

Rexroth IndraDrive Drive System

R911309636
Edition 03

Project Planning Manual



Title	Rexroth IndraDrive Drive System
Type of Documentation	Project Planning Manual
Document Typecode	DOK-INDRV*-SYSTEM*****-PR03-EN-P
Internal File Reference	120-2400-B321-03/EN
Purpose of Documentation	This documentation describes the project planning of the drive system.

Record of Revisions

Description	Release Date	Notes
DOK-INDRV*-SYSTEM*****-PR01-EN-P	11.2004	First edition
DOK-INDRV*-SYSTEM*****-PR02-EN-P	03.2005	Corrected edition for online help MPx03
DOK-INDRV*-SYSTEM*****-PR03-EN-P	01.2006	3 rd edition: chapter on EMC revised; HMV02, HMS02 included, combinations

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Published by Bosch Rexroth AG
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1 Introduction

1.1 About this Documentation

**WARNING**

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

⇒ Take contents of the listed reference documentations into account.

Purpose of Documentation

This documentation provides...

- overview information on the drive system Rexroth IndraDrive
- a presentation of the documentations on the drive system Rexroth IndraDrive
- help for selecting the system components of the drive system Rexroth IndraDrive

Contents of Project Planning Manual for System

Contents of the Project Planning Manual for the system are information on the interaction of the components, such as

- description of allowed combinations
- specifications for all components (ambient and operating conditions)
- application descriptions of system characteristics

Note: For detailed technical data of the individual components see the respective Project Planning Manual (see reference documents).

This documentation contains safety regulations, technical data and operating instructions for the drive system Rexroth IndraDrive. The individual chapters have the following main focuses:

Main Focuses of the Chapters

Chapter	Title	Content
1	Introduction	general information
2	Important directions for use	safety
3	Safety Instructions for Electric Drives and Controls	
4	Brief Description, Applications	product description (for those doing project planning)
5	Specifications for the Components of the Drive System	
6	Configuration of the Drive System Rexroth IndraDrive	
7	Arranging the Components in the Control Cabinet	
8	Electromagnetic Compatibility (EMC)	
9	Types of Mains Connection	
10	Requirements to the Mains Connection	
11	Control Circuits for the Mains Connection	
12	Connections of the Components in the Drive System	
13	Fusing and Selecting the Mains Contactor	
14	Accessories in the Drive System Rexroth IndraDrive	
15	Calculations	
19	Appendix	
16	Replacing Devices	practical application (for operators and maintenance staff)
17	Disposal and Environmental Protection	general information
18	Service & Support	
20	Index	

Fig. 1-1: Main focuses of the chapters

Reference Documentations - Overview

Title	Kind of documentation	Document typecode ¹⁾
Rexroth IndraDrive Drive Controllers Control Sections Cxx	Project Planning Manual	DOK-INDRV*-CSH*****-PRxx-EN-P
Rexroth IndraDrive Supply Units HMV01	Project Planning Manual	DOK-INDRV*-HMV-*****-PRxx-EN-P
Rexroth IndraDrive M Drive Controllers Power Sections HMx01	Project Planning Manual	DOK-INDRV*-HMS+HMD****-PRxx-EN-P
Rexroth IndraDrive C Drive Controllers Power Sections HCS02.1	Project Planning Manual	DOK-INDRV*-HCS02.1****-PRxx-EN-P
Rexroth IndraDrive C Drive Controllers Power Sections HCS03.1	Project Planning Manual	DOK-INDRV*-HCS03.1****-PRxx-EN-P
Rexroth IndraDrive Additional Components	Project Planning Manual	DOK-INDRV*-ADDCOMP****-PRxx-EN-P
Rexroth IndraDrive Integrated Safety Technology	Functional and Application Description	DOK-INDRV*-SI*-**VRS**FKxx-EN-P
Rexroth IndraDrive Firmware for Drive Controllers	Functional Description	DOK-INDRV*-MP*-02VRS**FKxx-EN-P
Rexroth IndraDrive Firmware for Drive Controllers	Functional Description	DOK-INDRV*-MP*-03VRS**FKxx-EN-P
Rexroth IndraDrive Firmware for Drive Controllers	Functional Description	DOK-INDRV*-MP*-04VRS**FKxx-EN-P
Rexroth IndraDrive Firmware for Drive Controllers	Parameter Description	DOK-INDRV*-GEN-**VRS**PAxx-EN-P
Rexroth IndraDrive Firmware for Drive Controllers	Troubleshooting Guide	DOK-INDRV*-GEN-**VRS**WAxx-EN-P
Rexroth Connection Cables	Selection Data	DOK-CONNEX-CABLE*STAND-AUxx-EN-P
Rexroth IndraDyn A Asynchronous Motors	Project Planning Manual	DOK-MOTOR*-MAD/MAF****-PRxx-EN-P
Rexroth IndraDyn H Frameless Synchronous Spindle Motors	Project Planning Manual	DOK-MOTOR*-MBS-H*****-PRxx-EN-P
Rexroth IndraDyn L Synchronous Linear Motors	Project Planning Manual	DOK-MOTOR*-MLF*****-PRxx-EN-P
Rexroth IndraDyn S Synchronous Motors	Project Planning Manual	DOK-MOTOR*-MSK*****-PRxx-EN-P
Rexroth IndraDyn T Synchronous Torque Motors	Project Planning Manual	DOK-MOTOR*-MBT*****-PRxx-EN-P
Third-Party Motors	Project Planning and Commissioning Manual	DOK-DRIVE*-3RDPART*MOT-AWxx-EN-P
Safety Instructions for Electrical Drives	Safety Guidelines	DOK-GENERAL-DRIVE*****-SVSx-MS-P

1) In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: PR01 means the first edition of a Project Planning Manual)

Fig. 1-2: Documentations - overview

Box with Project Planning Manuals on Rexroth IndraDrive

You can order all the Project Planning Manuals on the drive system Rexroth IndraDrive in a box; this box contains:

- Project Planning Manual Drive System
- Project Planning Manual Control Sections CSx
- Project Planning Manual Supply Units HMV01
- Project Planning Manual Power Sections HMx
- Project Planning Manual Power Sections HCS02.1
- Project Planning Manual Power Sections HCS03.1
- Project Planning Manual Additional Components

Order data of the box:

- part number: R911310293
- document typecode: DOK-INDRV*-PROJEKTIER*-8201-EN-P

Standards

German, European and international technical standards are mentioned in this documentation. Standard documents and sheets are subject to copyright protection and Rexroth mustn't pass them on. If required, contact the authorized sales agencies; in Germany directly contact:

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Your Feedback

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Inform us about mistakes you discovered and change requests; we would be grateful for your feedback.

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1.2 Overview and Contents of the Documentations on the Drive System Rexroth IndraDrive

Rexroth IndraDrive Platform The drive system is composed of the individual components of the IndraDrive product range and established on the Rexroth IndraDrive platform.

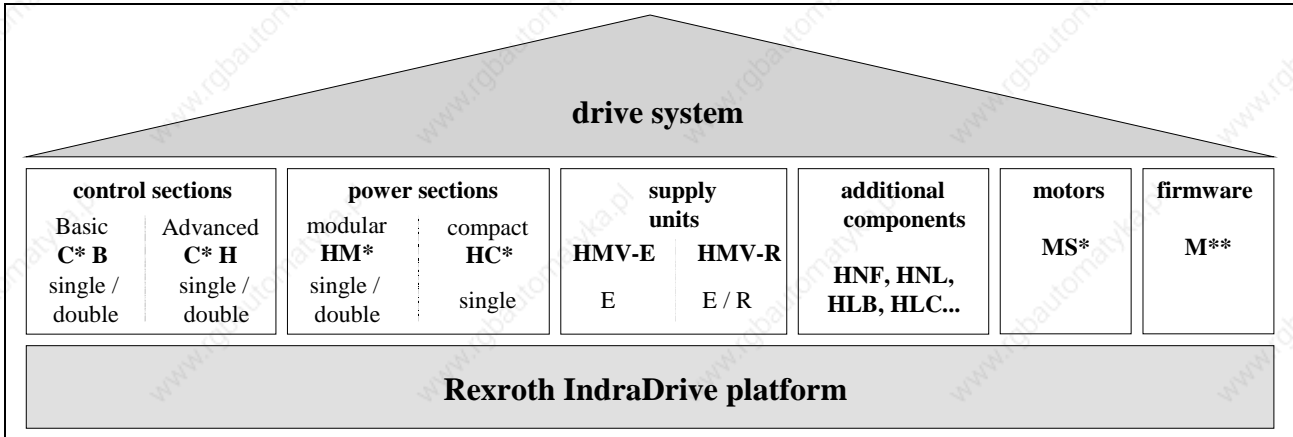


Fig. 1-3: IndraDrive products

Hierarchical Levels of Rexroth IndraDrive The assignment of the fundamental components to the hierarchical levels product platform, product type, product range, product line and component is illustrated in the figure below.

component	W0012...70	W0070...210	W0018..	W0020..	W0012..	01, 02, 03, 04, 05	02, 03	01
line	HCS02	HCS03	HMV01	HMS01	HMD01	CSB	CDB	CSH
range	Rexroth IndraDrive C		Rexroth IndraDrive M			Basic		Advanced
type	Rexroth IndraDrive power sections					Rexroth IndraDrive control sections		
platform	Rexroth IndraDrive platform							

Fig. 1-4: Hierarchical levels

Docu House The technical data of the respective components are available in the form of documentations. The figure below contains an overview of the available documentations.

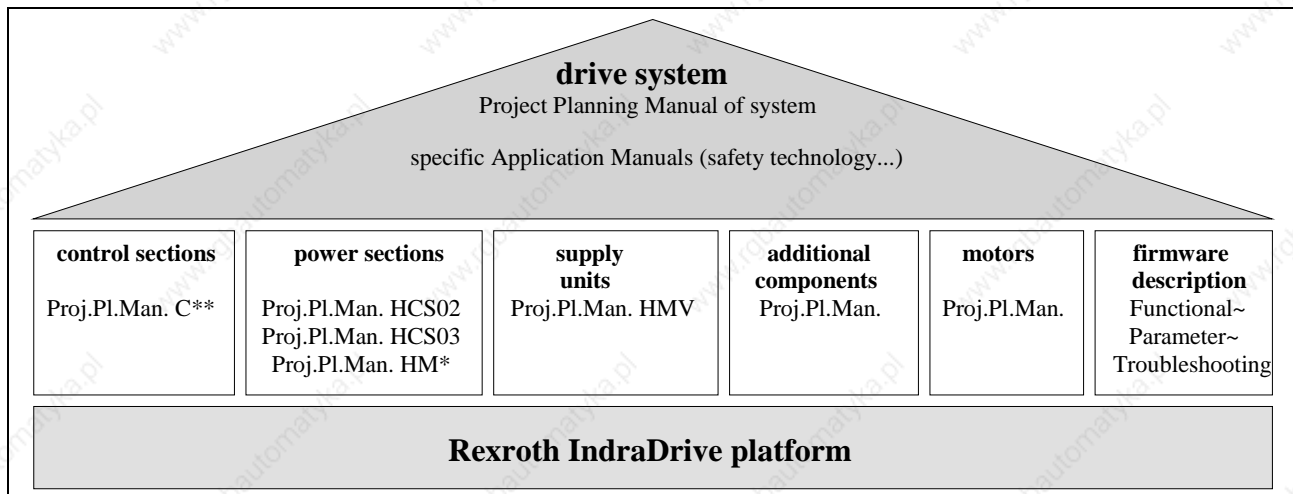


Fig. 1-5: "House" of documentations

Contents of Project Planning Manuals on Components

Contents of the Project Planning Manuals of components are all technical data, such as

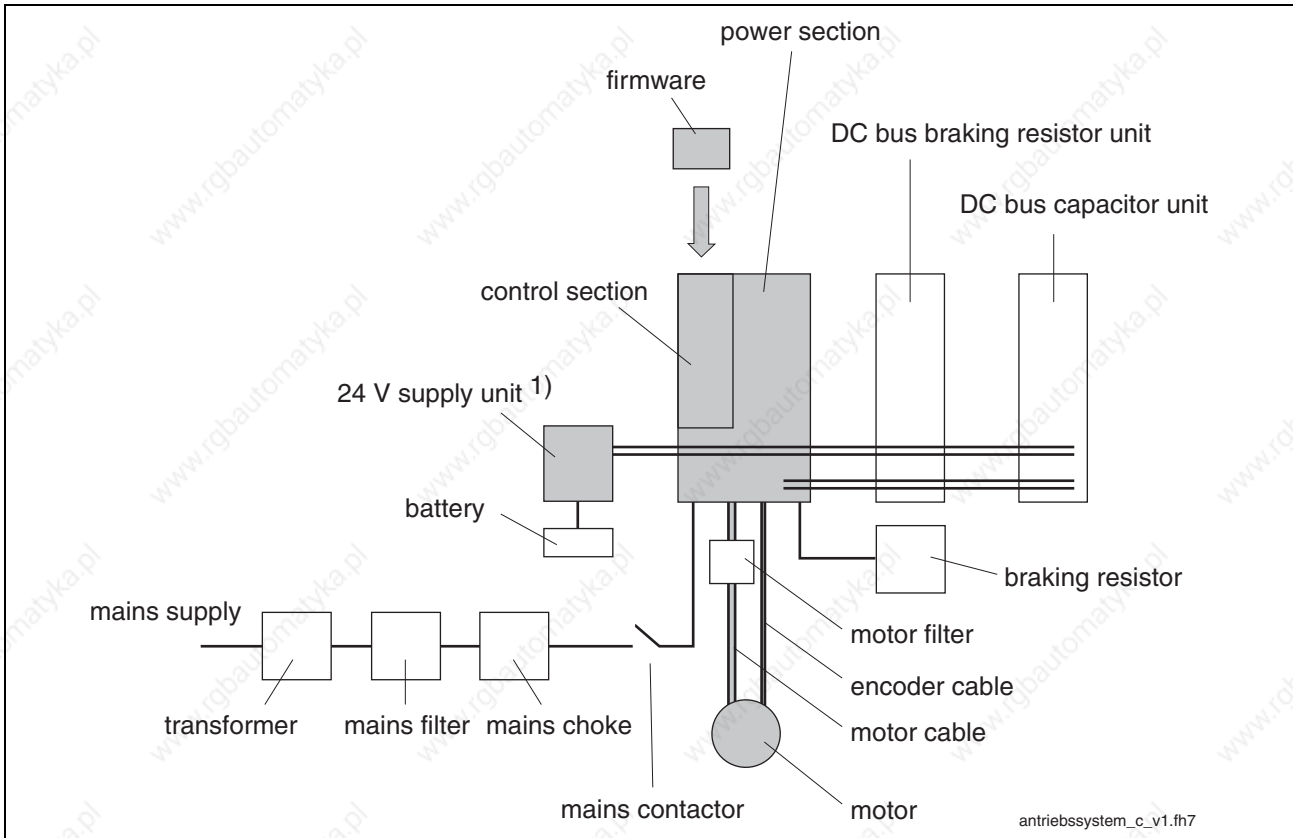
- current, voltage and performance data
- dimensions and weights
- pin assignment

1.3 Introducing the System

Drive System, Definition of Term The drive system Rexroth IndraDrive comprises all components from mains supply to motor shaft. It consists of the components supply module with mains connection phase, power section with control section incl. firmware, as well as motor and possibly required additional components and corresponding system connections.

Drive System Rexroth IndraDrive C

The figure below illustrates the individual components of the drive system Rexroth IndraDrive C (system elements).



The components marked with gray background color are absolutely necessary.

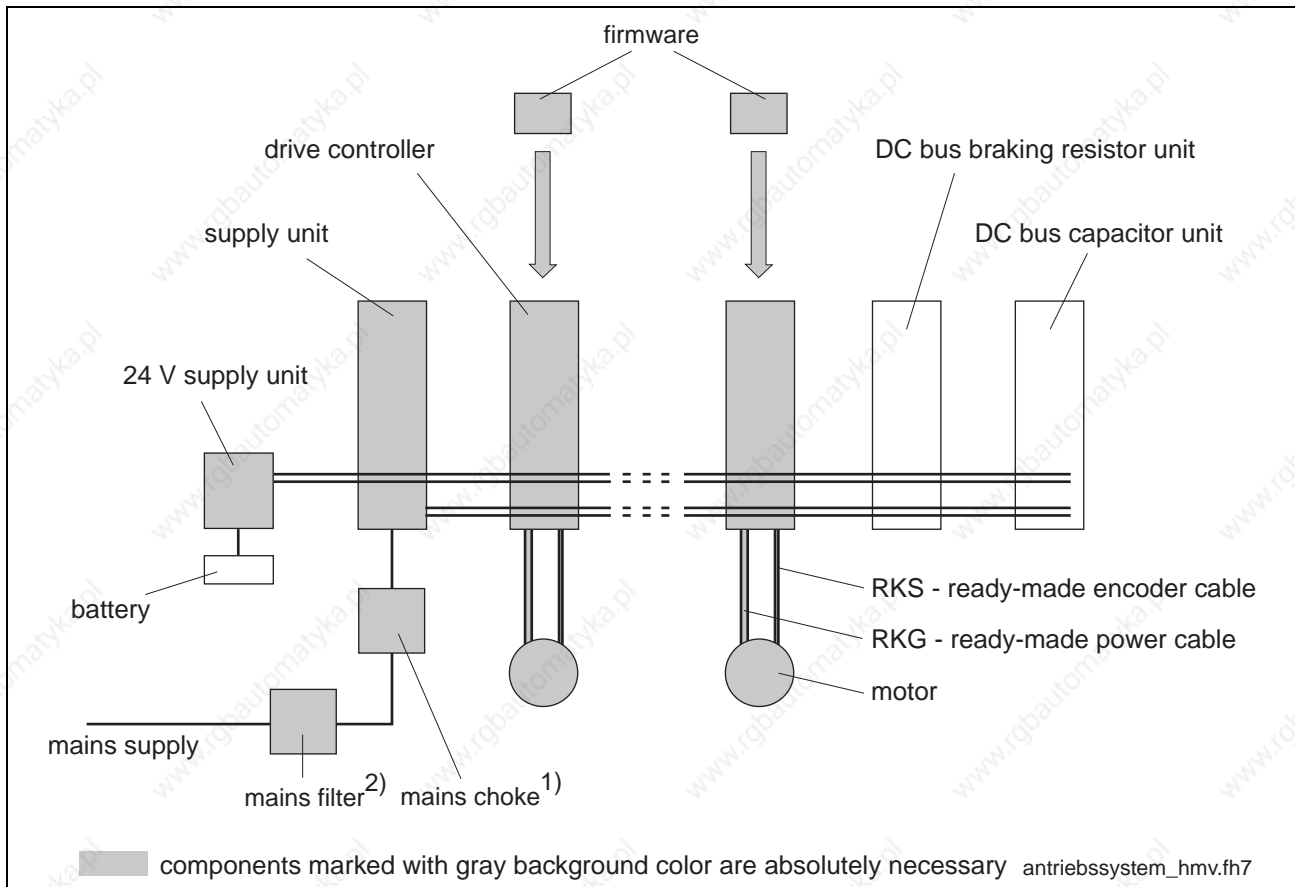
- 1) 24V power supply unit can be omitted when using devices with integrated 24V power supply (HCS02.1E- or HCS03.1E-...-NNNV with control section CSB01.1N-FU)

Fig. 1-6: Drive system Rexroth IndraDrive C

Note: If you use mains filter HNK at HCS03 devices, connect the mains contactor between mains supply and mains filter.

Drive System Rexroth IndraDrive M

The figure below illustrates the individual components of the drive system Rexroth IndraDrive M (system elements).



- 1) optional for HMV01.1E, required for HMV01.1R
- 2) mains filter to be used optionally and depending on the EMC requirements

Fig. 1-7: Drive system Rexroth IndraDrive M

System Elements - Components of the System

The drive system Rexroth IndraDrive consists of the following system elements:

System elements	Types	Characteristic
transformer	autotransformer	DST
	isolating transformer	DLT
mains filter	1-phase	NFE
	3-phase	NFD03.1; HNF01.1;
	combined filter with int. mains choke	HNK01.1
mains choke	standard	HNL01.1E
	to be used for regeneration back to the mains	HNL01.1R
	current compensated	HNL01.1R-...S
mains contactor	n.s.	n.s.
mains supply	infeeding	HMV01.1E

System elements	Types	Characteristic
	regenerative	HMV01.1R HMV02.1R
power sections	single-axis modular inverters	HMS01.1
	double-axis modular inverters	HMD01.1
power sections with integrated mains supply	compact converters mounting depth 265	HCS02.1
	compact converters mounting depth 322	HCS03.1
control sections	scope of functions Basic	CSB01.1
	scope of functions Advanced	CSH01.1
firmware	scope of functions Basic	MPB
	scope of functions double-axis	MPD
	scope of functions Advanced	MPH
24V power supply unit	n.s.	n.s.
battery	n.s.	n.s.
DC bus resistor unit	mounting depth 265	HLB01.1C
	mounting depth 322	HLB01.1D
braking resistor		HLR01.1
DC bus capacitor unit	mounting depth 265	HLC01.1C
	mounting depth 322	HLC01.1D
output filter	n.s.	n.s.
motor cable	shielded	RKL
motor	rotary motors	MSK, MBS, MBA etc.
	linear motors	M
encoder cable	n.s.	RKS
accessories	basic accessories	HAS01.1
	other accessories	HAS02, HAS03, HAS04, HAS05
cooling fan unit	external cooling fan unit for HMV01.1R-W0120	HAB01

Fig. 1-8: System elements Rexroth IndraDrive

Differences between Rexroth IndraDrive C and Rexroth IndraDrive M

The product ranges IndraDrive C and IndraDrive M were created on the IndraDrive platform.

Rexroth IndraDrive C

Rexroth IndraDrive C is the compact form of the product range.

Compact Converters

The drive controllers HCS02 and HCS03 are the fundamental components of IndraDrive C, they are compact converters containing the mains supply.

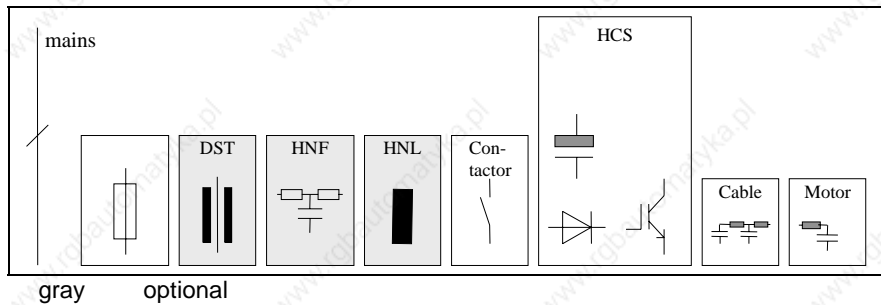


Fig. 1-9: Block diagram Rexroth IndraDrive C

Basic features of Rexroth IndraDrive C:

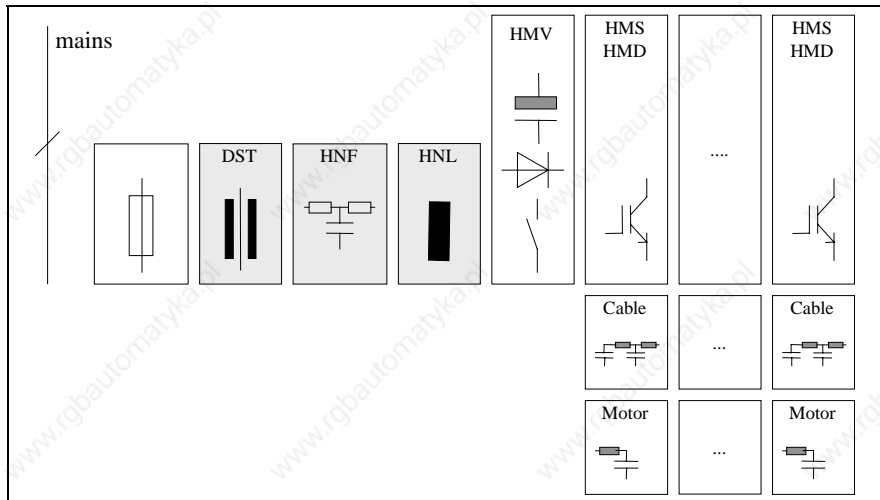
- integrated power supply
- integrated braking resistor (as an option, external for HCS03)
- integrated 24V control voltage supply (optional for HCS02)
- additional components DC bus resistor units and DC bus capacitance modules, as well as braking resistors

Rexroth IndraDrive M - Modular Inverters

Rexroth IndraDrive M is the modular form of the product range.

Modular Inverters

The combination of an HVM supply module and HMS and HMD drive controllers to form a modular drive system allows operating several motors.



optionally required components are marked with gray background color

Fig. 1-10: Block diagram Rexroth IndraDrive M

Basic features of Rexroth IndraDrive M:

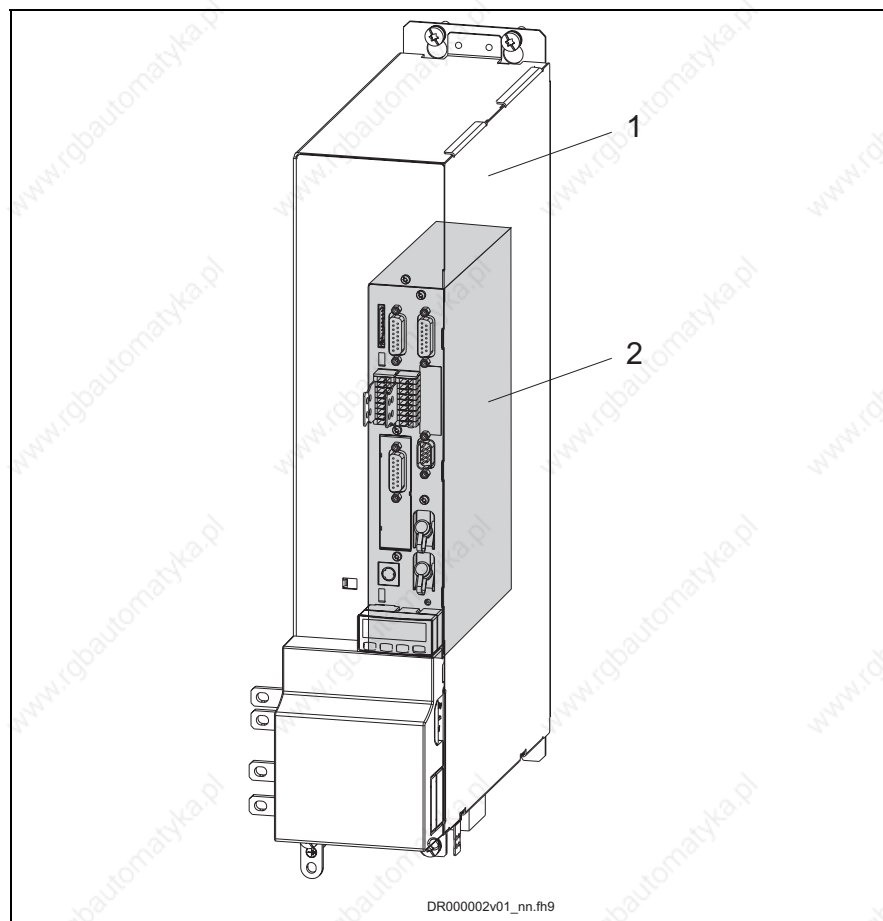
- scaleable power supply
- integrated mains contactor
- modular extension of number of axis is possible
- additional components DC bus resistor units and DC bus capacitance modules

Combination of Rexroth IndraDrive C and Rexroth IndraDrive M

On the common platform Rexroth IndraDrive it is possible to combine the components of the product ranges IndraDrive C and IndraDrive M to form drive systems of optimum costs and performance. For information on the allowed combinations see chapter "Configuration of the Drive System Rexroth IndraDrive".

1.4 Basic Design of the Devices

Basic Design of Drive Controllers



- 1: power section
2: control section

Fig. 1-11: Basic design

The drive controller consists of two essential parts:

- power section
- control section

Power Section

The power section incorporates the control section and has the following connections:

- mains voltage connection (at supply modules and HCS devices)
- motor connection (with optional motor holding brake and motor temperature monitor)
- 24 V control voltage
- DC bus connection
- module bus connection for cross communication in the case of DC bus connection with other devices
- connection for external braking resistor (at HCS devices)

Control Section

The control section is a separate component that is plugged into the power section; it consists of

- the basic control section circuit board with interfaces
- the optional modules in the case of configurable control sections

The optional modules are included on the basic control section circuit board in optional slots. As an example, the figure below illustrates optional slots Option1...4.

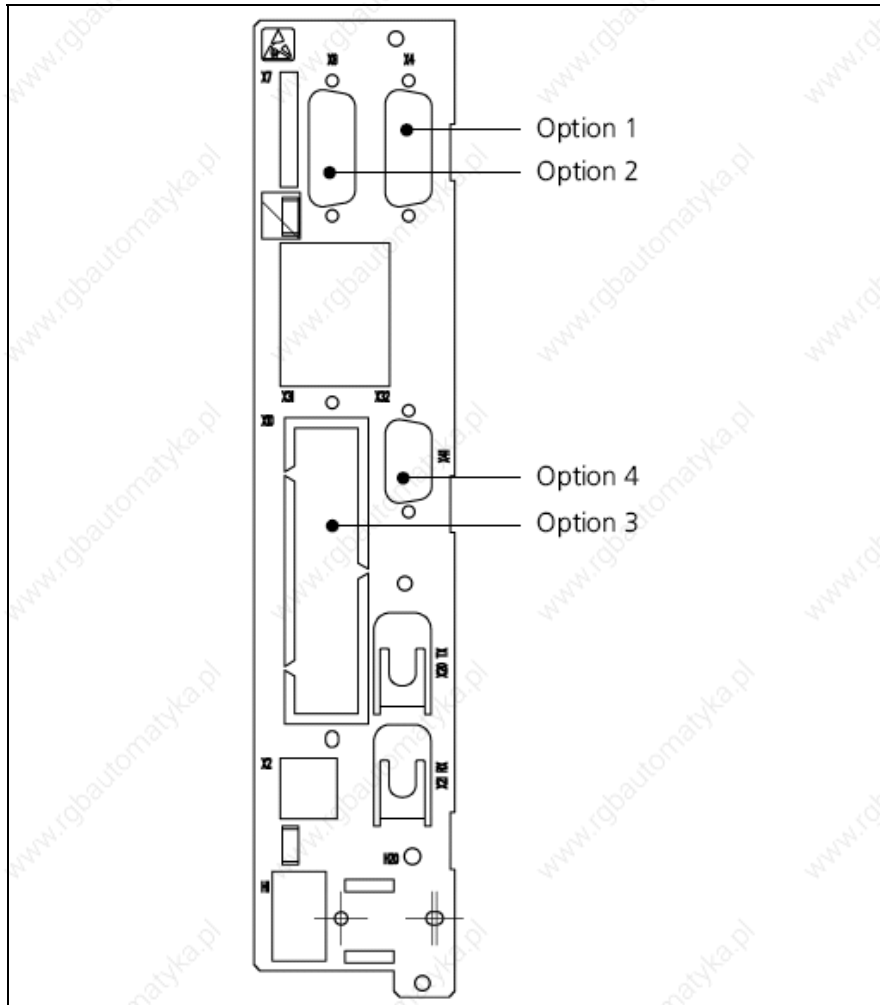


Fig. 1-12: Optional slots on control section

The drive controller is supplied complete with factory-installed (possibly configured) control section.

Note: The control section may only be replaced by qualified personnel.

1.5 Available Type Currents and Performances

To allow you selecting appropriate drive controllers for a multitude of applications the Rexroth IndraDrive product range provides a wide range of type currents and performances. The table below shows fundamental data of drive controllers and supply modules, for further details see the corresponding data sheets.

Selecting the Drive Controllers

Order with ascending continuous current.

Compact converters	Modular inverters	Type current	Contin. current I_{out_cont1} [A] (1)	Peak current I_{out_max} [A] (1)	Nominal motor power [kW] (2)
HCS02	--	W0012	4	12	1,5
--	HMD01		tbd	12	--
--	HMS01	W0020	12,1	20	--
--	HMD01		12,1	20	--
HCS02	--	W0028	11	28	4,0
	HMS02		13	28	--
--	HMS01	W0036	21,3	36	--
--	HMD01		20	36	--
HCS02	--	W0054	22	54	7,5
	HMS01		35	54	--
--	HMS02		25	54	
HCS02	--	W0070	28	70	11
HCS03	--		45	70	18,5
--	HMS01		42,4	70	--
HCS03	--	W0100	73	100	30
	HMS01	W0110	tbd	110	--
HCS03	--	W0150	95	150	45
--	HMS01		100	150	--
HCS03	--	W0210	145	210	75
--	HMS01		145	210	--

tbd to be defined

(1) at $f_s=4$ kHz; without overload

(2) for standard motor, with use of mains choke HNL01; at 3 AC 400 V variable torque, low degree of overload

Fig. 1-13: Type current and type performances

Selecting the Component for Mains Supply

Order with ascending continuous power.

Compact converters	Modular mains supply	Type current or power	Contin. power "ON" P_{DC_cont} [kW] (1)	Peak power "ON" P_{DC_peak} [kW] (1)	Contin. braking power [kW]	Max. braking power [kW]
HCS02	--	E-W0028	4,2	10	0,15	10
HCS02	--	E-W0054	9,1	16	0,35	18
HCS02	--	E-W0070	13,3	19	0,5	25
--	HMV01	R-W0018	18	45	0,4	36
HCS03	--	E-W0070	25	40	opt.	opt.
--	HMV01	E-W0030	30	45	1,5	36
HCS03	--	E-W0100	43	59	opt.	opt.
HCS03	--	E-W0150	56	89	opt.	opt.
--	HMV02	R-W0015	15	37,5	0,3	33
--	HMV01	R-W0045	45	112	0,4	90
--	HMV01	R-W0065	65	162	0,4	130
--	HMV01	E-W0075	75	112	2	90
HCS03	--	E-W0210	85	124	opt.	opt.
--	HMV01	E-W0120	120	180	2,5	130
--	HMV01	R-W0120	120	180	0	0

opt. equipment to be optionally ordered
(1) with use of mains choke HNL01; at 3 AC 400 V

Fig. 1-14: Performance data of mains supply units

Note: The data of peak power and continuous power show the maximum possible limit values. For the actually available performance profiles please see the corresponding data sheets.

Notes

2 Important Directions for Use

2.1 Appropriate Use

Introduction

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

The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

Note: 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.

Areas of Use and Application

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

Control and monitoring of the motors may require additional sensors and actors.

Note: The drive controllers may only be used with the accessories and parts specified in this document. If a component has not been specifically named, then it may not be either mounted or 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.

Every drive controller has to be programmed before commissioning, making it possible for the motor to execute the specific functions of an application.

The drive controllers have been developed for use in single- and multi-axis drive and control tasks.

To ensure an application-specific use, the drive controllers are available with different drive power and different interfaces.

Typical applications of the drive controllers include:

- handling and mounting systems,
- packaging and food machines,
- printing and paper processing machines and
- machine tools.

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

2.2 Inappropriate Use

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

Drive controllers must 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, the 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!

3 Safety Instructions for Electric Drives and Controls

3.1 General Information

Using the Safety Instructions and Passing them on to Others

Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device.

If the device is resold, rented and/or passed on to others in any other form, then these safety instructions must be delivered with the device.



WARNING

Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

Instructions for Use

Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.

- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations:
 - Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
 - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.

- The devices have been designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded.
Safety-relevant are all such applications which can cause danger to persons and material damage.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.

The machine and installation manufacturer must

- make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
- make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only permitted if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".
- The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.
- Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions:




Warning symbol with signal word	Degree of hazard seriousness according to ANSI Z 535
 DANGER	Death or severe bodily harm will occur.
 WARNING	Death or severe bodily harm may occur.
 CAUTION	Bodily harm or material damage may occur.

Fig. 3-1: Hazard classification (according to ANSI Z 535)

Hazards by Improper Use



DANGER

**High electric voltage and high working current!
Risk of death or severe bodily injury by electric shock!**



DANGER

Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!



WARNING

High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock!



WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!



CAUTION

Hot surfaces on device housing! Danger of injury! Danger of burns!



CAUTION

Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting, or improper handling of pressurized lines!



CAUTION

Risk of injury by improper handling of batteries!

3.2 Instructions with Regard to Specific Dangers

Protection Against Contact with Electrical Parts

Note: This section only concerns devices and drive components with voltages of more than 50 Volt.

Contact with parts conducting voltages above 50 Volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.



DANGER

High electrical voltage! Danger to life, electric shock and severe bodily injury!

- ⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.
- ⇒ Follow general construction and safety regulations when working on electrical power installations.
- ⇒ Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.
- ⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- ⇒ Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit. Provide a safeguard to prevent reconnection.
- ⇒ With electrical drive and filter components, observe the following:
Wait 30 minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.
- ⇒ Never touch the electrical connection points of a component while power is turned on.
- ⇒ Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.
- ⇒ A residual-current-operated circuit-breaker or r.c.d. cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device according to the relevant standards.
- ⇒ Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.

European countries: according to EN 50178/ 1998,

section 5.3.2.3.

USA: See National Electrical Code (NEC), National Electrical Manufacturers' Association (NEMA), as well as local engineering regulations. The operator must observe all the above regulations at any time.

With electrical drive and filter components, observe the following:



DANGER

**High housing voltage and large leakage current!
Risk of death or bodily injury by electric shock!**

- ⇒ Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.
- ⇒ The equipment grounding conductor of the electrical equipment and the units must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.
- ⇒ Over the total length, use copper wire of a cross section of a minimum of 10 mm² for this equipment grounding connection!
- ⇒ Before start-up, also in trial runs, always attach the equipment grounding conductor or connect with the ground wire. Otherwise, high voltages may occur at the housing causing electric shock.

Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 5 and 50 Volt at Rexroth products are protective extra-low voltage systems which are provided with touch guard according to the product standards.



WARNING

**High electric voltage by incorrect connection!
Risk of death or bodily injury by electric shock!**

- ⇒ To all connections and terminals with voltages between 0 and 50 Volt, only devices, electrical components, and conductors may be connected which are equipped with a PELV (Protective Extra-Low Voltage) system.
- ⇒ Connect only voltages and circuits which are safely isolated from dangerous voltages. Safe isolation is achieved for example by isolating transformers, safe optocouplers or battery operation without mains connection.

Protection Against Dangerous Movements

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

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

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

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material 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.

**DANGER****Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!**

⇒ For the above reasons, ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation.

They have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

⇒ Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:

- use safety fences
- use safety guards
- use protective coverings
- install light curtains or light barriers

⇒ Fences and coverings must be strong enough to resist maximum possible momentum.

⇒ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the device if the emergency stop is not working.

⇒ Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.

⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.

⇒ Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example:

- mechanically securing the vertical axes,
- adding an external braking/ arrester/ clamping mechanism or
- ensuring sufficient equilibration of the vertical axes.

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!

- ⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection 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 electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.
-

Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.



WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

- ⇒ Persons with heart pacemakers and metal implants are not permitted to enter following areas:
 - Areas in which electrical equipment and parts are mounted, being operated or commissioned.
 - Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.
 - ⇒ If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The interference immunity of present or future implanted heart pacemakers differs greatly, so that no general rules can be given.
 - ⇒ Those with metal implants or metal pieces, as well as with hearing aids must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.
-

Protection Against Contact with Hot Parts



CAUTION

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

- ⇒ Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!
 - ⇒ Do not touch housing surfaces of motors! Danger of burns!
 - ⇒ According to operating conditions, temperatures can be **higher than 60 °C, 140 °F** during or after operation.
 - ⇒ Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require **up to 140 minutes!** Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.
 - ⇒ After switching drive controllers or chokes off, 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, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.
-

Protection During Handling and Mounting

In unfavorable conditions, handling and assembling certain parts and components in an improper way can cause injuries.



CAUTION

Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!

- ⇒ Observe the general construction and safety regulations on handling and assembly.
- ⇒ Use suitable devices for assembly and transport.
- ⇒ Avoid jamming and bruising by appropriate measures.
- ⇒ Always use suitable tools. Use special tools if specified.
- ⇒ Use lifting equipment and tools in the correct manner.
- ⇒ If necessary, use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
- ⇒ Do not stand under hanging loads.
- ⇒ Immediately clean up any spilled liquids because of the danger of skidding.

Battery Safety

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



CAUTION

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 recharge the batteries as this may cause leakage or explosion.
- ⇒ Do not throw batteries into open flames.
- ⇒ Do not dismantle batteries.
- ⇒ Do not damage electrical parts installed in the devices.

Note: Environmental protection and disposal! The batteries installed 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 separate from other waste. Observe the local regulations in the country of assembly.

Protection Against Pressurized Systems

According to the information given in the Project Planning Manuals, motors cooled with liquid and compressed air, as well as drive controllers, can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids, and cooling lubricating agents. In these cases, improper handling of external supply systems, supply lines, or connections can cause injuries or damages.



CAUTION

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 dismantling lines, relieve pressure and empty medium.
- ⇒ Use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
- ⇒ Immediately clean up any spilled liquids from the floor.

Note: Environmental protection and disposal! The agents used to operate the product might not be economically friendly. Dispose of ecologically harmful agents separate from other waste. Observe the local regulations in the country of assembly.

4 Brief Description, Applications

In terms of "Appropriate Use", cases of operation and applications not mentioned in this chapter are not allowed.

4.1 Applications of the Drive System Rexroth IndraDrive

The digital intelligent automation system Rexroth IndraDrive is the cost-efficient solution with a high degree of functionality for single-axis and multi-axis drive and control tasks.

The IndraDrive automation system can be used for realizing a large number of drive tasks in the most varied applications.

Applications Typical applications are the industrial sectors

- printing and paper converting
- packaging and food
- mounting and handling
- wood machining
- machine tools
- metal forming
- general automation

For these applications there are different device types of graduated performance available.

4.2 Mains Transformers DST and DLT

Applications

DST and DLT transformers are used to transform mains voltages to the allowed nominal voltage of the device.

DLT transformers are used to

- prevent overvoltage between outer conductor and ground
- keep away leakage currents from other loads

Device type	Application
DST autotransformer	adjusting voltage range in grounded mains
DLT isolating transformer	adjusting voltage range in ungrounded mains

Fig. 4-1: Transformer applications

Note: As a matter of principle, DLT isolating transformers have to be used at ungrounded mains.

4.3 Mains Filters HNF, HNK, NFE, HNS02, and NFD

Applications

Mains filters are used to

- reduce radio interference
- reduce mains pollution

The different mains filters can be used as follows:

Device type	Application
NFE01.1	mains filter for interference suppression of supply units up to 230 V
NFE02.1	mains filter for interference suppression of single-phase drive controllers up to 230 V
NFD03.1	mains filter for interference suppression of three-phase drive controllers up to 480 V for 1-6 axes and motor cable lengths up to max. 75 m single-axis / 120 m multi-axis (HCS02.1E)
HNF01.1	mains filter for interference suppression of three-phase drive controllers up to 480 V for drive systems with a high number of axes and long motor cables, as well as for reduction of leakage current
HNK01.1	mains filter for interference suppression of three-phase drive controllers HCS03.1E up to 500 V
HNS02	mains filter for interference suppression of three-phase drive controllers up to 480 V for drive systems with a maximum of 12 axes and a maximum of 150 m motor cable; integrated switch-disconnector

Fig. 4-2: Mains filter applications

Note: Use only expressly allowed components at the mains filters.
Example: You are not allowed to operate fans, pumps etc. at mains filters HNF.

See also section 8.3 Measures to Reduce Noise Emission section Protecting Mains Filters Against Overload.

4.4 Mains Chokes HNL01 and HNL02

Applications HNL01.1E, HNL01.1R and HNL02.1R

(**Standard**) mains chokes HNL01.1E, HNL01.1R and HNL02.1R are used to

- reduce harmonics in the mains current
- increase the allowed DC bus continuous power
- operate regenerative supply modules at the mains

Current-compensated mains chokes HNL01.1E-****-S and HNL01.1R-****-S are used to reduce line-frequency, asymmetric currents in the mains connection phase of the drive system.

The different types can be used **exclusively** as follows:

Device type	Application
HNL01.1R	mains chokes for connection to components with regeneration to the supply mains (HMV01.1R)
HNL01.1E	mains chokes for connection to components without regeneration to the supply mains (HMV01.1E, HCS02.1E; HCS03.1E)
HNL01.1*****-S	current-compensated chokes for use with HNL01.1 mains chokes to reduce line-frequency leakage currents (HMV01.1E, HMV01.1R; HCS02.1E; HCS03.1E)
HNL02.1R	mains chokes in housing for control cabinet mounting for connection to components with regeneration to the supply mains (HMV02.1R)

Fig. 4-3: Mains choke applications

4.5 Supply Units HMV01 / HMV02

Applications

HMV supply modules are used to supply modular devices HMS and HMD.

The different supply modules can be used as follows:

Device type	Application
HMV01.1E	infeeding to supply drive controllers HMS01 and HMD01
HMV01.1R	regenerative to supply drive controllers HMS01 and HMD01
HMV02.1R	regenerative to supply drive controllers HMS01, HMS02 and HMD01

Fig. 4-4: Supply module applications

4.6 Drive Controllers HMD01, HMS01

Applications

Drive controllers HMS and HMD are used to operate single axes or two axes in modular systems.

The different drive controllers can be used as follows:

Device type	Application
HMD01.1	have two power outputs to operate two motors independently of each other are used at HMV supply modules and HCS drive controllers
HMS01.1	have a power output to operate a motor are used at HMV01 supply modules and HCS02 and HCS03 drive controllers
HMS02.1	have a power output to operate a motor are used at HMV02 supply modules and HCS02 drive controllers

Fig. 4-5: Drive controller HM* applications

4.7 Control Sections CSH01, CSB01, CDB01

Applications

Control sections CSH, CSB and CDB are used to operate drive controllers HMS, HMD and HCS.

The different control sections can be used as follows:

Device type	Application
CSH01	Advanced is used in HMS, HCS02 and HCS03 drive controllers
CSB01	BASIC single-axis is used in HMS, HCS02 and HCS03 drive controllers
CDB01	BASIC double-axis is used in HMD01 drive controllers

Fig. 4-6: Control section applications

4.8 Drive Controllers HCS02

Applications

Drive controllers HCS02 are used to operate single axes.

The different drive controllers can be used as follows:

Device type	Application
HCS02	have a power output to operate a motor cover the power range from 1.5 kW to 11 kW

Fig. 4-7: Drive controller HCS applications

4.9 Drive Controllers HCS03

Applications

Drive controllers HCS03 are used to operate single axes.

The different drive controllers can be used as follows:

Device type	Application
HCS03	have a power output to operate a motor cover the power range from 18,5 kW to 75 kW

Fig. 4-8: Drive controller HCS applications

Note: In their standard design -NNNV, drive controllers HCS03 are not regenerative.
For applications where regenerative power is generated, use HCS03.1 of the -NNBV design and HLR braking resistors as additional components.

4.10 DC Bus Resistor Unit HLB01

Applications

DC bus resistor units HLB01 are used to

- convert generated kinetic energy into thermal energy
- increase the continuous regenerative power in the drive system
- increase the peak regenerative power in the drive system
- have the DC bus short circuit function available in the drive system

The different DC bus resistor units can be used as follows:

Device type	Applications
HLB01.1C	in drive systems with components of the product range Rexroth IndraDrive C and Rexroth IndraDrive M
HLB01.1D	in drive systems with components of the product range Rexroth IndraDrive M

Fig. 4-9: DC bus resistor unit HLB applications

4.11 Braking Resistor HLR01

Applications

Braking resistors HLR01 are used to convert generated kinetic energy into thermal energy.

The different braking resistors can be used as follows:

Device type	Application
HLR01	in drive controllers of the Rexroth IndraDrive C range; for this purpose, the drive controllers have to be equipped with a standard or optional brake chopper

Fig. 4-10: DC bus resistor units HLR

4.12 DC Bus Capacitor Units HLC01

Applications

DC bus capacitor units HLC01 are used to store energy in the DC bus of the drive system.

The different DC bus capacitor units can be used as follows:

Device type	Application
HLC01.1C	in drive systems of the product ranges Rexroth IndraDrive C and Rexroth IndraDrive M
HLC01.1D	in drive systems of the product ranges Rexroth IndraDrive C and Rexroth IndraDrive M

Fig. 4-11: DC bus capacitor unit HLC applications

4.13 Motor Filters HMF01

Applications

HMF01 motor filters are used to

- reduce the rise of the output voltage of drive controllers
- reduce leakage currents of the motor lines
- reduce interference voltage on the motor lines

The different motor filters can be used as follows:

Device type	Application
HMF01.1	at the motor output of HCS03 drive controllers

Fig. 4-12: Motor filter HMF01 applications

4.14 Accessories HAS

Applications

HAS accessories are used to support the operation and combination of components in the drive system Rexroth IndraDrive.

The different accessories and their use are described in chapter "Accessories".

4.15 Housing HAC01 for Control Sections

Applications

The additional component HAC01 is used to

- insert control sections in it
- supply control sections with 24V control voltage

Device type	Application
HAC01.1-002-NNN-NN	to insert CDB01 control sections in it

Fig. 4-13: HAC01 type

5 Specifications for the Components of the Drive System

5.1 Tests and Certifications

Certifications

Declaration of Conformity

For Rexroth IndraDrive components there are declarations of conformity available. These declarations confirm, that the components are designed according to valid EC directives. If required, you can ask your sales representative for these declarations.

CE Label



Fig. 5-1: CE label

C-UL-US Listing

The components are labeled:



Fig. 5-2: C-UL-US label

C-UL-US Listed Components

Product	Component	File Number
HMS01.1N-	W0020, W0036, W0054, W0070, W0150, W0210	E 134201
HMS02.1N-	W0028, W0054	E 134201
HMD01.1N-	W0012, W0020, W0036	E 134201
HCS02.1E-	W0012, W0028, W0054, W0070	E 134201
HCS03.1E-	W0070, W0100, W0150, W0210	Manufacturer REFU E254781
HMV01.1E-	W0030-A-07, W0075-A-07, W0120-A-07	E 134201
HMV01.1R-	W0018-A-07, W0045-A-07, W0065-A-07	E 134201
HMV02.1R-	W0015	E 134201

Product	Component	File Number
HLB01.1C-	01K0-N06R0-A-007-NNN	E 134201
HLB01.1D-	02K0-N03R4-A-007-NNN	E 134201
HLC01.1C-	01M0-A-007, 02M4-A-007	E 134201
HLC01.1D-	05M0-A-007	E 134201
NFD03.1-	-007, -016, -030, -055, -075, -130, -180	E 172117 and CSA Cert. 1038841 Master Contr. 171321
HNL01.1-	CSA Cert. 1492099 Master Contr. 222887
HNF01.1	In Vorbereitung	E 134201
HNK01.1	In Vorbereitung	E 134201
HLR01.1	In Vorbereitung	E 134201

Fig 5-3: c-UL-US listed Rexroth IndraDrive components

Note: The components are listed by the file number of "Underwriters Laboratories Inc.®" (UL). The documented evidence of listing can be seen on the internet: <http://www.ul.com>, "Certifications", enter file number or "Company name": Rexroth.

The control sections are included in the listing of the power sections. The control sections are not listed separately.

Note: For using the devices in the scope of C-UL, take the C-UL limit values of the individual devices into account. In addition, take the following aspects into account:

- use 60/75 °C copper wire only for mains connection
- use Class 1 wire only or equivalent for mains connection
- mains connection suitable for use on a circuit capable of delivering not more than 8 kA (10 kA) rms symmetrical amperes for a maximum voltage of 500 V (400 V)

CCC (China Compulsory Certification)

The CCC test symbol comprises a required certification of safety and quality for certain products, which are mentioned in the product catalog "First Catalogue of Products Subject to Compulsory Certification" and the CNCA document "Application Scope for Compulsory Certification of Products acc. first Catalogue" and are put in circulation in China. This required certification has been existing since 2003.

CNCA is the responsible Chinese authority for directives of certifications. When a product is imported in China, the certification will be checked at the customs by means of entries in a data base. For requirement of certification three criteria are normally relevant:

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

For Rexroth drive components described in this documentation a **certification is not required yet**, thus they are not CCC certified. Negative certifications will not be issued.

Tests

Tests

high-voltage test	routine test according to EN50178
high voltage and insulation test	routine test according to EN50178
separation between control and power voltage circuits	safe separation according to EN50178
clearances and creepage distances	according to EN50178

Fig. 5-4: Tests

Applied-Overvoltage Withstand Test

Observe the following note before you carry out a high voltage test or an applied-overvoltage withstand test.

Note: Disconnect all connections to the devices or disconnect the plug-in connections to protect the electronic components.

5.2 Transport and Storage

Transport of the Devices

Conditions

temperature	-25...70 °C
relative humidity	5...95%; climatic category 2K3
absolute humidity	1...60 g/m ³ climatic category 2K3
moisture condensation	not allowed
icing	not allowed
shock test out of operation according to EN 60068-2-27	half sine in 3 axes: 10g / 11ms

Fig. 5-5: Conditions for transport

Storage of the Devices

Conditions

temperature	-25...55 °C
relative humidity	5...95%; climatic category 1K3
absolute humidity	1...29 g/m ³ climatic category 1K3
moisture condensation	not allowed
icing	not allowed

Fig. 5-6: Conditions for storage

Extended Storage

Some devices contain electrolytic capacitors which may deteriorate during storage.

-
- Note:** When storing these devices for a longer period of time, operate them once a year for at least 1 hour with power ON:
- devices HCS and HMD with mains voltage U_{LN}
 - devices HMS, HMD, HLC with DC bus voltage U_{DC}
-

5.3 Installation Conditions

Ambient and Operating Conditions

The drive controllers and their additional components are designed for control cabinet mounting!

Note: The user must check that the ambient conditions, in particular the control cabinet temperature, are complied with by calculating the heat levels in the control cabinet and making the corresponding measurements.

In the Technical Data the power dissipation is indicated as an input value for calculating the heat levels.

Designation	Data
degree of protection	IP20 according to IEC529
ambient temperature	0...+40 °C
ambient temperature with power reduction	0...+55 °C; see characteristic in Fig. 5-8
temperature during storage	see section 5.2 Transport and Storage
temperature during transport	see section 5.2 Transport and Storage
installation altitude with nominal data	< 1000 m above sea level
installation altitude with power reduction *	see characteristic in Fig. 5-9
maximum installation altitude *	4000 m (upper temperature level reduced to 40 °C instead of 55 °C)
relative humidity (operation)	5%...95% Cl.3K5 with restriction, as not -5 °C
absolute humidity	1...29 g/m ³
climatic category	Cl. 3K3 according to IEC721
degree of dirt contamination	degree of dirt contamination 2 in accordance with EN50178
dust, steam	allowed according to EN 50178, table A.2
sine vibration during operation according to EN 60068-2-6	amplitude and frequency: 0.15 mm (peak-peak) at 10...57 Hz acceleration and frequency: 1 g at 57...150 Hz tolerance: ±15 %
noise vibration (random) during operation according to IEC 68-2-36	frequency: 20...150 Hz spectral acceleration density amplitude: 0.005 g ² /Hz tolerance: ± 3 dB rms value of the total acceleration: 1.0 g

* For installation altitudes of more than 2000 m, an overvoltage limiter for transient overvoltage 1.2/50 μs must be installed in the installation or building in order to limit the voltage to 1.0 kV between the outer conductors and to 2.5 kV between conductor-ground.

Fig. 5-7: Ambient and operating conditions

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 our controls and drives, it cannot be completely ruled out that any reactions with the materials used by Bosch Rexroth 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/our housing materials.

Capacity Utilization

Where installation conditions differ, the following performance data are reduced in accordance with the diagrams (see "Fig. 5-8: Capacity utilization at higher ambient temperature" and "Fig. 5-9: Capacity utilization at higher installation altitude"):

drive controller:

- allowed continuous DC bus power
- continuous power of braking resistor
- continuous current

motor:

- power
- continuous torque at standstill
- S1 continuous torques
- short-time service torque MKB

If differing ambient temperatures and higher installation altitudes occur simultaneously, both capacity utilization factors must be multiplied. The installation altitude must only be taken into account once, deviating ambient temperatures must be taken into account separately for motor and drive controller.

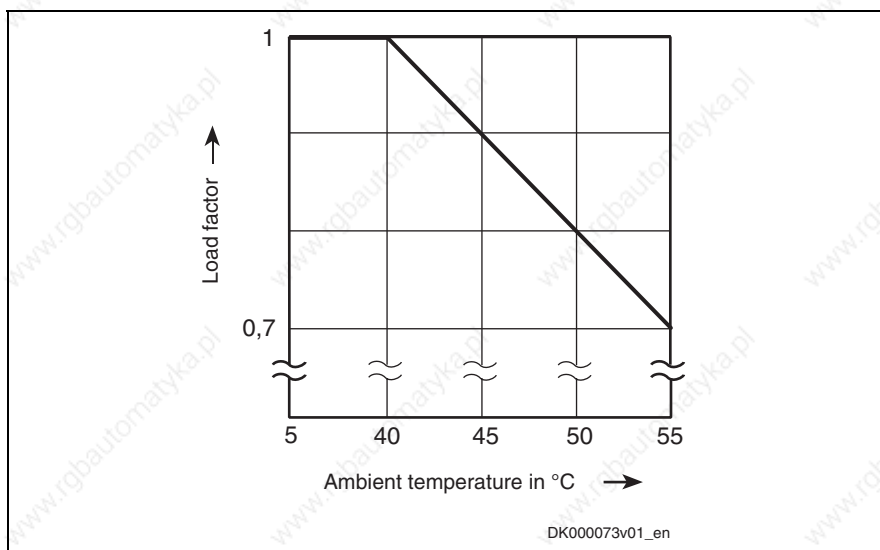


Fig. 5-8: Capacity utilization at higher ambient temperature

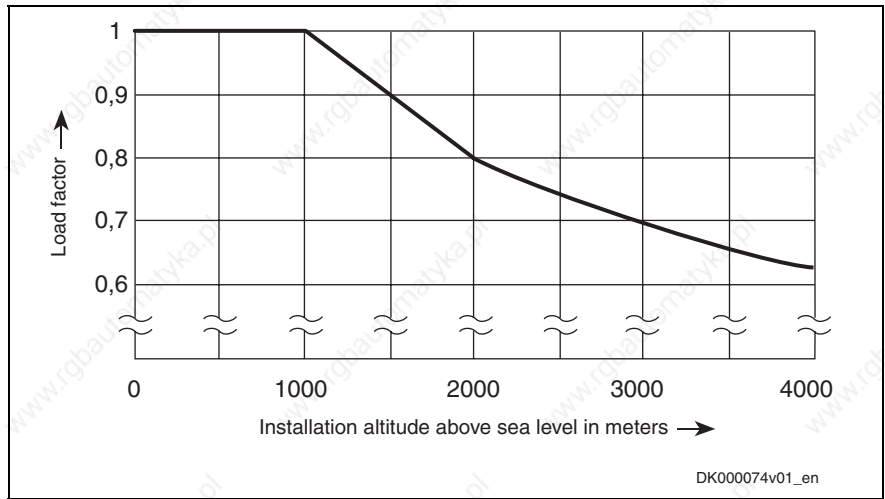


Fig. 5-9: Capacity utilization at higher installation altitude

5.4 Supply Voltages

Control Voltage 24V Supply

For the devices of the IndraDrive range, the specifications for supply with control voltage contained in the table below are generally valid.

Standard Range and Extended Range of Control Voltage

Designation	Symbol	Unit	Value
standard range of control voltage	U_{N3}	V	<ul style="list-style-type: none"> $24 \pm 5\%$
extended range of control voltage	U_{N3}	V	<ul style="list-style-type: none"> $24 \pm 20\%$ (if no motor holding brake has to be supplied) If motor holding brakes are to be supplied, observe the data of the motor documentation. The following values are normally sufficient: $24 \pm 5\%$ at motor cable length < 50 m $26 \pm 5\%$ at motor cable length > 50 m
max. ripple content	w	-	mustn't exceed the control voltage range
max. allowed overvoltage	U_{N3max}	V	33 (max. 1 ms)

Fig. 5-10: Control voltage

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

This equipment includes:

- 24V power supply units that reduce incoming overvoltages 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 overvoltages by inductive or capacitive coupling.

Assignment of Control Voltage Ranges

Designation	Supply units	Drive controllers	Additional components
standard range of control voltage	HMV01.1E HMV01.1R HMV02.1R		HLB01.1D
extended range of control voltage		HMS01.1 HMS02.1 HMD01.1 HCS02.1E HCS03.1E	HLB01.1C

Abb. 5-11: Assignment of control voltage

Note: Observe section 10.4 Limit Values for Interference-Free Operation at Mains also for the 24 V voltage supply.
For HVM supply units use 24 V supplies with buffer times of 100 ms at least (e.g. UPS), if commutation drops and short-time interruptions in the application exceed the specified values.

Power Voltage Supply

For the devices of the IndraDrive range, the specifications for supply with power voltage contained in the table below are generally valid.

The indicated values represent the common **standard range**.

Standard Range of Power Voltage

Designation	Symbol	Unit	Values
allowed range of mains input voltage, three-phase; TN-S, TN-C, TT mains	U_{LN}	V	3 * AC (400...480) +10% -15%
allowed range of mains input voltage, three-phase; IT mains	U_{LN}	V	3 * AC 230 +10% -10%
rotary field			no rotary field condition
allowed range of mains frequency	f_{LN}	Hz	(50...60) + - 2
max. allowed mains frequency change	$d f_{LN}/t$	Hz/s	2% * f_{LN}

Fig. 5-12: Standard range of power voltage

Depending on the device characteristic, the following **extended range** can be used for power voltage supply.

Extended Range of Power Voltage

Designation	Symbol	Unit	HCS02.1E	HMV01.1E HMV01.1R	HCS03.1E
allowed range of mains input voltage, three-phase; TN-S, TN-C, TT mains	U_{LN}	V	3 * AC (200...500) + -10%	3 * AC (230...480) + -10%	3 * AC (400...500) +10% -15%
allowed range of mains input voltage, three-phase; IT mains	U_{LN}	V	3 * AC (200...230) + -10%	3 * AC 230 + -10%	not allowed
allowed range of mains input voltage, single-phase	U_{LN}	V	1 * AC (200...250) + -10%	not allowed	not allowed

Fig. 5-13: Extended range of power voltage

Note: When using HCS02 and HCS03 devices in the mains voltage range up to 3 * AC 500 V, make sure the additional components you use may be operated in this mains voltage range. NFD mains filters, for example, can only be used up to 3 * AC 480 V.

6 Configuration of the Drive System Rexroth IndraDrive

6.1 Allowed Combination of Individual Components in Drive System Rexroth IndraDrive

Within the product range Rexroth IndraDrive you may combine components of the subranges Rexroth IndraDrive C and Rexroth IndraDrive M.

Allowed Combination of Range Components from IndraDrive M and IndraDrive C

Drive controller or supply unit	Range components				
	HMS01	HMS02	HMD01	HCS02	HCS03
HMV01	X	--	X	--	--
HMV02	--	X	--	--	--
HCS02	X	--	X	X	--
HCS03	X	--	X	--	X

X: allowed
--: not allowed

Fig. 6-1: Combination of range components

Allowed Combinations with Additional Components

Drive controller or supply unit	HLB01.1C	HLB01.1D	HLC01.1C	HLC01.1D	HLR01.1	HMF01.1
HMV01.1E	--	X	X	X	--	--
HMV01.1R	--	X	X	X	--	--
HMV02.1R	X	--	X	--	--	--
HCS02.1	X	X	X	X	X	--
HCS03.1	--	X	--	X (1)	X	X

X: allowed
--: not allowed
(1) only allowed for HCS03.1E-...-W0210 (not allowed for W0070, W0100, W0150)

Fig. 6-2: Combinations with additional components

Note: For simultaneous operation of HLR01 and HLB01 at HCS02 and HCS03 observe the following aspects:

- The continuous power of the selected HLR01 has to be at least as high as the continuous power of the HLB used.
- Due to differences in balance, the total continuous power available is lower than the sum of the individual continuous powers.

Allowed Components in Mains Connection Phase

Note: Operating supply units with regeneration back to the mains **requires** components mains choke and mains filter appropriate for this purpose in the mains connection phase.
Make sure the type code sections **-R** or **-E** are matching.

Drive controller or supply unit	Auto-transf.	Isolating transf.	Mains filter			Mains filter with		Mains choke		
						mains choke	switch disconnector			
	DST	DLT	NFD 03.1	HNF01.1* ****-R****	HNF01.1* ****-E****	HNK 01.1	HNS 02.1	HNL01.1E; HNL01.1E- ****-S	HNL01.1R; HNL01.1R- ****-S	HNL 02.1
HMV01.1E	X	X	--	--	X	--	--	X	--	--
HMV01.1R	X	X	--	X	--	--	--	--	X	--
HMV02.1R	X	X	--	--	--	--	X	--	--	X
HCS02.1E	X	X	X	X ¹⁾	X ¹⁾	--	--	X	--	--
HCS03.1E	X	X	--	X ¹⁾	X ¹⁾	X	--	X	--	--

X: allowed

--: not allowed

1) take minimum capacitance against ground at DC bus into account

Fig. 6-3: Combination in mains connection phase

Minimum Capacitance against Ground

Note: Using HNF01.1 mains filters requires minimum capacitance against ground at the DC bus of the connected drive controllers.

The minimum capacitance is 330 nF against ground at each of L+ and L-.

The required capacitance at L+ and L- against ground is made available by the drive controllers or supply units. For the value see the technical data "capacitance power section against housing - C_{Kop} "; the table below contains an excerpt and indicates whether additional capacitances against ground are required.

Drive controller / supply unit	Capacitance against housing [nF]	Additional capacitances against ground required?
HMS01	2 * 100	for supply via HCS; not at HMV
HMD01	2 * 68	for supply via HCS; not at HMV
HCS02	2 * 100	for less than 4 HCS02 drive controllers; for supply of less than 3 HMS01 / HMD01
HCS03	2 * 100	for less than 4 HCS03 drive controllers; for supply of less than 3 HMS01 / HMD01
HAS04	2 * 470	--
HMV01.1E	2 * 470	no
HMV01.1R	2 * 470	no
HMV02.1R	2 * 470	no

Fig. 6-4: Capacitances at L+ and L-

The requirement of minimum capacitance is, for example,

- fulfilled when using 4 * HMS01
- not fulfilled when using 4 * HMD01
- fulfilled when using 1 * HAS04 (accessory for HCS)
- fulfilled when using the HMV01 and HMV02 supply units
- fulfilled when using 1 * HAS04 at an HCS02 in group supply without DC bus connection

Combination HMV01, HMV02 with HMS/HMD (Rexroth IndraDrive M)

Group Supply with DC Bus Connection HMV01, HMV02 (Parallel Operation)

Parallel operation of HMV01.1 supply units increases the available DC bus power.

Parallel operation of HMV01 supply units

- is only allowed with HMV01.1E supply units of the same type current
- requires an individual mains choke for each supply unit (for current sharing)
- does not increase the max. allowed number if drive controllers or axes for operation without mains filter
- requires a control circuit master-slave; see chapter "Control Circuits"
- for detailed information on derating and mounting, the specification with document number 109-1261-4102-** is available on request.

Supply unit type	Max. allowed number of supply units at common DC bus							
	E-W**** (infeeding)			R-W**** (regenerative)				
HMV01.1	0030	0075	0120	0018	0045	0065	0120	0016
HMV01.1E-W0030	--	--	--	--	--	--		
HMV01.1E-W0075	--	2	--	--	--	--		
HMV01.1E-W0120	--	--	2	--	--	--		
HMV01.1R-W0018	--	--	--	1	--	--		
HMV01.1R-W0045	--	--	--	--	1	--		
HMV01.1R-W0065	--	--	--	--	--	1		
HMV01.1R-W0120	--	--	--	--	--	--	1	
HMV02.1R-W0015	--	--	--	--	--	--	--	1

--: not allowed

Fig. 6-5: Parallel operation HMV01

Note: Instead of using two W0030 devices connected in parallel, it is better to use one W0075 device.

Central Supply HMV01, HMV02

Up to the indicated maximum allowed number, drive controllers may be combined at the common DC bus according to the table below. The number is limited by the ability of HMV to charge Y-capacitors in connected components.

Note: At the common DC bus means that the DC bus connections of the involved devices are interconnected.

Allowed IndraDrive M components at common DC bus with supply via HMV01.1 devices					
supply unit	HMS	HMD01.1N	max. allowed number of axis	HLB01.1	HLC01.1
HMV01.1E-W0030	up to max. W0070	up to max. W0036	21 (21 * HMS01 or 11* HMD01)	2	take max. allowed external DC bus capacitance C_{DCext} into account
HMV01.1E-W0075	up to max. W0210	up to max. W0036			
HMV01.1E-W0120	up to max. W0210	up to max. W0036			
HMV01.1R-W0018	up to max. W0054	up to max. W0036			
HMV01.1R-W0045	up to max. W0150	up to max. W0036			
HMV01.1R-W0065	up to max. W0210	up to max. W0036			
HMV01.1R-W0120	up to max. W0210	up to max. W0036			
HMV02.1R-W0015	up to max. W0054	--	12 (12 * HMS02)		

Fig. 6-6: Allowed Rexroth IndraDrive M components at common DC bus



CAUTION

Damage to the supply unit!

- ⇒ Do not exceed allowed peak and continuous powers in the DC bus.
- ⇒ Observe minimum value of mean phase control factor $\bar{\alpha}$ (see section "Calculations").

Note: Depending on the mains filter used and the mains choke, the number of axes is additionally restricted.

Combination HCS02 with HCS02 (Rexroth IndraDrive C)

Group Supply with DC Bus Connection HCS02 (Parallel Operation)

Note: Group supply with DC bus connection is only allowed with HCS02.1E drive controllers of the same type current.

Up to the indicated maximum allowed number of axes, drive controllers with braking resistor may be combined at the common DC bus according to the table below.

Note: At the common DC bus means that the DC bus connections of the involved devices are interconnected.

Type of mains connect. (1)	Maximum number of IndraDrive C components at common DC bus					
	HCS02.1E-				HLB01.1	HLC01.1
group supply with DC bus connection	W0012	W0028	W0054	W0070		
HCS02.1E-W0012	--	--	--	--	--	--
HCS02.1E-W0028	--	8	--	--	1	1
HCS02.1E-W0054	--	--	6	--	1	1
HCS02.1E-W0070	--	--	--	4	1	1

--: not allowed
(1) for explanation see chapter "Types of Mains Connection"
Fig. 6-7: Maximum number of IndraDrive C components at common DC bus

Central Supply HCS02 with HCS02

Up to the indicated maximum allowed number of axes, drive controllers with braking resistor may be combined at the common DC bus according to the table below. The number is limited by the ability of the supplying HCS02 to charge Y-capacitors.

You may make replacements up to the maximum allowed sum of the type currents.

Type of mains connect. (1)	Maximum number of IndraDrive C components at common DC bus				
	HCS02.1E	max. allowed sum of type currents	max. allowed number of axes	HLB01.1C	HLC01.1C
central supply via HCS02.1E-W0028	--	--	--	1	1
central supply via HCS02.1E-W0054 without assigned mains choke	up to max. W0054	166	12	1	1
central supply via HCS02.1E-W0054 with assigned mains choke	up to max. W0054	222	12	1	1
central supply via HCS02.1E-W0070 without assigned mains choke	up to max. W0070	264	12	1	1
central supply via HCS02.1E-W0070 with assigned mains choke	up to max. W0070	402	12	1	1

--: not allowed

(1) for explanation see chapter "Types of Mains Connection"

Fig. 6-8: Maximum number of IndraDrive C components at common DC bus

Example central supply via **HCS02.1E-W0070 with** assigned HNL01.1 mains choke:

- 1 * HCS02.1E-W0070 (supplying device)
- 7 * HCS02.1E-W0028
- 2 * HCS02.1E-W0054
- 1 * HCS02.1E-W0070
- 1 * HLB01.1C
- 1 * HLC01.1C

Checking the combination:

Checking the sum of type currents to be supplied:

$$7 \cdot 28 + 2 \cdot 54 + 1 \cdot 70 = 374; 374 < 402$$

→ Sum of type currents is allowed

Checking the sum of drive controllers:

$$1 \cdot 1 + 7 \cdot 1 + 2 \cdot 1 + 1 \cdot 1 = 11; 11 < 12$$

→ max. allowed number of axes is not exceeded

Checking the sum of drive controllers with braking resistor:

$$1 \cdot 1 + 7 \cdot 1 + 2 \cdot 1 + 1 \cdot 1 + 1 \cdot 1 = 12; 12 \leq 12$$

→ max. allowed number of drive controllers is not exceeded



CAUTION

Damage to the drive controller!

⇒ Do not exceed allowed peak and continuous powers in the DC bus.

Combination HCS03 with HCS03 (Rexroth IndraDrive C)

Note: Group supply with DC bus connection is only allowed with HCS03.1E drive controllers of the same type current.

Note: At HCS03.1E drive controllers, do **not** operate any external additional capacitances at the DC bus.

Exceptions:

For drive controllers HCS03.1E-...-W0210 this is allowed.

Operating HAS accessories with capacitances against housing is allowed.

Group Supply with DC Bus Connection HCS03 (Parallel Operation)

Type of mains connect. (1)	Maximum number of IndraDrive C components at common DC bus					
	HCS03.1E-				HLB01.1	HLC01.1
group supply with DC bus connection	W0070	W0100	W0150	W0210		
HCS03.1E-W0070	10	--	--	--	1	--
HCS03.1E-W0100	--	8	--	--	1	--
HCS03.1E-W0150	--	--	6	--	1	--
HCS03.1E-W0210	--	--	--	4	1	take max. allowed external DC bus capacitance C_{DCext} into account

--: not allowed

(1) for explanation see chapter "Types of Mains Connection"

Fig. 6-9: Maximum number of IndraDrive C components at common DC bus

Example parallel operation of HCS03.1E: 6 * HCS03.1E-W00150

Central Supply HCS03

Central supply of HCS03.1E is not allowed with HCS03.1E drive controllers.

Combination HCS02 with HMS / HMD (Rexroth IndraDrive C with Rexroth IndraDrive M)

Combining HCS02 drive controllers with HMS / HMD requires using

- accessory HAS04 (capacitances at DC bus against ground)
- accessory HAS03 (to adjust different mounting depths)
- additional capacitors at the DC bus (external DC bus capacitance C_{DCext}), if
 - the output currents I_{out} in the arithmetical mean, are **greater than** I_{out} of the device to be supplied
 - the resulting load profiles of the output currents I_{out} and the DC bus power P_{DC} (superposition of the individual load profiles) are **greater than** the allowed load profiles.

