

Rexroth IndraDrive ML

Drive systems with HMU05

Project Planning Manual R911344279

Edition 01



Title Rexroth IndraDrive ML

Drive systems with HMU05

Type of Documentation Project planning manual

Document Typecode DOK-INDRV*-HXX05******-PR01-EN-P

Internal File Reference RS-bdff4382be37d8ef0a6846a5002ff107-1-en-US-11

Purpose of Documentation

- Overview of Rexroth IndraDrive Hxx05 drive system
- Description of permitted system component combinations
- Selection of drive system components
- General component specification (ambient and operating conditions)
- Application description of system characteristics

Record of Revision

Edition	Release Date	Notes	
01	10/2014	First edition	

Copyright © Bosch Rexroth AG 2014

This document, as well as the data, specifications and other information set forth in it, are the exclusive property of Bosch Rexroth AG. It may not be reproduced or given to third parties without its consent.

Liability

The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.

		Page
1	System presentation	7
1.1	Drive range Rexroth IndraDrive ML	
1.1.1	Overview – Rexroth IndraDrive ML	7
1.1.2	Areas of application and target applications	9
1.1.3	Features	10
	Features	10
	Performance features	11
	Interfaces	11
	Supported encoder systems	11
1.2	System configuration	12
1.2.1	System structure	12
1.2.2	System components	13
	Universal inverter HMU05	13
	Control sections	14
	Optional cards	17
	Installing and removing control sections and optional cards	17
	Firmware	20
1.2.3	About this documentation	21
	Purpose	21
	Documentation	21
	Your feedback	22
2	Important directions for use	23
2.1	Appropriate use	23
2.1.1	Introduction	23
2.1.2	Areas of use and application	23
2.2	Inappropriate use	24
3	Safety instructions for electric drives and controls	25
3.1	Definitions of terms	
3.2	General information	26
3.2.1	Using the Safety instructions and passing them on to others	26
3.2.2	Requirements for safe use	
3.2.3	Hazards by improper use	
3.3	Instructions with regard to specific dangers	
3.3.1	Protection against contact with electrical parts and housings	
3.3.2	Protective extra-low voltage as protection against electric shock	
3.3.3	Protection against dangerous movements	
3.3.4	Protection against electromagnetic and magnetic fields during operation and mounting	
3.3.5	Protection against contact with hot parts	
3.3.6	Protection during handling and mounting	
3.3.7	Battery safety	
3.3.8	Protection against pressurized systems	
	-3	

		Page
3.4	Explanation of signal words and the Safety alert symbol	34
4	Combining individual components	37
4.1	Documentation	37
4.2	Brief description of individual components	37
4.2.1	HMU05 - brief description and design	37
4.3	Configuring drive systems	
4.3.1	Firmware	
	Firmware and device types	
4.3.2	Motors	
	Third-party motors	
4.3.3	Cables	
	Motor power cables	
	Encoder cables	
4.4	Installation conditions	
4.4.1	Ambient and operating conditions	
4.4.2	Control cabinet	
	Air cooling	
	Liquid cooling	
4.4.3	UL data	
4.4.4	Compatibility with foreign matters	
4.5	Mechanical project planning	
4.5.1	Dimensions	
	HMU05.1N-F0140-0350	
	HMU05.1N-F0170-0430	
	HMU05.1N-F0220-0510	
	HMU05.1N-F0270-0660	
	HMU05.1N-F0340-0820 HMU05.1N-F0430-1040	
4 5 0	HMU05.1N-F0540-1300	
4.5.2 4.5.3	Dimensions, mass, insulation, sound pressure level	
4.5.3 4.5.4	Temperatures, cooling, power dissipation, distances	
4.5.4 4.6	Mounting positions of components Electrical project planning	
4.6 4.6.1	Overall connection diagram (HMU05 as drive controller)	
4.6.2	Overall connection diagram (HMU05 as supply unit)	
4.6.3	Planning control voltage	
4.0.3	Control voltage for drive systems	
	Sizing control voltage supply	
4.6.4	Mains connection	
4.0.4	Residual-current-operated circuit breakers (RCD, RCCB) as additional fusing	
	Mains types	
	Mains connection type	
	Mains connected load and mains current	
	Sizing line thicknesses and fuses	
	Sizing and selecting mains transformer	
	Oizing and selecting mains transionnel	92

		Page
	Combining mains filter, mains choke, restrictor and capacitance pack	93
4.6.5	Running multiple HMU05s in parallel	95
4.7	Acceptance tests and approvals	98
5	Condition on delivery, identification, transport and storage	101
5.1	Condition on delivery	101
5.1.1	Factory testing	101
	Voltage test and insulation resistance test	101
5.1.2	Customer testing	101
5.2	Identification	102
5.2.1	Type plates	102
	Design	102
5.2.2	Contents of delivery	102
5.3	Transporting components	102
5.4	Storing components	103
6	Mounting and installation	105
6.1	Mounting HMU05 devices in control cabinet	
6.2	Electrical connection	
6.2.1	Overall connection diagram (HMU05 as drive controller)	
6.2.2	Overall connection diagram (HMU05 as supply unit)	
6.2.3	Connection points	
	HMU05 connection point layout	
	Equipment grounding conductor connection point	
	L1, L2, L3, mains/motor connection	
	XG3, motor temperature monitoring, motor holding brake, motor fan control	
	XG32, HNA bus	
	XG1, IndraBus	116
	XD10, 24 V supply (control voltage)	117
	L+ L-, DC bus connection	118
	Shield connection	119
	Ground connection	120
6.2.4	Optional cards	120
	HPC01.1-MN0x-NN	120
	HPC01.1-P001-NN	120
6.2.5	EMC measures for design and installation	121
	Rules for designing installations with drive controllers in compliance with EMC	121
	EMC-optimal installation in system and control cabinet	122
	Ground connections	129
	Installing signal lines and signal cables	130
	General interference suppression measures for relays, contactors, switches, chokes and	d inductive
	loads	
6.3	WATER IN/OUT, cooling liquid connection	132

Bosch Rexroth AG

		Page
7	Technical component data	133
7.1	Power section	133
7.1.1	Control voltage	133
7.1.2	Mains voltage	135
7.1.3	DC bus	138
7.1.4	Inverter	139
8	Cables, accessories, additional components	145
8.1	Overview	145
8.1.1	Cables	
8.1.2	Accessories	
8.1.3	Additional components	
8.2	Accessories	146
8.2.1	Mounting and connection accessories (HAS03)	
8.2.2	Cabinet installation kit (HAS08.1-008)	
8.2.3	Blank covers, motor monitor grounding, mounting plates (HAS10)	149
	Type code HAS10	
	Blank covers (HAS10.1-002-003)	149
	Motor monitor grounding (HAS10.1-002-004)	
	Mounting plate for device width 200 mm (HAS10.1-002-005)	
	Mounting plate for device width 220 mm (HAS10.1-002-006)	
8.3	Additional components	
8.3.1	HNA05 mains connecting module	158
	Type code HNA05	
	Dimensions	
	Data	
	Connection points	
	Display elements	
8.3.2	HNC05 mains capacitor	
	Type code HNC05	
	Dimensions	
	Data	
	Assignment to HMU05	
8.3.3	HNF05 mains filter	
	Type code HNF05	
	Dimensions	
	Data	185
	Assignment to HMU05	
8.3.4	HNL05 mains choke	186
	Type code HNL05	
	Type plate	187
	Dimensions	188
	Data	
	Assignment to HMU05	
8.3.5	HML05 motor choke/balancing choke	
	Type code HML05	203

		Page
	HML05 to HMU05 assignment	204
	Dimensions	205
	Data	206
8.3.6	HLL05 DC bus choke	207
	Type code HLL05	207
	Sizing	208
	Dimensions	209
	Data	217
8.3.7	HLR05 external braking resistor	218
	Type code HLR05	218
	Dimensions	219
	Data	219
	Installation	219
8.3.8	HLT05 brake controller	221
	Type code HLT05	221
	Dimensions	222
	Data	
	Connection diagram	
	Connection points	
	Display elements	
8.3.9	HAH01 heat exchanger	
	Type code HAH01	
	Water-water heat exchanger	
	Data	
^		044
9	Environmental protection and disposal	
9.1	Environmental protection	
9.2	Disposal	241
10	Service and support	243
11	Appendix	245
11.1	Dimensioning the line cross sections and fuses	
11.2	DC bus fuses	
11.3	Determining leakage capacitance	
11.4	Leakage capacitances	
11.4.1	Power cable leakage capacitances	
11.5	THD	
11.6	Liquid cooling	
11.6.1	Sizing liquid cooling	
	Calculation criteria	
	Sizing aids	
11.6.2	_	
11.6.3	1 /1	
	· · · · · · · · · · · · · · · · · · ·	

VI/277

	Page
Index	269

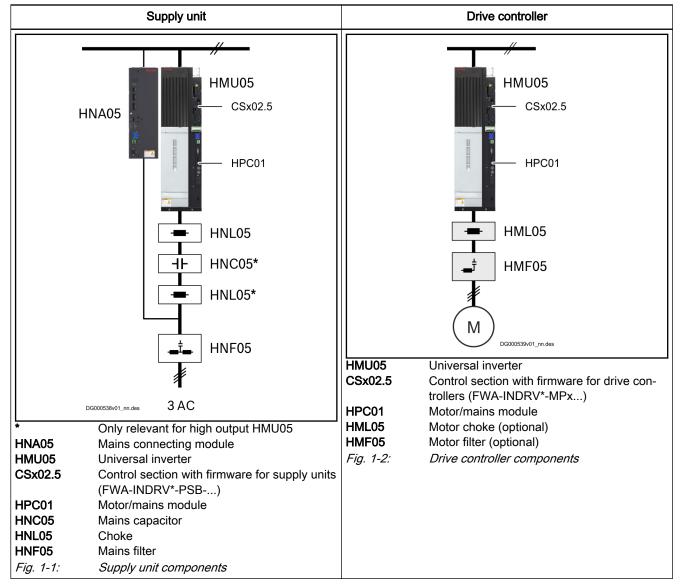
1 System presentation

1.1 Drive range Rexroth IndraDrive ML

1.1.1 Overview – Rexroth IndraDrive ML



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



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 Areas of application and target applications



Forming method

- Servo press main drive
- Winders
- Straightener drives
- Profiler drives



Plastics

- Extruders
- Kneaders
- Pumps
- Injector and profiling axis drives



Marine/offshore

- Fishing winches
- Anchor handling winches
- Nautical winches
- Shiplifts



Metallurgy

- Roller conveyors
- Transfer lifters



Others

- Paper manufacturing (pumps, rollers)
- Press machines (winders, sheet cutters, rollers)
- General automation (pumps, cranes, testing stations)

Tab. 1-3: Areas of application and target applications

1.1.3 Features

Bosch Rexroth AG

Features

- Universal power sections for inverters and regenerative supply units
- Power sections (HMU05.1N-F0340 to -F0680) with the same output can be connected in parallel
- Compact construction
- Protection class 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)
- Power-based fan control on low output HMU05
- Water cooling on high output HMU05; no additional fan cooling required

Performance features

HMU05.1N-	→	0140-0350	0170-0430	0220-0510	0270-0660	0340-0820	0430-1040	0540-1300	0680-1690
Mains connection voltage	٧				3 AC 380 to	500 +10%			
Continuous cur- rent	Α	254	306	392	490	616	771	1002	1185
Maximum current	Α	355	427	515	660	825	1037	1297	1686
Typical motor output	kW	110	132	160	200	250	315	400	500

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

Interfaces

Overview

- Compatible with IndraDrive platform
- Ethernet-based communication with the following supported protocols:
 - sercos III
 - PROFINET IO
 - EtherNet/IP
 - 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

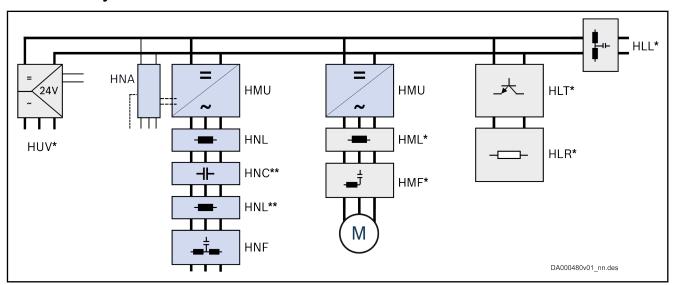
Encoder systems with a supply voltage of 5 and 12 V:

- IndraDyn encoder
- 1V_{pp} sine/cosine encoder; HIPERFACE®
- 1V_{pp} sine/cosine encoder; EnDat 2.1; (EnDat 2.2 in progress)
- 1V_{pp} sine/cosine encoder; with reference track
- 5V TTL square-wave encoder; with reference track
- SS
- Combined encoder for SSI (combination of SSI and 1V_{pp} sine/cosine encoder)
- Resolver (resolvers are **not** supported if optional "Safe Motion" safety technology is also in use)

1.2 System configuration

Bosch Rexroth AG

1.2.1 System structure



* Optional

** Only relevant for high output HMU05

HLL DC bus choke
HLR Braking resistor
HLT Braking unit
HMF Motor filter
HML Motor choke
HMU Universal inverter

HNA Mains connecting module

HNC Mains capacitor
HNF Mains filter
HNL Choke

HUV Power supply unit

M Motor

Fig. 1-3: Drive system Rexroth IndraDrive ML

1.2.2 System components

Universal inverter HMU05

Type code HMU05

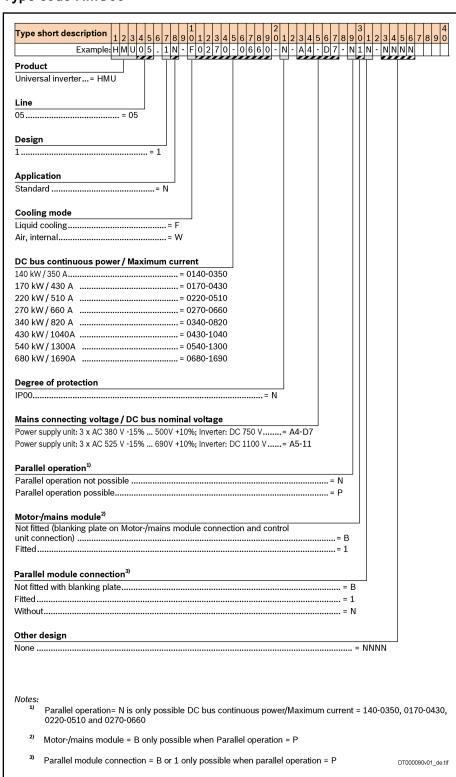


Fig. 1-4: Type code HMU05

Bosch Rexroth AG



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

Control sections

CSB02.5

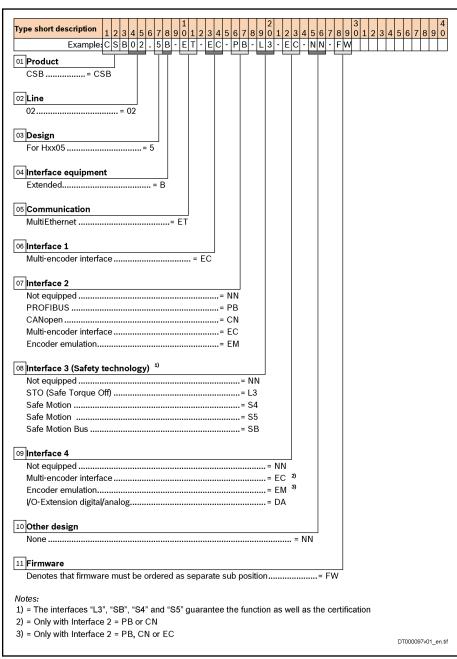


Fig. 1-5: Type code CSB02.5

CSH02.5

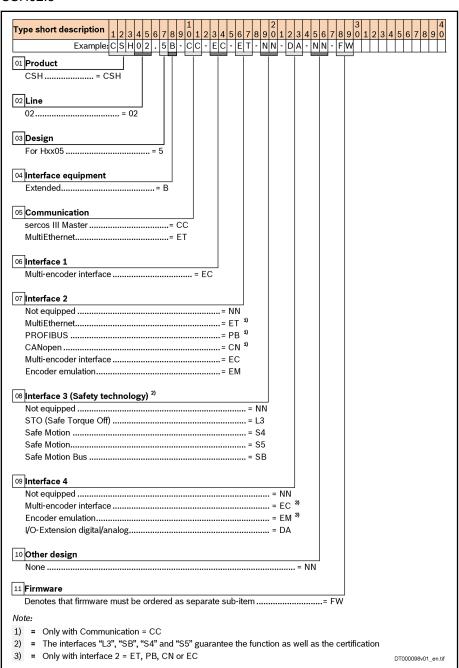


Fig. 1-6: Type code CSH02.5

Control section CSB02.5 vs CSH02.5

	CSB02.5B-ET	CSH02.5B-CC/S3	
Functional equipment	(BASIC)	(ADVANCED)	
Communication	Multi-Ethernet	CC: sercos III master	
	(incl. sercos III)	S3: sercos III slave	
	Alternative interface ¹⁾	Alternative interface ¹⁾	
	(PROFIBUS, CANopen) ²⁾	(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)	L3 (Safe Torque Off)	
	S0 (Safe Stop 1)	S0 (Safe Stop 1)	
	S4 (Safe Motion)	S4 (Safe Motion)	
	S5 (Safe Motion Enhanced)	S5 (Safe Motion Enhanced)	
IndraMotion	MLD-S ³⁾	MLD-S ³⁾	
		MLD-M ³⁾	
Freely configurable digital inputs/outputs (incl. probe)	✓	1	
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. 1-5: ECONOMY vs. BASIC vs. ADVANCED

Optional cards

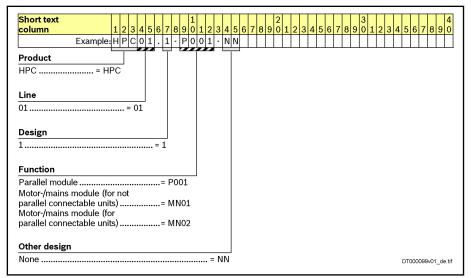


Fig. 1-7: Type code HPC01

Optional card	Function	
HPC01.1-MN01	Motor/mains module (built-in) for devices that cannot be connected in parallel. Devices can only be operated individually.	
	Motor: temperature sensor, brake control	
	HNA05 mains connecting 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 connecting module: communication	
HPC01.1-P001	Parallel connecting module; when running multiple HMU05s in parallel, the HMU05s with only this optional card are slaves.	
	Controlling/balancing HMU05s	
	Forwarding safety signals	

Tab. 1-6: Optional cards

Installing and removing control sections and optional cards

Training

NOTICE Risk of damage from improper handling.

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

ESD protection

NOTICE

Risk of damage and impairment to reliability from electrostatic discharge.

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

Such exposed conductive parts include:

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

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

Limited number of insertions and removals

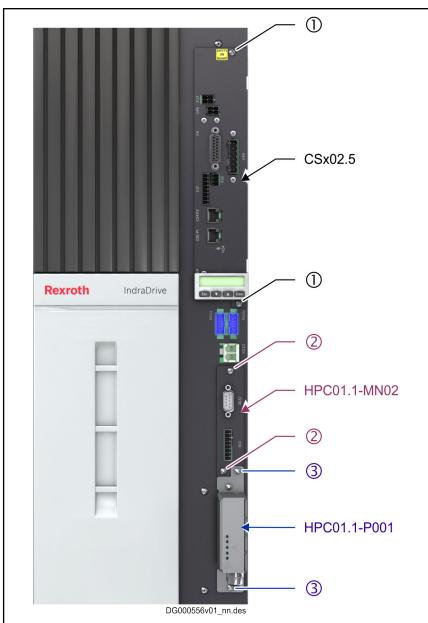
NOTICE

Risk of damage from frequent installation and removal.

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

Instructions

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



1023 Mounting screws: 10 CSx02.5 control section, 20

HPC01.1-MN02, ③ HPC01.1-P001

Fig. 1-8: 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.

Bosch Rexroth AG

Firmware

Firmware for drive controllers	Assigned device type
FWA-INDRV*-MP B-19 VRS-D5-x-NNN-NN	CSB02.5 control section (BASIC)
FWA-INDRV*-MP C-19 VRS-D5-x-xxx-xx	CSH02.5 control section (ADVANCED)

Tab. 1-7: Drive firmware

Firmware for supply units	Assigned device type
FWA-INDRV*-PS B-19 VRS-D5-x-NNN-NN	CSB02.5 control section (BASIC)

Tab. 1-8: Supply 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

A WARNING

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

Observe the contents of the documentation relevant to your drive system (see chapter "Documentation" on page 21).

This documentation contains the following:

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

Documentation

Drive systems, system components

Title	Documentation type	Document typecode ¹⁾	Part no.
Rexroth IndraDrive		DOK-INDRV*	de (en)
ML, Drive systems with HMU05	Project planning manual	HXX05*****-PRxx-EN-P	R911344278
			(R911344279)
Control sections CBS02, CSE02,	Project planning manual	CXX02*****-PRxx-EN-P	R911338961
CSH02, CDB02			(R911338962)

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

project planning manual)

Tab. 1-9: Documentation – drive systems, system components

Firmware

Title	Documentation type	Document typecode ¹⁾	Part no.
Rexroth IndraDrive		DOK-INDRV*	de (en)
Power Supply Basic PSB-19	Application manual	PSB-19VRS**-APxx-EN-P	R911345601
Functions			(R911345602)
MPx-19	Release notes	MP*-19VRS**-RNxx-EN-P	R911345603
Version notes			(R911345604)
MPx-18	Application manual	MP*-18VRS**-APxx-EN-P	R911338674
Functions			(R911338673)
MPx-15 to MPx-19 and PSB	Reference	GEN1-PARA**-RExx-EN-P	R911328650
Parameters			(R911328651)
MPx-15 to MPx-19 and PSB	Reference	GEN1-DIAG**-RExx-EN-P	R911326539
Diagnostic messages			(R911326738)

Bosch Rexroth AG

System presentation

Title	Documentation type	Document typecode ¹⁾	Part no.
Rexroth IndraDrive		DOK-INDRV*	de (en)
tIntegrated Safety Technology	Application manual	SI3-**VRS**-APxx-EN-P	R911332633
"Safe Torque Off" (MPx-16 and higher)			(R911332634)
tIntegrated Safety Technology	Application manual	SI3*SMO-VRS-APxx-EN-P	R911338919
"Safe Motion" (MPx-18 and higher)			(R911338920)
Rexroth IndraMotion MLD	Reference	MLD-SYSLIB3-RExx-EN-P	R911338915
Libraries as of MPx-18			(R911338916)
Rexroth IndraMotion MLD	Application manual	MLD3-**VRS*-APxx-EN-P	R911338913
MPx-18 and higher			(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)

Tab. 1-10: Documentation - Firmware

Your feedback

礟

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

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

Please send your remarks to:

Address for your feedback

Bosch Rexroth AG

Dept. DC-IA/EDY1

Buergermeister-Dr.-Nebel-Str. 2

97816 Lohr, Germany

E-mail: dokusupport@boschrexroth.de

Important directions for use

2 Important directions for use

2.1 Appropriate use

2.1.1 Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

▲ WARNING

Personal injury and property damage caused by incorrect use of the products!

The products have been designed for use in the industrial environment and may only be used in the appropriate way. If they are not used in the appropriate way, situations resulting in property damage and personal injury can occur.



Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

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

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the products take the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

2.1.2 Areas of use and application

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

Control and monitoring of the Drive controllers may require additional sensors and actuators.



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

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

Drive controllers must be programmed before commissioning, making it possible for the motor to execute the specific functions of an application.

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

Important directions for use

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

2.2 Inappropriate use

Bosch Rexroth AG

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

Drive controllers may not be used, if ...

- they are subject to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extremely high maximum temperatures.
- Furthermore, Drive controllers must not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general safety instructions!



Components of the Rexroth IndraDrive ML system with a mains input current < 400 A are products of categorie C3 (with restricted distribution) according to IEC 61800-3.

Components of the Rexroth IndraDrive ML system with a mains input current > 400 A are products of categorie C4 (with restricted distribution) according to IEC 61800-3.

To ensure that these categories (limit values) are maintained, suitable mains filters must be used in the drive system.

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

3 Safety instructions for electric drives and controls

3.1 Definitions of terms

Installation

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

Electric drive system

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

User

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

Application documentation

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

Electrical equipment

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

Device

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

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.

Component

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

Machine

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

Product

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

Project Planning Manual

A project planning manual is part of the application documentation used to support the sizing and planning of systems, machines or installations.

Qualified persons

In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work

Bosch Rexroth AG

requires. To comply with these qualifications, it is necessary, among other things,

- 1) to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them
- 2) to be trained or instructed to maintain and use adequate safety equipment
- 3) to attend a course of instruction in first aid

Control system

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

3.2 General information

3.2.1 Using the Safety instructions and passing them on to others

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

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

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

3.2.2 Requirements for safe use

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

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

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

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

The machine and installation manufacturers must

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

The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.

The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user has to comply with

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

3.2.3 Hazards by improper use

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

Bosch Rexroth AG

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

3.3 Instructions with regard to specific dangers

3.3.1 Protection against contact with electrical parts and housings



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

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

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

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:
 - Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

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

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

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

Cross section outer con- ductor	Minimum cross section equipment grounding conductor Leakage current ≥ 3.5 mA	
	1 equipment grounding conductor	2 equipment grounding conductors
1.5 mm ² (16 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)	10 mm ² (8 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)		-
25 mm ² (4 AWG)	16 mm ² (6 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) mm² (applies to X ≥ 50)	-

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

3.3.2 Protective extra-low voltage as protection against electric shock

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

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

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

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

3.3.3 Protection against dangerous movements

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

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

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

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

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

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

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

To avoid accidents, injury and/or property damage:

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

Bosch Rexroth AG

- 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!

Hazards for persons with active medical implants or passive metallic implants, as well as for pregnant women.

 Persons with active medical implants (e.g. heart pacemakers), passive metallic implants (e.g. hip implants) and pregnant women might possibly risk hazards by electromagnetic or magnetic fields in the immediate vicinity of components of the electric drive and control system and the associated current-carrying conductors.

Entering the following areas can cause danger to these persons:

- Areas in which components of the electric drive and control system and the associated current-carrying conductors are mounted, commissioned and operated.
- Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- Before entering these areas, the above-mentioned persons should seek advice from their physician.
- Observe the occupational safety and health regulations applicable at the site of operation, for installations equipped with components of the electric drive and control system and the associated current-carrying conductors.

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.

Bosch Rexroth AG

- 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.

Safety instructions for electric drives and controls

A 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.

Rexroth IndraDrive ML Drive systems with HMU05

4 Combining individual components

4.1 Documentation

See chapter "Documentation" on page 21

4.2 Brief description of individual components

4.2.1 HMU05 - brief description and design

Brief description

HMU05 components belong to the Rexroth IndraDrive ML produce range and are used to run Rexroth IndraDyn or third-party motors.

HMU05-Types:

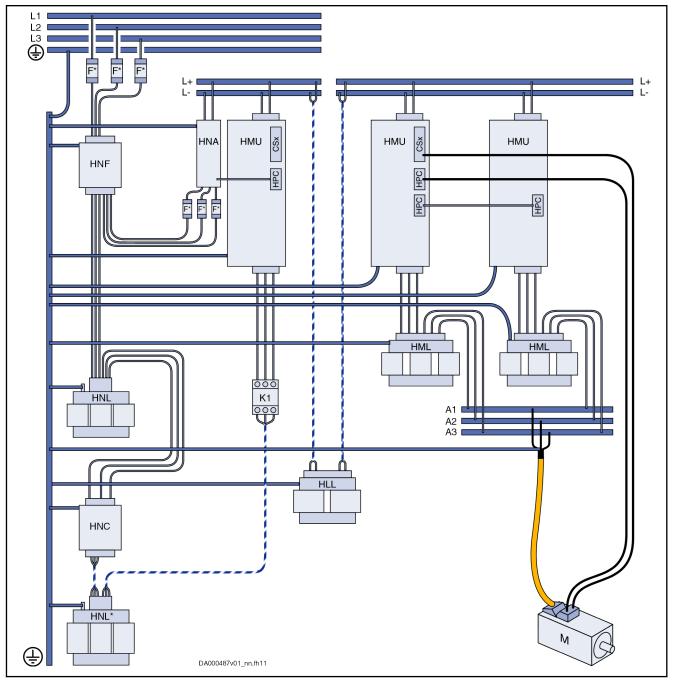
Universal inverter (HMU05):

DC bus voltage: 450 to 850 V DC; nominal: 750 V DC

Supply unit (HMU05 + HNA05):

Mains connection voltage: 3 AC 380 ... 500 V

Bosch Rexroth AG



CSx Control section

F Fuse

HLL DC bus choke **HML** Motor choke HMU Universal inverter

HNA Mains connecting module

HNC Mains capacitor Mains filter **HNF** HNL Mains choke

HPC Plug-in module for power section

K1 External mains contactor

М Motor

Fig. 4-1: Design of a drive system

4.3 Configuring drive systems

4.3.1 Firmware

Firmware and device types

Firmware for drive controllers	Assigned device type
FWA-INDRV*-MP B-19 VRS-D5-x-NNN-NN	CSB02.5 control section (BASIC)
FWA-INDRV*-MP C-19 VRS-D5-x-xxx-xx	CSH02.5 control section (ADVANCED)

Tab. 4-1: Drive firmware

Firmware for supply units	Assigned device type
FWA-INDRV*-PS B-19 VRS-D5-x-NNN-NN	CSB02.5 control section (BASIC)

Tab. 4-2: Supply firmware

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.

Unavailable motor designs

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 must 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:

- Induction motors, rotary
- Induction motors, linear
- Synchronous motors, rotary

Bosch Rexroth AG

Synchronous motors, linear

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



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

Synchronous motors

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



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

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

Requirements on third-party motors

General information

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

- Third-party motor being controlled can handle the voltage loads
- Which drive controller is suitable based on the motor torques being delivered
- Third-party motor has the necessary minimum inductance
- Motor can be protected against unacceptable temperature increase in case of overload (temperature evaluation)
- The 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 V_{ss} and
- Voltage change dv/dt

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



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

Using the HMF motor filter

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

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

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

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



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

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

Minimum inductance of third-party motor

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

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

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

f_s Desired switching frequency in kHz

Tab. 4-3: Minimum inductances depending on drive controller data, supply units and supply voltage

Install a three-phase choke in the motor feed wire if the inductance of the third-party motor is smaller than indicated in the table above. This choke has

to increase the inductance that can be measured between two motor terminals to the minimum value.



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

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

Mounting 3x L_{Dr} (three-phase choke)

Planned third-party motor

Calculate the leakage inductance (induction 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.

Choke requirements:

• $I_{n Dr} \ge I_{n Mot}$

Fig. 4-2:

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. 4-4: 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 must 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 induction motor encoder

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

Advantageous combination

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

Tab. 4-5: 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 must first be checked to see if they are suited for motor encoders. The following resolver data is required to check if they can be evaluated by the drive controllers:

- Data of resolver system being compared must 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 must be greater than the required average power.

Bosch Rexroth AG

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 cables

When selecting the motor power cable, observe the following:

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

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

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

Encoder cables

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

Tab. 4-6: Cable length

Installation conditions 4.4

4.4.1 Ambient and operating conditions

WARNING

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

Exclusively operate the device

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

Control cabinet

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

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

Ambient and operating conditions

Description	Symbol	Unit	Value	
Conductive dirt contamination			Not permitted (You can protect the devices against conductive dirt contamination, e.g., by mounting them in control cabinets with a protection class of IP54 in accordance with IEC529.)	
Protection class (IEC529)			IP00	
Use in scope of CSA/UL			For use in NFPA 79 applications only.	
Temperature during storage			See chapter 5.4 "Storing components" on page 103	
Temperature during transport			See chapter 5.3 "Transporting components" on page 102	
Permitted mounting position			G1	
Installation altitude	h _{nom}	m	1000	
Ambient temperature range	T _{a_work}	°C	0 to 40	
Derating vs. ambient temperature:		1		
The performance data is 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 load factor $f_{Ta} = 2$ %, the rated power is reduced to		^π _ε	Dktool28v03_rn.in11	
$P_{DC_cont_red} = P_{DC_cont} \times F_{Ta} =$	T _{a_work} T _{a_work_red} T _a →			
$P_{DC_cont} x (1 - [(50 - 40) \times 0.02]) = P_{DC_cont} \times 0.8$	T _{a_work_red}	c_red °C 40 to 55		
Operation at ambient temperatures outside of T_{a_work} and $T_{a_work_red}$ is not permitted.	f _{Ta}	%/K	Load factor: see technical data for each component (data for cooling and power dissipation \rightarrow derating of P_{DC_cont} , P_{BD} , I_{out_cont} when $T_{a_work} < T_a < T_{a_work_red}$)	
Derating vs. installation altitude:		1 -		
At an installation altitude h > h_{nom} , the performance data ²⁾ reduced by factor f is available. At an installation altitude in the range $h_{max_without}$ to h_{max} , an isolating transformer has to be installed on the drive system mains connection. Use above h_{max} is not permitted.		0,9 0,8 0,7 0,7 0,6	h _{nenn} h _{max_ohne} h _{max}	
	h _{max_with-}	m	2000	
	h _{max}	m	4000	
Simultaneous derating for ambient temperature and installation altitude	Permitted; reduce with factors f and f _{Ta}			
Relative humidity		%	5 to 95	
Absolute humidity		g/m³	1 to 29	

Bosch Rexroth AG

Combining individual components

Description	Symbol	Unit	Value
Moisture condensation			Not permitted
Climatic category (IEC721)			3K3
Permitted degree of contamination (EN 50178)			2
Permitted dust, steam			EN 50178 tab. A.2
Vibration sine: Amplitude (peak-peak) at 10 to 57 Hz ¹⁾		mm	0.15
Vibration sine: Acceleration at 57 to 150 Hz ¹⁾		g	1
Overvoltage category			III (according to IEC60664-1)

1) According to EN 60068-2-6

2) Reduced performance data for drive controllers: permitted DC bus continuous power, permitted mains voltage, braking resis-

tor continuous power, continuous current

Tab. 4-7: Ambient and operating conditions

4.4.2 Control cabinet

Air cooling

Control cabinet design and cooling



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

Possibilities of heat dissipation

Closed control cabinet with air circulation	Closed control cabinet with heat exchanger	Control cabinet with fan	Closed control cabinet with air conditioning unit
DF000644v01_nn.tif	DF000645v01_nn.tif	DF000646v01_nn.tif	DF000647v01_rm.til
P _Q ~ 400 W	P _Q ~ 1700 W	P _Q ~ 2700 W	P _Q ~ 4000 W

P_Q Dissipated heat output

Tab. 4-8: Possibilities of heat dissipation

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

Requirements for control cabinets with fan

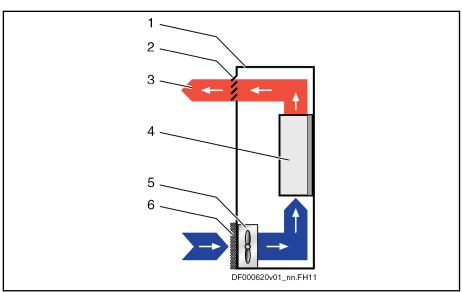
NOTICE

Risk of damage by unclean air in the control cabinet!

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

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

Control cabinet ventilation (schematic diagram)



Control cabinet
 Air outlet opening
 Heat discharge

Device in control cabinet
Control cabinet fan
Filter at air intake opening

Fig. 4-3: Control cabinet ventilation (schematic diagram)

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

Liquid cooling

General information

Cooling devices

There are three types of cooling devices for liquid cooling:

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

Bosch Rexroth AG

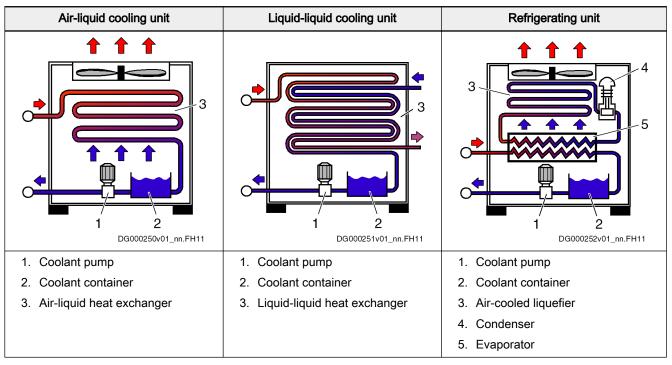
Power dissipation in control cabi-

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 liquidcooled 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.



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

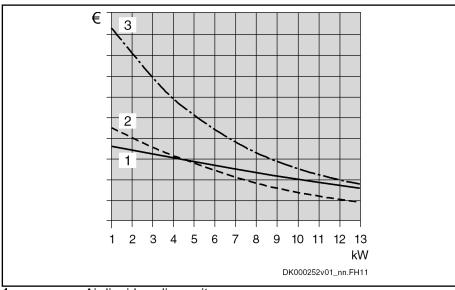
Tab. 4-10: Comparison of cooling devices

Application

Air-	Particularly suited for individual workshop machines.		
liquid	Is used		
cooling unit	Where there is no higher-level cooling circuit available		
	Where there are no high demands on the stability of the coolant temperature		
liquid	Particularly suited for systems with central recooling.		
liquid	,		
cooling unit	coolant temperature.		
	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



Air-liquid cooling unit 2

Liquid-liquid cooling unit

Refrigerating unit

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

Cooling device components

Overview

A liquid cooling system consists of:

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

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

Bosch Rexroth AG

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

ΔpPressure decreaseΣQRequired flow rate

Fig. 4-5: Basic arrangement of a liquid cooling system

Coolant reservoir

Recommendation for sizing the coolant reservoir:

	$V_T = V_{Ks} + 1,3 \times V_{T_{min}}$	
V_T	Required volume of coolant reservoir	
V_{Cs}	Coolant circulating in cooling system	
V_{T_min}	Minimum required coolant volume	
Fig. 4-6:	Required volume of coolant reservoir	

$\bigvee_{Ks} = \bigvee_{Wt} + \bigvee_{Arm} + \bigvee_{ch} + \bigvee_{Ltg}$

V_{Cs} Coolant volume of cooling system (circulating coolant)

V_{He} Coolant volume in heat exchanger

 $\begin{array}{ll} V_{\text{Ftg}} & \text{Coolant volume in fittings of cooling system} \\ V_{\text{Dc}} & \text{Coolant volume in drive components} \end{array}$

V_L Coolant volume in coolant lines Fig. 4-7: 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

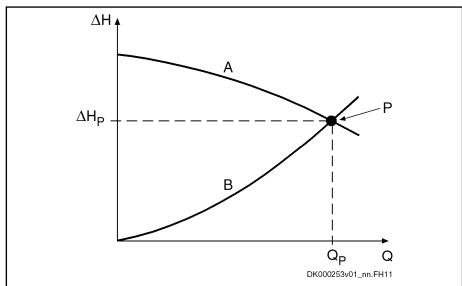
pressure corresponding to the total pressure decrease of the cooling system at the required flow rate.

