Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

Rexroth
Bosch Group

Rexroth IndraDrive Cs
Drive Systems With HCS01

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Project Planning Manual

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Drive Systems With HCS01

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1.1 Drive Range Rexroth IndraDrive Cs

1.1.1 Overview – Rexroth IndraDrive Cs

Rexroth IndraDrive Cs			
Converter HCS01		Motors MSM	Motors MSK
			

Fig. 1-1: Components of the Rexroth IndraDrive Cs Range

1.1.2 Target Applications

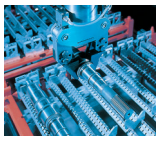
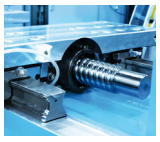
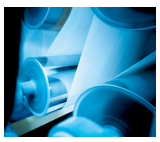
	**General automation, handling, assembly** Automated assembly and handling systems, palletizing systems, pick-and-place systems, logistics …
	**Machine tools** Compact machines (e.g., for wood machining), secondary and servo drives …
	**Food and packaging industry** Filling and closing, palletizing, erecting cartons, closing cartons, labeling …
	**Printing machines** Label printing, labeling, digital printing, positioning, servo drives …
	**Semiconductor industry** Semiconductor/wafer production and handling, metalizing, cleaning, solar cell production …
	**Medical technology** Diagnostics, monitoring, patient lifters, medical chairs, laboratory equipment …

Fig. 1-2: Target Applications

1.1.3 Functional and Performance Features

Functional Features

- Compact type of construction
- Degree of protection IP20
- Control panel with programming module function (suited for hot plug)
- Multi-encoder interface for all standard encoders (HIPERFACE®, EnDat2.1, SSI, TTL, sin/cos, resolver, MSM encoder)
- DC bus connection (at HCS01.1E-W00xx-x-03 devices)
- Analog input (14 bit, ±10 V)
- Scaleable signal processing and firmware:
  - ECONOMY
    - SERCOS III
    - Integrated safety technology "Safe Torque Off" (in preparation)
  - BASIC UNIVERSAL
    - Multi-Ethernet interface (SERCOS III, EtherCAT, ProfiNet, Ethernet IP)
    - Additional interface for communication "PROFIBUS DP" or encoder evaluation
    - Integrated safety technology "Safe Torque Off" and "Safe Motion" (in preparation)
    - IndraMotion MLD-S (in preparation)
- Performance-dependent blower control
- Integrated brake current measurement and monitoring
- Winding short circuit at motor output for shutdown
- Compact MSM motors
- Battery box for buffering the data of MSM encoders (mounting near the motor is possible)

Performance Features

Converter		 Size 1 (Width: 50 mm)						 Size 2 (Width: 70 mm)	
Type HCS01.1E-…		**W0003**	**W0006**	**W0009**	**W0013**	**W0005**	**W0008**	**W0018**	**W0028**
Mains connection voltage	V	3 AC 110 … 230 V*				3 AC 200 … 500 V**			
Continuous current	A_{rms}	1,1	2,0	3,0	4,4	1,7	2,7	6,0	11,5
Maximum current	A_{rms}	3,3	6,0	9,0	13,0	5,0	8,0	18,0	28,0
Mechanical continuous power	W	100	200	400	750	400	750	1500	3500 1)

* Single-phase operation allowed; for HCS01.1E-W0013 with derating
** Single-phase operation not allowed
1) With external choke

Fig. 1-3: Converter HCS01 - Performance Features

Motor MSM 	Continuous power	Continuous torque at standstill	Maximum torque	Maximum speed	Degree of protection
	P_N [W]	M_O [Nm]	M_{max} [Nm]	n_{max} [min^{-1}]	
019A	50	0,16	0,48	5000	IP54 (Shaft IP40)
019B	100	0,32	0,95		
031B	200	0,64	1,91		
031C	400	1,3	3,8		
041B	750	2,4	7,1	4500	

Fig. 1-4: Motor MSM - Performance Features

System Presentation

Combination of HCS01 and MSM/MSK

	HCS01							
	3 AC 110 … 230 V				3 AC 200 … 500 V			
	W0003	W0006	W0009	W0013	W0005	W0008	W0018	W0028
MSM MSM019 … MSM041	■				T			-
MSK MSK030 … MKS070	-				■			

■ Optimum combination

T Allowed combination (transformer required, as operation of MSM only allowed with a maximum of 3 AC 230 V)

- Combination not allowed

Fig.1-5: Converter HCS01 and Motors MSM/MSK

Detailed Table For a detailed table with all possible combinations of HCS01 converters and MSM / MSK motors, see this documentation under the index entry "Motor → Supported motors".

Interfaces

Overview

- Compatible with IndraDrive platform
- Ethernet-based communication with the following supported protocols:
  - SERCOS III
  - PROFINET IO
  - EtherNet/IP
  - EtherCAT
- Alternative communication: PROFIBUS DP
- Analog input
- Freely configurable digital inputs/outputs

HCS01 - ECONOMY vs. BASIC UNIVERSAL

Functional equipment	HCS01.1E-W00**-A-0*-…	
	…E (ECONOMY)	…B (BASIC UNIVERSAL)
Communication	SERCOS III	Multi-Ethernet (incl. SERCOS III)
		Additional interface[1] (PROFIBUS DP)
Encoder evaluation	Multi-encoder interface	Multi-encoder interface
		Additional interface[1]
Integrated safety technology[2]	Safe Torque Off	Safe Torque Off
		Safe Motion
IndraMotion[2]	–	MLD-S
Freely configurable digital inputs/outputs (incl. probe)	✓	✓
Analog input	✓	✓
Control panel with programming module function	✓	✓

1) **One** additional interface per converter for communication "PROFIBUS DP" **or** encoder evaluation
2) In preparation

Fig. 1-6: ECONOMY vs. BASIC UNIVERSAL

Supported Encoder Systems

Supported Encoder Systems

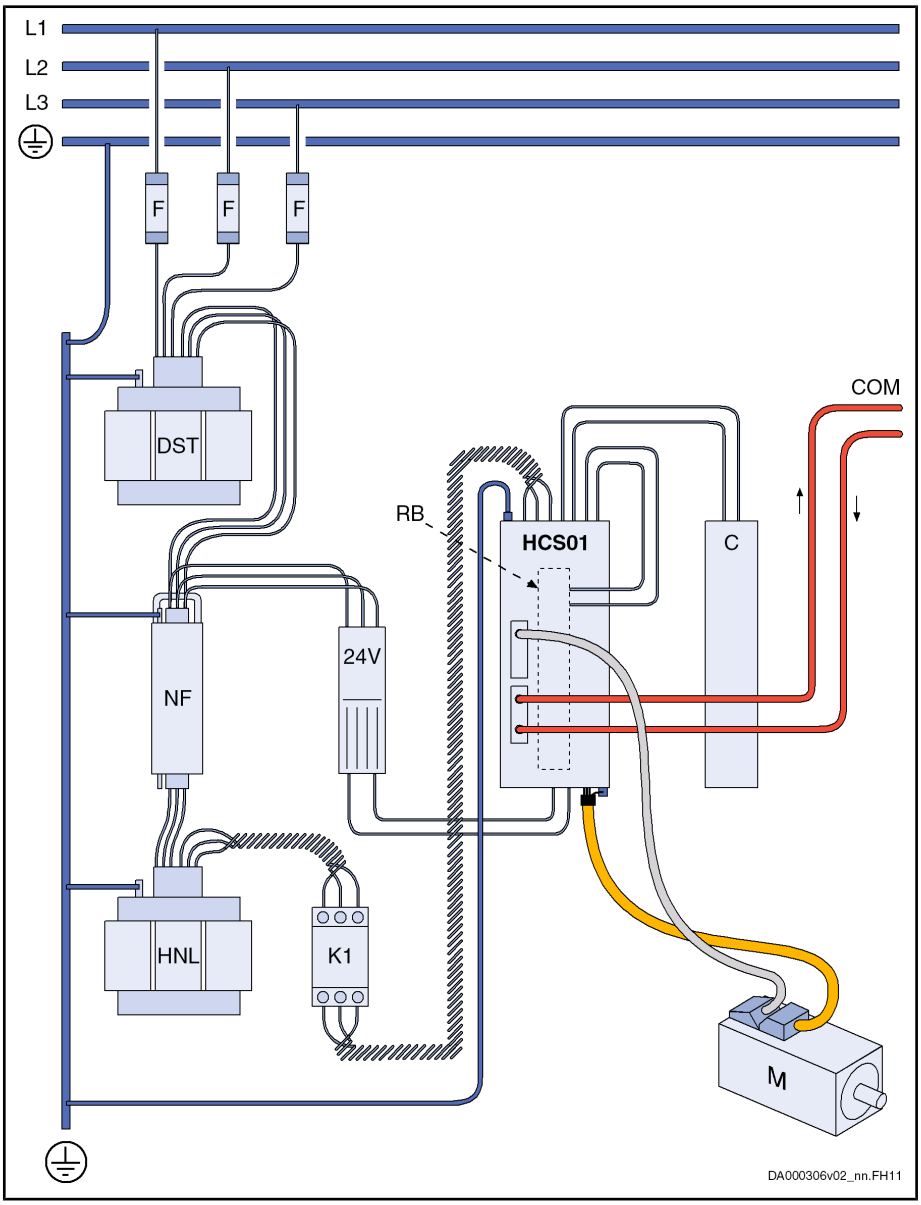
Encoders with a supply voltage of **5 and 12 volt**

Encoder Systems

- MSM motor encoder
- MSK motor encoder
- Sin-cos encoder 1 V_{pp}; HIPERFACE®
- Sin-cos encoder 1 V_{pp}; EnDat 2.1
- Sin-cos encoder 1 V_{pp}; with reference track
- 5V-TTL square-wave encoder; with reference track
- SSI
- Resolver

1.2 System Configuration

1.2.1 System Structure



24V	Control voltage supply
C	DC bus capacitor unit (for devices with DC bus connection)
COM	Communication
DST	Autotransformer; optional
F	Fuses
HCS01	Converter
NF	Mains filter; optional (depends on EMC requirements)
HNL	Mains choke; optional
K1	External mains contactor
M	Motor (MSM, MSK)
RB	Braking resistor (at the back of the drive controller)

Fig. 1-7: Drive System Rexroth IndraDrive Cs

1.2.2 Components of the System

Drive Controllers HCS01

Type Code

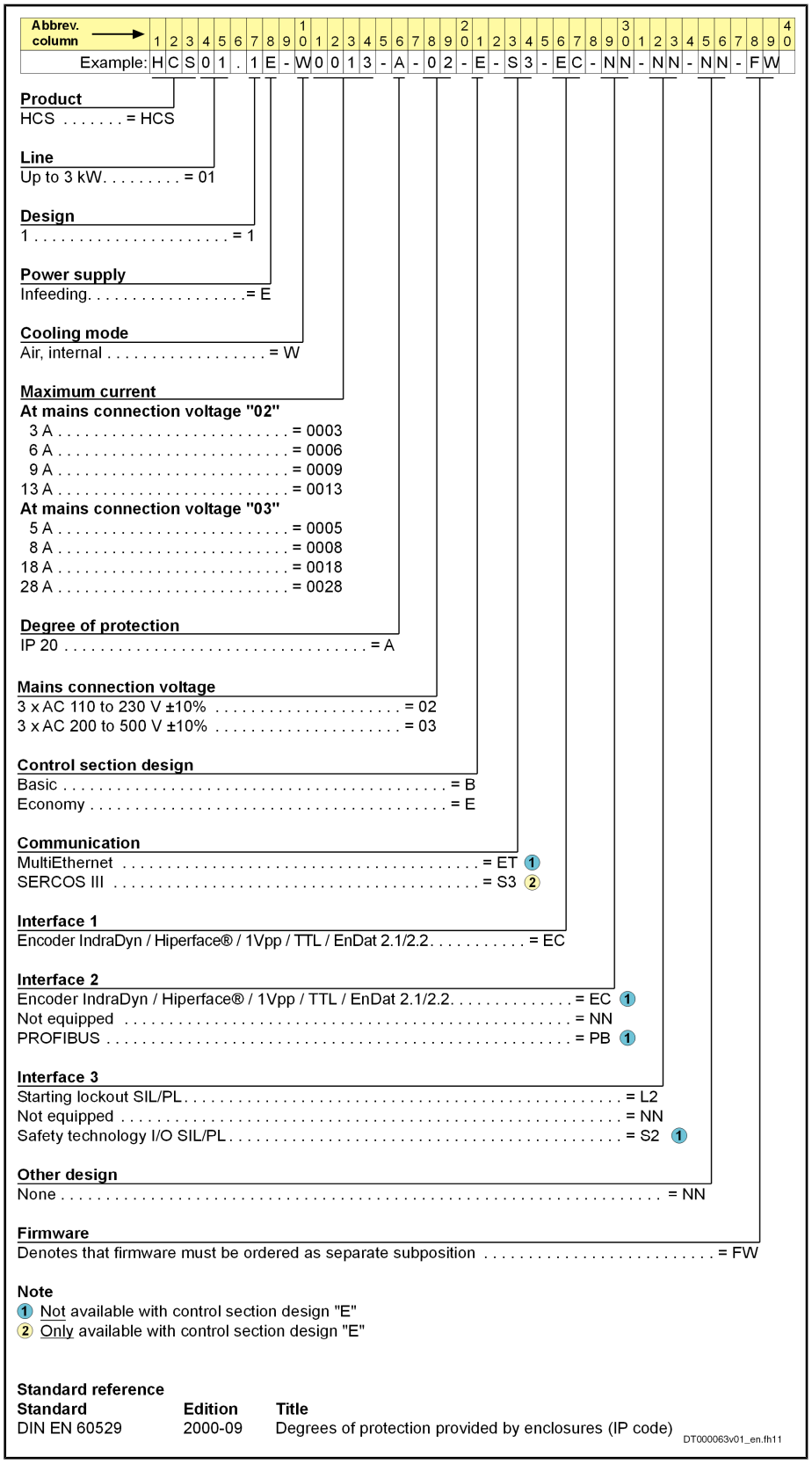


Fig. 1-8: Type Code HCS01

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

Motors MSM and MSK

For the motors "Rexroth IndraDyn S Synchronous Motors MSM" and "Rexroth IndraDyn S Synchronous Motors MSK", there are separate documentations (see "Reference Documentations").

Firmware Types

Structure of the Firmware Type Designation

The type designation of the firmware consists of the following type code elements:

Firmware	Base package of variant ...	Version	Release	Language	Characteristic Open-loop / Closed-loop	Alternative expansion packages	Additive expansion packages
FWA-INDRV*-	MP**B**-	16	VRS-	D5-	x-	xxx-	xx
FWA-INDRV*-	MP**E**-	16	VRS-	D5-	x-	xxx-	xx

Fig. 1-9: Basic Structure of the Firmware Type Designation

Function-Specific Abbreviations in Type Designation of Firmware

Base package (application and performance)

- **MPB** → Firmware with BASIC performance and BASIC functionality
- **MPE** → Firmware with ECONOMY performance and ECONOMY functionality

Characteristic (open-loop/closed-loop)

- **0** → Open-loop
- **1** → Closed-loop

Alternative expansion packages

- **NNN** → Without alternative expansion package
- **SRV** → Functional package "Servo function"
- **SNC** → Functional package "Synchronization"
- **MSP** → Functional package "Main spindle"
- **ALL** → All alternative expansion packages

Additive expansion packages

- **NN** → Without additive expansion package

☞ The Rexroth sales representative in charge will help you with the current status of available firmware types.

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

1.2.3 About This Documentation

Purpose

WARNING

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

Observe the contents of the reference documentations relevant to your drive system (see "Reference Documentations").

This documentation provides information on

- the Rexroth IndraDrive Cs drive system
- the allowed combinations of Rexroth IndraDrive Cs system components
- the selection of system components of the Rexroth IndraDrive Cs drive system
- the specification applying to all components (ambient and operating conditions)
- the application description of system characteristics

Reference Documentations

Drive Systems, System Components

Title Rexroth IndraDrive …	Kind of documentation	Document typecode[1)] DOK-INDRV*-…	Part number R911…
Cs Drive Systems	Project Planning Manual	HCS01******-PRxx-EN-P	322210

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

Fig. 1-10: Documentations – Drive Systems, System Components

Motors

Title Rexroth IndraDyn …	Kind of documentation	Document typecode[1)] DOK-MOTOR*-…	Part number R911…
S MSK Synchronous Motors	Project Planning Manual	MSK********-PRxx-EN-P	296289
S Synchronous Motors MSM	Data Sheet	MSM********-DAxx-EN-P	329338

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

Fig. 1-11: Documentations – Motors

Cables

Title	Kind of documentation	Document typecode[1)] DOK-CONNEC-…	Part number R911…
Rexroth Connection Cables	Selection Data	CABLE*STAND-AUxx-EN-P	282688

1) In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: AU03 is the third edition of the documentation "Selection Data")

Fig. 1-12: Documentations – Cables

System Presentation

Firmware

Title Rexroth IndraDrive …	Kind of documentation	Document typecode[1)] DOK-INDRV*-…	Part number R911…
MPB-16, MPM-16, MPE-16 Functions	Application Manual	MP*-16VRS**-APxx-EN-P	326767
MPB-16, MPM-16, MPE-16 Version Notes	Release Notes	MP*-16VRS**-RNxx-EN-P	329272
MPx-16 Parameters	Reference Book	GEN1-PARA**-RE01-EN-P	328651
MPx-16 Diagnostic Messages	Reference Book	GEN1-DIAG**-RE01-EN-P	326738

1) In the document typecodes, "xx" is a wild card for the current edition of the documentation (example: RE02 is the second edition of a reference documentation)

Fig.1-13: Documentations – Firmware

Your Feedback

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

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

Please send your remarks to:

Address for Your Feedback

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2 Important Directions for Use

2.1 Appropriate Use

2.1.1 Introduction

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

WARNING

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

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

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

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

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

2.1.2 Areas of Use and Application

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

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

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

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

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

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

To ensure application-specific use of Drive controllers, device types of different drive power and different interfaces are available.

Typical applications include, for example:

- Handling and mounting systems,
- Packaging and food machines,
- Printing and paper processing machines and
- Machine tools.

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, Drive controllers must not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

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

3 Safety Instructions for Electric Drives and Controls

3.1 Definitions of Terms

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

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

Control System Several interconnected control components placed on the market as a single functional unit.

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

Drive System A group of components consisting of electric motor(s), motor encoder(s) and cable(s), supply units and drive controllers, as well as possible auxiliary and additional components, such as mains filter, mains choke, etc.

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

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

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

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

Product Produced device, component, part, system, software, firmware, among other things.

Project Planning Manual Part of the application documentation used to support the dimensioning and planning of systems, machines or installations.

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

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

- to be trained or instructed to maintain and use adequate safety equipment,
- to attend a course of instruction in first aid.

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

3.2 General Information

3.2.1 Using the Safety Instructions and Passing Them on to Others

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

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

WARNING

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

Observe the safety instructions!

3.2.2 Requirements for Safe Use

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

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

this is not the case, they are excluded. Safety-relevant are all such applications which can cause danger to persons and property damage.

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

  The machine and installation manufacturer must

  – make sure that the delivered components are suited for his individual application and check the information given in this application documentation with regard to the use of the components,

  – make sure that his individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.

- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

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

National regulations which the user must take into account

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

3.2.3 Hazards by Improper Use

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

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

3.2.4 Explanation of Safety Symbols and Hazard Classification

The safety instructions describe the following hazard classification. The hazard classification informs about the consequences resulting from non-compliance with the safety instructions:

Safety symbol	Signal word	Hazard classification according to ANSI Z535.4-2002
	Danger	Death or serious injury **will** occur.
	Warning	Death or serious injury **could** occur.
	Caution	Minor or moderate injury or property damage may occur.

Fig.3-1: Hazard Classification (According to ANSI Z535.4-2002)

3.3 Instructions with Regard to Specific Dangers

3.3.1 Protection Against Contact with Electrical Parts and Housings

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

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

WARNING

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

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

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- As a basic principle, residual-current-operated circuit-breakers cannot be used for electric drives to prevent direct contact.
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

WARNING

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

- Before switching on and before commissioning, ground or connect the components of the drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Establish an equipment grounding connection with a copper wire of a cross section of at least 10 mm^2 (8 AWG) or additionally run a second equipment grounding conductor of the same cross section as the original equipment grounding conductor.

3.3.2 Protective Extra-Low Voltage as Protection Against Electric Shock

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

All connections and terminals with voltages between 5 and 50 volts at the components of the Rexroth drive and control system are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic

insulation (such as programming devices, PCs, notebooks, display units) to these connections.

WARNING

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

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

3.3.3 Protection Against Dangerous Movements

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

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

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

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

WARNING

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

- A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the drive and control system are installed. As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stop switches in the immediate reach of the operator. Before commissioning, verify that the emergency stop equipment works. Do not operate the machine if the emergency stop switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of an emergency stop circuit or use a safe starting lockout.
- 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 holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the components of the drive and control system using the master switch and secure them from 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 electric/electronic components of the drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, before initial commissioning of the drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

3.3.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors or permanent magnets of electric motors represent a serious danger to persons with heart pacemakers, metal implants and hearing aids.

WARNING

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

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
  - Areas in which components of the drive and control systems are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of 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.

3.3.5 Protection Against Contact with Hot Parts

CAUTION

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

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers 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 and according to the respective safety regulations, the manufacturer of the machine or installation has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

3.3.6 Protection During Handling and Mounting

CAUTION

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

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

3.3.7 Battery Safety

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

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 attempt to recharge the batteries as this may cause leakage or explosion.
- Do not throw batteries into open flames.
- Do not dismantle batteries.
- When replacing the battery/batteries, do not damage the electrical parts installed in the devices.
- Only use the battery types specified for the product.

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

3.3.8 Protection Against Pressurized Systems

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

WARNING

Risk of injury by improper handling of pressurized lines!

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

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

4 Combining the Individual Components

4.1 Reference Documentations

See index entry "Reference documentations".

4.2 Brief Description of the Individual Components

4.2.1 HCS01 - Brief Description and Design

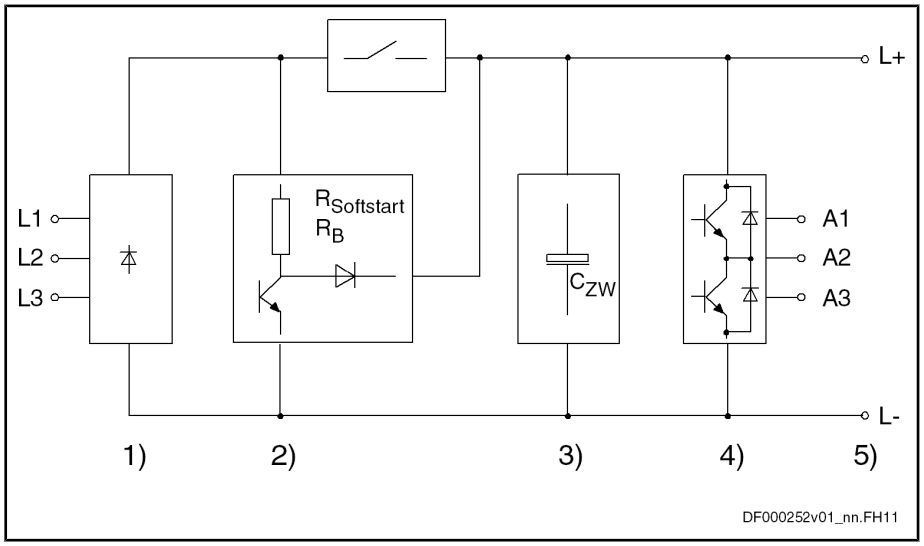
Brief Description

The compact converters HCS01 are part of the Rexroth IndraDrive Cs product range and are used to operate "MSM" or "MSK" motors.

HCS01 types:

- **02:** Mains connection voltage **3 AC 110 ... 230 V**
- **03:** Mains connection voltage **3 AC 200 ... 500 V**

Design, Block Diagram



1) Mains input with rectifier
2) Braking resistor circuit; charging current limitation
3) DC bus capacitances
4) DC bus connection
5) Inverter stage with output to motor

Fig.4-1: Block Diagram HCS01

4.3 Configuring the Drive System

4.3.1 Converter

The selection of the appropriate converter depends on

- Mains type
- Mains voltage
- Mains supply (1-phase or 3-phase)

Combining the Individual Components

Mains Type and Mains Voltage

IT mains Mains with grounded outer conductor		TN-S mains TN-C mains TT mains
Mains voltage ≤ 3 AC 230V?		To be noticed with 1-phase mains voltage: See table "Mains Supply"
Yes	No (3 AC 230 … 500 V)	
No transformer required	Isolating transformer with grounded neutral point required	
HCS01.1E-W0003-A-**02** HCS01.1E-W0006-A-**02** HCS01.1E-W0009-A-**02** HCS01.1E-W0013-A-**02** HCS01.1E-W0005-A-**03** HCS01.1E-W0008-A-**03** HCS01.1E-W0018-A-**03** HCS01.1E-W0028-A-**03**	HCS01.1E-W0005-A-**03** HCS01.1E-W0008-A-**03** HCS01.1E-W0018-A-**03** HCS01.1E-W0028-A-**03**	HCS01.1E-W0003-A-**02** HCS01.1E-W0006-A-**02** HCS01.1E-W0009-A-**02** HCS01.1E-W0013-A-**02** HCS01.1E-W0005-A-**03** HCS01.1E-W0008-A-**03** HCS01.1E-W0018-A-**03** HCS01.1E-W0028-A-**03**

Fig.4-2: Mains Type and Mains Voltage

Mains Supply

1-phase[1)]	3-phase	
1 AC 110 … 230 V	3 AC 200 ... 500 V	
	Autotransformer	-
	3 AC 110 … 230 V	-
HCS01.1E-W0003-A-**02** HCS01.1E-W0006-A-**02** HCS01.1E-W0009-A-**02** HCS01.1E-W0013-A-**02**		HCS01.1E-W0005-A-**03** HCS01.1E-W0008-A-**03** HCS01.1E-W0018-A-**03** HCS01.1E-W0028-A-**03**
Mains supply		
Individual supply		Individual supply
		Group supply
		Central supply

1) With single-phase mains supply, you can connect the mains supply line to connector X3 at L1, L2 or L3

Fig.4-3: Mains Supply

DC Bus Coupling

If energy compensation is to be available between the individual devices, the DC buses of these devices must be coupled. DC bus coupling restricts the selection of HCS01 converters. For detailed information on DC bus coupling, see this documentation under the index entry "DC bus → Coupling".

4.3.2 Functional Equipment

Functional equipment	HCS01.1E-W00**-A-0*-…	
	…E (ECONOMY)	…B (BASIC UNIVERSAL)
Communication	SERCOS III	Multi-Ethernet (incl. SERCOS III)
		Additional interface[1] (PROFIBUS DP)
Encoder evaluation	Multi-encoder interface	Multi-encoder interface
		Additional interface[1]
Integrated safety technology[2]	Safe Torque Off	Safe Torque Off
		Safe Motion
IndraMotion[2]	–	MLD-S
Freely configurable digital inputs/outputs (incl. probe)	✓	✓
Analog input	✓	✓
Control panel with programming module function	✓	✓

1) **One** additional interface per converter for communication "PROFIBUS DP" **or** encoder evaluation
2) In preparation

Fig.4-4: ECONOMY vs. BASIC UNIVERSAL

4.3.3 Firmware

Firmware and Device Types

Firmware	Assigned device type
FWA-INDRV*-MP**B**-**16**VRS-D5-x-xxx-xx	HCS01.1E-W00**-A-0*-**B** (BASIC UNIVERSAL)
FWA-INDRV*-MP**E**-**16**VRS-D5-x-xxx-xx	HCS01.1E-W00**-A-0*-**E** (ECONOMY)

Fig.4-5: Device Types and Firmware

Firmware Types

Structure of the Firmware Type Designation

The type designation of the firmware consists of the following type code elements:

Combining the Individual Components

Firmware	Base package of variant ...	Version	Release	Lan-guage	Characteris-tic Open-loop / Closed-loop	Alternative expansion packages	Additive ex-pansion packages
FWA-INDRV*-	MP**B**-	16	VRS-	D5-	x-	xxx-	xx
FWA-INDRV*-	MP**E**-	16	VRS-	D5-	x-	xxx-	xx

Fig.4-6: Basic Structure of the Firmware Type Designation

Function-Specific Abbreviations in Type Designation of Firmware

Base package (application and performance)

- **MPB** → Firmware with BASIC performance and BASIC functionality
- **MPE** → Firmware with ECONOMY performance and ECONOMY functionality

Characteristic (open-loop/closed-loop)

- **0** → Open-loop
- **1** → Closed-loop

Alternative expansion packages

- **NNN** → Without alternative expansion package
- **SRV** → Functional package "Servo function"
- **SNC** → Functional package "Synchronization"
- **MSP** → Functional package "Main spindle"
- **ALL** → All alternative expansion packages

Additive expansion packages

- **NN** → Without additive expansion package

☞ The Rexroth sales representative in charge will help you with the current status of available firmware types.

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

Firmware Variants

Firmware variant →		MPB		MPE[1)]
Characteristic →		OL	CL	-
Base package	Basic functions	■	■	■
	Base package "open-loop"	■	■	–
	Base package "closed-loop"	■	■	■
Alternative functional packages	Servo function	–	■	–
	Synchronization	■	■	–
	Main spindle	■	■	–

MPB Firmware with Basic performance
MPE Firmware with Economy performance
OL Open-loop characteristic
CL Closed-loop characteristic
1) For firmware MPE, there is only one expanded base package available
Fig.4-7: Firmware Variants

4.3.4 Motors

The table below contains an overview of the combinations of MSM / MSK motors and HCS01 converters.

	HCS01.1E-…							
Motor	W0003	W0006	W0009	W0013	W0005	W0008	W0018	W0028
MSM019A	■	□	□	□	T	T	-	-
MSM019B	■	□	□	□	T	T	-	-
MSM031B	×	■	□	□	T	T	-	-
MSM031C	-	×	■	□	T	T	-	-
MSM041B	-	-	×	■	-	T	-	-
MSK030B-0900	-	-	-	-	■	■	□	□
MSK030C-0900	-	-	-	-	■	■	□	□
MSK040B-0450	-	-	-	-	■	■	□	□
MSK040B-0600	-	-	-	-	-	■	□	□
MSK040C-0450	-	-	-	-	-	×	■	□
MSK040C-0600	-	-	-	-	-	-	■	□
MSK050B-0300	-	-	-	-	-	■	-	□
MSK050B-0450	-	-	-	-	-	-	■	□
MSK050B-0600	-	-	-	-	-	-	■	□
MSK050C-0300	-	-	-	-	-	-	■	□
MSK050C-0450	-	-	-	-	-	-	■	□
MSK050C-0600	-	-	-	-	-	-	■	■
MSK060B-0300	-	-	-	-	-	-	■	□
MSK060B-0600	-	-	-	-	-	-	×	■

Combining the Individual Components

	HCS01.1E-…							
Motor	W0003	W0006	W0009	W0013	W0005	W0008	W0018	W0028
MSK060C-0300	-	-	-	-	-	-	×	■
MSK060C-0600	-	-	-	-	-	-	-	×
MSK070C-0150	-	-	-	-	-	-	■	□
MSK070C-0300	-	-	-	-	-	-	-	×
MSK070C-0450	-	-	-	-	-	-	-	×
MSK070D-0150	-	-	-	-	-	-	-	■
MSK070D-0300	-	-	-	-	-	-	-	×
MSK070D-0450	-	-	-	-	-	-	-	-
MSK070E-0150	-	-	-	-	-	-	-	■
	W0003	W0006	W0009	W0013	W0005	W0008	W0018	W0028

■ Optimum combination
□ Allowed combination (converter overdimensioned)
× Allowed combination (motor overdimensioned)
T Allowed combination (transformer required, as operation of MSM motors only allowed with a maximum of 3 AC 230 V)
- Combination not allowed

Fig.4-8: Combination of HCS01 Converters and MSM/MSK Motors

4.3.5 Cables

Motor Power Cables

Power Cables for Motor Operation 60K Without Blower Unit [1)]

	HCS01.1E-…							
Motor	W0003	W0006	W0009	W0013	W0005	W0008	W0018	W0028
MSM019A	RKL0013 (RKL0035, optional extension)						-	-
MSM019B							-	-
MSM031B							-	-
MSM031C							-	-
MSM041B							-	-

<table>
<tr><th></th><th colspan="8">HCS01.1E-...</th></tr>
<tr><th>Motor</th><th>W0003</th><th>W0006</th><th>W0009</th><th>W0013</th><th>W0005</th><th>W0008</th><th>W0018</th><th>W0028</th></tr>
<tr><td>MSK030B-0900</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2" rowspan="14">RKL0014
(RKL4305, optional extension)</td><td colspan="2" rowspan="14">RKL0019
(RKL4305, optional extension)</td></tr>
<tr><td>MSK030C-0900</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK040B-0450</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK040B-0600</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK040C-0450</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK040C-0600</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK050B-0300</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK050B-0450</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK050B-0600</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK050C-0300</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK050C-0450</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK050C-0600</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK060B-0300</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK060B-0600</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK060C-0300</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK060C-0600</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK070C-0150</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2" rowspan="5">RKL0016
(RKL4311, optional extension)</td><td colspan="2" rowspan="5">RKL0017
(RKL4311, optional extension)</td></tr>
<tr><td>MSK070C-0300</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK070C-0450</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK070D-0150</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK070D-0300</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>MSK070D-0450</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">RKL0018
(RKL4312, optional extension)</td></tr>
<tr><td>MSK070E-0150</td><td>-</td><td>-</td><td>-</td><td>-</td><td colspan="2">RKL0016
(RKL4311, optional extension)</td><td colspan="2">RKL0017
(RKL4311, optional extension)</td></tr>
<tr><th></th><th>W0003</th><th>W0006</th><th>W0009</th><th>W0013</th><th>W0005</th><th>W0008</th><th>W0018</th><th>W0028</th></tr>
</table>

1) Motor operation with blower unit see cable selection DOK-CONNEC-CABLE*INDRV-CAxx-xx-x

\- Combination not allowed

Fig.4-9: Power Cables for HCS01 Converters and MSM/MSK Motors

Combining the Individual Components

Encoder Cables

MSM Motors

	HCS01.1E-…							
Motor	W0003	W0006	W0009	W0013	W0005	W0008	W0018	W0028
MSM019A	RKG0033 (RKG0034, optional extension)						-	-
MSM019B							-	-
MSM031B							-	-
MSM031C							-	-
MSM041B							-	-

\- Combination not allowed

Fig.4-10: Encoder Cables for HCS01 Converters and MSM Motors

MSK Motors

See documentation "Rexroth Connection Cables" → "Selecting Encoder Cables".

4.4 Installation Conditions

4.4.1 Ambient and Operating Conditions

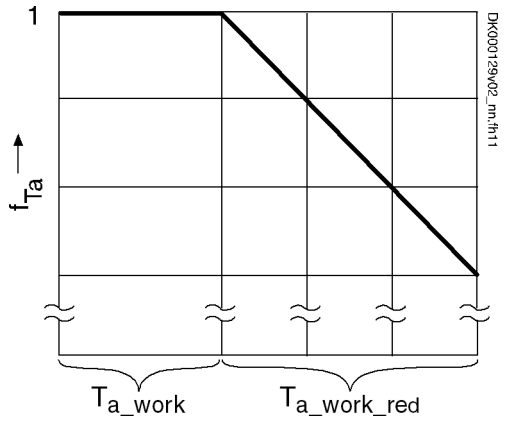
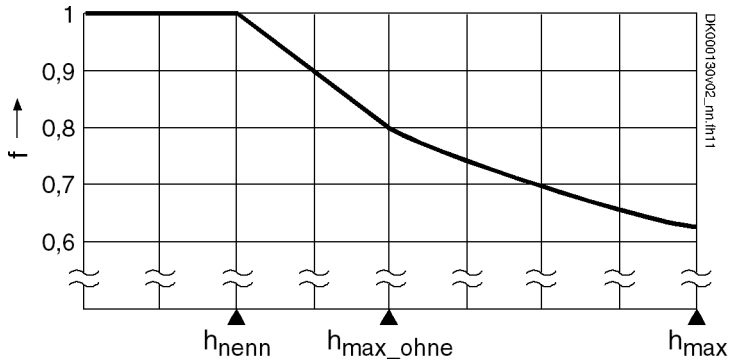
The drive controllers and their additional components have been designed for **control cabinet mounting**.

Check that the ambient conditions, in particular the control cabinet temperature, are complied with by calculating the heat levels in the control cabinet. Afterwards, make the corresponding measurements to find out that the ambient conditions have actually been complied with.

In the technical data of the individual components, the power dissipation is indicated as an important input value for calculating the heat levels.

Ambient and Operating Conditions

Description	Symbol	Unit	Value
Degree of protection (IEC529)			IP20
Use in the scope of CSA / UL			For use in NFPA 79 Applications only.
Temperature during storage			See chapter "Storage of the Components"
Temperature during transport			See chapter "Transport of the Components"
Allowed mounting position Definition of mounting positions: See index entry "Mounting positions"			G1
Ambient temperature range	T_{a_work}	°C	0 … 40
Installation altitude	h_{nenn}	m	1000

Description	Symbol	Unit	Value
Derating vs. ambient temperature: In the ambient temperature range $T_{a\_work\_red}$, reduce the performance data[3) 4)] by the reduction factor f_{Ta}. Use outside of T_{a_work} or $T_{a\_work\_red}$ is not allowed!			
	$T_{a\_work\_red}$	°C	40 … 55
	f_{Ta}	%/K	2,0 See also Technical Data of the individual components
Derating vs. installation altitude: With installation altitudes h > h_{nenn}, the available performance data are reduced by the factor f[3) 4)]. With installation altitudes in the range of h_{max_ohne} to h_{max}, an **overvoltage limiter** against transient overvoltage must be installed in the installation. Use above h_{max} is not allowed!			
	h_{max_ohne}	m	2000
	h_{max}	m	4000
Simultaneous derating for ambient temperature **and** installation altitude	Allowed; reduce with factors f and f_{Ta}		
Relative humidity		%	5 … 95
Absolute humidity		g/m^3	1 … 29
Climatic category (IEC721)			3K3
Allowed pollution degree (EN50178)			2
Allowed dust, steam			EN50178 tab. A.2
Vibration sine: Amplitude (peak-peak) at 10 … 57 Hz[1)]		mm	0,15 ±15 %
Vibration sine: Acceleration at 57 … 150 Hz[1)]		g	1 ±15 %
Vibration noise (random) frequency[1)]		Hz	20 … 150
Vibration noise (random) spectral acceleration density, amplitude[1)]		g^2/Hz	0,005 ±3 dB

Combining the Individual Components

Description	Symbol	Unit	Value
Vibration noise (random) rms value of total acceleration[1)]		g	1
Vibration sine: Acceleration at 10 … 2000 Hz [2)], axial		g	-
Vibration sine: Acceleration at 10 … 2000 Hz [2)], radial		g	-
Overvoltage category			III (according to IEC60664-1)

1) According to EN 60068-2-36
2) According to EN 60068-2-6
3) Reduced performance data for drive controllers: Allowed DC bus continuous power, braking resistor continuous power, continuous current
4) Reduced performance data for motors: Performance, torque S1 and S3

Fig.4-11: Ambient and Operating Conditions

4.4.2 UL Ratings

This chapter contains:

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

Ambient and Operating Conditions - UL Ratings

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Short circuit current rating (UL)	SCCR	A rms	42000							
Rated input voltage, power (UL) [1)]	U_{LN_nenn}	V	3 x AC 110...230				3 x AC 200...500			
Rated input current (UL)	I_{LN}	A	0,6	1,2	2,3	4,5	1,5	2,5	5,0	10,0
Output voltage (UL)	U_{out}	V	3 x AC 0...230				3 x AC 0...500			
Output current (UL)	I_{out}	A	1,1	2,0	3,0	4,5	1,7	2,7	6,0	11,5
Last modification: 2009-07-28										

1) DC bus L+, L-; mains input L1, L2, L3

Fig.4-12: HCS - Ambient and Operating Conditions - UL Ratings

4.4.3 Compatibility With Foreign Matters

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

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

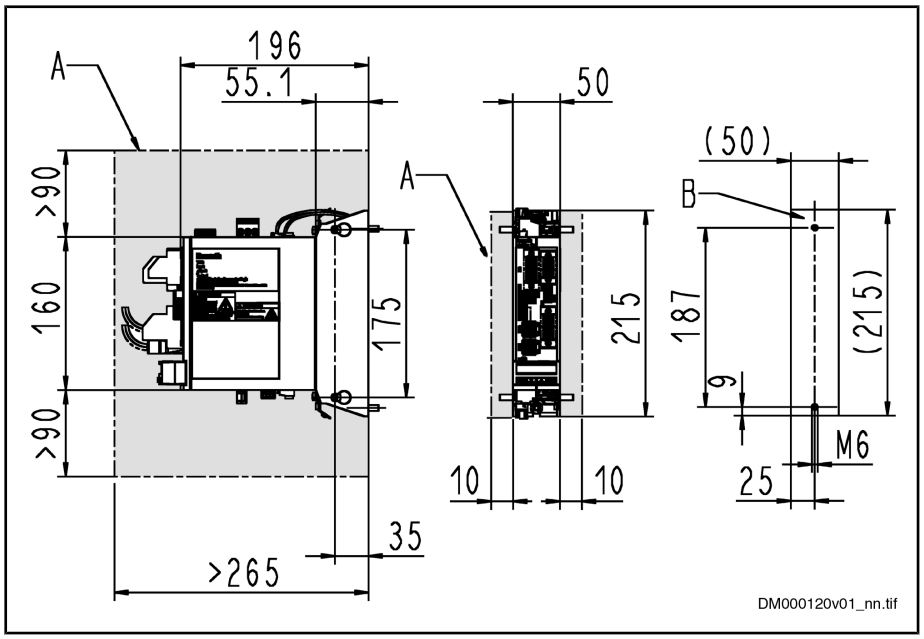
For this reason, before using the respective material a compatibility test has to be carried out for new lubricants, cleaning agents etc. and our housings/materials.

