rexroth
A Bosch Company

IndraDrive ML

Drive Systems with HMU05

Project Planning Manual
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Edition 03

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1 System presentation

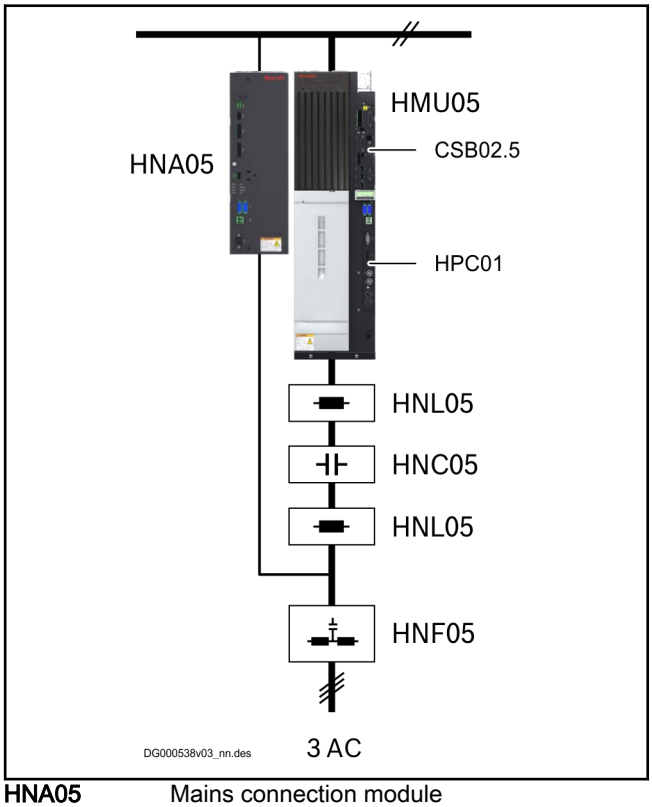
1.1 Rexroth IndraDrive ML range

1.1.1 Overview – Rexroth IndraDrive ML

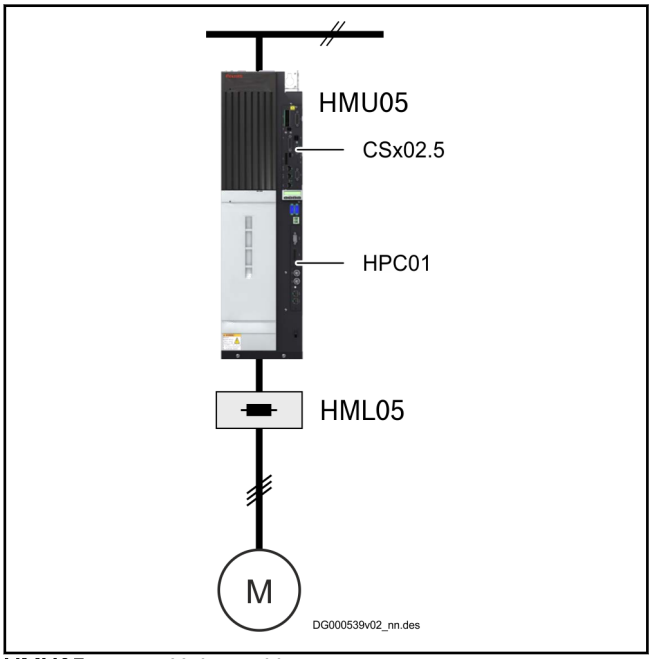
Rexroth IndraDrive ML
HMU05
DG000573v01_nn.tif

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

Supply unit	Drive controller



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



HMU05 Universal inverter
CSx02.5 Control section with firmware for drive controllers (FWA-INDRV*-**MPx**-…)
HPC01 Motor/mains module
HML05 Motor choke (optional)
Fig. 1-2: Drive controller components

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 • Winding machine • Straightener drives • Profiler drives
	Plastics • Extruders • Kneaders • Pumps • Injector and profiling axis drives
	Maritime / offshore applications • Ship elevators • Fishing winches • Anchor handling winches • Nautical winches
	Metallurgy • Roller conveyors • Transfer lifters
	Others • Paper manufacturing (pumps, rollers) • Printing machines (winding computation, cross cutters, rollers) • General automation (pumps, cranes, test stands)

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 or air cooling

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

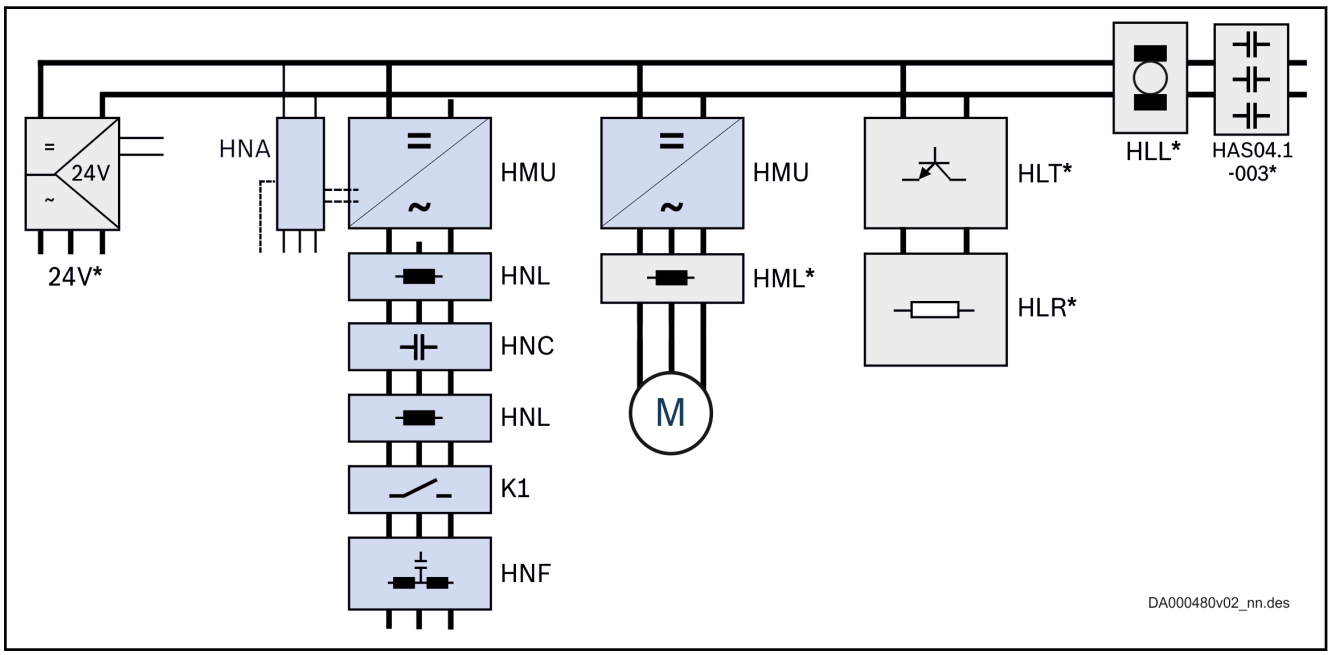
Encoder systems with a supply voltage of **5 and 12 V**:

- 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
- 5-V-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
24V	24V power supply unit (AC/DC power supply unit; optional DC/DC power supply unit for redundancy in the case of mains failure)
HAS04.1-003	DC bus ground capacitor pairs
HLL	DC bus choke
HLR	Braking resistor
HLT	Braking unit
HML	Motor choke
HMU	Universal inverter
HNA	Mains connection module
HNC	Mains capacitor
HNF	Mains filter
HNL	Choke
K1	Mains contactor
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	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	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
⑦	**Degree of protection:** N = IP00
⑧	**Mains connection voltage / Nominal DC bus voltage:** A4-D7 = supply unit: 3 x AC 380 V -15% ... 500 V +10%; inverter: DC 750 V A5-11 = supply unit: 3 x AC 525 V -15% ... 690 V +10%; inverter: DC 1100 V
⑨	**Parallel operation:** N = Parallel operation is not possible P = Parallel operation is possible

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	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								

⑩	**Motor/mains module connection:** B = Not equipped (with blank cover at motor/mains module connection and control section connection) 1 = Equipped
⑪	**Parallel module connection:** B = Not equipped, with blank cover 1 = Equipped N = Without
⑫	**Other design:** NNNN = None ND01 = DC voltage NS01 = Modified maximum currents in a standstill position MNNN = Design for maritime applications

Tab. 1-4: HMU05, type code

		DC bus continuous power / Maximum current												
		0140-0350	0170-0430	0220-0510	0270-0660	0340-0820	0430-1040	0540-1300	0140-0210	0170-0250	0220-0300	0270-0370	0400-0600	0540-0750
Mains connection voltage / Nominal DC bus voltage	A4-D7	✓	✓	✓	✓	✓	✓	✓	–	–	–	–	–	–
	A5-11	–	–	–	–	–	–	–	✓	✓	✓	✓	✓	✓
Cooling type	F	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	W	✓	✓	✓	✓	✓	–	–	–	–	–	–	–	–

Tab. 1-5: DC bus continuous power / Maximum current

		Other design				Parallel operation	
		MNNN	NNNN	NS01	ND01	N	P
Mains connection voltage / Nominal DC bus voltage	A4-D7	✓	✓	✓	✓	✓	✓
	A5-11	✓	–	–	✓	–	✓
DC bus continuous power ./ Maximum current	0140-0350	✓	✓	✓	✓	✓	✓
	0170-0430	✓	✓	✓	✓	✓	✓
	0220-0510	✓	✓	✓	✓	✓	✓
	0270-0660	✓	✓	✓	✓	✓	✓
	0340-0820	✓	✓	✓	✓	–	✓
	0430-1040	✓	✓	–	✓	–	✓
	0540-1300	✓	✓	–	✓	–	✓
	0140-0210	✓	–	–	✓	–	✓
	0170-0250	✓	–	–	✓	–	✓
	0220-0300	✓	–	–	✓	–	✓
	0270-0370	✓	–	–	✓	–	✓
	0400-0600	✓	–	–	✓	–	✓
	0540-0750	✓	–	–	✓	–	✓
Cooling type	F	✓	✓	✓	✓	✓	✓
	W	–	✓	–	✓	–	✓

Tab. 1-6: Other design, parallel operation

		Motor/mains module connection		Parallel module connection	
		B	1	B	1
Parallel operation	N	–	✓	–	–
	P	✓	✓	✓	✓

Tab. 1-7: Connection motor/mains module, parallel module

Our sales representative in charge will help you with the currently available designs.

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

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													

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. 1-8: CSB02.5 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:	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	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	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. 1-9: 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 interface[1)] (PROFIBUS, CANopen)[2)]	Alternative interface[1)] (Multi-Ethernet, PROFIBUS, CANopen)
Encoder evaluation	Multi-encoder interface	Multi-encoder interface
	Optional multi-encoder interface[1)]	Optional multi-encoder interface[1)]
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-S[3)]	MLD-S[3)] MLD-M[3)]
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. 1-10: BASIC vs. ADVANCED

Optional cards

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	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. 1-11: HPC01, type code

Optional card	Function
HPC01.1-MN01	Motor/mains module (permanently allocated) 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. 1-12: 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.

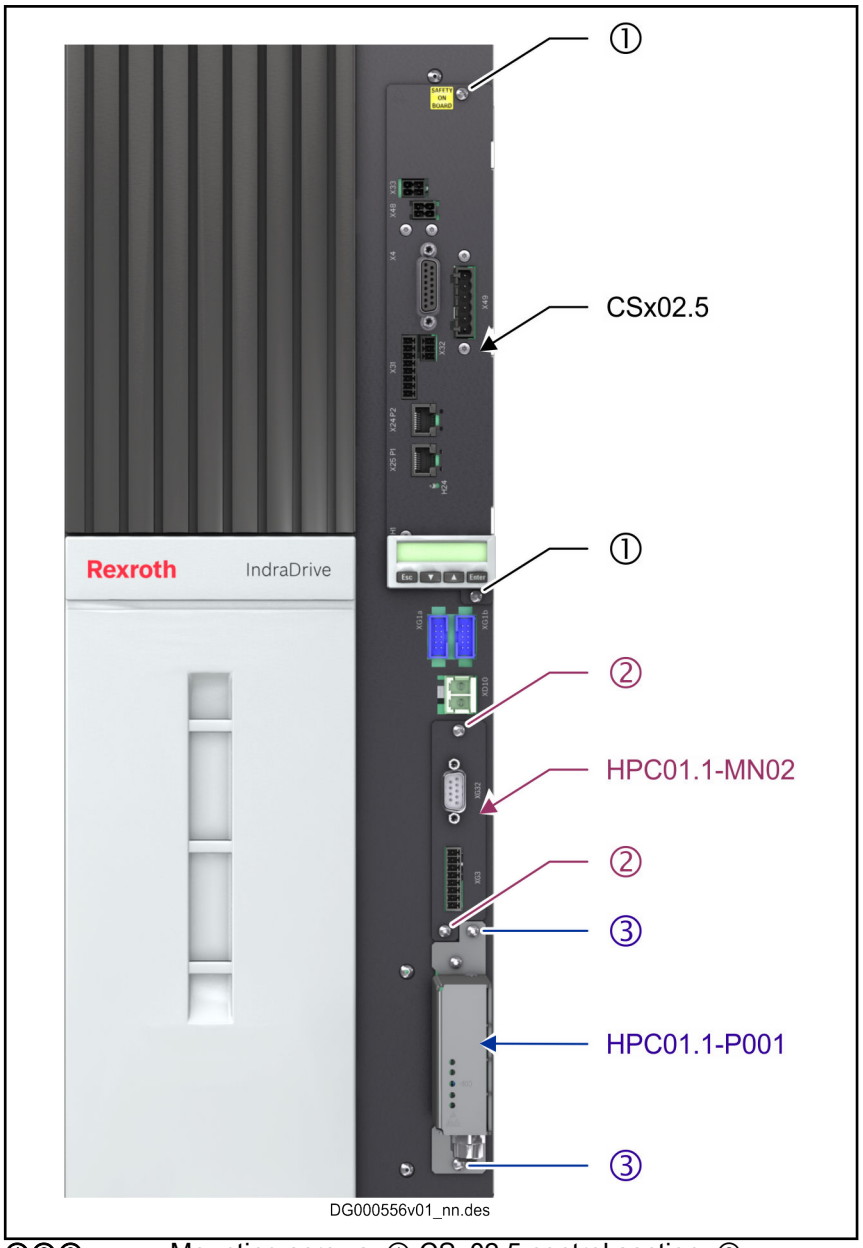
Limited number of plug-in actions

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. 1-13: 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. 1-14: 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 incorrect project planning for installations, machines and applications!**

Observe the contents of the documentation relevant to your drive system (see chapter "Documentations" on page 17).

This documentation contains

- 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

Editions of this documentation

Edition	Release date	Notes
01	2014-10	-
02	2016-09	-
03	2019-05	-

Tab. 1-15: Editions

Documentations

Drive systems, system components

Title	Type of documentation	Document typecode[1)] DOK-...	Material number de (en)
IndraDrive ML, Drive Systems with HMU05	Project Planning Manual	INDRV*-HXX05******-PRxx-EN-P	R911344278 (R911344279)
IndraDrive Control Sections CBS02, CSE02, CSH02, CDB02	Project Planning Manual	INDRV*-CXX02******-PRxx-EN-P	R911338961 (R911338962)
Offshore / Maritime; EMC, Design IndraDrive	Project Planning Manual	DRIVE*-CABINETMARE-PRxx-EN-P	R911394125 (R911394126)
Control Cabinet; Air Conditioning, EMC, Design, IP Code, Electrics, IndraDrive, Rexroth EFC/Fv, Sytronix	Project Planning Manual	DRIVE*-CABINET****-PRxx-EN-P	R911344987 (R911344988)

1) In the documentation 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. 1-16: Documentations – drive systems, system components

Firmware

Title IndraDrive ...	Type of documentation	Document typecode[1)] DOK-INDRV*-…	Material number de (en)
IndraDrive MPx-21 Functions	Application Manual	MP*-21VRS**-APxx-EN-P	R911385759 (R911385758)
IndraDrive Power Supply Basic PSB-21 Functions	Application Manual	PSB-21VRS**-APxx-EN-P	R911385755 (R911385754)
IndraDrive Power Supply Basic PSB-21 Version Notes	Release Notes	PSB-21VRS**-RNxx-EN-P	R911385753 (R911385752)
IndraDrive Power Supply Basic PSB-20 Functions	Application Manual	PSB-20VRS**-APxx-EN-P	R911345609 (R911345610)
IndraDrive Power Supply Basic PSB-20 Version Notes	Release Notes	PSB-20VRS**-RNxx-EN-P	R911345611 (R911345612)
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)
IndraDrive Power Supply Basic PSB-19 Functions	Application Manual	PSB-19VRS**-APxx-EN-P	R911345601 (R911345602)
MPx-16 to MPx-21 and PSB Parameters	Reference Book	GEN1-PARA**-RExx-EN-P	R911328650 (R911328651)
MPx-16 to MPx-21 and PSB Diagnostics	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)
IndraMotion MLD Libraries as of MPx-18	Reference Book	MLD-SYSLIB3-RExx-EN-P	R911338915 (R911338916)
IndraMotion MLD MPx-18 and above	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. 1-17: Documentations – firmware

Your comments

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

If you find any mistakes in this documentation or have suggestions for changes, please send your feedback to the following address:

Bosch Rexroth AG
Dept. DC-AE/EPI5
Bürgermeister-Dr.-Nebel-Str. 2
97816 Lohr am Main, Germany
Email: dokusupport@boschrexroth.de

2 Important directions for use

2.1 Intended use

2.1.1 Introduction

Rexroth products are developed and manufactured to the state-of-the-art. The products are tested prior to 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 as intended. Failure to use them in the intended way may cause situations resulting in property damage and personal injury.

☞ Rexroth as the manufacturer shall not honor any warranty, liability or compensatory claims for damages resulting from unintended use of the products. The user alone shall bear the risks of unintended use of the products.

Before using Rexroth products, make sure that all the prerequisites for an intended 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 intended use.
- Leave hardware products in their original state, i.e., do not make any structural modifications. It is not permitted to 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 as described in the relevant documentation.

2.1.2 Areas of use and application

Drive controllers 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. Components that are not expressly mentioned may neither be attached nor connected. The same applies to cables and lines.

Operation is only allowed in the specified configurations and combinations of the 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 functions specific to the 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 specified in this documentation, in the specified mounting position and under the specified ambient conditions (temperature, degree of protection, humidity, EMC, etc.).

2.2 Unintended use

"Unintended use" refers to using the drive controllers outside of the operating conditions, technical data and specifications described in this documentation.

Drive controllers must not be used, if …

- they are exposed to operating conditions that do not meet the specified 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. Therefore, please carefully follow the specifications outlined in the general safety instructions!

☞ Components of the Rexroth IndraDrive ML system 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.

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 grid 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.

---

3 Safety instructions for electric drives and controls

3.1 Definitions of terms

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.

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.

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

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.

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.

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.

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.

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.

Manufacturer 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.

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

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

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 Technology". 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 electrical 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 electrical components from the mains or from the power supply unit. Secure the electrical component from reconnection.
- With electrical components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electrical component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch. Measure the electrical voltage both conductor against conductor and conductor against ground (PE).

  Particularly if **DC bus ground capacitor pairs without discharging resistors (HAS04.1-003-NN1-NN)** are used, dangerous voltages against ground may be present for more than **24 hours** after the power supply was switched off. Only when voltage cannot be measured anymore between the positive and the negative DC bus connections is it allowed to discharge the DC bus ground capacitor pairs against ground. For this purpose, use the appropriate high-resistance device (e.g., DUSPOL® by "Benning Elektrotechnik und Elektronik GmbH & Co. KG"; observe the Operating Manual!).
- 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!

- 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 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 mm^2 (8 AWG), the alternative connection of two equipment grounding conductors is allowed, each having the same cross section as the outer conductors.

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

Tab. 3-1: Minimum cross section of 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 17

4.2 Brief description of the 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)

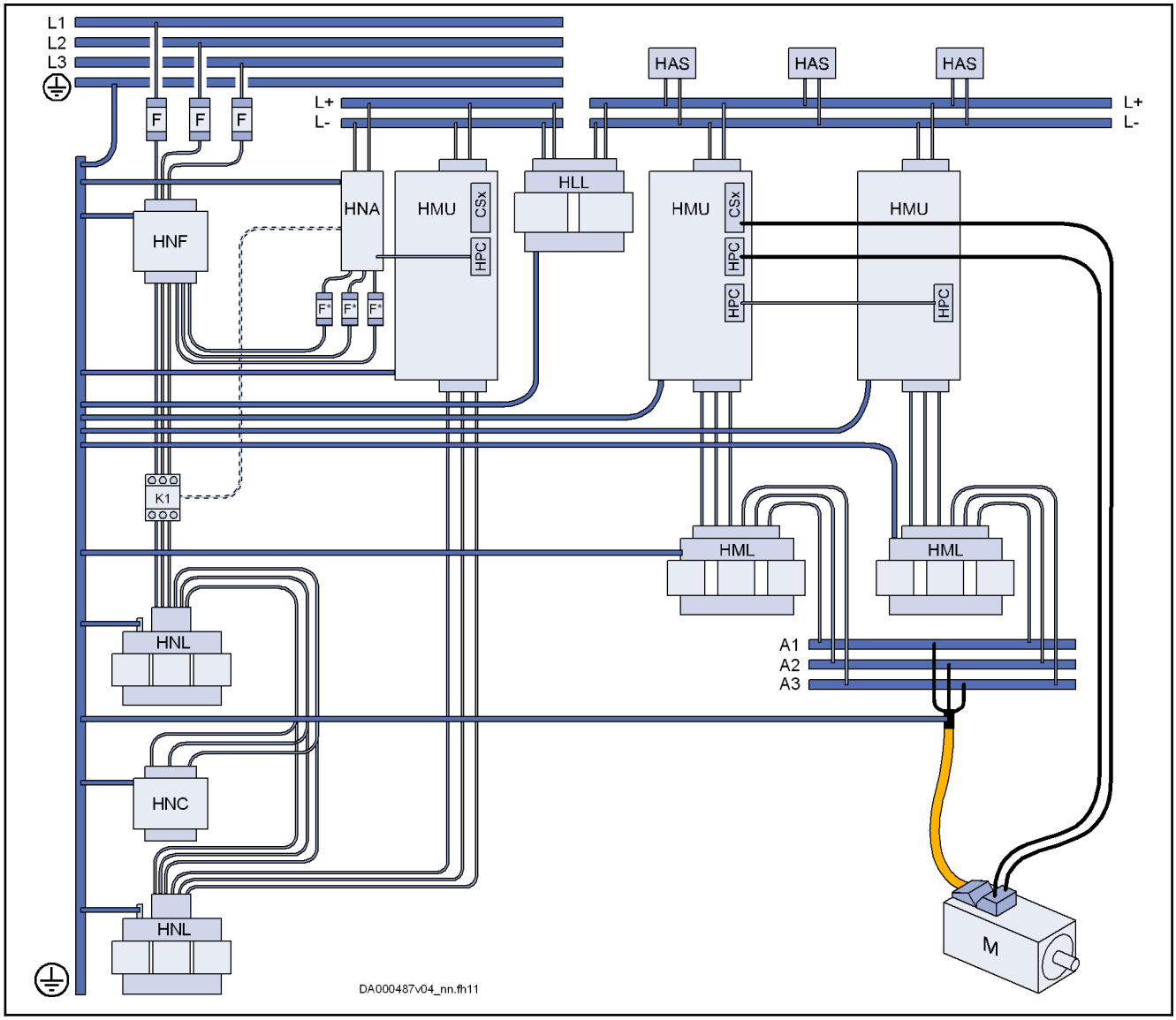
  Maximum DC bus voltage that can be set:

  – HMU05-…-A4-D7: DC 800 V
  – HMU05-…-A5-11: DC 1120 V

- **Supply unit** (HMU05 + HNA05 + firmware for supply units)

  Mains connection voltage:

  – HMU05-…-A4-D7: 3 AC 380 … 500 V
  – HMU05-…-A5-11: 3 AC 525 … 690 V



CSx	Control section
F	Fuse
HAS	DC bus ground 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 (controlled by HNA)
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 16.

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 properties.

☞ 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 motor filters

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

- Allowed voltage change (dv/dt) of third-party motor: **< 5 kV/µs**

- Permitted periodic peak voltage (crest value) of third-party motor between phase-phase and phase-housing:
  - With mains voltage 3 AC 380 V … 500 V: < 1500 V
  - With mains voltage 3 AC 525 V … 690 V: < 2200 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 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!

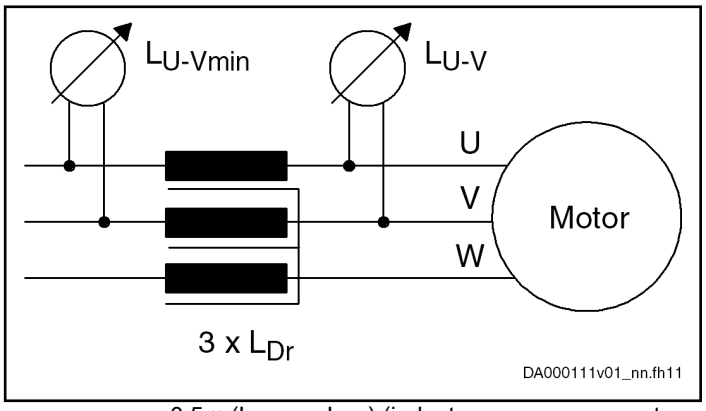
$L_{U-V} = U_{DC} \div (8 \times f_s \times \sqrt{2} \times I_{Type} \times 0.2)$
L_{U-V}: Minimum inductance (measured between 2 phases) in mH
U_{DC}: DC bus voltage (e.g. regulated DC bus 750 V_{DC} or 1100 V_{DC}; unregulated DC bus at 400 V_{AC} ⇒ 565 V_{DC})
f_s: Switching frequency in kHz
I_{Type}: Maximum current of drive controller according to the nameplate (rms value)

Tab. 4-1: Calculating the minimum inductance

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**.

Available third-party motor	Planned third-party motor
	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.
L_{Dr} = 0.5 × (L_{U-Vmin} - L_{U-V}) (inductance measurement with 1 kHz)	
Fig. 4-2: Mounting 3x L_{Dr} (three-phase choke)	
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.	

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 (maximum current of driver controller) and installation method of the motor power cable.
- **Leakage capacitance:** See chapter 4.3.4 "Leakage capacitances" on page 43

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.

See also chapter 11.7.1 "Determining the leakage capacitance" on page 615.

Maximum allowed leakage capacitances:

Supply units [1]	Derating	Maximum allowed leakage capacitance [nF] [2]	
		without HLL	with n×HLL + DC bus ground capacitor pairs
1 × HMU05-…-A4-D7	1	500	1200
n × HMU05-…-A4-D7	0.95	n_{HMU05} × 500 × 0.95	n_{HLL05} × 1200 × 0.95
1 × HMU05-…-A5-11	1	- [3]	800
n × HMU05-…-A5-11	0.95	- [3]	n_{HLL05} × 800 × 0.95

1) Number and operation mode (individual or parallel operation) of the HMU05 inverters are irrelevant.

2) Observe the allowed leakage capacitance of the motor/balancing chokes. See chapter "Data" on page 281

3) It is not allowed to operate HMU05-…-A5-11 without DC bus choke.

Tab. 4-5: Maximum allowed leakage capacitances

DC bus choke, DC bus ground capacitor pairs

NOTICE **It is possible to damage the DC bus ground capacitor pairs!**

If the leakage current is distributed unevenly, DC bus ground capacitor pairs may be overloaded and damaged!

Evenly distribute DC bus ground capacitor pairs in accordance with the leakage capacitances connected to the inverters.

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.

- HMU05…-A4-D7:

  Maximum of 3 DC bus chokes per supply line (HMU, HNL, HNC, HNF) allowed
- HMU05…-A5-11:

  Maximum of 2 DC bus chokes per supply line (HMU, HNL, HNC, HNF) allowed

  (In general, at least one DC bus choke is required.)

Normally, 3 DC bus ground capacitor pairs (HAS04.1-003) are assigned to each DC bus choke.

Example: 3 inverters at the DC bus with the same connected leakage capacitance. Consequently: 1 DC bus ground capacitor pair is connected at the DC bus of each inverter.

2 DC bus ground capacitor pairs per DC bus choke are sufficient if one of the following conditions has been fulfilled:

- *Any **additional** capacitance > 2 × 2.5 µF per DC bus choke that may be available.*

  Additional capacitances are, for example, axes from other device series (e.g. HMS01, HMS02 IndraDrive) with integrated DC bus ground capacitors and the leakage capacitances of the axes (motor cable, motor housing).
- *Clock frequencies ≥ 2 kHz and leakage capacitance < 600 nF (500-V series) or 400 nF (690-V series)*

  In the **entire** DC bus system, only clock frequencies ≥ 2 kHz are used and the leakage capacitance at the motor outputs of all axes supplied by the DC bus choke is in total < 600 nF (500-V series) or 400 nF (690-V series).

  When determining the lowest clock frequency, take the "PMW switching depending on load" and the "PWM switching depending on velocity" into account.

DC bus ground capacitor pair See chapter 8.3.7 "DC bus ground capacitor pair (HAS04.1-003)" on page 304.

DC bus choke See chapter 8.3.6 "HLL05 DC bus choke" on page 285.

Operating HMU05 together with HMS01/HMD01

☞ Only HMU05.1N-…-**A4-D7** may be operated together with HMS01/HMD01.

Topologies

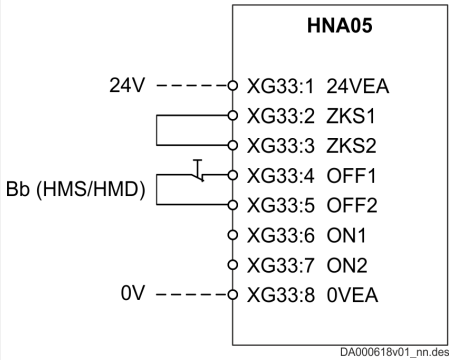
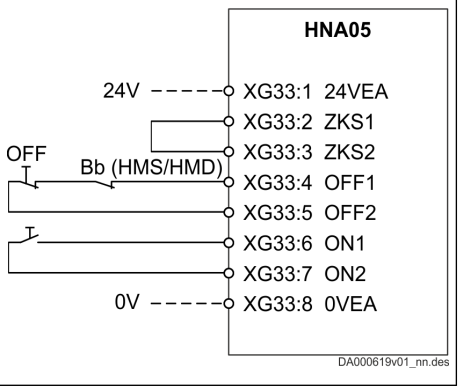
HMS01 or HMD01 drive controllers of the IndraDrive M product range may only be operated at HMU05 supply units, if at least one **HLL DC bus choke** with the corresponding **DC bus ground capacitor pairs** is used.

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 11.5 "DC bus fuses" on page 612.

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.

Control via communication	Control via HNA
	

Tab. 4-6: Wiring examples

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 DC bus continuous power of the respective drive system:

47 µF per kilowatt [kW] of DC bus continuous power

Mount **DC bus ground capacitor pairs** close to the HMS/HMD drive controllers.

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

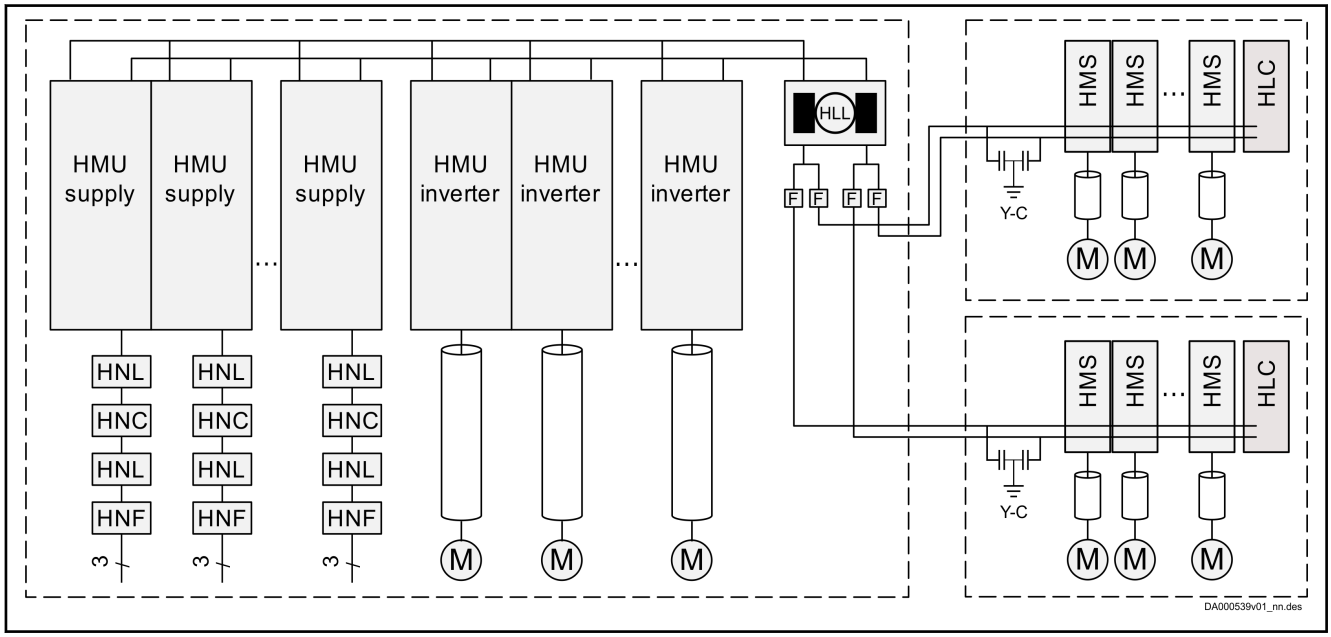


Fig. 4-3: HMU05 systems without a central DC bus choke

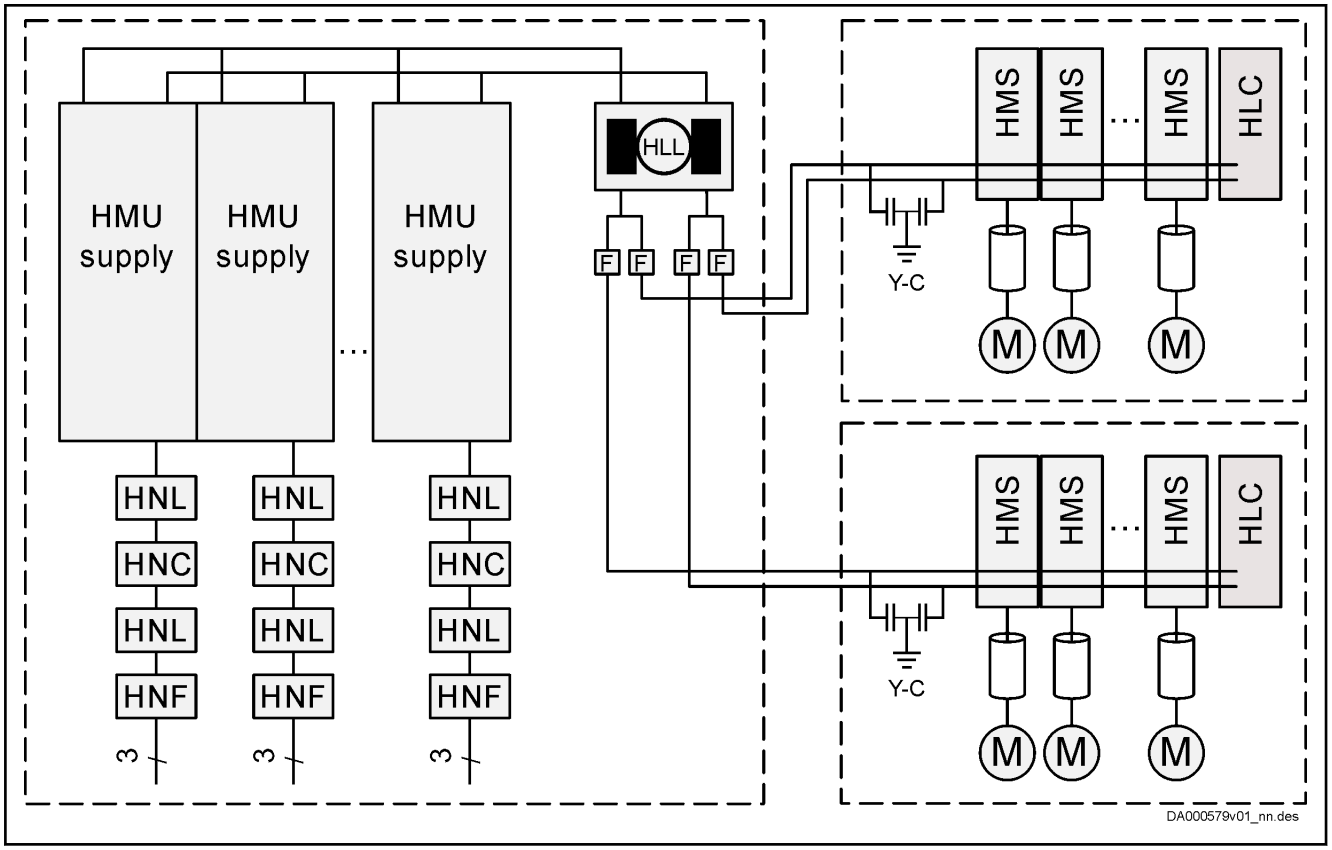


Fig. 4-4: HMU05 systems without a central DC bus choke and without an HMU05 inverter

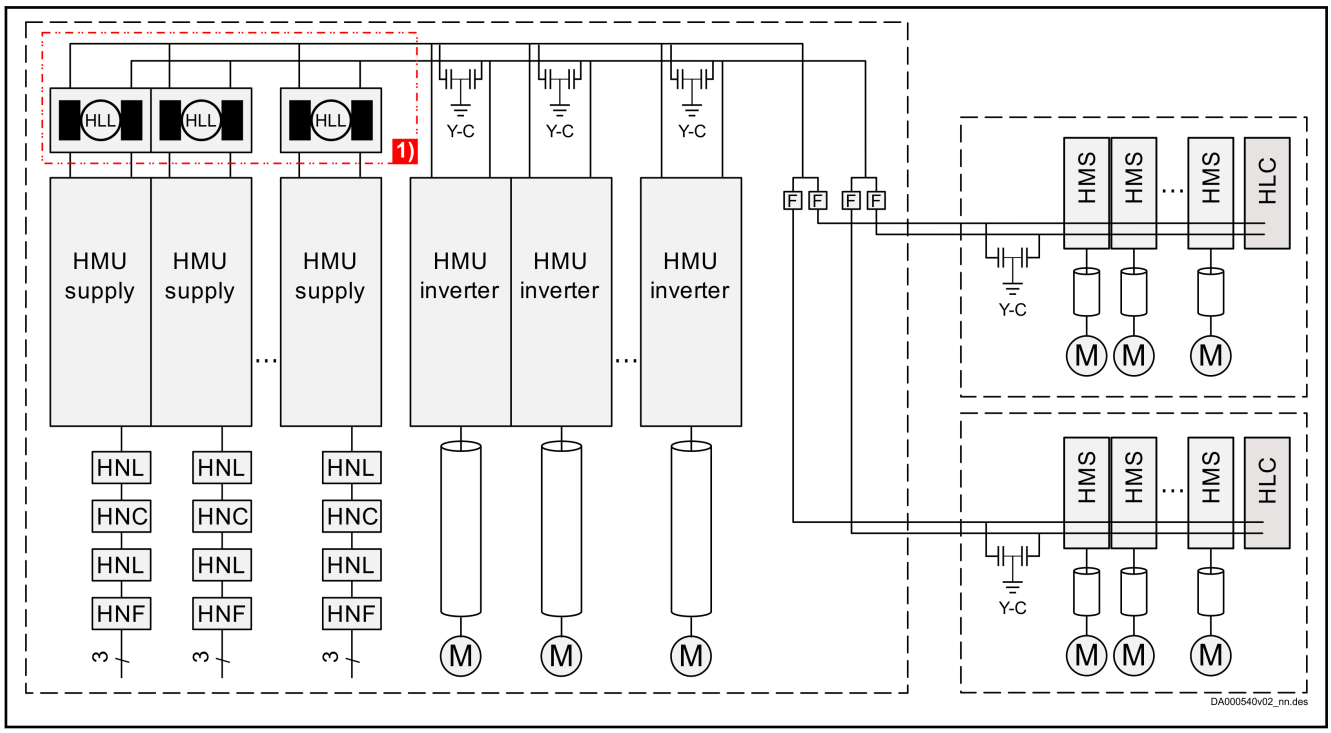
HMU05 systems with a central DC bus choke

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 DC bus ground capacitor pairs are distributed proportionately in accordance with the sum of leakage capacitances.

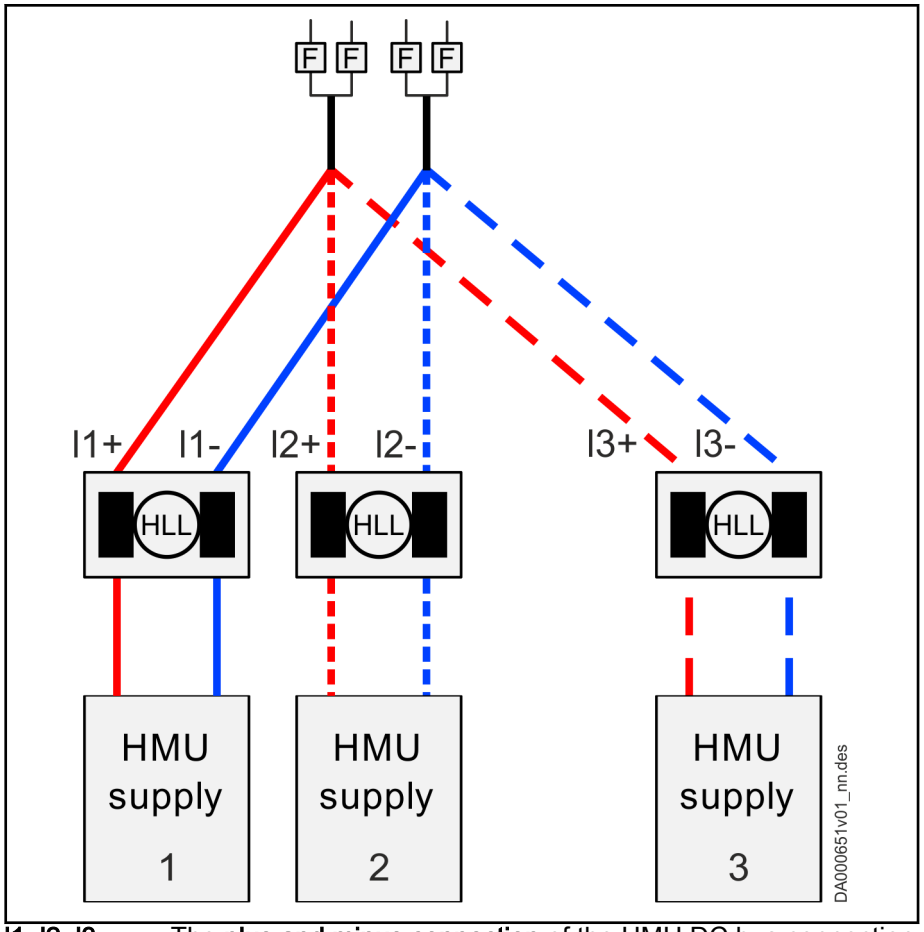
HLC DC bus capacitor units have to be installed in the HMS/HMD drive lines. Dimension the minimum size of the HLC DC bus capacitor unit in accordance with the planned DC bus continuous power of the respective drive system:

47 µF per kilowatt [kW] of DC bus continuous power



1) See fig. 4-6 "Symmetrical connection of the DC bus chokes" on page 49

Fig. 4-5: HMU05 systems with a central DC bus choke



I1, I2, I3 The **plus and minus connection** of the HMU DC bus connection via the HLL DC bus choke must be executed **symmetrically** with the parallel connection until convergence (same length, same cross section; I1+ = I1-, I2+ = I2-, I3+ = I3-)

Fig. 4-6: Symmetrical connection of the DC bus chokes

4.4 Installation conditions

4.4.1 Ambient and operating conditions

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

Only operate the device

- with the connectors plugged on (even if no lines have been connected to the connectors) and
- with the equipment grounding conductor connected!

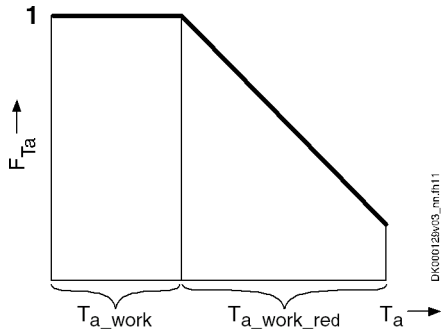
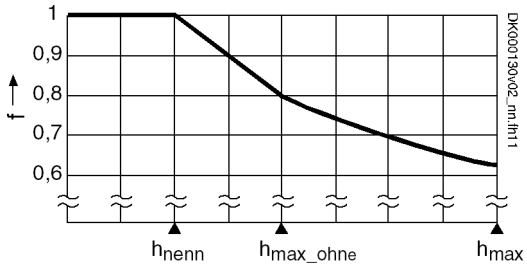
Control cabinet

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 complied with 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. In the technical data of the individual components, the power dissipation is specified 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, for example by mounting them in control cabinets of the degree of protection 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 131
Temperature during transport			See chapter 5.3 "Transporting components" on page 130
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 40 … 50 (valid for air-cooled HMUs + control section with safety technology)
	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 $T_{a_work} < T_a < T_{a_work_red}$) chapter 4.5.3 "Temperatures, cooling, power dissipation, distances" on page 90
Derating vs. installation altitude: Valid for air-cooled devices: At an installation altitude h > h_{nenn}, the available performance data are reduced by the factor f[2)]. Valid for air and liquid-cooled devices: At an installation altitude in the range h_{max_ohne} to h_{max}, voltage-limiting measures (overvoltage limiter) must be installed at the drive system mains connection. Use above h_{max} is not allowed!			Valid for air-cooled devices:  Liquid-cooled devices: No derating vs. installation altitude existing
	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

Description	Symbol	Unit	Value
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. 4-7: Ambient and operating conditions

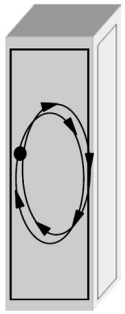
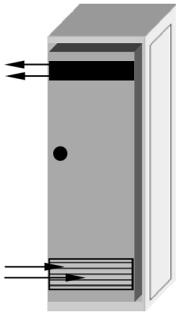
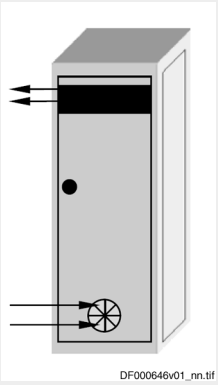
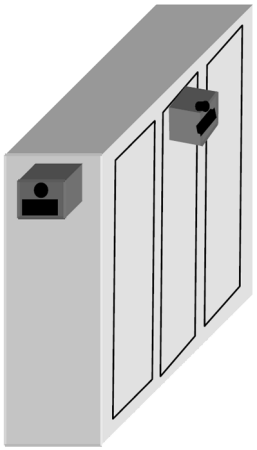
4.4.2 Control cabinet

Air cooling

Control cabinet design and cooling

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

Possible ways 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. 4-8: Possible ways of heat dissipation

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

Requirements for control cabinets with fan

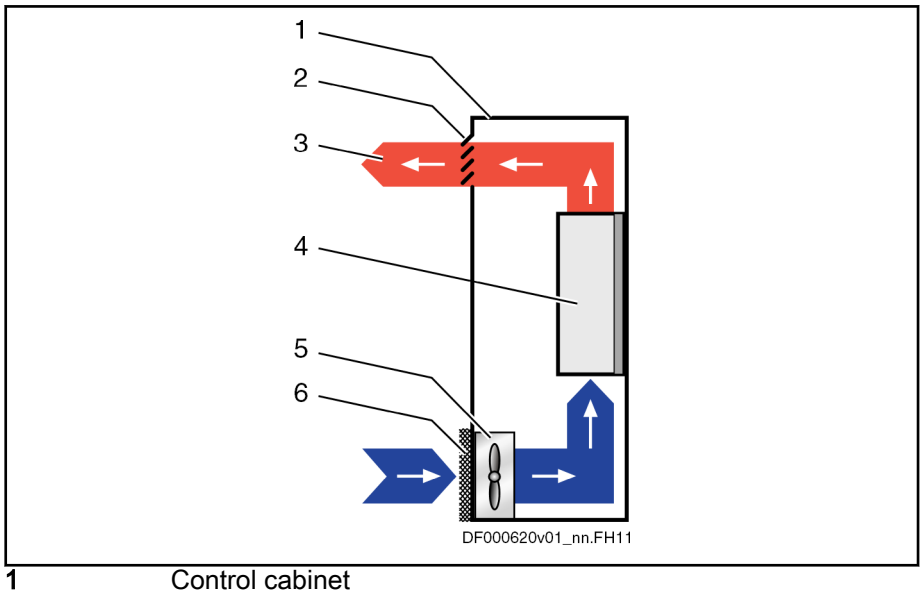
NOTICE **Risk of damage by unclean air in the control cabinet!**

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. 4-7: 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

- **Permissible materials** in the cooling circuit:
  - Aluminum
  - Stainless steel
  - Plastic

  Non-ferrous metals and galvanized components are **not allowed**.
- The cooling system must be a **closed system**.

Cooling devices

There are three types of cooling devices for liquid cooling:

- Air-liquid cooling unit

- Liquid-liquid cooling unit
- Refrigerating unit

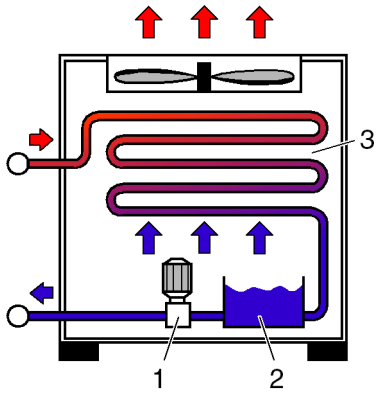
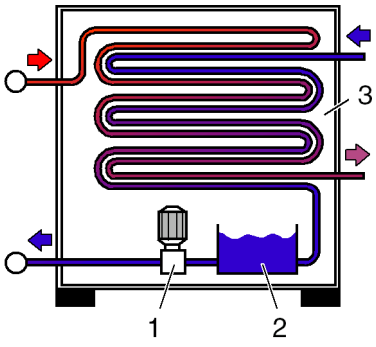
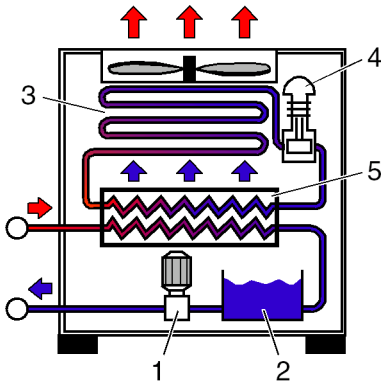
Power dissipation in control cabinet

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.

Air-liquid cooling unit	Liquid-liquid cooling unit	Refrigerating unit
		
1. Coolant pump 2. Coolant container 3. Air-liquid heat exchanger	1. Coolant pump 2. Coolant container 3. Liquid-liquid heat exchanger	1. Coolant pump 2. Coolant container 3. Air-cooled liquefier 4. Condenser 5. Evaporator

Tab. 4-9: 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

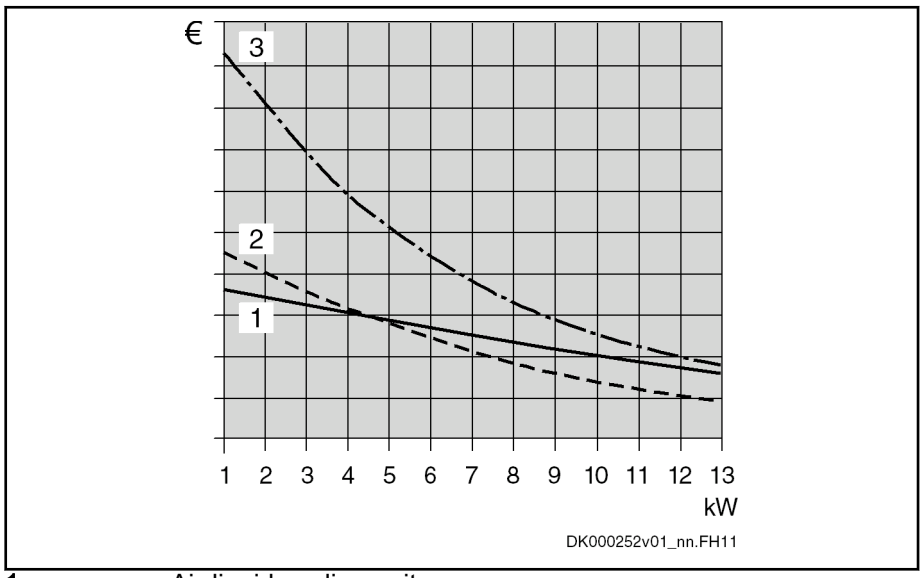
Tab. 4-10: Comparison of cooling devices

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. 4-11: Uses of cooling devices

Cost comparison



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

Fig. 4-8: Approximate cost comparison of the cooling devices

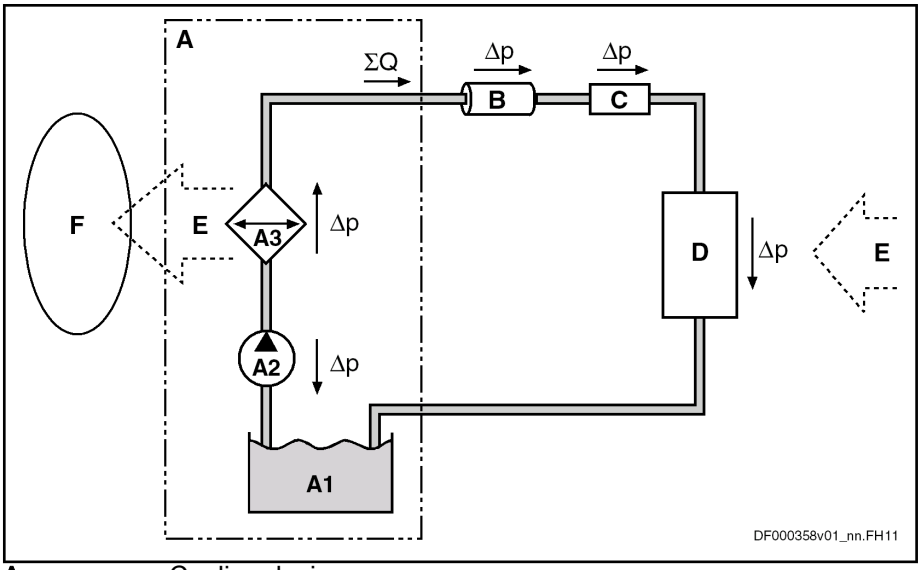
Components of the Cooling Device

Overview

A liquid cooling system consists of:

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

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



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. 4-9: Basic arrangement of a liquid cooling system

Coolant Container

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. 4-10: 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_{ch}	Coolant volume in drive components
V_L	Coolant volume in coolant lines

Fig. 4-11: 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

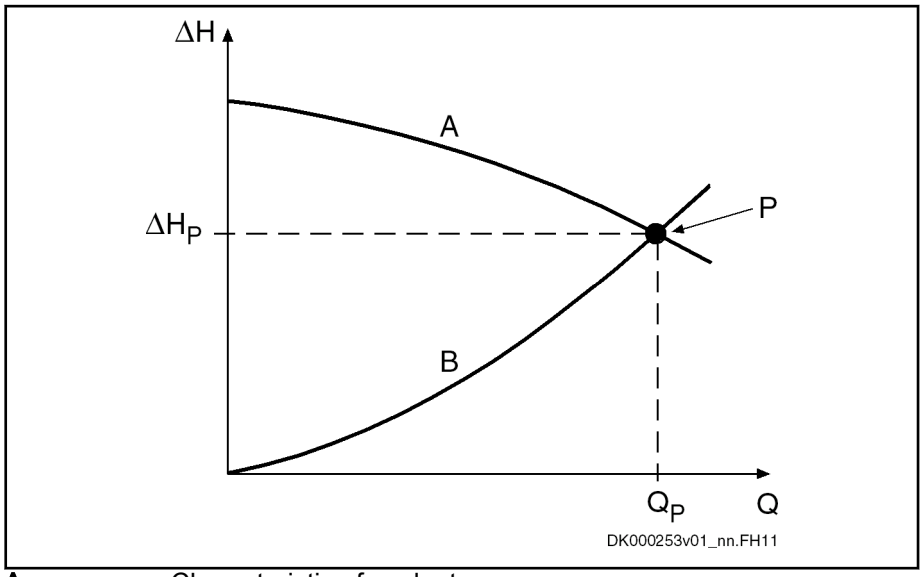
pressure corresponding to the total pressure decrease of the cooling system at the required flow rate.

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. 4-12: Working point of a coolant pump

Delivery rate

Parallel connection

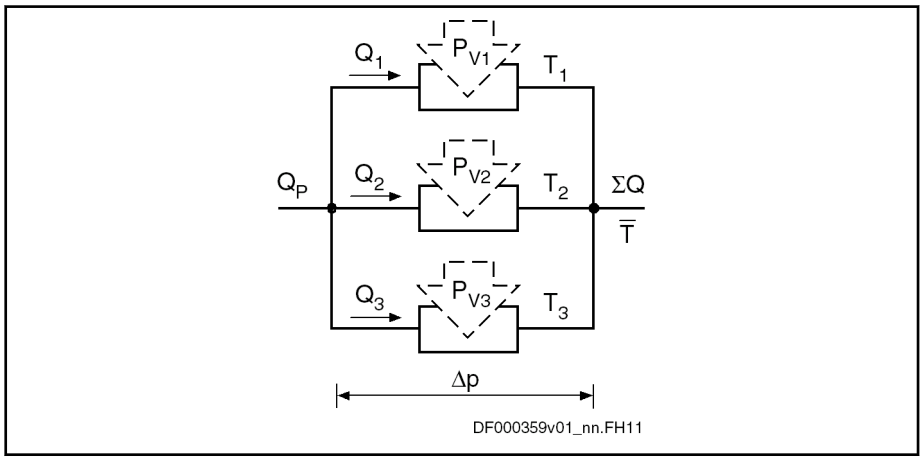


Fig. 4-13: Parallel connection of components

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

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

Q_P Delivery rate of coolant pump

$Q_{1\ to\ n}$ Required flow rates of drive components

Fig. 4-14: Delivery rate of the coolant pump with parallel connection

Series connection

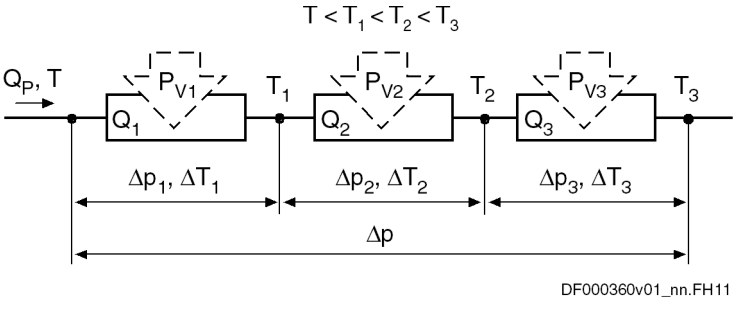


Fig. 4-15: Series connection of components

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.

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

Q_P Delivery rate of coolant pump

$Q_{1\ to\ n}$ Required flow rates of drive components

Fig. 4-16: 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
- Drive components connected in parallel and/or in series
- 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 (Wt: heat exchanger, Arm: fittings, ch: drive component; Ltg: lines)

Δp_p Delivery pressure of coolant pump

Fig. 4-17: Required delivery pressure of coolant pump

Coolant line pressure decrease

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

$\Delta p_{Ltg}/\Delta l$ Length-based pressure decrease in hPa/m
l Line length in m

Fig. 4-18: 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:

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

$\Delta p_{Ltg}/\Delta l$ Pressure decrease for tube with same inner diameter in hPa/m

Fig. 4-19: Fittings pressure decrease

Heat exchanger pressure decrease

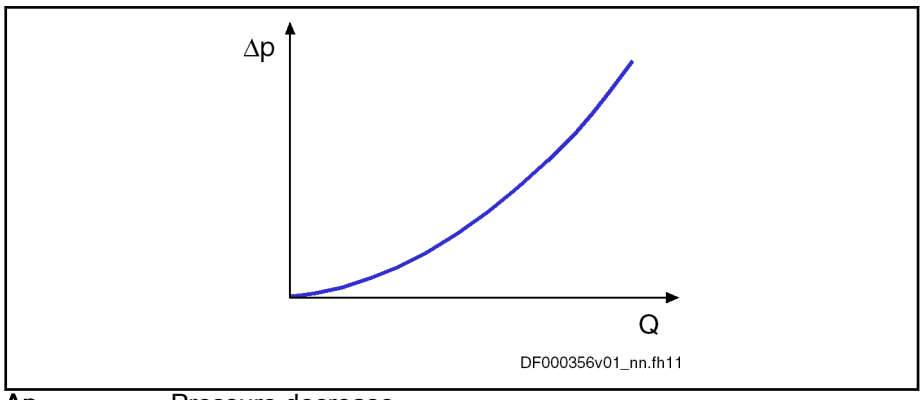
See manufacturer's specification for pressure drop Δp_{Wt}.

Drive components pressure decrease

The resulting pressure decrease Δp_{ch} generally differs from the specified Δp_n, since 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. 4-20: 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. 4-21: 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 allowed 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_{ein}	Inlet temperature of coolant in heat exchanger in °C

Fig. 4-22: 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_{Km}	Specific thermal capacity of coolant in kJ/kgK
Q	Flow rate of coolant in l/min

Fig. 4-23: Coolant temperature change

Air temperature change

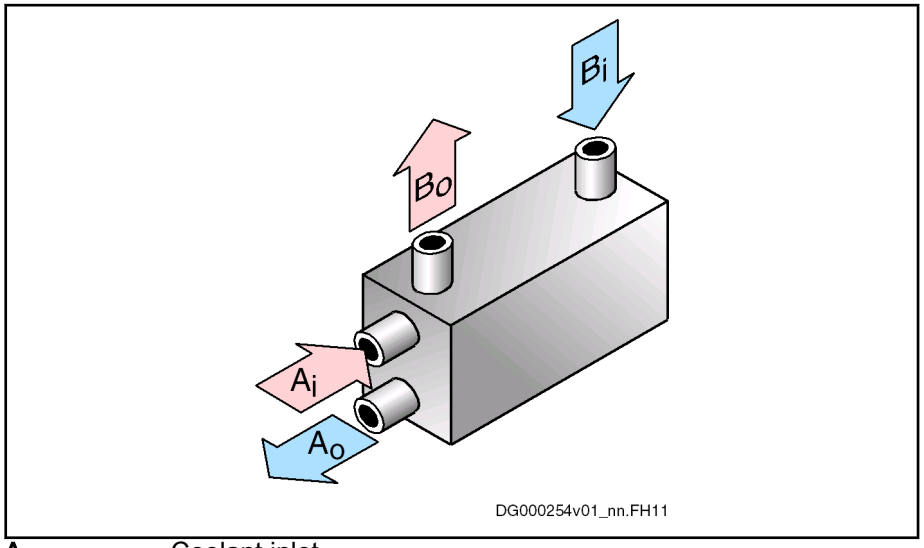
$$\Delta T_L = \frac{P_V \times 60 \frac{s}{min}}{1{,}3 \times 10^{-3} \frac{kg}{l} \times 0{,}72 \frac{kJ}{kgK} \times Q_L}$$

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

Fig. 4-24: 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 65)

Liquid-Liquid Cooling Unit



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

Fig. 4-25: 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. 4-26: 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. 4-27: Cooling warmer medium (coolant)

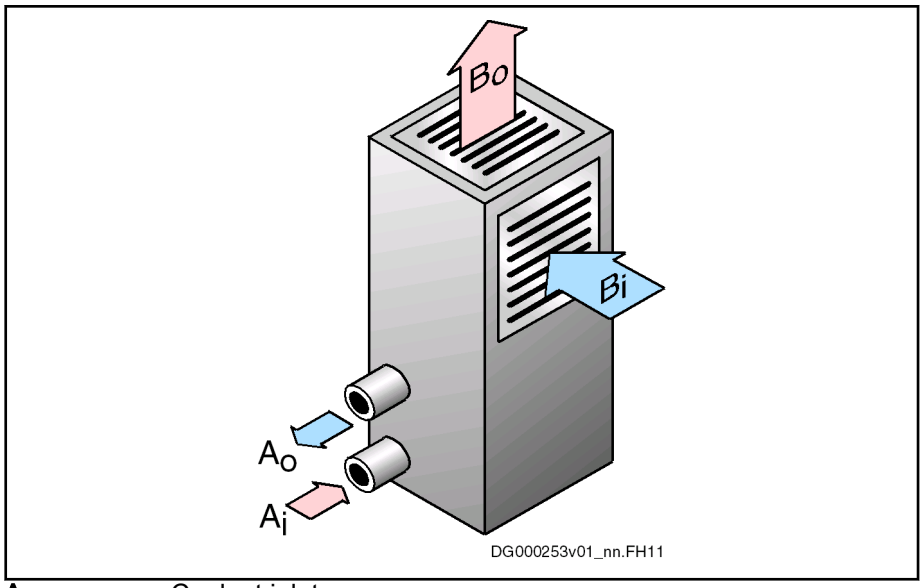
Temperature increase of colder medium (utilities)

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

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. 4-28: 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. 4-29: 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. 4-30: Determining refrigerating capacity

Cooling of the drive components

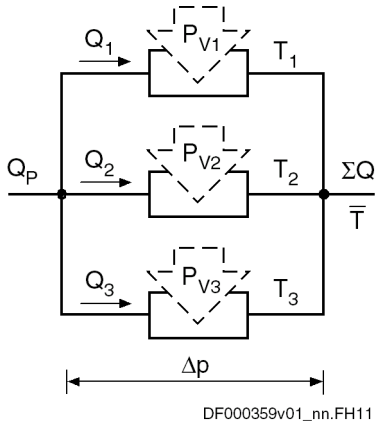
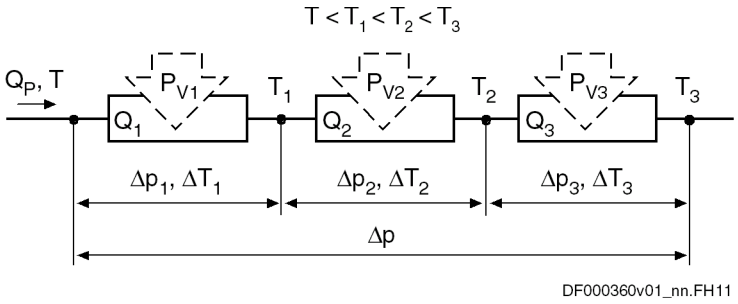
Technical data

☞ 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").

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

Parallel connection	Series connection
	

Tab. 4-12: 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

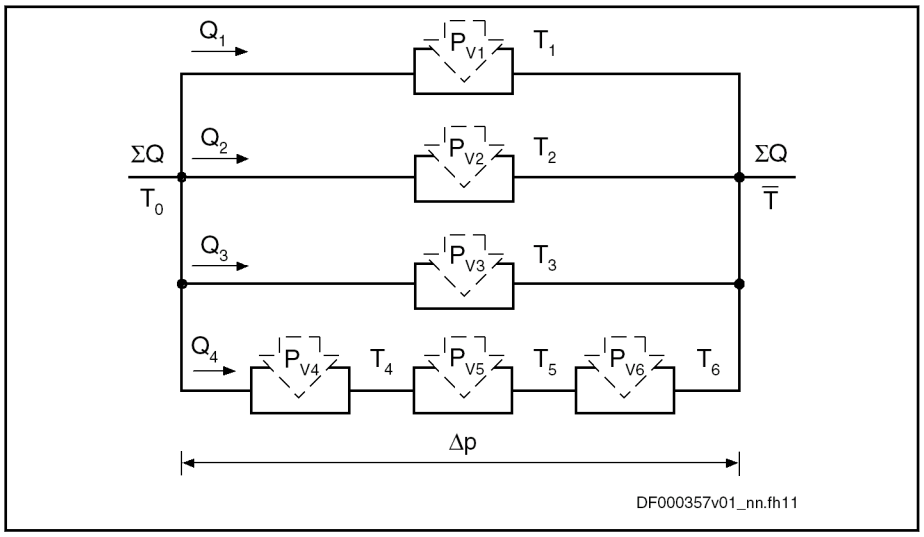


Fig. 4-31: Combined interconnection of drive components being cooled

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.

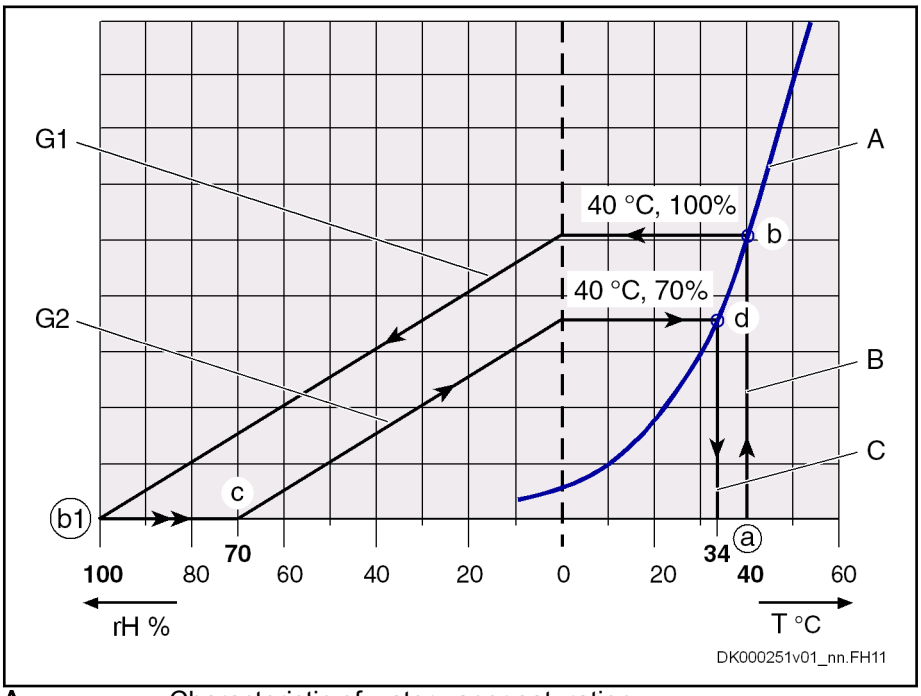
Drive components with the protection class IPx0, such as drive controllers and supply units, do not have sufficient protection against water. This is why condensation cannot be allowed to form on them.

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. 4-32: 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 (water glycol mixture)

NOTICE **Risk of damage to the 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 volumetric content of 20% glycol-based coolant additives.

When increasing the volumetric content, observe the power derating. See information provided by the manufacturer of the coolant additive.

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

Water glycol mixtures are frost-resistant depending on the mixing ratio. See manufacturer specifications.

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. The mixing ratio is at least 20% volumetric content (50% volumetric content possible with derating).

  Check the condition and concentration of the coolant additive at least once a year. Most manufacturers of coolant additives offer this check free of charge.

  Deviations from the prescribed mixing ratio may 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 suggested addition of 20% volumetric content, calculate the cooling system with the resulting coolant.

Check the compatibility of the coolant with plastics and gasket materials. If necessary, contact the coolant manufacturer.

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 is not in a position to give general statements or carry out investigations regarding applicability of process-related coolants, 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

Allowed water glycol mixtures are, for example:

- Water + Antifrogen N or L
- Water + Glysofor N

Please refer to the data sheets of the manufacturer (minimum concentration, properties of water, check and condition of the coolant etc.) or use ready mixes such as 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)

HMU05.1N-Fxxxx-xxxx

Inverter

HMU05.1N-F… -A4-D7-P

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	U_{LN_nom}	V	DC 450...750			
Rated input current	I_{LN}	A	242.0	291.0	373.0	467.0
Branch circuit protection fuse[1)]		A	300	350	450	600
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: 2019-02-20*						

1) Use listed AC input line fuses (class J; 600 V AC).

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
Short circuit current rating	SCCR	A rms	85000		
Rated input voltage, power	U_{LN_nom}	V	DC 450...750		
Rated input current	I_{LN}	A	587.0	734.0	954.0
Branch circuit protection fuse[1)]		A	700	900	1200
Output voltage	U_{out}	V	3 x AC 0...500		
Output current	I_{out}	A	616.0	771.0	1002.0
Last modification: 2019-02-20*					

1) Use listed AC input line fuses (class L; 600 V AC).

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

HMU05.1N-F… -A5-11-P

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Short circuit current rating	SCCR	A rms	85000					
Rated input voltage, power[1)]	U_{LN_nom}	V	DC 750…1100					
Rated input current	I_{LN}	A	165.0	198.0	254.0	318.0	419.0	651.0
Branch circuit protection fuse[1)]		A	200*	250*	300*	350*	600*	700**
Output voltage	U_{out}	V	3 x AC 0…780					
Output current	I_{out}	A	147.0	177.0	227.0	284.0	374.0	581.0
Last modification: 2019-02-20*								

1) Use listed AC input line fuses (*: class J; **: class L; 600 V AC).

Tab. 4-15: HMU – ambient and operating conditions – UL ratings

Supply units

HMU05.1N-F… -A4-D7-P

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	U_{LN_nom}	V	3 x AC 380...500			
Mains frequency	f_{LN}	Hz	50...60			
Rated input current	I_{LN}	A	218.00	262.00	327.00	409.00
Branch circuit protection fuse[1)]		A	300	350	450	600
Output voltage	U_{out}	V	DC 750			
Output power	P_{out}	kW	144.00	173.00	216.00	270.00
Last modification: 2019-02-20*						

1) Use listed AC input line fuses (class J; 600 V AC).

Tab. 4-16: 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
Short circuit current rating	SCCR	A rms	85000		
Rated input voltage, power	U_{LN_nom}	V	3 x AC 380...500		
Last modification: 2019-02-20*					

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
Mains frequency	f_{LN}	Hz	50...60		
Rated input current	I_{LN}	A	514.00	652.00	811.00
Branch circuit protection fuse[1)]		A	700	900	1200
Output voltage	U_{out}	V	DC 750		
Output power	P_{out}	kW	340.00	430.00	540.00
					Last modification: 2019-02-20*

1) Use listed AC input line fuses (class L; 600 V AC).

Tab. 4-17: HMU – ambient and operating conditions – UL ratings

HMU05.1N-F… -A5-11-P

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Short circuit current rating	SCCR	A rms	85000					
Rated input voltage, power	U_{LN_nom}	V	3 x AC 525…600					
Mains frequency	f_{LN}	Hz	50...60					
Rated input current	I_{LN}	A	127.00	152.00	190.00	238.00	352.00	471.00
Branch circuit protection fuse[2)]		A	200*	250*	300*	350*	600*	700**
Output voltage	U_{out}	V	DC 1100					
Output power[1)]	P_{out}	kW	144.00	173.00	216.00	270.00	400.00	535.00
								Last modification: 2019-02-20*

1) The values shown refer to an input voltage of 690 V

2) Use listed AC input line fuses (*: class J; **: class L; 600 V AC).

Tab. 4-18: HMU – ambient and operating conditions – UL ratings

HMU05.1N-Wxxxx-xxxx

Inverter

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Short circuit current rating	SCCR	A rms	85000				
Rated input voltage, power	U_{LN_nom}	V	DC 450...750				
							Last modification: 2019-03-18*

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Rated input current	I_{LN}	A	242	291	373	448	587
Branch circuit protection fuse[1)]		A	300*	350*	450*	600*	700**
Output voltage	U_{out}	V	3 x AC 0...500				
Output current	I_{out}	A	254	306	392	470	616
Last modification: 2019-03-18*							

1) Use listed AC input line fuses (*: class J; **: class L; 600 V AC).

Tab. 4-19: HMU – ambient and operating conditions – UL ratings

Supply units

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Short circuit current rating	SCCR	A rms	85000				
Rated input voltage, power	U_{LN_nom}	V	3 x AC 380...500				
Mains frequency	f_{LN}	Hz	50...60				
Rated input current	I_{LN}	A	242	291	373	448	587
Branch circuit protection fuse[1)]		A	300*	350*	450*	600*	700**
Output voltage	U_{out}	V	DC 750				
Output power	P_{out}	kW	140	170	220	270	340
Last modification: 2019-03-18*							

1) Use listed AC input line fuses (*: class J; **: class L; 600 V AC).

Tab. 4-20: 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.

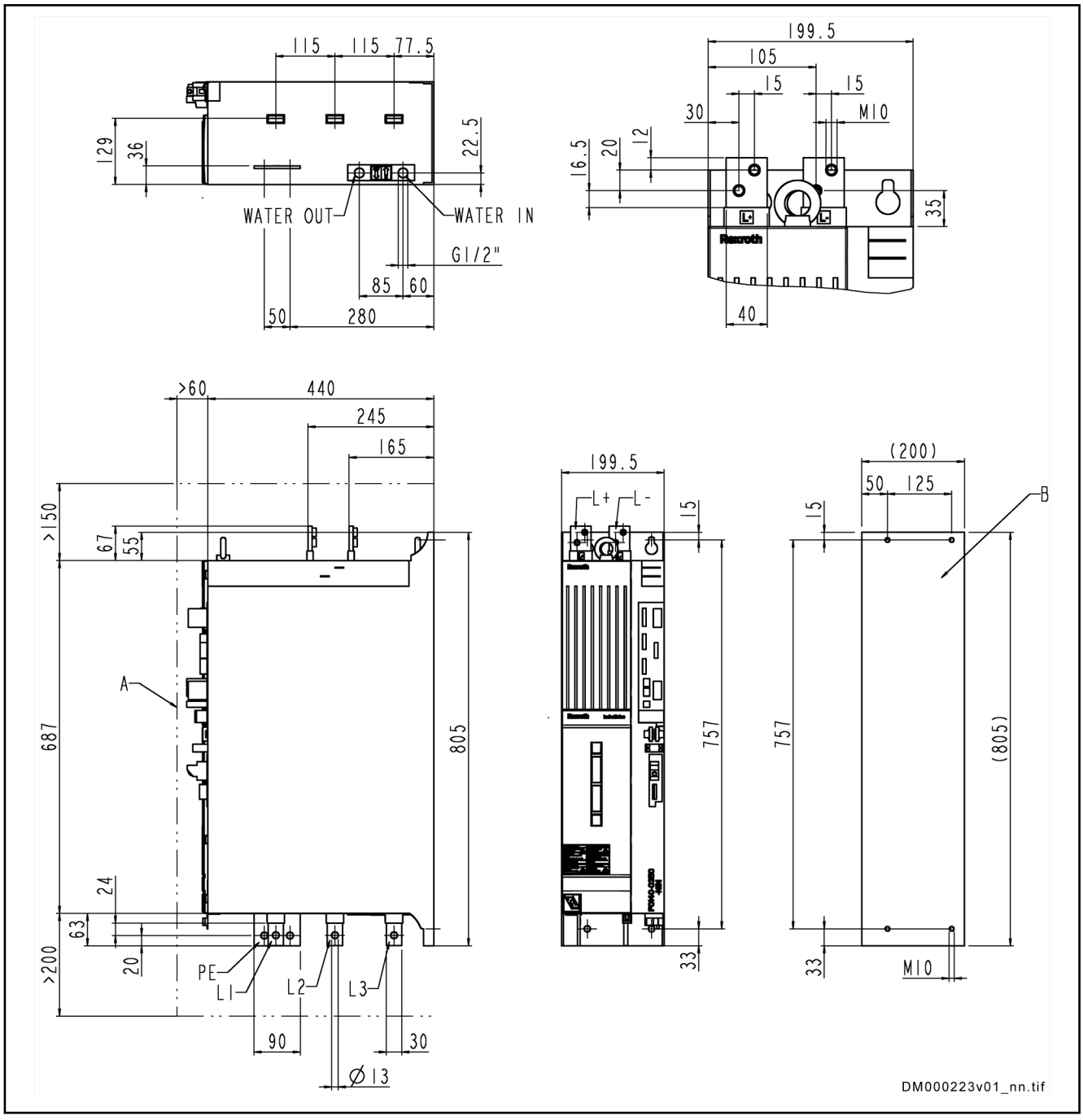
For this reason, before using the respective material a compatibility test has to be carried out for new lubricants, cleaning agents etc. and our housings/ materials.

4.5 Mechanical project planning

4.5.1 Dimensions

HMU05.1N-Fxxxx-xxxx

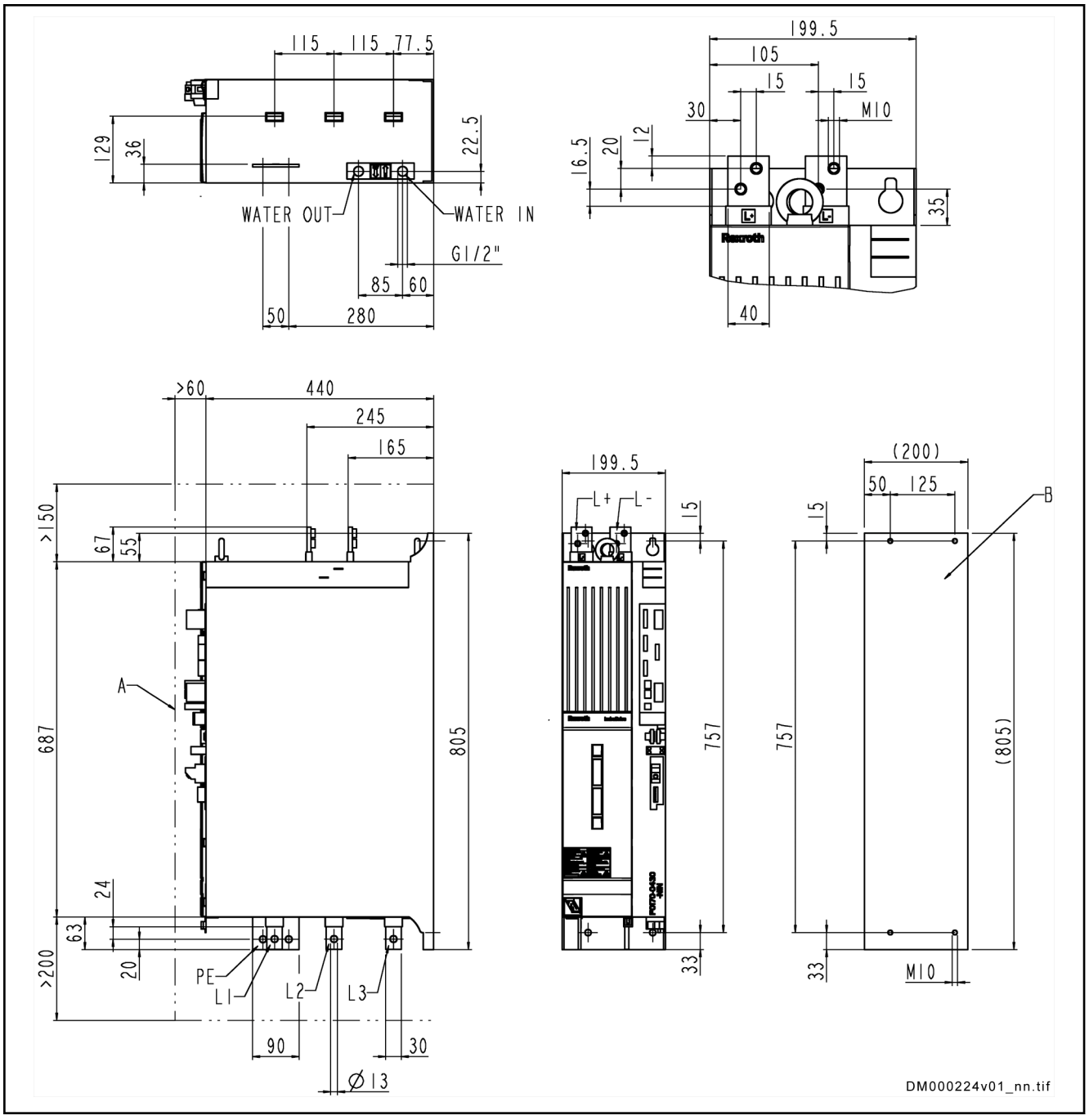
HMU05.1N-F0140-0210, -0350



A Minimum mounting clearance
B Boring dimensions

Fig. 4-33: HMU05.1N-F0140-0210, -0350

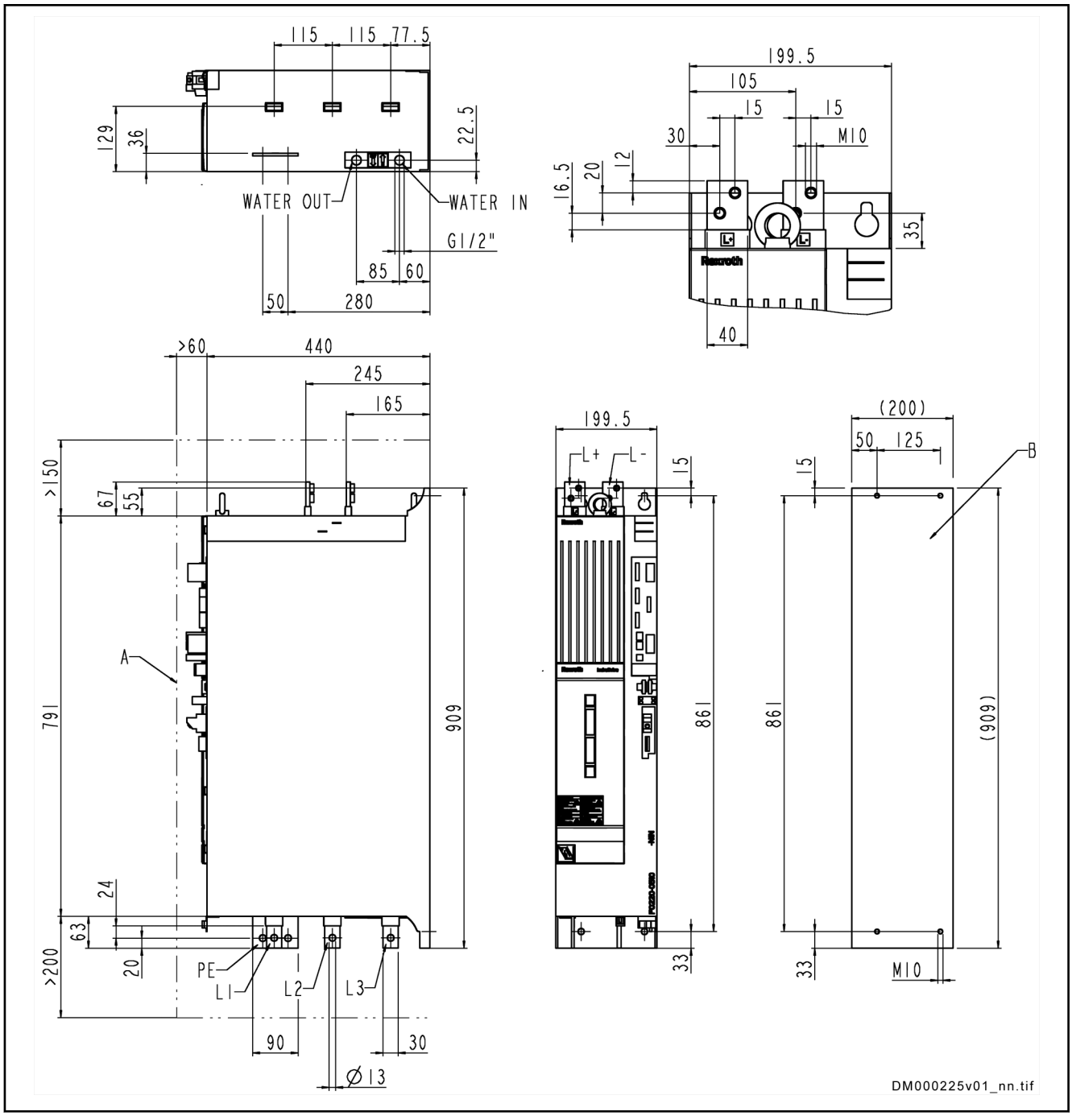
HMU05.1N-F0170-0250, -0430



A Minimum mounting clearance
B Boring dimensions

Fig. 4-34: HMU05.1N-F0170-0250, -0430

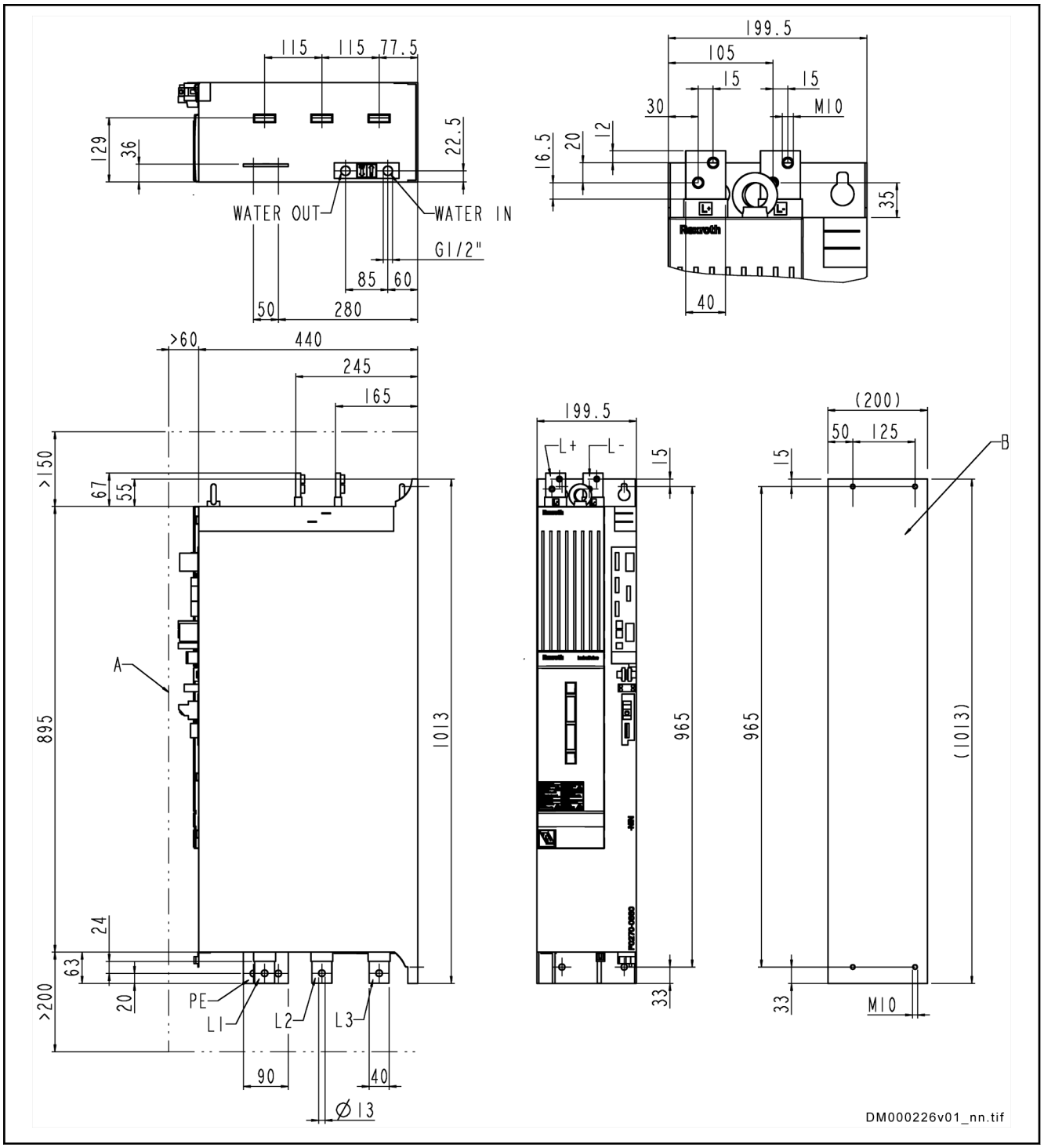
HMU05.1N-F0220-0300, -0510, HMU05.1N-F0270-0370



A Minimum mounting clearance
B Boring dimensions

Fig. 4-35: HMU05.1N-F0220-0300, -0370, HMU05.1N-F0270-0510

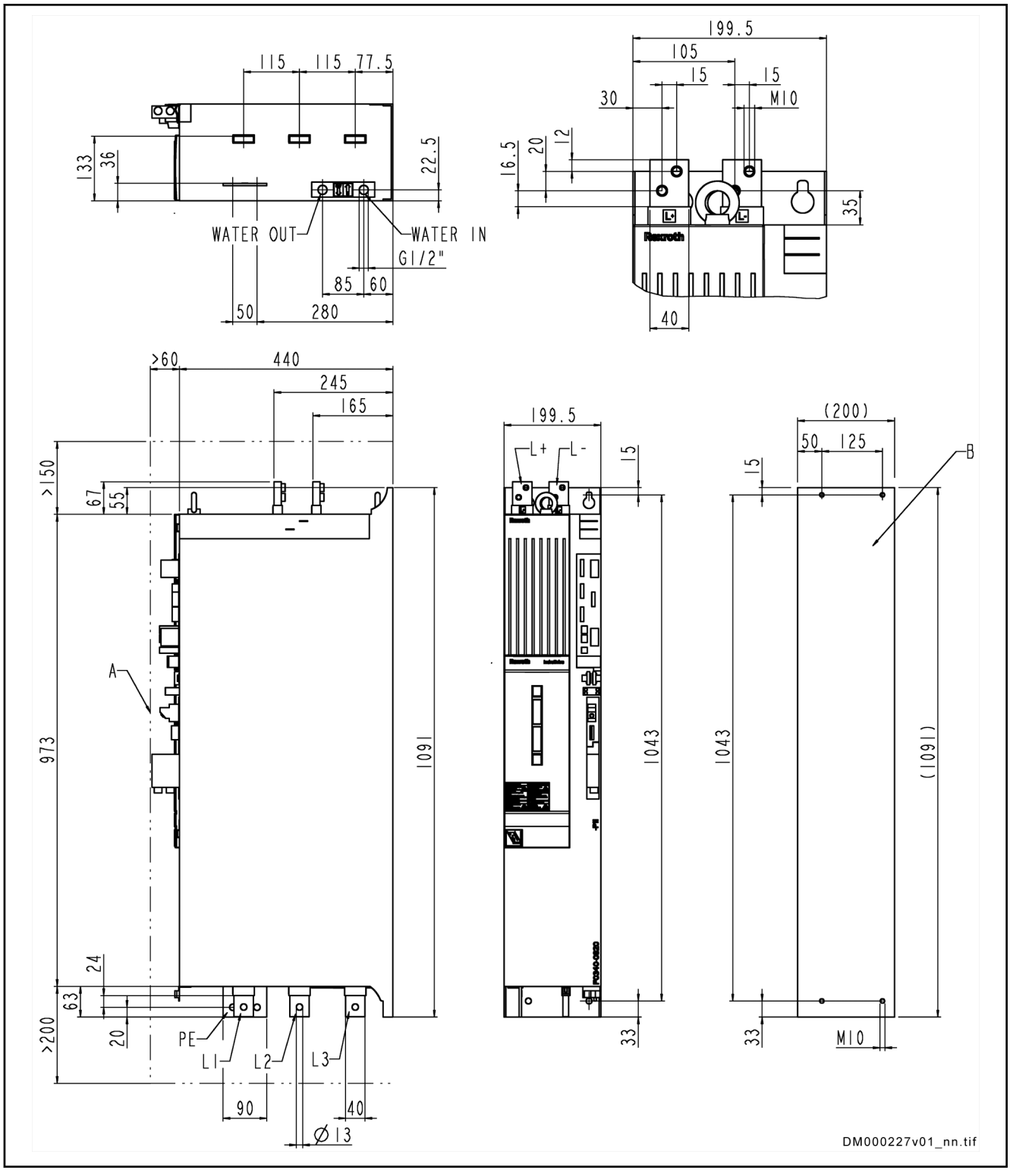
HMU05.1N-F0270-0660



A Minimum mounting clearance
B Boring dimensions

Fig. 4-36: HMU05.1N-F0270-0660

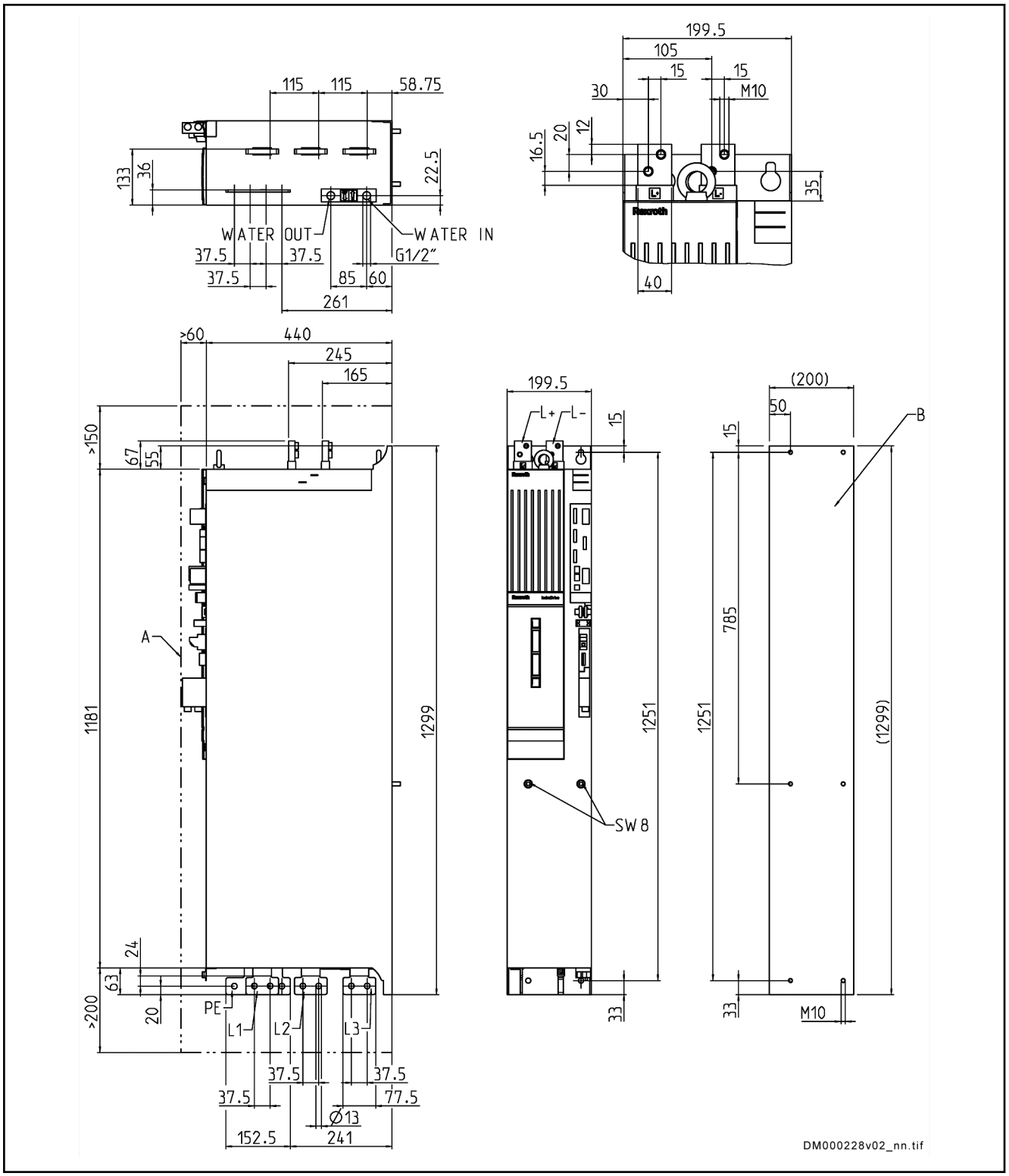
HMU05.1N-F0340-0820, HMU05.1N-F0400-0600



A Minimum mounting clearance
B Boring dimensions

Fig. 4-37: HMU05.1N-F0340-0820, HMU05.1N-F0400-0600

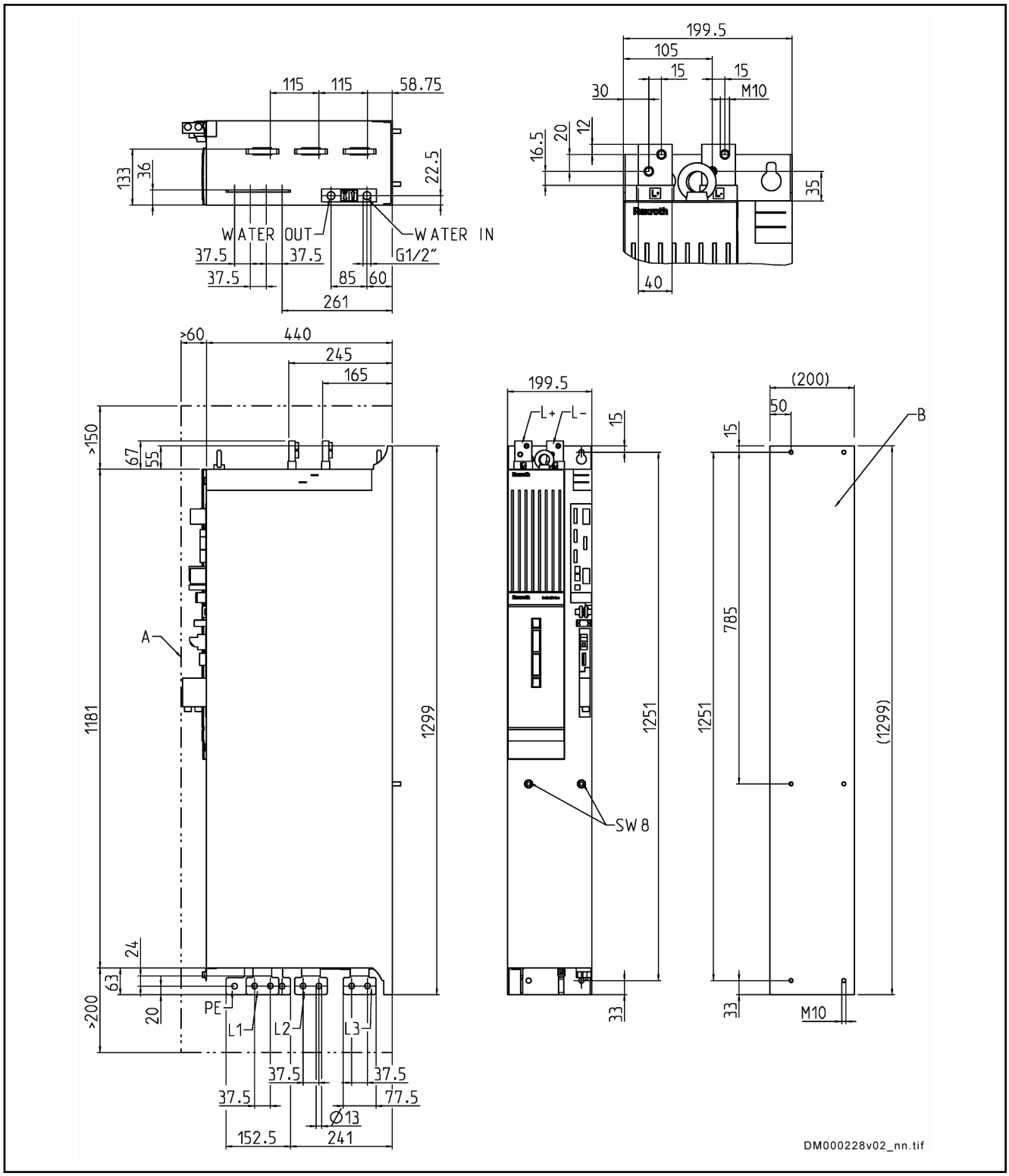
HMU05.1N-F0430-1040



A Minimum mounting clearance
B Boring dimensions

Fig. 4-38: HMU05.1N-F0430-1040

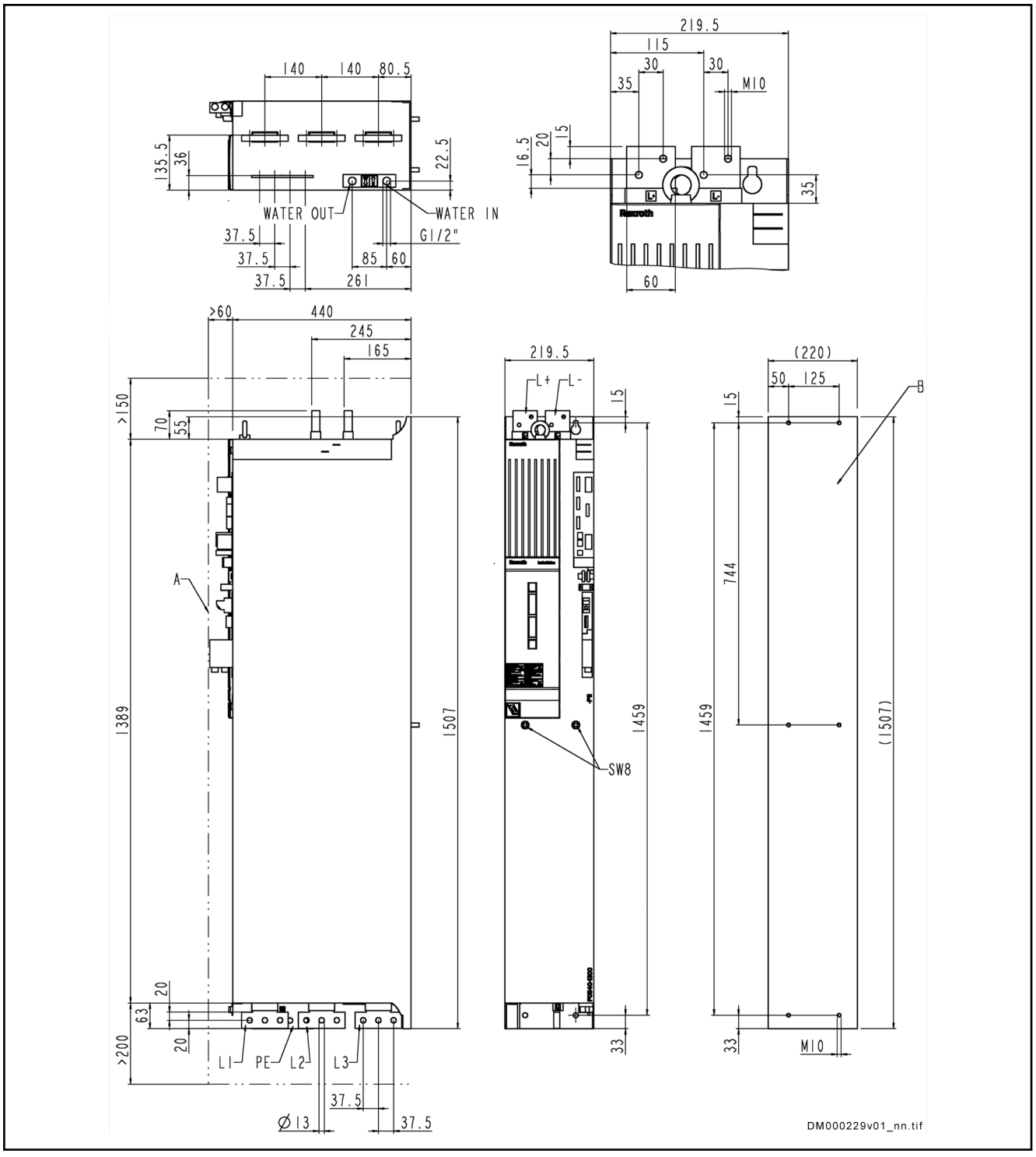
HMU05.1N-F0540-0750



A Minimum mounting clearance
B Boring dimensions

Fig. 4-39: HMU05.1N-F0540-0750

HMU05.1N-F0540-1300

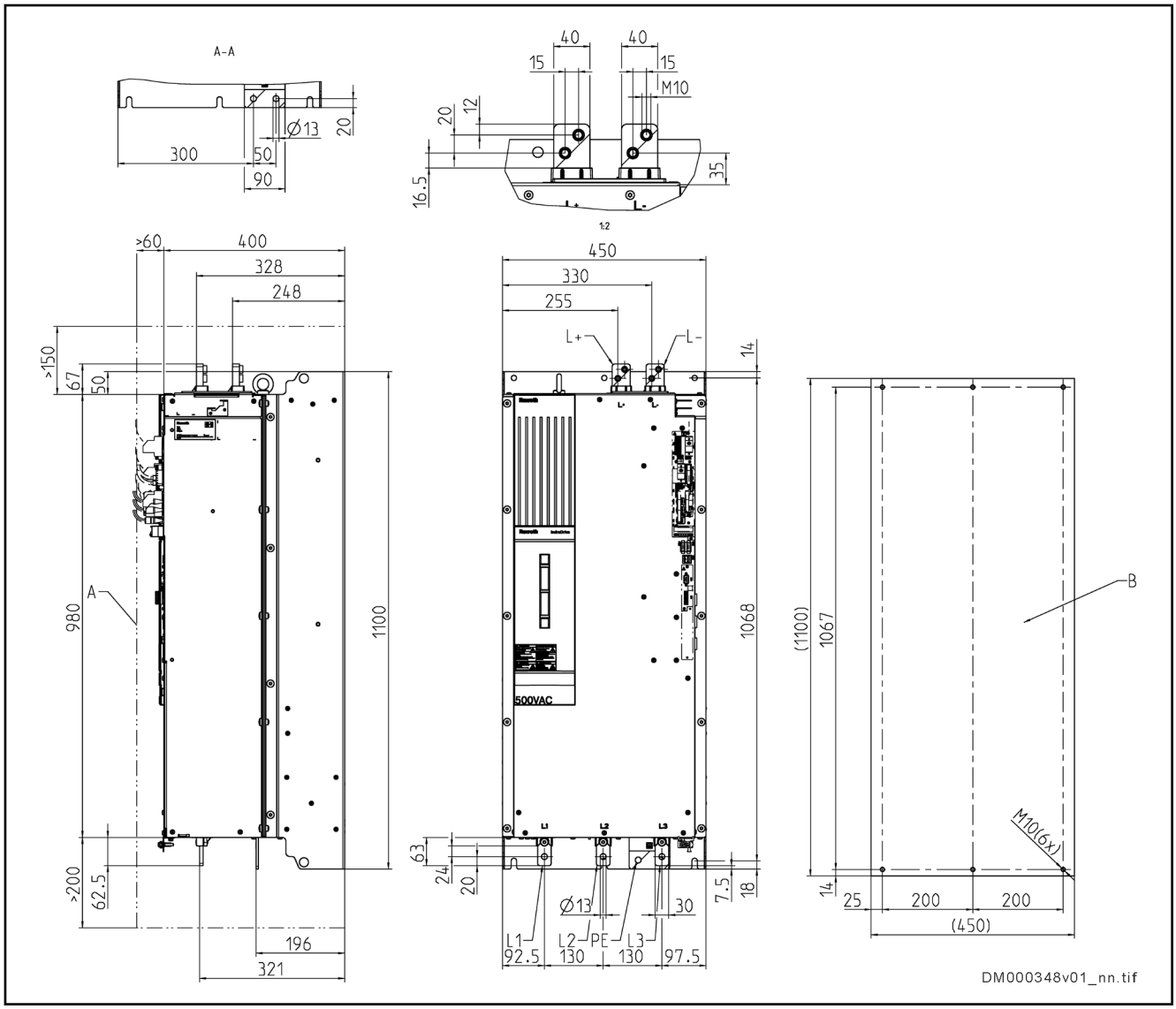


A Minimum mounting clearance
B Boring dimensions

Fig. 4-40: HMU05.1N-F0540-1300

HMU05.1N-Wxxxx-xxxx

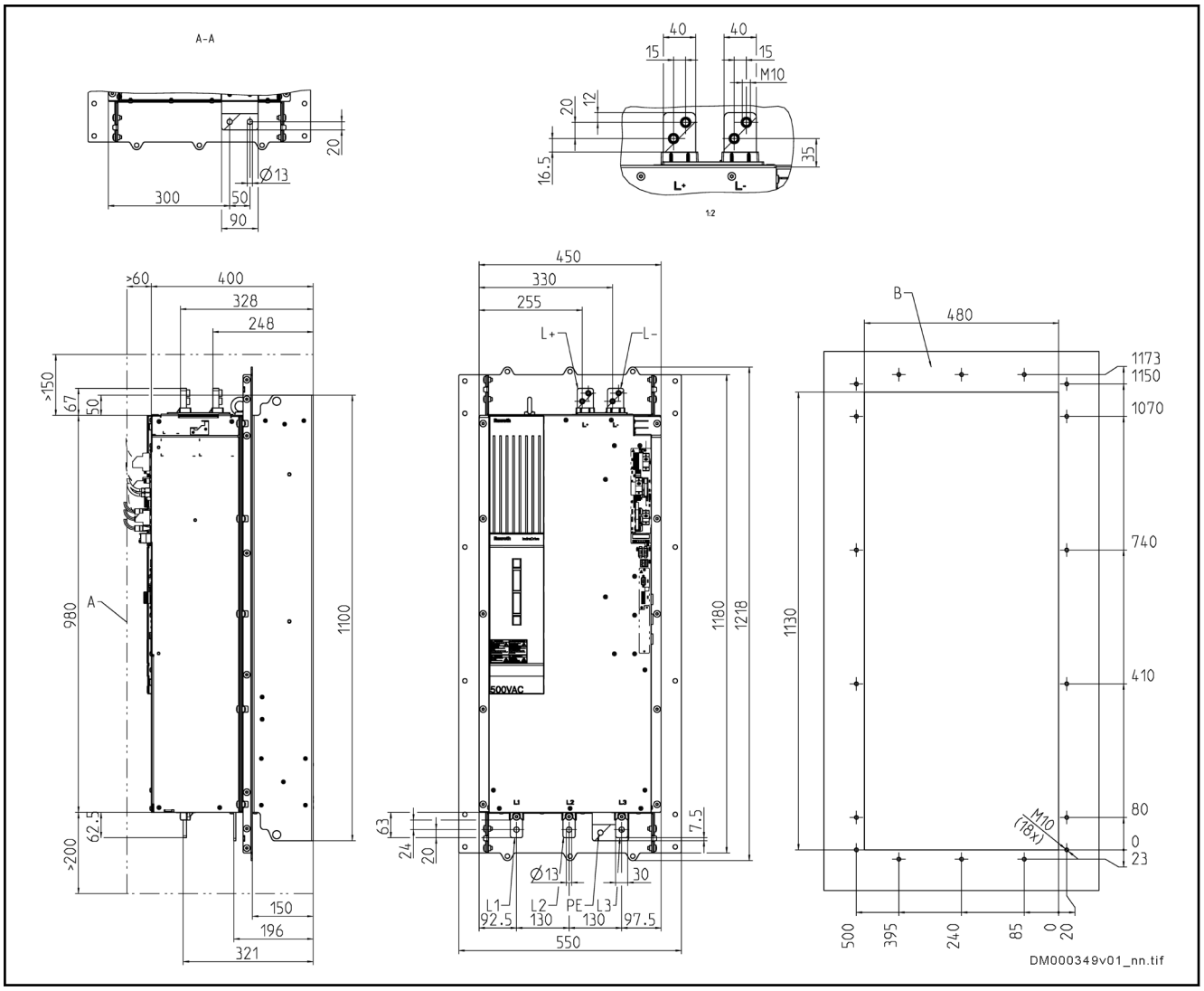
HMU05.1N-W0140, -W0170 (wall mounting)



A Minimum mounting clearance
B Boring dimensions

Fig. 4-41: HMU05.1N-W0140, -W0170 (wall mounting)

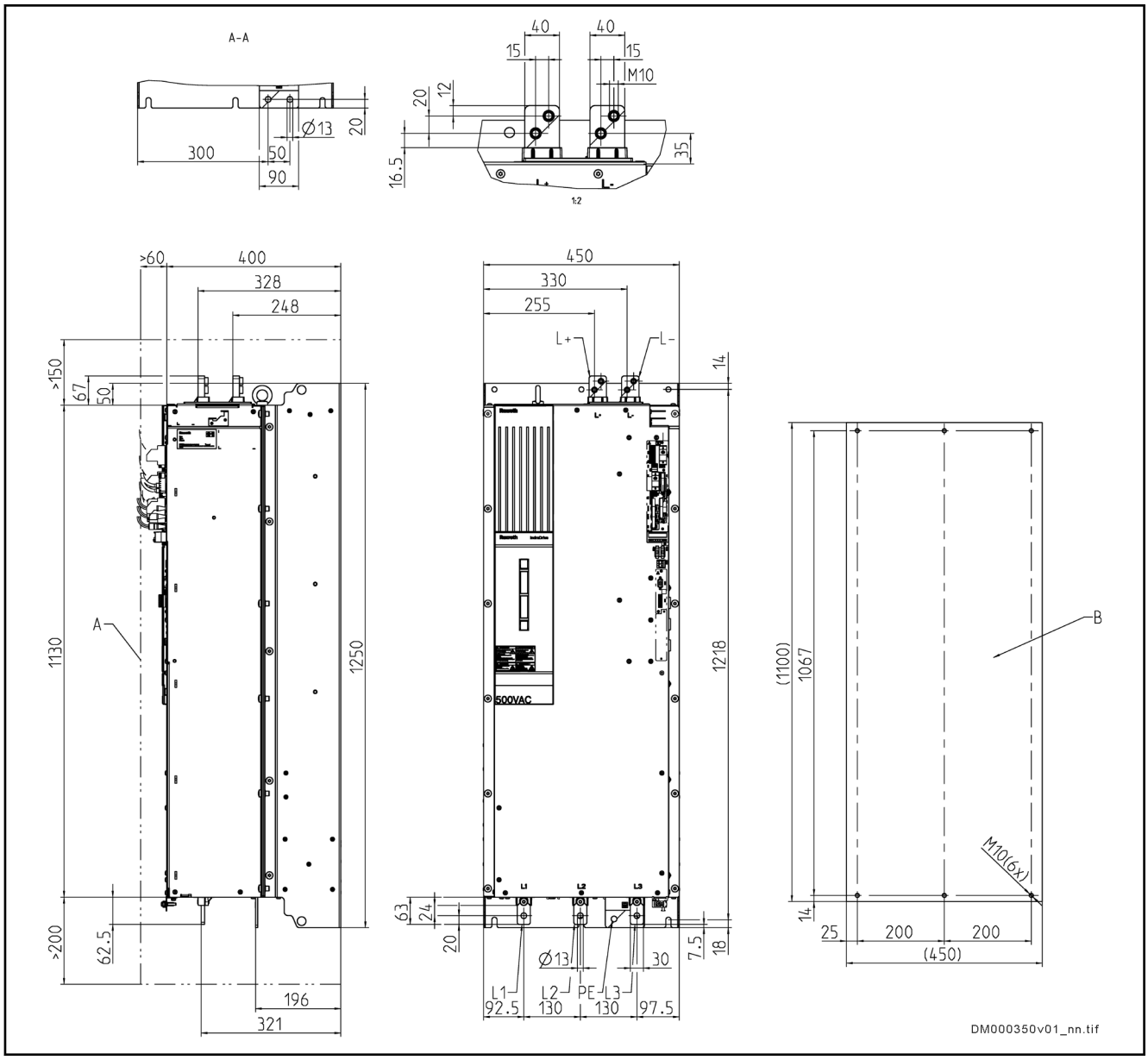
HMU05.1N-W0140, -W0170 (push-through mounting)



A Minimum mounting clearance
B Boring dimensions

Fig. 4-42: HMU05.1N-W0140, -W0170 (push-through mounting)

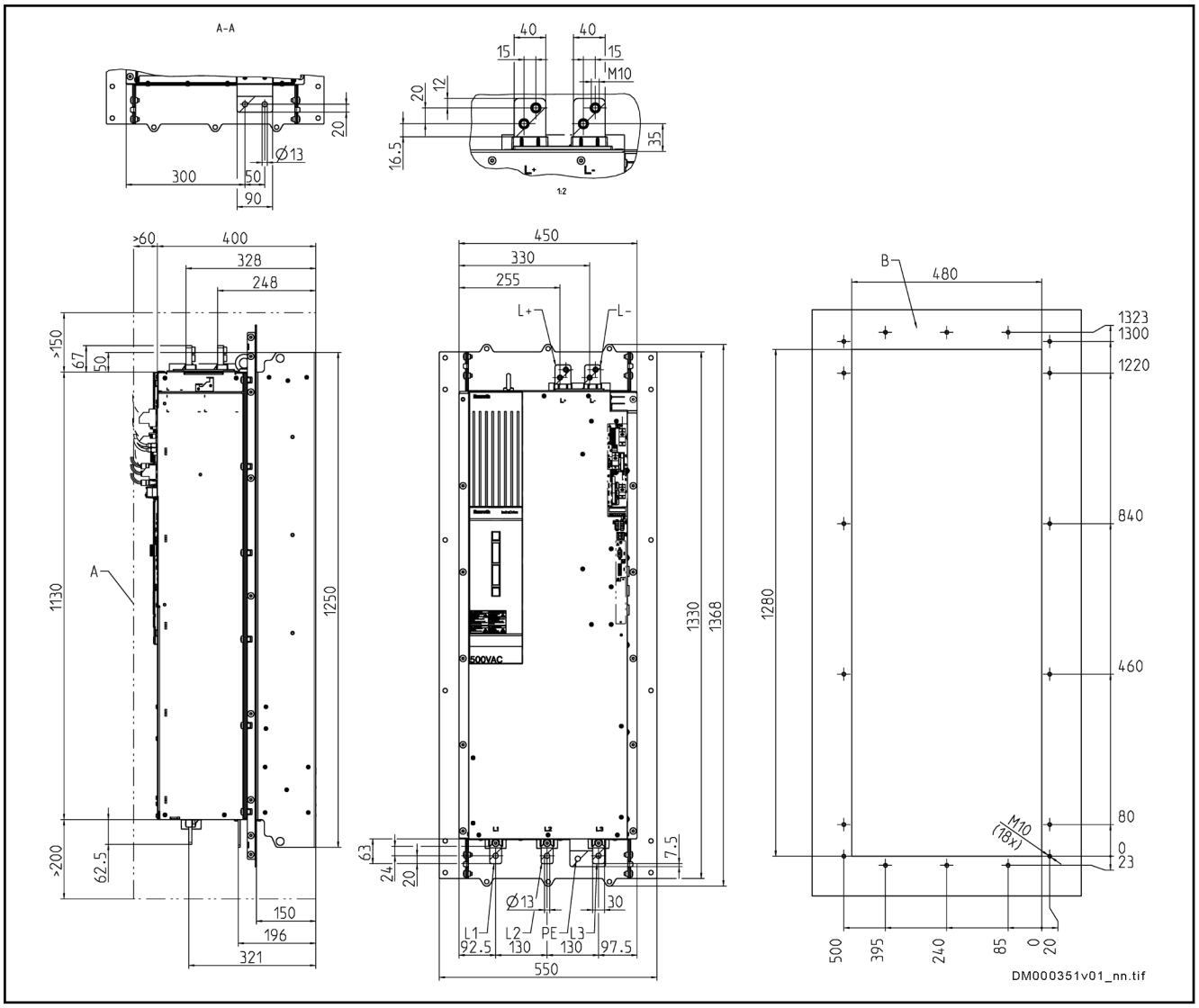
HMU05.1N-W0220 (wall mounting)



A Minimum mounting clearance
B Boring dimensions

Fig. 4-43: HMU05.1N-W0220 (wall mounting)

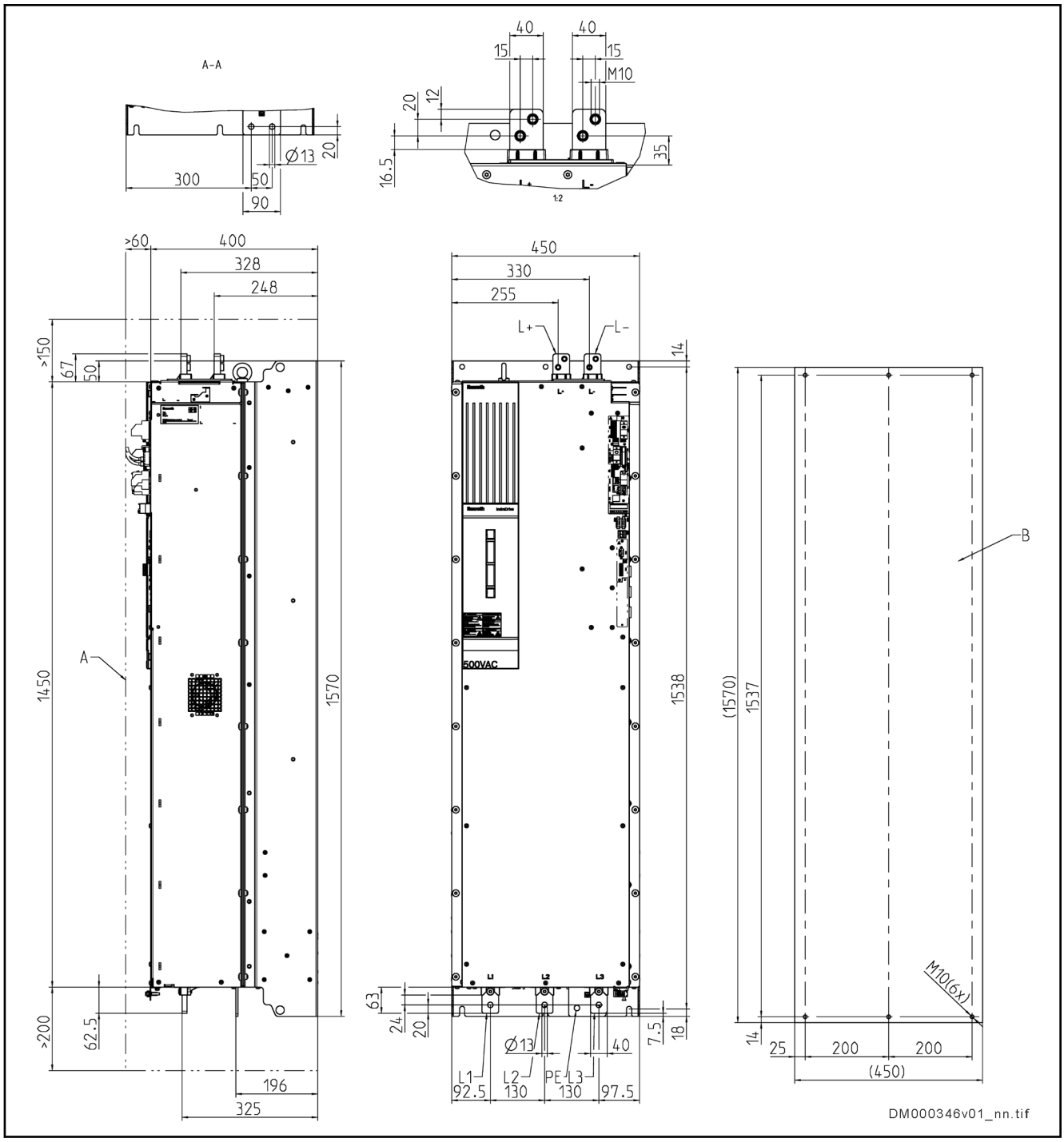
HMU05.1N-W0220 (push-through mounting)



A Minimum mounting clearance
B Boring dimensions

Fig. 4-44: HMU05.1N-W0220 (push-through mounting)

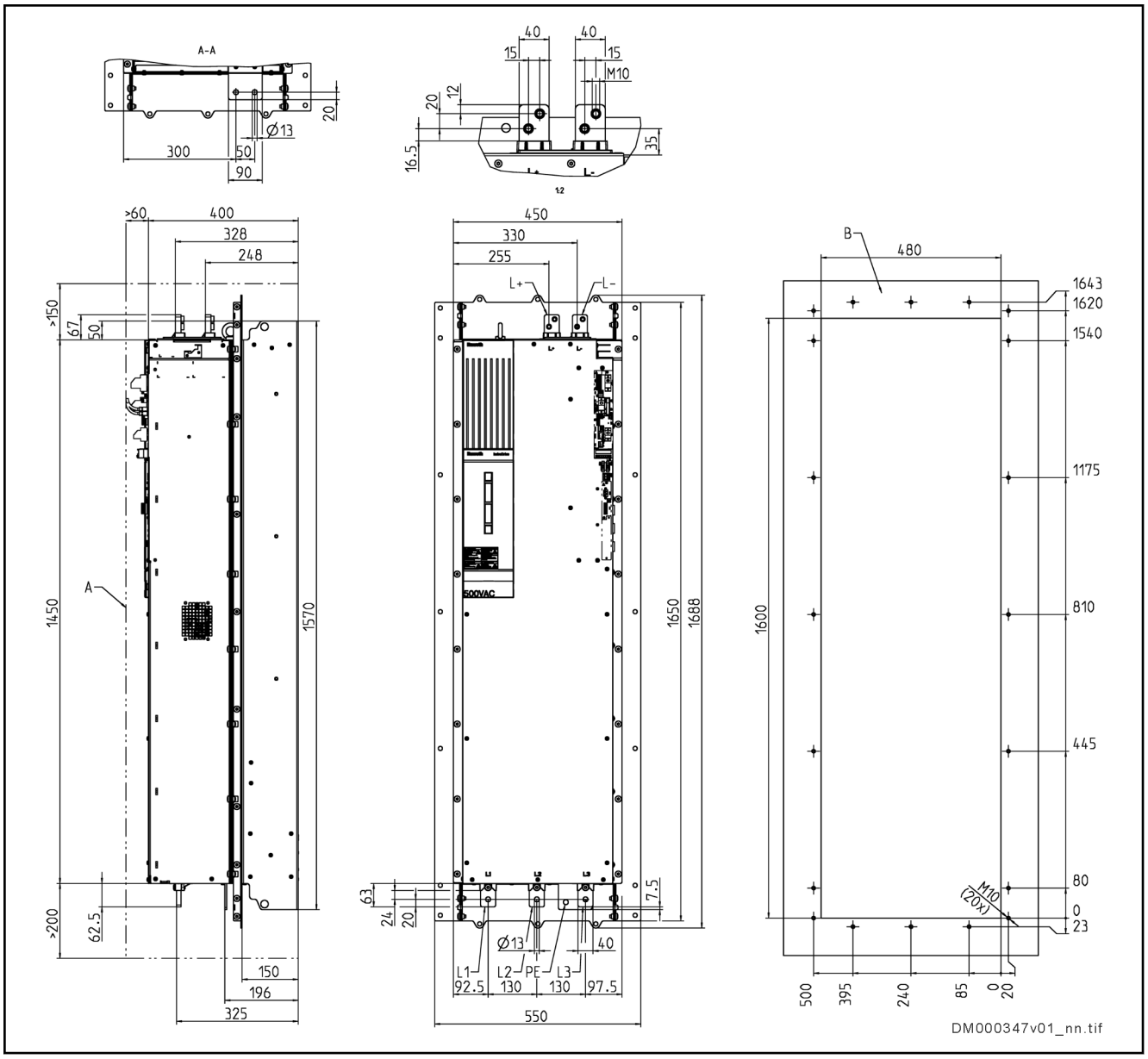
HMU05.1N-W0270, -W0340 (wall mounting)



A Minimum mounting clearance
B Boring dimensions

Fig. 4-45: HMU05.1N-W0270, -W0340 (wall mounting)

HMU05.1N-W0270, -W0340 (push-through mounting)



A Minimum mounting clearance
B Boring dimensions

Fig. 4-46: HMU05.1N-W0270, -W0340 (push-through mounting)

4.5.2 Dimensions, mass, insulation, sound pressure level

HMU05.1N-Fxxxx-xxxx

HMU05.1N-F… -A4-D7

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: 2019-02-20*						

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at 1 m distance, out of cabinet

Tab. 4-21: 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
Mass	m	kg	70.00	83.00	103.00
Device height[1)]	H	mm	1103	1311	1522
Device depth[2)]	T	mm	440		
Device width[3)]	B	mm	200		220
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: 2019-02-20*					

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at 1 m distance, out of cabinet

Tab. 4-22: HMU – data for mass, dimensions, sound pressure level, insulation

HMU05.1N-F… -A5-11

Data for mass, dimensions, sound pressure level, insulation

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Mass	m	kg	51.00		58.00		70.00	83.00
Device height[1)]	H	mm	817		921		1103	1311
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: 2019-02-20*								

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at 1 m distance, out of cabinet

Tab. 4-23: HMU – data for mass, dimensions, sound pressure level, insulation

HMU05.1N-Wxxxx-xxxx

Data for mass, dimensions, sound pressure level, insulation

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Mass	m	kg	110.00		126.00	172.00	
Device height[1)]	H	mm	1100		1250	1570	
Device depth[2)]	T		400				
Device width[3)]	B		450				
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: 2019-02-20*							

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at 1 m distance, out of cabinet

Tab. 4-24: HMU – data for mass, dimensions, sound pressure level, insulation

4.5.3 Temperatures, cooling, power dissipation, distances

HMU05.1N-Fxxxx-xxxx

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	f_s	kHz	Inverter: 2, 4, 8 Supply units: 4.2			
Inverter switching frequency (nominal value)	f_{snenn}	kHz	4			
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)[1)]	$P_{Diss_0A_fs\ min}$	W	230	250	270	320
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn)[1)]	$P_{Diss_0A_fs\ nenn}$	W	250	275	300	350
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn) (supply units)[1)]	$P_{Diss_0A_fs\ nenn_supply}$	W	250	275	300	350
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)[2)]	$P_{Diss_0A_fs\ max}$	W	300	325	350	400
Power dissipation at continuous current and continuous DC bus power respectively[3)]	P_{Diss_cont}	W	2500	3000	4250	5500
Power dissipation at continuous current and continuous power respectively (supply units)[3)]	$P_{Diss_cont_supply}$	W	2500	3000	4250	5500
Liquid cooling data						
Power dissipation ratio (liquid) with continuous current/ continuous power	$P_{Diss_cont_F}$	W	2100	2500	3500	4500
Power dissipation ratio (liquid) with continuous current/ continuous power (supply units)	$P_{Diss_cont_F_supply}$	W	2100	2500	3500	4500
Coolant inlet temperature	T_{in}	°C	< 60			
Required minimum coolant flow for $P_{Diss_cont_F}$	Q_{min}	l/min	4,5	5.4	7.3	9.2
Required minimum coolant flow for $P_{Diss_cont_F_supply}$ (supply units)	Q_{min_supply}	l/min	4,5	5.4	7.3	9.2
Temperature increase for Q_{min} and $P_{Diss_cont_F}$	ΔT	K	< 10			
Pressure drop for Q_{min}	Δp	bar	0.4		0.5	
Last modification: 2019-03-19*						

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
Maximum allowed operating pressure	p_{max}	bar	5.00			
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	500	750	1000
Power dissipation ratio (air) with continuous current/continuous power (supply units)	$P_{Diss_cont_A_supply}$	W	400	500	750	1000
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			
Capacity utilization factor: Derating vs. Ambient temperature (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			
Volumetric capacity of forced cooling	V	m^3/h	-			
Minimum distance on the top of the device[4)]	d_{top}	mm	100			
Minimum distance on the bottom of the device[5)]	d_{bot}	mm	100			
Temperature increase with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	10			
						Last modification: 2019-03-19*

1) 2) Plus dissipation of braking resistor and control section; find interim values by interpolation to P_{Diss_cont}

3) Plus dissipation of braking resistor and control section

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

Tab. 4-25: 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
Allowed mounting position			G1		
Allowed switching frequencies	f_s	kHz	Inverter: 2, 4, 8 Supply units: 4.2		
Inverter switching frequency (nominal value)	f_{snenn}	kHz	2		
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)[1)]	$P_{Diss_0A_fs\ min}$	W	350	400	450
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn)[1)]	$P_{Diss_0A_fs\ nenn}$	W	350	400	450
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn) (supply units)[1)]	$P_{Diss_0A_fs\ nenn_supply}$	W	400	450	500
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)[2)]	$P_{Diss_0A_fs\ max}$	W	450	500	550
Power dissipation at continuous current and continuous DC bus power respectively[3)]	P_{Diss_cont}	W	5500	6500	8700
Power dissipation at continuous current and continuous power respectively (supply units)[3)]	$P_{Diss_cont_supply}$	W	6000	7500	9500
Liquid cooling data					
Power dissipation ratio (liquid) with continuous current/ continuous power	$P_{Diss_cont_F}$	W	4500	5500	7500
Power dissipation ratio (liquid) with continuous current/ continuous power (supply units)	$P_{Diss_cont_F_supply}$	W	5000	6400	8000
Coolant inlet temperature	T_{in}	°C	< 60		
Required minimum coolant flow for $P_{Diss_cont_F}$	Q_{min}	l/min	9	11.4	15.8
Required minimum coolant flow for $P_{Diss_cont_F_supply}$ (supply units)	Q_{min_supply}	l/min	9.5	12	16
Temperature increase for Q_{min} and $P_{Diss_cont_F}$	ΔT	K	< 10		
Pressure drop for Q_{min}	Δp	bar	0.6	1	1.3
Maximum allowed operating pressure	p_{max}	bar	5.00		
Coolant channel volume	V_{ch}	ml	851	966	1024
Coolant channel material			Aluminum		

Last modification: 2019-03-19*

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
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		1200
Power dissipation ratio (air) with continuous current/continuous power (supply units)	$P_{Diss_cont_A_supply}$	W	1000	1100	1300
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		
Capacity utilization factor: Derating vs. Ambient temperature (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		
Volumetric capacity of forced cooling	V	m^3/h	-		
Minimum distance on the top of the device[4)]	d_{top}	mm	100		
Minimum distance on the bottom of the device[5)]	d_{bot}	mm	100		
Temperature increase with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	10		
					Last modification: 2019-03-19*

1) 2) Plus dissipation of braking resistor and control section; find interim values by interpolation to P_{Diss_cont}

3) Plus dissipation of braking resistor and control section

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

Tab. 4-26: HMU – cooling and power dissipation data

Cooling and power dissipation data

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Allowed mounting position			G1					
Allowed switching frequencies	f_s	kHz	Inverter: 2, 4, 8 Supply units: 4.2					
								Last modification: 2019-03-19*

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Inverter switching frequency (nominal value)	f_{snenn}	kHz	4			2		
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)[1)]	$P_{Diss_0A_fs\ min}$	W	90				150	1150
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn)[1)]	$P_{Diss_0A_fs\ nenn}$	W	170			90	150	1150
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn) (supply units)[1)]	$P_{Diss_0A_fs\ nenn_supply}$	W	180				310	2390
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)[2)]	$P_{Diss_0A_fs\ max}$	W	330				588	4560
Power dissipation at continuous current and continuous DC bus power respectively[3)]	P_{Diss_cont}	W	3850	4460	5670	5970	6730	12080
Power dissipation at continuous current and continuous power respectively (supply units)[3)]	$P_{Diss_cont_supply}$	W	3270	3910	4810	6130	8480	13560
Liquid cooling data								
Power dissipation ratio (liquid) with continuous current/ continuous power	$P_{Diss_cont_F}$	W	3660	4240	5390	5670	6400	11480
Power dissipation ratio (liquid) with continuous current/ continuous power (supply units)	$P_{Diss_cont_F_supply}$	W	3110	3720	4570	5830	8060	12880
Coolant inlet temperature	T_{in}	°C	< 60					
Required minimum coolant flow for $P_{Diss_cont_F}$	Q_{min}	l/min	5.8	6.8	8.7	9.2	10.3	18.5
Required minimum coolant flow for $P_{Diss_cont_F_supply}$ (supply units)	Q_{min_supply}	l/min	5	6	7.4	9.4	13	19
Temperature increase for Q_{min} and $P_{Diss_cont_F}$	ΔT	K	< 10					
Pressure drop for Q_{min}	Δp	bar	0.3		0.4		0.5	1.2
Maximum allowed operating pressure	p_{max}	bar	5.00					
Coolant channel volume	V_{ch}	ml	609		667		851	966
Coolant channel material			Aluminum					
Constant for determining pressure drop	$K_{\Delta p}$		tbd					
Air cooling data								
Last modification: 2019-03-19*								

Description	Symbol	Unit	HMU05.1 N-F0140-0 210-N-A5-11-P	HMU05.1 N-F0170-0 250-N-A5-11-P	HMU05.1 N-F0220-0 300-N-A5-11-P	HMU05.1 N-F0270-0 370-N-A5-11-P	HMU05.1 N-F0400-0 600-N-A5-11-P	HMU05.1 N-F0540-0 750-N-A5-11-P
Power dissipation ratio (air) with continuous current/continuous power	$P_{Diss_cont_A}$	W	190	220	260	300	330	600
Power dissipation ratio (air) with continuous current/continuous power (supply units)	$P_{Diss_cont_A_supply}$	W	160	190	240	300	420	680
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					
Capacity utilization factor: Derating vs. Ambient temperature (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					
Volumetric capacity of forced cooling	V	m^3/h	-					
Minimum distance on the top of the device[4)]	d_{top}	mm	100					
Minimum distance on the bottom of the device[5)]	d_{bot}	mm	100					
Temperature increase with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	10					
Last modification: 2019-03-19*								

1) 2) Plus dissipation of braking resistor and control section; find interim values by interpolation to P_Diss_cont
3) Plus dissipation of braking resistor and control section
4) 5) See fig. "Air intake and air outlet at device"

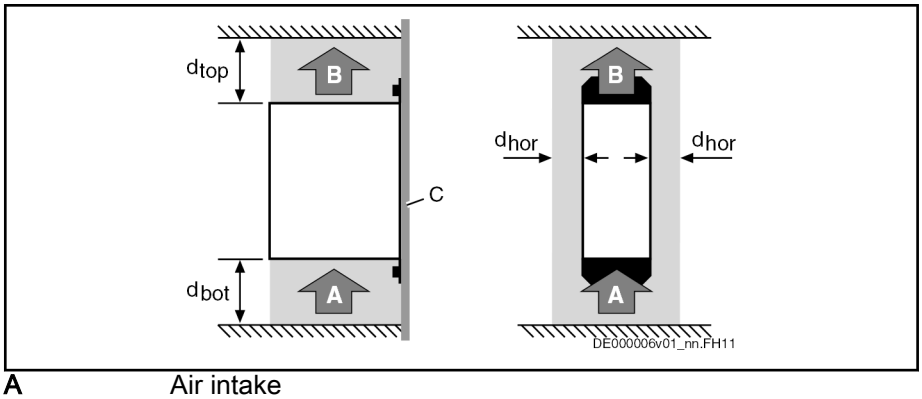
Tab. 4-27: HMU – cooling and power dissipation data

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. 4-47: Air intake and air outlet at device

HMU05.1N-Wxxxx-xxxx

Cooling and power dissipation data

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Allowed mounting position			G1				
Cooling type			Air-cooled				
Allowed switching frequencies	f_s	kHz	Inverter: 2, 4, 8 Supply units: 4.2				
Inverter switching frequency (nominal value)	f_{snenn}	kHz	4				2
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)[1)]	$P_{Diss_0A_fs\ min}$	W	350				
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn)[1)]	$P_{Diss_0A_fs\ nenn}$	W	250	275	300	350	
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (nenn) (supply units)[1)]	$P_{Diss_0A_fs\ nenn_supply}$	W	350		375	400	
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)[2)]	$P_{Diss_0A_fs\ max}$	W	450				
Power dissipation at continuous current and continuous DC bus power respectively[3)]	P_{Diss_cont}	W	2300	3000	4800	5600	5000
Power dissipation at continuous current and continuous power respectively (supply units)[3)]	$P_{Diss_cont_supply}$	W	2200	2600	4200	5000	6200
Last modification: 2019-03-19*							

Description	Symbol	Unit	HMU05.1 N-W0140-0350-N-A4-D7-P	HMU05.1 N-W0170-0430-N-A4-D7-P	HMU05.1 N-W0220-0510-N-A4-D7-P	HMU05.1 N-W0270-0660-N-A4-D7-P	HMU05.1 N-W0340-0820-N-A4-D7-P
Ambient temperature range for operation with nominal data	T_{a_work}	°C	0...40				
Ambient temperature range for operation with reduced nominal data **without** operation of a safety technology	$T_{a_work_red}$	°C	0...55				
Ambient temperature range for operation with reduced nominal data **with** operation of a safety technology	$T_{a_work_red_SI}$	°C	0...50				
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				
Volumetric capacity of forced cooling	V	m^3/h	-	-	-	-	-
Minimum distance on the top of the device[4)]	d_{top}	mm	150				
Minimum distance on the bottom of the device[5)]	d_{bot}	mm	200				
Temperature increase with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	20	25		30	35
Last modification: 2019-03-19*							

1) 2) Plus dissipation of braking resistor and control section; find interim values by interpolation to P_Diss_cont
3) Plus dissipation of braking resistor and control section
4) 5) See fig. "Air intake and air outlet at device"

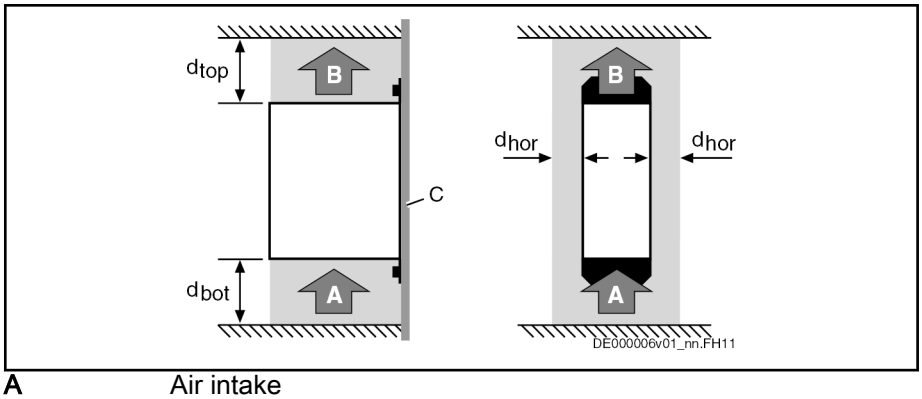
Tab. 4-28: HMS - Data for Cooling and Power Dissipation

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. 4-48: Air intake and air outlet at device

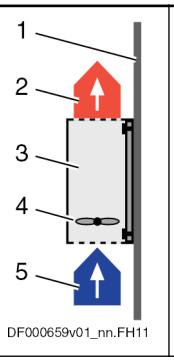
4.5.4 Mounting positions of components

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. 4-29: Mounting position G1

4.6 Electrical project planning

4.6.1 Overall connection diagram (HMU05 as drive controller)

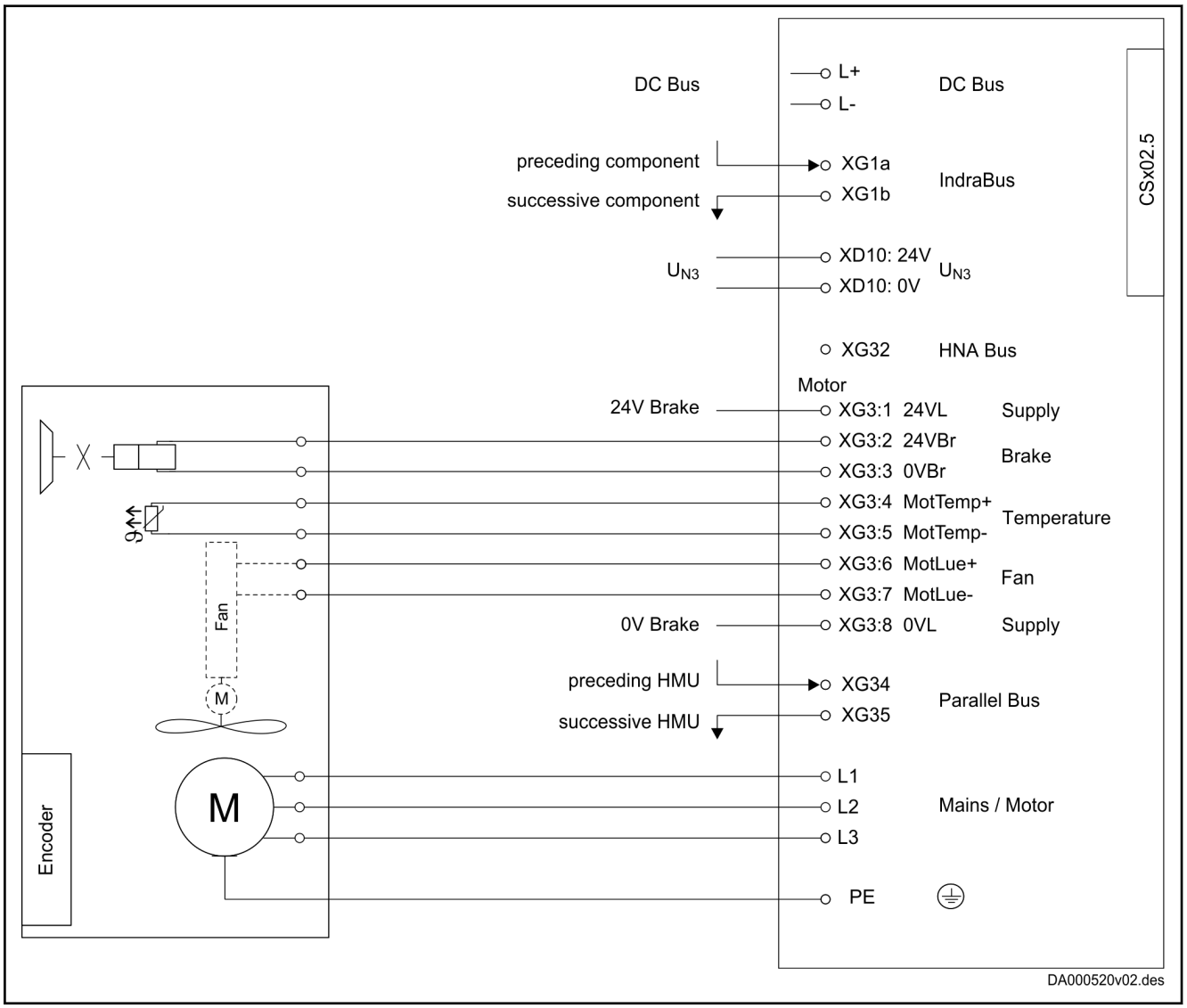


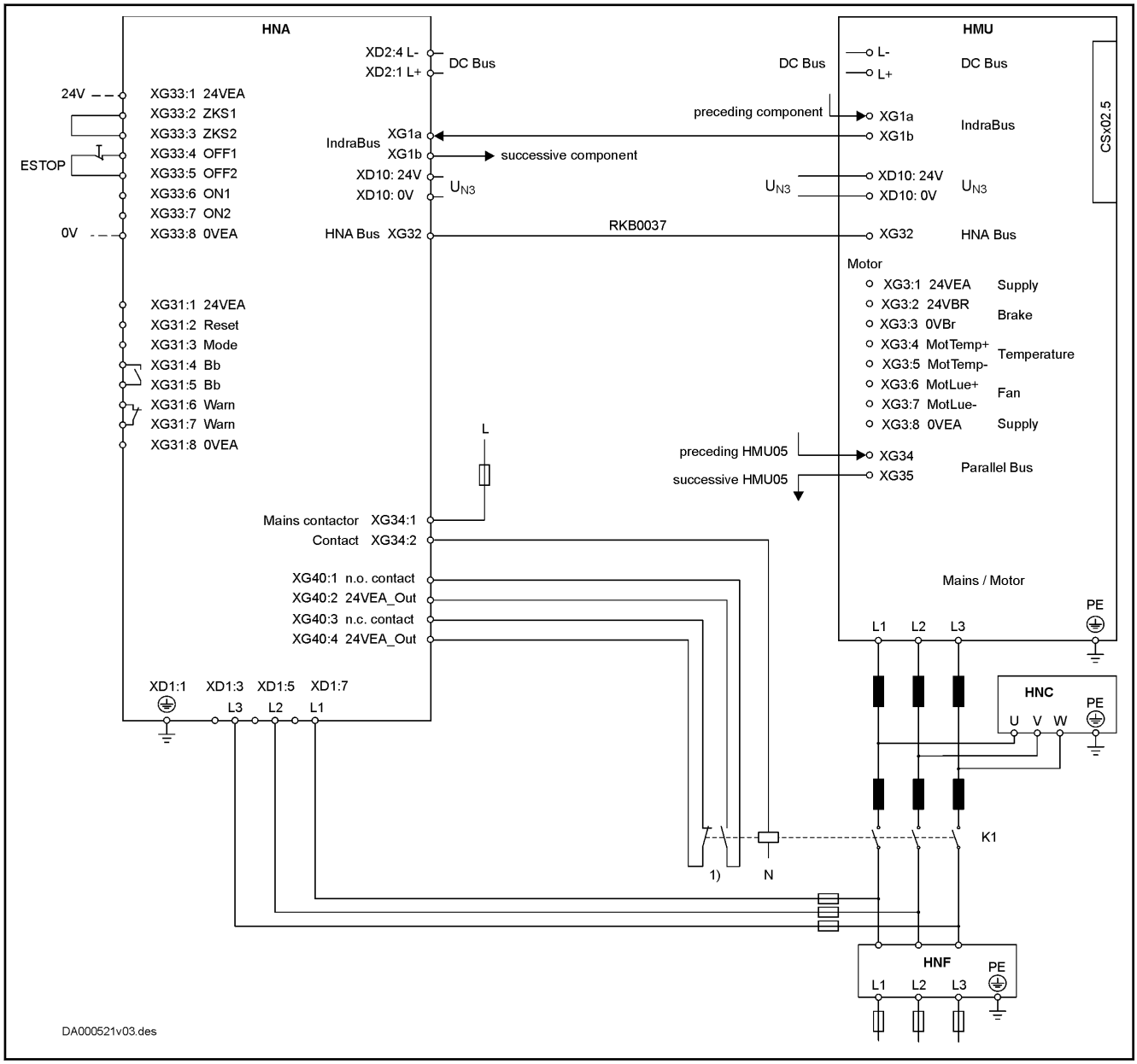
Fig. 4-49: Connection diagram (HMU05 as drive controller)

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).

XG33 (HNA) must also be wired if the supply unit is controlled via the communication.



1) With multiple contactors connected in parallel, connect the N/O contacts and N/C contacts in series. See fig. 4-61 "Mains contactor wiring in the case of parallel connection" on page 117.

K1 Load contactor

Fig. 4-50: Connection diagram with load contactor (HMU05 as supply unit)

HLT05

Connection diagram with HLT05:

See chapter "HLT05 / HNA05 / HMU05" on page 325.

Reactive power, reactive current

Reactive power: chapter 11.2 "Reactive power" on page 599.

HNC05 reactive current: chapter "Reactive current with supply unit locked" on page 218

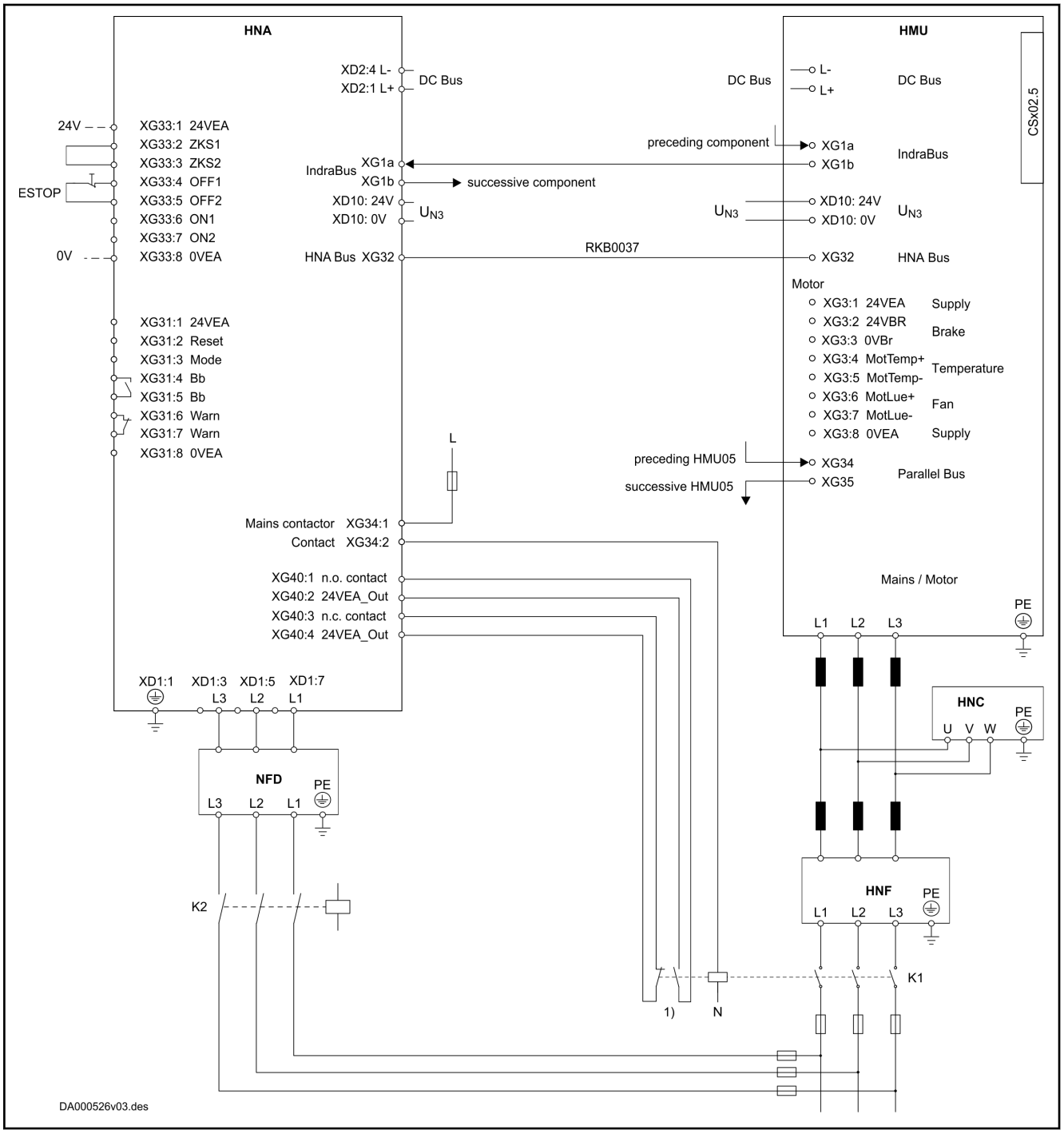
HNF05 reactive current: chapter "Reactive current with supply unit locked" on page 227

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. See fig. 4-61 "Mains contactor wiring in the case of parallel connection" on page 117.