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

Characteristic of cooling system

ΔH Delivery height

P Working point of coolant pump

Q Delivery rate

Fig. 4-8: Working point of a coolant pump

Delivery rate

Parallel connection

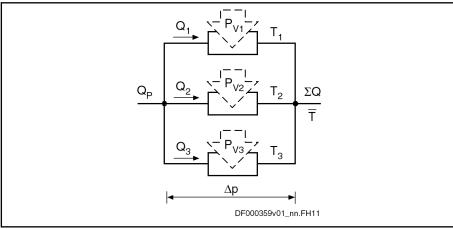


Fig. 4-9: Parallel connection of components

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

Bosch Rexroth AG

$$Q_p \ge Q_1 + Q_2 + \dots + Q_n = \sum Q$$

Delivery rate of coolant pump $\overline{\mathsf{Q}_{\mathsf{P}}}$

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

Fig. 4-10: Delivery rate of the coolant pump with parallel connection

Series connection

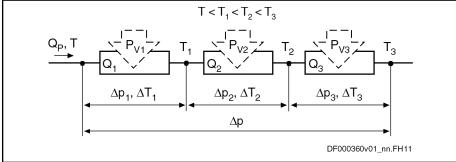


Fig. 4-11: Series connection of components

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.

$$Q_p \ge Maximum(Q_1,Q_2...Q_n)$$

Delivery rate of coolant pump Q_P

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

Fig. 4-12: Delivery rate of series coolant pump

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

Delivery pressure

Required delivery pressure of coolant pump

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

The flow path passes through:

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

$$\triangle p_p \ge \triangle p_{Wt} + \triangle p_{Arm} + \triangle p_{ch} + \triangle p_{Ltg} = \sum \triangle p_{ch}$$

 Δp_{xx} Pressure decreases in individual cooling system components

on flow path (He: heat exchanger; Ftg: fittings; Dc: drive com-

ponents; L: lines)

Delivery pressure of coolant pump Δp_{p} Fig. 4-13: Required delivery pressure of coolant pump

Coolant line pressure decrease

$$\triangle p_{Ltg} = \triangle p_{Ltg}/\triangle I \times I$$

Δp_L/Δl Length-based pressure decrease in hPa/m

I Line length in m

Fig. 4-14: 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:

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

Δp_L/Δl Pressure decrease for tube with same inner diameter in hPa/m

Fig. 4-15: Fittings pressure decrease

Heat exchanger pressure decrease

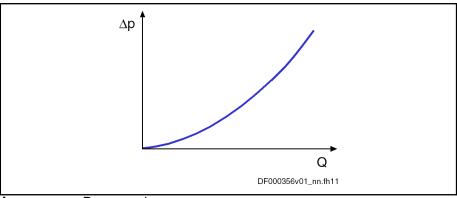
See manufacturer's specification for pressure decrease $\Delta p_{\text{He}}.$

Drive components pressure decrease

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

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

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



Δp Pressure decrease

Q Flow rate Fig. 4-16: 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

Bosch Rexroth AG

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

ΔH Delivery height in m

Δp_p Pressure of coolant pump in hPa
 ρ Specific weight of coolant in kg/l
 Fig. 4-17: Coolant pump delivery height

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

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

Cooling unit or refrigerating unit

Air-liquid cooling unit and control cabinet air cooler

Data for selection

Determining specific cooling capacity

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

P_V Power dissipation being discharged in kW

P₀₁ Specific cooling capacity in kW/K

T_{amb} Ambient temperature in °C

T_{in} Inlet temperature of coolant in heat exchanger in °C

Fig. 4-18: 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

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

Pv Power dissipation being discharged in kW

ρ Density of coolant in kg/l

c_{Cl} Specific thermal capacity of coolant in kJ/kgK

Q Flow rate of coolant in I/min Fig. 4-19: Coolant temperature change

Air temperature change

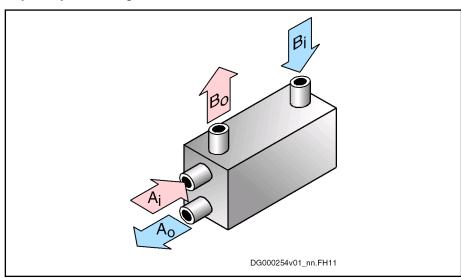
$$\Delta T_L = \frac{P_V \times 60 \frac{s}{min}}{1,3 \times 10^{-3} \frac{kg}{l} \times 0,72 \frac{kJ}{kgK} \times Q_L}$$

Pv Power dissipation being discharged in kW

Q_L Air flow in I/min
Fig. 4-20: Air temperature change

For control cabinet air cooling, measure the air flow Q_L such that the resulting air temperature change is $\Delta T_L = 10$ K. (Avoiding condensation: see chapter "Condensation protection" on page 59)

Liquid-liquid cooling unit



AiCoolant inletAoCoolant outletBiUtilities inletBoUtilities outlet

Fig. 4-21: 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.

56/277

Combining individual components

Data for selection Determining specific cooling capacity

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

Pv Power dissipation being discharged in kW

P₀₁ Specific cooling capacity in kW/K
T₁ Inlet temperature of coolant in °C
T₂ Inlet temperature of utilities in °C
Fig. 4-22: Determining specific cooling capacity

Cooling warmer medium (coolant)

 $\Delta T_1 = \frac{3.6 \times P_V}{\rho_1 \times c_1 \times Q_1 \times 0.06}$

ΔT₁ Temperature reduction of coolant in K

 $\begin{array}{ll} \rho_1 & \text{Density of coolant in kg/l} \\ P_V & \text{Power dissipation in kW} \end{array}$

c₁ Specific thermal capacity of coolant in kJ/kgK

Q₁ Flow rate of coolant in l/min
 Fig. 4-23: Cooling warmer medium (coolant)
 Temperature increase of colder medium (utilities)

 $\Delta T_2 = \frac{3.6 \times P_V}{\rho_2 \times c_2 \times Q_2 \times 0.06}$

ΔT₂ Temperature increase of utilities in K

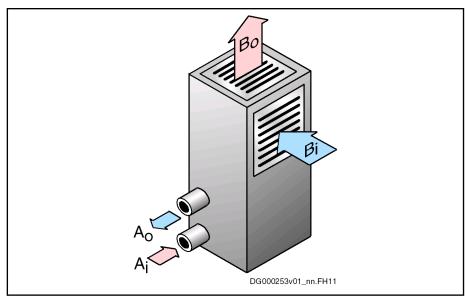
 ho_2 Density of utilities in kg/l ho_V Power dissipation in kW

c₂ Specific thermal capacity of utilities in kJ/kgK

Q₂ Flow rate of utilities in I/min

Fig. 4-24: Temperature increase of colder medium (utilities)

Refrigerating unit



AiCoolant inletAoCoolant outletBiAir intakeBoAir outletFig. 4-25: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

$$P_C \ge \sum P_V$$

P_C Refrigerating capacity of refrigerating unit ∑P_V Sum of power dissipations being discharged

Fig. 4-26: Determining refrigerating capacity

Cooling of the drive components

Technical data



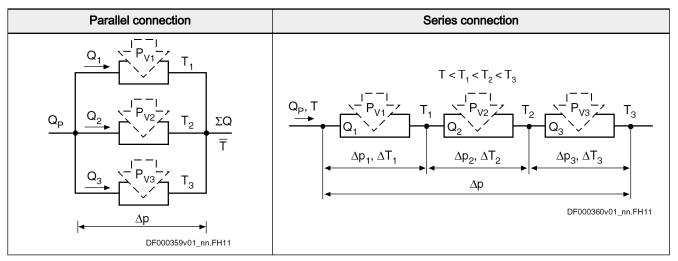
The technical data needed to size the cooling system can be found in the project planning manuals of the drive components used (see "Other applicable documentation").

Bosch Rexroth AG

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



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

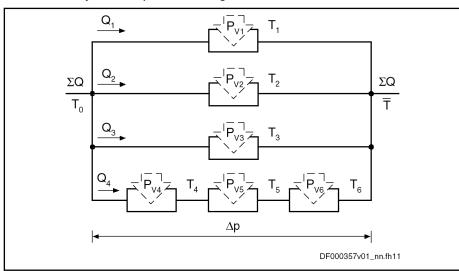


Fig. 4-27: Combined interconnection of drive components being cooled

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.

Bosch Rexroth AG

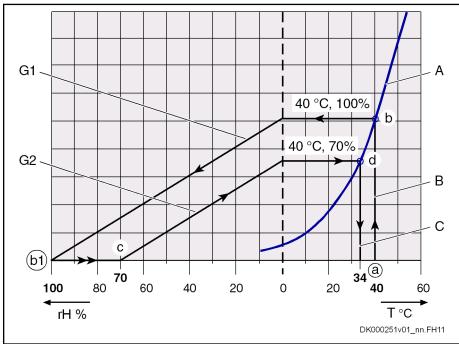
Drive components with the protection class IPx0, such as drive controllers and supply units, do not have sufficient protection against water. This is why condensation cannot be allowed to form on them.

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
В	Maximum temperature of ambient air
С	Condensation temperature
G1, G2	Artificial lines
rH	Relative humidity
Т	Ambient temperature
а	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)
С	Convert 100% humidity value graphically by parallel translation
	of artificial line G1 to expected humidity value (e.g., 70%) (⇒ ar-
	tificial line G2)
d	Intersection point of expected humidity value and characteristic
	of water vapor saturation leads to expected condensation tem-
	perature of drive component (34°C)
	· · · · · · · /

Determining condensation temperature

Fig. 4-28:



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

Coolant

Water-based coolant

NOTICE

Risk of damage to components.

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

Required properties

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

The water-based coolant must have the following properties:

- pH value: 7-8.5
- Hardness: max. 10 °dH (England: 12.5 °e; France: 17.8 °f; USA: 178 ppm CaCO₃)
- Chloride: max. 20 mg/l
- Nitrate: max. 10 mg/l
- Sulfate: max. 100 mg/l
- Insoluble substances: max. 250 mg/l

Drinking water in Germany complies with these requirements.

Antifreeze

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

Protection against corrosion

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



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

Anti-corrosion additive

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

Bosch Rexroth AG



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

Coolant additives

Recommended manufacturer of coolant additives

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



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

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

Water-based coolant

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

Non-water-based coolant

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

Sizing liquid cooling

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

4.4.3 UL data

This chapter contains:

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

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N- F0140-0350	HMU05.1N- F0170-0430	HMU05.1N- F0220-0510	HMU05.1N- F0270-0660	
Short circuit current rating	SCCR	kA rms	85 (preliminary)				
Nominal voltage for input, power ¹⁾	V_{LN_nom}	V	450 to 750 DC				
Nominal input current	I _{LN}	Α	242	291	373	467	
Output voltage	V _{out}	V	3x 0 to 500 AC				
Output current	l _{out}	Α	254	306	392	490	

1) Mains input L1, L2, L3; approved only for use on a solidly grounded, star-connected source.

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

Ambient and operating conditions - UL ratings

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690	
Short circuit current rating	SCCR	kA rms	85 (preliminary)				
Nominal voltage for input, power ¹⁾	V_{LN_nom}	V	450 to 750 DC				
Rated input current	I _{LN}	Α	587	734	954	1129	
Output voltage V _{out} V			3x 0 to 500 AC				
Output Current	I _{out}	Α	616	771	1002	1185	

1) Mains input L1, L2, L3; approved only for use at a solidly grounded, star-connected source.

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

Bosch Rexroth AG

4.4.4 Compatibility with foreign matters

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

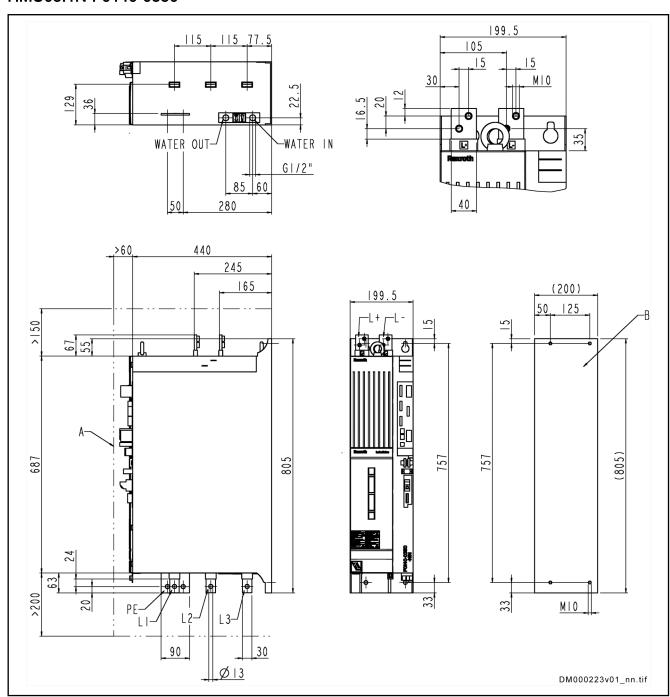
As it is impossible to follow the continuing development of all materials (e.g. lubricants in machine tools) which may interact with the controls and drives, it cannot be completely ruled out that any reactions with the materials we use might occur.

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

4.5 Mechanical project planning

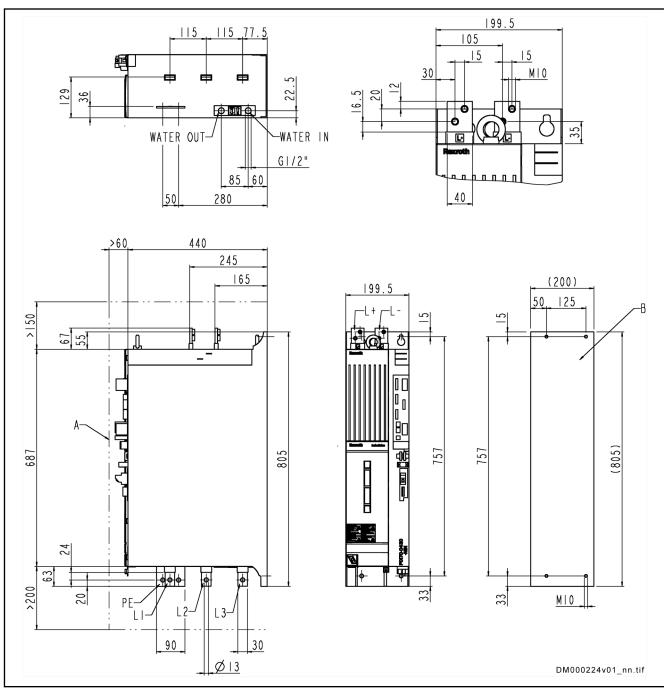
4.5.1 Dimensions

HMU05.1N-F0140-0350



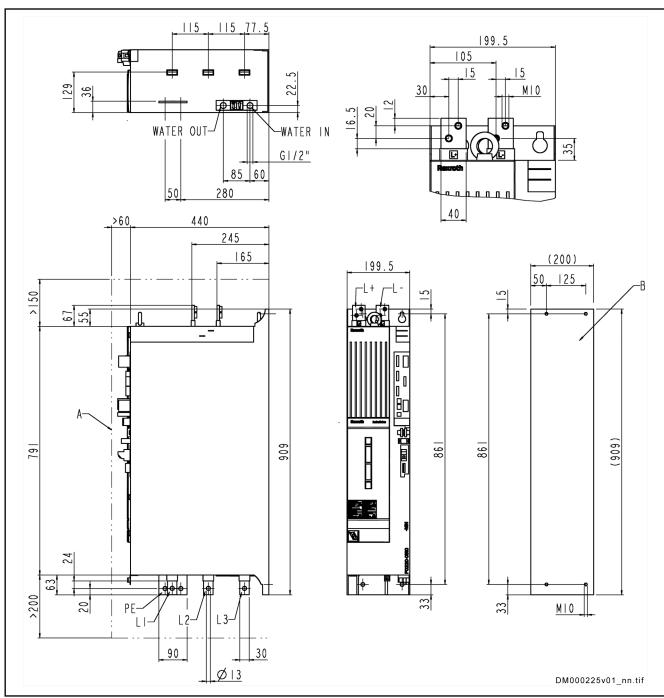
A Minimum mounting clearance
B Boring dimensions
Fig. 4-29: HMU05.1N-F0140-0350

HMU05.1N-F0170-0430



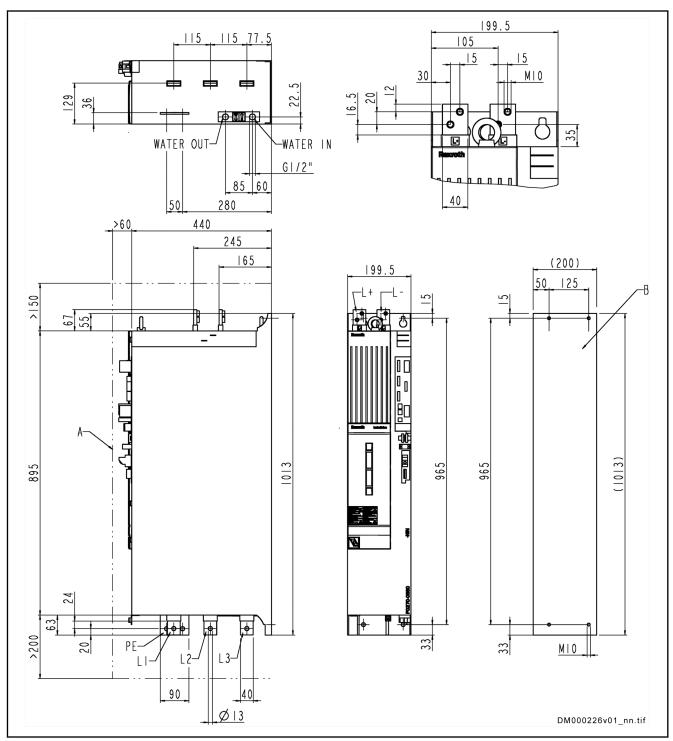
A Minimum mounting clearance B Boring dimensions
Fig. 4-30: HMU05.1N-F0170-0430

HMU05.1N-F0220-0510



A Minimum mounting clearance B Boring dimensions
Fig. 4-31: HMU05.1N-F0220-0510

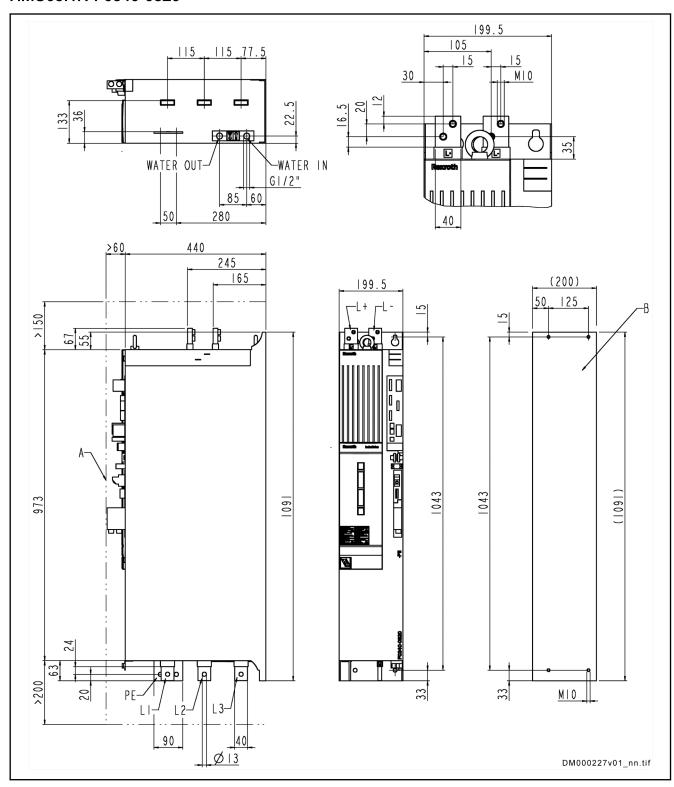
HMU05.1N-F0270-0660



A Minimum mounting clearance B Boring dimensions

Fig. 4-32: HMU05.1N-F0270-0660

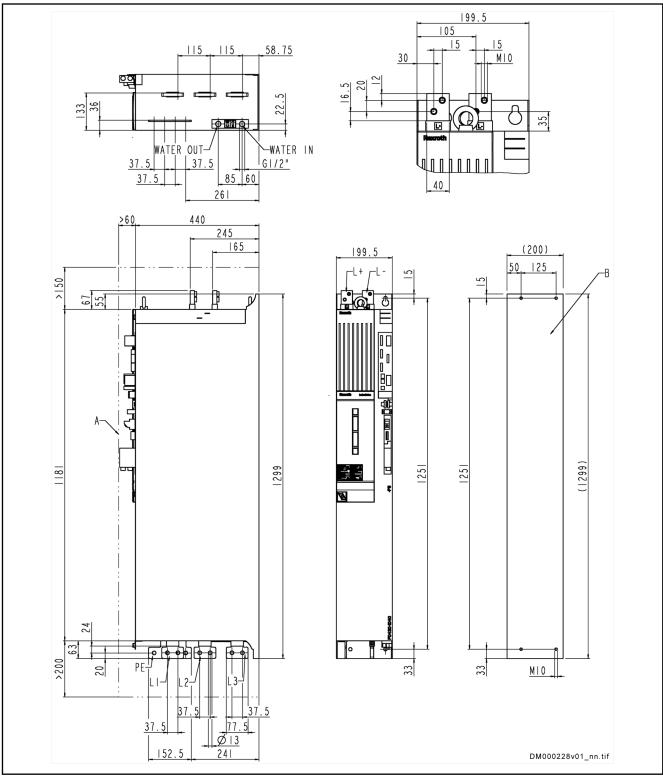
HMU05.1N-F0340-0820



A Minimum mounting clearance B Boring dimensions

Fig. 4-33: HMU05.1N-F0340-0820

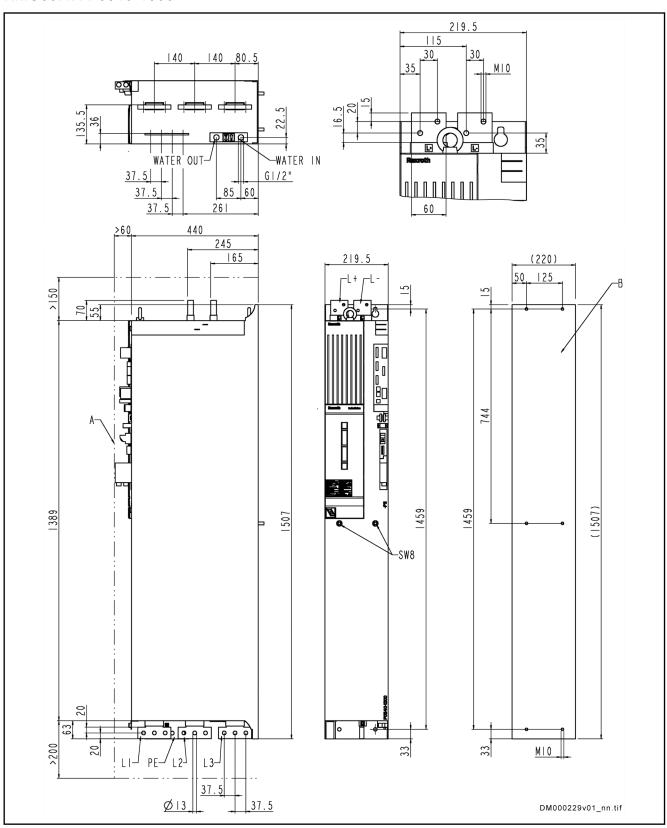
HMU05.1N-F0430-1040



A Minimum mounting clearance

B Boring dimensions Fig. 4-34: HMU05.1N-F0430-1040

HMU05.1N-F0540-1300



A Minimum mounting clearance B Boring dimensions

Fig. 4-35: HMU05.1N-F0540-1300

4.5.2 Dimensions, mass, insulation, sound pressure level

Data for mass, dimensions, sound pressure level, insulation

Description	Symbol	Unit	HMU05.1N- F0140-0350	HMU05.1N- F0170-0430	HMU05.1N- F0220-0510	HMU05.1N- F0270-0660		
Mass	m	kg	tbd	tbd	tbd	tbd		
Device height ¹⁾	Н	mm	817 817		921	1025		
Device depth ²⁾	Т	mm	440					
Device width ³⁾	В	mm		20	00			
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)	-					

1) 2) 3) Housing dimension; see also related dimensional drawing

According to DIN EN ISO 11205; comparative value at 1 m distance, out of cabinet

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

Data for mass, dimensions, sound pressure level, insulation

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690		
Mass	m	kg	53	tbd	103	tbd		
Device height ¹⁾	Н	mm	1103 1311		1522	tbd		
Device depth ²⁾	Т	mm	440 tbc					
Device width ³⁾	В	mm	200 220 t					
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)	-					

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

4.5.3 Temperatures, cooling, power dissipation, distances

Cooling and power dissipation data

Description	Symbol	Unit	HMU05.1N- F0140-0350	HMU05.1N- F0170-0430	HMU05.1N- F0220-0510	HMU05.1N- F0270-0660	
Permitted mounting position			G1				
Permitted switching frequencies ¹⁾	f _s	kHz	2, 4, 8				
Power dissipation when $I_{out_cont} = 0 \text{ A}; f_s = f_s \text{ (min.)}^2$	P _{Diss_0A_fsmin}	W	230	250	270	320	

Description	Symbol	Unit	HMU05.1N- F0140-0350	HMU05.1N- F0170-0430	HMU05.1N- F0220-0510	HMU05.1N- F0270-0660	
Power dissipation when $I_{out_cont} = 0 \text{ A}$; $f_s = f_s \text{ (max.)}^{3)}$	P _{Diss_0A_fsmax}	W	300	325	350	400	
Power dissipation with continuous current/continuous power ⁴⁾	P _{Diss_cont}	W	2500.00	3000.00	4250.00	5500.00	
Liquid cooling data				•		•	
Power dissipation ratio (liquid) with continuous current/continuous power	P _{Diss_cont_F}	W	2100.0	2500.0	3500.0	4500.0	
Coolant inlet temperature	T _{in}	°C		<	60		
Required minimum coolant flow for P _{Diss_cont_F}	Q_{min}	l/min	4	5	7	9	
Temperature increase for Q_{min} and $P_{Diss_cont_F}$	ΔΤ	К		<	10		
Pressure decrease for Q _{min}	Δp	bar	0	.4	0	.5	
Maximum permitted operating pressure	p _{max}	bar		2	2		
Coolant channel volume	V_{ch}	ml	0.	75	0	.8	
Coolant channel material				Alum	inum		
Constant for determining pressure decrease	K_{\Deltap}			tb	od		
Air cooling data							
Power dissipation ratio (air) with continuous current/continuous power	P _{Diss_cont_A}	W	400.0	500.0	750.0	1000.0	
Ambient temperature range for operation with nominal data	T _{a_work}	°C		0 tc	40		
Ambient temperature range for operation with reduced nominal data	$T_{a_work_red}$	°C	0 to 55				
Derating of P_{DC_cont} ; P_{BD} ; I_{out_cont} when $T_{a_work} < T_a < T_{a_work_red}$	f _{Ta}	%/K	2.0				
Volumetric capacity of forced cooling	V	m³/h	-				
Minimum distance on top of device ⁵⁾	d_{top}	mm	100				
Minimum distance on bottom of device ⁶⁾	d_bot	mm	100				
Temperature increase with minimum distances d _{bot} ; d _{top} ; P _{BD}	ΔΤ	К		1	0		

1) Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of power output stage"; see "P-0-4058, Amplifier type data"

2) 3) Plus dissipation of braking resistor and control section; find in-

terim values by interpolation to P_Diss_cont

4) Plus dissipation of braking resistor and control section

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

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

Cooling and power dissipation data

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690	
Permitted mounting position				G	61		
Permitted switching frequencies ¹⁾	f _s	kHz		2, 4	4, 8		
Power dissipation when $I_{out_cont} = 0 A$; $f_s = f_s (min.)^{2}$	P _{Diss_0A_fsmin}	W	350	400	450	500	
Power dissipation when $I_{out_cont} = 0 A$; $f_s = f_s (max.)^3$	P _{Diss_0A_fsmax}	W	450	500	550	600	
Power dissipation with continuous current/continuous power ⁴⁾	P _{Diss_cont}	W	5500.00	6500.00	8700.00	10000.00	
Liquid cooling data							
Power dissipation ratio (liquid) with continuous current/continuous power	P _{Diss_cont_F}	W	4500.0	5500.0	7500.0	8500.0	
Coolant inlet temperature	T _{in}	°C		<	60		
Required minimum coolant flow for P _{Diss_cont_F}	Q_{min}	l/min	9	9 11		18	
	ΔΤ	К	< 10				
Pressure decrease for Q _{min}	Δр	bar	0.6	1	1	.3	
Maximum permitted operating pressure	p _{max}	bar		2	2		
Coolant channel volume	V_{ch}	ml	0.92	1.0	1.1	tbd	
Coolant channel material				Alum	ninum		
Constant for determining pressure decrease	K_{\Deltap}			tk	od		
Air cooling data							
Power dissipation ratio (air) with continuous current/continuous power	P _{Diss_cont_A}	W	1000.0 1200.0		1500.0		
Ambient temperature range for operation with nominal data	T _{a_work}	°C	0 to 40				
Ambient temperature range for operation with reduced nominal data	$T_{a_work_red}$	°C	0 to 55				
Derating of P_{DC_cont} ; P_{BD} ; I_{out_cont} when $T_{a_work} < T_a < T_{a_work_red}$	f _{Ta}	%/K		2	.0		

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690
Volumetric capacity of forced cooling	V	m³/h	-			
Minimum distance on top of device ⁵⁾	d_{top}	mm	100			
Minimum distance on bottom of device ⁶⁾	d _{bot}	mm	100			
Temperature increase with minimum distances d _{bot} ; d _{top} ; P _{BD}	ΔΤ	К	10			

1)	Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of power output
	stage"; see "P-0-4058, Amplifier type data"
2) 3)	Plus dissipation of braking resistor and control section; find in-
	terim values by interpolation to P_Diss_cont
4)	Plus dissipation of braking resistor and control section
5) 6)	See fig. "Air intake and air outlet on device"
Tab. 4-18:	HMU – cooling and power dissipation data

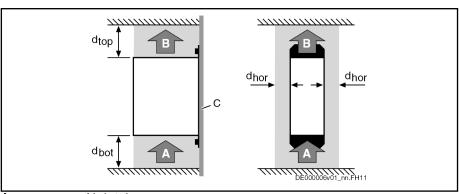
NOTICE

Property damage due to temperatures higher than 105 °C!

Observe the indicated minimum distances!

Above the devices there may only be such materials which

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



Α	Air intake
В	Air outlet
С	Mounting surface in control cabinet
d_{top}	Distance top
d _{bot}	Distance bottom
d_{hor}	Distance horizontal
Fig. 4-36:	Air intake and air outlet at device

Bosch Rexroth AG

4.5.4 Mounting positions of components

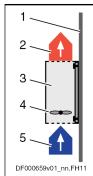
NOTICE

Risk of damage to the components by incorrect mounting position!

Only operate the components in their allowed mounting positions.

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

Mounting position G1



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

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

Tab. 4-19: Mounting position G1

4.6 Electrical project planning

4.6.1 Overall connection diagram (HMU05 as drive controller)

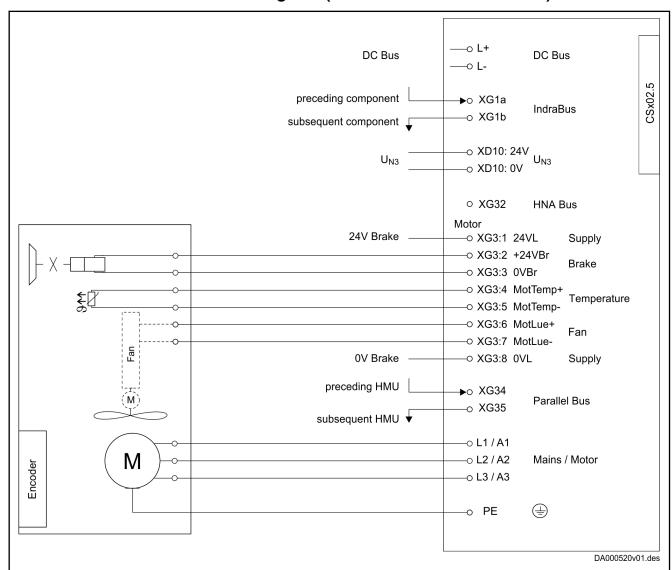


Fig. 4-37: Connection diagram (HMU05 as drive controller)

Rexroth IndraDrive ML Drive systems with HMU05

Combining individual components

4.6.2 Overall connection diagram (HMU05 as supply unit)

Overall connection diagram with load contactor

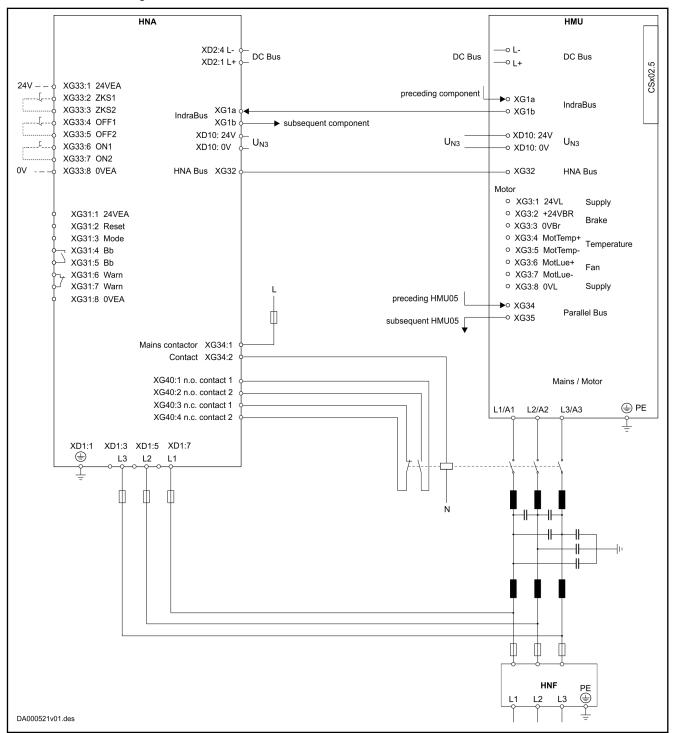


Fig. 4-38: Connection diagram with load contactor (HMU05 as supply unit)

Overall connection diagram with switchable main switch

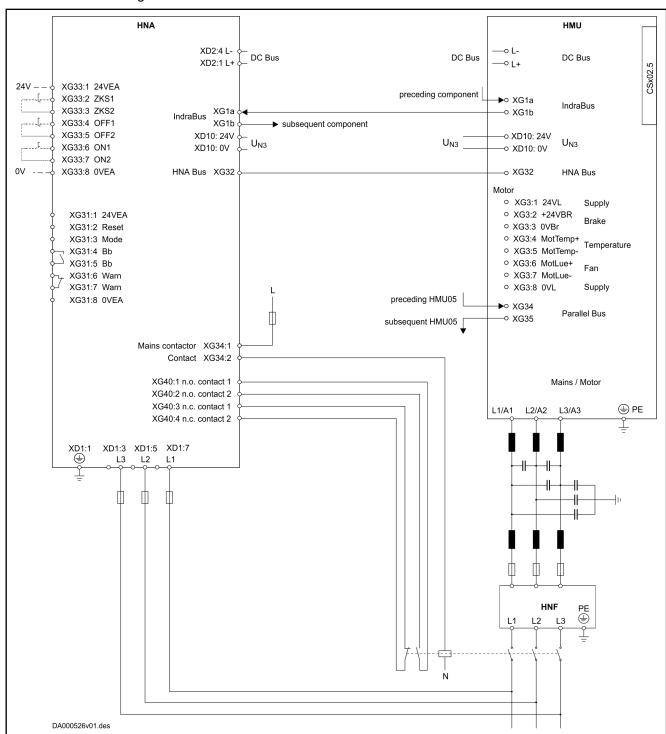


Fig. 4-39: Connection diagram with switchable main switch (HMU05 as supply unit)

4.6.3 Planning control voltage

Control voltage for drive systems

Bosch Rexroth AG

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

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

Sizing control voltage supply

Determining power requirements

Drive controller power requirements

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

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

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

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

Basic device power requirements

The power requirements of the basic device result from

- Maximum current of drive controller
- Design of control section (data: see project planning manual for control section)

HMU05.1N	Power	Current consumption of control voltage supply
	[kW]	[A _{eff}]
F0120-0290	90/110	1.9
F0140-0350	110/132	1.7
F0170-0430	132/160	2.0
F0220-0510	160/200	2.2
F0270-0660	200/250	1.9
F0340-0820	250/315	2.0
F0430-1040	315/400	2.3
F0540-1300	400/500	2.4
F0680-1690	500/630	2.7

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

Power requirements of 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 external consumers

External consumers include

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

The drive controller must supply the external consumers with power.

Table 3: Power requirements of external consumers

External consumer	Power requirement
5 V encoder system	P = I _{encoder} x 5 V x 1.75 ^{1), 5)}
12 V encoder system	P = I _{encoder} x 12 V x 1.25 ^{1), 5)}
Load on digital output	$P = I_{load} \times V_{N3}^{2), 4}$
Motor holding brake	$P = I_{brake} \times V_{N3}^{3), 4}$

1) I_{encoder}: Current consumption of encoder system

2) I_{load}: Current consumption of external load

 I_{brake} : Current consumption of motor holding brake

 V_{N3} : Control voltage supply of drive controller

5) The sum of the power consumption of all connected encoder

systems incl. encoder emulation cannot exceed 6 W.