4.5 Mechanical Project Planning

4.5.1 Drive Controller

Dimensional Drawings

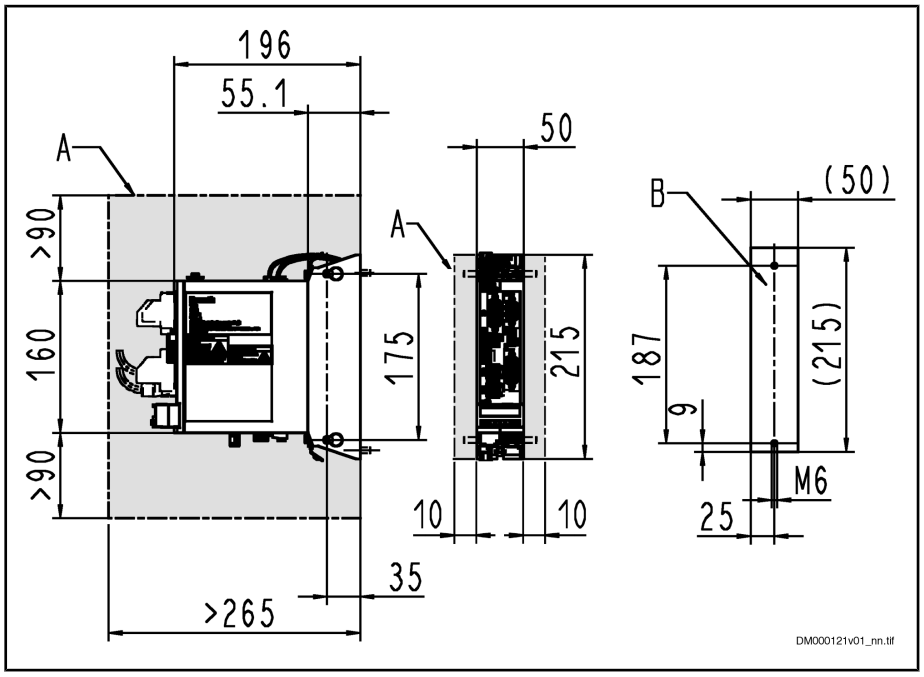
HCS01.1E-W0005/0008



A Minimum mounting clearance
B Boring dimensions

Fig.4-13: Dimensional Drawing HCS01.1E-W0005/0008

HCS01.1E-W0003/0006/0009/0013

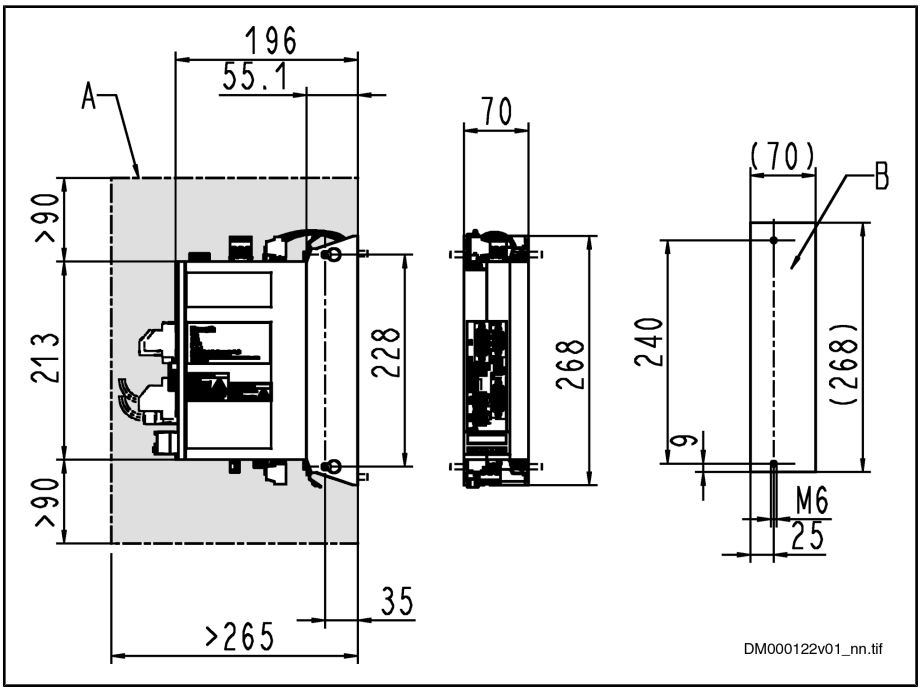


A Minimum mounting clearance
B Boring dimensions

Fig.4-14: Dimensional Drawing HCS01.1E-W0003/0006/0009/0013

Combining the Individual Components

HCS01.1E-W0018/0028



A Minimum mounting clearance
B Boring dimensions
Fig.4-15: Dimensional Drawing HCS01.1E-W0018/0028

Dimensions, Mass, Insulation, Sound Pressure Level

Data for Mass, Dimensions, Sound Pressure Level, Insulation

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Mass (weight)	m	kg	0,72						1,70	
Device height (UL)[1)]	H	mm	215						268	
Device depth (UL)[2)]	T	mm	196							
Device width (UL)[3)]	B	mm	50						70	
Insulation resistance at DC 500 V	R_{is}	Mohm	10,00							
Capacitance against housing	C_Y	nF	68,00							
Average sound pressure level (accuracy class 2) at P_{DC_cont}[4)]	L_P	dB (A)	tbd							
Last modification: 2009-07-28										

1) 2) 3) Housing dimension; see also related dimensional drawing
4) According to DIN EN ISO 11205; comparative value at distance 1 m, out of cabinet; HCS types with order code -L***: load-dependent
Fig.4-16: HCS - Data for Mass, Dimensions, Sound Pressure Level, Insulation

Temperatures, Cooling, Power Dissipation, Distances

Data for Cooling and Power Dissipation

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Ambient temperature range for operation with nominal data	T_{a_work}	°C	0...40							
Ambient temperature range for operation with reduced nominal data	$T_{a\_work\_red}$	°C	0...55							
Derating of P_{DC_cont}; P_{BD}; I_{out_cont} at $T_{a\_work} < T_a < T_{a\_work\_red}$	f_{Ta}	%/K	2							
Allowed mounting position			G1							
Cooling type			Not ventilated			Ventilated				
Volumetric capacity of forced cooling	V	m^3/h	-			11,00			56,00	
Allowed switching frequencies [1]	f_s	kHz	4, 8, 12, 16							
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (min.)[2]	$P_{Diss\_0A\_fs\ min}$	W	4		4,5		23		24	29
Power dissipation at I_{out_cont} = 0 A; $f_s = f_s$ (max.)[3]	$P_{Diss\_0A\_fs\ max}$	W	15		17		65		85	91
Power dissipation at continuous current and continuous DC bus power respectively (UL)[4]	P_{Diss_cont}	W	8,00	10,00	12,00	20,00	11,00	46,00	80,00	120,00
Minimum distance on the top of the device[5]	d_{top}	mm	100							
Minimum distance on the bottom of the device[6]	d_{bot}	mm	100							
Horizontal spacing on the device[7]	d_{hor}	mm	10						0	
Temperature rise with minimum distances d_{bot}; d_{top}; P_{BD}	ΔT	K	tbd				tbd		tbd	

Last modification: 2009-07-28

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

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

4) Plus dissipation of braking resistor and control section

5) 6) 7) See fig. "Air Intake and Air Outlet at Device"

Fig.4-17: HCS - Data for Cooling and Power Dissipation

Combining the Individual Components

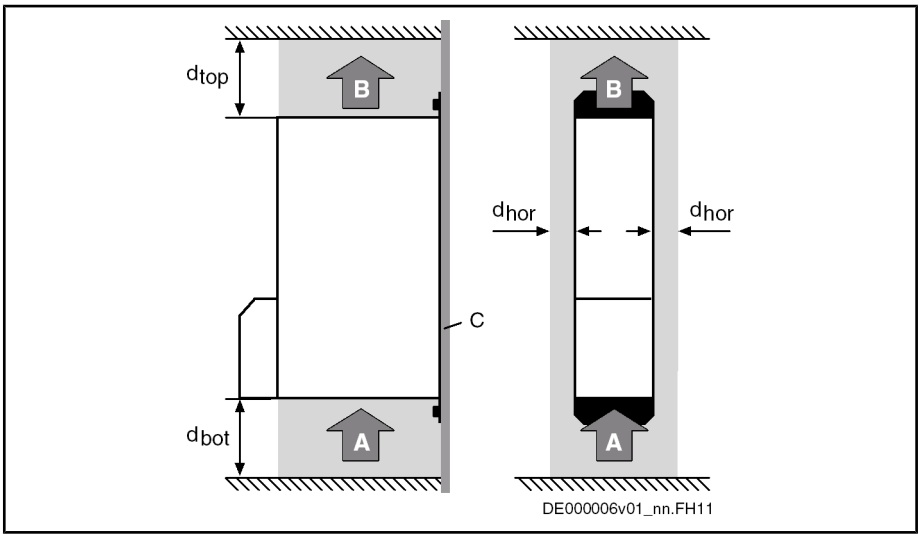
CAUTION

Property damage due to temperatures higher than 105 °C!

Observe the indicated minimum distances!

Above the devices there may only be such materials which

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



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

Fig.4-18: Air Intake and Air Outlet at Device

Mounting Positions of Components

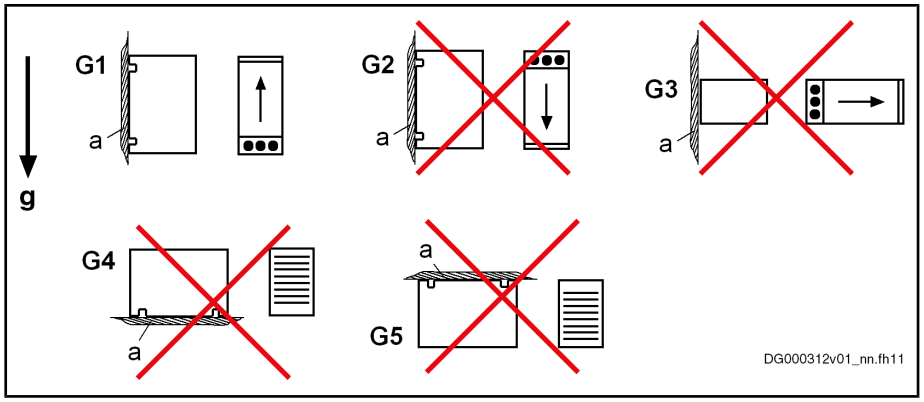
CAUTION

Risk of damage to the components!

Only operate the components in their allowed mounting positions.

Allowed Mounting Position of the Components

Only the mounting position **G1** is allowed for HCS01 components.



a	Mounting surface
g	Direction of gravitational force
G1	Normal mounting position. The natural convection supports the forced cooling air current. This avoids the generation of pockets of heat in the component.
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

Fig.4-19: Allowed Mounting Position of the Components

4.5.2 Control Cabinet - Ventilation and Cooling

General Information

All devices operated in the control cabinet generate heat due to their power dissipation. The power dissipation increases the temperature inside the control cabinet compared to the ambient temperature of the control cabinet. The temperature inside the control cabinet is decisive as the ambient temperature of the devices.

You may only operate the devices within the allowed ambient temperature range T_{a_work} (with derating within $T_{a\_work\_red}$). The control cabinet must therefore be cooled. It is possible to cool the control cabinet in a passive or active way.

With **liquid-cooled** drives, the cooling system dissipates most of the dissipation heat generated in the drive components to the cooling device. Particularly with drive controllers and supply units, a small part of the generated dissipation heat is dissipated to the internal air of the control cabinet.

The table below contains an orientation guide showing the criteria on which the type of cooling depends.

The following table does not replace your detailed calculation of the heat levels. The data required for this calculation are explained in the following paragraphs.

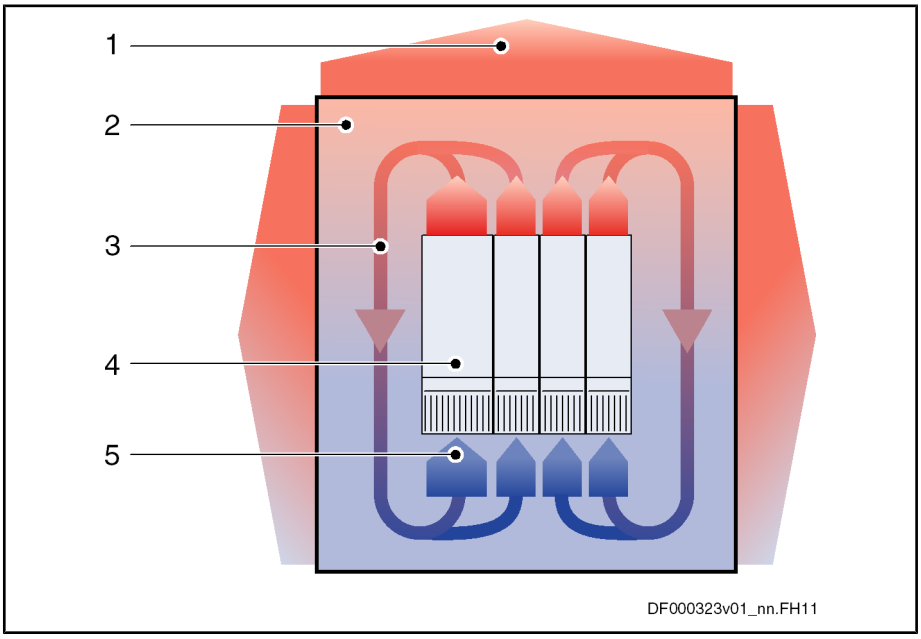
Check your calculation of the heat levels by measuring the temperature in the control cabinet at the air intake of the components under full load operation.

Criterion	Small temperature difference $T_{a\_work} - T_a$	Big temperature difference $T_{a\_work\_red} - T_a$	Low degree of power dissipation	High degree of power dissipation (e.g. with HMVxx.xE, HLBxx.x)
Low degree of power dissipation (e.g. with derating)	A, B	A	-	-
High degree of power dissipation (e.g. with HMVxx.xE, HLBxx.x)	C	B, C	-	-
Small control cabinet surface	B, C	B	B	C
Big control cabinet surface	B, C	A	A	C

A Cooling via the surface of the control cabinet
B Forced ventilation of control cabinet
C Cooling or refrigerating unit
Fig.4-20: Orientation Guide for the Appropriate Cooling Type

Passive Control Cabinet Cooling

Cooling via the Surface of the Control Cabinet



1 Heat dissipation via surface of control cabinet
2 Interior of control cabinet
3 Convection flow of air in control cabinet
4 Device in control cabinet
5 Air intake at device
Fig.4-21: Control Cabinet Airtight to the Outside

Advantage: Control cabinet airtight to the outside without blower and filter.

The surface of the control cabinet required for discharging the power dissipation is to be calculated below.

☞ Avoid additional heating of the control cabinet, e.g. by directly attached constructions and solar radiation.

Allow the cooling air to freely circulate in the control cabinet. For devices with cooling by natural convection of the air, use additional blowers, if necessary, to force the circulation.

Required Surface

$$A_{wirk} \geq \frac{\sum P_{Diss}}{k \times (T_{a\_work} - T_a)}$$

ΣP_{Diss}	Power dissipation of all devices installed in the control cabinet
T_a	Maximum temperature outside of the control cabinet
T_{a_work}	Maximum allowed ambient temperature of the devices
k	Heat transition coefficient resulting from material and surface condition of the control cabinet

Fig.4-22: Required Surface

Exemplary Calculation

Power sections

2 × HCS02.1E-W0012 with

- P_{Diss_cont} = 80 W (at I_{out_cont})
- P_{BD} = 50 W
- P_{N3} = 12 W

Control sections

2 × CSB01.1N-FC with P_{N3} = 8.5 W

General conditions

- Material of control cabinet: Lacquered steel plate
- Maximum temperature outside of the control cabinet: 30 °C

Result

ΣP_{Diss}= 2 × (80 + 50 + 12) + 2 × 8.5 = 301 W

T_a = 30 °C

T_{a_work} = 40 °C

k ~ 5.5 W/(m²K) (lacquered steel plate)

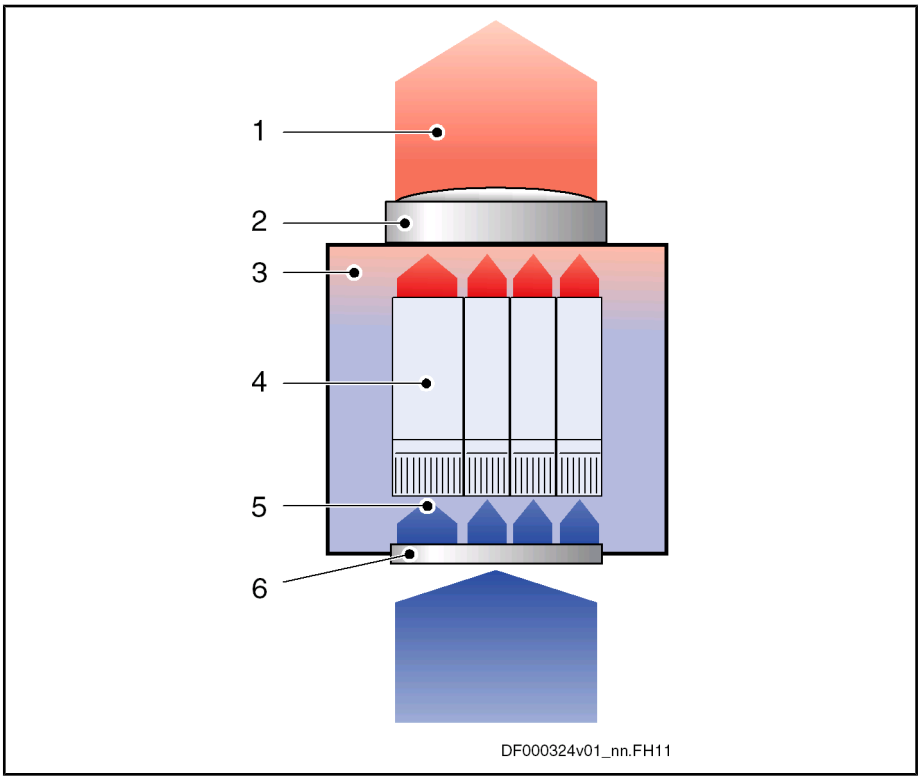
Required effective surface:

$$A_{wirk} \geq \frac{301}{5{,}5 \times (40 - 30)} = 5{,}472 \approx 5{,}5\ m^2$$

Combining the Individual Components

Active Control Cabinet Cooling

Ventilation of the Control Cabinet



1	Heat dissipation via control cabinet blower
2	Control cabinet blower
3	Interior of control cabinet
4	Device in control cabinet
5	Air intake at device
6	Air intake at control cabinet

Fig.4-23: Ventilation of the Control Cabinet

Advantage: Compact control cabinet

The cooling air current required for discharging the power dissipation from the control cabinet is to be calculated below. This will allow selecting the appropriate control cabinet blower.

Required Cooling Air Current

$$\dot{V}_{min} = \frac{\sum P_{Diss}}{T_{a\_work} - T_a} \times f_{air}$$

ΣP_{Diss}	Power dissipation of all devices installed in the control cabinet
T_a	Maximum temperature outside of the control cabinet
T_{a_work}	Maximum allowed ambient temperature of the devices
f_{air}	Air constant

Fig.4-24: Required Cooling Air Current

Installation altitude h / m	Air constant $f_{air}(h)$ / m³K/Wh
0...100	3,1
100...250	3,2

Installation altitude h / m	Air constant $f_{air}(h)$ / m³K/Wh
250...500	3,3
500...750	3,4
750...1000	3,5

Fig.4-25: Air Constant vs. Installation Altitude

Exemplary Calculation

Power sections

2 × HCS02.1E-W0012 with

- P_{Diss_cont} = 80 W (at I_{out_cont})
- P_{BD} = 50 W
- P_{N3} = 12 W

Control sections

2 × CSB01.1N-FC with P_{N3} = 8.5 W

General conditions

Maximum temperature outside of the control cabinet: 30 °C

Result

ΣP_{Diss}= 2 × (80 + 50 + 12) + 2 × 8.5 = 301 W

T_a = 30 °C

T_{a_work} = 40 °C

f_{air} ~ 3.5 m³ K/Wh (1000 m)

Required cooling air current:

$$\dot{V}_{min} \geq \frac{301}{40 - 30} \times 3{,}5 = 105{,}35 \approx 106 \frac{m^3}{h}$$

☞ The **integrated blowers of the devices** have been dimensioned with regard to the pressure conditions of their cooling systems and are not provided for control cabinet cooling.

Select a **control cabinet blower** which at least conveys the calculated cooling air current. Take into account that filter elements in the air intake openings, for example, reduce the output of the control cabinet blower.

☞ For active cooling, you can also use **air-liquid cooling units**.

Arrangement of Cooling Units

Unless the nominal data are reduced, the drive controller may only be operated up to a specified maximum ambient temperature. A cooling unit might therefore be required.

CAUTION

Possible damage to the drive controller! Operational safety of the machine endangered!

Observe the instructions below.

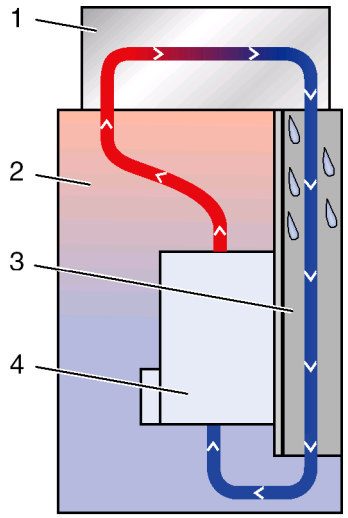
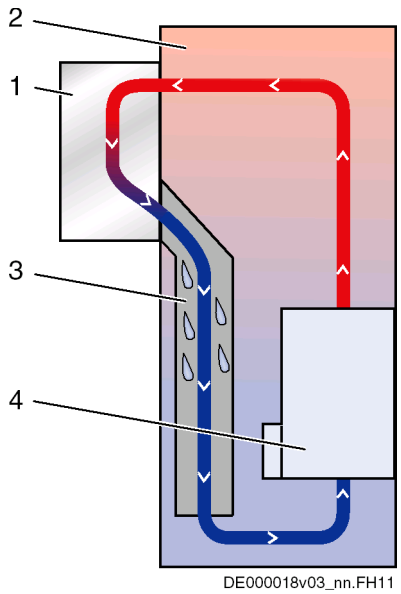
Combining the Individual Components

Avoiding Dripping or Spraying Water

Due to their operating principle, condensation water is formed when cooling units are used.

For this reason, observe the following aspects:

- Always position cooling units in such a way that condensation water cannot drip onto the devices 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 the devices in the control cabinet. Mount the air duct in the control cabinet accordingly.

Cooling Unit on Top of the Control Cabinet	Cooling Unit at the Front of the Control Cabinet
	

1 Cooling unit
2 Interior of control cabinet
3 Air duct (protects devices against condensation water)
4 Device in control cabinet

Fig.4-26: Arrangement of Cooling Units

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 not 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. For this reason, sufficient circulation must be provided inside the control cabinet.

Multiple-Line Design of the Control Cabinet

☞ **Arrangement of the devices, air guides/drip protections, blowers**

Pay particular attention to the maximum allowed air intake temperature of devices when they are arranged in multiple lines in the control cabinet.

If possible, place devices with a high degree of power dissipation (e.g. supply units with braking resistors, DC bus resistor units)

- in the top line and
- near the outlet air aperture to the cooling unit

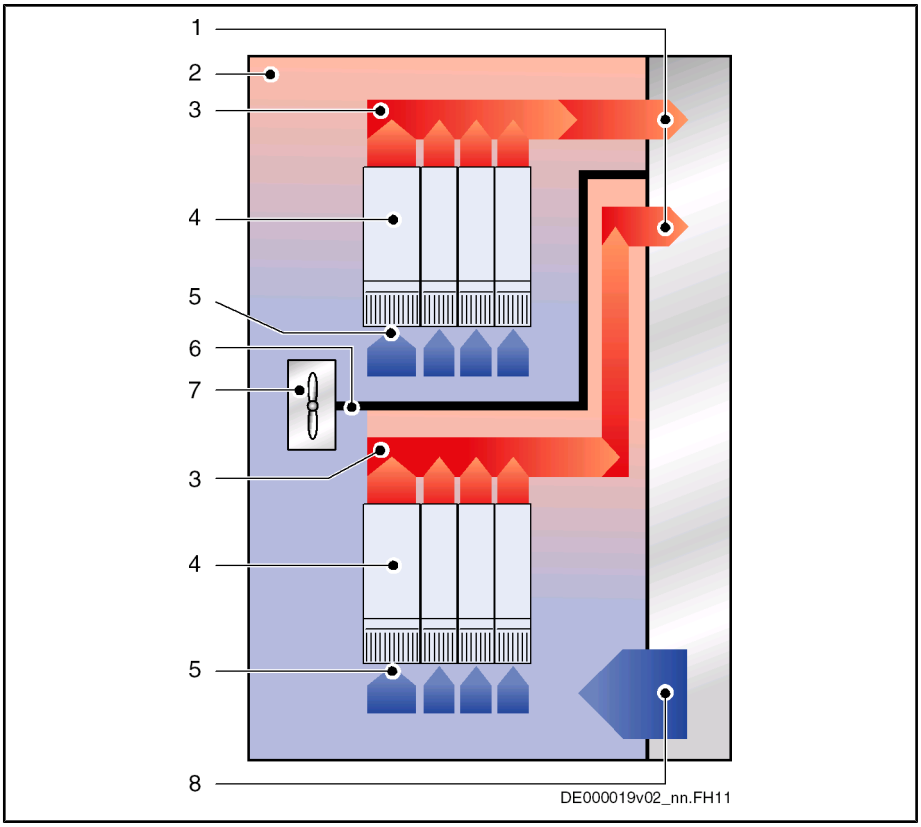
Mount **air guides** between the lines to

- protect the devices in the upper lines against the warm outlet air of the devices beneath and
- protect the devices beneath against penetration of liquids (e.g. dripping condensation water or leaking cooling liquid)

Additional blowers convey the outlet air to the cooling unit and cooling air to the upper lines.

At the installed control cabinet, check the air intake temperature of all devices.

Combining the Individual Components

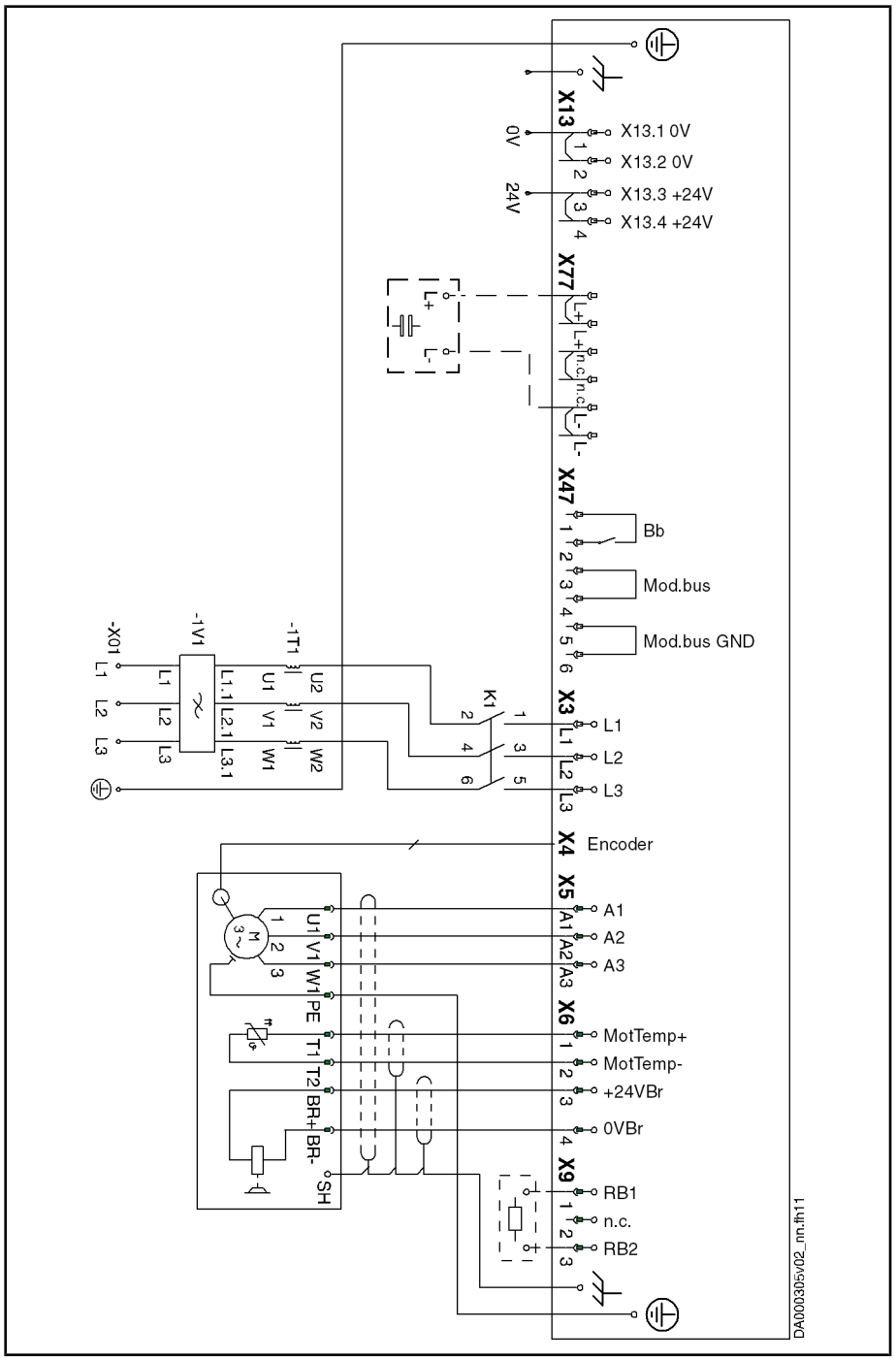


1	Discharge of heated air to cooling unit
2	Interior of control cabinet
3	Conveying direction of heated air in area where air flows off
4	Device in control cabinet
5	Air intake at device
6	Air guide in control cabinet (for liquid cooling, this is also the drip protection for the devices beneath)
7	Blower in control cabinet
8	Supply of cooled air from cooling unit

Fig.4-27: Example of Arrangement for Double-Line Design

4.6 Electrical Project Planning

4.6.1 Overall Connection Diagram



X47	Module bus (X47.3…6) only at HCS01.1E-W00xx-x-03 devices; for signaling the readiness for operation of the device, the Bb relay contact (X47.1, X47.2) must be wired, too
X77 (L+, L-)	Only at HCS01.1E-W00xx-x-03 devices
T1, T2	Not available at MSM motors

Fig.4-28: Connection Diagram

4.6.2 Project Planning of Control Voltage

Control Voltage for Drive Systems

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

- **Allowed tolerances of the supply voltage** depending on the length of the motor cable and the use of motor holding brakes
- Power consumption of the **drive controllers**
- Power consumption of **other loads** (e.g. motor holding brake, digital outputs)
- **Current carrying capacity of the connection point** for control voltage supply at the component for the purpose of looping through the control voltage to other components

Dimensioning the Control Voltage Supply

Determining the Power Requirement

The **total power requirement** of the control voltage supply results from the power requirement of:

- Basic device (drive controller without connected encoders and without incorporated optional modules)
- Encoder evaluation/encoder system
- Incorporated optional modules (e.g. communication, additional encoder evaluation)

	Power requirement	
Basic device	B (Basic)	E (Economy)
HCS01.1E-W0003-A-02-**x**-xx-EC-NN-NN-NN	702 mA	471 mA
HCS01.1E-W0006-A-02-**x**-xx-EC-NN-NN-NN		
HCS01.1E-W0009-A-02-**x**-xx-EC-NN-NN-NN		
HCS01.1E-W0013-A-02-**x**-xx-EC-NN-NN-NN		
HCS01.1E-W0005-A-03-**x**-xx-EC-NN-NN-NN		
HCS01.1E-W0008-A-03-**x**-xx-EC-NN-NN-NN		
HCS01.1E-W0018-A-03-**x**-xx-EC-NN-NN-NN	870 mA	639 mA
HCS01.1E-W0028-A-03-**x**-xx-EC-NN-NN-NN		
Digital output	100 mA[1)]	
Motor holding brake	100 mA[1)]	
Encoder evaluation		
Standard encoder evaluation "EC" at connection point **X4**		
Encoder system: 5 V, max. 500 mA	91 mA[2)]	
Encoder system: 12 V, max. 500 mA	75 mA[2)]	
Optional standard encoder evaluation "EC" at connection point **X8** [3)]		
Increased power requirement of basic device	54 mA	

	Power requirement
Encoder system: 5 V, max. 500 mA	91 mA[2)]
Encoder system: 12 V, max. 500 mA	75 mA[2)]
Communication	
Optional communication PROFIBUS "PB"	56 mA
Optional communication Multi-Ethernet "ET"	135 mA

1) Increased power requirement **per 100 mA** of the current to be supplied by the basic device
2) Increased power requirement **per 100 mA** encoder current
3) If you operate standard encoder evaluation "EC" **simultaneously at X4 and X8**, you may only use **encoder systems with a maximum current consumption of 350 mA**.

Fig.4-29: Power Requirement

Exemplary Calculation

Component HCS01.1E-W0028-A-03-B-PB-EC-EC-NN-NN		**Power requirement**
Basic device	HCS01.1E-**W0028**-A-03-**B**	1 × 870 mA
Encoder system	12 V / 200 mA	2 × 75 mA = 150 mA
Optional encoder system	5 V / 300 mA	Part of basic device: 1 × 54 mA Part of encoder: 3 × 91 mA = 273 mA
Optional communication	PROFIBUS "PB"	1 × 56 mA
Digital output active	250 mA	1 × 250 mA
Total current consumption I_{N3} = 870 + 150 + 54 + 273 + 56 + 250 = 1653 mA **= 1.653 A** **Power consumption P_{N3}** = I_{N3} × U_{N3} = 1.653 A × 24 V **= 39.7 W**		

Fig.4-30: Exemplary Calculation

Requirements to the 24V Power Supply Unit

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

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

Required Continuous Power

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

If required, determine the continuous current I_{N3} for selecting the 24V power supply unit:

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

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

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

Experience has shown that the **typical power consumption** of drive systems is at **approx. 70%** of the calculated maximum value.

Required Peak Current

When switched on, the 24V power supply unit must supply the sum of the occurring inrush currents I_{EIN3} or charges $I_{EIN3} \times t_{EIN3Lade}$.

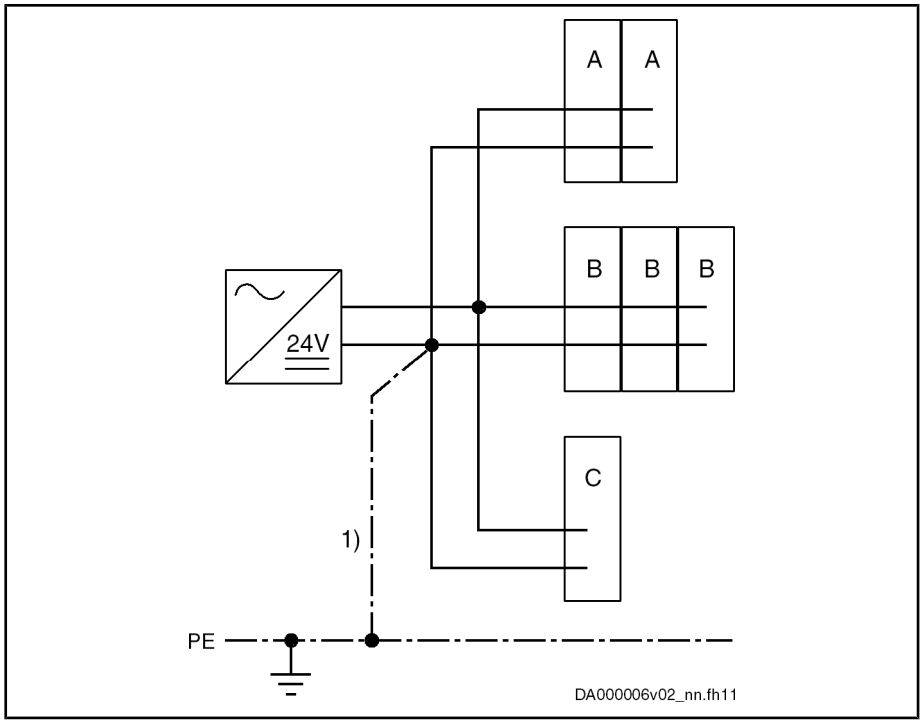
When the 24V power supply unit is switched on, the 24V power supply unit is loaded with the charging current of the capacitors of the connected components. An electronic circuit in each component limits the charging current to the value I_{EIN3}.

24V power supply units with **integrated dynamic current limitation** control the occurring charging process $I_{EIN3} \times t_{EIN3Lade}$, if these 24V power supply units allow the 1.2-fold continuous current for at least 1 second. Therefore, use 24V power supply units with integrated dynamic current limitation the continuous power of which is **at least 20%** above the determined sum of power consumptions P_{N3}.

Installation of 24V Supply

Notes on Installation

- As a matter of principle, the 24V supply of the components of the drive system Rexroth IndraDrive Cs should be installed in **star-shaped form**. For each group of drive controllers or third-party components it is therefore necessary that you run separate supply lines. This, too, applies to multiple-line arrangement in the case of supply from a supply unit, for example.
- Route lines with sufficiently dimensioned line cross sections to reduce load-dependent voltage drops.
- For looping through the control voltage, observe the maximum current carrying capacity of the connection points. The maximum current carrying capacity limits the number of devices to which the control voltage can be looped through.



A	Device group of components with a current consumption of ≤ 5 A / component
B	Device group of components with a current consumption of ≤ 3.3 A / component
C	Third-party component (e.g. PLC, valve etc.)
1)	Connection to central ground point (e.g. earth-circuit connector PE)

Fig.4-31: Installation of 24V Supply

☞ If you use several 24V power supply units:

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

Chronological Order of 24V Supply and Mains Voltage

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

Looping Through the Control Voltage

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

CAUTION

Property damage in case of error caused by too small line cross section!

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

☞ The **current carrying capacity** of connection point **X13** (Y-connector) for control voltage supply of the HCS01 components is **10 A**.

Combining the Individual Components

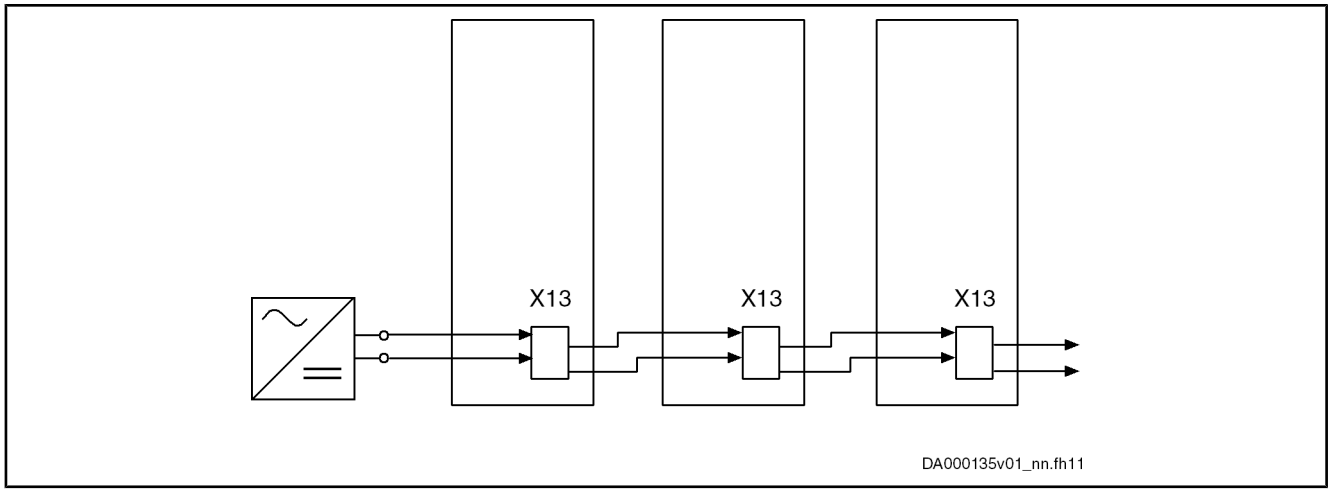


Fig.4-32: Looping Through the Control Voltage

Exemplary calculation for 3 drive controllers:

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

Fig.4-33: Continuous Current

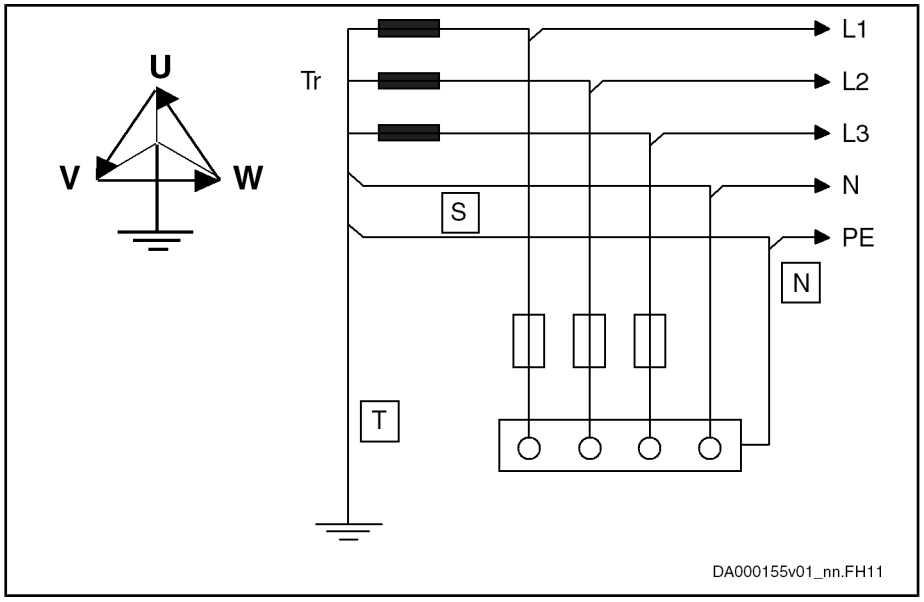
The result I_D must be smaller than the specified current carrying capacity of the connection point.

4.6.3 Mains Connection

Mains Types

TN-S Mains Type

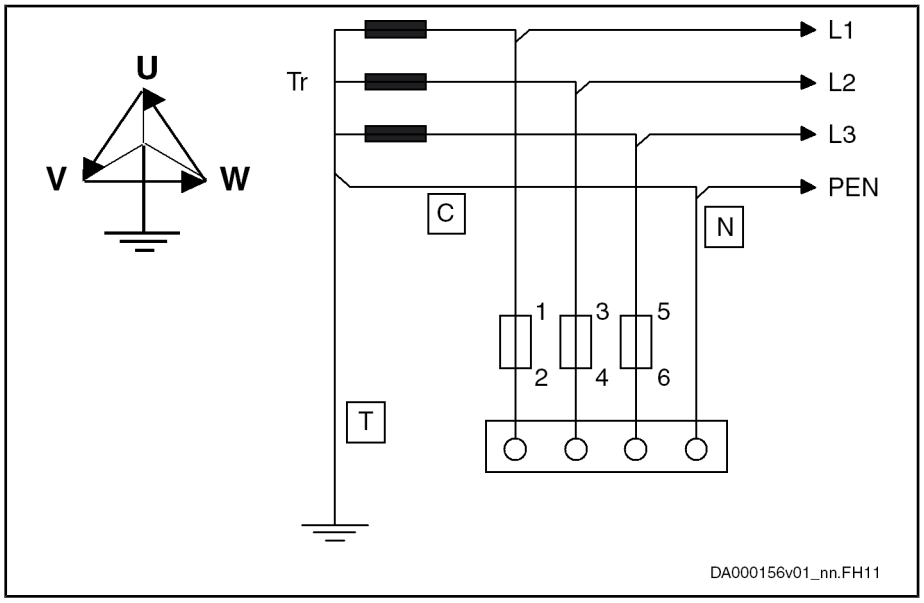
The TN-S mains type is the usual mains type in Europe.



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

Fig.4-34: TN-S Mains Type

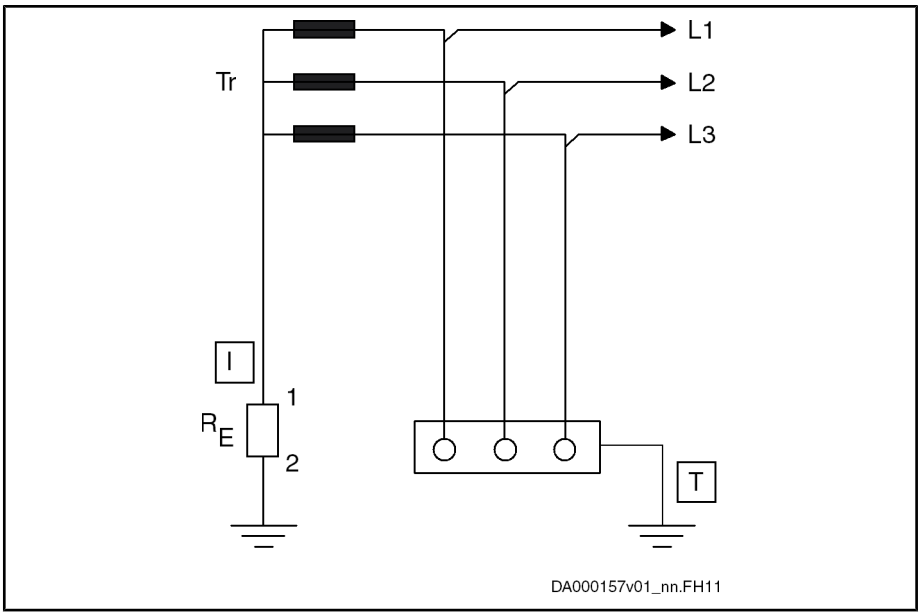
TN-C Mains Type



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

Fig.4-35: TN-C Mains Type

IT Mains Type



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

Fig.4-36: IT Mains Type

Notes on Project Planning

Damage to the devices by voltage arcing!

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

Voltage increase in the case of ground fault!

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

For operation at the IT mains type, the drive system including mains filter and mains choke should be galvanically decoupled from the mains via an **isolating transformer**.