K1 Main switch

K2 Auxiliary switch

Fig. 4-51: 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, take the requirements of the drive system components into account:

- **Allowed tolerances of the supply voltage** depending on the length of the motor cable and the use of motor holding brakes
- 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 at the component for the purpose of looping through the control voltage to other components

Sizing the control voltage supply

Determining the power requirements

Power requirement of the drive controller

The **total power requirement** of the control voltage supply of a drive controller results 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

For the configuration of your drive controller, see the type plate and the type code.

Power requirement of the basic device

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)

See chapter 7.2.1 "Control voltage" on page 151.

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	$P = I_{Encoder} \times 12\ V \times 1.25$ [1), 5)]
Load at digital output	$P = I_{Load} \times U_{N3}$ [2), 4)]
Motor holding brake	$P = I_{Brake} \times U_{N3}$ [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 consumptions of all connected encoder systems incl. encoder emulation cannot exceed **6 W**.

Tab. 4-30: 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 24V 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 24V power supply unit, determine the continuous current I_{N3} of all components:

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

1) Protective Extra Low Voltage

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

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

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

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

Required peak current

When the 24V control voltage unit is switched on, the 24V power supply unit is loaded with the charging current of the capacitors of 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.

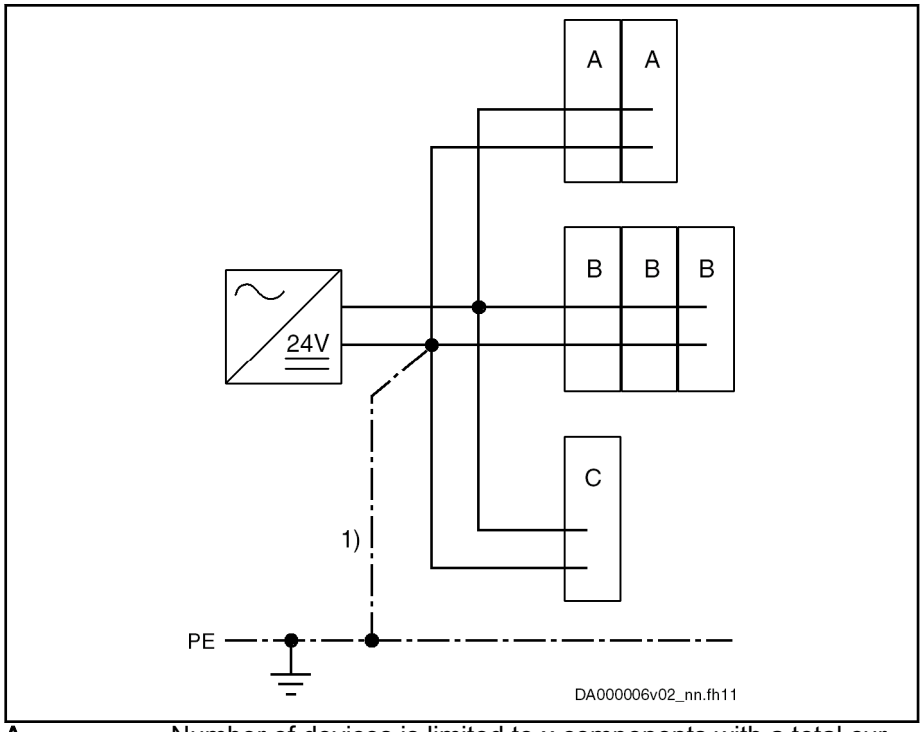
Required inrush current

See chapter 7.2.1 "Control voltage" on page 151

Installing the 24V supply

Notes on installation

- The 24 V supply of the Rexroth IndraDrive ML drive system components should 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, too, applies to multiple-line arrangement in the case of supply from a supply unit, for example.
- Run lines with sufficiently dimensioned line cross sections 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., earth-circuit connector PE)

Fig. 4-52: Installing the 24V supply

If you use multiple 24V power supply units:

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

Chronological order of 24V supply and mains voltage

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

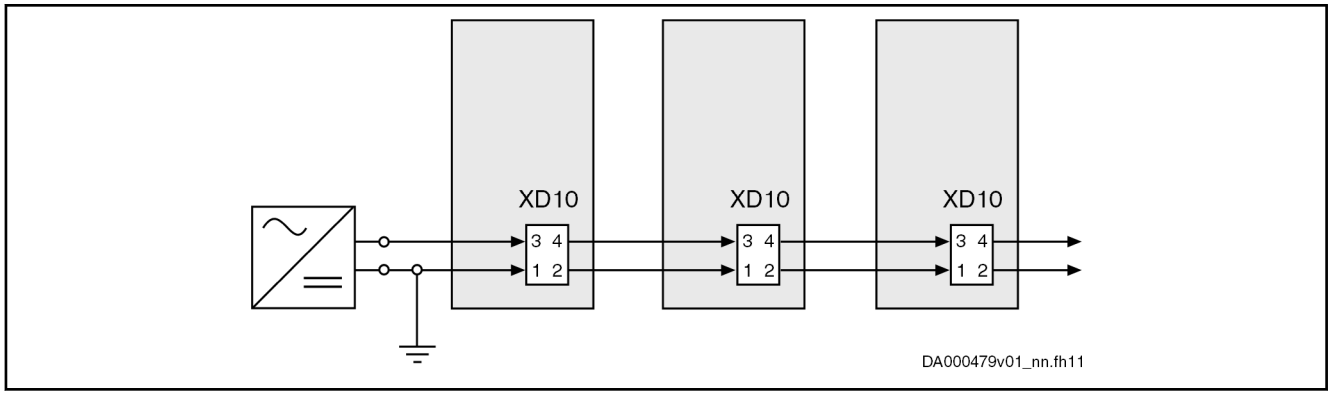


Fig. 4-53: Looping through the control voltage

Exemplary calculation for 3 drive controllers:

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

Fig. 4-54: 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.

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 network
- 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 make low leakage currents possible 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 no improvement is 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.

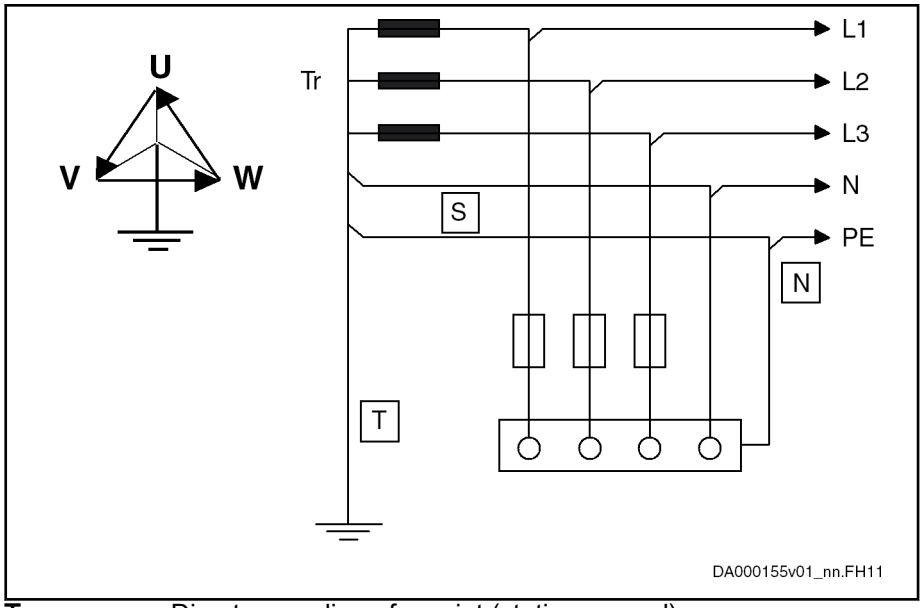
Electronic equipment that has a nominal power higher than 4 kVA or is destined for permanent connection normally does not need residual-current-operated circuit breakers. Observe the country-specific standards.

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

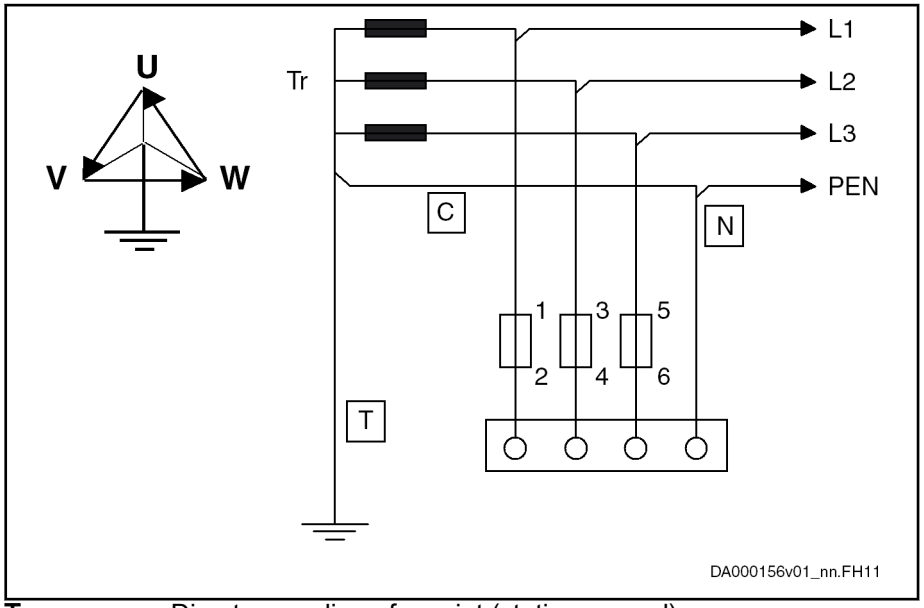
The TN-S mains type is the usual mains type in Europe.



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. 4-55: TN-S mains type

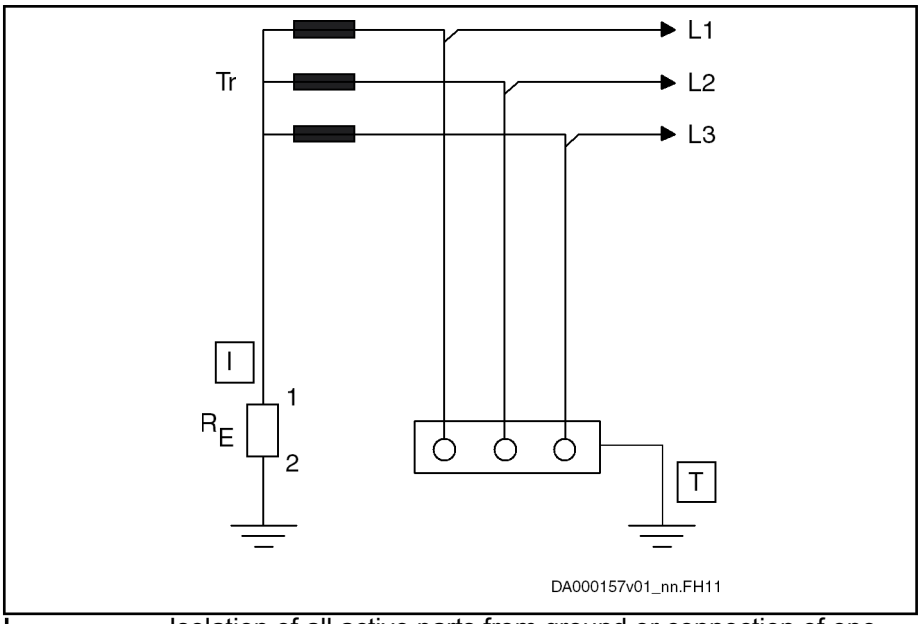
TN-C mains type



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. 4-56: TN-C mains type

IT mains type



I Isolation of all active parts from ground or connection of one point to ground via an R_E impedance

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

Fig. 4-57: IT mains type

Notes on project planning

If you would like to do project planning for installations at the IT-mains, it is absolutely necessary that you consult Rexroth.

NOTICE **Risk of damage to the devices by voltage flashovers!**

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

NOTICE **Risk of damage to the devices by voltage increase in the case of ground fault!**

If a "ground fault" occurs in the IT mains type, the voltages against ground (device housing) acting on the device are higher than in error-free operation.

Where applicable, the "ground fault" in the IT mains type is only possible **temporarily** with the IndraDrive components.

- **"Mains-side ground fault":**

  If a "ground fault" occurs, it is **not** possible to continue operating mains capacitors (HNC) of the 400 V series with ground capacitors (HNC05.1…-A4-NNNN). They have to be immediately disconnected from the mains.

  Mains filters (HNF05.1) and mains capacitors of the 690 V series (HNC05.1…-A5-) as well as all mains capacitors without ground capacitors (HNC05.1…-C001) may still be operated for a limited period of time in case a mains-side ground fault occurs.

  If it is required to operate devices with 690 V for a limited period of time in case a mains-side ground fault occurs, please use the more voltage-resistant type HAS04.1-003-NN**1**-NN for DC bus ground capacitors.

- **"Motor-side ground fault":**

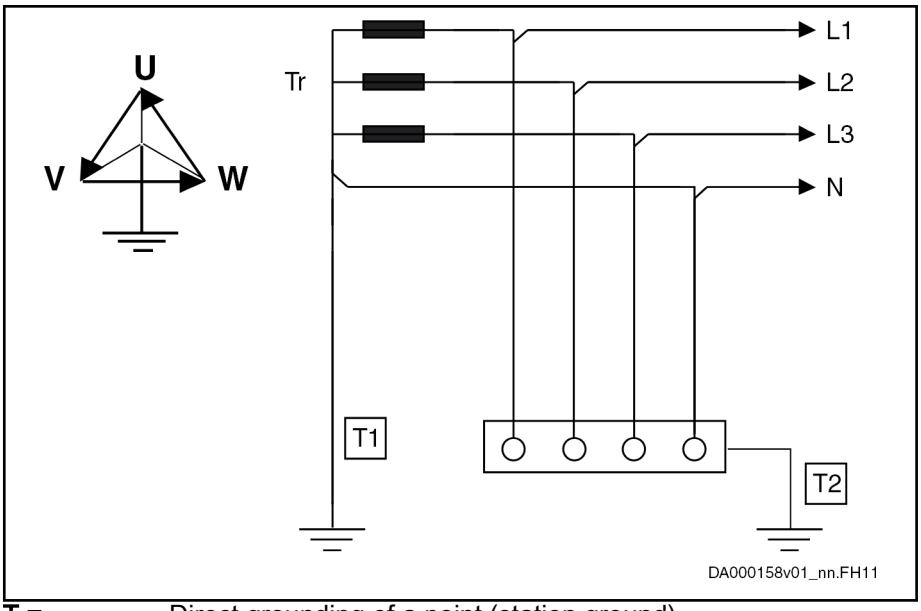
  If a motor-side ground fault occurs, it is **not allowed** to continue operating:

  – Mains filter (HNF05.1…)
  – Mains capacitors with ground capacitors (HNC05.1…-NNNN)
  – DC bus ground capacitors (HAS04.1-003)

  Continued operation leads to immediate destruction of these components.

  Mains capacitors without ground capacitors (HNC05.1…-C001) may still be operated for a limited period of time in case a motor-side ground fault occurs. However, it must be ensured that the other components of the drive system and the entire IT mains are designed for this.

TT system

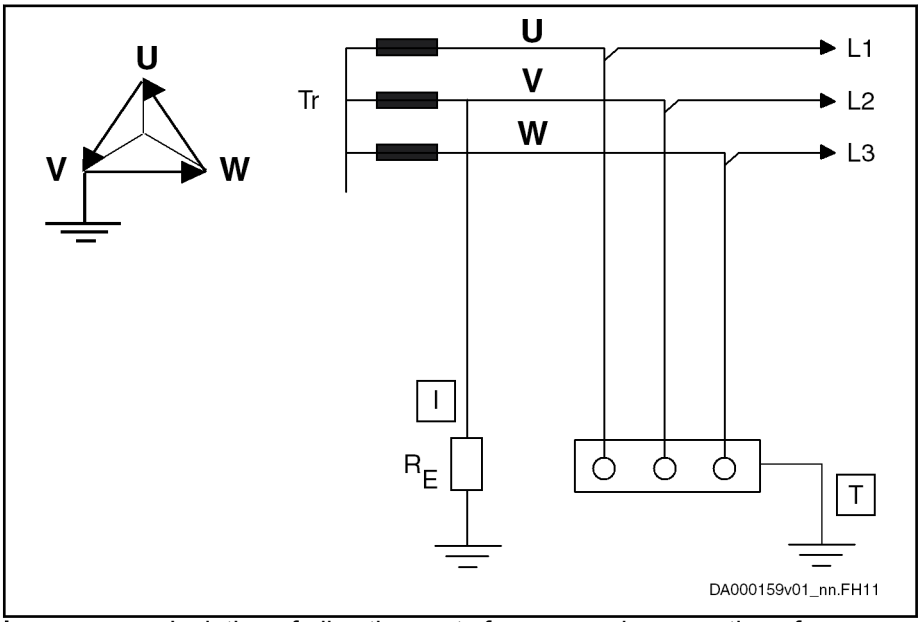


T = Direct grounding of a point (station ground)
T = Exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig. 4-58: TT mains system

The EMC requirements are only complied with by specific measures (such as specific 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. 4-59: Mains with grounded outer conductor

Notes on project planning

- Observe the allowed mains voltages.
  See chapter 7.2.2 "Mains voltage" on page 154.
- The EMC requirements are only complied with by specific measures (such as specific 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

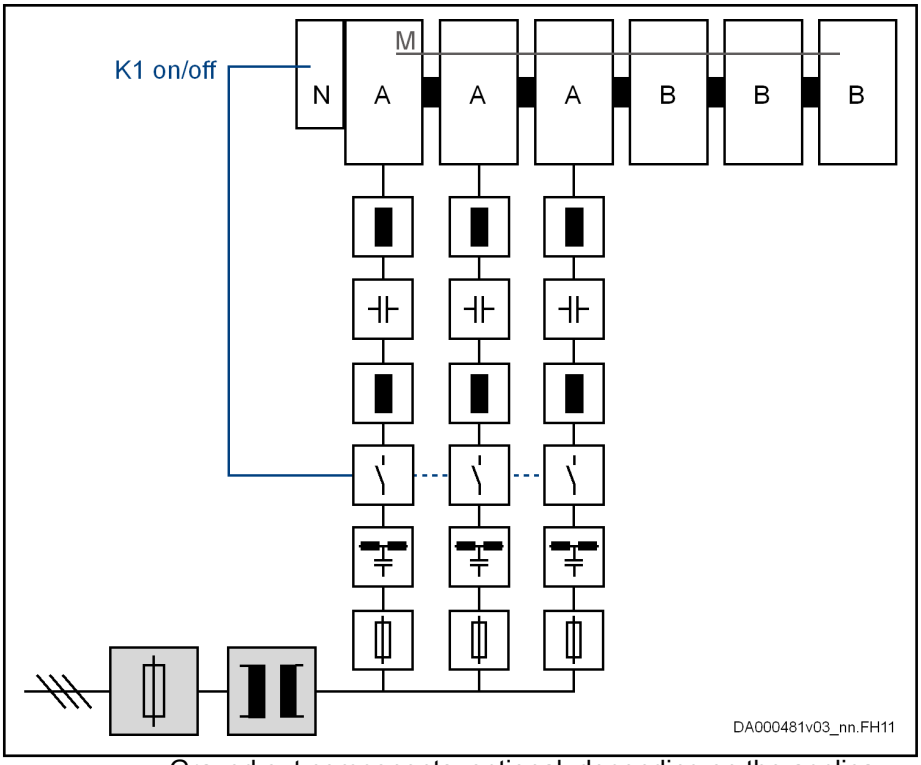
---

Mains connection type

See also chapter 4.6.4 "Mains connection" on page 108.

Parallel connection

Multiple components HMU05 (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 power grid 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. 4-60: Parallel connection; multiple HMU05 components connected to supply mains

Mains contactor wiring in the case of parallel connection

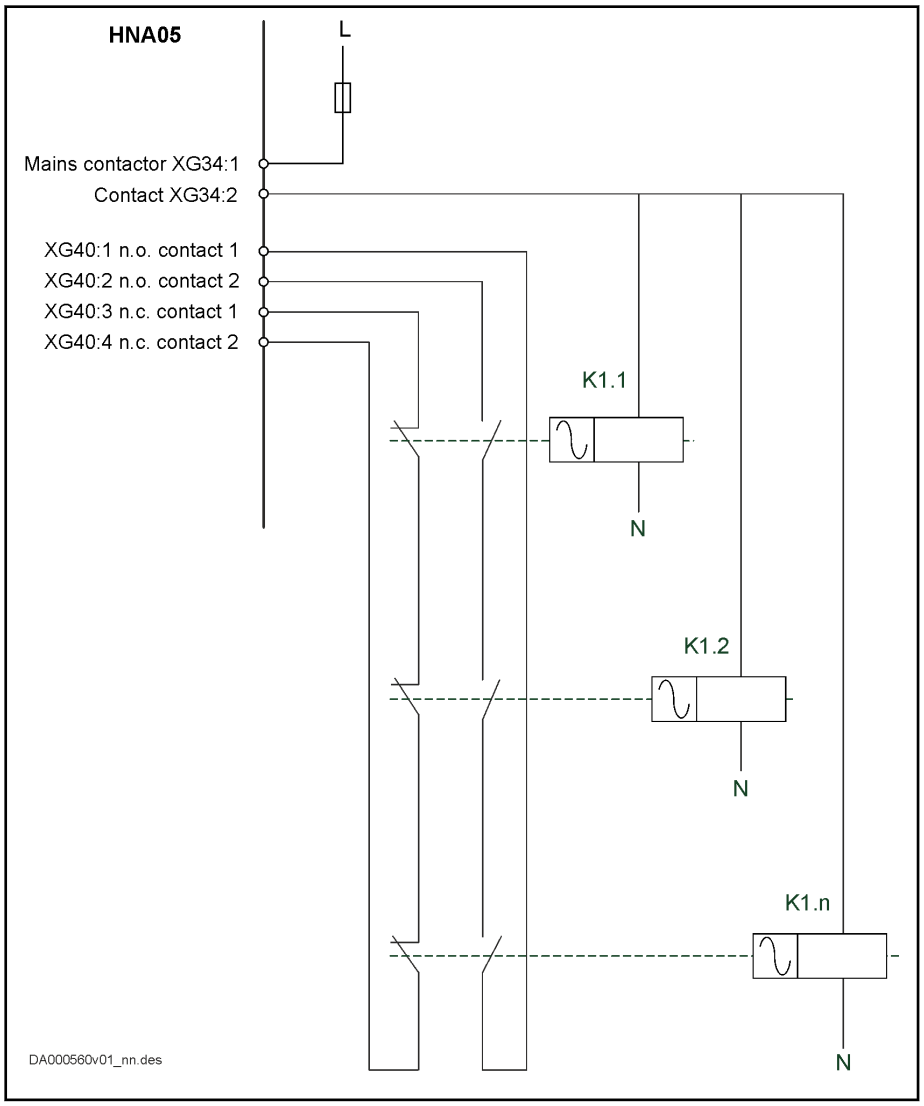


Fig. 4-61: Mains contactor wiring in the case of parallel connection

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 supply feeder (see IEC 60204-1, chapter Appendix A).

Observe the data for sizing 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 154
- See chapter 7.2.3 "DC bus" on page 158

Calculating the mains-side phase current

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

- Selecting the mains contactor
- Determining the fuses in the mains connection
- Determining the 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 may involve 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 the **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 the **DC bus power** from motor power and efficiency

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

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

3. Add the **powers of all axes** at the common DC bus and put them into relation to the rated power of the supply unit
   ⇒ Partial load of P_{DC_cont} is known
4. Determine the **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 the **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 the **mains-side phase current**

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

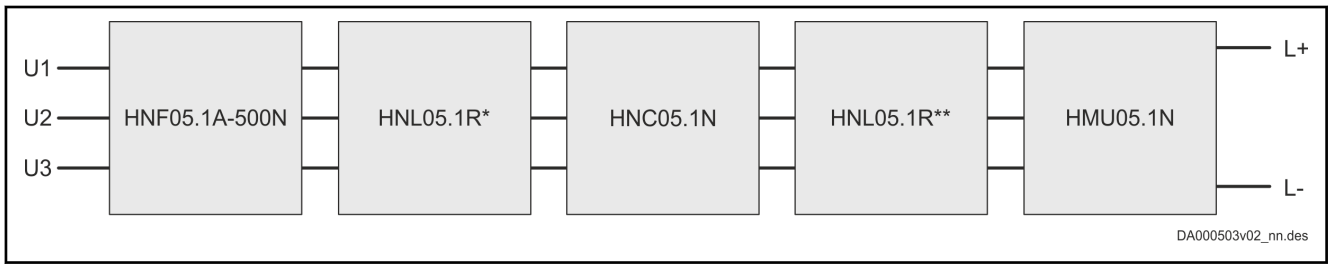
I_{LN}	Mains-side phase current in [A]
S_{LN}	Mains connected load [VA]
U_{LN}	Voltage between phases of mains [V]

7. Select the **mains contactor**
8. Determine the **mains circuit breaker and line cross section**
   See chapter 11.4 "Sizing the line cross sections and fuses " on page 601

Dimensioning the line cross sections and fuses

☞ Some standards provide recommendations for dimensioning the line cross sections and fuses.
See chapter 11.4 "Sizing the line cross sections and fuses " on page 601.

Combining mains filter, mains choke, preconnected choke and mains capacitor



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

Fig. 4-62: Components for mains connection

Components		Supply unit HMU05.1N-F…-A4-D7 (liquid-cooled)						
		F0140-0350	F0170-0430	F0220-0510	F0270-0660	F0340-0820	F0430-1040	F0540-1300
Chopper choke HNL05.1R-…-N-A4-NNNF	0219-N0218	✓						
	0182-N0262		✓					
	0135-N0327			✓				
	0117-N0409				✓			
	0130-N0514					✓		
	0113-N0652						✓	
	0100-N0811							✓
Preconnected choke HNL05.1R-	0045-N0327	(✓)	(✓)	✓				
	0054-N0409				✓			
	0043-N0514					✓		
	0050-N0652						✓	
	0040-N0811							✓
Mains capacitor HNC05.1N-…-NNNN	0050-A4	✓	✓					
	0075-A4			✓				
	0100-A4				✓	✓	✓	✓
Mains filter HNF05.1A-	500N-R0250	✓						
	500N-R0320		✓					
	500N-R0400			✓				
	500N-R0600				✓	✓		
	500N-R1000						✓	✓

(✓) Optional

Tab. 4-31: Components for mains connection (HMU05.1N-F…-A4-D7)

Components		Supply unit HMU05.1N-W…-A4-D7 (air-cooled)				
		F0140-0350	F0170-0430	F0220-0510	F0270-0660	F0340-0820
Chopper choke HNL05.1R-…-N-A4-NNNW	0219-N0262	✓	✓			
	0135-N0327			✓		
	0117-N0409				✓	
	0130-N0514					✓
Preconnected choke HNL05.1R-	0045-N0327	(✓)	(✓)	✓		
	0054-N0409				✓	
	0043-N0514					✓
Mains capacitor HNC05.1N-…-NNNN	0050-A4	✓	✓			
	0075-A4			✓		
	0100-A4				✓	✓
Mains filter HNF05.1A-	500N-R0250	✓				
	500N-R0320		✓			
	500N-R0400			✓		
	500N-R0600				✓	✓

(✓) Optional

Tab. 4-32: Components for mains connection (HMU05.1N-W…-A4-D7)

Components		Supply unit HMU05.1N-F…-A5-11 (liquid-cooled)					
		0140-0210	0170-0250	0220-0300	0270-0370	0400-0600	0540-0750
Chopper choke HNL05.1R-	0649-N0127-N-A5	✓					
	0542-N0152-N-A5		✓				
	0434-N0190-N-A5			✓			
	0346-N0238-N-A5				✓		
	0234-N0352-N-A5					✓	
	0175-N0471-N-A5						✓
Preconnected choke HNL05.1R-	0125-N0152-N-A5	(✓)	✓				
	0100-N0190-N-A5			✓			
	0080-N0238-N-A5				✓		
	0054-N0352-N-A5					✓	
	0040-N0471-N-A5						✓
Mains capacitor HNC05.1N-…-NNNN	0040-A5	✓	✓				
	0050-A5			✓			
	0070-A5				✓		
	0100-A5					✓	
	0125-A5						✓
Mains filter HNF05.1A-	500N-R0150-N-A5	✓					
	500N-R0180-N-A5		✓				
	500N-R0250-N-A5			✓	✓		
	500N-R0400-N-A5					✓	
	500N-R0600-N-A5						✓

(✓) Optional

Tab. 4-33: Components for mains connection (HMU05.1N-…-A5-11)

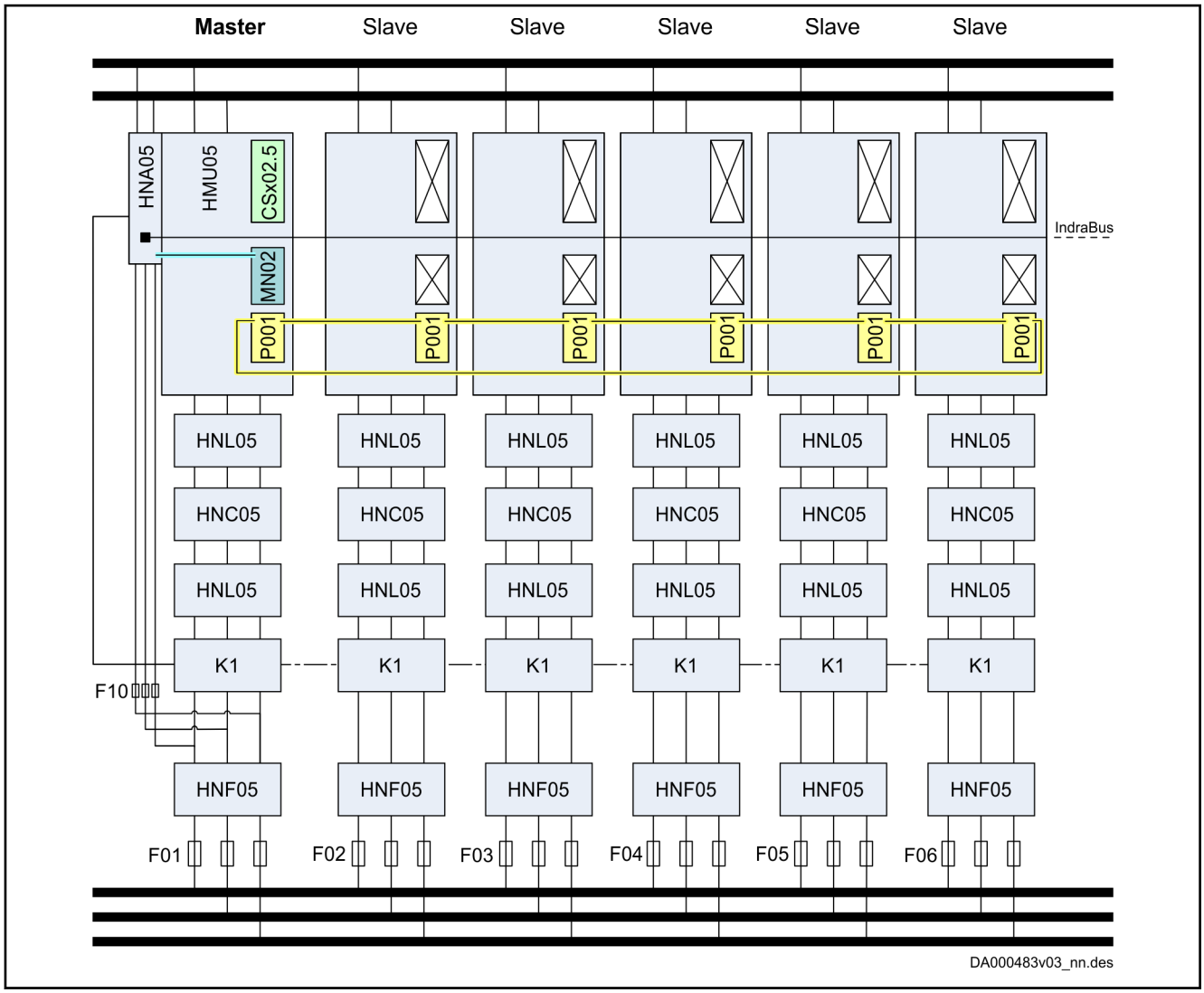
4.6.5 Running multiple HMU05s in parallel

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

The allowed number of paralleled HMU05s depends on the **clock frequency**.

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

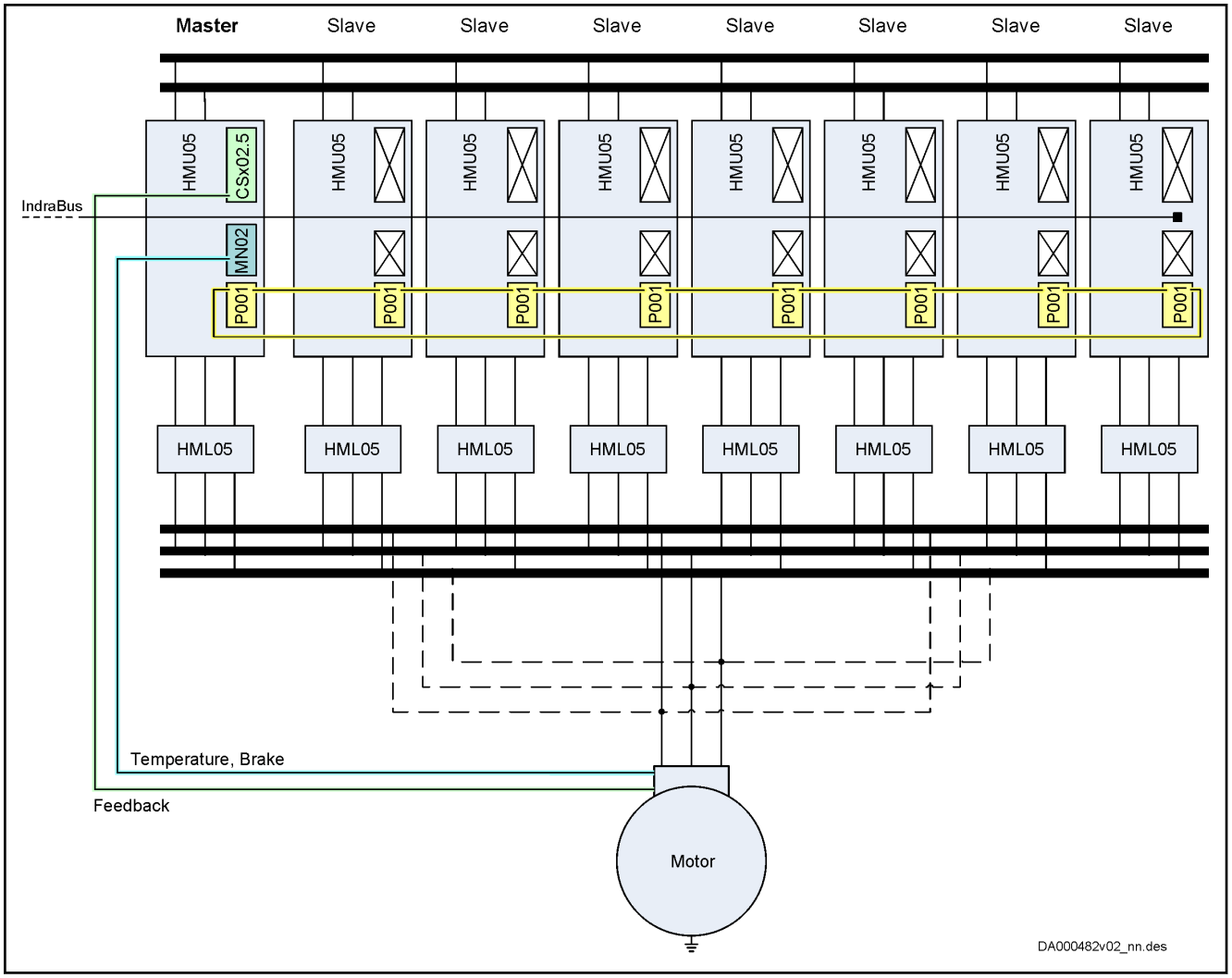
Operation as supply unit uses HNL05 mains chokes to balance parallel operation.



Clock frequency: 4.2 kHz Maximum of 6 paralleled HMU05s

*Fig. 4-63: Parallel operation of HMU05 to run as **supply unit***

Operation as drive controller uses HML05 motor chokes.



Clock frequency Parallel HMU05s can only be operated at clock frequencies < 8 kHz:

6 kHz Maximum of 3 paralleled HMU05s

4 kHz Maximum of 8 paralleled HMU05s

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

*Fig. 4-64: 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%** at precautionary applications and no highly dynamic drive applications
- **10%** at highly dynamic drive applications

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

4.7.1 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.

CE DX000011v01_en.FH11	**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. 4-34: CE - applied standards

EAC	**Drive controllers**
EAC-conformity with regard to low-voltage devices	TR ZU 004/2011
EAC-conformity with regard to EMC	TR ZU 020/2011
Certificate number	0278446

Tab. 4-35: EAC label

4.7.2 C-UL-US listing

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

Proof of certification can be found online. Enter the terms "UL" and "databases" in a search engine to get to the relevant UL web page. With the file number you will find the proof of certification.

c UL us **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. 4-36: 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 specified **short-circuit current rating SCCR** is not exceeded, e.g. by providing appropriate fuses in the mains connection of the supply unit.

UL wiring material

In the scope of CSA / UL, only use class 1 copper wires (or equivalent) with minimum permissible conductor temperature of 75°C for wiring the components.

Allowed pollution degree

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

UL/CSA approvals of the choke and filter components

Component[1)]	UL/CSA approval	Notes
Mains filter HNF05.1R-…-A5	recognized (cUR US); E172117 according to UL1283; CSA C22.2 No.8	1)
Mains choke HNL05.1R-…-A4-NNNN HNL05.1R-…-A4-NNNF	recognized (cUR US); E472843	-
Mains choke HNL05.1R-…-A4-NNNW	Isolating system (UR) according to E181051 "F2"	-
Mains choke HNL05.1R-…-A5	Isolating system (UR) according to E181051 "F2"	1)
Mains capacitor HNC05.1N-...-NNNN	cUL US; E134201	-

Component[1)]	UL/CSA approval	Notes
Mains capacitor HNC05.1N-...-C001	As per 2019-05: no UL/CSA approval	-
DC bus choke HLL05.1…-N-D7-01U2	Listed (cUL US); E472843	-
DC bus choke HLL05.1F…-N-11-01U2 HLL05.1W-04M0-S0202-N-D11-01U2 HLL05.1W-04M0-S0303-N-D11-01U2		1)
HLL05.1W-04M0-S0475-N-D11-01U2	Isolating system (UR) according to E181051 "F2"	-
Motor/balancing choke HML05.1W-D…-N-500	recognized (cUR US); E472843	-
Motor/balancing choke HML05.1W-D…-N-690	Isolating system (UR) according to E181051 "F2"	1)

1) Operation of the components "A5"" (690 V) within the scope of UL/CSA under nominal conditions was not yet allowed at the time of documentation creation. If necessary, please ask your sales partner.

Tab. 4-37: UL/CSA approvals of the choke and filter components

4.7.3 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.

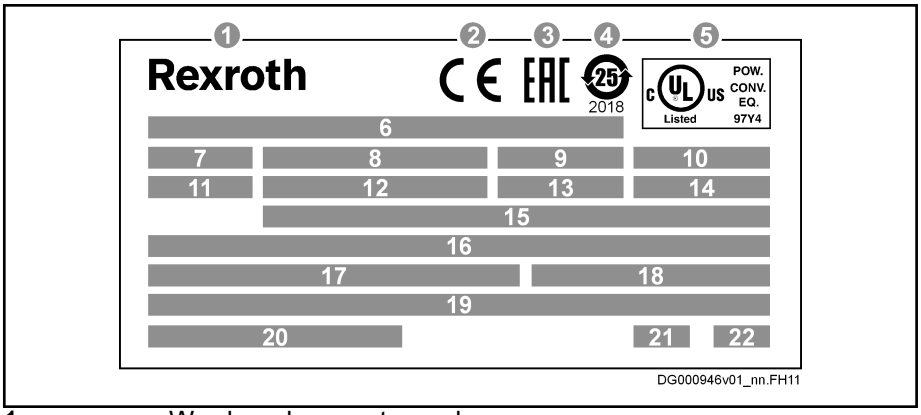
5.2 Identification

5.2.1 Type plate

1 Type designation
2 Country of manufacture
3 Factory
4 Customer material number
5 Material number
6 Bar code, 2D code
7 Serial number
8 Production week; 18W23, for example, means year 2018, week 23
9 Hardware index

Fig. 5-1: Type plate

5.2.2 Rating plate



1	Word mark or customer logo
2	CE conformity mark
3	EAC conformity mark
4	China RoHS 2 conformity label, production year
5	UL label
6	Type designation
7	Supply input data
8	Input voltage
9	Input current
10	Input frequency
11	Supply output data
12	Output voltage
13	Output current
14	Output frequency
15	UL text 2
16	UL text 1
17	SCCR
18	Ambient temperature during operation
19	Company address
20	Designation of origin
21	Degree of protection provided by enclosure
22	Factory

Fig. 5-2: Rating plate (electrical equipment)

5.2.3 Scope of supply

Standard
Documentation

Tab. 5-2: Scope of supply 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

Description	Symbol	Unit	Value
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 of liquid-cooled devices

- When mounting, observe the mandatory **minimum distances** between components (see chapter "HMU05.1N-Fxxxx-xxxx" on page 74).
- **Tightening torque** of the **M10** mounting screws: **48 Nm**
- 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 178.
  - 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 180.

Notes on mounting of air-cooled devices

- When mounting, observe the mandatory **minimum distances** between components (see chapter "HMU05.1N-Wxxxx-xxxx" on page 82).
- **Tightening torque** of the **M10** mounting screws: **48 Nm**
- Mounting accessories for push-through mounting:
  - Mounting frame: chapter "Push-through technology mounting frame (HAS10.1-002-012/013/014)" on page 182

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 99.

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 100.

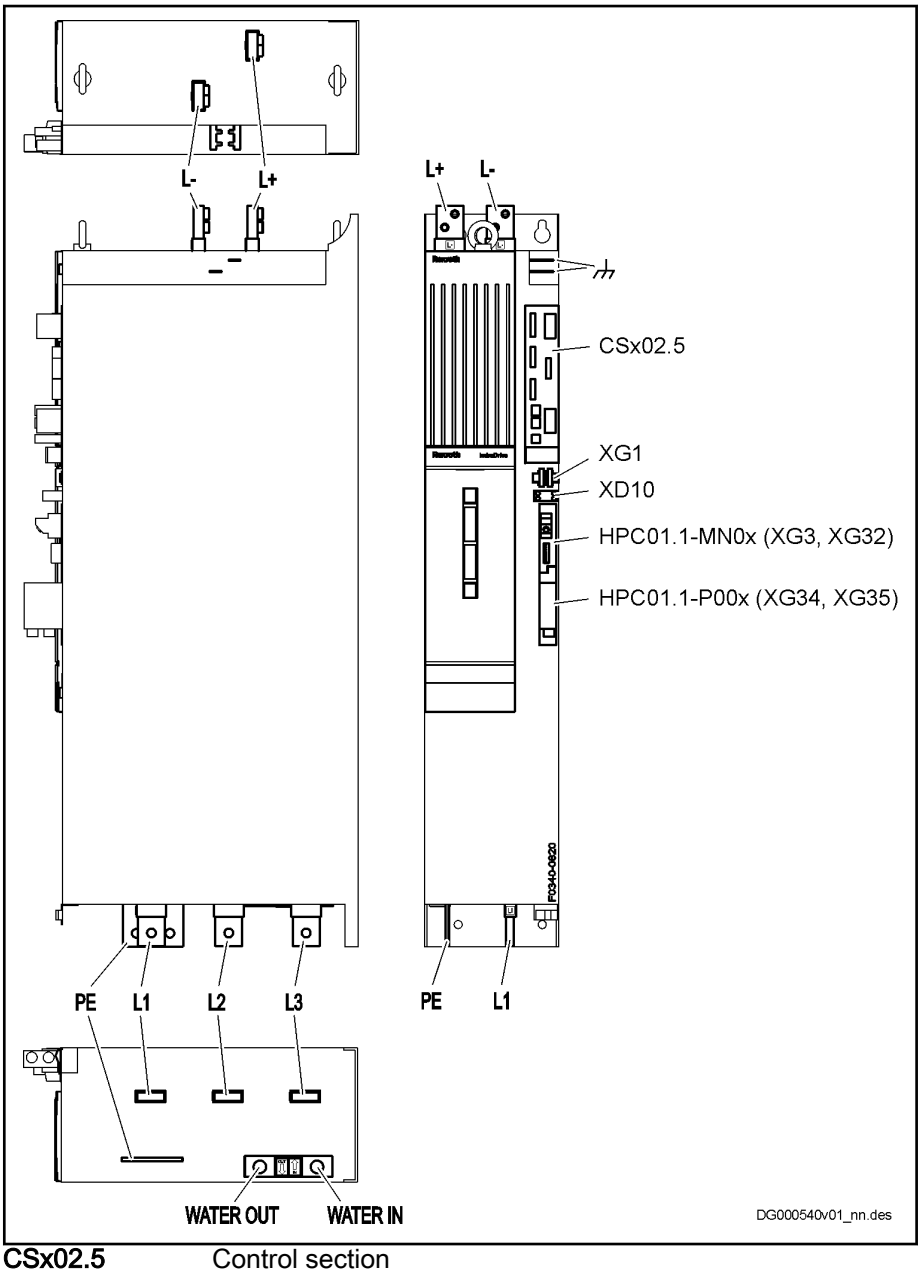
Overall connection diagram with a controllable main switch

See chapter "Overall connection diagram with a controllable main switch" on page 102.

6.2.3 Connection points

Arrangement of HMU05 connection points

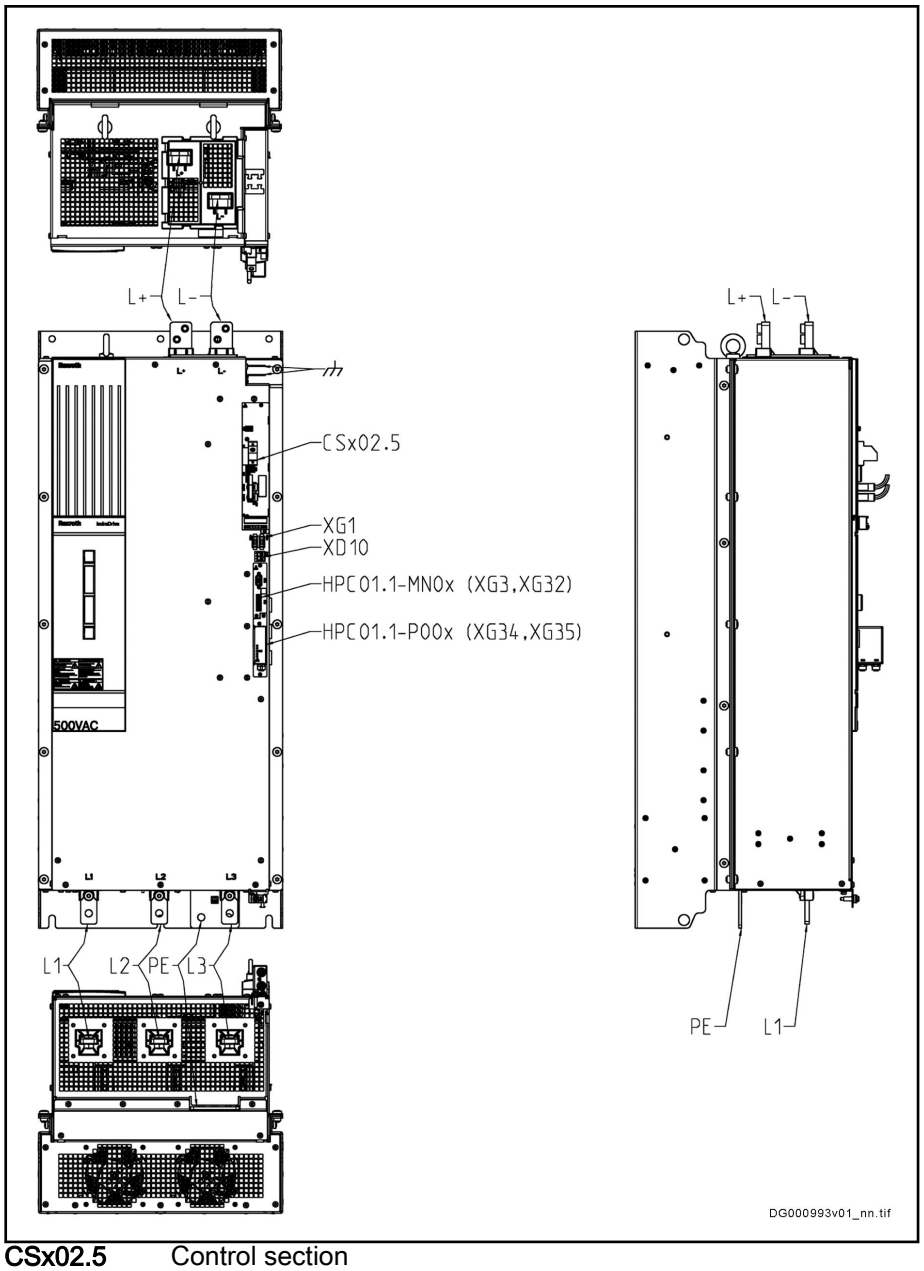
HMU05.1N-Fxxxx-xxxx



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: HMU05.1N-Fxxxx-xxxx connection points

HMU05.1N-Wxxxx-xxxx



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

Fig. 6-2: HMU05.1N-Wxxxx-xxxx connection points

Connection of equipment grounding conductor

⚠ WARNING **High housing voltage and high leakage current! Danger to life, risk of injury by 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 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.
- Make sure the copper equipment grounding connection wire is large enough (see table "Minimum cross section of equipment grounding connection").

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

Only operate the device

- with the connectors plugged on (even if no lines have been connected to the connectors) and
- with the equipment grounding conductor connected!

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

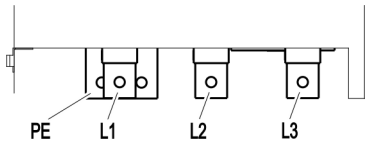
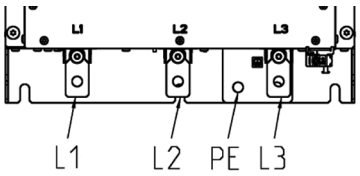
Use the same metal (e.g., copper) for the equipment grounding conductor as for the outer conductors.

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 cross section of equipment grounding connection".

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.

View	Identification	Function
HMU05.1N-Fxxxx-xxxx:  HMU05.1N-Wxxxx-xxxx:  	PE	Connection to equipment grounding system

Connecting bolt	Unit	min.	max.
Hole diameter	mm	13	
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	Minimum 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 (applies to X ≥ 50)

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

Notes on installation

- The cable is connected to the connection point using **ring cable lugs**.

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

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

L1, L2, L3, mains/motor connection

Important notes

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

Only operate the device

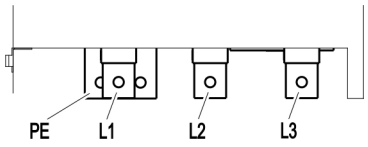
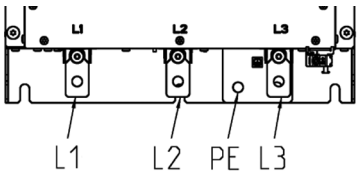
- with the connectors plugged on (even if no lines have been connected to the connectors) and
- with the equipment grounding conductor connected!

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	Identification	Function
HMU05.1N-Fxxxx-xxxx:  HMU05.1N-Wxxxx-xxxx:  	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 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 input of the motor temperature evaluation is **not** galvanically isolated from the housing. Excess voltage at the input (e.g., by the motor winding voltage flashing over) can get to the housing. Make sure that the temperature sensor of the connected motor is **double**-insulated from the motor winding.

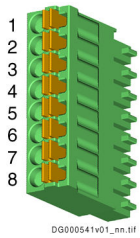
NOTICE **Risk of damage to device from excess voltage at motor temperature evaluation input!**

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 the motor temperature
- Controlling the 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 the 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 cables	mm^2	0.25	1.5
Stranded wire	AWG	24	16
Stripped length	mm	10	
Current carrying capacity XG3 output (motor holding brake)	A	-	2
Time constant of load	ms	-	50
Number of switching actions		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)	

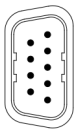
Tab. 6-4: Function, pin assignment

Notes on installation

Make sure the **power supply** is sufficient for the motor holding brake at the motor. Observe that voltage drops on the supply line. Use connection lines with the largest possible cross section of single strands.

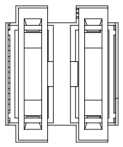
An **external contact element** is required, if motor holding brakes with higher currents than the allowed current load are to be supplied at X6.

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

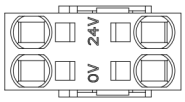
XG1, IndraBus

View	Connection	Function
	XG1a XG1b	Connects the 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 *Cables* • 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. In combination with other devices, the RBS0025 terminating plug on the first device (left) must be plugged in at the left side of XG1 and the terminating plug on the last device (right) must be plugged in at the right side.

Tab. 6-6: XG1, IndraBus

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	
	0V	0V	Reference potential for power supply
		0V	

Tab. 6-7: XD10, 24 V supply

Mechanical data

Spring terminal (connector)	Unit	min.	max.
Connection cables Solid wire	mm^2	1	10
Connection cables Stranded wire **without** ferrule	mm^2	1	6
	AWG	16	10
Connection cables 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} 1)
Power consumption	W	-	P_{N3} 1)
Current carrying capacity (looping through)	A	-	40 (UL: 31)
Allowed inductance	µH	-	100 (2 twisted single strands, 75 m long)

1) See chapter 7.2.1 "Control voltage" on page 151

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 might possibly 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!

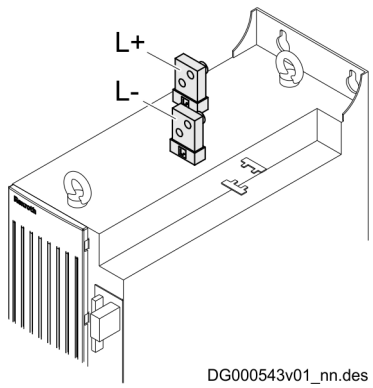
Before accessing the device, wait at least **30 minutes** after switching off the supply voltages to allow **discharging**.

The discharge time can be more than 30 minutes if DC bus ground capacitor pairs are used.

Mount a **touch guard**!

Function, pin assignment

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

View	Identification	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		By fusing elements in the incoming circuit of the mains connection
Overload protection		By an internal temperature/load model

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

Notes on installation

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

Make sure the polarity is correct.

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

Install an HLL DC bus choke and the DC bus ground capacitor pairs near the inverters when the routing the DC bus outside the control cabinet. This way,

the interference radiation of the line is decreased and the EMC behavior is improved.

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.

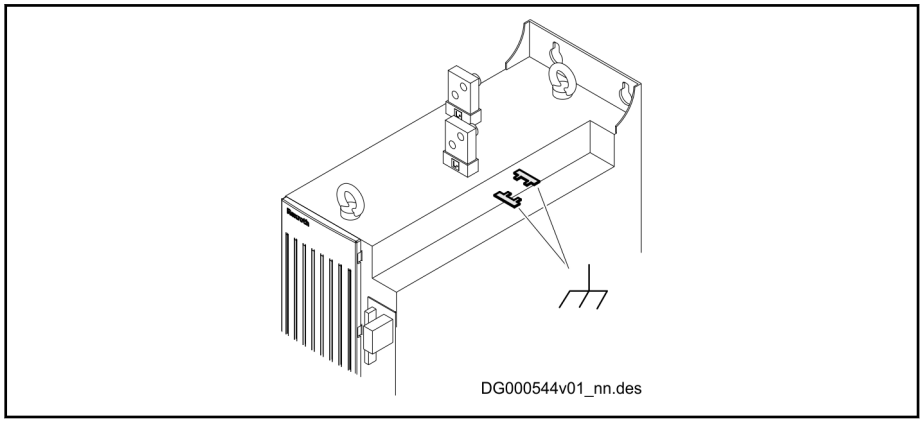


Fig. 6-3: Shield connection of shielded control lines

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.
2. Connect the bare metal mounting surface of the control cabinet in conductive form to the equipment grounding system.

   See also Project Planning Manual "Control Cabinet: Air Conditioning, EMC, Design, IP Code, Electrics; IndraDrive, Rexroth EFC/Fv, Sytronix" (R911344988).
3. For the ground connection, observe the maximum allowed ground resistance.
4. Use a ground connection with a cross section ≥ 10 mm^2 to the drive controller.

6.2.4 Optional cards

HPC01.1-MN0x-NN

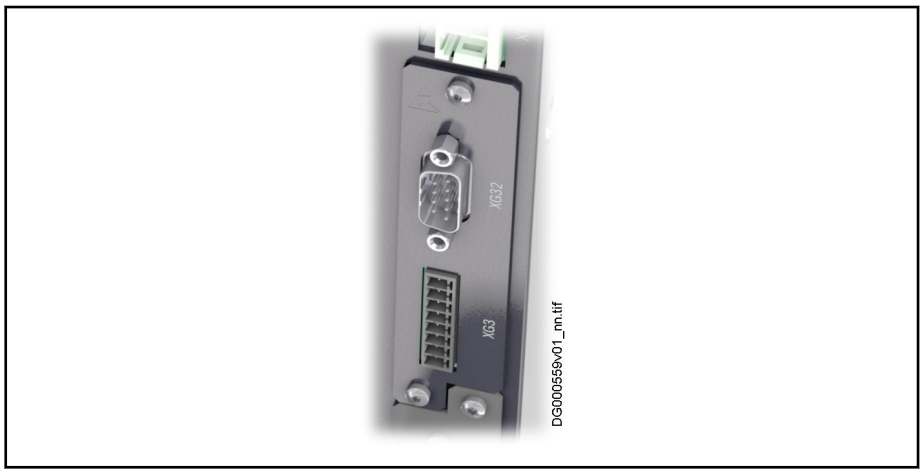


Fig. 6-4: HPC01.1-MN0x-NN

XG3 See chapter "XG3, motor temperature monitoring, motor holding brake, motor fan control " on page 140

XG32 See chapter "XG32, HNA bus" on page 142

Cables **RKB0037**; cable connects HPC01.1-MN0x-NN with HNA

HPC01.1-P001-NN

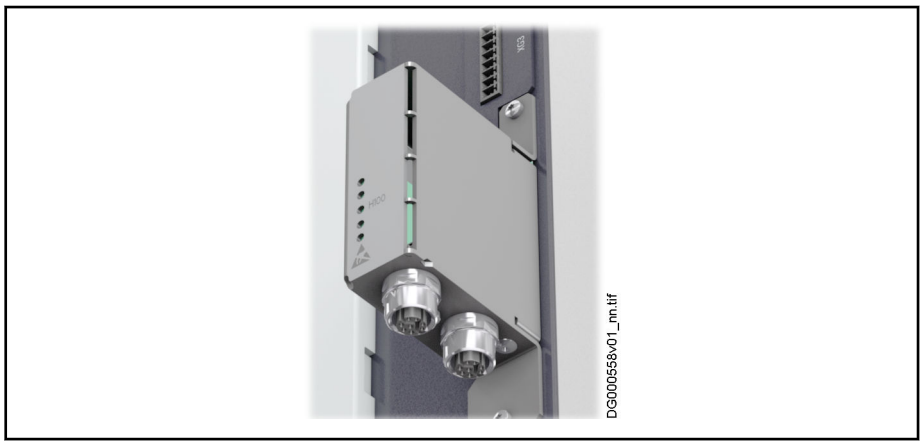


Fig. 6-5: HPC01.1-P001-NN

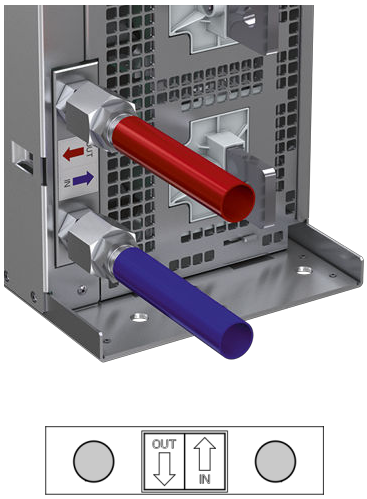
Cables **RKB0038**; cable connects several HPC01.1-P001-NN

☞ 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	Identification	Function
	WATER IN	Supply
	WATER OUT	Outlet

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

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.

See chapter "Condensation protection" on page 65.

7 Technical data of the components

7.1 Ambient and operating conditions

7.2 Power section

7.2.1 Control voltage

HMU05.1N-Fxxxx-xxxx

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
Rated control voltage input	U_{N3}	V	24 ±20%			
Control voltage when using motor holding brake with motor cable length < 50 m[1)]	U_{N3}	V	24 ±5%			
Control voltage when using motor holding brake with motor cable length > 50 m[1)]	U_{N3}	V	26 ±5%			
Max. inrush current at 24-V-supply	I_{EIN3_max}	A	< 8			
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	< 20			
Input capacitance	C_{N3}	mF	< 0,01			
Rated power consumption control voltage input at U_{N3} and nominal switching frequency	P_{N3}	W	41	48	53	46
Last modification: 2019-02-20*						

1) Data refer to the HPC01.1-MN0x optional card

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

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
Rated control voltage input	U_{N3}	V	24 ±20%		
Control voltage when using motor holding brake with motor cable length < 50 m[1)]	U_{N3}	V	24 ±5%		
Control voltage when using motor holding brake with motor cable length > 50 m[1)]	U_{N3}	V	26 ±5%		
Max. inrush current at 24-V-supply	I_{EIN3_max}	A	< 8		
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	< 20		
Last modification: 2019-02-20*					

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
Input capacitance	C_{N3}	mF	< 0,01		
Rated power consumption control voltage input at U_{N3} and nominal switching frequency	P_{N3}	W	48	56	58
					Last modification: 2019-02-20*

1) Data refer to the HPC01.1-MN0x optional card

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

Control voltage supply data

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Rated control voltage input	U_{N3}	V	24 ±20%					
Control voltage when using motor holding brake with motor cable length < 50 m[1)]	U_{N3}	V	24 ±5%					
Control voltage when using motor holding brake with motor cable length > 50 m[1)]	U_{N3}	V	26 ±5%					
Max. inrush current at 24-V-supply	I_{EIN3_max}	A	< 8					
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	< 20					
Input capacitance	C_{N3}	mF	< 0,01					
Rated power consumption control voltage input at U_{N3} and nominal switching frequency	P_{N3}	W	36	39	40	34	42	49
								Last modification: 2019-02-20*

1) Data refer to the HPC01.1-MN0x optional card

Tab. 7-3: HMU – control voltage supply data

Overvoltage

Overvoltage greater than 33 V has to be discharged by 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 also 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.

HMU05.1N-Wxxxx-xxxx

Control voltage supply data

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Rated control voltage input	U_{N3}	V	24 ±20%				
Control voltage when using motor holding brake with motor cable length less than 50 m[1)]	U_{N3}	V	24 ±5%				
Control voltage when using motor holding brake with motor cable length more than 50 m[1)]	U_{N3}	V	26 ±5%				
Max. inrush current at 24-V-supply	I_{EIN3_max}	A	< 8				
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	< 20				
Input capacitance	C_{N3}		< 0,01				
Rated power consumption control voltage input at U_{N3}	P_{N3}		48		53	46	48
Last modification: 2019-02-20*							

1) Data refer to the HPC01.1-MN0x optional card

Tab. 7-4: HMU – control voltage supply data

Overvoltage

Overvoltage greater than 33 V has to be discharged by 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 also 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

HMU05.1N-Fxxxx-xxxx

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			
Tolerance input frequency		Hz	±2			
Rotary field condition			None			
Mains voltage, single-phase	U_{LN}	V	-			
Three-phase mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	380…500			
Mains voltage, three-phase at IT mains[1)]	U_{LN}	V	380…500			
Nominal mains voltage	U_{LN_nom}	V	3 AC 400			
Mains voltage, three-phase at Corner-grounded-Delta mains[1)]	U_{LN}	V	200...230			
Tolerance rated input voltage U_{LN}		%	+10 / -15			
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)	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: 2019-04-04*

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

Tab. 7-5: HMU – electrical data – currents, voltages, power

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
Mains frequency	f_{LN}	Hz	50...60		
Tolerance input frequency		Hz	±2		
Rotary field condition			None		
Mains voltage, single-phase	U_{LN}	V	-		
					Last modification: 2019-04-04*

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
Three-phase mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	380...500		
Mains voltage, three-phase at IT mains[1)]	U_{LN}	V	380...500		
Nominal mains voltage	U_{LN_nom}	V	3 AC 400		
Mains voltage, three-phase at Corner-grounded-Delta mains[1)]	U_{LN}	V	200...230		
Tolerance rated input voltage U_{LN}		%	+10 / -15		
Assigned type of mains choke			HNL05.1R-0130-N0514	HNL05.1R-0113-N0652	HNL05.1R-0100-N0811
Assigned type of mains filter			HNF05.1A-500N-R0600	HNF05.1A-500N-R1000	
Nominal current	I_{LN}	A	514.00	652.00	811.00
Required wire size in accordance with NFPA 79 and UL 508 A (internal wiring)	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: 2019-04-04*					

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

Tab. 7-6: HMU – electrical data – currents, voltages, power

Electrical data – currents, voltages, power

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Mains frequency	f_{LN}	Hz	50...60					
Tolerance input frequency		Hz	-2.5...+3.0					
Rotary field condition			None					
Mains voltage, single-phase	U_{LN}	V	-					
Three-phase mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	525...690					
Mains voltage, three-phase at IT mains[1)]	U_{LN}	V	525...690					
Nominal mains voltage	U_{LN_nom}	V	3 AC 690					
Mains voltage, three-phase at Corner-grounded-Delta mains[1)]	U_{LN}	V	300...400					
Last modification: 2019-04-04*								

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Tolerance rated input voltage U_{LN}		%	+10 / -15					
Assigned type of mains choke			HNL05.1R-0649-N0127-N-A5	HNL05.1R-0542-N0152-N-A5	HNL05.1R-0434-N0190-N-A5	HNL05.1R-0346-N0238-N-A5	HNL05.1R-0234-N0352-N-A5	HNL05.1R-0175-N0471-N-A5
Assigned type of mains filter			HNF05.1A-500N-R0150-N-A5	HNF05.1A-500N-R0180-N-A5	HNF05.1A-500N-R0250-N-A5		HNF05.1A-500N-R0400-N-A5	HNF05.1A-500N-R0600-N-A5
Nominal current	I_{LN}	A	127.00	152.00	190.00	238.00	352.00	471.00
Required wire size in accordance with NFPA 79 and UL 508 A (internal wiring)	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: 2019-04-04*								

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

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

HMU05.1N-Wxxxx-xxxx

Electrical data – currents, voltages, power

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Mains frequency	f_{LN}	Hz	50...60				
Tolerance input frequency		Hz	±2				
Rotary field condition			None				
Mains voltage, single-phase	U_{LN}	V	-				
Three-phase mains voltage at TN-S, TN-C, TT mains	U_{LN}	V	380…500				
Mains voltage, three-phase at IT mains[1)]	U_{LN}	V	380…500				
Nominal mains voltage	U_{LN_nom}	V	3 AC 400				
Mains voltage, three-phase at Corner-grounded-Delta mains[1)]	U_{LN}	V	200…230				
Tolerance rated input voltage U_{LN}		%	+10 / -15				
Last modification: 2019-04-04*							

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
Assigned type of mains choke			HNL05.1R-0219-N0262		HNL05.1R-0135-N0327	HNL05.1R-0117-N0409	HNL05.1R-0130-N0514
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}		218.00	262.00	327.00	409.00	514.00
Required wire size in accordance with NFPA 79 and UL 508 A (internal wiring);	A_{LN}		Project Planning Manual appendix				
Power factor TPF (λ_L) at P_{DC_cont} with mains choke; U_{LN_nenn}	TPF		0.99				
Last modification: 2019-04-04*							

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

Tab. 7-8: HMU – electrical data – currents, voltages, power

7.2.3 DC bus

HMU05.1N-Fxxxx-xxxx

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

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

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

- With $U_{DC} < U_{DC_nenn}$ (rated DC bus voltage), a derating of U_{DC} / U_{DC_nenn} has to be taken into account for the DC bus power.
- With $U_{DC} > U_{DC_nenn}$, 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...800			
Nominal DC bus voltage	U_{DC_nenn}	V	DC 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			24
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	-			
Monitoring value maximum DC bus voltage, braking resistor switch-on threshold	$U_{DC_limit_Bleeder}$	V	820			
Allowed external DC bus capacitance (nom.) at U_{LN_nenn}	C_{DCext}	mF	2500			
Nominal power	P_{DC_cont}	kW	140	170	220	270
Maximum allowed DC bus power at U_{LN_nenn}	P_{DC_max}	kW	180	216	260	324
						Last modification: 2019-04-04*

Tab. 7-9: 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
DC bus voltage	U_{DC}	V	DC 450...800		
Nominal DC bus voltage	U_{DC_nenn}	V	DC 750		
Capacitance in DC bus	C_{DC}	mF	9.90	13.20	16.50
DC-resistance in DC bus (L+ to L-)	R_{DC}	kOhm	24	15	12
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	-		
Monitoring value maximum DC bus voltage, braking resistor switch-on threshold	$U_{DC_limit_Bleeder}$	V	820		
Allowed external DC bus capacitance (nom.) at U_{LN_nenn}	C_{DCext}	mF	2500		
Nominal power	P_{DC_cont}	kW	340	430	540
Maximum allowed DC bus power at U_{LN_nenn}	P_{DC_max}	kW	405	509	645
Last modification: 2019-04-04*					

Tab. 7-10: HMU – power section data – DC bus

Power section data - DC bus

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
DC bus voltage	U_{DC}	V	DC 450…1120					
Nominal DC bus voltage	U_{DC_nenn}	V	DC 1100					
Capacitance in DC bus	C_{DC}	mF	2.20		3.30		4.40	6.60
DC-resistance in DC bus (L+ to L-)	R_{DC}	kOhm	45					36
Monitoring value maximum DC bus voltage, switch-off threshold	$U_{DC_limit_max}$	V	1200					
Monitoring value minimum DC bus voltage, undervoltage threshold	$U_{DC_limit_min}$	V	-					
Monitoring value maximum DC bus voltage, braking resistor switch-on threshold	$U_{DC_limit_Bleeder}$	V	1150					
Last modification: 2019-04-04*								

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Allowed external DC bus capacitance (nom.) at U_{LN_nenn}	C_{DCext}	mF	2500					
Nominal power	P_{DC_cont}	kW	140	170	220	270	400	540
Maximum allowed DC bus power at U_{LN_nenn}	P_{DC_max}	kW	180	216	260	324	473	645
Last modification: 2019-04-04*								

Tab. 7-11: HMU – power section data – DC bus

HMU05.1N-Wxxxx-xxxx

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

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

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

- With $U_{DC} < U_{DC_nenn}$ (rated DC bus voltage), a derating of U_{DC} / U_{DC_nenn} has to be taken into account for the DC bus power.
- With $U_{DC} > U_{DC_nenn}$, the DC bus power remains limited to the nominal value.

Power section data - DC bus

Description	Symbol	Unit	HMU05.1N-W0140-0350-N-A4-D7-P	HMU05.1N-W0170-0430-N-A4-D7-P	HMU05.1N-W0220-0510-N-A4-D7-P	HMU05.1N-W0270-0660-N-A4-D7-P	HMU05.1N-W0340-0820-N-A4-D7-P
DC bus voltage	U_{DC}	V	DC 450...800				
Capacitance in DC bus	C_{DC}	mF	5.00	6.60	8.30	9.90	11.60
DC-resistance in DC bus (L+ to L-)	R_{DC}	kΩ	30		24		
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	-				
Monitoring value maximum DC bus voltage, braking resistor switch-on threshold	$U_{DC_limit_Bleeder}$	V	820				
Last modification: 2019-04-04*							

Description	Symbol	Unit	HMU05.1 N-W0140-0350-N-A4-D7-P	HMU05.1 N-W0170-0430-N-A4-D7-P	HMU05.1 N-W0220-0510-N-A4-D7-P	HMU05.1 N-W0270-0660-N-A4-D7-P	HMU05.1 N-W0340-0820-N-A4-D7-P
Allowed external DC bus capacitance (nom.) at U_{LN_nenn} 1)	C_{DCext}	mF	2500				
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	170	220	270	340
Maximum allowed DC bus power at U_{LN_nenn}; with mains choke	P_{DC_max}		180	216	260	324	405
Last modification: 2019-04-04*							

1) Use assigned mains choke

Tab. 7-12: HMU – power section data – DC bus

7.2.4 Inverter

HMU05.1-Fxxxx-xxxx

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	f_s	kHz	2, 4, 8			
Nominal switching frequency	f_{s_nenn}	kHz	4			
Output voltage, fundamental wave in V/Hz (U/f)-control	U_{out_eff}	V	~ UDC x 0.71			
Output voltage, fundamental wave in closed-loop operation	U_{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%)[1]	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%)[2]	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 to detect motor standstill[3]	f_{out_still}	Hz	6			
Maximum output current when f_s = 2 kHz	I_{out_max2}	A	357	427	515	660
Maximum output current when f_s = 4 kHz	I_{out_max4}	A	357	427	515	660
Maximum output current when f_s = 8 kHz	I_{out_max8}	A	242	362	430	476
Continuous output current when f_s = 2 kHz	I_{out_cont2}	A	254	306	392	490
Continuous output current when f_s = 4 kHz	I_{out_cont4}	A	254	306	392	490
Continuous output current when f_s = 8 kHz	I_{out_cont8}	A	182	260	315	350
Continuous output current when f_s = 1 kHz; output frequency $f_{out} < f_{out_still}$[4]	$I_{out_cont0Hz_1}$	A	210	251	302	388
Last modification: 2019-04-04*						

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 = 2 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_2}$	A	210	251	302	388
Continuous output current when f_s = 4 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_4}$	A	210	230	302	320
Continuous output current when f_s = 8 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_8}$	A	150	185	213	
Last modification: 2019-04-04*						

1) 2) Guide value, see following note
3) See following note regarding output current reduction
4) 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. 7-13: 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
Allowed switching frequencies	f_s	kHz	2, 4, 8		
Nominal switching frequency	f_{s_nenn}	kHz	2		
Output voltage, fundamental wave in V/Hz (U/f)-control	U_{out_eff}	V	~ UDC x 0.71		
Output voltage, fundamental wave in closed-loop operation	U_{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%)[1)]	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%)[2)]	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 to detect motor standstill[3)]	f_{out_still}	Hz	6		
Last modification: 2019-04-04*					

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
Maximum output current when f_s = 2 kHz	I_{out_max2}	A	825	1037	1297
Maximum output current when f_s = 4 kHz	I_{out_max4}	A	765	838	1000
Maximum output current when f_s = 8 kHz	I_{out_max8}	A	510	650	736
Continuous output current when f_s = 2 kHz	I_{out_cont2}	A	616	771	1002
Continuous output current when f_s = 4 kHz	I_{out_cont4}	A	546	624	775
Continuous output current when f_s = 8 kHz	I_{out_cont8}	A	364	465	526
Continuous output current when f_s = 1 kHz; output frequency $f_{out} < f_{out_still}$ [4)]	$I_{out_cont0Hz_1}$	A	485	610	705
Continuous output current when f_s = 2 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_2}$	A	485	610	650
Continuous output current when f_s = 4 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_4}$	A	450	493	500
Continuous output current when f_s = 8 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_8}$	A	298		
					Last modification: 2019-04-04*

1) 2) Guide value, see following note
3) See following note regarding output current reduction
4) 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. 7-14: HMU – power section data – inverter

Power section data - inverter

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Allowed switching frequencies	f_s	kHz	2, 4, 8					
Nominal switching frequency	f_{s_nenn}	kHz	4			2		
								Last modification: 2019-04-04*

Description	Symbol	Unit	HMU05.1N-F0140-0210-N-A5-11-P	HMU05.1N-F0170-0250-N-A5-11-P	HMU05.1N-F0220-0300-N-A5-11-P	HMU05.1N-F0270-0370-N-A5-11-P	HMU05.1N-F0400-0600-N-A5-11-P	HMU05.1N-F0540-0750-N-A5-11-P
Output voltage, fundamental wave in V/Hz (U/f)-control	U_{out_eff}	V	~ UDC x 0.71					
Output voltage, fundamental wave in closed-loop operation	U_{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%)[1)]	dv/dt	kV/µs	5.00					
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-ground (10-90%)[2)]	dv/dt	kV/µs	4.00					
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 to detect motor standstill[3)]	f_{out_still}	Hz	6					
Maximum output current when f_s = 2 kHz	I_{out_max2}	A	207	248	298	367	600	751
Maximum output current when f_s = 4 kHz	I_{out_max4}	A	207	248	298		425	482
Maximum output current when f_s = 8 kHz	I_{out_max8}	A	130				220	160
Continuous output current when f_s = 2 kHz	I_{out_cont2}	A	147	177	227	284	379	587
Continuous output current when f_s = 4 kHz	I_{out_cont4}	A	147	177	227		269	377
Continuous output current when f_s = 8 kHz	I_{out_cont8}	A	100				139	125
Continuous output current when f_s = 1 kHz; output frequency $f_{out} < f_{out_still}$[4)]	$I_{out_cont0Hz_1}$	A	122	146	175	216	353	442
Continuous output current when f_s = 2 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_2}$	A	122	146	175	216	345	439
Last modification: 2019-04-04*								

Description	Symbol	Unit	HMU05.1 N- F0140-0 210-N- A5-11-P	HMU05.1 N- F0170-0 250-N- A5-11-P	HMU05.1 N- F0220-0 300-N- A5-11-P	HMU05.1 N- F0270-0 370-N- A5-11-P	HMU05.1 N- F0400-0 600-N- A5-11-P	HMU05.1 N- F0540-0 750-N- A5-11-P
Continuous output current when f_s = 4 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_4}$	A	122	139			222	227
Continuous output current when f_s = 8 kHz; output frequency $f_{out} < f_{out_still}$	$I_{out_cont0Hz_8}$	A	72				116	44.5
Last modification: 2019-04-04*								

1) 2) Guide value, see following note
3) See following note regarding output current reduction
4) 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. 7-15: 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.

The rise of voltage is influenced by the line length and type.

☞ **Reduced output current at motor standstill**

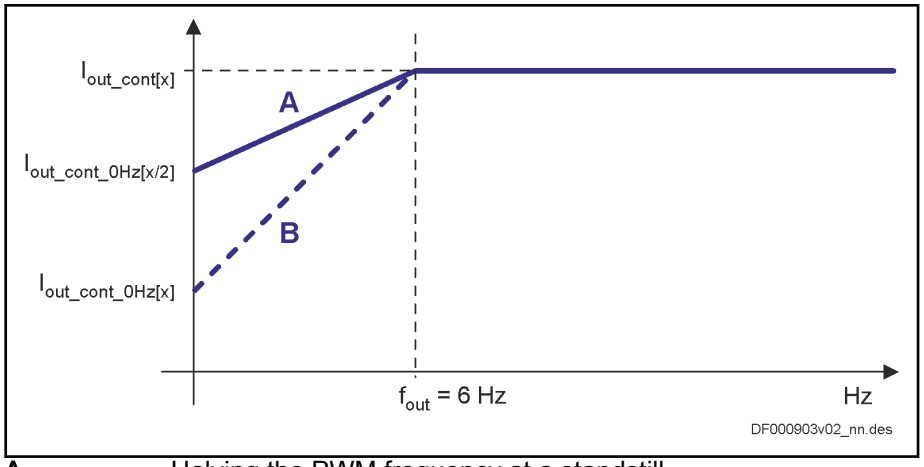
Depending on the electric output frequency, the output current is reduced for thermal protection of the power section.

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

Output current reduction at a standstill

An increased current at standstill is allowed for 0.5 s for single motor start-ups.

This process can be repeated every 10 minutes.



A Halving the PWM frequency at a standstill
B Constant PWM frequency

Fig. 7-1: Current profile during acceleration

☞ The configuration tool "IndraSize" by Rexroth is designed for detailed configuration.

https://www.boschrexroth.com/en/xc/products/product-support/econfigurators-and-tools/indrasize/indrasize-2

HMU05.1-Wxxxx-xxxx

Power section data - inverter

Description	Symbol	Unit	HMU05.1 N-W0140-0350-N-A4-D7-P	HMU05.1 N-W0170-0430-N-A4-D7-P	HMU05.1 N-W0220-0510-N-A4-D7-P	HMU05.1 N-W0270-0660-N-A4-D7-P	HMU05.1 N-W0340-0820-N-A4-D7-P
Allowed switching frequencies[1)]	f_s	kHz	2, 4, 8				
Nominal switching frequency	f_{s_nenn}	V	4				2
Output voltage, fundamental wave in V/Hz (U/f)-control	U_{out_eff}	V	~ UDC x 0.71				
Output voltage, fundamental wave in closed-loop operation	dv/dt	kV/µs	~ 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)]	f_{out_2k}	Hz	4.00				
Output frequency range when f_s = 2 kHz	f_{out_4k}	Hz	0..200				
Output frequency range when f_s = 4 kHz	f_{out_8k}	Hz	0..400				
Last modification: 2019-04-04*							

Description	Symbol	Unit	HMU05.1 N-W0140-0350-N-A4-D7-P	HMU05.1 N-W0170-0430-N-A4-D7-P	HMU05.1 N-W0220-0510-N-A4-D7-P	HMU05.1 N-W0270-0660-N-A4-D7-P	HMU05.1 N-W0340-0820-N-A4-D7-P
Output frequency range when f_s = 8 kHz	f_{out_still}	Hz	0..800				
Output frequency threshold to detect motor standstill[4)]	I_{out_max2}	A	6				
Maximum output current when f_s = 2 kHz	I_{out_max4}	A	357	427	515	660	825
Maximum output current when f_s = 4 kHz	I_{out_max8}	A	357	427	515	660	748
Maximum output current when f_s = 8 kHz	I_{out_cont2}	A	225		270	357	
Continuous output current when f_s = 2 kHz	I_{out_cont4}	A	254	306	392	470	616
Continuous output current when f_s = 4 kHz	I_{out_cont8}	A	254	306	392	470	
Continuous output current when f_s = 8 kHz	$I_{out_cont0Hz_1}$	A	160	180	200	225	
Continuous output current when f_s = 1 kHz; output frequency f_{out} less than f_{out_still}[5)]	$I_{out_cont0Hz_2}$	A	210	250	352	470	504
Continuous output current when f_s = 2 kHz; output frequency f_{out} less than f_{out_still}	$I_{out_cont0Hz_4}$	A	210	250	352	470	504
Continuous output current when f_s = 4 kHz; output frequency f_{out} less than f_{out_still}	$I_{out_cont0Hz_8}$	A	190	200	264	345	
Continuous output current when f_s = 8 kHz; output frequency f_{out} less than f_{out_still}	$I_{out_cont0Hz_8}$	A	120		140	160	
Last modification: 2019-04-04*							

1) 2) Guide value, see following note
3) See following note regarding output current reduction
4) 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. 7-16: 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

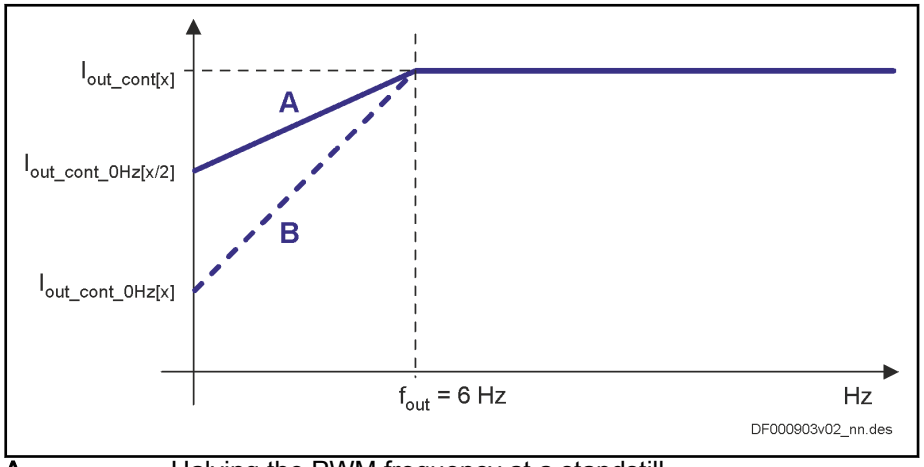
Depending on the electric output frequency, the output current is reduced for thermal protection of the power section.

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

Output current reduction at a standstill

An increased current at standstill is allowed for 0.5 s for single motor start-ups.

This process can be repeated every 10 minutes.



A Halving the PWM frequency at a standstill
B Constant PWM frequency

Fig. 7-2: Current profile during acceleration

The configuration tool "IndraSize" by Rexroth is designed for detailed configuration.

https://www.boschrexroth.com/en/xc/products/product-support/econfigurators-and-tools/indrasize/indrasize-2

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
HAS10: Blank covers, motor monitor grounding, mounting plates, fixing clips	

Tab. 8-2: Accessories - overview

8.1.3 Additional components

Type	Additional component
HAH02	Heat exchanger
HAS04	DC bus ground capacitor pair
HLL05	DC bus choke
HML05	Motor choke
HNA05	Mains connection module
HNC05	Mains capacitor
HNF05	Mains filter
HNL05	Mains choke
HLR05	Braking resistor
HLT05	Braking unit
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	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	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 Blank covers, motor monitor grounding, mounting plates, fixing clips, push-through technology frame (HAS10)

HAS10 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	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
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 = Blank cover for mounting bays: 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 007 = Fixing clip for increased vibration resistance (maritime applications) 008 = 335 mm Cross bar (for HAS10.1-002-007-NN) 009 = 555 mm Cross bar (for HAS10.1-002-007-NN) 010 = 775 mm Cross bar (for HAS10.1-002-007-NN) 011 = 995 mm Cross bar (for HAS10.1-002-007-NN) 012 = Push-through technology frame, size 1 013 = Push-through technology frame, size 2 014 = Push-through technology frame, size 3
⑥	**Other design:** NN = None

1) Device assignment "001" is only available with Other properties "001" and "002".

2) Device assignment "002" is only available with Other properties "003" to "011".

Tab. 8-5: HAS10, type code

Blank covers (HAS10.1-002-003)

This accessory contains blank covers for covering unused mounting bays.

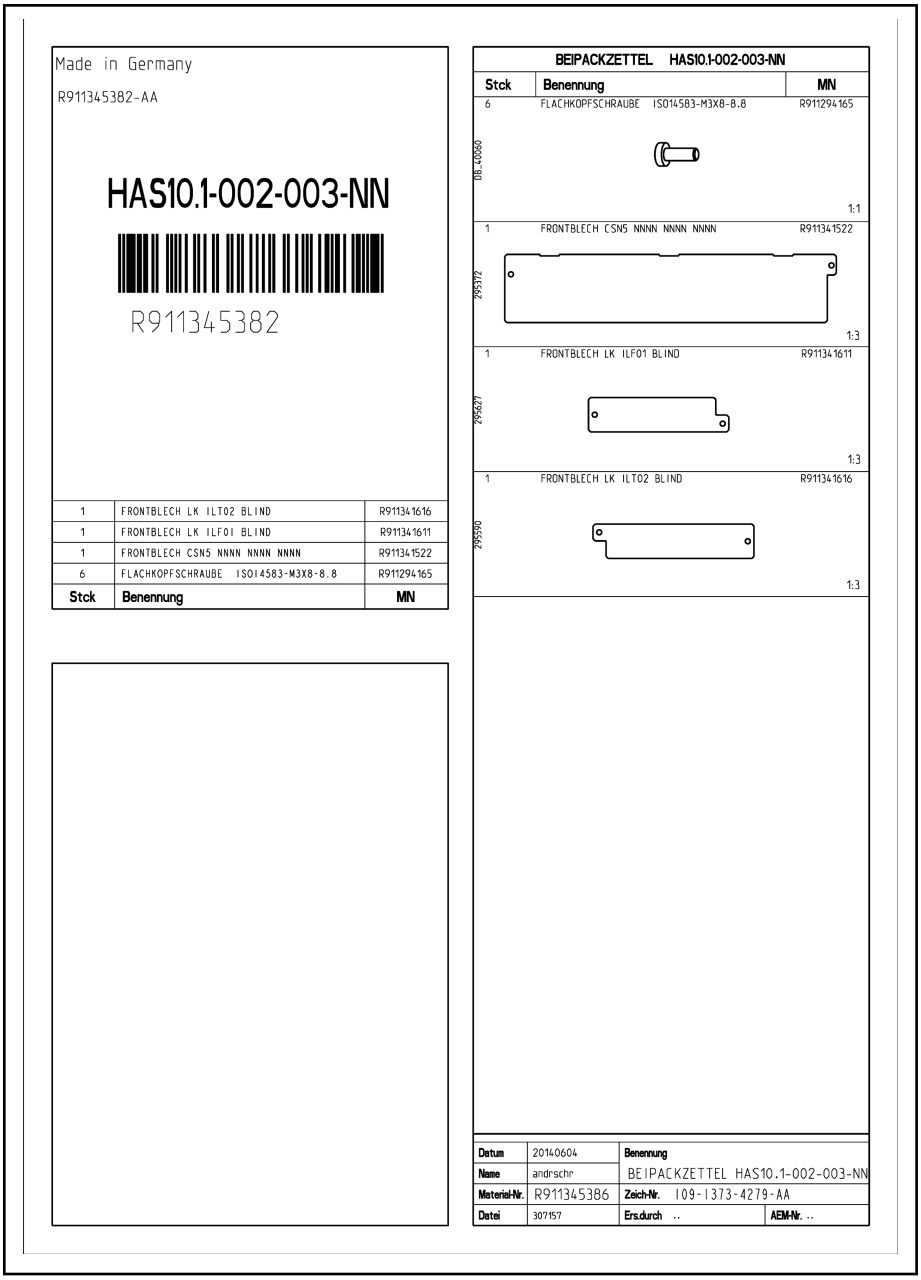


Fig. 8-1: Product insert (HAS10.1-002-003)

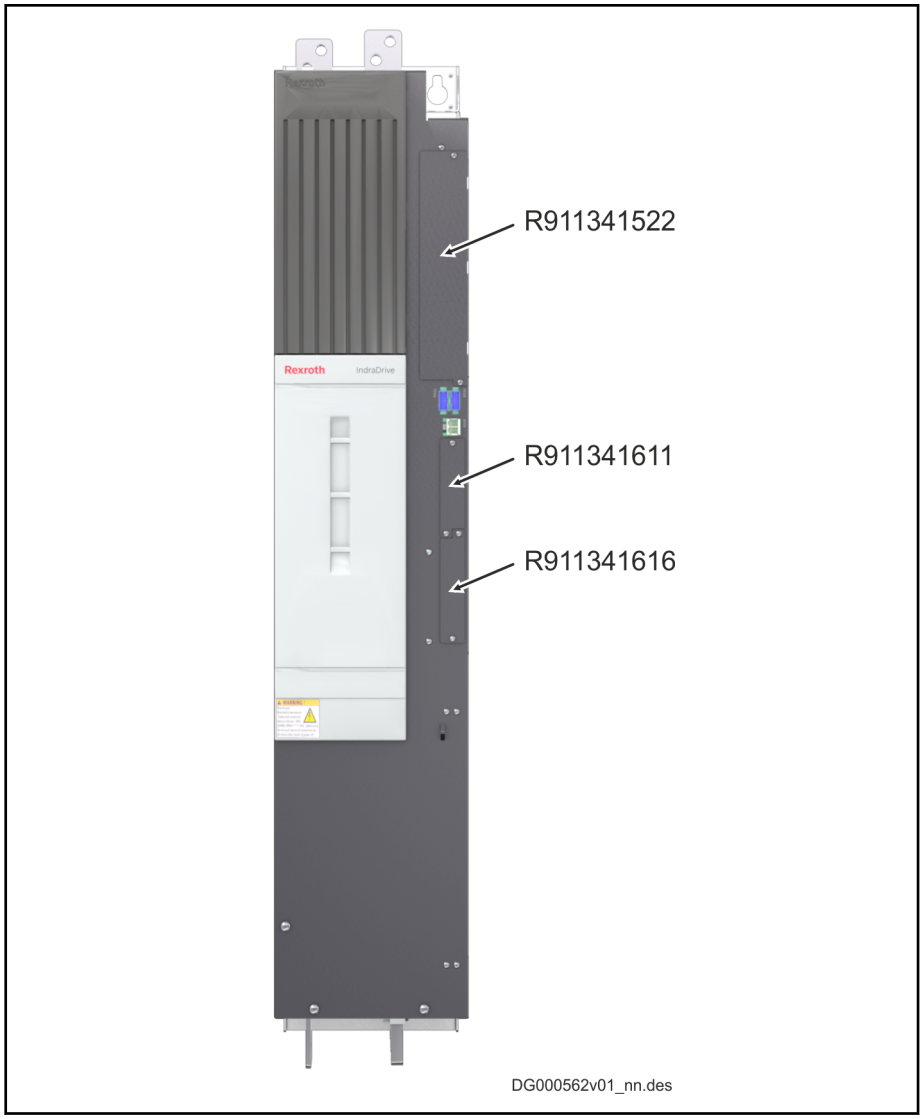


Fig. 8-2: Blank covers (HAS10.1-002-003)

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

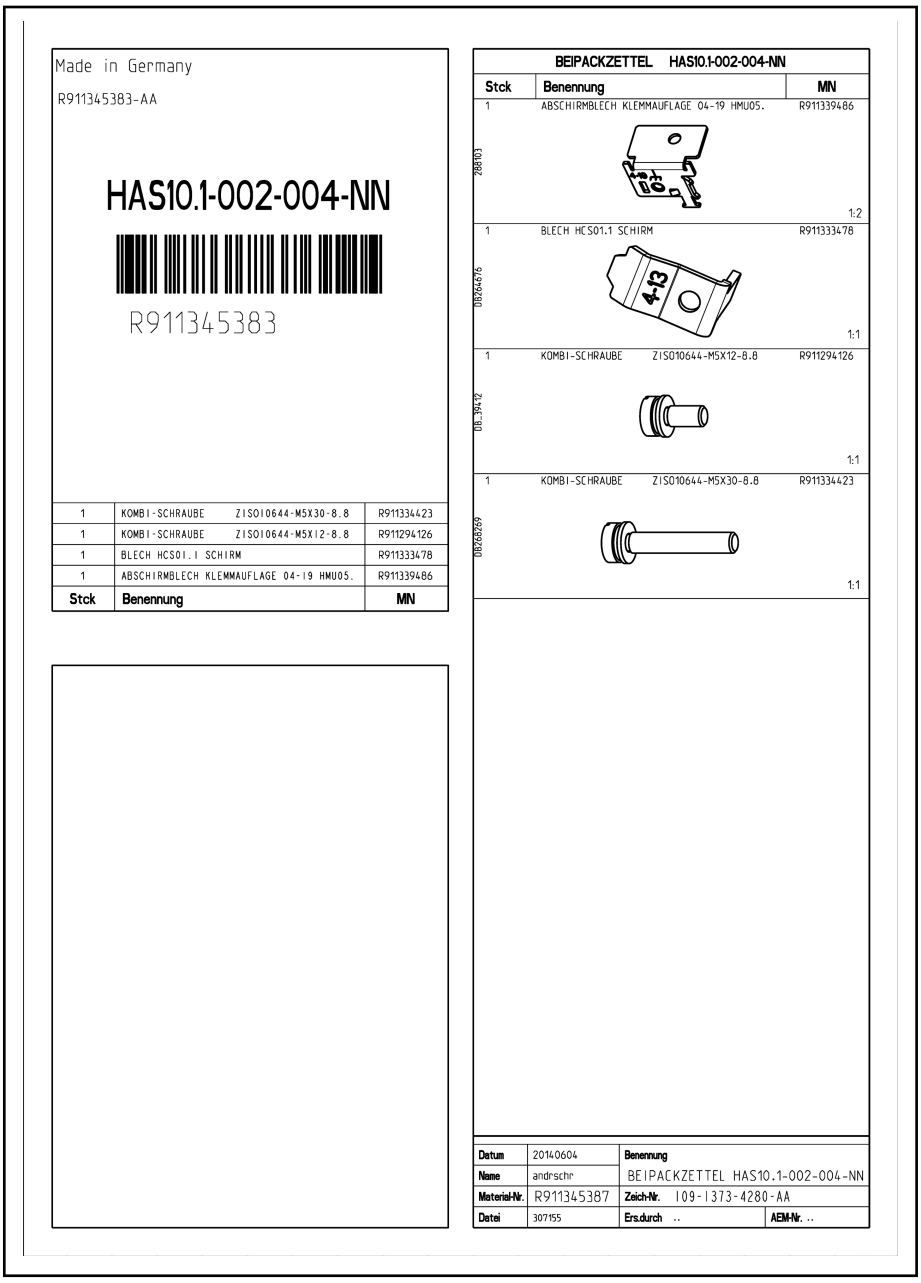
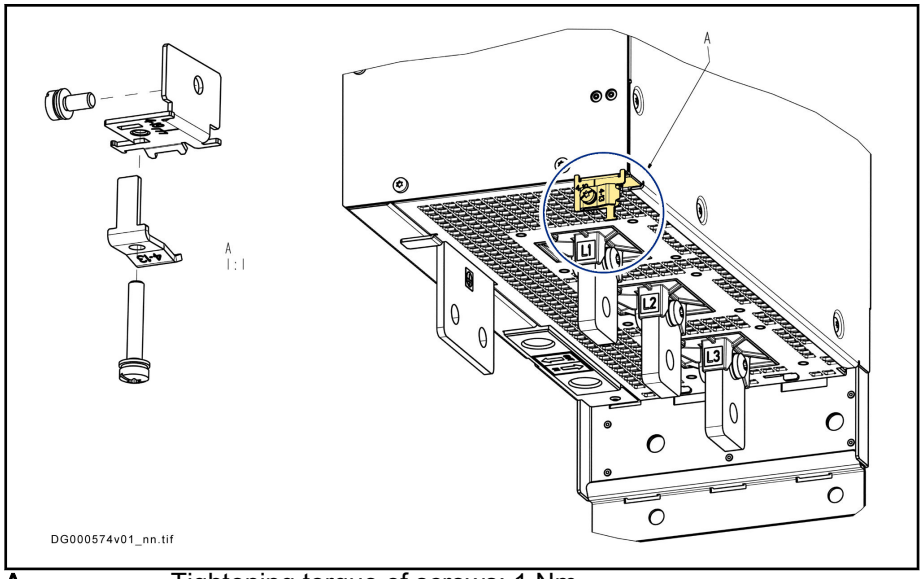


Fig. 8-3: Product insert (HAS10.1-002-004)



A Tightening torque of screws: 1 Nm

Fig. 8-4: Use (HAS10.1-002-004)

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

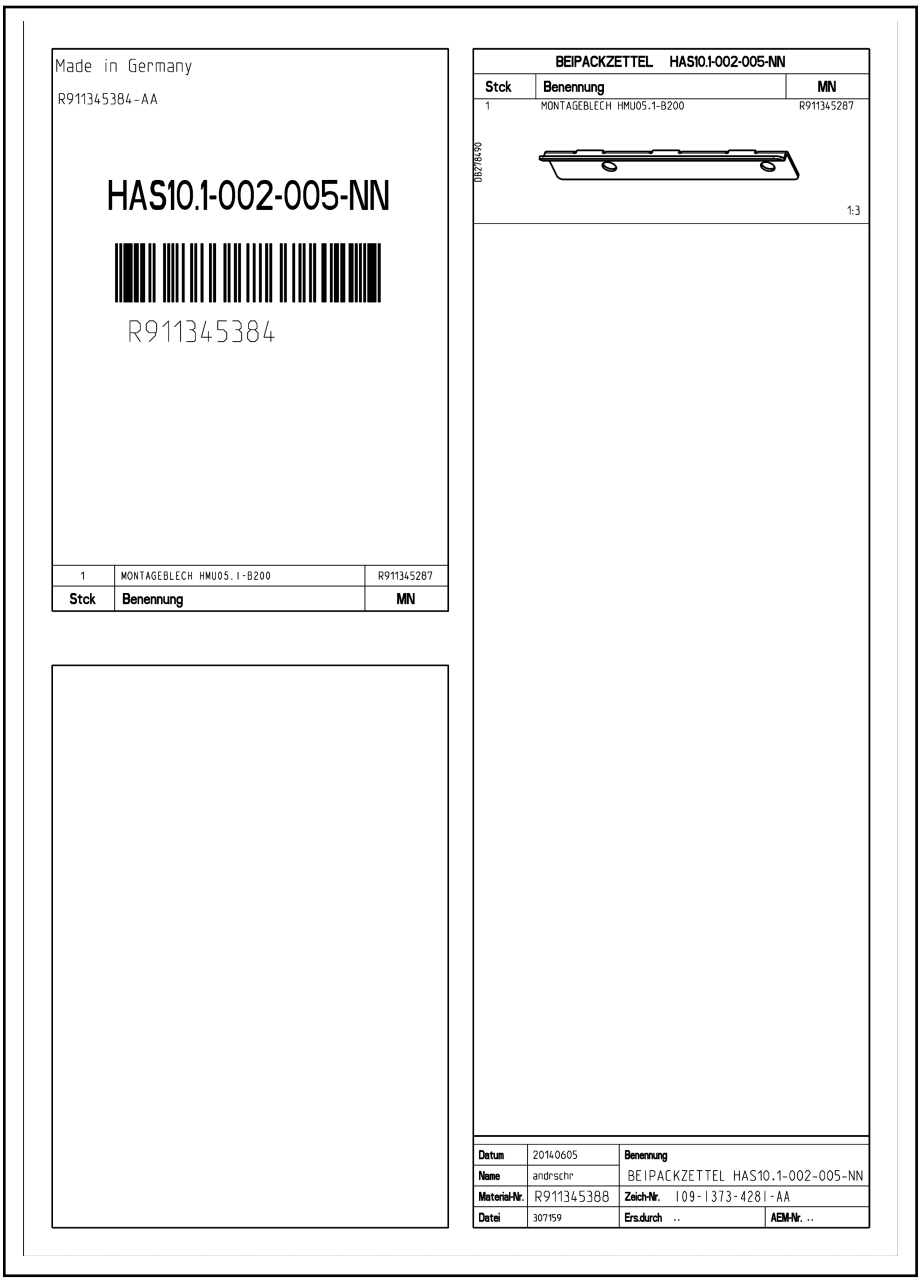
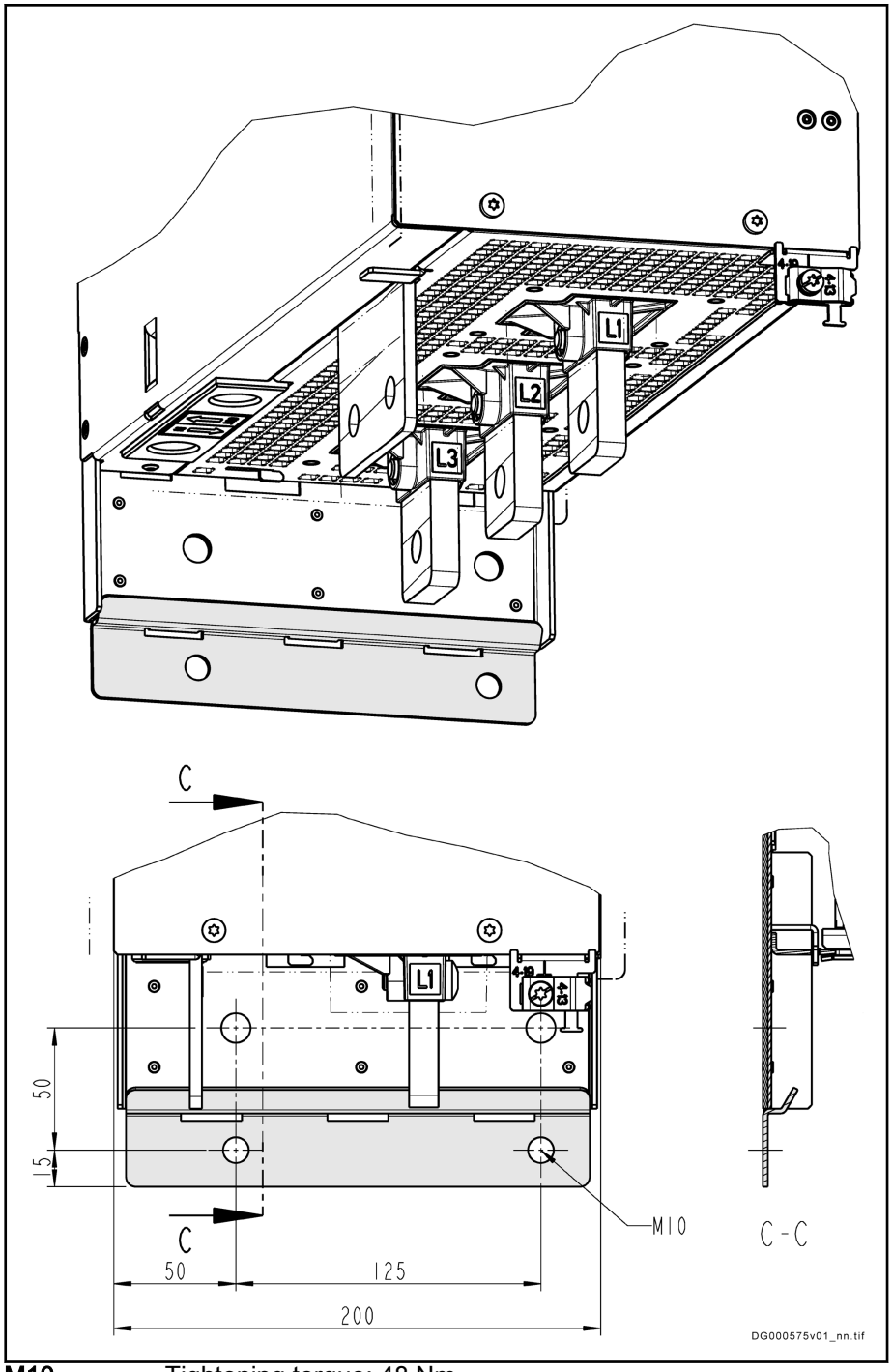


Fig. 8-5: Product insert (HAS10.1-002-005)



M10 Tightening torque: 48 Nm

Fig. 8-6: Use (HAS10.1-002-005)

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

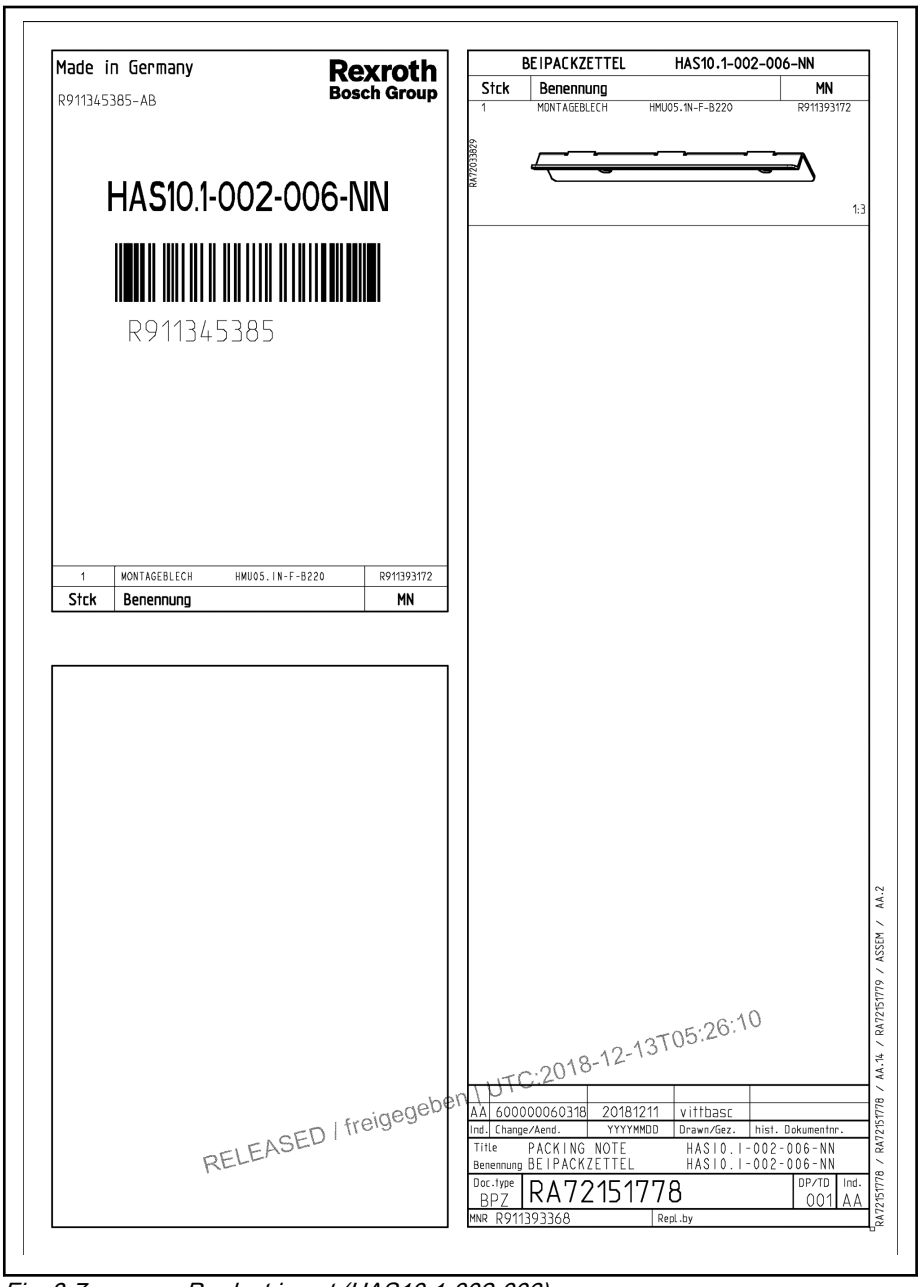
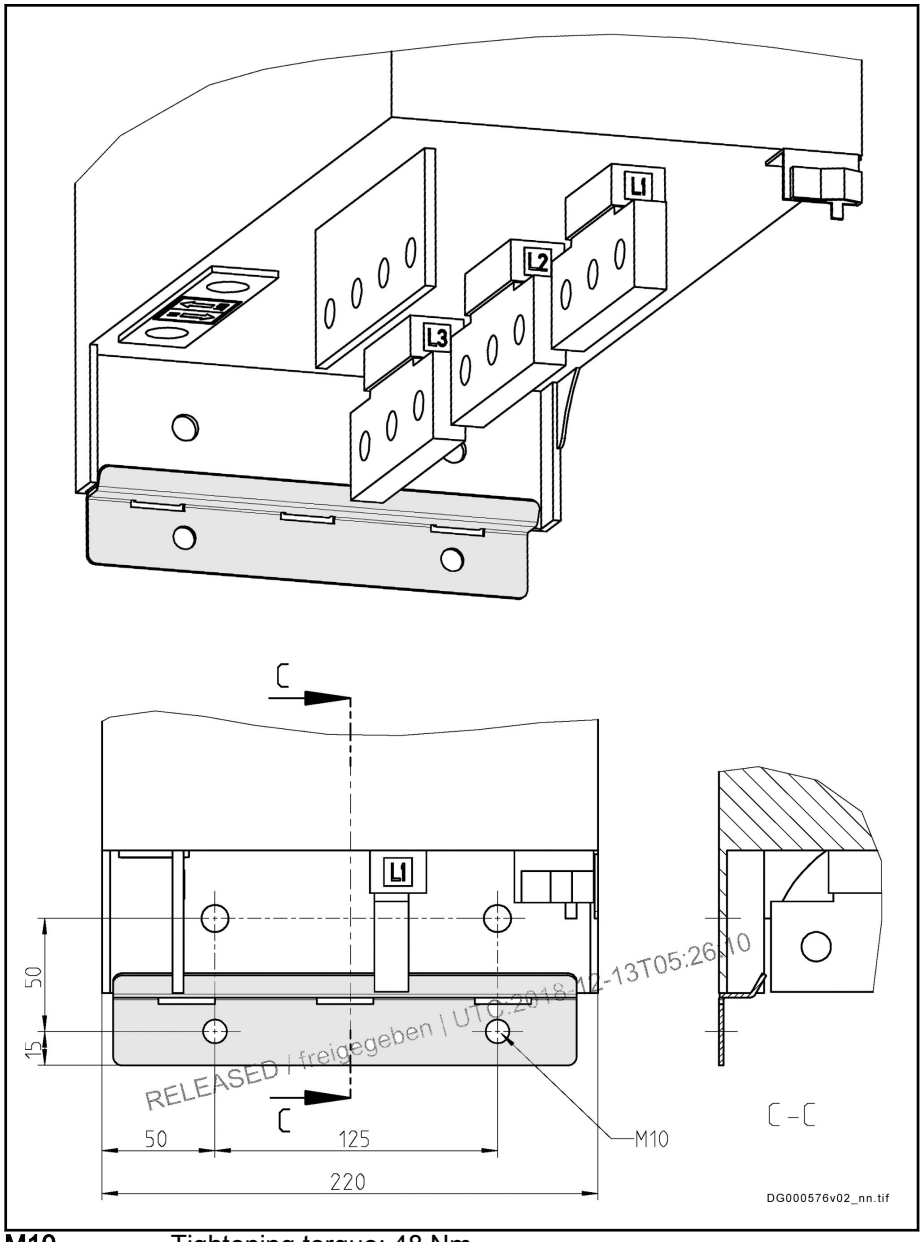


Fig. 8-7: Product insert (HAS10.1-002-006)



M10 Tightening torque: 48 Nm

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

Push-through technology mounting frame (HAS10.1-002-012/013/014)

rexroth
A Bosch Company

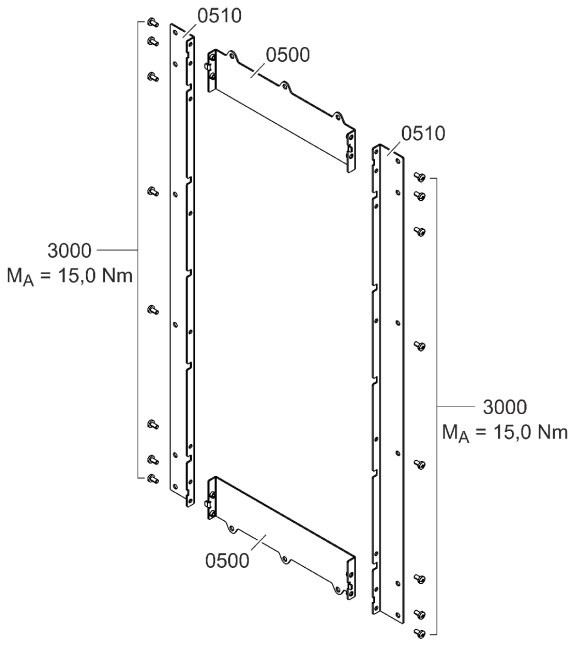
HAS10.1-002-012-NN

Beipackzettel

R911391894
AA 2018-07

R911391708

Position	Materialnummer	Benennung	Menge	Einheit
0500	R911389493	MONTAGEBLECH QUER HMU05.1N LUFTGE&	2	ST
0510	R911389497	MONTAGEBLECH LAENGS HMU05.1N-W014&	2	ST
3000	R911294188	FLACHKOPFSCHRAUBE ISO14583-M8X16-8.8-T&	16	ST



BEIPACKZETTEL HAS10.1-002-012-NN, R911391894, AA 2018-07, **Bosch Rexroth AG**

Fig. 8-9: HAS10.1-002-012

rexroth
A Bosch Company

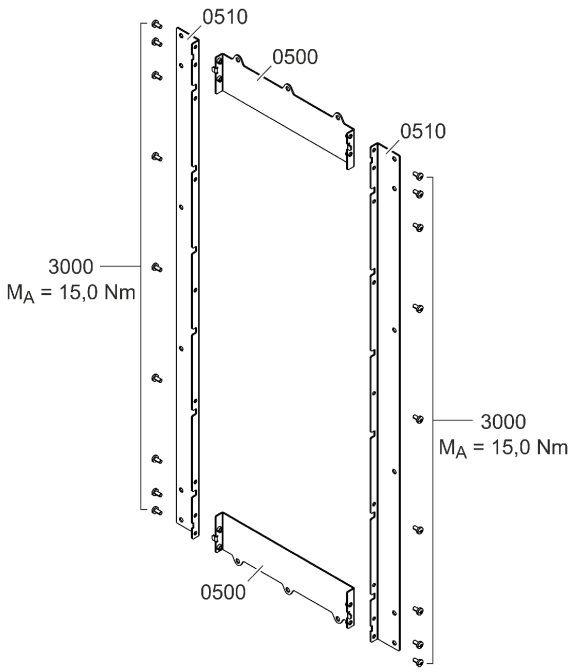
HAS10.1-002-013-NN

Beipackzettel

R911391893
AA 2018-07

R911391709

Position	Materialnummer	Benennung	Menge	Einheit
0500	R911389493	MONTAGEBLECH QUER HMU05.1N LUFTGE&	2	ST
0510	R911389495	MONTAGEBLECH LAENGS HMU05.1N-W022&	2	ST
3000	R911294188	FLACHKOPFSCHRAUBE ISO14583-M8X16-8.8-T&	18	ST



BEIPACKZETTEL HAS10.1-002-013-NN, R911391893, AA 2018-07, **Bosch Rexroth AG**

Fig. 8-10: HAS10.1-002-013

rexroth
A Bosch Company

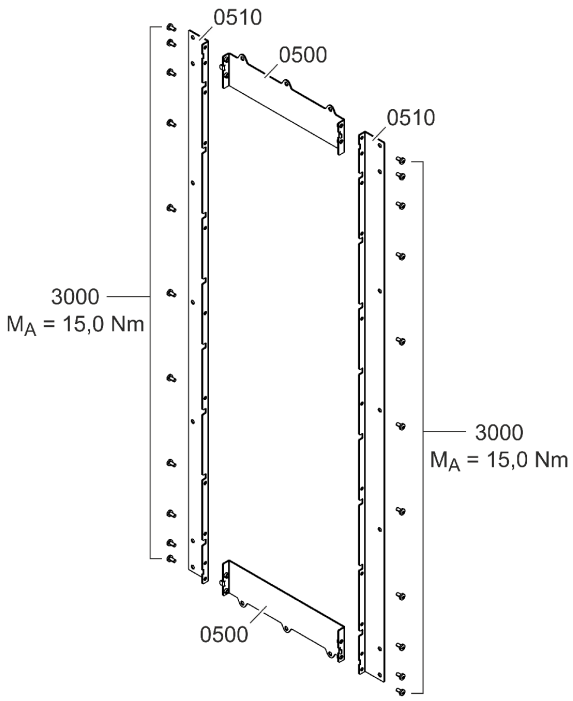
HAS10.1-002-014-NN

Beipackzettel

R911391892
AA 2018-07

R911391710

Position	Materialnummer	Benennung	Menge	Einheit
0500	R911389493	MONTAGEBLECH QUER HMU05.1N LUFTGE&	2	ST
0510	R911389496	MONTAGEBLECH LAENGS HMU05.1N-W034&	2	ST
3000	R911294188	FLACHKOPFSCHRAUBE ISO14583-M8X16-8.8-T&	22	ST



BEIPACKZETTEL HAS10.1-002-014-NN, R911391892, AA 2018-07, **Bosch Rexroth AG**

Fig. 8-11: HAS10.1-002-014

8.3 Additional components

8.3.1 HNA05 mains connection module

HNA05 type code

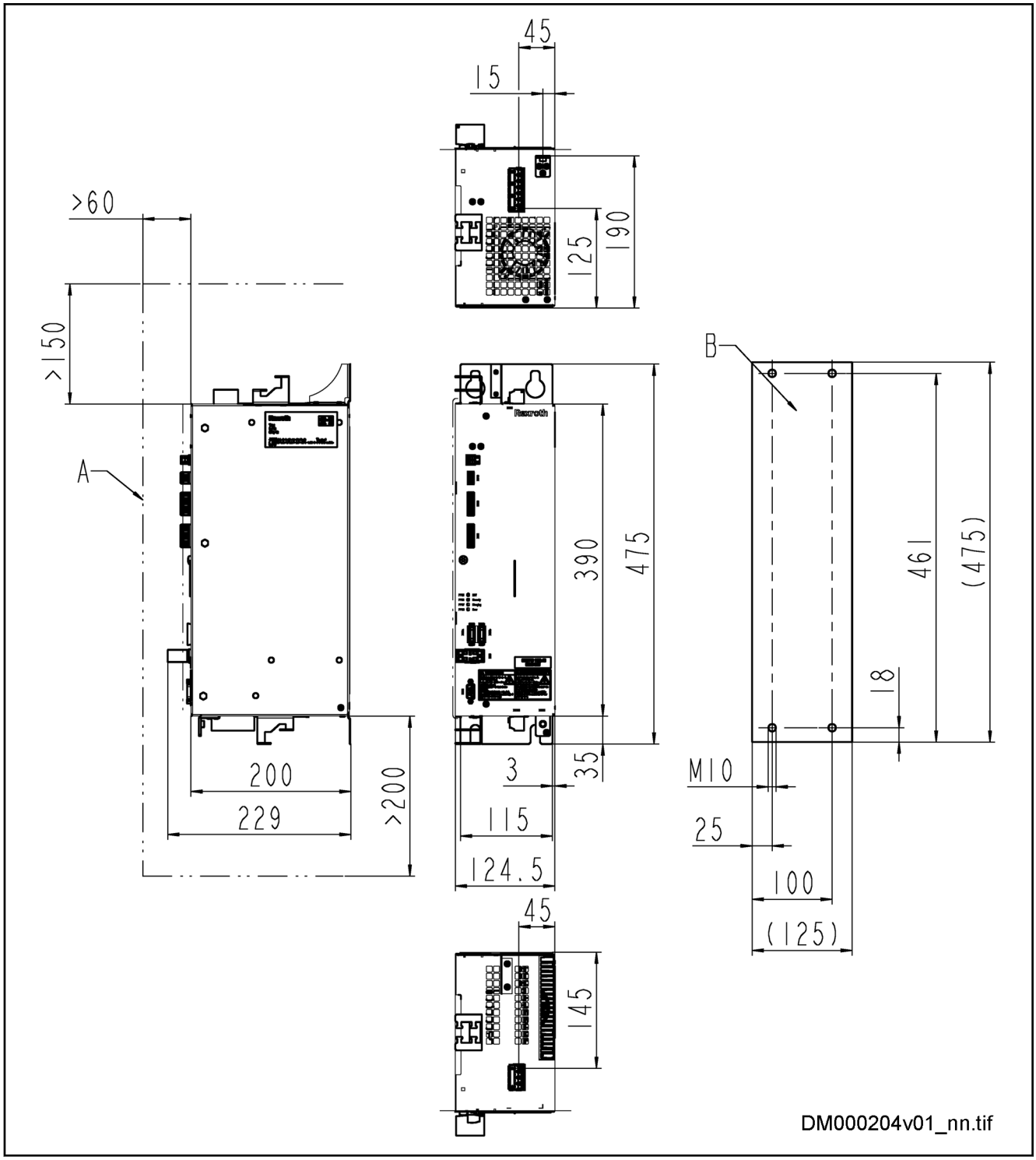
Short type designation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	H	N	A	0	5	.	1	N	-	W	R	0	2	F	5	-	A	4	-	A	-	N	N	N	N																
	①			②			③	④		⑤	⑥	⑦					⑧			⑨		⑩																			

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. 8-6: HNA05, type code

Dimensions

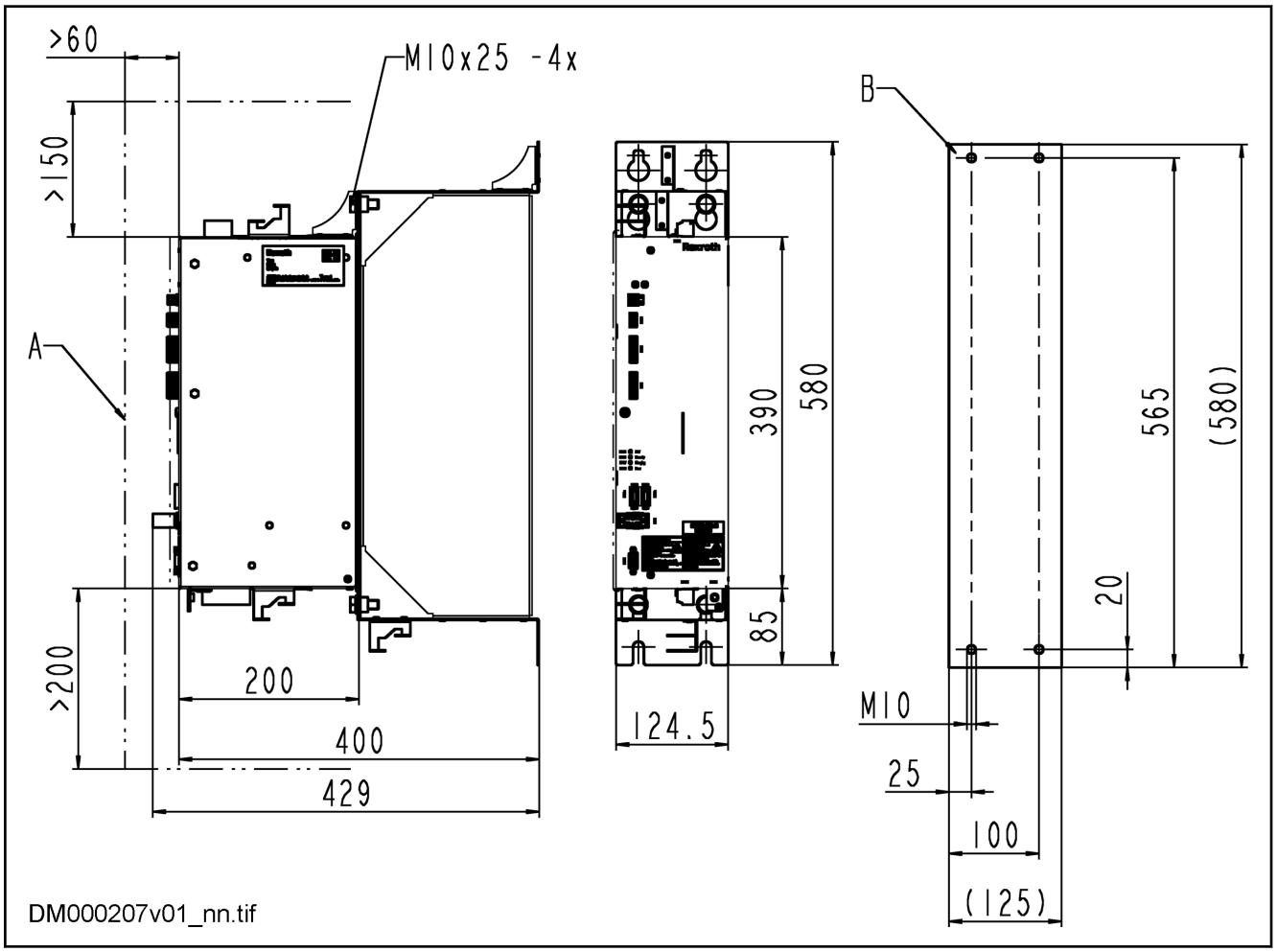
HNA05, dimensional drawing



M10 Tightening torque: 40 Nm

Fig. 8-12: HNA05, dimensional drawing

HNA05 with HAS03.1-006 mounting plate (200 mm), dimensional drawing

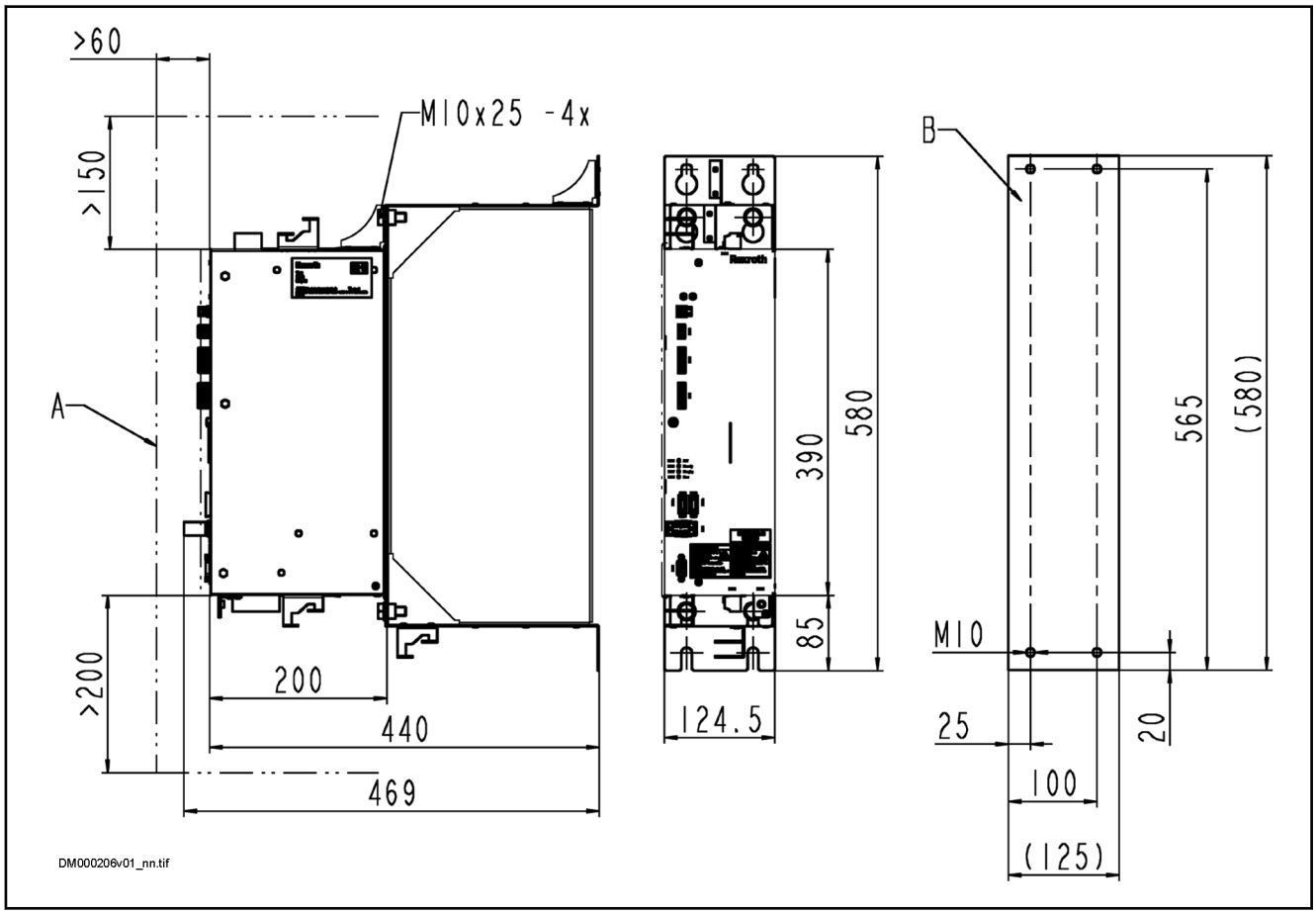


M10 Tightening torque: 40 Nm

Fig. 8-13: HNA05 with HAS03.1-006 mounting plate for height leveling and depth leveling to 400 mm depth, dimensional drawing

The mounting plate is used to combine HNA05 and **air-cooled HMU05 without push-through technology**.

HNA05 with HAS03.1-007 mounting plate (240 mm), dimensional drawing



M10 Tightening torque: 40 Nm

Fig. 8-14: HNA05 with HAS03.1-007 mounting plate for height leveling and depth leveling to 440 mm depth, dimensional drawing

The mounting plate is used to combine HNA05 and **liquid-cooled HMU05**.

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	
Tolerance input frequency	Hz	±2	
Rotary field condition		None	
Min. 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	1200
Output voltage	V	$U_{nom} \times \sqrt{2} + 30$	
Nominal output current	A	10	
Max. chargeable energy	kWs	816	1512
Max. chargeable output voltage	V	808	1100
Max. charging time	s	202	275
Maximum capacitance	F	2.5	
Minimum capacitance at output	mF	1	
Short circuit current rating (SCCR)	kA rms	85	
Activation time of the mains contactor between activation and response of the acknowledgment signals	s	< 2	

Tab. 8-7: HNA05 ratings

Connection diagram

See chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 100

Maximum allowed operating cycles for charging circuit

Worst case: **ON(4 × 3 min) + OFF(10 min)**

HNA05 may charge the maximum capacitance 4 times in a row. The charging process takes about 3 minutes. After approx. 12 minutes (4 x 3 minutes), a 10 minute break is necessary. This results in a cycle time of 22 minutes (12 + 10).

The maximum allowed operating cycles are thereby calculated from the maximum allowed duty cycle of the HNA05 of 55% of the cycle time.

Instead of "ON(4 × 3 min) + OFF(10 min)", e.g. "ON(6 × 2 min) + OFF(10 min)" would also be possible.

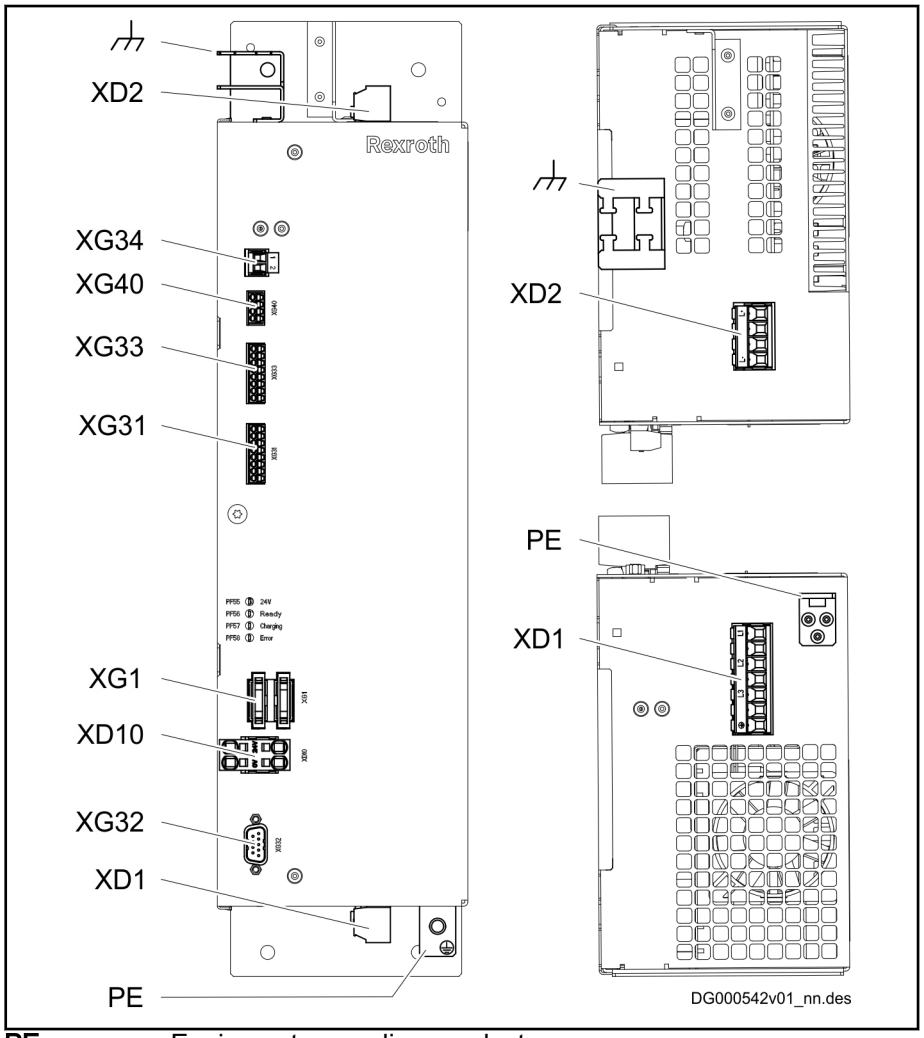
The exact value also depends on the existing DC bus capacitance (number and size of HMUs, additional capacitance connected).

☞ The DC bus capacitance is charged by a constant current source with nominal output current.

The end of the charging process depends on the mains voltage level.

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. 8-15: HNA05 connection points

Connection diagram: See chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 100

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".

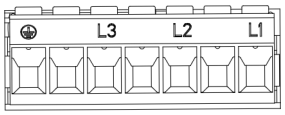
Cross-sectional area A of outer conductors	Minimum cross-sectional area A_{PE} of equipment grounding connection
A ≤ 16 mm²	A
16 mm² < A ≤ 35 mm²	16
35 mm² < A	A / 2

Tab. 8-8: 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. 8-9: Equipment grounding conductor connection point

XD1, mains voltage, equipment grounding conductor

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

Tab. 8-10: XD1, mains voltage, ground

Mechanical data

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

Tab. 8-11: Mechanical data

Electrical data

	Unit	min.	max.
Voltage	V		690
Current	A		41

Tab. 8-12: Electrical data

XD2, DC bus

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

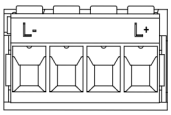
Before working on live parts: De-energize system and secure power switch against unintentional or unauthorized reconnection.

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

Before accessing the device, wait at least **30 minutes** after switching off the supply voltages to allow **discharging**.

The discharge time can be more than 30 minutes if DC bus ground capacitor pairs are used.

Mount a **touch guard**!

View	Identification	Function
	L-	DC bus connection (-)
		n. c.
		n. c.
	L+	DC bus connection (+)

Tab. 8-13: XD2, DC bus

Mechanical data

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

Tab. 8-14: Mechanical data

Electrical data

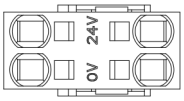
	Unit	min.	max.
Voltage	V		1200
Current	A		41

Tab. 8-15: 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	
	0V	0V	Reference potential for power supply
		0V	

Tab. 8-16: XD10, 24 V supply

Mechanical data

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

Tab. 8-17: Mechanical data

Electrical data

	Unit	min.	max.
Voltage load capacity	V	-	U_{N3} 1)
Power consumption	W	-	P_{N3} 1)
Current carrying capacity (looping through)	A	-	40 (UL: 31)
Allowed inductance	µH	-	100 (2 twisted single strands, 75 m long)

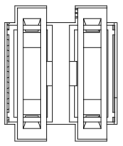
1) See chapter 7.2.1 "Control voltage" on page 151

Tab. 8-18: 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 might possibly have to connect another device directly to the 24-V supply and then loop through the control voltage from this device to other devices.

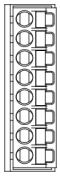
XG1, IndraBus

View	Connection	Function
	XG1a XG1b	Connects the 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 *Cables* • 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. In combination with other devices, the RBS0025 terminating plug on the first device (left) must be plugged in at the left side of XG1 and the terminating plug on the last device (right) must be plugged in at the right side.

Tab. 8-19: XG1, IndraBus

XG31, messages

Pin assignment

View	Connection	I/O	Function
	1	E	Supply voltage of inputs/outputs (**24VEA**)
	2	E	Reset input for resetting error messages: 1: Reset active 0: Reset not active
	3	E	Input for selecting between **stand-alone mode** and **slave mode**: 1: Stand-alone mode 0: Slave mode
	4	A	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	A	Isolated **warning contact** (N/C) N/C contact signals warning states. **Open** with: Overtemperature at supply unit
	7		
	8	E	Reference potential of supply voltage (**0VEA**)

Tab. 8-20: XG31, messages

☞ Operating HNA05 with HMU05 (slave mode) does not require XG31 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. 8-21: Mechanical data

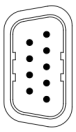
Electrical data

	Unit	Min.	Max.
Digital inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Switching voltage	V	24 -6%	

	Unit	Min.	Max.
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	

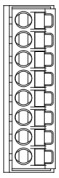
Tab. 8-22: Electrical data

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. 8-23: Function, pin assignment, properties

XG33, on, off, ZKS (DC bus short circuit) status

View	Connection	I/O	Function
	1	E	Supply voltage of inputs/outputs (24VEA*)
	2	A	ZKS1*: Output for interconnection with ZKS2
	3	E	DC bus short-circuit input for signaling an active DC bus short circuit (ZKS2*) **Not connected:** ZKS active **Connected to 24VEA:** ZKS not active The mains contactor opens in the case of an active DC bus short circuit.
	4	A	OFF1*: 24 V output for connection with OFF2 input
	5	E	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	A	Supply voltage for external ON output (ON1*) Output (24VEA) is used to connect input XG33.7
	7	E	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	E	Reference potential of supply voltage (0VEA*)

* Description in connection diagram (see chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 100)

Tab. 8-24: 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.

See chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 100.

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	

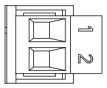
Tab. 8-25: Mechanical data

Electrical data

	Unit	Min.	Max.
Digital Inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Supply outputs	-		
Total output current	mA		300

Tab. 8-26: Electrical data

XG34, mains contactor (contact)

View	Connection	Function
	1	Connection to outer conductor L
	2	Mains contactor connection

Tab. 8-27: Function, pin assignment, properties

Mechanical data

Screw connection at connector	Unit	min.	max.
Tightening torque	Nm	0.6	0.8
Connection cables Stranded wire **without** ferrule	mm^2	0.2	2.5
	AWG	24	12
Connection cables Stranded wire **with** ferrule	mm^2	0.25	2.5
Stripped length	mm	10	

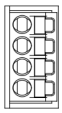
Tab. 8-28: Mechanical data

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. 8-29: Electrical data

XG40, mains contactor (acknowledgment messages)

View	Connection	I/O	Function
	1	E	Acknowledgment message: **N/O contact** of external mains contactor
	2	A	Output (24VEA)
	3	E	Acknowledgment message: **N/C contact** of external mains contactor
	4	A	Output (24VEA)

Tab. 8-30: Function, pin assignment

Mechanical data

Spring terminal (connector)	Unit	min.	max.
Connection cables Stranded wire **without** ferrule	mm^2	0.2	1.5
	AWG	24	16
Connection cables Stranded wire **with** ferrule	mm^2	0.25	0.75
Stripped length	mm	10	

Tab. 8-31: Mechanical data

Electrical data

	Unit	min.	max.
Digital inputs	-	Digital inputs correspond to IEC 61131-2 Type 1	
Current load of the auxiliary contacts	mA	3	
Supply outputs	-		
Total output current	mA		300

Tab. 8-32: Electrical data

Display elements

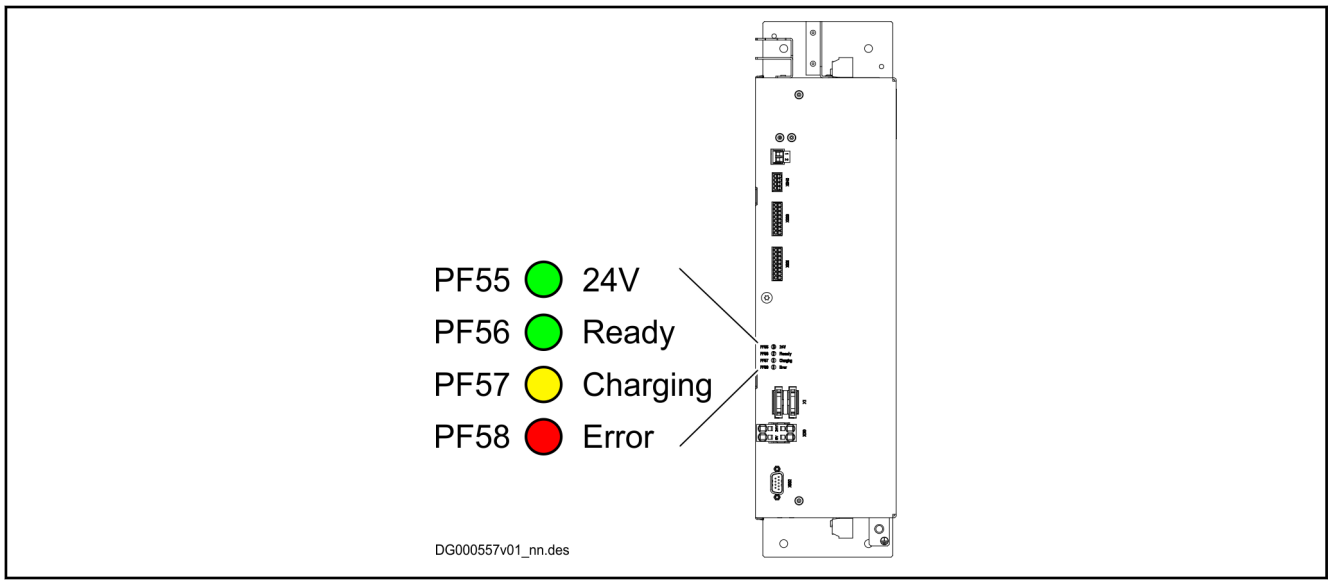


Fig. 8-16: LEDs at HNA05

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. 8-33: 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
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 C001 = Without ground capacitors

Tab. 8-34: HNC05, type code

Possible combinations:

Mains voltage	Other design	Capacitance					
		0040	0050	0070	0075	0100	0125
A4	NNNN	–	✓	–	✓	✓	✓
A5	NNNN	✓	✓	✓	–	✓	✓
A4	C001	–	–	–	–	✓	–
A5	C001	–	–	–	–	✓	✓

Tab. 8-35: Possible combinations

Dimensions

	Overview
HNC05.1N-xxxx-A4	chapter "HNC05.1N-0050/0075/0100-A4" on page 207
HNC05.1N-xxxx-A5	chapter "HNC05.1N-0040/0050-A5" on page 208 chapter "HNC05.1N-0070/0100-A5" on page 209 chapter "HNC05.1N-0125-A5" on page 210

HNC05.1N-0050/0075/0100-A4

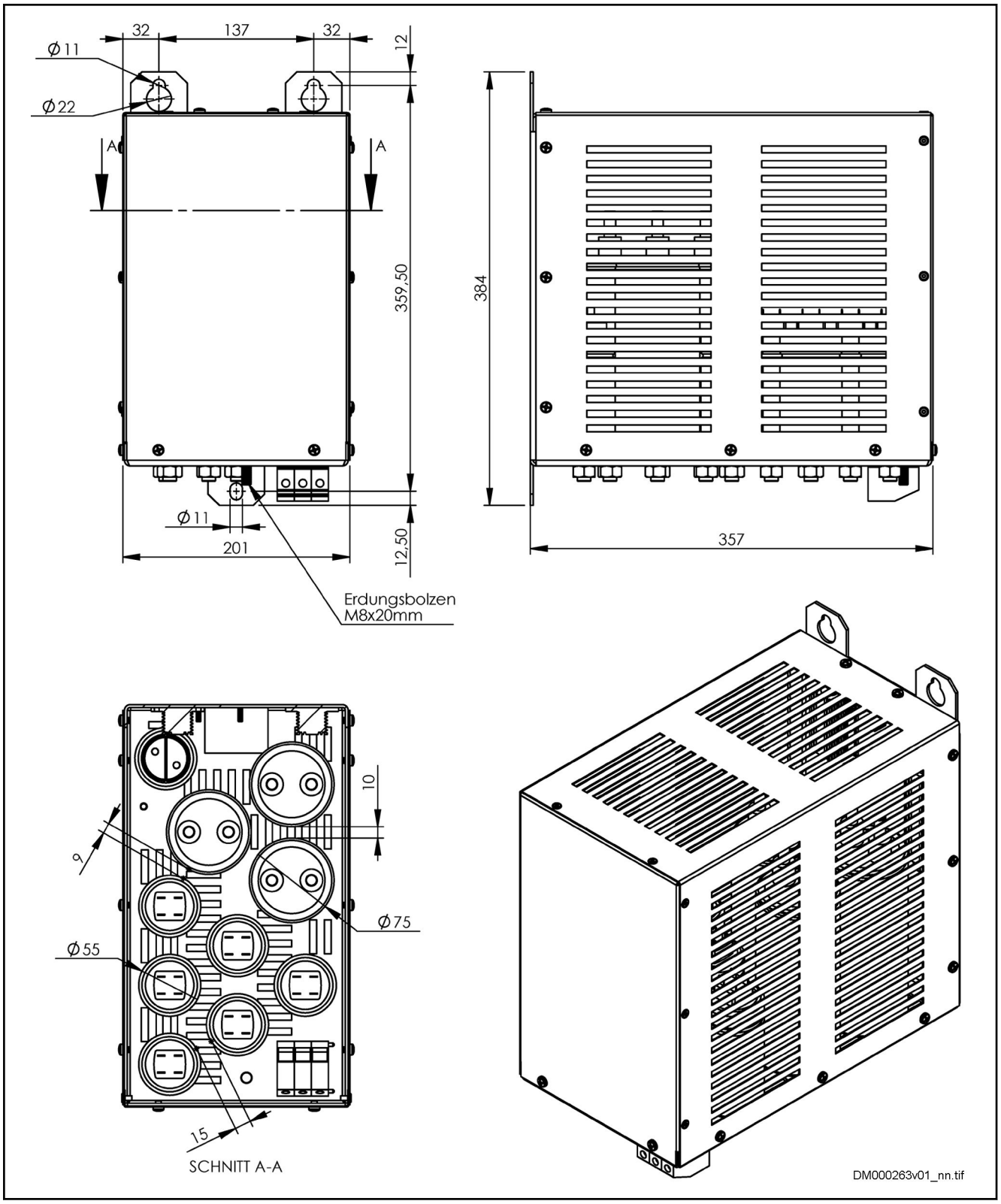


Fig. 8-17: HNC05.1N-0050/0075/0100-A4

HNC05.1N-0040/0050-A5

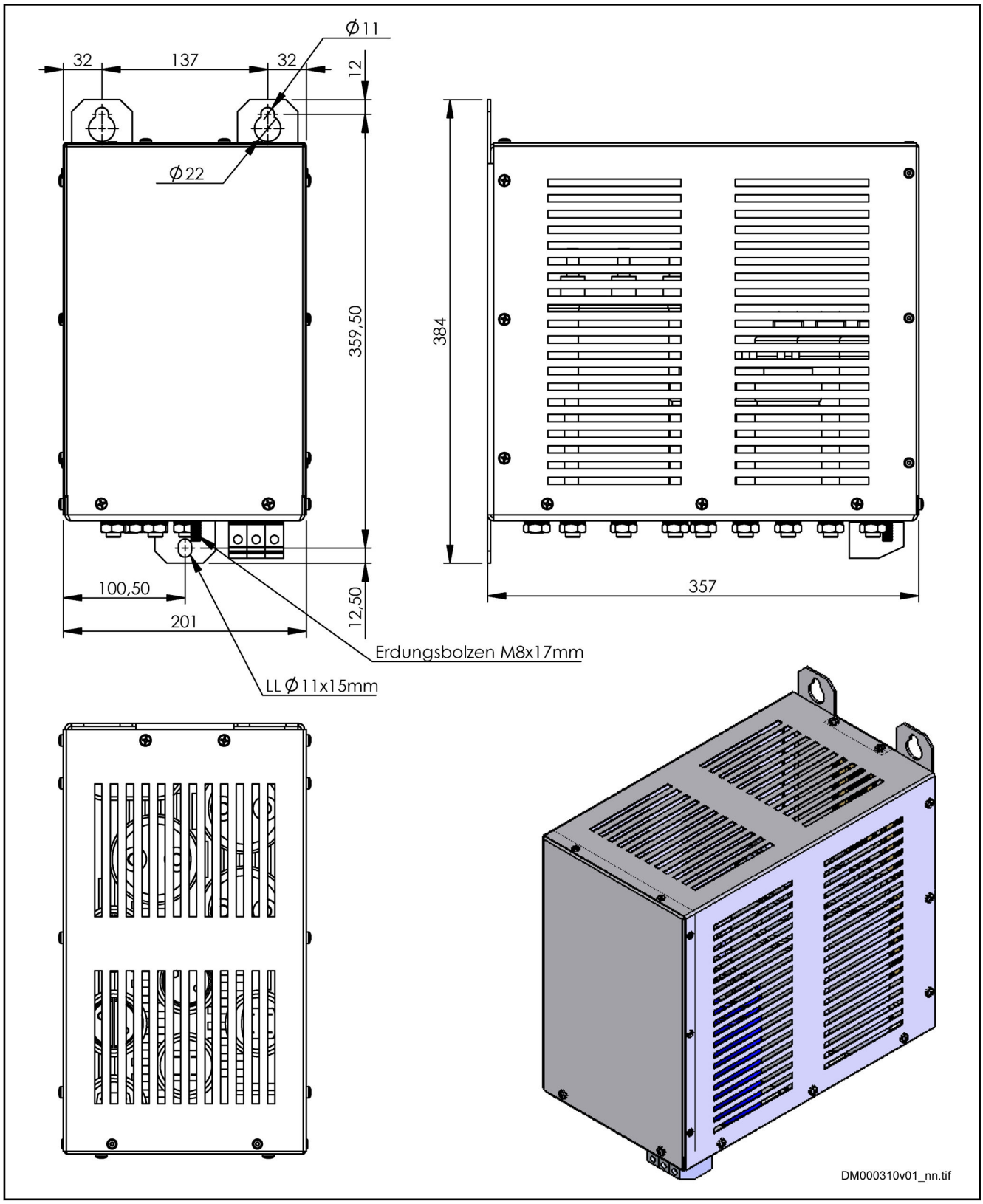


Fig. 8-18: HNC05.1N-0040/0050-A5

HNC05.1N-0070/0100-A5

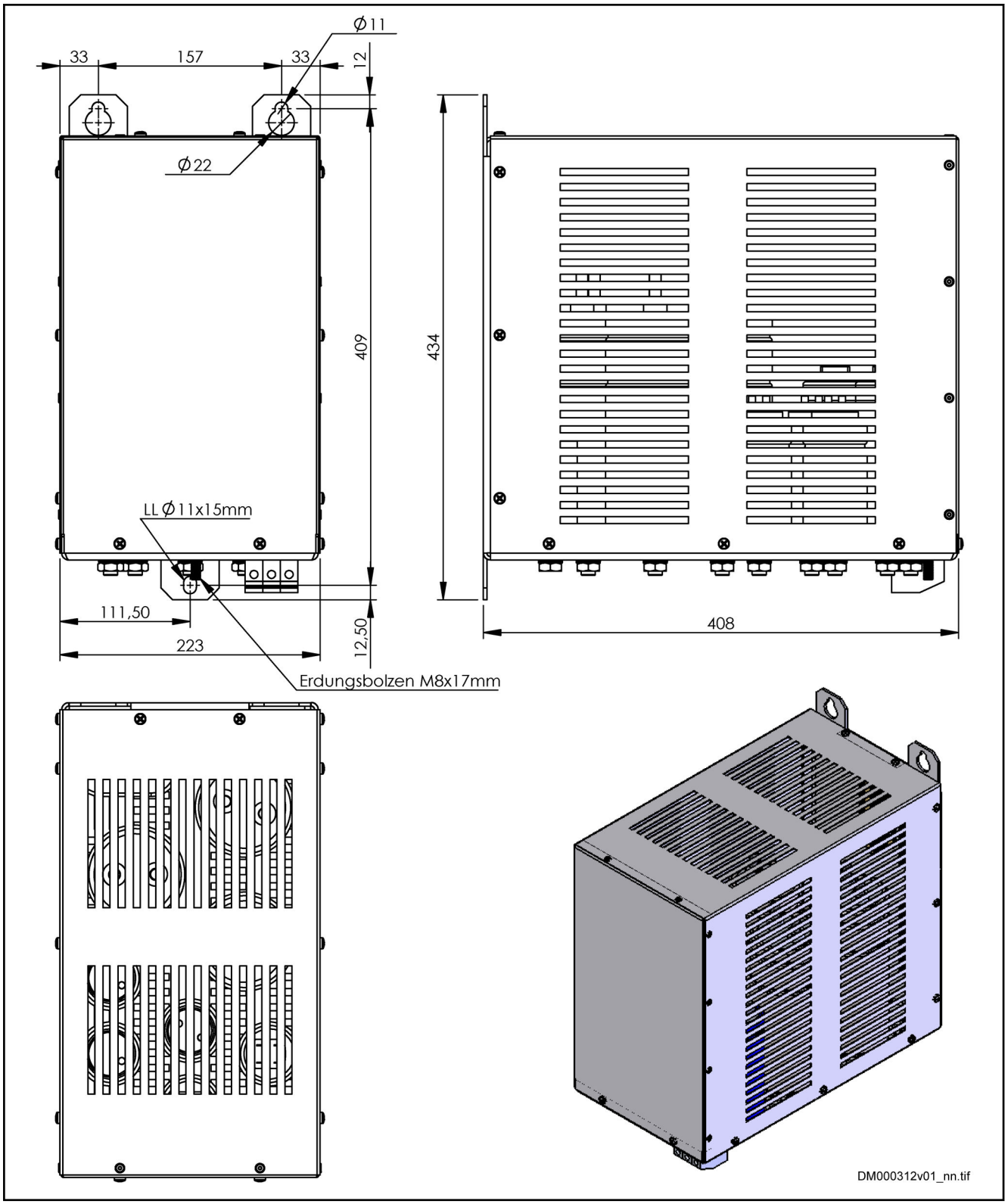


Fig. 8-19: HNC05.1N-0070/0100-A5

HNC05.1N-0125-A5

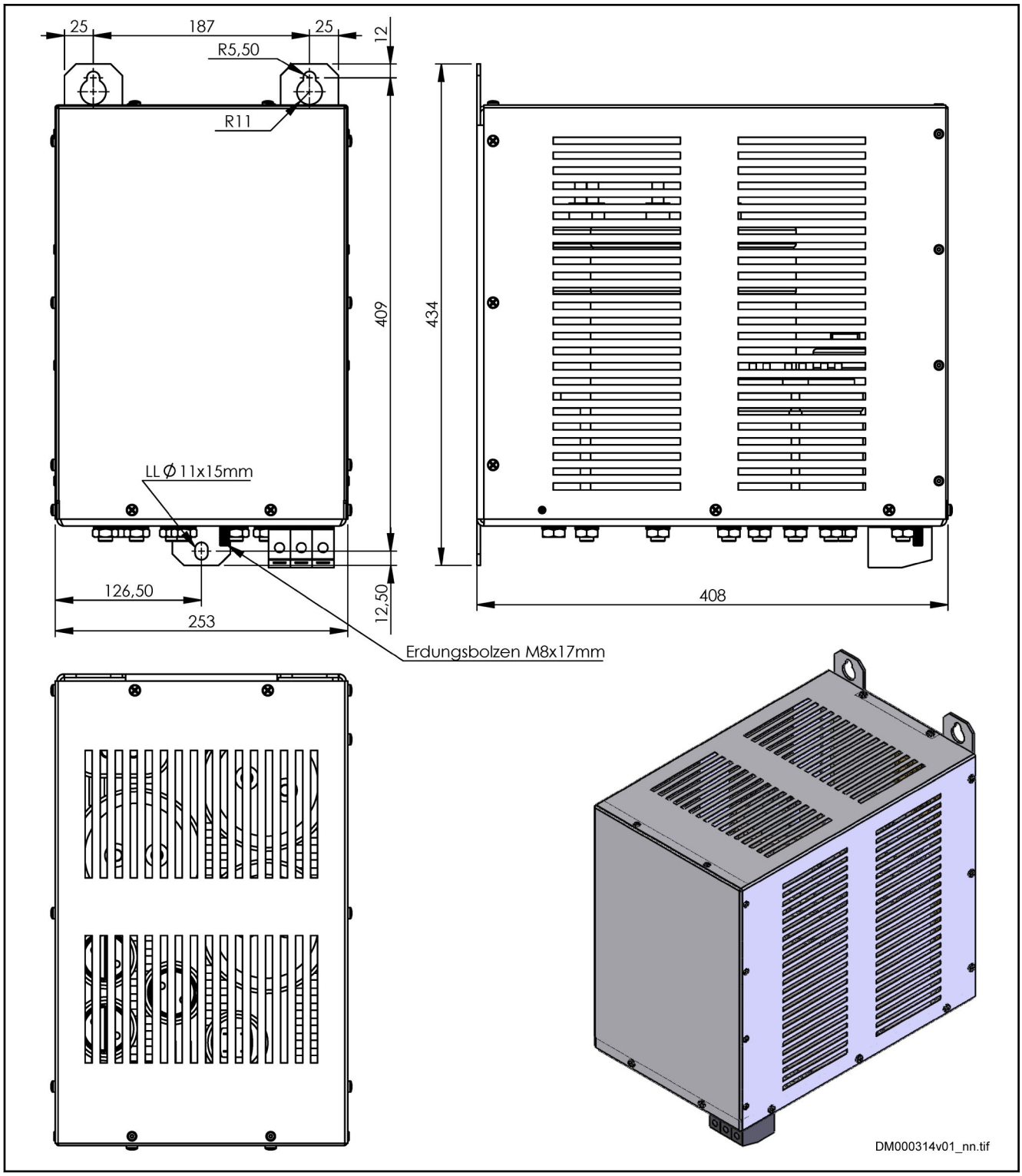
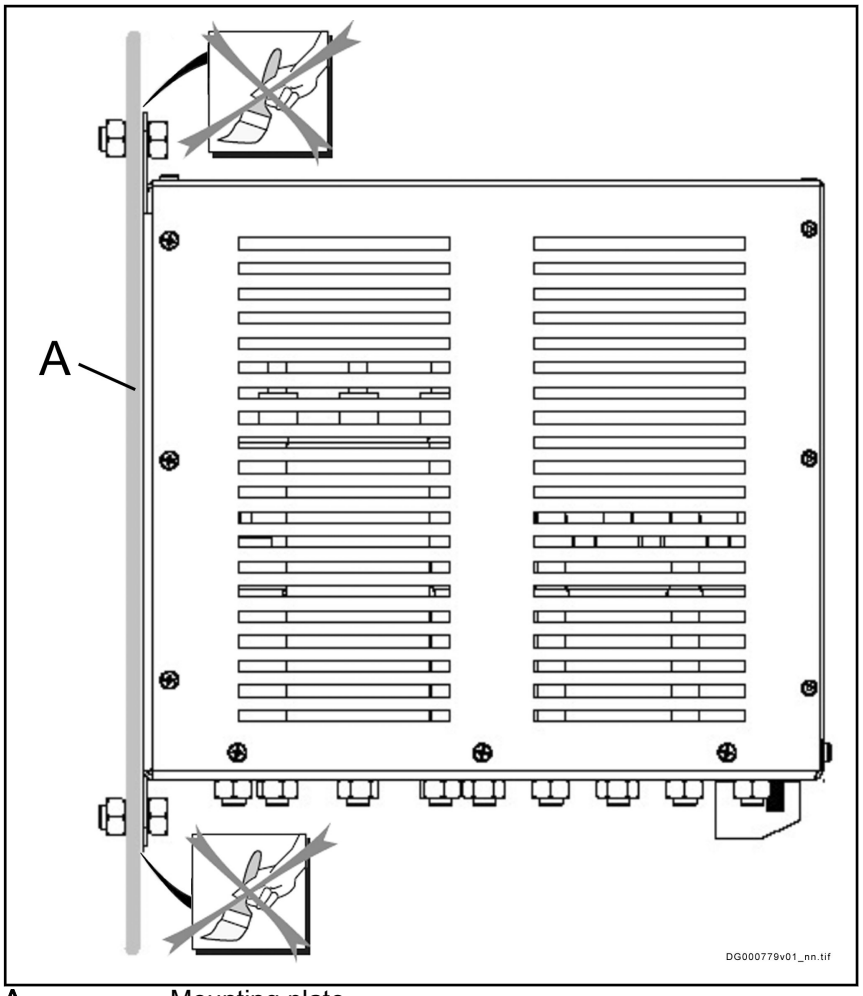


Fig. 8-20: HNC05.1N-0125-A5

Mounting

- Mount the component to the mounting plate over the largest possible surface area to establish a good electrical connection. Reason: EMC, heat dissipation

  (Not necessary for mains capacitors without ground capacitors (HNC05…-C001))
- Mounting position: vertically hanging



A Mounting plate

Fig. 8-21: HNC05 mounting

⚠ WARNING **High ground leakage current! Danger to life, risk of injury by electric shock!**

Always operate the component with the connected **equipment grounding conductor**!