Note: To determine the required capacitance values the following **guide values** apply when using HLC01.1 DC bus capacitor unit:

- **10 uF** per A type current for HMS01 drive controllers
- **20 uF** per A type current for HMD01 drive controllers

Central Supply HCS02 with HMS / HMD

Up to the indicated maximum allowed number of axes, drive controller **axes** may be combined at the common DC bus according to the table below.

You may make replacements up to the maximum allowed sum of the type currents.

HMD01.1N drive controllers add the double value of their type currents to the sum of allowed type currents.

Type of mains connect. (1)	Allowed IndraDrive M components at common DC bus with supply via HCS02.1E devices				
	HMS01.1N-	HMD01.1N-	max. allowed sum of type currents	max. allowed number of axes	HLC01.1
central supply via HCS02.1E-W0028	--	--	--	12 (12 * HMS01 or 2 * HMS02 or 6 * HMD01)	--
central supply via HCS02.1E-W0054 without assigned mains choke	up to max. W0036	up to max. W0020	120		take max. allowed external DC bus capacitance C_{DCext} into account
central supply via HCS02.1E-W0054 with assigned mains choke	up to max. W0054	up to max. W0020	198		
central supply via HCS02.1E-W0070 without assigned mains choke	up to max. W0036	up to max. W0020	120		
central supply via HCS02.1E-W0070 with assigned mains choke	up to max. W0054	up to max. W0036	270		

--: not allowed
 (1) for explanation see chapter "Types of Mains Connection"
 Fig. 6-10: Maximum number of IndraDrive M components at common DC bus

Example central supply via **HCS02.1E-W0070** with assigned HNL01.1 mains choke:

- 1 * HCS02.1E-W0070 (supplying device)
- 1 * HMS01.1N-W0054
- 1 * HMS01.1N-W0036
- 1 * HMS01.1N-W0020
- 1 * HMD01.1N-W0036
- 1 * HMD01.1N-W0020
- 2 * HMD01.1N-W0012

Checking the combination:

1. Checking the sum of type currents to be supplied:
 $54 + 36 + 20 + 36 + 20 + 2 \cdot 12 \cdot 2 = 214$; $214 < 270$
→ Sum of type currents is allowed
2. Checking the sum of drive controller axes:
 $1 + 1 + 1 + 1 + 1 + 1 + 2 \cdot 2 = 9$; $9 < 12$
→ max. allowed number of axes is not exceeded

Note: HMS01, HMS02 and HMD01 are generally mounted to the right.

Mount the required HAS04 at the HCS02 mounted to the left.

Place the additional capacitance module HLC01.1 at the junction between HCS02.1 and HMS01.1 or HMD01.1.



CAUTION

Damage to the drive controller!

⇒ Do not exceed allowed peak and continuous powers in the DC bus.

Combination HCS03 with HMS / HMD

Note: For combinations HCS03 with HMD01 and HMS01 we recommend using brake chopper and braking resistor.
Using external DC bus capacitances C_{Dcext} is not required.

Central Supply HCS03 with HMS / HMD

Up to the indicated maximum allowed number of axes, drive controller **axes** may be combined at the common DC bus according to the table below.

You may make replacements up to the maximum allowed sum of the type currents.

HMD01.1N drive controllers add the double value of their type currents to the sum of allowed type currents.

Type of mains connect. (1)	Allowed IndraDrive M components at common DC bus with supply via HCS03.1E devices			
	HMS01.1N-	HMD01.1N-	max. allowed sum of type currents	max. allowed number of axes
central supply via HCS03.1E-W0070 without assigned mains choke HNL01.1	up to W0054	up to W0036	120	12 (12 * HMS01 or 6 * HMD01)
central supply via HCS03.1E-W0070 with assigned mains choke HNL01.1	up to W0054	up to W0036	270	
central supply via HCS03.1E-W0100 without assigned mains choke HNL01.1	up to W0070	up to W0036	270	
central supply via HCS03.1E-W0100 with assigned mains choke HNL01.1	up to W0070	up to W0036	270	
central supply via HCS03.1E-W0150 without assigned mains choke HNL01.1	up to W0070	up to W0036	270	
central supply via HCS03.1E-W0150 with assigned mains choke HNL01.1	up to W0070	up to W0036	270	
central supply via HCS03.1E-W0210 without assigned mains choke HNL01.1	up to W0150	up to W0036	270	
central supply via HCS03.1E-W0210 with assigned mains choke HNL01.1	up to W0150	up to W0036	270	

--: not allowed
X: allowed
(1) for explanation see chapter "Types of Mains Connection"
Fig. 6-11: Maximum number of IndraDrive M components at common DC bus

Example central supply via **HCS03.1E-W0070 with** assigned HNL01.1 mains choke:

- 1 * HCS03.1E-W0070 (supplying device)
- 1 * HMS01.1N-W0054
- 1 * HMS01.1N-W0036
- 1 * HMS01.1N-W0020
- 1 * HMD01.1N-W0036
- 1 * HMD01.1N-W0020
- 2 * HMD01.1N-W0012

Checking the combination:

1. Checking the sum of type currents to be supplied:
 $54 + 36 + 20 + 36 + 20 + 2 \cdot 12 \cdot 2 = 214$; $214 < 270$
 → Sum of type currents is allowed
2. Checking the sum of drive controller axes:
 $1 + 1 + 1 + 1 + 1 + 1 + 1 + 2 \cdot 2 = 9$; $9 < 12$
 → max. allowed number of axes is not exceeded



CAUTION

Damage to the drive controller!

⇒ Do not exceed allowed peak and continuous powers in the DC bus.

Combinations at Common DC Bus that are Not Allowed



CAUTION

Property damage caused by combinations that are not allowed!

⇒ Only operate allowed combinations.

Operating the following combinations **at the common DC bus** is not allowed

- HCS02 with HMV
- HCS03 with HMV
- HCS02 with HCS03
- HMS02 with HMS01

Note: Operating components not mentioned in this documentation at the common DC bus with Rexroth IndraDrive components requires Rexroth's explicit confirmation.

6.2 Allowed Combinations in Mains Connection Phase with Mains Chokes HNL, Mains Filters HNF and Mains Chokes HNK

The modular structure of the Rexroth IndraDrive system allows a multitude of combinations for mains connection.

The combinations of mains filters and mains chokes listed below are functionally allowed in the mains connection phase.

For the behavior of the combinations regarding EMC limit values, as well as restrictions, such as number of axes, see chapter "Electromagnetic Compatibility (EMC)".

You can use the following combinations up to the nominal power of the supply unit. If you want to use components with lower nominal data, you have to calculate the actually developed load in detail and make sure that the load is lower than the allowed load of the individual components in the mains connection phase.

Mains Connection Phase for HMV with Mains Chokes HNL and Mains Filters HNF

HMV01.1E Supply Units

Supply unit	Mains chokes	Mains filters	Explanation
HMV01.1E-W0030	HNL01.1E-0400-N0051	HNF01.1A-F240-E0051	standard combination
	without	HNF01.1A-F240-E0051	red. performance data see Project Planning Manual
	HNL01.1E-0400-N0051	HNF01.1A-M900-E0051	standard combination
	without	HNF01.1A-M900-E0051	red. performance data see Project Planning Manual
	HNL01.1E-0400-N0051 with HNL01.1E-5700-S0051	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
	without	without	not allowed
HMV01.1E-W0075	HNL01.1E-0200-N0125	HNF01.1A-F240-E0125	standard combination
	without	HNF01.1A-F240-E0125	red. performance data see Project Planning Manual
	HNL01.1E-0200-N0125	HNF01.1A-M900-E0125	standard combination
	without	HNF01.1A-M900-E0125	red. performance data see Project Planning Manual
	HNL01.1E-0200-N0125 with HNL01.1E-2800-S0125	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
	without	without	red. number of axes and allowed motor cable length see fig. 8-6

Supply unit	Mains chokes	Mains filters	Explanation
HMV01.1E-W0120	HNL01.1E-0100-N0202	HNF01.1A-F240-E0202	standard combination
	without	HNF01.1A-F240-E0202	red. performance data see Project Planning Manual
	HNL01.1E-0100-N0202	HNF01.1A-M900-E0202	standard combination
	without	HNF01.1A-M900-E0202	red. performance data see Project Planning Manual
	HNL01.1E-0100-N0202 with HNL01.1E-3400-S0202	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
	without	without	red. number of axes and allowed motor cable length see fig. 8-6

Fig. 6-12: Mains connection phase HMV01.1E

HMV01.1R Supply Units

Supply unit	Mains chokes	Mains filters	Explanation
HMV01.1R-W0018	HNL01.1R-0980-C0026	HNF01.1A-F240-R0026	standard combination
	without		not allowed
	HNL01.1R-0980-C0026	HNF01.1A-M900-R0026	standard combination
	without		not allowed
	HNL01.1R-0980-C0026 with HNL01.1R-4200-S0026	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
	without	without	not allowed
HMV01.1R-W0045	HNL01.1R-0590-C0065	HNF01.1A-F240-R0065	standard combination
	without	HNF01.1A-F240-R0065	not allowed
	HNL01.1R-0590-C0065	HNF01.1A-M900-R0065	standard combination
	without	HNF01.1A-M900-R0065	not allowed
	HNL01.1R-0590-C0065 with HNL01.1R-6300-S0065	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
	without	without	not allowed
HMV01.1R-W0065	HNL01.1R-0540-C0094	HNF01.1A-F240-R0094	standard combination
	without	HNF01.1A-F240-R0094	not allowed
	HNL01.1R-0540-C0094	HNF01.1A-M900-R0094	standard combination
	without	HNF01.1A-M900-R0094	not allowed
	HNL01.1R-0540-C0094 with HNL01.1R-3000-S0094	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
	without	without	not allowed
HMV01.1R-W0120	HNL01.1R-0300-C0180	HNF01.1A-H350-R0180	standard combination
	without	HNF01.1A-H350-R0180	not allowed

Fig. 6-13: Mains connection phase HMV01.1R

HMV02.1R Supply Units

Supply unit	Mains chokes	Mains filters	Explanation
HMV02.1R-W0015	HNL01.1R-0980-C0026	HNF01.1A-F240-R0026	standard combination
	HNL02.1R-0980-C0023	HNS02.1A-Q150-R0023	standard combination

Fig. 6-14: Mains connection phase HMV02.1R

Mains Connection Phase for HCS with Mains Chokes HNL and Mains Filters HNF resp. NFD

HCS02 Drive Controller with HNF01.1 resp. NFD03.1 Mains Filters

It is allowed to use HNF01.1 resp. NFD03.1 mains filters at HCS02 drive controllers. Observe the rules mentioned below:

Rules for Use of HNF01.1 resp. NFD03.1 and HNL01.1 with HCS02

The mains current determined for the application has to be smaller than the type current of the mains filter and the mains choke.

Depending on the number of axes there are minimum capacitances required at the DC bus of the drive controllers against ground (Y-capacitors, e.g. HAS04).

For the interference limit values to be achieved see chapter "Electromagnetic Compatibility (EMC)".

Note: HNF01.1 resp. NFD03.1 mains filters are not suited for operation on mains grounded via outer conductor mains.

Observe allowed mains connection voltage in the respective Project Planning Manual (max. 3AC480V)!

Note: For operation without mains choke take reduced performance data of the supply units or HCS into account.

Observe performance data contained in the respective Project Planning Manual!

HCS02 Drive Controllers

Supply unit	Mains chokes	Mains filters	Explanation
HCS02.1E-W0012	HNL01.1E-1000-N0012	NFD03.1-480-007	standard for operating one drive controller at the mains filter
	without	NFD03.1-480-007	red. performance data see Project Planning Manual of HSC02
HCS02.1E-W0028	HNL01.1E-1000-N0012	NFD03.1-480-016	standard for operating one drive controller at the mains filter
	without	NFD03.1-480-016	red. performance data see Project Planning Manual of HSC02
HCS02.1E-W0054	HNL01.1E-1000-N0020	NFD03.1-480-030	standard for operating one drive controller at the mains filter
	without	NFD03.1-480-030	red. performance data see Project Planning Manual of HSC02
HCS02.1E-W0070	HNL01.1E-0600-N0032	NFD03.1-480-055	standard for operating one drive controller at the mains filter
	without	NFD03.1-480-055	red. performance data see Project Planning Manual of HSC02

Fig. 6-15: Mains connection phase HCS02

HCS03 Drive Controller with HNF01.1 Mains Filters

It is allowed to use HNF01.1 mains filters at HCS03 drive controllers. Observe the rules mentioned below:

Rules for Use of HNF01.1 and HNL01.1 with HCS03

The mains current determined for the application has to be smaller than the type current of the mains filter and the mains choke.

Depending on the number of axes there are minimum capacitances required at the DC bus of the drive controllers against ground (Y-capacitors).

For the interference limit values to be achieved see chapter "Electromagnetic Compatibility (EMC)".

Note: HNF01.1 mains filters are not suited for operation on mains grounded via outer conductor mains.

Observe allowed mains connection voltage in the respective Project Planning Manual (max. 3AC480V)!

Note: For operation without mains choke take reduced performance data of the supply units or HCS into account.

Observe performance data contained in the respective Project Planning Manual!

HCS03 Drive Controller with HNK01.1 Mains Filters

HNK01 mains filters are intended **exclusively** for use at HCS03 drive controllers and were designed for being mechanically mounted to the HCS03. For assignment of HNK01 to HCS03 see the tables below.

HCS03 Drive Controllers

Supply unit	Mains chokes	Mains filters	Explanation
HCS03.1E-W0070	integrated in HNK	HNK01.1A-A075-E0050	standard for operating one drive controller at the mains filter
	HNL01.1E-0571-N0050		standard for operating one drive controller without mains filter
	without	HNHF01.1A-F240-E0051	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0571-N0050	HNHF01.1A-F240-E0051	standard for operating several drive controllers at the mains filter
	without	HNHF01.1A-M900-E0051	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0571-N0050	HNHF01.1A-M900-E0051	standard for operating several drive controllers at the mains filter
	HNL01.1E-0400-N0051 with HNL01.1E-5700-S0051	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
HCS03.1E-W0100	integrated in HNK	HNK01.1A-A075-E0080	standard for operating one drive controller at the mains filter
	HNL01.1E-0362-N0080		standard for operating one drive controller without mains filter
	without	HNHF01.1A-F240-E0125	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0362-N0080	HNHF01.1A-F240-E0125	standard for operating several drive controllers at the mains filter
	without	HNHF01.1A-M900-E0125	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0362-N0080	HNHF01.1A-M900-E0125	standard for operating several drive controllers at the mains filter
	HNL01.1E-0362-N0080 with HNL01.1E-2800-S0125	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents

Supply unit	Mains chokes	Mains filters	Explanation
HCS03.1E-W0150	integrated in HNK	HNK01.1A-A075-E0106	standard for operating one drive controller at the mains filter
	HNL01.1E-0240-N0106	without	standard for operating one drive controller without mains filter
	without	HNHF01.1A-F240-E0125	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0240-N0106	HNHF01.1A-F240-E0125	standard for operating several drive controllers at the mains filter
	without	HNHF01.1A-M900-E0125	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0240-N0106	HNHF01.1A-M900-E0125	standard for operating several drive controllers at the mains filter
	HNL01.1E-0240-N0106 with HNL01.1E-2800-S0125	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents
HCS03.1E-W0210	integrated in HNK	HNK01.1A-A075-E0146	standard for operating one drive controller at the mains filter
	HNL01.1E-0170-N0146	without	standard for operating one drive controller without mains filter
	without	HNHF01.1A-F240-E0202	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0170-N0146	HNHF01.1A-F240-E0202	standard for operating several drive controllers at the mains filter
	without	HNHF01.1A-M900-E0202	red. performance data see Project Planning Manual of HSC03
	HNL01.1E-0170-N0146	HNHF01.1A-M900-E0202	standard for operating several drive controllers at the mains filter
	HNL01.1E-0170-N0146 with HNL01.1E-3400-S0202	customer-side	standard mains choke connected in series with current-compensated mains choke to reduce line-frequency leakage currents

Fig. 6-16: Mains connection phase HCS03

6.3 Allowed Combinations with Motor Filters HMF01

In conjunction with long motor cables, the steep switching edges at the motor output of the drive controllers cause transient overvoltages and high rise of voltage at the motor.



CAUTION

Damage caused by too high switching frequency!

⇒ Only operate HMF01 motor filters up to the maximum allowed switching frequency f_s of 4 kHz.

Drive Controllers HCS03 with HMF01

The combinations of motor filters and HCS03 drive controllers listed below are functionally allowed.

Assignment of HMF01 Motor Filters to HCS03 Drive Controllers

Motor filter HNK01	Drive controller
HMF01.1A-N0K2-D0045-...	HCS03.1E-W0070
HMF01.1A-N0K2-D0073-...	HCS03.1E-W0100
HMF01.1A-N0K2-D0095-...	HCS03.1E-W0150
HMF01.1A-N0K2-D0145-...	HCS03.1E-W0210

Fig. 6-17: Assignment HMF01 to HCS03

6.4 Combinations of Firmware, Control Section and Drive Controller

The modular structure of the IndraDrive controllers allows a multitude of combinations of control sections and drive controllers. Depending on the firmware design, the firmware of the Rexroth IndraDrive product range supports the combinations of control section and power section listed below.

Combination Control Section - Firmware

The table below contains allowed combinations of firmware components and control sections for the drive controllers.

Firmware	MPB	MPH	MPD
Control section			
CSH01.1-C ¹⁾	--	X	--
CSB01.1-N ²⁾	X	--	--
CSB01.1-C ¹⁾	X	--	--
CDB01.1-C ¹⁾	--	--	X

X: allowed

--: not allowed

1) control section can be configured

2) control section cannot be configured

Fig. 6-18: Combination control section - firmware

Combination Control Section - Power Section

The table below contains allowed combinations of control sections and power sections.

Power section	HMS01	HMS02	HMD01	HCS02	HCS03
Control section					
CSH01.1-C ¹⁾	X	X	--	X	X
CSB01.1-N ²⁾	X	X	--	X	X
CSB01.1-C ¹⁾	X	X	--	X	X
CDB01.1-C ¹⁾	--	--	X	--	--

X: allowed

--: not allowed

1) control section can be configured

2) control section cannot be configured

Fig. 6-19: Combination control section - power section

Note: The allowed number of "plug control section into power section" actions is limited to a max. of 20. If this number is exceeded, the electrical data of the internal connection can be above the specified minimum requirements.

This can cause malfunction of the drive controllers.

Required Equipment of Control Section for Motor Encoder System

The control sections of the Rexroth IndraDrive product range support different encoder systems. For the assignment of encoder system to required equipment of control section with options see table below.

Note: For the motor encoder code see the type code of the selected motor.

Abbrev. Column	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Example:	M	S	K	0	7	0	C	-	0	4	5	0	-	N	N	-	S	1	-	U	G	0	-	N	N	N	N	N	N	N

6. Encoder

6.1 Optical encoder, singleturn hiperface, with 128 increments = S1

6.2 Optical encoder, singleturn EnDat2.1, with 2048 increments = S2

6.3 Optical encoder, multiturn-absolute hiperface, with 128 increments = M1

6.4 Optical encoder, multiturn-absolute EnDat2.1, = M2

DT000002v01_de.EPS

Fig. 6-20: Type code section of motor

Code of motor encoder	Brief description of motor encoder (informal)	Equipment / options of control section			Cable for direct connection 1)
		ENS	EN1	EN2	
R0	resolver	--	X	--	IKS 4043
R1	resolver with integrated absolute multi-turn encoder	--	X	--	IKS 4043
S0	optical encoder single-turn IIC, 512 increments, supply voltage 8 V	--	X	--	IKS 4042
S1	optical encoder single-turn HIPERFACE, 128 increments, supply voltage 7...12 V	X	--	--	RKG 4200
S2	optical encoder single-turn EnDat2.1, 2048 increments, supply voltage 12 V	X	--	--	RKG 4200
M0	optical encoder multi-turn absolute IIC, 512 increments, supply voltage 8 V	--	X	--	IKS 4042
M1	optical encoder multi-turn absolute HIPERFACE, 128 increments, supply voltage 7...12 V	X	--	--	RKG 4200
M2	optical encoder multi-turn absolute EnDat2.1, 2048 increments, supply voltage 12 V	X	--	--	RKG 4200
C0	optical encoder incremental 1 Vpp, 2048 increments (sin/cos)	--	--	X	RKG 0014

1) without control cabinet ducts and cable extension
 X: allowed
 --: not allowed

Fig. 6-21: Combination control section equipment - motor encoder

Note: Operating other encoder systems than the ones listed above requires detailed control of the technical data of the encoder system used and the interface specification of the control

section. In particular, take the supply voltage data into account.

6.5 Combination with Other Rexroth Components

Combination with Components of the Control Range Rexroth IndraControl V

Small Operator Terminals VCP

For comfortable operation of the Rexroth IndraDrive drive system with the IndraControl V control range there are small operator terminals of the VCP series available.

The small operator terminals VCP 01, VCP 02, VCP 05, VCP 08, VCP 20 and VCP 25 are suited for control cabinet mounting and are operated via the serial interface RS232 (X2) of the control sections.

Note: The optional equipment "C" and "S" that can be plugged in is similar to the VCP 01 small operator terminal. In the Project Planning Manual of the control sections the hardware of the options is described as comfort control panel ("C") or standard control panel ("S"). The function of the control panels is described in the Functional Description of the firmware.

Simultaneous operation of VCP small operator terminals and standard control panels or comfort control panels is allowed.

Combinations with Components of the Drive Range ANAX

To modernize machines the drive range Rexroth IndraDrive provides the possibility of operating drive controllers of the ANAX range with analog command value input.

SERCOS Analog Converter

The SERCOS analog converter is used to

- connect control units with SERCOS interface to components with analog interface
- convert SERCOS position command values to analog speed command values

The following components are required for SERCOS analog converters:

- housing for **HAC01.1-002** control sections
- configurable control section with SERCOS master communication, e.g. **BASIC CDB01.1C-SE-NNN-NNN-MA1-NNN-NN-S-NN-FW**
- firmware, e.g. **FWA-INDRV*-MPD-04VRS-**-*_**_****

Note: Observe, that parameter **P-0-0860, Converter configuration** is set to "operation as SERCOS analog converter" (Bit 15 = 1). A wrong setting generates the error message **F8091 Power section defective**.

6.6 Selecting Connection Cables to Motor

Keep in mind, that the allowed maximum motor cable length is depending on the switching frequency of the power output stage. On principle, the higher the switching frequency, the shorter the allowed cable length (in order to protect the drive controllers against overload).

Note: Always use switching frequencies supported by the components of your drive system. Observe the technical data of the drive controllers and motors.



See also Parameter Description "P-0-0001, Switching frequency of the power output stage".

Limited Length of Motor Power Cables

The lengths indicated in the table below are recommended as guide values (at an ambient temperature of $\leq 40\text{ °C}$ in accordance with EN 60 204).

Allowed line lengths for motor connection **without** filter measures at motor output:

PWM frequency [kHz]	Max. allowed line length [m]	
	Shielded line	Unshielded line ¹⁾
2 ²⁾	100	175
4	75	150
8	38	150
12	25	not allowed
16	18	not allowed

1) only allowed at HCS drive controllers

2) depending on the drive controller

Fig. 6-26: Line lengths

Operation with unshielded motor cables of up to 150 m

- aims at applications with "operation without encoder" (Open-Loop)
- does not include the control voltage lines to the motor
- requires additional measures with regard to EMC on the part of the operating company

Allowed line lengths for motor connection **with** additional components HMF or HML:

PWM frequency [kHz]	Max. allowed line length [m]	
	Shielded line	Unshielded line ¹⁾
4 ²⁾	75	200

1) only allowed at HCS03 drive controllers

2) higher PWM frequencies are not allowed

Fig. 6-27: Line lengths

Documentation Motor Power Cables

The documentation "**Rexroth Connection Cables; Selection Data**" is available for selecting the motor power cables and other connections, such as encoder cables.

Rexroth IndraDrive drive systems have to be equipped with shielded motor power cables of the RKL line.

Third-Party Motor Power Cables

Requirements on third-party motor power cables:

Maximum allowed **cable length** at A1, A2, A3:

- see Fig. 6-26

Maximum allowed **capacitance per unit length** at A1, A2, A3:

- against ground, each: 0.5 nF/m
- against each other: 0.5 nF/m

Maximum allowed **inductance per unit length** at A1, A2, A3:

- 100 nH/m each

Note:

If you use third-party motor power cables not corresponding to the requirements, Rexroth's guarantee for the drive system will expire.

Use ready-made Rexroth cables.

6.7 Third-Party Motors at IndraDrive Controllers

General Information on Third-Party Motors

Why Use Third-Party Motors at IndraDrive?

Today machine axes are mainly moved with electric drives. Motors of standard design are used in most cases as this is the most cost-efficient solution.

Special Requirements

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

Undeliverable Motor Design

For these cases there is the demand on the drive supplier to realize, apart from the deliverable standard drive consisting of (standard) motor, controller, cable and, if required, machine control unit, drives with motors that are not included in his own product range due to the special design.

Check Before Using Third-Party Motors

At Rexroth controllers of the IndraDrive range it is also possible to use third-party motors. For this purpose, check whether the third-party motor complies with the requirements of use.

Which are the Important Directives?

Additional Aspects to be Observed

According to the legal requirements

- of the EU directives EMC89/336/EEC and
- the German EMC laws

installations and machines have to be designed and built according to the present state of standardization. In order to comply with the machine directives regarding "electromagnetic compatibility (EMC)", a conformity test of the drive system (motor with controller and connection design) has to be carried out. The test of the drive system and compliance with the directives have to be guaranteed by the machine manufacturer.

Third-Party Motors to be Controlled

Motor Types The following motor types can be controlled:

- asynchronous motors, rotary
- asynchronous motors, linear
- synchronous motors, rotary
- synchronous motors, linear

These motors can be operated within the scope of the technical data of the selected IndraDrive controller. If motors have been provided with a holding brake, it should be controlled via the controller. Make sure that the relevant technical data of the motor holding brake are complying with those of the holding brake output.

Note: For third-party motors Bosch Rexroth, as a matter of principle, does not assume the guarantee for the power data at the motor shaft!

Synchronous Motors In the case of synchronous motors, the commutation offset has to 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.

Note: Observe the restrictions in conjunction with the commutation offset determination when using synchronous motors!
See Functional Description of Firmware "Motor Control: Commutation Setting" in chapter "Drive Control"

Possibly available 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; the respective bit of **P-0-4014, Type of construction of motor** therefore mustn't be set!

Requirements on Third-Party Motors

For successful and fail-safe use of a third-party motor check

- whether the third-party motor to be controlled satisfies the voltage loads,
- which controller, including supply, is suitable due to the motor power to be delivered,
- whether the third-party motor has the required minimum inductance,
- whether the motor can be protected against inadmissible temperature rise in the case of overload (temperature evaluation),
- whether the mounted position measuring system can be evaluated by the controller or which position measuring system can be selected for kit motors.

Voltage Load of the Third-Party Motor

The voltage load of the insulation system of a motor occurring in practical application is mainly influenced by the following characteristics:

- The output variables of the drive controller which is used (feed the transmission distance).
- The cable parameters depending on cable design and length (determine the properties of the transmission distance, such as the attenuation).

- The motor design regarding capacitive and inductive properties (from the end of the transmission distance).

As a result of the variables, the insulation system of the third-party motor, as regards voltage, is loaded by the values

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

The occurring peak voltages at the motor are caused by reflections in the motor cable. The insulation of the motor is thereby loaded with other peak voltages and voltage changes than the ones occurring at the output of the power section.

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

Use of Voltage-Reducing Components, Motor Filter HMF

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

- allowed voltage change (dv/dt) of third-party motor **smaller than 5kV/μs**
- allowed peak voltage (crest value) of third-party motor between phase-phase and phase-housing **smaller than 1500V**
- motor cable length **smaller than 25 m**
- mains voltage **greater than AC440V**

Note: Apart from the nominal current I_N , especially take the maximum allowed switching frequency of the power output stage (f_s) into account with which the motor filter HMF may be operated.

Verify the success of the voltage-reducing measure.

Minimum Inductance of Third-Party Motor

Depending on the controller used, the motor has to have a minimum value for inductance. The actually available inductance of a motor can be measured directly between two motor terminals by means of an inductance measuring bridge. The measurement has to be made for a complete motor wired for normal operation but not yet connected. During the measurement one motor terminal remains open!

For asynchronous motors the measured value can only be used if the rotor doesn't have closed slots!

Controller type	Minimum required motor inductance
HCS with 3*AC230V	$L_{U-V} = 60 * 4 / (\sqrt{2} * I_{Typ} * f_s)$ (in mH)
HMS, HMD at HMV (3*AC400V) HMS, HMD at HCS (3*AC400V)	$L_{U-V} = 80 * 4 / (\sqrt{2} * I_{Typ} * f_s)$ (in mH)
HMS, HMD at HMV (3*AC480V) HMS, HMD at HCS (3*AC480V)	$L_{U-V} = 116 * 4 / (\sqrt{2} * I_{Typ} * f_s)$ (in mH)

I_{Typ} : maximum controller current acc. to type code (rms value)
 f_s : desired switching frequency in kHz

Fig. 6-28: Minimum inductance depending on controller data, supply units and supply voltage

Use 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.

Note: 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 **in standstill!**

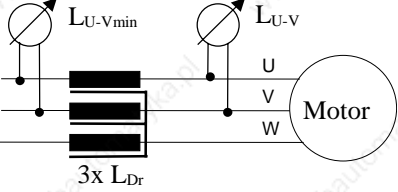
Available third-party motor	Planned third-party motor
 <p data-bbox="582 784 981 884"> $L_{Dr} = 0,5 * (L_{U-Vmin} - L_{U-V})$ (inductance measurement with 1 kHz) mounting of $3x L_{Dr}$ (three-phase choke) </p>	<p data-bbox="1054 560 1442 750">Calculating the leakage inductance (asynchronous motor) or inductance (synchronous motor) of the third-party motor by means of the single-phase equivalent circuit diagram (manufacturer's specification!).</p> <p data-bbox="1054 761 1442 817">Determine choke by means of calculation, if necessary.</p> <p data-bbox="1054 828 1442 884">It is recommended to contact Rexroth!</p>
<p data-bbox="582 907 877 929">Requirements on the choke:</p> <ul data-bbox="582 940 1442 1198" style="list-style-type: none"> - $I_{n_Dr} \geq I_{n_Mot}$ The rated current of the choke has to be greater than or equal to the rated motor current. - Depending on the maximum speed, the choke is loaded with the respective output frequency and the PWM frequency of the controller. - The insulation class has to correspond at least to that of the motor or has to be dimensioned for higher temperatures. - The voltage load of the choke depends on the controller used. 	

Fig. 6-29: Data for possibly required choke

Temperature Evaluation of Third-Party Motor

Only operate such motors with incorporated temperature sensor at IndraDrive controllers so that the motor can be thermally monitored by the controller and protected against destruction by too high temperature rise (see P-0-0512, Temperature sensor).

When, in exceptional cases, you want to operate third-party motors without temperature sensor at IndraDrive controllers, you must determine the thermal time constants of motor housing (P-0-4035) and motor winding (P-0-4034, P-0-4037). The firmware-internal motor temperature model can thereby reflect the cooling situation of the motor correctly.

Note: In case the motor housing or blower is dirty, this worsens the cooling situation of the motor and protection against thermal overload is therefore insufficient!

Requirements on the Encoder of the Third-Party Motor

Motor Encoder of Asynchronous Third-Party Motor

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

Motor Encoder of Synchronous Third-Party Motor

For fail-safe drives with synchronous third-party motors at IndraDrive controllers the following possible combinations or restrictions have to be taken into account when selecting the measuring system:

Drive range	Motor measuring system	Synchronous third-party motor
IndraDrive	absolute	+
	relative	o

+ ... advantageous combination

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

Fig. 6-30: Possible combinations of synchronous third-party motor and motor measuring system

Note: The control section integrated in the controller can evaluate measuring systems as a motor encoder if they are contained in **P-0-0074, Encoder type 1 (motor encoder)** (see also Project Planning Manual of the IndraDrive control sections).

For information on absolute and relative measuring systems see section "Measuring Systems" of Functional Description of firmware!

Notes on Selection and Commissioning

Selecting the Controller as Regards Continuous Current

The controller required for the respective motor and the supply unit are determined by comparing the motor data to the data of these devices (see documentation for HMS/HMD and HMV or HCS).

Note: The continuous current of the controller should be greater than that of the motor, the continuous power of the supply must be greater than the sum of all average powers of the axes of the drive system!

Selecting the Connection Technique

The available power and encoder cables are described in the documentation "Connection Cables; Selection Data" (DOK-CONN-CABLE*STAND-AU...).

Notes on Commissioning

Note: For further information, notes on commissioning and supporting documents (e.g. forms for entering the required data) see Functional Description of firmware.

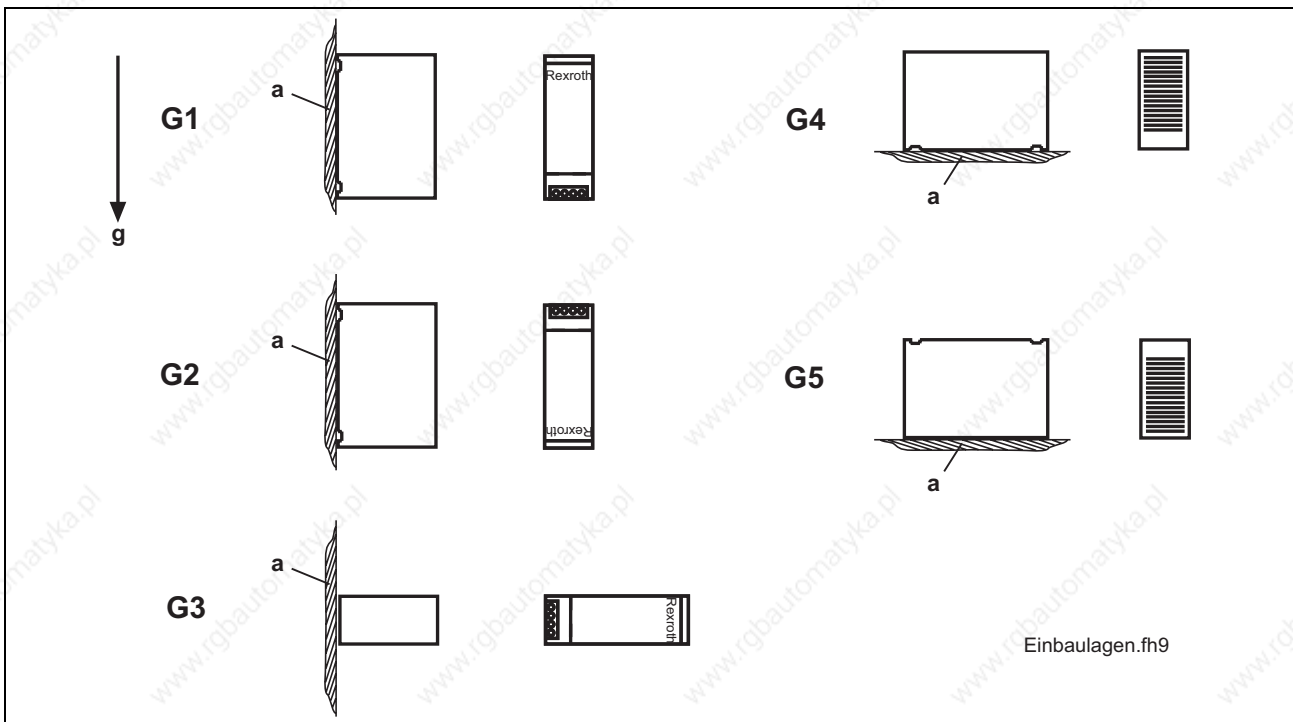
Notes

7 Arranging the Components in the Control Cabinet

7.1 Arranging Components in Control Cabinet from Mainly Mechanical Point of View

Position of Normal Use and Mounting Position

Mounting Positions The drive controllers and additional components **mustn't** be operated in **all** indicated positions of normal use and mounting positions. The allowed positions of normal use and mounting positions are described in the figure below.



a mounting surface
g direction of gravitational force

Fig. 7-1: Positions of normal use and mounting positions

Brief Description of Positions of Normal Use and Mounting Positions

Normal Mounting Position

- G1: Normal mounting position. The natural convection supports the forced cooling air current. This avoids the generation of pockets of heat in the drive controller. G1 is the preferred mounting position for Rexroth IndraDrive components.
- G2: 180° to normal mounting position
- G3: turned by 90° from vertical to horizontal mounting position
- G4: bottom mounting, mounting surface on bottom of control cabinet
- G5: top mounting, mounting surface at top of control cabinet

Allowed Mounting Positions

Positions of normal use and mounting positions **allowed** for the individual devices and reduction factors connected with them are contained in the table below.

Allowed positions of normal use and mounting positions with reduction factor

Component	Mounting position / reduction factor					Notes
	G1	G2	G3	G4	G5	
HCS02.1E	100%	--	--	--	--	
HCS03.1E	100%	--	--	--	--	
HMV01.1E	100%	--	--	--	--	
HMV01.1R	100%	--	--	--	--	
HMS01.1	100%	--	--	--	--	
HMS02.1	100%	--	--	--	--	
HMD01.1	100%	--	--	--	--	
NFD03.1	100%	100%	80%	100%	80%	reduction of maximum allowed continuous current
HNF01.1	100%	--	--	--	--	
HNL01.1	100%	100%	100%	100%	100%	
HNL02.1	100%	--	--	--	--	
HNK01.1	100%	--	--	--	--	
HNS02.1	100%	--	--	--	--	
HLB01.1C	100%	--	--	--	--	
HLB01.1D	100%	--	--	--	--	
HLC01.1C	100%	--	--	--	--	
HLC01.1D	100%	--	--	--	--	
HLR01.1	100%	--	--	--	--	

-- not allowed

Fig. 7-2: Allowed positions of normal use and mounting positions

Example "NFD03.1 in position of normal use G5":

In position of normal use G5 the mains filter NFD03.1 may only be loaded with 80% of the maximum allowed continuous current. The reduced load must be guaranteed by the application.

Main Dimensions of the System Components

The main differences in the dimensions of the individual products of the range are contained in the figure and table below.

Note: The mounting depths of the IndraDrive product range have been optimized for mounting in control cabinets with 300 mm or 400 mm.

The figure and table contain a rough overview of the main dimensions; for details and required mounting dimensions see the dimension sheets of the components.

Device Depths and Device Heights

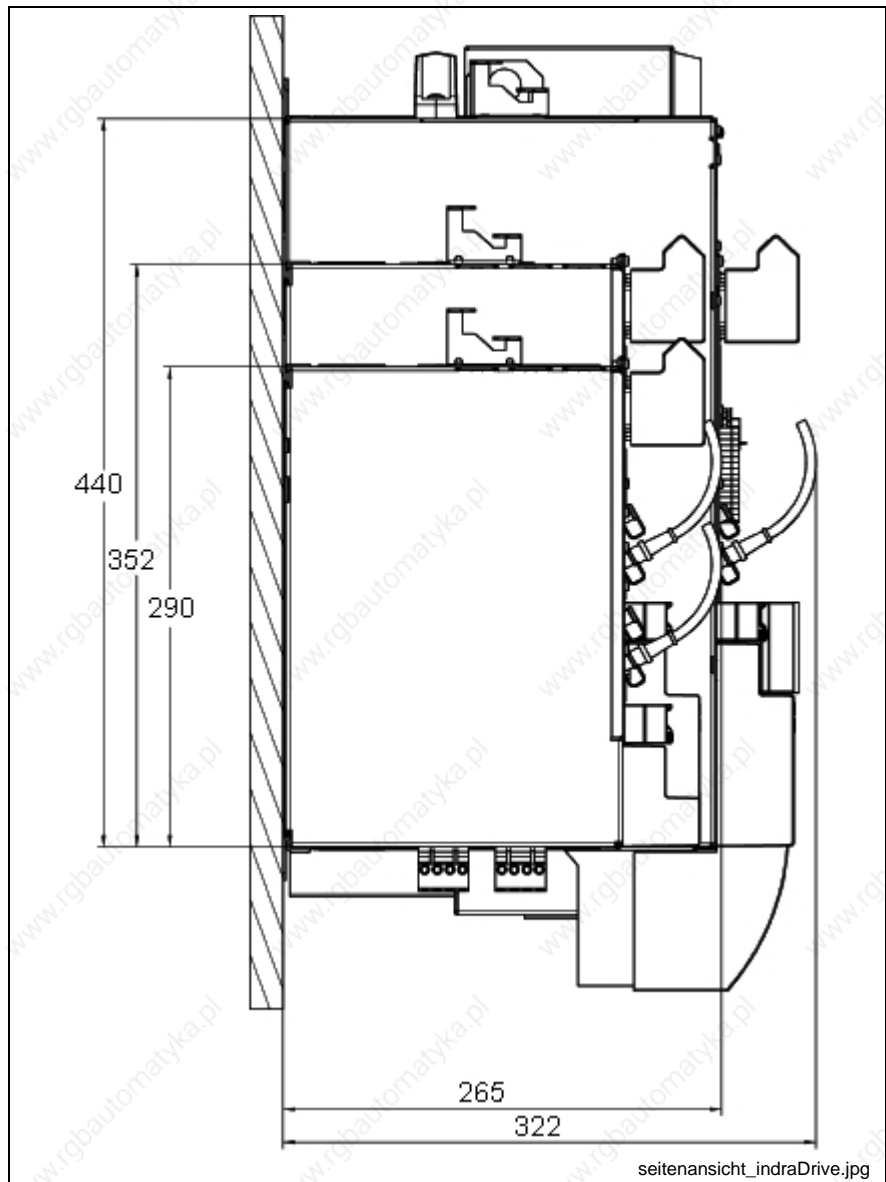


Fig. 7-3: Main dimensions in [mm]

Device Depths, Heights and Widths

Device	Device width C [mm]	Min. mounting width [mm] 1)	Device height [mm] 2)	Device depth [mm] 3)
HNL02.1R-0980	165	165	352	120
HLC01.1C-01M0	50	50	352	265 for control cabinets with at least 300 mm of depth
HLC01.1C-02M4				
HCS02.1E-W0012	65	70	290	
HCS02.1E-W0028			352	
HLB01.1C				
HCS02.1E-W0054	105	110	352	
HCS02.1E-W0070				
HMV02.1R-W0015	150	150	352	
HMS02.1N-W0028	50	50		
HMS02.1N-W0054	75	75		
HNS02.1A-Q150	80	80		
HMS01.1N-W0020	50	50	440	
HMS01.1N-W0036				
HMD01.1N-W0012				
HMS01.1N-W0054	75	75		
HMD01.1N-W0036				
HLC01.1D-05M0				
HMS01.1N-W0070	100	100		
HLB01.1D				
HCS03.1E-W0070	125	125		
HMS01.1N-W0150	150	150		
HMV01.1E-W0030				
HMV01.1R-W0018	175	175		
HMS01.1N-W0210	200	200		
HCS03.1E-W0100	225	225		
HCS03.1E-W0150				
HMV01.1E-W0075	250	250		
HMV01.1R-W0045				
HCS03.1E-W0210	350	350		
HMV01.1R-W0065				

- 1) incl. minimum distance between the components
- 2) device body without mounting flange on top and bottom, as well as minimum distances for ventilation and installation
- 3) incl. touch guard, connector housing, bending radius of fiber optic cable, control panel "C"

Fig. 7-4: Mounting dimensions

Distances for Drive Controllers

In addition to the mounting dimensions, the components of the Rexroth IndraDrive range require additional mounting clearance

- to ventilate the components
- to mount accessories and connections
- to take temperature limits of neighboring mounting parts, such as cable ducts etc., into account

To determine the required mounting clearances in the control cabinet, take additional distances between the components and on their tops and bottoms into account.

Distance between Drive Controllers

Owing to power dissipation in the components, especially due to installed braking resistors in compact devices, the temperatures of neighboring components are rising. In the case of lateral mounting, trouble-free operation therefore requires the following minimum distances in [mm] between the components.

from	to					
	HCS02	HCS03 (HNK01, HLR01)	HMV01	HMV02	HMS01 / HMD01	HMS02
HCS02.1E	5	--	--	--	5	5
HCS03.1E with HNK01 and HLR01	--	0	--	--	0	--
HMV01.1E / HMV01.1R	--	--	0	--	0	--
HMS01.1 / HMD01.	5	0	0	--	0	--
HMV02.1R	--	--	--	--	--	0
HMS02.1	5	0	0	0	0	0

-- not allowed

Fig. 7-5: Minimum distance in [mm]

Note: For arrangement of the components in the control cabinet, take their dimension sheets and the required minimum distances into account.

Distances on Top and Bottom of Components

Owing to power dissipation in the components, the temperature of the cooling air current at the device outlet is rising to values higher than ambient temperature at device inlet.

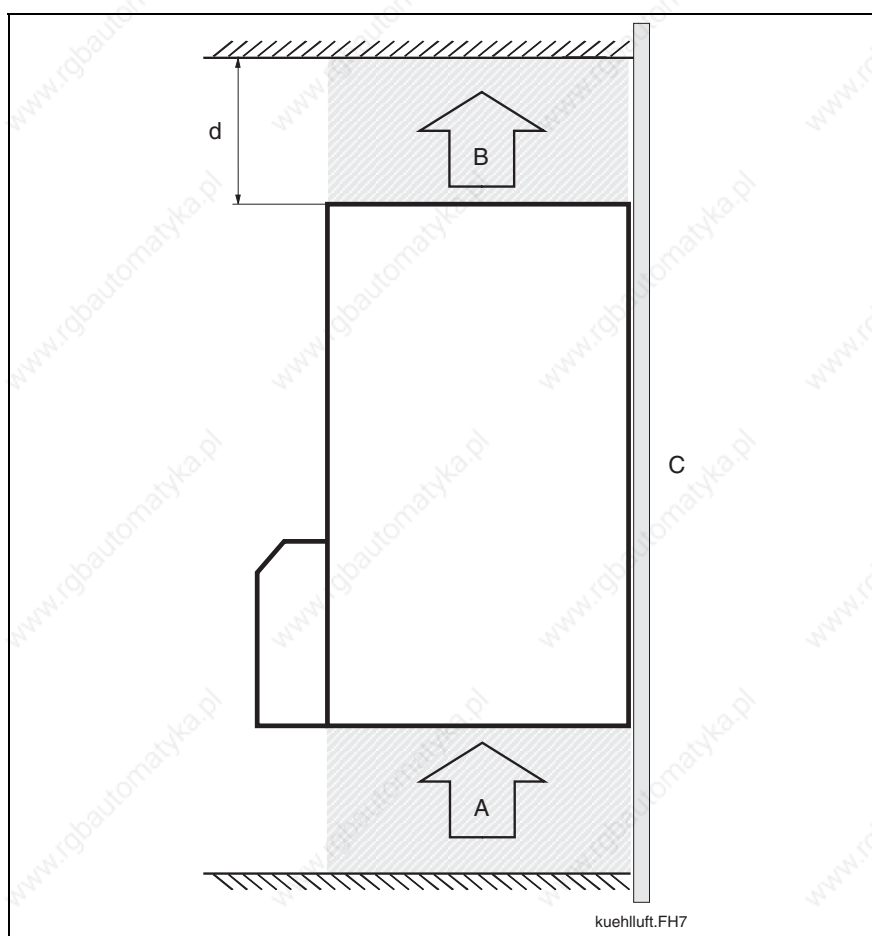


CAUTION

Property damage due to temperatures higher than 105 °C!

⇒ Comply with indicated minimum distances!

In order that drive controllers can discharge the power dissipation generated inside of them, they need space on their top (A) and bottom (B).



- A: air intake
- B: air outlet
- C: mounting surface in control cabinet
- d: distance to top of device

Fig. 7-6: Air intake and air outlet at drive controller

For sufficient ventilation of the components you have to comply with the minimum distances below. At components **without integrated braking resistor**, there will be temperatures of up to 105 °C at the air outlet (B) (with an air intake temperature of 45 °C).

Component	Minimum distance for ventilation		Notes
	at the bottom (A) [mm] 1)	at the top (B) [mm] 2)	
HMS01; HMD01	100	80	
HCS02	80	80	additionally take power at braking resistor into account
HCS03	100	80	
HMV01	100	300	take additional distance to the side into account
HMV02	80	300	
HMS02	80	80	
HLC01.1C	80	80	
HLC01.1D	80	80	
HLB01.1C	80	300	
HLB01.1D	100	300	

1) for additional mounting parts, such as HAS, see dimensional drawings

2) integrated braking resistors require additional distance

Fig. 7-7: Minimum distance for ventilation

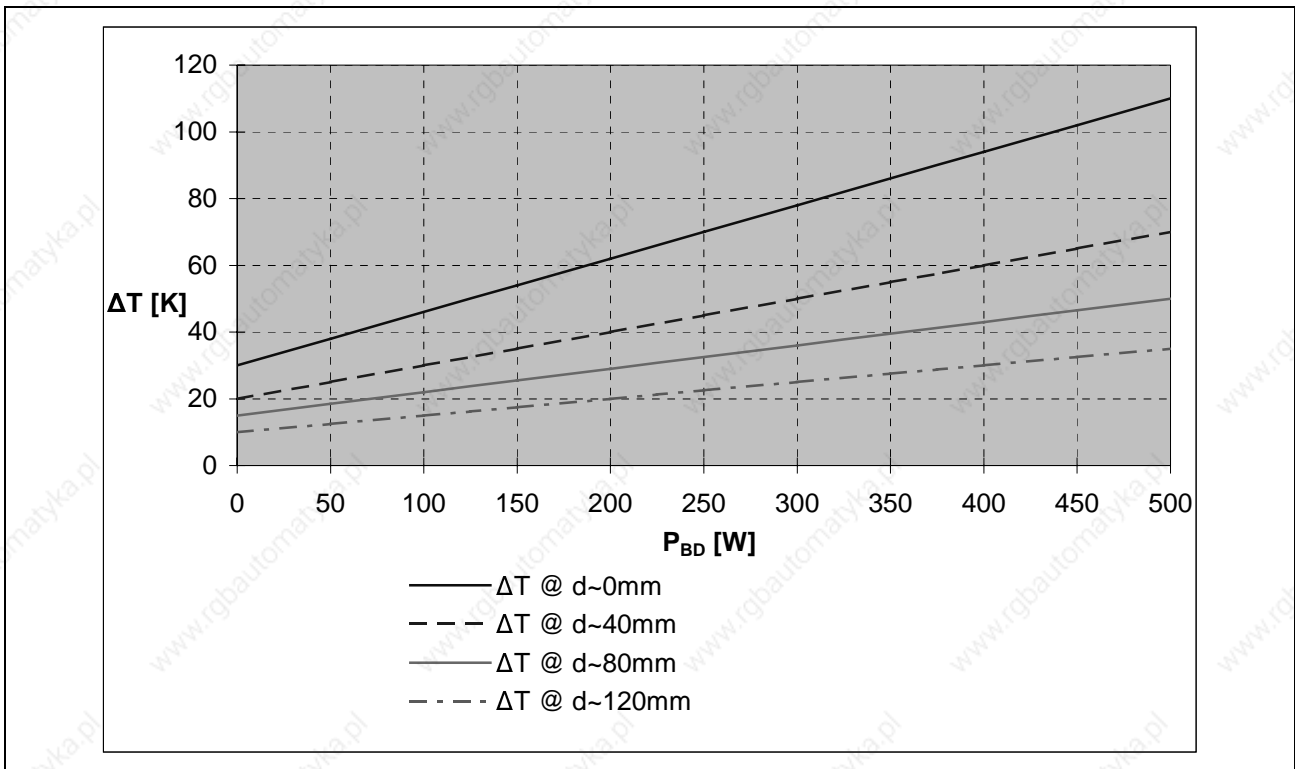
Note: If there are different minimum distances for the individual components in a drive system, the greatest value determines the minimum distance to be observed.

Minimum Distance to Braking Resistor

For components with integrated braking resistor (supply units, DC bus resistor units, HCS02 drive controllers) their higher outlet temperatures have to be taken into account.

To determine the required distances the resulting outlet temperatures are indicated in diagrams in the technical data of the components.

Input value in the diagrams is the generated power of the braking resistors or the individual output current. See exemplary diagram below:



P_{BD} : average continuous braking resistor power
 d : distance to top of device

Fig. 7-8: Exemplary diagram

The minimum distance for these mounting parts results from the intersection of the input value with the allowed temperature rise.

Minimum Distance at HMV Devices

The braking resistor in the HMV01.1E heats up during operation, the braking resistor in the HMV01.1R and HMV02.1R after power is switched off. For materials that can be damaged by heat generation, such as lines or cable ducts, a minimum distance of 300 mm to the top and 40 mm to the side has to be observed.

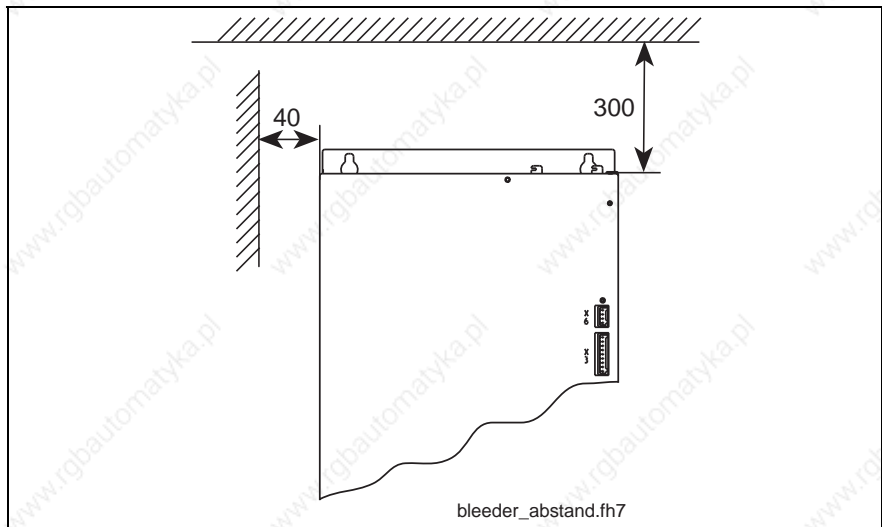


Fig. 7-9: Minimum distance at HMV supply units

Boring Dimensions for the Mounting Plate

Individually Arranged Drive Controllers

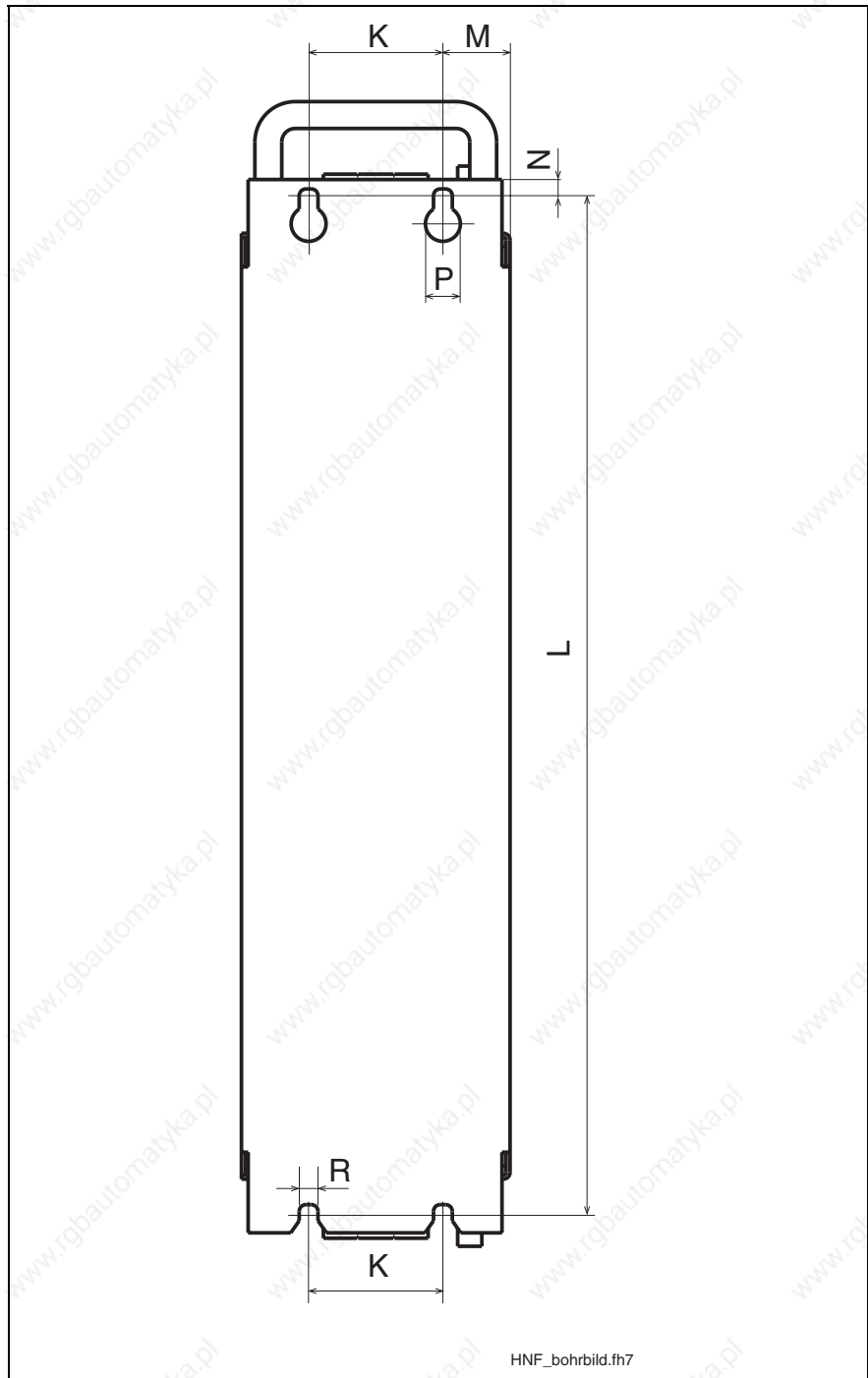


Fig. 7-10: Boring dimensions

Note: The figure shows the back of the devices.

Device	K [mm]	L [mm]	M [mm]	P [mm]	R [mm]	Notes
HCS02.1E-W0012	0	316	32,5	13	7	observe additional distance to lateral neighboring devices
HCS02.1E-W0028	0	378	32,5	13	7	observe additional distance to lateral neighboring devices
HCS02.1E-W0054	55	378	25	13	7	observe additional distance to lateral neighboring devices
HCS02.1E-W0070	55	378	25	13	7	observe additional distance to lateral neighboring devices
HCS03.1E-W0070	75	466	25	13	7	
HCS03.1E-W0100	175	466	25	13	7	
HCS03.1E-W0150	175	466	25	13	7	
HCS03.1E-W0210	250	466	50	13	7	
HMV01.1E-W0030	100	466	25	13	7	
HMV01.1E-W0075	200	466	25	13	7	
HMV01.1E-W0120	300	466	25	13	7	
HMV01.1R-W0018	125	466	25	13	7	
HMV01.1R-W0045	200	466	25	13	7	
HMV01.1R-W0065	300	466	25	13	7	
HMV02.1R-W0015	100	378	25	13	7	
HMS01.1N-W0020	0	466	25	13	7	
HMS01.1N-W0036	0	466	25	13	7	
HMS01.1N-W0054	0	466	25	13	7	
HMS01.1N-W0070	50	466	25	13	7	
HMS01.1N-W0150	100	466	25	13	7	
HMS01.1N-W0210	150	466	25	13	7	
HMS02.1N-W0028	0	378	25	13	7	
HMS02.1N-W0054	0	378	25	13	7	
HMD01.1N-W0012	0	466	25	13	7	
HMD01.1N-W0020	0	466	25	13	7	
HMD01.1N-W0036	0	466	25	13	7	
HNL02.1	100	378	20	13	7	
HNS02.1	0	378	55	13	7	
HLB01.1C	0	378	32,5	13	7	
HLB01.1D	50	466	25	13	7	
HLC01.1C-01M0	0	378	25	13	7	
HLC01.1C-02M4	0	378	25	13	7	
HLC01.1D-05M0	0	466	25	13	7	

Fig. 7-11: Boring dimensions

Ground the housings of the drive controllers!

1. Connect the bare metal back panel of the drive controller in conductive form to the mounting surface in the control cabinet.
2. Use the supplied mounting screws and fix the screws with a tightening torque of typ. 6 Nm.
3. Connect the mounting surface of the control cabinet in conductive form to the equipment grounding system.

Combination of Drive Controllers of the Rexroth IndraDrive M Product Range

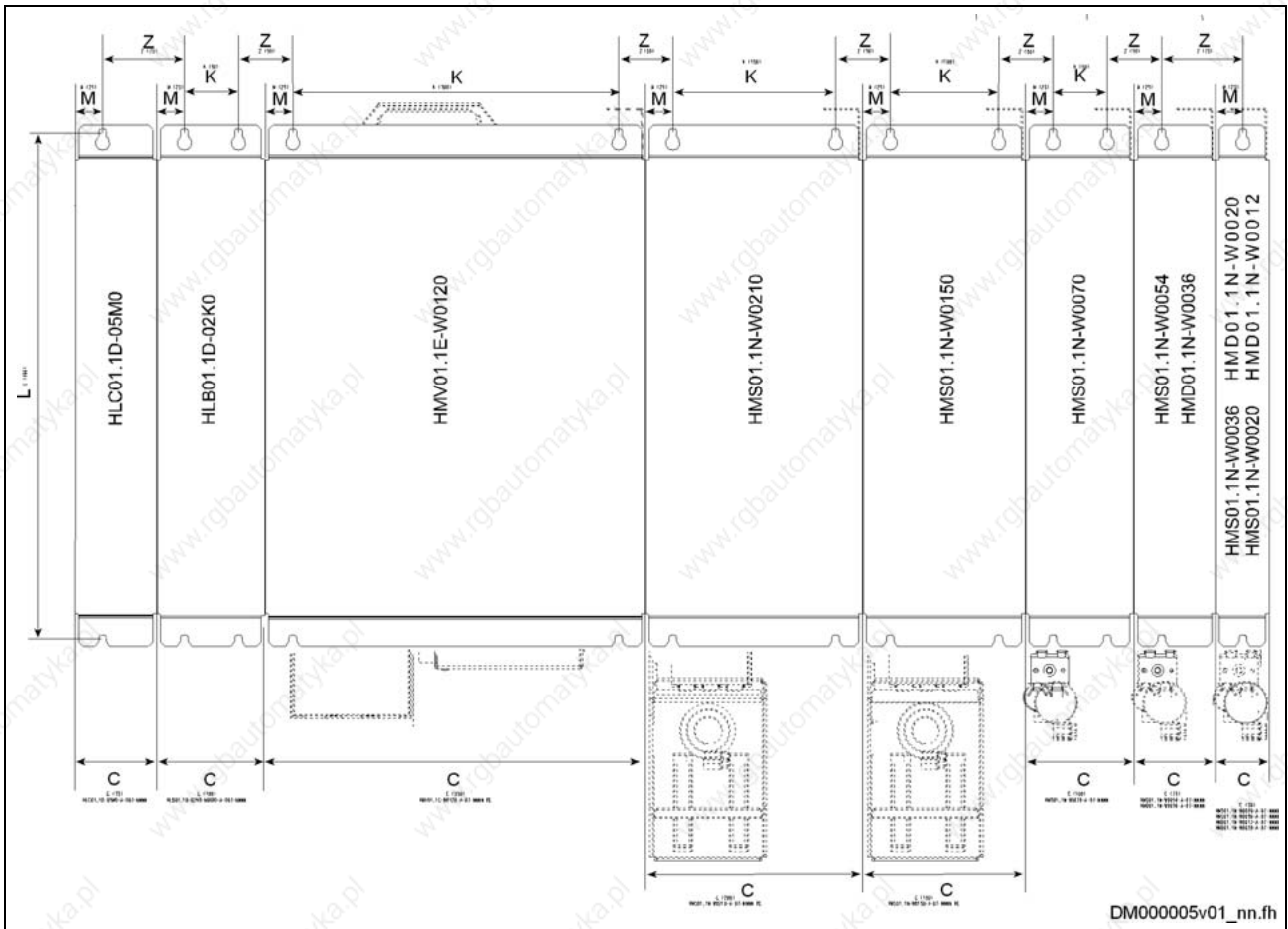


Fig. 7-12: Rexroth IndraDrive M components

Note: The prevailing grid of fixing bores within the Rexroth IndraDrive M product range is 25 mm.
 For performance-dependent arrangement of the components see Rexroth IndraDrive M Fig. 7-21: Example of an arrangement.
 The **HAS02** accessories in the figure require additional mounting clearance.

Dimension Z is significantly determined by the involved components. The table below contains the dimensions Z between the component arranged to the left and the component arranged to the right.

Component left	Component right	Dimension Z [mm]
HMV01.1E-W0030 HMV01.1E-W0075 HMV01.1E-W0120 HMV01.1R-W0018 HMV01.1R-W0045 HMV01.1R-W0065 HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0070 HMS01.1N-W0150 HMS01.1N-W0210 HMD01.1N-W0012 HMD01.1N-W0020	HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0054 HMS01.1N-W0070 HMS01.1N-W0150 HMS01.1N-W0210 HMD01.1N-W0012 HMD01.1N-W0020 HMD01.1N-W0036 HLC01.1D-05M0 HLB01.1D	50
HMS01.1N-W0054 HMD01.1N-W0036 HLC01.1D-05M0	HMV01.1E-W0030 HMV01.1E-W0075 HMV01.1E-W0120 HMV01.1R-W0018 HMV01.1R-W0045 HMV01.1R-W0065 HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0070 HMS01.1N-W0150 HMS01.1N-W0210 HMD01.1N-W0012 HMD01.1N-W0020 HLC01.1D-05M0 HLB01.1D	75

Component left	Component right	Dimension Z [mm]
HLC01.1C-01M0 HLC01.1C-02M4	HMV01.1E-W0030 HMV01.1E-W0075 HMV01.1E-W0120 HMV01.1R-W0018 HMV01.1R-W0045 HMV01.1R-W0065 HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0070 HMS01.1N-W0150 HMS01.1N-W0210 HMD01.1N-W0012 HMD01.1N-W0020 HLC01.1D-05M0 HLB01.1D	57,5
HLC01.1C-01M0 HLC01.1C-02M4	HLC01.1C-01M0 HLC01.1C-02M4	65

Fig. 7-13: Table for dimension Z

Combination of Drive Controllers of the Rexroth IndraDrive C Product Range

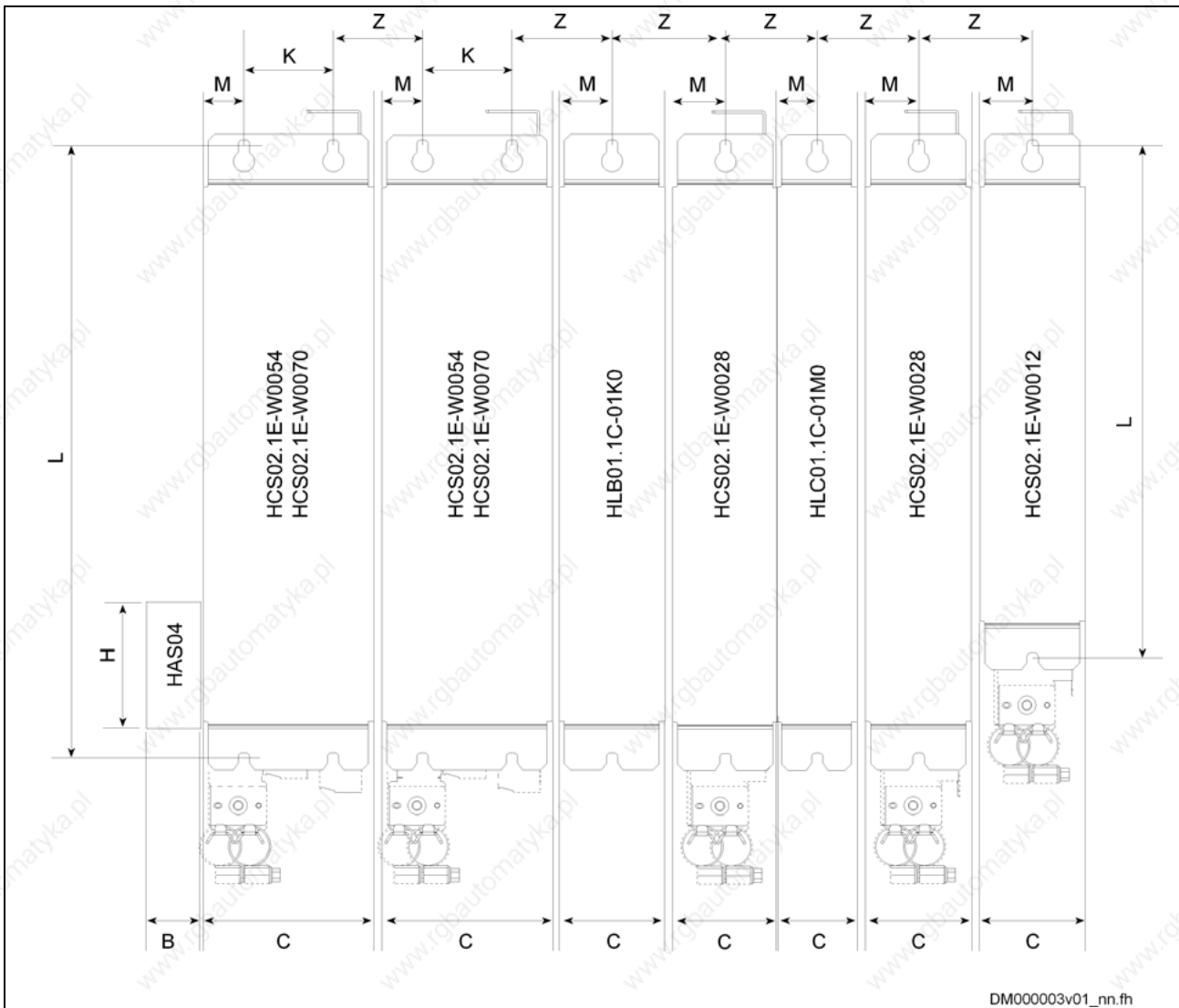


Fig. 7-14: Rexroth IndraDrive C components

Note: Observe that using **HAS04** accessory at the HCS arranged at the utmost left position requires additional space (dimensions: see section "Accessories in the Drive System Rexroth IndraDrive").

Rexroth IndraDrive components are arranged in line **to the right** starting from the supplying device. Arrange the drive controllers with high capacity as close to the supplying unit as possible.

The **HAS02** accessories in the figure require additional mounting clearance.

Dimension Z is significantly determined by the involved components. The table below contains the dimensions Z between the component arranged to the left and the component arranged to the right.

Component left	Component right	Dimension Z [mm]
HCS02.1E-W0012 HCS02.1E-W0028 HLB01.1C	HCS02.1E-W0012 HCS02.1E-W0028 HLB01.1C	70
HCS02.1E-W0054 HCS02.1E-W0070	HCS02.1E-W0054 HCS02.1E-W0070	55
HLC01.1C-01M0 HLC01.1C-02M4 HCS02.1E-W0054 HCS02.1E-W0070	HLC01.1C-01M0 HLC01.1C-02M4	50 (without distance between the components)
HCS02.1E-W0012 HCS02.1E-W0028 HLB01.1C	HLC01.1C-01M0 HLC01.1C-02M4	57,5 (without distance between the components)
HCS02.1E-W0054 HCS02.1E-W0070 HLC01.1C-01M0 HLC01.1C-02M4	HCS02.1E-W0012 HCS02.1E-W0028 HLB01.1C	62,5
HCS03.1E-W0070 HCS03.1E-W0100 HCS03.1E-W0150	HCS03.1E-W0070 HCS03.1E-W0100 HCS03.1E-W0150	50 (without distance between the components)
HCS03.1E-W0210	HCS03.1E-W0210	100 (without distance between the components)
HCS03.1E-W0070 HCS03.1E-W0100 HCS03.1E-W0150	HCS03.1E-W0210	75 (without distance between the components)
HCS03.1E-W0210	HCS03.1E-W0070 HCS03.1E-W0100 HCS03.1E-W0150	75 (without distance between the components)

Fig. 7-15: Table for dimension Z

Combination of Drive Controllers of the Rexroth IndraDrive C and IndraDrive M Product Ranges

Note: Observe that using **HAS04** accessory at the HCS arranged at the utmost left position requires additional space (dimensions: see section "Accessories in the Drive System Rexroth IndraDrive").

Rexroth IndraDrive M components are arranged in line **to the right** starting from the supplying drive controller HCS.

Dimension Z is significantly determined by the involved components. The table below contains the dimensions Z between the component arranged to the left and the component arranged to the right.

HCS02 Drive Controllers

Component left	Component right	Dimension Z [mm]
HCS02.1E-W0054 HCS02.1E-W0070	HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0054 HMD01.1N-W0012 HMD01.1N-W0020 HMD01.1N-W0036 HLC01.1D-05M0 HLB01.1D	50 (without distance between the components)

Fig. 7-16: Table for dimension Z

HCS03 Drive Controllers

Component left	Component right	Dimension Z [mm]
HCS03.1E-W0070 HCS03.1E-W0100 HCS03.1E-W0150 HCS03.1E-W0210	HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0054 HMS01.1N-W0070 HMS01.1N-W0150 HMS01.1N-W0210 HMD01.1N-W0012 HMD01.1N-W0020 HMD01.1N-W0036	50 (without distance between the components)
HCS03.1E-W0210	HMS01.1N-W0020 HMS01.1N-W0036 HMS01.1N-W0054 HMS01.1N-W0070 HMS01.1N-W0150 HMS01.1N-W0210 HMD01.1N-W0012 HMD01.1N-W0020 HMD01.1N-W0036	75 (without distance between the components)

Fig. 7-17: Table for dimension Z

Note: For the dimensions Z between other combinations see previous tables.

7.2 Arranging Components in Control Cabinet from Mainly Thermal Point of View

Multiple-Line Arrangement of Drive Controllers

Control Cabinet with Multiple-Line Structure

Note: Particular attention should be paid to the maximum allowed air intake temperature of components when they are arranged in multiple lines in the control cabinet. Where necessary, cooling air guides are to be provided with blowers specially used for this purpose.