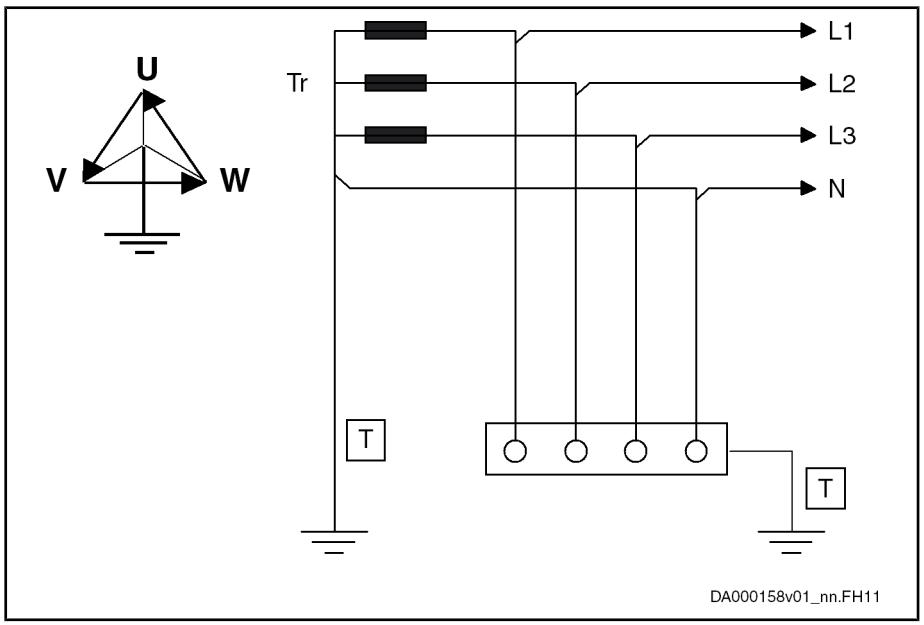
In this way, the ground fault detection or monitoring can remain effective in the installation.

When operating drive systems with HCS converters in other applications **without isolating transformer** at the IT mains type:

- Observe the allowed mains voltage U_{LN} at the IT mains type of the corresponding devices
- Observe the allowed switching frequency f_s; see note below
- Check whether the ground fault detection of the mains does not trigger accidentally
- Check whether the interference suppression (that is only activated via the parasitic mains capacitances of the ungrounded mains) is still sufficient to comply with the required limit values

The EMC requirements are only complied with by further measures (special mains filters, among other things)!

TT System

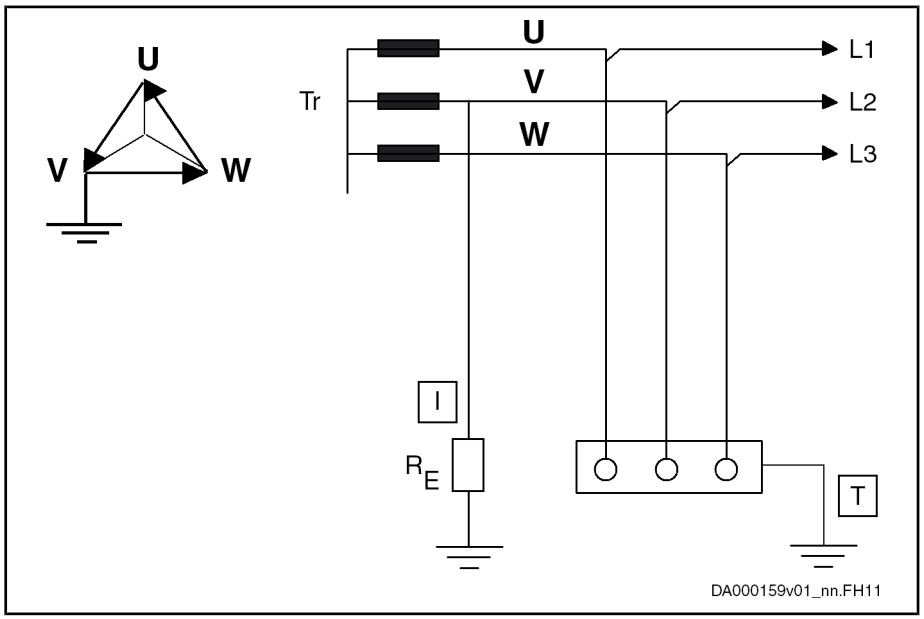


T = Direct grounding of a point (station ground)
T = Exposed conductive parts directly grounded, independent of grounding of current source (station ground)

Fig.4-37: TT Mains System

The EMC requirements are only complied with by specific measures (special mains filters, among other things).

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.4-38: Mains With Grounded Outer Conductor

Combining the Individual Components

Notes on Project Planning

The EMC requirements are only complied with by specific measures (special mains filters, among other things).

Mains filters HNF01, NFD at mains grounded via outer conductor

HNF01.1 or NFD03.1 mains filters are not suited for operation on mains grounded via outer conductor. Use isolating transformers.

Allowed mains connection voltage: See technical data of the respective device

Type of Mains Connection

Mains Supply

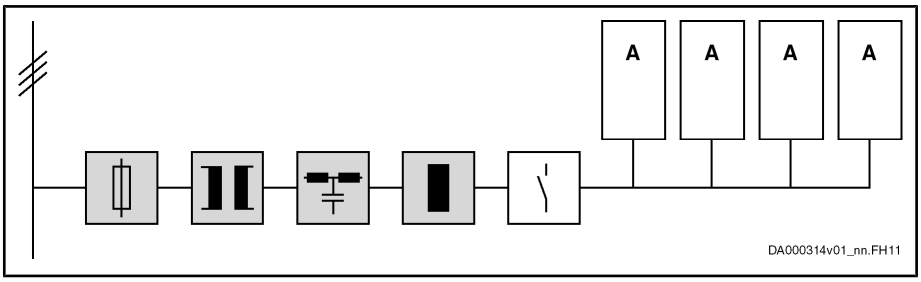
1-phase[1)]	3-phase	
1 AC 110 … 230 V	3 AC 200 ... 500 V	
	Autotransformer	-
	3 AC 110 … 230 V	-
HCS01.1E-W0003-A-**02** HCS01.1E-W0006-A-**02** HCS01.1E-W0009-A-**02** HCS01.1E-W0013-A-**02**		HCS01.1E-W0005-A-**03** HCS01.1E-W0008-A-**03** HCS01.1E-W0018-A-**03** HCS01.1E-W0028-A-**03**
Mains supply		
Individual supply		Individual supply
		Group supply
		Central supply

1) With single-phase mains supply, you can connect the mains supply line to connector X3 at L1, L2 or L3

Fig.4-39: Mains Supply

Individual Supply

Each component is **individually** connected to the supply mains. There is **no** DC bus connection between the devices.



Components marked with gray background color: Optional, depending on the application

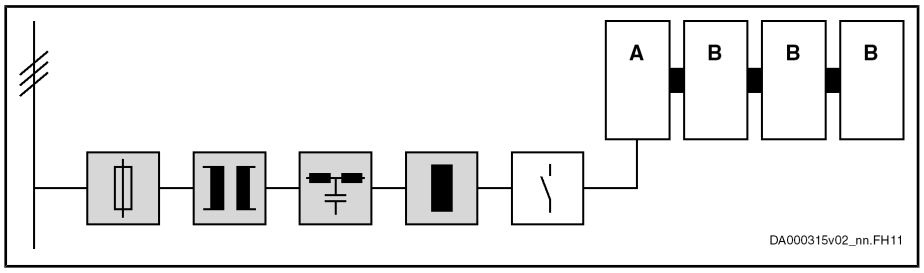
A Component HCS01

Fig.4-40: Individual Supply

Central Supply

- Only HCS01.1E-W0028 components are suited for central supply.
- Central supply via HCS02.1, HCS03.1, HMV01.1 or HMV02.1 components is not allowed.
- Use the corresponding mains chokes to increase the DC bus continuous power.
- Wire the Bb relay contacts.

One powerful component supplies other components via the common DC bus connection.



Components marked with gray background color: Optional, depending on the application

A Component HCS01 (more powerful than component B); connected to other components via DC bus

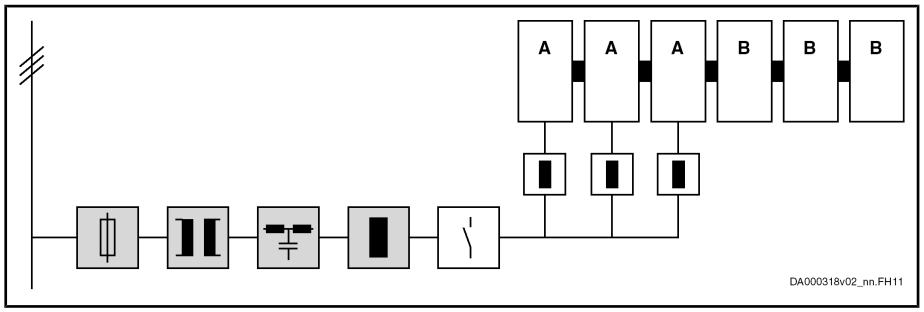
B Component HCS01 (less powerful than component A); connected to other components via DC bus

Fig.4-41: Central Supply

Group Supply

- Option 1:

  Several powerful components HCS01 (of the same size!) are connected to the mains and supply other components via the common DC bus connection. This requires balancing chokes between supply mains and components.



Components marked with gray background color: Optional, depending on the application

A Component HCS01 (more powerful than component B; all components A identical); connected to supply mains via balancing chokes; connected to other components via DC bus

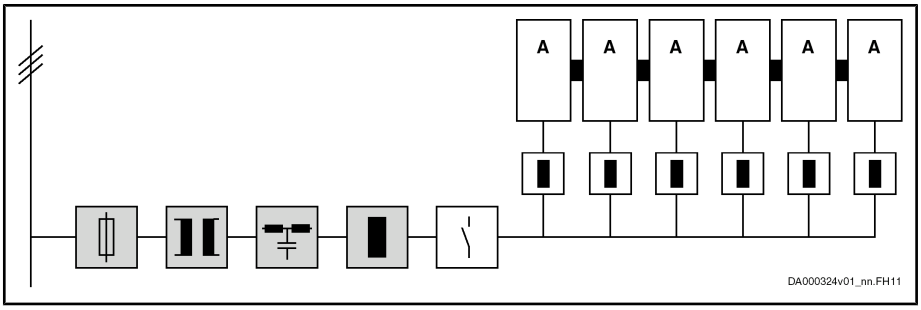
B Component HCS01 (less powerful than component A); connected to other components via DC bus

Fig.4-42: Group Supply; Several HCS01 Components Connected to Supply Mains

- Option 2:

  All components HCS01 (of the same size!) are connected to the mains and interconnected via the common DC bus connection. This requires balancing chokes between supply mains and components.

Combining the Individual Components



Components marked with gray background color: Optional, depending on the application

A Component HCS01 (all components A identical); connected to supply mains via balancing chokes; interconnected via DC bus

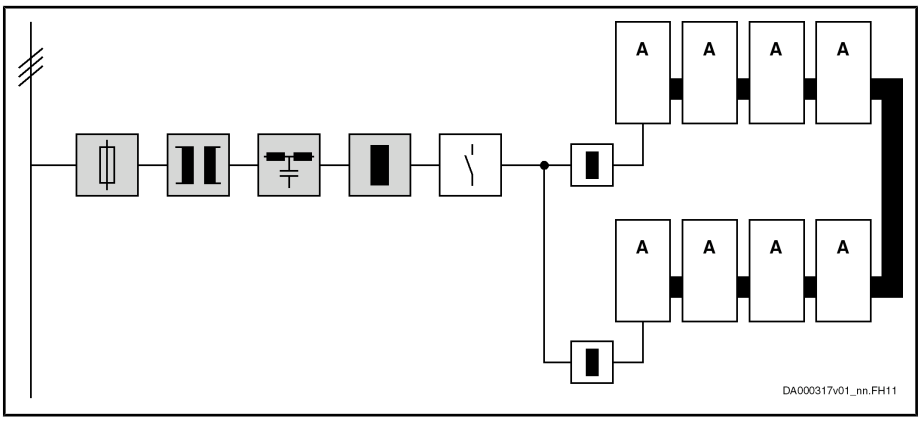
Fig.4-43: Group Supply; all HCS01 Components Connected to Supply Mains

Parallel Operation

Group supply or central supply allows parallel operation of the HCS01 components to increase the DC bus continuous power.

☞ Parallel operation of HCS01 components is only allowed under the following conditions:

- The components are of the same range HCS01
- The infeeding HCS01 components are of the same type
- Additional chokes balance the mains current



Components marked with gray background color: Optional, depending on the application

A Component HCS01; connected to all other components HCS01 via DC bus

Fig.4-44: Parallel Operation

☞ Connect the Bb relay contacts of all supplying components in series. You thereby ensure that the mains contactor is switched off in case there is an error in a component.

Mains Connected Load and Mains Current

Technical Data of the Components

See index entry

- HCS01 → Mains voltage, data
- HCS01 → DC bus, data

Calculating the Mains-Side Phase Current

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

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

Operation Under Rated Conditions

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

Operation at Partial Load

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

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

1. Determine **motor power**

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

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

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

Fig.4-45: Calculating the DC Bus Power

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

   ⇒ Partial load of P_{DC_cont} is available

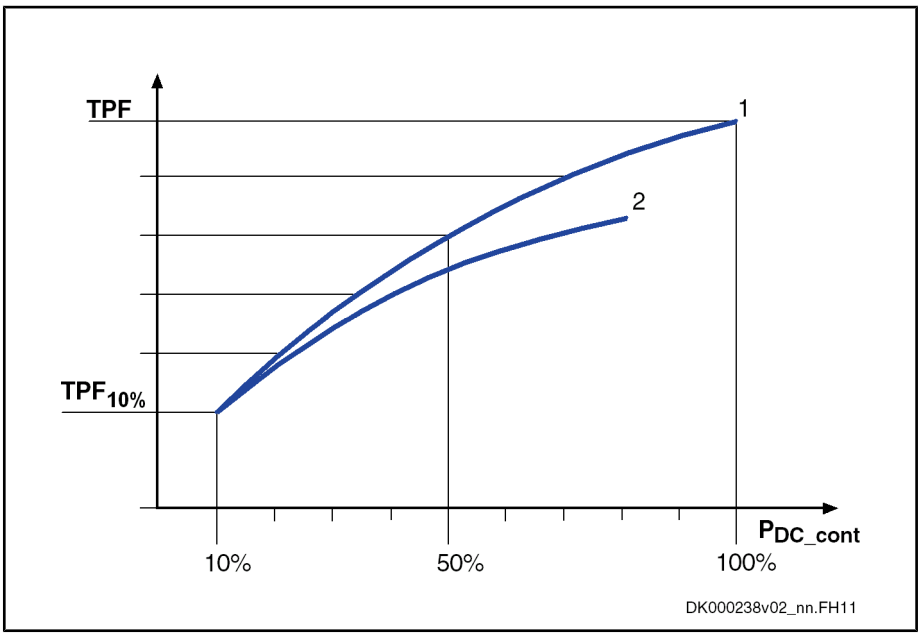
4. Determine **power factor TPF** for partial load (TPF = Total Power Factor)

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

   Transfer the data to the diagram and determine the TPF for operation at partial load.

Combining the Individual Components

Qualitative Characteristic TPF vs. DC Bus Power P_{DC_cont}



$TPF_{10\%}$; TPF	Values from table "Data for Mains Voltage Supply"; TPF = Total Power Factor at rated power, $TPF_{10\ \%}$ = Total Power Factor at 10% rated power
P_{DC_cont}	Value from table "Data of Power Section - DC Bus"
1	**With** mains choke
2	**Without** mains choke

Fig.4-46: Qualitative Characteristic TPF vs. DC Bus Power P_{DC_cont}

5. Calculate **mains connected load**

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

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

Fig.4-47: Calculating Mains Connected Load

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

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

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

Fig.4-48: Calculating Mains-Side Phase Current

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

   See index entry "Line cross sections → Dimensioning".

Dimensioning of Line Cross Sections and Fuses

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

1. Determine current in supply feeder of drive system and correct it with correction factors for ambient temperature and bundling.

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

Country of use: International except for USA/Canada		
Current I	Nominal current fuse	Cross section A for installation type B1
A	A	mm^2
1,6	2	1,5 Minimum cross section acc. to EN 60204-1:2006, table 5 (Main circuits; outside of housings; permanently installed; single-core lines; stranded wire design class 2)
3,3	4	
5,0	6	
8,6	10	
10,3	16	
13,5	16	
18,3	20	2,5
22	25	4
31	35	6
35	40	10
44	50	10
59	63	16
77	80	25
96	100	35
117	125	50
149	160	70
180	200	95
208	250	120
227	250	150
257	315	185

Combining the Individual Components

Country of use: International except for USA/Canada		
Current I	Nominal current fuse	Cross section A for installation type B1
A	A	mm²
301	355	240
342	400	300

Fig.4-49: Line Cross Sections and Fuses, B1 According to EN 60204-1:2006, Table 6, as of 150mm² DIN IEC 60364-5-52:2004, Table B.52-4

Country of use: International except for USA/Canada		
Current I	Nominal current fuse	Cross section A for installation type B2
A	A	mm²
1,6	2	0,75 Minimum cross section acc. to EN 60204-1:2006, table 5 (Main circuits; outside of housings; permanently installed; multicore lines)
3,3	4	
5,0	6	
8,5	10	
10,1	16	1,0
13,1	16	1,5
17,4	20	2,5
23	25	4
30	35	6
35	40	10
40	50	10
54	63	16
70	80	25
86	100	35
103	125	50
130	160	70
156	200	95
179	200	120
195	224	150
221	250	185
258	315	240
294	355	300

Fig.4-50: Line Cross Sections and Fuses, B2 According to EN 60204-1:2006, Table 6, as of 150mm² DIN IEC 60364-5-52:2004, Table B.52-4

Country of use: International except for USA/Canada		
Current I	Nominal current fuse	Cross section A (according to UL508A) for installation type E
A	A	mm²
1,6	2	0,75 Minimum cross section acc. to EN 60204-1:2006, table 5 (Main circuits; outside of housings; permanently installed; multi-core lines)
3,3	4	
5,0	6	
8,3	10	
10,4	16	
12,4	16	1
16,1	20	1,5
22	25	2,5
30	35	4
37	40	6
44	50	10
52	63	10
70	80	16
88	100	25
110	125	35
133	160	50
171	200	70
207	250	95
240	315	120
277	355	150
316	400	185
374	425	240
432	500	300

Fig.4-51: Line Cross Sections and Fuses, E According to EN 60204-1:2006, Table 6, as of 150mm² DIN IEC 60364-5-52:2004, Table B.52-10

Country of use: USA/Canada		
Current I	Nominal current fuse	Cross section A
A	A	AWG
1,6	2	14 Minimum cross section acc. to UL 508 A:2007, chapter 29.6
3,3	4	14
5,0	6	14

Country of use: USA/Canada		
Current I	Nominal current fuse	Cross section A
A	A	AWG
8,3	10	14
13	16	14
15	20	14
20	25	12
30	40	10
50	70	8
65	80	6
85	100	4
100	110	3
115	125	2
130	150	1
150	175	1/0
175	200	2/0
200	225	3/0
230	250	4/0
255	300	250 kcmil
285	300	300 kcmil
310	350	350 kcmil
335	350	400 kcmil
380	400	500 kcmil
420	450	600 kcmil

Fig.4-52: Line Cross Sections and Fuses According to UL508A:2007, Table 28.1

Dimensioning variables of the table values

1. Ambient temperature T_A of routed lines ≤ 40 °C
2. Temperature T_L at conductor at nominal current: 90 °C for UL-listed lines (USA/Canada) or 70 °C for PVC lines
3. The nominal current of the fuse is approx. 10–20 % above the nominal current I_{LN} of the converter/supply unit or the determined current of the drive system.
4. Installation types:
   - B1 according to IEC 60364-5-52, e.g. stranded wires routed in cable duct
   - B2 according to IEC 60364-5-52, e.g. multi-core line routed in cable duct
   - E according to EN 60204-1, e.g. multi-core line routed on open cable tray
   - According to NFPA 79 (external wiring), UL508A (internal wiring), NEC, NFPA 70:

– 1 cable with 3 conductors, 1 neutral conductor and 1 equipment grounding conductor
– Routed in pipe on the wall

Internal wiring: Routing inside of control cabinet or inside of devices

External wiring: Routing outside of control cabinet

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

5. Recommendation for design of the fuses:
   - **International except for USA/Canada**: Class gL-gG; 500V, 690V; design NH, D (DIAZED) or D0 (NEOZED)

☞ **Characteristic**

In the case of error (e.g. ground fault at connections L+, L-), fuses of characteristic **gL** (general-purpose fuse link for cables and lines) and **gG** (general-purpose fuse link for general installations), as well as circuit breakers, protect the **lines** in the supply feeder to the drive system.

To **protect the semiconductors** in the input of supply units and converters, you can use fuses of characteristic **gR**.

   - **USA / Canada**: Class J; 600V

☞ **Circuit breakers**

As an alternative to fuses, you can use circuit breakers with lower peak let-through current and lower let-through energy than the corresponding fuse.

☞ **Correction factors**

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

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

Correction Factor Ambient Temperature

Ambient temperature T_A / °C	30	35	40	45	50	55	60
Correction factor according to EN 60204-1:2006, table D.1	0,87	0,93	1,00	1,1	1,22	1,41	1,73
Correction factor according to NFPA 79:2002, table 13.5.5(a)	0,88	0,94	1,00	1,1	1.18	1.32	1,52

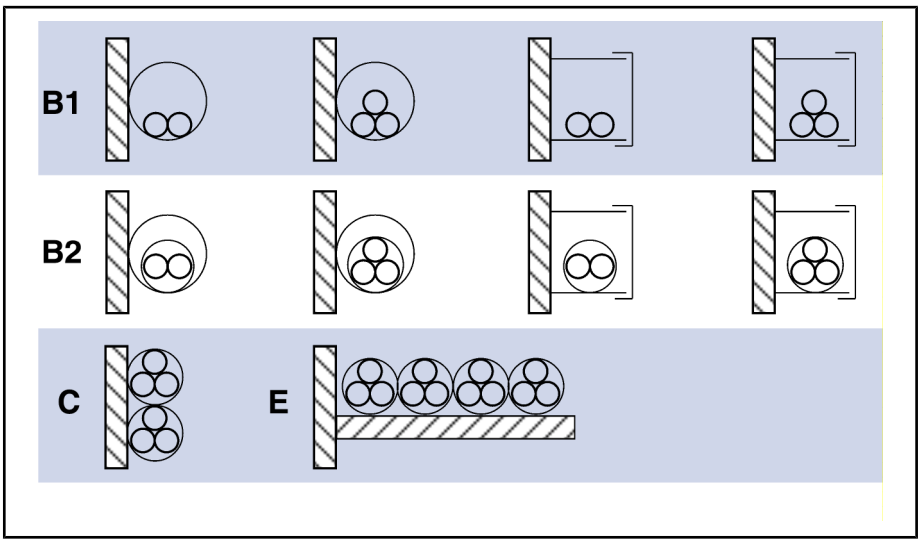
Fig.4-53: Correction Factor Ambient Temperature According to EN 60204-1:2006 and NFPA 79:2002

Correction Factor for Bundling of Lines (Installation Methods B2 and E) and Circuits (Installation Method B1[1])

Number of lines	1	2	3	4	5
Correction factor according to EN 60204-1:2006, table D.2	1	1,25	1,43	1,54	1,67
Correction factor according to NFPA 79:2002, table 13.5.5(b)	1	1,25			

Fig.4-54: Correction Factor for Bundling of Lines and Circuits According to EN 60204-1:2006 and NFPA 79:2002

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



B1 Conductors in installation pipes and in installation channels that can be opened
B2 Cables or lines in installation pipes and in installation channels that can be opened
C Cables or lines on walls
E Cables or lines on open cable trays

Fig.4-55: Installation Types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

Dimensioning the Mains Contactor

Required data:

- Nominal current I_{LN} of the drive controller
- Number of drive controllers connected to the mains contactor

For the nominal current I_{LN} see the technical data of the drive controller (Data for Mains Voltage Supply; see index entry "HCS01 → Mains voltage, data").

If you use mains contactors of utilization category AC-1, observe the conventional thermal continuous current I_{th} (see data sheet of mains contactor) when dimensioning the mains contactor.

The minimum required conventional thermal continuous current I_{th} results from the sum of nominal currents ΣI_{LN} of all connected drive controllers.

Mains Filter

Dimensioning the Mains Filter

Criteria for Selecting the Mains Filter

Take the following criteria into account for selecting the appropriate mains filter:

- EMC limit value class on site
- Ambient conditions on site
- Harmonics on mains voltage on site
- Loading by mains voltage and frequency on site
- Loading by harmonics on site
- Loading by mains-side phase current
- Total length of connected power cables
- Sum of leakage capacitances

How to Proceed for Selecting the Mains Filter

The selection of the mains filter is significantly determined by the operating conditions. How to proceed for selecting the mains filter:

1. Determine the required EMC limit value class for the application.
2. Determine the maximum applied mains voltage.
   Observe that not all Rexroth IndraDrive Cs mains filters are suited for a mains voltage of 3 AC 500 V.

   Check whether the mains voltage of the mains filter is loaded with harmonics and still allowed for the mains filter. You can find the allowed operating data depending on existing harmonics in a separate chapter (see index entry "Harmonics → Mains current").

   If necessary, reduce the harmonics on site.
3. Determine the kind of mains connection, such as central supply, group supply etc. (to do this, it is useful to outline the involved components and their interaction).
4. Calculate the **mains-side phase current** of the mains filter.
   You can find the procedure for calculating the mains-side phase current in a separate chapter (see index entry "Phase current → Calculating"). For selecting the components, calculate the effective rms value.

   Check or determine the maximum occurring ambient temperature. Select a mains filter with higher nominal current, when the ambient temperature is between 45 °C and 55 °C.
5. Select a mains contactor the nominal current of which does not exceed nominal current of the mains filter.
6. Determine the number of drive axes.
7. Determine the total length of the connected power cables.
8. Determine the sum of the leakage capacitances on the load side of the mains filter.
   The sum of the leakage capacitances results from the number of operated axes and the length of the connected power cables. You can find the procedure for determining the leakage capacitance in a separate chapter (see index entry "Leakage capacitance → Determining").
9. Select the appropriate mains connection (supply unit/converter, mains choke, mains filter) from the tables in the corresponding chapter (see index entry "Mains connection → Transformer, mains filter, mains choke").

Notes on Installation

☞ When using NFE01, NFE02 or NFD03 mains filters at **mains grounded via outer conductor**, install an isolating transformer between mains and mains filter.

Determining Mains Choke

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 (standard): Only one drive controller or supply unit is connected to the mains choke (individual supply and central supply).

Selection criteria:

- Use of assigned mains choke according to Project Planning Manual of drive controller or supply unit.

Case 2: Several drive controllers or 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.4-56: Mains Choke Conditions

- **Nominal inductance**: The nominal inductance of the mains choke has to be at least as high as the inductance of the greatest assigned mains choke of the connected drive controllers or supply units.

Dimensioning and Selecting the Mains Transformer

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

Grounded Mains

As a matter of principle, the mains voltage for grounded mains is adjusted by means of **autotransformers**.

Ungrounded Mains

As a matter of principle, the mains voltage for ungrounded mains is adjusted by means of **isolating transformers** to avoid prevent overvoltages between outer conductor and ground.

Applications for Autotransformers

With HCS01 components, there are two applications for which autotransformers are necessary:

1. HCS01.1E-W00xx-A-**02** components are used:

   With a mains voltage of 3 AC 400 V, the voltage must be adjusted via an autotransformer to use HCS01.1E-W00xx-A-**02** components with an input voltage range of 3 AC 110…230 V.

2. An MSM motor is used in conjunction with an HCS01.1E-W00xx-A-**03** component:

   MSM motors have been dimensioned for a voltage of 230 V. To operate MSM motors at a mains voltage of 3 AC 400 V at an HCS01.1E-W00xx-A-**03** component, the mains voltage must be adjusted to 3 AC 230 V via an autotransformer.

Combining Transformer, Mains Filter and Mains Choke

HCS01.1E	Transformer		Mains filter				Mains choke		
	DST[3]	DLT[4]	NFE 01.1	NFE 02.1	NFD 03.1	HNF01.1*-****-**E****	HNK 01.1	HNL01.1**E**	HNL01.1**R**
W0003 W0006 W0009 W0013	■	■	■	■	■	[1]	-	-	-
W0005 W0008 W0018 W0028	■	■	-	-	■	[1]	-	■[2]	-

■ Allowed
- Not allowed
1) We are currently checking whether it is possible to combine HNF mains filters and several HCS01 components.
2) Only possible with --W0018 and -W0028 components
3) DST = Autotransformer
4) DLT = Isolating transformer

Fig.4-57: Additional Components in the Mains Connection of HCS01 Components

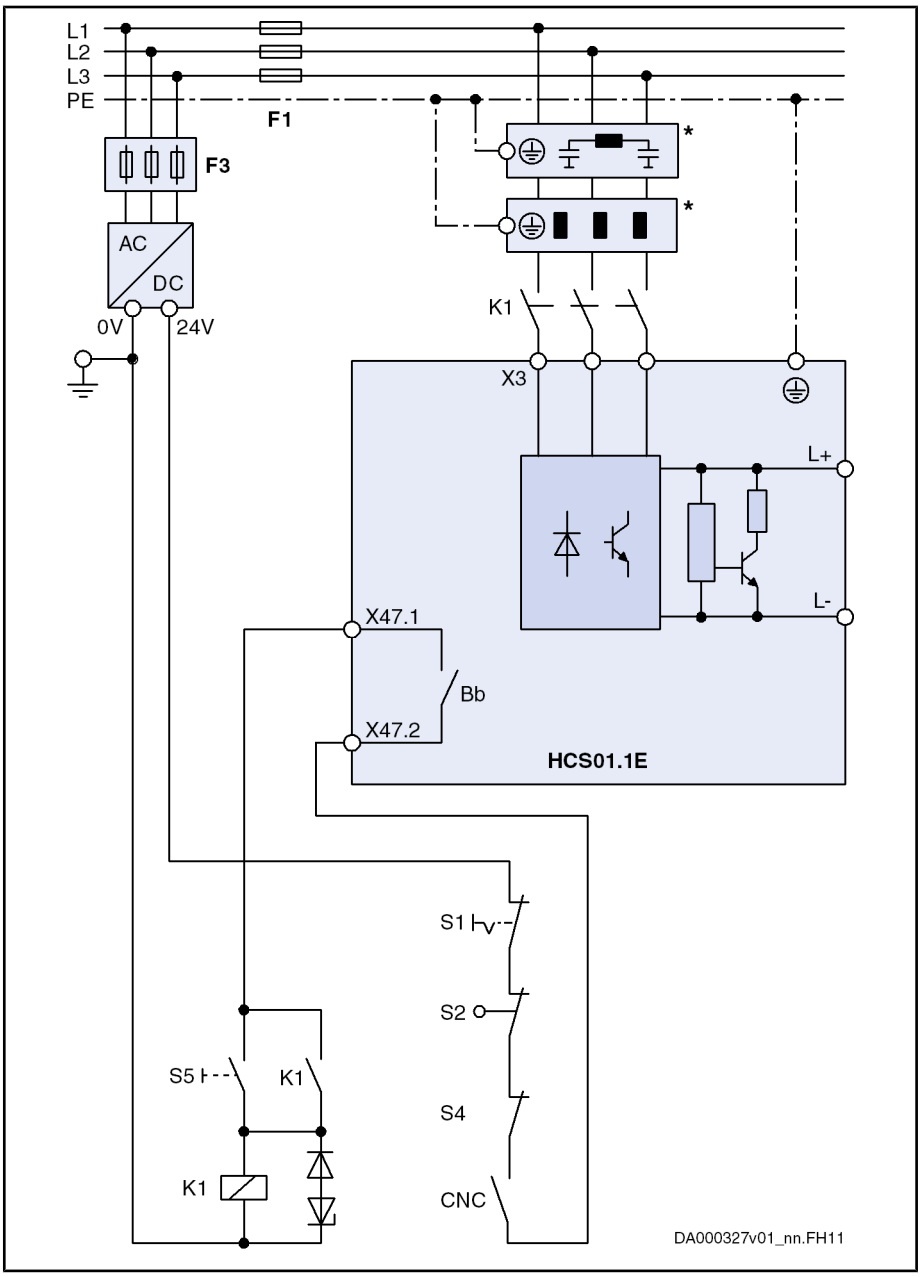
Converter HCS01.1E	Mains chokes	Mains filter	Explanation	EMC limit value class to be achieved[1]: Max. leakage capacitance C_{ab_g}
W0003 W0006	-	NFE01.1-250-006	Standard combination for **1 converter** with single-phase mains voltage supply	A2.1
W0009		NFD03.1-480-007	Standard combination for **1 converter** with three-phase mains voltage supply	A2.1
W0013	-	NFE02.1-230-008	Standard combination for **1 converter** with single-phase mains voltage supply	A2.1
		NFD03.1-480-007	Standard combination for **1 converter** with three-phase mains voltage supply	A2.1
W0005 W0008 W0018	-	NFD03.1-480-007	Standard combination for **1 converter**	A2.1
W0028	HNL01.1E-1000-N0012 (optional)	NFD03.1-480-016	Standard combination for **1 converter**	A2.1

1) In grounded mains

Fig.4-58: Mains Connection HCS01

Combining the Individual Components

Control Circuit for Mains Connection



*	Optional
Bb	Bb relay contact (see connection point X47)
CNC	Lag error message of control unit
F1	Fuse of power supply
F3	Fuse of 24V power supply unit
K1	External mains contactor
S1	Emergency stop
S2	Axis end position
S4	Power Off
S5	Power On

Fig.4-59: Control Circuit for the Mains Connection

4.6.4 DC Bus Coupling

Requirements for DC Bus Coupling

Device Types

Only devices of the "HCS01.1E-W00**-*-**03**" type are suited for DC bus coupling. DC bus coupling takes place via the optionally available DC bus connector at the connection point X77.

☞ **Parameterization:** For all devices which are only supplied via the DC bus, "DC bus → inverter mode" must be set as the source of power supply in parameter "P-0-0860, Converter configuration" (see also Parameter Description of the firmware used).

Mains Connection

DC bus coupling is possible for the following types of mains connection:

- Central supply
- Group supply

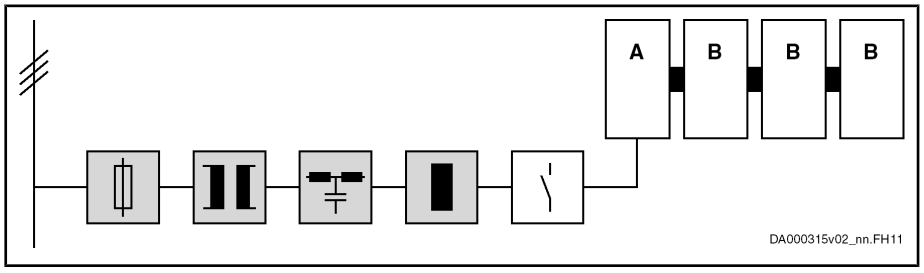
Central Supply and DC Bus Coupling

Use this type of DC bus coupling, when the DC bus continuous power of the infeeding device makes available sufficient power reserves to supply other HCS01 devices. The devices in the group can be of different types. For the project planning of the application, observe that the supplying devices can only make available the DC bus power for other devices which they do not consume themselves.

With central supply, **one** HCS01 **device** charges the DC bus and the other devices are supplied via DC bus coupling.

Features

- The supplying device must be of the **HCS01.1E-W0028** type
- Energy compensation between the devices is possible (the DC bus capacitors of the devices are connected in parallel)
- Balancing of the integrated braking resistors exists (equal load of all braking resistors integrated in the devices)
- No balancing measures required in the supply feeder
- To increase the DC bus power, a mains choke can be optionally used
- It is possible to connect DC bus capacitor units
- Small wiring effort for the mains connection
- DC bus short circuit functionality must be realized externally, if required



Components marked with gray background color: Optional, depending on the application

A Component HCS01 (more powerful than component B); connected to other components via DC bus

B Component HCS01 (less powerful than component A); connected to other components via DC bus

Fig.4-60: Central Supply

Group Supply and DC Bus Coupling

Possibilities of DC Bus Coupling

For group supply with DC bus coupling, there are **two options**:

1. **At least two devices** supply the DC bus and other devices are supplied via th common DC bus connection
2. **All devices** with common DC bus connection supply the DC bus

☞ When dimensioning the devices for group supply, observe the **balancing factor**:

- 0.8 (when balancing is used)
- 0.5 (when balancing is not used)

Balancing: To distribute the charging process of the DC bus equally over all supplying devices, balancing chokes or balancing resistors must be installed in the supply feeder.

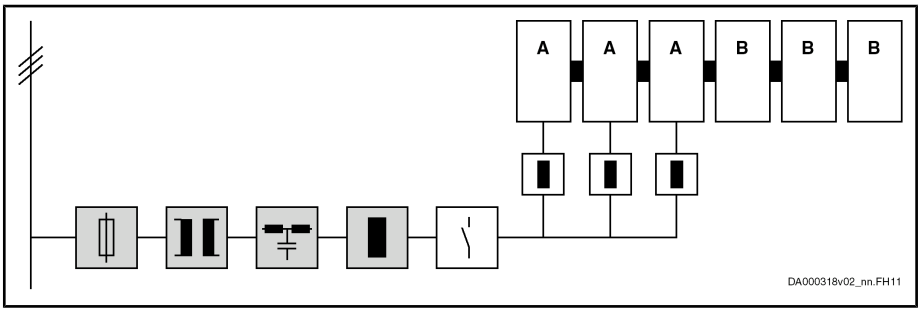
Balancing choke for HCS01.1E-W0028: Mains choke HNL01.1E-100 0-N0012-A-500-NNNN

The firmware provides for the balancing of the power over all braking resistors. See also the documentation of the firmware used (parameter "P-0-0860, Converter configuration").

☞ The parallel connection of the braking resistors causes **derating/ reduction of power** of the continuous braking resistor power to the factor 0.8.

Supply via at Least Two Devices

Use this type of DC bus coupling if you use **different HCS01 device types** in your application.



Components marked with gray background color: Optional, depending on the application

A Component HCS01 (more powerful than component B; all components A identical); connected to supply mains via balancing chokes; connected to other components via DC bus

B Component HCS01 (less powerful than component A); connected to other components via DC bus

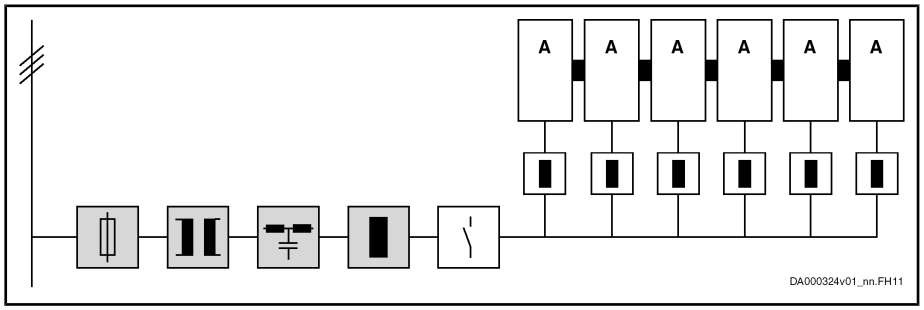
Fig.4-61: Group Supply; Several HCS01 Components Connected to Supply Mains

Features

- The supplying devices[1) 2)] must be of the **HCS01.1E-W0028** type
- DC bus continuous power of the supplying devices reduced by parallel operation
- Energy compensation between the devices is possible (the DC bus capacitors of the devices are connected in parallel)
- Balancing of the integrated braking resistors exists (equal load of all braking resistors integrated in the devices)
- Balancing chokes or balancing resistors required in supply feeder
- It is possible to connect DC bus capacitor units
- Wiring effort for the mains connection relatively small
- It is possible to use a common mains contactor, as well as a common mains filter
- DC bus short circuit functionality must be realized externally, if required

Supply via all Devices

Use this type of DC bus coupling if you exclusively use **one HCS01 device type** in your application.



Components marked with gray background color: Optional, depending on the application

A Component HCS01 (all components A identical); connected to supply mains via balancing chokes; interconnected via DC bus

Fig.4-62: Group Supply; all HCS01 Components Connected to Supply Mains

Features

- All devices must be of the **same type**
- DC bus continuous power of the supplying devices reduced by parallel operation
- Energy compensation between the devices is possible (the DC bus capacitors of the devices are connected in parallel)
- Balancing of the integrated braking resistors exists (equal load of all braking resistors integrated in the devices)
- Balancing chokes or balancing resistors required in supply feeder
- It is possible to connect DC bus capacitor units
- Wiring effort for the mains connection of all devices relatively big
- DC bus short circuit functionality must be realized externally, if required

1) ***Supplying*** *devices are devices connected to the mains which supply power to other devices via a DC bus connection*

2) ***Supplied*** *devices are devices not connected to the mains which are supplied with power by the supplying devices via a DC bus connection*

☞ With group supply, the **Bb relay contacts of all supplying devices** must be connected **in series**. This guarantees that the mains contactor is switched off in the case of error in a device.

Implementation of DC Bus Coupling

Maximum Number of Devices

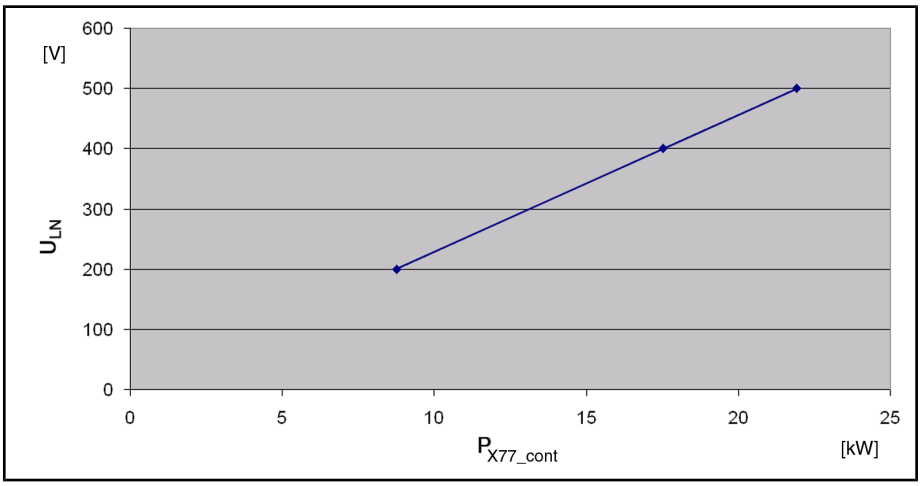
The maximum number of devices which can be interconnected via DC bus coupling depends on

- the power reserves of the supplying devices

  (The power reserve results from the difference between the possible DC bus continuous power of the device and the power consumed by the motor connected to the device.)
- the type of DC bus connection:
  1. Connection looped through via DC bus connector X77
  2. DC bus connecting bar
- the sum of DC bus continuous powers of all supplied devices
- the mains voltage value
- the maximum continuous power which can be looped through via the DC bus connector X77

  (The continuous power results from the current carrying capacity of the DC bus connector X77 and the mains voltage value.)

Load of DC Bus Connector at I = 31 A



U_{LN} Mains voltage

P_{X77_cont} Continuous power at DC bus connector X77

Fig.4-63: Load of DC Bus Connector

U_{LN}	P_{X77_cont}
200 V AC	9 kW
400 V AC	18 kW
500 V AC	22 kW

Fig.4-64: Selected Values of Continuous Power via DC Bus Connector X77 (P_{X77_cont}) Depending on Mains Voltage

Number of supplied devices:

If the sum of power reserves ($P_{reserve}$) of the supplying devices is **greater then** the continuous power of X77 (P_{X77_cont}), the maximum number of supplied devices results from P_{X77_cont} minus the respective DC bus continuous power of the individual devices at average speed.

If the sum of power reserves ($P_{reserve}$) of the supplying devices is **smaller** than the continuous power of X77 (P_{X77_cont}), the maximum number of supplied devices results from $P_{reserve}$ minus the respective DC bus continuous power of the individual devices at average speed.

