Industrial Hydraulics | **Electric Drives and Controls** | Linear Motion and Assembly Technologies | Pneumatics | Service Automation | Mobile Hydraulics

Rexroth
Bosch Group

Rexroth Diax 04
HVE and HVR
2nd Generation Power Supply Units

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Edition 07

Application Manual

Title DIAX04
HVE and HVR
2nd Generation Power Supply Units

Type of Documentation Application Manual

Document Typecode DOK-POWER*-HVE+HVR**G2-AW06-EN-P

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Purpose of Documentation The purpose of this documentation is to ....

- choose and calculate the power supply unit for the drive controllers types DIAX04 (HDD and HDS), which is appropriate for your applications
- plan the construction of the control cabinet
- mount and connect the power supply units

Record of Revisions

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Contents

1 System overview

1.1 AC drive system

The AC drive system DIAX04, has been developed by us in a modular design so that the performance and functionality of the drives will meet your application requirements. Furthermore, it is possible for you to operate several drive controllers on one power supply unit; that is, every drive system, consisting of the power supply unit and drive and control system(s), needs only one mains connection.

This documentation describes the power supply unit types HVE and HVR from the DIAX04 family.

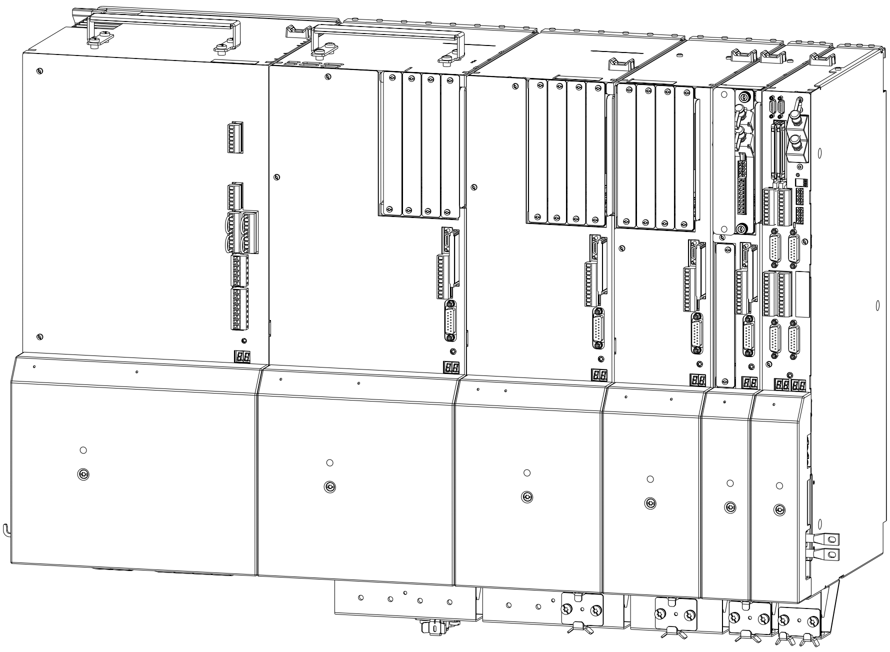

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Fig. 1-1: Exemplary structure of a modular Rexroth AC drive system

1.2 Principal working mode of the power supply units

Rectification

The 3-phase AC voltage is rectified by the power rectifier of the power supply units HVR and HVE.

The HVR power supply units provide a regulated DC bus voltage whereas the HVE power supply units provide an unregulated DC bus voltage for the drive controllers.

Generative operation

When using a HVE power supply unit and running in generator mode the regenerated energy is dissipated as heat via a bleeder resistor.

When using a HVR power supply unit and running in generator mode the energy is regenerated back into the mains.

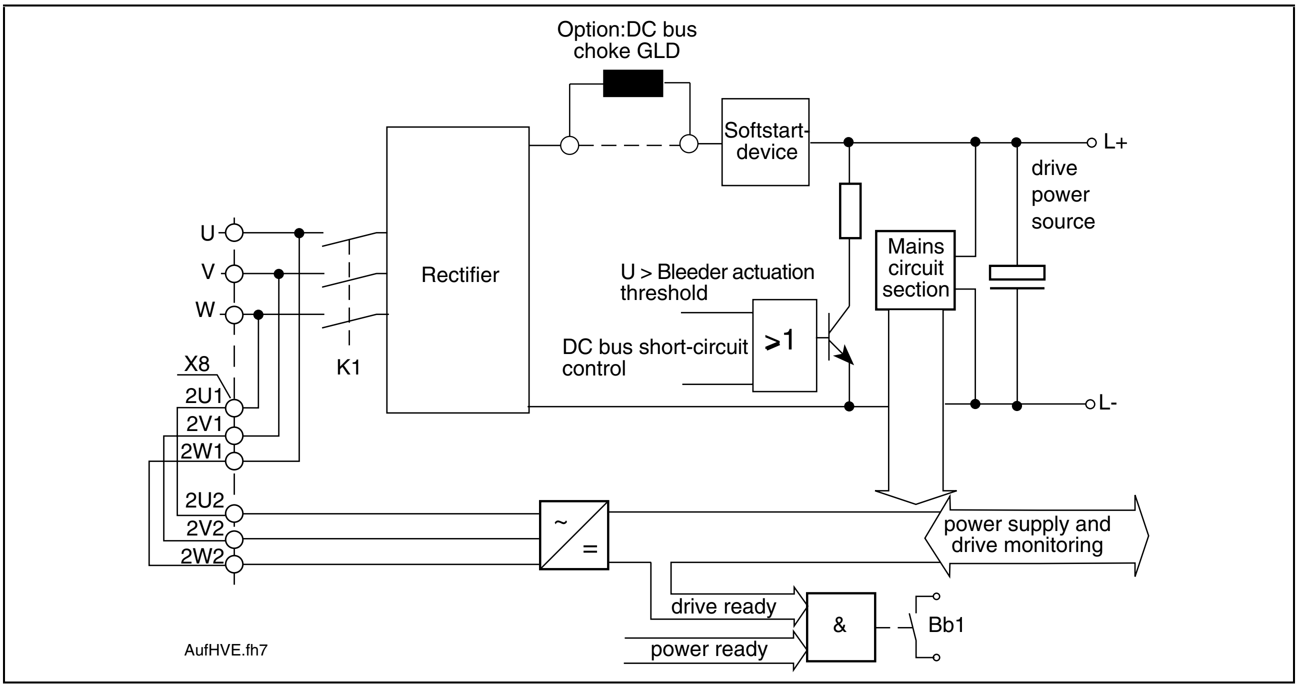


Fig. 1-2: Structure of the HVE power supply unit

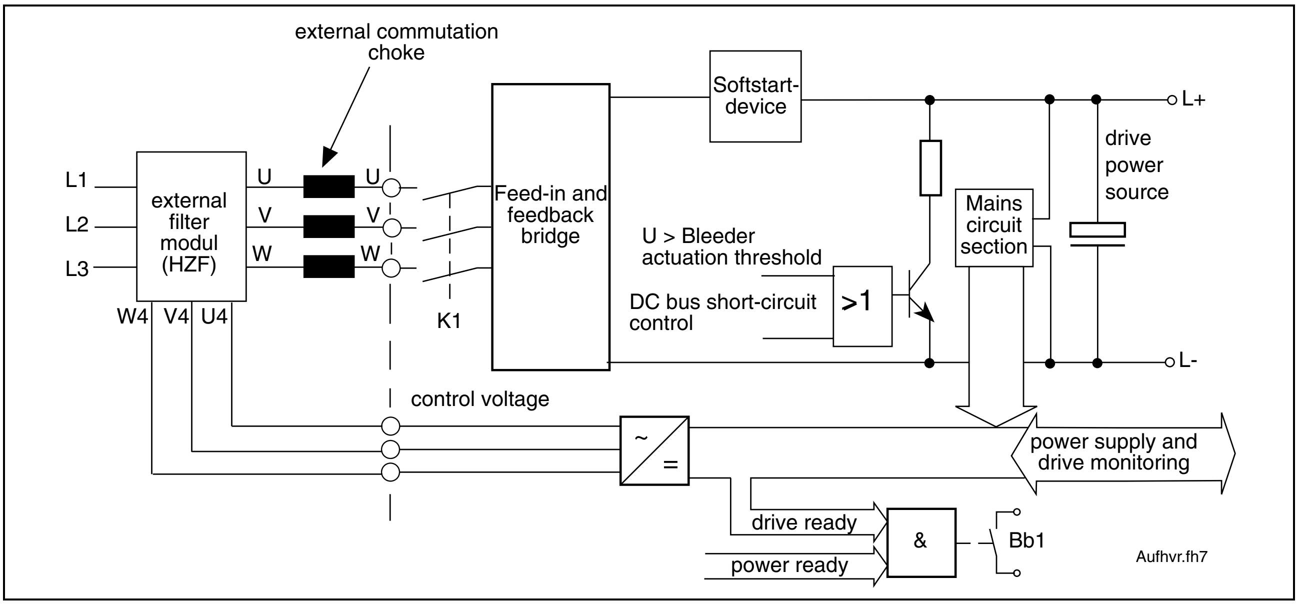


Fig. 1-3: Structure of the HVR power supply unit

Shutdown

With both power supply unit types, motors with permanent magnet energizing can be braked by the short-circuit bus also in the event of a fault in the drive electronics.

In the event of a mains failure or shut down power supply unit, motors are braked controlled by the bleeder in the HVR.

Due to the internal power contactor of the power supply units, the drive controllers can be separated from the mains.

Control voltage supply

HVR and HVE provide the control voltage for all connected drive controllers.

In the case of a mains failure, the control voltage will be provided by the DC bus voltage of the power supply unit. In regenerative mode the drive electronic remains fully operational, supplied by the DC bus voltage.

Monitoring of the drive system

HVR and HVE are equipped with substantial monitoring functions. The power supply units communicate with the drive controllers via the control bus voltage.

Most important for the functionality of the drive systems is the Bb1 contact. Once closed, the internal power contactor can be connected.

1.3 Areas of application

HVR and HVE power supply units can be connected to mains voltages consisting of 3 x AC 380 ... 480 V. They are necessary for the power and control voltage supply by Rexroth drive and control system types HDD and HDS.

Motors of a maximum continuous mechanical power of 36 kW are connected to the HVR power supply units, motors of a maximum of 60 kW can be connected to HVE power supply units.

1.4 Overview of the unit features

Direct mains connection

HVE and HVR power supply units can be connected to 3 x AC 380 ... 480 V ± 10 %, 50 ... 60 Hz power systems without the need for transformers.

Small space requirements

The high DC bus voltage permits small unit dimensions with high unit performance.

Contactor integrated into unit shuts down power

A contactor is integrated into power supply unit which shuts down the power supply.

High ON time in brake mode possible

In the case of HVR power supply units, the energy created when braking the drives is fed back into the mains with little loss.

Optimum matching of the power requirements to an application

Power supply units of the HVE and HVR line are available in six variations. This means that the power supply can be optimumly adapted to a specific application.

Regulated DC bus voltage

Power supply units of the HVR line are working with regulated DC bus voltage, i. e. drive dynamics do not drop with undervoltage.

High short-term operating load

Triple output can be generated short-term to accelerate the drives.

Safety even with faulty drive electronics

Motors with permanent magnetic excitation can be braked by unit's internal DC bus dynamic brake in the event of a fault in the drive electronics.

Charging current limits

Due to unit integrated capacitors, the energizing current does not have to be considered when the control units are chosen for the power supply. The service life of the control units is prolonged.

High load capabilities of the control voltage

Several drive modules can be connected to one power supply unit.

Ease of servicing

The connection of the signal lines is effected via plug-in terminals.

The power supply units include an alphanumeric display. This display serves for diagnostics and makes it possible to clear faults more easily.

2 Important directions for use

2.1 Appropriate use

Introduction

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

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

Note: Bosch Rexroth AG, 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 product takes the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

Areas of Use and Application

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

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

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

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

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

The drive controllers are designed for use in single or multiple-axis drive and control applications.

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

Typical applications of drive controllers are:

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

The drive controllers may only be operated under the assembly, installation and ambient conditions as described here (temperature, system of protection, humidity, EMC requirements, etc.) and in the position specified.

2.2 Inappropriate Use

Using the drive controllers outside of the above-referenced areas of application or under operating conditions other than described in the document and the technical data specified is defined as “inappropriate use".

Drive controllers may not be used if

- they are subject to operating conditions that do not meet the above specified ambient conditions. This includes, for example, operation under water, in the case of extreme temperature fluctuations or extremely high maximum temperatures or if
- Bosch Rexroth has not specifically released them for that intended purpose. Please note the specifications outlined in the general safety instructions!

3 Safety Instructions for Electric Drives and Controls

3.1 Introduction

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

Do not attempt to install or start up this equipment without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation of the equipment prior to working with the equipment at any time. If you do not have the user documentation for your equipment, contact your local Rexroth representative to send this documentation immediately to the person or persons responsible for the safe operation of this equipment.

If the equipment is resold, rented or transferred or passed on to others, then these safety instructions must be delivered with the equipment.

WARNING

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

3.2 Explanations

The safety instructions describe the following degrees of hazard seriousness in compliance with ANSI Z535. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions.

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

Fig. 3-1: Hazard classification (according to ANSI Z535)

3.3 Hazards by Improper Use

DANGER	**High voltage and high discharge current! Danger to life or severe bodily harm by electric shock!**

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

WARNING	**High electrical voltage due to wrong connections! Danger to life or bodily harm by electric shock!**

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

CAUTION	**Surface of machine housing could be extremely hot! Danger of injury! Danger of burns!**

CAUTION	**Risk of injury due to improper handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock or incorrect handling of pressurized systems!**

CAUTION	**Risk of injury due to incorrect handling of batteries!**

3.4 General Information

- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this equipment.
- Only persons who are trained and qualified for the use and operation of the equipment may work on this equipment or within its proximity.
  - The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
  - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and equipment on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The equipment is designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Use only safety features and applications that are clearly and explicitly approved in the Project Planning Manual.
  For example, the following areas of use are not permitted: construction cranes, elevators used for people or freight, devices and vehicles to transport people, medical applications, refinery plants, transport of hazardous goods, nuclear applications, applications sensitive to high frequency, mining, food processing, control of protection equipment (also in a machine).
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
  The machine and installation manufacturer must
  - make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
  - make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only permitted if the national EMC regulations for the application are met.
  The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".
  The machine or installation manufacturer is responsible for

compliance with the limiting values as prescribed in the national regulations.

- Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

3.5 Protection Against Contact with Electrical Parts

Note: This section refers to equipment and drive components with voltages above 50 Volts.

Touching live parts with voltages of 50 Volts and more with bare hands or conductive tools or touching ungrounded housings can be dangerous and cause electric shock. In order to operate electrical equipment, certain parts must unavoidably have dangerous voltages applied to them.

DANGER

High electrical voltage! Danger to life, severe bodily harm by electric shock!

⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain or repair this equipment.

⇒ Follow general construction and safety regulations when working on high voltage installations.

⇒ Before switching on power the ground wire must be permanently connected to all electrical units according to the connection diagram.

⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the ground wire is not permanently connected to the points of the components provided for this purpose.

⇒ Before working with electrical parts with voltage higher than 50 V, the equipment must be disconnected from the mains voltage or power supply. Make sure the equipment cannot be switched on again unintended.

⇒ The following should be observed with electrical drive and filter components:

⇒ Wait five (5) minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.

⇒ Never touch the electrical connection points of a component while power is turned on.

⇒ Install the covers and guards provided with the equipment properly before switching the equipment on. Prevent contact with live parts at any time.

⇒ A residual-current-operated protective device (RCD) must not be used on electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.

⇒ Electrical components with exposed live parts and uncovered high voltage terminals must be installed in a protective housing, for example, in a control cabinet.

To be observed with electrical drive and filter components:

DANGER

High electrical voltage on the housing!
High leakage current! Danger to life, danger of injury by electric shock!

⇒ Connect the electrical equipment, the housings of all electrical units and motors permanently with the safety conductor at the ground points before power is switched on. Look at the connection diagram. This is even necessary for brief tests.

⇒ Connect the safety conductor of the electrical equipment always permanently and firmly to the supply mains. Leakage current exceeds 3.5 mA in normal operation.

⇒ Use a copper conductor with at least 10 mm² cross section over its entire course for this safety conductor connection!

⇒ Prior to startups, even for brief tests, always connect the protective conductor or connect with ground wire. Otherwise, high voltages can occur on the housing that lead to electric shock.

3.6 Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 0 and 50 Volts on Rexroth products are protective low voltages designed in accordance with international standards on electrical safety.

WARNING

High electrical voltage due to wrong connections! Danger to life, bodily harm by electric shock!

⇒ Only connect equipment, electrical components and cables of the protective low voltage type (PELV = Protective Extra Low Voltage) to all terminals and clamps with voltages of 0 to 50 Volts.

⇒ Only electrical circuits may be connected which are safely isolated against high voltage circuits. Safe isolation is achieved, for example, with an isolating transformer, an opto-electronic coupler or when battery-operated.