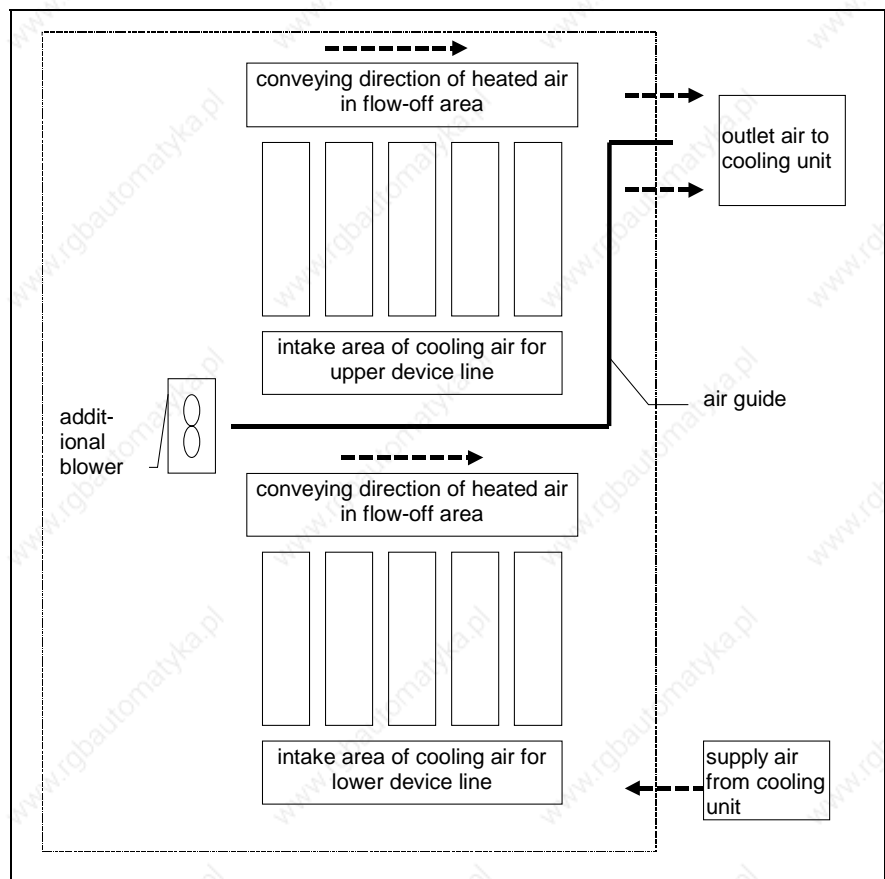


Fig. 7-18: Example of arrangement for multiple-line structure with components

Arrangement of Cooling Units



CAUTION

Possible damage to the drive controller

Operational safety of the machine endangered!
Note the following instructions!

Avoiding Dripping or Sprayed Water

Due to the operating principle, condensation water is formed when cooling units are used. For this reason, please observe the following information:

- Always position cooling units in such a way that condensation water cannot drip onto electronic equipment in the control cabinet.
- Position the cooling unit in such a way that the blower of the cooling unit does not spray accumulated condensation water onto electronic equipment.

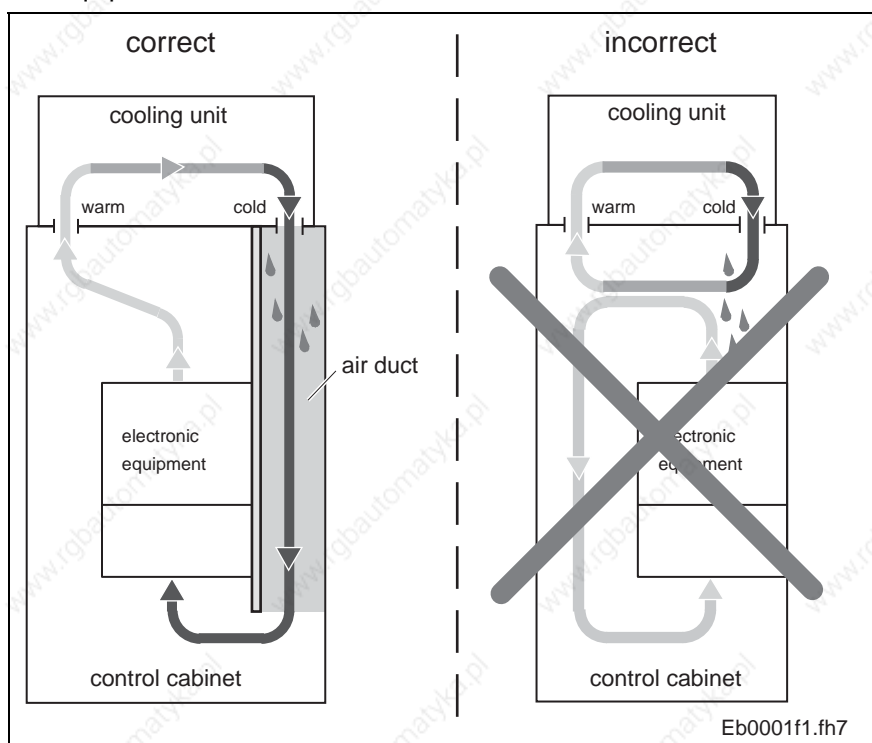


Fig. 7-19: Arranging the cooling unit on the control cabinet

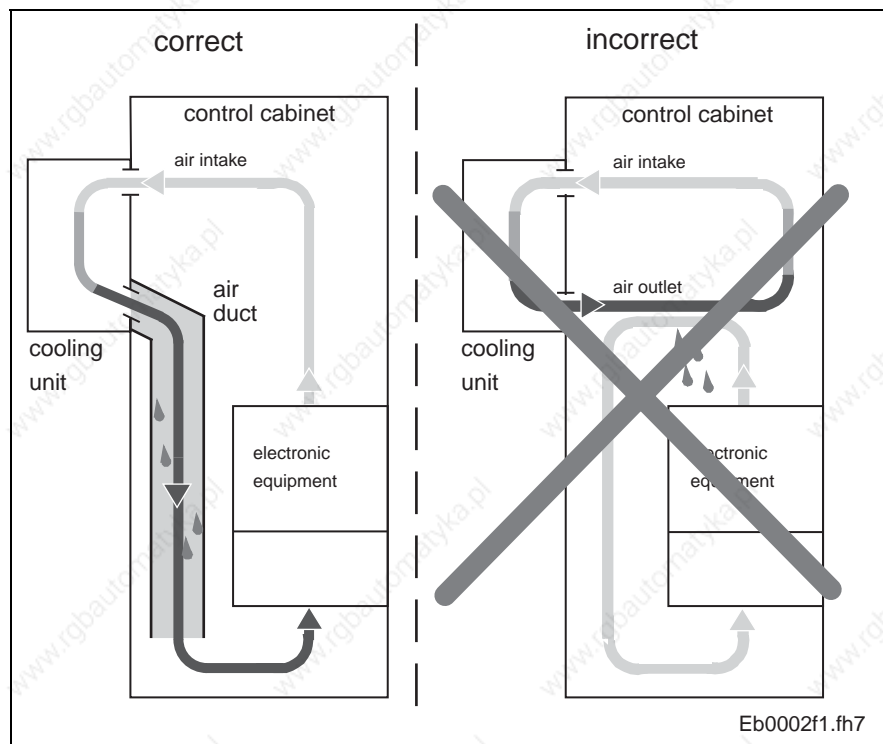


Fig. 7-20: Arranging the cooling unit at the front of the control cabinet

Avoiding Moisture Condensation

Moisture condensation occurs when the temperature of the device is lower than the ambient temperature.

- Set cooling units with temperature adjustment to the maximum surrounding temperature and not lower!
- Set cooling units with follow-up temperature in such a way that the interior temperature of the control cabinet is no lower than the temperature of the surrounding air. Set the temperature limitation to the maximum surrounding temperature!
- Only use well-sealed control cabinets so that moisture condensation cannot arise as a result of warm and moist external air entering the cabinet.

In the event that control cabinets are operated with the doors open (commissioning, servicing etc.) it is essential to ensure that after the doors are closed the drive controllers cannot at any time be cooler than the air in the control cabinet, as otherwise moisture condensation can occur. For this reason sufficient circulation must be provided inside the control cabinet to avoid pockets of heat.

7.3 Arranging Components in Control Cabinet from Mainly Electrical Point of View

The section below contains information and recommendations on the arrangement of the components in the control cabinet from mainly electrical points of view. These points of view include aspects of performance-dependent arrangement and installation in compliance with EMC.

Performance-Dependent Arrangement

Performance-Dependent Arrangement

The HMV01 supply units can supply HMS and HMD drive controllers on both sides.

Arrange drive controllers according to their performance.

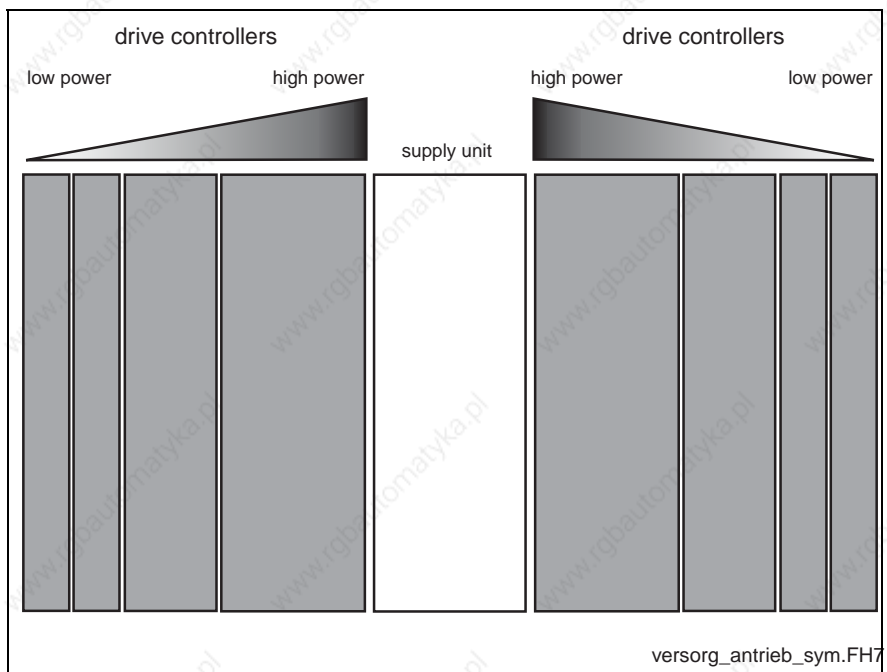


Fig. 7-21: Example of an arrangement

Note: When you use HNS02 and HNL02, the supply units HMV02 only allow mounting them on one side to the right.

Arrangement of Additional Components

- Arrange drive controllers with high performance as close to the supply unit as possible. Ideally the drive controllers should be distributed equally to the left and right side of the supply unit.

Note: If you operate HCS drive controllers with the type of mains connection "central supply", arrange the supplied drive controllers at the right side of the HCS drive controllers.

- Position DC bus capacitor unit next to drive controller with the greatest DC bus continuous power.
- Position DC bus resistor unit next to drive controller with the greatest regenerative power.
- Arrange HLR braking resistors in "standard" design above the HCS03 drive controller.
- When using DC bus resistor unit and DC bus capacitor unit in a drive system, arrange the DC bus capacitor unit between supply unit and DC bus resistor unit.

EMC Measures for Design and Installation

Rules for Design of 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	Correctly use a mains filter recommended by Rexroth for radio interference suppression in the supply feeder of the AC drive system.
Control Cabinet Grounding	All metal parts of the cabinet have to be connected with one another over the largest possible surface area to establish a good electrical connection. This, too, applies to the mounting of the EMC filter. If required, use serrated washers which cut through the paint surface. The cabinet door should be connected to the cabinet using the shortest possible grounding straps.
Line Routing	<p>Avoid coupling routes between lines with high potential of noise and noise-free lines, therefore signal, mains and motor lines and power cables have to be routed separately from another (this eliminates mutual interference!). Minimum clearance: 10 cm. Provide separating sheets between power and signal lines. Separating sheets have to be grounded at several points.</p> <p>Lines with high potential of noise at the drive controller are lines for the mains supply (incl. mains synchronization), lines at the motor connection and DC bus connections.</p> <p>Generally, interference injection are reduced by routing cables close to grounded sheet steel panels. For this reason, cables and wires should not be routed freely in the cabinet, but close to the cabinet housing or mounting panels. The incoming and outgoing cables of the radio interference suppression filter have to be separated.</p>
Interference Suppression Elements	Contactors, relays, solenoid valves, electromechanical operating hour counters etc. in the control cabinet must be provided with interference suppression combinations. These combinations must be connected directly at each coil.
Twisted Wires	Non-shielded cables belonging to the same circuit (feeder and return cable) have to be twisted or the surface between feeder and return cable has to be kept as small as possible. Ground cables that are not used at both ends.
Lines of Measuring Systems	Lines of measuring systems have to be shielded. The shield has to be connected 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	The shields of digital signal lines have to be grounded at both ends (transmitter and receiver) over the largest possible surface area and with low impedance. Bad ground connection between transmitter and receiver requires additional routing of a bonding conductor (min. 10 mm ²). Braided shields are to be preferred to foil shields.
Analog Signal Lines	The shields of analog signal lines generally have to be grounded at one end (transmitter or receiver) over the largest possible surface area and

Connection of Mains Choke to Drive Controller

with low impedance, in order to avoid low-frequency interference current (in the mains frequency range) on the shield.

Keep connection lines of mains chokes as short as possible and twist them.

Installation of Motor Power Cable

Preferably use the motor power cables with shield provided by Rexroth. If you use other motor power cables, they have to be run in shielded form.

Keep length of motor power cable as short as possible.

Ground shield of motor cable at both ends over the largest possible surface area to establish a good electrical connection.

Run motor lines in shielded form inside the control cabinet.

Do not use any steel-shielded lines.

The shield of the motor cable mustn't be interrupted by mounted components, such as output chokes, sine filters, motor filters.

EMC-Optimal Installation in Facility and Control Cabinet

With regard to EMC-optimal installation, a spatial separation of the interference-free area (mains connection) and the interference-susceptible area (drive components) is recommended, as shown in the figures below.

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

Division into Areas (Zones)

The arrangement in the control cabinet can be seen from Fig. 7-22:

Separation of interference-free area and interference-susceptible area in control cabinet.

There are three areas to be distinguished:

1. Interference-free area of control section (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 via the mains filter of the AC drives
- all components that aren't electrically connected with the drive system

2. Interference-susceptible area (area B):

- mains connections between drive system and mains filter for drives, mains contactor
- interface lines of drive controller

3. Strongly interference-susceptible area (area C):

- motor cable including single strands

Never run lines of one of these areas in parallel with lines of another area so that there isn't any unwanted interference injection from one area to the other and that the filter is jumpered with regard to high frequency. Keep connection lines as short as possible.

For complex systems it is recommended to put the drive components into a cabinet and the controls into a separate second cabinet.

Badly grounded control cabinet doors act as antennas. It is recommended to connect the doors to the control section on top, in the middle and on the bottom via short equipment grounding conductors with a cross section of at least 6 mm² or, even better, via grounding straps with the same cross section. Make sure connection points have good contact.

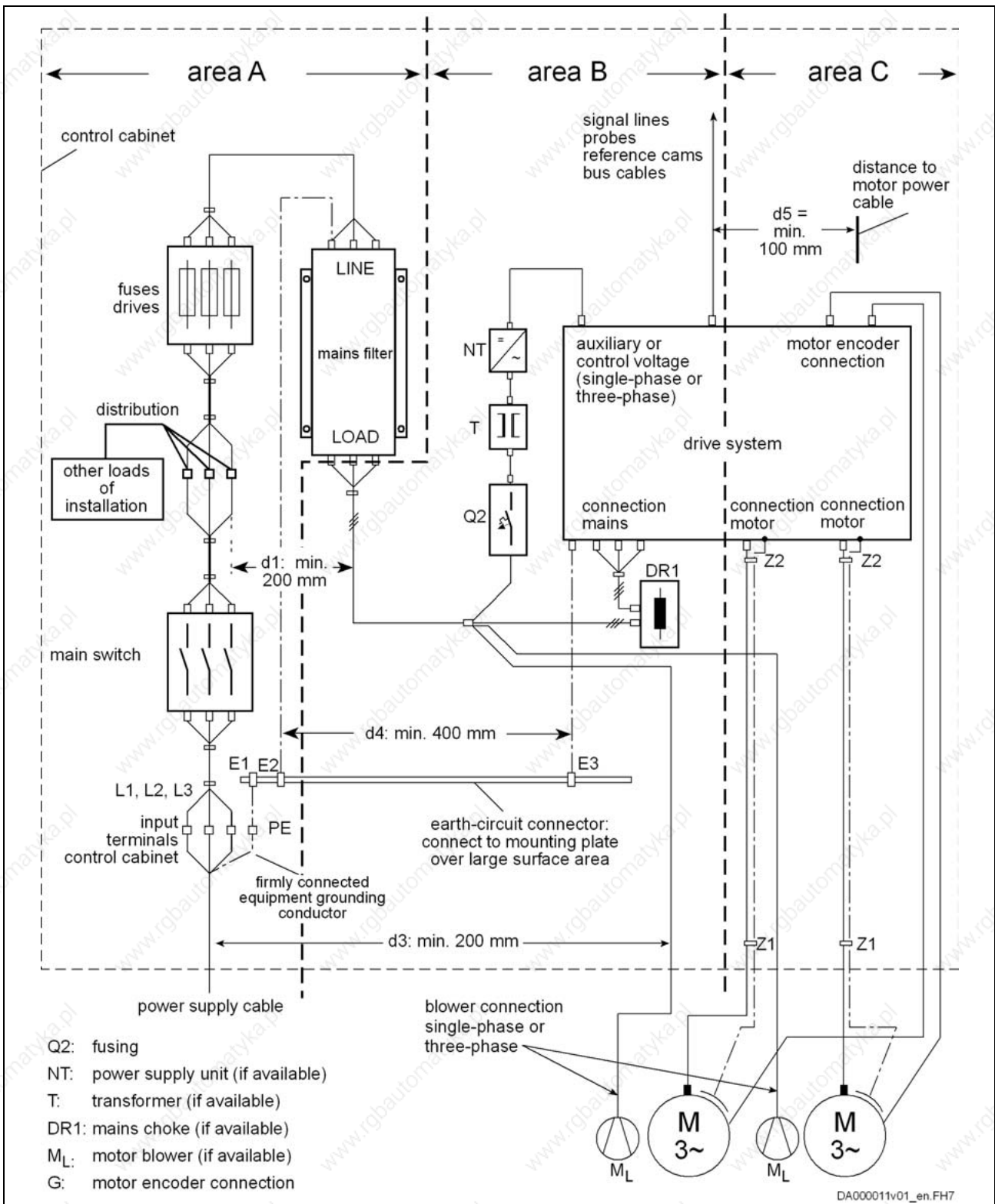


Fig. 7-22: Separation of interference-free area and interference-susceptible area in control cabinet

Design and Installation in Interference-Free Area of Control Cabinet (Area A)

Arranging the Components in the Control Cabinet

When arranging the components in the control cabinet, it is recommended that you place the components and electrical elements (switches, pushbuttons, fuses, terminal connectors) in the interference-free zone A with a distance of at least $d_1 = 200$ mm to the components in both other zones B and C.

In particular, a distance of at least $d_2 = 500$ mm has to be kept in zone A between magnetic components, such as transformers, line reactors and DC-link reactors, that are directly connected to the power terminals of the drive system and the interference-free components and lines between supply system and filter including the mains filter. If this distance is not kept, the magnetic leakage fields are injected to the interference-free components and lines connected to the mains so that the limit values at the supply connection are exceeded in spite of the installed filter.

Cable Routing of the Interference-Free Lines to the Mains Connection

The distance between the power input line and the lines between filter and exit point from the control cabinet in area A and the lines in areas B and C must be at least 200 mm (distances d_1 and d_3 in the figure) at all points.

If this is impossible, there are two alternatives:

- Install these lines with a shield and connect the shield, at several points, but at least at the beginning and at the end of the line, to the mounting plate or the control cabinet housing over a large surface area, or:
- Separate these lines from the other interference-susceptible lines in zones B and C by means of a grounded distance plate vertically attached to the mounting plate.

In addition, these lines have to be kept as short as possible within the control cabinet and installed directly on the grounded metal surface of the mounting plate or of the control cabinet housing.

Mains supply lines from zones B and C must not be connected to the mains without a filter.

Note: In case the information on cable routing given in this section is not observed, the effect of the mains filter is totally or partly neutralized. You must therefore expect the noise level of the interference emission to be higher within the range of 150 kHz to 40 MHz and the limit values at the connection points of the machine or installation to be exceeded.

Routing and Connecting a Neutral Conductor (N)

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

Connecting Motor Blowers

Single-phase or three-phase supply lines of motor ventilators, that are usually routed in parallel with motor cables or interference-susceptible lines, also have to be provided with a filter. They either have to be filtered via a separate single-phase filter (NFE type) or three-phase filter (HNF, NFD type) near the supply connection of the control cabinet, or to be connected at the load side of the existing three-phase filter for the power connector of the drive system. When switching power off, make sure the ventilator is not switched off.

Shielding Mains Supply Lines in Control Cabinet

If there is a high degree of interference injection to the power input line within the control cabinet, in spite of you having observed the above instructions (to be found out by standard EMC measurement), the lines in area A have to be routed in shielded form. In this case the shields have to be connected to the mounting plate at the beginning and the end of the line by means of clips. The same procedure may be required for long cables of more than 2 m between the point of power supply connection of the control cabinet and the filter within the control cabinet.

Mains Filters for AC Drives

The mains filter ideally should be mounted on the parting line between area A and B. Make sure the ground connection between filter housing and housing of the drive controllers has good electrically conductive properties. If single-phase loads are connected on the load side of the filter, their current may only be a maximum of 10% of the three-phase operating current. A highly imbalanced load of the filter would deteriorate its interference suppression capacity.

If the mains voltage is more than 480 V, the filter has to be connected on the output side of the transformer and not on its supply side.

Grounding

In the case of bad ground connections in the installation, the distance between the lines to the grounding points E1, E2 in area A and the other grounding points of the drive system should be at least $d_4 = 400 \text{ mm}$, in order to minimize interference injection from ground and ground cables to the power input lines.

See also Fig. 7-22: Separation of interference-free area and interference-susceptible area in control cabinet

Point of Connection for Equipment Grounding Conductor of Machine, Installation, Control Cabinet

The equipment grounding conductor of the power cable of the machine, installation or control cabinet of the has to be **firmly connected** at point PE and have a **cross section of at least 10 mm^2** or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN50178/ 1997, section 5.3.2.1). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor has to be adjusted accordingly.

Design and Installation in Interference-Susceptible Area of Control Cabinet (Area B)**Arranging Components and Lines**

Modules, components and lines in area B should be placed at a distance of at least $d_1 = 200 \text{ mm}$ from modules and lines in area A or shielded by distance plates mounted vertically on the mounting plate. As an alternative, the lines can be shielded.

Power supply units for auxiliary or control voltage connections in the drive system mustn't be directly connected to the mains, but have to be connected to the mains via a mains filter, as indicated in Fig. 7-22:

Separation of interference-free area and interference-susceptible area in control cabinet.

Keep line length between drive controller and filter as short as possible. Avoid unnecessary lengths.

Control Voltage or Auxiliary Voltage Connection

Only in exceptional cases should a connection of power supply unit and fusing for the control voltage connection be made at phase and neutral conductor. In this case these components have to be mounted and installed in area A, far away from the areas B and C of the drive system. For details see chapter "Design and Installation in Interference-Free Area of Control Cabinet (Area A)".

The connection between control voltage connection of the drive system and power supply unit used has to be run 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 Strongly Interference-Susceptible Area of Control Cabinet (Area C)

Area C mainly concerns the motor cables, especially at the connection point at the device.

Influence of the Motor Power Cable The discharge capacitance is limited to ensure compliance with the limit values. The calculation of the discharge capacitance can be found in the "Calculations" chapter.

If the applications allows this, the cable length should always be kept short. Avoid unnecessary line lengths.

Routing the Motor Cables The motor cables have to be run in shielded form. Besides they are always to be routed with a distance of $d_5 = 100 \text{ mm}$ to the other interference-free lines and to signal cables and lines, or to be separated from them by a grounded distance plate. The latter is not required for the feedback cables of Rexroth motors.

At the drive controller connection the motor cables and the (unfiltered) power connection lines may only be routed in parallel for a distance of 300 mm. After that distance, motor cables and power supply cables have to be routed in opposite directions in separate cables ducts, as illustrated in the following figures (Fig. 7-23: Option 1: separate routing of motor cable and mains connection lines via 2 cable ducts; Fig. 7-24: Option 2: separate routing of motor cable and mains connection lines) by the example of a drive system with separate mains connection per drive axis IndraDrive HCS.

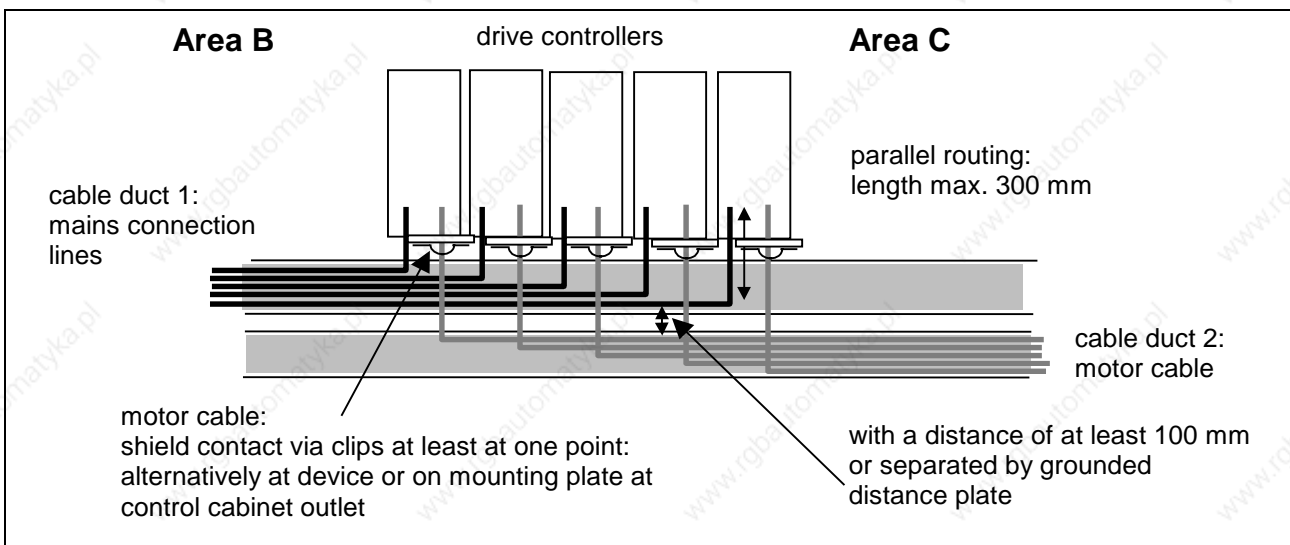


Fig. 7-23: Option 1: separate routing of motor cable and mains connection lines via 2 cable ducts

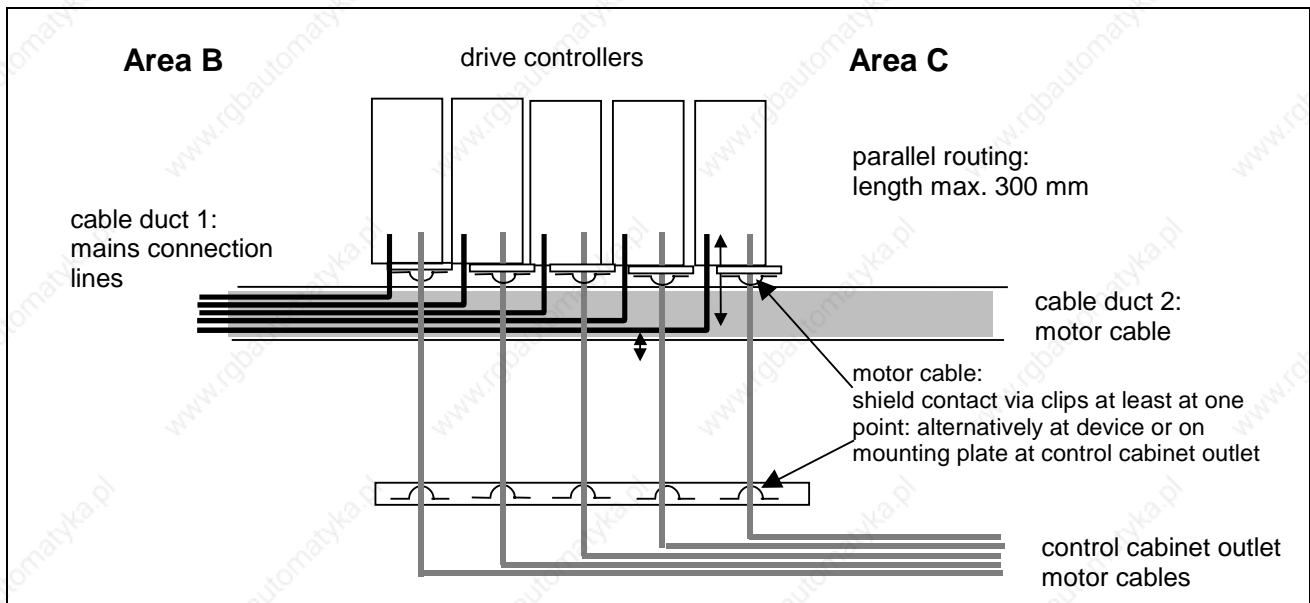


Fig. 7-24: Option 2: separate routing of motor cable and mains connection lines

Additional Recommendations on Cable Routing

The motor cables should be routed along grounded metal surfaces, both inside the control cabinet and outside of it, in order to minimize radiation of interference fields. If possible the motor cables should be routed in metal-grounded cable ducts.

The outlet of the motor cables at the control cabinet should ideally be provided in a distance of at least $d3 = 200 \text{ mm}$ from the (filtered) power supply cable.

Connection of Motor Cable to Drive Controller

There are the following minimum requirements for connecting the motor cables to the drive controller:

- Connect the shield of the motor cable **over the largest possible surface area (with low impedance)** to the drive controller. The connection of cable shields by means of round wires (so-called "pig tails") at the cable ends to ground and housing is normally insufficient.
- Make sure there is sufficient **strain relief** for the motor cable itself.

Shield Connection with Accessory HAS02

Optional accessory HAS02 to be used with connection over a large surface area directly to the device. This is the best solution. The figure below illustrates this by the example of HCS02 drive controllers:

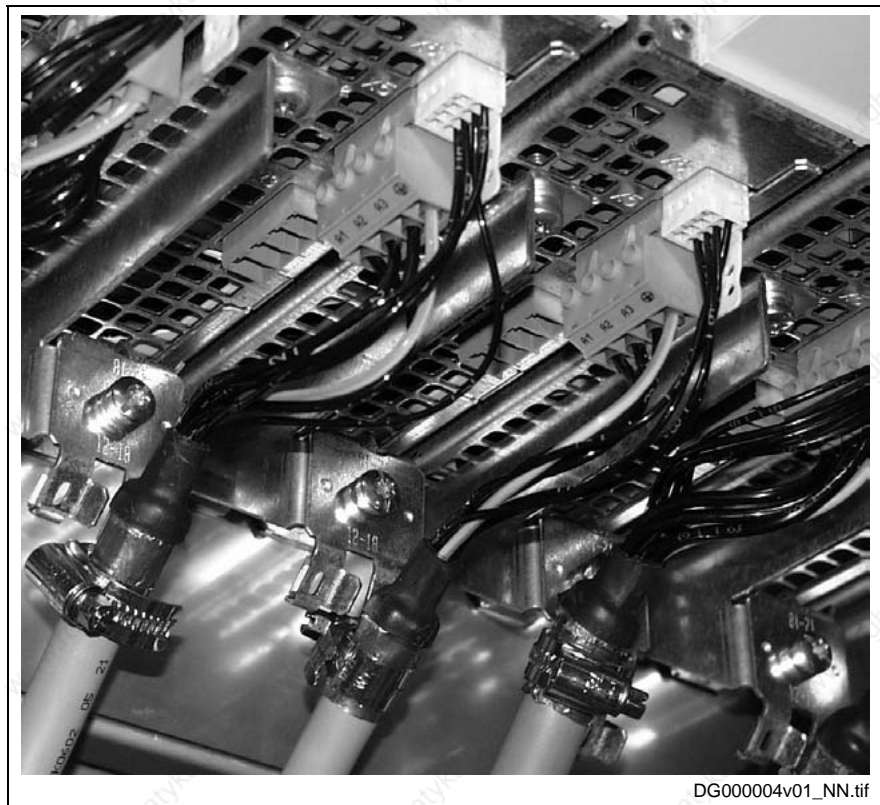


Fig. 7-25: Connecting HAS02 to HCS02

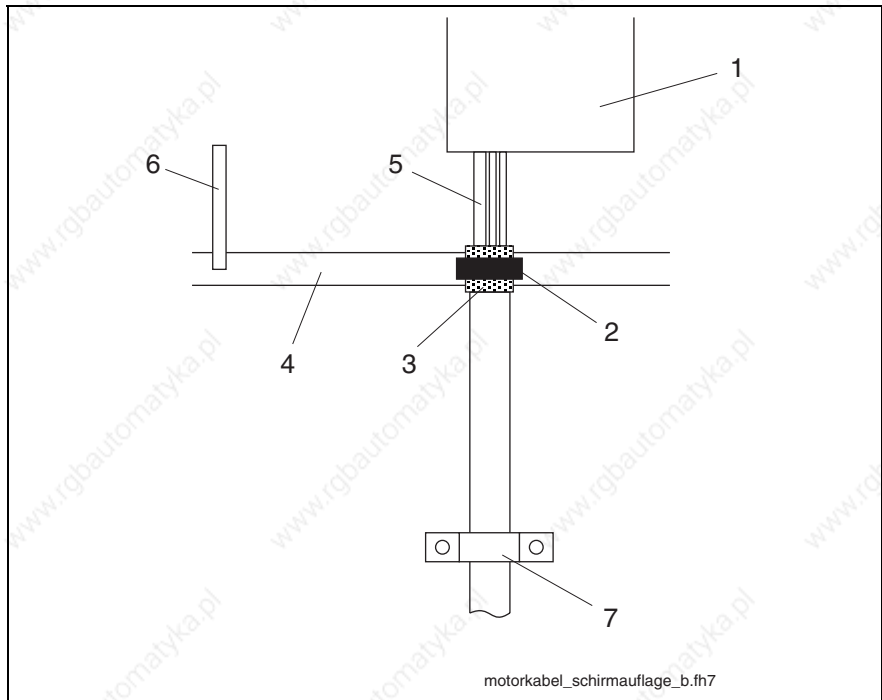
Shield Connection without Accessory HAS02

For shield connection without HAS02 accessory connect the cable shield with the lowest possible impedance to the drive controller.

The following paragraphs describe two basic alternatives of this kind of connection.

Alternative 1

Connect cable shield to a ground bus. The maximum distance between ground bus and device connection is 100 mm. For this purpose take the given length of the single strands at the cable end into account for ready-made Rexroth motor power cables.

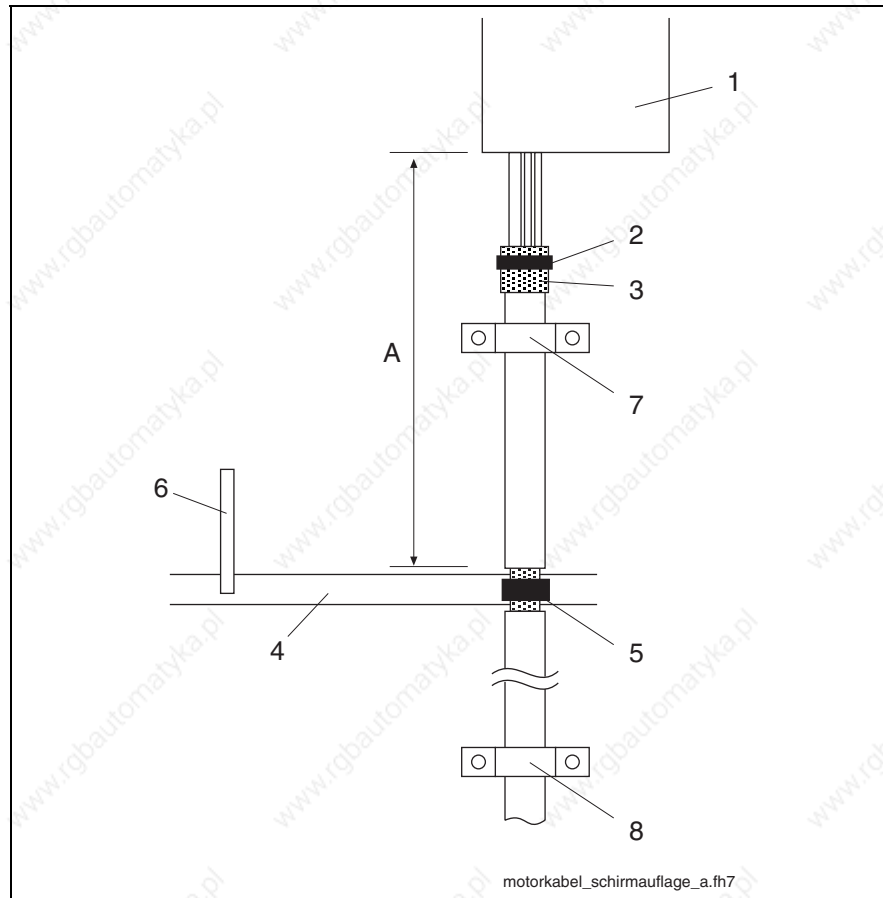


- 1: drive controller
- 2: clip for shield contact
- 3: overall shield of the motor power cable folded back
- 4: ground bus in control cabinet
- 5: single strands of motor power cable
- 6: connection of ground bus to supplying device
- 7: strain relief (as near as possible to control cabinet outlet)

Fig. 7-26: Shield contact, alternative 1

- With a clip (2) connect overall shield of motor power cable (3) to ground bus (4).
(If you use your own cable make sure the shields of the two inner pairs of wires are in contact with the overall shield.)
- With a cable (6) (line cross section at least 10 mm²) connect ground bus (4) to ground connection at supplying device (Rexroth IndraDrive supply unit or Rexroth IndraDrive drive controller HCS).

Alternative 2 Connect cable shield to a ground bus. The cable length between device and ground bus mustn't be more than a max. of 1 m. For this purpose prepare the motor cable in accordance with the description below:



- 1: drive controller
- 2: cable tie
- 3: overall shield of the motor power cable folded back
- 4: ground bus in control cabinet
- 5: connection between overall shield of motor power cable laying bare and ground bus
- 6: connection of ground bus to supplying device
- 7: strain relief (as near as possible to the drive-side cable end)
- 8: strain relief (as near as possible to control cabinet outlet)
- A: cable length between ground bus and device: < 1m

Fig. 7-27: Shield contact, alternative 2

- With a cable tie (2) press the drive-side cable end in such a way that the shields of the two inner pairs of wires (motor temperature, holding brake) have good contact with the overall shield of the motor power cable (3).
(If you use your own cable make sure the shields of the two inner pairs of wires are in contact with the overall shield.)
- On the level of the ground bus in the control cabinet remove a piece of the cable sheath from the motor power cable in order to lay bare the overall shield (5).
- Connect overall shield (5) to ground bus in the control cabinet with an appropriate connection (clip). The connection must have a cross section of at least 10 mm².
- With a cable (6) (line cross section at least 10 mm²) connect ground bus (4) to ground connection at supplying device (Rexroth IndraDrive supply unit or Rexroth IndraDrive drive controller HCS).
- Make sure there is sufficient strain relief for the motor power cable as near as possible to the drive-side cable end (7).

- In addition, make sure there is sufficient strain relief for the motor power cable as near as possible to the control cabinet outlet of the motor power cable (8).

Note: Do not remove the shield of the motor cable between ground bus and device.

If the motor cables are routed to the control cabinet via flange boxes, the shield is directly connected to the wall of the control cabinet over a large surface area via the housing of the flange box. Make sure there is sufficient separate strain relief.

Bonding Conductor

Bad ground connection between motor housing and control cabinet housing, as well as long motor cables, can require additional routing of a bonding conductor of a cross section of normally 10 mm² between control cabinet housing and motor housing.

Note: For cable lengths of more than 50 m the cross section should be at least 35 mm².

Shield Connection of Kit Motors

For kit motors make sure that the connection lines are run in shielded form or under metal between winding and terminal box, if the terminal box is not directly mounted on the spindle case.

Shield Connection for Linear Motors

For linear motors connect the shield of the connection cable between primary part and terminal box via clips to machine housing or metal shell.

Shielding of Temperature Monitor and Brake

The inner shields of temperature monitor and brake in the motor cable are connected to the drive controller at one end.

Ground Connections

Housing and Mounting Plate

By means of appropriate ground connections it is possible to avoid the emission of interference, because interference is discharged to earth on the shortest possible way. Ground connection of the metal housings of 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 over a large surface area and well contacted. This also applies to all screw connections of between mounting plate and control cabinet wall and to the mounting of a ground bus to the mounting plate.

For this purpose it is recommended to use a zinc-coated or chromated mounting plate. Compared to a lacquered plate, the connections in this case have a good long-time stability.

Connection Elements

For lacquered mounting plates always use screw connections with tooth lock washers and zinc-coated, tinned screws as connection elements. At the connection points selectively scratch off the lacquer so that there is safe electrical contact over a large surface area. Contact over a large surface area is established by means of bare connection surfaces or several connection screws. For screw connections the contact to lacquered surfaces is ensured by using tooth lock washers.

Metal Surfaces

In any case use connection elements with good electroconductive surface.

Bare zinc-coated, tinned and chromated metal surfaces have **good electroconductive properties**. Anodized, yellow chromated, black gunmetal finish or lacquered metal surfaces have **bad electroconductive properties** and therefore shouldn't be used for connection elements (screws, nuts, plain washers).

Ground Wires and Shield Connections

For connecting ground wires and shield connections it is not the cross section but the size of contact surface that is important, as the high-frequency interference currents mainly flow on the surface of the conductor.

Any connection of cable shields, especially of shields of the motor power cables with ground potential (see section "Connection of Motor Cable to Drive Controller") always has to be provided over a large surface area.

Installing Signal Lines and Cables

Line Routing

For measures to prevent interference see the Project Planning Manuals of the respective device. In addition, observe the following recommendations:

Signal and control lines have to be routed separately from the power cables with a minimum distance of $d_5 = 100 \text{ mm}$ (see Fig. 7-22:

Separation of interference-free area and interference-susceptible area in control cabinet) or with a grounded separating sheet. The optimum way is to route them in separate cable ducts. If possible, lead signal lines into control cabinet at one point only.

Exception: If there is no other way to do it, motor feedback cables can be routed together with the motor power cables.

If signal lines are crossing power cables, they should be routed in an angle of 90° in order to avoid interference injection.

Spare cables that are not used and have been connected should be grounded at least at both ends so that they don't have any antenna effect.

Avoid unnecessary line lengths.

Run cables as close as possible to grounded metal surfaces (reference potential). The ideal solution are closed, grounded cable ducts or metal pipes which, however, is only obligatory for high requirements (sensitive instrument leads).

Avoid suspended lines or lines routed along synthetic carriers, because they are functioning both like good reception antennas (noise immunity) and like good transmitting antennas (emission of interference). Exceptional cases are trailing cable installations over short distance of a max. of 5 m.

Shielding

The cable shield has to be connected immediately at the devices in the shortest and most direct possible way and over the largest possible surface area.

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

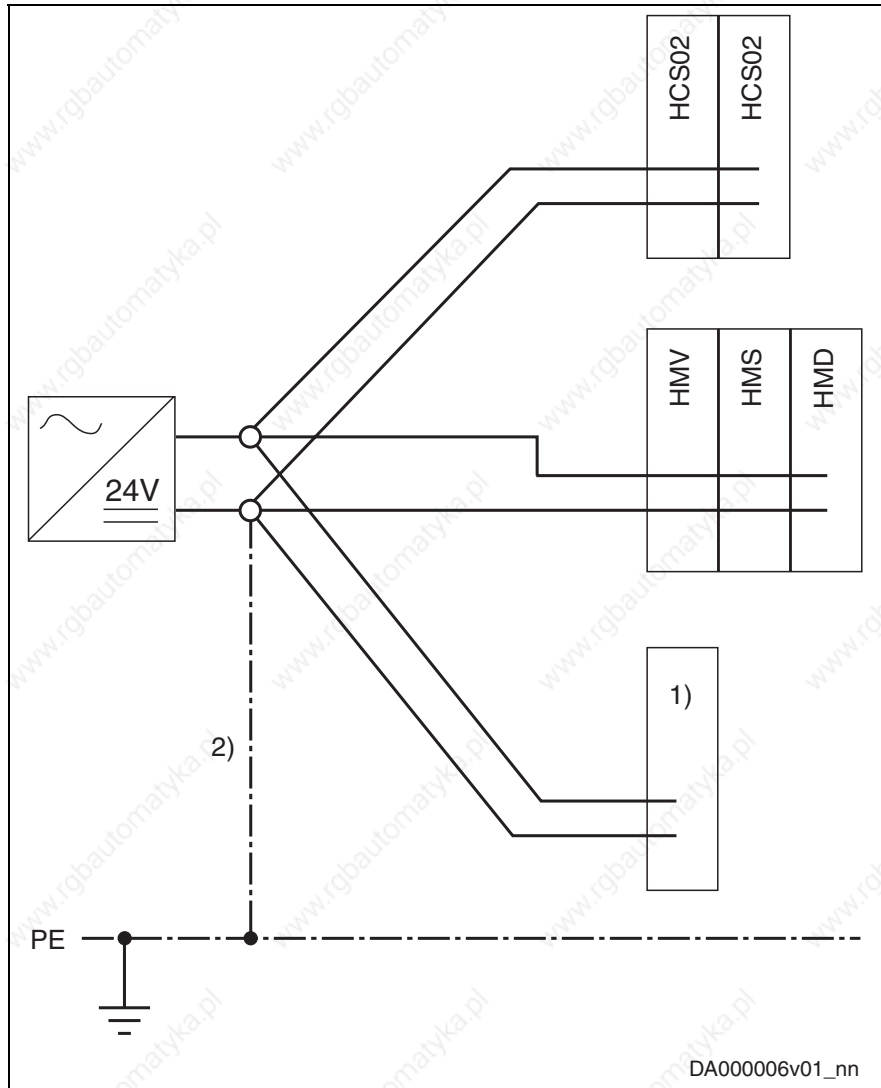
The shield of digital signal lines is connected at both ends over a large surface area and in short form. In the case of potential differences between beginning and end of the line, run an additional bonding conductor in parallel. The guide value for the cross section is 10 mm^2 .

You absolutely have to equip separable connections with connectors with grounded metal housing.

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

Installing the 24V Supply

As a matter of principle, the 24V supply of the components of the drive system Rexroth IndraDrive has to be installed in star-shaped form, i.e. for each group of drive controllers or third-party components it is necessary to run separate supply lines. This, too, applies to multiple-line arrangement in the case of supply from a supply unit, for example.



- 1) third-party component (e.g. PLC, valve etc.)
 2) connection to central ground point (e.g. earth-circuit connector)

Fig. 7-28: Installing the 24V supply

Note: If you use several power supply units for 24 V supply, make sure that

- the reference conductors 0V of the individual power supply units are interconnected with low impedance
- the output voltages of the power supply units are within the allowed voltage range
- the power supply units are synchronously switched on and off.

General Measures of Radio Interference Suppression for Relays, Contactors, Switches, Chokes, Inductive Loads

If, in conjunction with electronic devices and components, inductive loads, such as chokes, contactors, relays are switched by contacts or semiconductors, appropriate interference suppression has to be provided for them. In the case of d.c. operation, this is achieved by arranging free-wheeling diodes and in the case of a.c. operation, by arranging usual RC interference suppression elements depending on the contactor type, immediately at the inductance. Only the interference suppression element arranged immediately at the inductance serves this purpose. Otherwise the emitted noise level is too high which can affect the function of the electronic system and of the drive.

If possible, mechanical switches and contacts should only be realized as snap contacts. Contact pressure and contact material must be suited for the corresponding switching currents.

Slow-action contacts should be replaced by snap switches or by solid-state switches, because slow-action contacts strongly bounce and are in an undefined switching status for a long time which emits electromagnetic waves in the case of inductive loads. These waves are an especially critical aspect in the case of manometric or temperature switches.

Notes

8 Electromagnetic Compatibility (EMC)

8.1 EMC Requirements

The electromagnetic compatibility (EMC) or electromagnetic interference (EMI) includes the following requirements:

- sufficient noise immunity of an electric installation or an electric device against external electric, magnetic or electromagnetic interference via lines or through air
- sufficiently low noise emission of electric, magnetic or electromagnetic noise of an electric installation or an electric device to other surrounding devices via lines or through air

Noise Immunity in Drive System

Basic Structure for Noise Immunity

The figure below illustrates the interfaces for definition of noise immunity requirements in the drive system.

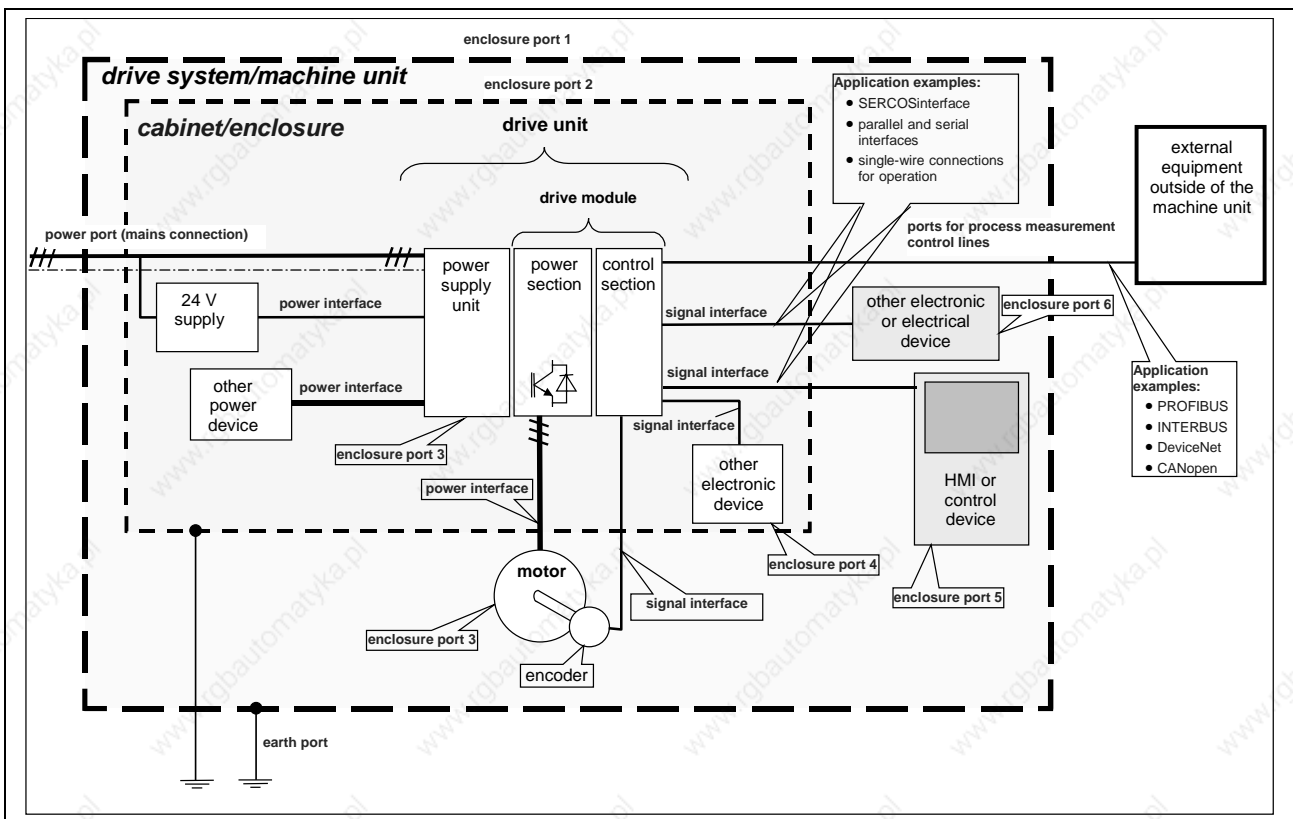


Fig. 8-1: Basic structure and noise immunity

Noise Immunity Limit Values

No	Place of effect	Phenomenon	Standard	Conditions	Coupling	Test values according standard EN 61800-3	Performance level
	Enclosure port		IEC 61000-4-2		CD, AD	6 kV CD, 8kV AD, if CD not possible	B
		RF Field	IEC 61000-4-3		Via antenna on EUT	10 V/ m	A
	Power port	Burst	IEC 61000-4-4	length > 3 m	mains connection I < 100 A: discoupling network I ≥ 100 A: clamp	4 kV/ 2,5 kHz (clamp)	B
		Surge	IEC 61000-4-5	Only mains connection; I < 63 A, light load test		Line – line 1 kV (2 Ohm) Line – earth 2 kV (12 Ohm)	B
			IEC 61000-4-6	length > 3 m	clamp	10 V, 0,15 – 80 MHz	A
	Power Interface	Burst	IEC 61000-4-4	length > 3 m	clamp		B
	Signal Interface	Burst	IEC 61000-4-4	length > 3 m	clamp		B
			IEC 61000-4-6	length > 3 m	Clamp or CDN	10 V, 0,15 – 80 MHz	B
	Ports of process; measurement control lines	Burst	IEC 61000-4-4	length > 3 m	clamp		B
			IEC 61000-4-6	length > 3 m	Clamp or CDN	10 V, 0,15 – 80 MHz	A

Fig. 8-2: Noise immunity limit values

Evaluation criterion	Explanation (abbreviated form from EN 1800-3)
A	Deviations within allowed range
B	Automatic recovery after interference
C	Switched off without automatic recovery. Device remains undamaged

Fig. 8-3: Evaluation criterion

Noise Emission of Drive System

Causes of Noise Emission

Controlled variable-speed drives contain converters containing snappy semiconductors. The advantage of modifying the speed with high precision is achieved by means of pulse width modulation of the converter voltage. This can generate sinusoidal currents with variable amplitude and frequency in the motor.

The steep voltage rise, the high clock rate and the resulting harmonics cause unwanted but physically unavoidable emission of interference

voltage and interference fields (wide band interference). The interference mainly is asymmetric interference against ground.

The propagation of this interference strongly depends on

- configuration
- conditions of mounting
- mounting site
- radiation conditions
- wiring and installation
- of the individual drive components in the machine or installation.

If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

Limit Values for Line-Based Disturbances

According to IEC EN 61800-3 or CISPR 11, the limit values in the table below are distinguished. For this documentation both standards are combined in the limit value classes A2.1 to B1.

IEC / EN 61800-3	CISPR 11	Explanation	In this documentation	Curves of limit value characteristic
Category C4 2nd environment	none	One of the following 3 requirements must have been fulfilled: Mains connection current >400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter. Adjust limit values to use and operation on site. User has to carry out and provide evidence of EMC planning.	none	--
Category C3 2nd environment; I >100 A	Class A; Group 2 I >100A	limit value in industrial areas to be complied with for applications operated at supply mains with nominal currents > 100A	A2.1	1.1 1.2
Category C3 2nd environment; I <100 A	Class A; Group 2 I <100A	limit value in industrial areas to be complied with for applications operated at supply mains with nominal currents < 100A	A2.2	2.1 2.2
Category C2 1st environment; restricted distribution	Class A; Group 1	Limit value in residential area or at facilities at low-voltage mains supplying buildings in residential areas. To be complied with for applications with restricted distribution.	A1	3.1 3.2
Category C1 1st environment; unrestricted distribution	Class B; Group 1	limit value in residential areas to be complied with for applications with unrestricted distribution	B1	4.1 4.2

Fig. 8-4: Limit value classes

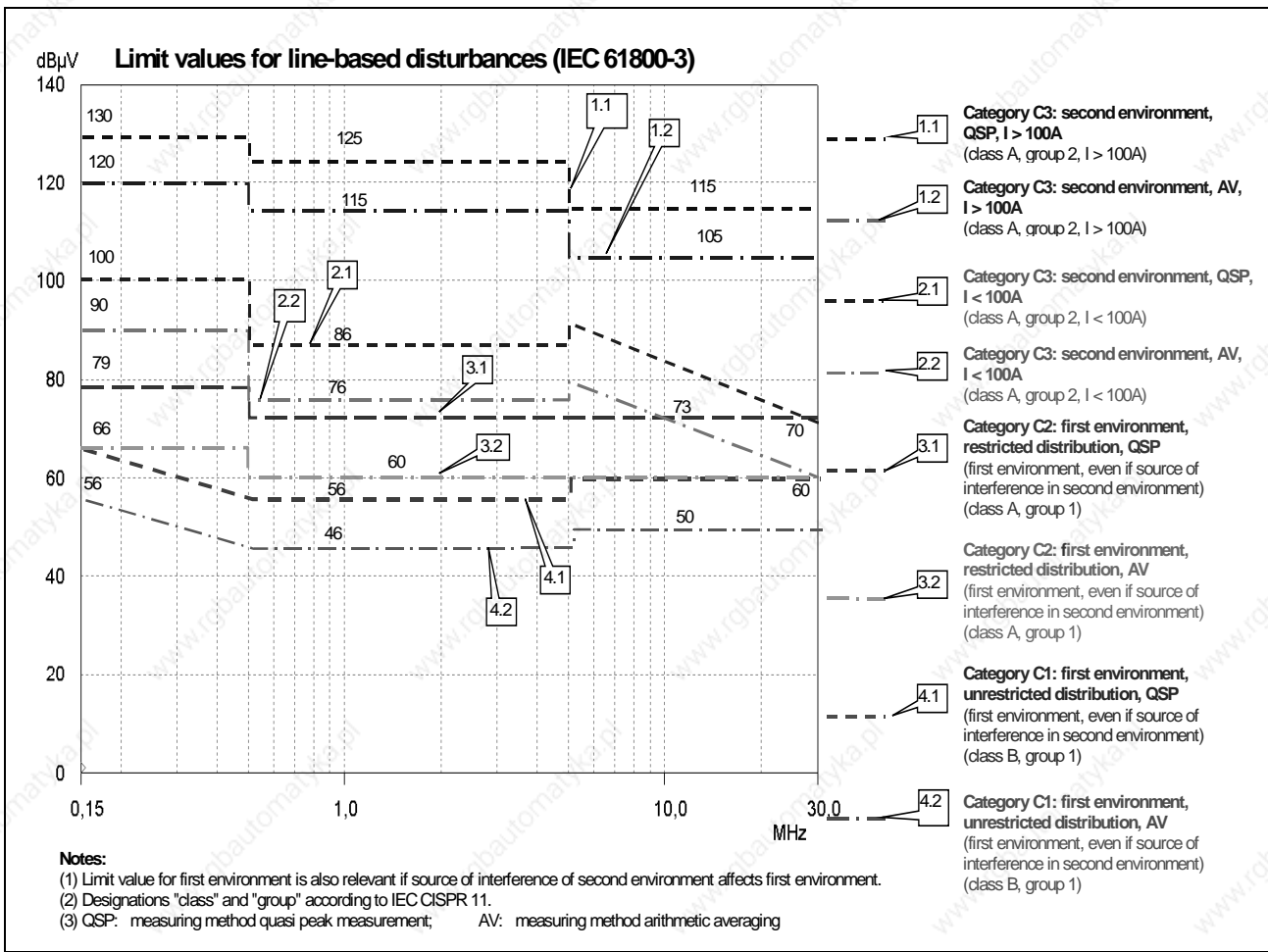


Fig. 8-5: Limit value characteristic through frequency range

Second Environment, Industrial Area Facilities not directly connected to a low-voltage mains to supply buildings in residential areas.

If the limit values in an industrial area separated from public supply by a transformer station only have to be complied with at the property boundary or in the neighboring low-voltage mains, the filter might not be necessary. In the vicinity of broadcast receivers or other sensitive devices as regards high-frequency, such as measuring sensors, measuring lines or measuring devices, it is normally required to use the interference suppression filter.

Increasing the noise immunity of a sensitive device can often be the economically better solution compared to measures of interference suppression at the drive system of the installation.

First Environment Environment containing residential areas and facilities directly connected, without interstage transformer, to a low-voltage mains supplying buildings in residential areas.

Medium-sized manufacturing plants and industrial establishments can be connected to the public low-voltage mains together with residential buildings. In this case there is a high risk for radio and television reception if there aren't any measures for radio interference suppression taken. Therefore, the indicated measures are generally recommended.

Nominal Current of Supply Mains The nominal current of the supply mains (>100A or <100A) is specified by the local power supply company at the connection point of the mains. For industrial companies, for example, such connection points are the interconnecting stations from the power supply system.

Unrestricted Distribution Channel of distribution for which placing on the market is independent of the EMC expert knowledge of the customer or user of electric drives.

Restricted Distribution Channel of distribution for which the placing on the market is restricted to traders, customers or users who individually or together have technical expert knowledge of EMC for the use of electric drives.

Since it is impossible to obtain the lower limit values for residential areas with all applications by means of the usual measures (like for example in the case of large and electrically not closed installations, longer motor cables or a high number of drives), the following note included in EN 61800-3 has to be observed.

Note: Components of the drive system Rexroth IndraDrive are **products of category C3** (with restricted distribution) according to IEC 61800-3. They are not provided for use in a public low-voltage mains supplying residential areas. If they are used in such a mains, high-frequency interference is to be expected. This can require additional measures of radio interference suppression.

See the following chapters for the limit value classes (as per categories C1, C2, C3, C4 according to EN 61800-3) which can be reached for the individual drive systems and devices.

8.2 Ensuring the EMC Requirements

Standards and Laws On the European level there are the EU directives. In the EU states these directives are transformed into laws valid on a national level. The relevant directive for EMC is EU directive 89/336/EEG which was transformed on the national level in Germany into the law EMVG ("Law concerning electromagnetic compatibility of devices") of 1992-11-09.

EMC Properties of Components Drive and control components by Rexroth are designed and built, in accordance with the present state-of-the-art of standardization, according to legal regulations of the EU directive 89/336/EEG and the German EMC law.

The compliance with EMC standards was tested by means of a typical arrangement with a test setup conforming to standard with the indicated mains filters. The limit values according to product standard EN 61800-3 have been complied with.

Apart from the internal test at the factory, a conformity test was carried out for individual drive systems in an accredited laboratory of a CE-responsible authority.

Applicability for End Product Measurements of the drive system with an arrangement typical for the system are not in all cases applicable to the status as installed in a machine or installation. Noise immunity and noise emission are strongly depending on

- configuration of the connected drives
- number of the connected drives
- conditions of mounting, mounting site
- radiation conditions, wiring
- installation of individual drive components

in the machine or installation.

In addition, the required measures depend on the requirements of electric safety technology and economic efficiency in the application.

In order to prevent interference as far as possible, notes on mounting and installation are contained in the application manuals of the components and in this documentation.

Note: Observe the descriptions and notes in chapter "Arranging the Components in the Control Cabinet".

Cases to Distinguish for Declaration of EMC Conformity

For validity of the harmonized standards, we distinguish the following cases:

- **Case 1: Delivery** of the drive system. According to the regulations, the product standard EN 61800-3 is complied with for Rexroth drive systems. The drive system is listed in the declaration of EMC conformity. This fulfills the legal requirements according to EMC directive.
- **Case 2: Acceptance test** of a machine or installation with the installed drive systems. The product standard for the respective type of machine/installation, if existing, applies to the acceptance test of the machine or installation. In the last years, some new product standards were created for certain machine types and some are being created at present. These new product standards contain references to the product standard EN 61800-3 for drives or specify higher-level requirements demanding increased filter and installation efforts. When

the machine manufacturer wants to put the machine/installation into circulation, the product standard relevant to his machine/installation has to be complied with for his end product "machine/installation". The authorities and test laboratories responsible for EMC normally refer to this product standard.

This documentation specifies the EMC properties which can be achieved, in a machine or installation, with a drive system consisting of the standard components.

It also specifies the conditions under which the indicated EMC properties can be achieved.

8.3 Measures to Reduce Noise Emission

To reduce noise emission there are mainly three possible measures:

- filtering by means of mains filter
- shielding by mounting and shielded cables
- grounding by electrical bonding

Noise Emission of the Drive Systems

In order to comply with the limit values for noise emission (mainly line-based radio interference of more than 9 kHz) at the connection points of the machine or installation, observe the notes on application contained in this documentation.

Shielding

Sufficient metallic shielding prevents radiation into the air. This is achieved by mounting the devices in a grounded control cabinet or in a housing (metallic encapsulation). The shielding of line connections is realized by shielded cables and lines, the shield has to be grounded over a large surface area.

Grounding

Grounding discharges interference to ground and makes it flow back to the source of interference over the shortest distance. Realize grounding via a sufficiently **short connection over the largest possible surface area** in order to achieve low inductive resistance with a low degree of line inductance. The higher the frequency of disturbances, the lower the line inductance of grounding has to be.

Note: In ungrounded mains the measure "grounding" cannot be generally used.

Filtering

Filtering prevents emission of noise via the lines, especially via the mains connection. For this purpose there are special interference suppression filters available, with which

- the allowed limit values of the line-based interference emission can be complied with in the range of 50 kHz to 30 MHz.
- interference via the mains connection to devices connected near by (e.g. control unit components) can be reduced.

Selecting the Mains Filter

For Rexroth drive systems there are the following mains filters for radio interference suppression available:

- NFE01.1, NFE02.1, NFD03.1, HNF01.1, HNK01.1; HNS02.1

These filters have been especially dimensioned for Rexroth drive systems. If you use other filters by other manufacturers, Rexroth cannot guarantee mains interference suppression with regard to allowed limit values.

Criteria for Selecting the Mains Filter

For selecting the appropriate mains filter, take the following criteria into account:

- required EMC limit value class
- ambient conditions on site
- loading by harmonics on site
- loading by mains voltage and frequency on site
- loading by mains-side phase current
- total length of connected motor cables
- sum of leakage capacitances

How to Proceed for Selecting the Mains Filter

There are the following criteria for selection of the mains filter; the criteria are decisively determined by the operating conditions. To select the mains filter proceed as follows:

1. Determine required EMC limit value class for application.
2. Check or determine max. occurring ambient temperature.
3. Determine max. applied mains voltage.
Observe that not all Rexroth IndraDrive mains filters are suited for mains voltage of 3AC500V.
4. Determine kind of mains connection, such as central supply, group supply etc. (to do this it is useful to outline involved components and their interaction).
5. Calculate mains-side phase current of mains filter.
For selecting components calculate the effective rms value. For help on calculations see chapter "Calculations" under "Calculations for Mains Connection".
6. Select a mains contactor the nominal current of which does not exceed nominal current of mains filter.
7. Determine number of drive axes, take into account that HMD01 are equipped with 2 axes.
8. Determine total length of connected motor cables.
9. Calculate sum of leakage capacitance on load side of mains filter.
Determine sum of leakage capacitance from number of operated axes and length of connected motor cables. Chapter "Calculations", section "Determining the Leakage Capacitance" helps you with the calculation.
10. Select appropriate mains filter from tables in chapter "Limit Value Classes to be Achieved with Mains Filters".

Mains-Side Phase Current

Note: Observe that the capacity of the mains filters regarding the max. allowed number of drive controllers and max. allowed total motor cable length depends on whether you use an HMV supply module or supply other drive controllers with HCS drive controllers.

For supply by HMV both the allowed number and allowed total length are higher.

- Allowed Operating Data** 11. Calculate allowed operating data of mains filter according to chapter "Calculations for Determining the Allowed Operating Data of Mains Filters". If necessary, make sure the harmonics are reduced on site.

Note: The selected mains filter has to comply with the criteria determined before.

Within a mains filter line you can replace mains filters of lower type current by such ones with higher type current.

Protecting Mains Filters Against Overload

The mains filters are provided for operation with Rexroth IndraDrive devices and risk overload in the case of incorrect use.



CAUTION

Property damage due to mains filter overload!

- ⇒ Avoid series connection of mains filters as this can cause resonance effects on current and voltage.
 - ⇒ Use only expressly allowed components at mains filters.
 - ⇒ When using mains filters at compensation units, make sure there aren't any resonance effects on current and voltage.
 - ⇒ Observe the allowed harmonic limit values (THD) of the filter components.
 - ⇒ Observe that the nominal current of the mains contactor does not exceed the nominal current of the mains filter.
-

To connect the shield at the motor, a suitable PG gland with shield connection can be used (e.g. "SKINDICHT SHV/SRE/E" from the Lapp Company, Stuttgart). Make sure that the connection between the motor terminal box and the motor housing has a low impedance. If necessary, use an additional grounding strap between them. Never use plastic motor terminal boxes!

Ungrounded Mains For operation at ungrounded mains it is recommended to galvanically decouple the drive system with the mains filter from the mains via an isolating transformer, if ground fault detection or monitoring is to remain effective in the installation.

Please note that residual-current-operated circuit-breakers trigger accidentally as a result of larger leakage current when connecting mains filters.

If the drive system is nevertheless operated directly at the ungrounded mains, make sure that

- the ground fault detection of the mains does not trigger accidentally and
- the interference suppression, that now is only activated via the parasitic mains capacitances of the ungrounded mains, is still sufficient to comply with the limit values required by the application.

8.4 Limit Value Classes to be Achieved with Mains Filters

For explanations on the dimensioning criterion limit value class see chapter 0 "Noise Emission of Drive System" under "Limit Values for Line-Based Disturbances".

For calculation formulas for determining the allowed leakage capacitances see chapter "Determining the Leakage Capacitance".

Mains Filters for Supply Modules HMV01.1E and HMV01.1R with HMS01/HMD01

Limit Value Classes for HMV01.1E Supply Units

Observe the notes and proceeding in chapter "Selecting the Mains Filter".

Supply unit type	Mains filter type	Max. allowed number of axes	Max. allowed total length of motor cable [m]	PWM frequ. [kHz]	Allowed leakage capacitance to comply with limit value class [nF]			
					A2.1	A2.2	A1	B1
assigned mains choke HNL01.1 optional					A2.1	A2.2	A1	B1
HMV01.1E-W0030	HNF01.1A-F240-E0051	12 (12 * HMS01 or 6 * HMD01)	280	4	tbd	290	290	-
			110	8 12 16				
HMV01.1E-W0030	without	not allowed						
HMV01.1E-W0030	HNF01.1A-M900-E0051	21 (21 * HMS01 or 11 * HMD01)	1050	4	tbd	1100	1100	-
			270	8 12 16				
HMV01.1E-W0075	without	1 (1 * HMS01 or 1 * HMD01)	40	4 8	40	--	--	--
HMV01.1E-W0075	HNF01.1A-F240-E0125	12 (12 * HMS01 or 6 * HMD01)	280	4	tbd	290	-	-
			110	8 12 16				
HMV01.1E-W0075	HNF01.1A-M900-E0125	21 (21 * HMS01 or 11 * HMD01)	1050	4	tbd	1100	-	-
			270	8 12 16				
HMV01.1E-W0120	without	1 (1 * HMS01 or 1 * HMD01)	40	4 8	40	--	--	--
HMV01.1E-W0120	HNF01.1A-F240-E0202	12 (12 * HMS01 or 6 * HMD01)	280	4	tbd	290	-	-
			110	8 12 16				
HMV01.1E-W0120	HNF01.1A-M900-E0202	21 (21 * HMS01 or 11 * HMD01)	1050	4	tbd	1100	-	-
			270	8 12 16				

tbd in preparation
Fig. 8-6: Supply modules HMV01.1E with / without mains filter HNF

Limit Value Classes for HMV01.1R Supply Units

Observe the notes and proceeding in chapter "Selecting the Mains Filter".

Note: Damage caused by missing mains choke! Always operate HMV01.1R supply units with the assigned mains choke HNL01.1R.

Supply unit type	Mains filter type	Max. allowed number of axes	Max. allowed total length of motor cable [m]	PWM frequ. [kHz]	Allowed leakage capacitance to comply with limit value class [nF]			
					A2.1	A2.2	A1	B1
assigned mains choke HNL01.1R required					A2.1	A2.2	A1	B1
HMV01.1R-W0018	HNF01.1A-F240-R0026	12 (12 * HMS01 or 6 * HMD01)	280	4	tdb	290	290	-
			110	8 12 16				
HMV01.1R-W0018	HNF01.1A-M900-R0026	21 (21 * HMS01 or 11 * HMD01)	1050	4	tdb	1100	1100	-
			270	8 12 16				
HMV01.1R-W0045	HNF01.1A-F240-R0065	12 (12 * HMS01 or 6 * HMD01)	280	4	tdb	290	290	-
			110	8 12 16				
HMV01.1R-W0045	HNF01.1A-M900-R0065	21 (21 * HMS01 or 11 * HMD01)	1050	4	tdb	1100	1100	-
			270	8 12 16				
HMV01.1R-W0065	HNF01.1A-F240-R0094	12 (12 * HMS01 or 6 * HMD01)	280	4	tdb	290	-	-
			110	8 12 16				
HMV01.1R-W0065	HNF01.1A-M900-R0094	21 (21 * HMS01 or 11 * HMD01)	1050	4	tdb	1100	-	-
			270	8 12 16				
HMV01.1R-W0120	HNF01.1A-H350-R0180	8 (8 * HMS01 or 4 * HMD01)	350	4	tdb	tdb	-	-
			tdb	8 12 16				
HMV02.1R-W0015	HNS02.1A-Q150-R0023	12 (12 * HMS02)	150	4	tdb	tdb	tdb	-
			tdb	8 12 16				

tdb in preparation
Fig. 8-7: Supply modules HMV01.1R with / without mains filter HNF

Mains Filters for Drive Controllers HCS02

Note: With HCS02.1E drive controllers the **limit value class A2.1** (see Noise Emission of Drive System) can already be achieved **without mains filters**.

- Observe notes in chapter "Arranging the Components in the Control Cabinet".

Limit Value Classes for HCS02 Drive Controllers

Observe the notes and proceeding in chapter "Selecting the Mains Filter".