Looping Through the DC Bus Connection via DC Bus Connector X77

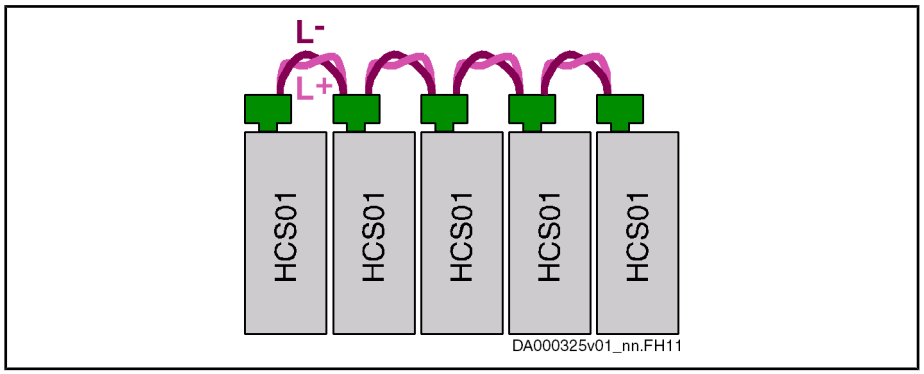


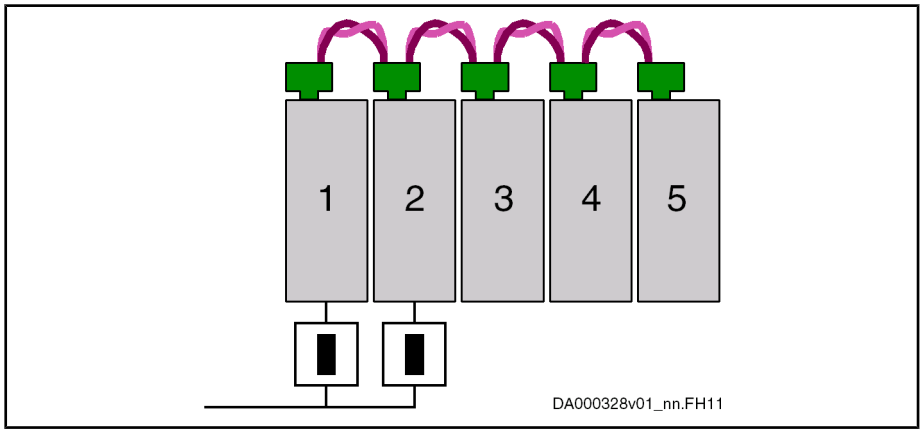
Fig.4-65: Looping Through via DC Bus Connector

The DC buses of the individual devices are connected via the DC bus connectors X77.

When the devices are supplied via group supply, the DC bus connector X77 of the last infeeding device is the limiting factor in the DC bus group.

☞ **Arrangement of the devices:** The higher the power consumption of a device, the nearer to the supplying devices it must be arranged.

Example:



1, 2 HCS01.1E-W0028 (supplying devices)
3, 4, 5 HCS01.1E-W0018 (supplied devices)

Fig.4-66: Looping Through

On the left, the two supplying HCS01.1E-W0028 devices have been arranged; to their right the three supplied HCS01.1E-W0018 devices.

The DC bus connector of the second device from the left (2) limits the possible number of devices at the common DC bus.

Combining the Individual Components

DC Bus Connecting Bar

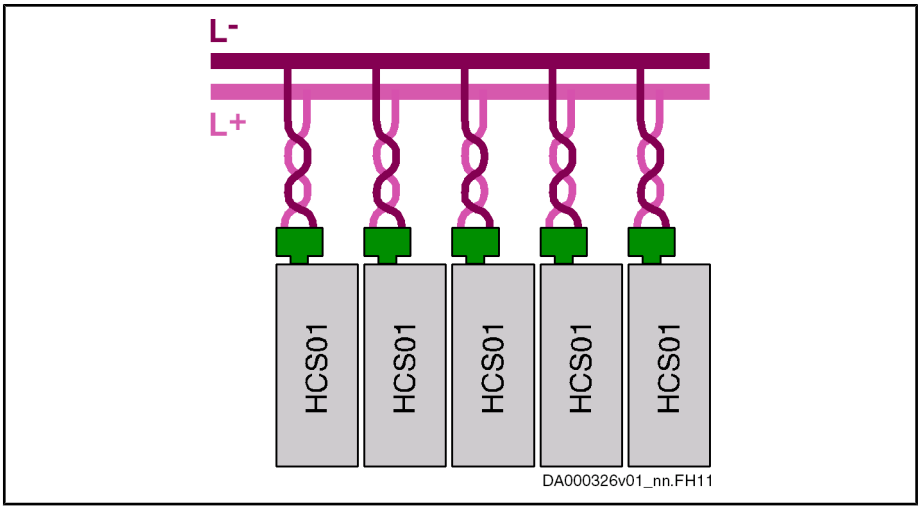


Fig.4-67: DC Bus Connection via Connecting Bar

Via a "spur line", the DC buses of the individual devices are connected to the DC bus connecting bar.

The power reserve of the supplying devices limits the number of devices at the common DC bus.

DC Bus Capacitor Units

Function

DC bus capacitor units are optional additional components and increase

- the DC bus continuous power
- the available DC bus energy

Connection

The maximum allowed capacitance of a DC bus capacitor unit depends on the device which assumes the DC bus supply. The maximum allowed capacitance is independent of the number of devices which supply the DC bus.

☞ Even if several devices supply the DC bus, the specific external DC bus capacitance of the supplying devices may only be connected **once** for the entire DC bus group!

For the maximum allowed external DC bus capacitance, see the technical data (index entry "DC bus → Data, HCS01").

The DC bus capacitor unit is connected to the device via the DC bus connection X77. In the case of DC bus coupling, the last unassigned connection point X77 can be used for this purpose.

Availability

Our sales representative will inform you on the availability of DC bus capacitor units for HCS01 converters.

Module Bus and Parameterization

Module Bus

The module bus is an internal system connection and is used to exchange data between the devices. To ensure the coordinated behavior of all devices of a drive system, the devices must exchange status information via the module bus.

☞ When several devices are coupled via the DC bus, it is obligatory to loop through the module bus.

Parameterization

For all devices which are only supplied via the DC bus, "DC bus → inverter mode" must be set as the source of power supply in parameter "P-0-0860, Converter configuration".

For detailed information, see the documentation of the firmware used:

- Parameter Description: "P-0-0860, Converter configuration"
- Functional Description: "Power Supply"

Bb Relay Contact

When several devices assume the DC bus supply (group supply), connect the Bb relay contacts (X47) of all supplying devices in series. This guarantees that the mains contactor is switched off in the case of error in a device.

For devices which are only supplied via the DC bus, it is sufficient that you establish the module bus connection. You do not need to connect the Bb relay contacts of these devices in series.

4.7 Acceptance Tests and Approvals

Declaration of Conformity

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

CE DX000011v01_nn.FH11	**Drive controllers, Supply units**	**Motors**
CE conformity regarding Low-Voltage Directive	EN61800-5-1 (IEC 61800-5-1:2007)	EN 60034-1 (IEC 60034-1:2004) EN 60034-5 (IEC 60034-5:2000 + Corrigendum 2001+A1:2006)
CE conformity regarding EMC product standard	EN61800-3 (IEC 61800-3:2004)	

Fig.4-68: CE - Applied Standards

C-UL-US Listing

The components are listed by **UL** (Underwriters Laboratories Inc.®). You can find the evidence of certification on the Internet under http://www.ul.com under "Certifications" by entering the file number or the "Company Name: Rexroth".

c UL us **Listed** **POW. CONV. EQ.** **97Y4** DX000009v01_nn.tif	• UL standard: UL 508 C • CSA standard: Canadian National Standard C22.2 No. 14-05
	Company Name BOSCH REXROTH ELECTRIC DRIVES & CONTROLS GMBH Category Name: Power Conversion Equipment
	File numbers Rexroth IndraDrive Cs components: E134201; E227957 The **control sections** are part of the listed components.

Fig.4-69: C-UL Listing

UL ratings

For using the component in the scope of CSA / UL, take the UL ratings of the individual components into account.

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

Wiring material UL

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

Allowed pollution degree

Comply with the allowed pollution degree of the components (see "Ambient and Operating Conditions").

C-UR-US Listing

The motors are listed by **UL** ("Underwriters Laboratories Inc.®"). You can find the evidence of certification on the Internet under http://www.ul.com under "Certifications" by entering the file number or the "Company Name: Rexroth".

c UL us CUR_Zeichen.fh11	• UL standard: UL 1004 • CSA standard: Canadian National Standard C22.2 No. 100
	Company Name BOSCH REXROTH ELECTRIC DRIVES & CONTROLS GMBH Category Name: Motors - Component
	File numbers • MSK motors: E163211 • MSM motors: E223837

Fig.4-70: C-UR Listing

Wiring material UL (ready-made cables by Rexroth)

In the scope of CSA / UL, use copper 60/75 °C only; class 6 or equivalent only.

Allowed pollution degree

Comply with the allowed pollution degree of the components (see "Ambient and Operating Conditions").

CCC (China Compulsory Certification)

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

CNCA is the Chinese authority responsible for certification directives. When a product is imported in China, the certification will be checked at the customs by

means of entries in a database. For the requirement of certification three criteria are normally relevant:

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

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

5 Condition as Supplied, Identification, Transport and Storage

5.1 Condition as Supplied

5.1.1 Factory-Side Test

Voltage Test and Insulation Resistance Test

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

Test	Test rate
Voltage test	100% (EN61800-5-1)
Insulation resistance test	100% (EN60204-1)

Fig.5-1: Applied Standards

5.1.2 Customer-Side Test

CAUTION

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

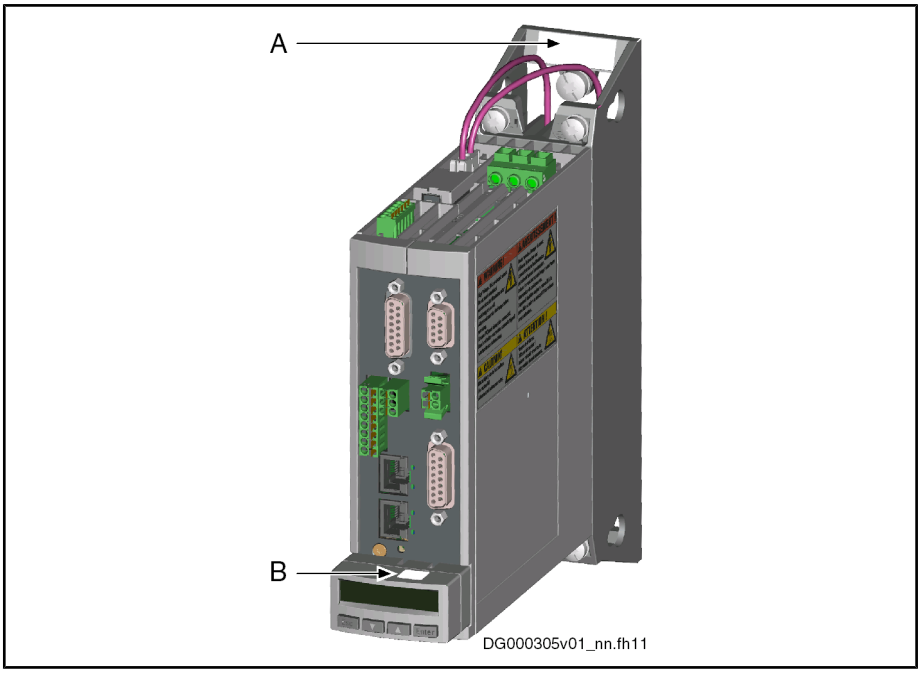
Disconnect all connections to the installed Rexroth components or disconnect the plug-in connections to protect the electronic components, before making

- a **voltage test** or
- an **insulation resistance test** for the **installation or machine** in which the components are used.

5.2 Identification

5.2.1 Type Plates

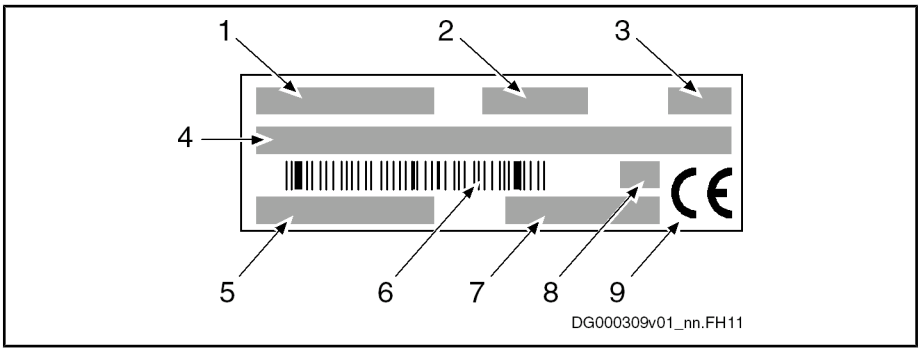
Arrangement



1 Type plate device
2 Type plate firmware
Fig.5-2: Type Plate Arrangement

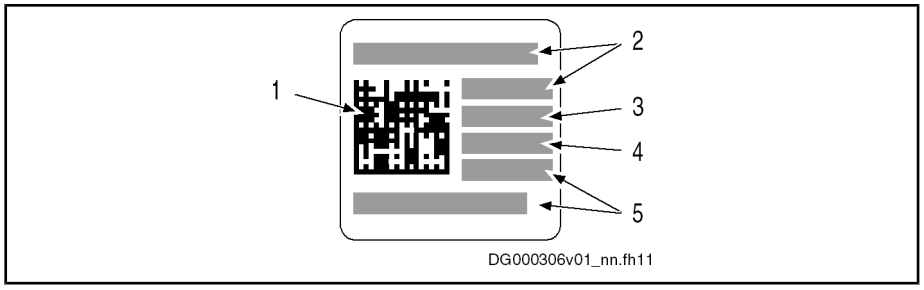
Design

Type Plate (Device)



1 Part number
2 Production week; 09W23, for example, means year 2009, week 23
3 Factory identifier
4 Device type
5 Serial number
6 Bar code
7 Country of manufacture
8 Hardware index
9 Identification
Fig.5-3: Type Plate (Device)

Type Plate (Firmware)



1	Bar code
2	Type
3	Factory identifier
4	Production week (example: 09W12 means: year 2009, week 12)
5	Serial number

Fig.5-4: Type Plate (Firmware)

5.2.2 Scope of Supply

Standard	To be ordered separately
Mounting and connection accessories HAS09	DC bus connector X77 (DC bus connection; for HCS01.1E-W00xx-x-**03** devices) Order code: RLS0778/K06
Connectors X3, X5, X6, X13, X31, X32, X47	
Touch guard X77 (DC bus connection; for HCS01.1E-W00xx-x-**03** devices)	
Instruction Manual (in the English language)	

Fig.5-5: Scope of Supply HCS01

5.3 Transport of the Components

Ambient and Operating Conditions - Transport

Description	Symbol	Unit	Value	
Temperature range	T_{a_tran}	°C	Supply units and drive controllers: -25 … +70	Motors: -20 … +80
			For **liquid-cooled** components: Drain coolant channels completely or use antifreeze	
Relative humidity		%	5 … 95	
Absolute humidity		g/m^3	1 … 60	
Climatic category (IEC721)			2K3	
Moisture condensation			Not allowed	
Icing			Not allowed	

Fig.5-6: Ambient and Operating Conditions - Transport

5.4 Storage of the Components

CAUTION

Damage to the component caused by long storage periods!

Some components contain electrolytic capacitors which may deteriorate during storage.

When storing the following components for a longer period of time, operate them **once a year for at least 1 hour**:

- HCS and HMV: Operation with mains voltage U_{LN}
- HMS, HMD, HLC: Operation with DC bus voltage U_{DC}

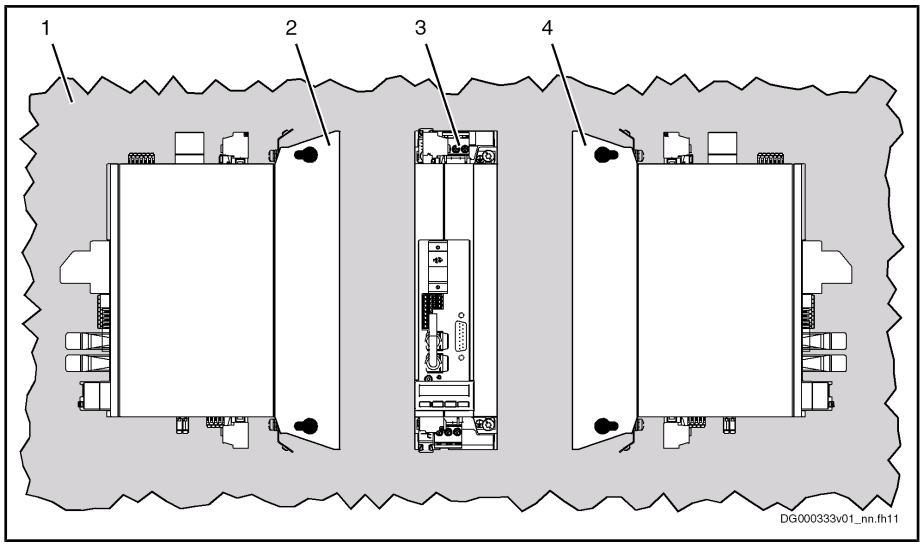
Ambient and Operating Conditions - Storage

Description	Symbol	Unit	Value	
Temperature range	T_{a_store}	°C	Supply units and drive controllers: -25 … 55	Motors: -20 … +60
			For **liquid-cooled** components: Drain coolant channels completely or use antifreeze	
Relative humidity		%	5 … 95	
Absolute humidity		g/m^3	1 … 29	
Climatic category (IEC721)			1K3	
Moisture condensation			Not allowed	
Icing			Not allowed	

Fig.5-7: Ambient and Operating Conditions - Storage

6 Mounting and Installation

6.1 Mounting HCS01 Devices in the Control Cabinet



1 Control cabinet wall
2 Left-hand mounting
3 Back-side mounting (standard mounting)
4 Right-hand mounting

Fig.6-1: Options for Mounting HCS01 Devices in the Control Cabinet

Notes on Mounting

- The **back-side mounting** (back of device directly mounted to control cabinet wall) is the standard and should be used, if possible.
- The **left-hand or right-hand mounting** (left or right side of device directly mounted to control cabinet wall) can be used, if the mounting clearance between control cabinet wall and control cabinet front is not sufficient for back-side mounting.

  CAUTION! Risk of damage by high temperatures! At the **back of the HCS01 devices**, there are **braking resistors** which can become very hot during operation. When arranging the devices in the control cabinet, make sure there aren't any heat-sensitive materials close to the braking resistors.

  In the case of left-hand or right-hand mounting, you must not **pile the devices**. Each device must have immediate contact to the control cabinet wall.
- Observe the **minimum distances** to be complied with for mounting (see technical data or dimensional drawings).

  The specified horizontal minimum distance refers to the distance to neighboring devices and not to the distance to the control cabinet wall.
- **Tightening torque** of the mounting screws: **6 Nm**
- On the sides of the devices, there are **adhesive labels with notes on safety**. The supplied accessory HAS09 additionally contains these adhesive labels. If the adhesive labels at the devices are no longer visible after mounting, place the adhesive labels from the accessory HAS09 clearly visibly at the device or in the immediate vicinity of the device.

Required Steps to Follow

HCS01 drive controllers were designed for control cabinet mounting. They are mounted with two screws (M6×20; contained in the supplied accessory HAS09).

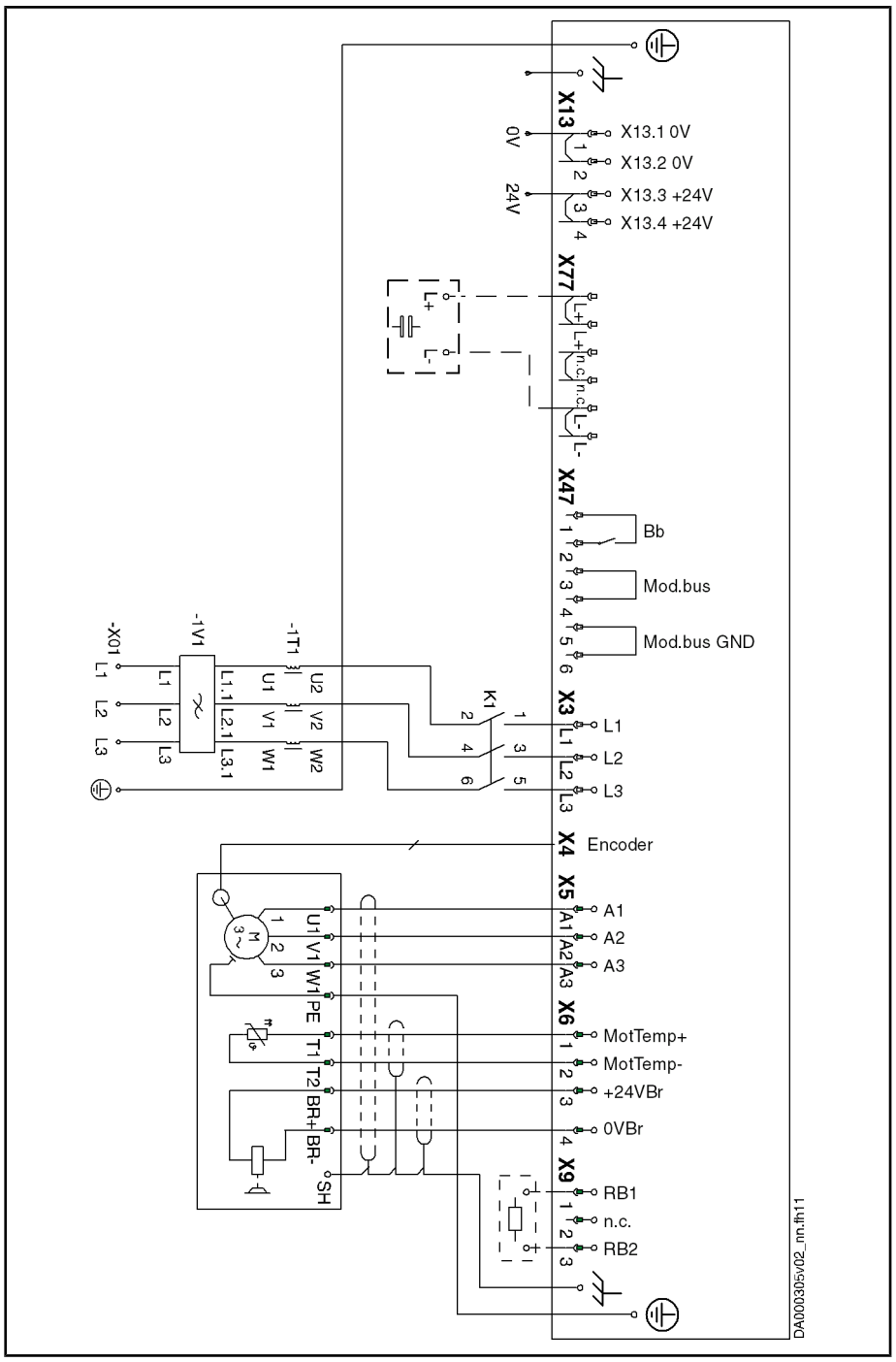
Mounting the drive controller

1. Fix screws to the back panel of the control cabinet.
2. Attach the drive controller to the screws.
3. Fix the screws with 6 Nm.

6.2 Electrical Connection

6.2.1 Overall Connection Diagram

Single Axis



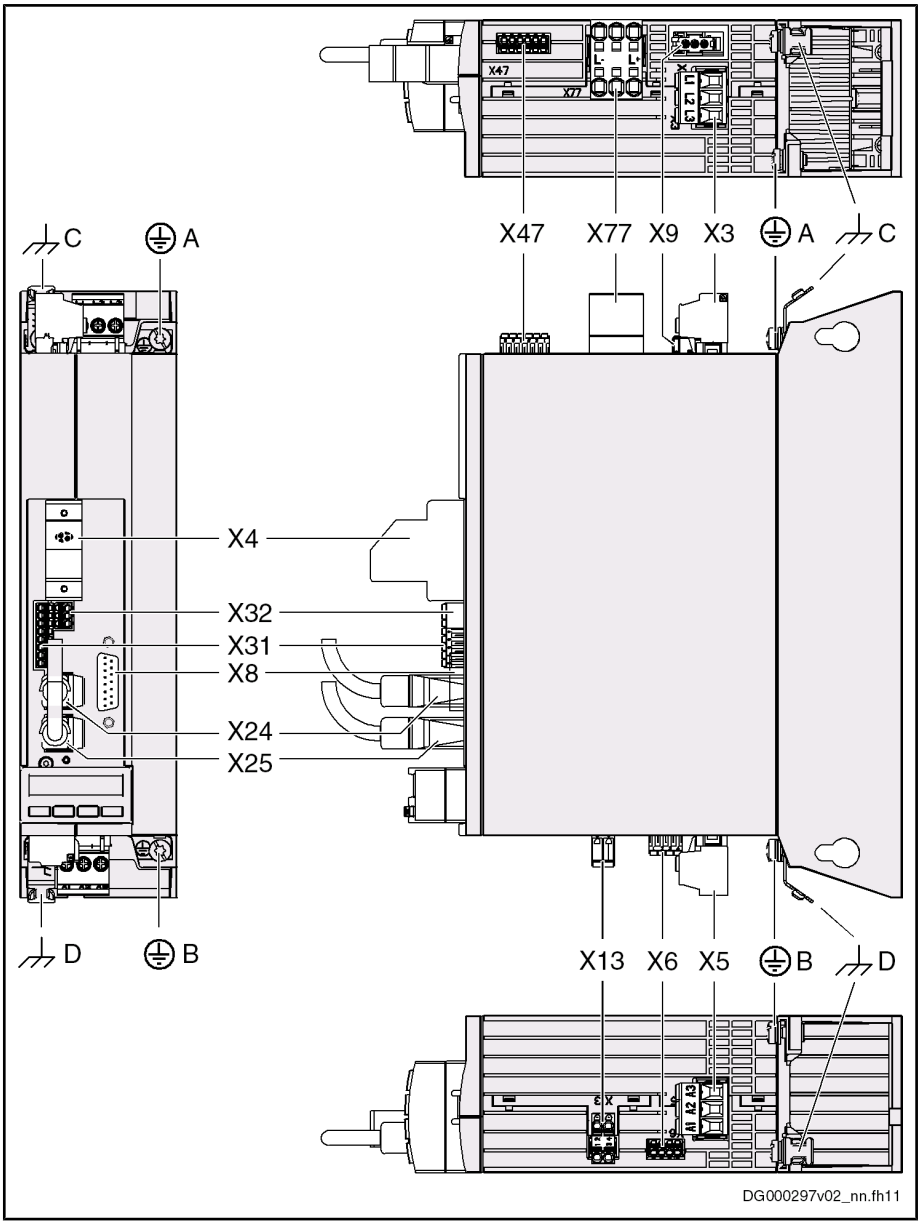
X47	Module bus (X47.3…6) only at HCS01.1E-W00xx-x-03 devices; for signaling the readiness for operation of the device, the Bb relay contact (X47.1, X47.2) must be wired, too
X77 (L+, L-)	Only at HCS01.1E-W00xx-x-03 devices
T1, T2	Not available at MSM motors

Fig.6-2: Connection Diagram

6.2.2 On-Board Connection Points

Arrangement of Connection Points HCS01

Connection Points HCS01



A	Connection point of equipment grounding conductor, mains
B	Connection point of equipment grounding conductor, motor
C	Shield connection control lines
D	Shield connection motor cable
X3	Mains connection
X4	Motor encoder
X5	Motor connection
X6	Motor temperature monitoring, motor holding brake
X8	Optional motor encoder
X9	Integrated/external braking resistor
X13	24V supply (control voltage)
X24, X25	Multi-Ethernet communication module
X31	Digital inputs, digital output
X32	Analog input

X47	Bb relay contact, module bus (module bus only at HCS01.1E-W00xx-x-03 devices)
X77	DC bus connection (only at HCS01.1E-W00xx-x-03 devices); DC bus connector optionally available (if the DC bus connector is not used, the DC bus connection must be covered with the supplied touch guard)

Fig.6-3: Connection Points HCS01

Connection of Equipment Grounding Conductor

WARNING

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

- Before switching on and before commissioning, ground or connect the components of the drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Establish an equipment grounding connection with a copper wire of a cross section of at least 10 mm^2 (8 AWG) or additionally run a second equipment grounding conductor of the same cross section as the original equipment grounding conductor.

WARNING

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

Exclusively operate the device

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

Equipment grounding conductor: Material and cross section

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

For the connections from the equipment grounding conductor connection of the device to the equipment grounding conductor system in the control cabinet, make sure the cross sections of the lines are sufficient.

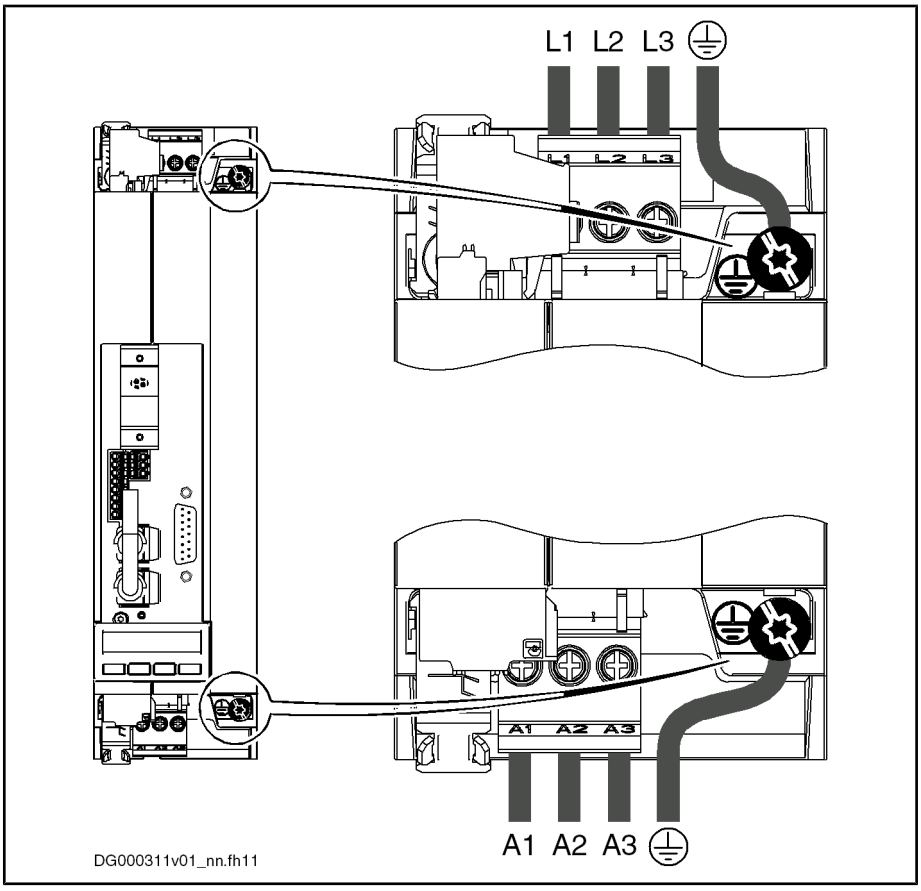
Cross sections of the equipment grounding connections:

For **HCS01** drive controllers, **at least 10 mm^2**, but not smaller than the cross sections of the outer conductors of the mains supply feeder.

Additionally, mount the housing to a bare metal mounting plate. Connect the mounting plate, too, with at least the same cross section to the equipment grounding conductor system in the control cabinet.

Installation

Connect the equipment grounding conductor of the mains or motor cable via thread **M5** to the housing of the device (identification mark ⏚). The screws **M5×12** required for this purpose are part of the supplied accessory HAS09.



L1, L2, L3 Mains connection
A1, A2, A3 Motor connection
Fig.6-4: Connection Point of Equipment Grounding Conductor

X3, Mains Connection

Important Notes

WARNING

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

Exclusively operate the device

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

Notes on Installation

The equipment grounding conductor is connected directly to the device and not via the connection point X3 (see description for connection of equipment grounding conductor).

Dimension the **required cross section** of the connection cables according to the determined phase current I_{LN} and the mains fuse.

CAUTION

Risk of damage to the device!

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

HCS01.1E-W0003...W0013-x-02, HCS01.1E-W0005-x-03, HCS01.1E-W0008-x-03

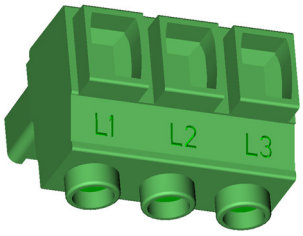
HCS01.1E-W0003...W0013-x-02, HCS01.1E-W0005-x-03, HCS01.1E-W0008-x-03			
View	**Identification**	**Function**	
	L1	Connection to supply mains (L1)	
	L2	Connection to supply mains (L2)	
	L3	Connection to supply mains (L3)	
Terminal block	**Unit**	**Min.**	**Max.**
Connection cable Stranded wire	mm^2	0,25	2,5
	AWG	24	12
Stripped length	mm	8	
Occurring current load and minimum required connection cross section		See technical data of device used (I_{LN} and A_{LN})	
Occurring voltage load		See technical data of device used (U_{LN} or U_{LN_nenn})	

Fig.6-5: Function, Pin Assignment, Properties

HCS01.1E-W0018-x-03, HCS01.1E-W0028-x-03

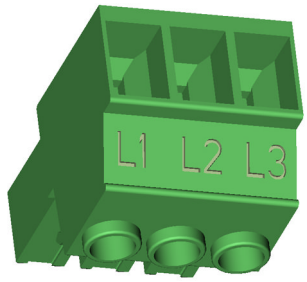
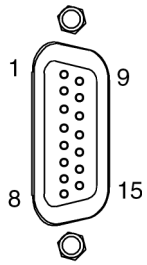
HCS01.1E-W0018-x-03, HCS01.1E-W0028-x-03			
View	**Identification**	**Function**	
	L1	Connection to supply mains (L1)	
	L2	Connection to supply mains (L2)	
	L3	Connection to supply mains (L3)	
Terminal block	**Unit**	**Min.**	**Max.**
Connection cable Stranded wire	mm^2	0,25	6,0
	AWG	24	8
Stripped length	mm	10	
Occurring current load and minimum required connection cross section		See technical data of device used (I_{LN} and A_{LN})	
Occurring voltage load		See technical data of device used (U_{LN} or U_{LN_nenn})	

Fig.6-6: Function, Pin Assignment, Properties

X4, Connection Motor Encoder

View	Identification	Function
 DA000053v01_nn.FH9	X4	Motor encoder connection

D-Sub, 15-pin, female	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,25	0,5
Kind of encoder evaluation		EC Technical data: See description "EC - Standard Encoder Evaluation"	

Fig.6-7: Function, Pin Assignment, Properties

Supported Encoder Systems

Encoders with a supply voltage of **5 and 12 volt**

Encoder Systems

- MSM motor encoder
- MSK motor encoder
- Sin-cos encoder 1 V_{pp}; HIPERFACE®
- Sin-cos encoder 1 V_{pp}; EnDat 2.1
- Sin-cos encoder 1 V_{pp}; with reference track
- 5V-TTL square-wave encoder; with reference track
- SSI
- Resolver

Pin Assignment

Connection	Signal	Function
1	GND_shld	Connection signal shields (internal shields)
2	A+	Track A analog positive
3	A-	Track A analog negative
4	GND_Encoder	Reference potential power supplies
5	B+	Track B analog positive
6	B-	Track B analog negative
7	EncData+	Data transmission positive
	A+TTL	Track A TTL positive
8	EncData-	Data transmission negative
	A-TTL	Track A TTL negative

Connection	Signal	Function
9	R+	Reference track positive
10	R-	Reference track negative
11	+12V	Encoder supply 12V
12	+5V	Encoder supply 5V
13	EncCLK+	Clock positive
	B+TTL	Track B TTL positive
14	EncCLK-	Clock negative
	B-TTL	Track B TTL negative
15	Sense-	Return of reference potential (Sense line)
	VCC_Resolver	Resolver supply
Connector housing		Overall shield

Fig.6-8: Pin Assignment

X5, Motor Connection

Important Notes

WARNING

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

Exclusively operate the device

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

CAUTION

Risk of damage to the device!

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

Notes on Installation

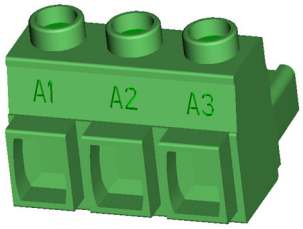
The equipment grounding conductor is connected directly to the device and not via the connection point X5 (see description for connection of equipment grounding conductor).

The indicated connection cross sections are the cross sections which can be connected. Dimension the **required cross section** of the connection lines according to the occurring current load.

- For optimum shield contact of the motor power cable, use the supplied accessory HAS09.
- For the connection between drive controller and motor, use our ready-made motor power cables, where possible (see documentation "Rexroth Connection Cables").
- When using NFD03.1 mains filters, the maximum allowed conductor cross section is limited to 4 mm^2.

Mounting and Installation

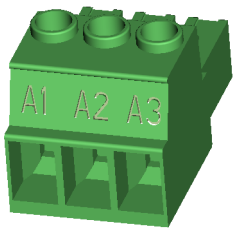
X5, Motor Connection HCS01.1E-W0003…W0013-x-02, -W0005-x-03, -W0008-x-03

View	Identification	Function
	A1	For power connection U1 at motor
	A2	For power connection V1 at motor
	A3	For power connection W1 at motor

Screw connection at connector	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,25	2,5
	AWG	24	12
Stripped length	mm	8	
Occurring current load and minimum required connection cross section	A	See technical data of device used (I_{out})	
Occurring voltage load	V	See technical data of device used (U_{out})	
Short circuit protection		A1, A2, A3 against each other and each of them against ground	
Connection of equipment grounding conductor		Via connection point of equipment grounding conductor ⏚ at device (see index entry "Connection → Equipment grounding conductor")	

Fig.6-9: Function, Pin Assignment, Properties

X5, Motor Connection HCS01.1E-W0018-x-03, -W0028-x-03

View	Identification	Function
	A1	For power connection U1 at motor
	A2	For power connection V1 at motor
	A3	For power connection W1 at motor

Screw connection at connector	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,25	6,0
	AWG	24	8
Stripped length	mm	10	
Occurring current load and minimum required connection cross section	A	See technical data of device used (I_{out})	

Occurring voltage load	V	See technical data of device used (U_{out})
Short circuit protection		A1, A2, A3 against each other and each of them against ground
Connection of equipment grounding conductor		Via connection point of equipment grounding conductor ⏚ at device (see index entry "Connection → Equipment grounding conductor")

Fig.6-10: Function, Pin Assignment, Properties

X6, Motor Temperature Monitoring and Motor Holding Brake

WARNING

Dangerous movements! Danger to persons from falling or dropping axes!

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

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

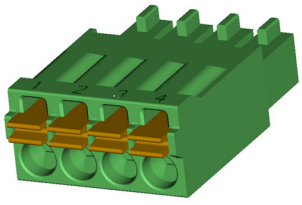
- Block off danger zones with safety fences or safety guards
- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
  - mechanically securing the vertical axes
  - adding external braking/arrester/clamping mechanisms
  - ensuring sufficient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

Function

The connection point X6 contains the connections for

- monitoring the motor temperature
- controlling the motor holding brake

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

View	Connection	Signal name	Function
	1	MotTemp+	Input motor temperature evaluation
	2	MotTemp-	
	3	+24VBr	Output for controlling the motor holding brake
	4	0VBr	

Spring terminal (connector)	Unit	Min.	Max.
Connection cable	mm^2	0,25	1,5
Stranded wire	AWG	24	16
Stripped length	mm	10	
Current carrying capacity outputs X6:			
HCS01.1	A	-	1,25

Mounting and Installation

Time constant of load	ms	-	50
Number of switching actions at maximum time constant of load		250.000	
Switching frequency	Hz	-	0,5
Short circuit protection		X6.3 against X6.4 (output for controlling the motor holding brake)	
Overload protection		X6.3 against X6.4 (output for controlling the motor holding brake)	

Fig.6-11: Function, Pin Assignment

Notes on Installation

Make sure the **power supply** for the motor holding brake at the motor is sufficient. You have to take into account that voltage drops on the supply line. Use connection lines with the highest possible cross section of the single strands.

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

Connection Diagram

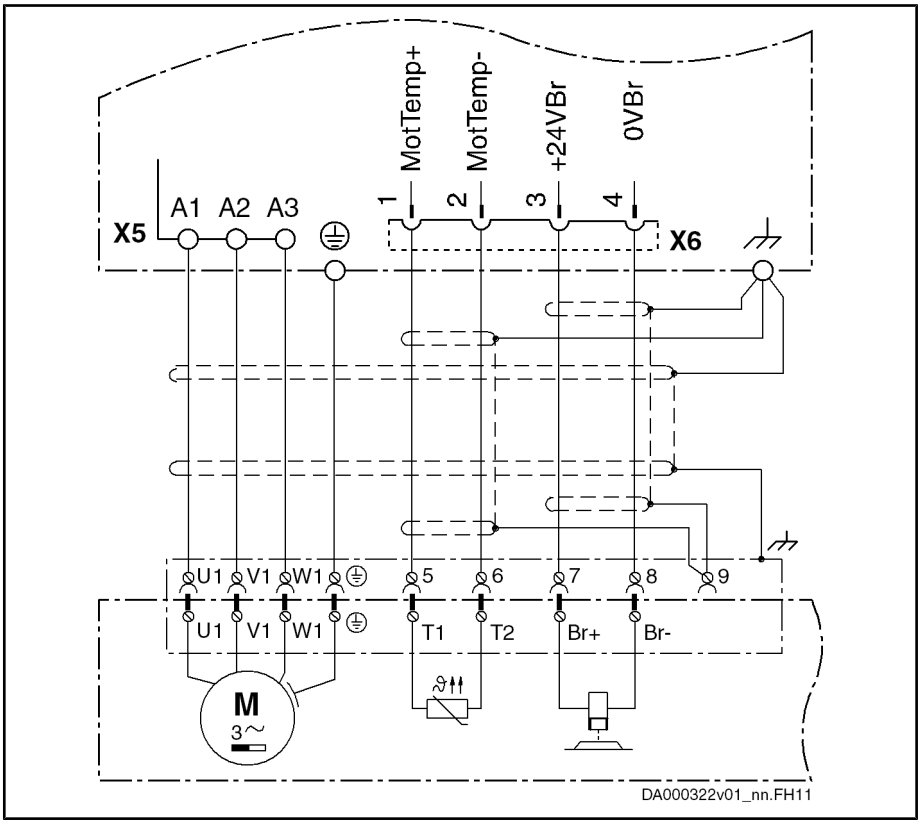


Fig.6-12: Connection of Motor Temperature Monitoring and Motor Holding Brake

X9, Integrated/External Braking Resistor

WARNING

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

Exclusively operate the device

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

Function

X9 is used to connect the integrated or external barking resistor **HLR**. By means of an internal switch, the braking resistor is connected to the DC bus.

☞ **Parameterize** the **external braking resistor** by means of the firmware to protect the drive controller and the braking resistor against overload:

- P-0-0860, Converter configuration
- P-0-0858, Data of external braking resistor

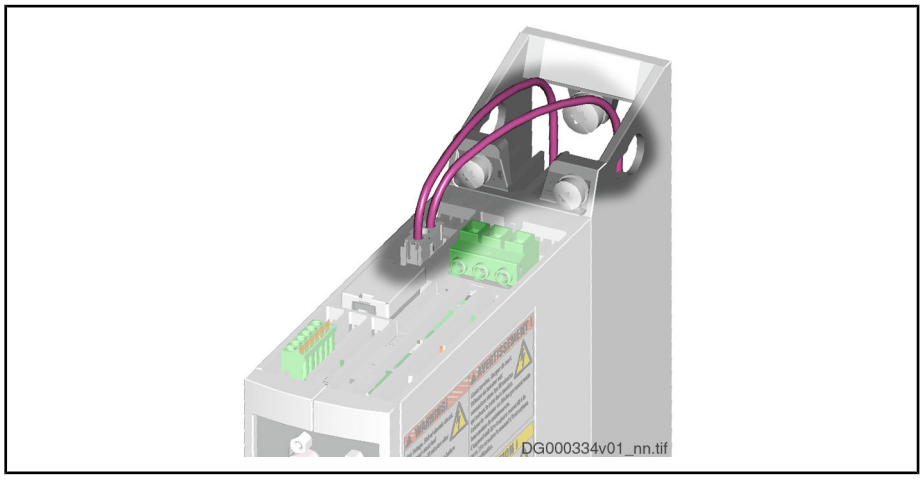


Fig.6-13: Connection of Braking Resistor

Notes on Installation

Maximum allowed line length to external braking resistor: **5 m**

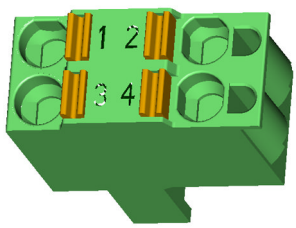
Twist unshielded lines.

