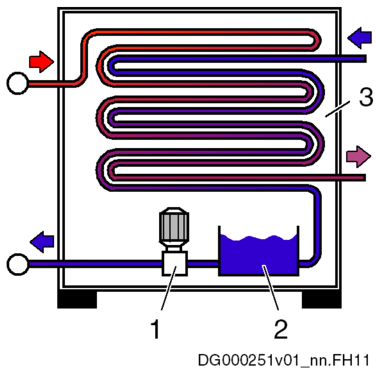
There are three different types of cooling devices. The names of the cooling devices correspond to the kind of heat exchange from one medium to the other.

Combining the individual components

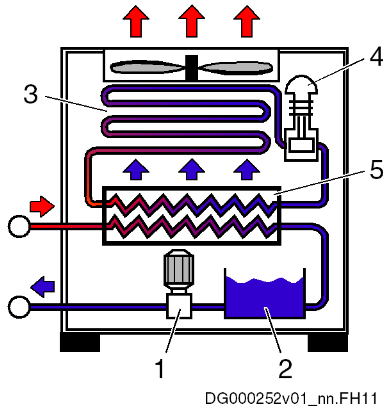
<table>
<tr><th>Air-liquid cooling unit</th><th>Liquid-liquid cooling unit</th><th>Refrigerating unit</th></tr>
<tr><td>



</td><td>



</td><td>



</td></tr>
<tr><td>1. Coolant pump
2. Coolant container
3. Air-liquid heat exchanger</td><td>1. Coolant pump
2. Coolant container
3. Liquid-liquid heat exchanger</td><td>1. Coolant pump
2. Coolant container
3. Air-cooled liquefier
4. Condenser
5. Evaporator</td></tr>
</table>

Tab. 4-7: Types of cooling devices

Features	Air-liquid cooling unit	Liquid-liquid cooling unit	Refrigerating unit
Temperature control precision of coolant	Low (±5 K)	Low (±5 K)	Good (±1 K)
Higher-level coolant circuit required?	No	Yes	No
Ambient air of machine heated up?	Yes	No	Yes
Recovery of power dissipation possible?	No	Yes	No
Spatial volume of cooing unit	Minor	Small	Big
Depending on ambient temperature?	Yes	No	No

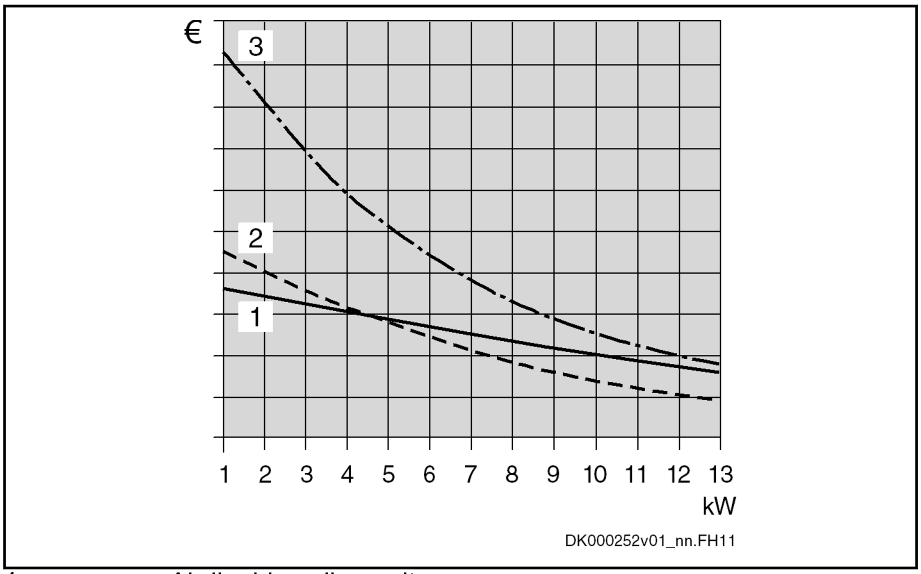
Tab. 4-8: Comparison of cooling devices

Application

Air-liquid cooling unit	Particularly suited for individual workshop machines. Is used • Where there is no higher-level cooling circuit available • Where there are no high demands on the stability of the coolant temperature
liquid liquid cooling unit	Particularly suited for systems with central recooling. Is used where there are no high demands on the stability of the coolant temperature.
Refrigerating unit	Particularly suited where a high degree of thermal stability in a system is required. A certain temperature is kept constant, the temperature increase from electrical components therefore does not have any effect on the precision of the system.

Tab. 4-9: Uses of cooling devices

Cost comparison



1 Air-liquid cooling unit
2 Liquid-liquid cooling unit
3 Refrigerating unit

Fig. 4-10: Approximate cost comparison of the cooling devices

Cooling device components

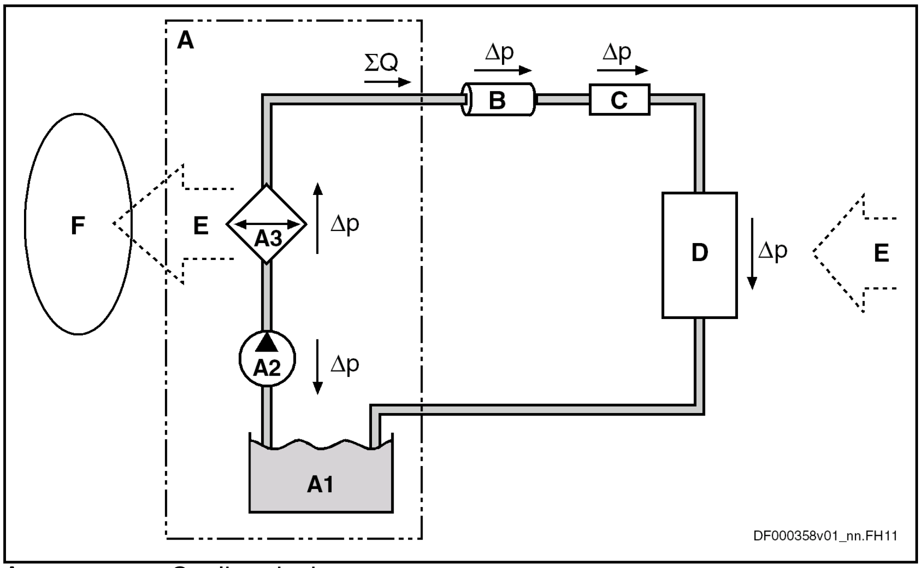
Overview

A liquid cooling system consists of:

- A cooling device and
- The drive components being cooled, including
  - Lines
  - Fittings
  - Shut-off devices, etc.

Heat is dissipated by a heat exchanger to a higher-level cooling medium.

Combining the individual components



A	Cooling device
A1	Coolant container
A2	Coolant pump
A3	Heat exchanger
B	Coolant lines
C	Fittings
D	to cooling, electrical drive components
E	Heat transfer
F	Higher-level cooling medium
Δp	Pressure decrease
ΣQ	Required flow rate

Fig. 4-11: Basic arrangement of a liquid cooling system

Coolant reservoir

Recommendation for sizing the coolant reservoir:

$$V_T = V_{Ks} + 1,3 \times V_{T\_min}$$

V_T	Required volume of coolant reservoir
V_{Cs}	Coolant circulating in cooling system
V_{T_min}	Minimum required coolant volume

Fig. 4-12: Required volume of coolant reservoir

$$V_{Ks} = V_{Wt} + V_{Arm} + V_{ch} + V_{Ltg}$$

V_{Cs}	Coolant volume of cooling system (circulating coolant)
V_{He}	Coolant volume in heat exchanger
V_{Ftg}	Coolant volume in fittings of cooling system
V_{Dc}	Coolant volume in drive components
V_L	Coolant volume in coolant lines

Fig. 4-13: Coolant circulating in cooling system

Coolant pump

General information

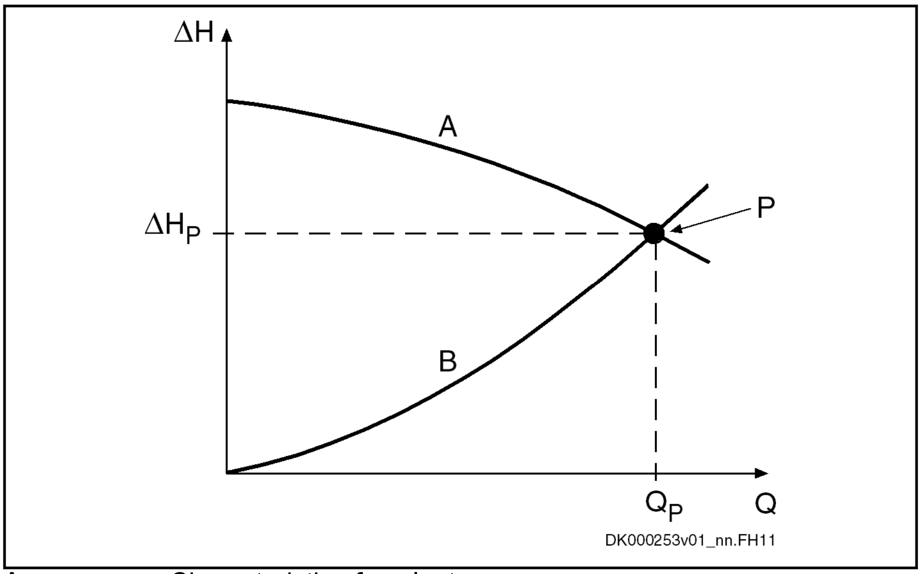
The coolant pump of a cooling device must generate the required flow rate of the cooling system. For this purpose, the coolant pump must generate a pressure corresponding to the total pressure decrease of the cooling system at the required flow rate.

A coolant pump is characterized by:

- Delivery rate
- Corresponding delivery height

The delivery height results from the total pressure decrease of the cooling system.

The intersection of the flow diagrams of cooling system and coolant pump is the **working point** of the coolant pump. The delivery rate in the working point must be greater than or equal to the flow rate required for the cooling system.



A	Characteristic of coolant pump
B	Characteristic of cooling system
ΔH	Delivery height
P	Working point of coolant pump
Q	Delivery rate

Fig. 4-14: Working point of a coolant pump

Delivery rate

Parallel connection

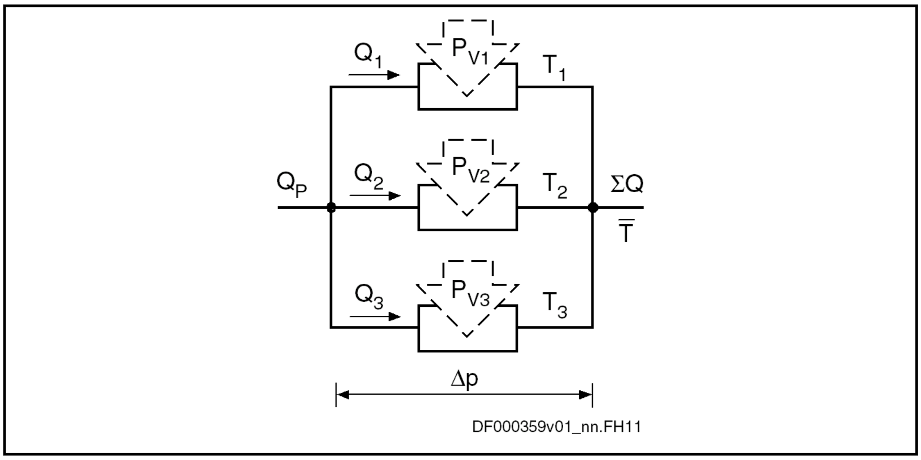


Fig. 4-15: Parallel connection of components

The delivery rate of the coolant pump (Q_P) must correspond to the total flow rate of all connected components (ΣQ):

Combining the individual components

$$Q_P \geq Q_1 + Q_2 + \ldots + Q_n = \sum Q$$

Q_P Delivery rate of coolant pump
$Q_{1\ to\ n}$ Required flow rates of drive components

Fig. 4-16: Delivery rate of the coolant pump with parallel connection

Series connection

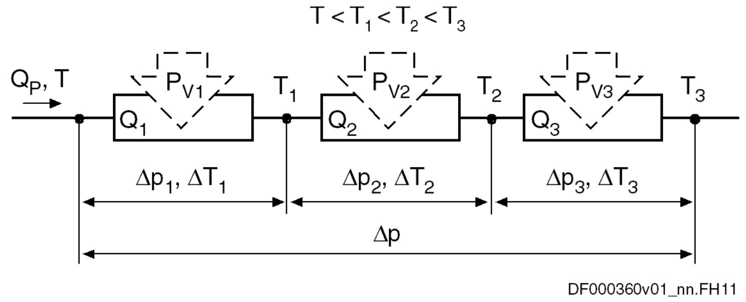


Fig. 4-17: Series connection of components

The delivery rate of the coolant pump must correspond to the flow rate of the component which requires the highest flow. This flow rate flows through all other connected components.

$$Q_P \geq \mathrm{Maximum}(Q_1, Q_2 \ldots Q_n)$$

Q_P Delivery rate of coolant pump
$Q_{1\ to\ n}$ Required flow rates of drive components

Fig. 4-18: Delivery rate of series coolant pump

The required flow rates of the liquid-cooled drive components are indicated in the technical data for each component (referring to a fixed temperature increase of the coolant water). When using different coolants or a different temperature increase, calculate the flow rate accordingly.

Delivery pressure

Required delivery pressure of coolant pump

The coolant pump must overcome all pressure decreases on the flow path of the coolant.

The flow path passes through:

- Heat exchanger
- Valves and fittings
- Main distribution
- Parallel and/or series drive components
- Coolant line

$$\Delta p_p \geq \Delta p_{Wt} + \Delta p_{Arm} + \Delta p_{ch} + \Delta p_{Ltg} = \sum \Delta p$$

Δp_{xxx} Pressure decreases in individual cooling system components on flow path (He: heat exchanger; Ftg: fittings; Dc: drive components; L: lines)
Δp_p Delivery pressure of coolant pump

Fig. 4-19: Required delivery pressure of coolant pump

Coolant line pressure decrease

$$\Delta p_{Ltg} = \Delta p_{Ltg} / \Delta l \times l$$

$\Delta p_L/\Delta l$	Length-based pressure decrease in hPa/m
l	Line length in m

Fig. 4-20: Coolant line pressure decrease

Use the data of the coolant line manufacturer for calculation.

Fittings pressure decrease

See manufacturer's specification for pressure drop. If no data is available, the following rough formula can be used:

$$\Delta p_{Arm} \approx \frac{\Delta p_{Ltg}}{\Delta l} \times 5m$$

$\Delta p_L/\Delta l$	Pressure decrease for tube with same inner diameter in hPa/m

Fig. 4-21: Fittings pressure decrease

Heat exchanger pressure decrease

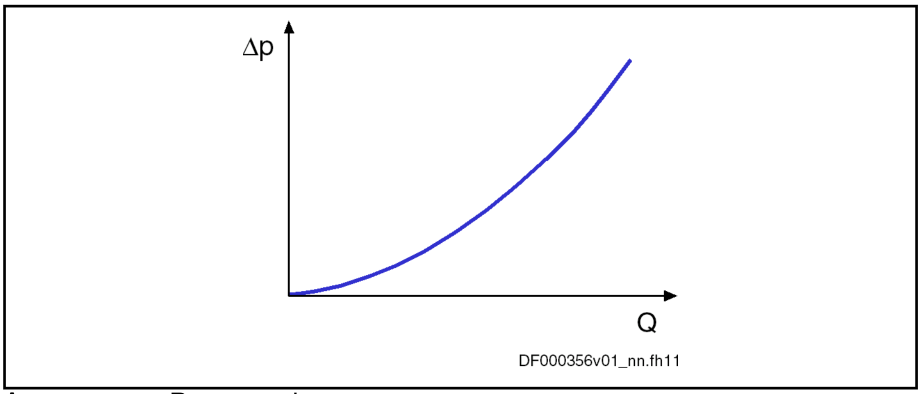
See manufacturer's specification for pressure decrease Δp_{He}.

Drive components pressure decrease

The resulting pressure decrease Δp_{Dc} generally differs from the indicated Δp_n, because the flow rate is mostly greater than Q_{min}.

Calculating pressure decrease: See chapter "Appendix" → "Liquid cooling" → "Calculation criteria".

The diagram below shows the relation of pressure decrease and flow rate.



Δp	Pressure decrease
Q	Flow rate

Fig. 4-22: Flow diagram

NOTICE **Components that are too small can considerably increase the pressure decrease.**

Size the components according to our specifications.

When selecting the coolant pump, its required delivery height ΔH must be known:

Coolant pump delivery height

$$\Delta H = \frac{\Delta p_P \times 10^2 \times kg \times m}{\rho \times 9{,}81 \times l \times hPa}$$

ΔH	Delivery height in m
Δp_p	Pressure of coolant pump in hPa
ρ	Specific weight of coolant in kg/l

Fig. 4-23: Coolant pump delivery height

A correctly sized coolant pump can be operated at or near the point of best efficiency. This requires the installation characteristic to be determined as precisely as possible. Excess safety margins often result in an unnecessarily large coolant pump that then has to be operated at partial load.

If the required pressure of the coolant pump is above the maximum permitted system pressure, it is necessary to size the tube diameter or the temperature increase ΔT in the cooling system again.

Cooling unit or refrigerating unit

Air-liquid cooling unit and control cabinet air cooler

Data for selection

Determining specific cooling capacity

$$P_{01} = \frac{\Sigma P_V}{(T_{ein} - T_{amb})}$$

P_V	Power dissipation being discharged in kW
P_{01}	Specific cooling capacity in kW/K
T_{amb}	Ambient temperature in °C
T_{in}	Inlet temperature of coolant in heat exchanger in °C

Fig. 4-24: Determining specific cooling capacity

For economic reasons, 50°C should be selected as the maximum outlet temperature of the drive components (= T_{in}) for air-liquid cooling units. An air-liquid cooling unit is only useful up to an ambient temperature of approx. 35°C and up to 3 kW.

Coolant temperature change

$$\Delta T_{Km} = \frac{P_V \times 60 \frac{s}{min}}{\rho \times c_{Km} \times Q}$$

P_V	Power dissipation being discharged in kW
ρ	Density of coolant in kg/l
c_{Cl}	Specific thermal capacity of coolant in kJ/kgK
Q	Flow rate of coolant in l/min

Fig. 4-25: Coolant temperature change

Air temperature change

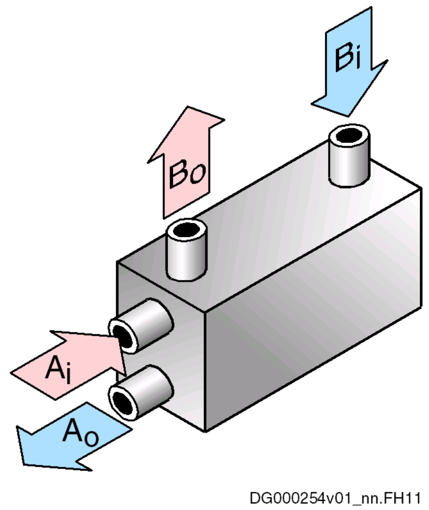
$$\Delta T_L = \frac{P_V \times 60 \frac{s}{min}}{1{,}3 \times 10^{-3} \frac{kg}{l} \times 0{,}72 \frac{kJ}{kgK} \times Q_L}$$

P_V Power dissipation being discharged in kW
Q_L Air flow in l/min

Fig. 4-26: Air temperature change

For control cabinet air cooling, measure the air flow Q_L such that the resulting air temperature change is ΔT_L = 10 K. (Avoiding condensation: see chapter "Condensation protection" on page 75)

Liquid-liquid cooling unit



A_i Coolant inlet
A_o Coolant outlet
B_i Utilities inlet
B_o Utilities outlet

Fig. 4-27: Liquid-liquid heat exchanger

In the liquid-liquid heat exchanger, two liquids are hydraulically separated and brought to the best possible thermal contact. The power dissipation absorbed by the coolant is thereby dissipated to the higher-level cooling circuit (utilities).

These cooling units are suited for the coolants specified in this documentation. Depending on the type of material, you can use fresh water, river water, industrial water, seawater or brackish water as utilities.

Data for selection

Determining specific cooling capacity

$$P_{01} = \frac{P_V}{(T_1 - T_2)}$$

P_V	Power dissipation being discharged in kW
P_{01}	Specific cooling capacity in kW/K
T_1	Inlet temperature of coolant in °C
T_2	Inlet temperature of utilities in °C

Fig. 4-28: Determining specific cooling capacity

Cooling warmer medium (coolant)

$$\Delta T_1 = \frac{3{,}6 \times P_V}{\rho_1 \times c_1 \times Q_1 \times 0{,}06}$$

ΔT_1	Temperature reduction of coolant in K
ρ_1	Density of coolant in kg/l
P_V	Power dissipation in kW
c_1	Specific thermal capacity of coolant in kJ/kgK
Q_1	Flow rate of coolant in l/min

Fig. 4-29: Cooling warmer medium (coolant)

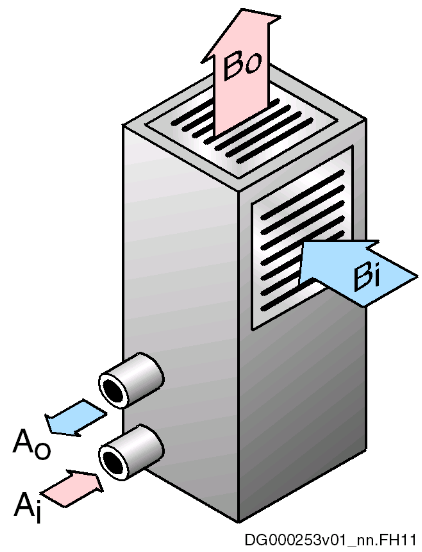
Temperature increase of colder medium (utilities)

$$\Delta T_2 = \frac{3{,}6 \times P_V}{\rho_2 \times c_2 \times Q_2 \times 0{,}06}$$

ΔT_2	Temperature increase of utilities in K
ρ_2	Density of utilities in kg/l
P_V	Power dissipation in kW
c_2	Specific thermal capacity of utilities in kJ/kgK
Q_2	Flow rate of utilities in l/min

Fig. 4-30: Temperature increase of colder medium (utilities)

Refrigerating unit



A_i	Coolant inlet
A_o	Coolant outlet
B_i	Air intake
B_o	Air outlet

Fig. 4-31: Refrigerating unit

A **refrigerating unit** consists of a refrigerant circuit and a coolant circuit. The water heated up by the drive components being cooled is conveyed by the coolant pump through the evaporator and cooled down there. The heat taken from the coolant is brought to a higher temperature level in the refrigerant circuit and dissipated to a higher-level cooling medium in the liquefier. The refrigerant circuit is automatically controlled using thermostats. The desired coolant temperature can be exactly set.

Refrigerating units are characterized by their **refrigerating capacity**.

For units with an air-cooled liquefier, the refrigerating capacity depends on the ambient temperature. The refrigerating capacity (in kW) of a refrigerating unit must always be greater than or equal to the total power dissipation to be discharged.

Determining refrigerating capacity

Data for selection

$$P_C \geq \sum P_V$$

P_C	Refrigerating capacity of refrigerating unit
$\sum P_V$	Sum of power dissipations being discharged

Fig. 4-32: Determining refrigerating capacity

Cooling of the drive components

Technical data

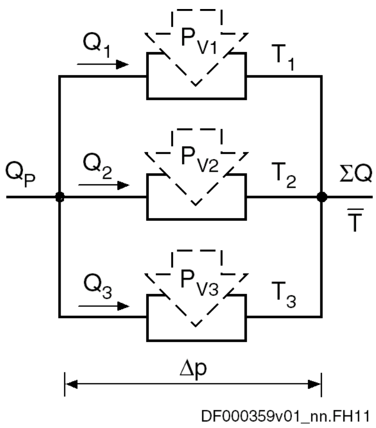
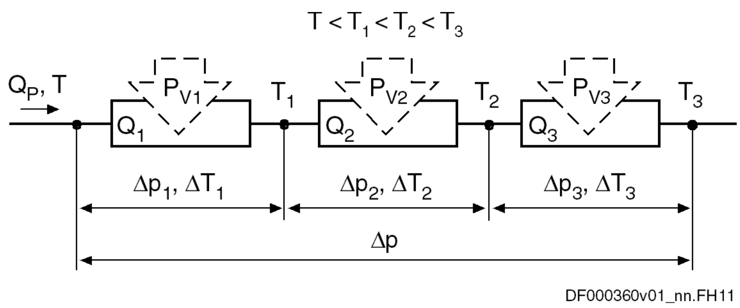
☞ The technical data needed to size the cooling system can be found in the project planning manuals of the drive components used (see "Other applicable documentation").

Combining the individual components

Interconnection

The two possible kinds of hydraulic component interconnection (series connection/parallel connection) show considerable differences with regard to:

- Pressure decrease of entire cooling system
- Delivery rate of coolant pump
- Temperature level and temperature controllability of the individual components being cooled

<table>
<tr><th>Parallel connection</th><th>Series connection</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Tab. 4-10: Parallel and series connection of drive components being cooled

Parallel connection

Parallel connection is characterized by nodal points in the hydraulic system. The following applies:

- The sum of the coolant flows which flow towards a nodal point equals the sum of the coolant flows which flow away from this nodal point.
- For all cooling system branches between two nodal points there is the same pressure difference (pressure decrease).

Aspects of application

The individual components being cooled

- Can be cooled with the individually required flow rate ⇒ high degree of thermal operational safety
- Have the same temperature level at the coolant inlet ⇒ steady machine temperature increase
- All have the same pressure difference between coolant inlet and outlet ⇒ high degree of hydraulic operational safety of the cooling system due to low total pressure.

Series connection

With series connection, one single coolant flow is flowing through all components to be cooled.

The following applies:

- The flow rates of all components are the same.
- Each component has a pressure decrease between inlet and outlet of the coolant. The individual pressure decreases add up to form the total pressure decrease of the drive components.

Aspects of application

The following properties of series connection generally have to be observed:

- Series connection does not allow setting the required flow rate individually for each of the connected components.
- The required system pressure corresponds to the sum of all pressure decreases of the connected individual components. This means a lower degree of hydraulic operational safety of due to high system pressure.
- The temperature level of the coolant increases from component to component because each power dissipation discharged to the coolant increases its temperature. This means uneven machine temperature increase by the components being cooled.

Combined interconnection

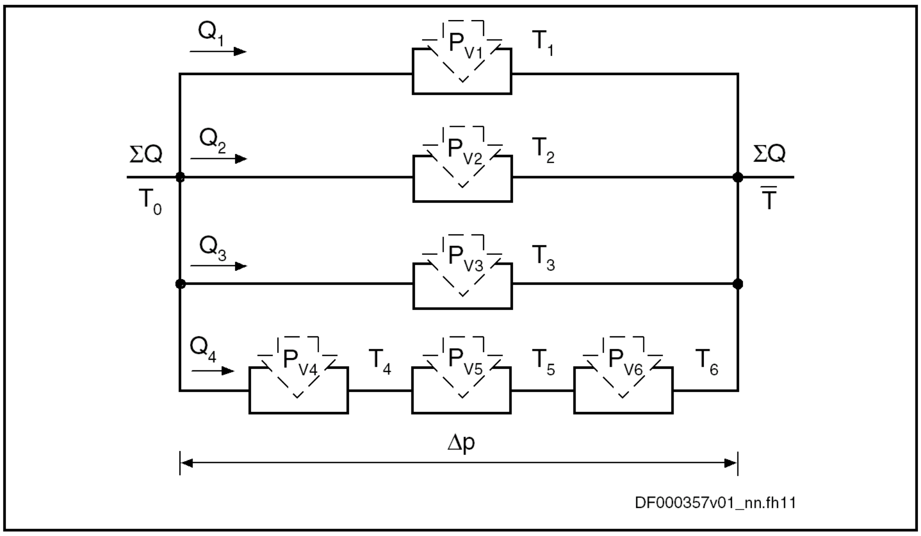


Fig. 4-33: Combined interconnection of drive components being cooled

The combined interconnection of the drive components being cooled allows using the advantages of parallel and series connection.

Condensation protection

NOTICE **Risk of damage. Drive components cannot build condensation.**

In temperate zones (up to 40°C and 70% humidity), the inlet temperature of the coolant may be at a maximum 5 K below the temperature in the control cabinet.

Safest protection against condensation:

Coolant inlet temperature = ambient temperature

The temperature of the coolant flowing through liquid-cooled drive components generally differs from the temperature of the ambient air.

Depending on the humidity, the ambient air contains water vapor. The amount of water vapor which can be absorbed by the air depends on the air temperature and air pressure. The warmer the air, the more water vapor it can absorb at the same air pressure.

When warm air gets in contact with a less warm object, a moist film (condensation) forms on the surface of the object if the temperature of the object is below the condensation temperature.

Drive components with protection classes IPx4, IPx5, IPx6 are not at risk from condensation because their design provides sufficient protection against water.

Combining the individual components

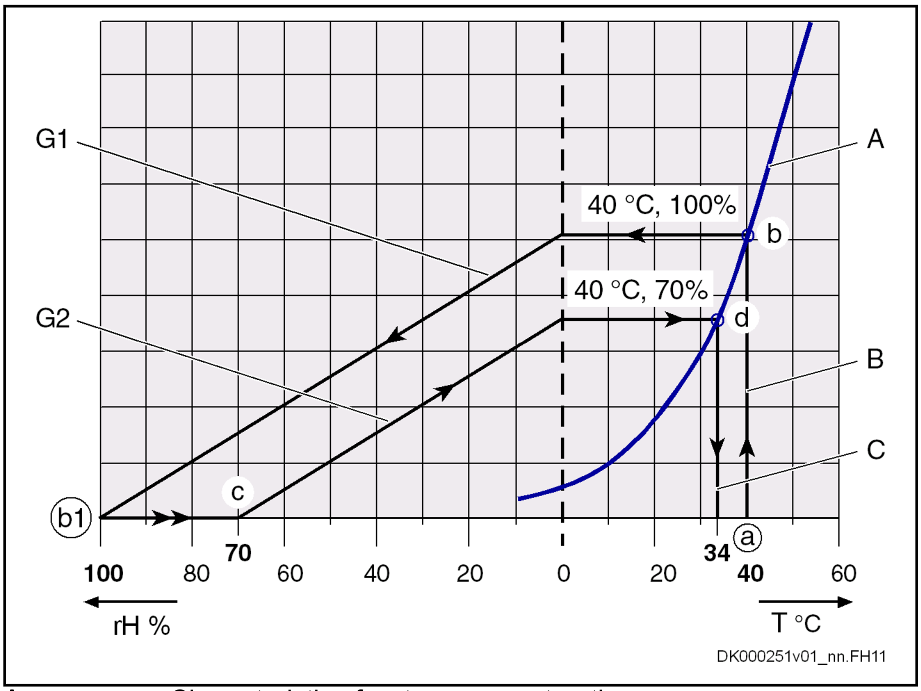
Drive components with the protection class IPx0, such as drive controllers and supply units, do not have sufficient protection against water. This is why condensation cannot be allowed to form on them.

Condensation temperature

In temperate zones (e.g., Central Europe), the condensation temperature is 34°C at

- Air temperatures up to 40°C and
- Relative humidity up to 70%

For climatic zones with higher air temperatures and/or higher relative humidities, the condensation temperature must be graphically determined according to the figure below. The maximum temperature difference between internal air of the control cabinet and coolant inlet temperature derives from the figure.



A	Characteristic of water vapor saturation
B	Maximum temperature of ambient air
C	Condensation temperature
G1, G2	Artificial lines
rH	Relative humidity
T	Ambient temperature
a	Maximum ambient temperature (e.g., 40°C)
b, b1	Intersection point of ambient air temperature and characteristic of water vapor saturation. This intersection point characterizes the 100% humidity value (b1)
c	Convert 100% humidity value graphically by parallel translation of artificial line G1 to expected humidity value (e.g., 70%) (⇒ artificial line G2)
d	Intersection point of expected humidity value and characteristic of water vapor saturation leads to expected condensation temperature of drive component (34°C)

Fig. 4-34: Determining condensation temperature

☞ The temperature difference between the actual ambient air temperature and the coolant inlet temperature must not be greater than between maximum ambient air temperature and moisture condensation temperature to be expected!

Coolant

Water-based coolant

NOTICE **Risk of damage to components.**

- Observe the required properties and the appropriate composition of the coolant.
- For transport and storage of the components, make sure sufficient antifreeze is provided (see chapter "Transport and storage").

Required properties

Most cooling systems use water as coolant. The values given in the technical data of the components thus refer to the coolant water with a maximum volumetric content of 3% coolant additives.

The water-based coolant must have the following properties:

- pH value: 7-8.5
- Hardness: max. 10 °dH (England: 12.5 °e; France: 17.8 °f; USA: 178 ppm $CaCO_3$)
- Chloride: max. 20 mg/l
- Nitrate: max. 10 mg/l
- Sulfate: max. 100 mg/l
- Insoluble substances: max. 250 mg/l

Drinking water in Germany complies with these requirements.

Antifreeze

Coolant with antifreeze may only be used for transport and storage of the components (see chapter "Transport and storage").

Protection against corrosion

- For protection against corrosion and chemical stabilization, an appropriate additive must be mixed with the cooling water.
- The required mixing ratio (according to manufacturer's data sheet) must be complied with and checked. Deviations can cause:
  - Reduction of cooling capacity
  - Changes in emulsion stability
  - Unexpected behavior with gasket materials
  - Reduction of protection against corrosion
- The coolant should be chemically neutral (pH-value approx. 7).
- **Use closed circuit.** An open circuit should not be used for cooling, because deposits and corrosion (e.g., from hard water) worsen the heat transfer or completely clog up cooling channels.

☞ If the required mixing ratio exceeds the maximum permitted addition, the cooling system must be calculated with the resulting coolant.

Anti-corrosion additive

Aqueous solutions ensure reliable protection against corrosion without notable changes in the physical properties of the water.

☞ Observe the safety instructions of the anti-corrosive manufacturer (e.g., DIN safety sheet).

Coolant additives

Recommended manufacturer of coolant additives

The proper chemical treatment of closed water systems is required to prevent corrosion, maintain heat transmission and minimize growth of bacteria in all parts of the system.

☞ Rexroth cannot make any general statements or inquiries into the suitability of system-specific cooling media, additives or operating conditions.

Testing the performance of the coolants used and sizing the liquid coolant system are generally the responsibility of the machine manufacturer.

Water-based coolant

Water + Antifrogen in a 4:1 ratio (e.g., "Rifrost" from Rittal).

Non-water-based coolant

Non-water-based coolants (e.g., oil) are **not permitted**.

Sizing liquid cooling

The corresponding information for sizing a cooling system with liquid cooling plus a sizing example can be found in the appendix.

4.4.3 UL ratings

Introduction

This chapter contains:

- Limit values for use within the scope of CSA / UL
- Applied standards (CE conformity, UL listing)

Inverter

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
Short circuit current rating	SCCR	A rms	85000			
Rated input voltage, power[1)]	U_{LN_nenn}	V	DC 450...750			
Rated input current	I_{LN}	A	242.0	291.0	373.0	467.0
Output voltage	U_{out}	V	3 x AC 0...500			
Output current	I_{out}	A	254.0	306.0	392.0	490.0
Last modification: 2015-12-03						

1) Mains input L1, L2, L3 (for HMV and HCS only); For use on a solidly grounded wye source only.

Tab. 4-11: HMU – ambient and operating conditions – UL ratings

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Short circuit current rating	SCCR	A rms	85000			
Rated input voltage, power[1)]	U_{LN_nenn}	V	DC 450...750			
Rated input current	I_{LN}	A	587.0	734.0	954.0	tbd
Output voltage	U_{out}	V	3 x AC 0...500			
Output current	I_{out}	A	616.0	771.0	1002.0	tbd
Last modification: 2015-12-03						

1) Mains input L1, L2, L3 (for HMV and HCS only); For use on a solidly grounded wye source only.

Tab. 4-12: HMU – ambient and operating conditions – UL ratings

Supply units

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
Short circuit current rating	SCCR	A rms	85000			
Rated input voltage, power[1)]	U_{LN_nenn}	V	3 x AC 380...500			
Mains frequency	f_{LN}	Hz	50...60			
Nominal current	I_{LN}	A	218.00	262.00	327.00	409.00
Output voltage	U_{out}	V	DC 750			
Output power	P_{out}	kW	144.00	173.00	216.00	270.00
Last modification: 2015-12-03*						

1) Mains input L1, L2, L3; For use on a solidly grounded wye source only.

Tab. 4-13: HMU – ambient and operating conditions – UL ratings

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Short circuit current rating	SCCR	A rms	85000			
Rated input voltage, power[1)]	U_{LN_nenn}	V	3 x AC 380...500			
Mains frequency	f_{LN}	Hz	50...60			
Nominal current	I_{LN}	A	514.00	652.00	811.00	1019.00
Output voltage	U_{out}	V	DC 750			
Output power	P_{out}	kW	339.00	430.00	535.00	672.00
Last modification: 2015-12-03*						

1) Mains input L1, L2, L3; For use on a solidly grounded wye source only.

Tab. 4-14: HMU – ambient and operating conditions – UL ratings

4.4.4 Compatibility with foreign matters

All Rexroth controls and drives are developed and tested according to the state-of-the-art technology.

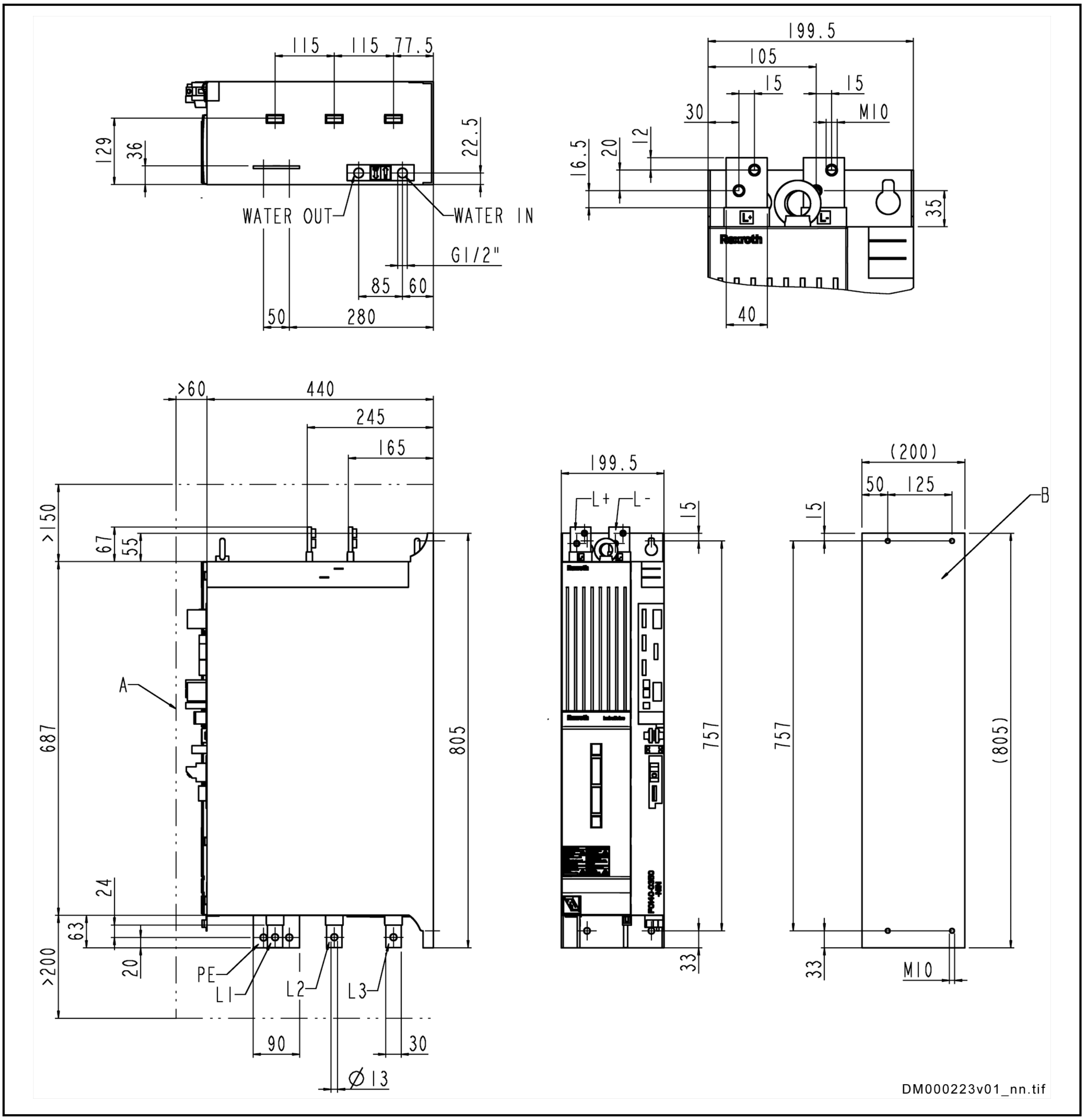
As it is impossible to follow the continuing development of all materials (e.g. lubricants in machine tools) which may interact with the controls and drives, it cannot be completely ruled out that any reactions with the materials we use might occur.

For this reason, before using the respective material a compatibility test has to be carried out for new lubricants, cleaning agents etc. and our housings/ materials.

4.5 Mechanical project planning

4.5.1 Dimensions

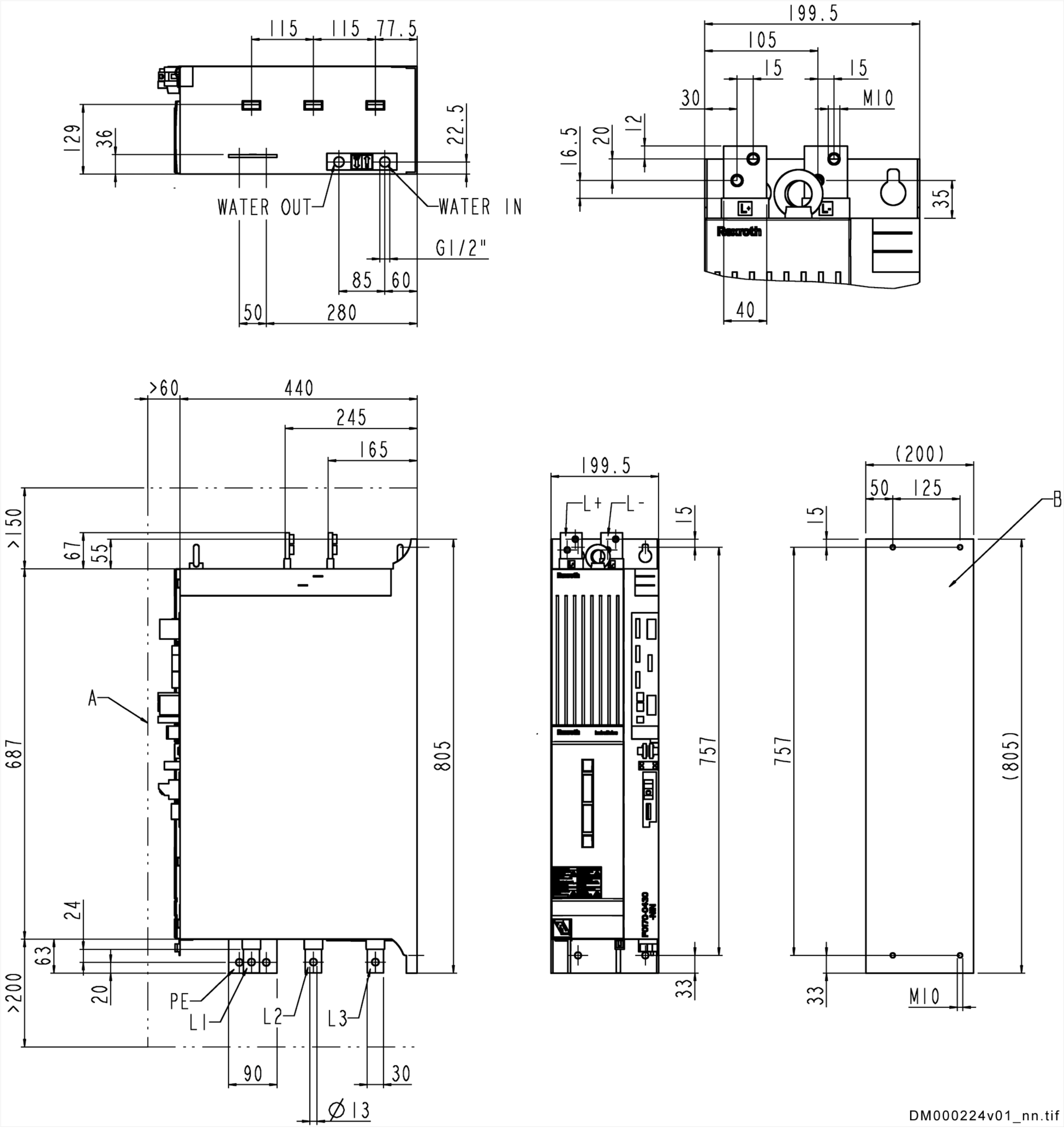
HMU05.1N-F0140-0350



A	Minimum mounting clearance
B	Boring dimensions

Fig. 4-35: HMU05.1N-F0140-0350

HMU05.1N-F0170-0430

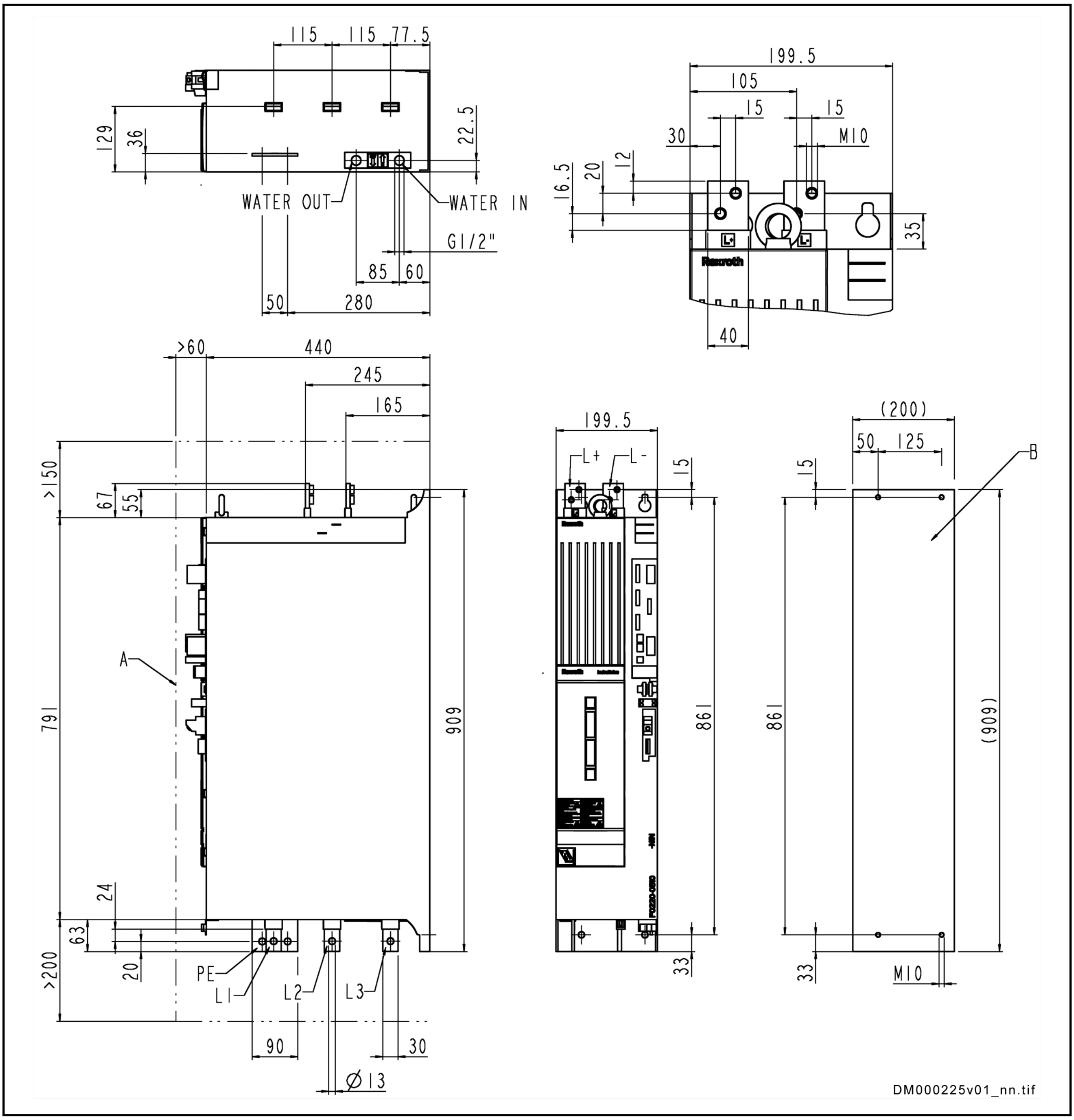


A Minimum mounting clearance
B Boring dimensions

Fig. 4-36: HMU05.1N-F0170-0430

Combining the individual components

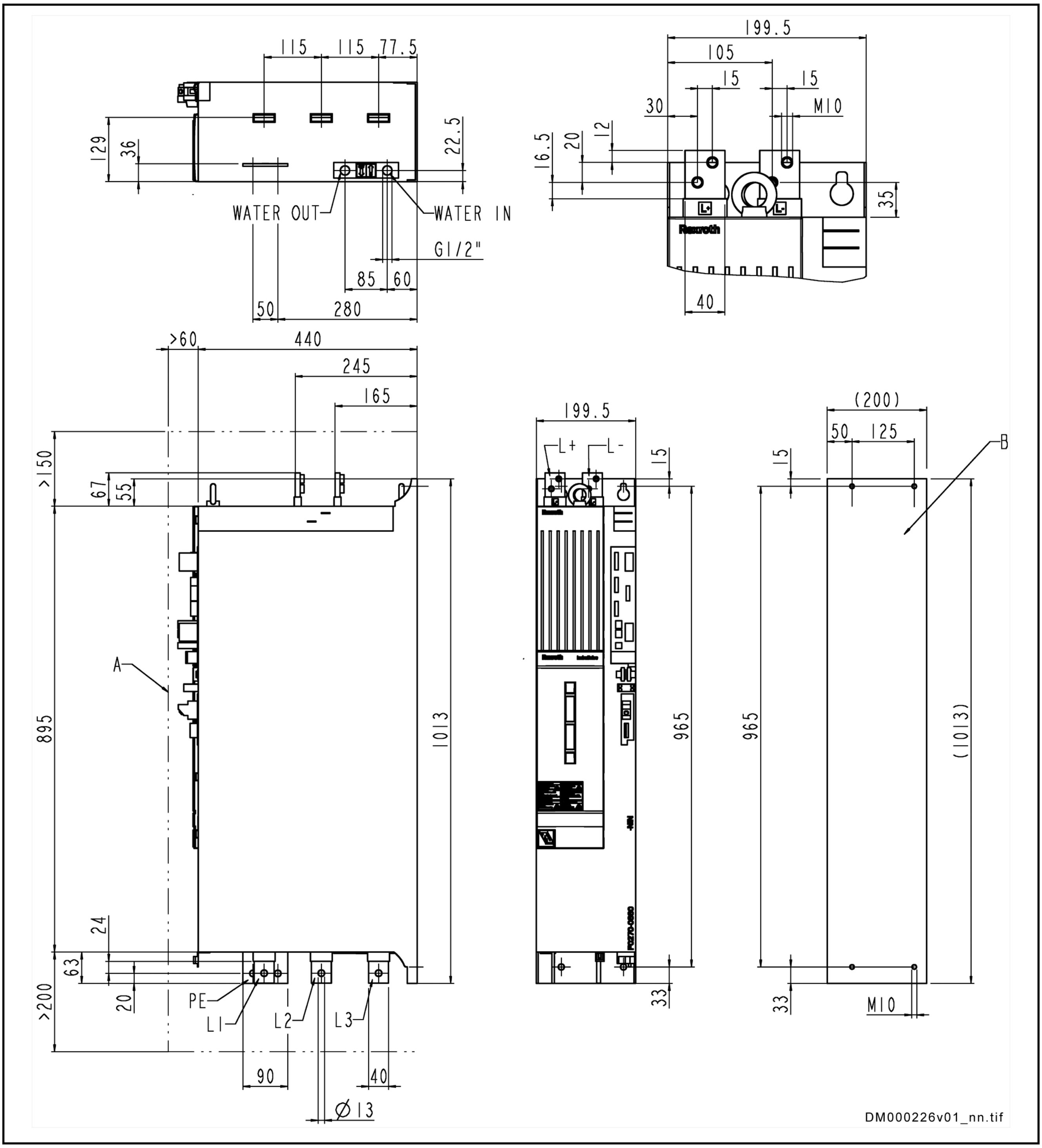
HMU05.1N-F0220-0510



A Minimum mounting clearance
B Boring dimensions

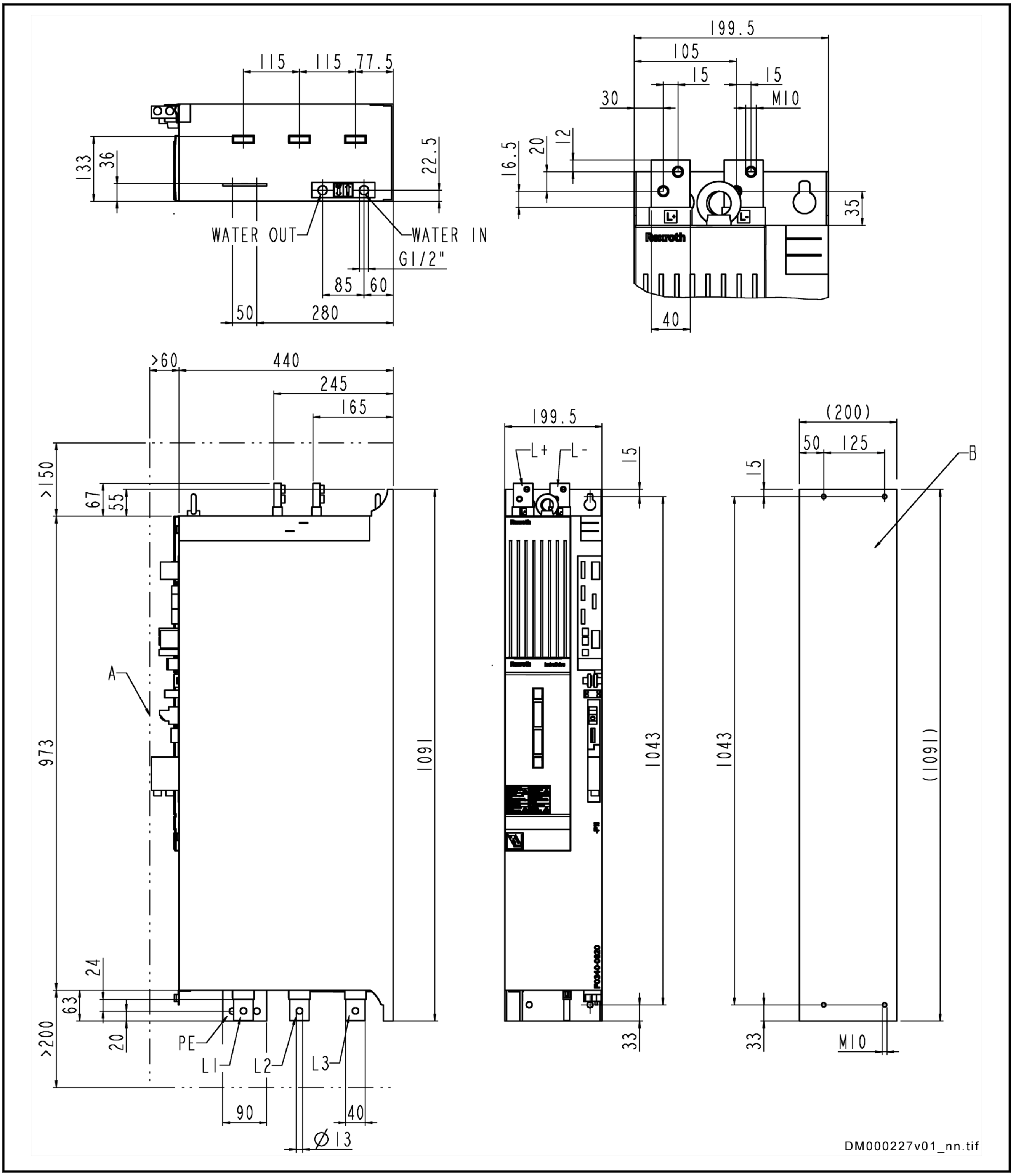
Fig. 4-37: HMU05.1N-F0220-0510

HMU05.1N-F0270-0660



A Minimum mounting clearance
B Boring dimensions
Fig. 4-38: HMU05.1N-F0270-0660

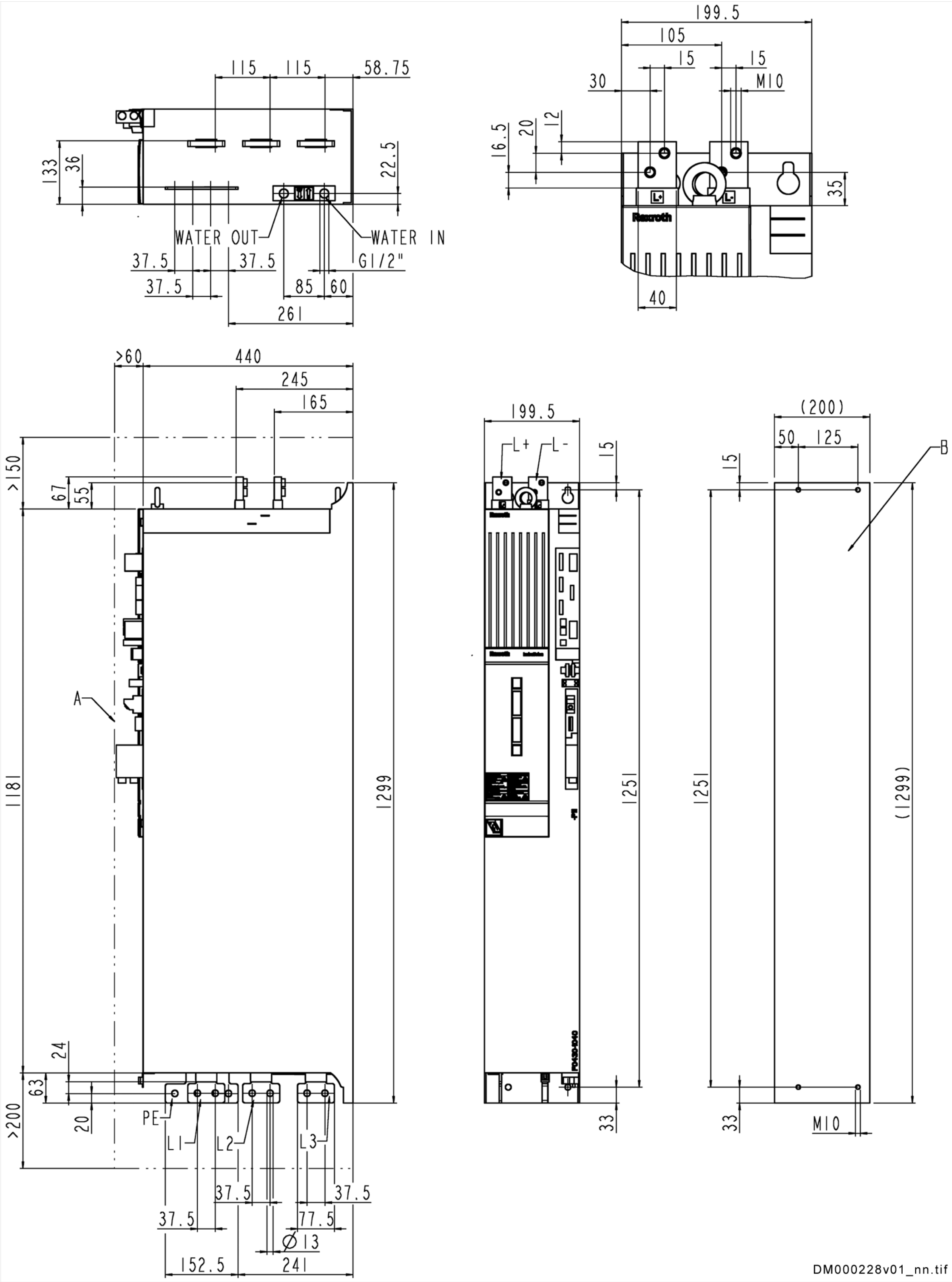
HMU05.1N-F0340-0820



A Minimum mounting clearance
B Boring dimensions

Fig. 4-39: HMU05.1N-F0340-0820

HMU05.1N-F0430-1040

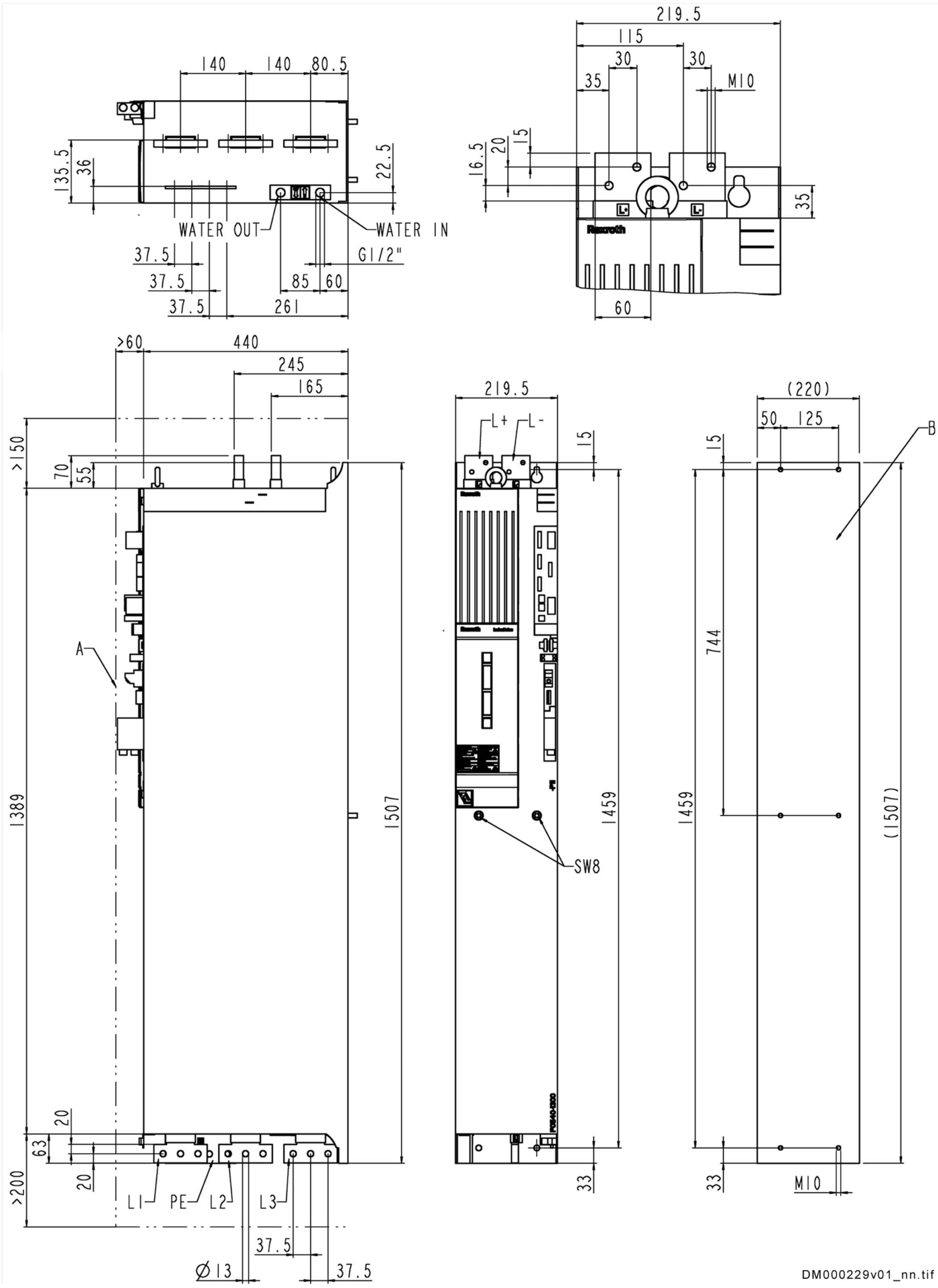


A Minimum mounting clearance
B Boring dimensions

Fig. 4-40: HMU05.1N-F0430-1040

Combining the individual components

HMU05.1N-F0540-1300



A Minimum mounting clearance
B Boring dimensions

Fig. 4-41: HMU05.1N-F0540-1300

4.5.2 Dimensions, mass, insulation, sound pressure level

Data for mass, dimensions, sound pressure level, insulation

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-N	HMU05.1N-F0170-0430-N-A4-D7-N	HMU05.1N-F0220-0510-N-A4-D7-N	HMU05.1N-F0270-0660-N-A4-D7-N
Mass	m	kg	51.00		58.00	65.00
Device height[1)]	H	mm	817		921	1025
Device depth[2)]	T	mm	440			
Device width[3)]	B	mm	200			
Insulation resistance at 500 V DC	R_{is}	Mohm	> 50			
Capacitance against housing	C_Y	nF	-			
Average sound pressure level (accuracy class 2) at P_{DC_cont}[4)]	L_P	dB (A)	-			
Last modification: 2016-06-16						

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at distance 1 m, out of cabinet; HCS types with order code -L***: load-dependent

Tab. 4-15: HMU – data for mass, dimensions, sound pressure level, insulation

Data for mass, dimensions, sound pressure level, insulation

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Mass	m	kg	70.00	83.00	103.00	tbd
Device height[1)]	H	mm	1103	1311	1522	tbd
Device depth[2)]	T	mm	440			tbd
Device width[3)]	B	mm	200		220	tbd
Insulation resistance at 500 V DC	R_{is}	Mohm	> 50			
Capacitance against housing	C_Y	nF	-			
Average sound pressure level (accuracy class 2) at P_{DC_cont}[4)]	L_P	dB (A)	-			
Last modification: 2016-06-16						

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at distance 1 m, out of cabinet; HCS types with order code -L***: load-dependent

Tab. 4-16: HMU – data for mass, dimensions, sound pressure level, insulation

4.5.3 Temperatures, cooling, power dissipation, distances

Cooling and power dissipation data

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
Allowed mounting position			G1			
Allowed switching frequencies[1)]	f_s	kHz	2,4,8			
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)[2)]	$P_{Diss\_0A\_fs\ min}$	W	230	250	270	320
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)[3)]	$P_{Diss\_0A\_fs\ max}$	W	300	325	350	400
Power dissipation at continuous current and continuous DC bus power respectively[4)]	P_{Diss_cont}	W	2500.00	3000.00	4250.00	5500.00
Liquid cooling data						
Power dissipation ratio (liquid) with continuous current/continuous power	$P_{Diss\_cont\_F}$	W	2100.0	2500.0	3500.0	4500.0
Coolant inlet temperature	T_{in}	°C	Less than 60			
Required minimum coolant flow for $P_{Diss\_cont\_F}$	Q_{min}	l/min	4	5	7	9
Temperature increase for Q_{min} and $P_{Diss\_cont\_F}$	ΔT	K	Less than 10			
Pressure drop for Q_{min}	Δp	bar	0.4		0.5	
Maximum allowed operating pressure	p_{max}	bar	2.00			
Coolant channel volume	V_{ch}	ml	609		667	724
Coolant channel material			Aluminum			
Constant for determining pressure drop	$K_{\Delta p}$		tbd			
Air cooling data						
Power dissipation ratio (air) with continuous current/continuous power	$P_{Diss\_cont\_A}$	W	400.0	500.0	750.0	1000.0
Ambient temperature range for operation with nominal data	T_{a_work}	°C	0...40			
Ambient temperature range for operation with reduced nominal data	$T_{a\_work\_red}$	°C	0...55			
Derating of P_{DC_cont}; P_{BD}; I_{out_cont} when $T_{a\_work} < T_a < T_{a\_work\_red}$	f_{Ta}	%/K	2.0			
						Last modification: 2016-06-17

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
Volumetric capacity of forced cooling	V	m^3/h	-			
Minimum distance on the top of the device5)	d_{top}	mm	100			
Minimum distance on the bottom of the device6)	d_{bot}	mm	100			
Temperature increase with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	10			
Last modification: 2016-06-17						

1) Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of the power output stage"; see "P-0-4058, Amplifier type data"; for supply units the switching frequency is 4.2 kHz
2) 3) Plus dissipation of braking resistor and control section; find interim values by interpolation to P_Diss_cont
4) Plus dissipation of braking resistor and control section
5) 6) See fig. "Air intake and air outlet at device"

Tab. 4-17: HMU – cooling and power dissipation data

Cooling and power dissipation data

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Allowed mounting position			G1			
Allowed switching frequencies1)	f_s	kHz	2,4,8			
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)2)	$P_{Diss\_0A\_fs\ min}$	W	350	400	450	500
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)3)	$P_{Diss\_0A\_fs\ max}$	W	450	500	550	600
Power dissipation at continuous current and continuous DC bus power respectively4)	P_{Diss_cont}	W	5500.00	6500.00	8700.00	10000.00
Liquid cooling data						
Power dissipation ratio (liquid) with continuous current/continuous power	$P_{Diss\_cont\_F}$	W	4500.0	5500.0	7500.0	8500.0
Coolant inlet temperature	T_{in}	°C	Less than 60			
Required minimum coolant flow for $P_{Diss\_cont\_F}$	Q_{min}	l/min	9	11	16	18
Last modification: 2016-06-17						

Combining the individual components

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Temperature increase for Q_{min} and $P_{Diss\_cont\_F}$	ΔT	K	Less than 10			
Pressure drop for Q_{min}	Δp	bar	0.6	1	1.3	
Maximum allowed operating pressure	p_{max}	bar	2.00			
Coolant channel volume	V_{ch}	ml	851	966	1024	tbd
Coolant channel material			Aluminum			
Constant for determining pressure drop	$K_{\Delta p}$		tbd			
Air cooling data						
Power dissipation ratio (air) with continuous current/continuous power	$P_{Diss\_cont\_A}$	W	1000.0		1200.0	1500.0
Ambient temperature range for operation with nominal data	T_{a_work}	°C	0...40			
Ambient temperature range for operation with reduced nominal data	$T_{a\_work\_red}$	°C	0...55			
	f_{Ta}	%/K	2.0			
Volumetric capacity of forced cooling	V	m^3/h	-			
Minimum distance on the top of the device[5)]	d_{top}	mm	100			
Minimum distance on the bottom of the device[6)]	d_{bot}	mm	100			
Temperature increase with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	10			
Last modification: 2016-06-17						

1) Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of the power output stage"; see "P-0-4058, Amplifier type data"; for supply units the switching frequency is 4.2 kHz

2) 3) Plus dissipation of braking resistor and control section; find interim values by interpolation to P_Diss_cont

4) Plus dissipation of braking resistor and control section

5) 6) See fig. "Air intake and air outlet at device"

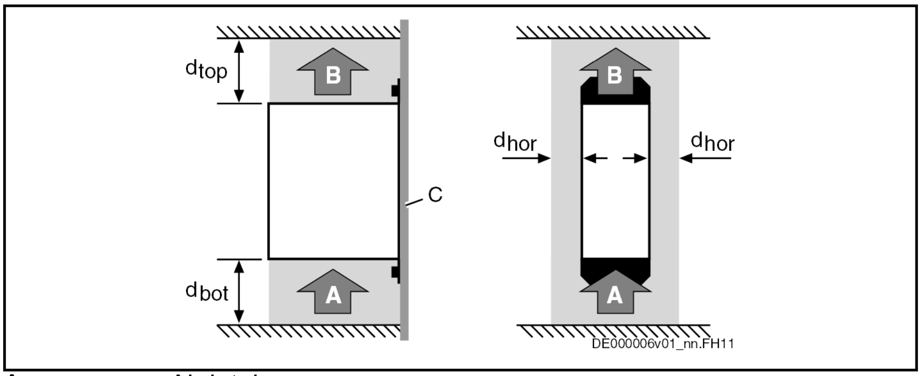
Tab. 4-18: HMU – cooling and power dissipation data

NOTICE **Property damage due to temperatures higher than 105 °C!**

Observe the indicated minimum distances!

Above the devices there may only be such materials which

- are not combustible
- are insensitive to the occurring high temperatures



A	Air intake
B	Air outlet
C	Mounting surface in control cabinet
d_{top}	Distance top
d_{bot}	Distance bottom
d_{hor}	Distance horizontal

Fig. 4-42: Air intake and air outlet at device

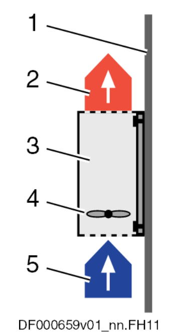
4.5.4 Mounting positions of components

NOTICE **Risk of damage to the components by incorrect mounting position!**

Only operate the components in their allowed mounting positions.

For supply units and drive controllers installed in control cabinets, only the mounting position G1 is allowed.

Mounting position G1



The air that is heated inside the component can flow out of the component in a vertical upward direction. The natural convection supports the forced cooling air current. This avoids the generation of pockets of heat in the component.

1. Mounting surface in control cabinet
2. Outgoing, heated air
3. Component
4. Fan within the component (forces the cooling air current)
5. Cooling air

Tab. 4-19: Mounting position G1

4.6 Electrical project planning

4.6.1 Overall connection diagram (HMU05 as drive controller)

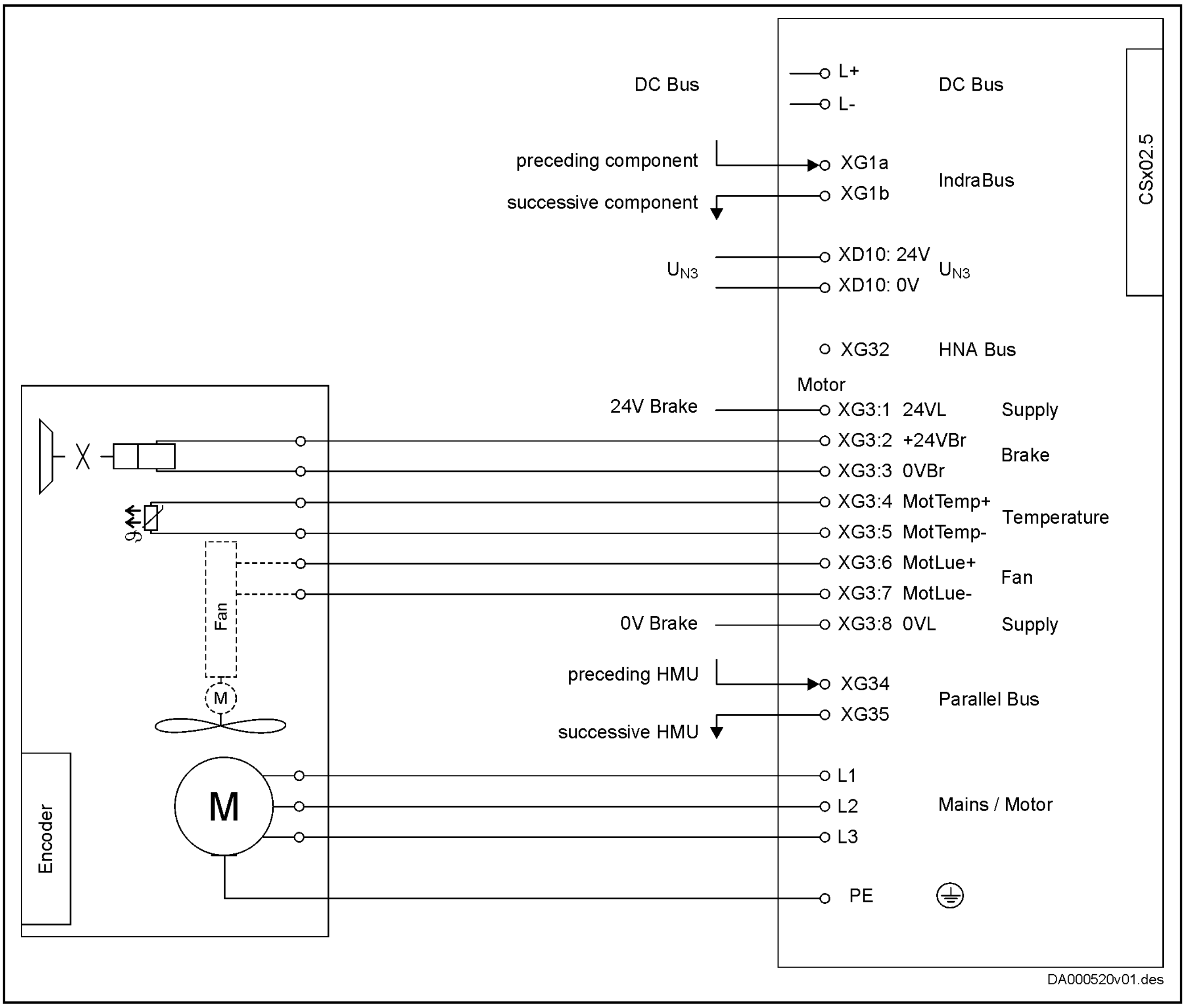
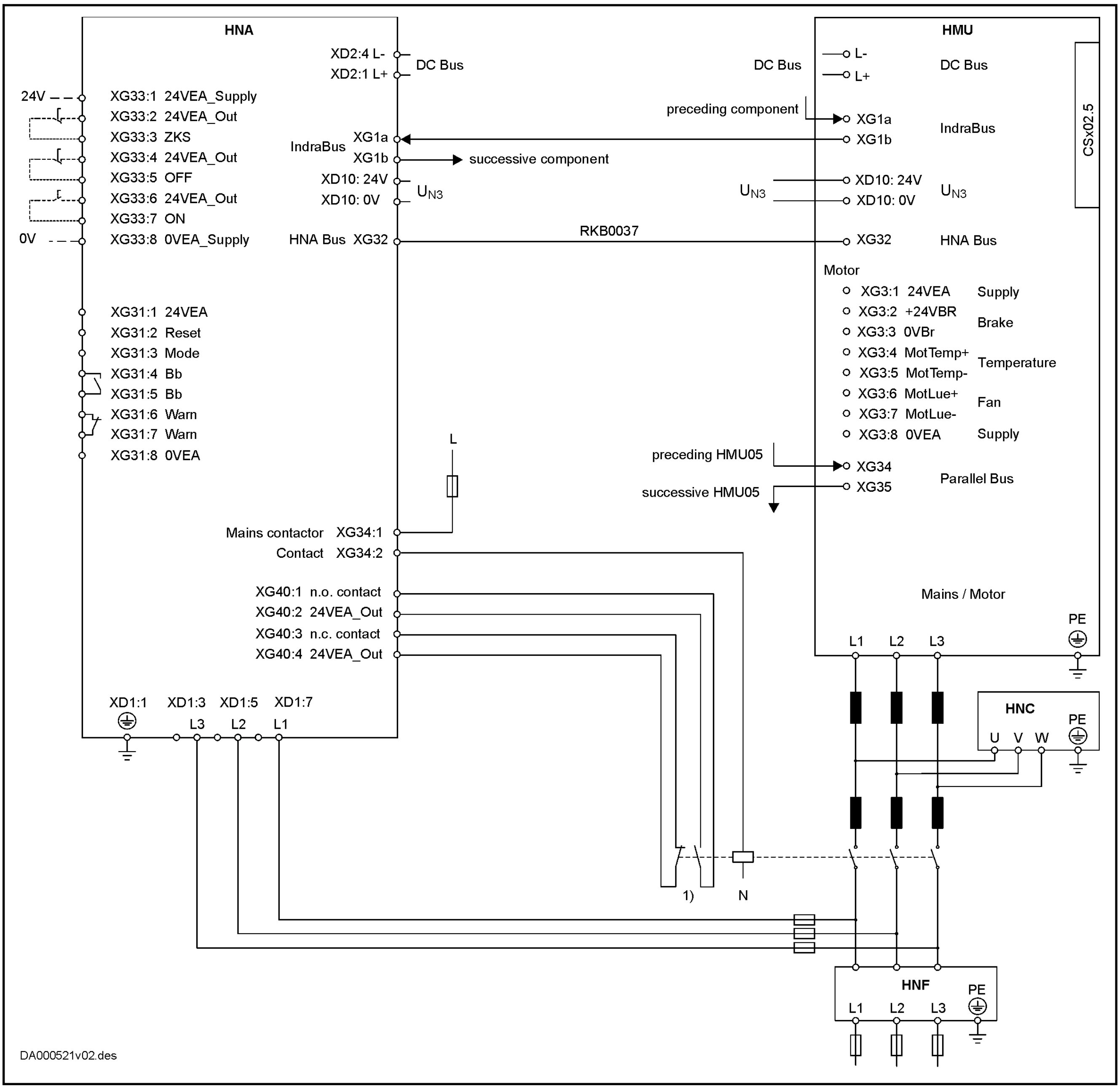


Fig. 4-43: Connection diagram (HMU05 as drive controller)

4.6.2 Overall connection diagram (HMU05 as supply unit)

Overall connection diagram with load contactor

For your drive system, preferably use the connection with a load contactor pictured here (instead of the connection with a controllable main switch).



1) With multiple contactors connected in parallel, connect the N/O contacts and N/C contacts in series.

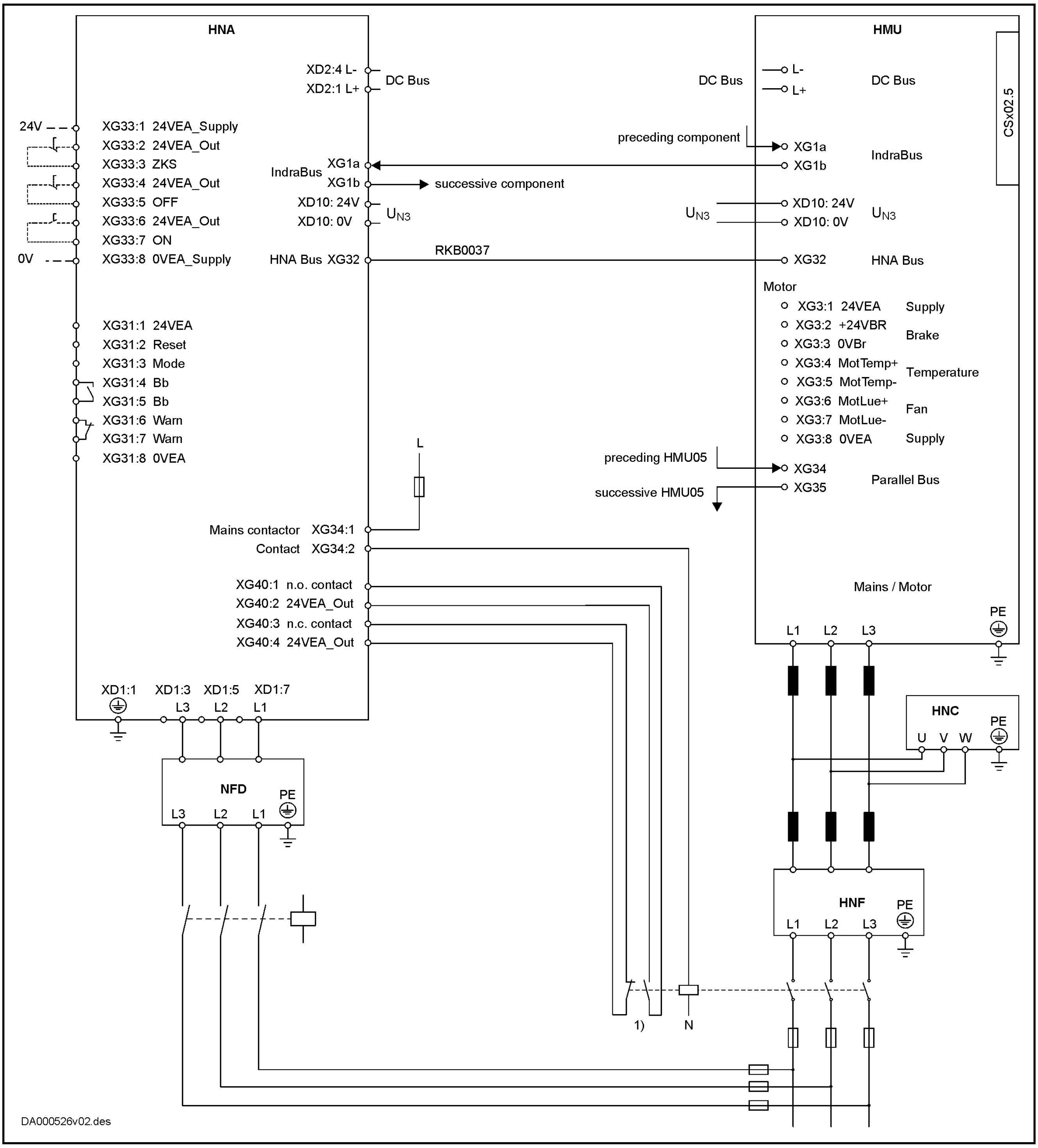
Fig. 4-44: Connection diagram with load contactor (HMU05 as supply unit)

Overall connection diagram with a controllable main switch

☞ For your drive system, preferably use the connection with a load contactor (instead of the connection with a controllable main switch).

☞ Transient oscillation processes between HNC and mains inductance can occur when the main switch is turned on. Therefore, select an appropriate main switch.

☞ Observe the local regulations regarding EMC and standards.



1) With multiple main switches connected in parallel, connect the N/O contacts and N/C contacts in series.

Fig. 4-45: Connection diagram with controllable main switch (HMU05 as supply unit)

4.6.3 Project planning of control voltage

Control voltage for drive systems

Some components of a drive system have to be supplied with control voltage. When doing the project planning for control voltage supply, include the drive system component requirements:

- Depending on the motor cable length and whether or not motor holding brakes are used, the **permitted tolerances of the supply voltage**
- Power consumption of the **drive controllers**
- Power consumption of **other loads** (e.g., motor holding brakes, digital outputs)
- **Current carrying capacity of the connection point** for control voltage supply on the component for the purpose of looping through the control voltage to other components

Sizing the control voltage supply

Determining the power requirements

Drive controller power requirements

The **total power requirements** of the control voltage supply of a drive controller result from the sum of the following power values:

- Basic device (drive controller without connected encoders)
- Optional connection interfaces (e.g., communication, additional encoder evaluation)
- Connected encoder systems
- External loads

See the type plate and type code for configuring your drive controller.

The tables below contain the individual power values required by the drive controller. The power requirement of the supplying 24 V power supply unit results from the sum of these individual power values.

Basic device power requirements

The power requirements of the basic device result from

- Maximum current of drive controller
- Inrush current of drive controller
- Control section design (data: see Project Planning Manual for control section)

HMU05.1N-...	performance [kW]	Current consumption of control voltage supply [A_{rms}]
F0140-0350	110/132	1.7
F0170-0430	132/160	2.0
F0220-0510	160/200	2.2
F0270-0660	200/250	1.9
F0340-0820	250/315	2.0
F0430-1040	315/400	2.3
F0540-1300	400/500	2.4
F0680-1690	500/630	2.7

Tab. 4-20: Current consumption of control voltage supply

Power requirements of the optional connection points

If the drive controller has optional connection points, the power requirements of the basic device are increased. (Data: see Project Planning Manual for control section)

Power requirements of the external loads

External loads include, for example,

- Encoder system of the motor
- Motor holding brake
- Load at a digital output

The drive controller has to supply the external loads with power.

Table 3: Power requirements of the external loads

External load	Power requirement
5 V encoder system	$P = I_{Encoder} \times 5\ V \times 1.75$ [1), 5)]
12 V encoder system	$P = I_{Encoder}$ x 12 V x 1.25 [1), 5)]
Load at digital output	$P = I_{Load}$ x U_{N3} [2), 4)]
Motor holding brake	$P = I_{Brake}$ x U_{N3} [3), 4)]

1) $I_{encoder}$: Current consumption of encoder system
2) I_{load} : Current consumption of external load
3) I_{brake} : Current consumption of motor holding brake
4) U_{N3} : Control voltage supply of drive controller
5) The sum of the power consumption of all connected encoder systems incl. encoder emulation cannot exceed 6 W.

Tab. 4-21: Power requirements of the external loads

Calculation formula

The total power consumption (P_{N3}) from the 24 V control voltage of a drive controller is calculated with:

$$P_{N3} = P_{basic\ device} + \Sigma P_{optional\ connection\ points} + \Sigma P_{external\ loads}$$

Requirements on the 24V power supply unit

PELV[1] for 24V power supply unit

For the 24V supply of the devices of the Rexroth IndraDrive ML range, use a power supply unit or a control-power transformer with protection by PELV according to IEC 60204-1 (section 6.4).

In the scope of CSA/UL, the data of the control-power transformer are limited to:

- Max. output voltage: 42.4 V_{peak} or 30 V_{ac}
- Max. output power: 10000 VA

The following **parameters** contain the essential electrical requirements on the 24 V power supply unit:

- **Output voltage** or output voltage range
- **Continuous power** which the 24 V power supply unit has to supply during operation
- **Peak current** which the 24 V power supply unit has to supply when switching on
- **Inrush current** which the 24 V power supply unit has to supply when switching on

Required continuous power

The continuous power of the 24 V power supply unit has to be greater than the sum of the power consumptions P_{N3} of the components being supplied.

To select the 24 V power supply unit, determine the continuous current I_{N3} of all components:

$I_{N3} = P_{N3} / U_{N3}$

(P_{N3} : power consumption of all components)

The calculated current I_{N3} corresponds to the continuous current of the 24 V power supply unit.

The power consumption is indicated as the maximum value of each component and can occur in **individual components**.

In drive systems with **several components**, the occurring power consumption under statistical assumptions will be lower than the calculated one.

Required peak current

When the 24 V control voltage unit is switched on, the 24 V power supply unit is loaded with the charging current of the capacitors from the connected components. This charging current is electronically limited in the components.

The required peak current of the power supply unit is calculated with:

$I_{PeakCurrent\_PowerSupplyUnit} = 1.2 \times P_{N3} / U_{N3}$

(P_{N3} : power consumption of all components)

The power supply unit has to provide the calculated peak current $I_{PeakCurrent\_PowerSupplyUnit}$ for at least one second.

Required inrush current

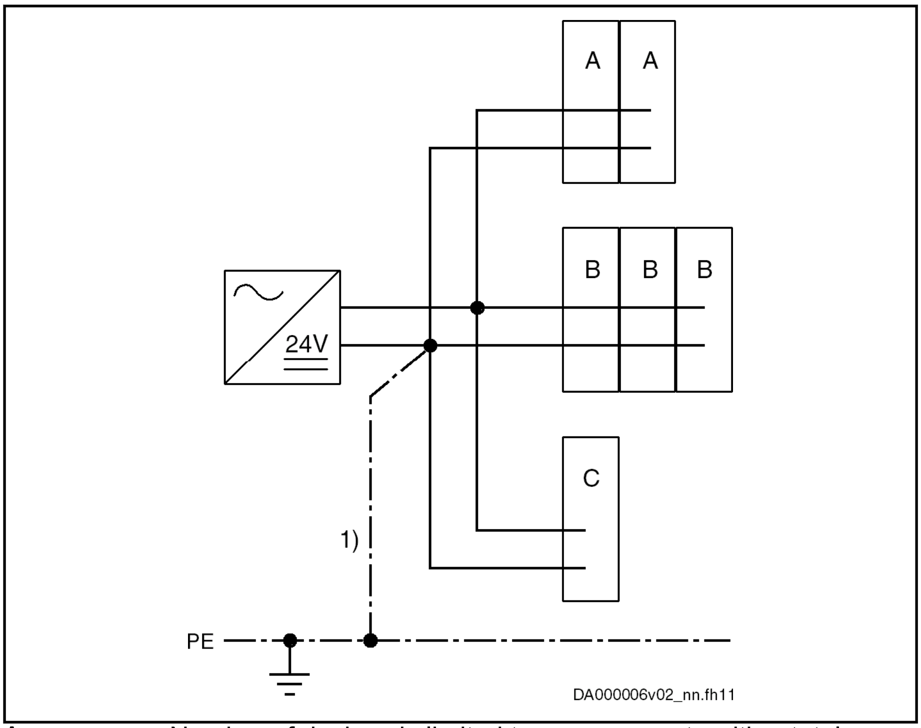
See chapter 7.2.1 "Control voltage" on page 137

[1] *Protective Extra Low Voltage*

Installing the 24V supply

Notes on installation

- The 24 V supply of the Rexroth IndraDrive ML drive system components should in principle be installed in a **star** layout. This means it is necessary to run separate supply lines for each group of drive controllers or third-party components. This also applies to multiple-line arrangement in case of supply from, e.g., a supply unit.
- Route lines of sufficient size to reduce load-dependent voltage drops.
- For looping through the control voltage, observe the maximum current carrying capacity of the connection points. The maximum current carrying capacity limits the number of devices to which the control voltage can be looped through.