Data

HNC05.1N-xxxx-A4

- **Wiring layout: Observe the wiring rated current (see data table)**
- If an overcurrent monitoring is to be installed in the cable branch to the mains capacitor, select the trigger level according to the "wiring rated current".

  The supply unit must be locked when triggering the overcurrent monitoring (e.g. version as motor protection switch; auxiliary contact interrupts the Bb signal chain when triggered).
- Cable cross section:
  - Due to the high leakage current, the cross section of the equipment grounding conductor has to match at least the cross section of the outer conductor.
  - HNC05.1N-0040-A5; HNC05.1N-0050-A5; HNC05.1N-0070-A5; HNC05.1N-0100-A5:

    Cable cross section: ≥ 25 mm^2 (AWG3)

    HNC05.1N-0125-A5:

    Cable cross section: ≥ 50 mm^2 (AWG1/0)
- 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 (mounting position: vertically hanging).

  Reason: EMC, heat dissipation

HNC05.1N-…-A4

Mains capacitor HNC05.1N-…-A4	Capacitance [µF]	Nominal current [A]	Wiring rated current [A]	Power dissipation [W]	Connection	Degree of protection	Weight [kg]
0050	3 × 50	60	60	100	Phases: Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	12
0075	3 × 75	80	80	100	Phases: Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	12
0100	3 × 100	80	80	150	Phases: Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	12

Tab. 8-36: HNC05.1N-…-A4, data

Discharge time 20 minutes

HNC05.1N-xxxx-A5

- **Wiring layout: Observe the wiring rated current (see data table)**
- If an overcurrent monitoring is to be installed in the cable branch to the mains capacitor, select the trigger level according to the "wiring rated current".

  The supply unit must be locked when triggering the overcurrent monitoring (e.g. version as motor protection switch; auxiliary contact interrupts the Bb signal chain when triggered).
- Cable cross section:
  - Due to the high leakage current, the cross section of the equipment grounding conductor has to match at least the cross section of the outer conductor.
  - HNC05.1N-0040-A5; HNC05.1N-0050-A5; HNC05.1N-0070-A5; HNC05.1N-0100-A5:

    Cable cross section: ≥ 25 mm^2 (AWG3)

    HNC05.1N-0125-A5:

    Cable cross section: ≥ 50 mm^2 (AWG1/0)
- 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 (mounting position: vertically hanging).

  Reason: EMC, heat dissipation

HNC05.1N-…-A5

Mains capacitor HNC05.1N-…-A5	Capacitance [µF]	Nominal current [A]	Wiring rated current [A]	Power dissipation [W]	Connection	Degree of protection	Weight [kg]
0040	3 × 40	32	65	150	Phases: Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	14
0050	3 × 50	37	65	150	Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	15
0070	3 × 70	47	70	170	Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	18
0100	3 × 100	66	80	200	Screw terminal, 25 mm^2 Tightening torque: 5 Nm Ground: Bolt, M8x20	IP10	18
0125	3 × 125	80	120	200	Screw terminal, 50 mm^2 Tightening torque: 6 Nm Ground: Bolt, M8x20	IP10	25

Tab. 8-37: HNC05.1N-…-A5, data

Discharge time 20 minutes

IT mains

Mains capacitor HNC05.1N-…	Phase-to-ground capacitance, resulting [µF]	Phase-to-ground discharge resistors; per phase [kΩ]	Mains-side ground fault: Further operation allowed for a limited time	Motor-side ground fault: Further operation allowed for a limited time
0050-A4-NNNN	3 × 50	1000	–	–
0075-A4-NNNN				
0100-A4-NNNN				
0040-A5-NNNN	3 × 30	2000	✓	–
0050-A5-NNNN				
0070-A5-NNNN				
0100-A5-NNNN				
0125-A5-NNNN				
0100-A4-C001	-	-	✓	✓
0100-A5-C001				
0125-A5-C001				

Tab. 8-38: Data for operation on the IT mains

HNC05.1N-…-C001 (mains capacitor without ground capacitors)

Mains capacitors without ground capacitors (HNC05.1N-…-C001) are only used for operation on the **IT-mains**.

☞ As per 2019-05: No UL/CSA approval for HNC05.1N-…-C001.

Operation of these mains capacitors requires a thorough **analysis of the entire IT mains**:

- Without ground capacitors, the drive systems can cause high overvoltages against ground on the mains connection.
- The ground leakage current through the axis-side leakage capacitance flows as a common mode current into the mains.

The following points must be analyzed:

- clearances and creepage distances
- Insulation
- EMC

The **overload of filter branches** against ground must be excluded in the entire IT-mains. Take the mains filters of all connected devices into account.

For the combination with **other IndraDrive components**, also note:

- If a mains capacitor without ground capacitors (HNC05.1N-…-C001) is to be operated with a mains filter (HNF05), the ground capacitors of the mains filter must not be overloaded through the leakage current. Countermeasure to a possible overload: e.g. interposing of an isolating transformer.
- When operating HLL05 DC bus chokes and DC bus ground capacitor pairs (HAS04.1-003), no resonances may be stimulated by the clock frequencies.

HNC05.1N-…-C001	HMU05.1N-x…-A4-D7 supply unit							HMU05.1N-F…-A5-11 supply unit					
	F0140-0350	F0170-0430	F0220-0510	F0270-0660	F0340-0820	F0430-1040	F0540-1300	0140-0210	0170-0250	0220-0300	0270-0370	0400-0600	0540-0750
0100-A4	✓	✓	✓	✓	✓	✓	✓	–	–	–	–	–	–
0100-A5	–	–	–	–	–	–	–	✓	✓	✓	✓	✓	–
0125-A5	–	–	–	–	–	–	–	–	–	–	–	–	✓

Tab. 8-39: Assigning the components

Reactive current with supply unit locked

The supply unit automatically compensates the reactive current of the components during operation when the reactive power compensation (S-0-1709.0.160, bit 0 = 1, bit = 0) is activated.

The specified reactive current refers to the situation in which the mains capacitor has already been connected to the mains, but the supply unit is still locked.

The reactive current of the HNF mains filter must be added for the entire reactive current of the drive system (see chapter "Reactive current with supply unit locked" on page 227). The impact of the chokes is negligible.

For the mains capacitors without ground capacitors (HNC05…-C001), the reactive current compensation must be reconfigured in the parameters of the supply unit, if applicable, due to a different size assignment.

HNC05.1N-…-A4	Mains frequency 50 Hz			Mains frequency 60 Hz		
	3 × 400 V_{rms} [A_{rms}]	3 × 480 V_{rms} [A_{rms}]	3 × 500 V_{rms} [A_{rms}]	3 × 400 V_{rms} [A_{rms}]	3 × 480 V_{rms} [A_{rms}]	3 × 500 V_{rms} [A_{rms}]
0050	15	17	18	17	21	22
0075	20	24	25	24	29	30
0100	25	30	32	30	37	38

Interim values can be calculated by interpolation or extrapolation.

Tab. 8-40: HNC05.1N-…-A4 capacitive reactive current

HNC05.1N-…-A5	Mains frequency 50 Hz		Mains frequency 60 Hz	
	3 × 600 V_{rms} [A_{rms}]	3 × 690 V_{rms} [A_{rms}]	3 × 600 V_{rms} [A_{rms}]	3 × 690 V_{rms} [A_{rms}]
0040	16	19	20	23
0050	20	23	23	27
0070	26	30	31	36
0100	36	41	43	50
0125	44	51	53	61

Interim values can be calculated by interpolation or extrapolation.

Tab. 8-41: HNC05.1N-…-A5 capacitive reactive current

See also chapter 11.2 "Reactive power" on page 599.

Assignment HNC05 to HMU05

See chapter "Combining mains filter, mains choke, preconnected choke and mains capacitor" on page 120.

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	1	6	0	0	-	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 E = DNVGL CP 0395
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
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. 8-42: HNF05, type code

Possible combinations:

		Mains connection voltage													
		A4							A5						
		Nominal current							Nominal current						
		0150	0180	0250	0320	0400	0600	1000	0150	0180	0250	0320	0400	0600	1000
EMC area	A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EMC area	E	–	–	–	–	–	–	–	✓	✓	✓	✓	✓	✓	✓

Tab. 8-43: Possible combinations

Dimensions

HNF05.1A-500N-R0150/R0180-N-A5

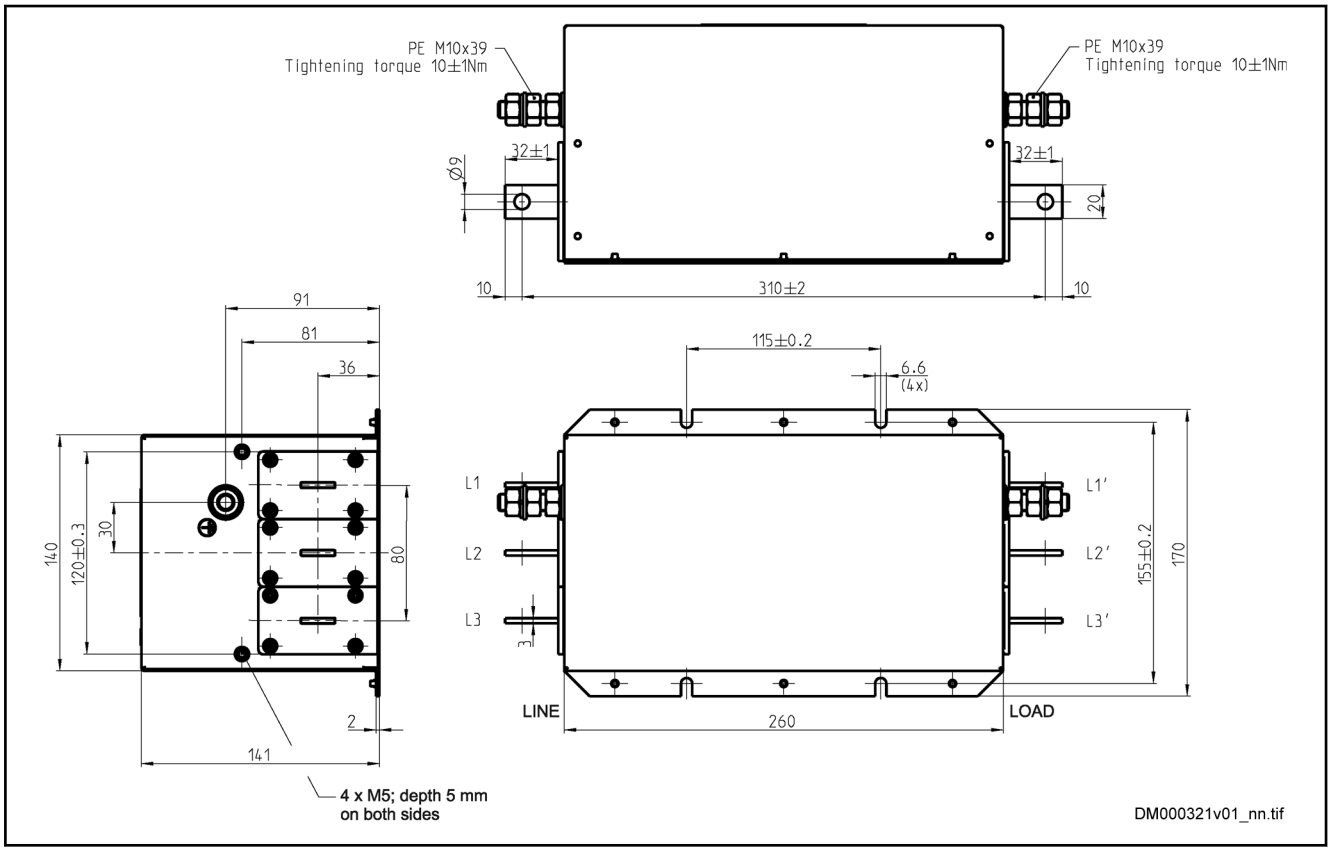


Fig. 8-22: HNF05.1A-500N-R0150/R0180-N-A5

HNF05.1A-500N-R0250-N-A5

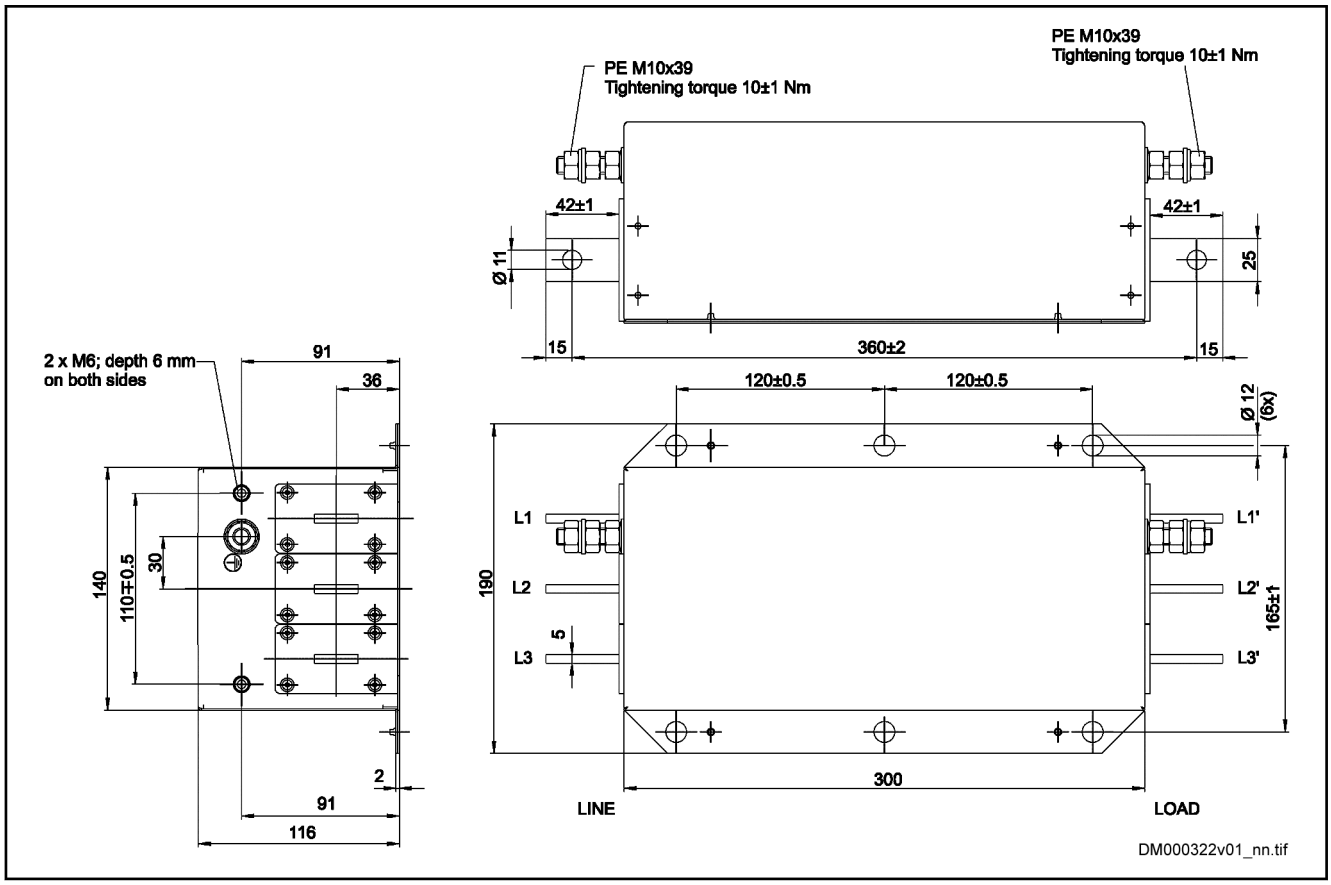


Fig. 8-23: HNF05.1A-500N-R0250-N-A5

HNF05.1A-500N-R0320/R0400-N-A5

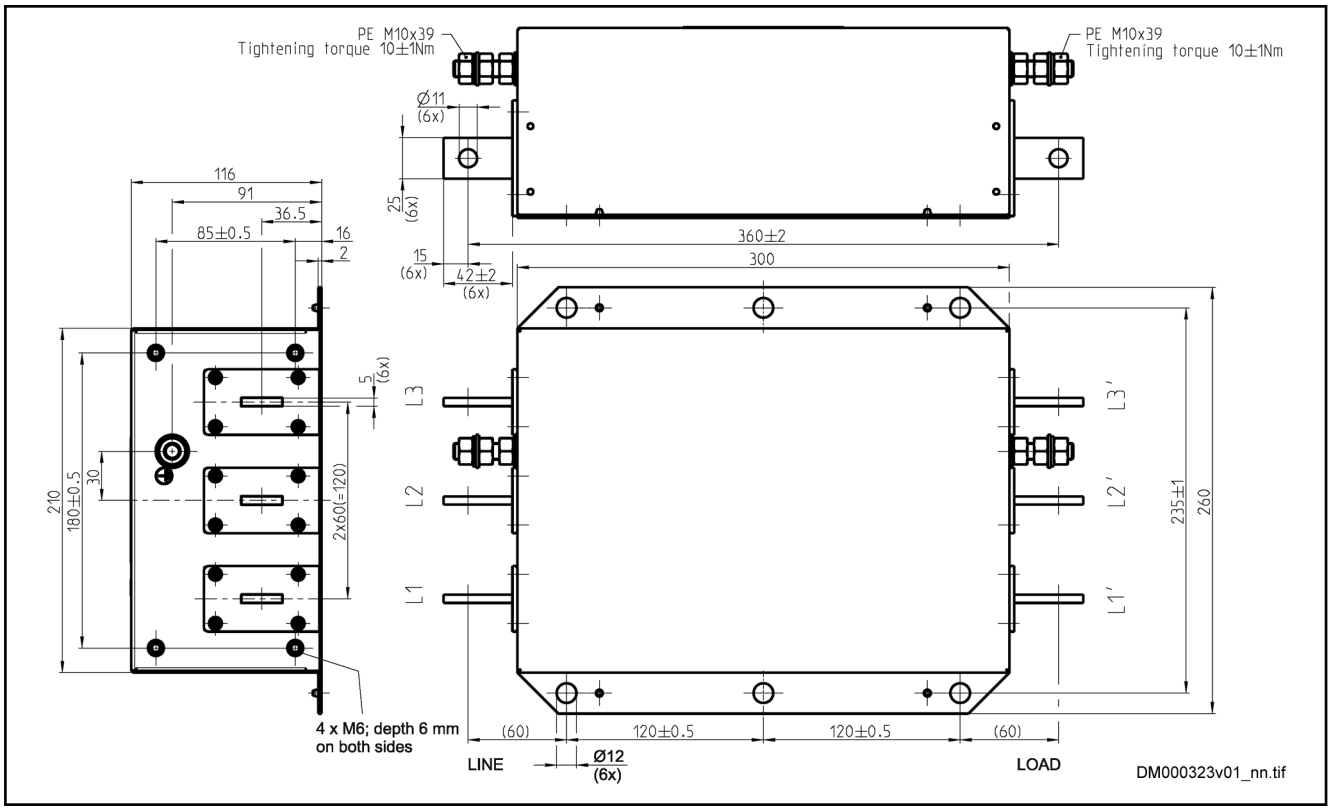


Fig. 8-24: HNF05.1A-500N-R0320/R0400-N-A5

HNF05.1A-500N-R0600-N-A5

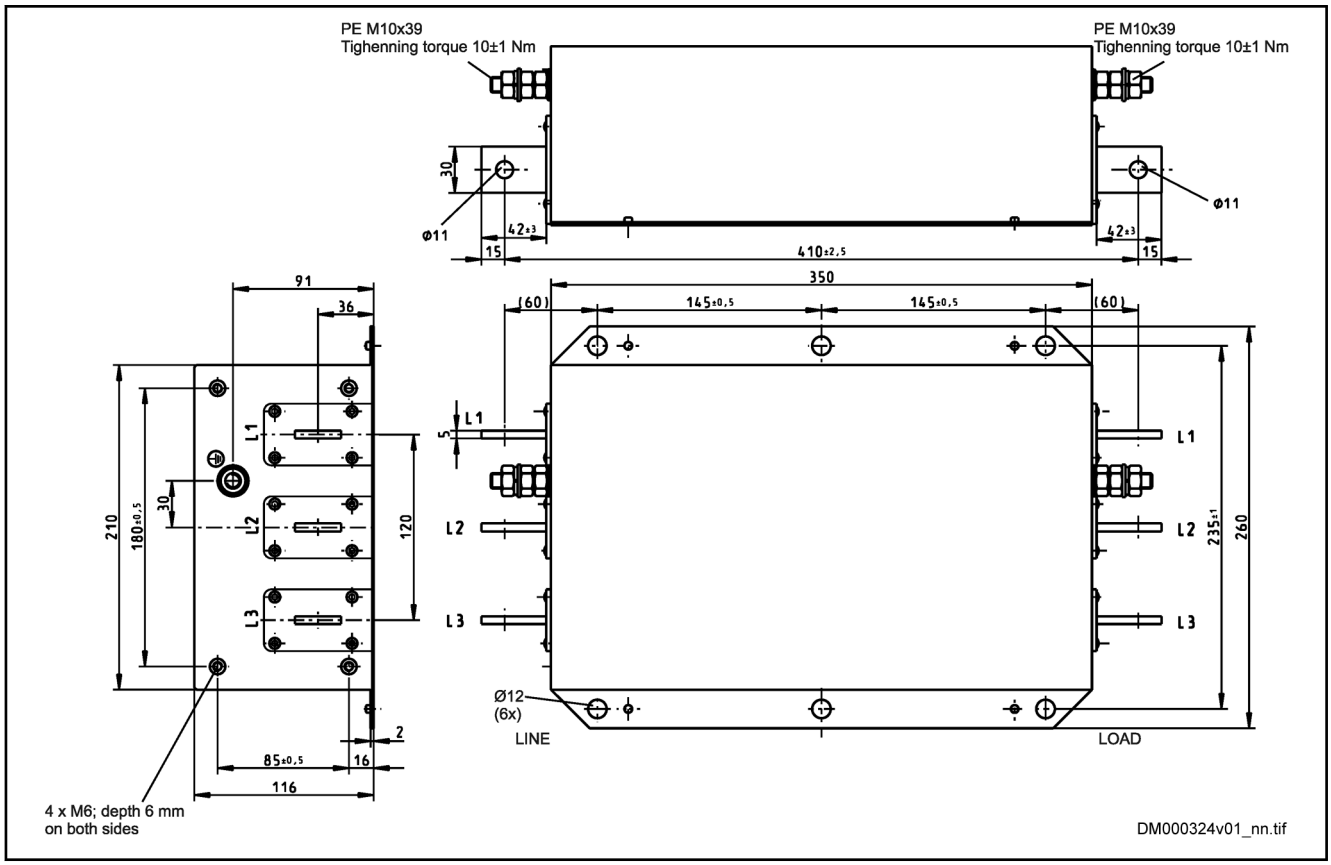


Fig. 8-25: HNF05.1A-500N-R0600-N-A5

HNF05.1A-500N-R1000-N-A5

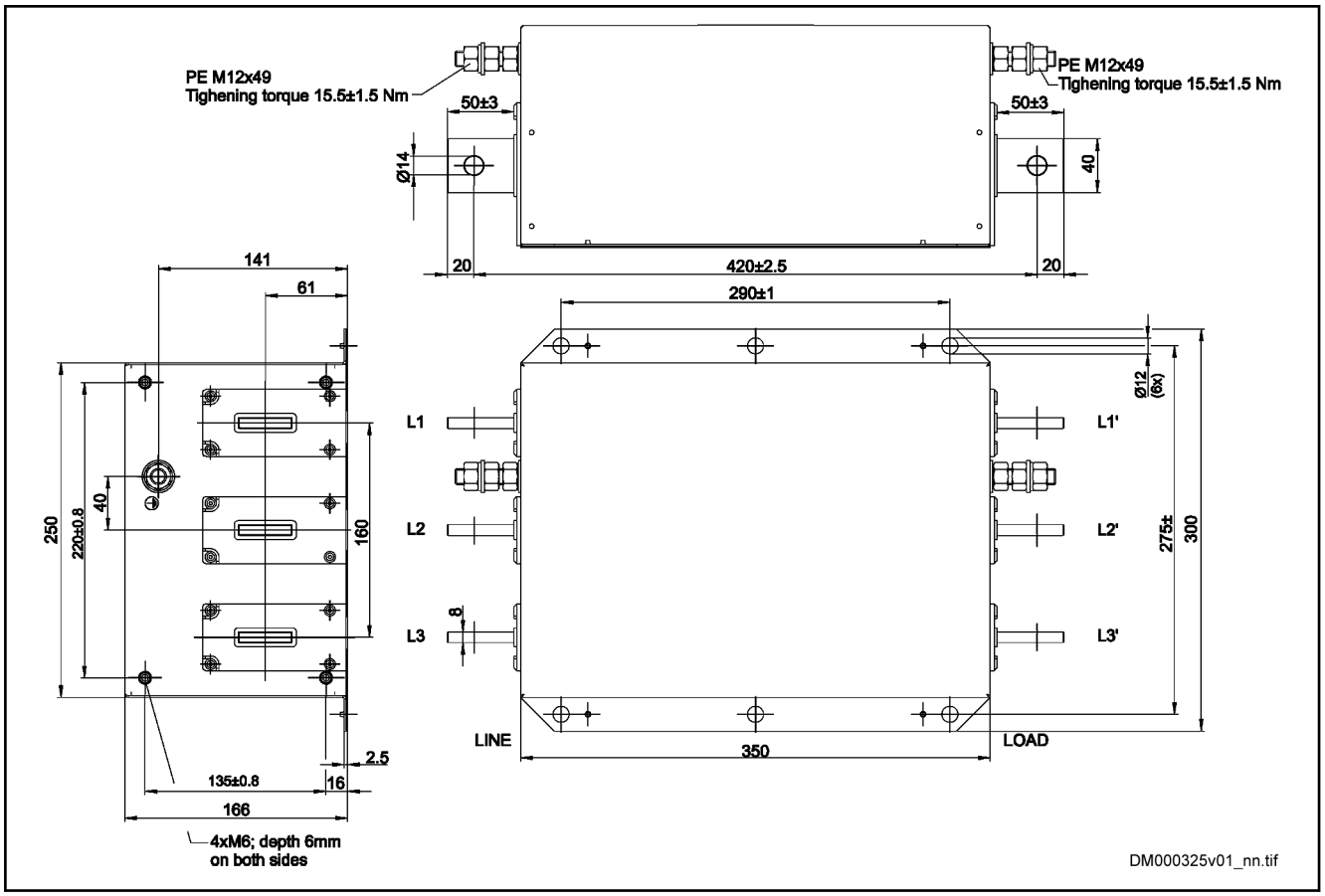


Fig. 8-26: HNF05.1A-500N-R1000-N-A5

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.

Mount the component to the mounting plate **over the largest possible surface area to establish a good electrical connection**.

A hanging mounting position on the roof of the control cabinet is not allowed.

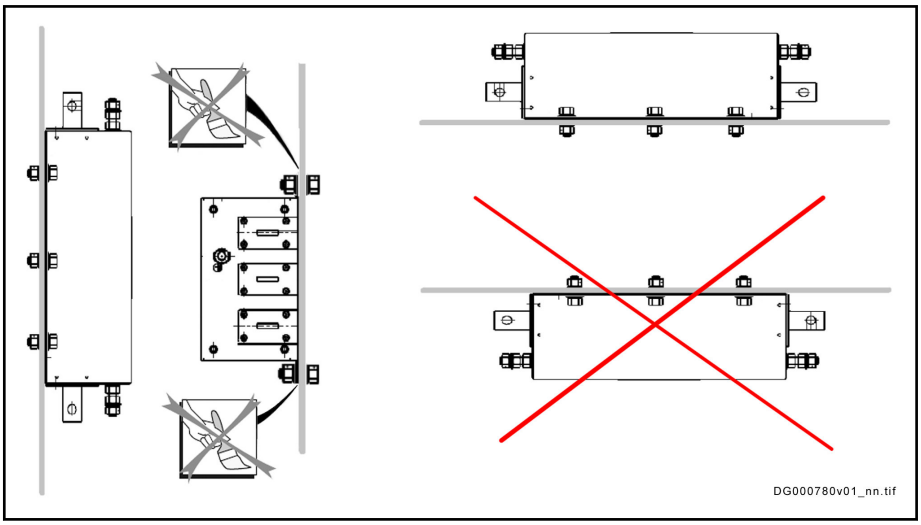


Fig. 8-27: HNF05 mounting positions

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

Degree of protection of the component: **IP00**

Mount a **touch guard**!

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. 8-44: Threaded bolt PE

⚠ WARNING **High ground leakage current! Danger to life, risk of injury by electric shock!**

Always operate the component with the connected **equipment grounding conductor**!

Data

HNF05.1A-500N-…-A5	Nominal voltage [V]	Nominal current [A]	Power dissipation 2) [W]	Leakage current [mA]	Resistance [µΩ]	Weight [kg]	Degree of protection
R0150	400/690, 50/60 Hz	150	28	< 905 1)	140	13	IP00
R0180		180	34		140	13	
R0250		250	34		63	15	
R0320		320	36		67	21	
R0400		400	53		67	21	
R0600		600	86		52	22	
R1000		1000	166		33	42	

1) With nominal voltage, 50 Hz
2) The power dissipation of a component is nearly independent of the mains voltage

Tab. 8-45: HNF05.1A-…-A5, data

Reactive current with supply unit locked

During operation, the supply unit automatically compensated the reactive current of the components.

A reactive current flows if the mains filter is supplied with mains voltage and the supply unit is still locked.

	Mains frequency 50 Hz				Mains frequency 60 Hz			
	400 V_{rms}	500 V_{rms}	600 V_{rms}	690 V_{rms}	400 V_{rms}	500 V_{rms}	600 V_{rms}	690 V_{rms}
Current [A_{rms}]	1.1	1.4	1.7	1.9	1.3	1.7	2.0	2.3

Interim values can be calculated by interpolation or extrapolation.

Tab. 8-46: HNF05, reactive current

See also chapter 11.2 "Reactive power" on page 599.

Assignment HNF05 to HMU05

See chapter "Combining mains filter, mains choke, preconnected choke and mains capacitor" on page 120.

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	-	N	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 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
⑥	**Additional option:** N = None

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	-	N	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
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 NNNW = Air, internal

Tab. 8-47: HNL05, type code

Possible combinations (mains connection voltage A4):

		Mains connection voltage															
		A4															
		Other design															
		NNNF							NNNN					NNNW			
		Nominal current															
		0218	0262	0327	0409	0514	0652	0811	0327	0409	0514	0652	0811	0262	0327	0409	0514
Nominal inductance	0040	–	–	–	–	–	–	–	–	–	–	–	✓	–	–	–	–
	0043	–	–	–	–	–	–	–	–	–	✓	–	–	–	–	–	–
	0045	–	–	–	–	–	–	–	✓	–	–	–	–	–	–	–	–
	0050	–	–	–	–	–	–	–	–	–	–	✓	–	–	–	–	–
	0054	–	–	–	–	–	–	–	–	✓	–	–	–	–	–	–	–
	0100	–	–	–	–	–	–	✓	–	–	–	–	–	–	–	–	–
	0113	–	–	–	–	–	✓	–	–	–	–	–	–	–	–	–	–
	0117	–	–	–	✓	–	–	–	–	–	–	–	–	–	–	✓	–
	0130	–	–	–	–	✓	–	–	–	–	–	–	–	–	–	–	✓
	0135	–	–	✓	–	–	–	–	–	–	–	–	–	–	✓	–	–
	0182	–	✓	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	0219	✓	–	–	–	–	–	–	–	–	–	–	–	✓	–	–	–

Tab. 8-48: Possible combinations (mains connection voltage A4)

Possible combinations (mains connection voltage A5):

		Mains connection voltage												
		A5												
		Other design												
		NNNF							NNNN					
		Nominal current												
		0127	0152	0190	0238	0352	0471	0592	0152	0190	0238	0352	0471	0592
Nominal inductance	0032	–	–	–	–	–	–	–	–	–	–	–	–	✓
	0040	–	–	–	–	–	–	–	–	–	–	–	✓	–
	0054	–	–	–	–	–	–	–	–	–	–	✓	–	–
	0080	–	–	–	–	–	–	–	–	–	✓	–	–	–
	0100	–	–	–	–	–	–	–	–	✓	–	–	–	–
	0125	–	–	–	–	–	–	–	✓	–	–	–	–	–
	0139	–	–	–	–	–	–	✓	–	–	–	–	–	–
	0175	–	–	–	–	–	✓	–	–	–	–	–	–	–
	0234	–	–	–	–	✓	–	–	–	–	–	–	–	–
	0346	–	–	–	✓	–	–	–	–	–	–	–	–	–
	0434	–	–	✓	–	–	–	–	–	–	–	–	–	–
	0542	–	✓	–	–	–	–	–	–	–	–	–	–	–
	0649	✓	–	–	–	–	–	–	–	–	–	–	–	–

Tab. 8-49: Possible combinations (mains connection voltage A5)

Dimensions HNL05.1R-…-A4

HNL05.1R-0219-N0218-N-A4-NNNF

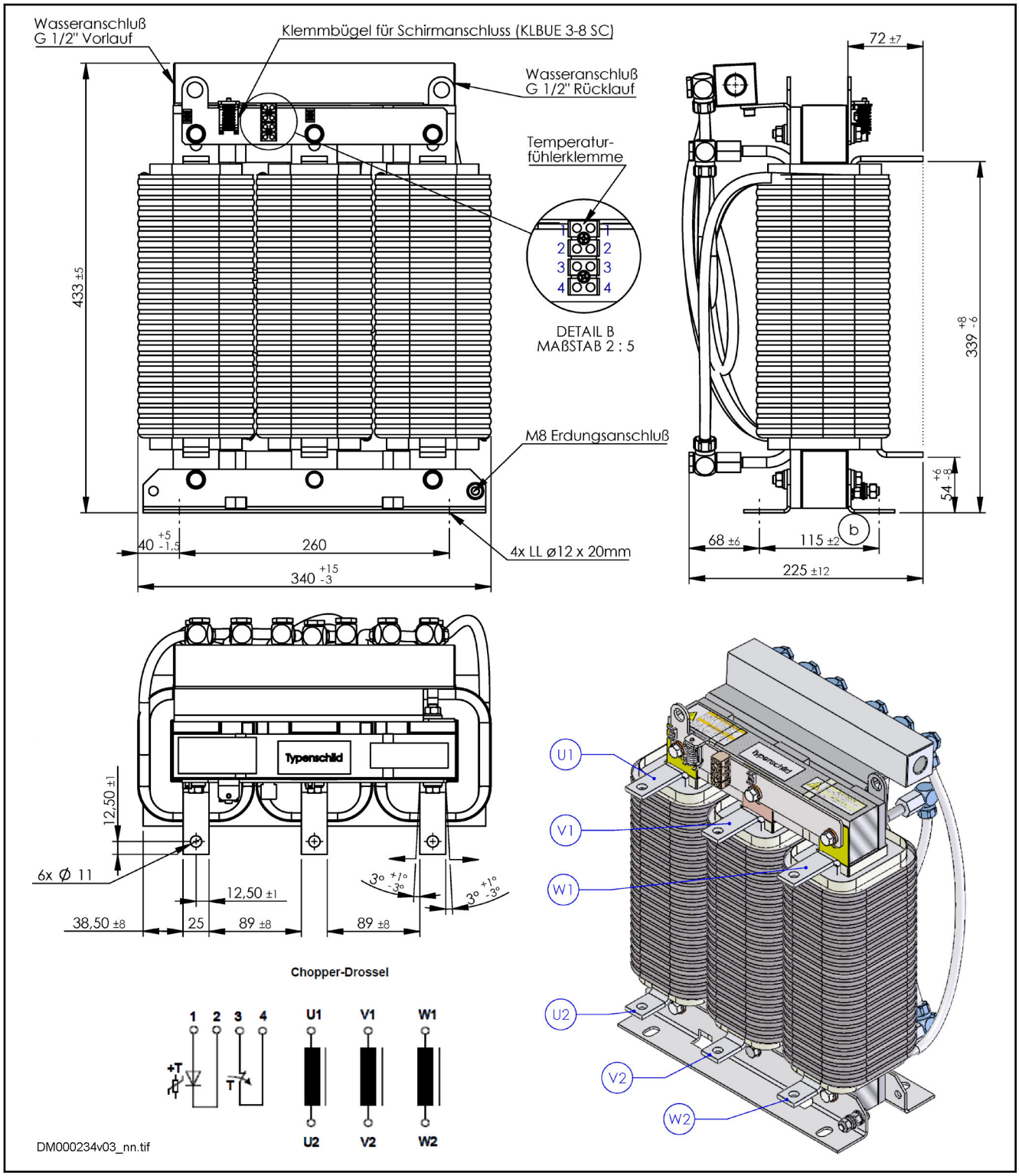


Fig. 8-28: HNL05.1R-0219-N0218-N-A4-NNNF

HNL05.1R-0182-N0262-N-A4-NNNF

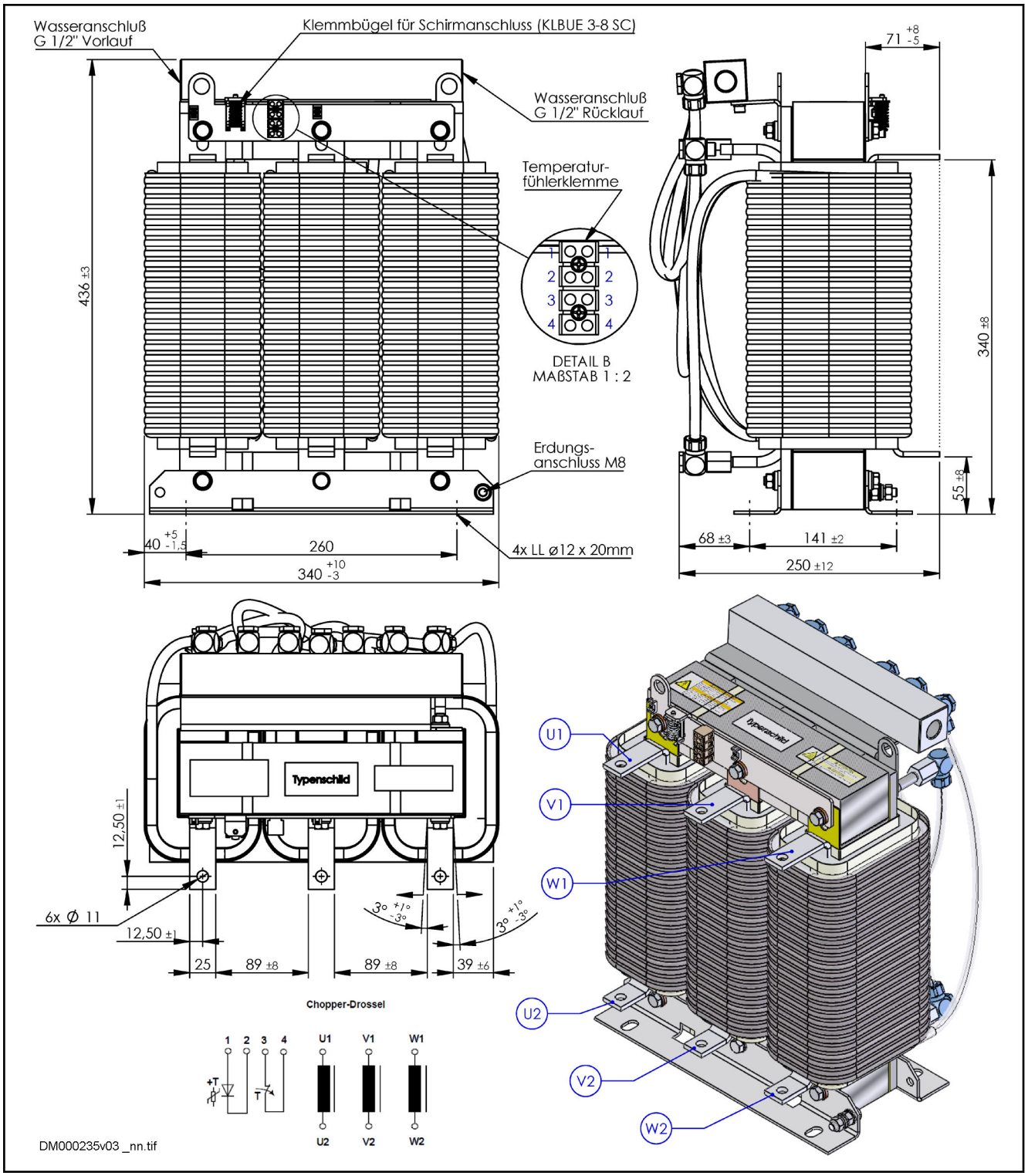


Fig. 8-29: HNL05.1R-0182-N0262-N-A4-NNNF

HNL05.1R-0219-N0262-N-A4-NNNW

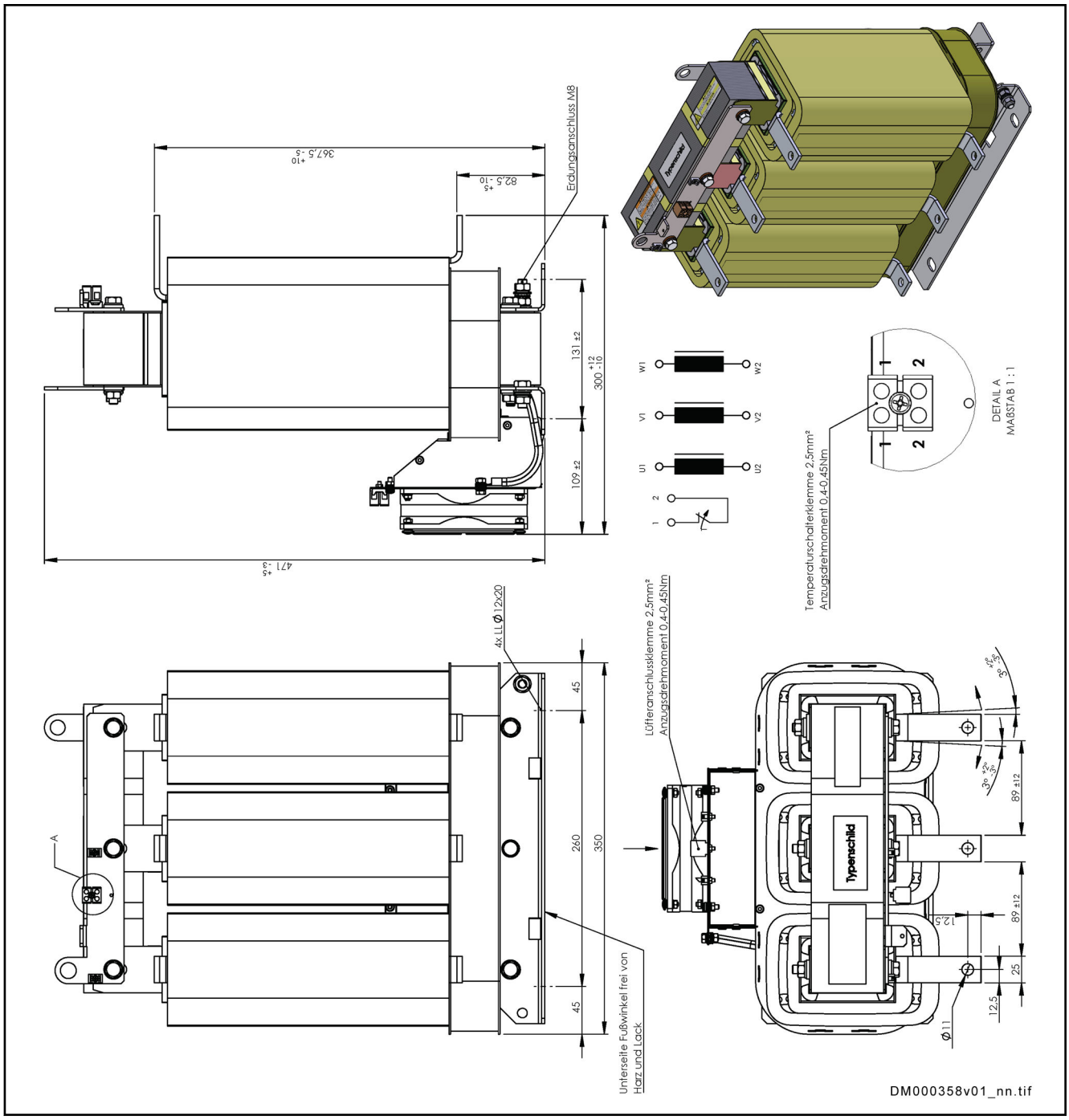


Fig. 8-30: HNL05.1R-0219-N0262-N-A4-NNNW

HNL05.1R-0135-N0327-N-A4-NNNW

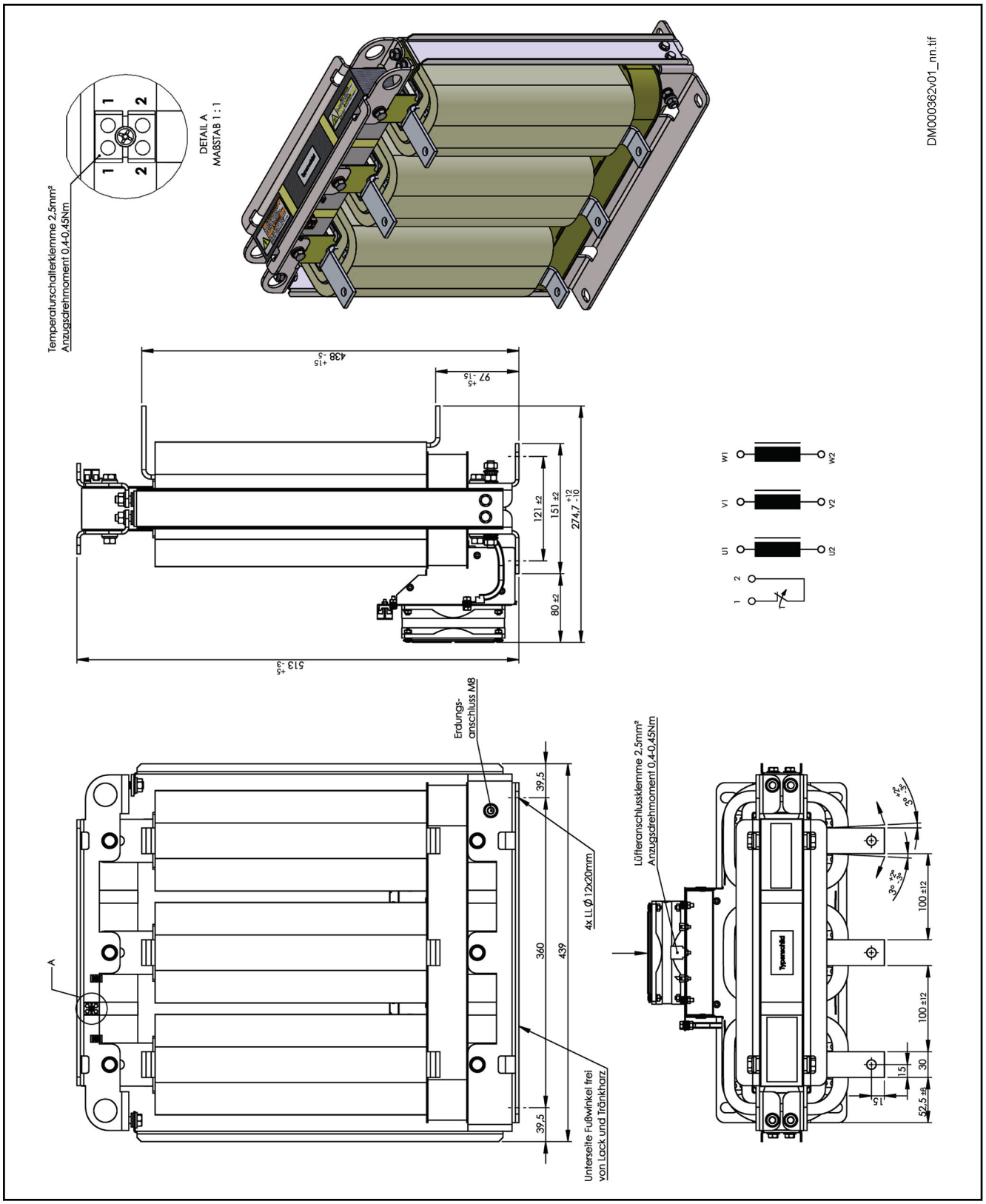


Fig. 8-31: HNL05.1R-0135-N0327-N-A4-NNNW

HNL05.1R-0135-N0327-N-A4-NNNF

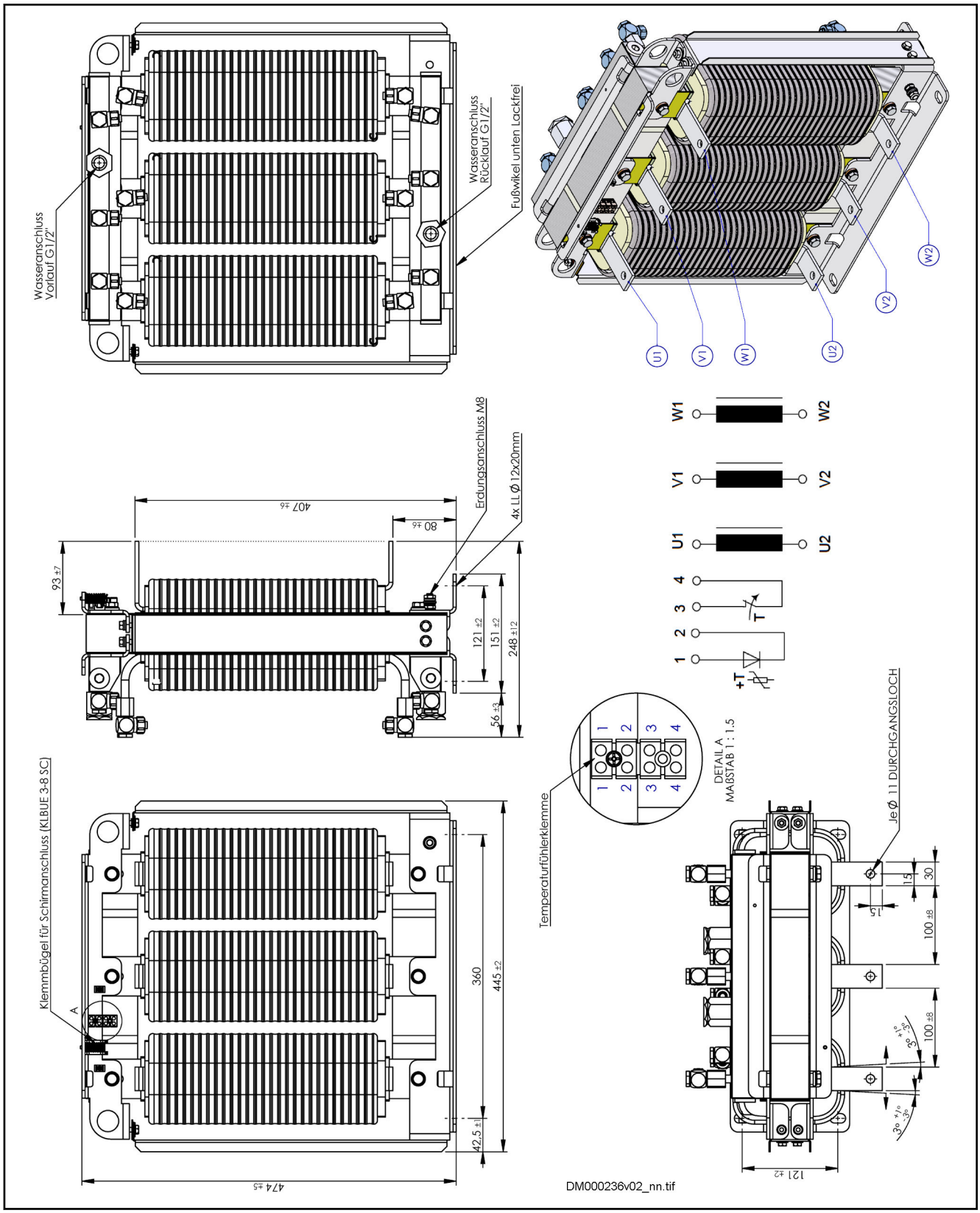


Fig. 8-32: HNL05.1R-0135-N0327-N-A4-NNNF

HNL05.1R-0045-N0327-N-A4-NNNN

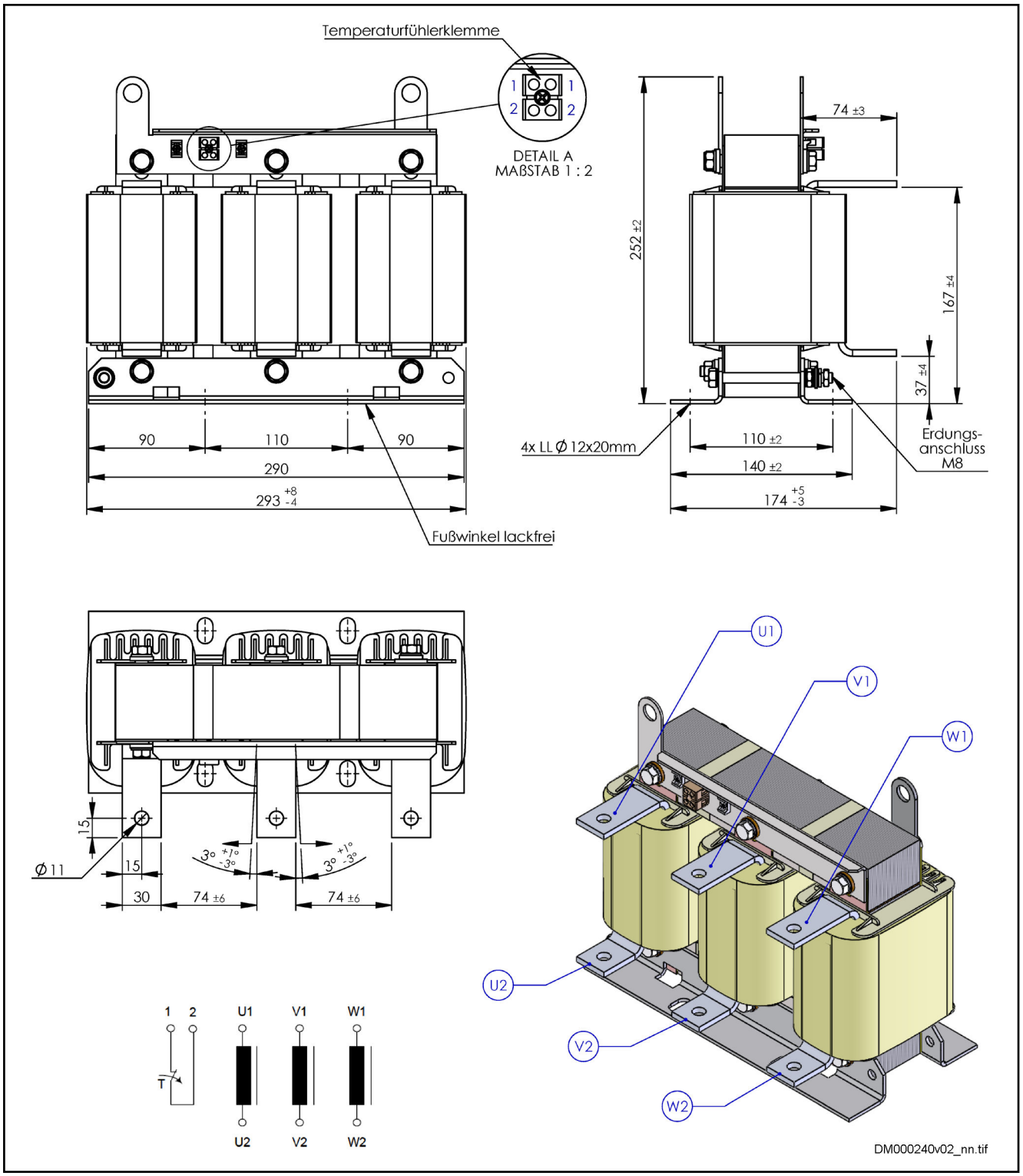


Fig. 8-33: HNL05.1R-0045-N0327-N-A4-NNNN

HNL05.1R-0054-N0409-N-A4-NNNN

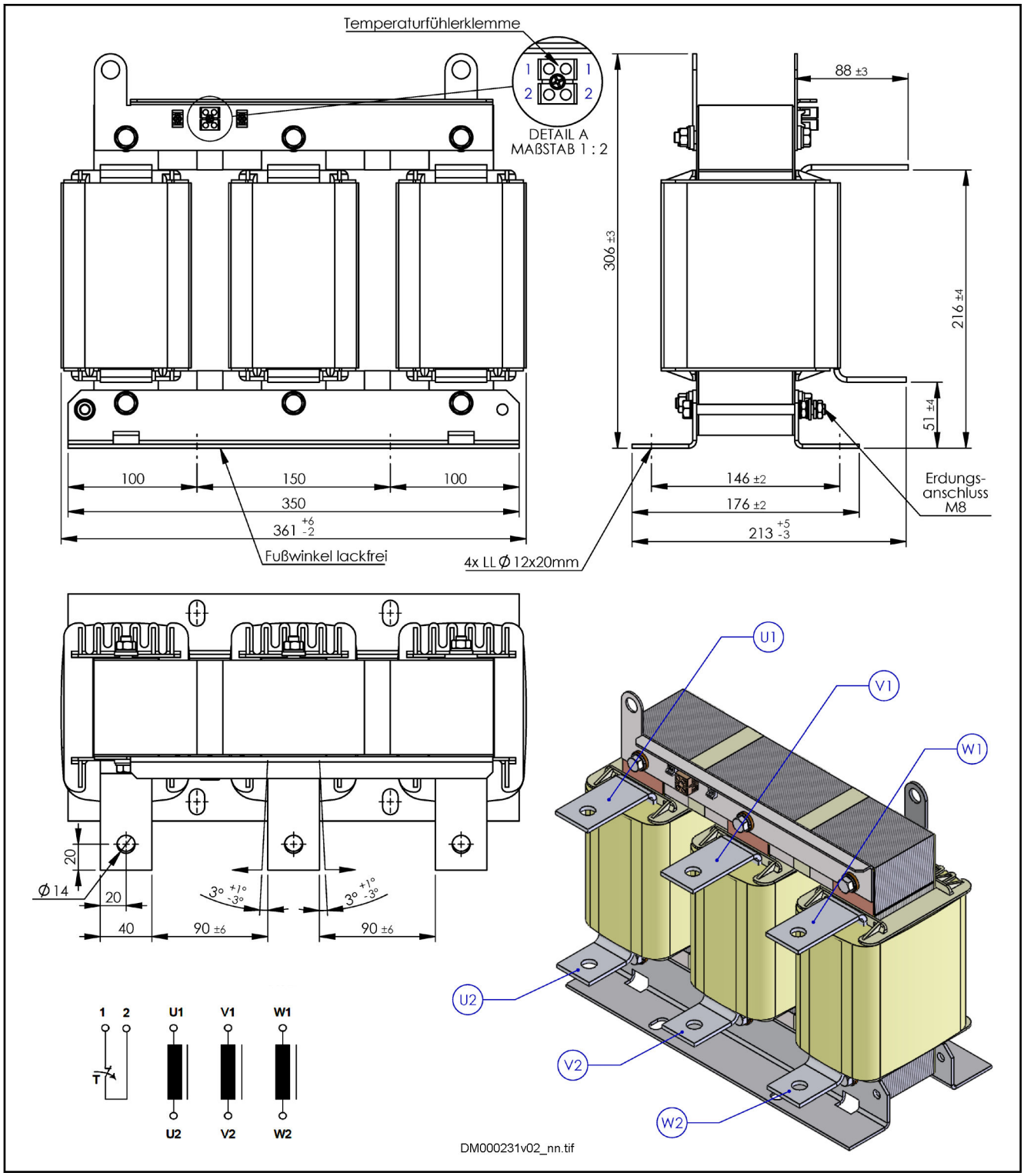


Fig. 8-34: HNL05.1R-0054-N0409-N-A4-NNNN

HNL05.1R-0117-N0409-N-A4-NNNW

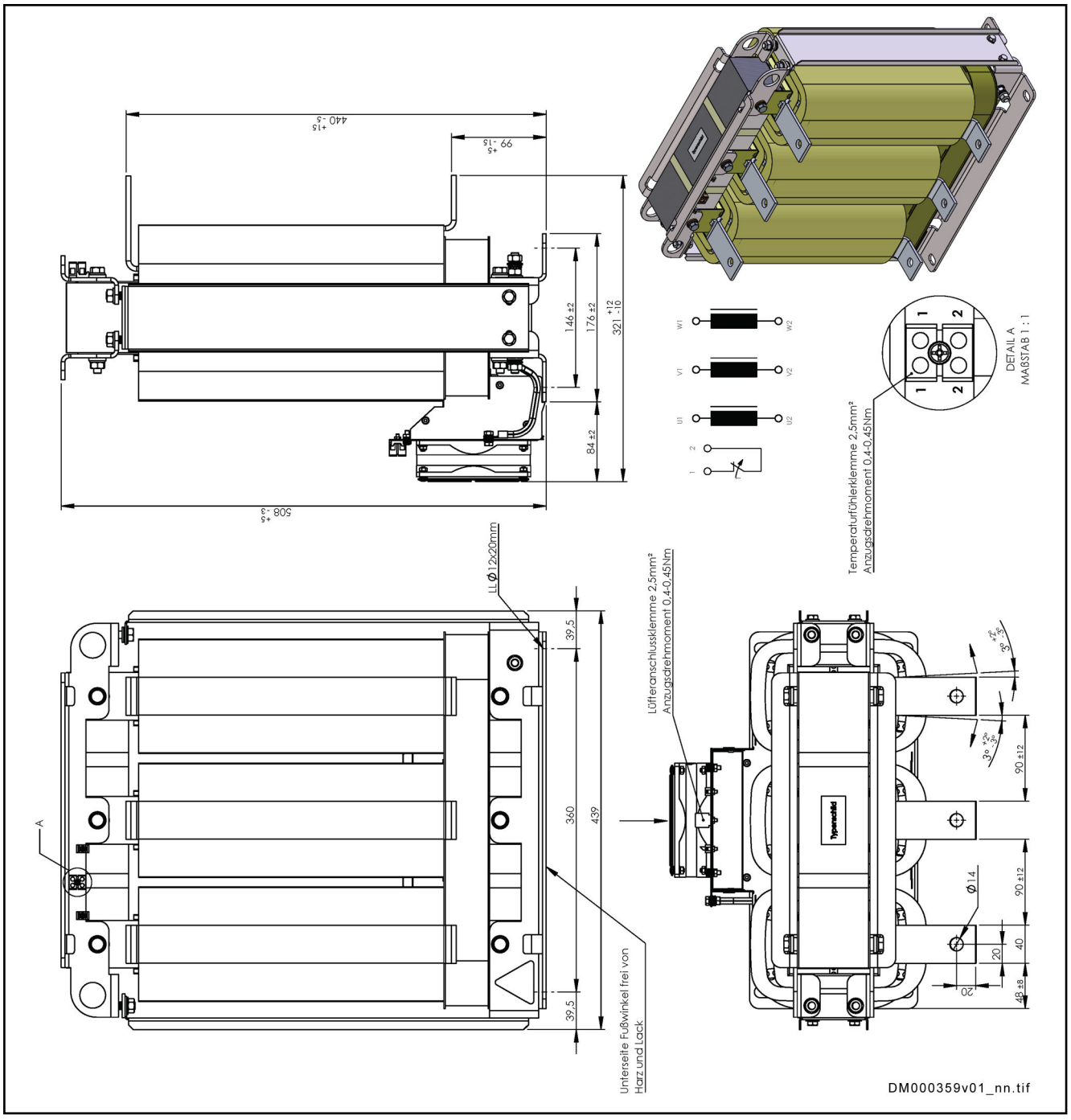


Fig. 8-35: HNL05.1R-0117-N0409-N-A4-NNNW

HNL05.1R-0117-N0409-N-A4-NNNF

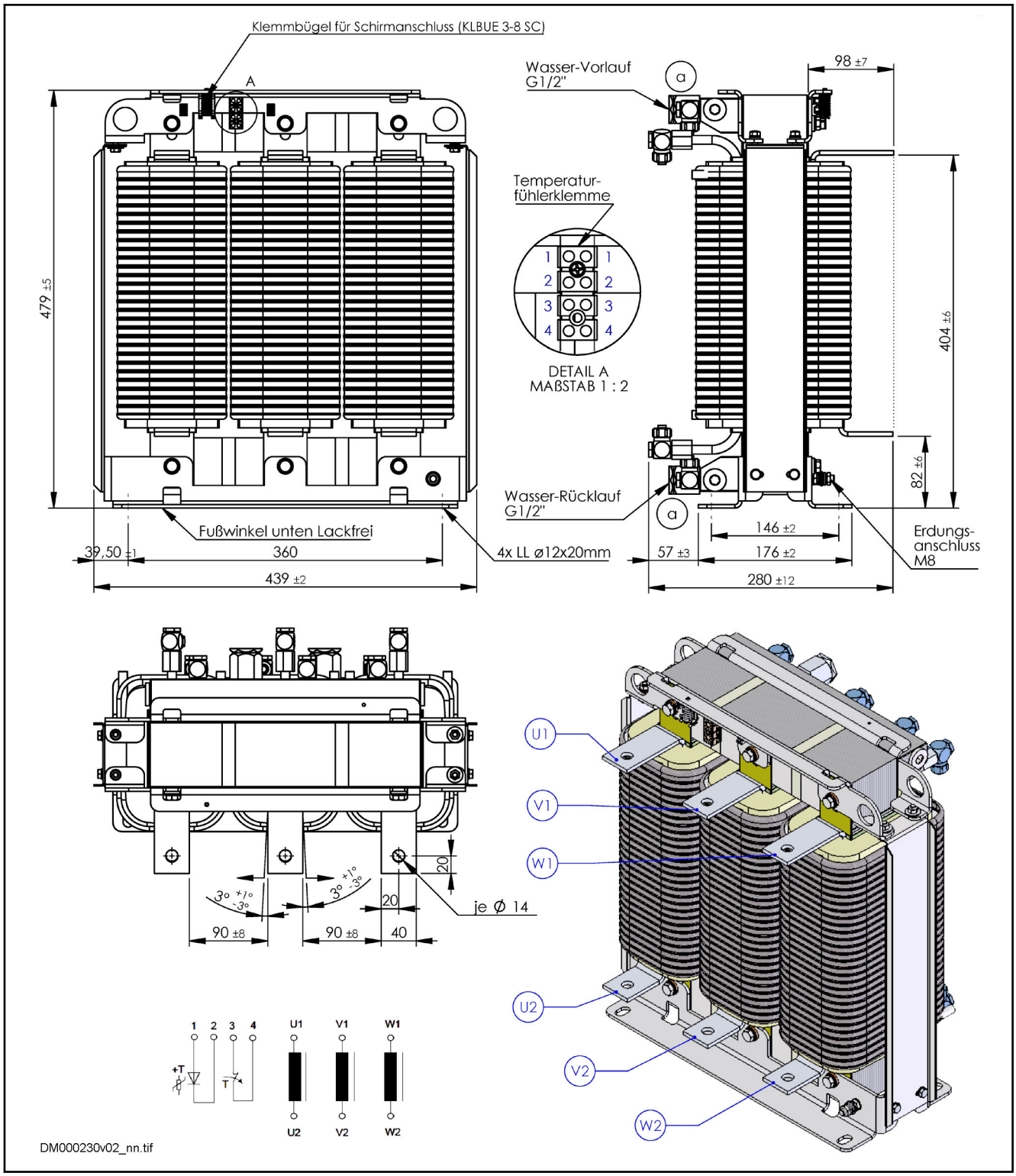


Fig. 8-36: HNL05.1R-0117-N0409-N-A4-NNNF

HNL05.1R-0043-N0514-N-A4-NNNN

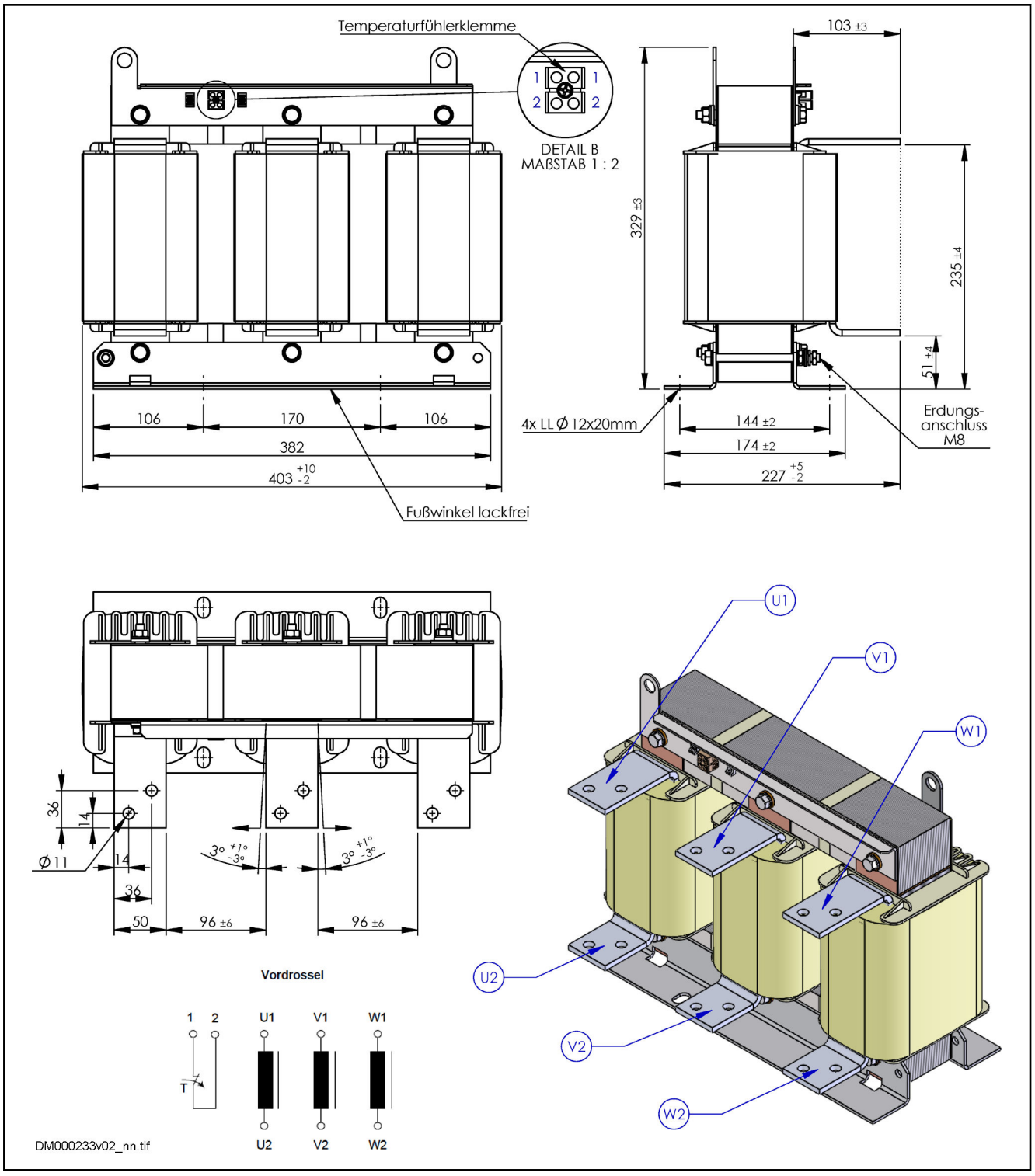


Fig. 8-37: HNL05.1R-0043-N0514-N-A4-NNNN

HNL05.1R-0130-N0514-N-A4-NNNW

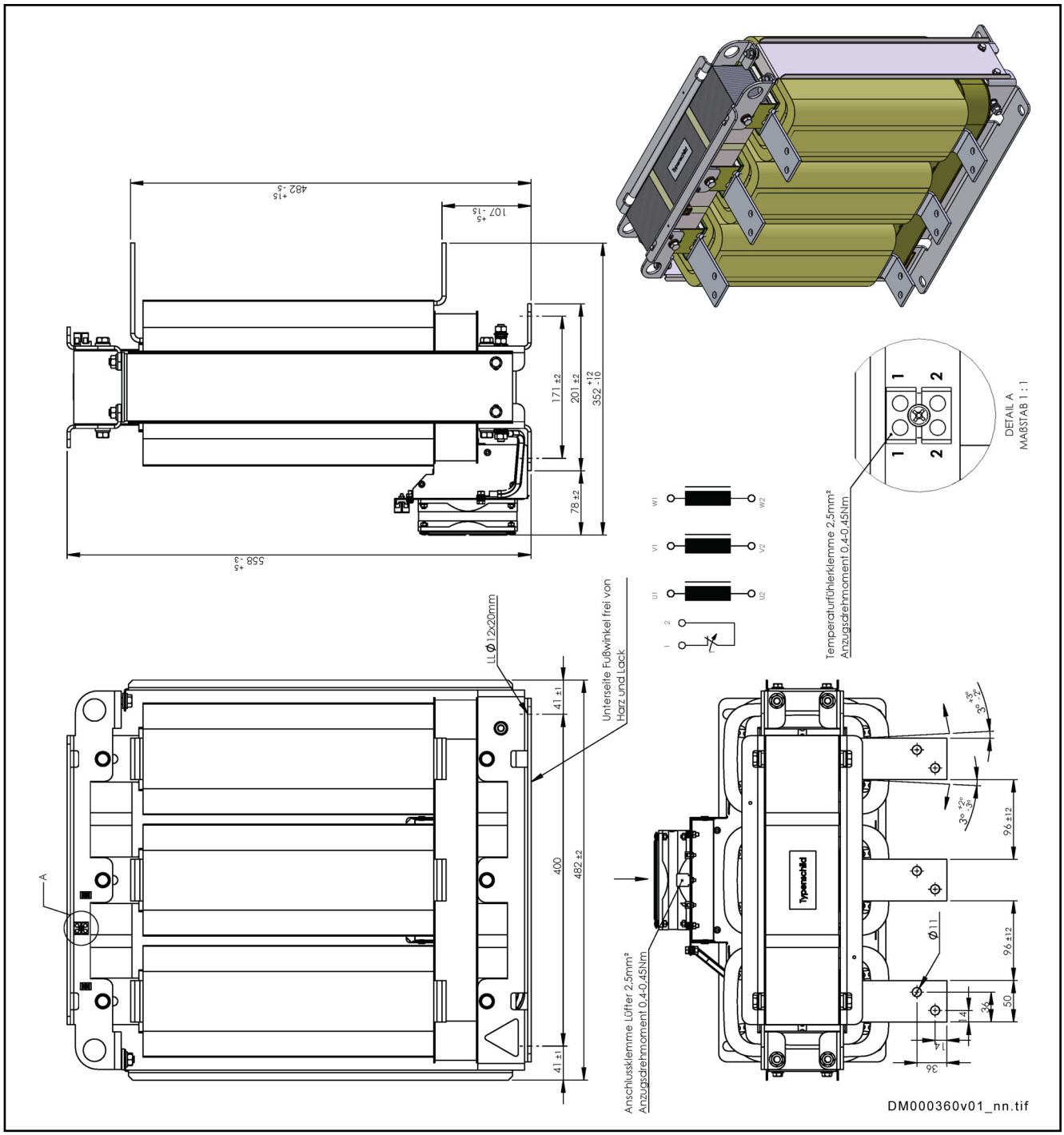


Fig. 8-38: HNL05.1R-0130-N0514-N-A4-NNNW

HNL05.1R-0130-N0514-N-A4-NNNF

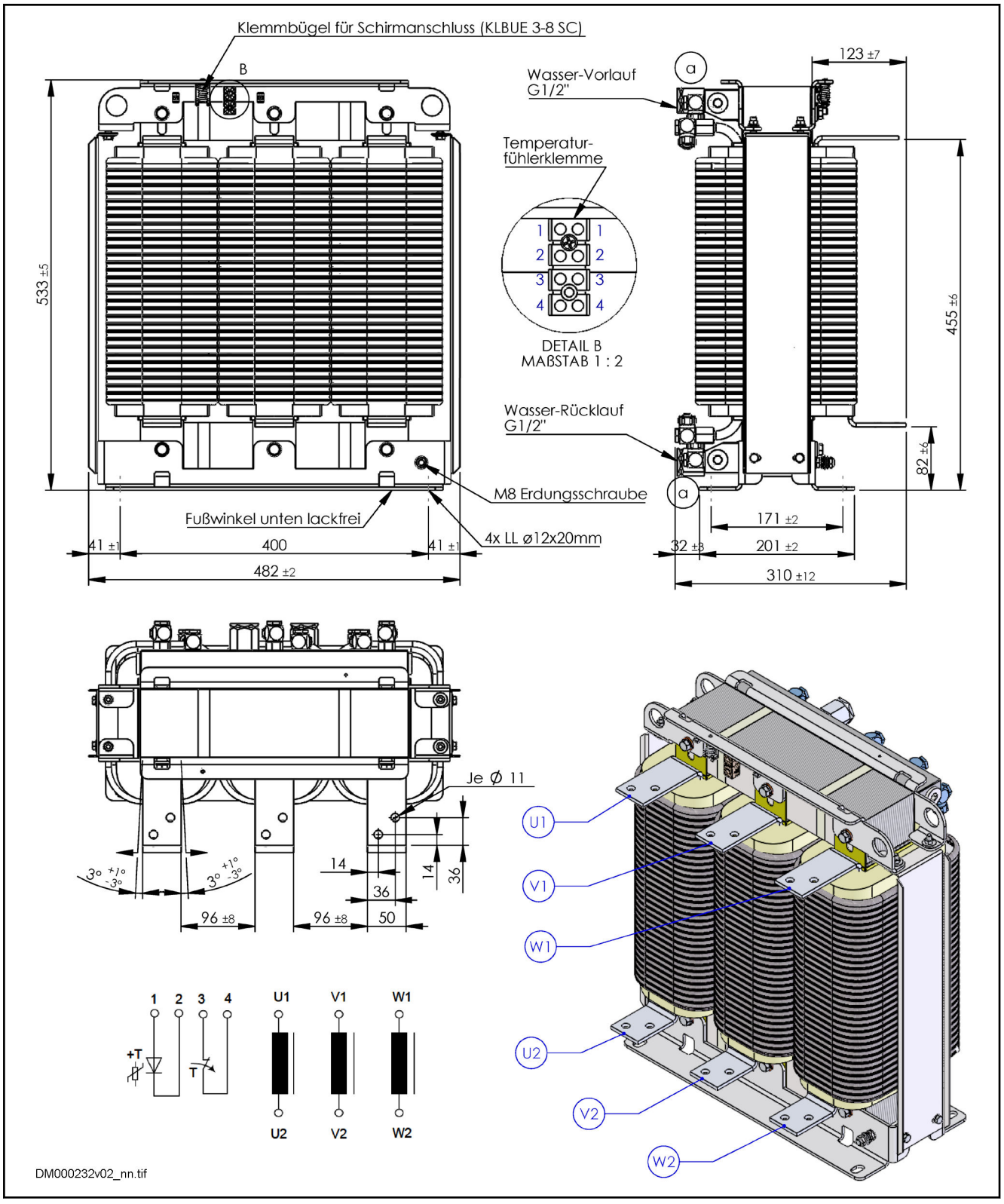


Fig. 8-39: HNL05.1R-0130-N0514-N-A4-NNNF

HNL05.1R-0050-N0652-N-A4-NNNN

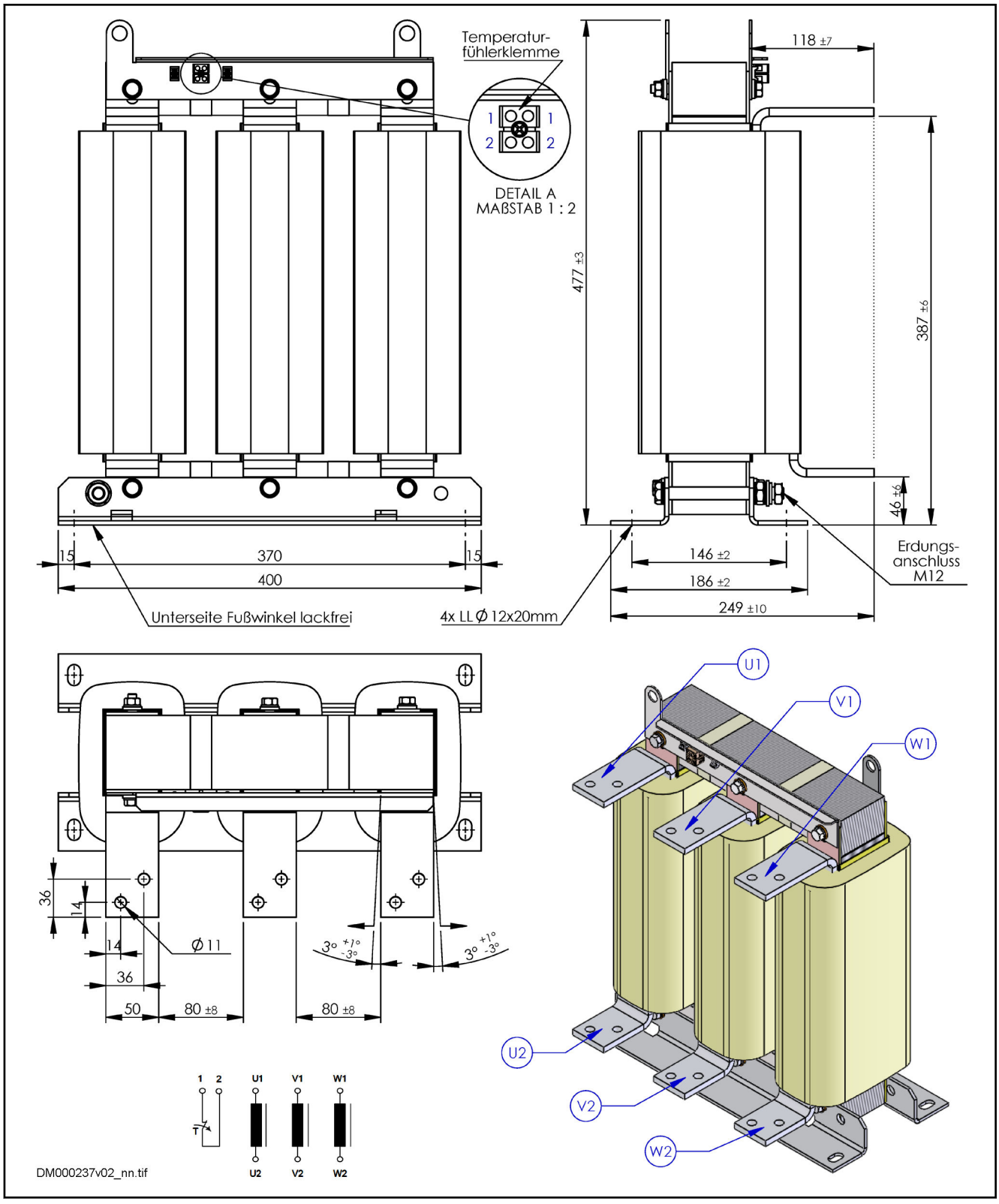


Fig. 8-40: HNL05.1R-0050-N0652-N-A4-NNNN

HNL05.1R-0113-N0652-N-A4-NNNF

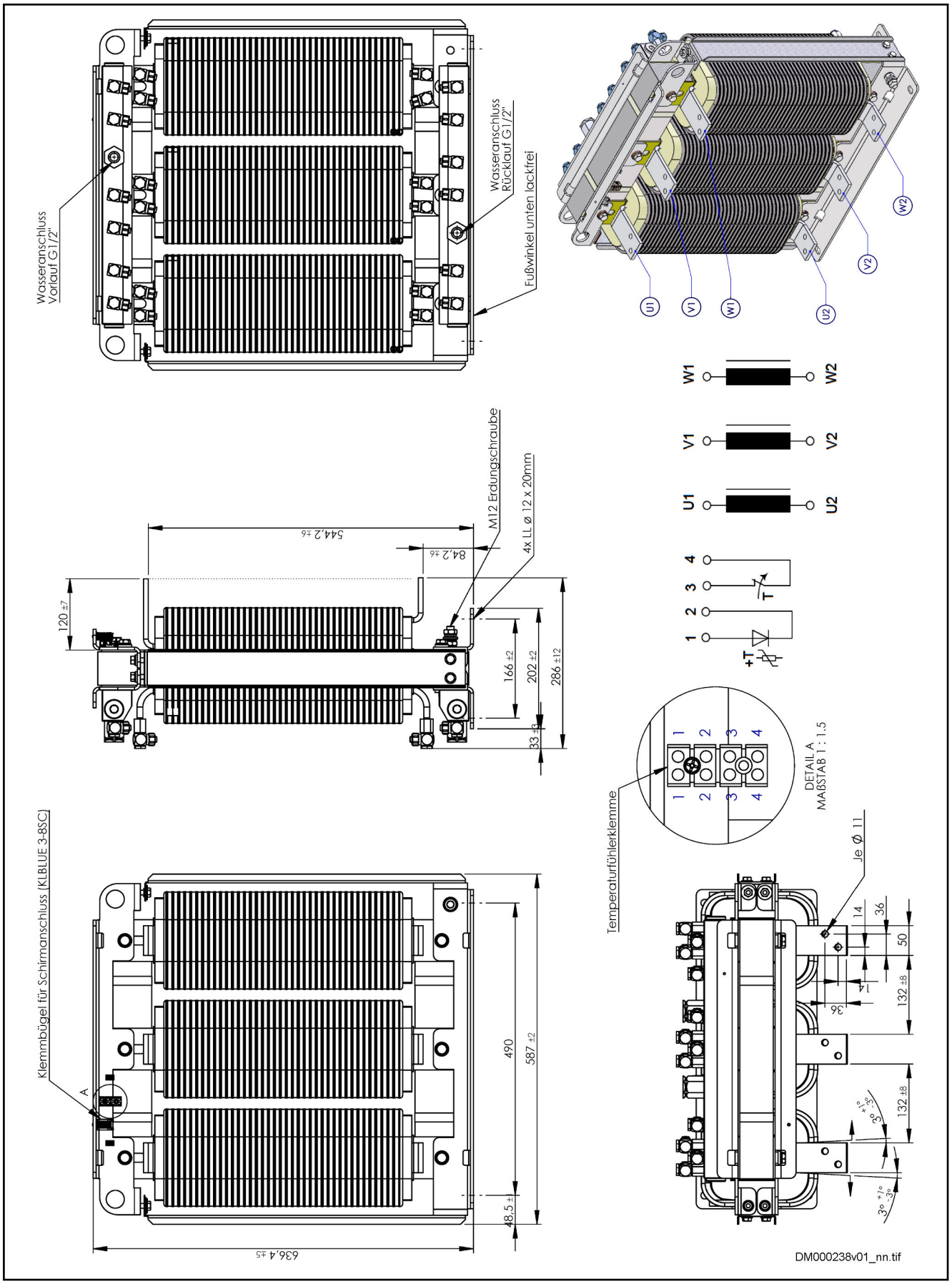


Fig. 8-41: HNL05.1R-0113-N0652-N-A4-NNNF

HNL05.1R-0040-N0811-N-A4-NNNN

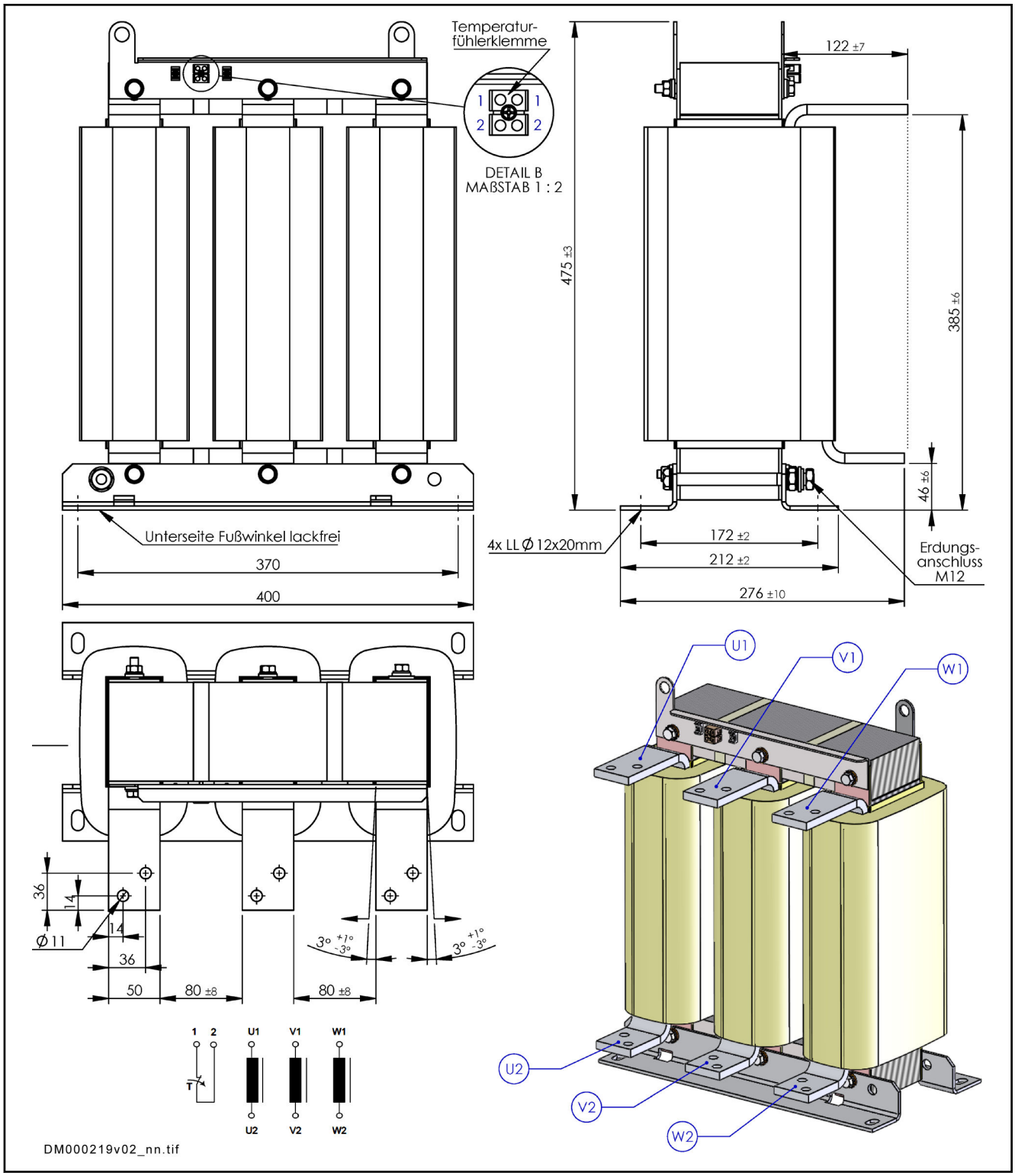


Fig. 8-42: HNL05.1R-0040-N0811-N-A4-NNNN

HNL05.1R-0100-N0811-N-A4-NNNF

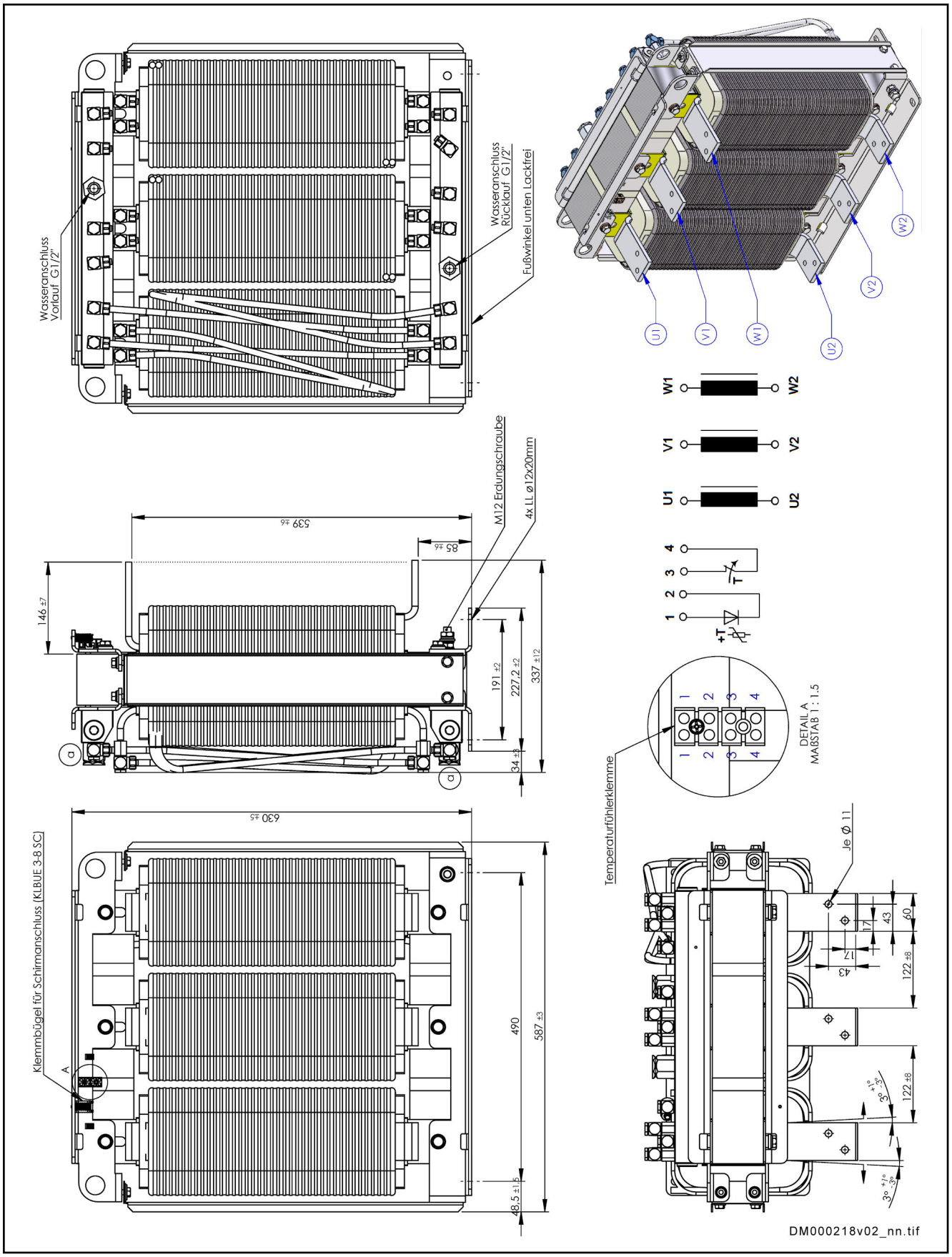


Fig. 8-43: HNL05.1R-0100-N0811-N-A4-NNNF

Dimensions HNL05.1R-…-A5

HNL05.1R-0649-N0127-N-A5-NNNF

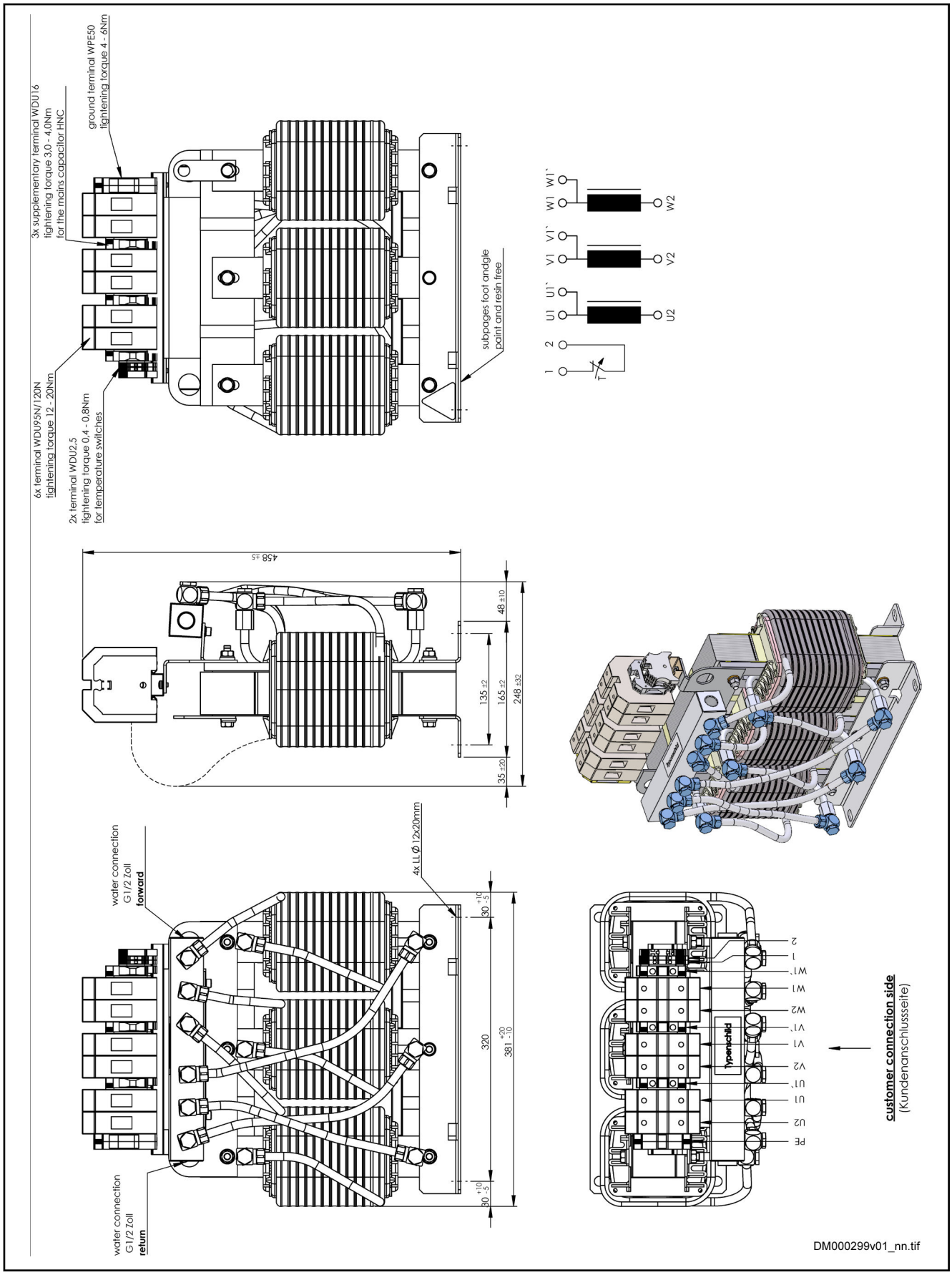


Fig. 8-44: HNL05.1R-0649-N0127-N-A5-NNNF

HNL05.1R-0125-N0152-N-A5-NNNN

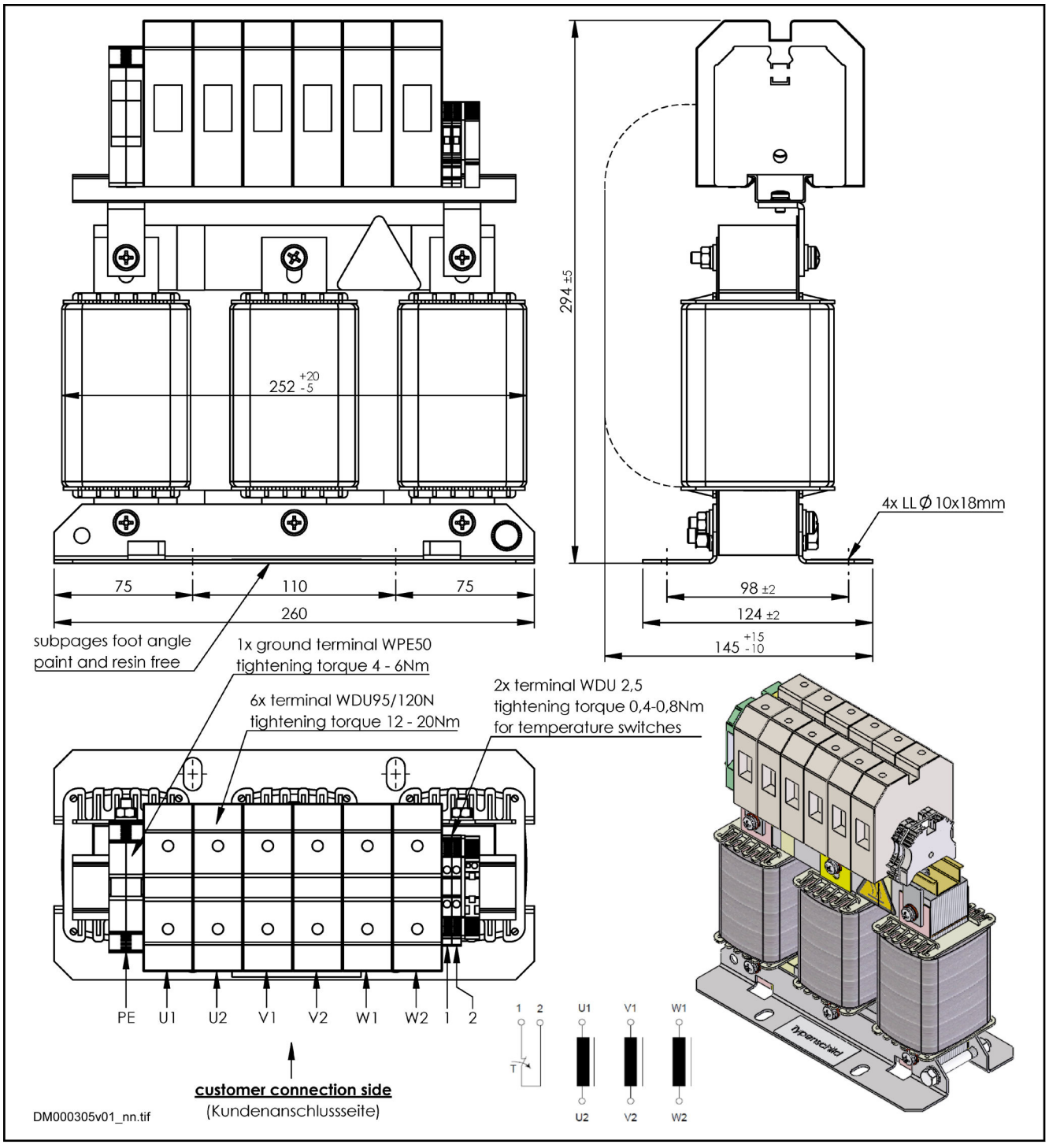


Fig. 8-45: HNL05.1R-0125-N0152-N-A5-NNNN

HNL05.1R-0542-N0152-N-A5-NNNF

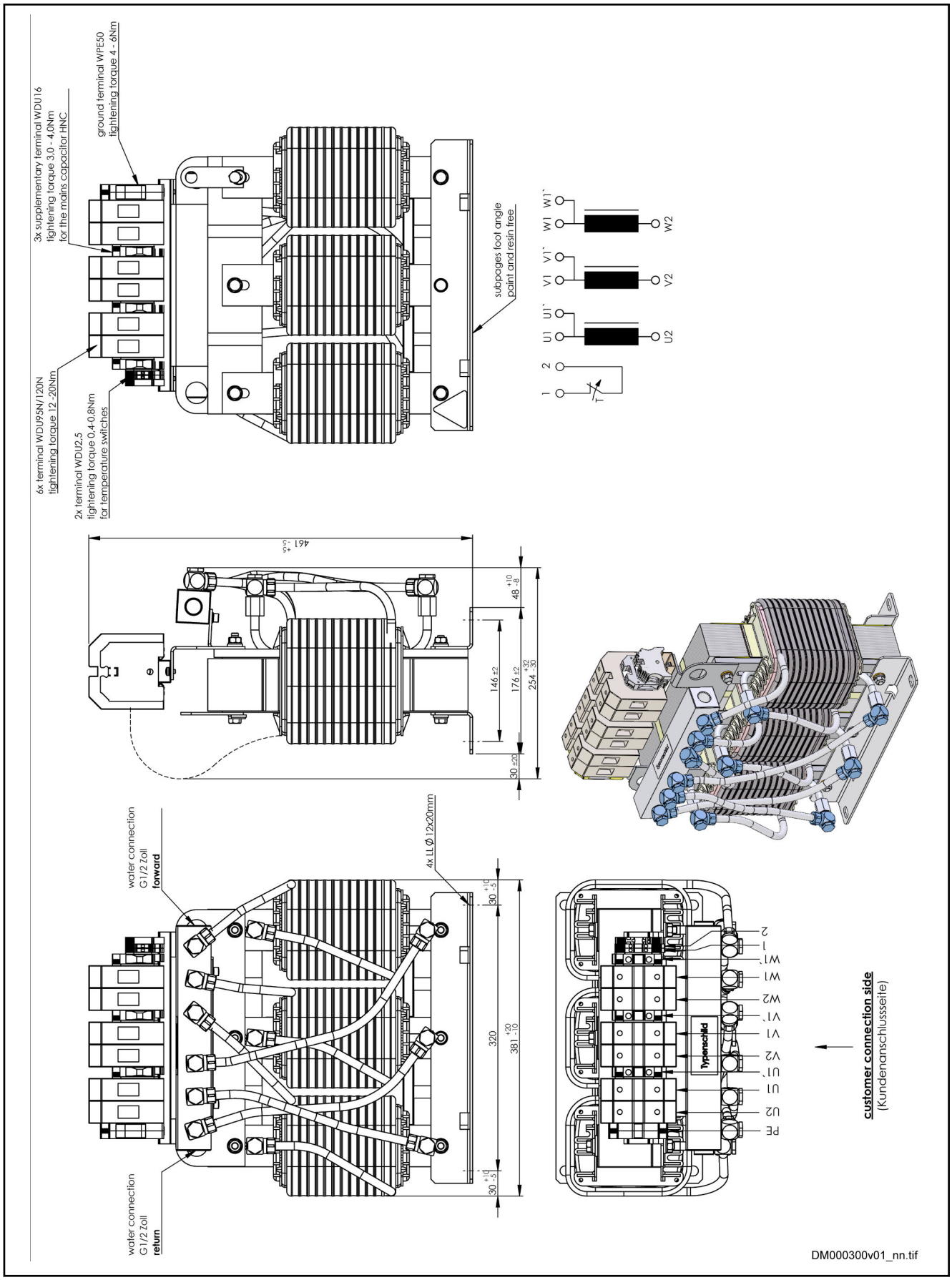


Fig. 8-46: HNL05.1R-0542-N0152-N-A5-NNNF

HNL05.1R-0100-N0190-N-A5-NNNN

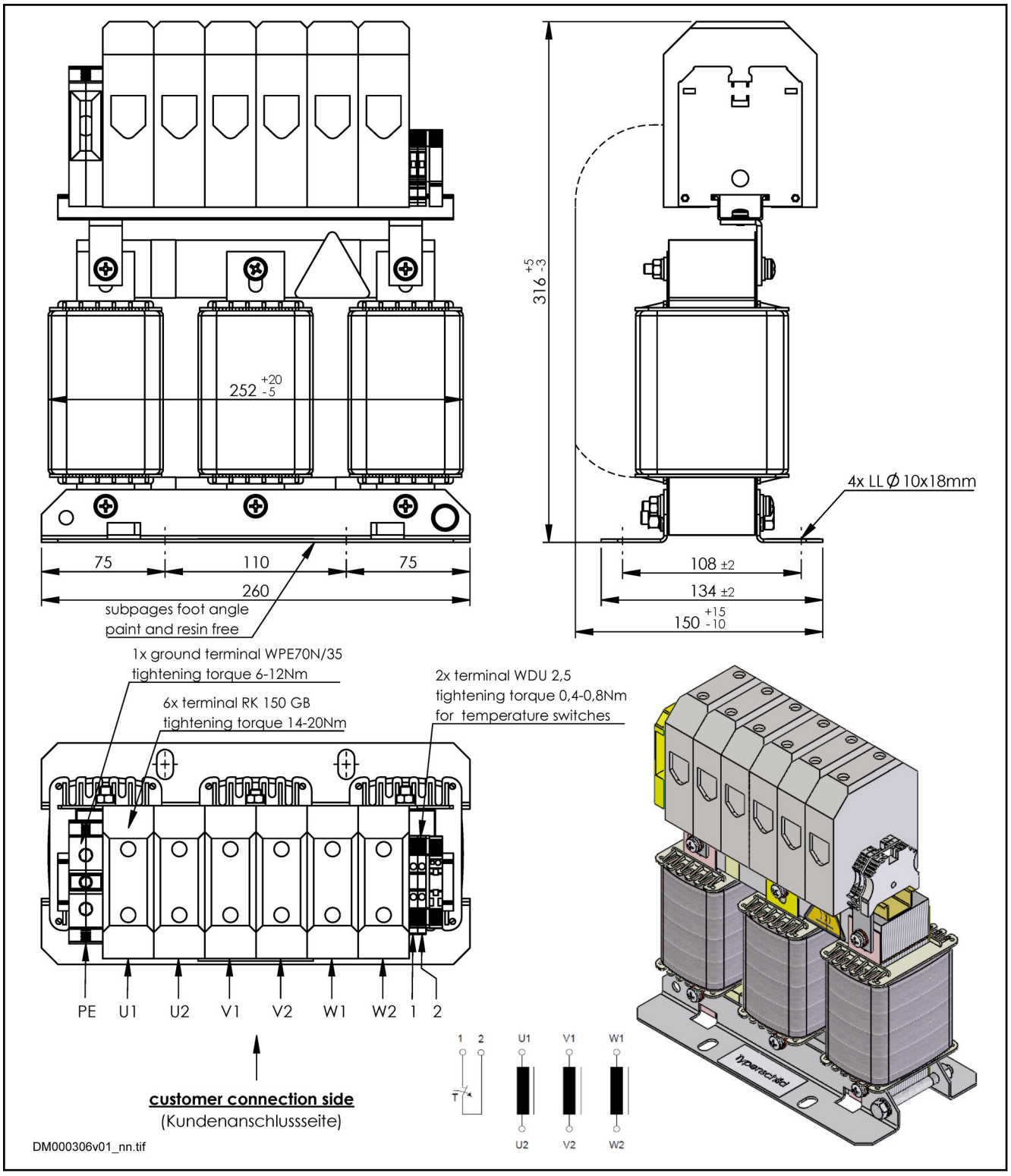


Fig. 8-47: HNL05.1R-0100-N0190-N-A5-NNNN

HNL05.1R-0434-N0190-N-A5-NNNF

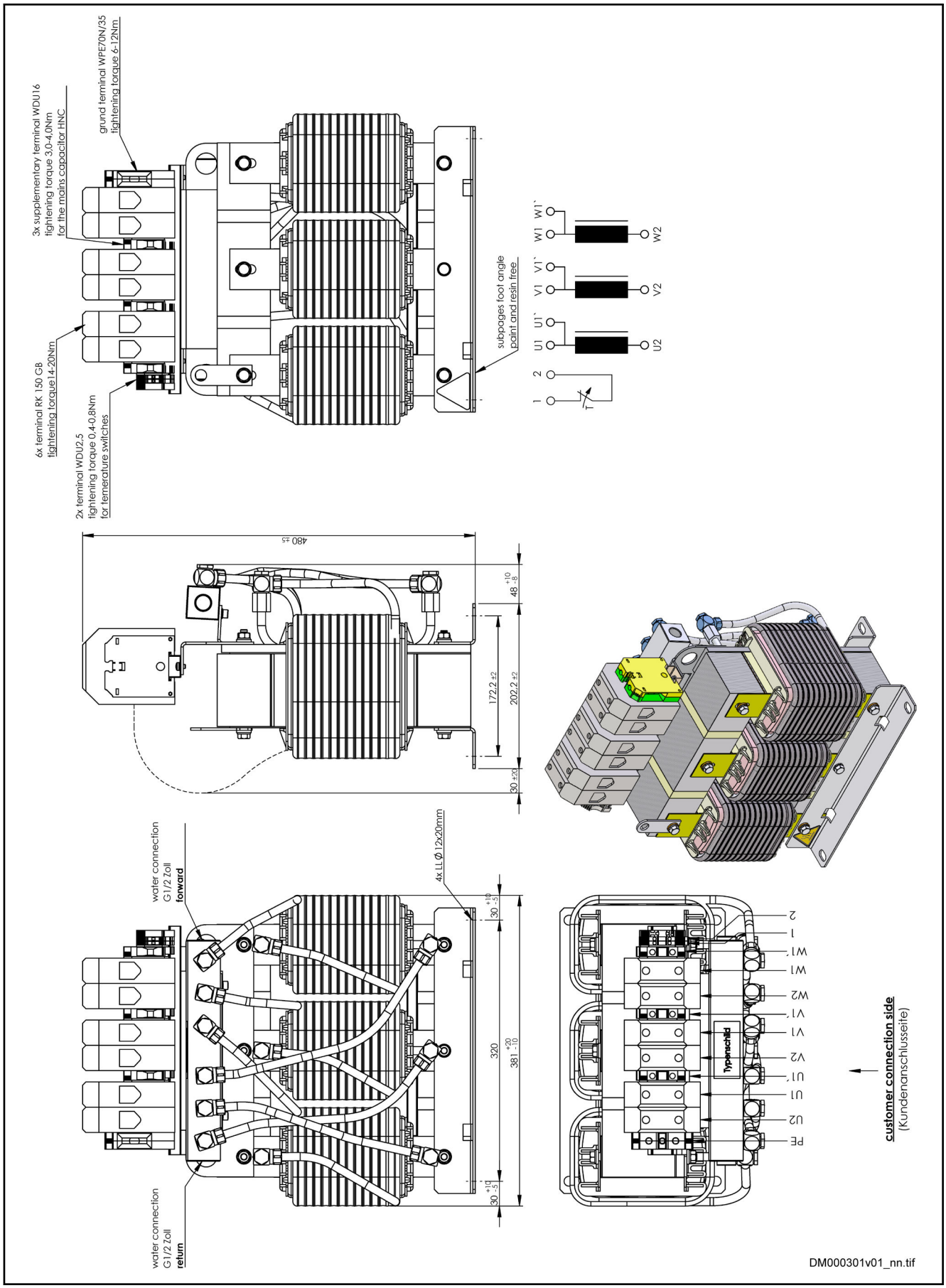


Fig. 8-48: HNL05.1R-0434-N0190-N-A5-NNNF

HNL05.1R-0080-N0238-N-A5-NNNN

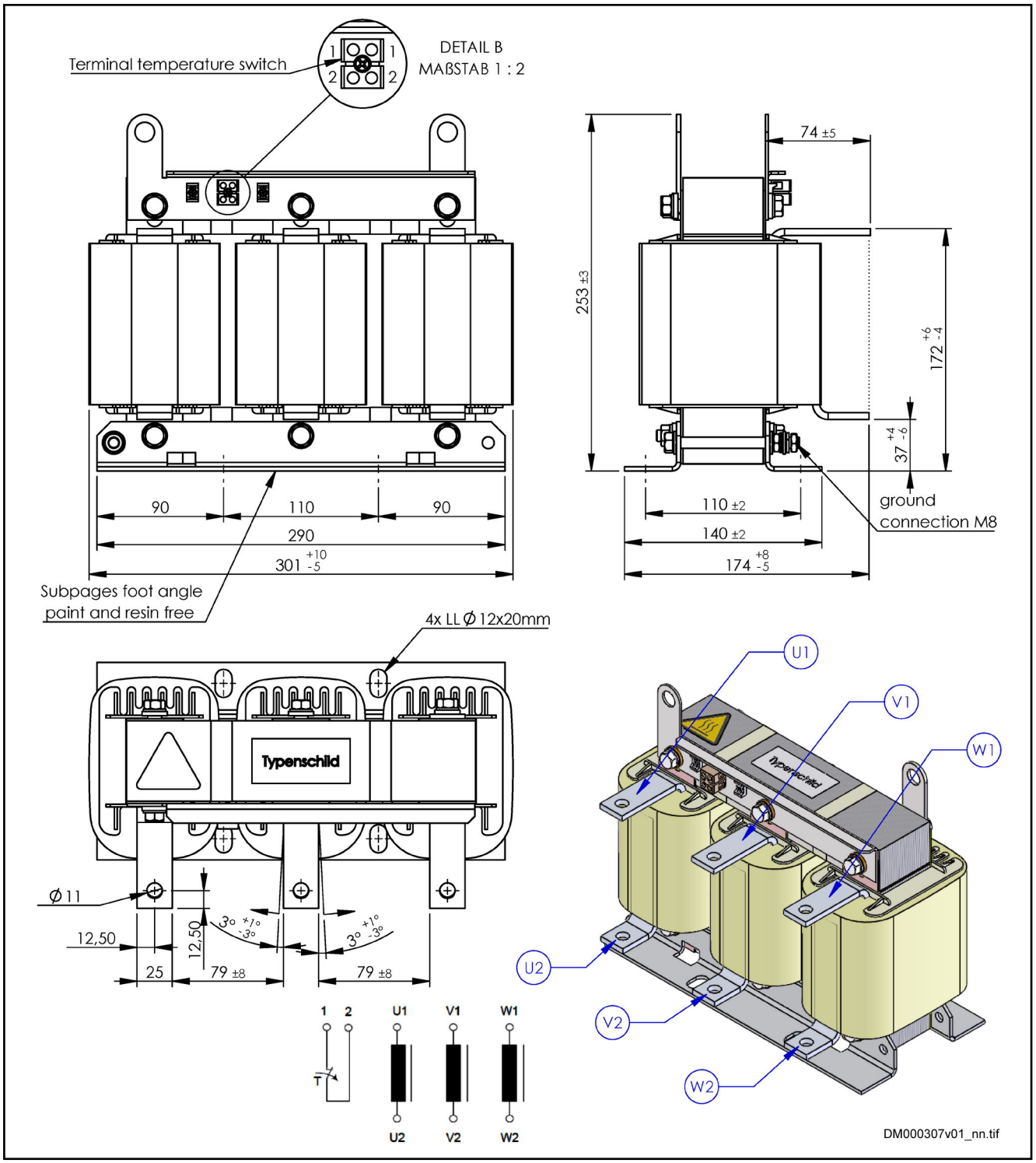


Fig. 8-49: HNL05.1R-0080-N0238-N-A5-NNNN

HNL05.1R-0346-N0238-N-A5-NNNF

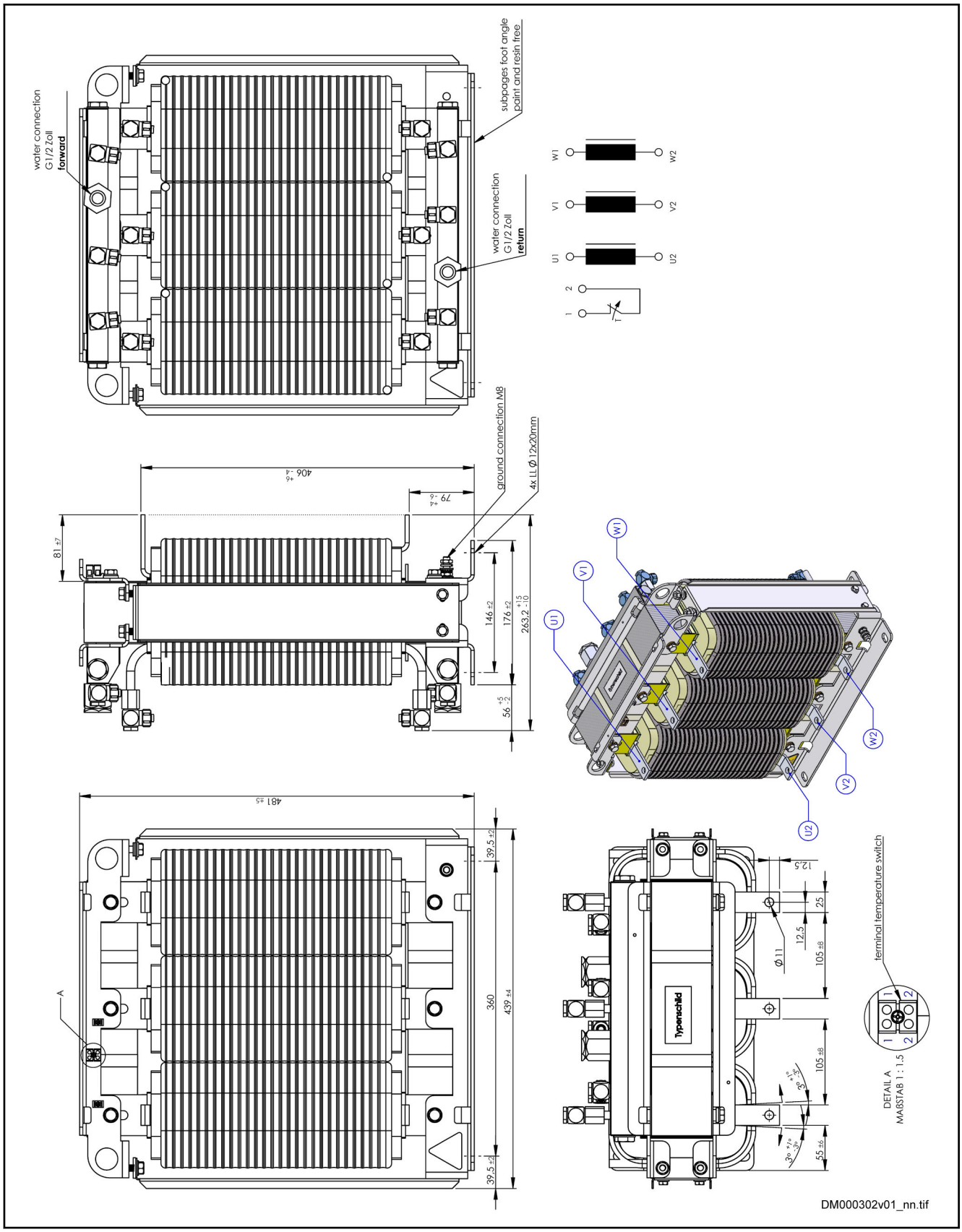


Fig. 8-50: HNL05.1R-0346-N0238-N-A5-NNNF

HNL05.1R-0054-N0352-N-A5-NNNN

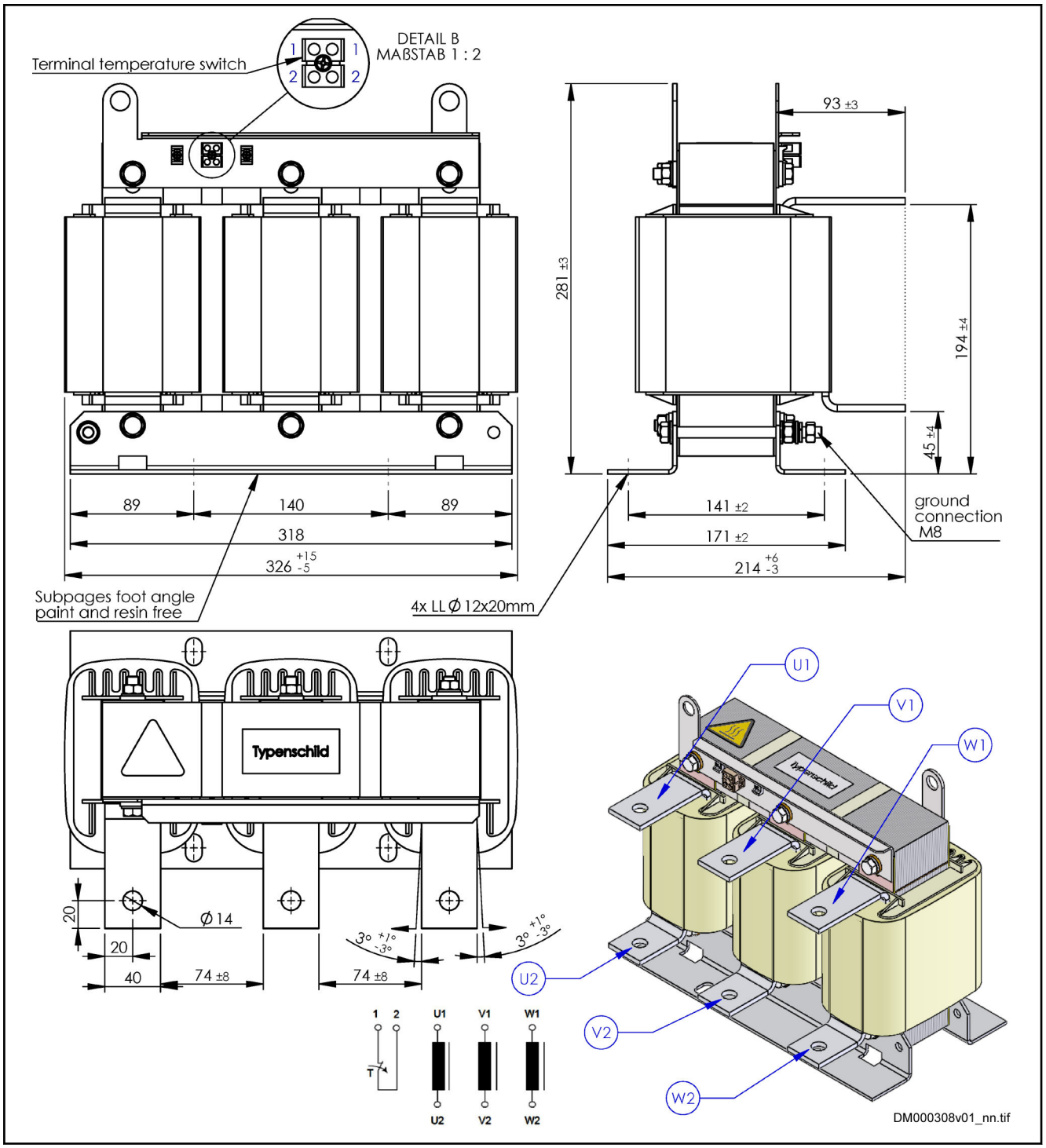


Fig. 8-51: HNL05.1R-0054-N0352-N-A5-NNNN

HNL05.1R-0040-N0471-N-A5-NNNN

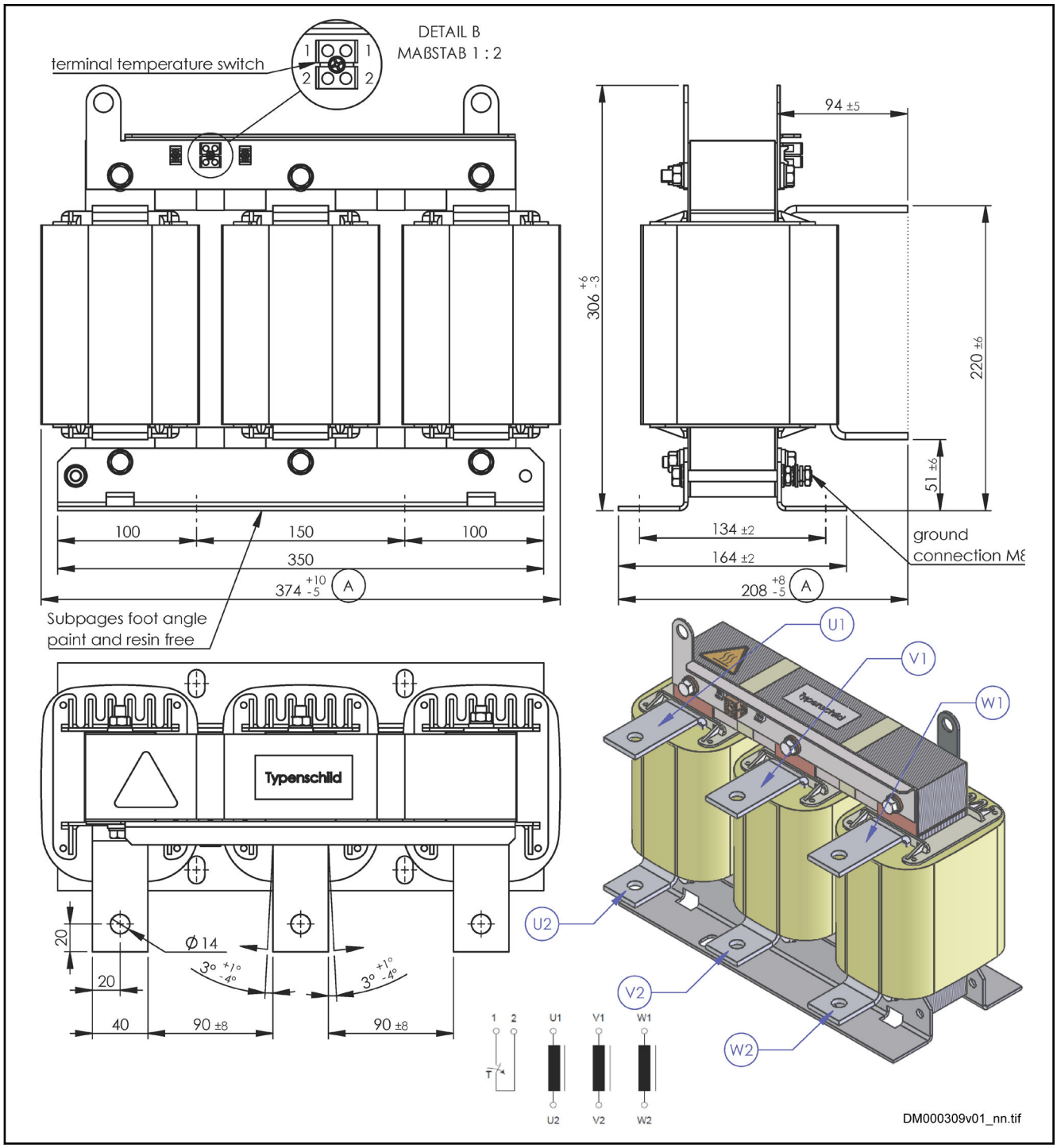


Fig. 8-52: HNL05.1R-0040-N0471-N-A5-NNNN

HNL05.1R-0175-N0471-N-A5-NNNF

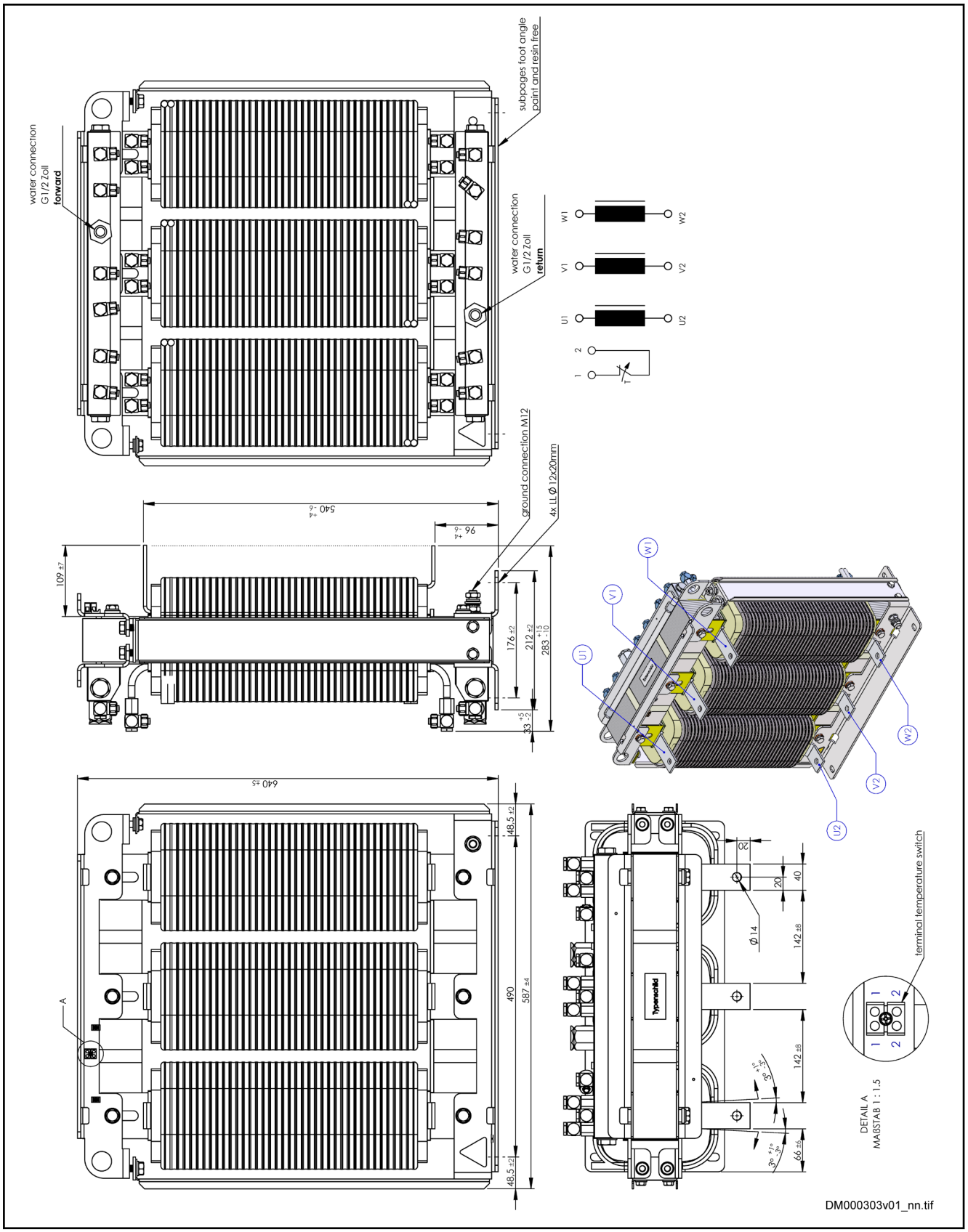


Fig. 8-53: HNL05.1R-0175-N0471-N-A5-NNNF

Data

HNL05.1R-…-A4	Use [4]	Inductance [µH]	Nominal current [A]	u_k [%]	Power dissipation [1] [W]		Degree of protection	Max. ambient temperature [2] [°C]	Weight [kg]
					Air	Water			
0219-N0218-…-NNNF [3]	C	219	218	6.5	1000	1000	IP00	40	37
0182-N0262-…-NNNF	C	182	262	6.5	1000	1000	IP00	40	53
0219-N0262-…-NNNW [5]	C	219	262	7.8	2300	-	IP00	40	60
0045-N0327-…-NNNN	V	45	327	2	230	-	IP00	40	21
0135-N0327-…-NNNF	C	135	327	6	900	1700	IP00	40	58
0135-N0327-…-NNNW [5]	C	135	327	6	2200	-	IP00	40	65
0054-N0409-…-NNNN	V	54	409	3	350	-	IP00	40	40
0117-N0409-…-NNNF	C	117	409	6.5	1200	2000	IP00	40	82
0117-N0409-…-NNNW [5]	C	117	409	6.5	2500	-	IP00	40	90
0043-N0514-…-NNNN	V	43	514	3	400	-	IP00	40	50
0130-N0514-…-NNNF	C	130	514	9.1	1350	2400	IP00	40	116
0130-N0514-…-NNNW [5]	C	130	514	9.1	3000	-	IP00	40	120
0050-N0652-…-NNNN	V	50	652	4.4	560	-	IP00	40	70
0113-N0652-…-NNNF	C	113	652	10	1500	2700	IP00	40	150
0040-N0811-…-NNNN	V	40	811	4.4	620	-	IP00	40	85
0100-N0811-…-NNNF	C	100	811	11	1650	3000	IP00	40	180

1) The air/water distribution was determined at an ambient temperature of 30 °C and a water inlet temperature of 50 °C

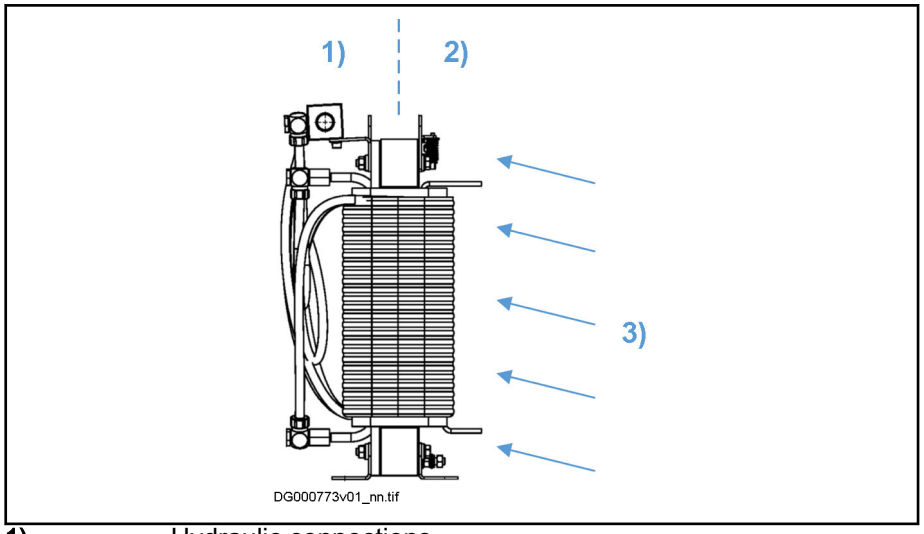
2) With current derating up to 55 °C

3) If leakage capacitance > 250 nF and clock frequency of the axes > 2 kHz and operation without DC bus choke: Additional cooling of the choke through forced convection on the side of the electrical connection necessary (see fig. 8-54 "Forced convection" on page 259)

4) C: Chopper choke; V: Preconnected choke

5) Fan, power supply 24 V DC ±10%; 300 mA

Tab. 8-50: HNL05.1R-…-A4, data



1) Hydraulic connections
2) Electrical connections
3) Air flow ≥ 3 m/s; reference level: 10 cm from the front edge of the choke

Fig. 8-54: Forced convection

HNL05.1R-…-A5	Use [3]	Inductance [µH]	Nominal current [A]	u_k [%]	Power dissipation [1] [W]		Degree of protection	Max. ambient temperature [2] [°C]	Weight [kg]
					Air	Water			
0649-N0127	C	649	127	6.5	1000	1000	IP00	40	50
0125-N0152	V	125	152	1.5	180	-	IP00	40	17
0542-N0152	C	542	152	6.5	1000	1000	IP00	40	60
0100-N0190	V	100	190	1.5	180	-	IP00	40	25
0434-N0190	C	434	190	6.5	1100	1100	IP00	40	75
0080-N0238	V	80	238	1.5	260	-	IP00	40	25
0346-N0238	C	346	238	6.5	1300	1400	IP00	40	85
0054-N0352	V	54	352	1.5	350	-	IP00	40	35
0234-N0352	C	234	352	6.5	1300	1900	IP00	40	110
0040-N0471	V	40	471	1.5	430	-	IP00	40	40
0175-N0471	C	175	471	6.5	1500	2300	IP00	40	160

1) The air/water distribution was determined at an ambient temperature of 30 °C and a water inlet temperature of 50 °C
2) With current derating up to 55 °C
3) C: Chopper choke; V: Preconnected choke

Tab. 8-51: HNL05.1R-…-A5, data

Temperature monitoring contact

- Trigger temperature: 160 °C
- N/C in one of the windings
- Electric switching capacity:
  - 1 A
  - AC 250 V
  - DC 24 V

Semiconductor temperature sensor (only for HNL05.1R-…-A4-NNNF)

- KTY84/130 (in medium winding)
- not connected (only for service or commissioning)
- connected to temperature sensor terminal block; shield clamp spring

Water cooling

Requirements

- maximum ambient temperature: 40 °C (with derating: 55 °C)
- maximum water inlet temperature: 60 °C
- maximum operating pressure: 4 bar

HNL05.1R-…-A4	Flow [l/min]	Filling capacity [l]	Pressure drop [bar]				
			5 l/min	6 l/min	7 l/min	8 l/min	9 l/min
0219-N0218	≥ 6	1.3	0.14	0.20	0.27	0.34	0.42
0182-N0262	≥ 6	1.5	0.15	0.22	0.29	0.37	0.46
0135-N0327	≥ 6	1.6	0.17	0.24	0.32	0.41	0.51
0117-N0409	≥ 6	2.0	0.21	0.29	0.39	0.49	0.62
0130-N0514	≥ 6	2.5	0.24	0.33	0.44	0.58	0.75
0113-N0652	≥ 8	3.4	0.03	0.04	0.06	0.08	0.10
0100-N0811	≥ 8	3.6	0.04	0.05	0.07	0.08	0.10

Tab. 8-52: HNL05.1R-…-A4, water cooling

HNL05.1R-…-A5	Flow [l/min]	Filling capacity [l]	Pressure drop [bar]				
			5 l/min	6 l/min	7 l/min	8 l/min	9 l/min
0649-N0127	≥ 6	0.9	0.07	0.10	0.12	0.15	0.19
0542-N0152	≥ 6	1.0	0.08	0.11	0.14	0.17	0.21
0434-N0190	≥ 6	1.1	0.08	0.11	0.14	0.18	0.23
0346-N0238	≥ 6	2.2	0.15	0.21	0.29	0.36	0.44
0234-N0352	≥ 6	2.6	0.20	0.29	0.38	0.48	0.58
0175-N0471	≥ 8	3.6	0.04	0.05	0.06	0.08	0.09

Tab. 8-53: HNL05.1R-…-A5, water cooling

Mounting

- Allowed mounting position: vertical
- Mount on a stable and highly conductive metal plate over the largest possible surface area to establish a good electrical connection

The components are dimensioned for operation in the control cabinet and may have a sound pressure level > 85 dBA.

When mounting the component outside a closed control cabinet, install a suitable noise protection.

Connection

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

Degree of protection of the component: **IP00**

Mount a **touch guard**!

HNL05.1R-…-A4	Connections
0219-N0218	Aluminum contact point [1)] Hole: 11 mm
0182-N0262	
0045-N0327	
0135-N0327	
0054-N0409	Aluminum contact point [1)] Hole: 14 mm
0117-N0409	
0043-N0514	Aluminum contact point [1)] Hole: 2 × 11 mm
0130-N0514	
0050-N0652	
0113-N0652	
0040-N0811	
0100-N0811	

1) Connection with cupal disks: See chapter 11.6 "Aluminum contact points and cupal disks" on page 613.

Tab. 8-54: HNL05.1R-…-A4, connection points

HNL05.1R-…-A5	Connections
0649-N0127	Screw terminal blocks: 95 mm^2/120 mm^2 Tightening torque: 12 … 20 Nm
0125-N0152	
0542-N0152	
0100-N0190	Screw terminal blocks: 150 mm^2 Tightening torque: 14 … 20 Nm
0434-N0190	
0080-N0238	Aluminum contact point [1)] Hole: 11 mm
0346-N0238	
0054-N0352	Aluminum contact point [1)] Hole: 14 mm
0234-N0352	
0040-N0471	
0175-N0471	

1) Connection with cupal disks: See chapter 11.6 "Aluminum contact points and cupal disks" on page 613.

Tab. 8-55: HNL05.1R-…-A5, connection points

Operation

⚠ CAUTION **Risk of burns and damage due to hot surfaces!**

Chokes become hot during operation.

Before working on the choke, allow it to cool down. Wear protective gloves.

Lead the cables and cooling water hoses to the choke at a sufficient distance. Cables or hoses must not touch the metal frame of the choke.

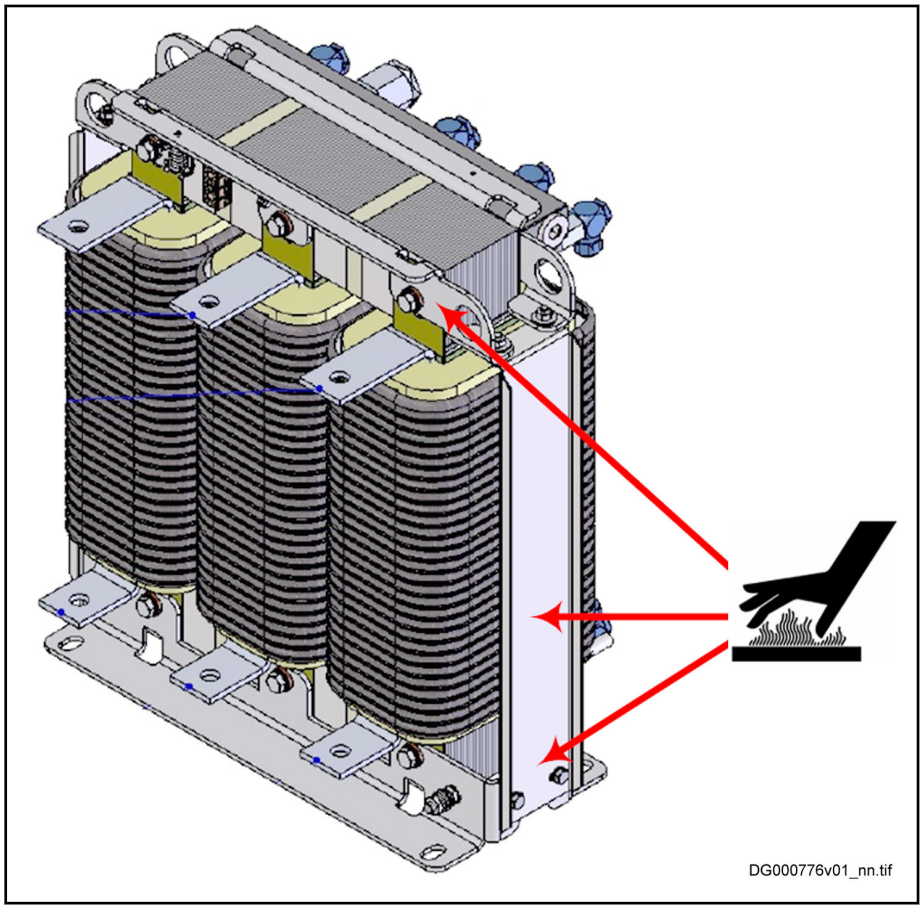


Fig. 8-55: Risk of burns on a choke

Assignment HNL05 to HMU05

See chapter "Combining mains filter, mains choke, preconnected choke and mains capacitor" on page 120.