Tab. 4-21: Power requirements of external consumers

Calculation formula

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

$$P_{N3} = P_{basic device} + \sum P_{optional connection points} + \sum P_{external consumers}$$

Bosch Rexroth AG

Requirements on 24 V power supply unit

礟

PELV¹⁾ for 24V power supply unit

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

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

Max. output voltage: 42.4 V_{peak} or 30 V_{ac}

Max. output power: 10000 VA

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

- Output voltage/output voltage range
- Continuous power which the 24 V power supply unit must supply during operation
- Peak current which the 24 V power supply unit must supply when switching on

Required continuous power

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

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

$$I_{N3} = P_{N3} \div V_{N3}$$

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

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

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

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

Required peak current

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

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

$$I_{peak\ ps} = 1.2 \times P_{N3} \div V_{N3}$$

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

The power supply unit must provide the calculated peak current I_{peak_ps} for at least one second.

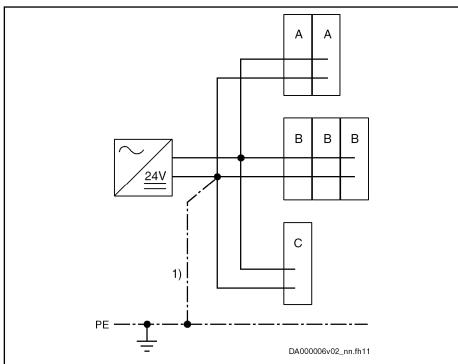
Installing 24 V supply

Notes on installation

The 24 V supply of the Rexroth IndraDrive ML drive system components should in principle be installed in a **star** layout. This means it is necessary to run separate supply lines for each group of drive controllers or third-party components. This also applies to multiple-line arrangement in case of supply from, e.g., a supply unit.

1) Protective Extra Low Voltage

- Route lines of sufficient size to reduce load-dependent voltage drops.
- For looping through the control voltage, observe the maximum current carrying capacity of the connection points. The maximum current carrying capacity limits the number of devices to which the control voltage can be looped through.



- A Number of devices is limited to x components with a current consumption of ≤ 31 A.
- B Number of devices is limited to y components with a current consumption of ≤ 31 A.
- Third-party component (e.g., PLC, valve, etc.)
- Connection to central ground point (e.g., PE earth-circuit connector)

Fig. 4-40: Installing the 24 V supply

图

If you use several 24 V power supply units:

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

Chronological order of 24 V supply and mains voltage

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

Bosch Rexroth AG

Looping through control voltage

NOTICE

Property damage can occur due to fault from line being too small.

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

You can only loop through the control voltage between the components, when the **sum** of current consumptions ΣI_{N3} of the individual components is smaller than **31 A** (current carrying capacity of the connection point X13).

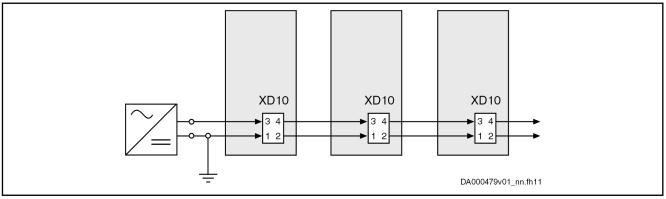


Fig. 4-41: Looping through control voltage

Sample calculation for 3 drive controllers:

$$P = 3 \times \frac{\Omega^{N3}}{\Delta^{N3}}$$

Fig. 4-42: Continuous current

The result I_D must 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)

B

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

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

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

Cause of leakage currents

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

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

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

- Kind of inrush current limitation
- Number, kind and size drives used
- Length and cross section of connected motor power cables
- Grounding conditions of the mains at the site of installation
- Unbalance of the three-phase system
- Kind 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 length

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

Kinds of residual-current-operated circuit breakers

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

 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,

Bosch Rexroth AG

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.

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.

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

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

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

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

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

Exclusive fusing by residual-current-operated circuit breaker

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

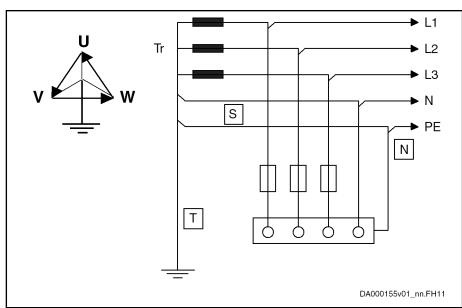
Electronic equipment that has a nominal power higher than 4 kVA or is destined for permanent connection does not need residual-current-operated circuit breakers.

According to IEC 364 and EN 50178, the supply-side protection against contact for indirect contact, i.e. in the case of insulation failure, has to be provided in a different way, for example by means of overcurrent protective 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.

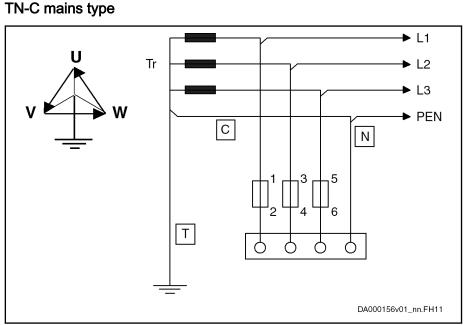


T = Direct grounding of a point (station ground)

N = Exposed conductive parts directly connected to station ground
 S = Separate neutral conductor and equipment grounding conduc-

tor in entire mains *TN-S mains type*

Fig. 4-43: TN-S main



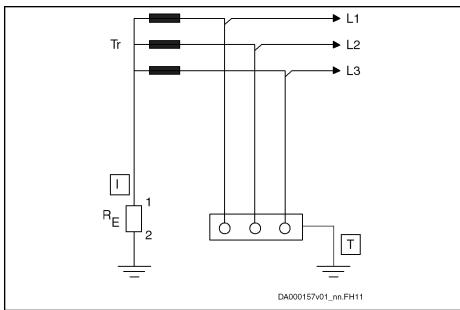
T = Direct grounding of a point (station ground)

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. 4-44: TN-C mains type

Bosch Rexroth AG

IT mains type



Insulation of all active parts from ground or connection of one point to ground via an impedance R_{E}

Т

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

Fig. 4-45: IT mains type

Notes on project planning

NOTICE

Risk to damage to devices from voltage arcing.

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



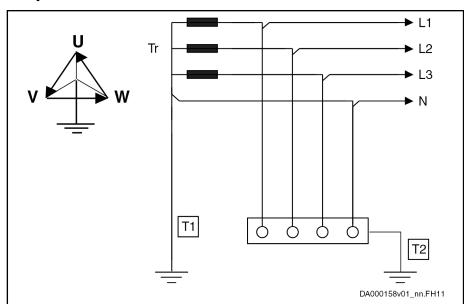
Voltage increase in case of ground fault.

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

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

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

TT system



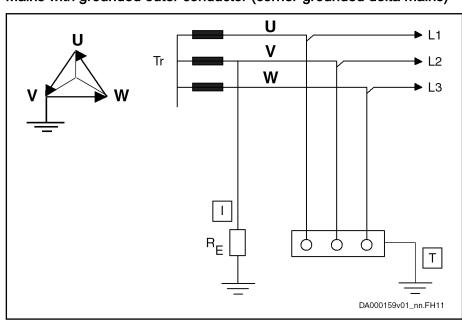
T = Direct grounding of a point (station ground)

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

Fig. 4-46: TT mains system

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

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



Insulation 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. 4-47: Mains with grounded outer conductor

Notes on project planning

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

Bosch Rexroth AG



HNF05 mains filter on mains grounded with outer conductor

HNF05 mains filters are not suited for operation on mains grounded with outer conductor. Use isolating transformers.

Permitted mains connection voltage: see technical data for each device

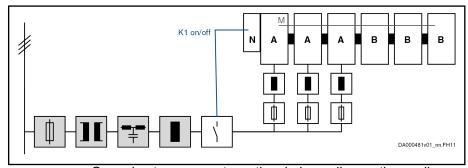
Mains connection type

See also chapter 4.6.4 "Mains connection" on page 84.

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

Parallel connection

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



Grayed out components: optional, depending on the applica-

tion; the choke is used to reduce current harmonics

Α HMU05 component (all components A identical); connected to

supply mains with balancing chokes; connected to other com-

ponents through DC bus

В HMU05 component (as HMS05 inverter); connected to other

components through DC bus

K1 on/off Mains contactor wiring

М IndraBus

Ν HNA05 mains connecting module

Parallel connection; multiple HMU05 components connected to supply Fig. 4-48:

mains

NOTICE

Risk of fire caused by missing fuses!

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

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

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

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

Mains connected load and mains current

Component technical data

- See chapter 7.1.2 "Mains voltage" on page 135
- See chapter 7.1.3 "DC bus" on page 138

Calculating the mains-side phase current

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

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

Operation under rated conditions

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

Operation at partial load

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

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

Determine motor power

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

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

P_{mHa} Mechanical nominal power for main drives (shaft

output) [kW]

M_n Nominal motor torque [Nm]

n_n Nominal motor speed [min⁻¹]

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

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

P_{DC} Required DC bus continuous power [W]

M_{rms} Effective torque in Nmn_m Average speed in min⁻¹

k Factor for motor and controller efficiency = 1.25

- 3. Add **powers of all axes** at common DC bus and put them into relation to rated power of supply unit
 - ⇒ Partial load of P_{DC cont} is available
- 4. Determine power factor TPF for partial load (TPF = Total Power Factor) For the value TPF at rated power and TPF₁₀ (at 10% of rated power), see technical data (mains voltage) of the component.
- Calculate mains connected load

Bosch Rexroth AG

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

S_{LN} Mains connected load [VA]
P_{DC} DC bus continuous power [W]

TPF Total Power Factor λ

6. Calculate mains-side phase current

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

3-phase:

I_{LN} Mains-side phase current in [A]S_{LN} Mains connected load [VA]

U_{LN} Voltage between phases of mains [V]

7. Select mains contactor

8. Determine mains circuit breaker and line cross section

See chapter 11.1 "Dimensioning the line cross sections and fuses " on page 245

Sizing line thicknesses and fuses

See chapter 11.1 "Dimensioning the line cross sections and fuses " on page 245.

Sizing and selecting mains transformer

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

Grounded mains

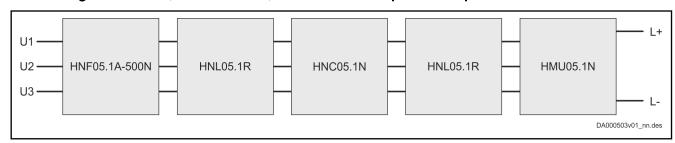
The mains voltage for grounded mains is generally adjusted with **autotransformers**.

Ungrounded mains

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

Combining mains filter, mains choke, restrictor and capacitance pack

Fig. 4-49:



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

Mains connection components

	Supply unit HMU05.1N-								
C	Components	F0140-0350 (BG 110 kW)	F0170-0430 (BG 132 kW)	F0220-0510 (BG 160 kW)	F0270-0660 (BG 200 kW)	F0340-0820 (BG 250 kW)	F0430-1040 (BG 315 kW)	F0540-1300 (BG 400 kW)	F0680-1690 (BG 500 kW)
	0219-N0218	✓							
	0182-N0262		✓						
0 4	0135-N0327			✓					
chok 5.1R	0117-N0409				✓				
Mains choke HNL05.1R-	0100-N0514					✓			
ΣI	0113-N0652						✓		
	0100-N0811							✓	
	0094-N1019								✓
	0045-N0327			✓					
باء ،	0054-N0409				✓				
Restrictor HNL05.1R-	0043-N0514					1			
Resti NLO	0050-N0652						✓		
-	0040-N0811							✓	
	0040-N1019								✓
5	0050	✓	✓						
acito	0075			✓					
Mains capacitor HNC05.1N-	0100				✓				
Tains	0150					✓			
2	0200						✓	✓	✓
	500N-R0250	✓							
<u>- 1</u>	500N-R0320		✓						
Mains filter HNF05.1A-	500N-R0400			✓					
lains INF0	500N-R0600				✓	✓			
< ⊥	500N-R1000						✓	✓	
	500N-R1600								✓

Tab. 4-22: Mains connection components

4.6.5 Running multiple HMU05s in parallel

Up to eight HMU05s with the same output (size F0340-0820 and up) can be operated in parallel to extend the power range.

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

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

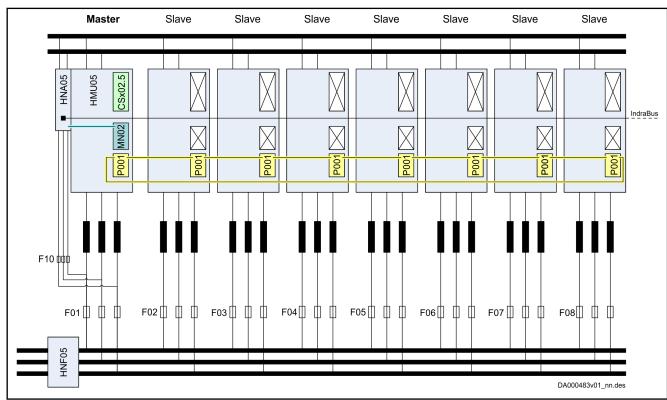
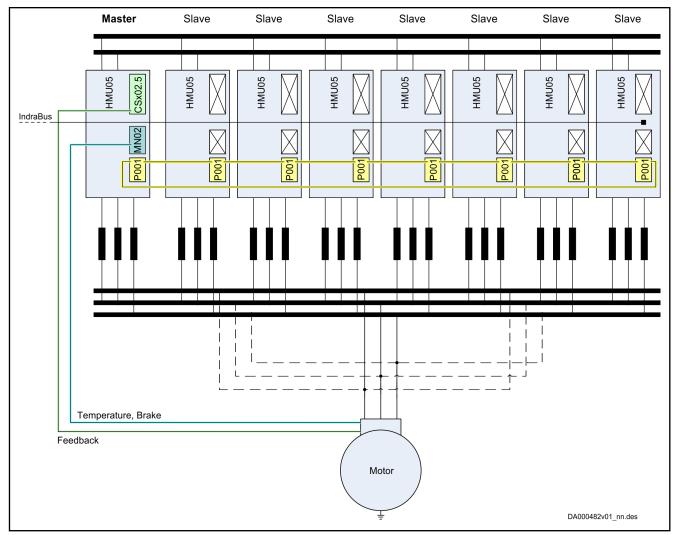


Fig. 4-50: Parallel operation of HMU05 to run as supply unit

Operation as drive controller uses additional HML05 motor chokes.

Bosch Rexroth AG



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

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

Fig. 4-51: 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).

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 mUnshielded: 150 m

Connection to HPC01.1-P001 optional cards

• 8 m

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

Derating

Parallel drive controllers:

Since the output current is not exactly distributed equally even with a symmetrical design, the output current is derated by **10%**. (90% of the calculated total power can therefore be used.)

• Parallel **supply units**:

Derating: 5%

4.7 Acceptance tests and approvals

Declaration of conformity

Bosch Rexroth AG

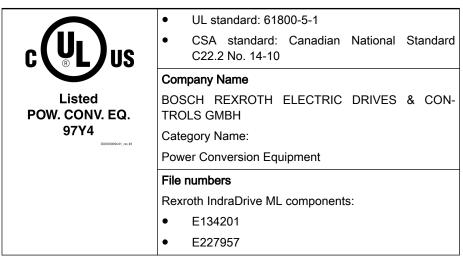
Declarations of conformity confirm that the components comply with the valid EN standards and EC directives. If required, our sales representative can provide you with the declarations of conformity for components.

DXXXXXIII DXXXXXIII III III III III II II II II II	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			

Tab. 4-23: CE - Applied Standards

C-UL-US listing

The components are listed by **UL** (Underwriters Laboratories Inc.®). Proof of certification can be found online at http://www.ul.com under "Certifications" by entering the file number or the "Company Name: Rexroth".



Tab. 4-24: C-UL listing

B

UL ratings

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

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

B

UL wiring material

Only use class 1 (or equivalent) copper wires with a minimum permitted conductor temperature of 75°C to wire components in the scope of CSA/UL

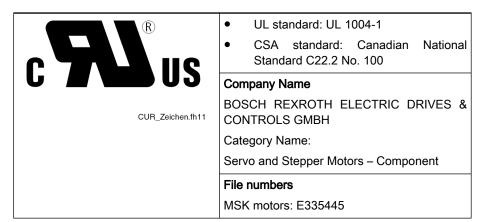
B

Permitted pollution degree

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

C-UR-US listing

The motors are listed by **UL** ("Underwriters Laboratories Inc.®"). Proof of certification can be found online at http://www.ul.com under "Certifications" by entering the file number or the "Company Name: Rexroth".



Tab. 4-25: C-UR Listing



UL wiring materials (prepared cabled from Rexroth)

Only use class 6 (or equivalent) copper wires with a minimum permitted conductor temperature of 75°C to wire components in the scope of CSA/UL.

B

Permitted pollution degree

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

CCC (China Compulsory Certification)

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

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

- 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 from Rexroth **described in this documentation, certification is currently not required**, so they are not CCC certified. Negative certifications will not be issued.

Condition on delivery, identification, transport and storage

5 Condition on delivery, identification, transport and storage

5.1 Condition on delivery

5.1.1 Factory testing

Voltage test and insulation resistance test

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

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

Tab. 5-1: Applied standards

5.1.2 Customer testing



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

Before making a voltage test or an insulation resistance test 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.

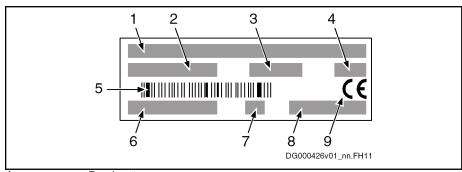
Condition on delivery, identification, transport and storage

5.2 Identification

5.2.1 Type plates

Design

Type plate (device)



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

5.2.2 Contents of delivery

Standard
HAS10.1-002-006-NN
Documentation

Tab. 5-2: Contents of delivery HMU05

5.3 Transporting components

Ambient and operating conditions for transport

Description	Symbol	Unit	Value
Temperature range	T _{a_tran}	°C	-25 to 70
Relative humidity		%	5 to 95
Absolute humidity		g/m³	1 to 60
Climatic category (IEC721)			2K3
Condensation			Not permitted
Icing			Not permitted

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

Condition on delivery, identification, transport and storage

5.4 Storing components

Rexroth IndraDrive ML Drive systems with HMU05

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}

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

Mounting and installation

6 Mounting and installation

6.1 Mounting HMU05 devices in control cabinet

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

Notes on mounting

- When mounting, observe the mandatory **minimum distances** between components (see chapter 4.5.1 "Dimensions" on page 65).
- Mounting tools: HAS08.1-008-NNN-MH
 See chapter 8.2.2 "Cabinet installation kit (HAS08.1-008)" on page 147.
- 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 154.
 - 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 156.

Rexroth IndraDrive ML Drive systems with HMU05

Mounting and installation

6.2 Electrical connection

6.2.1 Overall connection diagram (HMU05 as drive controller)

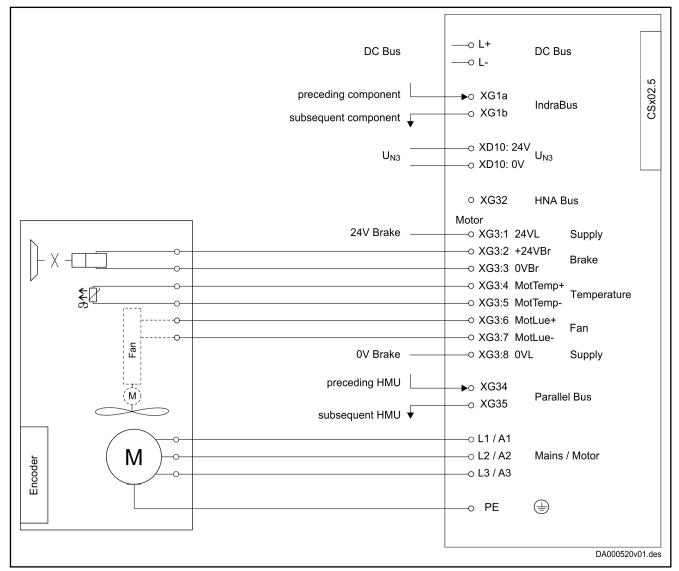


Fig. 6-1: Connection diagram (HMU05 as drive controller)

6.2.2 Overall connection diagram (HMU05 as supply unit)

Overall connection diagram with load contactor

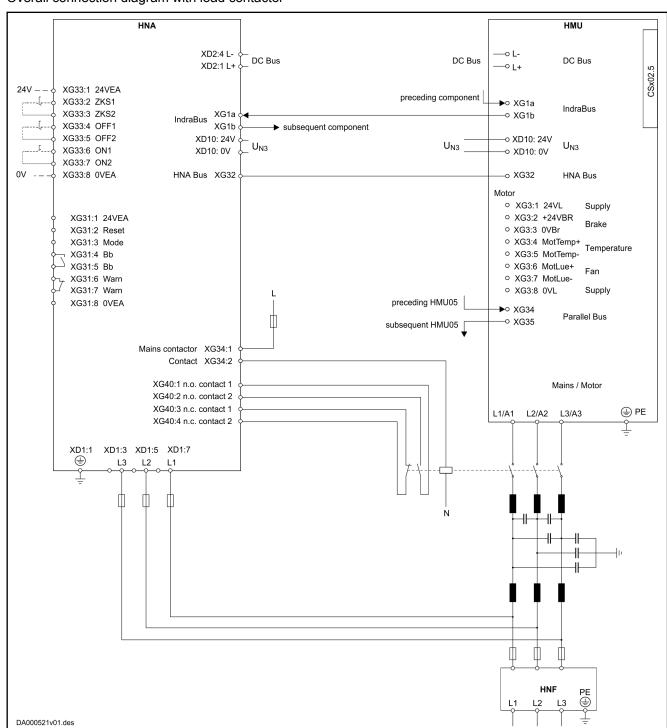


Fig. 6-2: Connection diagram with load contactor (HMU05 as supply unit)

Overall connection diagram with switchable main switch

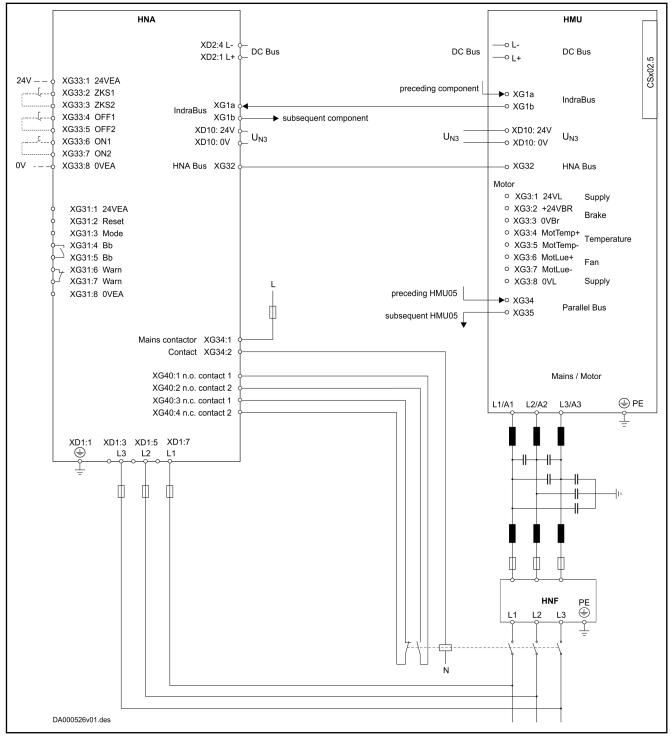
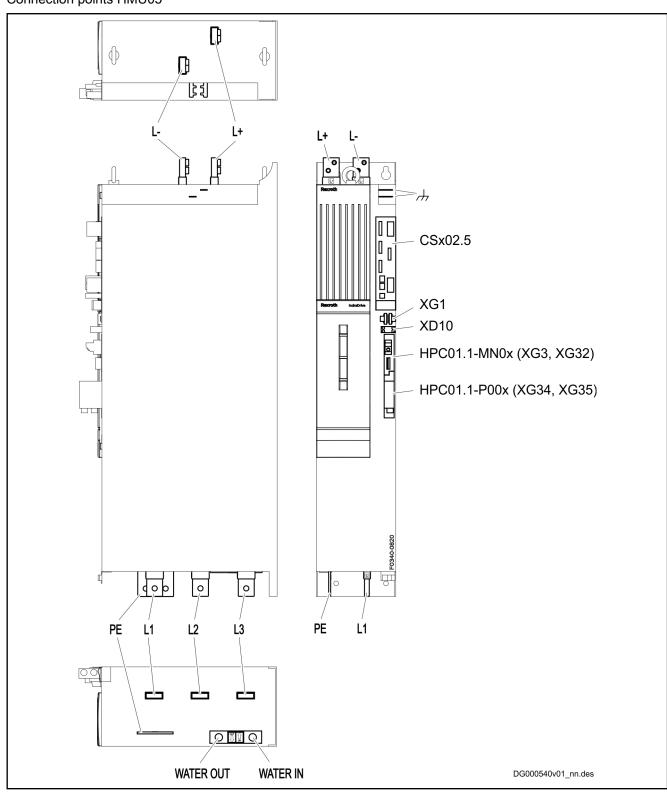


Fig. 6-3: Connection diagram with switchable main switch (HMU05 as supply unit)

6.2.3 Connection points

HMU05 connection point layout

Connection points HMU05



CSx02.5 HPC01

Control section Optional card

L1, L2, L3 Mains/motor connection

DC bus

L+, L-PE Equipment grounding conductor

XG1 IndraBus XD10 Control voltage WATER IN/OUT Cooling liquid

Connection points HMU05 Fig. 6-4:

Equipment grounding conductor connection point

WARNING

High housing voltage and high leakage current. Risk of death or serious injury from electric shock!

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

▲ WARNING

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

Exclusively operate the device

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

礟

Equipment grounding conductor: material and cross section

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

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

Equipment grounding connection cross sections:

see table "Minimum equipment grounding connection cross section".

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

112/277

View	ID	Function		
PE L1 L2 L3	PE	Connection to equipment grounding system		
Connecting pin	Unit	Min.	Max.	
Hole diameter	mm	13		
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 dev	vice used (V _{LN} or V _{LN_nom})	

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

Minimum cross section of equipment grounding connection

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

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

L1, L2, L3, mains/motor connection

Important information

WARNING

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

Exclusively operate the device

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

Notes on installation

- The cable is connected to the connection point using eyelet 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	ID	Function		
	L1	Connection to mains powe	r supply (L1) or motor (A1)	
10000	L2	Connection to mains power supply (L2) or motor (A2)		
PE L1 L2 L3	L3	Connection to mains power supply (L3) or motor (A3)		
Connecting pin	Unit	Min.	Max.	
Hole diameter	mm	1	3	
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 (V _{LN} or V _{LN_nom})		

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

A WARNING

Fatal electric shock from live parts with more than 50 V.

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

NOTICE

Risk of damage to device from excess voltage on motor temperature evaluation input.

Only the permitted control voltage for the device is permitted on the motor temperature evaluation input. Excess voltage on the input can damage the device.

Function

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



The power section uses an integrated contact element (BR) to switch the voltage of the **external** 24 V supply to the output for controlling the motor holding brake.

View	Connec- tion	Signal name	Function		
1	1	+24 VL	Supply voltage		
2 3	2	+24 VBr	Output for controlling motor hold-		
2 3 4 5 5 6	3	0 VBr	ing brake		
6 7 8	4	MotTemp+	Input for motor temperature eval-		
	5	MotTemp-	uation		
DG000541v01_nn.tif	6	MotLue+	Analog output for connecting a		
	7	MotLue-	motor fan frequency converter		
	8	0 VL	Supply voltage		
Spring terminal (connector)	Unit	Min.	Max.		
Connection cable	mm²	0.25	1.5		
Stranded wire	AWG	24	16		
Stripped length	mm	1	0		
XG3 output current rating	Α	-	1.25		
Time constant of load	ms	-	50		
Number of switching actions at max. time constant of load		Wear-free ele	ctronic contact		
Switching frequency	Hz	-	0.5		
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

Motor holding brake: selection Max

Maximum current rating of XG3 outputs: 2 A

$$\Rightarrow R_{br (min)} = V_{br (max)} \div 2 A$$

 $R_{\text{br (min)}}$: minimum permitted resistance of motor holding brake

V_{br (max)}: maximum supply voltage of motor holding brake

If $V_{br (max)} = 24 \text{ V} + 5\% = 25.2 \text{ V}$, then:

 $R_{br (min)}$ = 12,6 Ω (valid for all operating and ambient conditions)

Motor holding brake: notes on installation

Make sure there is enough **power supply** to the motor for the motor holding brake. Note that voltage drops on the supply line. Use connection lines with the largest cross section of single strands.

Use an external contact element in accordance with the required safety category if you want to supply motor holding brakes with higher currents than the current load permitted for X6. Make sure to comply with the required minimum current consumption of 100 mA when using an external contact element. Otherwise the brake current monitor will report an error.

The "Safe Brake Control" safety function also requires an HAT control unit.

XG32, HNA bus

View	ID	Function			
	XG32	HNA bus			
D-Sub, 9-pin, male	Unit	Min.	Max.		
Connection cross section	mm ²	0.25	0.5		

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

XG1, IndraBus

View	Connec- tion	Function
	XG1a	Connects parallel components through a ribbon cable.
	XG1b	Output for quickly reporting critical errors to other devi- ces
		Input for detecting critical errors from other devices
		Blocking and releasing DC bus short-circuit by a brake resistance unit
		Reporting DC bus availability
		Cable
		Unshielded length: < 3 m
		Cable designation: RKB0036
		Shielded length: < 100 m
		Cable designation: RKB0035

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 for:

- The control section and power section of the drive controller
- Brake control via XG3

View	Connec- tion	Signal name	Function	
	24 V	+24 V	Power supply	
		+24 V		
	0 V	0 V	Reference potential for pow-	
		0 V	er supply	
Spring terminal (connector)	Unit	Min.	Max.	
Connection cable	mm ²	1.0	10	
Stranded wire	AWG	16	8	
Stripped length	mm	1	0	
Power consumption	W	P _{N3} (see Contr	ol voltage data)	
Voltage rating	V	V _{N3} (see Contr	ol voltage data)	
Current carrying capacity "looping through" from 0 V to 0 V, 24 V to 24 V	А	40		
Polarity reversal protection		Within the permitted voltage range by internal protective of ode		
Insulation monitoring		Pos	sible	

Tab. 6-7: Function, pin assignment, properties

Notes on installation

Requirements for connecting to 24 V supply:

- Minimum minimum cross-section: 1 mm²
- Maximum permitted inductance 100 μH (2 twisted single strands, 75 m long)
- Parallel wire routing where possible

Depending on the power consumption of the devices and the current carrying capacity of the connector X10, check the number of devices through which one line for 24 V supply can be looped through. You may have to connect another device directly to the 24 V supply and then loop through the control voltage from this device to other devices.

L+ L-, DC bus connection

A WARNING

Fatal 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.

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

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

Secure the DC bus connections against being touched.

Function, pin assignment

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

View	ID	Function
	L+	Connections for fastening DC bus rails
L+ L-	L-	Threads on connection pins: 2 x M10
DG000543v01_nn.des		
	Unit	
Dimensions		See component dimensional drawing
Short-circuit protection		Upstream fuse elements in mains connection
Overload protection		Upstream fuse elements in mains connection

Tab. 6-8: Function, pin assignment, properties

Notes on installation

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

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

Make sure the polarity is correct.

Shield connection

Control line shield connection

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

B

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

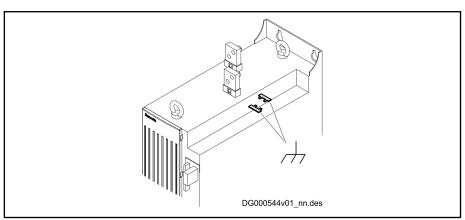


Fig. 6-5: Shield connection of shielded control lines

Motor cable shield connection

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

Bosch Rexroth AG

Ground connection

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

Ground the housings of the drive controllers:

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

6.2.4 Optional cards

HPC01.1-MN0x-NN

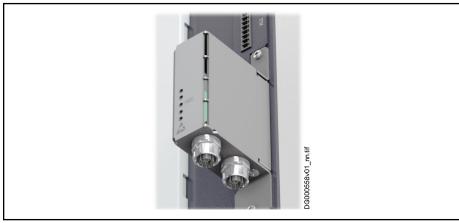


Fig. 6-6: HPC01.1-MN0x-NN

XG3 See chapter "XG3, motor temperature monitoring, motor holding brake, motor fan control " on page 113

XG32 See chapter "XG32, HNA bus" on page 116

HPC01.1-P001-NN



HPC01.1-P001-NN Fig. 6-7:

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

6.2.5 EMC measures for design and installation

Rules for designing installations with drive controllers in compliance with EMC

The following rules are the basics for designing and installing drives in compliance with EMC.

Mains filter

Properly use a mains filter recommended by Rexroth for radio interference suppression in the supply feeder of the drive system.

Control cabinet grounding

Connect all metal parts of the cabinet with one another over the largest possible surface area to establish a good electrical connection. This also applies to mounting the mains filter. If required, use serrated washers which cut through the paint surface. Connect the cabinet door to the control cabinet using the shortest possible grounding straps.

Line routing

Avoid coupling routes between lines with high potential of noise and noise-free lines; therefore, route signal, mains and motor lines, and power cables separately from another. Minimum distance: 10 cm. Provide separating sheets between power and signal lines. Ground separating sheets several times.

The lines with high potential of noise include:

- Lines on the mains connection (incl. synchronization connection, if available)
- Lines on the motor connection
- Lines on the DC bus connection

Generally, interference injections are reduced by routing cables close to grounded sheet steel plates. For this reason, cables and wires should not be routed freely in the cabinet, but close to the cabinet housing or mounting plates. Separate the incoming and outgoing cables for the radio interference suppression filter.

Interference suppression elements

Equip the following components in the control cabinet with interference suppression combinations:

- Contactors
- Relay
- Solenoid valves
- Electromechanical operating hours counters

Connect these combinations directly at each coil.

Twisted wires

Twist unshielded wires belonging to the same circuit (feeder and return cable) or keep the surface between feeder and return cable as small as possible. Wires that are not used have to be grounded at both ends.

Lines for measuring systems

Lines for measuring systems must be shielded. Connect the shield to ground at both ends and over the largest possible surface area. The shield may not be interrupted, e.g., using intermediate terminals.

Digital signal lines

Ground the shields of digital signal lines at both ends (transmitter **and** receiver) over the largest possible surface area and with low impedance. In the case of bad ground connection between transmitter and receiver, also route a bonding conductor (min. 10 mm²). Braided shields are better than foil shields.

Analog signal lines

Ground the shields of analog signal lines at one end (transmitter **or** receiver) over the largest possible surface area and with low impedance. This avoids low-frequency interference current (in the mains frequency range) on the shield.

Connecting the mains choke

Keep connection lines of the mains choke on the drive controller as short as possible and twist them.

Installing the motor power cable

Bosch Rexroth AG

- Use shielded motor power cables or run motor power cables in a shielded duct
- Use the shortest possible motor power cables
- Ground motor power cable shield at both ends over the largest possible surface area to establish a good electrical connection
- Run shielded motor lines inside the control cabinet
- Do not use any steel-shielded lines
- The shield of the motor power cable cannot be interrupted by mounted components, such as output chokes, sine filters or motor filters

EMC-optimal installation in system and control cabinet

General information

For EMC-optimal installation, it is recommended to spatially separate the area free from interference (mains connection) from the area prone to interference (drive components), as shown in the figures below.



Recommendation: For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.

Division into areas (zones)

Sample arrangements in the control cabinet: See section Control cabinet design by interference areas – sample arrangements, page 123.

There are three areas:

1. Control cabinet area free from interference (area A):

This includes:

- Supply feeder, input terminals, fuse, main switch, mains side of mains filter for drives and corresponding connecting lines
- Control voltage or auxiliary voltage connection with power supply unit, fuse and other parts unless connection is run through the mains filter of the AC drives
- All components that are not electrically connected to the drive system
- 2. Area prone to interference (area B):
 - Mains connections between drive system and mains filter for drives, mains contactor
 - Interface lines for drive controller
- 3. Area highly prone to interference (area C):
 - Motor power cables including single cores

Never run lines from one of these areas along lines from another area to eliminate any unwanted interference injection from one area to the other and jumper the filter with regard to high frequency. Use the shortest possible connecting lines.

Recommendation for complex systems: Install drive components in one cabinet and the control units in a second, separate cabinet.

Poorly grounded control cabinet doors can act as antennas. For this reason, connect the control cabinet doors to the cabinet on top, in the middle and on the bottom with short equipment grounding conductors that are at least

6 mm² thick or, even better, with grounding straps of the same cross section. Make sure connection points have good contact.

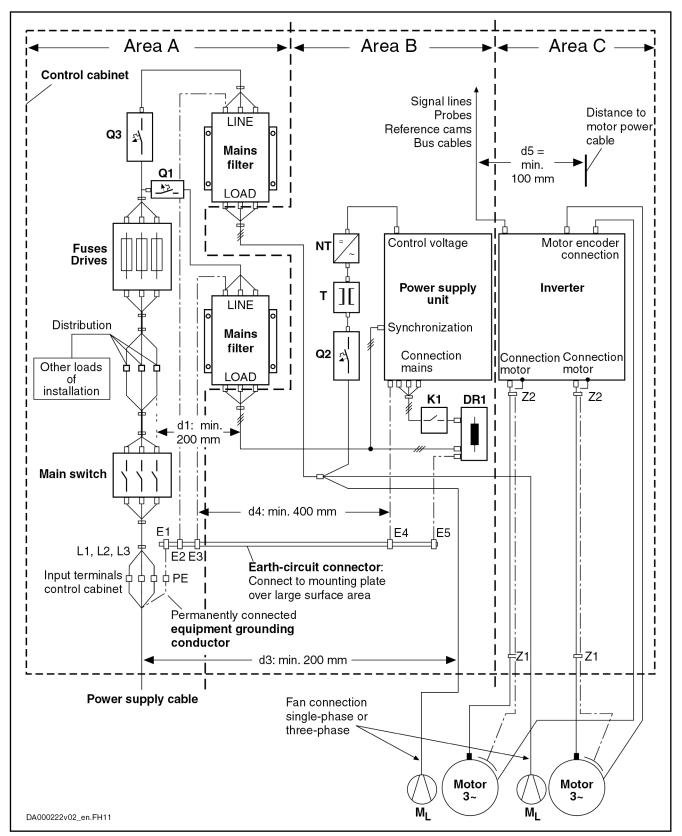
Control cabinet design by interference areas – sample arrangements



Do not run any other consumers on the mains filter.