A	Number of devices is limited to x components with a total current consumption of < 40 A (in accordance with UL: 31 A).
B	Number of devices is limited to y components with a total current consumption of < 40 A (in accordance with UL: 31 A).
C	Third-party component (e.g., PLC, valve, etc.)
1)	Connection to central ground point (e.g., PE earth-circuit connector)

Fig. 4-46: Installing the 24 V supply

☞ If you use several 24 V power supply units:

- Output voltages of the 24 V power supply units have to be within the allowed voltage range
- Interconnect reference conductors 0 V of the individual 24 V power supply units with low impedance
- Always switch 24 V power supply units on and off synchronously

---

Chronological order of 24 V supply and mains voltage

Before mains voltage or DC bus voltage is applied to the components, they have to be supplied by the 24 V supply.

Looping through the control voltage

NOTICE **Property damage in case of error from line cross section being too small!**

Observe the current carrying capacity of the connection points for control voltage supply at the components used.

You can only loop through the control voltage between the components, if the **sum** of current consumptions ΣI_{N3} of the individual components is smaller than **40 A** (in accordance with UL: 31 A) (current carrying capacity of the connection point XD10).

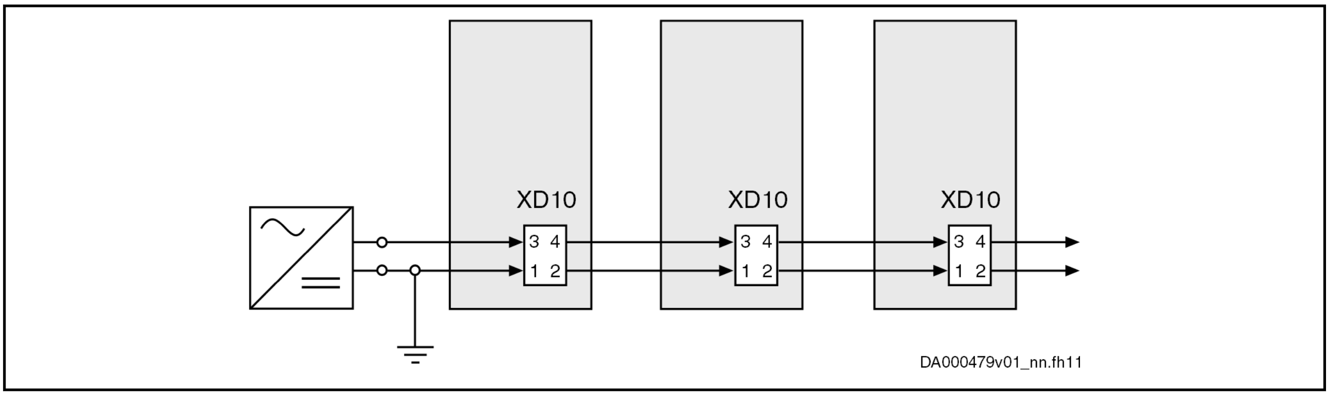


Fig. 4-47: Looping through the control voltage

Sample calculation for 3 drive controllers:

$$I_D = 3 \times \frac{P_{N3}}{U_{N3}}$$

Fig. 4-48: Continuous current

The result I_D has to be smaller than the specified current carrying capacity of the connection point.

4.6.4 Mains connection

Residual-current-operated circuit breakers (RCD, RCCB) as additional fusing

General information

The following designations are used for residual-current-operated circuit breakers:

- RCCB (Residual-Current-Operated Circuit Breaker)
- RCD (Residual-Current-Operated Device)
- RCM (Residual-Current Monitoring Device)
- Earth-leakage circuit breaker (voltage-independent)
- Residual-current circuit breaker (voltage-dependent)

☞ It is only to a limited extent that residual-current-operated circuit breakers can be used with Rexroth IndraDrive ML systems.

If these circuit breakers are to be used, the company erecting the installation has to check the mutual compatibility of the residual-current-operated circuit breakers and installation or machine with the drive system, in order to avoid accidental triggering of the residual-current-operated circuit breaker. This has to be taken into account

- for switch-on processes, due to high asymmetric inrush currents and
- during operation of the installation, due to leakage currents produced in normal operation.

Cause of leakage currents

For the purpose of stepless speed variation with a high degree of positioning accuracy and dynamic response, certain modulation procedures are necessary for drive systems. For physical reasons, these modulation procedures give rise to inevitable leakage current produced during normal operation. Especially with unbalanced loads of the mains phases or a large number of drives it can easily reach some amperes (rms value).

The leakage current is not sinusoidal but pulse-shaped. For this reason, measuring instruments normally sized for alternating currents in the range of 50 Hz are not suited. Use measuring instruments with rms value measuring ranges up to at least 150 kHz.

The degree of leakage current depends on the following features of the installation:

- Type of inrush current limitation
- Number, type and size of drives used
- Length and cross section of connected motor power cables
- Grounding conditions of the mains at the site of installation
- Unbalance of the three-phase system
- Types of filters and chokes connected in the incoming circuit
- EMC measures that are taken

If measures are taken to improve the electromagnetic compatibility (EMC) of the installation (mains filters, shielded lines), the leakage current in the ground wire is inevitably increased, especially when switching on or in the case of mains unbalance. Given these operating conditions, residual-current-operated circuit breakers can trigger without an error having occurred.

The EMC measures are mainly based on capacitive short-circuiting of the interference currents within the drive system. Inductive filter measures can reduce the leakage currents, but affect the dynamic response of the drive and bring about

- higher construction volume
- higher weight
- expensive core material

Possibilities of use

Motor cable lengths

Keep the motor cables as short as possible. Only short motor cables do allow low leakage currents and thereby enable residual-current-operated circuit breakers to work.

Types of residual-current-operated circuit breakers

There are two types of residual-current-operated circuit breakers:

1. **Residual-current-operated circuit breakers sensitive to power pulse current** (type A acc. to IEC 60755)

   These are normally used. However, it is only pulsating direct fault currents of a maximum of 5 mA and sinusoidal alternating fault currents that they switch off safely. This is why they are not allowed for devices that can generate smoothed direct fault currents. In the case of smoothed direct fault currents that can be produced in power supply units, mains rectifiers and drive controllers with power converters in B6 circuit, the residual-current-operated circuit breaker is not triggered. This blocks the triggering of a residual-current-operated circuit breaker sensitive to power pulse current in the case of ground contact, i.e. in the case of error.

Residual-current-operated circuit breakers sensitive to power pulse current do not provide any protection against inadmissible contact voltage.

2. **Residual-current-operated circuit breakers sensitive to universal current** (type B acc. to IEC 60755)

   These circuit breakers are suited for smoothed direct fault currents, too, and safely switch off devices with B6 input rectifiers.

   If a current with 30 mA triggers the residual-current-operated circuit breaker, it is possible to use a residual-current-operated circuit breaker with a higher tripping current for machine protection.

   If this residual-current-operated circuit breaker triggers accidentally, too, check in how far the above conditions and dependencies can be improved (for example, by connecting current-compensated mains chokes in the incoming circuit, increasing the inrush current limitation).

Using isolating transformer to reduce leakage current in mains

If there is no improvement achieved and the residual-current-operated circuit breaker, due to specific mains conditions on site, has to be used nevertheless on the mains input side, connect an isolating transformer between mains connection and power connection of the drive system. This reduces the leakage current in the ground wire of the mains that is produced during normal operation which allows the residual-current-operated circuit breaker to be used. Connect the neutral point of the secondary winding of the isolating transformer to the equipment grounding conductor of the drive system.

Adjust the ground-fault loop impedance to the overcurrent protective device so that the unit can be switched off in the case of failure.

Before operating enable, check the correct function of the overcurrent protection device including activation in the case of failure.

Exclusive fusing by residual-current-operated circuit breaker

For drive systems with electronic drive controllers, exclusive protection by means of a residual-current-operated circuit breaker normally is not possible and not allowed.

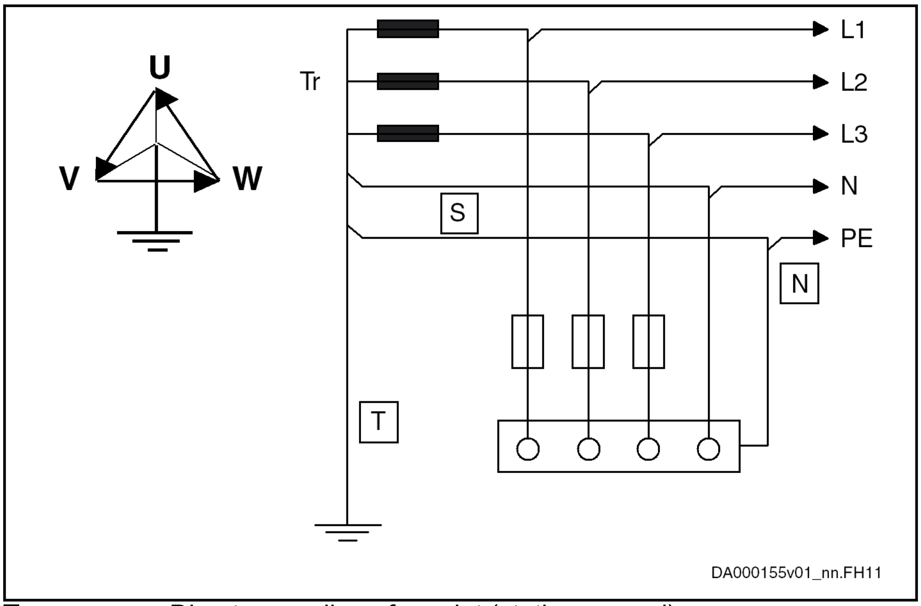
Electronic equipment that has a nominal power higher than 4 kVA or is destined for permanent connection does not need residual-current-operated circuit breakers.

According to IEC 60204-1 and IEC 61800-5-1, the mains-side protection against indirect contact, i.e. in the case of insulation failure, has to be provided in a different way, for example by means of an overcurrent protection device, protective grounding, protective-conductor system, protective separation or total insulation.

Mains types

TN-S mains type

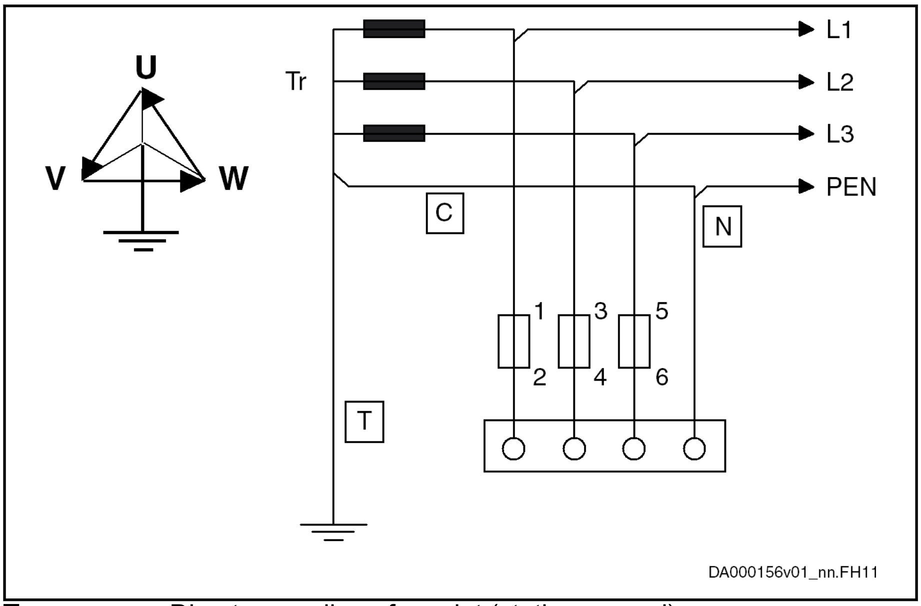
The TN-S mains type is the usual mains type in Europe.



T = Direct grounding of a point (station ground)
N = Exposed conductive parts directly connected to station ground
S = Separate neutral conductor and equipment grounding conductor in entire mains

Fig. 4-49: TN-S mains type

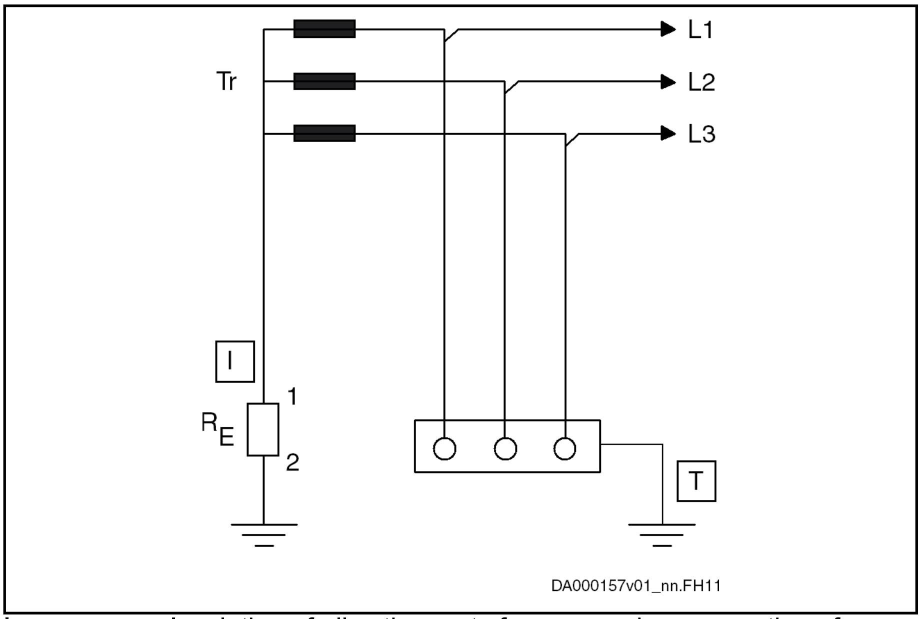
TN-C mains type



T = Direct grounding of a point (station ground)
N = Exposed conductive parts directly connected to station ground
C = Neutral conductor and equipment grounding conductor functions in entire mains combined in a single conductor, the PEN conductor.

Fig. 4-50: TN-C mains type

IT mains type



I	Insulation of all active parts from ground or connection of one point to ground via an impedance R_E
T	Exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig. 4-51: IT mains type

Notes on project planning

NOTICE **Risk to damage to devices from voltage arcing.**

For applications with static charging (e.g., printing, packaging) and operation on **IT mains type**, use an **isolating transformer** with $U_K \leq 2.5\%$.

☞ **Voltage increase in the case of ground fault!**

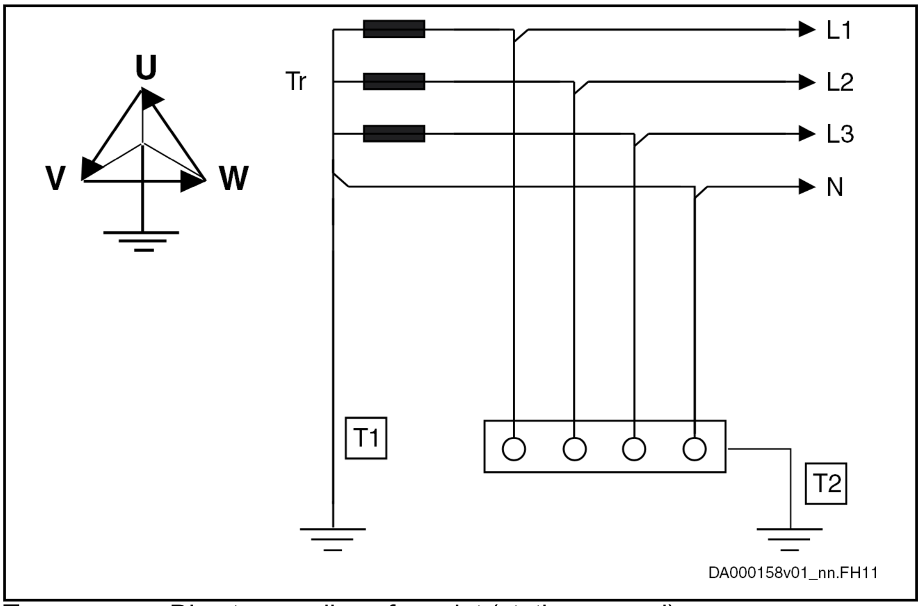
In case of a "ground fault" in the IT mains type, higher voltages against ground (device housing) affect the device as opposed to error-free operation.

The "ground fault" in the IT mains type is only possible temporarily with the IndraDrive components.

For operation on the IT mains type, the drive system including mains filter and mains choke should be electrically separated from the mains by an **isolating transformer**.

In this way, the ground fault detection or monitoring can remain effective in the system.

TT system

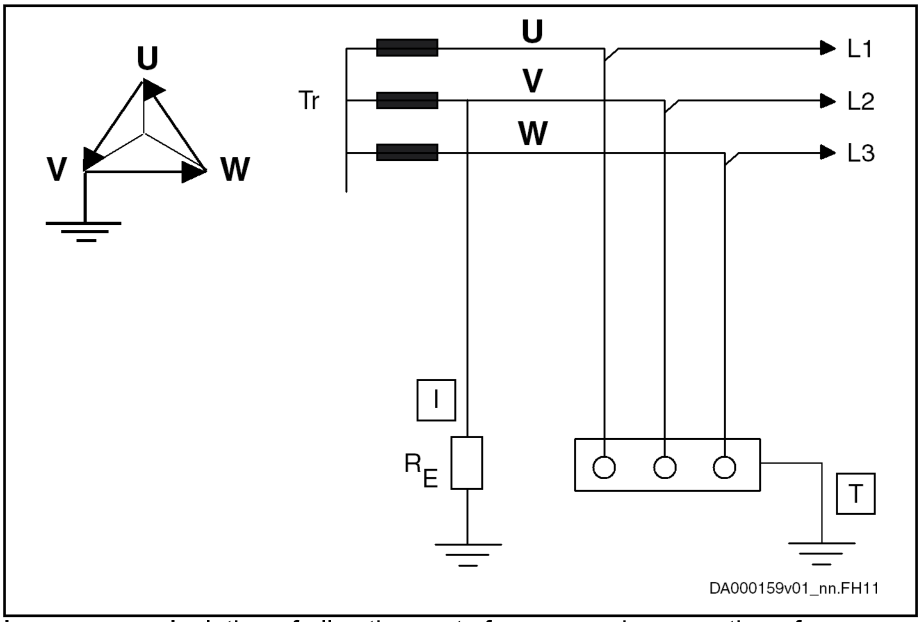


T = Direct grounding of a point (station ground)
T = Exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig. 4-52: TT mains system

The EMC requirements are only observed through specific measures (incl. special mains filters).

Mains with grounded outer conductor (Corner-grounded delta mains)



I = Isolation of all active parts from ground, connection of one phase - generally phase V - to ground or via an impedance R_E
T = Exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig. 4-53: Mains with grounded outer conductor

Notes on project planning

The EMC requirements are only observed through specific measures (incl. special mains filters).

HNF05 mains filter and HNC05 mains capacitors on mains grounded with outer conductor

HNF05 mains filter and HNC05 mains capacitors are not suited for operation on mains grounded with outer conductor. Use isolating transformers.

Allowed mains connection voltage: see technical data for each device

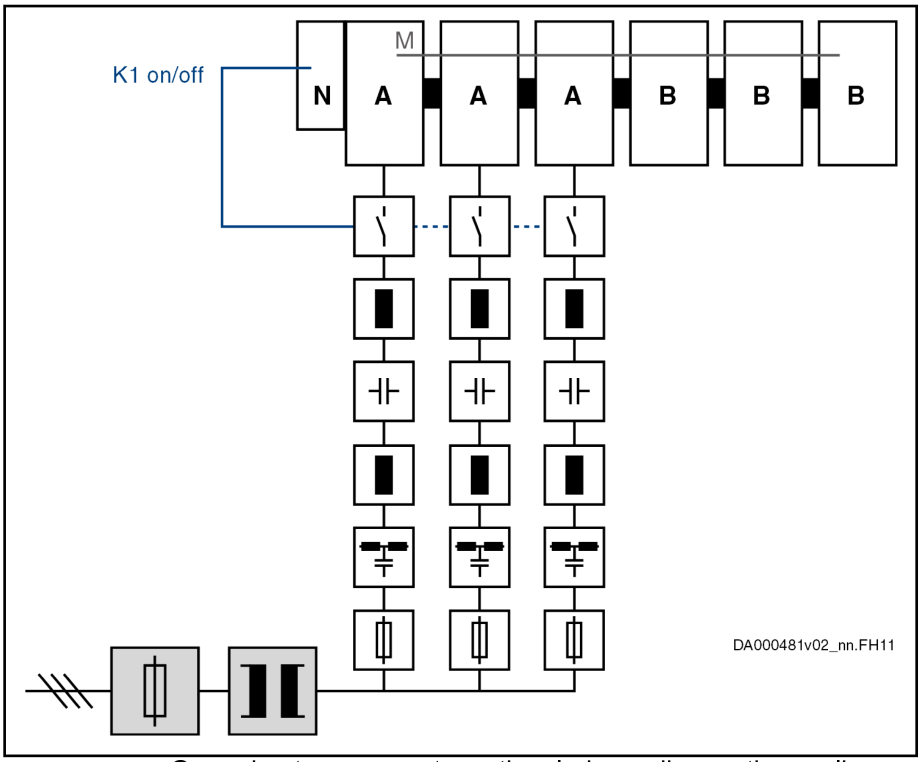
Mains connection type

See also chapter 4.6.4 "Mains connection" on page 102.

Wire the **ready relay contacts** of the drive controllers supplied with mains voltage in the control circuit of the mains contactor.

Parallel connection

Multiple HMU05 components (same size) are connected to the mains and in parallel to a larger HMV05. Each HMU05 has its own mains choke and mains filter.



	Grayed out components: optional, depending on the application
A	HMU05 component (all components A identical); connected to supply mains with mains chokes; connected to other components through DC bus
B	HMU05 component (as HMS05 inverter); connected to other components through DC bus
K1 on/off	Mains contactor wiring; connect the auxiliary contacts of the mains contactors in series (see picture below)
M	IndraBus
N	HNA05 mains connection module

Fig. 4-54: Parallel connection; multiple HMU05 components connected to supply mains

Mains contactor wiring in the case of parallel connection

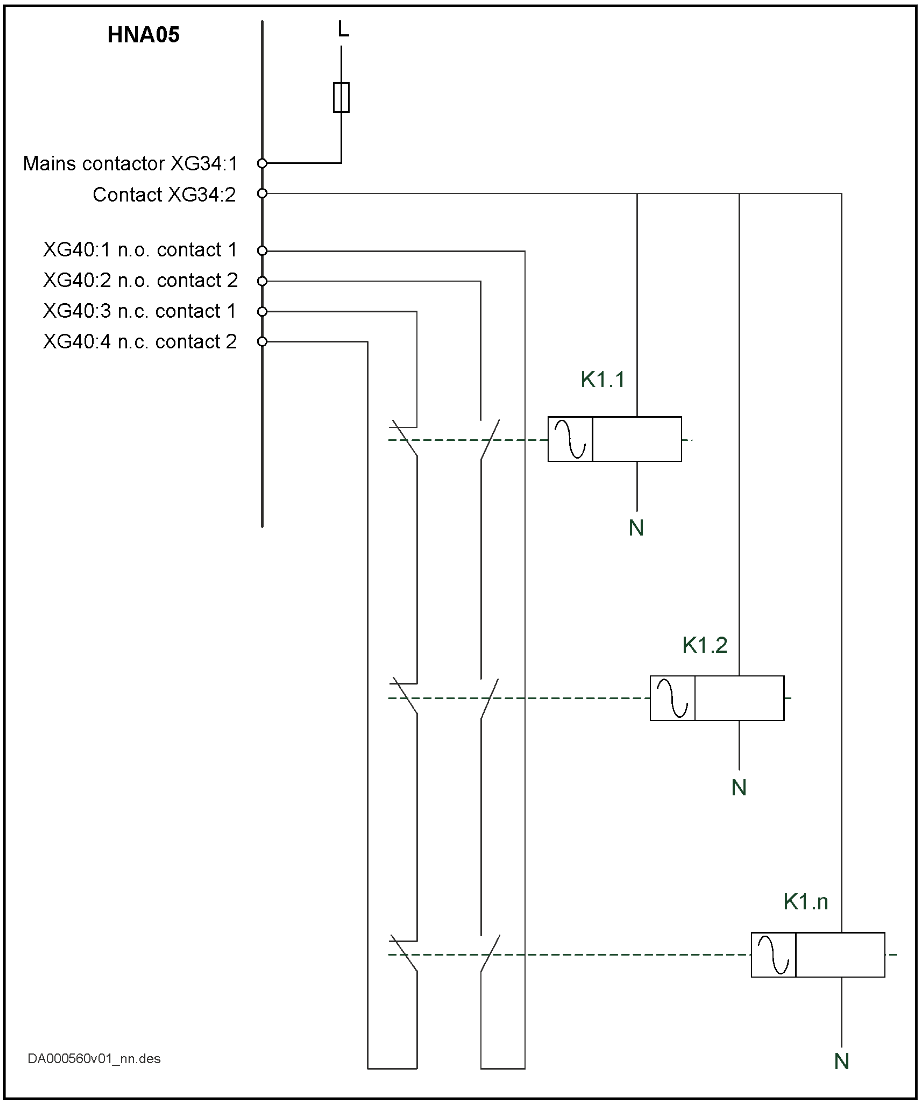


Fig. 4-55: Mains contactor wiring in the case of parallel connection

☞ **Mains contactor wiring:** Connect the auxiliary contacts of the mains contactors in series. The auxiliary contacts are evaluated by HNA05.

Switch-on process: N/O contacts are monitored

Switch-off process: N/C contacts are monitored

NOTICE	Risk of fire caused by missing fuses!

Install fuses. In case a short circuit occurs in the drive controller, a fuse provides optimum safety against overheating or fire (see also IEC 61800-5-1 and UL 508C).

For distribution in North America, single fuses are required for this type of mains connection (see UL 508A).

In the scope of international and European standards (IEC/EN, not North America), it is allowed to use a group fuse instead of the single fuses. When selecting the nominal current of the group fuse, observe the loop impedance, the line length and the line cross section of the mains supply feeder (see IEC 60204-1, chapter Appendix A).

Observe the data for dimensioning line cross sections and fuses (see also IEC 60204-1, UL 508A and NFPA 79).

Mains connected load and mains current

Technical data of the components

- See chapter 7.2.2 "Mains voltage" on page 139
- See chapter 7.2.3 "DC bus" on page 141

Calculating the mains-side phase current

The mains-side phase current is required for the following cases:

- Selecting mains contactor
- Determining fuses in the mains connection
- Determining line cross section
- Selecting other components in the mains connection (mains filter, mains choke)

Operation under rated conditions

For data on mains contactor, fuses and cross section in operation under rated conditions, see technical data of the respective component.

Operation at partial load

Operation at partial load can lead to smaller mains contactors, fuses and line cross sections.

If defined data for operation at partial load are available, the mains-side phase current can be determined as follows:

1. Determine **motor power**

   Take power of drive controller-motor combination from Rexroth IndraSize or calculate it.

   $$P_{mHa} = \frac{M_n \times n_n}{9550}$$

P_{mHa}	Mechanical nominal power for main drives (shaft output) [kW]
M_n	Nominal motor torque [Nm]
n_n	Nominal motor speed [min^{-1}]

2. Determine **DC bus power** from motor power and efficiency

$$P_{DC} = \frac{M_{eff} \times n_m \times 2\pi}{60} \times k$$

P_{DC}	Required DC bus continuous power [W]
M_{eff}	Effective torque in Nm
n_m	Average speed in min^{-1}
k	Factor for motor and controller efficiency = 1.25

3. Add **powers of all axes** at common DC bus and put them into relation to rated power of supply unit

   ⇒ Partial load of P_{DC_cont} is available

4. Determine **power factor TPF** for partial load (TPF = Total Power Factor)

   For the value **TPF** at rated power and **TPF_{10}** (at 10% of rated power), see technical data (mains voltage) of the component.

5. Calculate **mains connected load**

$$S_{LN} = \frac{P_{DC}}{TPF}$$

S_{LN}	Mains connected load [VA]
P_{DC}	DC bus continuous power [W]
TPF	Total Power Factor λ

6. Calculate **mains-side phase current**

   3-phase:
$$I_{LN} = \frac{S_{LN}}{U_{LN}\sqrt{3}}$$

I_{LN}	Mains-side phase current in [A]
S_{LN}	Mains connected load [VA]
U_{LN}	Voltage between phases of mains [V]

7. Select **mains contactor**
8. Determine **mains circuit breaker and line cross section**

   See chapter 11.2 "Dimensioning the line cross sections and fuses " on page 371

Dimensioning the line cross sections and fuses

See chapter 11.2 "Dimensioning the line cross sections and fuses " on page 371.

Dimensioning and selecting the mains transformer

Mains transformers are always needed when the mains voltage is outside of the allowed nominal voltage of the component.

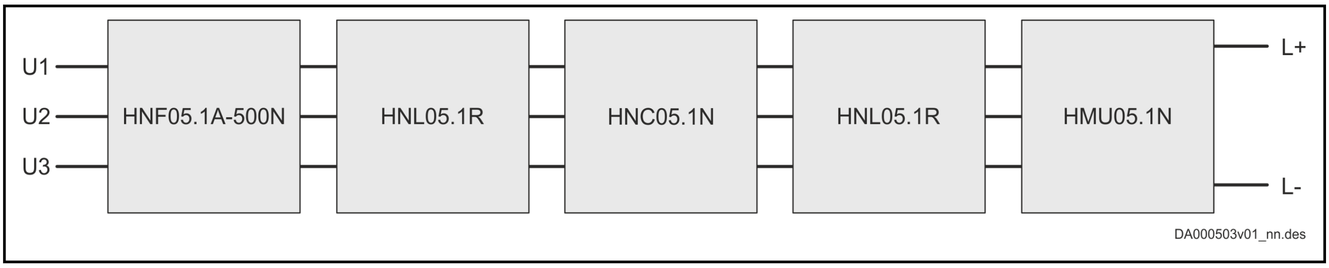
Grounded mains

The mains voltage for grounded mains is generally adjusted with **autotrans-formers**.

Ungrounded mains

The mains voltage for ungrounded mains is generally adjusted with **isolating transformers** to prevent overvoltages between outer conductor and ground. Short-circuit voltage of the isolating transformer: ≤ 6%

Combining mains filter, mains choke, preconnected choke and capacitance pack



HNF05.1A-500N	Mains filter
HNL05.1R	Preconnected choke
HNC05.1N	Mains capacitor
HNL05.1R	Mains choke
HMU05.1N	Universal inverter

Fig. 4-56: Mains connection components

Components		Supply unit HMU05.1N-…							
		F0140-0350 (110 kW size)	F0170-0430 (132 kW size)	F0220-0510 (160 kW size)	F0270-0660 (200 kW size)	F0340-0820 (250 kW size)	F0430-1040 (315 kW size)	F0540-1300 (400 kW size)	F0680-1690 (500 kW size)
Mains choke HNL05.1R-	0219-N0218	✓							
	0182-N0262		✓						
	0135-N0327			✓					
	0117-N0409				✓				
	0130-N0514					✓			
	0113-N0652						✓		
	0100-N0811							✓	
	0094-N1019								✓
Preconnected choke HNL05.1R-	0045-N0327			✓					
	0054-N0409				✓				
	0043-N0514					✓			
	0050-N0652						✓		
	0040-N0811							✓	
	0040-N1019								✓
Mains capacitor HNC05.1N-	0050	✓	✓						
	0075			✓					
	0100				✓	✓	✓	✓	✓
Mains filter HNF05.1A-	500N-R0250	✓							
	500N-R0320		✓						
	500N-R0400			✓					
	500N-R0600				✓	✓			
	500N-R1000						✓	✓	
	500N-R1600								✓

Tab. 4-22: Mains connection components

Combining the individual components

4.6.5 Running multiple HMU05s in parallel

Up to eight HMU05 with the same performance can be operated in parallel to extend the power range.

Parallel HMU05s can be operated both as supply units and drive controllers.

Operation as supply unit uses HNL05 mains chokes to balance parallel operation.

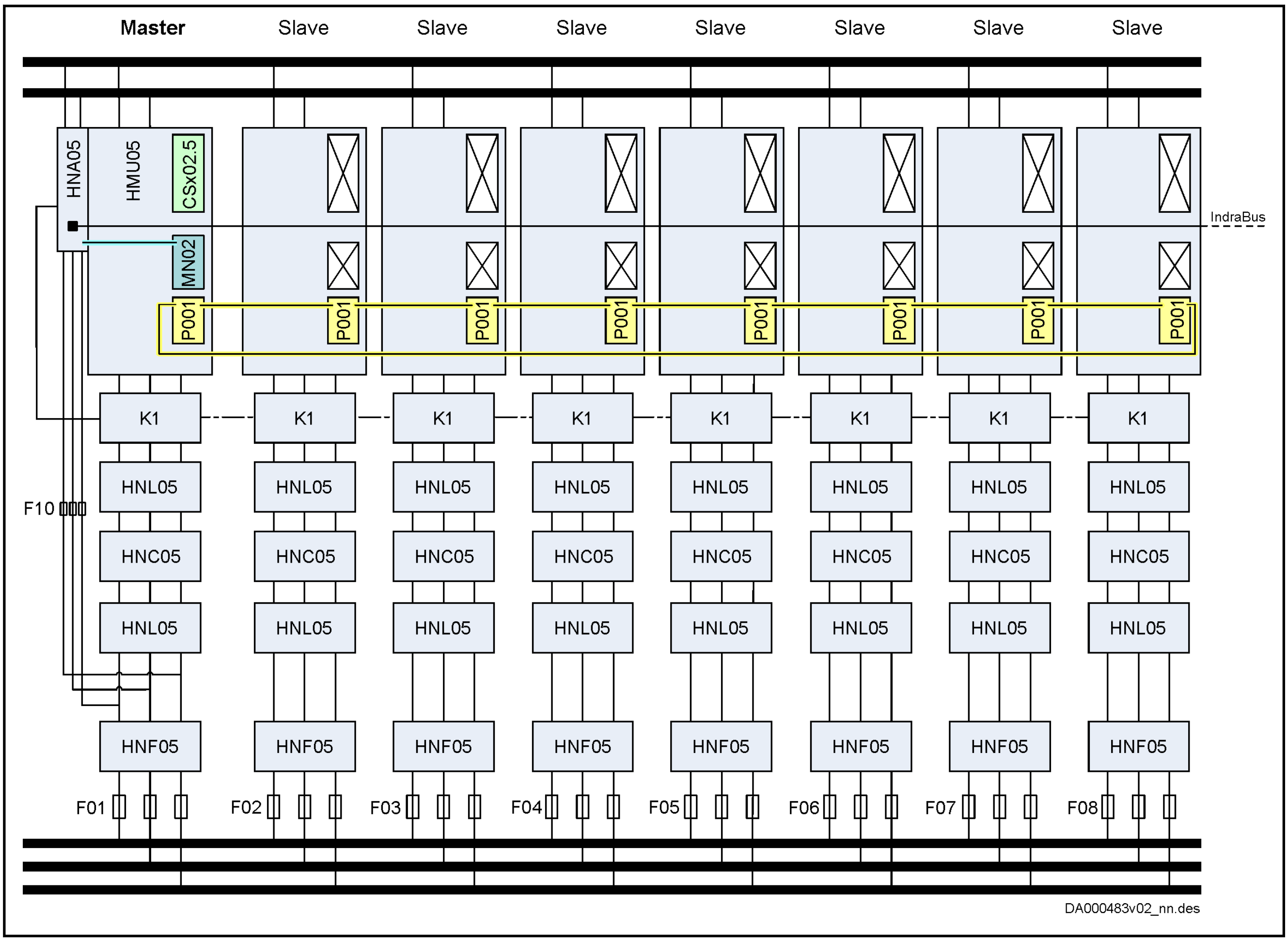
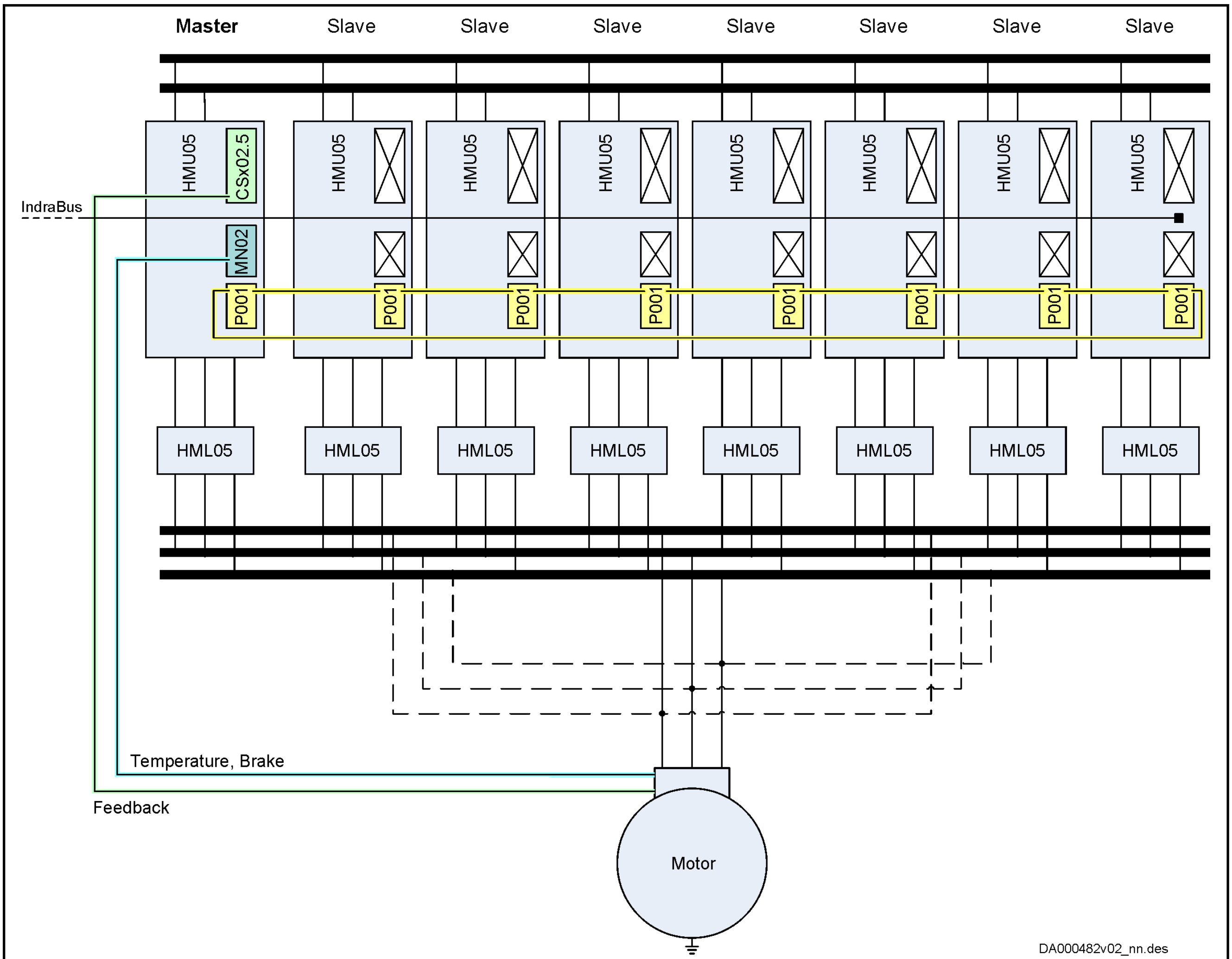


*Fig. 4-57: Parallel operation of HMU05 to run as **supply unit***

Operation as drive controller uses additional HML05 motor chokes.



Clock frequency Parallel HMU05s can only be operated at clock frequencies below 8 kHz.

Motor A motor can be operated with electrically isolated windings. A motor cannot be operated with phase-shifted windings.

Fig. 4-58: Parallel operation of HMU05 to run as ***drive controller***

When running in parallel, one HMU05 is the "master" and the other HMU05s are the "slaves".

The master has a CSx02.5 control section and an HPC01.1-**MN02** optional card. The master communicates with the slaves through the HPC01.1-**P001** optional cards (ring topology). Connection cables to the HPC01.1-P001 optional cards always have to be run **inside the control cabinet**. Comply with maximum allowed line lengths.

The power outputs have to be wired **symmetrically** to ensure the output current of the HMU05s are symmetrically distributed and no HMU05s are overloaded. To do this, the power outputs are connected to a common busbar. The motor is then connected directly to the busbar.

Maximum line lengths

Between HMU05 and motor:

- Shielded: 100 m
- Unshielded: 150 m

Comply with the allowed cable capacitance for motor chokes or balancing chokes.

Connection to HPC01.1-P001 optional cards

- 1 m: Between two neighboring devices
- 8 m: Between the last and first device

(Lines may not be routed outside the control cabinet.)

Derating

5%

Since the output current is not exactly distributed equally even with a symmetrical design, the output current is derated. Therefore, it is impossible to use 100% of the calculated total power.

4.7 Acceptance tests and approvals

Declaration of conformity

Declarations of conformity confirm that the components comply with the valid EN standards and EC directives. If required, our sales representative can provide you with the declarations of conformity for components.

	Drive controllers, Supply units	**Motors**
CE conformity regarding Low-Voltage Directive	EN 61800-5-1:2007	EN 60034-1:2010+Cor.:2010 EN 60034-5:2001+A1:2007
CE conformity regarding EMC product standard	EN 61800-3:2004 + A1:2012	

Tab. 4-23: CE - applied standards

C-UL-US listing

The components are listed by **UL** (Underwriters Laboratories Inc.®).

Proof of certification can be found online:

www.ul.com/database

Under "UL File Number" enter the file number or under "Company Name" enter the company name "Bosch Rexroth AG".

Listed POW. CONV. EQ. 97Y4	• UL standard: 61800-5-1 • CSA standard: Canadian Standard CSA C22.2 No. 274-13
	Company Name BOSCH REXROTH ELECTRIC DRIVES & CONTROLS GMBH Category Name: Power Conversion Equipment
	File numbers Rexroth IndraDrive ML components (HMU05, HNA05, HNC05, HNF05, HNL05, HML05, HLL05, HPC01): • E134201

Tab. 4-24: C-UL listing

UL ratings

When using the component in the scope of CSA / UL, observe the UL ratings for each component.

Make sure that the indicated **SCCR short-circuit rating** is not exceeded, e.g., by using appropriate fuses in the mains connection of the supply unit.

UL wiring material

In the scope of CSA / UL, use copper 60/75 °C only; class 1 or equivalent only.

Allowed pollution degree

Comply with the allowed pollution degree of the components (see "Ambient and operating conditions").

CCC (China Compulsory Certification)

The CCC mark is a compulsory certification of safety and quality for certain products mentioned in the product catalog "First Catalogue of Products Subject to Compulsory Certification" and in the CNCA document "Application Scope for Compulsory Certification of Products acc. first Catalogue" and put in circulation in China. This compulsory certification has existed since 2003.

CNCA is the Chinese authority responsible for certification guidelines. When a product is imported in China, the certification will be checked at customs using the entries in a database. Three criteria are typically critical for certification being required:

1. Customs tariff number (HS code) according to CNCA document "Application Scope for Compulsory Certification of Products acc. first Catalogue".
2. Area of application according to CNCA document "Application Scope for Compulsory Certification of Products acc. first Catalogue".
3. For the IEC product standard used, a corresponding Chinese GB standard must exist.

For the drive components by Rexroth described in this documentation, **certification is currently not required**, so they are not CCC certified. Negative certifications will not be issued.

5 Condition as supplied, identification, transport and storage

5.1 Condition as supplied

5.1.1 Factory testing

Voltage testing and insulation resistance testing

According to standard, the **components** of the Rexroth IndraDrive ML range are tested with voltage.

Testing	Test rate
Voltage testing	100% (EN 61800-5-1)
Insulation resistance testing	100% (EN 60204-1)

Tab. 5-1: Applied standards

5.1.2 Customer testing

NOTICE **Risk of damage to the installed Rexroth components by customer-side testing of the machine or installation!**

Before conducting voltage testing or insulation resistance testing for an **installation or machine** in which these components are used:

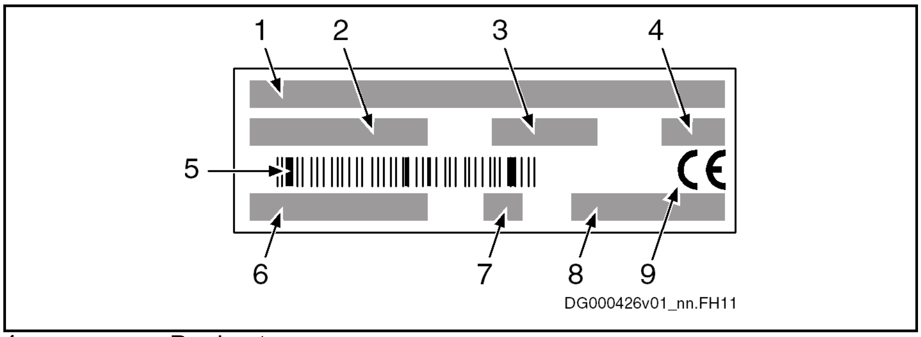
Disconnect all connections to the Rexroth components or disconnect the plug-in connections to protect the electronic components.

5.2 Identification

5.2.1 Type plates

Design

Type plate (device)



1 Device type
2 Part number
3 Production week; 11W36, for example, means year 2011, week 36
4 Factory identifier
5 Bar code
6 Serial number
7 Hardware index
8 Country of manufacture
9 Identification

Fig. 5-1: Type plate (device)

5.2.2 Contents of delivery

Standard
HAS10.1-002-006-NN
Documentation

Tab. 5-2: Contents of delivery HMU05

5.3 Transporting components

Ambient and operating conditions for transport

Description	Symbol	Unit	Value
Temperature range	T_{a_tran}	°C	-25 to 70
Relative humidity		%	5 to 95
Absolute humidity		g/m^3	1 to 60
Climatic category (IEC721)			2K3
Condensation			Not permitted
Icing			Not permitted

Tab. 5-3: Ambient and operating conditions for transport

5.4 Storing components

NOTICE **Risk of damage to components from long-term storage.**

Some components contain electrolytic capacitors which may deteriorate during storage.

When storing the following components for a longer period of time, run them **once per year for at least one hour**:

- Converters and supply units: operated with line voltage V_{LN}
- Inverters and DC bus capacitor units: operated with DC bus voltage V_{DC}

NOTICE **Risk of damage to liquid-cooled components from frost.**

Before storing, fully drain coolant channels or use antifreeze.

Ambient and operating conditions for storage

Description	Symbol	Unit	Value
Temperature range	T_{a_store}	°C	-25 to 55
Relative humidity		%	5 to 95
Absolute humidity		g/m^3	1 to 29
Climatic category (IEC721)			1K3
Condensation			Not permitted
Icing			Not permitted

Tab. 5-4: Ambient and operating conditions for storage

6 Mounting and installation

6.1 Mounting HMU05 devices in control cabinet

HMU05 drive controllers were designed to be mounted in control cabinets.

Notes on mounting

- When mounting, observe the mandatory **minimum distances** between components (see chapter 4.5.1 "Dimensions" on page 82).
- **Tightening torque** of the **M10** mounting screws: **48 Nm**
- Mounting tools: HAS08.1-008-NNN-MH

  Description of the individual mounting steps: See chapter 8.2.2 "Cabinet installation kit (HAS08.1-008)" on page 149.
- Mounting accessories:
  - Mounting plate for device width 200 mm: HAS10.1-002-005

    See chapter "Mounting plate for device width 200 mm (HAS10.1-002-005)" on page 162.
  - Mounting plate for device width 220 mm: HAS10.1-002-006

    See chapter "Mounting plate for device width 220 mm (HAS10.1-002-006)" on page 164.

6.2 Electrical connection

6.2.1 Overall connection diagram (HMU05 as drive controller)

See chapter 4.6.1 "Overall connection diagram (HMU05 as drive controller)" on page 94.

6.2.2 Overall connection diagram (HMU05 as supply unit)

Overall connection diagram with load contactor

See chapter "Overall connection diagram with load contactor" on page 95.

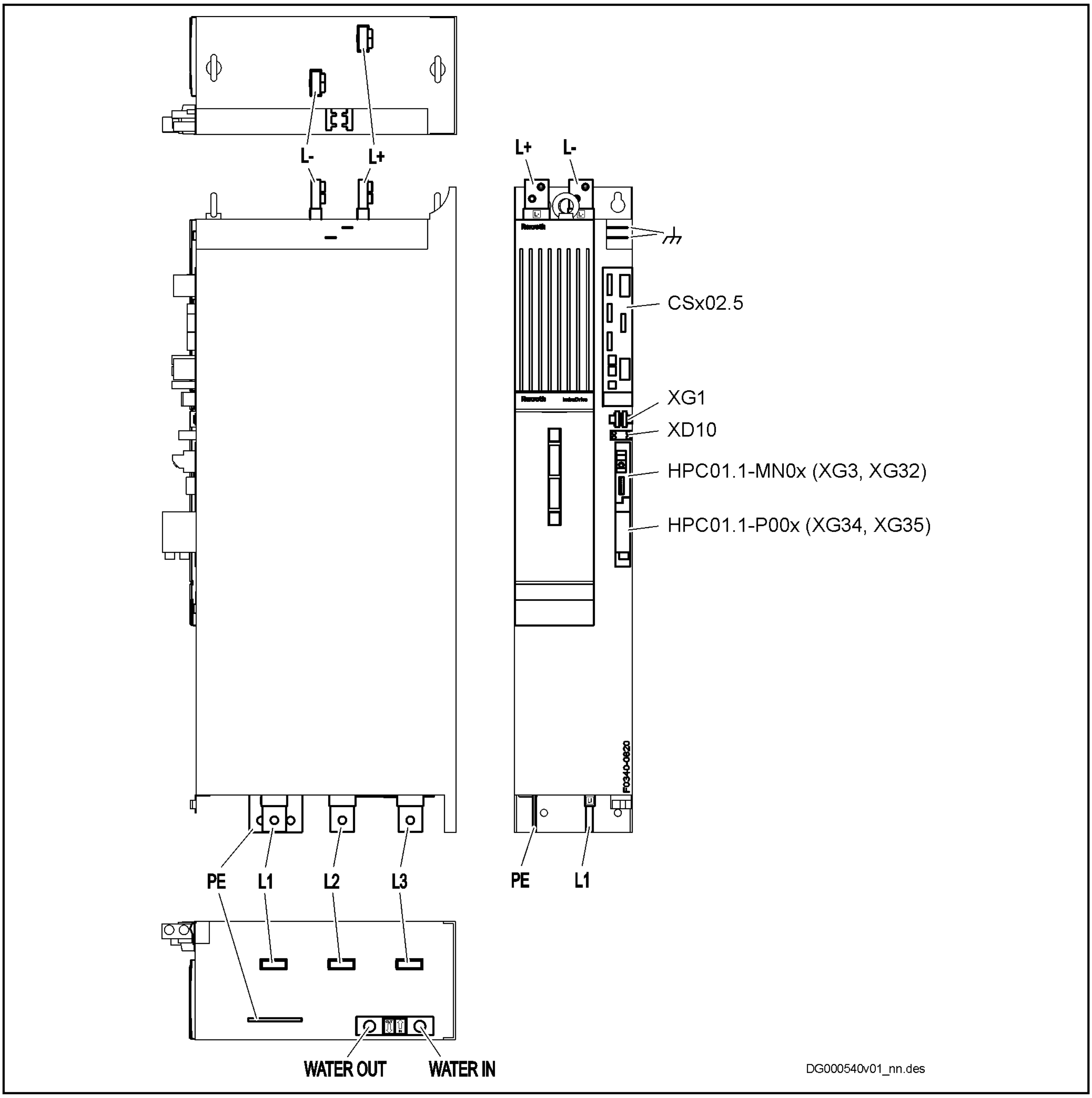
Overall connection diagram with controllable main switch

See chapter "Overall connection diagram with a controllable main switch" on page 96.

6.2.3 Connection points

Arrangement of HMU05 connection points

HMU05 connection points



CSx02.5	Control section
HPC01	Optional card
L1, L2, L3	Mains/motor connection
L+, L-	DC Bus
PE	Equipment grounding conductor
XG1	IndraBus
XD10	Control voltage
WATER IN/OUT	Cooling liquid

Fig. 6-1: HMU05 connection points

Connection point of equipment grounding conductor

⚠ WARNING **High housing voltage and high leakage current! Danger to life, risk of injury from electric shock!**

- Ground or connect the electrical drive and control system components with the equipment grounding conductor to the grounding points before power-on and commissioning.
- Connect the equipment grounding conductor of the electric drive and control system components permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Make sure the copper equipment grounding connection wire is large enough (see table "Minimum equipment grounding connection cross section").

⚠ WARNING **Lethal electric shock by live parts with more than 50 V!**

Exclusively operate the device

- with plugged on connectors (even if there haven't been any lines connected to the connectors) and
- with connected equipment grounding conductor!

☞ **Equipment grounding conductor: material and cross section**

Use the same metal (e.g., copper) for the equipment grounding conductor as for the outer conductors.

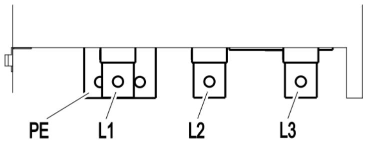
Make sure the lines for the connections from the device's equipment grounding conductor to the equipment grounding conductor system in the control cabinet are large enough.

Equipment grounding connection cross sections:

see table "Minimum equipment grounding connection cross section".

Also mount the housing on a bare metal mounting plate. Be sure to connect the mounting plate to the equipment grounding system in the control cabinet with at least the same cross section of wire.

Mounting and installation

View	Identification	Function	
	PE	Connection to equipment grounding system	
Connecting bolt	**Unit**	**Min.**	**Max.**
Hole diameter	mm	13	
Tightening torque M10	Nm	25	
Tightening torque M12	Nm	48	
Occurring current load and minimum required connection cross section		See technical data of device used (I_{LN} and A_{LN})	
Occurring voltage load		See technical data of device used (U_{LN} or U_{LN_nenn})	

Tab. 6-1: Function, pin assignment, properties

Minimum cross section of equipment grounding connection

Outer conductor cross section	Min. cross section of equipment grounding conductor Leakage current ≥ 3.5 mA
16 mm² (6 AWG)	16 mm² (6 AWG)
25 mm² (4 AWG)	
35 mm² (2 AWG)	
50 mm² (1/0 AWG)	25 mm² (4 AWG)
70 mm² (2/0 AWG)	35 mm² (2 AWG)
X mm²	(X × 0.5) mm² (valid for X ≥ 50)

Tab. 6-2: Minimum cross section of equipment grounding connection

L1, L2, L3, mains/motor connection

Important notes

⚠ WARNING **Lethal electric shock by live parts with more than 50 V!**

Exclusively operate the device

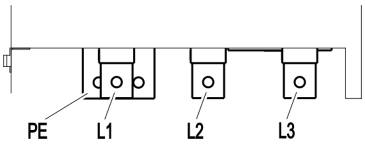
- with plugged on connectors (even if there haven't been any lines connected to the connectors) and
- with connected equipment grounding conductor!

Notes on installation

- The cable is connected to the connection point using **ring cable lugs**.
- Measure the **necessary cross section** of the connection cables according to the determined phase current I_{LN} and the mains fuse.

NOTICE **Risk of damage to the device!**

Provide strain relief for the terminal connectors of the device in the control cabinet.

View	Identifica-tion	Function	
	L1	Connection to mains power supply (L1) or motor (A1)	
	L2	Connection to mains power supply (L2) or motor (A2)	
	L3	Connection to mains power supply (L3) or motor (A3)	
Connecting bolt	**Unit**	**Min.**	**Max.**
Hole diameter	mm	13	
Tightening torque M10	Nm	25	
Tightening torque M12	Nm	48	
Occurring current load and minimum required connection cross section		See technical data of device used (I_{LN} and A_{LN})	
Occurring voltage load		See technical data of device used (U_{LN} or U_{LN_nenn})	

Tab. 6-3: Function, pin assignment, properties

XG3, motor temperature monitoring, motor holding brake, motor fan control

⚠ WARNING **Dangerous movements! Danger to persons from falling or dropping axes!**

The standard motor holding brake provided or an external motor holding brake controlled directly by the drive controller are not sufficient on their own to guarantee personal safety!

Personal safety must be achieved using higher-level, fail-safe measures:

- Block off danger zones with safety fences or safety guards
- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
  – mechanically securing the vertical axes
  – adding external braking/arrester/clamping mechanisms
  – ensuring sufficient equilibration of the vertical axes

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

The motor temperature evaluation input is **not** electrically isolated from the housing. If excessive voltage is applied to the input (e.g., from motor winding voltage flashover), this voltage can travel to the housing. Make sure the temperature sensor of the connected motor is **double** insulated from the motor winding.

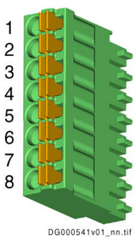
NOTICE **Risk of damage to device from excess voltage at motor temperature evaluation input!**

Only the allowed control voltage for the device is allowed at the motor temperature evaluation input. Excess voltage at the input can damage the device.

Function

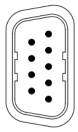
- Monitoring motor temperature
- Controlling motor holding brake
- Analog output for connecting a motor fan frequency converter

☞ Via an integrated contact element (BR), the power section switches the voltage of the **external** 24 V supply to the output for controlling the motor holding brake.

View	Connection	Signal name	Function
	1	24VEA	24 V supply voltage
	2	24VBr	Output for controlling motor holding brake
	3	0VBr	
	4	MotTemp+	Motor temperature evaluation input
	5	MotTemp-	
	6	MotLue+	Motor fan output (0 … 10 V)
	7	MotLue0V	Reference to motor fan output (0 V)
	8	0VEA	0 V supply voltage
Spring terminal (connector)	**Unit**	**Min.**	**Max.**
Connection cable Stranded wire	mm^2	0.25	1.5
	AWG	24	16
Stripped length	mm	10	
Current carrying capacity XG3 output (motor holding brake)	A	-	2
Number of switching actions at max. time constant of load		Wear-free electronic contact	
Short circuit protection		XG3.2 against XG3.3 (output for controlling motor holding brake)	
Overload protection		XG3.2 against XG3.3 (output for controlling motor holding brake)	

Tab. 6-4: Function, pin assignment

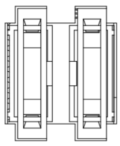
XG32, HNA bus

View	Identification	Function
	XG32	HNA bus

D-Sub, 9-pin, male	Unit	Min.	Max.
Connection cross section	mm^2	0.25	0.5
Cable: RKB0037	m	0.5 or 0.66	1

Tab. 6-5: Function, pin assignment, properties

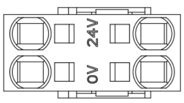
XG1, IndraBus

View	Connection	Function
	XG1a XG1b	Connects parallel components through a ribbon cable. • Output for quickly reporting critical errors to other devices • Input for detecting critical errors from other devices • Blocking and releasing DC bus short circuit by a braking resistor unit • Reporting DC bus availability *Cable* • Unshielded length: < 3 m Cable designation: RKB0036 • Shielded length: < 100 m Cable designation: RKB0035 In individual operation (that is to say not in combination with other devices of the Hxx05.1 series), both IndraBus **RBS0025 terminating plugs** must have been plugged in.

Tab. 6-6: XG1, IndraBus

XD10, 24 V supply (control voltage)

Function, pin assignment The 24 V supply is applied externally via connection point X10.

View	Connection	Signal name	Function
	24V	+24V	Power supply
		+24V	
	0V	0V	Reference potential for power supply
		0V	

Tab. 6-7: XD10, 24 V supply

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Solid wire	mm^2	1	10
Connection cable Stranded wire **without** ferrule	mm^2	1	6
	AWG	16	10
Connection cable Stranded wire **with** ferrule	mm^2	1	4
Stripped length	mm	10	

Tab. 6-8: Mechanical data

Electrical data

	Unit	Min.	Max.
Voltage load capacity	V	-	U_{N3}
Power consumption	W	-	P_{N3}
Current carrying capacity (looping through)	A	-	40 (UL: 31)
Allowed inductance	µH	-	100 (2 twisted single strands, 75 m long)

Tab. 6-9: Electrical data

Notes on installation

Depending on the power consumption of the devices and the current carrying capacity of the connector XD10, check the number of devices through which one line for 24 V supply can be looped through. You may have to connect another device directly to the 24 V supply and then loop through the control voltage from this device to other devices.

L+ L-, DC bus connection

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Before working on live parts: De-energize system and secure power switch against unintentional or unauthorized reconnection.

Make sure voltage has fallen below 50 V before touching live parts!

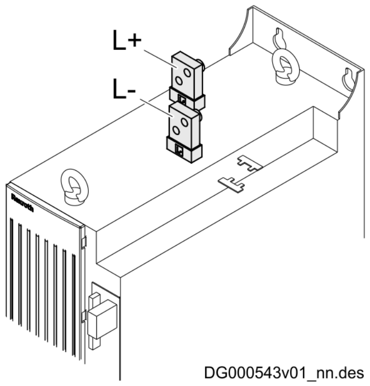
Wait at least **30 minutes** after switching off the supply voltages to allow **discharging** before accessing the device.

The discharge time can be more than 30 minutes if Y capacitor pairs are used.

Secure the DC bus connections against being touched.

Function, pin assignment

The DC bus connection connects the DC buses of multiple components.

View	Identifica-tion	Function
	L+ L-	Connections for screwing on DC bus bars Threads on connecting bolt: 2 x M10 Tightening torque: 48 Nm
	Unit	
Dimensions		See component dimensional drawing
Short circuit protection		Upstream fuse elements in mains connection
Overload protection		Upstream fuse elements in mains connection

Tab. 6-10: Function, pin assignment, properties

Notes on installation

Select the connection cross section according to the maximum current load occurring on the DC bus and the installation method for the connections.

NOTICE **Risk of damage by reversing the polarity of the DC bus connections L- and L+**

Make sure the polarity is correct.

Shield connection

Control line shield connection

Shield connection for control lines of the control section, motor, etc. whose connectors do not have a shield connection.

☞ Always connect the shields with the largest possible metal-to-metal contact surface.

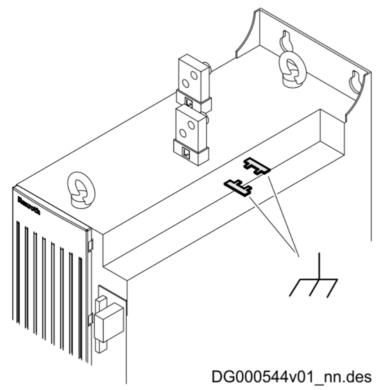


Fig. 6-2: Shield connection of shielded control lines

Motor power cable shield connection

The motor power cable shield is connected at a separate location in the control cabinet and not directly at HMU05.

Ground connection

The ground connection of the housing is used to provide functional safety of the drive controllers and protection against contact in conjunction with the equipment grounding conductor.

Ground the housings of the drive controllers:

1. Connect the bare metal back panel of the drive controller in conductive form to the mounting surface in the control cabinet. To do this, use the supplied mounting screws.
2. Connect the mounting surface of the control cabinet in conductive form to the equipment grounding system.
3. For the ground connection, observe the maximum allowed ground resistance.

6.2.4 Optional cards

HPC01.1-MN0x-NN

Fig. 6-3: HPC01.1-MN0x-NN

XG3 See chapter "XG3, motor temperature monitoring, motor holding brake, motor fan control " on page 127

XG32 See chapter "XG32, HNA bus" on page 129

HPC01.1-P001-NN

Fig. 6-4: HPC01.1-P001-NN

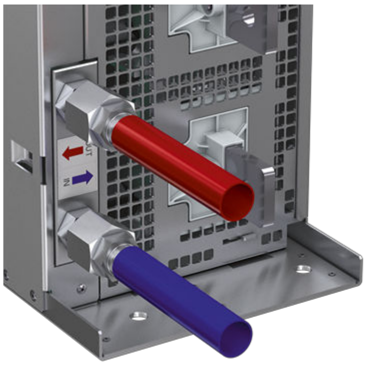
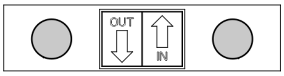
Cable RKB0038; cable for connecting multiple HPC01.1-P001-NN

It is **not** allowed to run the lines outside the control cabinet!

Maximum allowed length

- **1 m**: between two neighboring devices
- **8 m**: between the last and first device

6.3 WATER IN/OUT, cooling liquid connection

View	ID	Function
 	WATER IN	Supply
	WATER OUT	Return

	Symbol	Unit	Min.	Max.
Connecting thread			G1/2"	
Coolant inlet temperature	T_{in}	°C	Ambient temperature - 5 K	60
Permitted operating pressure	p_{max}	bar	-	2

Tab. 6-11: Function, properties

NOTICE **Risk of damage. Drive components cannot build condensation.**

In temperate zones (up to 40°C and 70% humidity), the inlet temperature of the coolant may be at a maximum 5 K below the temperature in the control cabinet.

Safest protection against condensation:

Coolant inlet temperature = ambient temperature

Condensation protection

Refer to the information on condensation protection.

7 Technical data of the components

7.1 Ambient and operating conditions

7.2 Power section

7.2.1 Control voltage

Control voltage supply data

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
Control voltage input[1]	U_{N3}	V	24 ±20%			
Control voltage when using motor holding brake with motor cable length less than 50 m (HCS01 less than 40 m)[2]	U_{N3}	V	24 ±5%			
Control voltage when using motor holding brake with motor cable length more than 50 m (HCS01 more than 40 m)[3]	U_{N3}	V	26 ±5%			
Max. inrush current at 24 V supply	I_{IN3_max}	A	less than 8			
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	less than 20			
Input capacitance	C_{N3}	mF	less than 0.01			
Rated power consumption control voltage input at U_{N3}[4]	P_{N3}	W	65	48	53	46
Last modification: 2015-12-03						

1) 2) 3) Observe supply voltage for motor holding brakes
4) See information on "Rated power consumption control voltage input at U_{N3}"

Tab. 7-1: HMU – control voltage supply data

Rated power consumption control voltage input at U_{N3}

Plus motor holding brake and control section, plus safety option

Control voltage supply data

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Control voltage input[1]	U_{N3}	V	24 ±20%			
Control voltage when using motor holding brake with motor cable length less than 50 m (HCS01 less than 40 m)[2]	U_{N3}	V	24 ±5%			
Last modification: 2015-12-03						

Technical data of the components

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Control voltage when using motor holding brake with motor cable length more than 50 m (HCS01 more than 40 m)3)	U_{N3}	V	26 ±5%			
Max. inrush current at 24 V supply	I_{IN3_max}	A	less than 8			
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	less than 20			
Input capacitance	C_{N3}	mF	less than 0.01			
Rated power consumption control voltage input at U_{N3}4)	P_{N3}	W	48	56	58	65
Last modification: 2015-12-03						

1) 2) 3) Observe supply voltage for motor holding brakes
4) See information on "Rated power consumption control voltage input at U_{N3}"

Tab. 7-2: HMU – control voltage supply data

Rated power consumption control voltage input at U_{N3}

Plus motor holding brake and control section, plus safety option

---

Overvoltage

Overvoltage greater than 33 V has to be discharged by means of the appropriate electrical equipment of the machine or installation.

This includes:

- 24V power supply units that reduce incoming overvoltage to the allowed value.
- Overvoltage limiters at the control cabinet input that limit existing overvoltage to the allowed value. This, too, applies to long 24V lines that have been run in parallel to power cables and mains cables and can absorb overvoltage by inductive or capacitive coupling.

7.2.2 Mains voltage

Electrical data – currents, voltages, power

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
Mains frequency	f_{LN}	Hz	50...60			
Mains frequency tolerance		Hz	± 2			
Rotary field condition			None			
Single-phase mains voltage	U_{LN}	V	-			
Three-phase mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	380..500			
Nominal mains voltage	U_{LN_nenn}	V	4 AC 400			
Three-phase mains voltage at IT mains[1)]	U_{LN}	V	380..500			
Three-phase mains voltage at Corner-grounded-Delta mains[2)]	U_{LN}	V	200..230			
Tolerance rated input voltage U_{LN}		%	+10 / -15			
Minimum inductance of mains supply (mains phase inductance)	L_{min}	µH	40			
Assigned type of mains choke			HNL05.1R-0219-N0218	HNL05.1R-0182-N0262	HNL05.1R-0135-N0327	HNL05.1R-0117-N0409
Assigned type of mains filter			HNF05.1A-500N-R0250	HNF05.1A-500N-R0320	HNF05.1A-500N-R0400	HNF05.1A-500N-R0600
Nominal current	I_{LN}	A	218.00	262.00	327.00	409.00
Required wire size in accordance with NFPA 79 and UL 508 A (internal wiring);[4)]	A_{LN}	AWG	Project Planning Manual appendix			
Power factor TPF (λ_L) at P_{DC_cont} with mains choke; U_{LN_nenn}	TPF		0.99			
Last modification: 2015-12-03*						

1) 2) Mains voltage > U_{LN}: Use a transformer with grounded neutral point, do not use autotransformers!

4) Copper wire; PVC-insulation (conductor temperature 90 °C; T_a ≤ 40 °C) in accordance with NFPA 79 chapter 12 and UL 508A chapter 28

Tab. 7-3: HMU – electrical data – currents, voltages, power

Technical data of the components

Electrical data – currents, voltages, power

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Mains frequency	f_{LN}	Hz	50...60			
Mains frequency tolerance		Hz	± 2			
Rotary field condition			None			
Single-phase mains voltage	U_{LN}	V	-			
Three-phase mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	380..500			
Nominal mains voltage	U_{LN_nenn}	V	4 AC 400			
Three-phase mains voltage at IT mains1)	U_{LN}	V	380..500			
Three-phase mains voltage at Corner-grounded-Delta mains2)	U_{LN}	V	200..230			
Tolerance rated input voltage U_{LN}		%	+10 / -15			
Minimum inductance of mains supply (mains phase inductance)	L_{min}	µH	40			
Assigned type of mains choke			HNL05.1R-0130N0514	HNL05.1R-0113-N0652	HNL05.1R-0100N0811	HNL05.1R-0094-N1019
Assigned type of mains filter			HNF05.1A-500N-R0600	HNF05.1A-500N-R1000		HNF05.1A-500N-R1600
Nominal current	I_{LN}	A	514.00	652.00	811.00	1019.00
Required wire size in accordance with NFPA 79 and UL 508 A (internal wiring);4)	A_{LN}	AWG	Project Planning Manual appendix			
Power factor TPF (λ_L) at P_{DC_cont} with mains choke; U_{LN_nenn}	TPF		0.99			
Last modification: 2015-12-03*						

1) 2) Mains voltage > U_{LN}: Use a transformer with grounded neutral point, do not use autotransformers!

4) Copper wire; PVC-insulation (conductor temperature 90 °C; T_a ≤ 40 °C) in accordance with NFPA 79 chapter 12 and UL 508A chapter 28

Tab. 7-4: HMU – electrical data – currents, voltages, power

7.2.3 DC bus

Mains input voltage (U_{LN}) and DC bus power (P_{DC}), derating

With $U_{LN} < U_{LNnenn}$ (rated mains input voltage), a derating of U_{LN} / U_{LNnenn} has to be taken into account for the DC bus power.

With $U_{LN} > U_{LNnenn}$, the DC bus power remains limited to the nominal value.

Power section data - DC bus

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-P	HMU05.1N-F0170-0430-N-A4-D7-P	HMU05.1N-F0220-0510-N-A4-D7-P	HMU05.1N-F0270-0660-N-A4-D7-P
DC bus voltage	U_{DC}	V	DC 450...750			
Capacitance in DC bus	C_{DC}	mF	5.00		6.60	8.25
DC resistance in DC bus (L+ to L-)	R_{DC}	kOhm	30.00			24.00
Monitoring value maximum DC bus voltage, switch-off threshold	$U_{DC\_limit\_max}$	V	900			
Monitoring value minimum DC bus voltage, undervoltage threshold	$U_{DC\_limit\_min}$	V	-			
Allowed external DC bus capacitance (nom.) at U_{LN_nenn} 1)	C_{DCext}	mF	2500.00			
Rated power (t > 10 min) at f_s = 4 kHz; U_{LN_nenn}; control factor a_0 > 0.8; with mains choke	P_{DC_cont}	kW	140.00	170.00	220.00	270.00
Maximum allowed DC bus power at U_{LN_nenn}; with mains choke	P_{DC_max}	kW	180.00	216.00	260.00	324.00
Last modification: 2016-06-16						

1) Use assigned mains choke

Tab. 7-5: HMU – power section data – DC bus

Power section data - DC bus

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
DC bus voltage	U_{DC}	V	DC 450...750			
Capacitance in DC bus	C_{DC}	mF	9.90	13.20	16.50	19.80
DC resistance in DC bus (L+ to L-)	R_{DC}	kOhm	24.00	15.00	12.00	
Monitoring value maximum DC bus voltage, switch-off threshold	$U_{DC\_limit\_max}$	V	900			
Last modification: 2015-12-03						

Technical data of the components

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Monitoring value minimum DC bus voltage, undervoltage threshold	$U_{DC\_limit\_min}$	V	-			
Allowed external DC bus capacitance (nom.) at U_{LN_nenn} 1)	C_{DCext}	mF	2500.00			
Rated power (t > 10 min) at f_s = 4 kHz; U_{LN_nenn}; control factor a_0 > 0.8; with mains choke	P_{DC_cont}	kW	340.00	430.00	540.00	tbd
Maximum allowed DC bus power at U_{LN_nenn}; with mains choke	P_{DC_max}	kW	405.00	509.00	645.00	tbd
Last modification: 2015-12-03						

1) Use assigned mains choke

Tab. 7-6: HMU – power section data – DC bus

7.2.4 Inverter

Power section data - inverter

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-N	HMU05.1N-F0170-0430-N-A4-D7-N	HMU05.1N-F0220-0510-N-A4-D7-N	HMU05.1N-F0270-0660-N-A4-D7-N
Allowed switching frequencies[1)]	f_s	kHz	2,4,8			
Output voltage, fundamental wave for V/Hz (U/f) control	V_{out_eff}	V	~ UDC x 0.71			
Output voltage, fundamental wave for closed-loop operation	V_{out_eff}	V	~ UDC x 0.71			
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-phase (10-90%)[2)]	dv/dt	kV/µs	5.00		3.00	
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-ground (10-90%)[3)]	dv/dt	kV/µs	2.00			
Output frequency range when f_s = 2 kHz	f_{out_2k}	Hz	0..200			
Output frequency range when f_s = 4 kHz	f_{out_4k}	Hz	0..400			
Output frequency range when f_s = 8 kHz	f_{out_8k}	Hz	0..800			
Output frequency threshold for detecting motor standstill[4)]	f_{out_still}	Hz	6			
Maximum output current when f_s = 2 kHz	I_{out_max2}	A	357.0	427.0	515.0	660.0
Maximum output current when f_s = 4 kHz	I_{out_max4}	A	357.0	427.0	515.0	660.0
Maximum output current when f_s = 8 kHz	I_{out_max8}	A	242.0	362.0	430.0	476.0
Continuous output current when f_s = 2 kHz	I_{out_cont2}	A	254.0	306.0	392.0	490.0
Continuous output current when f_s = 4 kHz	I_{out_cont4}	A	254.0	306.0	392.0	490.0
Continuous output current when f_s = 8 kHz	I_{out_cont8}	A	182.0	260.0	315.0	350.0
Continuous output current when f_s = 1 kHz; output frequency f_{out} less than f_{out_still}[5)]	$I_{out\_cont0Hz\_1}$		210.0	251.0	302.0	388.0
Continuous output current when f_s = 2 kHz; output frequency f_{out} less than f_{out_still}	$I_{out\_cont0Hz\_2}$	A	210.0	251.0	302.0	388.0
Last modification: 2015-12-03*						

Description	Symbol	Unit	HMU05.1N-F0140-0350-N-A4-D7-N	HMU05.1N-F0170-0430-N-A4-D7-N	HMU05.1N-F0220-0510-N-A4-D7-N	HMU05.1N-F0270-0660-N-A4-D7-N
Continuous output current when f_s = 4 kHz; output frequency f_{out} less than f_{out_still}	$I_{out\_cont0Hz\_4}$	A	210.0	230.0	302.0	320.0
Continuous output current when f_s = 8 kHz; output frequency f_{out} less than f_{out_still}	$I_{out\_cont0Hz\_8}$	A	150.0	185.0	213.0	
Last modification: 2015-12-03*						

1) Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of power output stage"; see "P-0-4058, Amplifier type data"; for supply units, the switching frequency is 4.2 kHz; operating HMU05s connected in parallel is only possible at clock frequencies below 8 kHz

2) 3) Guide value, see following note

4) See following note regarding output current reduction

5) The switching frequency f_s = 1 kHz is not allowed; this setting is only relevant if the "halving the PWM frequency in the standstill range" function is used; see "P-0-0045, Control word of current controller"

Tab. 7-7: HMU – power section data – inverter

Power section data - inverter

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Allowed switching frequencies[1]	f_s	kHz	2,4,8			
Output voltage, fundamental wave for V/Hz (U/f) control	V_{out_eff}	V	~ UDC x 0.71			
Output voltage, fundamental wave for closed-loop operation	V_{out_eff}	V	~ UDC x 0.71			
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-phase (10-90%)[2]	dv/dt	kV/µs	3.00			
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-ground (10-90%)[3]	dv/dt	kV/µs	2.00			
Output frequency range when f_s = 2 kHz	f_{out_2k}	Hz	0..200			
Output frequency range when f_s = 4 kHz	f_{out_4k}	Hz	0..400			
Output frequency range when f_s = 8 kHz	f_{out_8k}	Hz	0..800			
Last modification: 2015-12-03*						

Description	Symbol	Unit	HMU05.1N-F0340-0820-N-A4-D7-P	HMU05.1N-F0430-1040-N-A4-D7-P	HMU05.1N-F0540-1300-N-A4-D7-P	HMU05.1N-F0680-1690-N-A4-D7-P Planned
Output frequency threshold for detecting motor standstill[4)]	f_{out_still}	Hz	6			
Maximum output current when f_s = 2 kHz	I_{out_max2}	A	825.0	1037.0	1297.0	1686.0
Maximum output current when f_s = 4 kHz	I_{out_max4}	A	765.0	838.0	1000.0	1303.0
Maximum output current when f_s = 8 kHz	I_{out_max8}	A	510.0	650.0	736.0	843.0
Continuous output current when f_s = 2 kHz	I_{out_cont2}	A	616.0	771.0	1002.0	1185.0
Continuous output current when f_s = 4 kHz	I_{out_cont4}	A	546.0	624.0	775.0	1185.0
Continuous output current when f_s = 8 kHz	I_{out_cont8}	A	364.0	465.0	526.0	592.0
Continuous output current when f_s = 1 kHz; output frequency f_{out} less than f_{out_still}[5)]	$I_{out\_cont0Hz\_1}$		485.0	610.0	705.0	992.0
Continuous output current when f_s = 2 kHz; output frequency f_{out} less than f_{out_still}	$I_{out\_cont0Hz\_2}$	A	485.0	610.0	650.0	992.0
Continuous output current when f_s = 4 kHz; output frequency f_{out} less than f_{out_still}	$I_{out\_cont0Hz\_4}$	A	450.0	493.0	500.0	766.0
Continuous output current when f_s = 8 kHz; output frequency f_{out} less than f_{out_still}	$I_{out\_cont0Hz\_8}$	A	298.0			496.0
Last modification: 2015-12-03*						

1) Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of power output stage"; see "P-0-4058, Amplifier type data"; for supply units, the switching frequency is 4.2 kHz; operating HMU05s connected in parallel is only possible at clock frequencies below 8 kHz

2) 3) Guide value, see following note

4) See following note regarding output current reduction

5) The switching frequency f_s = 1 kHz is not allowed; this setting is only relevant if the "halving the PWM frequency in the standstill range" function is used; see "P-0-0045, Control word of current controller"

Tab. 7-8: HMU – power section data – inverter

Guide value "Rise of voltage at output"

Note that the load on the motor is virtually independent of the power section used.

When using **standard motors** in particular, make sure they can handle the voltage load.

Reduced output current at motor standstill

Depending on the electric output frequency, the output current is reduced for thermal protection of the power section.

The output current is reduced, when the electric output frequency has fallen below the threshold to detect motor standstill.

For the highest possible acceleration, the maximum current I_{max} may not flow for more than 400 mss every 10 minutes.

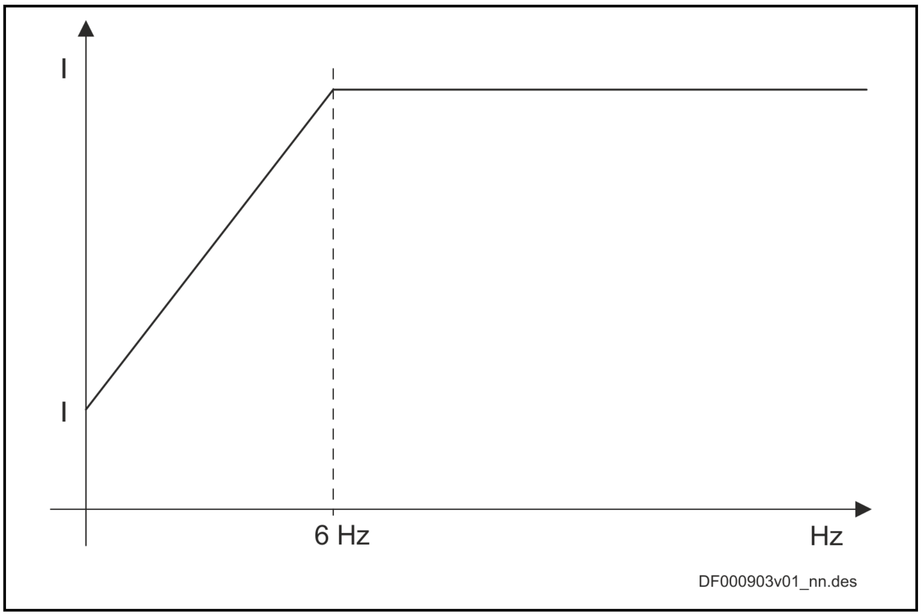


Fig. 7-1: Current profile during acceleration

8 Cables, accessories, additional components

8.1 Overview

8.1.1 Cables

Function	Cables, connectors
IndraBus	RKB0035 (shielded, < 100 m) RKB0036 (shielded, < 3 m) RBS0025 (terminating plug)
HNA bus	RKB0037
Connection between HPC01.1-P001-NN parallel connecting modules	RKB0038

Tab. 8-1: Cables - overview

8.1.2 Accessories

Accessories	Note
HAS03: Mounting and connection accessories	For mounting an HNA05/HLT05
HAS08: Cabinet installation kit (mounting kit)	For mounting an HMU05
HAS10: Blank covers, motor monitor grounding, mounting plates	

Tab. 8-2: Accessories - overview

8.1.3 Additional components

Type	Additional component
HAH01	Heat exchanger
HAS04	Y capacitor pair
HLL05	DC bus choke
HMF05	Motor filter
HML05	Motor choke
HNA05	Mains connection module
HNC05	Mains capacitor
HNF05	Mains filter
HNL05	Mains choke
HLR05	Braking resistor
HLT05	Braking unit

Cables, accessories, additional components

Type	Additional component
QT20.241 QTD20.241 QT40.241	24V power supply unit
YR40.241 YR80.241	Redundancy module

Tab. 8-3: Additional components - overview

8.2 Accessories

8.2.1 Mounting and connection accessories (HAS03)

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	A	S	0	3	.	1	-	0	0	2	-	N	N	N	-	N	N																						
	①			②			③		④				⑤				⑥																							

①	**Product:** HAS = IndraDrive accessories
②	**Series:** 03 = Control cabinet adapter
③	**Design:** 1 = 1
④	**Device assignment:** 002 = HCS02.1E-W0012 002 = HCS02.1E-W0028 002 = HLB01.1C-01K0-N06R0-A-007-NNNN 002 = HLC01.1C-01M0-A-007-NNNN 002 = HLC01.1C-02M4-A-007-NNNN 004 = HCS02.1E-W0054 004 = HCS02.1E-W0070 006 = HNA05.1, HLT05.1W-105K (height leveling + depth leveling 200 mm) 007 = HNA05.1, HLT05.1W-105K (height leveling + depth leveling 240 mm)
⑤	**Other properties:** NNN = None
⑥	**Other design:** NN = None

Tab. 8-4: HAS03, type code

Use Accessories are used to mount HNA05 mains connection modules or HLT05 braking units in the control cabinet and even out the height (defined offset parallel to the mounting surface) or depth (defined offset vertical to the mounting surface).

8.2.2 Cabinet installation kit (HAS08.1-008)

Type code

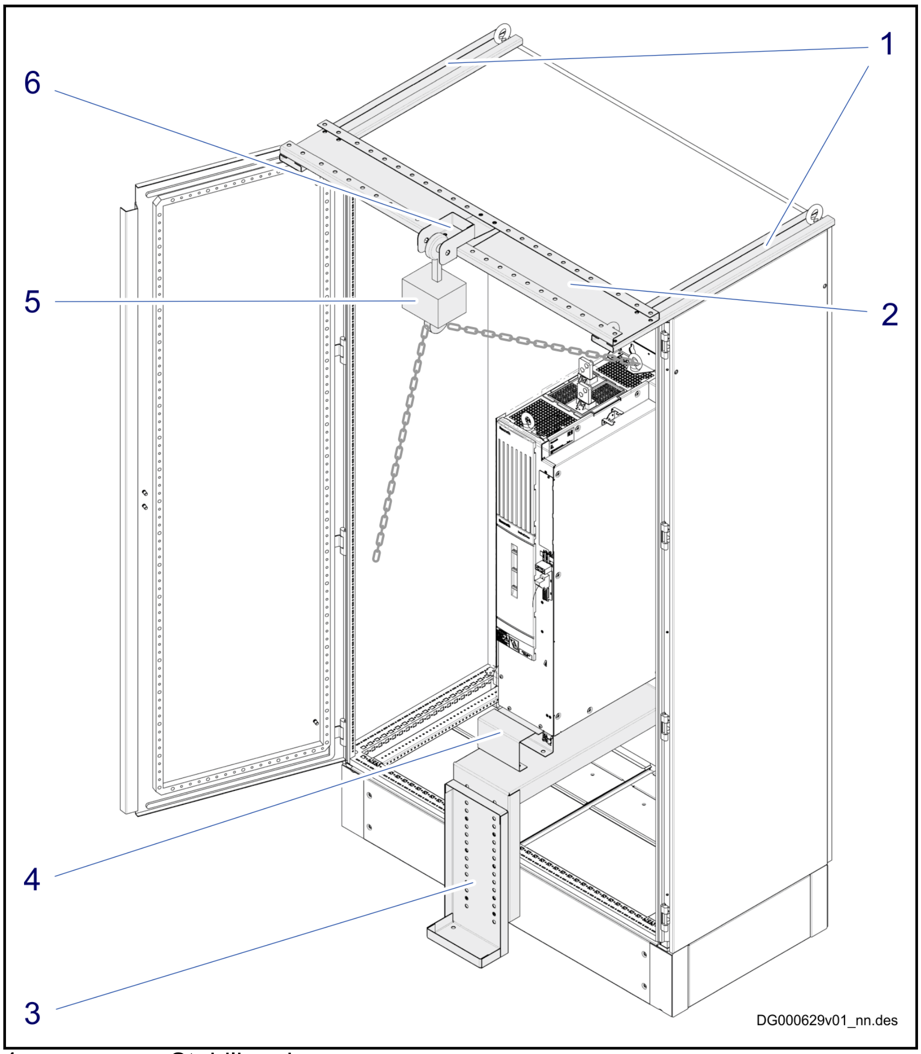
Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	A	S	0	8	.	1	-	0	0	1	-	P	5	4	-	F	L																						
	①			②			③		④				⑤				⑥																							

①	**Product:** HAS = IndraDrive accessories
②	**Series:** 08 = Cabinet installation kit
③	**Design:** 1 = 1
④	**Device assignment:** 001 = HCS04.2E-W0290 002 = HCS04.2E-W0350 003 = HCS04.2E-W0420 004 = HCS04.2E-W0520 005 = HCS04.2E-W0640 005 = HCS04.2E-W0790 006 = HCS04.2E-W1010 006 = HCS04.2E-W1240 007 = HCS04.2E-W1540 008 = HMU05
⑤	**Degree of protection:** P00 = IP00 P23 = IP23 P54 = IP54 NNN = Not relevant
⑥	**Other design:** NN = None FL = Filter fan GL = Separate air flow MH = Mounting kit, dismounting kit

Tab. 8-5: HAS08, type code

Parts

The HAS08.1-008-NNN-MH accessory contains parts for assembling a mounting kit.