3.7 Protection Against Dangerous Movements

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

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

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

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

DANGER

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

⇒ Ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. Unintended machine motion is possible if monitoring devices are disabled, bypassed or not activated.

⇒ Pay attention to unintended machine motion or other malfunction in any mode of operation.

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

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

⇒ Fences and coverings must be strong enough to resist maximum possible momentum, especially if there is a possibility of loose parts flying off.

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

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

⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone. Safe standstill can be achieved by switching off the power supply contactor or by safe mechanical locking of moving parts.

⇒ 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
- ensuring sufficient equilibration of the vertical axes

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

⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
- maintenance and repair work
- cleaning of equipment
- long periods of discontinued equipment use

⇒ Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such equipment cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

3.8 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated near current-carrying conductors and permanent magnets in motors represent a serious health hazard 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 electrical equipment!

⇒ Persons with heart pacemakers, hearing aids and metal implants are not permitted to enter the following areas:
- Areas in which electrical equipment and parts are mounted, being operated or started up.
- Areas in which parts of motors with permanent magnets are being stored, operated, repaired or mounted.

⇒ If it is necessary for a person with a heart pacemaker to enter such an area, then a doctor must be consulted prior to doing so. Heart pacemakers that are already implanted or will be implanted in the future, have a considerable variation in their electrical noise immunity. Therefore there are no rules with general validity.

⇒ Persons with hearing aids, metal implants or metal pieces must consult a doctor before they enter the areas described above. Otherwise, health hazards will occur.

3.9 Protection Against Contact with Hot Parts

CAUTION

Housing surfaces could be extremely hot! Danger of injury! Danger of burns!

⇒ Do not touch housing surfaces near sources of heat! Danger of burns!

⇒ After switching the equipment off, wait at least ten (10) minutes to allow it to cool down before touching it.

⇒ Do not touch hot parts of the equipment, such as housings with integrated heat sinks and resistors. Danger of burns!

3.10 Protection During Handling and Mounting

Under certain conditions, incorrect handling and mounting of parts and components may cause injuries.

CAUTION

Risk of injury by incorrect handling! Bodily harm caused by crushing, shearing, cutting and mechanical shock!

⇒ Observe general installation and safety instructions with regard to handling and mounting.

⇒ Use appropriate mounting and transport equipment.

⇒ Take precautions to avoid pinching and crushing.

⇒ Use only appropriate tools. If specified by the product documentation, special tools must be used.

⇒ Use lifting devices and tools correctly and safely.

⇒ For safe protection wear appropriate protective clothing, e.g. safety glasses, safety shoes and safety gloves.

⇒ Never stand under suspended loads.

⇒ Clean up liquids from the floor immediately to prevent slipping.

3.11 Battery Safety

Batteries contain reactive chemicals in a solid housing. Inappropriate handling may result in injuries or material damage.

CAUTION

Risk of injury by incorrect handling!

⇒ Do not attempt to reactivate discharged batteries by heating or other methods (danger of explosion and cauterization).

⇒ Never charge non-chargeable batteries (danger of leakage and explosion).

⇒ Never throw batteries into a fire.

⇒ Do not dismantle batteries.

⇒ Do not damage electrical components installed in the equipment.

Note: Be aware of environmental protection and disposal! The batteries contained in the product should be considered as hazardous material for land, air and sea transport in the sense of the legal requirements (danger of explosion). Dispose batteries separately from other waste. Observe the legal requirements in the country of installation.

3.12 Protection Against Pressurized Systems

Certain motors and drive controllers, corresponding to the information in the respective Project Planning Manual, must be provided with pressurized media, such as compressed air, hydraulic oil, cooling fluid and cooling lubricant supplied by external systems. Incorrect handling of the supply and connections of pressurized systems can lead to injuries or accidents. In these cases, improper handling of external supply systems, supply lines or connections can cause injuries or material damage.

CAUTION

Danger of injury by incorrect handling of pressurized systems!

⇒ Do not attempt to disassemble, to open or to cut a pressurized system (danger of explosion).

⇒ Observe the operation instructions of the respective manufacturer.

⇒ Before disassembling pressurized systems, release pressure and drain off the fluid or gas.

⇒ Use suitable protective clothing (for example safety glasses, safety shoes and safety gloves)

⇒ Remove any fluid that has leaked out onto the floor immediately.

Note: Environmental protection and disposal! The media used in the operation of the pressurized system equipment may not be environmentally compatible. Media that are damaging the environment must be disposed separately from normal waste. Observe the legal requirements in the country of installation.

Notes

4 Technical data

4.1 Ambient and operating conditions

Note: If the controllers are to be used outside of the indicated range, then it is necessary to take the "**load factors**" into consideration (see chapter 7.1).

Item	Symbol	Unit	Devices: **HVE0x.2-W0xxx** **HVR0x.2-W0xxN** **HZF01.1-W0xxN** **KD xx / KD xx C** **HZS01.2-W300N** **HZK02.1-W003N** **HZB02.2-W002N** **GLD xx** **SUP-E0x-HVR**
Permissible ambient temperature with rated data	T_{A1}	°C	+5....+45
Maximum permissible ambient temperature with derated data	T_{A2}	°C	+55
Storage and transport temperature	T_L	°C	-30....+85
Installation elevation above sea level without power reduction		m	1000
Installation elevation above sea level with power reduction		m	4000
Maximum permissible relative humidity		%	95
Maximum permissible absolute humidity		g/m^3	25
Protection category		--	IP10 per EN60529 / IEC529
Degree of dirt contamination		--	no dirt contamination, no condensation

Fig. 4-1: Ambient conditions

With installation elevations of more than 2000 m above sea level

For installation elevations of more than 2000 m, an overvoltage limiter for transient overvoltage 1.2/50 µs must be installed in the installation or building in order to limit the voltage

- to 1.0 kV between the outer conductors and
- to 2.5 kV between conductor-ground.

Storage of the power supply units

The power supply units contain sensitive electrolytic capacitors. Therefore, in the case of long storage periods, operate the power supply units once a year for at least 1 hour with power on (DC bus voltage must be applied).

Data for vibration test

The devices have been designed for the following test values:

Item	**Devices:** **HVE0x.2-W0xxx** **HVR0x.2-W0xxN** **HZF01.1-W0xxN** **HZS01.2-W300N** **HZK02.1-W003N** **HZB02.2-W002N** **GLD xx** **SUP-E0x-HVR**
Vibration sinus in operation according to EN 60068-2-6	
Amplitude and frequency	0,15 mm (peak-peak) at 10...57 Hz
Acceleration and frequency	1,0 g at 57...500 Hz
Vibration distortion (Random) in operation according to IEC 68-2-36	
Frequency	20...150 Hz
Spectral acceleration density amplitude	0,005 g^2/Hz, 1 g
Shock test when out of operation (Ea) according to EN 60068-2-27	
Half sine 3 x in pos., 3 x in neg. direction	10 g / 11 ms
Tip-over test when out of operation over 6 edges according to EN 60068-2-31	packaging dimensioned for tipping over each edge

Fig. 4-2: Data for vibration test

4.2 Power supply units HVE

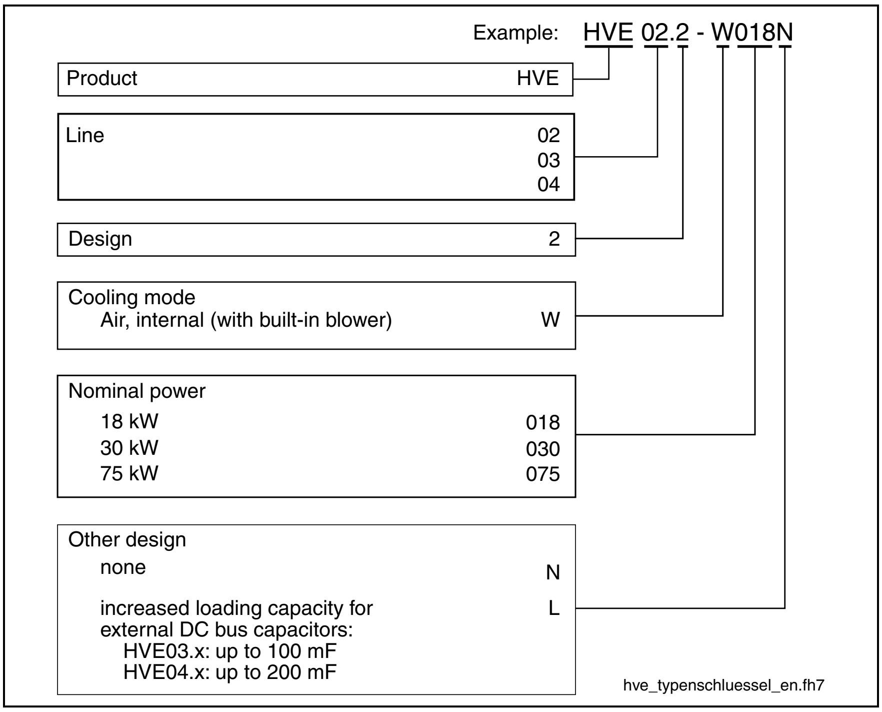


Fig. 4-3: Type code of power supply units HVE

A bleeder absorbs the energy regenerated by the HVE power supply units. Rexroth motors with a continuous mechanical power of 60 kW can be connected.

The HVE power supply units operate with unregulated DC bus voltage. The usable unit power depends on the power voltage. Therefore, power data for the connection to four mains nominal voltages are indicated:

- 3 x AC 380 V,
- 3 x AC 400 V,
- 3 x AC 440 V and
- 3 x AC 480 V.

The power supply units of the HVE series are available in three variations and 2 other types. The HVE0x.2-W0xx**N** type can, if necessary, be combined with the DC bus choke GLD. This makes an optimum adjusting to the power requirements of the application possible.

The HVE03.2-W030**L** type can charge DC bus capacitors up to 100 mF, the HVE04.2-W075**L** type can charge DC bus capacitors up to 200 mF.

Note: The types HVE03.2-W030**L** and HVE04.2-W075**L** **always have to be** combined with DC bus chokes of the GLD type. For the technical data of the DC bus choke GLD see chapter 6.2.

The HVE02.2 power supply unit is only available in type "N".

P_{ZW} [kW]	P_{KB30} [kW]	P_{KB03} [kW]	P_{BD} [kW]	P_{BS} [kW]	W_{MAX} [kWs]	**Mains supply components**	
						Power supply unit	**DC bus choke**
HVE power data when connected to 3 x AC 380 V							
12	19	36	1	100	70	HVE02.2-W018N	-
18	29	54	1	100	70	HVE02.2-W018N	GLD13
18	36	54	1,5	100	100	HVE03.2-W030N	-
28	56	84	1,5	100	100	HVE03.2-W030N/L	GLD12
33	66	99	2,5	270	250	HVE04.2-W075N	-
70	140	210	2,5	270	250	HVE04.2-W075N/L	GLD20
HVE power data when connected to 3 x AC 400 V							
13	20	39	1	100	70	HVE02.2-W018N	-
19	30	57	1	100	70	HVE02.2-W018N	GLD13
19	38	57	1,5	100	100	HVE03.2-W030N	-
30	60	90	1,5	100	100	HVE03.2-W030N/L	GLD12
35	70	105	2,5	270	250	HVE04.2-W075N	-
75	150	225	2,5	270	250	HVE04.2-W075N/L	GLD20
HVE power data when connected to 3 x AC 440 V							
14	22	42	1	100	70	HVE02.2-W018N	-
21	33	63	1	100	70	HVE02.2-W018N	GLD13
21	42	63	1,5	100	100	HVE03.2-W030N	-
32	64	96	1,5	100	100	HVE03.2-W030N/L	GLD12
38	76	114	2,5	270	250	HVE04.2-W075N	-
82	164	246	2,5	270	250	HVE04.2-W075N/L	GLD20
HVE power data when connected to 3 x AC 480 V							
15	24	45	1	100	70	HVE02.2-W018N	-
23	36	69	1	100	70	HVE02.2-W018N	GLD13
23	46	69	1,5	100	100	HVE03.2-W030N	-
35	70	105	1,5	100	100	HVE03.2-W030N/L	GLD12
42	84	126	2,5	270	250	HVE04.2-W075N	-
90	180	270	2,5	270	250	HVE04.2-W075N/L	GLD20

P_{ZW}: DC bus continuous power
P_{KB30}: DC bus short-term power (for 30 s)
P_{KB03}: DC bus peak power (for 0,3 s)
P_{BD}: bleeder continuous power
P_{BS}: bleeder peak power
W_{MAX}: maximum regenerated energy

Fig. 4-4: Power data of the HVE power supply units

To accelerate feed and spindle drives it is possible to apply the following short-term loads to the HVE as illustrated in the diagram below:

CAUTION

Damages due to an overloaded power supply unit!

⇒ Maximum short-term loads must be taken into consideration during the project planning phase and may not be exceeded.

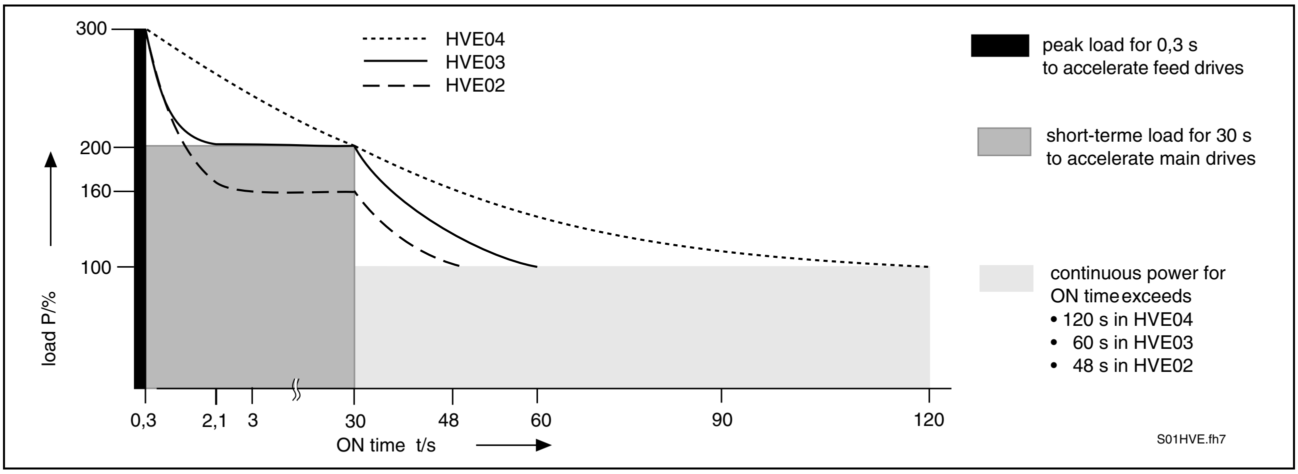


Fig. 4-5: Short-term output of the power supply units HVE02.2, HVE03.2 and HVE04.2

Designation	Symbol	Unit	Designation of the power supply unit				
			HVE02.2-W018N	HVE03.2-		HVE04.2-	
				W030N	W030L	W075N	W075L
Power supply							
Input voltage	U_{N1}	V	3 x 380 ... 480 (± 10 %)				
Frequency	f_{N1}	Hz	50 ... 60 (± 2 Hz)				
Power factor	cos φ		See Project Planning Manual "Electromagnetic Compatibility (EMC) in Drive and Control Systems", document typecode DOK-GENERL-EMV********-PRxx-xx-P				
DC bus voltage	U_{ZW}	V	530 ... 670 (± 10 %)				
Output power							
DC bus continuous power	P_{ZW}	kW	see Fig. 4-4: Power data of the HVE power supply units				
DC bus peak power (0,3 s)	P_{ZWS03}	kW					
Regenerated power (Bleeder power)							
Bleeder continuous power	P_{BD}	kW	1	1,5		2,5	
Bleeder peak power	P_{BS}	kW	100	100		270	
Maximum regenerated energy	W_{MAX}	kWs	70	100		250	
DC bus capacity							
Internal capacity (nominal)	C_{int}	mF	0,8	1,4		3,75	
Maximum DC bus capacity to be externally connected	C_{ext}	mF	10	10	100	10	200
Charging time	t_{Lade}	s	1,6	1,6	6	1,6	6
Power loss							
DC bus short-time power (for 3 s)	P_{KB3}	kW	25	60		105	
Basic losses	P_{VG}	W	125	175		175	
Power losses per kW DC bus continuous power	$P_{V/kW}$	W/kW	7	6		6	
Weight	m	kg	13	16		28	
Control voltage supply							
Input voltage	U_{N2}	V	3 x 380 ... 480 (± 10 %)				
Frequency	f_{N2}	Hz	50 ... 60 (± 2 Hz)				
Average charging current	I_{lade}	A	≤ 14				
Charging duration	t_{lade}	ms	≤ 5				
Max. current pulse/duration	i_{peak}		≤ 35 A for 0,25 ms				
Power input with maximum load	S_{N2}	VA	500				
Control voltage output	P_{St}	W	300				

Fig. 4-6: Data sheet HVE

4.3 Power supply unit HVR

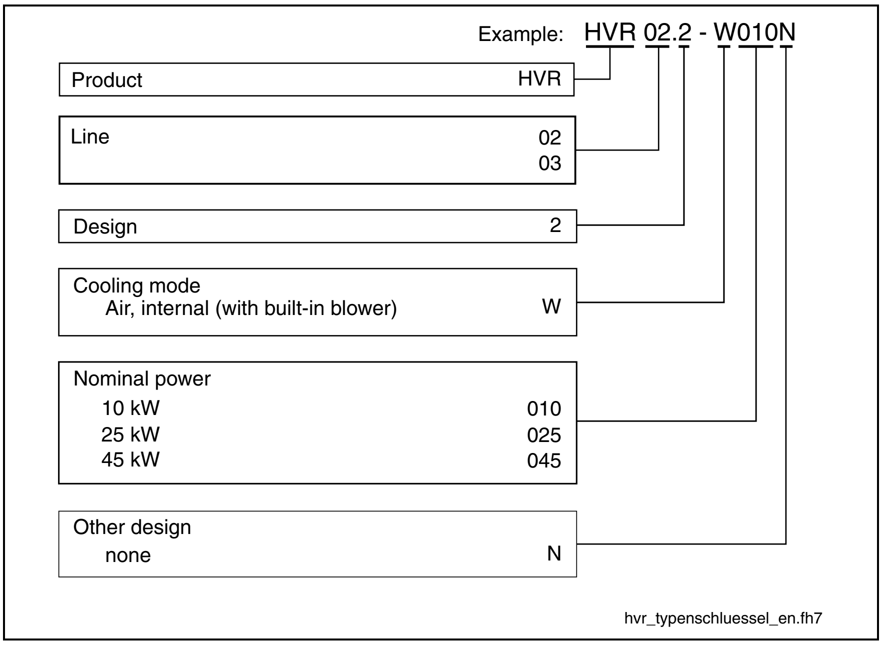


Fig. 4-7: Type code of power supply units HVR

HVR power supply units operate with regulated DC bus voltage. They can use mains voltages from 3 x AC 380 to 480 V (± 10 %).