Do not run any other consumers on the connection from the mains filter output to the mains connection of the supply unit.

Use separate mains filters for, e.g., motor fans and power supply units.



DR1 Mains choke
E1 to E5 Equipment grounding conductor of the components

K1 External mains contactor for supply units without integrated

mains contactor

M_L Motor fan

NT Power supply unit

Q1, Q2, Q3 Fusing Transformer

Z1, Z2 Shield connection points for cables

Fig. 6-8: EMC areas in control cabinet

Design and installation in area A – control cabinet area free from interference

Arrangement of components in control cabinet

Maintain the recommended distance of at least 200 mm (distance d1 in the figure):

 Between components and electrical elements (switches, pushbuttons, fuses, terminal connectors) in interference-free area A and the components in the two other areas B and C

Maintain the recommended distance of at least **400 mm** (distance d4 in the figure):

 Between magnetic components (such as transformers, mains chokes and DC bus chokes that are directly connected to the power connections of the drive system) and the components and lines free from interference between mains and filter including the mains filter in area A

If these distances are not maintained, the magnetic leakage fields are injected onto the components and lines free from interference connected to the mains, and the limit values at the mains connection are exceeded in spite of the installed filter.

Cable routing for interference-free lines to mains connection

Maintain the recommended distance of at least **200 mm** (distances d1 and d3 in the figure):

 Between supply feeder or lines between filter and control cabinet exit point in area A and the lines in area B and C

If this is not possible, there are two alternatives:

- 1. Install shielded lines and connect the shield at several points (at least at the beginning and end of the line) to the mounting plate or the control cabinet housing over a large surface area.
- 2. Separate lines from the other lines prone to interference in areas B and C with a grounded distance plate vertically attached to the mounting plate.

Install the shortest possible lines within the control cabinet and install them directly on the grounded metal surface of the mounting plate or control cabinet housing.

Mains supply lines from areas B and C cannot be connected to the mains without a filter.



Failure to observe the information on cable routing given in this section will partially or completely neutralize the effect of the mains filter. This will cause the noise level of the interference emission to be higher within the 150 kHz to 40 MHz range and the limit values at the connection points of the machine or system will be exceeded. The specified distances are recommendations, provided the dimensions of the control cabinet allow the lines to be installed accordingly.

Routing and connecting a neutral conductor (N)

If a neutral conductor is used together with a three-phase connection, it cannot be installed unfiltered in areas B and C in order to keep interference off the mains.

Motor fan on mains filter

Bosch Rexroth AG

Single-phase or three-phase supply lines for motor fans that are usually routed parallel to motor power cables or lines prone to interference must be fil-

- In drive systems with regenerative supply units through a separate single-phase (NFE type) or three-phase filter (HNF type) near the mains connection of the control cabinet
- In drive systems with only feeding supply units through the available three-phase filter of the drive system

When switching power off, make sure the fan is not switched off.

Consumers on drive system mains filter

B

Only operate allowed loads at the mains filter of the drive system!

At the three-phase filter for the power connection of regenerative supply units, it is only allowed to operate the following loads:

HMV supply unit with mains choke and, if necessary, mains contactor

Do not operate any motor fans, power supply units etc. at the mains filter of the drive system.

Shielding mains supply lines in control cabinet

If there is still a high degree of interference injection on the mains supply line in the control cabinet although you have observed the above instructions (determine using EMC measurement to standard), proceed as follows:

- Only use shielded lines in area A
- Connect shields to the mounting plate at the beginning and end of the line with clips

The same procedure may be required for cables longer than 2 m between the point of power supply connection for the control cabinet and the filter in the control cabinet.

Mains filters for AC drives

Ideally, mount the mains filter on the parting line between areas A and B. Make sure the ground connection between filter housing and drive controller housing is electrically highly conductive.

If single-phase consumers are connected on the load side of the filter, their current may be a maximum of 10% of the three-phase operating current. A highly imbalanced load on the filter would reduce its interference suppression capacity.

If the mains voltage is more than 480 V, connect the filter to the output side of the transformer and not to the supply side of the transformer.

Grounding

In the case of bad ground connections in the system, the distance between the lines to grounding points E1 and E2 in area A and the other grounding points of the drive system should be at least d4 = 400 mm in order to minimize interference injection from ground and ground cables to the power input lines.

See also Division into areas (zones), page 122.

Equipment grounding conductor connection point on machine, system, control cabinet

The equipment grounding conductor of the power cable for the machine, system or control cabinet has to be permanently connected at point PE and be at least 10 mm² thick, or be complemented by a second equipment grounding conductor using separate terminal connectors (according to 61800-5-1:2007, Section 4.3.5.5.2). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor must also be bigger.

Design and installation in area B – interference-prone area of control cabinet

Arranging components and lines

Modules, components and lines in area B should be placed at a distance of at least d1 = 200 mm from modules and lines in area A.

Alternative: Shield modules, components and lines in area B using distance plates mounted vertically on the mounting plate from modules and lines in area A or use shielded lines.

Only connect power supply units for auxiliary or control voltage connections in the drive system to the mains with a mains filter. See Division into areas (zones), page 122.

Install the shortest possible lines between drive controller and filter.

Control voltage or auxiliary voltage connection

Only in exceptional cases should you connect power supply unit and fusing for the control voltage connection to phase and neutral conductor. In this case, mount and install these components in area A far away from the areas B and C of the drive system. For details, see section Design and installation in area A – control cabinet area free from interference, page 125.

Run the connection between the control voltage connection of the drive system and the power supply unit used through area B over the shortest distance.

Line routing

Run the lines along grounded metal surfaces in order to minimize radiation of interference fields to area A (transmitting antenna effect).

Design and installation in area C – control cabinet area highly prone to interference

Area C mainly concerns the motor power cables, especially at the connection point at the drive controller.

Influence of the Motor Power Ca-

The longer the motor power cable, the greater its leakage capacitance. To comply with a certain EMC limit value, the allowed leakage capacitance of the mains filter is limited. For the calculation of the leakage capacitance, see the documentation on the drive system of the drive controller used.



- Run the shortest possible motor power cables.
- Only use **shielded** motor power cables from Rexroth.

Routing motor power and motor encoder cables

Route the motor power and motor encoder cables along grounded metal surfaces both inside and outside the control cabinet in order to minimize radiation from interference fields. If possible, route the motor power and motor encoder cables in metal-grounded cable ducts.

Route the motor power and motor encoder cables:

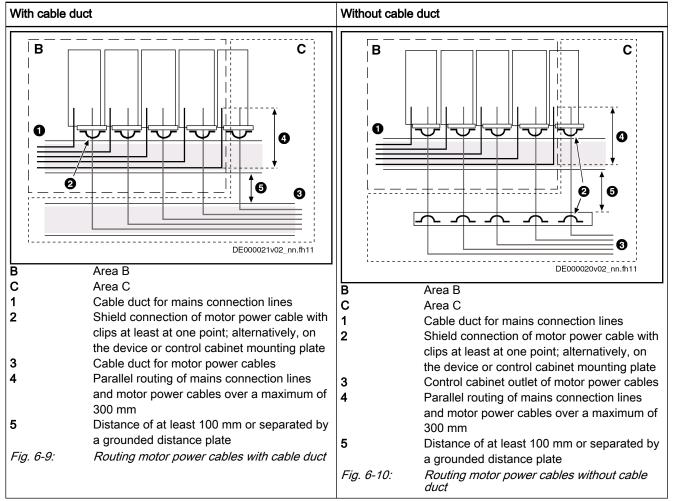
- With a distance of at least d5 = 100 mm from interference-free lines, as well as to signal cables and signal lines
 - (alternatively separated by a grounded distance plate)
- In separate cable ducts, if possible

Routing motor power cables and mains connection lines

For converters (drive controllers with individual mains connection), route motor power cables and (unfiltered) mains connection lines **parallel to one another at a maximum distance of 300 mm**. After that distance, route motor power cables and power supply cables in opposite directions and preferably in separate **cable ducts**.

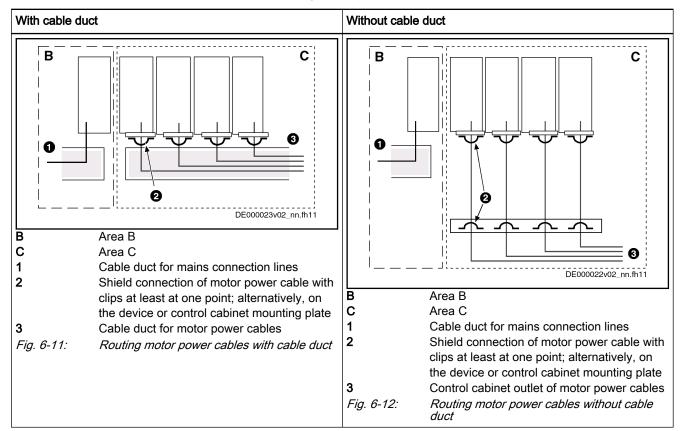
Ideally, the the motor power cables should exit the control cabinet at a distance of at least **d3 = 200 mm** from the (filtered) power supply cable.

Converter - routing motor power cables



Tab. 6-9: Routing converter cables

Inverter - routing motor power cables



Tab. 6-10: Routing inverter cables

Ground connections

Housing and mounting plate

It is possible to avoid the emission of interference with proper ground connections because interference is discharged to ground through the most direct route.

Ground connections of the metal housings for EMC-critical components (such as filters, devices of the drive system, connection points of the cable shields, devices with microprocessor and switching power supply units) have to be solidly contacted over a large surface area. This also applies to all screw connections between mounting plate and control cabinet wall and to mounting a ground bus to the mounting plate.

The best solution is to use a zinc-coated mounting plate. Compared to a varnished plate, the connections in this case have good long-term stability.

Connection elements

For varnished mounting plates, always use screw connections with tooth lock washers and zinc-coated, tinned screws as connection elements. At the connection points, remove the varnish so that there is safe electrical contact over a large surface area. Achieve contact over a large surface area using bare connection surfaces or several connection screws. For screw connections, you can establish the contact to varnished surfaces by using tooth lock washers.

Metal surfaces

Always use connection elements (screws, nuts, plain washers) with a highly conductive surface.

Highly conductive surfaces are those with bare, zinc-coated or tinned metal surfaces.

Bosch Rexroth AG

Mounting and installation

Poorly conductive surfaces are those with anodized, yellow chromatized, black gunmetal finished or lacquered metal surfaces.

Ground wires and shield connections

When connecting ground wires and shield connections, what is important is not the thickness of the wire, but the area of the contact surface, since high-frequency interference currents mainly flow on the surface of the conductor.

Always connect cable shields, especially shields for the motor power cables, to ground potential over a large surface area.

Installing signal lines and signal cables

Line routing

For measures to prevent interference, see the project planning manuals for each device. We also recommend the following:

- Route signal and control lines away from power cables at a minimum distance of d5 = 100 mm (seeDivision into areas (zones), page 122) or with a grounded separating sheet. The best way is to route them in separate cable ducts. If possible, only route signal lines into the control cabinet at one point.
- If signal lines cross power cables, route them at an angle of 90° in order to avoid interference injection.
- Ground unused and connected spare cables at both ends at least in order to avoid an antenna effect.
- Do not use more line than is necessary.
- Run cables as close to grounded metal surfaces as possible (reference potential). Closed, grounded cable ducts or metal pipes are ideal, but are only needed to meet strict requirements (sensitive instrument leads).
- Avoid suspended lines or lines routed along synthetic carriers, because they function like reception antennas (noise immunity) and transmitting antennas (emission of interference). Exceptional cases are flexible cable tracks over short distances of at most 5 m.

Shielding

Connect the cable shield immediately on the devices in the shortest and most direct way possible and over the largest possible surface area.

Connect the shield of **analog signal lines** at one end over a large surface area, normally in the control cabinet on the analog device. Make sure the connection to ground/housing is short and over a large surface area.

Connect the shield of **digital signal lines** at both ends over a large surface area and in short form. In case of potential differences between line beginning and end, run an additional bonding conductor in parallel. This prevents compensating current from flowing via the shield. The recommended thickness is 10 mm².

Separable connections absolutely must be equipped with connectors that have a grounded metal housing.

In case of unshielded lines belonging to the same circuit, twist feeder and return cable.

General interference suppression measures for relays, contactors, switches, chokes and inductive loads

If inductive loads, such as chokes, contactors or relays are switched by contacts or semiconductors in conjunction with electronic devices and components, they must be suitably dejammed:

- By arranging free-wheeling diodes for DC operation
- By arranging commercial RC interference suppression elements based on contactor type directly on the inductance for AC operation

Rexroth IndraDrive ML Drive systems with HMU05

Mounting and installation

Only the interference suppression element arranged immediately on the inductance serves this purpose. Otherwise, the emitted noise level is too high and can affect the function of the electronic system and the drive.

Bosch Rexroth AG

6.3 WATER IN/OUT, cooling liquid connection

View	II)	Function	
	WATER IN		Supply	
	WATER OUT		Return	
	Symbol	Unit	Min.	Max.
Connecting thread			G1	/2"
Coolant inlet temperature	T _{in}	°C	Ambient temperature - 5 K	60
Permitted operating pressure	p _{max}	bar	-	2

Tab. 6-11: Function, properties

Risk of damage. Drive components cannot build condensation.

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

Safest protection against condensation:

Coolant inlet temperature = ambient temperature

Condensation protection Refer to the information on condensation protection.

7 Technical component data

7.1 Power section

7.1.1 Control voltage

Control voltage supply data

Description	Symbol	Unit	HMU05.1N- F0140-0350	HMU05.1N- F0170-0430	HMU05.1N- F0220-0510	HMU05.1N- F0270-0660
Control voltage input ¹⁾	V _{N3}	V		24 ±	20%	
Control voltage when using motor holding brake with motor cable length < 50 m ²⁾		V	24 ±5%			
Control voltage when using motor holding brake with motor cable length > 50 m ³⁾		V	26 ±5%			
Max. inrush current on 24 V supply	I _{IN3_max}	Α	< 8			
Pulse width of I _{IN3}	t _{IN3Charge}	ms	< 20			
Input capacitance	C _{N3}	mF	< 0.01			
Control voltage power consumption for $V_{\rm N3}$	P _{N3}	W	65	48	53	46

1) 2) 3) Observe supply voltage for motor holding brakes *Tab. 7-1: HMU – control voltage supply data*

Control voltage supply data

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690	
Control voltage input ¹⁾	V _{N3}	V		24 ±	20%		
Control voltage when using motor holding brake with motor cable length $< 50 \text{ m}^2$)		V	24 ±5%				
Control voltage when using motor holding brake with motor cable length > 50 m ³⁾		V	26 ±5%				
Max. inrush current on 24 V supply	I _{IN3_max}	А	< 8				
Pulse width of I _{IN3}	t _{IN3Charge}	ms	< 20				
Input capacitance	C _{N3}	mF	< 0.01				
Control voltage power consumption for $V_{\rm N3}$	P _{N3}	W	48	56	58	65	

1) 2) 3) Observe supply voltage for motor holding brakes *Tab. 7-2: HMU – control voltage supply data*



Overvoltage

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

This includes:

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

7.1.2 Mains voltage

Electrical data - currents, voltages, power

·				1	i	ı
Description	Symbol	Unit	HMU05.1N- F0140-0350- N-A4-D7-N1	HMU05.1N- F0170-0430- N-A4-D7-N1	HMU05.1N- F0220-0510- N-A4-D7-N1	HMU05.1N- F0270-0660- N-A4-D7-N1
Control voltage input ¹⁾	V_{N3}	V		24 ±	:20%	1
Control voltage power consumption for $V_{N3}^{2)}$	P _{N3}	W	65	48	53	46
Mains frequency	f _{LN}	Hz		50 t	o 60	
Mains frequency tolerance		Hz		±	:2	
Rotary field condition				No	one	
Single-phase mains voltage	V_{LN}	V			-	
Three-phase mains voltage on TN-S, TN-C, TT mains	V_{LN}	V		380 t	o 500	
Tolerance V _{LN}		%		10/	/-15	
Three-phase mains voltage on IT mains ³⁾	V_{LN}	V	200 to 230			
Three-phase mains voltage on mains with grounded outer conductor ⁴⁾	V_{LN}	V	200 to 230			
Min. inductance of mains supply (mains phase inductance) ⁵⁾	L _{min}	μH		4	.0	
Nominal power (t > 10 min) when $f_s = 4.2$ kHz; VL_{N_nom} ; control factor $a_0 > 0.8$; with mains choke	P _{DC_cont}	kW	144	173	216	270
Nominal input current (continuous)	I _{LN}	Α	218	262	327	409
TPF power factor (λ_L) for P_{DC_cont} with mains choke; V_{LN_nom}	TPF			0.	99	
Capacitance in DC bus	C _{DC}	mF	5.	00	6.60	8.30
Permitted external DC bus capacitance (nom.) for $V_{LN_nom}^{7}$	C_{DCext}	mF		250	0.00	
Nominal braking resistance	R _{DC_Bleeder}	ohm			-	
Braking resistor continuous power	P _{BD}	kW			-	
Braking resistor peak power	P _{BS}	kW			-	
Regenerative power to be absorbed	W_{R_max}	kWs	-			
Braking resistor switch-on threshold – independent of mains voltage ⁸⁾	$V_{R_DC_On_f}$	V	-			
Braking resistor switch-on threshold – depending on mains voltage ⁹⁾	$V_{R_DC_On_v}$				-	

1) Observe supply voltage for motor holding brakes

3) 4) Mains voltage $> V_{LN}$: Use a transformer with a grounded neutral point, do not use autotransformers.

5) Otherwise use HNL mains choke

6) PVC-insulated copper wire (conductor temperature 90°C;

 $T_a \le 40$ °C) in accordance with NFPA 79 Chapter 12 and

UL 508A Chapter 28

7) Use assigned mains choke

8) 9) Factory setting

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

Electrical data - currents, voltages, power

Description	Symbol	Unit	HMU05.1N- F0340-0820- N-A4-D7-N1	HMU05.1N- F0430-1040- N-A4-D7-N1	HMU05.1N- F0540-1300- N-A4-D7-N1	HMU05.1N- F0680-1690- N-A4-D7-N1	
Control voltage input ¹⁾	V_{N3}	V	24 ±20%				
Control voltage power consumption for $V_{\rm N3}$	P _{N3}	W	48	56	58	65	
Mains frequency	f _{LN}	Hz		50 t	o 60		
Mains frequency tolerance		Hz		±	2		
Rotary field condition				No	one		
Single-phase mains voltage	V_{LN}	V			-		
Three-phase mains voltage on TN-S, TN-C, TT mains	V_{LN}	V		380 t	o 500		
Tolerance V _{LN}		%		+10	/ -15		
Three-phase mains voltage on IT mains ³⁾	V_{LN}	V		200 t	o 230		
Three-phase mains voltage on mains with grounded outer conductor ⁴⁾	V_{LN}	V	200 to 230				
Min. inductance of mains supply (mains phase inductance) ⁵⁾	L _{min}	μH		4	.0		
Nominal power (t > 10 min) when $f_s = 2.1$ kHz; VL_{N_nom} ; control factor $a_0 > 0.8$; with mains choke	P_{DC_cont}	kW	339 430 535			672	
Nominal input current (continuous)	I _{LN}	Α	514	652	811	1019	
TPF power factor (λ_L) for P_{DC_cont} with mains choke; V_{LN_nom}	TPF		0.99				
Capacitance in DC bus	C_{DC}	mF	9.90	13.20	16.50	19.80	
Permitted external DC bus capacitance (nom.) for V _{LN_nom} ⁷⁾	C_DCext	mF	2500.00				
Nominal braking resistance	R _{DC_Bleeder}	ohm	-				
Braking resistor continuous power	P_{BD}	kW	-				
Braking resistor peak power	P _{BS}	kW			_		

Description	Symbol	Unit	HMU05.1N- F0340-0820- N-A4-D7-N1	HMU05.1N- F0430-1040- N-A4-D7-N1	HMU05.1N- F0540-1300- N-A4-D7-N1	HMU05.1N- F0680-1690- N-A4-D7-N1	
Regenerative power to be absorbed	$W_{\text{R_max}}$	kWs			-		
Braking resistor switch-on threshold – independent of mains voltage ⁸⁾	$V_{R_DC_On_f}$	V	-				
Braking resistor switch-on threshold – depending on mains voltage ⁹⁾	$V_{R_DC_On_v}$				-		
	1) 3) 4) 5) 6)	Observe supply voltage for motor holding brakes Mains voltage > V_{LN} : Use a transformer with grounded neutral point, do not use autotransformers. Otherwise use HNL mains choke PVC-insulated copper wire (conductor temperature 90°C; $T_a \le 40$ °C) in accordance with NFPA 79 Chapter 12 and UL 508A Chapter 28					

Use assigned mains choke

HMU – electrical data – currents, voltages, power

Factory setting

7) 8) 9)

Tab. 7-4:

7.1.3 DC bus

Power section data - DC bus

Description	Symbol	Unit	HMU05.1N- F0140-0350- N-A4-D7-N1	HMU05.1N- F0170-0430- N-A4-D7-N1	HMU05.1N- F0220-0510- N-A4-D7-N1	HMU05.1N- F0270-0660- N-A4-D7-N1	
DC bus voltage	V_{DC}	V	254 to 850				
Capacitance in DC bus	C _{DC}	mF	5.00		6.60	8.30	
DC resistance in DC bus (L+ to L-)	R _{DC}	kOhm	30.00			24.00	
Max. DC bus voltage monitoring value, switch-off threshold	$V_{DC_limit_max}$	V	900				
Min. DC bus voltage monitoring value, undervoltage threshold	V _{DC_limit_min}	V			-		

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

Power section data - DC bus

Description	Symbol	Unit	HMU05.1N- F0340-0820- N-A4-D7-N1	HMU05.1N- F0430-1040- N-A4-D7-N1	HMU05.1N- F0540-1300- N-A4-D7-N1	HMU05.1N- F0680-1690- N-A4-D7-N1	
DC bus voltage	V_{DC}	V	254 to 850				
Capacitance in DC bus	C _{DC}	mF	9.90	13.20	16.50	19.80	
DC resistance in DC bus (L+ to L-)	R _{DC}	kOhm	24.00	15.00	12.00		
Max. DC bus voltage monitoring value, switch-off threshold	$V_{DC_limit_max}$	V	900				
Min. DC bus voltage monitoring value, undervoltage threshold	$V_{DC_limit_min}$	V			-		

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

7.1.4 Inverter

Power section data - inverter

-							
Description	Symbol	Unit	HMU05.1N- F0140-0350- N-A4-D7-N1	HMU05.1N- F0170-0430- N-A4-D7-N1	HMU05.1N- F0220-0510- N-A4-D7-N1	HMU05.1N- F0270-0660- N-A4-D7-N1	
Permitted switching frequencies ¹⁾	f _s	kHz	2, 4, 8				
Output voltage, fundamental wave for V/f control	V_{out_eff}	V		~ V _{DC}	× 0.71		
Output voltage, fundamental wave for closed-loop operation	V_{out_eff}	V		~ V _{DC}	× 0.71		
Rise of voltage at output for V _{LN_nom} and 15 m phase-to-phase motor cable (10 to 90%) ²⁾	dv/dt	kV/µs		5.	00		
Rise of voltage at output for V _{LN_nom} and 15 m phase-to-ground motor cable (10 to 90%) ³⁾	dv/dt	kV/µs	5.00				
Output frequency range when $f_s = 2 \text{ kHz}$	f _{out_2k}	Hz		0 to	200		
Output frequency range when f _s = 4 kHz	f _{out_4k}	Hz		0 to	400		
Output frequency range when f _s = 8 kHz	f _{out_8k}	Hz		0 to	800		
Output frequency range when f _s = 12 kHz	f _{out_12k}	Hz			-		
Output frequency range when f _s = 16 kHz	f _{out_16k}	Hz			-		
Output frequency threshold for detecting motor standstill ⁴⁾	f_{out_still}	Hz		(6		
Max. output current when $f_s = 2 \text{ kHz}$	I _{out_max2}	А	357.0	427.0	515.0	660.0	
Max. output current when f _s = 4 kHz	I _{out_max4}	А	357.0	427.0	515.0	660.0	
Max. output current when f _s = 8 kHz	I _{out_max8}	А	242.0	362.0	430.0	476.0	
Max. output current when $f_s = 12 \text{ kHz}$	I _{out_max12}	А	-				
Max. output current when $f_s = 16 \text{ kHz}$	I _{out_max16}	А	-				
Continuous output current when $f_s = 2 \text{ kHz}$	I _{out_cont2}	А	254.0	306.0	392.0	490.0	

Description	Symbol	Unit	HMU05.1N- F0140-0350- N-A4-D7-N1	HMU05.1N- F0170-0430- N-A4-D7-N1	HMU05.1N- F0220-0510- N-A4-D7-N1	HMU05.1N- F0270-0660- N-A4-D7-N1	
Continuous output current when $f_s = 4 \text{ kHz}$	I _{out_cont4}	А	254.0	306.0	392.0	490.0	
Continuous output current when $f_s = 8 \text{ kHz}$	I _{out_cont8}	Α	182.0	260.0	315.0	350.0	
Continuous output current when $f_s = 12 \text{ kHz}^{5)}$	I _{out_cont12}	Α	-				
Continuous output current when $f_s = 16 \text{ kHz}^{6)}$	I _{out_cont16}	А	-				
Continuous output current when f _s = 2 kHz; output frequency f _{out} < f _{out_still}	I _{out_cont0Hz_2}	А	210.0	251.0	302.0	388.0	
Continuous output current when $f_s = 4$ kHz; output frequency $f_{out} < f_{out_still}$	I _{out_cont0Hz_4}	А	210.0	230.0	302.0	320.0	
Continuous output current when $f_s = 8 \text{ kHz}$; output frequency $f_{out} < f_{out_still}$	I _{out_cont0Hz_8}	A	150.0	185.0 213.0			
Continuous output current when $f_s = 12 \text{ kHz}$; output frequency $f_{out} < f_{out_still}^{7)}$	I _{out_cont0Hz_12}	А	-				
Continuous output current when $f_s = 16 \text{ kHz}$; output frequency $f_{\text{out}} < f_{\text{out_still}}^{8)}$	I _{out_cont0Hz_16}	A	-				
Assigned output filters with nominal data; f _s = 4 kHz				TE	BD		

Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of power output stage"; see "P-0-4058, Amplifier type data"

2) 3) Guide value, see following note

4) See following note regarding reduction output current

5) 6) 7) 8) See parameter description "P-0-0556, Axis controller configuration", load-dependent reduction of switching frequency f_s

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

Power section data - inverter

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690
Permitted switching frequencies ¹⁾	f_s	kHz	2, 4, 8			
Output voltage, fundamental wave for V/f control	V_{out_eff}	V	~ V _{DC} × 0.71			
Output voltage, fundamental wave for closed-loop operation	V_{out_eff}	V	~ V _{DC} × 0.71			

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690		
Rise of voltage at output for V _{LN_nom} and 15 m phase-to-phase motor cable (10 to 90%) ²⁾	dv/dt	kV/μs	5.00					
Rise of voltage at output for V_{LN_nom} and 15 m phase-to-ground motor cable (10 to $90\%)^{3)}$	dv/dt	kV/μs	5.00					
Output frequency range when $f_s = 2 \text{ kHz}$	f _{out_2k}	Hz		0 to	200			
Output frequency range when $f_s = 4 \text{ kHz}$	f _{out_4k}	Hz		0 to	400			
Output frequency range when $f_s = 8 \text{ kHz}$	f _{out_8k}	Hz		0 to	800			
Output frequency range when $f_s = 12 \text{ kHz}$	f _{out_12k}	Hz			-			
Output frequency range when $f_s = 16 \text{ kHz}$	f _{out_16k}	Hz	-					
Output frequency threshold for detecting motor standstill ⁴⁾	f _{out_still}	Hz			6			
Max. output current when $f_s = 2 \text{ kHz}$	I _{out_max2}	А	825.0	1037.0	1297.0	1686.0		
Max. output current when $f_s = 4 \text{ kHz}$	I _{out_max4}	А	765.0	838.0	1000.0	1303.0		
Max. output current when f _s = 8 kHz	I _{out_max8}	А	510.0	650.0	736.0	843.0		
Max. output current when $f_s = 12 \text{ kHz}$	I _{out_max12}	А			-			
Max. output current when $f_s = 16 \text{ kHz}$	I _{out_max16}	А			-			
Continuous output current when f _s = 2 kHz	I _{out_cont2}	А	616.0	771.0	1002.0	1185.0		
Continuous output current when f _s = 4 kHz	I _{out_cont4}	А	546.0	624.0	775.0	915.0		
Continuous output current when f _s = 8 kHz	I _{out_cont8}	А	364.0 465.0 526.0 592.0					
Continuous output current when $f_s = 12 \text{ kHz}^{5)}$	I _{out_cont12}	А	-					
Continuous output current when $f_s = 16 \text{ kHz}^{6)}$	I _{out_cont16}	А			-			

Bosch Rexroth AG

Technical component data

Description	Symbol	Unit	HMU05.1N- F0340-0820	HMU05.1N- F0430-1040	HMU05.1N- F0540-1300	HMU05.1N- F0680-1690	
Continuous output current when $f_s = 2 \text{ kHz}$; output frequency $f_{\text{out}} < f_{\text{out_still}}$	I _{out_cont0Hz_2}	А	485.0	610.0	650.0	992.0	
Continuous output current when $f_s = 4 \text{ kHz}$; output frequency $f_{\text{out}} < f_{\text{out_still}}$	I _{out_cont0Hz_4}	А	450.0	493.0	500.0	766.0	
	I _{out_cont0Hz_8}	А	298.0 496.				
Continuous output current when $f_s = 12 \text{ kHz}$; output frequency $f_{out} < f_{out_still}^{7/}$	I _{out_cont0Hz_12}	А	-				
	I _{out_cont0Hz_16}	А	-				
Assigned output filters with nominal data; f _s = 4 kHz			tbd				

Also depending on firmware and control section; see parameter description "P00001, Switching frequency of power output

stage"; see "P04058, Amplifier type data"

2) 3) Guide value, see following note

See following note regarding reduction output current

5) 6) 7) 8) See parameter description "P-0-0556, Axis controller configura-

tion", load-dependent reduction of switching frequency fs

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

B

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.

Technical component data

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

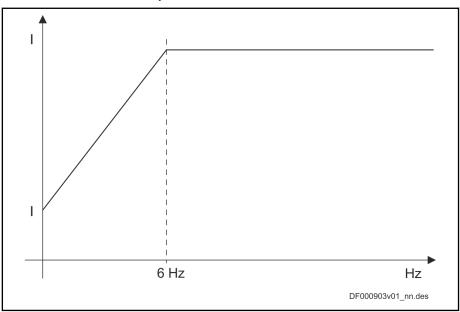


Fig. 7-1: Current profile during acceleration

8 Cables, accessories, additional components

8.1 Overview

8.1.1 Cables

Function	Cable
IndraBus	RKB0035 (shielded, < 100 m)
	RKB0036 (shielded, < 3 m)
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
HAS08: cabinet installation kit	For mounting an HMU05
HAS10: blank covers, motor monitor grounding, mounting plates	

Tab. 8-2: Accessories - overview

8.1.3 Additional components

Туре	Additional component
HAH01	Heat exchanger
HLL05	DC bus choke
HMF05	Motor filter
HML05	Motor choke
HNA05	Mains connecting module
HNC05	Mains capacitor
HNF05	Mains filter
HNL05	Mains choke
HLR05	Braking resistor
HLT05	Braking unit

Tab. 8-3: Additional components - overview

8.2 Accessories

8.2.1 Mounting and connection accessories (HAS03)

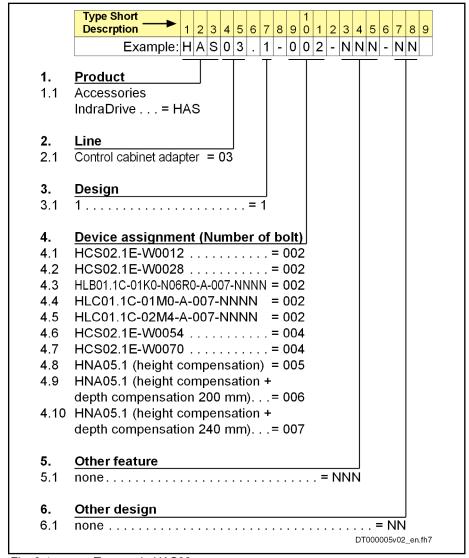


Fig. 8-1: Type code HAS03

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

8.2.2 Cabinet installation kit (HAS08.1-008)

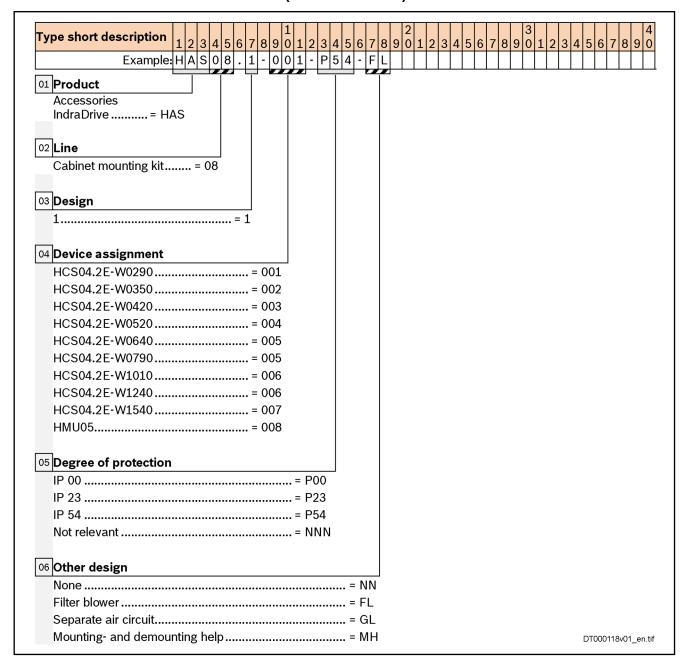


Fig. 8-2: Type code HAS08

Use The HAS08.1-008-NNN-MH accessory contains tools for mounting an HMU05 in a control cabinet.

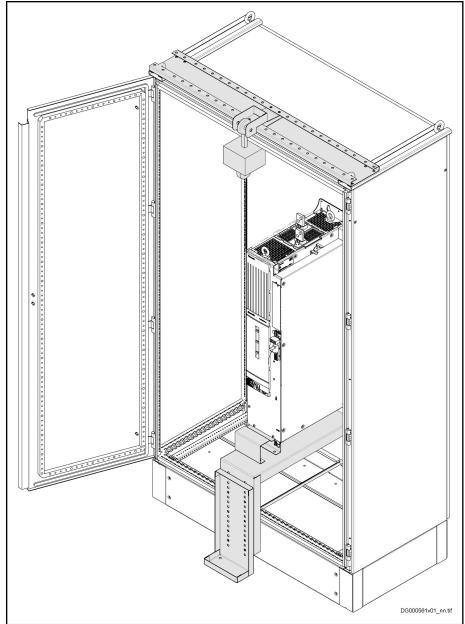


Fig. 8-3: HAS08.1-008-NNN_MH mounting tools

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

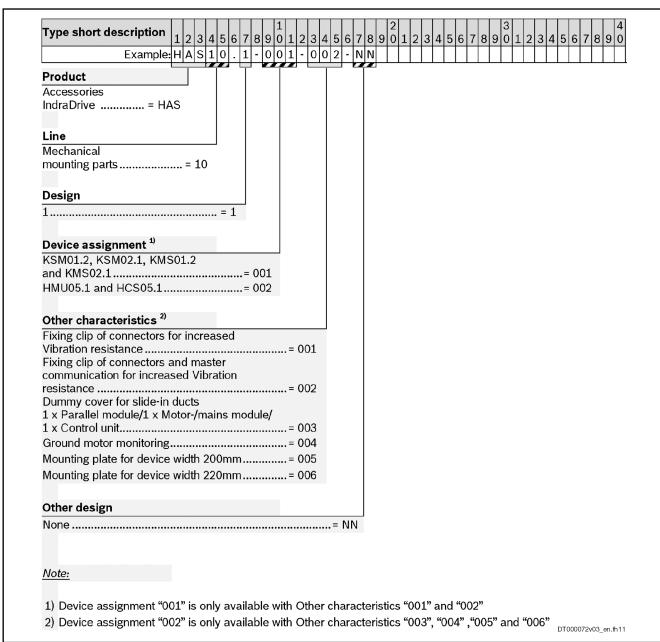


Fig. 8-4: Type code HAS10

Blank covers (HAS10.1-002-003)

This accessory contains blank covers for covering unused mounting bays.