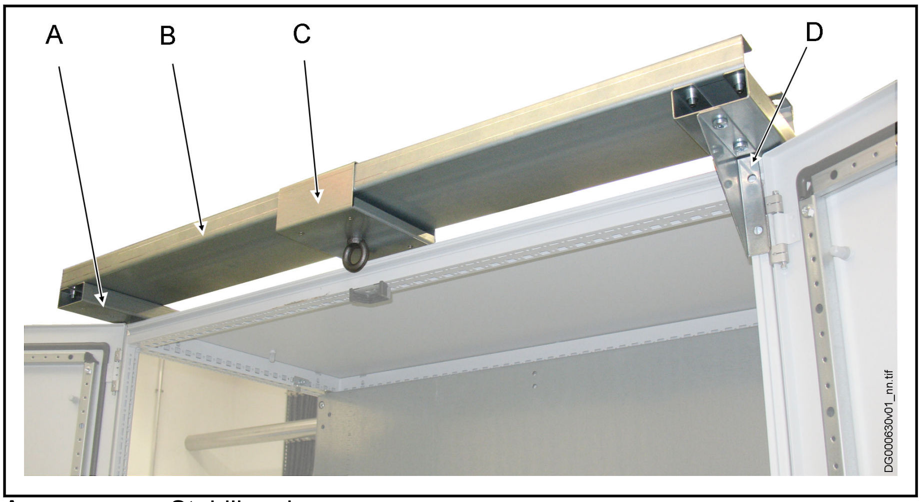


1	Stabilizer bar
2	Supporting bar
3	Stand
4	Stop plate
5	Block and tackle
6	Plate with eyebolt

Fig. 8-1: HAS08.1-008-NNN_MH mounting kit

Mounting

On top of control cabinet



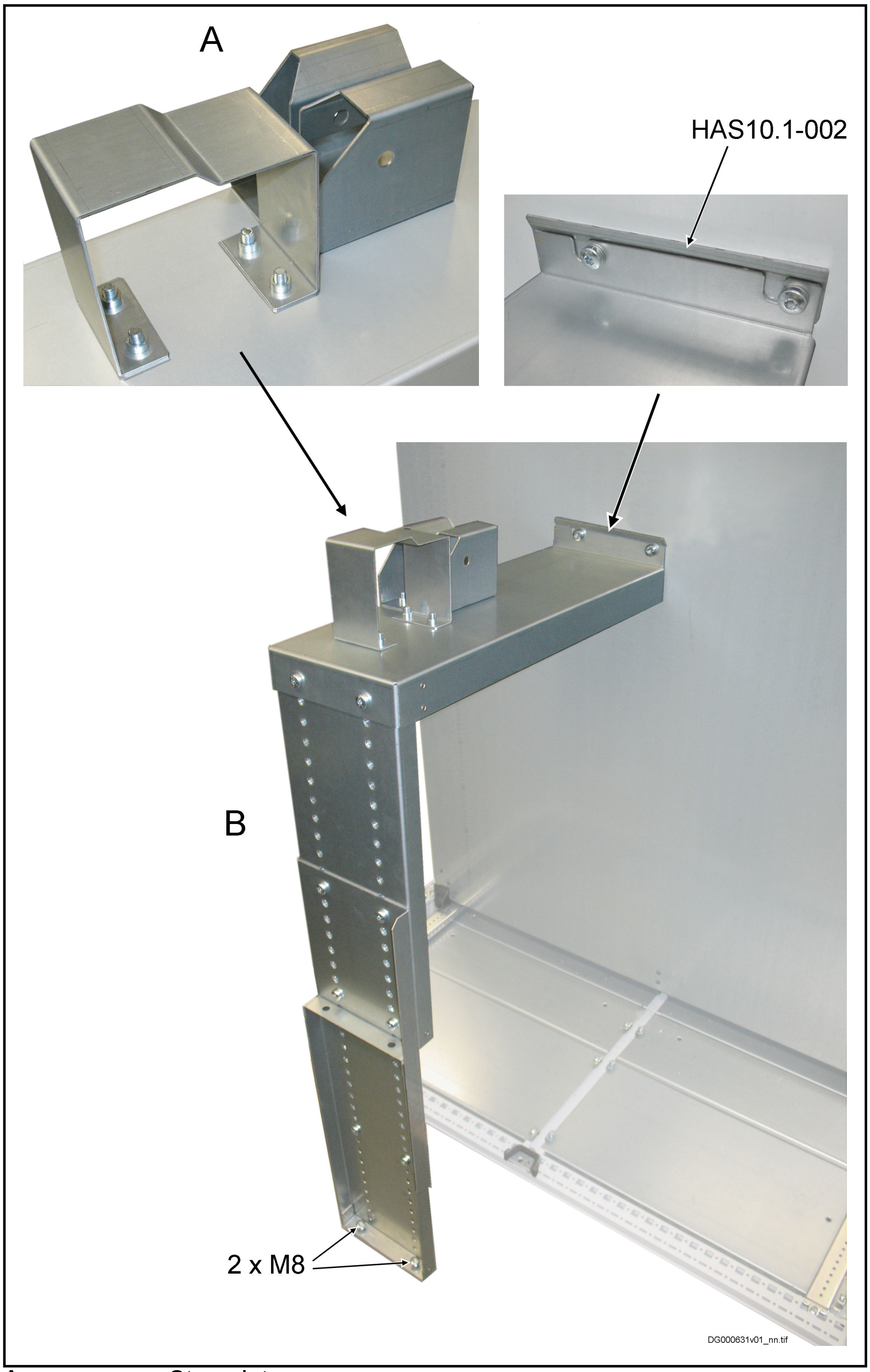
A	Stabilizer bar
B	Supporting bar
C	Plate with eyebolt
D	Support plate

Fig. 8-2: Stabilizer bars, plate with eyebolt, supporting bar, support plate

Steps to follow

1. Mount **stabilizer bars** on top of control cabinet using 4 × M12.
2. Fit **plate with eyebolt** to supporting bar.
3. Mount **supporting bar** to stabilizer bars using 8 × M8.
4. Align **plate with eyebolt** and screw it on using 4 × M8.
5. For heavy devices, additionally mount **support plates** to stabilizer bars using 4 × M8.

In front of control cabinet



A	Stop plates
B	Stand
HAS10.1-002	Mounting plate
2 x M8	Screws to adjust the hight of the stand

Fig. 8-3: Stand, stop plates

Steps to follow

1. **Drill all holes** for mounting the device in control cabinet, incl. holes for HAS10.1-002 mounting plates.
2. Mount **stop plates** to top plate using 8 × M8.
3. Pre-assemble **stand** using M8 and adjust it to device size (1, 2 or 3 plates)
4. Fit **stand** to screws of HAS10.1-002 mounting plate and screw it on.
5. To **adjust**, screw 2 × M8 to bottom plate of stand.

Mounting the device

Steps to follow

1. Attach **block and tackle** to eyebolt of supporting bar.
2. Attach **device** to block and tackle using rear eyebolt and lift device.

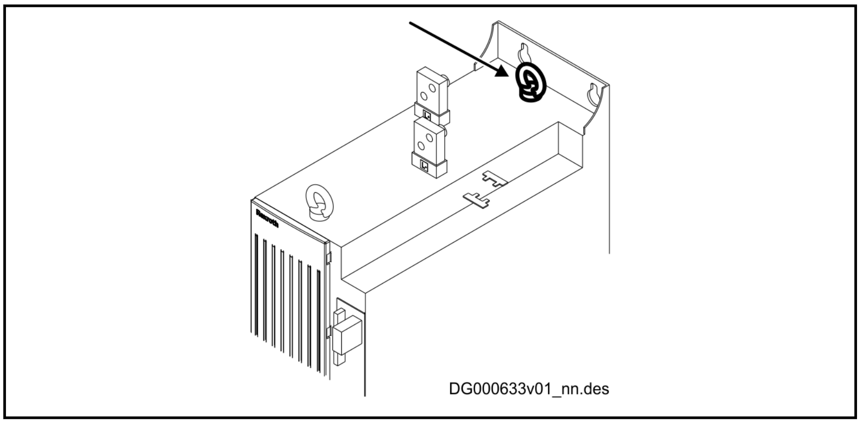


Fig. 8-4: Rear eyebolt

Fig. 8-5: Device at block and tackle

3. Put **edge of device** on front stop plate.
4. Align **equipment grounding conductor connection point** with rear stop plate.

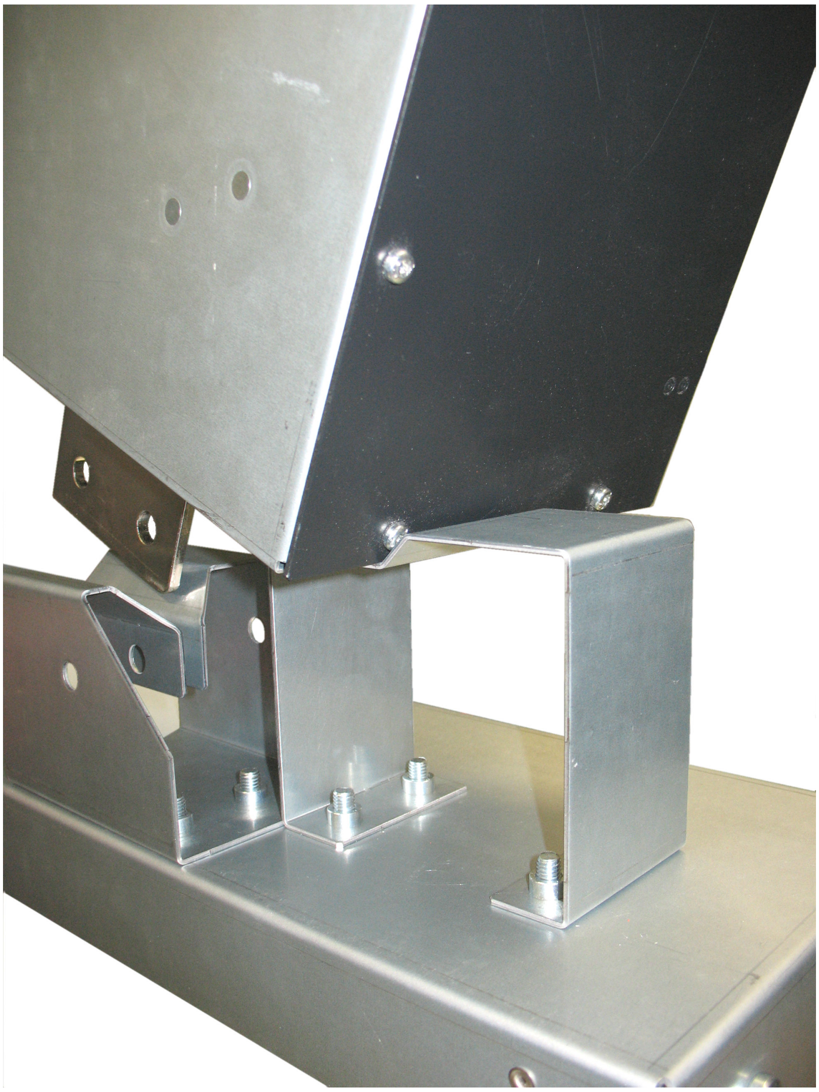


Fig. 8-6: HMU05 on front stop plate

5. Push device into control cabinet putting your hand at front of device, and lower device using block and tackle.
6. Screw on device.
7. Disassemble mounting kit.

Dismounting the device

Steps to follow

1. Assemble mounting kit: See chapters chapter "On top of control cabinet" on page 151 and chapter "In front of control cabinet" on page 152.
2. Attach device to block and tackle.
3. Unscrew device screws.
4. Slightly push device into control cabinet putting your hand at front of device, and lift device using block and tackle.

   Device will tilt outwards over first stop plate.
5. Put device down.
6. Disassemble mounting kit.

8.2.3 Blank covers, motor monitor grounding, mounting plates (HAS10)

HAS10 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	A	S	1	0	.	1	-	0	0	1	-	0	0	2	-	N	N																						
	①			②			③		④				⑤				⑥																							

①	**Product:** HAS = IndraDrive accessories
②	**Series:** 10 = Mechanical mounting parts
③	**Design:** 1 = 1
④	**Device assignment** [1]**:** 001 = KSM01.2, KSM02.1 KMS01.2 and KMS02.1 002 = HMU05.1 and HCS05.1
⑤	**Other properties** [2]**:** 001 = Fixing clip of connectors for increased vibration resistance 002 = Fixing clip of connectors and master communication for increased vibration resistance 003 = Dummy cover for slide-in ducts: 1 × parallel module / 1 × motor mains module / 1 × control section 004 = Motor monitor grounding 005 = Mounting plate for device width 200 mm 006 = Mounting plate for device width 220 mm
⑥	**Other design:** NN = None

Tab. 8-6: HAS10, type code

Blank covers (HAS10.1-002-003)

This accessory contains blank covers for covering unused mounting bays.

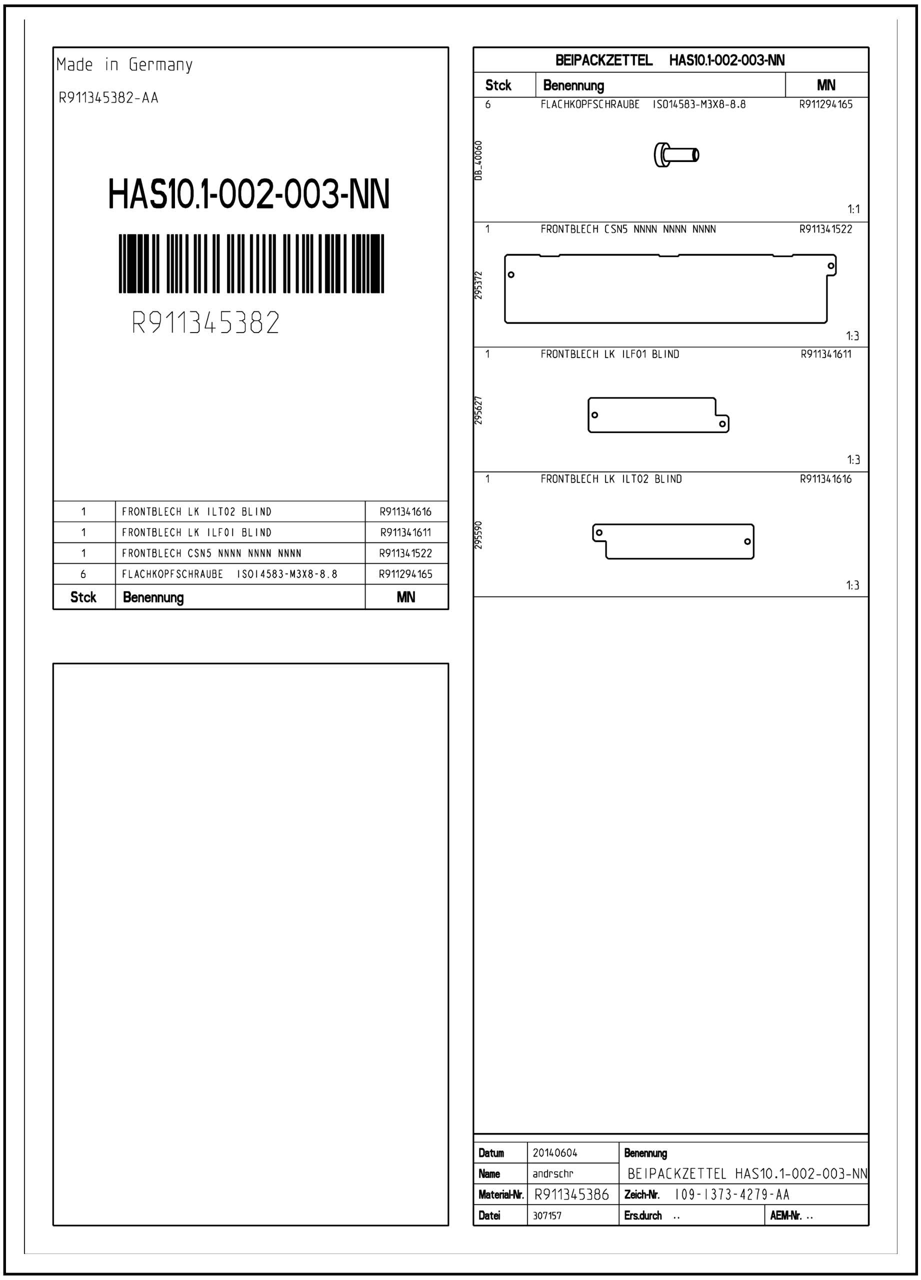


Fig. 8-7: Product insert (HAS10.1-002-003)

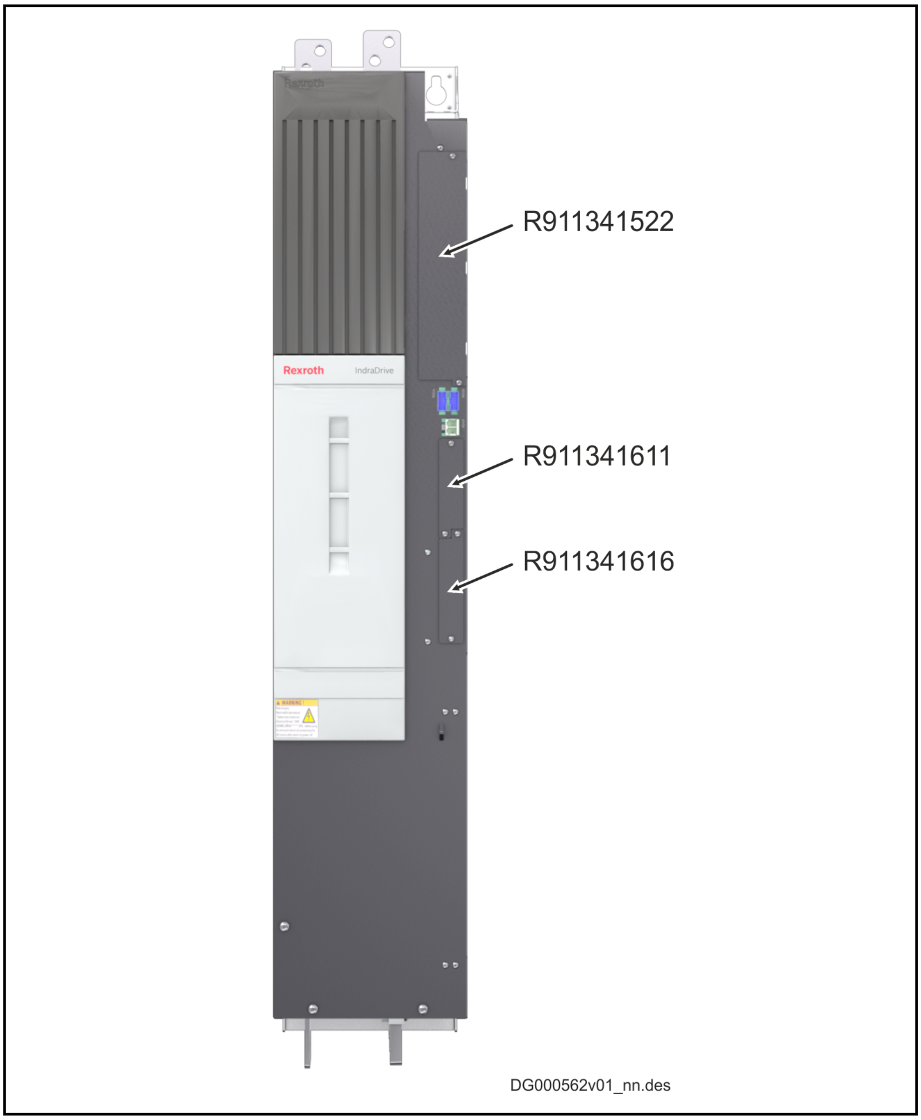


Fig. 8-8: Blank covers (HAS10.1-002-003)

Motor monitor grounding (HAS10.1-002-004)

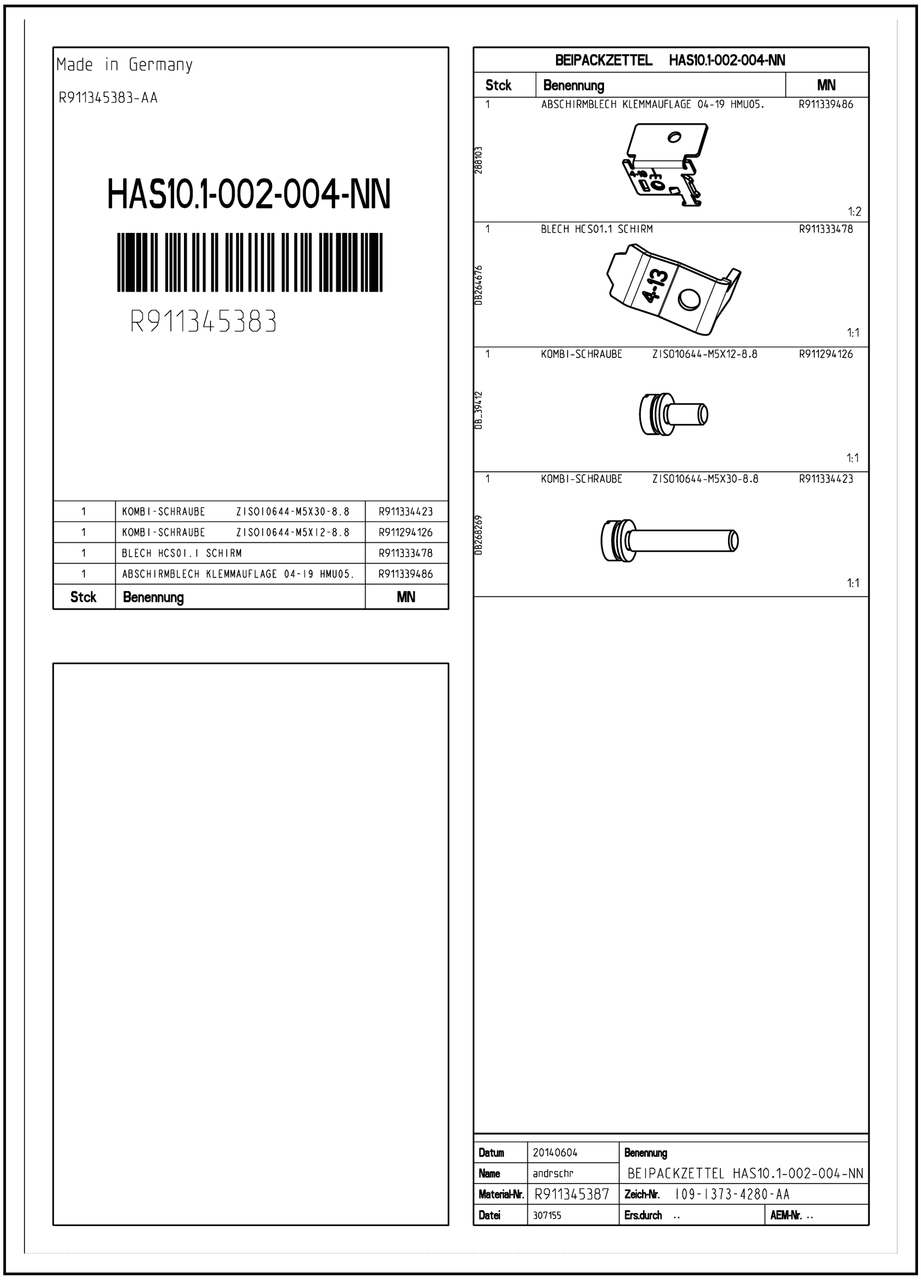
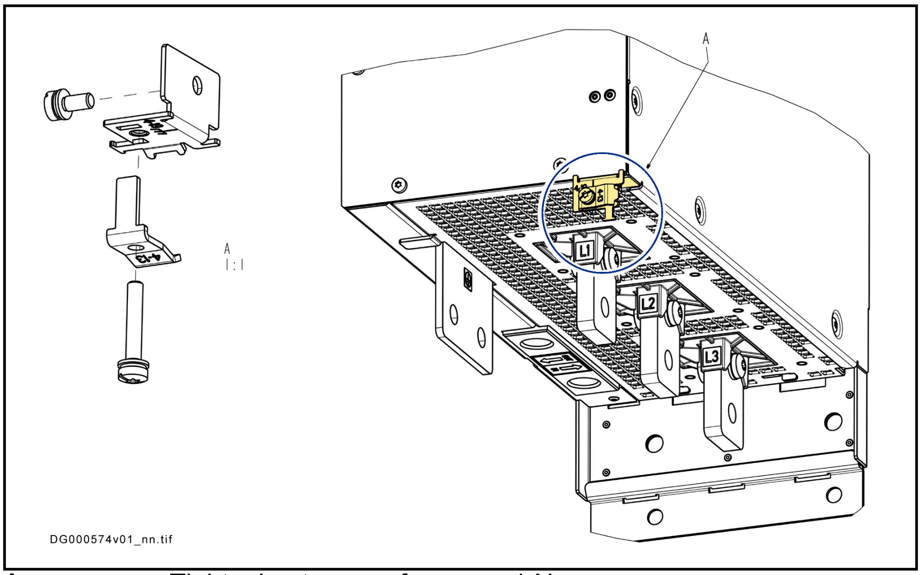


Fig. 8-9: Product insert (HAS10.1-002-004)



A Tightening torque of screws: 1 Nm

Fig. 8-10: Use (HAS10.1-002-004)

Mounting plate for device width 200 mm (HAS10.1-002-005)

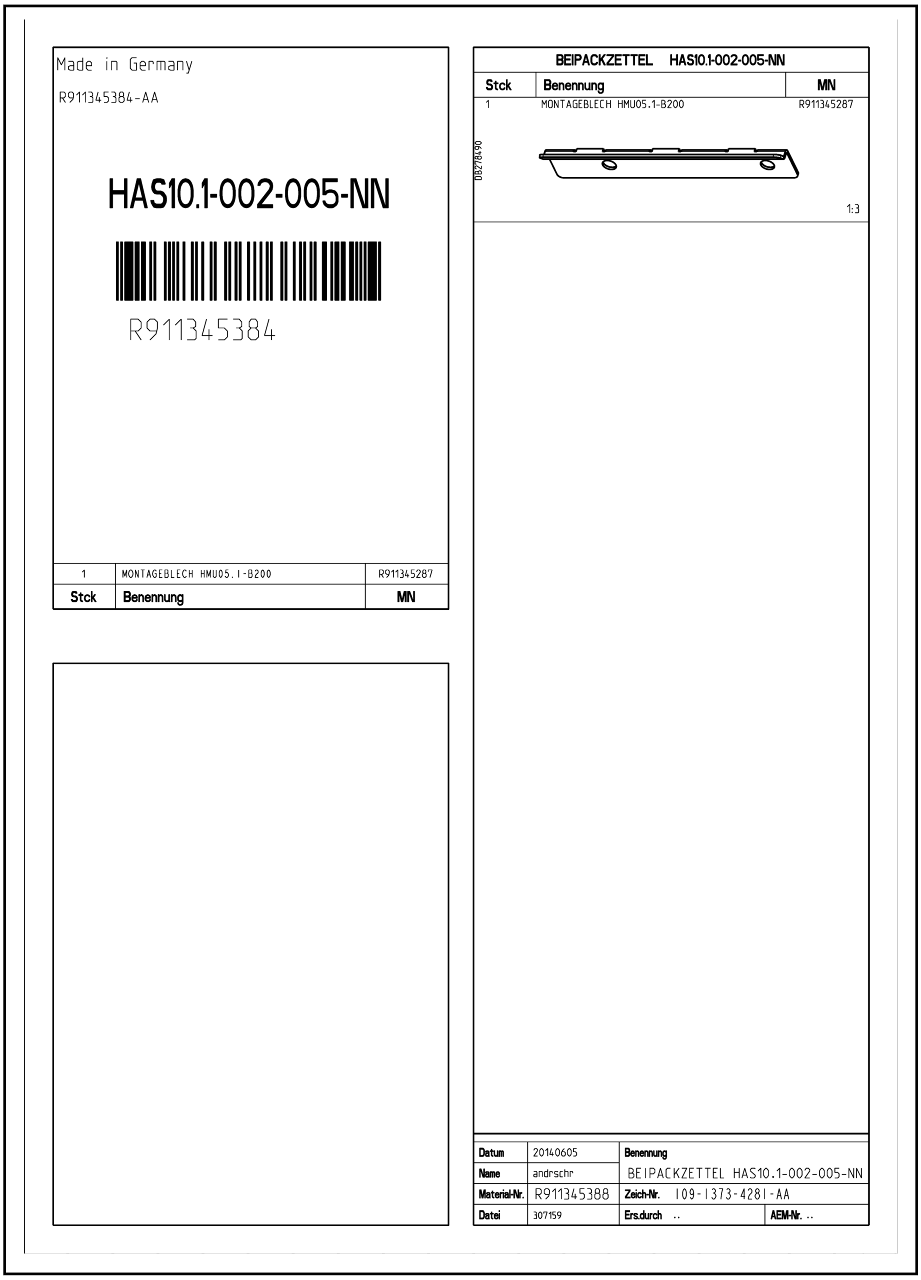
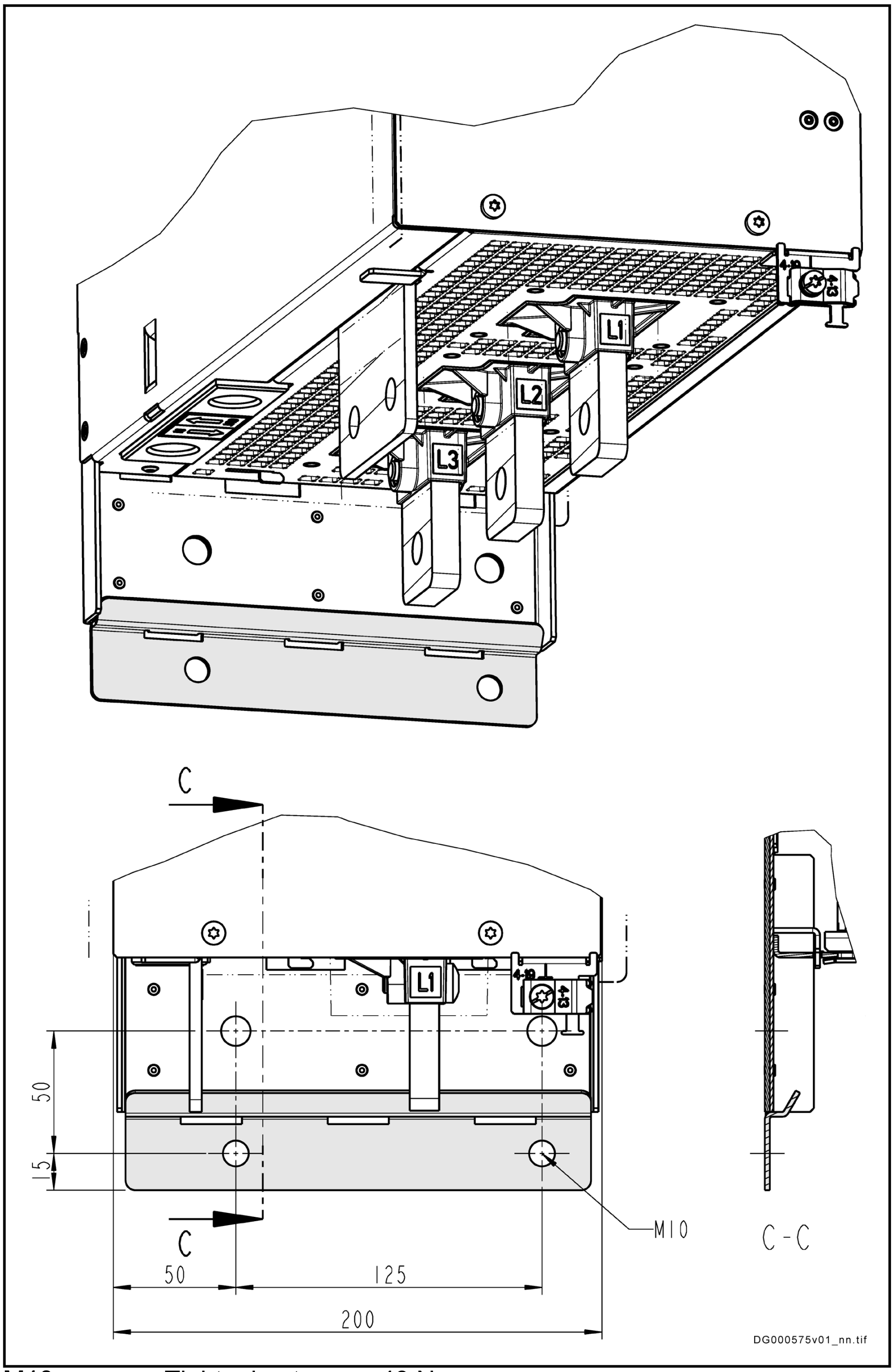


Fig. 8-11: Product insert (HAS10.1-002-005)



M10 Tightening torque: 48 Nm

Fig. 8-12: Use (HAS10.1-002-005)

Mounting plate for device width 220 mm (HAS10.1-002-006)

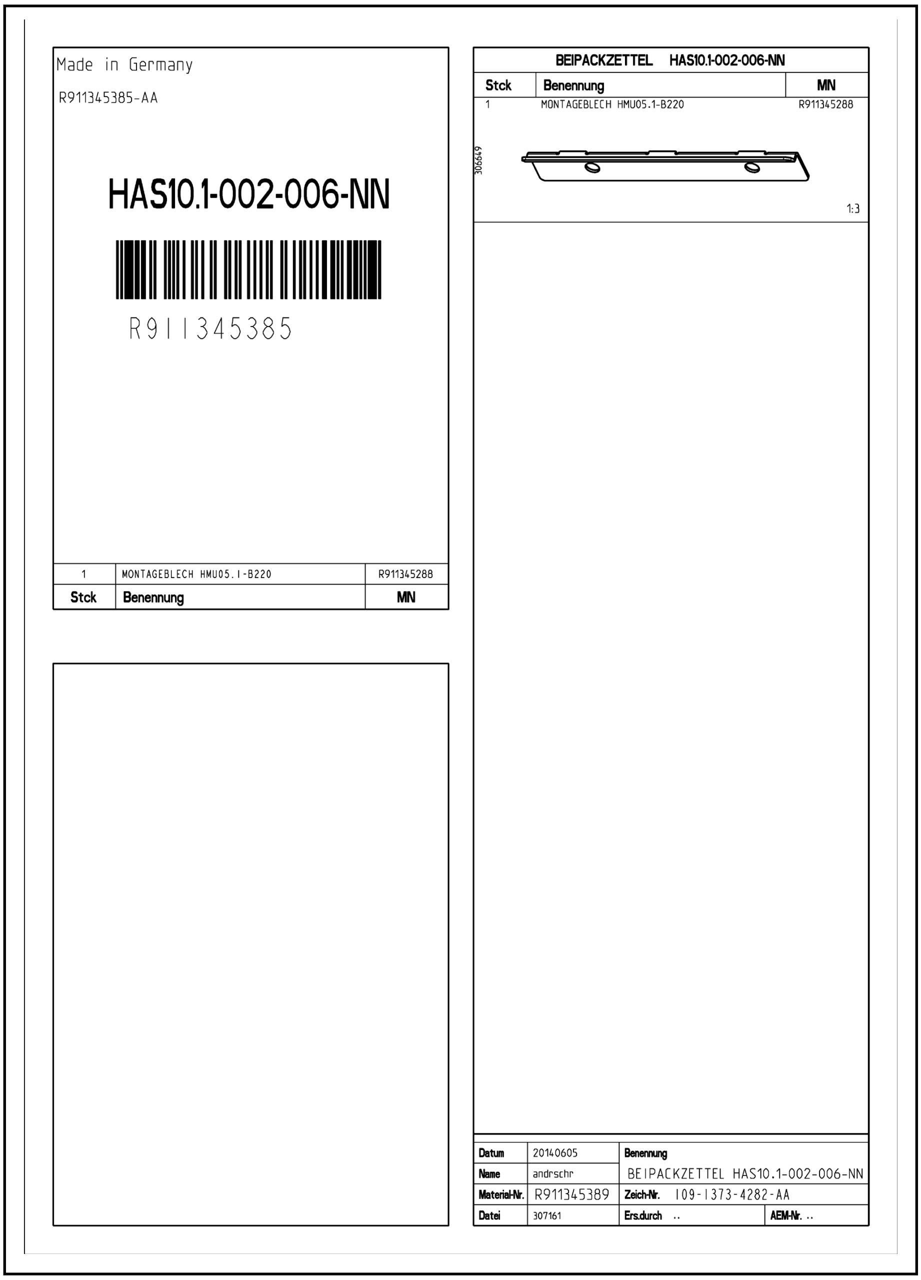
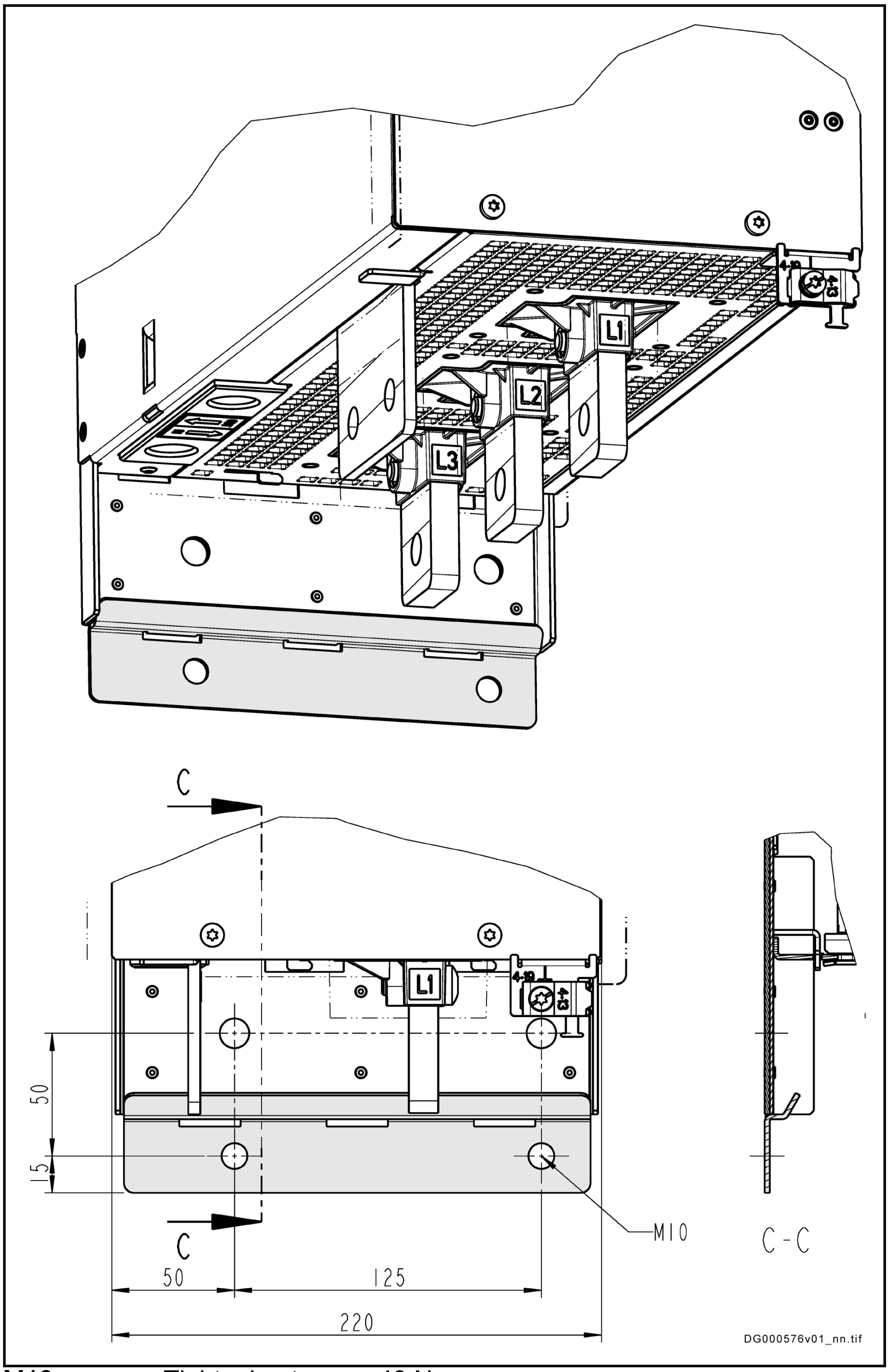


Fig. 8-13: Product insert (HAS10.1-002-006)



M10 Tightening torque: 48 Nm

Fig. 8-14: Use (HAS10.1-002-006)

8.3 Additional components

8.3.1 HNA05 mains connection module

HNA05 type code

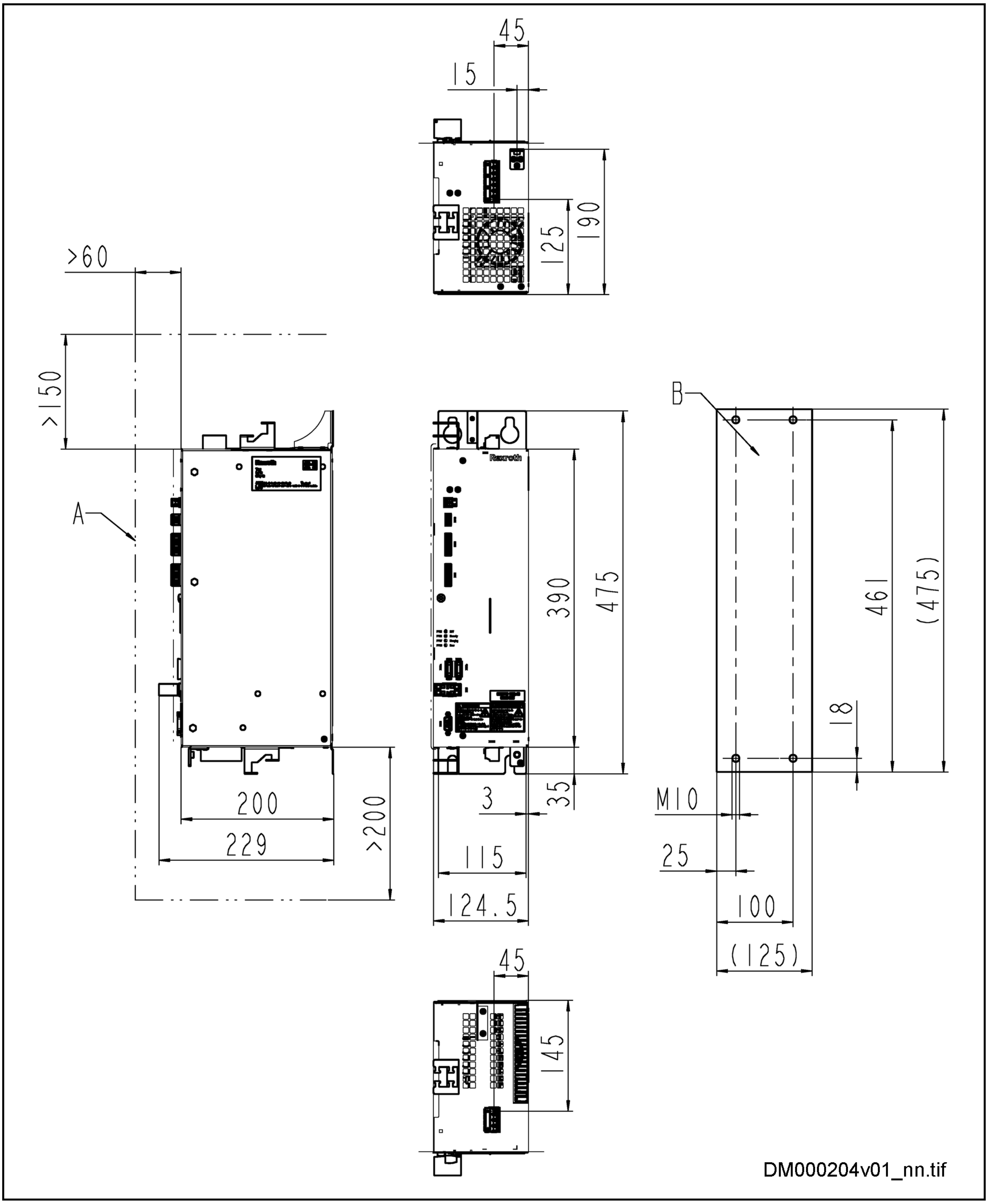
										1										2										3										4
Short type designation	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	H	N	A	0	5	.	1	N	-	W	R	0	2	F	5	-	A	4	-	A	-	N	N	N	N															
	①			②			③	④		⑤	⑥	⑦					⑧			⑨		⑩																		

①	**Product:** HNA = Mains connection module
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Application:** N = Standard
⑤	**Cooling type:** W = Air, internal
⑥	**Supply system:** R = For regenerative devices only
⑦	**Charging power:** 02F5 = 2.5 F (example)
⑧	**Mains connection voltage:** A4 = 3 × AC 380 V -15% ... 3 × AC 500 V +10% A5 = 3 × AC 380 V -15% ... 3 × AC 690 V +10%
⑨	**Degree of protection:** A = IP20
⑩	**Other design:** NNNN = None

Tab. 8-7: HNA05, type code

Dimensions

HNA05, dimensional drawing

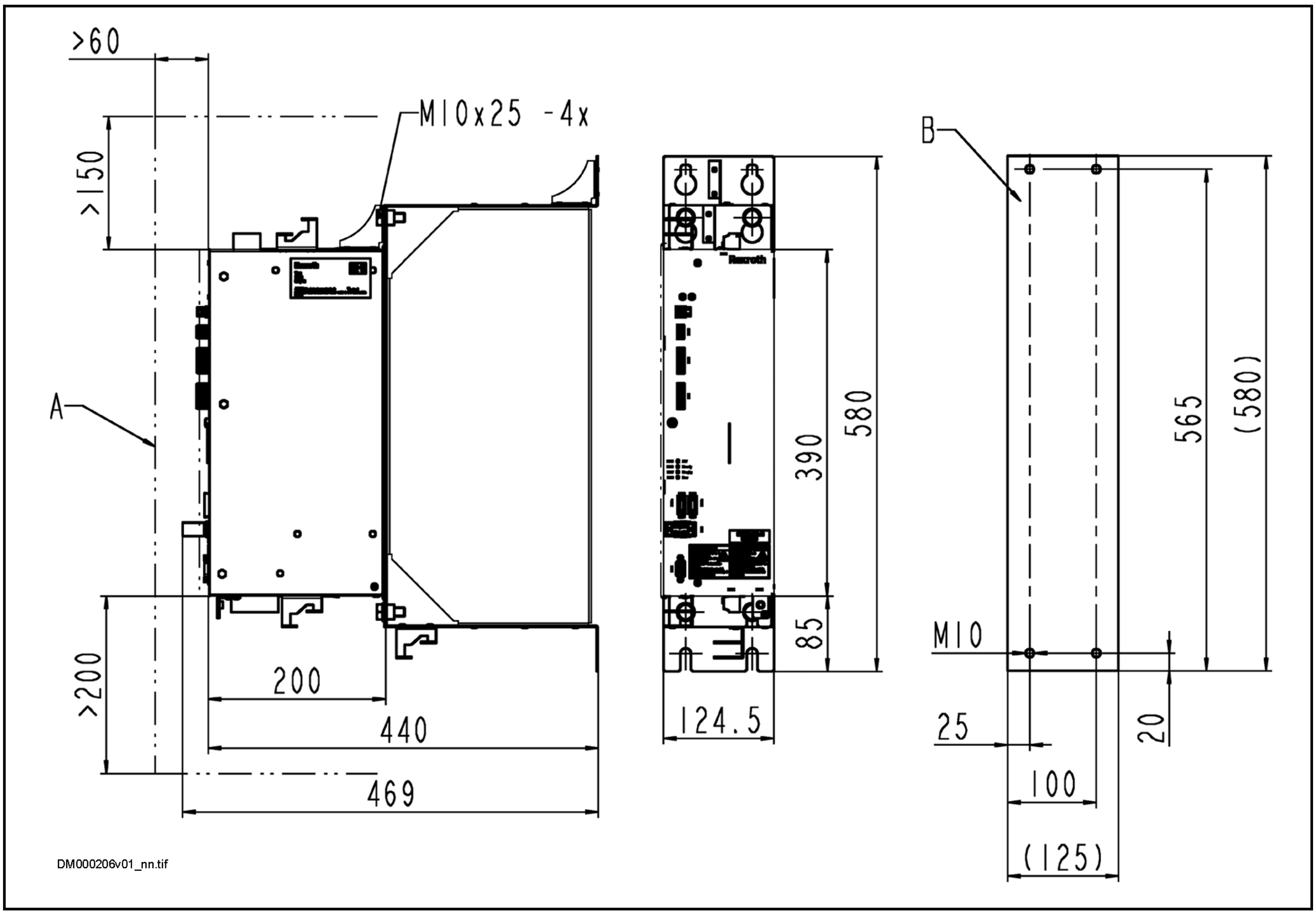


M10 Tightening torque: 40 Nm

Fig. 8-15: HNA05, dimensional drawing

Cables, accessories, additional components

HNA05 with mounting plate (440 mm), dimensional drawing



M10 Tightening torque: 40 Nm

Fig. 8-16: HNA05 with HAS03.1-007 mounting plate for height leveling and depth leveling to 440 mm depth, dimensional drawing

Data

Description	Unit	HNA05.1N-WR02F5-…	
		A4	A5
Degree of protection		IP20	
Allowed mounting position		G1	
Ambient temperature range	°C	0 … 55	
Mass	kg	6,70	
Insulation resistance	MΩ	50	
Y-capacitance		-	
Installation height	mm	390	
Installation width	mm	124.5	
Cooling type		Air cooling	
Distance top	mm	80	
Distance bottom	mm	80	
Distance side	mm	0	
Charging power dissipation	W	150	
Basic power dissipation in operation	W	50	
Rated power consumption control voltage input at U_{N3}	W	< 15	
Control voltage inrush current	A	< 3	
Inrush current duration	ms	< 2	
Control voltage U_{N3}	V	24	
Tolerance of control voltage U_{N3}	%	±20	
Input capacitance of control voltage U_{N3}	mF	0.05	
Control voltage input current	mA	500	
Rated mains input voltage U_{nenn}	V	AC 400	AC 690
Three-phase mains input voltage (TN-S, TN-C, TT mains)	V	AC 380 … 500	AC 380 … 690
Mains input voltage tolerance	%	+10 / -15	
Mains frequency	Hz	50 … 60	
Maximum allowed mains frequency change	Hz/s	1	
Mains frequency tolerance	Hz	±2	
Rotary field condition		None	
Minimum inductance of mains supply	µH	40	
Charging mains input current	A	< 10	
Mains fuse	A	≤ 16	
Power mains input connection cross section	mm^2	2.5	
DC bus connection cross section	mm^2	2.5	

Description	Unit	HNA05.1N-WR02F5-...	
		A4	A5
DC bus connection cable length	m	< 2; twisted	
Upper DC bus voltage limit	V	900	1300
Output voltage	V	$U_{nenn} \times \sqrt{2} + 30$	
Nominal output current	A	10	
Max. chargeable energy	kWs	680	1265
Max. chargeable output voltage	V	808	1100
Max. charging time	s	240	
Maximum capacitance at 500 V	F	2.5	
Minimum capacitance at output	mF	1	
Short circuit current rating (SCCR)	kA rms	85	

Tab. 8-8: HNA05 ratings

Connection diagram

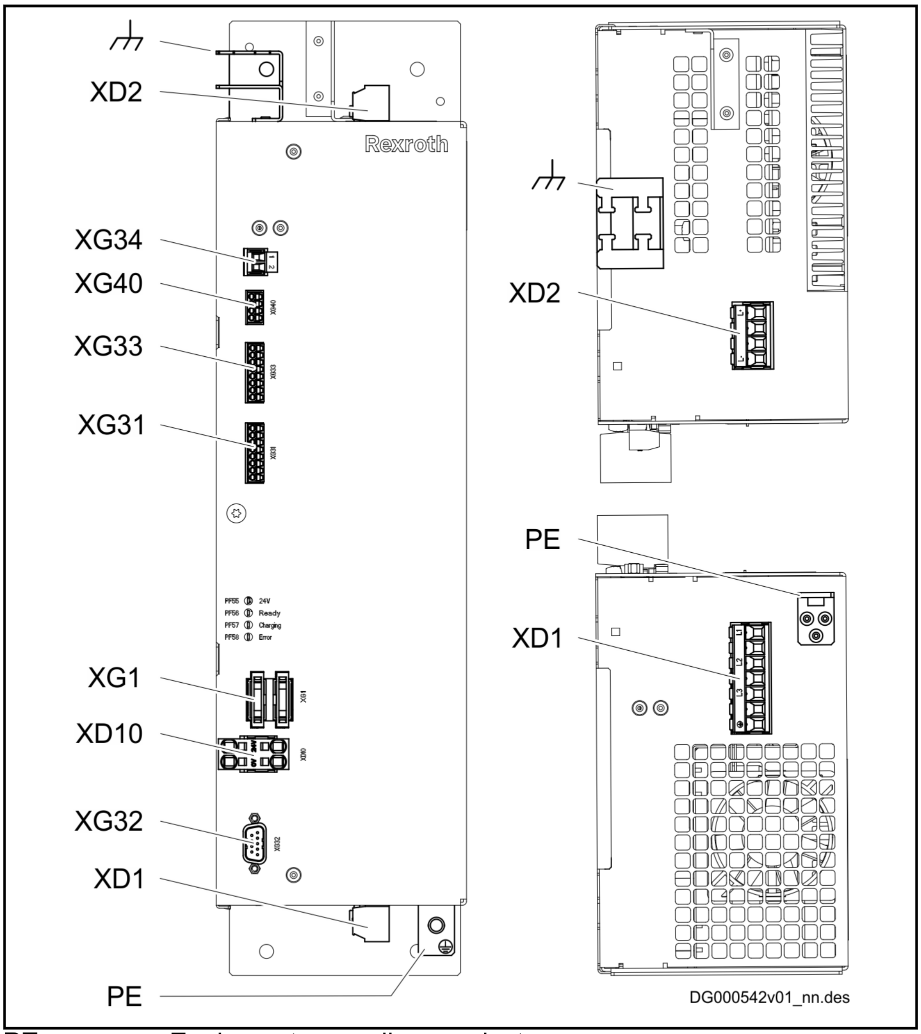
See chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 95

Maximum allowed operating cycles for charging circuit

The exact value depends on the existing DC bus capacitance (number and size of HMUs, additional capacitance connected).

Connection points

Overview



PE	Equipment grounding conductor
XD1	Mains voltage, equipment grounding conductor (L1, L2, L3, PE)
XD2	DC bus (L+, L-)
XD10	Control voltage (0 V, 24 V)
XG1	IndraBus
XG31	Connection for messages
XG32	HNA bus
XG33	On, off, ZKS (DC bus short circuit) status
XG34	Contact for external mains contactor
XG40	Acknowledgment messages of mains contactor

Fig. 8-17: HNA05 connection points

Equipment grounding conductor connection point

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Connect the equipment grounding conductor to the equipment grounding system of the control cabinet.

Check the continuity of the equipment grounding conductors from the mains connection to the connected motors.

Equipment grounding conductor: material and cross section

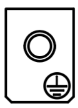
Use the same metal (e.g., copper) for the equipment grounding conductor as for the outer conductors.

Make sure the lines for the connections from the device's equipment grounding conductor to the equipment grounding conductor system in the control cabinet are large enough.

For outer conductors with a cross section greater than 16 mm², you can reduce the cross section of the equipment grounding connection according to the table "Equipment grounding conductor cross section".

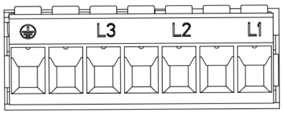
Cross-sectional area A of outer conductors	Minimum cross-sectional area A_{PE} of equipment grounding connection
A ≤ 16 mm²	A
16 mm² < A ≤ 35 mm²	16
35 mm² < A	A / 2

Tab. 8-9: Equipment grounding conductor cross section

View	Identification	Function	
	⏚	Connection to equipment grounding system	
Screw connection	**Unit**	**Min.**	**Max.**
Screw		M6x25	
Tightening torque	Nm	9.5	10.5

Tab. 8-10: Equipment grounding conductor connection point

XD1, mains voltage, equipment grounding conductor

View	Connection	Function
	⏚	Equipment grounding conductor
	L3	Connection to mains power supply (L3)
	L2	Connection to mains power supply (L2)
	L1	Connection to mains power supply (L1)

Tab. 8-11: XD1, mains voltage, ground

Mechanical data

Screw connection at connector	Unit	Min.	Max.
Tightening torque	Nm	0.8	
Connection cable Solid wire	mm^2	0.2	10
Connection cable Stranded wire **without** ferrule	mm^2	0.2	6
	AWG	24	10
Connection cable Stranded wire **with** ferrule	mm^2	0.25	4
Stripped length	mm	10	

Tab. 8-12: Mechanical data

Electrical data

	Unit	Min.	Max.
Voltage	V		630
Current	A		41

Tab. 8-13: Electrical data

XD2, DC bus

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

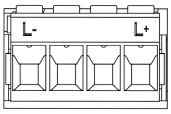
Before working on live parts: De-energize system and secure power switch against unintentional or unauthorized reconnection.

Make sure voltage has fallen below 50 V before touching live parts!

Wait at least **30 minutes** after switching off the supply voltages to allow **discharging** before accessing the device.

The discharge time can be more than 30 minutes if Y capacitor pairs are used.

Secure the DC bus connections against being touched.

View	Identification	Function
	L-	DC bus connection (-)
		n. c.
		n. c.
	L+	DC bus connection (+)

Tab. 8-14: XD2, DC bus

Mechanical data

Screw connection at connector	Unit	Min.	Max.
Tightening torque	Nm	0.8	
Connection cable Solid wire	mm^2	0.2	10
Connection cable Stranded wire **without** ferrule	mm^2	0.2	6
	AWG	24	10
Connection cable Stranded wire **with** ferrule	mm^2	0.25	4
Stripped length	mm	10	

Tab. 8-15: Mechanical data

Electrical data

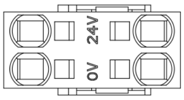
	Unit	Min.	Max.
Voltage	V		1000
Current	A		41

Tab. 8-16: Electrical data

XD10, 24 V supply (control voltage)

Function, pin assignment

The 24 V supply is applied externally via connection point X10.

View	Connec-tion	Signal name	Function
	24V	+24V	Power supply
		+24V	
	0V	0V	Reference potential for pow-er supply
		0V	

Tab. 8-17: XD10, 24 V supply

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Solid wire	mm^2	1	10
Connection cable Stranded wire **without** ferrule	mm^2	1	6
	AWG	16	10
Connection cable Stranded wire **with** ferrule	mm^2	1	4
Stripped length	mm	10	

Tab. 8-18: Mechanical data

Electrical data

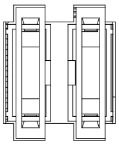
	Unit	Min.	Max.
Voltage load capacity	V	-	U_{N3}
Power consumption	W	-	P_{N3}
Current carrying capacity (looping through)	A	-	40 (UL: 31)
Allowed inductance	μH	-	100 (2 twisted single strands, 75 m long)

Tab. 8-19: Electrical data

Notes on installation

Depending on the power consumption of the devices and the current carrying capacity of the connector XD10, check the number of devices through which one line for 24 V supply can be looped through. You may have to connect another device directly to the 24 V supply and then loop through the control voltage from this device to other devices.

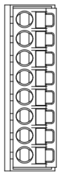
XG1, IndraBus

View	Connection	Function
	XG1a XG1b	Connects parallel components through a ribbon cable. • Output for quickly reporting critical errors to other devices • Input for detecting critical errors from other devices • Blocking and releasing DC bus short circuit by a braking resistor unit • Reporting DC bus availability *Cable* • Unshielded length: < 3 m Cable designation: RKB0036 • Shielded length: < 100 m Cable designation: RKB0035 In individual operation (that is to say not in combination with other devices of the Hxx05.1 series), both IndraBus RBS0025 terminating plugs must have been plugged in.

Tab. 8-20: XG1, IndraBus

XG31, messages

Pin assignment

View	Connec-tion	I/O	Function
	1	I	Supply voltage of inputs/outputs (**24VEA**)
	2	I	Reset input for resetting error messages: 1: Reset active 0: Reset not active
	3	I	Input for selecting between **stand-alone mode** and **slave mode**: 1: Stand-alone mode 0: Slave mode
	4	O	Isolated **Bb contact** (N/O) N/O contact signals readiness for operation. **Closed** with: Readiness for operation of supply unit **Open** with: • Error messages: F2800 … F2899 • Error messages: F8069, F8070
	5		
	6	O	Isolated **warning contact** (N/C) N/C contact signals warning states. **Open** with: Overtemperature at supply unit
	7		
	8	I	Reference potential of supply voltage (**0VEA**)

Tab. 8-21: XG31, messages

☞ Operating HNA05 with HMU05 (slave mode) does not require XG31 to be connected.

If the master communication has been deactivated, it is necessary to connect Bb contact, warning contact and reset input.

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cable Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

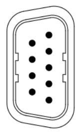
Tab. 8-22: Mechanical data

Electrical data

	Unit	Min.	Max.
Digital inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Switching voltage	V	24 -6%	
Output current	mA		500
Energy absorption capacity	mJ		700
Overload protection	-	Short circuit protection	
Bb and warning contact	-	Digital outputs correspond to IEC 61131-2 Type 1	
Switching voltage	V_{DC}	30	
Continuous current	A		1
Switching current	A		5
Load current	mA	10	
Switching cycles	-	3×10^5	

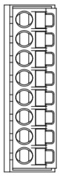
Tab. 8-23: Electrical data

XG32, HNA bus

View	Identification	Function	
	XG32	HNA bus	
D-Sub, 9-pin, male	**Unit**	**Min.**	**Max.**
Connection cross section	mm^2	0.25	0.5
Cable: RKB0037	m	0.5 or 0.66	1

Tab. 8-24: Function, pin assignment, properties

XG33, on, off, ZKS (DC bus short circuit) status

View	Connection	I/O	Function
	1	I	Supply voltage of inputs/outputs (24VEA*)
	2	O	Supply voltage for external, current sourcing output (ZKS1*) Output (24VEA) is used to connect input XG33.3
	3	I	DC bus short-circuit input for signaling an active DC bus short circuit (ZKS2*) **Not connected:** ZKS active **Connected to 24VEA of XG33.2:** ZKS not active The mains contactor opens in the case of an active DC bus short circuit.
	4	O	Supply voltage for external OFF output (OFF1*) Output (24VEA) is used to connect input XG33.5
	5	I	OFF input (OFF2*) Connection for N/C contact to switch off the supply unit The input is always available, irrespective of whether or not a master communication has been activated. Compared to the master communication, the input is of higher priority. The input can be used, for example, to loop in an emergency stop circuit or the like.
	6	O	Supply voltage for external ON output (ON1*) Output (24VEA) is used to connect input XG33.7
	7	I	ON input (ON2*) Connection for N/O contact to switch on the supply unit. The input is edge-controlled. The input is only available, if the master communication has been deactivated (P-0-4089.0.1).
	8	I	Reference potential of supply voltage (0VEA*)

* Description in connection diagram (see chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 95)

Tab. 8-25: Function, pin assignment

☞ Operating HNA05 with HMU05 (slave mode) requires at least the OFF input and the DC bus short circuit input (ZKS) to be connected.

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cable Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

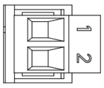
Tab. 8-26: Mechanical data

Electrical data

	Unit	Min.	Max.
Digital Inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Supply outputs	-		
Total output current	mA		300

Tab. 8-27: Electrical data

XG34, mains contactor (contact)

View	Connec-tion	Function
	1	Connection to outer conductor L
	2	Mains contactor connection

Tab. 8-28: Function, pin assignment, properties

Mechanical data

Screw connection at connector	**Unit**	**Min.**	**Max.**
Tightening torque	Nm	0.6	0.8
Connection cable Stranded wire **without** ferrule	mm^2	0.2	2.5
	AWG	24	12
Connection cable Stranded wire **with** ferrule	mm^2	0.25	2.5
Stripped length	mm	10	

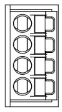
Tab. 8-29: Mechanical data

Electrical data

	Unit	Min.	Max.
Switching voltage	V	5Vac / 5Vdc	~250Vac / 50Vdc
Continuous current	A		1
Switching current	A		5
Load current	mA	10	
Switching cycles		3×10^5	

Tab. 8-30: Electrical data

XG40, mains contactor (acknowledgment messages)

View	Connection	I/O	Function
	1	I	Acknowledgment message: **N/O contact** of external mains contactor
	2	O	Output (24VEA) is used to connect XG40.1
	3	I	Acknowledgment message: **N/C contact** of external mains contactor
	4	O	Output (24VEA) is used to connect XG40.3

Tab. 8-31: Function, pin assignment

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cable Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

Tab. 8-32: Mechanical data

Electrical data

	Unit	Min.	Max.
Digital inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Supply outputs	-		
Total output current	mA		300

Tab. 8-33: Electrical data

Display elements

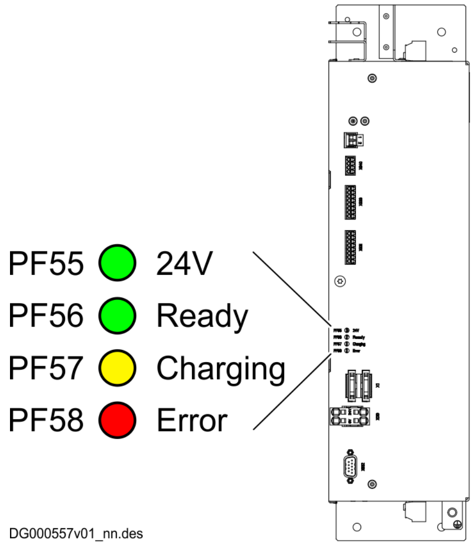


Fig. 8-18: LEDs at HNA05

LED	Color/status		Meaning
PF55		Green	24 V power supply applied
		Off	24 V power supply < 19.2 V
PF56		Green	HNA ready
		Flashing green	HNA ready; no mains voltage
		Off	HNA not ready
PF57		Yellow	Charging complete (DC bus capacitance charged)
		Flashing yellow	Charging
		Off	Charging interrupted
PF58		Red	Error
		Flashing red	Warning
		Off	No error, no warning

Tab. 8-34: LED displays

8.3.2 HNC05 mains capacitor

HNC05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	H	N	C	0	5	.	1	N	-	0	2	0	0	-	A	4	-	N	N	N	N																			
	①			②			③	④		⑤					⑥			⑦																						

①	**Product:** HNC = Mains capacitor
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Degree of protection:** N = IP00
⑤	**Capacitance value:** 0040 = 40 µF 0050 = 50 µF 0070 = 70 µF 0075 = 75 µF 0100 = 100 µF 0125 = 125 µF 0150 = 150 µF 0200 = 200 µF
⑥	**Mains voltage:** A4 = 3 x AC 380 V -15% ... 500 V +10% A5 = 3 x AC 525 V -15% ... 690 V +10%
⑦	**Other design:** NNNN = None

Tab. 8-35: HNC05, type code

Possible combinations:

Mains voltage	Capacitance							
	0040	0050	0070	0075	0100	0125	0150	0200
A4	–	✓	–	✓	✓	–	✓	✓
A5	✓	✓	✓	–	✓	✓	✓	–

Tab. 8-36: Possible combinations

Dimensions

HNC05.1N-0050

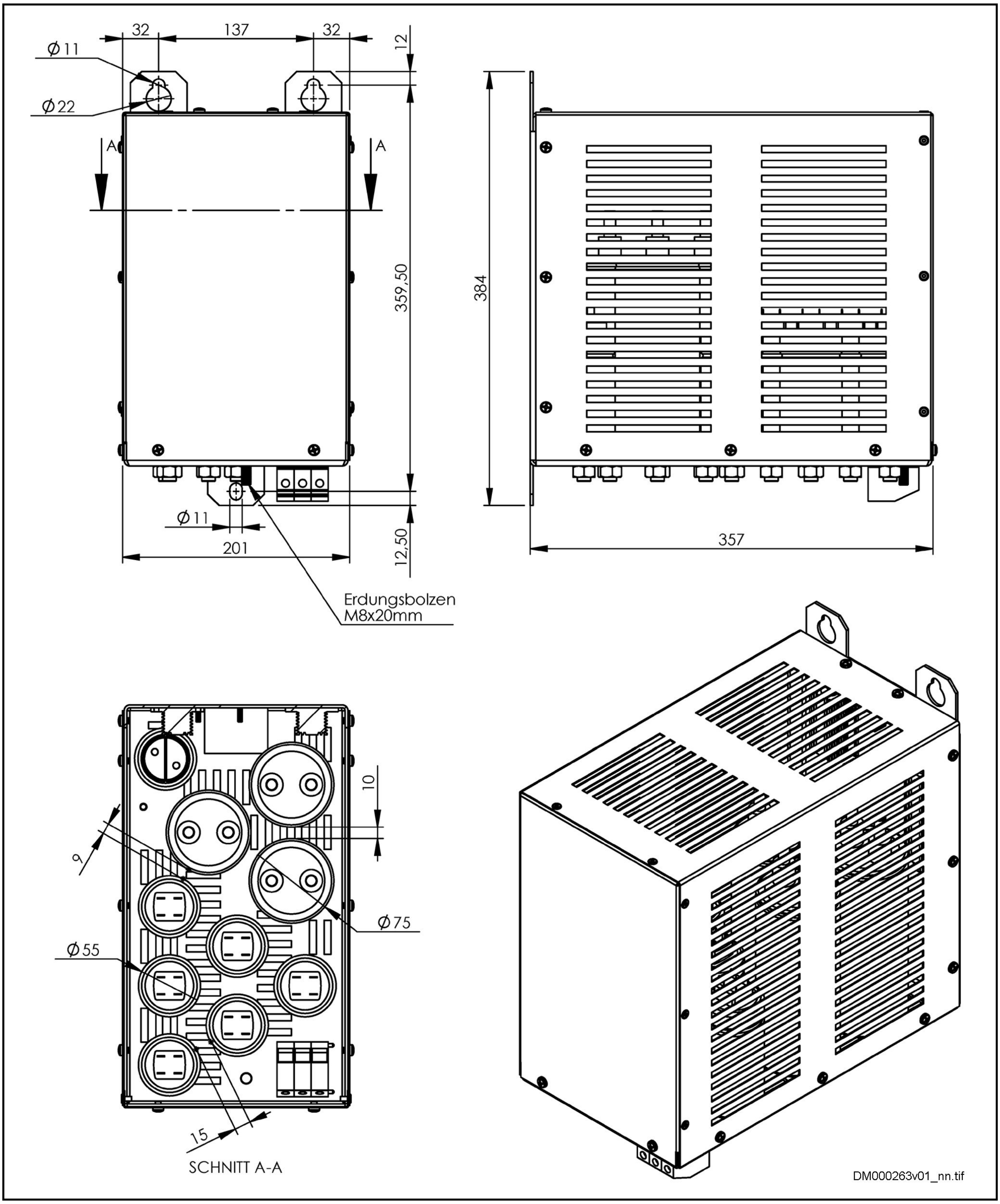


Fig. 8-19: HNC05.1N-0050

HNC05.1N-0075

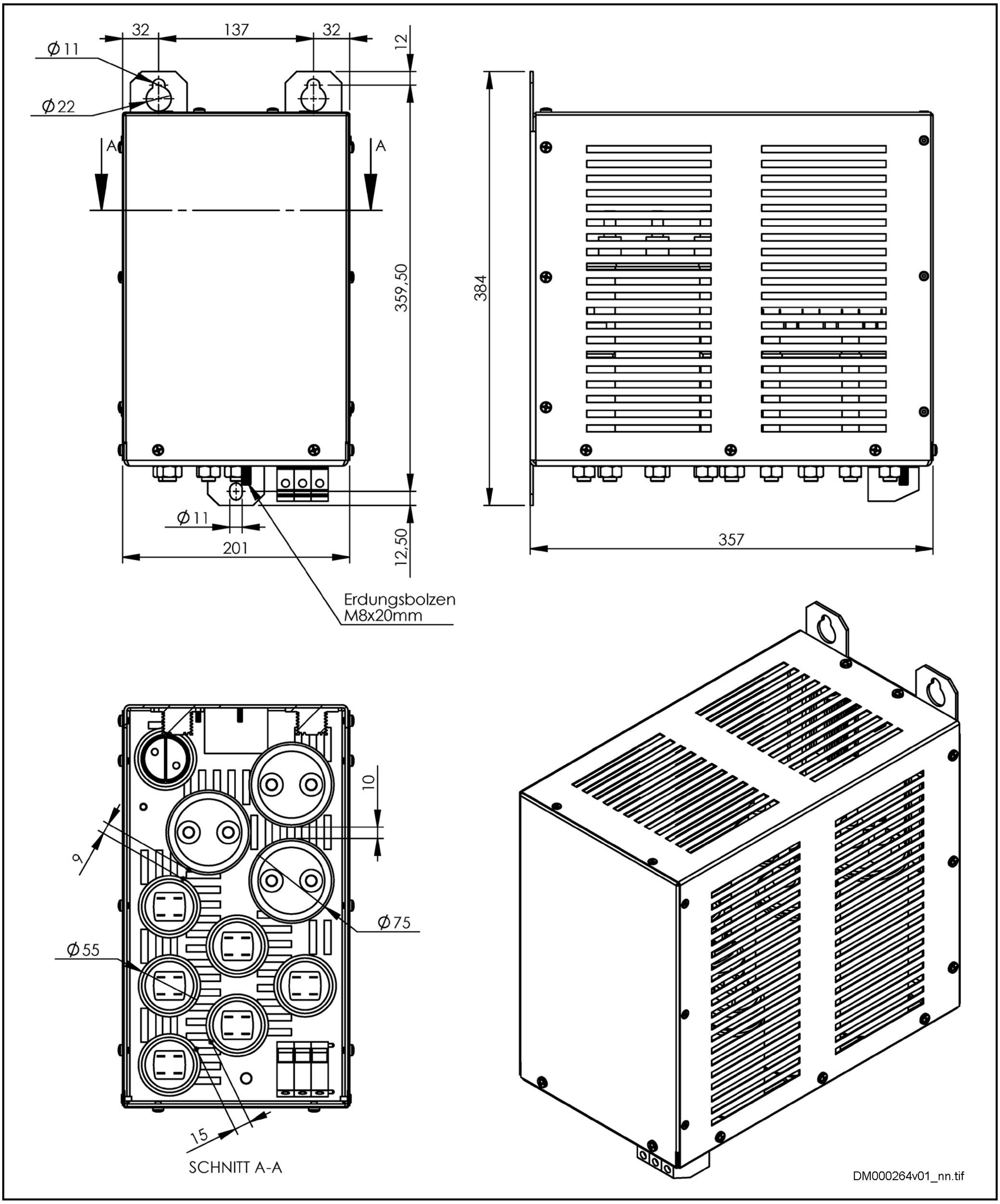


Fig. 8-20: HNC05.1N-0075

Cables, accessories, additional components

HNC05.1N-0100

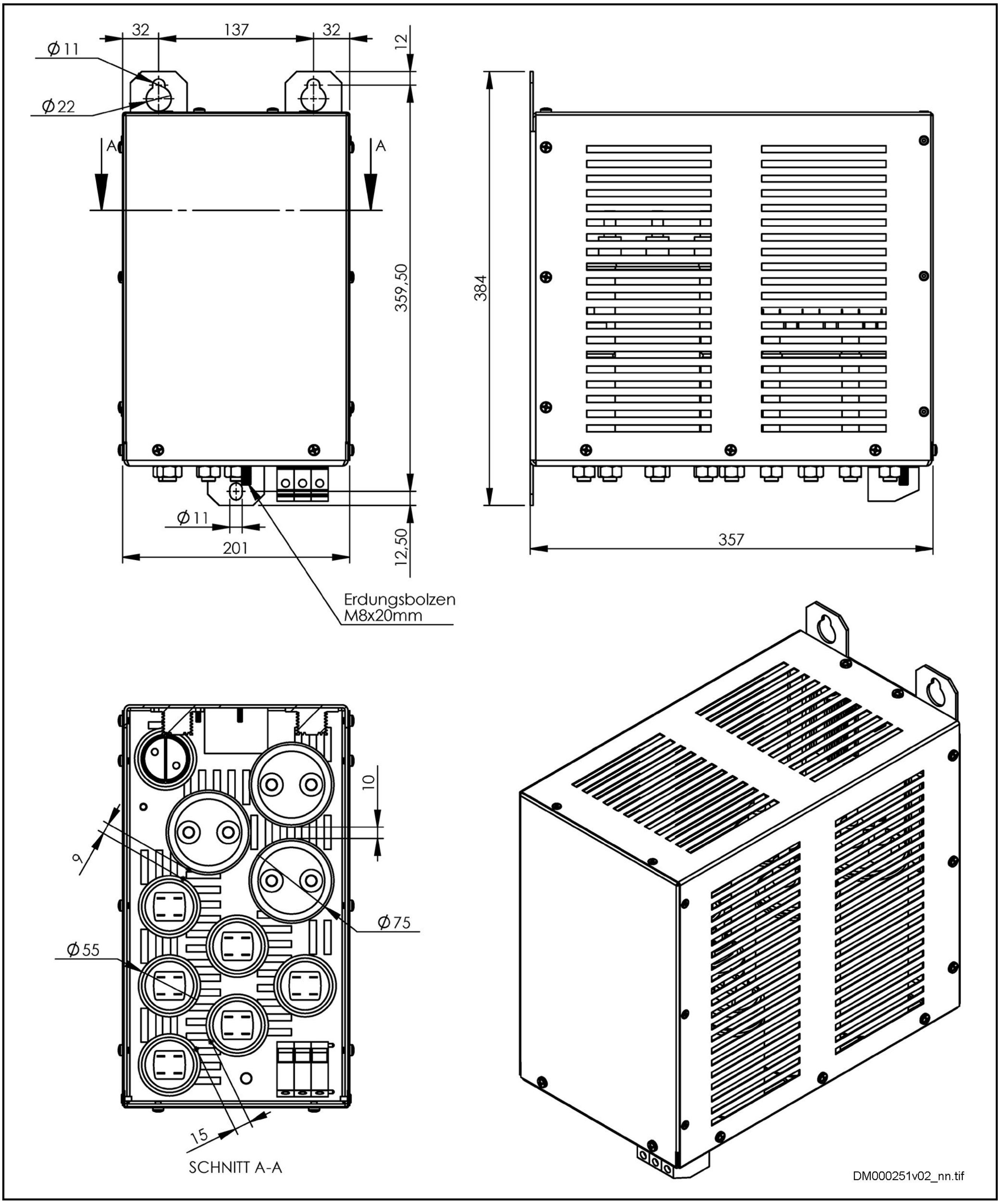


Fig. 8-21: HNC05.1N-0100

Data

- Equipment grounding conductor cross section = outer conductor cross section!
- Keep supply lines as short as possible.
- Mount mains capacitors to the back panel of the control cabinet over the largest possible surface area to establish a good electrical connection. Reason: EMC, heat dissipation

Mains capacitor HNC05.1N-…	Capacitance [µF]	Nominal current [A]	Power dissipation [W]	Connection	Degree of protection	Weight [kg]
0050	50	60	100	Phases: Screw terminal, 25 mm² Tightening torque: 4 … 4.5 Nm Ground: Bolt, M8x20	IP20	11.6
0075	75	80	100	Phases: Screw terminal, 25 mm² Tightening torque: 5 Nm Ground: Bolt, M8x20	IP20	11.6
0100	100	80	150	Phases: Screw terminal, 25 mm² Tightening torque: 5 Nm Ground: Bolt, M8x20	IP20	11.6

Tab. 8-37: HNC05.1N, data

Discharge time

20 minutes

Assignment to HMU05

See chapter "Combining mains filter, mains choke, preconnected choke and capacitance pack" on page 112.

Cables, accessories, additional components

8.3.3 HNF05 mains filter

HNF05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	H	N	F	0	5	.	1	A	-	5	0	0	N	-	R	0	8	1	1	-	N	-	A	4	-	N	N	N	N											
	①			②			③	④		⑤					⑥	⑦					⑧		⑨			⑩														

①	**Product:** HNF = Mains filter
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**EMC area:** A = Category C3 in accordance with DIN EN 61800-3 B = Category C1 in accordance with DIN EN 61800-3 C = Category C2 in accordance with DIN EN 61800-3 D = Extended frequency range in accordance with EMC integration guidelines of the automotive industry for production environment
⑤	**Leakage capacitance:** 500N = 500 nF (example)
⑥	**Supply system:** R = For regenerative devices only
⑦	**Nominal current:** 0150 = 150 A 0180 = 180 A 0250 = 250 A 0320 = 320 A 0400 = 400 A 0600 = 600 A 1000 = 1000 A 1600 = 1600 A
⑧	**Degree of protection:** N = IP00
⑨	**Mains connection voltage:** A4 = 3 x AC 380 V -15% ... 500 V +10% A5 = 3 x AC 380 V -15% ... 690 V +10%
⑩	**Other design:** NNNN = None

Tab. 8-38: HNF05, type code

Possible combinations:

		Mains connection voltage							
		A4, A5							
		Nominal current							
		0150	0180	0250	0320	0400	0600	1000	1600
EMC area	A	✓	✓	✓	✓	✓	✓	✓	✓

Tab. 8-39: Possible combinations

Dimensions

HNF05.1A-500N-R0250

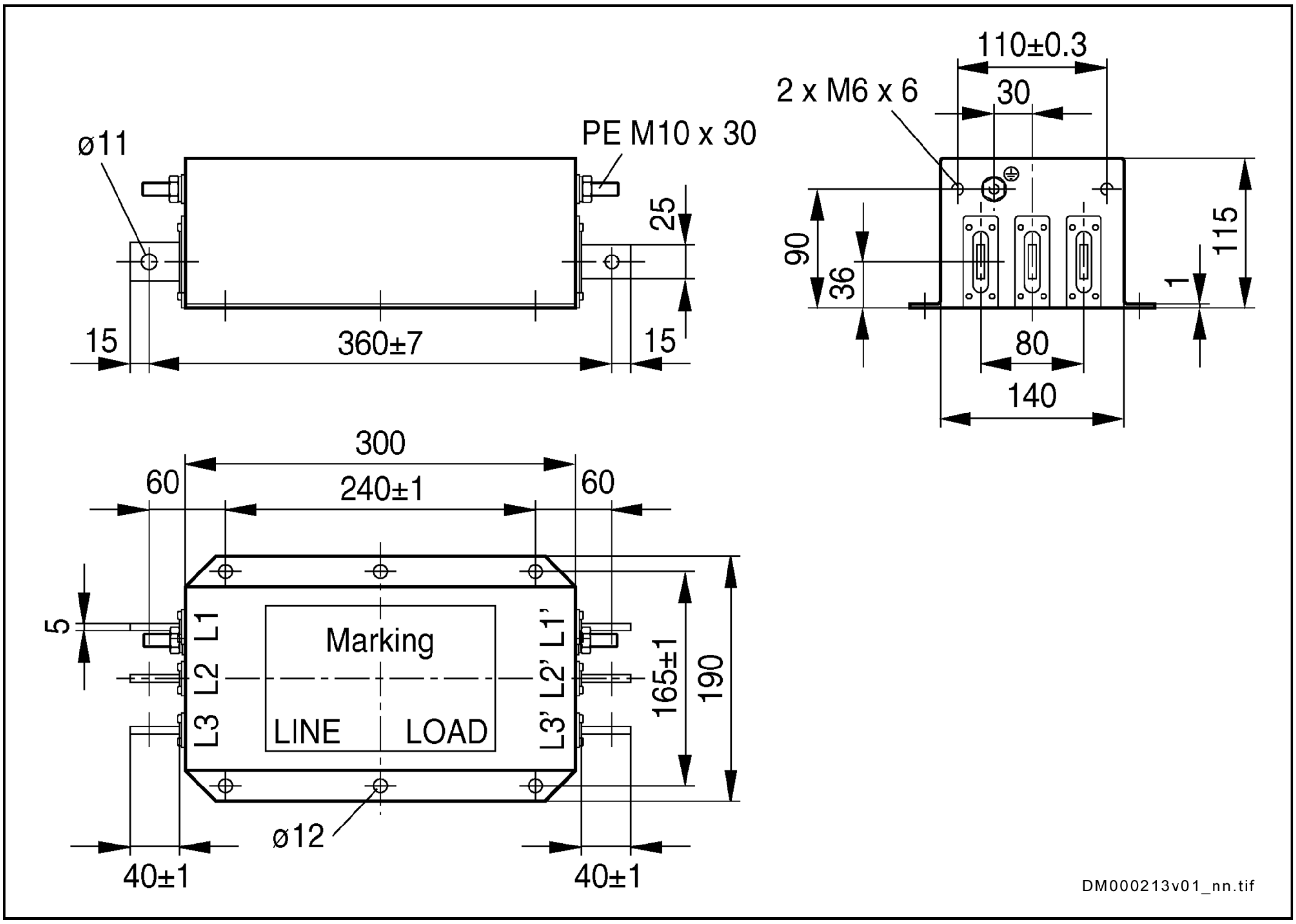


Fig. 8-22: HNF05.1A-500N-R0250

HNF05.1A-500N-R0320, -R0400

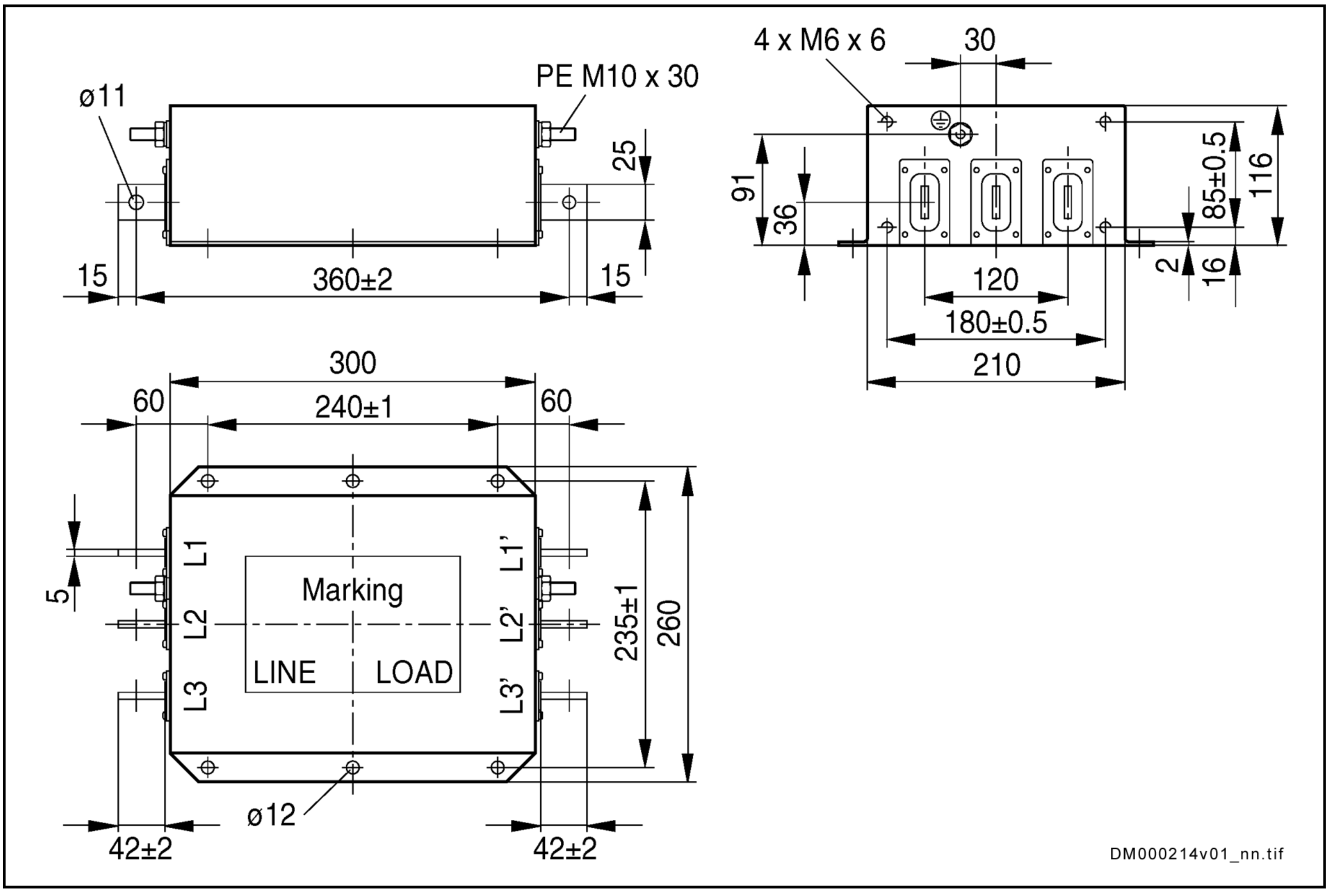


Fig. 8-23: HNF05.1A-500N-R0320, -R0400

Cables, accessories, additional components

HNF05.1A-500N-R0600

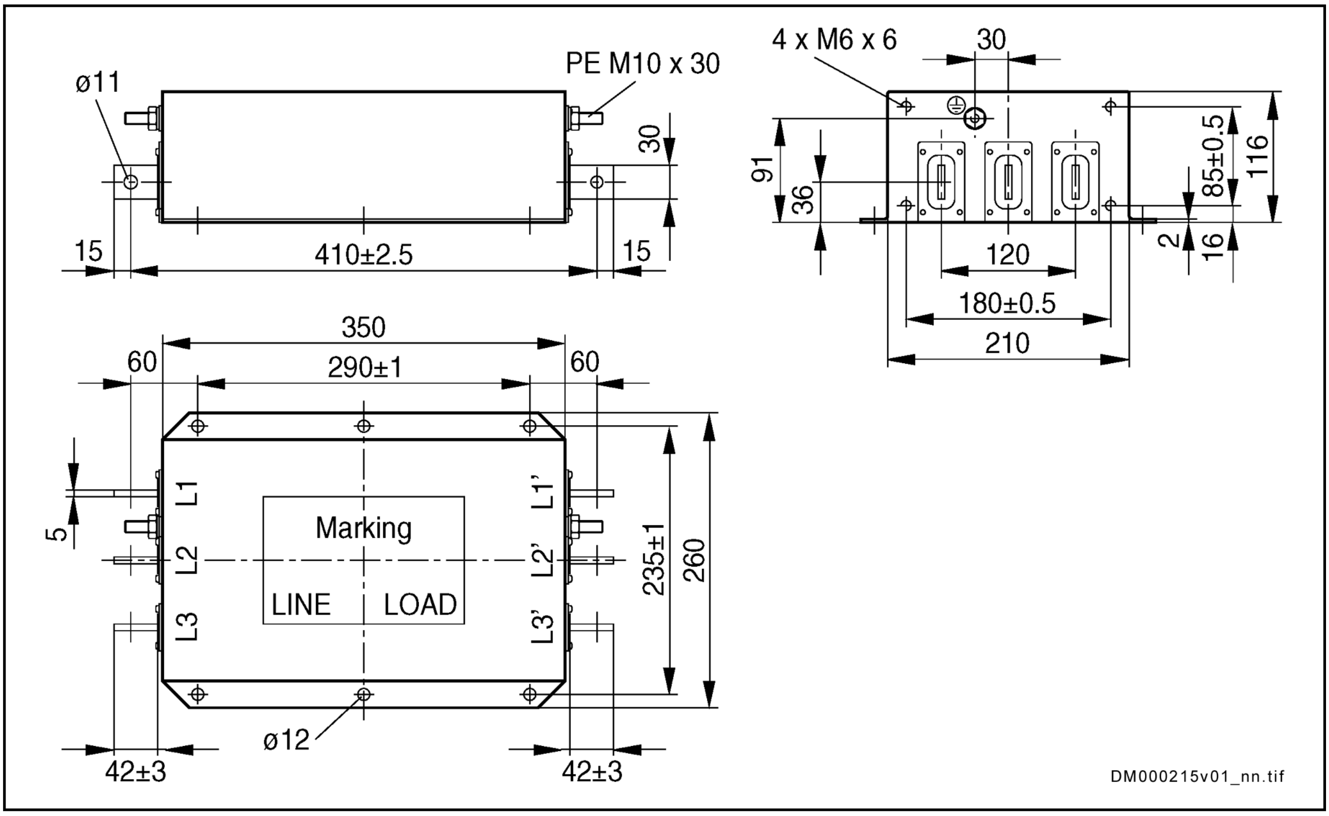


Fig. 8-24: HNF05.1A-500N-R0600

HNF05.1A-500N-R1000

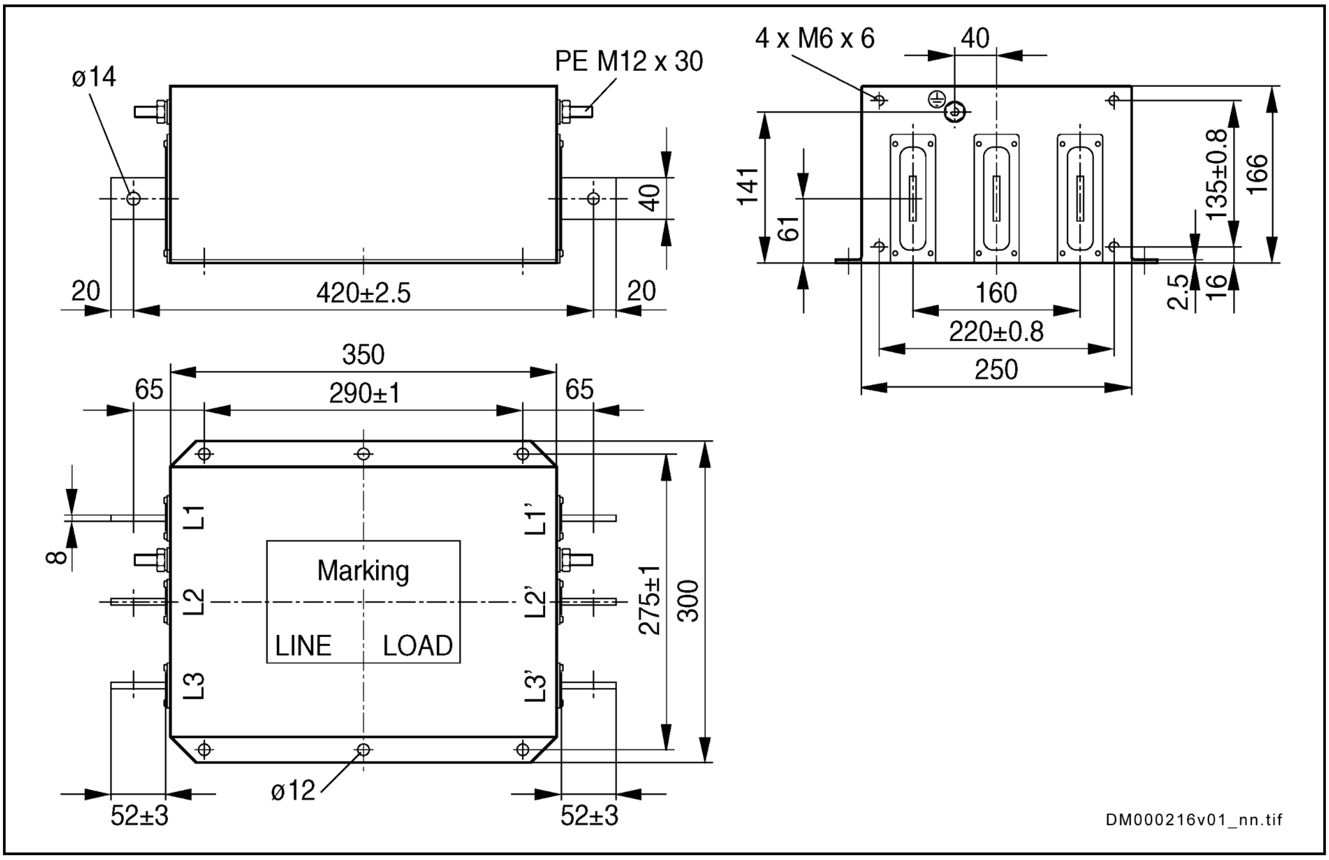


Fig. 8-25: HNF05.1A-500N-R1000

HNF05.1A-500N-R1600

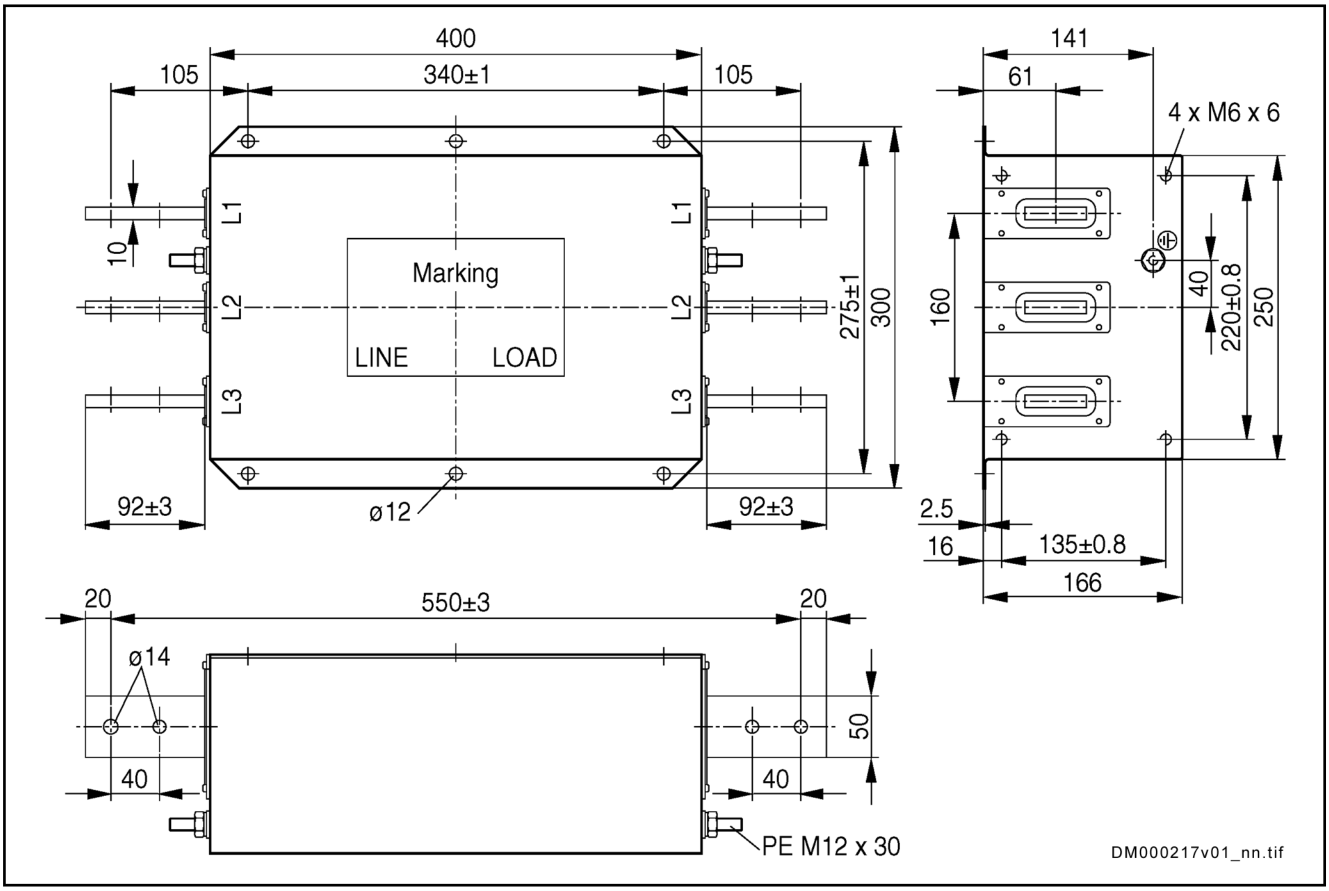


Fig. 8-26: HNF05.1A-500N-R1600

Mounting

Mounting position Observe the mounting position of the filters! Generally, mount the device in such a way that the natural convection is not impaired.