To accelerate feed and main drives it is possible to apply the following short-term loads to the power supply units as illustrated in the diagram below.

CAUTION

Damages due to an overloaded power supply unit!

⇒ Maximum short-term loads must be taken into consideration during the project planning phase and may not be exceeded.

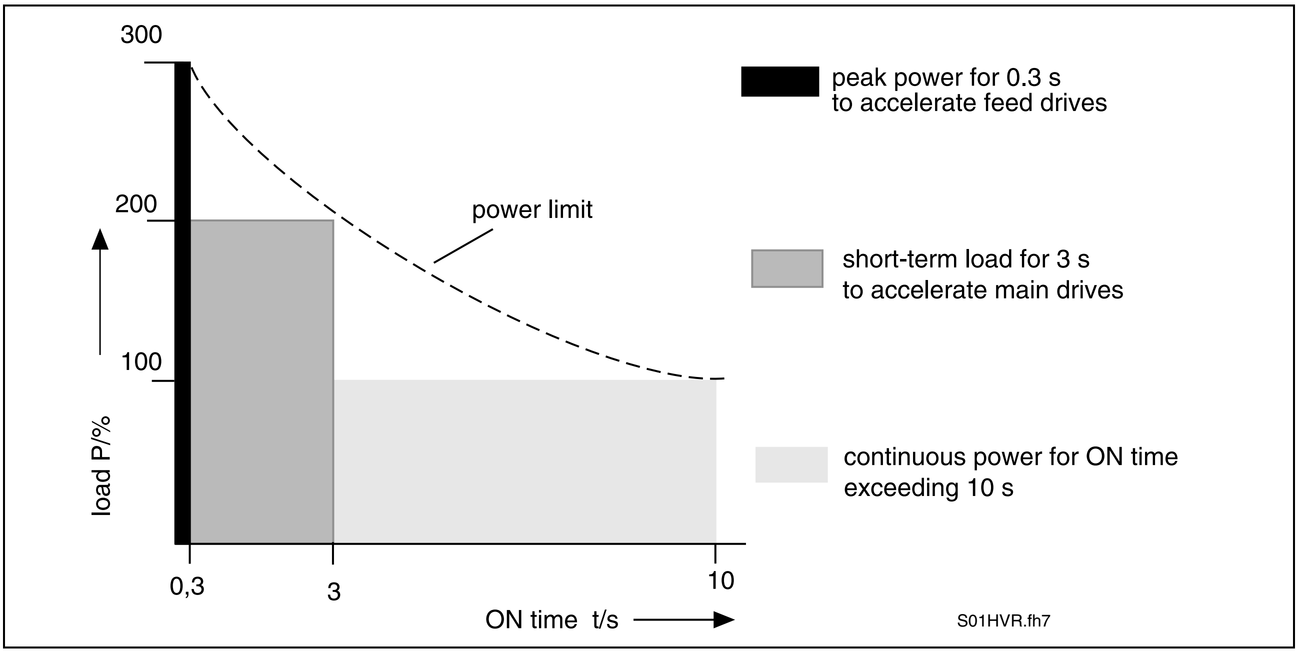


Fig. 4-8: Short-term output of the power supply unit HVR02.2 and HVR03.2

Designation	Symbol	Unit	Designation of the power supply unit		
			HVR02.2-W010N	HVR02.2-W025N	HVR03.2-W045N
Power supply					
Input voltage	U_{N1}	V	3 x 380 ... 480 (± 10 %)		
Frequency	f_{N1}	Hz	50 ... 60 (± 2 Hz)		
Power factor	cos φ		See Project Planning Manual "Electromagnetic Compatibility (EMC) in Drive and Control Systems", document typecode DOK-GENERL-EMV********-PRxx-xx-P		
DC bus voltage	U_{ZW}	V	750		
Output power (*1)					
DC bus continuous power (for U_{N1}=400 V)(*2)	P_{ZW}	kW	10	25	45
DC bus peak output (for 0,3 s)	P_{ZWS03}	kW	30	75	135
DC bus short-time power (for 3 s)	P_{KB3}	kW	25	60	105
Regenerated power (Bleeder power)					
Continuous regenerative power	P	kW	10	25	45
Peak regenerative power	P	kW	30	75	90
Bleeder continuous power	P_{BD}	kW	0 (Bleeder has been designed for Emergency Stop)		
Bleeder peak power	P_{BS}	kW	120		
Maximum regenerated energy	W_{MAX}	kWs	80		
DC bus capacity					
Internal capacity (nominal)	C_{int}	mF	0,8	1,2	2,0
Maximum DC bus capacity to be externally connected	C_{ext}	mF	20	20	20
Power loss					
Power loss at max. continuous output (without bleeder losses)	P_V	W	300	750	1350
Basic losses	P_{VG}	W	150		
Power losses per kW DC bus continuous power	$P_{V/kW}$	W/kW	15	24	27
Weight	m	kg	21	21	31

Control voltage supply			
Input voltage	U_{N2}	V	3 x 380 ... 480 (± 10 %)
Frequency	f_{N2}	Hz	50 ... 60 (± 2 Hz)
Average charging current	I_{lade}	A	≤ 14
Charging duration	t_{lade}	ms	≤ 5
Max. current pulse/duration	i_{peak}		≤ 35 A for 0,25 ms
Power input with maximum load	S_{N2}	VA	500
Control voltage output	P_{St}	W	300

(*1): The same values apply to feeding and regeneration

(*2): With mains voltages of less than 400 V, the DC bus continuous power is reduced according to the relation: $P_{ZW} * \frac{U_{N1}}{400\ V}$

(*3): With installation elevations of more than 2000 m, additional external components must be used for voltage limitation (1,5 kV). Depending on the applicable regulation (DIN 0110, CSA, NEMA), an isolating transformer may be required for voltage limitation.

Fig. 4-9: Data sheet HVR

4.4 Commutation choke KD

Item	Symbol	Unit	Commutation choke		
			KD 27 KD 27 C	KD 28 KD 28 C	KD 30 KD 30 C
Continuous nominal current	I_{nenn}	A	45	80	18
Inductance at I_{nenn}	L_{nenn}	mH	0,7	0,5	1,0
Operating frequency	f	Hz	50...60 (±2 Hz)		
Power loss					
Basic losses	P_{VG}	W	250	300	150
Load dependent losses	$P_{V/kW}$	W/kW	10	7	15
Total power loss at maximum continuous power of the connected supply unit	P_V	W	500	600	300
Weight	m	kg	22	42	8

Basic losses: arise with existing DC bus voltage; drives in "AF"; drive is shut down
Load dependent losses: arise per kW DC bus power
Power loss: (total losses) the same values apply to feeding and regeneration

Fig. 4-10: Commutation choke KD

Note: Commutation chokes of the KD xx C type are required for operating HVR on asymmetric mains together with SUP-E0x-HVR!

4.5 Combining filter HZF

Type code

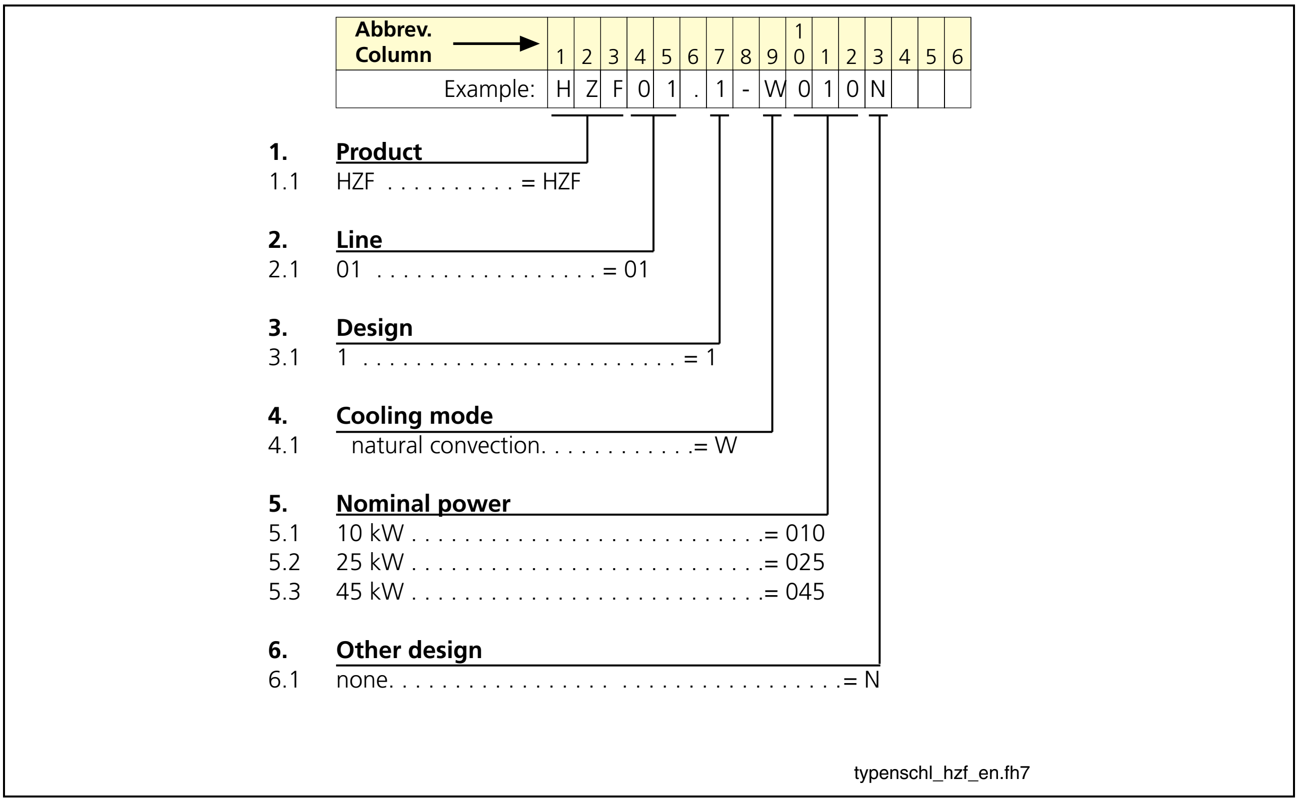


Fig. 4-11: Type code

Technical data

Item	Symbol	Unit	Commutation choke		
			HZF01.1-W010N	HZF01.1-W025N	HZF01.1-W045N
Continuous nominal current	I_{nenn}	A	18	45	80
Operating frequency	f	Hz	50...60 (± 2 Hz)		
Power loss					
Basic losses	P_{VG}	W	100	150	200
Load dependent losses	$P_{V/kW}$	W/kW	10	6,0	4,5
Total power loss at maximum continuous power of the connected supply unit	P_V	W	200	300	400
Weight	m	kg	18	22	25

Basic losses: arise with existing DC bus voltage; drives in "AF"; drive is shut down
Load dependent losses: arise per kW DC bus power
Power loss: (total losses) the same values apply to feeding and regeneration

Fig. 4-12: Data sheet combining filter HZF

4.6 Tests and certifications

CE Mark

CEf1.fh7

Fig. 4-13: CE Mark

C-UL-US listing

In accordance with UL508 C

The devices are C-UL-US listed under the item "Rexroth".

Listed component	UL file number
HVR02.2-W010N, -W025N, HVR03.2-W045N	E 134201
HVE02.2-W018N, HVE03.2-W030x, HVE04.2-W075x	
HZF01.1-W010N, -W025N, -W045N	E 64388

Fig. 4-14: C-UL listing

Tests

High-voltage test	according to EN50178 routine test with DC 2800 V / 1 s
Insulation test	according to EN50178 routine test with DC 500 V / 1 s
Separation between the electrical circuits of the control and high voltage power	safe separation according to EN50178
Clearances and creepage distances	according to EN50178
Vibration test	according to EN60068-2-6

Fig. 4-15: Tests

Notes

5 Determination of appropriate power supply units

5.1 Introduction

The mains supply for an AC drive system of the DIAX04 product family mainly consists of the power supply unit. Depending on the tasks and design of the supply unit and the conditions of its use, it may be necessary to add link reactors, auxiliary capacitors, bleeder modules and transformers as needed.

The mains supply must make available to the drives the DC bus continuous power and the DC bus peak power for acceleration. During regenerative operation it must be able to store continuous and peak regenerated power. The supply unit also makes the control voltage for the drive controllers available.

Prior to selecting supply unit and auxiliary components it is necessary to determine the motors and drive controllers which will be used.

It is advisable to carry out calculations in accordance with the following chapters in order to make sure that the layout of the mains supply is correct.

5.2 DC bus continuous power

Note: It is possible to connect DC bus chokes of the GLD type to HVE supply modules so that the usable DC bus continuous power is increased (see Fig. 4-4).

The DC bus continuous power is calculated from the mechanical power and based on the efficiency of motor and controller as well as coincidence factors.

Mechanical power

$$P_m\,[W] = M * \omega = \frac{M * 2\pi n}{60} \quad \text{or}$$

$$P_m\,[kW] = \frac{M * n}{9550}$$

P_m: mechanical power
M: torque [Nm]
ω: angular speed [min^{-1}]
n: motor speed [min^{-1}]

Fig. 5-1: Mechanical power

Continuous mechanical power for servo drives

The effective motor torque and average motor speed are needed to calculate the mechanical continuous power of a servo drive.

The effective motor torque of the servo drive calculations can be assumed. The average motor speed is determined as follows:

Average motor speed

The average motor speed equals approximately 25% of the rapid motion speed - in the case of servo drive tasks in conventional NC machine tools. In some cases, however, this approximate estimation is not sufficient. A precise calculation of the average motor speed is necessary.