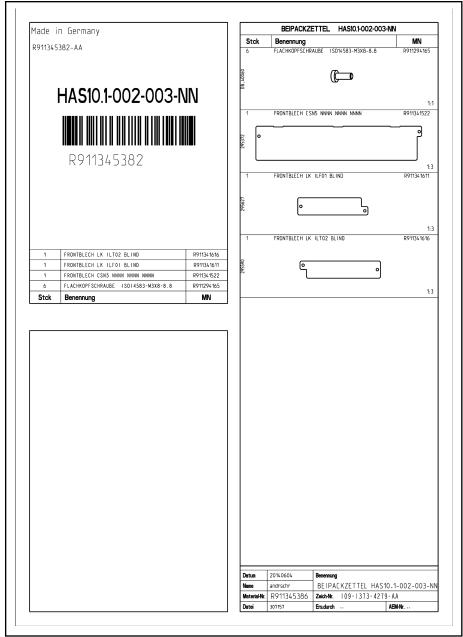


Fig. 8-5: Product insert (HAS10.1-002-003)

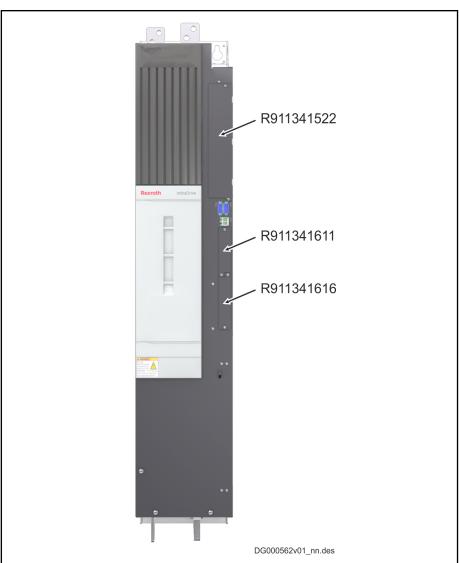


Fig. 8-6: Blank covers (HAS10.1-002-003)

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

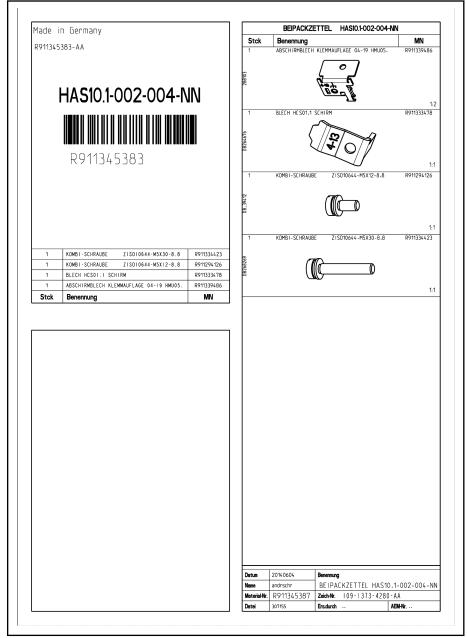


Fig. 8-7: Product insert (HAS10.1-002-004)

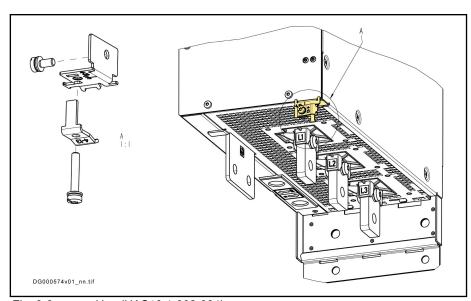


Fig. 8-8: Use (HAS10.1-002-004)

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

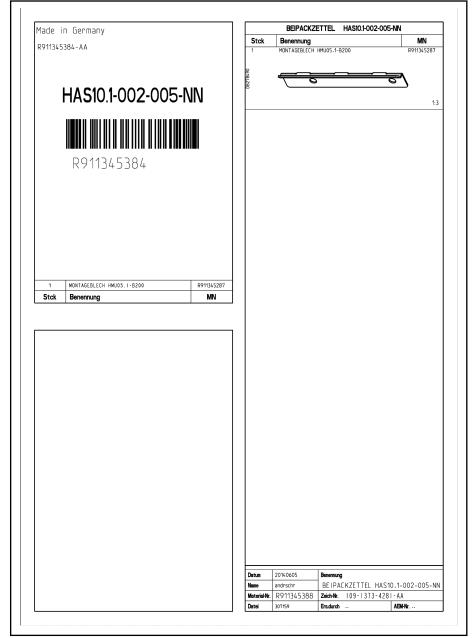


Fig. 8-9: Product insert (HAS10.1-002-005)

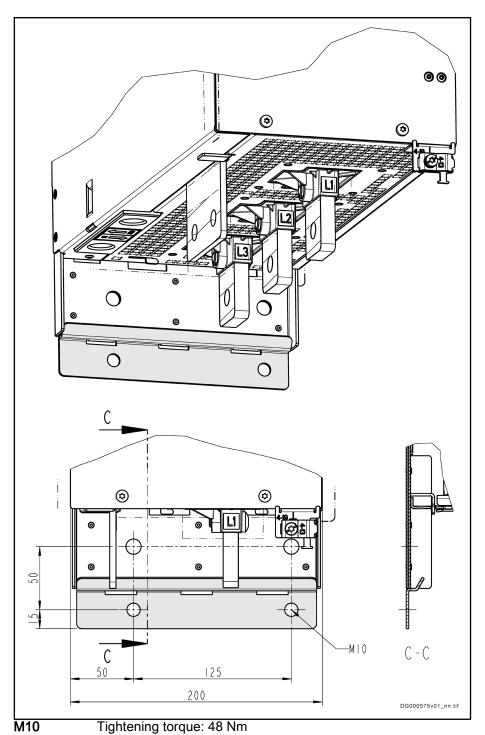


Fig. 8-10: Use (HAS10.1-002-005)

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

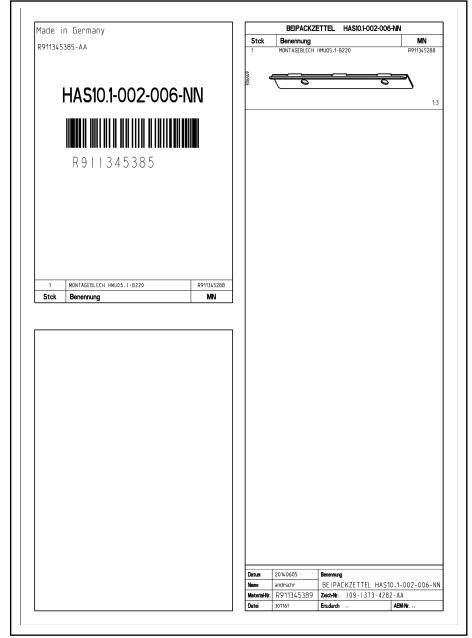


Fig. 8-11: Product insert (HAS10.1-002-006)

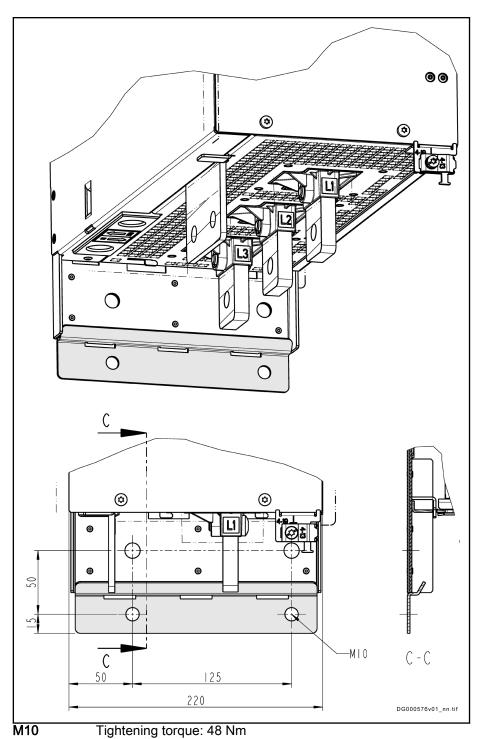


Fig. 8-12: Use (HAS10.1-002-006)

8.3 Additional components

8.3.1 HNA05 mains connecting module

Type code HNA05

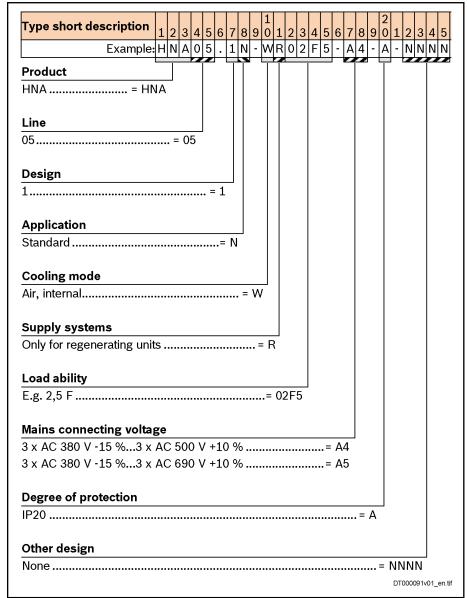
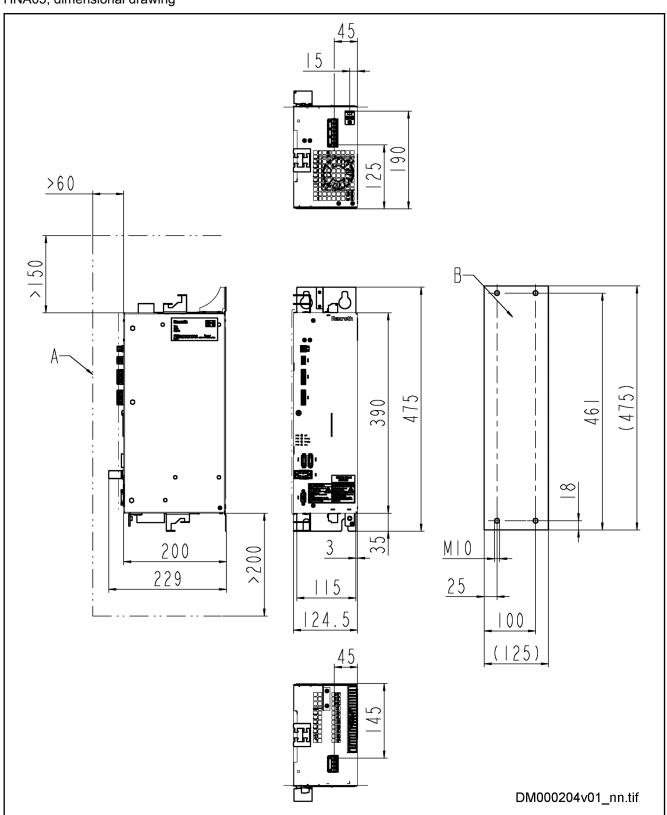


Fig. 8-13: Type code HNA05

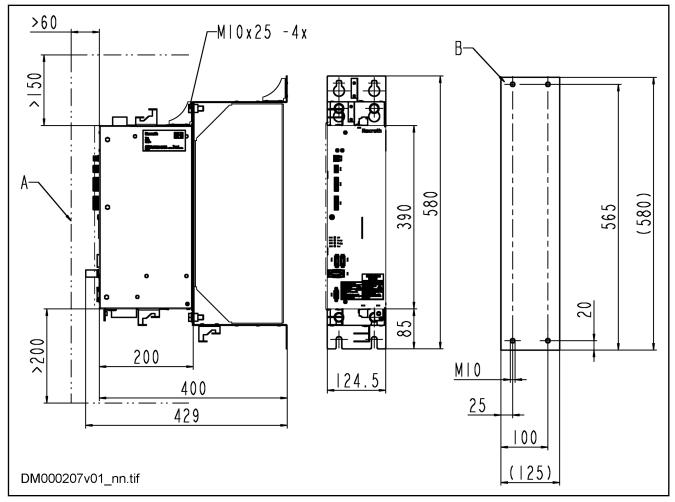
Dimensions

HNA05, dimensional drawing



M10 Tightening torque: 40 Nm *Fig. 8-14: HNA05, dimensional drawing*

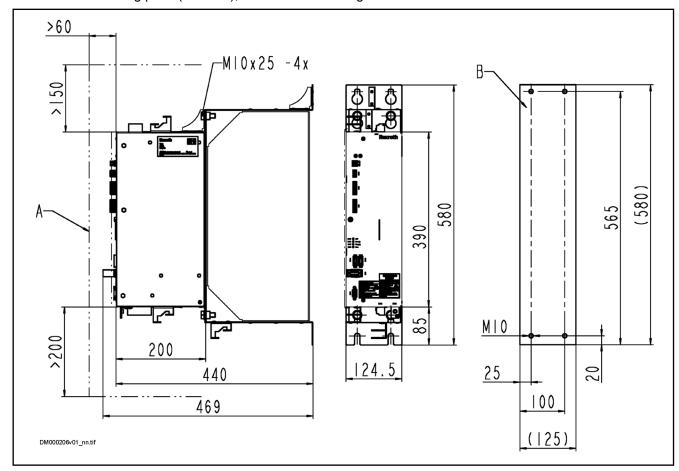
HNA05 with mounting plate (400 mm), dimensional drawing



M10 Tightening torque: 40 Nm

Fig. 8-15: HNA05 with HAS03.1-006 mounting plate for height leveling and depth leveling to 400 mm depth, dimensional drawing

HNA05 with mounting plate (440 mm), dimensional drawing



M10 Tightening torque: 40 Nm
Fig. 8-16: HNA05 with HAS03.1-007 mounting plate for height leveling and depth leveling to 440 mm depth, dimensional drawing

Data

Description	Unit	HNA05.1N-WR02F5		
		A4	A5	
Protection class		IP20		
Permitted mounting position		G1		
Ambient temperature range	°C	0 to	55	
Mass	kg	6.7	70	
Insulation resistance	ΜΩ	5	0	
Y capacitance		-		
Installation height	mm	39	90	
Installation width	mm	124	4.5	
Cooling type		Air co	ooling	
Distance top	mm	8	0	
Distance bottom	mm	8	0	
Distance side	mm	C)	
Charging power dissipation	W	15	50	
Basic power dissipation in operation	W	50		
Power consumption for control voltage V _{N3}	W	< 15		
Control voltage inrush current	А	< 3		
Inrush current duration	ms	< 2		
Control voltage V _{N3}	V	24		
Tolerance of control voltage V _{N3}	%	±20		
Input capacitance of control voltage V _{N3}	mF	0.05		
Mains nominal input voltage	V	AC 400	AC 690	
Three-phase mains input voltage (TN-S, TN-C, TT mains)	V	AC 380 to 500	AC 380 to 690	
Mains input voltage tolerance	%	+10	/ -15	
Mains frequency	Hz	50 to	o 60	
Maximum permitted mains frequency change	Hz/s	1		
Mains frequency tolerance	Hz	±2		
Rotary field condition		None		
Min. inductance of mains supply	μH	40		
Charging mains input current	А	< 10		
Recommended mains fuse	А	16		
Power mains input connection cross section	mm ²	2.5		
DC bus connection cross section	mm ²	2.5		
DC bus connection cable length	m	< 2; twisted		

Description	Unit	HNA05.1N-WR02F5	
		A4	A5
Upper DC bus voltage limit	V	900	1300
Output voltage	V	$V_{\text{nom}} \times \sqrt{2 + 30}$	
Nominal output current	A	10	
Max. chargeable energy	kWs	625	
Max. chargeable output voltage	V	808 1100	
Max. charging time	S	240	
Max. capacitance at 500 V	F	2.5	
Min. capacitance at output	mF	1	

Tab. 8-4: HNA05 data

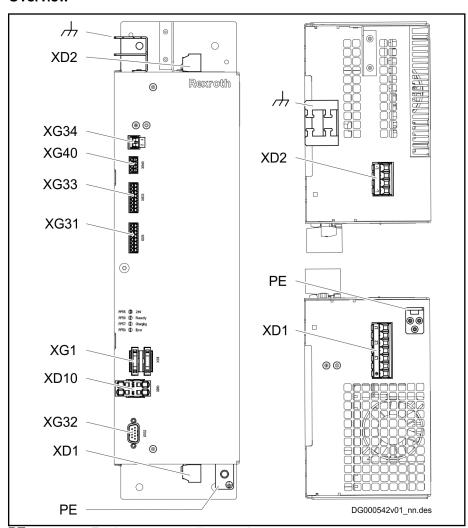
Connection diagram See chapter 4.6.2 "Overall connection diagram (HMU05 as supply unit)" on page 78

Maximum permitted operating cycles for charging circuit

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

Connection points

Overview



PE Equipment grounding conductor XD1 Mains voltage, equipment grounding conductor (L1, L2, L3, PE) XD2 DC bus (L+, L-) XD10 Control voltage (0 V, 24 V) XG1 IndraBus **XG31** Connection for messages XG32 HNA bus XG33 Mains contactor control and DC bus short-circuit

XG40 Acknowledgment messages for mains contactor

Contact for external mains contactor

Fig. 8-17: HNA05 connection points

XG34

Connection point for equipment grounding conductor

A WARNING Fatal 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.

EFF

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	А
16 mm² < A ≤ 35 mm²	16
35 mm² < A	A / 2

Tab. 8-5: Equipment grounding conductor cross section

View	ID	Function		
		Connection to equipment grounding system		
Screw connection	Unit	Min.	Max.	
Screw		M6 × 25		
Tightening torque	Nm	9.5 10.5		

Tab. 8-6: Equipment grounding conductor connection point

XD1, mains voltage, equipment grounding conductor

View	Connec- tion	Function
₩ L3 L2 L1		Equipment grounding conductor
	L3	Connection to mains power supply (L3)
	L2	Connection to mains power supply (L2)
	L1	Connection to mains power supply (L1)

Tab. 8-7: XD1, mains voltage, ground

Mechanical data

Screw connection on connector	Unit	Min.	Max.
Tightening torque	Nm	0.5	0.8
Connection cable	mm ²	0.2	10
Solid wire			
Connection cable	mm ²	0.2	6
Stranded wire without ferrule	AWG	24	10
Connection cable	mm ²	0.25	4
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-8: Mechanical data

	Unit	Min.	Max.
Voltage	V		630
Current	Α		41

Tab. 8-9: Electrical data

XD2, DC bus

WARNING

Fatal 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.

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

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

Secure the DC bus connections against being touched.

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

Tab. 8-10: XD2, DC bus

Mechanical data

Screw connection on connector	Unit	Min.	Max.
Tightening torque	Nm	0.5	0.8
Connection cable	mm²	0.2	10
Solid wire			
Connection cable	mm ²	0.2	6
Stranded wire without ferrule	AWG	24	10
Connection cable	mm²	0.25	4
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-11: Mechanical data

	Unit	Min.	Max.
Voltage	V		1000
Current	Α		41

Tab. 8-12: Electrical data

XD10, 24 V supply (control voltage)

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

View	Connec- tion	Signal name	Function
	24 V	+24 V	Power supply
		+24 V	
	0 V	0 V	Reference potential for pow-
		0 V	er supply

Tab. 8-13: XD10, 24 V supply

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm²	1	10
Solid wire			
Connection cable	mm²	1	6
Stranded wire without ferrule	AWG	16	10
Connection cable	mm²	1	4
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-14: Mechanical data

Electrical data

	Unit	Min.	Max.
Voltage	V	-	1000
Current	Α	-	41
Permitted inductance	μH	-	100
			(2 twisted single strands, 75 m long)

Tab. 8-15: Electrical data

Notes on installation

Depending on the power consumption of the devices and the current carrying capacity of the connector X10, check the number of devices through which one line for 24 V supply can be looped through. You may have to connect another device directly to the 24 V supply and then loop through the control voltage from this device to other devices.

XG1, IndraBus

View	Connec- tion	Function
	XG1a	Connects parallel components through a ribbon cable.
	XG1b	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 brake resistance unit
		Reporting DC bus availability
		Cable
		Unshielded length: < 3 m
		Cable designation: RKB0036
		Shielded length: < 100 m
		Cable designation: RKB0035

Tab. 8-16: XG1, IndraBus

XG31, messages

Pin assignment

View	Connec- tion	I/O	Function
	1	E	Supply voltage for inputs/outputs
	2	E	Reset input to reset error messages
	3	Е	Input for selecting between individual operation and parallel operation (slave mode)
()(,)	4	Α	Isolated ready contact (N/O)
	5		This contact is only used in individual operation.
	6	Α	Isolated warning contact (N/C)
	7		
	8	E	Reference potential for supply voltage

Tab. 8-17: XG31, messages

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm ²	0.2	1.5
Stranded wire without ferrule	AWG	24	16
Connection cable	mm²	0.25	0.75
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-18: Mechanical data

	Unit	Min.	Max.
Digital outputs	-	Digital outputs correspond to IEC 61131-2 Type	
Switching voltage	V	24 -6%	
Output current	mA	500	
Energy absorption capacity	mJ		700
Overload protection	-	Short circuit protection	
Ready and warning contact	-	Digital inputs correspo	nd 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. 8-19: Electrical data

XG32, HNA bus

View	ID	Function		
	XG32	HNA bus		
D-Sub, 9-pin, male	Unit	Min.	Max.	
Connection cross section	mm²	0.25	0.5	

Tab. 8-20: Function, pin assignment, properties

XG33, mains contactor (control, DC bus short-circuit)

View	Connec- tion	I/O	Function
	1	E	Supply voltage for inputs/outputs
	2	А	Supply voltage for external, current carrying outputs
	3	E	DC bus short-circuit input for reporting an active DC bus short circuit
	4	А	Supply voltage for external OFF output
	5	E	OFF input
	6	Α	Supply voltage for external ON output
	7	E	ON input
	8	E	Reference potential for supply voltage

Tab. 8-21: Function, pin assignment

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm²	0.2	1.5
Stranded wire without ferrule	AWG	24	16
Connection cable	mm²	0.25	0.75
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-22: Mechanical data

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

Tab. 8-23: Electrical data

XG34, mains contactor (contact)

View	Connec- tion	Function
	1	Contact for mains contactor control
2	2	

Tab. 8-24: Function, pin assignment, properties

Mechanical data

Screw connection at connector	Unit	Min.	Max.
Tightening torque	Nm	0.5	0.6
Connection cable	mm ²	0.2	2.5
Stranded wire without ferrule	AWG	24	12
Connection cable	mm ²	0.25	2.5
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-25: Mechanical data

	Unit	Min.	Max.
Switching voltage	V AC	~2	50
Continuous current	А		1
Switching current	Α		5
Load current	mA	10	
Switching cycles		3 × 10 ⁵	

Tab. 8-26: Electrical data

XG40, mains contactor (acknowledgment messages)

View	Connec- tion	I/O	Function
	1	Е	Acknowledgment message:
			Normally open contact for external mains contactor
	2	А	24 V
	3	E	Acknowledgment message: Normally closed contact for external mains contactor
	4	Α	24 V

Tab. 8-27: Function, pin assignment

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm ²	0.2	1.5
Stranded wire without ferrule	AWG	24	16
Connection cable	mm ²	0.25	0.75
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-28: Mechanical data

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

Tab. 8-29: Electrical data

Display elements

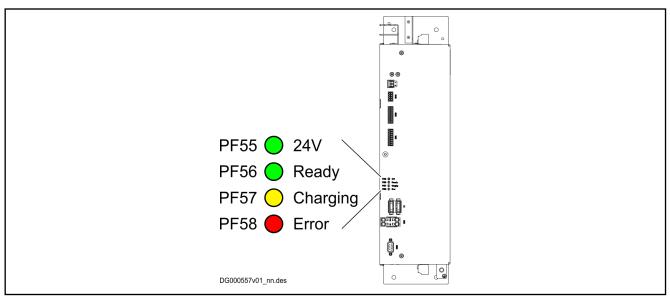


Fig. 8-18: LEDs on HNA05

LED	LED Color/status		Meaning
PF55	*	Green	24 V power supply applied
	0	Off	24 V power supply < 19.2 V
PF56	*	Green	HNA ready
	-:	Flashing green	HNA ready; no mains voltage
	0	Off	HNA not ready
PF57	*	Yellow	Charging complete (DC bus capacitance charged)
		Flashing yellow	Charging
	0	Off	Charging interrupted
PF58	*	Red	Error
		Flashing red	Warning
	0	Off	No error, no warning

Tab. 8-30: LED displays

Rexroth IndraDrive ML Drive systems with HMU05

Cables, accessories, additional components

8.3.2 HNC05 mains capacitor

Type code HNC05

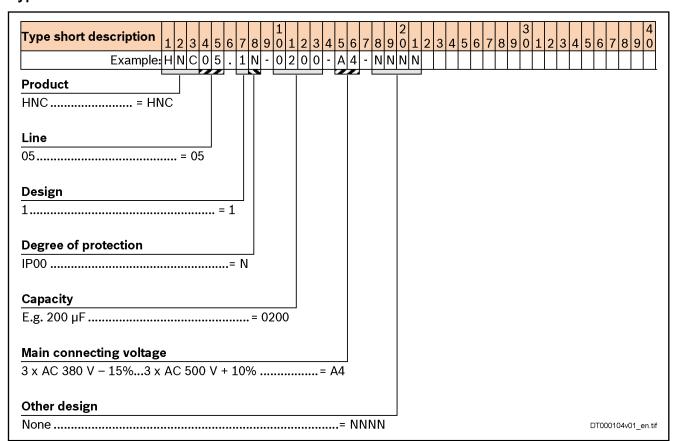


Fig. 8-19: Type code HNC05

Dimensions

HNC05.1N-0100

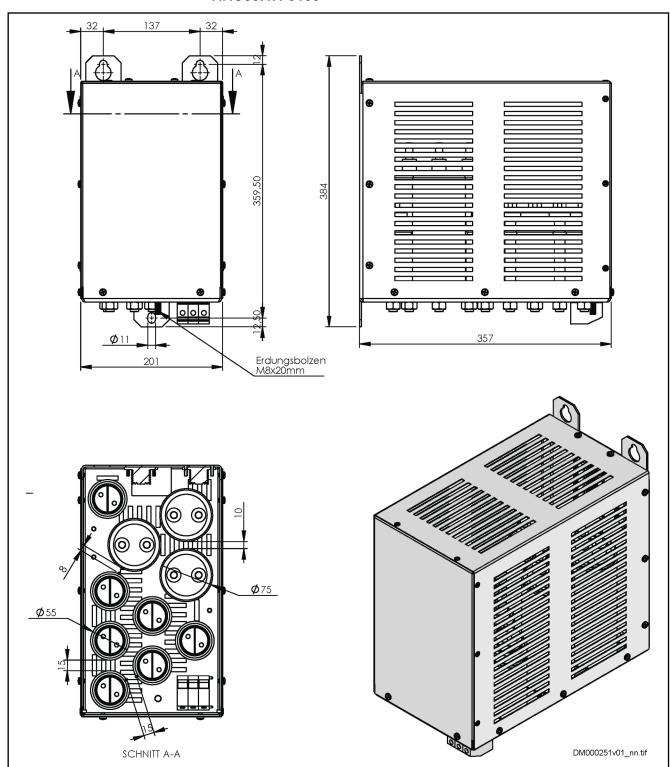


Fig. 8-20: HNC05.1N-0100

HNC05.1N-0150

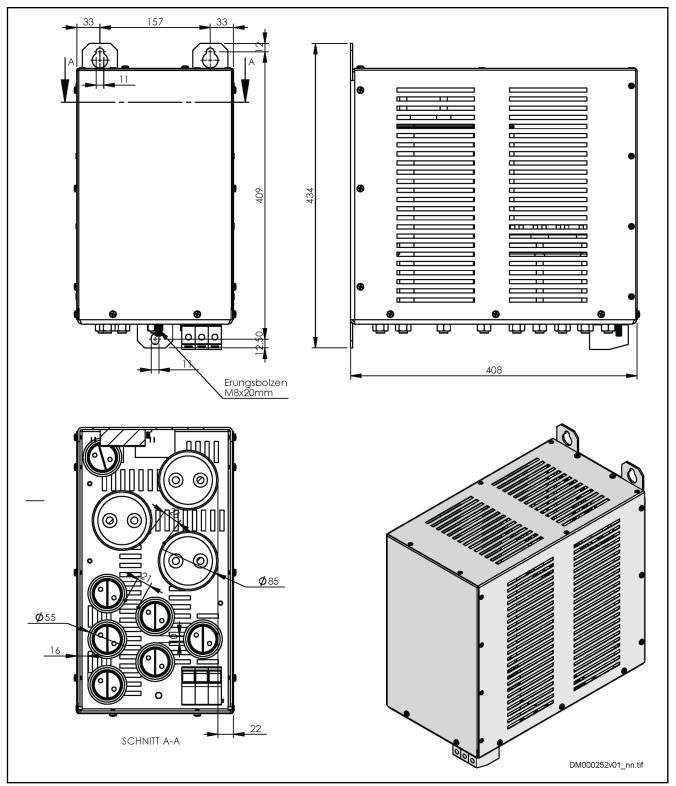


Fig. 8-21: HNC05.1N-0150

HNC05.1N-0200

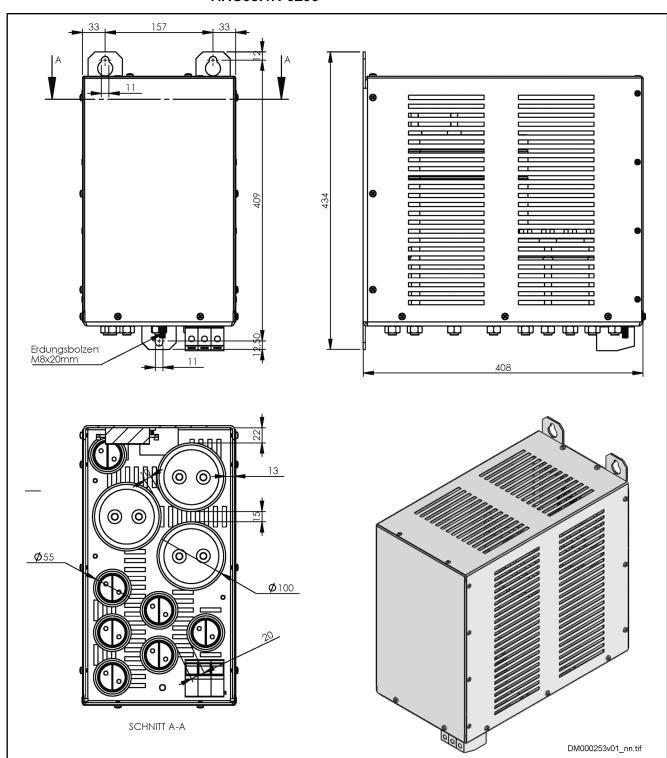


Fig. 8-22: HNC05.1N-0200

Data

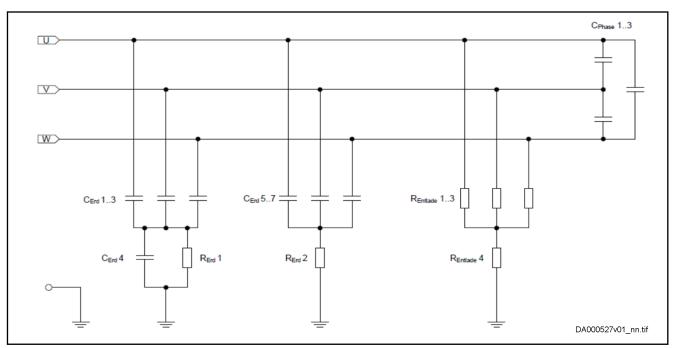


Fig. 8-23: HNC05

Mains capacitor	Capacitance C [µF]	Current I [A] +	Connection	Protection	Weight
HNC05.1N	+	Power P [W]		class	[kg]
	Resistance R [kΩ]				
0100	C _{Phase1-3} = 100	I _{Phase1-3} = 48	Phases:	IP20	tbd
	$C_{Ground1-3} = 40$	I _{Ground1-3} = 15	Screw terminal, 25 mm ²		
	C _{Ground4} = 20	I _{Ground4} = 30	Ground:		
	C _{Ground5-7} = 10	I _{Ground5-7} = 5	Bolt, M8x20		
	$R_{Ground1} = 0.001$	P _{Ground1} = 150			
	$R_{Ground2} = 0.001$	P _{Ground2} = 100			
	R _{Discharge1-3} = 1000	P _{Discharge1-3} = 0.5			
	R _{Discharge4} = 1000	P _{Discharge4} = 0.5			
0150	C _{Phase1-3} = 150	I _{Phase1-3} = 70	Phases:	IP20	tbd
	$C_{Ground1-3} = 40$	I _{Ground1-3} = 15	Screw terminal, 50 mm ²		
	C _{Ground4} = 20	I _{Ground4} = 30	Ground:		
	C _{Ground5-7} = 10	I _{Ground5-7} = 5	Bolt, M8x20		
	$R_{Ground1} = 0.001$	P _{Ground1} = 150			
	R _{Ground2} = 0.001	P _{Ground2} = 100			
	R _{Discharge1-3} = 470	P _{Discharge1-3} = 0.5			
	R _{Discharge4} = 1000	P _{Discharge4} = 0.5			
0200	C _{Phase1-3} = 200	I _{Phase1-3} = 102	Phases:	IP20	tbd
	$C_{Ground1-3} = 40$	I _{Ground1-3} = 15	Screw terminal, 50 mm ²		
	C _{Ground4} = 20	I _{Ground4} = 30	Ground:		
	C _{Ground5-7} = 10	I _{Ground5-7} = 5	Bolt, M8x20		
	R _{Ground1} = 0.001	P _{Ground1} = 150			
	R _{Ground2} = 0.001	P _{Ground2} = 100			
	R _{Discharge1-3} = 470	P _{Discharge1-3} = 0.5			
	R _{Discharge4} = 1000	P _{Discharge4} = 0.5			

Tab. 8-31: HNC05.1R, data

Discharge time 20 minutes

Assignment to HMU05

See chapter "Combining mains filter, mains choke, restrictor and capacitance pack" on page 93.

8.3.3 HNF05 mains filter

Type code HNF05

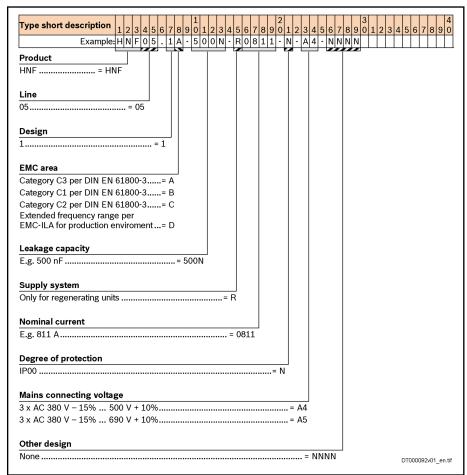


Fig. 8-24: Type code HNF05

Dimensions

HNF05.1A-500N-R0250

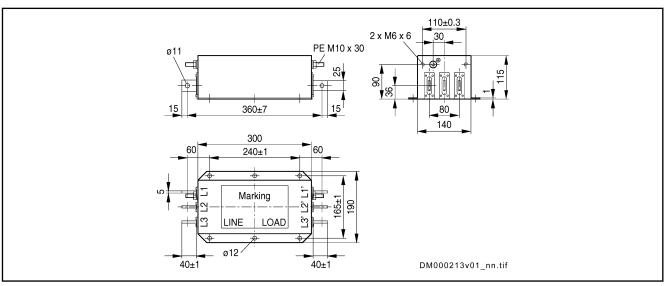


Fig. 8-25: HNF05.1A-500N-R0250

HNF05.1A-500N-R0320, -R0400

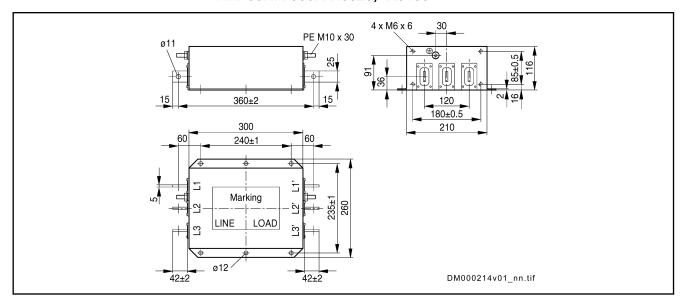


Fig. 8-26: HNF05.1A-500N-R0320, -R0400

HNF05.1A-500N-R0600

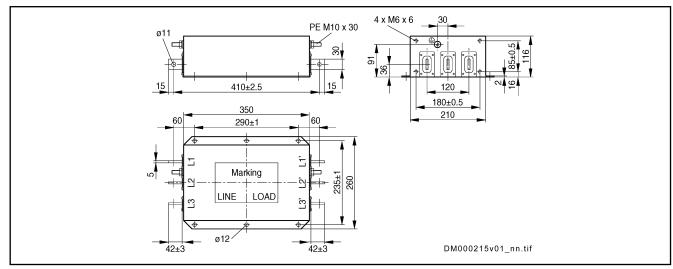


Fig. 8-27: HNF05.1A-500N-R0600

HNF05.1A-500N-R1000

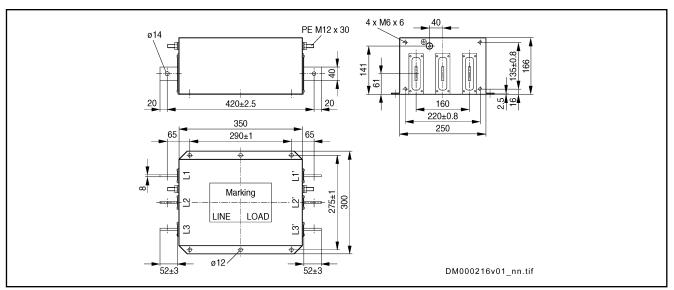


Fig. 8-28: HNF05.1A-500N-R1000

HNF05.1A-500N-R1600

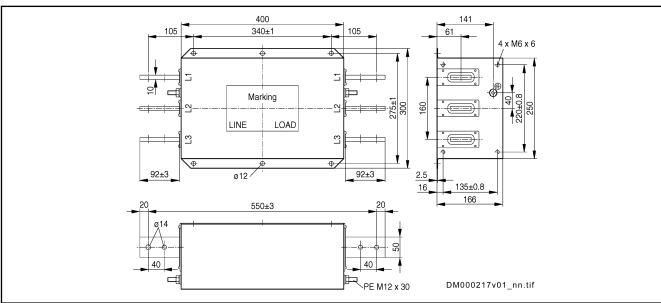


Fig. 8-29: HNF05.1A-500N-R1600

Data

HNF05.1A- 500N-R	Nominal volt- age [V]	Nominal current [A]	Leakage current [mA]	Resistance [μΩ]	Weight [kg]
0250	690/400,	250	< 905 ¹⁾	63	15
0320	50/60 Hz	320		67	21
0400		400			
0600		600		52	22
1000		1000		33	28
1600		1600		22	34

1) With nominal voltage, 50 Hz

Tab. 8-32: HNF05.1A, data

Assignment to HMU05

See chapter "Combining mains filter, mains choke, restrictor and capacitance pack" on page 93.