Mounting points As a matter of principle, the mechanical fixing, for example, can be carried out using 4 mounting points, and the other 2 mounting points are used as a PE connection to the mounting plate with metallic conduction properties. In this case, mark the 2 PE connections with the symbol for the equipment grounding conductor connection point. The metallic connection to the mounting plate has to comply with the valid standards.

Threaded bolt PE

Nominal size	Tightening torque [Nm]	Tolerance [Nm]
M10	10.0	9.0 … 11.0
M12	15.5	14.0 … 17.0
M16	30	27.0 … 33.0

Tab. 8-40: Threaded bolt PE

Data

HNF05.1A-500N-R…	Nominal voltage [V]	Nominal current [A]	Power dissipation [W]	Leakage current [mA]	Resistance [μΩ]	Weight [kg]
0250	690/400, 50/60 Hz	250	34	< 905 [1)]	63	15
0320		320	36		67	21
0400		400	53			
0600		600	86		52	22
1000		1000	166		33	28
1600		1600	283		22	34

1) With nominal voltage, 50 Hz

Tab. 8-41: HNF05.1A, data

Assignment to HMU05

See chapter "Combining mains filter, mains choke, preconnected choke and capacitance pack" on page 112.

8.3.4 HNL05 mains choke

HNL05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	H	N	L	0	5	.	1	R	-	0	1	8	2	-	C	0	8	1	1	-	N	-	A	4	-	N	N	N	F											
	①			②			③	④		⑤					⑥	⑦					⑧		⑨			⑩														

①	Product: HNL = Mains choke
②	Series: 05 = 05
③	Design: 1 = 1
④	Supply system: R = For regenerative devices only
⑤	Nominal inductance: 0040 = 40 µH 0043 = 43 µH 0045 = 45 µH 0050 = 50 µH 0054 = 54 µH 0080 = 80 µH 0094 = 94 µH 0100 = 100 µH 0113 = 113 µH 0117 = 117 µH 0125 = 125 µH 0130 = 130 µH 0135 = 135 µH 0139 = 139 µH 0175 = 175 µH 0182 = 182 µH 0219 = 219 µH 0234 = 234 µH 0346 = 346 µH 0434 = 434 µH 0542 = 542 µH 0649 = 649 µH 1019 = 1019 µH
⑥	Additional option: N = None

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	N	L	0	5	.	1	R	-	0	1	8	2	-	C	0	8	1	1	-	N	-	A	4	-	N	N	N	F											
	①			②			③	④		⑤					⑥	⑦					⑧		⑨			⑩														

⑦	**Nominal current:** 0127 = 127 A 0152 = 152 A 0190 = 190 A 0218 = 218 A 0238 = 238 A 0262 = 262 A 0327 = 327 A 0352 = 352 A 0409 = 409 A 0471 = 471 A 0514 = 514 A 0592 = 592 A 0652 = 652 A 0811 = 811 A 1019 = 1019 A
⑧	**Degree of protection:** N = IP00
⑨	**Mains connection voltage:** A4 = 3 x AC 380 V – 15% … 500 V + 10% A5 = 3 x AC 525 V – 15% … 690 V + 10%
⑩	**Other design:** NNNF = Liquid cooling NNNN = None

Tab. 8-42: HNL05, type code

Possible combinations (mains connection voltage A4):

		Mains connection voltage													
		A4													
		Other design													
		NNNF								NNNN					
		Nominal current													
		0218	0262	0327	0409	0514	0652	0811	1019	0327	0409	0514	0652	0811	1019
Nominal inductance	0040	–	–	–	–	–	–	–	–	–	–	–	–	✓	✓
	0043	–	–	–	–	–	–	–	–	–	–	✓	–	–	–
	0045	–	–	–	–	–	–	–	–	✓	–	–	–	–	–
	0050	–	–	–	–	–	–	–	–	–	–	–	✓	–	–
	0054	–	–	–	–	–	–	–	–	–	✓	–	–	–	–
	0094	–	–	–	–	–	–	–	✓	–	–	–	–	–	–
	0100	–	–	–	–	–	–	✓	–	–	–	–	–	–	–
	0113	–	–	–	–	–	✓	–	–	–	–	–	–	–	–
	0117	–	–	–	✓	–	–	–	–	–	–	–	–	–	–
	0130	–	–	–	–	✓	–	–	–	–	–	–	–	–	–
	0135	–	–	✓	–	–	–	–	–	–	–	–	–	–	–
	0182	–	✓	–	–	–	–	–	–	–	–	–	–	–	–
	0219	✓	–	–	–	–	–	–	–	–	–	–	–	–	–

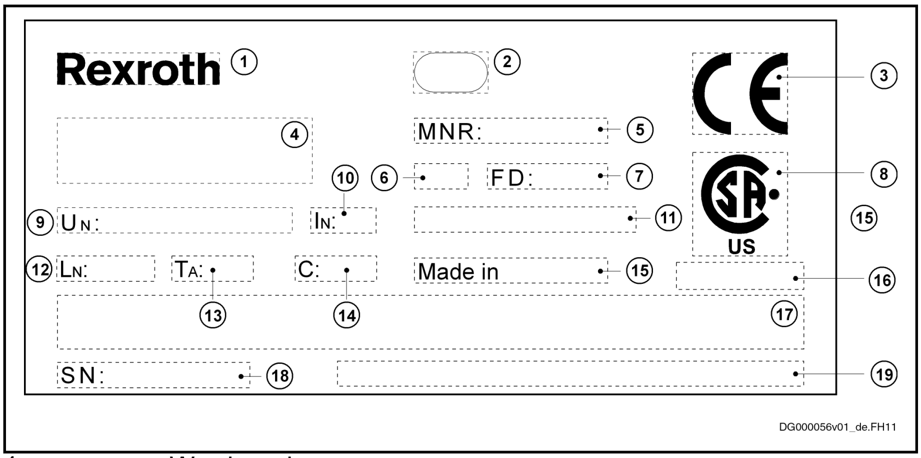
Tab. 8-43: Possible combinations (mains connection voltage A4)

Possible combinations (mains connection voltage A5):

		Mains connection voltage												
		A5												
		Other design												
		NNNF							NNNN					
		Nominal current												
		0592	0471	0352	0238	0190	0152	0127	0592	0471	0352	0238	0190	0152
Nominal inductance	0032	–	–	–	–	–	–	–	✓	–	–	–	–	–
	0040	–	–	–	–	–	–	–	–	✓	–	–	–	–
	0054	–	–	–	–	–	–	–	–	–	✓	–	–	–
	0080	–	–	–	–	–	–	–	–	–	–	✓	–	–
	0100	–	–	–	–	–	–	–	–	–	–	–	✓	–
	0125	–	–	–	–	–	–	–	–	–	–	–	–	✓
	0139	✓	–	–	–	–	–	–	–	–	–	–	–	–
	0175	–	✓	–	–	–	–	–	–	–	–	–	–	–
	0234	–	–	✓	–	–	–	–	–	–	–	–	–	–
	0346	–	–	–	✓	–	–	–	–	–	–	–	–	–
	0434	–	–	–	–	✓	–	–	–	–	–	–	–	–
	0542	–	–	–	–	–	✓	–	–	–	–	–	–	–
	0649	–	–	–	–	–	–	✓	–	–	–	–	–	–

Tab. 8-44: Possible combinations (mains connection voltage A5)

Type plate



1 Word mark
2 Business facility number
3 CE label
4 Type designation (two lines, 20 characters each)
5 Part number
6 Change release
7 Production date (YYWww)
8 Certification label
9 Nominal voltage / frequency
10 Nominal current
11 Number of design specification
12 Nominal inductance
13 Temperature
14 Number and value of additional capacitors
15 Designation of origin
16 Approval number
17 Bar code (39 or 93)
18 Serial number
19 Company address

Fig. 8-27: Type plate

Dimensions

HNL05.1R-0219-N0218

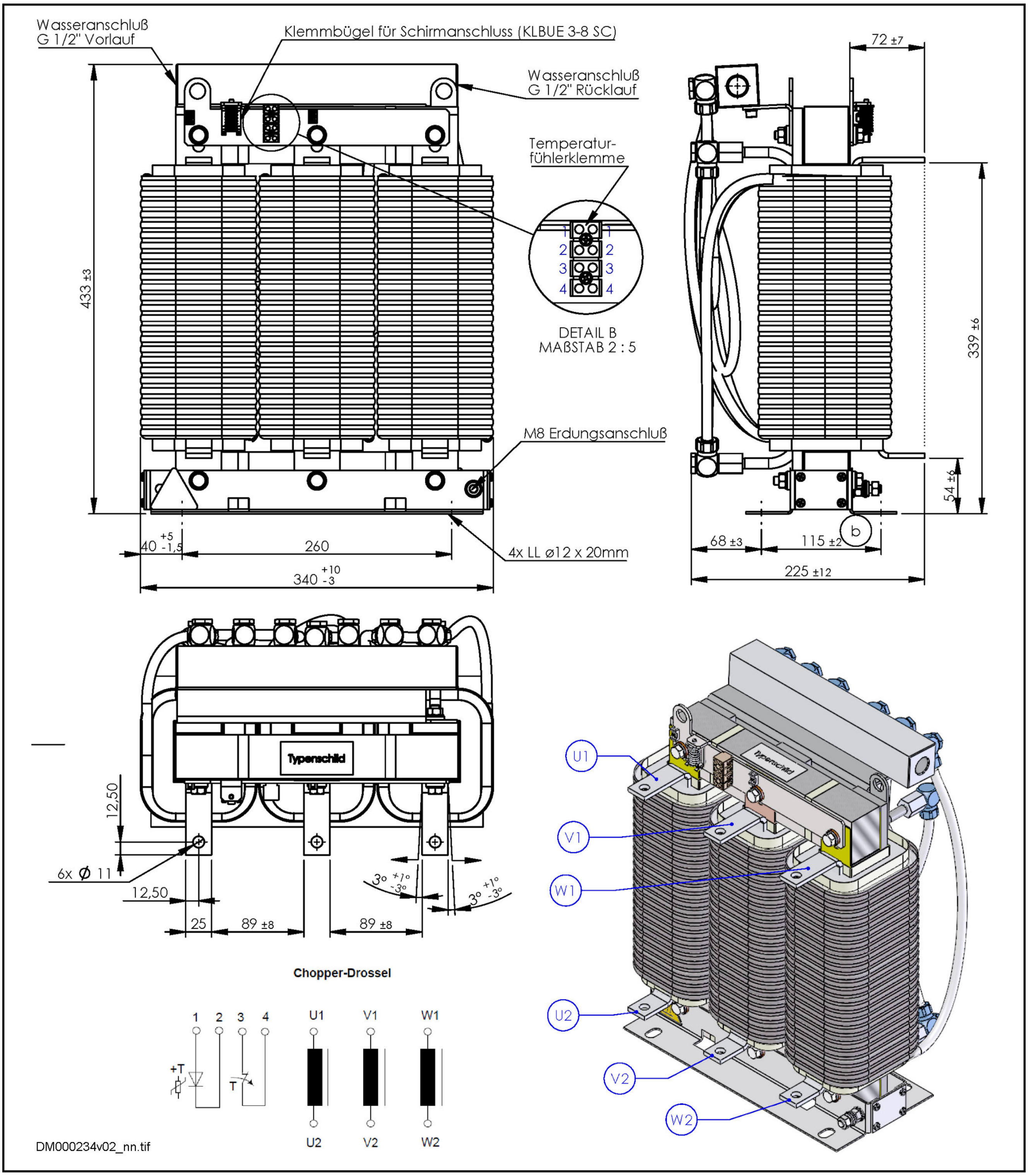


Fig. 8-28: HNL05.1R-0219-N0218

HNL05.1R-0182-N0262

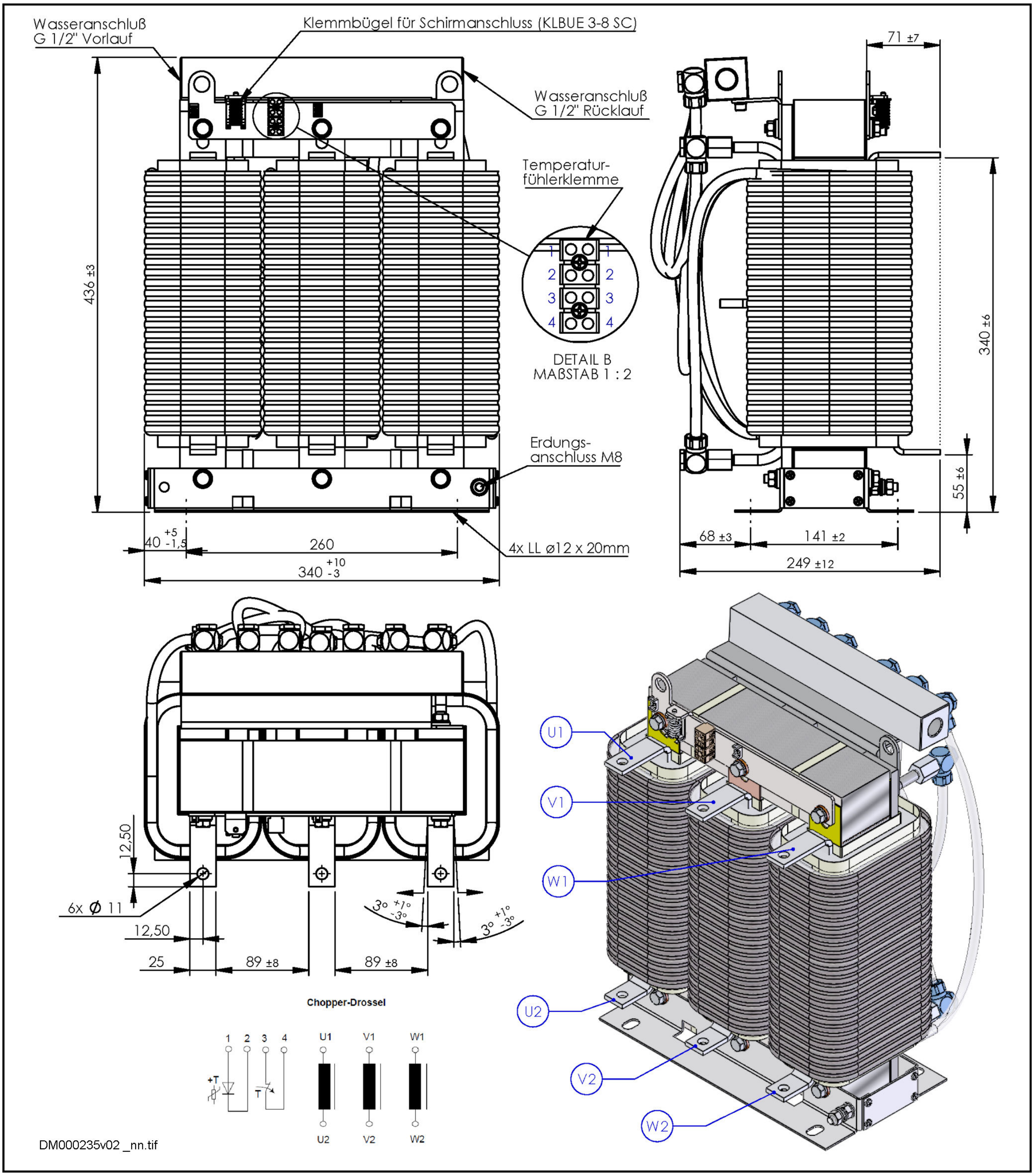


Fig. 8-29: HNL05.1R-0182-N0262

HNL05.1R-0045-N0327

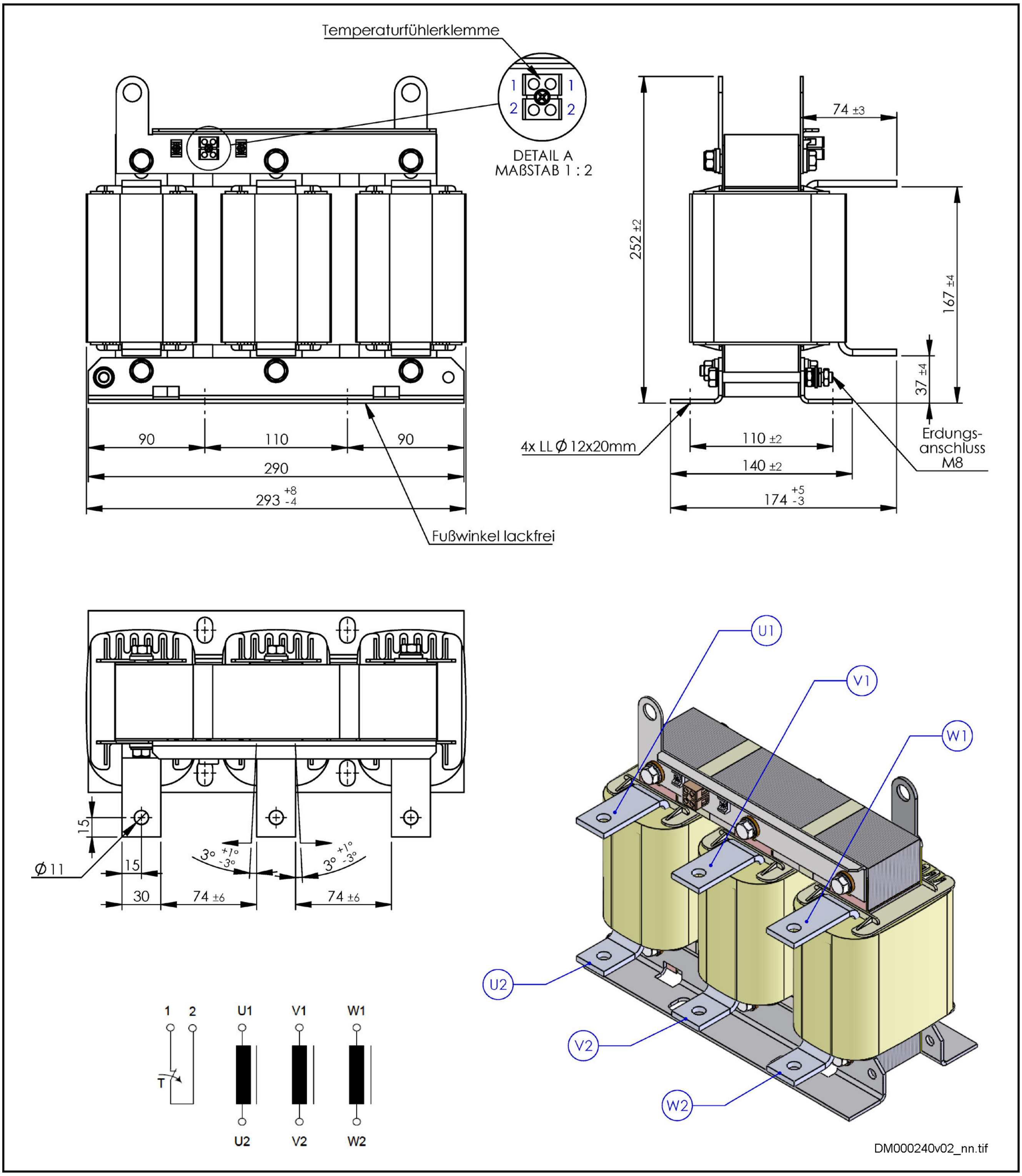


Fig. 8-30: HNL05.1R-0045-N0327

HNL05.1R-0135-N0327

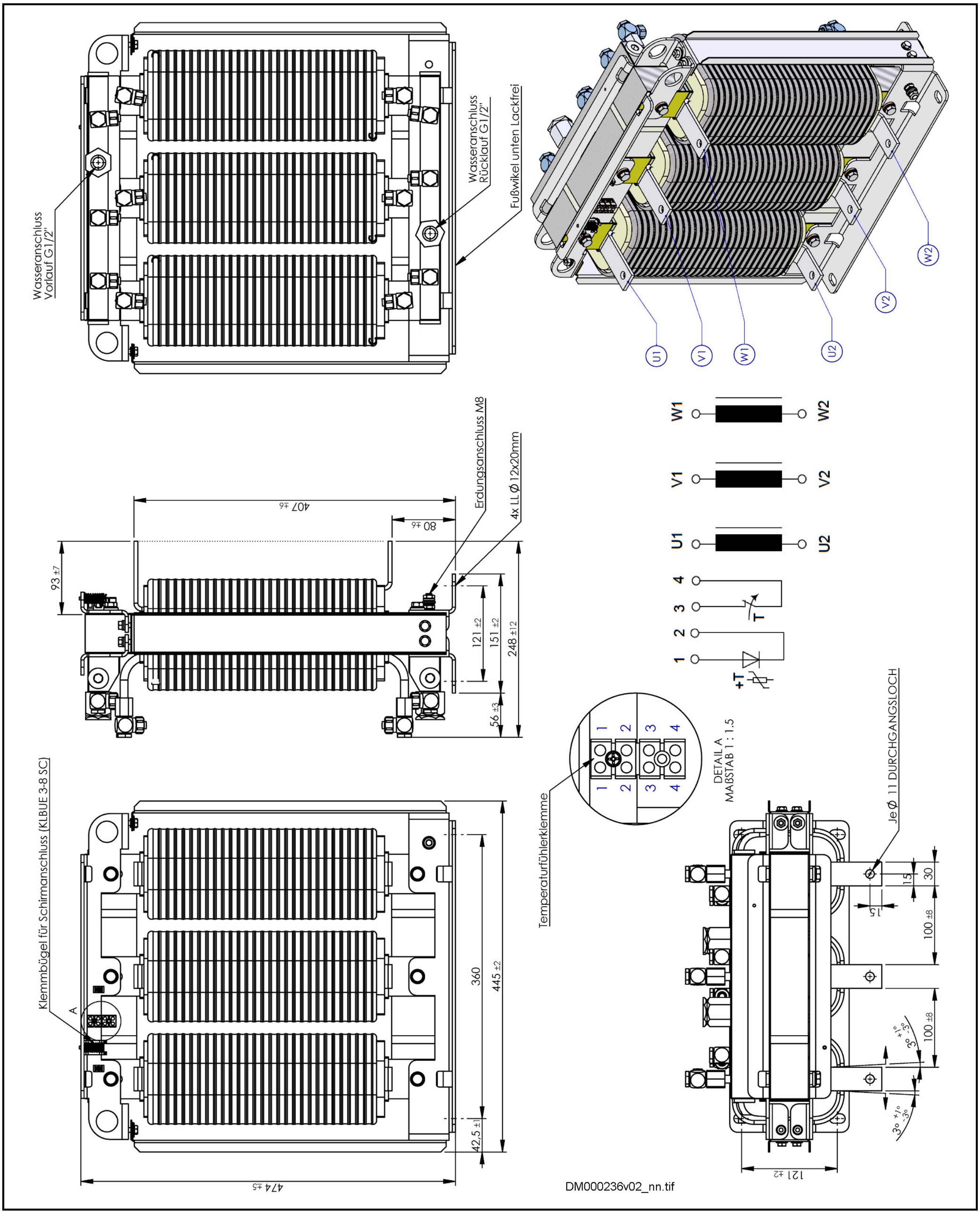


Fig. 8-31: HNL05.1R-0135-N0327

HNL05.1R-0054-N0409

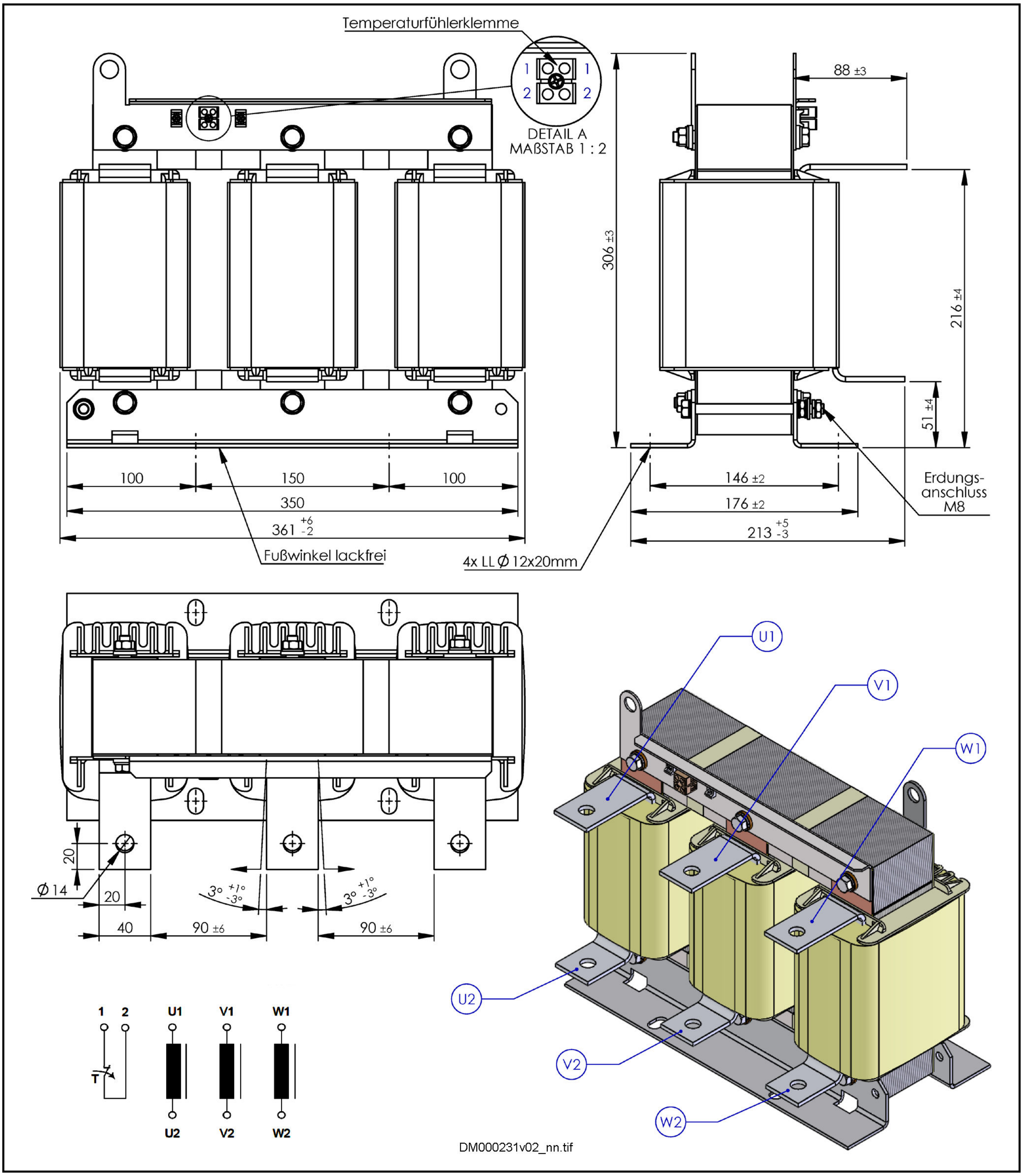


Fig. 8-32: HNL05.1R-0054-N0409

HNL05.1R-0117-N0409

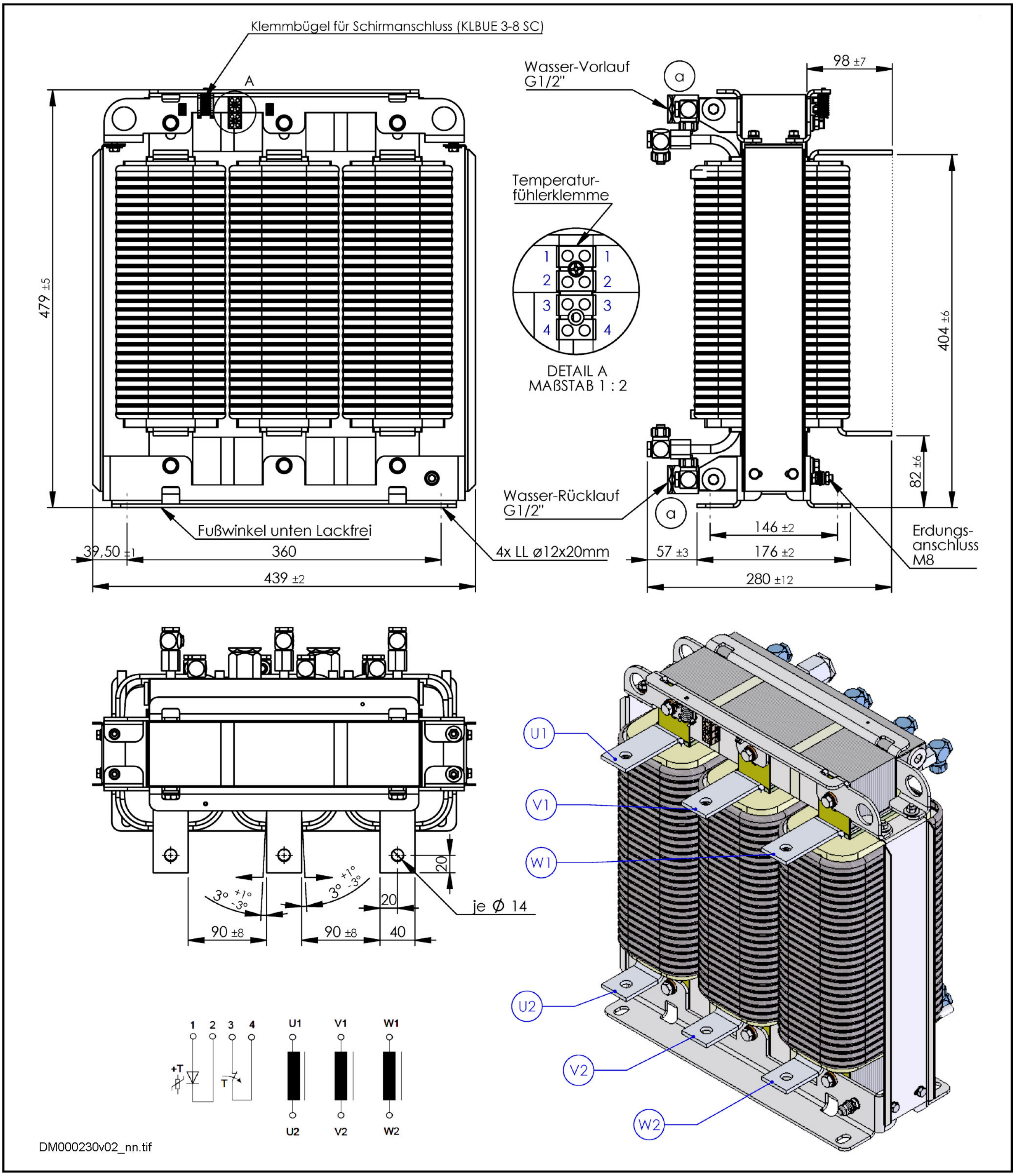


Fig. 8-33: HNL05.1R-0117-N0409

HNL05.1R-0043-N0514

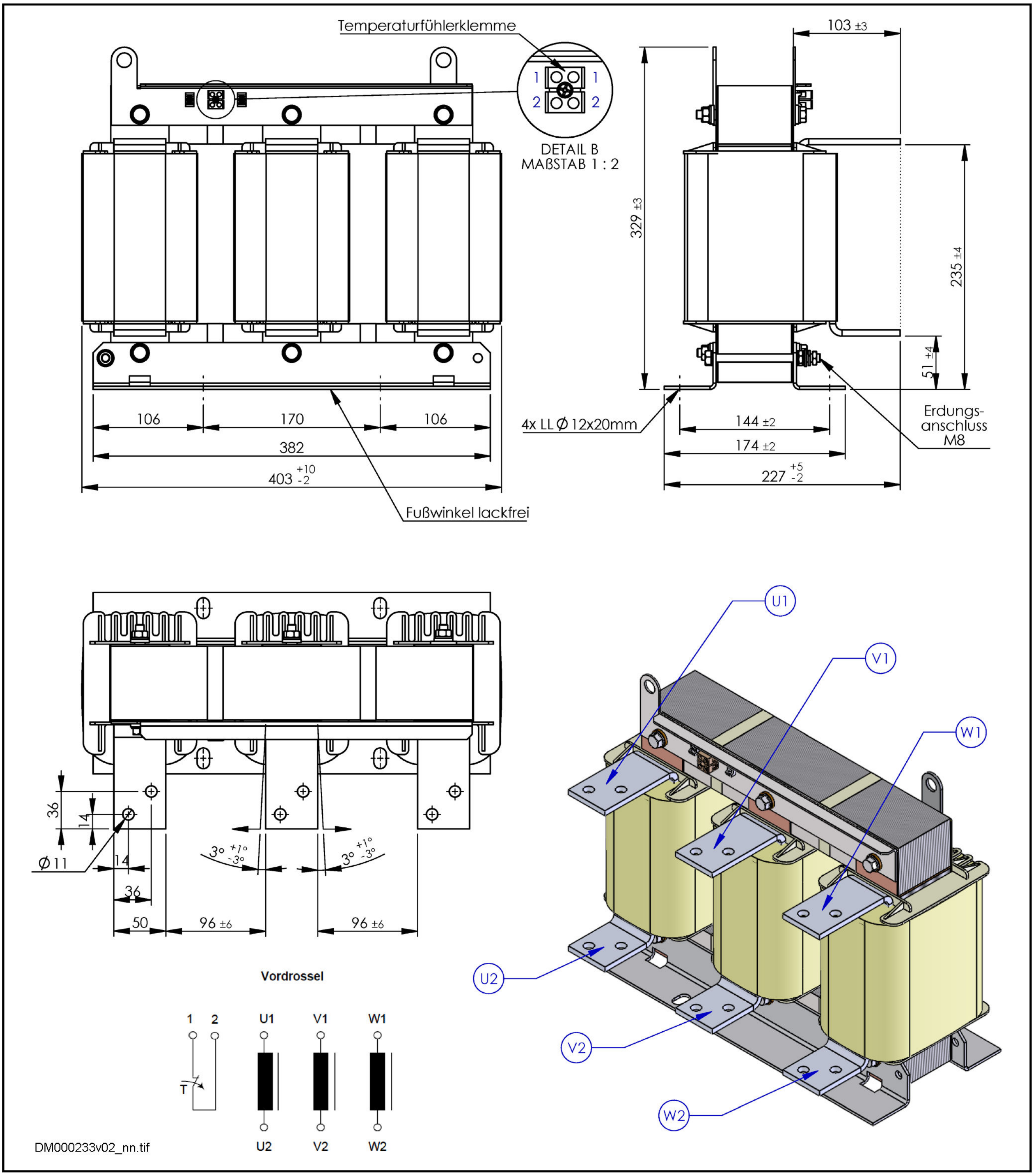


Fig. 8-34: HNL05.1R-0043-N0514

HNL05.1R-0130-N0514

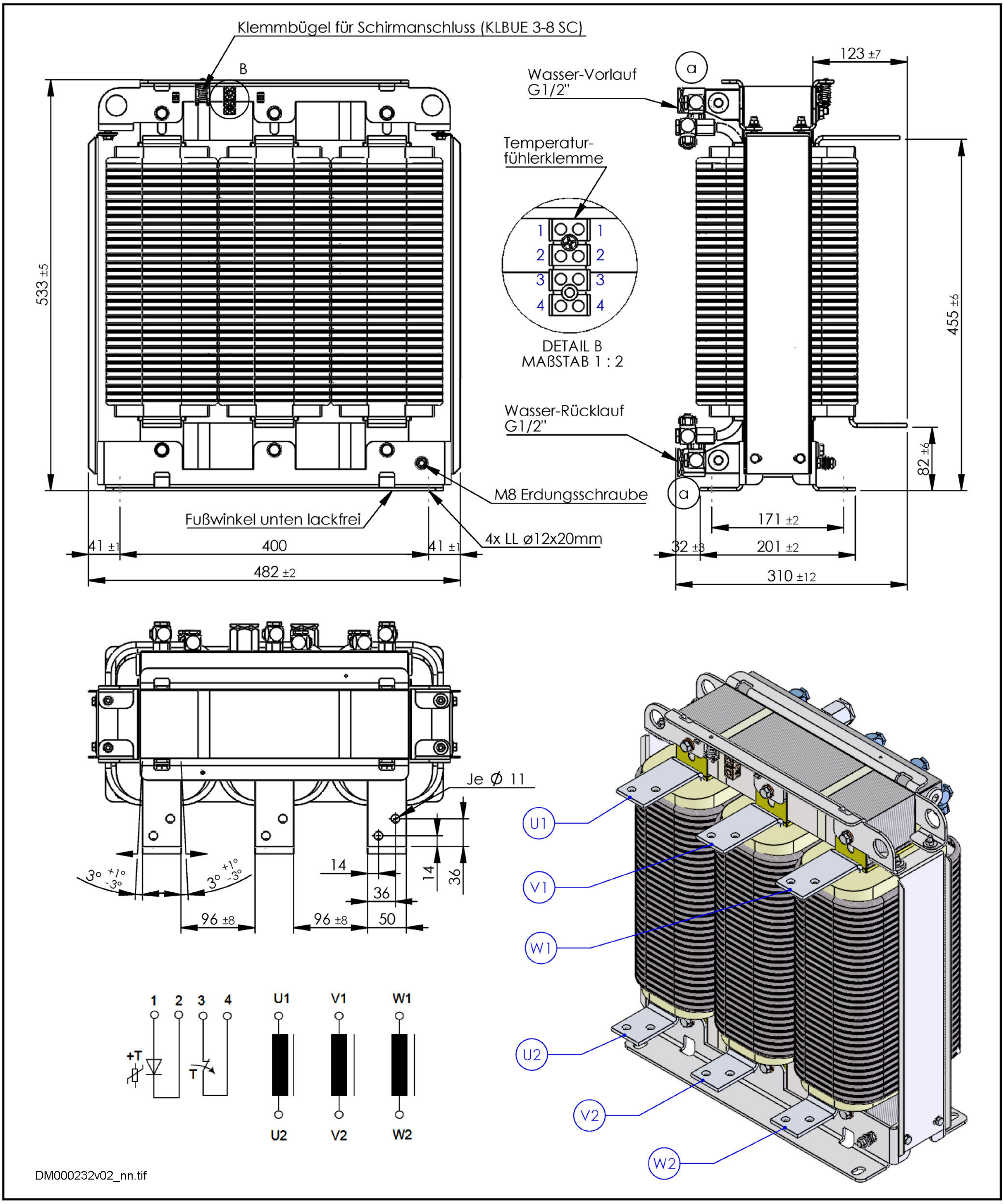


Fig. 8-35: HNL05.1R-0130-N0514

HNL05.1R-0050-N0652

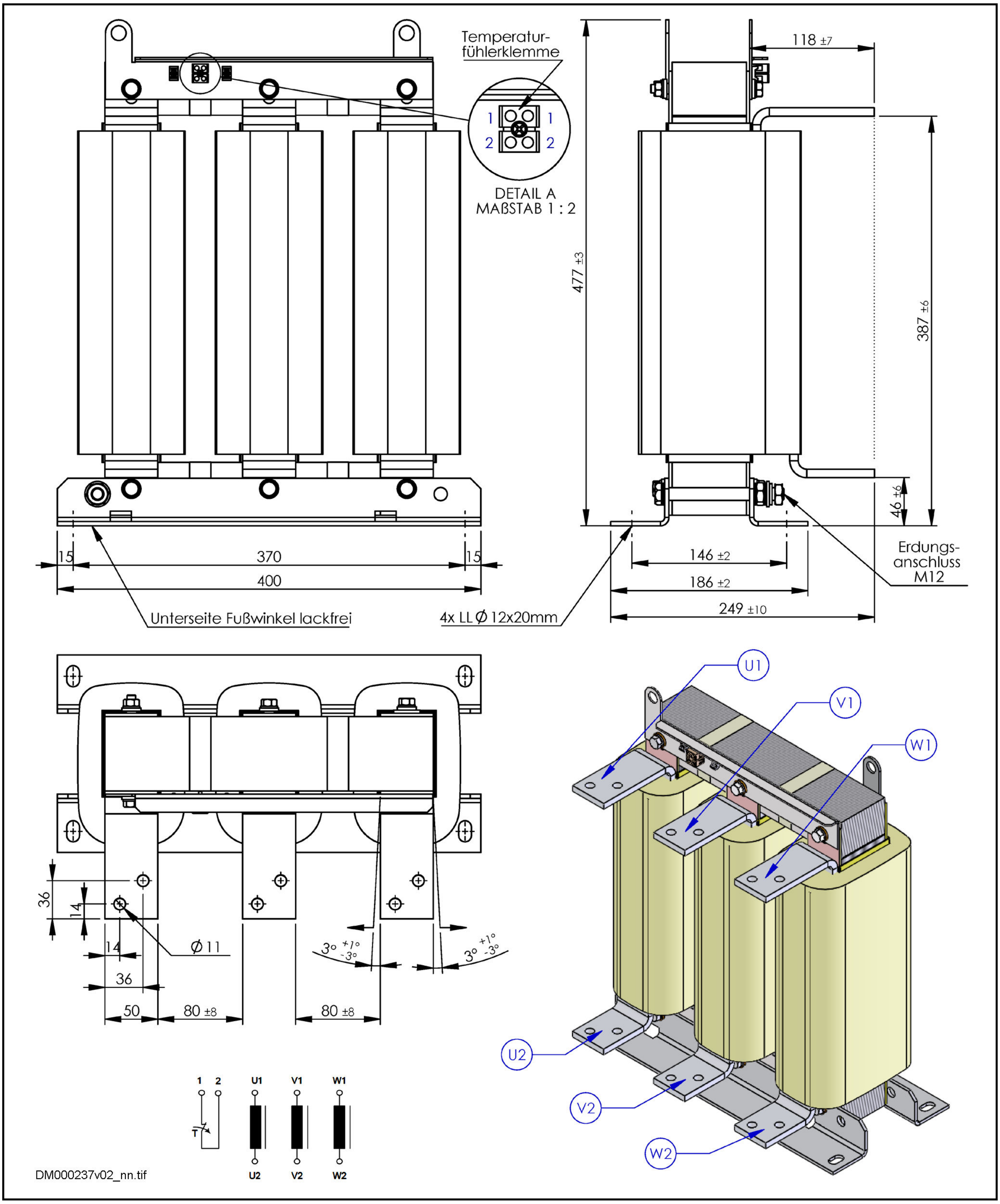


Fig. 8-36: HNL05.1R-0050-N0652

HNL05.1R-0113-N0652

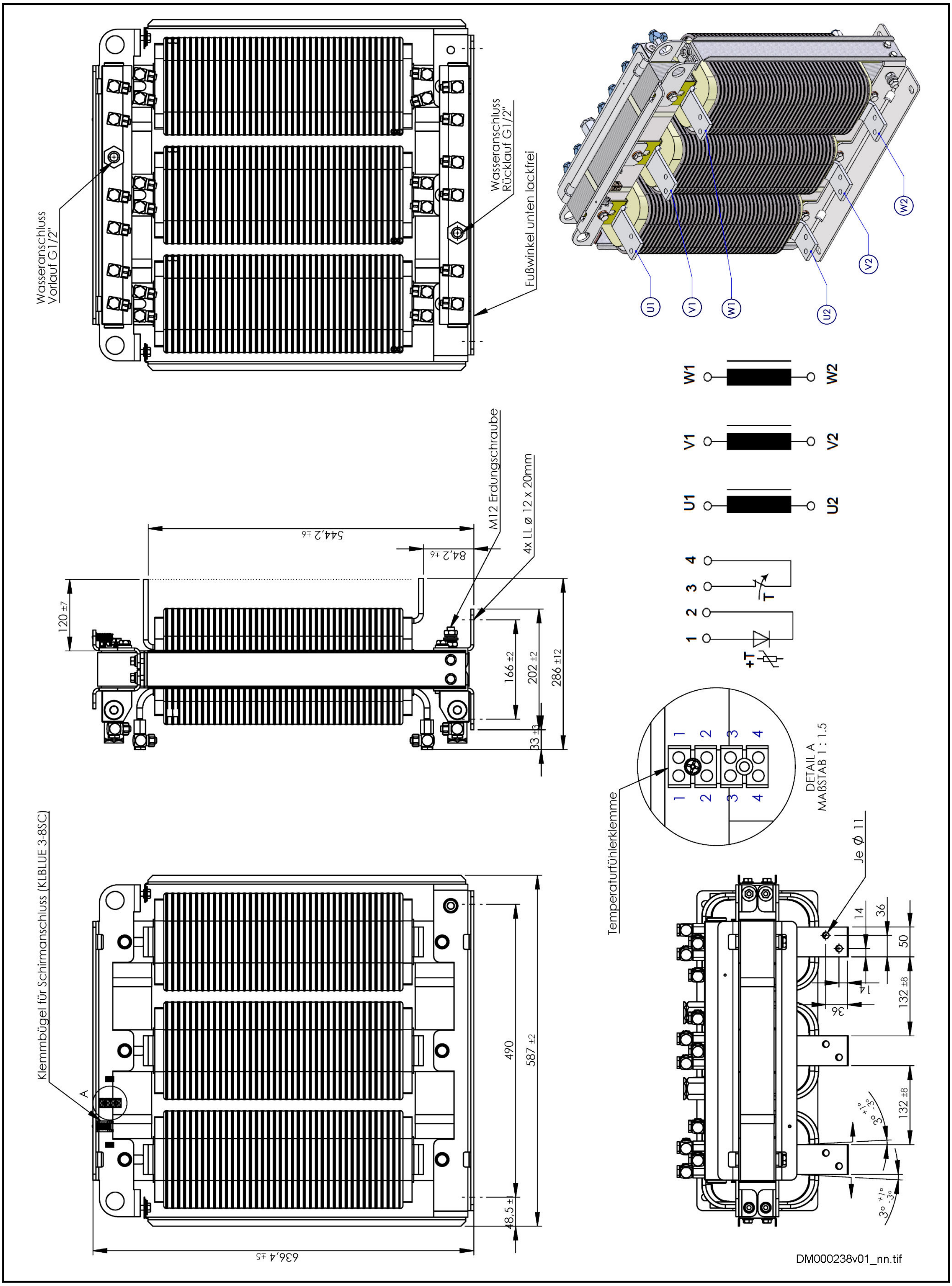


Fig. 8-37: HNL05.1R-0113-N0652

HNL05.1R-0040-N0811

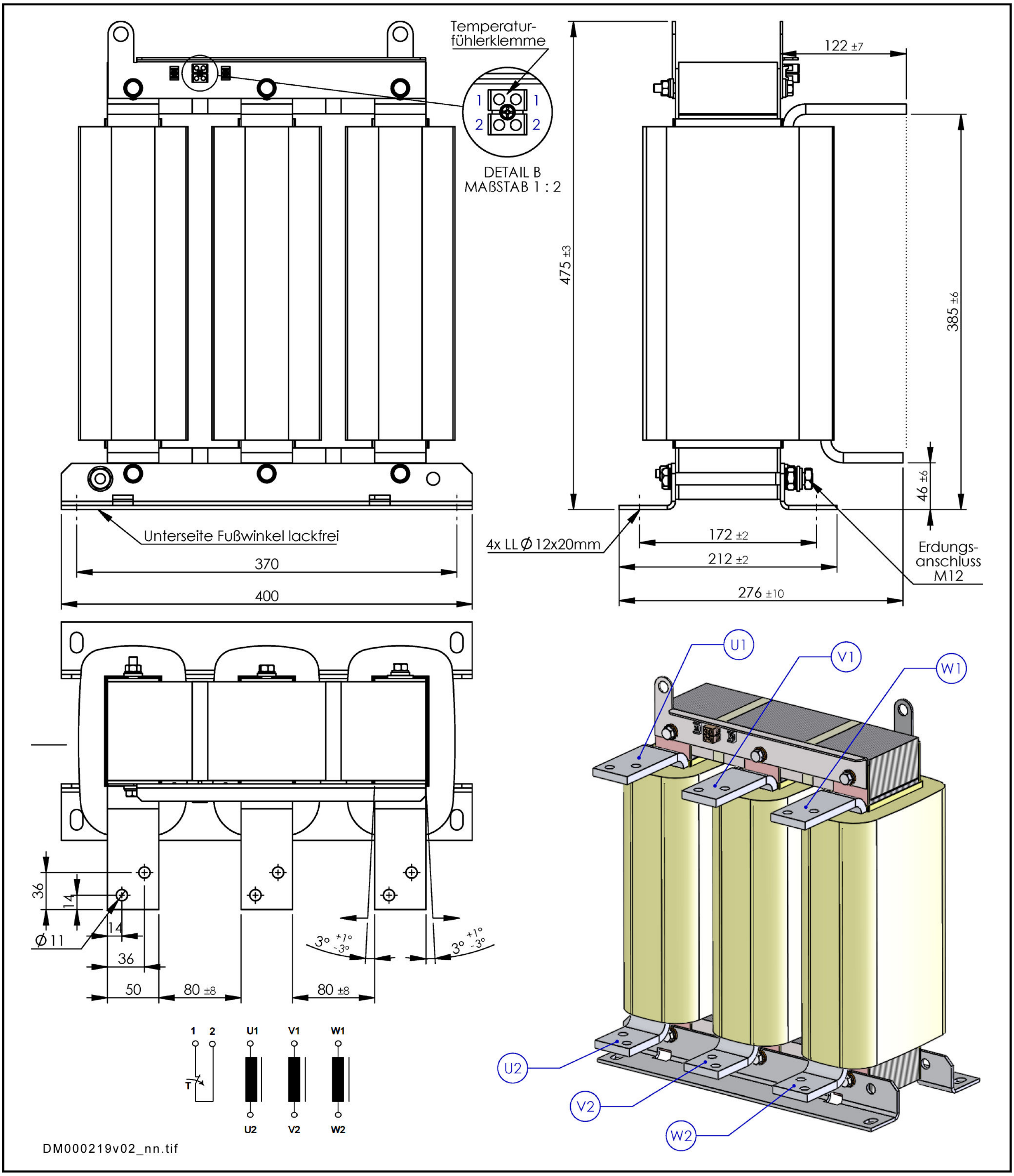


Fig. 8-38: HNL05.1R-0040-N0811

HNL05.1R-0100-N0811

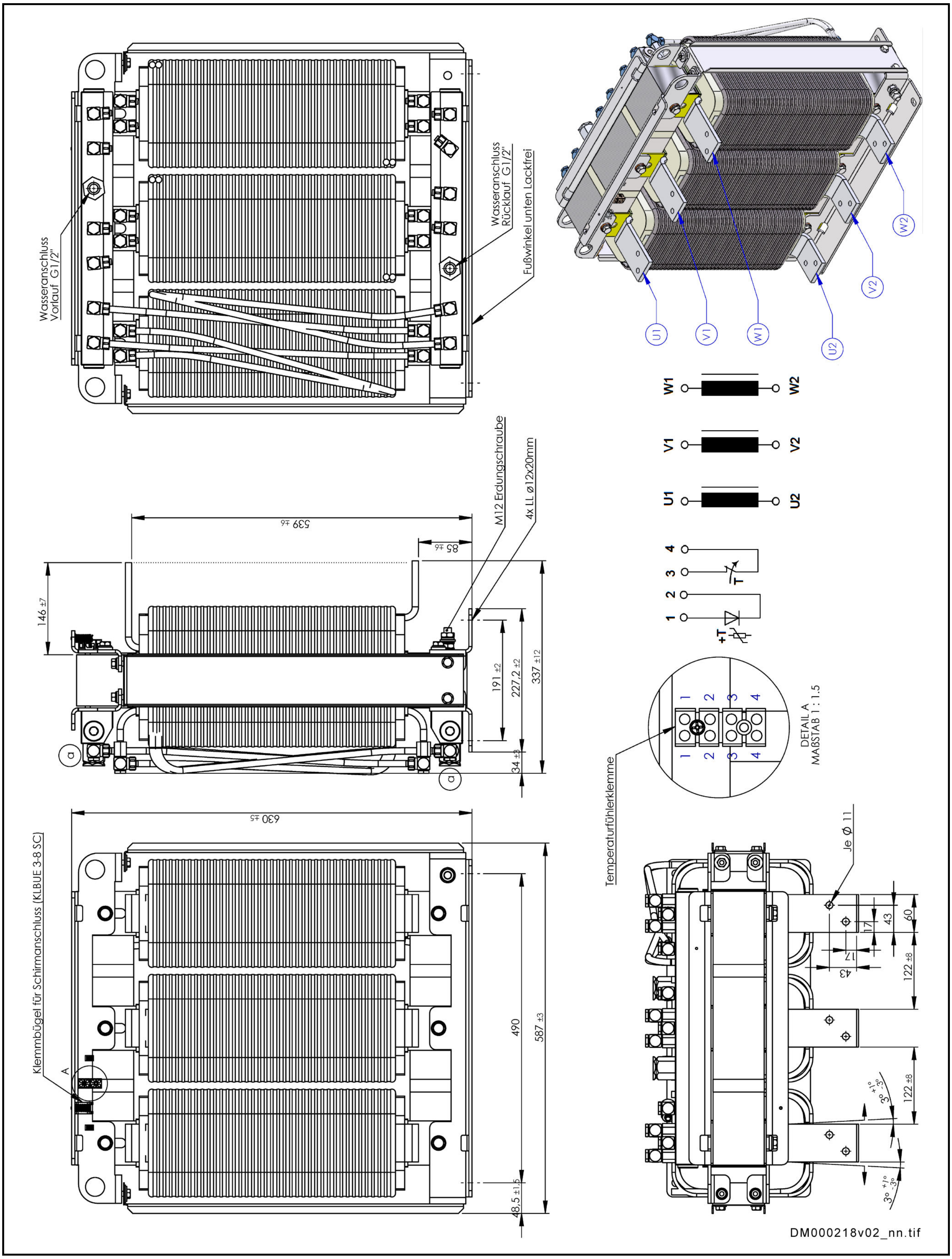


Fig. 8-39: HNL05.1R-0100-N0811

HNL05.1R-0040-N1019

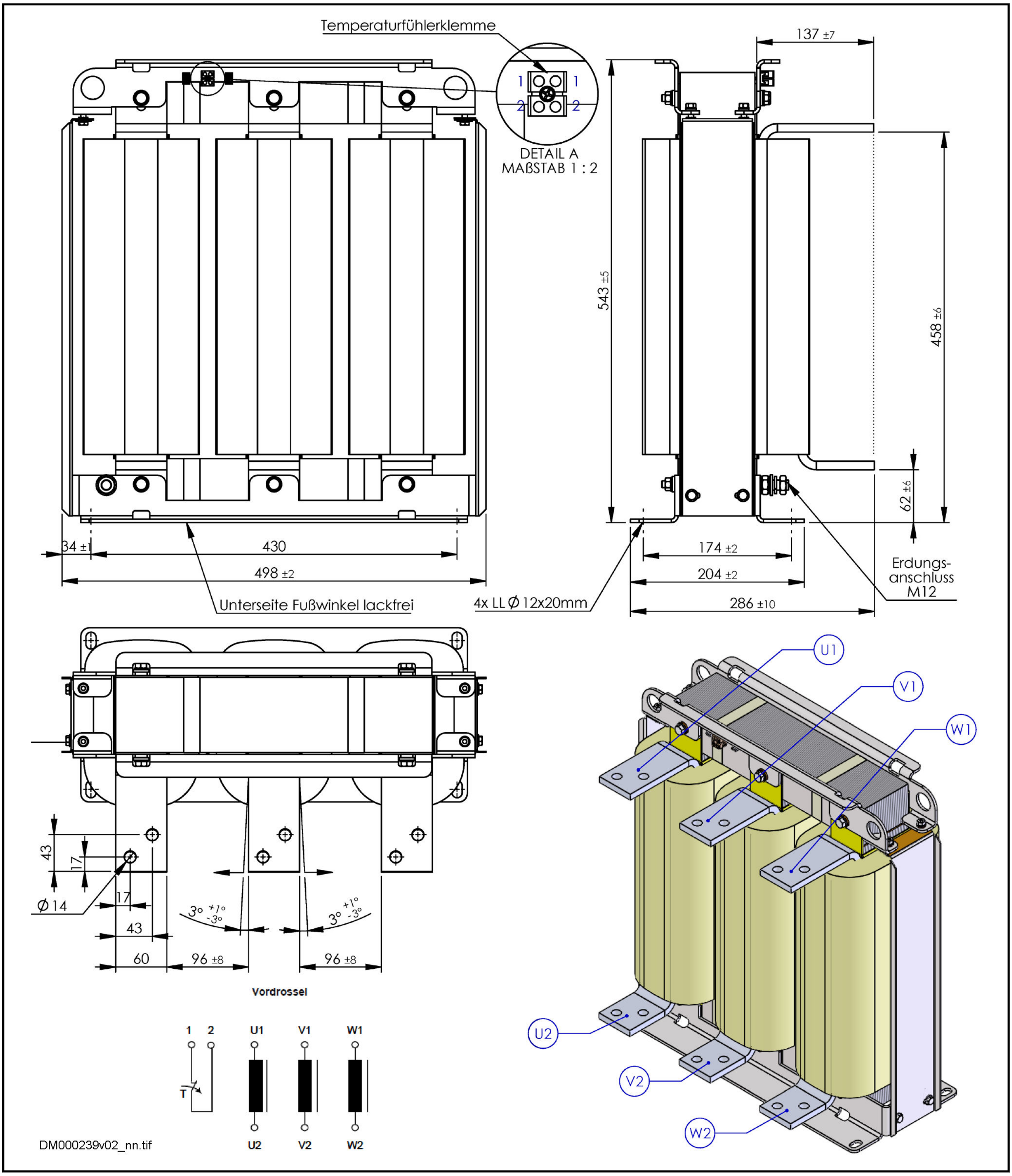


Fig. 8-40: HNL05.1R-0040-N1019

Cables, accessories, additional components

HNL05.1R-0094-N1019

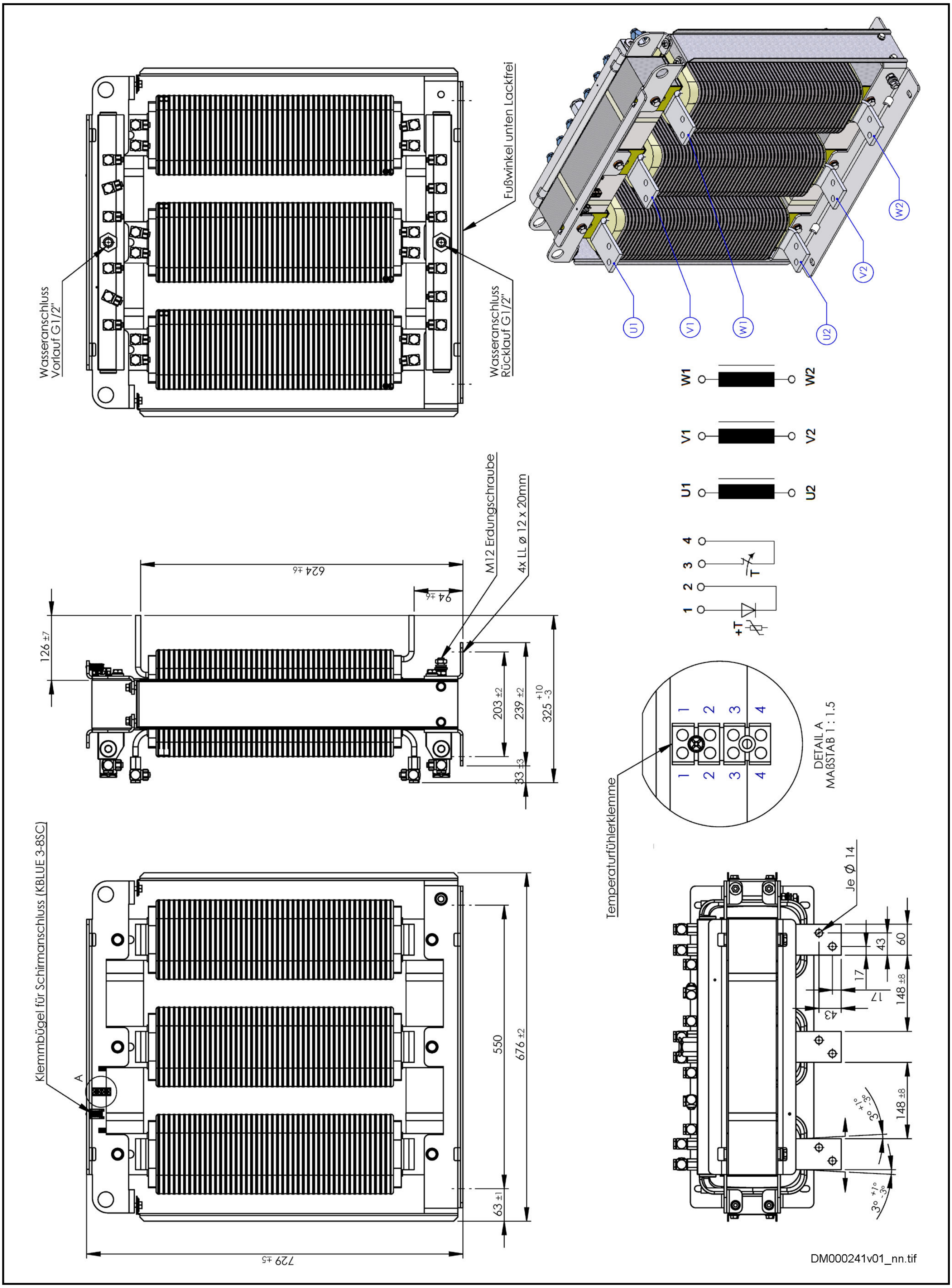


Fig. 8-41: HNL05.1R-0094-N1019

Data

HNL05.1R-…	Inductance [µH]	Nominal current [A]	Power dissipation 1) [W]		Degree of protection	Max. ambient temperature 2) [°C]	Weight [kg]
			Air	Water			
0219-N0218	219	218	1300	1400	IP00	40	37
0182-N0262	182	262	1350	1500	IP00	40	53
0045-N0327	45	327	230	-	IP00	40	21
0135-N0327	135	327	900	1700	IP00	40	58
0054-N0409	54	409	350	-	IP00	40	40
0117-N0409	117	409	1200	2000	IP00	40	82
0043-N0514	43	514	400	-	IP00	40	50
0130-N0514	130	514	1350	2400	IP00	40	116
0050-N0652	50	652	560	-	IP00	40	70
0113-N0652	113	652	1500	2700	IP00	40	150
0040-N0811	40	811	620	-	IP00	40	85
0100-N0811	100	811	1650	3000	IP00	40	180
0040-N1019	40	1019	850	-	IP00	40	121
0094-N1019	94	1019	1950	3500	IP00	40	225

1) The air/water distribution was determined at an ambient temperature of 30 °C and a water inlet temperature of 50 °C
2) Up to 55°C with current derating

Tab. 8-45: HNL05.1R, data

Temperature monitoring contact

- Trigger temperatureAuslösetemperatur: 160 °C
- N/C in one of the windings
- Electric switching capacity:
  – 1 A
  – AC 250 V
  – DC 24 V

Water cooling

HNL05.1R-...	Flow [l/min]	Filling capacity [l]	Pressure decrease [bar]		
			5 l / min	7 l / min	9 l / min
0219-N0218	> 6	1.3	0.14	0.27	0.42
0182-N0262	> 6	1.5	0.15	0.29	0.46
0135-N0327	> 6	1.6	0.17	0.32	0.51
0117-N0409	> 6	2.0	0.21	0.39	0.62
0130-N0514	> 6	2.5	0.24	0.44	0.75
0113-N0652	> 8	3.4	0.03	0.06	0.10
0100-N0811	> 8	3.6	0.04	0.07	0.10
0094-N1019	> 8	4.1	0.04	0.07	0.12

Tab. 8-46: Water cooling

Connection

See chapter 11.4 "Aluminum contact points and cupal disks" on page 381.

Assignment to HMU05

See chapter "Combining mains filter, mains choke, preconnected choke and capacitance pack" on page 112.

8.3.5 HML05 motor choke/balancing choke

HML05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	H	M	L	0	5	.	1	W	-	D	9	8	0	U	-	N	1	0	0	2	-	N	-	5	0	0	-	N	N	N	N									
	①			②			③	④		⑤	⑥					⑦	⑧					⑨		⑩				⑪												

①	**Product:** HML = Motor choke/balancing choke
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Cooling type, type of construction:** W = Air cooling
⑤	**Choke type:** D = dv/dt choke
⑥	**Nominal inductance:** 980U = 980 μH (example)
⑦	**Additional option:** N = None
⑧	**Nominal current:** 1002 = 1002 A (example)
⑨	**Degree of protection:** N = IP00
⑩	**Rated voltage:** 500 = 3 × AC 500 V 690 = 3 × AC 690 V
⑪	**Other design:** NNNN = None

Tab. 8-47: HML05, type code

HML05 to HMU05 assignment

Balancing chokes are necessary if a higher output drive controller is formed using multiple HMUs that can be connected in parallel. One balancing choke per HMU motor output.

HMU05.1N-…	HML05.1W-…
F0140-0350	D021U-N0254-N-500-NNNN
F0170-0430	D018U-N0306-N-500-NNNN
F0220-0510	D014U-N0392-N-500-NNNN
F0270-0660	D009U-N0490-N-500-NNNN
F0340-0820	D009U-N0616-N-500-NNNN
F0430-1040	D007U-N0771-N-500-NNNN
F0540-1300	D006U-N1002-N-500-NNNN
F0680-1690	D004U-N1185-N-500-NNNN

Tab. 8-48: HML05 ↔ HMU05 assignment

Dimensions

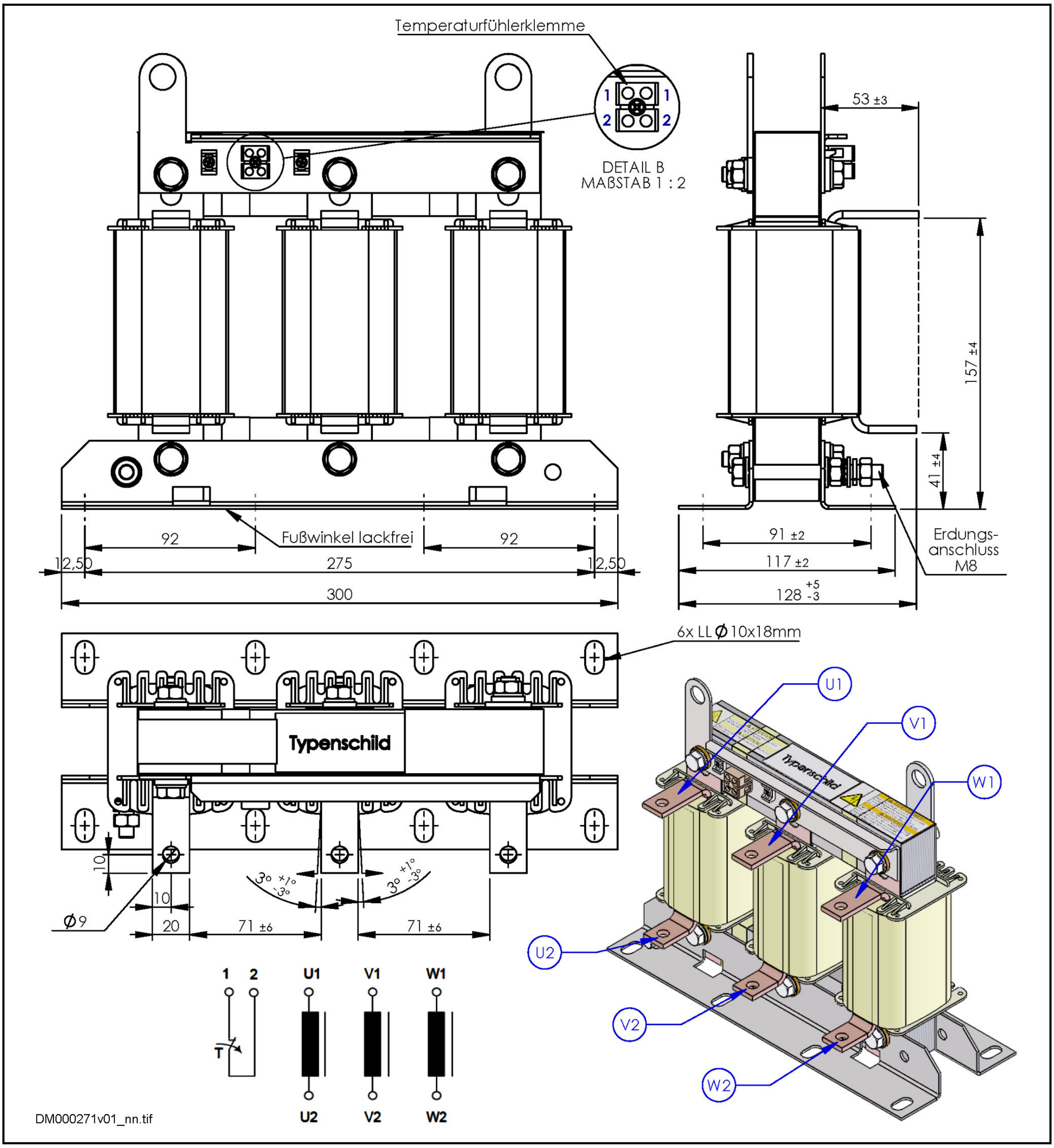


Fig. 8-42: HML05.1W-D021U-N0254-N-500-NNNN, dimensions

Cables, accessories, additional components

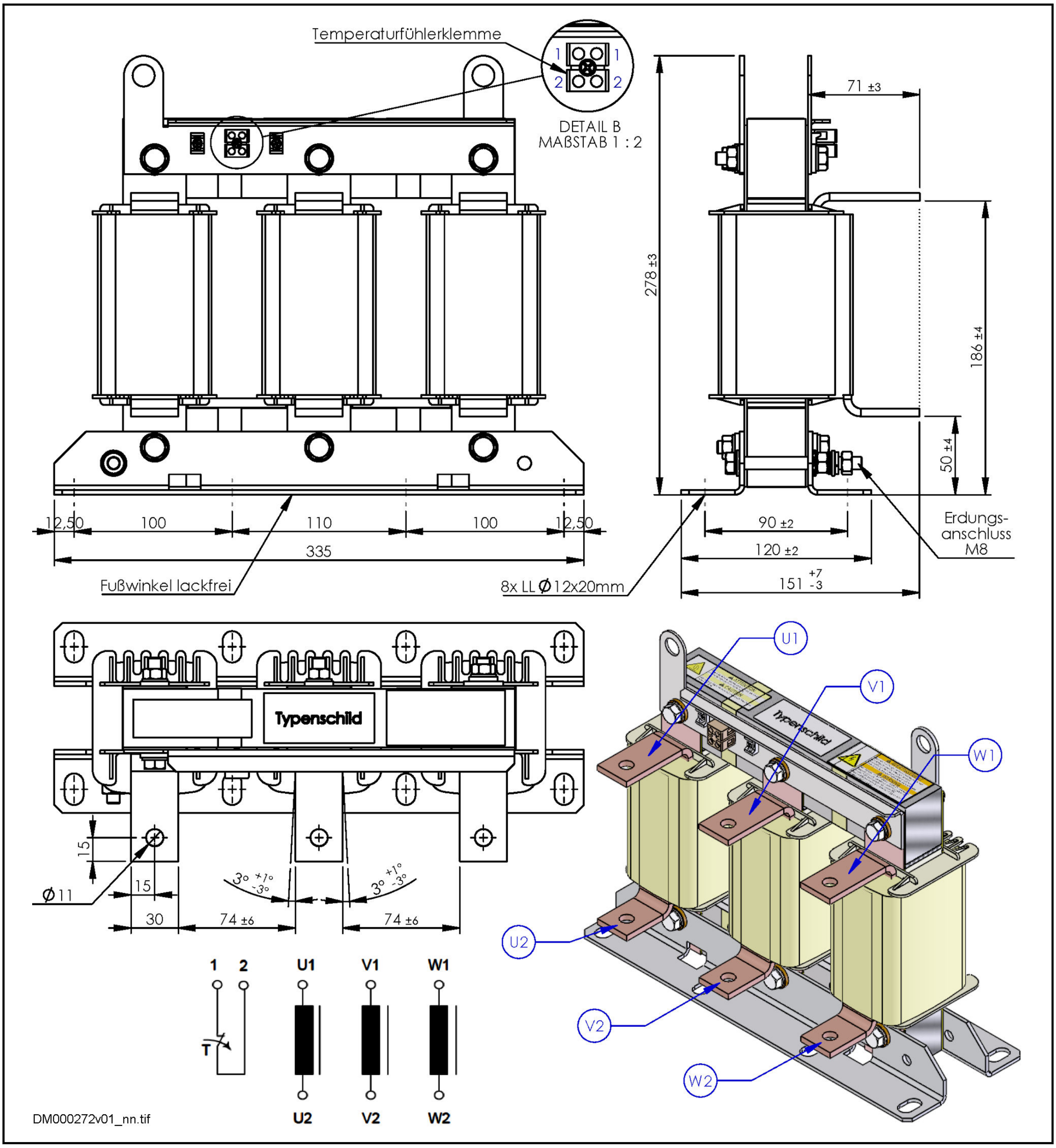


Fig. 8-43: HML05.1W-D018U-N0306-N-500-NNNN, dimensions

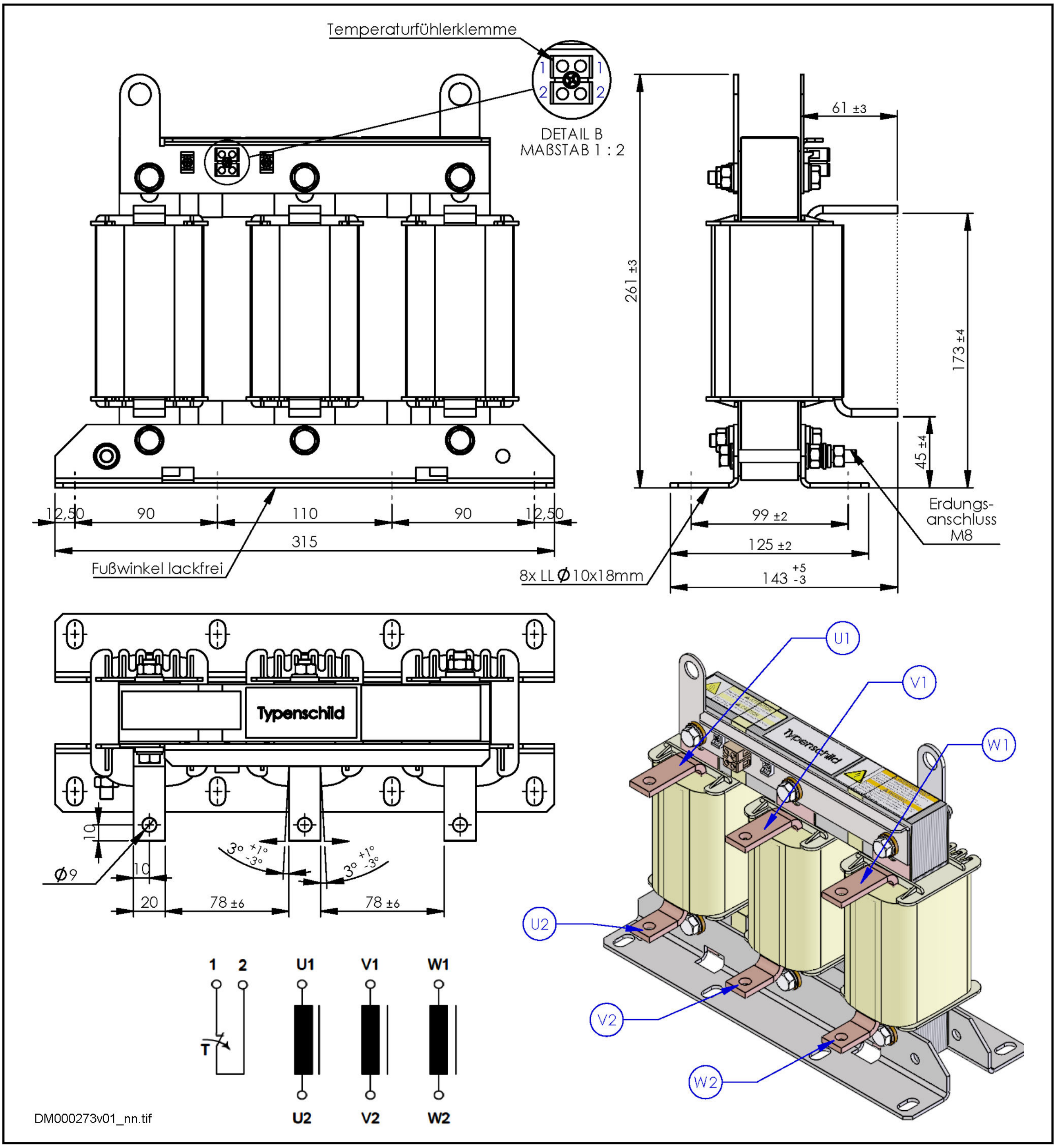


Fig. 8-44: HML05.1W-D014U-N0392-N-500-NNNN, dimensions

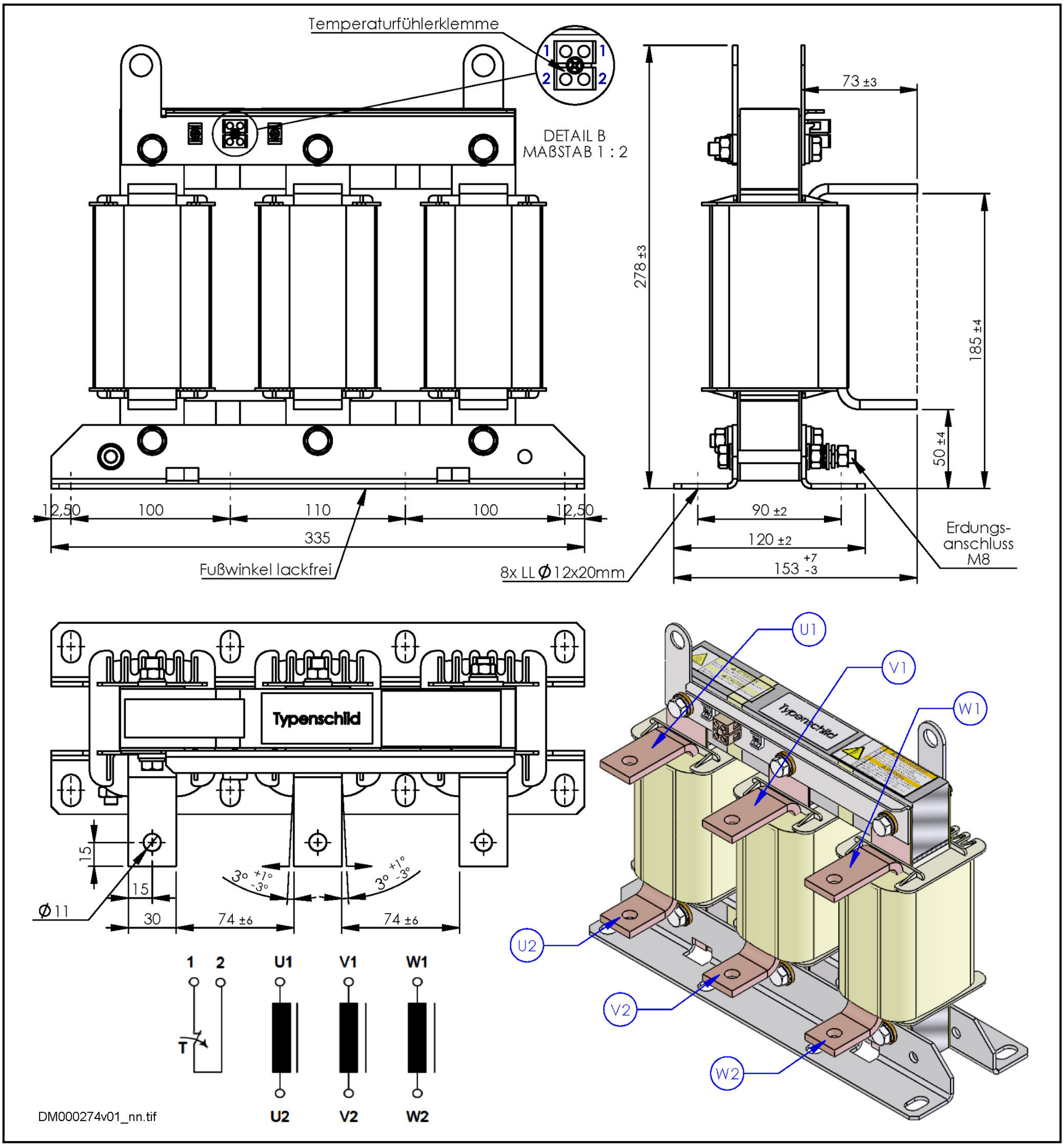


Fig. 8-45: HML05.1W-D009U-N0490-N-500-NNNN, dimensions

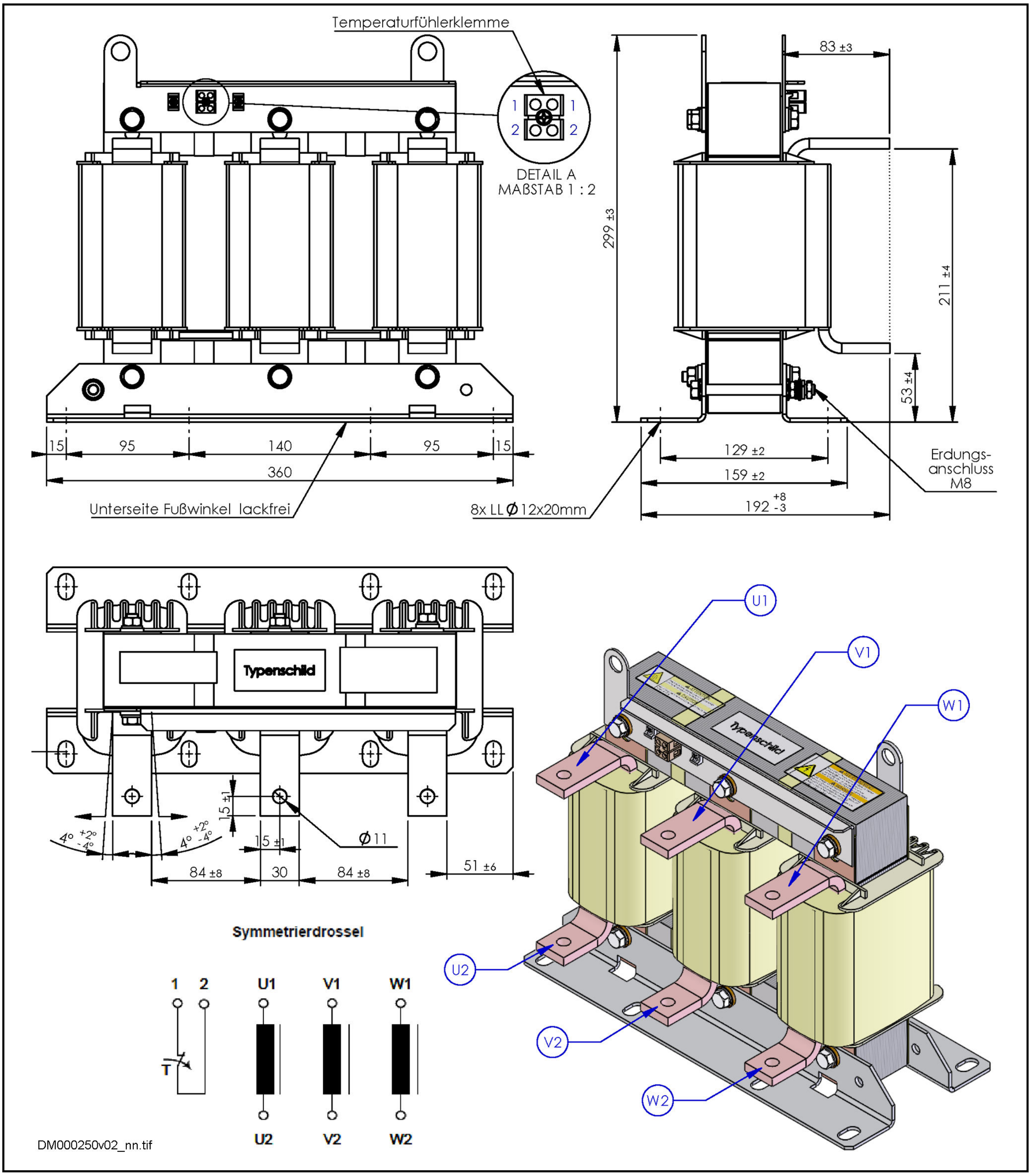


Fig. 8-46: HML05.1W-D009U-N0616-N-500-NNNN, dimensions

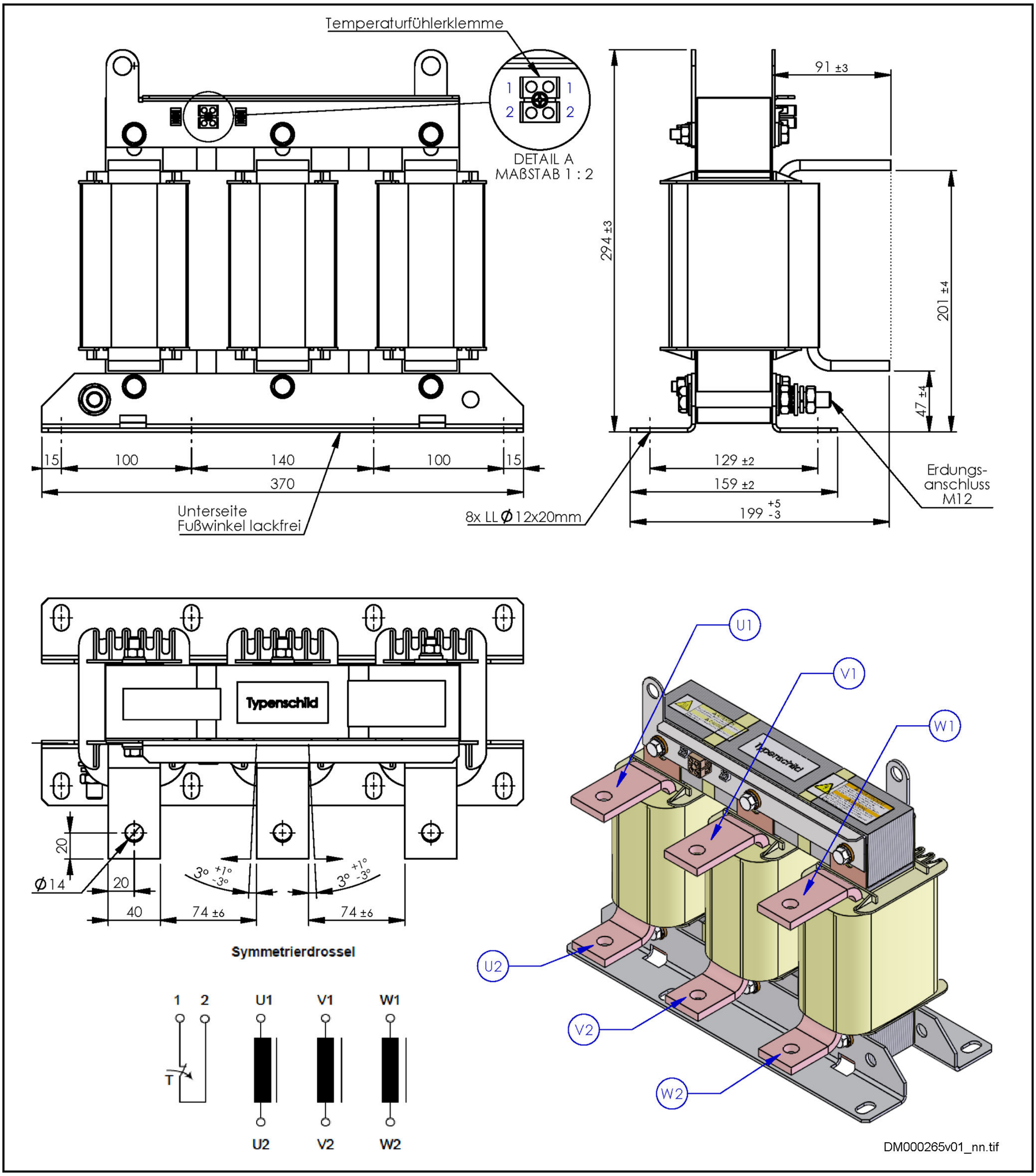


Fig. 8-47: HML05.1W-D007U-N0771-N-500-NNNN, dimensions

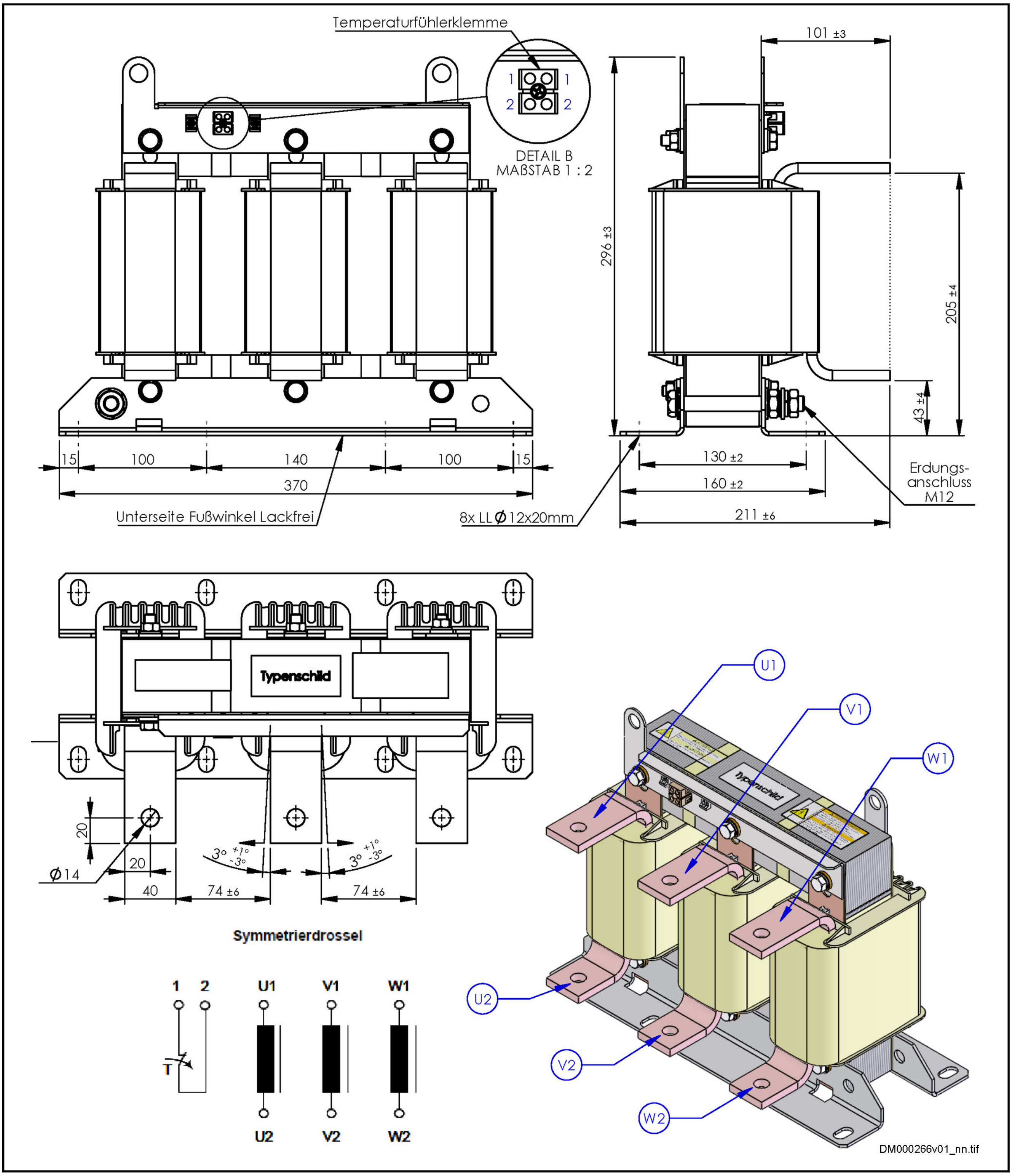


Fig. 8-48: HML05.1W-D006U-N1002-N-500-NNNN, dimensions

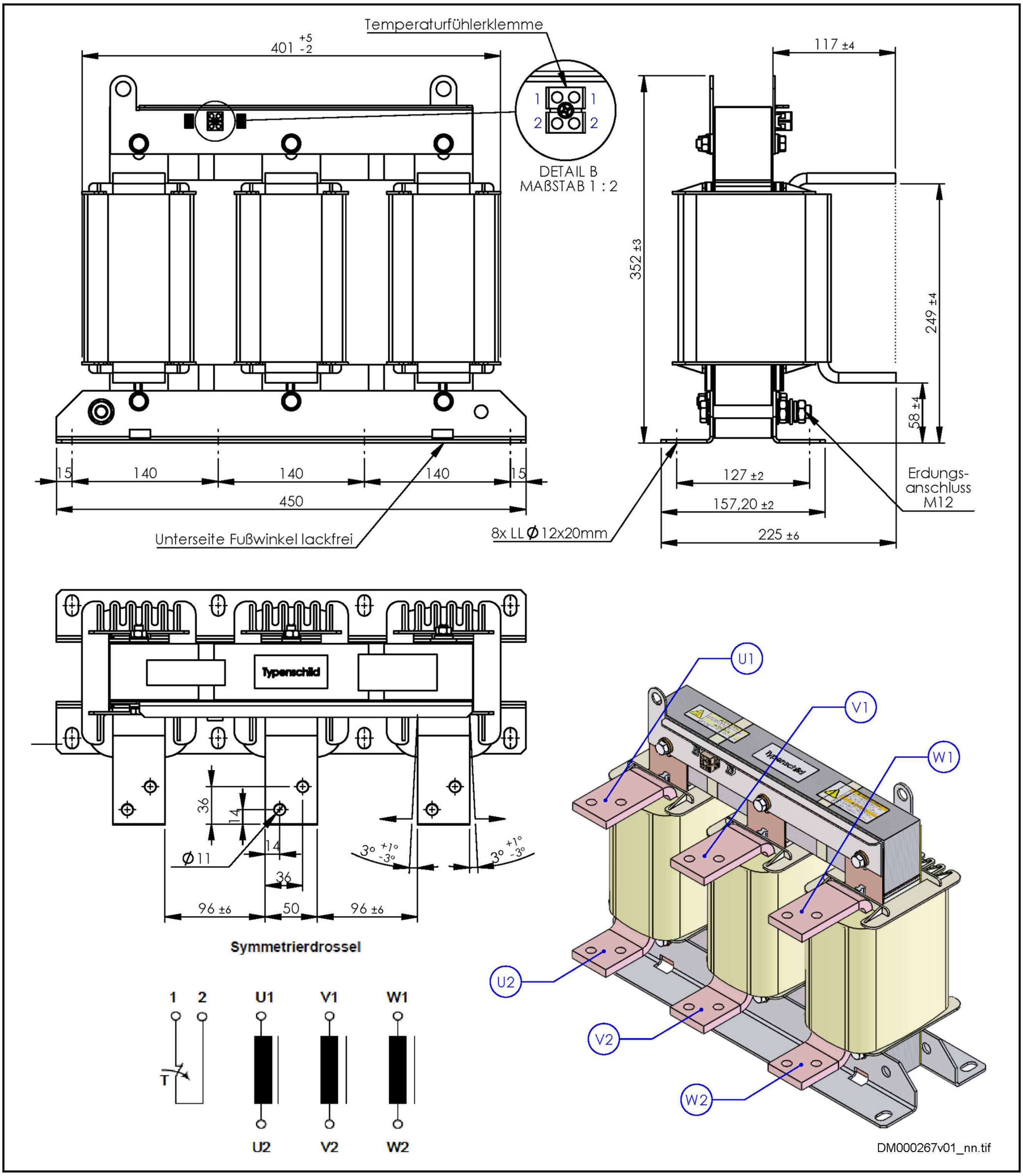


Fig. 8-49: HML05.1W-D004U-N1185-N-500-NNNN, dimensions

Data

Description			HML05.1W-D … -N-500-NNNN							
		Unit	021U-N0254	018U-N0306	014U-N0392	009U-N0490	009U-N0616	007U-N0771	006U-N1002	004U-N1185
Relative u_k		%	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Inductance		µH	3 × 21	3 × 18	3 × 14	3 × 9.1	3 × 8.9	3 × 7.0	3 × 5.6	3 × 4.5
Motor inductance in working point, typ.		µH	533	448	352	228	224	176	141	112
Working point 1: 2 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	254	306	392	490	616	771	1002	1185
	Maximum phase-phase capacitance (motor cable)	nF	30	30	30	30	50	50	50	tbd
	Maximum leakage capacitance	nF	180	180	180	180	300	300	300	tbd
Working point 2: 4 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	254	306	392	490	546	632	775	1008
	Maximum phase-phase capacitance (motor cable)	nF	20	20	20	20	30	30	30	tbd
	Maximum leakage capacitance	nF	120	120	120	120	180	180	180	tbd
Working point 3: 4 kHz clock frequency; ≤ 400 Hz rotary field frequency	Nominal current	A_{rms}	254	306	392	490	546	632	775	1008
	Maximum phase-phase capacitance (motor cable)	nF	10	10	10	10	30	30	30	tbd
	Maximum leakage capacitance	nF	60	60	60	60	180	180	180	tbd
Stable inductance up to …		A_{rms}	314	377	454	582	727	915	1144	1488
Power dissipation		W	200	250	300	300	350	330	425	tbd
Voltage		V	3 × 500							
Protection class		-	Class I							
Degree of protection		-	IP00							
Weight		kg	15	20	25	25	34	38	40	42

Tab. 8-49: HML05, data

NOTICE **Thermal overload of the chokes!**

Observe the specified maximum values of **cable and leakage capacitances**. Otherwise, the motor/balancing chokes are thermally overloaded.