Drive controller type	Mains filter type 2)	Max. allowed number axes	Max. all. total length of motor cable [m]	PWM frequ. [kHz]	Max. all. leakage capac. 1) [nF]	Allowed leakage capacitance to comply with limit value class [nF]			
						A2.1	A2.2	A1	B1
assigned mains choke HNL01.1 optional						A2.1	A2.2	A1	B1
group supply without DC bus connection to HCS02.1E-W0012	NFD03.1-480-007	6 (6 * HCS02)	120	4; 8 12, 16	80 (70) tbd	x	75 tbd	65 tbd	45 tbd
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028	NFD03.1-480-016	6 (6 * HCS02)	120	4; 8 12, 16	70(65) tbd	x	60 tbd	50 tbd	40 tbd
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028 or central supply via HCS02.1E-W0054, HCS02.1E-W0070	NFD03.1-480-030	6 (6 * HCS02 or 6 * HMS01 or 3 * HMD01)	120	4; 8 12, 16	100 (60) tbd	x	80 tbd	50 tbd	-- --
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028 or central supply via HCS02.1E-W0054, HCS02.1E-W0070	NFD03.1-480-055	6 (6 * HCS02 or 6 * HMS01 or 3 * HMD01)	120	4; 8 12, 16	130 (65) tbd	x	100 tbd	70 tbd	52 tbd
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028 or central supply via HCS02.1E-W0054, HCS02.1E-W0070	NFD03.1-480-075	6 (6 * HCS02 or 6 * HMS01 or 3 * HMD01)	120	4; 8 12, 16	150 (65) tbd	x	110 tbd	70 tbd	55 tbd

Drive controller type	Mains filter type 2)	Max. allowed number axes	Max. all. total length of motor cable [m]	PWM frequ. [kHz]	Max. all. leakage capac. 1) [nF]	Allowed leakage capacitance to comply with limit value class [nF]			
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028 or central supply via HCS02.1E-W0054, HCS02.1E-W0070	HNF01.1A- F240-R0026	6 (6 * HCS02 or 6 * HMS01 or 3 * HMD01)	240	4; 8 12, 16	350 tbd	x	350	300	89
							tbd	tbd	tbd
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028 or central supply via HCS02.1E-W0054, HCS02.1E-W0070	HNF01.1A-M900-R0026	12 (12*HCS02 or 12*HMS01 or 6 * HMD01)	900	4; 8 12, 16	400 tbd	x	350	350	350
							tbd	tbd	tbd
group supply without DC bus connection to HCS02.1E-W0012, HCS02.1E-W0028 or central supply via HCS02.1E-W0054, HCS02.1E-W0070	HNF01.1A-M900-E0051	12 (12*HCS02 or 12*HMS01 or 6 * HMD01)	900	4; 8 12, 16	400 tbd	x	350	--	--
							tbd	tbd	

- 1) saturation limit of filter
 - 2) observe allowed current load of mains filter
 - x: limit value is observed without mains filter
 - () for unbalanced distribution; when leakage capacitance between axes differs by more than 50%
 - tbd in preparation
- Fig. 8-8: HCS02 with mains filter

Note: HNF01.1 mains filters are not suited for operation on mains grounded via outer conductor.
Observe allowed mains connection voltage in the respective Project Planning Manual (max. 3AC480V)!

Mains Filters for Drive Controllers HCS03

Note: At HCS03.1E drive controllers, do **not** operate any external additional capacitances at the DC bus.

Exception: For drive controllers HCS03.1E-...-W0210 this is allowed.

Limit Value Classes for HCS03 Drive Controllers with HNK01

Observe the notes and proceeding in chapter "Selecting the Mains Filter".

Drive controller type	Mains filter type	Max. allowed number of axes	Max. allowed total length of motor cable [m]	PWM frequ. [kHz]	Allowed leakage capacitance to comply with limit value class [nF]			
					A2.1	A2.2	A1	B1
HCS03.1E-W0070	HNK01.1A-A075-E0050	1	75	4 8 12 16	tbd	tbd	tbd	tbd
HCS03.1E-W0100	HNK01.1A-A075-E0080	1	75	4 8 12 16	tbd	tbd	tbd	tbd
HCS03.1E-W0150	HNK01.1A-A075-E0106	1	75	4 8 12 16	tbd	tbd	tbd	tbd
HCS03.1E-W0210	HNK01.1A-A075-E0146	1	75	4 8 12 16	tbd	tbd	tbd	tbd

tbd in preparation
Fig. 8-9: HCS03 with mains filter HNK

Limit Value Classes for HCS03 Drive Controllers with HMS, HMD and HNF01 Drive Controllers

Observe the notes and proceeding in chapter "Selecting the Mains Filter".

Drive controller type	Mains filter type	Max. allowed number of axes	Max. allowed total length of motor cable [m]	PWM frequ. [kHz]	Allowed leakage capacitance to comply with limit value class [nF]			
					A2.1	A2.2	A1	B1
HCS03.1E-W0070	HNF01.1A-F240-E0051	6 (6 * HMS01 or 3 * HMD01)	240	4	tbd	tbd	tbd	tbd
			110	8 12 16				
HCS03.1E-W0070	HNF01.1A-M900-E0051	12 (12*HMS01 or 6 * HMD01)	900	4	tbd	tbd	tbd	tbd
			270	8 12 16				
HCS03.1E-W0100	HNF01.1A-F240-R0094	6 (6 * HMS01 or 3 * HMD01)	240	4	tbd	tbd	tbd	tbd
			110	8 12 16				
HCS03.1E-W0100	HNF01.1A-M900-R0094	12 (12*HMS01 or 6 * HMD01)	900	4	tbd	tbd	tbd	tbd
			270	8 12 16				
HCS03.1E-W0150	HNF01.1A-F240-E0125	6 (6 * HMS01 or 3 * HMD01)	240	4	tbd	tbd	tbd	tbd
			110	8 12 16				
HCS03.1E-W0150	HNF01.1A-M900-E0125	12 (12*HMS01 or 6 * HMD01)	900	4	tbd	tbd	tbd	tbd
			270	8 12 16				
HCS03.1E-W0210	HNF01.1A-F240-E0202	6 (6 * HMS01 or 3 * HMD01)	240	4	tbd	tbd	tbd	tbd
			110	8 12 16				
HCS03.1E-W0210	HNF01.1A-M900-E0202	12 (12*HMS01 or 6 * HMD01)	900	4	tbd	tbd	tbd	tbd
			270	8 12 16				

tdb in preparation
Fig. 8-10: HCS03 with mains filter HNF01

Note: HNF01.1 mains filters are not suited for operation on mains grounded via outer conductor.

Observe allowed mains connection voltage in the respective Project Planning Manual (max. 3AC480V)!

Notes

9 Types of Mains Connection

Drive systems with Rexroth IndraDrive controllers can be connected to the mains in different ways. We distinguish the following types of mains connection:

- individual supply
- group supply without DC bus DC bus connection
- group supply with DC bus connection
- central supply

The following table illustrates the allowed types of mains connection, they are described in detail below.

Note: For further information on configuration and parameter setting of the drive controllers see Functional Description in chapter "Power Supply".
In this chapter you will find the settings for configuring the Bb contact and involved parameters.

9.1 Allowed Types of Mains Connection

Drive controller or supply module	Individual supply	Group supply without DC bus DC bus connection	Group supply with DC bus connection	Central supply
HMV01.1E	x	x	x	x
HMV01.1R	x	x	--	x
HCS02.1E	x	x	x	x
HCS03.1E	x	x	x	x
HMV02.1R	x	x	--	x

X: allowed

--: not allowed

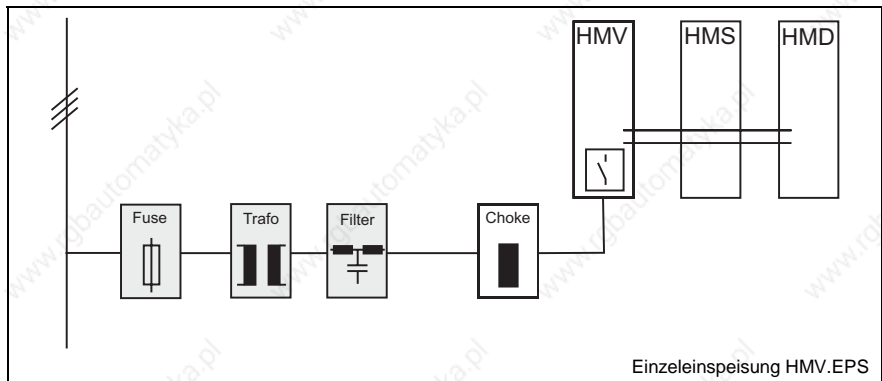
Fig. 9-1: Allowed types of mains connection

9.2 Individual Supply

The mains connection individual supply is the standard type of connection. It is characterized by one mains connection (mains circuit breaker, mains transformer, mains filter, mains choke) for each drive system.

Individual Supply with HMV

It is possible to connect further drive controllers and additional components to the supply module.

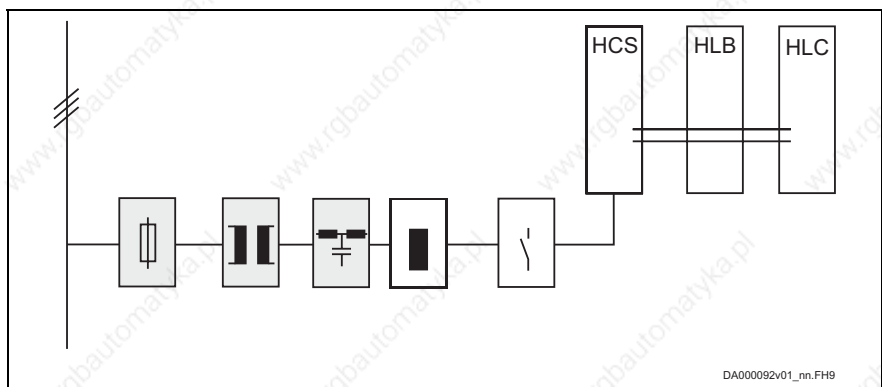


optionally required components are marked with gray background color

Fig. 9-2: Individual supply HMV

Individual Supply with HCS

It is possible to connect further additional components to the HCS drive controller.



optionally required components are marked with gray background color

Fig. 9-3: Individual supply HCS

Note: Apart from the connection of the drive controller to the mains, the following connections have to be wired:

- Bb contact at control section (see Project Planning Manual for control section)
- control voltage supply
- equipment grounding conductor

Note: When using the component HCS03.1E with HNK01.1 connect the mains contactor electrically between the mains connection and the HNK.

9.3 Group Supply

Group supply means that a component of the mains connection (mains circuit breaker, mains transformer, mains filter, mains choke) is used by several drive systems.

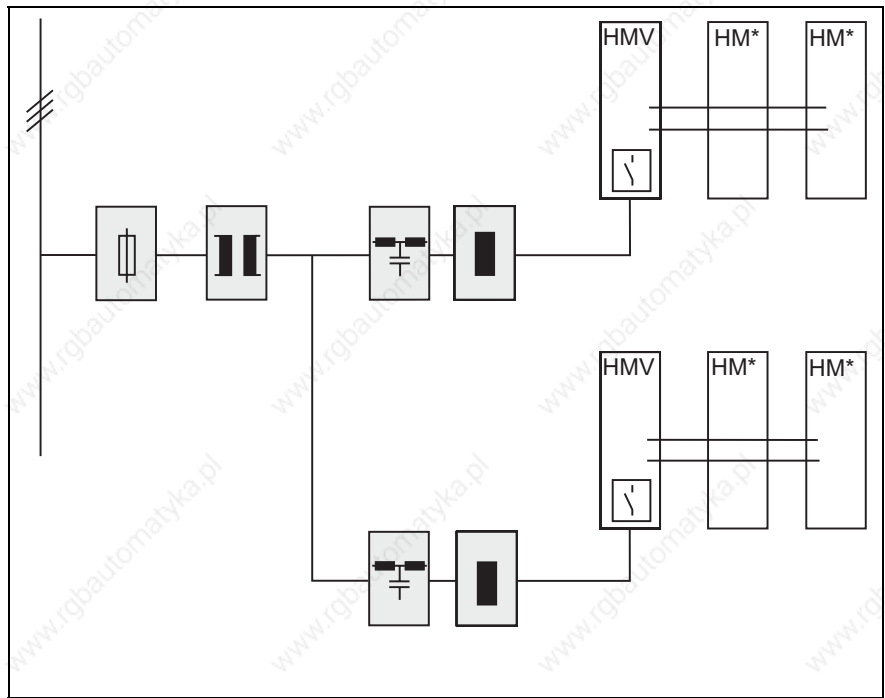
Group Supply without DC Bus Connection of the Groups

Note: Apart from the connection of the drive controller to the mains, the following connections have to be wired:

- Bb contact at control section (see Project Planning Manual for control section)
 - control voltage supply
 - equipment grounding conductor
-

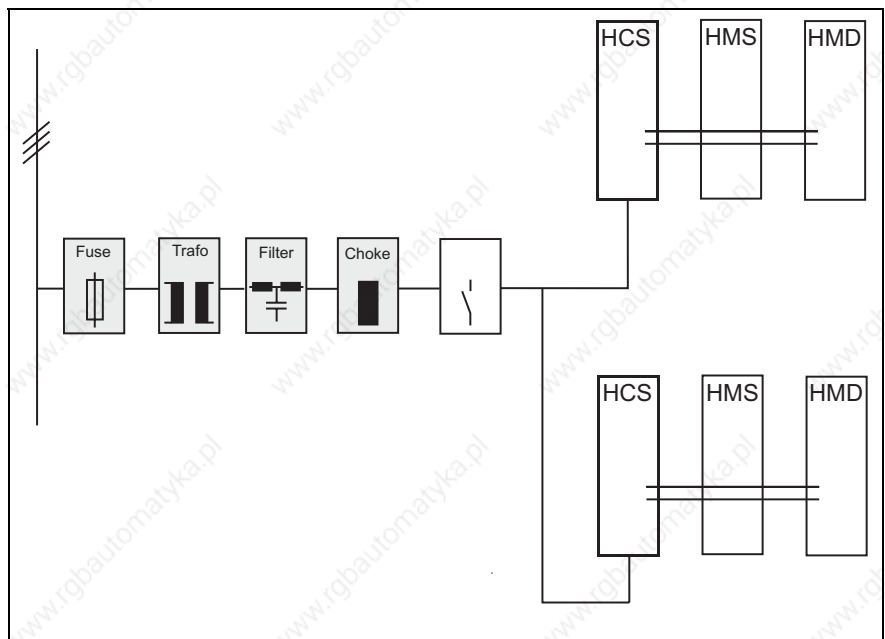
Note: The device-specific power data are available at each drive controller or drive system, particularly the allowed DC bus continuous power and the continuous regenerative power.

Group Supply HMV without DC Bus Connection of the Groups



optionally required components are marked with gray background color
 Fig. 9-4: Group supply HMV without DC bus connection of the groups

Group Supply HCS without DC Bus Connection of the Groups



optionally required components are marked with gray background color
 Fig. 9-5: Group supply HCS without DC bus connection of the groups

Note: When using the component HCS03.1E with HNK01.1 connect the mains contactor electrically between the mains connection and the HNK.

Group Supply with DC Bus Connection of the Groups

Group supply with DC bus connection increases the available regenerative power, the continuous braking resistor and infeeding power in the common DC bus of several drive controllers or drive systems.

Note: Apart from the illustrated connection of the drive controller to the mains and to the DC bus, the following connections have to be wired:

- Bb contacts at control section (see Project Planning Manual for control section)
- control voltage supply
- module bus
- equipment grounding conductor

Note: The connection lines to the drive controllers should preferably have the same impedances in order to achieve balanced load distribution at the power input of the drive controllers. From the common node of the lines, you therefore have to make sure that

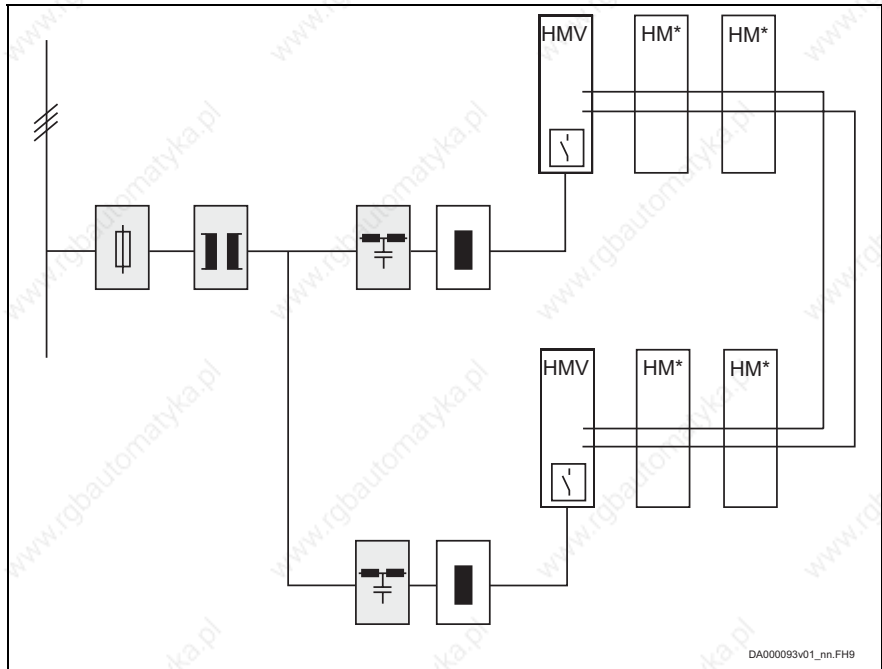
- the lengths of the supply lines and
- the cross sections of the supply lines are the same.

Note: At the common DC bus there is less than the sum of the device-specific power data available. This particularly applies to the continuous DC bus power $P_{DC\ cont}$ and the continuous regenerative power P_{BD} . Both power data are included in the sum in reduced form. The reduction takes place with the corresponding balancing factors for parallel operation. For these data see the Project Planning Manual of the respective component.

Note: Only realize group supply with DC bus connection with drive controllers or supply modules of the same type current or type performance.

Group Supply HMV with DC Bus Connection of the Groups, Parallel Operation HMV01.1E

This type of mains connection is allowed for HMV01.1E (not allowed for HMV01.1R). This mains connection is used for high-performance drive systems.



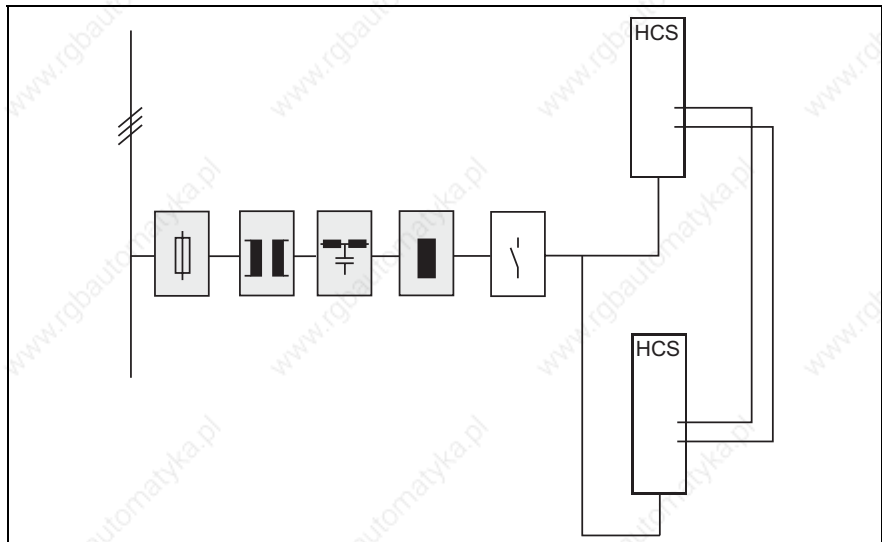
optionally required components are marked with gray background color

Fig. 9-6: Group supply HMV with DC bus connection

Note: Observe the control circuit "master-slave" for parallel operation HMV01.1E.

Group Supply HCS with DC Bus Connection of the Groups

This type of mains connection corresponds to parallel operation of HCS drive controllers.



optionally required components are marked with gray background color

Fig. 9-7: Group supply HCS with DC bus connection

Note: When using the component HCS03.1E with HNK01.1 connect the mains contactor electrically between the mains connection and the HNK.

9.4 Central Supply

With "central supply" only one drive controller or supply modules in central form supplies power to several drive controllers via a common DC bus. The characteristic aspect of "central supply" is central power supply by one drive controller that is connected to mains voltage via a **single mains contactor**, comparable to a modular supply unit.

Rules for Central Supply

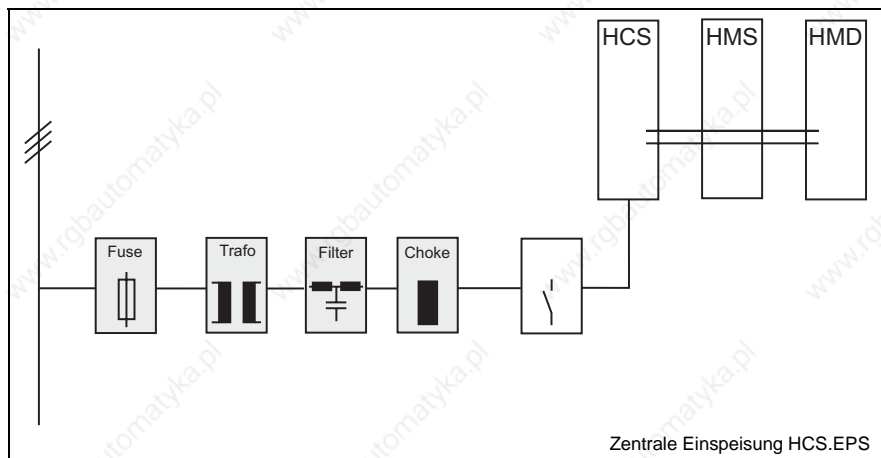
In the case of "central supply", mains supply take place at the drive controller with the highest type current.

Note: Apart from the illustrated connection of the drive controller to the mains and to the DC bus, the following connections have to be wired:

- Bb contact at control section (see Project Planning Manual for control section)
- control voltage supply
- module bus
- equipment grounding conductor (connect to equipment grounding system)

Central Supply HCS

With the type of mains connection "central supply" the compact IndraDrive C line is similar to the modular IndraDrive M line. We speak of "central supply" when an HCS drive controller supplies other drive controllers HCS, HMS or HMD which are not connected to the mains.



optionally required components are marked with gray background color

Fig. 9-8: Central supply HCS

Note: When using the component HCS03.1E with HNK01.1 connect the mains contactor electrically before the HNK.

Notes

10 Requirements to the Mains Connection

10.1 General Information

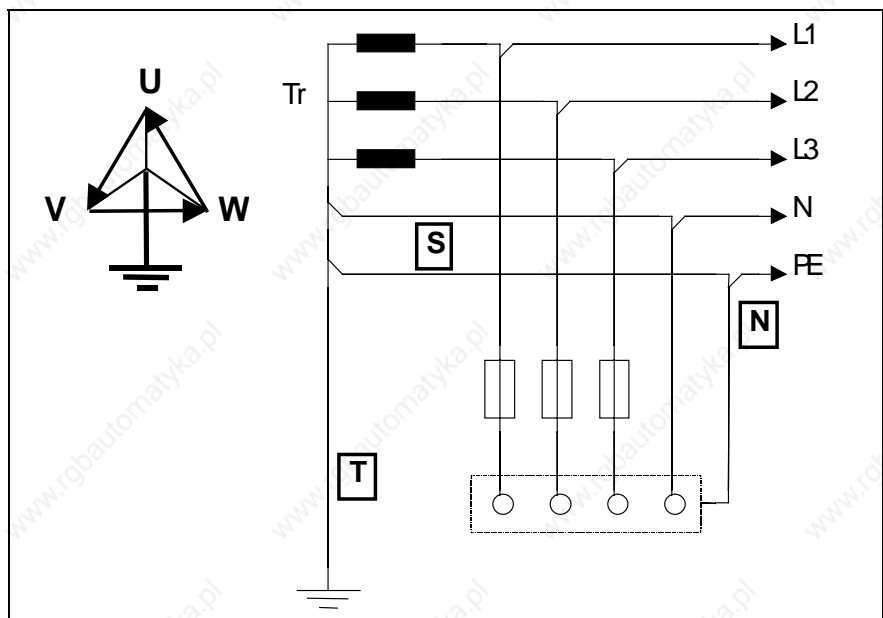
Note: A permanent connection to the supply mains is required for Rexroth IndraDrive controllers.

10.2 Mains Types

The devices can be operated at the following mains systems. The requirements are indicated under the respective mains type.

TN-S System

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



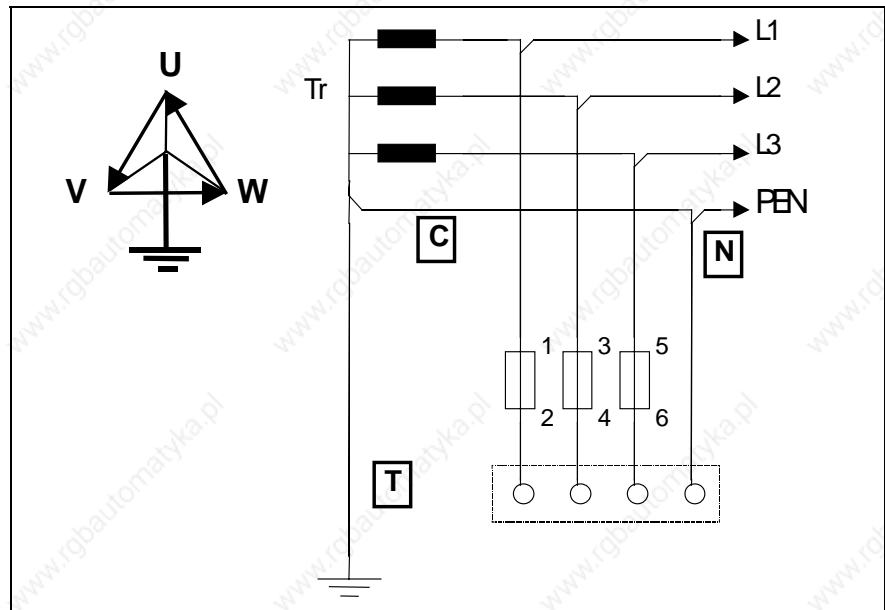
T = direct grounding of a point (station ground)

N = exposed conductive parts directly connected to station ground

Separate neutral conductor and equipment grounding conductor in entire mains

Fig. 10-1: Mains type TN-S

TN-C System



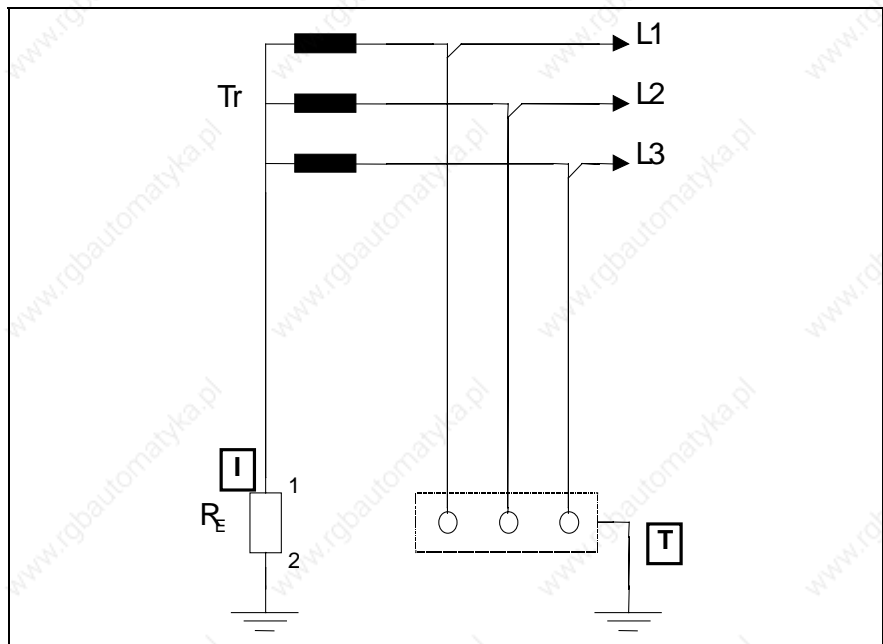
T = direct grounding of a point (station ground)

N = exposed conductive parts directly connected to station ground

Neutral conductor and equipment grounding conductor functions in entire mains combined in a single conductor, the PEN conductor.

Fig. 10-2: Mains type TN-C

IT System

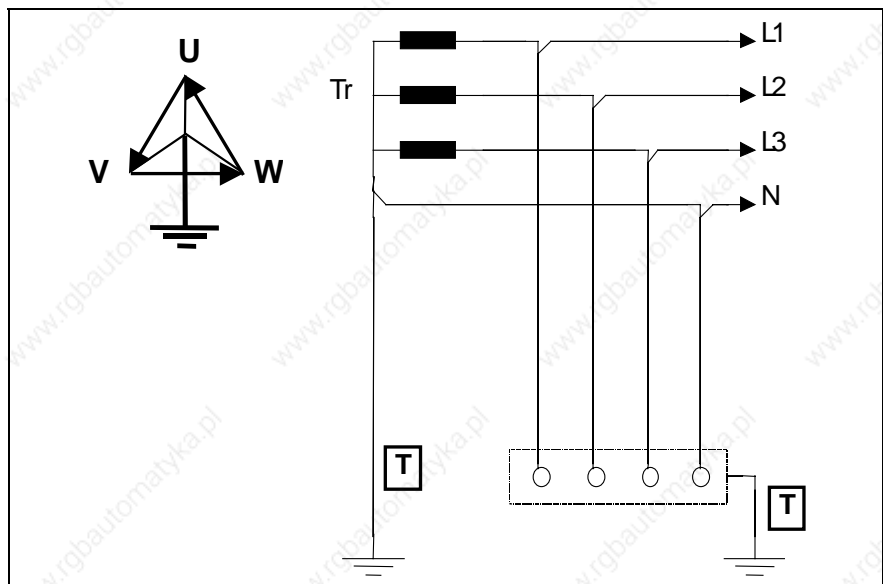


I = isolation of all active parts from ground or connection of one point to ground via an impedance
 T = exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig. 10-3: IT mains system

Compliance with EMC requirements in this case is only possible under restricted conditions. Can therefore only be used for industrial area with its own mains.

TT System

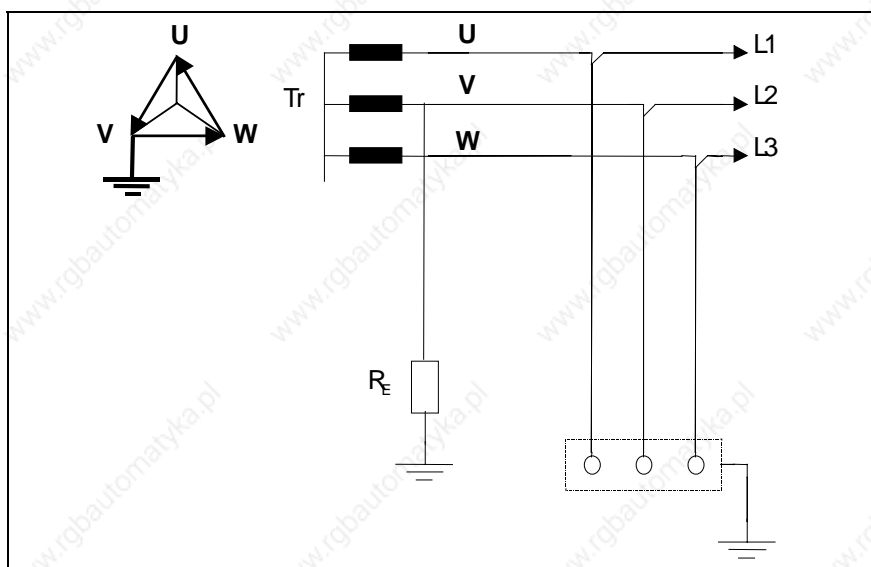


T = direct grounding of a point (station ground)
 T = exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig. 10-4: TT mains system

Compliance with EMC requirements in this case is only possible under restricted conditions. Can therefore only be used for industrial area with its own mains.

Mains with Grounded Outer Conductor (Corner Grounded Delta Mains)



I = isolation of all active parts from ground, connection of one phase - generally phase v - to ground or via an impedance

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

Fig. 10-5: Mains with grounded outer conductor

Compliance with EMC requirements in this case is only possible under restricted conditions. Can therefore only be used for industrial area with its own mains.

10.3 Mains Short-Circuit Power and System Impedance – Minimum Values at Connection Point

The maximum possible connected load at the connection point of the mains depends on its mains internal resistance (system impedance) or its minimum mains short-circuit power.

The following criteria are decisive:

- For the protection of devices a mains choke has to be connected in the incoming circuit in the case of high mains short-circuit power S_k .
- In order to limit mains pollution and have sufficiently high voltage available for realizing the drive performance, the mains has to have sufficiently high mains short-circuit power with reference to the connected load of the drive system.

The mains short-circuit power indicated the power at nominal voltage U_N between the phases and the maximum mains short-circuit current I_k at the connection point:

$$S_k = \sqrt{3} U_N \times I_k$$

S_k : short-circuit power of the mains
 I_k : short-circuit current
 U_N : mains voltage

Fig. 10-6: Mains short-circuit power

Note: For the mains short circuit power of the point of supply ask your local power supply company.

I_k results in the case of a short circuit at the point of power supply connection. It is calculated as follows:

$$I_k = \frac{U_N}{\sqrt{3} X_k}$$

X_k : system impedance
 U_N : mains voltage

Fig. 10-7: Mains short-circuit current

Mains Classes We basically distinguish the following mains, graded according to mains short-circuit power and system impedance:

Classification	S_k	$U_N = 400 \text{ V}$		$U_N = 480 \text{ V}$	
		X_k	L_k	X_k	L_k
	MVA	mOhm	μH	mOhm	μH
1 rigid mains	200	0,80	2,55	1,15	3,67
	150	1,07	3,40	1,54	4,89
	100	1,60	5,09	2,30	7,33
	50	3,20	10,19	4,61	14,67
2 semi-rigid mains	40	4,00	12,73	5,76	18,33
	30	5,33	16,98	7,68	24,45
	20	8,00	25,46	11,52	36,67
	15	10,67	33,95	15,36	48,89
	10	16,00	50,93	23,04	73,34
	5	32,00	101,86	46,08	146,68
	4	40,00	127,32	57,60	183,35
3 non-rigid mains	3	53,33	169,77	76,80	244,46
	2	80,00	254,65	115,20	366,69
	1	160,00	509,30	230,40	733,39
	0,6	266,67	848,83	384,00	1222,31

S_k : short-circuit power of the mains
 X_k : system impedance
 L_k : inductance of mains phase

Fig. 10-8: Mains classified according to mains short circuit power and mains internal resistance

Note: The minimum inductances of the mains connection specified in the respective Project Planning Manual refer to the inductances L_k mentioned above.

The specified minimum inductances protect the drive controllers (especially the DC bus capacitances) during operation at mains with low impedance and high mains short-circuit power.

With a **specified minimum inductance of 40 μH** , for example, it is necessary to use a mains choke at mains with $U_N = 400 \text{ V } S_k > 10 \text{ MVA } (L_k < 40 \mu\text{H})$.

Maximum Connected Load to a Mains

The maximum connected load to a mains depends on the allowed distortion of the mains voltage due to the load current with harmonics (mains pollution). The distortion is described by the distortion factor or the total harmonic distortion (THD) of the mains current (see chapter "Calculations").

In order to limit the distortion of the mains voltage take the mains short-circuit ratio R_{sc} (ratio of the source) into account:

$$R_{sc} = I_k / I_{1N} = S_k / S_A$$

- I_k : mains short-circuit current
- I_{1N} : fundamental wave of nominal current of all loads at connection point
- S_k : mains short-circuit power
- S_A : connected load of all electric loads at connection point (apparent power of fundamental wave)

Fig. 10-9: Mains short-circuit ratio R_{sc}

Measures for Compliance with Allowed THD or Distortion Factor

For public mains we distinguish

- Mains connections under 16 A: With an $R_{sc} \geq 1000$ there normally isn't any restriction of the allowed mains current distortion (according to EN 61000-3-2).
- Mains connections over 16 A for which the power supply company determines the restrictions. Unless there are other values available, the following data can be considered as guide values.

R_{sc}	Allowed THD of mains current	Allowed distortion factor of mains current
≥ 1000	THD > 48%	$K > 45\%$
≥ 120	THD $\leq 48\%$	$K \leq 45\%$
> 33	THD < 13%	$K < 12\%$

Fig. 10-10: Required THD/distortion factor with given R_{sc} of the mains ($U < 600$ V)

Measures to comply with the maximum allowed THD or distortion factor are

- use of mains chokes
- use of supply units with incorporated power factor correction PFC

Note: The following fact applies to mains chokes: the higher the inductance of the choke, the lower the TDH/distortion factor and the mains pollution.

Kind of drive controller	Realizable THD of mains current	Realizable distortion factor of mains current	Drive controller or supply unit with and without mains choke	
all devices	THD \geq 50%	K \geq 60%	HMV01.1E HCS03.1 HCS02.1	without
device with mains choke	THD < 48%	K < 45 %	HMV01.1E HCS03.1 HCS02.1	HNL01.1
devices with Power Factor Control (PFC)	THD < 13%	K < 12 %	HMV01.1R HMV02.1R	HNL01.1 HNL02.1

Fig. 10-11: Realizable THD/distortion factor for drive controllers

Note: The allowed distortion factors can be achieved with the indicated combinations of drive controller and mains choke. Observe the assignment of mains choke to drive controller in the corresponding Project Planning Manual.

Selecting Mains Connection Components

We recommend the following procedure for selecting the required mains connection components.

- Determine max. current I of mains connection. Note: Classification for public mains according to European standards in
 - $I < 16$ A (EN 61000-3-2)
 - 16 A < $I < 75$ A (EN 61000-3-12)
 - $I > 75$ A (at present, not defined by any standard)
- Determine mains short-circuit power S_K of mains at place of destination of application (ask power supply company).
- Determine sum of connected loads S_A .
- Determine ratio R_{sc} .
- Determine allowed THD or distortion factor K of mains current at place of destination of application (ask power supply company).
- Select appropriate mains supply unit with additional component.

Note: The table below does not replace the recommended procedure.

The table is used for first estimation of maximum allowed connected load S_A at point of power supply connection in low-voltage mains at known mains short-circuit power S_K .

		Rsc=250	Rsc=200	Rsc=100	Rsc=50
Classification	S _k	S _A	S _A	S _A	S _A
	MVA	kVA	kVA	kVA	kVA
1 rigid mains	200	800,00	1000,00	2000,00	4000,00
	150	600,00	750,00	1500,00	3000,00
	100	400,00	500,00	1000,00	2000,00
	50	200,00	250,00	500,00	1000,00
2 semi-rigid mains	40	160,00	200,00	400,00	800,00
	30	120,00	150,00	300,00	600,00
	20	80,00	100,00	200,00	400,00
	15	60,00	75,00	150,00	300,00
	10	40,00	50,00	100,00	200,00
	5	20,00	25,00	50,00	100,00
	4	16,00	20,00	40,00	80,00
3 non-rigid mains	3	12,00	15,00	30,00	60,00
	2	8,00	10,00	20,00	40,00
	1	4,00	5,00	10,00	20,00
	0,6	2,40	3,00	6,00	12,00

R_{sc}: mains short-circuit ratio

S_k: mains short-circuit power

S_A: connected load of all electric loads at connection point (apparent power of fundamental wave)

Fig. 10-12: Maximum allowed connected load

10.4 Limit Values for Interference-Free Operation at Mains

The data below specify the limit values under which the drive system can be operated at the mains without interference.

Mains Frequency Tolerance

See chapter 5 "Specifications for the Components of the Drive System"

Voltage Tolerances and Voltage Changes

See chapter 5 "Specifications for the Components of the Drive System"

Mains Voltage Unbalance

The voltage unbalance is described by a three-phase system consisting of the combination of a

- clockwise a.c. system (positive-sequence system U_m)
- counter-clockwise a.c. system (negative-sequence system U_g)
- d.c. system (U₀)

$$\text{voltage unbalance \%} = 100 \frac{|U_X - U_{AVE}|}{U_{AVE}}$$

U_X : phase-to-phase voltage with highest deviation from average value
 U_{AVE} : $(U_{12} + U_{23} + U_{31}) / 3$; U_{12} , U_{23} , U_{31} being voltages between the phases.

Fig. 10-13: Definition of voltage unbalance

Max. allowed voltage unbalance	Standard reference
3 %	IEC 61000-2-4, class 3

Fig. 10-14: Maximum allowed voltage unbalance

Commutation Drops

Drop on mains voltage	Standard reference
depth 40% of mains amplitude, total surface 250% x degrees (see diagram)	IEC 60146-1-1, class 3

Fig. 10-15: Maximum commutation drops in % of mains voltage

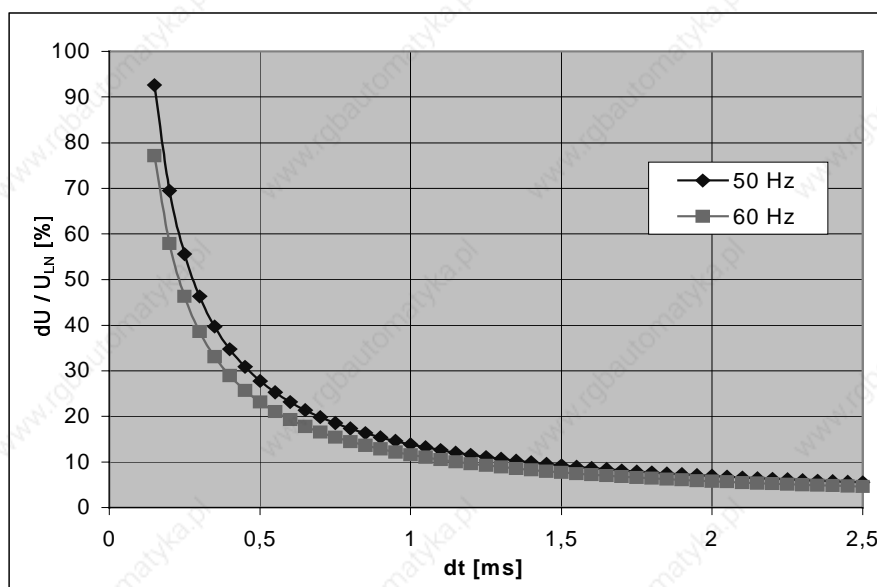


Fig. 10-16: Maximum commutation drops in % of mains voltage

Short-Time Interruptions

A drive system is used for energy conversion and a voltage drop is a loss of available energy.

The effect of the voltage drop (energy reduction) on the process cannot be determined without detailed knowledge of the respective process. The effect is a system and rating aspect and generally will be greatest when the power demand (including the losses) of the drive system is greater than the available power.

In the case of a voltage drop on the mains, the voltage in the DC bus can be reduced. This can cause the drive system to be cut off the mains when voltage falls below certain levels and certain durations are exceeded. When voltage returns the drive system has to be reactivated in order to continue operation.

Harmonics of the Mains

The devices can be operated on a mains with the following THD:

Max. allowed THD	Standard reference
10 %	IEC 61000-2-4, class 3

Fig. 10-17: Maximum allowed harmonics

Maximum Allowed Mains Overvoltages

The devices were dimensioned only up to a certain level of mains over voltage. Higher overvoltage has to be limited by other measures, e.g. overvoltage protection on site.

Circuit	Against environment and ground (1)	Between the conductors within the circuit (1)
mains connection 230...500 V	2 kV	1 kV
supply connection 24V and relay contact connections	50 V	30 V
other connections	$U_N+5\%$	$U_N+5\%$

(1): impulse withstand voltage 1,2/ 50 μ s and 8/ 20 μ s

Fig. 10-18: Maximum allowed mains overvoltages

The figure below illustrates the voltage pulse.

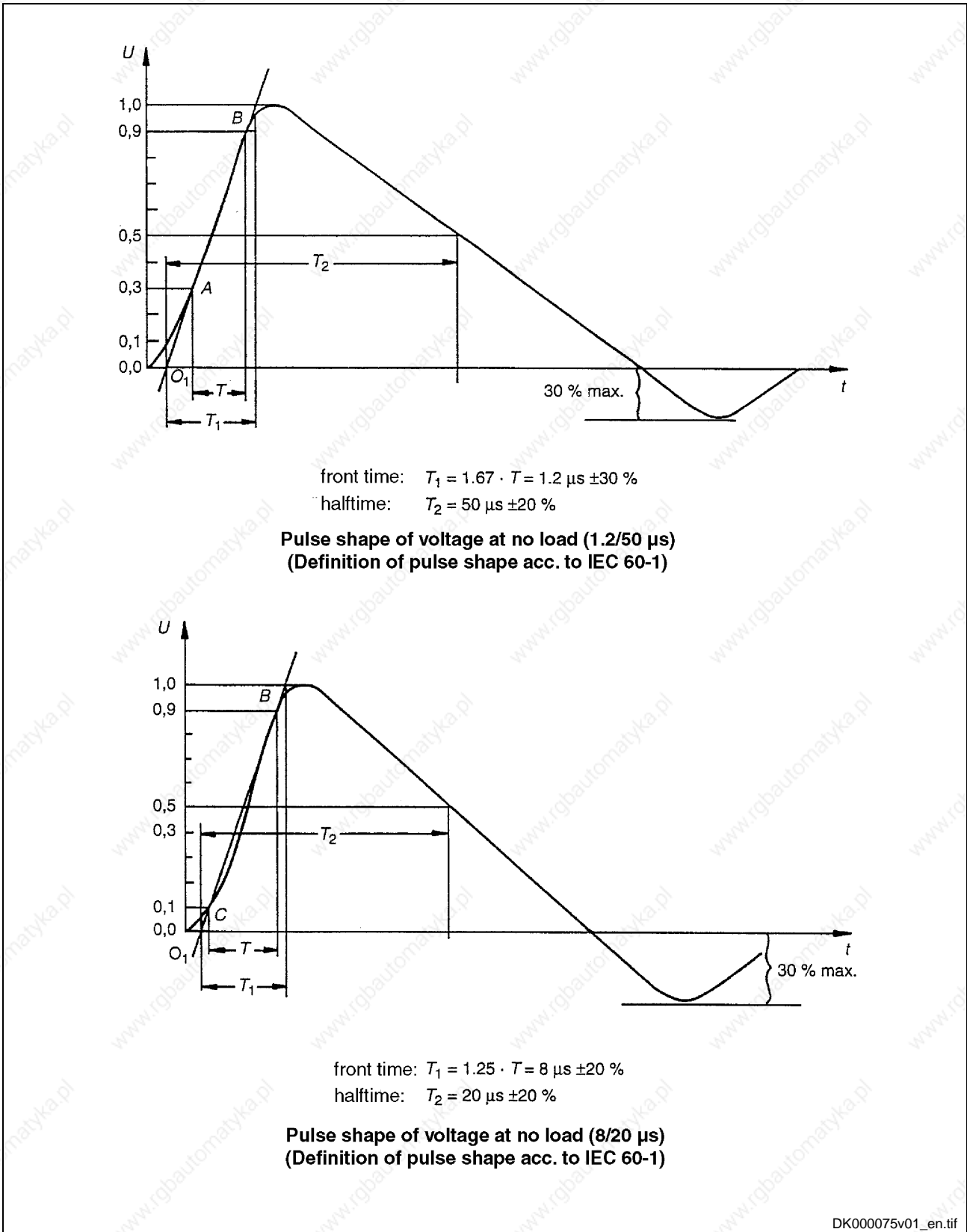


Fig. 10-19: Impulse withstand voltage 1,2/ 50 μs and 8/ 20 μs according to EN 61000

If higher overvoltage values can occur in the application, measures for limitation of the values have to be taken in the electrical equipment of the machine or installation.

Note: Overvoltage at the components can occur

- due to lightning strikes or
- due to inductive or capacitive coupling on lines.

Use overvoltage limiters at the machine or installation when the overvoltage occurring at the Rexroth components is greater than the max. allowed overvoltage.

Use the overvoltage limiters at long lines run through the building / the hall and run in parallel with power and mains cables.

Electrically place the overvoltage limiter at the control cabinet input.

10.5 Power Factors and Emitted Mains Harmonics of the Device

Due to their electric design, the drive controllers and supply units generate harmonics in the mains current and on the mains voltage during operation at the mains. Using appropriate mains chokes decisively influences power factors and mains harmonics.

Power Factors $\cos\phi_1$ (DPF) and $\cos\phi$ (TPF)

Note: You find comments on the short terms used here in section 15.2 Calculations for Mains Connection.

The power factors are decisively influenced by mains chokes.

Type of drive controller or supply unit		Type of mains choke	P_{DC_cont}	3AC400V		3AC480V		3AC500V	
			[%]	DPF $\cos\phi_1$	TPF λ	DPF $\cos\phi_1$	TPF λ	DPF $\cos\phi_1$	TPF λ
HCS02	W0012	without	100	0,97	0,59	tbd	tbd	tbd	tbd
			100	0,97	0,59	tbd	tbd	tbd	tbd
			100	0,97	0,55	tbd	tbd	tbd	tbd
			100	0,97	0,58	tbd	tbd	tbd	tbd
	W0012	HNL01	100	0,95	--	tbd	tbd	tbd	tbd
			100	0,95	0,83	tbd	tbd	tbd	tbd
			100	0,95	0,77	tbd	tbd	tbd	tbd
			100	0,95	0,66	tbd	tbd	tbd	tbd
HCS03	W0070	without	100	0,97	0,57	tbd	tbd	tbd	tbd
			100	0,97	0,59	tbd	tbd	tbd	tbd
			100	0,97	0,61	tbd	tbd	tbd	tbd
			100	0,97	0,62	tbd	tbd	tbd	tbd
	W0070	HNL01	100	0,95	0,85	tbd	tbd	tbd	tbd
			100	0,95	0,83	tbd	tbd	tbd	tbd
			100	0,94	0,81	tbd	tbd	tbd	tbd
			100	0,93	0,78	tbd	tbd	tbd	tbd
HMV01.1E	W0030	without	100	0,97	0,64	tbd	tbd	--	--
			75	0,97	tbd	0,99	0,64	--	--
			100	0,97	0,64	0,99	0,64	--	--
			100	0,97	0,63	0,97	0,86	--	--
			75	0,97	tbd	0,99	0,64	--	--
	W0030	HNL01	100	0,97	0,88	0,97	0,86	--	--
			75	0,97	0,85			--	--
			50	0,97	0,79			--	--
			25	0,98	0,73			--	--
			100	0,97	0,97	0,97	0,88	--	--

Type of drive controller or supply unit		Type of mains choke	P _{DC_cont}	3AC400V		3AC480V		3AC500V	
				DPF cosφ1	TPF λ	DPF cosφ1	TPF λ	DPF cosφ1	TPF λ
			[%]						
	W0120		75	0,97	0,87			--	--
			50	0,97	0,83			--	--
			25	0,97	0,75			--	--
			100	0,97	0,88	0,97	0,86	--	--
			75	0,97	0,85			--	--
			50	0,97	0,79			--	--
			25	0,98	0,74			--	--
HMV01.1R	W0018	HNL01	100	0,99	0,99	tbd	tbd	--	--
	W0045		100	0,99	0,99	tbd	tbd	--	--
	W0065		100	0,99	0,99	tbd	tbd	--	--
HMV02.1R	W0015	HNL02	100	0,99	0,99	tbd	tbd	--	--

--: not allowed
 tbd: in preparation
 U_N: nominal voltage of mains between the conductors

Fig. 10-20: Power factor DPF, cosφ1

Harmonics Factors THD and Distortion Factor k

The mains harmonics are decisively reduced by mains chokes.

Type of drive controller or supply unit		Type of mains choke	P _{DC_cont}	3AC400V		3AC480V		3AC500V	
				THD	k	THD	k	THD	k
			[%]	[%]	[%]	[%]	[%]	[%]	
HCS02	W0012	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0028	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0054	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0070	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0012	HNL01	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0028	HNL01	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0054	HNL01	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0070	HNL01	100	tbd	tbd	tbd	tbd	tbd	tbd
HCS03	W0070	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0100	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0150	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0210	without	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0070	HNK01	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0100	HNK01	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0150	HNK01	100	tbd	tbd	tbd	tbd	tbd	tbd
	W0210	HNK01	100	tbd	tbd	tbd	tbd	tbd	tbd
HMV01.1E	W0030	without	100	120	77	tbd	tbd	--	--
			75			120	77	--	--
	W0075	without	100	122	77	120	77	--	--

Type of drive controller or supply unit		Type of mains choke	P _{DC_cont}	3AC400V		3AC480V		3AC500V		
				THD	k	THD	k	THD	k	
			[%]	[%]	[%]	[%]	[%]	[%]	[%]	
	W0120	without	100	122	77	120	77	--	--	
	W0030	HNL01	100	43	48	52	46	--	--	
			75	56	49			--	--	
			50	72	58			--	--	
			25	88	66			--	--	
	W0075	HNL01	100	42	39	46	42	--	--	
			75	49	44			--	--	
			50	61	52			--	--	
			25	83	64			--	--	
	W0120	HNL01	100	48	44	52	46	--	--	
			75	57	49			--	--	
			50	72	59			--	--	
			25	88	66			--	--	
	HMV01.1R	W0018	HNL01	100	3	3	3	3	--	--
		W0045	HNL01	100	2	2	2	2	--	--
		W0065	HNL01	100	4	4	4	4	--	--
HMV02.1R	W0015	HNL02	100	3	3	3	3	--	--	

-- not allowed

tbd: in preparation

U_N: nominal voltage of mains between the conductors

Fig. 10-21: Harmonics factors THD, k

Mains Current Harmonics

The data below represent typical harmonics on the mains current of an **HMV01.1E-W0030** supply unit at rated load (is up to 100% of P_{DC_cont}).

f [Hz]	I _{LN} [%]			
	with HNL01		without HNL01	
	3AC400V	3AC480V	3AC400V	3AC480V
50	100	100	100	100
75	0,5			
88	0,9	0,5		
113	1	0,6		
125	0,7	0,6		
175	0,7			
188	0,7			
213	0,5			
250	43,7	46,6	85	84,6
350	17,8	20,8	71	70,9
475			1	
550	6,9	7,0	40	39,8

f [Hz]	I _{LN} [%]			
	with HNL01		without HNL01	
	3AC400V	3AC480V	3AC400V	3AC480V
650	3,6	4,2	26	25,4
850	3,1	3,2	5	5,8
950	1,7	1,8	3	4,2
1150	1,7	1,8	5	5,6
1250	1,2	1,2	4	4,4

Fig. 10-22: Mains current harmonics

Note: Amplitudes of frequencies not mentioned are below 0.5% of the mains current.

With **HMV01.1R** supply units the relevant harmonics in the frequency range $(50...80) \cdot f_{LN}$ relating to the amplitude of the crest value are below 3%.

Mains Voltage Harmonics

The voltage harmonics depend on the structure of the mains, especially on the mains inductance or the mains short-circuit power at the connection point. At different mains and mains connection points, the same load can cause different voltage harmonics.

For a normal mains the harmonics content of the mains voltage when operating drives generally is below 10%. Short-time drops in mains voltage are below 20%.

More precise values can only be calculated with exact knowledge of the mains data (mains topology), such as line inductance, line capacitance related to the connection point.

These values, however, can temporally vary quite strongly, according to the switch status of the mains. The harmonics of the mains voltage thereby change, too.

Rough estimated values of the mains data are not sufficient for pre-calculation of the harmonics, as mainly the resonance points always present in the mains have a strong influence on the harmonics content.

In order to keep the degree of mains voltage harmonics as low as possible, it is recommended not to connect capacitors or compensation units (capacitor batteries) directly to the mains, if possible. If absolutely required, only connect them to the mains via chokes.

10.6 Protection Systems for the Mains Connection

General Information

Protection against contact always depends on the kind and structure of the supply mains and the mains conditions. For project planning of an installation, the typical behavior of the loads and supply mains should always be taken into account.

For protection against contact (indirect contact) in a machine or plant in which a drive system is used, the overcurrent protective device normally used is one with protective grounding according to IEC 364 and EN 50178 (Electronic equipment for use in power installations). This is also specified in UL 508C (Industrial Control Equipment) for North America. Housing cover or encapsulation by closed housing is used as protection against direct contact with live conductors.

Fusing by Protective Grounding

Overcurrent protection normally is realized in the form of fuses or overcurrent release devices (circuit breakers, motor circuit breakers) installed at the mains connection. For details see fig. 1.

A grounding resistance of 2 Ohm is considered to be sufficient for grounding.

Overcurrent protection generally is dimensioned or set with a release current of 1.3 x nominal current of the loads connected to this connection point.

In the case of an insulation error or a connection between mains phase and device housing connected to the equipment grounding conductor, the drive is disconnected from the mains.

Fusing by Protective Grounding in TN-S Mains

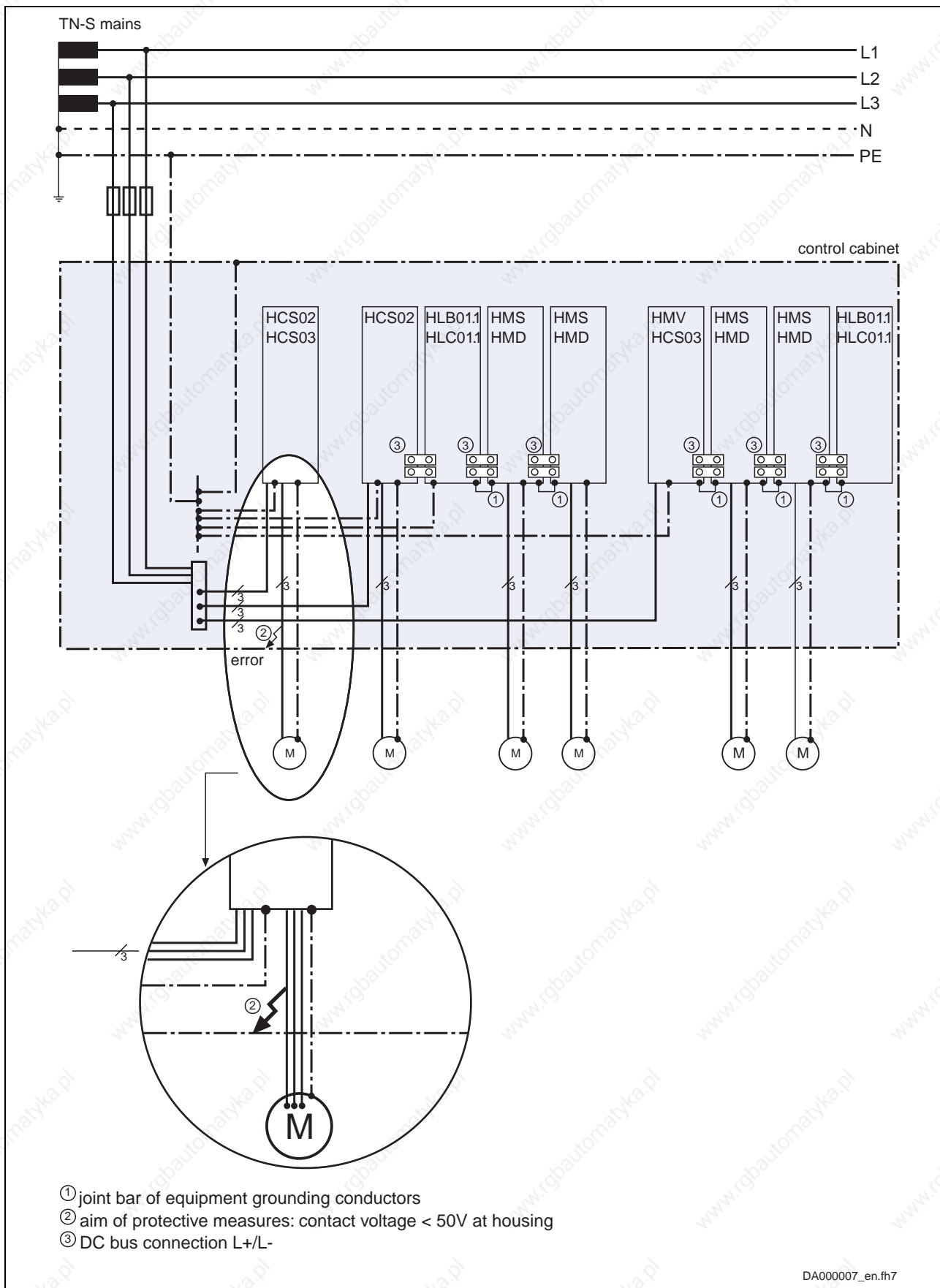


Fig. 10-23: Protection against contact by protective grounding with overcurrent protection device in TN-S mains

Fusing by Protective Grounding in TN-C Mains

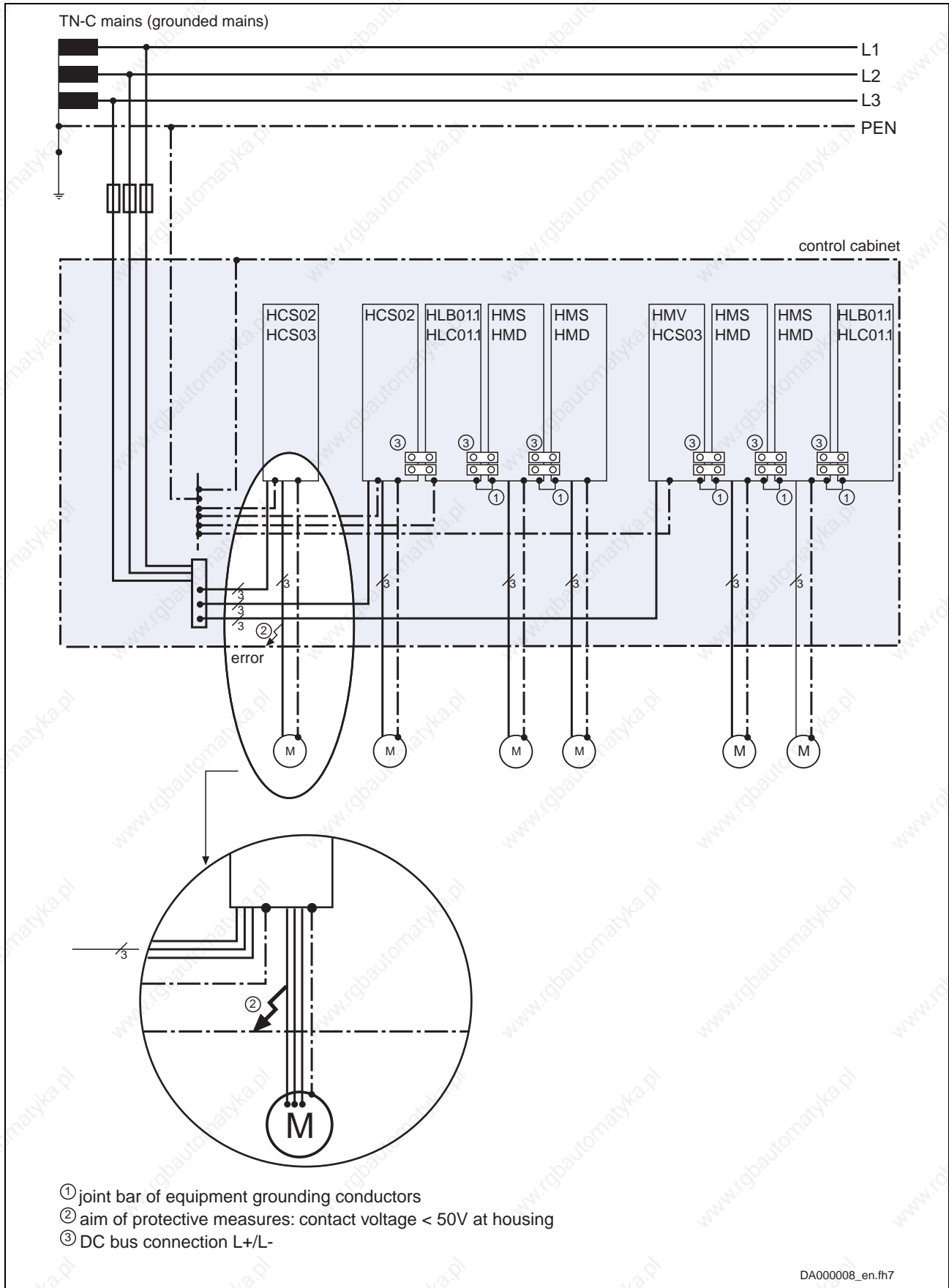


Fig. 10-24: Protection against contact by overcurrent protection device in TN-C mains

Fusing by Protective Grounding in IT Mains (Ungrounded Mains)

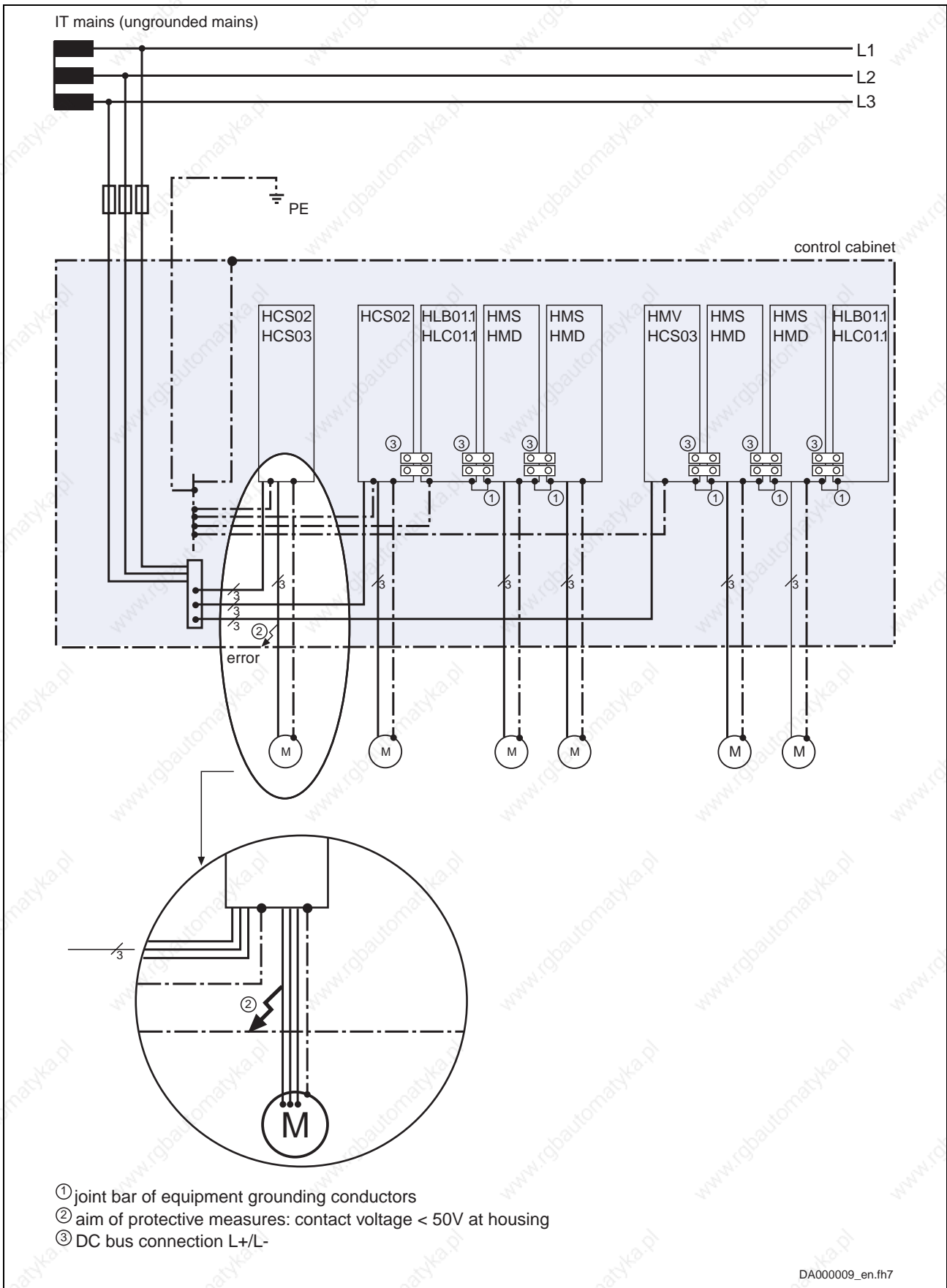


Fig. 10-25: Protection against contact by overcurrent protection device in IT mains

Connecting Equipment Grounding Conductor



WARNING

Lethal electric shock when touching the housing caused by faulty connection of equipment grounding conductor!

⇒ Observe the mentioned notes on installation in any case, in order to prevent danger by electric shock when touching the housing, even in case an equipment grounding conductor connection is broken.

Equipment Grounding Connection between the Components

Observe the notes on installation in chapter "Connections of the Components in the Drive System", section "Connection Point of Equipment Grounding Conductor and Equipment Grounding Connections".

Connecting Equipment Grounding Conductor to Mains

According to the standards "Electronic equipment for use in power installations" (EN 50178, chapter 5.3.2.1) and "Adjustable speed electrical power drive systems" (EN 61800-5-1, chapter 4.2.5.4.2), a **stationary connection** of the equipment grounding conductor is required and one or more of the following requirements have to be complied with:

- cross section of equipment grounding conductor at least 10 mm² (reason: sufficient mechanical stability required)
- mains and current supply automatically cut off when equipment grounding conductor interrupted (case of error)
- Routing of a second equipment grounding conductor, via separate terminal connectors, with the same cross section as the first equipment grounding conductor. Mounting of an additional terminal connector for this equipment grounding conductor.

Use of Residual-Current-Operated Circuit-Breakers (RCCB, RCD) as Additional Fusing

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)

Note: Rexroth IndraDrive drive systems can only be used with residual-current-operated circuit-breakers to a limited extent.

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 indispensable 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 100 mA of rms value.

The leakage current is not sinusoidal but pulse-shaped. For this reason, measuring instruments normally dimensioned for alternating currents in the range of 50 Hz are not suited, as measuring errors occur. 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 mounting site
- imbalance 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 and expensive core material.

Possibilities of Use

Motor Cable Length

Keep the motor cable length as short as possible. Only a short motor cable length causes low leakage currents and enables a residual-current-operated circuit-breakers to work.

Kinds of Residual-Current-Operated Circuit-Breakers

We distinguish two kinds of residual-current-operated circuit-breakers:

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

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

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

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

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

When a 30 mA residual-current-operated circuit-breaker triggers, it is possible to use a residual-current-operated circuit-breaker with higher trigger 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, 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. The neutral point of the secondary winding of the isolating transformer is connected to the equipment grounding conductor of the drive system.

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

Before operating enable please check for correct function 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 to have 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.

Using Residual-Current-Operated Circuit-Breakers with HCS02 Drive Controllers

A residual-current-operated circuit-breaker can be used at HCS02 drive controllers under the following conditions:

HCS02 Drive Controllers with Residual-Current-Operated Circuit-Breaker

- residual-current-operated circuit-breakers of type B (IEC60755)
- trip limit of residual-current-operated circuit-breaker is ≥ 300 mA
- supplying TN-S mains
- length of motor cable 20 m max. in shielded design
- use of a mains filter HNF01 or NFD03
- each residual-current-operated circuit-breaker only supplies one HCS02 drive controller
- only Rexroth components and accessories including cables and filters are used

Insulation Monitoring Devices

Insulation monitoring devices are normally used in IT mains with insulated neutral point. The aim is to have a monitor triggered in the case of ground fault - i.e. in the case of error - without having to switch off the electrical equipment.

When the monitor signals an error, the ground fault is detected and removed without operation being switched off. Switch-off only takes place if a second ground fault occurs before the first one has been removed.

As insulation monitoring devices are also measuring the ground current at the mains input of the building, too high leakage current can cause accidental false triggering.

There are the same notes on application applying as mentioned in the previous section "Use of Residual-Current-Operated Circuit-Breakers (RCCB, RCD) as Additional Fusing".

Notes

11 Control Circuits for the Mains Connection

Application and Arranging the Mains Contactor

The HMV01.1 supply units of the Rexroth IndraDrive M range have an integrated mains contactor.

To supply HCS drive controllers of the Rexroth IndraDrive C product range with mains voltage, external mains contactors are recommended.



DANGER

**High electric voltage and high working current!
Risk of death or severe bodily injury by electric shock!**

- ⇒ Design the mains connection according to valid standards.
- ⇒ Observe the protection goals "Electrical safety", "Mechanical safety with incorrect movements" and "Protection against fire".
- ⇒ Make sure you can provide evidence of the mechanisms of protection by means of FMEA and hazard analysis.

Note: You do not need to use external mains contactors if the safety-related requirements of the application and the local safety regulations on site allow this.

Before doing without external mains contactors, make sure that operator protection is as good as with external mains contactors!

11.1 Control Circuits for the Mains Connection – General Information

Conditions of Control

The controls of mains contactor and DC bus short circuit for supply units and drive controllers suggested in this documentation explain the functional principles. The different possibilities of control are shown in this chapter.

Note: The selection of the control and its effects depend on the extent of the functions and the operating sequence of the installation or machine. The selection falls to the installation or machine manufacturer's responsibility.

Conditions of Control with Rexroth IndraDrive C

Control Circuits HCS02

HCS02 drive controllers

- control via external mains contactor
- control via external mains contactor for devices with integrated control voltage supply
- control via external mains contactor with DC bus resistor unit HLB01.1C

- Control Circuits HCS03** HCS03 drive controllers
- control via external mains contactor

Conditions of Control with Rexroth IndraDrive M

Note: Observe the following order when separating **HMV01.1R** supply units from the mains voltage:

- request mains OFF (X32.6 / X32.7)
- delay time at least 10 ms
- switch mains supply off

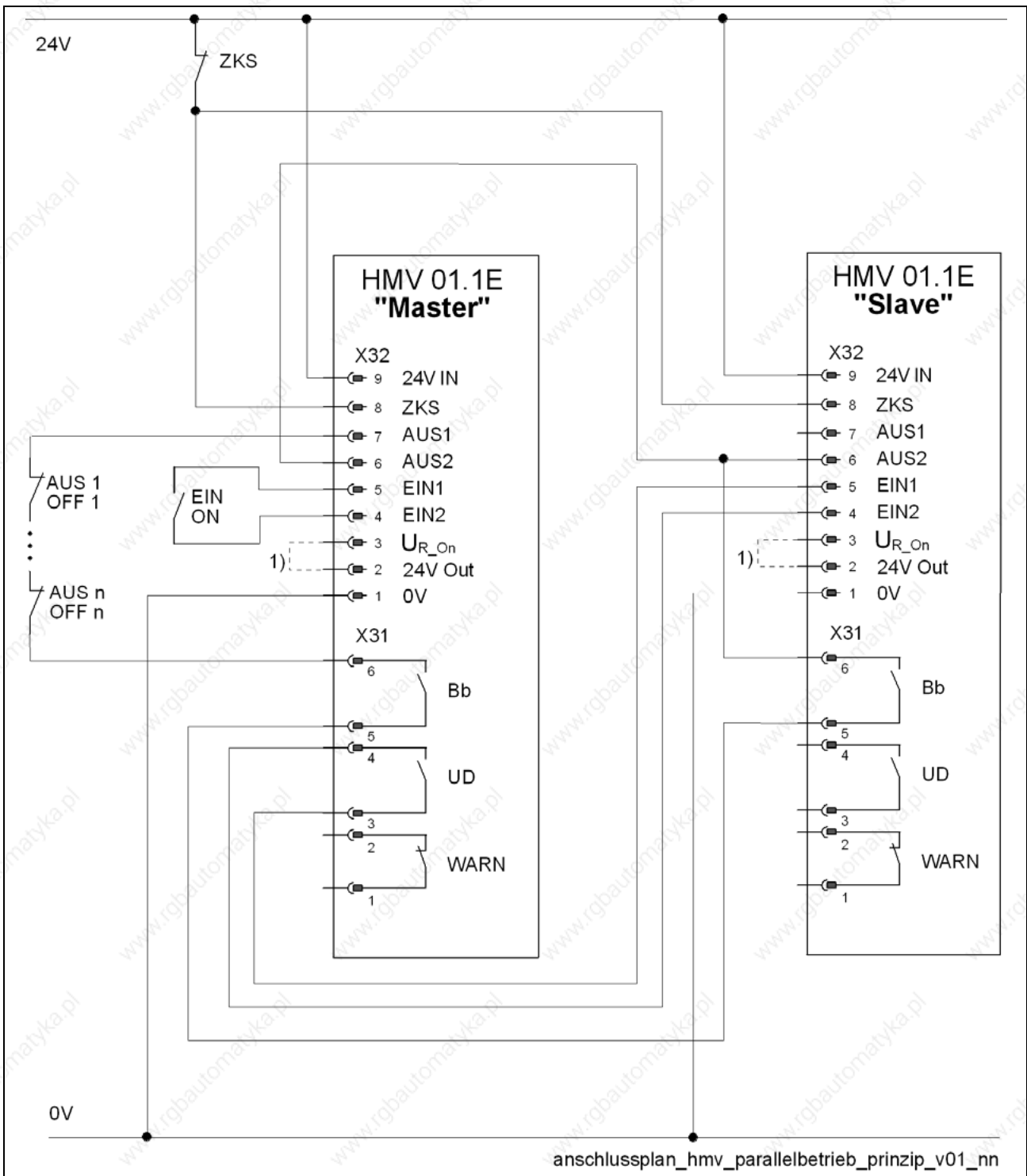
You can make sure this order is observed by switch elements (e.g. switch-disconnector as main switch) with leading auxiliary contact. For this purpose connect the auxiliary contact in series with mains OFF.