8.3.4 HNL05 mains choke

Type code HNL05

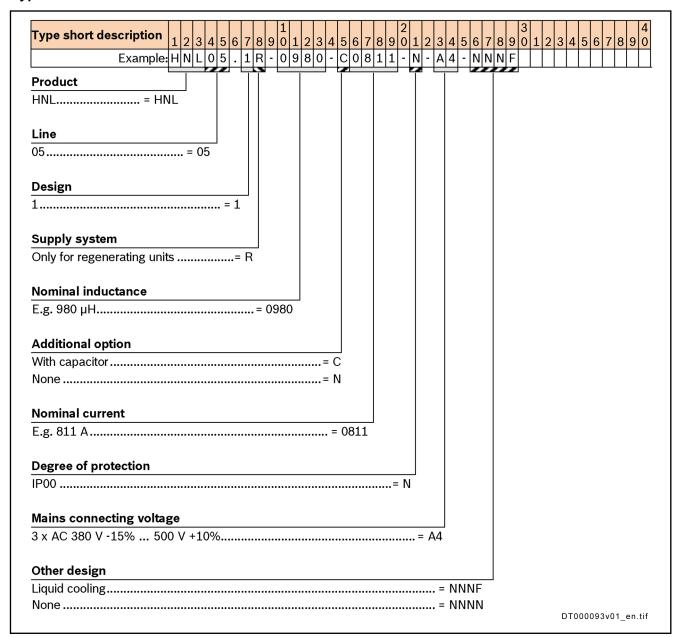
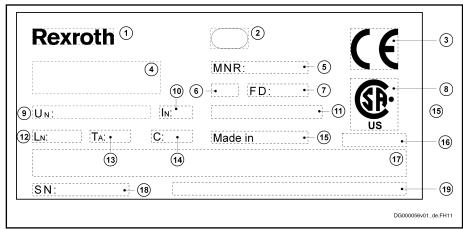


Fig. 8-30: Type code HNL05

Type plate



1	Word mark
2	Business facility number
3	CE label
4	Type designation (two lines, 20 characters each)
5	Part number
6	Change release
7	Production date (YYWww)
8	Certification label
9	Nominal voltage / frequency
10	Nominal current
11	Number of design specification
12	Nominal inductance
13	Temperature
14	Number and value of additional capacitors
15	Designation of origin
16	Approval number
17	Bar code (39 or 93)
18	Serial number
19	Company address

Fig. 8-31:

Type plate

Dimensions

HNL05.1R-0219-N0218

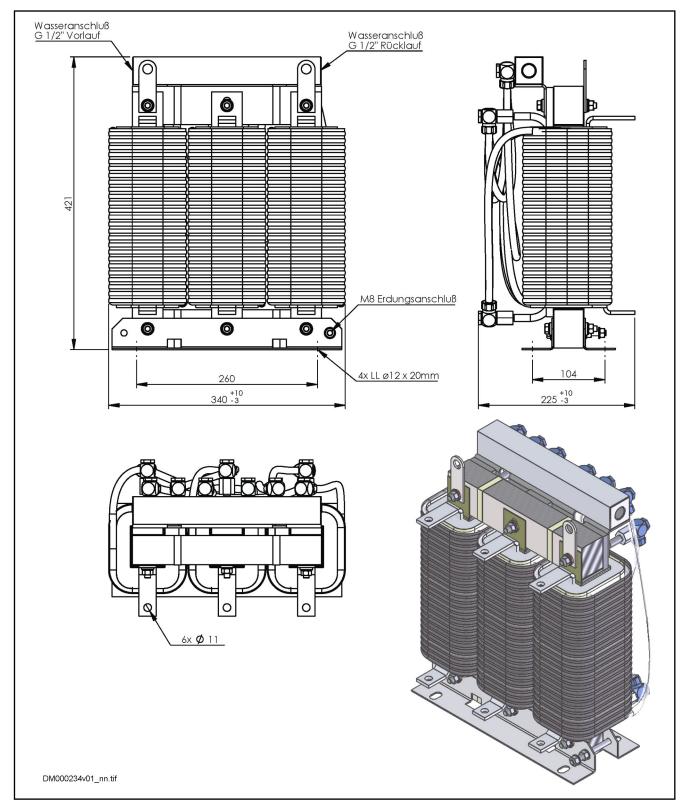


Fig. 8-32: HNL05.1R-0219-N0218

HNL05.1R-0182-N0262

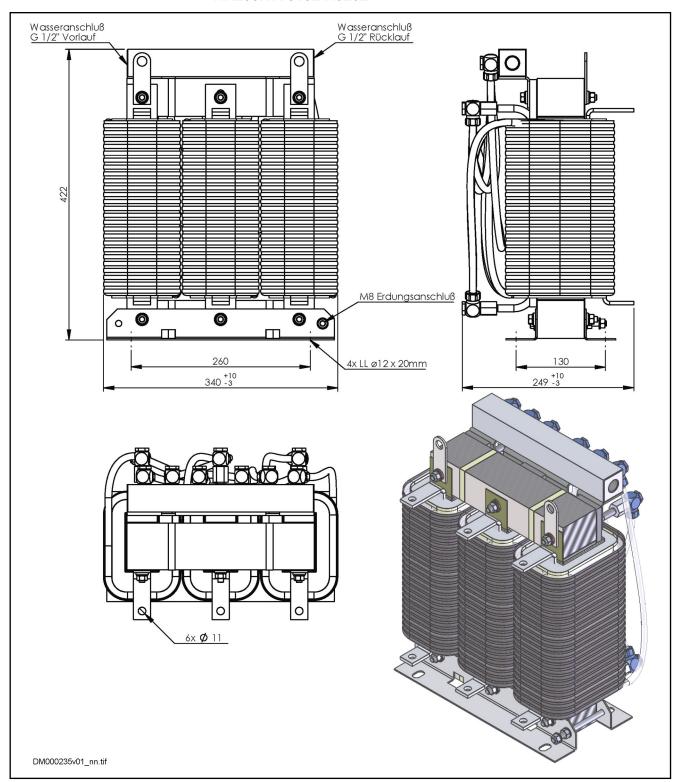


Fig. 8-33: HNL05.1R-0182-N0262

HNL05.1R-0045-N0327

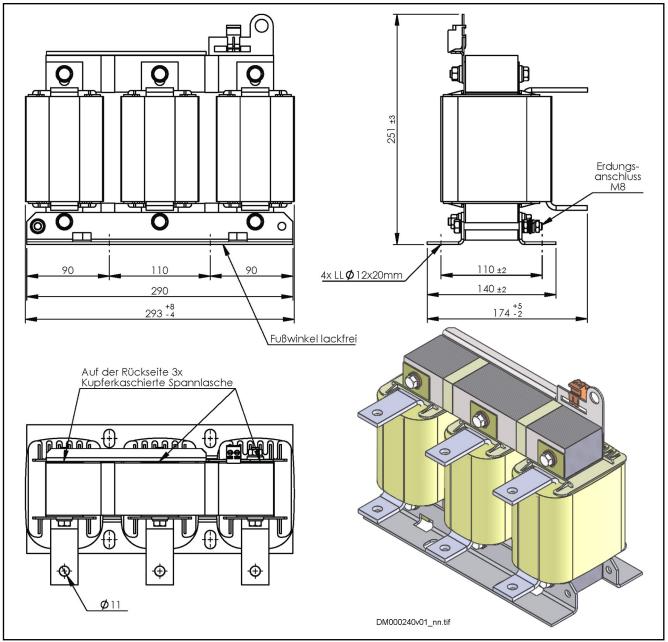


Fig. 8-34: HNL05.1R-0045-N0327

HNL05.1R-0135-N0327

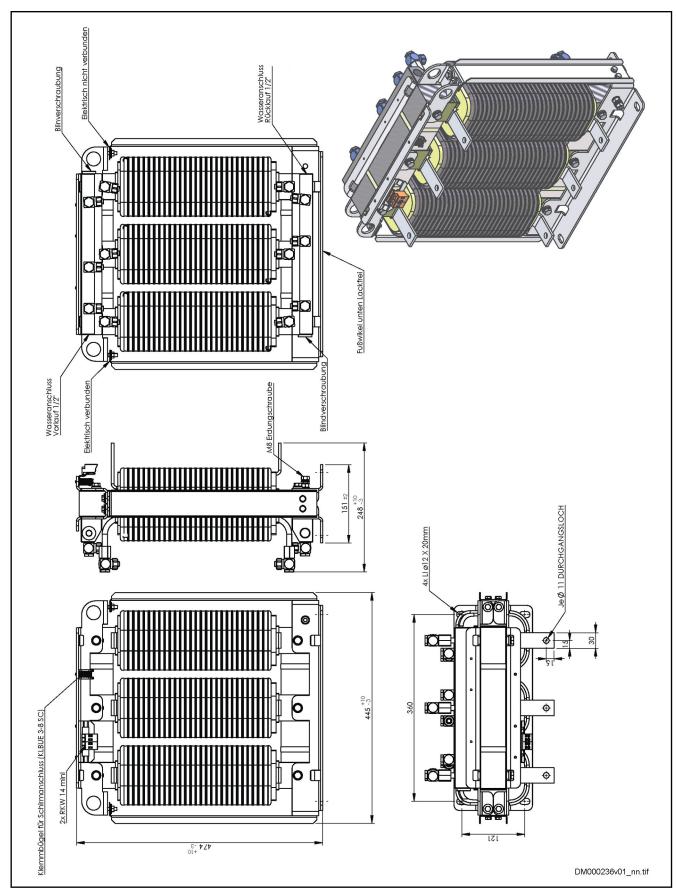


Fig. 8-35: HNL05.1R-0135-N0327

HNL05.1R-0117-N0409

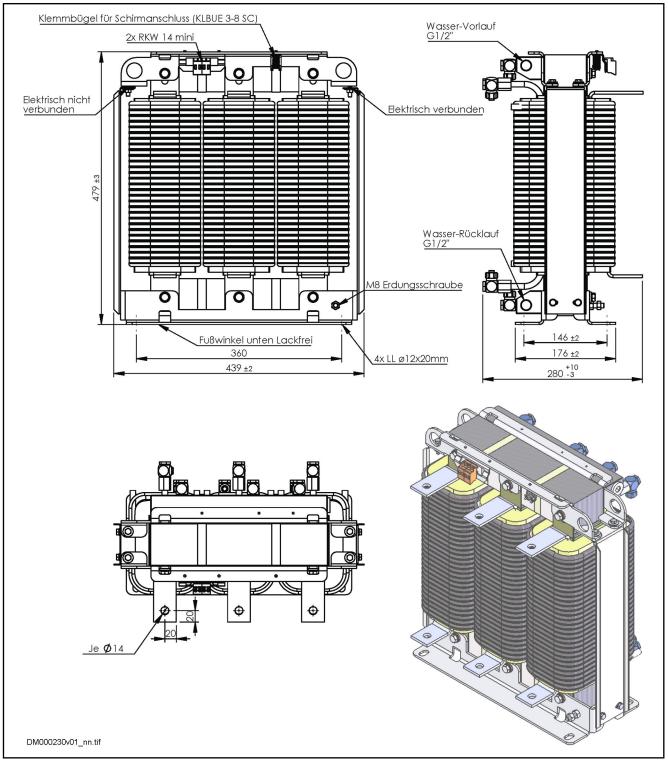


Fig. 8-36: HNL05.1R-0117-N0409

HNL05.1R-0054-N0409

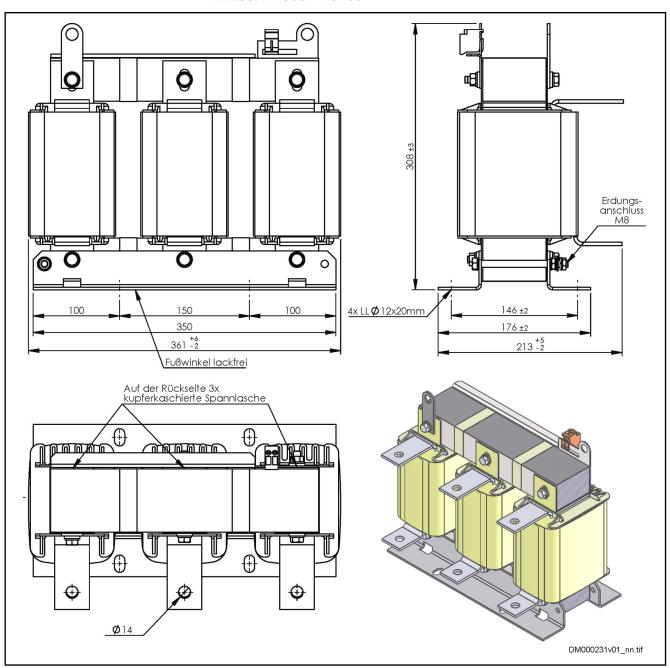


Fig. 8-37: HNL05.1R-0054-N0409

HNL05.1R-0130-N0514

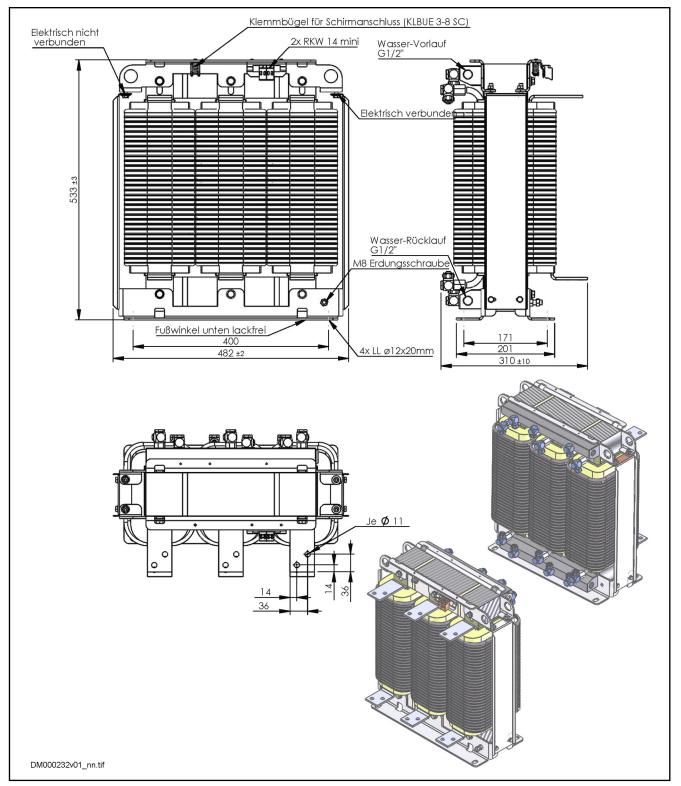


Fig. 8-38: HNL05.1R-0130-N0514

HNL05.1R-0043-N0514

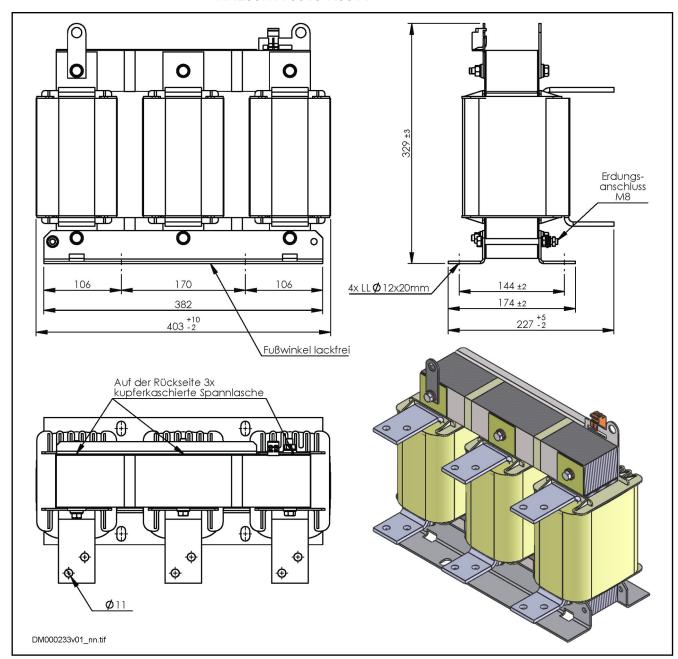


Fig. 8-39: HNL05.1R-0043-N0514

HNL05.1R-0050-N0652

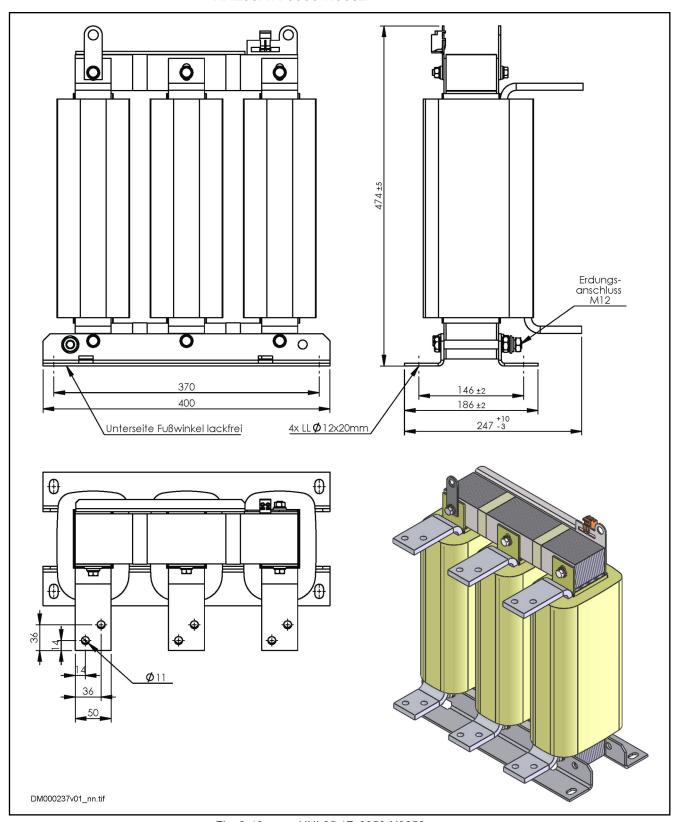


Fig. 8-40: HNL05.1R-0050-N0652

HNL05.1R-0113-N0652

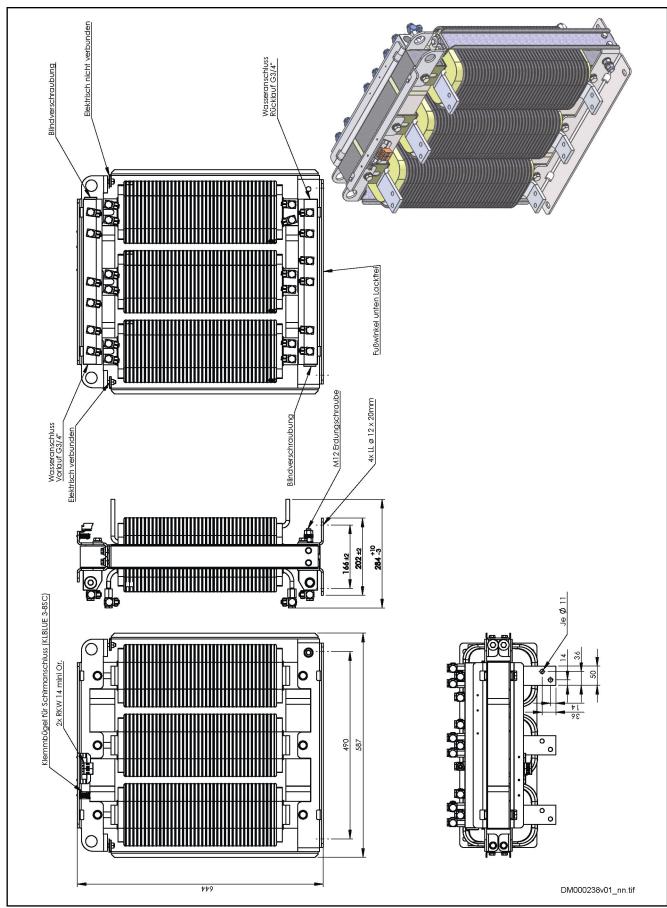


Fig. 8-41: HNL05.1R-0113-N0652

HNL05.1R-0040-N0811

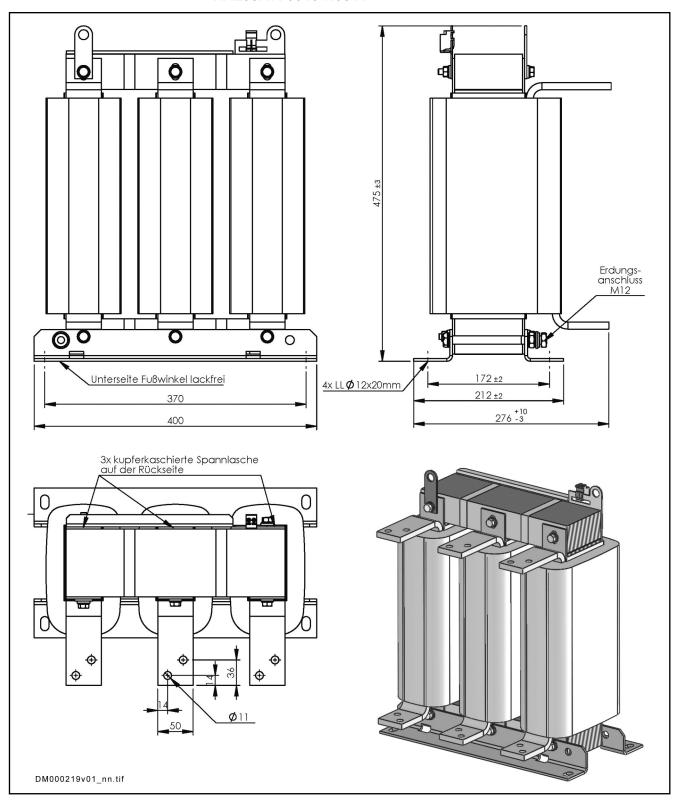


Fig. 8-42: HNL05.1R-0040-N0811

HNL05.1R-0100-N0811

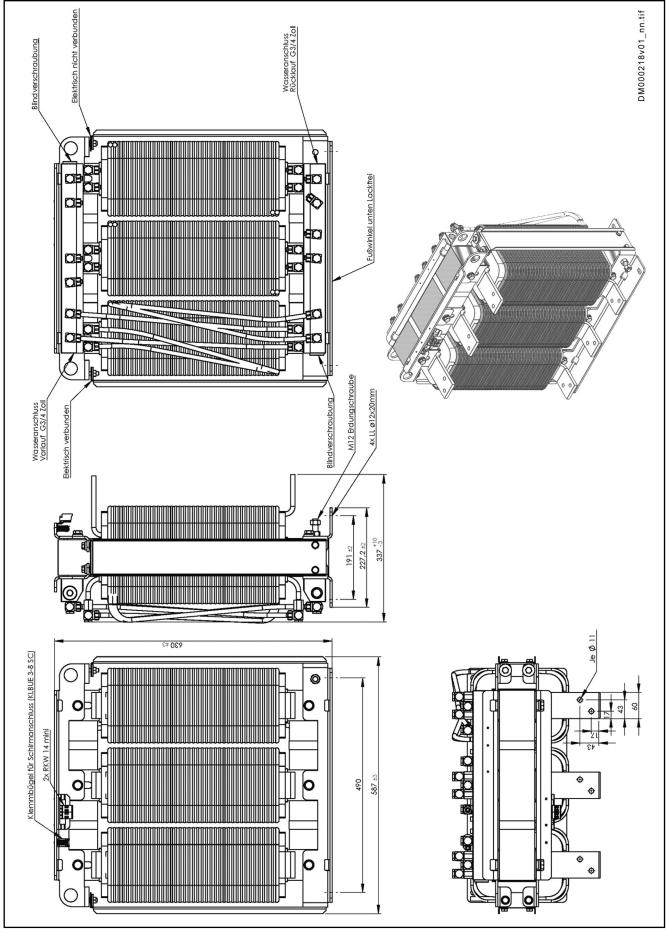


Fig. 8-43: HNL05.1R-0100-N0811

HNL05.1R-0040-N1019

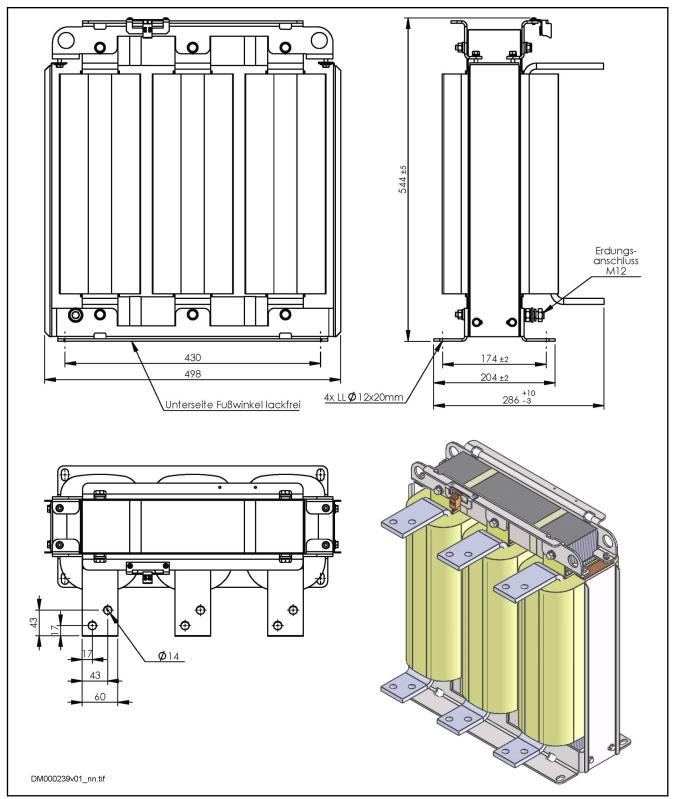


Fig. 8-44: HNL05.1R-0040-N1019

HNL05.1R-0094-N1019

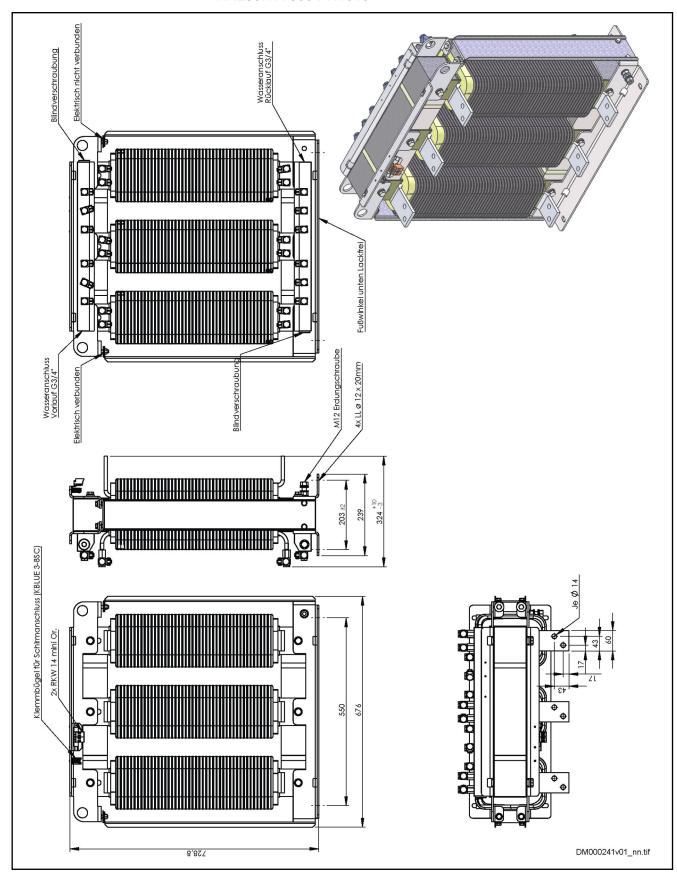


Fig. 8-45: HNL05.1R-0094-N1019

Data

Choke HNL05.1R	Inductance [µH]	Nominal cur- rent [A]	Power dissipation [W]	Protection class	Max. ambient temperature [°C]	Weight [kg]
0219-N0218	219	218	1662	IP00	40	tbd
0182-N0262	182	262	1700	IP00	40	tbd
0045-N0327	45	327	213	IP00	40	25
0135-N0327	135	327	1931	IP00	40	tbd
0054-N0409	54	409	315	IP00	40	40
0117-N0409	117	409	2140	IP00	40	83
0043-N0514	43	514	363	IP00	40	48
0130-N0514	130	514	2694	IP00	40	118
0050-N0652	50	652	513	IP00	40	56
0113-N0652	113	652	3059	IP00	40	tbd
0040-N0811	40	811	568	IP00	40	90
0100-N0811	100	811	3340	IP00	40	180
0040-N1019	40	1019	tbd	IP00	40	115
0094-N1019	94	1019	tbd	IP00	40	tbd

Tab. 8-33: HNL05.1R, data

Assignment to HMU05

See chapter "Combining mains filter, mains choke, restrictor and capacitance pack" on page 93.

8.3.5 HML05 motor choke/balancing choke

Type code HML05

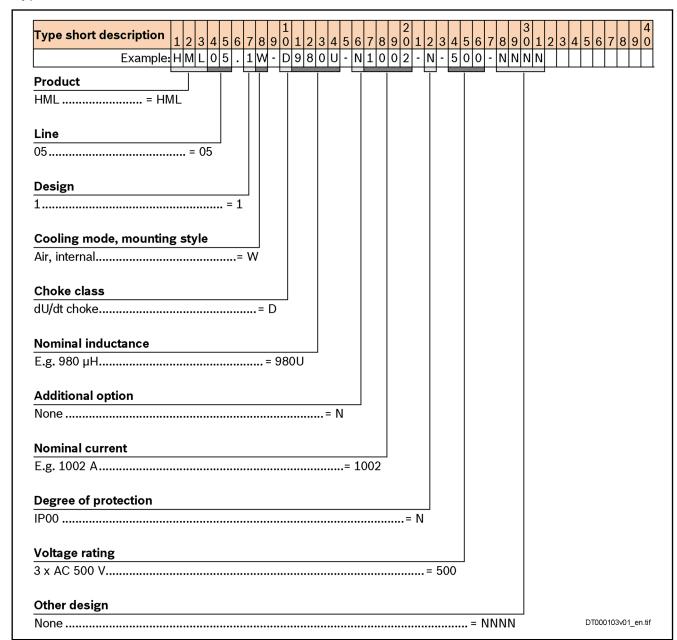


Fig. 8-46: Type code HML05

HML05 to HMU05 assignment

Balancing chokes are necessary if a higher output drive controller is formed using multiple HMUs that can be connected in parallel. One balancing choke per HMU motor output.

HMU05.1N	HML05.1W
F0120-0290-N-A4-D7-PNNNN	tbd
F0140-0350-N-A4-D7-PNNNN	tbd
F0170-0430-N-A4-D7-PNNNN	tbd
F0220-0510-N-A4-D7-PNNNN	tbd
F0270-0660-N-A4-D7-PNNNN	tbd
F0340-0820-N-A4-D7-PNNNN	D009U-N0616-N-500-NNNN
F0430-1040-N-A4-D7-PNNNN	D007U-N0771-N-500-NNNN
F0540-1300-N-A4-D7-PNNNN	D006U-N1002-N-500-NNNN
F0680-1690-N-A4-D7-PNNNN	D004U-N1185-N-500-NNNN

Tab. 8-34: HML05 ↔ HMU05 assignment

Dimensions

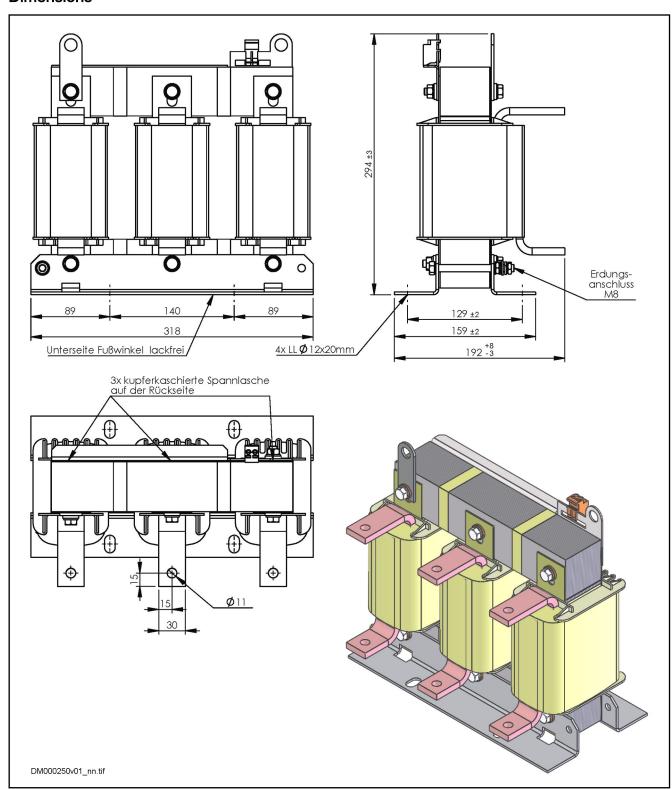


Fig. 8-47: HML05.1W-D009U-N0616-N-500-NNNN, dimensions

Data

Description	Unit	Value
Relative u _k	%	0.8
Inductance	μH	3 x 9
Working point 1 frequency	Hz	400
Working point 1 nominal current	A	546
Working point 2 frequency	Hz	200
Working point 2 nominal current	A	616
Voltage	V	3 x 500
Power dissipation	W	≤ 300
Appliance class		Class I
Protection class		IP00
Weight	kg	tbd

Tab. 8-35: HML05.1W-D009U-N0616-N-500-NNNN, data

8.3.6 HLL05 DC bus choke

Type code HLL05

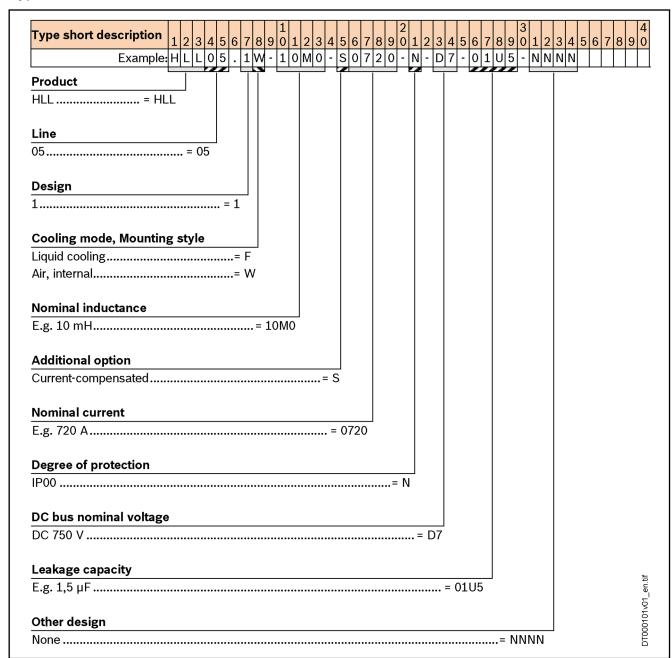


Fig. 8-48: Type code HLL05

Bosch Rexroth AG

Sizing

An HLL DC bus choke is always necessary when the leakage capacitance of the overall system incl. cable and motor capacitance is greater than **500 nF**.

The DC bus choke is sized according to the DC bus current in each drive train.

The lowest DC bus voltage V_{DCmin} that occurs is always used to determine the DC bus current I_{DC} :

$$\mathsf{I}_{\mathsf{DC}} = \mathsf{P}_{\mathsf{DC}} \div \mathsf{V}_{\mathsf{DCmin}}$$

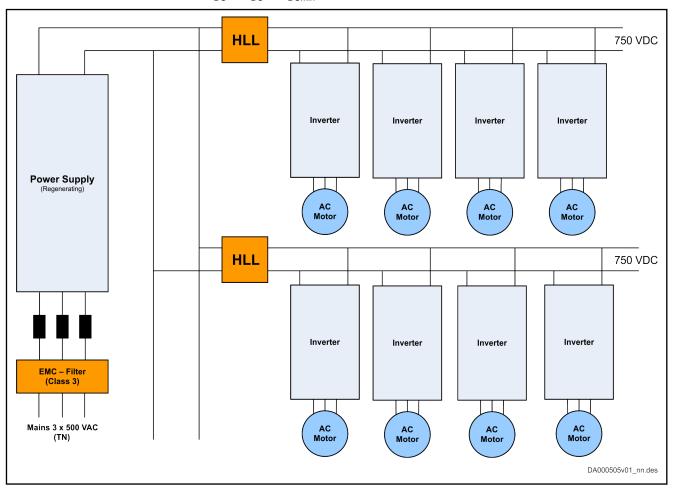


Fig. 8-49: Overall system with HLL DC bus choke

图

HLL is always necessary when IndraDrive M (HMS01, HMD01) components are connected to the DC bus.