The **motor inductance** should not fall considerably below the minimum value in the working point. For axes connected in parallel using balancing chokes, the motor inductance may be lower by the corresponding factor.

For **applications with a high continuous load**, thermally gauge the motor/balancing chokes during commissioning. In particular, this applies if all parameters are not reliably known (e.g., motor inductance in the working point).

In case of doubt, install a forced ventilation or use the next bigger size, if the rise of voltage at the motor allows this (bigger size has lower inductance).

Installing a **DC bus choke** does **not** relieve the motor/balancing chokes.

8.3.6 HLL05 DC bus choke

HLL05 type code

Short type designation	1	2	3	4	5	6	7	8	9	1 0	1	2	3	4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0
Example:	H	L	L	0	5	.	1	F	-	0	4	M	0	-	S	0	7	2	0	-	N	-	D	7	-	0	1	U	2	-	N	N	N	N						
	①			②			③	④		⑤					⑥	⑦					⑧		⑨			⑩					⑪									

①	**Product:** HLL = DC bus choke
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Cooling type, type of construction:** F = Liquid cooling W = Air cooling
⑤	**Nominal inductance:** 04M0 = 4 mH
⑥	**Additional option:** S = Current-compensated
⑦	**Nominal current:** 0202 = 202 A 0243 = 243 A 0303 = 303 A 0380 = 380 A 0475 = 475 A 0603 = 603 A 0720 = 720 A 0942 = 942 A
⑧	**Degree of protection:** N = IP00
⑨	**Nominal DC bus voltage:** D7 = DC 750 V 11 = DC 1100 V
⑩	**Leakage capacitance:** 01U2 = 1.2 µF
⑪	**Other design:** NNNN = None

Tab. 8-50: HLL05, type code

Sizing

An HLL DC bus choke is always necessary if the leakage capacitance of the overall system incl. cable and motor capacitance is greater than 500 nF.

☞ See also chapter 4.3.4 "Leakage capacitances" on page 53.

The DC bus choke is sized according to the DC bus current in each drive line.

The lowest DC bus voltage U_{DCmin} that occurs is always used to determine the DC bus current I_{DC}:

$I_{DC} = P_{DC} / U_{DCmin}$

☞ An HLL DC bus choke is always necessary if IndraDrive M (HMS01, HMD01) components are connected to the DC bus.

See chapter "Operating HMU05 together with HMS01/HMD01" on page 56.

Dimensions

HLL05.1W-04M0-S0202

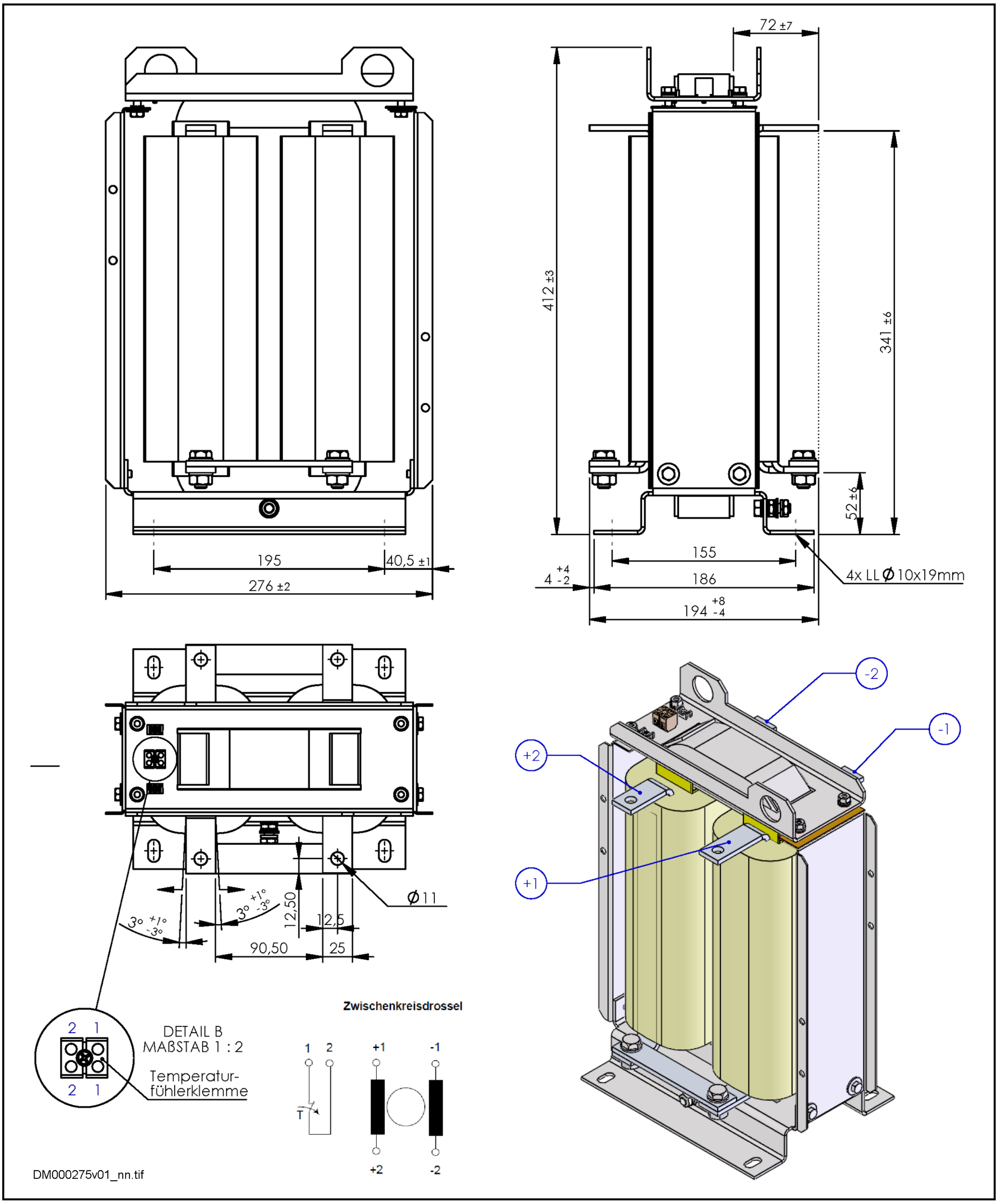


Fig. 8-50: HLL05.1W-04M0-S0202

HLL05.1F-04M0-S0202

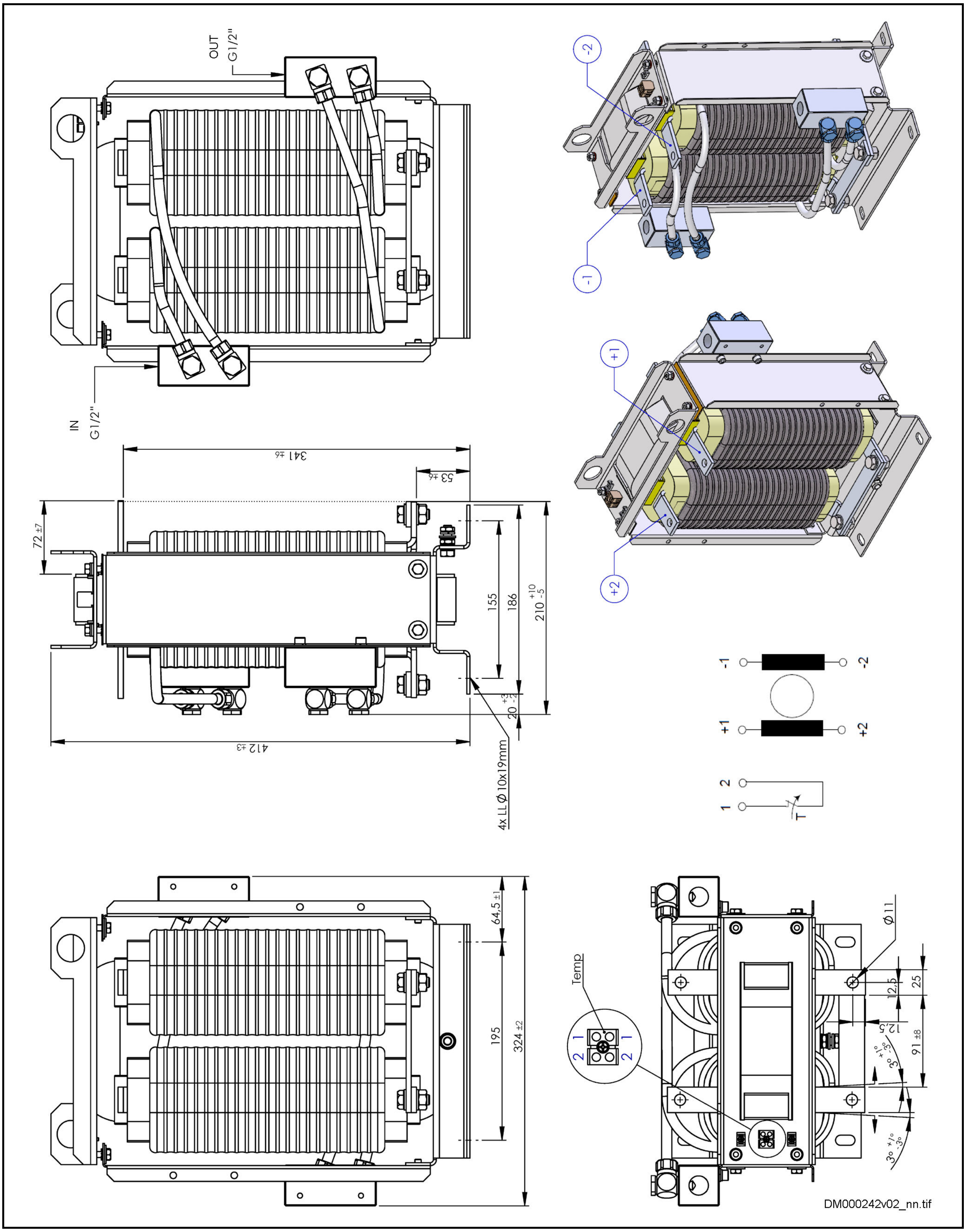


Fig. 8-51: HLL05.1F-04M0-S0202

HLL05.1F-04M0-S0243

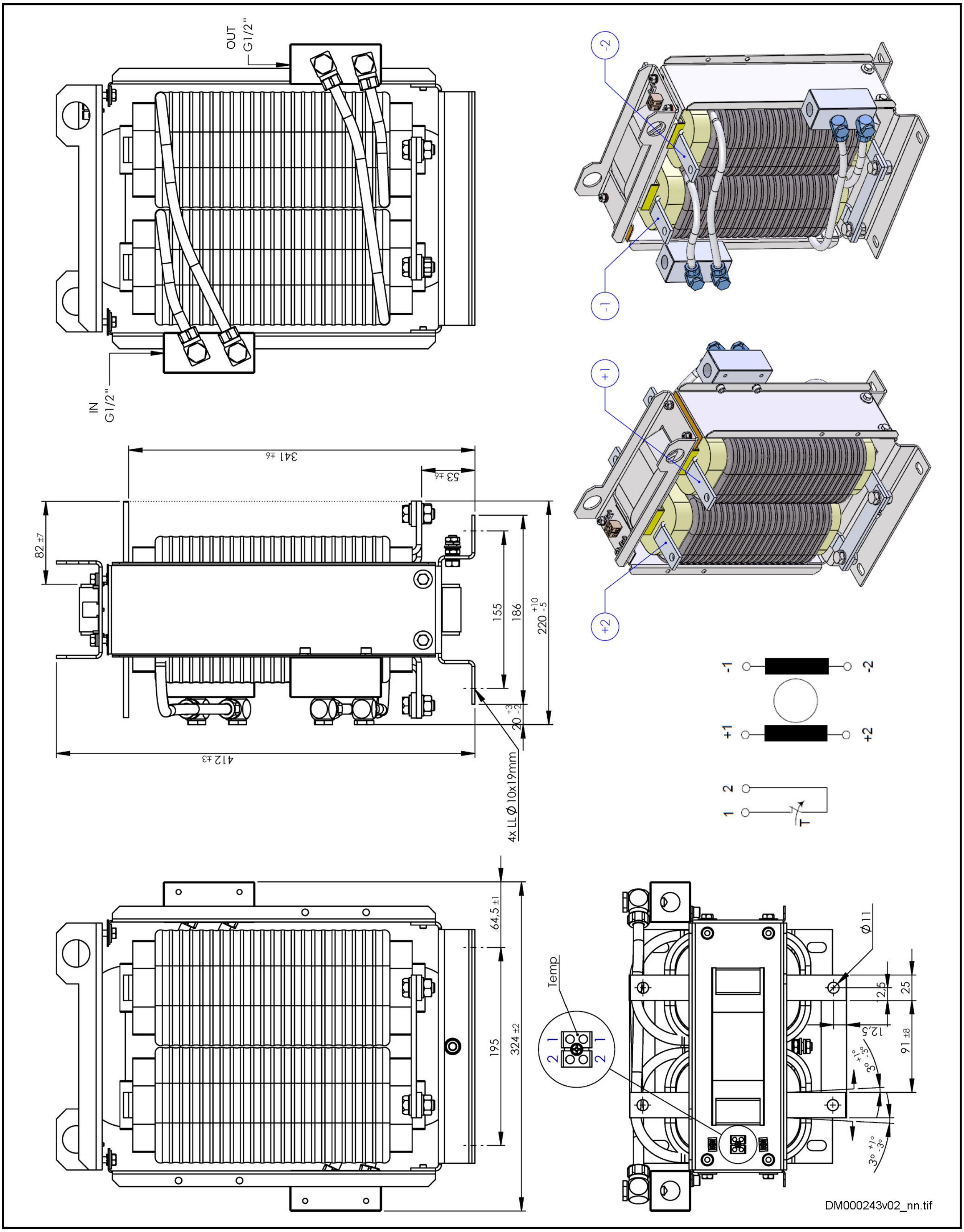


Fig. 8-52: HLL05.1F-04M0-S0243

HLL05.1W-04M0-S0303

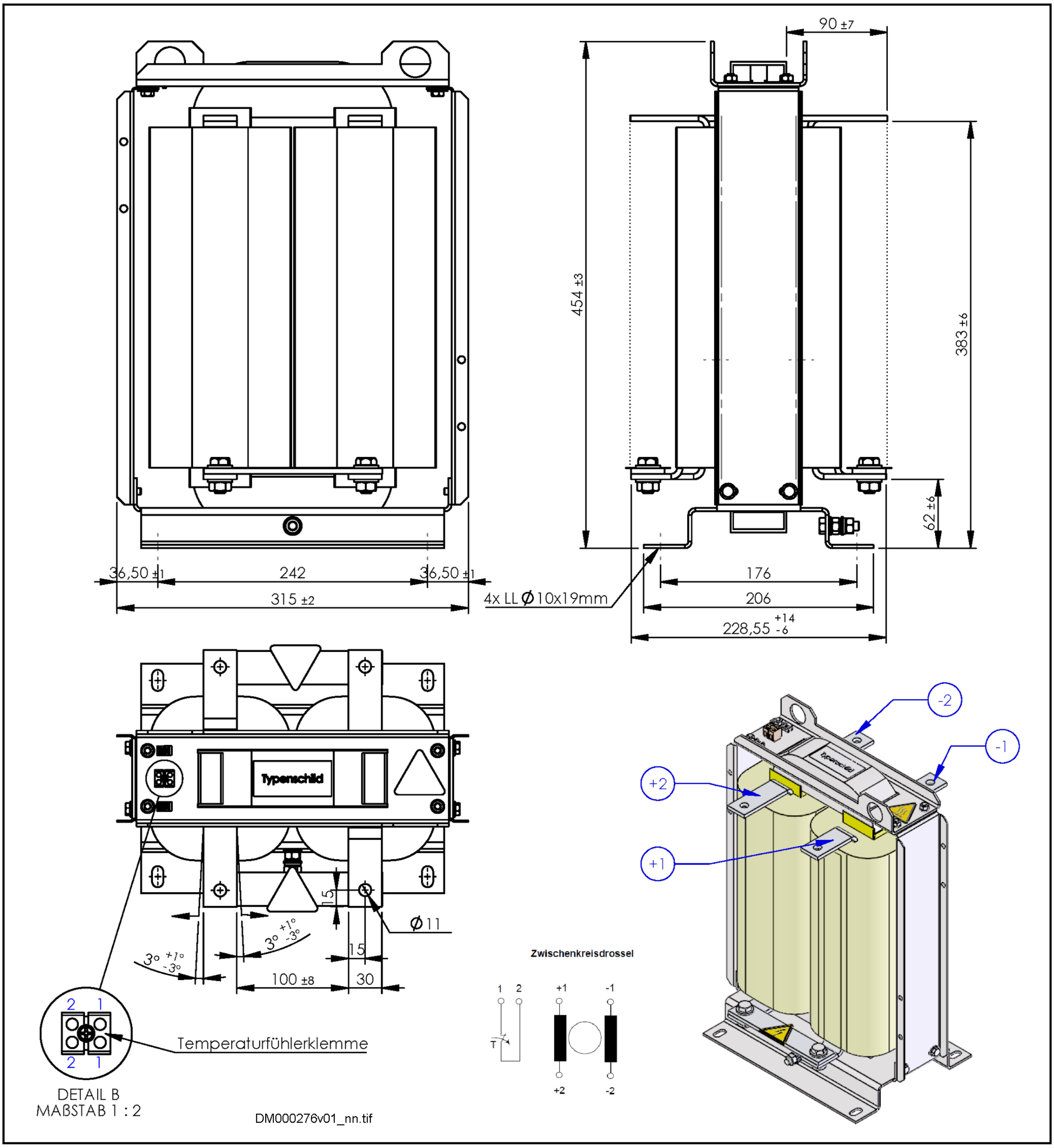


Fig. 8-53: HLL05.1W-04M0-S0303

HLL05.1F-04M0-S0303

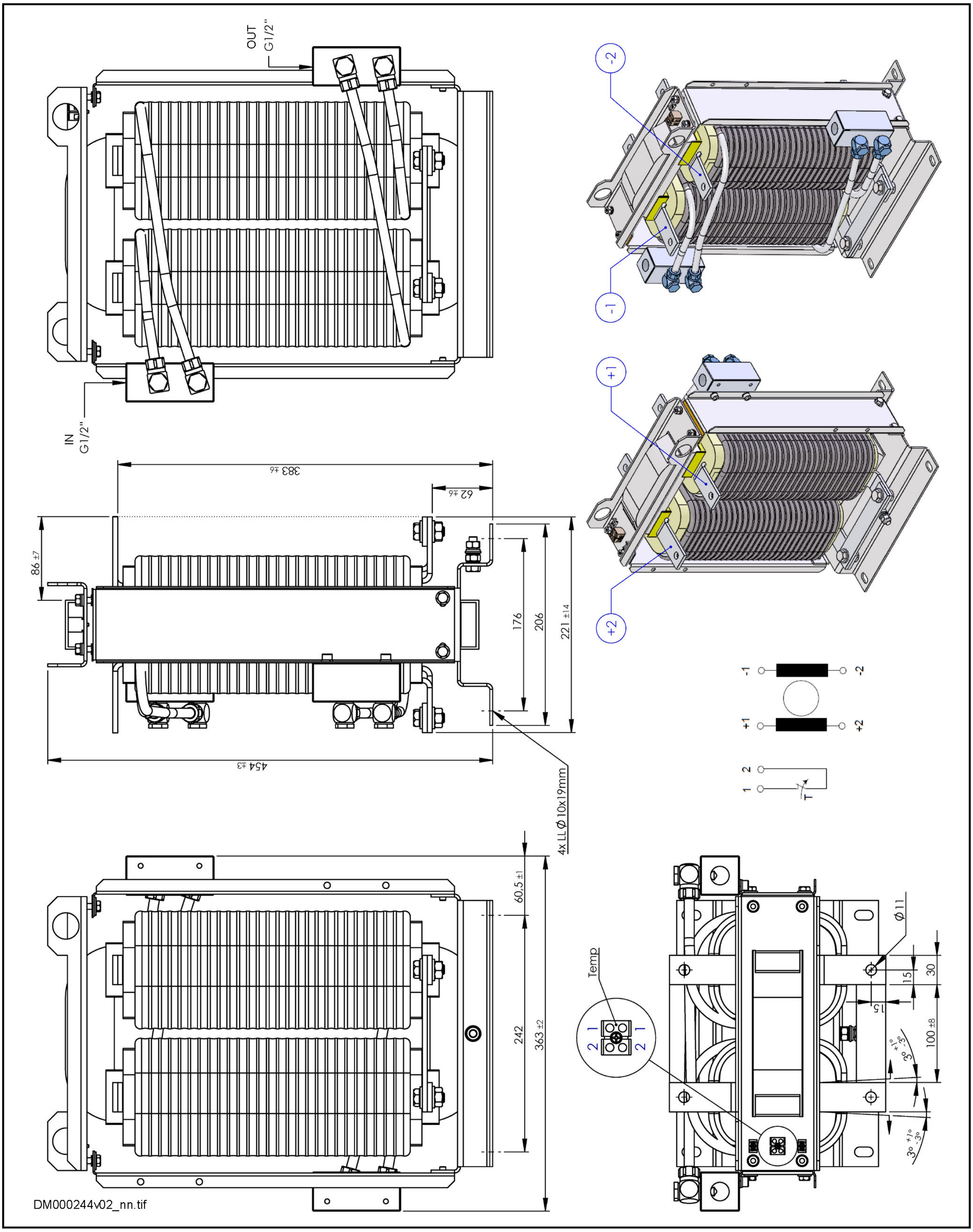


Fig. 8-54: *HLL05.1F-04M0-S0303*

HLL05.1F-04M0-S0380

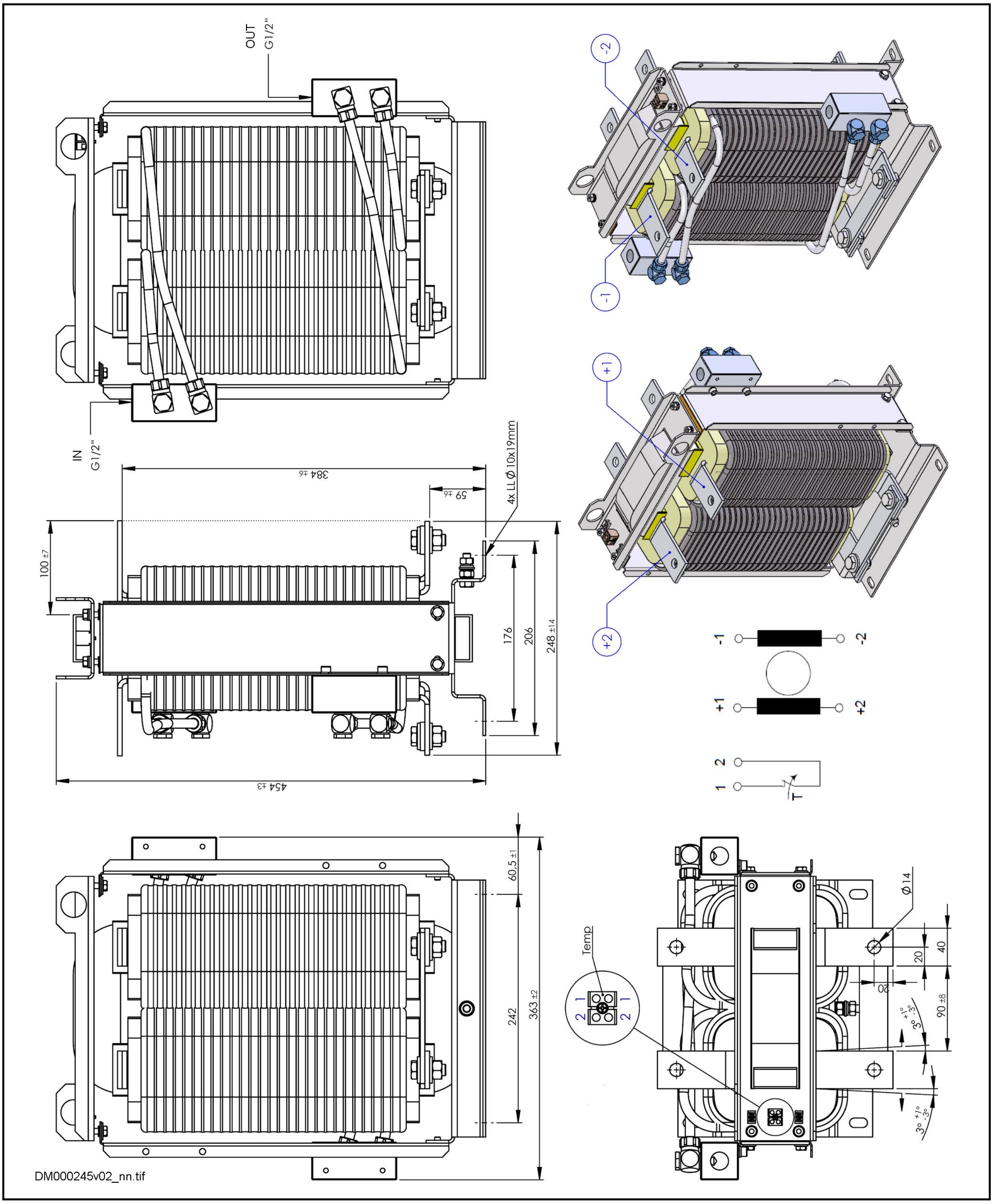


Fig. 8-55: HLL05.1F-04M0-S0380

HLL05.1F-04M0-S0475

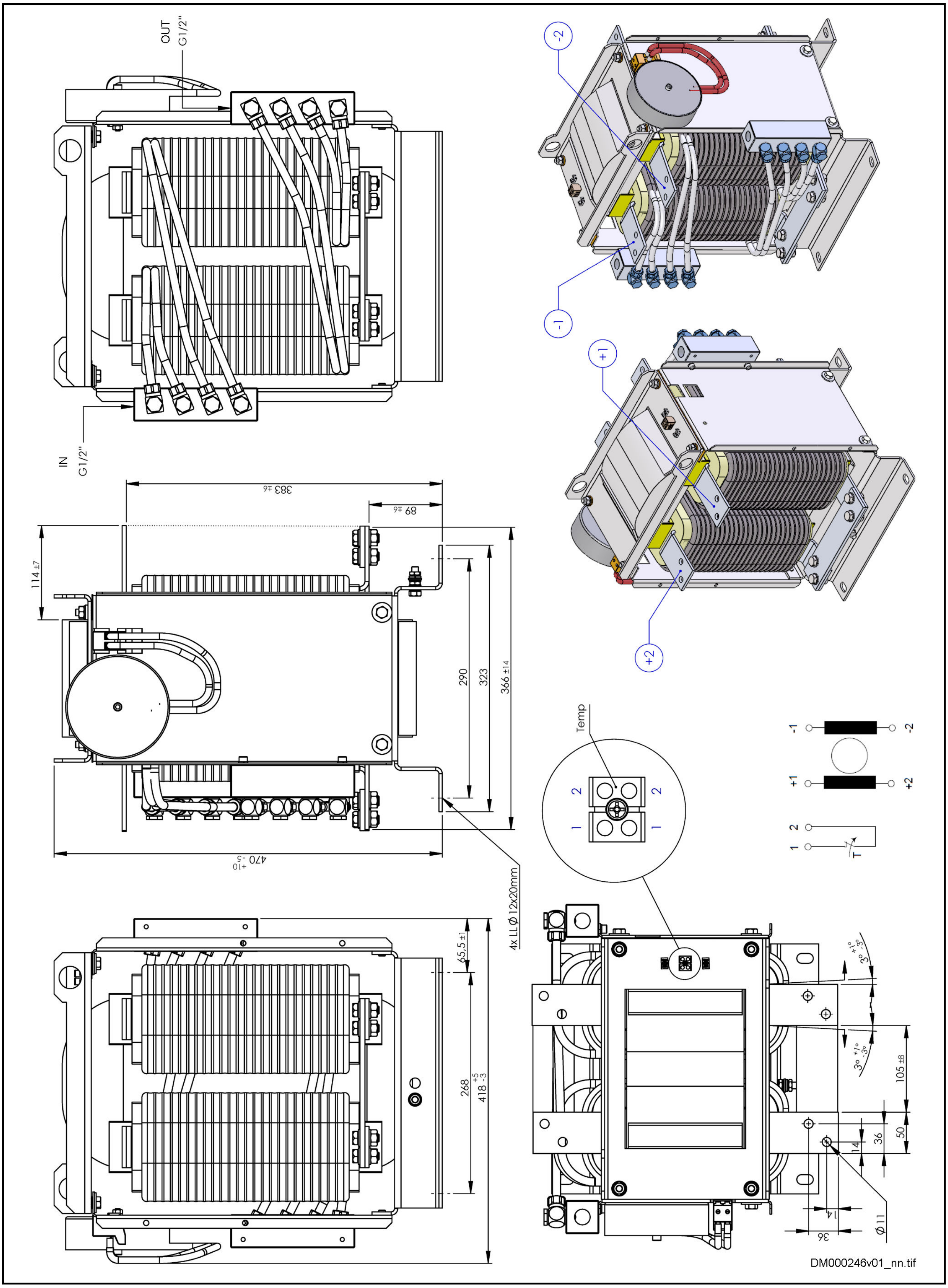


Fig. 8-56: HLL05.1F-04M0-S0475

HLL05.1F-04M0-S0603

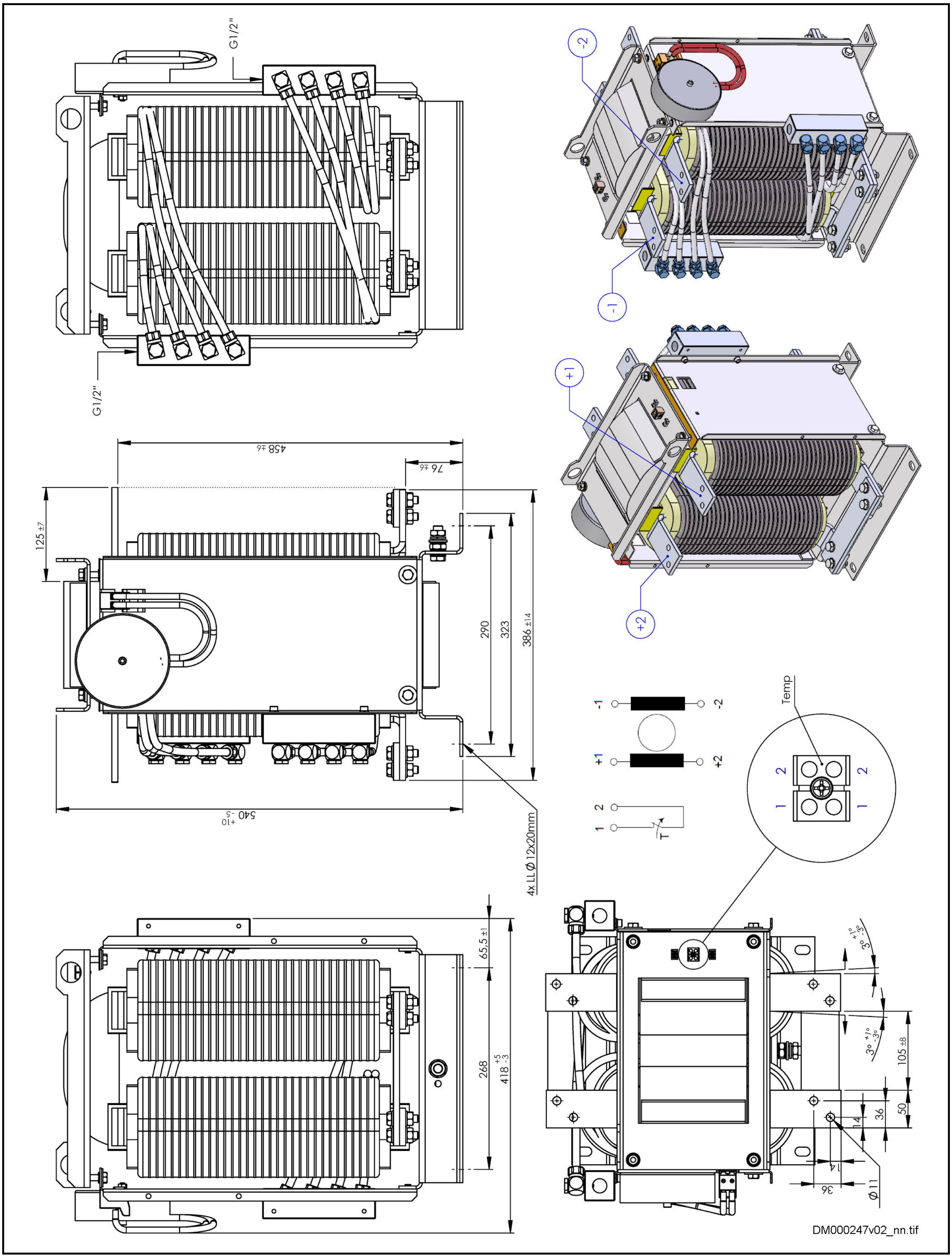


Fig. 8-57: HLL05.1F-04M0-S0603

HLL05.1F-04M0-S0720

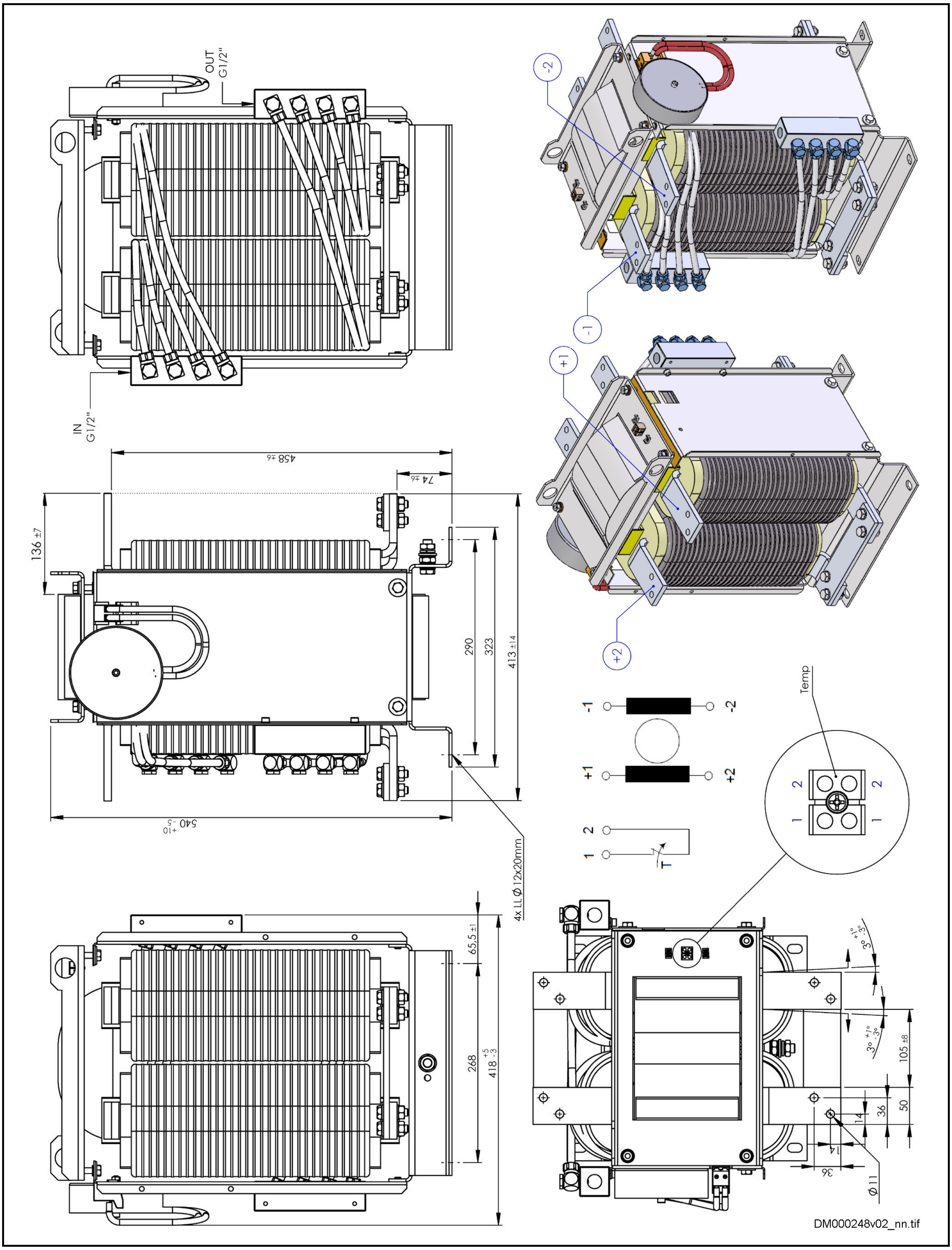


Fig. 8-58: HLL05.1F-04M0-S0720

HLL05.1F-04M0-S0942

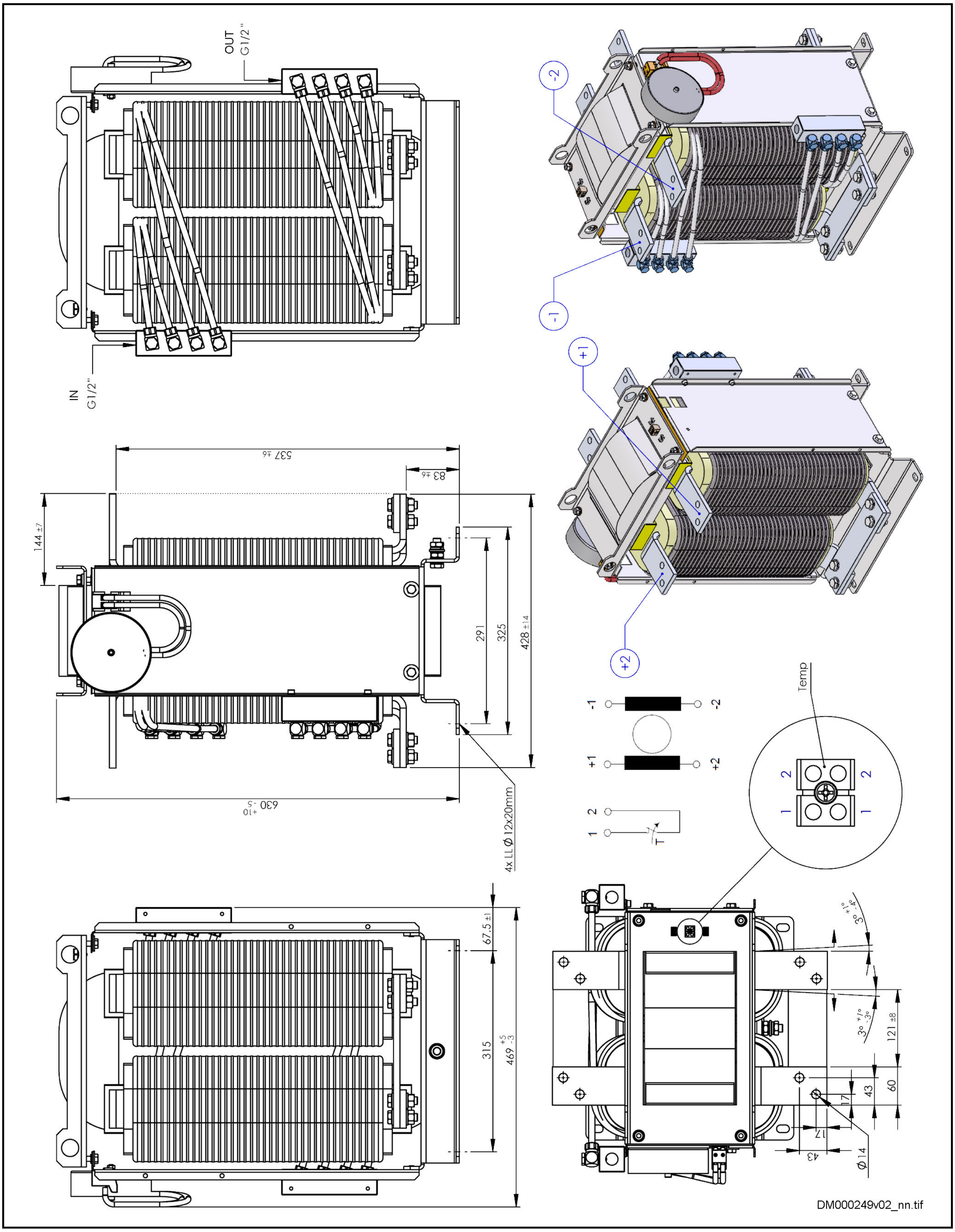


Fig. 8-59: HLL05.1F-04M0-S0942

Data

Choke HLL05.1x -04M0-…	Inductance [mH]	Continuous current [A]	Power dissipation [W]		Allowed leakage capacitance [µF]	Degree of protection	Ambient temperature [1)] [°C]	Weight [kg]
			Air	Water [2)]				
S0202 (air-cooled)	4	202	380	-	1.2	IP00	40	27
S0202 (water-cooled)	4	202	230	400	1.2	IP00	40	23
S0243	4	243	240	430	1.2	IP00	40	25
S0303 (air-cooled)	4	303	400	-	1.2	IP00	40	38
S0303 (water-cooled)	4	303	270	480	1.2	IP00	40	33
S0380	4	380	330	580	1.2	IP00	40	36
S0475	4	475	420	760	1.2	IP00	40	86
S0603	4	603	530	940	1.2	IP00	40	98
S0720	4	720	540	960	1.2	IP00	40	110
S0942	4	942	680	1220	1.2	IP00	40	152

1) Maximum ambient temperature: 55 °C (with derating)
2) Maximum water inlet temperature: 60 °C

Tab. 8-51: HLL05.1F, data

Temperature monitoring contact

- Trigger temperatureAuslösetemperatur: 160 °C
- N/C in one of the windings
- Electric switching capacity:
  - 1 A
  - AC 250 V
  - DC 24 V

Water cooling

HLL05.1F-04M0-…	Flow [l/min]	Filling capacity [l]	Pressure decrease [bar]		
			5 l/min	7 l/min	9 l/min
S0202	> 6	0.7	0.09	0.17	0.27
S0243	> 6	0.8	0.10	0.18	0.28
S0303	> 6	1.0	0.12	0.22	0.35
S0380	> 6	1.1	0.14	0.25	0.40
S0475	> 6	1.2	0.01	0.03	0.04
S0603	> 8	1.7	0.02	0.04	0.06
S0720	> 8	1.9	0.02	0.04	0.06
S0942	> 8	2.3	0.03	0.05	0.08

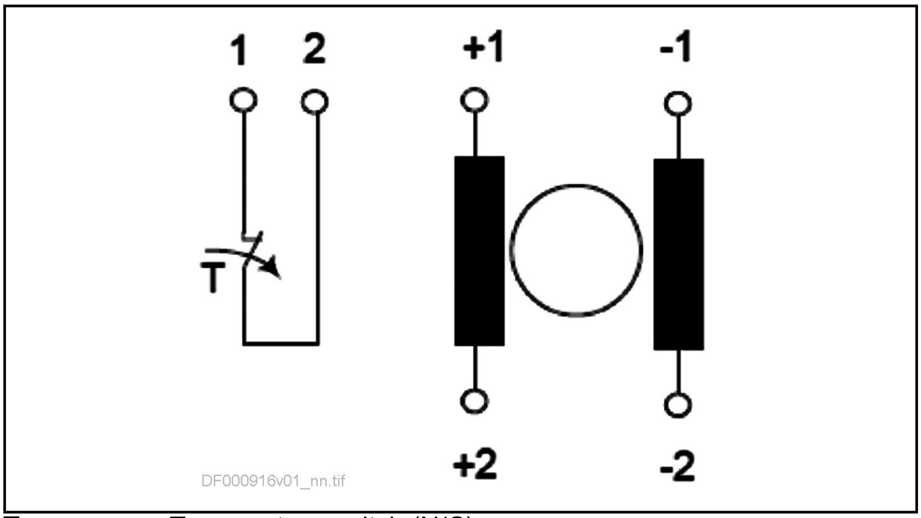
Tab. 8-52: Water cooling

Assignment

Components		Supply unit HMU05.1N-…							
		F0140-0350 (110 kW size)	F0170-0430 (132 kW size)	F0220-0510 (160 kW size)	F0270-0660 (200 kW size)	F0340-0820 (250 kW size)	F0430-1040 (315 kW size)	F0540-1300 (400 kW size)	F0680-1690 (500 kW size)
DC bus choke HLL05.1F-04M0-	S0202	✓							
	S0243		✓						
	S0303			✓					
	S0380				✓				
	S0475					✓			
	S0603						✓		
	S0720							✓	
	S0942								✓

Tab. 8-53: HLL05 ↔ HMU05 assignment

Circuit diagram



T Temperature switch (N/C)
+1 +2, -1 -2 DC bus connection

Fig. 8-60: Circuit diagram

☞ The DC bus connections of the choke may be switched **on both sides**.

Connection

☞ DC bus chokes should **not** be simultaneously connected in parallel at the input and at the output.

Use cupal disks for the aluminum contact point connection: See chapter 11.4 "Aluminum contact points and cupal disks" on page 381.

8.3.7 Y capacitor pair (HAS04.1-003)

Type code

										1										2										3										4
Short type designation	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	H	A	S	0	4	.	1	-	0	0	1	-	N	N	N	-	N	N																						
	①			②			③		④				⑤				⑥																							

①	**Product:** HAS = IndraDrive accessories
②	**Series:** 04 = Capacitor
③	**Design:** 1 = 1
④	**Capacitor:** 001 = 2 × 470 nF (HCS02.x) 002 = 2 × 470 nF (HCS03.x) 003 = 2 × 2.5 µF (HLL05)
⑤	**Other contents:** NNN = None
⑥	**Other design:** NN = None

Tab. 8-54: HAS04, type code

Data

Description	Unit	Value
Voltage	V	AC 500
		DC 1200
Capacitance	µF	2.5 ±20%

Tab. 8-55: Data

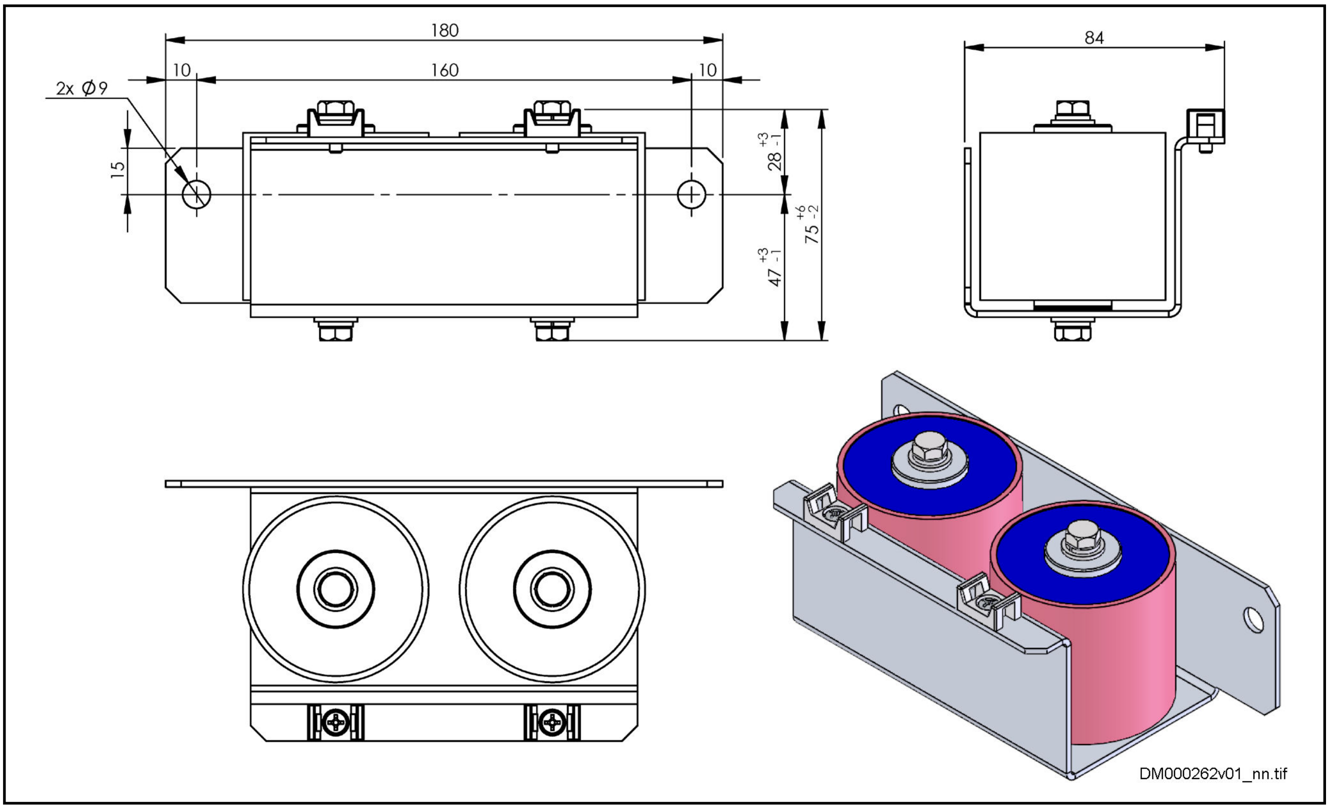


Fig. 8-61: Dimensions

8.3.8 HLR05 external braking resistor

HLR05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	L	R	0	5	.	1	W	-	5	4	K	0	-	N	0	5	R	4	-	A	-	D	7	-	N	N	N	N											
	①			②			③	④		⑤					⑥	⑦					⑧		⑨			⑩														

①	**Product:** HLR = Braking resistor
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Cooling type, type of construction:** W = Air cooling
⑤	**Continuous power:** 54K0 = 54 kW 1) 70K0 = 70 kW 2)
⑥	**Additional option:** N = None
⑦	**Resistance value:** 04R0 = 4.0 ohm 2) 05R4 = 5.4 ohm 1)
⑧	**Degree of protection:** A = IP20
⑨	**Nominal DC bus voltage:** D7 = DC 750 V 1) 2) 11 = DC 1100 V
⑩	**Other design:** NNNN = None

1) "54K0" continuous power only with "05R4" resistance value and "D7" nominal DC bus voltage

2) "70K0" continuous power only with "04R0" resistance value and "D7" nominal DC bus voltage

Tab. 8-56: HLR05, type code

Cables, accessories, additional components

Dimensions

HLR05.1W-54K0-N05R4, …-70K0-N04R0

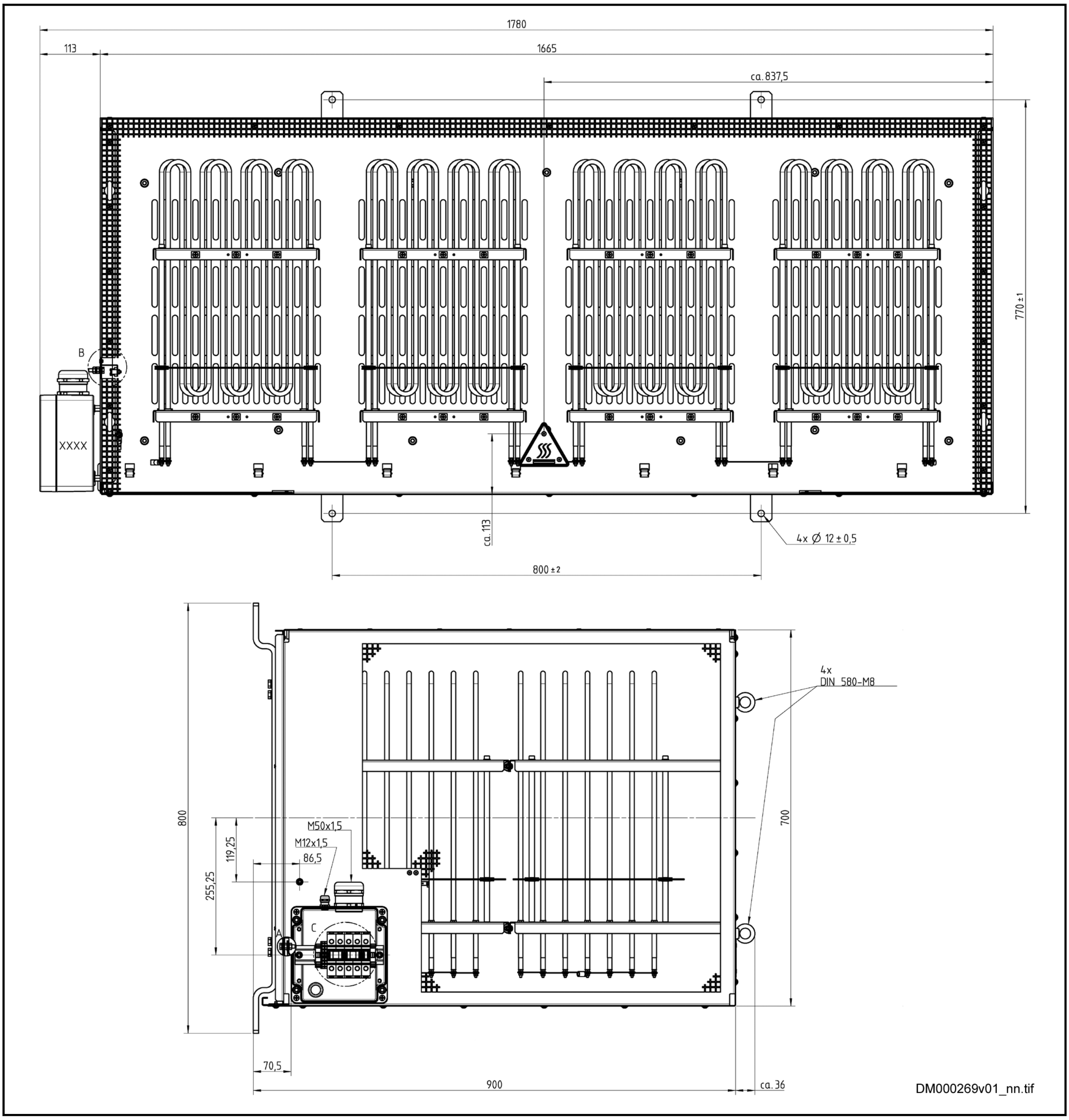


Fig. 8-62: HLR05.1W-54K0-N05R4, …-70K0-N04R0; dimensions in mm

Data

Description	Unit	HLR05.1W-…	
		54K0-N05R4	70K0-N04R0
Resistance	Ω	5.4 ±10%	4 ±10%
Continuous power	kW	54	70
650 V_{DC} peak power	kW	78	106
820 V_{DC} peak power	kW	124	168
650 V_{DC} duty cycle peak power (120 s max. cycle)	%	70	66
820 V_{DC} duty cycle peak power (120 s max. cycle)	%	38	41
Maximum energy absorption	kWs	6500	8400
Weight	kg	145	145
Power connections cross section	mm^2	25	35

Tab. 8-57: HLR05.1W, data

Installation

NOTICE **Property damage due to temperatures higher than 105 °C!**

Observe the indicated minimum distances!

Above the devices there may only be such materials which

- are not combustible
- are insensitive to the occurring high temperatures

Mounting

- Mounting position: Upright on horizontal surfaces
  Do not mount on walls!
- Keep **min. 200 mm distance** from adjacent parts and walls
  Surface temperatures can reach 150 °C.
- Ensure unhindered entry of cooling air
- Ensure unhindered exit of heated air
- Do not mount below fire alarm sensors
- Do not mount near flammable materials

Cables

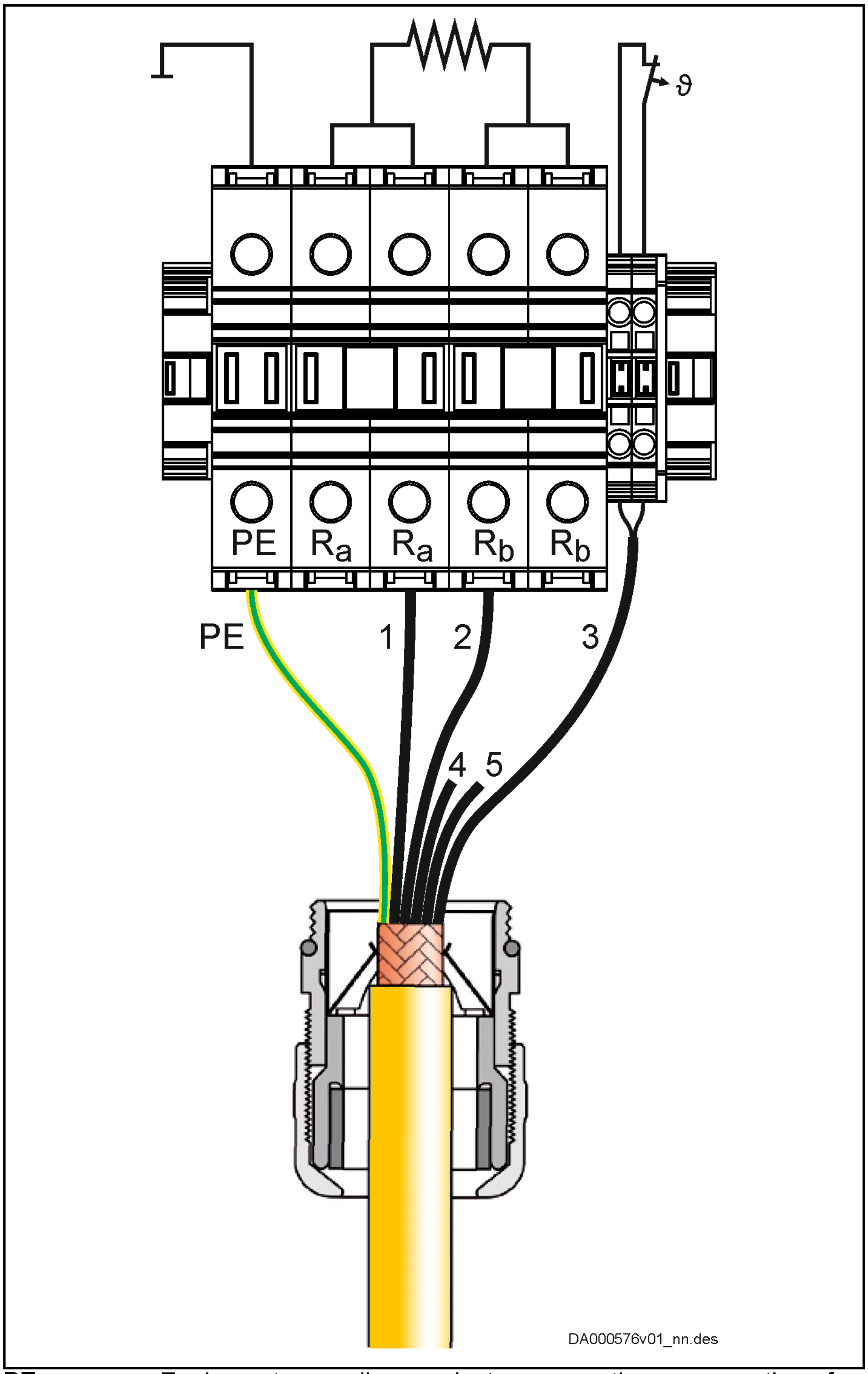
- Length: ≤ 100 m
- Keep feeder and return cables in parallel and as close together as possible or twist them
- Place cables away from signal and data lines
- Place so they are protected against short-circuiting and ground faults

You can use Rexroth cables:

HLR05.1W-…	Cables
54K0-N05R4	INK0607, mat. no.: R911245289
70K0-N04R0	INK0667, mat. no.: R911245292

Tab. 8-58: Cables

Connection point



PE	Equipment grounding conductor; connection cross section of terminal: 6…35 mm^2
1	Stranded wire for HLT terminal connector XD4a; connection cross section of HLR terminal: 6…35 mm^2
2	Stranded wire for HLT terminal connector XD4b; connection cross section of HLR terminal: 6…35 mm^2
3	Stranded wires for HLT terminal connector XG3; connection cross section of HLR terminal: 0.25…2.5 mm^2
4	Wire not used

5	Filler strand not used

Fig. 8-63: Connection point

8.3.9 HLT05 braking unit

HLT05 type code

Short type designation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	L	T	0	5	.	1	W	-	1	0	5	K	-	N	-	D	7	-	N	N	N	N																	
	①			②			③	④		⑤					⑥		⑦			⑧																				

①	**Product:** HLT = Braking unit
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Cooling type, type of construction:** W = Air cooling
⑤	**Nominal power:** 045K = 45 kW 1) 105K = 105 kW 245K = 245 kW 1)
⑥	**Degree of protection:** N = IP00
⑦	**Nominal DC bus voltage:** D7 = DC 750 V 1) 11 = DC 1100 V
⑧	**Other design:** NNNN = None

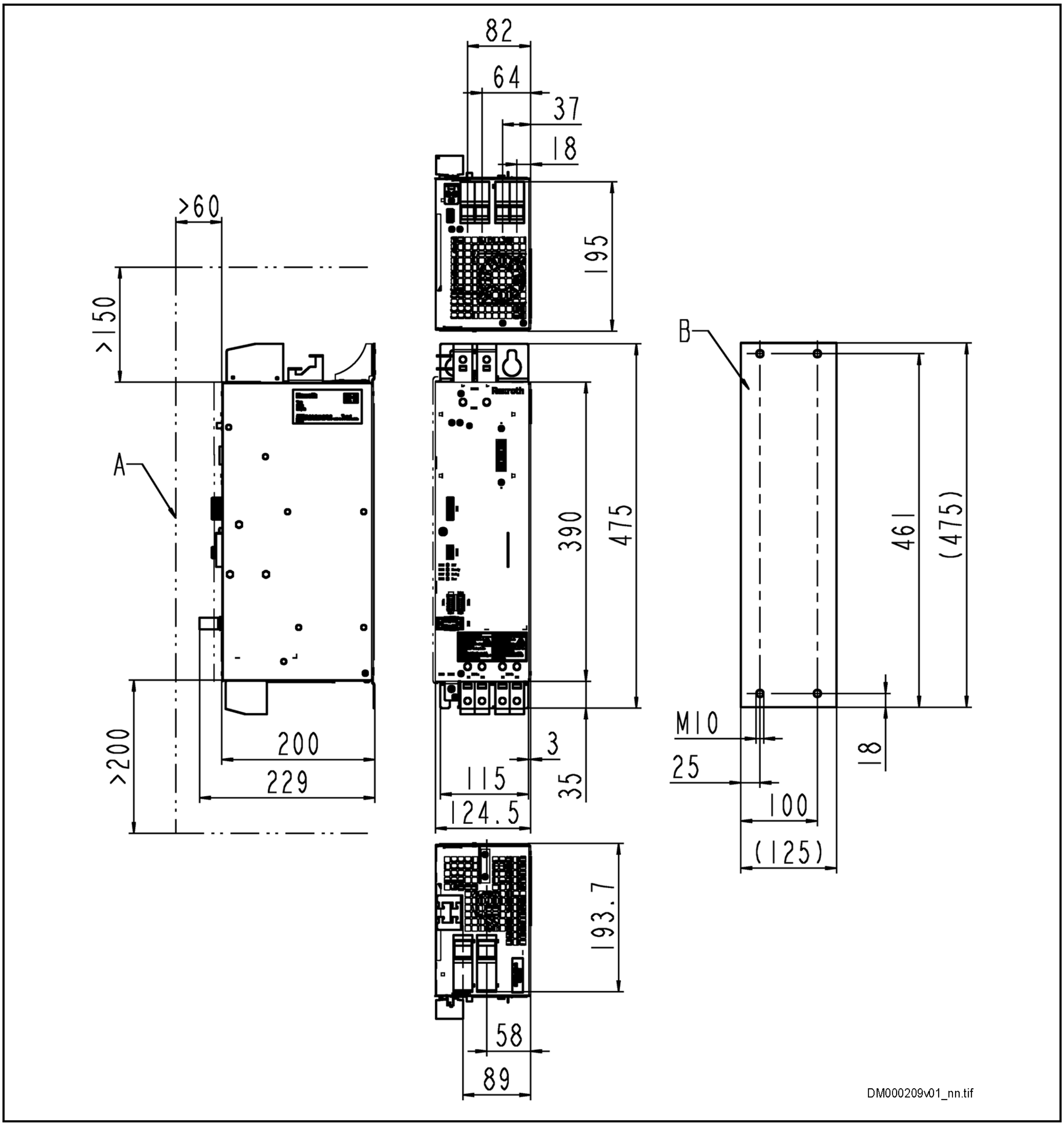
1) "045K" and "245K" nominal power only with "D7" nominal DC bus voltage

Tab. 8-59: HLT05, type code

Dimensions

☞ **5 mm of horizontal spacing** required, if 2 HLTs arranged side by side.

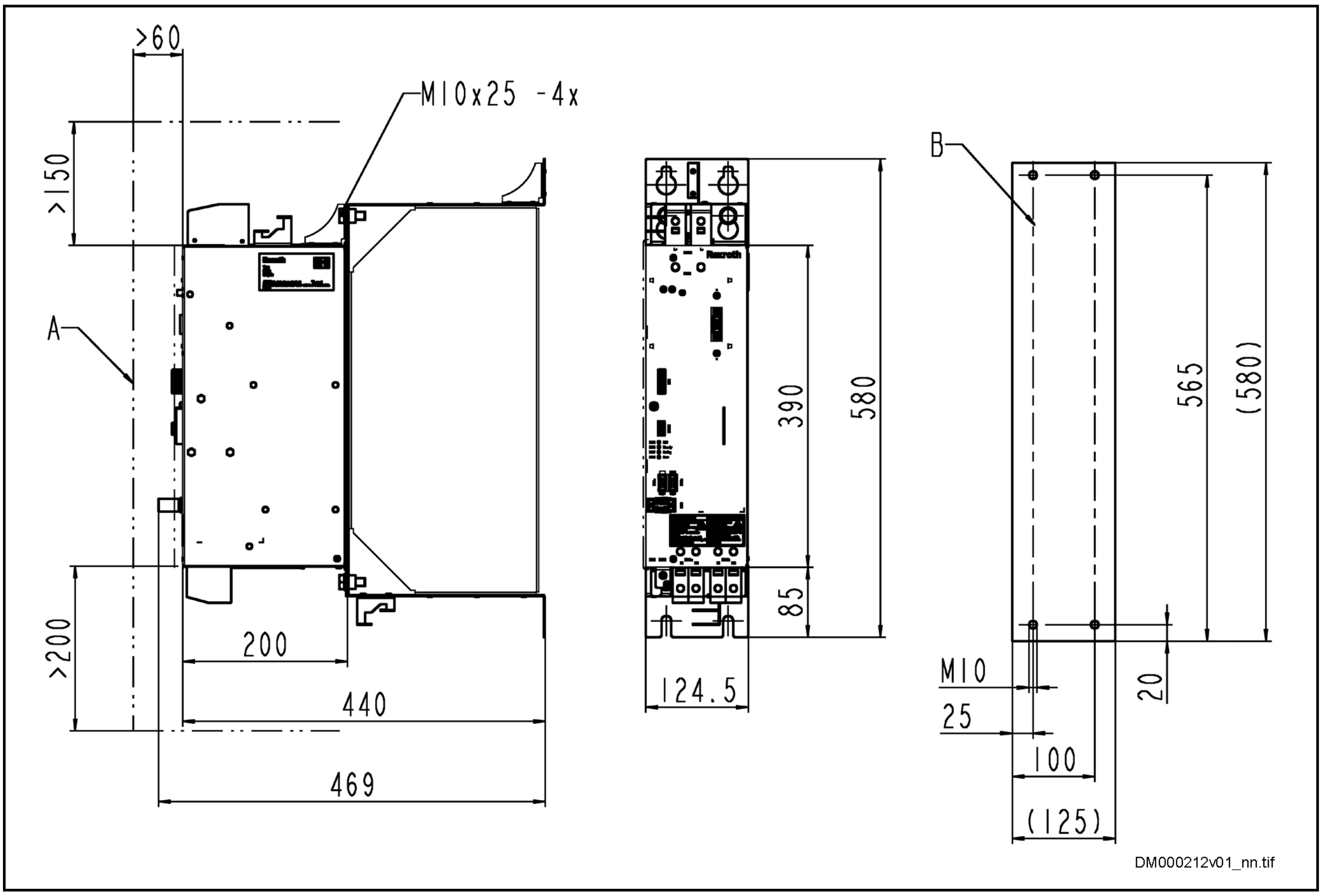
HLT05.1W-045K, -105K, dimensional drawing



A Minimum mounting clearance
B Boring dimensions

Fig. 8-64: HLT05.1W-045K, -105K, dimensional drawing

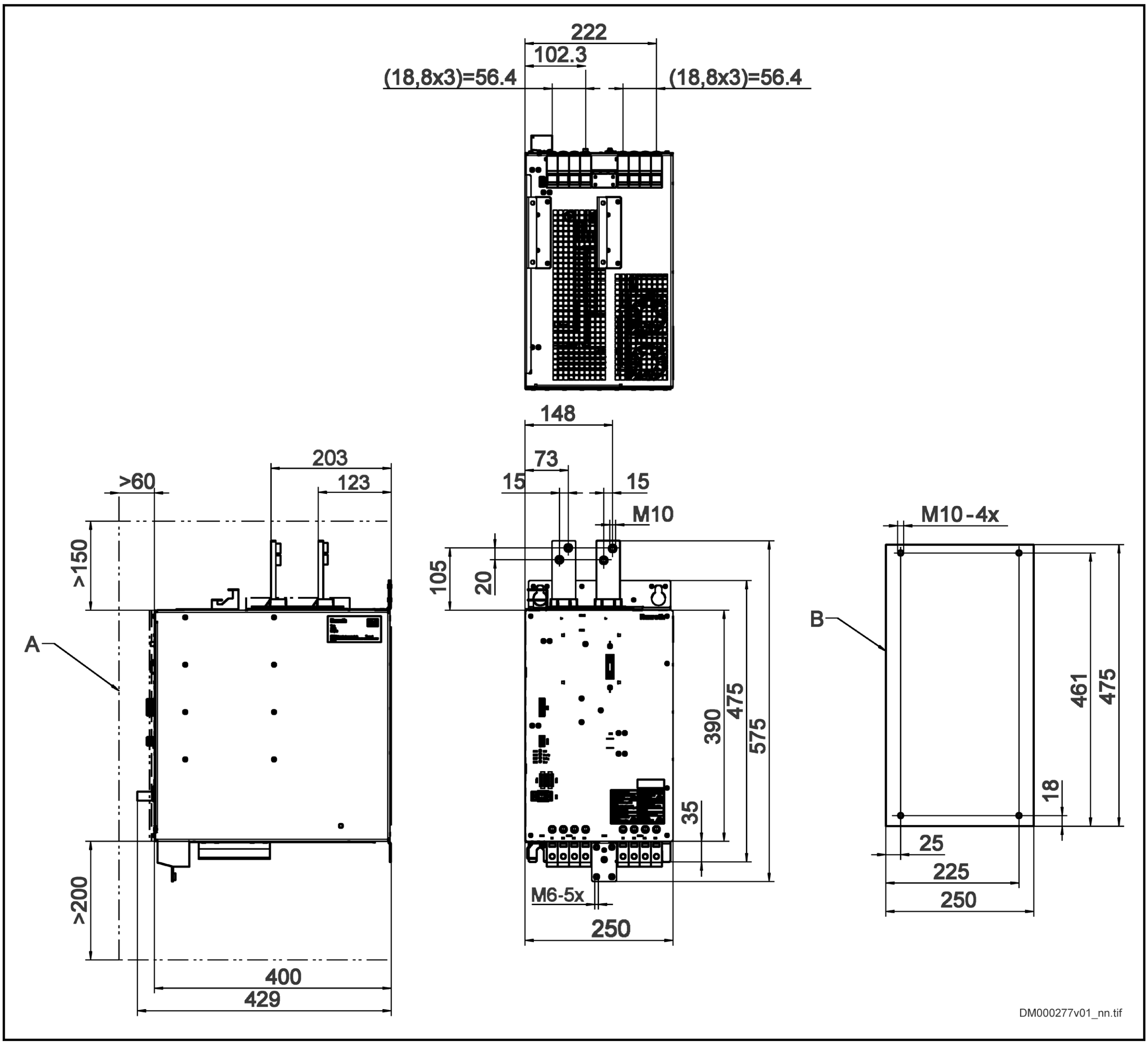
HLT05.1W-045K, -105K with mounting plate (440 mm), dimensional drawing



A	Minimum mounting clearance
B	Boring dimensions
M10x25	Tightening torque = 40 Nm

Fig. 8-65: HLT05.1W-045K, -105K with mounting plate HAS03.1-007 for height leveling and depth leveling to 440 mm depth, dimensional drawing

HLT05.1W-245K, dimensional drawing



A	Minimum mounting clearance
B	Boring dimensions

Fig. 8-66: HLT05.1W-245K, dimensional drawing

Data

Description	Symbol	Unit	HLT05.1W- ... -0-N-D7-NNNN		
			45K	105K	245K
Continuous power	P_{BD}	kW	45	105	245
Short time power (60 s)	P_{BK}	kW	60	145	350
Peak power (2 s)	P_{BS}	kW	85	205	495
Minimum braking resistance	R_{min}	Ω	5.4	2.7	1.0
Balancing factor for P_{BD} (for parallel operation at common DC bus)	f		0.95		
Min. braking transistor switch-on threshold	$U_{HLT\_On\_min}$	V	820		
Max. braking transistor switch-on threshold	$U_{HLT\_On\_max}$	V	850		
Workload-based delay of braking transistor switch-on threshold	$U_{HLT\_On\_d}$	V	30		
Emergency comparator switch-on voltage	U_{Not}	V	943 ±2.5%		
Max. input voltage	U_{max}	V	980		
Continuous current for DC connection points	I_{nom}	A	100	200	500
Power dissipation (full load)	P_{Diss_max}	W	250	400	1000
Power dissipation (standby)	P_{Diss_min}	W	20		
Rated control voltage input	U_{N3}	V	24 ±20%		
Control voltage input current	I_{N3}	mA	470		630
Short circuit current rating	SCCR	kA rms	85		
Weight	m	kg	7.5		23

Tab. 8-60: HLT05, ratings

Cables, accessories, additional components

Connection diagram

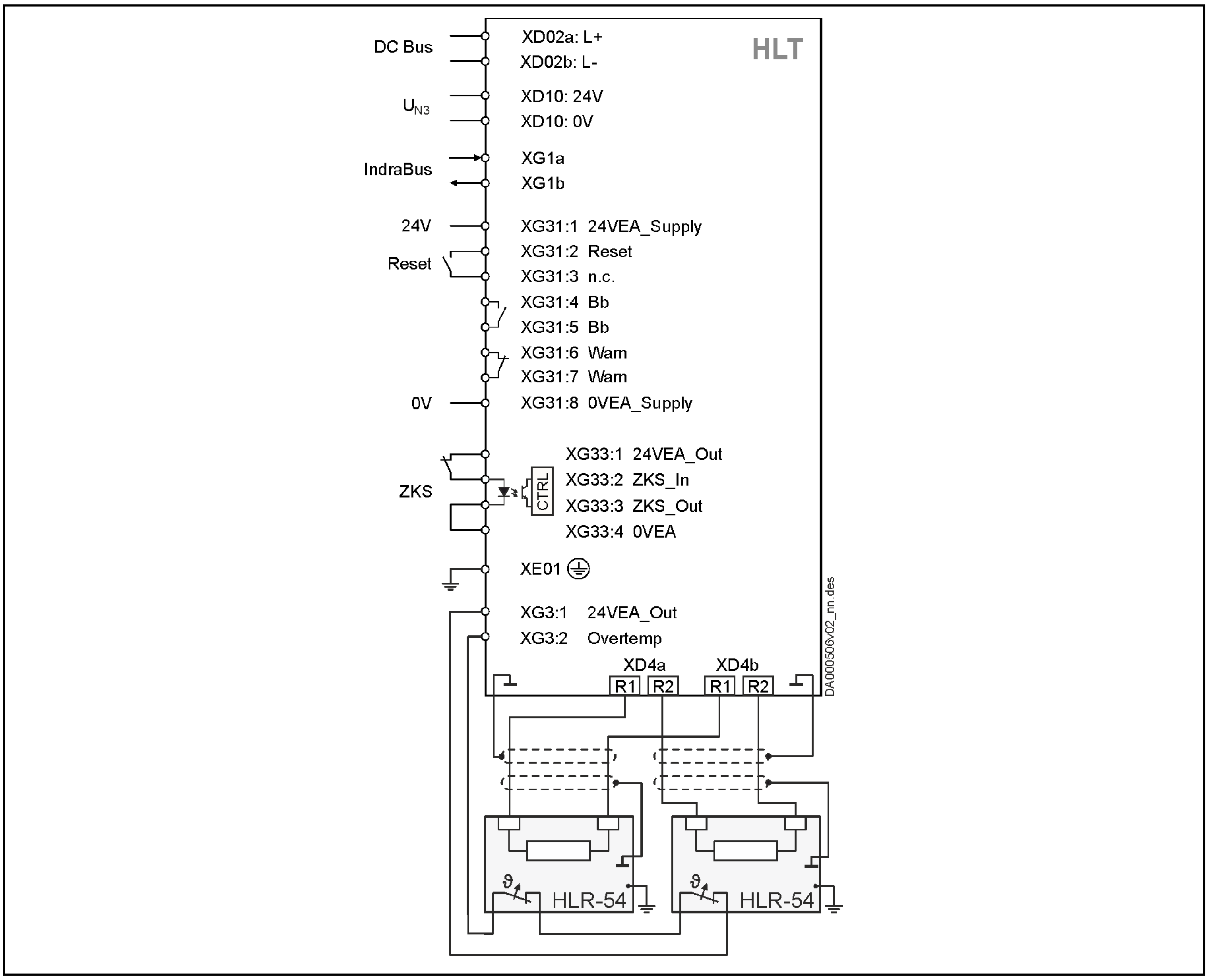


Fig. 8-67: HLT05.1W-045K, -105K connection diagram

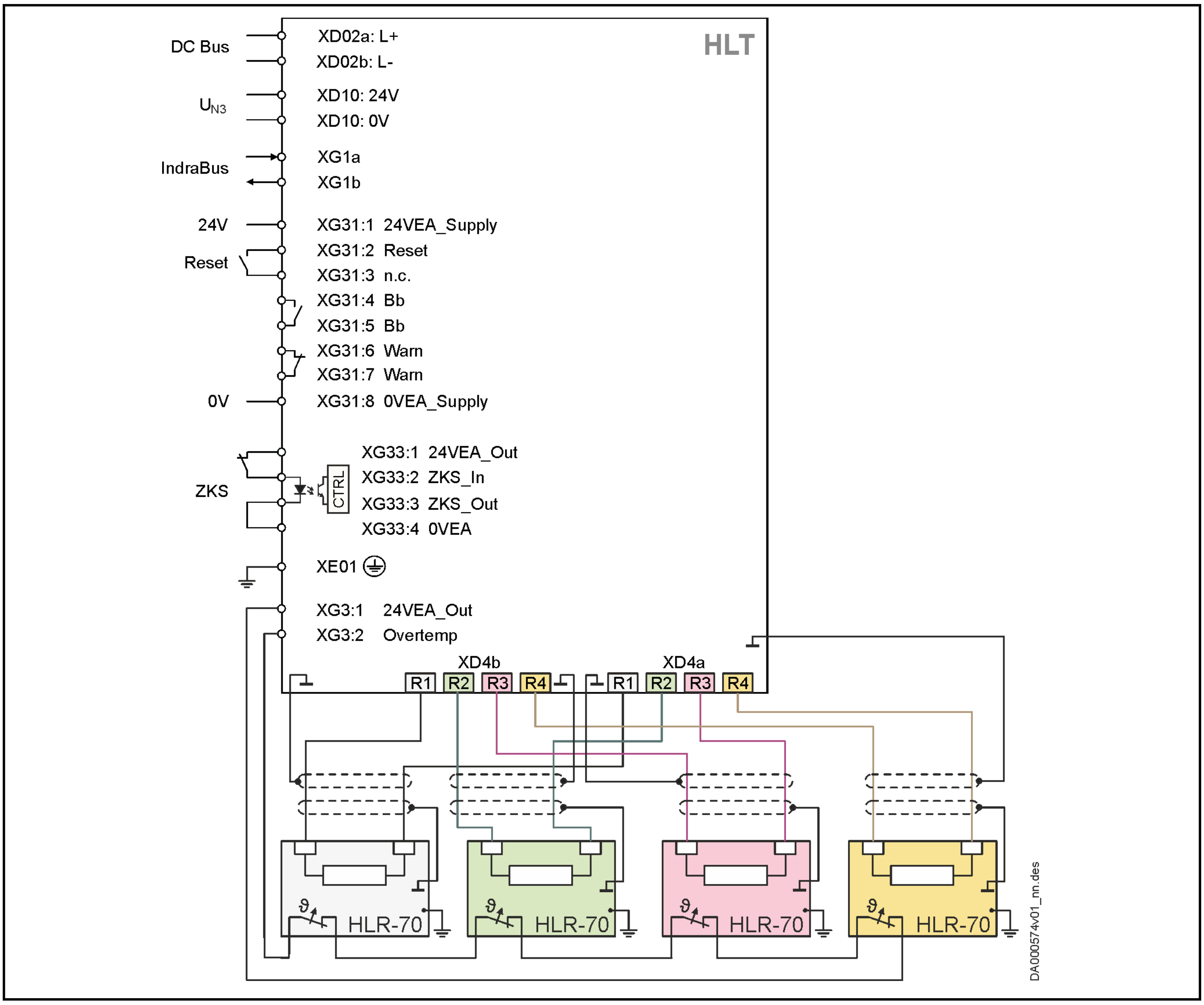


Fig. 8-68: HLT05.1W-245K connection diagram

Internal wiring of connection points XD02 and XD4:

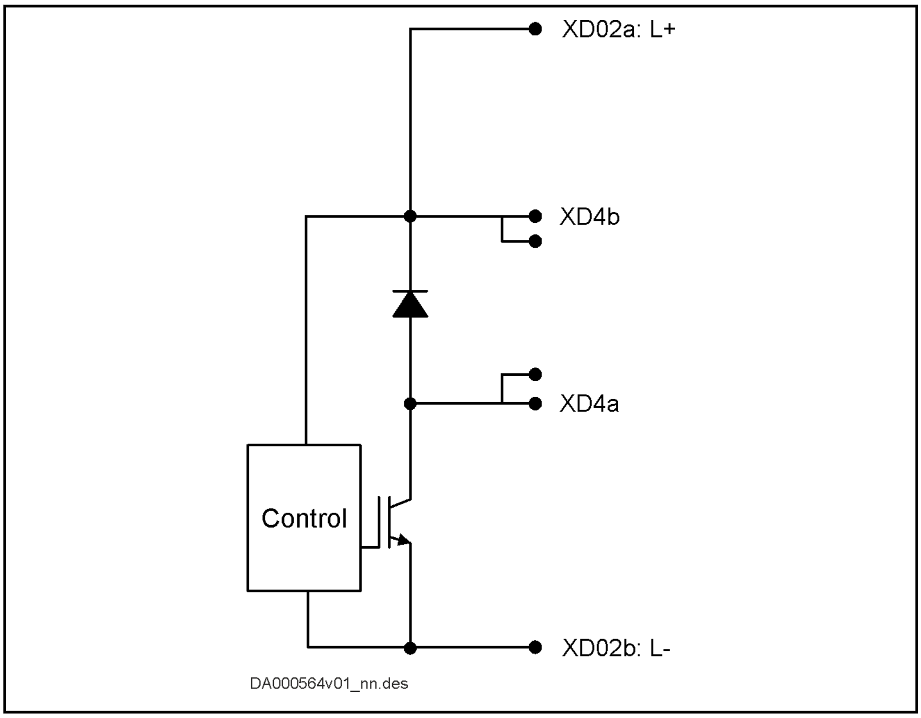
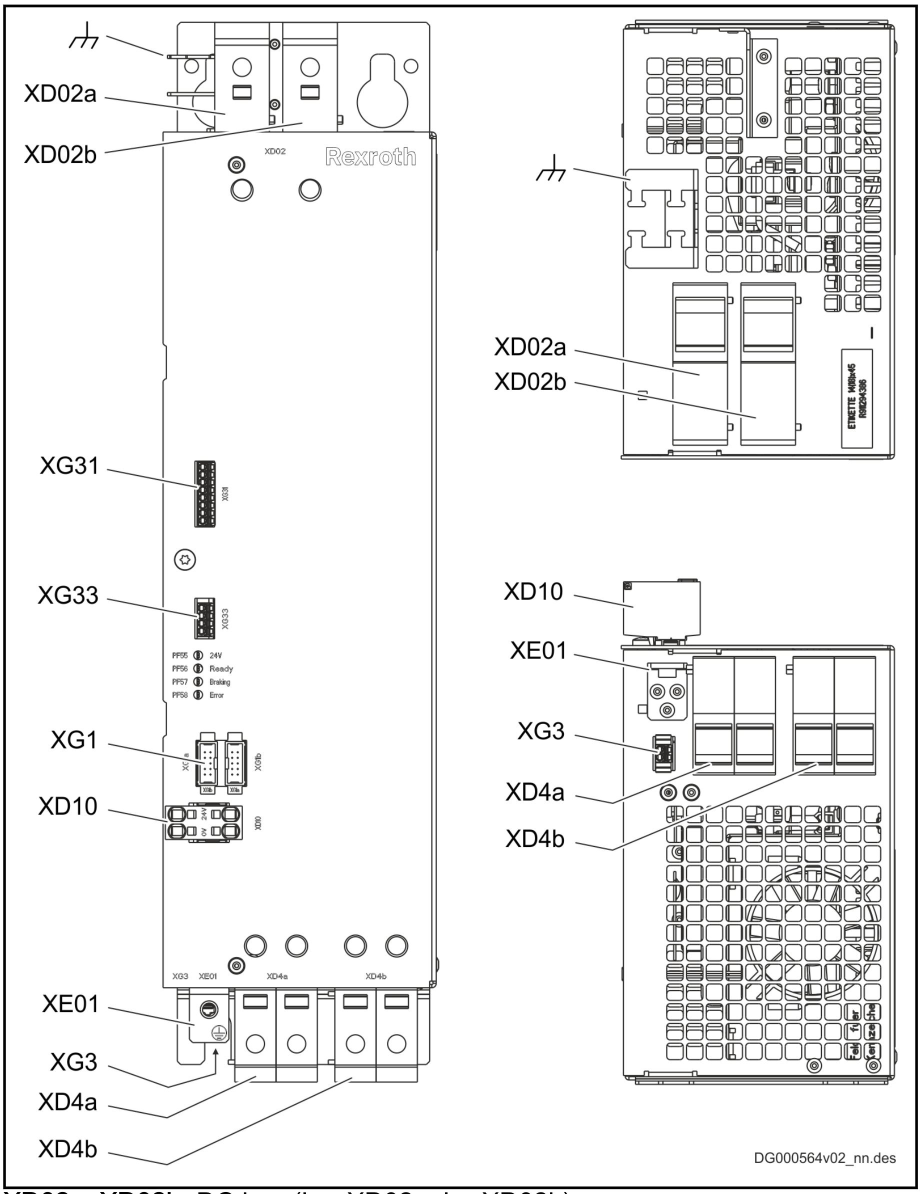


Fig. 8-69: Internal wiring of connection points XD02 and XD4

Connection points

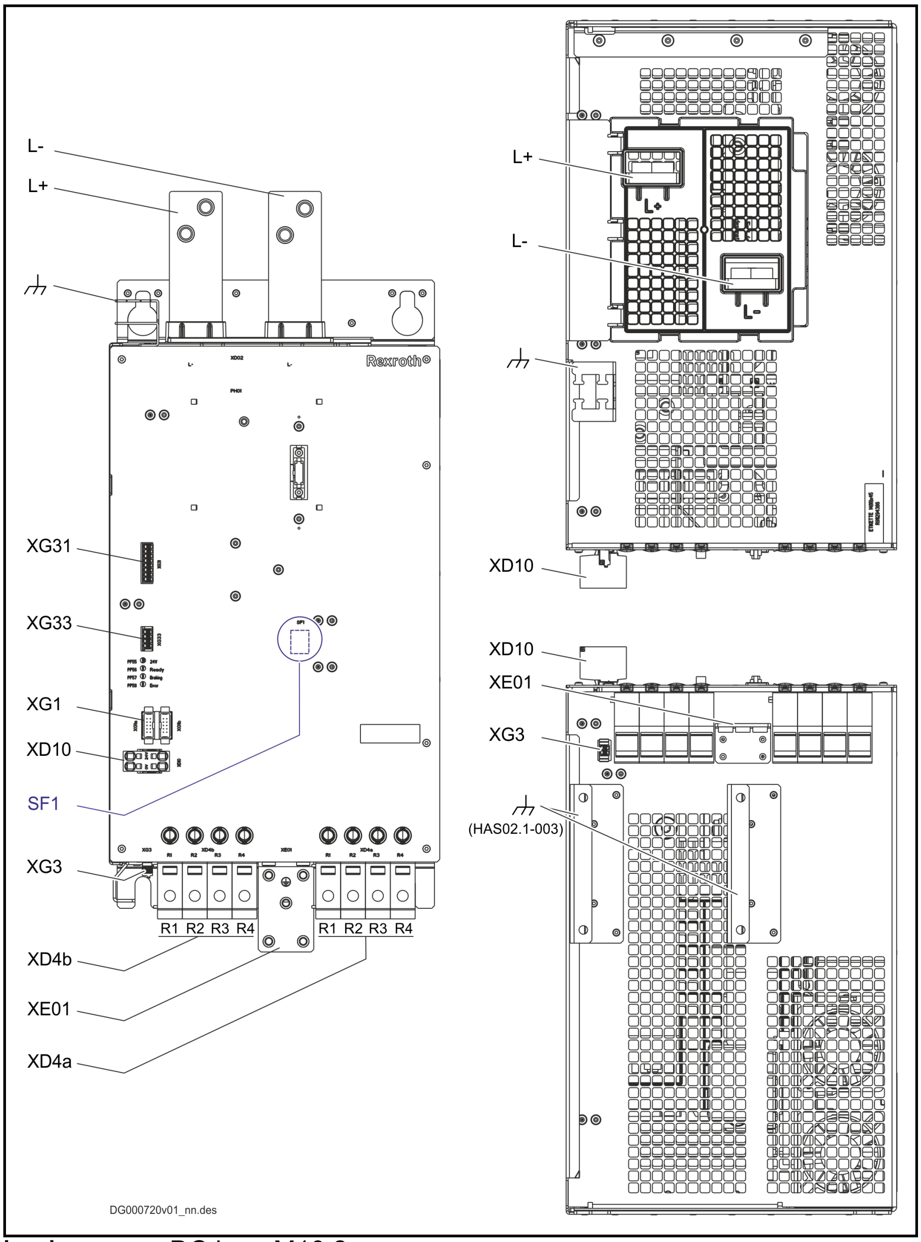
Overview



XD02a, XD02b	DC bus (L+: XD02a, L-: XD02b)
XD4a, XD4b	Braking resistor
XD10	Control voltage (0 V, 24 V)
XE01	Equipment grounding conductor
XG1	IndraBus; (In individual operation (i.e. not in combination with Hxx05 devices) plug in both RBS0025 terminating plugs at XG1.)
XG3	Braking resistor overtemperature signal contact (N/C contact)
XG31	Signal contact (Bb, warning) and reset input for resetting error messages
XG33	DC bus short-circuit (ZKS) function

Fig. 8-70: HLT05.1W-045K, -105K connection points

Cables, accessories, additional components



L+, L-	DC bus; M10 2x
SF1	"Auto-ZKS" (auto DC bus short-circuit) switch
XD4a, XD4b	Braking resistor
XD10	Control voltage (0 V, 24 V)
XE01	Equipment grounding conductor; M6 5x
XG1	IndraBus; (In individual operation (i.e. not in combination with Hxx05 devices) plug in both RBS0025 terminating plugs at XG1.)
XG3	Braking resistor overtemperature signal contact (N/C contact)
XG31	Signal contact (ready, warning) and reset input for resetting error messages
XG33	DC bus short-circuit (ZKS) function
Shield	Shield connection on the bottom with HAS02.1-003 accessories

Fig. 8-71: HLT05.1W-245K connection points

XE01, equipment grounding conductor connection point

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Connect the equipment grounding conductor to the equipment grounding system of the control cabinet.