X13, 24V Supply (Control Voltage)

Function, Pin Assignment

The external 24V supply is applied via connection point X13 for

- the control section and power section of the drive controller
- brake control via X6
- the digital inputs and the digital output to X31 / X32

View	Connection	Signal name	Function
	1	0V	Reference potential for power supply
	2	0V	
	3	+24V	Power supply
	4	+24V	

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	1,0	2,5
	AWG	16	12
Stripped length	mm	10	
Power consumption	W	P_{N3} (see data for control voltage)	

Voltage load capacity	V	U_{N3} (see data for control voltage)
Current carrying capacity "looping through" from 0V to 0V, 24V to 24V	A	10
Polarity reversal protection		Within the allowed voltage range by internal protective diode
Insulation monitoring		Possible

Fig.6-14: Function, Pin Assignment, Properties

Notes on Installation

Requirements on the connection to the 24V supply:

- Minimum cross section: 1 mm^2
- Maximum allowed inductance: 100 µH (2 twisted single strands, 75 m long)
- Parallel line routing where possible

Depending on the power consumption of the devices and the current carrying capacity of the connector X13, check via how many devices one line for 24V supply can be looped through. You might possibly have to connect another device directly to the 24V supply and then loop through the control voltage from this device to other devices.

X24, X25, Multi-Ethernet - ET

Description

With the optional module "ET", drive controllers can be integrated in different Ethernet field bus systems (e.g. SERCOS III, EtherCAT or ProfiNet).

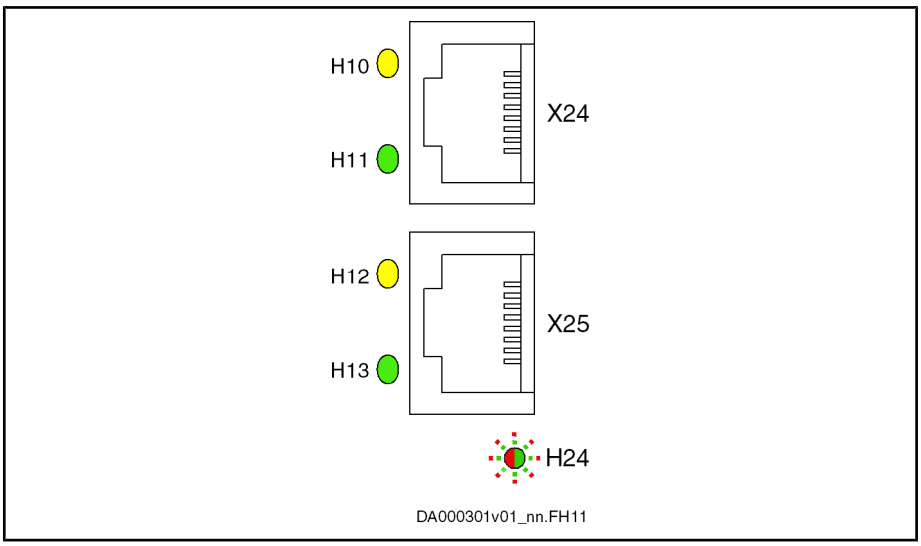


Fig.6-15: ET, Connection Point X24, X25

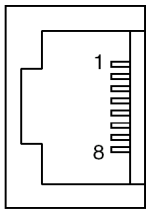
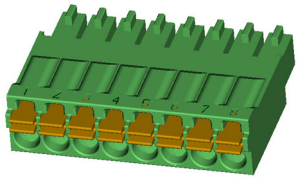
View	Connection	Signal name	Function
 DA000041v01_nn.FH	1	TD+	Transmit, Differential Output A
	2	TD-	Transmit, Differential Output B
	3	RD+	Receive, Differential Input A
	4	n. c.	-
	5	n. c.	-
	6	RD-	Receive, Differential Input B
	7	n. c.	-
	8	n. c.	-
	Housing		Shield connection
Properties			
Standard	• Ethernet • Type: RJ-45, 8-pin		
Compatibility	100Base-TX according to IEEE 802.3u		
Recommended cable type	• According to **CAT5e**; type of shield ITP (Industrial Twisted Pair) • Ready-made cables which can be ordered: – **RKB0011** Long cables (100 m at maximum) to connect the drive system to the higher-level control unit. Minimum bending radius: – 48.75 mm with flexible installation – 32.50 mm with permanent installation Order code for a 30 m long cable: RKB0011/030,0 – **RKB0013** Short cables to connect devices arranged side by side in the control cabinet. Order code for a 0.55 m long cable: RKB0013/00,55 Minimum bending radius: 120.50 mm		

Fig.6-16: Function, Pin Assignment, Properties

LEDs See index entry "LED → H10, H11, H12, H13"

Mounting and Installation

X31, Digital Inputs, Digital Output

View	Connection	Signal name	Function
	1	I_1	Digital input [1] (Probe: I_1, I_2)
	2	I_2	
	3	I_3	
	4	I_4	
	5	I_5	
	6	I_6	
	7	I_7	
	8	I/O_8	Digital input/output [1]

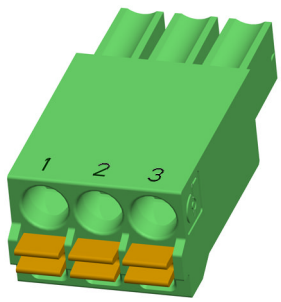
Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,2	1,5
	AWG	24	16
Stripped length	mm	10	
Input current	A	-	0,01
Output current I/O_8	A	-	0,5
Input voltage	V	-	24

1) The **reference potential** for the digital inputs and the digital input/output is applied to **X13.1** and **X13.2**.

Fig.6-17: Function, Pin Assignment, Properties

Technical Data See index entry "Technical data → Digital inputs"

X32, Analog Input

View	Connection	Signal name	Function
	1	GND	GND reference
	2	I_a_1-	Analog input
	3	I_a_1+	

Spring terminal (connector)	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,2	1,5
	AWG	24	16
Stripped length	mm	10	

Input current	A	-	0,01
Input voltage	V	-	±10

Fig.6-18: Function, Pin Assignment, Properties

Technical Data See index entry "Technical data → Analog input"

X47, Bb Relay Contact, Module Bus

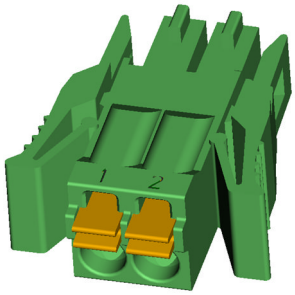
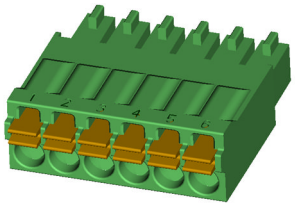
HCS01.1E-W0003...W0013-x-02			
View	**Connection**	**Signal name**	**Function**
	1	Rel1	Bb relay contact
	2	Rel2	Bb relay contact
Spring terminal (connector)	**Unit**	**Min.**	**Max.**
Connection cable Stranded wire	mm^2	0,2	1,5
	AWG	24	16
Stripped length	mm	10	

Fig.6-19: Function, Pin Assignment, Properties

Technical Data See index entry "Technical data → Relay contact"

HCS01.1E-W0005...W0028-x-03			
View	**Connection**	**Signal name**	**Function**
	1	Rel1	Bb relay contact [1]
	2	Rel2	Bb relay contact [1]
	3	Mod1	Module bus [2]
	4	Mod2	Module bus [2]
	5	0V_Mod	Module bus GND [2]
	6	0V_Mod	Module bus GND [2]
Spring terminal (connector)	**Unit**	**Min.**	**Max.**

Connection cable Stranded wire	mm^2	0,2	1,5
	AWG	24	16
Stripped length	mm	10	

1) Wire the Bb relay contact in the control circuit for mains connection (see index entry "Mains connection → Control circuit"). When the contact opens, the mains contactor must interrupt the power supply. When several devices assume the DC bus supply (group supply), connect the Bb relay contacts (X47) of all supplying devices in series.

2) At HCS01.1E-W0005…W0028-x-03 devices, the pins 3, 4 and 5, 6 at X47 have been jumpered in the device. This allows looping through the module bus from one device to the next.

Fig.6-20: Function, Pin Assignment, Properties

Technical Data See index entry "Technical data → Relay contact"

X77, L+ L-, DC Bus Connection

WARNING

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

Before working on live parts: De-energize installation and secure power switch against unintentional or unauthorized re-energization.

Before accessing the device, wait at least **30 minutes** after switching off the supply voltages to allow discharging. To shorten the waiting time until voltage has fallen below 50 V, you can use a discharging device (see chapter "Appendix").

Check whether voltage has fallen below 50 V before touching live parts!

Never operate the drive controller without touch guard or without DC bus connector. Only remove the touch guard, if you want to use the DC bus connector at the drive controller. If you do not use the DC bus connector any longer, you have to cover the DC bus connection with the supplied touch guard.

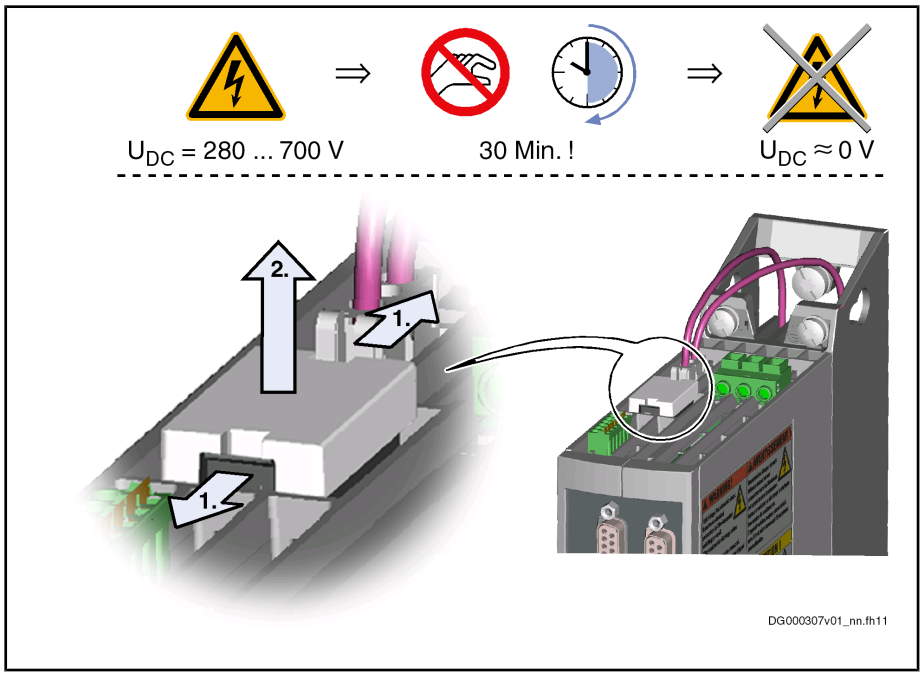
☞ Observe the information on DC bus coupling (see index entry "DC bus → Coupling").

Function, Pin Assignment The DC bus connection connects

- several HCS01.1E-W00xx-x-**03** to each other
- one drive controller to a DC bus capacitor unit (to backup the DC bus voltage)

Touch Guard The DC bus connection has been provided with a touch guard at the factory. To plug the DC bus connector, you have to remove the tough guard.

How to Remove the Touch Guard:



U_{DC}	DC bus voltage
30 Min. !	Before accessing the device, wait at least 30 minutes after switching off the supply voltages to allow discharging.
1.	With a small screwdriver (blade width < 3 mm), push the fixing device outwards and simultaneously lever out the touch guard.
2.	Pull off touch guard.
3.	Store the touch guard in a place where you can find it later on. If you want to operate the device without DC bus connector, you have to have to plug the touch guard on connection point X77 again.

Fig.6-21: How to Remove the Touch Guard

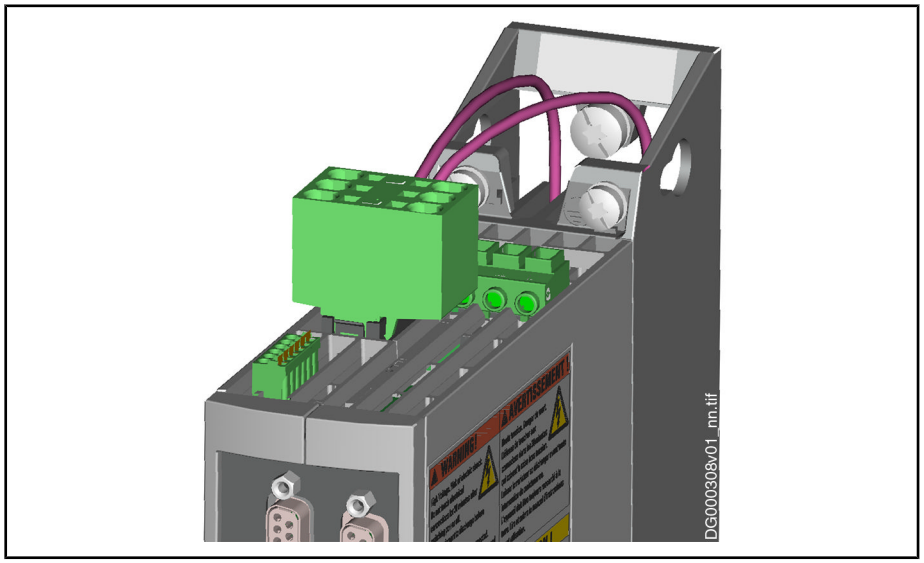
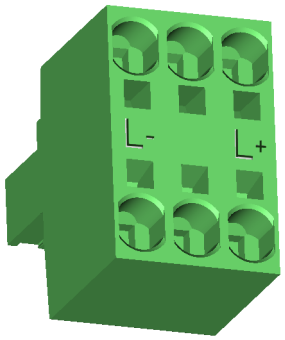


Fig.6-22: DC Bus Connector at Device

Mounting and Installation

View	Identification	Function
	L-	Connection points for connecting DC bus connections of several devices (The DC bus connector is available as an accessory; see index entry "Accessories → DC bus connector")
	L-	
	n. c.	
	n. c.	
	L+	
	L+	

	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,25	6
	AWG	24	10
Stripped length	mm	15	
Short circuit protection		Via fusing elements connected in the incoming circuit to the mains connection	
Overload protection		Via fusing elements connected in the incoming circuit to the mains connection	
Current carrying capacity "looping through" from L+ to L+, L- to L-	A	-	31

Fig.6-23: Function, Pin Assignment, Properties

Notes on Installation

To wire the DC bus, use the shortest possible flexible, **twisted** wires.

CAUTION

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

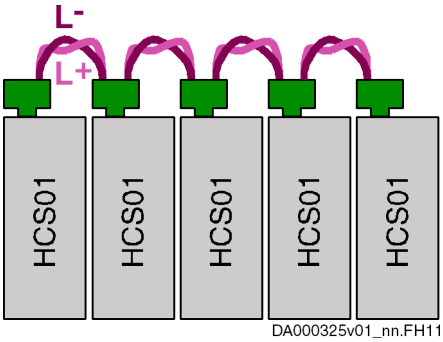
Make sure the polarity is correct.

Length of twisted wire	Max. 2 m
Line cross section	Min. 4 mm^2, but not smaller than cross section of supply feeder
Line protection	By means of fuses in the mains connection
Dielectric strength of single strand against ground	≥ 750 V (e.g.: strand type – H07)

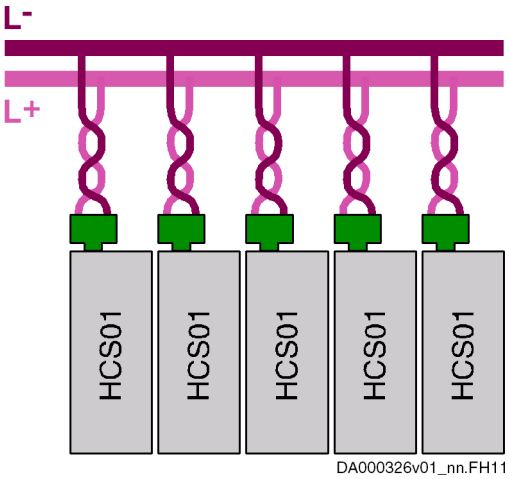
Fig.6-24: DC Bus Line

There are two options for interconnecting the DC buses of several devices:

- Direct connection of the DC bus connections:



- Connection of DC bus connections via connecting bars:

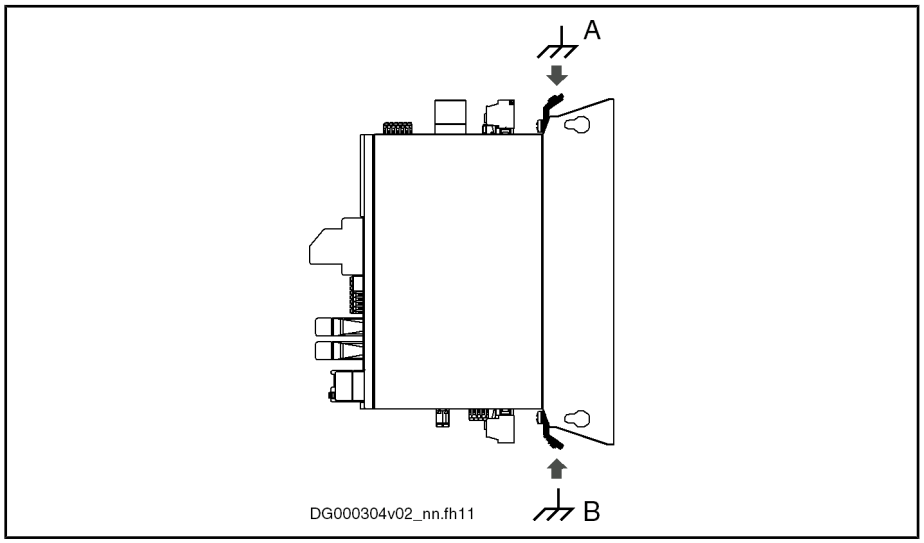


For further information on DC bus coupling, see index entry "DC bus → Coupling".

Shield Connection

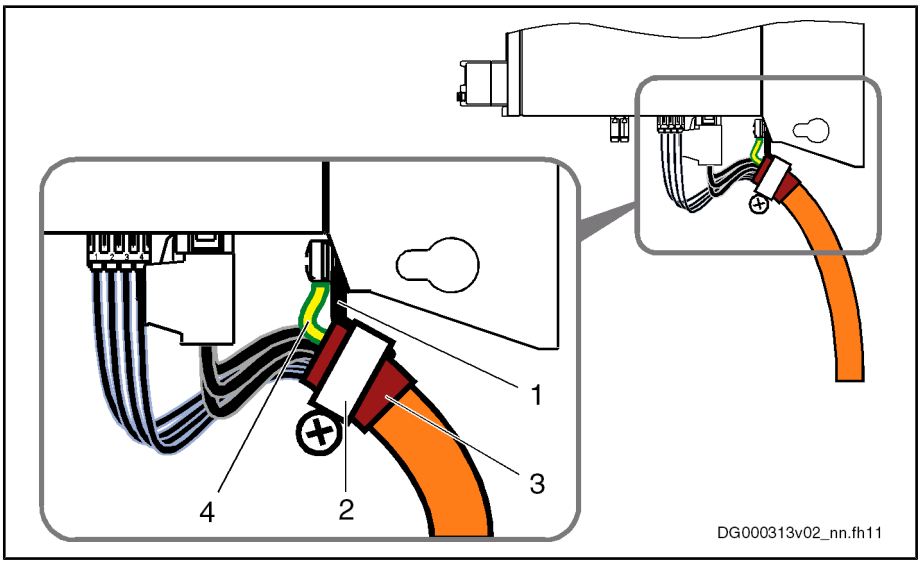
Special plates are used for shield connection of cables which are connected to the device. The cables are fixed to the plates with clips. This also provides strain relief for the cables.

The plates are part of the accessory **HAS09** and are screwed to the device.



A Shield connection control lines
B Shield connection motor cable
Fig.6-25: Shield Connection

Shield Connection Motor Cable



1	Plate (accessory HAS09)
2	Clip (accessory HAS09)
3	Shield of motor cable
4	Equipment grounding conductor

Fig.6-26: Shield Connection Motor Cable

Ground Connection

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

Ground the housings of the drive controllers:

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

6.2.3 Optional Connection Points

X8, Optional Encoder

You can connect an optional encoder to connection point X8.

Technical data: See description of connection point X4.

X22/X23, Multi-Ethernet / SERCOS III

Technical data: See description "X24, X25, Multi-Ethernet - ET"

X30, PROFIBUS PB

Description

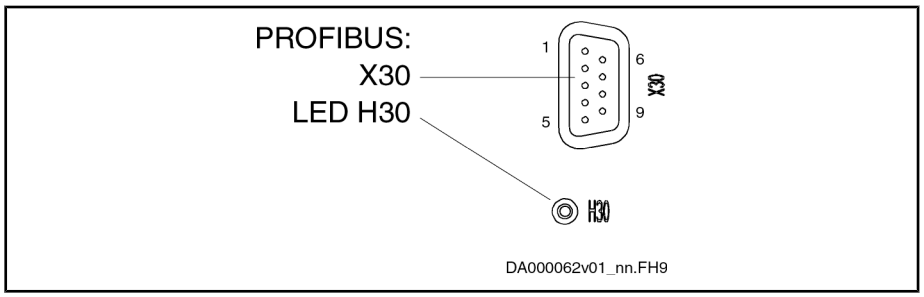
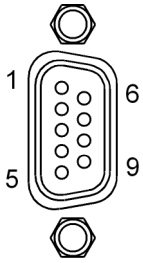


Fig.6-27: PROFIBUS Interface

View	Identification	Function
 DA000054v01_nn.FH9	X30	PROFIBUS PB

D-Sub, 9-pin, female	Unit	Min.	Max.
Connection cable Stranded wire	mm^2	0,08	0,5

Fig.6-28: Function, Pin Assignment, Properties

Pin Assignment

Pin	DIR	Signal	Function
1		-	n. c.
2		-	n. c.
3	I/O	RS485+	Receive/transmit data-positive
4	O	CNTR-P	Repeater control signal
5		0 V	0 V
6	O	+5 V	Repeater supply
7		-	n. c.
8	I/O	RS485-	Receive/transmit data-negative
9		0V	0 V

Fig.6-29: Signal Assignment

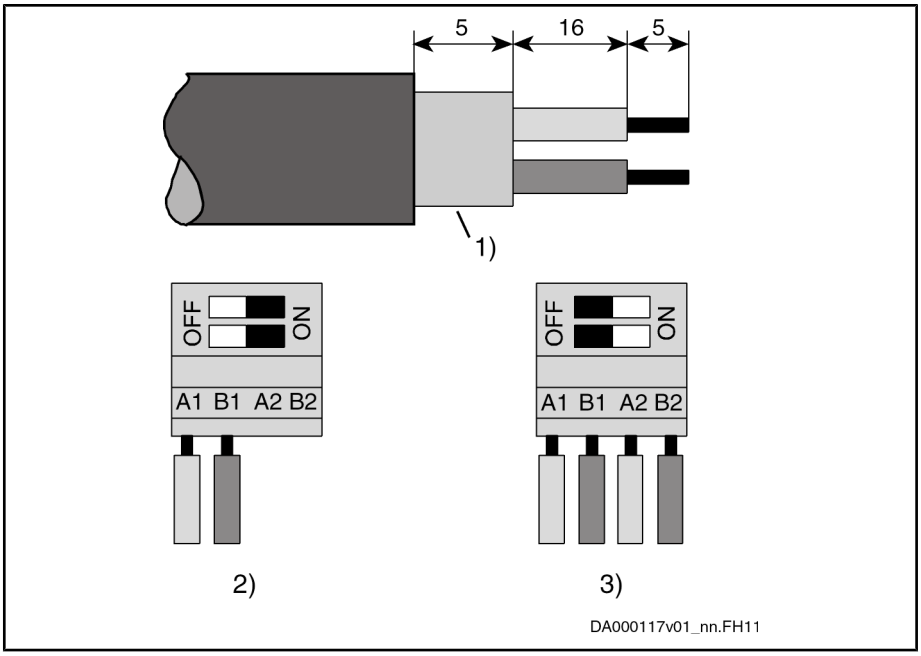
Shield Connection Via D-sub mounting screws and metallized connector housing.

Compatibility of the Interface According to DIN EN 50 170

Recommended Cable Type According to DIN EN 50 170 - 2, cable type A

Bus Connectors The PROFIBUS connectors each have a connectable terminating resistor. The terminating resistor must always be active at both the first and last bus node. Carry out the connection as shown in the figures below.

Mounting and Installation



1) Shield
2) Bus connection and switch position for first node and last node
3) Bus connection and switch position for all other nodes

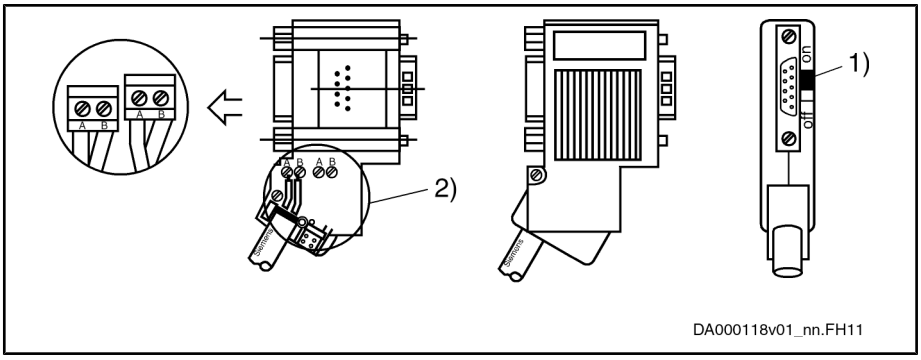
Fig.6-30: Preparing a Cable for Connecting a Bus Connector

To assemble the bus cable, proceed as follows:

- Use cable according to DIN EN50170 / 2 edition 1996
- Strip cable (see figure above)
- Insert both cores into screw terminal block

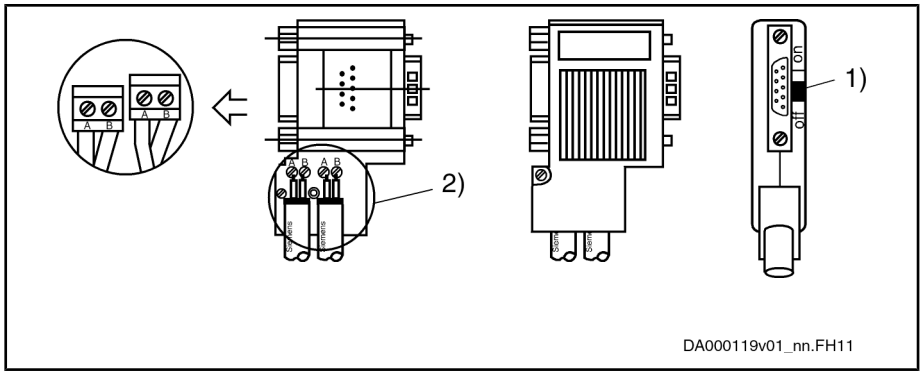
Do not interchange the cores for A and B.

- Press cable sheath between both clamps
- Screw on both cores in screw terminals



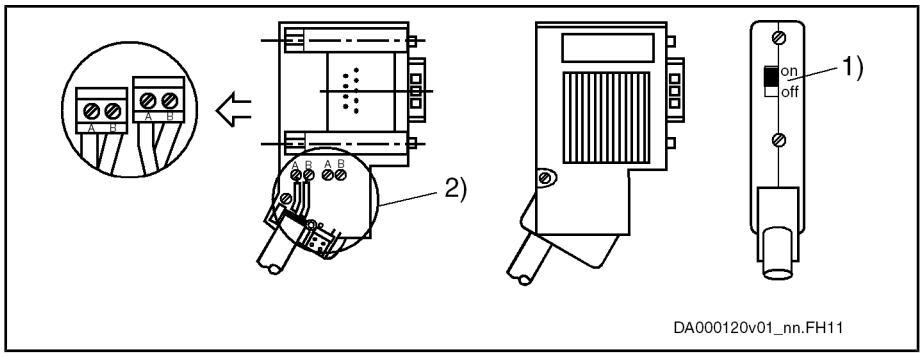
1) Switch position for first slave and last slave in PROFIBUS-DP
2) Cable shield must have direct contact to metal

Fig.6-31: Bus Connection for First and Last Slave, Bus Connector With 9-pin D-Sub Female Connector, INS0541



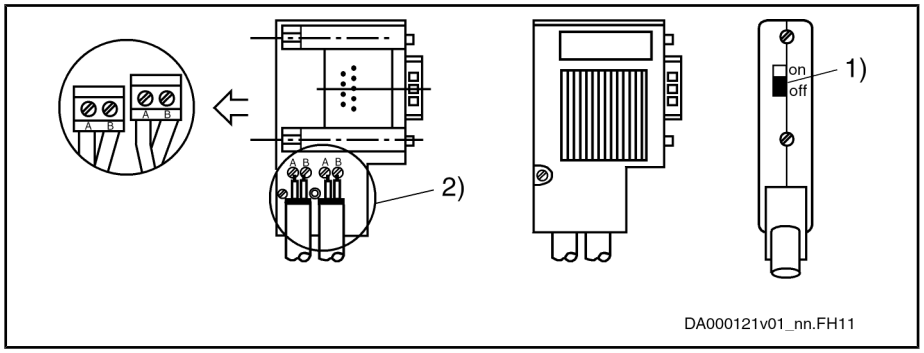
1) Terminating resistor is off
2) Cable shield must have direct contact to metal

Fig.6-32: Bus Connection for all Other Slaves, Bus Connector With 9-pin D-Sub Female Connector, INS0541



1) Switch position for first slave and last slave in PROFIBUS-DP
2) Cable shield must have direct contact to metal

Fig.6-33: Bus Connection for First and Last Slave, Without 9-pin D-Sub Female Connector, INS0540



1) Terminating resistor is off
2) Cable shield must have direct contact to metal

Fig.6-34: Bus Connection for all Other Slaves, Without 9-pin D-Sub Female Connector, INS0540

Connect the drive controller to a control unit using a shielded two-wire line in accordance with DIN 19245/Part 1.

Signal Specification See index entry "PROFIBUS → Signal specification"

6.2.4 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.

Mounting and Installation

Mains Filter

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

Control Cabinet Grounding

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

Line Routing

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

The lines with high potential of noise include:

- Lines at the mains connection (incl. synchronization connection)
- Lines at the motor connection

  Lines at the DC bus connection

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

Interference Suppression Elements

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

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

Connect these combinations directly at each coil.

Twisted Wires

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

Lines of Measuring Systems

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

Digital Signal Lines

Ground the shields of digital signal lines at both ends (transmitter **and** receiver) over the largest possible surface area and with low impedance. In the case of bad ground connection between transmitter and receiver, additionally route a bonding conductor (min. 10 mm^2). Braided shields are better than foil shields.

Analog Signal Lines

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

Connection of Mains Choke

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

Installation of Motor Power Cable

- Use shielded motor power cables or run motor power cables in a shielded duct
- Use the shortest possible motor power cables
- Ground shield of motor power 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 power cable mustn't be interrupted by mounted components, such as output chokes, sine filters or motor filters

EMC-Optimal Installation in Facility and Control Cabinet

General Information

For 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.

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

Division Into Areas (Zones)

Exemplary arrangements in the control cabinet: See section Control Cabinet Mounting According to Interference Areas - Exemplary Arrangements, page 116.

We distinguish three areas:

1. Interference-free area of control cabinet **(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 are not 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 power cables including single cores

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. Use the shortest possible connecting lines.

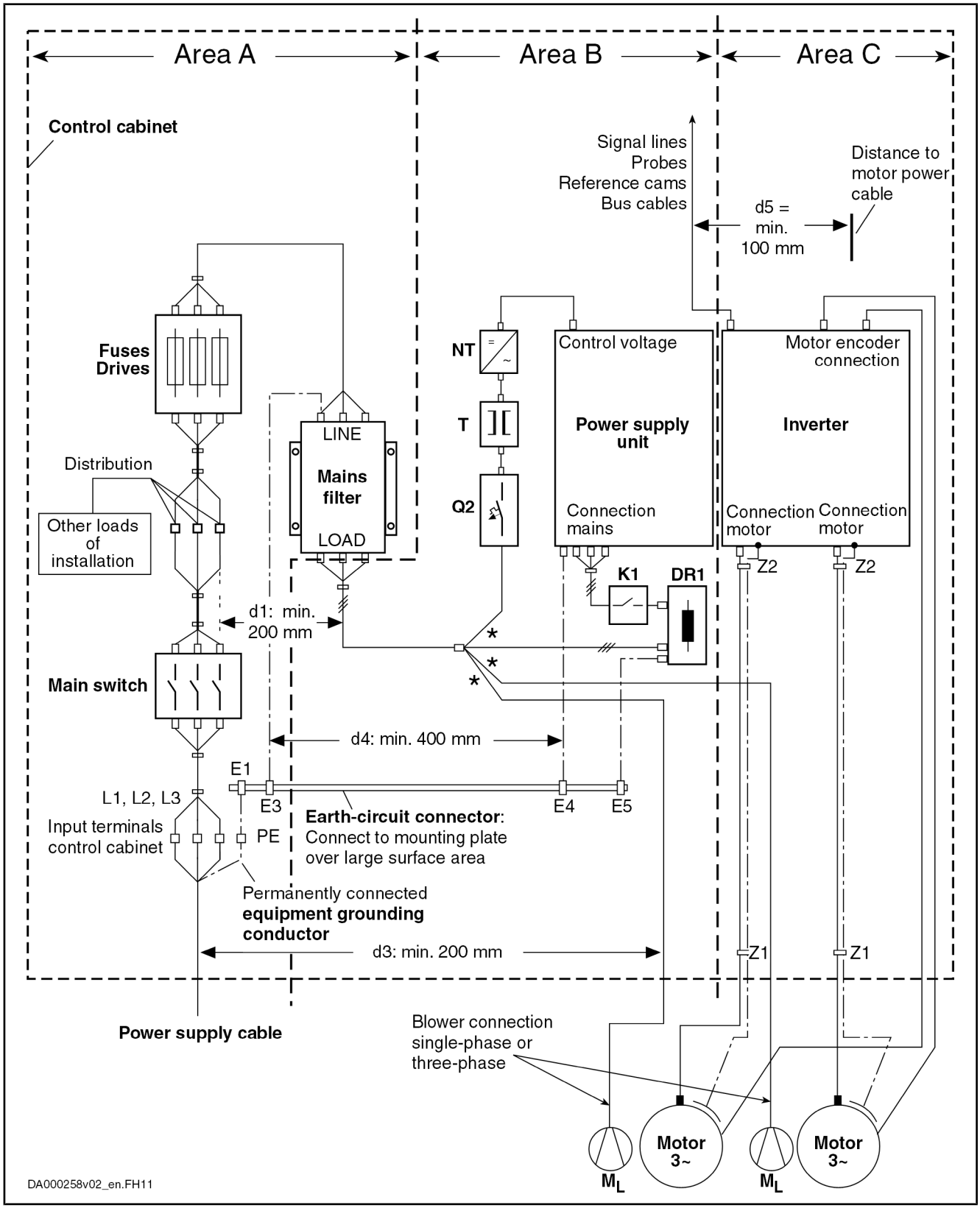
Recommendation for complex systems: Install drive components in one cabinet and the control units in a second, separate cabinet.

Badly grounded control cabinet doors act as antennas. Therefore, connect the control cabinet doors to the cabinet on top, in the middle and on the bottom via short equipment grounding conductors with a cross section of at least 6 mm^2 or, even better, via grounding straps with the same cross section. Make sure connection points have good contact.

Mounting and Installation

Control Cabinet Mounting According to Interference Areas - Exemplary Arrangements

HMVxx.xE Supply Unit or HCSxx.xE Converter



DR1 Mains choke (optional)

E1…E5	Equipment grounding conductor of the components
K1	External mains contactor for supply units and converters without integrated mains contactor
M_L	Motor blower
NT	Power supply unit
Q2	Fusing
T	Transformer
Z1, Z2	Shield connection points for cables
*	Not allowed at HNF mains filter

Fig.6-35: HMVxx.xE; HCSxx.xE – EMC Areas in the Control Cabinet

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

Arrangement of the Components in the Control Cabinet

Comply with a distance of at least **200 mm** (distance d1 in the figure):

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

Comply with a distance of at least **400 mm** (distance d4 in the figure):

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

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

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

Comply with a distance of at least **200 mm** (distance d1 and d3 in the figure):

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

If this is impossible, there are two alternatives:

1. Install lines in shielded form and connect the shield at several points (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.
2. Separate lines from the other interference-susceptible lines in areas B and C by means of a grounded distance plate vertically attached to the mounting plate.

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

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

☞ In case you do not observe the information on cable routing given in this section, the effect of the mains filter is totally or partly neutralized. This will cause 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 will thereby 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.

Motor Blower at Mains Filter

Single-phase or three-phase supply lines of motor blowers, that are usually routed in parallel with motor power cables or interference-susceptible lines, must be filtered:

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

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

Loads at Mains Filter of Drive System

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

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

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

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

Shielding Mains Supply Lines in Control Cabinet

If there is a high degree of interference injection to the mains supply line within the control cabinet, although you have observed the above instructions (to be found out by EMC measurement according to standard), proceed as follows:

- Only use shielded lines in area A
- Connect shields 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

Ideally, mount the mains filter 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 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, connect the filter to the output side of the transformer and not to the supply side of the transformer.

Grounding

In the case of bad ground connections in the 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 d4 = 400 mm, in order to minimize interference injection from ground and ground cables to the power input lines.

See also Division Into Areas (Zones), page 115.

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

The equipment grounding conductor of the power cable of the machine, installation or control cabinet has to be **permanently connected** at point PE and have a **cross section of at least 10 mm²** 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 must be accordingly bigger.

Design and Installation in Area B - Interference-Susceptible Area of Control Cabinet

Arranging Components and Lines

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

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

Only connect power supply units for auxiliary or control voltage connections in the drive system to the mains via a mains filter. See Division Into Areas (Zones), page 115.

Install the shortest possible lines between drive controller and filter.

Control Voltage or Auxiliary Voltage Connection

Only in exceptional cases should you connect power supply unit and fusing for the control voltage connection to phase and neutral conductor. In this case, mount and install these components in area A far away from the areas B and C of the drive system. For details see section Design and Installation in Area A - Interference-Free Area of Control Cabinet, page 117.

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

Line Routing

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

Design and Installation in Area C - Strongly Interference-Susceptible Area of Control Cabinet

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

Influence of the Motor Power Cable

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

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

Routing the Motor Power Cables and Motor Encoder Cables

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

Route the motor power cables and motor encoder cables

- with a distance of at least **d5 = 100 mm** to interference-free lines, as well as to signal cables and signal lines

  (alternatively separated by a grounded distance plate)
- in separate cable ducts, if possible

Routing the Motor Power Cables and Mains Connection Lines

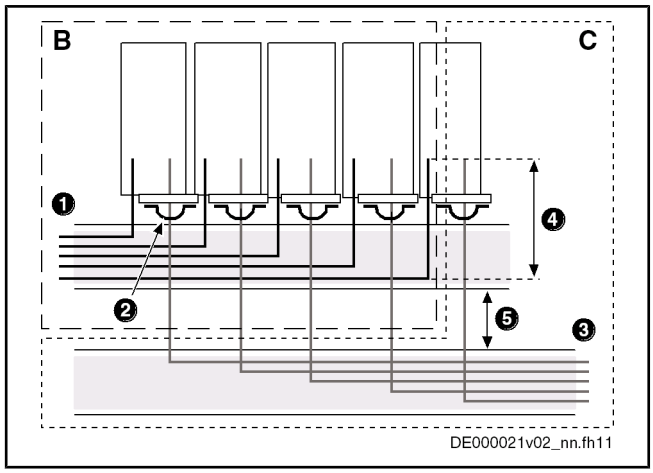
For converters (drive controllers with individual mains connection), route motor power cables and (unfiltered) mains connection lines **in parallel for a maximum distance of 300 mm**. After that distance, route motor power cables and power supply cables in opposite directions and preferably in separate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

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

Mounting and Installation

IndraDrive C and Cs - Routing the Motor Power Cables

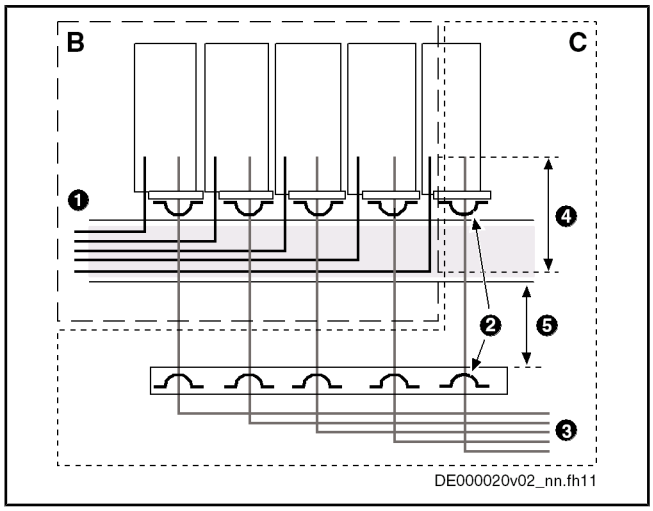
With cable duct



B	Area B
C	Area C
1	Cable duct for mains connection lines
2	Shield connection of motor power cable via clips at least at one point; alternatively, at the device or on mounting plate at control cabinet
3	Cable duct for motor power cables
4	Parallel routing of mains connection lines and motor power cables over a maximum of 300 mm
5	Distance of at least 100 mm or separated by a grounded distance plate

Fig.6-36: Routing of Motor Power Cables With Cable Duct

Without cable duct



B	Area B
C	Area C
1	Cable duct for mains connection lines
2	Shield connection of motor power cable via clips at least at one point; alternatively, at the device or on mounting plate at control cabinet
3	Control cabinet outlet of motor power cables
4	Parallel routing of mains connection lines and motor power cables over a maximum of 300 mm
5	Distance of at least 100 mm or separated by a grounded distance plate

Fig.6-37: Routing of Motor Power Cables Without Cable Duct

Fig.6-38: Routing of Cables for IndraDrive C and Cs

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 ground on the shortest possible way.

Ground connections 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 well contacted over a large surface area. This also applies to all screw connections between mounting plate and control cabinet wall and to the mounting of a ground bus to the mounting plate.

The best solution is to use a zinc-coated 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, remove the lacquer so that there is safe electrical contact over a large surface area. You achieve contact over a large surface area by means of bare connection surfaces or several connection screws. For screw connections, you can establish the contact to lacquered surfaces by using tooth lock washers.

Metal Surfaces

Always use connection elements (screws, nuts, plain washers) with good electroconductive surface.

Bare zinc-coated or tinned metal surfaces have **good electroconductive properties**.

Anodized, yellow chromatized, black gunmetal finish or lacquered metal surfaces have **bad electroconductive properties**.

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.

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

Installing Signal Lines and Signal Cables

Line Routing

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

- Route signal and control lines separately from the power cables with a minimum distance of **d5 = 100 mm** (see Division Into Areas (Zones), page 115) or with a grounded separating sheet. The optimum way is to route them in separate cable ducts. If possible, lead signal lines into the control cabinet at one point only.
- If signal lines are crossing power cables, route them in an angle of 90° in order to avoid interference injection.
- Ground spare cables, that are not used and have been connected, at least at both ends so that they do not 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 like reception antennas (noise immunity) and like transmitting antennas (emission of interference). Exceptional cases are flexible cable tracks over short distances of a maximum of 5 m.

Shielding

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

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

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

General Measures of Radio Interference Suppression for Relays, Contactors, Switches, Chokes and 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:

- By arranging free-wheeling diodes in the case of d.c. operation
- 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 does serve 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.