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. 8-56: HML05, type code

Dimensions

Overview

HML05.1W-…-500

chapter "HML05.1W-D021U-N0254-N-500" on page 266
chapter "HML05.1W-D018U-N0306-N-500" on page 267
chapter "HML05.1W-D014U-N0392-N-500" on page 268
chapter "HML05.1W-D009U-N0490-N-500" on page 269
chapter "HML05.1W-D009U-N0616-N-500" on page 270
chapter "HML05.1W-D007U-N0771-N-500" on page 271
chapter "HML05.1W-D006U-N1002-N-500" on page 272
chapter "HML05.1W-D004U-N1185-N-500" on page 273

HML05.1W-…-690

chapter "HML05.1W-D052U-N0147-N-690" on page 274
chapter "HML05.1W-D043U-N0177-N-690" on page 275
chapter "HML05.1W-D034U-N0227-N-690" on page 276
chapter "HML05.1W-D027U-N0284-N-690" on page 277
chapter "HML05.1W-D020U-N0374-N-690" on page 278
chapter "HML05.1W-D013U-N0581-N-690" on page 279

HML05.1W-D021U-N0254-N-500

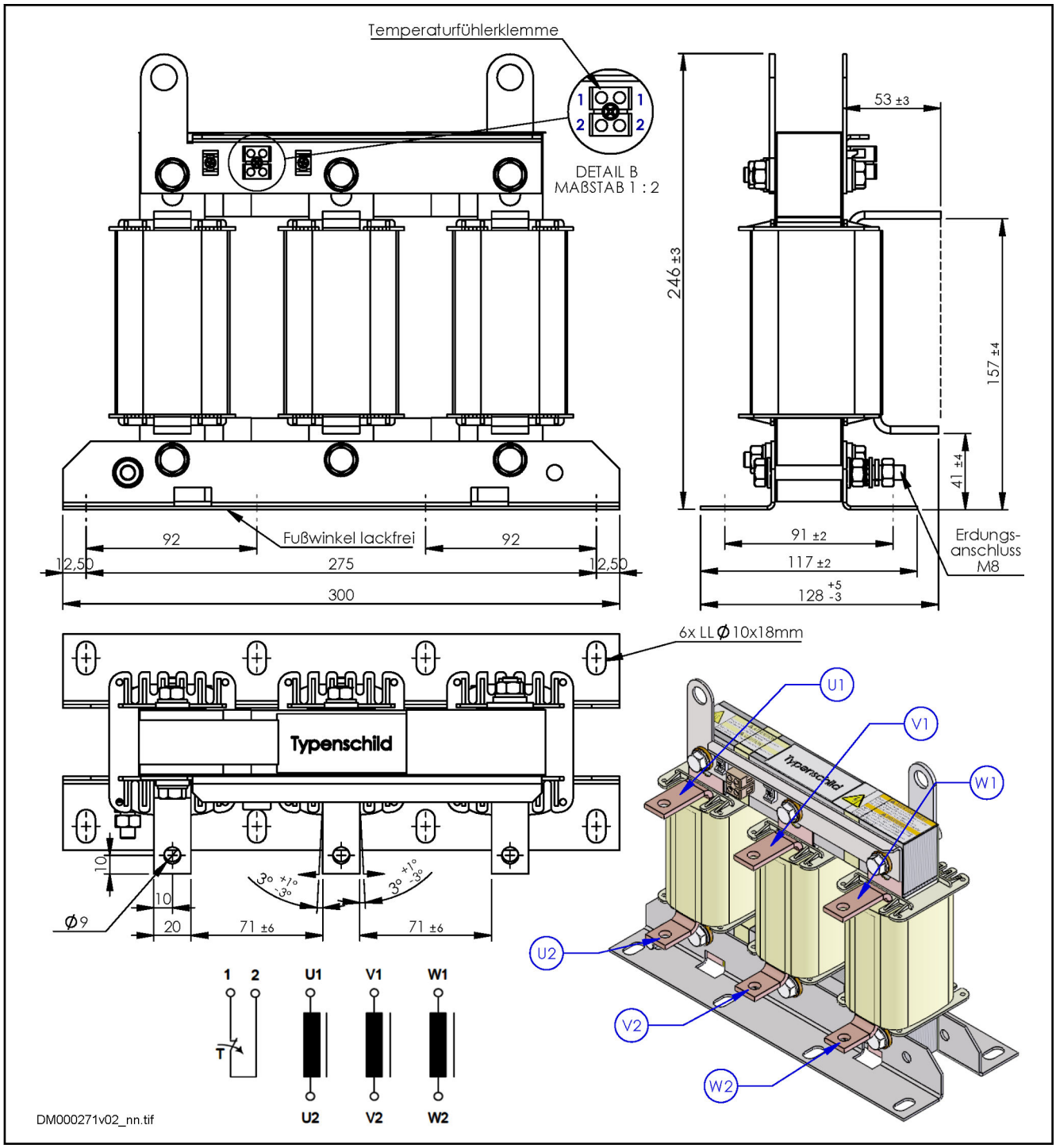


Fig. 8-56: HML05.1W-D021U-N0254-N-500, dimensions

HML05.1W-D018U-N0306-N-500

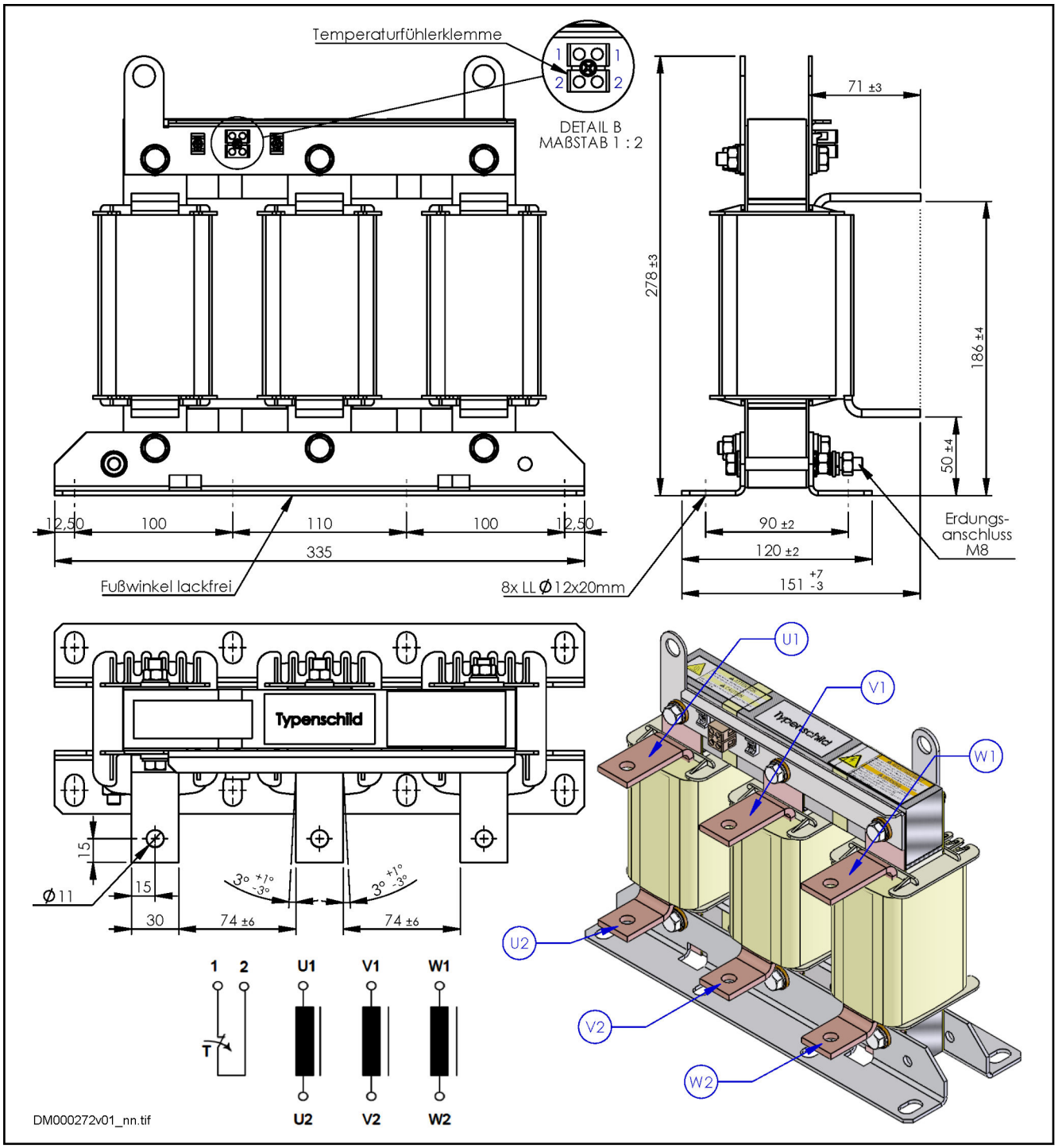


Fig. 8-57: HML05.1W-D018U-N0306-N-500, dimensions

HML05.1W-D014U-N0392-N-500

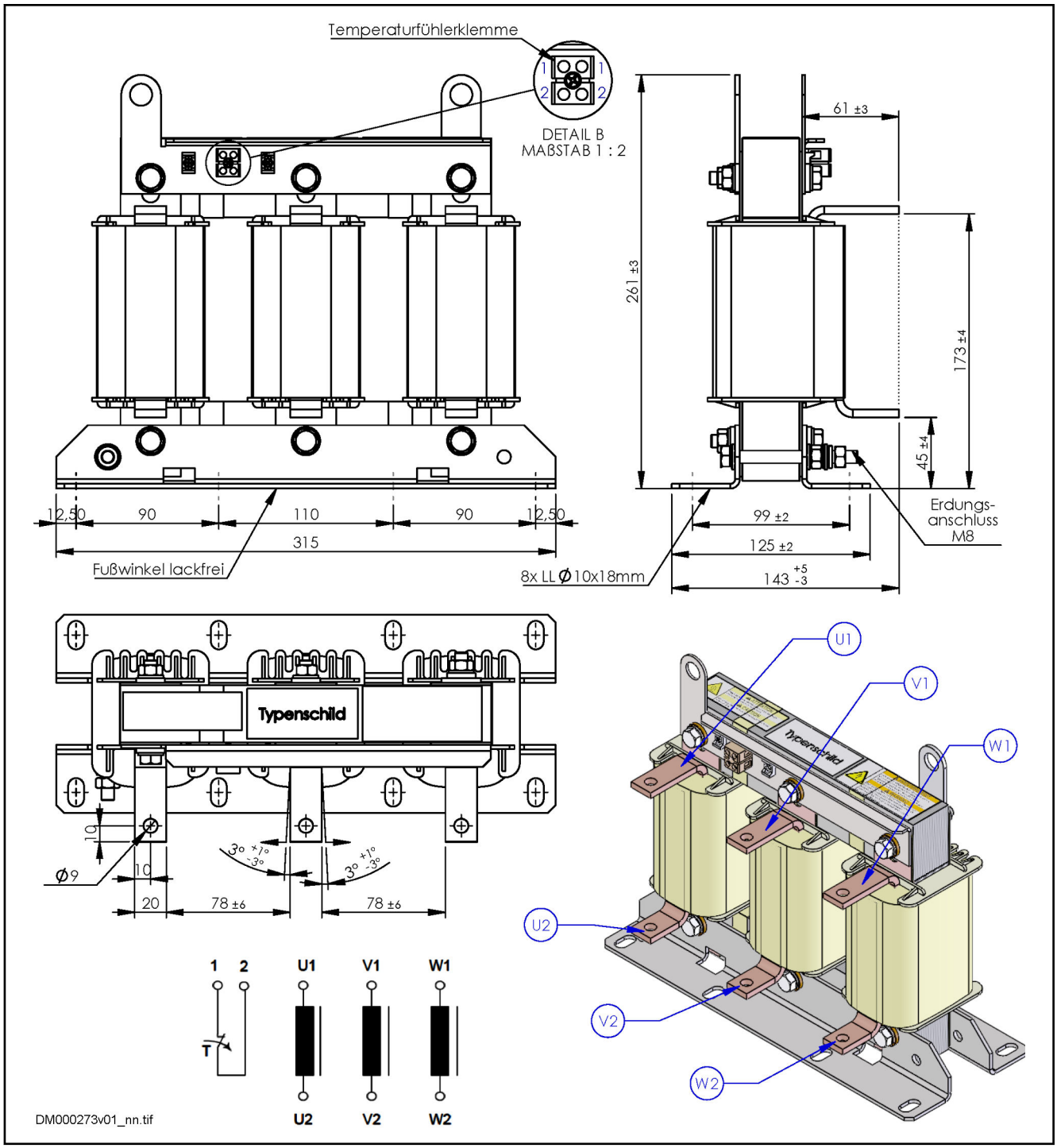


Fig. 8-58: HML05.1W-D014U-N0392-N-500, dimensions

HML05.1W-D009U-N0490-N-500

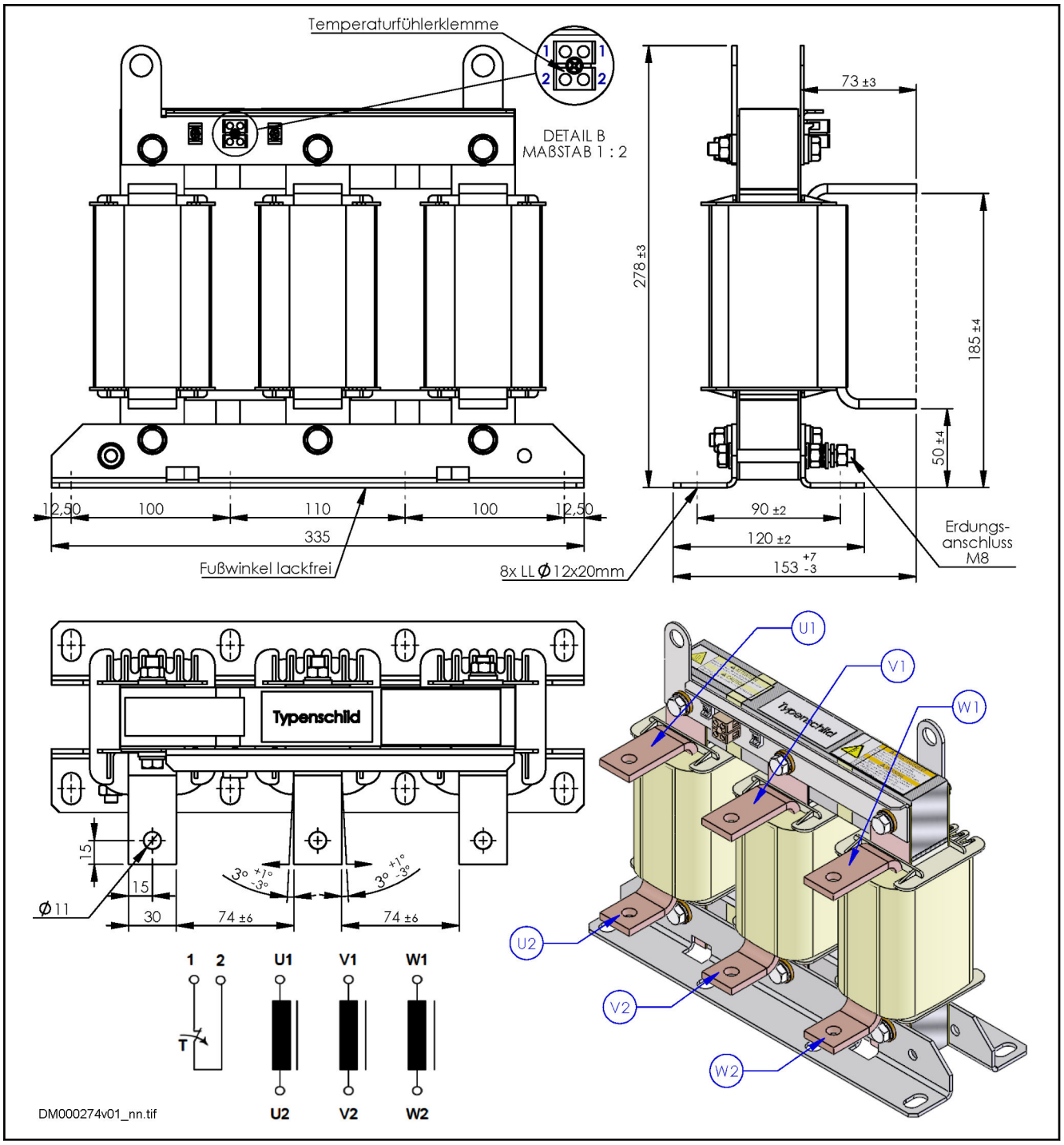


Fig. 8-59: HML05.1W-D009U-N0490-N-500, dimensions

HML05.1W-D009U-N0616-N-500

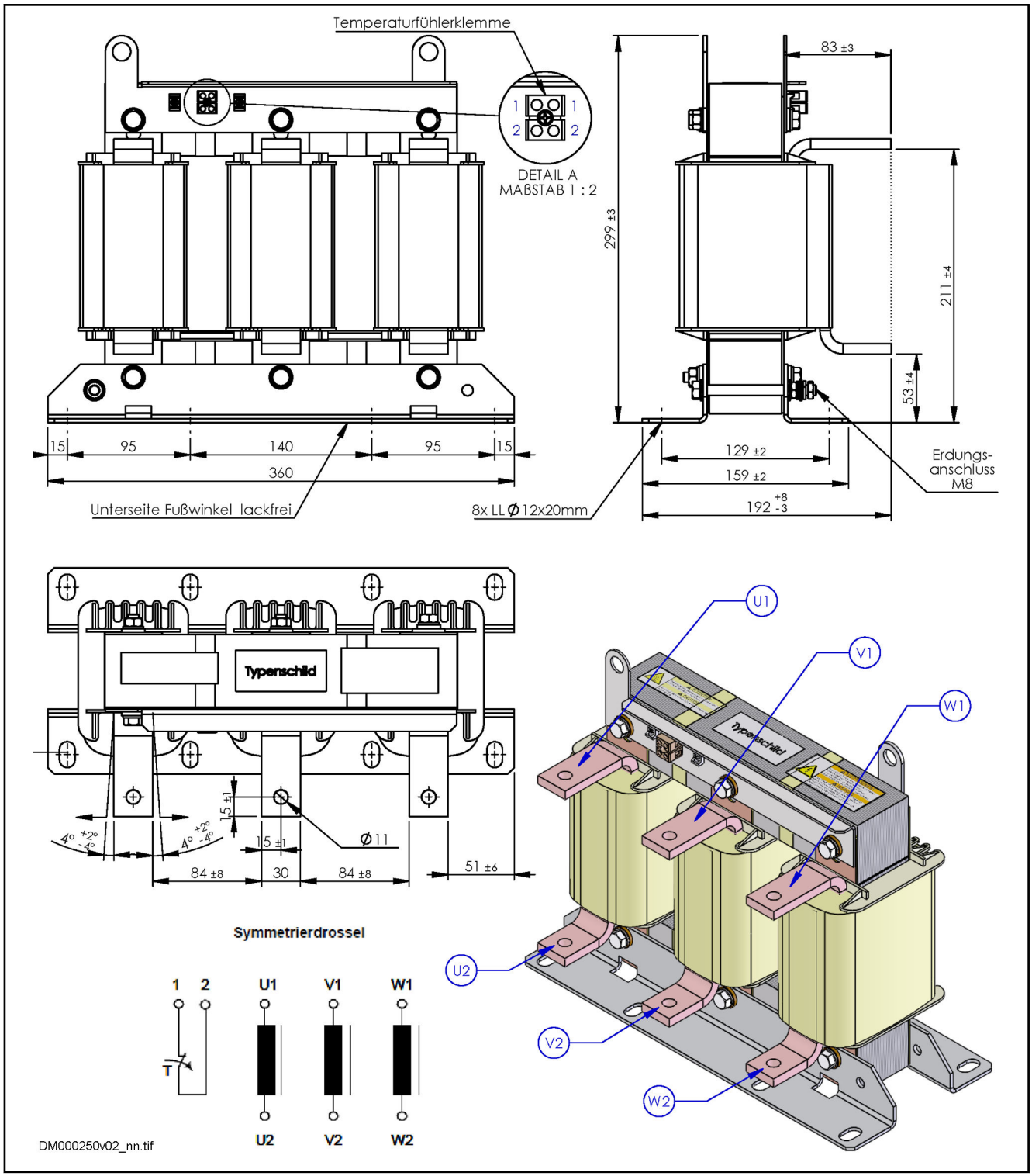


Fig. 8-60: HML05.1W-D009U-N0616-N-500, dimensions

HML05.1W-D007U-N0771-N-500

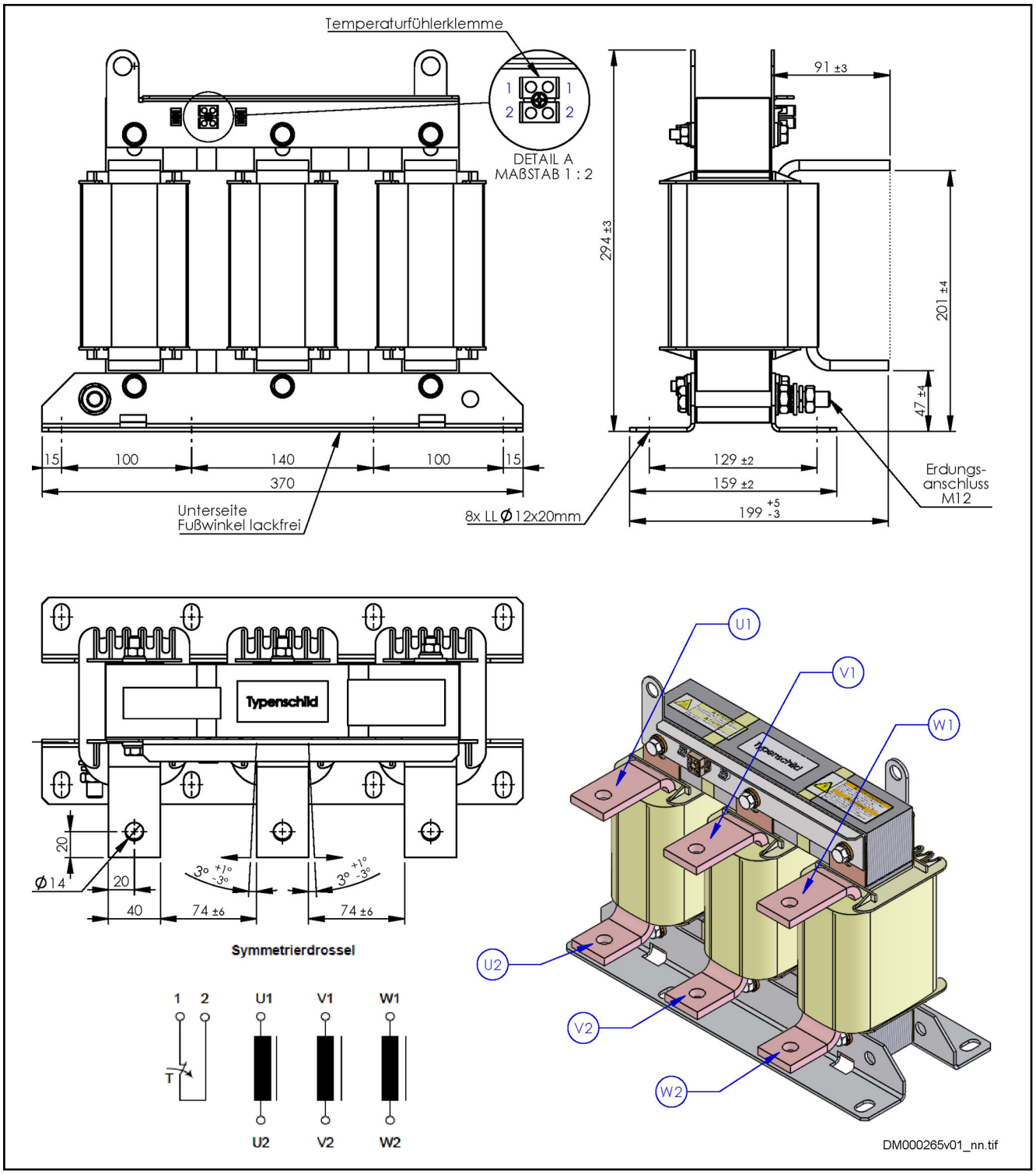


Fig. 8-61: HML05.1W-D007U-N0771-N-500, dimensions

HML05.1W-D006U-N1002-N-500

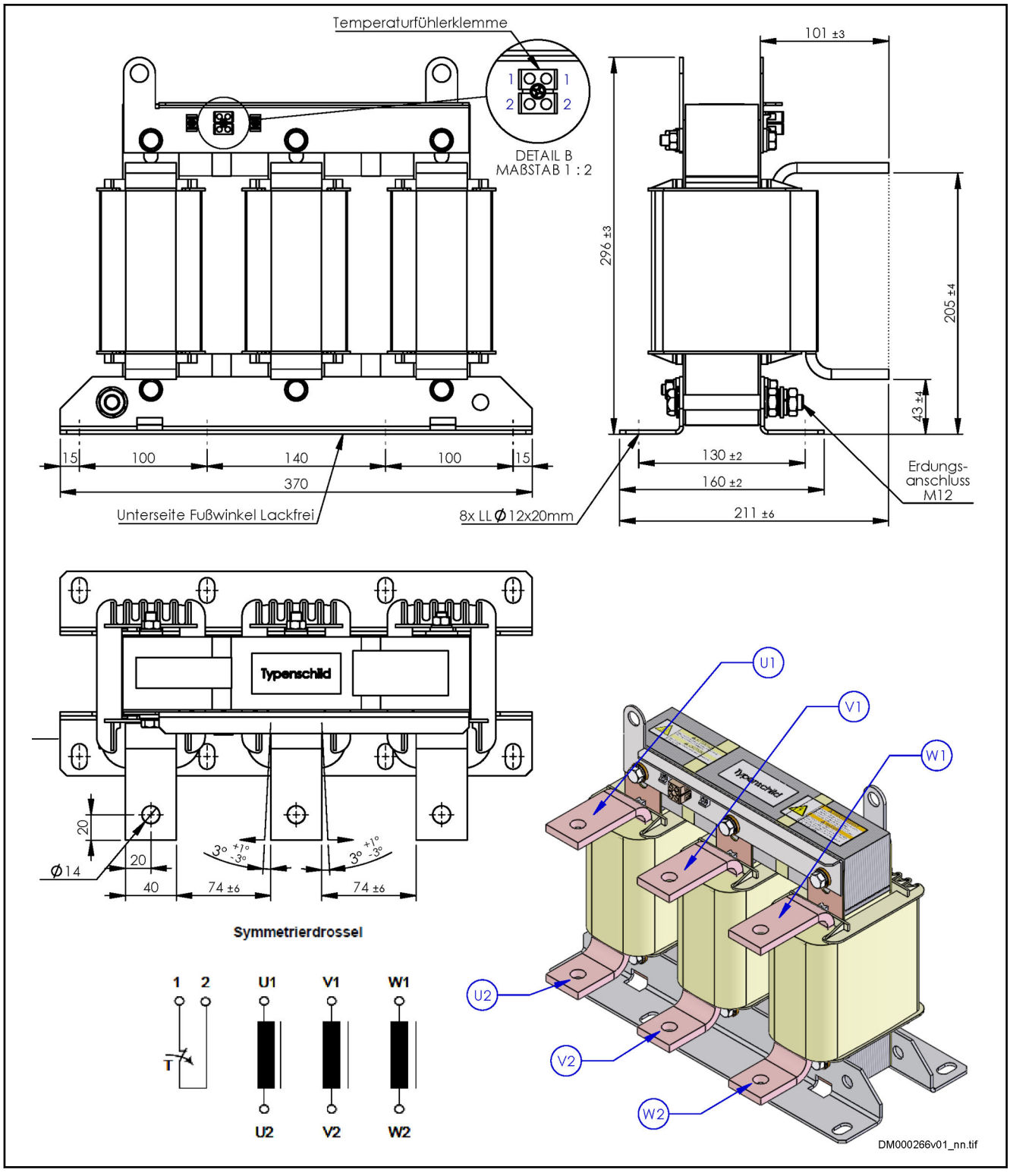


Fig. 8-62: HML05.1W-D006U-N1002-N-500, dimensions

HML05.1W-D004U-N1185-N-500

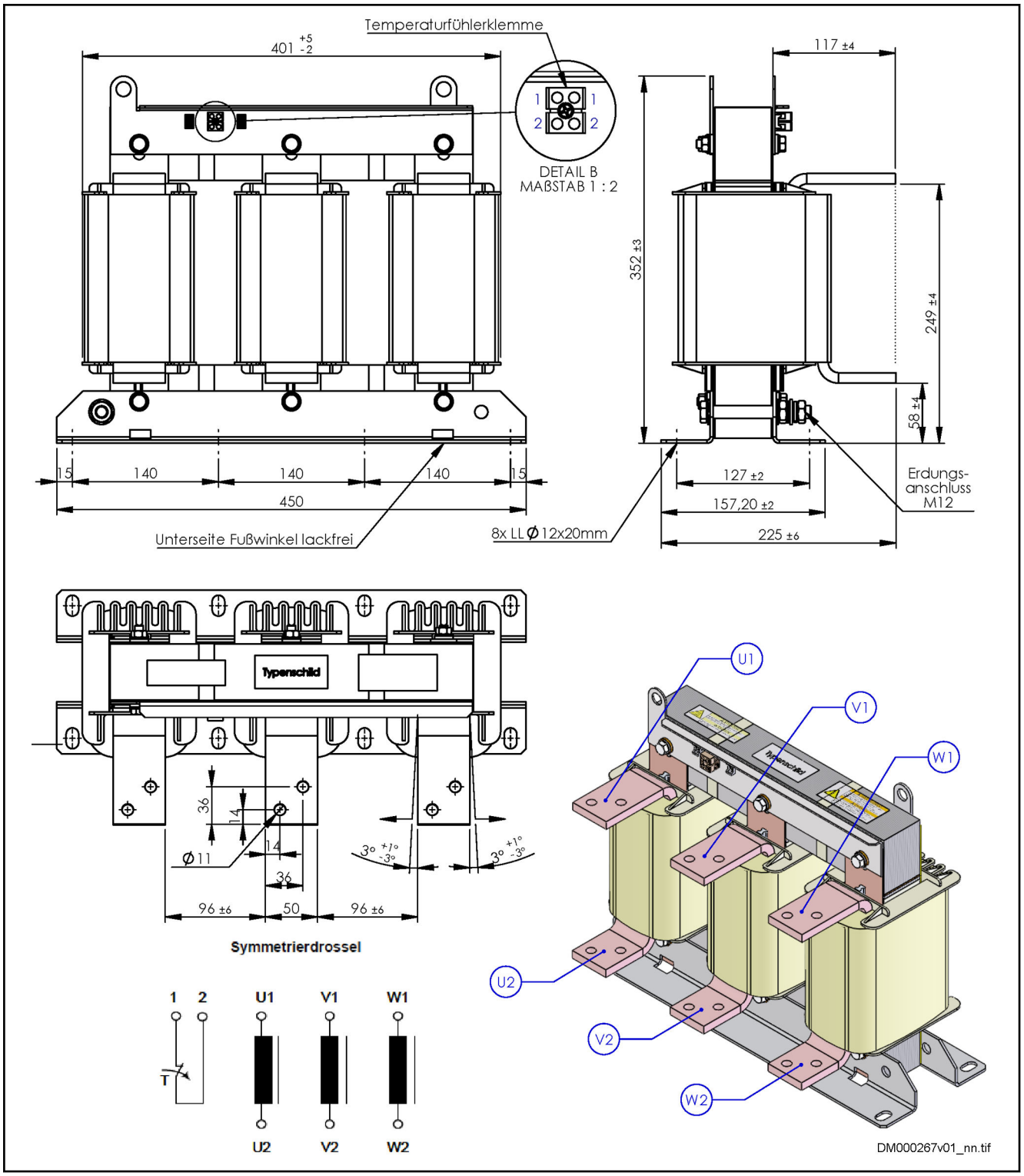


Fig. 8-63: HML05.1W-D004U-N1185-N-500, dimensions

HML05.1W-D052U-N0147-N-690

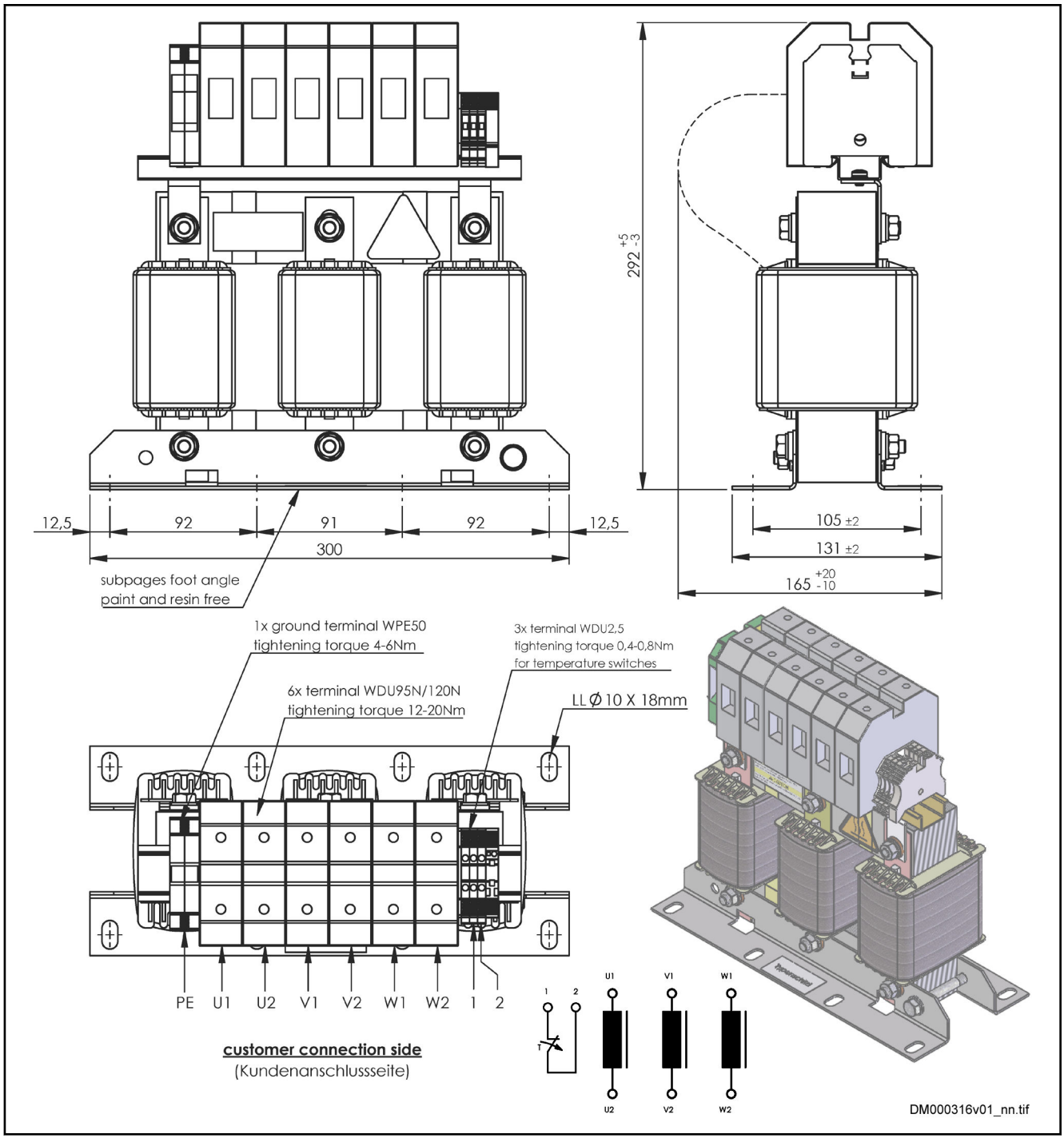


Fig. 8-64: HML05.1W-D052U-N0147-N-690

HML05.1W-D043U-N0177-N-690

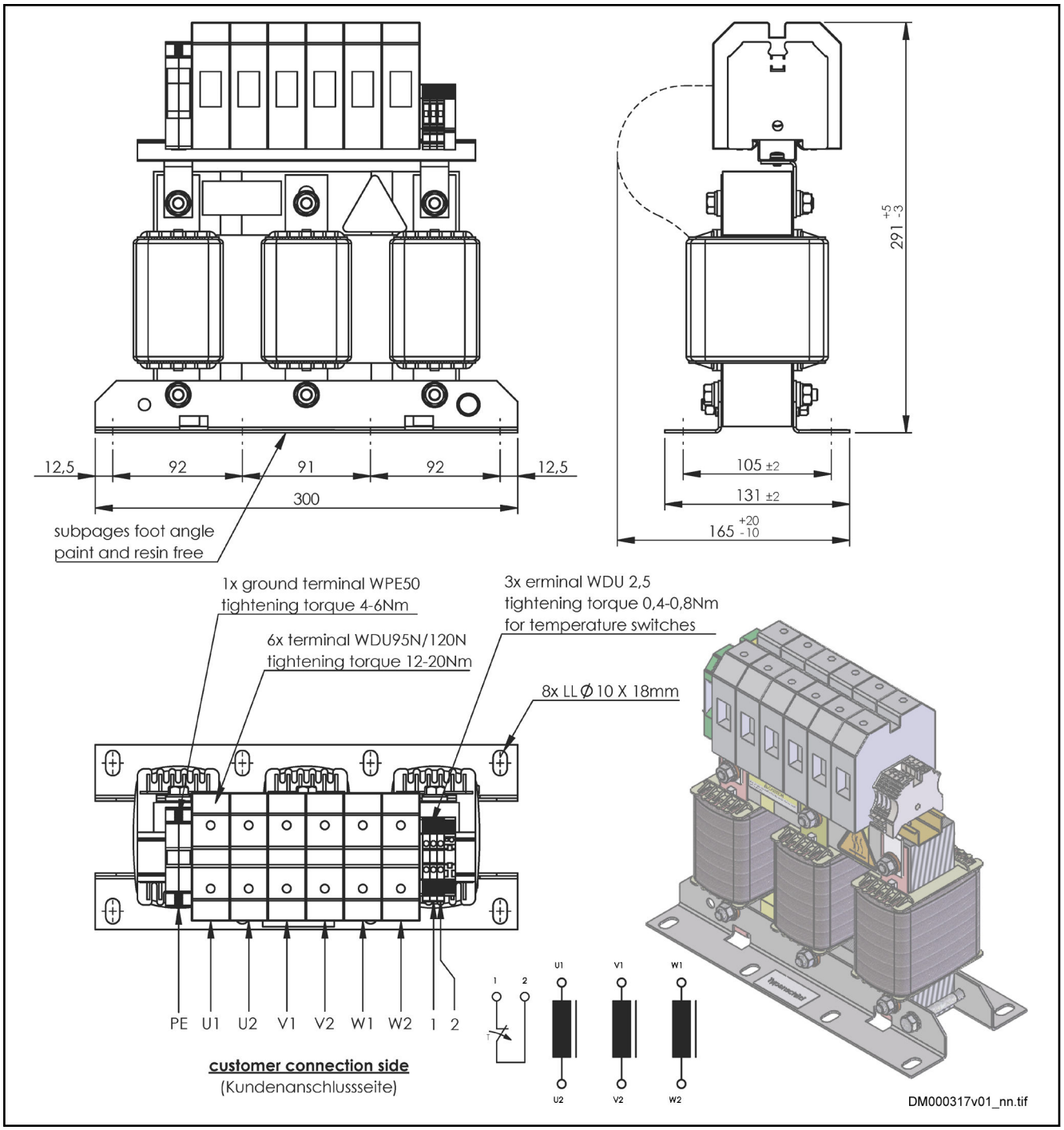


Fig. 8-65: HML05.1W-D043U-N0177-N-690

HML05.1W-D034U-N0227-N-690

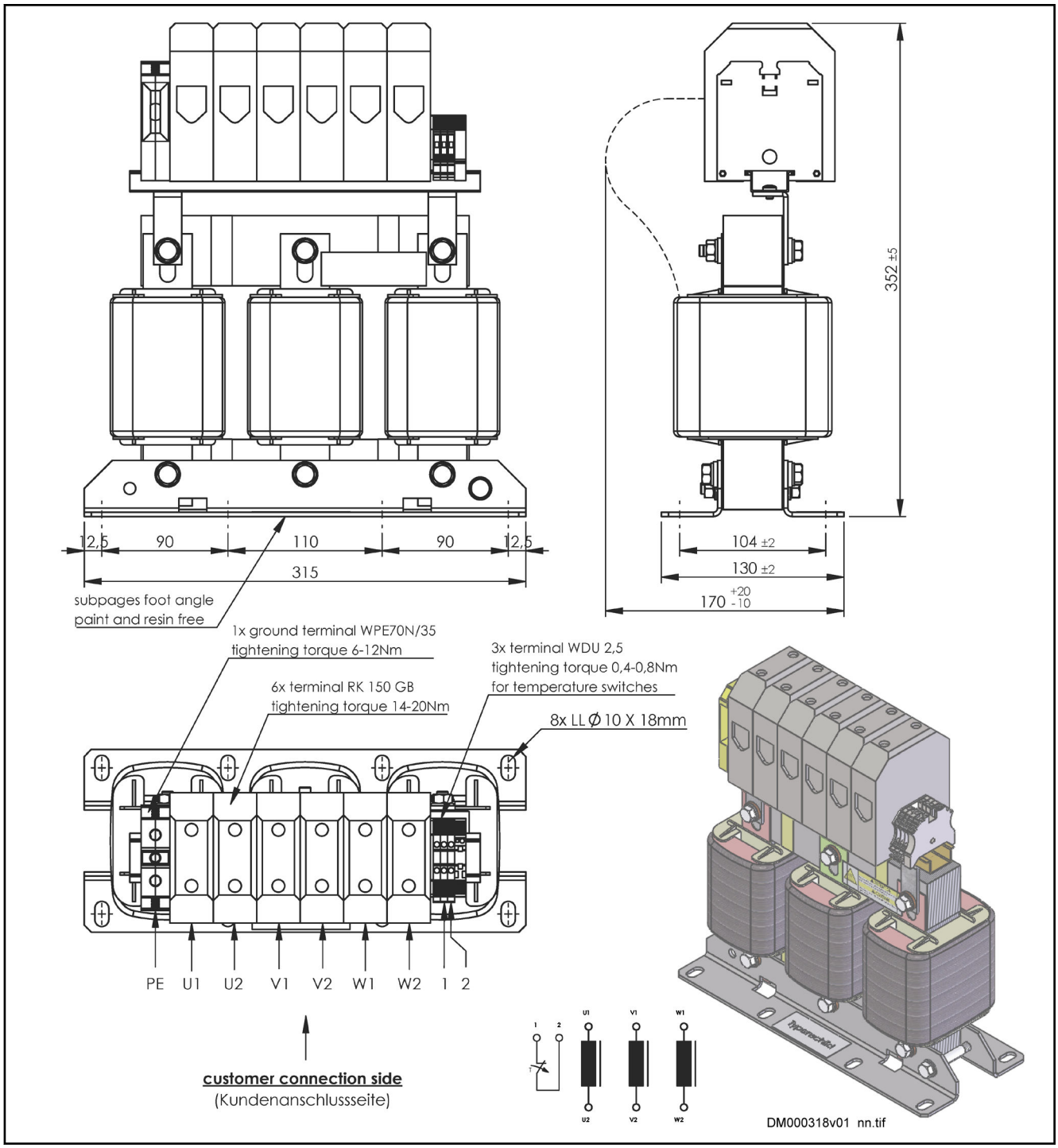


Fig. 8-66: HML05.1W-D034U-N0227-N-690

HML05.1W-D027U-N0284-N-690

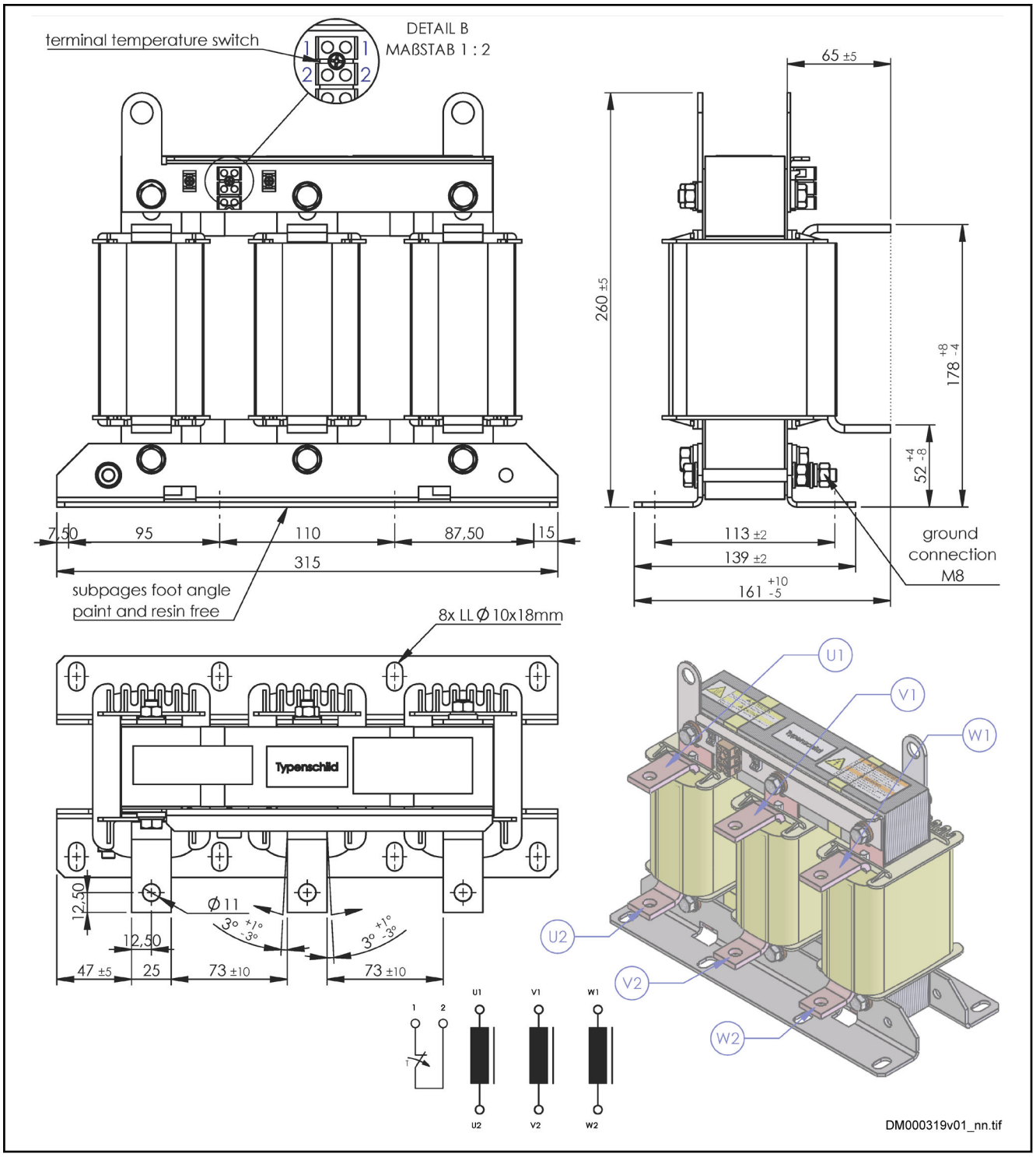


Fig. 8-67: HML05.1W-D027U-N0284-N-690

HML05.1W-D020U-N0374-N-690

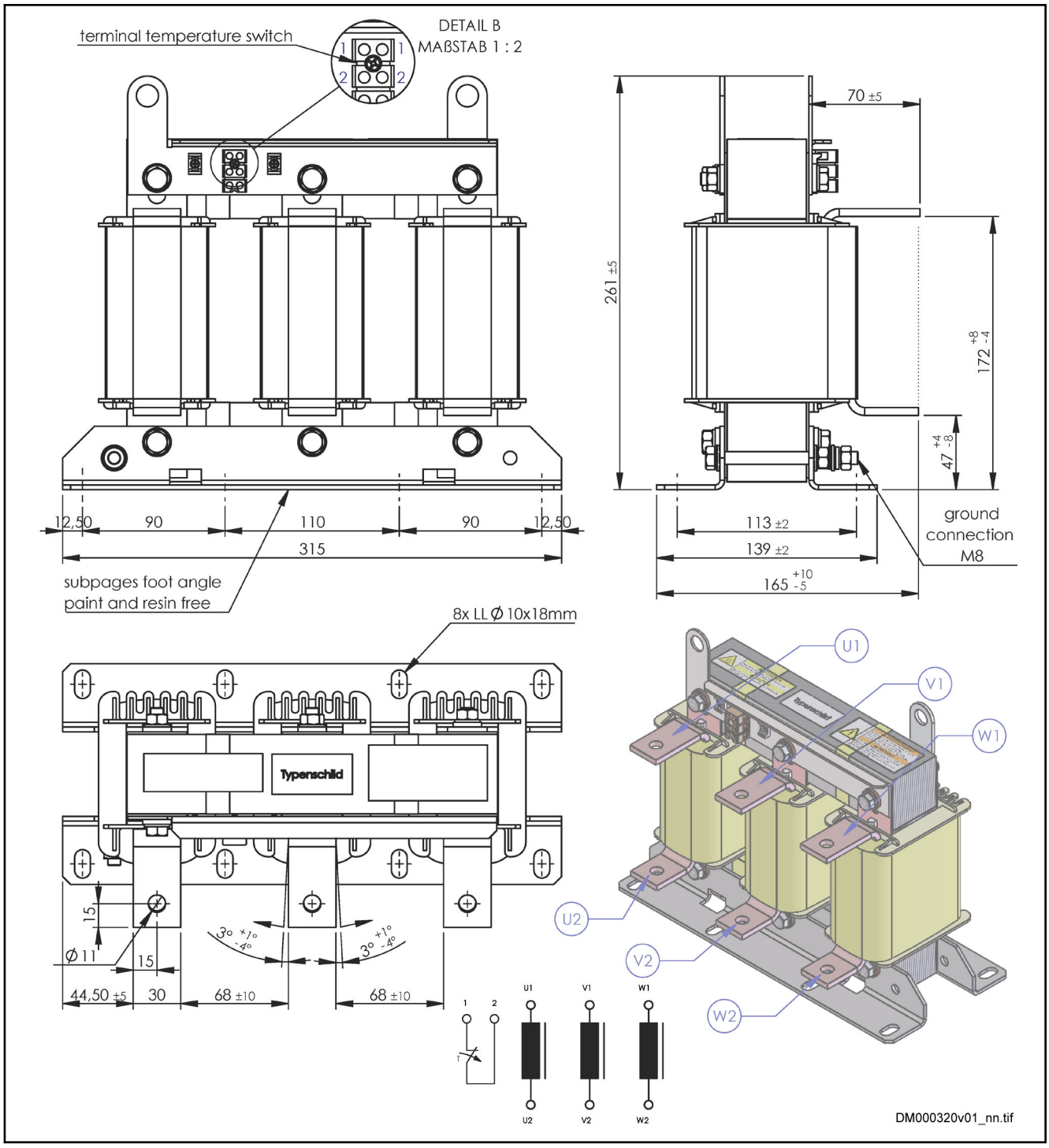


Fig. 8-68: HML05.1W-D020U-N0374-N-690

HML05.1W-D013U-N0581-N-690

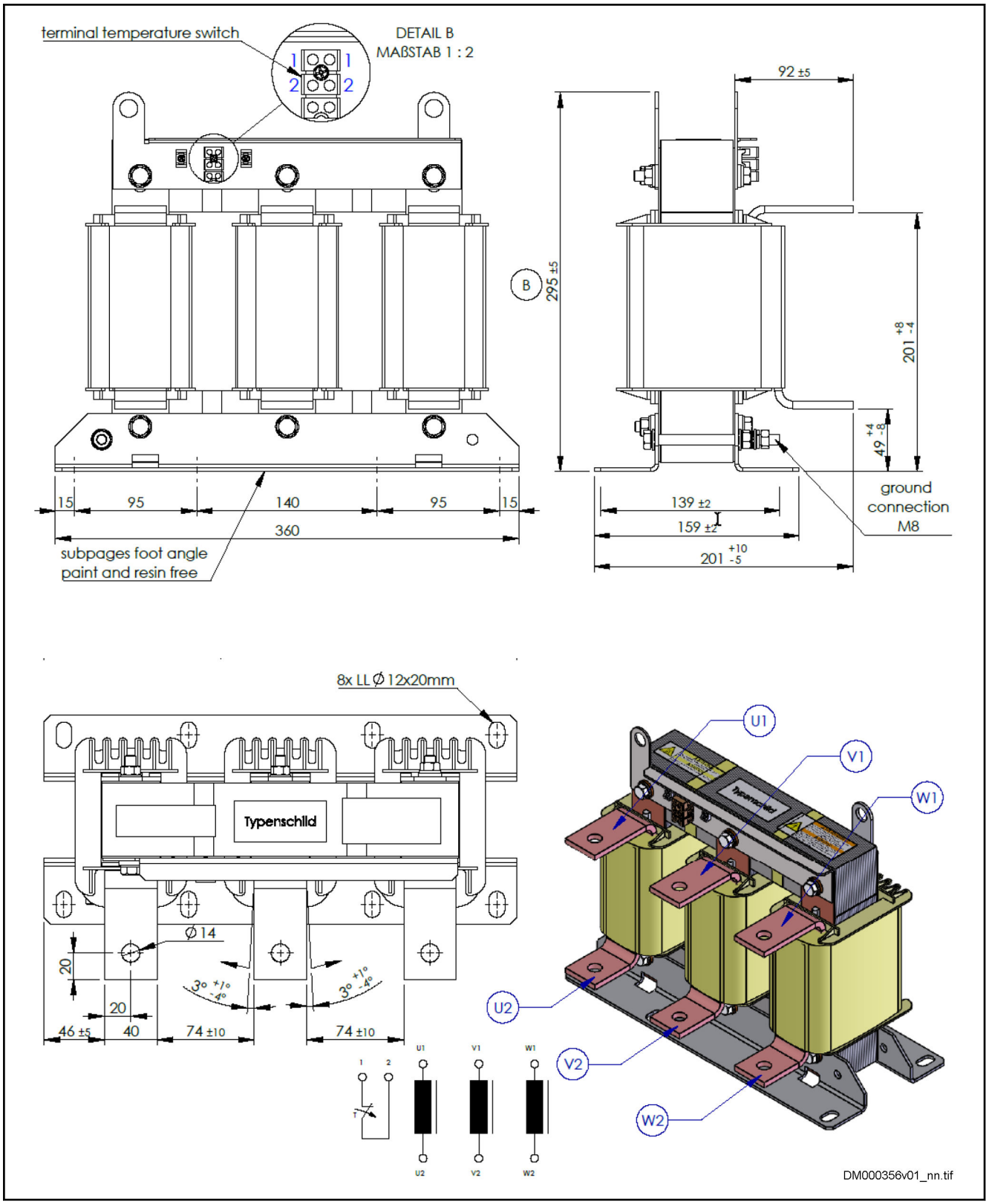
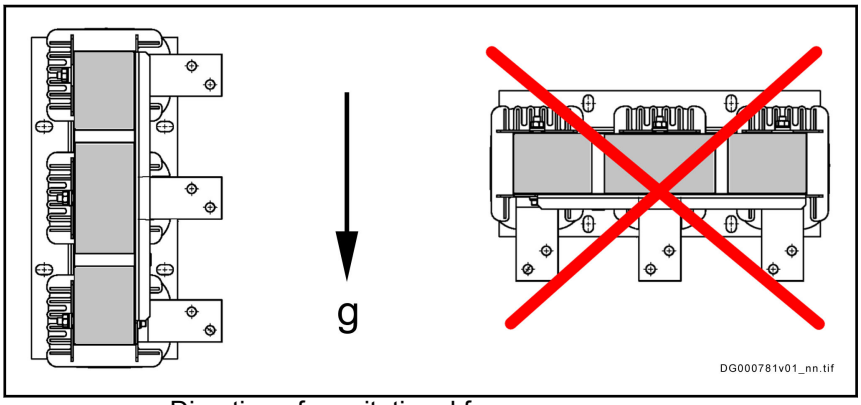


Fig. 8-69: HML05.1W-D013U-N0581-N-690

Mounting

Allowed mounting positions:

- Vertical
- Hanging with vertical orientation of the 3 windings



g Direction of gravitational force

Fig. 8-70: Hanging mounting position

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

Degree of protection of the component: **IP00**

Mount a **touch guard**!

Data

HML05.1W-D … -500

Description			HML05.1W-D … -N-500-NNNN						
		Unit	021U-N0254	018U-N0306	014U-N0392	009U-N0490	009U-N0616	007U-N0771	006U-N1002
Relative u_k		%	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
Motor inductance in working point, typ.		µH	533	448	352	228	224	176	141
Working point 1: 2 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	254	306	392	490	616	771	1002
	Phase-phase capacitance (motor cable)	nF	30	30	30	30	50	50	50
	Leakage capacitance	nF	180	180	180	180	300	300	300
Working point 2: 4 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	254	306	392	490	546	632	775
	Phase-phase capacitance (motor cable)	nF	20	20	20	20	30	30	30
	Leakage capacitance	nF	120	120	120	120	180	180	180
Working point 3: 4 kHz clock frequency; ≤ 400 Hz rotary field frequency	Nominal current	A_{rms}	254	306	392	490	546	632	775
	Phase-phase capacitance (motor cable)	nF	10	10	10	10	30	30	30
	Leakage capacitance	nF	60	60	60	60	180	180	180
Inductance, saturation limit		A_{rms}	314	377	454	582	727	915	1144
Power dissipation		W	200	250	300	300	350	330	425
Nominal voltage		V	3 × 500						
Rise of voltage at output with U_{LN_nenn} and 6 m motor cable length phase-phase (10 … 90%)		kV/µs	2						
Rise of voltage at output with U_{LN_nenn} and 6 m motor cable length phase-ground (10 … 90%)		kV/µs	1.7						
Degree of protection		-	IP00						
Weight		kg	15	20	25	25	34	38	40

Tab. 8-57: HML05.1W-D … -N-500, data

HML05.1W-D … -690

Description		Unit	HML05.1W-D … -N-690-NNNN					
			052U-N0147	043U-N0177	034U-N0227	027U-N0284	020U-N0374	013U-N0581
Relative u_k		%	0.6	0.6	0.6	0.6	0.6	0.6
Inductance		µH	3 × 52	3 × 43	3 × 34	3 × 27	3 × 20	3 × 13
Motor inductance in working point, typ.		µH	1308	1086	847	677	514	331
2 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	147	177	227	284	374	581
	Phase-phase capacitance (motor cable)	nF	10	10	10	10	13	13
	Leakage capacitance	nF	60	60	60	60	75	75
Working point 1 [1]: 2 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	147	177	227	284	374	581
	Phase-phase capacitance (motor cable)	nF	60	60	60	60	65	80
	Leakage capacitance	nF	360	360	360	360	400	500
Working point 2 [1]: 4 kHz clock frequency; ≤ 200 Hz rotary field frequency	Nominal current	A_{rms}	147	177	227	284	269	377
	Phase-phase capacitance (motor cable)	nF	25	25	30	30	33	50
	Leakage capacitance	nF	150	150	180	180	200	300
Working point 3 [1]: 4 kHz[1] clock frequency; ≤ 400 Hz rotary field frequency	Nominal current	A_{rms}	147	177	227	284	269	377
	Phase-phase capacitance (motor cable)	nF	25	25	30	30	33	40
	Leakage capacitance	nF	150	150	180	180	200	240
Inductance, saturation limit		A_{rms}	207	248	298	367	600	751
Power dissipation		W	300	300	400	400	400	400
Power dissipation at forced convection		W	800	800	1000	1000	1000	1000
Nominal voltage		V	3 × 780					
Rise of voltage at output with U_{LN_nenn} and 6 m motor cable length phase-phase (10 … 90%)		kV/µs	tbd					
Rise of voltage at output with U_{LN_nenn} and 6 m motor cable length phase-ground (10 … 90%)		kV/µs	tbd					

Description	Unit	HML05.1W-D … -N-690-NNNN					
		052U-N0147	043U-N0177	034U-N0227	027U-N0284	020U-N0374	013U-N0581
Degree of protection	-	IP00					
Weight	kg	20	20	25	25	25	40

1) Forced convection necessary (see fig. 8-71 "Forced convection (600 m³/h)" on page 283)

Tab. 8-58: HML05.1W-D … -N-690-NNNN, data

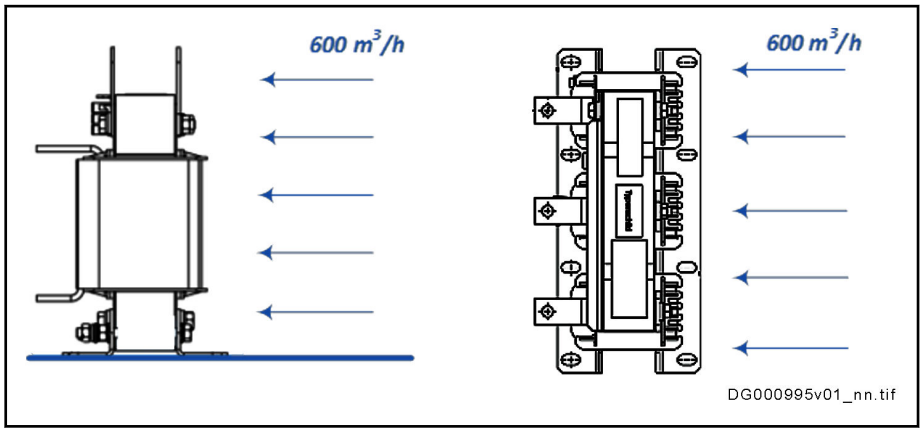


Fig. 8-71: Forced convection (600 m³/h)

HML05.1W-D … -N-**690**-NNNN has an additional temperature contact at the core (N/C, series connection with temperature contact in the winding).

Temperature monitoring contact

- Trigger temperature: 160 °C
- N/C in one of the windings
- Electric switching capacity:
  - 1 A
  - AC 250 V
  - DC 24 V

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.

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.

See also: chapter 4.6.5 "Running multiple HMU05s in parallel" on page 124

HMU05.1N-…-A4-D7	HML05.1W-…-500
F0140-0350	D021U-N0254
F0170-0430	D018U-N0306
F0220-0510	D014U-N0392
F0270-0660	D009U-N0490
F0340-0820	D009U-N0616
F0430-1040	D007U-N0771
F0540-1300	D006U-N1002

Tab. 8-59: Assignment HML05.1W-…-500 ↔ HMU05

HMU05.1N-…-A5-11	HML05.1W-…-690
F0140-0210	D052U-N0147
F0170-0250	D043U-N0177
F0220-0300	D034U-N0227
F0270-0370	D027U-N0284
F0400-0600	D020U-N0374
F0540-0750	D013U-N0581

Tab. 8-60: Assignment HML05.1W-…-690 ↔ HMU05

8.3.6 HLL05 DC bus choke

HLL05 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	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:** 01M0 = 1 mH 02M0 = 2 mH 04M0 = 4 mH 500U = 500 µH
⑥	**Additional option:** S = Current-compensated G = Smoothing choke
⑦	**Nominal current:** 0200 = 200 A 0202 = 202 A 0243 = 243 A 0303 = 303 A 0320 = 320 A 0380 = 380 A 0475 = 475 A 0600 = 600 A 0603 = 603 A 0720 = 720 A
⑧	**Degree of protection:** N = IP00
⑨	**Nominal DC bus voltage:** D7 = DC 750 V 11 = DC 1100 V

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	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											
⑩	**Leakage capacitance:** 01U2 = 1.2 µF NNNN = Not relevant																																							
⑪	**Other design:** NNNN = None																																							

Tab. 8-61: HLL05, type code

Possible combinations:

		Nominal inductance				additional option		Nominal current									
		01M0	02M0	04M0	500U	S	G	0200	0202	0243	0303	0320	0380	0475	0600	0603	0720
Cooling type	F	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Type of construction	W	–	–	✓	–	✓	–	–	✓	–	✓	–	–	✓	–	–	–

Tab. 8-62: Possible combinations

Possible combinations:

		Nominal current										Nominal DC bus voltage		Leakage capacitance	
		0200	0202	0243	0303	0320	0380	0475	0600	0603	0720	D7	11	01U2	NNNN
Nominal inductance	01M0	–	–	–	–	–	–	–	✓	–	–			–	✓
	02M0	✓	–	–	–	–	–	–	–	–	–			–	✓
	04M0	–	✓	✓	✓	–	✓	✓	–	✓	✓	✓	✓	✓	–
	500U	–	–	–	–	✓	–	–	–	–	–	✓	–	–	✓
additional option	S	–	✓	✓	✓	–	✓	✓	–	✓	✓			✓	–
	G	✓	–	–	–	✓	–	–	✓	–	–			–	✓

Tab. 8-63: Possible combinations

Possible combinations:

		Nominal current									
		0200	0202	0243	0303	0320	0380	0475	0600	0603	0720
Nominal DC bus voltage	D7	–	–	–	–	✓	–	–	–	–	–
	11	✓	✓	✓	✓	–	✓	✓	✓	✓	✓

Tab. 8-64: Possible combinations

Sizing

HMU05.1N-...-A4-D7 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**.

HMU05.1N-...-A5-11 An HLL DC bus choke is **always** necessary.

See also chapter 4.3.4 "Leakage capacitances" on page 43.

Sizing 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 45.

Dimensions

HLL05.1W-04M0-S0202

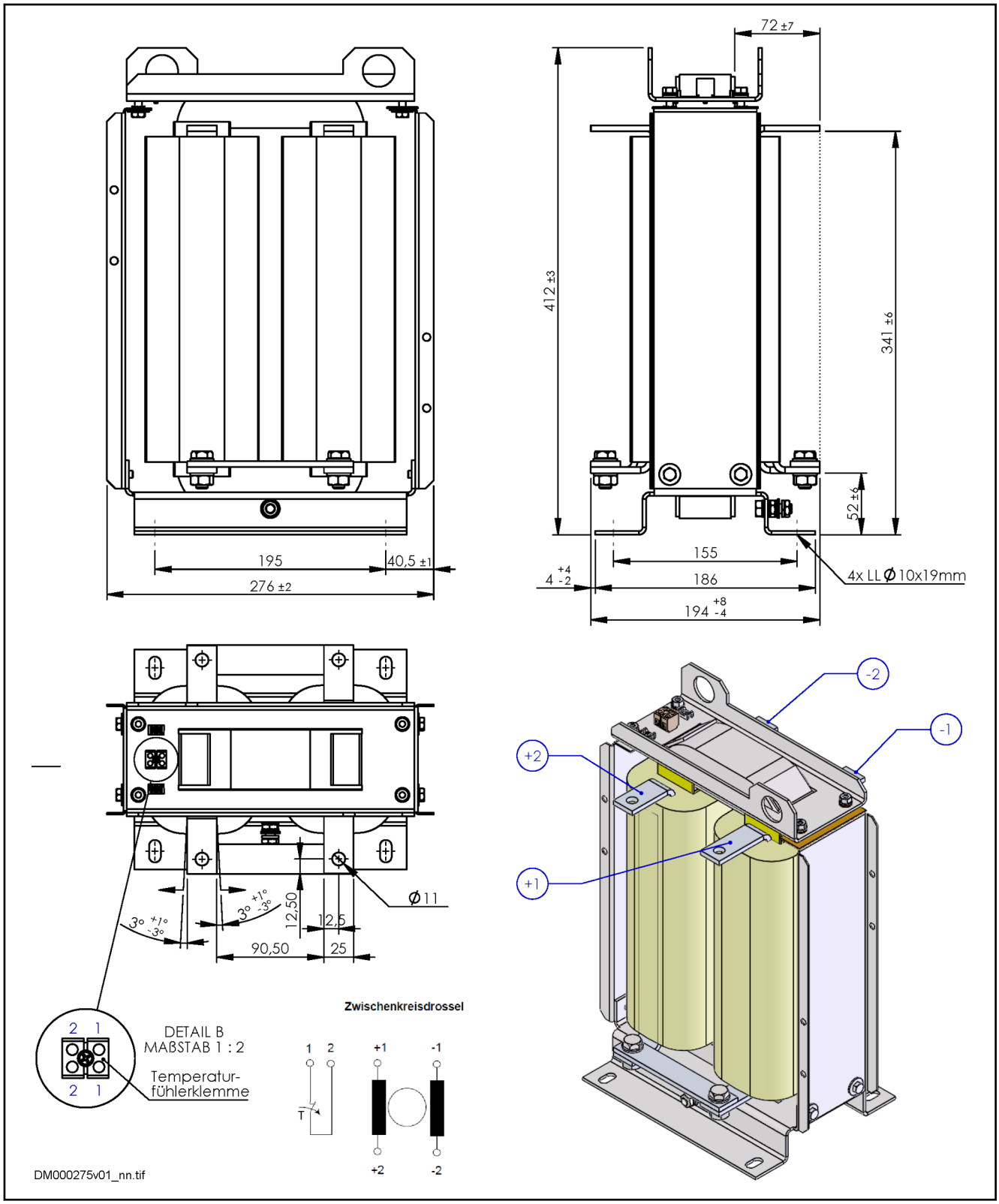


Fig. 8-72: HLL05.1W-04M0-S0202

HLL05.1F-04M0-S0202

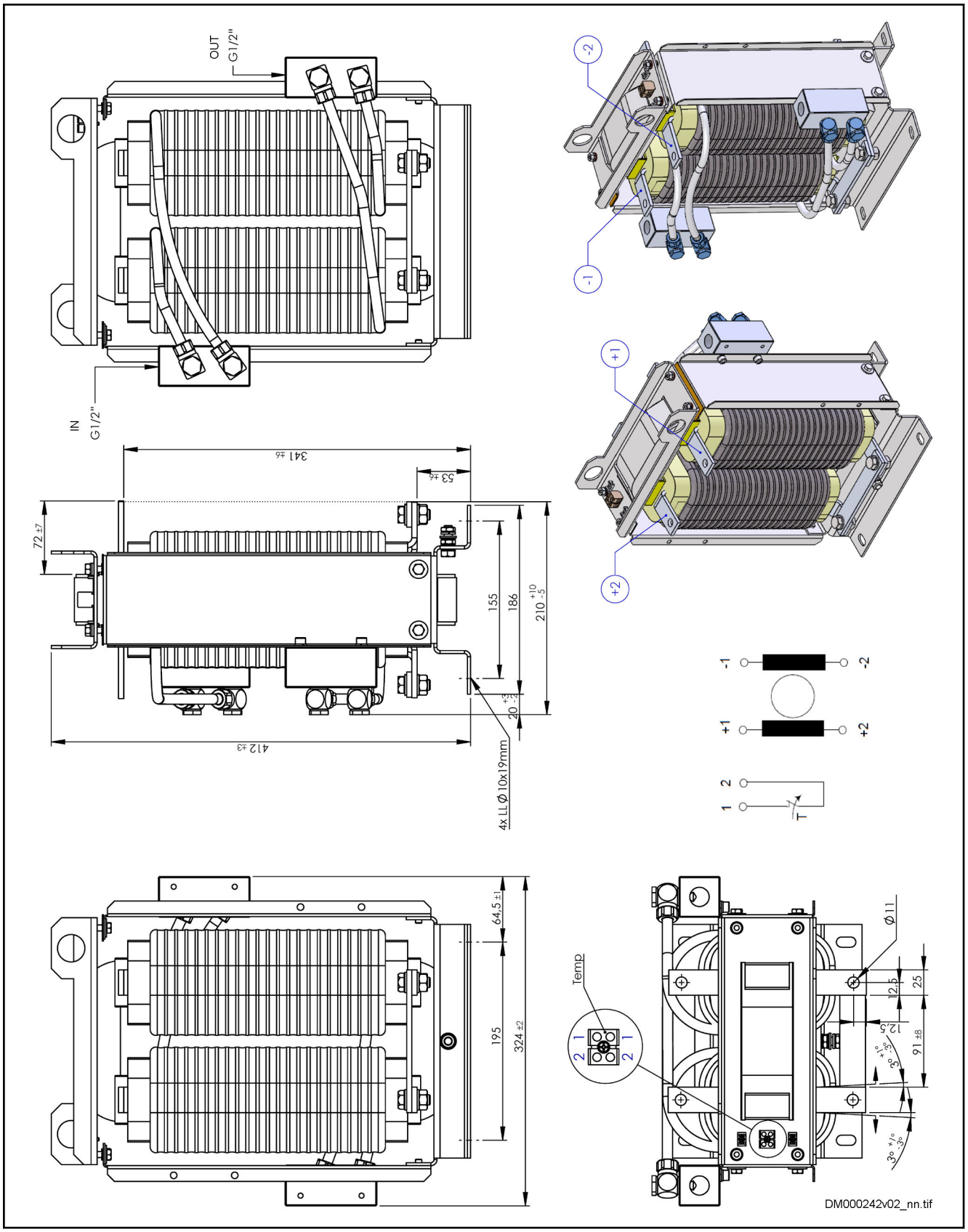


Fig. 8-73: HLL05.1F-04M0-S0202

HLL05.1F-04M0-S0243

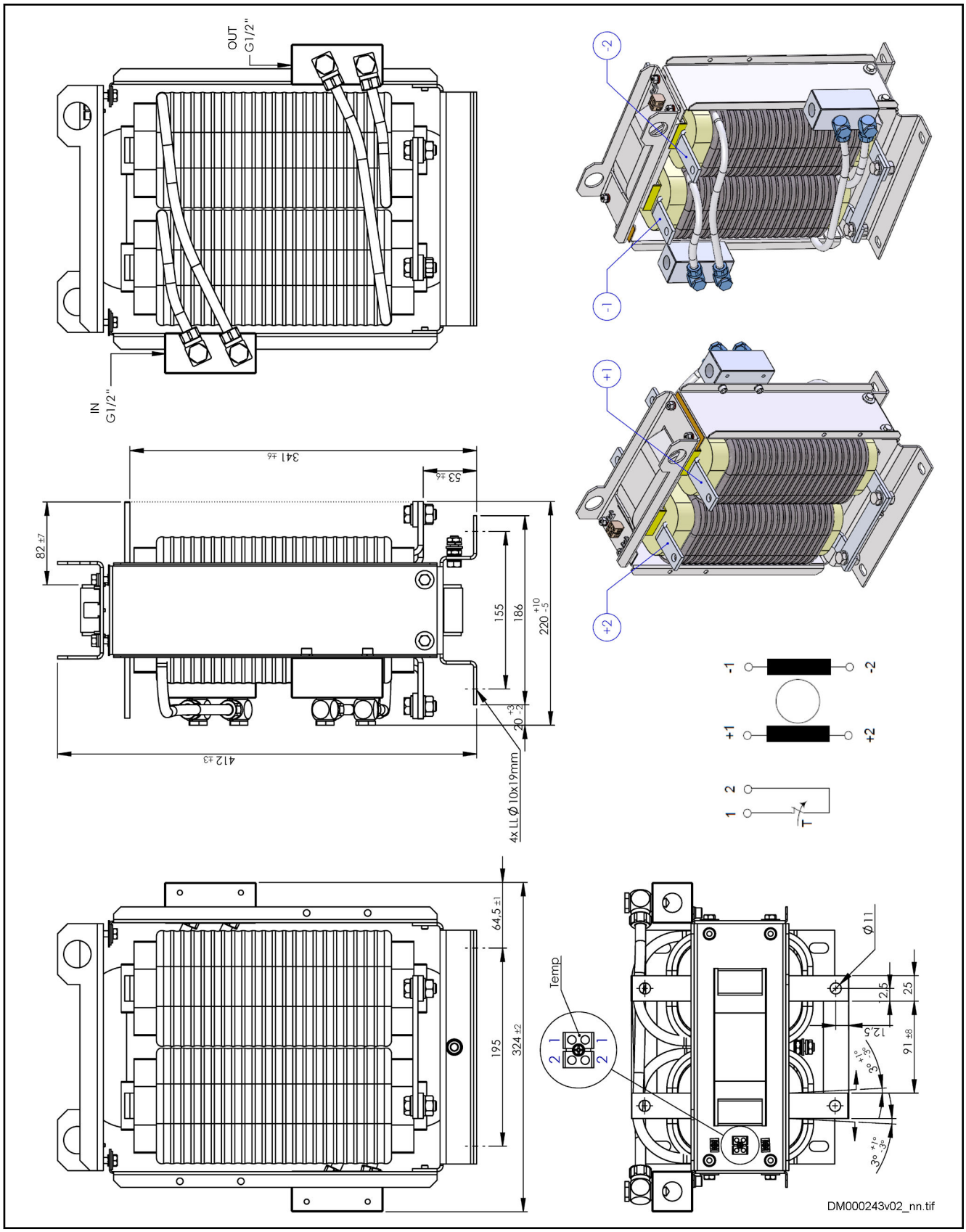


Fig. 8-74: HLL05.1F-04M0-S0243

HLL05.1W-04M0-S0303

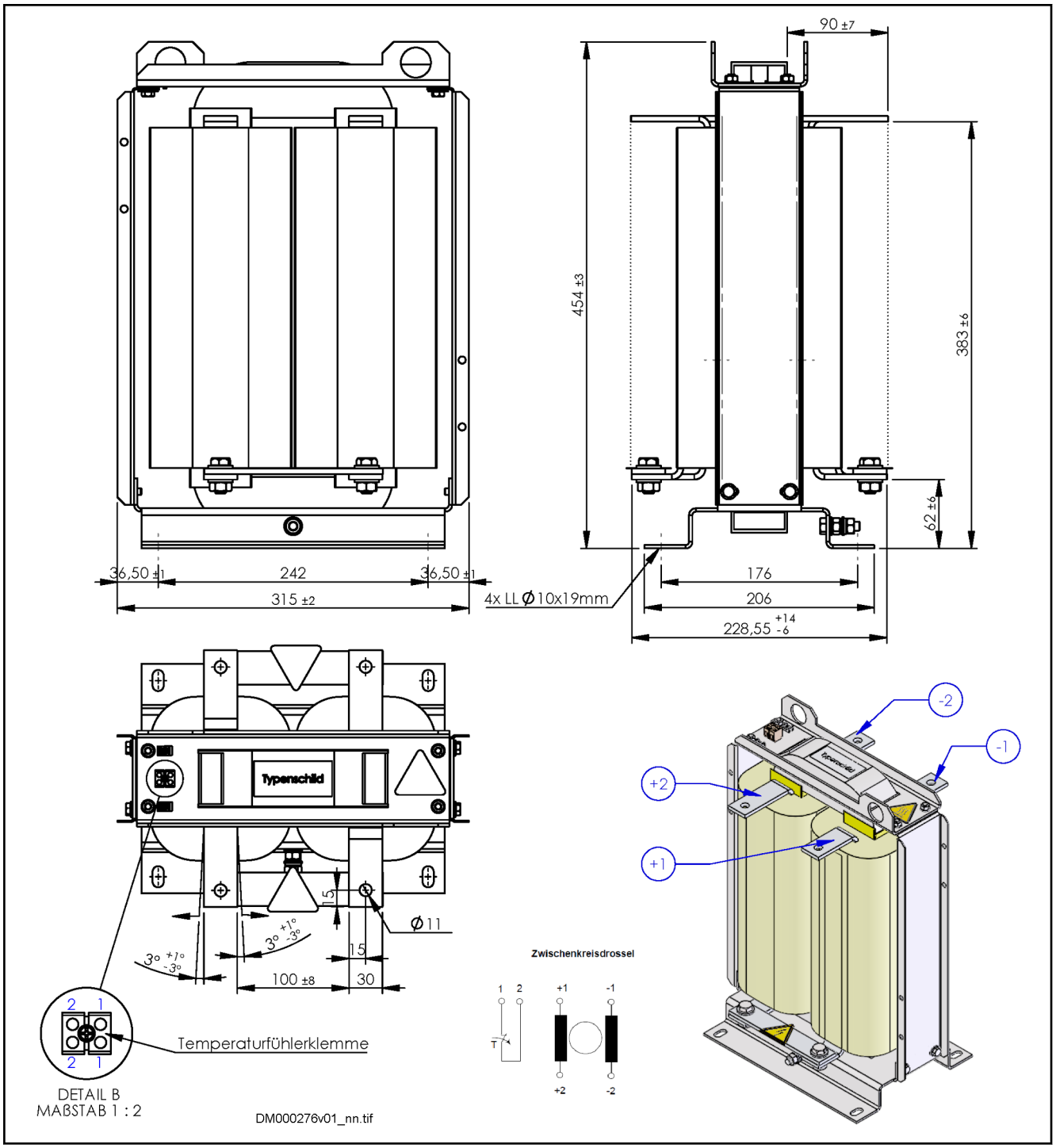


Fig. 8-75: HLL05.1W-04M0-S0303

HLL05.1F-04M0-S0303

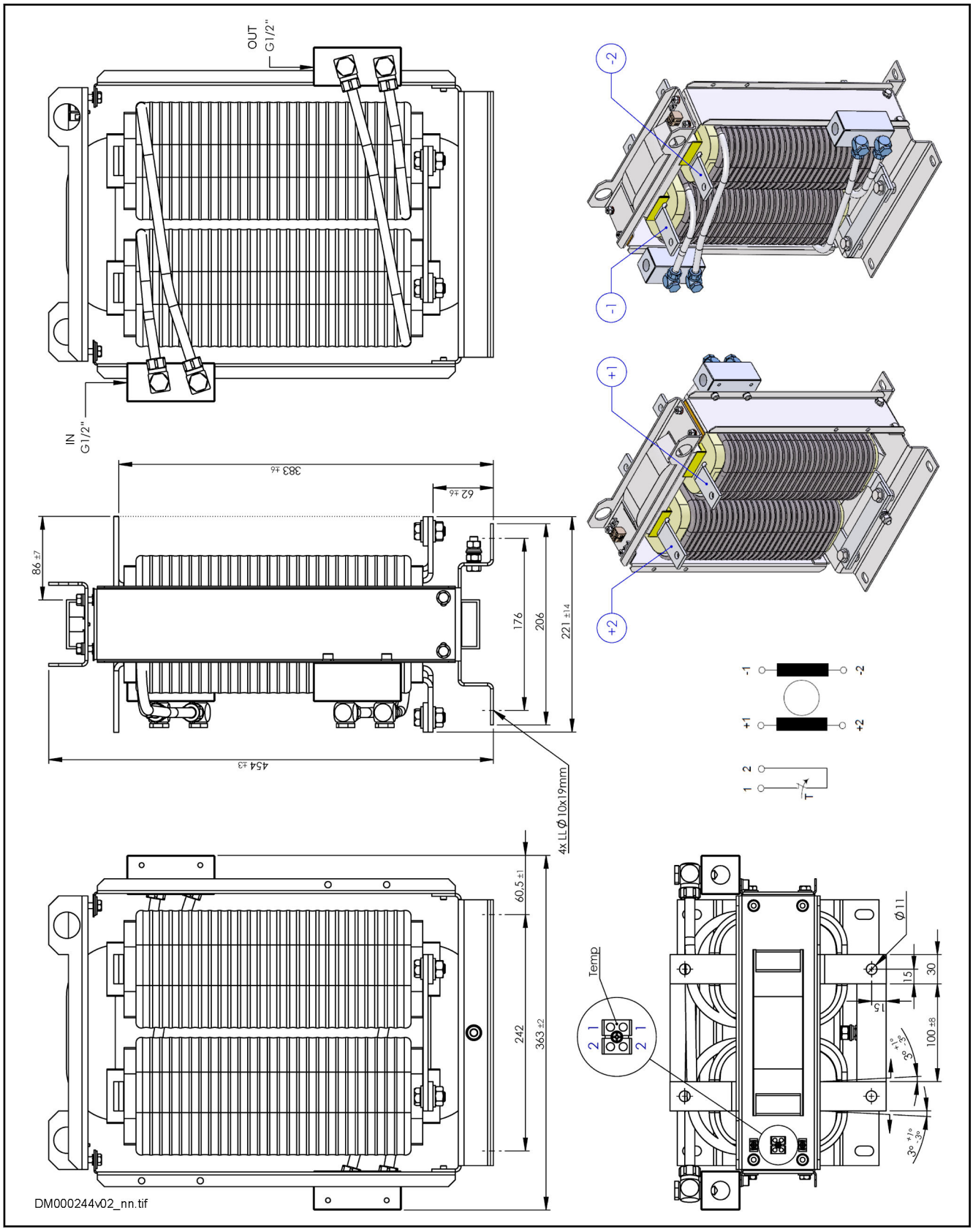


Fig. 8-76: HLL05.1F-04M0-S0303

HLL05.1F-04M0-S0380

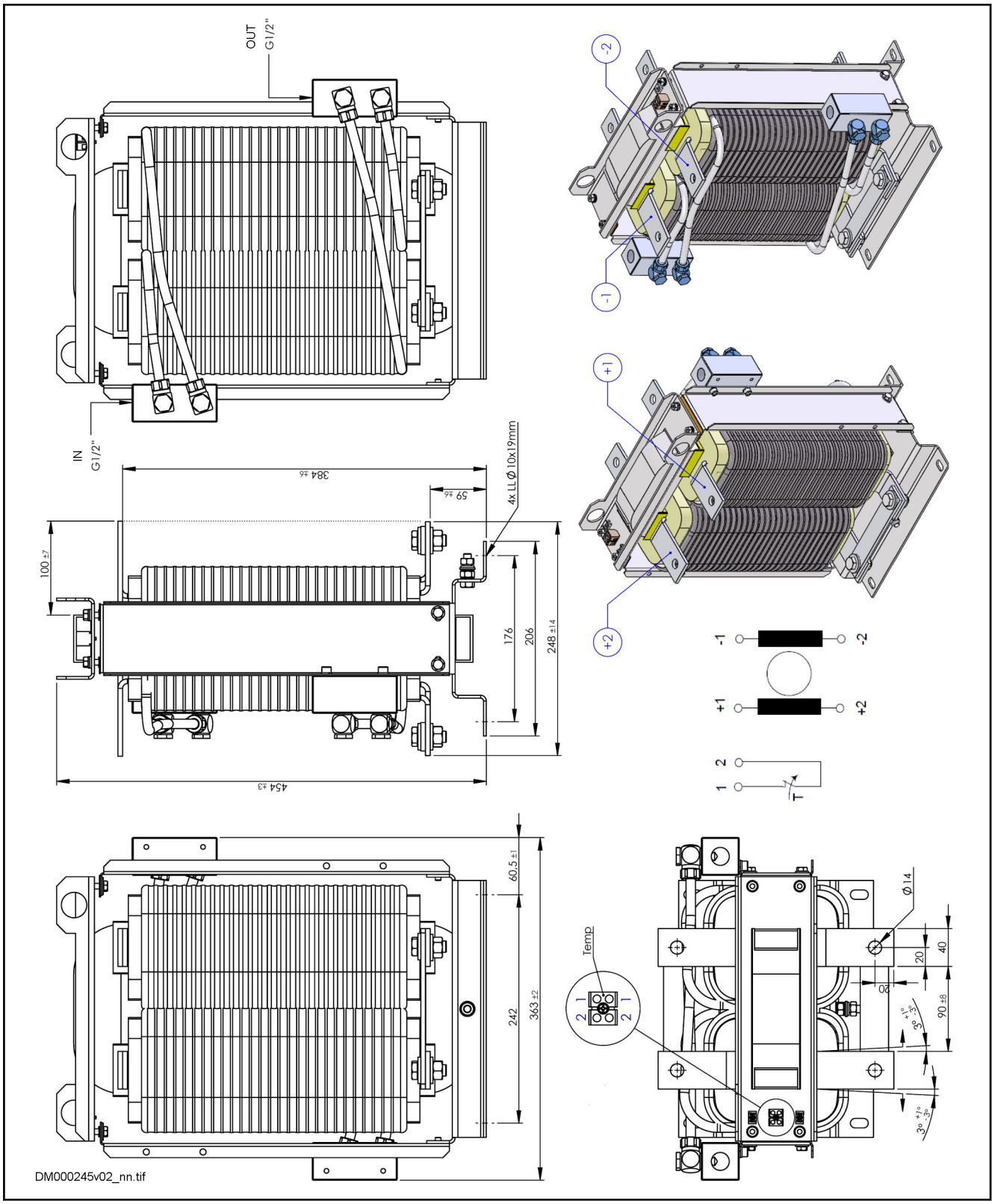


Fig. 8-77: HLL05.1F-04M0-S0380

HLL05.1F-04M0-S0475

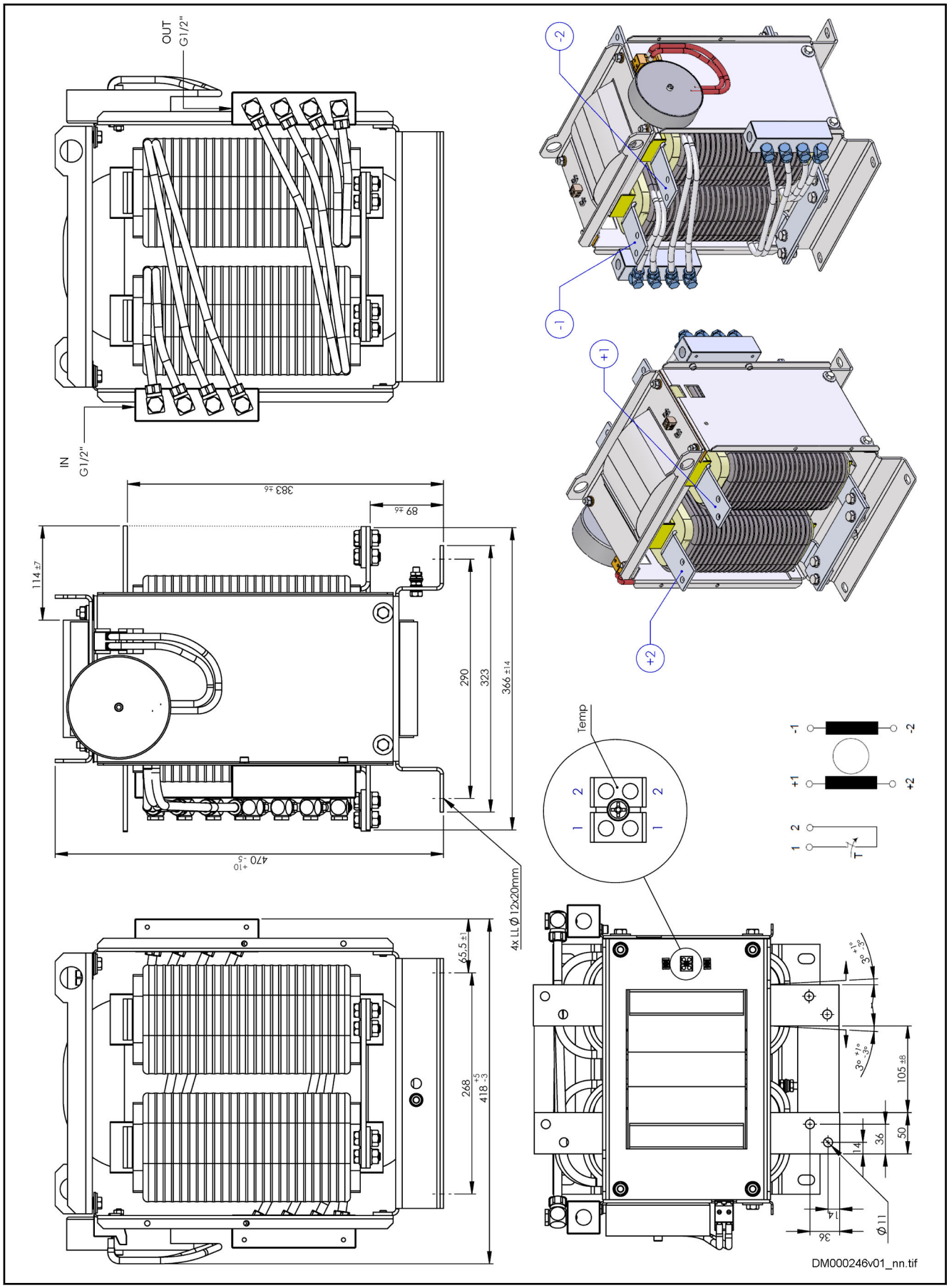


Fig. 8-78: HLL05.1F-04M0-S0475

HLL05.1W-04M0-S0475

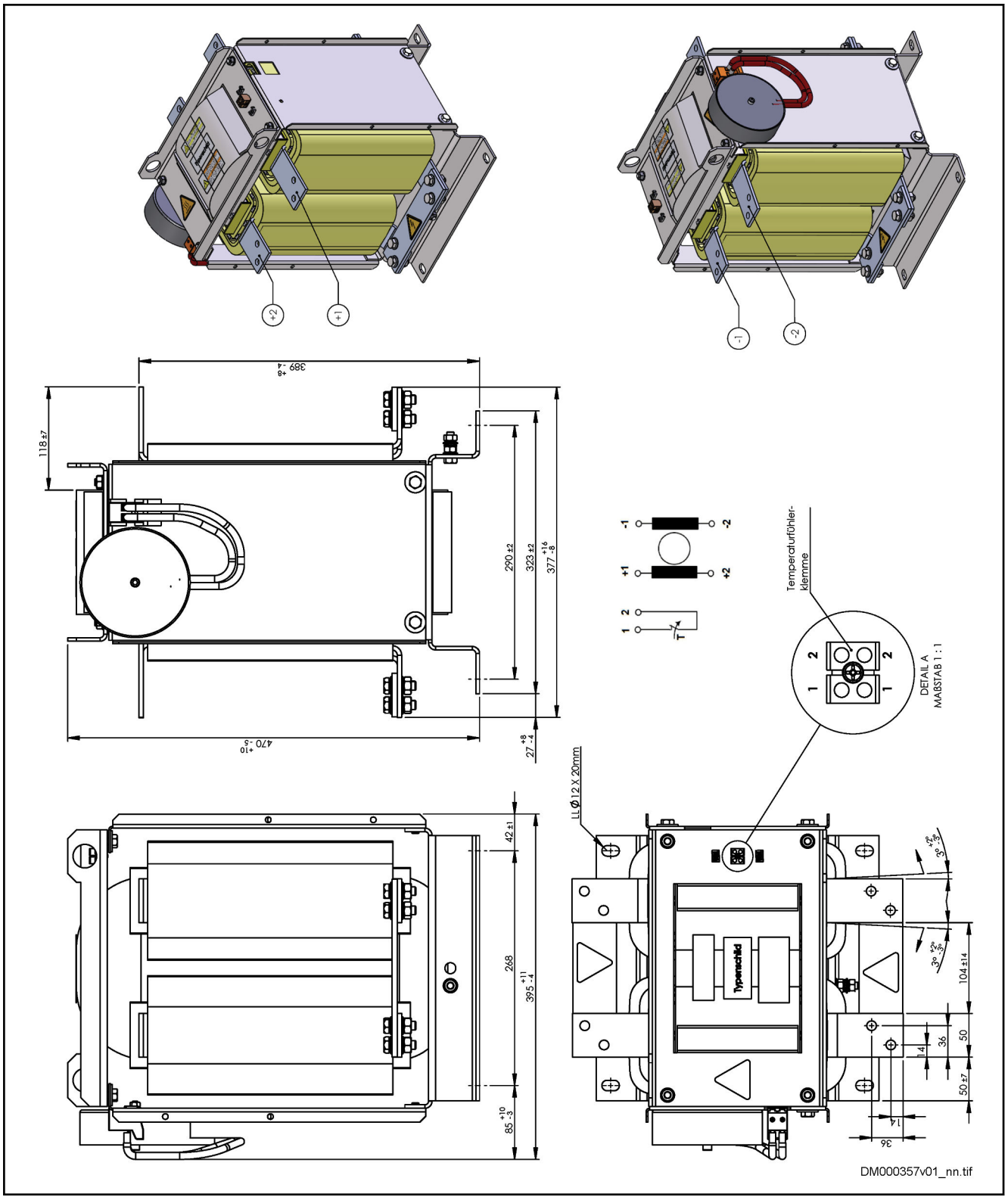


Fig. 8-79: HLL05.1W-04M0-S0475

HLL05.1F-04M0-S0603

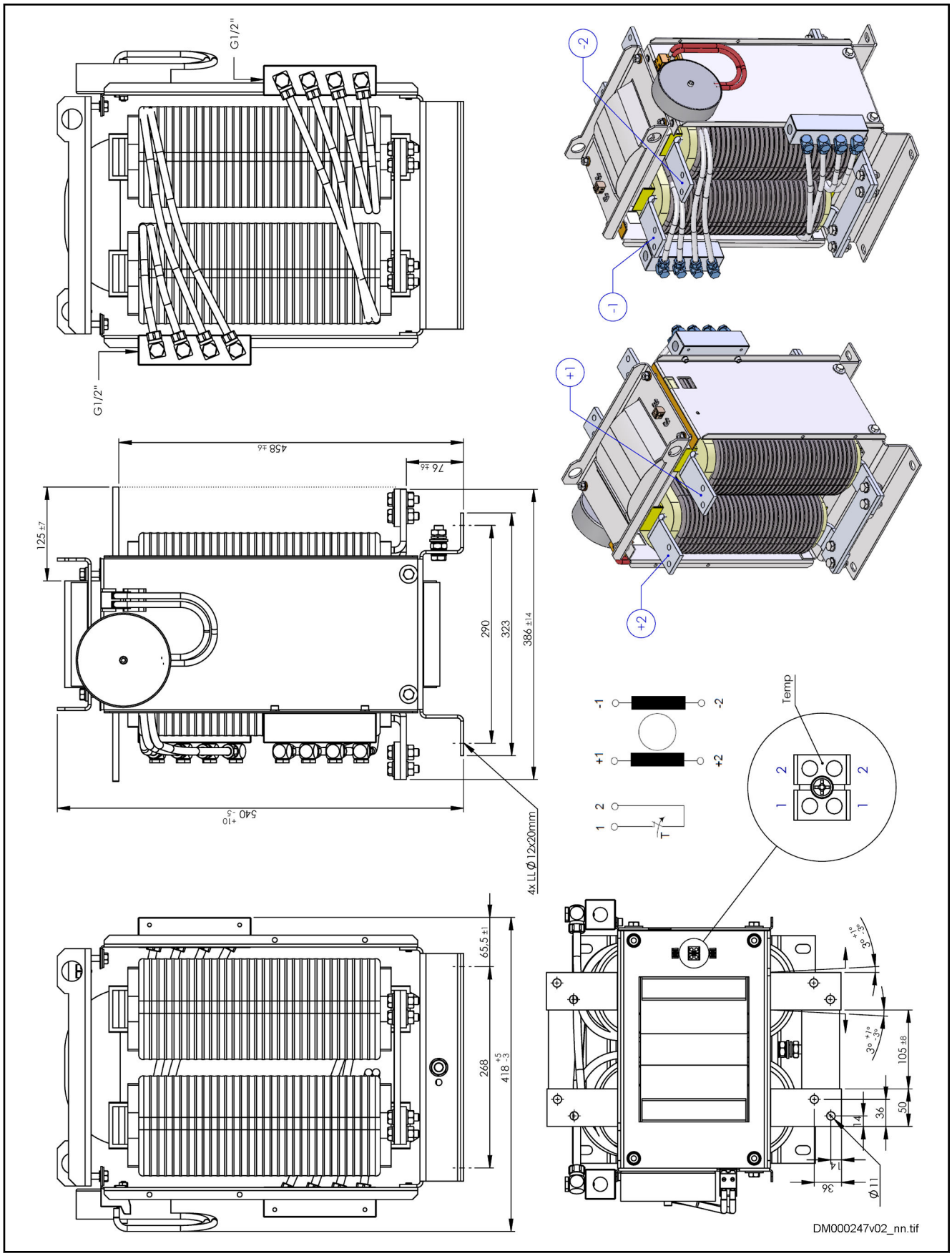


Fig. 8-80: HLL05.1F-04M0-S0603

HLL05.1F-04M0-S0720

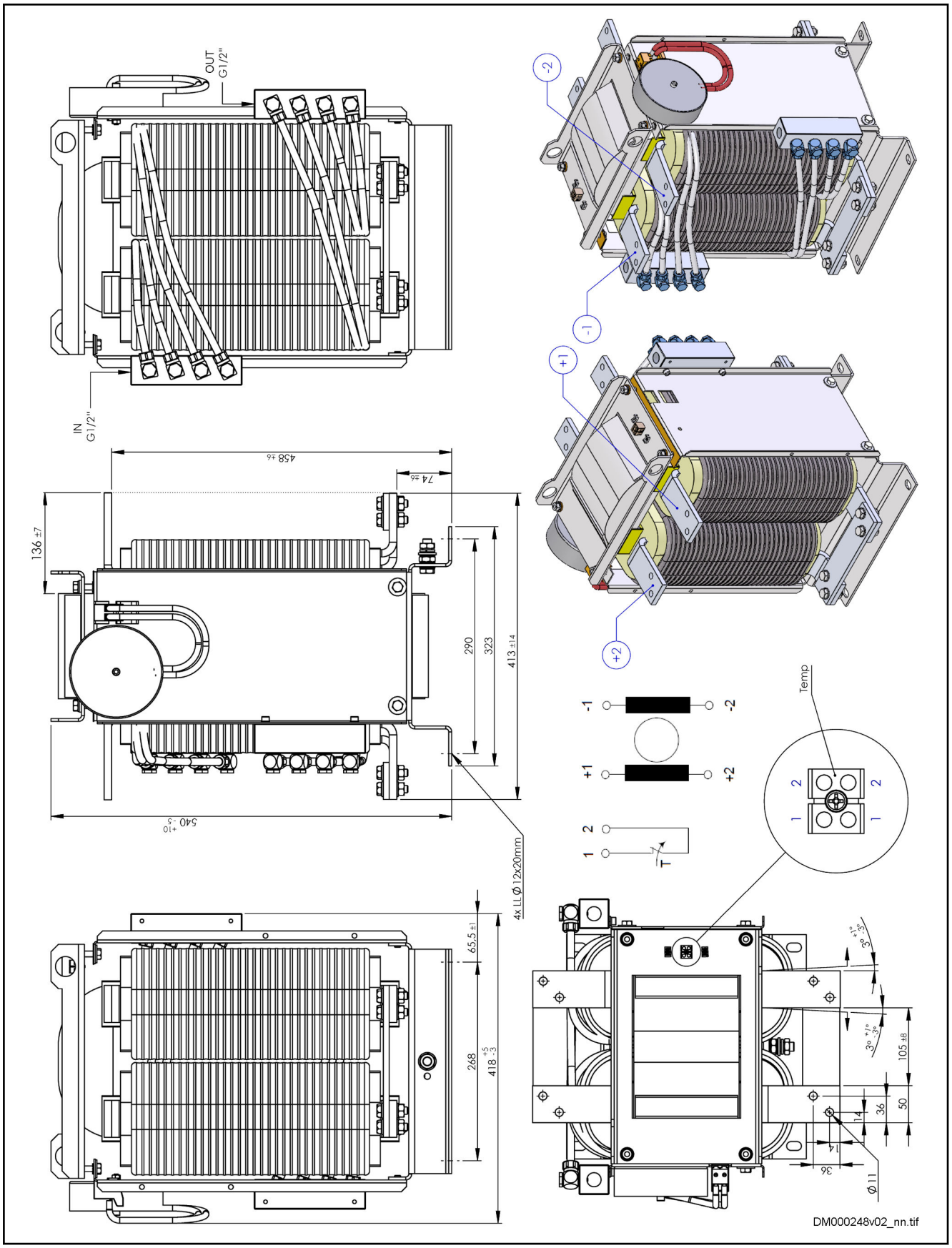


Fig. 8-81: HLL05.1F-04M0-S0720

Data

Choke HLL05.1x -04M0-…	Inductance [mH]	U_{DC} = 750 V		U_{DC} = 1100 V 1)		Power dissipation 2) [W]		Weight [kg]
		Continuous current [A]	Allowed leakage capacitance [µF]	Continuous current [A]	Allowed leakage capacitance [µF]	Air	Water	
S0202 (air-cooled)	4	202	1.2	156	0.8	380	-	27
S0202 (water-cooled)	4	202	1.2	156	0.8	230	400	23
S0243	4	243	1.2	187	0.8	240	430	25
S0303 (air-cooled)	4	303	1.2	234	0.8	400	-	38
S0303 (water-cooled)	4	303	1.2	234	0.8	270	480	33
S0380	4	380	1.2	293	0.8	330	580	36
S0475 (air-cooled)	4	475	1.2	367	0.8	850	-	85
S0475 (water-cooled)	4	475	1.2	367	0.8	420	760	86
S0603	4	603	1.2	465	0.8	530	940	98
S0720	4	720	1.2	556	0.8	540	960	110

1) Use HLL05.1x-…-**11**-01U2
2) At an ambient temperature of 30 °C and a water inlet temperature of 50 °C

Tab. 8-65: HLL05.1, data

Temperature monitoring contact

- Trigger temperature: 160 °C
- N/C in one of the windings
- Electric switching capacity:
  - 1 A
  - AC 250 V
  - DC 24 V

Water cooling

Requirements

- maximum ambient temperature: 40 °C (with derating: 55 °C)
- maximum water inlet temperature: 60 °C
- maximum operating pressure: 4 bar

HLL05.1F-04M0-…-N-D7/11	Flow [l/min]	Filling capacity [l]	Pressure drop [bar]				
			5 l/min	6 l/min	7 l/min	8 l/min	9 l/min
S0202	≥ 6	0.7	0.09	0.13	0.17	0.22	0.27
S0243	≥ 6	0.8	0.10	0.14	0.18	0.23	0.28
S0303	≥ 6	1.0	0.12	0.17	0.22	0.28	0.35
S0380	≥ 6	1.1	0.14	0.19	0.25	0.32	0.40
S0475	≥ 6	1.2	0.01	0,02	0.03	0.04	0.04
S0603	≥ 8	1.7	0,02	0.03	0.04	0.05	0.06
S0720	≥ 8	1.9	0,02	0.03	0.04	0.05	0.06

Tab. 8-66: Water cooling

Mounting

Allowed mounting position: vertical

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

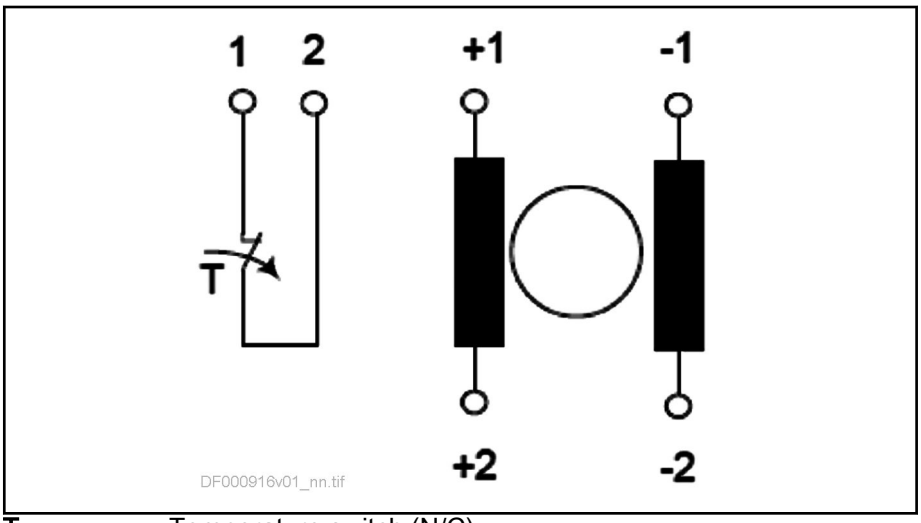
Degree of protection of the component: **IP00**

Mount a **touch guard**!

☞ The components are dimensioned for operation in the control cabinet and may have a sound pressure level > 85 dBA.

When mounting the component outside a closed control cabinet, install a suitable noise protection.

Circuit diagram



T Temperature switch (N/C)
+1 +2, -1 -2 DC bus connection
Fig. 8-82: Circuit diagram

☞ The DC bus connections of the choke may be switched **on both sides**.

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!

Before accessing the device, wait at least **30 minutes** after switching off the supply voltages to allow **discharging**.

The discharge time can be more than 30 minutes if DC bus ground capacitor pairs are used.

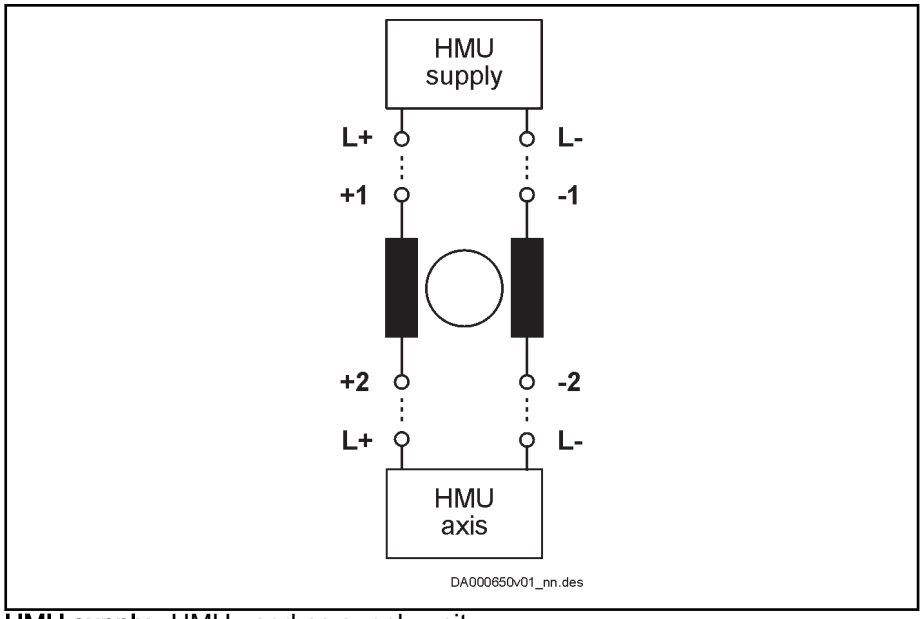
Mount a **touch guard**!

⚠ WARNING **Risk of burns and damage due to hot surfaces!**

Chokes reach high temperatures during operation.

Before working on the choke, allow it to cool down. Wear protective gloves.

Lead the cables and cooling water hoses to the choke at a sufficient distance. Cables or hoses must not touch the metal frame of the choke.



HMU supply HMU used as supply unit
HMU axis HMU used as drive controller

Fig. 8-83: Connection diagram

DC bus chokes should **not** be simultaneously connected in parallel at the input and at the output.

The contact bars of a DC bus choke carry high voltages and become hot.

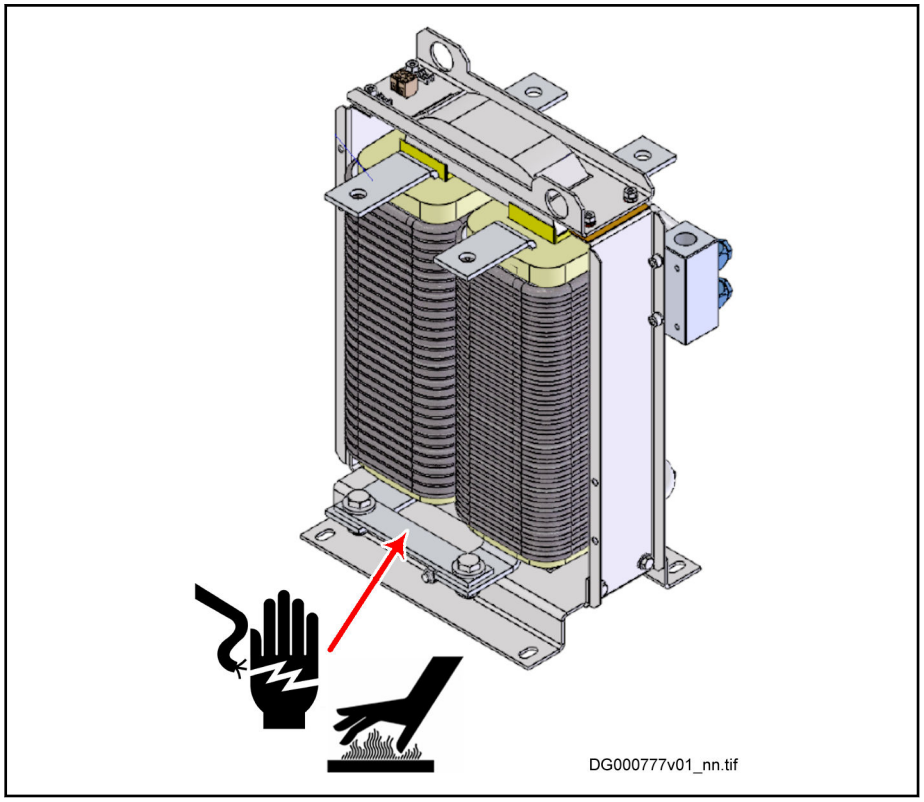


Fig. 8-84: DC bus choke

HLL05.1…	Connection points
W-04M0-S0202…	Aluminum contact point [1]; hole: 11 mm
F-04M0-S0202…	
F-04M0-S0243…	
W-04M0-S0303…	
F-04M0-S0303…	
F-04M0-S0380…	Aluminum contact point [1]; hole: 14 mm
W-04M0-S0475…	Aluminum contact point [1]; hole: 2 × 11 mm
F-04M0-S0475…	
F-04M0-S0603…	
F-04M0-S0720…	

1) Use cupal disks for the aluminum contact point connection: See chapter 11.6 "Aluminum contact points and cupal disks" on page 613.

Tab. 8-67: Connection points

HLL05 to HMU05 assignment

HLL05		HMU05.1N-…-A4-D7						
		F0140-0350	F0170-0430	F0220-0510	F0270-0660	F0340-0820	F0430-1040	F0540-1300
HLL05.1x-04M0-…-N-D7/11	S0202	✓						
	S0243		✓					
	S0303			✓				
	S0380				✓			
	S0475					✓		
	S0603						✓	
	S0720							✓

Tab. 8-68: Assignment HLL05 ↔ HMU05.1N-…-A4-D7

HLL05		HMU05.1N-…-A5-11					
		F0140-0210	F0170-0250	F0220-0300	F0270-0370	F0400-0600	F0540-0750
HLL05.1x-04M0-…-N-11	S0202	✓	✓				
	S0243			✓			
	S0303				✓		
	S0380						
	S0475					✓	
	S0603						✓
	S0720						

Tab. 8-69: Assignment HLL05 ↔ HMU05.1N-…-A5-11

☞ In general, HLL05 DC bus chokes must only be operated in connection with **DC bus ground capacitor pairs (HAS04.1-003)**.

8.3.7 DC bus ground capacitor pair (HAS04.1-003)

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	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 NN1 = Without discharging resistors																																								
⑥	**Other design:** NN = None																																								

Tab. 8-70: HAS04, type code

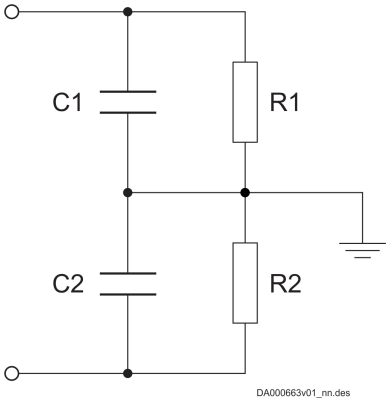
data

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

Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electrical component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch. Measure the electrical voltage both conductor against conductor and conductor against ground (PE).

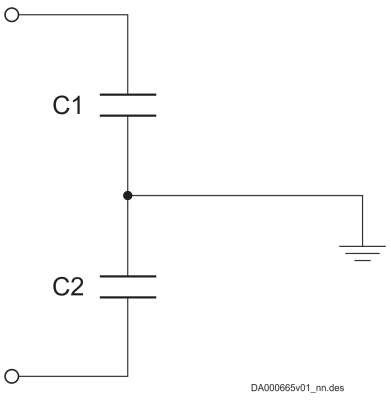
Particularly if **DC bus ground capacitor pairs without discharging resistors (HAS04.1-003-NN1-NN)** are used, dangerous voltages against ground may be present for more than **24 hours** after the power supply was switched off. Only when voltage cannot be measured anymore between the positive and the negative DC bus connections is it allowed to discharge the DC bus ground capacitor pairs against ground. For this purpose, use the appropriate high-resistance device (e.g., DUSPOL® by "Benning Elektrotechnik und Elektronik GmbH & Co. KG"; observe the Operating Manual!).

HAS04.1-003-NNN-NN (with discharging resistors)

Description	Unit	Value	Circuit diagram	Degree of protection
Voltage	V	AC 500		IP00
		DC 1200		
		Superposition AC, DC $1.4 \times U_{rms,AC} + U_{DC} \leq 1200$ V f ≤ 1 kHz		
Maximum current (f ≥ 10 kHz)	A_{rms}	2 × 30		
Capacitance	µF	2 × 2.5 ±20%		
Discharging resistors	MΩ	2 × 10		

Tab. 8-71: Data, HAS04.1-003-NNN-NN

HAS04.1-003-NN1-NN (without discharging resistors)

Description	Unit	Value	Circuit diagram	Degree of protection
Voltage	V	AC 550		IP00
		DC 1500		
		Superposition AC, DC $1.4 \times U_{rms,AC} + U_{DC} \leq 1500$ V f ≤ 1 kHz		
Maximum current (f ≥ 10 kHz)	A_{rms}	2 × 30		
Capacitance	µF	2 × 2.5 ±20%		

Tab. 8-72: Data, HAS04.1-003-NN1-NN

If there is **no IT mains** available, always use DC bus ground capacitor pairs **with** discharging resistors (HAS04.1-003-NN**N**-NN)!

There are applications in **IT mains**, for which the isolation monitoring does not allow any discharging resistors against ground. For this purpose, there are DC bus ground capacitor pairs **without** discharging resistors (HAS04.1-003-NN**1**-NN).

Check for IT mains in individual cases if the condition for voltage "superposition AC, DC" is fulfilled for the required cases of error (e.g. continued operation for a limited period of time in case a mains-side ground fault occurs) (see tab. 8-71 "Data, HAS04.1-003-NNN-NN" on page 305, tab. 8-72 "Data, HAS04.1-003-NN1-NN" on page 305).

If possible, HAS04.1-003-NNN-NN should also be used in IT mains if this is allowed by the isolation monitoring and the proof voltage!

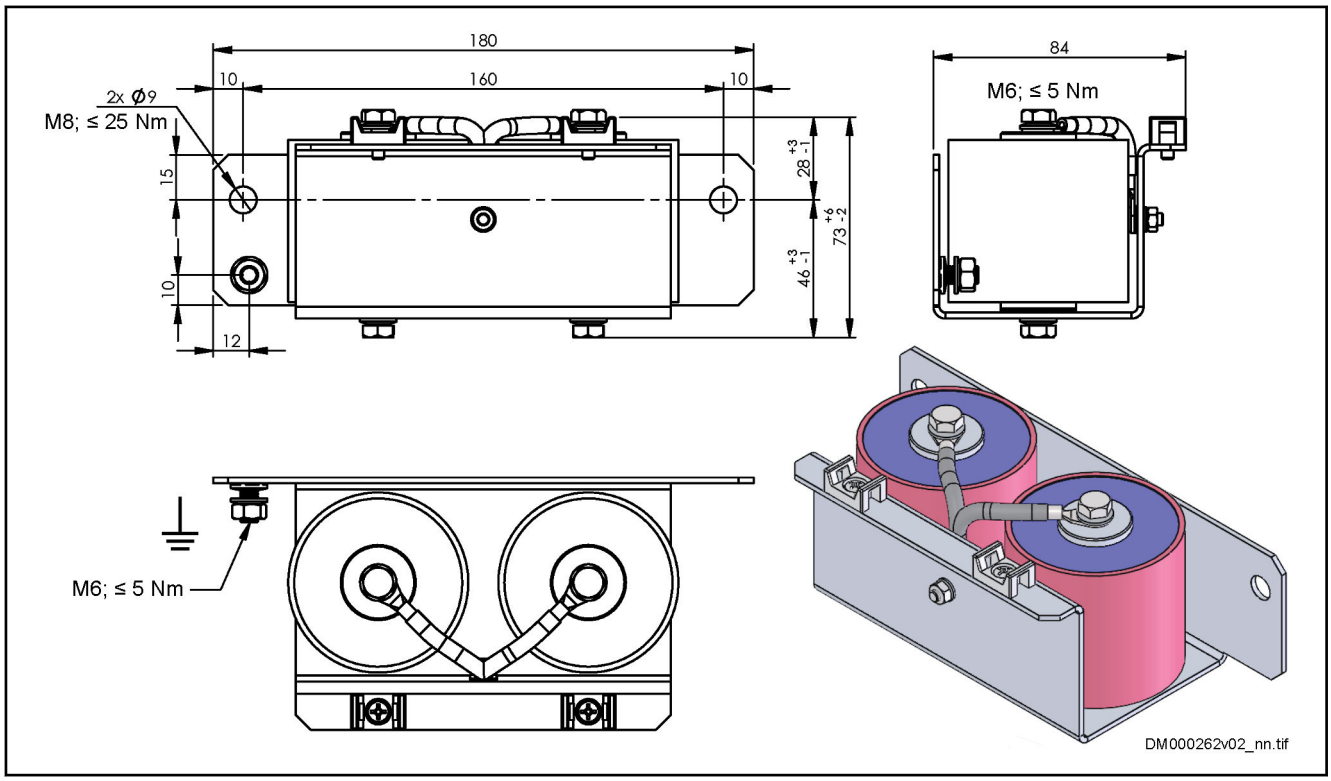


Fig. 8-85: HAS04.1-003-NNN-NN (with discharging resistors); dimensions

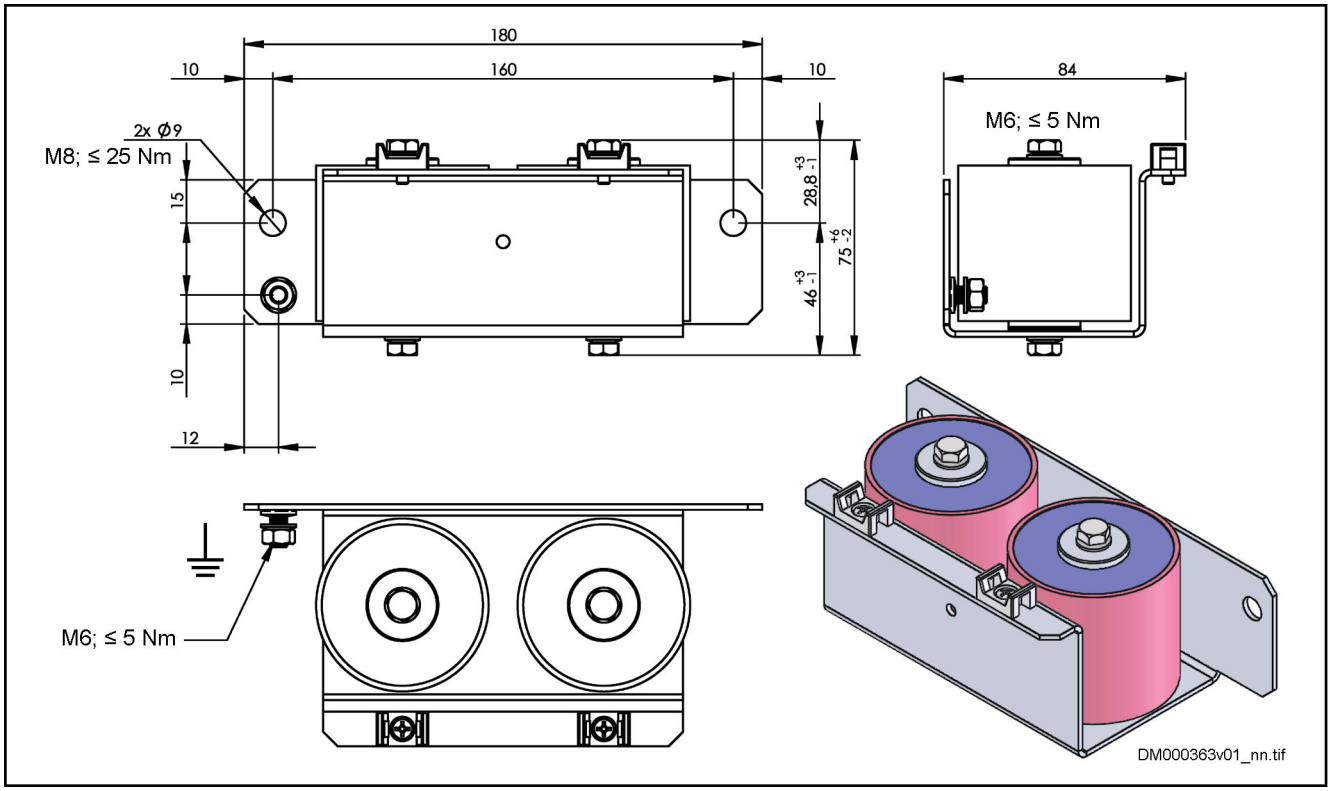


Fig. 8-86: HAS04.1-003-NN1-NN (without discharging resistors); dimensions

Mounting

⚠ WARNING **High ground leakage current! Danger to life, risk of injury by electric shock!**

Always operate the component with the connected **equipment grounding conductor**!

Mounting the DC bus ground 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.

  Screws: M8; tightening torque: ≤ 25 Nm
- Allowed mounting position: any
- Connect the DC bus ground capacitor pairs with short cables (cross section: 25 mm ^{2}) with L+ and L- of the DC bus bar.

  Connection: M6; tightening torque: ≤ 5 Nm
- Ground the DC bus ground capacitor pairs at the grounding point with a copper wire (at least 10 mm^2)
- Mounting the touch guard of the DC bus connections
- An additional warning label is attached to every HAS04.1-003-NN**1**-NN DC bus ground capacitor pair (version without discharging resistors). The warning label indicates that the **entire** DC bus loading also leads to ground.

  Place the warning labels near the DC bus connections (e.g. protective covers, HMU connections, DC bus choke) so that they are clearly visible.

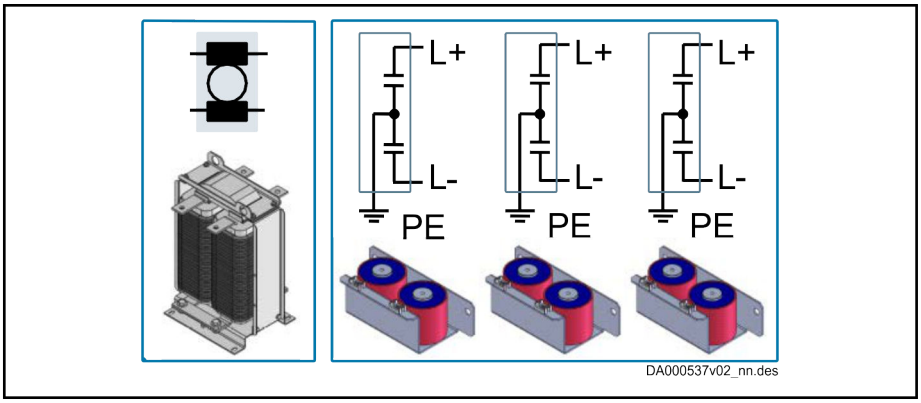
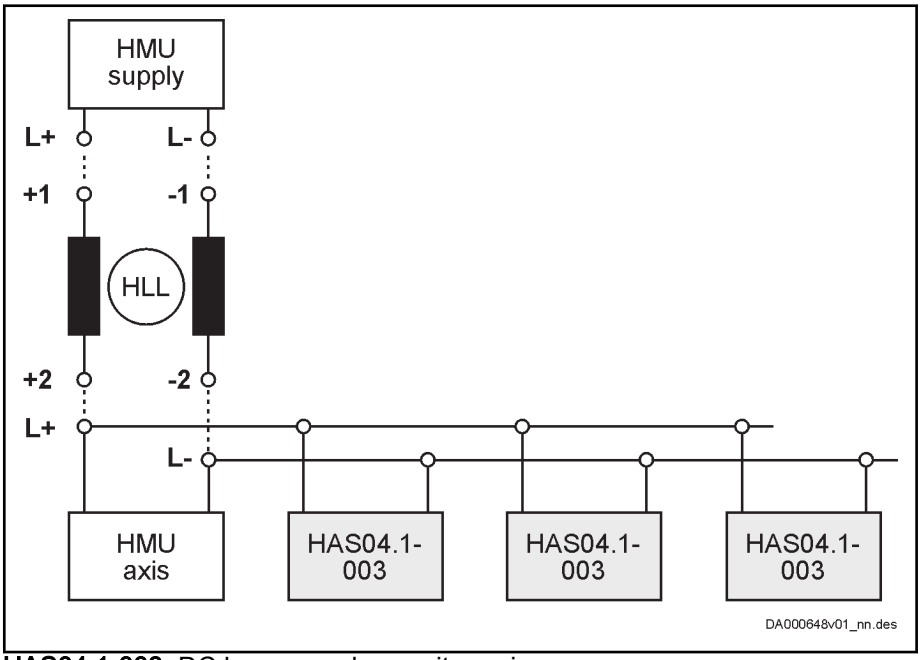


Fig. 8-87: HLL DC bus choke (left) and 3 DC bus ground capacitor pairs (right)



HAS04.1-003 DC bus ground capacitor pair
HLL DC bus choke
HMU supply HMU used as supply unit
HMU axis HMU used as drive controller

Fig. 8-88: Connection

8.3.8 HLR05 external braking resistor

HLR05 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	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. 8-73: HLR05, type code

Dimensions

HLR05.1W-54K0-N05R4, …-70K0-N04R0

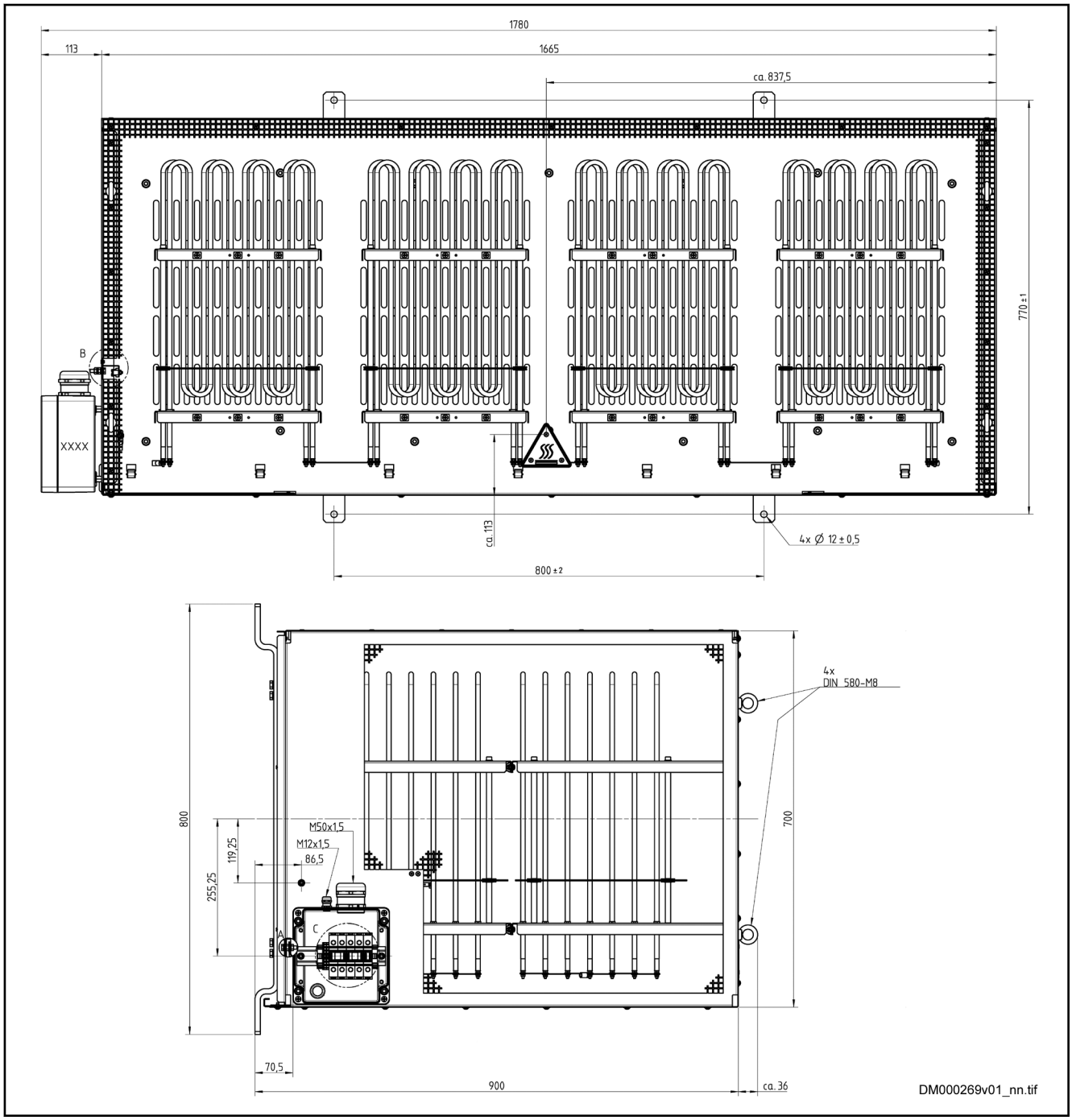


Fig. 8-89: HLR05.1W-54K0-N05R4, …-70K0-N04R0; dimensions in mm

Data

Description	Unit	HLR05.1W-…	
		54K0-N05R4	70K0-N04R0
Resistance	Ω	5.4 ±10%	4 ±10%
Continuous power	kW	54	70
820 V_{DC} peak power	kW	124	168
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. 8-74: HLR05.1W, data

Installation

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

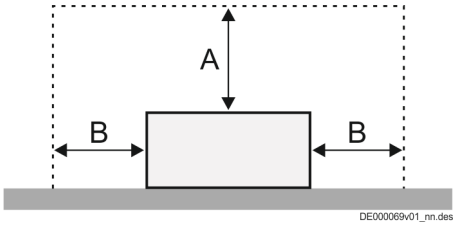
Observe the indicated minimum distances!

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!
- 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
- Minimum distance to non-flammable, heat-sensitive components:



A: 1000 mm

B: 600 mm

Cables

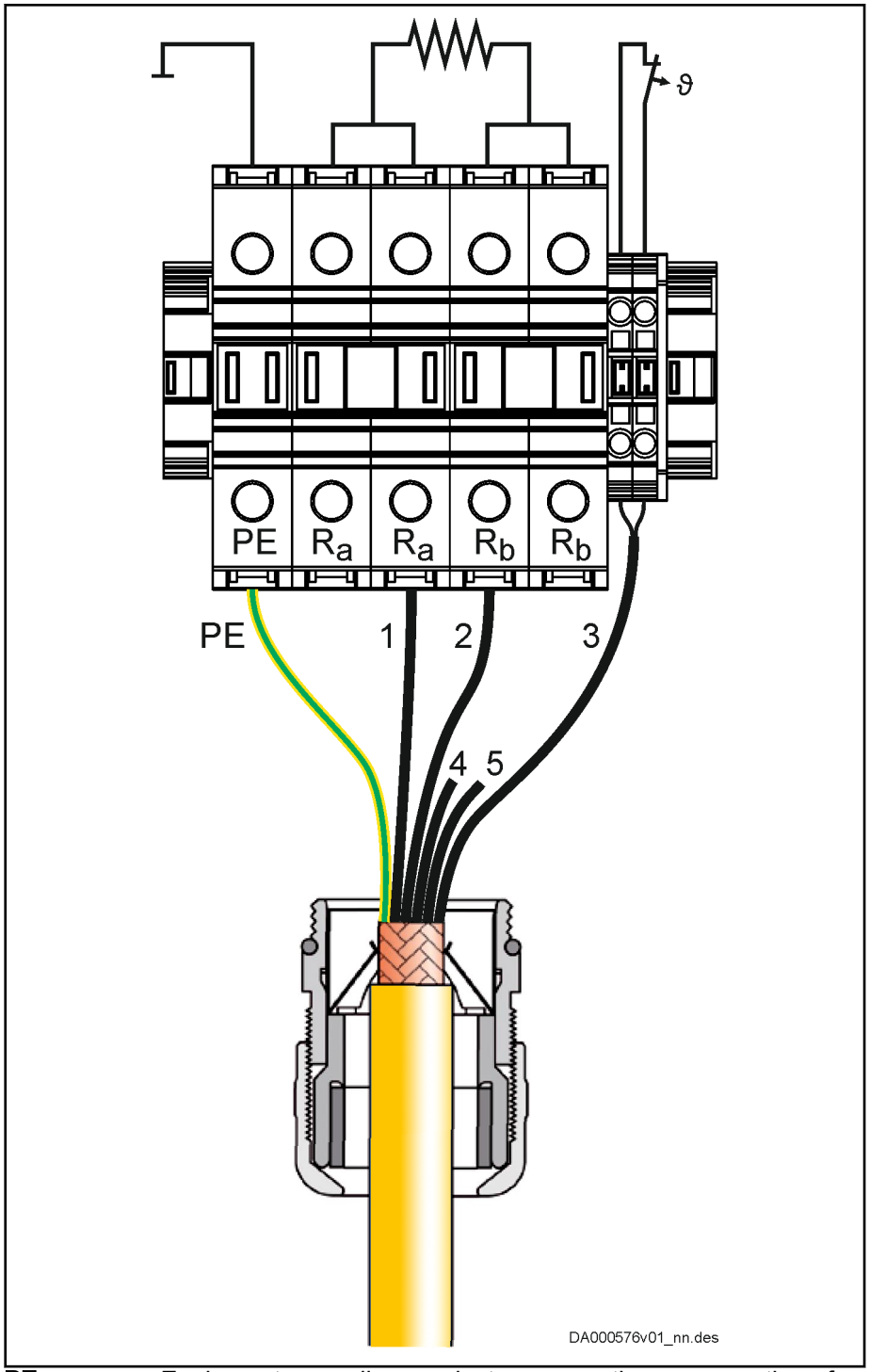
- Length: ≤ 100 m
- Keep supply and return lines in parallel and as close together as possible or twist them
- Place cables away from signal and data lines
- Place so they are protected against short-circuiting and ground faults

You can use Rexroth cables:

HLR05.1W-…	Cables
54K0-N05R4	INK0607, mat. no.: R911245289
70K0-N04R0	INK0667, mat. no.: R911245292

Tab. 8-75: 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. 8-90: Connection point

8.3.9 HLT05 braking unit

HLT05 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	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																					

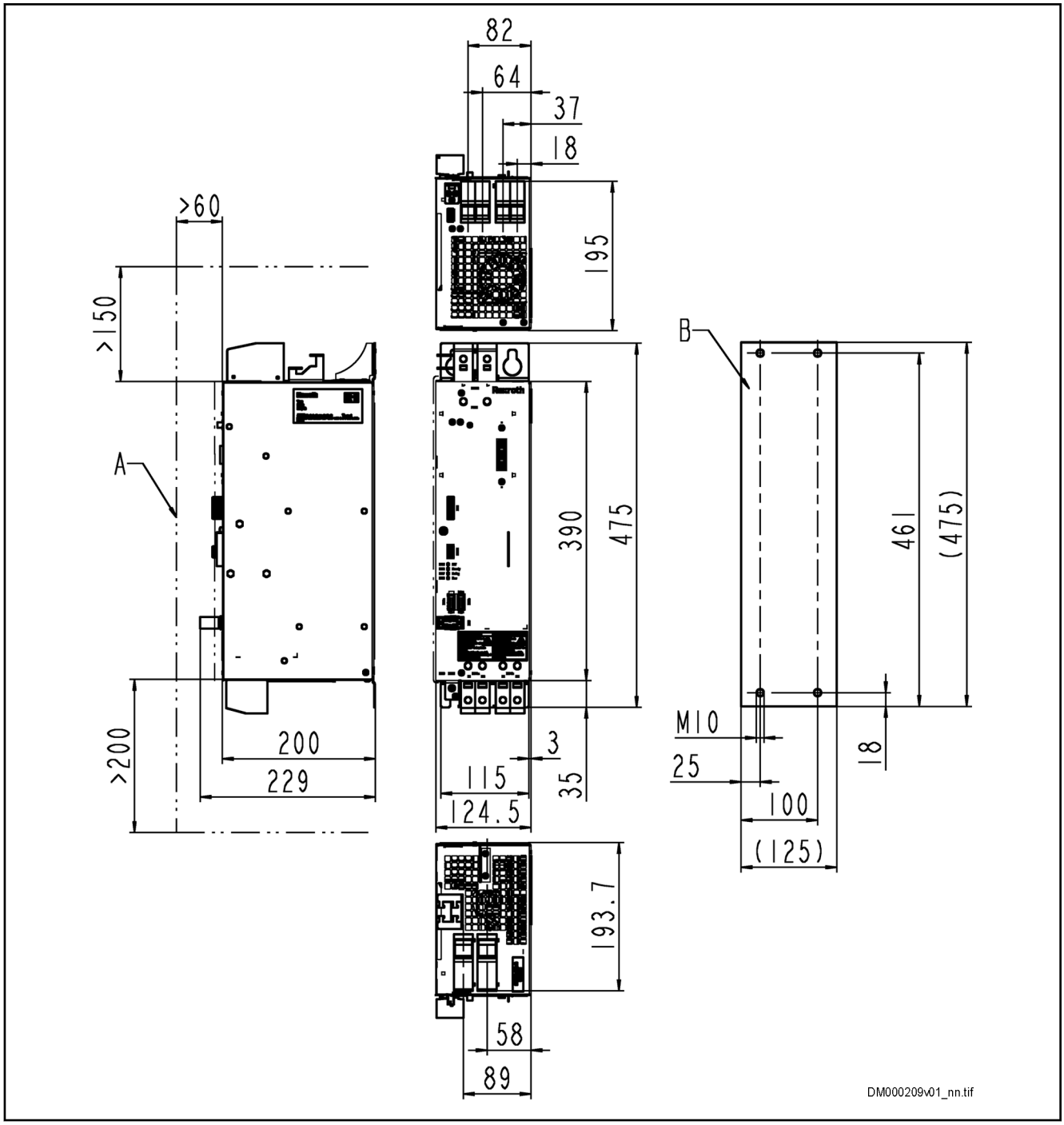
①	**Product:** HLT = Braking unit
②	**Series:** 05 = 05
③	**Design:** 1 = 1
④	**Cooling type, type of construction:** W = Air cooling
⑤	**Nominal power:** 045K = 45 kW [1)] 105K = 105 kW 245K = 245 kW [1)]
⑥	**Degree of protection:** N = IP00
⑦	**Nominal DC bus voltage:** D7 = DC 750 V [1)] 11 = DC 1100 V
⑧	**Other design:** NNNN = None

1) "045K" and "245K" nominal power only with "D7" nominal DC bus voltage

Tab. 8-76: HLT05, type code

Dimensions HLT05

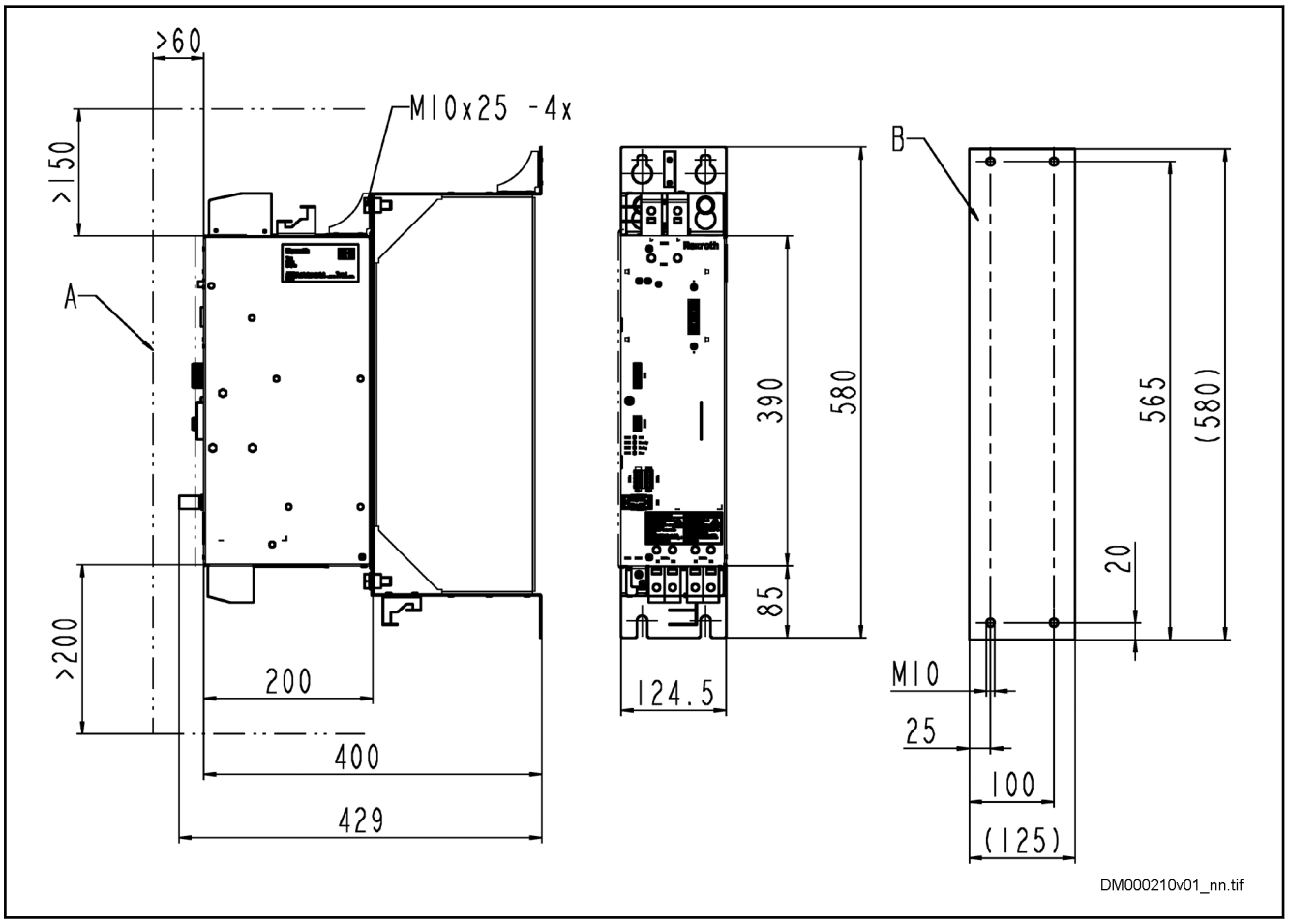
HLT05.1W-045K, -105K, dimensional drawing



A Minimum mounting clearance
B Boring dimensions

Fig. 8-91: HLT05.1W-045K, -105K, dimensional drawing

HLT05.1W-045K, -105K with HAS03.1-006 mounting plate (200 mm), dimensional drawing

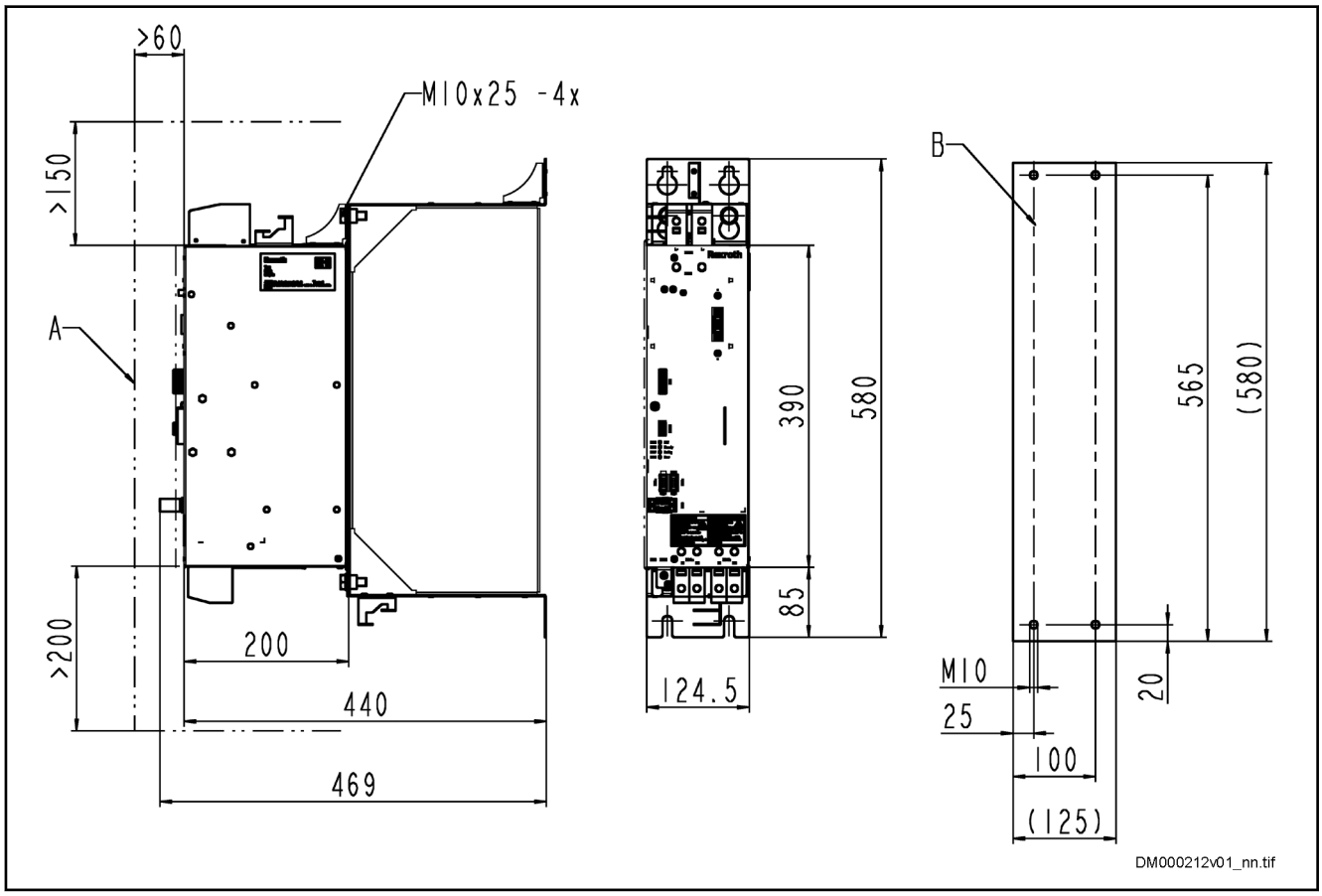


M10x25 Tightening torque = 40 Nm

Fig. 8-92: HLT05.1W-045K, -105K with mounting plate HAS03.1-006 for height leveling and depth leveling to 400 mm depth, dimensional drawing

The mounting plate is used to combine HNA05 and **air-cooled HMU05 without push-through technology**.

HLT05.1W-045K, -105K with HAS03.1-007 mounting plate (240 mm), dimensional drawing

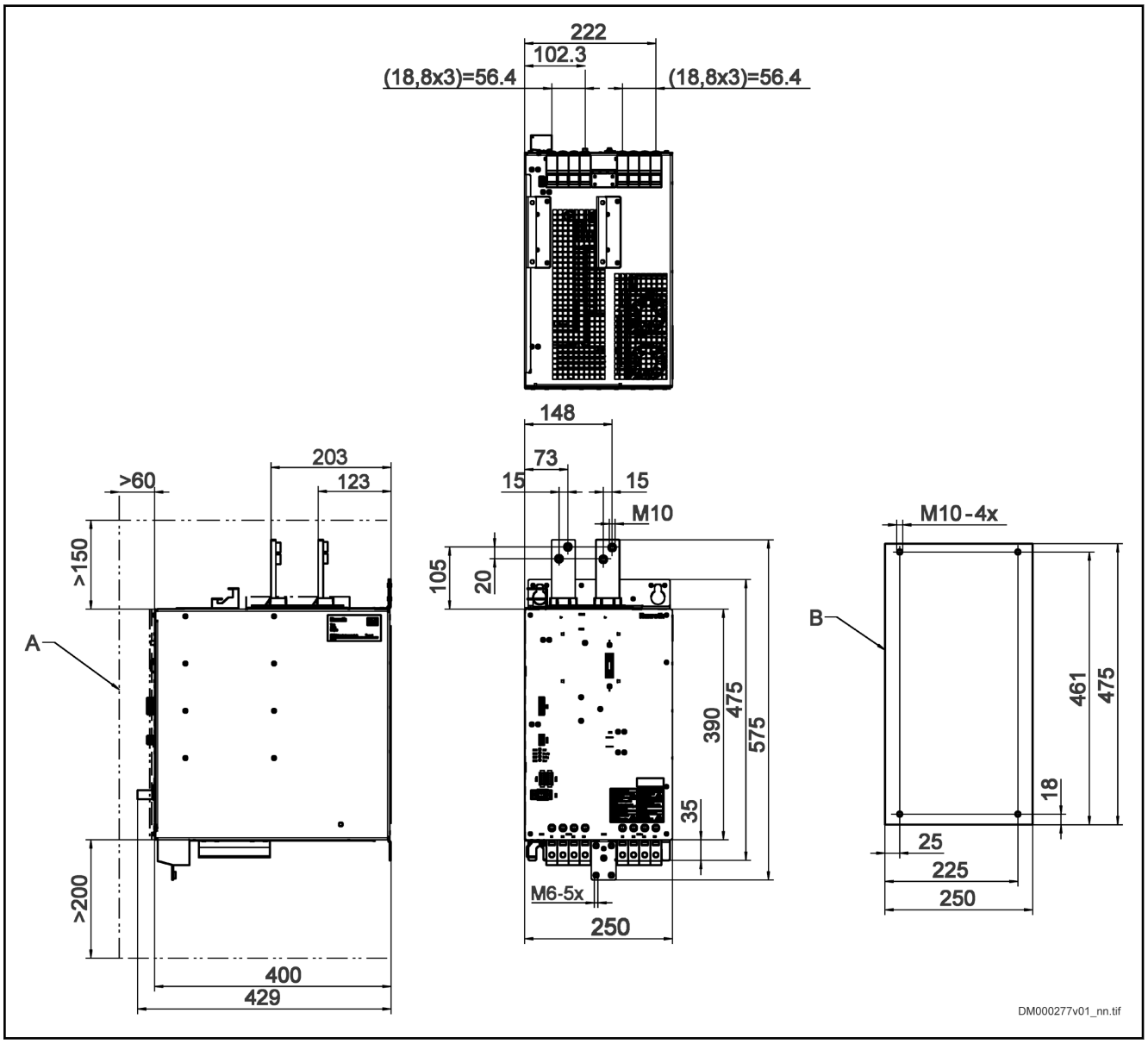


A Minimum mounting clearance
B Boring dimensions
M10x25 Tightening torque = 40 Nm

Fig. 8-93: HLT05.1W-045K, -105K with mounting plate HAS03.1-007 for height leveling and depth leveling to 440 mm depth, dimensional drawing

The mounting plate is used to combine HNA05 and **liquid-cooled HMU05**.