If the duration over which the drive is operated at constant speed is considerably greater than the accel and decel time, then it applies:

Average speed without accel and decel time

$$n_{av} = \frac{n_1 * t_1 + n_2 * t_2 + ... + n_n * t_n}{t_1 + t_2 ... + t_n}$$

n_{av}: average motor speed [min^{-1}]
n_1 ... n_n: motor speed [min^{-1}]
t_1 ... t_n: ON time [s]

Fig. 5-2: Average speed; influence of accel and decel time is not taken into consideration

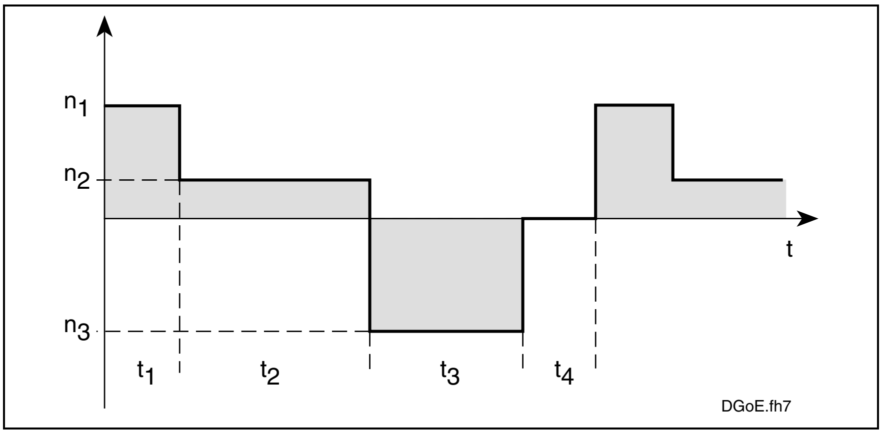


Fig. 5-3: Speed cycle; influence of accel and decel time is not taken into consideration

Accel and decel times with short cycle times must be taken into consideration in such dynamic applications as is the case with rollers and nibble machines:

Average speed with accel and decel times

$$n_{av} = \frac{\frac{n}{2} * t_H + n * t_1 + \frac{n}{2} * t_B}{t_H + t_1 + t_B + t_2}$$

n_{av}: average motor speed [min^{-1}]
n: motor speed [min^{-1}]
t: time [s]
t_H: accel time [s]
t_B: decel time [s]

Fig. 5-4: Average speed; influence of accel and decel time is taken into consideration

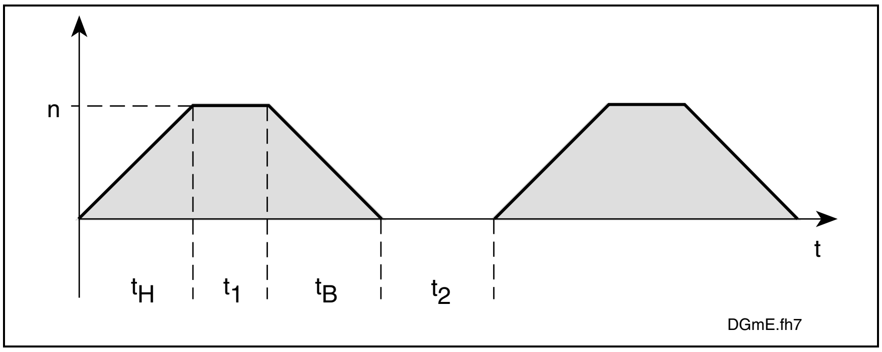


Fig. 5-5: Average speed; influence of accel and decel time is taken into consideration

Mechanical power for servo drives

$$P_{mSe} = \frac{M_{eff} * n_{av}}{9550}$$

P_{mSe}: continuous mech. power for servo drives [kW]
M_{eff}: effective motor torque [Nm]
n_{av}: average motor speed [min^{-1}]

Fig. 5-6: Mechanical power for servo drives

Mechanical power for main drives

Main drives are primarily used with constant power over a specific speed range. This means that when planning power supply, nominal power is important. The mechanical nominal power of the main drives is illustrated in the operating characteristics or it can be calculated using nominal speed and torque.

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

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

Fig. 5-7: Mechanical power for main drives

DC bus continuous power for servo drives

The power supply unit must make the DC bus continuous power available to all servo drives. All drives are operated simultaneously in only a few applications which means that only the simultaneously occurring output needs to be considered. For the calculation of the required DC bus continuous power for typical NC feed axes on tool machines, it has proven in practice that a so-called coincidence factor is included:

Number of Axes	1	2	3	4	5	6
Coincidence factor (F_G)	1	1,15	1,32	1,75	2,0	2,25

Fig. 5-8: Coincidence factors

$$P = \frac{(P_{mSe1} + P_{mSe2} + ... + P_{mSen}) * 1{,}25}{F_G}$$

P_{ZWSe}: DC bus continuous power for servo drives [kW]
P_{mSe1} ... P_{mSen}: cont. mech. power for servo drives [kW]
F_G: coincidence factor
1,25: constant for motor and controller efficiency

Fig. 5-9: DC bus continuous power for servo drives

DC bus continuous power for main drives

If several main drives are operated on one DC bus, then add the simultaneously required power:

$$P_{ZWHa} = (P_{mHa1} + P_{mHa2} + ... + P_{mHan}) * 1{,}25$$

P_{ZWHa}: DC bus continuous power for main drives [kW]
P_{mHa1} ... P_{mHan}: mech. cont. power for main drives [kW]
1,25: constant for motor and controller efficiency

Fig. 5-10: DC bus continuous power for main drives

Chokes and auxiliary capacitors are selected in terms of the actually required DC bus continuous power. It is fixed by the nominal power of the spindle drives.

Note: When selecting the power supply unit make sure that the DC bus continuous power does not limit the short-term power of the main drives.

DC bus continuous power for main and servo drives

If main and servo drives are operated on a power supply unit, the required DC bus continuous power needs to be added.

It is the spindle drive in a NC machine tool that primarily determines the DC bus power needed. Therefore, the following equation should be applied in such applications:

$$P_{ZW} = [P_{mHa} + 0{,}3 * (P_{mSe1} + P_{mSe2} + ... P_{mSen})] * 1{,}25$$

0,3:	experimental value for standard machine tools
1,25:	constant for motor and controller efficiency
P_{ZW}:	DC bus continuous power [kW]
P_{mSe1} ... P_{mSen}:	continuous mech. servo drive output [kW]
P_{ZWHa}:	nominal power for spindle drives (shaft output) [kW]

Fig. 5-11: DC bus continuous power for spindle and servo drives in machine tools

5.3 DC bus peak power

The DC bus peak power is demanded of the power supply unit when, e.g., several axes of a machine tool simultaneously accelerate to rapid traverse and then go to a workpiece after a tool change.

CAUTION

Damages due to overloaded power supply unit!

⇒ Damages to the power supply unit can be avoided, if the sum of the peak power of all drives does not exceed the DC bus peak power of the power supply unit.

$$P_{ZWS} = \frac{(M_{NC} \pm M_G) * n_{eil} * 1{,}25}{9550}$$

1,25:	constant for motor and controller efficiency
M_{NC}:	acceleration torque in NC mode [Nm]
M_G:	weight torque in vertical axes [Nm]
n_{eil}:	speed in rapid traverse [min^{-1}]
P_{ZWS}:	DC bus peak power [kW]

Fig. 5-12: DC bus peak power per drive

$$\sum P_{ZWS} \leq P_{ZWS03}$$

P_{ZWS}:	DC bus peak power [kW]
P_{ZWS03}:	DC bus peak power of the power supply unit [kW]

Fig. 5-13: Sum of DC bus peak powers

5.4 Regenerated energy

The energy content of all main and servo drives that brake simultaneously under unfavorable conditions may not be greater than the maximum regenerated energy of the power supply unit as specified in the data sheet. If this is not taken into consideration during the layout stage, then there could be thermal damage to the bleeder resistor in the power supply unit!

CAUTION

Property damages due to overloaded bleeder resistor!

⇒ Use a power supply unit that is appropriate for the consumption of the regenerated power which arises when all the main and servo drives connected to the power supply unit brake simultaneously.

$$W_{rot} = \frac{J_G}{2} * \left(n_{eil} * \frac{2\pi}{60} \right)^2$$

W_{rot}: rotary energy [Ws]
n_{eil}: rapid traverse speed [min^{-1}]
J_G: inertia of motor and load inertia reduced to shaft [kgm^2]

Fig. 5-14: Regenerated energy per drive

$$\sum W_{rot} \leq W_{MAX}$$

W_{rot}: rotary energy [Ws]
W_{MAX}: max. permissible regenerated energy of the power supply module [kWs]

Fig. 5-15: Sum of regenerated energies

Auxiliary capacitance as energy storage in the HVE

In servo drive applications with numerous accel and decel procedures, as is the case, for example, with nibble machines and rollers, it is advisable to connect additional capacitors to the DC bus. The following advantages result from this:

- This prevents the bleeder resistor in the HVE power supply unit from being actuated while braking: The heat dissipated within the control cabinet is considerably reduced.
- The stored energy can be used to accelerate thus reducing energy requirements of the installation.

$$W_{ZW} = \frac{C_{ZW}}{2} * \left(U_B^2 - U_{ZW}^2 \right)$$

W_{ZW}: energy stored in the DC bus
C_{ZW}: DC bus capacitor [F]
U_B: bleeder actuation threshold (approx. 820 V)
U_{ZW}: DC bus nominal voltage [in the HVR: U_{DC}=750 V; in the HVE: U_{DC}=1,41*U_{N1}+10% (overvoltage), (U_{N1}=nominal mains voltage (380 ... 480 V)]

Fig. 5-16: Energy that can be stored in the DC bus

The auxiliary capacitor must be designed so that it is capable of storing rotary drive energy:

$$C_{Zu} \geq \frac{2W_{rot}}{\left(U_B^2 - U_{ZW}^2\right)} * 1000 - C_{int}$$

U_B: bleeder actuation threshold (approx. 820 V)
U_{ZW}: DC bus nominal voltage [in the HVR: U_{DC}=750 V; in the HVE: U_{DC}=1,41*U_{N1}+10% (overvoltage), (U_{N1}=nominal mains voltage (380 ... 480 V)]
W_{rot}: rotatory energy [Ws]
C_{Zu}: auxiliary capacitor [mF]
C_{int}: internal capacitance of power supply unit (see Technical Data) [mF]

Fig. 5-17: Required auxiliary capacitance [mF]

In power supply units with regulated DC bus voltage, e.g., HVR, approximately 75 Ws per mF auxiliary capacitance can be stored.

In power supply units with unregulated DC bus voltage, e.g., HVE, the auxiliary capacitance should be designed for 10% overvoltage. The storable energy per mF auxiliary capacitance is listed in the table below.

Mains voltage	3 x AC 380 V	3 x AC 400 V	3 x AC 440 V	3 x AC 480 V
storable energy per mF auxiliary capacitance	145 Ws	126 Ws	86 Ws	41 Ws

Fig. 5-18: Storable energy with auxiliary capacitance on an HVE

5.5 Continuous regenerated power

The average sum of the continuous regenerated power of all drives may not exceed the continuous regenerated power in the HVR or the continuous bleeder power in the HVE.

Note: For operation with continuous power, an additional load caused by DC bus short circuit is **no longer** allowed.

The processing time in servo drive applications given a typical NC machine tool, is relatively long in terms of the entire cycle time. There is little regenerated continuous power. An exact calculation is generally not required. It suffices if the peak regenerated power is not exceeded.

An exact calculation is needed in specific cases such as, for example:

- servo drive applications with numerous accel / decel procedures such as is the case in nibble machines and rollers
- machine tools with modular main drives
- applications in which excessive masses must be lowered as is the case with those overhead gantries used with storage and transport technologies

To calculate continuous regenerated power, the rotary energy of the drives and the potential energy of non-compensated masses must be known.

$$W_{rot} = \frac{J_g}{2} * \left(n_{eil} * \frac{2\pi}{60}\right)^2 * z$$

W_{rot}: rotary energy [Ws]
n_{eil}: speed in rapid traverse [min^{-1}]
J_g: moment of inertia (motor + load) [kgm²]
z: number of decels per cycle

Fig. 5-19: Rotary energy

$$W_{pot} = m * g * h * z$$

W_{pot}: potential energy [Ws]
m: load mass [kg]
g: gravity constant = 9,81 m/s²
h: drop height [m]
z: number of drops per cycle

Fig. 5-20: Potential energy of non-compensated masses

$$P_{RD} = \frac{W_{potg} + W_{rotg}}{t_z} \qquad P_{RD} \leq P_{BD}$$

P_{RD}: continuous regenerated power [kW]
P_{BD}: continuous bleeder power [kW]
t_z: cycle time [s]
W_{potg}: sum of potential energy [kWs]
W_{rotg}: sum of rotary energies [kWs]

Fig. 5-21: Continuous regenerated energy

5.6 Peak regenerated power

The peak regenerated power usually arises, when an Emergency Stop signal has been released and all the axes brake simultaneously.

CAUTION

Property damages due to longer braking periods/paths!

⇒ Choose the power supply unit such that the sum of the peak regenerated power of the all drives does not exceed the bleeder peak power of the power supply unit.

The peak regenerated power of the servo drives is listed in the motor selection documentation.

Roughly estimated, the peak regenerated power can be calculated as follows:

$$P_{RS} = \frac{M_{max} * n_{max}}{9550 * 1{,}25} \qquad \sum P_{Rs} \leq P_{BS}$$

P_{RS}: peak regenerated power [kW]
P_{BS}: peak bleeder power [kW]
M_{max}: max. drive torque [Nm]
n_{max}: max. NC usable speed [min^{-1}]
1,25: constant for motor and controller efficiency

Fig. 5-22: Peak regenerated power

5.7 Connected load of the power supply unit

The connected load is calculated to be able to determine mains fuses, line cross sections and, if needed, commutation chokes and transformers.

The connected load is dependent on the continuous power of the drives and the functional principle of the power supply unit.

$$\text{without DC choke (GLD)}: \quad S_{N1} = P_{ZW} * 1{,}6$$
$$\text{with DC choke (GLD)}: \quad S_{N1} = P_{ZW} * 1{,}07$$

S_{N1}: connected load [kVA]
P_{ZW}: DC bus continuous power [kW]

Fig. 5-23: Connected load for power supply units of the HVE line

$$S_{N1} = P_{ZW} * 1{,}05$$

S_{N1}: connected load [kVA]
P_{ZW}: DC bus continuous power [kW]

Fig. 5-24: Connected load for power supply units of the HVR line

$$I_{N1} = \frac{S_{N1} * 1000}{\sqrt{3} * U_{N1}}$$

I_{N1}: mains current [I]
S_{N1}: connected load [kVA]
U_{N1}: mains voltage [U]

Fig. 5-25: Mains current

5.8 Using the control voltage

CAUTION

Property damage due to overloaded control voltage outlet!

⇒ The control voltage power of the power supply unit may not be overloaded when the drive controller processes signals. If the control voltages are used outside of the drive system, e.g., to supply auxiliary relays, then this must be taken into account (see data in Fig. 4-6 and Fig. 4-9).

6 Additional modules and components

Note: When you use the devices beyond the quoted operating conditions you have to take the load factors into consideration (see chapter 7.1).

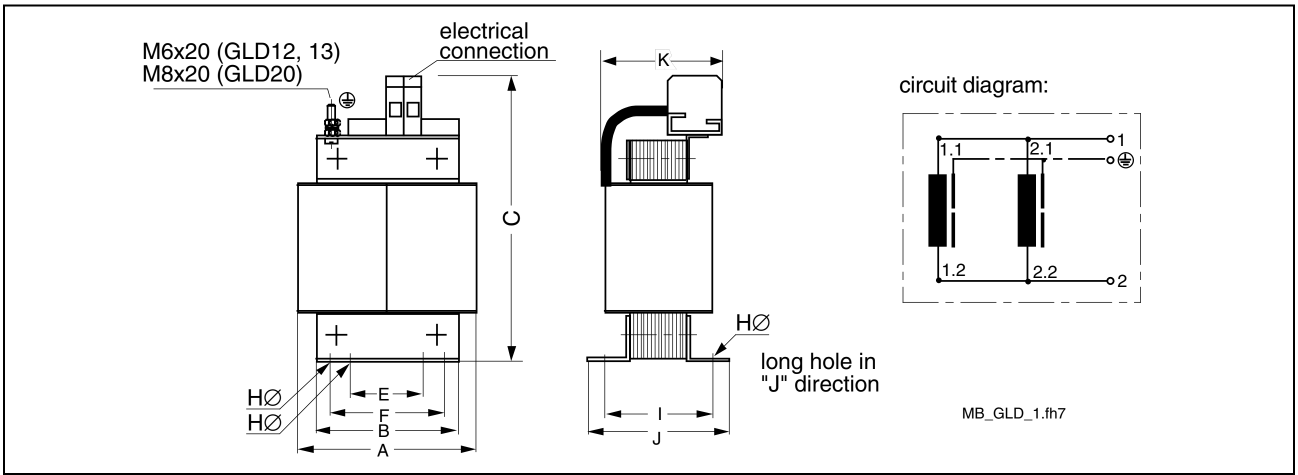
6.1 Ambient and operating conditions

See chapter 4.1

6.2 DC bus choke GLD

DC bus chokes GLD may be connected to HVE supply modules so that the usable DC bus power is increased.

The following figures show the unit dimensions and the technical data of the DC bus chokes. For the DC bus power with or without chokes on the corresponding supply module types please see figure Fig. 4-4.



Type	Dimensions [mm]								
	A	B	C	E	F	HØ	I	J	K
GLD12	160	121	285	60	100	7 x 14	97	121	-
GLD13	122	90	225	-	60	6 x 10	66	82	-
GLD20	225	170	380	-	135	10 x 18	145	175	190

Fig. 6-1: Dimension drawing of the DC bus chokes GLD

Item	Symbol	Unit	Choke		
			GLD13	GLD12	GLD20
Continuous nominal current	I_{nenn}	A	50	100	140
Inductance at I_{nenn}	L_{nenn}	mH	1,0		
Power loss					
Basic losses	P_{VG}	W	25	50	100
Load dependent losses	$P_{V/kW}$	W/kW	1,4	1,7	1,3
Total power loss at maximum continuous power	P_V	W	50	100	200
Connection					
Design			screw terminal		
max. cross section (multi-core with connector sleeve)	A	mm^2	16 / AWG 6	35 / AWG 2	50 / AWG 0
Weight	m	kg	4,8	13,5	35,0

Basic losses: arise with existing bus voltage; drive in "AF"; drive in shut down

Load dependent losses: arise per kW DC bus power

Power loss: consists of the basic losses and the load dependent losses

Fig. 6-2: Technical data of the DC bus chokes GLD

6.3 Additional capacitance module HZK

The additional capacitance modules HZK fulfill the following characteristics:

Reduce loss of heat

High losses of heat arise on systems whose feed axes need to accelerate constantly and brake in short intervals (e.g. nibble machines, surface grinding machines, roll feeds, etc.). With additional capacitance on the DC bus, the bleeder continuous power and thus the loss of heat can be reduced.