7 Technical Data of the Components

7.1 Control Section

7.1.1 EC - Standard Encoder Evaluation

Properties

Supported Encoder Systems

Encoders with a supply voltage of **5 and 12 volt**

Encoder Systems

- MSM motor encoder
- MSK motor encoder
- Sin-cos encoder 1 V_{pp}; HIPERFACE®
- Sin-cos encoder 1 V_{pp}; EnDat 2.1
- Sin-cos encoder 1 V_{pp}; with reference track
- 5V-TTL square-wave encoder; with reference track
- SSI
- Resolver

Input Circuit for Sine Signals A+, A- or B+, B- or R+, R-

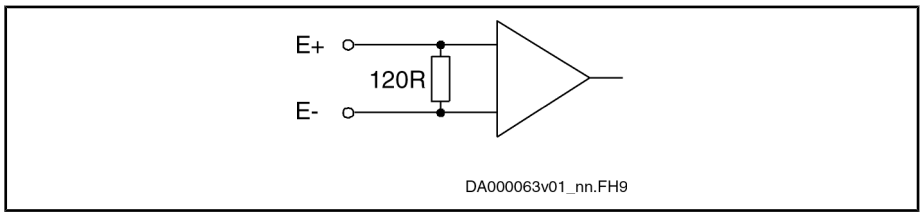


Fig.7-1: Input Circuit for Sine Signals (Block Diagram)

Properties of Differential Input for Sine Signals

Data	Unit	Min.	Typ.	Max.
Amplitude of encoder signal peak-peak ($U_{PPencodersignal}$)	V	0,8	1,0	1,2
Cut-off frequency (-3 dB)	kHz		400	
Converter width A/D converter	Bit		12	
Input resistance	ohm		120	

Fig.7-2: Differential Input Sine

Resolver Input Circuit for A+, A- or B+, B-

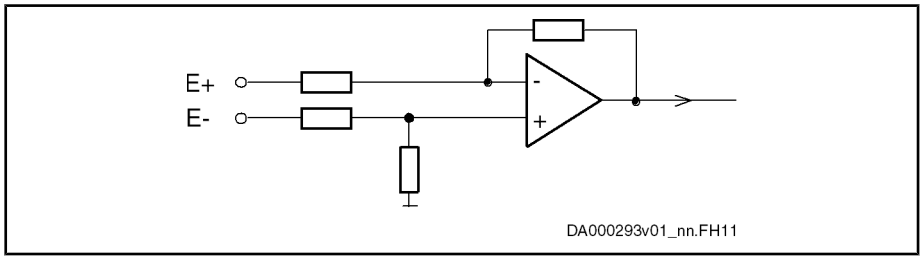


Fig.7-3: Input Circuit for Resolver Evaluation (Block Diagram)

Technical Data of the Components

Differential Input for Resolver Operation

Data	Unit	Min.	Typ.	Max.
Amplitude encoder signal sine (U_{pp})	V		1,0	1,2
Input resistance	kOhm		12	
Converter width A/D converter	Bit		12	

Fig.7-4: Input Data Resolver Operation

Input Circuit for Square-Wave Signals

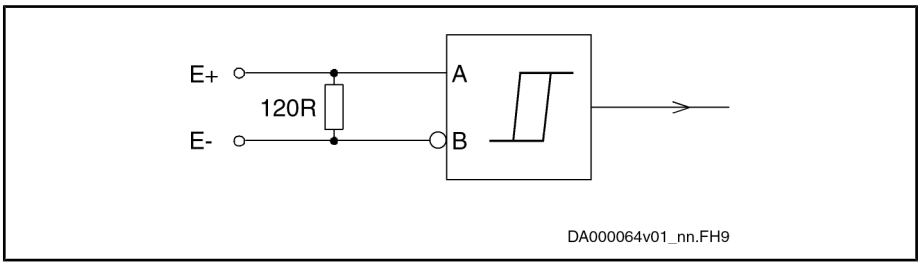


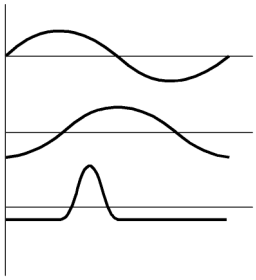
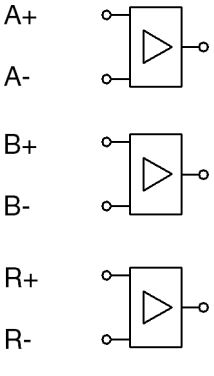
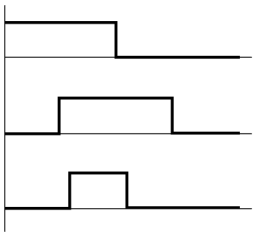
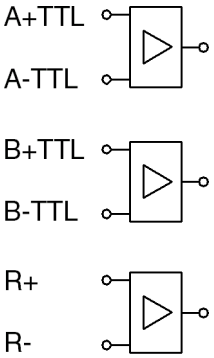
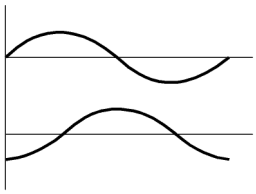
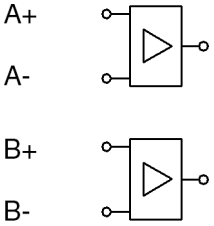
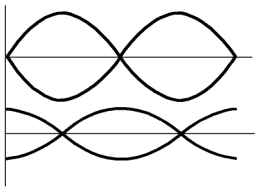
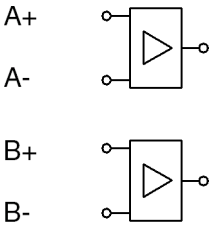
Fig.7-5: Input Circuit for Square-Wave Signals (Block Diagram)

Properties of Differential Input for Square-Wave Signals

Data	Unit	Min.	Typ.	Max.
Input voltage "high"	V	2,4		5,0
Input voltage "low"	V	0		0,8
Input frequency	kHz			1000
Input resistance	ohm		120	

Fig.7-6: Differential Input Square-Wave Signals

Signal Assignment to the Actual Position Value

Signal assignment [1]	Signal designation	Signal shape	Actual position value (with default setting)
 DK000089v01_nn.FH9	 DF000381v01_nn.FH11	Sine (1 V_{pp}) Without absolute value	Increasing
 DK000090v01_nn.FH9	 DF000380v01_nn.FH11	Square-wave (TTL) Without absolute value	Increasing
 DK000088v01_nn.FH9	 DF000382v01_nn.FH11	Sine (1 V_{pp}) With absolute value (e.g. EnDat)	Increasing
 DK000087v01_nn.FH9 Amplitude-modulated signal	 DF000382v01_nn.FH11	Resolver	Increasing

1) See following note

Fig.7-7: Signal Assignment to the Actual Position Value

The encoder signal assignment to the inputs is based on clockwise rotation (front view to motor shaft).

- Track A (A+, A-) advances track B (B+, B-) 90° electrically.
- The actual position value increases in this case (unless negation takes effect).
- If available, the reference track R (R+, R-) provides the reference mark pulse at positive signals of track A and track B (in the so-called "0-th" quadrant).

Standard setting: See Functional Description of firmware

Connection for 12V Encoder Systems

Power Supply

Data	Unit	Min.	Typ.	Max.
Voltage for encoder supply	V	11,4	12	12,6
Output current	mA			500 1)

1) Allowed total encoder current: max. 700 mA. If several EC encoder evaluations are used in a drive controller, the allowed total encoder current mustn't be exceeded.

Fig.7-8: 12V Encoder Supply

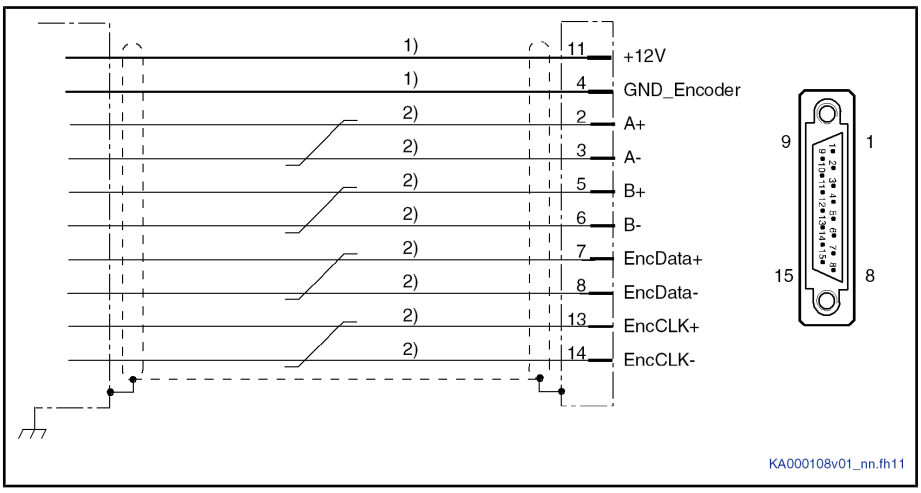
Allowed Encoder Cable Lengths at EC

The maximum allowed encoder cable length for 12V encoder systems is **40 m**.

Connection Diagrams for 12V Encoder Systems

For encoder supply, use lines with the same line cross section.

EC With MSK/QSK Encoder Interface for Encoder Systems S1/M1, S2/M2, S5/M5



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-9: Connection Diagram MSK/QSK Encoder Interface for Encoder Systems S1/M1, S2/M2, S5/M5

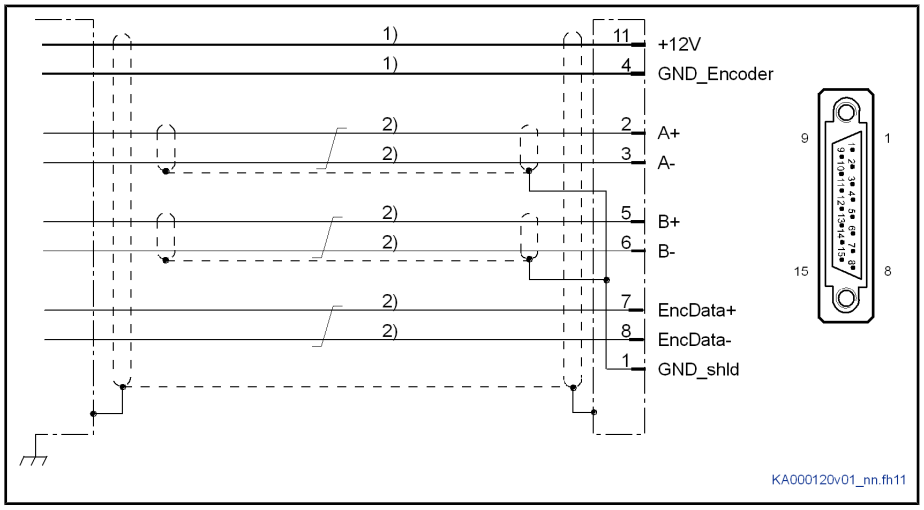
☞ For **direct** connection to the encoder system use our cable **RKG4200**. For connector type and encoder connector pin assignment, see documentation "Rexroth Connection Cables".

Connection Diagrams for 12V Encoder Systems With Third-Party Encoder

☞ For encoder supply, use lines with the same line cross section.

☞ Observe that the third-party encoder used has to be suited for the voltage available at the encoder evaluation EC as voltage for encoder supply.

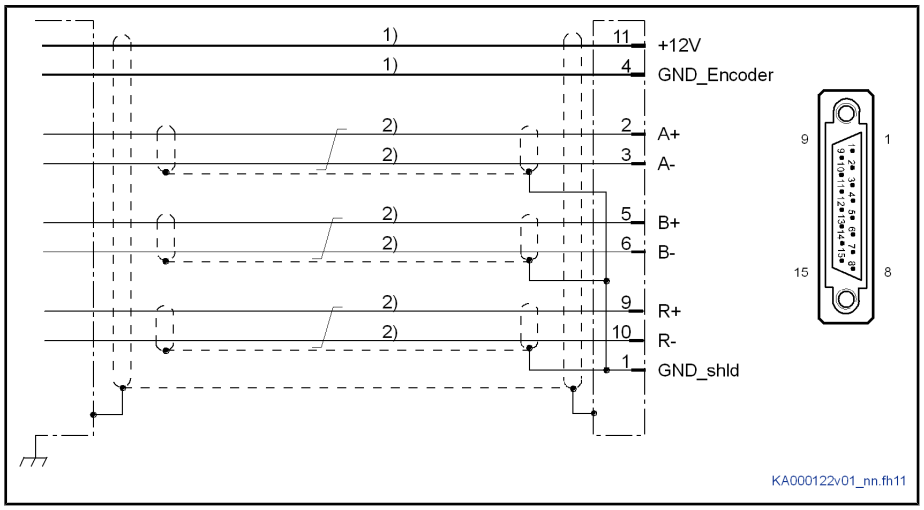
EC With Encoder System HIPERFACE®, 12V Supply Voltage



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-10: Connection Diagram Encoder System HIPERFACE®

EC With Encoder System $1V_{pp}$, 12V Supply Voltage

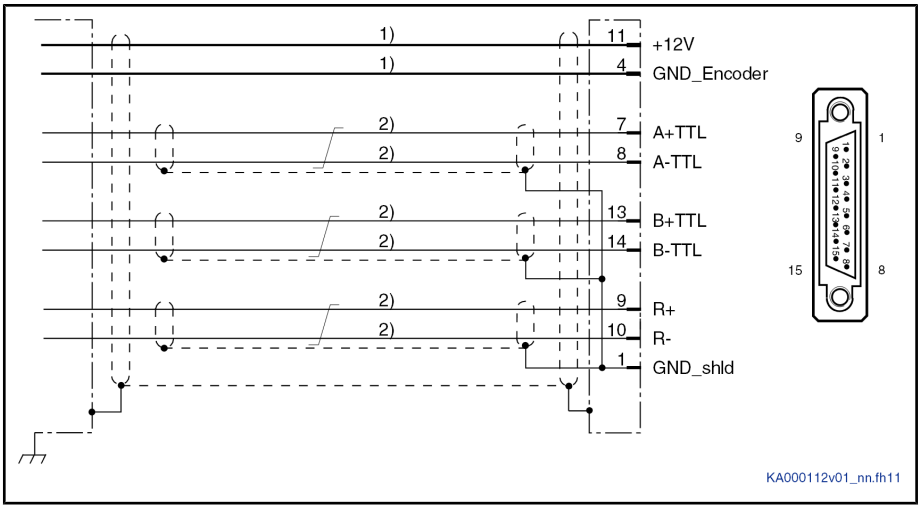


1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-11: Connection Diagram Encoder System $1V_{pp}$

Technical Data of the Components

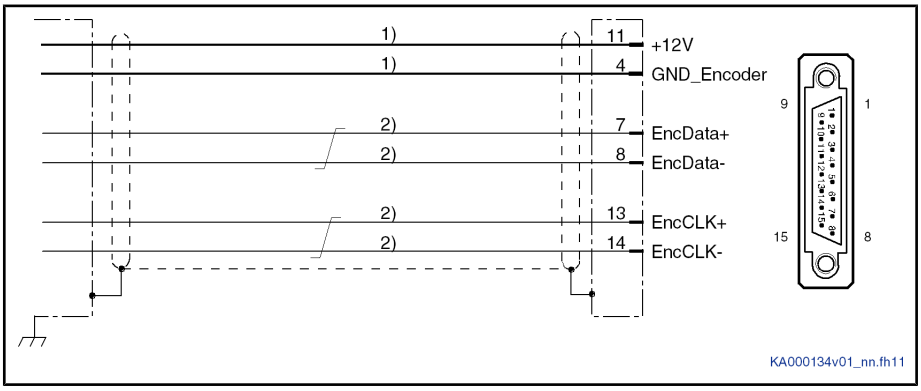
EC With Encoder System TTL, 12V Supply Voltage



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-12: Connection Diagram Encoder System TTL

EC With Encoder System SSI, 12V Supply Voltage



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-13: Connection Diagram Encoder System SSI

Connection for 5V Encoder Systems With and Without Sense

Power Supply

Data	Unit	Min.	Typ.	Max.
DC output voltage +5V **without** voltage return (Sense-)	V	5,1		5,27
Output current	mA			500[1)]
D.C. resistance of load	ohm	35		

1) Allowed total encoder current: max. 700 mA. If several EC encoder evaluations are used in a drive controller, the allowed total encoder current mustn't be exceeded.

Fig.7-14: 5V Encoder Supply

Allowed Encoder Cable Lengths for 5V Encoder Systems With and Without Sense

The "Sense" function is supported at the EC encoder evaluation for 5V encoder systems.

Functional principle:

The current consumption of the connected encoder system generates a voltage drop due to the ohmic resistance of the encoder cable (line cross section and line length). This reduces the signal at the encoder input.

The drive controller can influence the voltage for encoder supply (+5V). For this purpose, the actual value of the 0V encoder potential can be detected with the "Sense" line (Sense-).

If the cable and the encoder system have a connection for the "Sense-" signal, this value is transmitted from the encoder to the drive controller.

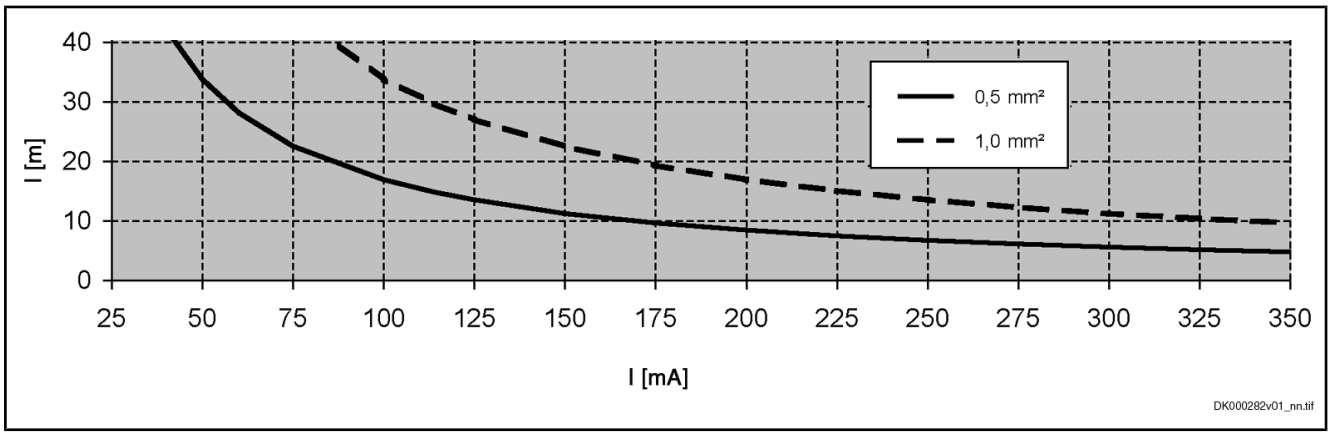
☞ When the **Sense function** is used, the 0V encoder potential must be connected to the "Sense" line on the encoder side. The "Sense+" connection possibly existing on the encoder side is not used.

For correct "Sense" evaluation, the encoder supply lines "+5V" and "GND_Encoder" must have the same line cross section..

In the diagram below, the following aspects have been taken into account:

- **Cross section of the lines** for supply voltage in the cable must be at least 0.5 mm^2
- **Allowed supply voltage** at the encoder is **5V ±5%**

Allowed Encoder Cable Length for 5V Encoders Without Sense Connection in Encoder Line



I [mA]	Encoder current consumption
l [m]	Cable length
0.5; 1.0 mm^2	Cable cross sections

Fig.7-15: Maximum Allowed Encoder Cable Lengths Without Sense Connection Depending on Cable Cross Section

Allowed Encoder Cable Length for 5V Encoders With Sense Connection in Encoder Line

☞
- The maximum allowed encoder cable length for 5V encoder systems **with** Sense connection is **40 m**.
- Prerequisite: Cross section of lines for supply voltage is at least **0.5 mm²**.

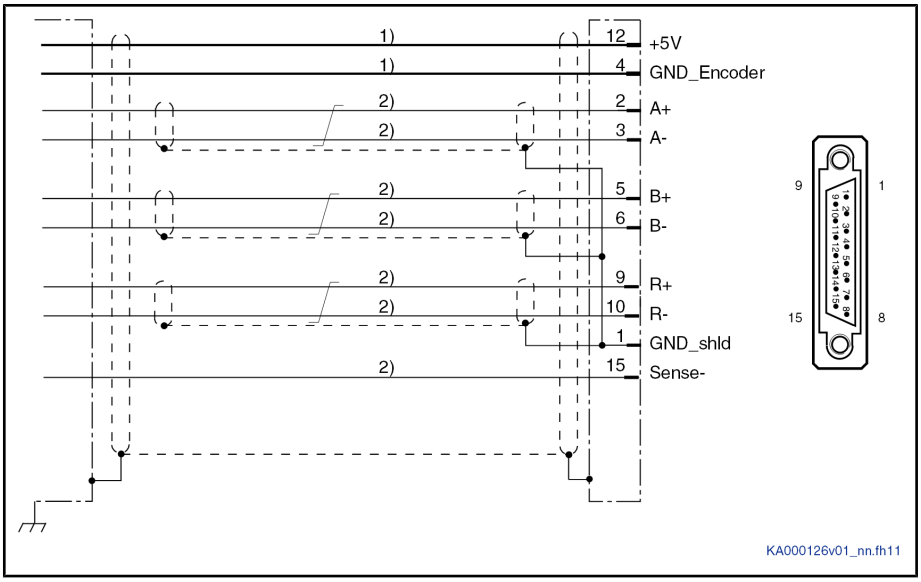
Connection Diagrams for 5V Encoder Systems With Third-Party Encoder

☞ For encoder supply, use lines with the same line cross section.

Observe that the third-party encoder used has to be suited for the voltage available at the encoder evaluation EC as voltage for encoder supply.

Technical Data of the Components

EC With Encoder System $1V_{pp}$, 5V Supply Voltage (According to Heidenhain Standard)

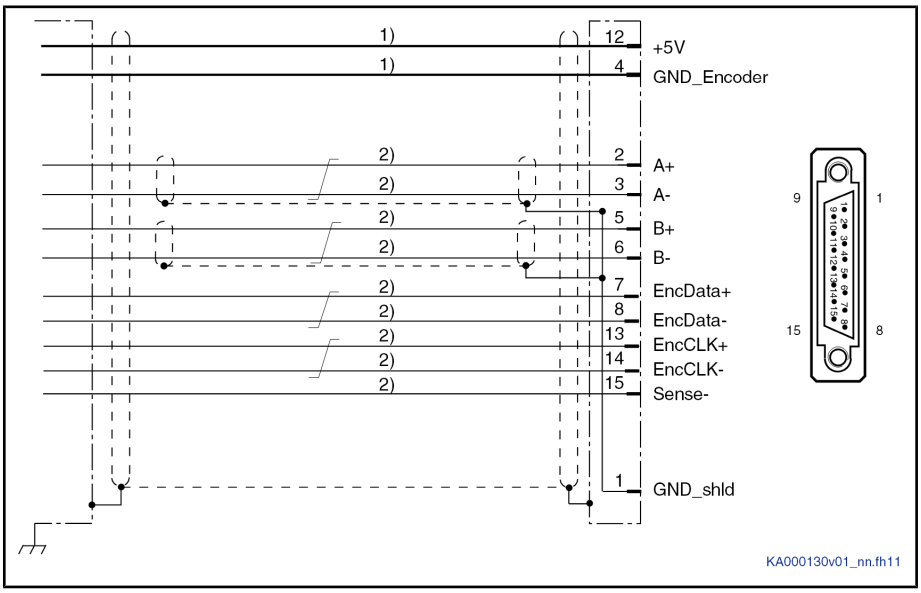


1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-16: Connection Diagram EC With Encoder System $1V_{pp}$

☞ For **direct** connection to the encoder system use our cable **RKG0035**. For connector type and encoder connector pin assignment, see documentation "Rexroth Connection Cables".

EC With Encoder System EnDat 2.1 (According to Heidenhain Standard), 5V Supply Voltage

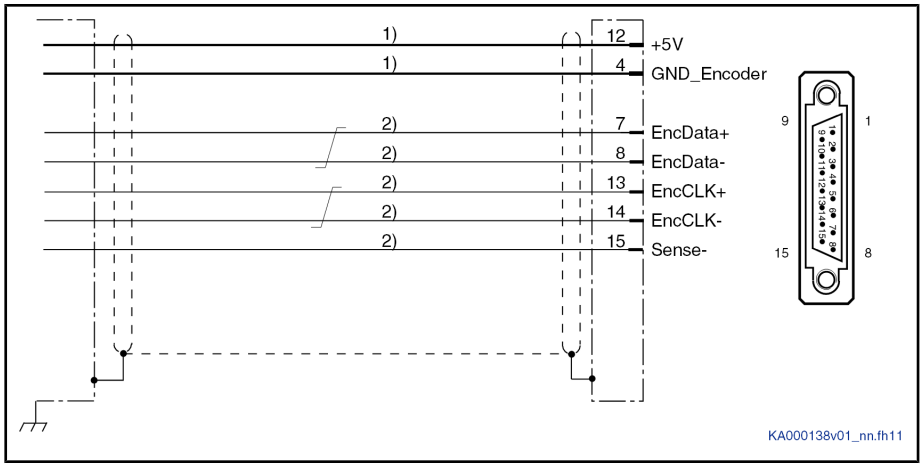


1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-17: Connection Diagram EC With Encoder System EnDat 2.1

☞ For **direct** connection to the encoder system use our cable **RKG0036**. For connector type and encoder connector pin assignment, see documentation "Rexroth Connection Cables".

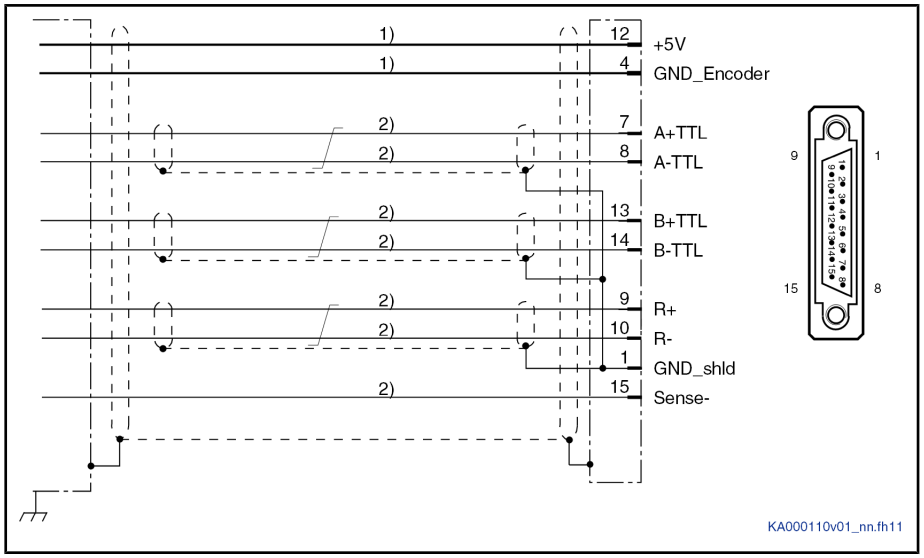
EC With Encoder System SSI, 5V Supply Voltage



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-18: Connection Diagram EC With Encoder System SSI

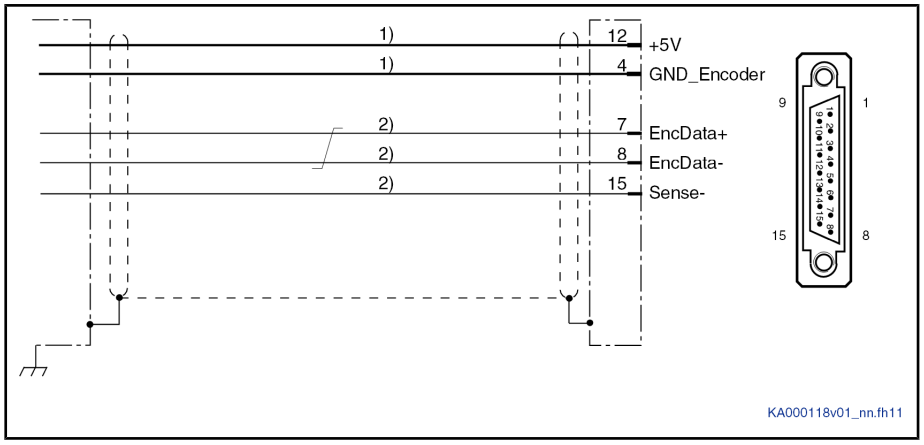
EC With Encoder System TTL, 5V Supply Voltage



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-19: Connection Diagram EC With Encoder System TTL

EC With Encoder System of IndraDyn S MSM Motors, 5V Supply Voltage



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-20: Connection Diagram EC With Encoder System of IndraDyn S MSM Motors

☞ For **direct** connection to the encoder system use our cable **RKG0033**. For connector type and encoder connector pin assignment, see documentation "Rexroth Connection Cables".

Connection for Resolver Encoder System

Power Supply

Voltage for Resolver Supply

Data	Unit	Min.	Typ.	Max.
AC output voltage VCC_Resolver (peak-peak value)	V		2,0	2,4
Output frequency sine	kHz		8	
Output current	mA		20	

Fig.7-21: Resolver Encoder Supply

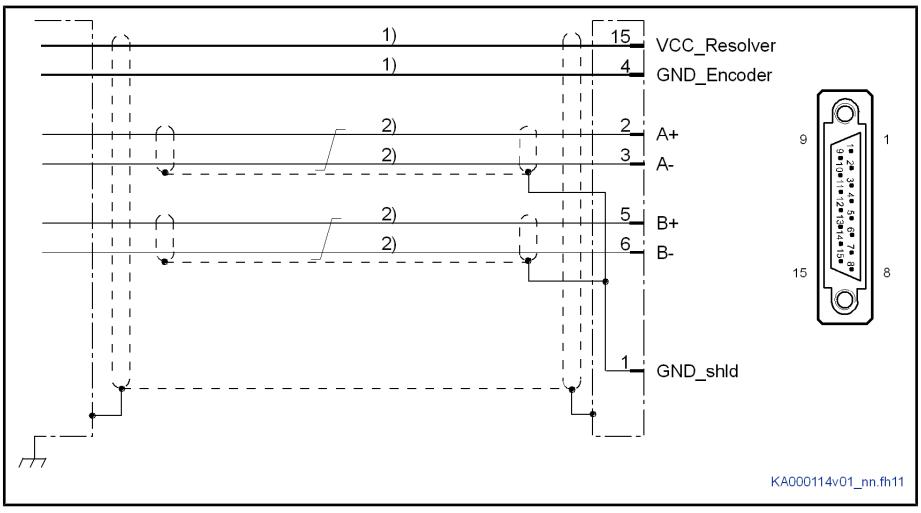
☞ The maximum allowed **encoder cable length** for resolver encoder systems is **40 m**.

Connection Diagram for Resolver Encoder System With Third-Party Encoder

☞ For encoder supply, use lines with the same line cross section.

☞ Observe that the third-party encoder used has to be suited for the voltage available at the encoder evaluation EC as voltage for encoder supply.

EC With Resolver Encoder System



1) Cable cross section ≥ 0.5 mm²; observe allowed encoder cable length
2) Cable cross section ≥ 0.14 mm²

Fig.7-22: Connection Diagram EC With Resolver Encoder System

7.1.2 ET - Multi-Ethernet

Display Elements

At both connectors, the optional module has 2 LED displays each and one LED display "network status" each. The significance of "network status" depends on the field bus system.

LED	Significance	Color	Description
H10, H12	Status	 Yellow	Data transmission running
H11, H13	Link	 Green	Connection to network available

Fig.7-23: Significance of Display Elements at Connector

Significance in Field Bus Systems "Ethernet/IP"

LED	Significance	Color	Description
H24	Not active	 Off	Interface has been switched off (24V supply) or has no IP address
	Not connected	 Flashing green	Interface has an IP address, but no connection
	Connected	 Green	Connection to network available, data transmission running
	Timeout	 Flashing red	Existing connection was aborted
	Invalid IP address	 Red	Assigned IP address is already used by another device
	Self test	 Flashing red-green	After switching on, interface carries out a self test

Fig.7-24: Significance of Display Element Network Status

7.1.3 Digital Inputs/Outputs

General Information

The digital inputs/outputs correspond to "IEC 61131, type 1".

Do not operate digital outputs at low-resistance sources!

In the Functional Description of the firmware, observe the Notes on Commissioning for digital inputs/outputs.

Digital Inputs

Digital Inputs Type 1 (Standard)

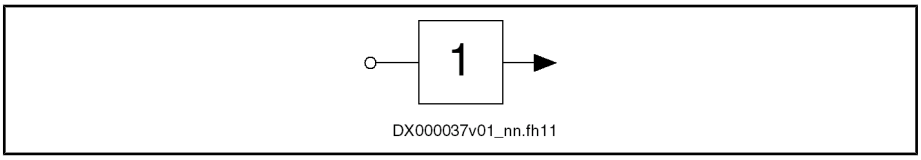


Fig.7-25: Symbol

Data	Unit	Min.	Typ.	Max.
Allowed input voltage	V	-3		30
On	V	15		
Off	V			5
Input current	mA	2		5
Input resistance	kΩ	7,42		
Sampling frequency	kHz	Depending on firmware		
Control delay	µs	20		100 + 1 cycle time of position control

Fig.7-26: Digital Inputs Type 1

Digital Inputs - Probe

Digital Inputs Type 2 (Probe)

Function

See "Probe" in the Functional Description of the firmware.

Technical Data

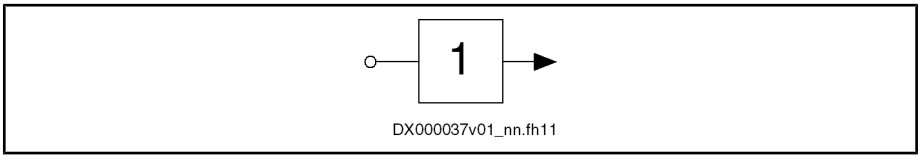
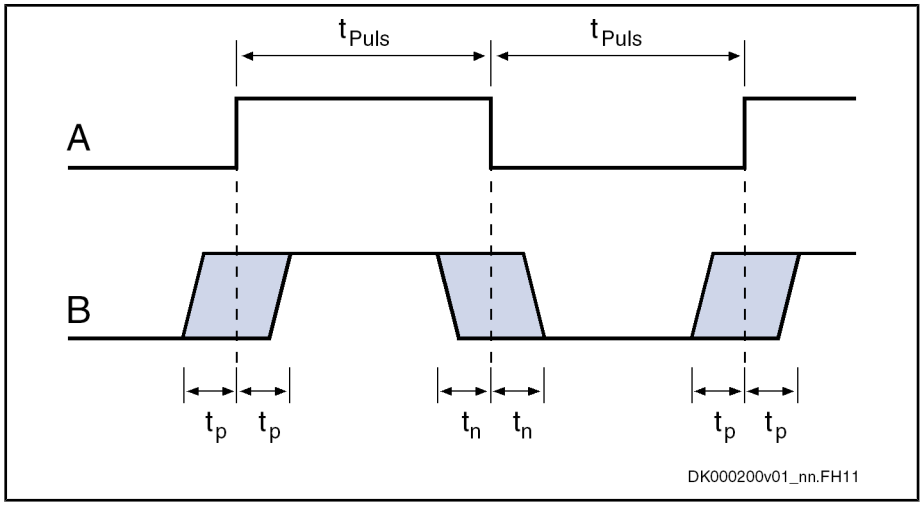


Fig.7-27: Symbol

Data	Unit	Min.	Typ.	Max.
Allowed input voltage	V	-3		30
On	V	15		
Off	V			5
Input current	mA	2		5
Input resistance	kΩ	7,42		
Pulse width t_{Puls}	µs	4		
Measuring accuracy t_x	µs			1

Fig.7-28: Digital Inputs Type 2



A	Signal
B	Signal detection at probe input
t_{Puls}	Pulse width
t_p	Measuring accuracy of the positive signal edge
t_n	Measuring accuracy of the negative signal edge

Fig.7-29: Signal detection at probe input

Use For detecting sophisticated measuring marks, e.g. when positioning glue dots.

Probe inputs are "rapid" inputs. For control use bounce-free switching elements (e.g. electronic switches) to avoid incorrect evaluation.

Digital Outputs

The digital outputs correspond to IEC 61131.

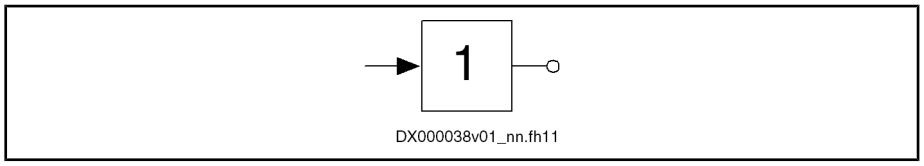


Fig.7-30: Symbol

Data	Unit	Min.	Typ.	Max.
Output voltage ON	V	U_{ext} - 0.5	24	U_{ext}
Output voltage OFF	V			2,1
Output current OFF	mA			0,05
Allowed output current per output	mA			500
Allowed output current per group (8 outputs)	mA			2000
Update interval	ns	Depending on firmware		
Short circuit protection		Present		
Overload protection		Present		

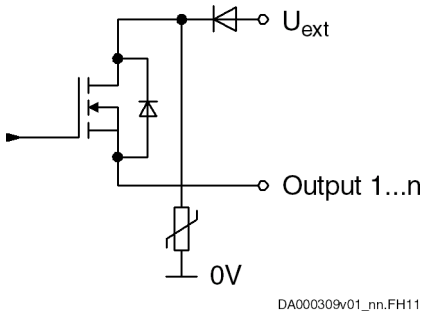
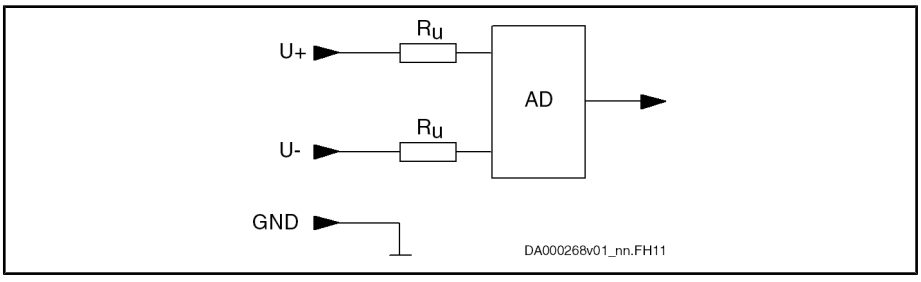
Data	Unit	Min.	Typ.	Max.
Allowed energy content of connected inductive loads, e.g. relay coils; only allowed as single pulse Per output	mJ			250
Allowed energy content of connected inductive loads, e.g. relay coils; only allowed as single pulse Per group (8 outputs)	mJ			1000
Block diagram output:				

Fig.7-31: Digital Outputs

- The digital outputs have been realized with high-side switches. This means that these outputs can actively supply current, but not sink it.
- The energy absorption capacity of the outputs is used to limit voltage peaks caused when inductive loads are switched off.

  Limit voltage peaks by using free-wheeling diodes directly at the relay coil.

7.1.4 Analog Input



AD Analog/digital converter
Fig.7-32: Analog Voltage Input

Data	Unit	Min.	Typ.	Max.
Allowed input voltage	V	-50		+50
Working range input voltage U_{on_work}	V	-10		+10
Input resistance	kΩ		240	
Input bandwidth (-3 dB)	kHz		1,3	

Data	Unit	Min.	Typ.	Max.
Common-mode range	V	-50		+50
Common-mode rejection	dB	50		
Relative measuring error at 90% U_{on_work}	%	-1		+1
Converter width A/D converter incl. polarity sign	Bit		12	
Oversampling			8-fold	
Dynamic converter width with oversampling	Bit		14	
Resulting resolution	mV/inc		1,23	
Cyclic conversion	µs	n.s.		
Conversion time	µs	n.s.		

Fig.7-33: Analog Voltage Input

7.1.5 Relay Contacts

Relay Contact Type 2

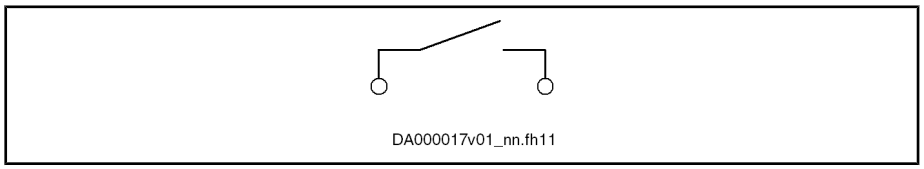


Fig.7-34: Relay Contact

Data	Unit	Min.	Typ.	Max.
Current carrying capacity	A			DC 1
Voltage load capacity	V			DC 30
Minimum load of the contacts	mA	10		
Contact resistance at minimum current	mΩ			1000
Switching actions at max. time constant of load			1×10^6	
Number of mechanical switching cycles			1×10^8	
Time constant of load	ms	ohmic		
Pick up delay	ms			10
Drop out delay	ms			10

Fig.7-35: Relay Contacts Type 2

7.1.6 PB - PROFIBUS

Signal Specification

Signal	Specification
+5V Repeater supply	+5 V (±10%) Max. 75 mA
Repeater control signal	TTL-compatible: • 1: Transmit • 0: Receive Output resistance: 350R V_{OL} ≤ 0.8 V at I_{OL} ≤ 2 mA V_{OH} ≥ 3.5 V at I_{OH} ≤ 1 mA
Receive/transmit data	EIA-RS485 standard

Fig.7-36: Signal Specification

CAUTION

Danger of destroying output "+5V repeater supply" by overload!

Do not short-circuit the output.

Do not exceed the maximum current.

Diagnostic Displays

For the significance of the diagnostic displays, see firmware documentation.

7.2 Standard Control Panel

☞ For a detailed description of the standard control panel, see the documentation "Application Manual, Functions" of the firmware used (index entry "Control panels").

Description

The standard control panel

- has a single-line display
- is **suited for hot plug**, i.e. you may plug it in and disconnect it when the drive controller has been switched on
- must have been plugged in when the drive controller is switched on so that it can be recognized
- can be used as programming module

Fig.7-37: Standard Control Panel

- The **display** shows operating states, command and error diagnoses and pending warnings.
- Using the four **keys**, the commissioning engineer or service technician, in addition to communication via the commissioning tool or NC control unit,

can have extended diagnoses displayed at the drive controller and trigger simple commands.