Check the continuity of the equipment grounding conductors from the mains connection to the connected motors.

☞ **Equipment grounding conductor: material and cross section**

Use the same metal (e.g., copper) for the equipment grounding conductor as for the outer conductors.

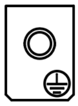
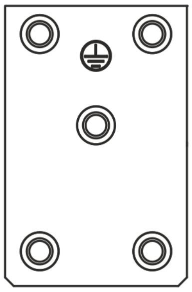
Make sure the lines for the connections from the device's equipment grounding conductor to the equipment grounding conductor system in the control cabinet are large enough.

For outer conductors with a cross section greater than 16 mm², you can reduce the cross section of the equipment grounding connection according to the table "Equipment grounding conductor cross section".

Cross-sectional area A of outer conductors	Minimum cross-sectional area A_{PE} of equipment grounding connection
A ≤ 16 mm²	A
16 mm² < A ≤ 35 mm²	16
35 mm² < A	A / 2

Tab. 8-61: Equipment grounding conductor cross section

Cables, accessories, additional components

View	Identification	Function	
HLT05.1W-045K, -105K:  HLT05.1W-245K: 	⏚	Connection to equipment grounding system	
Screw connection	**Unit**	**Min.**	**Max.**
Screw		M6x25	
Tightening torque	Nm	9.5	10.5

Tab. 8-62: Equipment grounding conductor connection point

XD02, DC bus

HLT05.1W-045K, -105K

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Before working on live parts: De-energize system and secure power switch against unintentional or unauthorized reconnection.

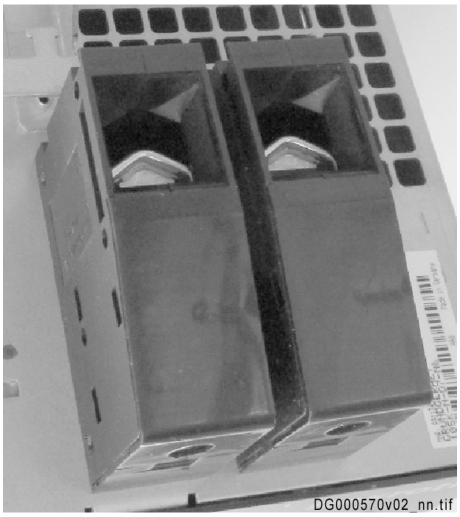
Make sure voltage has fallen below 50 V before touching live parts!

Wait at least **30 minutes** after switching off the supply voltages to allow **discharging** before accessing the device.

The discharge time can be more than 30 minutes if Y capacitor pairs are used.

Secure the DC bus connections against being touched.

HLT05.1W-045K, -105K

View	Connection	Signal name	Function
	XD02a	L+	Positive pole DC bus voltage
	XD02b	L-	Negative pole DC bus voltage

Tab. 8-63: XD02, DC bus

Mechanical data

Screw connection	Unit	Min.	Max.
Connection cable	mm²	85	95
	AWG	3/0	4/0
Cable length 1)	m		1
Stripped length	mm	27	
Tightening torque (M8)	Nm	15	

1) Place the HLT05 braking unit close to the DC bus capacitors. If this is impossible, connect an external capacitor (e.g., HLC) to the braking unit.

Tab. 8-64: Mechanical data

Electrical data

	Unit	Min.	Max.
Nominal voltage as per UL 1059	V	-	600
Nominal current as per UL 1059	A	-	230

Tab. 8-65: Electrical data

HLT05.1W-245K

⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Before working on live parts: De-energize system and secure power switch against unintentional or unauthorized reconnection.

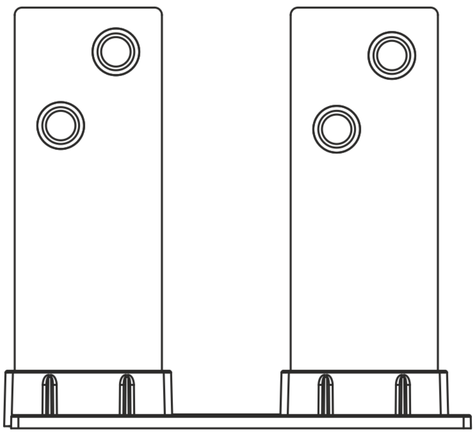
Make sure voltage has fallen below 50 V before touching live parts!

Wait at least **30 minutes** after switching off the supply voltages to allow **discharging** before accessing the device.

The discharge time can be more than 30 minutes if Y capacitor pairs are used.

Secure the DC bus connections against being touched.

HLT05.1W-245K

View	Connection	Signal name	Function
	L+	L+	Positive pole DC bus voltage
	L-	L-	Negative pole DC bus voltage

Tab. 8-66: XD02, DC bus

Mechanical data

Screw connection	Unit	Min.	Max.
Contact bar	mm^2	288	-
Connection cable	mm^2	2 × 120	-
	kcmil	2 × 250	-
Cable length 1)	m	-	1
Tightening torque (M10)	Nm	48	

1) Place the HLT05 braking unit close to the DC bus capacitors. If this is impossible, connect an external capacitor (e.g., HLC) to the braking unit.

Tab. 8-67: Mechanical data

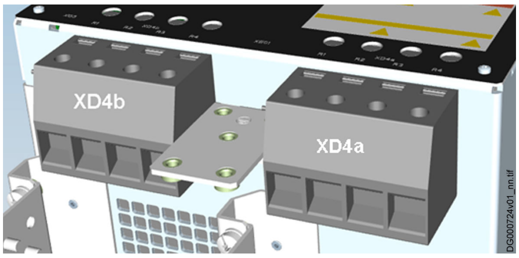
Electrical data

	Unit	Min.	Max.
Nominal voltage as per UL 1059	V	-	600
Nominal current as per UL 1059	A	-	500

Tab. 8-68: Electrical data

XD4, braking resistor

Function, pin assignment Braking resistors are connected to the XD4 connection point.

View	Connec-tion	Signal name	Function
HLT05.1W-045K, -105K:  HLT05.1W-245K: 	XD4a	E	Braking resistor
	XD4b	E	Braking resistor

Tab. 8-69: XD04, braking resistor

Mechanical data

Screw connection	Unit	Min.	Max.
HLT05.1W-045K, -105K connection cable	mm^2	25	50
	AWG	4	1/0
HLT05.1W-245K connection cable	mm^2	50	
	AWG	1/0	
Stripped length	mm	24	
Tightening torque (M6)	Nm	6	

Tab. 8-70: Mechanical data

Electrical data

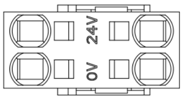
	Unit	Min.	Max.
Nominal voltage as per UL 1059	V	-	600
Nominal current as per UL 1059 (per terminal) [1)]	A	-	145

1) The rms current I_{rms} should not exceed the nominal current of the terminal connector ($I_{rms} = \sqrt{(P_{cont} / R_{load})}$; P_{cont}: continuous braking power, R_{load}: load resistance).

Tab. 8-71: Electrical data

XD10, 24 V supply (control voltage)

Function, pin assignment The 24 V supply is applied externally via connection point XD10.

View	Connection	Signal name	Function
	24V	+24V	Power supply
		+24V	
	0 V	0 V	Reference potential for power supply
		0 V	

Tab. 8-72: XD10, 24 V supply

Mechanical data

Screw connection at connector	Unit	Min.	Max.
Connection cable Solid wire	mm^2	1	10
Connection cable Stranded wire **without** ferrule	mm^2	1	6
	AWG	16	10
Connection cable Stranded wire **with** ferrule	mm^2	1	4
Stripped length	mm	10	

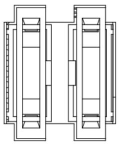
Tab. 8-73: Mechanical data

Electrical data

	Unit	Min.	Max.
Voltage	V	-	60
Current	A	-	1

Tab. 8-74: Electrical data

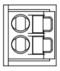
XG1, IndraBus

View	Connection	Function
	XG1a XG1b	Connects parallel components through a ribbon cable. ● Output for quickly reporting critical errors to other devices ● Input for detecting critical errors from other devices ● Blocking and releasing DC bus short circuit by a braking resistor unit ● Reporting DC bus availability *Cable* ● Unshielded length: < 3 m Cable designation: RKB0036 ● Shielded length: < 100 m Cable designation: RKB0035 In individual operation (that is to say not in combination with other devices of the Hxx05.1 series), both IndraBus RBS0025 terminating plugs must have been plugged in.

Tab. 8-75: XG1, IndraBus

XG3, braking resistor overtemperature signal contact

Pin assignment

View	Connec-tion	I/O	Function (N/C contact)
	1	O	Relay contact supply voltage
	2	I	Digital input of relay contact

Tab. 8-76: XG3, braking resistor signal contact

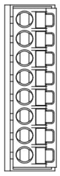
Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cable Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

Tab. 8-77: Mechanical data

XG31, signal contact (Bb, warning) and reset input

Pin assignment

View	Connection	I/O	Function
	1	I	Supply voltage of inputs/outputs (24VEA_Supply)
	2	I	Reset input to reset error messages 1: Reset active 0: Reset not active
	3	-	n. c.
	4	O	N/O contact signals readiness for operation Closed with: Readiness for operation of device Open with: Error messages: F****
	5		
	6	O	N/C contact signals warning states Open with: Overtemperature at device/braking resistor
	7		
	8	I	Reference potential of supply voltage (0VEA_Supply)

Tab. 8-78: XG31, messages

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cable Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

Tab. 8-79: Mechanical data

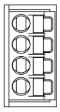
Electrical data

	Unit	Min.	Max.
Digital inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Switching voltage	V	24 -6%	
Output current	mA		500
Energy absorption capacity	mJ		700
Overload protection	-	Short circuit protection	
Bb and warning contact	-	Digital outputs correspond to IEC 61131-2 Type 1	
Switching voltage	V_{DC}	30	
Continuous current	A		1
Switching current	A		5

	Unit	Min.	Max.
Load current	mA	10	
Switching cycles	-	3×10^5	

Tab. 8-80: Electrical data

XG33, DC bus short-circuit (ZKS)

View	Connec-tion	I/O	Function
	1	O	DC bus short-circuit input supply voltage (24VEA_Out)
	2	I	DC bus short-circuit 1 – positive connection for controlling DC bus short-circuit function Typical wiring: Connect XG33.1 to XG33.2 using an N/C contact
	3	I	DC bus short-circuit 2 – negative connection for controlling DC bus short-circuit function Typical wiring: Connect XG33.4 to XG33.3
	4	O	Reference potential of supply voltage (0VEA)

Tab. 8-81: Function, pin assignment

The DC bus short-circuit function requires a 24 V control voltage.

In the event of a control voltage failure, the DC bus will not discharge automatically.

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cable Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

Tab. 8-82: Mechanical data

Electrical data

	Unit	Min.	Max.
Digital Inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Supply outputs	-		
Total output current	mA		300

Tab. 8-83: Electrical data

SF1 switch

Use

Activate or deactivate "Auto-ZKS" (auto DC bus short-circuit) function.

With the "Auto-ZKS" (auto DC bus short-circuit) function, the device automatically executes a DC bus short circuit (ZKS) if the external 24 V control voltage supply fails.

The "Auto-ZKS" (auto DC bus short-circuit) function is deactivated by default.

Type

DIP; 2-pin

Fig. 8-72: SF1 switch

The switch sits underneath a cover. The cover can be removed using a screwdriver.

Function

Switch 1	Switch 2	Auto-ZKS (auto DC bus short-circuit) activated?
ON	ON	–
ON	OFF	✓
OFF	ON	✓
OFF	OFF	✓

ON Move switch down to the lowermost position
OFF Move switch up to the topmost position
Sliding force 8 N

Tab. 8-84: Function

Display elements

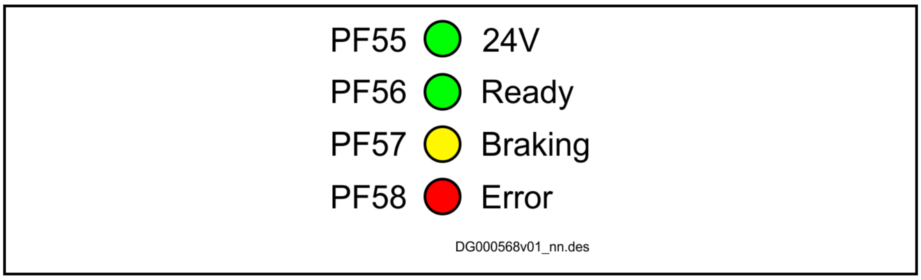


Fig. 8-73: LEDs on HLT05

LED	Color / status	Significance
PF55	Green	24 V power supply applied
	Off	24 V power supply < 19.2 V
PF56	Green	Ready for operation
	Off	Not ready for operation
PF57	Yellow	Active
	Off	Inactive
PF58	Red	Error
	Flashing red	Warning
	Off	No error, no warning

Tab. 8-85: HLT05 LED displays

8.3.10 24V power supply unit

Features

The following PULS products are suitable for IndraDrive ML systems:

Product	Use
QT20.241	24V power supply unit; supply via mains Output current: 20 A
QTD20.241	24V power supply unit; supply via DC bus Output current: 20 A
QT40.241	24V power supply unit; supply via mains Output current: 40 A
YR40.241	Redundancy module for establishing a redundant power supply. 2 × 20 A input, 1 × 40 A output
YR80.241	Redundancy module for establishing a redundant power supply. 2 × 40 A input, 1 × 80 A output

Tab. 8-86: Power supply units, redundancy modules

Important properties:

- SELV/PELV power supply unit[1)]
- Overvoltage protection available
- Overtemperature protection available
- Exclusively 3-phase operation allowed
- UL approval (E198865)

Documentation

Product documentations can be found online:
http://www.pulspower.com/index.php?reqNav=download

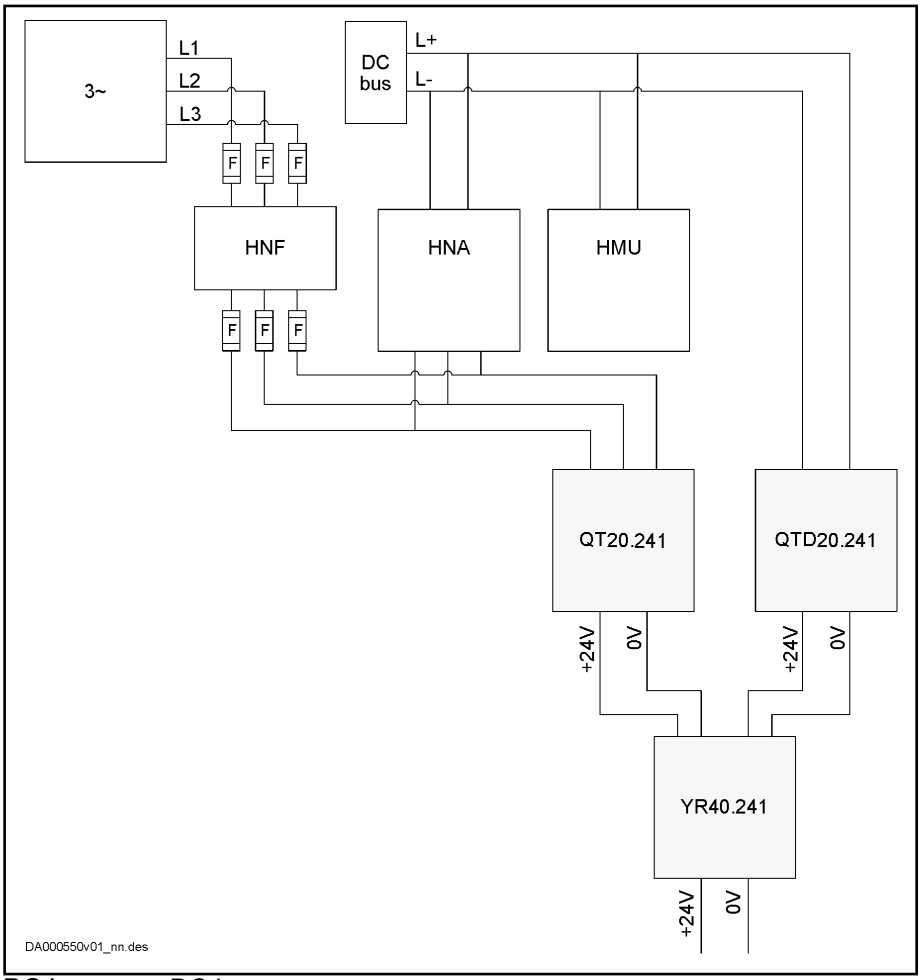
1) *SELV: Safety Extra Low Voltage; PELV: Protected Extra Low Voltage*

Data

Description	Unit	QT20.241	QTD20.241	QT40.241
Mains input voltage	V	3 AC 380 … 480 -15%/+20%	-	3 AC 380 … 480 -15%/+20%
DC bus input voltage	V_{DC}	-	480 … 840 (continuously) 360 … 480 (< 60 s) 840 … 900 (< 60 s)	-
Input current	A	0.79 (400 V)	0.85 (600 V_{DC})	1.65 (400 V)
Output voltage	V_{DC}	DC 24		
Output current (24 V)	A_{DC}	20 (continuously) 30 (< 4 s)	20 (continuously) 25 (< 4 s)	40 (continuously) 60 (< 4 s)
Output power (24 V)	W	480 600 (< 4 s)	480 720 (< 4 s)	960 1440 (< 4 s)
Input line fuses	-	-	Present (2 ×)	Present (3 ×)
Degree of protection	-	IP20		
Weight	kg	0.87	0.89	1.5
Dimensions	mm (W×H×D)	65×124×127		110×124×127
Mounting	-	Top-hat rail Wall-mounted (with optional accessories)		

Tab. 8-87: Data

24V/20A connection diagram



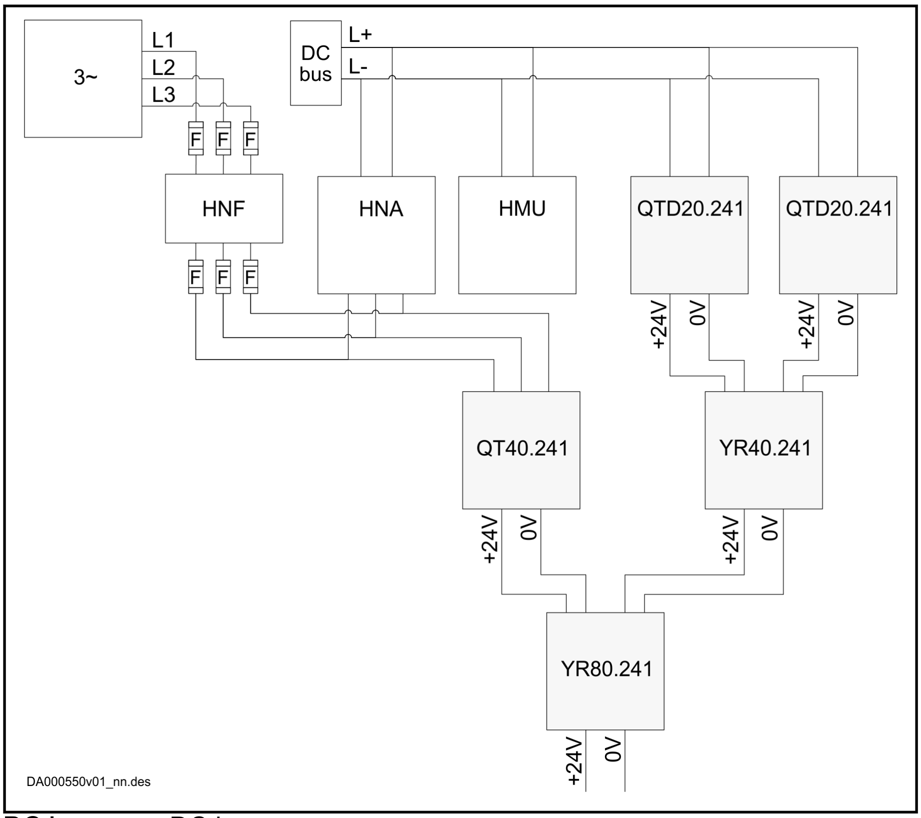
DC bus DC bus
QT20.241 Power supply unit
QTD20.241 DC bus power supply unit
YR40.241 Redundancy module

Fig. 8-74: 24V/20A connection diagram

☞ Setting the output voltage:

- QT20.241: 25.5 V
- QTD20.241: 24 V

24V/40A connection diagram



DC bus	DC bus
QT20.241	Power supply unit
QT40.241	Power supply unit
QTD20.241	DC bus power supply unit
YR40.241	Redundancy module
YR80.241	Redundancy module

Fig. 8-75: 24V/40A connection diagram

☞ Setting the output voltage:

- QT40.241: 25.5 V
- QTD20.241: 24 V

8.3.11 Heat Exchanger HAH01

Type Code HAH01

Type short description	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40
Example:	H	A	H	0	1	.	2	-	W	A	0	3	5	K	-	0	0	9	0	-	0	1	5	-	0	0	0	1												
	①			②			③		④	⑤	⑥					⑦					⑧				⑨															

①	**Product:** HAH = Heat exchanger
②	**Line:** 01 = 1
③	**Design:** 2 = 2
④	**Cooling circuit drive side:** W = Water
⑤	**Cooling circuit customer side 1):** A = Air W = Water
⑥	**Cooling power 1):** 008K = 8 kW 035K = 35 kW 060K = 60 kW
⑦	**Flow rate circuit drive side 1):** 0020 = 20 liter/minute 0090 = 90 liter/minute 0180 = 180 liter/minute
⑧	**Pressure circuit drive side:** 015 = 1,5 bar
⑨	**Other design:** 0001 = Configuration 1

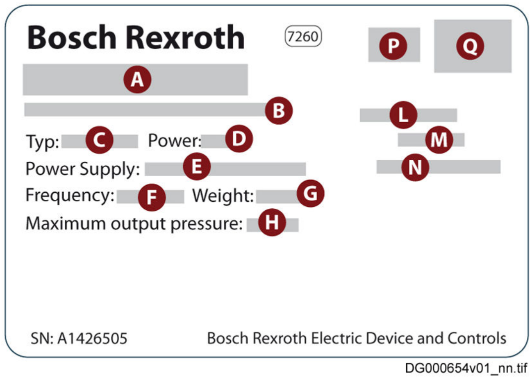
1) Locking cooling power with flow rate circuit drive side and cooling circuit customer side done:
Cooling power "008K" only available with flow rate circuit drive side "0020"
Cooling power "035K" only available with flow rate circuit drive side "0090"
Cooling power "060K" only available with flow rate circuit drive side "0180" and cooling circuit customer side "W"

Tab. 8-88: HAH01, Type Code

General Information

Manufacturer’s details and machine identification details

A	Manufacturer’s details
B	Customer product description
C	Machine type
D	Installed power
E	Power supply
F	Power supply frequency
G	Weight
H	Maximum output pressure
L	Customer product code
M	Week and year of manufacture
N	Article number
P	"EEEW" (RAEE) marking concerning the obligation to dispose of electrical and electronic equipment separately from household waste
Q	"CE" marking of conformity



Tab. 8-89: Manufacturer’s details and machine identification details

Declaration of conformity

Rexroth
Bosch Group

EU declaration of conformity - *original*

Doc. No.: DCTC-30134-001
Date: 2016-04-20

- ☒ in accordance with Machinery Directive 2006/42/EC
- ☐ in accordance with Low Voltage Directive 2014/35/EU
- ☒ in accordance with EMC Directive 2014/30/EU
- ☐ in accordance with ATEX Directive 2014/34/EU

The manufacturer,
Bosch Rexroth AG
Bürgermeister-Dr.-Nebel-Straße 2
97816 Lohr am Main / Germany

hereby declares that the products below

Name: Liquide cooling unit for industrial converters

Series: HAH01.2...

From the date of manufacture: 2016-04-20

were developed, designed and manufactured in compliance with the above-mentioned EU directives.

Harmonized Standards applied:

Standard	Title	Edition
EN 60204-1 *(IEC 60204-1)*	Safety of machinery – Electrical equipment of machines – Part 1: General requirements	2006 *(2005, modified)*
EN 61000-6-2 *(IEC 61000-6-2)*	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments	2005 *(2005)*
EN 61000-6-4 *(IEC 61000-6-4)*	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments	2007 + A1:2011 *(2006 + A1:2010)*

The individual below is authorized to compile the relevant technical files:
Name, address: Christian Russo, DC-IA/EDY4, Bürgermeister-Dr.-Nebel-Str. 2, 97816 Lohr am Main / Germany

Lohr am Main, dated 2016-04-20
Place Date

Daniel Voegeli
Vice President Product Management and Product Marketing

Eberhard Schemm
Vice President Drive Solutions

We reserve the right to make changes to the content of the EU Declaration of Conformity. Current issue on request.

Page 1 / 1

DCTC-30134-001_KOE_N_EN_2016-04-20.docx

Fig. 8-76: Declaration of conformity

Disclaimer notice

The manufacturer cannot be held responsible for the following:

- machine misuse
- unauthorised modifications and/or repairs
- missing or inadequate maintenance
- use of non-original spare parts or parts not designed specifically for the model concerned

Safety Information

General safety warnings

The majority of accidents at work are due to lack of attention, non-compliance with the most basic safety rules and improper use of tools and equipment.

Being prudent and attentive when operating the machine is the best way to prevent accidents and injuries.

Read the instruction manual provided carefully and strictly follow the instructions, particularly those related to safety.

All specialised technicians that perform work on the machine must have technical skills, ability and experience to perceive the risks and dangers that may result from the specific activity to be performed.

Familiarise yourself with the meanings of the symbols on the stickers: their shape and colour are important for safety purposes; make sure they are always legible and always observe the information given.

Do not tamper with, circumvent, eliminate or bypass the locking and safety devices; failure to comply with this requirement may cause serious risks to the health and safety of persons.

Waste (coolant, etc.) must be disposed of correctly to prevent ecological and environmental damage.

Dispose of all packing materials according to their composition in compliance with the laws in force.

Liquid-Liquid Heat Exchanger

Technical Information

General description of the machine

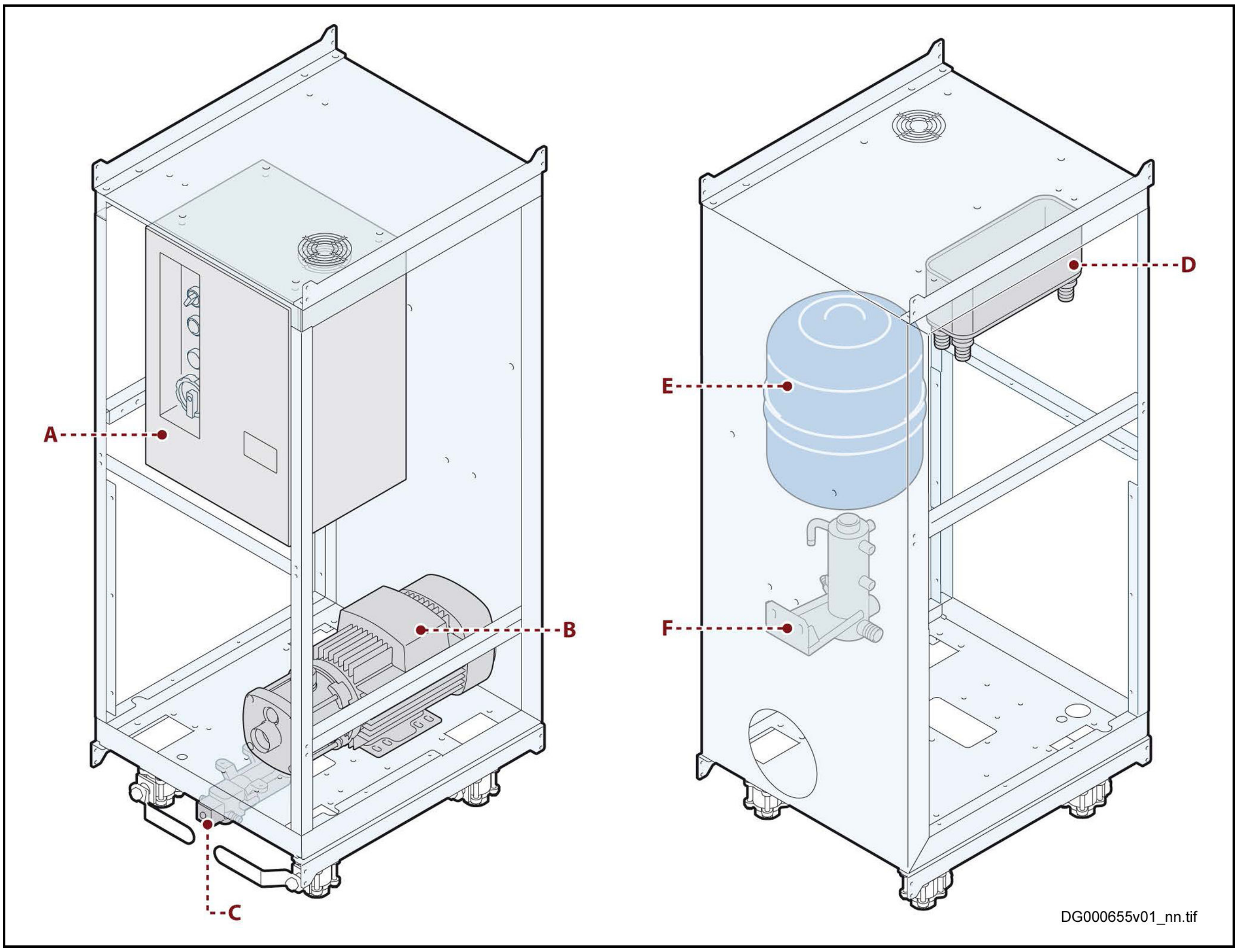
The machine is designed and manufactured for the purpose of cooling devices or equipment by means of a liquid solution made of glycol and demineralised water.

The cooling system is mainly based on the exchange of heat between two fluids that circulate in two independent circuits (customer side circuit and drive circuit) and a heat exchanger.

The cold liquid, provided by the owner, flows in the customer side circuit and through the heat exchanger it cools the liquid in the drive circuit.

The equipment or machine to be cooled is connected to the drive circuit.

Main parts



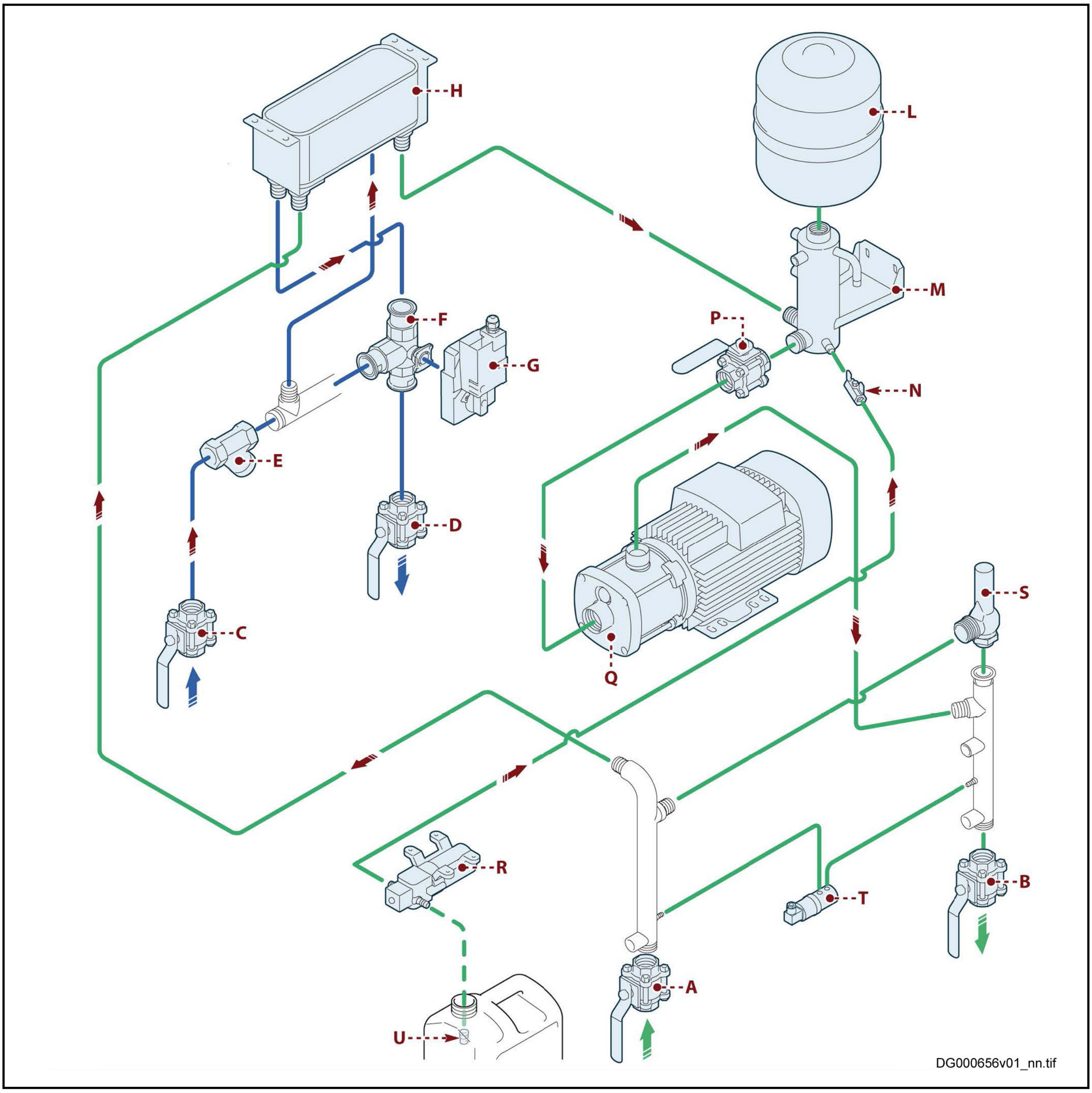
A	Electrical panel
B	Main pump
C	Filling pump
D	Heat exchanger
E	Expansion tank
F	Coolant distribution manifold

Fig. 8-77: Main parts

Operational cycle and component description

In the customer side circuit, the cold liquid coming from the owner's external system, via the heat exchanger, cools the fluid in the drive circuit and consequently the machine to be cooled.

The temperature of the fluid in the drive circuit is controlled by the mixing valve of the primary circuit that adjusts the flow of the cold liquid into the heat exchanger.



A Ball valve: it opens and closes the return fluid from the equipment to be cooled

B Ball valve: it opens and closes the delivery fluid to the equipment to be cooled

C Ball valve: it opens and closes the flow of the coolant from the owner's system

D Ball valve: it opens and closes the flow of the coolant towards the owner's system

E Filter: it filters the incoming liquid

F Mixing valve: it automatically varies the flow rate of the coolant in the heat exchanger in order to increase or decrease the temperature of the fluid in the drive circuit

G Actuator: it controls the mixing valve in order to shut the cold liquid in the heat exchanger

H	**Heat exchanger:** it lowers the temperature of the coolant in the drive circuit
L	**Expansion tank:** it maintains the pressure in the drive circuit constant
M	**Coolant distribution manifold**
N	**Valve:** this is used to open and close the flow from the filling pump
P	**Valve:** this is used to open and close the flow of the main pump
Q	**Main pump:** it makes the coolant circulate in the drive circuit
R	**Filling pump:** it fills the cooling circuit of the owner's equipment
S	**By-pass valve:** it limits the pressure of the output liquid
T	**Pressure sensor:** this measures the differential pressure between the intake and the outlet of the machine to be cooled
U	**Check valve:** this is used to stop the filling pump intake pipe draining

Fig. 8-78: Operational cycle and component description

Guards

The owner must fit the machine with suitable guards in conformity with the regulations in force, in order to prevent the risk of injury.

Overpressure devices

The owner is obliged to install a safety device in the drive circuit, on the return pipe to the machine, which limits the pressure in the system to a maximum of 2 bar.

Overall dimensions

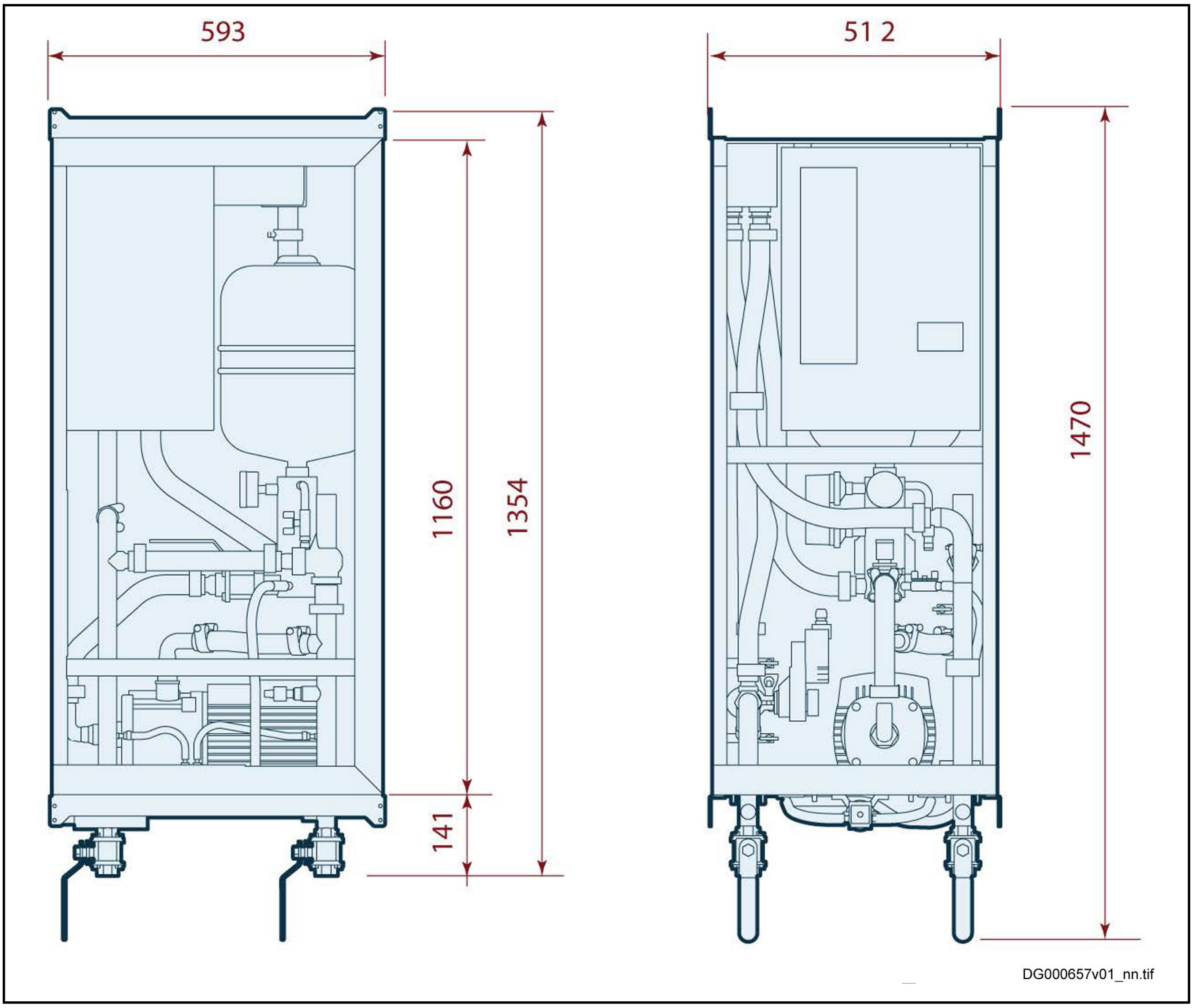


Fig. 8-79: Overall dimensions

Specifications

Machine Specification

Item	Unit	WW0008K-0020	WW0035K-0090
Power voltage	Vac	380 (-15%) … 500 (+10%)	
Frequency	Hz	50/60	
Input current	A	2,3	3,5
Maximum power that can be dissipated	kW	8	35
Maximum customer side circuit input flow rate	l/min	120	120
Maximum drive circuit output flow rate	l/min	20	90
Maximum customer side circuit input liquid pressure	bar	7	
Maximum drive circuit input liquid pressure	bar	2	
Maximum drive circuit output liquid pressure	bar	4,5	
Maximum coolant temperature (customer side circuit)	°C	50	
Minimum coolant temperature (customer side circuit)	°C	10	
Maximum coolant temperature (drive circuit)	°C	70	
Minimum coolant temperature (drive circuit)	°C	30	
Drive circuit coolant (monoethyl glycol and demineralised water solution)	-	25% glycol	
Customer side circuit coolant		See tab. 8-91 "Water quality specification (TIU_14_0003)" on page 295	
Weight	kg	115	120

Tab. 8-90: Machine specification

Water quality specification

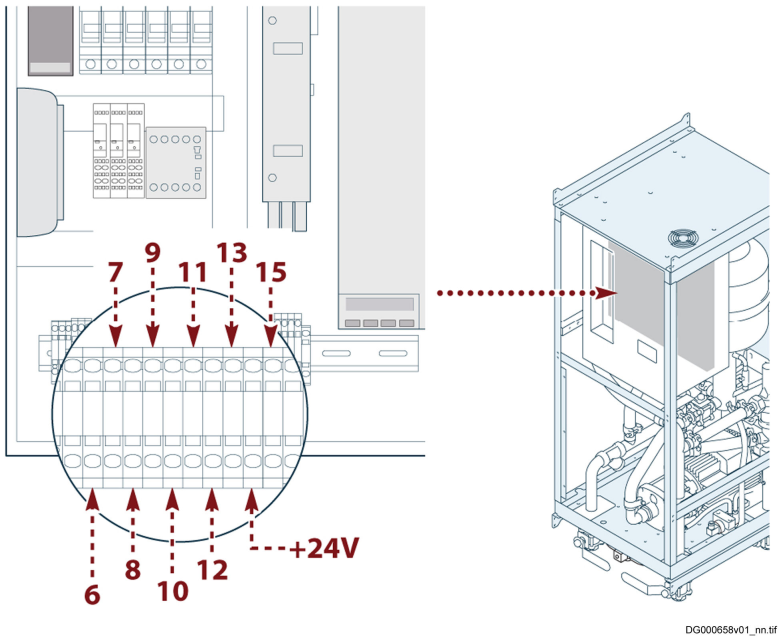
Pos.	Chemical element	Unit	Requirement
1	PH value	Range	7 … 8,5
2	Temporary hardness	°F	< 5,0
3	Total hardness	°F	< 10,0
4	Conductivity range	µS/cm	150 … 1000
5	Particle dimension	mm	0,02
6	Suspended particles	mg/l	< 0,2
7	Residue at 105°	mg/l	< 450
8	$KMnO_4$ consumption	mg/l	< 0,1
9	Ammonia	mg/l	< 0,1
10	Mineral oil	mg/l	< 0,1
11	Iron (Fe)	mg/l	< 0,5
12	Zinc (Zn)	mg/l	< 0,5
13	Manganese (Mn)	mg/l	< 0,2
14	Phosphor (P)	mg/l	< 1,0
15	Copper (Cu)	mg/l	< 0,2
16	Fluorides (F^-)	mg/l	< 1,0
17	Nitrates (NO_3^-)	mg/l	< 10,0
18	Free carbonic acid	mg/l	8 … 15
19	Oxygen (O)	mg/l	< 0,2
20	Alkalinity ($CaCO_3$)	mg/l	< 200
21	Solphate ions (SO_4^{2-})	mg/l	< 100
22	Cloride ions (Cl^-)	mg/l	< 50

Tab. 8-91: Water quality specification (TIU_14_0003)

ENABLE, UNIT ERROR and UNIT WARNING connections

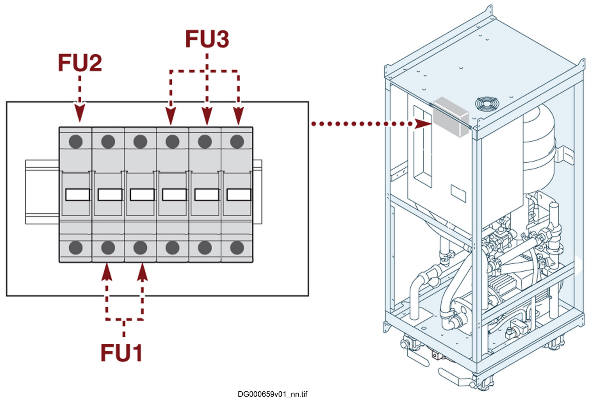
The signals to enable the relative machine status using the owner’s operating terminal are transmitted via the terminal board shown.

Connect up the cables using the terminals shown in the table titled "Connecting the terminals".

Pos.	Meaning	Terminals
24V - 15	Terminals to enable machine via owner’s operating terminal (ENABLE)	
6 - 7 8 - 9	Machine error signal terminals. Closed contact: no error.	
10 - 11 12 - 13	Warning signal terminals. Closed contact: no Warning.	

Tab. 8-92: Connecting the terminals

Fuses description

Name	Current (A)		Type	Rated voltage (Vac)	Inter-rupting capacity (kW)	Fuse	Position
	35-90	08-20					
FU1	1	1	CC	600	200	Delayed	
FU2	4	4					
FU3	6	3					

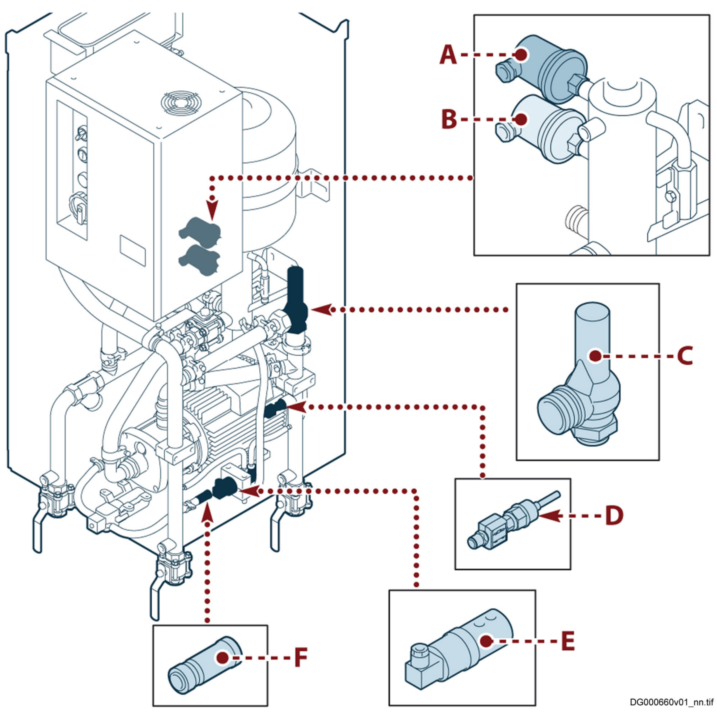
Tab. 8-93: Fuses

Processing and protection devices

⚠ WARNING Serious health and safety risks

Do not tamper with, circumvent, remove or bypass processing and protection devices; failure to comply with this requirement may cause serious health and safety risks.

A	**Pressure switch (0,5 bar):** this detects the pressure level in the intake manifold. The pressure switch allows a warning to be signalled when the pressure falls below 0,5 bar.
B	**Pressure switch (0,2 bar):** this detects the pressure level in the intake manifold. The pressure switch allows an "error" to be signalled when the pressure falls below 0,2 bar and stops machine operation.
C	**Bypass valve:** this is used to keep the fluid pressure in the drive circuit outlet pipe within the maximum limit allowed.
D	**Temperature sensor:** this detects the coolant temperature in the drive circuit outlet pipe. Depending on the temperature detected, the system will signal either a "Warning"(temperature too high) or an "Error" (temperature continues to rise, resulting in machine shutdown).
E	**Pressure sensor:** this detects, in real time, the differential pressure between the intake pipe and the drive circuit output pipe. Through the sensor, the drive circuit outlet pipe pressure is kept constant.
F	**Check valve:** this is used to stop the filling pump intake pipe draining.



Tab. 8-94: Processing and protection devices

Environmental conditions for operation

The machine works correctly with an ambient temperature of between 5 and 55 °C and a maximum humidity level of 95% (without condensation).

The machine is able to function properly at altitudes up to 2000 m above sea level.

Permitted use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

Any other use than that specified, or not included or inferable from this manual, should be considered mishandling and therefore not permitted.

Improper and unauthorised uses

It is forbidden to use coolants with characteristics different from those specified by the manufacturer.

It is forbidden to use the machine in a potentially flammable or explosive atmosphere.

It is forbidden to start the machine until the system or machine in which it is incorporated has been declared compliant with the national and local regulations in force.

Residual risks

Risk of crushing: when moving the machine, incorrect manoeuvres or improper handling of the load may pose a risk of injury to the operators involved.

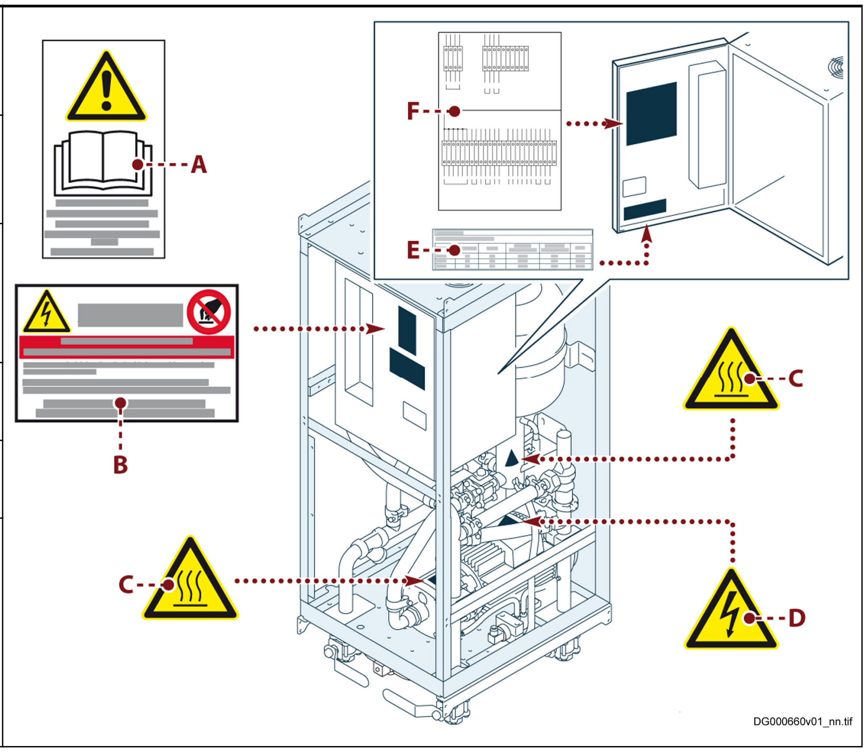
Risk of electric shock: maintenance operations or replacement of components may involve a risk of electric shock due to accidental contact with live electrical components.

Thermal risk: contact with hot surfaces can cause burns; allow the machine to cool down before any operation.

Information and safety signs

WARNING

Check that all the plates are legible; if they are not, clean them or - if they are damaged - replace them, applying the new ones in the same place as the old ones.

A	This indicates the obligation for operators to read the instruction manual before operating the machine	
B	Indicates risk of electric shock and that no works must be carried out in live electrical parts.	
C	This indicates that there is the risk of burns due to contact with hot surfaces; allow the machine to cool down before any operation.	
D	This indicates that there is the risk of electric shock.	
E	This shows the fuses technical characteristics.	
F	This shows the electrical connections of the terminals in the electrical panel.	

Tab. 8-95: Information and safety signs

Information concerning handling and installation

Handling and installation safety recommendations

The staff assigned to handling the load must have the required ability and experience and must be skilled in the use of the lifting means adopted.

Use lifting equipment of a capacity suitable to lift and move the load.

The person authorised to handle the appliance will have to take the appropriate measures to guarantee his/her own safety and the safety of those directly involved.

Place the package on a steady surface.

When stacking packages, the specified limits should be observed to avoid sudden movements.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents; in case of damaged or missing items, contact the importer or the manufacturer directly to discuss the procedure to be adopted.

Package description

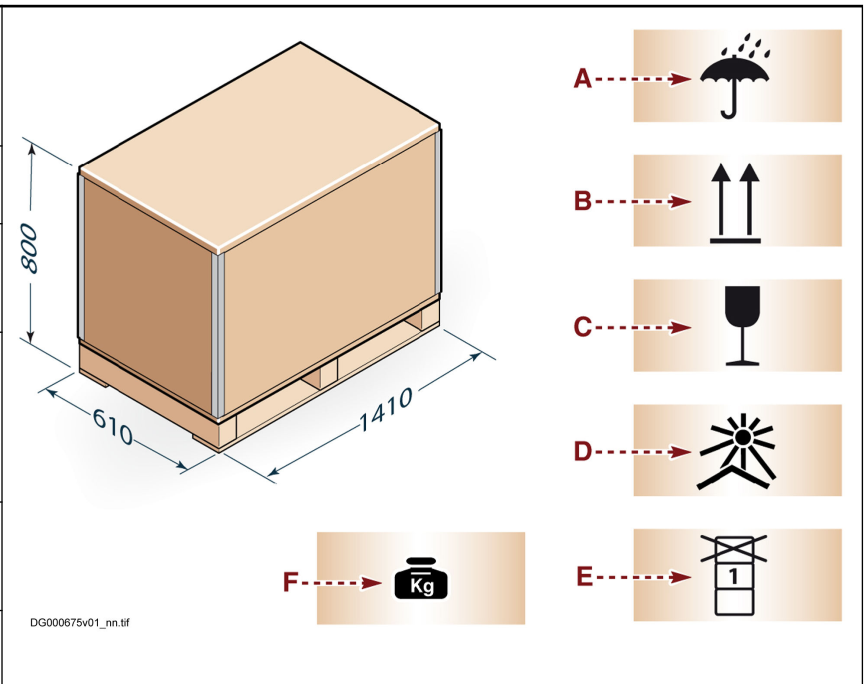
The type of packing is chosen according to the selected means of transport and the destination.

The parcels can be loaded onto a means of transport directly or in suitable containers if shipped by sea or air or to far-off destinations.

To make transport easier some components are removed and duly protected.

The figure describes the most common package types, their maximum dimensions, warning symbols and information affixed to the packages.

A	This symbol means the packed machine must be stored in a dry place: its contents may be damaged by dampness.
B	This symbol means the packed machine must be kept upright.
C	This symbol means the packed machine must be handled with care: its contents are fragile.
D	This symbol indicates that the package must be kept away from direct sunlight and heat sources to avoid exposing its content to excessively high temperatures.
E	This symbol indicates the maximum number of packages that can be stacked.
F	This symbol indicates the overall weight of the package.



Tab. 8-96: Package description

Handling and lifting the packed unit

The figure describes the package lifting mode.

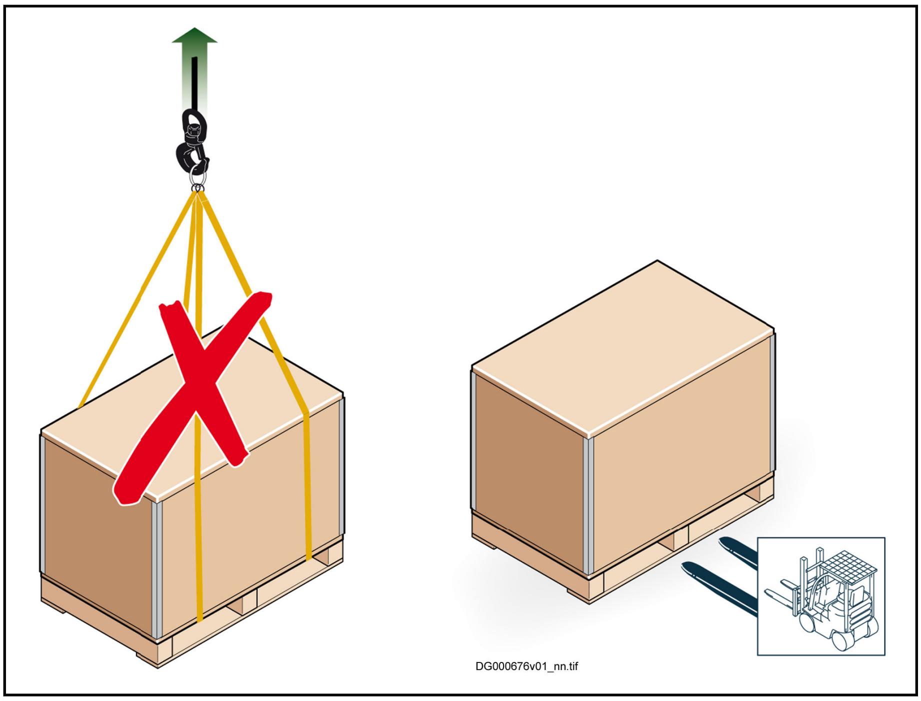


Fig. 8-80: Handling and lifting the packed unit

Storage

If the machine is not going to be used for an extended period, it should be stored (possibly without unpacking it, or at least adequately protected) in a sheltered place protected from atmospheric agents at a temperature between -20 and +60 °C.

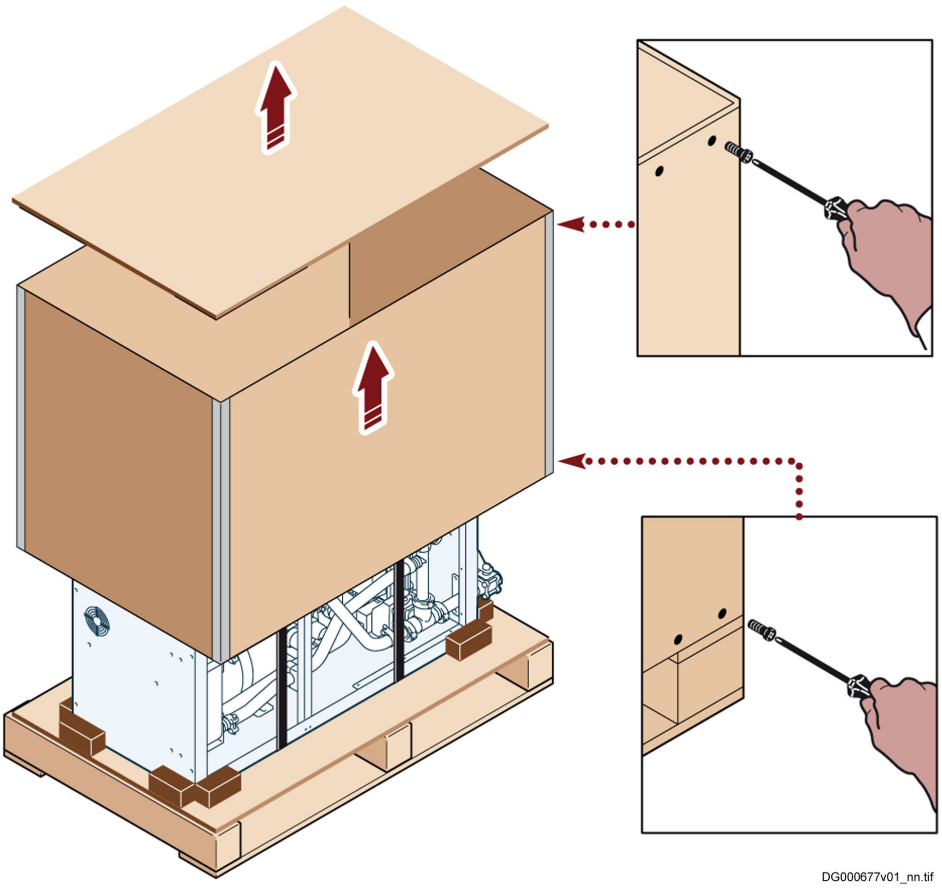
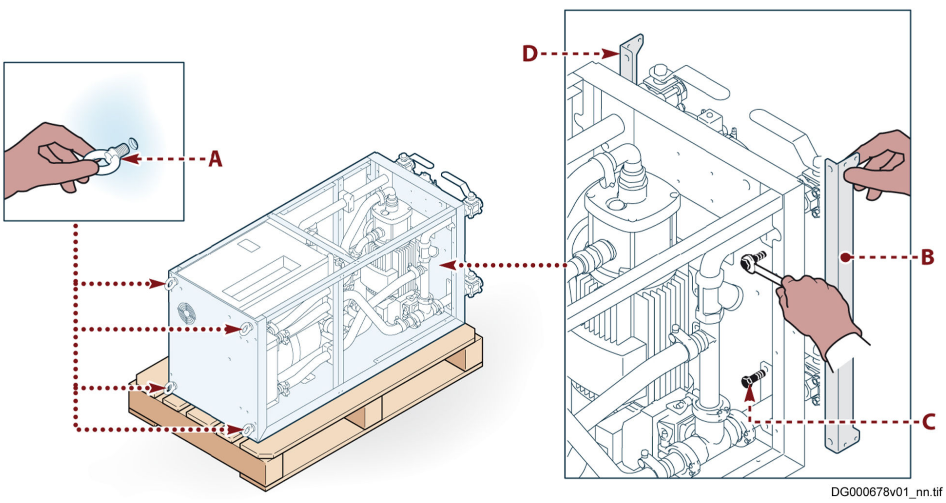
Avoid storing the machine in places where weather conditions could prejudice its good working order.

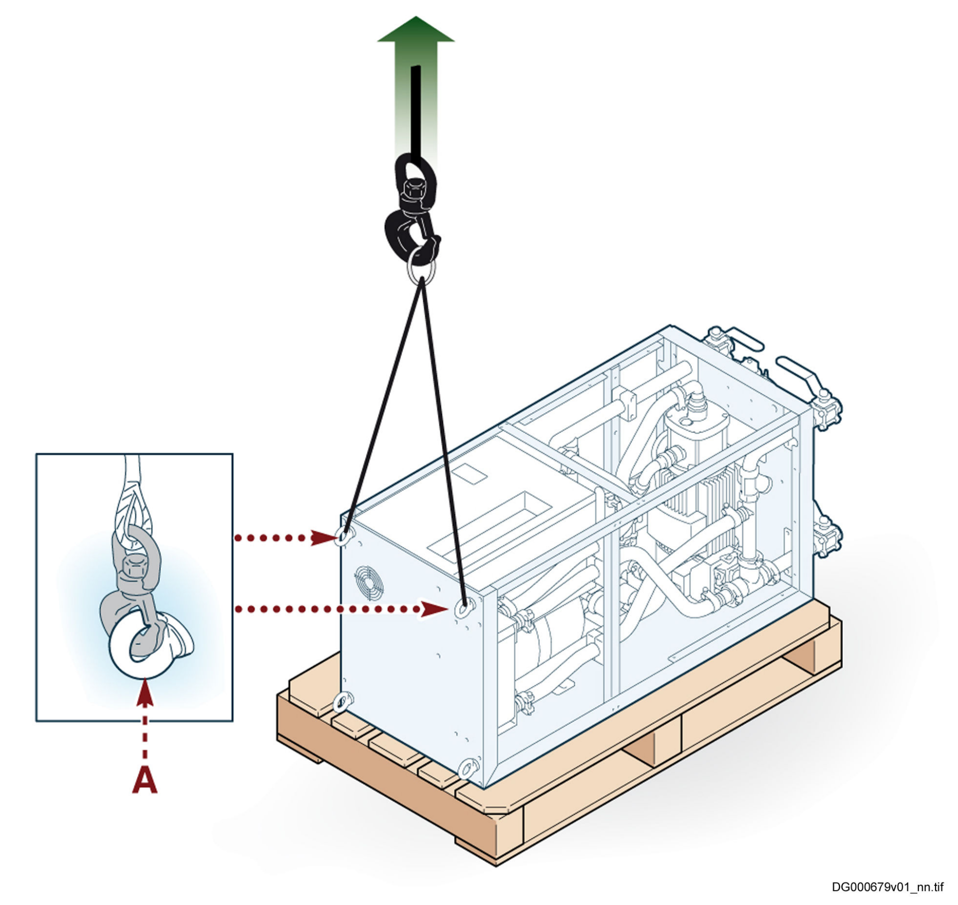
Unpacking

It is advisable to unpack the machine near the installation area to facilitate assembly.

The figure shows how to unpack the machine properly.

Proceed as outlined below.

1	Unscrew the screws.	
2	Remove the cover.	
3	Lift the side walls of the package.	
4	Remove the locking items and the straps.	
5	Screw in the eyebolts (**A**).	
6	Position the bracket (**B**).	
7	Tighten the screws (**C**).	
8	Fit the bracket (**D**) with the relevant screws.	

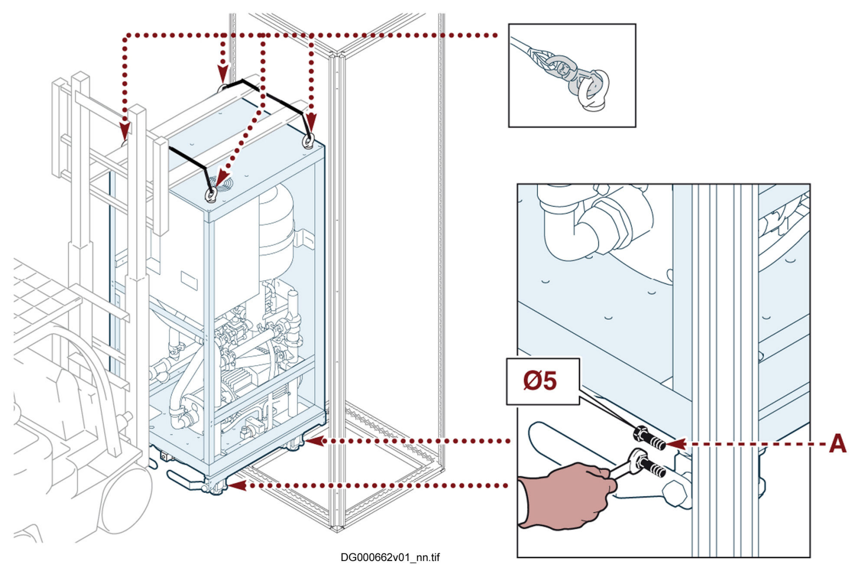
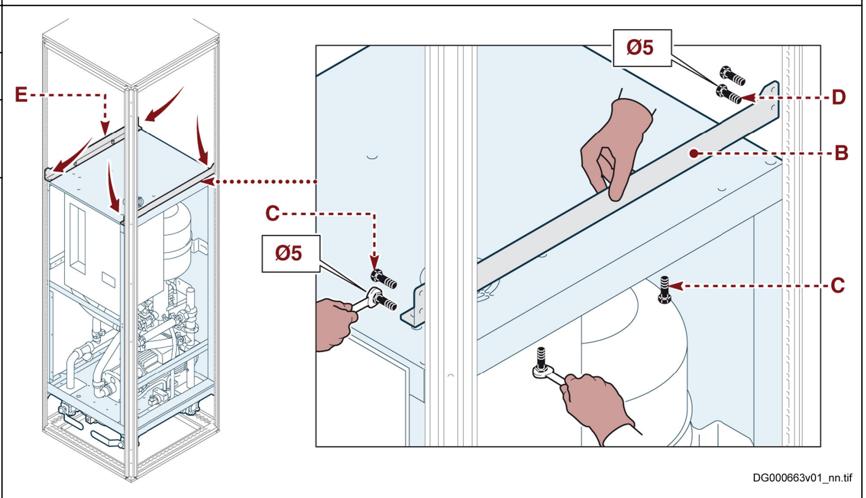
9	Hook the ropes onto the eyebolts (**A**).	
10	**WARNING!** When lifting pay attention to the machine swinging movement as the lifting point is never perfectly barycentric; sudden movements may injure the people involved in the operations. Remove the machine. The packaging material (wood, propylene, etc,.) can be kept for future use or properly disposed of according to the regulations in force.	

Tab. 8-97: Unpacking

Assembling the machine

The installation area must be provided with electrical connections and connections for transmission of machine enabling/status signals.

Carry out the operations described.

1	Strap up the machine as shown in the figure.	
2	Lift the machine and place it in the installation area.	
3	Screw in the self-tapping screws (**A**) to lock the machine onto the support.	
4	Lock the machine in the same way on the opposite side.	
5	Unscrew the eyebolts.	
6	Position the bracket (**B**).	
7	Tighten the screws (**C**).	
8	Screw in the self-tapping screws (**D**).	
9	Fit the bracket (**E**) in the same way.	

Tab. 8-98: Assembling the machine

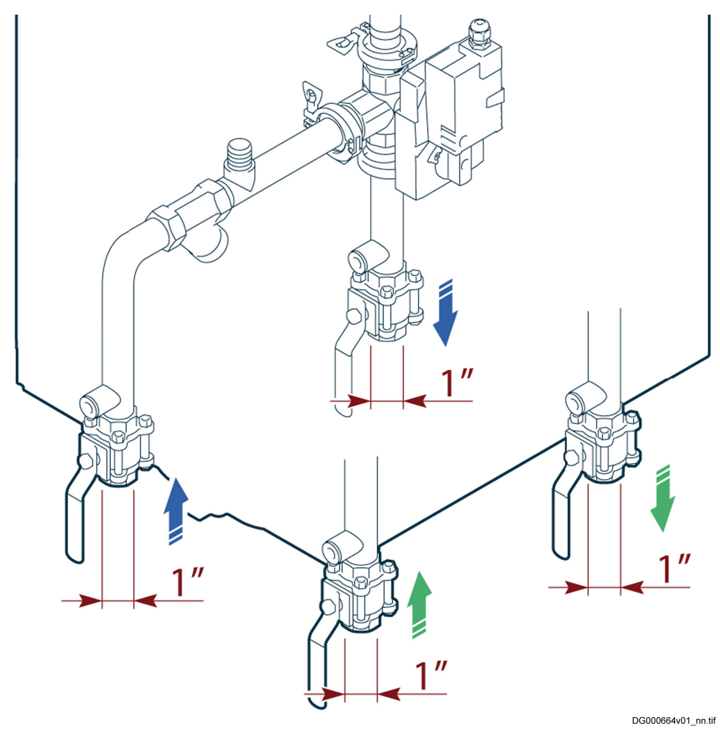
Electrical connection

The electrical connections must be performed at professional standards in compliance with all legislative requirements and regulations.

Use a 4 G-AWG 12 cable (three-phase conductors + earth conductor).

Connect the three phases (L1, L2, and L3) and the earth wire to the relevant terminals inside the electrical panel.

Hose connections

The owner must install devices to adjust the pressure and discharge in the input pipe of the customer side circuit and in the return pipe of the drive circuit. Adjust the pressure in the input and return pipes to the value shown in chapter "Specifications" on page 294. Use flexible tubes with an internal diameter of not less than 25 mm. Use connectors with an internal diameter of not less than 20 mm.	

Tab. 8-99: Hose connections

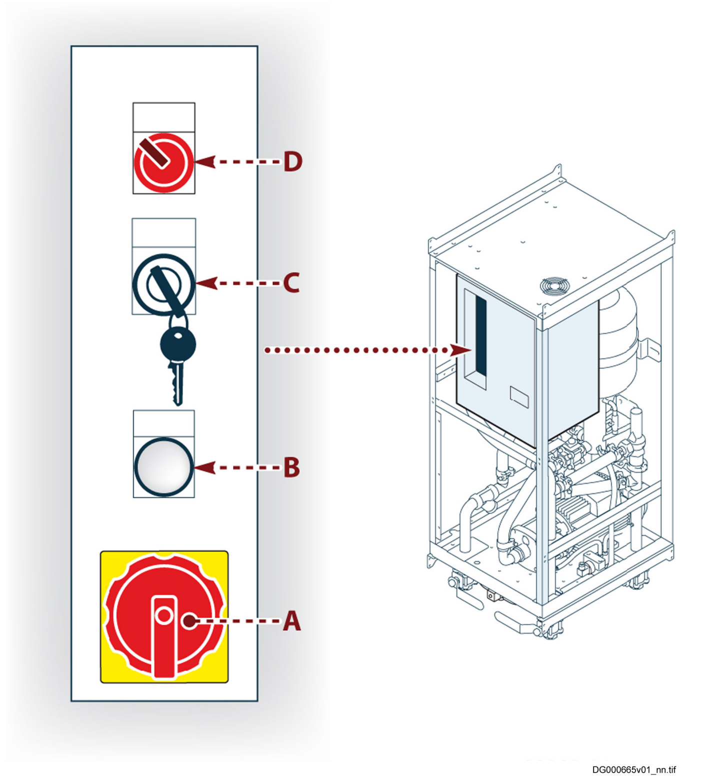
Information for Use

Safety advice concerning use

Before starting the machine, make sure that the system or machine in which it has been fitted is in compliance with local regulations and directives in force.

Description of the controls and signal lights

A	**Main disconnect switch:** it is used for connecting and disconnecting the power supply to machine. The indicator lamp (**B**) lights up.
B	**Indicator lamp (white light):** indicates that the power supply to the machine is enabled.
C	**Key-operated two-position stay-put selector switch:** this is used to enable “service” and “automatic” operation modes. The key must be kept by the designated staff member and available to the staff responsible for technical servicing.
D	**Two-position stay-put back-lit switch (red light):** this is used to switch the filling pump on and off.

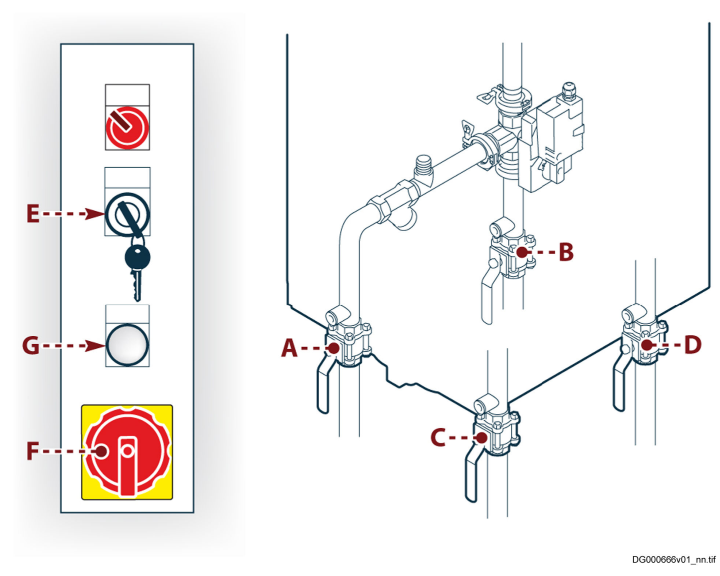


Tab. 8-100: Information and safety signs

Starting procedure

When starting the machine for the first time fill the drive circuit (see chapter "Procedure to fill the drive circuit" on page 310).

To start the machine, proceed as described.

1	Open the ball valves (**A - B - C - D**).	
2	Make sure that there is fluid flowing through the customer side circuit.	
3	Turn the main disconnect switch (**F**) to the "ON" position. The indicator lamp (**G**) lights up.	
4	Turn the key selector (**E**) to "automatic" position. Machine start-up must be performed using the operating terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR and UNIT WARNING connections" on page 296).	

Tab. 8-101: Starting procedure

Stopping procedure

Stopping with the main switch

1. Turn the main cut-off switch (A) to the "OFF" position.

- The signal light (B) will switch off.
- Machine operation stops and the electricity supply to the electrical panel is interrupted.
- The terminals for the connection to the mains remain live.

Stopping with the key-operated switch

This stop mode is reserved for authorised personnel.

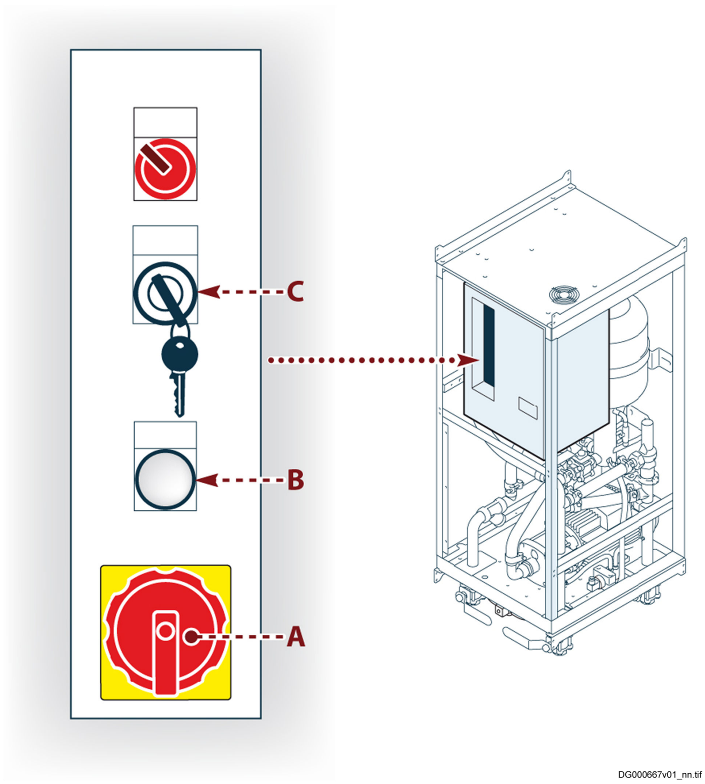
1. Insert the key into the selector switch (C).
2. Turn the selector switch to the "Service" position.

- Operation of the main pump stops.
- The electrical panel on the machine remains live.

Remote-controlled stopping

Remote-controlled stopping must be performed using the owner's operating terminal, via the "ENABLE" connection.

- Operation of the main pump stops.
- The electrical panel on the machine remains live.



Tab. 8-102: Stopping procedure

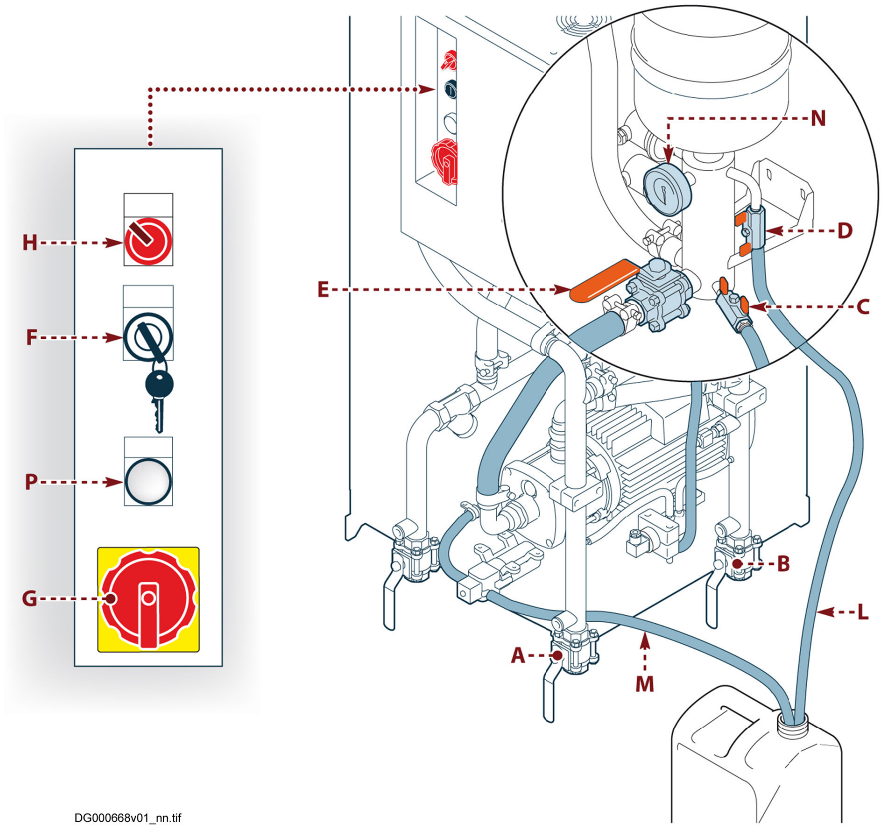
Stopping in emergency conditions

To stop the appliance in the event of imminent danger (emergency stop), turn the main cut-off switch (A) to the "OFF" position.