Dimensions

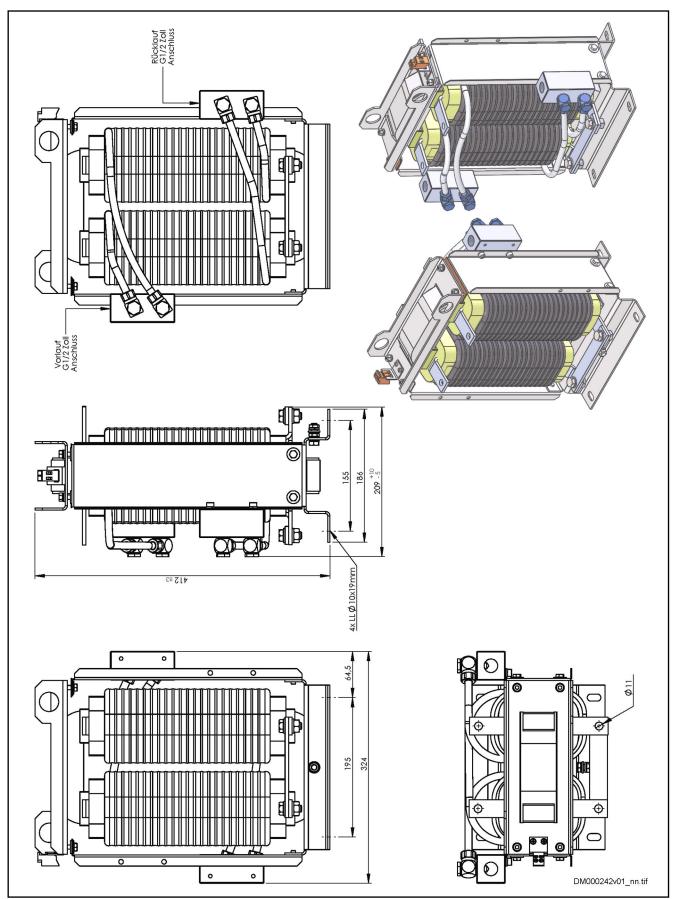


Fig. 8-50: HLL05.1F-04M0-S0202

210/277

Cables, accessories, additional components

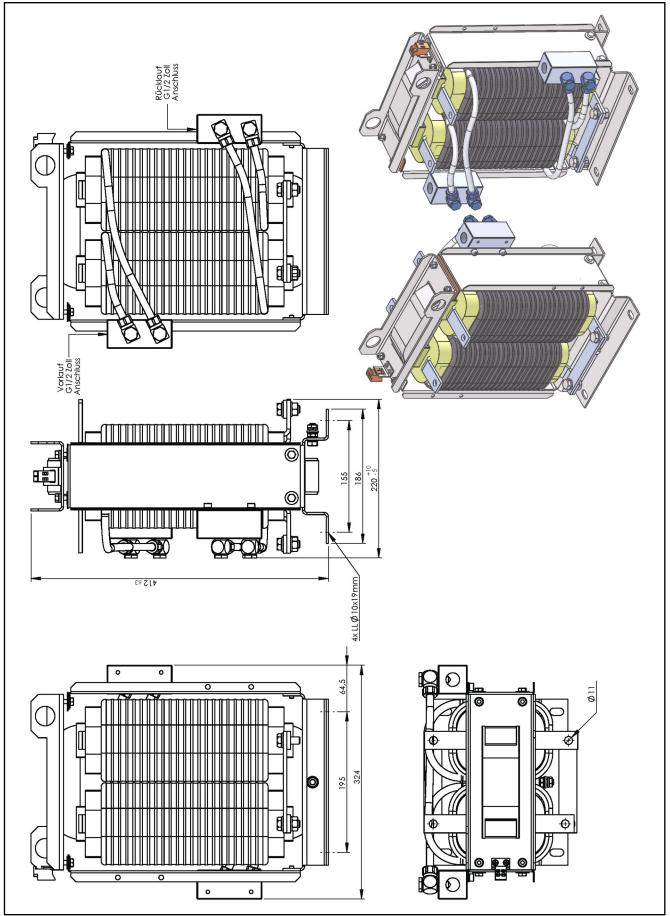


Fig. 8-51: HLL05.1F-04M0-S0243

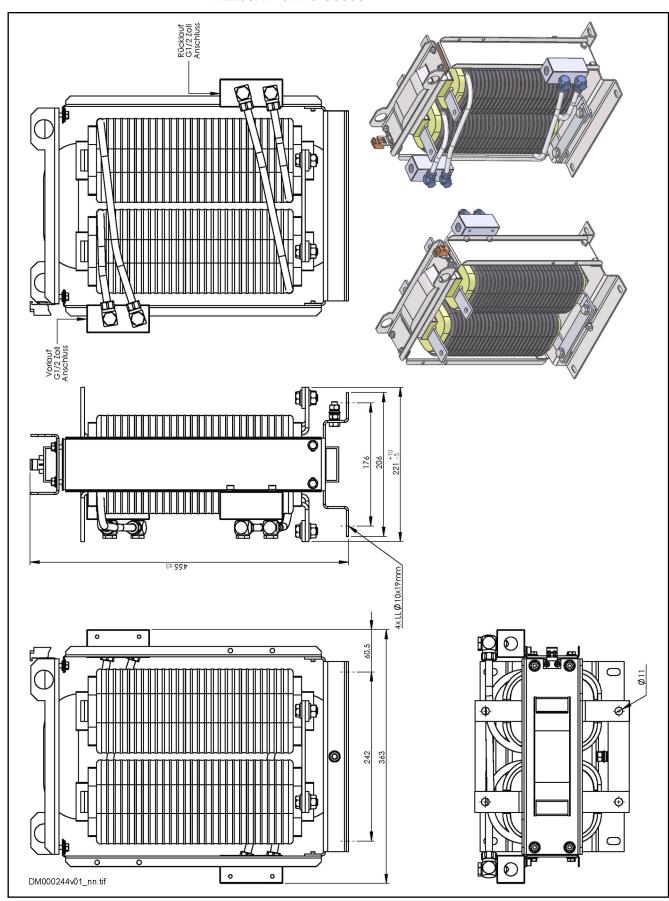


Fig. 8-52: HLL05.1F-04M0-S0303

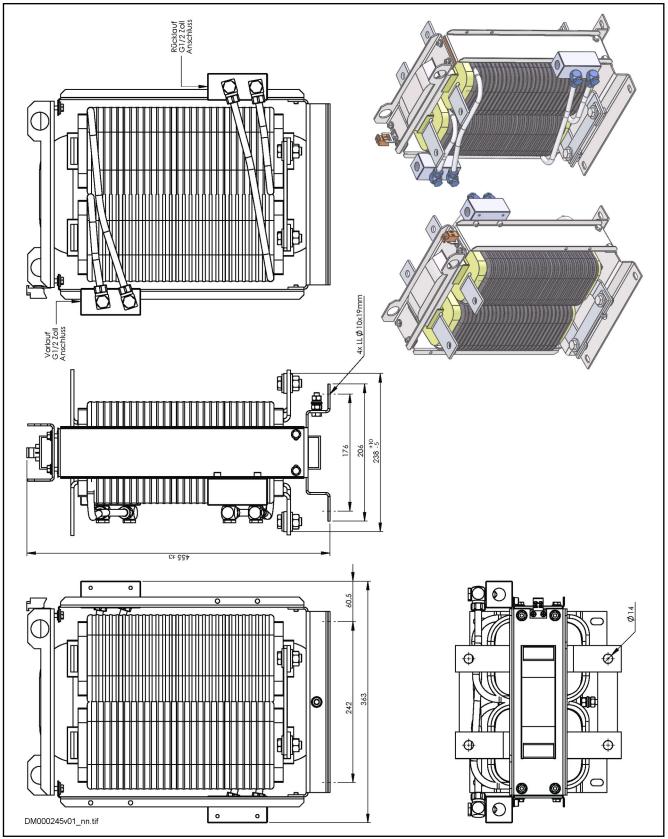


Fig. 8-53: HLL05.1F-04M0-S0380

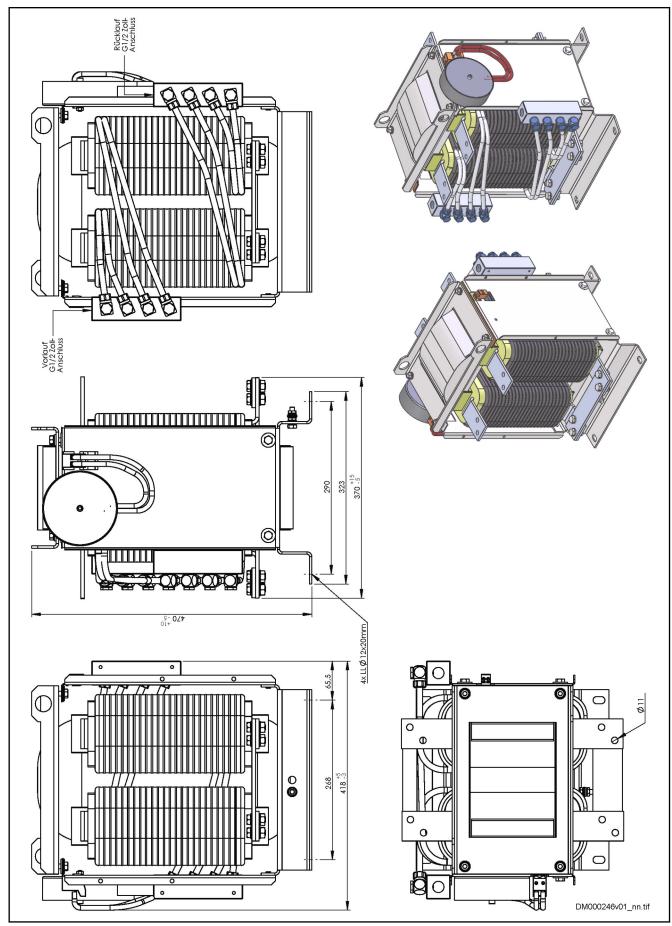


Fig. 8-54: HLL05.1F-04M0-S0475

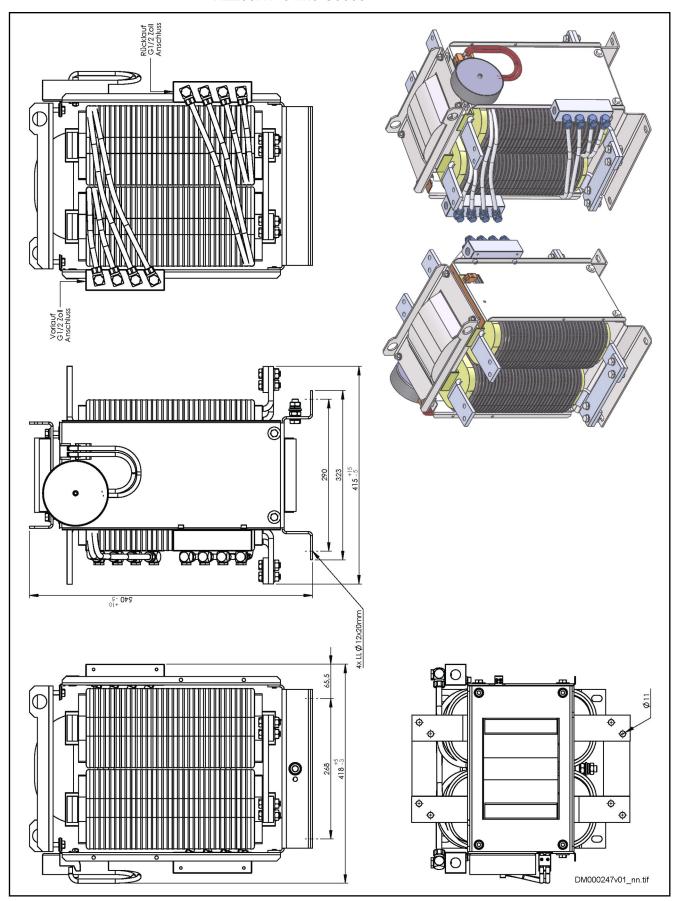


Fig. 8-55: HLL05.1F-04M0-S0603

HLL05.1F-04M0-S0720

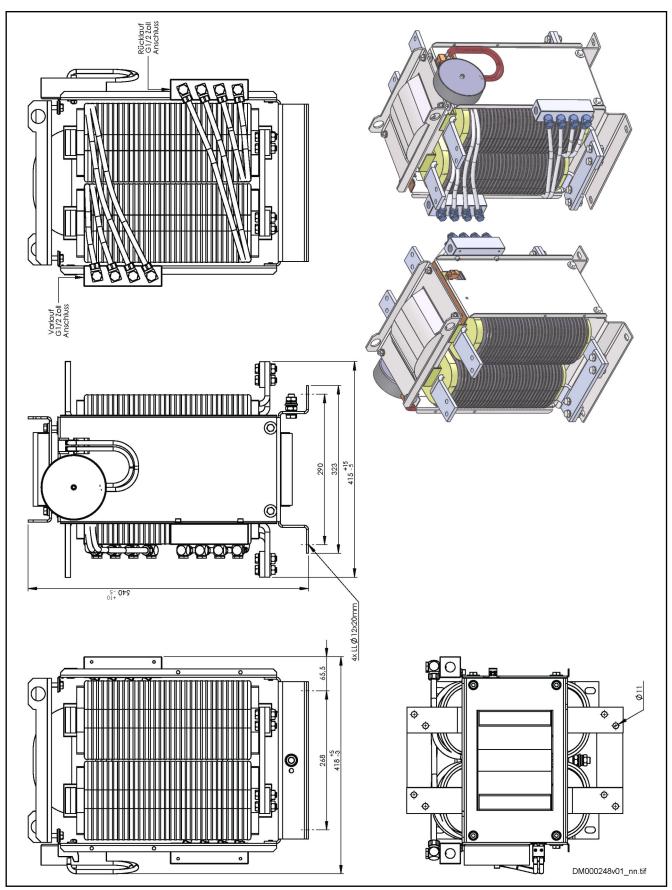


Fig. 8-56: HLL05.1F-04M0-S0720

HLL05.1F-04M0-S0942

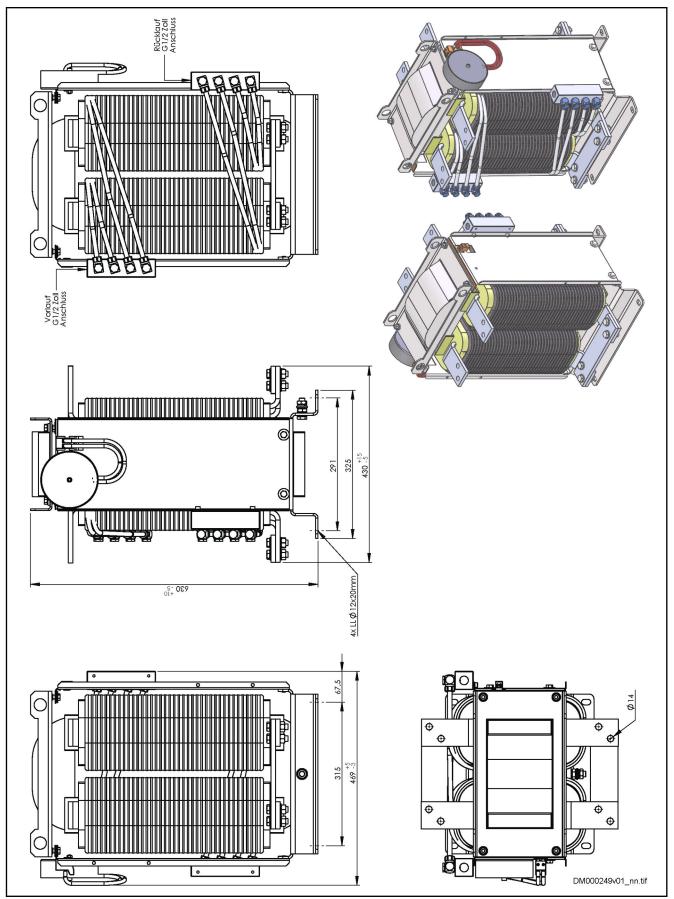


Fig. 8-57: HLL05.1F-04M0-S0942

Data

Choke HLL05.1F-04M0	Inductance [mH]	Nominal current [A]	Power dissipation [W]	Protection class	Max. ambient temperature [°C]	Weight [kg]
S0202	4	202	460	IP00	40	tbd
S0243	4	243	476	IP00	40	tbd
S0303	4	303	529	IP00	40	25
S0380	4	380	646	IP00	40	tbd
S0475	4	475	840	IP00	40	40
S0603	4	603	1047	IP00	40	83
S0720	4	720	1066	IP00	40	48
S0942	4	942	tbd	IP00	40	118

Tab. 8-36: HLL05.1F, data

Rexroth IndraDrive ML Drive systems with HMU05

Cables, accessories, additional components

8.3.7 HLR05 external braking resistor

Type code HLR05

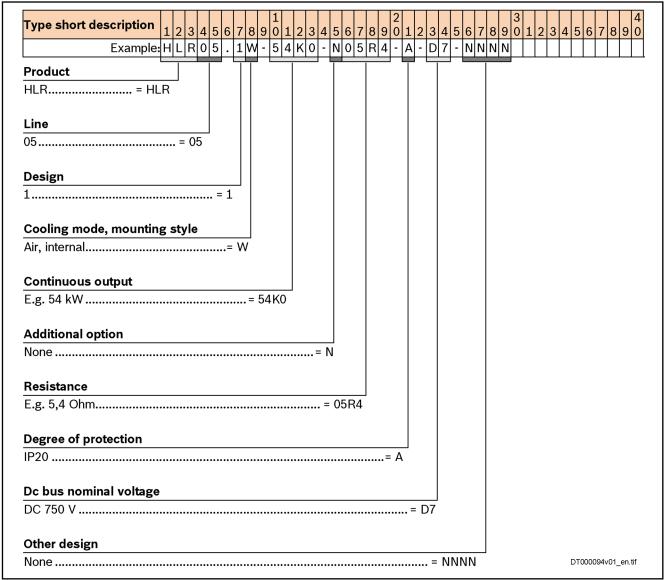


Fig. 8-58: Type code HLR05

Dimensions

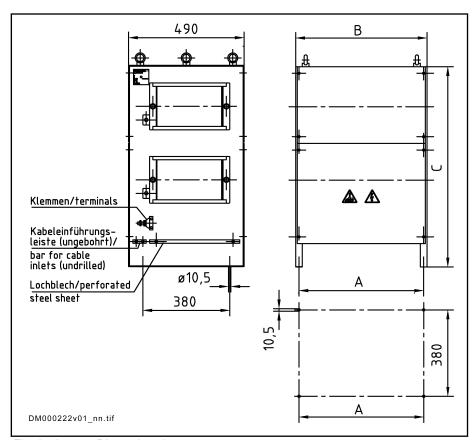


Fig. 8-59: Dimensions in mm

HLR05.1W	Α	В	С
54K0-N05R4-A-D7-NNNN	970	995	960

Tab. 8-37: HLR05.1W, dimensions

Data

Braking resistor HLR05.1W	Continuous power [kW]	Resistance [Ω]	Energy absorption [kWs]	Weight [kg]
54K0-N05R4-A-D7-NNNN	54	5.4	≤ 6500	126

Tab. 8-38: HLR05.1W, data

Installation

- Mounting position: upright on flat surfaces
 Do not mount on walls
- Keep min. 200 mm distance from adjacent parts and walls
- Ensure unhindered entry of cooling air
- Do not mount below fire alarm sensors
- Do not mount near flammable materials
 Surface temperatures can reach 200°C
- Cable:

Bosch Rexroth AG

- Minimum cross section: 26 mm²
- Length: ≤ 100 m
- Keep feeder and return cables as close together as possible or twist together
- Place cables away from signal and data lines
- Place so they are protected against short-circuiting and ground faults

8.3.8 HLT05 brake controller

Type code HLT05

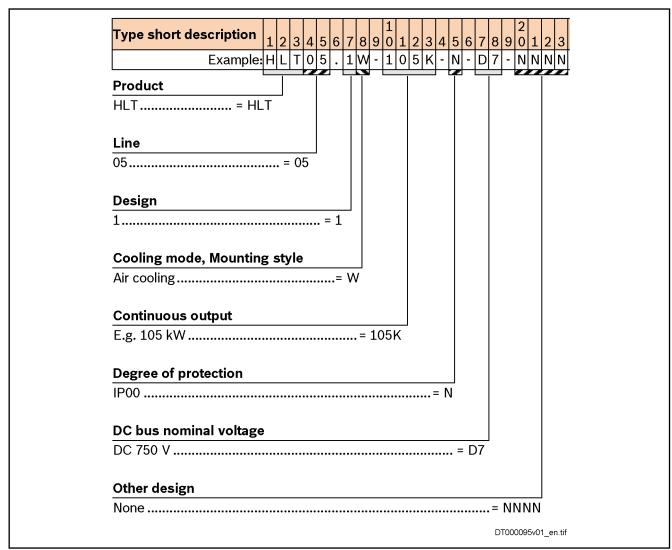


Fig. 8-60: Type code HLT05

Bosch Rexroth AG

Dimensions

HLT05, dimensional drawing

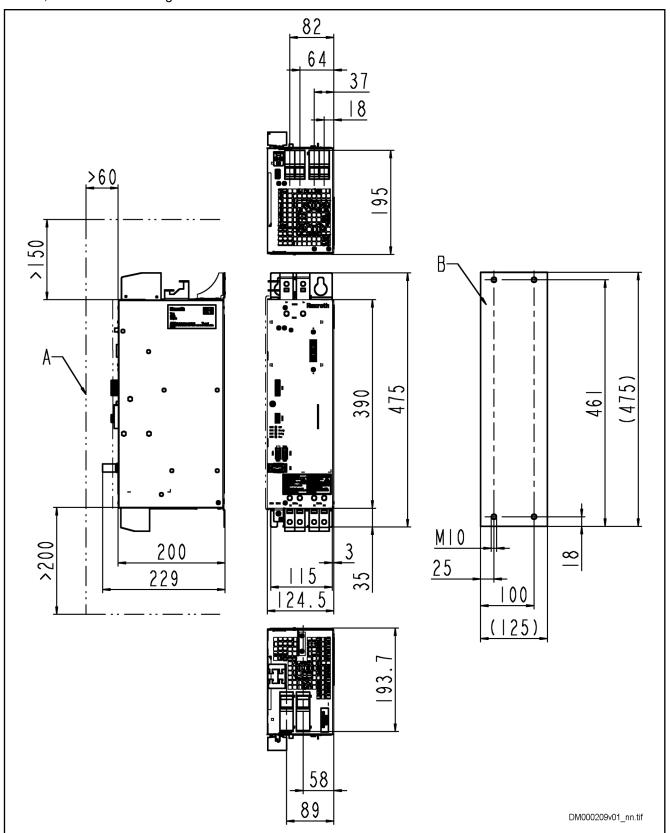
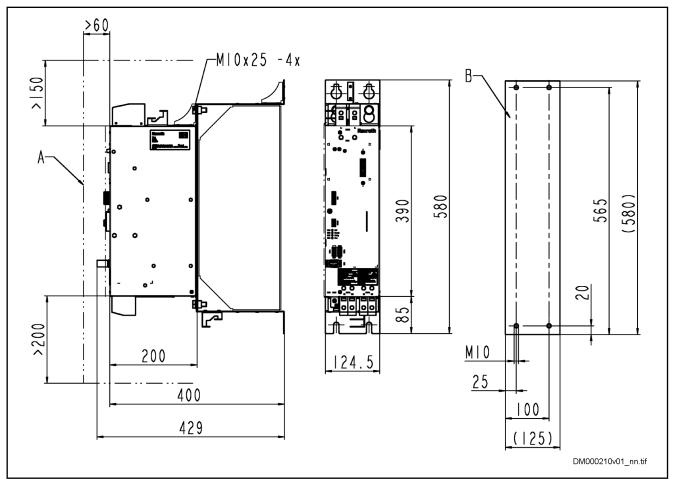


Fig. 8-61: HLT05, dimensional drawing

HLT05 with mounting plate (400 mm), dimensional drawing



M10x25

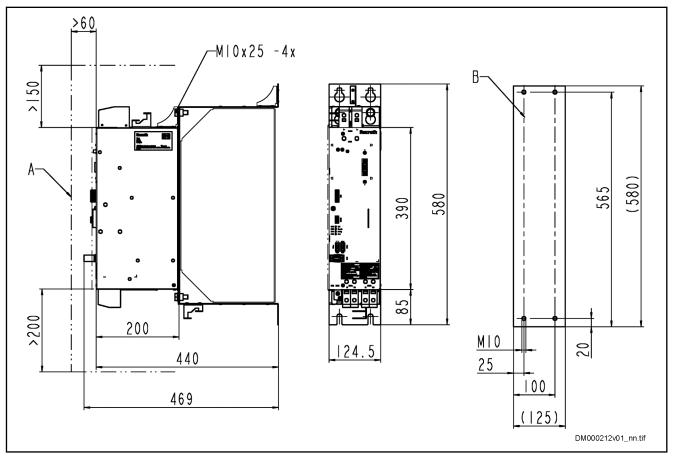
Tightening torque = 40 Nm

Fig. 8-62:

HLT05 with HAS03.1-006 mounting plate for height leveling and depth leveling to 400 mm depth, dimensional drawing

Bosch Rexroth AG

HLT05 with mounting plate (440 mm), dimensional drawing



M10x25

Tightening torque = 40 Nm

Fig. 8-63:

HLT05 with HAS03.1-007 mounting plate for height leveling and depth leveling to 440 mm depth, dimensional drawing

Data

Description	Symbol	Unit	Value
Continuous power	P _{BD}	kW	105
Short time power (60 s)	P _{BK}	kW	145
Peak power (2 s)	P _{BS}	kW	205
Balancing factor for P _{BD} (for parallel operation on common DC bus)	f		0.95
Min. braking transistor switch-on threshold	V _{HLT_On_min}	V	820
Max. braking transistor switch-on threshold	V _{HLT_On_max}	V	850
Workload-based delay of braking transistor switch-on threshold	$V_{HLT_On_d}$	V	30
Emergency comparator switch-on voltage	V_{Emg}	V	890
Max. input voltage	V _{max}	V	900
Continuous current for DC connection points	I _{nom}	А	200
Power dissipation (full load)	P _{Diss_max}	W	600
Power dissipation (standby)	P _{Diss_min}	W	20
Control voltage input	V _{N3}	V	24
Control voltage input current	I _{N3}	mA	300
Weight	m	kg	7.5

Tab. 8-39: HLT05.1W-105K-N-D7-NNNN, data

Connection diagram

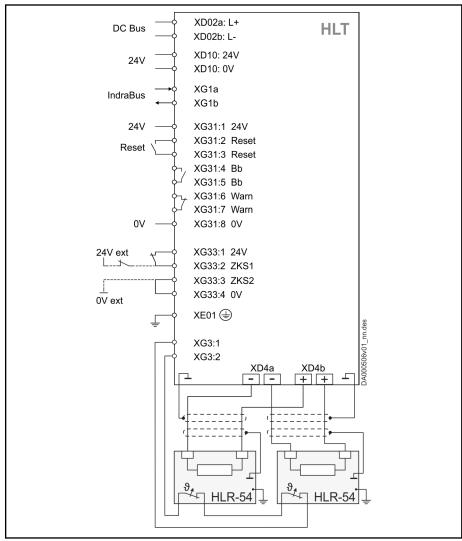
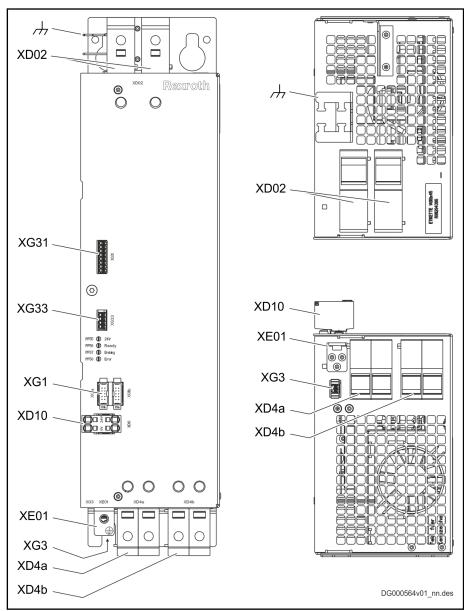


Fig. 8-64: HLT05 connection diagram

Connection points

Overview



XD02 DC bus (L+, L-)
XD4a Braking resistor
XD4b Braking resistor

XD10 Control voltage (0 V, 24 V)
XE01 Equipment grounding conductor

XG1 IndraBus

XG3 Braking resistor over-temperature signal contact (N/C contact)
XG31 Signal contact (ready, warning) and reset input for resetting

error messages

XG33 DC bus short-circuit function *Fig. 8-65: HLT05 connection points*

XE01, equipment grounding conductor connection point

⚠ WARNING Fatal 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.

REP.

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	Α
16 mm² < A ≤ 35 mm²	16
35 mm² < A	A / 2

Tab. 8-40: Equipment grounding conductor cross section

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

Tab. 8-41: Equipment grounding conductor connection point

XD02, DC bus

Function, pin assignment

The DC bus is connected through the connection point XD02.

A WARNING

Fatal 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.

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

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

Secure the DC bus connections against being touched.

View	Connec- tion	Signal name	Function
	XD02a	L+	Plus pole DC bus voltage
DG000570v01_nn.tif	XD02b	L-	Minus pole DC bus voltage

Tab. 8-42: XD02, DC bus

Mechanical data

Screw connection	Unit	Min.	Max.
Connection cable	mm ²	85	95
	AWG	3/0	4/0
Stripped length	mm	27	
Tightening torque (M8)	Nm	15	20

Tab. 8-43: Mechanical data

Rexroth IndraDrive ML Drive systems with HMU05

Cables, accessories, additional components

	Unit	Min.	Max.
Nominal voltage as per UL 1059	V	-	600
Nominal current as per UL 1059	Α	-	230

Tab. 8-44: Electrical data

XD04, braking resistor

Function, pin assignment Braking resistors are connected to the connection point XD04.

View	Connec- tion	Signal name	Function
	XD04a	E	Braking resistor
	XD04b	E	Braking resistor

Tab. 8-45: XD04, braking resistor

Mechanical data

Screw connection	Unit	Min.	Max.
Connection cable	mm ²	10	50
	AWG	6	1/0
Stripped length	mm	24	
Tightening torque (M6)	Nm	4	8

Tab. 8-46: Mechanical data

	Unit	Min.	Max.
Nominal voltage as per UL 1059	V	-	600
Nominal current as per UL 1059	Α	-	145

Tab. 8-47: Electrical data

232/277

Cables, accessories, additional components

XD10, 24 V supply (control voltage)

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

View	Connec- tion	Signal name	Function
	24 V	+24 V	Power supply
		+24 V	
	0 V	0 V	Reference potential for pow-
		0 V	er supply

Tab. 8-48: XD10, 24 V supply

Mechanical data

Screw connection at connector	Unit	Min.	Max.
Connection cable	mm ²	1	10
Solid wire			
Connection cable	mm²	1	6
Stranded wire without ferrule	AWG	16	10
Connection cable	mm ²	1	4
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-49: Mechanical data

	Unit	Min.	Max.
Voltage	V	-	60
Current	Α	-	1

Tab. 8-50: Electrical data

XG1, IndraBus

View	Connec- tion	Function
	XG1a	Connects parallel components through a ribbon cable.
	XG1b	Output for quickly reporting critical errors to other devi- ces
		Input for detecting critical errors from other devices
		Blocking and releasing DC bus short-circuit by a brake resistance unit
		Reporting DC bus availability
		Cable
		Unshielded length: < 3 m
		Cable designation: RKB0036
		Shielded length: < 100 m
		Cable designation: RKB0035

Tab. 8-51: XG1, IndraBus

XG3, braking resistor over-temperature signal contact Pin assignment

View	Connec- tion	I/O	Function (N/C contact)
	1	Α	Relay contact supply voltage
	2	Е	Digital input of relay contact

Tab. 8-52: XG3, braking resistor signal contact

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm ²	0.2	1.5
Stranded wire without ferrule	AWG	24	16
Connection cable	mm²	0.25	0.75
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-53: Mechanical data

	Unit	Min.	Max.	
Digital outputs	-	Digital outputs correspon	d 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		
Ready and warning contact	-	Digital inputs correspond	d to IEC 61131-2 Type 1	
Switching voltage	V _{DC}	30		
Continuous current	А		1	
Switching current	Α		5	
Load current	mA	10		
Switching cycles	-	3 × 10 ⁵		

Tab. 8-54: Electrical data

XG31, signal contact (ready, warning) and reset input Pin assignment

View	Connec- tion	I/O	Function
	1	E	Supply voltage for inputs/outputs
	2	E	Reset input to reset error messages
	3	-	n. c.
	4	Α	Isolated ready contact (N/O)
	5		
	6	А	Isolated warning contact (N/C)
	7		
	8	E	Reference potential for supply voltage

Tab. 8-55: XG31, messages

Mechanical data

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm ²	0.2	1.5
Stranded wire without ferrule	AWG	24	16
Connection cable	mm²	0.25	0.75
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-56: Mechanical data

	Unit	Min.	Max.	
Digital outputs	-	Digital outputs 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		
Ready and warning contact	-	Digital inputs correspond	d to IEC 61131-2 Type 1	
Switching voltage	V _{DC}	30		
Continuous current	А		1	
Switching current	А		5	
Load current	mA	10		
Switching cycles	-	3 × 10 ⁵		

Tab. 8-57: Electrical data

XG33, DC bus short-circuit

View	Connec- tion	I/O	Function
	1	Α	DC bus short-circuit input supply voltage
	2	E	DC bus short-circuit 1 – positive connection for controlling DC bus short-circuit function
	3	Е	DC bus short-circuit 2 – negative connection for controlling DC bus short-circuit function
	4	Α	Reference potential for supply voltage

Tab. 8-58: 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	mm ²	0.2	1.5
Stranded wire without ferrule	AWG	24	16
Connection cable	mm²	0.25	0.75
Stranded wire with ferrule			
Stripped length	mm	10	

Tab. 8-59: Mechanical data

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

Tab. 8-60: Electrical data

Display elements

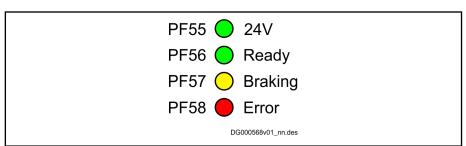


Fig. 8-66: LEDs on HLT05

LED	Color/status		Meaning
PF55	*	Green	24 V power supply applied
	0	Off	24 V power supply < 19.2 V
PF56	*	Green	Ready
	0	Off	Not ready
PF57	*	Yellow	Active
	0	Off	Inactive
PF58	*	Red	Error
		Flashing red	Warning
	0	Off	No error, no warning

Tab. 8-61: HLT05 LED displays

8.3.9 HAH01 heat exchanger

Type code HAH01

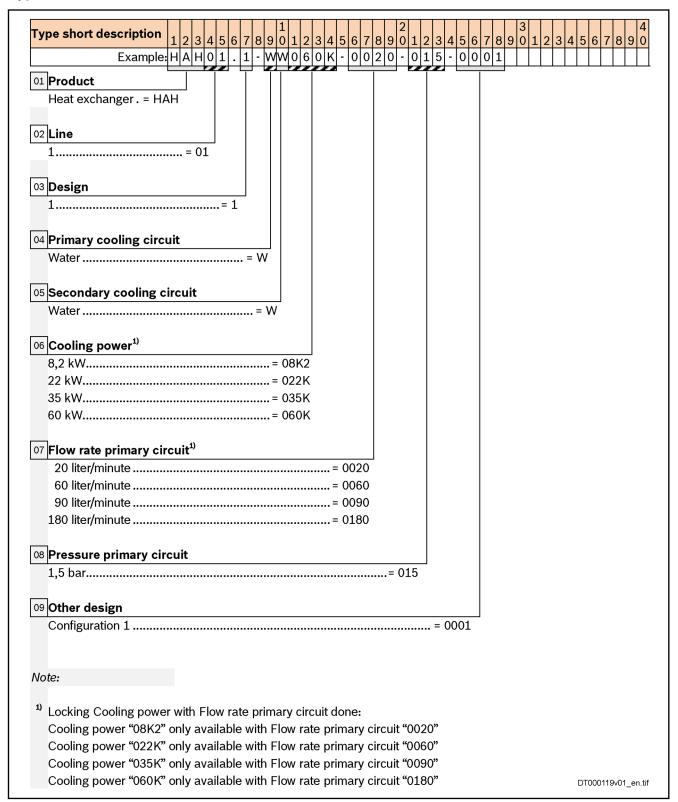
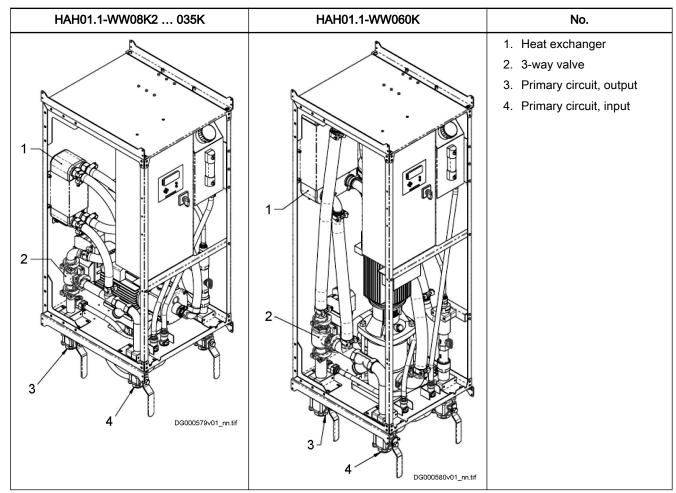


Fig. 8-67: Type code HAH01

Water-water heat exchanger



Tab. 8-62: HAH01 water-water heat exchanger

Data

		HAH01.1-WW				
Description	Unit	08K2	022K	035K	060K	
Continuous power dissipation at primary supply temperature of 40°C	kW	8	22	35	60	
Max. flow rate (secondary circuit) at 1.5 bar	l/min	20	60	90	180	
Max. flow rate (primary circuit)	l/min	40	100	150	300	
Max. supply water temperature (secondary circuit)	°C		5	0		
Max. return water temperature (secondary circuit)	°C		6	0		
Max. operating pressure (primary circuit)	bar		!	5		
Max. operating pressure (secondary circuit)	bar	5				
Coolant (secondary circuit)		75% water/25% glycol (e.g., Antifrogen)				
Max. supply water temperature (primary circuit)	°C	50				
Protection class		IP21				
Ambient temperature	°C	5 to 40				
Service life of pump	h		≥ 30	0000		
Supply voltage for pump	V, Hz		400 V, 50) to 60 Hz		
Power dissipation	kW	0.55	0.75	1.5	2.2	
Materials used in secondary circuit			Aluminum, stain	less steel, plastic	;	
Materials used in primary circuit			Stainle	ss steel		
Leakage test pressure (primary and secondary circuit)	bar	10				
Reservoir	1	2				
Tank	1	10				
Connection		G1", female G1-1/2", fema				
Weight	kg	85 90 150				
Dimensions	mm WxDxH	512×592×1258 512×592×168				

Tab. 8-63: HAH01, data

Environmental protection and disposal

9 Environmental protection and disposal

9.1 Environmental protection

Production processes

The products are made with energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

No release of hazardous substan-

ces

Our products do not contain any hazardous substances which may be released in the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

Significant components

Basically, our products contain the following components:

Electronic devices	Motors		
• steel	steel		
aluminum	 aluminum 		
• copper	copper		
 synthetic materials 	brass		

electronic components and modules
 magnetic materials

electronic components and modules

9.2 Disposal

Return of products

Our products can be returned to our premises free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

Furthermore, the products returned for disposal must not contain any undue foreign material or foreign components.

Send the products "free domicile" to the following address:

Bosch Rexroth AG Electric Drives and Controls Buergermeister-Dr.-Nebel-Strasse 2 97816 Lohr am Main, Germany

Packaging

The packaging materials consist of cardboard, wood and polystyrene. These materials can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.

The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people's health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be properly disposed of according to the country-specific collection.

Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual modules.