Increase power in the case of a power failure

The possibility to move on a certain traverse path (e.g. for a reverse motion), even when a power failure occurs, requires the storage of energy in the DC bus. The storable energy can be increased through additional capacitance on the DC bus.

Technical Data

Item	Symbol	Unit	Device: HZK02.1-W003N
Power supply			
Input voltage	U_{N1}	V	System voltage DIAX04 or 500 - 800V DC
Capacitances			
Internal capacitance	C_{intern}	mF	3,0
Weight	m	kg	7,0

Fig. 6-3: Technical Data

Dimensioning and unit arrangement

Maximum possible additional capacitance

It is possible to connect following additional capacitances to the DC bus of the supply modules:

HVE (Design "N")	HVE (Design "L")	HVR
10 mF	100 resp. 200 mF	20 mF

Fig. 6-4: Additional capacitances which can be connected

It is necessary to combine several additional capacitance modules of the type HZK02.1-W003N so that the above-mentioned additional capacitance can be realized. Every additional capacitance module of this type has a nominal capacity of 3 mF. As a result, a maximum of three HZK modules can be connected to the DC bus of HVE units and a maximum of six HZK modules can be connected to the DC bus of HVR units.

Arrangement

The HZK modules must be located next to the drives of greatest performance in the DIAX04 package.

Connection, monitoring and diagnostics

There is no monitoring or diagnosis logic in the HZK available. Therefore, the connection of the X1-bus is only necessary, if other units are mounted on both sides of the HZK.

It is necessary to connect the DC bus and the operating ground so that a proper and safe operation can be ensured.

Note: With regard to the control voltage load, the HZK does **not** count as an axis.

Front view

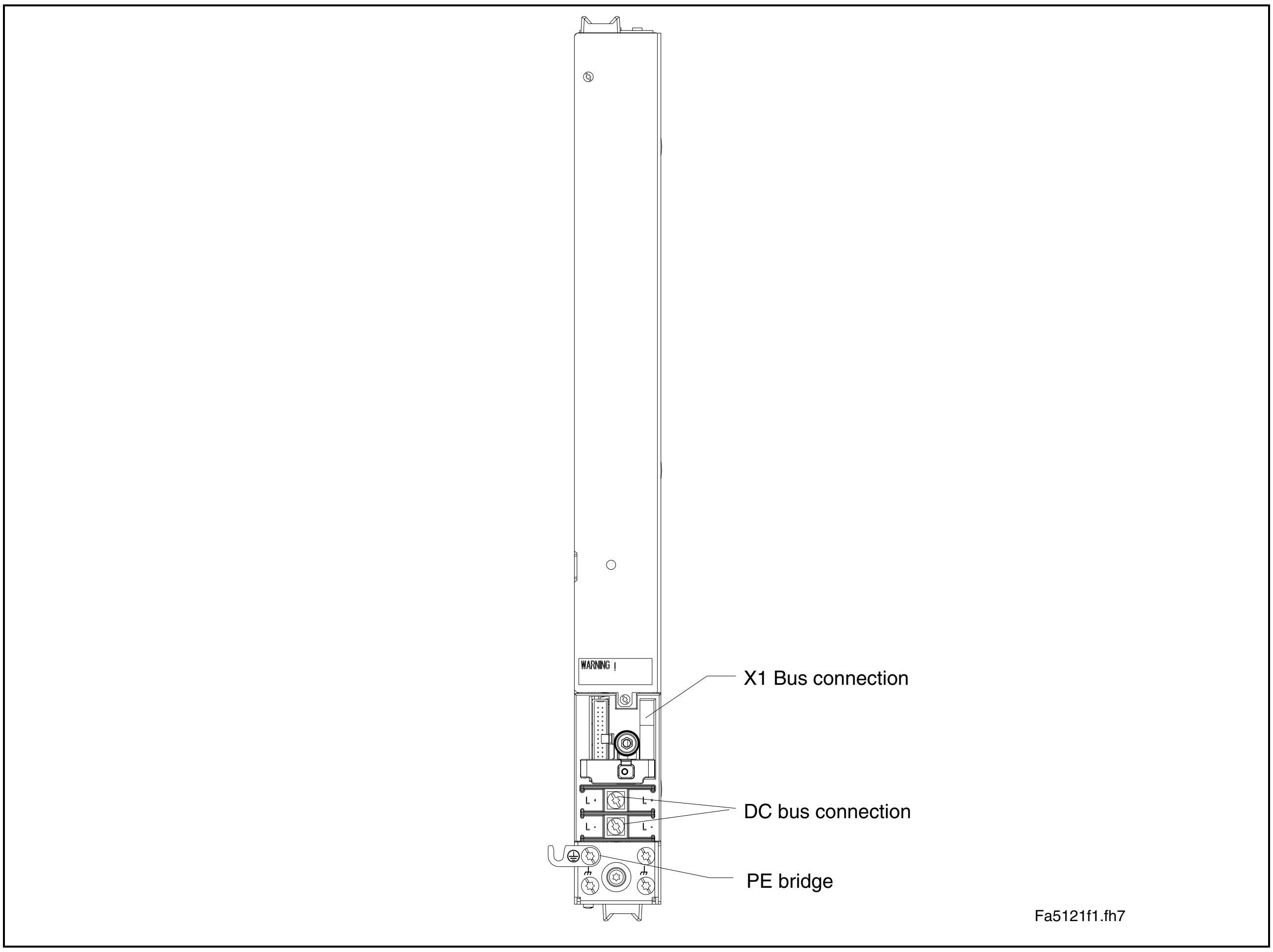


Fig. 6-5: Front view HZK02.1-W003N

Note: The scope of supply includes the copper strand for the DC bus connection as well as the PE jumper.

The flat cable on the X1 terminal is firmly connected to the unit (X1 is also the designation of the free multiple contact strip for looping through the X1 connections).

Unit dimensions

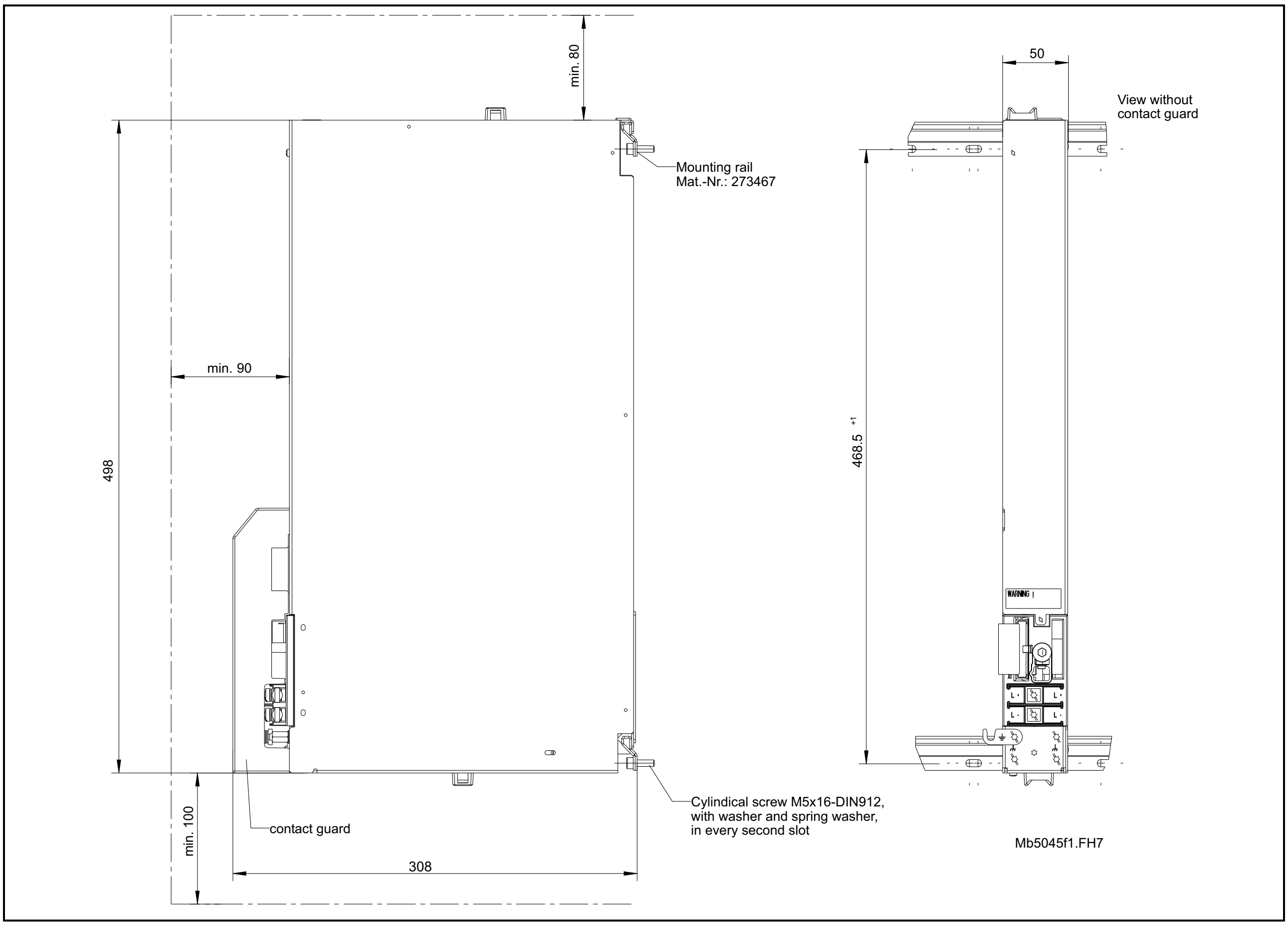


Fig. 6-6: Dimension drawing HZK02.1-W003N

6.4 Additional bleeder module HZB

The additional bleeder module is required, if the bleeder power of the applied HVE supply module is not sufficient for the braking energy arising in the application.

It can also be applied together with a regenerative HVR supply unit in order to manage great braking energies in case of power failures.

Unit arrangement

The additional bleeder module must always be located next to the supply unit in the drive package.

Note: A maximum of one additional bleeder module is allowed per power supply unit.
With regard to the control voltage load, the HZB counts as an axis.

Technical Data

Item	**Symbol**	**Unit**	**Device:**
			HZB02.2-W002N
Nominal input voltage of DC bus	U_{N1}	V	System voltage DIAX04 or 500 - 800V DC
Bleeder trigger voltage	U_{Bl}	**V**	820 V DC (± 20 V)
Regenerated power (bleeder power)			
Bleeder continuous power	P_{BD}	kW	2
Bleeder peak power	P_{BS}	kW	240
Maximum regenerated power	W_{MAX}	kWs	250
Power loss			
Basic losses	P_{VG}	W	125
Weight	m	kg	13,5

Fig. 6-7: Technical data

Connection power supply unit – additional bleeder

For communication between HVx power supply unit and additional bleeder module it is necessary to establish the following connections.

- X0 at power supply unit with X0 at additional bleeder module as in Fig. 6-8
- X1-bus at power supply unit with X1-bus at additional bleeder module
- DC bus L+/L-

The X0-terminal connectors at the powers supply unit (condition as supplied with jumpers) have to be connected to the remaining unassigned slots at each last additional module.

Note: Make sure the wiring of the X0-connection between power supply unit and additional component is correct, because otherwise the connected components can be damaged!

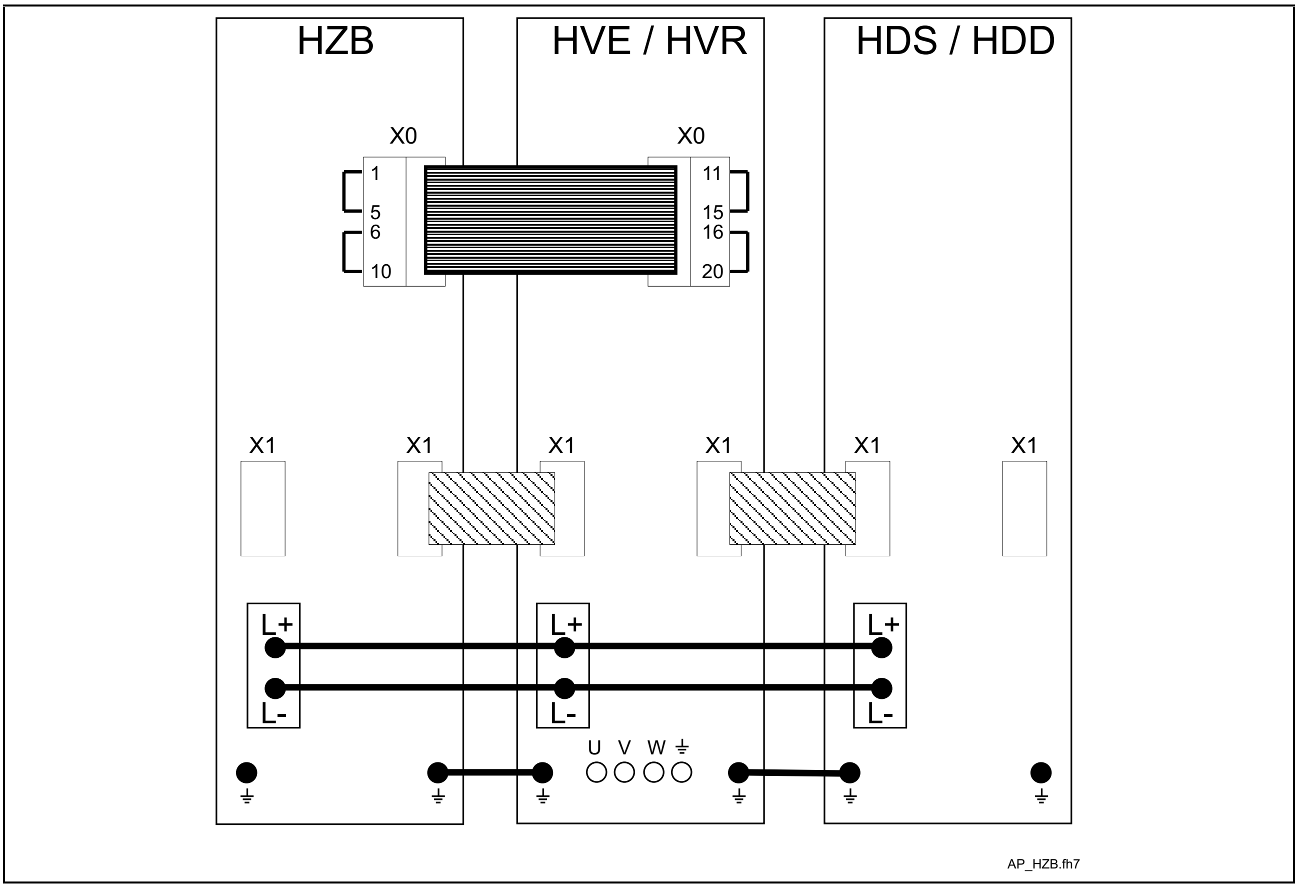


Fig. 6-8: Unit wiring when an HZB unit is used

Regenerated power

When operating HVE or HVR together with the additional bleeder module HZB, please observe the following relations:

- Regenerated continuous power

  $\sum P_{BD} \leq 0{,}8 * (P_{BD,HVE} + P_{BD,HZB})$

  $P_{BD,HVE}$: regenerated continuous power HVE

  $P_{BD,HZB}$: regenerated continuous power HZB

- Regenerated peak power

  $\sum P_{BS} \leq 0{,}8 * (P_{BS,HVx} + P_{BS,HZB})$

  $P_{BD,HVx}$: regenerated peak power HVE or HVR

  $P_{BD,HZB}$: regenerated peak power HZB

- Regenerated power

  $\sum W_{ROT,MAX} + \sum W_{POT,MAX} \leq 0{,}75 * (W_{MAX,HVx} + W_{MAX,HZB})$

  $W_{MAX,HVx}$: maximum regenerated power HVE or HVR

  $W_{MAX,HZB}$: maximum regenerated power HZB

Monitored values and diagnostic messages

Monitored values of HZB:

- load of bleeder
- temperature of bleeder
- temperature of power electronics

Note: The following description of the unit monitoring is visualized in the next figure (Fig. 6-9).

If one of the three monitored values achieves 90% of the permissible maximum value, a warning will be displayed on the supply module (additional component warning) as well as on the HZB display.

The warning opens simultaneously the pre-warning contact (terminal X7, pin 5 and 6) in the supply module HVx.