Eliminate the cause of the emergency stop before re-starting the machine.

Procedure to fill the drive circuit

Check that the installation, electrical connections and hydraulic connections are made to a professional standard in accordance with the manufacturer's instructions.



DG000668v01_nn.tif

1	Fill a tank with an appropriate amount of fluid solution (see chapter "Specifications" on page 294).
2	Fit the pipes (**L** - **M**) into the tank.
3	Open the ball valve (**A**).
4	Open the ball valve (**B**).
5	Open the valve (**C**).
6	Open the valve (**D**).
7	Open the valve (**E**).
8	Turn the key-operated selector switch (**F**) to "service" to prevent unexpected activation of the main pump.
9	Make sure that the remote-controlled "ENABLE" function is activated.
10	**NOTICE!** Do not turn the selector switch (F) to "automatic" as this could cause damage to the main pump. Open any of the valves installed outside the machine on the circuit for the machine to be cooled.
11	Turn the main cut-off switch (**G**) to the "ON" position. The indicator lamp (**P**) lights up.
12	Turn the selector switch (**H**) to activate the filling pump. Always keep the fluid in the tank at a sufficient level.
13	Close the valve (**D**) when the fluid is running out of the clear tube (**L**) in a steady stream (no bubbles) and the pressure has reached 1,5 bar. The pressure is shown by the pressure gauge (**N**).
14	Open the valve (**D**).
15	Turn the key-operated selector switch (**F**) to "automatic" to activate the main pump.

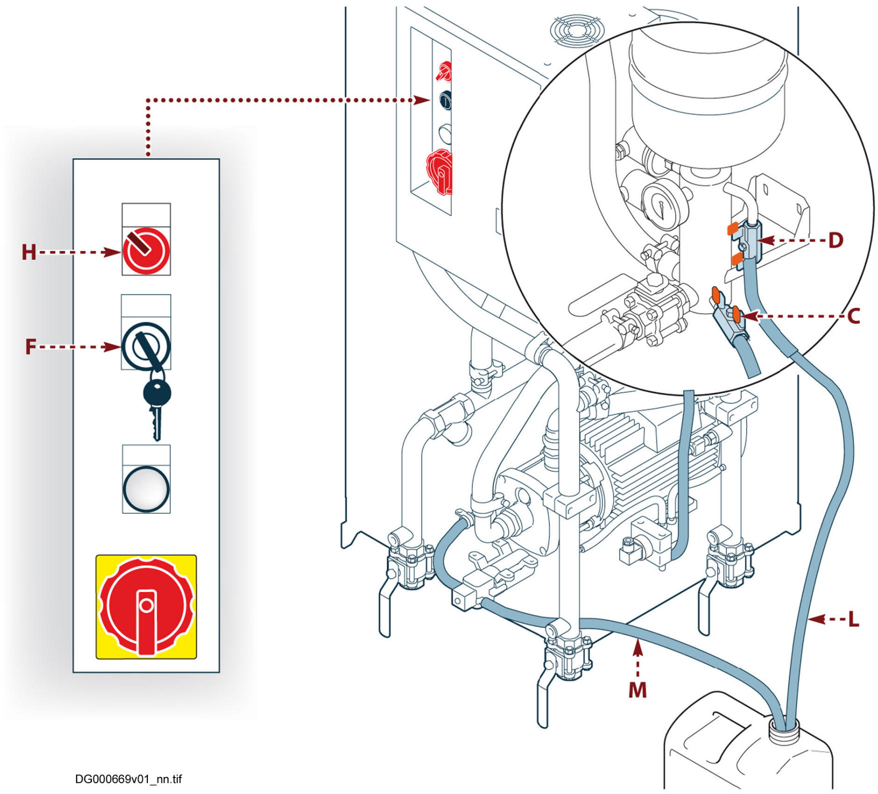
16	**NOTICE!** The main pump is activated only when the circuit pressure reaches over 0,2 bar. During this stage, a sudden drop in pressure may occur, caused by the air pumped into the circuit as a result of activation of the main pump. Turn the main pump on and off, from time to time, using the selector switch (F) to facilitate circuit bleeding and pressurisation. Make sure that the key-operated switch is set to "automatic". If it is hard for the system to get up to pressure, close the valve (D). If the pressure exceeds 1,5 bar, turn off the filling pump and temporarily open the spigot (D) until the correct pressure is reached. Turn the selector switch (**H**) to deactivate the filling pump.
17	Close the valve (**C**).
18	Remove the pipes from the tank.
19	Remove the key from the selector switch (F) and store in a safe place. After one hour of operation, check that the pressure is correct, and if it is not carry out the restore procedure (see chapter "Pressure restore procedure" on page 312).

Tab. 8-103: Procedure to fill the drive circuit

Pressure restore procedure

This procedure can be carried out only if the pressure is above 0,8 bar and the main pump is activated.

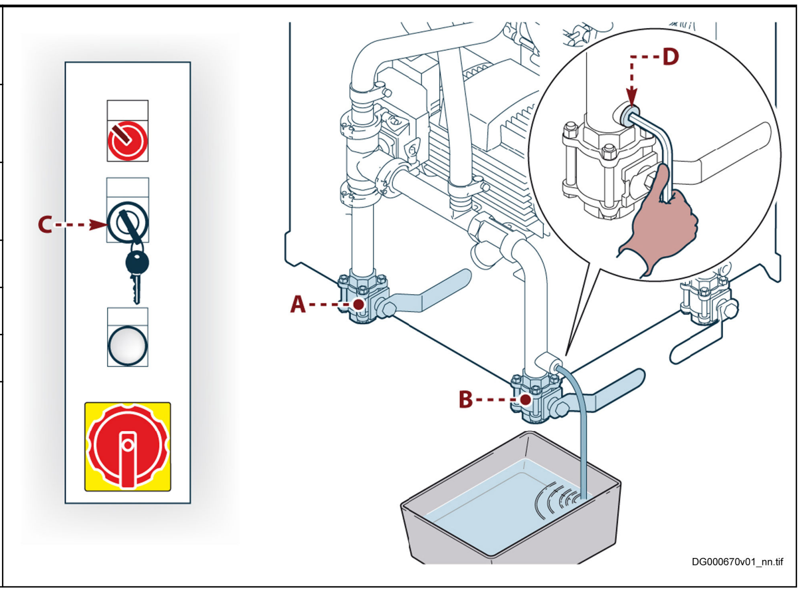
If the pressure is below this level, carry out the circuit filling procedure (see chapter "Procedure to fill the drive circuit" on page 310).

1	Fill a tank with an appropriate amount of fluid solution (see chapter "Specifications" on page 294).	
2	Fit the pipes (**L** - **M**) into the tank.	
3	Open the valve (**C**).	
4	Turn the selector switch (**H**) to activate the filling pump.	
5	Open the spigot (**D**) and keep open until the fluid is running out of the clear tube (**L**) in a steady stream (no bubbles) and the pressure has reached 1,5 bar.	
6	**NOTICE!** If the pressure exceeds 1,5 bar, turn off the filling pump and temporarily open the valve (D) until the correct pressure is reached. Turn the selector switch (**H**) to deactivate the filling pump.	
7	Close the valve (**C**).	
8	Remove the pipes from the tank.	
9	Remove the key from the selector switch (**F**) and store in a safe place.	

Tab. 8-104: Pressure restore procedure

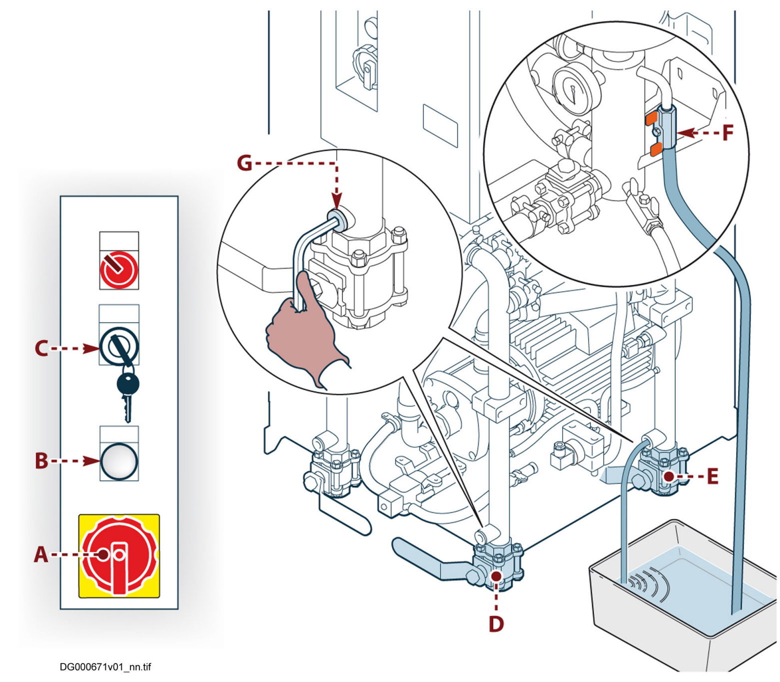
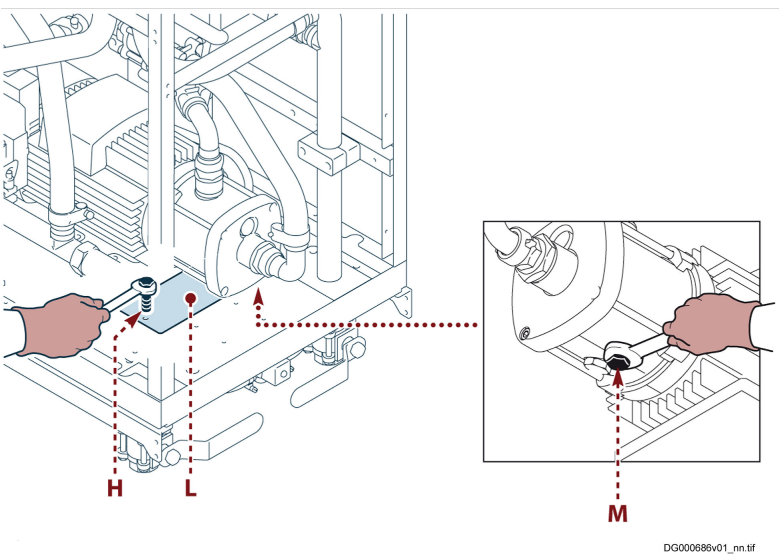
Customer side circuit drainage procedure

1	Position a suitable container in which to collect the coolant.
2	Stop the machine (see chapter "Stopping procedure" on page 309).
3	Turn the key selector (**C**) to "Service" position.
4	Close the ball valves (**A** - **B**).
5	Unscrew cap (**D**).
6	Drain out all the coolant.
7	Screw on the cap (**D**). **NOTICE!** Do not dump the coolant; dispose of it in accordance with the laws in force.



Tab. 8-105: Customer side circuit drainage procedure

Drive circuit drainage procedure

1	Position a suitable container in which to collect the coolant.	
2	Stop the machine (see chapter "Stopping procedure" on page 309).	
3	Turn the key selector (**C**) to "Service" position.	
4	Turn the main cut-off switch (**A**) to the "OFF" position.	
5	The signal light (**B**) will switch off.	
6	Close the ball valves (**D - E**).	
7	Open the valve (**F**).	
8	Unscrew caps (**G**).	
9	Drain out all the coolant.	
10	Close the valve (**F**).	
11	Screw on the caps (**G**).	
12	Unscrew the screws (**H**).	
13	Remove the fixed guard (**L**).	
14	Unscrew the cap (**M**) and allow the liquid to flow out from the main pump.	
15	Screw on the cap (**M**).	
16	Put the fixed guard (**L**) back in place.	
17	Tighten the screws (**H**). **NOTICE!** Do not dump the coolant; dispose of it in accordance with the laws in force.	

Tab. 8-106: Drive circuit drainage procedure

Maintenance Information

Safety advice for maintenance

For personal safety reasons, before conducting maintenance interventions, check that all safety devices are activated and warn the people present in the workplace that such intervention is underway.

In particular, disconnect the power supply to the machine.

Make sure that the electricity cannot be accidentally restored.

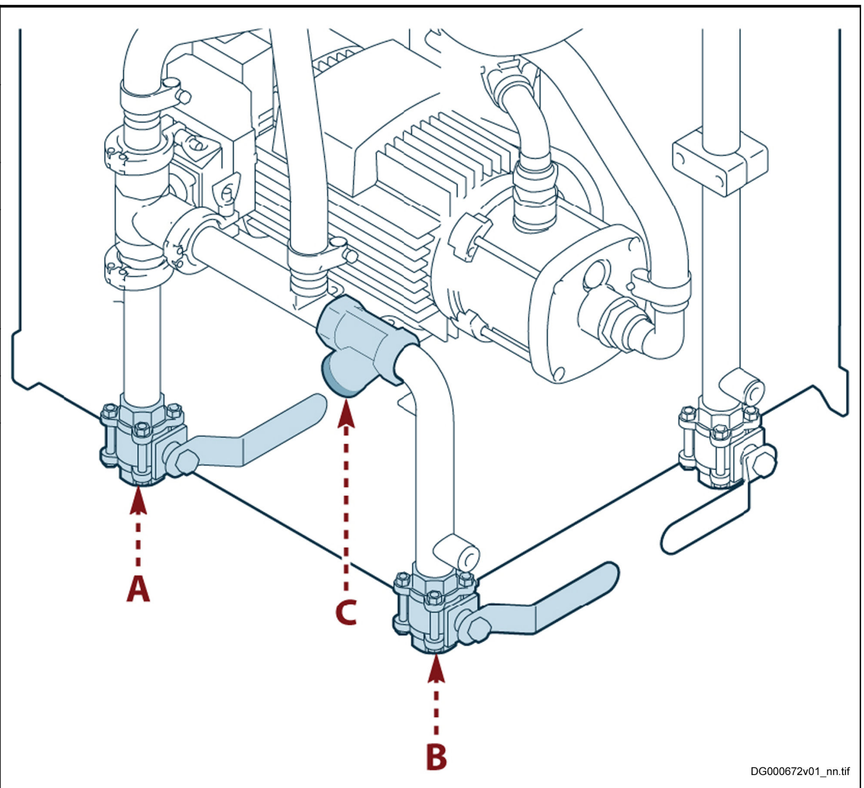
The operator must allow the machine to cool down before carrying out any intervention to prevent scalds or burns.

Scheduled maintenance chart

Interval		Component	Type of work	Reference
Every 1600 hours of work	Every 30000 hours of work	–	–	–
✓	–	Filter	Cleaning	See chapter "Cleaning the customer side circuit filter" on page 315
–	✓	Main pump	Replacement	See chapter "Replacing the main pump" on page 319
–	✓	Coolant	Replacement	

Tab. 8-107: Scheduled maintenance chart

Cleaning the customer side circuit filter

1	Drain the liquid from the customer side circuit.	
2	Close the inlet and outlet ball valves (**A** - **B**).	
3	Unscrew cap (**C**).	
4	Remove and wash the filter. Do not use aggressive, flammable or toxic detergents.	
5	Position the filter.	
6	Screw on the cap. (**C**).	
7	Open the ball valves (**A** - **B**).	

Tab. 8-108: Cleaning the customer side circuit filter

Machine cleaning

Clean the machine with detergents allowed by the legislation in force.

Breakdown Information

The following list contains a number of common problems that may arise during work, together with the ways to solve them.

Code	Type	Fault	Likely cause	Solution
E2011	Warning 1	Low pressure	The circuit pressure is below 0,5 bar (in Drive side)	Pressurise the circuit to 1,5 bar
E2012	Warning 2	The machine does not start	Pump CP-1 does not start in the speed check mode	Make sure the system is in a "AF" status before enabling
E2013	Warning 3	The machine does not maintain the set point temperature	The 3MV-1 3-way mixing valve may have a mechanical fault or the electrical connection cable may be broken The level of thermal output to be dissipated is higher than the machine’s rated thermal input	Check the 3MV-1 mixing valve Reduce the thermal output
E2014	Warning 4	Outlet fluid temperature too high	The fluid temperature at the outlet is higher than the set point temperature (T_set) plus a ΔT defined by parameter P-0-1380 for a given time, defined by parameter P-0-1381 (see IndraDrive programming)	If necessary, change the P-0-1380 and/or P-0-1381 parameters
F2011	Error 1	Low pressure alarm	The circuit pressure is below 0,2 bar (in Drive side)	Pressurise the circuit to 1,5 bar
F2012	Error 2	High temperature alarm	The fluid temperature (in the Drive side) is above the maximum allowed temperature limit (see parameter P-0-1382)	If necessary, change the P-0-1382 parameter

Tab. 8-109: Errors and Warnings

Information Concerning Replacements

Safety advice in case of replacements

For personal safety reasons, before conducting maintenance interventions, check that all safety devices are activated and warn the people present in the workplace that such intervention is underway.

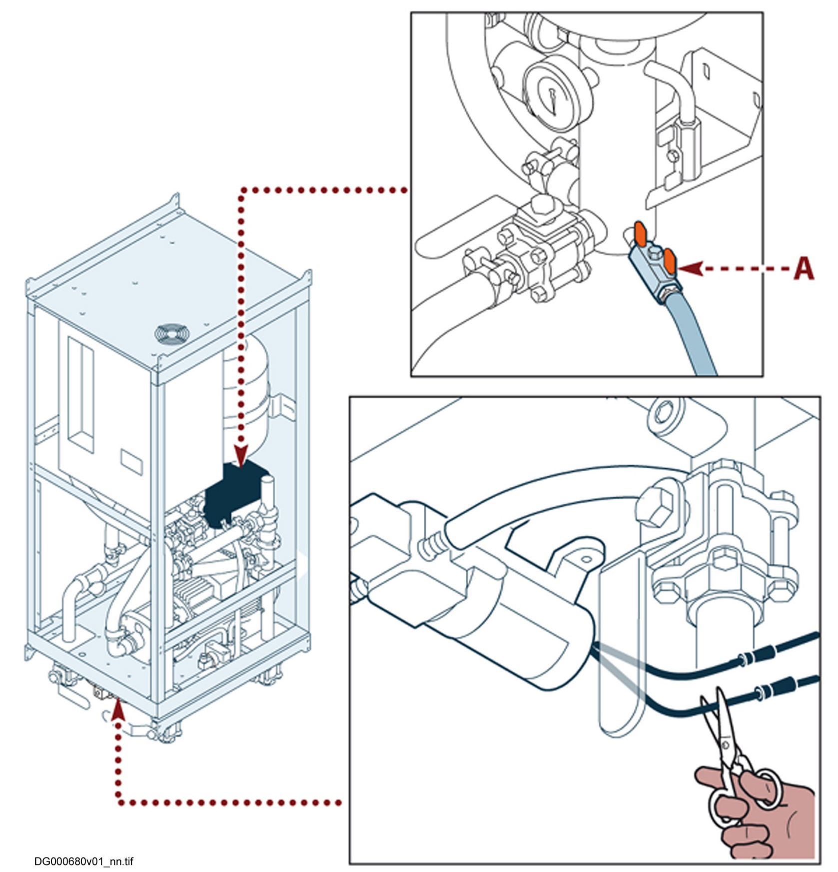
In particular, disconnect the power supply to the machine.

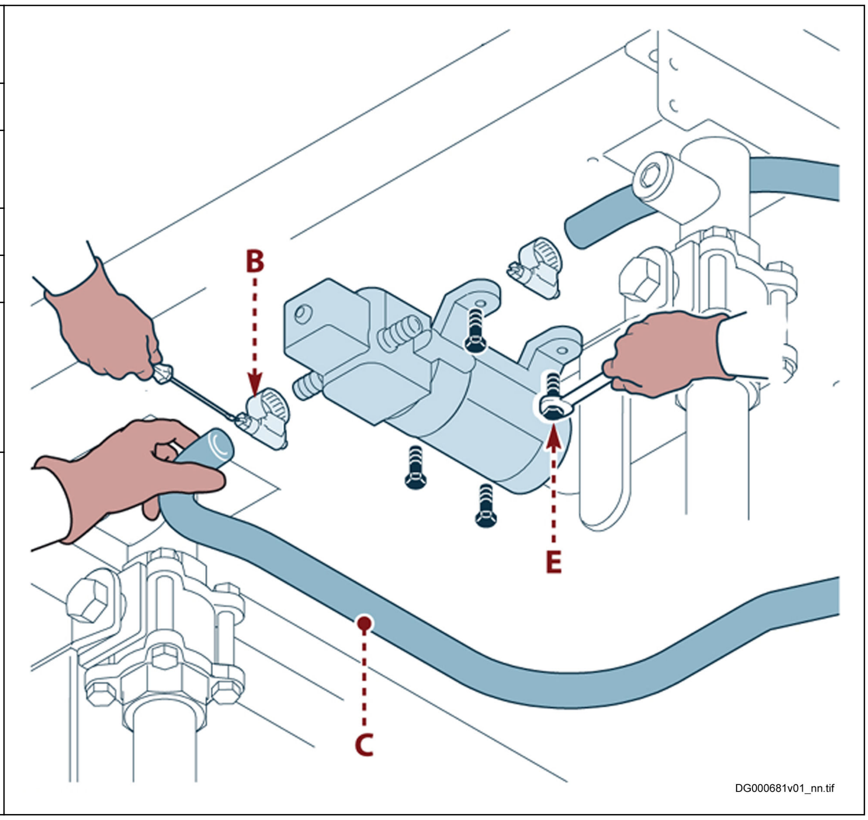
Make sure that the electricity cannot be accidentally restored.

The operator must allow the machine to cool down before carrying out any intervention to prevent scalds or burns.

Replace worn or damaged parts with original spare parts.

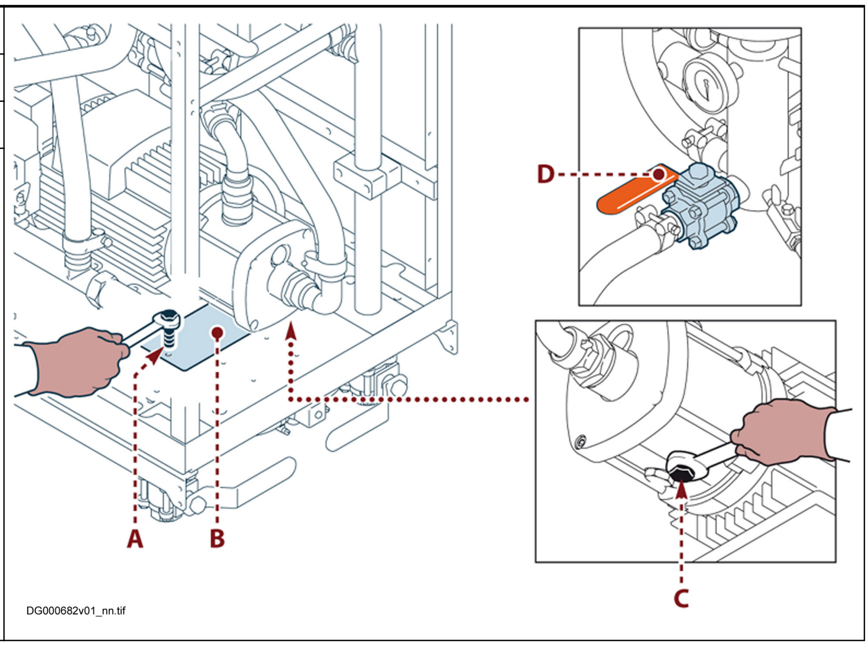
Replacing the filling pump

1	Close the valve (A).	
2	Cut the power supply cables.	

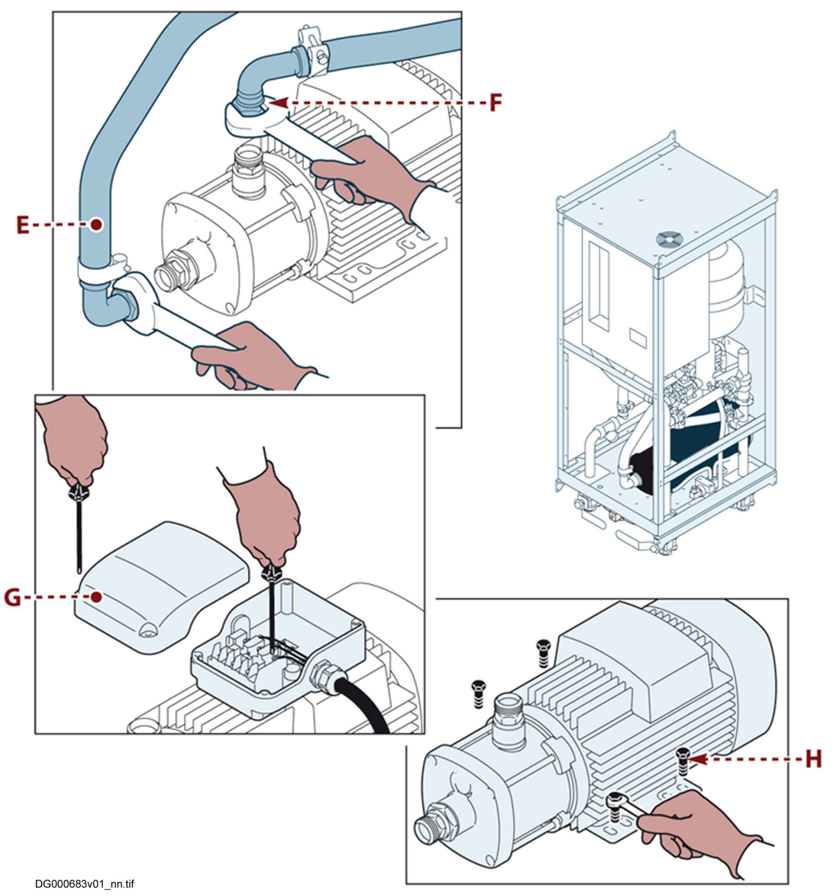
3	Undo the screw and remove the strap (**B**).	
4	Extract the hose (**C**).	
5	Repeat the same operations to remove the other flexible tube.	
6	Unscrew the screws (**E**).	
7	Remove the pump.	
8	Install the new pump. To fit the new pump carry out the removal operations described in reverse order.	
9	Fill the drive circuit (see chapter "Procedure to fill the drive circuit" on page 310).	

Tab. 8-110: Replacing the filling pump

Replacing the main pump

1	Close the valve (**D**).	
2	Unscrew the screws (**A**).	
3	Remove the fixed guard (**B**).	
4	Unscrew cap (**C**).	

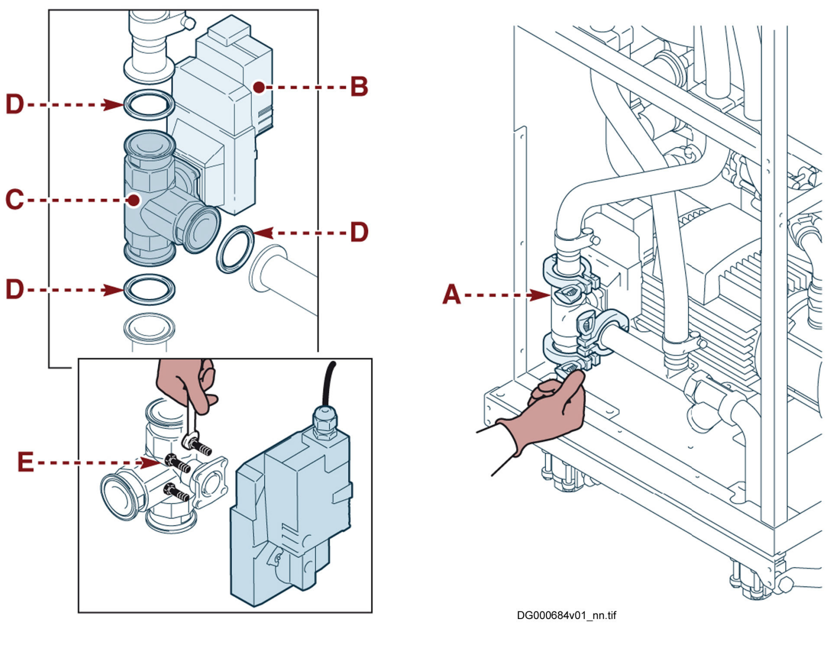
5	Disconnect the hosing (**E**).
6	Disconnect the hosing (**F**).
7	Remove the cover (**G**).
8	Disconnect the cables from the terminals.
9	Unscrew the screws (**H**).
10	Remove the pump.
11	Install the new pump. To fit the new pump carry out the removal operations described in reverse order.
12	Fill the drive circuit (see see chapter "Procedure to fill the drive circuit" on page 310).



Tab. 8-111: Replacing the main pump

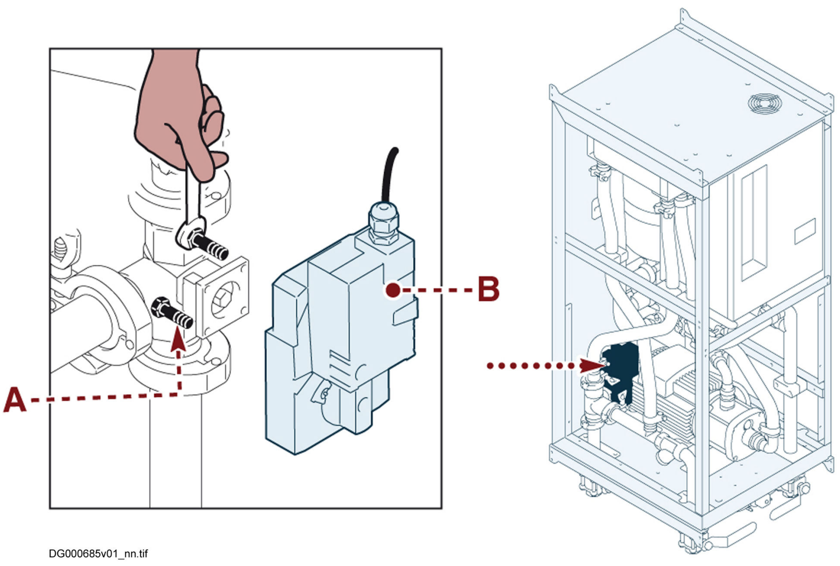
Replacing the mixing valve

1	Unscrew the collars (**A**).
2	Remove the valve (**B**) and the actuator (**C**).
3	Remove the gaskets (**D**).
4	Unscrew the screws (**E**).
5	Separate the valve from the actuator.
6	Join the new valve to the actuator.
7	Position the gaskets (**D**). Replace the gaskets if damaged or worn.
8	Place the valve and actuator in their position.
9	Screw in the collars (**A**). To fit the new valve carry out the removal operations described in reverse order.



Tab. 8-112: Replacing the mixing valve

Replacing the actuator

<table>
<tr><td>1</td><td>Disconnect the electricity supply cables from the actuator (see wiring diagram enclosed).</td><td rowspan="3">
</td></tr>
<tr><td>2</td><td>Unscrew the screws (A).</td></tr>
<tr><td>3</td><td>Remove the actuator (B).
To fit the new actuator carry out the removal operations described in reverse order.</td></tr>
</table>

Tab. 8-113: Replacing the actuator

Replacing the fuses

Before replacing the fuse, remove the cause of the problem.

Replace the interrupted fuse only with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Fuses description" on page 297.

Scrapping and disposal

Scrapping operations must be handled by specialised personnel with suitable skills for the job.

When dismantling the machine, all components must be collected separately for disposal according to their chemical properties, in accordance with the relevant regulations in force.

With reference to European Directive (RAEE), electric and electronic components must be either disposed of in authorized landfill sites, or, in case of a new purchase, the machine, complete of the said parts, must be returned to the dealer.

The owner is responsible for delivering the machine, at the end of its working life, to the appropriate collection structures; failure to comply shall lead to penalties foreseen by the regulations in force.

Hydraulic diagrams

WW0035K-0090 Hydraulic diagram

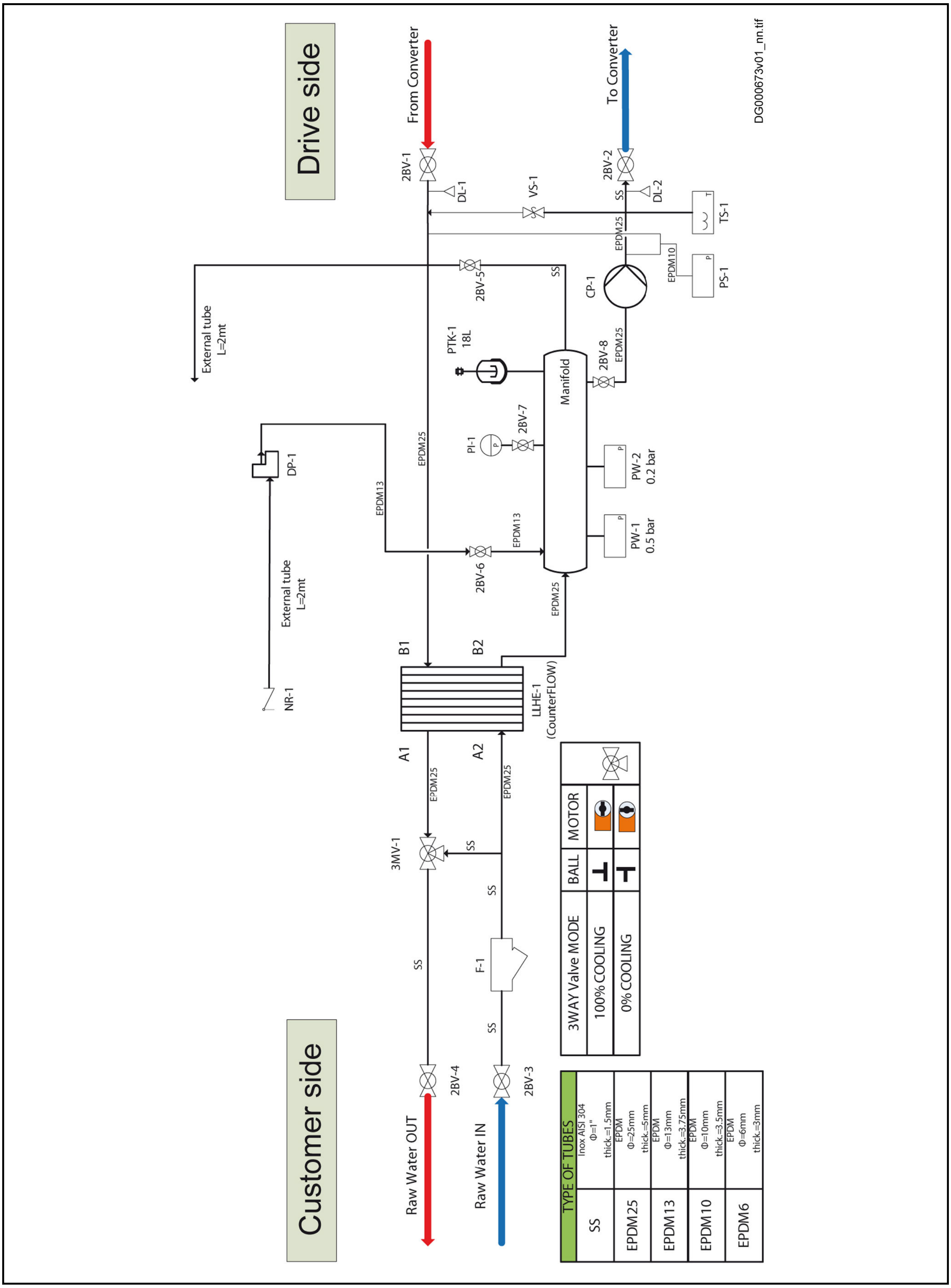


Fig. 8-81: WW0035K-0090 Hydraulic diagram

Designation	Description
PW-1	Pressure Switch 0,5 bar
VS-1	Safety Valve 2 bar
PW-2	Pressure Switch 0,2 bar
PI-1	Pressure Indicator 0 … 4 bar
PTK-1	18L Expansion Vessel
PS-1	Diff. Pressure Sensor 0 … 6 bar; Out: 0 … 10 V
CP-1	Main Pump 400 Vac 50/60 Hz CM5-5
LLHE-1	Water-Water Heatexchanger
TS-1	Temperature Sensor Pt100
-	Pt100 Converter - Out: 0 … 10 V (M12)
DP-1	24Vdc Pressurization Pump
3MV-1	3 Way Valve Actuator
NR-1	One-Way Valve

Tab. 8-114: Designations

WW0008K-0020 Hydraulic diagram

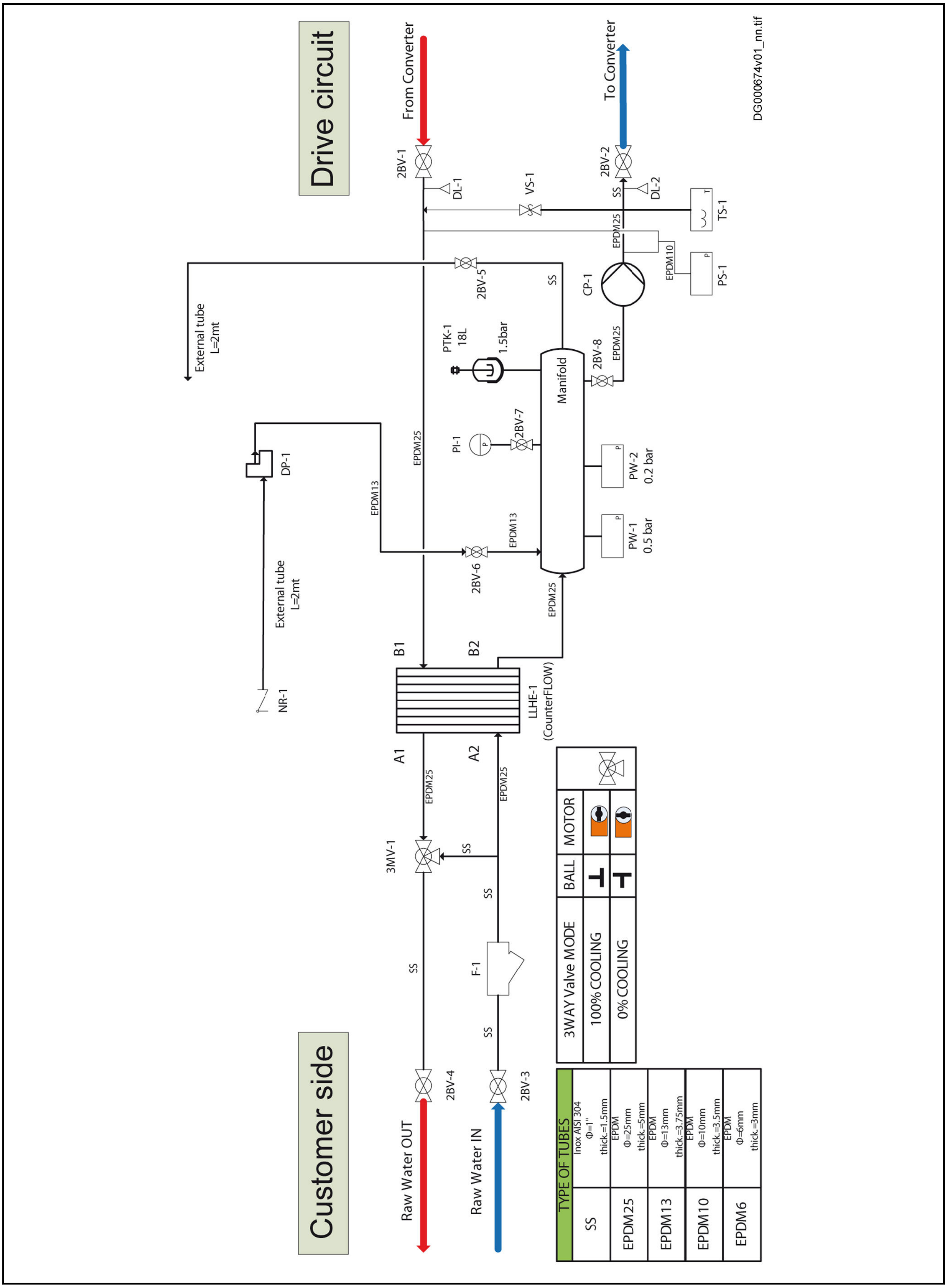


Fig. 8-82: WW0008K-0020 Hydraulic diagram

Designation	Description
PW-1	Pressure Switch 0,5 bar
VS-1	Safety Valve 2 bar
PW-2	Pressure Switch 0,2 bar
PI-1	Pressure Indicator 0 … 4 bar
PTK-1	18L Expansion Vessel
PS-1	Diff. Pressure Sensor 0 … 6 bar; Out: 0 … 10 V
CP-1	Main Pump 400 Vac 50/60 Hz CM1-4
LLHE-1	Water-Water Heatexchanger
TS-1	Temperature Sensor Pt100
-	Pt100 Converter - Out: 0 … 10 V (M12)
DP-1	24 Vdc Pressurization Pump
3MV-1	3 Way Valve Actuator
NR-1	One-Way Valve

Tab. 8-115: Designations

Air-Liquid Heat Exchanger

Technical Information

General description of the machine

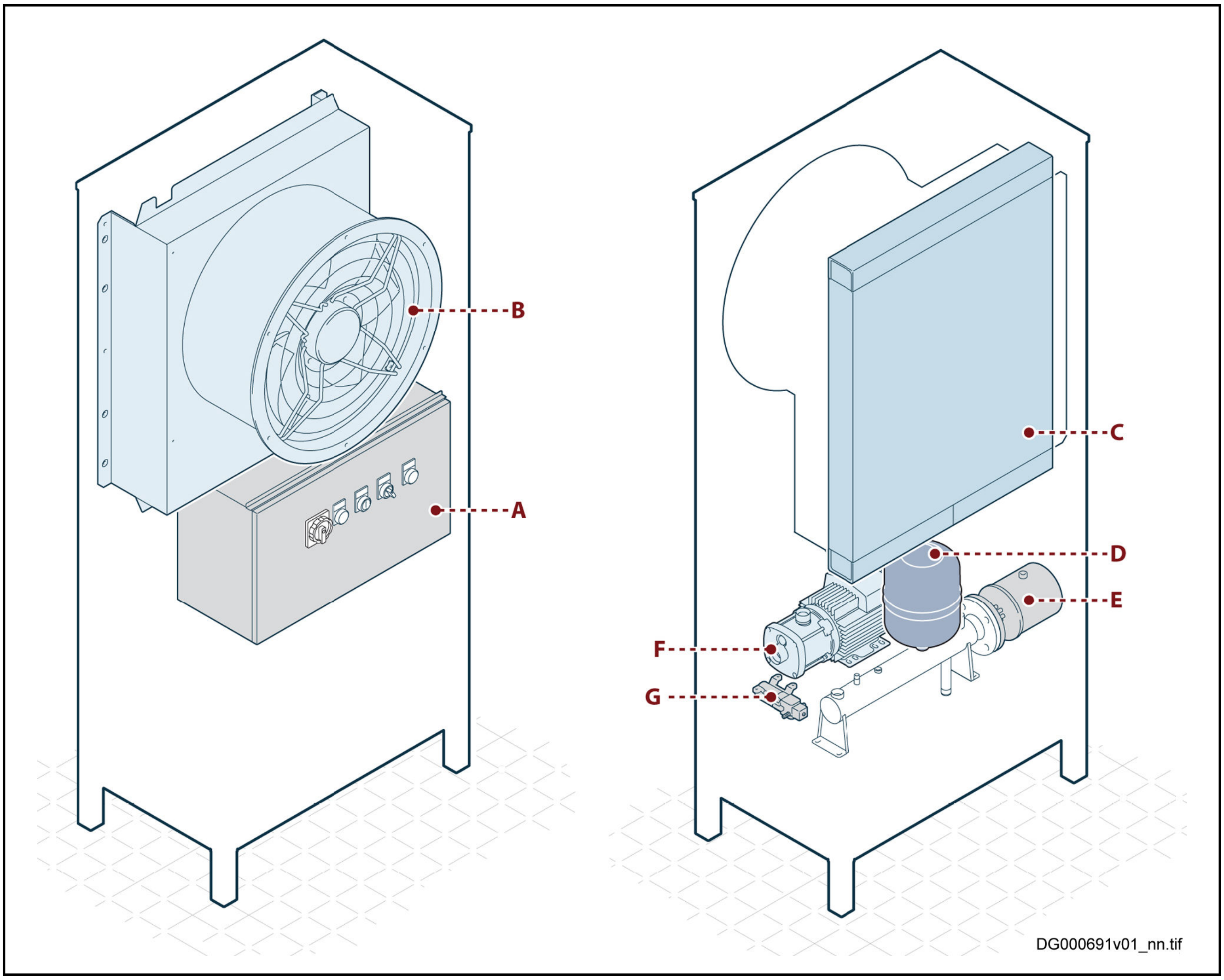
The machine is designed and manufactured for the purpose of cooling devices or equipment by means of a liquid solution made of glycol and demineralised water.

The underlying principle of the cooling method is the exchange of heat between air and liquid through a heat exchanger.

The fluid is circulated by a pump inside the radiator and cooled by the air flow generated by an electric fan.

The machine can be equipped with a heater to increase the temperature of the ingoing liquid.

Main parts

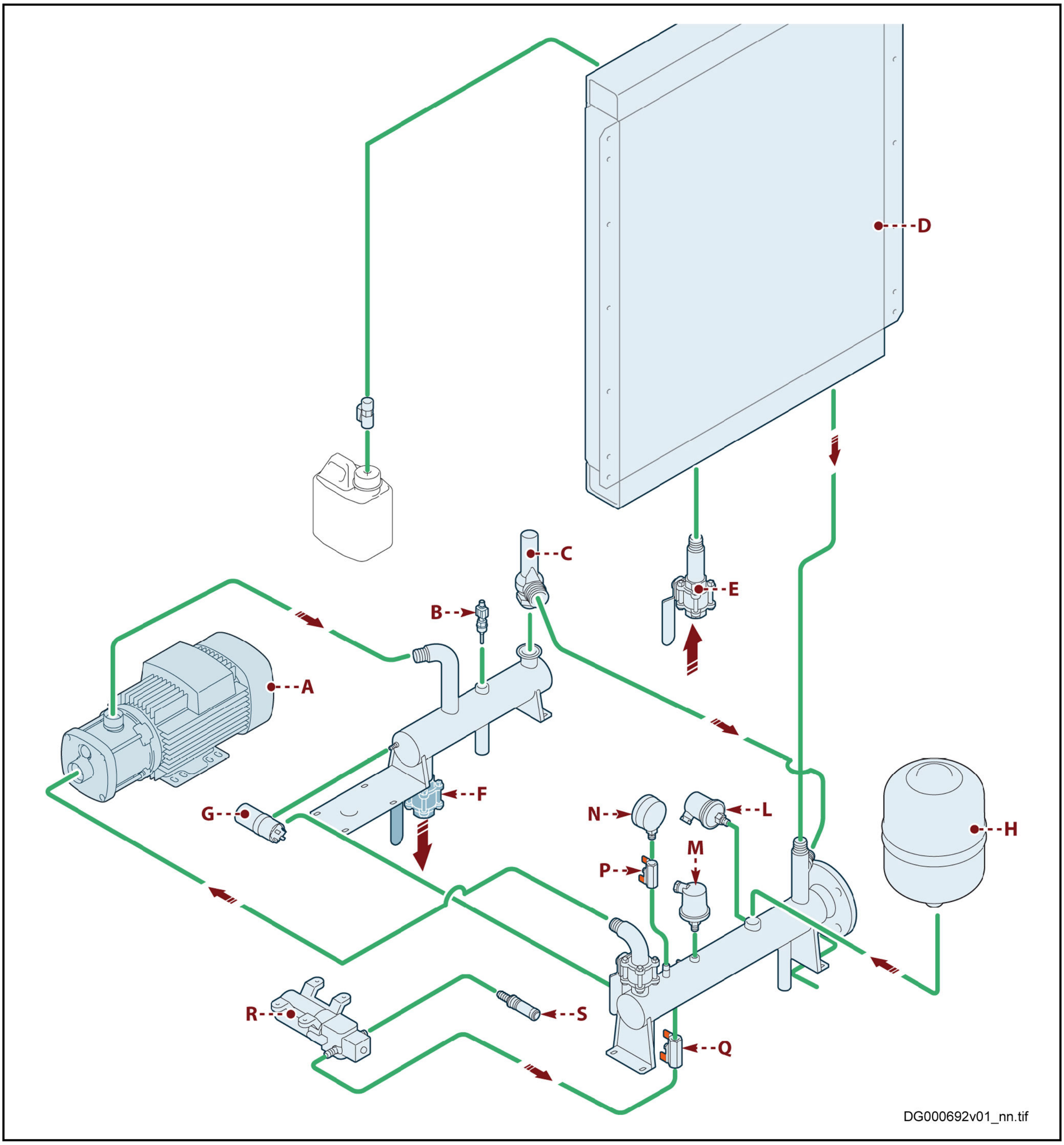


A	Electrical panel
B	Electric fan
C	Heat exchanger
D	Expansion tank
E	Heater
F	Main pump
G	Filling pump

Fig. 8-83: Main parts

Operational cycle and component description

The illustration shows the operating principle.



A Main pump: this is used to circulate the coolant around the hydraulic circuit.

B **Temperature sensor:** this detects the coolant temperature in the outlet pipe.

C **By-pass valve:** it limits the pressure of the output liquid.

D **Heat exchanger:** this is used to lower the temperature of the coolant.

E **Ball valve:** it opens and closes the flow of the coolant from the owner’s system.

F **Ball valve:** it opens and closes the flow of the coolant towards the owner’s system.

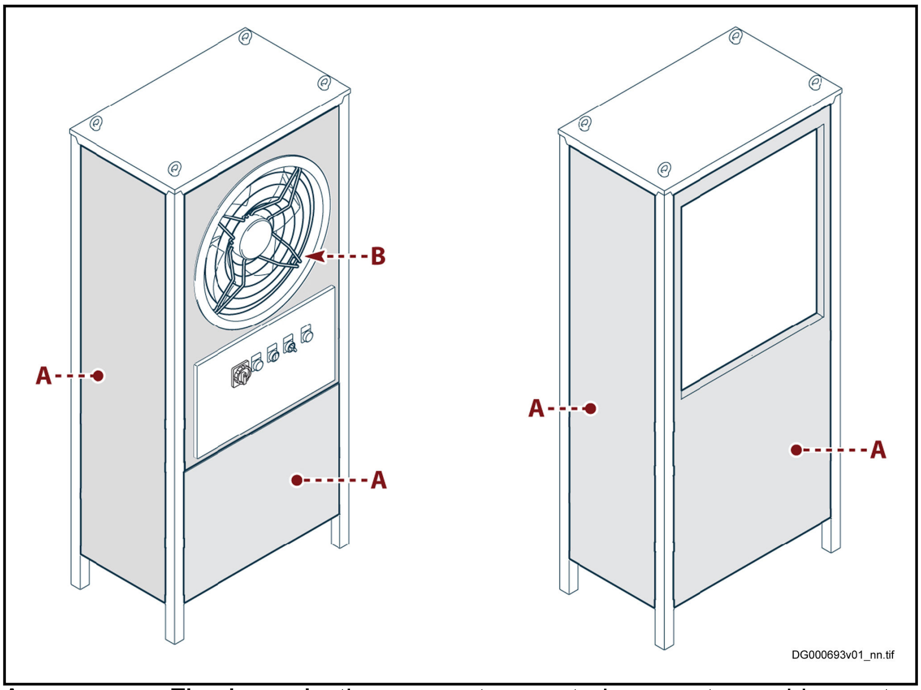
G	**Pressure sensor:** this detects, in real time, the differential pressure between the intake pipe and the output pipe.
H	**Expansion tank:** this is used to ensure constant circuit pressure.
L	**Pressure switch (0,2 bar):** this detects the pressure level in the intake manifold.
M	**Pressure switch (0,5 bar):** this detects the pressure level in the intake manifold.
N	**Pressure gauge:** this is used to detect the liquid pressure in the intake manifold.
P	**Valve:** this is used to open and close the flow to the pressure gauge (**N**).
Q	**Valve:** this is used to open and close the flow from the filling pump.
R	**Filling pump:** it fills the cooling circuit of the owner’s equipment.
S	**Check valve:** this is used to stop the filling pump intake pipe draining.

Fig. 8-84: Operational cycle and component description

Guards

⚠ WARNING **Risk of injury.**

Never use the machine without the fixed guards.



A	**Fixed guards:** they prevent unwanted access to machine parts.
B	**Fixed guard:** this prevents inadvertent contact with the fan.

Fig. 8-85: Guards

Overpressure devices

The owner is required to install a safety device, on the return pipe to the machine, that keeps the system pressure within the maximum limit of 2 bar.

Overall dimensions

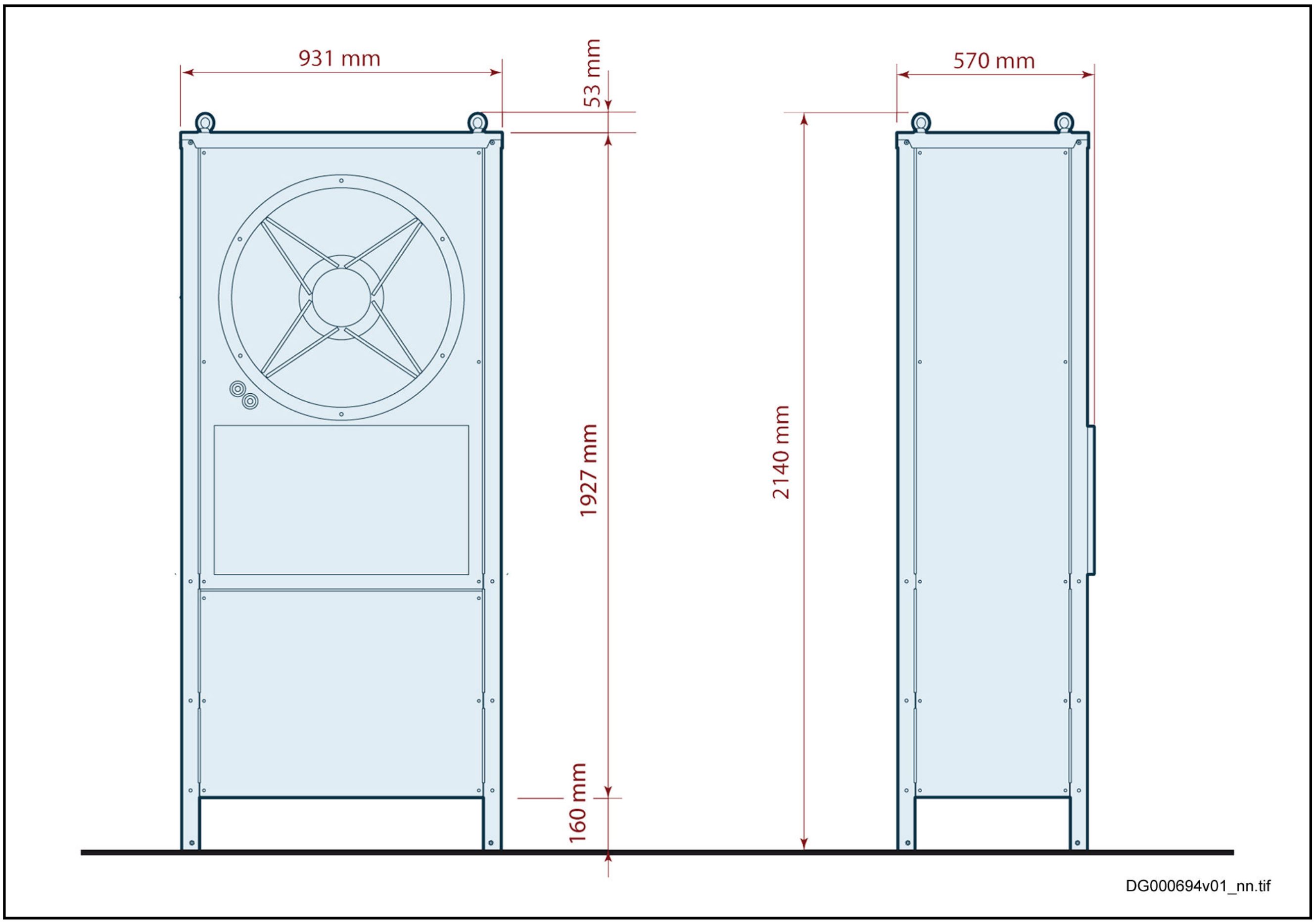


Fig. 8-86: Overall dimensions

Specifications

Machine Specification

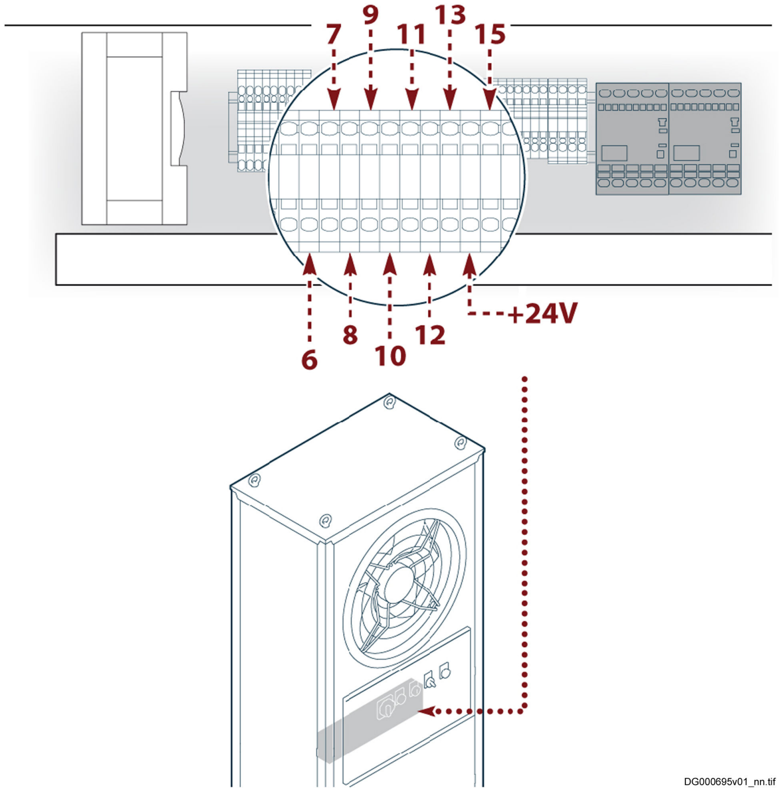
Item	Unit	WA0035K-0090
Power voltage	Vac	380 (-15%) ÷ 500 (+10%)
Frequency	Hz	50/60
Input current	A	11
Maximum power that can be dissipated	kW	35
Maximum output flow rate	l/min	90
Maximum ingoing coolant pressure	bar	2
Maximum outgoing coolant pressure	bar	4,5
Maximum coolant temperature	°C	70
Minimum coolant temperature	°C	5
Drive circuit coolant (monoethyl glycol and demineralised water solution)	-	25% glycol
Degree of protection	IP	54
Weight	kg	250

Tab. 8-116: Machine specification

ENABLE, UNIT ERROR and UNIT WARNING connections

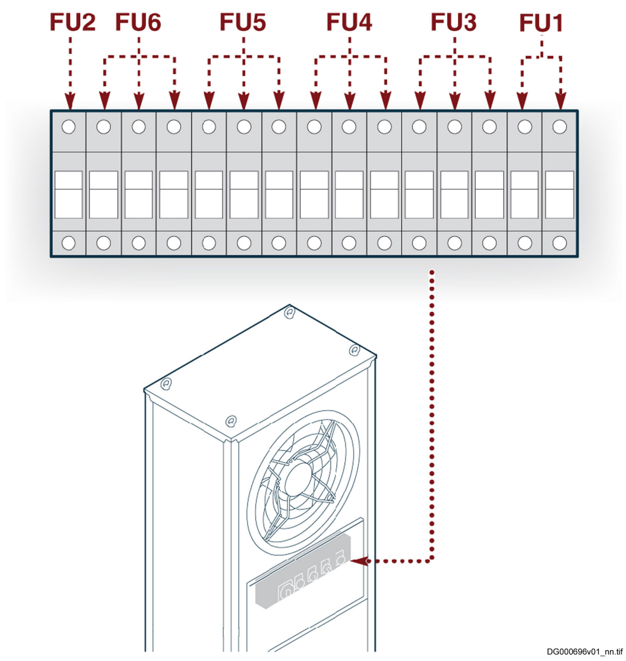
The signals to enable the relative machine status using the owner’s operating terminal are transmitted via the terminal board shown.

Connect up the cables using the terminals shown in the table titled "Connecting the terminals".

Pos.	Meaning	Terminals
24V - 15	Terminals to enable machine via owner’s operating terminal (ENABLE)	
6 - 7 8 - 9	Machine error signal terminals. Closed contact: no error.	
10 - 11 12 - 13	Warning signal terminals. Closed contact: no Warning.	

Tab. 8-117: Connecting the terminals

Fuses description

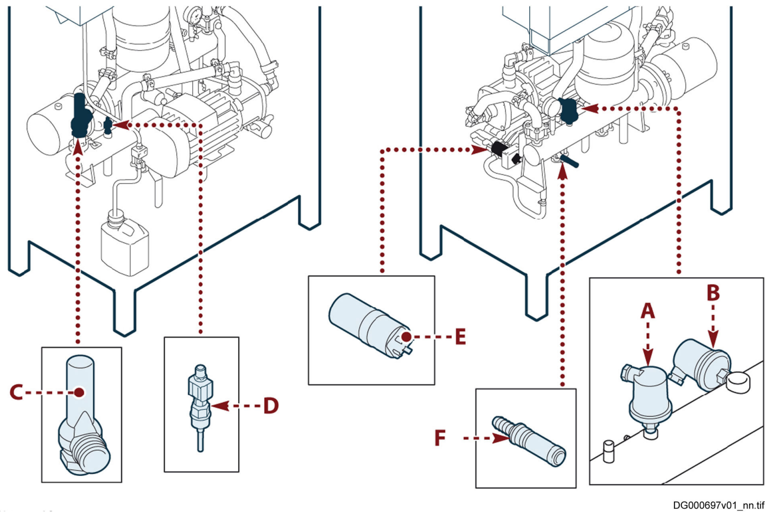
Name	Current (A)	Type	Rated voltage (Vac)	Inter-rupting capacity (kW)	Fuse	Position
FU1	1	CC	600	200	Delayed	
FU2	4					
FU3	6					
FU4	4					
FU5	4					
FU6	6					

Tab. 8-118: Fuses

Processing and protection devices

⚠ WARNING Serious health and safety risks!

Do not tamper with, circumvent, remove or bypass processing and protection devices; failure to comply with this requirement may cause serious health and safety risks.

A	**Pressure switch (0,5 bar):** this detects the pressure level in the intake manifold. The pressure switch allows a "Warning" to be signalled when the pressure falls below 0,5 bar.	
B	**Pressure switch (0,2 bar):** this detects the pressure level in the intake manifold. The pressure switch allows an "Error" to be signalled when the pressure falls below 0,2 bar and stops machine operation.	
C	**Bypass valve:** this is used to keep the fluid pressure in the outlet pipe within the maximum limit allowed.	
D	**Temperature sensor:** this detects the coolant temperature in the outlet pipe. Depending on the temperature detected, the system will signal either a "Warning"(temperature too high) or an "Error" (temperature continues to rise, resulting in machine shutdown).	
E	**Pressure sensor:** this detects, in real time, the differential pressure between the intake pipe and the output pipe. Through the sensor, the outlet pipe pressure is kept constant.	
F	**Check valve:** this is used to stop the filling pump intake pipe draining.	

Tab. 8-119: Processing and protection devices

Environmental conditions for operation

The machine works correctly with an ambient temperature of between -20 and 40 °C and a maximum humidity level of 95% (without condensation).

The machine is able to function properly at altitudes up to 2000 m above sea level.

Permitted use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

The machine must be used in conformity with its technical characteristics; it is forbidden to make modifications or use the machine for improper uses.

The machine can be used either indoors or outdoors, in areas exposed to the weather.

Any other use than that specified, or not included or inferable from this manual, should be considered mishandling and therefore not permitted.

Improper and unauthorised uses

It is forbidden to use coolants with characteristics different from those specified by the manufacturer.

It is forbidden to use the machine in a potentially flammable or explosive atmosphere.

It is forbidden to start the machine until the system or machine in which it is incorporated has been declared compliant with the national and local regulations in force.

Residual risks

Risk of crushing: when moving the machine, incorrect manoeuvres or improper handling of the load may pose a risk of injury to the operators involved.

Risk of electric shock: maintenance operations or replacement of components may involve a risk of electric shock due to accidental contact with live electrical components.

Thermal risk: contact with hot surfaces can cause burns; allow the machine to cool down before any operation.

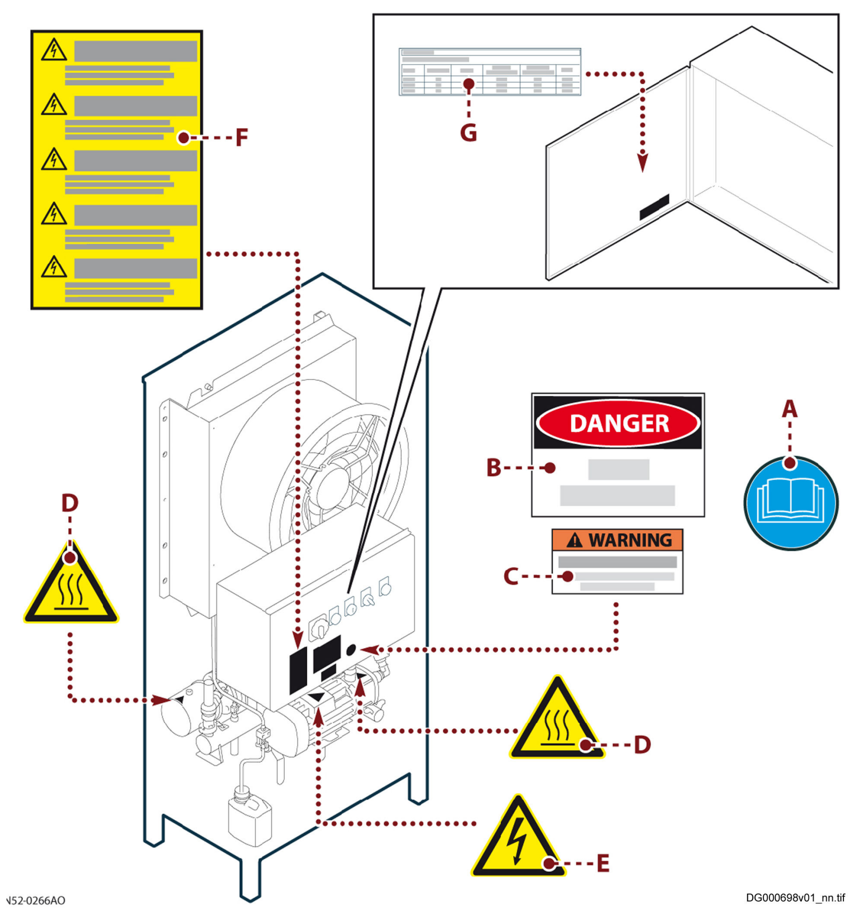
Cables, accessories, additional components

Information and safety signs

⚠ WARNING

Check that all the plates are legible; if they are not, clean them or - if they are damaged - replace them, applying the new ones in the same place as the old ones.

A	This indicates the obligation for operators to read the instruction manual before operating the machine.
B	This shows that the voltage inside the electrical panel is hazardous.
C	This shows the risk of arc discharges and electric shocks. Wear appropriate personal protective equipment.
D	This indicates that there is the risk of burns due to contact with hot surfaces; allow the machine to cool down before any operation.
E	This indicates that there is the risk of electric shock.
F	Indicates risk of electric shock and that no works must be carried out in live electrical parts.
G	This shows the fuses technical characteristics.



Tab. 8-120: Information and safety signs

Information Concerning Handling and Installation

Handling and installation safety recommendations

The staff assigned to handling the load must have the required ability and experience and must be skilled in the use of the lifting means adopted.

Use lifting equipment of a capacity suitable to lift and move the load.

The person authorised to handle the appliance will have to take the appropriate measures to guarantee his/her own safety and the safety of those directly involved.

Place the package on a steady surface.

Do not place the packed machines on top of each other as they are not designed to be stacked.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents; in case of damaged or missing items, contact the importer or the manufacturer directly to discuss the procedure to be adopted.

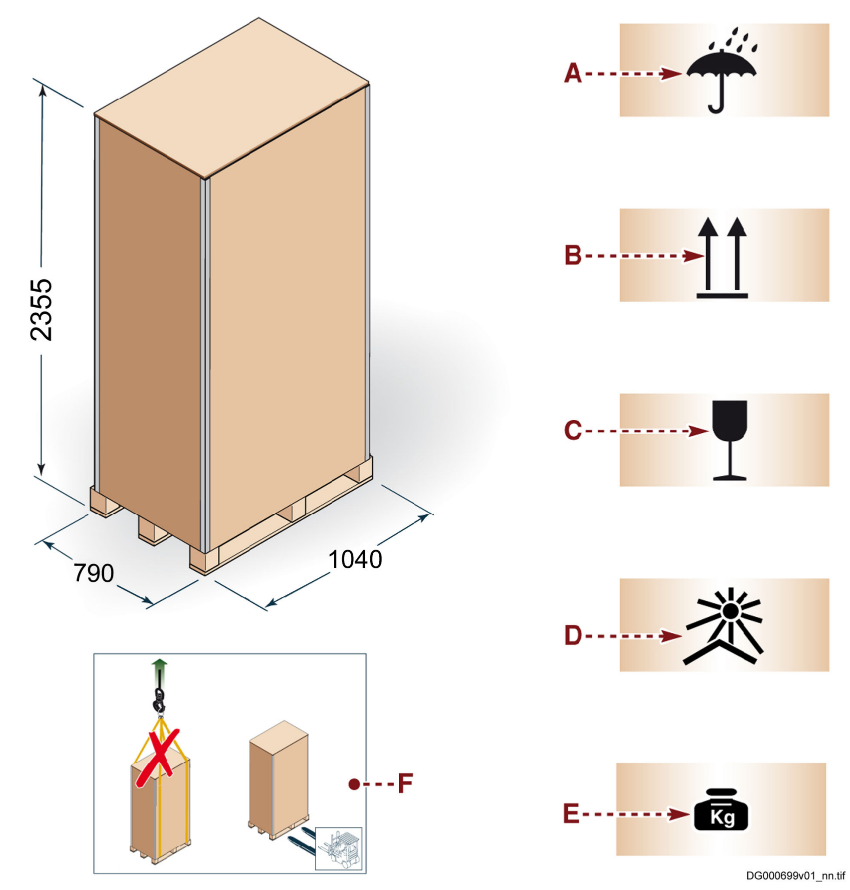
Package description

The type of packing is chosen according to the selected means of transport and the destination.

The parcels can be loaded onto a means of transport directly or in suitable containers if shipped by sea or air or to far-off destinations.

To make transport easier some components are removed and duly protected.

The figure describes the most common package types, their maximum dimensions, warning symbols and information affixed to the packages.

<table>
<tr><td>A</td><td>This symbol means the packed machine must be stored in a dry place: its contents may be damaged by dampness.</td><td rowspan="6">
</td></tr>
<tr><td>B</td><td>This symbol means the packed machine must be kept upright.</td></tr>
<tr><td>C</td><td>This symbol means the packed machine must be handled with care: its contents are fragile.</td></tr>
<tr><td>D</td><td>This symbol indicates that the package must be kept away from direct sunlight and heat sources to avoid exposing its content to excessively high temperatures.</td></tr>
<tr><td>E</td><td>This symbol indicates the overall weight of the package.</td></tr>
<tr><td>F</td><td>The plate shows the procedure for lifting the package.</td></tr>
</table>

Tab. 8-121: Package description

Handling and lifting the packed unit

The figure describes the package lifting mode.

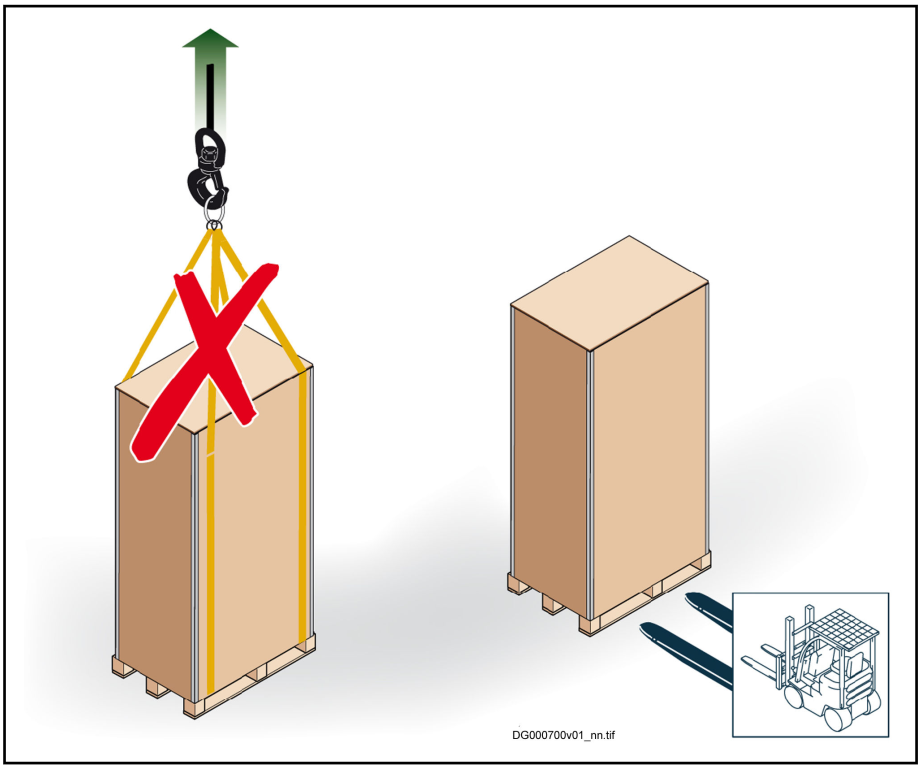


Fig. 8-87: Handling and lifting the packed unit

Storage

If the machine is not going to be used for an extended period, it should be stored (possibly without unpacking it, or at least adequately protected) in a sheltered place protected from atmospheric agents at a temperature between -20 and +60 °C.

Avoid storing the machine in places where weather conditions could prejudice its good working order.

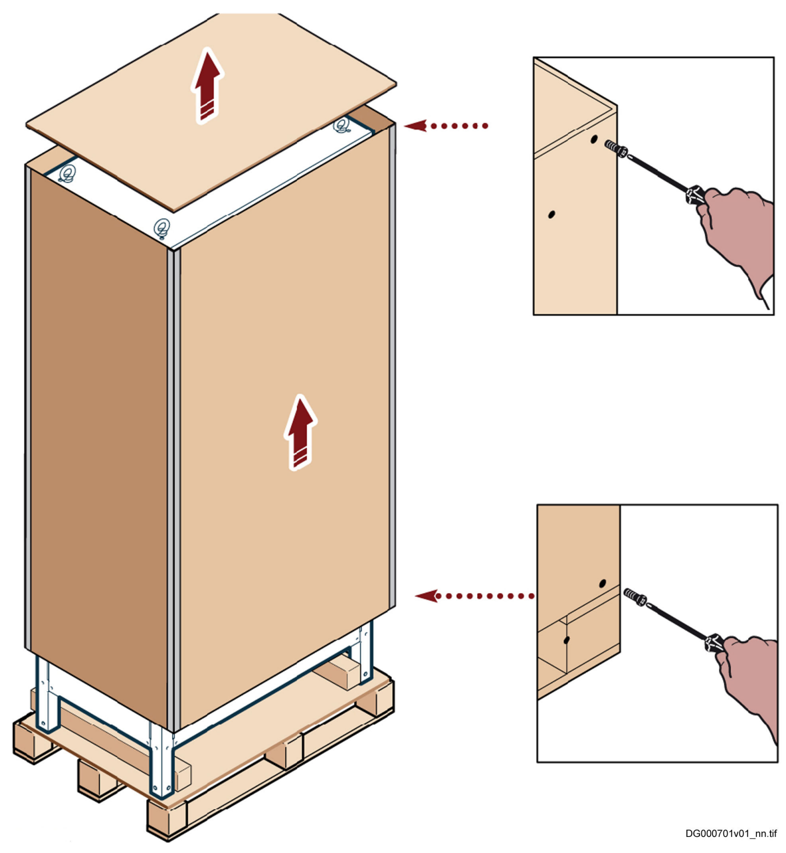
Unpacking

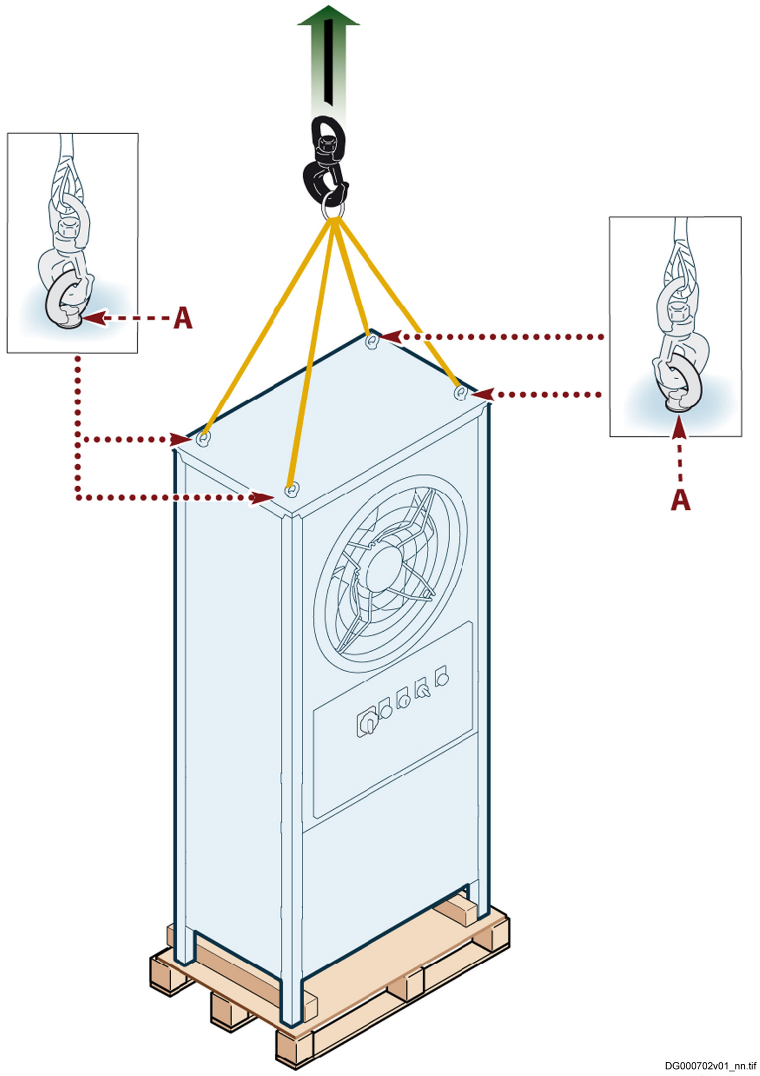
It is advisable to unpack the machine near the installation area to facilitate assembly.

The figure shows how to unpack the machine properly.

Proceed as outlined below.

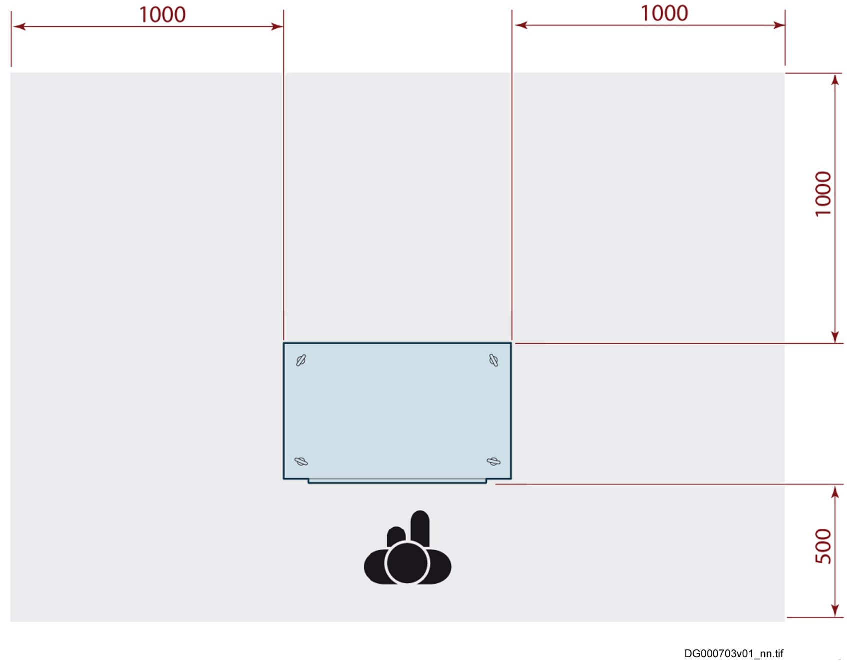
1	Unscrew the screws.
2	Remove the cover.
3	Lift the side walls of the package.



4	Tighten the eyebolts (**A**) provided.	
5	Hook the ropes onto the eyebolts (**A**).	
6	Lift the machine. **WARNING!** When lifting pay attention to the machine swinging movement as the lifting point is never perfectly barycentric; sudden movements may injure the people involved in the operations. The packaging material (wood, propylene, etc,.) can be kept for future use or properly disposed of according to the regulations in force.	

Tab. 8-122: Unpacking

Installation

Installation area The installation area must be flat and level, and meet the designed load factor and be wired up for electrical connections and for the transmission of the "UNIT ERROR" - "UNIT WARNING" signals as well as having all the hydraulic connections required by regulations and laws in force. The area must be adequately ventilated and illuminated, in accordance with the relevant workplace health and safety regulations. Make sure to leave enough space around the installation area so that interventions can be carried out under safe conditions.	

Tab. 8-123: Installation area

Electrical connection

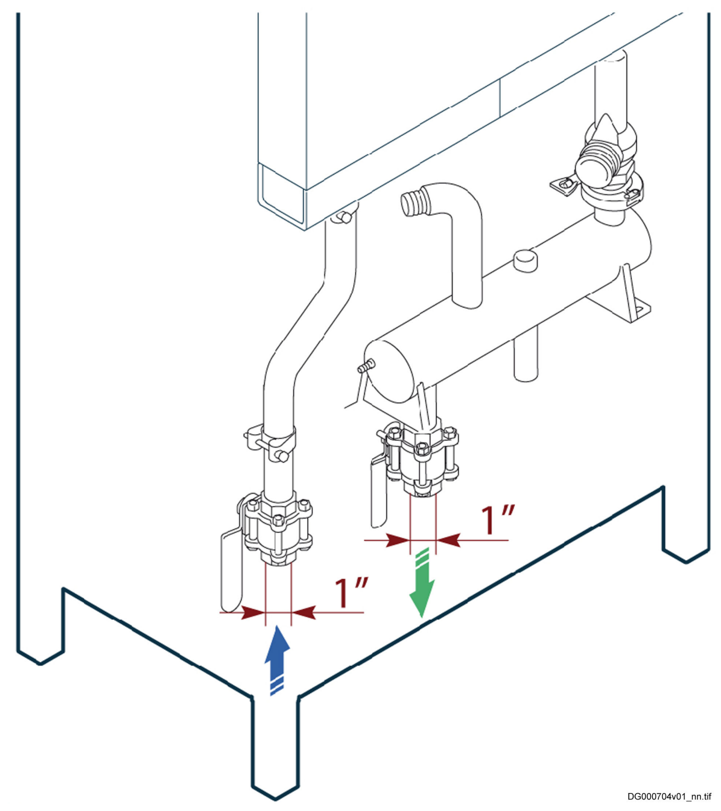
The electrical connections must be carried out according to the instructions supplied by the manufacturer in the wiring diagram enclosed.

The electrical connections must be performed at professional standards in compliance with all legislative requirements and regulations.

Use a 4 G-AWG 12 cable (three-phase conductors + earth conductor).

Connect the three phases (L1, L2, L3) and the earth wire to the relevant terminals inside the electrical panel.

Hose connections

The owner must install a pressure regulating device on the return pipe. Adjust the pressure in the input and return pipes to the value shown in chapter "Specifications" on page 333. Use flexible tubes with an internal diameter of not less than 25 mm. Use connectors with an internal diameter of not less than 20 mm.	

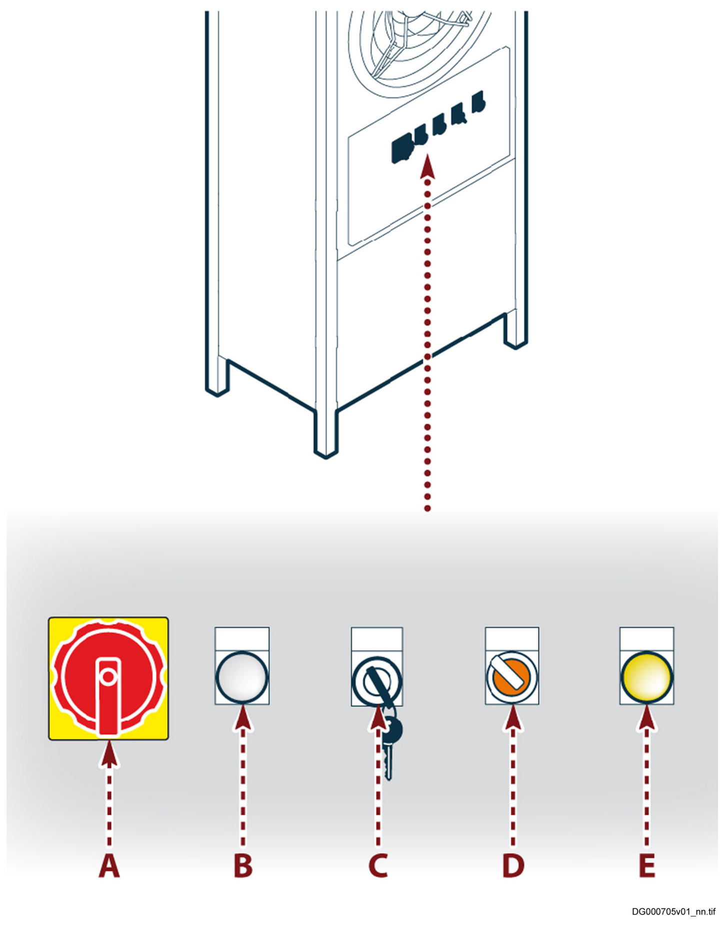
Tab. 8-124: Hose connections

Information for Use

Safety advice concerning use

Before starting the machine, make sure that the system or machine in which it has been fitted is in compliance with local regulations and directives in force.

Description of the controls and signal lights

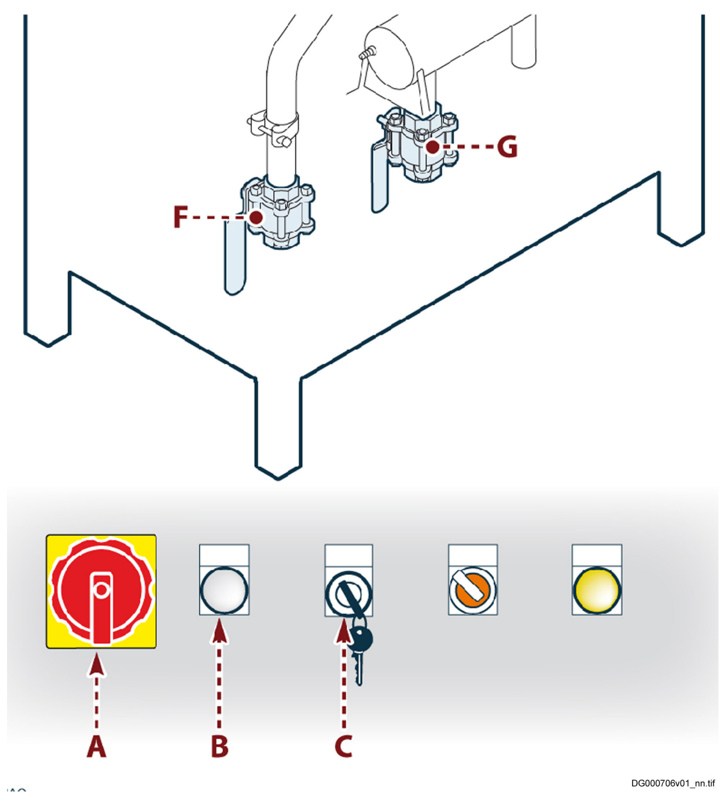
A	**Main disconnect switch:** it is used for connecting and disconnecting the power supply to machine. The indicator lamp (**B**) lights up.	
B	**Indicator lamp (white light):** indicates that the power supply to the machine is enabled.	
C	**Key-operated two-position stay-put selector switch:** this is used to enable and disable main pump operation. The key must be kept by the designated staff member and available to the staff responsible for technical servicing.	
D	**Two-position stay-put back-lit switch (red light):** this is used to switch the filling pump on and off.	
E	**Signal light (yellow):** this shows automatic shut-down of the heater (optional) triggered by over-temperature of the liquid solution.	

Tab. 8-125: Description of the controls and signal lights

Starting procedure

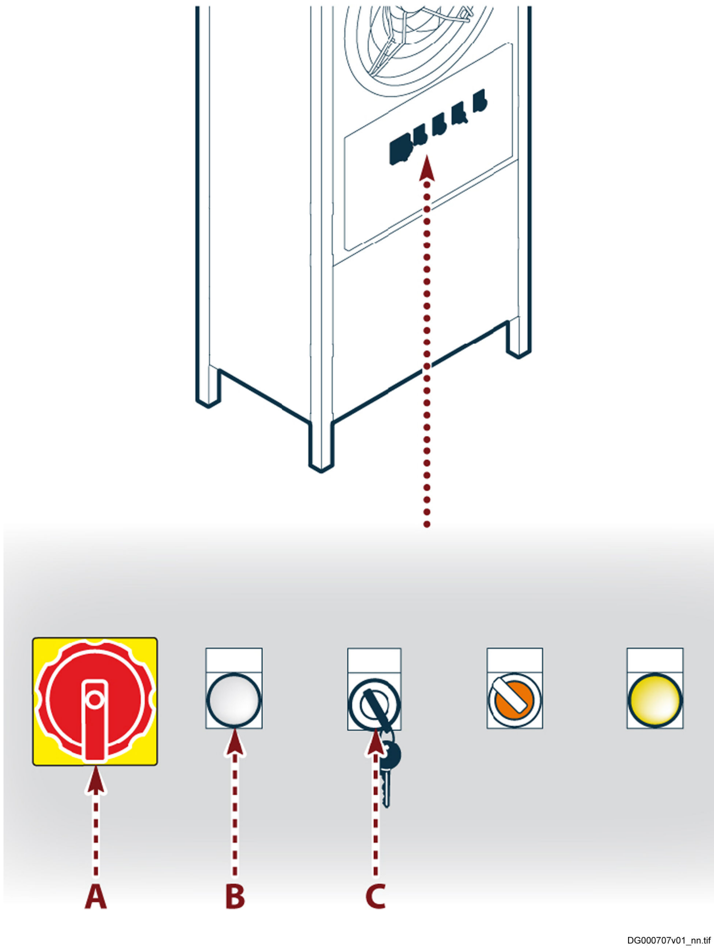
At first start-up, carry out the circuit filling procedure (see chapter "Procedure to fill the hydraulic circuit" on page 349).

To start the machine, proceed as described.

1	Open the ball valves (**F - G**).	
2	Turn the main cut-off switch (**A**) to the "ON" position. The indicator lamp (**B**) lights up.	
3	Turn the key selector (**C**) to "automatic" position. Machine start-up must be performed using the operating terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR and UNIT WARNING connections" on page 334).	