In case this order is not observed, the supply unit risks getting damaged.

- Control Circuits HMV** HMV01.1E, HMV01.1R, and HMV02.1R supply units
- deceleration in the case of disturbed electronic system of drive
 - deceleration in the case of E-Stop or mains failure
 - control by E-Stop relay with DC bus short circuit
 - control by E-Stop relay without DC bus short circuit
 - control by control unit
 - combination with DC bus resistor unit HLB01.1D

**Control Circuit for Parallel
Operation HMV01.1E
"Master-Slave"**

For the type of mains connection "group supply with DC bus connection", use the control circuit master-slave when using HMV01.1E supply units. See the block diagram below:



1) braking resistor switch-on threshold activated

Fig. 11-1: Block diagram control circuit master-slave for parallel operation HMV01.1E

Bb Contact Ready for Operation

The mains contactor depends on the error status of the drive controller or supply unit. At the control section of the HCS drive controllers and at the supply units there is an isolated contact available for this purpose (relay contact Rel1) that has been configured as Bb contact in the condition as supplied (see Project Planning Manual for Control Section). When the Bb contact closes, the drive or drive system is ready for power on.

**CAUTION****Danger of damage!**

⇒ Make sure that the mains contactor opens, too, when the Bb contact opens.

Switch States

See Project Planning Manual for control section

See also Functional Description of firmware: "Power Supply"

Note: When the internal line contactor is switched off, the contactor coil causes overvoltages. These overvoltages may result in a premature failure of the Bb contact. To attenuate overvoltages, use overvoltage limiters with diode combination.

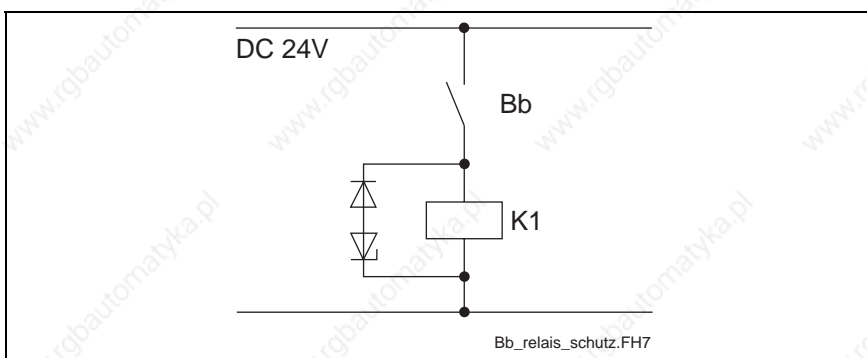


Fig. 11-2: Recommended suppressor circuit

Varistors and RC elements may not be used as suppressor circuit. Varistors are subject to aging and increase their reverse currents. RC elements overload the operating capacity of the Bb contact. This results in premature failure of the connected components and devices.

Note: Comply with the load capability limits of the Bb contact. Contactors with AC excitation and contactors exceeding the load capability limits of the involved contact elements (Bb contacts, etc.) should be controlled via contactor relays.

11.2 Control Circuits for Mains Connection of Drive Controllers Rexroth IndraDrive C

The mains contactor connected in the incoming circuit controls the energy flow to the drive controller allowing separation from the mains in the case of error. The control circuit is decisively influenced by the Bb contact at the control section of the drive controller or the Bb contact of the mains supply.

Configuration Rel 1 as Bb contact

Power voltage is only switched to drive system after Bb contact signals readiness for power voltage on by its closed status.

For this purpose there is an isolated contact "Rel 1" available at the control sections. You can configure the behavior of this contact of drive controllers via parameter "P-0-0860, Converter configuration":

- behaves as **converter** if drive controller is to get supply voltage via mains connection (e.g. for type of mains connection individual supply or central supply)
- behaves as **inverter** if drive controller is to get supply voltage via connection DC bus (L+, L-) (e.g. for type of mains connection central supply as supplied device)

Include the converter contacts in the control circuit in such a way that they make the mains contactor drop out in the case of error (when the contact opens).

You can assign other information to the "Rel 1" contacts of the drive controllers configured as inverters. Via this contact you can, for example, control a second holding brake by entering a signal from "S-0-0398, IDN list of configurable data in signal status word" in parameter "P-0-0300, Digital I/Os, assignment list".

(See also Functional Description of firmware: "Power Supply" and Parameter Description of firmware for P-0-0300 and P-0-0861)

Control via External Mains Contactor - HCS02 and HCS03

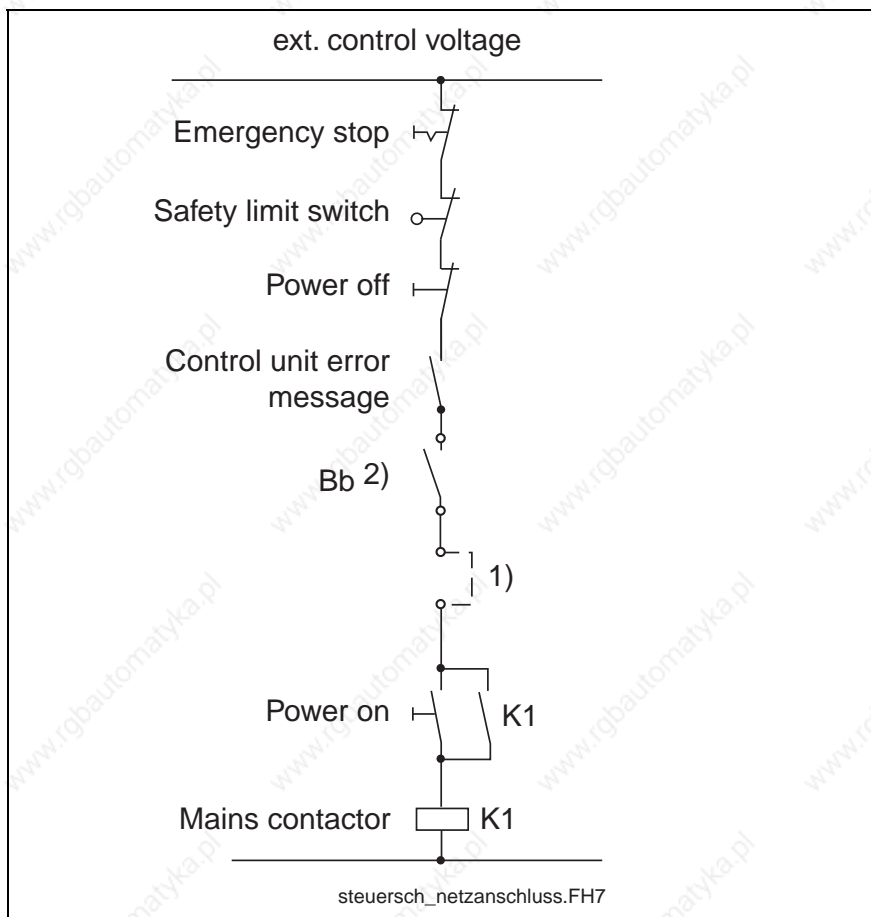


CAUTION

Damage to the device!

⇒ Before switching the drive controller on again, wait at least for 300 ms plus the switch-off delay of the mains contactor.

Standard Design for HCS02 and HCS03 Drive Controllers



- 1) integrating the Bb contacts of other devices and configuration (see "Configuration Rel 1)
- 2) take switching capacity of Bb contact into account

Fig. 11-3: Control circuit

Design for HCS02 and HCS03 Drive Controllers with Integrated 24V Control Voltage Supply

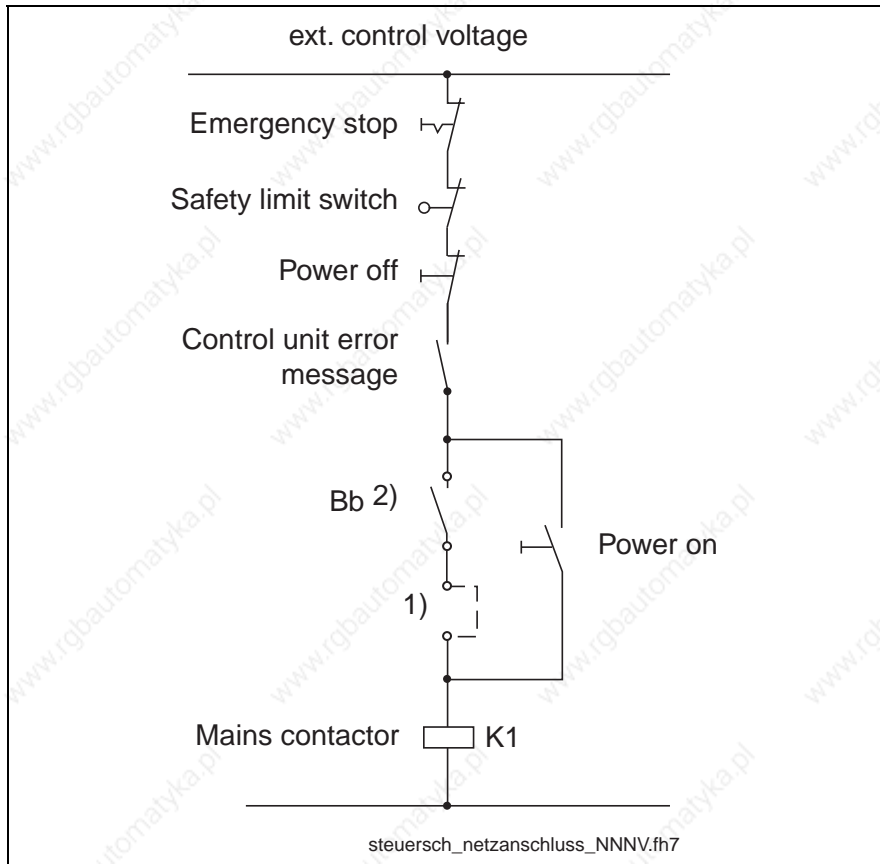
Drive controllers with integrated 24V control voltage supply are used, for example, to maintain signal processing for controlled return motion in case the external 24V control voltage supply fails.

Note: The integrated 24V control voltage supply cannot be used for motor brake supply.

To supply the motor brakes use an external 24V supply.

Design for HCS02 and HCS03 Drive Controllers with Integrated 24V Control Voltage Supply and CSB01.1N-FU Control Sections

When using the drive controllers HCS02.1E-...-NNNV and HCS03.1E-...-NNNV with control sections CSB01.1N-FU it is possible to do without the external 24V control voltage supply.



- 1) integrating the Bb contacts of other devices and configuration (see "Configuration Rel 1")
- 2) take switching capacity of Bb contact into account (Project Planning Manual of control section), CSB01.1N-FU control sections have switch contacts with high switching capacity

Fig. 11-4: Control circuit for HCS02.1E-...-NNNV drive controllers

Note: Observe the allowed switching capacity of the Bb contact of the CSB01.1-FU control sections.

Compared to other control sections, only the CSB01.1-FU control section has a Bb contact with allowed switching voltage of AC250V.

Note: During the time required until the internal supply voltages are built up and the firmware is actively working in the drive controller, the Bb contact at the control section of the drive controller is open.

Take these times into account for the design of the mains connection.

Control Circuits HCS02 with DC Bus Resistor Unit HLB01.1C

- Application** You should use this variant when
- only motors with permanent magnet excitation are connected.
 - motors with permanent magnet excitation and asynchronous motors (induction machines) are connected.

Features Due to the DC bus short circuit, motors with permanent magnet excitation can be shutdown with deceleration even if the electronic system of the drive is disturbed. (see also section Deceleration in the Case of E-Stop or Mains Failure)



WARNING

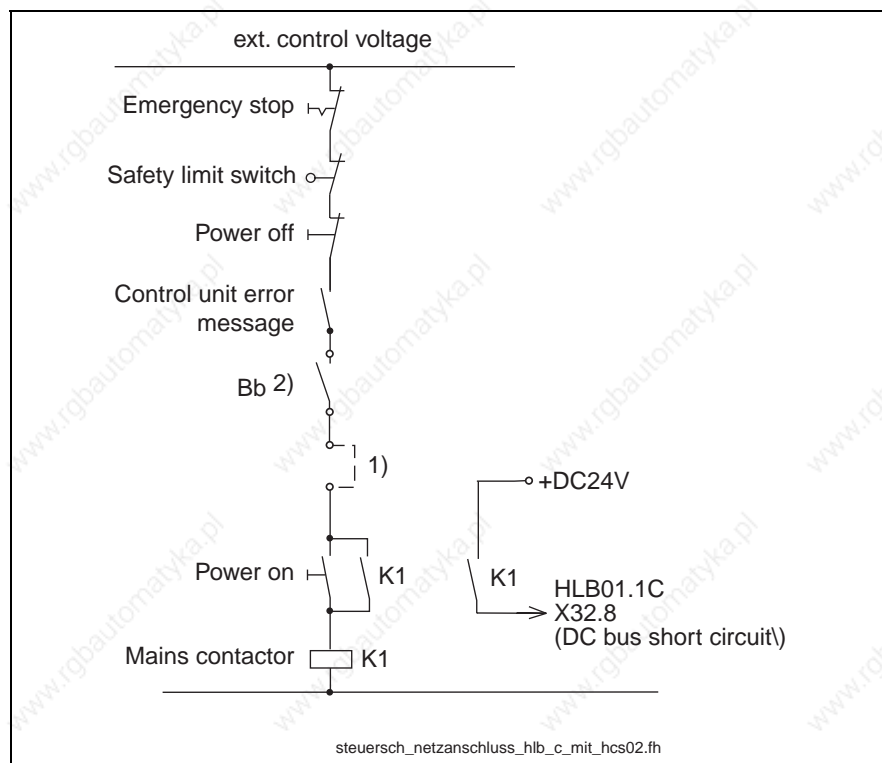
Personal injury caused by uncontrolled axis motion!

The DC bus short circuit protects machines in the case of drive errors. By itself it cannot assume the function of personal protection. In the case of errors in the drive or supply unit, uncontrolled drive motion can occur even when the DC bus short circuit has been activated.

Asynchronous machines do not brake when the DC bus has been short-circuited. Personal injury can occur according to the machine design.

⇒ Provide additional monitors and protective devices on the installation side.

Operating Principle When the E-Stop pushbutton is actuated, the mains contactor drops out which activates the DC bus short circuit device in the HLB.



- 1) integrating the Bb contacts of other devices and configuration (see "Configuration Rel 1")
- 2) take switching capacity of Bb contact into account (Project Planning Manual of control section)

Fig. 11-5: Wiring diagram HLB01.1 and HCS

Note: Connect the Bb contact of HLB in series with the Bb contacts of the involved IndraDrive components so that the mains contactor can be opened even if the module bus is defective.

11.3 Control Circuits for Mains Connection of Supply Units Rexroth IndraDrive M

Deceleration in the Case of Disturbed Electronic System of Drive

As a safety measure in addition to shutdown with deceleration of the drives in case the electronic system is disturbed, it is possible to short-circuit the DC bus voltage.

When the DC bus voltage is short-circuited, motors with permanent magnet excitation are always shut down with deceleration. In this case it is irrelevant whether the electronic system of the drive is still functioning or not.

Note: Asynchronous drives do not decelerate when the DC bus voltage has been short-circuited!

If the electronic system is disturbed and the DC bus voltage is not short-circuited, motors with permanent magnet excitation coast in an uncontrolled way.

Deceleration in the Case of E-Stop or Mains Failure

In the case of E-Stop or mains failures, the drives normally are shutdown by drive control.

In the case of E-Stop or when the drive-internal monitors trigger, the drive control inputs the command value "zero". The drives are thereby decelerating in a controlled way with maximum torque.

In some applications (e.g. electronically coupled gear cutting machines) it is required that the drive shutdown is controlled by the control unit in the case of E-Stop or mains failures, In the case of E-Stop or when the drive-internal monitors trigger, the control unit decelerates the drives in a position-controlled way.

For further details see the Functional Description of the firmware under the index entry "best possible deceleration".

Control by E-Stop Relay

With DC Bus Short Circuit

If you control the mains contactor in the supply unit by an E-Stop relay and short-circuit the DC bus, you achieve a high degree of safety with little effort. The monitoring functions of the drive system are used in the most effective way.

Application You should use this variant when

- only motors with permanent magnet excitation are connected.
- motors with permanent magnet excitation and asynchronous motors (induction machines) are connected.
- the E-Stop switch has to be duplicated or a safety door monitor, for example, is required.
- your drive system has an extensive emergency stop circuit.

Note: The pickup current of the auxiliary relay for control of the mains contactor flows via the emergency stop circuit. In order that the mains contactor picks up reliably, the total resistance of the emergency stop circuit taking effect between connections X32/1 and X32/9 has to be below 45 Ω!

Features Due to the DC bus short circuit, motors with permanent magnet excitation can be shutdown with deceleration even if the electronic system of the drive is disturbed. In order to trigger a DC bus short circuit in such a case, the Bb contacts **of the drive controllers** have to be connected in series with the control contact and wired in the E-Stop circuit. The DC bus short circuit only triggers in the case of drive failure. If E-Stop is actuated, asynchronous drives therefore are braking, too.

When the Bb contacts **of the supply unit** are connected in series with the control contact in the E-Stop circuit, the DC bus dynamic brake is only triggered in the case of a supply unit error.

In the case of E-Stop or when the monitors of the supply unit trigger (e.g. mains failure), the electronic system of the drives shuts them down according to the error reaction that was set.



WARNING

Personal injury caused by uncontrolled axis motion!

The DC bus short circuit protects machines in the case of drive errors. By itself it cannot assume the function of personal protection. In the case of errors in the drive and supply unit, uncontrolled drive motion can occur even when the DC bus short circuit has been activated.

Asynchronous machines do not brake when the DC bus has been short-circuited. Personal injury can occur according to the machine design.

- ⇒ Provide additional monitors and protective devices on the installation side.
 - ⇒ Use the Integrated Safety Technology by Rexroth.
-

Operating Principle When the E-Stop pushbutton is actuated, the mains contactor in the supply unit drops out. The E-Stop relay or an auxiliary contact of the mains contactor switches off the drive enable signals. The drives are shut down according to the error reaction set in the drive controller.

The mains contactor is switched off and the DC bus short circuit triggers when there is a drive error message by the supply unit (Bb1 contact), an error message by the control unit (servo error) or a limit switch has been passed.

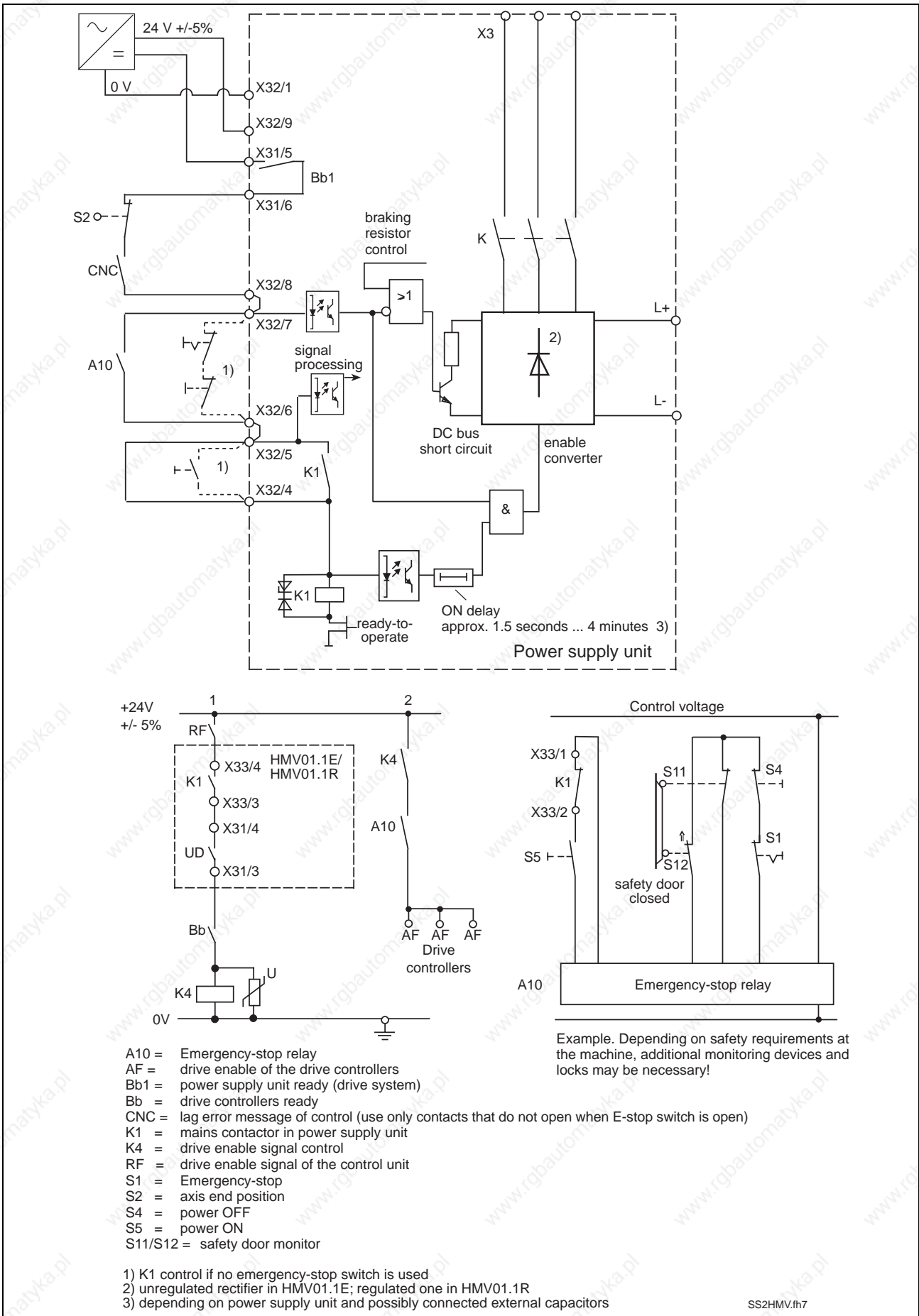


Fig. 11-6: Controlling the supply unit when electronic system of drive disturbed with DC bus short circuit

Designing the DC Bus Short Circuit

To design the DC bus short circuit there are the HLB01.1 components available.

Calculating the resulting braking distance when using the DC bus short circuit requires, apart from the Rexroth components, knowledge of the following application parameters:

- velocities
- friction conditions
- ...

With these data the resulting braking distance can be approximately determined. For the calculation formulas see Appendix.

Note: It is not recommended to short-circuit the motor connections with the drive controller connected.

Use the HLB01 components with integrated device for DC bus short circuit.

Without DC Bus Short Circuit

- Application**
- If unbraked coasting to stop of the drives does not damage the installation.
 - If only asynchronous motors are connected to the supply unit.
 - If the end positions of the feed axes have been sufficiently cushioned.
 - If external braking devices are used.

Features The DC bus voltage is not short-circuited.

In the case of E-Stop or when the monitors of the supply unit trigger (e.g. mains failure), the drives are shut down according to the error reaction set in the drive controller.

Operating Principle When the E-Stop circuit opens, the mains contactor in the supply unit drops out immediately. The E-Stop relay or an auxiliary contact of the mains contactor switches off the drive enable signals. The drives are shut down according to the error reaction set in the drive controller.



CAUTION

Damage to machines caused by unbraked coasting to stop of the drives in case their electronic system is disturbed!

- ⇒ Use motors with mechanical brake (a holding brake mustn't be used as service brake).
 - ⇒ Sufficiently cushion end positions of feed axes.
-

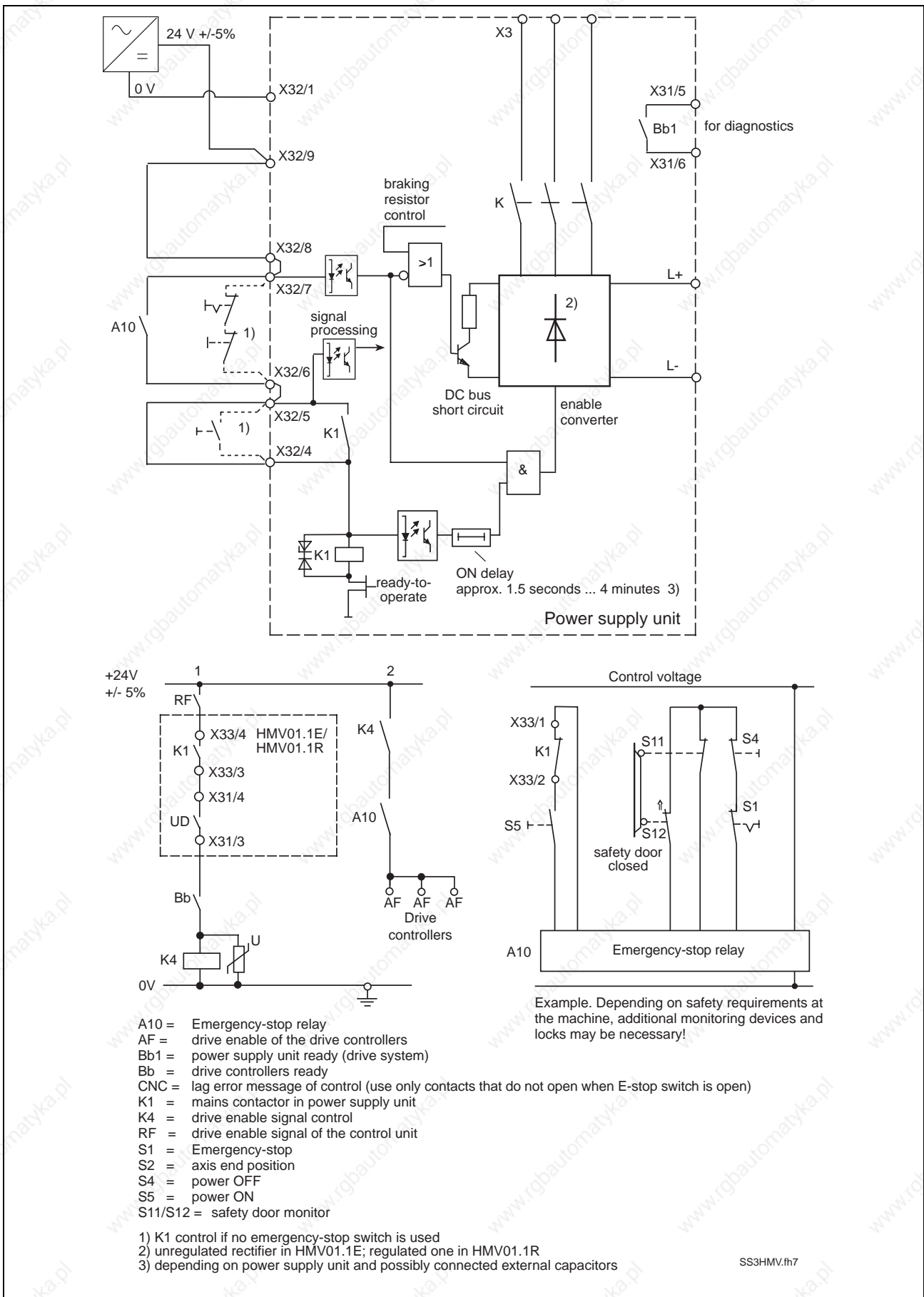


Fig. 11-7: Controlling the supply unit without DC bus short circuit

Control by the Control Unit

If the mains contactor is controlled by the control unit, the drive, in the case of E-Stop or when the drive-internal monitor triggers, can be shut down in a position-controlled way by a control unit.

Application This kind of mains contactor control is mainly used for electronically coupled drives that are shut down synchronously even in the case of mains failure.

Features The DC bus voltage is not short-circuited so that there is energy available for position-controlled shutdown of the drives.

Note: The energy stored in the DC bus or the regenerated energy has to be greater than the energy required for excitation of asynchronous machines or for return motions.

The parameter "Activation of NC reaction on error" has to be set accordingly in the drive controller (P-0-0117, bit 0=1).

In the case of E-Stop or when the monitors of the supply unit trigger (e.g. mains failure), the drives are shut down in a position-controlled way by the positioning control.

Operating Principle When the E-Stop circuit opens or the monitors of the supply unit trigger (e.g. mains failure), the mains contactor in the supply unit drops out.

For drives with SERCOS interface the error is signaled to the control unit and the drives can be shut down in a position-controlled way.

For drives without SERCOS interface the control unit has to evaluate the UD contact. When the UD contact triggers, the control unit has to shut down the drives.



CAUTION

Damage to machines caused by unbraked coasting to stop of the drives in case DC bus voltage is too low!

⇒ The control unit should evaluate the UD contact and shut the drives down when the contact triggers.

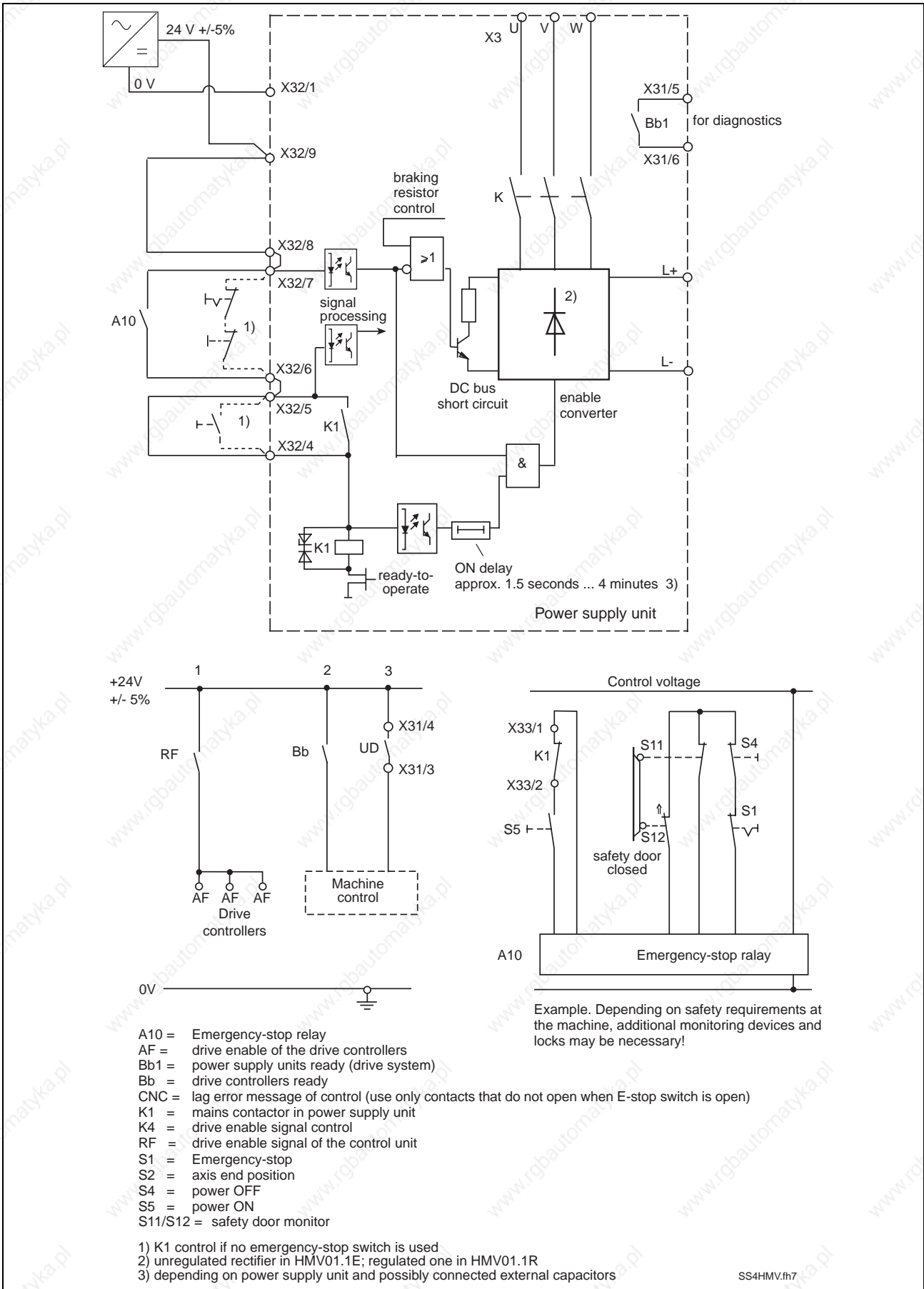


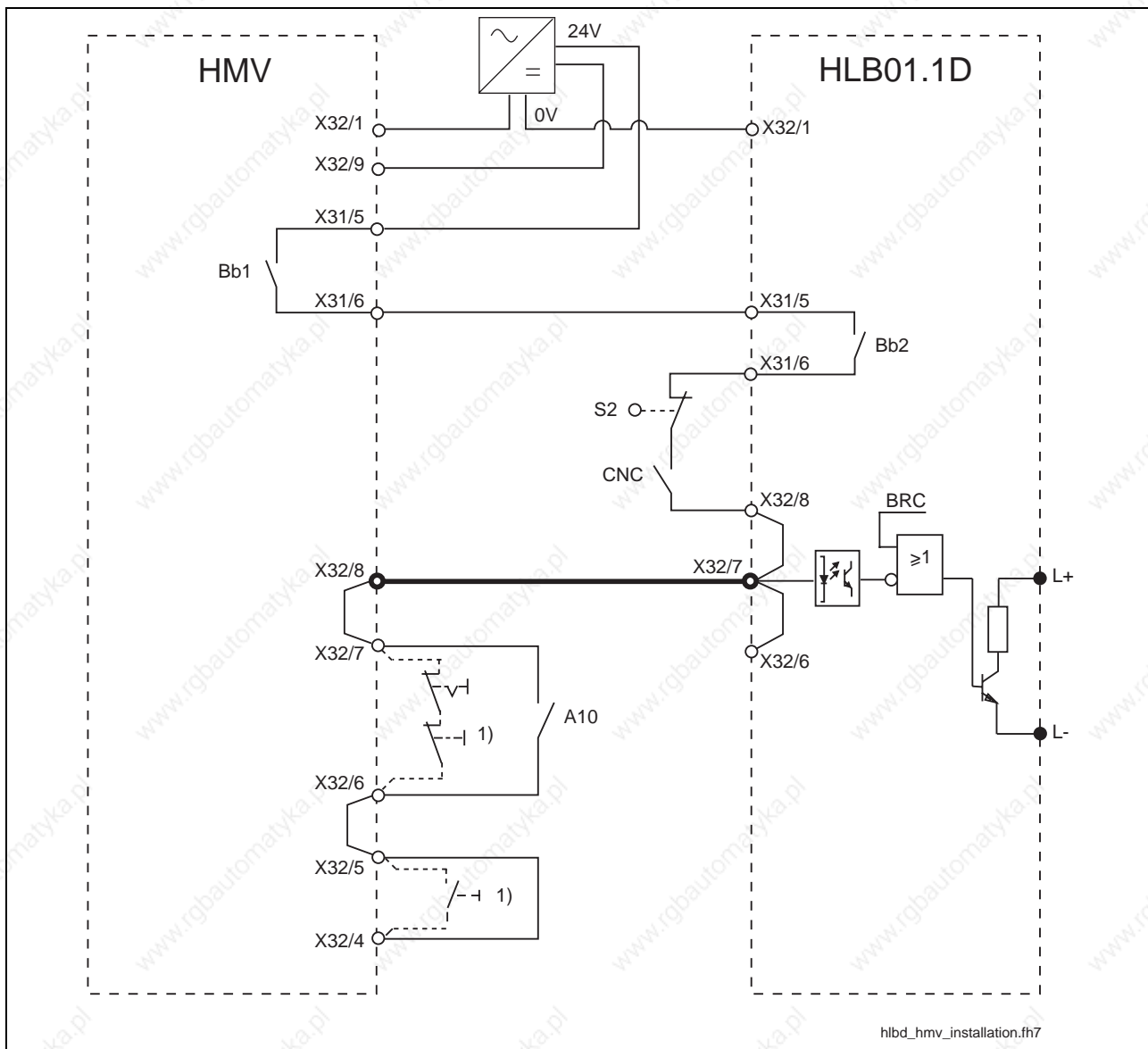
Fig. 11-8: Control for position-controlled shutdown of the drives by control unit (without DC bus short circuit)

Combination of Supply Unit HMV01.1 and DC Bus Resistor Unit HLB01.1D



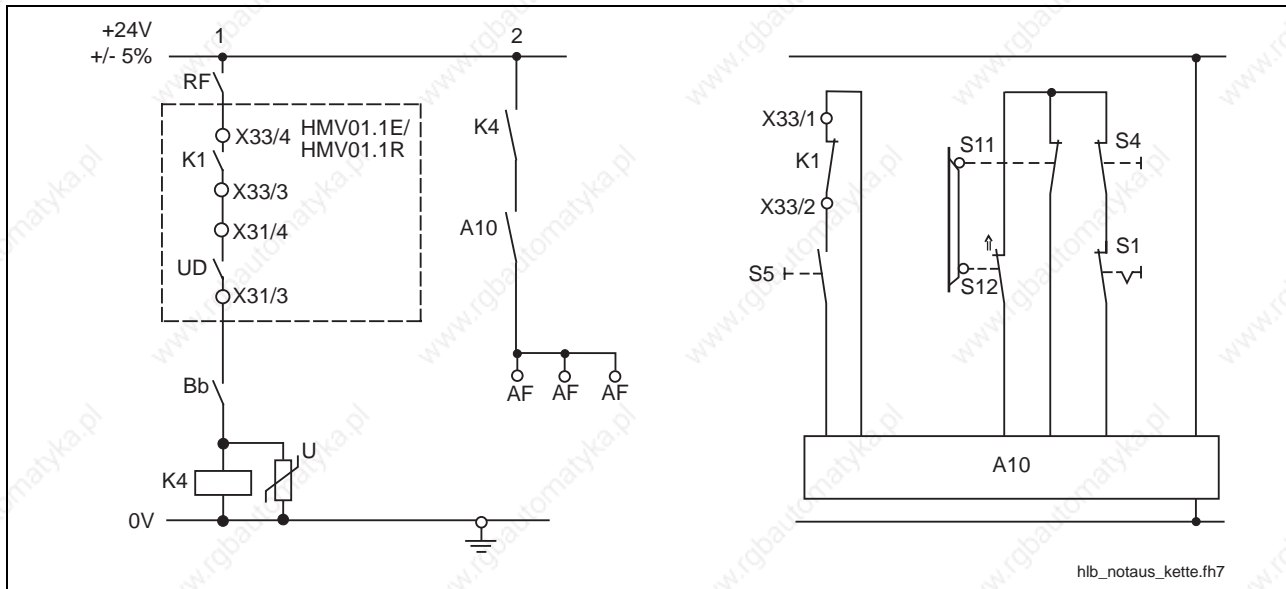
Risk of damage to the device!

⇒ If the connection of HMV_X32/8 and HLB_X32/7 is missing and the DC bus short circuit function is used, the DC bus resistor unit can be damaged.



- A10: E-Stop relay
 - BRC: (device-internal signal name) braking resistor control
 - CNC: lag error message of the control unit (only use contact that doesn't open when the E-Stop switch is open)
 - S2: axis end position
 - 1) control of K1 when there is no E-Stop relay used
- Fig. 11-9: Wiring diagram HLB01.1D and HMV with HLB01.1D

Preferred Wiring of E-Stop Circuit



- A10: E-Stop relay
- AF: drive enable of drive controllers
- Bb: readiness for operation of drive controllers
- K1: mains contactor in supply unit
- K4: control of drive enable
- S1: E-Stop
- S2: axis end position
- S4: power Off
- S5: power On
- S11/S12: safety door monitor

Fig. 11-10: Preferred wiring of E-Stop circuit

Notes

12 Connections of the Components in the Drive System

12.1 System Connections of the Components

To operate the drive system Rexroth IndraDrive the following electrical connections, for example, have to be established.

In the system environment

- connection PE of X3 to equipment grounding system
- connection X3 to supply with power voltage
- connection X13 or terminal block 0V / +24V to supply with control voltage
- connection to control unit and/or master communication

Within the drive system connect, among other things

- equipment grounding conductors PE of X3 or PE joint bars
- DC bus connections L+ with bus bars
- DC bus connections L- with bus bars
- control voltage connections 0V with bus bars
- control voltage connections +24V with bus bars
- module bus connections X1 via supplied ribbon cable
- motor power connections via system cable to X5
- connections for motor temperature monitoring and motor holding brake via system cable to X6

Note: The connections to X5 and X6 are made via a **single** Rexroth motor cable.

Position of System Connections

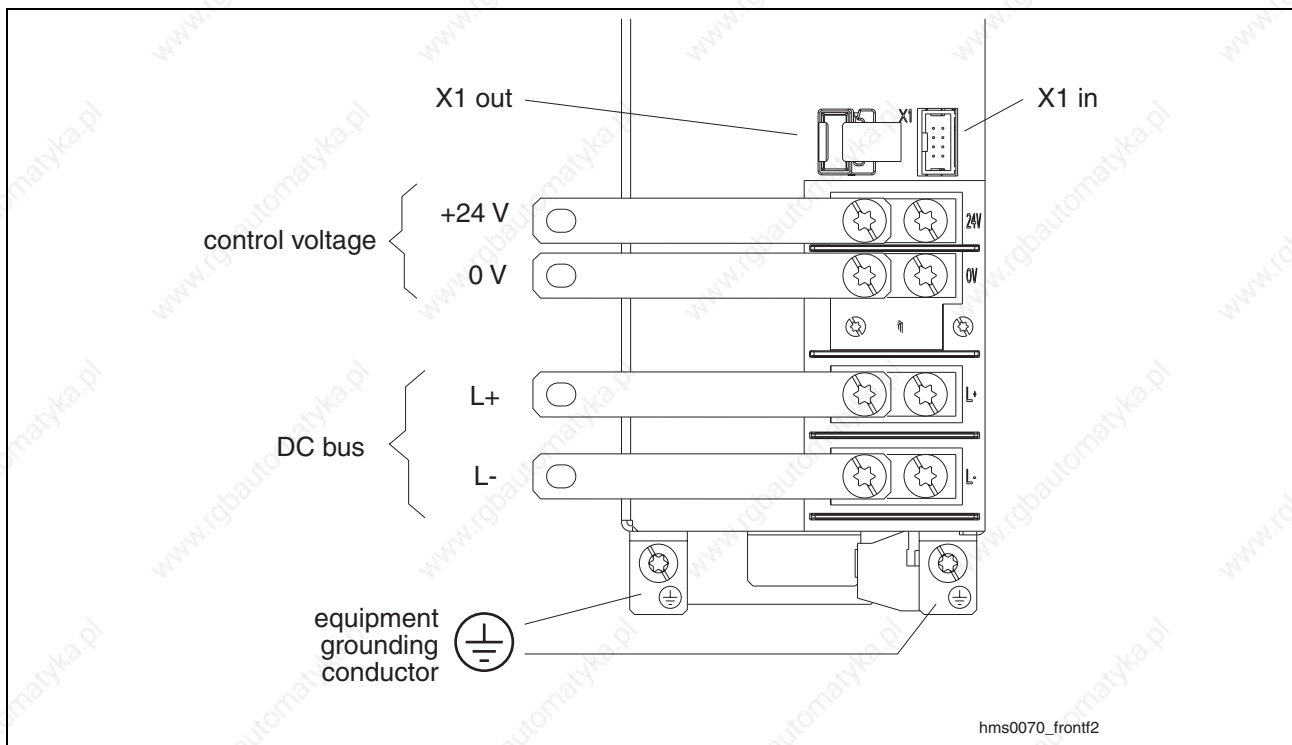


Fig. 12-1: Connections at power section

Ground Connection of Housing

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. Connect the bare metal back panel of the mains filter in conductive form to the mounting surface in the control cabinet and establish a connection with the lowest possible impedance to the mounting surface of the drive controllers (see item 1).

Connection Point of Equipment Grounding Conductor and Equipment Grounding Connections

The connection points of the equipment grounding conductors of the drive controllers and their connection to the equipment grounding system are important parts of electrical safety.



DANGER

Dangerous contact voltage at device housing! Lethal electric shock!

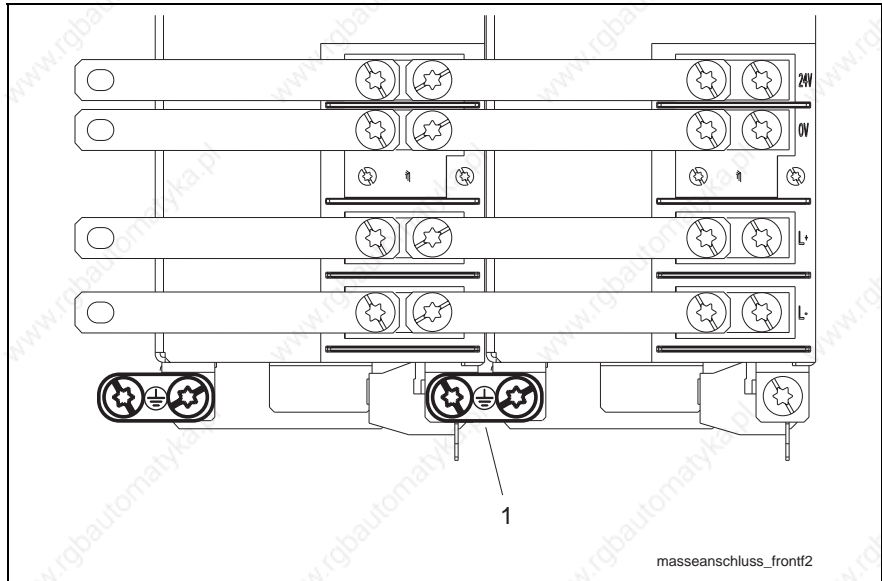
- ⇒ Always operate drive controllers with connected equipment grounding conductor.
- ⇒ Observe the explanations below.

In the drive system Rexroth IndraDrive, the connection points of equipment grounding conductors of all drive controllers and additional components have to be connected to the equipment grounding system. Establish the connection depending on the involved devices.

Involved devices	Equipment grounding connections between devices	Connection to equipment grounding system in control cabinet at devices
HMV01 HCS03 HMS01 HMD01 HLB01.1D HLC01.1D HLC01.1C	interconnect joint bars at front of devices	HMV01 HCS03 HMS01 HMD01 HLB01.1D HLC01.1D HLC01.1C realized in central form ; one connection at HMV01 HCS03
HCS02 with HAS04 HLB01.1C HLC01.1C HMS01 HMD01	interconnect joint bars at front of devices	HAS04 HLB01.1C HLC01.1C HMS01 HMS02 HMD01 realized in central form ; one connection at HCS02
HCS02 without HAS04 HCS02 HMS01 HMS02 HMD01 HLB01.1C HLC01.1C HLB01.1D HLC01.1D	interconnect joint bars at front of devices	HMS01 HMS02 HMD01 HLB01.1C HLC01.1C HLB01.1D HLC01.1D one connection each at all and one connection at connected drive system, consisting of all HMS01 HMS02 HMD01 HLB01.1C HLC01.1C HLB01.1D HLC01.1D
HMV02 HMS02 HNL02 HNS02	interconnect joint bars at front of devices	HMV02 HMS02 one connection each at all and one connection at connected drive system, consisting of all HNL02 HNS02 HMV02 HMS02

Fig. 12-2: Equipment grounding connections

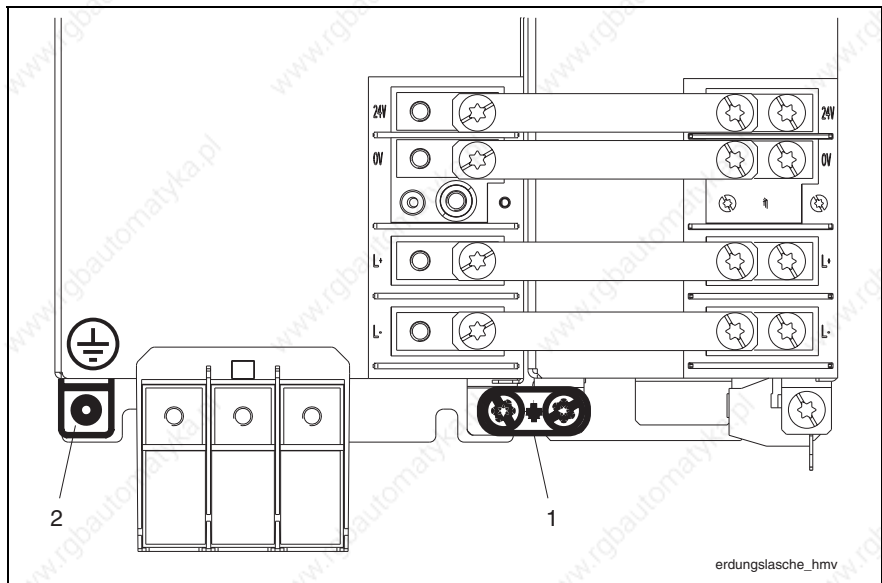
Equipment Grounding Connections Between Devices



1: joint bar

Fig. 12-3: Equipment grounding connections between devices

Connection to Equipment Grounding System in Control Cabinet



1: joint bar

2: connection point for connection to equipment grounding system in control cabinet

Fig. 12-4: Equipment grounding connections

Note: Provide sufficient cross sections of the lines for connecting the equipment grounding conductor of the device to the equipment grounding system in the control cabinet.
If lines are used for the equipment grounding connections, they must have a cross section of **at least 10 mm²** for HCS03.1E drive controllers and HMV01 supply units (however not smaller than the supply feeder cross section). For HCS02.1E drive controllers choose the cross section at least as big as for the supply feeder.

Connection of Mains Choke

Via connection to the mains choke the supply units resp. the drive controllers are connected to the mains power supply.

The connection wires to the mains choke carry a high potential of interferences. Thus, keep them as short as possible and twist them.

Note: At supply units HMV, wires with a **maximum length of 5 m** between mains choke and mains input are allowed.

See also within section 7.3 Arranging Components in Control Cabinet from Mainly Electrical Point of View the section EMC Measures for Design and Installation.

DC Bus Connection (L+, L-)



CAUTION

Property damage in case of error caused by too low line cross section!

- ⇒ Observe the current carrying capacity of the connection lines at the DC bus connections.
- ⇒ Realize the connection lines at the DC bus connections in such a way that they are protected by the line protection at the mains connection of the supply unit.

Single-Line Arrangement

The figure below illustrates the connection point and connection of the DC bus connections for system components HMV01, HMS01, HMD01; HLB01.1D and HCS03 in single-line arrangement **with contact rails**.

Design

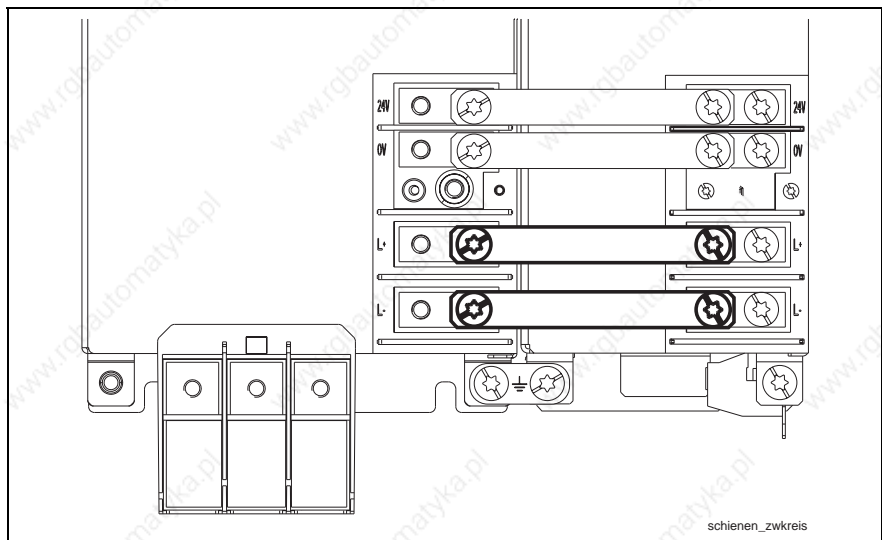


Fig. 12-5: Contact bars

Multiple-Line Arrangement

For multiple-line arrangement of drive controllers the connection for DC bus and control voltage supply is realized **with cables**.

**CAUTION****Damage to the drive controller!**

- ⇒ The DC bus connections of stacked drive controllers must be correctly interconnected.
- ⇒ Connect L+ connections only to other L+ connections and L- connections only to other L- connections.
- ⇒ Observe the measures regarding max. allowed line lengths and min. required line cross sections.

Maximum Allowed Line Lengths at DC Bus Connection

The line length at the DC bus connection is limited to protect the devices. For the maximum allowed values of line length between the electrical connections see table below.

Allowed line length [m]								
from	to							
	HMV01	HMV02	HCS03	HCS02	HMS01/ HMD01	HMS02	HLB01	HLC01
HMV01	0,5	--	--	--	2	--	0,35	0,35
HMV02	--	0,5	--	--	--	0,35	0,35	0,35
HCS03	--	--	0,5	--	2	--	--	0,35
HCS02	--	--	--	0,5	2	0,35	0,35	0,35
HMS01/ HMD01	--	--	--	--	0,35	--	0,35	0,35
HMS02	--	--	--	--	--	0,35	0,35	0,35
HLB01	--	--	--	--	--	--	0,35	0,35
HLC01	--	--	--	--	--	--	--	0,35

--: not allowed

Fig. 12-6: Max. allowed line lengths at DC bus

Note: Multiple-line arrangement or distance between the components requires the accessory RKB 0001 (see chapter "Accessories") to establish the **module bus connection** between the components.

To arrange supply units supplying decentralized drive controllers you have to take specific measures if the line lengths exceed 2 m.

- Use HLC01 DC bus capacitor modules at every drive system. Dimension the minimum size of HLC01 according to the projected continuous power of the respective drive system. Allow 47 µF per kilowatt [kW] of continuous power.

Example: 50 kW calculated continuous power in DC bus requires 2350 µF at this system, thus at least 1 HLC01.1D-02M4.

Minimum Requirements to the Connection Lines**Dielectric Strength**

The connection lines from the supply unit to the axis systems and between the axis systems have to have a dielectric strength of at least:

- 1000 V against each other
- 700 V against ground

Line Cross Section Determine the minimum line cross section from supply unit to axis systems and between axis systems by means of the rated current. For rated current use the higher value from the following calculations:

- calculate the mains-side phase current
- calculate the current in the branch with the greatest DC bus power

Note: To connect required line cross sections of xx mm² use our accessory HASxx.

Routing The connection lines from supply unit to axis systems and between axis systems

- have to be twisted with a maximum length of lay of 30 mm
- have to be routed with minimum mechanical distance to ground potential
- have to be routed with a minimum distance of 200 mm to control voltage lines.

The figures below illustrate the correct DC bus connection for stacked drive controllers. The illustrated way of connection keeps bare wire sections from being situated directly vis-à-vis. This avoids voltage arcing.

The cables have to be twisted.



CAUTION

Risk of damage!

- ⇒ If the total power when using HMV supply units is more than 60 kW, the DC bus connection has to be realized to both sides so that the connection elements are not overloaded.
 - ⇒ Connect the devices both to the left and to the right screw connection at the terminal block.
 - ⇒ Observe the notes in chapter "Arranging the Components in the Control Cabinet".
-

Cable Routing to the Left



Damage caused by voltage arcing!

⇒ Insulate ring terminals and connecting lines with a heat-shrinkable sleeve. Afterwards only strip the insulation of the contact surface of the ring terminal. Realize connections according to figure.

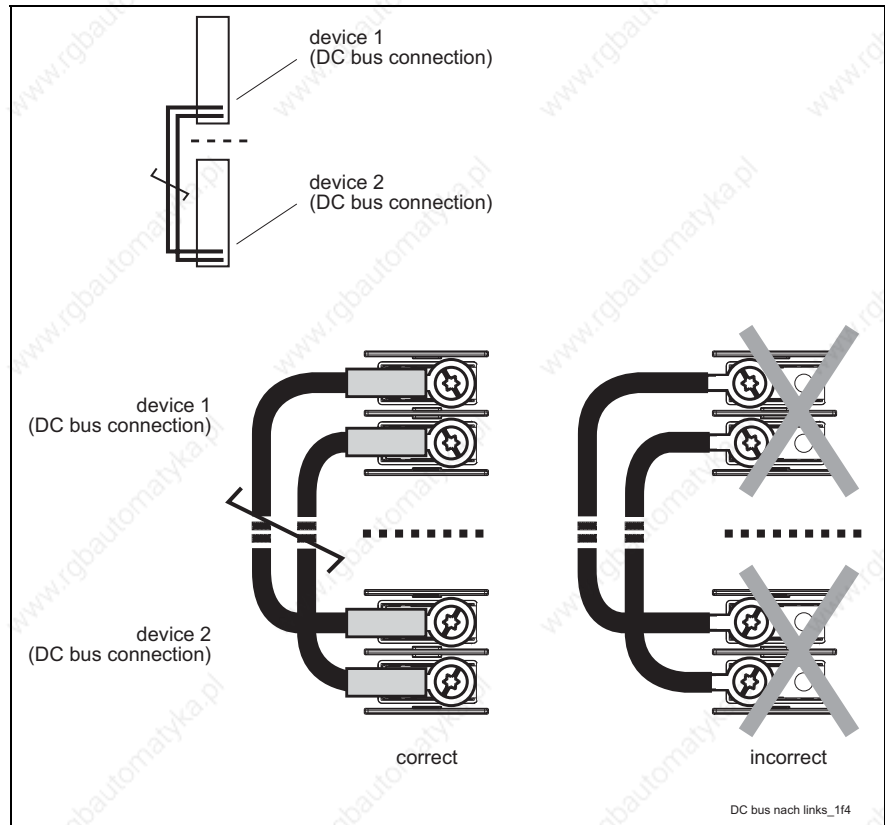


Fig. 12-7: DC bus connections for cable routing to the left

Cable Routing to the Right



CAUTION

Damage caused by voltage arcing!

⇒ Insulate ring terminals and connecting lines with a heat-shrinkable sleeve. Afterwards only strip the insulation of the contact surface of the ring terminal.

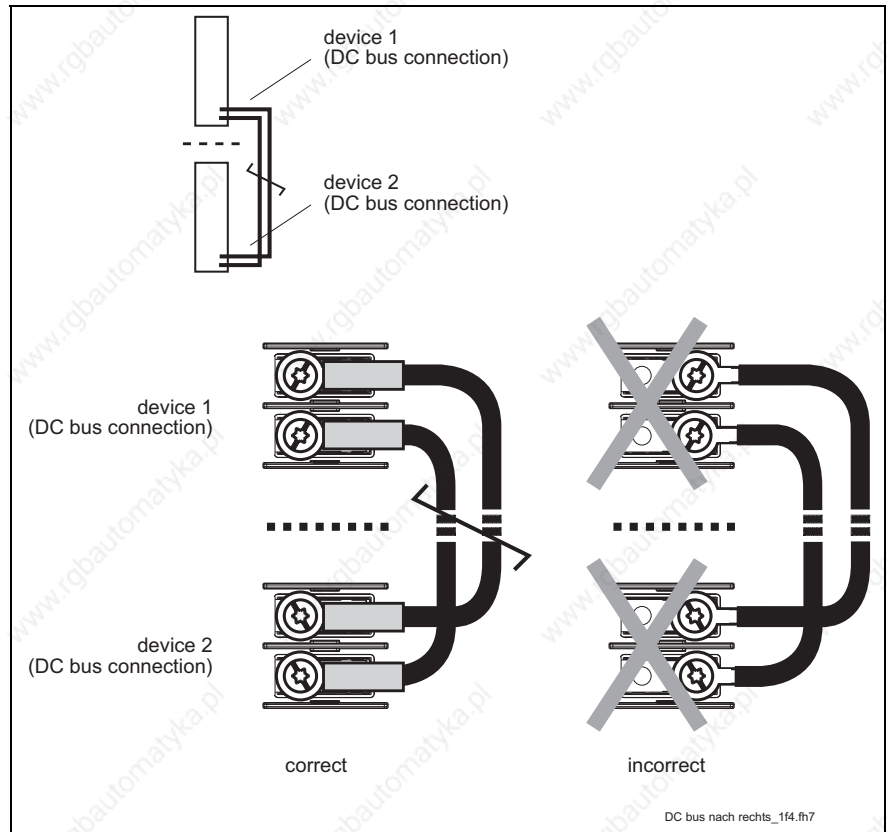


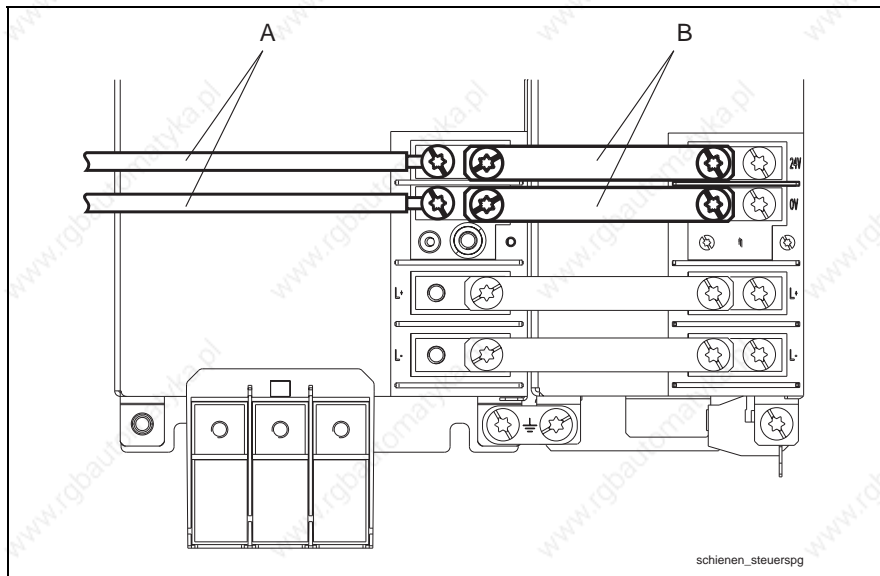
Fig. 12-8: DC bus connections for cable routing to the right

Control Voltage Connection (0 V, + 24 V)

Note: The input 0 V is connected in conductive form with the housing potential. It is therefore impossible to use an insulation monitor at +24 V and 0 V against housing.

Single-Line Arrangement

The figure below illustrates the connection point and connection of the control voltage connections for system components **HMV01**, **HMV02**, **HMS01**, **HMS02**, **HMD01**, **HLB01.1D** and **HCS03** in single-line arrangement..



A: cable (to source of control voltage supply)
B: contact bars

Fig. 12-9: Connection points and connections of control voltage

Note: Connect the system components **HCS02** and **HLB01.1C** to the control voltage supply. To do this connect each connection point X13 to the control voltage supply. Make use of the loop-through contacts and observe the allowed load.

Multiple-Line Arrangement

The following figures show the correct control voltage connection for stacked drive controllers. The illustrated way of connection ensures that the touch guard can be correctly mounted and the required clearances and creepage distances can be complied with.

The cables have to be twisted. Observe the notes in chapter "Arranging the Components in the Control Cabinet", section "Installing the 24V Supply".

Cable Routing to the Left

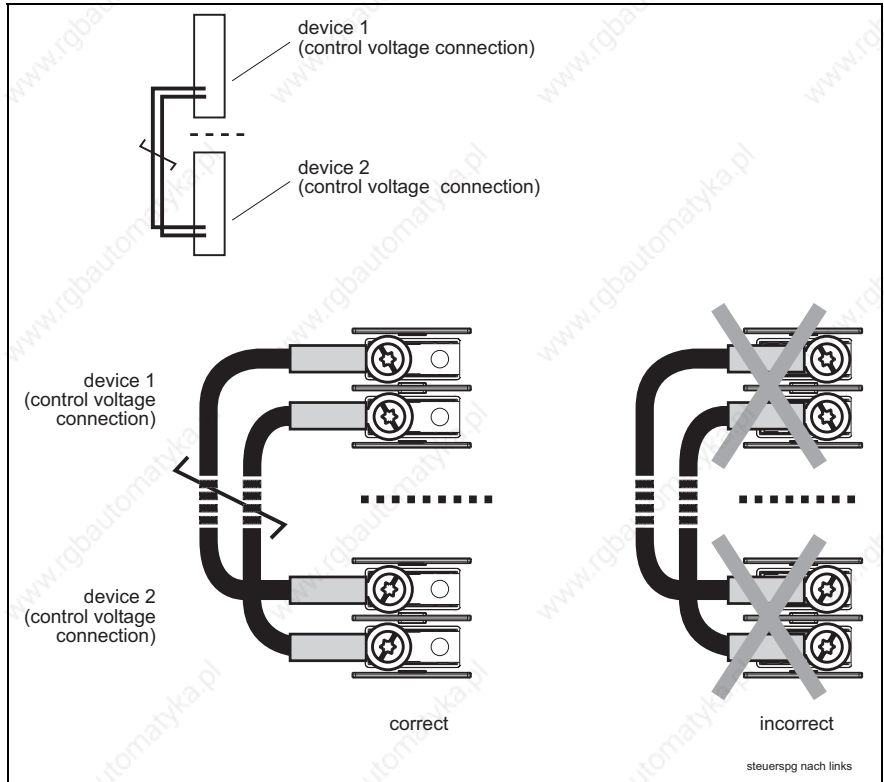


Fig. 12-10: Control voltage connections for cable routing to the left

Cable Routing to the Right

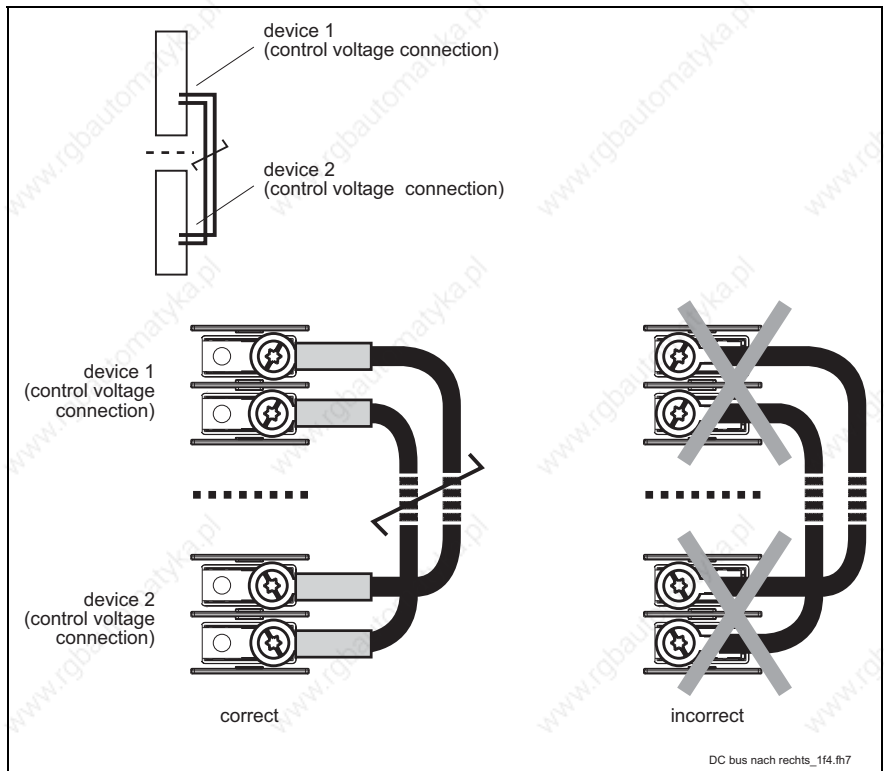


Fig. 12-11: Control voltage connections for cable routing to the right

Module Bus Connection X1

The module bus connection is used for signal exchange within the drive system and has to be established via the supplied ribbon cables.

Graphic Representation

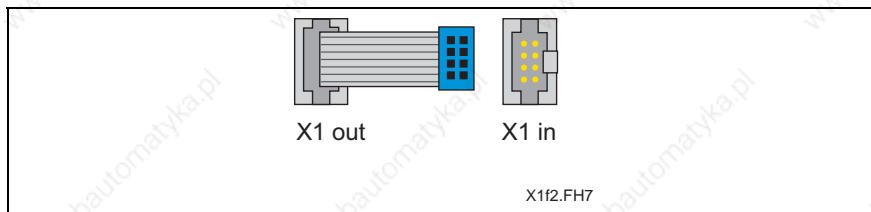


Fig. 12-12: X1

Note: When extension cables are used for the module bus, they must be **shielded**. Their total length mustn't exceed a **maximum of 40 m**.
The module bus extension accessory is available to extend the module bus connection.

Motor Connection

Power Connection, X5

- outputs to motor A1, A2, A3
- equipment grounding conductor connection

Control Contacts Connection, X6

- motor temperature monitoring
- motor holding brake

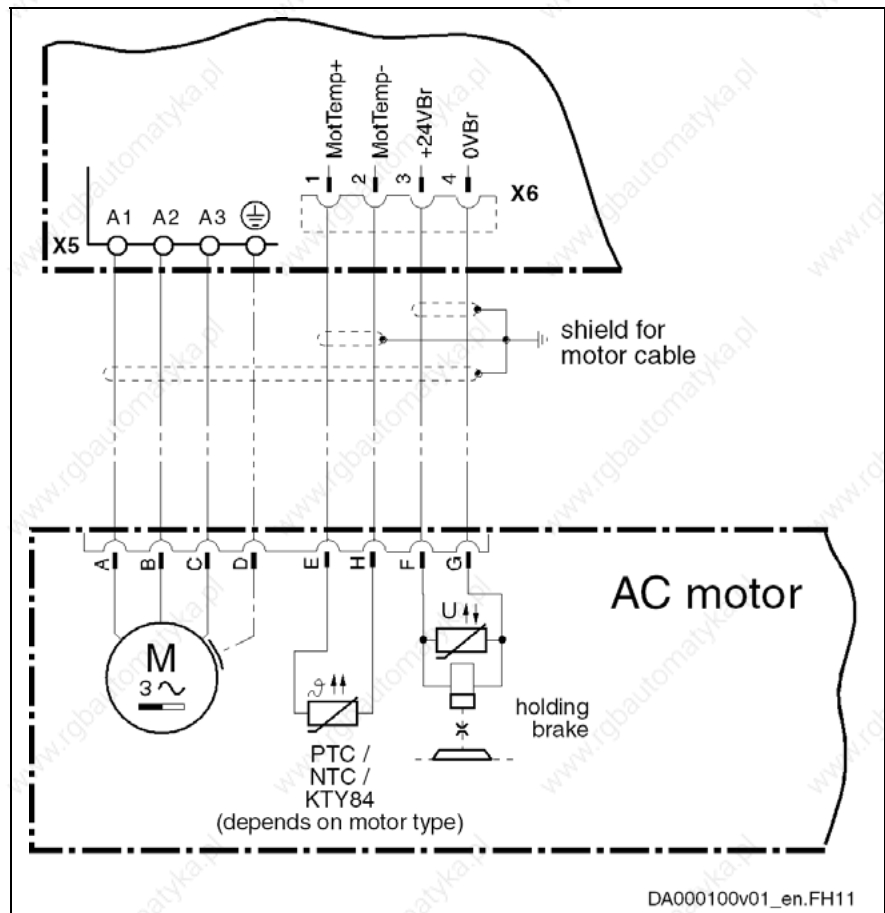


Fig. 12-13: Motor connection

Cables for Motor Connection

Note: For detailed information, particularly on suitable additional parts, such as control cabinet ducts and extensions, see documentation "Rexroth Connection Cables".

12.2 Overall Connection Diagrams of the System

To draw up the overall connection diagrams there are ePlan macros of the components available. Please ask our sales representative.

Notes

13 Fusing and Selecting the Mains Contactor

13.1 Fusing and Selecting the Mains Contactor for Mains Connection

The data below are recommended values applying under the conditions that

- the listed devices are operated with individual supply.
- the performance data are not exceeded.
- the line cross sections according to EN60204 - installation type B1 (or E for mains currents higher than 100A) - are to be selected without taking correction factors into account.
- easily separable contact-welded connections at the contactor are allowed after a short-circuit which corresponds to assignment type "2" according to DIN IEC 60947-4.

Applications deviating from these conditions require detailed calculation of the mains connection values.

If several drive controllers are to be operated at one fuse and one mains contactor, the mains-side phase currents and inrush currents calculated for the individual drives have to be added.



CAUTION

Damage to the drive controller caused by overload!

⇒ Make sure the specified performance data - peak power and continuous power - are complied with by correct drive dimensioning and selective fusing in the mains connection.

Note: Fuses of characteristic gR protect the involved semiconductors against further damage in the case of short circuit.

Fuses of characteristic gL protect the lines.

For the switch-off delay of the mains contactor see the technical data of the selected type. Take into account that additional components at the operating coil cause changes in the switch-off delay.