HLT05.1W-245K, dimensional drawing



A Minimum mounting clearance
B Boring dimensions

Fig. 8-94: HLT05.1W-245K, dimensional drawing

Data HLT05

HLT05.1W- ... -D7

Description	Symbol	Unit	HLT05.1W- ... -D7		
			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	$U_{emergency}$	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. 8-77: HLT05.1W- ... -D7, data

HLT05.1W- ... -11

Description	Symbol	Unit	HLT05.1W- ... -11
			105K
Continuous power	P_{BD}	kW	105
Short time power (60 s)	P_{BK}	kW	145
Peak power (2 s)	P_{BS}	kW	205
Minimum braking resistance	R_{min}	Ω	5.2
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	1150
Max. braking transistor switch-on threshold	$U_{HLT_On_max}$	V	1180
Workload-based delay of braking transistor switch-on threshold	$U_{HLT_On_d}$	V	30
Emergency comparator switch-on voltage	$U_{emergency}$	V	1255
Max. input voltage	U_{max}	V	1290
Continuous current for DC connection points	I_{nom}	A	150
Power dissipation (full load)	P_{Diss_max}	W	400
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
Short circuit current rating	SCCR	kA rms	85
Weight	m	kg	7.5

Tab. 8-78: HLT05.1W- ... -11, data

Connection diagram

HLT05

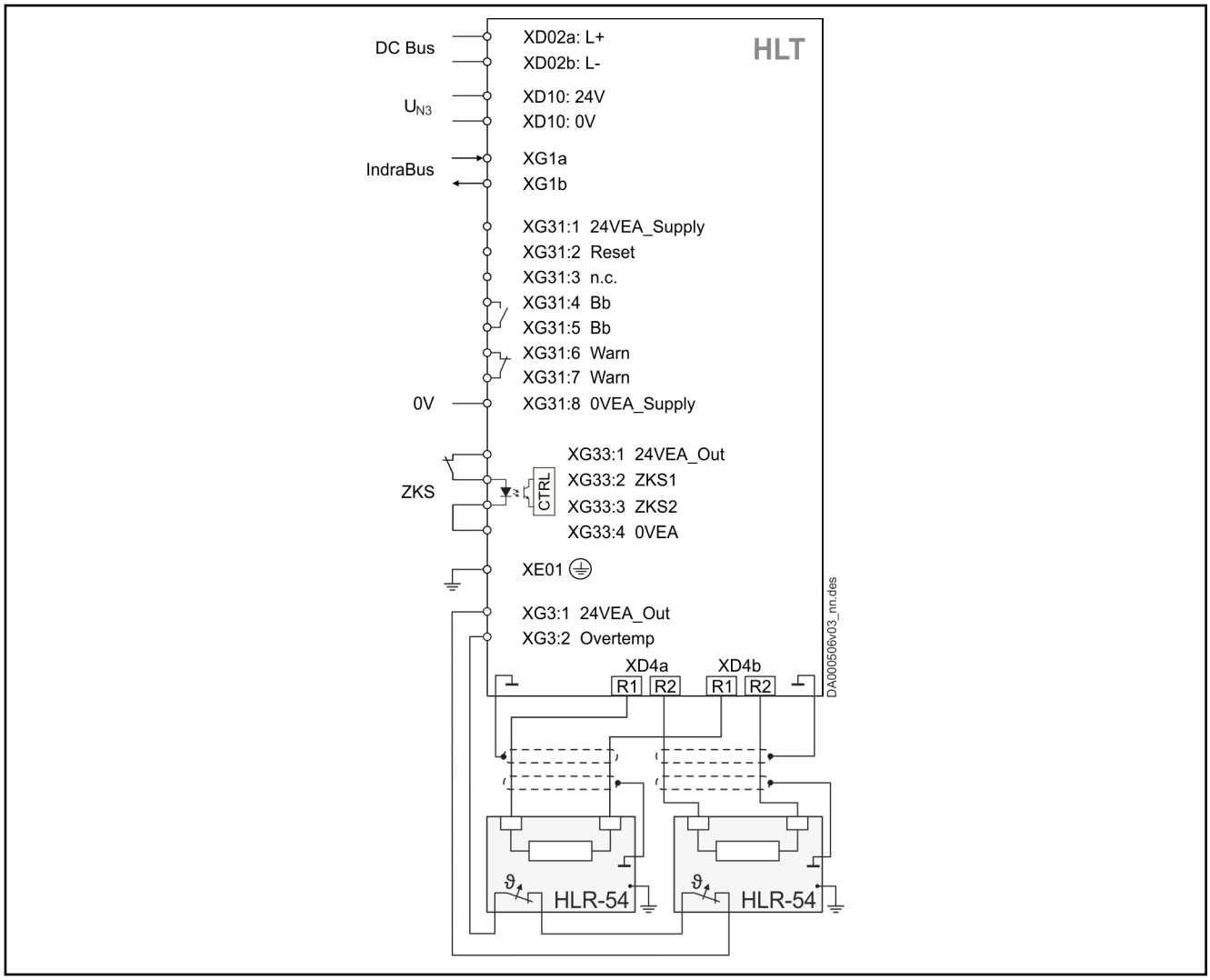


Fig. 8-95: HLT05.1W-045K, -105K connection diagram

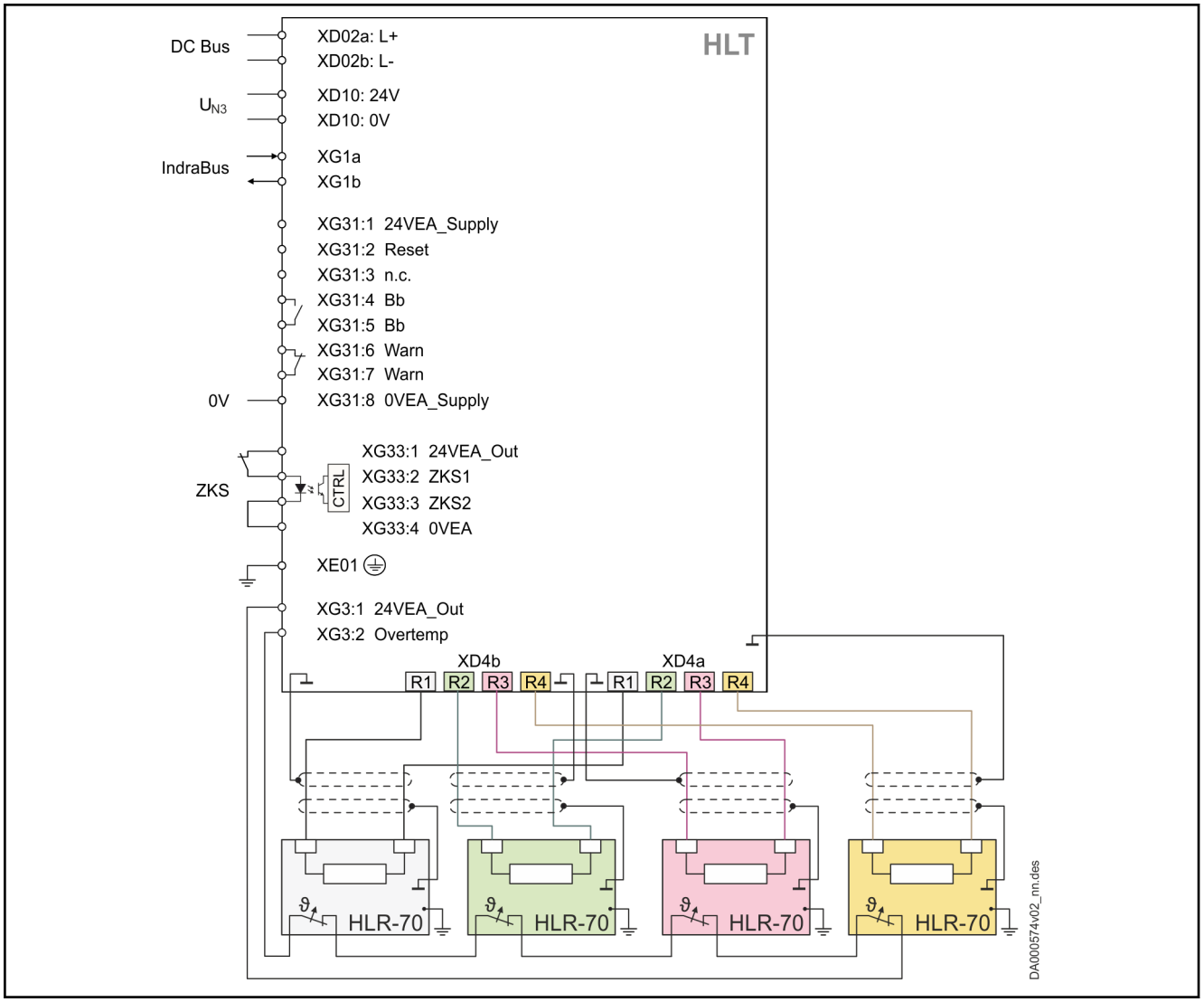


Fig. 8-96: HLT05.1W-245K connection diagram

Internal wiring of connection points XD02 and XD4:

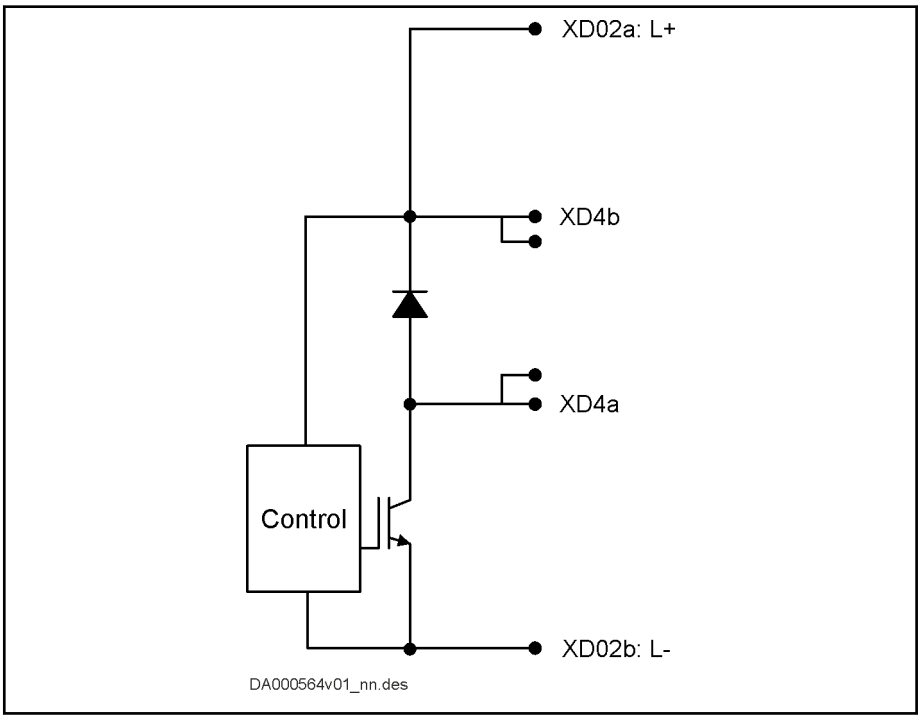


Fig. 8-97: Internal wiring of connection points XD02 and XD4

HLT05 / HNA05 / HMU05

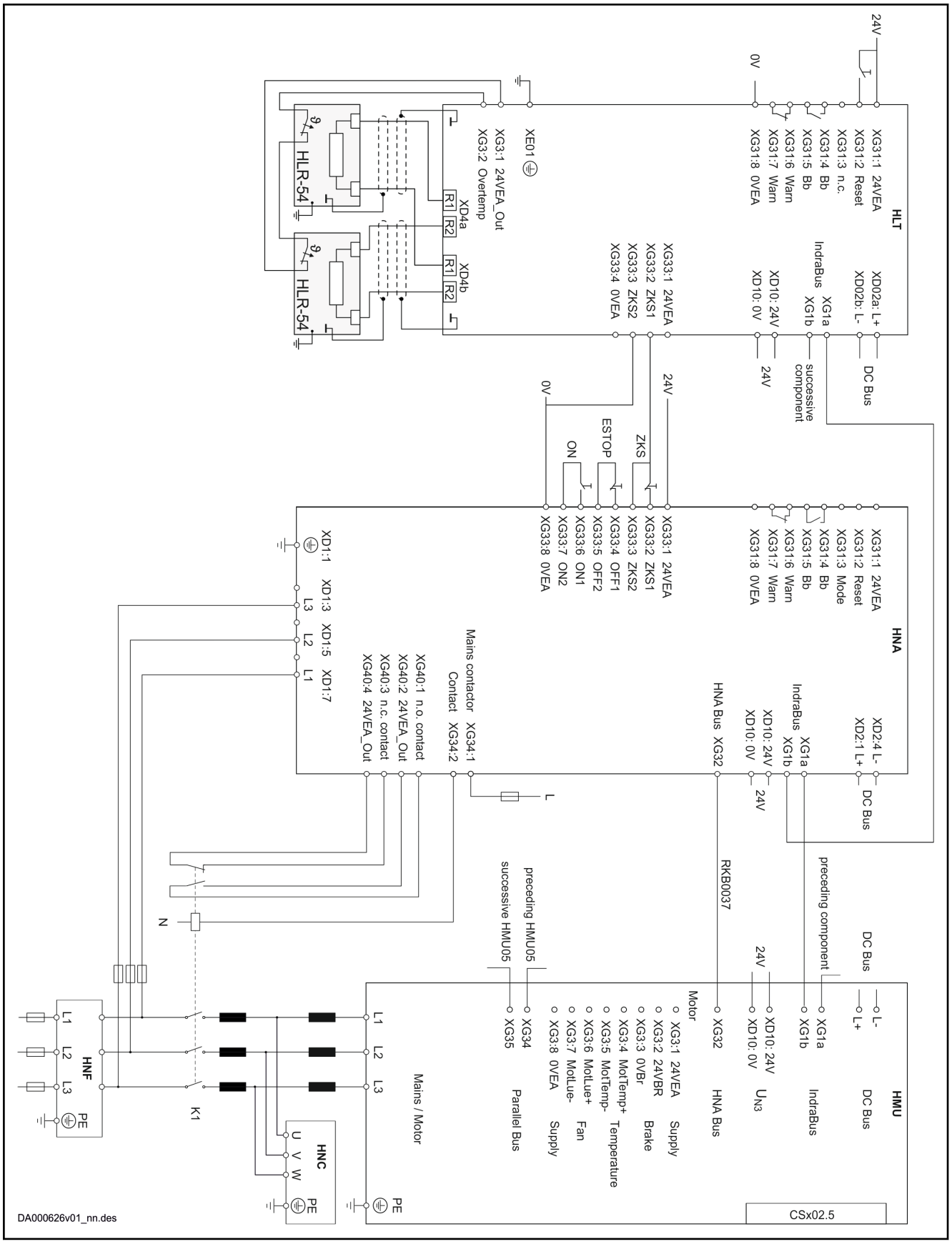
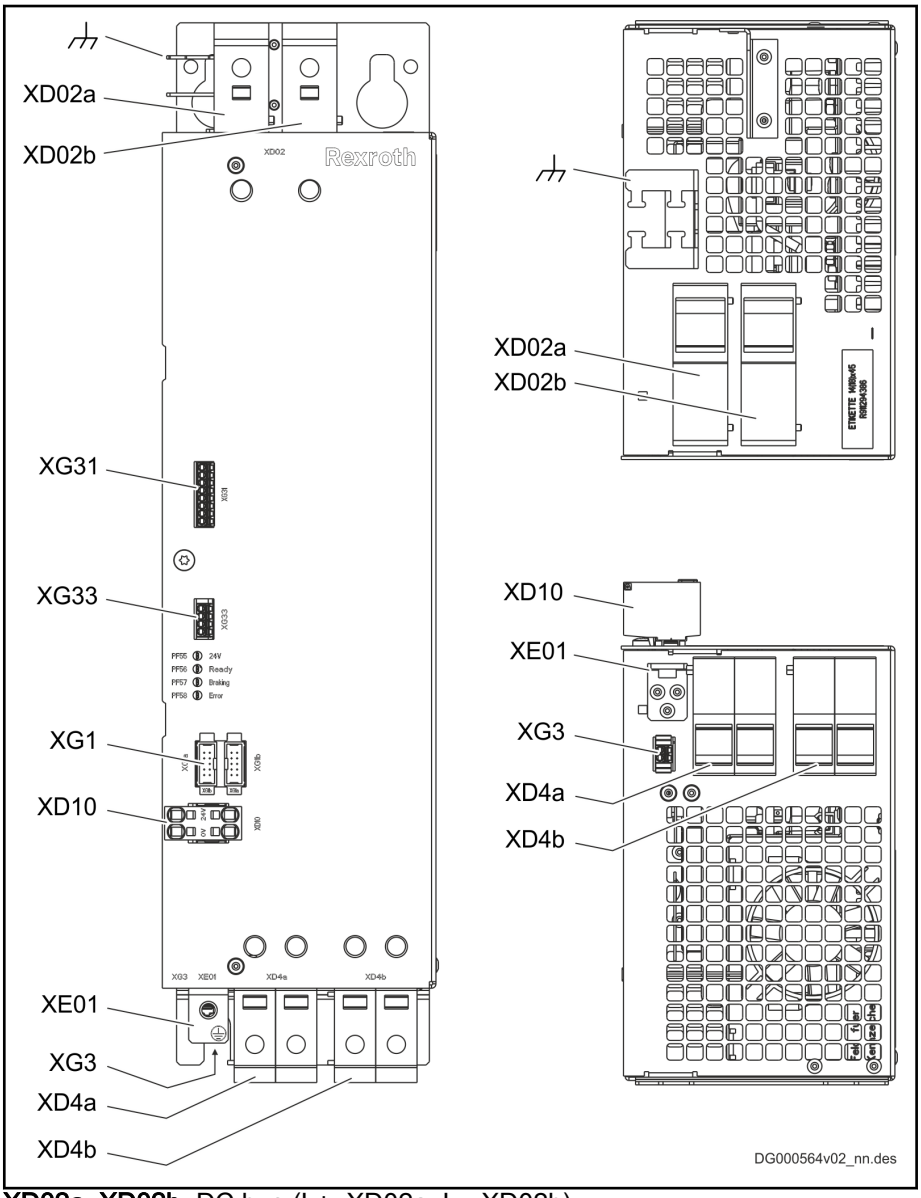


Fig. 8-98: Wiring diagram HLT05, HNA05, HMU05

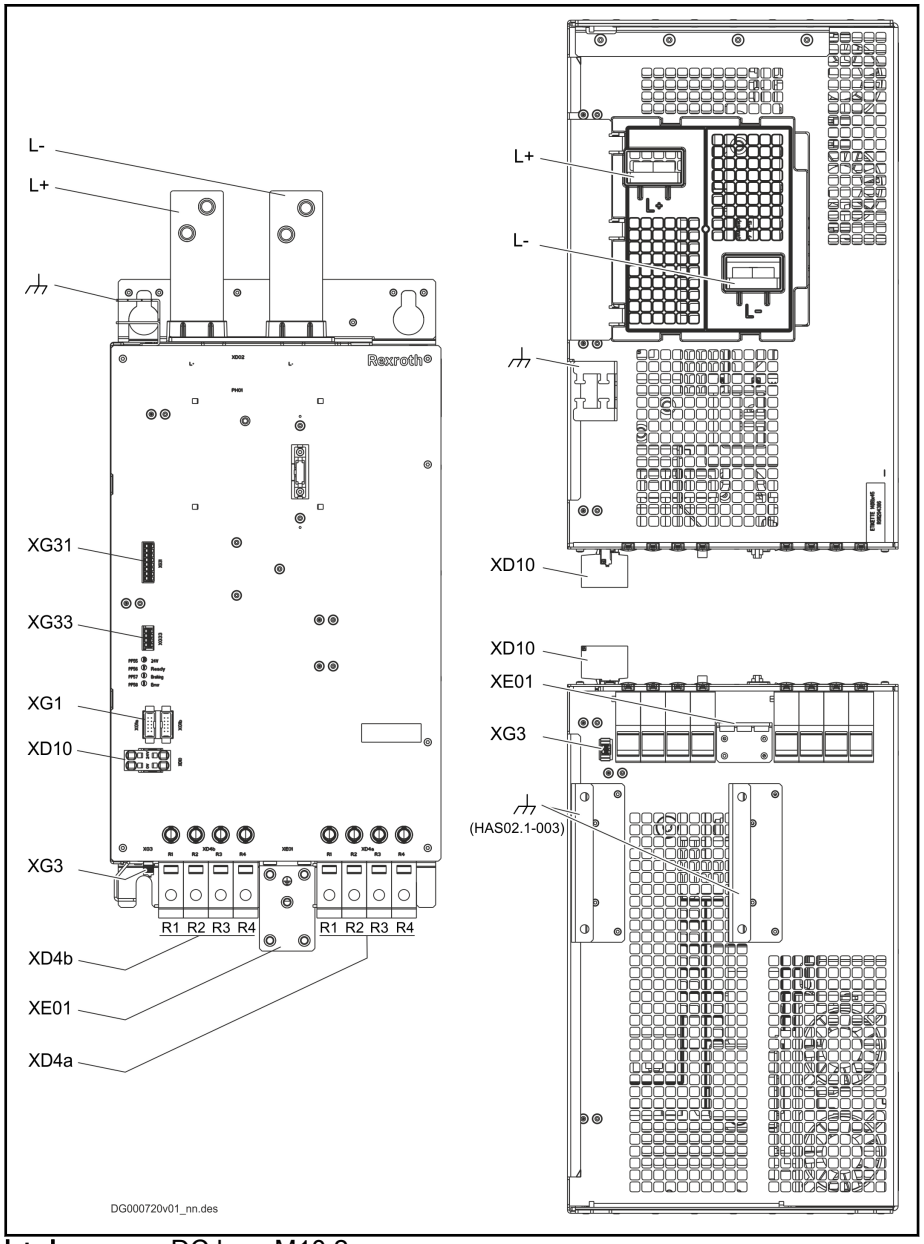
Connection points

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 Signaling contact (Bb, warning) and reset input for resetting error messages
XG33 DC bus short-circuit (ZKS) function

Fig. 8-99: HLT05.1W-045K, -105K connection points



L+, L-	DC bus; M10 2x
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	Signaling contact (Bb, 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. 8-100: 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**

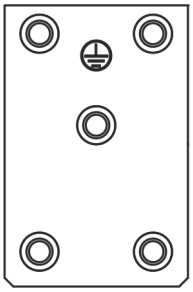
Use the same metal (e.g., copper) for the equipment grounding conductor as for the outer conductors.

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. 8-79: Equipment grounding conductor cross section

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. 8-80: 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.

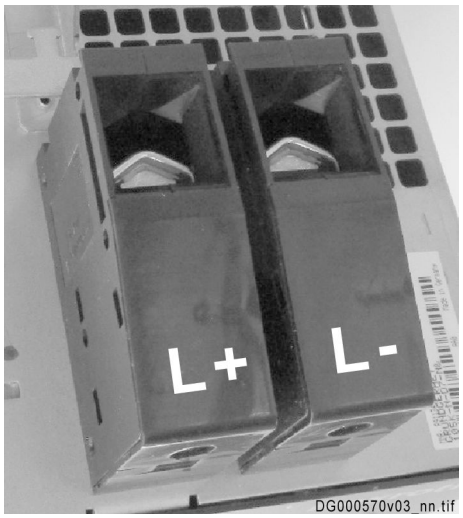
Make sure voltage has fallen below 50 V before touching live parts!

Before accessing the device, wait at least **30 minutes** after switching off the supply voltages to allow **discharging**.

The discharge time can be more than 30 minutes if DC bus ground capacitor pairs are used.

Mount a **touch guard**!

HLT05.1W-045K, -105K

View	Connection	Signal name	Function
	XD02a	L+	Positive pole DC bus voltage
	XD02b	L-	Negative pole DC bus voltage

Tab. 8-81: XD02, DC bus

Mechanical data

Screw connection	Unit	min.	max.
Connection cables	mm^2	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. 8-82: Mechanical 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.

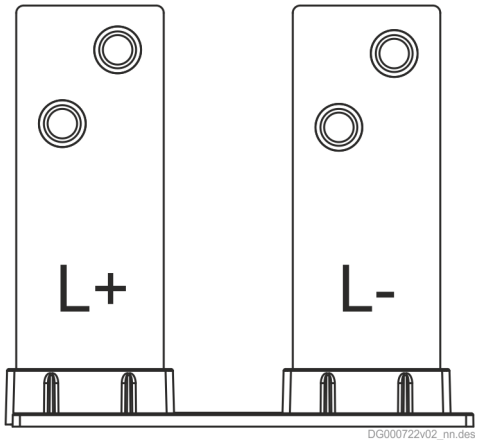
Make sure voltage has fallen below 50 V before touching live parts!

Before accessing the device, wait at least **30 minutes** after switching off the supply voltages to allow **discharging**.

The discharge time can be more than 30 minutes if DC bus ground capacitor pairs are used.

Mount a **touch guard**!

HLT05.1W-245K

View	Connection	Signal name	Function
	L+	L+	Positive pole DC bus voltage
	L-	L-	Negative pole DC bus voltage

Tab. 8-83: XD02, DC bus

Mechanical data

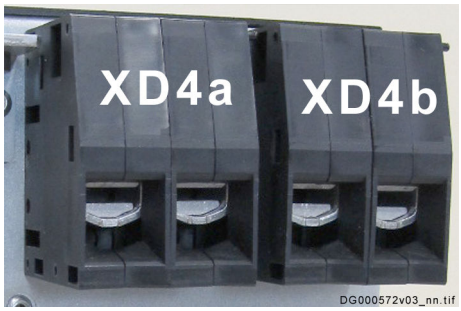
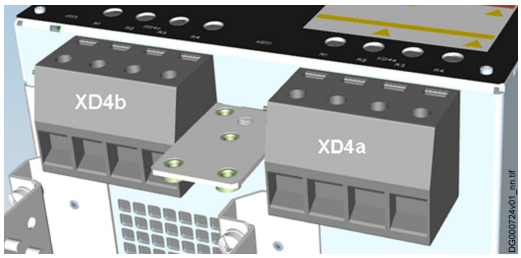
Screw connection	Unit	min.	max.
Contact bar	mm^2	288	-
Connection cables	mm^2	2 × 120	-
	kcmil	2 × 250	-
Cable length [1)]	m	-	1
Tightening torque (M10)	Nm	48	

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. 8-84: Mechanical data

XD4, braking resistor

Function, pin assignment Braking resistors are connected to the XD4 connection point.

View	Connection	Signal name	Function
HLT05.1W-045K, -105K:  HLT05.1W-245K: 	XD4a	E	Braking resistor
	XD4b	E	Braking resistor

Tab. 8-85: XD04, braking resistor

Mechanical data

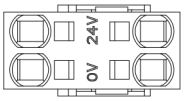
Screw connection	Unit	min.	max.
HLT05.1W-045K, -105K connection cable	mm^2	25	50
	AWG	4	1/0
HLT05.1W-245K connection cable	mm^2	50	
	AWG	1/0	
Stripped length	mm	24	
Tightening torque (M6)	Nm	6	

Tab. 8-86: Mechanical 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	
	0V	0V	Reference potential for power supply
		0V	

Tab. 8-87: XD10, 24 V supply

Mechanical data

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

Tab. 8-88: Mechanical data

Electrical data

	Unit	min.	max.
Voltage load capacity	V	-	U_{N3} 1)
Power consumption	W	-	P_{N3} 1)
Current carrying capacity (looping through)	A	-	40 (UL: 31)
Allowed inductance	µH	-	100 (2 twisted single strands, 75 m long)

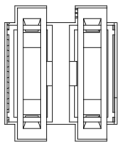
1) See chapter 7.2.1 "Control voltage" on page 151

Tab. 8-89: 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 might possibly 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 the 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 *Cables* • 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. In combination with other devices, the RBS0025 terminating plug on the first device (left) must be plugged in at the left side of XG1 and the terminating plug on the last device (right) must be plugged in at the right side.

Tab. 8-90: XG1, IndraBus

XG3, braking resistor overtemperature signaling contact

Pin assignment

View	Connection	I/O	Function (N/C contact)
	1	A	Relay contact supply voltage
	2	E	Digital input of relay contact

Tab. 8-91: XG3, braking resistor signal contact

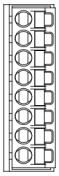
Mechanical data

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. 8-92: Mechanical data

XG31, signaling contact (Bb, warning) and reset input

Pin assignment

View	Connection	I/O	Function
	1	E	Supply voltage of inputs/outputs (24VEA_Supply)
	2	E	Reset input for resetting error messages 1: Reset active 0: Reset not active
	3	-	n. c.
	4	A	N/O contact signals readiness for operation Closed with: Readiness for operation of device Open with: Error messages: F****
	5		
	6	A	N/C contact signals warning states Open with: Overtemperature at device/braking resistor
	7		
	8	E	Reference potential of supply voltage (0VEA_Supply)

Tab. 8-93: 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. 8-94: Mechanical data

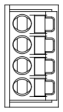
Electrical data

	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. 8-95: Electrical data

XG33, DC bus short-circuit (ZKS)

View	Connection	I/O	Function
	1	A	DC bus short-circuit input supply voltage (24VEA_Out)
	2	E	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	E	DC bus short-circuit 2 – negative connection for controlling DC bus short-circuit function Typical wiring: Connect XG33.4 to XG33.3
	4	A	Reference potential of supply voltage (0VEA)

Tab. 8-96: 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. 8-97: 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. 8-98: Electrical data

Display elements

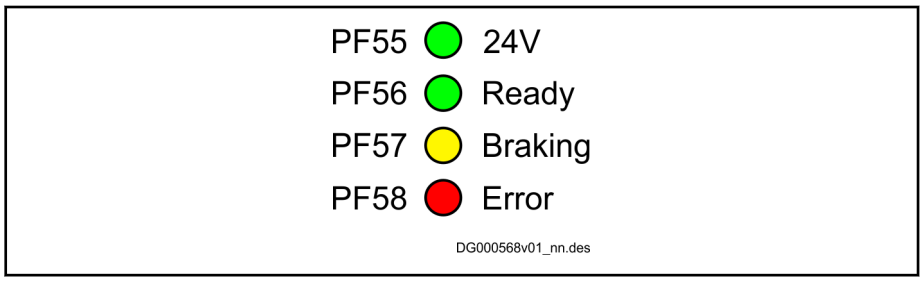


Fig. 8-101: LEDs at HLT05

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. 8-99: 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. 8-100: 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

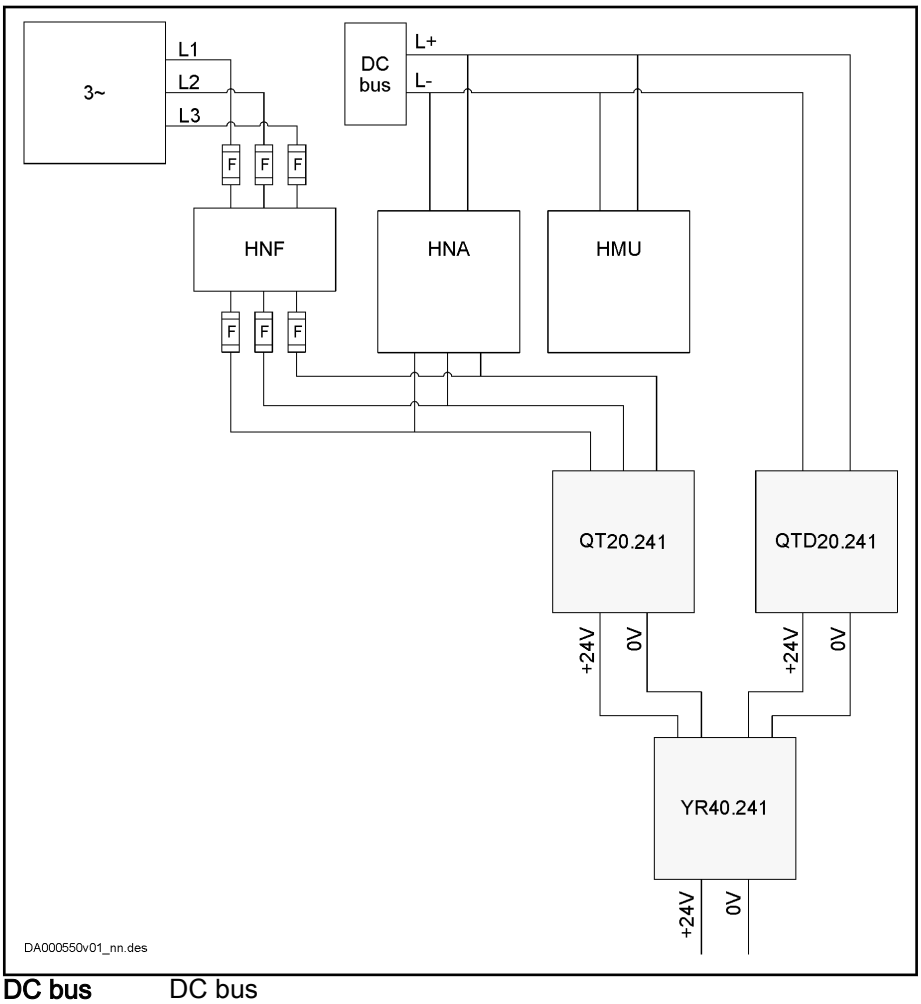
[1)] *SELV: Safety Extra Low Voltage; PELV: Protected Extra Low Voltage*

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. 8-101: Data

24V/20A connection diagram

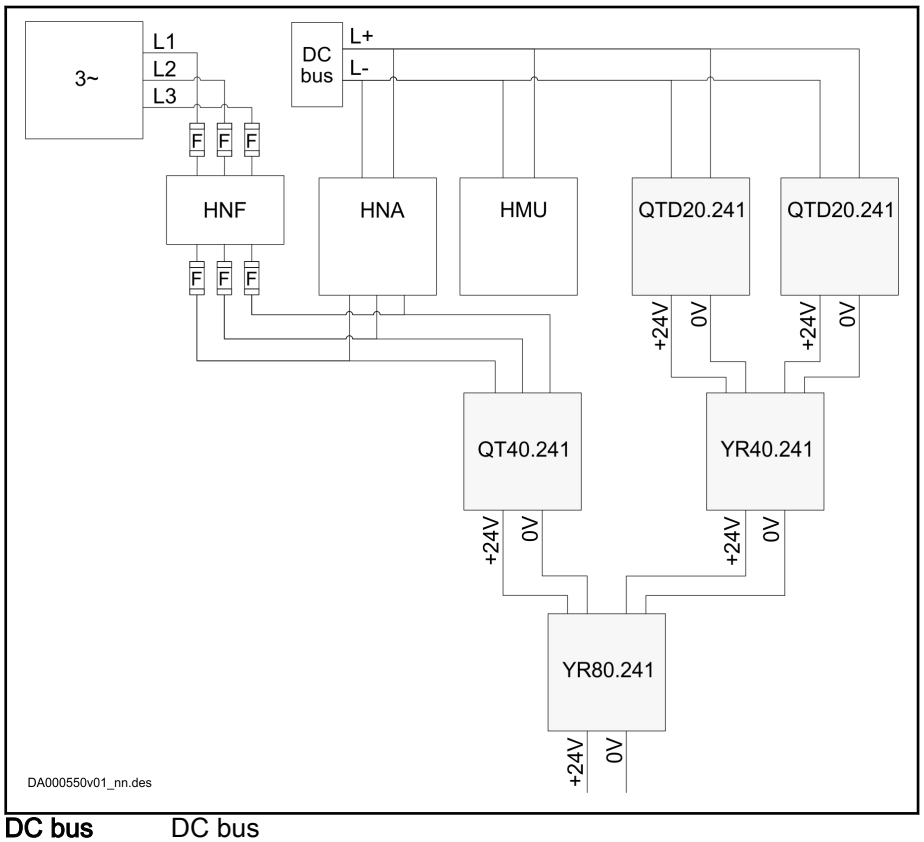


DC bus DC bus
QT20.241 Power supply unit
QTD20.241 DC bus power supply unit
YR40.241 Redundancy module
Fig. 8-102: 24V/20A connection diagram

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. 8-103: 24V/40A connection diagram

Setting the output voltage:

- QT40.241: 25.5 V
- QTD20.241: 24 V

8.3.11 HAH02 Heat exchanger

HAH02 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	A	H	0	2	.	1	-	W	A	0	3	5	-	0	9	0	-	1	5	-	S	1	-	1	-	4	8	-	N	N	N	N								
	①			②			③		④	⑤	⑥				⑦				⑧			⑨			⑩		⑪			⑫											

①	**Product:** HAH = Heat exchanger
②	**Series:** 02 = 2
③	**Design:** 1 = 1
④	**Cooling medium drive side circuit:** W = Water
⑤	**Cooling medium customer side circuit** [a]**:** A = Air W = Water
⑥	**Cooling capacity** [a]**:** 008 = 8 kW 012 = 12 kW 020 = 20 kW 025 = 25 kW 035 = 35 kW 060 = 60 kW
⑦	**Flow rate drive side circuit** [a]**:** 020 = 20 liter/minute 060 = 60 liter/minute 090 = 90 liter/minute 180 = 180 liter/minute
⑧	**Pressure drive side circuit** [a]**:** 15 = 1,5 bar 20 = 2.0 bar
⑨	**Structure** [a]**:** C1 = Chassis unit S1 = Stand-alone
⑩	**Heating** [a]**:** N = without heating 1 = heating in drive side circuit and cabinet heating 2 = heating in drive side circuit and reinforced cabinet heating

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	A	H	0	2	.	1	-	W	A	0	3	5	-	0	9	0	-	1	5	-	S	1	-	1	-	4	8	-	N	N	N	N								
	①			②			③		④	⑤	⑥				⑦				⑧			⑨			⑩		⑪			⑫											
⑪	**Mains voltage [a]:** 48 = 3 × AC 380 - 480 V 50 = 3 × AC 380 - 500 V 69 = 3 × AC 525 - 690 V																																							
⑫	**Other design:** NNNN = none S001 = reduced height S002 = extended temperature range -40 … 45 °C MNNN = Suited for maritime applications																																							

a) Available combinations: See following tables

Tab. 8-102: HAH02, type code

⑥ Cooling capacity	⑦ Flow rate drive side circuit	⑤ Cooling medium customer side circuit
008	020	W
012	020	A
020	090	A
025	060	W
035	090	A, W
060	180	W

Tab. 8-103: Combination regarding cooling capacity

⑩ Heating	⑤ Cooling medium customer side circuit	⑥ Cooling capacity
1	A	035
2	A	020

Tab. 8-104: Combination regarding heating

⑪ Mains voltage	⑤ Cooling medium customer side circuit
48	A
50	A
48	W
50	W
69	-

Tab. 8-105: Combination regarding mains voltage

⑨ Structure	⑤ Cooling medium customer side circuit
S1	A
C1	W

Tab. 8-106: Combination regarding structure

⑧ Pressure drive side circuit	⑥ Cooling capacity	⑦ Flow rate drive side circuit
15	008	020
15	012	020
20	020	090
15	025	060
15	035	090
15	060	180

Tab. 8-107: Combination regarding pressure drive side circuit

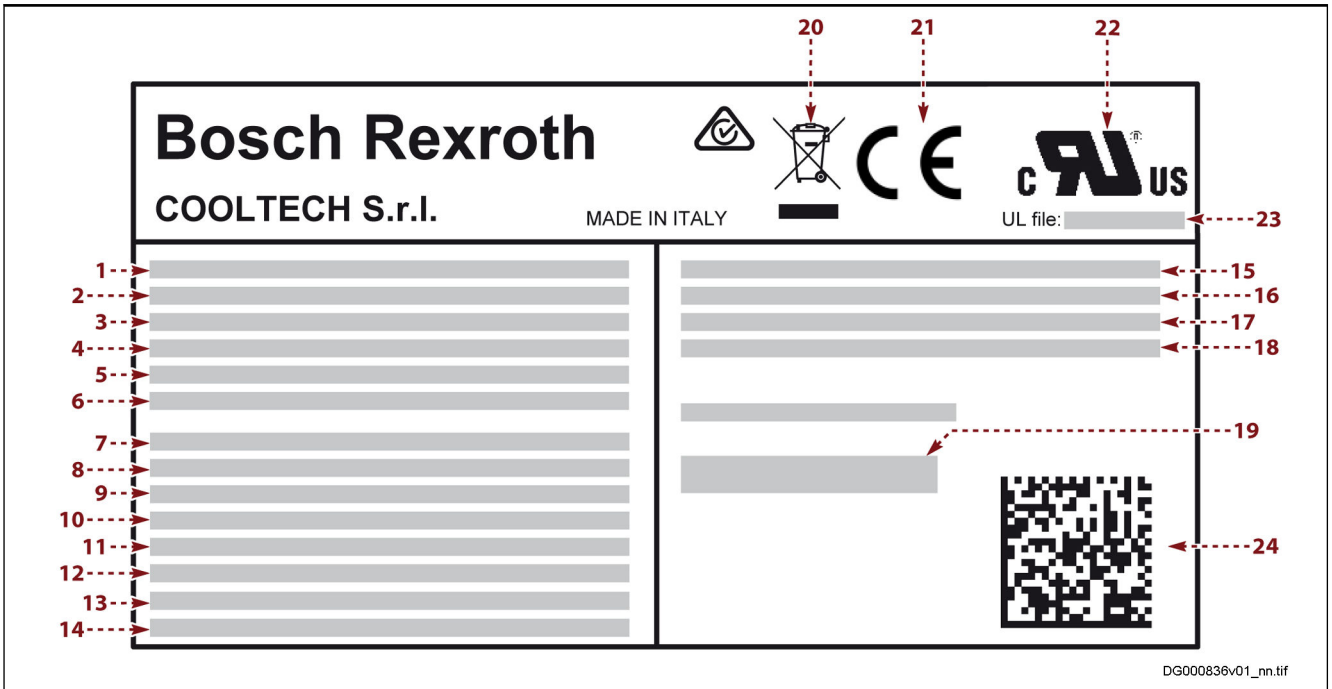
⑫ Other design	HAH02.1
MNNN	HAH02.1-WA025-060-15-C1-N-48-MNNN
S001	HAH02.1-WA035-090-15-S1-1-48-S001
S002	HAH02.1-WA020-090-20-S1-2-48-S002

Tab. 8-108: Combination regarding design

General information

Manufacturer's details and machine identification details

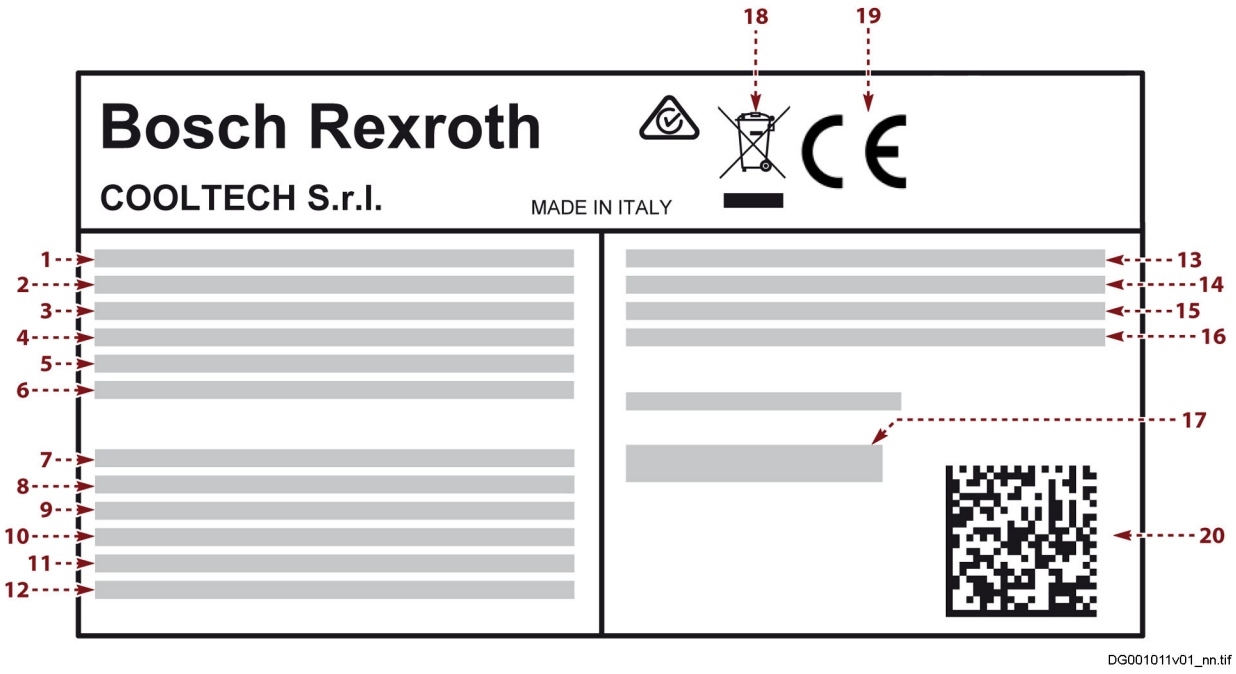
Water-water heat exchanger (HAH02.1-WW)



1	Model (Bosch Rexroth)		13	Fluid temperature range "drive side"
2	Model (Cooltech)		14	Ambient temperature range
3	Device number (Cooltech)		15	Power voltage
4	Device number (Bosch Rexroth)		16	Power voltage frequency
5	Serial number		17	Phases
6	Date of production		18	Input current
7	Coolant		19	Place of production
8	Weight		20	EEEW (RAEE) marking concerning the obligation to dispose of electrical and electronic equipment separately from household waste
9	Maximum fluid pressure "customer side"		21	CE marking of conformity
10	Maximum fluid pressure output "drive side"		22	UL conformity marking (file number SA44341)
11	Maximum fluid pressure input "drive side"		23	UL file number
12	Fluid temperature range "customer side"		24	QR code

Tab. 8-109: Manufacturer's details and machine identification details (HAH02.1-WW)

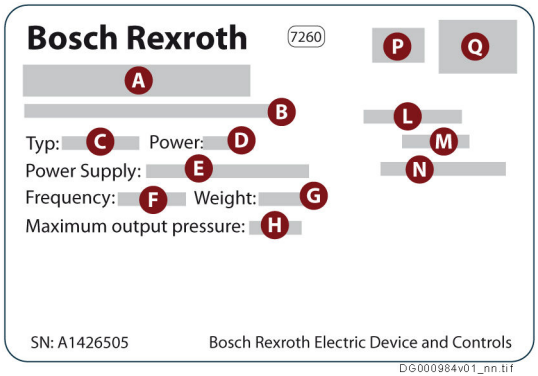
Air-water heat exchanger (HAH02.1-WA020-090, -WA035-090)



1	Model (Bosch Rexroth)	11	Fluid temperature range
2	Model (Cooltech)	12	Ambient temperature range
3	Device number (Cooltech)	13	Power voltage
4	Device number (Bosch Rexroth)	14	Power voltage frequency
5	Serial number	15	Phases
6	Date of production	16	Input current
7	Coolant	17	Place of production
8	Weight	18	EEEW (RAEE) marking concerning the obligation to dispose of electrical and electronic equipment separately from household waste
9	Maximum fluid pressure output side	19	CE marking of conformity
10	Maximum fluid pressure input side	20	QR code

Tab. 8-110: Manufacturer's details and machine identification details (HAH02.1-WA020-090, -WA035-090)

Air-water heat exchanger (HAH02.1-WA012-020)



A	Manufacturer		**H**	Maximum output pressure
B	Product		**L**	Product code
C	Type of machine		**M**	Date of production
D	performance		**N**	Device number
E	Power voltage		**P**	EEEW (RAEE) marking concerning the obligation to dispose of electrical and electronic equipment separately from household waste
F	Power voltage frequency		**Q**	CE marking of conformity
G	Weight			

Tab. 8-111: Manufacturer's details and machine identification details (HAH02.1-WA012-020)

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.

Strictly follow the regulations and laws valid for your workplace.

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.

Water-water heat exchanger (WW008-020, WW035-090)

Technical information

General description of the machine

The machine is designed and manufactured for the purpose of cooling devices or equipment using a liquid solution made of glycol and demineralized 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.

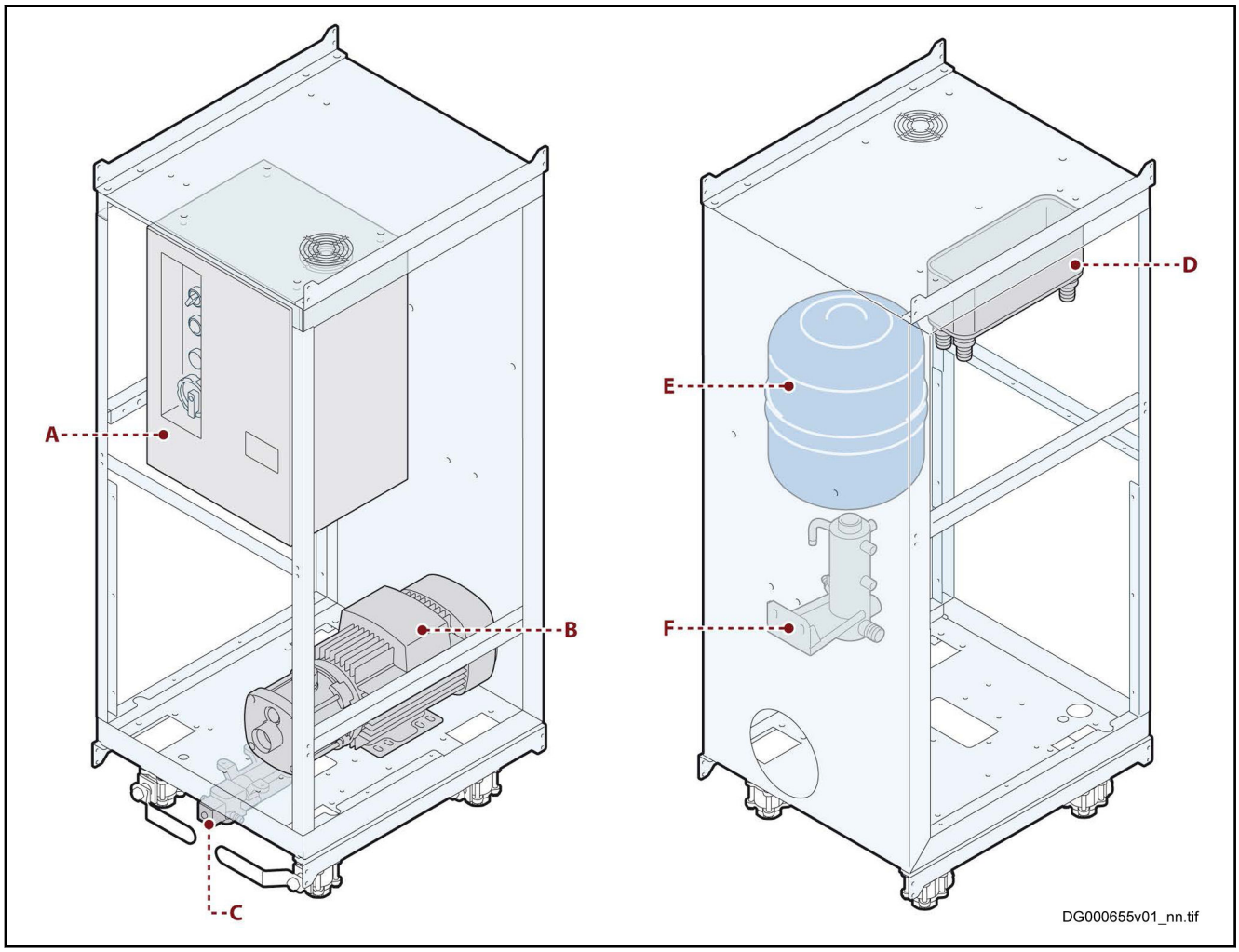
The cold liquid, provided by the owner, flows in the customer side circuit and through the heat exchanger it cools the liquid in the drive circuit.

The equipment or machine to be cooled is connected to the drive circuit.

Pressure and temperature control is done via IndraMotion MLD, the drive-integrated Motion Logic Control according to IEC 61131-3. See chapter "Control with MLD" on page 392.

See also chapter "Liquid Cooling" on page 53.

Main parts



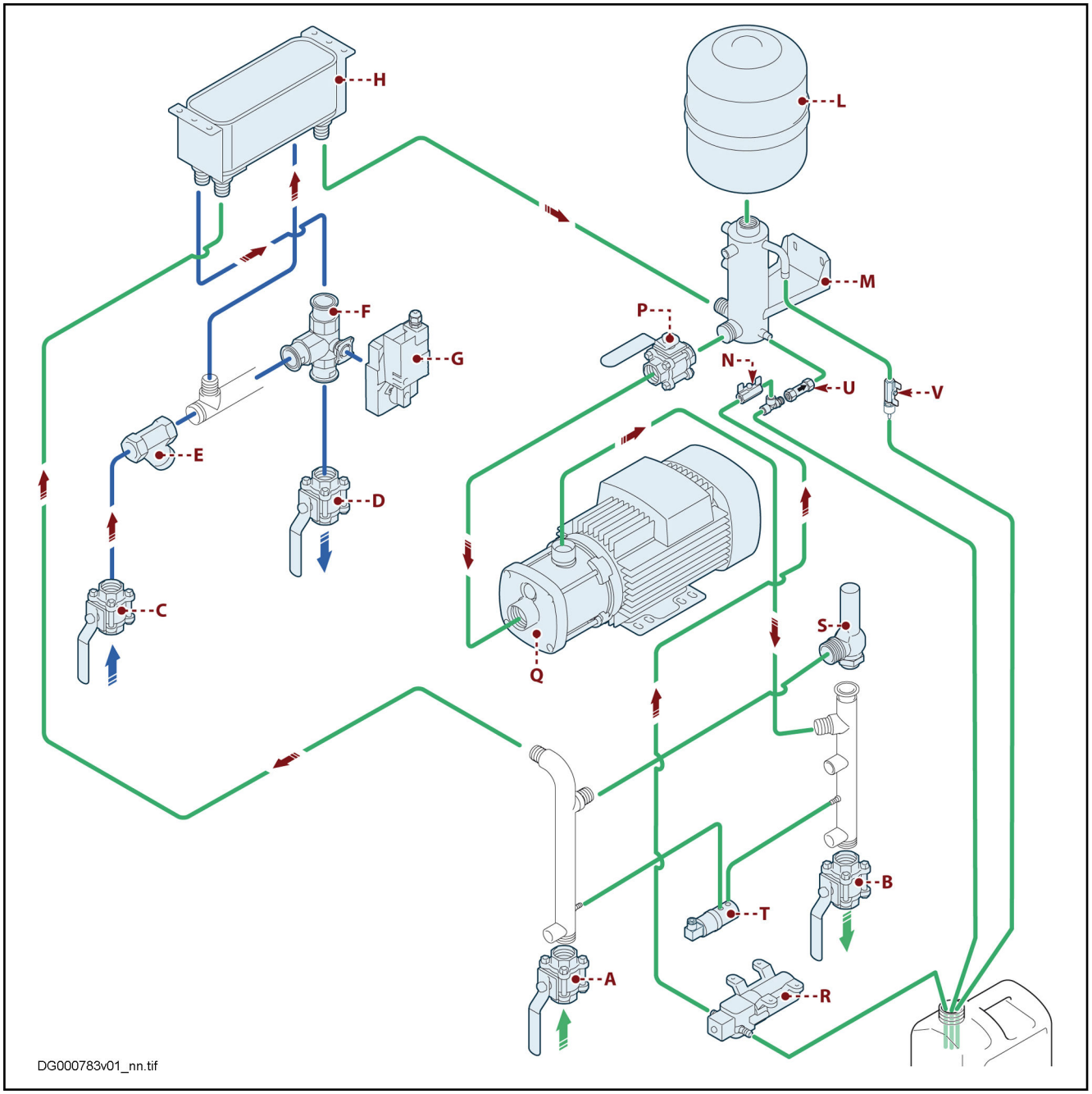
A	Terminal box
B	Main pump
C	Filling pump
D	Heat exchanger
E	Expansion tank
F	Coolant distribution manifold

Fig. 8-104: 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 adjust 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 release any backpressure in the filling pump delivery line and facilitate priming.
P	**Valve:** It 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	**Bypass valve:** It limits the pressure of the output liquid
T	**Pressure sensor:** It measures the differential pressure between the intake and the outlet of the machine to be cooled
U	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.
V	**Bleed valve:** For exhausting air from the system

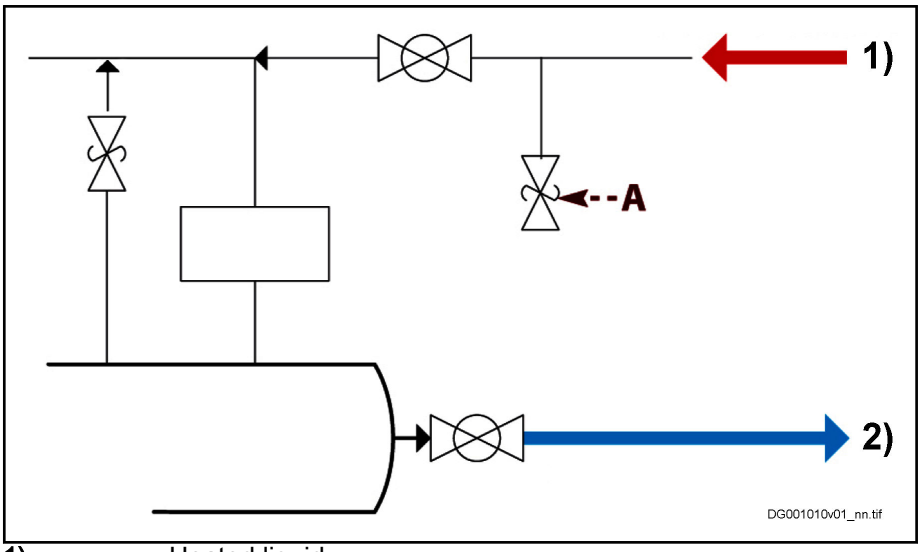
Fig. 8-105: Operational cycle and component description

Guards

The owner has to fit the machine with suitable guards in conformity with the regulations in force, in order to prevent the risk of injury.

Overpressure devices

If additional pumps (external to the machine) are installed on the circuit or if the drop in pressure of the hydraulic load is less than 1.5 bar, the owner has to fit a pressure limiting valve. The valve has to limit the pressure to a maximum of 2 bar in the return pipe to the machine.



1)	Heated liquid
2)	Cooled liquid
A	Pressure limiting valve

Fig. 8-106: Positioning of the pressure limiting valve (A)

Overall dimensions

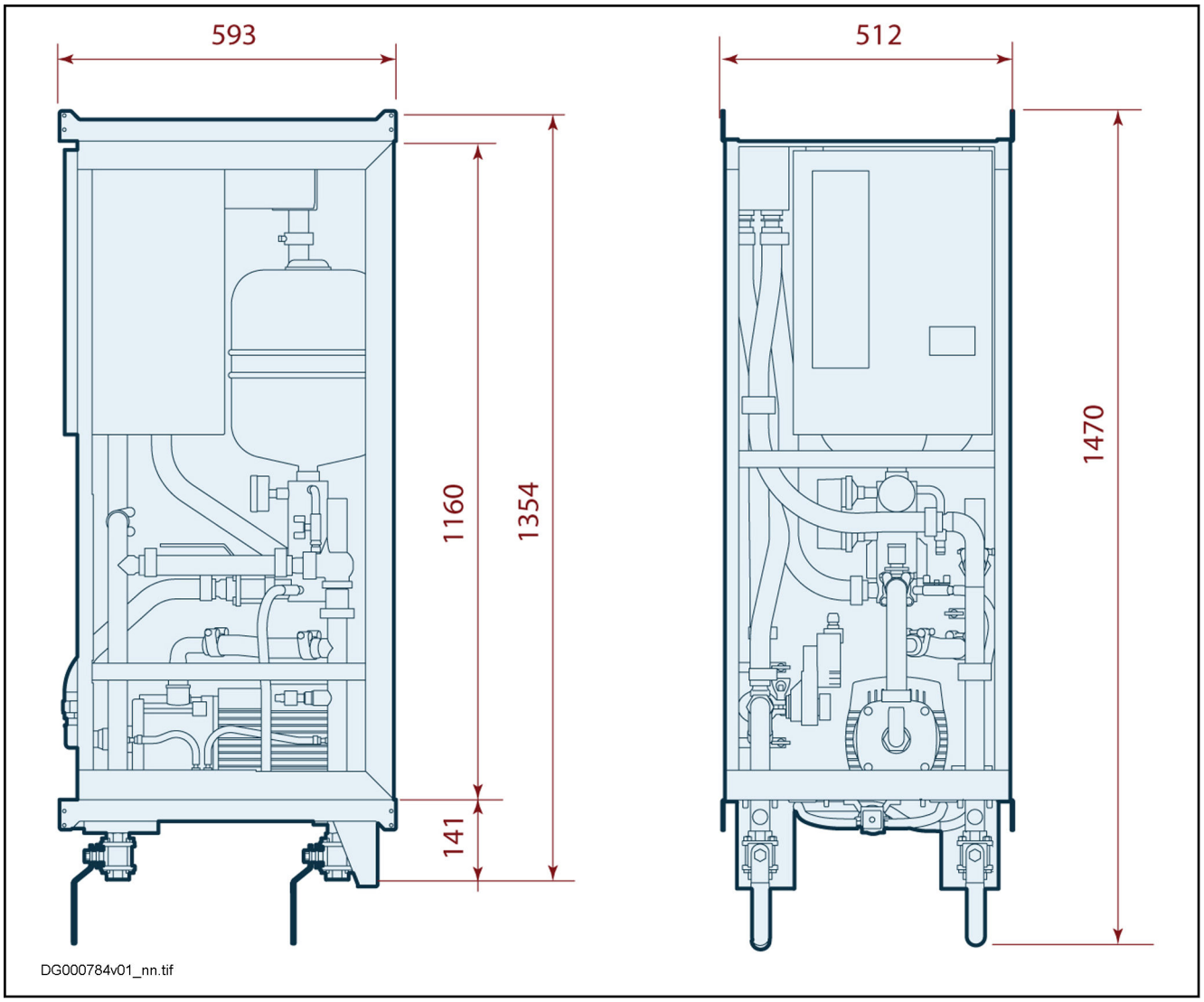


Fig. 8-107: Overall dimensions

Data

Technical data - machine

Description	Unit	WW008-020	WW035-090
Power voltage	Vac	380 (-15%) … 500 (+10%)	
Frequency	Hz	50/60	
Input current	A	2.3	3.5
Maximum cooling capacity	kW	8	35
Maximum input flow rate in the customer side circuit	l/min	30	120
Maximum output flow rate in the drive circuit	l/min	20	90
Maximum input pressure of the cooling liquid in the customer side circuit	bar	7	
Maximum input pressure of the cooling liquid in the drive circuit	bar	2	
Maximum output pressure of the cooling liquid in the drive circuit	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 demineralized water solution) See also chapter "Liquid Cooling" on page 53.	-	20% glycol	
Estimated amount of coolant (heat exchanger only)	l	approx. 30	
Customer side circuit coolant	-	See tab. 8-113 "Water quality specification" on page 357	
Ambient temperature during operation	°C	+5 … +55	
Ambient temperature during operation (compliant with UL)	°C	+5 … +40	
Maximum relative humidity without condensation	%	95	
Maximum installation altitude	m	2000	
Weight	kg	115	120

Tab. 8-112: Technical data - machine

Water quality specification

Pos.	Chemical element	Unit	Requirement
1	pH value	Range	7 … 8,5
2	Temporary hardness	°fH	< 5,0
3	Total hardness	°fH	< 10,0
4	Conductance	µS/cm	150 … 1000
5	Particle size	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	Fluoride (F^-)	mg/l	< 1,0
17	Nitrate (NO_3^-)	mg/l	< 10,0
18	Free carbon dioxide	mg/l	8 … 15
19	Oxygen (O)	mg/l	< 0,2
20	Alkalinity ($CaCO_3$)	mg/l	< 200
21	Sulfate (SO_4^{2-})	mg/l	< 100
22	Chloride (Cl^-)	mg/l	< 50

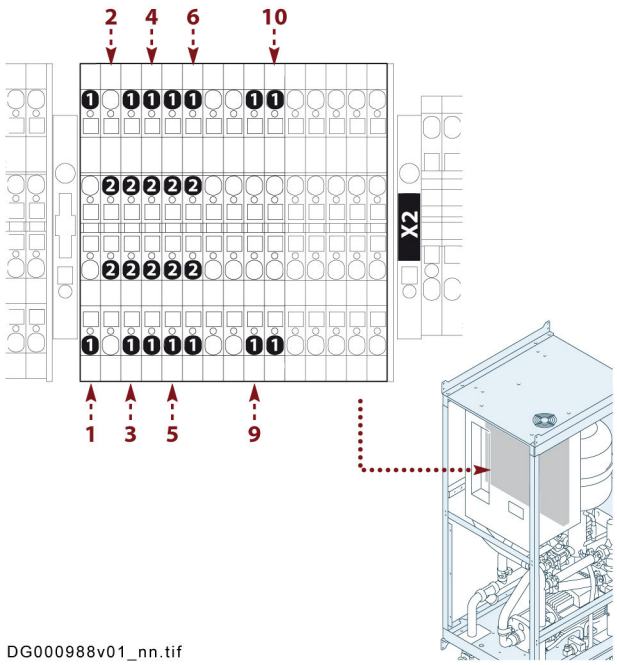
Tab. 8-113: Water quality specification

ENABLE, UNIT ERROR and UNIT WARNING connections

The signals for releasing the relative machine status using the owner's operator terminal are transmitted via the terminal block shown.

Connect the lines to the terminals shown in table "Connecting the terminals".

Terminal box X2

Pos.	Significance	Terminals
9.1 - 2.2	Terminals for machine enabling via the owner's operator terminal (ENABLE)	
3.1 - 3.2 4.1 - 4.2	Machine error signal terminals Closed contact: no error	
5.1 - 5.2 6.1 - 6.2	Warning signal terminals Closed contact: no warning	
10.1 - 1.1	Terminals for remote-controlled alarm reset.	

Tab. 8-114: Connection terminals (terminal box X2)

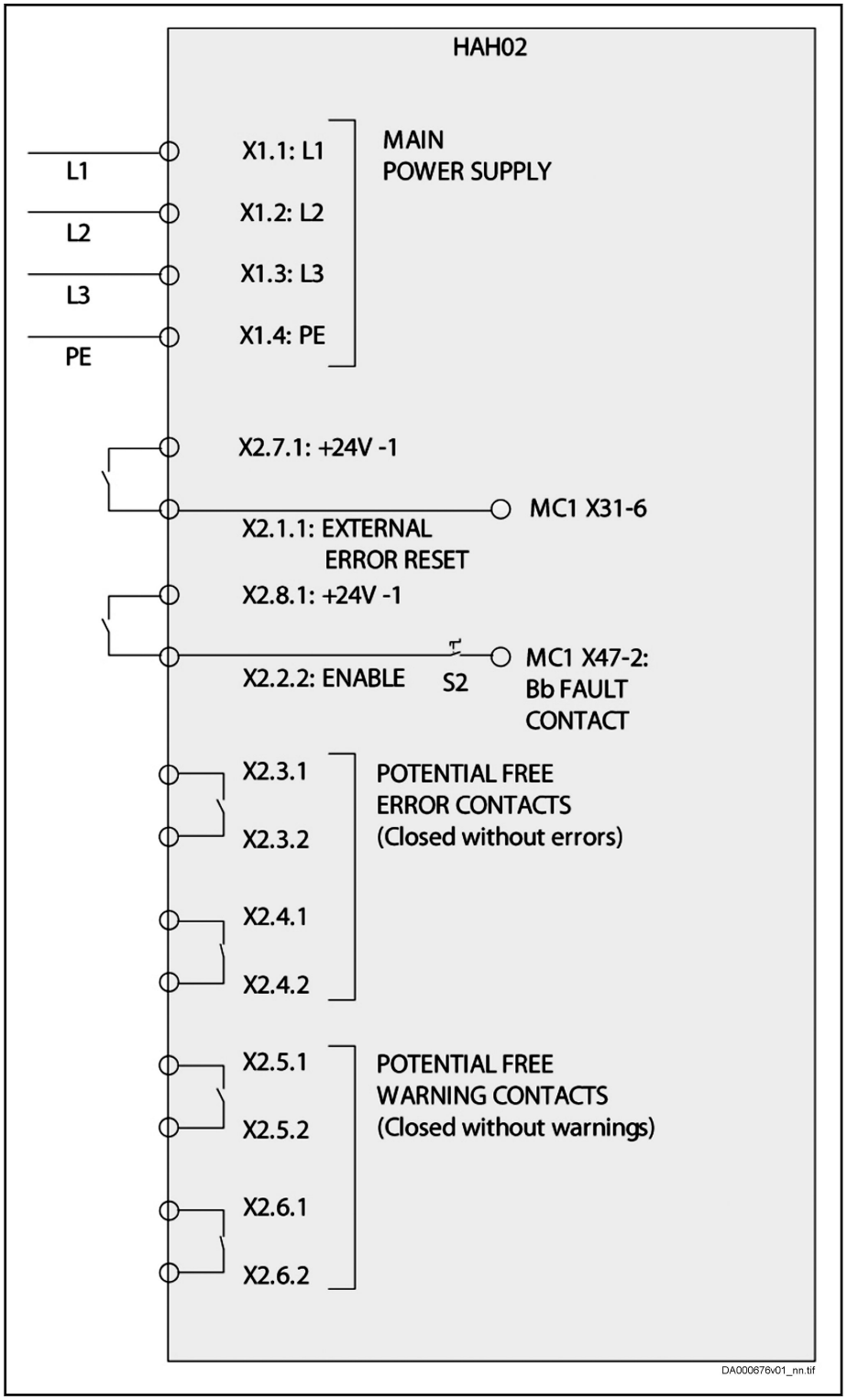
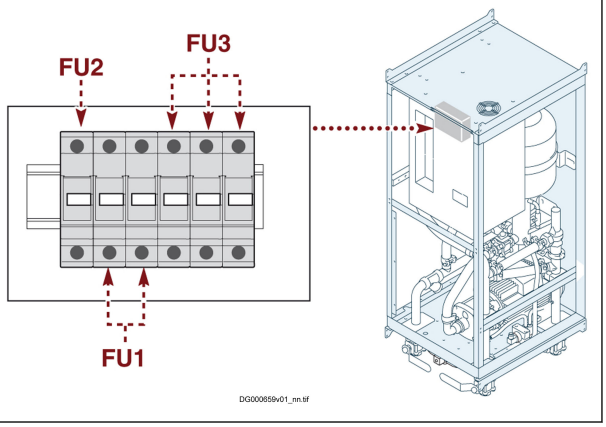


Fig. 8-108: Wiring diagram

Fuses

Name	Current (A)		Type	Rated voltage (Vac)	Interrupting capacity (kW)	Fuse	Position
	35-90	08-20					
FU1	1	1	CC	600	200	Delayed	
FU2	4	4					
FU3	6	3					

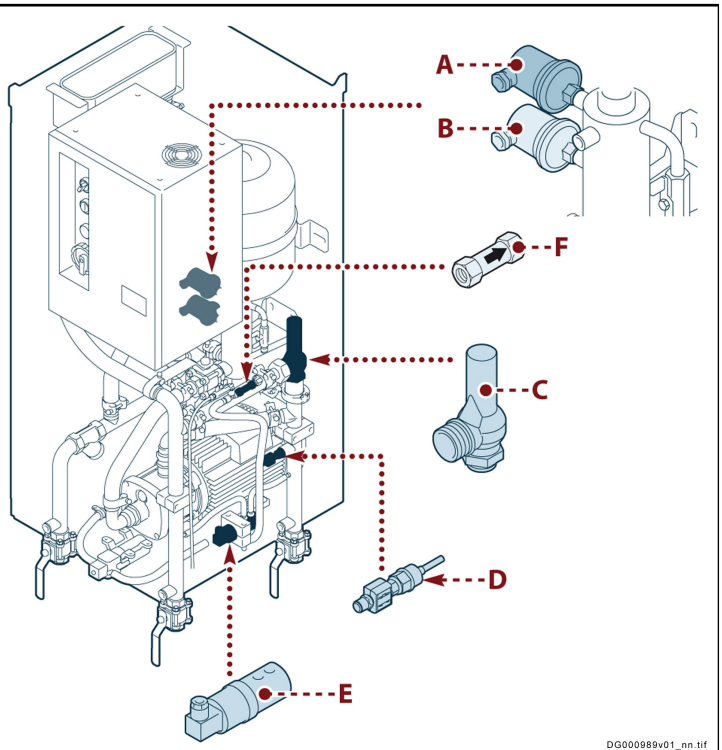
Tab. 8-115: Fuses

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 signaled 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 signaled 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 outlet pipe. The pressure in the drive circuit outlet pipe is kept constant through the sensor.
F	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.



Tab. 8-116: Processing and protection devices

Ambient conditions for operation

The machine works properly at the specified ambient conditions (chapter "Data" on page 356).

The machine is able to function properly at altitudes up to 2000 m above sea level.

Intended use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

The machine must be installed in closed spaces and protected from environmental influences.

Any other use than that specified, or not included or inferable from this project planning instructions, should be considered mishandling and therefore not permitted.

Unintended and unauthorized uses

It is not permitted to use coolants with properties other than those specified by the manufacturer.

It is not permitted to use machines in a flammable or explosive environment.

Commissioning of the machine is only permitted if it is ensured that the system or the machine in which it is installed complies with national and local regulations.

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.

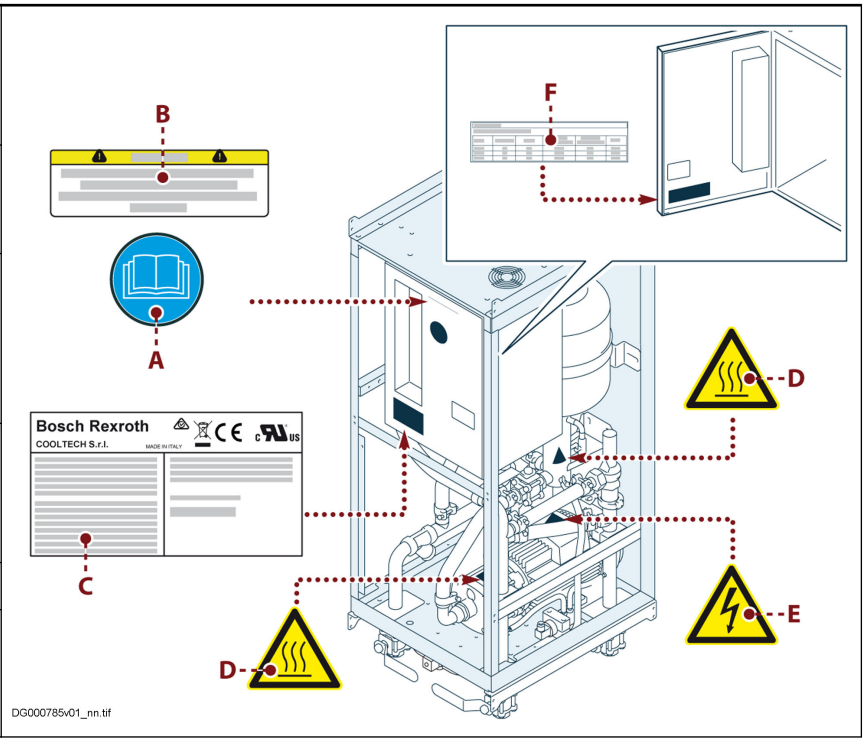
Thermal risk: Contact with hot surfaces can cause burns. Allow the machine to cool down before any operation.

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 one.

A	This indicates the obligation for operators to read the instruction manual before operating the machine.
B	Risk of severe injury or death. Disconnect the machine from the mains prior to operation.
C	Technical data of the machine and manufacturer's specification (chapter "Manufacturer's details and machine identification details" on page 347).
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	Risk of electric shock
F	Shows the technical properies of the fuses



Tab. 8-117: Information and safety signs

Transporting and installing

Transport and installation safety recommendations

Personnel responsible for transport of the load must have the required qualification and experience and must be trained in handling the lifting gear used.

Use lifting gear with suitable load capacity in order to lift and move the load.

Persons authorized for transport must take appropriate measures to ensure their own safety and the safety of persons directly involved.

Place the package on a stable surface.

Observe the specified limit when stacking packages in order to prevent sudden shifts.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents. In case items are damaged or missing, contact the importer or the manufacturer directly to discuss the procedure to be adopted.

Packaging

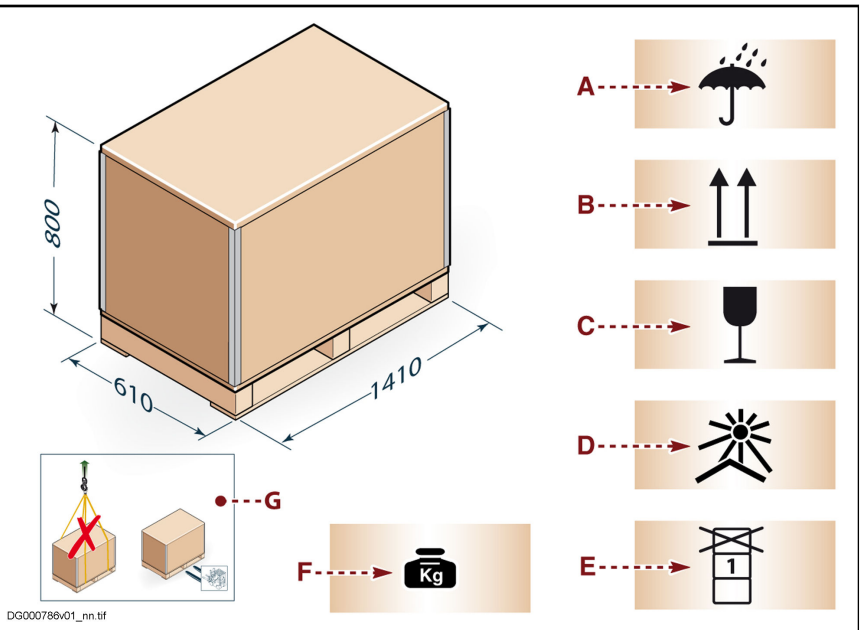
The packaging is selected according to the selected means of transport and the destination.

Packages can either be loaded directly onto a means of transport or into suitable containers if shipped by sea or air or to far-off destinations.

In order to facilitate transport, some components are removed and properly protected.

The figure shows the type of packaging most frequently used and the maximum dimensions as well as the warning symbols and notices attached 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.
G	The plate shows the procedure for lifting the package.



Tab. 8-118: Package description

Transporting and lifting the packed machine

The figure shows how to lift the package.

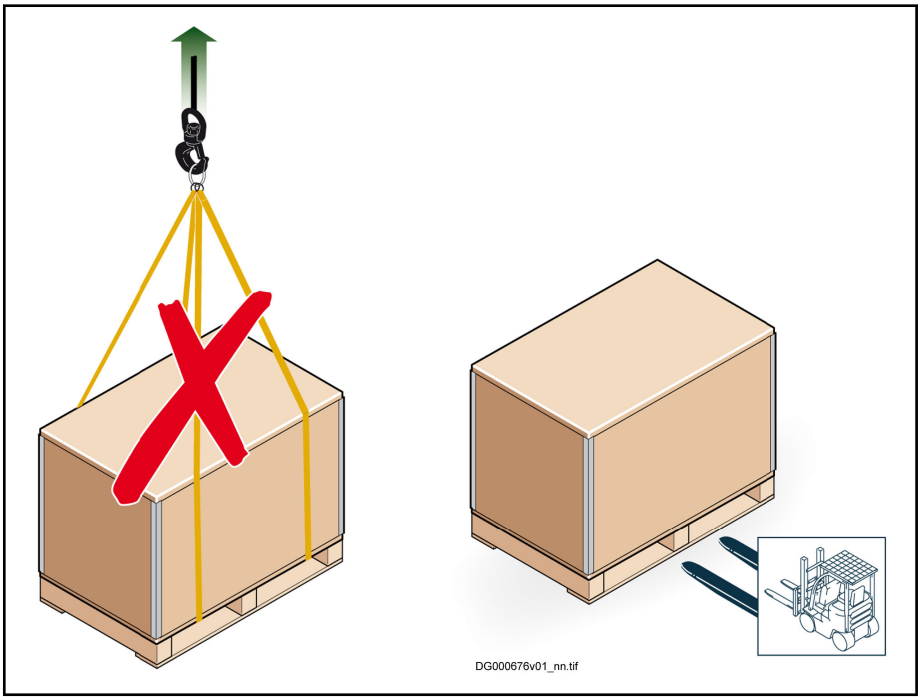


Fig. 8-109: Transporting and lifting the packed machine

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.

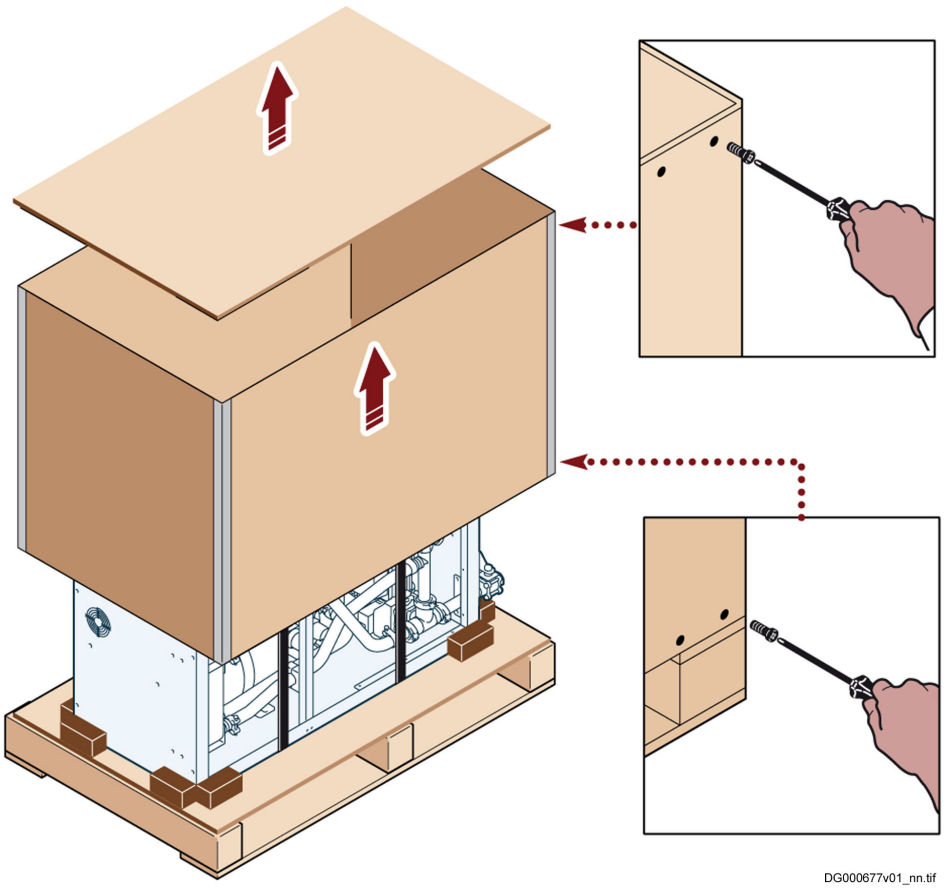
Unpacking

It is advisable to unpack the machine near the installation area to facilitate assembly.

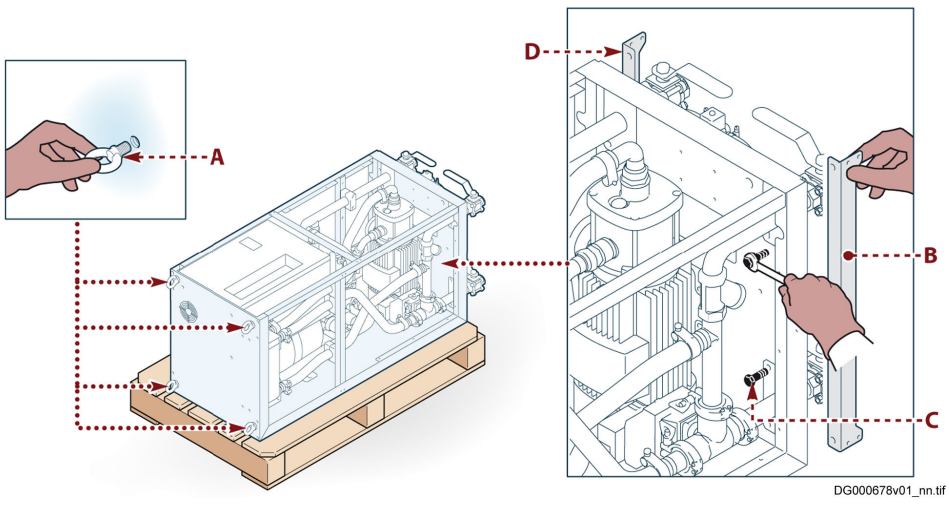
The figure shows how to unpack the machine properly.

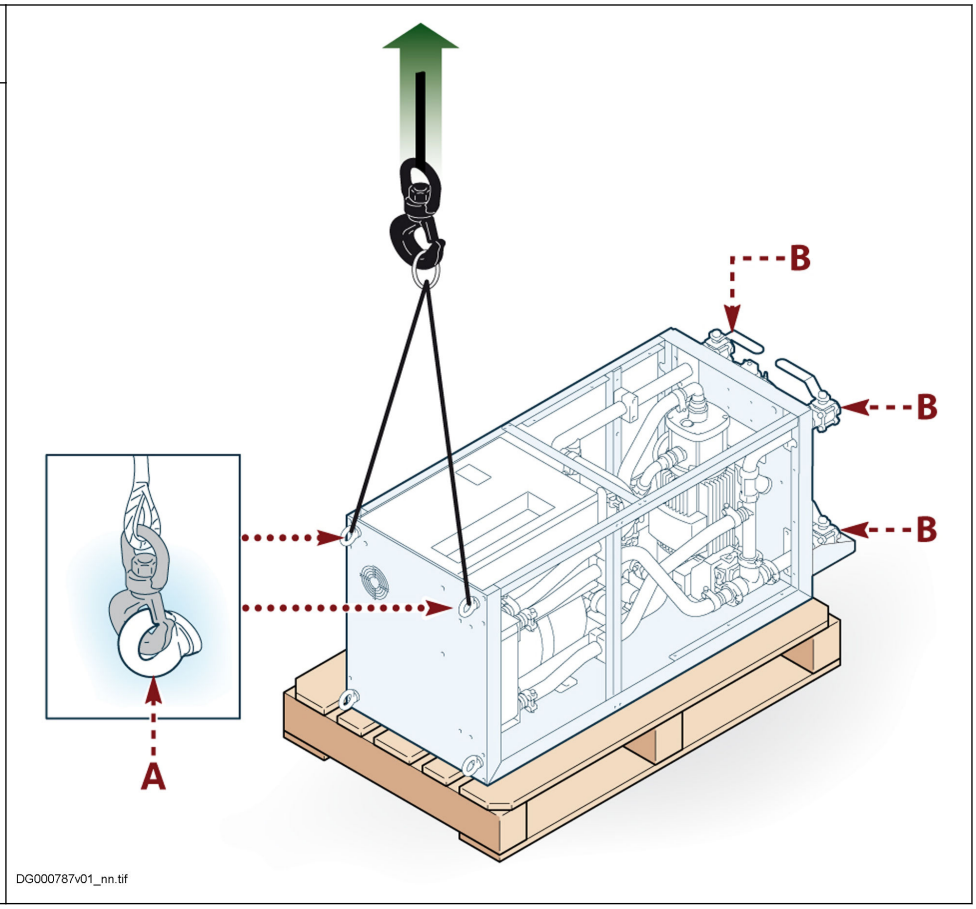
Proceed as described.

1	Unscrew the screws.
2	Remove the cover.
3	Lift the side walls of the packaging.
4	Remove the locking items and retaining straps.



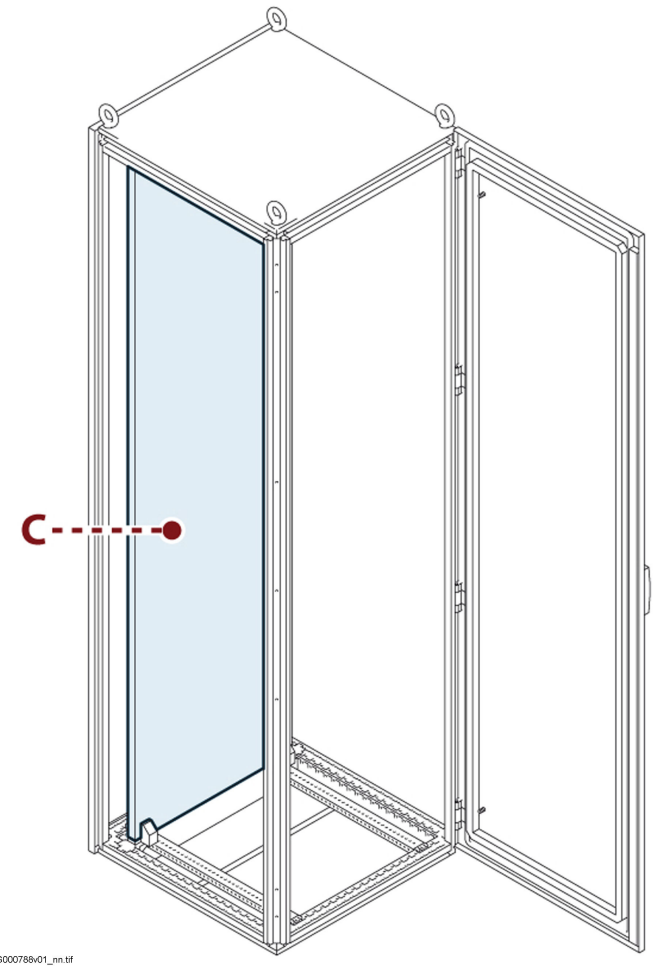
5	Screw in the eyebolts (**A**).
6	Position the bracket (**B**).
7	Tighten the screws (**C**).
8	Fit the bracket (**D**) with the relevant screws.



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. **NOTICE!** When lifting, take care not to damage the valves (**B**). Lift 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. 8-119: Unpacking

Mounting the machine

The machine is intended for installation into a RITTAL cabinet (model TS8 8006-500). Before mounting the machine, remove the wall (**C**).	

Tab. 8-120: Control cabinet

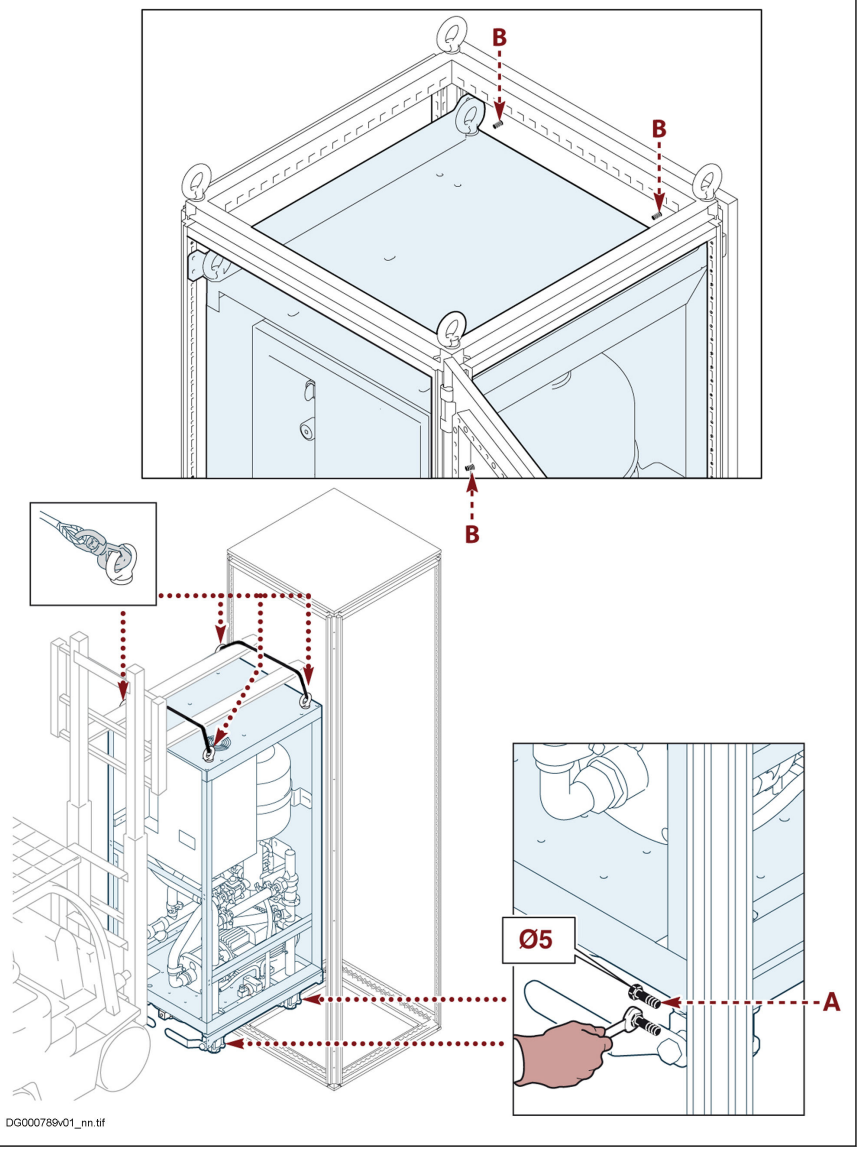
The installation area has to be provided with electrical connections and connections for transmission of machine enabling/status signals.

Carry out the following work as described.

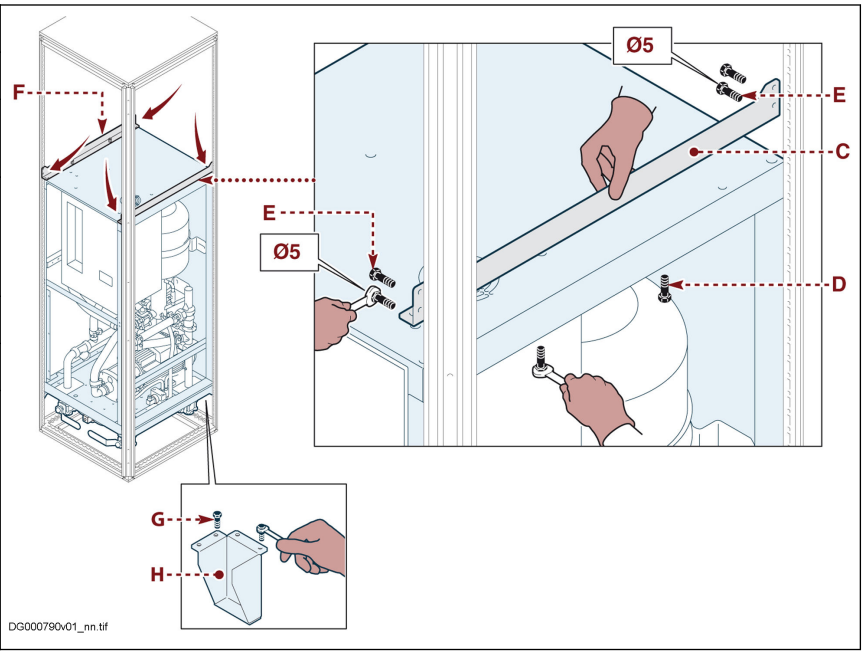
There must be enough space above the machine to connect the grounding points (B) of the cabinet.

Align the holes for attaching the machine in accordance with the nearest holes of the cabinet so that the required space above the machine is available.

1	Strap up the machine as shown in the figure.
2	Lift the machine and place the machine 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 (**C**).
7	Tighten the screws (**D**).
8	Screw in the self-tapping screws (**E**).
9	Fit the bracket (**F**) in the same way. Decide whether the valve caps can be removed or not.
10	Unscrew the screws (**G**).
11	Remove the protection device (**H**).
12	Repeat the process for removing the other protection device.



Tab. 8-121: Mounting the machine

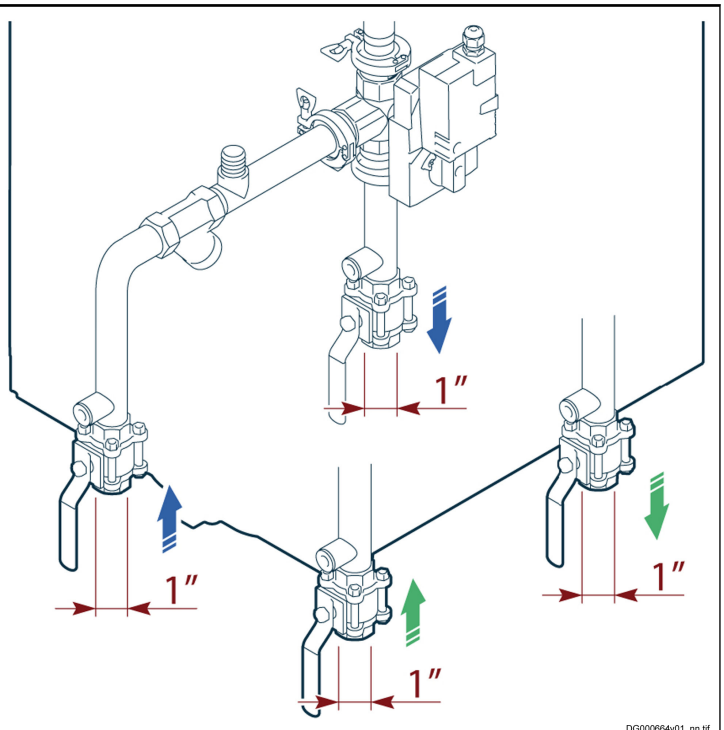
Electrical connection

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 + equipment grounding conductor).

Connect the three phases (L1, L2 and L3) and the equipment grounding conductor to the relevant terminals inside the terminal box.

Hose connections

The owner has to install devices to adjust the pressure and discharge in the intake pipe of the customer side circuit and in the return pipe of the drive circuit. Set the pressure in the intake and return pipes to the values shown in chapter "Data" on page 356. 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.	

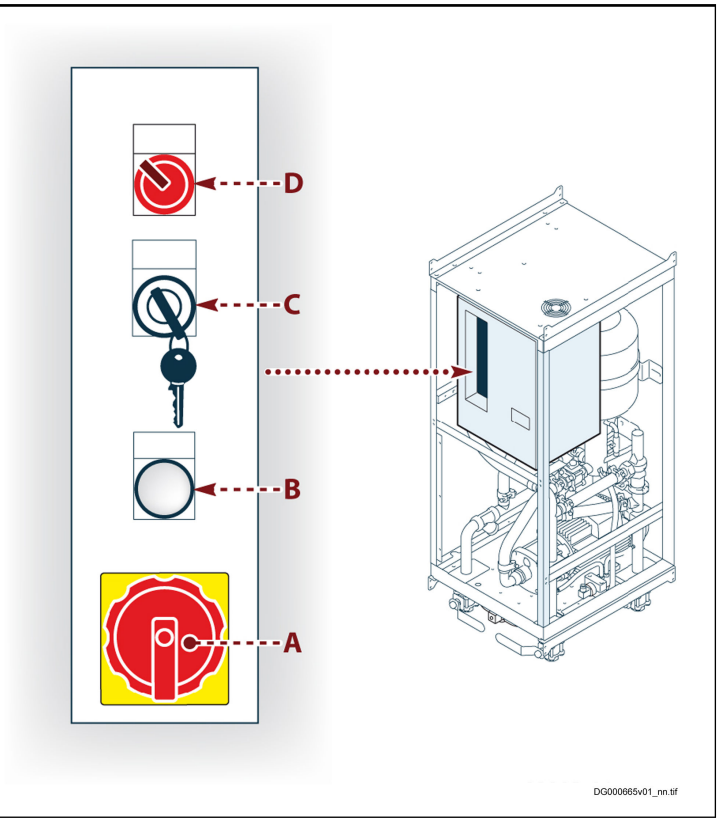
Tab. 8-122: Hose connections

Use

Safety advice for use

Before starting the machine, ensure that the system or the machine in which it has been fitted complies with applicable local regulations and directives.

Control elements and indicator lamps

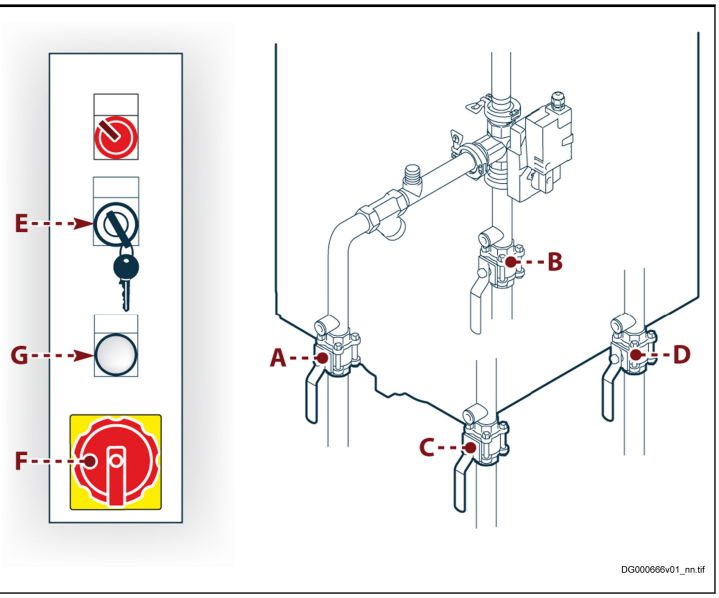
A	**Main switch:** It is used for connecting and disconnecting the power supply to machine. The indicator lamp (**B**) lights up.	
B	**Indicator lamp (white light):** Indicates that the power supply to the machine has been enabled.	
C	**Key-operated two-position stay-put selector switch:** For releasing or locking the main pump. The key has to 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. 8-123: Information and safety signs

Switching on

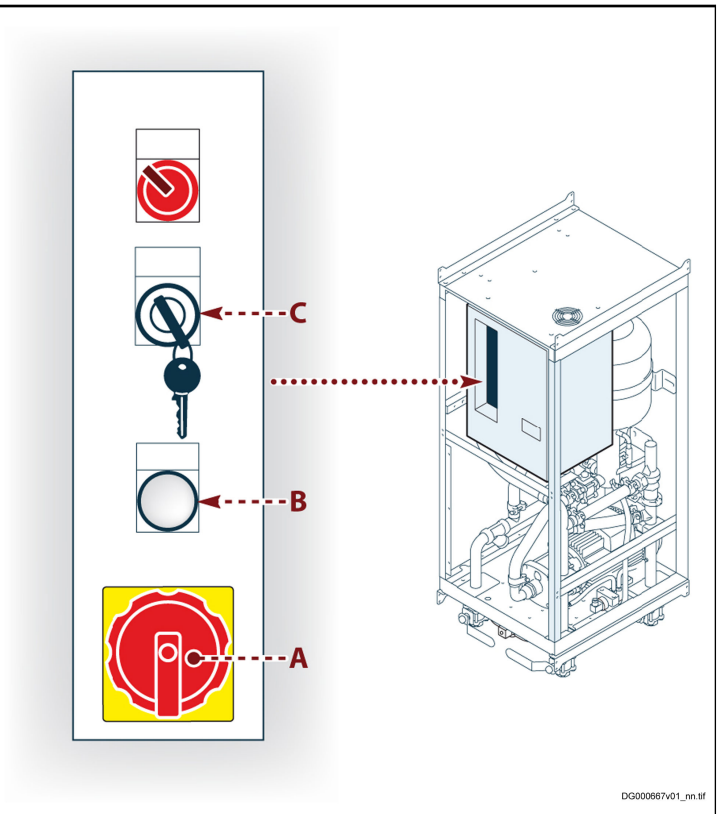
When starting the machine for the first time fill the drive circuit (see chapter "Filling the drive circuit" on page 376).

To start the machine, proceed as follows.

1	Open the ball valves (**A - B - C - D**).	
2	Ensure that liquid flows through the customer side circuit.	
3	Turn the main switch (**F**) to the "ON" position. The indicator lamp (**G**) lights up.	
4	Turn the key selector (**E**) to the "ON" position. Machine start-up has to be performed using the operator terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR and UNIT WARNING connections" on page 551).	

Tab. 8-124: Switching on

Switching off

Switching off with the main switch 1. Turn the main switch (A) to the "OFF" position. • The indicator lamp (B) will switch off. • Machine operation stops and the voltage supply to the terminal box is interrupted. • The supply terminals remain live.	
Switching off with the key-operated switch This switch-off mode is reserved for authorized 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 terminal box at the machine remains live.	
Remote-controlled switch-off Remote-controlled switch-off has to be performed using the owner's operator terminal, via the "ENABLE" connection. • Operation of the main pump stops. • The terminal box at the machine remains live.	
Switching off automatically The machine stops automatically if the pressure in the cooling circuit drops below 0.2 bar and the temperature of the cooling liquid exceeds the preset upper limit (parameter P-0-1318).	

Tab. 8-125: Switching off

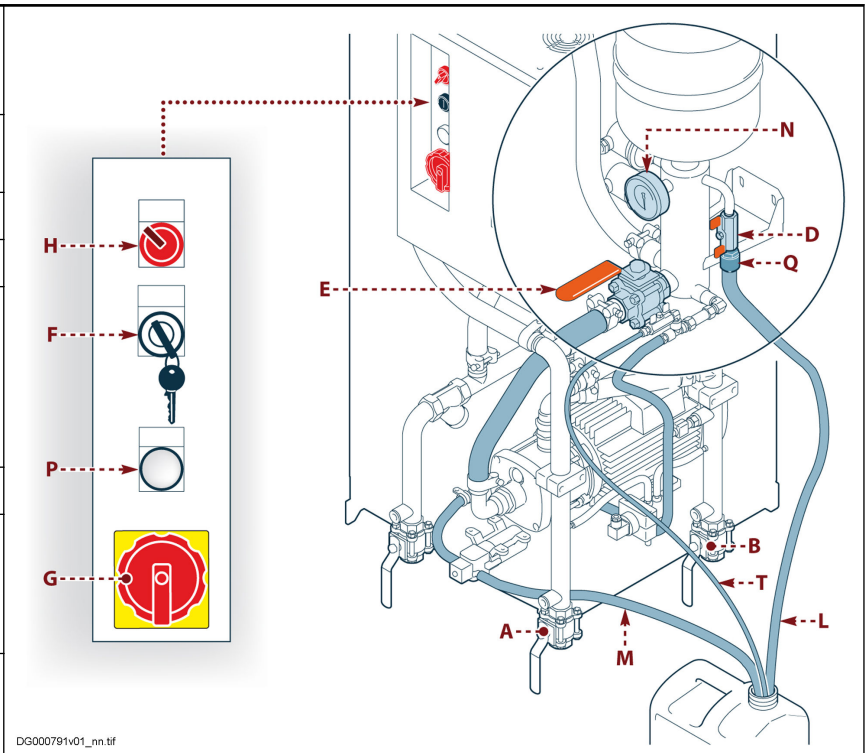
Switching off in emergency conditions

To switch off the device in the event of imminent danger (emergency stop), turn the main switch (**A**) to the "OFF" position.

Fix the cause for the emergency stop before restarting the machine.

Filling the drive circuit

Check if the installation as well as electrical and hydraulic connections are executed professionally in accordance with the manufacturer's specifications.

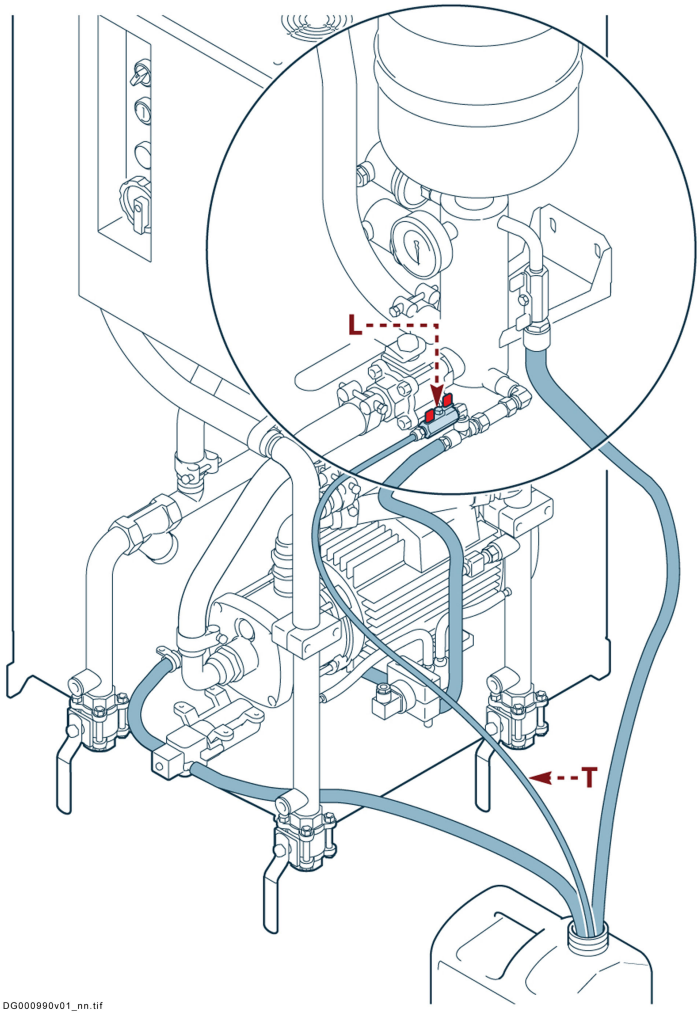
1	Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 356).	
2	Fit the pipes (**L - M - T**) into the tank.	
3	Open the ball valve (**A**).	
4	Open the ball valve (**B**).	
5	Open the valve (**D**). If there is no liquid coming, clean the connector (**Q**) (see chapter "Cleaning the connector of the bleed valve" on page 383).	
6	Open the valve (**E**).	
7	Turn the key-operated selector switch (**F**) to the "OFF" position to prevent unexpected activation of the main pump.	
8	Ensure that the remote-controlled "ENABLE" function is activated.	
9	**NOTICE!** Do **not** turn the key-operated selector switch (F) to the "ON" position since this could cause damage to the main pump. Open any existing valves that are installed outside the machine on the circuit of the machine to be cooled.	
10	Turn the main switch (**G**) to the "ON" position. The indicator lamp (**P**) lights up.	
11	Turn the selector switch (**H**) to activate the filling pump. Make sure that there is always enough liquid in the tank. If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 378).	
12	When the fluid is running out of the clear tube (**L**) in a steady stream (no bubbles) and the pressure has reached 1.4 … 2.2 bar, turn the key-operated selector switch (F) to the "ON" position to activate the main pump in the automatic mode. The pressure is indicated on the pressure gauge (**N**). **NOTICE!** The filling pump is activated and deactivated automatically and keeps the pressure at 1.4 … 2.2 bar. 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. The pressure drop is caused by the air pumped into the circuit as a result of activation of the main pump. Make sure that the key-operated switch is set to "ON".	

13	Keep the filling pump and the main pump running for at least 30 minutes in order to rinse the cooling circuit thoroughly. **NOTICE!** 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. **NOTICE!** If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 378).
14	Turn the selector switch (**H**) to deactivate the filling pump.
15	Close the valve (**D**) when the pressure in the circuit has reached 1.5 bar.
16	Remove the pipes from the tank.
17	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. If it is not correct, carry out the pressure restore procedure (see chapter "Restoring the pressure" on page 379).

Tab. 8-126: Filling the drive circuit

Filling pump priming procedure

If the filling pump does not prime automatically, proceed as described:

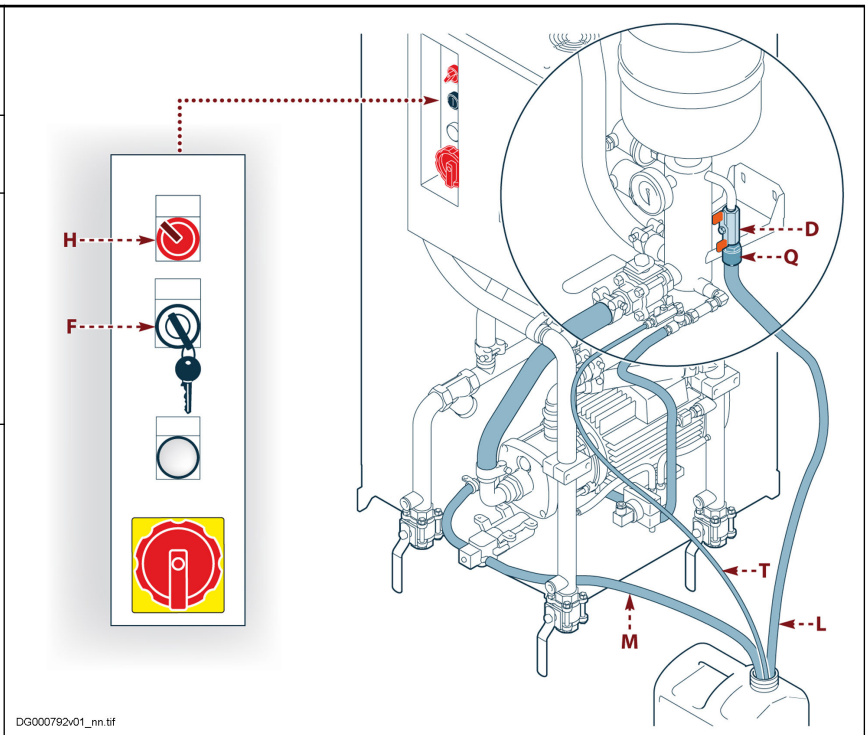
1	When the filling pump is active, open the valve (**L**).	
2	Wait for the coolant to start flowing out of the transparent hose (**T**).	
3	Close the valve (**L**) and leave the filling pump working. The filling pump is primed and starts pumping the coolant into the hydraulic circuit.	

Tab. 8-127: Perform the filling pump priming procedure

Restoring the pressure

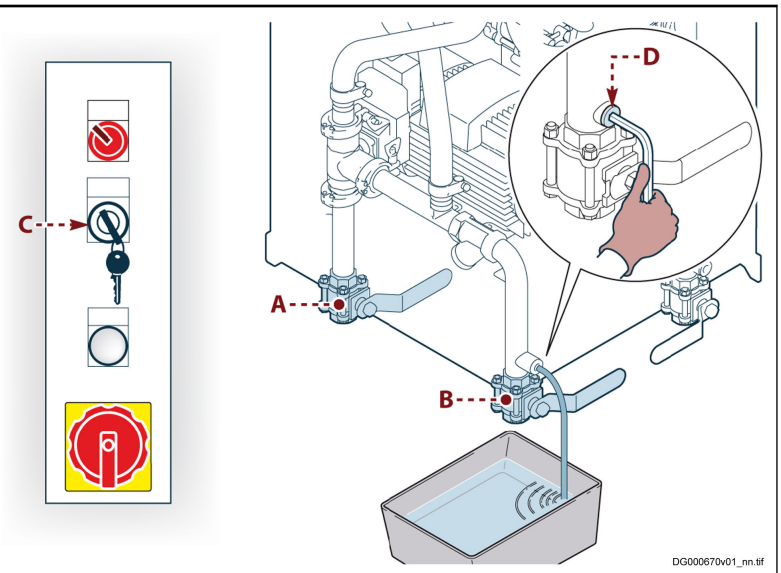
This procedure can be carried out only if the pressure is above 0.8 bar and the main pump is activated.

If the pressure is below this level, carry out the circuit filling procedure (see chapter "Filling the drive circuit" on page 376).

1	Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 356).	
2	Fit the pipes (**L - M - T**) into the tank.	
3	Turn the selector switch (**H**) to activate the filling pump. If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 378).	
4	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. If there is no liquid coming, clean the connector (**Q**) (see chapter "Cleaning the connector of the bleed valve" on page 383).	
5	**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. **NOTICE!** If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 378). Turn the selector switch (**H**) to deactivate the filling pump.	
6	Remove the pipes from the tank.	
7	Remove the key from the selector switch (**F**) and store in a safe place.	

Tab. 8-128: Restoring the pressure

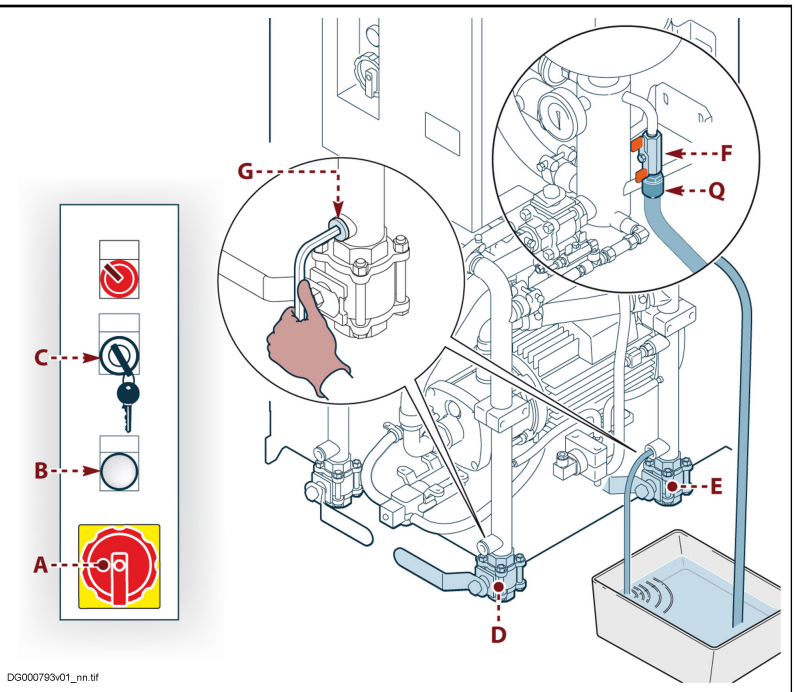
Emptying the customer side circuit

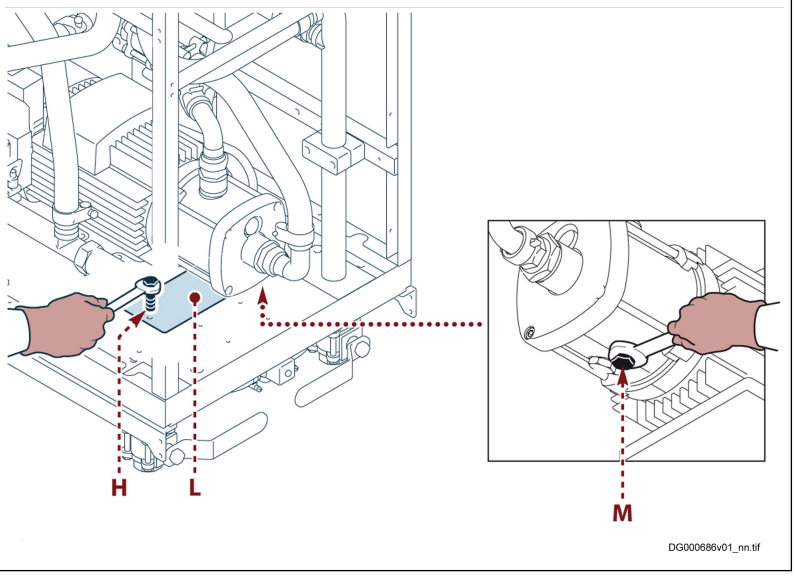
1	Position a suitable container for collecting the coolant.	
2	Switch off the machine (see chapter "Switching off" on page 375).	
3	Turn the key selector (**C**) to the "OFF" position.	
4	Close the ball valves (**A - B**).	
5	Unscrew the cap (**D**).	
6	Drain out all the coolant.	
7	Screw the cap (**D**) back on. **NOTICE!** Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.	

Tab. 8-129: Emptying the customer side circuit

Emptying the drive circuit

1	Position a suitable container for collecting the coolant.
2	Switch off the machine (see chapter "Switching off" on page 375).
3	Turn the key selector (**C**) to the "OFF" position.
4	Turn the main switch (**A**) to the "OFF" position.
5	The indicator lamp (**B**) will switch off.
6	Close the ball valves (**D - E**).
7	Open the valve (**F**). If there is no liquid coming, clean the connector (**Q**) (see chapter "Cleaning the connector of the bleed valve" on page 383).
8	Unscrew the caps (**G**).
9	Drain out all the coolant.
10	Close the valve (**F**).
11	Screw the caps (**G**) back on.
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 the cap (**M**) back on.
16	Reattach the fixed guard (**L**).
17	Tighten the screws (**H**). **NOTICE!** Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.





Tab. 8-130: Emptying the drive circuit

Maintenance

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.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

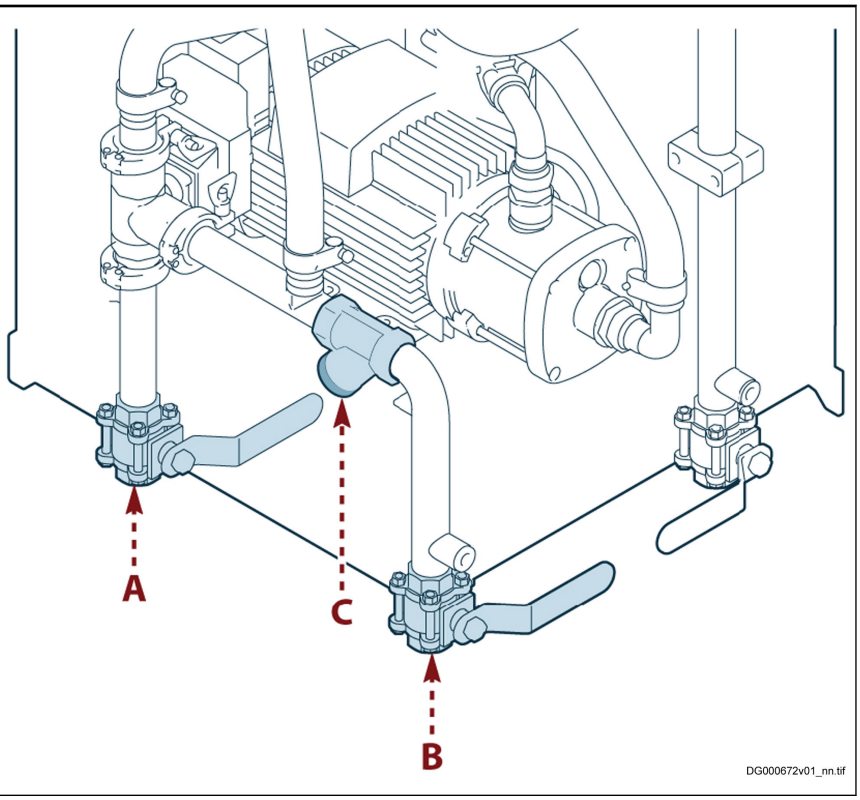
Maintenance schedule

Interval		Component	Type of work	Cross reference
Every 1600 operating hours	Every 30,000 operating hours	–	–	–
✓	–	Filter	Cleaning	See chapter "Filter cleaning in the customer side circuit" on page 382
–	✓	Main pump	Replacement	See chapter "Replacing the main pump" on page 388
–	✓	Coolant	Replacement	

Tab. 8-131: Maintenance schedule

Filter cleaning in the customer side circuit

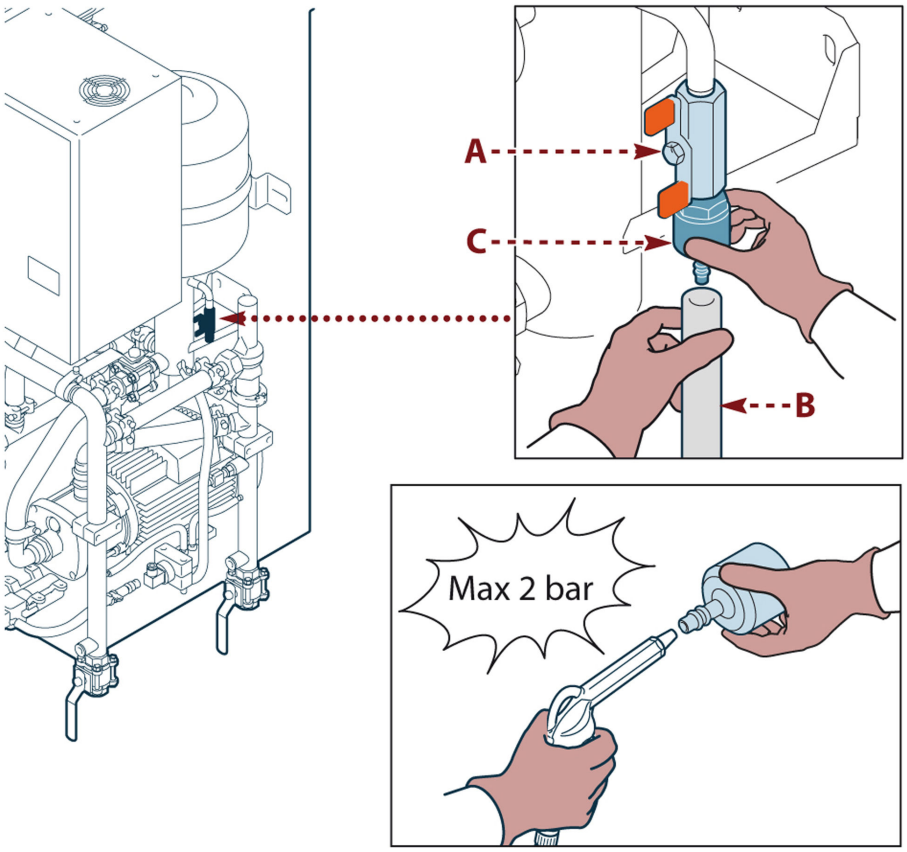
1	Drain the cooling liquid from the customer side circuit.
2	Close the intake and outlet ball valves (**A - B**).
3	Unscrew the cap (**C**).
4	Remove and clean the filter. Do not use aggressive, flammable or toxic detergents.
5	Reinsert the filter.
6	Screw the cap (**C**) back on.
7	Open the ball valves (**A - B**).



Tab. 8-132: Filter cleaning in the customer side circuit

Cleaning the connector of the bleed valve

1	Close the bleed valve (**A**).
2	Remove the hose (**B**).
3	Unscrew the connector (**C**).
4	Clean the connector with compressed air. Keep the pressure on the level indicated in the picture.
5	Screw on the connector (**C**).
6	Attach the hose (**B**) to the connector.
7	Open the bleed valve (**A**).



Tab. 8-133: Cleaning the connector

Cleaning the machine

Clean the machine with detergents that are approved in accordance with the applicable legal regulations.

Troubleshooting

The following table contains a number of faults that may occur during operation as well as appropriate corrective measures.

Code	Type	Malfunction	Likely cause	Remedy
E2011	Warning 1	Low pressure, please refill	For at least 0.5 s, the system pressure is lower than 0.5 bar (loss of water, maintenance)	Refill cooling system up to 1.5 bar
E2012	Warning 2	Unable to start drive	Motor does not start in velocity control operation	Switch off the start command for at least 10 seconds Ensure that the system has the status "AF" before starting
E2013	Warning 3	Mixing valve is not following	3MV mixing valve may have a mechanical defect or the electrical connecting cable may be damaged	Check 3MV mixing valve Check feedback signal
E2014	Warning 4	Overtemperature	Temperature exceeds the defined value (P-0-1316) of the maximum permissible deviation from required temperature (T_{set}) for a defined duration (P-0-1317)	Check cooling system Adjust parameter P-0-1316 and/or P-0-1317
E2016	Warning 6	Lower motor speed limitation active	Motor velocity < 360 min^{-1}	Increase the value of parameter P-0-1374 (> 360 min^{-1}) Ensure that the motor can run with a velocity > 360 min^{-1}
F2011	Error 1	System pressure	System pressure lower than 0.2 bar	Refill cooling system up to 1.5 bar
F2012	Error 2	Overtemperature	The fluid temperature (on the drive side) has exceeded the maximum allowed temperature limit (see parameter P-0-1318)	Check cooling system Change the value of parameter P-0-1318 if too low
		Slight leakage of cooling liquid between pump and motor	Start after long inactivity of the machine Changing the ambient conditions	Start pump [1)]

Code	Type	Malfunction	Likely cause	Remedy
		The filling pump does not start priming automatically	Suction hose empty following long period of machine disuse No coolant in the tank High backpressure in the filling pump delivery line	Perform the filling pump priming procedure
		The filling pump does not inject the coolant into the circuit	The filling pump is not primed The filling pump bleed valve is open	Perform the filling pump priming procedure Close the filling pump bleed valve

1) The pump is mechanically sealed by the cooling liquid. This type of seal (mechanical) may lead to a slight leakage of cooling liquid under certain conditions. It takes some time to minimize the leakage if the pump is started after stopping the machine or after being inactive. The required time depends on the operating conditions. The leaked cooling liquid usually evaporates immediately. The leaked cooling liquid is not visible then. **This type of leakage is not a malfunction.** Contact the service if the leakage persists for a longer period of time.

Tab. 8-134: Errors and warnings

Replacing the component

Safety advice for component exchange

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.

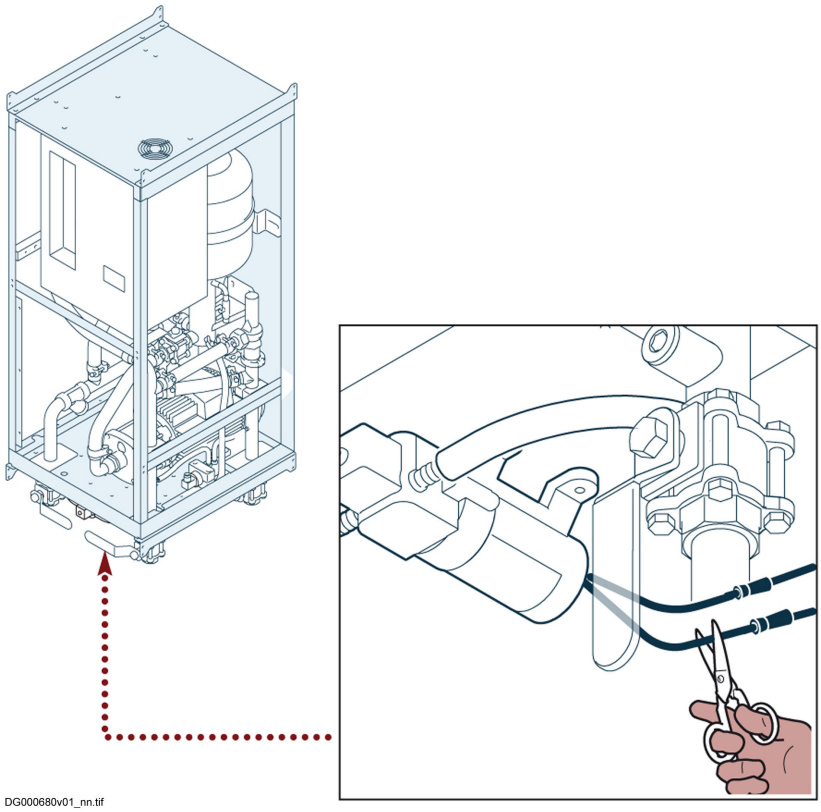
In particular, disconnect the power supply to the machine.

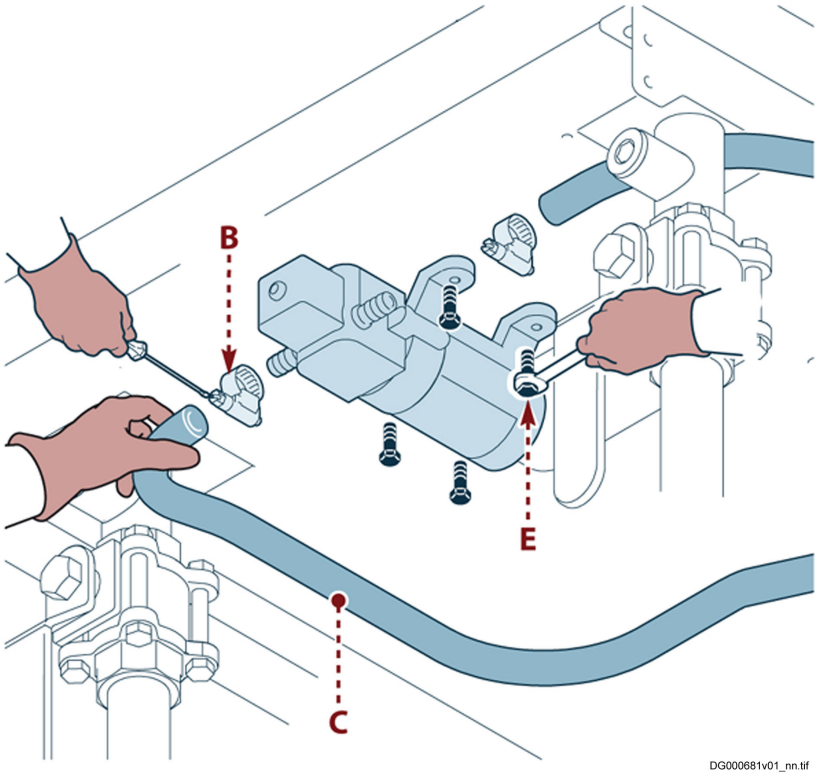
Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

Replace worn or damaged parts by original spare parts.

Replacing the filling pump

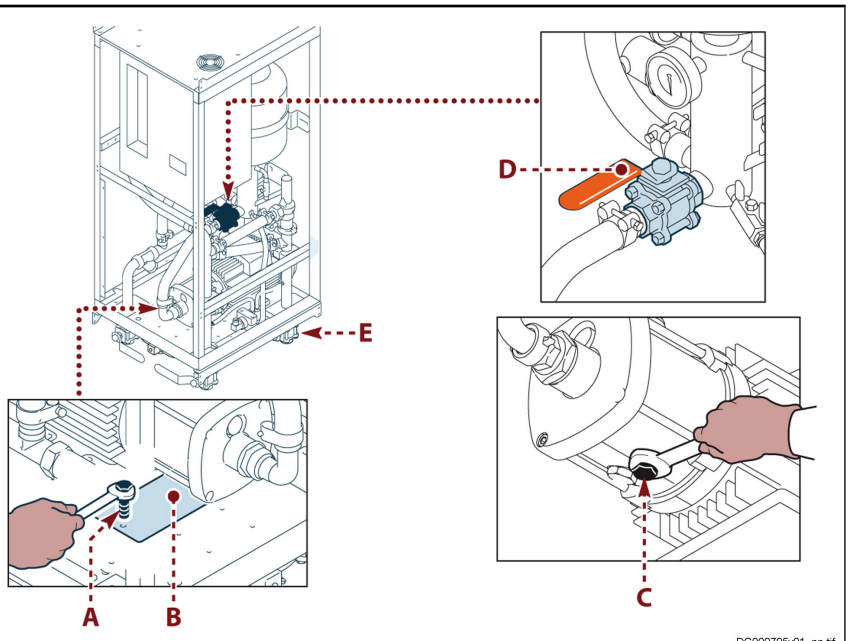
1	Disconnect the machine from the power supply source.	
2	Cut the mains cables.	

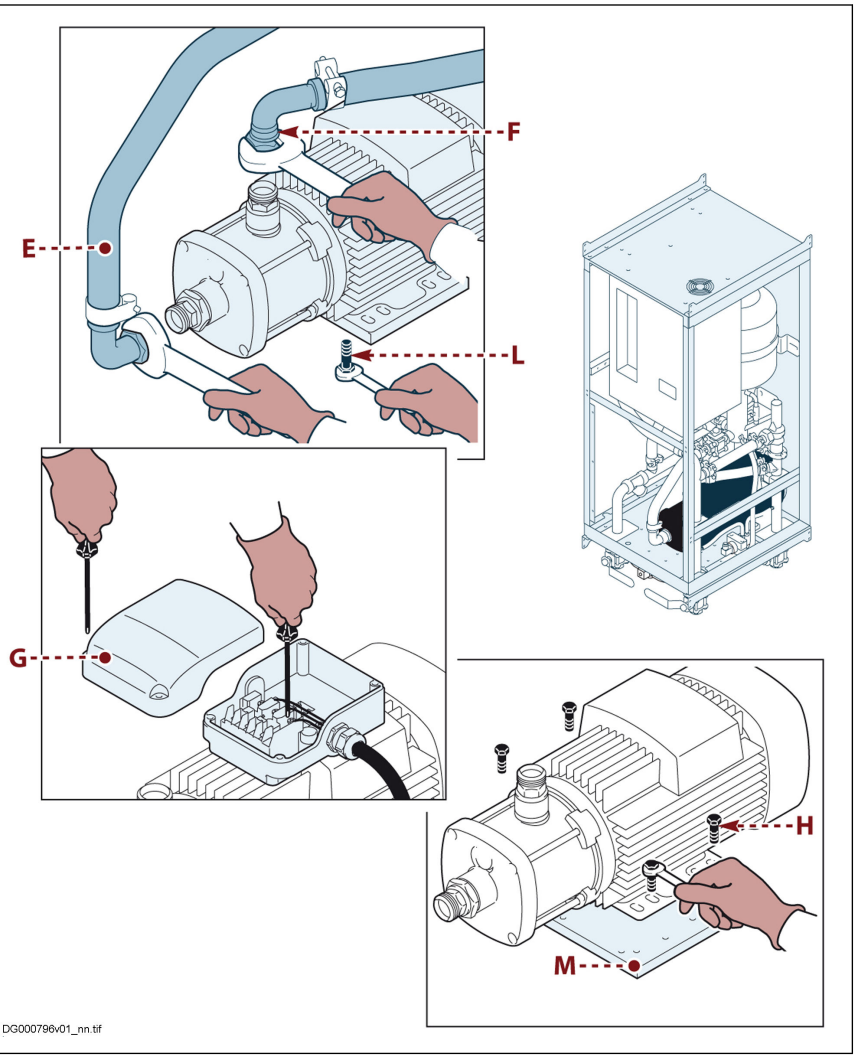
3	Undo the screw and remove the strap (**B**).	
4	Extract the hose (**C**).	
5	Repeat the same operations to remove the other flexible tube.	
6	Unscrew the screws (**E**).	
7	Remove the pump.	
8	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump.	
9	Fill the drive circuit (see chapter "Filling the drive circuit" on page 376).	

Tab. 8-135: Replacing the filling pump

Replacing the main pump

1	Disconnect the machine from the power supply source.
2	Allow the machine to cool down.
3	Close the valve (**D**).
4	Close the ball valve (**E**).
5	Unscrew the screws (**A**).
6	Remove the fixed guard (**B**).
7	Unscrew the cap (**C**).

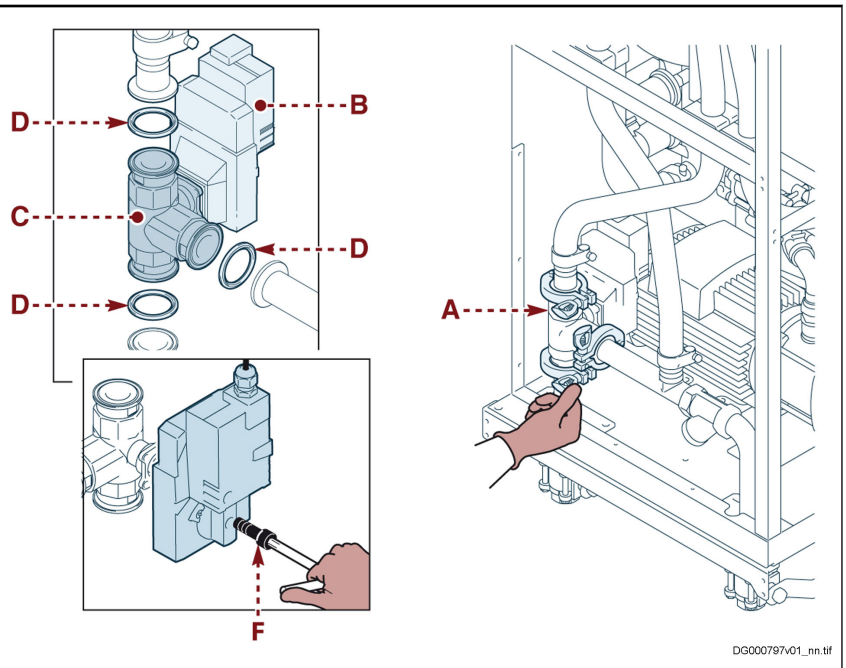


8	Disconnect the hosing (**E**).	
9	Remove the hose (**F**).	
10	Remove the cover (**G**).	
11	Disconnect the cables from the terminals.	
12	Unscrew the screws (**L**).	
13	Remove the pump.	
14	Unscrew the screws (**H**).	
15	Remove the plate (**M**).	
16	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump. **NOTICE!** The spare pump is supplied with the fittings mounted. Do not remove the fittings as this could cause liquid leakage.	
17	Fill the drive circuit (see chapter "Filling the drive circuit" on page 376).	

Tab. 8-136: Replacing the main pump

Replacing the mixing valve

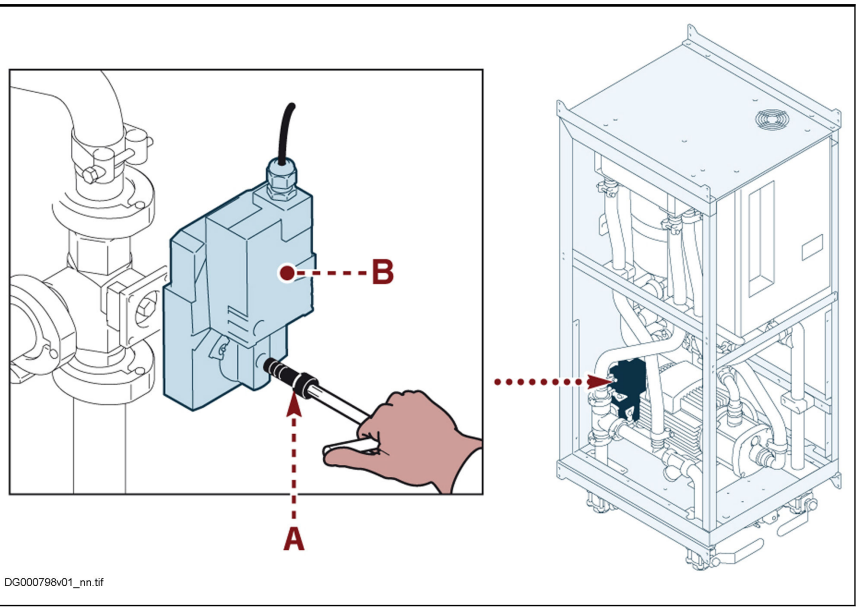
1	Disconnect the machine from the power supply source.
2	Allow the machine to cool down.
3	Unscrew the clamps (**A**).
4	Remove the valve (**C**) and the actuator (**B**).
5	Remove the gaskets (**D**).
6	Unscrew the screw (**F**).
7	Disconnect the valve from the actuator.
8	Connect the new valve with the actuator.
9	Position the gaskets (**D**). Replace the gaskets if they are damaged or worn.
10	Bring the valve and the actuator to correct position.
11	Screw on the clamps (**A**). In order to install the new valve, proceed in reverse order to the removal of the valve.



Tab. 8-137: Replacing the mixing valve

Replacing the actuator

1	Disconnect the machine from the power supply source.
2	Allow the machine to cool down.
3	Disconnect the electric cables from the actuator (see wiring diagram).
4	Unscrew the screw (**A**).
5	Remove the actuator (**B**). In order to install the new actuator, proceed in reverse order to the removal of the actuator.



Tab. 8-138: Replacing the actuator

Replacing the fuses

Before replacing the fuse, fix the cause of the malfunction.

Only replace the interrupted fuse with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Fuses" on page 360.

Disposing of old equipment

Scrapping operations must be handled by specialized personnel with suitable skills for the job.

In accordance with the applicable regulations, all individual components must be collected separately for disposal according to their chemical properties when dismantling the machine.

With reference to the European Directive (RAEE), electric and electronic components must either be disposed of in authorized landfill sites or the machine, complete of the said parts, must be returned to the dealer in case of a new purchase.

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.

Control with MLD

Pressure control

The differential pressure between the machine's intake and its outlet has to be kept at a constant rate (1.5 bar, for example) so that the cooling liquid flow to the devices to be cooled can be easily set.

To control the pressure, the pump speed is varied based on the intake/outlet differential pressure.

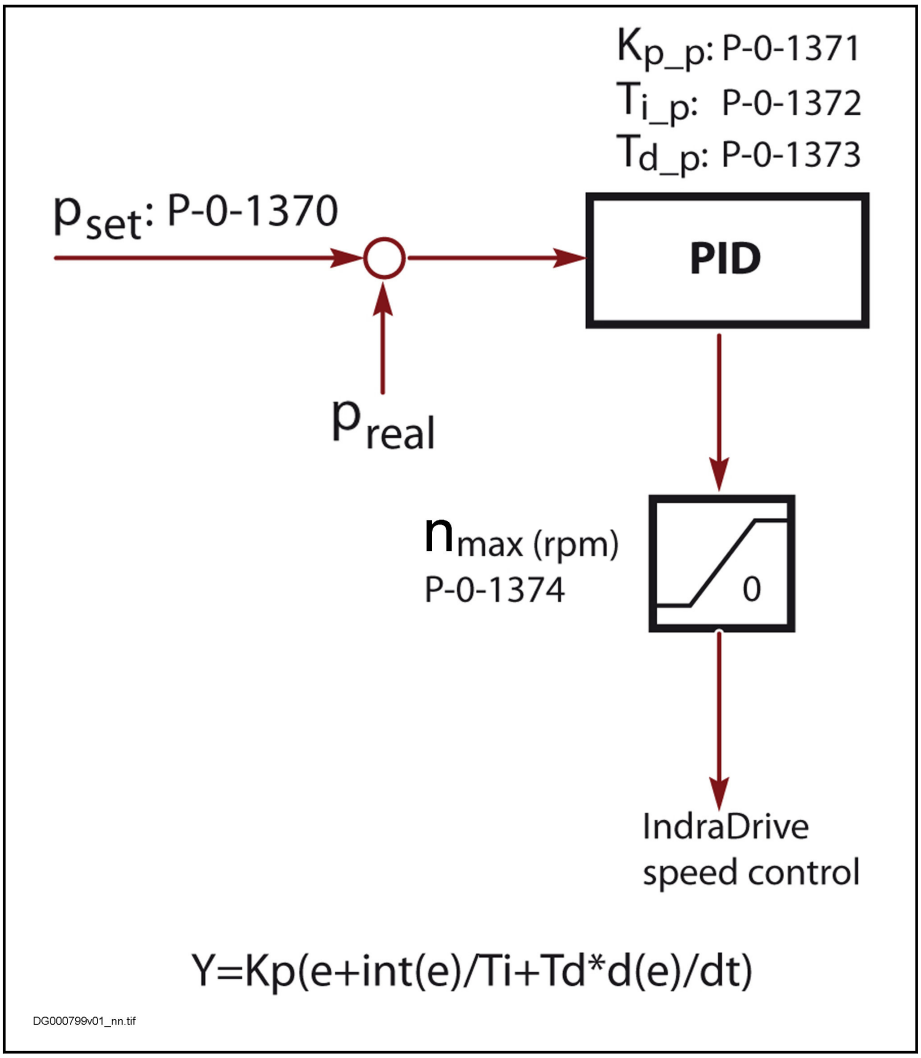


Fig. 8-110: Pressure control

Name	Parameter	Unit
p_{set}	P-0-1370	bar
K_{p_p}	P-0-1371	min^{-1}/bar
T_{i_p}	P-0-1372	s
T_{d_p}	P-0-1373	s
n_{max}	P-0-1374	min^{-1}

Tab. 8-139: Pressure control parameters

Temperature control

The temperature of the fluid in the drive circuit has to be kept at a constant value (between 40 °C and 60 °C) to prevent condensation from forming in the devices to be cooled.

The temperature of the fluid is set using a three-way mixing valve.

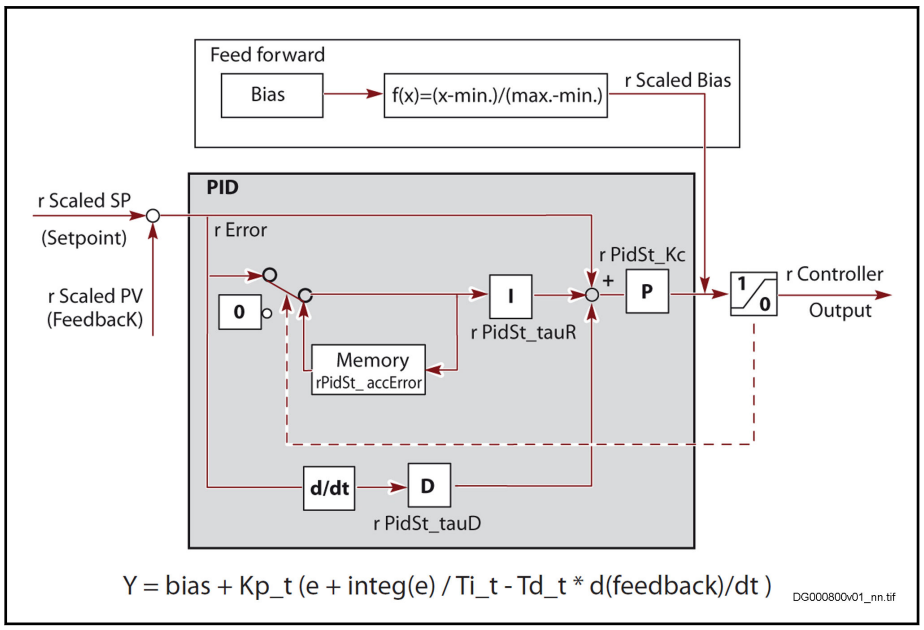


Fig. 8-111: Temperature control

Name	Parameter	Unit
t_{set}	P-0-1375	°C
K_{p_t}	P-0-1376	V / °C
T_{i_t}	P-0-1377	s
T_{d_t}	P-0-1378	s
Feed forward	P-0-1379	V

Tab. 8-140: Temperature control parameters

Feed forward (P-0-1379)

The "feed forward" feature allows the temperature regulation system to adjust more quickly when the machine is started up.

The "feed forward" feature adds a value at the regulator output so that the cooling process can begin before the command value is signaled to have been exceeded.

When the "feed forward" feature is used (P-0-1379 > 0), it is important to make sure the temperature rise at machine start-up is not too high. An empirical method for calculating the "feed forward" is shown below:

$FF = [X - K_{p_t} \times (t_{set} - t_{act})] \div 10$
FF: Feed forward X: 30 … 60

Tab. 8-141: Calculation of "Feed forward"

☞ The "Feed forward" shown here is different to the "Feed forward" implemented in an IndraDrive drive controller.

Name	Parameter	Unit	Standard value
p_{set}	P-0-1370	bar	1.5
K_{p_p}	P-0-1371	min^{-1}/bar	40
T_{i_p}	P-0-1372	s	0.05
T_{d_p}	P-0-1373	s	0
n_{max}	P-0-1374	min^{-1}	3000
t_{set}	P-0-1375	°C	50
K_{p_t}	P-0-1376	V / °C	-5
T_{i_t}	P-0-1377	s	40
T_{d_t}	P-0-1378	s	0
Feed forward	P-0-1379	V	0

Tab. 8-142: Temperature control parameters

Starting the machine

The machine is started (as per the predefined setting) solely with the digital command:

ENABLE (X31.1, P-0-1390)

You can set the type of machine enabling (starting via digital input or starting via the communication).

Start	Parameters	Input
Start selection 1	P-0-1380	digital
Start selection 2	P-0-1381	digital
Start command via communication	P-0-1382	digital

Tab. 8-143: Start options

The parameters **P-0-1380 and P-0-1381** can be set to "0" or "1".

If both parameters are set to the **same value** (0 or 1), the machine can be started via the digital input with **P-0-1390** (0 = off, 1 = on).

If both parameters are set to **different values**, the machine can be started via the communication with **P-0-1382** (0 = off, 1 = on).

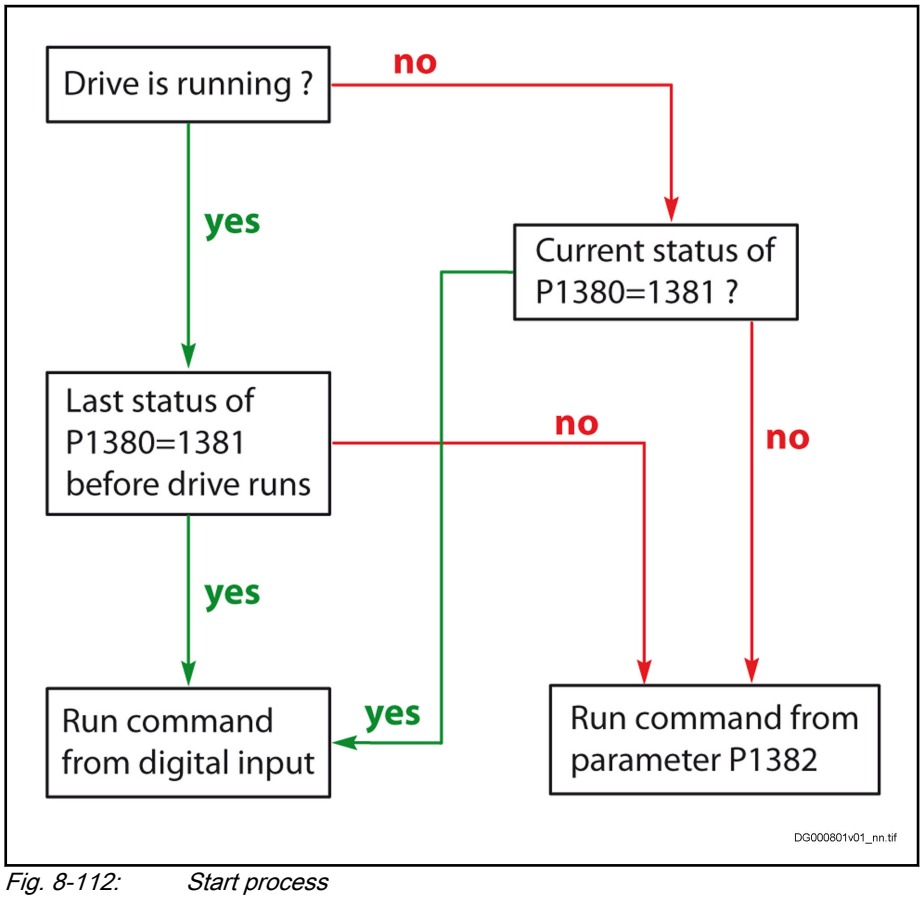


Fig. 8-112: Start process

Example: By setting the parameter P-0-1380 as a digital input and monitoring the parameters P-0-1381 and P-0-1382 via the PLC, the power-up command

for the machine can be transmitted either via the digital input or the PLC, from two different workstations.

Parameters

Name	Parameter	Unit	Minimum value	Maximum value	Standard value WW008/035/060
p_{set} (pressure command value)	P-0-1370	bar	0	2.0	1.5
K_{p_p} (pressure control)	P-0-1371	min^{-1}/bar	0	10000	40
T_{i_p} (pressure control)	P-0-1372	s	0.0	1000.0	0.05
T_{d_p} (pressure control)	P-0-1373	s	0.0	1000.0	0.0
n_{max}	P-0-1374	min^{-1}	0	8000	3000
Temperature setpoint	P-0-1375	°C	0	60	50
K_{p_T} (temperature control)	P-0-1376	V / °C	-1000	0	-5
T_{i_T} (temperature control)	P-0-1377	s	0	10000	40
T_{d_T} (temperature control)	P-0-1378	s	0	1000	0
Feed forward	P-0-1379	V	0	1000	0
Start selection 1	P-0-1380	-	0	1	0
Start selection 2	P-0-1381	-	0	1	0
Start command via communication	P-0-1382	-	0	1	0
p_{set_2} (pressure command value 2)	P-0-1385	bar	0.0	2.0	0.2
Control word switching to p_{set_2} (see also "Switching the pressure command value" on page 398)	P-0-1295	bit	-	-	0
High temperature warning differential value	P-0-1316	°C	0	20	10
High temperature warning time	P-0-1317	s	0	100	3
Overtemperature limit value	P-0-1318	°C	40	100	90
Tolerance pressure control	P-0-1320	bar	0.0	10.0	0.5
Low motor velocity - deceleration	P-0-1321	s	0	100	5

Tab. 8-144: Parameters

Name	Parameter	Unit	Type *	Scaling
Analog I/O monitoring parameters (read-only)				
3-way mixing valve control voltage	P-0-1270	V	AO	2-10 V, 0-100% open
Pressure (difference between input and output)	P-0-1271	bar	-	-
Cooling water temperature in °C	P-0-1272	°C	-	-
Cooling water temperature in °F	P-0-1273	°F	-	-
Pressure sensor	P-0-1280	V	AI	0-10 V, 0-6 bar
Temperature sensor	P-0-1281	V	AI	0-10 V, 0-100 °C
3-way mixing valve position feedback	P-0-1282	V	AI	2-10 V, 0-100% open
Digital I/O parameters				
Drive enable	P-0-1390	bit 0	DI	
Pressure monitoring > 0.5 bar	P-0-1391	bit 0	DI	
Pressure monitoring > 0.2 bar	P-0-1391	bit 1	DI	
Status word machine	P-0-1410			
Cooler is running	P-0-1410	bit 0		Start command + P-0-1410.4 + no warning + no error
Pressure command value attained	P-0-1410	bit 1		abs(P-0-1370 - P-0-1271) < P-0-1320
Cooler is running (warning ignored)	P-0-1410	bit 3		Start command + P-0-1410.4 + no error
Motor is running	P-0-1410	bit 4		Motor velocity (S40) ≥ 360
Drive warning	P-0-1412	bit 0	DO	"high" for no warning
Drive error	P-0-1412	bit 1	DO	"high" for no error

* AI: analog input; AO: analog output; DI: digital input; DO: digital output

Tab. 8-145: Parameters

Switching the pressure command value

The pressure command value can be switched via control word (P-0-1295.0). This function can be used for a more economical operation (lower energy consumption, less wear) if the new pressure command value is set to a lower value.

Pressure command value (p_{set})	P-0-1370
Pressure command value 2 (p_{set_2})	P-0-1385
Control word	P-0-1295.0
P-0-1295.0 = 0	Pressure command value: P-0-1370
P-0-1295.0 = 1	Pressure command value: P-0-1385

Tab. 8-146: Switching the pressure command value

With a pressure command value of 0.2 bar instead of 1.5 bar, laboratory measurements showed energy savings of 92% (40 W instead of 500 W). The motor speed decreased from 2200 min^{-1} to 760 min^{-1} resulting in a longer service life of the motor.

Water-water heat exchanger (WW060-180)

Technical information

General description of the machine

The machine is designed and manufactured for the purpose of cooling devices or equipment using a liquid solution made of glycol and demineralized 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.

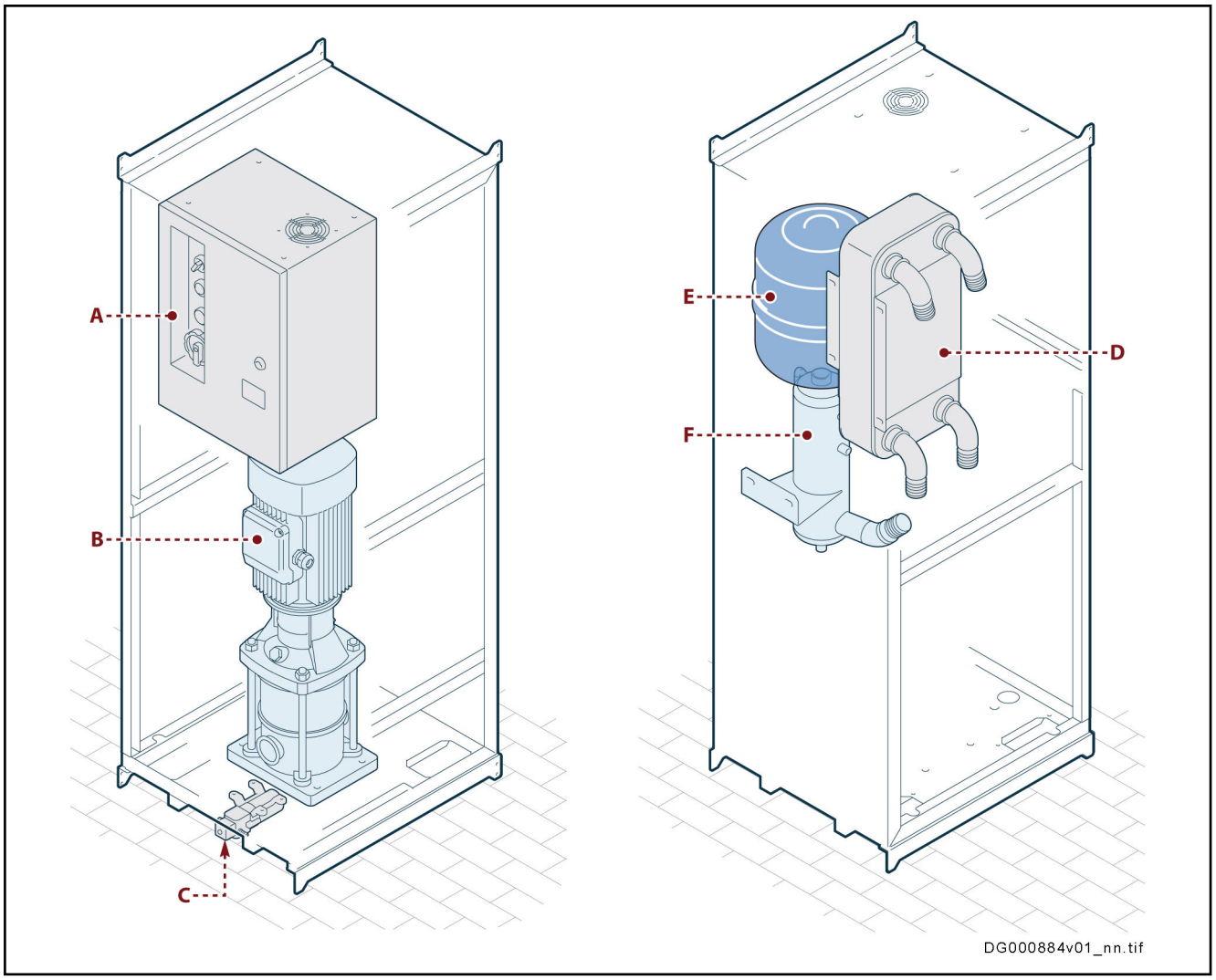
The cold liquid, provided by the owner, flows in the customer side circuit and through the heat exchanger it cools the liquid in the drive circuit.

The equipment or machine to be cooled is connected to the drive circuit.

Pressure and temperature control is done via IndraMotion MLD, the drive-integrated Motion Logic Control according to IEC 61131-3. See chapter "Control with MLD" on page 392.

See also chapter "Liquid Cooling" on page 53.