Tab. 8-126: Starting procedure

Stopping procedure

<table>
<tr>
<td>
Stopping with the main switch
1. Turn the main cut-off switch (A) to the "OFF" position.
● The signal light (B) will switch off.
● Machine operation stops and the electricity supply to the electrical panel is interrupted.
● The terminals for the connection to the mains remain live.
</td>
<td rowspan="2">


</td>
</tr>
<tr>
<td>
Stopping with the key-operated switch
This stop mode is reserved for authorised personnel.
1. Insert the key into the selector switch (C).
2. Turn the selector switch to the "OFF" position.
● Operation of the main pump stops.
● The electrical panel on the machine remains live.
</td>
</tr>
<tr>
<td colspan="2">
Remote-controlled stopping
● Remote-controlled stopping must be performed using the owner’s operating terminal, via the "ENABLE" connection.
● Operation of the main pump stops.
● The electrical panel on the machine remains live.
</td>
</tr>
<tr>
<td colspan="2">
Automatic stop
● The machine stops automatically if the circuit pressure drops below 0,2 bar and the fluid temperature goes above the preset upper limit (see parameter P-0-1382).
</td>
</tr>
</table>

Tab. 8-127: Stopping procedure

Stopping in emergency conditions

To stop the appliance in the event of imminent danger (emergency stop), turn the main cut-off switch (A) to the "OFF" position.

Eliminate the cause of the emergency stop before re-starting the machine.

Procedure to fill the hydraulic circuit

Check that the installation, electrical connections and hydraulic connections are made to a professional standard in accordance with the manufacturer's instructions.

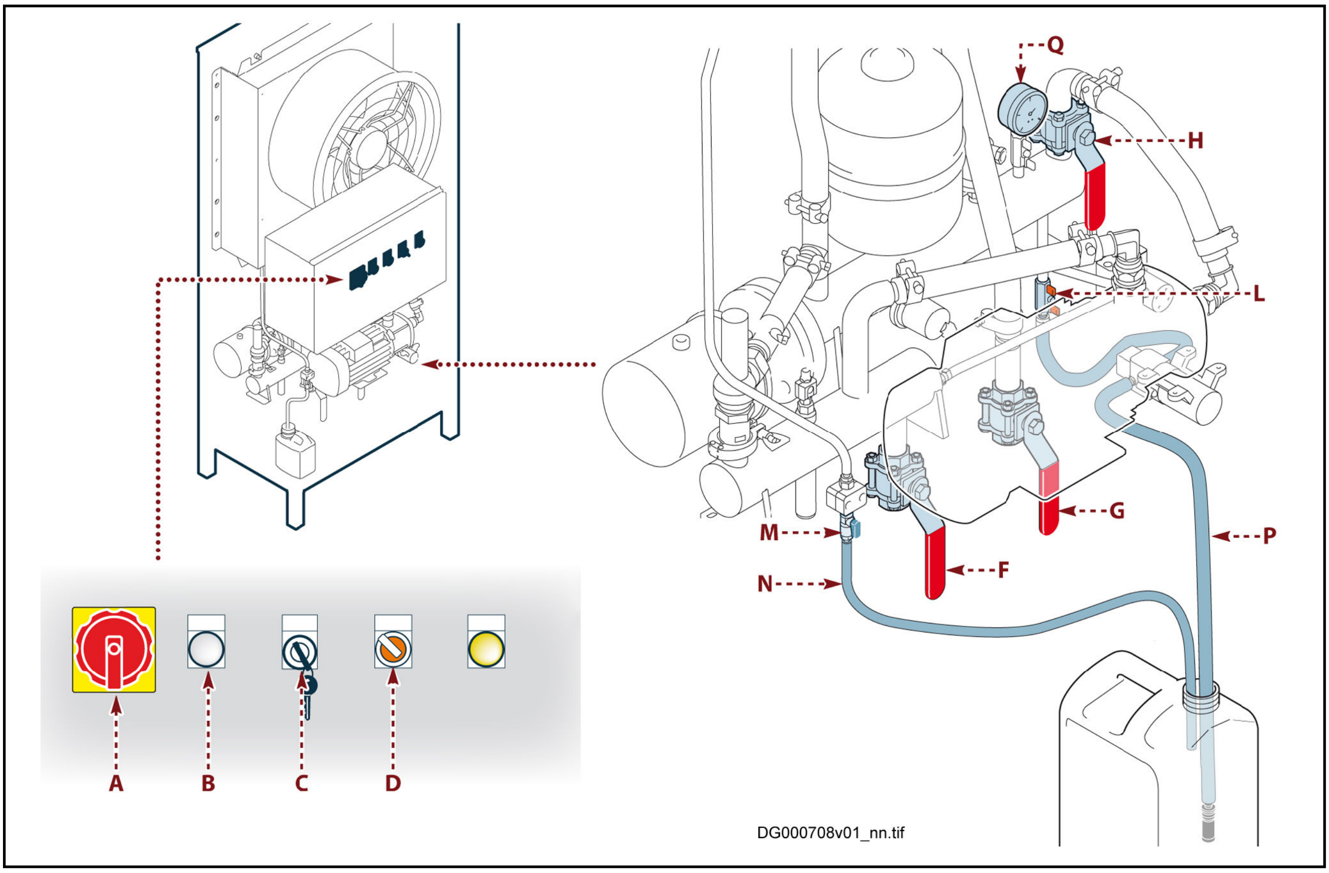


Fig. 8-88: Procedure to fill the hydraulic circuit

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Specifications" on page 333).
2. Fit the pipes (**P - N**) into the tank.
3. Open the ball valve (**G**).
4. Open the ball valve (**F**).
5. Open the valve (**M**).
6. Open the valve (**L**).
7. Open the valve (**H**).
8. Turn the key-operated selector switch (**C**) to "OFF" to prevent unexpected activation of the main pump.
9. Make sure that the remote-controlled "ENABLE" function is activated.
10. **NOTICE!** Do not turn the selector switch (**C**) to "ON" as this could cause damage to the main pump.

    Open any of the valves installed outside the machine on the circuit for the machine to be cooled.
11. Turn the main cut-off switch (**A**) to the "ON" position.

    The indicator lamp (**B**) lights up.

12. Turn the selector switch (**D**) to activate the filling pump.

    Always keep the fluid in the tank at a sufficient level.
13. When the fluid is running out of the clear tube (**N**) in a steady stream (no bubbles) and the pressure has reached 1,5 bar close the valve (**M**).

    The pressure is shown by the pressure gauge (**Q**).
14. Open the valve (**M**).
15. Turn the selector switch (**C**) to "ON" to activate the main pump.
16. **NOTICE!** The main pump is activated only when the circuit pressure reaches over 0,2 bar.

    During this stage, a sudden drop in pressure may occur, caused by the air pumped into the circuit as a result of activation of the main pump.

    Turn the main pump on and off, from time to time, using the selector switch (C) to facilitate circuit bleeding and pressurisation.

    Make sure that the key-operated switch is set to "ON".

    If it is hard for the system to get up to pressure, close the valve (**M**).

    If the pressure exceeds 1,5 bar, turn off the filling pump and temporarily open the valve (M) until the correct pressure is reached.

    Turn the selector switch (**D**) to deactivate the filling pump.
17. Close the spigot (**M**) when the pressure in the circuit reaches 1,5 bar
18. Close the valve (**L**).
19. Remove the pipes from the tank.
20. Remove the key from the selector switch (**C**) and store in a safe place.

    After one hour of operation, check that the pressure is correct, and if it is not carry out the restore procedure (see chapter "Pressure restore procedure" on page 351).

Pressure restore procedure

This procedure can be carried out only if the pressure is above 0,8 bar and the main pump is activated.

If the pressure is below this level, carry out the circuit filling procedure (see chapter "Procedure to fill the hydraulic circuit" on page 349).

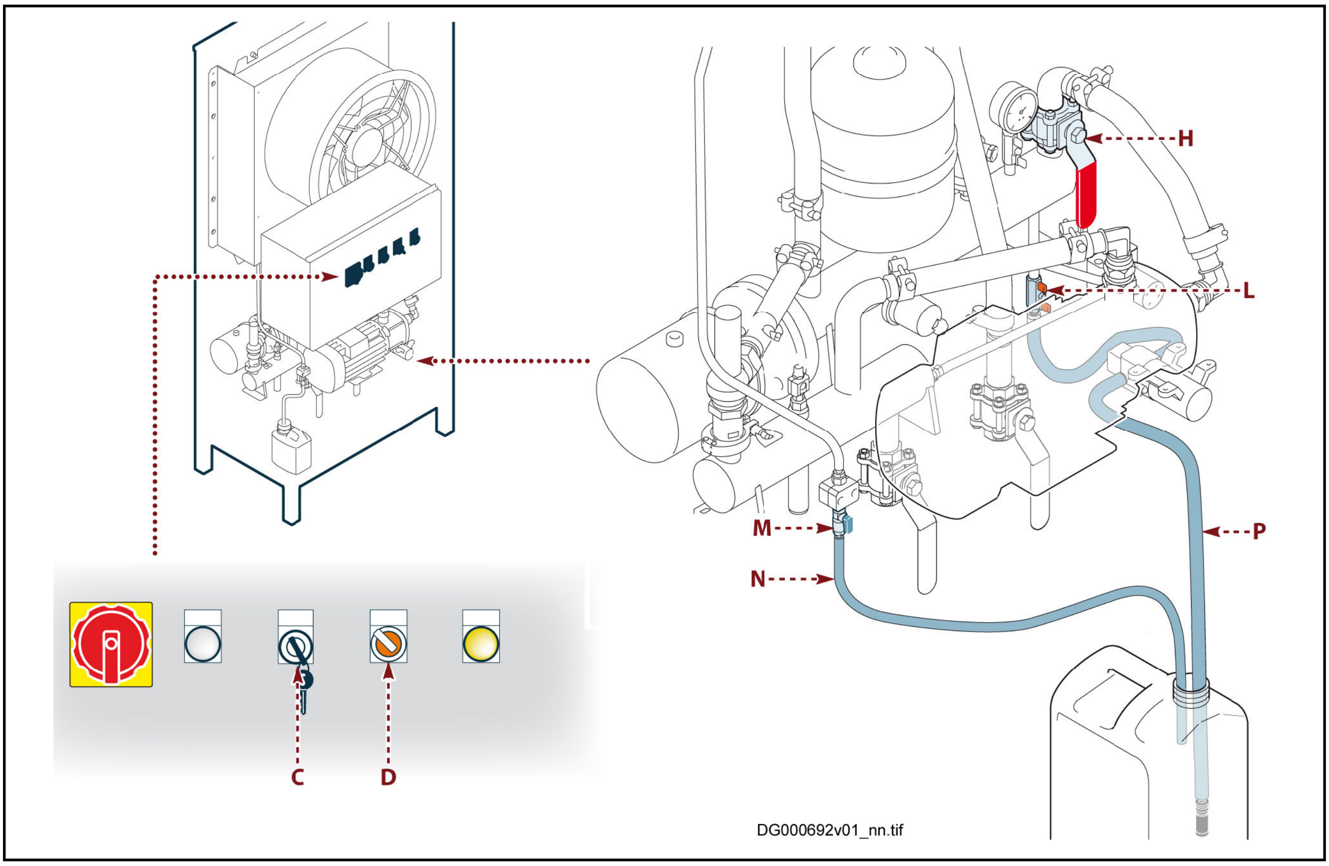


Fig. 8-89: Pressure restore procedure

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Specifications" on page 333).
2. Fit the pipes (**N - P**) into the tank.
3. Open the valve (**L**).
4. Turn the selector switch (**D**) to activate the filling pump.
5. Open the spigot (**M**) and keep open until the fluid is running out of the clear tube (**N**) in a steady stream (no bubbles) and the pressure has reached 1,5 bar.
6. **NOTICE!** If the pressure exceeds 1,5 bar, turn off the filling pump and temporarily open the valve (**M**) until the correct pressure is reached.

   Close the valve (**M**).
7. Turn the selector switch (**D**) to deactivate the filling pump.
8. Close the valve (**L**).
9. Remove the pipes from the tank.
10. Remove the key from the selector switch (**C**) and store in a safe place.

Procedure to empty the hydraulic circuit

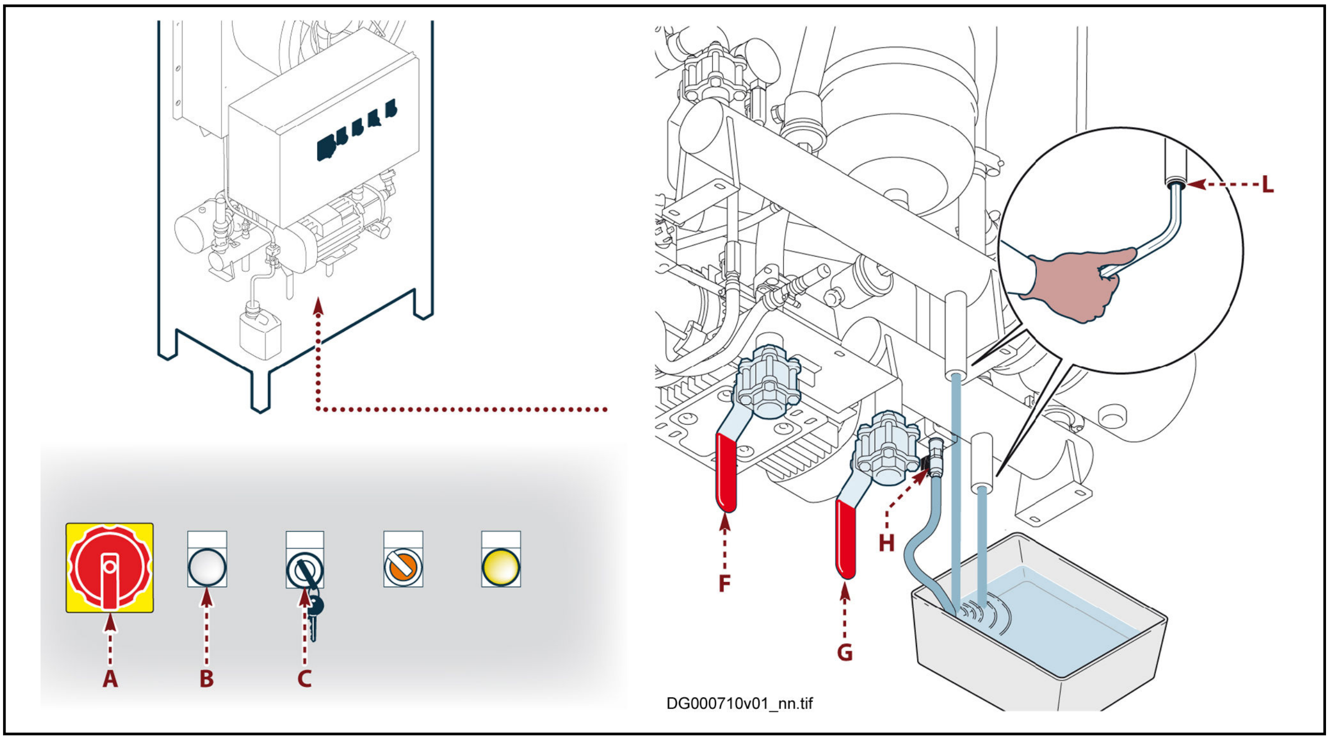


Fig. 8-90: Procedure to empty the hydraulic circuit

1. Position a suitable container in which to collect the coolant.
2. Stop the machine (see chapter "Stopping procedure" on page 348).
3. Turn the key selector (**C**) to "OFF" position.
4. Turn the main cut-off switch (**A**) to the "OFF" position.
5. The signal light (**B**) will switch off.
6. Close the ball valves (**F - G**).
7. Open the valve (**H**).
8. Unscrew caps (**L**).
9. Drain out all the coolant.
10. Close the valve (**H**).
11. Screw on the caps (**L**).

NOTICE! Do not dump the coolant; dispose of it in accordance with the laws in force.

Maintenance Information

Safety advice for maintenance

For personal safety reasons, before conducting maintenance interventions, check that all safety devices are activated and warn the people present in the workplace that such intervention is underway.

In particular, disconnect the power supply to the machine.

Make sure that the electricity cannot be accidentally restored.

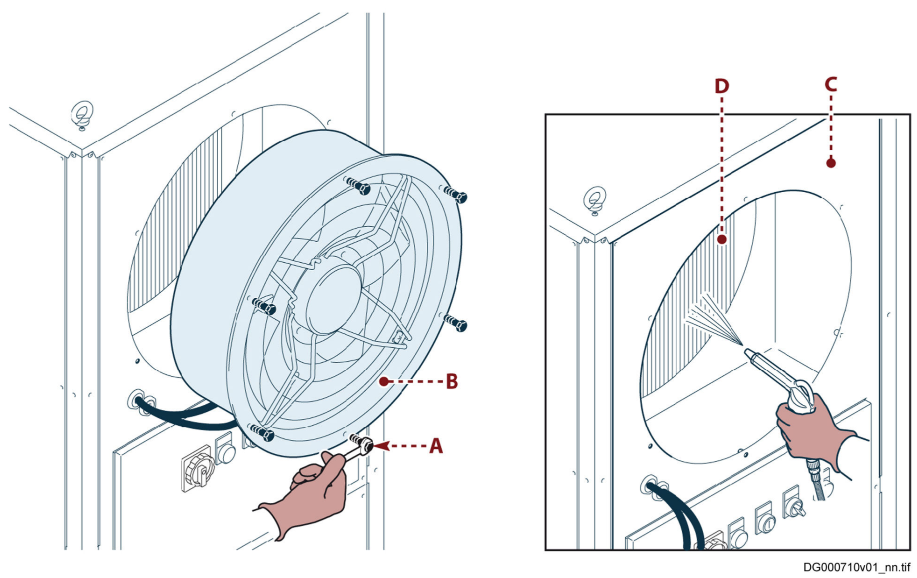
The operator must allow the machine to cool down before carrying out any intervention to prevent scalds or burns.

Scheduled maintenance chart

Interval			Component	Type of work	Reference
Every 5000 hours of work	Every 30000 hours of work	Every 10 years of work	–	–	–
✓	–	–	Radiator - channel	Cleaning	See chapter "Cleaning the radiator and the channel" on page 354
–	✓	–	Main pump	Replacement	See chapter "Replacing the main pump" on page 358
–	✓	–	Cooling fan	Replacement	See chapter "Replacing the electric fan" on page 360
–	✓	–	Coolant	Replacement	See chapter "Replacing the coolant" on page 360
–	–	✓	EPDM rubber hoses	Replacement	–

Tab. 8-128: Scheduled maintenance chart

Cleaning the radiator and the channel

1	Disconnect the machine from the power supply source.	
2	Unscrew the screws (**A**).	
3	Remove and prop up the electric fan unit (**B**).	
4	Vacuum away the dust and dirt inside the channel (**C**).	
5	Clean the core of the radiator (**D**) using compressed air.	
6	Vacuum away the dirt in the channel again.	
7	Place the electric fan unit in position.	
8	Tighten the screws (**A**).	

Tab. 8-129: Cleaning the radiator and the channel

Machine cleaning

Clean the machine with detergents allowed by the legislation in force.

Breakdown Information

The following list contains a number of common problems that may arise during work, together with the ways to solve them.

Code	Type	Fault	Likely cause	Solution
E2011	Warning 1	Low pressure	The circuit pressure is below 0,5 bar (in Drive side)	Pressurise the circuit to 1,5 bar
E2012	Warning 2	The machine does not start	Pump CP-1 does not start in the speed check mode	Make sure the system is in a "AF" status before enabling
E2014	Warning 4	Outlet fluid temperature too high	The fluid temperature at the outlet is higher than the set point temperature (T_set) plus a ΔT defined by parameter P-0-1380 for a given time, defined by parameter P-0-1381 (see IndraDrive programming)	If necessary, change the P-0-1380 and/or P-0-1381 parameters
F2011	Error 1	Low pressure alarm	The circuit pressure is below 0,2 bar	Pressurise the circuit to 1,5 bar
F2012	Error 2	High temperature alarm	The fluid temperature is above the maximum allowed temperature limit (see parameter P-0-1382)	If necessary, change the P-0-1382 parameter Clean the radiator Reduce the level of thermal output to be dissipated
F2013	Error 3	Electric fan alarm	Electric fan failure Blown fuses	Replace the electric fan Replace the interrupted fuse
		Liquid temperature too high (yellow signal light on)	Heater temperature safety thermostat triggered	Check the circuit pressure and, if necessary, restore correct level Bleed the circuit Reset the heater thermostat

Tab. 8-130: Errors and Warnings

Information Concerning Replacements

Safety advice in case of replacements

For personal safety reasons, before conducting maintenance interventions, check that all safety devices are activated and warn the people present in the workplace that such intervention is underway.

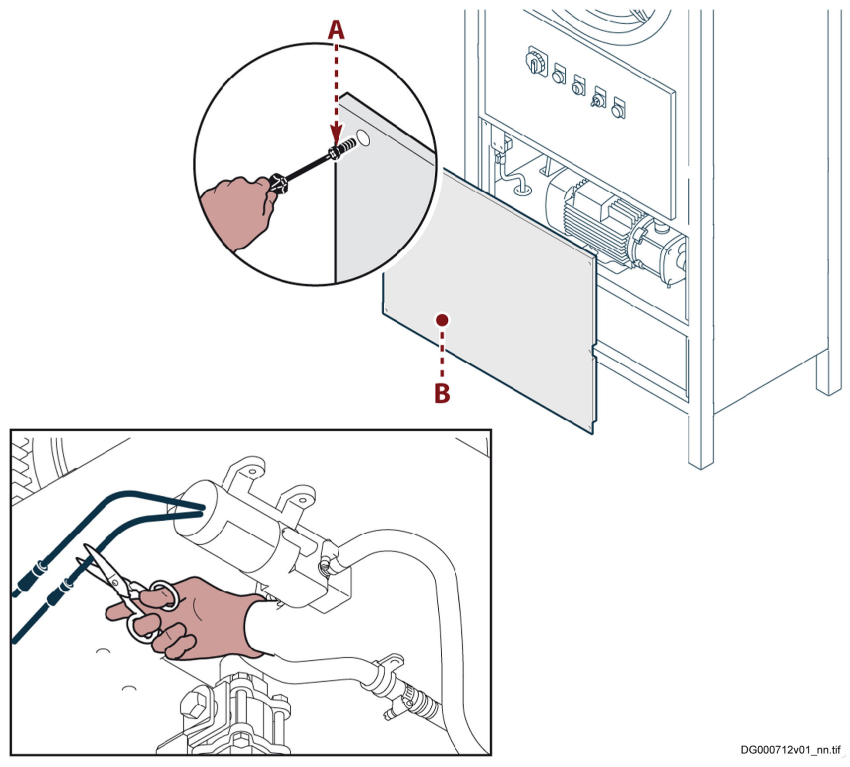
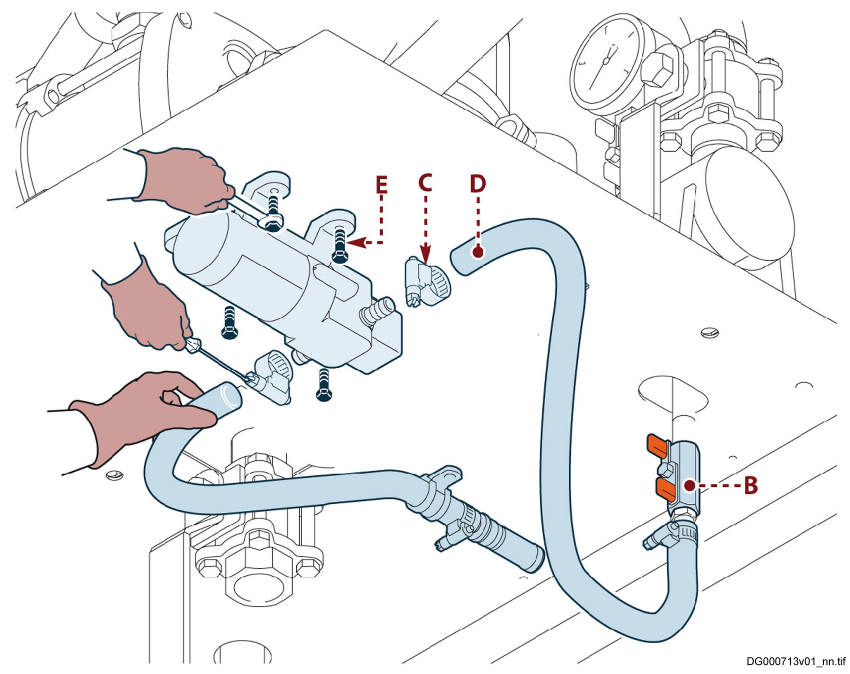
In particular, disconnect the power supply to the machine.

Make sure that the electricity cannot be accidentally restored.

The operator must allow the machine to cool down before carrying out any intervention to prevent scalds or burns.

Replace worn or damaged parts with original spare parts.

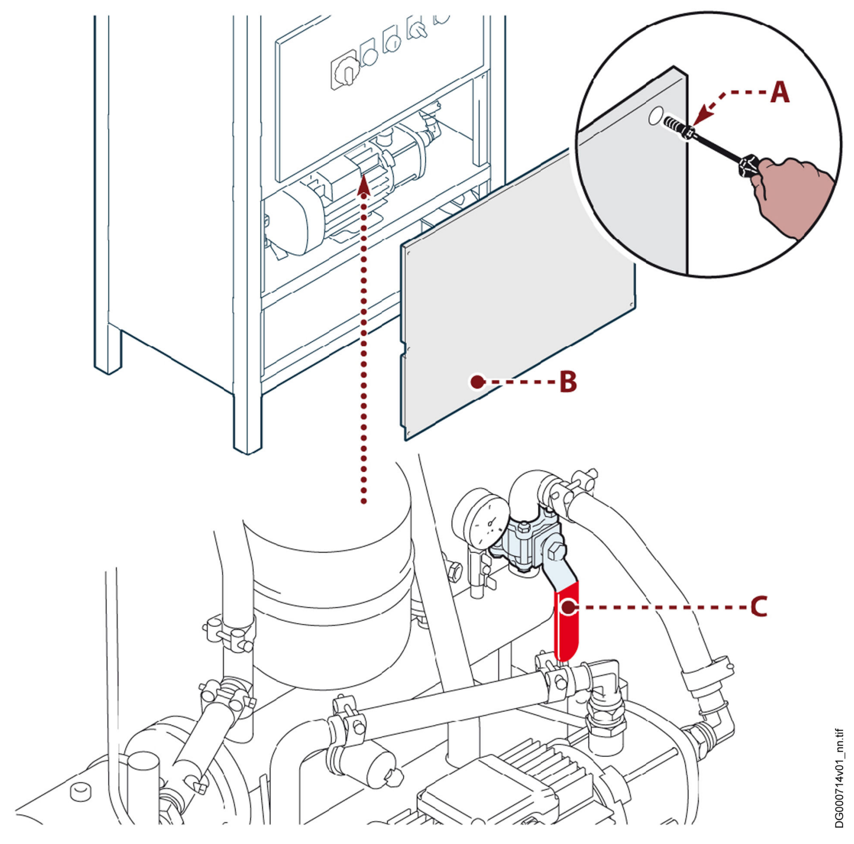
Replacing the filling pump

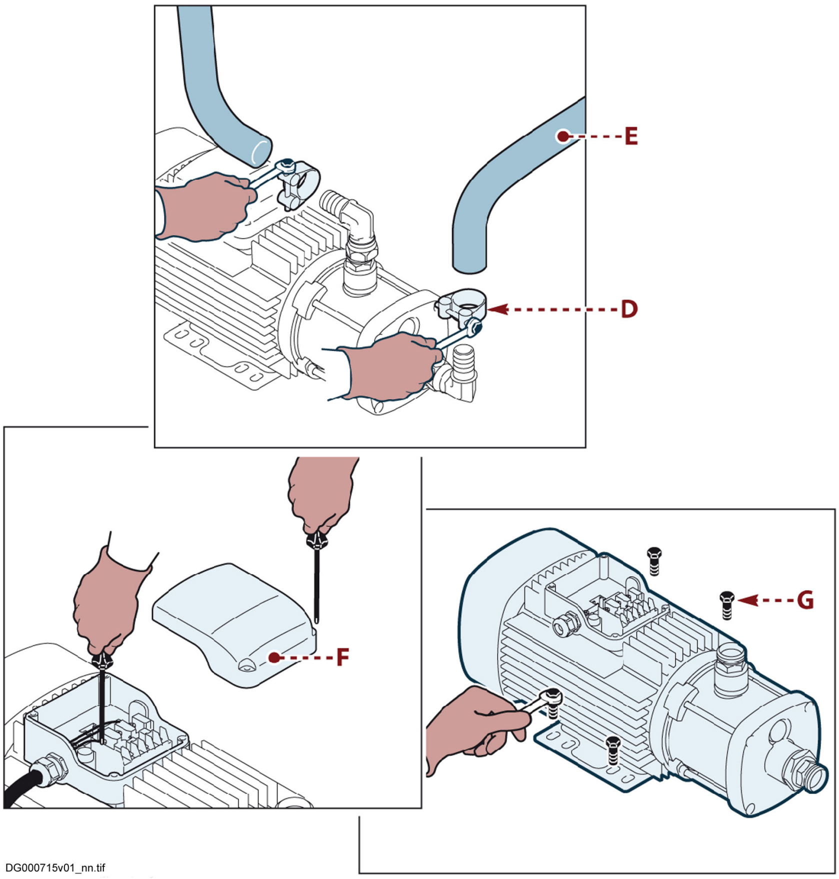
1	Disconnect the machine from the power supply source.	
2	Unscrew the screws (**A**).	
3	Remove the fixed guard (**B**).	
4	Cut the power supply cables.	
5	Make sure that the valve (**B**) is closed.	
6	Undo the screw and remove the strap (**C**).	
7	Extract the hose (**D**).	
8	Repeat the same operations to remove the other flexible tube.	
9	Unscrew the screws (**E**).	
10	Remove the pump.	
11	Install the new pump. To fit the new pump carry out the removal operations described in reverse order.	

Tab. 8-131: Replacing the filling pump

Replacing the main pump

1	Disconnect the machine from the power supply source.
2	Unscrew the screws (**A**).
3	Remove the fixed guard (**B**).
4	Close the valve (**C**).

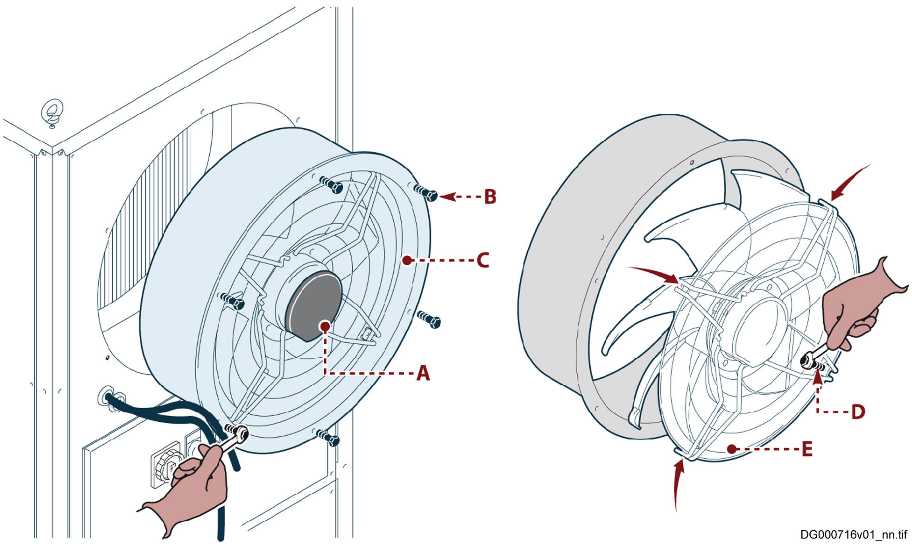


<table>
<tr><td>5</td><td>Undo the screw and remove the strap (D).</td><td rowspan="8">
</td></tr>
<tr><td>6</td><td>Disconnect the hosing (E).</td></tr>
<tr><td>7</td><td>Repeat the same operations to remove the other flexible tube.</td></tr>
<tr><td>8</td><td>Remove the cover (F).</td></tr>
<tr><td>9</td><td>Disconnect the cables from the terminals.</td></tr>
<tr><td>10</td><td>Unscrew the screws (G).</td></tr>
<tr><td>11</td><td>Remove the pump.</td></tr>
<tr><td>12</td><td>Install the new pump.
To fit the new pump carry out the removal operations described in reverse order.
NOTICE! The spare pump is supplied with the fittings mounted.
Do not unscrew the fittings as this could cause liquid leakage.</td></tr>
</table>

Tab. 8-132: Replacing the main pump

Replacing the electric fan

1	Disconnect the machine from the power supply source.
2	Remove the cover (A).
3	Disconnect the cables from the terminals.
4	Unscrew the screws (B).
5	Remove the electric fan unit (C).
6	Unscrew the screws (D).
7	Remove the electric fan (E).
8	Place the replacement electric fan in position.
9	Tighten the screws (D).
10	Place the electric fan unit in position.
11	Tighten the screws (B).
12	Connect up the wires (using the wiring diagram for reference).
13	Fit the cover (A).



Tab. 8-133: Replacing the electric fan

Replacing the fuses

☞ Before replacing the fuse, remove the cause of the problem.

Replace the interrupted fuse only with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Fuses description" on page 335.

Replacing the coolant

Drain out the machine's hydraulic circuit (see chapter "Procedure to empty the hydraulic circuit" on page 352).

Fill the hydraulic circuit (see chapter "Procedure to fill the hydraulic circuit" on page 349).

Scrapping and disposal

Scrapping operations must be handled by specialised personnel with suitable skills for the job.

When dismantling the machine, all components must be collected separately for disposal according to their chemical properties, in accordance with the relevant regulations in force.

With reference to European Directive (RAEE), electric and electronic components must be either disposed of in authorized landfill sites, or, in case of a new purchase, the machine, complete of the said parts, must be returned to the dealer.

The owner is responsible for delivering the machine, at the end of its working life, to the appropriate collection structures; failure to comply shall lead to penalties foreseen by the regulations in force.

Hydraulic diagrams

WA0035K-0090 Hydraulic diagram

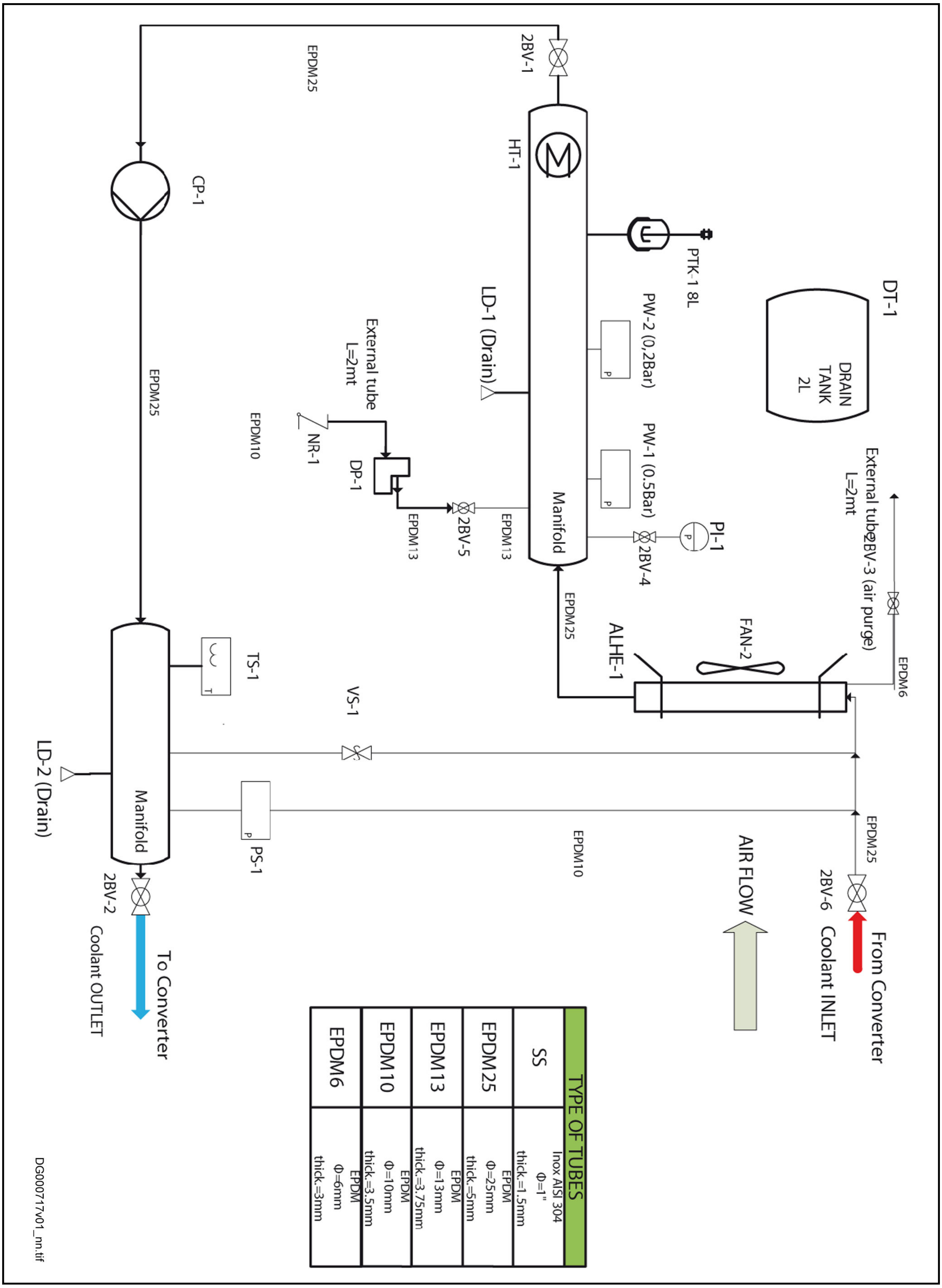


Fig. 8-91: WA0035K-0090 Hydraulic diagram

Designation	Description
VS-1	Safety Valve 2 bar
PW-1	Pressure Switch 0,5 bar
HT-1	2 kW 380-500 Vac Heater SS
PTK-1	8L Expansion Vessel
PW-2	Pressure Switch 0,2 bar
CP-1	Main Pump 400 Vac 50/60 Hz CM5-5
FAN-2	Fan 200-480 Vac 50/60 Hz 3P - IP55
TS-1	Temperature Sensor Pt100
-	Pt100 Converter - Out: 0 … 10 V (M12)
DP-1	24Vdc Pressurization Pump
PS-1	Diff. Pressure Sensor 0 … 6 bar; Out: 0 … 10 V
ALHE-1	Air-Water Heatexchanger
DT-1	Drain Tank 2L
PI-1	Pressure Indicator 0 … 4 bar
NR-1	One-Way valve

Tab. 8-134: Designations

9 Environmental protection and disposal

9.1 Environmental protection

Production processes

The products are made with energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

No release of hazardous substances

Our products do not contain any hazardous substances which may be released in the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

Significant components

Basically, our products contain the following components:

Electronic devices
- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

Motors
- steel
- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

9.2 Disposal

Return of products

Our products can be returned to our premises free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

Furthermore, the products returned for disposal must not contain any undue foreign material or foreign components.

Send the products ”free domicile” to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Buergermeister-Dr.-Nebel-Strasse 2
97816 Lohr am Main, Germany

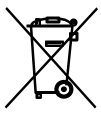
Packaging

The packaging materials consist of cardboard, wood and polystyrene. These materials can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.



The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be properly disposed of according to the country-specific collection.

Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual modules.

Metals contained in electric and electronic modules can also be recycled by means of special separation processes.

Products made of plastics can contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the valid legal requirements.

10 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	+49 9352 40 5060
Fax:	+49 9352 18 4941
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com/

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

11 Appendix

11.1 Switching supply units on and off

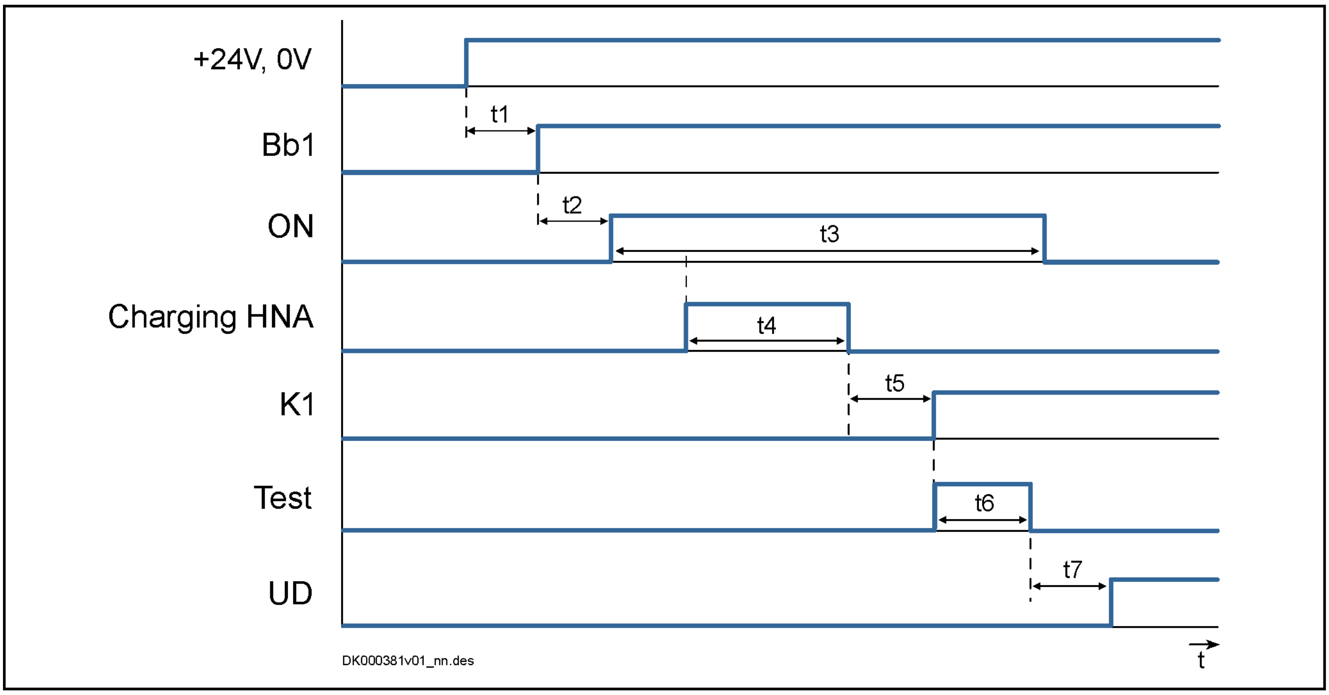
11.1.1 Switching on

NOTICE **Risk of damage to the supply units when they are switched on simultaneously!**

With 3 or more supply units at common mains power supply:

Switch on supply units one after the other with a **time interval of at least 0.5 seconds** so that the inrush currents are not added.

In the switch-on sequence of the supply unit, the supplying mains is loaded with the current $I_{L\_trans\_max\_on}$ for the purpose of analysis. During the unloading process, voltage overshoot can occur at the mains components connected in the incoming circuit (e.g. mains filters) due to inductances connected in the incoming circuit, e.g. the leakage inductance of the mains transformer.



t1	Time depends on whether the supply unit is connected to a control unit via the communication, and on how fast this control unit is booting up.
t2	Time can be set by the user. Take the time into account which is required for run-up of all devices connected to IndraBus. This time depends on the control unit or the machine.
t3	Switch-on pulse
t4	HNA charges the DC bus and switches the m
t5	Time depends on DC bus capacitance (internal, external) and mains voltage Mains contactor is switched on by HNA.
t6	Time for internal test routines
t7	Time depends on the supply unit and the connected DC bus capacitances. Supply unit goes to "LB" (ready for power output) status

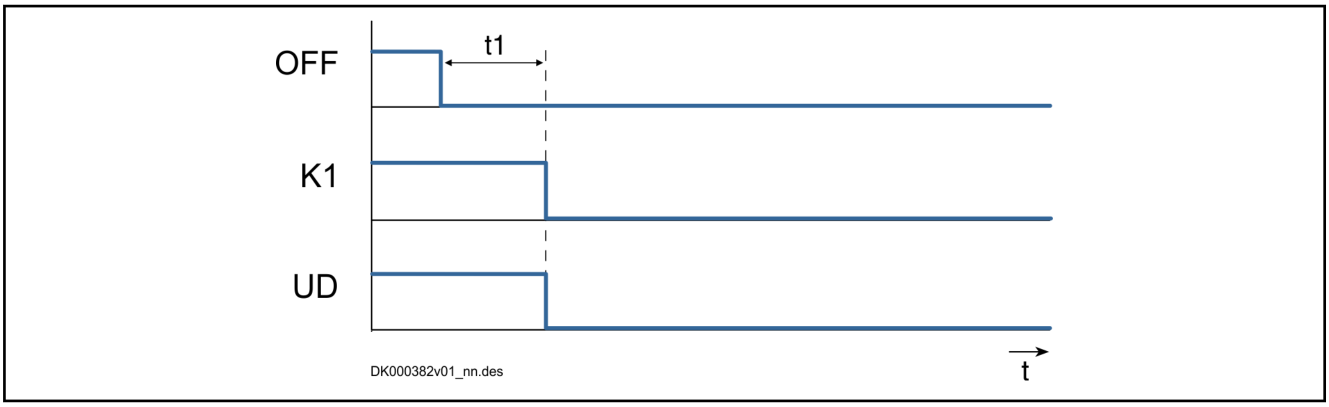
Fig. 11-1: Signal sequences when switching on with digital inputs/outputs

11.1.2 Switching off

NOTICE **Damage to the supply unit!**

At regenerative supply units, **at least 10 ms** have to elapse between the mains OFF request and the disconnection of the mains voltage, so that the energy flow has been interrupted when the disconnection process starts.

You can make sure this order is observed by appropriate switch elements (e.g., by a control cabinet main switch with leading auxiliary contact). For this purpose, connect the auxiliary contact in series with mains OFF.



t1 Time depends on device (mains contactor off delay); OFF relates to the hardware input

Fig. 11-2: Signal sequences when switching off

11.2 Dimensioning the line cross sections and fuses

Dimensioning the line cross sections and fuses in the supply feeder and branches to the drive system:

1. Determine current in supply feeder of drive system and correct it with correction factors for ambient temperature and bundling.

   (In the technical data of the components in section "Data for mains voltage supply", you can find standardized data for connection cross section and mains circuit breaker at operation under rated conditions.)
2. Determine country of use ("international except for USA/Canada" or "USA/Canada")
3. Determine installation type (e.g., B1 or B2)
4. In "Current carrying capacity" table row, select the value that is immediately above the value determined in the first step
5. In "Fuse" table row, read corresponding fuse
6. In "Cross section A …" table row, read corresponding required cross section

International except for USA/Canada; installation type B1

Country of use: international except for USA/Canada				
Fuse I_N [A]			Current carrying capacity (× 0.87) $I_{Z(40)}$ [A]	Cross section A [mm^2] Installation type B1
1 ×	2 ×	3 ×		
2			1.6	1.5
4			3.3	1.5
6			5.0	1.5
10			8.6	1.5
16			10.3	1.5
16			13.5	1.5
20			18.27	2.5
35			24.36	4
35			31.32	6
50			43.50	10
80			59.16	16
100			77.43	25
125			95.70	35
160			116.58	50
200			148.77	70
200			180.09	95
250			207.93	120
250			227.94	150
315			257.52	185
355			301.02	240

Country of use: international except for USA/Canada				
Fuse I_N [A]			Current carrying capacity (× 0.87) $I_{Z(40)}$ [A]	Cross section A [mm^2] Installation type B1
1 ×	2 ×	3 ×		
400			342.78	300
	160		238.03	2 × 70
	160		288.14	2 × 95
	200		332.69	2 × 120
	200		364.70	2 × 150
	250		412.03	2 × 185
	315		481.63	2 × 240
	315		548.45	2 × 300
		125	312.42	3 × 70
		160	378.19	3 × 95
		160	436.65	3 × 120
		200	478.67	3 × 150
		200	540.79	3 × 185
		250	632.14	3 × 240
		315	719.84	3 × 300

Tab. 11-1: Line cross sections and fuses, B1 according to EN 60204-1:2006, Table 6, for 150mm² and more DIN IEC 60364-5-52:2004, Table B. 52-4

International except for USA/ Canada; installation type B2

Country of use: international except for USA/Canada				
Fuse I_N [A]			Current carrying capacity (× 0.87) $I_{Z(40)}$ [A]	Cross section A [mm^2] Installation type B2
1 ×	2 ×	3 ×		
2			1.6	0.75
4			3.3	0.75
6			5.0	0.75
10			8.5	0.75
16			10.1	1.0
16			13.05	1.5
20			17.40	2.5
25			23.49	4
35			29.58	6
50			40.02	10
63			53.94	16
80			69.60	25

Country of use: international except for USA/Canada				
Fuse I_N [A]			Current carrying capacity (× 0.87) $I_{Z(40)}$ [A]	Cross section A [mm^2] Installation type B2
1 ×	2 ×	3 ×		
100			86.13	35
125			102.66	50
160			129.63	70
200			155.73	95
200			179.22	120
224			195.75	150
250			221.85	185
315			258.39	240
355			294.93	300
	125		207.41	2 × 70
	160		249.17	2 × 95
	160		286.75	2 × 120
	200		313.20	2 × 150
	200		354.96	2 × 185
	250		413.42	2 × 240
	315		471.89	2 × 300
		100	272.22	3 × 70
		125	327.03	3 × 95
		160	376.36	3 × 120
		160	411.08	3 × 150
		200	465.89	3 × 185
		200	542.62	3 × 240
		250	619.35	3 × 300

Tab. 11-2: Line cross sections and fuses, B2 according to EN 60204-1:2006, Table 6, for 150mm² and more DIN IEC 60364-5-52:2004, Table B. 52-4

International except for USA/ Canada; installation type E

Country of use: international except for USA/Canada				
Fuse I_N [A]			Current carrying capacity (× 0.87) $I_{Z(40)}$ [A]	Cross section A [mm^2] Installation type E
1 ×	2 ×	3 ×		
2			1.6	2
4			3.3	4
6			5.0	6
10			8.3	10

Country of use: international except for USA/Canada				
Fuse I_N [A]			Current carrying capacity (× 0.87) $I_{Z(40)}$ [A]	Cross section A [mm²] Installation type E
1 ×	2 ×	3 ×		
16			10.4	16
16			12.4	16
20			16.10	1.5
25			21.75	2.5
35			29.58	4
50			37.41	6
63			52.20	10
80			69.60	16
100			87.87	25
125			109.62	35
160			133.11	50
200			170.52	70
250			207.06	95
315			240.12	120
355			277.53	150
400			316.68	185
425			374.10	240
500			432.39	300
	160		272.83	2 x 70
	200		331.30	2 x 95
	250		384.19	2 x 120
	250		444.05	2 x 150
	315		506.69	2 x 185
	400		598.56	2 x 240
	400		691.82	2 x 300
		160	358.09	3 x 70
		200	434.83	3 x 95
		200	504.25	3 x 120
		250	582.81	3 x 150
		250	665.03	3 x 185
		315	785.61	3 x 240
		400	908.02	3 x 300

Tab. 11-3: Line cross sections and fuses, E according to EN 60204-1:2006, Table 6, for 150mm² and more DIN IEC 60364-5-52:2004, Table B. 52-10

USA/Canada; installation type E

Country of use: USA/Canada					
Fuse I_N				Current carrying capacity I_Z [A]	Cross section A Installation type E
1 ×	2 ×	3 ×	4 ×		
2				1.6	14 AWG
4				3.3	14 AWG
6				5	14 AWG
10				8.3	14 AWG
16				13	14 AWG
20				15	14 AWG
25				20	12 AWG
40				30	10 AWG
70				50	8 AWG
80				65	6 AWG
100				85	4 AWG
110				100	3 AWG
125				115	2 AWG
150				130	1 AWG
175				150	1/0 AWG
200				175	2/0 AWG
225				200	3/0 AWG
250				230	4/0 AWG
300				255	250 kcmil
300				285	300 kcmil
350				310	350 kcmil
350				335	400 kcmil
400				380	500 kcmil
450				420	600 kcmil
600				460	700 kcmil
600				475	750 kcmil
600				490	800 kcmil
600				520	900 kcmil
800				545	1000 kcmil
800				590	1250 kcmil
800				625	1500 kcmil
800				650	1750 kcmil

Country of use: USA/Canada					
Fuse I_N				Current carrying capacity I_Z [A]	Cross section A Installation type E
1 ×	2 ×	3 ×	4 ×		
800				665	2000 kcmil
	200			300	2 × 1/0 AWG
	225			350	2 × 2/0 AWG
	250			400	2 × 3/0 AWG
	300			460	2 × 4/0 AWG
	300			510	2 × 250 kcmil
	350			570	2 × 300 kcmil
	350			620	2 × 350 kcmil
	400			670	2 × 400 kcmil
	450			760	2 × 500 kcmil
	600			840	2 × 600 kcmil
	600			920	2 × 700 kcmil
	600			950	2 × 750 kcmil
	600			980	2 × 800 kcmil
	800			1040	2 × 900 kcmil
	800			1090	2 × 1000 kcmil
		200		450	3 × 1/0 AWG
		225		525	3 × 2/0 AWG
		250		600	3 × 3/0 AWG
		300		690	3 × 4/0 AWG
		300		765	3 × 250 kcmil
		350		855	3 × 300 kcmil
		350		930	3 × 350 kcmil
		400		1005	3 × 400 kcmil
		450		1140	3 × 500 kcmil
			200	600	4 × 1/0 AWG
			225	700	4 × 2/0 AWG
			250	800	4 × 3/0 AWG
			300	920	4 × 4/0 AWG
			300	1020	4 × 250 kcmil
			350	1140	4 × 300 kcmil
			350	1240	4 × 350 kcmil

Country of use: USA/Canada					
Fuse I_N				Current carrying capacity I_Z [A]	Cross section A Installation type E
1 ×	2 ×	3 ×	4 ×		
			400	1340	4 × 400 kcmil
			450	1520	4 × 500 kcmil

Tab. 11-4: Line cross sections and fuses according to UL508A:2007, Table 28.1

Dimensioning variables of the table values

1. Ambient temperature T_A of routed lines ≤ 40 °C
2. Temperature T_L at conductor at nominal current: 90 °C for UL-listed lines (USA/Canada) or 70 °C for PVC lines
3. The nominal current of the fuse is approx. 10-20% above the nominal current I_{LN} of the converter/supply unit or the determined current of the drive system.
4. Installation types:
   - B1 in accordance with IEC 60364-5-52, e.g. stranded wires routed in cable duct
   - B2 in accordance with IEC 60364-5-52, e.g. multi-core line routed in cable duct
   - E in accordance with EN 60204-1, e.g. multi-core line routed on open cable tray
   - In accordance with NFPA 79 (external wiring), UL508A (internal wiring), NEC, NFPA 70:
     – 1 cable with 3 conductors, 1 neutral conductor and 1 equipment grounding conductor
     – Routed in pipe on the wall

     Internal wiring: Routing inside of control cabinet or inside of devices

     External wiring: Routing outside of control cabinet

     Field wiring: Data of cross sections of terminal connectors wired by the user (in the field)
5. Recommendation for design of the fuses:
   - **International except for USA/Canada**:
     – Fuse-link in accordance with IEC 60269-1, characteristic gG (fuses)
     – Circuit breakers in accordance with IEC 60898-1/2, type B or C
     – Circuit breakers in accordance with IEC 60947-2/6-2
   - **USA/Canada**:
     – Class J; 600 V

Correction factors

For deviating dimensioning variables, the corresponding standards specify correction factors.

Below you can find the correction factors for ambient temperature and numbers of routed lines and circuits. If necessary, multiply the determined current in the supply feeder with these factors.

Ambient temperature correction factor

Ambient temperature T_A / °C	30	35	40	45	50	55	60
Correction factor according to EN 60204-1:2006, table D.1	0.87	0.93	1.00	1.1	1.22	1.41	1.73
Correction factor according to NFPA 79:2007, table 12.5.5(a)	0.88	0.94	1.00	1.1	1.18	1.32	1.52

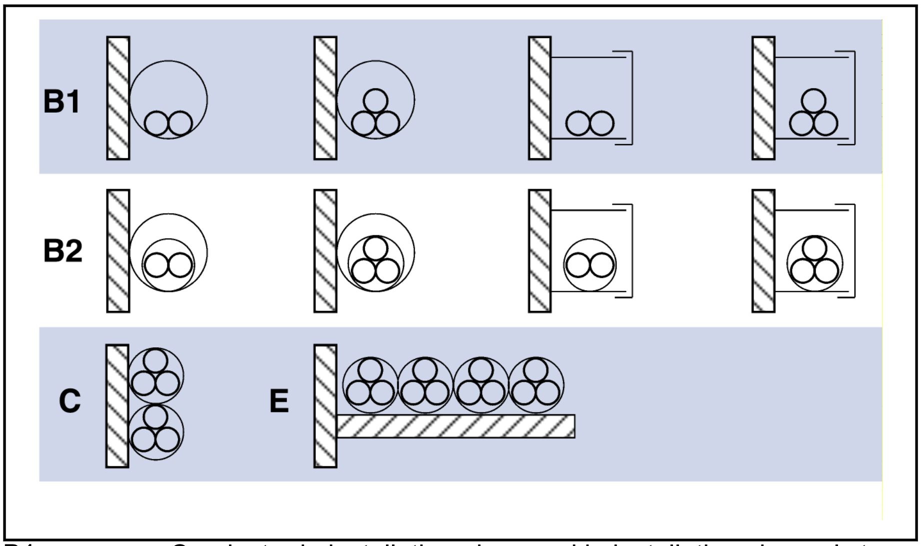
Tab. 11-5: Ambient temperature correction factor in accordance with EN 60204-1:2006 and NFPA 79:2007

Correction factor for bundling lines (installation methods B2 and E) and circuits (installation method B1[1)])

Number of lines	1	2	3	4	5
Correction factor according to EN 60204-1:2006, table D.2	1	1.25	1.43	1.54	1.67
Correction factor according to NFPA 79:2007, table 12.5.5(b)	1	1.25			

1) Three single cores (L1, L2, L3) for mains supply of a device are to be considered as one circuit.

Tab. 11-6: Correction factor for bundling lines and circuits in accordance with EN 60204-1:2006 and NFPA 79:2007



B1	Conductor in installation pipes and in installation channels to be opened
B2	Cables or lines in installation pipes and in installation channels to be opened
C	Cables or lines on walls
E	Cables or lines on open cable trays.

Fig. 11-3: Installation methods (compare IEC 60364-5-52; VDE0298-7; EN 60204-1)

11.3 DC bus fuses

If lower output drive components (e.g., IndraDrive M or IndraDrive C) are also connected to the DC bus, the cross section has to be tapered.

For IndraDrive C/M series drive components, sizes between 110 and 350 A can be connected with a maximum DC bus cable length of 2 m without DC bus fuses.

For drive components lower than 110 A or a DC bus cable length over 2 m, DC bus fuses should be installed.

11.4 Aluminum contact points and cupal disks

11.4.1 Introduction

The following components have **aluminum contact points**:

- Preconnected choke
- Chopper choke
- DC bus choke

Aluminum contact points require a specific screw connection for establishing contact.

11.4.2 Preparation

The aluminum contact points come prepared for instant connection and do not need to be adapted when installed for the first time. The contact points are clean and have an anticorrosive coating.

The components with aluminum contact points come with bimetallic **cupal disks**. Cupal is a composite made of copper (Cu) and aluminum (Al).

Use cupal disks whenever contact is established between the aluminum contact point and any material other than aluminium.

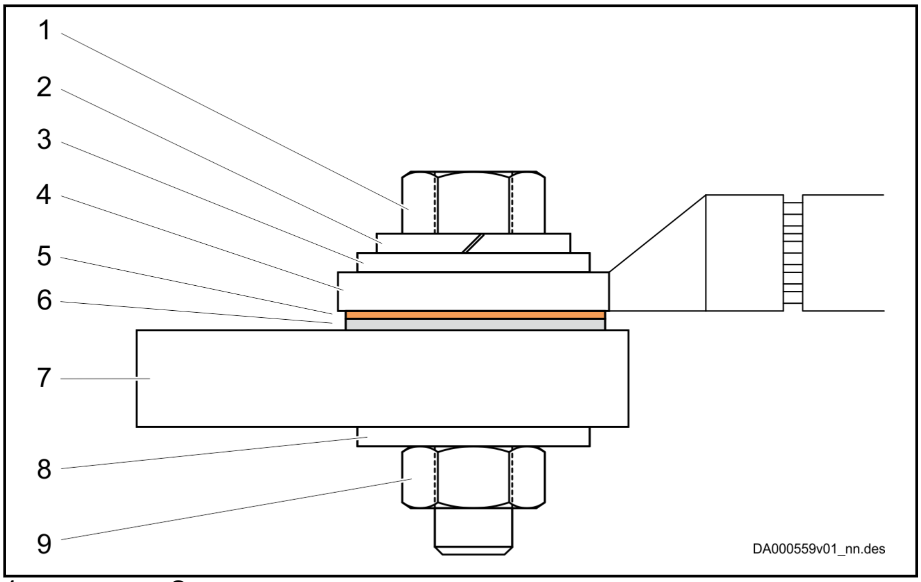
Clean both sides of the cupal disks with abrasive fleece before connecting them, and then grease the cupal disks with a thin layer of contact grease.

If the connection is opened after operation, abrade and grease the connections and the cupal disks again.

11.4.3 Cupal disk

The aluminum side of the cupal disk always has to have direct contact to the aluminum contact point!

If contact is established on both sides of the aluminum contact point, also use a cupal disk on the opposite side.



1	Screw
2	Spring washer
3	Washer
4	Ring terminals
5	**Cupal disk (copper side)**
6	**Cupal disk (aluminum side)**
7	**Aluminum contact point**
8	Washer
9	Nut

Fig. 11-4: Connecting an aluminum contact point using a cupal disk

Tightening torque

NOTICE **Risk of damage from mechanical stress!**

Keep the aluminum contact point from inadmissible mechanical stress:

Always **hold the aluminum contact point and ring terminal in place** when tightening the screw connection.

Screw	Tightening torque [Nm]
M4	1.9
M5	3.7
M6	6.3
M8	15
M10	30
M12	52

Tab. 11-7: Tightening torque

Protection against corrosion

To protect the connection against corrosion, apply a thin layer of anticorrosive paste (contact grease) to the connection.

Suitable anticorrosive paste: acid- and alkali-free petrolatum

11.5 Determining the leakage capacitance

The capacitances that generate so-called leakage currents against ground at the inverter outputs are referred to as leakage capacitance C_{ab}. The relevant values for the total value of leakage capacitance C_{ab_g} are:

- Capacitances of output filters
- Capacitances of power cables (capacitance per unit length against shield and ground wire)
- Capacitances of motors (winding capacitance against housing)

Leakage capacitance consists of the power cable and motor values for all individual drives operated on the mains filter.

Calculation:

$$C_{ab\_g} = C_{ab\_Mg} + C_{ab\_Kg}$$

C_{ab_g} Total value of leakage capacitance
C_{ab_Mg} Total value of motor leakage capacitance
C_{ab_Kg} Total value of cable leakage capacitance

Fig. 11-5: Total leakage capacitance

The total capacitance C_{ab_Mg} is the sum of the capacitances of the individual motors. See motor documentation for these capacitances.

$$C_{ab\_Mg} = C_{ab(Motor\_1)} + C_{ab(Motor\_2)} \cdots + C_{ab(Motor\_n)}$$

$C_{ab(motor)}$ Leakage capacitance of a motor

Fig. 11-6: Total leakage capacitance of motor

$$C_{ab\_Kg} = C_{Y\_K\,typ\,(K1)} \times l_{(K1)} + C_{Y\_K\,typ\,(K2)} \times l_{(K2)} \cdots + C_{Y\_K\,typ\,(Kn)} \times l_{(Kn)}$$

$C_{Y\_K\,typ}$ Capacitance per unit length of cables
C_{ab_Kg} Total leakage capacitance of cables

Fig. 11-7: Total leakage capacitance of cables

The total capacitance C_{ab_Kg} is the sum of capacitances of the individual power cables. See the technical data of the power cables for these capacitances per unit length.

11.6 Leakage capacitances

11.6.1 Leakage capacitance of power cables

The "RKL" series power cables (bulk cables) from Rexroth have the following capacitances per unit length. The values refer to the sum of the individual capacitances of power cores 1, 2 and 3 against the overall shield.

See also Rexroth connection cables - bulk cables data sheet.

Leakage capacitance is specified in C per cable. In the case of parallel connection, the total value is the sum of individual cables.

Excerpt of data sheet on bulk cables

Type	Power core cross section	Leakage capacitance
	mm^2	$C_{Y\_K\_typ}$ nF/m
INK0653	1.0	0.6
INK0650	1.5	0.8
INK0602	2.5	0.7
INK0603	4.0	0.8
INK0604	6.0	0.8
INK0605	10.0	1.0
INK0606	16.0	1.2
INK0607	25.0	1.1
INK0667	35.0	1.2
INK0668	50.0	1.3
		Last modification: 2007-11-08

Tab. 11-8: INK - technical data (excerpt)

Excerpt of data sheet on bulk cables

Type	Power core cross section	Leakage capacitance $C_{Y\_K\_typ}$
	mm^2	nF/m
REH0800	2.5	0.2

Tab. 11-9: REH - technical data (excerpt)

☞ The rough calculation with the following values is allowed:

- Cross section 1 … 6 mm^2: 1 nF/m
- Cross section 10 … 50 mm^2: 1.2 nF/m
- Cross section 50 … 300 mm^2: 1.3 nF/m

11.7 Total Harmonic Distortion (THD)

The parameters individually set for drive control have a strong influence on the **THDi** (mains current) and **THDu** (mains voltage) values. Therefore, the table shows typical values for the parameters set by default.

Size	Mains voltage [VAC]	Chopper frequency [KHz]	THDi mains current [%]	THDu mains voltage [%]	Load
HMU05.1-F0140	400	4.2	3,993	4,940	Partial load 50%
HMU05.1-F0140	400	4.2	4,332	4,843	Nominal load
HMU05.1-F0140	400	4.2	2,529	4,851	Peak load
HMU05.1-F0140	500	4.2	3,622	4,272	Partial load 50%
HMU05.1-F0140	500	4.2	2,217	3,882	Nominal load
HMU05.1-F0140	500	4.2	1,585	3,904	Peak load
HMU05.1-F0170	400	4.2	2,489	4,014	Partial load 50%
HMU05.1-F0170	400	4.2	0,785	4,867	Nominal load
HMU05.1-F0170	400	4.2	1,262	5,157	Peak load
HMU05.1-F0170	500	4.2	3,786	3,455	Partial load 50%
HMU05.1-F0170	500	4.2	0,453	4,150	Nominal load
HMU05.1-F0170	500	4.2	2,135	4,564	Peak load
HMU05.1-F0220	400	4.2	3,189	4,224	Partial load 50%
HMU05.1-F0220	400	4.2	2,247	1,646	Nominal load
HMU05.1-F0220	400	4.2	2,244	2,482	Peak load
HMU05.1-F0220	500	4.2	4,871	3,620	Partial load 50%
HMU05.1-F0220	500	4.2	1,427	4,687	Nominal load
HMU05.1-F0220	500	4.2	1,797	5,155	Peak load
HMU05.1-F0270	400	4.2	2,780	1,577	Partial load 50%
HMU05.1-F0270	400	4.2	2,012	3,197	Nominal load
HMU05.1-F0270	400	4.2	3,335	2,009	Peak load
HMU05.1-F0270	500	4.2	3,205	3,406	Partial load 50%
HMU05.1-F0270	500	4.2	1,245	3,805	Nominal load
HMU05.1-F0270	500	4.2	1,820	0,954	Peak load

Size	Mains voltage [VAC]	Chopper frequency [KHz]	THDi mains current [%]	THDu mains voltage [%]	Load
HMU05.1-F0340	400	4.2	3,087	3,152	Partial load 50%
HMU05.1-F0340	400	4.2	2,201	3,617	Nominal load
HMU05.1-F0340	400	4.2	1,983	3,824	Peak load
HMU05.1-F0340	500	4.2	3,265	2,870	Partial load 50%
HMU05.1-F0340	500	4.2	2,447	3,391	Nominal load
HMU05.1-F0340	500	4.2	2,112	3,554	Peak load
HMU05.1-F0430	400	4.2	5,076	3,511	Partial load 50%
HMU05.1-F0430	400	4.2	3,781	3,925	Nominal load
HMU05.1-F0430	400	4.2	3,440	3,948	Peak load
HMU05.1-F0430	500	4.2	4,911	3,338	Partial load 50%
HMU05.1-F0430	500	4.2	3,887	3,789	Nominal load
HMU05.1-F0430	500	4.2	3,772	3,892	Peak load
HMU05.1-F0540	400	4.2	3,175	3,334	Partial load 50%
HMU05.1-F0540	400	4.2	2,344	3,784	Nominal load
HMU05.1-F0540	400	4.2	2,080	3,869	Peak load
HMU05.1-F0540	500	4.2	3,352	3,121	Partial load 50%
HMU05.1-F0540	500	4.2	2,467	3,600	Nominal load
HMU05.1-F0540	500	4.2	2,378	3,729	Peak load

Tab. 11-10: Total Harmonic Distortion (THD)

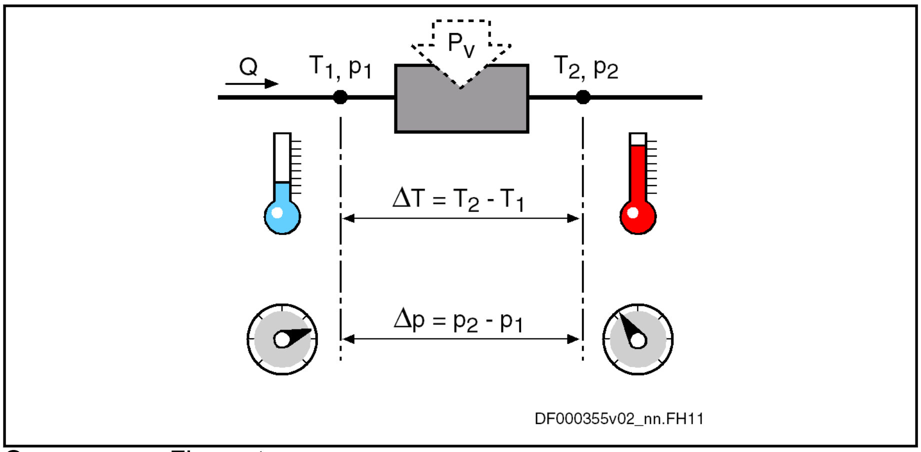
11.8 Liquid cooling

11.8.1 Sizing liquid cooling

Calculation criteria

Physical data

The figure below shows the fundamental physical data of a liquid-cooled drive component.



Q	Flow rate
$\Delta T = T_2 - T_1$	Temperature increase
$\Delta p = p_2 - p_1$	Pressure decrease
P_v	Power dissipation to be discharged

Fig. 11-8: Physical data

Flow rate

Flow rate

Coolant flows through liquid-cooled components. The flow rate Q indicates how much coolant volume ΔV per time interval Δt flows through the component.

$$Q = \frac{\Delta V}{\Delta t}$$

Q	Flow rate in l/min
ΔV	Coolant volume in l
Δt	Time interval in minutes in which ΔV flows

Fig. 11-9: Flow rate

Calculating the required flow rate

If the power dissipation P_V and the coolant are known, the required flow rate Q can be calculated with a selected coolant temperature increase ΔT.

The required flow rate Q can be calculated from the physical data of the component being cooled.

$$Q = \frac{P_V \times 60}{\Delta T \times \rho \times c}$$

P_V	Power dissipation to be discharged in kW
ΔT	Temperature rise of coolant in K
ρ	Density of coolant in kg/l
c	Specific thermal capacity of coolant in kJ/kgK

Fig. 11-10: Calculating the flow rate

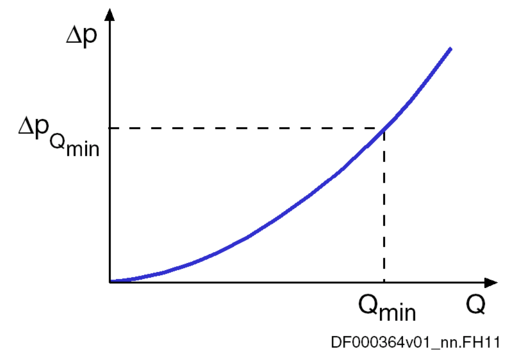
The flow rates are indicated in the technical data of the liquid-cooled components (referring to a fixed temperature increase of the coolant water). For any other temperature increase, calculate the flow rate using the above formula.

Pressure decrease

The coolant flow in a drive component is subject to changes in volume and direction. This results in losses in the drive components due to friction and change of direction. These losses cause the pressure decrease Δp.

The flow diagram shows how the pressure decrease Δp depends on the flow rate Q of a specific component.

Flow diagram



Δp	Pressure decrease
Δp_{Qmin}	Pressure decrease for Q_{min}
Q	Flow rate
Q_{min}	Min. required flow rate (see technical data for each component)

Fig. 11-11: Flow diagram

All other parts of the cooling system through which the coolant flows (tubes, valves, etc.) also cause pressure decreases.

Calculating pressure decrease

The pressure decrease Δp in liquid-cooled drive components is indicated in the technical data of each drive component. It refers to the indicated flow rate of the coolant water. These pressure decrease values only refer to drive components from Rexroth. The pressure decrease caused by equipment connected by the customer, such as screw connections, connecting bends, hose nozzles, etc., must be added to the pressure decrease of the drive component.

The flow rate-based pressure decrease can be calculated with the following formula:

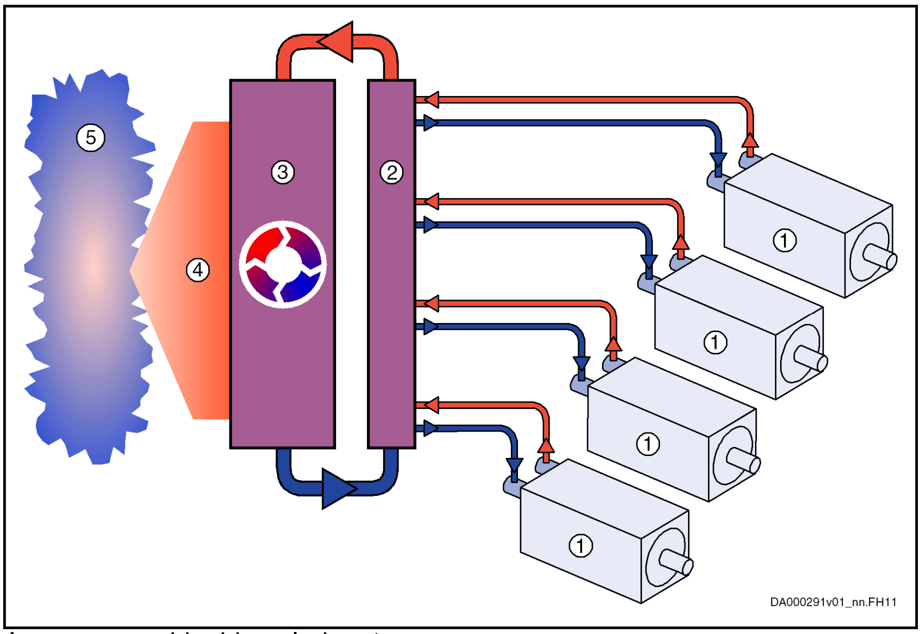
$$\Delta p = K_{\Delta p} \times Q^{1.75}$$

Δp	Pressure decrease
$K_{\Delta p}$	Constant (see technical data for each component)
Q	Flow rate in l/min

Fig. 11-12: Pressure decrease vs. flow rate

Sizing aids

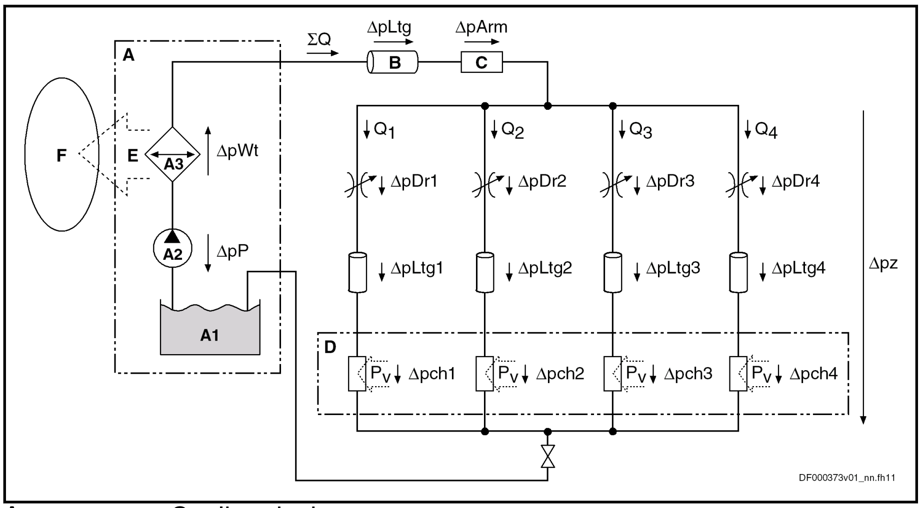
The following sizing aids are based on a cooling system with four motors connected in parallel.



1	Liquid-cooled motor
2	Main distributor of cooling liquid
3	Cooling device (cooling or refrigerating unit)
4	Heat dissipation
5	Higher-level cooling medium

Fig. 11-13: Arrangement with liquid-cooled motors

Liquid cooling circuit diagram



A	Cooling device
A1	Coolant container
A2	Coolant pump
A3	Heat exchanger
B	Coolant lines
C	Fittings
D	Drive components being cooled
E	Heat transfer
F	Higher-level cooling medium
Q	Flow rate
Δp	Pressure decrease (Ftg: fittings; Dc: drive components; Chk: choke; L: line; P: coolant pump; He: heat exchanger)
ΔP_v	Power dissipation of a drive component being discharged

Fig. 11-14: Liquid cooling circuit diagram for four liquid-cooled drive components

Sizing a cooling system

Liquid-cooled drive components have been selected

Gather technical data (for ΔT = 10 K)

(see below "Form: Collecting technical data")

Temperature increase = 10 K?

No: Convert technical data

Yes

Check requirements and ambient conditions:

- Temperature control precision?
- Which higher-level cooling medium can be used?

Select cooling device:

- Cooling capacity $P \geq \Sigma P_v$
- Type of cooling device?
  - Air-liquid cooling unit (P_{01} = kW/K)
  - Liquid-liquid cooling unit (P_{01} = kW/K)
  - Refrigerating unit (P_{Refrig} = kW)

Make installation plan:

- Components: determine interconnection (series/parallel)
- Lines: determine lengths and diameters

Size coolant pump:

- Fluidic data of cooling system branches
- Parallel connection of branches
- Series connection of branches
- Pressure decrease in overall system
- Working point of pump:
  - ΔH = ……… m
  - Q_p = ……… l/min

(see below "Form: Sizing a coolant pump")

$\Sigma \Delta p$ > 3000 hPa ?

Yes: Increase temperature difference?

No (Increase temperature difference?): back to "Check requirements and ambient conditions"

Yes (Increase temperature difference?): Go to "Convert technical data"

No ($\Sigma \Delta p$ > 3000 hPa ?): Tank volume of cooling device:

V_{Tank} = ………… l

Sizing complete

Tab. 11-11: Sizing a cooling system

Form: Gathering technical data

Drive component	P_v [kW] Coolant	P_v [kW] Air	Q [l/min]	Δp [hPa]	ΔT [°C]	V [l]
	ΣP_{vCl}	ΣP_{vAir}				

Tab. 11-12: Gathering technical data

Form: Sizing a coolant pump

Fluidic data of cooling system branches									
Cooling system branch				1	2	3	4	5	…
Drive component	Type designation								
	Flow rate	Q_{chn}	l/min						
Pressure decreases	Coolant line	Length l_n	m						
		Added length l_{add}	m						
		Ø d	mm						
		$\Delta p_L/\Delta l$ for Q_{ch}	hPa/m						
		Δp_{Ln}	hPa	+	+	+	+	+	+
	Drive component	Δp_{chn}	hPa	+	+	+	+	+	+
	Additional component	Δp_{Add}	hPa	+	+	+	+	+	+
Total pressure decrease:	Without choker valve	Δp_{Bn}	hPa	=	=	=	=	=	=
(Only with parallel connection)	With choker valve [1]	Δp_{Bn}	hPa	=	=	=	=	=	=
Parallel connection of branches no. ……………									
Total pressure decrease		Δp_b	hPa						

Total flow rate	With choker valve [1)]	ΣQ_{ch}	l/min						
	Without choker valve [2)]	Approximation Q_{chn}	l/min						
		ΣQ_{ch}	l/min						
Series connection of branches no. ……………									
Total pressure decrease		$\Sigma \Delta p_{Bn}$	hPa						
Total flow rate		ΣQ_{chnmax}	l/min						
Pressure decrease in overall system									
	Cooling system branches	Δp_B or Σp_{Bn}	hPa	+					
	Coolant line	Length l_0	m						
		Added length l_{add0}	m						
		Diameter d_0	mm						
		ΣQ_{ch}	l/min						
		$\Delta p_L/\Delta l$ for Q_{ch}	hPa/m						
		Δp_L	hPa	+					
	Heat exchanger	Δp_{He}	hPa	+					
	Fittings	Δp_{Ftg}	hPa	+					
	Additional component	Δp_{Add}	hPa	+					
	Overall cooling system	Δp_{Cs}	**hPa**	+					
Working point of coolant pump									
	Required delivery height	ΔH	m						
	Required delivery rate	Q_P	l/min						

1) The required coolant flow Q_{chn} is set with the choker valve in the cooling system branch.

2) The coolant flow Q_{chn} is set according to the pressure decrease over the cooling system branches Δp_b.

Tab. 11-13: Form for sizing coolant pump

11.8.2 Sizing example

The calculation for the cooling device is shown using a drive system to clarify the sizing calculation.

Components

- 1x supply unit with P = 400 kW
- 1x drive controller with P = 250 kW
- 1x drive controller with P = 132 kW

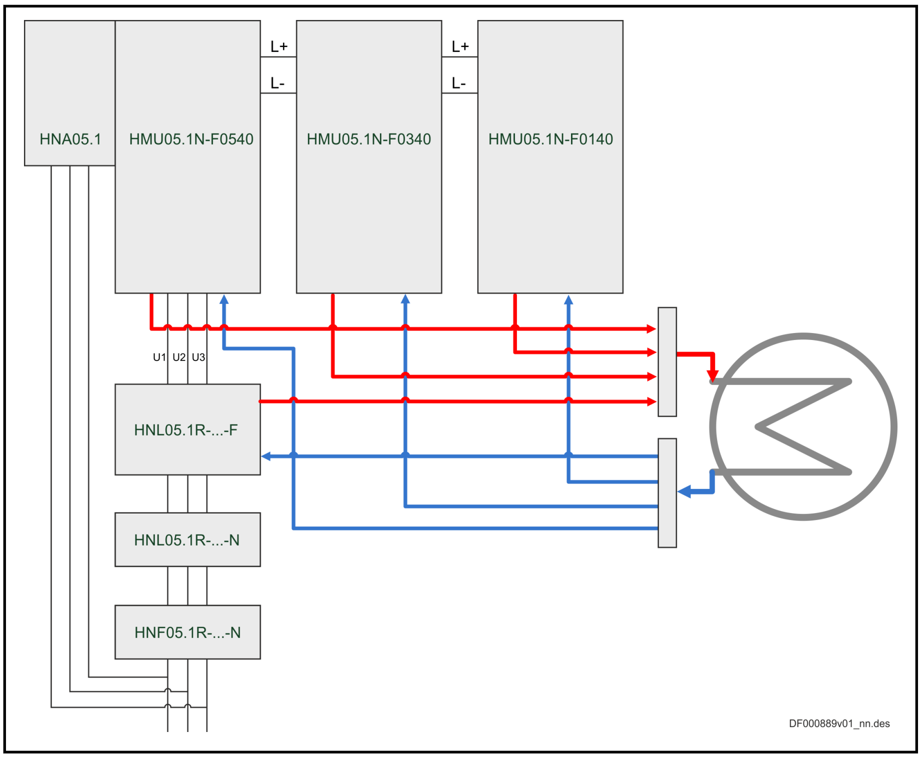


Fig. 11-15: Components

Form: Gathering technical data (for temperature increase = 10 K)

Drive component	P_v [kW] Coolant	P_v [kW] Air	Q [l/min]	Δp [hPa]	ΔT [°C]	V [l]
HMU05.1N-F0540	7.5	1.2	15.8	1.3	10	xxx
HMU05.1N-F0340	4.5	1	9	0.6		xxx
HMU05.1N-F0140	2.5	0.5	4.5	0.4		xxx
HNL05.1R	4	1.8	10	1.5		xxx
HNA05.1	-	0.15				
	ΣP_{vCl} = 18.5 kW	ΣP_{vAir} = 4.65 kW				ΣV_{ch} xxx

Tab. 11-14: Gathering technical data

Coolant

The coolant should be a 4:1 mixture of water and Antifrogen N or L (e.g., Ri-Frost 1:4 from Rittal).

Do **not** mix Antifrogen N with Antifrogen L. When switching the coolant (N for L or vice-versa), thoroughly rinse out all components and lines before adding the new coolant.

Maximum coolant temperature

At nominal power dissipation, the temperature increase in the coolant is 10 K at the indicated minimum flow rates. If the maximum coolant inlet temperature is 60°C, the maximum coolant temperature is 70°C.

Requirements for ambient conditions

No higher-level liquid cooling system is available at the installation site. The requirements on the temperature accuracy of the coolant are low (±5 K).

Selecting the cooling device

The absorbed thermal energy should be dissipated into the ambient air with an air-liquid cooling unit.

The cooling liquid must dissipate 18.5 kW of heat output into the ambient air. The maximum expected air temperature is 35°C.

Specific cooling capacity:

$$P_{01} = \frac{\Sigma P_V}{(T_{ein} - T_{amb})}$$

ΣP_V = 18.5 kW (sum of power dissipations from technical data of drive components)

T_{in} = 60°C, max. coolant inlet temperature into cooling unit

T_{amb} = 35°C according to ambient conditions

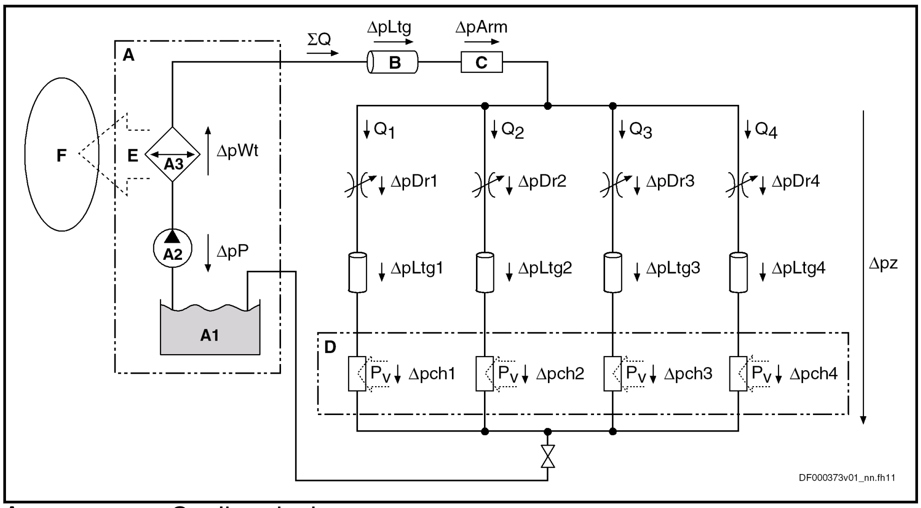
P_{01} = 18.5 ÷ (60 - 35) = 0.74 kW/°C

In addition, a cooling device should be installed on the control cabinet that can absorb the power of 4.65 kW dissipated into the air.

Fluidic interconnection

Due to the very different coolant flow rates of the drive components, the fluidic connection of the cooling system branches for the drive components is in parallel.

Creating an installation plan



A	Cooling device
A1	Coolant container
A2	Coolant pump
A3	Heat exchanger
B	Coolant lines
C	Fittings
D	Drive components being cooled
E	Heat transfer
F	Higher-level cooling medium
Q	Flow rate
Δp	Pressure decrease (Ftg: fittings; Dc: drive components; Chk: choke; L: line; P: coolant pump; He: heat exchanger)
ΔP_v	Power dissipation of a drive component being discharged

Fig. 11-16: Liquid cooling circuit diagram

Sizing the coolant pump

Fluidic data of cooling system branches								
Cooling system branch				1	2	3	4	…
Drive component	Type designation							
	Flow rate	Q_{chn}	l/min					
Pressure decreases	Coolant line	Length l_n	m					
		Added length l_{add}	m					
		Diameter d	mm					
		$\Delta p_L/\Delta l$ for Q_{ch}	hPa/m					
		Δp_{Ln}	hPa					
	Drive component	Δp_{chn}	hPa					
	Additional component	Δp_{Add}	hPa	+ /	+ /	+ /	+ /	
Total pressure decrease:	Without choker valve	Δp_{Bn}	hPa					
(Only with parallel connection)	With choker valve 1)	Δp_{Bn}	hPa					

Parallel connection of branches no.1, 2, 3, 4								
Total pressure decrease		Δp_b	hPa					
Total flow rate	With choker valve 1)	ΣQ_{ch}	l/min					
	Without choker valve 2)	Approximation Q_{chn}	l/min	/	/	/	/	
		ΣQ_{ch}	l/min	/				
Series connection of branches no. ………………								
Total pressure decrease		$\Sigma \Delta p_{Bn}$	hPa					
Total flow rate		ΣQ_{chnmax}	l/min					
Pressure decrease in overall system								
	Cooling system branches	Δp_B or Σp_{Bn}	hPa					
	Coolant line	Length l_0	m					
		Added length l_{add0}	m					
		Diameter d_0	mm					
		ΣQ_{ch}	l/min					
		$\Delta p_L/\Delta l$ at ΣQ_{ch}	hPa/m					
		Δp_L	hPa					
	Heat exchanger	Δp_{He}	hPa					
	Fittings	Δp_{Ftg}	hPa					
	Additional component	Δp_{Add}	hPa	+ /				
	Overall cooling system	Δp_{Cs}	**hPa**					
Working point of coolant pump								
	Required delivery height	ΔH	m					
	Required delivery rate	Q_P	l/min					

1) The required coolant flow Q_{chn} is set with the choker valve in the cooling system branch.

2) The coolant flow Q_{chn} is set according to the pressure decrease over the cooling system branches Δp_b.

Tab. 11-15: Sizing the coolant pump

Since the pressure decrease of the overall cooling system falls below the permitted input pressure, the coolant pump has been sized.

Tank

$$V_T = V_{Ks} + 1,3 \times V_{T\_min}$$

$$V_{Ks} = V_{Wt} + V_{Arm} + V_{ch} + V_{Ltg}$$

whereby

V_{He} = ……… from the heat exchanger manufacturer's specifications

V_{Ftg} = ……… from the specifications of the fittings manufacturer

V_{Dc} = ……… gathered from the technical data of the drive components

V_L= line lengths x flow cross-section

V_{Dist} = as indicated by the distributor manufacturer

Conclusion

The data determined for the cooling device can be retained in the procedure diagram. This data can be used to contact the supplier of the cooling device.

Index

Index

Index

Notes

The Drive & Control Company

Rexroth
Bosch Group

Bosch Rexroth AG
Electric Drives and Controls
P.O. Box 13 57
97803 Lohr, Germany
Bgm.-Dr.-Nebel-Str. 2
97816 Lohr, Germany
Phone +49 9352 18 0
Fax +49 9352 18 8400
www.boschrexroth.com/electrics

R911344279

DOK-INDRV*-HXX05******-PR02-EN-P