7.3 Power Section

7.3.1 Control Voltage

Data for Control Voltage Supply

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Rated control voltage input (UL)[1)]	U_{N3}	V	24 ± 5%							
Control voltage when using motor holding brake with motor cable length < 50 m (HCS01< 40 m)[2)]	U_{N3}	V	24 ± 5%							
Control voltage when using motor holding brake with motor cable length > 50 m[3)]	U_{N3}	V	-							
Maximum inrush current at 24V supply	I_{EIN3_max}	A	3,30							
Pulse width of I_{EIN3}	$t_{EIN3Lade}$	ms	2							
Input capacitance	C_{N3}	mF	0,22							
Rated power consumption control voltage input at U_{N3} (UL) [4)]	P_{N3}	W	27		28		27	28	34	
Last modification: 2009-07-28										

1) 2) 3) Observe supply voltage for motor holding brake
4) HMS, HMD, HCS plus motor holding brake and control section; HCS01 including control section

Fig.7-38: HCS - Data for Control Voltage Supply

Overvoltage

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

This includes:

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

7.3.2 Mains Voltage

Technical Data of the Components

Data for Mains Voltage Supply

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
Input frequency (UL)	f_{LN}	Hz	50...60			
Tolerance input frequency (UL)		Hz	± 2			
Maximum allowed mains frequency change	$\Delta f_{LN}/\Delta t$	Hz/s	2% x fLN			
Rotary field condition			None			
Short circuit current rating (UL)	SCCR	A rms	42000			
Nominal mains voltage	U_{LN_nenn}	V	3 AC 230			
Mains voltage single-phase	U_{LN}	V	110...230			
Mains voltage three-phase at TN-S, TN-C, TT mains	U_{LN}	V	110...230			
Mains voltage three-phase at IT mains[1)]	U_{LN}	V	110...230			
Mains voltage three-phase at Corner-grounded-Delta mains[2)]	U_{LN}	V	110...230			
Tolerance rated input voltage (UL)		%	± 10			
Minimum inductance of the mains supply (inductance of mains phase)[3)]	L_{min}	µH	40			
Assigned type of mains choke			-			
Minimum short circuit power of the mains for failure-free operation	S_{k_min}	MVA	0,02	0,03	0,1	
Assigned type of mains filter						
Inrush current	$I_{L\_trans\_max\_on}$	A	2,80			
Maximum allowed ON-OFF cycles per minute[4)]			1			
Power factor TPF (λ_L) at P_{DC_cont} with mains choke; U_{LN_nenn}	TPF		-			
Power factor TPF (λ_L) at P_{DC_cont} without mains choke; U_{LN_nenn}[5)]	TPF		0,60			
Power factor TPF (λ_L) at 10% P_{DC_cont} without mains choke; U_{LN_nenn}[6)]	$TPF_{10\%}$		-			
Power factor TPF (λ_L) at P_{DC_cont} (single-phase); U_{LN} = 1 AC 230 V	TPF		0,40			
Power factor of fundam. component DPF at P_{DC_cont} with mains choke	$\cos\varphi^{h1}$		-			

Last modification: 2009-07-28

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
Power factor of fundam. component DPF at P_{DC_cont} without mains choke	$\cos\varphi^{h1}$		0,97			
Mains connection power at P_{DC_cont}; U_{LN_nenn} with mains choke	S_{LN}	kVA	-			
Mains connection power at P_{DC_cont}; U_{LN_nenn} without mains choke	S_{LN}	kVA	0,23	0,46	0,92	1,72
Rated input current (UL)	I_{LN}	A	0,6	1,2	2,3	4,5
Nominal current AC1 for mains contactor at nom. data			I LN			
Mains fuse according to EN 60204-1		A	-			
Required wire size according to EN 60204-1[7)]	A_{LN}	mm^2	1,5			
Required wire size according to UL 508 A (internal wiring); (UL)[8)]	A_{LN}	AWG	AWG 14			
Last modification: 2009-07-28						

1) 2) Mains voltage > ULN: Use a transformer with grounded neutral point, don´t use autotransformers!
3) Otherwise use mains choke HNL
4) Observe allowed number of switch-on processes; without external capacitors at the DC bus
5) 6) Find interim values by interpolation
7) Copper wire; PVC-insulation (conductor temperature 70 °C); installation method B1; table 6
8) Copper wire; PVC-insulation (conductor temperature 90 °C); table 13.5.1; Ta ≤ 40 °C

Fig.7-39: HCS - Data for Mains Voltage Supply

Data for Mains Voltage Supply

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Input frequency (UL)	f_{LN}	Hz	50...60			
Tolerance input frequency (UL)		Hz	± 2			
Maximum allowed mains frequency change	$\Delta f_{LN}/\Delta t$	Hz/s	2% x fLN			
Rotary field condition			None			
Short circuit current rating (UL)	SCCR	A rms	42000			
Nominal mains voltage	U_{LN_nenn}	V	3 AC 400			
Mains voltage single-phase	U_{LN}	V	Not allowed			
Mains voltage three-phase at TN-S, TN-C, TT mains	U_{LN}	V	200...500			
Last modification: 2009-07-28						

Technical Data of the Components

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Mains voltage three-phase at IT mains[1)]	U_{LN}	V	200...230			
Mains voltage three-phase at Corner-grounded-Delta mains[2)]	U_{LN}	V	200...230			
Tolerance rated input voltage (UL)		%	± 10			
Minimum inductance of the mains supply (inductance of mains phase)[3)]	L_{min}	µH	40			
Assigned type of mains choke			-			HNL01.1E-1000-N0012-A-500-NNNN
Minimum short circuit power of the mains for failure-free operation	S_{k_min}	MVA	0,1		0,2	0,4
Assigned type of mains filter						
Inrush current	$I_{L\_trans\_max\_on}$	A	3,40		6,10	9,00
Maximum allowed ON-OFF cycles per minute[4)]			1			
Power factor TPF (λ_L) at P_{DC_cont} with mains choke; U_{LN_nenn}	TPF		-			0,70
Power factor TPF (λ_L) at P_{DC_cont} without mains choke; U_{LN_nenn}[5)]	TPF		0,60			
Power factor TPF (λ_L) at 10% P_{DC_cont} without mains choke; U_{LN_nenn}[6)]	$TPF_{10\%}$		-		0,40	
Power factor TPF (λ_L) at P_{DC_cont} (single-phase); U_{LN} = 1 AC 230 V	TPF		Not allowed			
Power factor of fundam. component DPF at P_{DC_cont} with mains choke	$cos\varphi^{h1}$		-			0,95
Power factor of fundam. component DPF at P_{DC_cont} without mains choke	$cos\varphi^{h1}$		0,97			
Mains connection power at P_{DC_cont}; U_{LN_nenn} with mains choke	S_{LN}	kVA	-			5,50
Mains connection power at P_{DC_cont}; U_{LN_nenn} without mains choke	S_{LN}	kVA	1,00	1,35	3,50	4,90
Rated input current (UL)	I_{LN}	A	1,5	2,5	5,0	10,0
Nominal current AC1 for mains contactor at nom. data			I LN			

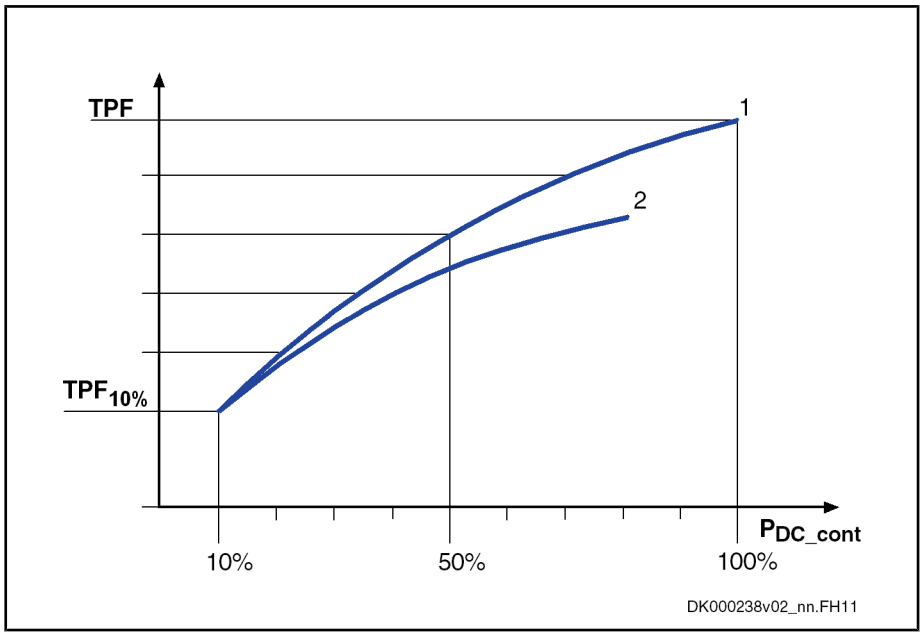
Last modification: 2009-07-28

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Mains fuse according to EN 60204-1		A	-			16
Required wire size according to EN 60204-1[7)]	A_{LN}	mm^2	1,5			
Required wire size according to UL 508 A (internal wiring); (UL)[8)]	A_{LN}	AWG	AWG 14			
Last modification: 2009-07-28						

1) 2) Mains voltage > ULN: Use a transformer with grounded neutral point, don´t use autotransformers!
3) Otherwise use mains choke HNL
4) Observe allowed number of switch-on processes; without external capacitors at the DC bus
5) 6) Find interim values by interpolation
7) Copper wire; PVC-insulation (conductor temperature 70 °C); installation method B1; table 6
8) Copper wire; PVC-insulation (conductor temperature 90 °C); table 13.5.1; Ta ≤ 40 °C

Fig.7-40: HCS - Data for Mains Voltage Supply

Qualitative Characteristic TPF vs. DC Bus Power P_{DC_cont}



$TPF_{10\%}$; TPF Values from table "Data for Mains Voltage Supply"; TPF = Total Power Factor at rated power, $TPF_{10\,\%}$ = Total Power Factor at 10% rated power
P_{DC_cont} Value from table "Data of Power Section - DC Bus"
1 **With** mains choke
2 **Without** mains choke

Fig.7-41: Qualitative Characteristic TPF vs. DC Bus Power P_{DC_cont}

Technical Data of the Components

7.3.3 DC Bus

Data of Power Section - DC Bus

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
DC bus voltage	U_{DC}	V	ULN x 1,41			
Capacitance in DC bus	C_{DC}	mF	0,44		0,78	
DC resistance in DC bus (L+ to L-)	R_{DC}	kOhm	663,00			
Rated power (t > 10 min) at f_s = 4 kHz; U_{LN_nenn}; control factor a_0 > 0,8; with mains choke	P_{DC_cont}	kW	-			
Rated power (t > 10 min) at f_s = 4 kHz; U_{LN_nenn}; control factor a_0 > 0.8; without mains choke	P_{DC_cont}	kW	0,15	0,25	0,46	0,80
Factor to reduce P_{DC_cont} at single-phase mains voltage	f_{1_3ph}		1,00			0,80
P_{DC_cont} and P_{DC_max} vs. mains input voltage; $U_{LN} \leq U_{LN\_nenn}$		%/V	PDC_cont (ULN) = PDC_cont x [1 - (230-ULN) x 0,0025]			
P_{DC_cont} and P_{DC_max} vs. mains input voltage; $U_{LN} > U_{LN\_nenn}$		%/V	No power increase			
Maximum allowed DC bus power at U_{LN_nenn}; with mains choke	P_{DC_max}	kW	-			
Maximum allowed DC bus power at U_{LN_nenn}; without mains choke	P_{DC_max}	kW	0,45	0,75	1,38	2,40
Balancing factor for P_{DC_cont} (for parallel operation at common DC bus) with mains choke			-			
Balancing factor for P_{DC_cont} (for parallel operation at common DC bus) without mains choke			-			
Monitoring value maximum DC bus voltage, switch-off threshold	$U_{DC\_limit\_max}$	V	420			
Monitoring value minimum DC bus voltage, undervoltage threshold	$U_{DC\_limit\_min}$	V	0.75 x ULN or "P-0-0114, Undervoltage threshold", if P-0-0114 > 0.75 x ULN			
Charging resistor continuous power	P_{DC_Start}	kW	0,03			
Maximum allowed external DC bus capacitance[1)]	C_{DCext}	mF	-			
Charging time at maximum allowed C_{DCext} external DC bus capacitance at U_{LN_nenn}	$t_{lade\_DC\_Cext}$	s	-			
Last modification: 2009-07-28						

1) Use assigned type of mains choke

Fig.7-42: HCS - Data of Power Section - DC bus

Data of Power Section - DC Bus

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
DC bus voltage	U_{DC}	V	ULN x 1,41			
Capacitance in DC bus	C_{DC}	mF	0,11		0,33	
DC resistance in DC bus (L+ to L-)	R_{DC}	kOhm	320,00		230,00	
Rated power (t > 10 min) at f_s = 4 kHz; U_{LN_nenn}; control factor a_0 > 0,8; with mains choke	P_{DC_cont}	kW	-			4,00
Rated power (t > 10 min) at f_s = 4 kHz; U_{LN_nenn}; control factor a_0 > 0.8; without mains choke	P_{DC_cont}	kW	0,46	0,86	1,70	2,60
Factor to reduce P_{DC_cont} at single-phase mains voltage	f_{1_3ph}		0,00			
P_{DC_cont} and P_{DC_max} vs. mains input voltage; $U_{LN} \leq U_{LN\_nenn}$		%/V	PDC_cont (ULN) = PDC_cont x [1 - (400-ULN) x 0,0025]			
P_{DC_cont} and P_{DC_max} vs. mains input voltage; $U_{LN} > U_{LN\_nenn}$		%/V	No power increase			
Maximum allowed DC bus power at U_{LN_nenn}; with mains choke	P_{DC_max}	kW	-			9,70
Maximum allowed DC bus power at U_{LN_nenn}; without mains choke	P_{DC_max}	kW	1,38	2,58	5,10	6,20
Balancing factor for P_{DC_cont} (for parallel operation at common DC bus) with mains choke			-		0,80	
Balancing factor for P_{DC_cont} (for parallel operation at common DC bus) without mains choke			-		0,50	
Monitoring value maximum DC bus voltage, switch-off threshold	$U_{DC\_limit\_max}$	V	900			
Monitoring value minimum DC bus voltage, undervoltage threshold	$U_{DC\_limit\_min}$	V	0.75 x ULN or "P-0-0114, Undervoltage threshold", if P-0-0114 > 0.75 x ULN			
Charging resistor continuous power	P_{DC_Start}	kW	0,03		0,05	0,15
Maximum allowed external DC bus capacitance[1)]	C_{DCext}	mF	1,00		3,80	4,50
Charging time at maximum allowed C_{DCext} external DC bus capacitance at U_{LN_nenn}	$t_{lade\_DC\_Cext}$	s	-			0,75
Last modification: 2009-07-28						

1) Use assigned type of mains choke

Fig.7-43: HCS - Data of Power Section - DC bus

Technical Data of the Components

7.3.4 Braking Resistor

Data of Integrated Braking Resistor

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
Braking resistor continuous power	P_{BD}	kW	0,02		0,03	
Braking resistor peak power	P_{BS}	kW	1,68			
Nominal braking resistance	$R_{DC\_Bleeder}$	ohm	100			
Braking resistor switch-on threshold - mains voltage independent[1)]	$U_{R\_DC\_On\_f}$	V	380			
Braking resistor switch-on threshold - mains voltage dependent[2)]	$U_{R\_DC\_On\_v}$		tbd			
Maximum allowed on-time duty	t_{on_max}	s	0,20			
Minimum allowed cycle time	T_{cycl}	s	16,80		11,20	
Maximum regenerative power to be absorbed	W_{R_max}	kWs	0,40			
Balancing factor for P_{BD} (for parallel operation at common DC bus)	f		-			
Cooling of integrated braking resistor			Not ventilated			Forced
Last modification: 2009-07-28						

1) 2) Factory setting

Fig.7-44: HCS - Data of Integrated Braking Resistor

Data of Integrated Braking Resistor

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Braking resistor continuous power	P_{BD}	kW	0,02	0,03	0,05	0,15
Braking resistor peak power	P_{BS}	kW	4,00		7,20	10,60
Nominal braking resistance	$R_{DC\_Bleeder}$	ohm	180		100	68
Braking resistor switch-on threshold - mains voltage independent[1)]	$U_{R\_DC\_On\_f}$	V	820			
Braking resistor switch-on threshold - mains voltage dependent[2)]	$U_{R\_DC\_On\_v}$		130% of parameter P-0-0815, max. 820V			
Maximum allowed on-time duty	t_{on_max}	s	0,20		0,32	0,28
Minimum allowed cycle time	T_{cycl}	s	40,00	26,70	45,40	20,00
Maximum regenerative power to be absorbed	W_{R_max}	kWs	0,80		2,25	3,00
Last modification: 2009-07-28						

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Balancing factor for P_{BD} (for parallel operation at common DC bus)	f		0,80			
Cooling of integrated braking resistor			Forced			
						Last modification: 2009-07-28

1) 2) Factory setting
Fig.7-45: HCS - Data of Integrated Braking Resistor

7.3.5 Inverter

Data of Power Section - Inverter

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
Allowed switching frequencies [1]	f_s	kHz	4, 8, 12, 16			
Output voltage, fundamental wave with open-loop operation	U_{out_eff}	V	~ UDC x 0,71			
Output voltage, fundamental wave with closed-loop operation	U_{out_eff}	V	~ UDC x 0,71			
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-phase (10-90%)[2]	dv/dt	kV/µs	5,00			
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-ground (10-90%)[3]	dv/dt	kV/µs	5,00			
Output frequency range at f_s = 4 kHz	f_{out_4k}	Hz	0...400			
Output frequency range at f_s = 8 kHz	f_{out_8k}	Hz	0...800			
Output frequency range at f_s = 12 kHz	f_{out_12k}	Hz	0...1200			
Output frequency range at f_s = 16 kHz	f_{out_16k}	Hz	0...1600			
Output frequency threshold to detect motor standstill[4]	f_{out_still}	Hz	4			
Maximum output current at f_s = 4 kHz	I_{out_max4}	A	3,3	6,0	9,0	13,0
Maximum output current at f_s = 8 kHz	I_{out_max8}	A	3,3	6,0	9,0	13,0
Maximum output current at f_s = 12 kHz	I_{out_max12}	A	3,3	6,0	9,0	13,0
Maximum output current at f_s = 16 kHz	I_{out_max16}	A	3,3	6,0	9,0	13,0
						Last modification: 2009-07-28

Technical Data of the Components

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
Allowed continuous output current at f_s = 4 kHz	I_{out_cont4}	A	1,4	2,3	3,0	4,4
Allowed continuous output current at f_s = 8 kHz	I_{out_cont8}	A	1,0	1,8	2,6	4,2
Allowed continuous output current at f_s = 12 kHz[5)]	I_{out_cont12}	A	0,6	1,2	1,7	2,7
Allowed continuous output current at f_s = 16 kHz[6)]	I_{out_cont16}	A	0,5	0,8	1,1	1,9
Allowed continuous output current at f_s = 4 kHz; output frequency $f_{out} < f_{out\_still}$	$I_{out\_cont0Hz\_4}$	A	1,1	2,1	3,0	4,4
Allowed continuous output current at f_s = 8 kHz; output frequency $f_{out} < f_{out\_still}$	$I_{out\_cont0Hz\_8}$	A	0,9	1,6	2,2	3,1
Allowed continuous output current at f_s = 12 kHz; output frequency $f_{out} < f_{out\_still}$[7)]	$I_{out\_cont0Hz\_12}$	A	0,5	1,0	1,4	2,0
Allowed continuous output current at f_s = 16 kHz; output frequency $f_{out} < f_{out\_still}$[8)]	$I_{out\_cont0Hz\_16}$	A	0,4	0,7	0,8	1,3
Assigned output filters at nom. data; f_s = 4 kHz			tbd			
Last modification: 2009-07-28						

1) Also depending on firmware and control section; see parameter description "P-0-0001, Switching frequency of the power output stage"; see "P-0-4058, Amplifier type data"
2) 3) Guide value, see following note
4) See following note regarding reduction output current
5) 6) 7) 8) See parameter description "P-0-0556, Config word of axis controller", load-depending reduction of PWM frequency fs

Fig.7-46: HCS - Data of Power Section - Inverter

Data of Power Section - Inverter

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Allowed switching frequencies [1)]	f_s	kHz	4, 8, 12, 16			
Output voltage, fundamental wave with open-loop operation	U_{out_eff}	V	~ UDC x 0,71			
Output voltage, fundamental wave with closed-loop operation	U_{out_eff}	V	~ UDC x 0,71			
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-phase (10-90%)[2)]	dv/dt	kV/µs	5,00			
Last modification: 2009-07-28						

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Rise of voltage at output with U_{LN_nenn} and 15 m motor cable length phase-ground (10-90%)[3)]	dv/dt	kV/µs	5,00			
Output frequency range at f_s = 4 kHz	f_{out_4k}	Hz	0...400			
Output frequency range at f_s = 8 kHz	f_{out_8k}	Hz	0...800			
Output frequency range at f_s = 12 kHz	f_{out_12k}	Hz	0...1200			
Output frequency range at f_s = 16 kHz	f_{out_16k}	Hz	0...1600			
Output frequency threshold to detect motor standstill[4)]	f_{out_still}	Hz	4			
Maximum output current at f_s = 4 kHz	I_{out_max4}	A	5,0	8,0	18,0	28,0
Maximum output current at f_s = 8 kHz	I_{out_max8}	A	4,2	6,2	12,1	20,1
Maximum output current at f_s = 12 kHz	I_{out_max12}	A	3,2	4,5	9,0	12,8
Maximum output current at f_s = 16 kHz	I_{out_max16}	A	2,2	2,7	5,8	9,0
Allowed continuous output current at f_s = 4 kHz	I_{out_cont4}	A	2,0	2,7	7,6	11,5
Allowed continuous output current at f_s = 8 kHz	I_{out_cont8}	A	1,6	2,3	6,1	9,1
Allowed continuous output current at f_s = 12 kHz[5)]	I_{out_cont12}	A	1,0	1,5	4,1	5,5
Allowed continuous output current at f_s = 16 kHz[6)]	I_{out_cont16}	A	0,7	1,0	2,5	3,8
Allowed continuous output current at f_s = 4 kHz; output frequency $f_{out} < f_{out\_still}$	$I_{out\_cont0Hz\_4}$	A	1,8	2,7	7,6	11,5
Allowed continuous output current at f_s = 8 kHz; output frequency $f_{out} < f_{out\_still}$	$I_{out\_cont0Hz\_8}$	A	1,3	1,9	3,0	5,5
Allowed continuous output current at f_s = 12 kHz; output frequency $f_{out} < f_{out\_still}$[7)]	$I_{out\_cont0Hz\_12}$	A	0,8	1,2	1,8	2,8

Last modification: 2009-07-28

Technical Data of the Components

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Allowed continuous output current at f_s = 16 kHz; output frequency $f_{out} < f_{out\_still}$ 8)	$I_{out\_cont0Hz\_16}$	A	0,6	0,8		1,6
Assigned output filters at nom. data; f_s = 4 kHz			tbd			
Last modification: 2009-07-28						

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

2) 3) Guide value, see following note

4) See following note regarding reduction output current

5) 6) 7) 8) See parameter description "P-0-0556, Config word of axis controller", load-depending reduction of PWM frequency fs

Fig.7-47: HCS - Data of Power Section - Inverter

Guide value "Rise of voltage at output"

Observe that the load at the motor is almost independent of the power section used.

Especially when using **standard motors**, make sure that they comply with the occurring voltage load.

Observe the information contained in the chapter "Third-Party Motors at IndraDrive Controllers" in the Project Planning Manual of the drive system.

Reduced output current at motor standstill

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

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

8 Cables, Accessories, Additional Components

8.1 Overview

8.1.1 Cables

Motor power cables	See index entry "Cables → Motor power cables, selection table"
Encoder cables	See index entry "Cables → Encoder cables, selection table"
Multi-Ethernet cables	• RKB0011 (To connect the drive system to the higher-level control unit) • RKB0013 (To connect devices arranged side by side) See also index entry "Cables → RKB0011" or "Cables → RKB0013"

Fig.8-1: Cables - Overview

8.1.2 Accessories

Accessories		Note
HAS09 (Mounting and connection accessories)	• Screws for mounting the drive controller • Screws for connecting the equipment grounding conductor • Parts for shield connection and strain relief of cables (plates, screws, clips) • Adhesive labels with notes on safety in the English and French languages	Standard supply
DC bus connector	Connector for connecting • the DC buses of several HCS01.1E-W00xx-x-**03** drive controllers • an HCS01.1E-W00xx-x-**03** drive controller to a DC bus capacitor unit	To be ordered separately
Battery box for multi-turn encoder	SUP-E01-MSM-BATTERYBOX (Accessory for operating MSM motors with absolute value encoder)	To be ordered separately
Replacement battery	SUP-E03-DKC*CS-BATTRY (Replacement battery for SUP-E01-MSM-BATTERYBOX)	To be ordered separately

Fig.8-2: Accessories - Overview

8.1.3 Additional Components

Additional component	Type
Transformer	DST (autotransformer)
Mains filter	NFE NFD
Mains choke	HNL01.1E
Braking resistor	In preparation
DC bus capacitor unit	In preparation

Fig.8-3: Additional Components - Overview

8.2 Accessories

8.2.1 HAS09

The accessory contains:

- Screws for mounting the drive controller
- Screws for connecting the equipment grounding conductor
- Parts for shield connection of cables (plates, screws, clips)
- Adhesive labels with notes on safety in the English and French languages. Place the adhesive labels clearly visibly at the device or in the immediate vicinity of the device, if the adhesive labels existing at the device are hidden by neighboring devices.

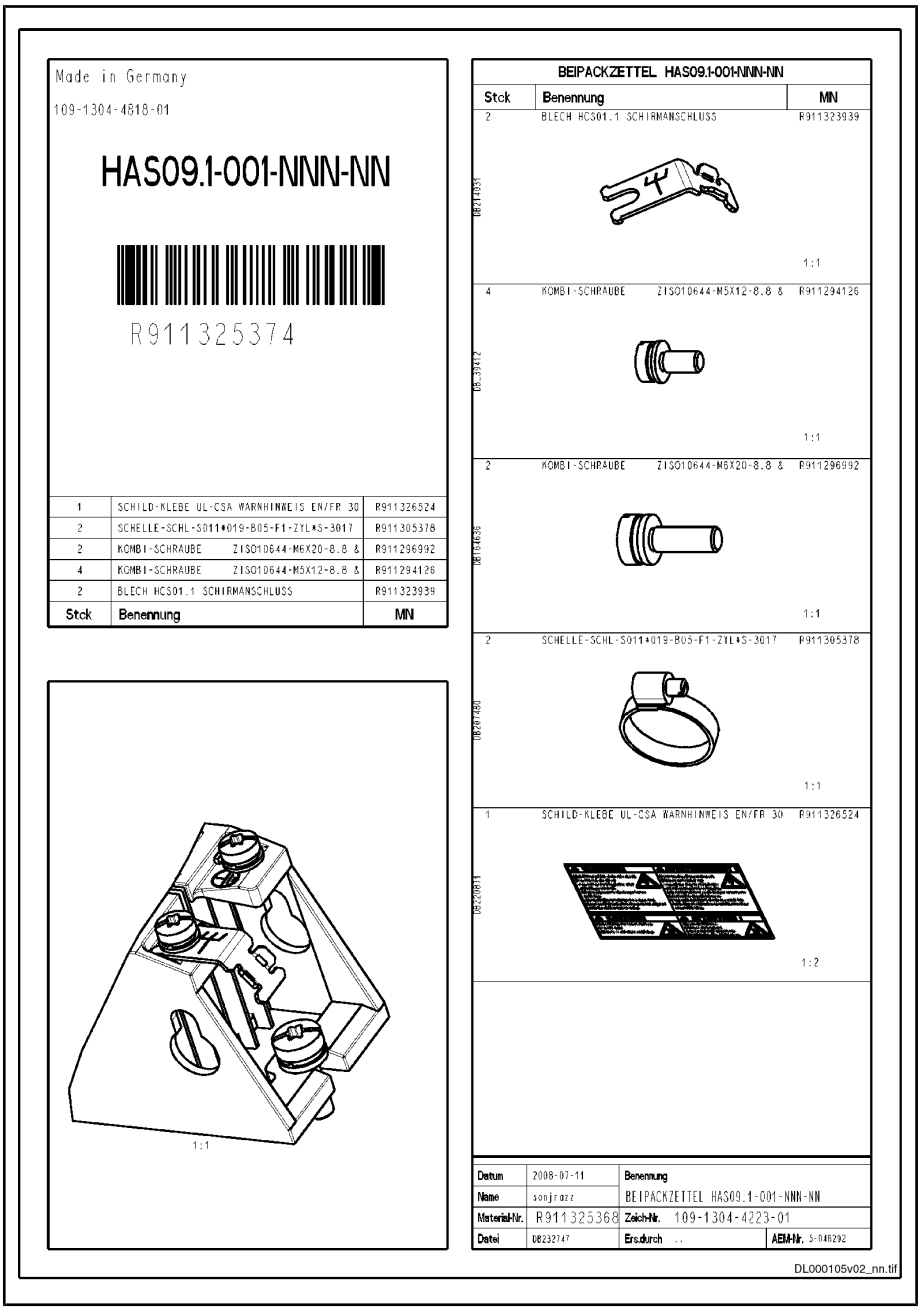


Fig.8-4: Product Insert HAS09

8.2.2 DC Bus Connector

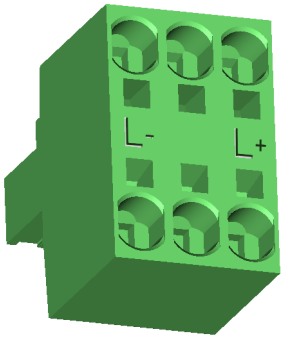
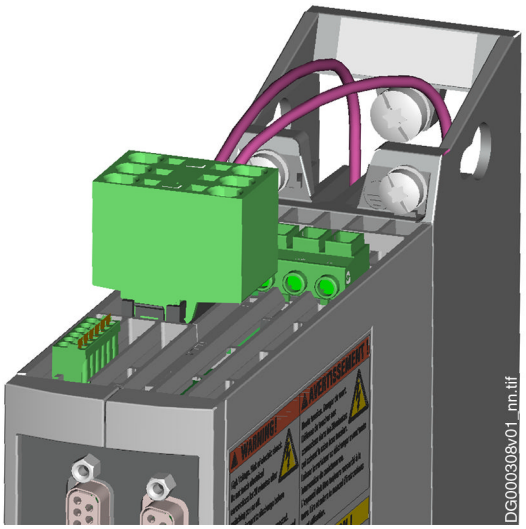
DC bus connector	DC bus connector at device (connection point X77)
 Order code: **RLS0778/K06**	

Fig.8-5: DC Bus Connector

Cables, Accessories, Additional Components

8.2.3 SUP-E01-MSM-BATTERYBOX

"SUP-E01-MSM-BATTERYBOX" is a set of accessories used to operate MSM motors with absolute value encoder and to backup the encoder data in case voltage is switched off.

Scope of Supply

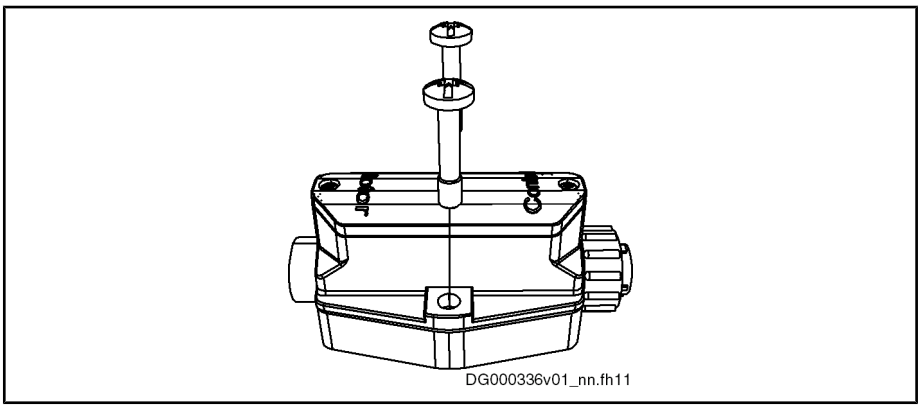


Fig.8-6: Battery Box

Battery box complete with

- Battery, type: ERC6, 3,6 V; 1800 mA, lithium
- Mounting screws: M6×30; Screw head: Torx and slot

Dimensions

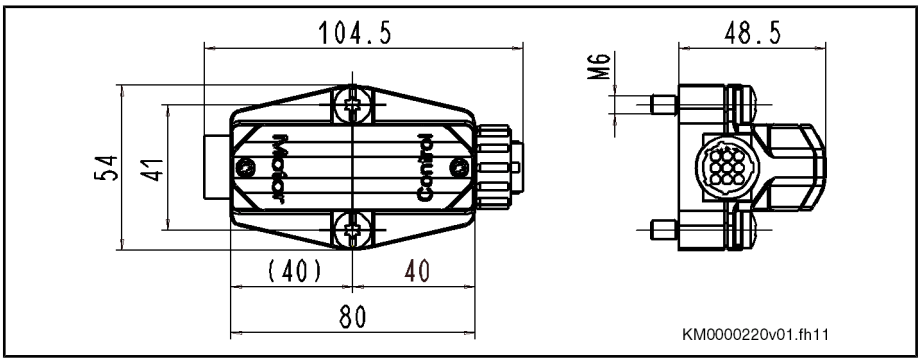


Fig.8-7: Dimensions

Weight 120 g

Mounting

Mount the battery box as near as possible to the motor (maximum distance approx. 2 m).

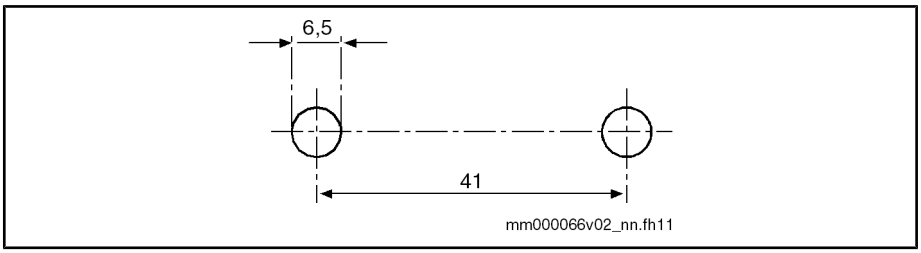


Fig.8-8: Boring Diagram for Battery Box

- Mounting screws: M6×30
- Tightening torque M_A: 3 Nm

The battery box "SUP-E01-MSM-BATTERYBOX" is supplied in ready-for-operation status with battery.

Wiring: MSM encoder plug-in connector → Battery box → HCS01

8.2.4 SUP-E03-DKC*CS-BATTRY

"SUP-E03-DKC*CS-BATTRY" contains accessories according to the enclosed product insert used to operate MSM motors with absolute value encoder. Use these accessories when it is necessary to replace the battery of the battery box "SUP-E01-MSM-BATTERYBOX".

Battery Type: ERC6, 3,6 V; 1800 mA, lithium

Resistance 10 ohm

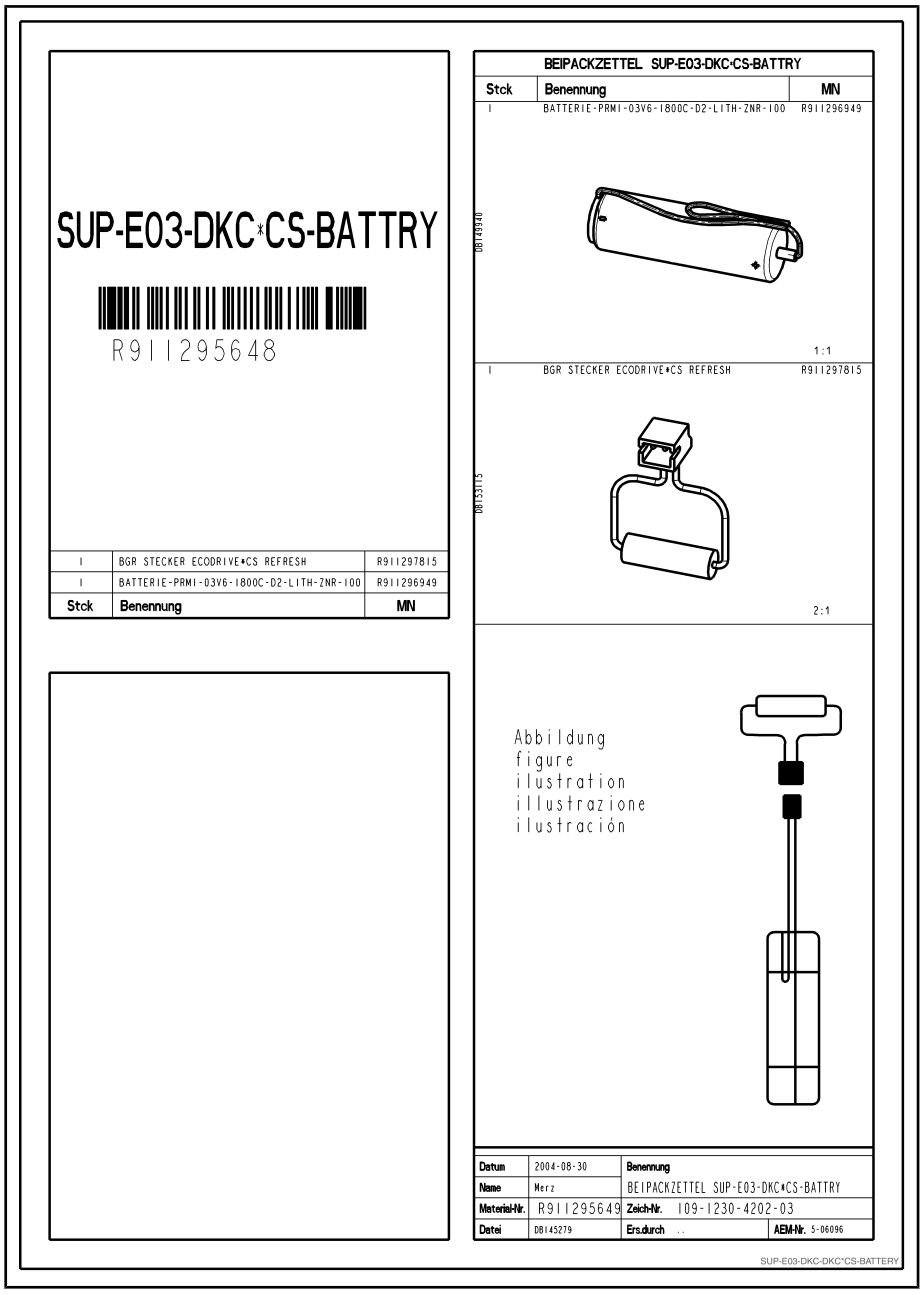
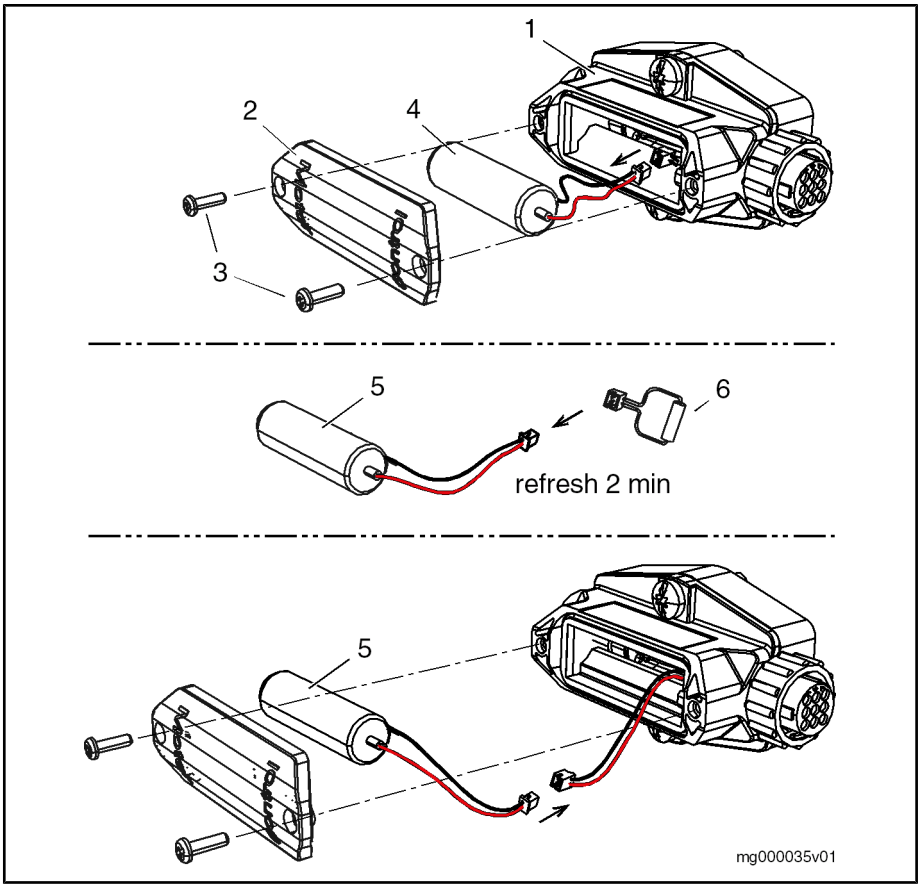


*Fig.8-9: SUP-E03-DKC*CS-BATTRY*

Refresh / Replacing the Battery **Before using a new battery, you must always carry out the so-called "refresh" procedure:**



1	Battery box housing
2	Battery box housing cover
3	Battery box housing screw (self-shaping screw 30×10; tightening torque 0.8 Nm)
4	Dispose of exhausted battery
5	Replacement battery from SUP-E03-DKC*CS-BATTRY
6	Refresh resistor from SUP-E03-DKC*CS-BATTRY

Fig.8-10: Battery Box

How to replace the battery

1. Loosen housing screws (3) of battery box (1) and remove cover (2) of battery box
2. Remove old battery (4)
3. Carry out "refresh" procedure for new battery (5): Connect battery for 2 minutes to refresh resistor
4. Insert new battery (5) into battery compartment
5. Connect connector of battery to mating connector in battery compartment
6. Put cover (2) of battery box (1) onto housing and screw down housing screws (3) with 0.8 Nm
7. Dispose of old battery (4) according to directives valid in your country

8.3 Additional Components

8.3.1 Transformers

General Information

Transformers are only needed if the mains voltage is outside of the allowed nominal voltage of the drive controller.

Grounded Mains For grounded mains, the mains voltage is adjusted to the nominal voltage of the device by means of **autotransformers** which have been dimensioned for **a specific output voltage range**.

Ungrounded Mains For voltage adjustment of ungrounded mains, always connect **isolating transformers** to prevent overvoltages between outer conductor and ground.

Cables, Accessories, Additional Components

Autotransformers for Drive Controllers

Types

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	T	R	A	F	O		D	S	T		•	4	,	0	0	/	L	/	3	8	0	,	4	1	5	,	4	4	0	-	2	2	0				1	0	M	M

1. Object
1.1 Transformer . . . . = TRAFO

2. Product
2.1 DST . . . . . = DST

3. Nominal power
3.1 2.0 kVA . . . . . = •2,00
3.2 2.5 kVA . . . . . = •2,50
3.3 4.0 kVA . . . . . = •4,00
3.4 5.0 kVA . . . . . = •5,00
3.5 7.5 kVA . . . . . = •7,50
3.6 10.0 kVA . . . . . = 10,00
3.7 12.5 kVA . . . . . = 12,50
3.8 15.0 kVA . . . . . = 15,00
3.9 18.0 kVA . . . . . = 18,00
3.10 20.0 kVA . . . . . = 20,00
3.11 25.0 kVA (for vertical mounting **only**) . . . . . = 25,00
3.12 35.0 kVA (for vertical mounting **only**) . . . . . = 35,00
3.13 50.0 kVA (for vertical mounting **only**) . . . . . = 50,00

4. Construction (design)
4.1 Suitable for mounting into IP55 housing . . . . . = G
4.2 Horizontal mounting . . . . . = L
4.3 Vertical mounting . . . . . = S

5. Nominal input voltage (phase-phase)
5.1 e.g., AC 380 V, AC 415 V, AC 440 V . . . . . = 380, 415, 440

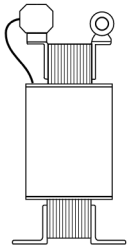
6. Nominal output voltage (phase-phase)
6.1 e.g., AC 230 V . . . . . = 220

7. Special design
7.1 Does not apply to standard transformers.
7.2 Frequency: e.g., 100 Hz . . . . . = 100HZ
7.3 Max. line diameter: e.g., 10 mm^2 . . . . . = 10MM
7.4 Degree of protection: e.g., IP23, in protective housing ST0 . . . . . = IP23
7.5 Nema type . . . . . = NEMA
7.6 UL standard . . . . . = UL-N

8. Standard reference

Standard	Title	Edition
DIN EN 60529	Degrees of protection provided by enclosures (IP code) (IEC 60529:1989 + A1:1999); German version EN 60529:1991 + A1:2000	2000-09

Illustration example: DST



Note:
• = Field does not apply

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Fig.8-11: Type Code DST

Selection

Select the autotransformer according to the mains voltage and the power requirements of the installation. For the selection, proceed as follows:

1. By means of the required nominal mains voltage range from the diagram "Classification of the Three-Phase Current Autotransformers in Type Groups", determine the type group and read the transformation ratio "i".
2. Calculate the actual transformer output voltage by means of the given nominal mains voltage and the transformation ratio "i".
3. Check the drive data. The output voltage of the transformer has an effect on the drive data.
4. Select the three-phase current autotransformer for the determined mains connected load S_{LN}.

   Determining the mains connected load: See Project Planning Manual "Rexroth IndraDrive, Drive System" → "Calculations" → "Calculations for the Mains Connection" → "Calculating the Mains-Side Phase Current"

   The nominal power of the transformer must at least equal the mains connected load S_{LN}.

   For DST transformers, the nominal power is identical to the throughput rating.