Main parts



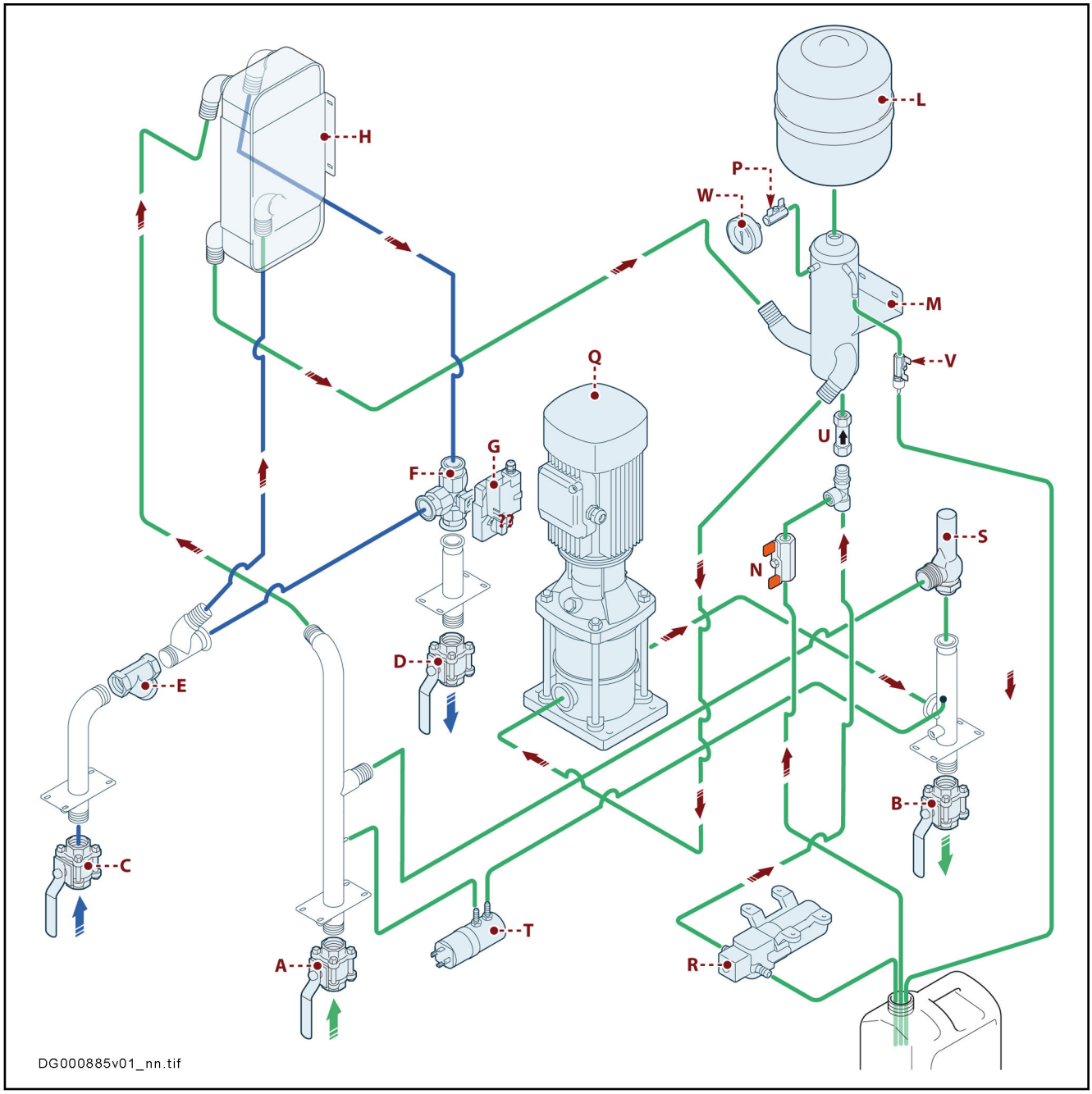
A	Terminal box
B	Main pump
C	Filling pump
D	Heat exchanger
E	Expansion tank
F	Coolant distribution manifold

Fig. 8-113: 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 adjust 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 release any backpressure in the filling pump delivery line and facilitate priming.
P	**Valve:** It 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	**Bypass valve:** It limits the pressure of the output liquid
T	**Pressure sensor:** It measures the differential pressure between the intake and the outlet of the machine to be cooled
U	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.
V	**Bleed valve:** For exhausting air from the system
W	**Pressure gauge:** Indicates the liquid pressure in the coolant distribution manifold

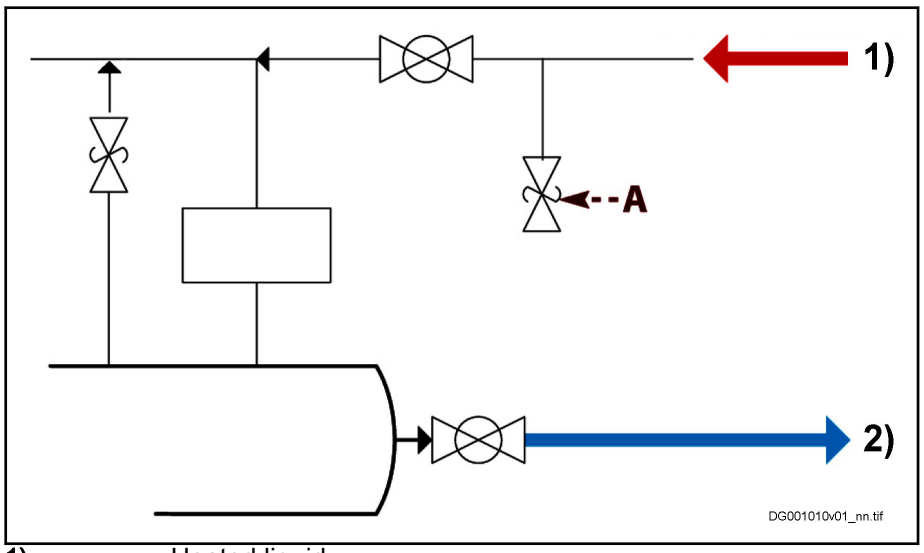
Fig. 8-114: Operational cycle and component description

Guards

The owner has to fit the machine with suitable guards in conformity with the regulations in force, in order to prevent the risk of injury.

Overpressure devices

If additional pumps (external to the machine) are installed on the circuit or if the drop in pressure of the hydraulic load is less than 1.5 bar, the owner has to fit a pressure limiting valve. The valve has to limit the pressure to a maximum of 2 bar in the return pipe to the machine.



1)	Heated liquid
2)	Cooled liquid
A	Pressure limiting valve

Fig. 8-115: Positioning of the pressure limiting valve (A)

Overall dimensions

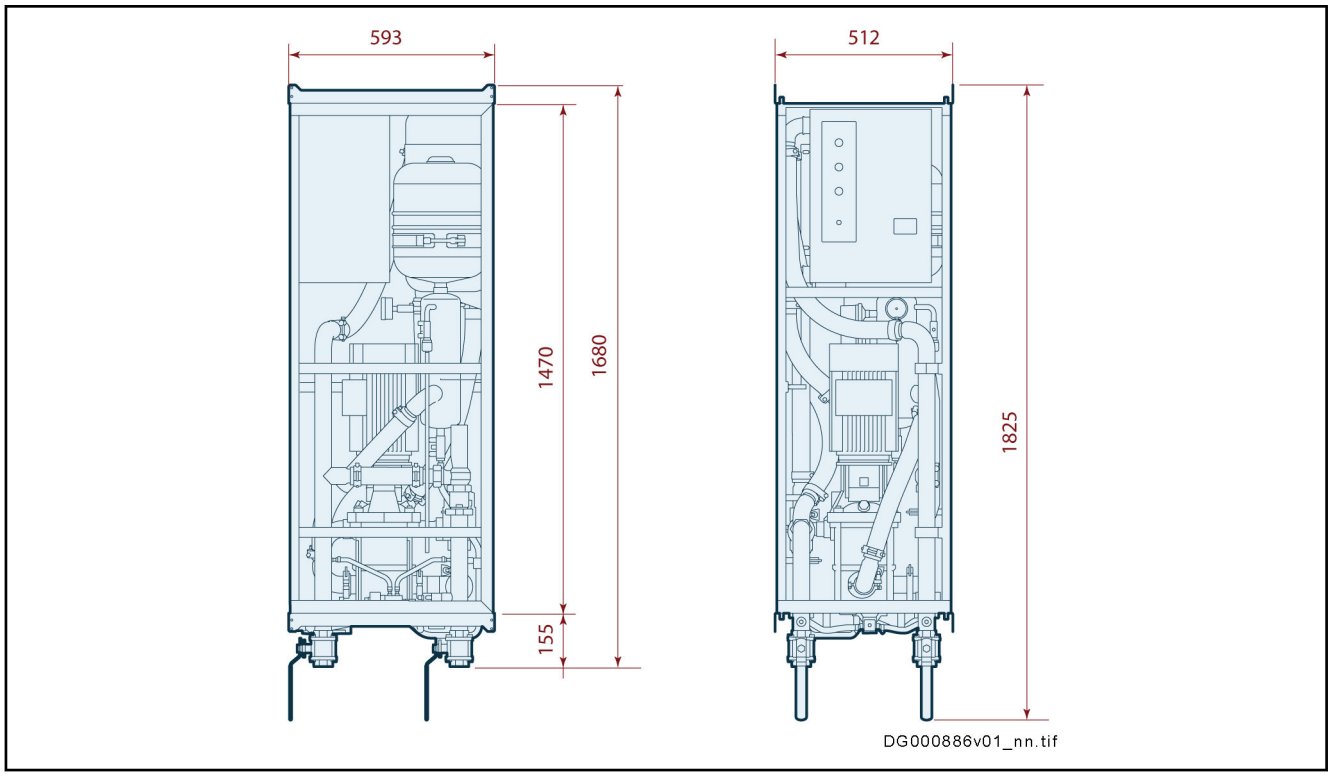


Fig. 8-116: Overall dimensions

Data

Technical data - machine

Description	Unit	WW060-180
Power voltage	Vac	380 (-15%) … 500 (+10%)
Frequency	Hz	50/60
Input current	A	4,5
Maximum cooling capacity	kW	60
Maximum input flow rate in the customer side circuit	l/min	300
Maximum output flow rate in the drive circuit	l/min	180
Maximum input pressure of the cooling liquid in the customer side circuit	bar	7
Maximum input pressure of the cooling liquid in the drive circuit	bar	2
Maximum output pressure of the cooling liquid in the drive circuit	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 demineralized water solution) See also chapter "Liquid Cooling" on page 53.	-	20% glycol
Estimated amount of coolant (heat exchanger only)	l	approx. 30
Customer side circuit coolant		See tab. 8-148 "Water quality specification" on page 406
Ambient temperature during operation	°C	+5 … +55
Ambient temperature during operation (compliant with UL)	°C	+5 … +40
Relative humidity without condensation	%	95
Maximum installation altitude	m	2000
Weight	kg	150

Tab. 8-147: Technical data - machine

Water quality specification

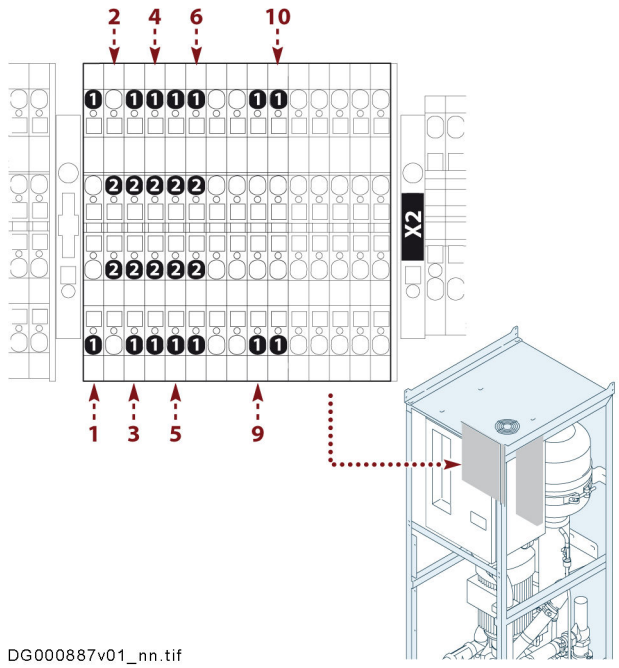
Pos.	Chemical element	Unit	Requirement
1	pH value	Range	7 … 8,5
2	Temporary hardness	°FH	< 5,0
3	Total hardness	°FH	< 10,0
4	Conductance	IS/cm	150 … 1000
5	Particle size	mm	0,02
6	Suspended particles	mg/l	< 0,2
7	Residue at 105°	mg/l	< 450
8	$KINO_4$ consumption	mg/l	< 0,1
9	Ammonia	mg/l	< 0,1
10	Mineral 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	Fluoride (F^-)	mg/l	< 1,0
17	Nitrate (NO_3^-)	mg/l	< 10,0
18	Free carbon dioxide	mg/l	8 … 15
19	Oxygen (O)	mg/l	< 0,2
20	Alkalinity ($CaCO_3$)	mg/l	< 200
21	Sulfate (SO_4^{2-})	mg/l	< 100
22	Chloride (Cl^-)	mg/l	< 50

Tab. 8-148: Water quality specification

ENABLE, UNIT ERROR and UNIT WARNING connections

The signals for releasing the relative machine status using the owner's operator terminal are transmitted via the terminal block shown.

Connect the lines to the terminals shown in table "Connecting the terminals".

X2	Significance	Terminals
9.1 - 2.2	Terminals for machine enabling via the owner's operator terminal (ENABLE)	
3.1 - 3.2 4.1 - 4.2	Machine error signal terminals. Closed contact: no error.	
5.1 - 5.2 6.1 - 6.2	Warning signal terminals. Closed contact: no warning.	
10.1 - 1.1	Terminals for remote-controlled reset of the warning signal	

Tab. 8-149: Connecting the terminals

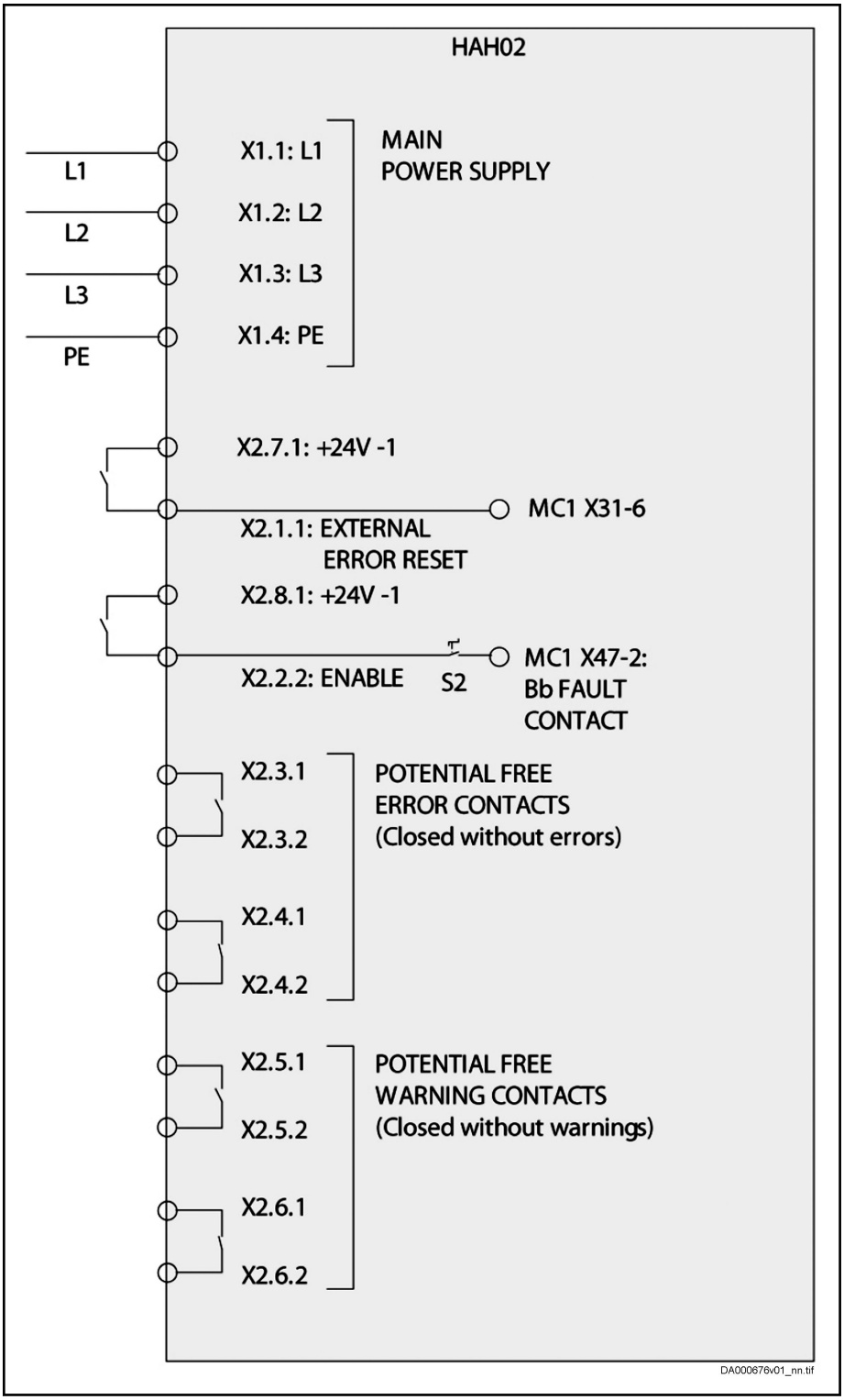
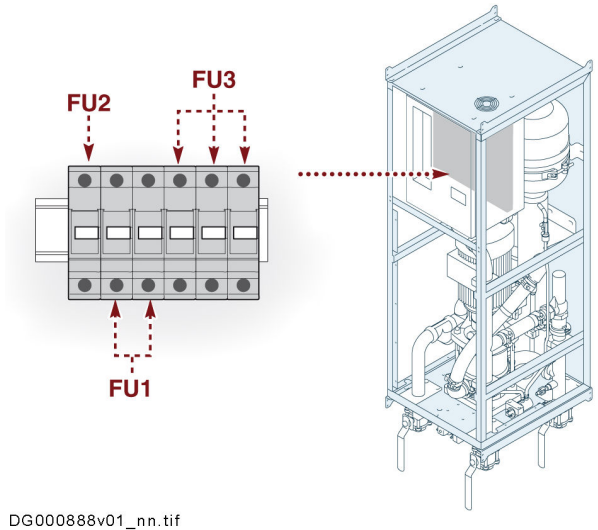


Fig. 8-117: Wiring diagram

Fuses

Name	Current (A)	Type	Rated voltage (Vac)	Interrupting capacity (kW)	Fuse	Position
FU1	1	CC	600	200	Delayed	
FU2	4					
FU3	7					

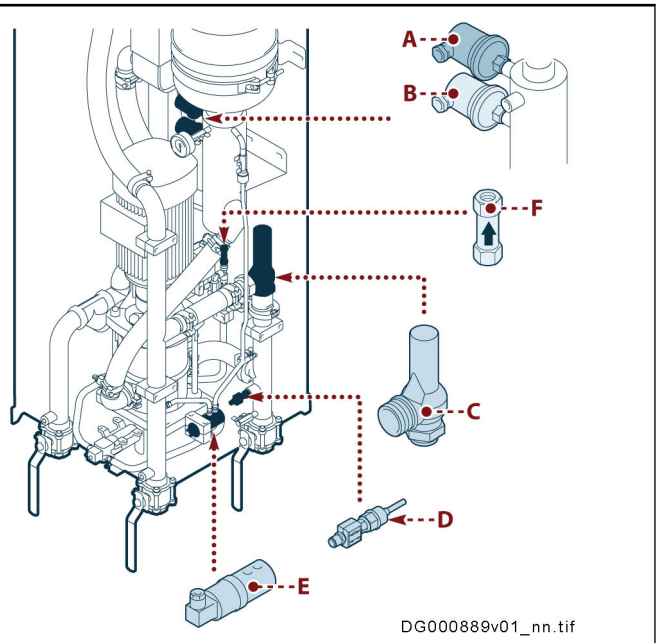
Tab. 8-150: Fuses

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 signaled 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 signaled 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 outlet pipe. The pressure in the drive circuit outlet pipe is kept constant through the sensor.
F	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.



Tab. 8-151: Processing and protection devices

Ambient conditions for operation

The machine works properly at the specified ambient conditions (chapter "Data" on page 405).

The machine is able to function properly at altitudes up to 2000 m above sea level.

Intended use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

The machine must be installed in closed spaces and protected from environmental influences.

Any other use than that specified, or not included or inferable from this project planning instructions, should be considered mishandling and therefore not permitted.

Unintended and unauthorized uses

It is not permitted to use coolants with properties other than those specified by the manufacturer.

It is not permitted to use machines in a flammable or explosive environment.

Commissioning of the machine is only permitted if it is ensured that the system or the machine in which it is installed complies with national and local regulations.

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.

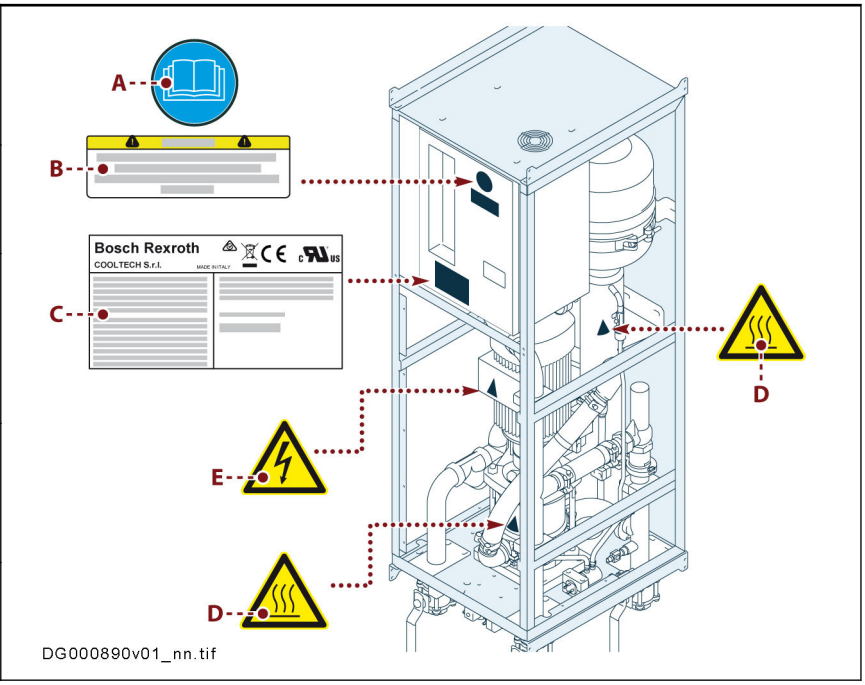
Thermal risk: Contact with hot surfaces can cause burns. Allow the machine to cool down before any operation.

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 one.

A	This indicates the obligation for operators to read the instruction manual before operating the machine.
B	Risk of severe injury or death. Disconnect the machine from the mains prior to operation.
C	Technical data of the machine and manufacturer's specification (chapter "Manufacturer's details and machine identification details" on page 347).
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	Risk of electric shock



Tab. 8-152: Information and safety signs

Transporting and installing

Transport and installation safety recommendations

Personnel responsible for transport of the load must have the required qualification and experience and must be trained in handling the lifting gear used.

Use lifting gear with suitable load capacity in order to lift and move the load.

Persons authorized for transport must take appropriate measures to ensure their own safety and the safety of persons directly involved.

Place the package on a stable surface.

Observe the specified limit when stacking packages in order to prevent sudden shifts.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents. In case items are damaged or missing, contact the importer or the manufacturer directly to discuss the procedure to be adopted.

Packaging

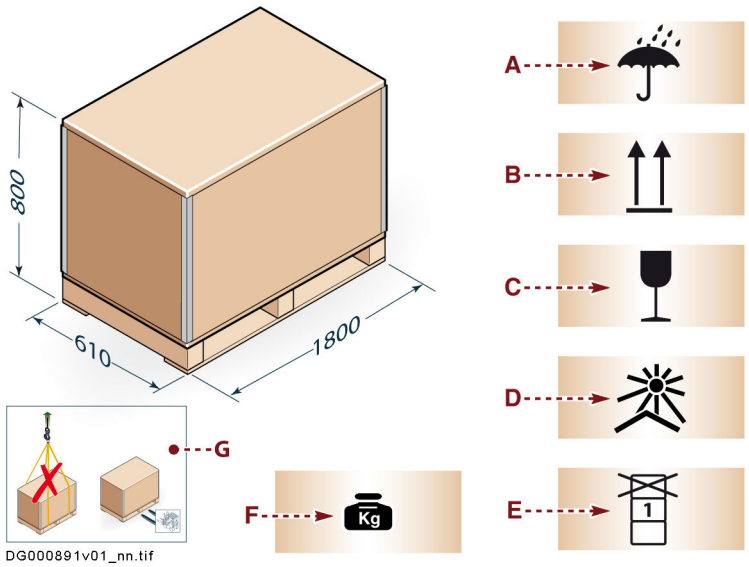
The packaging is selected according to the selected means of transport and the destination.

Packages can either be loaded directly onto a means of transport or into suitable containers if shipped by sea or air or to far-off destinations.

In order to facilitate transport, some components are removed and properly protected.

The figure shows the type of packaging most frequently used and the maximum dimensions as well as the warning symbols and notices attached 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.
G	The plate shows the procedure for lifting the package.



Tab. 8-153: Package description

Transporting and lifting the packed machine

The figure shows how to lift the package.

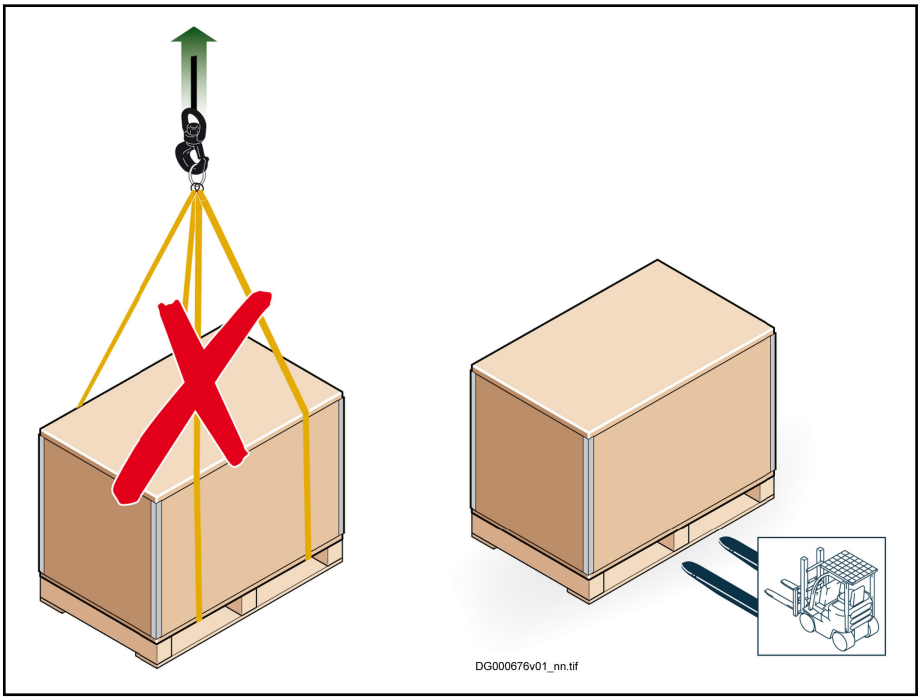


Fig. 8-118: Transporting and lifting the packed machine

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.

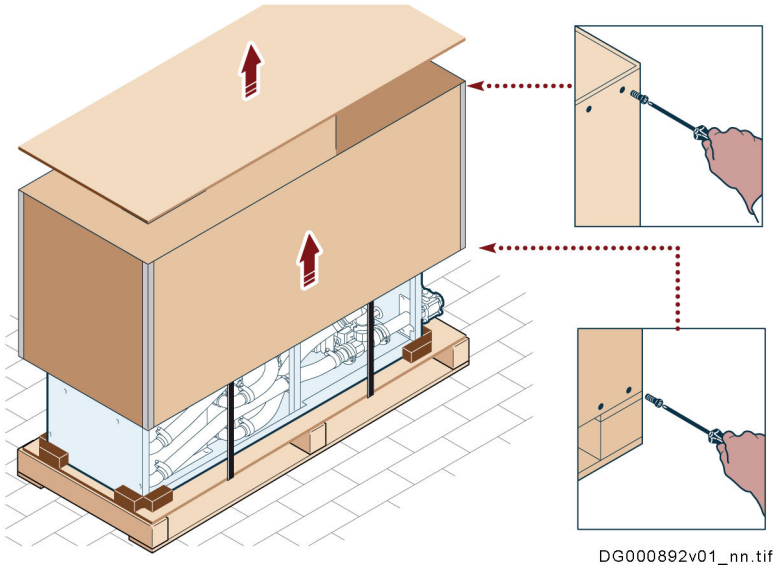
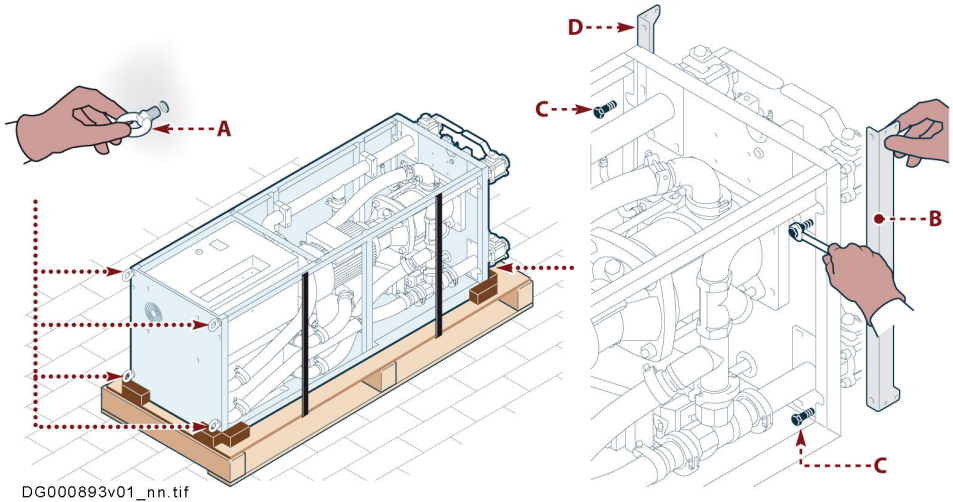
Avoid storing the machine in places where weather conditions could prejudice its good working order.

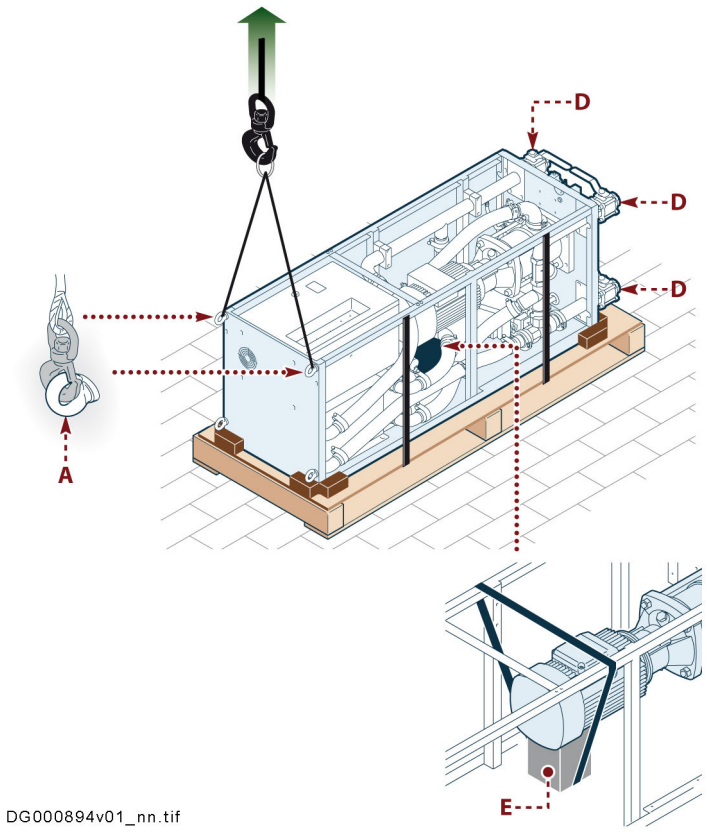
Unpacking

It is advisable to unpack the machine near the installation area to facilitate assembly.

The figure shows how to unpack the machine properly.

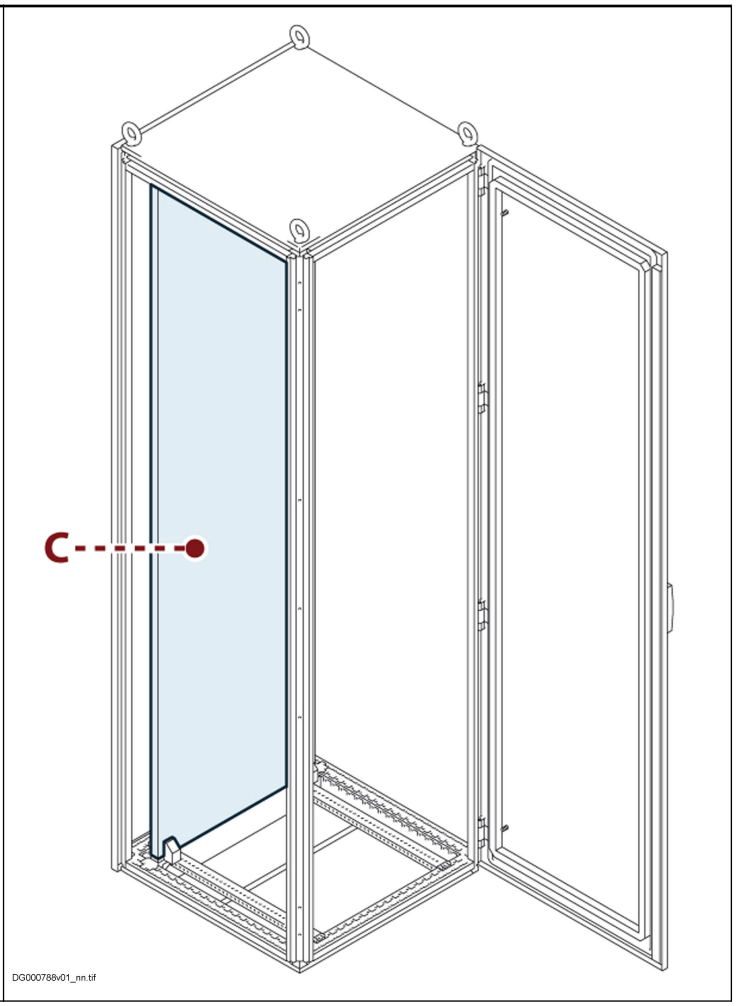
Proceed as described.

1	Unscrew the screws.	 DG000892v01_nn.tif
2	Remove the cover.	
3	Lift the side walls of the packaging.	
4	Remove the locking items and retaining straps.	
5	Screw in the eyebolts (**A**).	 DG000893v01_nn.tif
6	Attach the bracket (**B, D**) using the corresponding screws (**C**).	

7	Hook the ropes onto the eyebolts (**A**).	
8	**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. **NOTICE!** When lifting, take care not to damage the valves (**D**). Lift the machine. Remove the clamping device (**E**). The packaging material (wood, propylene, etc,.) can be kept for future use or properly disposed of according to the regulations in force.	

Tab. 8-154: Unpacking

Mounting the machine

The machine is intended for installation into a RITTAL cabinet (model TS8 8006-500). Before mounting the machine, remove the wall (**C**).	

Tab. 8-155: Control cabinet

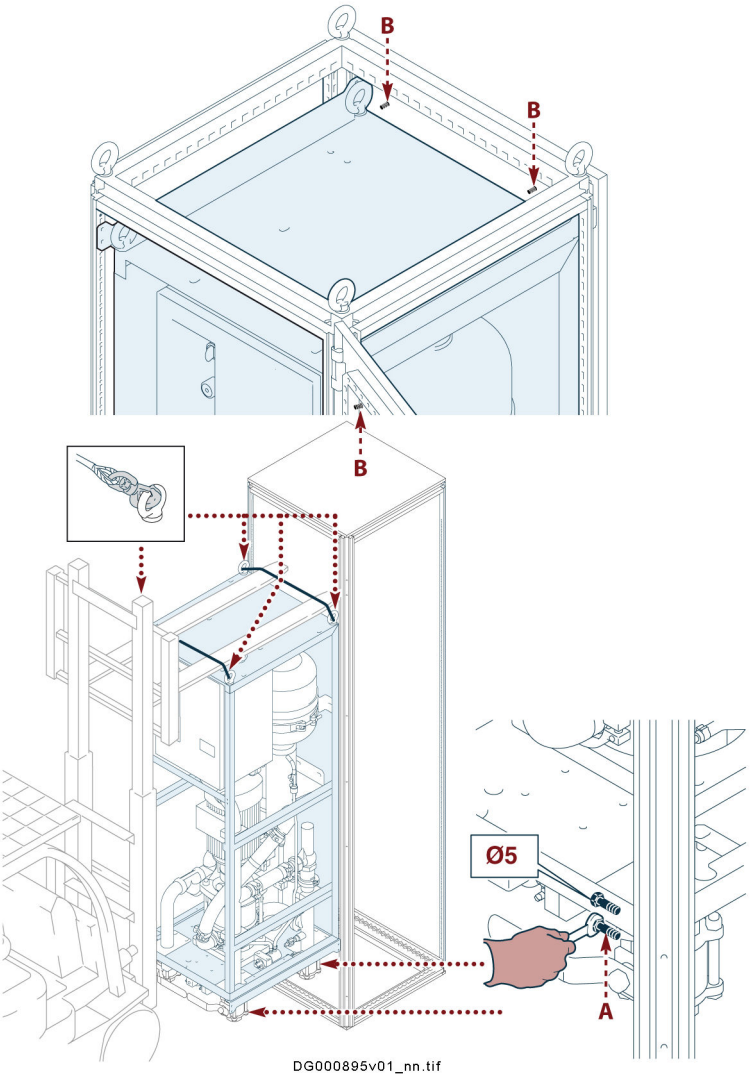
The installation area has to be provided with electrical connections and connections for transmission of machine enabling/status signals.

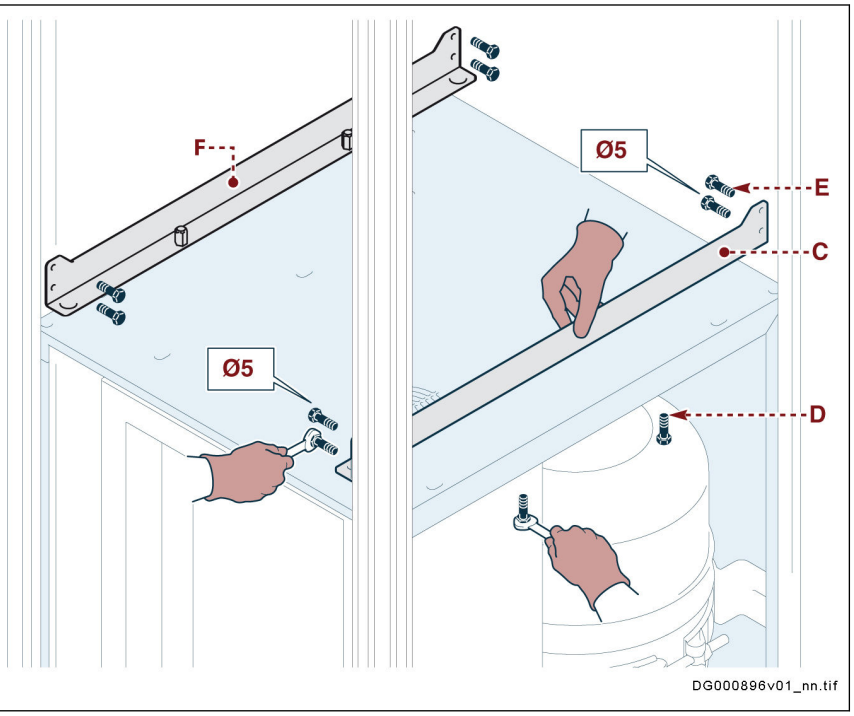
Carry out the following work as described.

There must be enough space above the machine to connect the grounding points (B) of the cabinet.

Align the holes for attaching the machine in accordance with the nearest holes of the cabinet so that the required space above the machine is available.

1	Strap up the machine as shown in the figure.
2	Lift the machine and place the machine 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 (**C**).	
7	Tighten the screws (**D**).	
8	Screw in the self-tapping screws (**E**).	
9	Fit the bracket (**F**) in the same way.	

Tab. 8-156: Mounting the machine

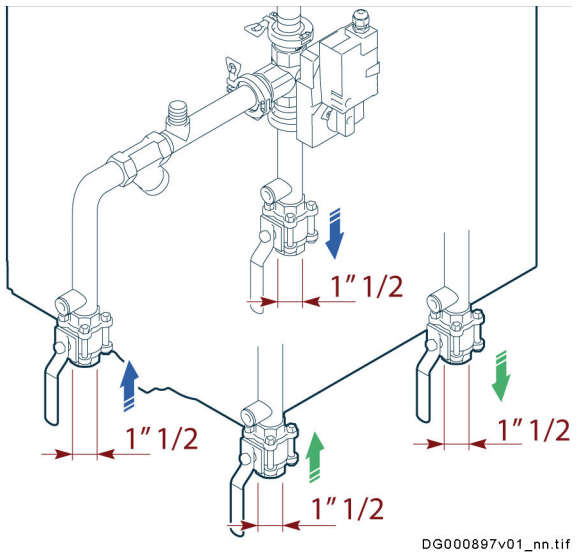
Electrical connection

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 + equipment grounding conductor).

Connect the three phases (L1, L2 and L3) and the equipment grounding conductor to the relevant terminals inside the terminal box.

Hose connections

The owner has to install devices to adjust the pressure and discharge in the intake pipe of the customer side circuit and in the return pipe of the drive circuit. Set the pressure in the intake and return pipes to the values shown in chapter "Data" on page 405. Use flexible tubes with an internal diameter of not less than 44.3 mm. Use connectors with an internal diameter of not less than 40 mm.	

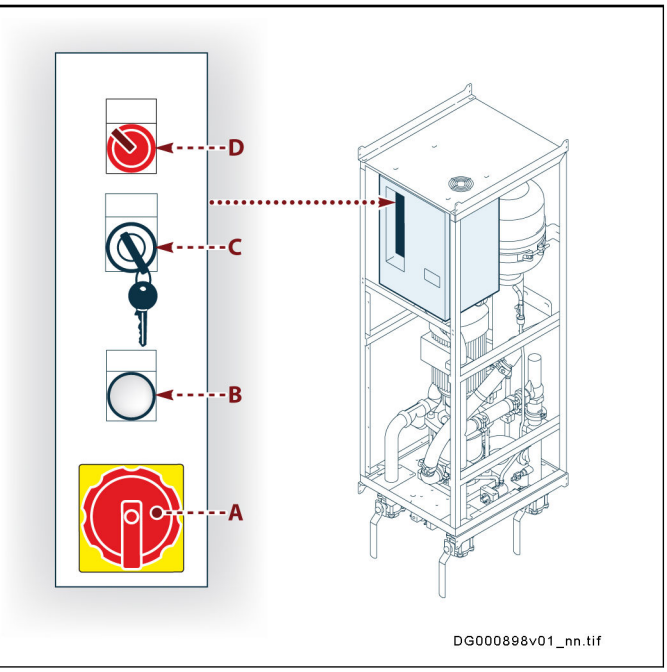
Tab. 8-157: Hose connections

Use

Safety advice for use

Before starting the machine, ensure that the system or the machine in which it has been fitted complies with applicable local regulations and directives.

Control elements and indicator lamps

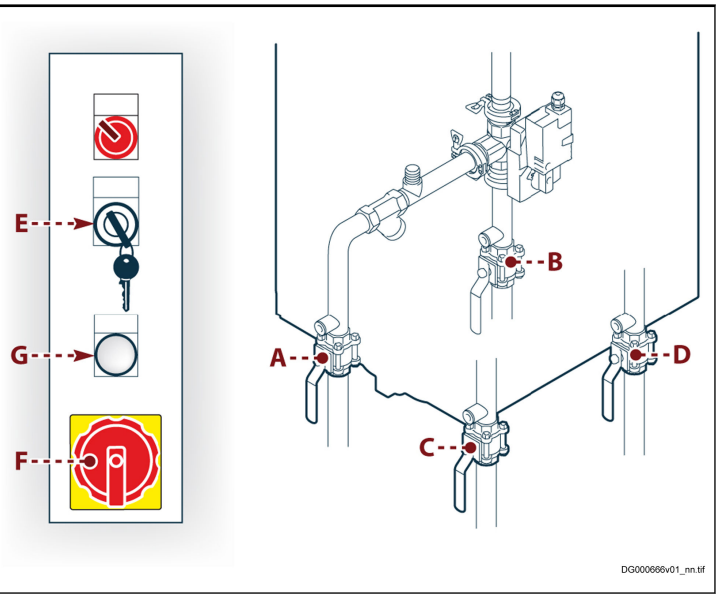
A	**Main switch:** It is used for connecting and disconnecting the power supply to machine. The indicator lamp (**B**) lights up.	
B	**Indicator lamp (white light):** Indicates that the power supply to the machine has been enabled.	
C	**Key-operated two-position stay-put selector switch:** For releasing or locking the main pump. The key has to 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. 8-158: Control elements and indicator lamps

Switching on

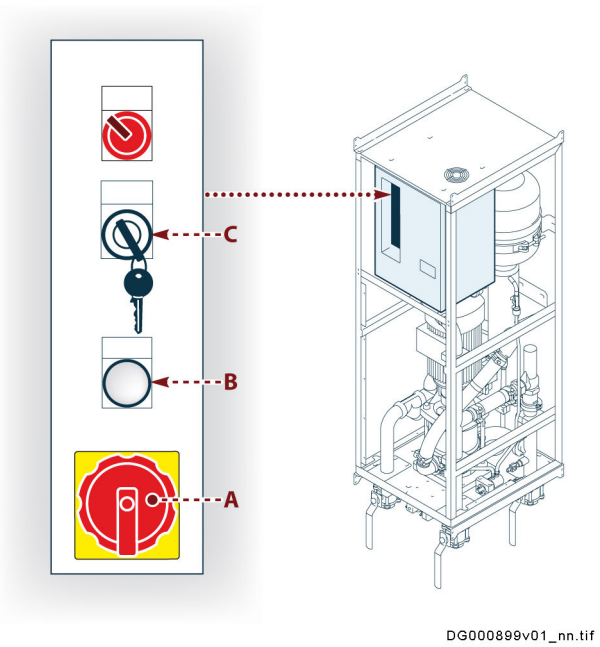
When starting the machine for the first time fill the drive circuit (see chapter "Filling the drive circuit" on page 424).

To start the machine, proceed as follows.

1	Open the ball valves (**A - B - C - D**).	
2	Ensure that liquid flows through the customer side circuit.	
3	Turn the main switch (**F**) to the "ON" position. The indicator lamp (**G**) lights up.	
4	Turn the key selector (**E**) to the "ON" position. Machine start-up has to be performed using the operator terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR and UNIT WARNING connections" on page 407).	

Tab. 8-159: Switching on

Switching off

Switching off with the main switch 1. Turn the main switch (**A**) to the "OFF" position. • The indicator lamp (**B**) will switch off. • Machine operation stops and the voltage supply to the terminal box is interrupted. • The supply terminals remain live.	
Switching off with the key-operated switch This switch-off mode is reserved for authorized 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 terminal box at the machine remains live.	
Remote-controlled switch-off Remote-controlled switch-off has to be performed using the owner's operator terminal, via the "ENABLE" connection. • Operation of the main pump stops. • The terminal box at the machine remains live.	
Switching off automatically The machine stops automatically if the pressure in the cooling circuit drops below 0.2 bar and the temperature of the cooling liquid exceeds the preset upper limit (parameter P-0-1318).	

Tab. 8-160: Switching off

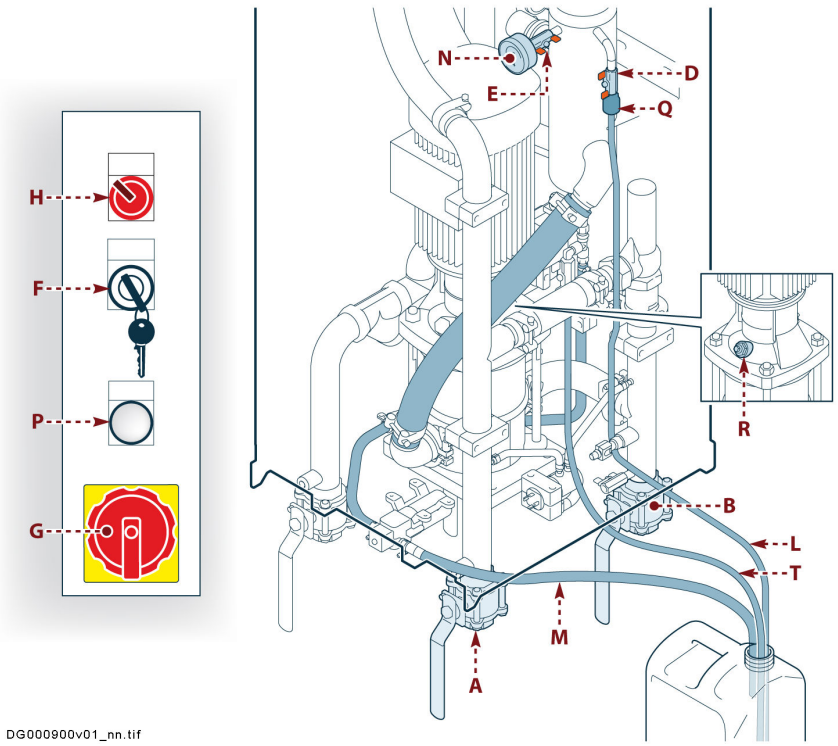
Switching off in emergency conditions

To switch off the device in the event of imminent danger (emergency stop), turn the main switch (**A**) to the "OFF" position.

Fix the cause for the emergency stop before restarting the machine.

Filling the drive circuit

Check if the installation as well as electrical and hydraulic connections are executed professionally in accordance with the manufacturer's specifications.

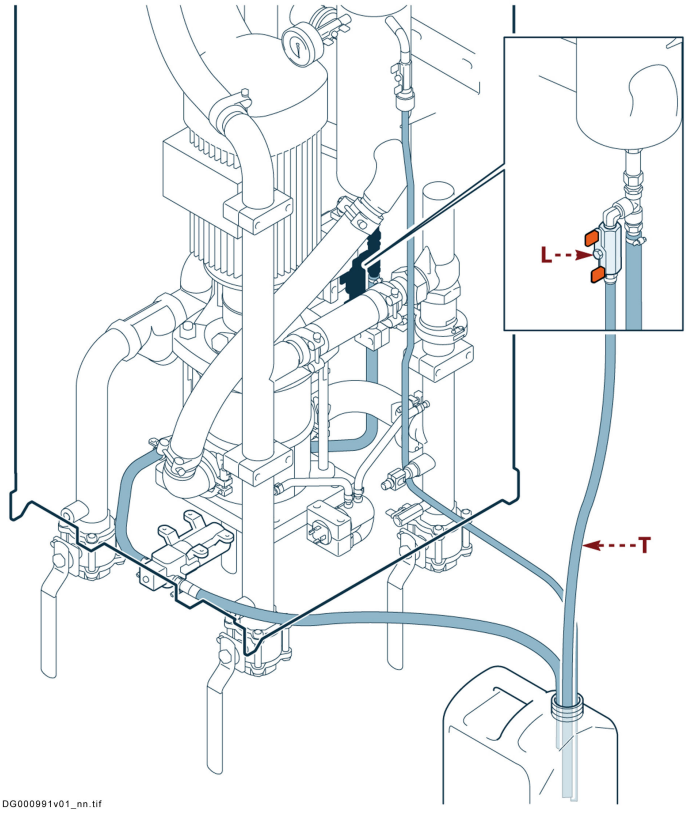
1	Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 405).	
2	Fit the pipes (**L - M - T**) into the tank.	
3	Open the ball valve (**A**).	
4	Open the ball valve (**B**).	
5	Open the valve (**E**).	
6	Open the valve (**D**). If there is no liquid coming, clean the connector (**Q**) (see chapter "Cleaning the connector of the bleed valve" on page 431).	
7	Turn the key-operated selector switch (**F**) to the "OFF" position to prevent unexpected activation of the main pump.	
8	Ensure that the remote-controlled "ENABLE" function is activated.	
9	**NOTICE!** Do **not** turn the key-operated selector switch (F) to the "ON" position since this could cause damage to the main pump. Open any existing valves that are installed outside the machine on the circuit of the machine to be cooled.	
10	Turn the main switch (**G**) to the "ON" position. The indicator lamp (**P**) lights up.	
11	Turn the selector switch (**H**) to activate the filling pump. Make sure that there is always enough liquid in the tank. If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 426).	
12	When the fluid is running out of the clear tube (**L**) in a steady stream (no bubbles) and the pressure has reached 1.4 … 2.2 bar, turn the key-operated selector switch (F) to the "ON" position to activate the main pump in the automatic mode. The pressure is indicated on the pressure gauge (**N**). **NOTICE!** The filling pump is activated and deactivated automatically and keeps the pressure at 1.4 … 2.2 bar. 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. The pressure drop is caused by the air pumped into the circuit as a result of activation of the main pump. Make sure that the key-operated switch is set to "ON".	
13	Keep the filling pump and the main pump running for at least 30 minutes in order to rinse the cooling circuit thoroughly.	

14	Remove the valve (**R**) to release the air from the inside of the main pump. When the fluid is running in a steady stream, close the valve (**R**). **NOTICE!** 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 valve (**D**) until the correct pressure is reached. **NOTICE!** If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 426).
15	Turn the selector switch (**H**) to deactivate the filling pump.
16	Close the valve (**D**) when the pressure in the circuit has reached 1.5 bar.
17	Remove the pipes from the tank.
18	Close the valve (**E**).
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. If it is not correct, carry out the pressure restore procedure (see chapter "Restoring the pressure" on page 427). **NOTICE!** Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Tab. 8-161: Filling the drive circuit

Filling pump priming procedure

If the filling pump does not prime automatically, proceed as described:

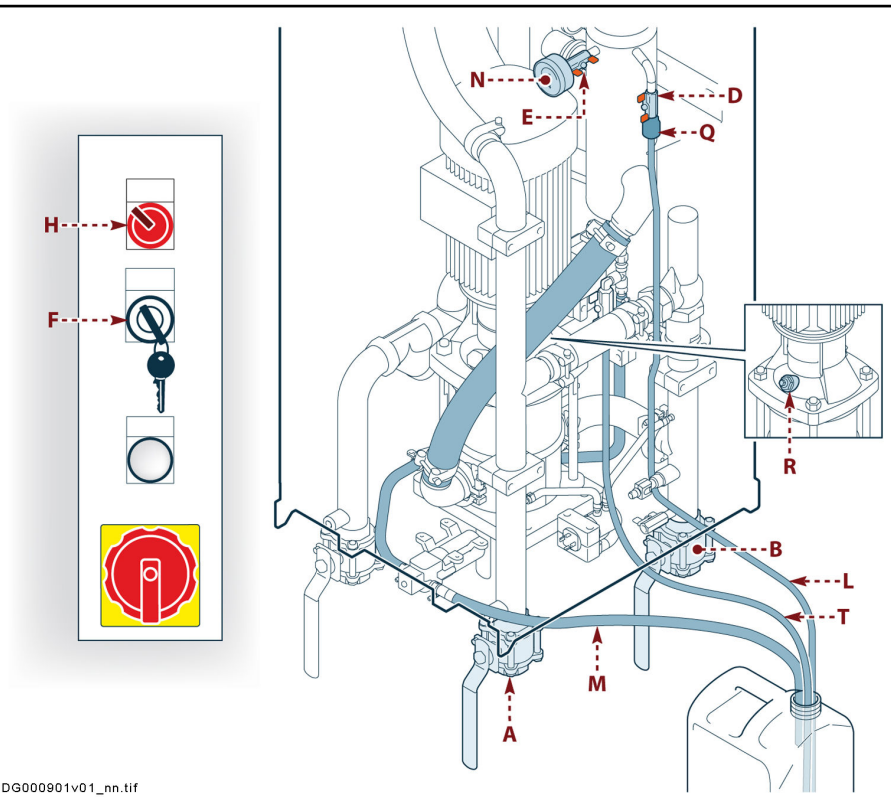
1	When the filling pump is active, open the valve (**L**).	
2	Wait for the coolant to start flowing out of the transparent hose (**T**).	
3	Close the valve (**L**) and leave the filling pump working. The filling pump is primed and starts pumping the coolant into the hydraulic circuit.	

Tab. 8-162: Perform the filling pump priming procedure

Restoring the pressure

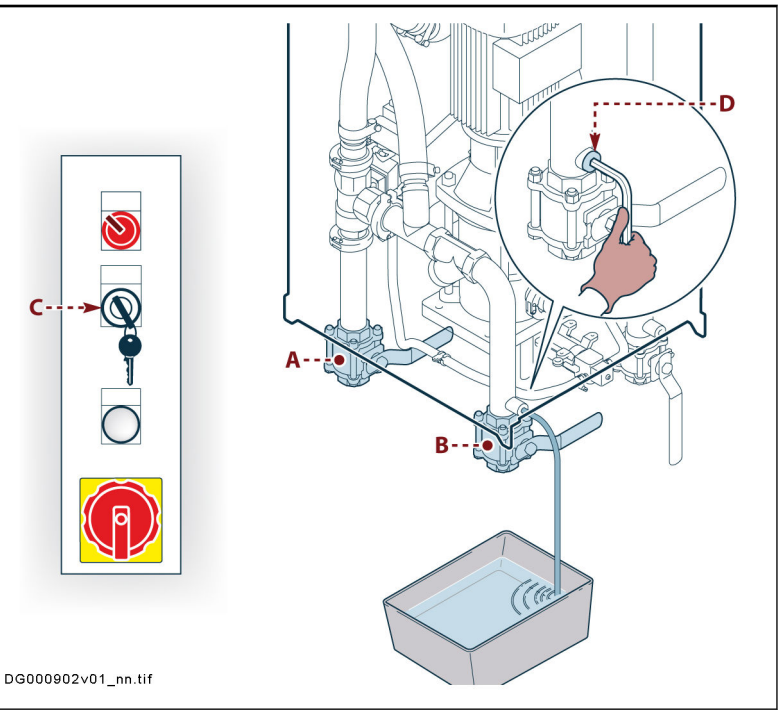
This procedure can be carried out only if the pressure is above 0.8 bar and the main pump is activated.

If the pressure is below this level, carry out the circuit filling procedure (see chapter "Filling the drive circuit" on page 424).

1	Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 405).	
2	Fit the pipes (**L - M - T**) into the tank.	
3	Open the valve (**E**).	
4	Turn the selector switch (**H**) to activate the filling pump. If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 426).	
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. If there is no liquid coming, clean the connector (**Q**) (see chapter "Cleaning the connector of the bleed valve" on page 431).	
6	Remove the valve (**R**) to release the air from the inside of the main pump.	
7	**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. **NOTICE!** If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 426). Turn the selector switch (**H**) to deactivate the filling pump.	
8	Remove the pipes from the tank.	
9	Remove the key from the selector switch (**F**) and store in a safe place.	
10	Close the valve (**E**). **NOTICE!** Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.	

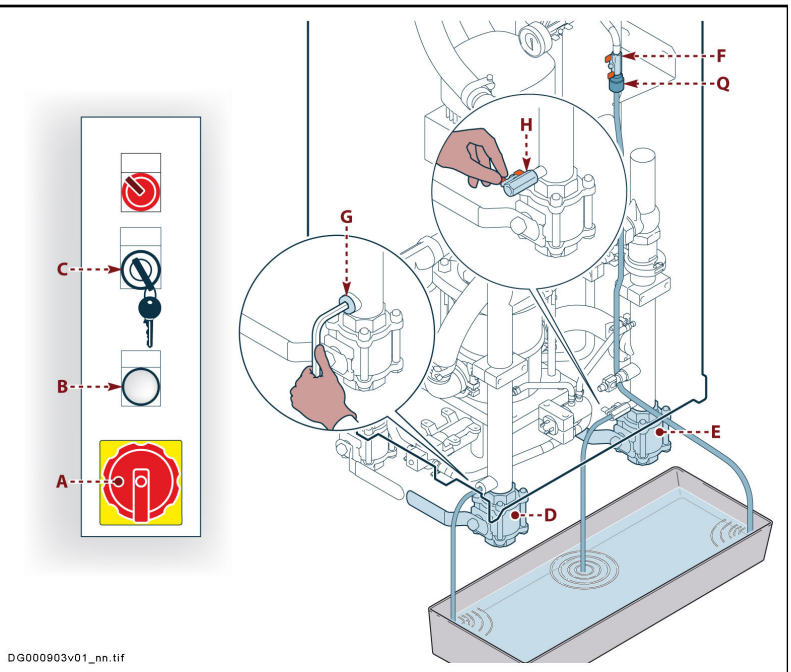
Tab. 8-163: Restoring the pressure

Emptying the customer side circuit

1	Position a suitable container for collecting the coolant.	
2	Switch off the machine (see chapter "Switching off" on page 423).	
3	Turn the key selector (**C**) to the "OFF" position.	
4	Close the ball valves (**A - B**).	
5	Unscrew the cap (**D**).	
6	Drain out all the coolant.	
7	Screw the cap (**D**) back on. **NOTICE!** Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.	

Tab. 8-164: Emptying the customer side circuit

Emptying the drive circuit

1	Position a suitable container for collecting the coolant.	
2	Switch off the machine (see chapter "Switching off" on page 423).	
3	Turn the key selector (**C**) to the "OFF" position.	
4	Turn the main switch (**A**) to the "OFF" position.	
5	The indicator lamp (**B**) will switch off.	
6	Close the ball valves (**D - E**).	
7	Open the valve (**F**). If there is no liquid coming, clean the connector (**Q**) (see chapter "Cleaning the connector of the bleed valve" on page 431).	
8	Open the valve (**H**).	
9	Unscrew the caps (**G**).	
10	Drain out all the coolant.	
11	Close the valve (**F**).	
12	Screw the caps (**G**) back on.	
13	Close the valve (**H**). **NOTICE!** Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.	

Tab. 8-165: Emptying the drive circuit

Maintenance

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.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

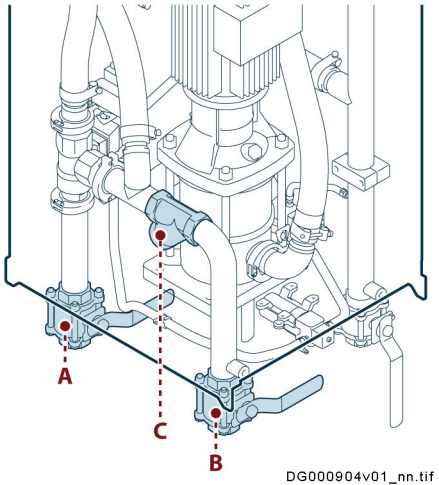
Maintenance schedule

Interval		Component	Type of work	Cross reference
Every 1600 operating hours	Every 30,000 operating hours	–	–	–
✓	–	Filter	Cleaning	See chapter "Filter cleaning in the customer side circuit" on page 430
–	✓	Main pump	Replacement	See chapter "Replacing the main pump" on page 437
–	✓	Coolant	Replacement	

Tab. 8-166: Maintenance schedule

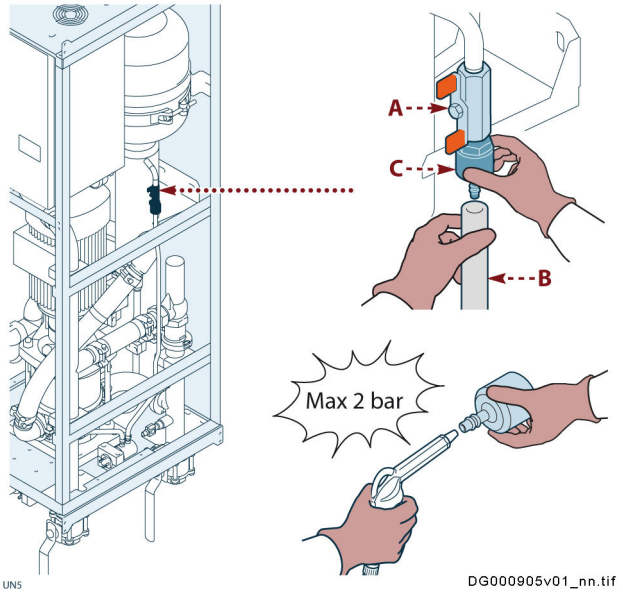
Filter cleaning in the customer side circuit

1	Drain the cooling liquid from the customer side circuit.
2	Close the intake and outlet ball valves (**A - B**).
3	Unscrew the cap (**C**).
4	Remove and clean the filter. Do not use aggressive, flammable or toxic detergents.
5	Reinsert the filter.
6	Screw the cap (**C**) back on.
7	Open the ball valves (**A - B**).



Tab. 8-167: Filter cleaning in the customer side circuit

Cleaning the connector of the bleed valve

1	Close the bleed valve (**A**).	
2	Remove the hose (**B**).	
3	Unscrew the connector (**C**).	
4	Clean the connector with compressed air. Keep the pressure on the level indicated in the picture.	
5	Screw on the connector (**C**).	
6	Attach the hose (**B**) to the connector.	
7	Open the bleed valve (**A**).	

Tab. 8-168: Cleaning the connector

Cleaning the machine

Clean the machine with detergents that are approved in accordance with the applicable legal regulations.

Troubleshooting

The following table contains a number of faults that may occur during operation as well as appropriate corrective measures.

Code	Type	Malfunction	Likely cause	Remedy
E2011	Warning 1	Low pressure, please refill	For at least 0.5 s, the system pressure is lower than 0.5 bar (loss of water, maintenance)	Refill cooling system up to 1.5 bar
E2012	Warning 2	Unable to start drive	Motor does not start in velocity control operation	Switch off the start command for at least 10 seconds Ensure that the system has the status "AF" before starting
E2013	Warning 3	Mixing valve is not following	3MV mixing valve may have a mechanical defect or the electrical connecting cable may be damaged	Check 3MV mixing valve Check feedback signal
E2014	Warning 4	Overtemperature	Temperature exceeds the defined value (P-0-1316) of the maximum permissible deviation from required temperature (T_{set}) for a defined duration (P-0-1317)	Check cooling system Adjust parameter P-0-1316 and/or P-0-1317
E2016	Warning 6	Lower motor speed limitation active	Motor velocity < 360 min^{-1}	Increase the value of parameter P-0-1374 (> 360 min^{-1}) Ensure that the motor can run with a velocity > 360 min^{-1}
F2011	Error 1	System pressure	System pressure lower than 0.2 bar	Refill cooling system up to 1.5 bar
F2012	Error 2	Overtemperature	The fluid temperature (on the drive side) has exceeded the maximum allowed temperature limit (see parameter P-0-1318)	Check cooling system Change the value of parameter P-0-1318 if too low
		Slight leakage of cooling liquid between pump and motor	Start after long inactivity of the machine Changing the ambient conditions	Start pump [1)]

Code	Type	Malfunction	Likely cause	Remedy
		The filling pump does not start priming automatically	Suction hose empty following long period of machine disuse No coolant in the tank High backpressure in the filling pump delivery line	Perform the filling pump priming procedure
		The filling pump does not inject the coolant into the circuit	The filling pump is not primed The filling pump bleed valve is open	Perform the filling pump priming procedure Close the filling pump bleed valve

1) The pump is mechanically sealed by the cooling liquid. This type of seal (mechanical) may lead to a slight leakage of cooling liquid under certain conditions. It takes some time to minimize the leakage if the pump is started after stopping the machine or after being inactive. The required time depends on the operating conditions. The leaked cooling liquid usually evaporates immediately. The leaked cooling liquid is not visible then. **This type of leakage is not a malfunction.** Contact the service if the leakage persists for a longer period of time.

Tab. 8-169: Errors and warnings

Replacing the component

Safety advice for component exchange

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.

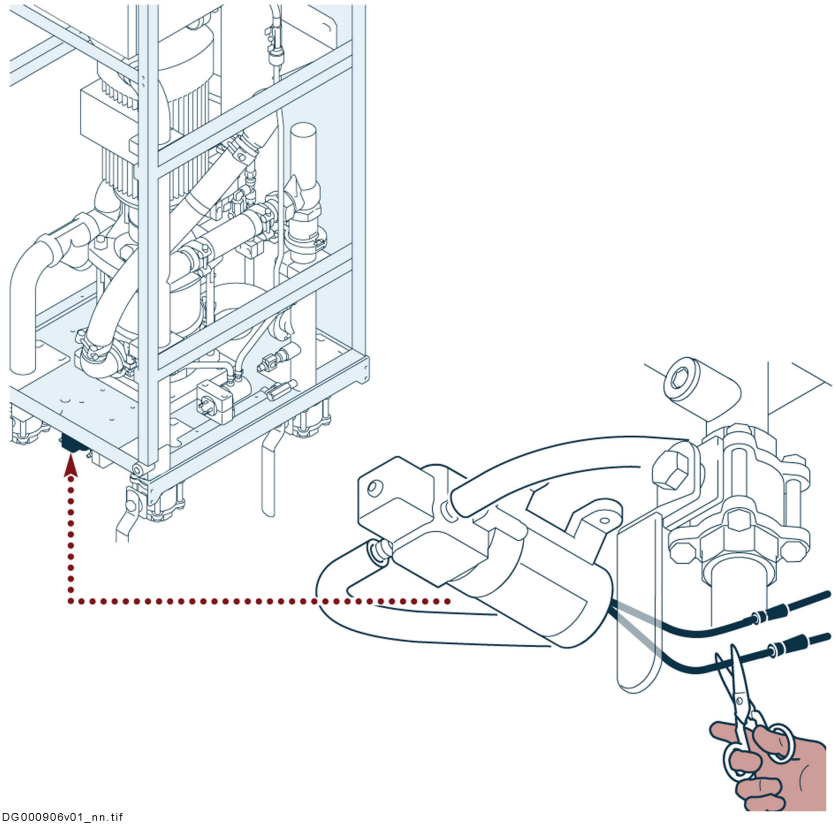
In particular, disconnect the power supply to the machine.

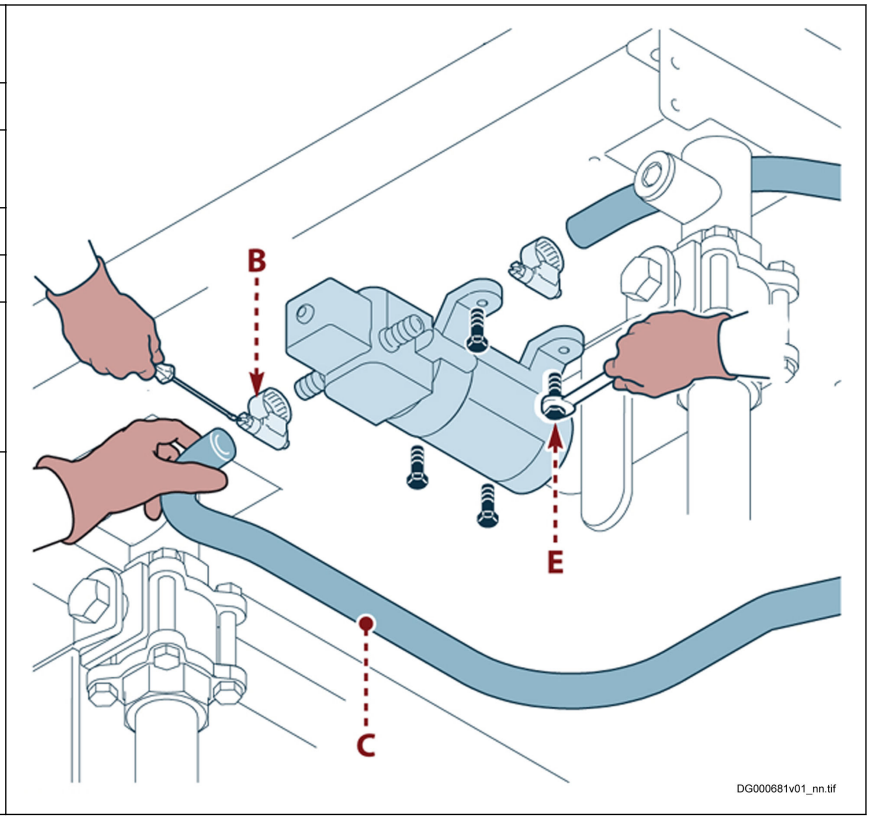
Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

Replace worn or damaged parts by original spare parts.

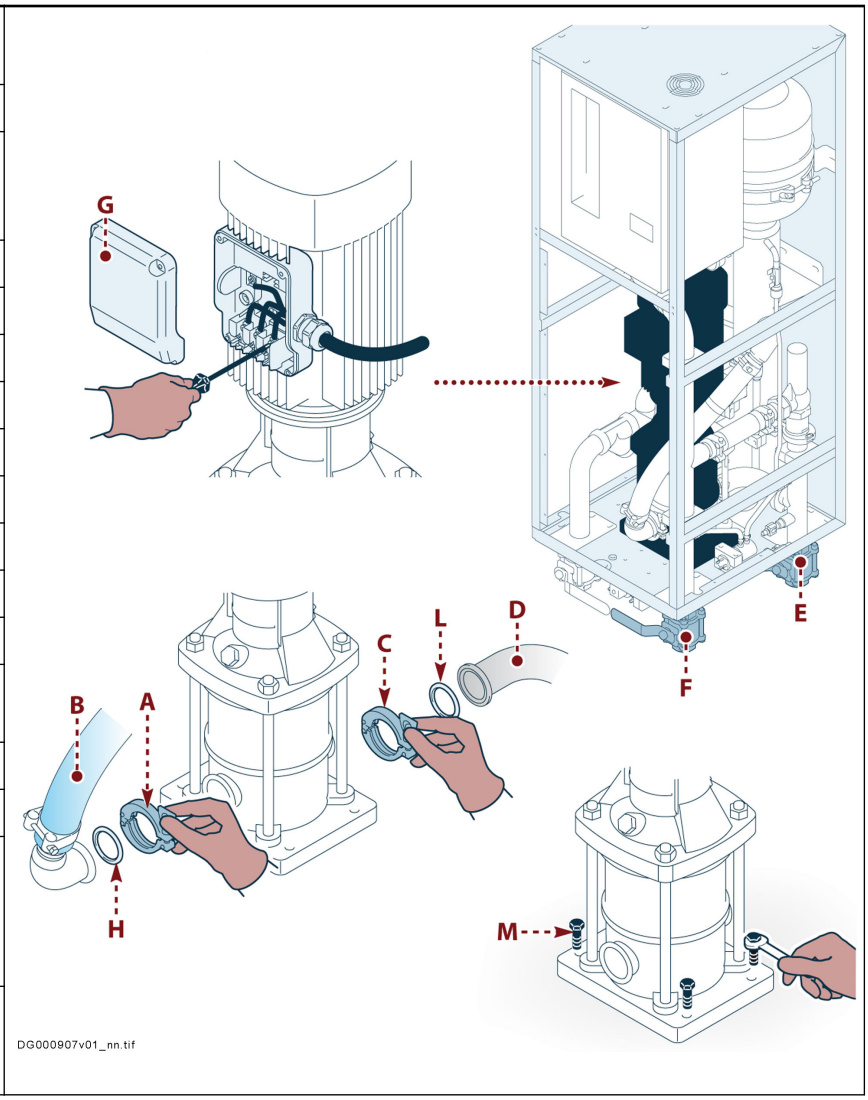
Replacing the filling pump

1	Disconnect the machine from the power supply source.	
2	Cut the mains 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. In order to install the new pump, proceed in reverse order to the removal of the pump.	
9	Fill the drive circuit (see chapter "Filling the drive circuit" on page 424).	

Tab. 8-170: Replacing the filling pump

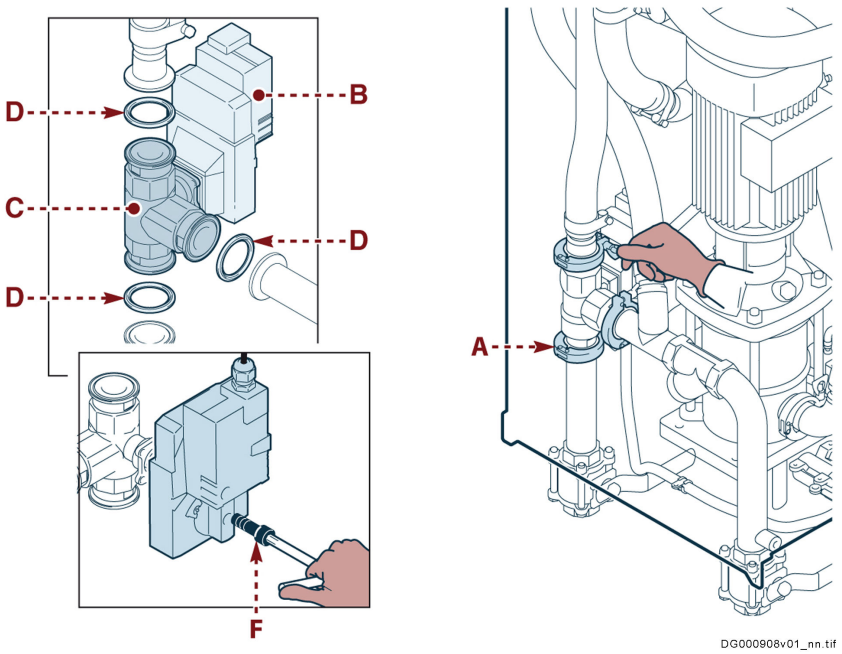
Replacing the main pump

1	Disconnect the machine from the power supply source.	
2	Allow the machine to cool down.	
3	Empty the drive circuit (see chapter "Emptying the drive circuit" on page 429).	
4	Close the valve (**E**).	
5	Close the valve (**F**).	
6	Remove the clamp (**A**).	
7	Disconnect the hosing (**B**).	
8	Remove the gasket (**H**).	
9	Remove the clamp (**C**).	
10	Remove the pipe (**D**).	
11	Remove the gasket (**L**).	
12	Remove the cover (**G**).	
13	Disconnect the cables from the terminals.	
14	Unscrew the screws (**M**).	
15	Remove the pump.	
16	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump.	
17	Fill the drive circuit (see chapter "Filling the drive circuit" on page 424).	

Tab. 8-171: Replacing the main pump

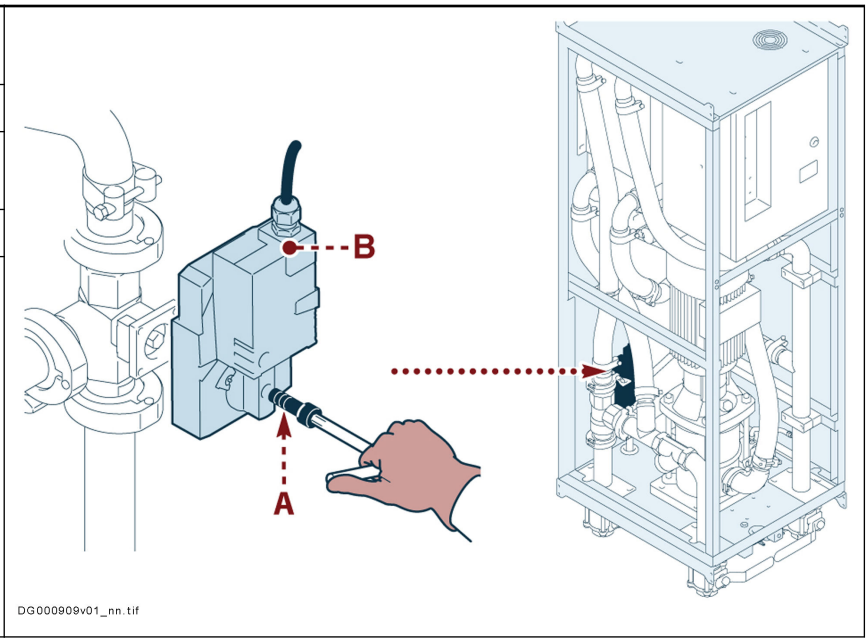
Replacing the mixing valve

1	Disconnect the machine from the power supply source.
2	Allow the machine to cool down.
3	Unscrew the clamps (**A**).
4	Remove the valve (**C**) and the actuator (**B**).
5	Remove the gaskets (**D**).
6	Unscrew the screw (**F**).
7	Disconnect the valve from the actuator.
8	Connect the new valve with the actuator.
9	Position the gaskets (**D**). Replace the gaskets if they are damaged or worn.
10	Bring the valve and the actuator to correct position.
11	Screw on the clamps (**A**). In order to install the new valve, proceed in reverse order to the removal of the valve.



Tab. 8-172: Replacing the mixing valve

Replacing the actuator

1	Disconnect the machine from the power supply source.	
2	Allow the machine to cool down.	
3	Disconnect the electric cables from the actuator (see wiring diagram).	
4	Unscrew the screw (**A**).	
5	Remove the actuator (**B**). In order to install the new actuator, proceed in reverse order to the removal of the actuator.	

Tab. 8-173: Replacing the actuator

Replacing the fuses

Before replacing the fuse, fix the cause of the malfunction.

Only replace the interrupted fuse with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Fuses" on page 409.

Disposing of old equipment

Scrapping operations must be handled by specialized personnel with suitable skills for the job.

In accordance with the applicable regulations, all individual components must be collected separately for disposal according to their chemical properties when dismantling the machine.

With reference to the European Directive (RAEE), electric and electronic components must either be disposed of in authorized landfill sites or the machine, complete of the said parts, must be returned to the dealer in case of a new purchase.

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.

Control with MLD

Pressure control

The differential pressure between the machine's intake and its outlet has to be kept at a constant rate (1.5 bar, for example) so that the cooling liquid flow to the devices to be cooled can be easily set.

To control the pressure, the pump speed is varied based on the intake/outlet differential pressure.

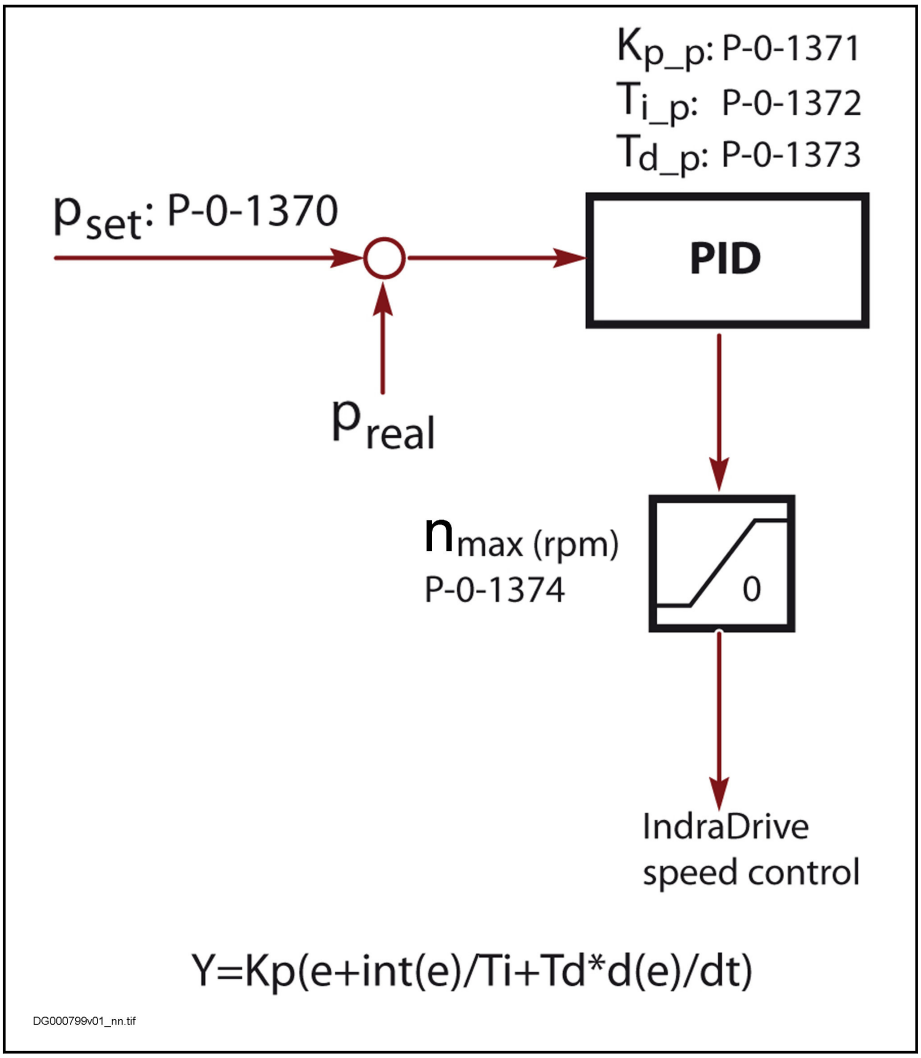


Fig. 8-119: Pressure control

Name	Parameter	Unit
p_{set}	P-0-1370	bar
K_{p_p}	P-0-1371	min^{-1}/bar
T_{i_p}	P-0-1372	s
T_{d_p}	P-0-1373	s
n_{max}	P-0-1374	min^{-1}

Tab. 8-174: Pressure control parameters

Temperature control

The temperature of the fluid in the drive circuit has to be kept at a constant value (between 40 °C and 60 °C) to prevent condensation from forming in the devices to be cooled.

The temperature of the fluid is set using a three-way mixing valve.

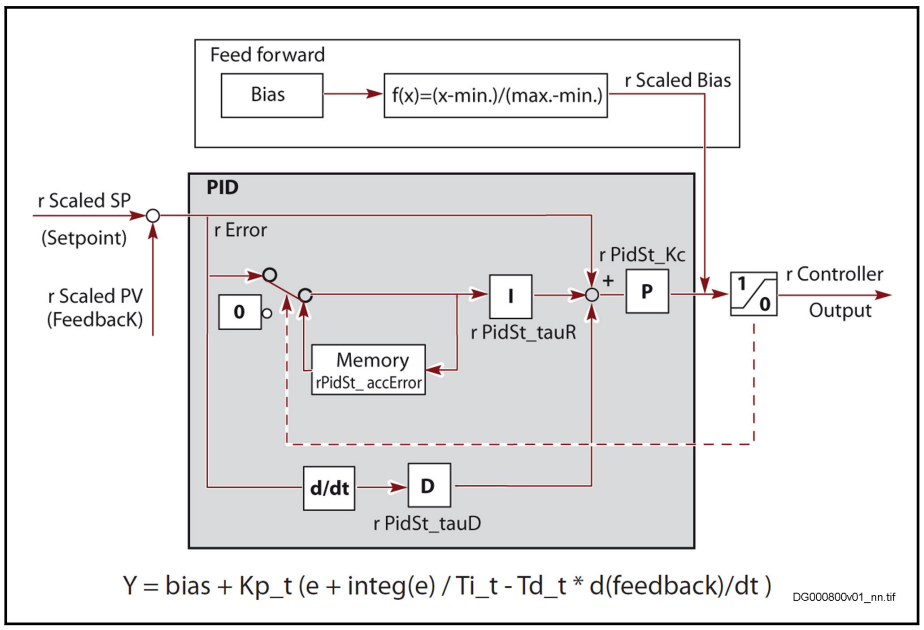


Fig. 8-120: Temperature control

Name	Parameter	Unit
t_{set}	P-0-1375	°C
K_{p_t}	P-0-1376	V / °C
T_{i_t}	P-0-1377	s
T_{d_t}	P-0-1378	s
Feed forward	P-0-1379	V

Tab. 8-175: Temperature control parameters

Feed forward (P-0-1379)

The "feed forward" feature allows the temperature regulation system to adjust more quickly when the machine is started up.

The "feed forward" feature adds a value at the regulator output so that the cooling process can begin before the command value is signaled to have been exceeded.

When the "feed forward" feature is used (P-0-1379 > 0), it is important to make sure the temperature rise at machine start-up is not too high. An empirical method for calculating the "feed forward" is shown below:

$FF = [X - K_{p_t} \times (t_{set} - t_{act})] \div 10$
FF: Feed forward X: 30 … 60

Tab. 8-176: Calculation of "Feed forward"

The "Feed forward" shown here is different to the "Feed forward" implemented in an IndraDrive drive controller.

Name	Parameter	Unit	Standard value
p_{set}	P-0-1370	bar	1.5
K_{p_p}	P-0-1371	min^{-1}/bar	40
T_{i_p}	P-0-1372	s	0.05
T_{d_p}	P-0-1373	s	0
n_{max}	P-0-1374	min^{-1}	3000
t_{set}	P-0-1375	°C	50
K_{p_t}	P-0-1376	V / °C	-5
T_{i_t}	P-0-1377	s	40
T_{d_t}	P-0-1378	s	0
Feed forward	P-0-1379	V	0

Tab. 8-177: Temperature control parameters

Starting the machine

The machine is started (as per the predefined setting) solely with the digital command:

ENABLE (X31.1, P-0-1390)

You can set the type of machine enabling (starting via digital input or starting via the communication).

Start	Parameters	Input
Start selection 1	P-0-1380	digital
Start selection 2	P-0-1381	digital
Start command via communication	P-0-1382	digital

Tab. 8-178: Start options

The parameters **P-0-1380 and P-0-1381** can be set to "0" or "1".

If both parameters are set to the **same value** (0 or 1), the machine can be started via the digital input with **P-0-1390** (0 = off, 1 = on).

If both parameters are set to **different values**, the machine can be started via the communication with **P-0-1382** (0 = off, 1 = on).

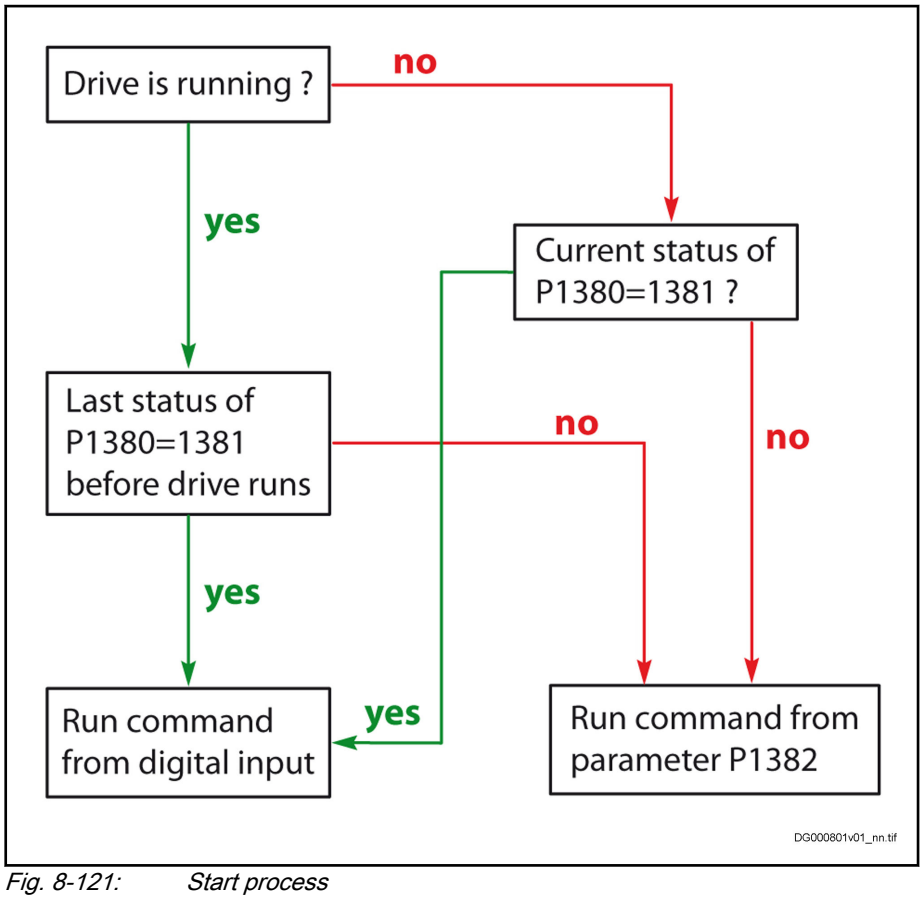


Fig. 8-121: Start process

Example: By setting the parameter P-0-1380 as a digital input and monitoring the parameters P-0-1381 and P-0-1382 via the PLC, the power-up command

for the machine can be transmitted either via the digital input or the PLC, from two different workstations.

Parameters

Name	Parameter	Unit	Minimum value	Maximum value	Standard value WW008/035/060
p_{set} (pressure command value)	P-0-1370	bar	0	2.0	1.5
K_{p_p} (pressure control)	P-0-1371	min^{-1}/bar	0	10000	40
T_{i_p} (pressure control)	P-0-1372	s	0.0	1000.0	0.05
T_{d_p} (pressure control)	P-0-1373	s	0.0	1000.0	0.0
n_{max}	P-0-1374	min^{-1}	0	8000	3000
Temperature setpoint	P-0-1375	°C	0	60	50
K_{p_T} (temperature control)	P-0-1376	V / °C	-1000	0	-5
T_{i_T} (temperature control)	P-0-1377	s	0	10000	40
T_{d_T} (temperature control)	P-0-1378	s	0	1000	0
Feed forward	P-0-1379	V	0	1000	0
Start selection 1	P-0-1380	-	0	1	0
Start selection 2	P-0-1381	-	0	1	0
Start command via communication	P-0-1382	-	0	1	0
p_{set_2} (pressure command value 2)	P-0-1385	bar	0.0	2.0	0.2
Control word switching to p_{set_2} (see also "Switching the pressure command value" on page 398)	P-0-1295	bit	-	-	0
High temperature warning differential value	P-0-1316	°C	0	20	10
High temperature warning time	P-0-1317	s	0	100	3
Overtemperature limit value	P-0-1318	°C	40	100	90
Tolerance pressure control	P-0-1320	bar	0.0	10.0	0.5
Low motor velocity - deceleration	P-0-1321	s	0	100	5

Tab. 8-179: Parameters

Name	Parameter	Unit	Type *	Scaling
Analog I/O monitoring parameters (read-only)				
3-way mixing valve control voltage	P-0-1270	V	AO	2-10 V, 0-100% open
Pressure (difference between input and output)	P-0-1271	bar	-	-
Cooling water temperature in °C	P-0-1272	°C	-	-
Cooling water temperature in °F	P-0-1273	°F	-	-
Pressure sensor	P-0-1280	V	AI	0-10 V, 0-6 bar
Temperature sensor	P-0-1281	V	AI	0-10 V, 0-100 °C
3-way mixing valve position feedback	P-0-1282	V	AI	2-10 V, 0-100% open
Digital I/O parameters				
Drive enable	P-0-1390	bit 0	DI	
Pressure monitoring > 0.5 bar	P-0-1391	bit 0	DI	
Pressure monitoring > 0.2 bar	P-0-1391	bit 1	DI	
Status word machine	P-0-1410			
Cooler is running	P-0-1410	bit 0		Start command + P-0-1410.4 + no warning + no error
Pressure command value attained	P-0-1410	bit 1		abs(P-0-1370 - P-0-1271) < P-0-1320
Cooler is running (warning ignored)	P-0-1410	bit 3		Start command + P-0-1410.4 + no error
Motor is running	P-0-1410	bit 4		Motor velocity (S40) ≥ 360
Drive warning	P-0-1412	bit 0	DO	"high" for no warning
Drive error	P-0-1412	bit 1	DO	"high" for no error

* AI: analog input; AO: analog output; DI: digital input; DO: digital output

Tab. 8-180: Parameters

Switching the pressure command value

The pressure command value can be switched via control word (P-0-1295.0). This function can be used for a more economical operation (lower energy consumption, less wear) if the new pressure command value is set to a lower value.

Pressure command value (p_{set})	P-0-1370
Pressure command value 2 (p_{set_2})	P-0-1385
Control word	P-0-1295.0
P-0-1295.0 = 0	Pressure command value: P-0-1370
P-0-1295.0 = 1	Pressure command value: P-0-1385

Tab. 8-181: Switching the pressure command value

With a pressure command value of 0.2 bar instead of 1.5 bar, laboratory measurements showed energy savings of 92% (40 W instead of 500 W). The motor speed decreased from 2200 min^{-1} to 760 min^{-1} resulting in a longer service life of the motor.

Air-water heat exchanger (WA012-020)

Technical information

General description of the machine

The machine is designed and manufactured for the purpose of cooling devices or equipment using a liquid solution made of glycol and demineralized water.

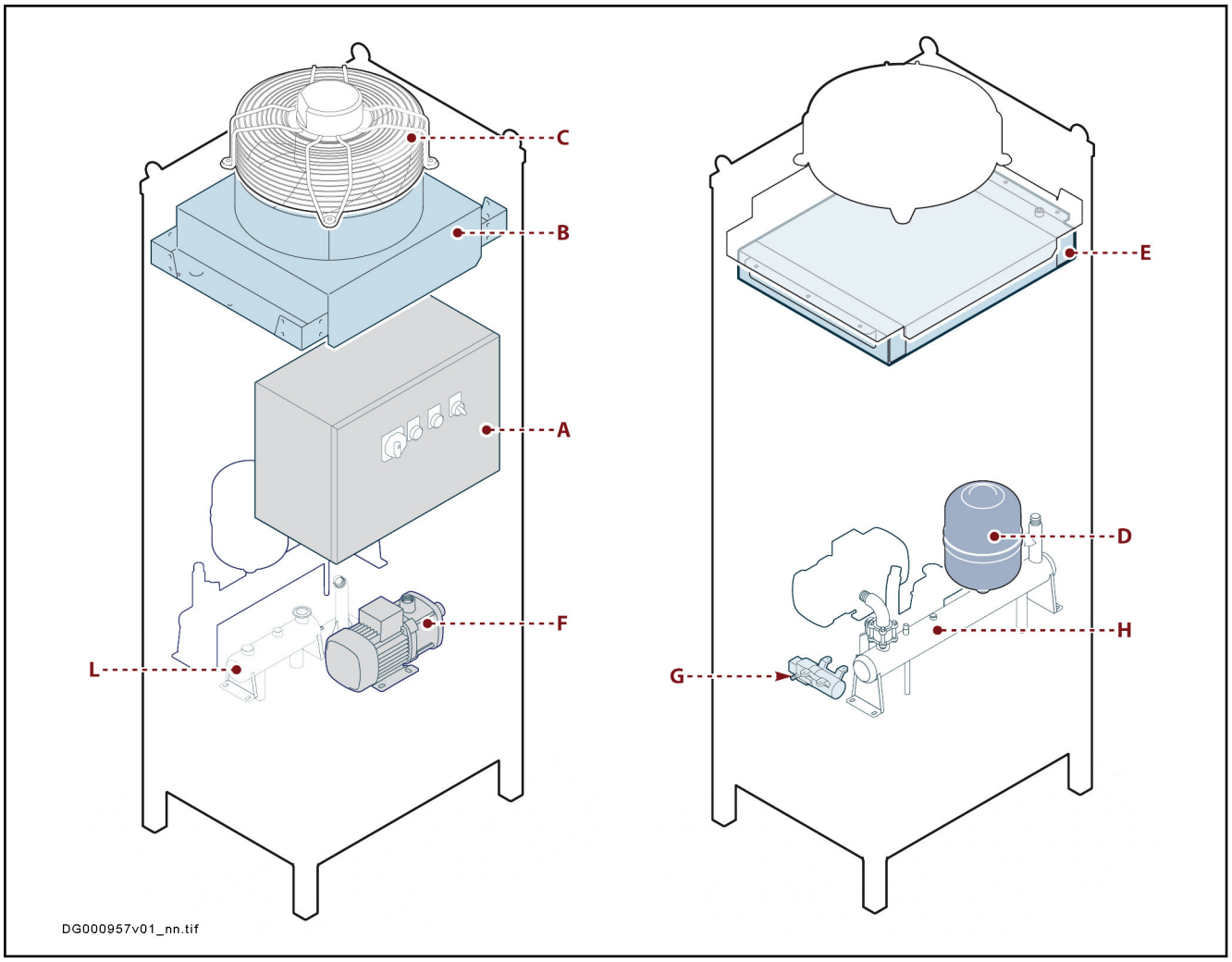
The underlying principle of the cooling method is the exchange of heat between air and water by means of a heat exchanger.

The liquid is circulated by a pump in the cooler and cooled by an air flow generated by an electric fan.

Pressure and temperature control is done via IndraMotion MLD, the drive-integrated Motion Logic Control according to IEC 61131-3. See chapter "Control with MLD" on page 488.

See also chapter "Liquid Cooling" on page 53.

Main parts

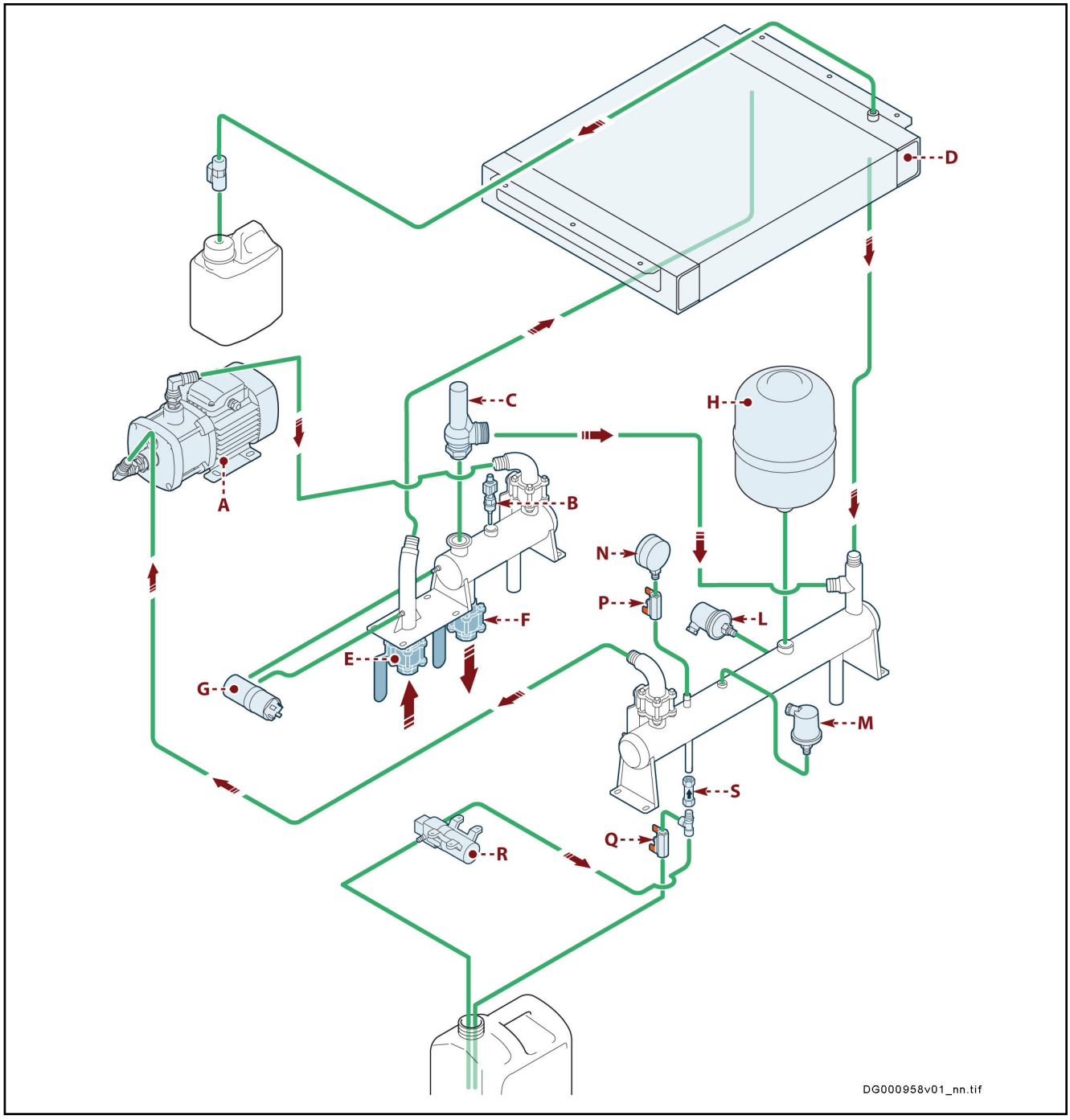


A	Terminal box
B	Suction channel
C	Electric fan
D	Expansion tank
E	Heat exchanger
F	Main pump
G	Filling pump
H	Intake manifold
L	Outlet manifold

Fig. 8-122: Main parts

Operational cycle and component description

The following figure shows the principle of operation.



A	**Main pump:** Circulates the coolant in the hydraulic circuit.
B	**Temperature sensor:** Detects the coolant temperature in the outlet pipe.
C	**Bypass valve:** Limits the pressure of the output cooling liquid.
D	**Heat exchanger:** Lowers the temperature of the coolant.
E	**Ball valve:** Regulates the flow of the coolant from the owner's system.
F	**Ball valve:** Regulates 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 outlet pipe.
H	**Expansion tank:** Ensures constant pressure in the circuit.

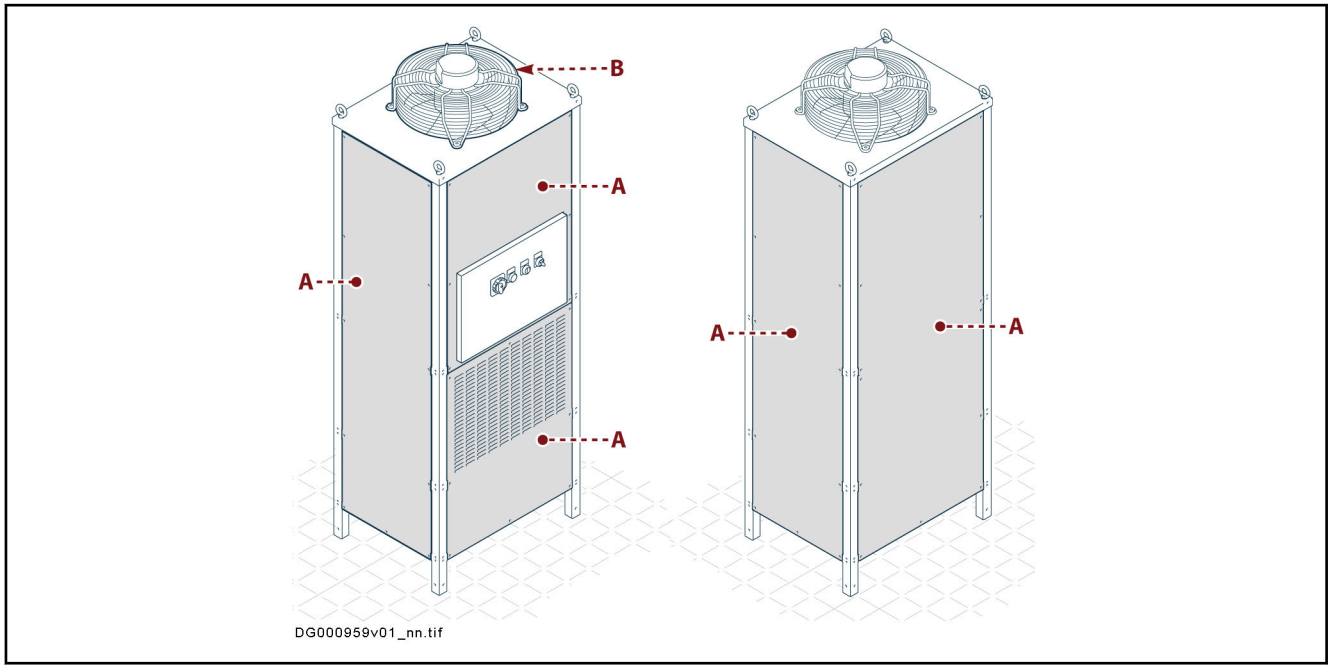
L	**Pressure switch (0.2 bar):** This detects the pressure level in the intake manifold.
M	**Pressure switch (0.5 bar):** This detects the pressure level in the intake manifold.
N	**Pressure gauge:** Detects the fluid pressure in the intake manifold.
P	**Valve:** Regulates the flow towards the pressure gauge (**N**).
Q	**Valve:** This is used to release any backpressure in the filling pump delivery line and facilitate priming.
R	**Filling pump:** Fills the cooling circuit.
S	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.

Fig. 8-123: Operational cycle and component description

Guards

⚠ WARNING **Risk of injury!**

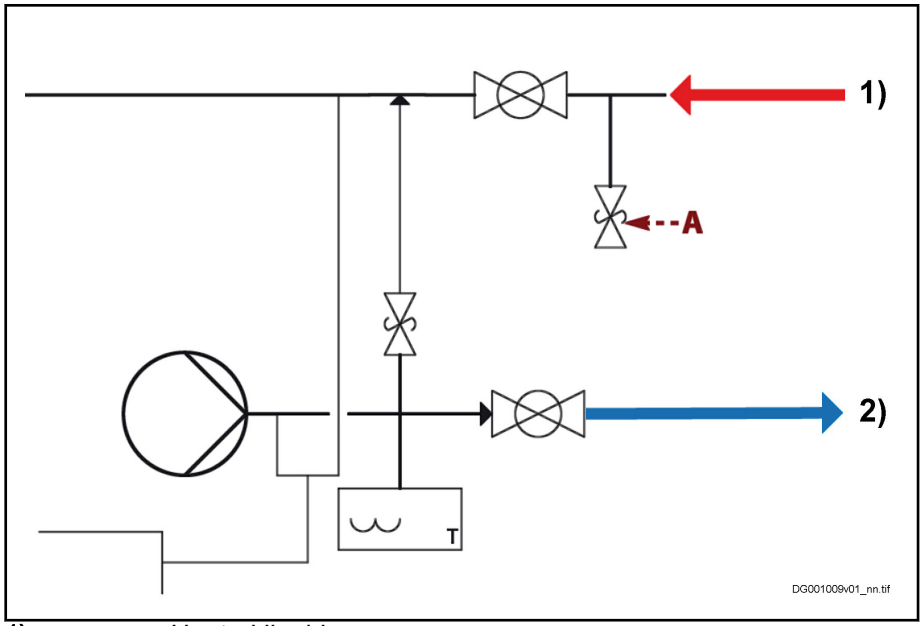
Never use the machine without the guards.



A **Guards:** Prevent unwanted access to machine parts.
B **Guard:** Prevents accidental touching of the fan.
Fig. 8-124: Guards

Overpressure devices

If additional pumps (external to the machine) are installed on the circuit or if the drop in pressure of the hydraulic load is less than 1.5 bar, the owner has to fit a pressure limiting valve. The valve has to limit the pressure to a maximum of 2 bar in the return pipe to the machine.



1) Heated liquid
2) Cooled liquid
A Pressure limiting valve

Fig. 8-125: Positioning of the pressure limiting valve (A)

Overall dimensions

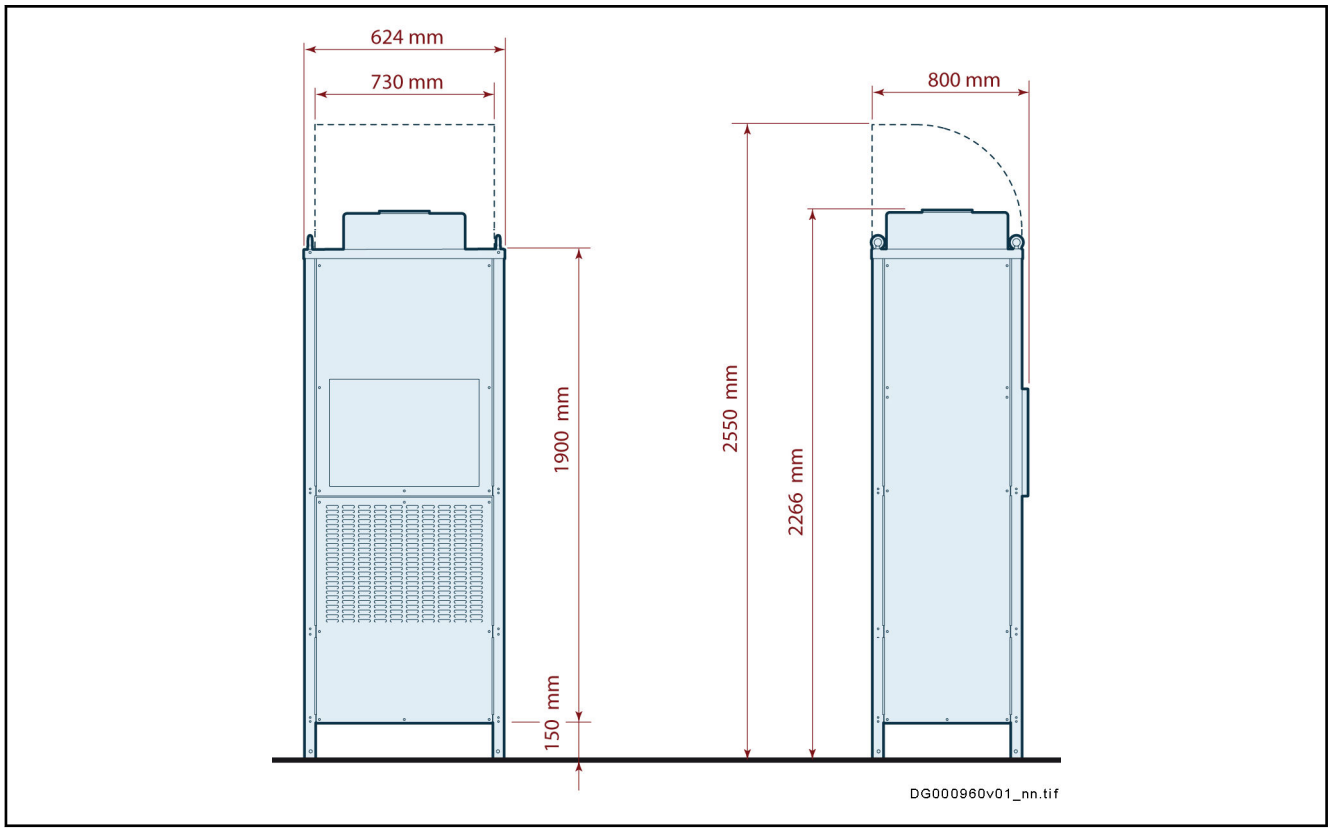


Fig. 8-126: Overall dimensions

Data

Technical data - machine

Description	Unit	Value
Power voltage	Vac	380 (-15%) … 500 (+10%)
Frequency	Hz	50/60
Current	A	5
Maximum cooling capacity	kW	12
Maximum output flow rate	l/min	20
Maximum pressure of the inflowing coolant	bar	2
Maximum pressure of the outflowing coolant	bar	4,5
Maximum coolant temperature	°C	70
Minimum coolant temperature	°C	5
Drive circuit coolant (monoethyl glycol and demineralized water solution) See also chapter "Liquid Cooling" on page 53.	-	20% glycol
Estimated amount of coolant (heat exchanger only)	l	approx. 50
Degree of protection	IP	54
Ambient temperature	°C	-+20 … +40
Maximum relative humidity without condensation	%	95
Maximum installation altitude	m	2000
Weight (heat exchanger)	kg	180

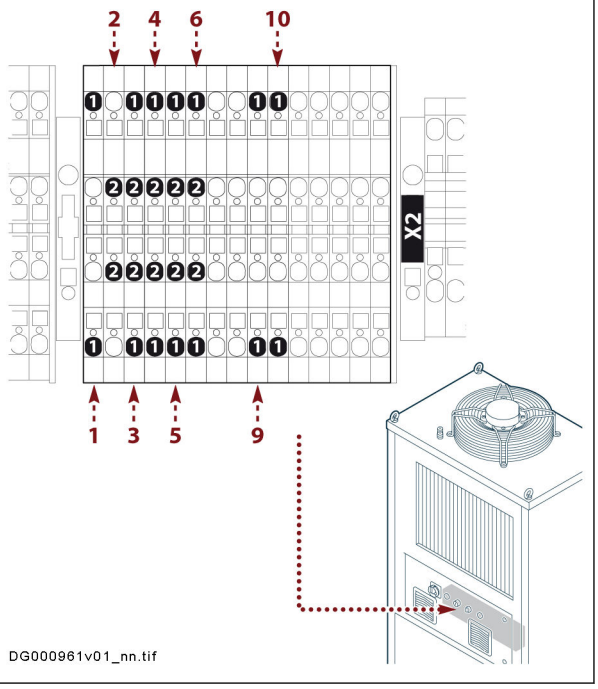
Tab. 8-182: Technical data - machine

ENABLE, UNIT ERROR, UNIT WARNING, ERROR RESET connections

The signals for releasing the relative machine status using the owner's operator terminal are transmitted via the terminal block shown.

Connect the lines to the terminals shown in table "Connection terminals".

Terminal connectors

Pos.	Significance	Terminals
9.1 - 2.2	Terminals for machine enabling via the owner's operator terminal (ENABLE)	
3.1 - 3.2 4.1 - 4.2	Machine error signal terminals Closed contact: no error	
5.1 - 5.2 6.1 - 6.2	Warning signal terminals Closed contact: no warning	
10.1 - 1.1	Terminals for remote-controlled alarm reset.	

Tab. 8-183: Terminal connectors

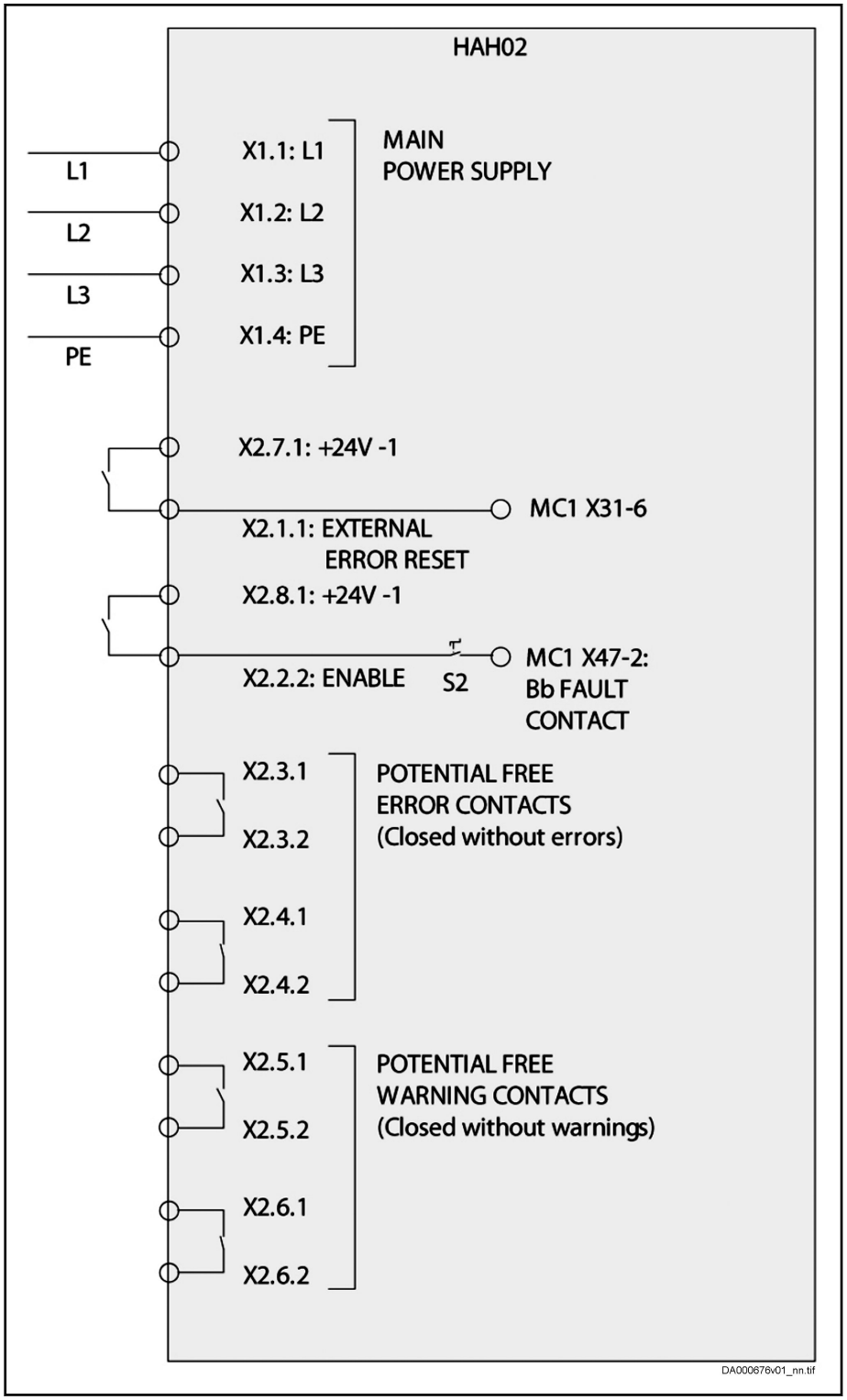
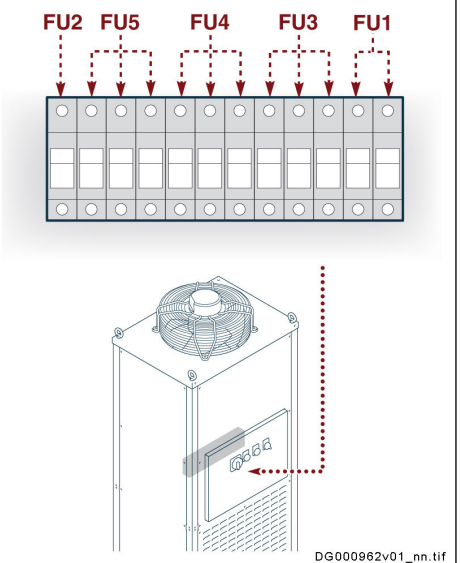


Fig. 8-127: Wiring diagram

Description of the fuses

Name	Current (A)	Type	Rated voltage (Vac)	Interrupting capacity (kW)	Fuse	Position
FU1	1	CC	600	200	Delayed	
FU2	4					
FU3	3					
FU4	4					
FU5	4					

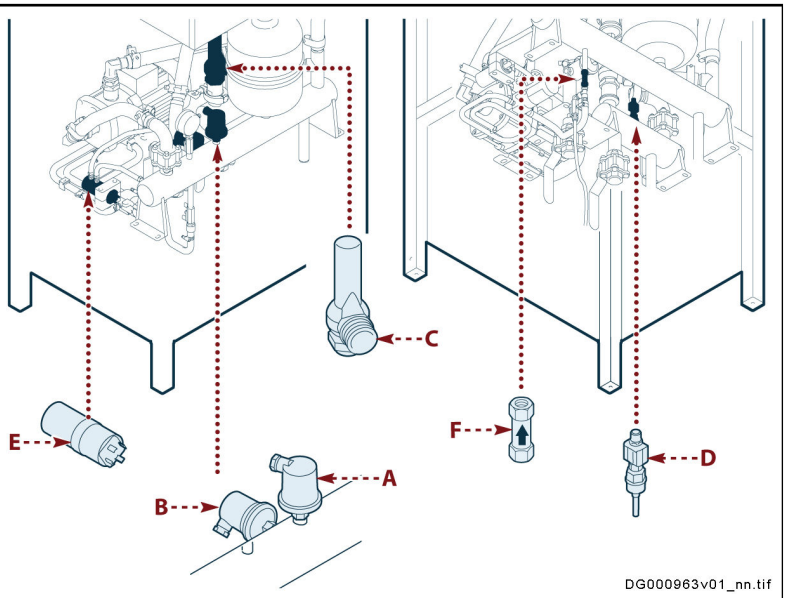
Tab. 8-184: Fuses

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 signaled 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 signaled when the pressure falls below 0.2 bar and stops machine operation.
C	**Bypass valve:** Keeps the fluid pressure in the outlet pipe within the maximum limit allowed.
D	**Temperature sensor:** 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 outlet pipe. The pressure in the outlet pipe is kept constant with the sensor.
F	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.



Tab. 8-185: Processing and protection devices

Ambient conditions for operation

The machine works properly at the specified ambient conditions (see chapter "Data" on page 455).

Intended use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

The machine must be used in accordance with its technical characteristics. It is not permitted to make changes or to use the machine for purposes other than those for which it was intended.

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.

Unintended and unauthorized uses

It is not permitted to use coolants with properties other than those specified by the manufacturer.

It is not permitted to use machines in a flammable or explosive environment.

Commissioning of the machine is only permitted if it is ensured that the system or the machine in which it is installed complies with national and local regulations.

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.

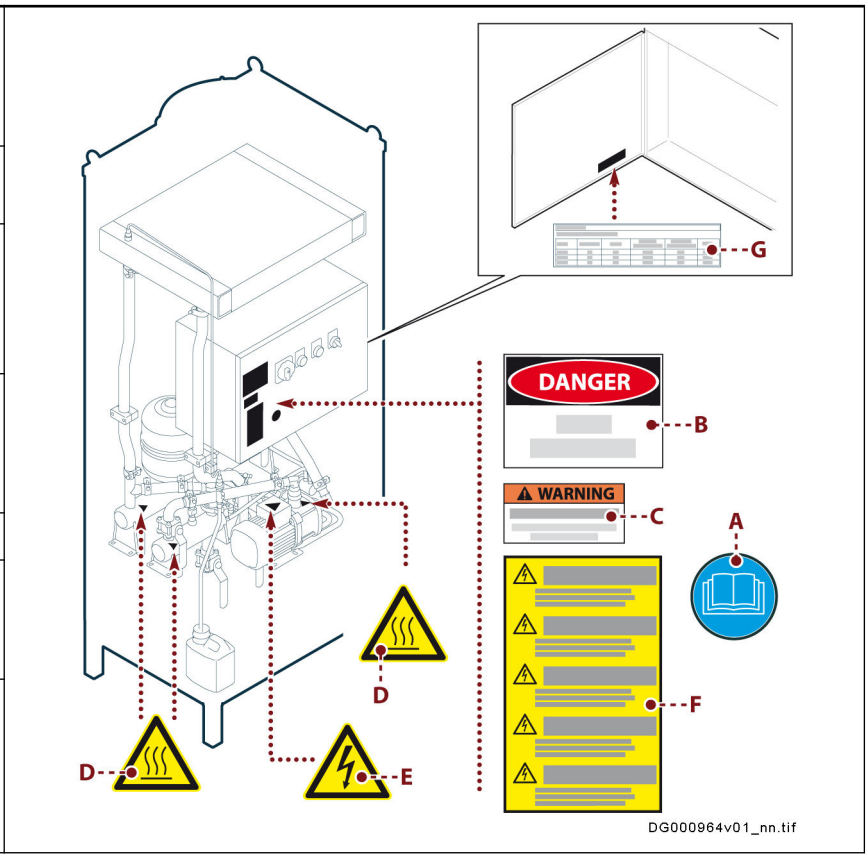
Thermal risk: Contact with hot surfaces can cause burns. Allow the machine to cool down before any operation.

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 one.

A	This indicates the obligation for operators to read the instruction manual before operating the machine.
B	This shows that the voltage inside the terminal box is hazardous.
C	Risk of arc discharge and electric shock. Wear suitable 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	Risk of electric shock
F	Risk of electric shock: Do not perform any work on live parts.
G	Fuses data



Tab. 8-186: Information and safety signs

Transporting and installing

Transport and installation safety recommendations

Personnel responsible for transport of the load must have the required qualification and experience and must be trained in handling the lifting gear used.

Use lifting gear with suitable load capacity in order to lift and move the load.

Persons authorized for transport must take appropriate measures to ensure their own safety and the safety of persons directly involved.

Place the package on a stable surface.

Do not place packed machines on top of each other as they are not intended for stacking.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents. In case items are damaged or missing, contact the importer or the manufacturer directly to discuss the procedure to be adopted.

Package description

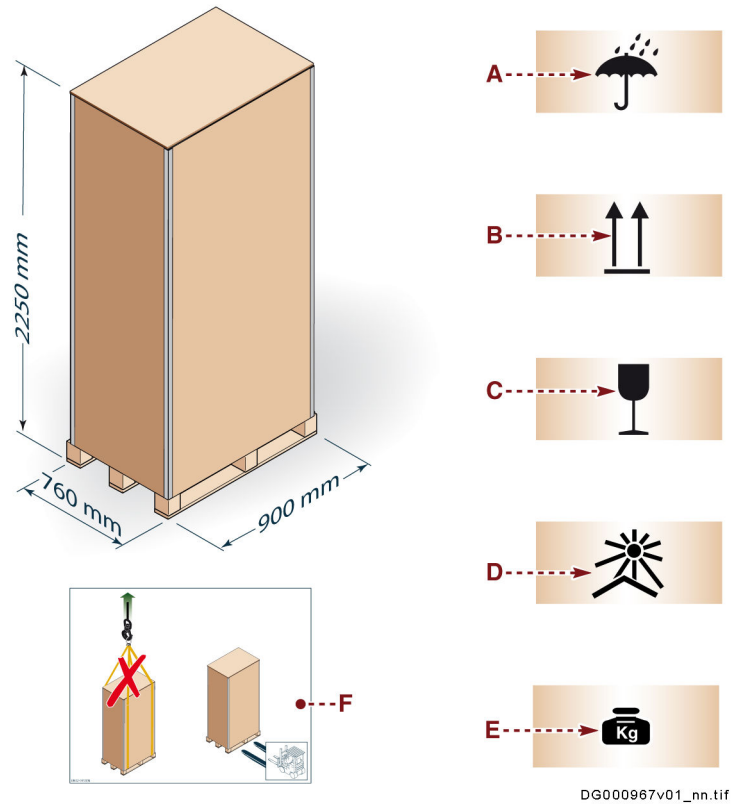
The packaging is selected according to the selected means of transport and the destination.

Packages can either be loaded directly onto a means of transport or into suitable containers if shipped by sea or air or to far-off destinations.

In order to facilitate transport, some components are removed and properly protected.

The figure shows the type of packaging most frequently used and the maximum dimensions as well as the warning symbols and notices attached 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 overall weight of the package.
F	The plate shows the procedure for lifting the package.



Tab. 8-187: Package description

Transporting and lifting the packed machine

The figure shows how to lift the package.

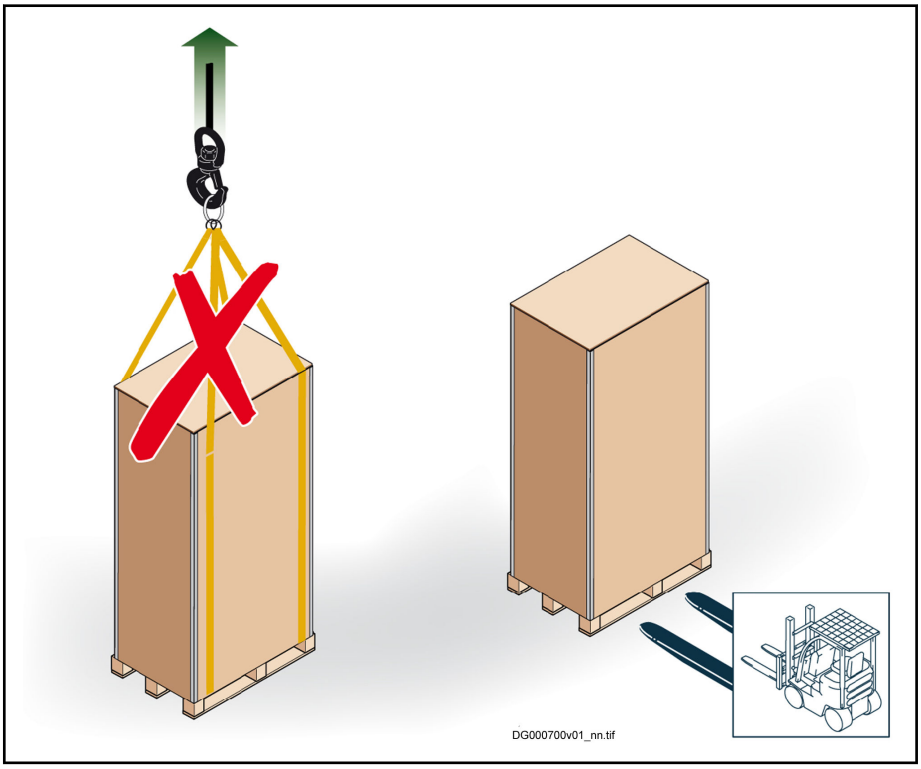


Fig. 8-128: Transporting and lifting the packed machine

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.

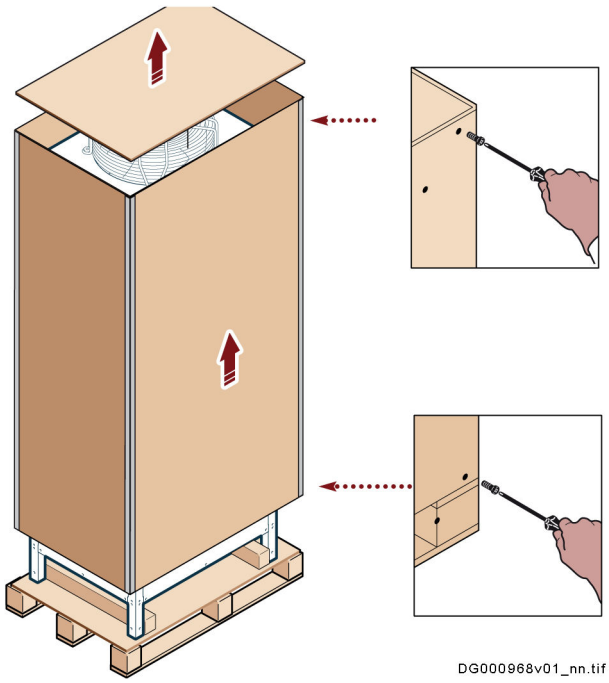
Unpacking

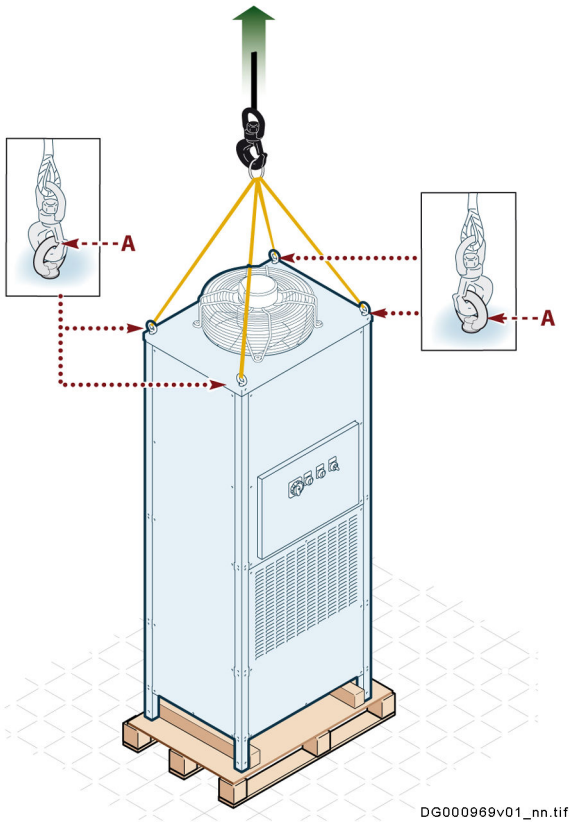
It is advisable to unpack the machine near the installation area to facilitate assembly.

The figure shows how to unpack the machine properly.

Proceed as described.

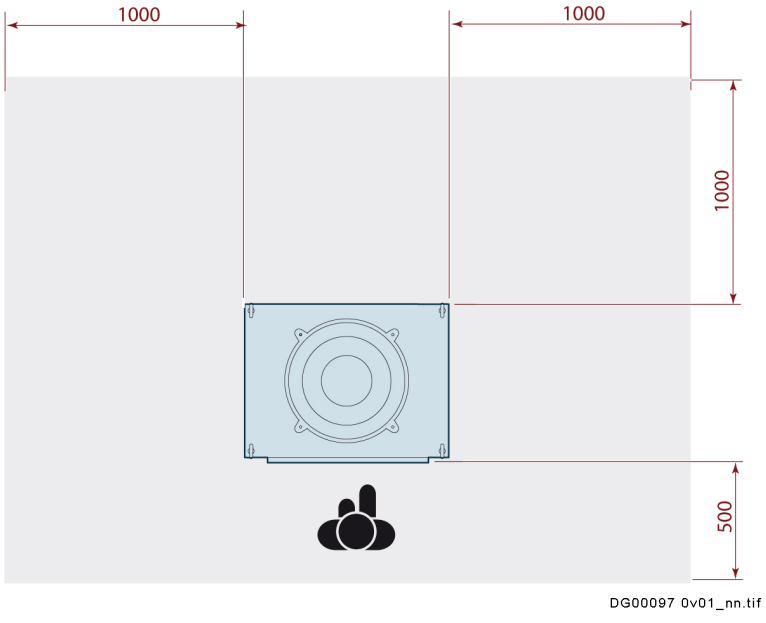
1	Unscrew the screws.
2	Remove the cover.
3	Lift the side walls of the packaging.



4	Hook the ropes onto the eyebolts (**A**).	
5	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. 8-188: Unpacking

Installation

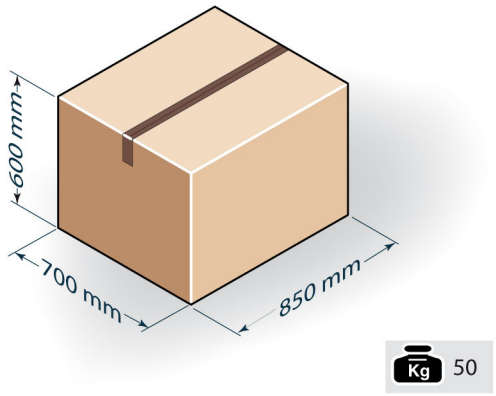
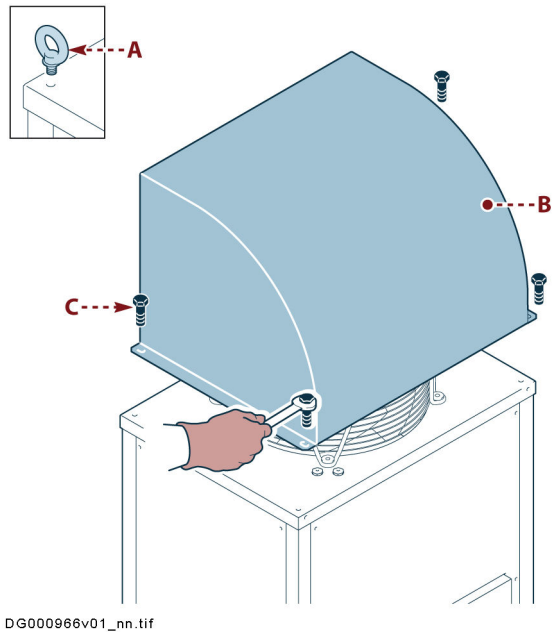
Installation area The installation area must be flat and horizontal and correspond to the default load factor. Electrical connections as well as the possibility of transmitting the signals "ENABLE", "UNIT ERROR", "UNIT WARNING", "ERROR RESET" must be available. Furthermore, all hydraulic connections must be available in accordance with legal regulations. According to the relevant regulations concerning health and safety at the working place, the area must have sufficient ventilation and lighting. Make sure that there is enough space around the installation area so that all work can be carried out safely.	

Tab. 8-189: Installation area

Fan cover

The fan cover serves for lateral flow of the intake air of the machine's electric fan.

The fan cover is usually delivered in special packaging.

Packaging	
Mounting: Remove the lifting rings (**A**). Position the fan cover (**B**). Tighten the screws (**C**).	

Tab. 8-190: Fan cover

Electrical connection

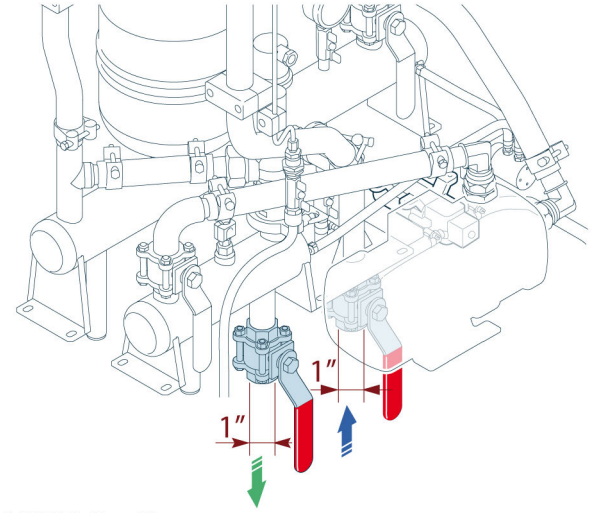
Electrical connections must be executed according to the manufacturer's specifications in the wiring diagram.

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 + equipment grounding conductor).

Connect the three phases (L1, L2, L3) and the equipment grounding conductor to the relevant terminals inside the terminal box.

Hose connections

The owner has to install a pressure regulating device in the return pipe. Set the pressure in the intake and return pipes to the values shown in chapter "Data" on page 455. 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.	

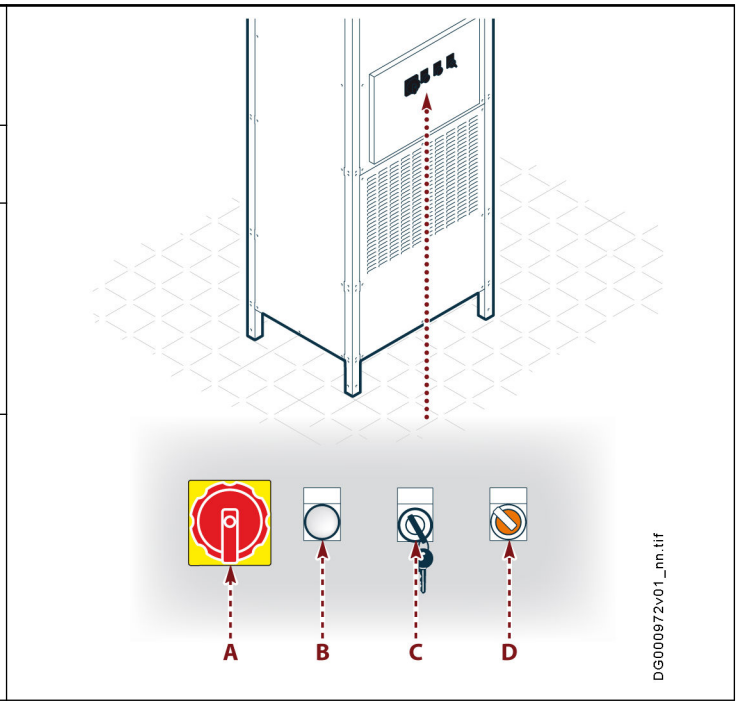
Tab. 8-191: Hose connections

Use

Safety advice for use

Before starting the machine, ensure that the system or the machine in which it has been fitted complies with applicable local regulations and directives.

Control elements and indicator lamps

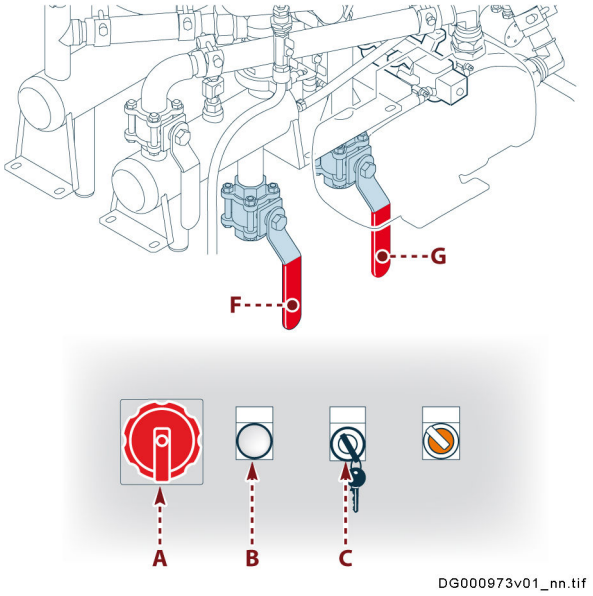
A	**Main switch:** It is used for connecting and disconnecting the power supply to machine. The indicator lamp (**B**) lights up.	
B	**Indicator lamp (white light):** Indicates that the power supply to the machine has been enabled.	
C	**Key-operated two-position stay-put selector switch:** This is used to switch the main pump operation on and off. The key has to 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. 8-192: Control elements and indicator lamps

Switching on

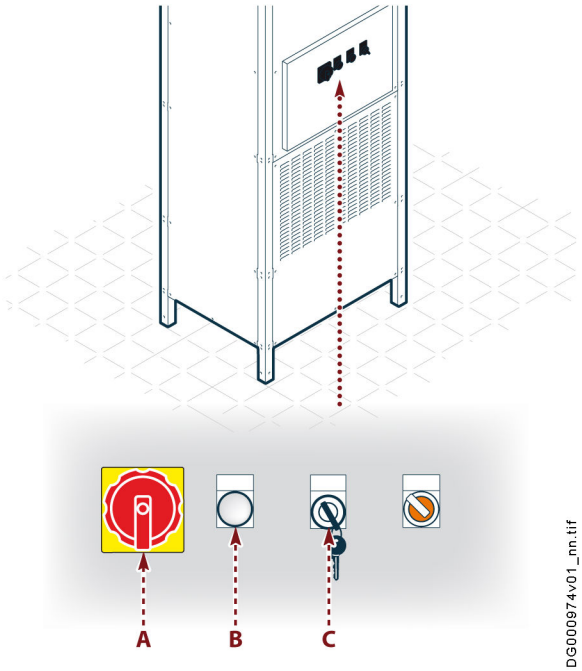
During the first run-up, carry out the circuit filling procedure (see chapter "Filling the hydraulic circuit" on page 472).

To start the machine, proceed as follows.

1	Open the ball valves (**F - G**).	
2	Turn the main switch (**A**) to the "ON" position. The indicator lamp (**B**) lights up.	
3	Turn the key selector (**C**) to "automatic" position. Machine start-up has to be performed using the operator terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR, UNIT WARNING, ERROR RESET connections" on page 456).	

Tab. 8-193: Switching on

Switching off

Switching off with the main switch 1. Turn the main switch (**A**) to the "OFF" position. • The indicator lamp (**B**) will switch off. • Machine operation stops and the voltage supply to the terminal box is interrupted. • The supply terminals remain live.	
Switching off with the key-operated switch This switch-off mode is reserved for authorized 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 terminal box at the machine remains live.	
Remote-controlled switch-off • Remote-controlled switch-off has to be performed using the owner's operator terminal, via the "ENABLE" connection. • Operation of the main pump stops. • The terminal box at the machine remains live.	
Switching off automatically • The machine switches off automatically if the pressure in the circuit falls below 0.2 bar and the temperature of the liquid exceeds the preset limit (see parameter P-0-1318).	

Tab. 8-194: Switching off

Switching off in emergency conditions

To switch off the device in the event of imminent danger (emergency stop), turn the main switch (**A**) to the "OFF" position.

Fix the cause for the emergency stop before restarting the machine.

Filling the hydraulic circuit

Check if the installation as well as electrical and hydraulic connections are executed professionally in accordance with the manufacturer's specifications.

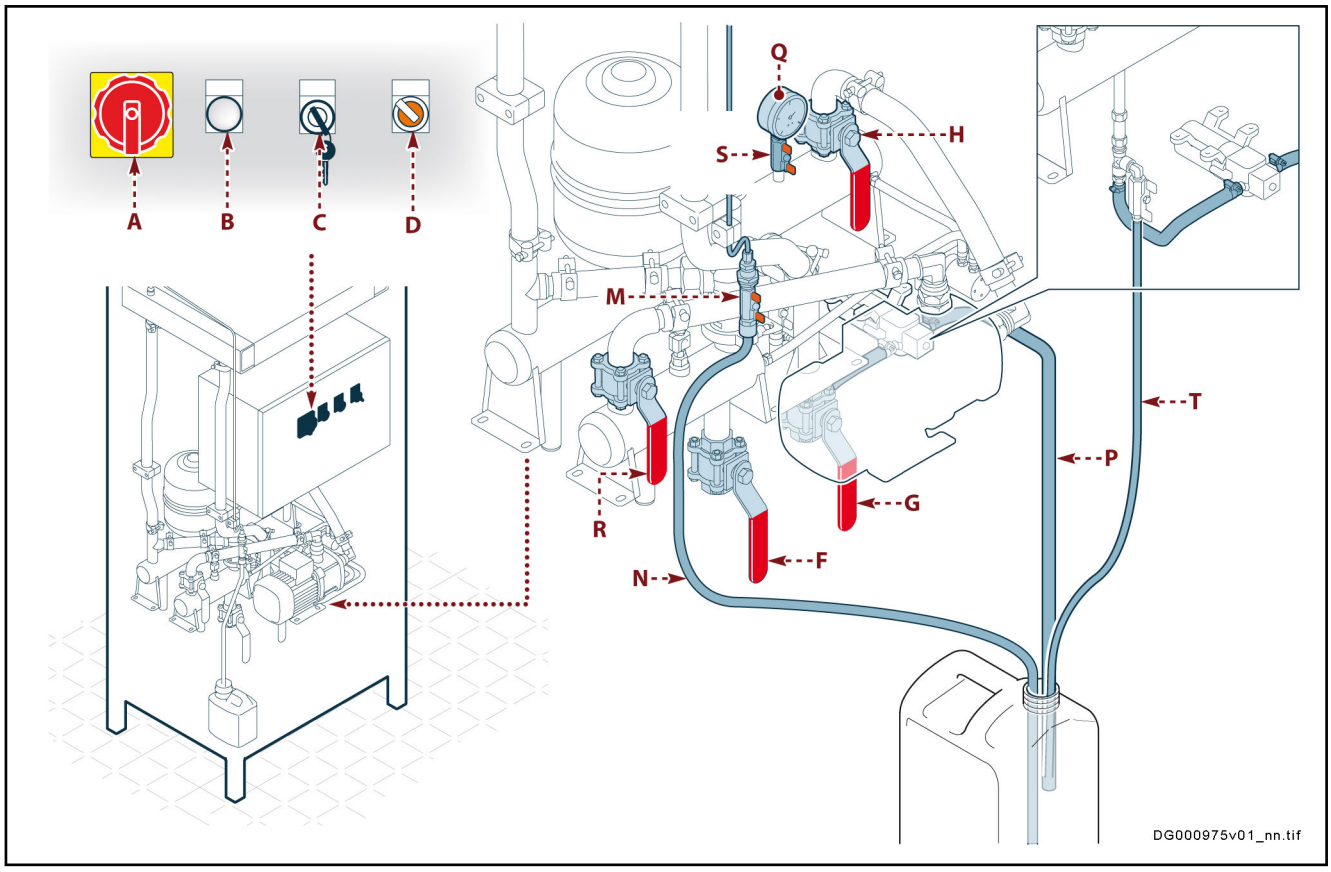


Fig. 8-129: Fill the hydraulic circuit

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 455).
2. Fit the pipes (**P - N - T**) into the tank.
3. Open the ball valve (**G**).
4. Open the ball valve (**F**).
5. Open the valve (**M**).
6. Open the valve (**S**).
7. Open the valve (**H**).
8. Open the valve (**R**).
9. Turn the key-operated selector switch (**C**) to the "OFF" position to prevent unexpected activation of the main pump.
10. Ensure that the remote-controlled "ENABLE" function is activated.
11. **NOTICE!** Do **not** turn the key-operated selector switch (**C**) to the "ON" position since this could cause damage to the main pump.

    Open any existing valves that are installed outside the machine on the circuit of the machine to be cooled.
12. Turn the main switch (**A**) to the "ON" position.

    The indicator lamp (**B**) lights up.
13. Turn the selector switch (**D**) to activate the filling pump.

Make sure that there is always enough liquid in the tank.

If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 474).

14. 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 indicated on the (**Q**) pressure gauge.

15. Open the valve (**M**).
16. Turn the key-operated switch (**C**) to the "ON" position the activate the main pump in the automatic mode.
17. **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. The pressure drop is caused by the air pumped into the circuit as a result of activation of the main pump. Switch the main pump on and off with the key-operated switch (C) from time to time to achieve venting and pressure build-up. Make sure that the key-operated switch (**C**) 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.

    NOTICE! If the filling pump priming procedure stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 474).

18. Turn the selector switch (**D**) to deactivate the filling pump.
19. Close the valve (**M**) when the pressure in the circuit has reached 1.5 bar.
20. Close the valve (**S**).
21. Remove the pipes from the tank.
22. 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. Perform the restore operation if the pressure is not correct (see chapter "Restoring the pressure" on page 475).

NOTICE **Risk of damage to the pressure gauge!**

Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Filling pump priming procedure

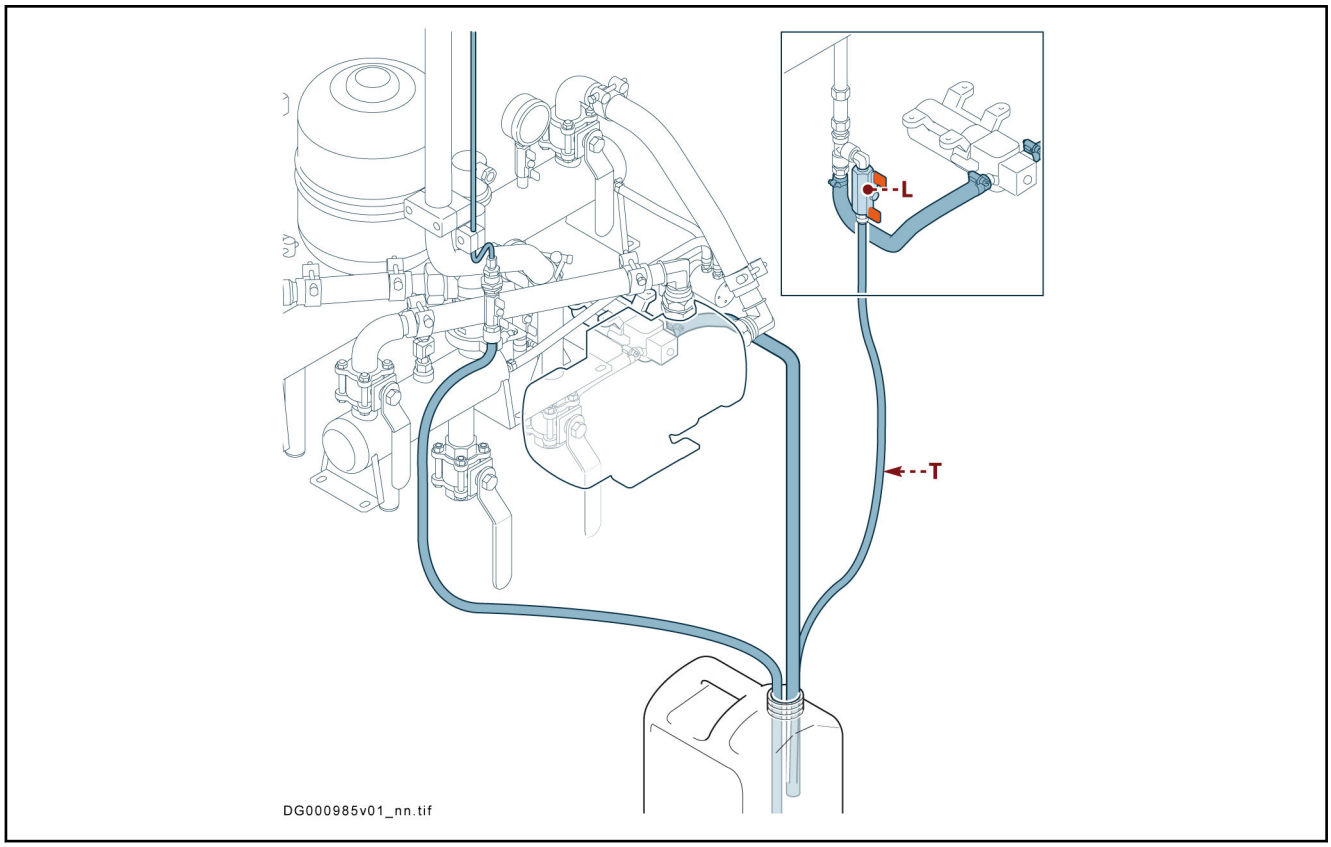


Fig. 8-130: Perform the filling pump priming procedure

If the filling pump does not prime automatically, proceed as described:

1. When the filling pump is active, open the valve (**L**).
2. Wait for the coolant to start flowing out of the transparent hose (**T**).
3. Close the valve (**L**) and leave the filling pump working.

The filling pump is primed and starts pumping the coolant into the hydraulic circuit.

Restoring the pressure

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 "Filling the hydraulic circuit" on page 472).

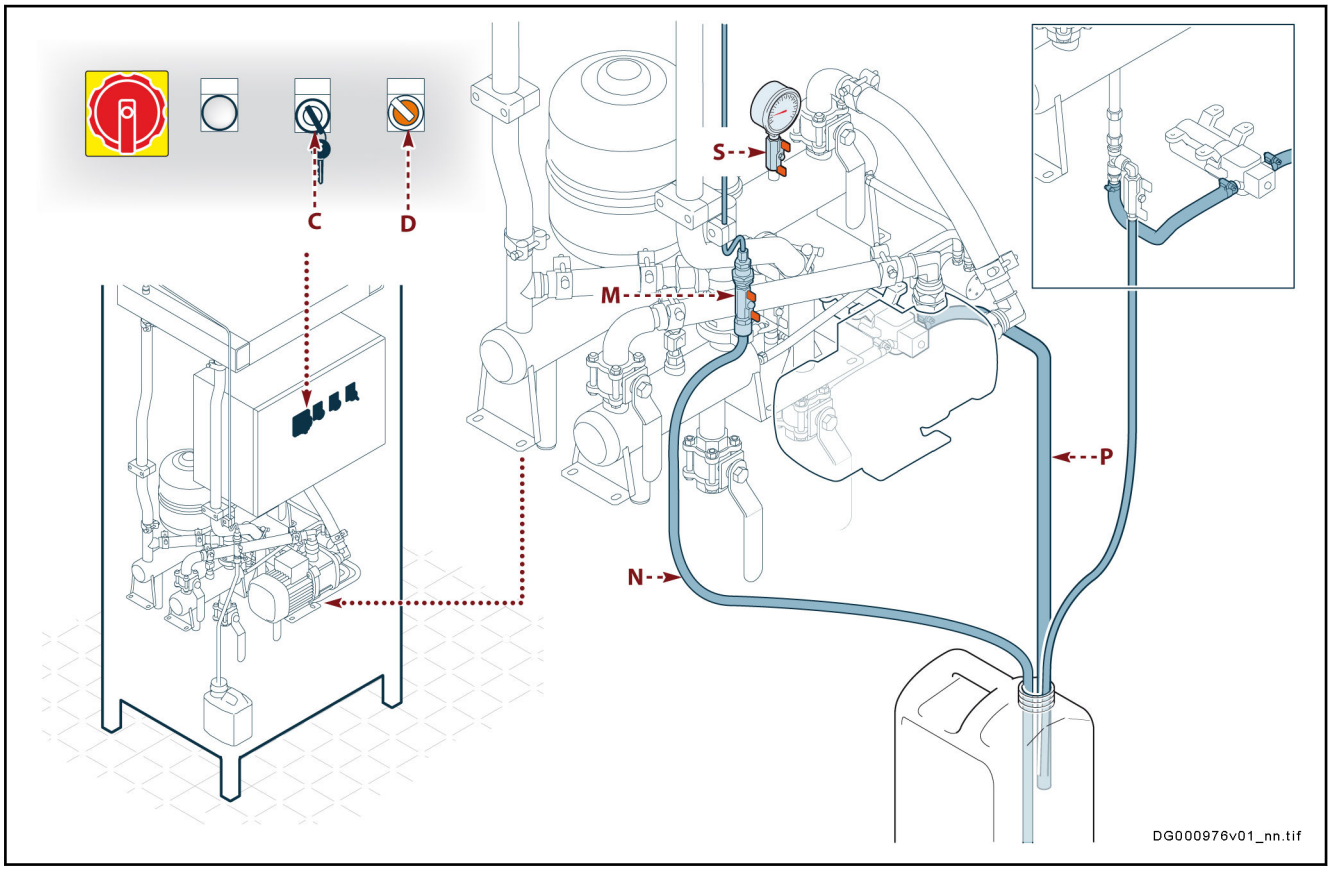


Fig. 8-131: Restoring the pressure

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 455).
2. Fit the pipes (**N - P - T**) into the tank.
3. Open the valve (**S**).
4. Turn the selector switch (**D**) to activate the filling pump.

   If the filling pump does not start priming, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 474).
5. Open the valve (**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.

   NOTICE! If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 474).