By way of example, the selection table shows types of certain manufacturers. Equivalent products by other manufacturers may be used as well.

Note: In order to prevent the mains contactor from being overloaded by the load current in the case of frequent cut-off, it is first necessary to switch off the drive, e.g. via the drive enable in the master communication, and then to switch off the mains contactor.

Fusing and Selecting the Mains Contactor

Mains voltage 3 AC 400 V

Device	Mains choke	Mains input contin. current $I_{L,cont}$	Min. nominal fuse current of characteristic		Autom. circuit-breaker [A]	Power circuit-breaker [A] (setting value)	Min. line cross section@ Ta40° [mm ²] ([AWG])	Recom- mended mains contactor Type	Max. allowed switch- off delay [ms]
			[A]	[A]					
Properties									
			gR	gL	tripping charact. C				
HCS03.1E	HNK01.1								
W0070	without	32,6	3NE1817-0	3NA6820-4	-	-	16 (6)	3RT1036	180
W0070	with	50	3NE1817-0	3NA6820-4	-	-	16 (6)	3RT1036	180
W0100	without	58,2	3NE1820-0	3NA6824-4	-	-	35 (4)	3RT1044	350
W0100	with	80	3NE1820-0	3NA6824-4	-	-	35 (4)	3RT1044	350
W0150	without	77,9	3NE1022-0	3NA6832-4	-	-	2x25/50 (2)	3RT1046	350
W0150	with	106	3NE1022-0	3NA6832-4	-	-	2x25/50 (2)	3RT1046	350
W0210	without	109,7	3NE1224-0	3NA6836-4	-	-	2x50/95 (1/0)	3RT1055	350
W0210	with	146	3NE1224-0	3NA6836-4	-	-	2x50/95 (1/0)	3RT1055	350
HCS02.1E	HNL01.1								
W0012	without	6	--	10	10	8	1,0 (16)	3RT1016	80
W0012	with	6	--	10	10	8	1,0 (16)	3RT1016	80
W0028	without	13	--	20	20	17	2,5 (13)	3RT1025	110
W0028	with	13	--	20	20	17	2,5 (13)	3RT1025	110
W0054	without	19	--	25	25	25	4,0 (11)	3RT1026	190
W0054	with	19	--	25	25	25	4,0 (11)	3RT1026	190
W0070	without	30	--	35	32	35	6,0 (9)	3RT1034	120
W0070	with	30	--	35	32	35	6,0 (9)	3RT1034	120

Device	Mains choke	Mains input contin. current $I_{L,cont}$	Min. nominal fuse current of characteristic		Autom. circuit-breaker	Power circuit-breaker	Min. line cross section@ Ta40° [mm²] ([AWG])	Recom- mended mains contactor	Max. allowed switch-off delay
			[A]	[A]					
		[A] eff @ P _{DC cont}			[A]	[A] (setting value)		Type	[ms]
			Properties						
			gR	gL	tripping charact. C				
HMV01.1 E	HNL01.1								
W0030	without	45	--	63	63	51	16 (6)	integrated	-
W0030	with	51	--	63	63	51	16 (6)	integrated	-
W0075	without	98	--	100	--	77	25 (2)	integrated	-
W0075	with	125	--	160	--	128	70 (1/0)	integrated	-
W0120	without	156	--	160	--	123	50 (1/0)	integrated	-
W0120	with	200	--	250	--	204	120 (0000)	integrated	-
HMV01.1 R	HNL01.1								
W0018	with	26	--	35	32	26	6 (10)	integrated	-
W0045	with	65	--	80	--	65	25 (4)	integrated	-
W0065	with	94	--	125	--	94	35 (2)	integrated	-
HMV02.1 R	HNL02.1								
W0015	with	23	50	35	32 integrated in HNS02	integrated in HNS02 (23)	6 (10)	integrated	

tbd: in preparation

Fig. 13-1: Fusing and selection of mains contactor 3AC400V

Mains voltage 3 AC 480 V

Device	Mains choke	Mains input contin. current $I_{L,cont}$	Min. nominal fuse current of characteristic		Autom. circuit-breaker	Power circuit-breaker	Min. line cross section@ Ta40°	Recom- mended mains contactor	Max. allowed switch-off delay
			[A]	[A]					
		[A] eff @ P_{DC} cont			[A]	[A] (setting value)	[mm ²] ([AWG])	Typ	[ms]
			Properties						
			gR	gL	tripping charact. C				
HCS03.1E	HNK01.1								
W0070	without	27,2	Littelfuse L50S50* Cooper-Bussmann FWH-50B*	3NA6..820	-	-	16 (6)	3RT10 44	180
W0070	with	42	Littelfuse L50S50* Cooper-Bussmann FWH-50B*	3NA6..820	-	-	16 (6)	3RT10 44	180
W0100	without	48,5	Littelfuse L50S70* Cooper-Bussmann FWH-70B*	3NA6..824	-	-	35 (4)	3RT10 44	350
W0100	with	67	Littelfuse L50S70* Cooper-Bussmann FWH-70B*	3NA6..824	-	-	35 (4)	3RT10 44	350
W0150	without	65	Littelfuse L50S100* Cooper-Bussmann FWH-100B*	3NA6..830	-	-	50 (2) 2x25 (2)	3RT10 46	350
W0150	with	88	Littelfuse L50S100* Cooper-Bussmann FWH-100B*	3NA6..830	-	-	50 (2) 2x25 (2)	3RT10 46	350
W0210	without	91,4	Littelfuse L50S125* Cooper-Bussmann FWH-125B*	3NA6..832	-	-	95 (1/0) 2x50 (1/0)	3RT10 55	350
W0210	with	122	Littelfuse L50S125* Cooper-Bussmann	3NA6..832	-	-	95 (1/0) 2x50 (1/0)	3RT10 55	350

Device	Mains choke	Mains input contin. current $I_{L,cont}$	Min. nominal fuse current of characteristic		Autom. circuit-breaker	Power circuit-breaker	Min. line cross section@ Ta40° [mm²] ([AWG])	Recom- mended mains contactor	Max. allowed switch-off delay
			[A]	[A]					
		[A] eff @ P_{DC} cont			[A]	[A] (setting value)		Typ	[ms]
			Properties						
			gR	gL	tripping charact. C				
			FWH-125B*						
HCS02.1E	HNL01.1								
W0012	without	6	--	10	10	8	1,0 (16)	3RT1016	80
W0012	with	6	--	10	10	8	1,0 (16)	3RT1016	80
W0028	without	13	--	20	20	17	2,5 (13)	3RT1025	110
W0028	with	13	--	20	20	17	2,5 (13)	3RT1025	110
W0054	without	19	--	25	25	25	4,0 (11)	3RT1026	190
W0054	with	19	--	25	25	25	4,0 (11)	3RT1026	190
W0070	without	30	--	35	32	35	6,0 (9)	3RT1034	120
W0070	with	30	--	35	32	35	6,0 (9)	3RT1034	120
HMV01.1 E	HNL01.1								
W0030	without	26	--	35	32	26	6 (10)	integrated	-
W0030	with	43	--	50	50	43	6 (10)	integrated	-
W0075	without	64	--	80	--	64	25 (4)	integrated	-
W0075	with	107	--	125	--	107	35 (2)	integrated	-
W0120	without	103	--	125	--	103	35 (2)	integrated	-
W0120	with	170	--	200	--	170	95 (000)	integrated	-
HMV01.1 R	HNL01.1								
W0018	with	22	--	35	32	22	4 (10)	integrated	-
W0045	with	54	--	63	63	54	16 (6)	integrated	-
W0065	with	78	--	100	--	78	35 (2)	integrated	-
HMV02.1 R	HNL02.1								
W0015	with	20	50	35	32 integrated in HNS02	integrated in HNS02 (20)	4 (10)	integrated	

tbd: in preparation

Fig. 13-2: Fusing and selection of mains contactor 3AC480V

Mains voltage 3 AC 500 V

Device	Mains choke	Mains input contin. current $I_{L,cont}$	Min. nominal fuse current of characteristic		Autom. circuit-breaker	Power circuit-breaker	Min. line cross section@ Ta40° [mm ²] ([AWG])	Recommended mains contactor	Max. allowed switch-off delay
			[A]	[A]					
		[A] eff @ P _{DC cont}	[A]	[A]	[A]	[A] (setting value)		Typ	[ms]
Properties									
			gR	gL	tripping charact. C				
HCS03.1E	HNK01.1								
W0070	without	26,1	3NE1802-0	3NA6817	-	-	16 (6)	3RT1044	180
W0070	with	40	3NE1802-0	3NA6817	-	-	16 (6)	3RT1044	180
W0100	without	46,5	3NE1820-0	3NA6824	-	-	25 (4)	3RT1044	350
W0100	with	64	3NE1820-0	3NA6824	-	-	25 (4)	3RT1044	350
W0150	without	62,4	3NE1021-0	3NA6830	-	-	2x25/50 (2)	3RT1046	350
W0150	with	85	3NE1021-0	3NA6830	-	-	2x25/50 (2)	3RT1046	350
W0210	without	87,8	3NE1022-0	3NA6832	-	-	2x50/95 (1/0)	3RT1055	350
W0210	with	117	3NE1022-0	3NA6832	-	-	2x50/95 (1/0)	3RT1055	350
HCS02.1E	HNL01.1								
W0012	without	6	--	10	10	8	1,0 (16)	3RT1016	80
W0012	with	6	--	10	10	8	1,0 (16)	3RT1016	80
W0028	without	13	--	20	20	17	2,5 (13)	3RT1025	110
W0028	with	13	--	20	20	17	2,5 (13)	3RT1025	110
W0054	without	19	--	25	25	25	4,0 (11)	3RT1026	190
W0054	with	19	--	25	25	25	4,0 (11)	3RT1026	190
W0070	without	30	--	35	32	35	6,0 (9)	3RT1034	120
W0070	with	30	--	35	32	35	6,0 (9)	3RT1034	120

tbd: in preparation

Fig. 13-3: Fusing and selection of mains contactor 3AC500V

Fusing Branches within the Control Cabinet

Branch to Synchronization Input HMV01.1R

In the wiring of the drive system components there are branches run from main lines to short circuit protection devices.

For example, a branch from the supply feeder has to be run from the output of the mains filters to the synchronization input of HMV01.1R mains supply modules.

According to EN 60 204 part 1, 5.2.4, such supply lines to short circuit protection devices branching off main lines do not need to be especially protected against short circuit, when the following requirements have been fulfilled:

- the supply lines to the short circuit protection device have at least the cross section of the conductors at the output of the short circuit protection device (line cross sections from and to motor circuit breaker have the same size),
- no supply line to the short circuit protection device is longer than 3 m,
- the lines are protected against external influence by a housing or a wiring duct,
- they are not run close to combustible material.

Notes

14 Accessories in the Drive System Rexroth IndraDrive

14.1 Overview of HAS Accessories

Allocation HAS01 Accessories

Gerät (Device)	Breite (Width) (mm)	HAS01.1																								
		HAS01.1-050-072-MN	HAS01.1-075-072-MN	HAS01.1-100-072-MN	HAS01.1-125-072-MN	HAS01.1-150-072-MN	HAS01.1-150-NNN-MN	HAS01.1-175-072-MN	HAS01.1-175-NNN-MN	HAS01.1-200-072-MN	HAS01.1-250-072-MN	HAS01.1-250-NNN-MN	HAS01.1-350-072-MN	HAS01.1-350-NNN-MN	HAS01.1-065-072-CN	HAS01.1-105-072-CN	HAS01.1-065-NNN-CN	HAS01.1-105-NNN-CN	HAS01.1-125-072-CN	HAS01.1-125-NNN-CN	HAS01.1-225-072-CN	HAS01.1-225-NNN-CN	HAS01.1-350-072-CN	HAS01.1-350-NNN-CN		
		HMS 01.1N-Ψ0020	50	X																						
HMS 01.1N-Ψ0036	50	X																								
HMD01.1N-Ψ0012	50	X																								
HMD01.1N-Ψ0020	50	X																								
HMD01.1N-Ψ0036	75		X																							
HMS 01.1N-Ψ0054	75		X																							
HMS 01.1N-Ψ0070	100			X																						
HMS 01.1N-Ψ0110	125				X																					
HMS 01.1N-Ψ0150	150					X																				
HMS 01.1N-Ψ0210	200								X																	
HLB 01.1D	100			X																						
HLC01.1D	100		X																							
HMV01.1E-Ψ0030	150					X	X																			
HMV01.1E-Ψ0075	250									X	X															
HMV01.1E-Ψ0120	350											X	X													
HMV01.1R-Ψ0018	175							X	X																	
HMV01.1R-Ψ0045	250									X	X															
HMV01.1R-Ψ0065	350											X	X													
HCS02.1E-Ψ0012	65																X									
HCS02.1E-Ψ0028	65													X		X										
HCS02.1E-Ψ0054	105														X		X									
HCS02.1E-Ψ0070	105														X		X									
HLB01.1C	65													X												
HLC01.1C	50	X																								
HCS03.1E-Ψ0070	125																X	X								
HCS03.1E-Ψ0100	225																			X	X					
HCS03.1E-Ψ0150	225																			X	X					
HCS03.1E-Ψ0210	350																						X	X		

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Fig. 14-1: Allocation HAS01 accessories

Allocation HAS02, HAS03, HAS04, HAS05 Accessories

Gerät (Device)	Breite (Width) (mm)	HAS02.1								HAS03.1		HAS04.1		HAS05.1			
		HAS02.1-001-NNNN-NN	HAS02.1-002-NNNN-NN	HAS02.1-003-NNNN-NN	HAS02.1-004-NNNN-NN	HAS02.1-005-NNNN-NN	HAS02.1-006-NNNN-NN	HAS02.1-007-NNNN-NN	HAS02.1-008-NNNN-NN	HAS02.1-009-NNNN-NN	HAS03.1-002-NNNN-NN	HAS03.1-004-NNNN-NN	HAS04.1-001-NNNN-NN	HAS04.1-002-NNNN-NN	HAS05.1-001-NNNN-NN	HAS05.1-002-NNNN-NN	HAS05.1-003-NNNN-NN
HMS 01.1N-W0020	50	X															
HMS 01.1N-W0036	50	X															
HMD01.1N-W0012	50		X														
HMD01.1N-W0020	50		X														
HMD01.1N-W0036	75		X														
HMS 01.1N-W0054	75	X															
HMS 01.1N-W0070	100	X															
HMS 01.1N-W0110	125			X													
HMS 01.1N-W0150	150			X				X									
HMS 01.1N-W0210	200			X				X									
HMV01.1E-W0030	150																
HMV01.1E-W0075	250																
HMV01.1E-W0120	350																
HMV01.1R-W0018	175																
HMV01.1R-W0045	250																
HMV01.1R-W0065	350																
HCS02.1E-W0012	65		X						X								
HCS02.1E-W0028	65		X						X		X						
HCS02.1E-W0054	105		X							X	X						
HCS02.1E-W0070	105		X							X	X						
HLB01.1C	65								X								
HLC01.1C	50								X								
HCS03.1E-W0070	125				X									X			
HCS03.1E-W0100	225					X											
HCS03.1E-W0150	225					X											
HCS03.1E-W0210	350								X								
HNK01.1A-...-E0050	125						X										
HNK01.1A-...-E0080	225							X									
HNK01.1A-...-E0106	225							X									
HNK01.1A-...-E0146	350								X								

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Fig. 14-2: Allocation HAS02, HAS03, HAS04, HAS05 accessories

14.2 Basic Accessories HAS01

Accessories for mounting and installation of drive controllers in combination, i.e. next to each other.

Type Code

Abbrev. Column	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0		
Example:	H	A	S	0	1	.	1	-	0	5	0	-	0	7	2	-	M	2																								
1. Product																																										
1.1 Accessories IndraDrive ... = HAS																																										
2. Line																																										
2.1 Basic kit = 01																																										
3. Design																																										
3.1 1 = 1																																										
4. Device width																																										
4.1 50 = 050																																										
4.2 65 = 065																																										
4.3 75 = 075																																										
4.4 100 = 100																																										
4.5 105 = 105																																										
4.6 125 = 125																																										
4.7 150 = 150																																										
4.8 175 = 175																																										
4.9 200 = 200																																										
4.10 225 = 225																																										
4.11 250 = 250																																										
4.12 350 = 350																																										
5. Bus-bar																																										
5.1 with cross-sectional area 48 mm ² = 048																																										
5.2 with cross-sectional area 72 mm ² = 072																																										
5.3 without = NNN ①																																										
6. Other design																																										
6.1 Compact units = CN																																										
6.2 Compact unit, HCS04.1E-x500 = CA																																										
6.3 Modular units in line "02" = M2																																										
6.4 Modular units = MN																																										
6.5 none = NN																																										
Note:																																										
① only for device width of "065", "105", "125", "150", "175", "225", "250" and "350"																																										

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Fig. 14-3: Type code HAS01.1

As adjusted to the device widths, the basic accessories are supplied with or without contact bars.

HAS01 **without** contact bars and HAS01 **with** contact bars.

- Example 1: **Without** contact bars (-NNN).
- Example 2: **With** contact bars to interconnect the DC buses (e.g. -048 or -072); the bars are adjusted to the device width.
- Example 3: **With** contact bars to interconnect the DC buses (e.g. -048 or -072); the bars are adjusted to the device width. In addition, the joint bars for connecting the equipment grounding conductors are contained in this case.

Note: Please observe that the contact bars of the basic accessories HAS01 are used for connection to the drive controller to the **left** side.

Applications

The HAS01 accessories are used to

- fasten the drive controllers on a mounting surface,
- interconnect the DC bus connections of drive controllers,
- connect the 24V supply of drive controllers of the Rexroth IndraDrive M range,
- establish the connection of the equipment grounding conductors from drive controller to drive controller or supply module,
- increase the current carrying capacity of the contact bars in the DC bus.

Scope of Supply

The basic accessories HAS01 **with** contact bars is contained in the standard scope of supply of the HMS and HMD drive controllers.

The basic accessories HAS01 **without** contact bars is contained in the standard scope of supply of the HCS02 drive controllers.


<p>Made in Germany 109-1253-4801-05</p> <p style="text-align: right;">Rexroth Bosch Group</p> <h2 style="text-align: center;">HAS01.1-050-072-MN</h2> <p style="text-align: center;">R911306620</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 5%;">Stck</th> <th style="width: 85%;">Benennung</th> <th style="width: 10%;">MNR</th> </tr> </thead> <tbody> <tr> <td>12</td> <td>SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41</td> <td>R911276873</td> </tr> <tr> <td>2</td> <td>SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*</td> <td>R911294165</td> </tr> <tr> <td>1</td> <td>SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30</td> <td>R911309089</td> </tr> <tr> <td>4</td> <td>SCHIENE-VERBINDUNG HAS01.1-050-072 ISOL.</td> <td>R911309945</td> </tr> <tr> <td>2</td> <td>SCHIENE-VERBINDUNG HAS01.1-032-042</td> <td>R911311751</td> </tr> <tr> <td>1</td> <td>LASCHE HMD/HMS01.1 ERDUNG</td> <td>R911294924</td> </tr> <tr> <td>5</td> <td>KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****</td> <td>R911222614</td> </tr> </tbody> </table>	Stck	Benennung	MNR	12	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873	2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165	1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089	4	SCHIENE-VERBINDUNG HAS01.1-050-072 ISOL.	R911309945	2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751	1	LASCHE HMD/HMS01.1 ERDUNG	R911294924	5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614	<p style="text-align: center;">BEIPACKZETTEL HAS01.1-050-072-MN</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 5%;">Stck</th> <th style="width: 85%;">Benennung</th> <th style="width: 10%;">MNR</th> </tr> </thead> <tbody> <tr> <td>5</td> <td>KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****</td> <td>R911222614</td> </tr> <tr> <td>1</td> <td>LASCHE HMD/HMS01.1 ERDUNG</td> <td>R911294924</td> </tr> <tr> <td>2</td> <td>SCHIENE-VERBINDUNG HAS01.1-032-042</td> <td>R911311751</td> </tr> <tr> <td>4</td> <td>SCHIENE-VERBINDUNG HAS01.1-050-072 ISOL.</td> <td>R911309945</td> </tr> <tr> <td>1</td> <td>SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30</td> <td>R911309089</td> </tr> <tr> <td>2</td> <td>SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*</td> <td>R911294165</td> </tr> <tr> <td>12</td> <td>SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41</td> <td>R911276873</td> </tr> </tbody> </table> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <td style="width: 20%;">Datum</td> <td style="width: 20%;">2004-02-20</td> <td style="width: 60%;">Benennung</td> </tr> <tr> <td>Name</td> <td>Hirt</td> <td>BEIPACKZETTEL HAS01.1-050-072-MN</td> </tr> <tr> <td>Material-Nr.</td> <td>R911306606</td> <td>Zeich-Nr. 109-1253-4201-06</td> </tr> <tr> <td>Datei</td> <td>DB166239</td> <td>Erskurch .. AEM-Nr. 5-017509</td> </tr> </table>	Stck	Benennung	MNR	5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614	1	LASCHE HMD/HMS01.1 ERDUNG	R911294924	2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751	4	SCHIENE-VERBINDUNG HAS01.1-050-072 ISOL.	R911309945	1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089	2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165	12	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873	Datum	2004-02-20	Benennung	Name	Hirt	BEIPACKZETTEL HAS01.1-050-072-MN	Material-Nr.	R911306606	Zeich-Nr. 109-1253-4201-06	Datei	DB166239	Erskurch .. AEM-Nr. 5-017509
Stck	Benennung	MNR																																																											
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2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165																																																											
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2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751																																																											
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924																																																											
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614																																																											
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4	SCHIENE-VERBINDUNG HAS01.1-050-072 ISOL.	R911309945																																																											
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089																																																											
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165																																																											
12	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873																																																											
Datum	2004-02-20	Benennung																																																											
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Material-Nr.	R911306606	Zeich-Nr. 109-1253-4201-06																																																											
Datei	DB166239	Erskurch .. AEM-Nr. 5-017509																																																											

Fig. 14-4: Accompanying note

Made in Germany
109-1253-4802-05

**Rexroth
Bosch Group**







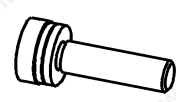
HAS01.1-075-072-MN



R911306619

12	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-075-072 ISOL.	R911309946
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR

BEIPACKZETTEL HAS01.1-075-072-MN

Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
DB14853		1:4
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
DB13923		1:2
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
DB14445		1:2
4	SCHIENE-VERBINDUNG HAS01.1-075-072 ISOL.	R911309946
DB166231		1:2
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
DB17505		2:5
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
DB-40060		1:1
12	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
DB-54729		1:1


Datum	2004-02-20	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-075-072-MN
Material-Nr.	R911306607	Zeich-Nr. 109-1253-4202-06
Datei	DB166241	Ers.durch .. AEM-Nr. 5-017509

Fig. 14-5: Accompanying note

Made in Germany
109-1253-4803-05

Rexroth
Bosch Group







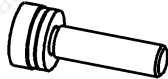
HAS01.1-100-072-MN



R911306621

14	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-100-072 ISOL.	R911309947
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR

BEIPACKZETTEL HAS01.1-100-072-MN

Stck	Benennung	MNR
DB16855		1:4
DB13903		1:2
DB18465		1:2
DB16623		1:2
DB17510		2:5
DB-40060		1:1
DB-54729		1:1


Datum	2004-02-20	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-100-072-MN
Material-Nr.	R911306608	Zeich-Nr. 109-1253-4203-06
Datei	DB166243	Ers.durch .. AEM-Nr. 5-017509

Fig. 14-6: Accompanying note

Made in Germany
109-1253-4804-05

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Bosch Group







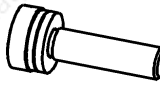
HAS01.1-150-072-MN



R911306622

17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-150-072 ISOL.	R911309949
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR


BEIPACKZETTEL HAS01.1-150-072-MN

Stck	Benennung	MNR
DB16855		1:4
DB13903		1:2
DB18465		1:2
DB16623		1:2
DB175105		2:5
DB-40060		1:1
DB-54729		1:1


Datum	2004-02-20	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-150-072-MN
Material-Nr.	R911306614	Zeich-Nr. 109-1253-4204-06
Datei	DB166245	Ers.durch .. AEM-Nr. 5-017509

Fig. 14-7: Accompanying note

Made in Germany
109-1253-4809-02

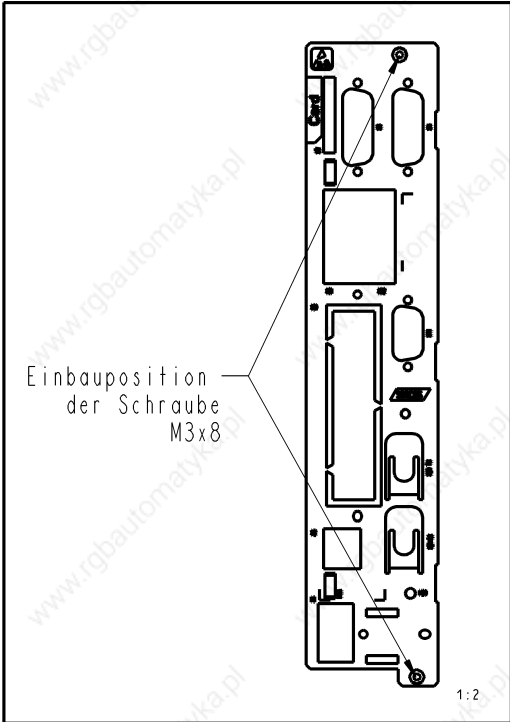


HAS01.1-150-NNN-MN








R911306629

2	WERKZ-BETAETIGUNG STECK-FK RMS,00	R911295969
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z4I	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR



1:2

BEIPACKZETTEL HAS01.1-150-NNN-MN		
Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
DB16635		1:4
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
DB115105		2:5
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
DB-40060		1:1
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z4I	R911276873
DB-34729		1:1
2	WERKZ-BETAETIGUNG STECK-FK RMS,00	R911295969
DB174739		1:1


Datum	2004-02-20	Benennung	BEIPACKZETTEL HAS01.1-150-NNN-MN
Name	Hirt		
Material-Nr.	R911306635	Zeich-Nr.	109-1253-4217-02
Datei	DB166332	Ers.durch	..
			AEM-Nr. 5-010883

Fig. 14-8: Accompanying note

Made in Germany
109-1253-4805-05

Rexroth
Bosch Group







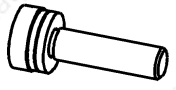
HAS01.1-175-072-MN



R911306623

17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-175-072 ISOL.	R911309950
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR


BEIPACKZETTEL HAS01.1-175-072-MN

Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
DB16855		1:4
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
DB13903		1:2
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
DB18465		1:2
4	SCHIENE-VERBINDUNG HAS01.1-175-072 ISOL.	R911309950
DB166234		7:20
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
DB175105		2:5
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
DB-40060		1:1
17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
DB-54729		1:1


Datum	2004-02-20	Benennung	BEIPACKZETTEL HAS01.1-175-072-MN
Name	Hirt	Material-Nr.	R911306615
Material-Nr.	R911306615	Zeich-Nr.	109-1253-4205-06
Datei	DB166274	Ers.durch	..
		AEM-Nr.	5-017509

Fig. 14-9: Accompanying note

Made in Germany
109-1253-4810-02

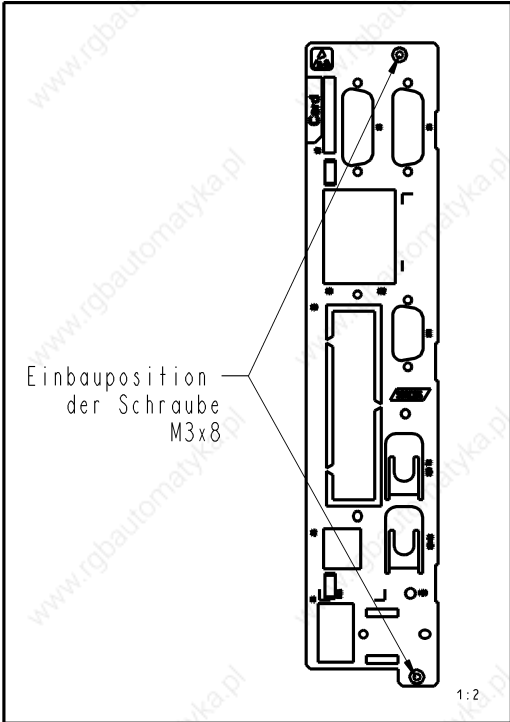


HAS01.1-175-NNN-MN



R911306630

2	WERKZ-BETAETIGUNG STECK-FK RMS,00	R911295969
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z4I	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR



1:2

BEIPACKZETTEL HAS01.1-175-NNN-MN		
Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z4I	R911276873
2	WERKZ-BETAETIGUNG STECK-FK RMS,00	R911295969


Datum	2004-02-20	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-175-NNN-MN
Material-Nr.	R911306636	Zeich-Nr. 109-1253-4218-02
Datei	DB166319	Ers.durch .. AEM-Nr. 5-010883

Fig. 14-10: Accompanying note

Made in Germany
109-1253-4806-05

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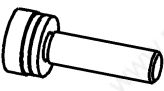
HAS01.1-200-072-MN





R911306624

17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-200-072 ISOL.	R911309951
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
Stck	Benennung	MNR

BEIPACKZETTEL HAS01.1-200-072-MN

Stck	Benennung	MNR
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
		
		1:2
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
		
		1:2
4	SCHIENE-VERBINDUNG HAS01.1-200-072 ISOL.	R911309951
		
		7:20
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
		
		2:5
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
		
		1:1
17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
		
		1:1

BEIPACKZETTEL HAS01.1-200-072-MN		
Stck	Benennung	MNR
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
		
		1:2
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
		
		1:4


Datum	2004-02-20	Benennung	BEIPACKZETTEL HAS01.1-200-072-MN	
Name	Hirt	Material-Nr.	R911306616	Zeich-Nr. 109-1253-4206-06
Datei	DB16624T	Ers.durch	..	AEM-Nr. 5-017509

Fig. 14-11: Accompanying note

Made in Germany
109-1253-4807-05

Rexroth
Bosch Group







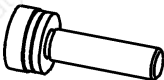
HAS01.1-250-072-MN



R911306625

17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-250-072 ISOL.	R911309953
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR

BEIPACKZETTEL HAS01.1-250-072-MN

Stck	Benennung	MNR
5 DB16855		R911222614 1:4
1 DB139203		R911294924 1:2
2 DB18465		R911311751 1:2
4 DB166236		R911309953 1:4
1 DB175105		R911309089 2:5
2 DB-40060		R911294165 1:1
17 DB-54729		R911276873 1:1


Datum	2004-02-20	Benennung	BEIPACKZETTEL HAS01.1-250-072-MN
Name	Hirt	Material-Nr.	R911306617
Material-Nr.	R911306617	Zeich-Nr.	109-1253-4207-06
Datei	DB166276	Ers.durch	..
		AEM-Nr.	5-017509

Fig. 14-12: Accompanying note


DOK-INDRV*-SYSTEM*****-PR03-EN-P

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Bosch Group

Made in Germany
109-1253-4811-02

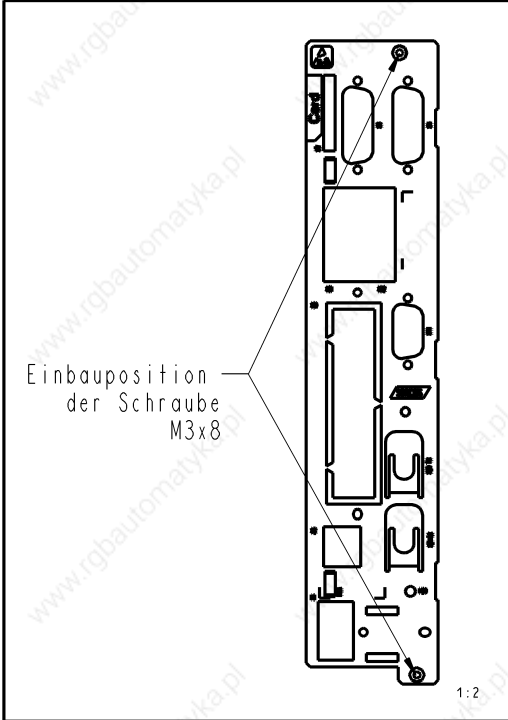


HAS01.1-250-NNN-MN



R911306631

2	WERKZ-BETAETIGUNG STECK-FK RMS,00	R911295969
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR



Einbauposition
der Schraube
M3x8

1:2

BEIPACKZETTEL HAS01.1-250-NNN-MN

Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	WERKZ-BETAETIGUNG STECK-FK RMS,00	R911295969


Datum	2004-02-20	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-250-NNN-MN
Material-Nr.	R911306637	Zeich-Nr. 109-1253-4219-02
Datei	DB166334	Ers.durch .. AEM-Nr. 5-010883

Fig. 14-13: Accompanying note

Made in Germany
109-1253-4808-06

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HAS01.1-350-072-MN



R911306626

Stck	Benennung	MN
4	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-350-072 ISOL.	R911309954
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
4	SCHIEBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
4	FEDERRING DIN127-B10-FST &	R911213251
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982

BEIPACKZETTEL HAS01.1-350-072-MN

Stck	Benennung	MN
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
4	SCHIEBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
4	SCHIENE-VERBINDUNG HAS01.1-350-072 ISOL.	R911309954
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
4	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050

Stck	Benennung	MN
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
4	FEDERRING DIN127-B10-FST &	R911213251
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614


Datum	Benennung	
2004-02-23	BEIPACKZETTEL HAS01.1-350-072-MN	
Name	Hirt	
Material-Nr.	R.911306618	Zeich-Nr. 109-1253-4208-07
Datei	DB166280	Ers.durch .. AEM-Nr. 5-017509

Fig. 14-14: Accompanying note

Made in Germany
109-1253-4812-05

Rexroth
Bosch Group







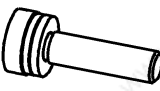

HAS01.1-350-NNN-MN



R911306632

4	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
15	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHEIBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
4	FEDERRING DIN127-B10-FST &	R911213251
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
Stck	Benennung	MN

BEIPACKZETTEL HAS01.1-350-NNN-MN

Stck	Benennung	MN
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
		1:2
4	FEDERRING DIN127-B10-FST &	R911213251
		1:1
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
		1:4
4	SCHEIBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
		1:1
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
		1:4
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
		1:1
15	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
		1:1
4	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
		1:2


Datum	2004-02-24	Benennung	BEIPACKZETTEL HAS01.1-350-NNN-MN
Name	Hirt	Material-Nr.	R911306633
Material-Nr.	R911306633	Zeich-Nr.	109-1253-4220-05
Datei	DB166325	Ers.durch	..
		AEM-Nr.	5-017509

Fig. 14-15: Accompanying note

Made in Germany
109-1253-4827-00

Rexroth
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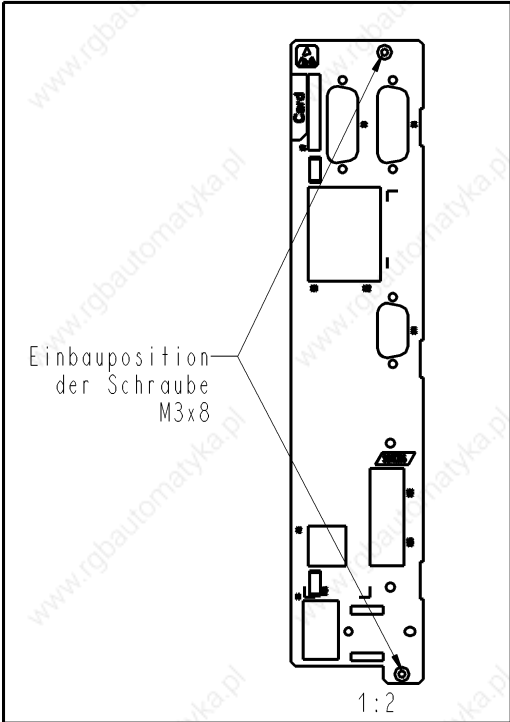
HAS01.1-065-072-CN



R911311807

6	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHIENE-VERBINDUNG HAS01.1-065-072 ISOL.	R911311806
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614






Stck	Benennung	MNR
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Einbauposition
der Schraube
M3x8

1:2

BEIPACKZETTEL HAS01.1-065-072-CN

Stck	Benennung	MNR
5 DB14855		R911222614 1:4
2 DB18734		R911311806 1:2
1 DB17505		R911309089 2:5
2 DB-40060		R911294165 1:1
6 DB-34729		R911276873 1:2


Datum	2005-06-01	Benennung
Name	rainhirt	BEIPACKZETTEL HAS01.1-065-072-CN
Material-Nr.	R911311810	Zeich-Nr. 109-1253-4265-00
Datei	DB187295	Ers.durch .. AEM-Nr. 5-017033

Fig. 14-16: Accompanying note

Made in Germany
109-1253-4828-00

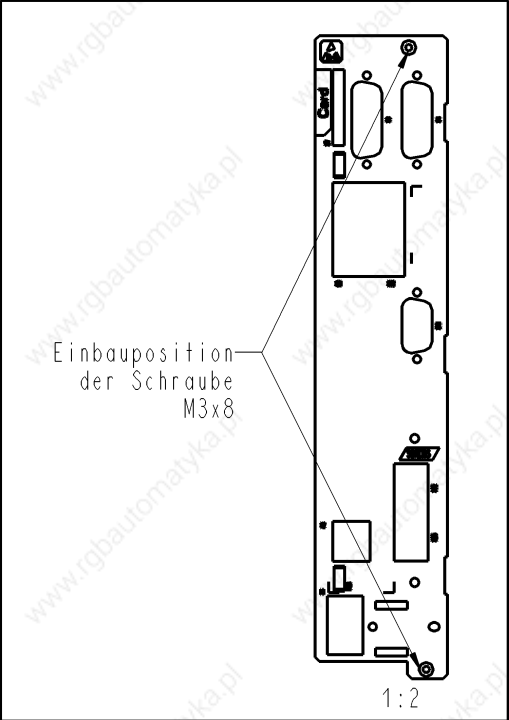
Rexroth
Bosch Group

HAS01.1-105-072-CN



R 911 311 808





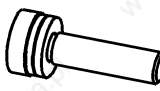
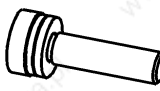
8	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHIENE-VERBINDUNG HAS01.1-105-072 ISOL.	R911311805
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR



Einbauposition
der Schraube
M3x8

1:2


BEIPACKZETTEL HAS01.1-105-072-CN

Stck	Benennung	MNR
5 DB176855		R911222614 1:4
2 DB187355		R911311805 1:2
1 DB175105		R911309089 2:5
2		SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML* R911294165 1:1
8 DB-40060		SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41 R911276873 1:1
DB-54729		1:1


Datum	2005-06-01	Benennung
Name	rainhirt	BEIPACKZETTEL HAS01.1-105-072-CN
Material-Nr.	R911311812	Zeich-Nr. 109-1253-4266-00
Datei	DB18729T	Ers.durch .. AEM-Nr. 5-017033

Fig. 14-17: Accompanying note

Made in Germany
109-1228-4812-02

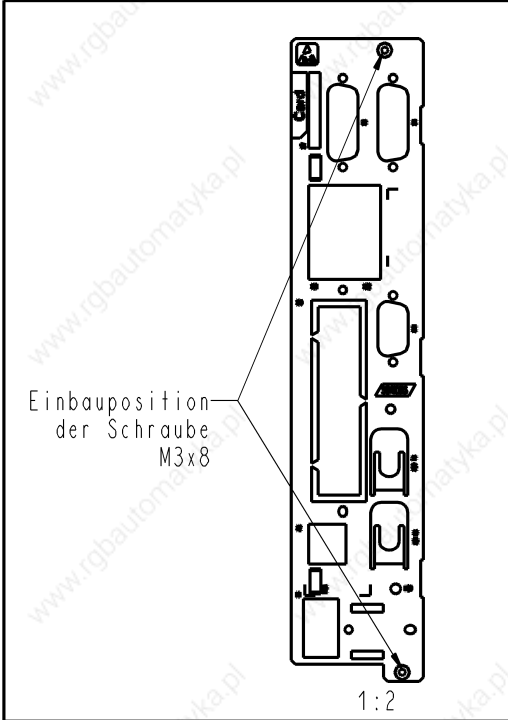


HAS01.1-065-NNN-CN



R911306007

2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970
2	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR



Einbauposition
der Schraube
M3x8


1:2

BEIPACKZETTEL HAS01.1-065-NNN-CN		
Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
2	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970


Datum	2004-01-29	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-065-NNN-CN
Material-Nr.	R911306096	Zeich-Nr. 109-1228-4230-03
Datei	DB165225	Ers.durch .. AEM-Nr. 5-010883

Fig. 14-18: Accompanying note

Made in Germany
109-1229-4813-02

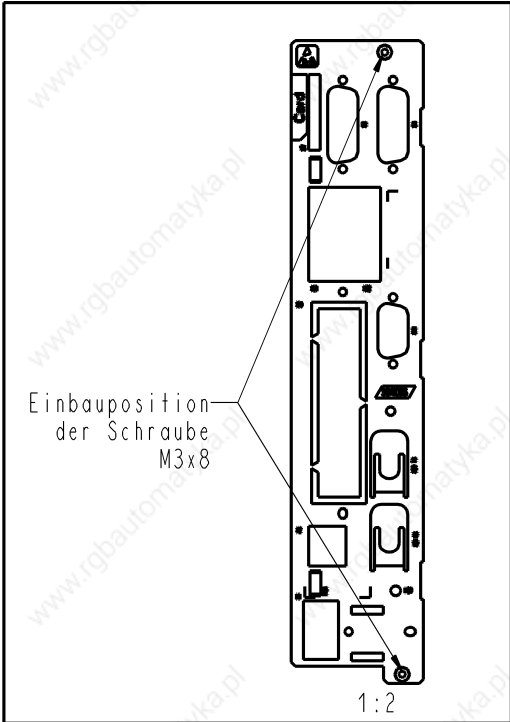


HAS01.1-105-NNN-CN








R911306008

2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970
4	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR



1:2

BEIPACKZETTEL HAS01.1-105-NNN-CN

Stck	Benennung	MNR
5 DB16853		R911222614 1:4
1 DB115105		R911309089 2:5
2 DB-40060		R911294165 1:1
4 DB-34729		R911276873 1:2
2 DB174743		R911295970 1:1


Datum	2004-01-29	Benennung
Name	Hirt	BEIPACKZETTEL HAS01.1-105-NNN-CN
Material-Nr.	R911306098	Zeich-Nr. 109-1229-4224-03
Datei	DB165229	Ers.durch .. AEM-Nr. 5-010883

Fig. 14-19: Accompanying note

Made in Germany
109-1253-4813-04

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Bosch Group




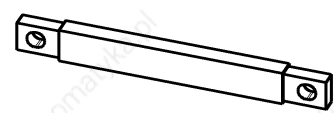


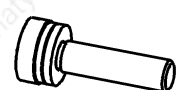
HAS01.1-125-072-CN



R911306664

15	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-125-072 ISOL.	R911309948
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR


BEIPACKZETTEL HAS01.1-125-072-CN

Stck	Benennung	MNR
DB16855		1:4
DB13903		1:2
DB18465		1:2
DB166341		1:2
DB175105		2:5
DB-40060		1:1
DB-54729		1:1


Datum	2004-02-26	Benennung
Name	Hirt / Steven	BEIPACKZETTEL HAS01.1-125-072-CN
Material-Nr.	R911306672	Zeich-Nr. 109-1253-4223-05
Datei	DB166375	Ers.durch .. AEM-Nr. 5-017509

Fig. 14-20: Accompanying note

Made in Germany
109-1253-4814-01

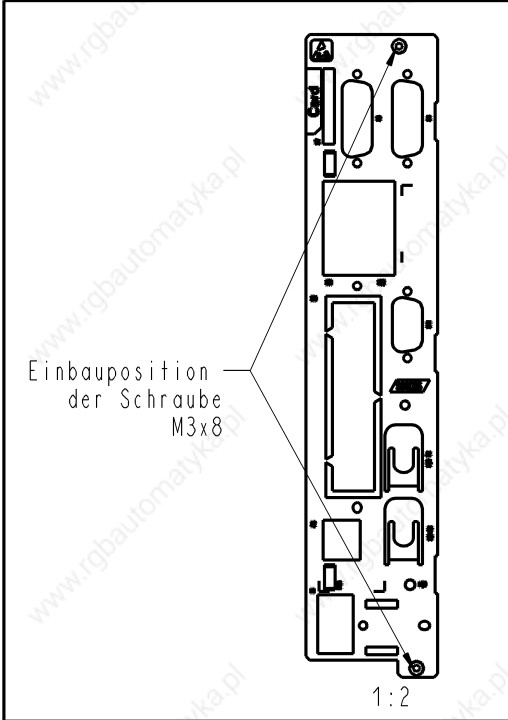


HAS01.1-125-NNN-CN



R911306665

2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970
11	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR	R911299476
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-****	R911222614
Stck	Benennung	MNR



Einbauposition
der Schraube
M3x8

1:2

BEIPACKZETTEL HAS01.1-125-NNN-CN		
Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-****	R911222614
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR	R911299476
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
11	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970


Datum	2004-02-26	Benennung
Name	Hirt / Steven	BEIPACKZETTEL HAS01.1-125-NNN-CN
Material-Nr.	R911306674	Zeich-Nr. 109-1253-4224-01
Datei	DB166377	Ers.durch .. AEM-Nr. 5-07273

Fig. 14-21: Accompanying note

Made in Germany
109-1253-4815-04

**Rexroth
Bosch Group**







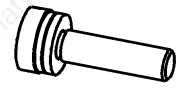
HAS01.1-225-072-CN



R911306666

21	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-225-072 ISOL.	R911309952
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
Stck	Benennung	MNR


BEIPACKZETTEL HAS01.1-225-072-CN

Stck	Benennung	MNR
5 DB16855		R911222614 1:4
1 DB139203		R911294924 1:2
2 DB18465		R911311751 1:2
4 DB166342		R911309952 1:4
1 DB175105		R911309089 2:5
2 DB-40060		R911294165 1:1
21 DB-54729		R911276873 1:1


Datum	2004-02-26	Benennung	BEIPACKZETTEL HAS01.1-225-072-CN
Name	Hirt / Steven	Material-Nr.	R911306675
Material-Nr.	R911306675	Zeich-Nr.	109-1253-4225-05
Datei	DB166379	Ers.durch	..
		AEM-Nr.	5-017509

Fig. 14-22: Accompanying note

Made in Germany
109-1253-4816-01

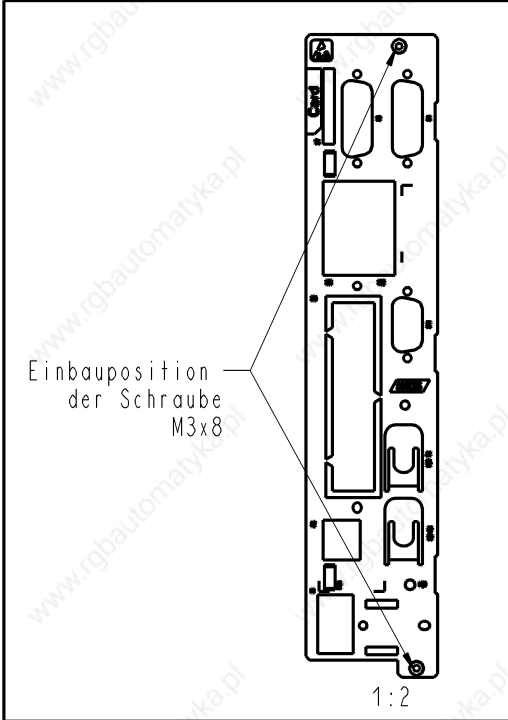


HAS01.1-225-NNN-CN



R911306667

2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970
17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z4I	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR	R911299476
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-****	R911222614
Stck	Benennung	MNR



1:2

BEIPACKZETTEL HAS01.1-225-NNN-CN		
Stck	Benennung	MNR
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-****	R911222614
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR	R911299476
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
17	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z4I	R911276873
2	WERKZ-BETAETIGUNG STECK-FK RM3,50	R911295970
1	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR	R911299476


Datum	2004-02-26	Benennung
Name	Hirt / Steven	BEIPACKZETTEL HAS01.1-225-NNN-CN
Material-Nr.	R911306677	Zeich-Nr. 109-1253-4226-01
Datei	DB166381	Ers.durch .. AEM-Nr. 5-07273

Fig. 14-23: Accompanying note

Made in Germany
109-1253-4817-06

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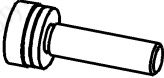


HAS01.1-350-072-CN



R911306668

1	SECHSKANTSCHRAUBE ISO4017-M8X25-8.8 &	R911292421
6	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
15	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
4	SCHIENE-VERBINDUNG HAS01.1-350-072 ISOL.	R911309954
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
6	SCHEIBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
1	LASCHE HCS03.1E-W0210 ERDUNG	R911025419
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
6	FEDERRING DIN127-B10-FST &	R911213251
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
Stck	Benennung	MN

BEIPACKZETTEL HAS01.1-350-072-CN

Stck	Benennung	MN
1	LASCHE HMD/HMS01.1 ERDUNG	R911294924
		1:2
6	SCHEIBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
		1:2
2	SCHIENE-VERBINDUNG HAS01.1-032-042	R911311751
		1:2
4	SCHIENE-VERBINDUNG HAS01.1-350-072 ISOL.	R911309954
		1:5
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
		1:4
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
		1:1
15	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
		1:1
6	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
		1:2
1	SECHSKANTSCHRAUBE ISO4017-M8X25-8.8 &	R911292421
		1:2

Datum	2004-02-28	Benennung	BEIPACKZETTEL HAS01.1-350-072-CN
Name	Hirt / Steven	Material-Nr.	R911306678
Material-Nr.	R911306678	Zeich-Nr.	109-1253-4227-07
Datei	DB16638T	Ers.durch	..
		AEM-Nr.	5-017509

BEIPACKZETTEL HAS01.1-350-072-CN






Stck	Benennung	MN
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
		1:2
6	FEDERRING DIN127-B10-FST &	R911213251
		1:1
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
		1:4
1	LASCHE HCS03.1E-W0210 ERDUNG	R911025419
		1:4

Fig. 14-24: Accompanying note

Made in Germany
109-1253-4818-06

Rexroth
Bosch Group





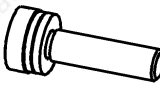


HAS01.1-350-NNN-CN



R 911 306 669

1	SECHSKANTSCHRAUBE ISO4017-M8X25-8.8 &	R911292421
6	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
6	SCHEIBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
1	LASCHE HCS03.1E-W0210 ERDUNG	R911025419
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
6	FEDERRING DIN127-B10-FST &	R911213251
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
Stck	Benennung	MN

BEIPACKZETTEL HAS01.1-350-NNN-CN

Stck	Benennung	MN
1	LASCHE HCS03.1E-W0210 ERDUNG	R911025419
		
1:4		
6	SCHEIBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
		
1:1		
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
		
1:4		
2	SCHR-LIN-M 3,0X 8,0-T-8.8-ISO7045-ZN-ML*	R911294165
		
1:1		
13	SCHR-LIN-M 6,0X25,0-K-8.8-ISO7045-ZN-Z41	R911276873
		
1:1		
6	SECHSKANTSCHRAUBE ISO4017-M10X30-8.8A1E	R913000050
		
1:2		
1	SECHSKANTSCHRAUBE ISO4017-M8X25-8.8 &	R911292421
		
1:2		

Datum	2004-02-26	Benennung	
Name	Hirt / Steven	BEIPACKZETTEL HAS01.1-350-NNN-CN	
Material-Nr.	R 911 306 669	Zeich-Nr.	109-1253-4228-07
Datei	DB166390	Ers.durch	..
		AEM-Nr.	5-017509





BEIPACKZETTEL HAS01.1-350-NNN-CN		
Stck	Benennung	MN
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
		
1:2		
6	FEDERRING DIN127-B10-FST &	R911213251
		
1:1		
5	KAB-BIND-D045-B4,8-C085-N220-TR-PA-*****	R911222614
		
1:4		

Fig. 14-25: Accompanying note

Made in Germany
109-1253-4849-00

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Bosch Group

HAS01.1-350-NNN-CA



R911315683

Stck	Benennung	MN
9	SECHSKANTSCHRAUBE ISO4017-M10X30-8-8A1E	R913000050
9	SECHSKANTMUTTER ISO4032-M10-8-E0P	R911213275
16	SCHR-LIN-M 6,0X25,0-K-8-8-ISO7045-ZN-Z41	R911276873
2	SCHR-LIN-M 3,0X 8,0-T-8-8-ISO7045-ZN-ML*	R911294165
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
9	SCHETBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
5	KAB-BIND-DO45-B4,8-C085-N220-TR-PA-*****	R911222614
9	FEDERRING DIN127-B10-FST &	R911213251
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982

BEIPACKZETTEL HAS01.1-350-NNN-CA

Stck	Benennung	MN
9	SCHETBE 10,50X 20,00X 2,00 DIN 125 A	R911213277
1	SCHILD-KLEBE UL-CSA WARNHINWEIS EN/FR 30	R911309089
2	SCHR-LIN-M 3,0X 8,0-T-8-8-ISO7045-ZN-ML*	R911294165
16	SCHR-LIN-M 6,0X25,0-K-8-8-ISO7045-ZN-Z41	R911276873
9	SECHSKANTMUTTER ISO4032-M10-8-E0P	R911213275
9	SECHSKANTSCHRAUBE ISO4017-M10X30-8-8A1E	R913000050

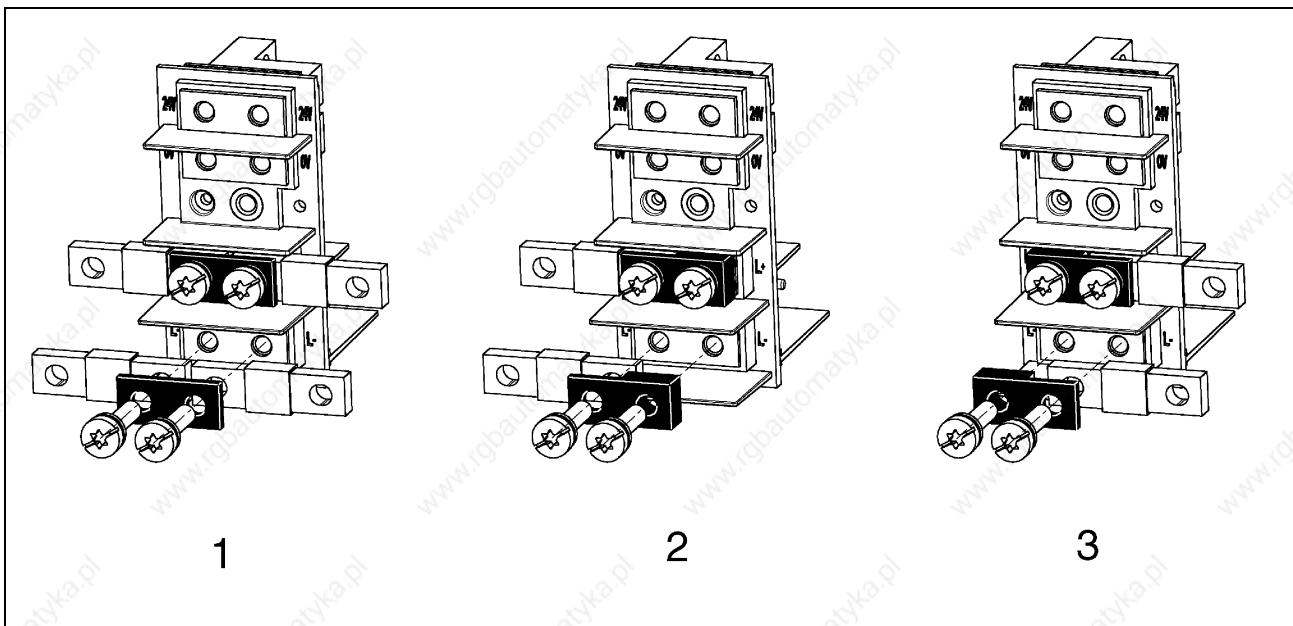
Stck	Benennung	MN
2	ENDSTUECK HAS01.1 SCHIENE-VERBINDUNG	R911311982
9	FEDERRING DIN127-B10-FST &	R911213251
5	KAB-BIND-DO45-B4,8-C085-N220-TR-PA-*****	R911222614

Datum	2006-01-17	Benennung	BEIPACKZETTEL HAS01.1-350-NNN-CA
Name	sonjrazz	Material-Nr.	R911315811
Material-Nr.	R911315811	Zeich-Nr.	109-1253-4283-00
Datei	08195173	Ers.durch	...
		AEM-Nr.	...

Abb. 14-26: Accompanying note

Mounting the Parts "Bar" and "End Piece" from the HAS01 Accessories

The parts "bar" and "end piece" increase the current carrying capacity of the DC bus connection by reducing the involved contact resistances.



- 1: bar
 2: end pieces (right end)
 3: end pieces (left end)

Fig. 14-27: Mounting bar and end piece from HAS01

- Ad 1: Use the bars contained in all HAS01.1-***-072-** at L+ and L- as illustrated above.
- Ad 2 and 3: Use the end pieces contained in all HAS01.1-350-***-** and HAS01.1-200-***-** at the right and left ends of the DC bus connections in the drive system.

14.3 Shield Connection HAS02

Accessories for appropriate connection of the motor cable to the drive controller, especially the shield connection of the motor cable.

There are appropriate HAS02 available for the different connection cross sections of the drive controllers.

Type Code

Abbrev. Column	1									2									3									4												
→	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
Example:	H	A	S	0	2	.	1	-	0	0	1	-	N	N	N	-	N	N																						

1. Product	
1.1 Accessories IndraDrive ... = HAS	
2. Line	
2.1 Shield connection. ... = 02	
3. Design	
3.1 1 = 1	
4. Device assignment	
4.1 HMS01.1N-W0020 = 001	
4.2 HMS01.1N-W0036 = 001	
4.3 HMS01.1N-W0054 = 002	
4.4 HMS01.1N-W0070 = 002	
4.5 HMD01.1N-W0020 = 002	
4.6 HMD01.1N-W0036 = 002	
4.7 HCS02.1E-W0012 = 002	
4.8 HCS02.1E-W0028 = 002	
4.9 HCS02.1E-W0054 = 002	
4.10 HCS02.1E-W0070 = 002	
4.11 HMS01.1N-W0150 = 003	
4.12 HMS01.1N-W0210 = 003	
4.13 HCS03.1E-W0070 = 004	
4.14 HCS03.1E-W0100 = 005	
4.15 HCS03.1E-W0150 = 005	
4.16 HNK01.1A-A075-E0050 = 006	
4.17 HNK01.1A-A075-E0080 = 007	
4.18 HNK01.1A-A075-E0106 = 007	
4.19 HCS03.1E-W0210 = 008	
4.20 HNK01.1A-A075-E0146 = 009	
4.21 HMS02.1N-W0028 = 010	
4.22 HMS02.1N-W0054 = 011	
4.23 HCS04.1E-X0500 = 012	
5. Other feature	
5.1 none = NNN	
6. Other design	
6.1 none = NN	

DT000004v01_en.fh

Fig. 14-28: Type code HAS02.1

Applications


The HAS02 accessories are used to

- provide the motor connection cables with a strain relief,
- connect the shield of the motor connection cables to the drive controller.


Scope of Supply

The HAS02 accessories are available as an option, they are not part of the standard scope of supply.

Made in Germany
109-1214-4805-02








HAS02.1-001-NNN-NN



R911306330

2	SCHR-LIN-M 6,0X12,0-K-8.8-1S07045-ZN-Z41	R911252551
1	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
1	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471
1	HALTERUNG HMS01.1 KABELD. 12-30	R911306336
1	BLECH HCS02.1 KABELBEFESTIGUNG	R911305851
Stck	Benennung	MN

BEIPACKZETTEL HAS02.1-001-NNN-NN

Stck	Benennung	MN
1 DB163070	BLECH HCS02.1 KABELBEFESTIGUNG 	R911305851 1:5
1 DB164826	HALTERUNG HMS01.1 KABELD. 12-30 	R911306336 7:20
1 DB_46879	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017 	R911274471 1:2
1 DB_46868	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017 	R911274472 1:2
2 DB_38105	SCHR-LIN-M 6,0X12,0-K-8.8-1S07045-ZN-Z41 	R911252551 1:1

Datum	2004-02-03	Benennung	BEIPACKZETTEL HAS02.1-001-NNN-NN
Name	Hirt	Material-Nr.	R911306332
Material-Nr.	R911306332	Zeich-Nr.	109-1214-4213-02
Datei	DB165406	Ers.durch	..
		ABM-Nr.	5-07273

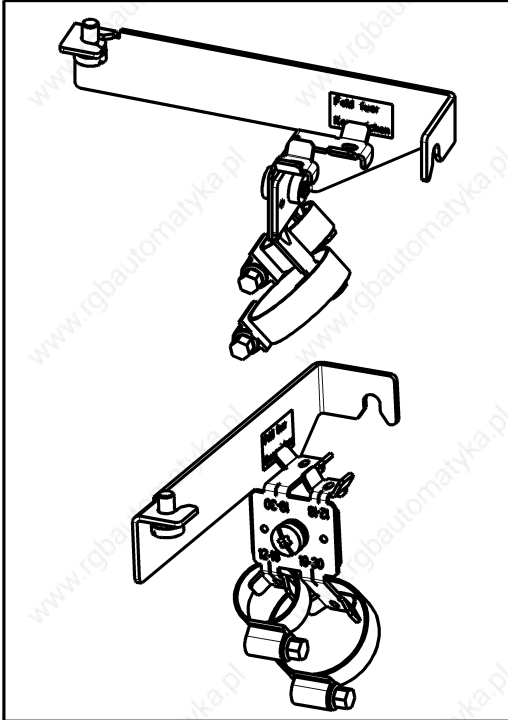




Fig. 14-29: Accompanying note

Made in Germany
109-1228-4815-02







HAS02.1-002-NNN-NN

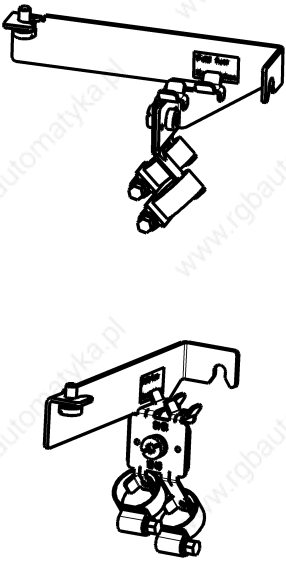


R911306106

2	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551
2	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471
1	HALTERUNG HCS02.1 KABELD. 12-18	R911305852
1	BLECH HCS02.1 KABELBEFESTIGUNG	R911305851
Stck	Benennung	MN

BEIPACKZETTEL HAS02.1-002-NNN-NN


Stck	Benennung	MN
1 DB163070	BLECH HCS02.1 KABELBEFESTIGUNG 	R911305851 1:5
1 DB163246	HALTERUNG HCS02.1 KABELD. 12-18 	R911305852 7:20
2 DB_46879	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017 	R911274471 1:2
2 DB_38405	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41 	R911252551 1:1




Datum	2004-01-30	Benennung	
Name	Born	BEIPACKZETTEL HAS02.1-002-NNN-NN	
Material-Nr.	R911306107	Zeich-Nr.	109-1228-4231-02
Datei	DB165311	Ers.durch	..
		ABM-Nr.	5-07273

Fig. 14-30: Accompanying note

Made in Germany
109-1217-4816-02









HAS02.1-003-NNN-NN

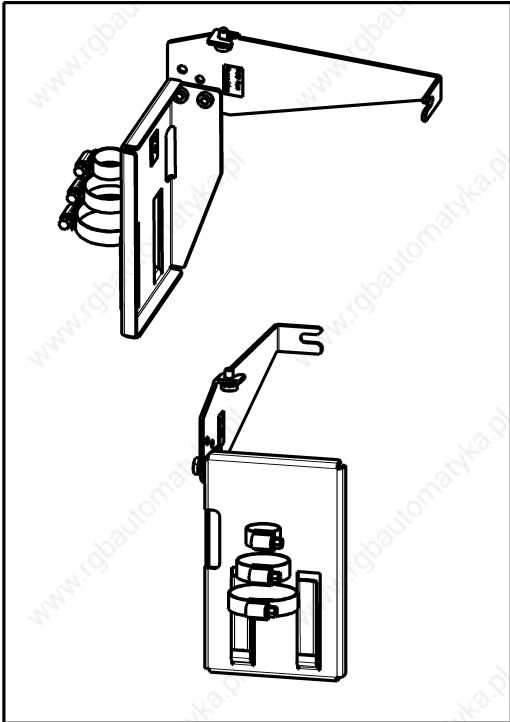


R 911306331

1	WINKEL HMS01.1-W0210 ABSCHIRMANSCHLUSS	R911305950
3	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551
1	SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565
1	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
1	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471
1	BLECH HMS01.1-W0210 ABSCHIRMANSCHLUSS	R911305940
Stck	Benennung	MN

BEIPACKZETTEL HAS02.1-003-NNN-NN


Stck	Benennung	MN
1 DB16405	 BLECH HMS01.1-W0210 ABSCHIRMANSCHLUSS	R911305940 1:4
1 DB_46879	 SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471 1:2
1 DB_46866	 SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472 1:2
1 DB168743	 SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565 2:5
3 DB_38405	 SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551 1:1
1 DB164163	 WINKEL HMS01.1-W0210 ABSCHIRMANSCHLUSS	R911305950 1:5




Datum	2004-02-03	Benennung	BEIPACKZETTEL HAS02.1-003-NNN-NN
Name	Koblinger	Material-Nr.	R 911306333
Zeich-Nr.	109-1217-4262-02	Datei	DB164151
Ers.durch	..	ABM-Nr.	5-07273

Fig. 14-31: Accompanying note

Made in Germany
109-1253-4819-01

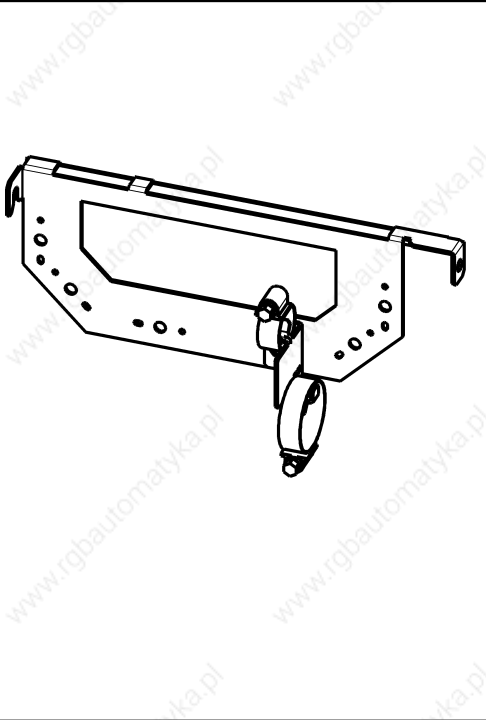





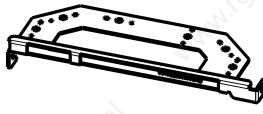
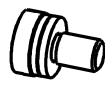
HAS02.1-004-NNN-NN



R911306720

I	SCHR-LIN-M 6,0X12,0-K-8.8-1S07045-ZN-Z41	R911252551
I	SCHIRMWINKEL	R911024542
I	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
I	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471
I	HALTERUNG HMS01.1 KABELD. 12-35	R911296081
Stck	Benennung	MN




BEIPACKZETTEL HAS02.1-004-NNN-NN		
Stck	Benennung	MN
DB_143411	 HALTERUNG HMS01.1 KABELD. 12-35	R911296081 7:20
DB_46879	 SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471 1:2
DB_46868	 SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472 1:2
DB165369	 SCHIRMWINKEL	R911024542 1:5
DB_38105	 SCHR-LIN-M 6,0X12,0-K-8.8-1S07045-ZN-Z41	R911252551 1:1


Datum	2004-03-02	Benennung		
Name	Hirt / Steven	BEIPACKZETTEL HAS02.1-004-NNN-NN		
Material-Nr.	R911306720	Zeich-Nr.	109-1253-4229-01	
Datei	DB166622	Ers.durch	..	ABM-Nr. 5-07273

Fig. 14-32: Accompanying note

Made in Germany
109-1253-4820-01

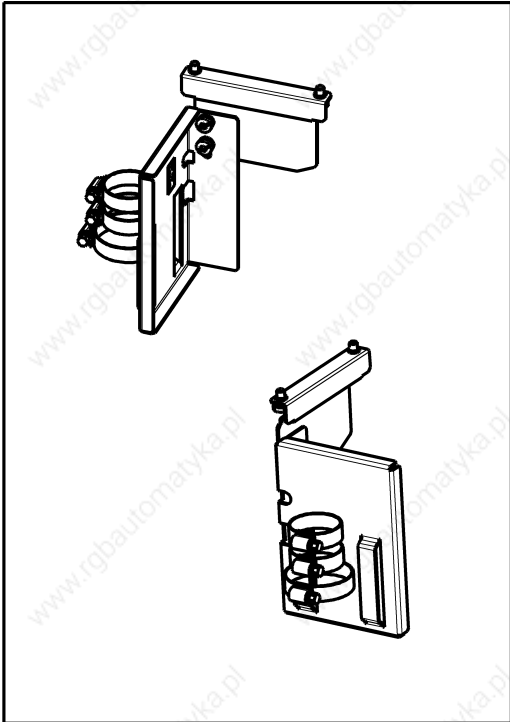


HAS02.1-005-NNN-NN



R911306721

1	WINKEL HMS01.1-W0150 ABSCHIRMANSCHLUSS	R911296068
4	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551
1	SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565
2	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
1	ABSCHIRMANSCHLUSS	R911024379
Stck	Benennung	MN




BEIPACKZETTEL HAS02.1-005-NNN-NN

Stck	Benennung	MN
DB166371	1 ABSCHIRMANSCHLUSS	R911024379 1:4
DB_46868	2 SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472 1:2
DB188743	1 SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565 7:20
DB_38405	4 SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551
DB174663	1 WINKEL HMS01.1-W0150 ABSCHIRMANSCHLUSS	R911296068 1:5


Datum	2004-03-02	Benennung
Name	Hirt / Steven	BEIPACKZETTEL HAS02.1-005-NNN-NN
Material-Nr.	R911306725	Zeich-Nr. 109-1253-4230-01
Datei	DB166623	Ers.durch .. AEM-Nr. 5-07273

Fig. 14-33: Accompanying note

Made in Germany
109-1253-4821-01









HAS02.1-006-NNN-NN

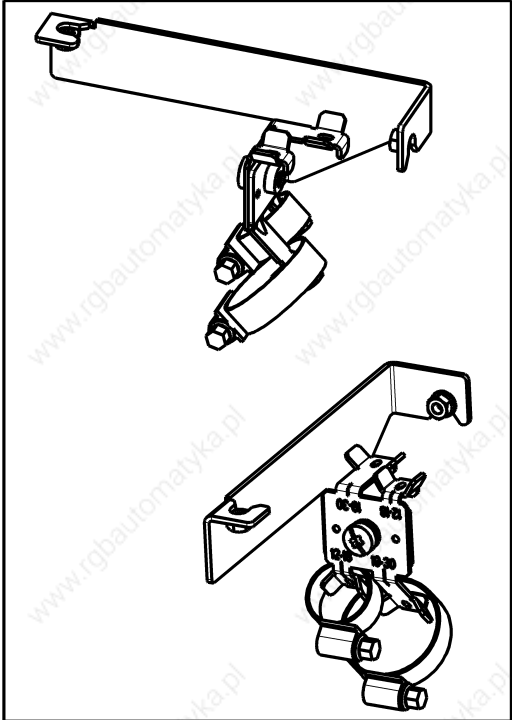


R911306722

1	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551
1	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
1	SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017	R911274471
2	MUTTER-KOM-M 5,0-D10-H05,80 A2-B	R911210162
1	HALTERUNG HMS01.1 KABELD. 12-30	R911306336
1	BLECH HCS02.1 KABELBEFESTIGUNG	R911305851
Stck	Benennung	MN

BEIPACKZETTEL HAS02.1-006-NNN-NN


Stck	Benennung	MN
DB_163070	1 BLECH HCS02.1 KABELBEFESTIGUNG 	R911305851 1:5
DB_164826	1 HALTERUNG HMS01.1 KABELD. 12-30 	R911306336 7:20
DB_39161	2 MUTTER-KOM-M 5,0-D10-H05,80 A2-B 	R911210162 1:1
DB_40879	1 SCHELLE-SCHL-S012*022-B12-ZN-SW7*S-3017 	R911274471 1:2
DB_40868	1 SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017 	R911274472 1:2
DB_38105	1 SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41 	R911252551 1:1




Datum	2004-03-02	Benennung	BEIPACKZETTEL HAS02.1-006-NNN-NN
Name	Hirt / Steven	Material-Nr.	R911306722
Zeich-Nr.	109-1253-4231-01	Datei	DB166624
Ers.durch	..	AEM-Nr.	5-07273

Fig. 14-34: Accompanying note

Made in Germany
109-1253-4822-01



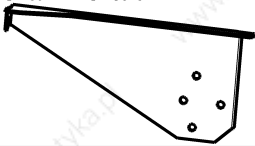
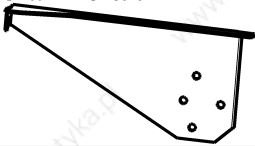


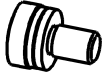
HAS02.1-007-NNN-NN



R911306723

3	SCHR-LIN-M 6,0X12,0-K-8.8-1S07045-ZN-Z41	R911252551
1	SCHIRMANBINDUNG	R911024565
1	SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565
2	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
1	HALTER SCHIRMANBINDUNG	R911024564
Stck	Benennung	MN

BEIPACKZETTEL HAS02.1-007-NNN-NN

Stck	Benennung	MN
1 DB166573	HALTER SCHIRMANBINDUNG 	R911024564 1:5
2 DB_46868	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017 	R911274472 1:2
1 DB168743	SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017 	R911296565 7:20
1 DB166572	SCHIRMANBINDUNG 	R911024565 1:4
3 DB_38105	SCHR-LIN-M 6,0X12,0-K-8.8-1S07045-ZN-Z41 	R911252551 1:1

Datum	2004-03-02	Benennung	BEIPACKZETTEL HAS02.1-007-NNN-NN
Name	Hirt / Steven	Material-Nr.	R911306727
		Zeich-Nr.	109-1253-4232-01
Datei	DB166625	Ers.durch	..
		ABM-Nr.	5-07273

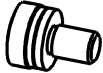




Fig. 14-35: Accompanying note

Made in Germany

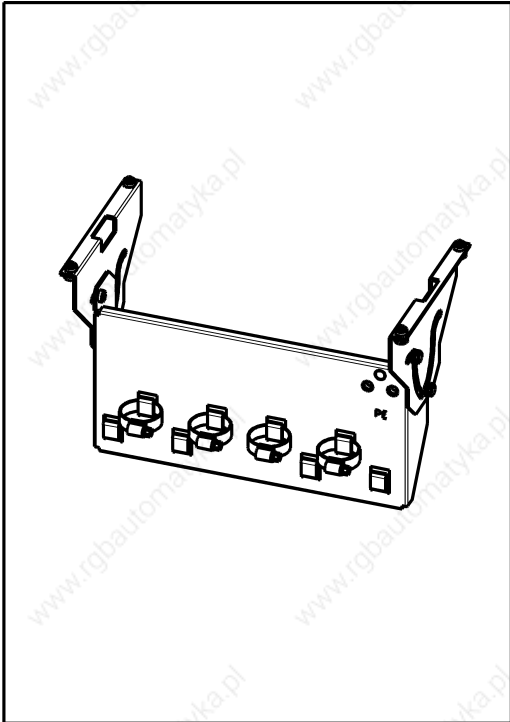


HAS02.1-008-NNN-NN










R911309579

4	SECHSKANTSCHRAUBE ISO4017-M6X12-8-8-A2C	R900014492
4	SCHR-LIN-M 6,0X12,0-K-8-8-ISO7045-ZN-Z41	R911252551
1	SCHIRMAUFLAGE HCS210	0025285
4	SHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
4	SCHEIBE 6,40X 12,00X 1,60 DIN 125	R911212427
2	HALTER SCHIRMAUFLAGE HCS210	0025286
4	FEDERRING B 6,0 DIN 127 ZN	R911213515
Stck	Benennung	MN




BEIPACKZETTEL HAS02.1-008-NNN-NN

Stck	Benennung	MN
4 DB_53462	FEDERRING B 6,0 DIN 127 ZN 	R911213515 1:1
2 DB178733	HALTER SCHIRMAUFLAGE HCS210 	0025286 3:20
4 DB_42275	SCHEIBE 6,40X 12,00X 1,60 DIN 125 	R911212427 1:1
4 DB_40668	SHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017 	R911274472 1:2
1 DB178731	SCHIRMAUFLAGE HCS210 	0025285 3:20
4 DB_38405	SCHR-LIN-M 6,0X12,0-K-8-8-ISO7045-ZN-Z41 	R911252551 1:1
4 DB178750	SECHSKANTSCHRAUBE ISO4017-M6X12-8-8-A2C 	R900014492 1:1


Datum	2004-11-08	Benennung
Name	Sleven	BEIPACKZETTEL HAS02.1-008-NNN-NN
Material-Nr.		Zeich-Nr. 109-1253-4233-00
Datei	DB178779	Ers.durch .. AEM-Nr. ...