The warning opens simultaneously the pre-warning contact (terminal X7, pin 5 and 6) as well as the bleeder pre-warning contact (terminal X7, pin 7 and 8) open in the HVE.

From the time when the warning occurs, the user has 30 seconds to prepare countermeasures. If the value does not remain under 90% during this time, the supply module (HVE only) announces "additional component error" and the main contactor K1 is deactivated.

If one of the maximum values is reached, the message "additional component error" will appear immediately. In this case the main contactor K1 is deactivated as well. The error message is stored in the HZB as long as it is reset manually by the reset button S1.

The messages of the HZB to the supply module are transmitted via the X0 and X1 buses.

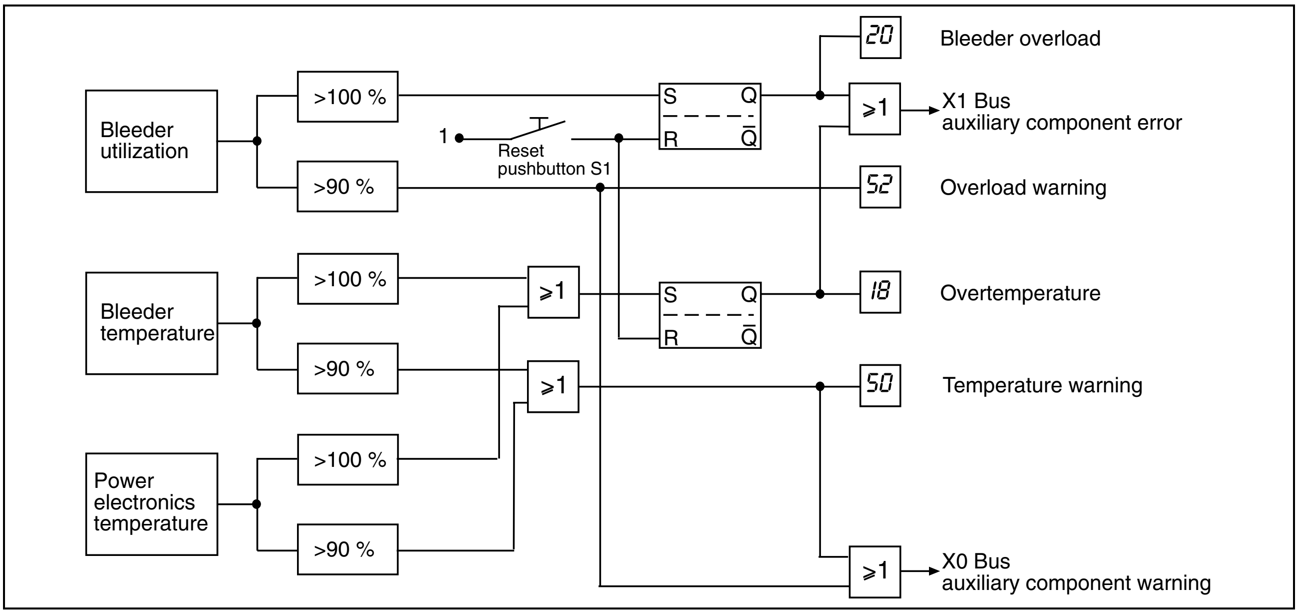


Fig. 6-9: Monitoring and diagnostic logic HZB02.2-W002N

X0, Additional component bus

Technical data of terminal

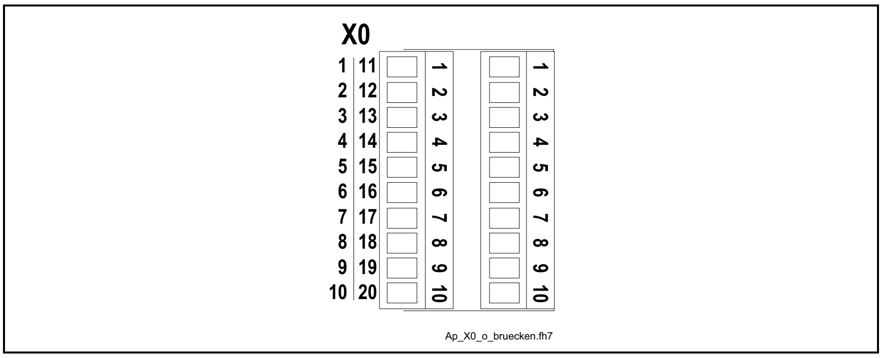


Fig. 6-10: Terminal X0 (condition as supplied with connectors)

Design

Type	Number of poles	Type of design
screw terminal	2 x 10	bushing at connector

Fig. 6-11: Design

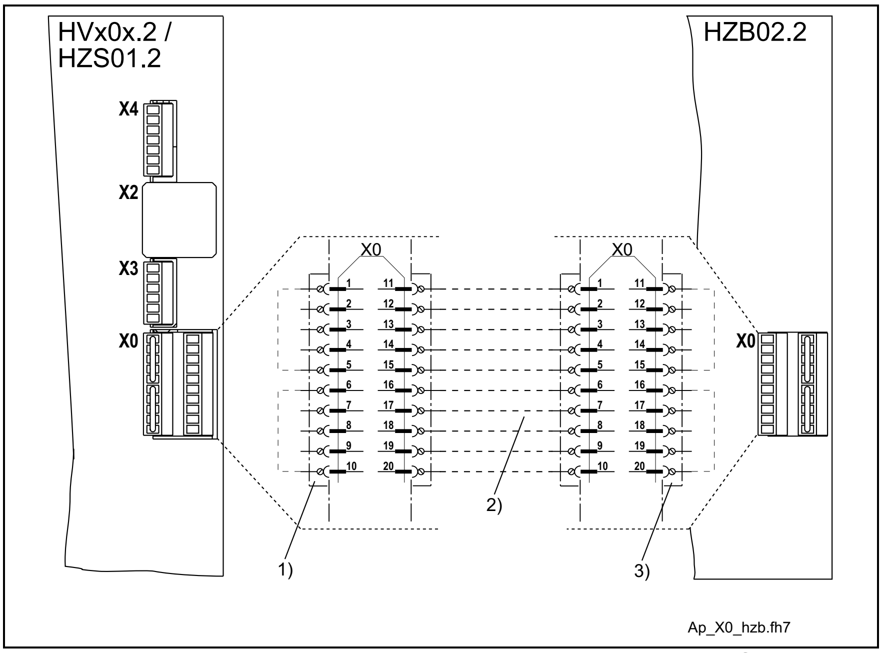
Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,14...1,5	0,25 - 1,5	28...16

Fig. 6-12: Connection cross section

Tightening torque 0,22 Nm

Terminal assignment



1: terminal connector with jumpers remaining at HVx or HZS
2: wiring to be made by customer
3: 2nd terminal connector of HVx or HZS

Fig. 6-13: Terminal assignment of terminal X0 with HZB mounted on right side. Accordingly when HZB mounted on left side!

Front view

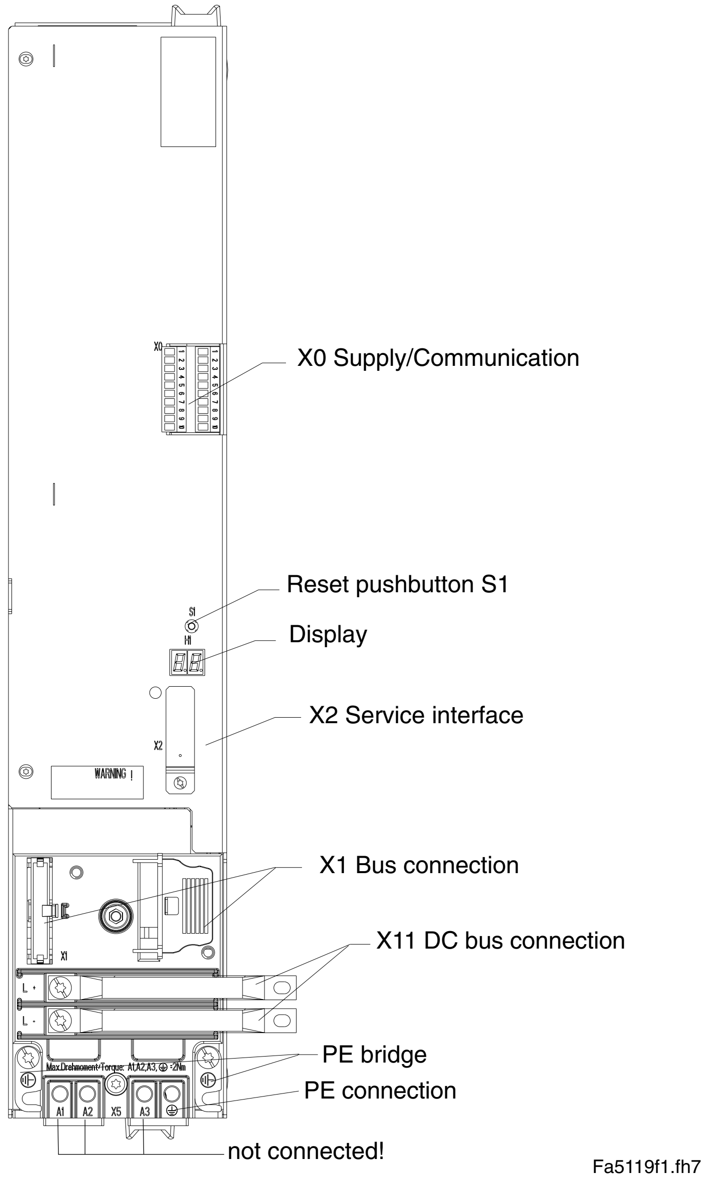


Fig. 6-14: Front view HZB02.2-W002N

Note: The scope of supply includes the copper strand for the DC bus connection as well as the PE jumper.

The flat cable on terminal X1 is firmly connected to the unit (X1 is also the designation of the free multiple contact strip for looping through the X1-connections).

Unit dimensions

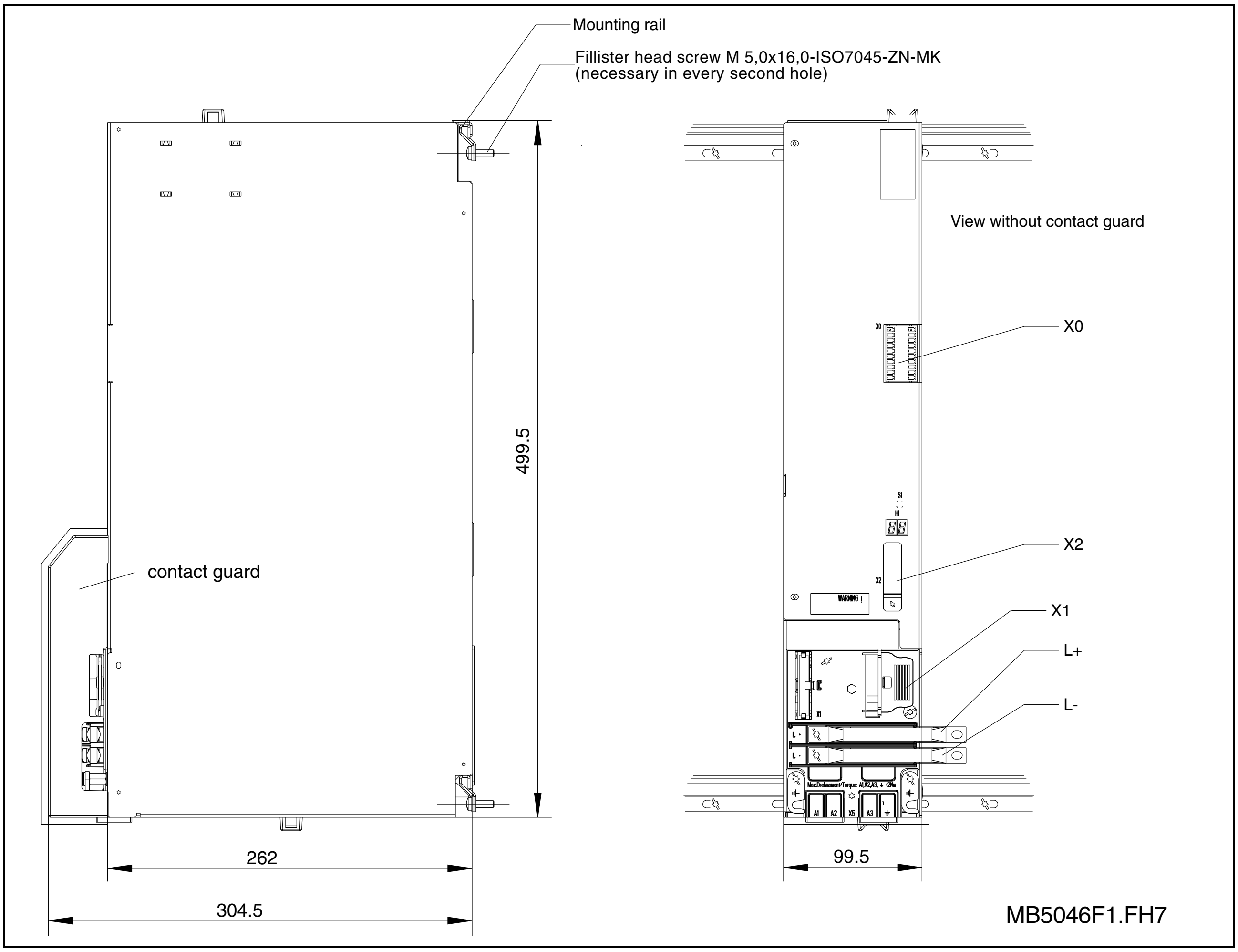


Fig. 6-15: Dimension drawing HZB02.2-W002N

6.5 Additional module HZS

General information

The additional module HZS supplies the control voltages and communication signals for the connected DIAX04 devices. The HZS contains furthermore capacities for buffering the power DC bus.

DANGER

High electrical voltage!

⇒ Wait 5 minutes after switching off power to allow capacitors to discharge before touching the devices. Measure the voltage on the DC bus connection before beginning to work to make sure that the equipment is safe to touch.

The power DC bus must be supplied by a power supply unit connected in the incoming circuit. This power supply unit can be:

- a DIAX04 supply unit HVx (system operation)
  (note: HVx = HVE or HVR)

or

- an external device with direct voltage DC bus (externally operated). In this case observe the allowed input voltage data.

Note: The DC bus connected in series and the supply of the HZS via its X8 interface must be operated at mains of equal mains voltage!

Position of the devices

DIAX04 drive controllers supplied by the HZS **must be** positioned **on the right side of the HZS**. A maximum of 12 axes can be connected to the HZS. The exact number depends on the control power consumption (see chapter 7.2 "Mounting an HVE or HVR into the control cabinet" in the DOK-POWER*-HVE+HVR**G2-AW06-EN-P Application Manual).

Connecting additional modules

It is possible to connect:

- additional bleeder modules HZB
- additional capacitance modules HZK

Please observe the respective requirements for additional modules (see chapter 6.2 "Additional capacitance module HZK" and chapter 6.3 "Additional bleeder module HZB").

Note: A maximum of one additional bleeder module is allowed per drive system or supply unit. In the case of a system with HVx supply unit, the additional bleeder module must be assigned to the HVx supply unit.

CAUTION

Devices may be damaged under non-specified operating conditions!

⇒ In the case of a drive system with an HVx supply unit and an HZS additional component you **mustn't** establish any **X0 bus connection** between these two devices as otherwise the DC bus short circuit function and the circuit interruption by means of DC bus dynamic brake are not available!

Monitoring functions and diagnostic messages

In the additional control voltage module HZS the following states, among other things, are monitored:

- control voltages for supplying the connected DIAX04 system
- mains input voltage
- DC bus voltage

The diagnoses displayed on the H1 display correspond to the displays of the HVE supply module (see chapter 11.5 "Diagnostic Display").

In a drive system with HVx supply unit the error messages of the drives are evaluated by the HVx. The HZS in this case is like an additional component.