   Close the valve (**M**).

7. Turn the selector switch (**D**) to deactivate the filling pump.
8. Close the valve (**S**).
9. Remove the pipes from the tank.
10. Remove the key from the selector switch (**C**) and store in a safe place.

NOTICE **Risk of damage to the pressure gauge!**

Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Emptying the hydraulic circuit

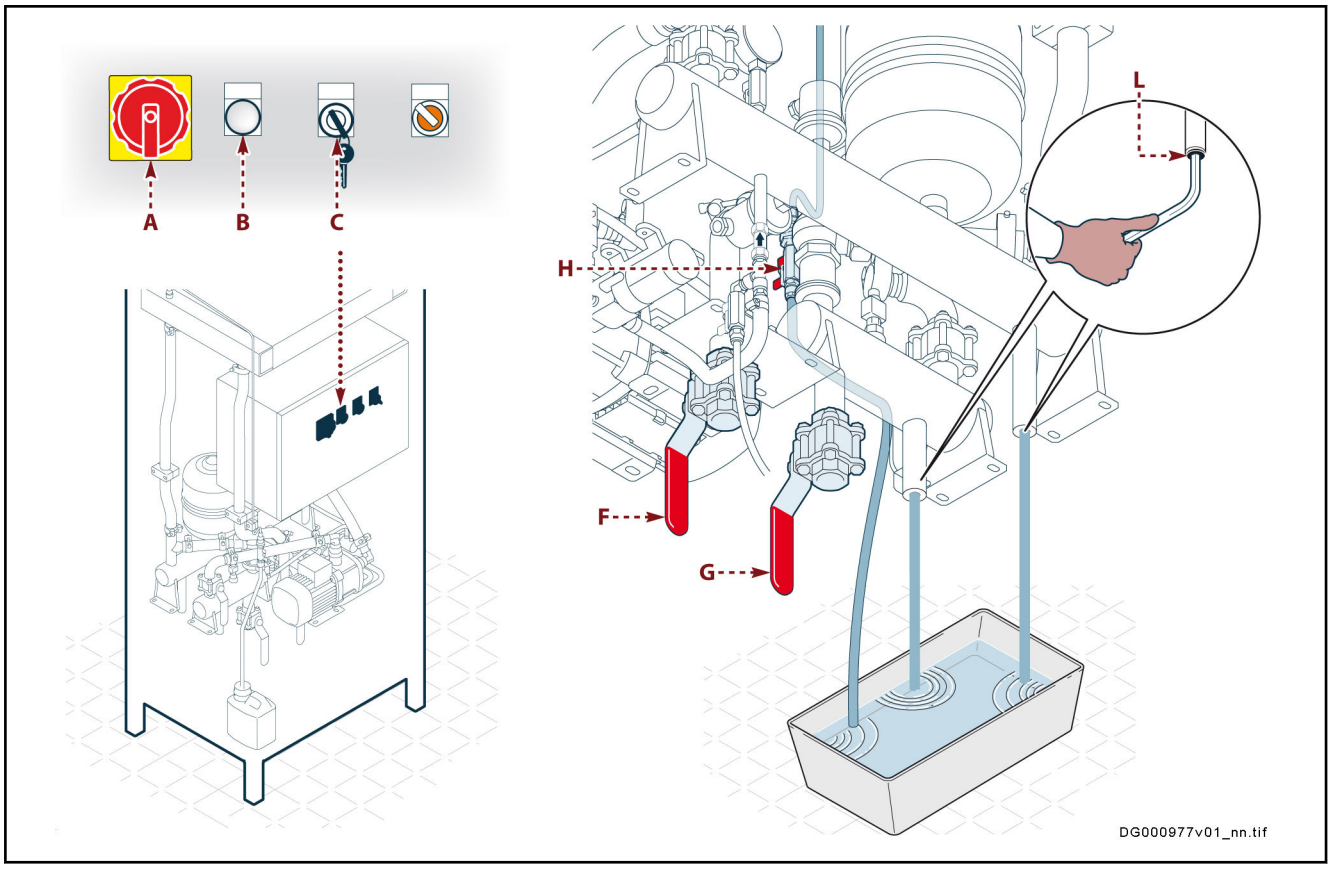


Fig. 8-132: Emptying the hydraulic circuit

1. Position a suitable container for collecting the coolant.
2. Switch off the machine (see chapter "Switching off" on page 471).
3. Turn the key selector (**C**) to the "OFF" position.
4. Turn the main switch (**A**) to the "OFF" position.
5. The indicator lamp (**B**) will switch off.
6. Close the ball valves (**F - G**).
7. Open the valve (**H**).
8. Open the caps (**L**).
9. Drain out all the coolant.
10. Close the valve (**H**).
11. Close the caps (**L**).
12. **NOTICE!** Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.

Maintenance

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.

The power supply to the machine must be switched off in particular.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

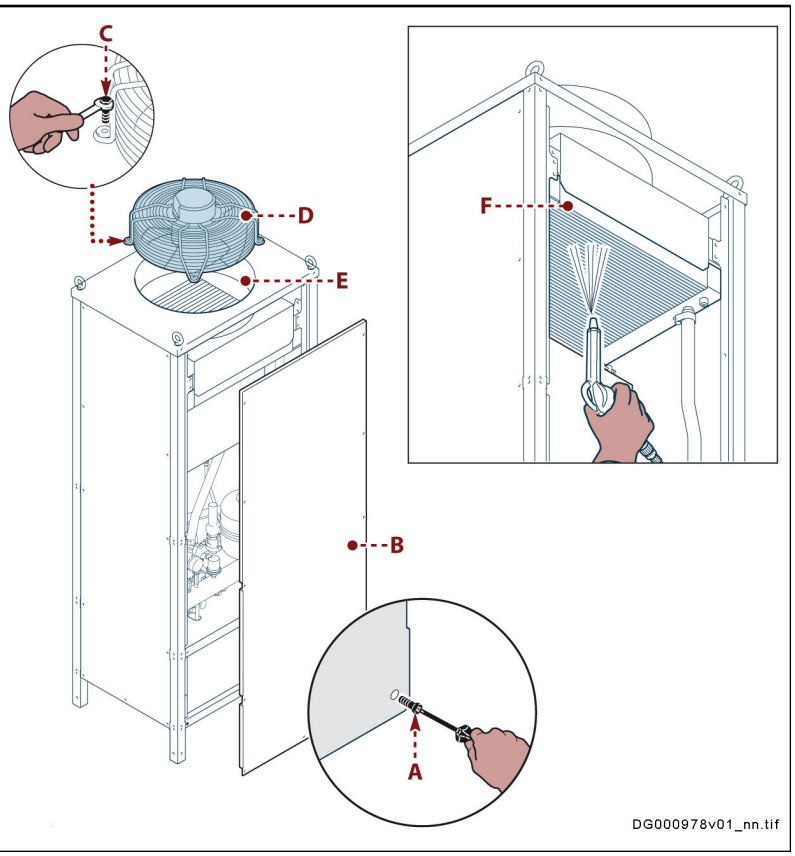
Maintenance schedule

Interval			Component	Type of work	Cross reference
Every 5000 operating hours	Every 30,000 operating hours	Every 10 years of operation	–	–	–
✓	–	–	Cooler - cooling channel	Cleaning	See chapter "Cleaning cooler and cooling channel" on page 479
–	✓	–	Main pump	Replacement	See chapter "Replacing the main pump" on page 485
–	✓	–	Fan	Replacement	See chapter "Replacing the fan" on page 486
–	✓	–	Coolant	Replacement	See chapter "Exchanging the coolant" on page 486
–	–	✓	EPDM rubber hoses	Replacement	–

Tab. 8-195: Maintenance schedule

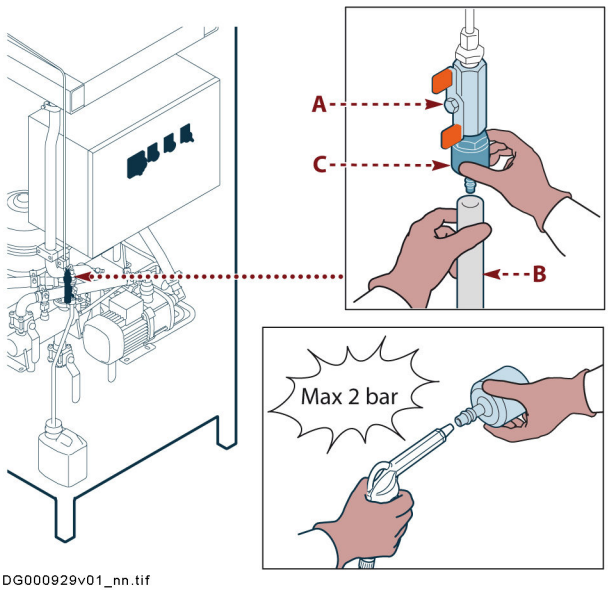
Cleaning cooler and cooling channel

1	Disconnect the machine from the voltage source.
2	Unscrew the screws (**A**).
3	Remove the guard (**B**).
4	Unscrew the screws (**C**).
5	Remove the fan (**D**) and support.
6	Suction dust and dirt in the cooling channel (**E**).
7	Clean the inside of the cooler (**F**) with compressed air.
8	Suction dust and dirt in the cooling channel (**E**) again.
9	Position the fan (**D**).
10	Tighten the screws (**C**).
11	Position the guard (**B**).
12	Tighten the screws (**A**).



Tab. 8-196: Cleaning the cooler and the cooling channel

Cleaning the connector of the bleed valve

1	Close the bleed valve (**A**).	
2	Remove the hose (**B**).	
3	Unscrew the connector (**C**).	
4	Clean the connector with compressed air. Keep the pressure on the level indicated in the picture.	
5	Screw on the connector (**C**).	
6	Attach the hose (**B**) to the connector.	
7	Open the bleed valve (**A**).	

Tab. 8-197: Cleaning the connector

Cleaning the machine

Clean the machine with detergents that are approved in accordance with the applicable legal regulations.

Troubleshooting

The following table contains a number of faults that may occur during operation as well as appropriate corrective measures.

Code	Type	Malfunction	Likely cause	Remedy
E2011	Warning 1	Low pressure, please refill	The system pressure is lower than 0.5 bar (loss of water, maintenance)	Refill cooling system up to 1.5 bar
E2012	Warning 2	Unable to start drive	Motor does not start in velocity control operation	Ensure that the system has the status "AF" before starting
E2013	Warning 3	Heater works	The heater switches on if the temperature of the liquid falls below 0°C.	Check operating temperature Check signal of the temperature sensor
E2014	Warning 4	Overtemperature	Temperature exceeds the defined value (P-0-1316) of the maximum permissible deviation from required temperature (t_{set}) for a defined duration (P-0-1317)	Check cooling system Clean cooling system, if necessary Reduce the level of the heat to be dissipated. If required, change the settings in the parameters P-0-1316 and/or P-0-1317
E2015	Warning 5	Fan	Fan signals error	Check fan and feedback signal
E2016	Warning 6	Lower motor speed limitation active	Motor velocity of the pressure control < 360 min^{-1}	Increase the value of parameter P-0-1374 (> 360 min^{-1}) Ensure that the motor can run with a velocity > 360 min^{-1}
F2011	Error 1	System pressure	System pressure lower than 0.2 bar	Refill cooling system up to 1.5 bar
F2012	Error 2	Overtemperature	The fluid temperature (on the drive side) has exceeded the maximum allowed temperature limit (see parameter P-0-1318)	If required, change the value of parameter P-0-1318 Clean fan Reduce the quantity of heat to be emitted
		Temperature of the heater is too high (yellow signal lamp lights up)	Thermostat of the heater is triggered	Check signal of the temperature sensor
		Heater does not heat	Thermostat of the heater was triggered in order to enable operation without liquid	Check the pressure of the cooling circuit and restore, if applicable
F2013	Error 3	Fan	Defective fan Fuses defective	Replace fan Replace fuses
		Slight leakage of cooling liquid between pump and motor	Start after long inactivity of the machine Changing the ambient conditions	Start pump [1)]

Code	Type	Malfunction	Likely cause	Remedy
		The filling pump does not start priming automatically	Suction hose empty following long period of machine disuse No coolant in the tank High backpressure in the filling pump delivery line	Perform the filling pump priming procedure
		The filling pump does not inject the coolant into the circuit	The filling pump is not primed The filling pump bleed valve is open	Perform the filling pump priming procedure Close the filling pump bleed valve

1) The pump is mechanically sealed by the cooling liquid. This type of seal (mechanical) may lead to a slight leakage of cooling liquid under certain conditions. It takes some time to minimize the leakage if the pump is started after stopping the machine or after being inactive. The required time depends on the operating conditions. The leaked cooling liquid usually evaporates immediately. The leaked cooling liquid is not visible then. **This type of leakage is not a malfunction.** Contact the service if the leakage persists for a longer period of time.

Tab. 8-198: Errors and warnings

Replacing the component

Safety advice for component exchange

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.

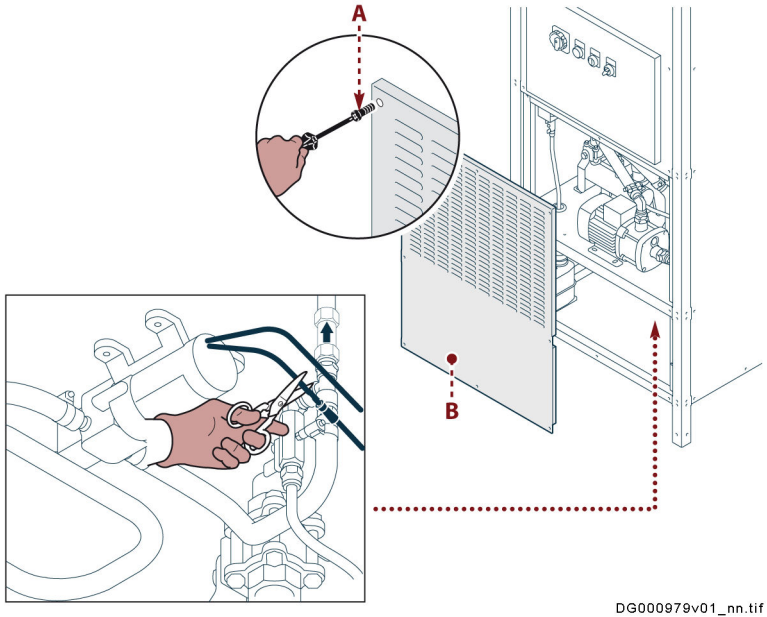
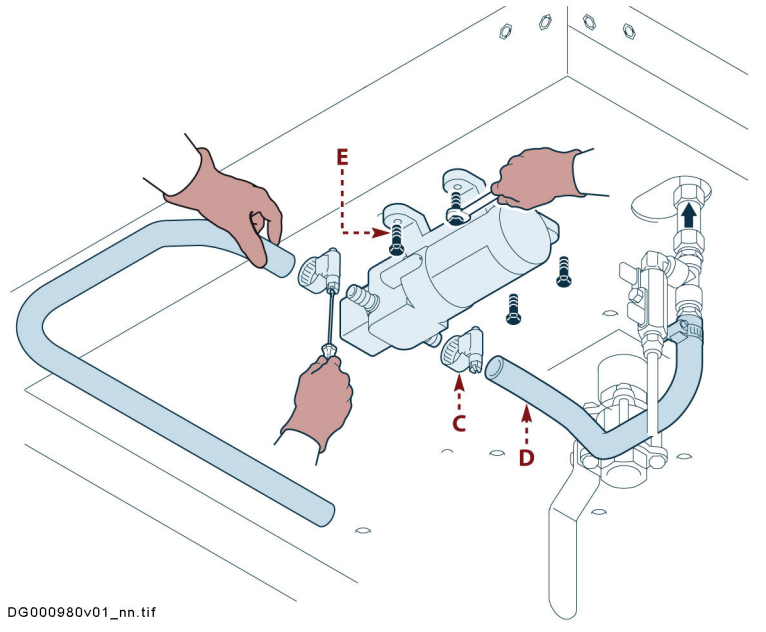
In particular, disconnect the power supply to the machine.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

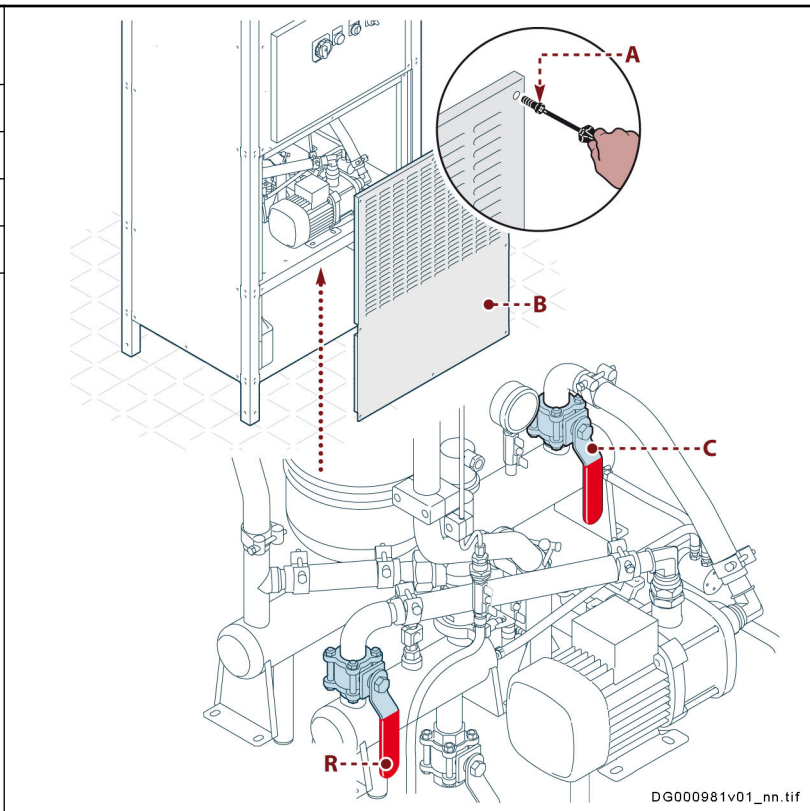
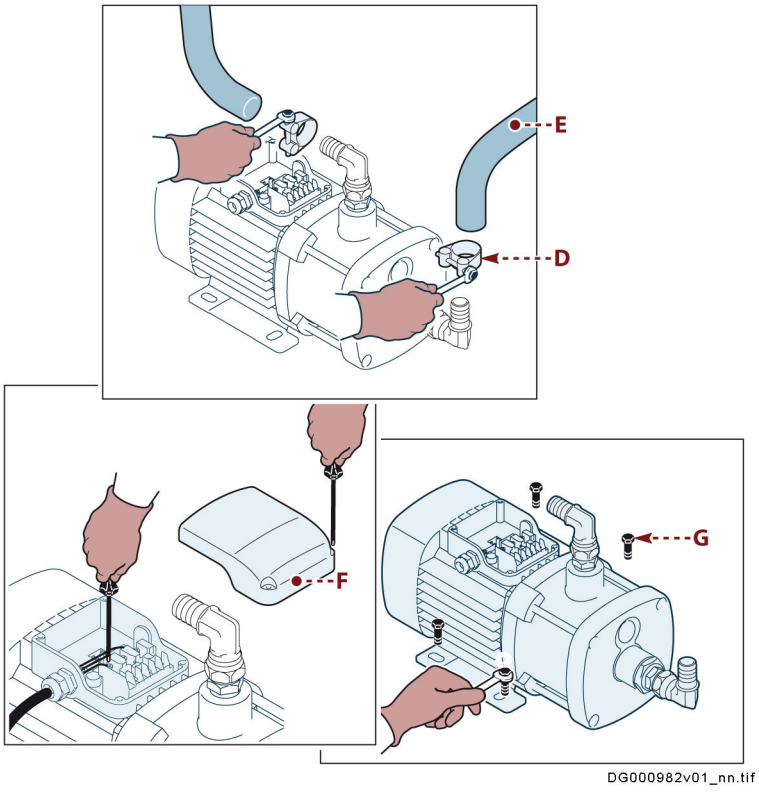
Replace worn or damaged parts by original spare parts.

Replacing the filling pump

1	Disconnect the machine from the power supply source.	
2	Unscrew the screws (**A**).	
3	Remove the guard (**B**).	
4	Cut the mains cables.	
5	Undo the screw and remove the strap (**C**).	
6	Disconnect the hosing (**D**).	
7	Repeat the process for the other hose.	
8	Unscrew the screws (**E**).	
9	Remove the pump.	
10	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump.	

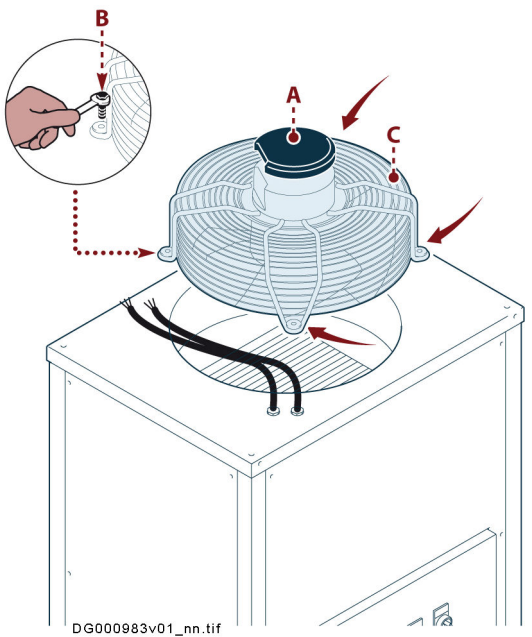
Tab. 8-199: Replacement of the filling pump

Replacing the main pump

1	Disconnect the machine from the power supply source.	
2	Allow the machine to cool down.	
3	Unscrew the screws (**A**).	
4	Remove the guard (**B**).	
5	Close the valve (**C**).	
6	Close the valve (**R**).	
7	Undo the screw and remove the strap (**D**).	
8	Disconnect the hosing (**E**).	
9	Repeat the process for the other hose.	
10	Remove the cover (**F**).	
11	Disconnect the cables from the terminals.	
12	Unscrew the screws (**G**).	
13	Remove the pump.	
14	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump. **NOTICE!** The spare pump is supplied with the fittings mounted. Do not remove the fittings as this could cause liquid leakage.	

Tab. 8-200: Replacement of the main pump

Replacing the 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 fan (**C**).	
6	Insert the replacement fan.	
7	Tighten the screws (**B**).	
8	Connect the cables (using the wiring diagram).	
9	Reattach the cover (**A**).	

Tab. 8-201: Replacement of the electric fan

Replacing the fuses

Before replacing the fuse, fix the cause of the malfunction.

Only replace the interrupted fuse with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Description of the fuses" on page 458.

Exchanging the coolant

Empty the hydraulic circuit of the machine (see chapter "Emptying the hydraulic circuit" on page 477).

Fill the hydraulic circuit (see chapter "Filling the hydraulic circuit" on page 472).

Disposing of old equipment

Scrapping operations must be handled by specialized personnel with suitable skills for the job.

In accordance with the applicable regulations, all individual components must be collected separately for disposal according to their chemical properties when dismantling the machine.

With reference to the European Directive (RAEE), electric and electronic components must either be disposed of in authorized landfill sites or the machine, complete of the said parts, must be returned to the dealer in case of a new purchase.

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.

Control with MLD

Pressure control

The differential pressure between the machine's intake and its outlet has to be kept at a constant rate (1.5 bar, for example) so that the flow to the devices to be cooled can be easily set.

To control the pressure, the pump speed is varied based on the intake/outlet differential pressure.

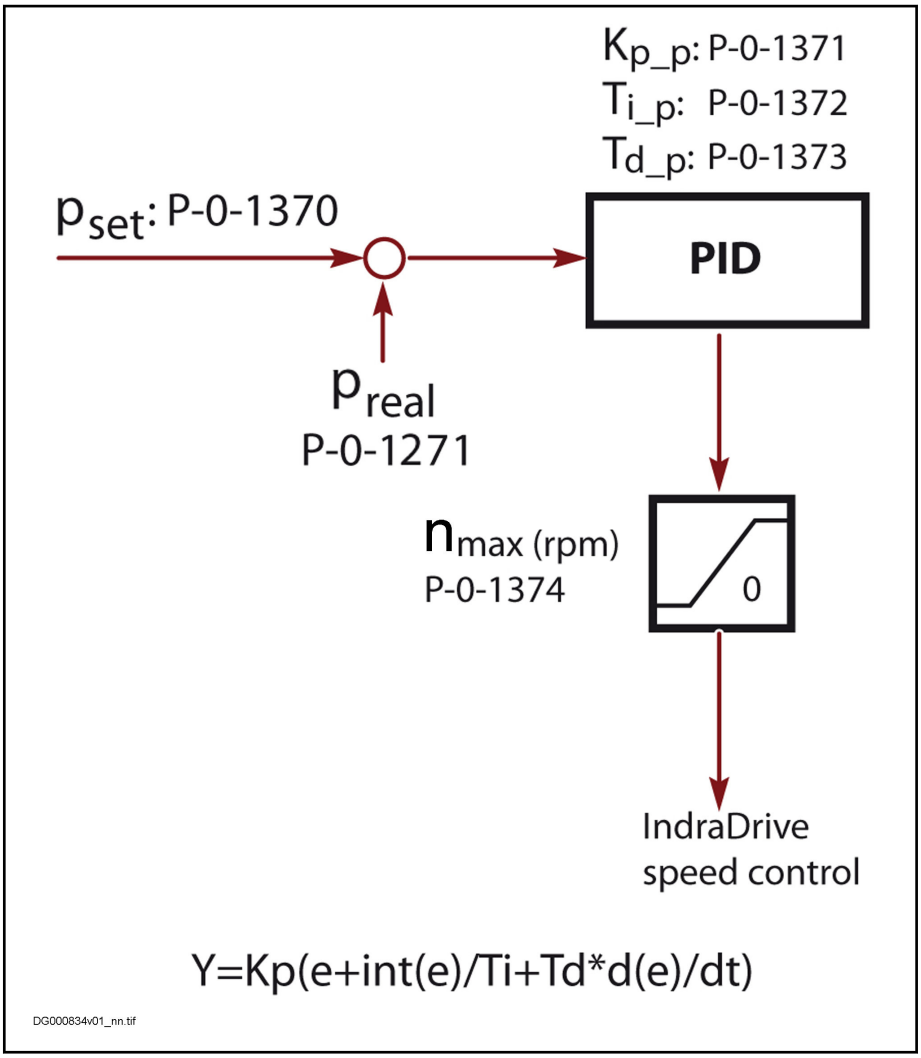


Fig. 8-133: Pressure control

Name	Parameter	Unit
p_{set}	P-0-1370	bar
K_{p_p}	P-0-1371	min^{-1}/bar
T_{i_p}	P-0-1372	s
T_{d_p}	P-0-1373	s

Name	Parameter	Unit
n_{max}	P-0-1374	min^{-1}
p_{real} (*)	P-0-1271	bar

* Read only

Tab. 8-202: Pressure control parameters

Temperature control

The temperature of the fluid in the drive circuit has to be kept at a constant value (between 40 °C and 60 °C) to prevent condensation from forming in the devices to be cooled.

The temperature of the fluid is controlled by a variable speed electric fan which cools the fluid flowing through the heat exchanger.

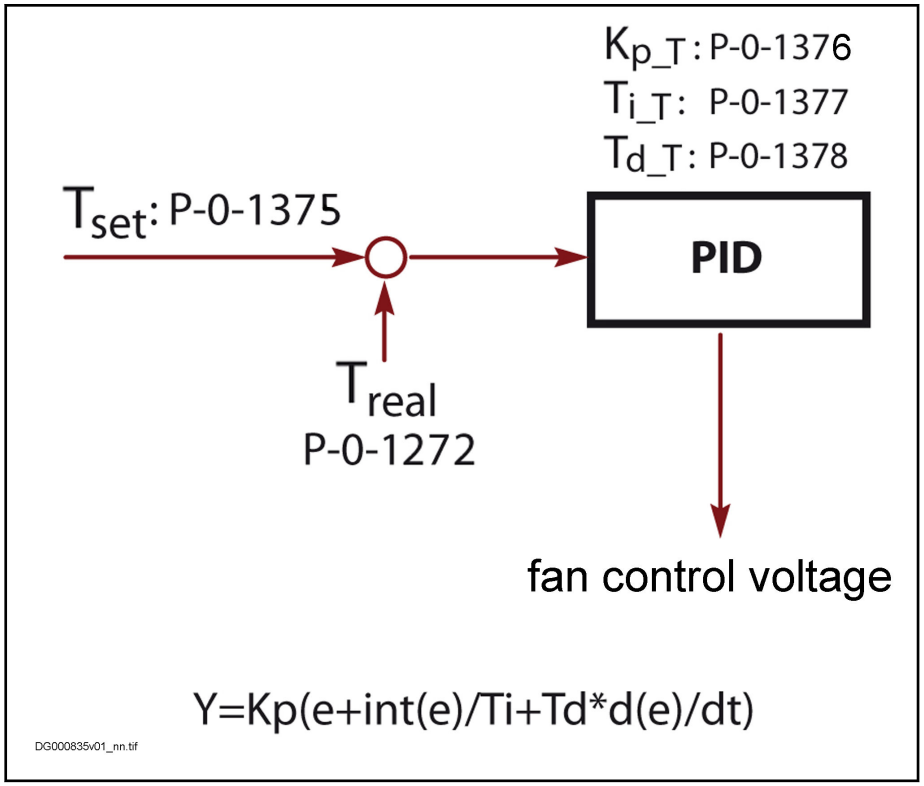


Fig. 8-134: Temperature control

Name	Parameter	Unit
T_{set}	P-0-1375	°C
K_{p_T}	P-0-1376	V / °C
T_{i_T}	P-0-1377	s
T_{d_T}	P-0-1378	s
T_{real} (*)	P-0-1272	°C
T_{real} (*)	P-0-1273	°F

* Read only

Tab. 8-203: Temperature control parameters

Starting the machine

The machine is started (as per the predefined setting) solely with the digital command:

ENABLE (X31.1, P-0-1390)

You can set the type of machine enabling (starting via digital input or starting via the communication).

Start	Parameters	Input
Start selection 1	P-0-1380	digital
Start selection 2	P-0-1381	digital
Start command via communication	P-0-1382	digital

Tab. 8-204: Start options

The parameters **P-0-1380 and P-0-1381** can be set to "0" or "1".

If both parameters are set to the **same value** (0 or 1), the machine can be started via the digital input with **P-0-1390** (0 = off, 1 = on).

If both parameters are set to **different values**, the machine can be started via the communication with **P-0-1382** (0 = off, 1 = on).

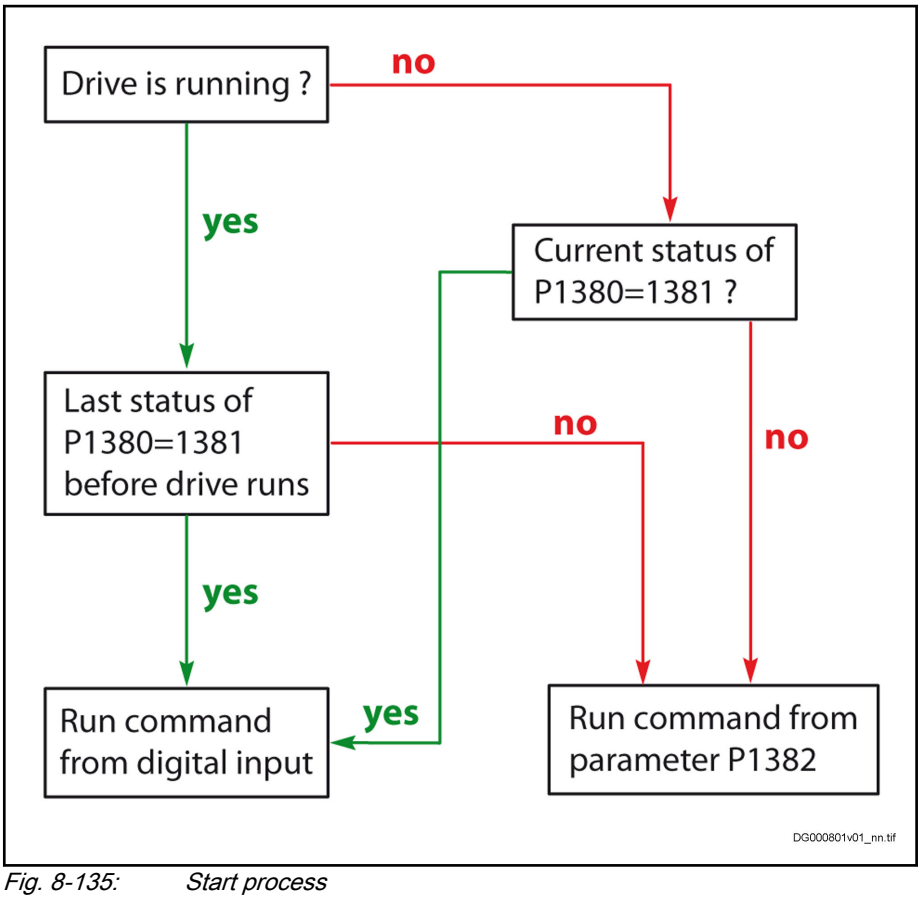


Fig. 8-135: Start process

Example: By setting the parameter P-0-1380 as a digital input and monitoring the parameters P-0-1381 and P-0-1382 via the PLC, the power-up command

for the machine can be transmitted either via the digital input or the PLC, from two different workstations.

Parameters

Name	Parameter	Unit	Minimum value	Maximum value	012-020	020-090	035-090
p_{set} (pressure command value)	P-0-1370	bar	0	2.0	1.5	1.5	1.5
K_p (pressure control)	P-0-1371	min^{-1}/bar	0	10000	40	40	40
T_i (pressure control)	P-0-1372	s	0.0	1000.0	0.05	0.05	0.05
T_d (pressure control)	P-0-1373	s	0.0	1000.0	0.0	0.0	0.0
n_{max}	P-0-1374	min^{-1}	0	8000	3000	3000	3000
Temperature setpoint	P-0-1375	°C	0	60	50	50	50
K_p (temperature control)	P-0-1376	V / °C	-1000.0	0.0	-0.5	-0.5	-5.0
T_i (temperature control)	P-0-1377	s	0	10000	10	10	40
T_d (temperature control)	P-0-1378	s	0.0	1000.0	0.0	0.0	0.0
Start selection 1	P-0-1380	-	0	1	0	0	0
Start selection 2	P-0-1381	-	0	1	0	0	0
Start command via communication	P-0-1382	-	0	1	0	0	0
p_{set_2} (pressure command value 2)	P-0-1385	bar	0.0	2.0	0.2	0.2	0.2
Control word switching to p_{set_2}	P-0-1295	bit	-	-	0	0	0
High temperature warning differential value	P-0-1316	°C	0	20	10	10	10
High temperature warning time	P-0-1317	s	0	100	3	3	3
Overtemperature limit value	P-0-1318	°C	40	100	90	90	90
Starting temperature control cabinet fan	P-0-1319	°C	0	70	50	50	50
Tolerance pressure control	P-0-1320	bar	0.0	10.0	0.5	0.5	0.5
Low motor velocity - deceleration	P-0-1321	s	0	100	5	5	5

Tab. 8-205: Parameters

Name	Parameter	Unit	Type *	Scaling
Analog I/O monitoring parameters (read-only)				
Fan control voltage	P-0-1270	V	AO	0-10 V, 0-100%
Pressure difference pump	P-0-1271	bar	-	-
Cooling water temperature	P-0-1272	°C	-	-
Cooling water temperature	P-0-1273	°F	-	-
Pressure sensor	P-0-1280	V	AI	0-10 V, 0-6 bar
Temperature sensor	P-0-1281	V	AI	0-10 V, -50-100 °C
Digital I/O parameters				
Drive enable	P-0-1390	bit 0	DI	
Pressure monitoring > 0.5 bar	P-0-1391	bit 0	DI	
Pressure monitoring > 0.2 bar	P-0-1391	bit 1	DI	
Fan monitoring	P-0-1391	bit 2	DI	TRUE for "Fan OK"
Status word machine	P-0-1410			
Cooler is running	P-0-1410	bit 0		Start command + P-0-1410.4 + no warning + no error
Pressure command value attained	P-0-1410	bit 1		abs(P-0-1370 - P-0-1271) < P-0-1320
Cooler is running (warning ignored)	P-0-1410	bit 3		Start command + P-0-1410.4 + no error
Motor is running	P-0-1410	bit 4		Motor velocity (S40) ≥ 360
Drive warning	P-0-1412	bit 0	DO	"high" for no warning
Drive error	P-0-1412	bit 1	DO	"high" for no error
Heater enable	P-0-1412	bit 2	DO	
Fan enable	P-0-1412	bit 3	DO	
Housing fan enable	P-0-1412	bit 4	DO	

* AI: analog input; AO: analog output; DI: digital input; DO: digital output

Tab. 8-206: Parameters

Switching the pressure command value

The pressure command value can be switched via control word (P-0-1295.0). This function can be used for a more economical operation (lower energy consumption, less wear) if the new pressure command value is set to a lower value.

Pressure command value (p_{set})	P-0-1370
Pressure command value 2 (p_{set_2})	P-0-1385
Control word	P-0-1295.0
P-0-1295.0 = 0	Pressure command value: P-0-1370
P-0-1295.0 = 1	Pressure command value: P-0-1385

Tab. 8-207: Switching the pressure command value

With a pressure command value of 0.2 bar instead of 1.5 bar, laboratory measurements showed energy savings of 92% (40 W instead of 500 W). The motor speed decreased from 2200 min^{-1} to 760 min^{-1} resulting in a longer service life of the motor.

Cabinet fan control

The cabinet fan control only applies to devices with cabinet heating (HAH02.1-WAxxx-xxx-xx-xx-**2**)

The cabinet fan will be turned on if the cabinet temperature (S-0-0384) is higher than the value in P-0-1319.

The cabinet fan will be turned off if the cabinet temperature (S-0-0384) is 5 °C/°F lower than value in P-0-1319.

Air-water heat exchanger (WA020-090)

Technical information

General description of the machine

The machine is designed and manufactured for the purpose of cooling devices or equipment using a liquid solution made of glycol and demineralized water.

The underlying principle of the cooling method is the exchange of heat between air and water by means of a heat exchanger.

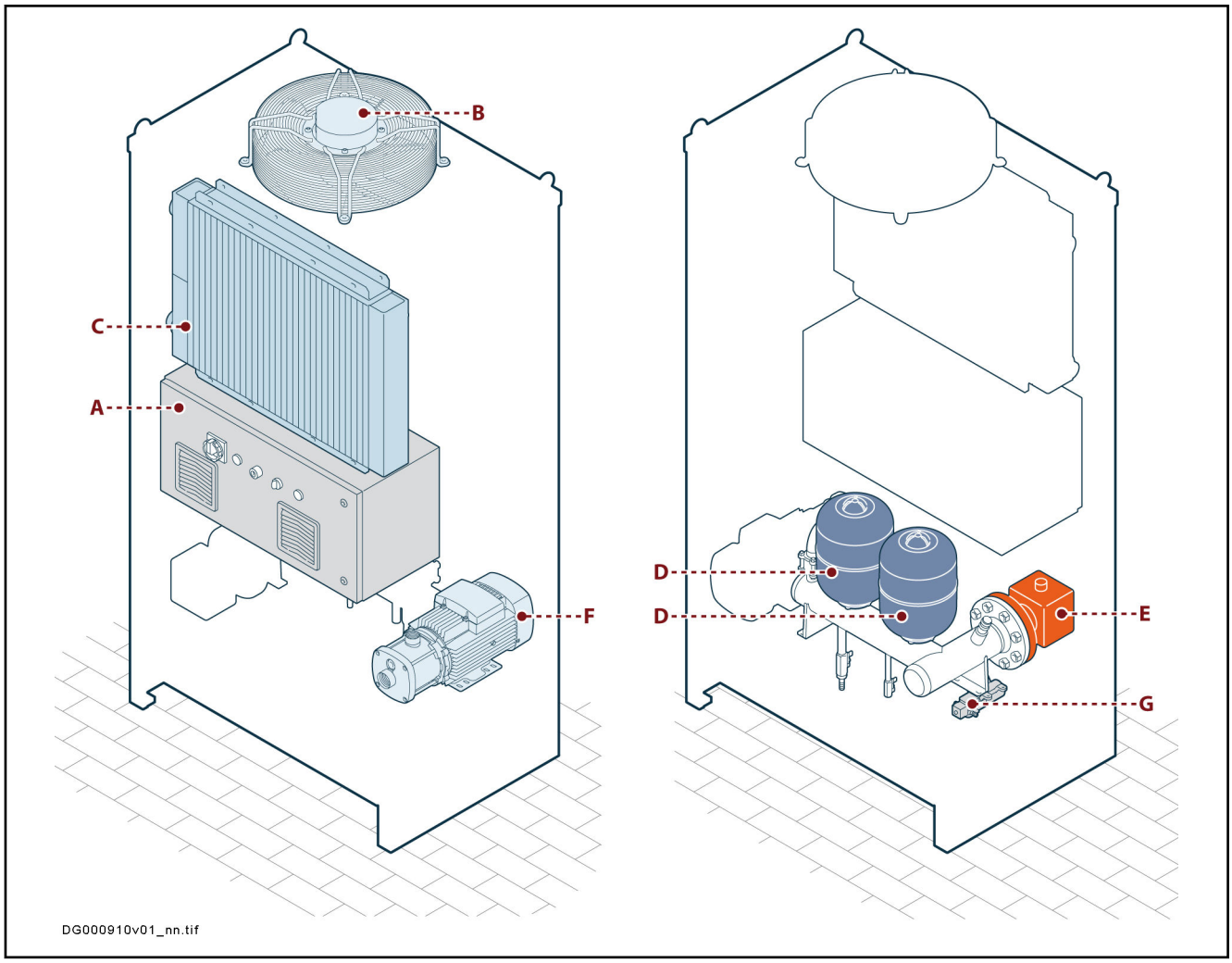
The liquid is circulated by a pump in the cooler and cooled by an air flow generated by an electric fan.

The machine is equipped with a heater in order to increase the temperature of the inflowing liquid.

Pressure and temperature control is done via IndraMotion MLD, the drive-integrated Motion Logic Control according to IEC 61131-3. See chapter "Control with MLD" on page 488.

See also chapter "Liquid Cooling" on page 53.

Main parts

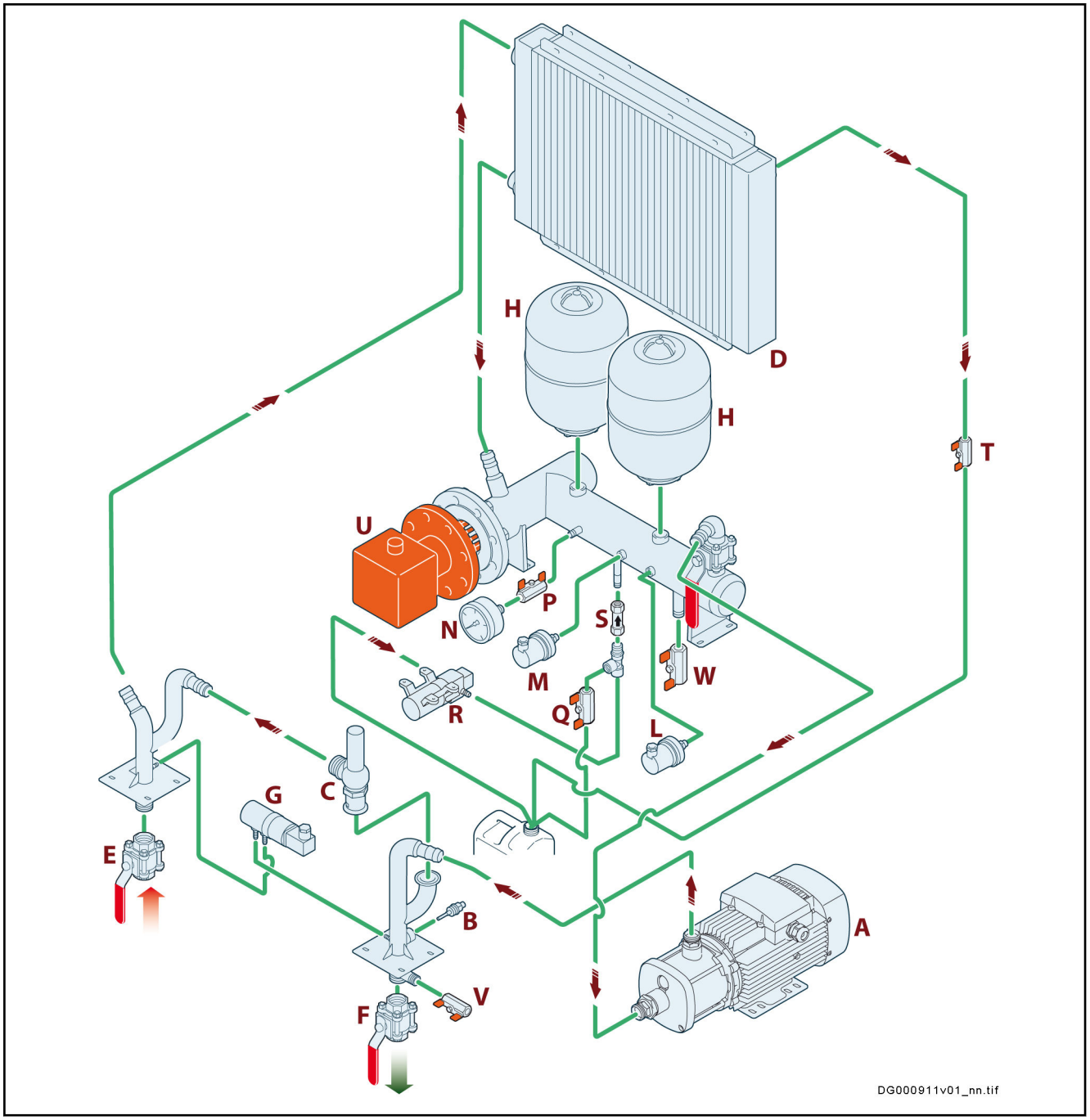


A	Terminal box
B	Electric fan
C	Heat exchanger
D	Expansion tank
E	Heater
F	Main pump
G	Filling pump

Fig. 8-136: Main parts

Operational cycle and component description

The following figure shows the principle of operation.



A	**Main pump:** Circulates the coolant in the hydraulic circuit.
B	**Temperature sensor:** Detects the coolant temperature in the outlet pipe.
C	**Bypass valve:** Limits the pressure of the output cooling liquid.
D	**Heat exchanger:** Lowers the temperature of the coolant.
E	**Ball valve:** Regulates the flow of the coolant from the owner's system.
F	**Ball valve:** Regulates 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 outlet pipe.
H	**Expansion tank:** Ensures constant pressure in the circuit.

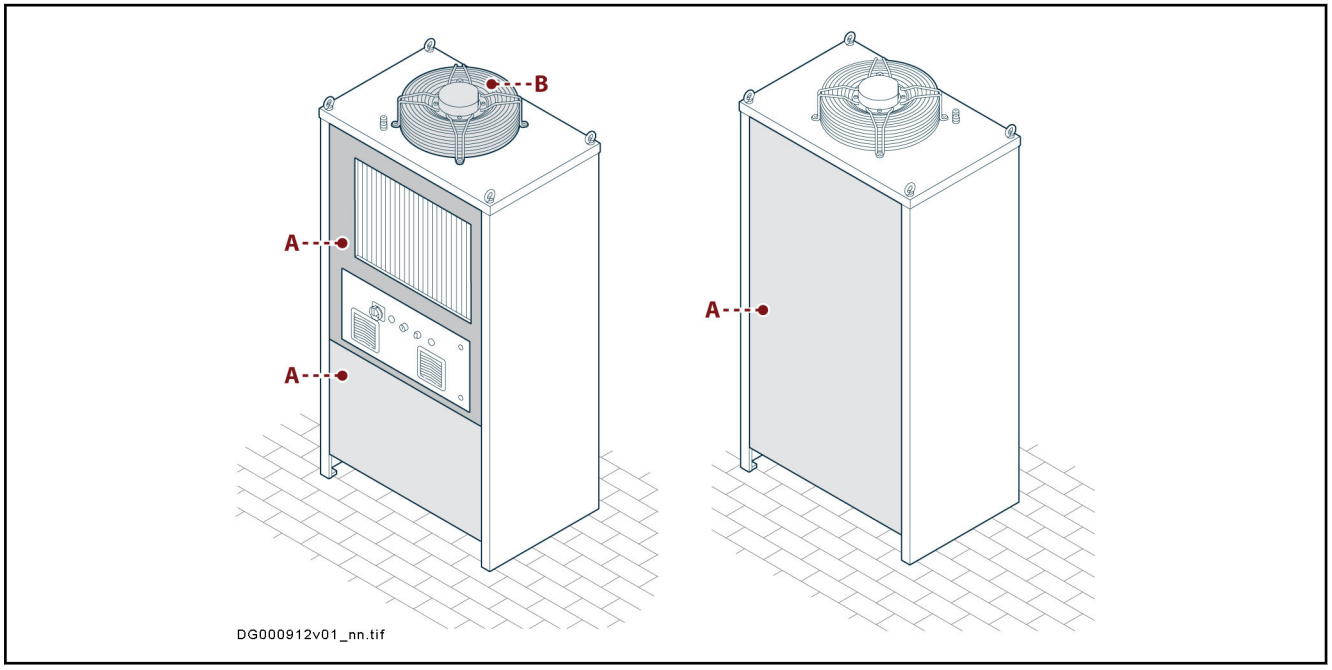
L	**Pressure switch (0.2 bar):** This detects the pressure level in the intake manifold.
M	**Pressure switch (0.5 bar):** This detects the pressure level in the intake manifold.
N	**Pressure gauge:** Detects the fluid pressure in the intake manifold.
P	**Valve:** Regulates the flow towards the pressure gauge (**N**).
Q	**Valve:** This is used to release any backpressure in the filling pump delivery line and facilitate priming.
R	**Filling pump:** Fills the cooling circuit.
S	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.
T	**Valve:** Air release valve
U	**Heater (optional):** Heats the liquid if the heat interchanger is operated at ambient temperatures below 0°C.
V	**Valve:** Serves the emptying of the cooling circuit.
W	**Valve:** Serves the emptying of the cooling circuit.

Fig. 8-137: Operational cycle and component description

Guards

⚠ WARNING **Risk of injury!**

Never use the machine without the guards.

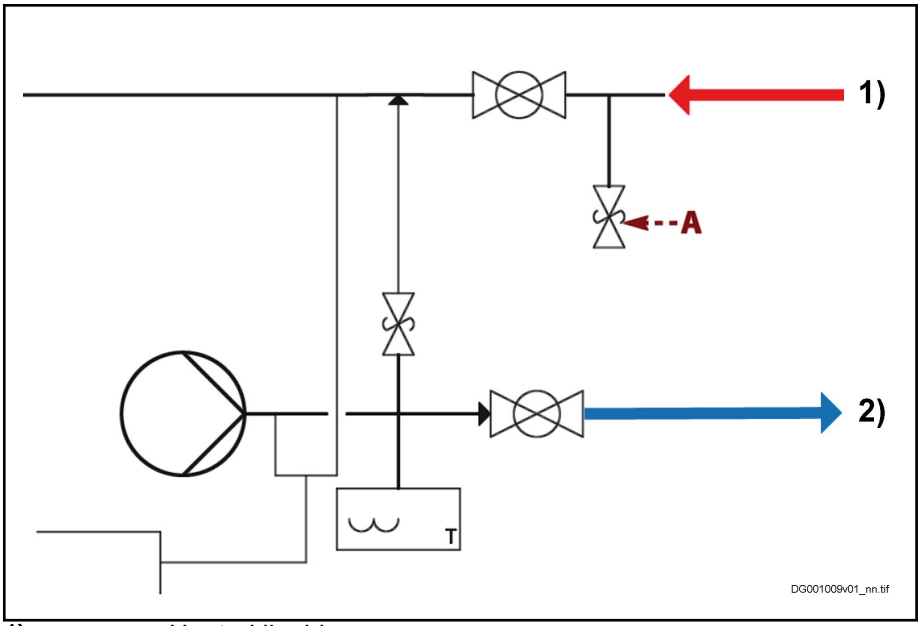


A **Guards:** Prevent unwanted access to machine parts.
B **Guard:** Prevents accidental touching of the fan.

Fig. 8-138: Guards

Overpressure devices

If additional pumps (external to the machine) are installed on the circuit or if the drop in pressure of the hydraulic load is less than 1.5 bar, the owner has to fit a pressure limiting valve. The valve has to limit the pressure to a maximum of 2 bar in the return pipe to the machine.



1) Heated liquid
2) Cooled liquid
A Pressure limiting valve

Fig. 8-139: Positioning of the pressure limiting valve (A)

Overall dimensions

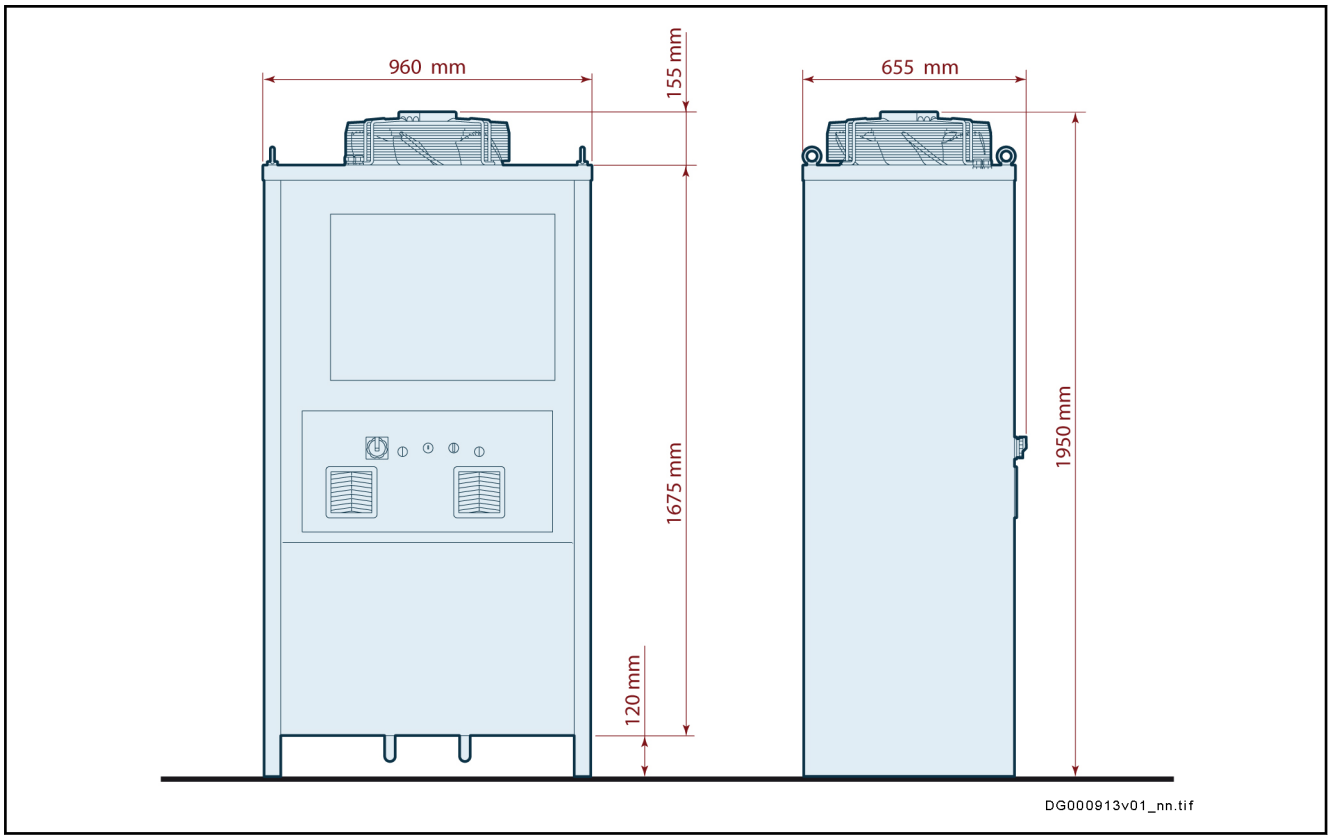


Fig. 8-140: Overall dimensions

Data

Technical data - machine

Description	Unit	Value
Power voltage	Vac	380 … 480 (±10%)
Frequency	Hz	50
Current	A	9
Maximum cooling capacity	kW	20
Maximum output flow rate	l/min	90
Maximum pressure of the inflowing coolant	bar	2
Maximum pressure of the outflowing coolant	bar	4,5
Maximum coolant temperature	°C	70
Minimum coolant temperature	°C	-40
Drive circuit coolant (monoethyl glycol and demineralized water solution) See also chapter "Liquid Cooling" on page 53.	-	20% glycol
Estimated amount of coolant (heat exchanger only)	l	approx. 50
Maximum installation altitude	m	2000
Ambient temperature*	°C	-+40 … +45
Relative humidity without condensation	%	95
Weight (heat exchanger)	kg	350
Weight (heat exchanger + packaging)	kg	440

* At temperatures below 0°C, the heating in the control cabinet must be switched on even if the machine is not running.

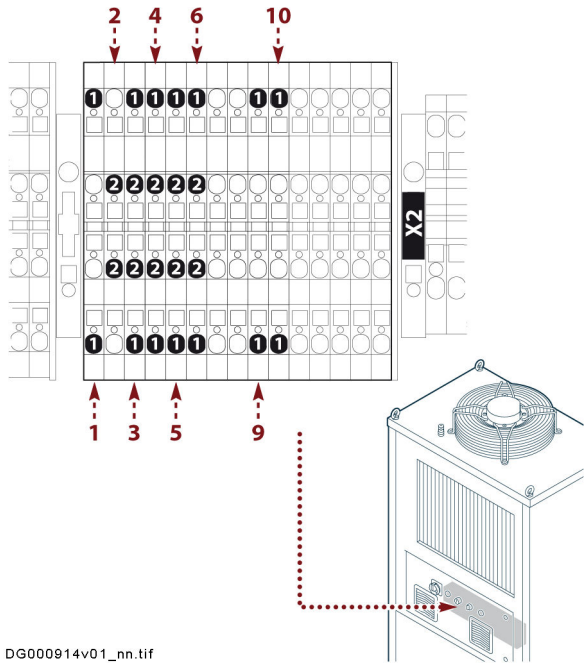
Tab. 8-208: Technical data - machine

ENABLE, UNIT ERROR and UNIT WARNING connections

The signals for releasing the relative machine status using the owner's operator terminal are transmitted via the terminal block shown.

Connect the lines to the terminals shown in table "Connecting the terminals".

Terminal box X2

Pos.	Significance	Terminals
9.1 - 2.2	Terminals for machine enabling via the owner's operator terminal (ENABLE)	
3.1 - 3.2 4.1 - 4.2	Machine error signal terminals Closed contact: no error	
5.1 - 5.2 6.1 - 6.2	Warning signal terminals Closed contact: no warning	
10.1 - 1.1	Terminals for remote-controlled alarm reset.	

Tab. 8-209: Connection terminals (terminal box X2)

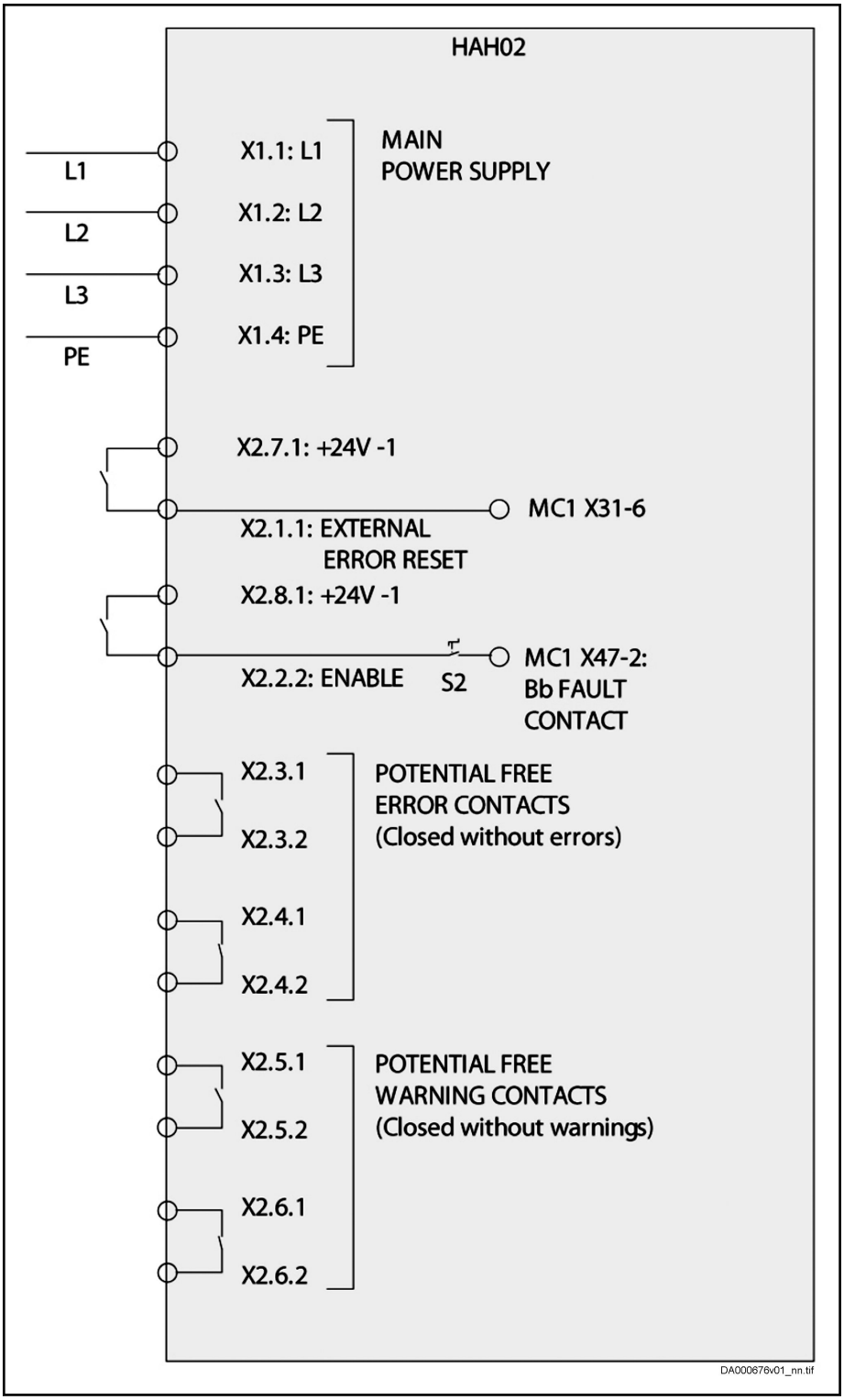
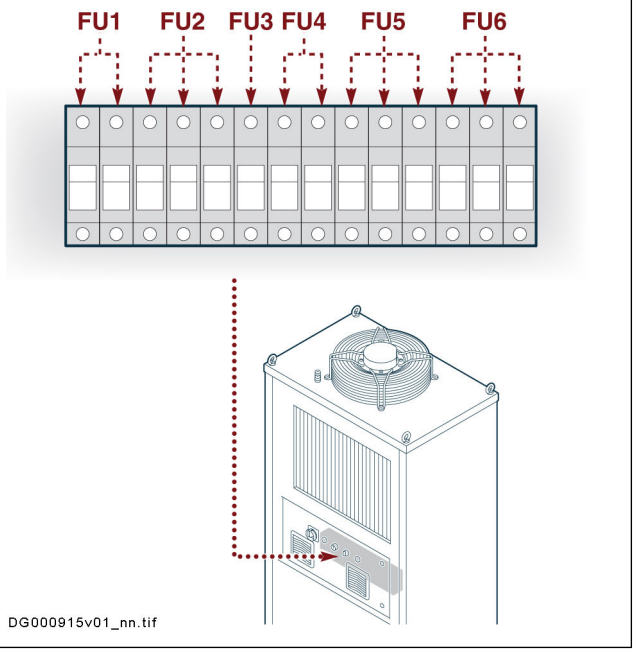


Fig. 8-141: Wiring diagram

Description of the fuses

Name	Current (A)	Type	Rated voltage (Vac)	Interrupting capacity (kW)	Fuse	Position
FU1	1	CC	600	200	Delayed	
FU2	6					
FU3	4					
FU4	1					
FU5	4					
FU6	10					

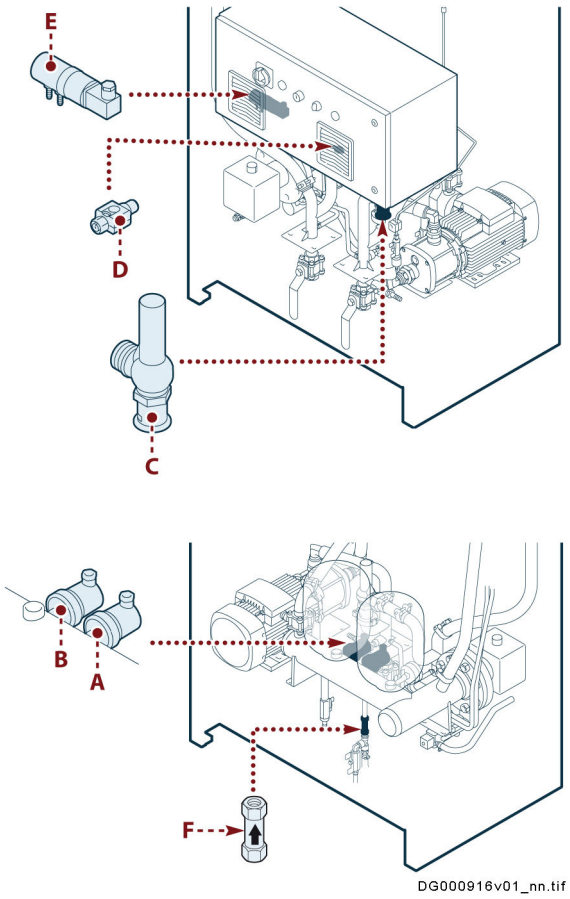
Tab. 8-210: Fuses

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 signaled 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 signaled when the pressure falls below 0.2 bar and stops machine operation.
C	**Bypass valve:** Keeps the fluid pressure in the outlet pipe within the maximum limit allowed.
D	**Temperature sensor:** 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 outlet pipe. The pressure in the outlet pipe is kept constant with the sensor.
F	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.



Tab. 8-211: Processing and protection devices

Ambient conditions for operation

The machine works properly at the specified ambient conditions (see chapter "Data" on page 502).

Intended use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

The machine must be used in accordance with its technical characteristics. It is not permitted to make changes or to use the machine for purposes other than those for which it was intended.

The machine must only be used indoors.

Any other use than that specified, or not included or inferable from this manual, should be considered mishandling and therefore not permitted.

Unintended and unauthorized uses

It is not permitted to use coolants with properties other than those specified by the manufacturer.

It is not permitted to use machines in a flammable or explosive environment.

Commissioning of the machine is only permitted if it is ensured that the system or the machine in which it is installed complies with national and local regulations.

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.

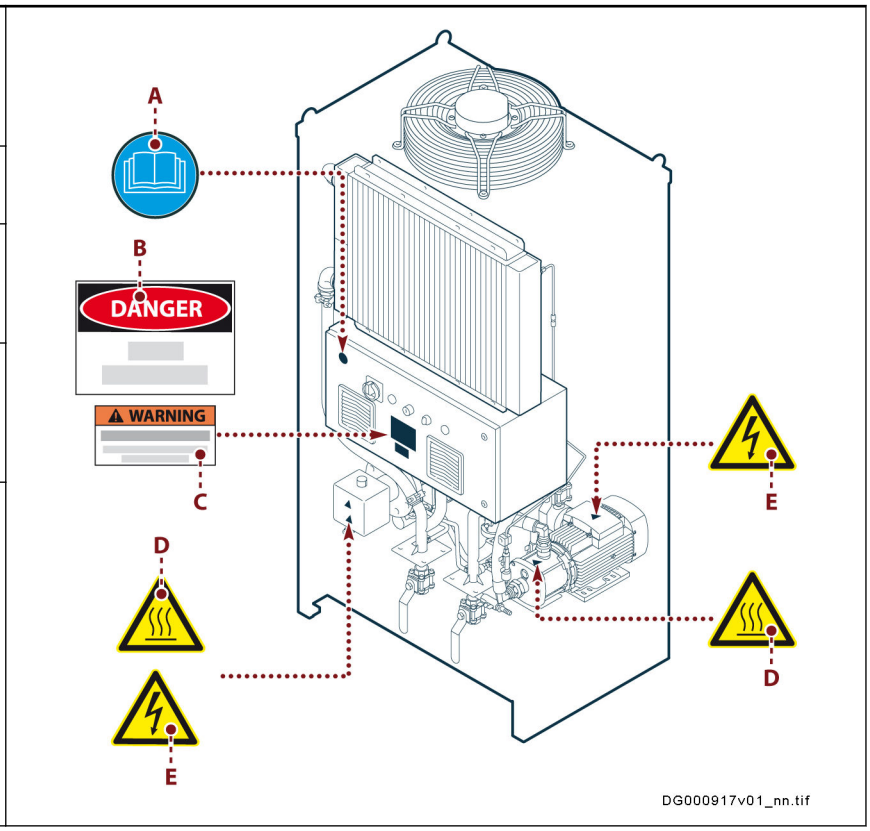
Thermal risk: Contact with hot surfaces can cause burns. Allow the machine to cool down before any operation.

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 one.

A	This indicates the obligation for operators to read the instruction manual before operating the machine.
B	This shows that the voltage inside the terminal box is hazardous.
C	Risk of death or severe injury. Disconnect the machine from the voltage mains prior to operation.
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	Risk of electric shock



Tab. 8-212: Information and safety signs

Transporting and installing

Transport and installation safety recommendations

Personnel responsible for transport of the load must have the required qualification and experience and must be trained in handling the lifting gear used.

Use lifting gear with suitable load capacity in order to lift and move the load.

Persons authorized for transport must take appropriate measures to ensure their own safety and the safety of persons directly involved.

Place the package on a stable surface.

Do not place packed machines on top of each other as they are not intended for stacking.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents. In case items are damaged or missing, contact the importer or the manufacturer directly to discuss the procedure to be adopted.

Package description

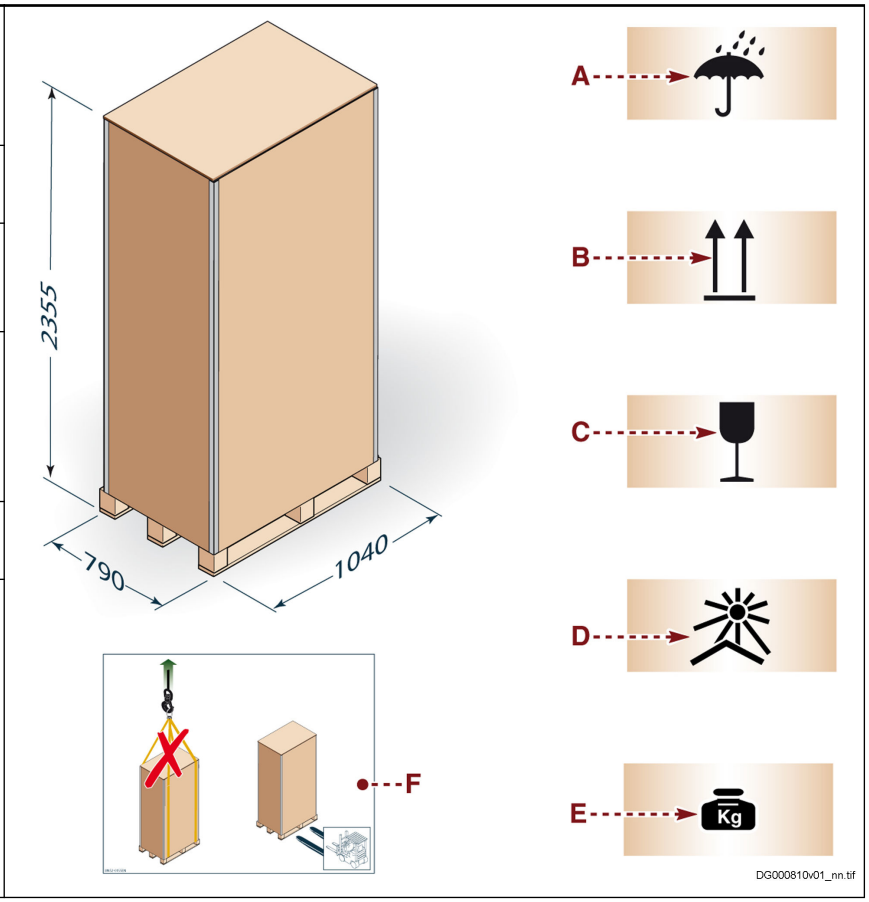
The packaging is selected according to the selected means of transport and the destination.

Packages can either be loaded directly onto a means of transport or into suitable containers if shipped by sea or air or to far-off destinations.

In order to facilitate transport, some components are removed and properly protected.

The figure shows the type of packaging most frequently used and the maximum dimensions as well as the warning symbols and notices attached 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 overall weight of the package.
F	The plate shows the procedure for lifting the package.



Tab. 8-213: Package description

Transporting and lifting the packed machine

The figure shows how to lift the package.

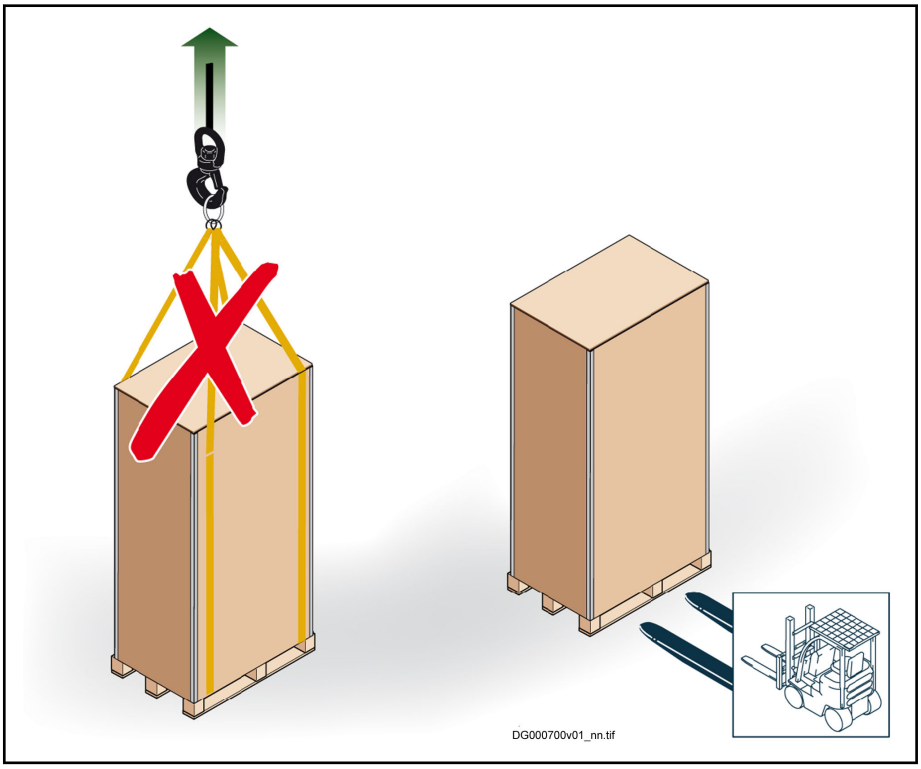


Fig. 8-142: Transporting and lifting the packed machine

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 +55 °C.

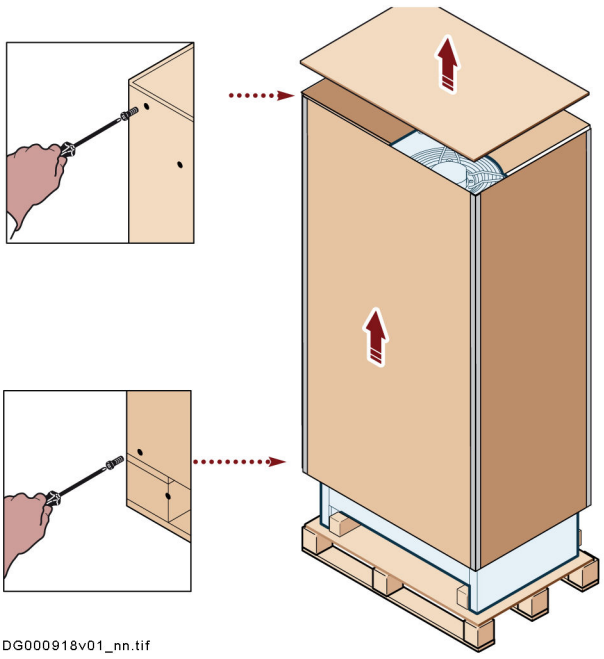
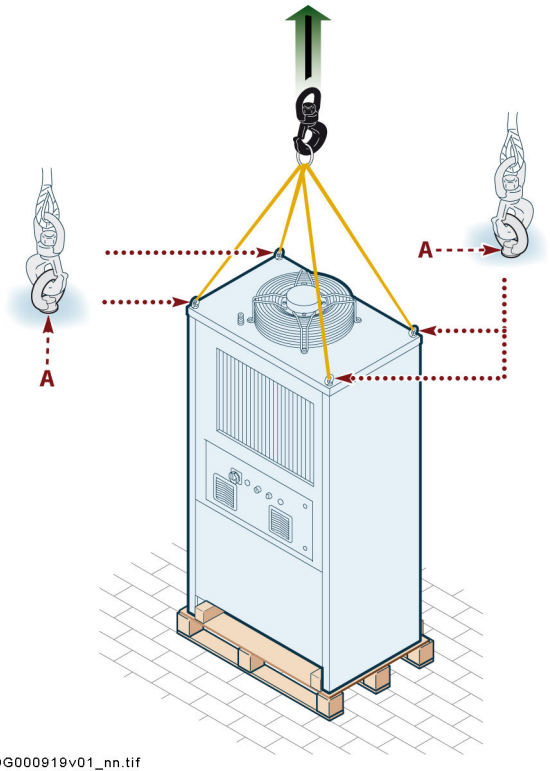
Avoid storing the machine in places where weather conditions could prejudice its good working order.

Unpacking

It is advisable to unpack the machine near the installation area to facilitate assembly.

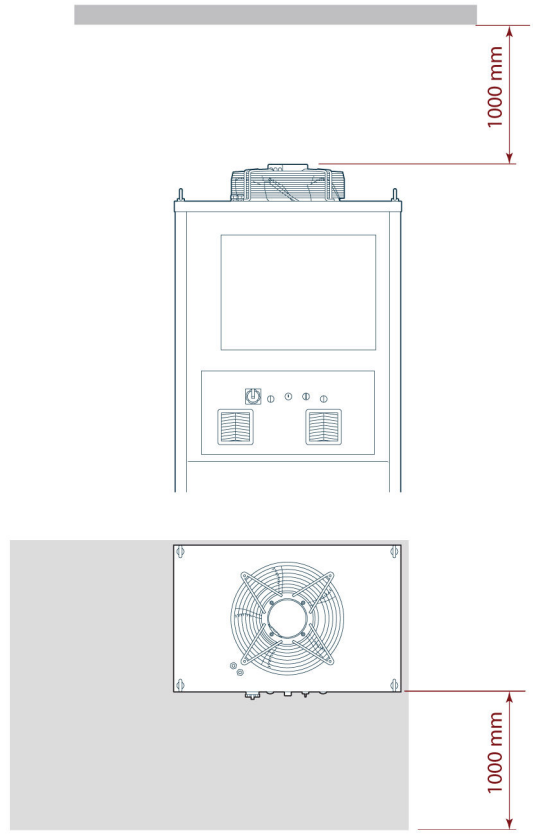
The figure shows how to unpack the machine properly.

Proceed as described.

1	Unscrew the screws.	
2	Remove the cover.	
3	Lift the side walls of the packaging.	
4	Tighten the eyebolts (**A**) supplied.	
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. 8-214: Unpacking

Installation

Installation area The installation area must be flat and horizontal and correspond to the default load factor. Electrical connections as well as the possibility of transmitting the signals "UNIT ERROR" - "UNIT WARNING" must be available. Furthermore, all hydraulic connections must be available in accordance with legal regulations. According to the relevant regulations concerning health and safety at the working place, the area must have sufficient ventilation and lighting. Make sure that there is enough space around the installation area so that all work can be carried out safely. The figure shows the minimum space required around and above the machine to ensure sufficient ventilation.	

Tab. 8-215: Installation area

Electrical connection

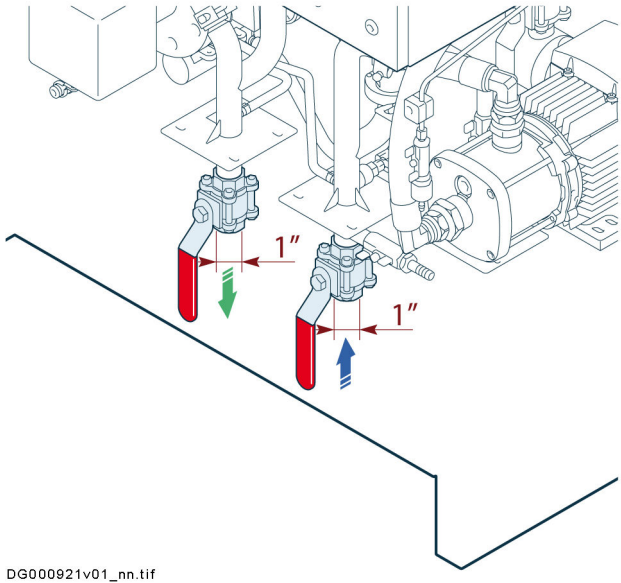
Electrical connections must be executed according to the manufacturer's specifications in the wiring diagram.

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 + equipment grounding conductor).

Connect the three phases (L1, L2, L3) and the equipment grounding conductor to the relevant terminals inside the terminal box.

Hose connections

The owner has to install a pressure regulating device in the return pipe. Set the pressure in the intake and return pipes to the values shown in chapter "Data" on page 502. 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. 8-216: Hose connections

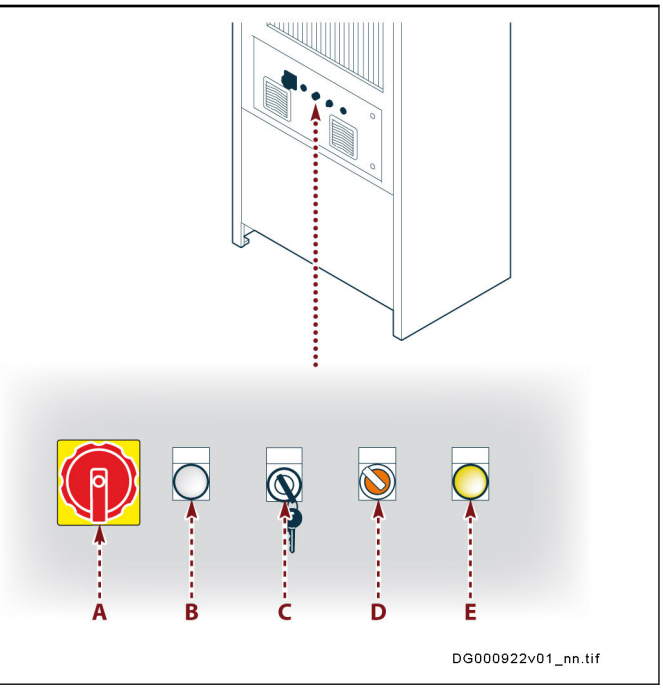
Use

Safety advice for use

Before starting the machine, ensure that the system or the machine in which it has been fitted complies with applicable local regulations and directives.

Control elements and indicator lamps

A	**Main 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 has been enabled.
C	**Key-operated two-position stay-put selector switch:** This is used to switch the main pump operation on and off. The key has to 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	**Indicator lamp (yellow):** Shows automatic shutdown of the heater triggered by overtemperature of the liquid solution.



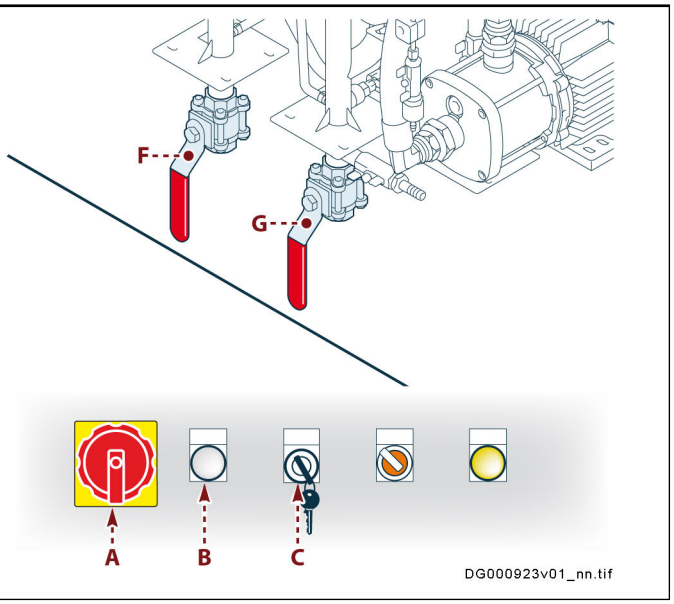
Tab. 8-217: Control elements and indicator lamps

Switching on

At temperatures below 0°C, the heating in the control cabinet must be switched on even if the machine is not running.

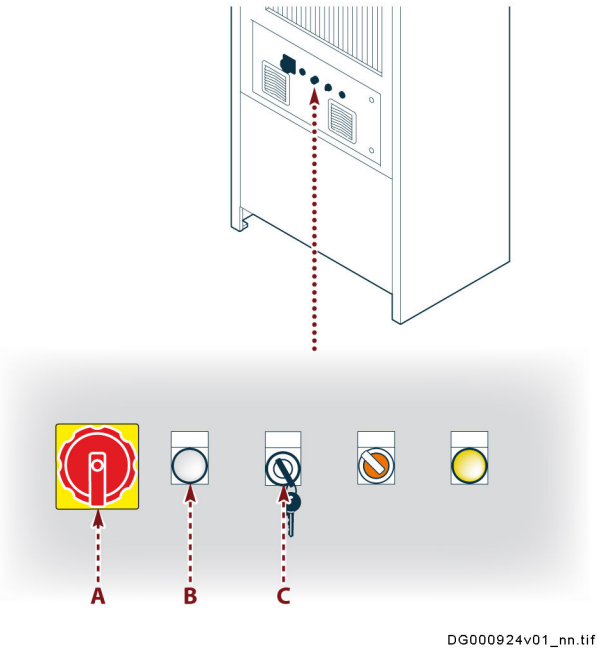
During the first run-up, carry out the circuit filling procedure (see chapter "Filling the hydraulic circuit" on page 517).

To start the machine, proceed as follows.

1	Open the ball valves (**F - G**).	
2	Turn the main switch (**A**) to the "ON" position. The indicator lamp (**B**) lights up.	
3	Turn the key selector (**C**) to "automatic" position. Machine start-up has to be performed using the operator terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR and UNIT WARNING connections" on page 503).	

Tab. 8-218: Switching on

Switching off

Switching off with the main switch 1. Turn the main switch (**A**) to the "OFF" position. • The indicator lamp (**B**) will switch off. • Machine operation stops and the voltage supply to the terminal box is interrupted. • The supply terminals remain live.	
Switching off with the key-operated switch This switch-off mode is reserved for authorized 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 terminal box at the machine remains live.	
Remote-controlled switch-off • Remote-controlled switch-off has to be performed using the owner's operator terminal, via the "ENABLE" connection. • Operation of the main pump stops. • The terminal box at the machine remains live.	
Switching off automatically • The machine switches off automatically if the pressure in the circuit falls below 0.2 bar and the temperature of the liquid exceeds the preset limit (see parameter P-0-1318).	

Tab. 8-219: Switching off

Switching off in emergency conditions

To switch off the device in the event of imminent danger (emergency stop), turn the main switch (**A**) to the "OFF" position.

Fix the cause for the emergency stop before restarting the machine.

Filling the hydraulic circuit

Check if the installation as well as electrical and hydraulic connections are executed professionally in accordance with the manufacturer's specifications.

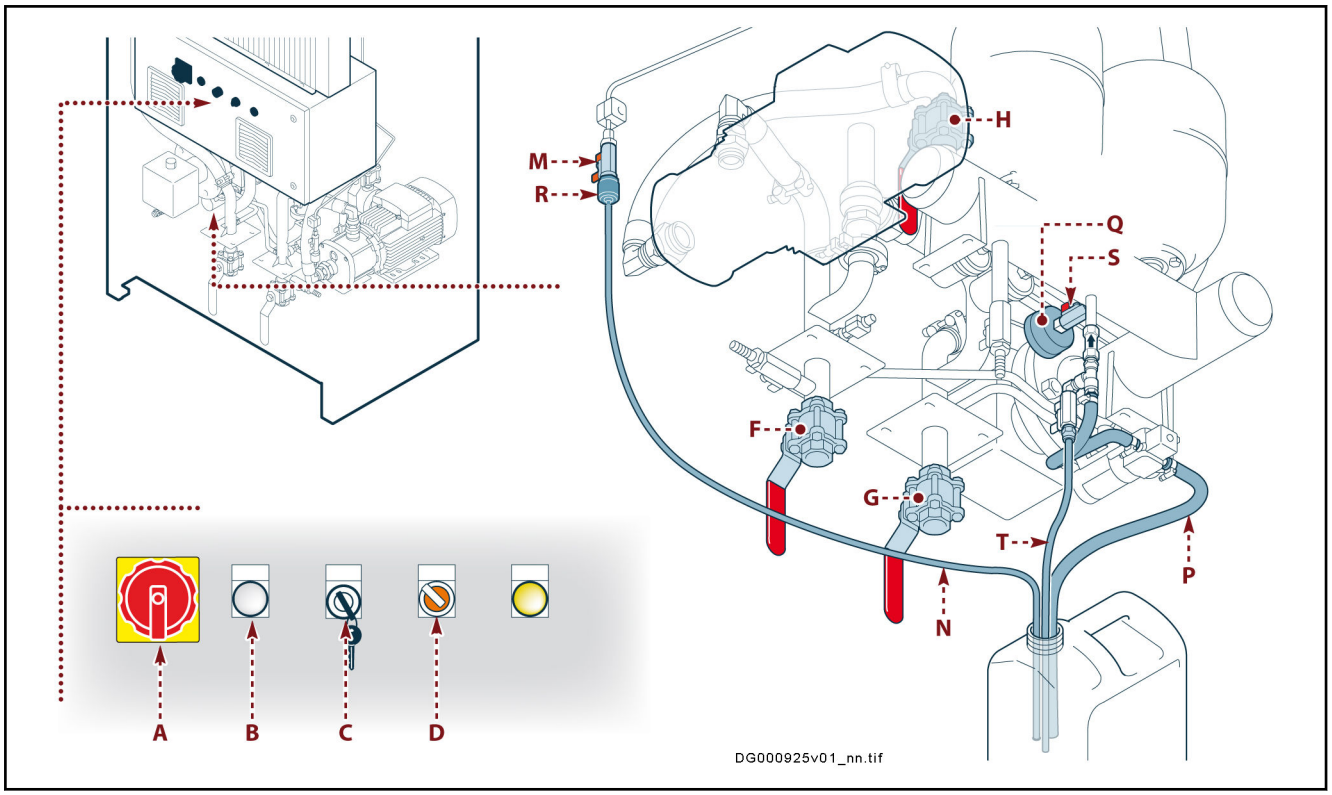


Fig. 8-143: Fill the hydraulic circuit

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 502).
2. Fit the pipes (**P - N - T**) into the tank.
3. Open the ball valve (**G**).
4. Open the ball valve (**F**).
5. Open the valve (**M**).

   If there is no liquid coming, clean the connector (**R**). See chapter "Cleaning the connector of the bleed valve" on page 524.
6. Open the ball valve (**H**).
7. Open the valve (**S**).
8. Turn the key-operated selector switch (**C**) to the "OFF" position to prevent unexpected activation of the main pump.
9. Ensure that the remote-controlled "ENABLE" function is activated.
10. **NOTICE!** Do **not** turn the selector switch (**C**) to the "ON" position since this could cause damage to the main pump.

    Open any existing valves that are installed outside the machine on the circuit of the machine to be cooled.
11. Turn the main switch (**A**) to the "ON" position.

    The indicator lamp (**B**) lights up.
12. Turn the selector switch (**D**) to activate the filling pump.

    Make sure that there is always enough liquid in the tank.

If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 519).

13. When the fluid is running out of the clear tube (**N**) in a steady stream (no bubbles) and the pressure has reached 1.4 … 2.2 bar, turn the key-operated selector switch (**C**) to the "ON" position to activate the main pump in the automatic mode.

    The pressure is indicated on the (**Q**) pressure gauge.

    NOTICE! The filling pump is activated and deactivated automatically and keeps the pressure between 1.4 … 2.2 bar. 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. The pressure drop is caused by the air pumped into the circuit as a result of activation of the main pump. Make sure that the key-operated switch (**C**) is set to "ON".

14. Keep the main pump and the filling pump running for at least 30 minutes in order to rinse the cooling circuit thoroughly.

    NOTICE! 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.

    NOTICE! If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 519).

15. Turn the selector switch (**D**) to deactivate the filling pump.
16. Close the valve (**M**) when the pressure in the circuit has reached 1.5 bar.
17. Close the valve (**S**).
18. Remove the pipes from the tank.
19. Remove the key from the selector switch (**C**) and store in a safe place.

    After one hour of operation, check if the pressure is correct – if this is not the case, perform the restore operation (see chapter "Restore pressure" on page 520).

    NOTICE! Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Filling pump priming procedure

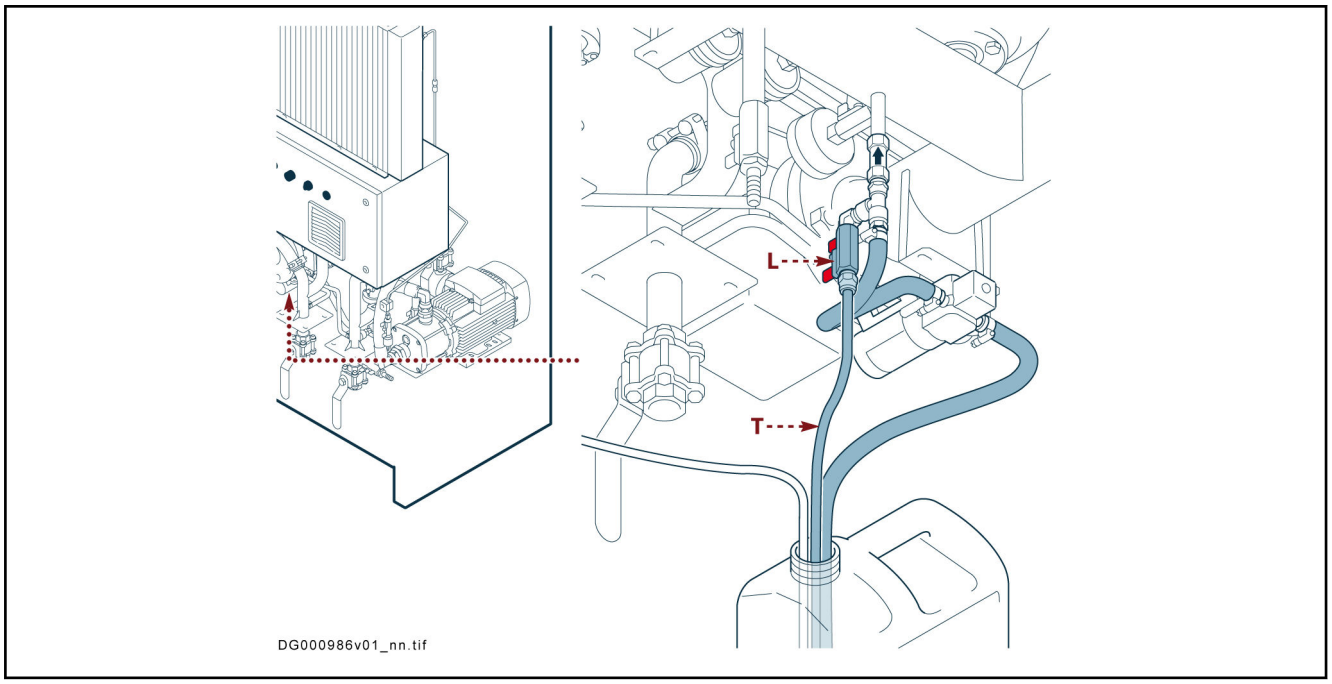


Fig. 8-144: Fill the hydraulic circuit

If the filling pump does not prime automatically, proceed as described:

1. When the filling pump is active, open the valve (**L**).
2. Wait for the coolant to start flowing out of the transparent hose (**T**).
3. Close the valve (**L**) and leave the filling pump working.

The filling pump is primed and starts pumping the coolant into the hydraulic circuit.

Restore pressure

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 "Filling the hydraulic circuit" on page 517).

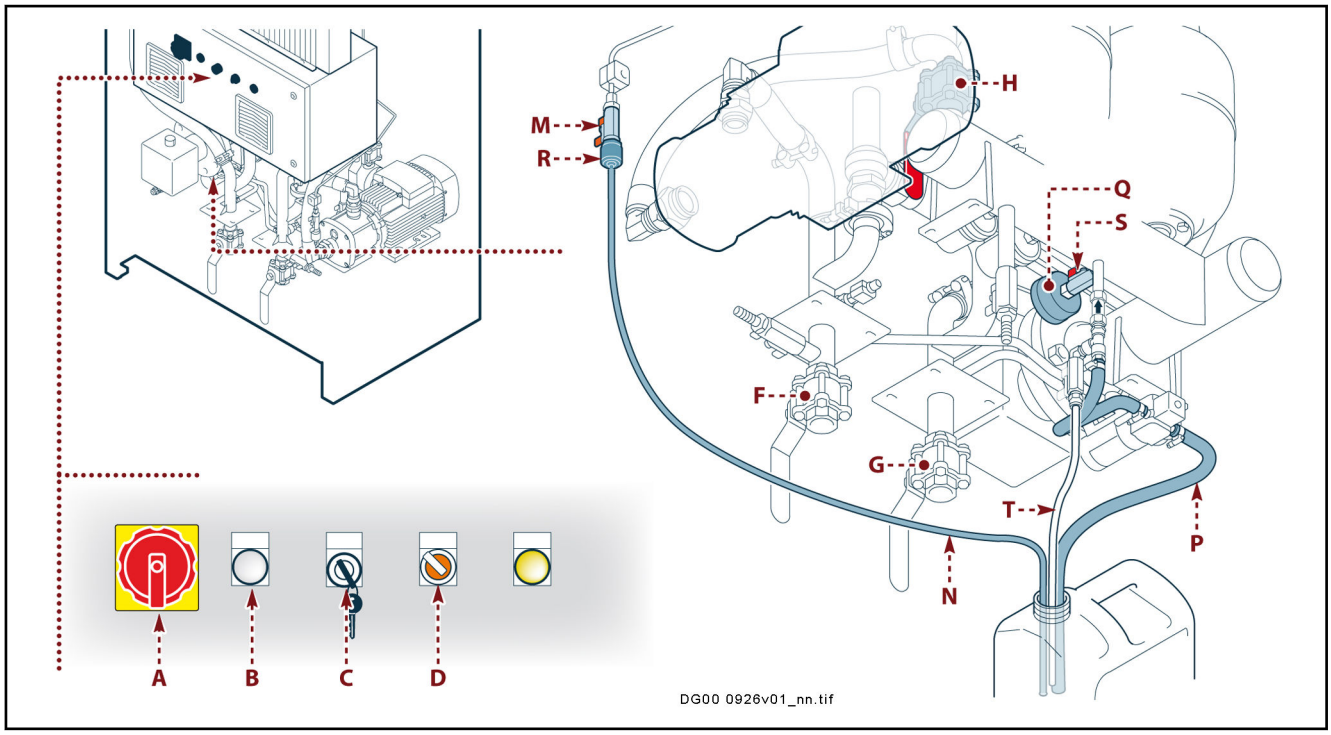


Fig. 8-145: Restoring the pressure

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 502).
2. Fit the pipes (**N - P - T**) into the tank.
3. Open the valve (**S**).
4. Turn the selector switch (**D**) to activate the filling pump. If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 519).
5. Open the valve (**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. The pressure gauge (**Q**) shows the pressure.

   If there is no liquid coming, clean the connector (**R**). See chapter "Cleaning the connector of the bleed valve" on page 524.
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.

   NOTICE! If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 519).

   Close the valve (**M**).
7. Turn the selector switch (**D**) to deactivate the filling pump.
8. Close the valve (**S**).

9. Remove the pipes from the tank.
10. Remove the key from the selector switch (**C**) and store in a safe place.

    NOTICE! Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Emptying the hydraulic circuit

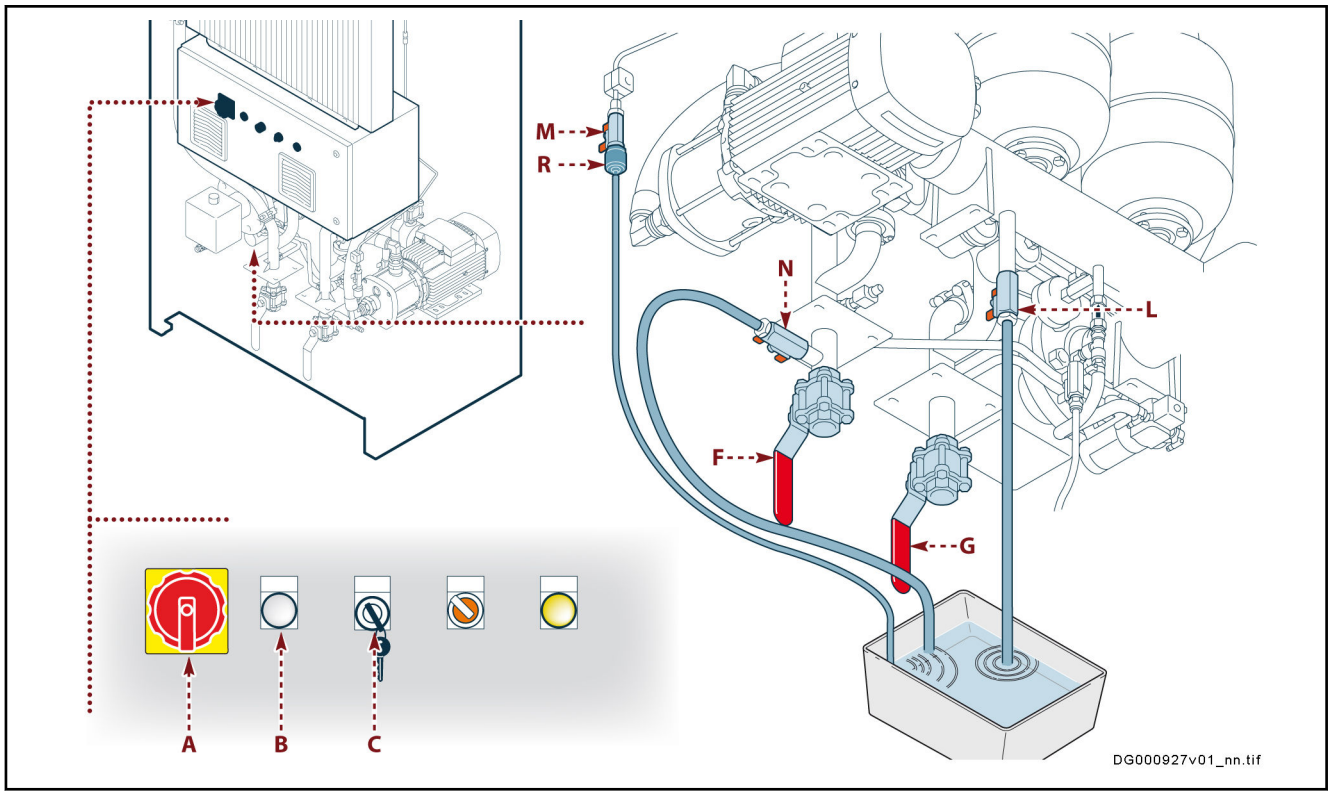


Fig. 8-146: Emptying the hydraulic circuit

1. Position a suitable container for collecting the coolant.
2. Switch off the machine (see chapter "Switching off" on page 516).
3. Turn the key selector (**C**) to the "OFF" position.
4. Turn the main switch (**A**) to the "OFF" position.
5. The indicator lamp (**B**) will switch off.
6. Close the ball valves (**F - G**).
7. Open the valve (**M**).

   If there is no liquid coming, clean the connector (**R**). See chapter "Cleaning the connector of the bleed valve" on page 524.
8. Open the valve (**L**).
9. Open the valve (**N**).
10. Drain out all the coolant.
11. Close the valve (**M**).
12. Close the valve (**L**).
13. Close the valve (**N**).

    NOTICE! Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.

Maintenance

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.
Ensure that the voltage cannot be switched on again unintentionally.
Allow the machine to cool down before any operation to prevent burns.

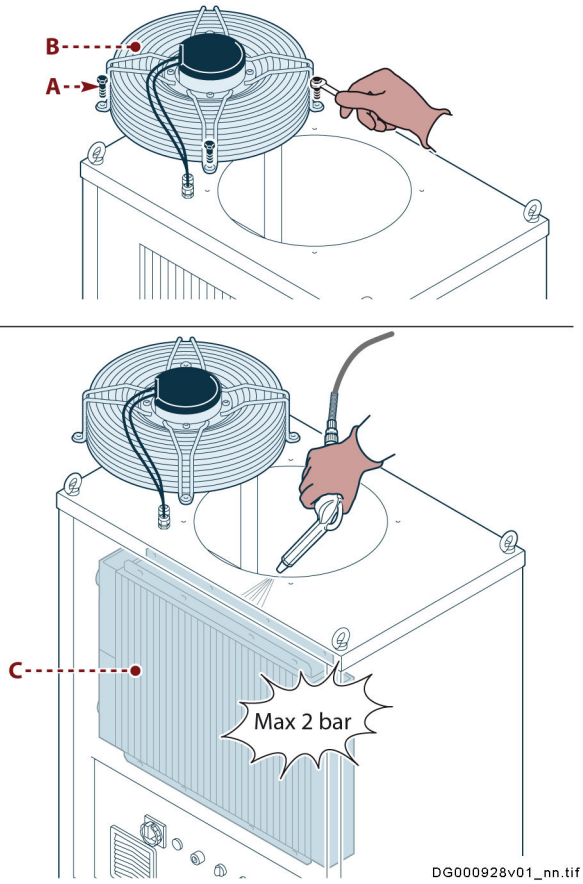
Maintenance schedule

Interval			Component	Type of work	Cross reference
Every 5000 operating hours	Every 30,000 operating hours	Every 10 years of operation	–	–	–
✓	–	–	Cooler - cooling channel	Cleaning	See chapter "Cleaning the cooler and cooling channel" on page 524
–	✓	–	Main pump	Replacement	See chapter "Replace the main pump" on page 529
–	✓	–	Cooling fan	Replacement	See chapter "Replacing the electric fan" on page 531
–	✓	–	Coolant	Replacement	See chapter "Exchanging the coolant" on page 534
–	–	✓	EPDM rubber hoses	Replacement	–

Tab. 8-220: Maintenance schedule

Cleaning the cooler and cooling channel

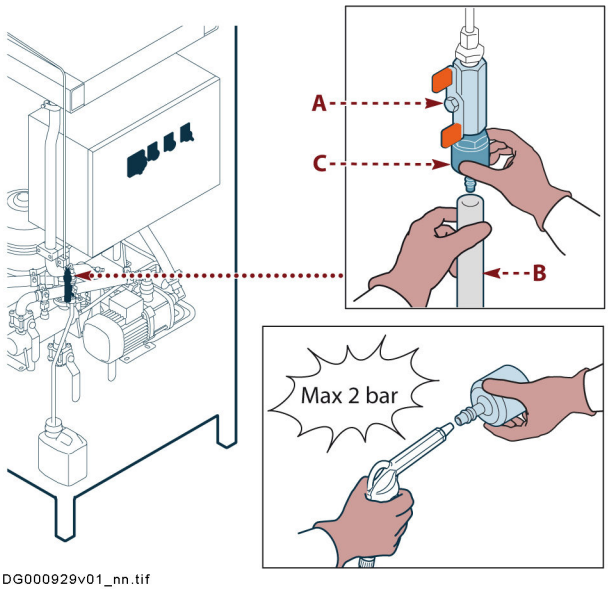
1	Disconnect the machine from the voltage source.
2	Unscrew the screws (**A**).
3	Move the fan (**B**) to the side.
4	Clean the inside of the cooler (**C**) with compressed air. Keep the pressure on the level indicated in the picture.
5	Position the fan (**B**).
6	Tighten the screws (**A**).



Tab. 8-221: Cleaning the cooler and the cooling channel

Cleaning the connector of the bleed valve

1	Close the bleed valve (**A**).
2	Remove the hose (**B**).
3	Unscrew the connector (**C**).
4	Clean the connector with compressed air. Keep the pressure on the level indicated in the picture.
5	Screw on the connector (**C**).
6	Attach the hose (**B**) to the connector.
7	Open the bleed valve (**A**).



Tab. 8-222: Cleaning the connector

Cleaning the machine

Clean the machine with detergents that are approved in accordance with the applicable legal regulations.

Troubleshooting

The following table contains a number of faults that may occur during operation as well as appropriate corrective measures.

Code	Type	Malfunction	Likely cause	Remedy
E2011	Warning 1	Low pressure, please refill	The system pressure is lower than 0.5 bar (loss of water, maintenance)	Refill cooling system up to 1.5 bar
E2012	Warning 2	Unable to start drive	Motor does not start in velocity control operation	Ensure that the system has the status "AF" before starting
E2013	Warning 3	Heater works	The heater switches on if the temperature of the liquid falls below 0°C.	Check operating temperature Check signal of the temperature sensor
E2014	Warning 4	Overtemperature	Temperature exceeds the defined value (P-0-1316) of the maximum permissible deviation from required temperature (t_{set}) for a defined duration (P-0-1317)	Check cooling system Clean cooling system, if necessary Reduce the level of the heat to be dissipated. If required, change the settings in the parameters P-0-1316 and/or P-0-1317
E2015	Warning 5	Fan	Fan signals error	Check fan and feedback signal
E2016	Warning 6	Lower motor speed limitation active	Motor velocity of the pressure control < 360 min^{-1}	Increase the value of parameter P-0-1374 (> 360 min^{-1}) Ensure that the motor can run with a velocity > 360 min^{-1}
F2011	Error 1	System pressure	System pressure lower than 0.2 bar	Refill cooling system up to 1.5 bar
F2012	Error 2	Overtemperature	The fluid temperature (on the drive side) has exceeded the maximum allowed temperature limit (see parameter P-0-1318)	If required, change the value of parameter P-0-1318 Clean fan Reduce the quantity of heat to be emitted
		Temperature of the heater is too high (yellow signal lamp lights up)	Thermostat of the heater is triggered	Check signal of the temperature sensor
		Heater does not heat	Thermostat of the heater was triggered in order to enable operation without liquid	Check the pressure of the cooling circuit and restore, if applicable
F2013	Error 3	Fan	Defective fan Fuses defective	Replace fan Replace fuses
		Slight leakage of cooling liquid between pump and motor	Start after long inactivity of the machine Changing the ambient conditions	Start pump [1)]

Code	Type	Malfunction	Likely cause	Remedy
		The filling pump does not start priming automatically	Suction hose empty following long period of machine disuse No coolant in the tank High backpressure in the filling pump delivery line	Perform the filling pump priming procedure
		The filling pump does not inject the coolant into the circuit	The filling pump is not primed The filling pump bleed valve is open	Perform the filling pump priming procedure Close the filling pump bleed valve

1) The pump is mechanically sealed by the cooling liquid. This type of seal (mechanical) may lead to a slight leakage of cooling liquid under certain conditions. It takes some time to minimize the leakage if the pump is started after stopping the machine or after being inactive. The required time depends on the operating conditions. The leaked cooling liquid usually evaporates immediately. The leaked cooling liquid is not visible then. **This type of leakage is not a malfunction.** Contact the service if the leakage persists for a longer period of time.

Tab. 8-223: Errors and warnings

Replacing the component

Safety advice for component exchange

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.

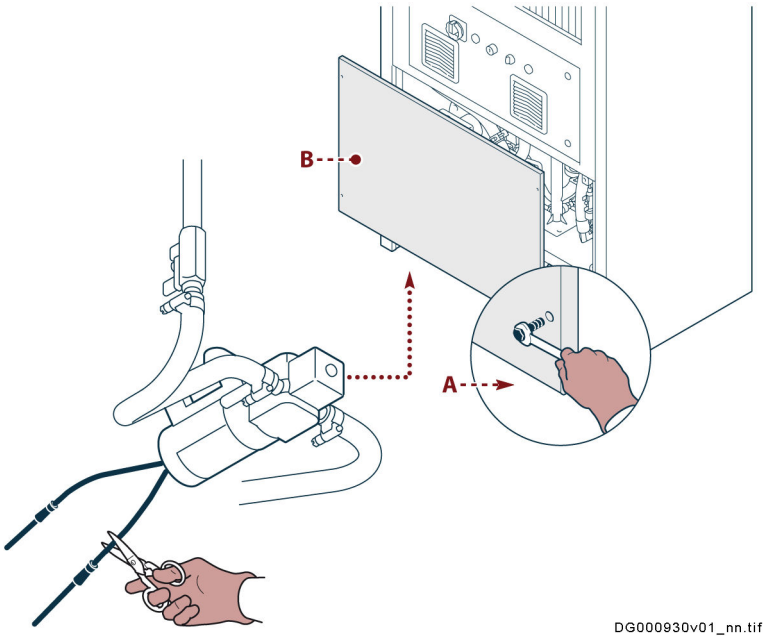
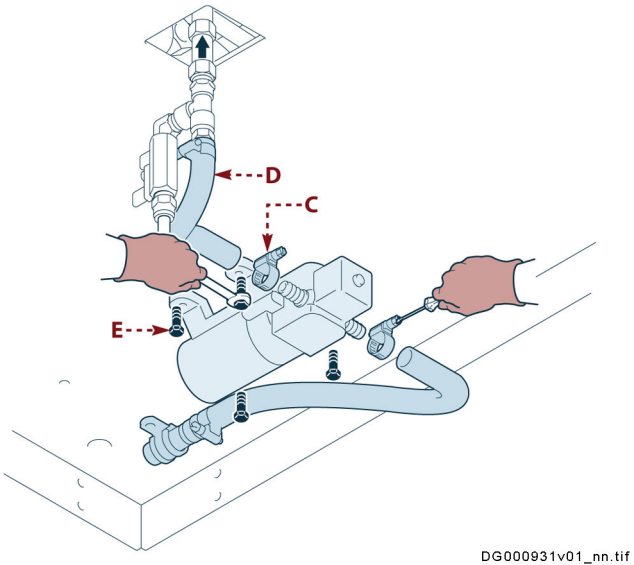
In particular, disconnect the power supply to the machine.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

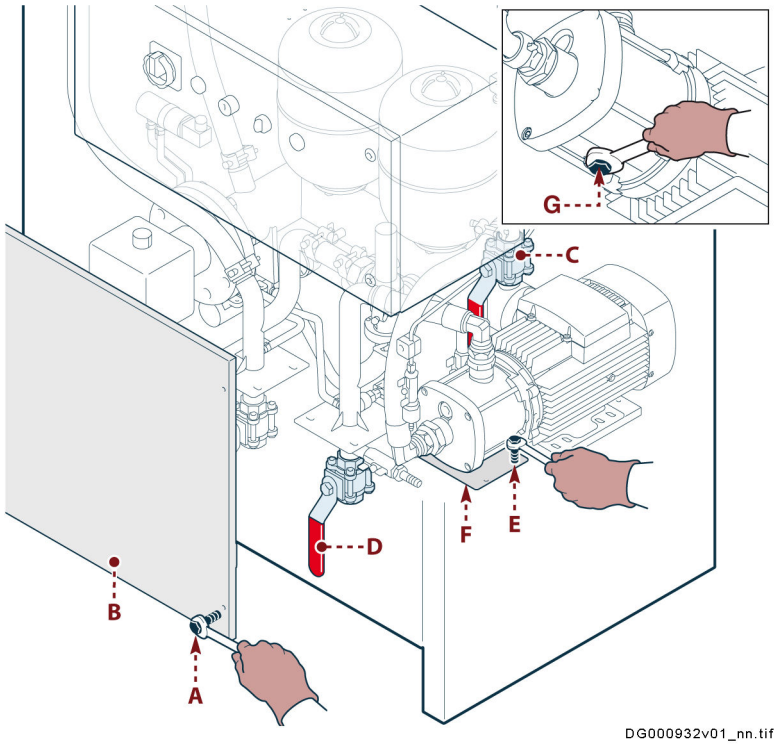
Replace worn or damaged parts by original spare parts.

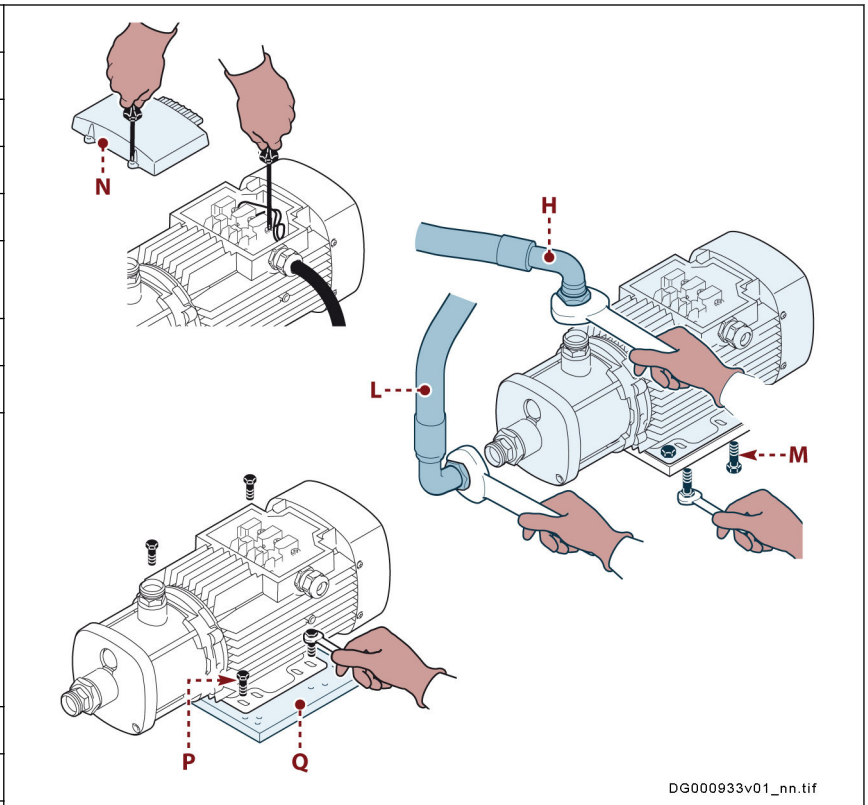
Replacing the filling pump

1	Disconnect the machine from the power supply source.	
2	Unscrew the screws (**A**).	
3	Remove the fixed guard (**B**).	
4	Cut the mains cables.	
5	Undo the screw and remove the strap (**C**).	
6	Extract the hose (**D**).	
7	Repeat the same operations to remove the other hose.	
8	Unscrew the screws (**E**).	
9	Remove the pump.	
10	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump.	

Tab. 8-224: Replacement of the filling pump

Replace the main pump

1	Disconnect the machine from the power supply source.	
2	Allow the machine to cool down.	
3	Unscrew the screws (**A**).	
4	Remove the fixed guard (**B**).	
5	Empty the hydraulic circuit of the machine (see chapter "Emptying the hydraulic circuit" on page 522).	
6	Close the valve (**C**).	
7	Close the valve (**D**).	
8	Unscrew the screw (**E**).	
9	Remove the fixed guard (**F**).	
10	Unscrew the lid (**G**). Discharge the entire cooling liquid.	

11	Disconnect the hosing (**H**).	
12	Disconnect the hosing (**L**).	
13	Unscrew the screws (**M**).	
14	Remove the pump.	
15	Remove the cover (**N**).	
16	Disconnect the cables from the terminals.	
17	Unscrew the screws (**P**).	
18	Remove the plate (**Q**).	
19	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump. **NOTICE!** The spare pump is supplied with the fittings mounted. Do not remove the fittings as this could cause liquid leakage.	
20	Open the valve (**C**).	
21	Open the valve (**D**).	
22	Fill the cooling circuit. See chapter "Filling the hydraulic circuit" on page 517.	

Tab. 8-225: Replacement of the main pump

Replacing the electric fan

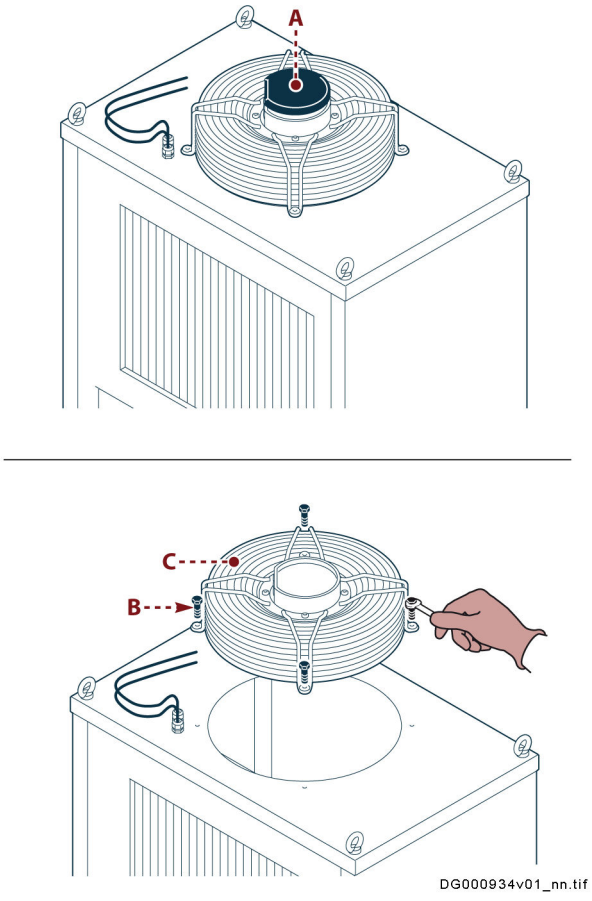
⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Due to the use of capacitors and even after the machine's power supply has been disconnected, there is a serious risk of electric shock by contact with live parts.

Before removing the cover, always wait several minutes after disconnecting the electricity to the machine.

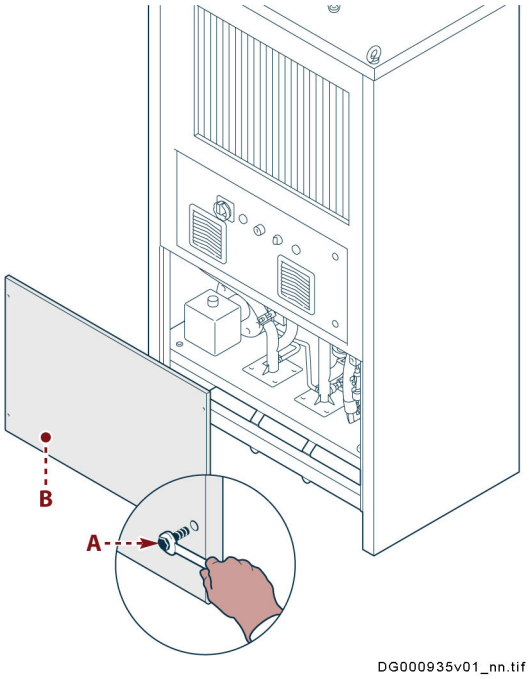
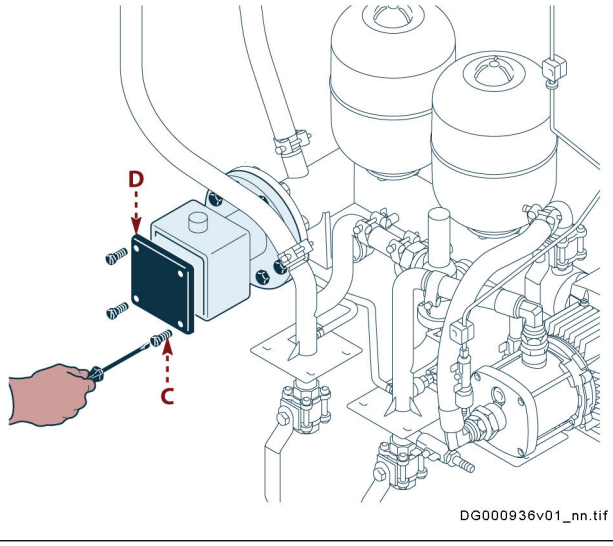
Make sure voltage has fallen below 50 V before touching live parts!

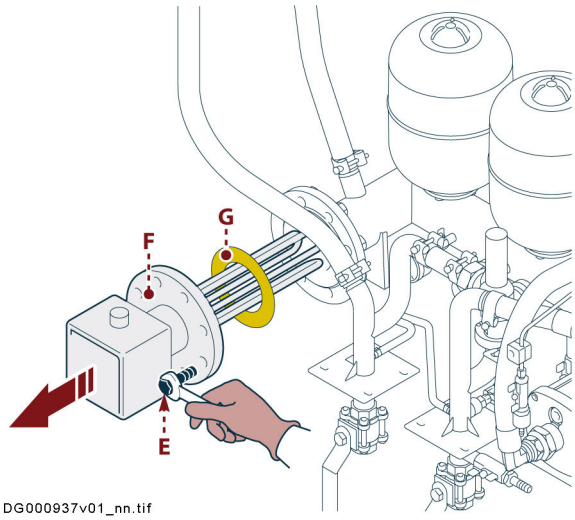
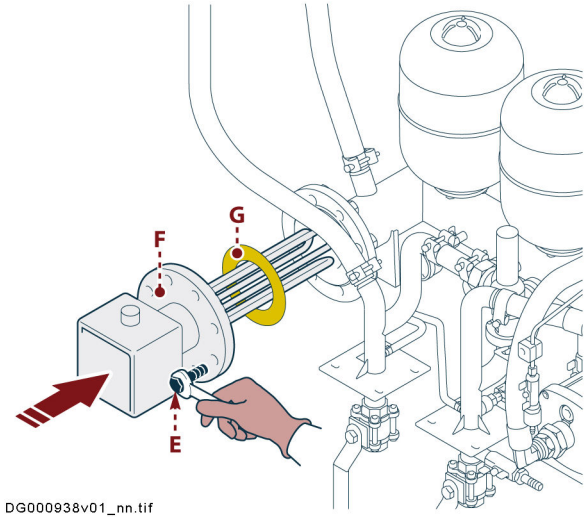
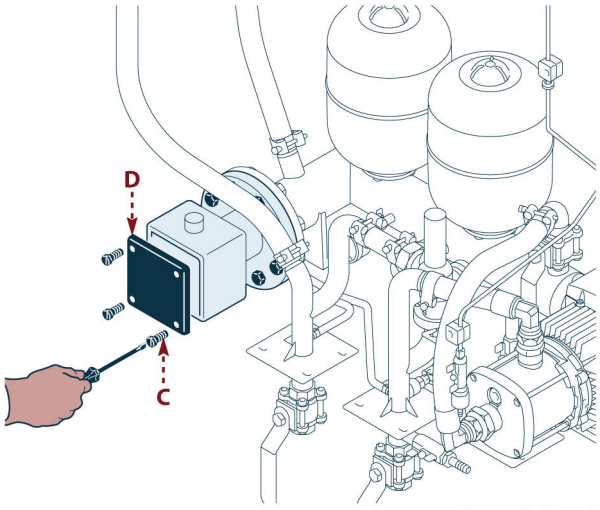
1	Disconnect the machine from the power supply source.
2	Remove the cover (**A**).
3	Disconnect the cables from the terminals.
4	Unscrew the screws (**B**).
5	Remove the electric fan (**C**).
6	Insert the electric replacement fan.
7	Tighten the screws (**B**).
8	Connect the lines (using the wiring diagram).
9	Reattach the cover (**A**).

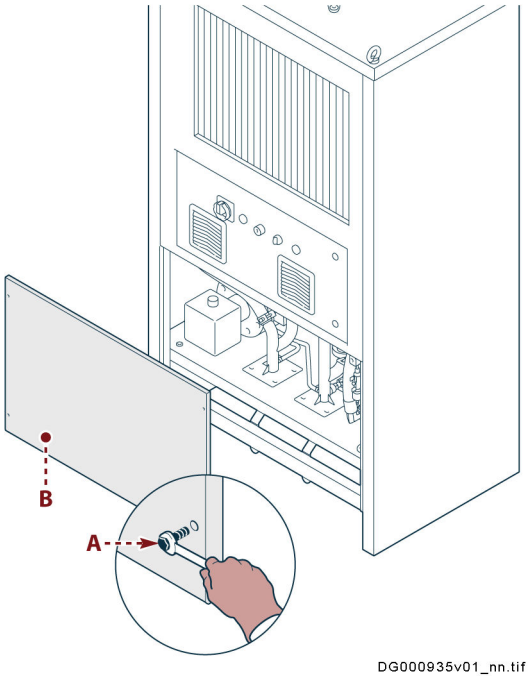


Tab. 8-226: Replacement of the electric fan

Replacing the heater

1	Disconnect the machine from the power supply source.	
2	Allow the machine to cool down.	
3	Empty the hydraulic circuit (see chapter "Emptying the hydraulic circuit" on page 522).	
4	Unscrew the screws (**A**).	
5	Remove the guard (**B**).	
6	Unscrew the screws (**C**).	
7	Remove the guard (**D**).	
8	Disconnect the cables from the terminals.	

9	Unscrew the screws (**E**).	 DG000937v01_nn.tif
10	Remove the heater (**F**).	
11	Remove the gasket (**G**). **When replacing the heater, also exchange the gasket.**	
12	Position the new heater without damaging the gasket (**G**).	 DG000938v01_nn.tif
13	Tighten the screws (**E**).	
14	Remove the cover of the new heater.	 DG000936v01_nn.tif
15	Connect the cables (see wiring diagram).	
16	Tighten the screws (**C**).	

17	Place the guard (**B**).	
18	Tighten the screws (**A**).	

Tab. 8-227: Replacing the heater

Replacing the fuses

Before replacing the fuse, fix the cause of the malfunction.

Only replace the interrupted fuse with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Description of the fuses" on page 505.

Exchanging the coolant

Empty the hydraulic circuit of the machine (see chapter "Emptying the hydraulic circuit" on page 522).

Fill the hydraulic circuit (see chapter "Filling the hydraulic circuit" on page 517).

Disposing of old equipment

Scrapping operations must be handled by specialized personnel with suitable skills for the job.

In accordance with the applicable regulations, all individual components must be collected separately for disposal according to their chemical properties when dismantling the machine.

With reference to the European Directive (RAEE), electric and electronic components must either be disposed of in authorized landfill sites or the machine, complete of the said parts, must be returned to the dealer in case of a new purchase.

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.

Control with MLD

Pressure control

The differential pressure between the machine's intake and its outlet has to be kept at a constant rate (1.5 bar, for example) so that the flow to the devices to be cooled can be easily set.

To control the pressure, the pump speed is varied based on the intake/outlet differential pressure.

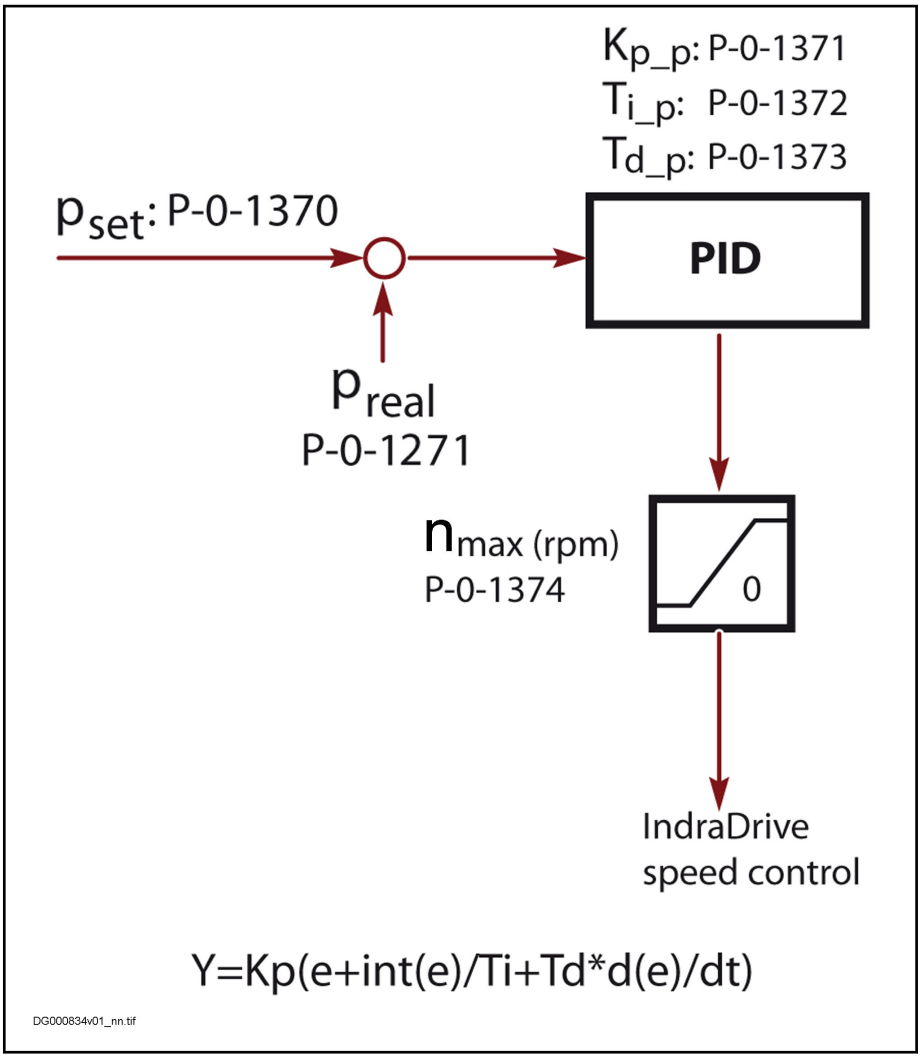


Fig. 8-147: Pressure control

Name	Parameter	Unit
p_{set}	P-0-1370	bar
K_{p_p}	P-0-1371	min^{-1}/bar
T_{i_p}	P-0-1372	s
T_{d_p}	P-0-1373	s

Name	Parameter	Unit
n_{max}	P-0-1374	min^{-1}
p_{real} (*)	P-0-1271	bar

* Read only

Tab. 8-228: Pressure control parameters

Temperature control

The temperature of the fluid in the drive circuit has to be kept at a constant value (between 40 °C and 60 °C) to prevent condensation from forming in the devices to be cooled.

The temperature of the fluid is controlled by a variable speed electric fan which cools the fluid flowing through the heat exchanger.

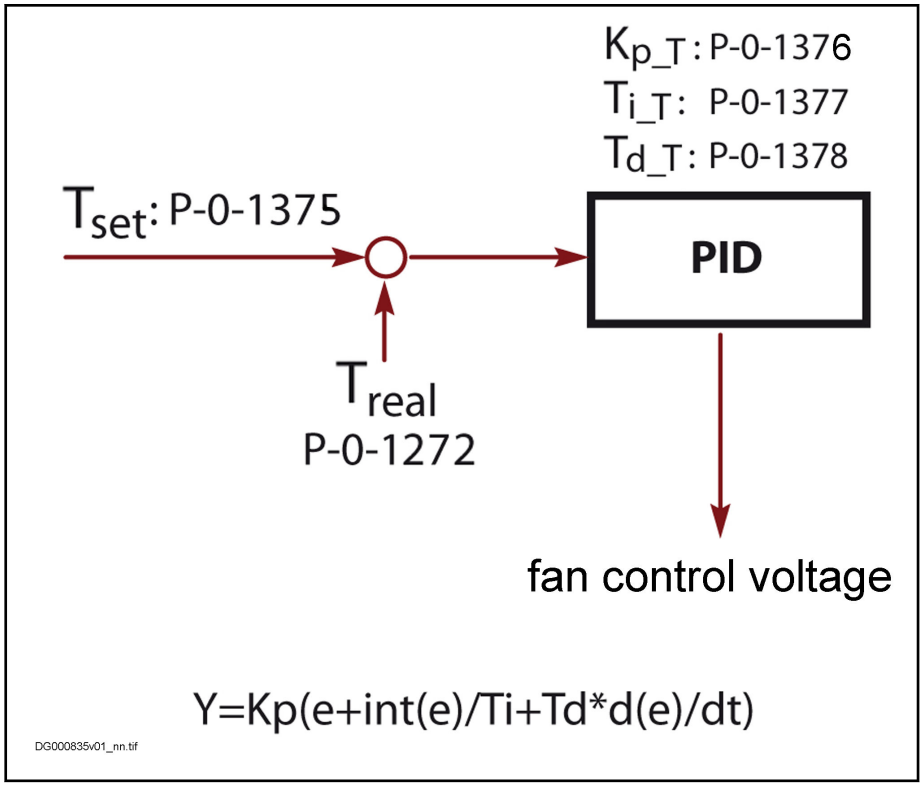


Fig. 8-148: Temperature control

Name	Parameter	Unit
T_{set}	P-0-1375	°C
K_{p_T}	P-0-1376	V / °C
T_{i_T}	P-0-1377	s
T_{d_T}	P-0-1378	s
T_{real} (*)	P-0-1272	°C
T_{real} (*)	P-0-1273	°F

* Read only

Tab. 8-229: Temperature control parameters

Starting the machine

The machine is started (as per the predefined setting) solely with the digital command:

ENABLE (X31.1, P-0-1390)

You can set the type of machine enabling (starting via digital input or starting via the communication).

Start	Parameters	Input
Start selection 1	P-0-1380	digital
Start selection 2	P-0-1381	digital
Start command via communication	P-0-1382	digital

Tab. 8-230: Start options

The parameters **P-0-1380 and P-0-1381** can be set to "0" or "1".

If both parameters are set to the **same value** (0 or 1), the machine can be started via the digital input with **P-0-1390** (0 = off, 1 = on).

If both parameters are set to **different values**, the machine can be started via the communication with **P-0-1382** (0 = off, 1 = on).

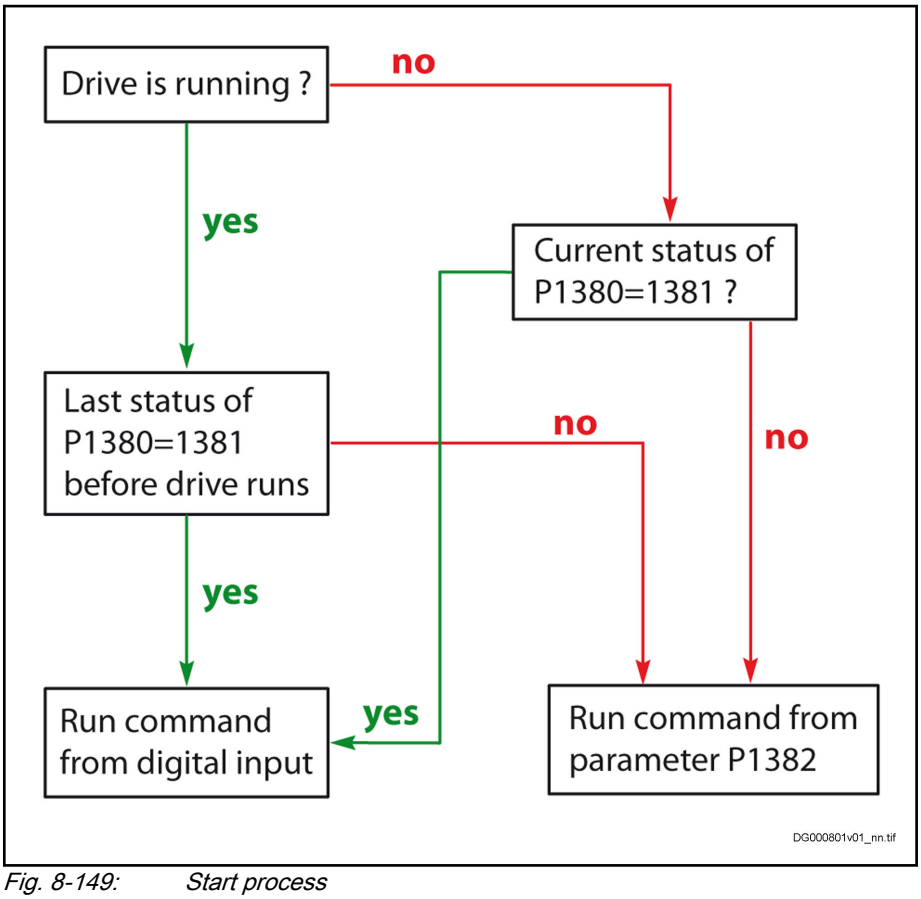


Fig. 8-149: Start process

Example: By setting the parameter P-0-1380 as a digital input and monitoring the parameters P-0-1381 and P-0-1382 via the PLC, the power-up command

for the machine can be transmitted either via the digital input or the PLC, from two different workstations.

Parameters

Name	Parameter	Unit	Minimum value	Maximum value	012-020	020-090	035-090
p_{set} (pressure command value)	P-0-1370	bar	0	2.0	1.5	1.5	1.5
K_p (pressure control)	P-0-1371	min^{-1}/bar	0	10000	40	40	40
T_i (pressure control)	P-0-1372	s	0.0	1000.0	0.05	0.05	0.05
T_d (pressure control)	P-0-1373	s	0.0	1000.0	0.0	0.0	0.0
n_{max}	P-0-1374	min^{-1}	0	8000	3000	3000	3000
Temperature setpoint	P-0-1375	°C	0	60	50	50	50
K_p (temperature control)	P-0-1376	V / °C	-1000.0	0.0	-0.5	-0.5	-5.0
T_i (temperature control)	P-0-1377	s	0	10000	10	10	40
T_d (temperature control)	P-0-1378	s	0.0	1000.0	0.0	0.0	0.0
Start selection 1	P-0-1380	-	0	1	0	0	0
Start selection 2	P-0-1381	-	0	1	0	0	0
Start command via communication	P-0-1382	-	0	1	0	0	0
p_{set_2} (pressure command value 2)	P-0-1385	bar	0.0	2.0	0.2	0.2	0.2
Control word switching to p_{set_2}	P-0-1295	bit	-	-	0	0	0
High temperature warning differential value	P-0-1316	°C	0	20	10	10	10
High temperature warning time	P-0-1317	s	0	100	3	3	3
Overtemperature limit value	P-0-1318	°C	40	100	90	90	90
Starting temperature control cabinet fan	P-0-1319	°C	0	70	50	50	50
Tolerance pressure control	P-0-1320	bar	0.0	10.0	0.5	0.5	0.5
Low motor velocity - deceleration	P-0-1321	s	0	100	5	5	5

Tab. 8-231: Parameters

Name	Parameter	Unit	Type *	Scaling
Analog I/O monitoring parameters (read-only)				
Fan control voltage	P-0-1270	V	AO	0-10 V, 0-100%
Pressure difference pump	P-0-1271	bar	-	-
Cooling water temperature	P-0-1272	°C	-	-
Cooling water temperature	P-0-1273	°F	-	-
Pressure sensor	P-0-1280	V	AI	0-10 V, 0-6 bar
Temperature sensor	P-0-1281	V	AI	0-10 V, -50-100 °C
Digital I/O parameters				
Drive enable	P-0-1390	bit 0	DI	
Pressure monitoring > 0.5 bar	P-0-1391	bit 0	DI	
Pressure monitoring > 0.2 bar	P-0-1391	bit 1	DI	
Fan monitoring	P-0-1391	bit 2	DI	TRUE for "Fan OK"
Status word machine	P-0-1410			
Cooler is running	P-0-1410	bit 0		Start command + P-0-1410.4 + no warning + no error
Pressure command value attained	P-0-1410	bit 1		abs(P-0-1370 - P-0-1271) < P-0-1320
Cooler is running (warning ignored)	P-0-1410	bit 3		Start command + P-0-1410.4 + no error
Motor is running	P-0-1410	bit 4		Motor velocity (S40) ≥ 360
Drive warning	P-0-1412	bit 0	DO	"high" for no warning
Drive error	P-0-1412	bit 1	DO	"high" for no error
Heater enable	P-0-1412	bit 2	DO	
Fan enable	P-0-1412	bit 3	DO	
Housing fan enable	P-0-1412	bit 4	DO	

* AI: analog input; AO: analog output; DI: digital input; DO: digital output

Tab. 8-232: Parameters

Switching the pressure command value

The pressure command value can be switched via control word (P-0-1295.0). This function can be used for a more economical operation (lower energy consumption, less wear) if the new pressure command value is set to a lower value.

Pressure command value (p_{set})	P-0-1370
Pressure command value 2 (p_{set_2})	P-0-1385
Control word	P-0-1295.0
P-0-1295.0 = 0	Pressure command value: P-0-1370
P-0-1295.0 = 1	Pressure command value: P-0-1385

Tab. 8-233: Switching the pressure command value

With a pressure command value of 0.2 bar instead of 1.5 bar, laboratory measurements showed energy savings of 92% (40 W instead of 500 W). The motor speed decreased from 2200 min^{-1} to 760 min^{-1} resulting in a longer service life of the motor.

Cabinet fan control

The cabinet fan control only applies to devices with cabinet heating (HAH02.1-WAxxx-xxx-xx-xx-**2**)

The cabinet fan will be turned on if the cabinet temperature (S-0-0384) is higher than the value in P-0-1319.

The cabinet fan will be turned off if the cabinet temperature (S-0-0384) is 5 °C/°F lower than value in P-0-1319.

Air-water heat exchanger (WA035-090)

Technical information

General description of the machine

The machine is designed and manufactured for the purpose of cooling devices or equipment using a liquid solution made of glycol and demineralized water.

The underlying principle of the cooling method is the exchange of heat between air and water by means of a heat exchanger.

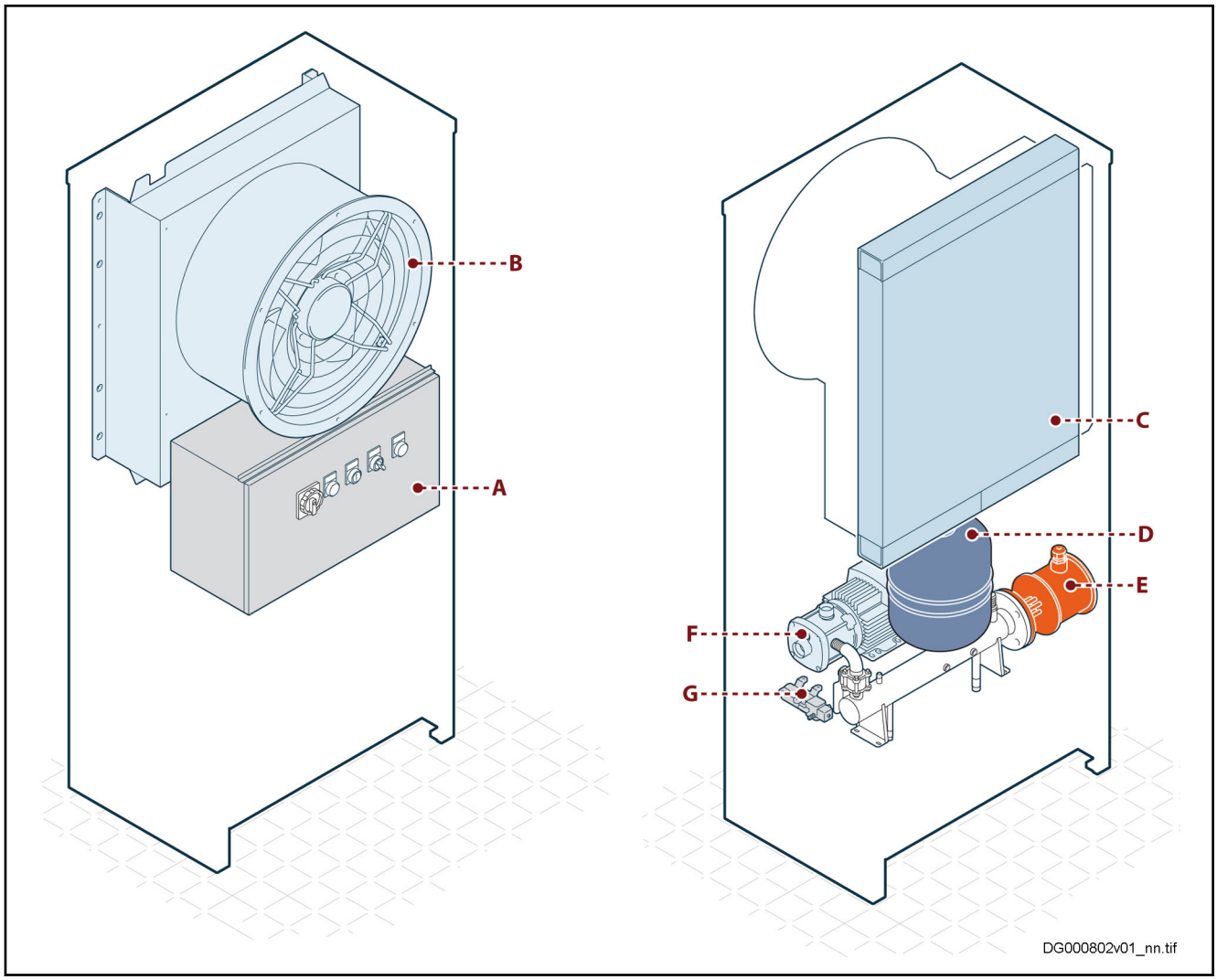
The liquid is circulated by a pump in the cooler and cooled by an air flow generated by an electric fan.

The machine can optionally be equipped with a heater in order to increase the temperature of the inflowing liquid.

Pressure and temperature control is done via IndraMotion MLD, the drive-integrated Motion Logic Control according to IEC 61131-3. See chapter "Control with MLD" on page 488.

See also chapter "Liquid Cooling" on page 53.

Main parts

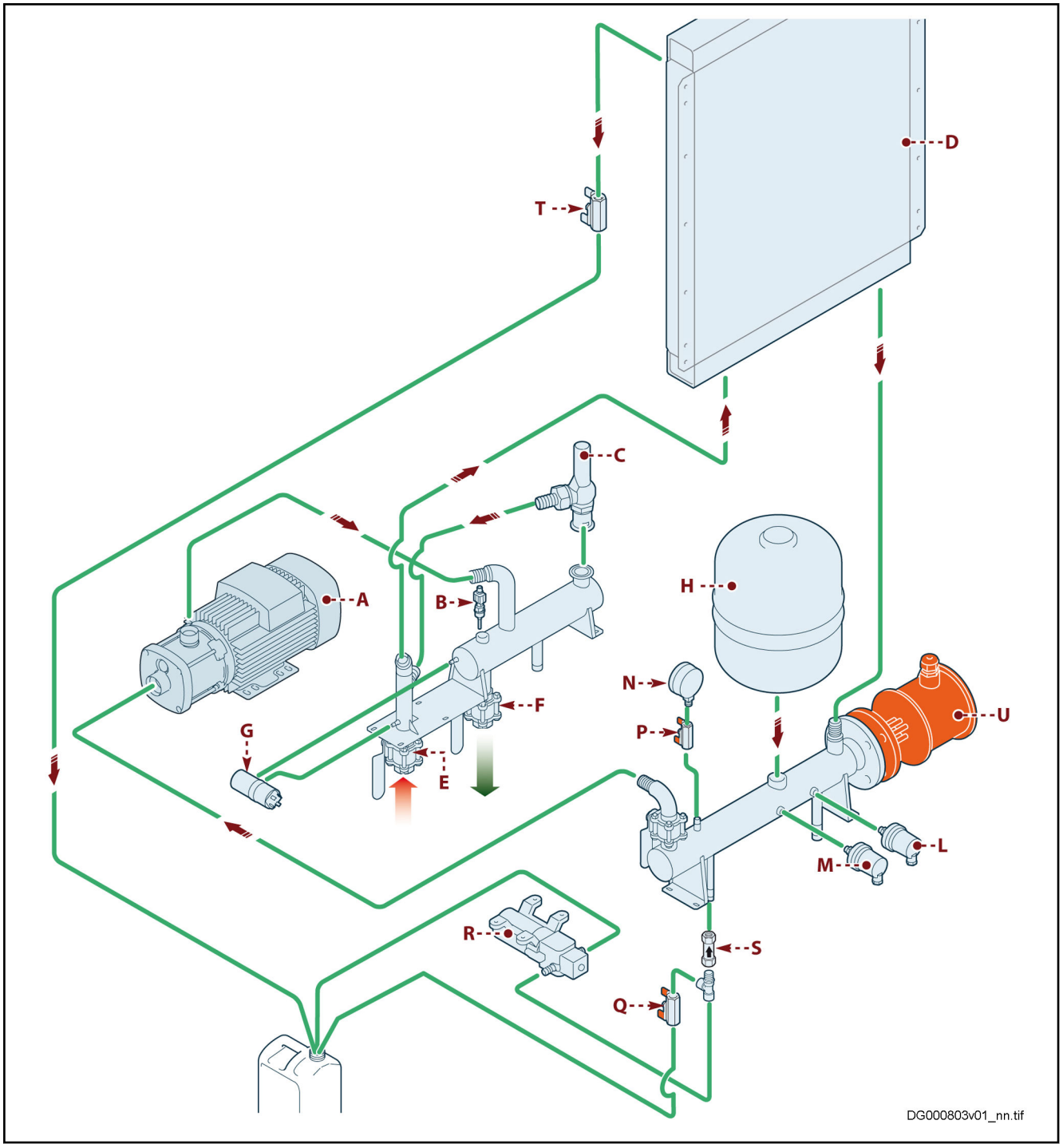


A	Terminal box
B	Electric fan
C	Heat exchanger
D	Expansion tank
E	Heater
F	Main pump
G	Filling pump

Fig. 8-150: Main parts

Operational cycle and component description

The following figure shows the principle of operation.



A	**Main pump:** Circulates the coolant in the hydraulic circuit.
B	**Temperature sensor:** Detects the coolant temperature in the outlet pipe.
C	**Bypass valve:** Limits the pressure of the output cooling liquid.
D	**Heat exchanger:** Lowers the temperature of the coolant.
E	**Ball valve:** Regulates the flow of the coolant from the owner's system.
F	**Ball valve:** Regulates 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 outlet pipe.

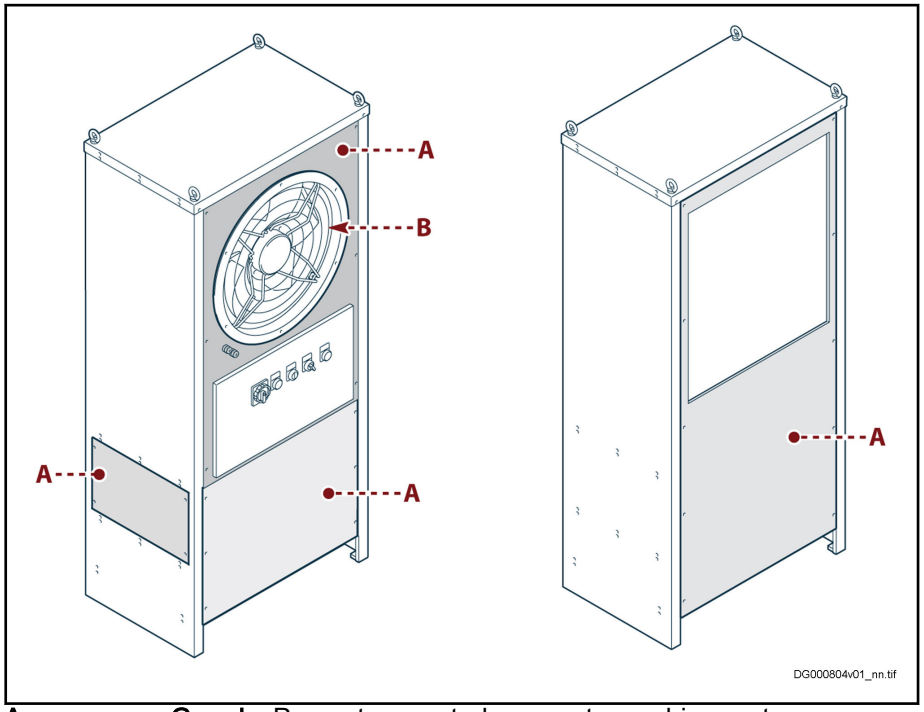
H	**Expansion tank:** Ensures constant pressure in the circuit.
L	**Pressure switch (0.2 bar):** This detects the pressure level in the intake manifold.
M	**Pressure switch (0.5 bar):** This detects the pressure level in the intake manifold.
N	**Pressure gauge:** Detects the fluid pressure in the intake manifold.
P	**Valve:** Regulates the flow towards the pressure gauge (**N**).
Q	**Valve:** This is used to release any backpressure in the filling pump delivery line and facilitate priming.
R	**Filling pump:** Fills the cooling circuit.
S	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.
T	**Valve:** Air release valve
U	**Heater (optional):** Heats the liquid if the heat interchanger is operated at ambient temperatures below 0°C.

Fig. 8-151: Operational cycle and component description

Guards

⚠ WARNING **Risk of injury!**

Never use the machine without the guards.