Environmental protection and disposal

Bosch Rexroth AG

Metals contained in electric and electronic modules can also be recycled by means of special separation processes.

Products made of plastics can contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the valid legal requirements.

Service and support

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 Dimensioning the line cross sections and fuses

Dimensioning the line cross sections and fuses in the supply feeder and branches to the drive system:

- 1. Determine current in supply feeder of drive system and correct it with correction factors for ambient temperature and bundling.
 - (In the technical data of the components in section "Data for Mains Voltage Supply", you can find standardized data for connection cross section and mains circuit breaker at operation under rated conditions.)
- Determine country of use ("international except for USA/Canada" or "USA/Canada")
- 3. Determine installation type (e.g. B1 or B2)
- 4. In table row "Current I", select value immediately above the value determined in the first step
- 5. In table row "Nominal current fuse", read corresponding fuse
- 6. In table row "Cross section A ...", read corresponding required cross section

Country of use: International except for USA/Canada						
Current I	Nominal current fuse	Cross section A				
		for installation type B1				
Α	A	mm²				
1.6	2	1,5				
3.3	4	Minimum cross section acc. to				
5.0	6	EN 60204-1:2006, table 5 (Main circuits; outside of hous-				
8.6	10	ings; permanently installed; sin-				
10.3	16	gle-core lines; stranded wire design class 2)				
13.5	16					
18.3	20	2.5				
22	25	4				
28	32	6				
31	40	6				
35	40	10				
44	50	10				
59	63	16				
77	80	25				
96	100	35				
117	125	50				
149	160	70				
180	200	95				

Country of use: International except for USA/Canada					
Current I	Nominal current fuse	Cross section A for installation type B1			
Α	A	mm²			
208	250	120			
227	250	150			
257	315	185			
301	355	240			
342	400	300			

 Tab. 11-1:
 Line Cross Sections and Fuses, B1 According to EN 60204-1:2006,

 Table 6, as of 150mm² DIN IEC 60364-5-52:2004, Table B.52-4

Country of use: International except for USA/Canada						
Current I	Nominal current fuse	Cross section A				
		for installation type B2				
Α	Α	mm²				
1.6	2	0,75				
3.3	4	Minimum cross section acc. to				
5.0	6	EN 60204-1:2006, table 5 (Main circuits; outside of hous-				
8.5	10	ings; permanently installed; mul- ti-core lines)				
10.1	16	1.0				
13.1	16	1.5				
17.4	20	2.5				
23	25	4				
28	32	6				
30	40	6				
35	40	10				
40	50	10				
54	63	16				
70	80	25				
86	100	35				
103	125	50				
130	160	70				
156	200	95				
179	200	120				
195	224	150				
221	250	185				

Country of use: International except for USA/Canada					
Current I Nominal current fuse Cross section A for installation type B2					
Α	Α	mm²			
258	315	240			
294	355	300			

Tab. 11-2: Line cross sections and fuses, B2 according to EN 60204-1:2006, table 6, as of 150mm² DIN IEC 60364-5-52:2004, table B.52-4

Country of use: International except for USA/Canada						
Current I	Nominal current fuse Cross section A					
		for installation type E				
Α	Α	mm ²				
1.6	2	0,75				
3.3	4	Minimum cross section acc. to EN 60204-1:2006, table 5				
5.0	6	(outside of housings; perma-				
8.3	10	nently installed; multi-core lines)				
10.4	16					
12.4	16	1				
16.1	20	1.5				
22	25	2.5				
28	32	4				
30	40	4				
37	40	6				
44	50	10				
52	63	10				
70	80	16				
88	100	25				
110	125	35				
133	160	50				
171	200	70				
207	250	95				
240	315	120				
277	355	150				
316	400	185				
374	425	240				
432	500	300				

Tab. 11-3: Line cross sections and fuses, E according to EN 60204-1:2006, table 6, as of 150mm² DIN IEC 60364-5-52:2004, table B.52-10

Country of use: USA/Canada						
Nominal current fuse	Cross section A					
Α	AWG					
2	14					
	Minimum cross section acc. to UL 508 A:2007, chapter 29.6					
4	14					
6	14					
10	14					
15	14					
20	14					
25	12					
40	10					
70	8					
80	6					
100	4					
110	3					
125	2					
150	1					
175	1/0					
200	2/0					
225	3/0					
250	4/0					
300	250 kcmil					
300	300 kcmil					
350	350 kcmil					
350	400 kcmil					
400	500 kcmil					
450	600 kcmil					
	A 2 4 6 10 15 20 25 40 70 80 100 110 125 150 175 200 225 250 300 350 350 350 400					

Tab. 11-4: Line cross sections and fuses according to UL508A:2007, table 28.1 Dimensioning variables of the table values

- 1. Ambient temperature T_A of routed lines \leq 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:

Bosch Rexroth AG

• 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 devi-

External wiring: Routing outside of control cabinet

Field wiring: Data of cross sections of terminal connectors wired by the user (in the field)

5. Recommendation for design of the fuses:

International except for USA/Canada:

- Fuse-link in accordance with IEC 60269-1, characteristic gG (fuses)
- Circuit breakers in accordance with IEC 60898-1/2, type B or C
- Circuit breakers in accordance with IEC 60947-2/6-2

USA / Canada:

Class J; 600 V

B

Correction factors

For deviating dimensioning variables, the corresponding standards specify correction factors.

Below you can find the correction factors for ambient temperature and numbers of routed lines and circuits. If necessary, multiply the determined current in the supply feeder with these factors.

Correction factor ambient temperature

Ambient temperature T _A / °C	30	35	40	45	50	55	60
Correction factor according to EN 60204-1:2006, table D.1	0.87	0.93	1.00	1.1	1.22	1.41	1.73
Correction factor according to NFPA 79:2007, table 12.5.5(a)	0.88	0.94	1.00	1.1	1.18	1.32	1.52

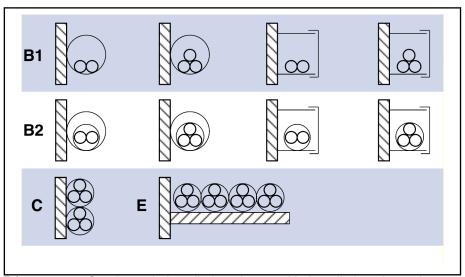
Tab. 11-5: Correction factor ambient temperature in accordance with EN 60204-1:2006 and NFPA 79:2007

Correction factor for bundling of lines (installation methods B2 and E) and circuits (installation method B1¹))

Number of lines	1	2	3	4	5
Correction factor according to EN 60204-1:2006, table D.2	1	1,25	1,43	1,54	1,67
Correction factor according to NFPA 79:2007, table 12.5.5(b)	1	1,25			

1) Three single cores (L1, L2, L3) for mains supply of a device are to be considered as one circuit.

Tab. 11-6: Correction factor for bundling of 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. 11-1: Installation methods (compare IEC 60364-5-52; VDE0298-7; EN

60204-1)

11.2 DC bus fuses

Bosch Rexroth AG

If lower output drive components (e.g., IndraDrive M or IndraDrive C) are also connected to the DC bus, the cross section must 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.

11.3 Determining leakage capacitance

The capacitances that generate "leakage currents" against ground at the inverter outputs are referred to as leakage capacitance C_{ab} . The authoritative values for the total value of leakage capacitance C_{ab} 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 q} Total value of leakage capacitance

 C_{ab_Mg} Total value of leakage capacitance of motor C_{ab_Kg} Total value of leakage capacitance of cable

Fig. 11-2: 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.

 $C_{\mathsf{ab_Mg}} = C_{\mathsf{ab(Motor_1)}} + C_{\mathsf{ab(Motor_2)}} \dots + C_{\mathsf{ab(Motor_n)}}$

C_{ab(motor)} Leakage capacitance of a motor Fig. 11-3: Total leakage capacitance of motor

 $C_{ab_Kg} \ = \ C_{Y_K \ typ \ (K1)} \ \times \ I_{(K1)} \ + \ C_{Y_K \ typ \ (K2)} \ \times \ I_{(K2)} \ \dots \ + \ C_{Y_K \ typ \ (Kn)} \ \times \ I_{(Kn)}$

C_{Y_K typ} Capacitance per unit length of cables
C_{ab_Kg} Total leakage capacitance of cables
Fig. 11-4: 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 for the power cables for these capacitances.

11.4 Leakage capacitances

Bosch Rexroth AG

11.4.1 Power cable leakage capacitances

The "RKL" series power cables (bulk cables) from Rexroth have the following capacitances per unit length. The values refer to the sum of the individual capacitances of power cores 1, 2 and 3 against the overall shield.

See also Rexroth Connection cables - bulk cables data sheet.

Excerpt of data sheet on bulk cables

Туре	Power core cross section	Leakage capacitance
	mm²	C _{Y_K_typ} nF/m
INK0653	1.0	0.6
INK0650	1.5	0.8
INK0602	2.5	0.7
INK0603	4.0	0.8
INK0604	6.0	0.8
INK0605	10.0	1.0
INK0606	16.0	1.2
INK0607	25.0	1.1
INK0667	35.0	1.2
INK0668	50.0	1.3
	•	Last modification: Nov. 8, 2007

Tab. 11-7: INK - technical data (excerpt)

Excerpt of data sheet on bulk cables

Туре	Power core cross section	Leakage capacitance $C_{Y_K_typ}$				
	mm²	nF/m				
REH0800	2.5	0.2				

Tab. 11-8: REH - technical data (excerpt)



The rough calculation with the following values is allowed:

- Cross section 1 to 6 mm²: 1 nF/m
- Cross section 10 to 50 mm²: 1.2 nF/m

11.5 THD

HMU05.1N	F0140	F0170	F0220	F0270	F0340	F0430	F0540	F0680
THD [%]	2.9	2.2	1.2	1.1	1.9	4.3	4.9	4.6

Tab. 11-9: THD

The indicated THD values apply for the following conditions:

System impedance	Chopper frequency	Output frequency	Operation
42 µH	4.2 kHz	100 Hz	Operation with nominal current at 400 V/50 Hz
X/R ≈ 10			
at RSC > 74			

Tab. 11-10: Conditions of THD values

11.6 Liquid cooling

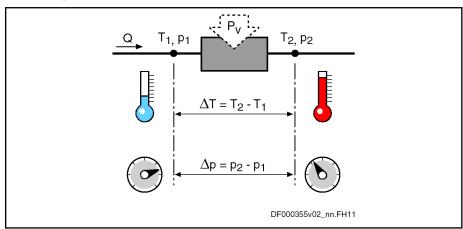
11.6.1 Sizing liquid cooling

Bosch Rexroth AG

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. 11-5: 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 I/min ΔV Coolant volume in I

 Δt Time interval in minutes in which ΔV flows

Fig. 11-6: 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. 11-7: Calculating the flow rate

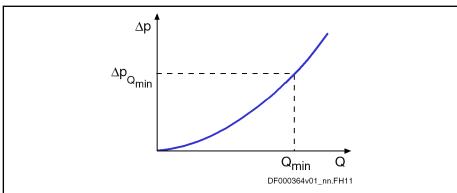
The flow rates are indicated in the technical data of the liquid-cooled components (referring to a fixed temperature increase of the coolant water). For any other temperature increase, calculate the flow rate using the above formula.

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

 \mathbf{Q}_{\min} Min. required flow rate (see technical data for each component)

Fig. 11-8: 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:

258/277

$$\Delta p = K_{\Delta p} \times Q^{1.75}$$

Δp K_{Δp} Pressure decrease

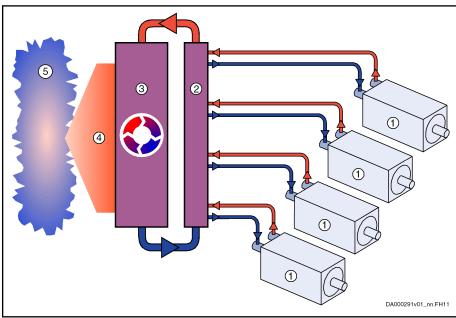
Constant (see technical data for each component)

Q Flow rate in I/min

Fig. 11-9: Pressure decrease vs. flow rate

Sizing aids

The following sizing aids are based on a cooling system with four motors connected in parallel.



Liquid-cooled motor

Main distributor of cooling liquid

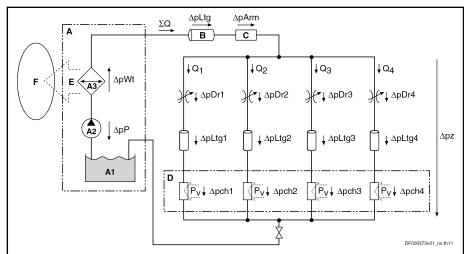
Cooling device (cooling or refrigerating unit)

2 3 4 Heat dissipation

5 Higher-level cooling medium

Fig. 11-10: Arrangement with liquid-cooled motors

Liquid cooling circuit diagram



Cooling device **A1** Coolant container **A2** Coolant pump А3 Heat exchanger В Coolant lines С **Fittings**

D Drive components being cooled

Ε Heat transfer

F Higher-level cooling medium

Q Flow rate

Pressure decrease (Ftg: fittings; Dc: drive components; Chk: Δр

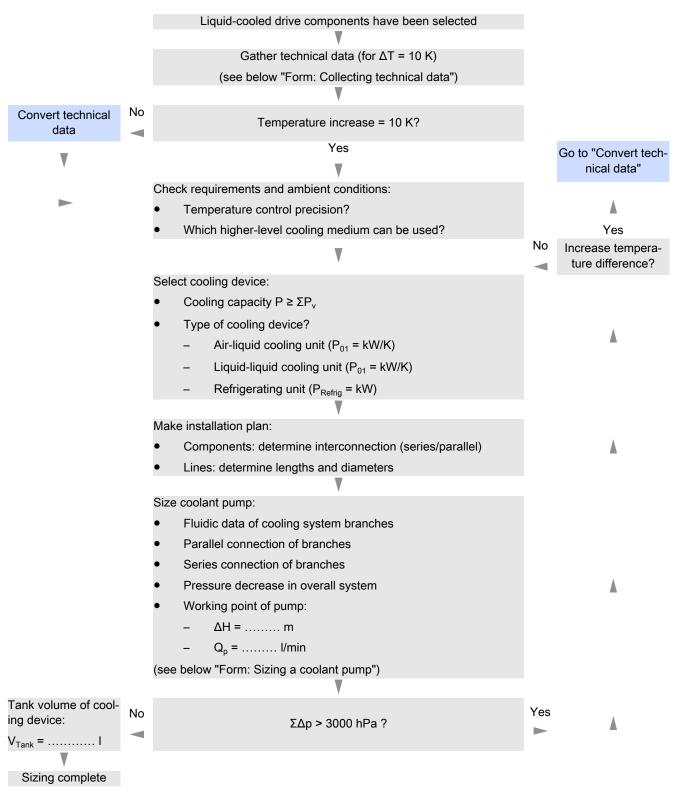
choke; L: line; P: coolant pump; He: heat exchanger)

 ΔP_{v} Power dissipation of a drive component being discharged

Fig. 11-11: Liquid cooling circuit diagram for four liquid-cooled drive components

260/277

Sizing a cooling system



Tab. 11-11: Sizing a cooling system

Form: Gathering technical data

Drive com- ponent	P _v [kW] Coolant	P _v [kW] Air	Q [l/min]	Δp [hPa]	ΔT [°C]	∨ [i]
	ΣP _{vCl}	ΣP _{vAir}				

Tab. 11-12: Gathering technical data

Form: Sizing a coolant pump

		ng a coolant pain	•						
Fluidic data of cooling sy	stem branches								
Cooling system branch	ooling system branch					3	4	5	
Drive component		Туре	designation						
	Flow rate	Q _{chn}	l/min					+ +	
Pressure decreases	Coolant line	Length I _n	m						
		Added length l _{add}	m						
		Ød	mm						
		$\Delta p_L/\Delta I$ for Q_{ch}	hPa/m						
		Δp_{Ln}	hPa	+	+	+	+	+	+
	Drive component	Δp_{chn}	hPa	+	+	+	+	+	+
	Additional component	Δp_{Add}	hPa	+	+	+	+	+	+
Total pressure de- crease:	Without choker valve	Δp_{Bn}	hPa	=	=	=	=	=	=
(Only with parallel connection)	With choker valve 1)	Δp_{Bn}	hPa	=	=	=	=	=	=
'						•	•		1
Parallel connection of br	anches no								
Total pressure de- crease		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				
				1	· · · · · · · · · · · · · · · · · · ·		
Series connection of b	ranches no						
Total pressure de- crease		$\Sigma\Delta p_{Bn}$	hPa				
Total flow rate		ΣQ_{chnmax}	l/min				
				•			
Pressure decrease in o	overall system						
	Cooling system	Δp _B or	hPa			+	
	branches	Σp_{Bn}					
	Coolant line	Length I ₀	m				
		Added length I _{add0}	m				
		Diameter d ₀	mm				
		ΣQ _{ch}	l/min				
		$\Delta p_L/\Delta I$ 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 coola	nt pump						
	Required delivery height	ΔН	m				
	Required delivery rate	Q_P	l/min				
	1						

1) The required coolant flow Q_{chn} is set with the choker valve in the cooling system branch.

The coolant flow Q_{chn} is set according to the pressure decrease over the cooling system branches Δp_b .

Tab. 11-13: Form for sizing coolant pump

11.6.2 Power dissipation, flow rate, pressure decrease

	Power dissi	pation at f _{nom}	Liquid cooli	ng data
	P _v - liquid [W]	P _v - air [W]	Flow rate [l/min ⁻¹]	Pressure de- crease [bar]
HMU05.1N-F0140-0350-N-A4-D7-N1N-NNNN	2100	400	4.5	0.4
HNL05.1R-0219-N0218-N-A4-NNNN	tbd	tbd	tbd	tbd
HMU05.1N-F0170-0430-N-A4-D7-N1N-NNNN	2500	500	5.4	0.4
HNL05.1R-0182-N0262-N-A4-NNNN	tbd	tbd	tbd	tbd
HMU05.1N-F0220-0510-N-A4-D7-N1N-NNNN	3500	750	7.3	0.5
HNL05.1R-0135-N0327-N-A4-NNNN HNL05.1R-0045-N0327-N-A4-NNNN	tbd	tbd	tbd	tbd
HMU05.1N-F0270-0660-N-A4-D7-N1N-NNNN	4500	1000	9.2	0.5
HNL05.1R-0117-N0409-N-A4-NNNN HNL05.1R-0054-N0409-N-A4-NNNN	1800	700	8	1
HMU05.1N-F0340-0820-N-A4-D7-PNNNN	4500	1000	9	0.6
HNL05.1R-0100-N0514-N-A4-NNNF HNL05.1R-0043-N0514-N-A4-NNNN	2500	1000	8	1
HMU05.1N-F0430-1040-N-A4-D7-PNNNN	5500	1000	11.4	1
HNL05.1R-0113-N0652-N-A4-NNNF HNL05.1R-0050-N0652-N-A4-NNNN	3150	1450	9	1.3
HMU05.1N-F0540-1300N-A4-D7-PNNNN	7500	1200	15.8	1.3
HNL05.1R-0100-N0811-N-A4-NNNF HNL05.1R-0040-N0811-N-A4-NNNN	4000	1800	10	1.5
HMU05.1N-F0680-1690-N-A4-D7-PNNNN	8500	1500	17.9	1.3
HNL05.1R-0094-N1019-N-A4-NNNF HNL05.1R-0040-N1019-N-A4-NNNN	tbd	tbd	tbd	tbd
HNA05.1	0	150	0	0
HLT05.1/BG 105	0	600	0	0

Tab. 11-14: Power dissipations

11.6.3 Sizing example

The calculation for the cooling device is shown using a drive system to clarify the sizing calculation.

Components

- 1x supply unit with P = 400 kW
- 1x drive controller with P = 250 kW
- 1x drive controller with P = 132 kW

264/277

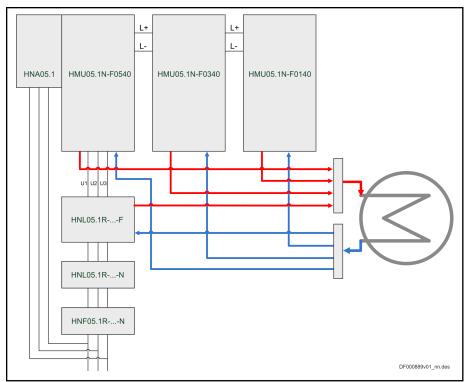


Fig. 11-12: Components

Form: Gathering technical data (for temperature increase = 10 K)

Drive com- ponent	P _v [kW]	P _v [kW]	Q [l/min]	Δp [hPa]	ΔT [°C]	V [i]
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}	ΣP _{vAir}				ΣV_{ch}
	= 18.5 kW	= 4.65 kW				xxx

Tab. 11-15: Gathering technical data

Coolant

The coolant should be a 4:1 mixture of water and Antifrogen N or L (e.g., Ri-Frost 1:4 from Rittal).

Do **not** mix Antifrogen N with Antifrogen L. When switching the coolant (N for L or vice-versa), thoroughly rinse out all components and lines before adding the new coolant.

Maximum coolant temperature

At nominal power dissipation, the temperature increase in the coolant is 10 K at the indicated minimum flow rates. If the maximum coolant inlet temperature is 60°C, the maximum coolant temperature is 70°C.

Requirements for ambient condi-

No higher-level liquid cooling system is available at the installation site. The requirements on the temperature accuracy of the coolant are low (±5 K).

Selecting the cooling device

The absorbed thermal energy should be dissipated into the ambient air with an air-liquid cooling unit.

The cooling liquid must dissipate 18.5 kW of heat output into the ambient air. The maximum expected air temperature is 35°C.

Specific cooling capacity:

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

 ΣP_V = 18.5 kW (sum of power dissipations from technical data of drive components)

 T_{in} = 60°C, max. coolant inlet temperature into cooling unit

T_{amb} = 35°C according to ambient conditions

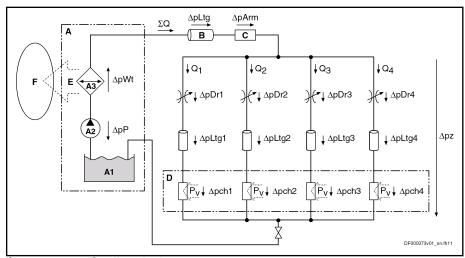
$$P_{01} = 18.5 \div (60 - 35) = 0.74 \text{ kW/}^{\circ}\text{C}$$

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

Drive components being cooled

E Heat transfer

F Higher-level cooling medium

Q Flow rate

Δp Pressure decrease (Ftg: fittings; Dc: drive components; Chk:

choke; L: line; P: coolant pump; He: heat exchanger)

ΔP_v Power dissipation of a drive component being discharged

Fig. 11-13: Liquid cooling circuit diagram

Sizing the coolant pump

Cooling system branch				1	2	3	4	ļ
Drive component	Type designation							
	Flow rate	Q _{chn}	l/min					
Pressure decreases	Coolant line	Length I _n	m					
		Added length l _{add}	m					
		Diameter d	mm					
		$\Delta p_L/\Delta I$ 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 brar	nches no.1, 2, 3, 4							
Total pressure decrease		Δp_b	hPa					Τ
Total flow rate	With choker valve 1)	ΣQ_{ch}	l/min					
	Without choker valve 2)	Approximation Q_{chn}	l/min	/	/	/	/	
		ΣQ_{ch}	l/min	1				
					•	'		
Series connection of branc	ches no							
Total pressure decrease		$\Sigma\Delta p_{Bn}$	hPa					
Total flow rate		ΣQ_{chnmax}	l/min					
Pressure decrease in over	rall system							
	Cooling system branches	Δp_B or	hPa					
		Σp_{Bn}						
	Coolant line	Length I ₀	m					
		Added length I _{add0}	m					
		Diameter d ₀	mm					
		ΣQ _{ch}	l/min					
		$\Delta p_L/\Delta I$ at ΣQ_{ch}	hPa/m					
		Δp_L	hPa					T
	Heat exchanger	Δp_{He}	hPa					T
	Fittings	Δp_{Ftg}	hPa					T
	Additional component	Δp_{Add}	hPa	+/				
	Overall cooling system	Δp _{Cs}	hPa					
				•	•	•	•	
Working point of coolant p	ump							
	Required delivery height	ΔΗ	m					T
	Required delivery rate	Q_P	l/min	1	1			\top

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. 11-16: Sizing the coolant pump

Since the pressure decrease of the overall cooling system falls below the permitted input pressure, the coolant pump has been sized.

Tank

$$\bigvee_{T} = \bigvee_{Ks} +1, 3 \times \bigvee_{T_min}$$

$$\bigvee_{Ks} = \bigvee_{Wt} + \bigvee_{Arm} + \bigvee_{ch} + \bigvee_{Lta}$$

whereby

V_{He} = from the heat exchanger manufacturer's specifications

 V_{Ftq} = from the specifications of the fittings manufacturer

 V_{Dc} = gathered from the technical data of the drive components

V_L= line lengths x flow cross-section

V_{Dist} = as indicated by the distributor manufacturer

Conclusion

The data determined for the cooling device can be retained in the procedure diagram. This data can be used to contact the supplier of the cooling device.

Index

0 9	Capacitance254
24 V supply	Encoder cables, selection table 44
Connection point 117, 168, 232	Leakage capacitance
Continuous power 82	Shield connection
Installation 82	Cables
Peak current82	Overview
Planning80	Calculations
·	Leakage capacitance
A	Liquid cooling
Acceptance tests	Mains-side phase current91
Accessories	Phase current91
Blank cover (HAS10)	Capacitance
	Power cable
Cabinet installation kit (HAS08.1-008-	CCC, China Compulsory Certification
NNN-MH)	CE label
HAS03146	Certifications
HAS08147	Characteristic
HAS10149	Fuses
Mounting and connection accessories	China Compulsory Certification (CCC)
(HAS03)	• • • • • • • • • • • • • • • • • • • •
Overview 145	Compatibility
Accumulators241	With foreign matters 64
Additional components	Components
Overview 145	Combining
Additional documentation	Mounting positions 76
ADVANCED	Condensation protection
CSH02.5	For liquid cooling 59
Air-liquid cooling unit	Condition on delivery 101
Cooling capacity	Conditions
Properties	Ambient and operating conditions 44
Ambient conditions	Configuration
Appropriate use 23	Drive system 39
Applications	Connection
Approvals 98	24 V supply (XD10) 117, 168, 232
• •	Connection diagram (HMU05 as drive
Areas of application IndraDrive ML9	controller) 77, 106
	Connection diagram (HMU05 as supply
Assignment	unit) 78, 107
HMU05 and additional components	Connection points, overview
Axis coupling	Control voltage (XD10) 117, 168, 232
	Cooling liquid
В	DC bus
BASIC	Electrical
CSB02.5	
Batteries	Equipment grounding conductor
Brake controller	Ground
HLT05221	Hydraulics
Braking resistor	Mains 84
External, HLR05	Mains/motor (L1, L2, L3) 113
HLR05, data	Motor fan control (XG3) 113
Brief description	Motor holding brake (XG3) 113
HMU05	Motor temperature monitoring (XG3) 113
1 IIVIO 0 3 37	Shield 119
	Connection points
C	HMU05, overview109
C-UL-US listing	Contained substances
C-UR-US listing	see "Significant components"
Cable	200 0.g211

Bosch Rexroth AG

Contents of delivery	HAH05	240
HMU05 102	HLL05	217
Control cabinet	HLR05	219
Area A, interference-free 125	HLT05	225
Area B, interference-prone 127	HML05	206
Area C, interference-prone 127	HMU05, control voltage	133
Cooling	HMU05, cooling	
Design 46	HMU05, DC bus	138
Interference areas 123	HMU05, dimensional drawing	
Control lines	HMU05, dimensions	
Cable, shield connection 119	HMU05, distances	
Control section	HMU05, housing dimensions	
Installation and removal	HMU05, Insulation	
Control voltage	HMU05, inverter	
Connection point XD10 117, 168, 232	HMU05, mains voltage	
Continuous power 82	HMU05, Mass	
Data	HMU05, power dissipation	
Determining power requirements 80	HMU05, temperatures	
- · · · · · · · · · · · · · · · · · · ·	HMU05, THD	
For drive systems		
	HMU05, UL data	
Installation	HNA05	
Loop-through contacts (XD10) 117, 168, 232	HNC05	
Looping through	HNF05	
Peak current 82	HNL05	
Planning 80	Operating conditions	44
Power supply unit requirements 82	DC bus	
Supply with 24 V control voltage 80	Connection point	118
Coolant	Data, HMU05	138
Non-water-based 62	Fuses	252
Water-based 61, 62	Fusing	252
Coolant pump50	DC bus choke	
Coolant reservoir50	HLL05	207
Cooling	DC bus coupling	
HMU05	Declaration of conformity	
Cooling device	Design	
Components49	HMU05	37
Cooling devices	Devices	
Cooling liquid	Mounting positions	76
Connection points	Dimensional drawing	70
Cooling system	HLL05	200
Sizing	HLR05	
Corner-grounded delta mains 89	HLT05	
	HML05	
Coupling	HMU05	
Axis coupling		
DC bus coupling	HNA05	
CSB02.5	HNC05	
BASIC	HNF05	
Type code 14	HNL05	188
CSH02.5	Dimensioning	
ADVANCED 16	Line cross sections and fuses	
Type code 15	Disposal	241
CSx02.5	Distances	
Functional equipment 16	HMU05	72
	Documentation	
D	Additional documentation	21
Data	Drive systems	
Ambient conditions44	Firmware	
, and one obtained by the second seco	Other applicable documentation	
	Caro: applicable accumentation	41

		Index
Overview	Type code	238
Purpose21	HAH05	
System components	Data	240
Drive range	HAS03	
Rexroth IndraDrive ML 7	Accessories (for mounting and installation	າ). 146
Drive system	Type code	
Configuring	HAS08	
System structure	Cabinet installation kit	147
Cyclom cardotal c	Type code	
E	HAS10	177
	Blank cover	149
Electric drive system	Type code	
Electrical connection	Hazardous substances	
Electrical project planning 77	Heat exchanger	241
EMC	HAH01	220
Measures for design and installation 121	Helpdesk	
Encoders	·	243
Supported encoder systems	HLL05	247
Environmental protection	Data	
Equipment grounding conductor	DC bus choke	
Connection 111	Dimensional drawing	
External braking resistor	Dimensions	
HLR05 218	Sizing	
External wiring	Type code	207
	HLR05	
F	Braking resistor (external)	
Features	Data	
HMU05 10	Dimensional drawing	
Field wiring 250	Dimensions	
File numbers	Installation	
UL	Type code	218
Firmware	HLT05	
Assigned HMU05 device types	Brake controller	
Documentation	Connection diagram	226
Flow rate	Connection points	
Calculation	Data	225
Foreign matters	Dimensional drawing	222
Compatibility	Dimensions	222
Functional equipment	Display elements	237
CSx02.5	LEDs	
Fuses	Type code	
Characteristic	HML05	
Circuit breaker	Assignment	204
DC bus	Data	
	Dimensional drawing	
Design	Dimensions	
Dimensioning 245	Type code	
	HMS05	200
G	Drive controller	8
G1	HMU05	
Mounting position76	Assigning additional components	03
Ground	Brief description	
Connection 120	Connection points, overview	
Ground connection 120	·	
Ground connections 129	Control voltage data	
	Control voltage, data	
Н	DC bus, data	
HAH01	Design (block diagram)	
Heat exchanger238	Dimensional drawing	
200	Dimensions	65

Bosch Rexroth AG

Distances	Type code	17
Features 10		
Firmware39		
Housing dimensions72	Identification	
Insulation72	Of components	102
Inverter, data 139	Inappropriate use	24
Mains voltage, data 135	Consequences, exclusion of liability	23
Mass 72	Individual components	
Mounting in control cabinet 105	Combining	37
Performance features 11	IndraDrive ML	
Power dissipation 72	Areas of application	9
Sound pressure level 72	Overview	
Supported motors	Target applications	
Temperatures72	Installation	
THD255	24 V supply	82
Type code 13	Connection points	
UL data 63	Control section	
HMV05	Control voltage supply	
Supply unit 8		
HNA bus	Electrical connection	
XG32 116, 171	EMC measures	
HNA05	Ground connections	
	Optional card	
Connection point for equipment ground-	Signal lines	
ing conductor	Installation conditions	
Connection points	Installation methods	251
Data	Installation type	
Dimensional drawing	B1 24	
Dimensions	B224	6, 249
Display elements 175	E 24	8, 249
LEDs 175	NFPA	249
Mains connecting module 158	UL508A	249
Type code 158	Insulation	
HNC05	HMU05	72
Data 180	Insulation resistance test	
Dimensional drawing 177	Interference suppression measures	
Dimensions 177	For relays, contactors, switches, chokes,	
Mains capacitor 176	inductive loads	130
Type code 176	Internal wiring	
HNF05	Inverter, data	
Data 185	HMU05	
Dimensional drawing 182	IT mains type	
Dimensions 182	Tr mains type	00
Mains filter 182	L	
Type code 182		
HNL	L+, L-	440
Type plate 187	DC bus	118
HNL05	L1, L2, L3	440
Data 202	Mains/motor connection	113
Dimensional drawing	Leakage capacitance	
-	Calculation	
Dimensions	Determining	
Type code	Power cable	254
Type plate	Leakage currents	
Hotline	Cause	85
Housing dimensions	Line	
HMU05 72	Correction factor	250
HPC01	Cross sections, dimensioning	
Connection points	Fuses, dimensioning	
Optional cards 17	•	

	Index
Liquid cooling	Mechanical project planning 65
Calculation criteria 256	Motor
Condensation protection 59	Cable, shield connection 119
Coolant 61	Motor fan control 113
Cooling device components 49	Motor fan control connection (XG3) 113
Flow rate 256	Motor holding brake 113
Interconnection 58	Motor holding brake connection (XG3) 113
Liquid cooling circuit diagram 259	Motor temperature monitoring
Parallel connection58	Motor temperature monitoring connection
Physical data256	(XG3) 113
Pressure decrease	Supported motors
Project planning manual 47	Third-party motors
Series connection	Motor connection
Sizing aids258	L1, L2, L3 113
Sizing example	Motor fan
Liquid cooling circuit diagram	Mains filter
Liquid cooling	Mounting
Liquid-liquid cooling unit	HMU05 in control cabinet
Cooling capacity55	Mounting position
Properties	G1
Listing	01
C-UL-US 98	0
C-UR-US	0
	Operating conditions
Lock nipple 132	Operation at partial load91
	Optional card
M	Installation and removal
Mains	Optional cards
With grounded outer conductor 89	HPC0117
Mains capacitor	Other applicable documentation
HNC05 176	Overview
Mains choke 186	Accessories145
Combining with mains filter	Additional components
HNL05 186	Cables 145
Mains connection	
L1, L2, L3	Р
Mains current	Packaging 241
Mains filter, mains choke	Parallel connection90
Parallel connection 90	Parallel operation
Planning 84	Power extension
Power 91	PELV
Types 90	Performance features
Mains current 91	HMU05 11
Mains filter	PF55, PF56, PF57, PF58
Combining with mains choke 93	LEDs, HNA05
HNF05 182	Phase current
Motor fan 126	Calculating91
Other consumers 126	Power extension
Mains transformer	Parallel operation
Selecting 92	Pressure decrease
Sizing 92	Calculation
Mains types 86	Production processes
Mains voltage	Project planning
HMU05 135	Electrical project planning
Mains-side phase current	Mechanical project planning
Calculating91	Protective extra-low voltage
Mass	i iotective extra-iow voitage
HMI 105 72	

Bosch Rexroth AG

₹	HMU05	255
RCCB 84	Third-party motors	
RCD 84	On drive controllers	39
Recycling 241	TN-C mains type	87
Refrigerating unit	TN-S mains type	86
Properties48	Transporting	
Refrigerating capacity 57	Components	102
Removal	TT system	
Control section	Type code	
Optional card	CSB02.5	14
Residual-current-operated circuit breakers 84	CSH02.5	
Return of products	HAH01	
Rexroth IndraDrive ML	HAS03	
	HAS08	
Areas of application	HAS10	
Drive range	HLL05	
Overview		
System presentation	HLR05	
Target applications 9	HLT05	
-	HML05	
3	HMU05	
Safety instructions for electric drives and	HNA05	
controls	HNC05	
Service hotline	HNF05	
Shield	HNL05	
Connection 119	HPC01	17
Control lines	Type plate	
Motor cable119	Device	102
Signal lines	HNL	187
Installation		
Significant components	U	
Sound pressure level	UL	
HMU0572	Data, HMU05	63
Standard motors	File numbers	
Voltage load 142	Listing	
State-of-the-art	Ratings, HMU05	
	Ungrounded mains	
Storing	•	00
Components	Use Appropriate use	22
Supply		
with 24 V control voltage 80	Inappropriate use	24
With mains voltage84		
Support 243	V	
System structure	Voltage test	101
Drive system 12		
	W	
Γ	WATER IN/OUT	
Farget applications	Cooling liquid connection	132
IndraDrive ML9	9 - 4	
Fechnical data	X	
HMU05, power section	XD1	
See also index entry Data		
Test	Mains voltage, equipment grounding con-	
Factory-side 101	ductor	166
Insulation resistance	XD02	000
	DC bus	229
Voltage test 101 Festing	XD2	
Customer 101	DC bus	167
FHD	XD04	
טווו	Braking resistor	231

XD10	
Control voltage (24 V) 117, 168,	232
XE01	
Equipment grounding conductor connec-	
tion point	228
XF1	132
XF2	132
XG1	
IndraBus 116, 169,	233
XG3	
Braking resistor signal contact	234
Motor temperature monitoring, motor	
holding brake, motor fan control	113
XG31	
Messages 170,	235
XG32	
HNA bus116,	171
XG33	
DC bus short-circuit	236
Mains contactor (control, DC bus short-	
circuit)	172
XG34	
Mains contactor (contact)	173
XG40	
Mains contactor (acknowledgment mes-	
sages)	174

Notes

Notes

The Drive & Control Company



Bosch Rexroth AG

Electric Drives and Controls P.O. Box 13 57 97803 Lohr, Germany Bgm.-Dr.-Nebel-Str. 2 97816 Lohr, Germany

Tel. +49 9352 18 0 Fax +49 9352 18 8400

www.boschrexroth.com/electrics



DOK-INDRV*-HXX05*****-PR01-EN-P