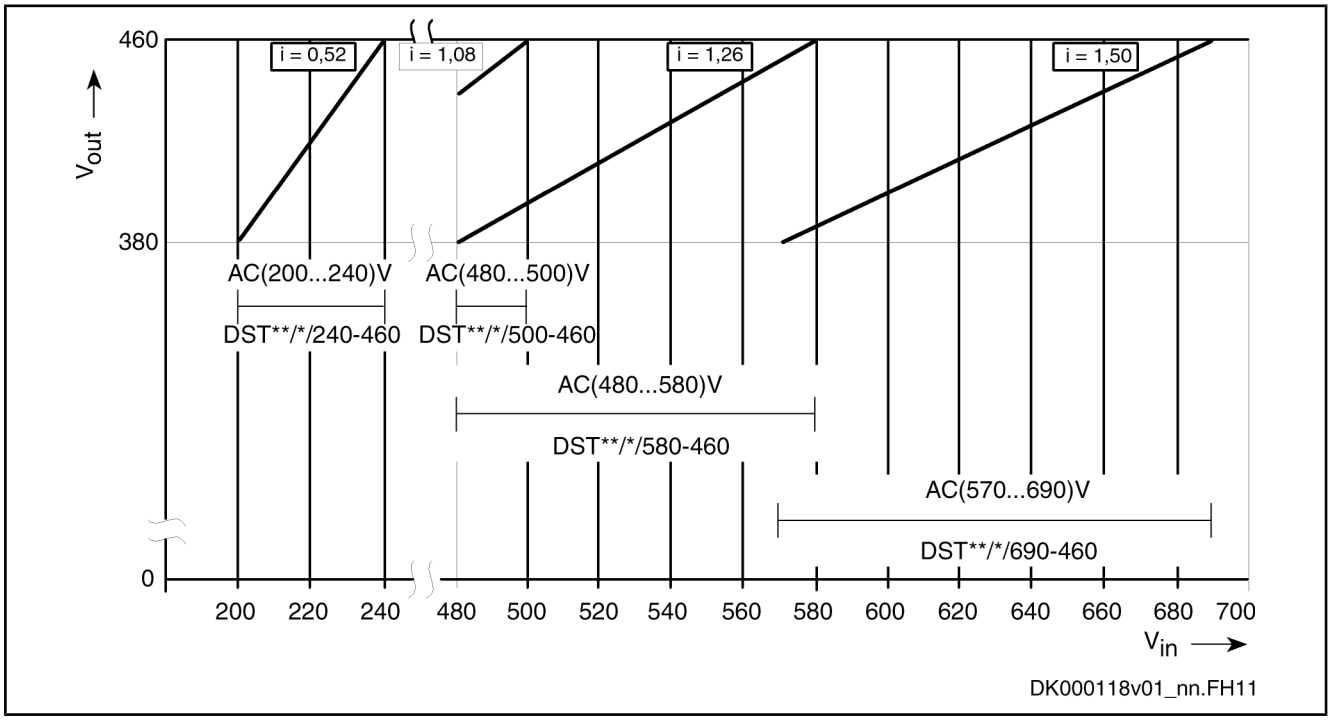


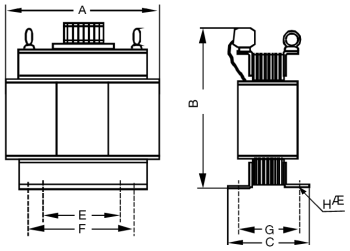
Fig.8-12: Classification of the Three-Phase Current Autotransformers in Type Groups

Cables, Accessories, Additional Components

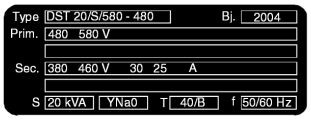
Technical Data

DST autotransformer with secondary or output voltage of AC 380 ... 460 V

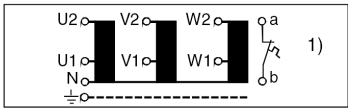
Vertical design for mounting with base: DST...../S



Type plate (example)



Circuit diagram



1)Temperature switch max. load:
DC 24V/1A; AC 230V/1A

Type designation DST...	Conn. load in kVA	Gear ratio	Dimensions in mm A	C	B	F	E	G	H∅	Power dissipation in W	Max. conn. cross section in mm²	Weight in kg
Input voltage: AC (200...240) V ±10%												
4/S/240-460	4		240	150	260	170	110	120	11	120	10	24.5
7,5/S/240-460	7.5		335	175	365	230	160	145	11	225	10	55
12,5/S/240-460	12.5	0.52	360	190	395	250	170	160	11	310	10	70
25/S/240-460	25		480	195	500	356	-----	158	13	500	35	135
50/S/240-460	50		580	265	540	400	270	215	18	750	70	195
Input voltage: AC (480...500) V ±10%												
4/S/500-460	4		180	105	190	125	80	75	7	160	4	8.5
7,5/S/500-460	7.5		205	130	210	145	95	95	7	260	4	13
12,5/S/500-460	12.5	1.08	240	140	260	170	110	110	11	440	10	22
25/S/500-460	25		300	155	325	210	140	125	11	750	16	36
50/S/500-460	50		335	175	365	230	160	145	11	1050	35	53
Input voltage: AC (480...580) V ±10%												
4/S/580-460	4		240	130	260	170	110	100	11	140	4	18
7,5/S/580-460	7.5		240	140	260	170	110	110	11	260	4	22
12,5/S/580-460	12.5	1.26	300	155	325	210	140	125	11	375	10	37
25/S/580-460	25		360	190	395	250	170	160	11	625	10	72
50/S/580-460	50		420	215	450	280	190	155	14	1000	35	95
Input voltage: AC (570...690) V ±10%												
4/S/690-460	4		240	140	260	170	110	110	11	140	10	22
7,5/S/690-460	7.5		300	155	325	210	140	125	11	225	10	37
12,5/S/690-460	12.5	1.5	335	175	365	230	160	145	11	375	10	57
25/S/690-460	25		420	205	450	280	190	145	14	500	16	88
50/S/690-460	50		480	222	500	356	-----	185	13	750	35	178

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Fig.8-13: DST Autotransformers for Drive Controllers for Mains Voltage Adjustment

8.3.2 Mains Filters NFD / NFE

Type Code NFE / NFD

NFE01.1 - Mains Filter, Single-Phase

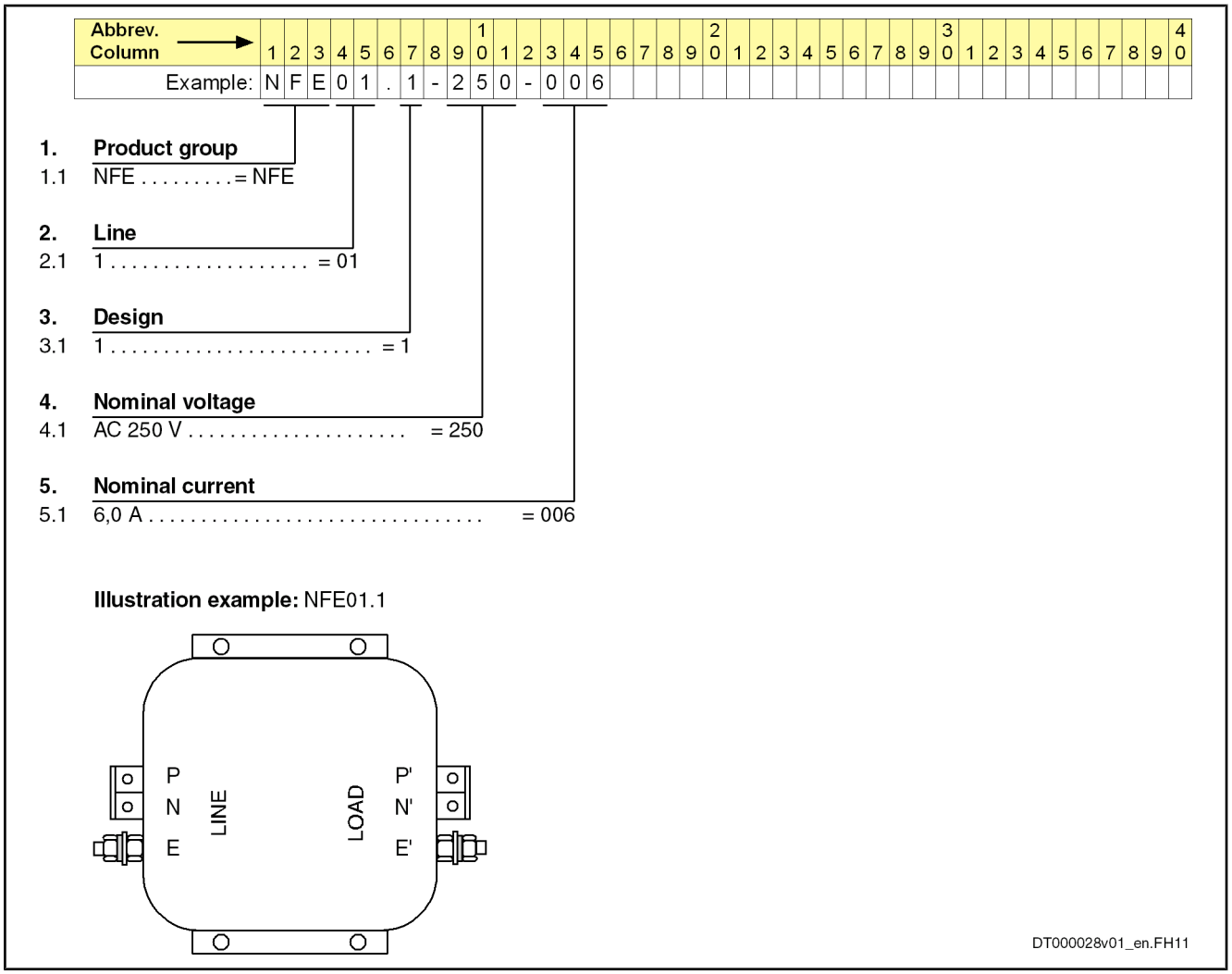

Fig.8-14: Type Code NFE01.1

Cables, Accessories, Additional Components

NFE02.1 - Mains Filter, Single-Phase

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

1. Product group
1.1 NFE . . . . . = NFE

2. Line
2.1 2 . . . . . = 02

3. Design
3.1 1 . . . . . = 1

4. Nominal voltage
4.1 AC 230 V . . . . . = 230

5. Nominal current
5.1 8,0 A . . . . . = 008

Illustration example: NFE02.1

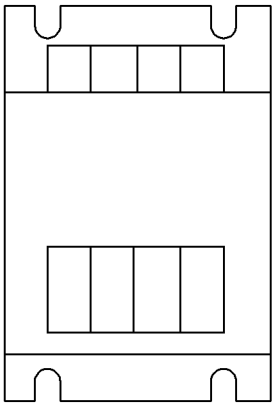

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Fig.8-15: Type Code NFE02.1

NFD03.1 - Mains Filter, 3-Phase

Abbrev. Column →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Example:	N	F	D	0	3	.	1	-	4	B	0	-	0	0	7																											

1. Product group
1.1 NFD . . . . . = NFD

2. Line
2.1 3 . . . . . = 03

3. Design
3.1 1 . . . . . = 1

4. Nominal voltage
4.1 AC 115 to 480 V . . . . . = 480

5. Rated current
5.1 7 A . . . . . = 007
5.2 16 A . . . . . = 016
5.3 30 A . . . . . = 030
5.4 55 A . . . . . = 055
5.5 75 A . . . . . = 075
5.6 130 A . . . . . = 130
5.7 180 A . . . . . = 180

Illustration example: NFD03.1

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Fig.8-16: Type Code NFD03.1

Cables, Accessories, Additional Components

Mechanical Data NFE / NFD

NFE01.1

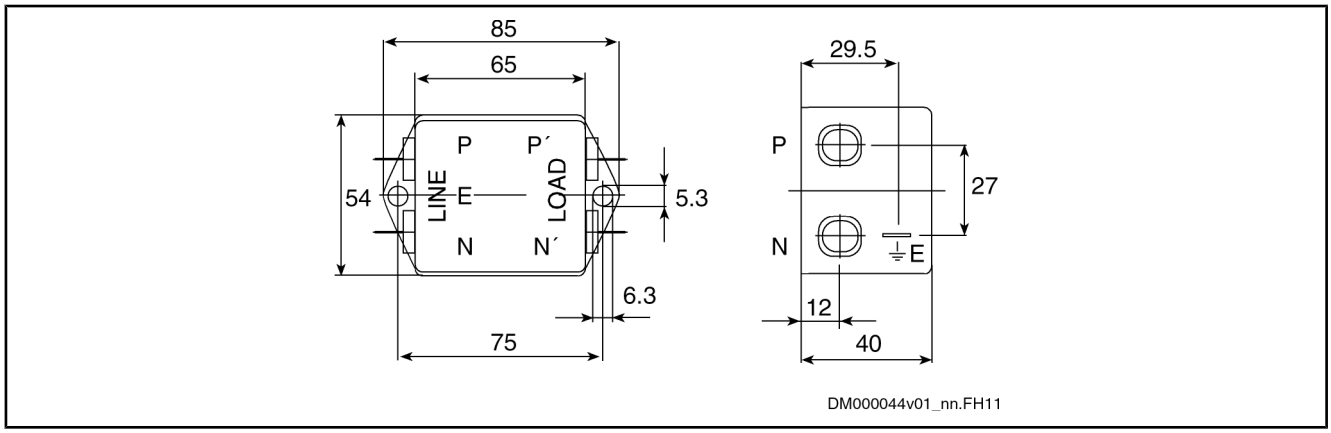
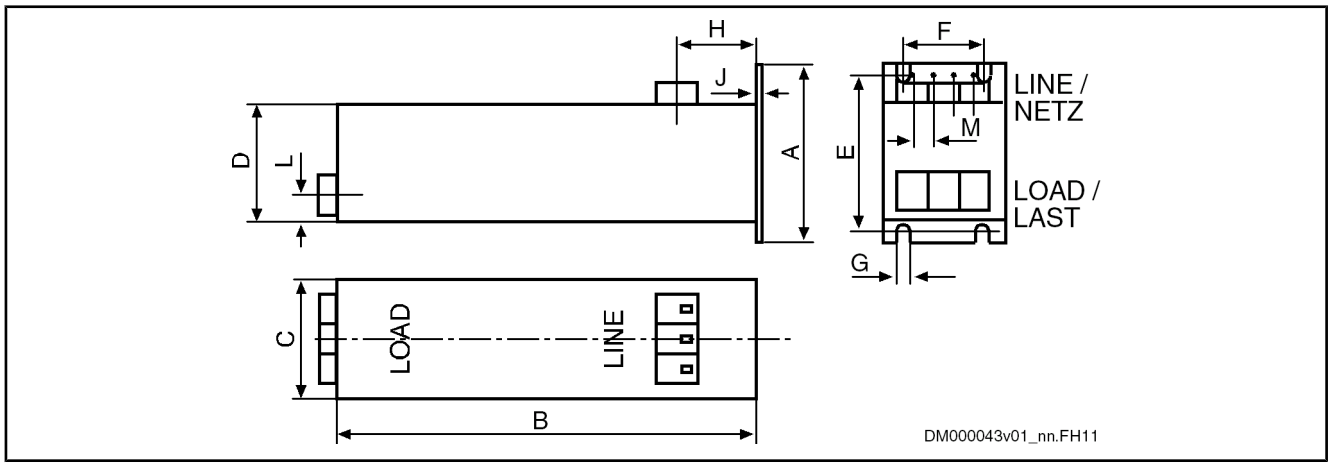


Fig.8-17: Single-Phase Filter NFE01.1-250-006 for Interference Suppression of Power Supply Unit NTM

☞ The mains filter is connected by means of tab receptacles (b = 6.3 mm, d = 1 mm).

NFE02.1



Type NFE02.1-230-008 (with 3 terminal connectors)

Fig.8-18: Single-Phase Filter NFE02.1 for Drives

NFD03.1

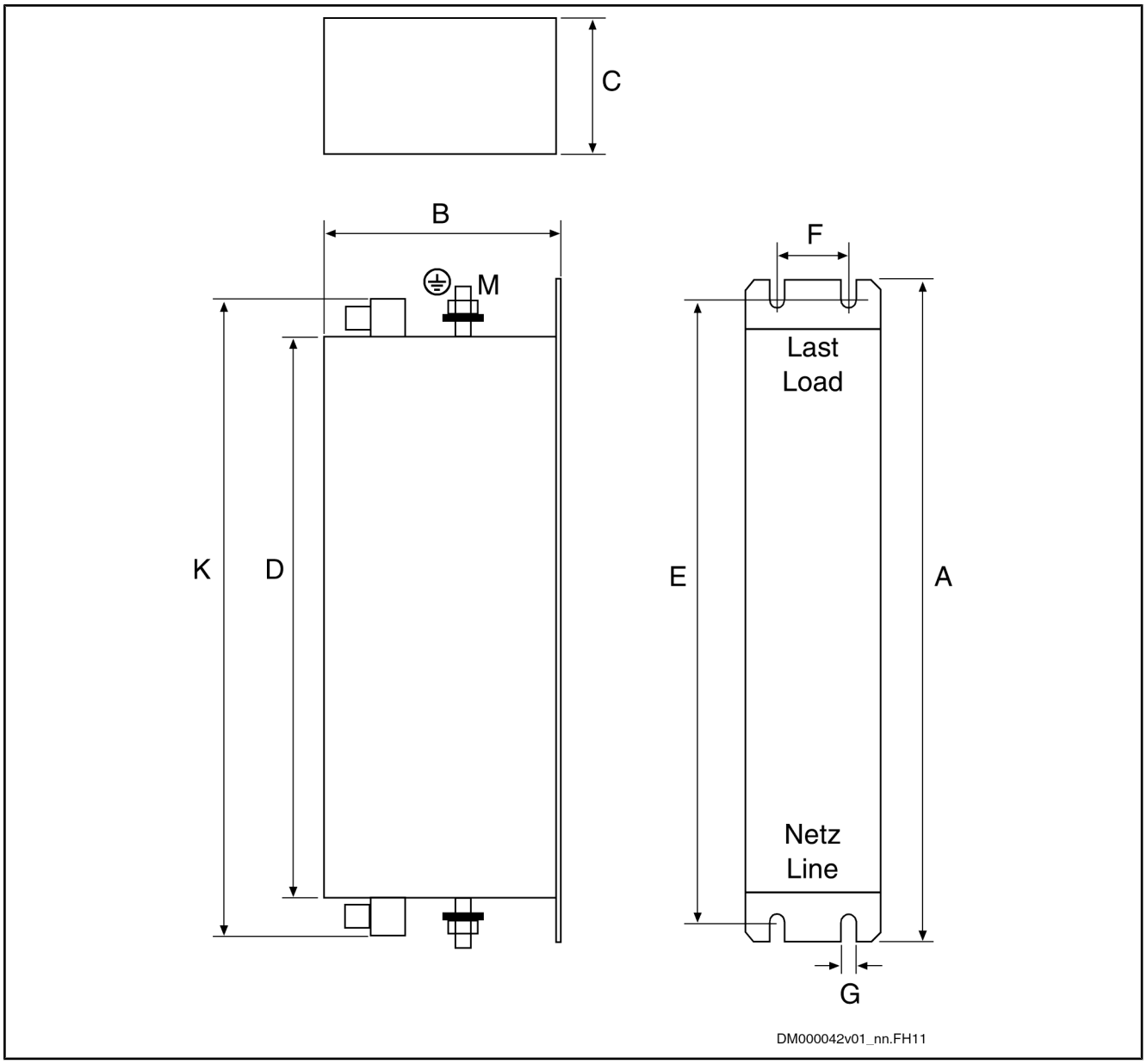


Fig.8-19: Three-Phase Current Filter NFD03.1 for Drives

Tolerance limits for NFD03.1:

- The dimensions B, C, D, K are maximum values. They can be reduced up to 15 mm.
- The ground studs M can also be arranged horizontally (protruding from the mounting flange), instead of vertically (as illustrated above).

Mains filter type	A	B	C	D	E	F	G	H	J	K	L	M	M_{AE}	M_{AKI}
NFD 03.1-480-007	190	90	50	160	180	20	5,4	–	–	190	–	M5	2,2	0,8
NFD 03.1-480-016	250	90	55	220	235	25	5,4	–	–	250	–	M5	2,2	0,8
NFD 03.1-480-030	270	100	60	240	255	30	5,4	–	–	270	–	M5	2,2	2
NFD 03.1-480-055	250	105	90	220	235	60	5,4	–	–	260	–	M6	4	2,2

Cables, Accessories, Additional Components

Mains filter type	A	B	C	D	E	F	G	H	J	K	L	M	M_{AE}	M_{AKI}
NFD 03.1-480-075	270	145	90	240	255	60	6,5	–	–	280	–	M6	4	4,5
NFD 03.1-480-130	270	160	100	240	255	65	6,5	–	–	330	–	M10	18	8
NFD 03.1-480-180	380	180	130	350	365	102	6,5	–	–	455	–	M10	18	20
NFE 02.1-230-008	90	210	60	60	80	40	5,3	40	0,75	–	15	10	0,8	0,8
NFE 01.1-250-006	See drawing													

M_{AE} Maximum tightening torque of the ground stud in Nm
M_{AKI} Maximum tightening torque of the terminal in Nm
Fig.8-20: Dimensions of the Mains Filters NFD/NFE

Electrical Data NFE / NFD

Using mains filters in mains grounded via outer conductor

When using mains filters NFD03 in **mains grounded via outer conductor**, use an isolating transformer between mains and mains filter.

Maximum mains connection voltage of mains 50 … 60 Hz U_N	Nominal mains current I_{nenn} (1)	Number of phases	Mains filter type	Terminal connectors (3)			Power dissipation approx.	Weight	Type of construction
In V	In A			Flexible [mm^2]	Rigid [mm^2]	AWG	W	kg	
AC 480V +10%	7	3	NFD 03.1-480-007	4 (3)	6 (3)	AWG 12	3,9	0,7	Vertical
AC 480V +10%	16	3	NFD 03.1-480-016	4 (3)	6 (3)	AWG 12	6,4	1,0	Vertical
AC 480V +10%	30	3	NFD 03.1-480-030	10	16	AWG 6	11,9	1,4	Vertical
AC 480V +10%	55	3	NFD 03.1-480-055	16	25	AWG 4	25,9	2,0	Vertical
AC 480V +10%	75	3	NFD 03.1-480-075	25	35	AWG 3	30,4	3,5	Vertical
AC 480V +10%	130	3	NFD 03.1-480-130	50	50	AWG 1/0	38	4,7	Vertical
AC 480V +10%	180	3	NFD 03.1-480-180	95	95	AWG 4/0	61	10	Vertical
AC 230V +10%	7,5	1	NFE 02.1-230-008	4 (3)	6 (3)	AWG 10	7,2	1,1	Vertical
AC 230 V +10%	4,7	1	NFE 01.1-250-006 (2)	Tab connectors 6.3 × 0.8 mm			4	0,245	Horizontal

NFD Three-phase filter
NFE Single-phase filter
(1) Mains-side maximum continuous current at 45 °C ambient temperature
(2) Only use for interference suppression of the power supply unit NTM
(3) For the equipment grounding conductor, connect a conductor cross section of 10 mm2 by means of terminal pin or ring cable lug
Fig.8-21: Technical Data

Operating frequency	From 0–60 Hz at 45 °C
Power dissipation	Measured 2 or 3 × $RI^2_{\text{Nenn DC}}$
Temperature range	-25 … +85 °C
Overload	1.5 × I_{Nenn} 1 minute per hour or 4 × I_{Nenn} for 10 s
Effective attenuation	Frequency range 0.15–30 MHz
Saturation behavior	Reduction of filter attenuation by 6 dB at 2.5-fold to 3-fold nominal current
Test voltage	L/N → PE or L → PE: DC 2700 V, 2 s at 25 °C L/ N → L: DC 2100 V, 2 s at 25 °C
Current reduction in the case of overtemperature	See formula for reduction in chapter "Calculations"
Leakage current at 50 Hz	Symmetrical three-phase operation: Typ. 30 mA Single-phase operation or in the case of tripped fuses of a phase: Typ. 175 … 190 mA
Degree of protection	IP 20, except for NFE01.1-250-006: IP 10

Fig.8-22: Technical Data

Cables, Accessories, Additional Components

8.3.3 Mains Chokes

Type Code

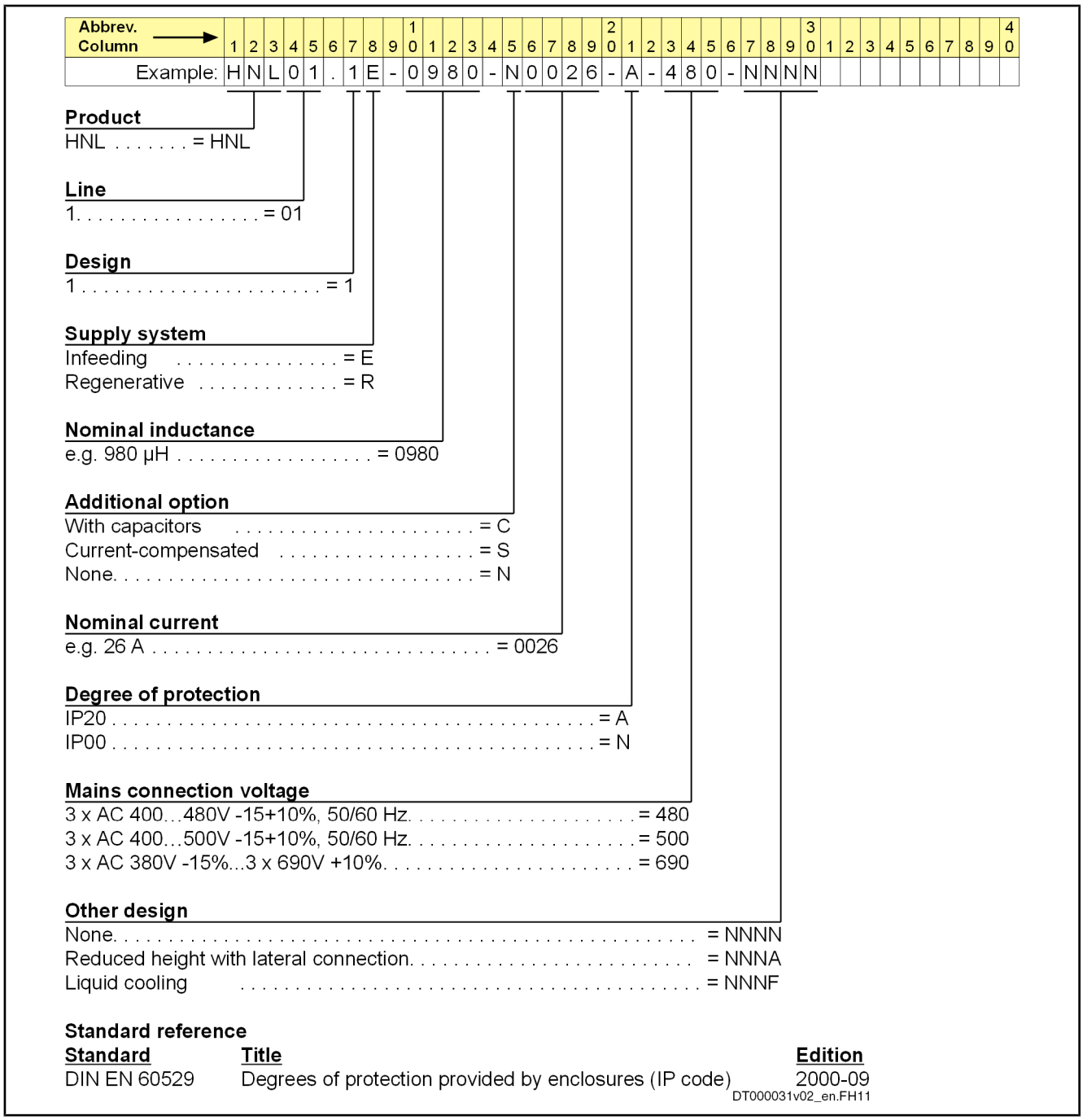
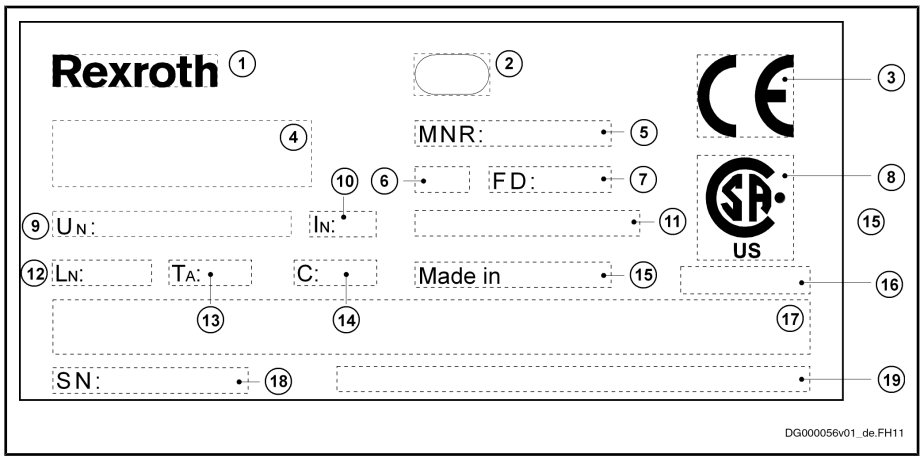


Fig.8-23: Type Code

Type Plate



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

Fig.8-24: Type Plate

Cables, Accessories, Additional Components

HNL01.1E - Mains Chokes, Infeeding

Technical Data

Mechanical System and Mounting

Dimensions Type 1:

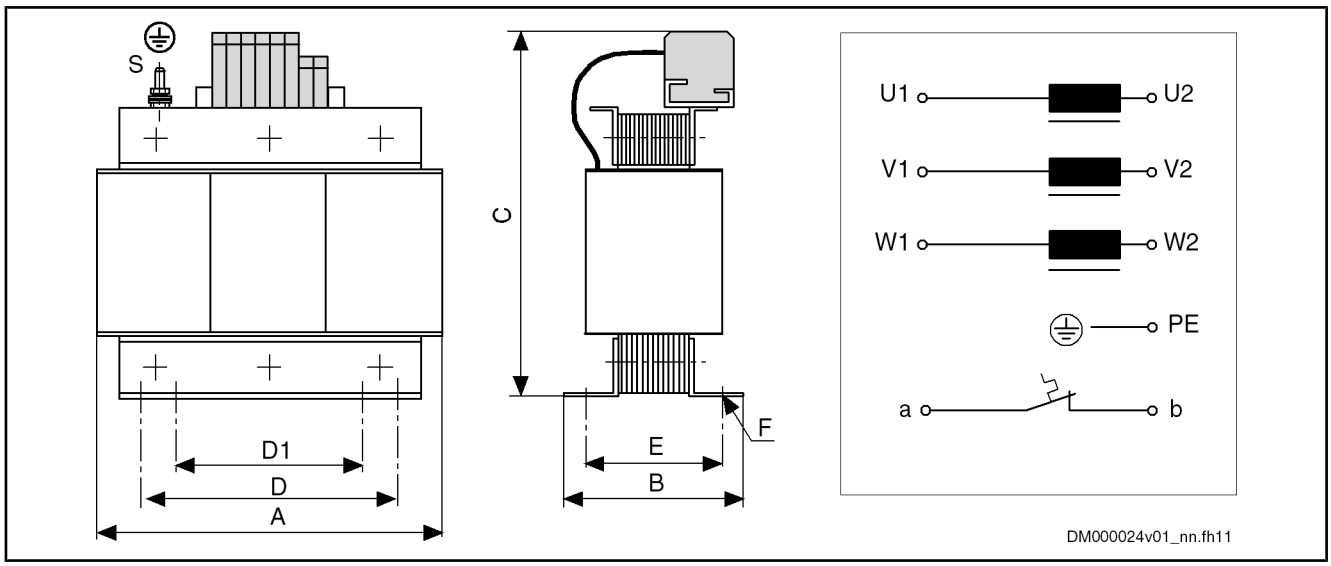


Fig.8-25: Dimensions Type 1

Mains choke	Type	Dimensions [mm]										Weight [kg]
		A	B	C	D	D1	E	F 1)	G	H	S	
HNL01.1E-1000-N0012-A-500-NNNN	1	120	61	164	81	-	44	6,4 × 11	-	-	M5	2,7

1) Long hole in "B" direction

Fig.8-26: Dimensions, Weight

Mains choke	Connection cross section mm² /AWG		Tightening torque Nm	
	U1, V1, W1 U2, V2, W2	a, b	U1, V1, W1 U2, V2, W2	a, b
HNL01.1E-1000-N0012-A-500-NNNN	4	4	Observe the data imprinted on the component.	

Fig.8-27: Connection Cross Section, Tightening Torque

Basic Data

Mains choke	U_N [V]	I_N [A]	L_N [µH]	P_V [W]	I_{max} [A]	L_{min} At I_{max}
HNL01.1E-1000-N0012-A-500-NNNN	500	12	3 × 1000	40	25	50% of LN

Fig.8-28: Electrical Data

Temperature Contact a, b

Switching capacity	Switching temperature
1 A / AC 250 V DC 24 V	125 °C HNL01.1E mains chokes of type 1 are equipped with a temperature contact (a, b), types 2, 3 and 4 are not.

Fig.8-29: Temperature Contact

8.3.4 External Braking Resistor

Requirements

Requirements on External Braking Resistor

Description	Symbol	Unit	HCS01.1E-W0003-_-02	HCS01.1E-W0006-_-02	HCS01.1E-W0009-_-02	HCS01.1E-W0013-_-02
Resistance value of external braking resistor[1)]	$R_{DC\_Bleeder}$	ohm	100,0			
Assigned braking resistor type HLR01[2)]			tbd			
						Last modification: 2009-07-28

1) See Parameter Description "P-0-0858, Data of external braking resistor"
2) See also Project Planning Manual "Additional Components"

Fig.8-30: HCS - Requirements on External Braking Resistor

Requirements on External Braking Resistor

Description	Symbol	Unit	HCS01.1E-W0005-_-03	HCS01.1E-W0008-_-03	HCS01.1E-W0018-_-03	HCS01.1E-W0028-_-03
Resistance value of external braking resistor[1)]	$R_{DC\_Bleeder}$	ohm	180,0		100,0	68,0
Assigned braking resistor type HLR01[2)]			tbd			
						Last modification: 2009-07-28

1) See Parameter Description "P-0-0858, Data of external braking resistor"
2) See also Project Planning Manual "Additional Components"

Fig.8-31: HCS - Requirements on External Braking Resistor

8.3.5 DC Bus Capacitor Unit

In preparation

9 Environmental Protection and Disposal

9.1 Environmental Protection

9.1.1 Production Processes

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

9.1.2 Prohibited Substances

We guarantee that our products do not contain any of the substances specified in the German regulation of prohibited chemicals ("Chemikalien-Verbotsverordnung"). We furthermore declare that our products are free of mercury, asbestos, PCB and chlorinated hydrocarbons.

9.1.3 No Release of Hazardous Substances

Our products do not contain any hazardous substances which may be released in the case of appropriate use. Accordingly, our products will normally not have any negative effect on the environment.

9.1.4 Principal Components

The principal components contained in our products are listed below:

Electronic devices	Motors
• steel • aluminum • copper • synthetic materials • electronic components and modules	• steel • aluminum • copper • brass • magnetic materials • electronic components and modules

Fig.9-1: Principal components

9.2 Disposal

9.2.1 Return of 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.

Furthermore, the products returned for disposal 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

9.2.2 Packaging Materials

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

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

9.2.3 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, the products must be disassembled into individual modules.

Metals contained in electric and electronic modules can also be recycled by means of special separation processes. The synthetic materials remaining after these processes can be thermally recycled.

If the products contain batteries or accumulators, these have to be removed before recycling and disposed of.

10 Service and Support

Our service helpdesk at out headquarters in Lohr, Germany, will assist you with all kinds of enquiries. Out of helpdesk hours please contact our German service department directly.

	Helpdesk	Service Hotline Germany	Service Hotline Worldwide
Time [1]	Mo-Fr 7:00 am - 6:00 pm CET	Mo-Fr 6:00 pm - 7:00 am CET Sa-Su 0:00 am - 12:00 pm CET	Outwith Germany please contact our sales/service office in your area first. For hotline numbers refer to the sales office addresses on the Internet.
Phone	+49 (0) 9352 40 50 60	+49 (0) 171 333 88 26 or +49 (0) 172 660 04 06	
Fax	+49 (0) 9352 40 49 41	–	
e-mail	service.svc@boschrexroth.de	–	
Internet	http://www.boschrexroth.com You will also find additional notes regarding service, maintenance (e.g. delivery addresses) and training.		

1) Central European Time (CET)

Preparing Information

For quick and efficient help please have the following information ready:

- detailed description of the fault and the circumstances
- information on the type plate of the affected products, especially type codes and serial numbers
- your phone, fax numbers and e-mail address so we can contact you in case of questions.

11 Appendix

11.1 Emitted Harmonics on Mains Current and Mains Voltage

11.1.1 General Information

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.

11.1.2 Harmonics of Mains Current

11.1.3 Harmonics on Mains Voltage

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, one device 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 and 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, you should, if possible, not connect capacitors or compensation units (capacitor batteries) directly to the mains. If capacitors or compensation units are absolutely required, you should only connect them to the mains via chokes.

11.2 Determining the Leakage Capacitance

The capacitances which generate so-called leakage currents against ground at the outputs of inverters are regarded as leakage capacitance C_{ab}. The decisive values for the total value C_{ab_g} of the leakage capacitance are:

- Capacitances of output filters
- Capacitances of power cables (capacitance per unit length against shield and ground wire)
- Capacitances of motors (winding capacitance against housing)

The leakage capacitance consists of the values of power cable and motor of all individual drives operated at the mains filter.

Calculation:

Appendix

$$C_{ab\_g} = C_{ab\_Mg} + C_{ab\_Kg}$$

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.11-1: Total Leakage Capacitance

The total capacitance $C_{\_ab\_Mg}$ results from the sum of capacitances of the individual motors. For these individual capacitances, see documentation of the motor. For a list of selected values, see Appendix of this documentation under "Leakage Capacitances".

$$C_{ab\_Mg} = C_{ab(Motor\_1)} + C_{ab(Motor\_2)} \cdots + C_{ab(Motor\_n)}$$

$C_{ab(motor)}$ Leakage capacitance of a motor
Fig.11-2: Total Leakage Capacitance of Motor

$$C_{ab\_Kg} = C_{Y\_K\,typ\,(K1)} \times l_{(K1)} + C_{Y\_K\,typ\,(K2)} \times l_{(K2)} \cdots + C_{Y\_K\,typ\,(Kn)} \times l_{(Kn)}$$

$C_{Y\_K\,typ}$ Capacitance per unit length of cables
C_{ab_Kg} Total leakage capacitance of cables
Fig.11-3: Total Leakage Capacitance of Cables

The total capacitance $C_{\_ab\_Kg}$ consists of the sum of capacitances of the individual power cables. For the individual capacitances per unit length, see the technical data of the power cables. For a list of selected values, see Appendix of this documentation under "Leakage Capacitances".

11.3 Leakage Capacitances

11.3.1 Leakage Capacitance of Motors

The data of the typical leakage capacitance refer to the total capacitance of the power connections U, V, W against the motor housing. The tables below contain excerpts from technical data of motors:

Leakage Capacitance

Type	Leakage capacitance of the component
	C_{ab} nF
MSM019A-0300-NN-__-___	0,3
MSM019B-0300-NN-__-___	0,7
MSM031B-0300-NN-__-___	0,7
MSM031C-0300-NN-__-___	1,4
MSM041B-0300-NN-__-___	1,3
	Last modification: 2008-11-20

Fig.11-4: MSM019A-0300-NN, MSM019B-0300-NN

Appendix

Type	Leakage capacitance of the component
	C_{ab} nF
MSK030B-0900-NN-__-___-____	0,7
MSK030C-0900-NN-__-___-____	1,3
MSK040B-0450-NN-__-___-____	1,3
MSK040C-0450-NN-__-___-____	2,0
MSK043C-0600-NN-__-___-____	2,1
MSK050B-0300-NN-__-___-____	2,1
MSK050C-0300-NN-__-___-____	2,6
MSK060B-0300-NN-__-___-____	2,1
MSK060C-0300-NN-__-___-____	2,1
MSK061B-0300-NN-__-___-____	1,8
MSK061C-0300-NN-__-___-____	2,4
MSK070C-0150-NN-__-___-____	3,8
MSK070D-0150-NN-__-___-____	5,0
MSK070E-0150-NN-__-___-____	6,3
MSK071C-0200-FN-__-___-____	4,6
MSK071D-0200-FN-__-___-____	6,9
MSK071E-0200-FN-__-___-____	8,9
MSK075C-0200-NN-__-___-____	
MSK075D-0200-NN-__-___-____	4,6
MSK075E-0200-NN-__-___-____	5,8
MSK076C-0300-NN-__-___-____	6,5
MSK100A-0200-NN-__-___-____	4,8
MSK100B-0200-NN-__-___-____	10,3
MSK100C-0200-NN-__-___-____	12,8
MSK100D-0200-NN-__-___-____	17,6
MSK101C-0200-FN-__-___-____	6,2
MSK101D-0200-FN-__-___-____	13,2
MSK101E-0200-FN-__-___-____	15,2
MSK103A-0300-NN-__-___-____	1,5
MSK103B-0300-NN-__-___-____	2,1
MSK103D-0300-NN-__-___-____	6,0
	Last modification: 2008-12-10

Appendix

Type	Leakage capacitance of the component
	C_{ab} nF
MSK131B-0200-NN-__-___-____	14,3
MSK131D-0200-NN-__-___-____	27,7
	Last modification: 2008-12-10

Fig.11-5: MSK - Leakage Capacitance (Excerpt)

See also Rexroth IndraDyn - Technical Data.

11.3.2 Leakage Capacitance of Power Cables

The power cables (bulk cables) of the "RKL" line by Rexroth have the capacitances per unit length listed below. The values refer to the sum of the single capacitances of power cores 1, 2 and 3 against the overall shield.

See also Rexroth Connection Cables - Data Sheet Bulk Cables.

Data Sheet Excerpt- Bulk Cables

Type	Cross section of power core	Leakage capacitance
	mm^2	$C_{Y\_K\_typ}$ nF/m
INK0653	1,0	0,6
INK0650	1,5	0,8
INK0602	2,5	0,7
INK0603	4,0	0,8
INK0604	6,0	0,8
INK0605	10,0	1,0
INK0606	16,0	1,2
INK0607	25,0	1,1
INK0667	35,0	1,2
INK0668	50,0	1,3
		Last modification: 2007-11-08

Fig.11-6: INK - Technical Data (Excerpt)

Data Sheet Excerpt- Bulk Cables

Type	Cross section of power core	Leakage capacitance $C_{Y\_K\_typ}$
	mm^2	nF/m
REH0800	2,5	0,2

Fig.11-7: REH - Technical Data (Excerpt)

☞ Approximate calculation is allowed with the following values:

- Cross section 1 … 6 mm^2: 1 nF/m
- Cross section 10 … 50 mm^2: 1.2 nF/m

11.4 Discharging of Capacitors

11.4.1 Discharging of DC Bus Capacitors

In the drive system Rexroth IndraDrive, capacitors are used in the DC bus as energy stores. In drive controllers and particularly in supply units, such capacitors have already been integrated.

Energy stores maintain their energy even when the supply voltage 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 capacitors (such as DC bus capacitor units) are connected, these capacitors, too, have to be 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 supply voltage was cut off, the voltage value falls below 50 V within a discharging time of a maximum of 30 minutes.

To shorten the waiting time until voltage has fallen below 50 V, you can take the following measures:

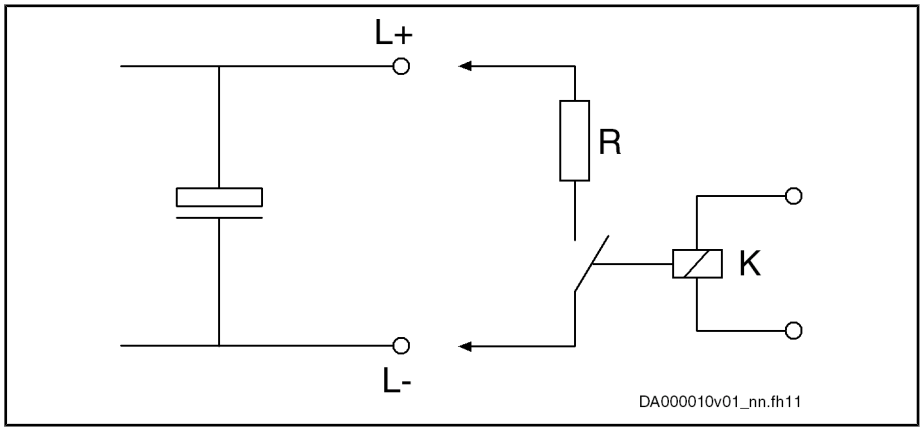
- When using HMV01 supply units (exception: HMV01.1R-W0120):

  Activate the function "ZKS" (ZKS = DC bus short circuit)
- Use the discharging device described below

11.4.2 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. 11-8: Operating Principle of Discharging Device

Appendix

Dimensioning

The individual components have to be sufficiently dimensioned:

- Value of the discharging resistor: 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 of the occurring continuous power).
- The contactor contact has to withstand the occurring direct voltage of a minimum of 1000 V.
- The contactor contact has to withstand the occurring discharge current according to the resistance value that is used, i.e. 1 A with 1000 ohm.

Installation

WARNING

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

Before working on live parts: De-energize the installation and secure the power switch against unintentional or unauthorized re-energization.

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

Check whether voltages have fallen below 50 V before touching live parts!

CAUTION

Risk of damage by intense heat!

During the discharging process, the discharging resistor generates intense heat. Therefore, place the discharging resistor as far as possible from heat-sensitive components.

How to install the discharging device

1. Preferably install discharging device **before switching on supply voltage for the first time**.

   If you install discharging device after having switched on supply voltage for the first time, wait 30 minutes to allow discharging. Check whether voltage has fallen below 50 V before touching live parts!
2. Place discharging resistor as far as possible from heat-sensitive components.

Activation

Observe the following order for activating the discharging device:

1. De-energize installation and secure power switch against unintentional or unauthorized re-energization.
2. Activate discharging device.

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Notes

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