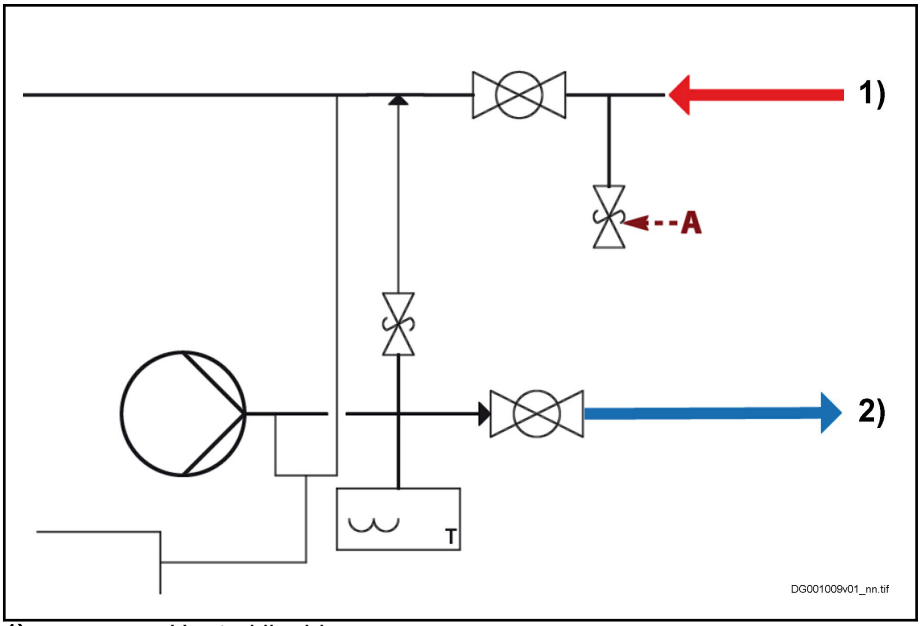


A **Guards:** Prevent unwanted access to machine parts.
B **Guard:** Prevents accidental touching of the fan.

Fig. 8-152: Guards

Overpressure devices

If additional pumps (external to the machine) are installed on the circuit or if the drop in pressure of the hydraulic load is less than 1.5 bar, the owner has to fit a pressure limiting valve. The valve has to limit the pressure to a maximum of 2 bar in the return pipe to the machine.



1) Heated liquid
2) Cooled liquid
A Pressure limiting valve

Fig. 8-153: Positioning of the pressure limiting valve (A)

Overall dimensions

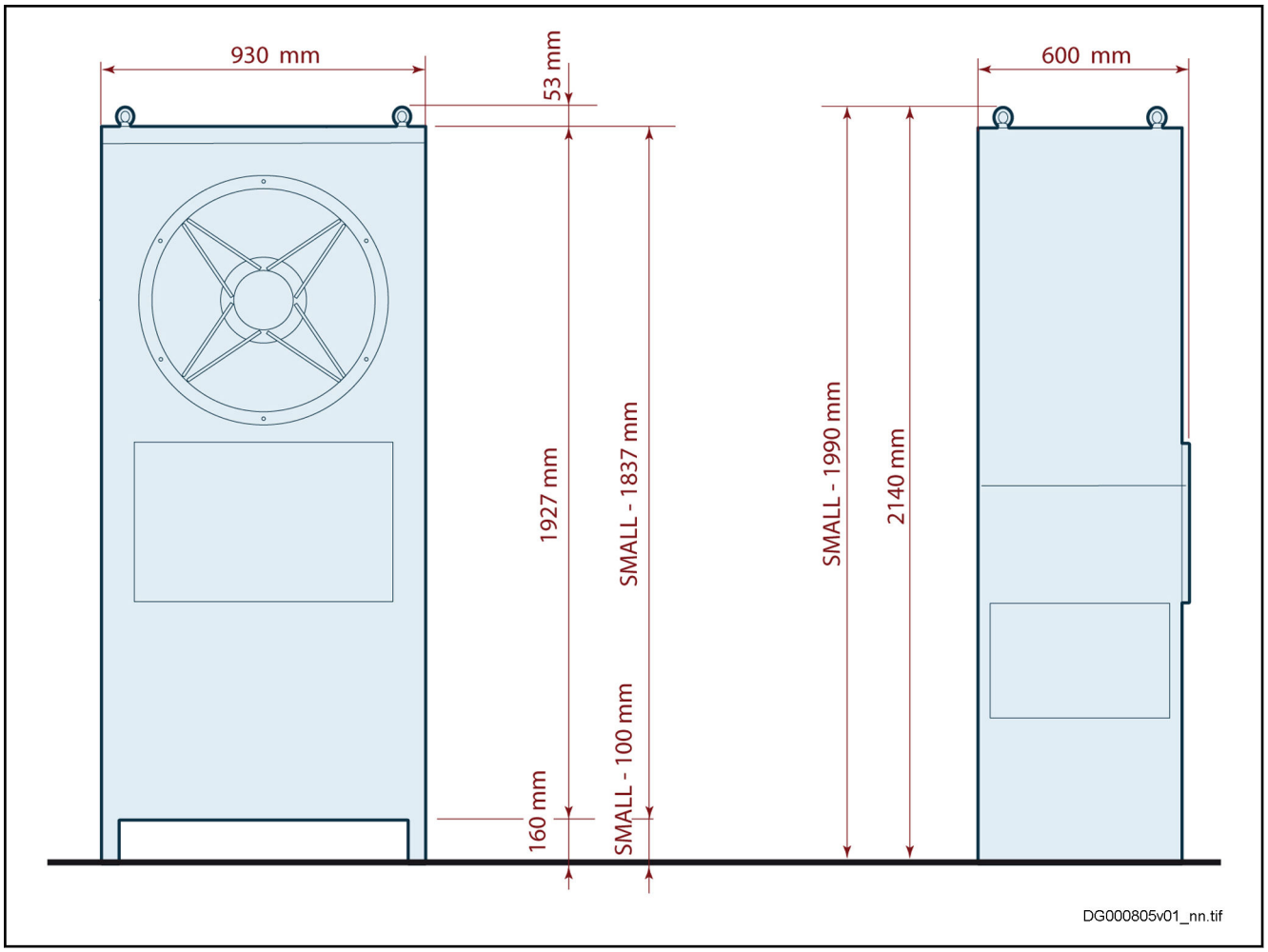


Fig. 8-154: Overall dimensions

Data

Technical data - machine

Description	Unit	Normal voltage		Increased voltage	
		with heating	without heating	with heating	without heating
Power voltage	Vac	380 (-15%) 480 (+10%)	380 (-15%) 480 (+10%)	380 (-15%) 500 (+10%)	380 (-15%) 500 (+10%)
Frequency	Hz	50/60	50/60	50/60	50/60
Current	A	11	6.5	11	6.5
Maximum cooling capacity	kW	35	35	35	35
Maximum output flow rate	l/min	90	90	90	90
Maximum pressure of the inflowing coolant	bar	2	2	2	2
Maximum pressure of the outflowing coolant	bar	4,5	4,5	4,5	4,5
Maximum coolant temperature	°C	70	70	70	70
Minimum coolant temperature	°C	-20	5	-20	5
Drive circuit coolant (monoethyl glycol and demineralized water solution) See also chapter "Liquid Cooling" on page 53.	-	50% glycol	20% glycol	50% glycol	20% glycol
Estimated amount of coolant (heat exchanger only)	l	approx. 50	approx. 50	approx. 50	approx. 50
Degree of protection	IP	54	54	54	54
Ambient temperature	°C	-+20 … +45	+5 … +45	-+20 … +45	+5 … +45
Relative humidity without condensation	%	95	95	95	95
Maximum installation altitude	m	2000	2000	2000	2000
Weight (heat exchanger)	kg	350	350	350	350
Weight (heat exchanger + packaging)	kg	440	440	440	440

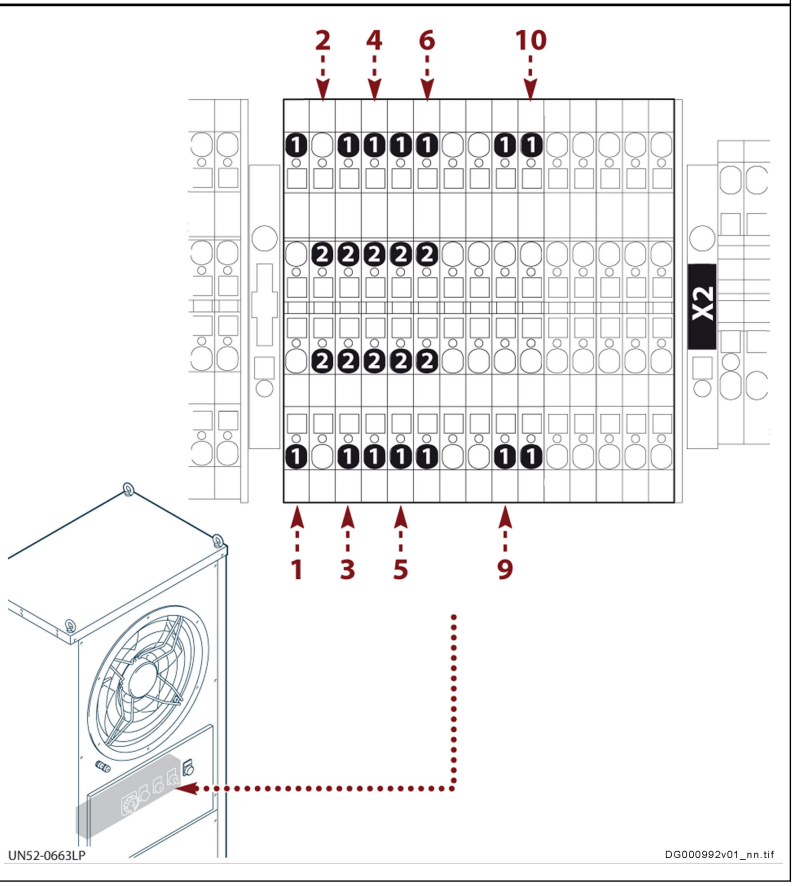
Tab. 8-234: Technical data - machine

ENABLE, UNIT ERROR and UNIT WARNING connections

The signals for releasing the relative machine status using the owner's operator terminal are transmitted via the terminal block shown.

Connect the lines to the terminals shown in table "Connecting the terminals".

Terminal box X2

Pos.	Significance	Terminals
9.1 - 2.2	Terminals for machine enabling via the owner's operator terminal (ENABLE)	
3.1 - 3.2 4.1 - 4.2	Machine error signal terminals Closed contact: no error	
5.1 - 5.2 6.1 - 6.2	Warning signal terminals Closed contact: no warning	
10.1 - 1.1	Terminals for remote-controlled alarm reset.	

Tab. 8-235: Connection terminals (terminal box X2)

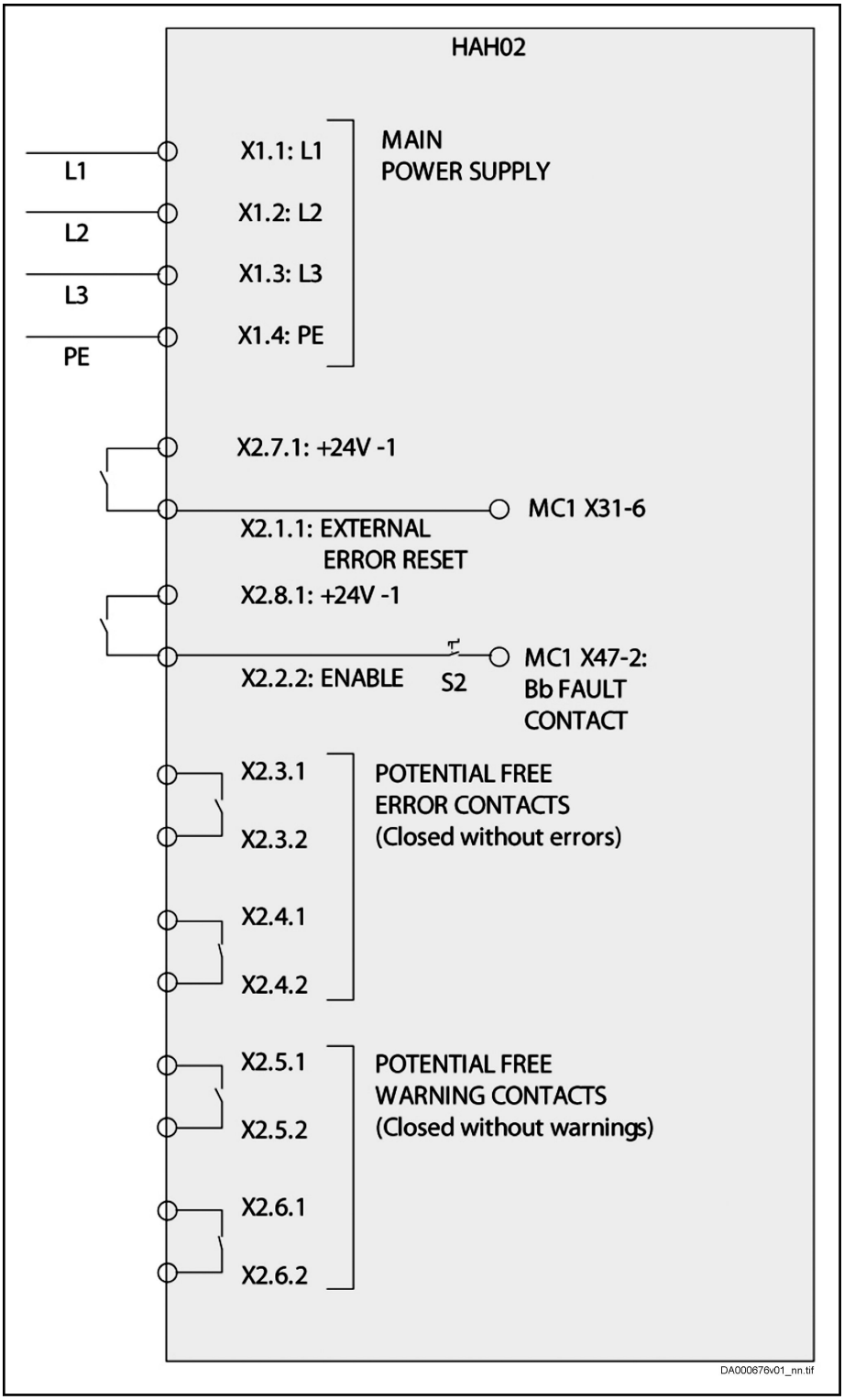
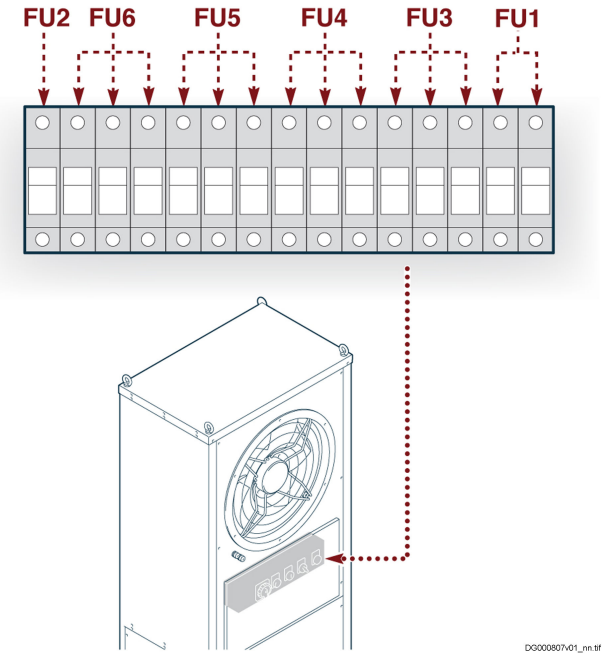


Fig. 8-155: Wiring diagram

Description of the fuses

Name	Current (A)	Type	Rated voltage (Vac)	Interrupting capacity (kW)	Fuse	Position
FU1	1	CC	600	200	Delayed	
FU2	4					
FU3	6					
FU4*	4					
FU5	4					
FU6**	6					

* Only for devices with 500 V
** Only for version OUTDOOR

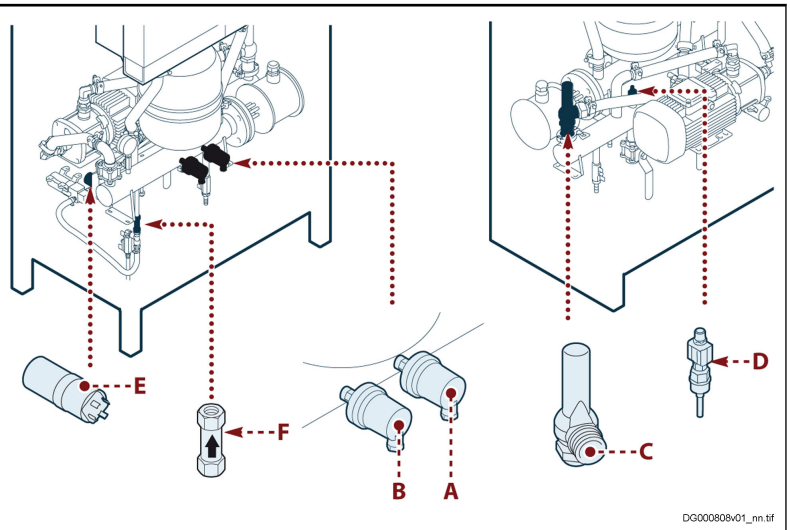
Tab. 8-236: Fuses

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 signaled 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 signaled when the pressure falls below 0.2 bar and stops machine operation.
C	**Bypass valve:** Keeps the fluid pressure in the outlet pipe within the maximum limit allowed.
D	**Temperature sensor:** 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 outlet pipe. The pressure in the outlet pipe is kept constant with the sensor.
F	**Check valve:** It prevents the liquid from flowing into the filling pump when it is being primed or is deactivated.



Tab. 8-237: Processing and protection devices

Ambient conditions for operation

The machine works properly at the specified ambient conditions (see chapter "Data" on page 550).

The machine is able to function properly at altitudes up to 2000 m above sea level.

Intended use

The machine is designed and manufactured to cool electric or electronic equipment or machines.

The machine must be used in accordance with its technical characteristics. It is not permitted to make changes or to use the machine for purposes other than those for which it was intended.

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 project planning instructions, should be considered mishandling and therefore not permitted.

Unintended and unauthorized uses

It is not permitted to use coolants with properties other than those specified by the manufacturer.

It is not permitted to use machines in a flammable or explosive environment.

Commissioning of the machine is only permitted if it is ensured that the system or the machine in which it is installed complies with national and local regulations.

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.

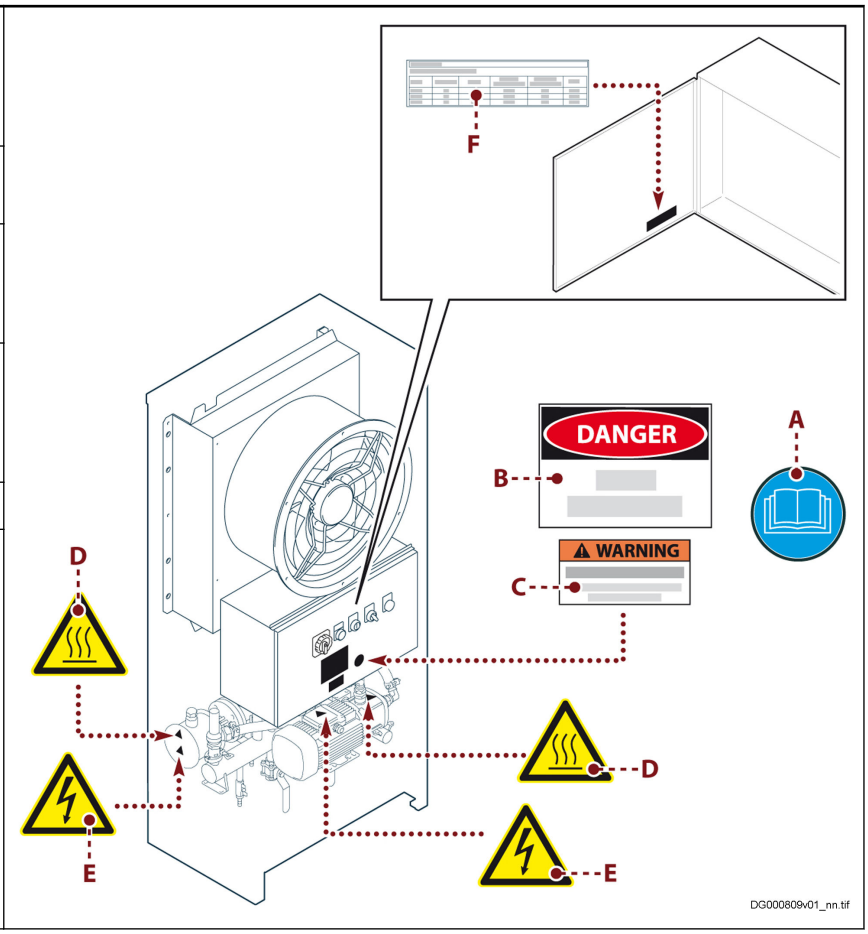
Thermal risk: Contact with hot surfaces can cause burns. Allow the machine to cool down before any operation.

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 one.

A	This indicates the obligation for operators to read the instruction manual before operating the machine.
B	This shows that the voltage inside the terminal box is hazardous.
C	Risk of death or severe injury. Disconnect the machine from the voltage mains prior to operation.
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	Risk of electric shock
F	Shows the technical properies of the fuses



Tab. 8-238: Information and safety signs

Transporting and installing

Transport and installation safety recommendations

Personnel responsible for transport of the load must have the required qualification and experience and must be trained in handling the lifting gear used.

Use lifting gear with suitable load capacity in order to lift and move the load.

Persons authorized for transport must take appropriate measures to ensure their own safety and the safety of persons directly involved.

Place the package on a stable surface.

Do not place packed machines on top of each other as they are not intended for stacking.

Upon reception, each package must be inspected to verify the integrity and the exact quantity of its contents. In case items are damaged or missing,

contact the importer or the manufacturer directly to discuss the procedure to be adopted.

Package description

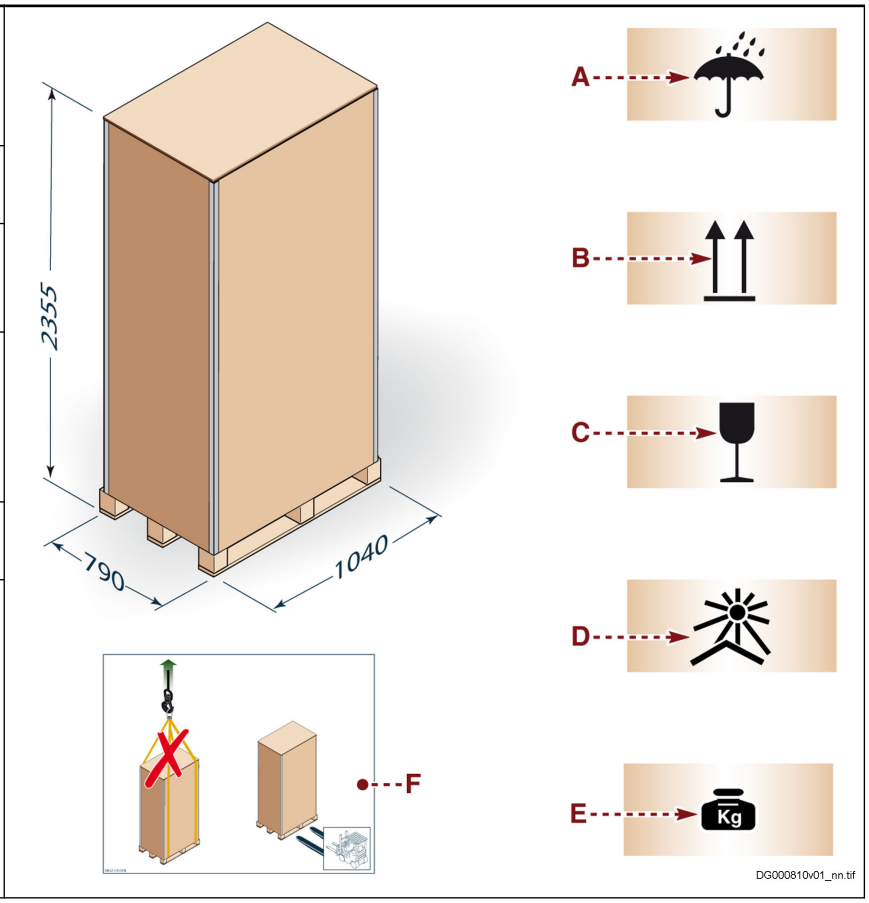
The packaging is selected according to the selected means of transport and the destination.

Packages can either be loaded directly onto a means of transport or into suitable containers if shipped by sea or air or to far-off destinations.

In order to facilitate transport, some components are removed and properly protected.

The figure shows the type of packaging most frequently used and the maximum dimensions as well as the warning symbols and notices attached 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 overall weight of the package.
F	The plate shows the procedure for lifting the package.



Tab. 8-239: Package description

Transporting and lifting the packed machine

The figure shows how to lift the package.

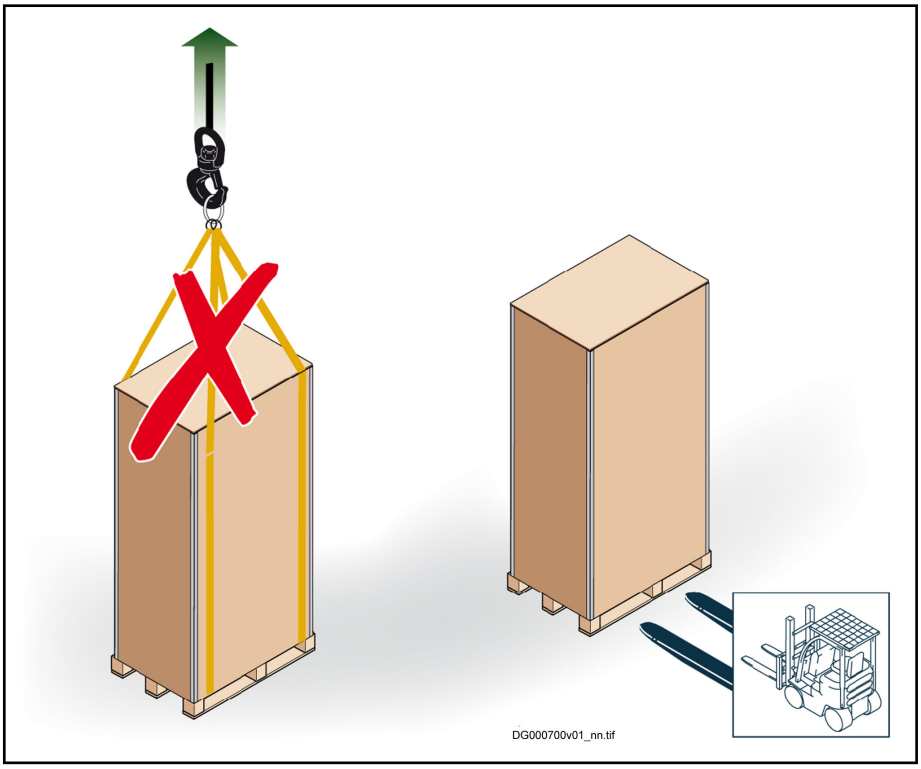


Fig. 8-156: Transporting and lifting the packed machine

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 +55 °C.

Avoid storing the machine in places where weather conditions could prejudice its good working order.

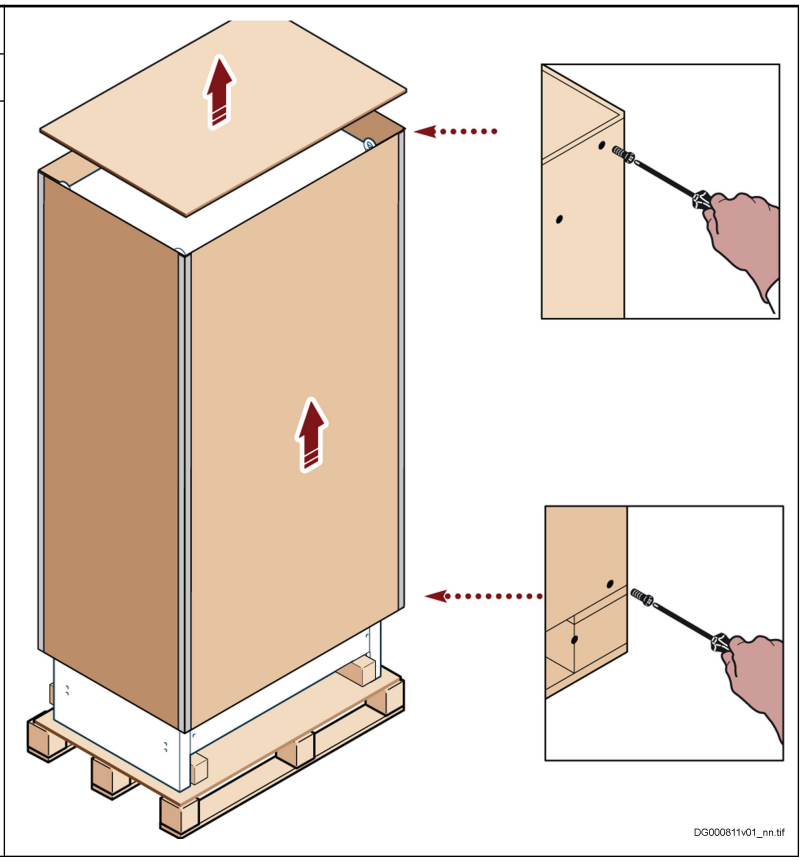
Unpacking

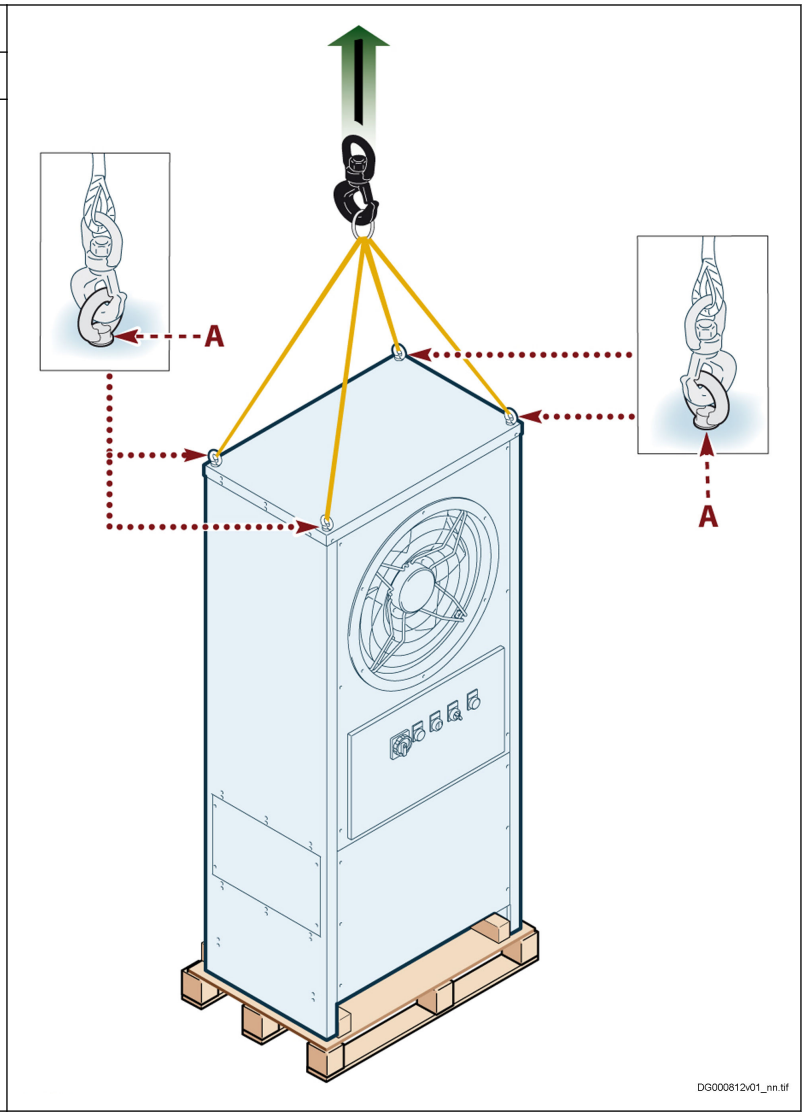
It is advisable to unpack the machine near the installation area to facilitate assembly.

The figure shows how to unpack the machine properly.

Proceed as described.

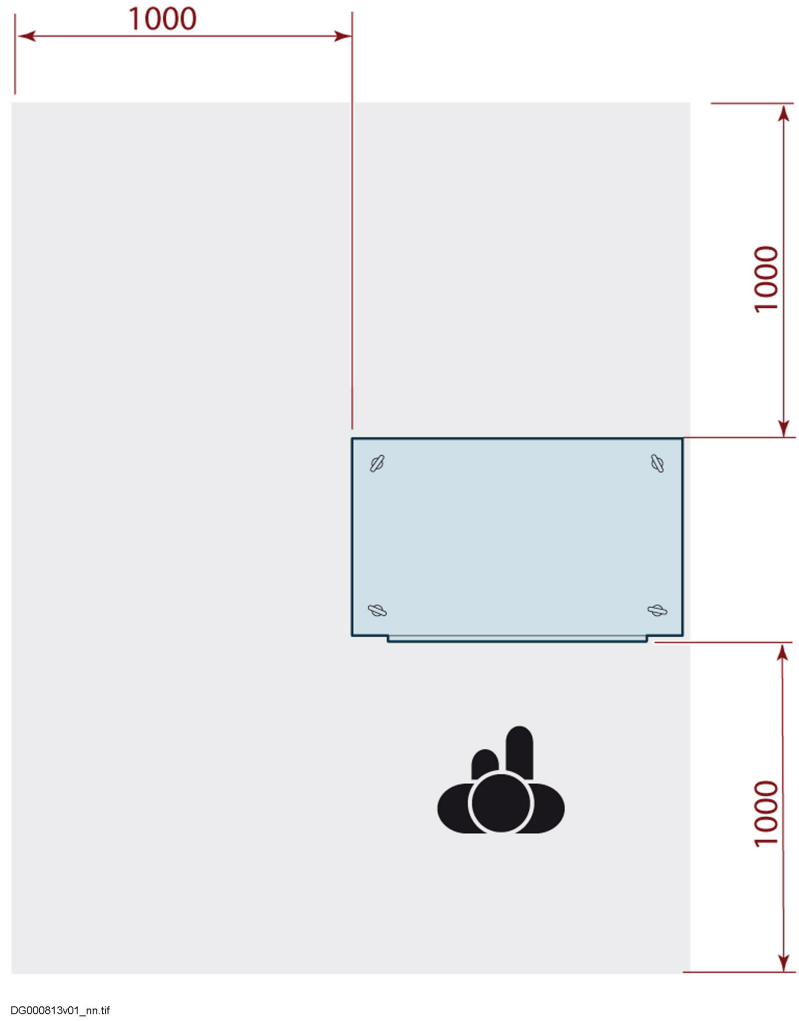
1	Unscrew the screws.
2	Remove the cover.
3	Lift the side walls of the packaging.



4	Tighten the eyebolts (**A**) supplied.	
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. 8-240: Unpacking

Installation

Installation area The installation area must be flat and horizontal and correspond to the default load factor. Electrical connections as well as the possibility of transmitting the signals "UNIT ERROR" - "UNIT WARNING" must be available. Furthermore, all hydraulic connections must be available in accordance with legal regulations. According to the relevant regulations concerning health and safety at the working place, the area must have sufficient ventilation and lighting. Make sure that there is enough space around the installation area so that all work can be carried out safely.	

Tab. 8-241: Installation area

Electrical connection

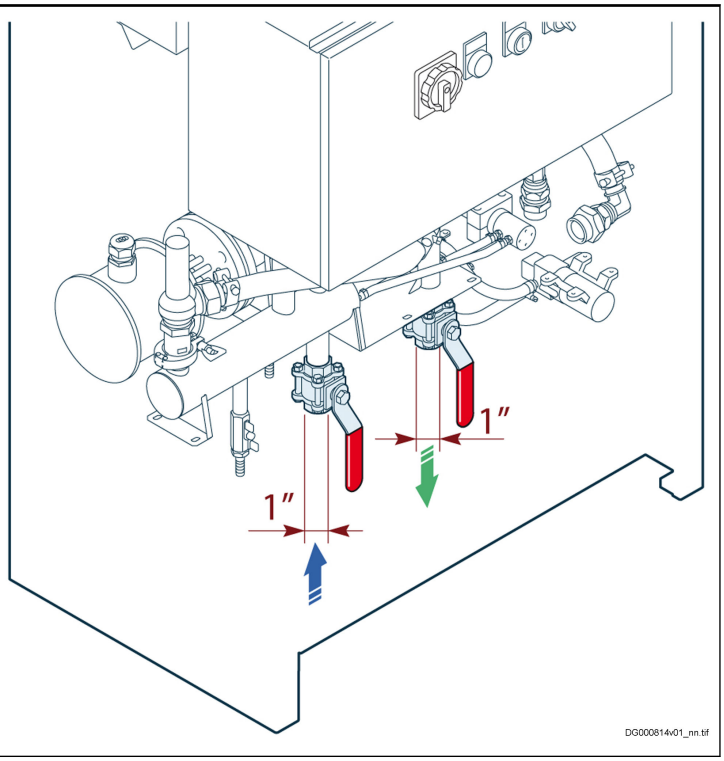
Electrical connections must be executed according to the manufacturer's specifications in the wiring diagram.

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 + equipment grounding conductor).

Connect the three phases (L1, L2, L3) and the equipment grounding conductor to the relevant terminals inside the terminal box.

Hose connections

The owner has to install a pressure regulating device in the return pipe. Set the pressure in the intake and return pipes to the values shown in chapter "Data" on page 550. 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. 8-242: Hose connections

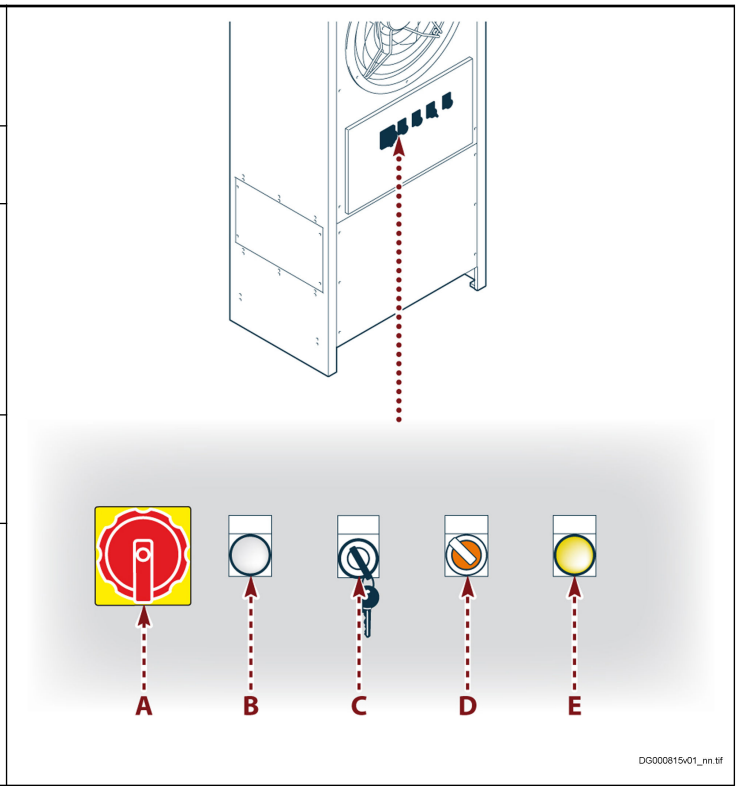
Use

Safety advice for use

Before starting the machine, ensure that the system or the machine in which it has been fitted complies with applicable local regulations and directives.

Control elements and indicator lamps

A	**Main 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 has been enabled.
C	**Key-operated two-position stay-put selector switch:** This is used to switch the main pump operation on and off. The key has to 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	**Indicator lamp (yellow):** This shows automatic shutdown of the heater (optional) triggered by overtemperature of the liquid solution (see chapter "Resetting the safety temperature controller of the heater" on page 572).

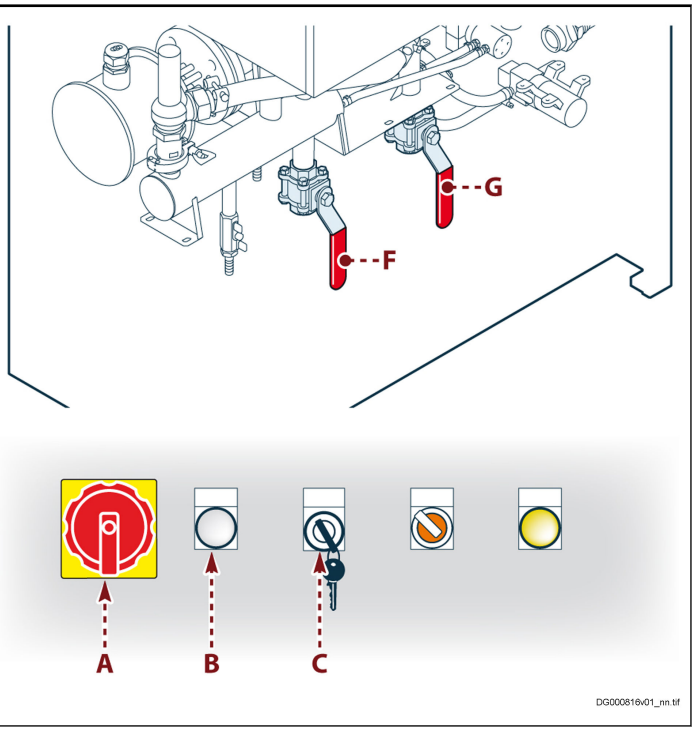


Tab. 8-243: Control elements and indicator lamps

Switching on

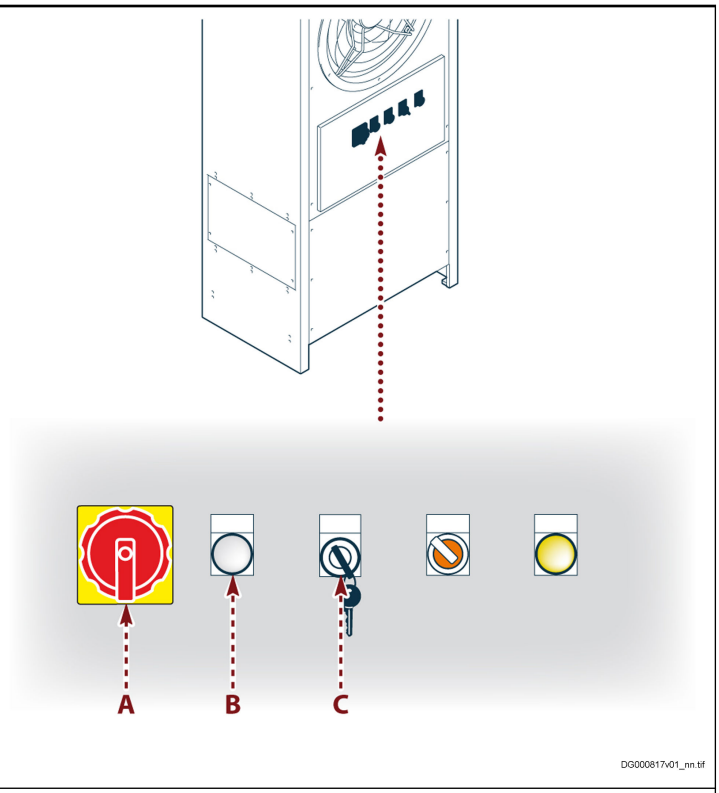
During the first run-up, carry out the circuit filling procedure (see chapter "Filling the hydraulic circuit" on page 566).

To start the machine, proceed as follows.

1	Open the ball valves (**F - G**).	
2	Turn the main switch (**A**) to the "ON" position. The indicator lamp (**B**) lights up.	
3	Turn the key selector (**C**) to "automatic" position. Machine start-up has to be performed using the operator terminal of the machine to be cooled, via the "ENABLE" connection (see chapter "ENABLE, UNIT ERROR and UNIT WARNING connections" on page 551).	

Tab. 8-244: Switching on

Switching off

Switching off with the main switch 1. Turn the main switch (**A**) to the "OFF" position. • The indicator lamp (**B**) will switch off. • Machine operation stops and the voltage supply to the terminal box is interrupted. • The supply terminals remain live.	
Switching off with the key-operated switch This switch-off mode is reserved for authorized 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 terminal box at the machine remains live.	
Remote-controlled switch-off • Remote-controlled switch-off has to be performed using the owner's operator terminal, via the "ENABLE" connection. • Operation of the main pump stops. • The terminal box at the machine remains live.	
Switching off automatically • The machine switches off automatically if the pressure in the circuit falls below 0.2 bar and the temperature of the liquid exceeds the preset limit (see parameter P-0-1318).	

Tab. 8-245: Switching off

Switching off in emergency conditions

To switch off the device in the event of imminent danger (emergency stop), turn the main switch (**A**) to the "OFF" position.

Fix the cause for the emergency stop before restarting the machine.

Filling the hydraulic circuit

Check if the installation as well as electrical and hydraulic connections are executed professionally in accordance with the manufacturer's specifications.

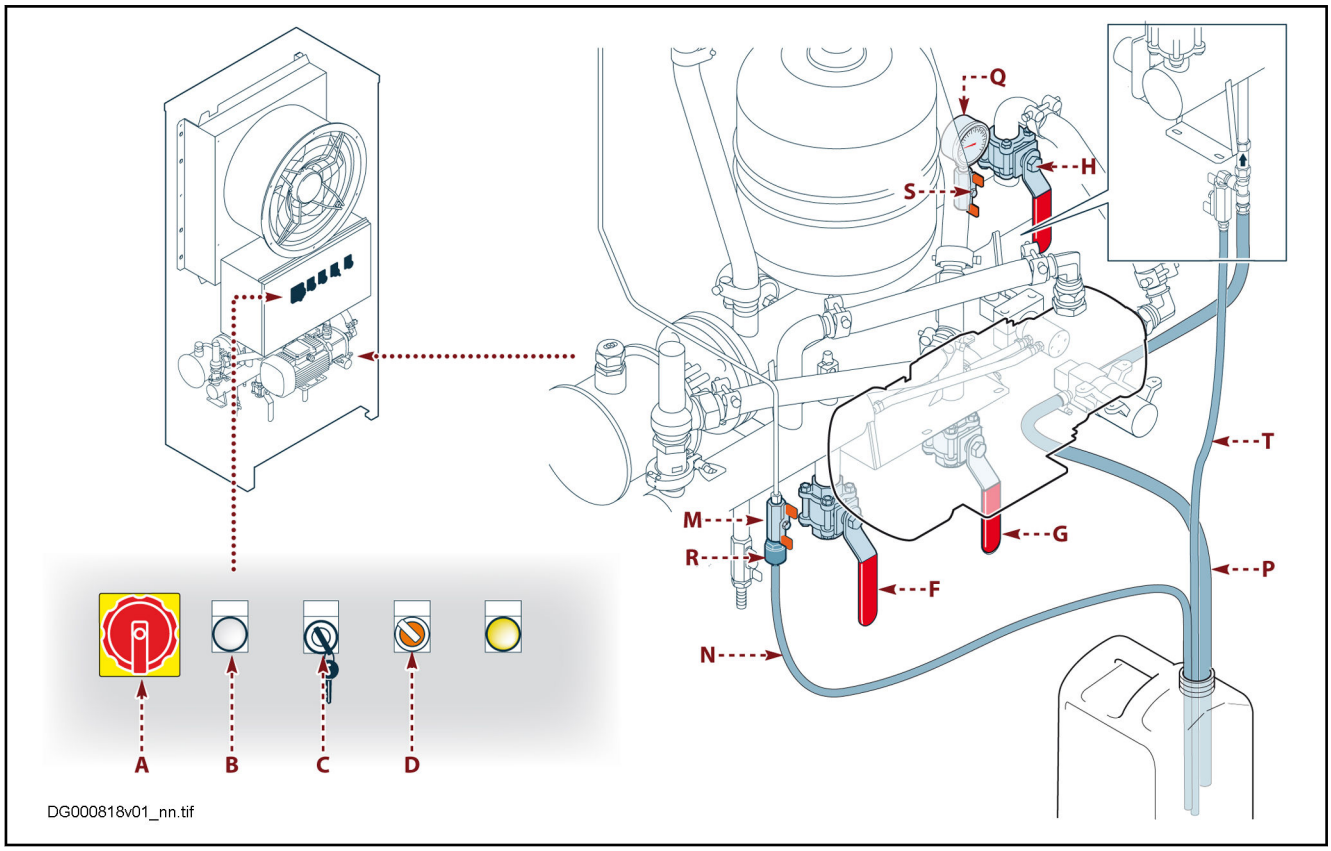


Fig. 8-157: Fill the hydraulic circuit

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 550).
2. Fit the pipes (**P - N - T**) into the tank.
3. Open the ball valve (**G**).
4. Open the ball valve (**F**).
5. Open the valve (**M**).

   If there is no liquid coming, clean the connector (**R**). See chapter "Cleaning the connector of the bleed valve" on page 575.
6. Open the valve (**S**).
7. Open the valve (**H**).
8. Turn the key-operated selector switch (**C**) to the "OFF" position to prevent unexpected activation of the main pump.
9. Ensure that the remote-controlled "ENABLE" function is activated.
10. **NOTICE!** Do **not** turn the selector switch (**C**) to the "ON" position since this could cause damage to the main pump.

    Open any existing valves that are installed outside the machine on the circuit of the machine to be cooled.
11. Turn the main switch (**A**) to the "ON" position.

    The indicator lamp (**B**) lights up.
12. Turn the selector switch (**D**) to activate the filling pump.

Make sure that there is always enough liquid in the tank.

If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 568).

13. When the fluid is running out of the clear tube (**N**) in a steady stream (no bubbles) and the pressure has reached 1.4 … 2.2 bar, turn the key-operated selector switch (**C**) to the "ON" position to activate the main pump in the automatic mode.

    The pressure is indicated on the (**Q**) pressure gauge.

    NOTICE! The filling pump is activated and deactivated automatically and keeps the pressure between 1.4 … 2.2 bar. 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. The pressure drop is caused by the air pumped into the circuit as a result of activation of the main pump. Make sure that the key-operated switch (**C**) is set to "ON".

14. Keep the main pump and the filling pump running for at least 30 minutes in order to rinse the cooling circuit thoroughly.

    NOTICE! 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.

    NOTICE! If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 568).

15. Turn the selector switch (**D**) to deactivate the filling pump.
16. Close the valve (**M**) when the pressure in the circuit has reached 1.5 bar.
17. Close the valve (**S**).
18. Remove the pipes from the tank.
19. Remove the key from the selector switch (**C**) and store in a safe place.

    After one hour of operation, check if the pressure is correct – if this is not the case, perform the restore operation (see chapter "Restoring the pressure" on page 569).

NOTICE! Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Filling pump priming procedure

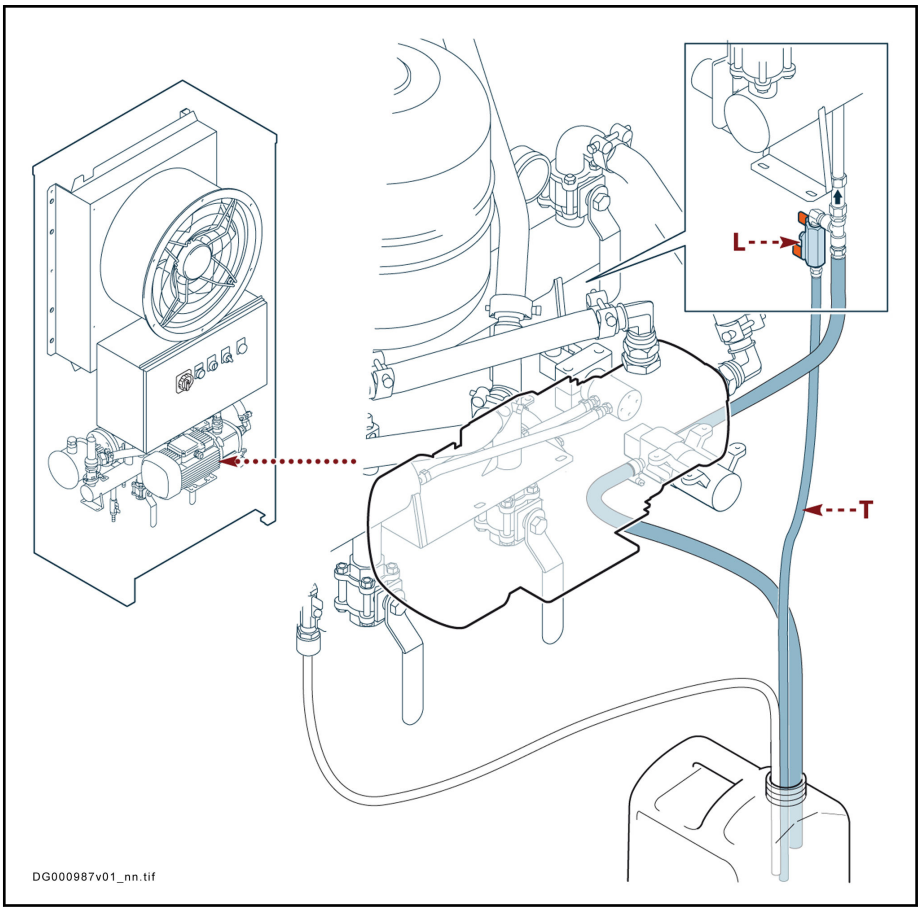


Fig. 8-158: Fill the hydraulic circuit

If the filling pump does not prime automatically, proceed as described:

1. When the filling pump is active, open the valve (**L**).
2. Wait for the coolant to start flowing out of the transparent hose (**T**).
3. Close the valve (**L**) and leave the filling pump working.

The filling pump is primed and starts pumping the coolant into the hydraulic circuit.

Restoring the pressure

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 "Filling the hydraulic circuit" on page 566).

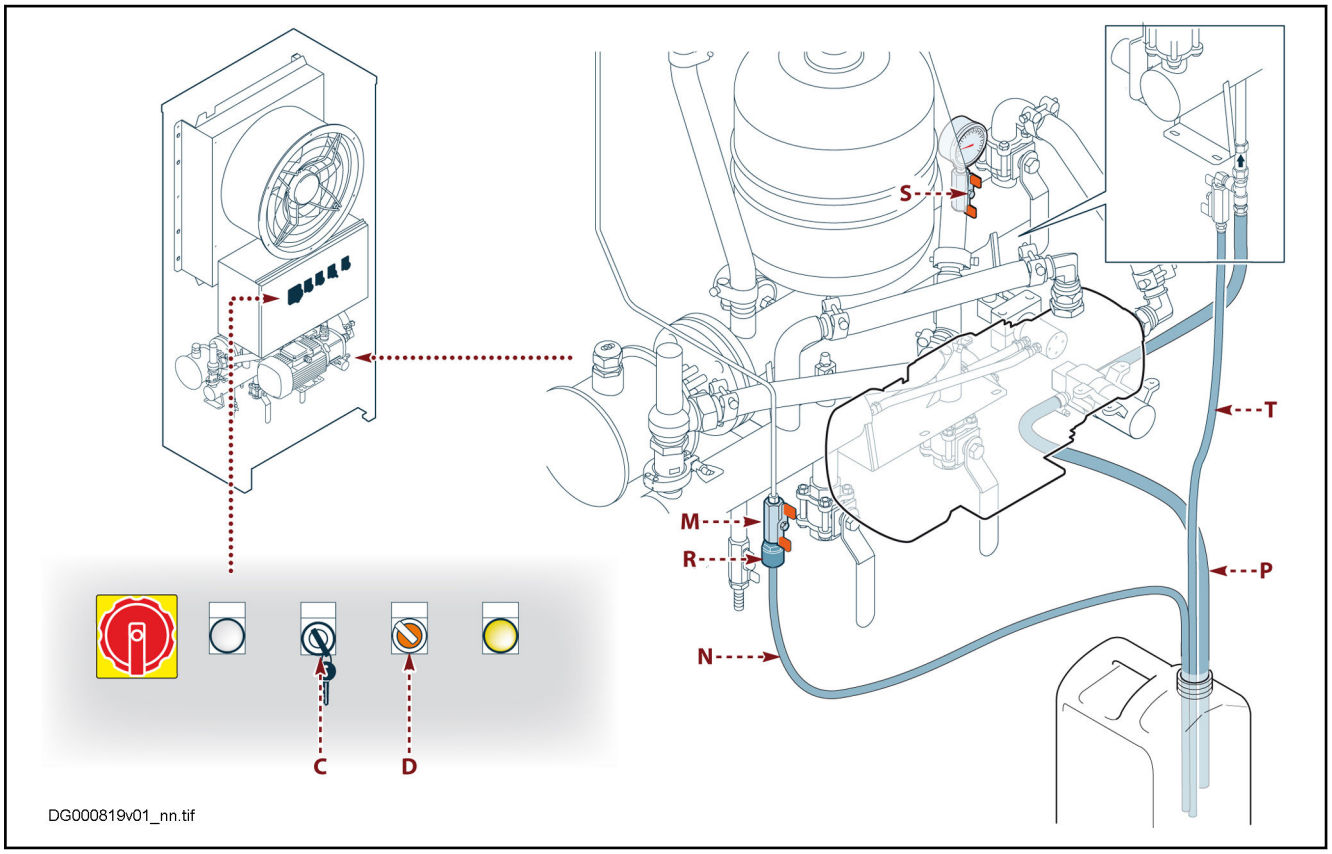


Fig. 8-159: Restoring the pressure

1. Fill a tank with an appropriate amount of fluid solution (see chapter "Data" on page 550).
2. Fit the pipes (**N - P - T**) into the tank.
3. Open the valve (**S**).
4. Turn the selector switch (**D**) to activate the filling pump. If the filling pump does not prime automatically, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 568).
5. Open the valve (**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.

   If there is no liquid coming, clean the connector (**R**). See chapter "Cleaning the connector of the bleed valve" on page 575.
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.

   NOTICE! If the filling pump priming stops during the filling stage, start the filling pump priming procedure (see chapter "Filling pump priming procedure" on page 568).

Close the valve (**M**).

7. Turn the selector switch (**D**) to deactivate the filling pump.
8. Close the valve (**S**).
9. Remove the pipes from the tank.
10. Remove the key from the selector switch (**C**) and store in a safe place.

NOTICE! Limit operation of the pressure gauge to the time necessary to perform the pressure reading. During operation, deactivate the pressure gauge to avoid damaging it.

Emptying the hydraulic circuit

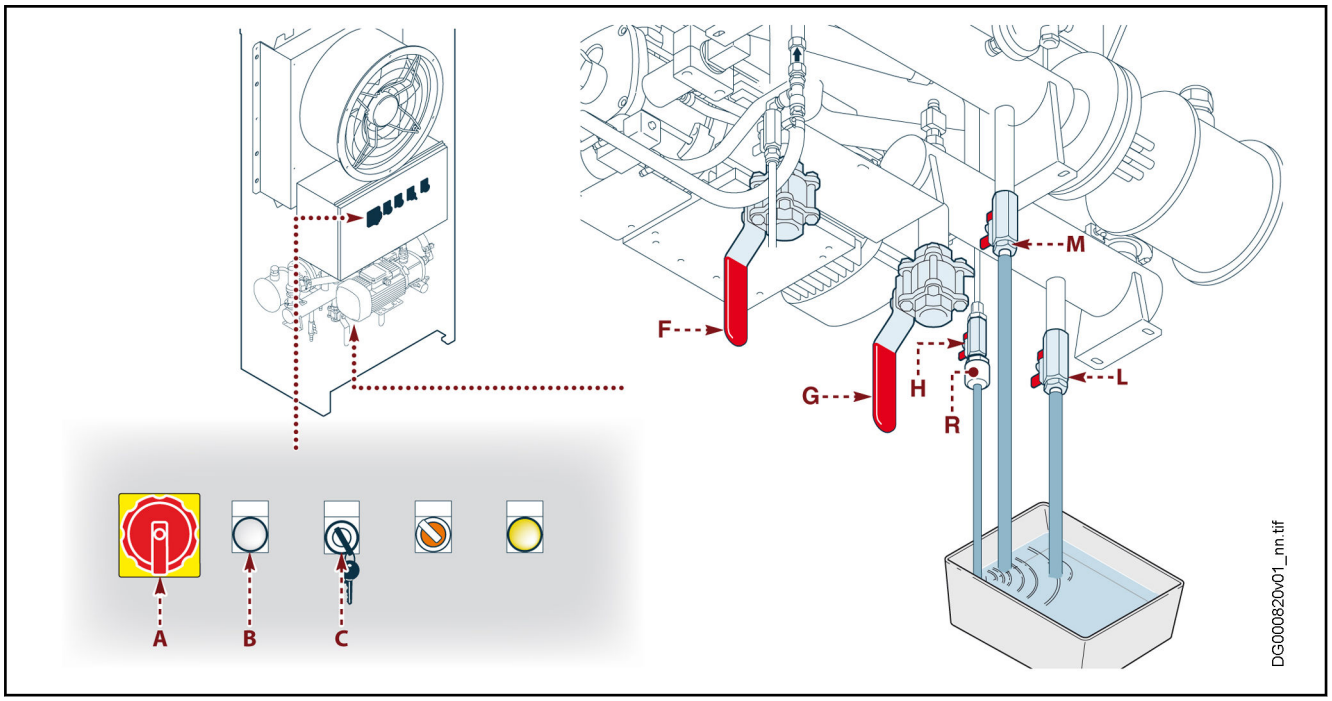


Fig. 8-160: Emptying the hydraulic circuit

1. Position a suitable container for collecting the coolant.
2. Switch off the machine (see chapter "Switching off" on page 565).
3. Turn the key selector (**C**) to the "OFF" position.
4. Turn the main switch (**A**) to the "OFF" position.
5. The indicator lamp (**B**) will switch off.
6. Close the ball valves (**F - G**).
7. Open the valve (**H**).

   If there is no liquid coming, clean the connector (**R**). See chapter "Cleaning the connector of the bleed valve" on page 575.
8. Open the valve (**L**).
9. Open the valve (**M**).
10. Drain out all the coolant.
11. Close the valve (**M**).
12. Close the valve (**L**).
13. Close the valve (**H**).

    NOTICE! Dispose of the coolant in an environmentally friendly manner in accordance with the applicable legal regulations.

Resetting the safety temperature controller of the heater

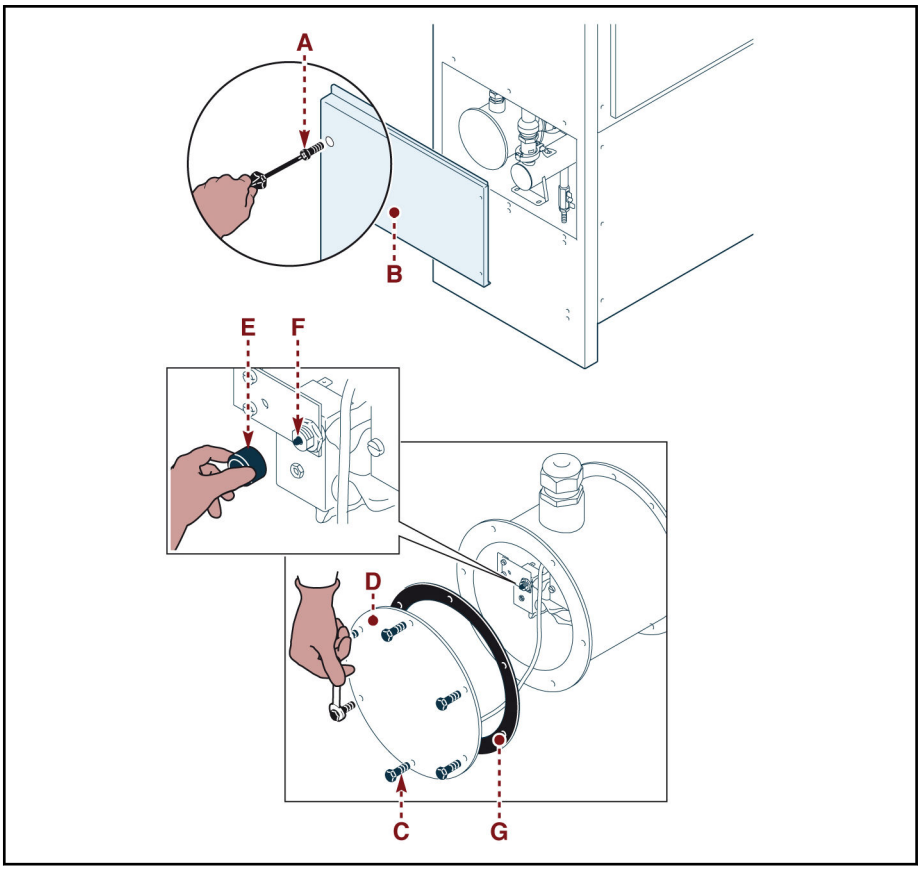


Fig. 8-161: Resetting the safety temperature controller of the heater

1. Disconnect the machine from the voltage source.
2. Allow the machine to cool down.
3. Remove the screws (**A**).
4. Remove the guard (**B**).
5. Remove the screws (**C**).
6. Remove cover (**D**).
7. Remove the lid (**E**).
8. Push the button (**F**).
9. Screw on the lid (**E**).
10. Adjust the gasket (**G**).
11. Adjust the cover (**D**) without damaging the gasket.
12. Tighten the screws (**C**).
13. Insert the guard (**B**).
14. Tighten the screws (**A**).

Maintenance

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.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

Maintenance schedule

Interval			Component	Type of work	Cross reference
Every 5000 operating hours	Every 30,000 operating hours	Every 10 years of operation	–	–	–
✓	–	–	Cooler - cooling channel	Cleaning	See chapter "Cleaning the cooler and cooling channel" on page 573
–	✓	–	Main pump	Replacement	See chapter "Replacing the main pump" on page 580
–	✓	–	Cooling fan	Replacement	See chapter "Replacing the electric fan" on page 581
–	✓	–	Coolant	Replacement	See chapter "Exchanging the coolant" on page 585
–	–	✓	EPDM rubber hoses	Replacement	–

Tab. 8-246: Maintenance schedule

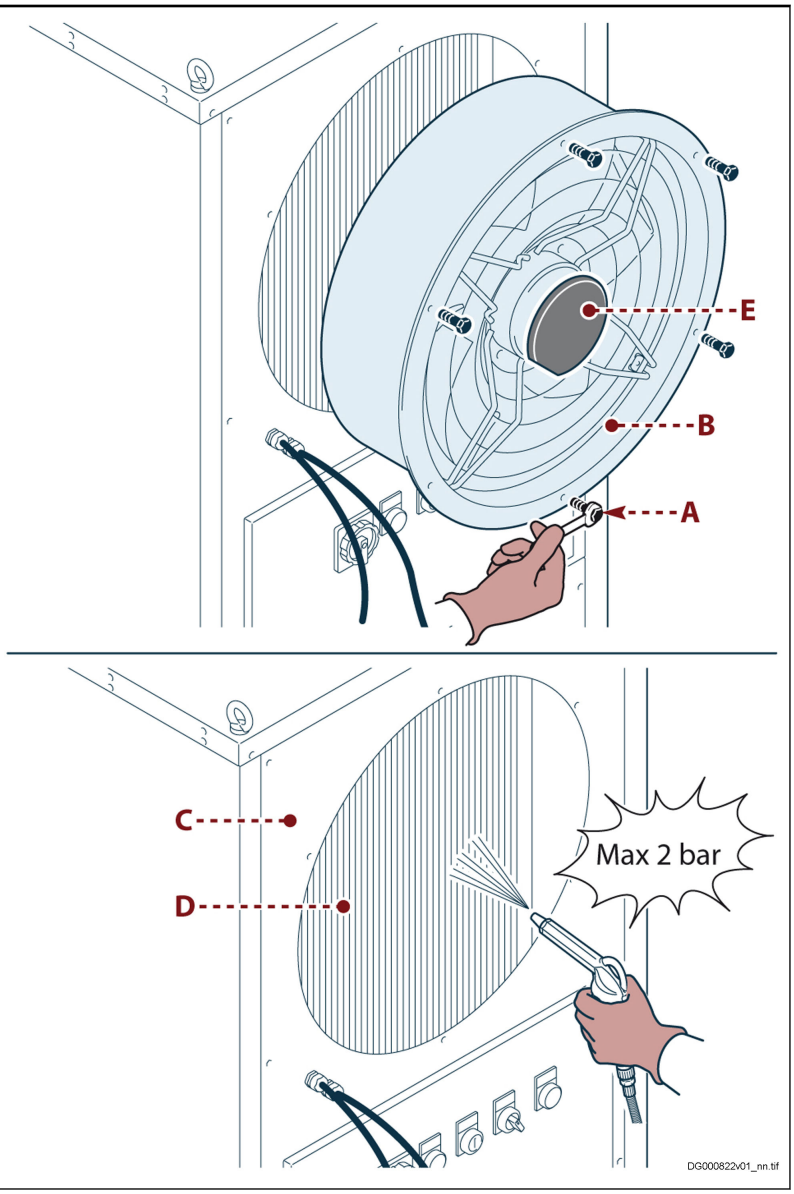
Cleaning the cooler and cooling channel

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

Due to the use of capacitors and even after the machine's power supply has been disconnected, there is a serious risk of electric shock by contact with live parts.

Before removing the cover, always wait several minutes after disconnecting the electricity to the machine.

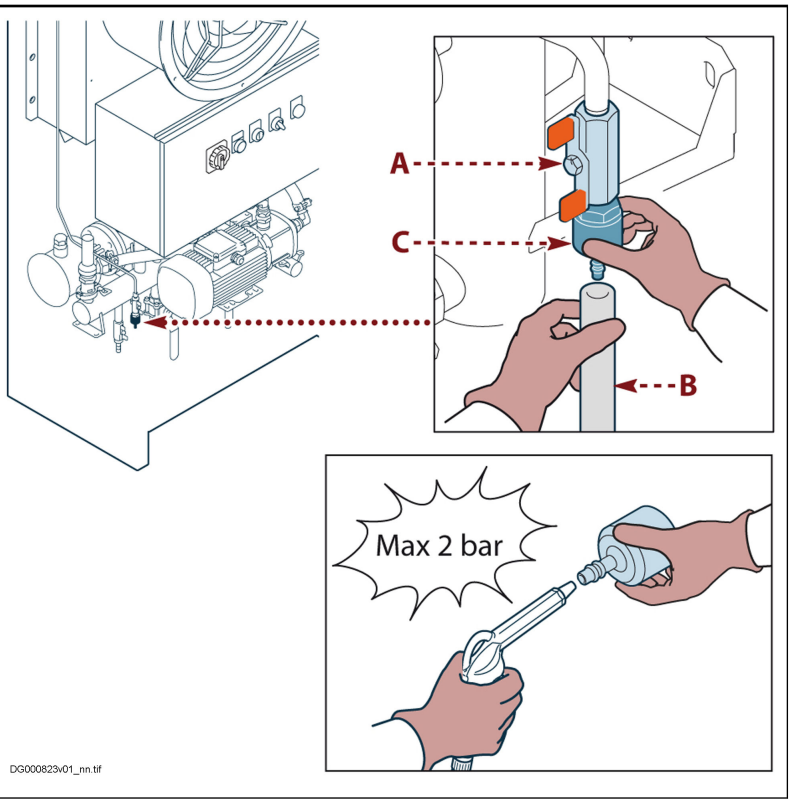
Make sure voltage has fallen below 50 V before touching live parts!

1	Disconnect the machine from the voltage source.	
2	Remove the protective cover (**E**).	
3	Remove the cable from the connection terminals.	
4	Unscrew the screws (**A**).	
5	Remove the electric fan unit (**B**).	
6	Suction the cooling channel (**C**) to remove dust and dirt.	
7	Clean the inside of the cooler (**D**) with compressed air. Keep the pressure on the level indicated in the picture.	
8	Suction the cooling channel (**C**) again.	
9	Insert the electric fan unit (**B**).	
10	Tighten the screws (**A**).	
11	Connect the cables (observe the wiring diagram).	
12	Put on the protective cover (**E**).	

Tab. 8-247: Cleaning the cooler and the cooling channel

Cleaning the connector of the bleed valve

1	Close the bleed valve (**A**).
2	Remove the hose (**B**).
3	Unscrew the connector (**C**).
4	Clean the connector with compressed air. Keep the pressure on the level indicated in the picture.
5	Screw on the connector (**C**).
6	Attach the hose (**B**) to the connector.
7	Open the bleed valve (**A**).



Tab. 8-248: Cleaning the connector

Cleaning the machine

Clean the machine with detergents that are approved in accordance with the applicable legal regulations.

Troubleshooting

The following table contains a number of faults that may occur during operation as well as appropriate corrective measures.

Code	Type	Malfunction	Likely cause	Remedy
E2011	Warning 1	Low pressure, please refill	The system pressure is lower than 0.5 bar (loss of water, maintenance)	Refill cooling system up to 1.5 bar
E2012	Warning 2	Unable to start drive	Motor does not start in velocity control operation	Ensure that the system has the status "AF" before starting
E2013	Warning 3	Heater works	The heater switches on if the temperature of the liquid falls below 0°C.	Check operating temperature Check signal of the temperature sensor
E2014	Warning 4	Overtemperature	Temperature exceeds the defined value (P-0-1316) of the maximum permissible deviation from required temperature (t_{set}) for a defined duration (P-0-1317)	Check cooling system Clean cooling system, if necessary Reduce the level of the heat to be dissipated. If required, change the settings in the parameters P-0-1316 and/or P-0-1317
E2015	Warning 5	Fan	Fan signals error	Check fan and feedback signal
E2016	Warning 6	Lower motor speed limitation active	Motor velocity of the pressure control < 360 min^{-1}	Increase the value of parameter P-0-1374 (> 360 min^{-1}) Ensure that the motor can run with a velocity > 360 min^{-1}
F2011	Error 1	System pressure	System pressure lower than 0.2 bar	Refill cooling system up to 1.5 bar
F2012	Error 2	Overtemperature	The fluid temperature (on the drive side) has exceeded the maximum allowed temperature limit (see parameter P-0-1318)	If required, change the value of parameter P-0-1318 Clean fan Reduce the quantity of heat to be emitted
		Temperature of the heater is too high (yellow signal lamp lights up)	Thermostat of the heater is triggered	Check signal of the temperature sensor
		Heater does not heat	Thermostat of the heater was triggered in order to enable operation without liquid	Check the pressure of the cooling circuit and restore, if applicable
F2013	Error 3	Fan	Defective fan Fuses defective	Replace fan Replace fuses
		Slight leakage of cooling liquid between pump and motor	Start after long inactivity of the machine Changing the ambient conditions	Start pump [1)]

Code	Type	Malfunction	Likely cause	Remedy
		The filling pump does not start priming automatically	Suction hose empty following long period of machine disuse No coolant in the tank High backpressure in the filling pump delivery line	Perform the filling pump priming procedure
		The filling pump does not inject the coolant into the circuit	The filling pump is not primed The filling pump bleed valve is open	Perform the filling pump priming procedure Close the filling pump bleed valve

1) The pump is mechanically sealed by the cooling liquid. This type of seal (mechanical) may lead to a slight leakage of cooling liquid under certain conditions. It takes some time to minimize the leakage if the pump is started after stopping the machine or after being inactive. The required time depends on the operating conditions. The leaked cooling liquid usually evaporates immediately. The leaked cooling liquid is not visible then. **This type of leakage is not a malfunction.** Contact the service if the leakage persists for a longer period of time.

Tab. 8-249: Errors and warnings

Replacing the component

Safety advice for component exchange

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.

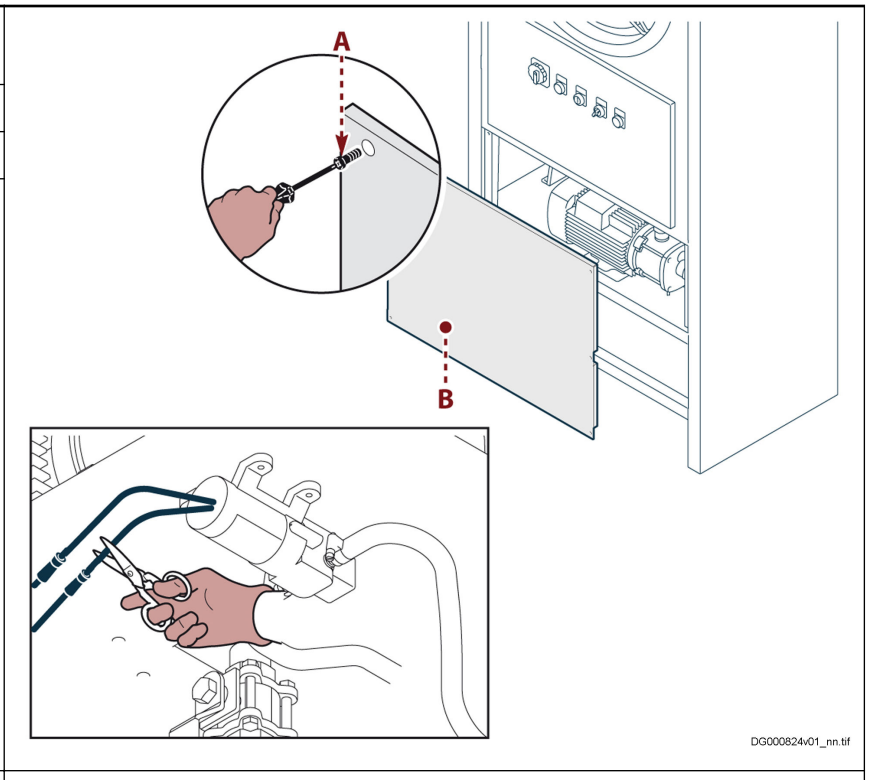
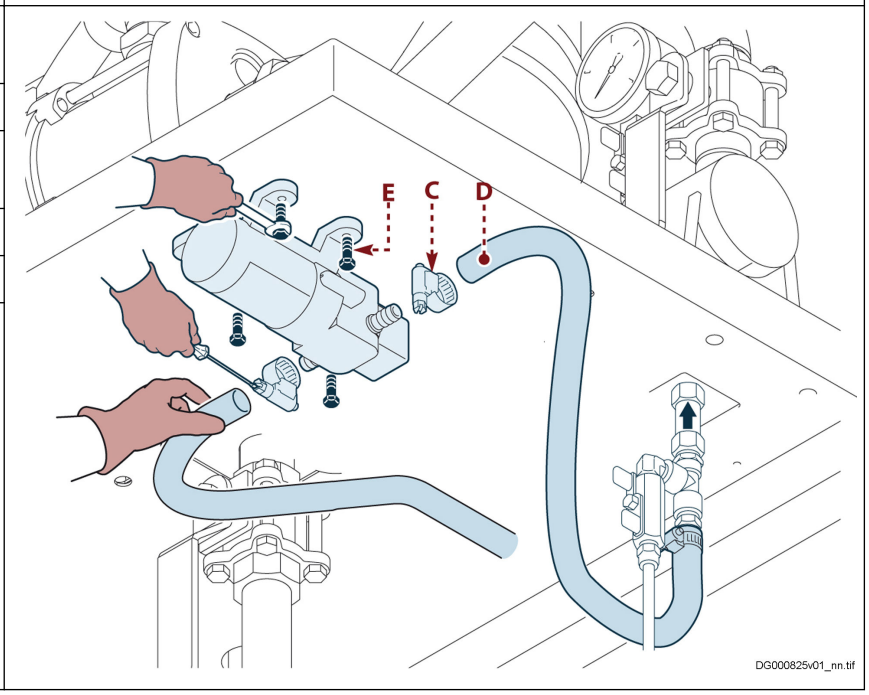
In particular, disconnect the power supply to the machine.

Ensure that the voltage cannot be switched on again unintentionally.

Allow the machine to cool down before any operation to prevent burns.

Replace worn or damaged parts by original spare parts.

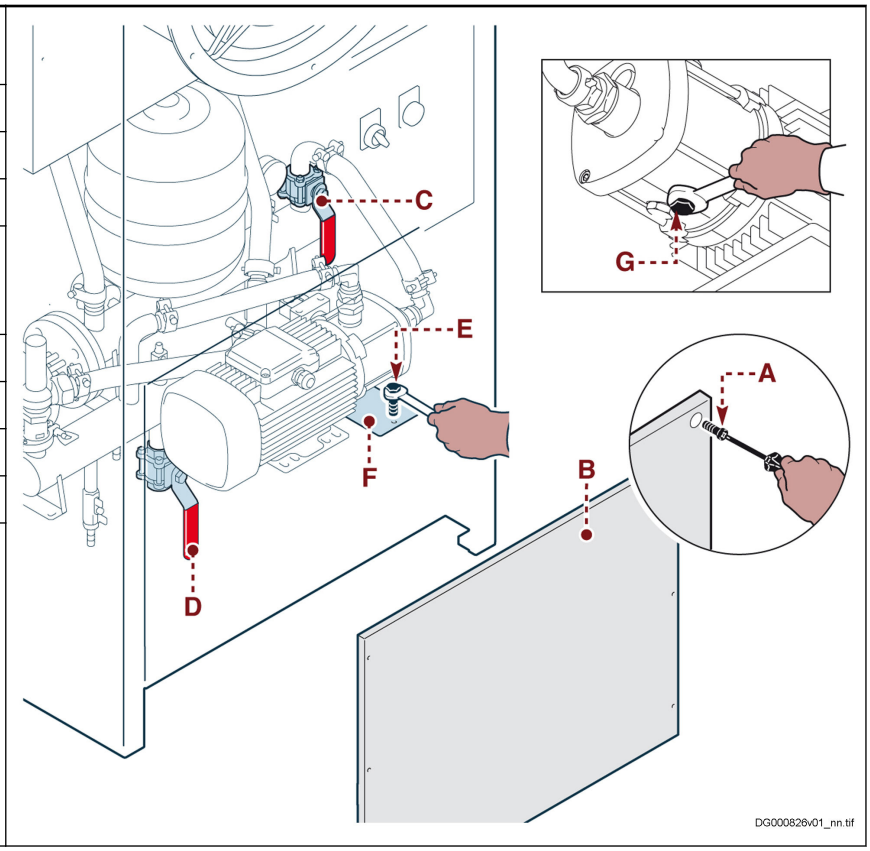
Replacing the filling pump

1	Disconnect the machine from the power supply source.	
2	Unscrew the screws (**A**).	
3	Remove the fixed guard (**B**).	
4	Cut the mains cables.	
5	Undo the screw and remove the strap (**C**).	
6	Extract the hose (**D**).	
7	Repeat the same operations to remove the other flexible tube.	
8	Unscrew the screws (**E**).	
9	Remove the pump.	
10	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump.	

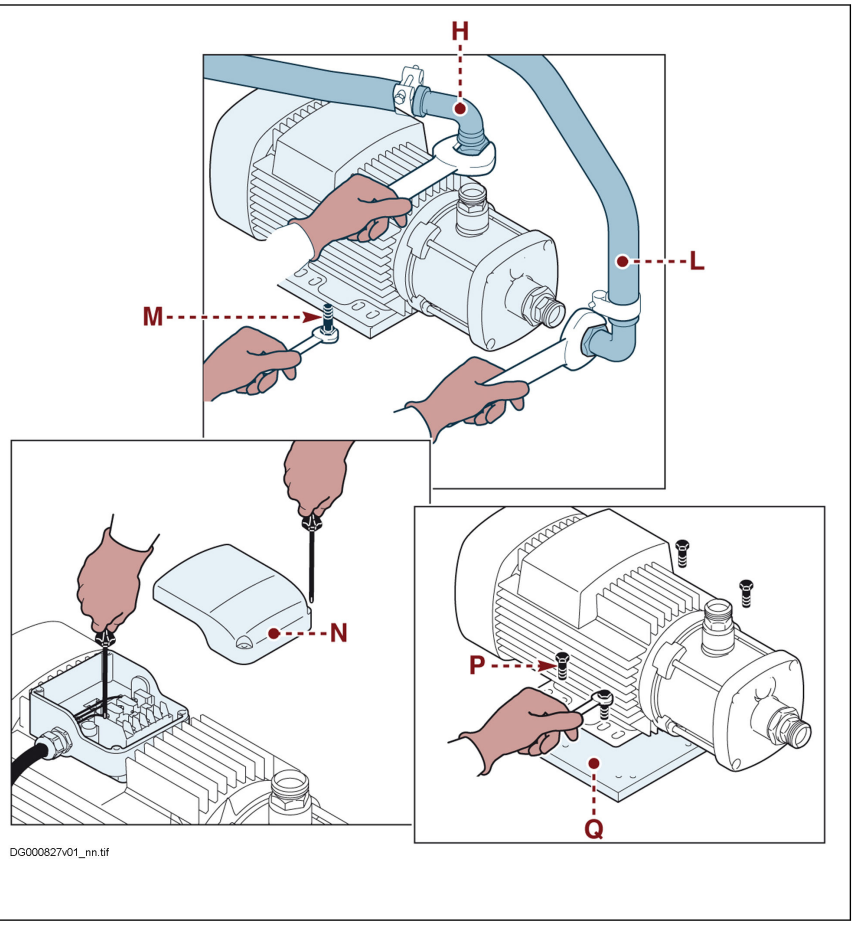
Tab. 8-250: Replacement of the filling pump

Replacing the main pump

1	Disconnect the machine from the power supply source.
2	Allow the machine to cool down.
3	Unscrew the screws (**A**).
4	Remove the fixed guard (**B**).
5	Empty the hydraulic circuit of the machine (see chapter "Emptying the hydraulic circuit" on page 571).
6	Close the valve (**C**).
7	Close the valve (**D**).
8	Unscrew the screw (**E**).
9	Remove the fixed guard (**F**).
10	Unscrew the lid (**G**). Discharge the entire cooling liquid.



11	Disconnect the hosing (**H**).
12	Disconnect the hosing (**L**).
13	Unscrew the screws (**M**).
14	Remove the pump.
15	Remove the cover (**N**).
16	Disconnect the cables from the terminals.
17	Unscrew the screws (**P**).
18	Remove the plate (**Q**).
19	Install the new pump. In order to install the new pump, proceed in reverse order to the removal of the pump. **NOTICE!** The spare pump is supplied with the fittings mounted. Do not remove the fittings as cooling liquid may leak.
20	Open the valve (**C**).
21	Open the valve (**D**).
22	Fill the cooling circuit. See chapter "Filling the hydraulic circuit" on page 566.



Tab. 8-251: Replacement of the main pump

Replacing the electric fan

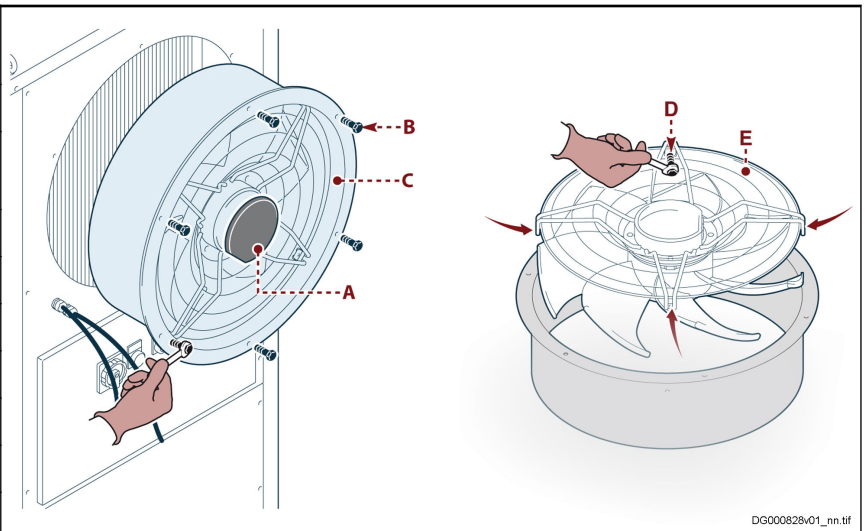
⚠ WARNING **Lethal electric shock from live parts with more than 50 V!**

Due to the use of capacitors and even after the machine's power supply has been disconnected, there is a serious risk of electric shock by contact with live parts.

Before removing the cover, always wait several minutes after disconnecting the electricity to the machine.

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

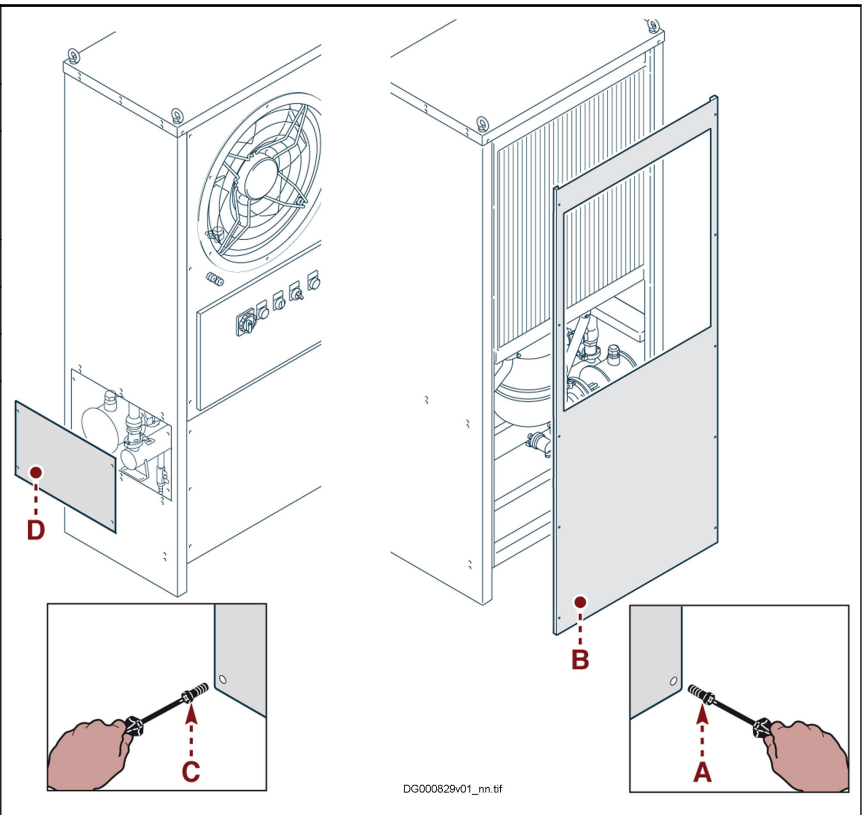
1	Disconnect the machine from the power supply source.
2	Remove the cover (**A**).
3	Disconnect the cables from the terminals.
4	Unscrew the screws (**B**).
5	Remove the electric fan unit (**C**).
6	Unscrew the screws (**D**).
7	Remove the electric fan (**E**).
8	Insert the electric replacement fan.
9	Tighten the screws (**D**).
10	Insert the electric fan unit.
11	Tighten the screws (**B**).
12	Connect the lines (using the wiring diagram).
13	Reattach the cover (**A**).

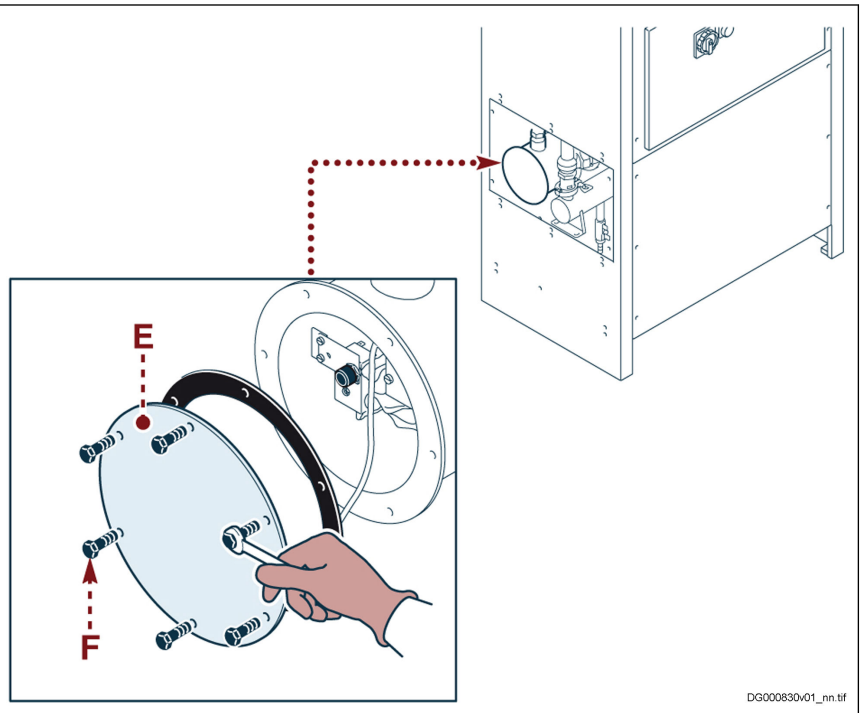
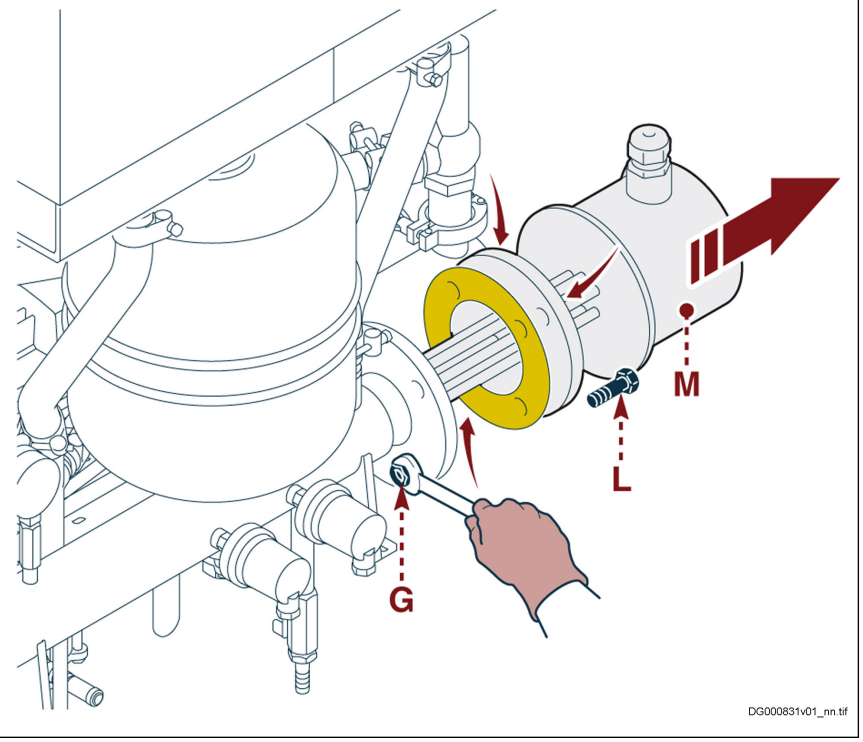


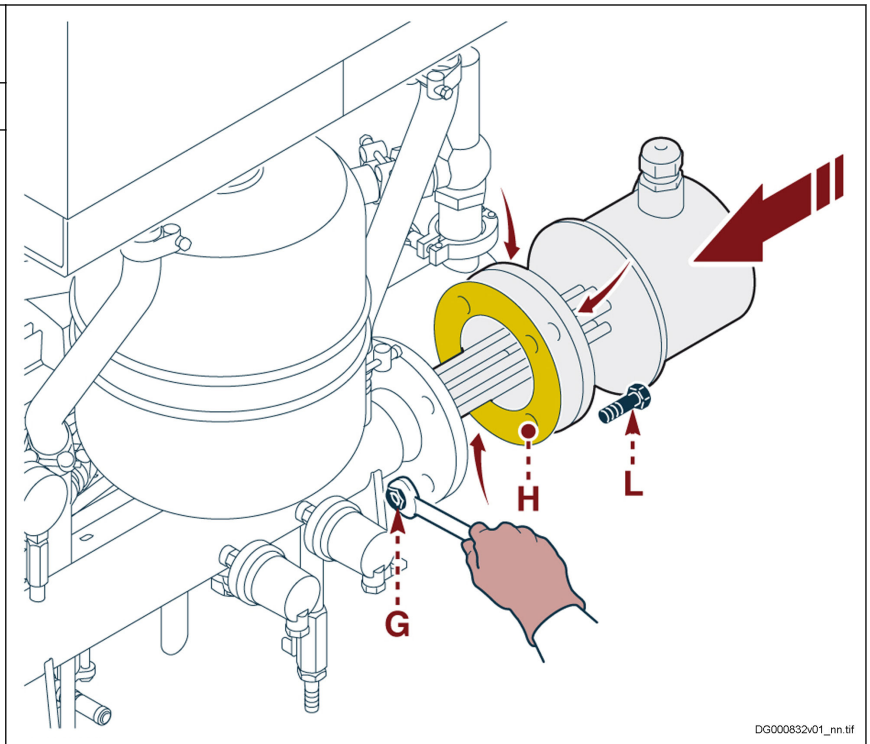
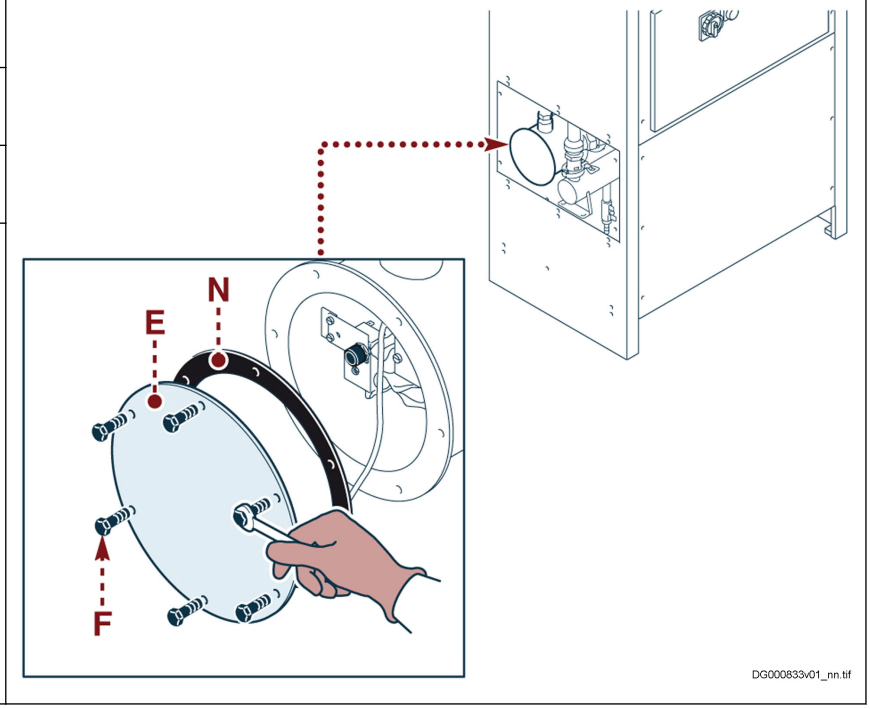
Tab. 8-252: Replacement of the electric fan

Replacing the heater

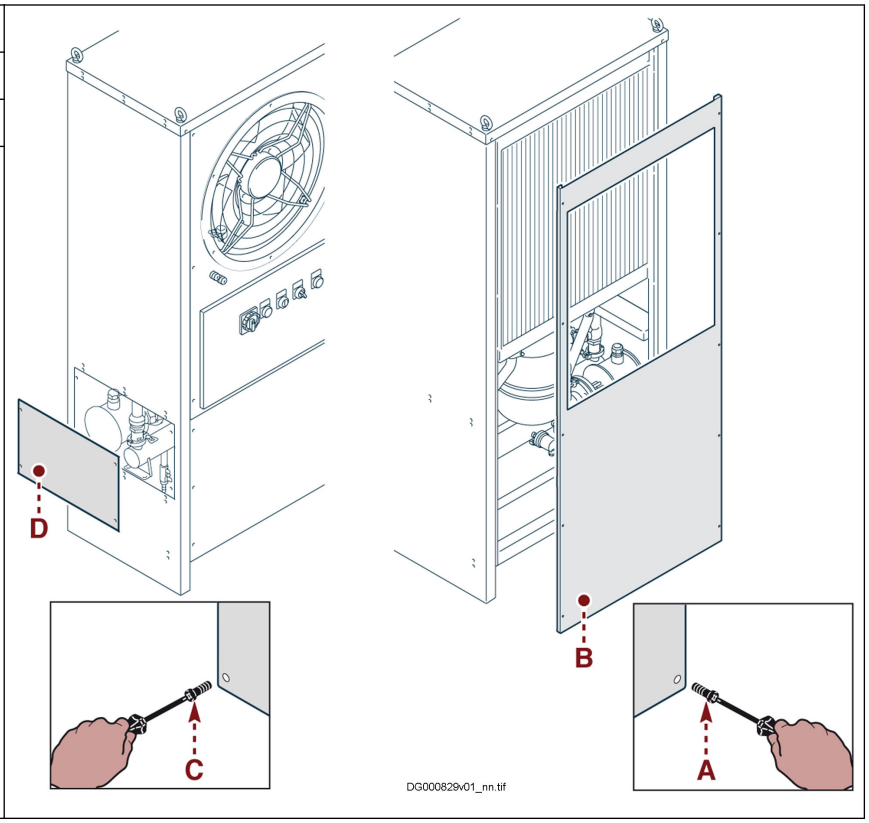
1	Disconnect the machine from the power supply source.
2	Allow the machine to cool down.
3	Empty the hydraulic circuit (see chapter "Emptying the hydraulic circuit" on page 571).
4	Unscrew the screws (**A**).
5	Remove the guard (**B**).
6	Unscrew the screws (**C**).
7	Remove the guard (**D**).



8	Unscrew the screws (**F**).	
9	Remove the cover (**E**).	
10	Disconnect the cables from the terminals.	
11	Unscrew the nuts (**G**).	
12	Unscrew the screws (**L**).	
13	Remove the heater (**M**).	

14	Position the new heater without damaging the gasket (**H**).	
15	Insert the screws (**L**).	
16	Tighten the nuts (**G**).	
17	Remove the cover of the new heater.	
18	Connect the cables (see wiring diagram).	
19	Position the cover (**E**) without damaging the gasket (**N**).	
20	Tighten the screws (**F**).	

21	Place the guard (**D**).
22	Tighten the screws (**C**).
23	Place the guard (**B**).
24	Tighten the screws (**A**).



Tab. 8-253: Replacing the heater

Replace fuses

Before replacing the fuse, fix the cause of the malfunction.

Only replace the interrupted fuse with a fuse with the same characteristics.

For the characteristics of the fuses see chapter "Description of the fuses" on page 553.

Exchanging the coolant

Empty the hydraulic circuit of the machine (see chapter "Emptying the hydraulic circuit" on page 571).

Fill the hydraulic circuit (see chapter "Filling the hydraulic circuit" on page 566).

Disposing of old equipment

Scrapping operations must be handled by specialized personnel with suitable skills for the job.

In accordance with the applicable regulations, all individual components must be collected separately for disposal according to their chemical properties when dismantling the machine.

With reference to the European Directive (RAEE), electric and electronic components must either be disposed of in authorized landfill sites or the machine, complete of the said parts, must be returned to the dealer in case of a new purchase.

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.

Control with MLD

Pressure control

The differential pressure between the machine's intake and its outlet has to be kept at a constant rate (1.5 bar, for example) so that the flow to the devices to be cooled can be easily set.

To control the pressure, the pump speed is varied based on the intake/outlet differential pressure.

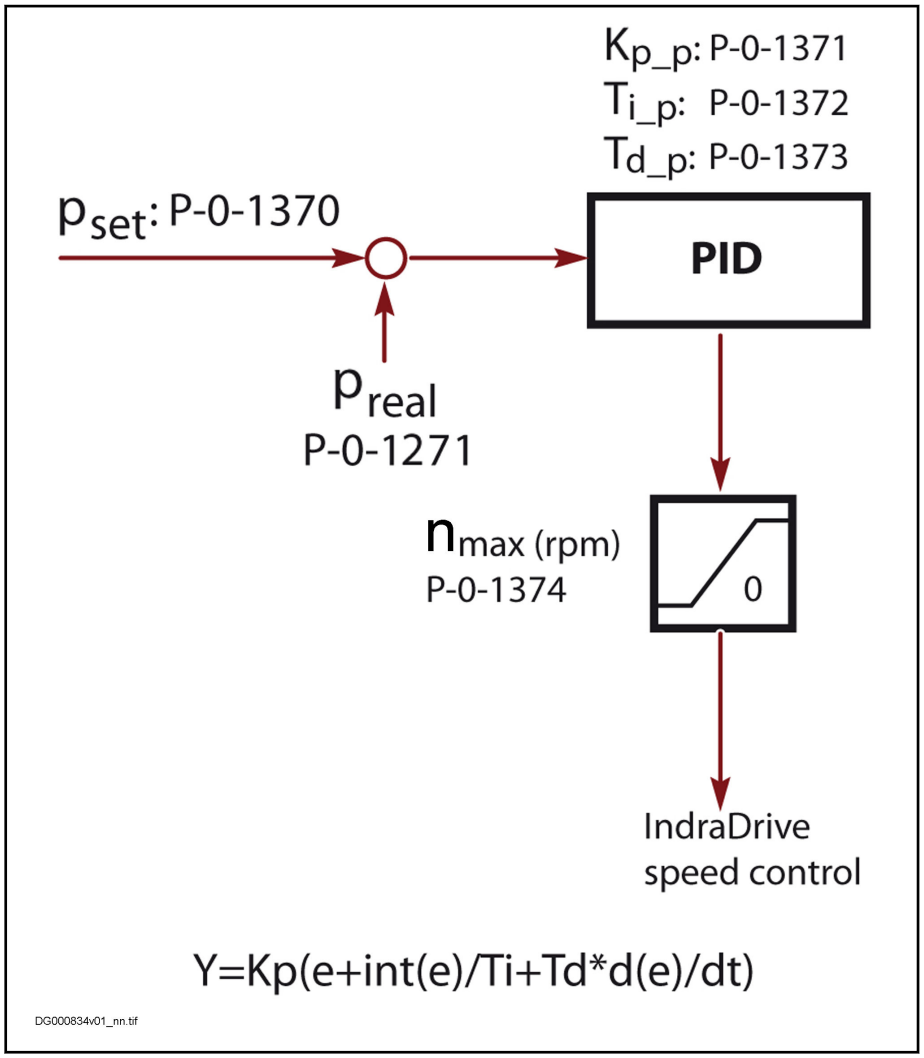


Fig. 8-162: Pressure control

Name	Parameter	Unit
p_{set}	P-0-1370	bar
K_{p_p}	P-0-1371	min^{-1}/bar
T_{i_p}	P-0-1372	s
T_{d_p}	P-0-1373	s

Name	Parameter	Unit
n_{max}	P-0-1374	min^{-1}
p_{real} (*)	P-0-1271	bar

* Read only

Tab. 8-254: Pressure control parameters

Temperature control

The temperature of the fluid in the drive circuit has to be kept at a constant value (between 40 °C and 60 °C) to prevent condensation from forming in the devices to be cooled.

The temperature of the fluid is controlled by a variable speed electric fan which cools the fluid flowing through the heat exchanger.

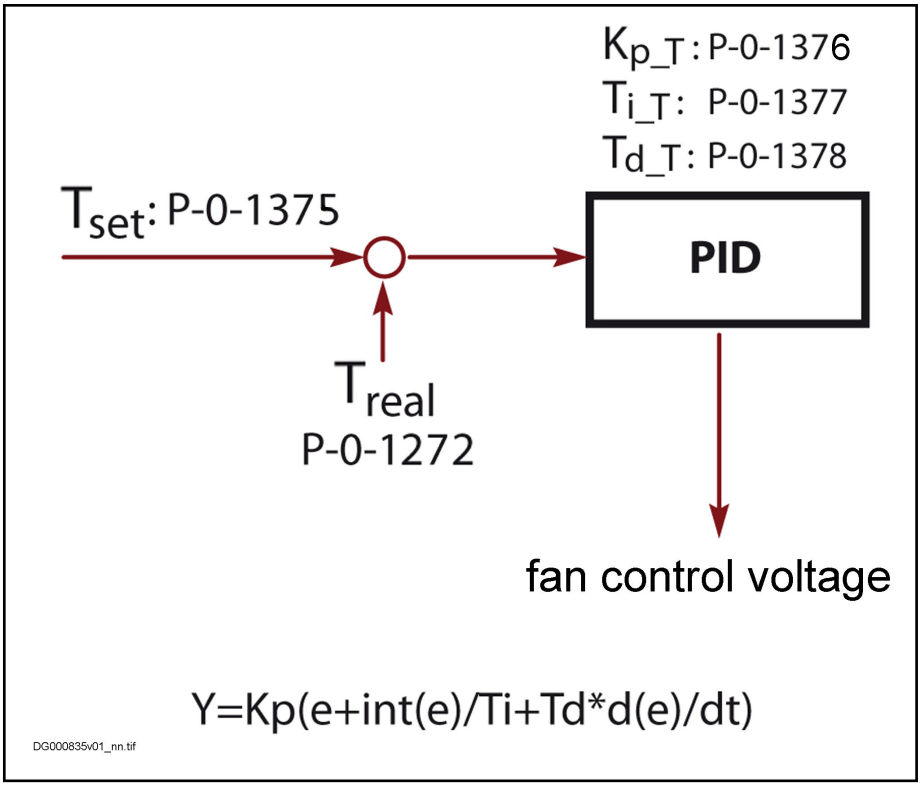


Fig. 8-163: Temperature control

Name	Parameter	Unit
T_{set}	P-0-1375	°C
K_{p_T}	P-0-1376	V / °C
T_{i_T}	P-0-1377	s
T_{d_T}	P-0-1378	s
T_{real} (*)	P-0-1272	°C
T_{real} (*)	P-0-1273	°F

* Read only

Tab. 8-255: Temperature control parameters

Starting the machine

The machine is started (as per the predefined setting) solely with the digital command:

ENABLE (X31.1, P-0-1390)

You can set the type of machine enabling (starting via digital input or starting via the communication).

Start	Parameters	Input
Start selection 1	P-0-1380	digital
Start selection 2	P-0-1381	digital
Start command via communication	P-0-1382	digital

Tab. 8-256: Start options

The parameters **P-0-1380 and P-0-1381** can be set to "0" or "1".

If both parameters are set to the **same value** (0 or 1), the machine can be started via the digital input with **P-0-1390** (0 = off, 1 = on).

If both parameters are set to **different values**, the machine can be started via the communication with **P-0-1382** (0 = off, 1 = on).

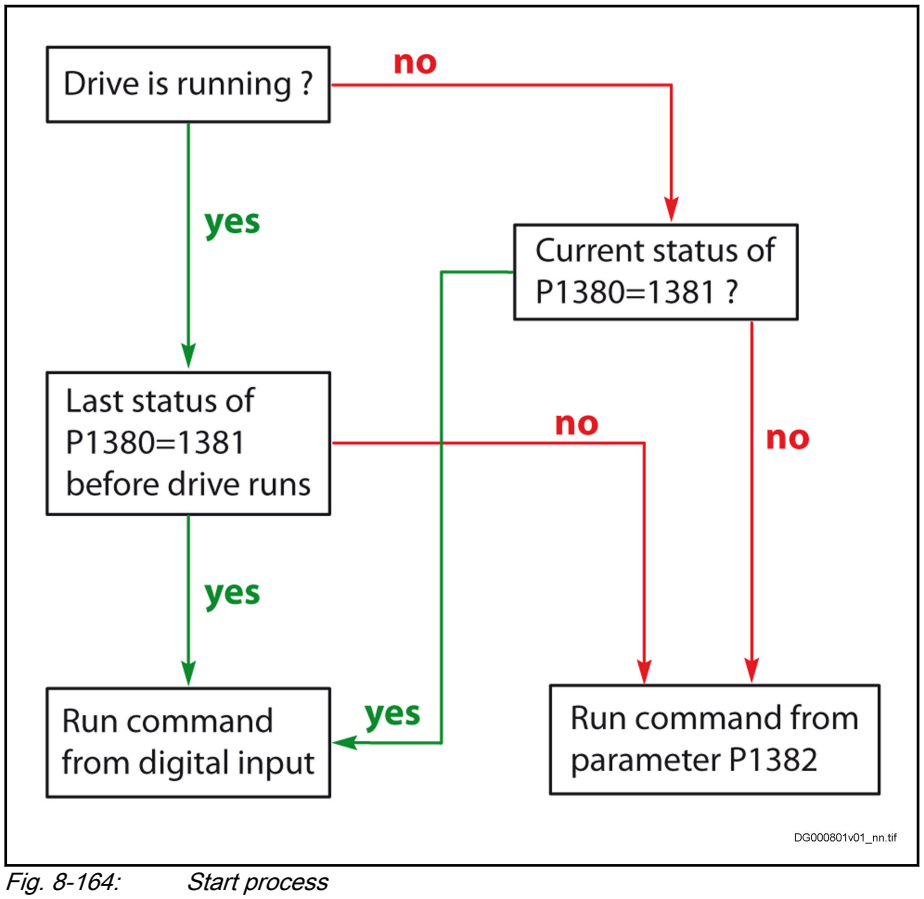


Fig. 8-164: Start process

Example: By setting the parameter P-0-1380 as a digital input and monitoring the parameters P-0-1381 and P-0-1382 via the PLC, the power-up command

for the machine can be transmitted either via the digital input or the PLC, from two different workstations.

Heating function (optional)

This feature is only available for machines equipped with an additional heater.

Heater operation is controlled automatically based on the temperatures of the fluid.

To measure the temperature, the same sensor is used as for temperature control.

The heater is switched on when the fluid temperature is below 0 °C and is switched off when the fluid temperature is above 30 °C.

When the heater has been switched on, the display at the drive controller shows "Heater is working".

Parameters

Name	Parameter	Unit	Minimum value	Maximum value	012-020	020-090	035-090
p_{set} (pressure command value)	P-0-1370	bar	0	2.0	1.5	1.5	1.5
K_p (pressure control)	P-0-1371	min^{-1}/bar	0	10000	40	40	40
T_i (pressure control)	P-0-1372	s	0.0	1000.0	0.05	0.05	0.05
T_d (pressure control)	P-0-1373	s	0.0	1000.0	0.0	0.0	0.0
n_{max}	P-0-1374	min^{-1}	0	8000	3000	3000	3000
Temperature setpoint	P-0-1375	°C	0	60	50	50	50
K_p (temperature control)	P-0-1376	V / °C	-1000.0	0.0	-0.5	-0.5	-5.0
T_i (temperature control)	P-0-1377	s	0	10000	10	10	40
T_d (temperature control)	P-0-1378	s	0.0	1000.0	0.0	0.0	0.0
Start selection 1	P-0-1380	-	0	1	0	0	0
Start selection 2	P-0-1381	-	0	1	0	0	0
Start command via communication	P-0-1382	-	0	1	0	0	0
p_{set_2} (pressure command value 2)	P-0-1385	bar	0.0	2.0	0.2	0.2	0.2
Control word switching to p_{set_2}	P-0-1295	bit	-	-	0	0	0
High temperature warning differential value	P-0-1316	°C	0	20	10	10	10
High temperature warning time	P-0-1317	s	0	100	3	3	3
Overtemperature limit value	P-0-1318	°C	40	100	90	90	90
Starting temperature control cabinet fan	P-0-1319	°C	0	70	50	50	50
Tolerance pressure control	P-0-1320	bar	0.0	10.0	0.5	0.5	0.5
Low motor velocity - deceleration	P-0-1321	s	0	100	5	5	5

Tab. 8-257: Parameters

Name	Parameter	Unit	Type *	Scaling
Analog I/O monitoring parameters (read-only)				
Fan control voltage	P-0-1270	V	AO	0-10 V, 0-100%
Pressure difference pump	P-0-1271	bar	-	-
Cooling water temperature	P-0-1272	°C	-	-
Cooling water temperature	P-0-1273	°F	-	-
Pressure sensor	P-0-1280	V	AI	0-10 V, 0-6 bar
Temperature sensor	P-0-1281	V	AI	0-10 V, -50-100 °C
Digital I/O parameters				
Drive enable	P-0-1390	bit 0	DI	
Pressure monitoring > 0.5 bar	P-0-1391	bit 0	DI	
Pressure monitoring > 0.2 bar	P-0-1391	bit 1	DI	
Fan monitoring	P-0-1391	bit 2	DI	TRUE for "Fan OK"
Status word machine	P-0-1410			
Cooler is running	P-0-1410	bit 0		Start command + P-0-1410.4 + no warning + no error
Pressure command value attained	P-0-1410	bit 1		abs(P-0-1370 - P-0-1271) < P-0-1320
Cooler is running (warning ignored)	P-0-1410	bit 3		Start command + P-0-1410.4 + no error
Motor is running	P-0-1410	bit 4		Motor velocity (S40) ≥ 360
Drive warning	P-0-1412	bit 0	DO	"high" for no warning
Drive error	P-0-1412	bit 1	DO	"high" for no error
Heater enable	P-0-1412	bit 2	DO	
Fan enable	P-0-1412	bit 3	DO	
Housing fan enable	P-0-1412	bit 4	DO	

* AI: analog input; AO: analog output; DI: digital input; DO: digital output

Tab. 8-258: Parameters

Switching the pressure command value

The pressure command value can be switched via control word (P-0-1295.0). This function can be used for a more economical operation (lower energy consumption, less wear) if the new pressure command value is set to a lower value.

Pressure command value (p_{set})	P-0-1370
Pressure command value 2 (p_{set_2})	P-0-1385
Control word	P-0-1295.0
P-0-1295.0 = 0	Pressure command value: P-0-1370
P-0-1295.0 = 1	Pressure command value: P-0-1385

Tab. 8-259: Switching the pressure command value

With a pressure command value of 0.2 bar instead of 1.5 bar, laboratory measurements showed energy savings of 92% (40 W instead of 500 W). The motor speed decreased from 2200 min^{-1} to 760 min^{-1} resulting in a longer service life of the motor.

Cabinet fan control

The cabinet fan control only applies to devices with cabinet heating (HAH02.1-WAxxx-xxx-xx-xx-**2**)

The cabinet fan will be turned on if the cabinet temperature (S-0-0384) is higher than the value in P-0-1319.

The cabinet fan will be turned off if the cabinet temperature (S-0-0384) is 5 °C/°F lower than value in P-0-1319.

9 Environmental protection and disposal

9.1 Environmental protection

Production processes

The products are manufactured in 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 case of appropriate use. Normally, our products will not have any negative influences on the environment.

Significant components

Significant components of our products are:

Electronic devices
- Steel
- Aluminum
- Copper
- Plastics
- Electronic components

Motors
- Steel / Stainless steel
- Aluminum
- Copper
- Brass
- Magnetic materials
- Elektronic components

9.2 Disposal

Return of products

Our products can be returned to us for disposal free of charge. However, this requires that the products be free from oil, grease or other dirt.

Furthermore, the products returned for disposal may not contain any undue foreign material or foreign components.

Deliver 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

Packaging materials consist of cardboard, wood and polystyrene They 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.

End users in the EU are legally bound to return used batteries and accumulators. Outside the validity of the EU Directive 2006/66/EC, the particularly applicable regulations must be followed.

Batteries and accumulators can contain hazardous substances which can harm the environment or people's health when improperly stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products must be properly disposed of according to the country-specific collection systems.

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 assemblies.

Metals contained in electric and electronic assemblies can also be recycled by means of special separation processes.

Plastic parts of the products may 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 applicable legal provisions.

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)

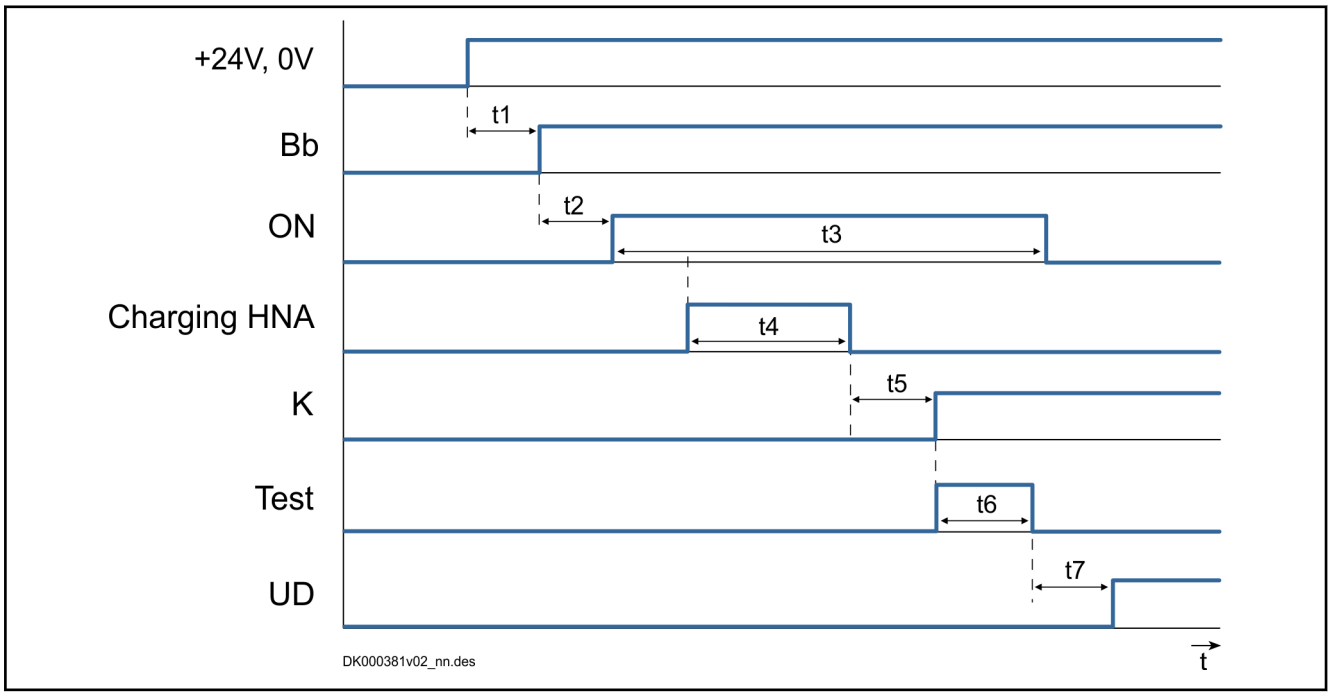
11 Appendix

11.1 Switching supply units on and off

11.1.1 Switching on

See also Application Manual "IndraDrive Power Supply Basic PSB, Functions":

Chapter "Commissioning", subchapter "Supply unit with HMU"



Bb Readiness of the device group
K Load contactor/load switch
UD Ready for power output
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. 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

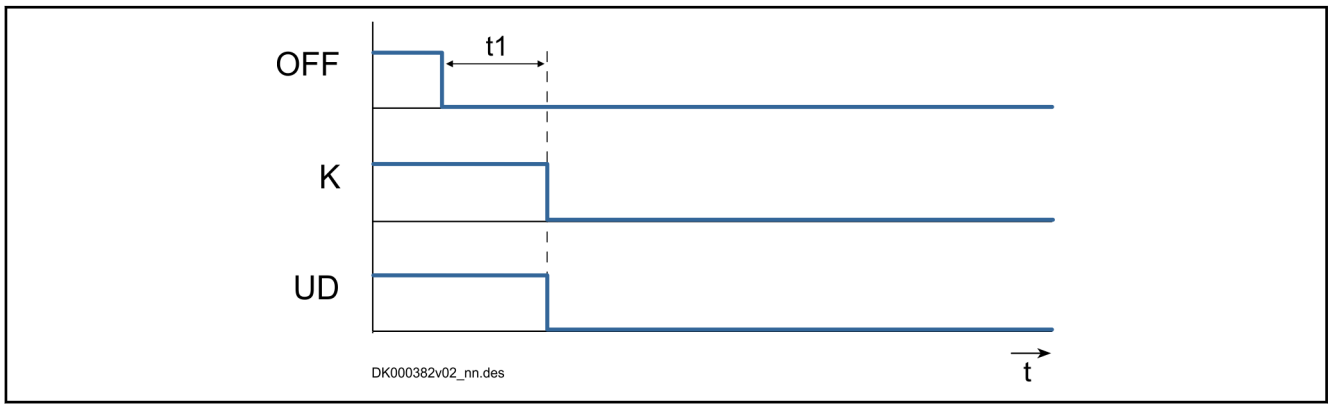
11.1.2 Switching off

☞ See also Application Manual "IndraDrive Power Supply Basic PSB, Functions":

Chapter "Commissioning", subchapter "Supply unit with HMU"

☞ 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.



K Load contactor/load switch
UD Ready for power output
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 Reactive power

The supply unit automatically compensates the reactive current of the components during operation when the reactive power compensation (S-0-1709.0.160, bit 0 = 1, bit 1 = 0) is activated.

Capacitive reactive current flows if the mains filter and, if necessary, the mains capacitor have already been connected to the mains, but the supply unit is not yet in operation. The impact of the chokes is negligible.

$I_{LN} = 2 \times \pi \times f_N \times U_{LN} \times C_{rms}$
I_{LN}: capacitive reactive current (phase current)
f_N: Mains frequency
U_{LN}: Line-to-line voltage of the mains
C_{rms}: Factor (see table below)

Tab. 11-1: Capacitive reactive current

Component		C_{rms} [As/V]
Mains filter	HNF05.1A- …	0.09×10^{-4}
Mains capacitor Mains voltage 3 × 500 V	HNC05.1N-0050-A4-NNNN	1.15×10^{-4}
	HNC05.1N-0075-A4-NNNN	1.59×10^{-4}
	HNC05.1N-0100-A4-NNNN	2.02×10^{-4}
	HNC05.1N-0150-A4-NNNN	2.89×10^{-4}
	HNC05.1N-0200-A4-NNNN	3.75×10^{-4}
Mains capacitor Mains voltage 3 × 690 V	HNC05.1N-0040-A5-NNNN	0.87×10^{-4}
	HNC05.1N-0050-A5-NNNN	1.04×10^{-4}
	HNC05.1N-0070-A5-NNNN	1.39×10^{-4}
	HNC05.1N-0100-A5-NNNN	1.91×10^{-4}
	HNC05.1N-0125-A5-NNNN	2.34×10^{-4}
	HNC05.1N-0150-A5-NNNN	2.77×10^{-4}

Tab. 11-2: Factor C_{rms}

11.3 Operation at third-party supply units

IndraDrive ML drive controllers are designed to be supplied via IndraDrive ML supply units.

In exceptional cases, other supply units (third-party supply units) can be used for supply (e.g. battery buffer, existing DC mains, ...) if the following **conditions** are met:

- The IndraBus in the IndraDrive ML drive system is closed and the Bb relays are wired into the EMERGENCY STOP chain of the third-party supply unit (or a connecting unit that separates the drive system from the DC bus).
- The DC bus capacitance (except for battery buffer without DC/DC converter) has to be at least as large as the corresponding capacity in an IndraDrive ML supply unit.
- For protection of the third-party supply unit, an HLL05 current-compensating DC bus choke has to be used between the third-party supply unit and the drive system.

  The DC bus ground capacitor pairs (HAS04.1-003) have to be mounted on the drive side. The sum of the leakage capacitances in the drive system (motors and cables) should not exceed 1.2 µF.
- The third-party supply unit should not contain any Y-capacitors in the DC bus. (Y-capacitors are allowed in the mains phases).
- An HLT05 braking unit with an external HLR05 braking resistor may be used.

☞ The quality of the mains is determined by the third-party supply unit with its mains-side filters.

The requirements of the corresponding standards or supplementary customer requirements on the quality of the mains have to be ensured by the manufacturer of the third-party supply unit.

11.4 Sizing the line cross sections and fuses

11.4.1 Introduction

The sizing of the line cross sections described here refers to the **short circuit protection** of the devices and not to the line protection.

Sizing the line cross sections and fuses in the supply feeder and branches to the drive system:

1. Determine the current in the supply feeder of the drive system and correct it with the correction factors for ambient temperature and bundling.
2. Determine the country of use ("international except for USA/Canada" or "USA/Canada")
3. Determine the installation type (e.g., B1 or B2)
4. In the "Current carrying capacity" table row, select the value that is immediately above the value determined in the first step
5. In the "Fuse" table row, read the corresponding fuse
6. In the "Cross section A …" table row, read the corresponding required cross section

11.4.2 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 [mm²] 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

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 B1
1 ×	2 ×	3 ×		
250			207.93	120
250			227.94	150
315			257.52	185
355			301.02	240
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. 11-3: 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

11.4.3 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 [mm²] 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
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

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 B2
1 ×	2 ×	3 ×		
		200	465.89	3 × 185
		200	542.62	3 × 240
		250	619.35	3 × 300

Tab. 11-4: 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

11.4.4 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 [mm²] Installation type E
1 ×	2 ×	3 ×		
2			1.6	0.75
4			3.3	0.75
6			5.0	0.75
10			8.3	0.75
16			10.4	0.75
16			12.4	1
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 × 70
	200		331.30	2 × 95
	250		384.19	2 × 120
	250		444.05	2 × 150
	315		506.69	2 × 185
	400		598.56	2 × 240
	400		691.82	2 × 300
		160	358.09	3 × 70
		200	434.83	3 × 95
		200	504.25	3 × 120

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 ×		
		250	582.81	3 × 150
		250	665.03	3 × 185
		315	785.61	3 × 240
		400	908.02	3 × 300

Tab. 11-5: 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

11.4.5 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. 11-6: Line cross sections and fuses according to UL508A:2007, Table 28.1

11.4.6 Sizing variables of the table values

1. Ambient temperature T_A of routed line ≤ 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 fuse design:
   - 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:
     – Use listed AC input line fuses (class J and class L; 600 V AC). If using inverse-time circuit breakers or type E combination motor controllers instead of recommended fuses, see UL 508C section 45.8.2

Correction factors

The corresponding standards specify correction factors for deviating sizing variables.

See tables below for 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

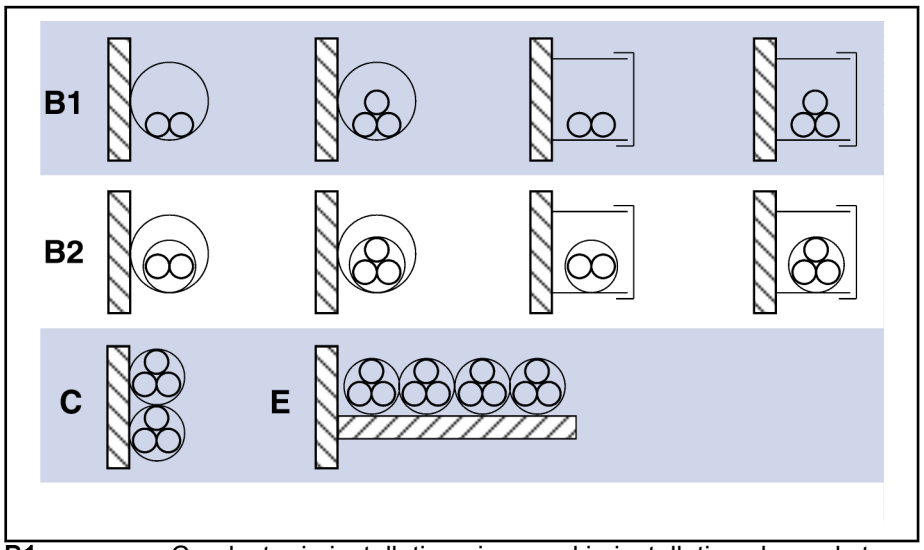
Tab. 11-7: Ambient temperature correction factor in accordance with EN 60204-1:2006 and NFPA 79:2007

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. 11-8: 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)

11.5 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.

11.6 Aluminum contact points and cupal disks

11.6.1 Introduction

Some components (e.g. chokes) may have **aluminum contact points** as connection points.

Aluminum contact points require a specific screw connection for establishing contact.

11.6.2 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.

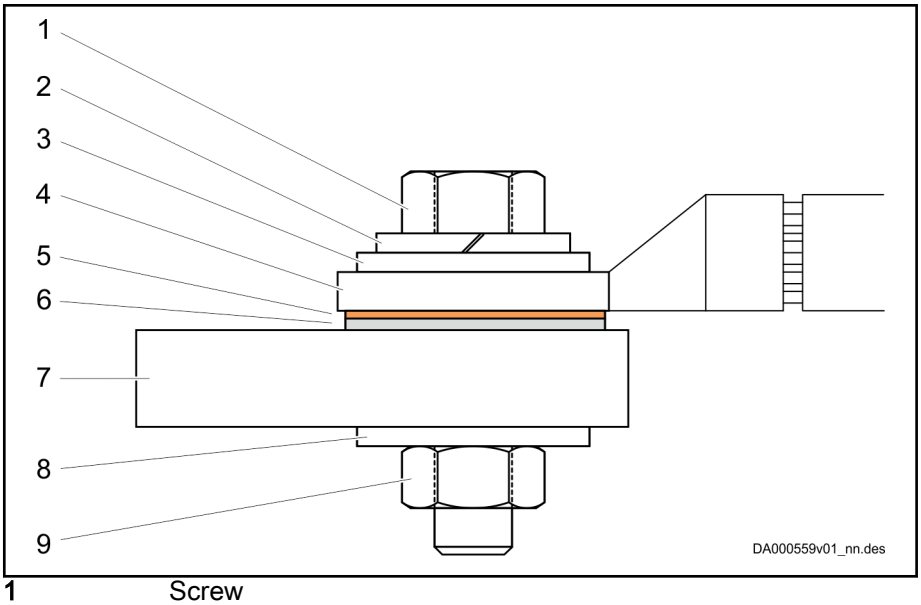
Clean both sides of the cupal disks with abrasive fleece before connecting them, and then grease the cupal disks with a thin layer of anticorrosive paste (contact grease).

If the connection is opened after operation, abrade and grease the connections and the cupal disks again.

11.6.3 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. 11-9: 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

11.7 Leakage capacitances

11.7.1 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_Mg} Total value of motor leakage capacitance
$C_{ab(motor)}$ Leakage capacitance of a motor

Fig. 11-6: Total leakage capacitance of motor

$$C_{ab_Kg} = C_{Y_K\,typ\,(K1)} \times I_{(K1)} + C_{Y_K\,typ\,(K2)} \times I_{(K2)} \cdots + C_{Y_K\,typ\,(Kn)} \times I_{(Kn)}$$

C_{ab_Kg} Total value of cable leakage capacitance
$C_{Y_K\,typ}$ Capacitance per unit length of cables
$I_{(K)}$ Cable length

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.

11.7.2 Leakage capacitance of power cables

Note the information in the specifications of the cable manufacturer.

Leakage capacitance is specified in C per cable. In the case of parallel connection, the total value is the sum of individual cables.

☞ The rough calculation with the following values is allowed for Rexroth power cables (INKxxxx bulk cable):

- Cross section 1 … 10 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

11.8 RSC - Relative Short Circuit Power

RSC

RSC is the relationship of the short-circuit power S_{k_mains} at the connection point of the mains to the maximum apparent power $S_{inverter}$ of the connected inverter or the relationship of the short-circuit current I_{k_mains} at the connection point of the mains to the maximum current $I_{inverter}$ of the inverter.

$RSC = S_{k_mains} \div S_{inverter}$

$RSC = I_{k_mains} \div I_{inverter}$

The RSC has a strong impact on low-frequency mains pollution transmitted by the inverter.

The stronger the mains is related to the converter load (RSC large), the lesser the harmonics produced by the inverter affect the shape of the mains voltage and thus other connected loads.

RSC > 50

"Strong mains": The mains current has slightly higher current harmonics at the same load. Current harmonics do not cause voltage distortions at the low mains impedance.

Operation of Rexroth IndraDrive ML is unproblematic.

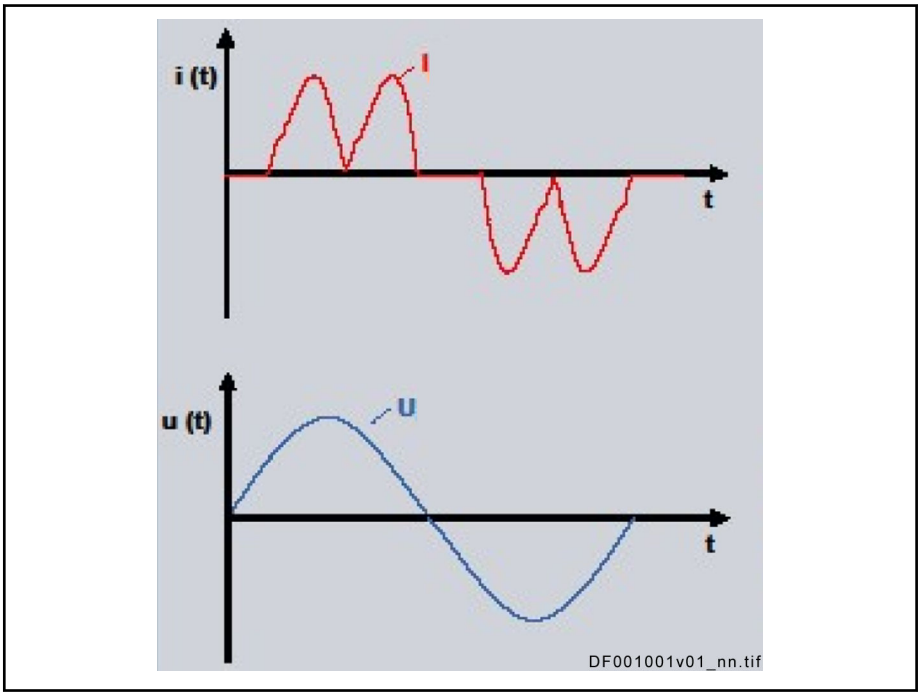


Fig. 11-8: Mains current (I) and mains voltage (U) curve at RSC > 50

15 < RSC < 50

Operation of Rexroth IndraDrive ML is unproblematic. THD values deteriorate with decreasing RSC

5 < RSC < 15

"Weak mains": Current harmonics cause significant voltage distortions at the high mains impedance.

Operation of Rexroth IndraDrive ML may be problematic:

- Increase of the mains voltage

- Impairment of the control dynamics
- Non-compliance with EMC limit values
- Reduced current protection

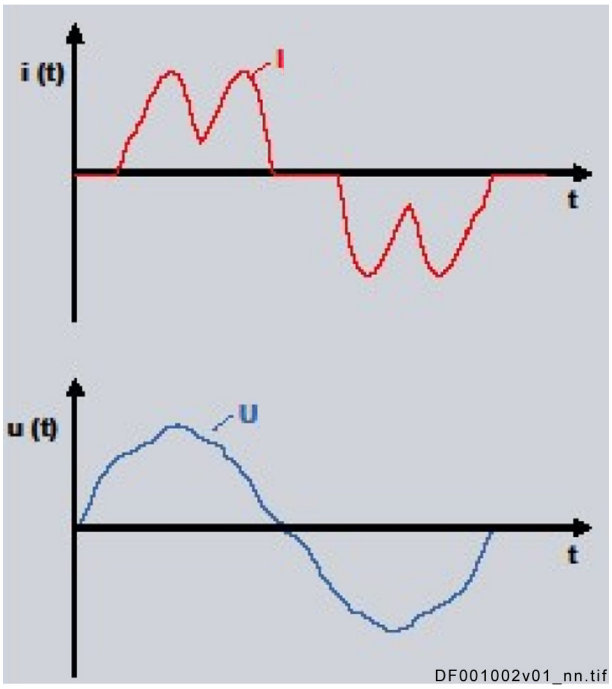


Fig. 11-9: Mains current (I) and mains voltage (U) curve at RSC < 15

RSC < 5 It is not allowed to operate Rexroth IndraDrive ML.

11.9 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.

Basic conditions of the indicated values:

- Equipment with 250 kW
- Operation at 400 V/50 Hz with
  - Partial load 50%
  - Nominal load
  - Peak load
- Switching frequency: 4.2 kHz
- Output frequency of the load: 100 Hz
- System impedance: 21 µH; X/R ≈ 16; RSC ≈ 118

HMU05.1N-…-A4-D7

Size	Mains voltage [VAC]	Switching 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

Size	Mains voltage [VAC]	Switching frequency [KHz]	THDi mains current [%]	THDu mains voltage [%]	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
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) HMU05.1N-…-A4-D7

HMU05.1N-…-A5-11

Size	Mains voltage [VAC]	Switching frequency [KHz]	THDi mains current [%]	THDu mains voltage [%]	Load
HMU05.1-F0140	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0140	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0140	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0140	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0140	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0140	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0170	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0170	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0170	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0170	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0170	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0170	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0220	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0220	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0220	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0220	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0220	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0220	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0270	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0270	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0270	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0270	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0270	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0270	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0400	tbd	tbd	tbd	tbd	Partial load 50%

Size	Mains voltage [VAC]	Switching frequency [KHz]	THDi mains current [%]	THDu mains voltage [%]	Load
HMU05.1-F0400	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0400	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0400	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0400	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0400	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0540	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0540	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0540	tbd	tbd	tbd	tbd	Peak load
HMU05.1-F0540	tbd	tbd	tbd	tbd	Partial load 50%
HMU05.1-F0540	tbd	tbd	tbd	tbd	Nominal load
HMU05.1-F0540	tbd	tbd	tbd	tbd	Peak load

Tab. 11-11: Total Harmonic Distortion (THD) HMU05.1N-…-A5-11

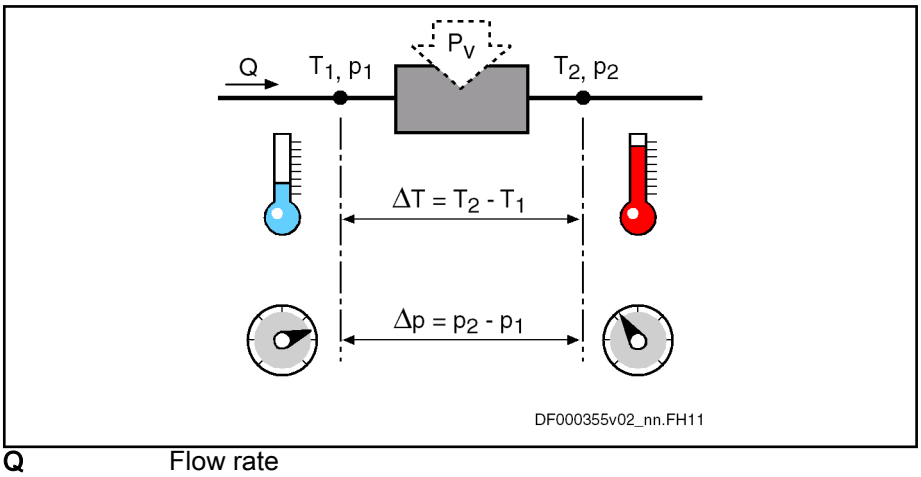
11.10 Liquid cooling

11.10.1 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. 11-10: 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. 11-11: 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. 11-12: Calculating the flow rate

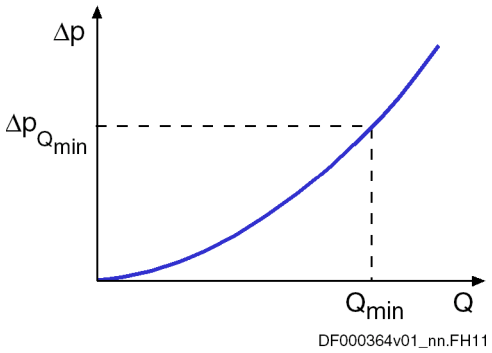
The flow rates are indicated in the technical data of the liquid-cooled components (referring to a fixed temperature increase of the coolant water). For any other temperature increase, calculate the flow rate using the above formula.

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. 11-13: 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:

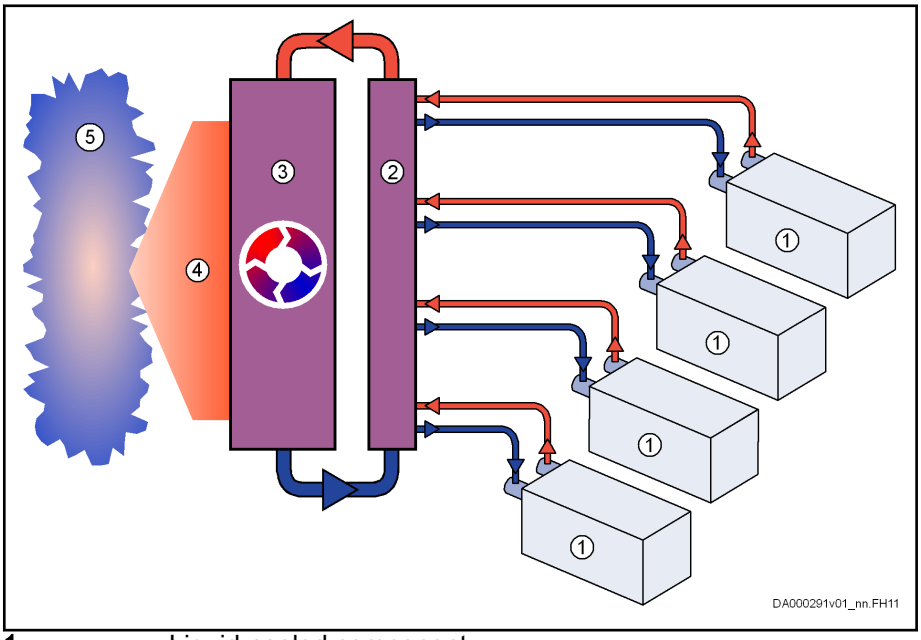
$$\Delta p = K_{\Delta p} \times Q^{1.75}$$

Δp	Pressure decrease
$K_{\Delta p}$	Constant (see technical data for each component)
Q	Flow rate in l/min

Fig. 11-14: Pressure decrease vs. flow rate

Sizing aids

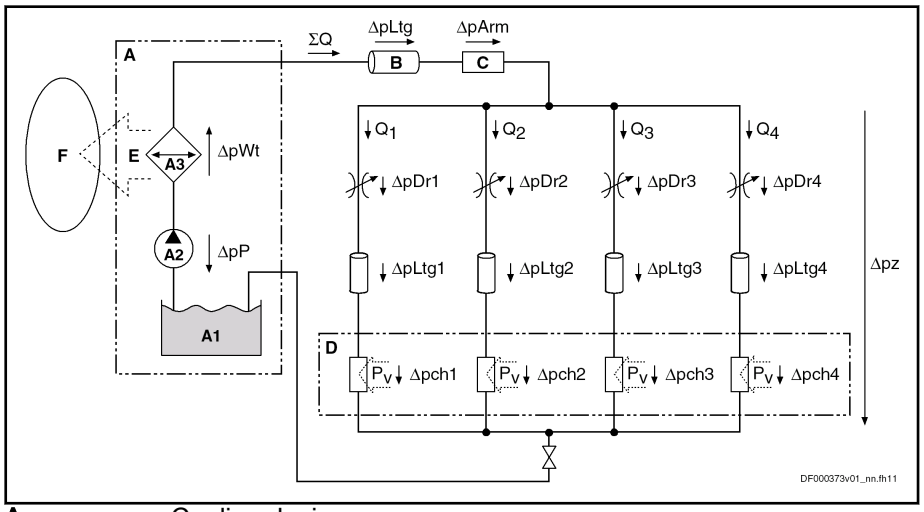
The following sizing aids are based on a cooling system with four components connected in parallel.



1	Liquid-cooled component
2	Main distributor of cooling liquid
3	Cooling device (cooling or refrigerating unit)
4	Heat dissipation
5	Higher-level cooling medium

Fig. 11-15: Arrangement with liquid-cooled components

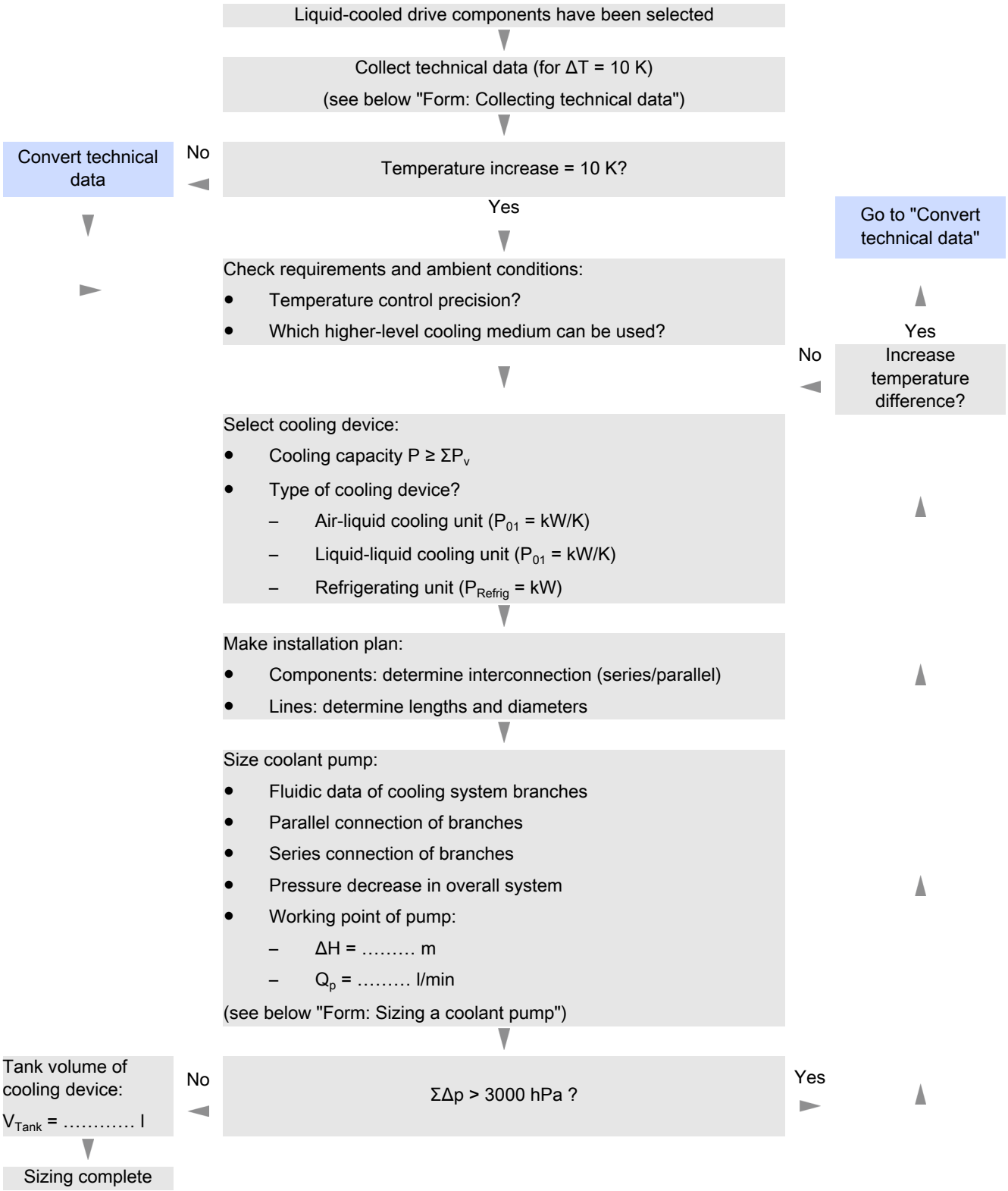
Liquid cooling circuit diagram



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 (Arm: fittings; ch: drive components; Dr: choke; Ltg: line; P: coolant pump; Wt: heat exchanger)
ΔP_v	Power dissipation of a drive component being discharged

Fig. 11-16: Liquid cooling circuit diagram for four liquid-cooled drive components

Sizing a cooling system



Tab. 11-12: Sizing a cooling system

Form: Collecting 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. 11-13: Collecting 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. 11-14: Form for sizing coolant pump

11.10.2 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
- 1 × drive controller with P = 132 kW

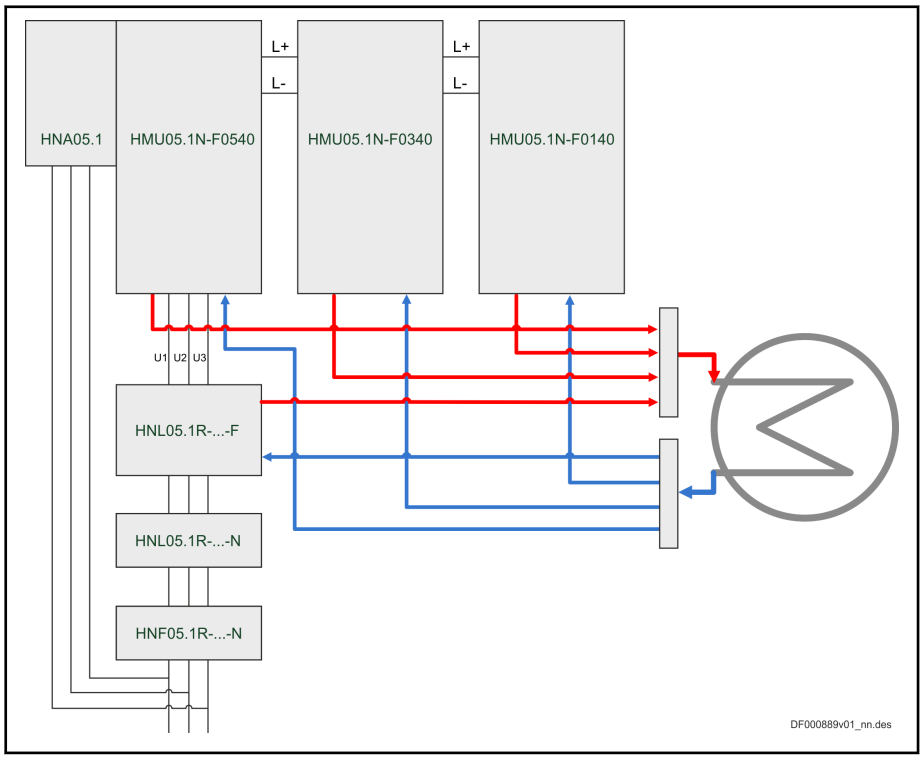


Fig. 11-17: Components

Form: Collecting 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. 11-15: Collecting technical data

Coolant

The coolant should be a 4:1 mixture of water and "Antifrogen" (N or L) or "Glysofor N" (e.g. RiFrost 1:4 from Rittal).

Do **not** mix "Antifrogen/Glysofor N" with "Antifrogen/Glysofor 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 given 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_{ein} = 60°C, max. coolant inlet temperature into cooling unit

T_{amb} = 35°C according to ambient conditions

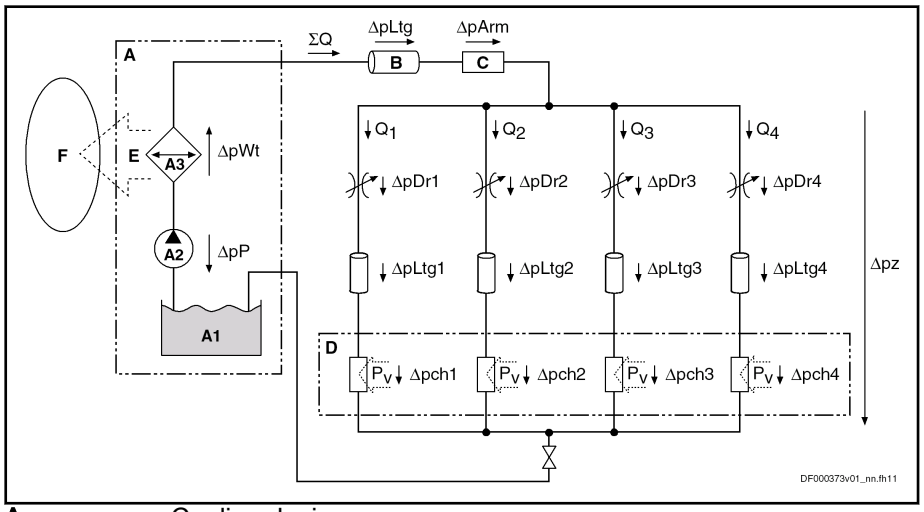
P_{01} = 18.5 ÷ (60 - 35) = 0.74 kW/°C

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 to be cooled
E	Heat transfer
F	Higher-level cooling medium
Q	Flow rate
Δp	Pressure drop (Arm: fittings, ch: drive component, Dr: choke, Ltg: line, P: coolant pump, Wt: heat exchanger)
ΔP_v	Power dissipation of a drive component to be discharged

Fig. 11-18: 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 drops	Coolant line	Length l_n	m					
		Added length l_{zn}	m					
		Ø d	mm					
		$\Delta p_{Ltg}/\Delta l$ at Q_{ch}	hPa/m					
		Δp_{Ltgn}	hPa					
	Drive component	Δp_{chn}	hPa					
	Additional component	Δp_{Zus}	hPa	+ /	+ /	+ /	+ /	
Total pressure drop:	Without choker valve	Δp_{Zn}	hPa					
(Only with parallel connection)	With choker valve [1)]	Δp_{Zn}	hPa					

Parallel connection of branches no. 1,2,3,4								
Total pressure drop		Δp_z	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 drop		$\Sigma \Delta p_{Zn}$	hPa					
Total flow rate		ΣQ_{chnmax}	l/min					
Pressure drop in overall system								
	Cooling system branches	Δp_Z or Σp_{Zn}	hPa					
	Coolant line	Length l_0	m					
		Added length l_{z0}	m					
		Ø d_0	mm					
		ΣQ_{ch}	l/min					
		$\Delta p_{Ltg}/\Delta l$ at ΣQ_{ch}	hPa/m					
		Δp_{Ltg}	hPa					
	Heat exchanger	Δp_{Wt}	hPa					
	Fittings	Δp_{Arm}	hPa					
	Additional component	Δp_{Zus}	hPa	+ /				
	Overall cooling system	**Δp_{KS}**	**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 generated according to the pressure drop over the cooling system branches Δp_z.

Tab. 11-16: Sizing the coolant pump

Since the pressure drop of the overall cooling system is below the allowed input pressure, the sizing of the coolant pump is completed.

Tank

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

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

with

V_{Wt} = …… from the heat exchanger manufacturer's specifications

V_{Arm} = …… from the fittings manufacturer's specifications

V_{ch} = …… collected from the technical data of the drive components

V_{Ltg} = line lengths x flow cross-section

V_{Vt} = from the distributor manufacturer's specifications

Conclusion The data determined for the cooling device can be retained in the procedure diagram. These data can be used to contact the supplier of the cooling device.

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