Technical data

Designation	Symbol	Unit	HZS01.2-W300N	
Power supply				
DC bus direct voltage	U_{ZW}	V	system voltage DIAX04 or 500 - 820 V DC	
Output power				
Operating mode	-	-	external direct voltage DC bus	system operation
DC bus continuous power	P_{ZW}	kW	30 kW	P_{ZWHVx}
DC bus peak power (for 0.3 s)	P_{ZWS03}	kW	90 kW	$P_{ZWS03HVx}$
Capacities				
Internal capacity	C_{int}	mF	1.41	
Power loss				
Basic losses	P_{VG}	W	15	
Power losses per kW DC bus continuous power	$P_{V/kW}$	W/kW	3	
Weight	m	kg	8	
Control voltage supply				
Input voltage	U_{N2}	V	3 x 400 ... 480 (± 10 %)	
Frequency	f_{N2}	Hz	50 ... 60 (± 2 Hz)	
Average charging current	I_{lade}	A	≤ 14	
Charging duration	t_{lade}	ms	≤ 5	
Max. current pulse/duration	i_{peak}		≤ 35 A for 0,25 ms	
Power input with maximum load	S_{N2}	VA	500	
Control voltage output	P_{St}	W	300	

Fig. 6-16: Technical data of HZS01.2-W300N

Interfaces at the HZS

X0, Additional component bus

Terminal X0

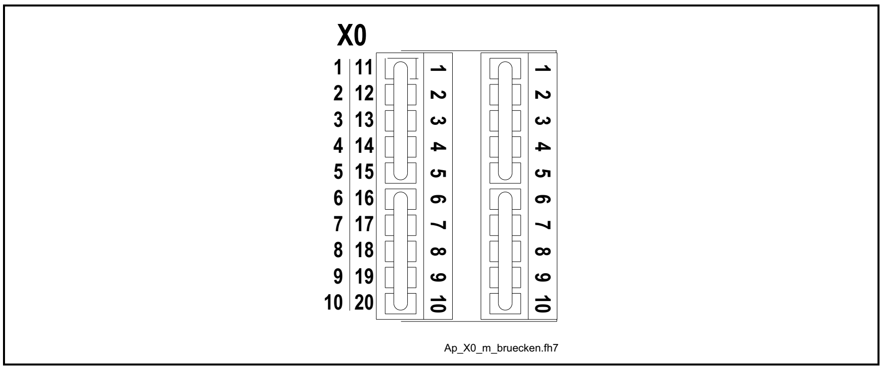


Fig. 6-17: Terminal X0 (condition as supplied with connectors and jumpers)

Design

Type	Number of poles	Type of design
screw terminal	2 x 10	bushing at connector

Fig. 6-18: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,14...1,5	0,25 - 1,5	28...16

Fig. 6-19: Connection cross section

Tightening torque 0,22 Nm

Terminal assignment

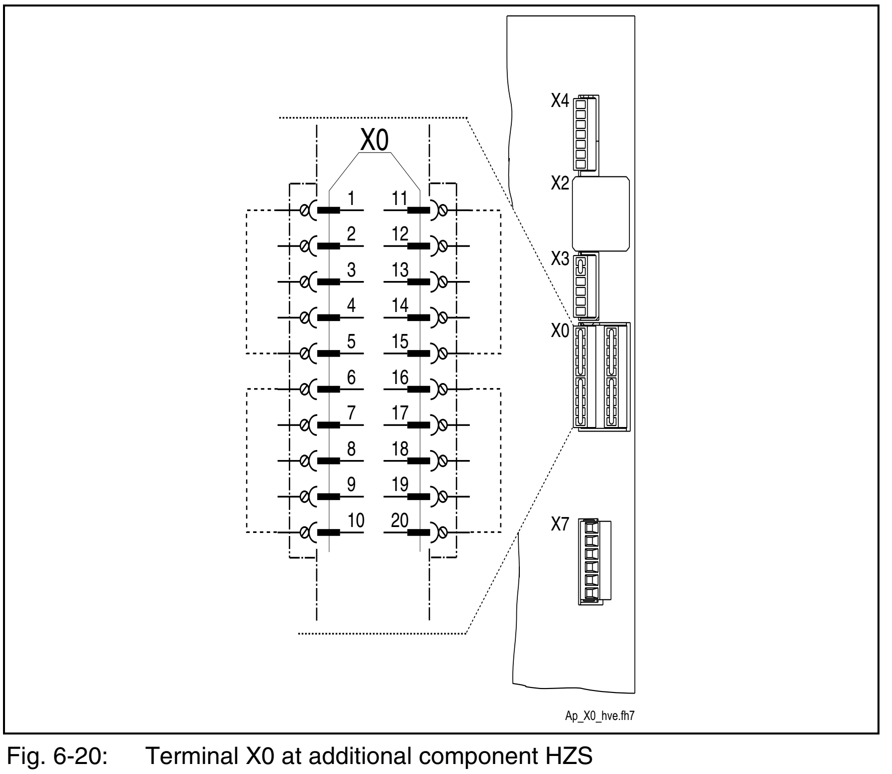


Fig. 6-20: Terminal X0 at additional component HZS

Note: At delivery, terminal 1 is jumpered with 5, 6 with 10, 11 with 15 and 16 with 20.

Enable inputs at X3

For transmitting messages to the drive controllers the HZS needs information on the operating status (ON or OFF) of the supply unit connected in series. The information can be provided by one of the two equal-priority enable inputs at X3.

In the case of system operation, the exchange of information with the HVx additionally takes place via the control voltage bus X1. To do this a jumper from X3.1 to X3.2 is sufficient. When the HZS is delivered this jumper is included.

Terminal X3

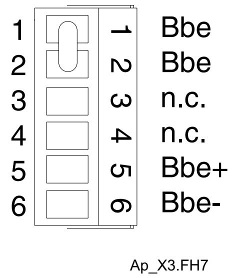


Fig. 6-21: Terminal X3 (condition as supplied with connector and jumper)

Design

Type	Number of poles	Type of design
screw terminal	1 x 6	bushing at connector

Fig. 6-22: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,14...1,5	0,25 - 1,5	28...16

Fig. 6-23: Connection cross section

Tightening torque

0,22 Nm

Terminal assignment

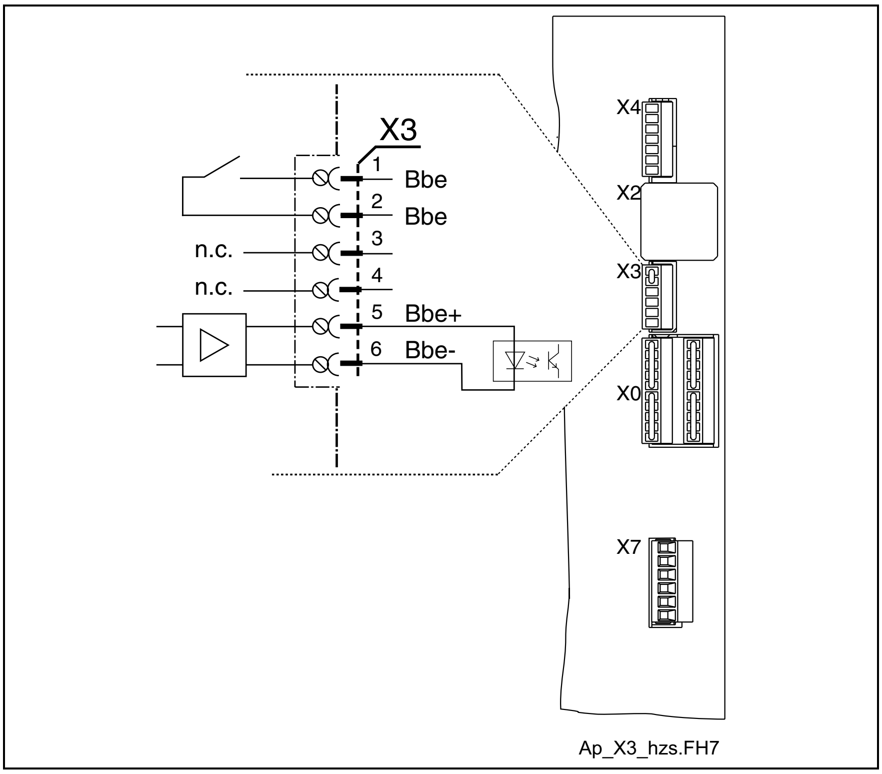


Fig. 6-24: Terminal assignment

The two enable inputs are of equal priority but realized differently:

- isolated (X3.1, X3.2)
- non-isolated (X3.5, X3.6)

Isolated enable input (X3.1, X3.2)

The HZS interprets a **closed** connection between X3.1 and X3.2 as the **readiness** of the external power supply unit for power output.

The HZS interprets an **open** connection between X3.1 and X3.2 as the **shutdown** of the external power supply unit.

Requirements for the switch contact X3.1, X3.2:

Switching voltage	DC 26 V ± 2 %
Switching current	DC 3.5 mA ± 0.5 mA

Fig. 6-25: Switch contact X3.1, X3.2

Non-isolated enable input (X3.5, X3.6)

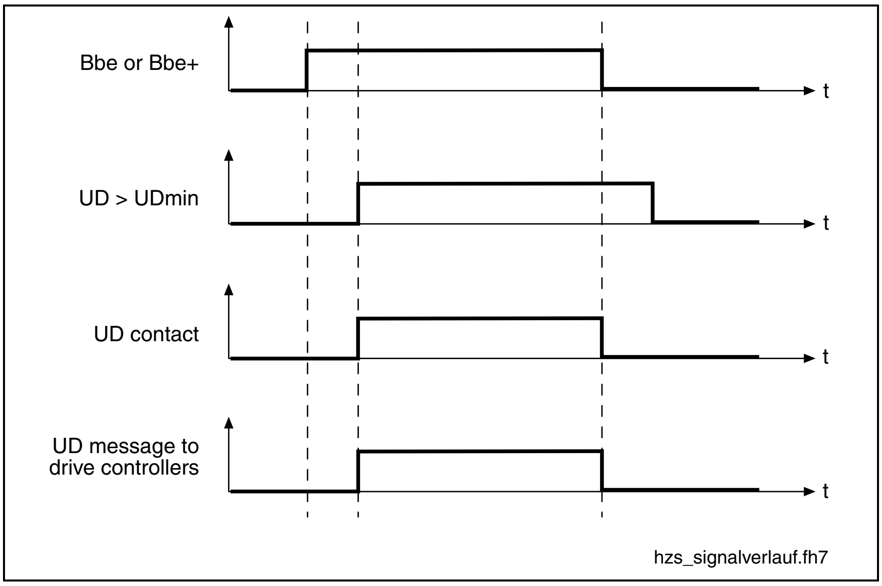
The HZS interprets a **high level at X3.5** as the **readiness** of the external power supply unit for power output.

The HZS interprets a **low level at X3.5** as the **shutdown** of the external power supply unit.

Note: For controlling via voltage output (X3.5, X3.6) the jumper at X3.1, X3.2 has to be removed.

Reference potential/ground	X3.6
Input resistance	> 5 kOhm
Voltage range at X3.5 for high level	+20 ... +26 V
Voltage range at X3.5 for low level	0 ... 5 V
Minimum required input current	2.5 mA

Fig. 6-26: Non-isolated enable input



Bbe / Bbe+: enable inputs at X3
UD > UDmin: DC bus voltage higher than minimum value;
the minimum value is calculated from 0.8*mains peak value
UD contact: relay contact at X7.3 to X7.4
UD message to drive controllers: internal message of the drive system via the control voltage bus X1

Fig. 6-27: Signal curves

X4, Control voltage

See page 10-6

X5, Mains connection

Terminal X5

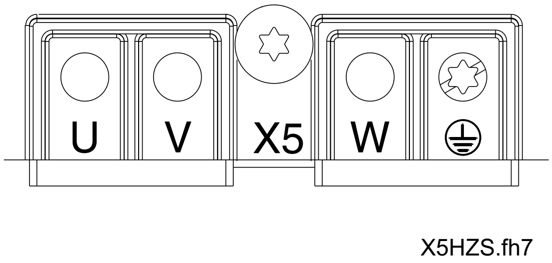


Fig. 6-28: Terminal X5

Design

Type	Number of poles	Type of design
screw terminal	1 x 1	bushing at device

Fig. 6-29: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
2,5...10	2,5...16	12...6

Fig. 6-30: Connection cross section

Tightening torque 2 Nm

Terminal assignment

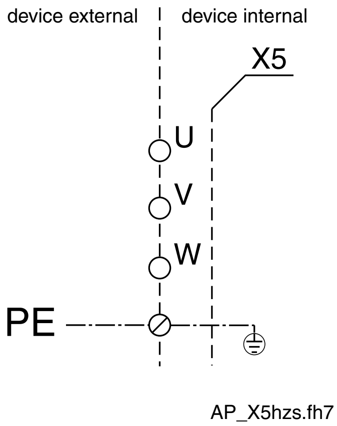


Fig. 6-31: Terminal assignment

X7, Ready-to-operate and other messages

See page 10-12

X8, Control voltage supply

Terminal X8

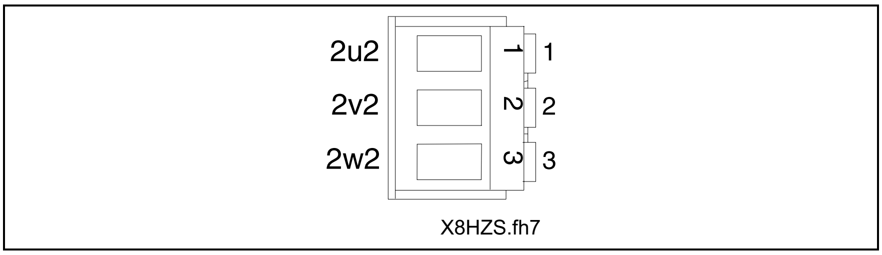


Fig. 6-32: Terminal X8

Design

Type	Number of poles	Type of design
screw terminal	1 x 3	bushing at connector

Fig. 6-33: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,4...4,0	0,25...4,0	24...10

Fig. 6-34: Connection cross section

Tightening torque 0,5 Nm

Terminal assignment

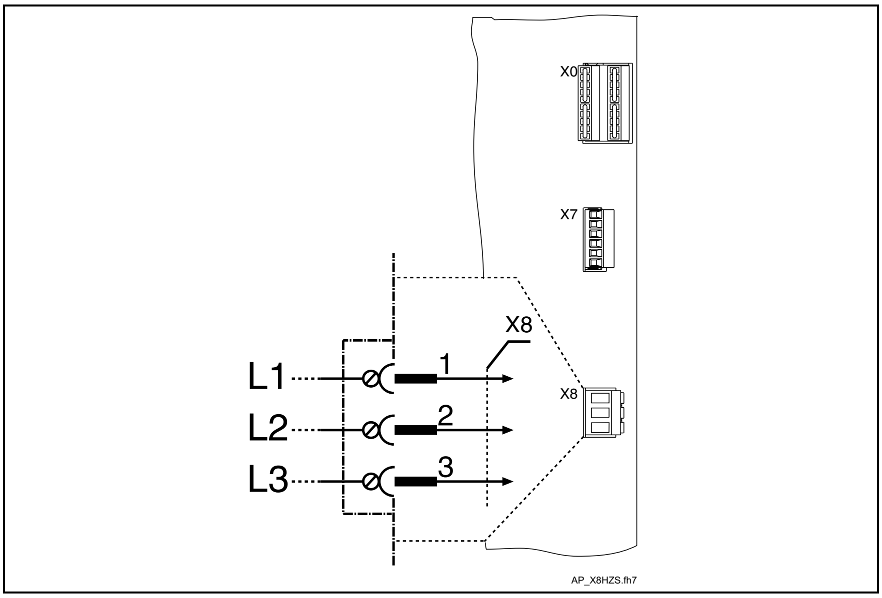


Fig. 6-35: Terminal assignment

X11, DC bus connection

See page 10-17

X12, Ground connection

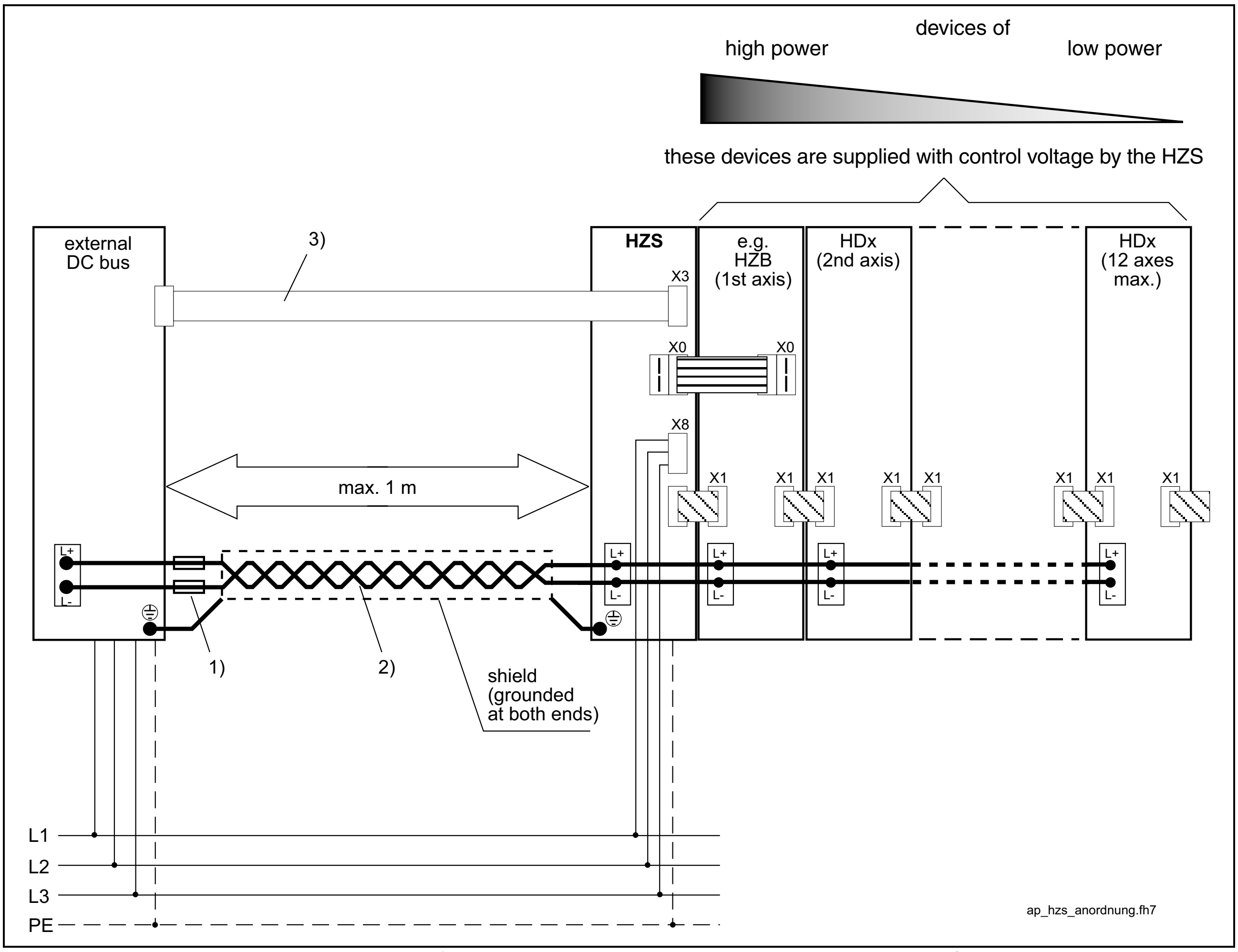
See page 10-19

Operation with external direct voltage DC bus

Principle

The drive system consisting of HZS and DIAX04 drive controllers receives its DC bus voltage from an external power supply unit with direct voltage DC bus (e.g. REFUdrive).