Fig. 14-36: Accompanying note

Made in Germany
109-1253-4824-00



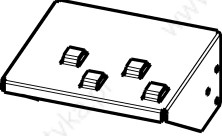
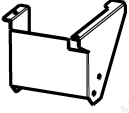



HAS02.1-009-NNN-NN



R911308225

6	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551
1	SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565
2	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017	R911274472
1	HALTER SCHIRMBLECH	R911025035
1	BLECH-SCHIRMAUFLAGE	R911025036
Stck	Benennung	MN

BEIPACKZETTEL HAS02.1-009-NNN-NN

Stck	Benennung	MN
1 <small>DB1171916</small>	BLECH-SCHIRMAUFLAGE 	R911025036 1:5
1 <small>DB1171914</small>	HALTER SCHIRMBLECH 	R911025035 1:10
2 <small>DB_48868</small>	SCHELLE-SCHL-S023*035*B12-ZN-SW7*S-3017 	R911274472 1:4
1 <small>DB1180143</small>	SCHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017 	R911296565 1:4
6 <small>DB_38105</small>	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41 	R911252551 1:1

Datum	2004-07-06	Benennung
Name	Hirt	BEIPACKZETTEL HAS02.1-009-NNN-NN
Material-Nr.	R911308255	Zeich-Nr. 109-1253-4234-00
Datei	DB171948	Ers.durch .. AEM-Nr. ...

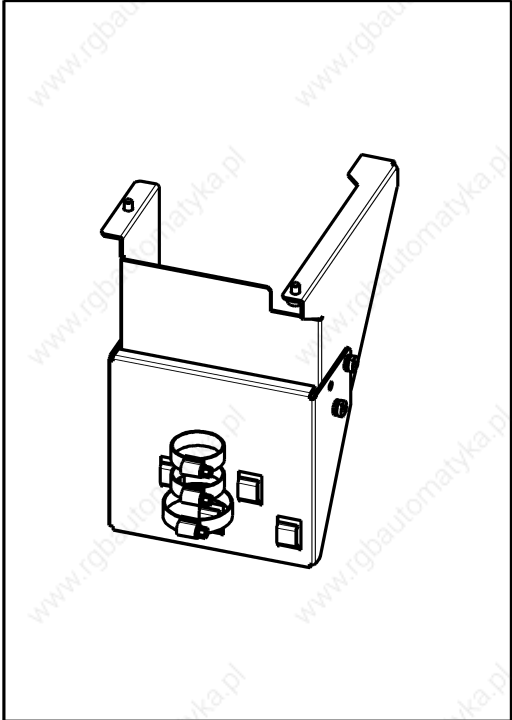



Fig. 14-37: Accompanying note

Made in Germany
109-1253-4850-00

Rexroth
Bosch Group

HAS02.1-012-NNN-NN







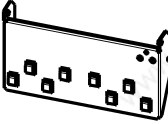


R911315682

1	WINKEL HCS03.1E-W0210 ABSCHIRMANSCHLUSS	R911025285
4	SECHSKANTSCHRAUBE ISO4017-M6X12-8-8-A2C	R900014492
4	SCHR-LIN-M 6,0X12,0-K-8-8-ISO7045-ZN-Z4I	R911252551
4	SHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565
4	SCHEIBE 6,40X 12,00X 1,60 DIN 125	R911212427
4	FEDERRING DIN127-B6-FST &	R911213515
2	BLECH HCS04.1E-W0500 ABSCHIRMANSCHLUSS	R911027316

Stck	Benennung	MN
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BEIPACKZETTEL HAS02.1-012-NNN-NN

Stck	Benennung	MN
DB193166	2 BLECH HCS04.1E-W0500 ABSCHIRMANSCHLUSS	R911027316
		1:10
DB-35162	4 FEDERRING DIN127-B6-FST &	R911213515
		1:1
DB-42215	4 SCHEIBE 6,40X 12,00X 1,60 DIN 125	R911212427
		1:1
DB178143	4 SHELLE-SCHL-S032*050-B12-ZN-SW7*S-3017	R911296565
		2:5
DB-38405	4 SCHR-LIN-M 6,0X12,0-K-8-8-ISO7045-ZN-Z4I	R911252551
		1:1
DB178150	4 SECHSKANTSCHRAUBE ISO4017-M6X12-8-8-A2C	R900014492
		1:1
DB186725	1 WINKEL HCS03.1E-W0210 ABSCHIRMANSCHLUSS	R911025285
		1:10

Datum	2006-01-19	Benennung	BEIPACKZETTEL HAS02.1-012-NNN-NN
Name	Sonjrazz	Material-Nr.	R911315849
Zeich-Nr.	109-1253-4284-00	Ers.durch	...
AEI-Nr.	DB195390		

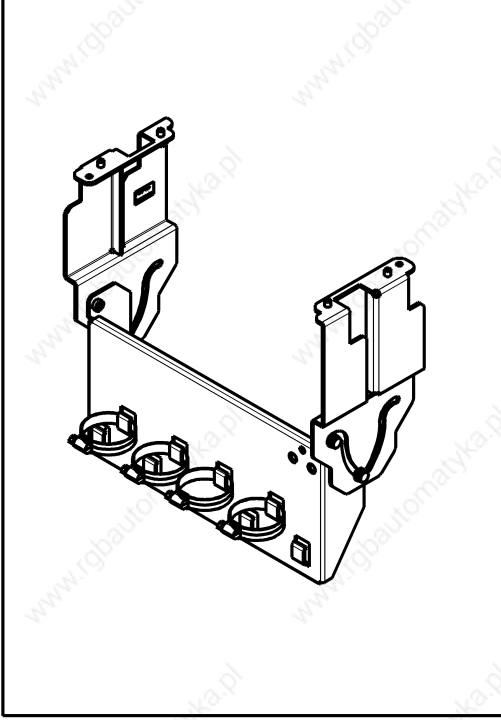


Abb. 14-38: Accompanying note

Mounting the HAS02 Accessories

The sheet metal of the accessories is screwed to the bottom of the drive controller (see also figure below):

- Unscrew bottom or bottom left fixing screw of drive controller.
- Put sheet metal of accessories to bottom of drive controller and screw down fixing screw of drive controller again.

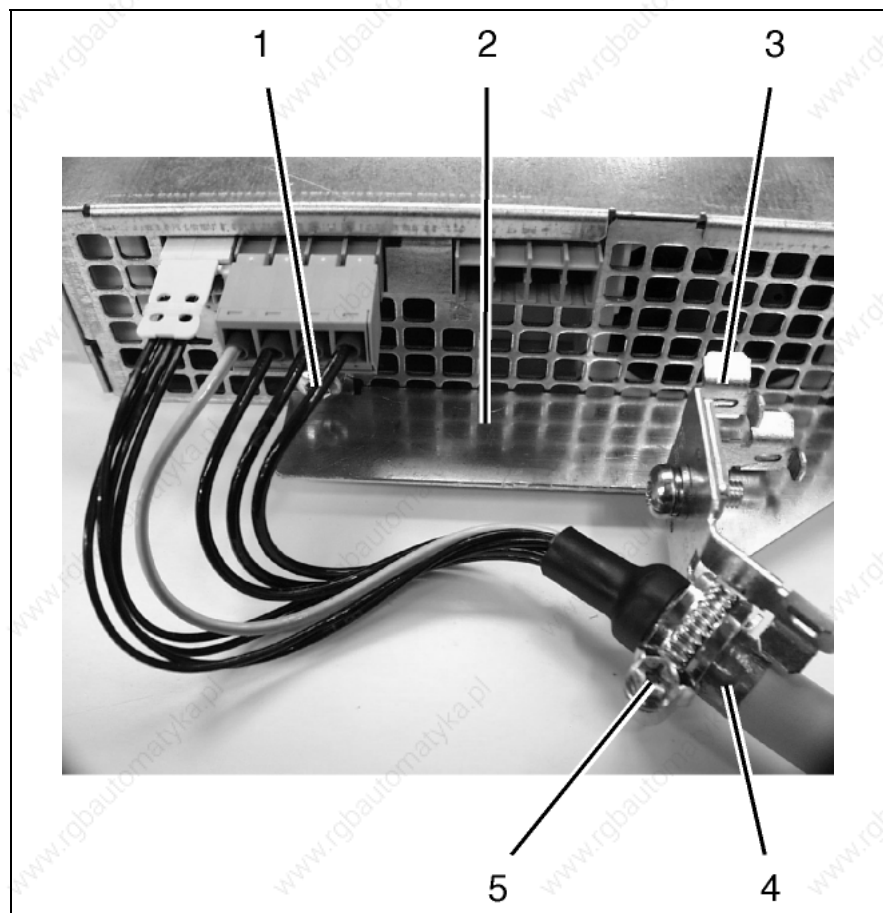


CAUTION

Risk of damage to the drive controller caused by too long screws!

⇒ Exclusively use the supplied screws of a length of 12 mm for the thread of the shield connection XS2.

- Screw second screw (M6 x 12) in thread XS2 at bottom of drive controller.
- Screw fixing device to sheet metal of accessories according to desired cable routing of motor cable (45° or horizontal). (The figure below illustrates cable routing with 45°.)
- According to diameter of motor cable, fix motor cable to corresponding support of fixing device (12-18 mm or 19-30 mm) with a clip. Make sure that shield of motor cable has good contact with fixing device.



- 1: screw in thread XS2
- 2: sheet metal of accessories
- 3: fixing device
- 4: shield of motor cable
- 5: clip

Fig. 14-39: Shield connection of motor cable

Mounting Shield Connection HAS02.1-004-NNN-NN to Drive Controller HCS03.1E-W0070

1. By means of supplied screws, fasten shield angle steel to bottom of drive controller.
2. Fix support to shield angle steel as required.

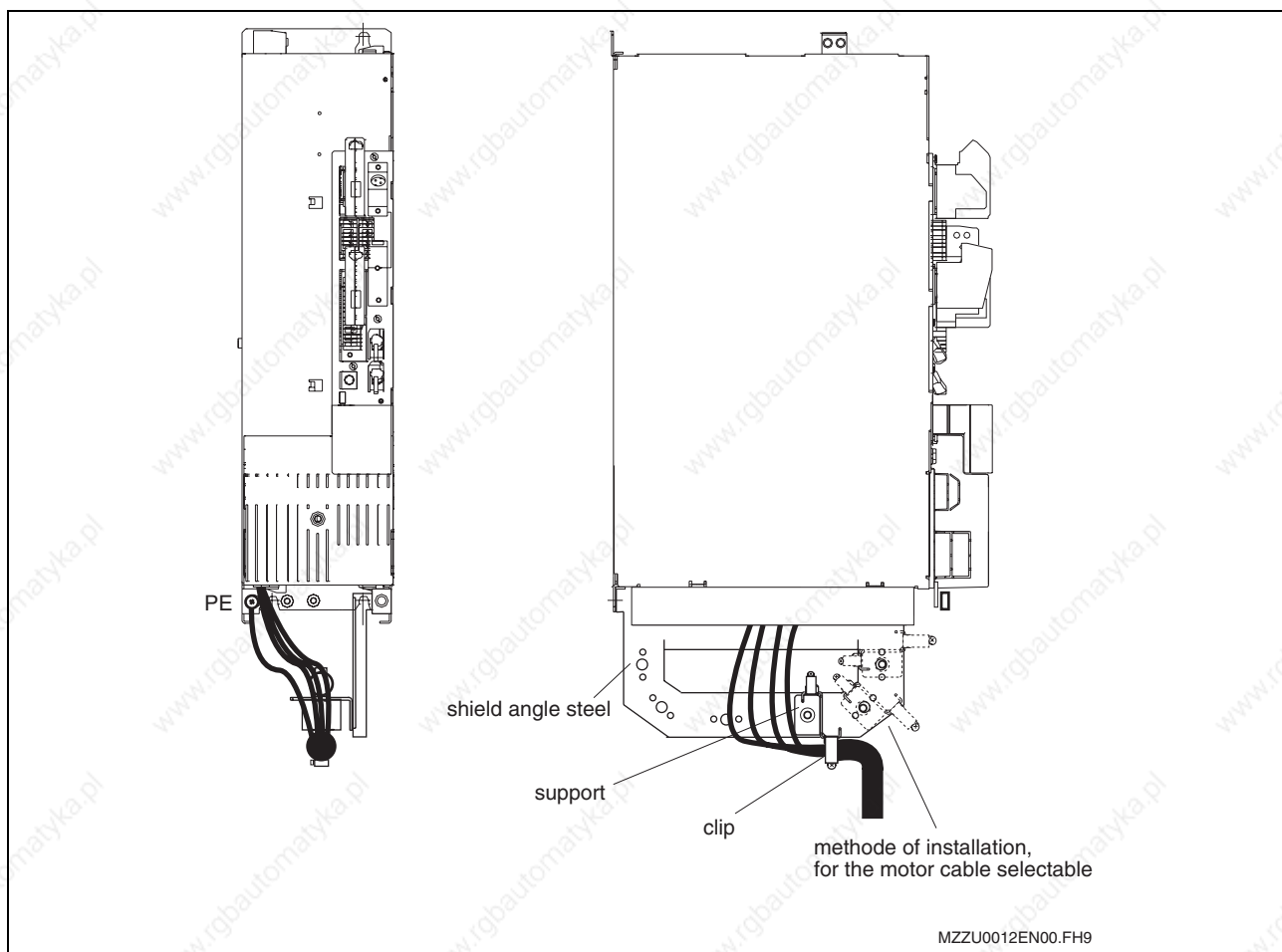


Fig. 14-40: Shielding plate HAS02.1-004-NNN-NN at the bottom of the drive controller HCS03.1E-W0070

3. Fix shield of motor cable to shielding plate with a clip.

Note: Adapt the size of the clip to the motor cable cross section.

Mounting Shield Connection HAS02.1-005-NNN-NN to Drive Controller HCS03.1E-W0100 / 150

1. Hang up support at guide section at bottom of drive controller and fasten it by means of supplied screws.
2. Screw shielding plate to shield angle steel.

According to required motor cable routing, it is possible to mount angle plate for shield connection in different positions:

- motor cable routed in parallel or
- 45° to bottom of drive controller.

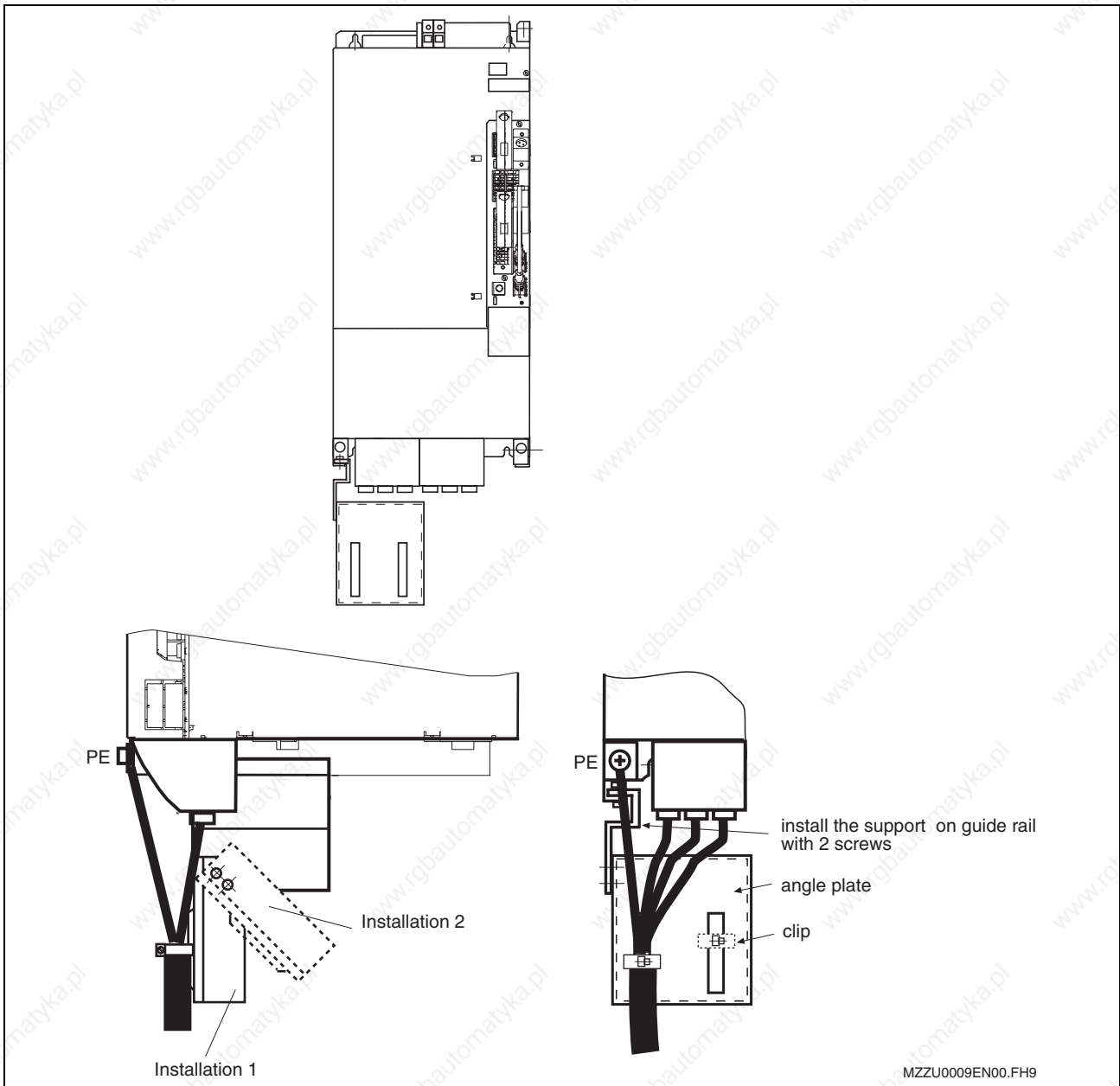


Fig. 14-41: Shielding plate HAS02.1-005-NNN-NN at the bottom of the drive controller HCS03.1E-W0100 / 0150

3. Fix shield of motor cable to shielding plate with a clip.

Note: Adapt the size of the clip to the motor cable cross section.

Mounting Shield Connection HAS02.1-008-NNN-NN to Drive Controller HCS03.1E-W0210

1. By means of supplied screws (from the accessories kit SCHR-LIN-M6,0 x 12,0), fasten support to bottom of drive controller.
2. By means of supplied screws (from the accessories kit SCREW...M6 x 12), fasten shielding plate between the supports.

According to required power supply cable and motor cable routing, it is possible to mount shielding plate for shield connection in different positions.

3. Fix shield of power supply cable and motor cable to shielding plate with a clip.

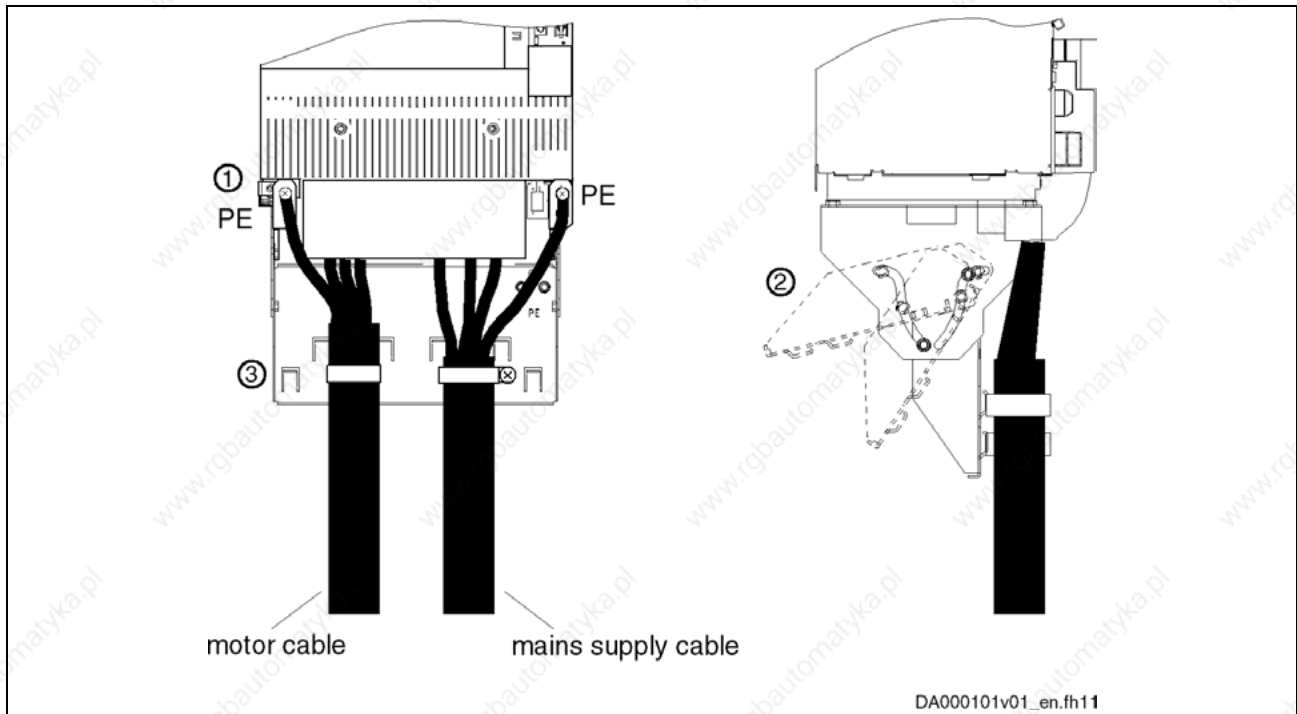


Fig. 14-42: Shielding plate HAS02.1-008-NNN-NN at the bottom of the drive controller HCS03.1E-W0210

Note: Adapt the size of the clip to the power supply cable and motor cable cross sections.

Shield Connection of Motor Cable via Mains Filter

For shield connection of the motor cable at the drive controller via the mains filter, a special shielding plate is available:

Note: Using the shielding plate guarantees optimum shield contact of the motor cable. You should therefore **always** use the shielding plate, **where possible**.

The shielding plate is only available as an option.

Shield Connection of Motor Cable HAS02.1-006-NNN-NN with Mains Filter Mounted

1. Hang up shielding plate at bottom of mains filter at threaded bolts and fasten with supplied nuts.
2. Screw support to shielding plate.

Clips can be mounted depending on motor cable cross section.

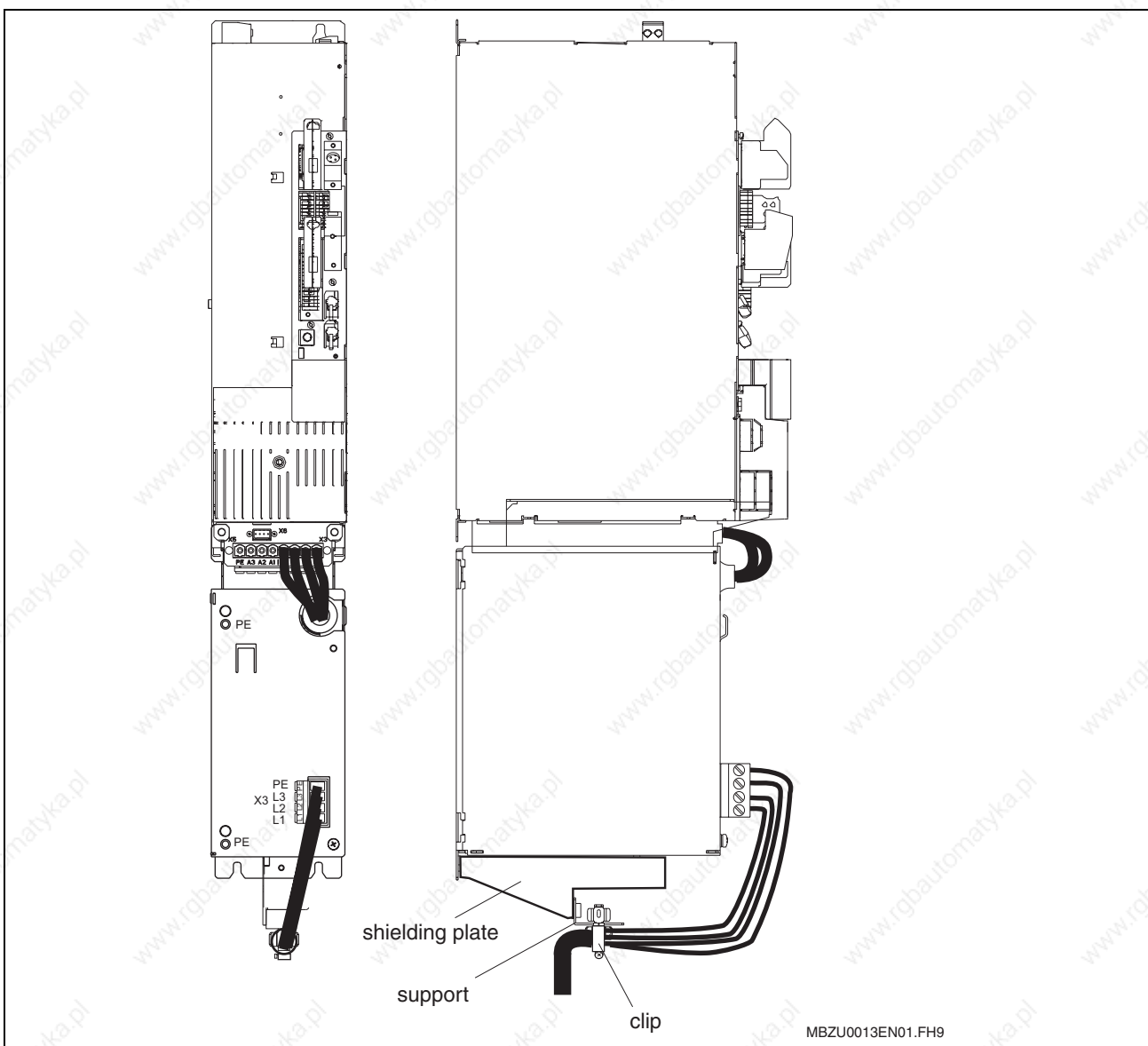


Fig. 14-43: Shielding plate HAS02.1-006-NNN-NN at the bottom of the mains filter (nominal current 50 A)

3. Fix shield of motor cable to shielding plate with a clip.

Note: The shield terminals must not be used to provide strain relief.

Shield Connection of Power Supply Cable HAS02.1-007-NNN-NN with Mains Filter Mounted

1. Hang up support at bottom of mains filter and fasten it by means of supplied screws.
2. Screw shielding plate of power supply cable to support.

According to required power supply cable routing, it is possible to mount shielding plate in different positions:

- power supply cable routed in parallel or,
- 45° to bottom of mains filter or,
- 90° to bottom of mains filter.

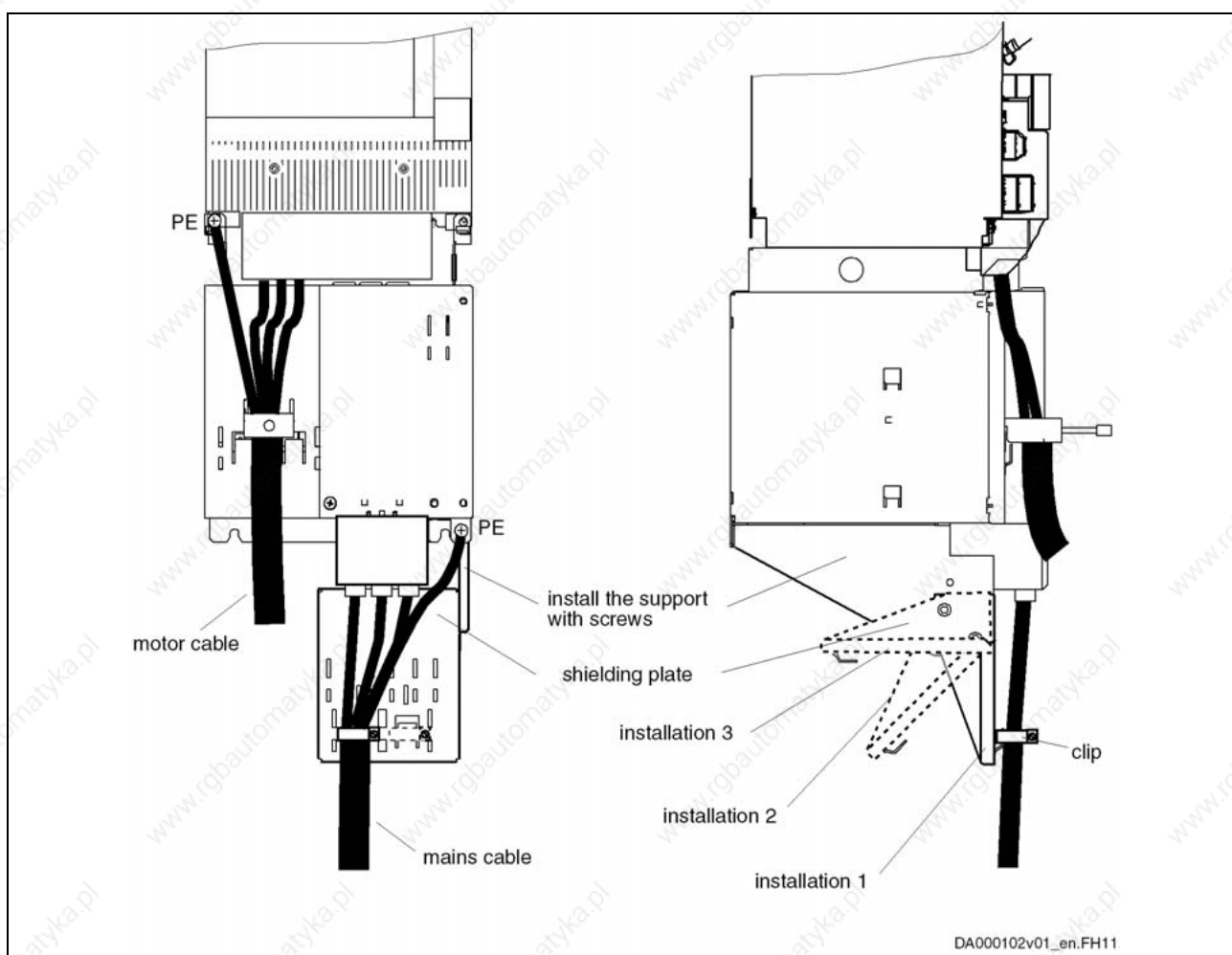


Fig. 14-44: Shielding plate HAS02.1-007-NNN-NN at the bottom of the mains filter (nominal current 80 A / 106 A)

3. Fix shield of power supply cable to front side of mains filter with a clip.
For shield connection of the power supply cable at the mains filter, clips of various sizes are available according to cross sections and number of cables, which are hung up to the punched holes.

Note: The shield terminals must not be used to provide strain relief.

Shield Connection of Power Supply Cable HAS02.1-009-NNN-NN with Mains Filter Mounted

1. Hang up support at bottom of mains filter and fasten it by means of supplied screws.
2. Screw shielding plate of power supply cable to support.

According to required power supply cable routing, it is possible to mount shield for shield connection in different positions:

- power supply cable routed in parallel or
- 45° to bottom of mains filter.

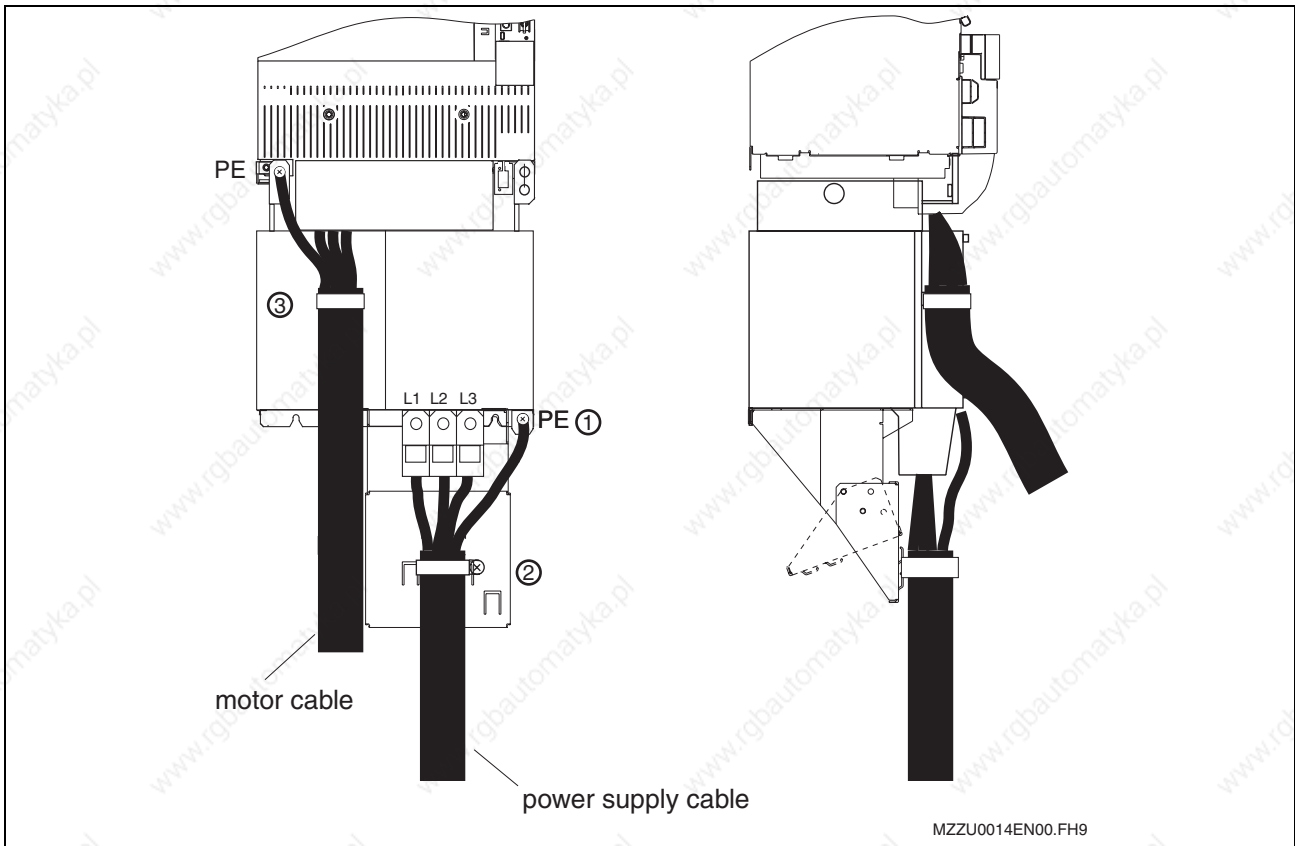


Fig. 14-45: Shielding plate HAS02.1-009-NNN-NN at the bottom of the mains filter (nominal current 146 A)

3. Fix shield of power supply cable to front side of mains filter with a clip. For shield connection of the motor cable at the mains filter, clips of various sizes are available according to cross sections and number of cables, which are hung up to the punched holes.

Note: The shield terminals must not be used to provide strain relief.

14.4 Control Cabinet Adapter HAS03

Type Code

Abbrev.	Column	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Example:		H	A	S	0	3	.	1	-	0	0	2	-	N	N	N	-	N	N	

- 1. Product**
- 1.1 Accessories
IndraDrive . . . = HAS

- 2. Line**
- 2.1 Control cabinet adapter = 03

- 3. Design**
- 3.1 1 = 1

- 4. Device assignment (Number of bolt)**
- 4.1 HCS02.1E-W0012 = 002
- 4.2 HCS02.1E-W0028 = 002
- 4.3 HLB01.1C-01K0-N06R0-A-007-NNNN = 002
- 4.4 HLC01.1C-01M0-A-007-NNNN = 002
- 4.5 HLC01.1C-02M4-A-007-NNNN = 002
- 4.6 HCS02.1E-W0054 = 004
- 4.7 HCS02.1E-W0070 = 004

- 5. Other feature**
- 5.1 none = NNN

- 6. Other design**
- 6.1 none = NN

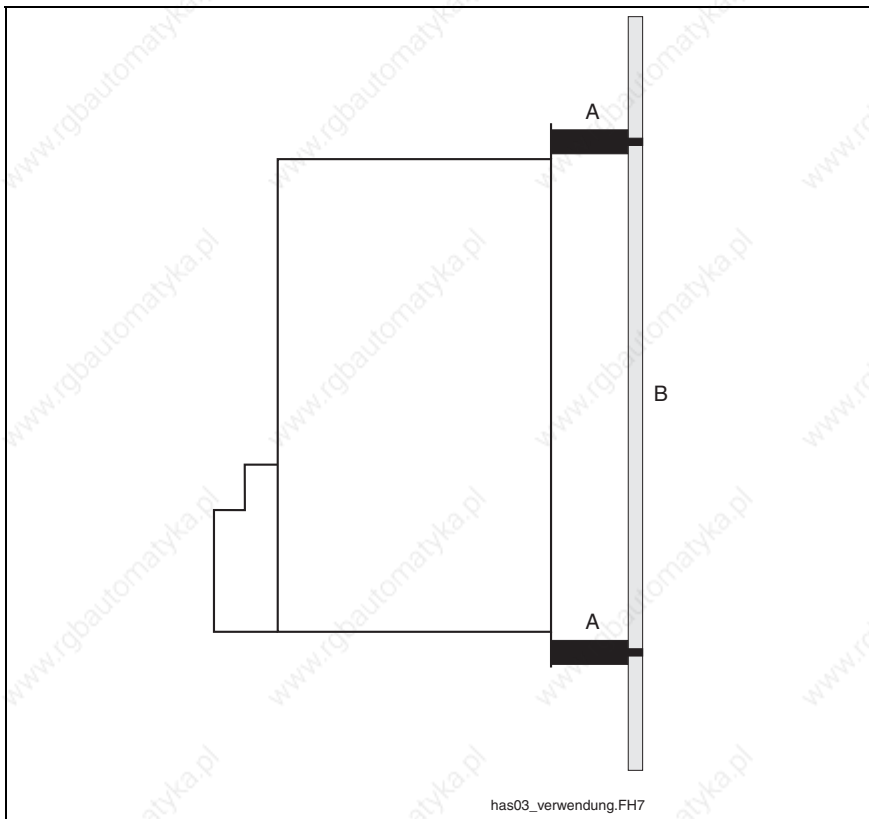
DT000005v01_en.fh

Fig. 14-46: Type code HAS03.1

Applications

The control cabinet adapter is used to

- compensate different mounting depths of drive controllers HCS02.1E and HLC01.1C and HMS01 / HMD01 when mounted to a common mounting surface.



A: control cabinet adapter
B: mounting surface in control cabinet

Fig. 14-47: How to use the control cabinet adapters



Note: Observe the maximum allowed tightening torque of 6 Nm at HAS03.

Scope of Supply

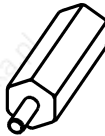
The HAS03 accessories are available as an option, they are not part of the standard scope of supply.

Note: Mechanical stability of the adapted device requires a rigid connection via DC bus rails to a neighboring device without adapter.

- Do not operate HAS03 without neighboring device.
- Mount HAS03 to bare metal mounting plate.

Made in Germany 109-1253-4825-01			
<h1 style="margin: 0;">HAS03.1-002-NNN-NN</h1>			
			
R911308567			
2	ABSTANDSBOLZEN BM 6,0X 57,0 SW19,0 ST-ZN	R911309313	
Stck	Benennung	MN	

BEIPACKZETTEL HAS03.1-002-NNN-NN		
Stck	Benennung	MN
2	ABSTANDSBOLZEN BM 6,0X 57,0 SW19,0 ST-ZN	R911309313



1:2

Datum	2004-08-04	Benennung	BEIPACKZETTEL HAS03.1-002-NNN-NN
Name	Hirt		
Material-Nr.	R911308566	Zeich-Nr.	109-1253-4235-01
Datei	DB173400	Ers.durch	..
		AEM-Nr.	5-011323

Fig. 14-48: Accompanying note




<p>Made in Germany 109-1253-4826-01</p>  <p style="font-size: 24pt; font-weight: bold; text-align: center;">HAS03.1-004-NNN-NN</p>  <p style="text-align: center;">R911308568</p>		<p style="text-align: center; font-weight: bold;">BEIPACKZETTEL HAS03.1-004-NNN-NN</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Stck</th> <th style="width: 70%;">Benennung</th> <th style="width: 20%;">MN</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">4</td> <td>ABSTANDSBOLZEN BM 6,0X 57,0 SW19,0 ST-ZN</td> <td style="text-align: center;">R911309313</td> </tr> </tbody> </table> <div style="text-align: center; margin-top: 20px;">  <p style="font-size: 10pt;">1:2</p> </div>		Stck	Benennung	MN	4	ABSTANDSBOLZEN BM 6,0X 57,0 SW19,0 ST-ZN	R911309313																				
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Datei	DB173398	Ers.durch	..																										
		AEM-Nr.	5-011323																										

Fig. 14-49: Accompanying note

14.5 Capacitor HAS04

Capacitors from the DC bus connections L+ and L- against housing.

Type Code

Abbrev. Column	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
Example:	H	A	S	0	4	.	1	-	0	0	1	-	N	N	N	-	N	N	N

1. **Product**
 - 1.1 Accessories
IndraDrive ... = HAS

2. **Line**
 - 2.1 Capacitor = 04

3. **Design**
 - 3.1 1 = 1

4. **Capacitor**
 - 4.1 2 x 470 nF (HCS02.x) = 001
 - 4.2 2 x 470 nF (HCS03.x) = 002

5. **Other feature**
 - 5.1 none = NNN

6. **Other design**
 - 6.1 none = NN

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Fig. 14-50: Type code HAS04

Note: Using the HAS04 accessories requires additional mounting clearance at the drive controller.
Observe the dimensions of HAS04.

Applications

The HAS04 accessories are used to

- operate HCS02 and HCS03 drive controllers at the HNF01.1 mains filter
- operate HMS01 drive controllers at HCS02 and HCS03 drive controllers

HAS04 type	Application
HAS04.1-001-NNN-NN	at DC bus connections of HCS02 drive controllers
HAS04.1-002-NNN-NN	at DC bus connections of HCS03 drive controllers

Fig. 14-51: HAS04 type

Scope of Supply

The HAS04 accessories are available as an option, they are not part of the standard scope of supply.



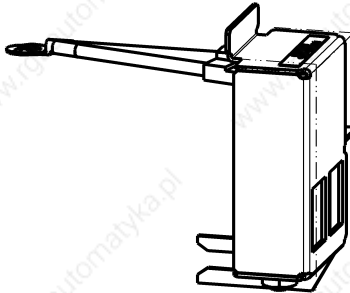


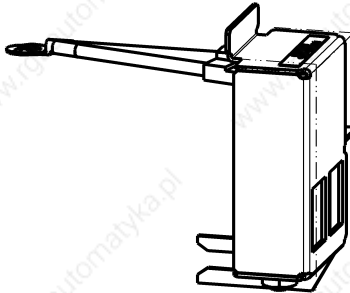


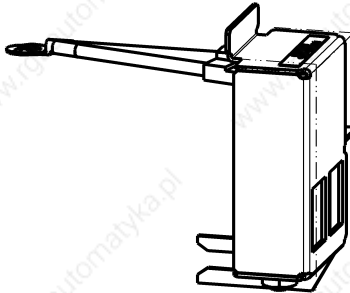


<p>Made in Germany 109-1228-4S05-00</p> <div style="text-align: right;">  </div> <h2 style="text-align: center; margin: 10px 0;">HAS04.1-001-NNN-NN</h2> <div style="text-align: center;">  R911309268 </div> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 5%;">Stck</th> <th style="width: 75%;">Benennung</th> <th style="width: 20%;">MN</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">3</td> <td>SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41</td> <td style="text-align: center;">R911252551</td> </tr> <tr> <td style="text-align: center;">1</td> <td>SCHIENE-VERBINDUNG HAS01.1-150-072</td> <td style="text-align: center;">R911306692</td> </tr> <tr> <td style="text-align: center;">1</td> <td>BGR HAS04.1-001-NNN-NN</td> <td style="text-align: center;">R911309270</td> </tr> </tbody> </table>	Stck	Benennung	MN	3	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551	1	SCHIENE-VERBINDUNG HAS01.1-150-072	R911306692	1	BGR HAS04.1-001-NNN-NN	R911309270	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: center;">BEIPACKZETTEL HAS04.1-001-NNN-NN</th> </tr> <tr> <th style="width: 5%;">Stck</th> <th style="width: 75%;">Benennung</th> <th style="width: 20%;">MN</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>BGR HAS04.1-001-NNN-NN</td> <td style="text-align: center;">R911309270</td> </tr> <tr> <td colspan="3" style="text-align: center;">  1:2 </td> </tr> <tr> <td style="text-align: center;">1</td> <td>SCHIENE-VERBINDUNG HAS01.1-150-072</td> <td style="text-align: center;">R911306692</td> </tr> <tr> <td colspan="3" style="text-align: center;">  1:2 </td> </tr> <tr> <td style="text-align: center;">3</td> <td>SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41</td> <td style="text-align: center;">R911252551</td> </tr> <tr> <td colspan="3" style="text-align: center;">  1:1 </td> </tr> <tr> <td colspan="3"> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <td style="width: 15%;">Datum</td> <td style="width: 35%;">2004-10-15</td> <td style="width: 50%;">Benennung</td> </tr> <tr> <td>Name</td> <td>Rozzo</td> <td>BEIPACKZETTEL HAS04.1-001-NNN-NN</td> </tr> <tr> <td>Material-Nr.</td> <td>R911309316</td> <td>Zeich-Nr. 109-1228-4236-01</td> </tr> <tr> <td>Datei</td> <td>DB177206</td> <td>Ers.durch 109-1228-4236-00 AEM-Nr. ohne</td> </tr> </table> </td> </tr> </tbody> </table>	BEIPACKZETTEL HAS04.1-001-NNN-NN			Stck	Benennung	MN	1	BGR HAS04.1-001-NNN-NN	R911309270	 1:2			1	SCHIENE-VERBINDUNG HAS01.1-150-072	R911306692	 1:2			3	SCHR-LIN-M 6,0X12,0-K-8.8-ISO7045-ZN-Z41	R911252551	 1:1			<table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <tr> <td style="width: 15%;">Datum</td> <td style="width: 35%;">2004-10-15</td> <td style="width: 50%;">Benennung</td> </tr> <tr> <td>Name</td> <td>Rozzo</td> <td>BEIPACKZETTEL HAS04.1-001-NNN-NN</td> </tr> <tr> <td>Material-Nr.</td> <td>R911309316</td> <td>Zeich-Nr. 109-1228-4236-01</td> </tr> <tr> <td>Datei</td> <td>DB177206</td> <td>Ers.durch 109-1228-4236-00 AEM-Nr. ohne</td> </tr> </table>			Datum	2004-10-15	Benennung	Name	Rozzo	BEIPACKZETTEL HAS04.1-001-NNN-NN	Material-Nr.	R911309316	Zeich-Nr. 109-1228-4236-01	Datei	DB177206	Ers.durch 109-1228-4236-00 AEM-Nr. ohne
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Datei	DB177206	Ers.durch 109-1228-4236-00 AEM-Nr. ohne																																																		

Fig. 14-52: Accompanying note

Made in Germany
109-1253-4847-00

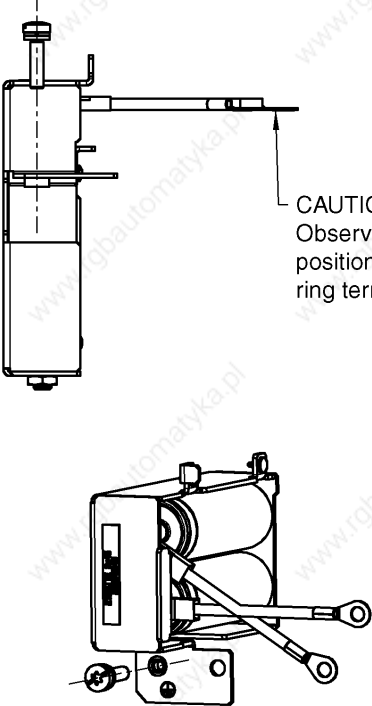
**Rexroth
Bosch Group**

HAS04.1-002-NNN-NN



R911315348

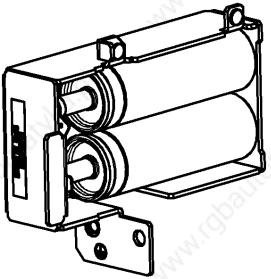
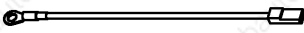
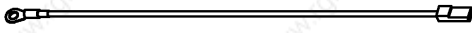
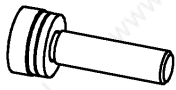
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2	LZE-PU0014-GY020-KA30S4/XXXX-SG27H9/XXXX	R911315725
1	BGR HAS04.1-002-NNN-NN	R911315347
Stck	Benennung	MN



CAUTION!
Observe mounting position of the ring terminal!

BEIPACKZETTEL HAS04.1-002-NNN-NN

1	BGR HAS04.1-002-NNN-NN	R911315347
2	LZE-PU0014-GY020-KA30S4/XXXX-SG27H9/XXXX	R911315725
2	LZE-PU0014-GY033-KA30S4/XXXX-SG27H9/XXXX	R911315727
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Datum	2005-10-06	Benennung	BEIPACKZETTEL HAS04.1-002-NNN-NN
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Datei	DB192241	Ers.durch	..
		AEM-Nr.	..

Fig. 14-53: Accompanying note

Capacitor

Connecting HAS04

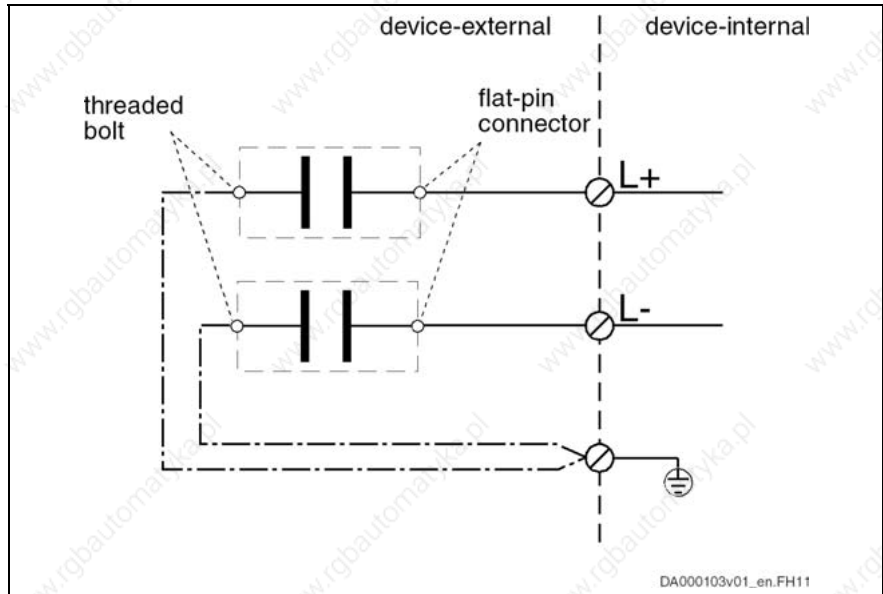


Fig. 14-54: Connecting HAS04

Dimensions

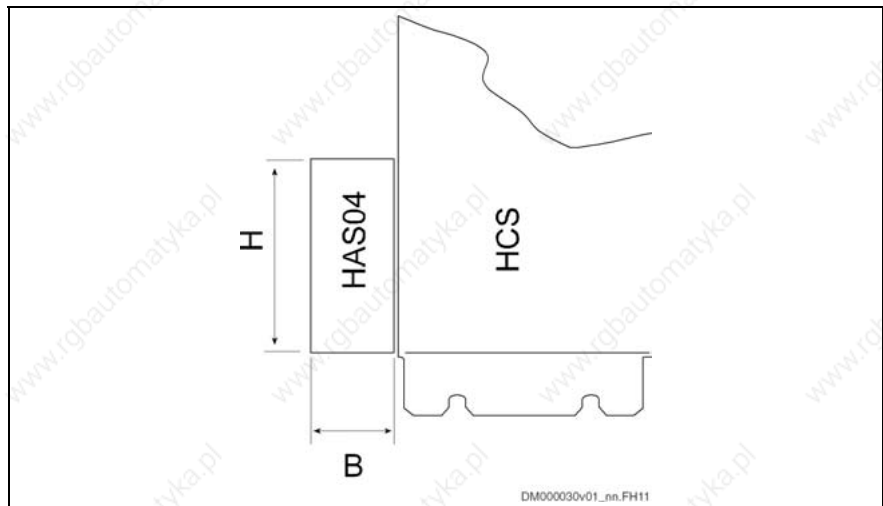


Fig. 14-55: Dimensions HAS04

Type	min. Width B [mm]	Height H [mm]	Depth [mm]
HAS04.1-001	30	75	<150
HAS04.1-002	40	75	<150

Fig. 14-56: Dimensions

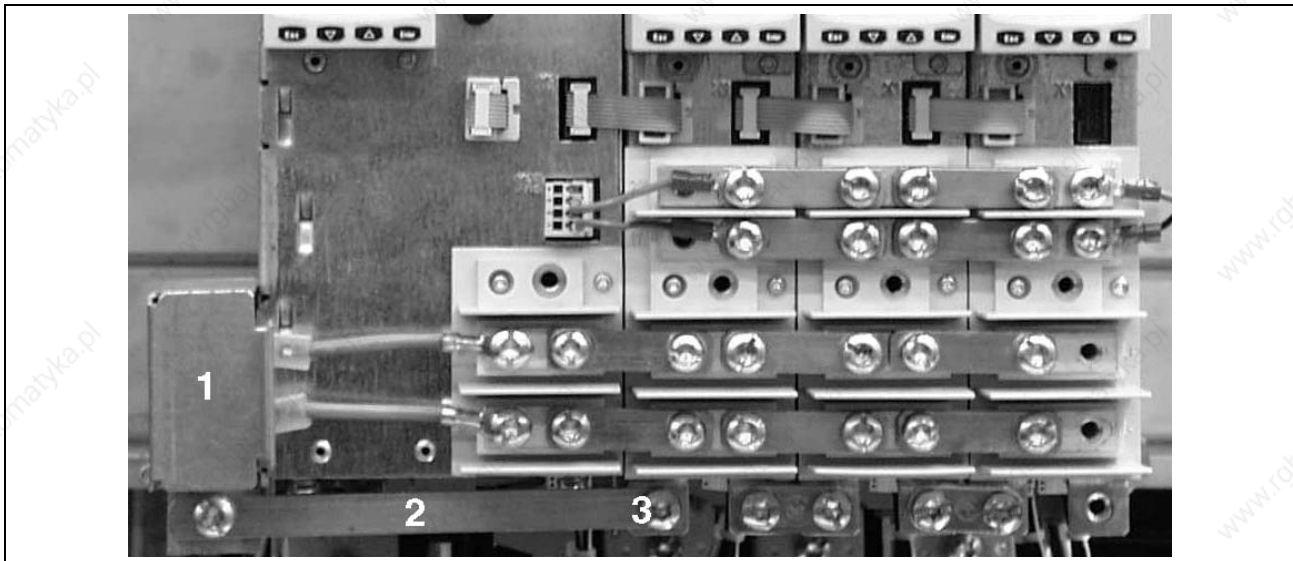
Mounting the HAS04.1-001 Accessories



WARNING

**Dangerous contact voltage at device housing!
Lethal electric shock!**

⇒ Connect HMx01 drive controllers to the HCS02 drive controller by means of joint bar 2 (see figure below). Joint bar 2 replaces the equipment grounding connection 3 at HMx01 (see figure below) to the equipment grounding system.



- 1 mounted HAS04.1-001 accessories with connection to L+ and L-
- 2 mounted joint bar
- 3 equipment grounding connection at HMx01

Fig. 14-57: HAS04.1-001 at drive system HCS02 with HMx01 without touch guard mounted



- 1 mounted HAS04.1-001 accessories
- 2 mounted joint bar

Fig. 14-58: HAS04.1-001 at drive system HCS02 with HMx01 with touch guard mounted

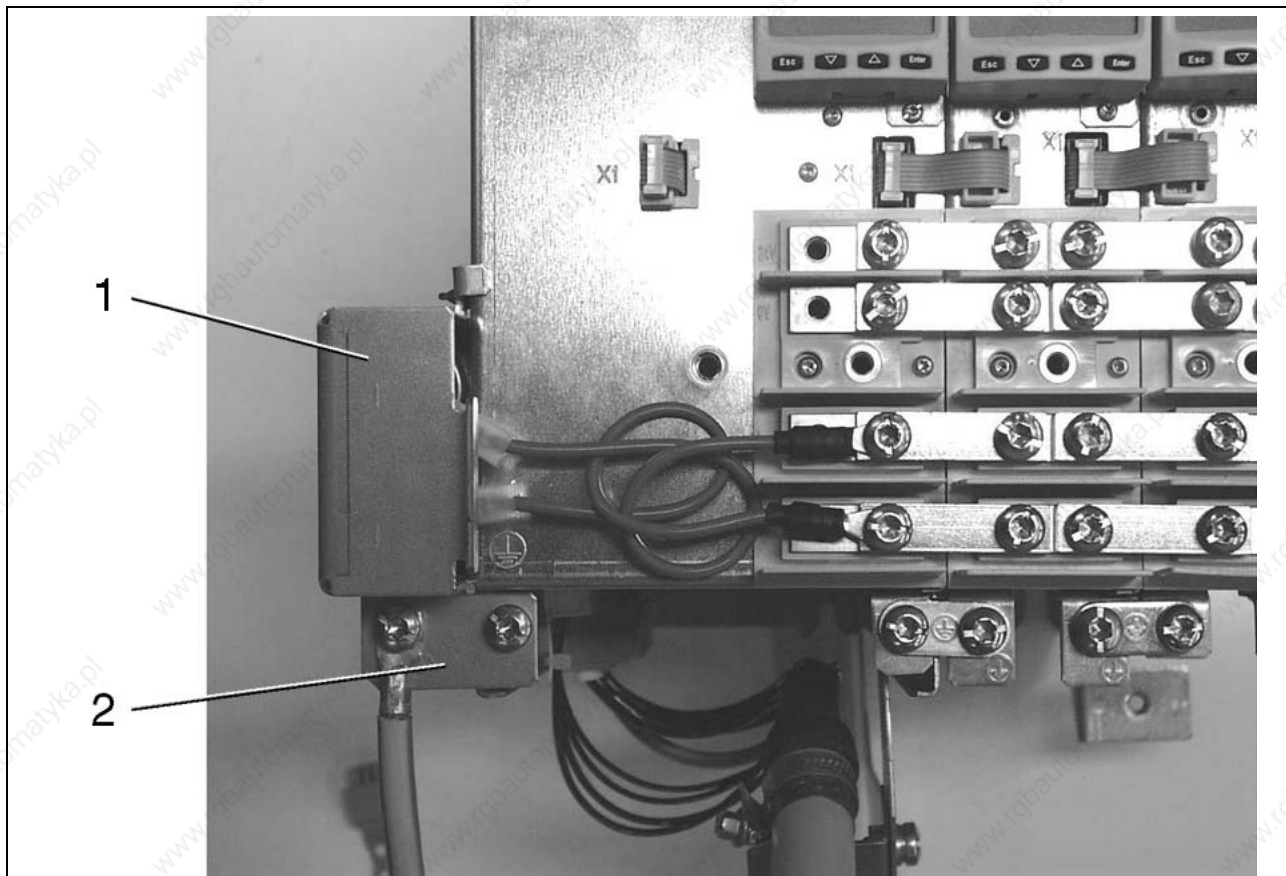
Mounting the HAS04.1-002 Accessories



WARNING

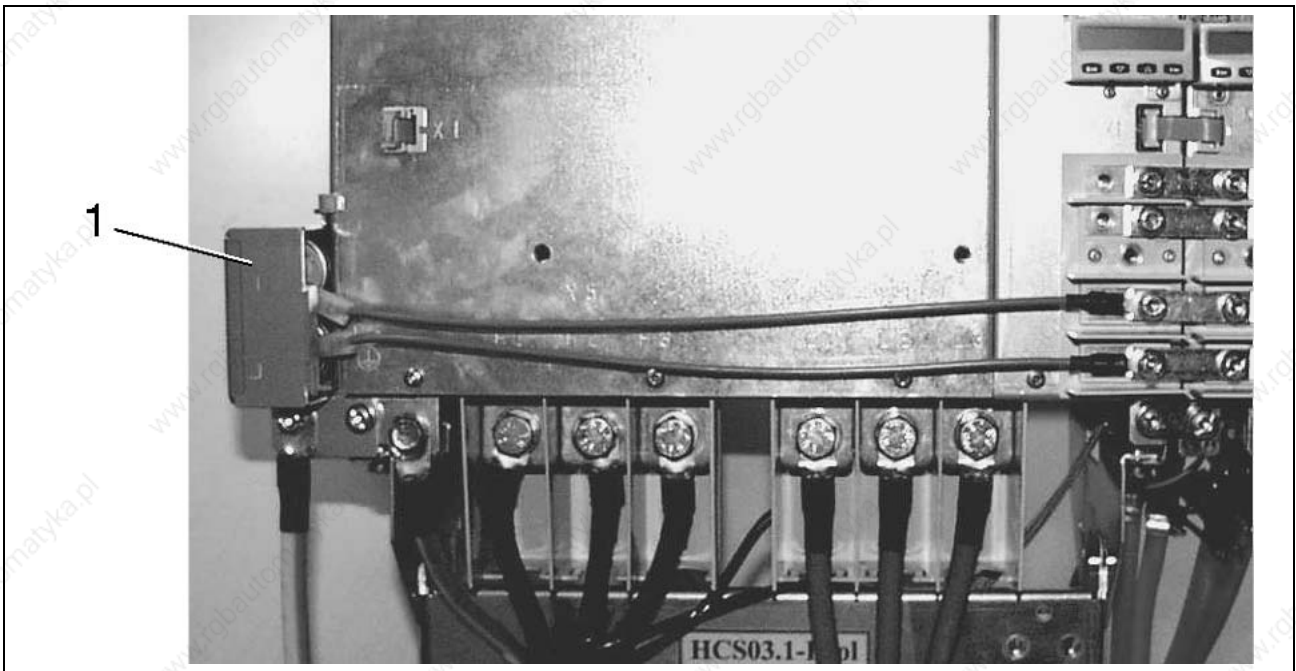
**Dangerous contact voltage at device housing!
Lethal electric shock!**

⇒ Connect the HAS04.1-002 accessories to drive controller HCS03 via the joint bar (see figure below).



1: mounted HAS04.1-002 accessories with connection to L+ and L- joint bar

Fig. 14-59: HAS04.1-002 at drive system HCS03.1E-W0070, -W0100, -W0150 with HMx01 without touch guard mounted



1 mounted HAS04.1-002 accessories with connection to L+ and L-
 Fig. 14-60: HAS04.1-002 at drive system HCS03.1E-W0210 with HMx01 without touch guard mounted

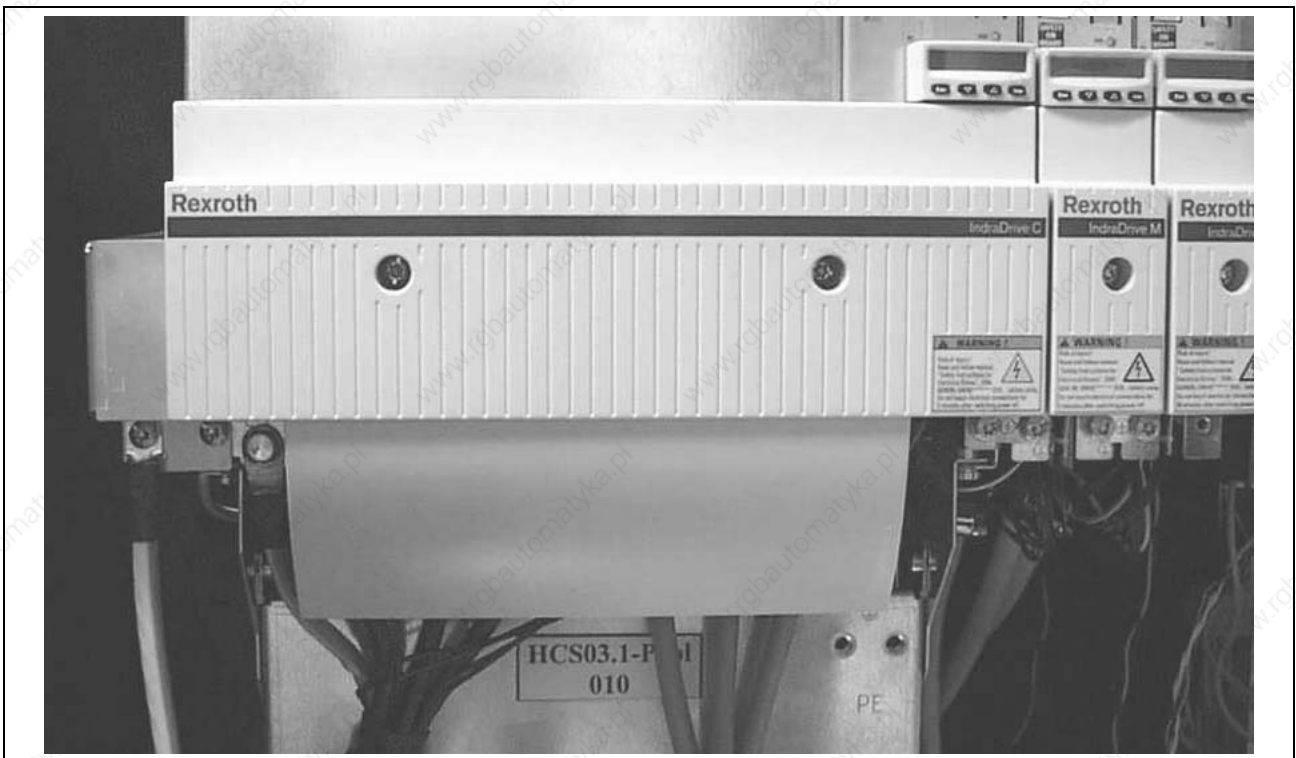


Fig. 14-61: HAS04.1-002 at drive system HCS03 with HMx01 with touch guard mounted

14.6 Accessories HAS05.1

Type Code HAS05.1

Abbrev. Column	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	
Example:	H	A	S	0	5	.	1	-	0	0	1	-	N	N	N	-	N	N																							

- 1. Product**
- 1.1 HAS. = HAS

- 2. Line**
- 2.1 Cable, connectors and adapter. = 05

- 3. Design**
- 3.1 1. = 1


- 4. Assignment**
- 4.1 Adapter
HCS03.1E-W0070 = 001
- 4.2 HMF01.1...0070 = 002
- 4.3 Level emulation Encoder emulation = 003
- 4.4 DC bus, 2 x 50 mm². = 004
- 4.5 RS232/RS485 converter = 005

- 5. Other features**
- 5.1 none = NNN
- 5.2 Fitting direction : on both sides = NNB
- 5.3 Fitting direction : lefthand = NNL
- 5.4 Fitting direction : righthand = NNR

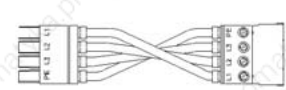
- 6. Other design**
- 6.1 none = NN

to field 4. Assignment

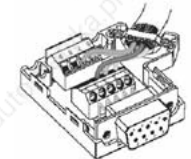
Adapter: "001"




Adapter: "002"




Adapter: "003"



Adapter: "004"



Adapter: "005"



DT000015v01_en.FH9

Fig. 14-62: Type code HAS05.1

Applications

The HAS05 accessories are used to:

HAS05 type	Application
HAS05.1-001-NNN-NN	is used for electrical connection between motor filter HMF01.1A-D0K2-D0045 and HCS03.1E-W0070, as well as between mains filter HNK01.1A-A075-E0050 and HCS03.1E-W0070
HAS05.1-002-NNN-NN	is used for electrical connection between mains filter HNK01.1A-A075-E0050 and HCS03.1E-W0070, if a motor filter has been mounted between HCS03.1 and mains filter
HAS05.1-003-NNN-NN	is used to increase voltage levels at output of optional module MEM to voltage range 5...30V
HAS05.1-004-NNN-NN	is used to increase the effective cross section of the DC bus contact bars at the connections L+ and L-
HAS05.1-005-NNN-NN	converts the serial interface of control sections from RS232 standard to RS485 standard

Fig. 14-63: HAS05 type

Scope of Supply

The HAS05.1 accessories have to be ordered separately.

Accessories HAS05.1-001-NNN-NN

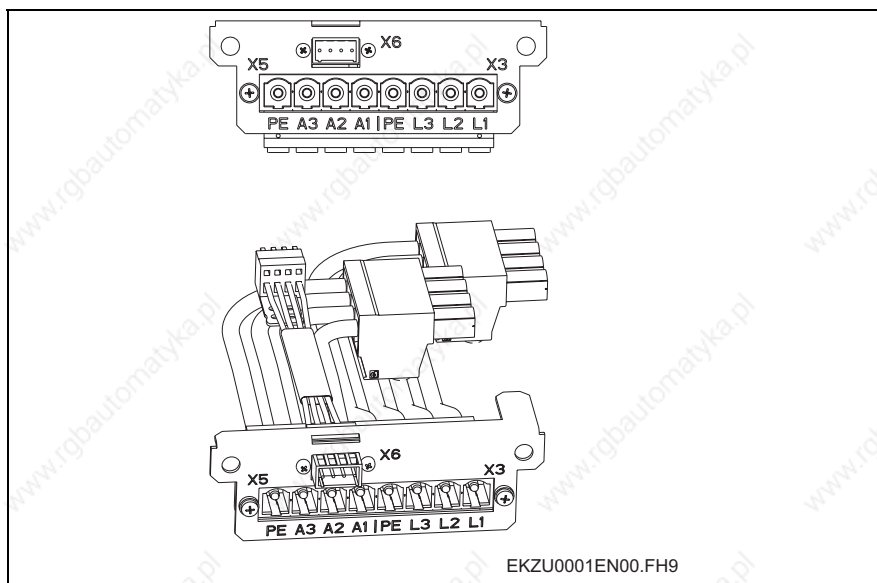


Fig. 14-64: Accessories HAS05.1-001

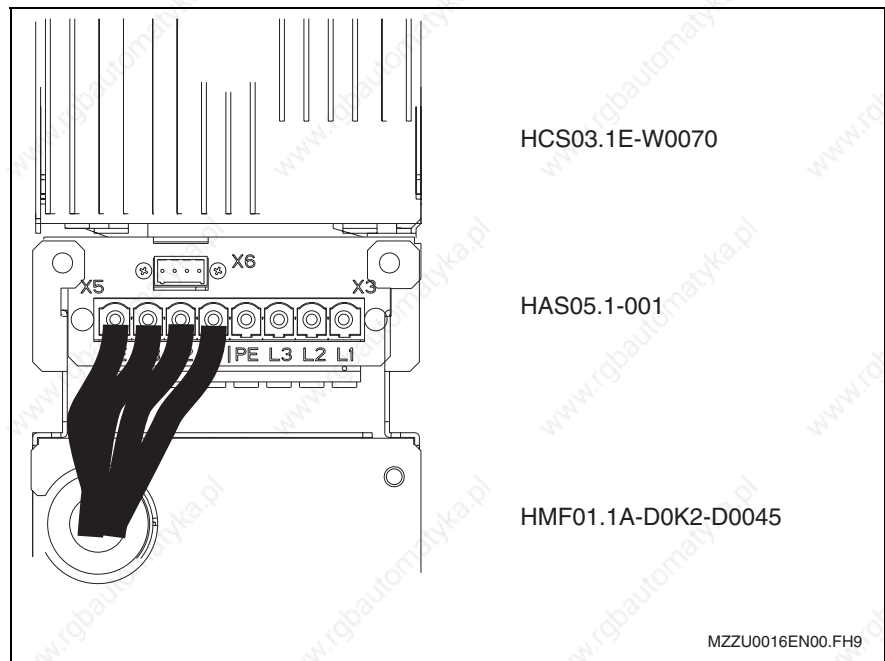


Fig. 14-65: Arrangement HCS / HAS / HMF

When mounting the motor filter HMF01.1 to HCS03.1, connection from filter to drive controller is established via connector X5 of HAS05.1-001.

When mounting the mains filter HNK01.1 to HCS03.1, connection from filter to drive controller is established via connector X3 of HAS05.1-001.

Accessories HAS05.1-002-NNN-NN

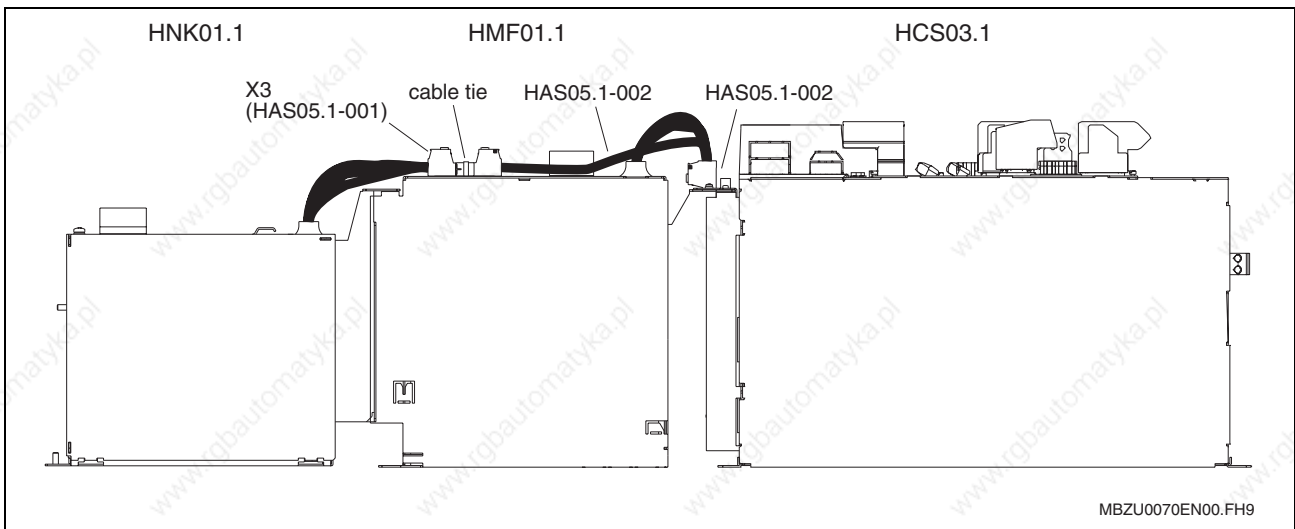


Fig. 14-66: Sample mounting HCS03.1 / HMF01.1 / HNK01.1 with accessories HAS05.1

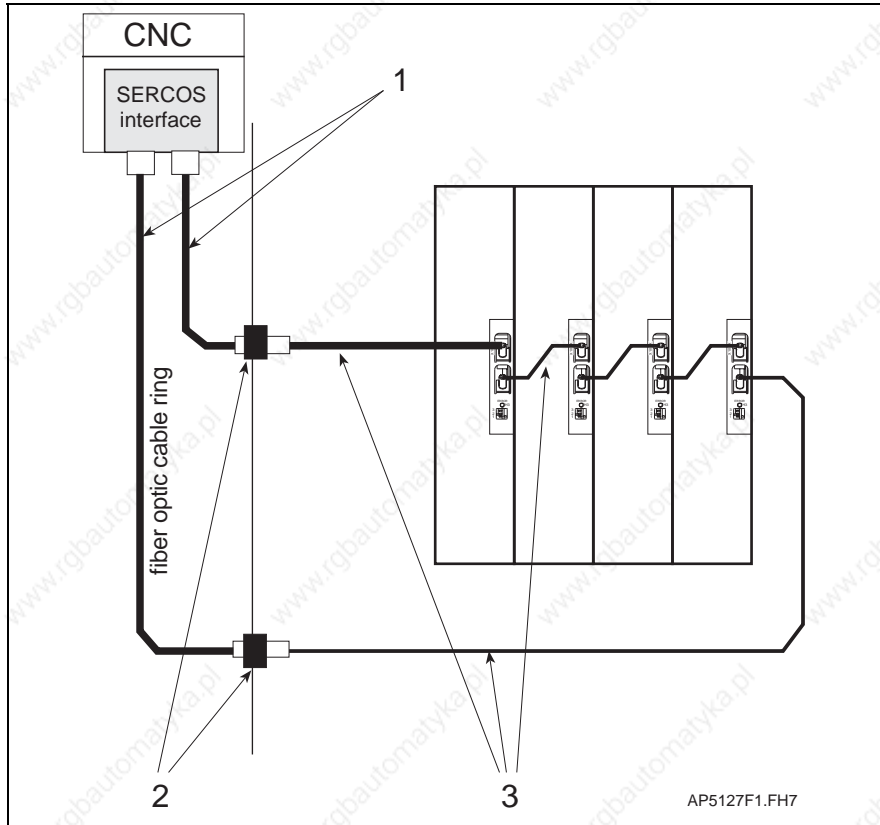
Accessories HAS05.1-003-NNN-NN and HAS05.1-005-NNN-NN

For the description of the accessories HAS05.1-003 and HAS05.1-005-NNN-NN see documentation "Rexroth IndraDrive, Drive Controllers, Control Sections, Project Planning Manual".

14.7 Accessories for Connection Technique

Fiber Optic Cable Connections

There are accessories available to connect drive controllers to the peripherals via fiber optic cables.



- 1: fiber optic cable connections outside of control cabinet
- 2: control cabinet duct
- 3: fiber optic cable connections inside of control cabinet

Fig. 14-67: Fiber optic cable connections

Installation location	Description	Type designation
outside of control cabinet	robust fiber optic cable connections from peripherals to control cabinet	RKO 0101
at control cabinet	control cabinet duct with plug-in connector	INS 0610
inside of control cabinet	fiber optic cable connections to and between drive controllers	RKO 0100

Fig. 14-68: Fiber optic cable connection elements

Note: For ordering the fiber optic cable connection you have to generate the complete order code containing details on type and length.

For the type designation please see the above table and add the required length to it.

Determine the length by means of the list of different device arrangements.

Example: Order code for arrangement HCS02 (left 105 mm) next to HCS02 (right 65 mm):

- required length: 0.25 m
- type designation: RKO 0100
- order code RKO 0101 / 0,25

Interconnection of Drive Controllers

For selecting the fiber optic cable connection of drive controllers take different possible combinations and different device widths into account.

Combination of HCS02 and HCS02

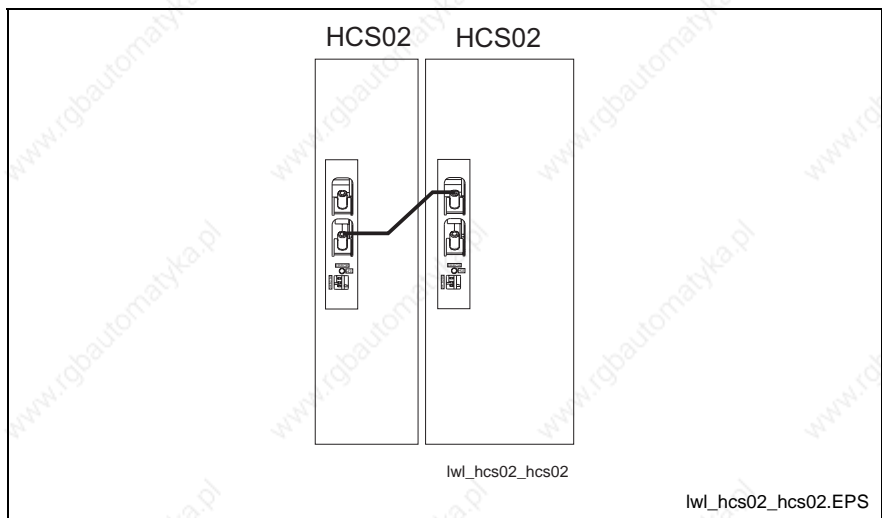


Fig. 14-69: HCS02 with HCS02

Required fiber optic cable length [m]		
Width left HCS02 [mm]	Width right HCS02 [mm]	
	65	105
65	0,15	0,15
105	0,25	0,25

Fig. 14-70: Fiber optic cable lengths

Combination of HCS02 to the Right of HMS or HMD

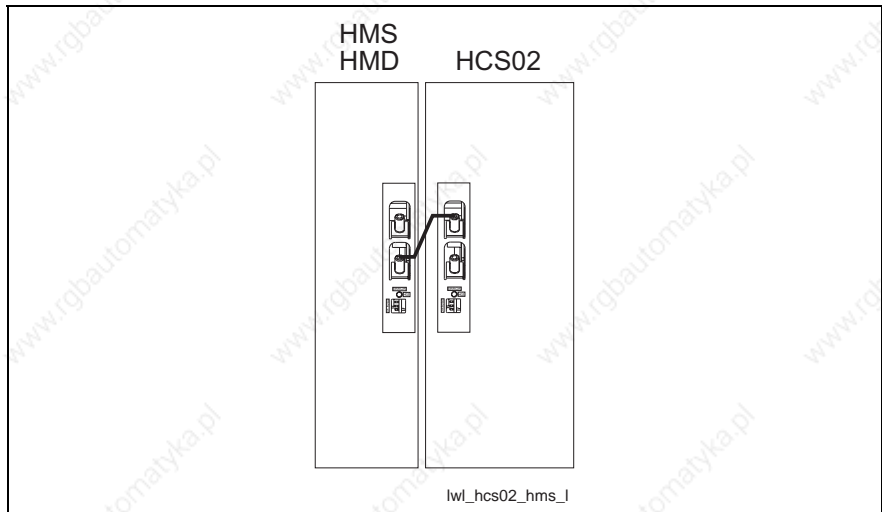


Fig. 14-71: HCS02 to the right of HMS or HMD

Independent of the width of the devices, cable length is 0.15 m.

Combination of HCS02 to the Left of HMS or HMD

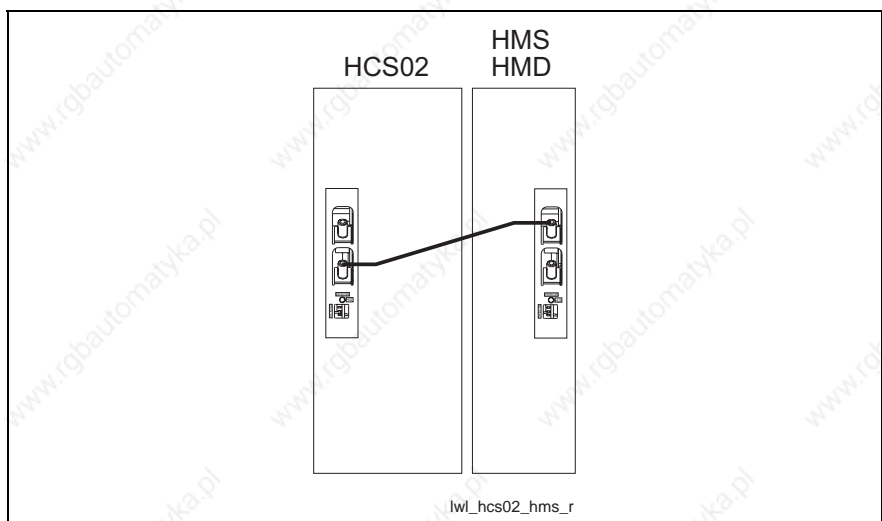


Fig. 14-72: HCS02 to the left of HMS or HMD

cable length = width HCS02 + width HMS/HMD + 10 cm

Required fiber optic cable length [m]				
Width HCS02 [mm]	Width HMS / HMD [mm]			
	50	75	100	125
65	0,25	0,25	--	--
105	0,25	0,30	0,30	0,30

Fig. 14-73: Fiber optic cable lengths

Combination of HCS03 to the Right of HMS or HMD

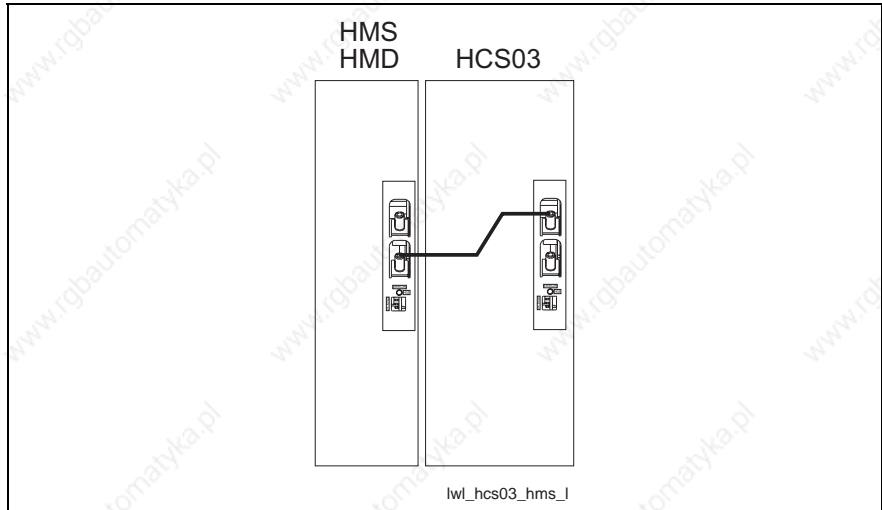


Fig. 14-74: HCS03 to the right of HMS or HMD

Combination of HCS03 to the Left of HMS or HMD

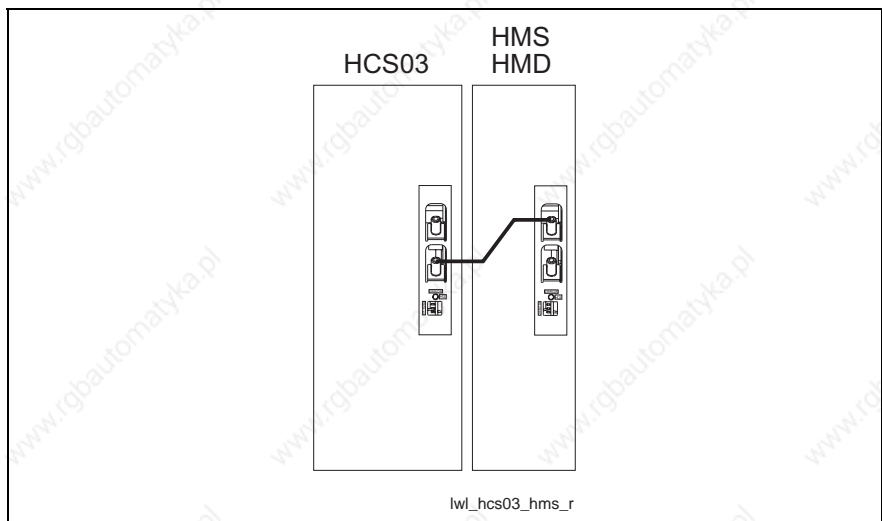


Fig. 14-75: HCS03 to the left of HMS or HMD

Required fiber optic cable length [m]								
Width left device [mm]	Width right device [mm]							
	50	75	100	125	150	200	225	350
50	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
75	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
100	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
125	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
150	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
200	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
225	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50
350	0,15	0,25	0,25	0,25	0,30	0,50	0,50	0,50

Fig. 14-76: Fiber optic cable lengths

Extension for Module Bus Connections

Application

The **bus cable RKB0001** is used to extend module bus connections of HMV01.1E and HMV01.1R devices with HMS01 / HMD01 drive controllers as well as HMV02.1R with HMS02.

The extension is required, if the distance between the drive controllers is more than 5 mm.

The bus cable can be ordered with lengths of 0.5 m to 40 m in steps of 0.5 m.

The cable consists of

- housing with hinged cover
- cable with strain relief mounted at both ends

For ordering generate the complete order code:

Example for required length 2.5 m:

- required length: 2.5 m
- type designation: RKB 0001
- order code RKB 0001 / 02,5

Scope of Supply

The RKB bus cable is available as an option, it is not part of the standard scope of supply.

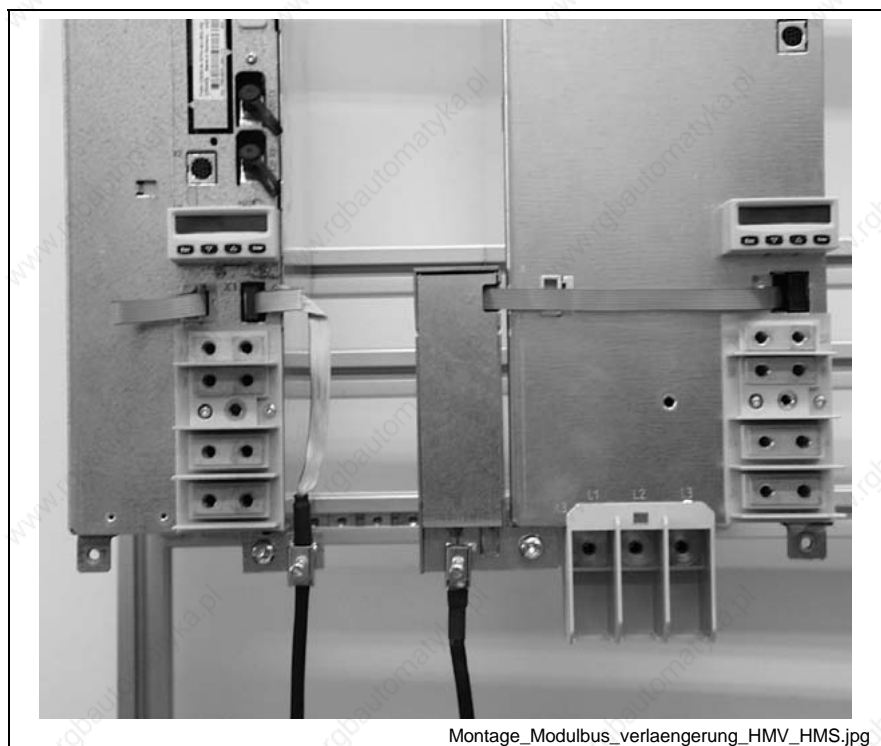


Fig. 14-77: Extension of module bus

How to Mount RKB Bus Cable

Mounting RKB bus cable:

1. Mount housing to ground strap.
2. Unscrew cover and plug ribbon cable of right device into circuit board.
3. Close cover.
4. Screw strain relief down to ground strap.
5. Plug ribbon cable into X1.

Note:

Make sure the connection between strain relief and ground strap is well conductive.

By means of appropriate wiring establish equipment grounding connections of devices that are not directly adjoining.

Notes

15 Calculations

15.1 Determining the Appropriate Drive Controller

Introduction

Supply for the drive system Rexroth IndraDrive takes place by means of compact converters HCS or mains supply modules HMV. According to drive task, design of drive controller and operating conditions, you can in addition use chokes, additional capacitors, braking resistors, transformers etc.

The drive controller or supply module has to make available the DC bus continuous power and for acceleration the DC bus peak power. With regenerative operation, they must be able to absorb the continuous recovery power and peak recovery power.

Before the drive controller or mains supply module and the additional components can be selected, the motors and drive controllers to be used must be defined.

To ensure correct dimensioning of the drive system, we recommend to do the calculations as described in the following sections.

DC Bus Continuous Power

DC bus continuous power is calculated from the mechanical power, taking into consideration the motor and controller efficiency, as well as simultaneity factors.

Mechanical Power

$$P_m [W] = M * \omega = \frac{M * n * 2\pi}{60} \quad \text{or}$$

$$P_m [kW] \approx \frac{M * n}{9550}$$

P_m : mechanical power
 M : torque [Nm]
 ω : angular velocity [min^{-1}]
 n : motor speed [min^{-1}]

Fig. 15-1: Mechanical power

Mechanical Continuous Power for Servo Drives

To calculate the mechanical continuous power of a servo drive, you need the effective motor torque and the average motor speed.

The effective motor torque can be taken over from the servo drive calculation. The average motor speed is determined as follows.

Average Motor Speed

For servo drive tasks at common NC machine tools, the average motor speed is approx. 25% of the rapid traverse speed. In some cases, however, this rough estimation is not sufficient. An exact calculation of the average motor speed is required.

If the period during which the motor is run at constant speed is significantly greater than the run-up and braking time, the following applies:

Average Speed with Run-Up and Braking Times not Taken into Account

$$n_{av} = \frac{n_1 * t_1 + n_2 * t_2 + \dots + n_n * t_n}{t_1 + t_2 \dots + t_n}$$

- n_{av}: average motor speed [min⁻¹]
- n₁ ... n_n: motor speed [min⁻¹]
- t₁ ... t_n: duty cycle [s]

Fig. 15-2: Average speed, effects of run-up and braking times not taken into account

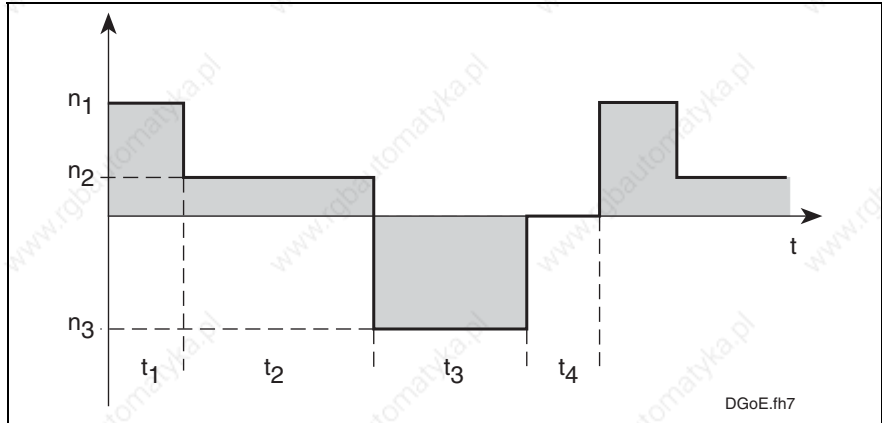


Fig. 15-3: Speed characteristic; effects of run-up and braking times not taken into account

In dynamic applications with short cycle times, e.g. roll feeds and nibbling machines, run-up and braking times must be taken into account.



CAUTION

Damage to the drive controller!

The DC bus capacitors in the drive controller have been dimensioned for loading with continuous power.

If loaded with cyclic charging and discharging processes of high energy content, the DC bus capacitors can be overloaded, especially with decreasing mains connection voltage.

⇒ Operate additional capacitors at the DC bus.

Average Speed with Run-Up and Braking Times Taken into Account

$$n_{av} = \frac{\frac{n}{2} * t_H + n * t_1 + \frac{n}{2} * t_B}{t_H + t_1 + t_B + t_2}$$

- n_{av}: average motor speed [min⁻¹]
- n: motor speed [min⁻¹]
- t: time [s]
- t_H: run-up time [s]
- t_B: braking time [s]

Fig. 15-4: Average speed; effects of run-up and braking times taken into account

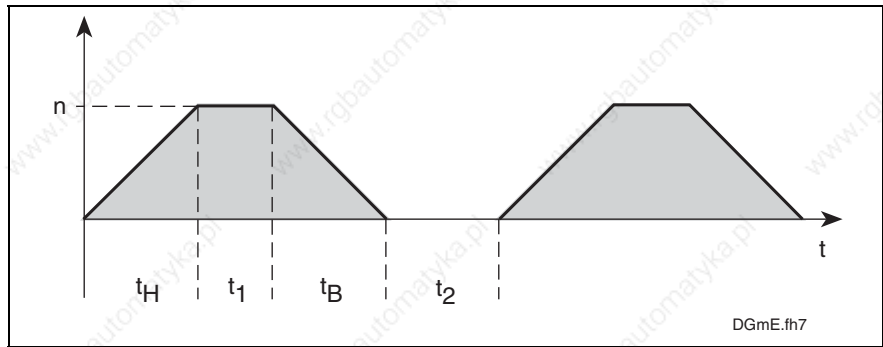


Fig. 15-5: Average speed; effects of run-up and braking times taken into account

Mechanical Power for Servo Drives

$$P_{mSe} = \frac{M_{eff} * n_{av}}{9550}$$

P_{mSe} : mechanical continuous power for servo drives [kW]
 M_{eff} : effective motor torque [Nm]
 n_{av} : average motor speed [min^{-1}]

Fig. 15-6: Mechanical power for servo drives

Mechanical Power for Main Drives

Main drives are drives which are mainly used in the constant power speed range. Thus, nominal power is decisive for dimensioning the mains supply. The mechanical nominal power of the main drives can be taken from the operation characteristic or calculated from nominal speed and nominal torque.

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

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

Fig. 15-7: Mechanical power for main drives

DC bus Continuous Power for Servo Drives

The drive controller or the combination of drive controllers has to make available the DC bus power. However, in most applications, simultaneous loading of all drives will not occur; thus, only the simultaneous load must be considered for calculating the DC bus continuous power to be made available for servo drives. To calculate the DC bus continuous power to be made available for typical NC feed axes at machine tools, inclusion of a so-called simultaneity factor has proved to be favorable in practical application:

Number of axes	1	2	3	4	5	6	n=7	n=n+1
Simultaneity factor (F_G)	1	1,15	1,32	1,75	2,0	2,25	$F_G=2,5$	$F_{Gn}=F_G+0,25$

Fig. 15-8: Simultaneity factors

$$P_{ZWDSe} = \frac{(P_{mSe1} + P_{mSe2} + \dots + P_{mSen}) * 1,25}{F_G}$$

P_{ZWDSe} : DC bus continuous power for servo drives [kW]
 $P_{mSe1} \dots P_{mSen}$: mechanical continuous power for servo drives [kW]
 F_G : simultaneity factor
 1,25: constant for motor and controller efficiency

Fig. 15-9: DC bus continuous power for servo drives

DC Bus Continuous Power for Main Drives

If several main drives are operated at one DC bus, the simultaneously required DC bus continuous powers must be added:

$$P_{ZWHa} = (P_{mHa1} + P_{mHa2} + \dots + P_{mHan}) * 1,25$$

P_{ZWHa} : DC bus continuous power for main drives [kW]
 $P_{mHa1} \dots P_{mHan}$: mechanical continuous power for main drives [kW]
 1,25: constant for motor and controller efficiency

Fig. 15-10: DC bus continuous power for main drives

Chokes and additional capacitors have to be selected according to the actually required DC bus continuous power. It is determined by the nominal power of the mains drives.

Note: When selecting the drive controllers, make sure that their maximum DC bus continuous power will not restrict the short-time operation power of the main drives.

CD Bus Continuous Power for Main and Servo Drives

When main and servo drives are operated at a drive controller, the required DC bus continuous powers must be added.

At a typical NC machine tool, the required DC bus continuous power will be primarily defined by the main drive. Accordingly, the following equation is to be used for such applications:

$$P_{ZWD} = [P_{mHa} + 0,3 * (P_{mSe1} + P_{mSe2} + \dots P_{mSen})] * 1,25$$

0,3: experimental value for standard machine tools
 1,25: constant for motor and controller efficiency
 P_{ZWD} : DC bus continuous power [kW]
 $P_{mSe1} \dots P_{mSen}$: mechanical continuous power for servo drives [kW]
 P_{mHa} : nominal power for main drive (shaft output) [kW]

Fig. 15-11: DC bus continuous power for main and servo drives at NC machine tools

$$\sum P_{ZWD, installation} \leq \sum P_{ZWD, devices}$$

$P_{ZWD, installation}$: generated DC bus continuous power of the installation
 $P_{ZWD, devices}$: allowed DC bus continuous power of the devices

Fig. 15-12: Supply condition: DC bus continuous power

DC Bus Peak Power

The drive controller or combination of drive controllers has to produce DC bus peak power for example when several axes of a machine tool simultaneously accelerate to rapid traverse rate after a tool change, approaching the workpiece.

**Damage due to supply unit overload!**

⇒ To avoid damage to the drive controller the sum of peak powers of all drives mustn't exceed the DC bus peak power of the supplying drive controller (central supply).

$$P_{ZWS} = \frac{(M_{NC} \pm M_G) * n_{eil} * 1,25}{9550}$$

- 1,25: constant for motor and controller efficiency
 M_{NC} : acceleration torque in the drive [Nm]
 M_G : torque due to weight for vertical axes [Nm]
 n_{eil} : speed at rapid traverse rate [min^{-1}]
 P_{ZWS} : DC bus peak power [kW]

Fig. 15-13: DC bus peak power per drive

$$\sum P_{ZWS, \text{installation}} \leq \sum P_{ZWS, \text{devices}}$$

- $P_{ZWS, \text{installation}}$: generated DC bus peak power of the installation
 $P_{ZWS, \text{devices}}$: allowed DC bus peak power of the devices

Fig. 15-14: Supply condition: DC bus peak power

Regenerative Power

When all main and servo drives connected to a drive controller or combination of drive controllers brake simultaneously, the generated regenerative power must not be greater than the maximum regenerative power of the drive controller or combination of drive controllers. If this is not taken into consideration in dimensioning the system, thermal destruction of the braking resistors in the drive controllers may occur.



CAUTION

Risk of damages due to braking resistor overload!

⇒ Only use a drive controller or combination of drive controllers that can absorb the resulting regenerative power generated when all main and servo drives connected to the drive controller or combination of drive controllers brake simultaneously.

$$W_{rot} = \frac{J_G}{2} * \left(n_{eil} * \frac{2\pi}{60} \right)^2$$

- W_{rot} : rotary energy [Ws]
 n_{eil} : speed at rapid traverse rate [min^{-1}]
 J_G : motor inertia and load inertia reduced to the motor shaft [kgm^2]

Fig. 15-15: Regenerative power per drive

$$\sum W_{R, \text{installation}} \leq \sum W_{R, \text{devices}}$$

- $W_{R, \text{installation}}$: generated regenerative power of the installation
 $W_{R, \text{devices}}$: allowed regenerative power of the devices

Fig. 15-16: Supply condition: regenerative power

Calculation to Reduce Generated Power Dissipation - Additional External Capacitances at DC Bus

When the drive brakes, the rotary energy present in the mechanical system is released as regenerative power in the DC bus of the drive controller or combination of drive controllers. It can

- be converted into dissipation heat via the braking resistor integrated in the drive controller or the additional braking resistor
- or -
- be stored as energy in the drive controllers and possibly available additional capacitors and reused for following acceleration processes. This reduces the power dissipation generated in the control cabinet and lowers the energy consumption.

The following applies to successful use of additional capacitors to avoid unnecessary power dissipation in the control cabinet:

$$\sum W_{R, \text{installation}} \leq \sum W_{ZW, \text{devices}}$$

$W_{R, \text{installation}}$: generated regenerative power of the installation

$W_{ZW, \text{devices}}$: storable energy of the DC bus capacitors

Fig. 15-17: Condition to avoid power dissipation from the regenerative power

Additional Capacitors as Energy Store

Many acceleration and deceleration processes are typical for applications with servo drives (e.g. nibbling machines or roll feeds). This is why it can be useful for such applications to connect additional capacitors to the DC bus of the drive controllers. This provides the following advantages:

- For drive controllers without mains regeneration function this prevents the braking resistor in the drive controller from being switched on when the drives brake: The dissipation heat in the control cabinet is considerably reduced.
- The energy stored in the DC bus capacitors can be used for acceleration. The energy demand of the drive is reduced.

Storable Energy in DC Bus

The specific energy absorption capacity of the drive controllers can be determined with the formula below.

$$W_{DC} = \frac{(C_{DC} + C_{DCext})}{2} * (U_{R_DC_On}^2 - U_{DC}^2)$$

W_{DC} : storable energy in DC bus

C_{DC} : DC bus capacitance in device [F]

C_{DCext} : external DC bus capacitance [F]

$U_{R_DC_On}$: braking resistor switch-on threshold

U_{DC} : DC bus voltage

Fig. 15-18: Storable energy in DC bus

The additional capacitor has to be dimensioned in such a way that it can store the rotary drive energy:

$$C_{DCext} \geq \frac{2W_{rot}}{(U_{R_DC\ On}^2 - U_{DC}^2)} - C_{DC}$$

$U_{R_DC\ On}$: braking resistor switch-on threshold

U_{DC} : DC bus voltage

W_{rot} : rotary energy [Ws]

C_{DC} : internal capacitance [F]

C_{DCext} : required external DC bus capacitance [F]

Fig. 15-19: Required additional capacitance [F]



CAUTION

Property damage caused by overload of H MV and HCS devices!

⇒ Comply with max. allowed external DC bus capacitance! See electrical data of the H MV and HCS components.



CAUTION

Property damage caused by overload of the additional external capacitors!

⇒ Use allowed components for drive system Rexroth IndraDrive.

⇒ The properties of the additional capacitors have to comply with minimum requirements:

min. **dielectric strength**: DC900V

min. **current load capacity**: $15A_{eff}$ / mF

min. **heat resistance**: 105 °C

max. **discharge time**: 30 min

Take measures against flammability in case of overload, e.g. by housing the capacitors.

⇒ **Connect correct polarity**: Connect L+ to positive pole and L- to negative pole of the additional capacitors.

Note: When using additional external capacitors, observe that the series connection of these units can require a balancing device.

Note: We recommend that you dimension the additional capacitors at the DC bus for 10% overvoltage at the mains connection.

Note: As the supply voltage increases the storable energy in the DC bus decreases, as the differential voltage between braking resistor threshold U_B and DC bus voltage U_{ZW} (crest value of supply voltage) is reduced.

The figure below illustrates the characteristic of the storable energy in the DC bus versus mains voltage with fixed switch-on threshold U_B by the example of HCS02.1E devices.

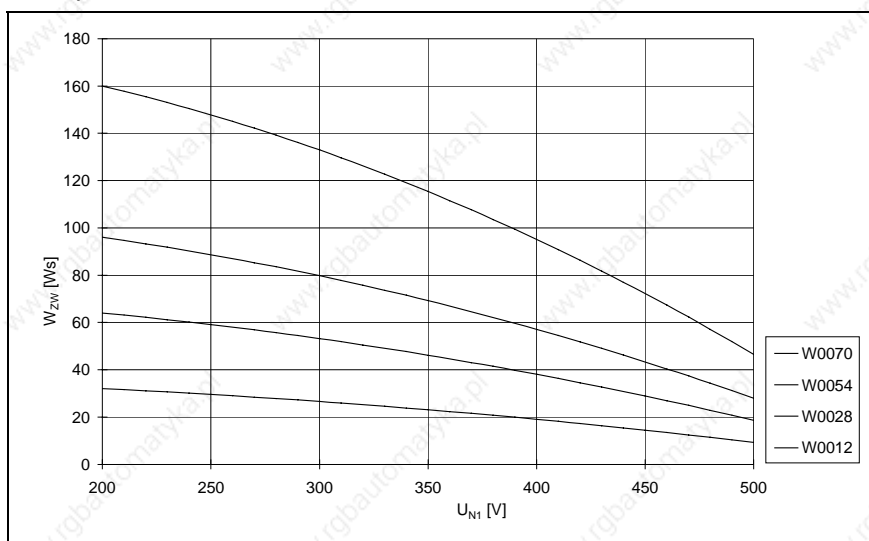


Fig. 15-20: Storable energy in DC bus

Continuous Regenerative Power

In terms of average period of time, the sum of the continuous regenerative power of all drives must not exceed the allowed continuous power of the braking resistor(s).

In applications with servo drives at typical NC machine tools, machining time is relatively long relative to the cycle time. Accordingly, the continuous regenerative powers are only small. For this type of applications, exact calculation is not required. It is sufficient to make sure that the regenerative peak power is not exceeded.

Exact calculation is required, for example, for one of the following applications:

- Applications with servo drives which are characterized by many acceleration and deceleration processes (e.g. nibbling machines or roll feeds).
- Machine tools with modular main drive.
- Applications which involve lowering of large masses, e.g. loading bridges, warehousing and transport systems.

Before the continuous regenerative power can be calculated, the rotary energy of the drives and the potential energy of non-balanced masses must be calculated.

$$W_{\text{rot}} = \frac{J_G}{2} * \left(n_{\text{eil}} * \frac{2\pi}{60} \right)^2 * z$$

W_{rot} : rotary energy [Ws]
 n_{eil} : speed at rapid traverse rate [min^{-1}]
 J_G : inertia (motor + load) [kgm^2]
 z : number of braking processes per cycle

Fig. 15-21: Rotary energy of the drives

$$W_{\text{pot}} = m * g * h * z$$

W_{pot} : potential energy [Ws]
 m : load mass [kg]
 g : gravitational acceleration = 9,81 m/s²
 h : lowering height [m]
 z : number of lowering processes per cycle

Fig. 15-22: Potential energy of non-balances masses

$$P_{RD,installation} = \frac{W_{\text{potg}} + W_{\text{rotg}}}{t_z} ; \sum P_{RD,installation} \leq \sum P_{BD,devices}$$

$P_{RD,installation}$: generated continuous regenerative power [kW]
 $P_{BD,devices}$: allowed braking resistor continuous power [kW]
 t_z : cycle time [s]
 W_{potg} : sum of potential energies [kWs]
 W_{rotg} : sum of rotary energies [kWs]

Fig. 15-23: Continuous regenerative power

Peak Regenerative Power

Usually, peak regenerative power will occur when an E-Stop signal is triggered and all axes brake simultaneously.



CAUTION

Risk of damage due to extended braking times and distances!

⇒ Select the device such that the sum of peak regenerative powers of all drives does not exceed braking resistor peak power of the supply unit.

See the respective motor selection documentation for the peak regenerative powers.

Peak regenerative power can be roughly estimated by the following equation:

$$P_{RS} = \frac{M_{\text{max}} * n_{\text{max}}}{9550 * 1,25} \quad \sum P_{RS,installation} \leq \sum P_{BS,devices}$$

$P_{RS,installation}$: generated peak regenerated power [kW]
 $P_{BS,devices}$: allowed braking resistor peak power [kW]
 M_{max} : maximum drive torque [Nm]
 n_{max} : maximum NC useful speed [min⁻¹]
 1,25: constant for motor and controller efficiency

Fig. 15-24: Peak regenerative power

Calculating Control Factor

The control factor of an inverter is the ratio of its output voltage to a reference output voltage.

The reference output voltage is the output voltage of the inverter at mains input voltage without overload.

$$a = \frac{U_{out}}{U_{out_ref}} = \frac{U_{out}}{U_{LN}}$$

U_{out} output voltage of inverter
 U_{ref} reference output voltage
 U_{LN} mains voltage

Fig. 15-25: Control factor

If several inverters have effect on one supply unit at the same time, you have to consider the so-called mean control factor.

$$\bar{a} = \frac{1}{n} * \sum_{i=1}^n a_i$$

a_i : several control factors

Fig. 15-26: Mean control factor

15.2 Calculations for Mains Connection

Calculating Mains-Side Phase Current

To select an appropriate mains contactor and the appropriate fusing of the power connection, the mains-side phase current I_N has to be calculated before.

The mains-side phase current I_N is determined from the mains connected load S_{LN} .

For max. mains connected load see technical data of the drive controllers or calculate according to formula below and formulas contained in appendix. For several drive controllers add the individual mains connected loads.

$$P_{DC} = \frac{M_{EFF} \cdot n_{MITTEL} \cdot 2 \cdot \pi \cdot k}{60}$$

- P_{DC} : required DC bus continuous power [W]
 M_{EFF} : effective torque [Nm]
 n_{MITTEL} : average speed [min⁻¹]
 k : factor for motor and controller efficiency = 1,25 (MKD, MHD)

Fig. 15-27: Calculating the DC bus power

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

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

Fig. 15-28: Calculating the mains connected load

single-phase connection:
$$I_{LN} = \frac{S_{LN}}{U_{LN}}$$

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

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

Fig. 15-29: Calculating the mains-side phase current

Calculating the Inrush Current

$$I_{EIN} = \frac{U_{LN} \cdot \sqrt{2}}{R_{DC(Start)}}$$

$$I_{EINGesamt} = \sum I_{EIN}$$

- I_{EIN} : inrush current of respective device [A]
 $I_{EINGesamt}$: total inrush current in A (relevant value for fusing)
 U_{LN} : mains input voltage
 $R_{DC(Start)}$: softstart resistor of the device (see respective technical data)

Fig. 15-30: Calculating the inrush current

Note: For calculating the inrush current take all devices connected to mains voltage into account.

Mains Contactor and Fusing

To facilitate the selection of an appropriate mains contactor and fusing device for power connection there are selection tables available in chapter "Fusing and Selecting the Mains Contactor".

Calculating the Mains Harmonics

Harmonic Load THD

The harmonic load of the mains is described by the THD (total harmonic distortion):

$$THD = \sqrt{\sum_{n=2}^{40} \left(\frac{I_n}{I_1} \right)^2}$$

- I_n : harmonic current of the n-th harmonic
- I_1 : rms value of the 1st harmonic (fundamental wave)
- I_2 : rms value of the 2nd harmonic
- I_n : rms value of the n-th harmonic

Fig. 15-31: THD (total harmonic distortion)

Harmonic Content / Distortion Factor k

The harmonic content of, for example, the mains current is described by the distortion factor k. The distortion factor contains all alternating components, both those of the fundamental wave (I_1) and of the harmonics (I_k). Direct components (I_0) are not contained.

$$k = \frac{\sqrt{\sum_{k=2}^n I_k^2}}{\sqrt{\sum_{k=1}^n I_k^2}} = \sqrt{\frac{I_2^2 + I_3^2 + \dots}{I_1^2 + I_2^2 + I_3^2 + \dots}}$$

- k: distortion factor or harmonic content
- I_k : harmonic current of the k-th harmonic
- I_1 : rms value of the 1st harmonic (fundamental wave)
- I_2 : rms value of the 2nd harmonic
- I_n : rms value of the n-th harmonic

Fig. 15-32: Distortion factor k or harmonic content

Power Factor $\cos\phi_1$ or DPF for Calculating the Reactive Power Load of the Mains

The power factor $\cos\phi_1$ or DPF (Distortion Power Factor) is used to calculate the reactive power load of the mains:

$$DPF = \cos \phi_1 = \frac{P_{netz}}{S_{1LN}}$$

- P_{netz} : effective mains power
- S_{1LN} : apparent mains power of fundamental wave

Fig. 15-33: Power factor $\cos \phi_1$ / DPF

Power Factor $\cos\varphi$ or TPF (λ)

The power factor $\cos\varphi$ or TPF is used for rating mains components (transformer, fuse etc.):

$$\text{TPF} = \lambda = \cos \varphi = \frac{P_{\text{netz}}}{S_{\text{LN}}}$$

P_{netz} : effective mains power

S_{LN} : apparent mains power

Fig. 15-34: Power Factor $\cos \varphi$ / TPF / λ

Note: Only for sinusoidal values does the power factor $\cos\varphi$ equal the total power factor TPF (λ).

Calculating Allowed Continuous Powers in Common DC Bus

By interconnecting the DC bus connections of several HCS02 and HLB01 drive controllers the regenerative power and continuous power generated in the common DC bus is equally distributed to all IndraDrive C components with braking resistor.

Distribution to the involved components takes place with high balancing factor.

For Central Supply and Group Supply with DC Bus Connection

$$\sum P_{BD, devices} = \sum (P_{BD, HCS} + P_{BD, HLB}) * f$$

$P_{BD, devices}$: braking resistor continuous power that all devices at common DC bus can process in continuous operation, in kW

$P_{BD, HCS02}$: braking resistor continuous power that the drive controller can process in continuous operation, in kW

$P_{BD, HLB01}$: braking resistor continuous power that the additional braking resistor module can process in continuous operation, in kW

f: **balancing factor for parallel operation (see electrical data)**

Fig. 15-35: Available braking resistor continuous power at common DC bus

$$\sum P_{ZW, devices} = \sum P_{ZW} * f$$

$P_{ZW, devices}$: available DC bus continuous power at common DC bus, in kW

P_{ZW} : DC bus continuous power of the individual devices, in kW

f: **balancing factor for parallel operation (see electrical data)**

Fig. 15-36: Available DC bus continuous power at common DC bus

For Individual Supply and Group Supply without DC Bus Connection

See chapters "Electrical Data" and "Mains Connection" in the respective Project Planning Manuals of the components.

15.3 Determining Appropriate Mains Connection Components

Mains Choke HNL

When using mains chokes, take their effect on the connected drive controllers into account. Due to their inductance, mains chokes have a smoothing effect on the current and thereby reduce harmonics.

To have the inductance available, comply with the nominal current of the mains choke.

Depending on the type of mains connection, we distinguish two cases.

Case 1: Only one drive controller or mains supply unit is connected to the mains choke (individual supply and central supply).

Selection criteria:

- Use of assigned mains choke acc. to Project Planning Manual of drive controller or mains supply unit.

Case 2: Several drive controllers or mains supply units are connected to the mains choke (group supply with and without DC bus connection).

Selection criteria:

- Nominal current:

$$I_N \geq \sum I_{LN}$$

I_{LN} : mains-side phase current in A

I_N : nominal current of mains choke in A

Fig. 15-37: Mains choke conditions

- Nominal inductance:
The nominal inductance of the individual mains choke has to be at least as high as the inductance of the greatest assigned mains choke of the connected drives or mains supply.

15.4 Using the Loop-Through Contacts for Control Voltage Supply

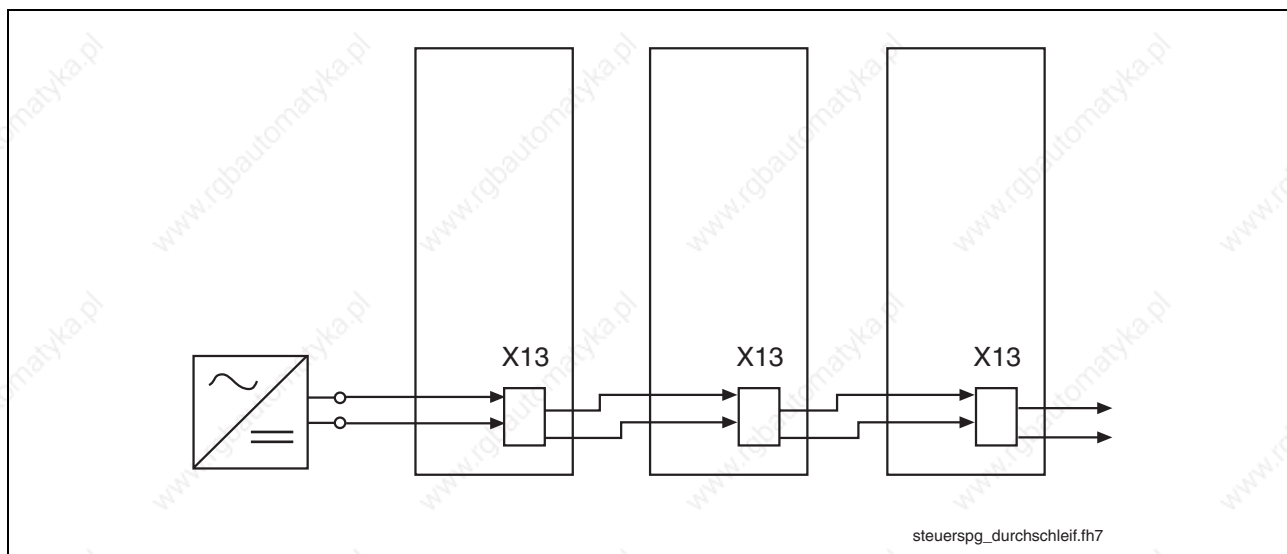


Fig. 15-38: Looping through the control voltage

Calculation for 3 drive controllers:

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

Fig. 15-39: Continuous current I_D

$$I_E = 3 \times I_{EIN3}$$

Fig. 15-40: Inrush current I_E

The inrush current peak is present for the specified duration $t_{EIN3Lade}$.

15.5 Determining the Leakage Capacitance

The leakage capacitance consists of the values of motor cable and motor of all individual drives operated at the mains filter. It is calculated as follows:

$$C_{_ab_G} = C_{_ab_MG} + C_{_ab_KG}$$

$C_{_ab_G}$: 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. 15-41: Total leakage capacitance

The total capacitance $C_{_ab_MG}$ consists of the sum of capacitances of the individual motors. For these individual capacitances see Project Planning Manual for motor (a list of selected values is contained in the appendix of this drive system documentation).

$$C_{_ab_MG} = C_{_ab} (Motor_1) + C_{_ab} (Motor_2) + \dots + C_{_ab} (Motor_n)$$

$C_{_ab}$: leakage capacitance of a motor

Fig. 15-42: Total leakage capacitance of motor

$$C_{_ab_KG} = C_{Belag_K1} * I_{K1} + C_{Belag_K2} * I_{K2} + \dots + C_{Belag_Kn} * I_{Kn}$$

C_{Belag_K1} : capacitance of cables

$C_{_ab_KG}$: total leakage capacitance of cables

Fig. 15-43: Total leakage capacitance of cables

The total capacitance $C_{_ab_KG}$ consists of the sum of capacitances of the individual motor cables. For the individual capacitances see the technical data of motor cables (a list of selected values is contained in the appendix of this drive system documentation).

15.6 Calculations for Determining the Allowed Operating Data of Mains Filters

Reducing Allowed Operating Voltage Depending on Actual Temperature Rise due to Harmonics

The mains filters may only be operated in the allowed mains voltage range. Harmonics (f_n) at the system voltage cause additional temperature rise of the dielectric of the capacitors used in the filter. Temperature rise can be calculated according to the following formula:

$$\Delta T_n = \frac{10 \times (U_{Mn})^2}{(U_{Gn})^2} [\text{K}]$$

U_{Mn} : measured voltage value at frequency f_n (harmonic)
 U_{Gn} : voltage limit value for frequency f_n
 ΔT_n : calculated temperature rise of the dielectric for frequency f_n

Fig. 15-44: Calculating the temperature rise of the dielectric

The temperature rises have to be added up for all frequencies $f_n \geq f_k$ (f_k : frequency at which the voltage derating of the filter starts; see Fig. 15-46):

$$\Delta T_{\text{ges}} = \sum_{v=1}^m \Delta T_v = \sum_{v=1}^m \frac{10 \times (U_{Mv})^2}{(U_{Gv})^2} [\text{K}] \leq 10 [\text{K}]$$

U_{Mv} : voltage value at frequency f_v
 U_{Gv} : voltage limit value for frequency f_v
 ΔT_{ges} : calculated temperature rise of the dielectric for all frequencies

Fig. 15-45: Calculating the temperature rise of the dielectric for all frequencies

By means of the above formulas and the measured voltages it is possible to determine the real load of a filter with voltages of higher frequencies. To this end, the rms value of the voltage on the mains side of the filter with all occurring frequencies (higher than f_k) must be measured by means of a Fourier analysis for all combinations of line/line and line/PE. You always have to measure the voltages under conditions of operation at the nominal working point, the filter having been installed. By means of the measured values it is then possible to calculate the temperature rise. To do this, the limit values of the following diagram are read at the respective frequency and used in the formula together with the measured value.

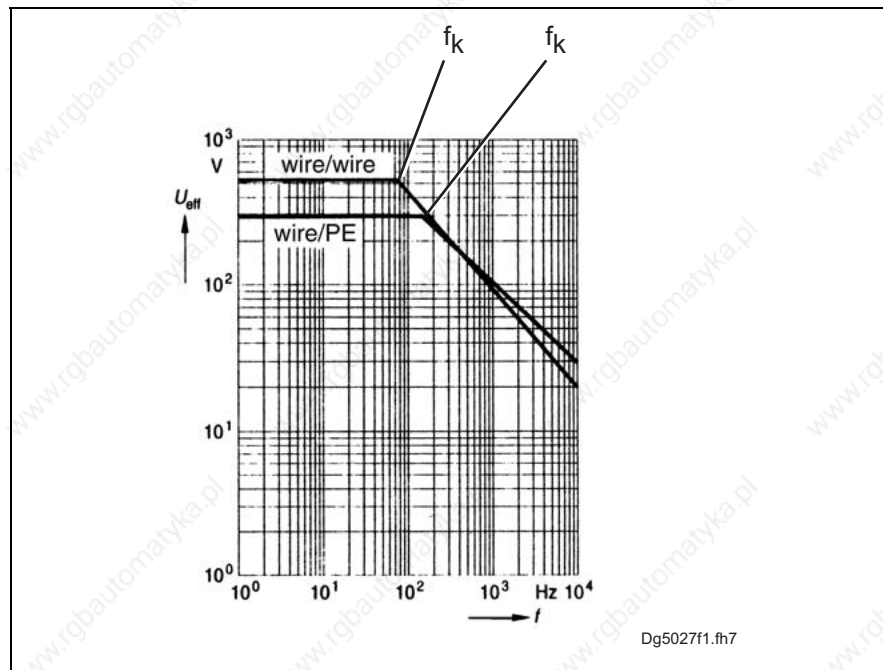


Fig. 15-46: Derating

If the total of the temperature values is greater than 10 K, the harmonics have to be reduced by means of appropriate measures.

Current Reduction in the Case of Overtemperature

The mains filters recommended by Rexroth have been dimensioned for an ambient temperature of 45 °C.

For higher temperatures reduce the mains current according to the following formula:

$$I = I_{\text{Netz}} \cdot \sqrt{\frac{85 - T_{\text{amb}}}{40}}$$

I_{Netz} : nominal current of filter at 45 °C

T_{amb} : ambient temperature

Fig. 15-47: Current reduction in the case of overtemperature

15.7 Determining the Data for Selecting the 24V Supply

At HCS02 and HLB01.1C devices the external 24V supply takes place via the connection X13, at the devices HCS03, HMS01, HMS02, HMD01, HLB01.1D, HMV02 and HMV01 via the connections 24V and 0V at the terminal block.

Via these connections the devices are supplied with 24V for

- the power section of the drive controller
- brake control via X6 and
- the control section of the drive controller.

The following performance data are required for selecting the control voltage supply:

- nominal voltage of supply
- continuous current capacity of supply
- peak current capacity of supply

Nominal Voltage of 24V Supply

The nominal voltage results from the intersection of the allowed voltage ranges of the components used.

Continuous Current Capacity of 24V Supply

The continuous current capacity of the control voltage supply has to correspond at least to the sum of continuous currents of the connected components. The continuous current results from the power PN3 of the components and the nominal voltage of the selected 24V supply.

-
- Note:** The continuous current of a drive controller consists of
- the continuous current of the control section
 - the continuous currents of the optional modules of the control section that are used
 - the continuous current of the power section
 - the continuous current of motor brakes to be operated.
-

Peak Current Capacity of 24V supply

The peak current capacity of the control voltage supply has to correspond at least to the sum of peak currents of the connected components for the duration of the inrush current.

-
- Note:** The peak current of a drive controller consists of
- the peak current of the control section
 - the peak currents of the optional modules of the control section that are used
 - the peak current of the power section
 - the peak current of motor brakes to be operated.
-

To determine the required peak current capacity of the 24V supply the following approximate calculation is allowed:

$$I_{peak} \geq 1,2 \times I_{cont}$$

I_{peak} : required peak current capacity

Fig. 15-48: Approximate calculation I_{peak} from I_{cont} for 24V supply

The 24V supply has to be able to supply the current I_{peak} for at least 100 ms.

15.8 Determining the Braking Behavior when Using DC Bus Resistor Unit HLB01 (DC Bus Short Circuit)

in preparation

15.9 Other Calculations

Loading the DC Bus

To estimate the delay time t_d which a supply unit or a converter needs to load the DC bus, consider the following aspects:

- delay time t_d from connecting the mains voltage to the device (from status "ready for operation") to status "drive ready".
See also parameter "P-0-0115, Device control: status word"

Delay Time t_d

$$t_d = R_{lade} * 1,2 * C_{DC} * 3 + 200ms$$

t_d delay time
 R_{lade} effective loading resistance
 C_{DC} effective DC bus capacitance

Fig. 15-49: Delay time for three-phase operation

Note: For single-phase operation take the time twice as much.

Effective Load Resistance with Several Mains Inputs

Effective load resistance of several drive controllers at common DC bus connected to mains voltage:

$$\frac{1}{R_{lade}} = \frac{1}{R_{lade_1}} + \frac{1}{R_{lade_2}} + \dots + \frac{1}{R_{lade_n}}$$

Fig. 15-50: Several loading resistances

Effective Load Resistance with One Mains Connection

Effective load resistance of one drive controller at common DC bus connected to mains voltage:

$$R_{lade} \approx \frac{U_{LNmax}}{I_{Ltrans\ max\ (on)}}$$

U_{LNmax} see technical data of drive controllers
 $I_{Ltrans\ max\ (on)}$ see technical data of drive controllers

Fig. 15-51: Loading resistance

Resulting DC bus Capacitance C_{DC}

Resulting DC bus capacitance of all drive controllers at common DC bus:

$$C_{DC} = C_{DC1} + C_{DC2} + \dots + C_{DCn} + C_{DCext}$$

C_{DC} see technical data of drive controllers

Fig. 15-52: DC bus capacitance

Notes

16 Replacing Devices

16.1 General Information

The diagnostic display enables aimed and effective troubleshooting in order to:

- avoid production downtimes due to extensive searches in individual devices and repairs of devices in the installation.
- start operating the installation again without extensive assembly and adjustments.
- quickly eliminate the problem and easily replace defective drive components.

When returning a defective device to our Customer Service, please enclose the completed Fault Report. The Fault Report is included in this chapter and may be copied for your convenience.

Note: The new drive component must have the same type designation as the faulty device. To ensure this, indicate the entire type designation when requesting replacement parts.

16.2 How to Proceed When Replacing Devices

Note: For replacing devices you absolutely have to observe the safety instructions contained in chapter 3!

Replacing the Drive Controller

- save parameter set
- open main switch
- make sure main switch cannot be switched on again
- make sure drive controller is completely de-energized



DANGER

Lethal electric shock caused by contact to live parts!

⇒ Before touching live parts allow the capacitors to discharge! Only then start working on the connection cables!

-
- remove touch guard and separate connecting lines from drive controller
 - unscrew screws on top and bottom of housing
 - take drive controller out of drive system
 - mount new drive controller
 - connect new drive controller as specified in machine circuit diagram
 - mount touch guard
 - copy firmware and parameter set to new drive controller (see firmware documentation)

Replacing the Motor

- open main switch
- make sure main switch cannot be switched on again
- disconnect plug-in connectors

Note: When replacing the motor, cover the open mating sites of power lines with protective caps if sprinkling with cooling liquid/lubricant or soiling may occur (allowed degree of soiling according to EN50178: 2).

- replace motor

Note: To mechanically replace the AC servo motor, observe the instructions of the machine manufacturer.

- connect plug-in connectors



WARNING

Risk of accident due to accidental axis movement.

⇒ Servo axes with indirect distance measuring system via the motor encoder will lose the position data reference when the motor is replaced! This position data reference to the machine coordinate system must therefore be reestablished after replacement.

-
- for servo axes with absolute motor encoder, reestablish the position data reference

Replacing Cables



WARNING

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

⇒ Power connectors of the cables may only be separated or connected if the installation has been de-energized!

Note: When replacing cables, observe the instructions of the machine manufacturer.

If you do not use ready-made Rexroth cables, check to ensure that the cables match the terminal diagram of the machine manufacturer!

- open main switch
- make sure main switch cannot be switched on again
- disconnect plug-in connectors

Note: When replacing cables, cover the open mating sites of power lines with protective caps if sprinkling with cooling liquid/lubricant or soiling may occur (allowed degree of soiling according to EN50178: 2).

- replace cable



CAUTION

Property damage caused by bad power connectors!

⇒ Only separate or connect clean and dry power connectors.

- connect plug-in connectors

16.3 Fault Report

<h1>Rexroth Bosch Group</h1>	<h2>Fault Report for Drive Systems</h2>	Date: Report No.:		
This fault report is intended to help eliminate problems that might possibly be related to drive systems. Please fill it out carefully and send it, together with the parameter file with which the fault occurred, to Bosch Rexroth .				
Contact person: Customer (machine manufacturer): End customer: Branch of industry:	Telephone: Fax: E-mail: @			
<h3>System description:</h3> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <p><u>Firmware</u> Firmware version: FWA- - - V -MS</p> <p><u>Software:</u> DriveTop version: SWA-DTOP**-INB- V -MS Operating system: Service pack: Language: PC designation: Hardware configuration (system RAM, hard disk memory,...):</p> </td> <td style="width: 50%; vertical-align: top;"> <p><u>Drive system</u></p> <p>Power section: Type code: - - - - Serial number: SN Hardware index:</p> <p>Control section: Type code: - - - - - - Serial number: SN Hardware index:</p> <p>Supply module: Type code: - - - - Serial number:</p> </td> </tr> </table>			<p><u>Firmware</u> Firmware version: FWA- - - V -MS</p> <p><u>Software:</u> DriveTop version: SWA-DTOP**-INB- V -MS Operating system: Service pack: Language: PC designation: Hardware configuration (system RAM, hard disk memory,...):</p>	<p><u>Drive system</u></p> <p>Power section: Type code: - - - - Serial number: SN Hardware index:</p> <p>Control section: Type code: - - - - - - Serial number: SN Hardware index:</p> <p>Supply module: Type code: - - - - Serial number:</p>
<p><u>Firmware</u> Firmware version: FWA- - - V -MS</p> <p><u>Software:</u> DriveTop version: SWA-DTOP**-INB- V -MS Operating system: Service pack: Language: PC designation: Hardware configuration (system RAM, hard disk memory,...):</p>	<p><u>Drive system</u></p> <p>Power section: Type code: - - - - Serial number: SN Hardware index:</p> <p>Control section: Type code: - - - - - - Serial number: SN Hardware index:</p> <p>Supply module: Type code: - - - - Serial number:</p>			
<p><u>Motor</u> Type designation: Serial number: S.No. Motor encoder: Mounting position:</p>	<p>Additional components (e.g. control system involved, external encoder, filter, cooling system in control cabinet,...):</p>			
Fault description (detailed description of situation before, during and after fault occurred):				
To quickly resolve your problem we ask you to send us also the parameter set with which the fault occurred. Name of parameter set file:				

General conditions:

Mode at time fault occurred: Operating mode Parameterization mode
 Switch phase

Operating mode active at time fault occurred: Encoder , ,

7-segment display... ..before fault occurred:
 ...after fault occurred:

Fault status	Causes	Other defects
<input type="checkbox"/> occurs permanently	<input type="checkbox"/> unknown	<input type="checkbox"/> problems in the mechanical system
<input type="checkbox"/> occurs during commissioning	<input type="checkbox"/> incorrect connection	<input type="checkbox"/> power section failure
<input type="checkbox"/> occurs sporadically	<input type="checkbox"/> external cause	<input type="checkbox"/> control system failure
<input type="checkbox"/> occurs after approx. hours	<input type="checkbox"/> mechanical damage	<input type="checkbox"/> motor failure
<input type="checkbox"/> occurs with shocks	<input type="checkbox"/> loose cable connect.	<input type="checkbox"/> cable break
<input type="checkbox"/> depends on temperature	<input type="checkbox"/> moisture in unit	<input type="checkbox"/> defective blower
	<input type="checkbox"/> foreign body in unit	<input type="checkbox"/> defective feedback

Wiring / mechanical setup (e. g. length of cables, grounding, assembly,...):

Information on the machine (e. g. operating hours, type, serial number,...):

Mains conditions (e. g. frequency, voltage,...):

Ambient conditions (e. g. ambient temperature, humidity,...):

In case of problems with DriveTop

Name of dialog in which fault occurred:

Drive connection:

Note: In order to resolve your DriveTop problem quickly, we would like to ask you to send us the file "debug.log". You can find it in the DriveTop directory.

Fig. 16-1: Fault report

Notes

17 Disposal and Environmental Protection

17.1 Disposal

Products

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

In addition, when returned the products mustn't contain any undue foreign matter or foreign component.

Please send the products free domicile to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Bürgermeister-Dr.-Nebel-Straße 2
D-97816 Lohr am Main

Packaging Materials

The packaging materials consist of cardboard, wood and polystyrene. They can be easily recycled. For ecological reasons you should not return the empty packages to us.

17.2 Environmental Protection

No Release of Hazardous Substances

Our products do not contain any hazardous substances that they can release in the case of appropriate use. Normally there aren't any negative effects on the environment to be expected.

Materials Contained in the Products

Electronic Devices

Electronic devices mainly contain:

- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

Motors

Motors mainly contain:

- steel
- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

Recycling

Due to their high content of metal most of the product components can be recycled. In order to recycle the metal in the best possible way it is necessary to disassemble the products into individual modules.

The metals contained in the electric and electronic modules can also be recycled by means of specific separation processes.

The synthetic materials remaining after these processes can be thermally recycled.

18 Service & Support

18.1 Helpdesk

Unser Kundendienst-Helpdesk im Hauptwerk Lohr am Main steht Ihnen mit Rat und Tat zur Seite. Sie erreichen uns

- telefonisch - by phone:
über Service Call Entry Center
- via Service Call Entry Center

Our service helpdesk at our headquarters in Lohr am Main, Germany can assist you in all kinds of inquiries. Contact us

+49 (0) 9352 40 50 60
Mo-Fr 07:00-18:00
Mo-Fr 7:00 am - 6:00 pm

- per Fax - by fax:

+49 (0) 9352 40 49 41

- per e-Mail - by e-mail: **service.svc@boschrexroth.de**

18.2 Service-Hotline

Außerhalb der Helpdesk-Zeiten ist der Service direkt ansprechbar unter

After helpdesk hours, contact our service department directly at

+49 (0) 171 333 88 26

oder - or

+49 (0) 172 660 04 06

18.3 Internet

Unter **www.boschrexroth.com** finden Sie ergänzende Hinweise zu Service, Reparatur und Training sowie die **aktuellen** Adressen *) unserer auf den folgenden Seiten aufgeführten Vertriebs- und Servicebüros.



Verkaufsniederlassungen



Niederlassungen mit Kundendienst

Außerhalb Deutschlands nehmen Sie bitte zuerst Kontakt mit unserem für Sie nächstgelegenen Ansprechpartner auf.

*) Die Angaben in der vorliegenden Dokumentation können seit Drucklegung überholt sein.

At **www.boschrexroth.com** you may find additional notes about service, repairs and training in the Internet, as well as the **actual** addresses *) of our sales- and service facilities figuring on the following pages.



sales agencies



offices providing service

Please contact our sales / service office in your area first.

*) Data in the present documentation may have become obsolete since printing.

18.4 Vor der Kontaktaufnahme... - Before contacting us...

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19 Appendix

19.1 Technical Data "Capacitances Against Ground"

The indicated capacitance values help selecting appropriate mains filters of the HNF01 and NFD03 lines.

Capacitance Data for Motors

The Rexroth motors have the typical capacitance values listed below. The data refer to the total capacitance of the power connections U, V, W against the motor housing.

Motor types	Frame length	Symbol	Unit	Typ. value
MKD025, MKE037	A	C _{ab}	nF	
	B	C _{ab}	nF	1,0
MKD, MHD, MHP041, MKE047	A	C _{ab}	nF	
	B	C _{ab}	nF	1,6
MKD, MHD, MHP071	A	C _{ab}	nF	1,2
	B	C _{ab}	nF	2,5
MKD, MHD, MHP090, MKE098	B	C _{ab}	nF	6,7
MHD, MHP093	A	C _{ab}	nF	4,8
	B	C _{ab}	nF	7,8
	C	C _{ab}	nF	9,5
MHD, MHP095	A	C _{ab}	nF	3,7
	B	C _{ab}	nF	5,3
	C	C _{ab}	nF	6,7
MKD, MHD, MHP112, MKE118	A	C _{ab}	nF	5,3
	B	C _{ab}	nF	10,3
	C	C _{ab}	nF	14,1
	D	C _{ab}	nF	20,2
MKD, MHD, MHP115	A	C _{ab}	nF	6,9
	B	C _{ab}	nF	13,2
	C	C _{ab}	nF	18,2
MHD131	B	C _{ab}	nF	13,9
	D	C _{ab}	nF	25,7
MSK050	B	C _{ab}	nF	2,1
	C	C _{ab}	nF	2,6
MSK060	B	C _{ab}	nF	2,1
	C	C _{ab}	nF	
MSK070	C	C _{ab}	nF	3,1
	D	C _{ab}	nF	
	E	C _{ab}	nF	

Fig. 19-1: Leakage capacitance of selected motors

The scope of available motors is continuously extended; please ask for data of motors not contained in this list.

Capacitance Data for Power Cables

The Rexroth motor cables of the RKL line have the capacitances listed below. The values refer to the sum of the single capacitances of power strands 1, 2 and 3 against the overall shield.

Cable type of non-assembled cable	Nom. cross section in [mm ²]	Symbol	Unit	Value
INK 653	1,0	C _{Y_K typ}	nF/m	0,6
INK 650	1,5	C _{Y_K typ}	nF/m	0,8
INK 602	2,5	C _{Y_K typ}	nF/m	0,7
INK 603	4	C _{Y_K typ}	nF/m	tbd
INK 604	6	C _{Y_K typ}	nF/m	0,8
INK 605	10	C _{Y_K typ}	nF/m	1,0
INK 606	16	C _{Y_K typ}	nF/m	1,2
INK 607	25	C _{Y_K typ}	nF/m	1,1
INK 667	35	C _{Y_K typ}	nF/m	tbd
INK 668	50	C _{Y_K typ}	nF/m	tbd

Fig. 19-2: Capacitance values of power cables

Note: Approximate calculation is allowed with the following values:

- 1 nF/m for cross sections of 1 mm² to 6 mm²
- 1.2 nF/m for cross sections of 10 mm² to 50 mm²

19.2 Short Designations of Products

Short designation	Type	Description
CZ 1.2	additional capacitor	
DLT	isolating transformer	
DST	matching transformer	
HCS02.1	drive controller	
HCS03.1	drive controller	
HLB01.1C	DC bus resistor unit	
HLB01.1D	DC bus resistor unit	
HLC01.1C	DC bus capacitor unit	
HLC01.1D	DC bus capacitor unit	
HMD01.1	drive controller	
HMS01.1	drive controller	
HMS02.1	drive controller	
HMV01.1E	supply unit	
HMV01.1R	supply unit	
HMV02.1R	supply unit	
HNF01.1	mains filter	
HNL01.1	mains choke	
HNL02.1	mains choke	mains choke with housing to be mounted in control cabinet
HNS02.1	mains filter	mains filter with integrated switch-disconnector and motor circuit breaker
HNK01.1	mains filter	mains filter with integrated mains choke, variant for assembly
MSK040	synchronous motor	
MSK050	synchronous motor	
MSK060	synchronous motor	
NFD03.1	mains filter	
RKL	ready-made motor power cable	
RKS	ready-made control cable	
RKG	ready-made encoder cable	
VCP01	small operator terminal	variant for assembly
VCP02	small operator terminal	variant for assembly
VCP05	small operator terminal	variant for assembly
VCP08	small operator terminal	variant for assembly
VCP20	small operator terminal	variant for assembly
VCP25	small operator terminal	variant for assembly

Fig. 19-3: Short designations of products

19.3 Discharging of Capacitors

Discharging of DC Bus Capacitors

In the drive system Rexroth IndraDrive capacitors are used in the DC bus as energy stores. In the drive controllers and particularly in the supply units such capacitors have already been integrated.

Energy stores maintain their energy even when energy supply has been cut off and have to be discharged before somebody gets in contact with them.

Discharging devices have been integrated in the components of the drive system Rexroth IndraDrive; within the indicated discharging time these devices discharge the voltage below the allowed 50 V.

If additional capacitances in the form of

- DC bus capacitor units or
- additional capacitors

are connected, make sure that these capacitors, too, are discharged before somebody gets in contact with them.

Due to the operating principle, the discharging time is the longer

- the bigger the energy store (the capacitance value)
- the higher the voltage to which the energy store has been charged
- the greater the resistance for discharging the capacitors.

Components of the drive system Rexroth IndraDrive have been dimensioned in such a way that after the energy supply was cut off the voltage value falls below 50 V within a discharging time of a maximum of 30 minutes.



WARNING

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

- ⇒ Wait at least 30 minutes after switching off power to allow discharging.
- ⇒ Check whether voltage has fallen below 50 V before touching live parts!

To shorten the waiting time until voltage has fallen below 50 V you can take the following measures:

- Activate the function "ZKS" (DC bus short circuit) when using HMV01 supply units.



WARNING

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

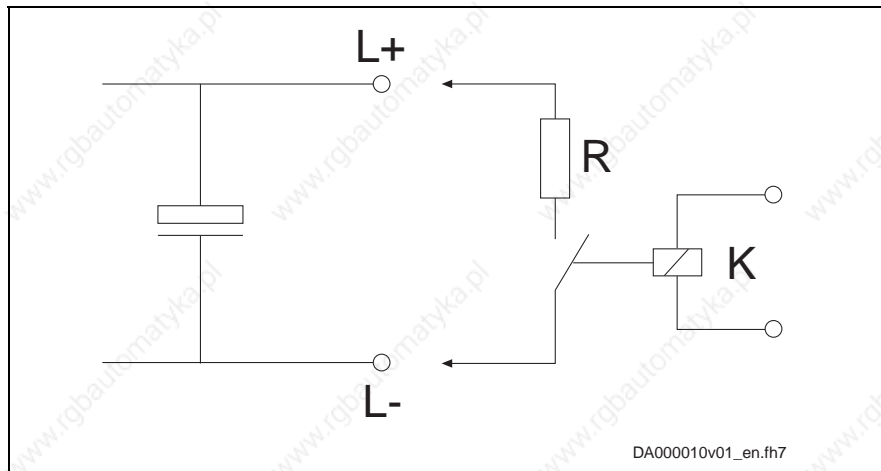
- ⇒ Before touching live parts check whether the voltage has fallen below 50 V!

- Use the discharging device described below.

Discharging Device

Operating Principle

A contactor is installed to switch a resistor to the terminals L+ and L- of the DC bus connection to discharge the capacitors. The contactor is activated via a control input which is supplied with appropriate control voltage.



R: discharging resistor

K: contactor contact

Fig. 19-4: Operating principle of discharging device

Dimensioning

The individual components have to be sufficiently dimensioned:

- The value of the discharging resistor has to be dimensioned with 1000 ohm and at least 1000 W.
- The discharging resistor and the contactor contact have to withstand the loads of practical operation (for example in the case of frequent use of the discharging device or the occurring continuous power).
- The contactor contact has to withstand the occurring direct voltage of min. 1000 V.
- The contactor contact has to withstand the occurring discharging current according to the resistance value that is used, i.e. 1 A with 1000 ohm.

How to Proceed for Discharging

Observe the proceeding when using the discharging device:

1. Install discharging device before switching energy supply on for the first time and establish safe electrical connection between discharging device and object to be discharged.
2. On mains side switch off energy supply to drive system before activating discharging device.
3. Activate discharging device.



WARNING

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

⇒ Before touching live parts check in any case whether the voltage between the DC bus terminals L+ and L- has fallen below 50 V!

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R911309636

Printed in Germany
DOK-INDRV*-SYSTEM*****-PR03-EN-P