The HZS monitors the DC bus voltage. Together with the enable signal sent from the power supply unit connected in series to X3, it transmits the respective operating status to the connected DIAX04 drive controllers.



1) fusing according to line cross section and/or power
2) line cross section: min. 16 mm², max. 35 mm²
3) enable signal "power ready"

Fig. 6-36: Operation with external direct voltage DC bus

Mains connection (L1, L2, L3)

See page 6-15, "Technical data of HZS01.2-W300N" in this documentation.

Note: The external DC bus and the supply of the HZS via X8 must be operated at mains of equal mains voltage.

Position of the devices

The DIAX04 drive controllers must be positioned **on the right side of the HZS**. The higher the power of a device the nearer to the HZS it must be positioned. A maximum of 12 axes can be connected. (See chapter 7.2 "Mounting an HVE or HVR into the control cabinet")

Distances between the devices

Allowed distance between the external power supply unit and the HZS: **1 m maximum**

Distances of more than 1 m require additional HZK capacitance modules. In addition, you have to check for each application whether the allowed load values of the internal DC bus capacitances have been observed. The allowed load values are made available on request.

Fusing of the DC supply

As a matter of principle, you always have to take measures for fusing the DIAX04 drive system, in the case of external supply, according to the cross section of the connection and/or the power.

Allowed continuous power of the total DIAX04 system

To make sure the expected service life of the internal DC bus capacitances is reached, the allowed continuous power, without other measures, is limited to **30 kW**.

The allowed continuous power can be increased by means of **additional capacitance modules HZK**. The continuous power, however, is limited to **75 kW** because the cross sections of the DC bus connections that can be connected are limited.

Connecting additional modules

When the additional bleeder module HZB is used, the additional component bus X0 has to be wired according to the description in chapter 6.4.

System operation at the DIAX04 drive system

Using the HZS together with a DIAX04 supply unit (HVE or HVR) at the modular drive system allows increasing the allowed number of axes of the total drive system.

Note: More than 12 axes are only allowed for supply units of the "HVE" series, if the fact that there is no SUP kit required additionally results from the calculation formula in chapter 8.11 "Applications with HVE0x.2-W0xx power supply unit"!

For applications with HVR supply units a maximum of 12 axes is possible.

The allowed number of axes at the DIAX04 supply unit is limited by the control voltage

- by the driver power of the control signals for 12 axes at the X1 bus connection

and/or

- by the maximum power of 0.3 kW of the control voltage output of the supply units

If one of the two limit values (12 axes or 0.3 kW) is exceeded the allowed number of axes of the total system can be increased by using an HZS. A maximum of 12 axes can be connected to the HZS. When determining the control power load of the HVx, the HZS is considered as one axis.

Note: Only one HZS is allowed per drive system!

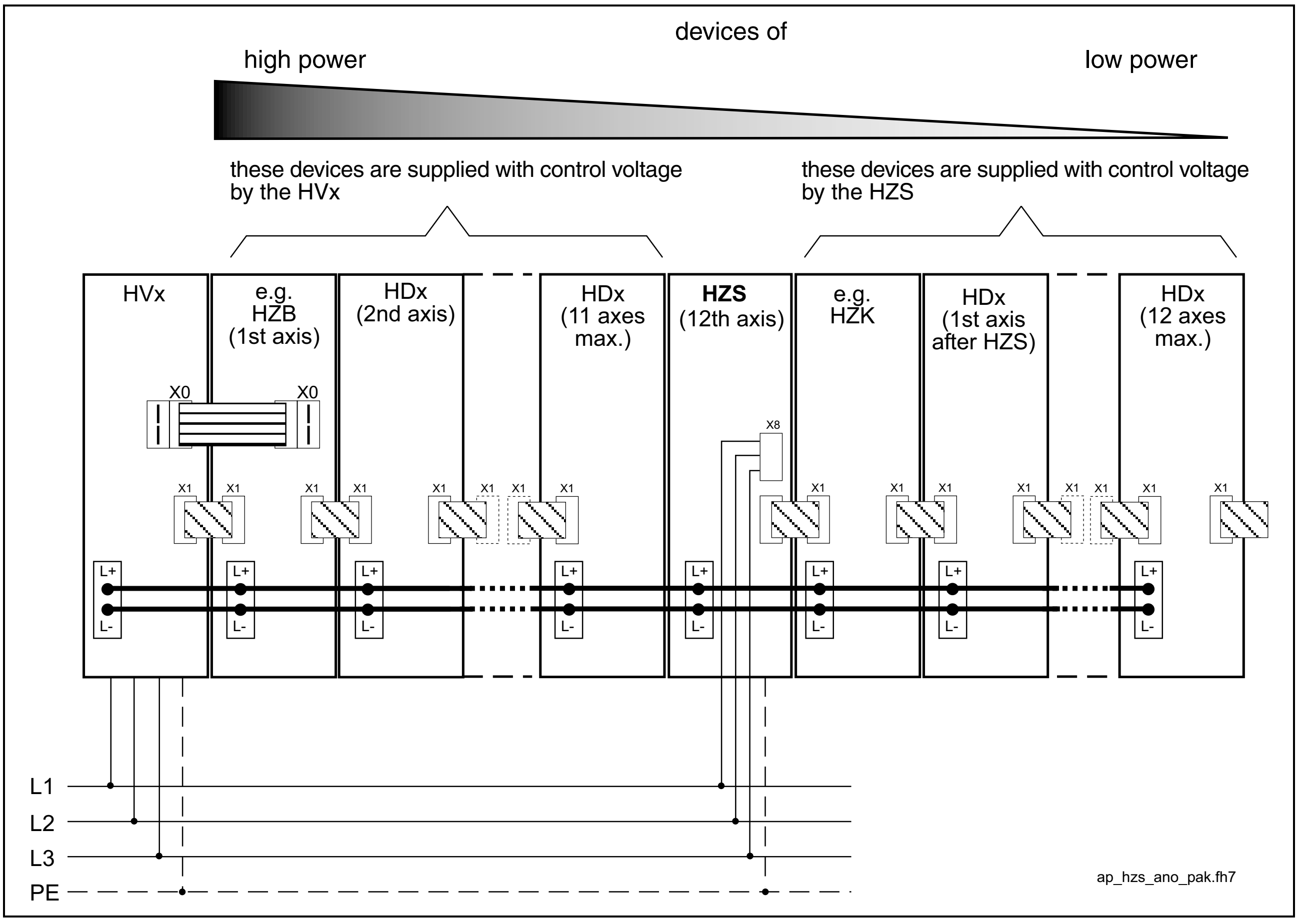


Fig. 6-37: Operation at the DIAX04 drive system

Mains connection

See page 6-15, "Technical data of HZS01.2-W300N" in this documentation.

Note: The power and control voltage connection (X5 and X8) of the HVx connected in the incoming circuit and the control voltage connection X8 of the HZS must be operated at mains of equal mains voltage.

Allowed power of the drive system

The total DC bus power of the drive system mustn't exceed the allowed power data of the supply unit.

Note: With the HZS it is impossible to increase the DC bus power of the supply unit!

The total power of the drives connected in series to the HZS mustn't exceed **30 kW**! The total power can be increased by additional capacitance modules.

The maximum allowed DC bus continuous power is **75 kW**!

Position of the devices

The above figure shows the position of the devices:

HVx → 11 drive controllers → HZS → a max. of 12 other drive controllers

Connecting additional modules

When the additional bleeder module HZB is used, the additional component bus X0 has to be wired according to the description in chapter 6.4. The X0 bus connection to the HZS mustn't be established because otherwise the DC bus short circuit function and the circuit interruption by means of DC bus dynamic brake won't work!

The HZS in this case has to be operated with the jumpers at X0 (condition as supplied)!

Front view

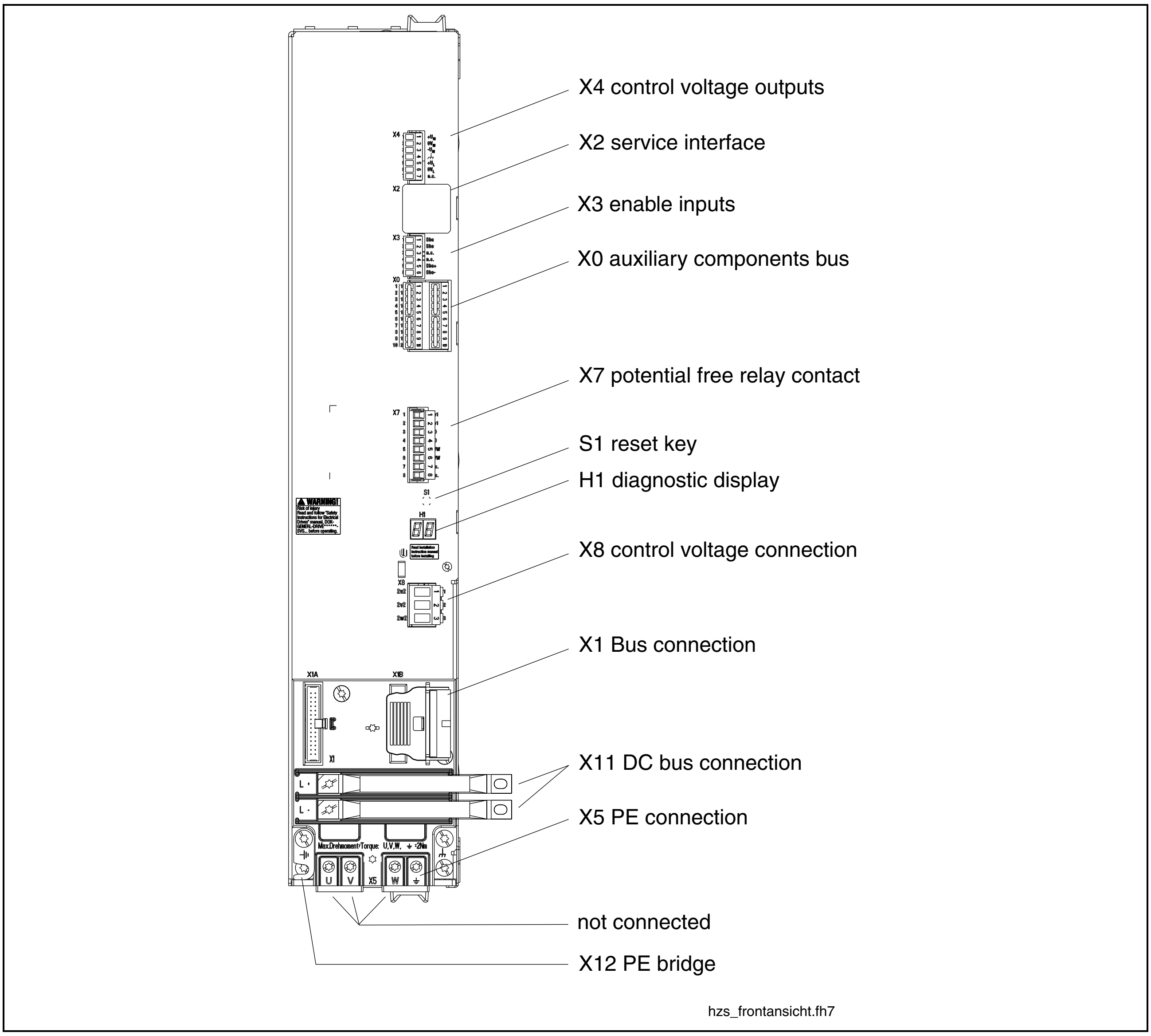


Fig. 6-38: Front view HZS01.2

Device dimensions

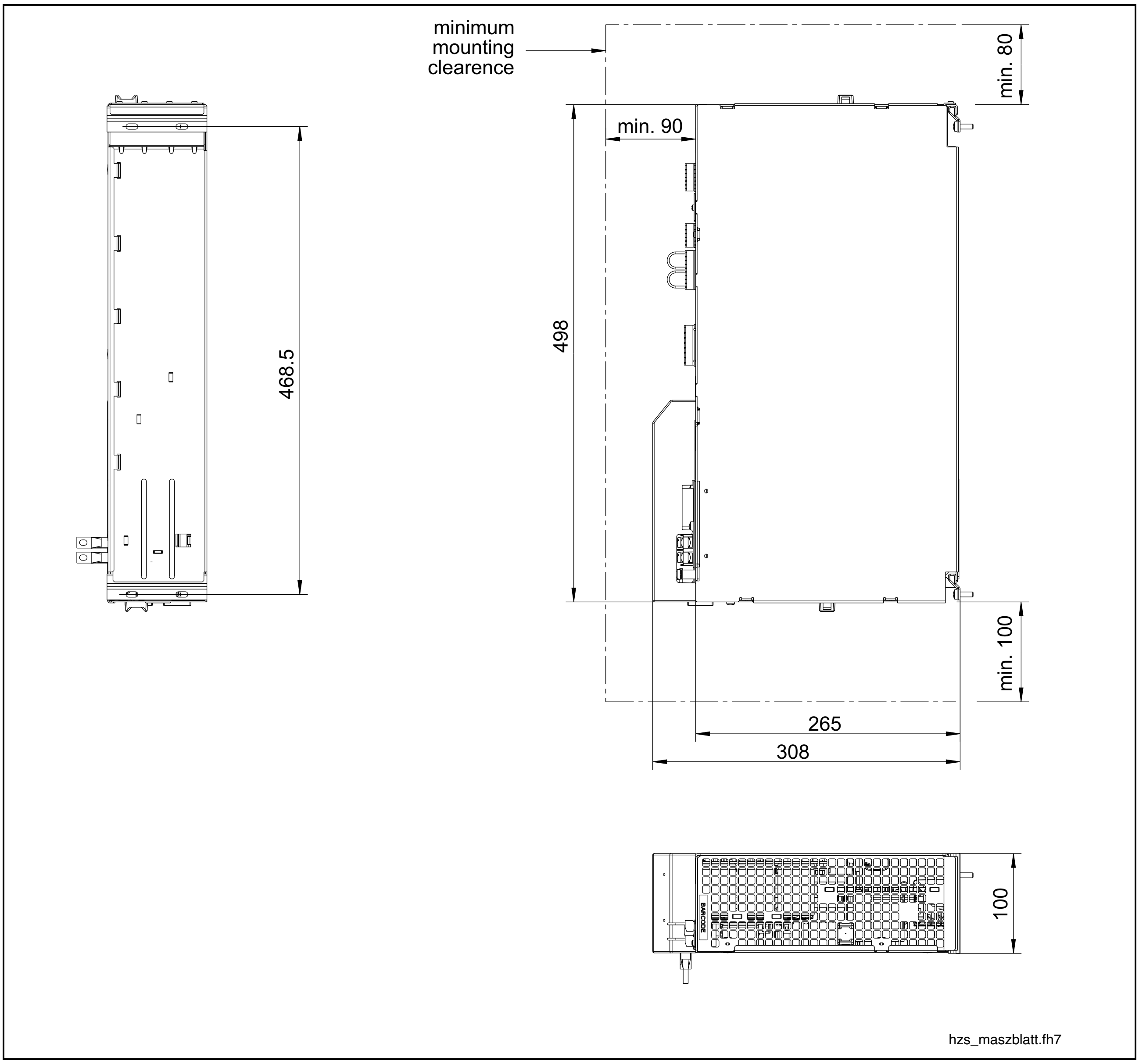


Fig. 6-39: Dimensional drawing HZS01.2

Overall connection diagram

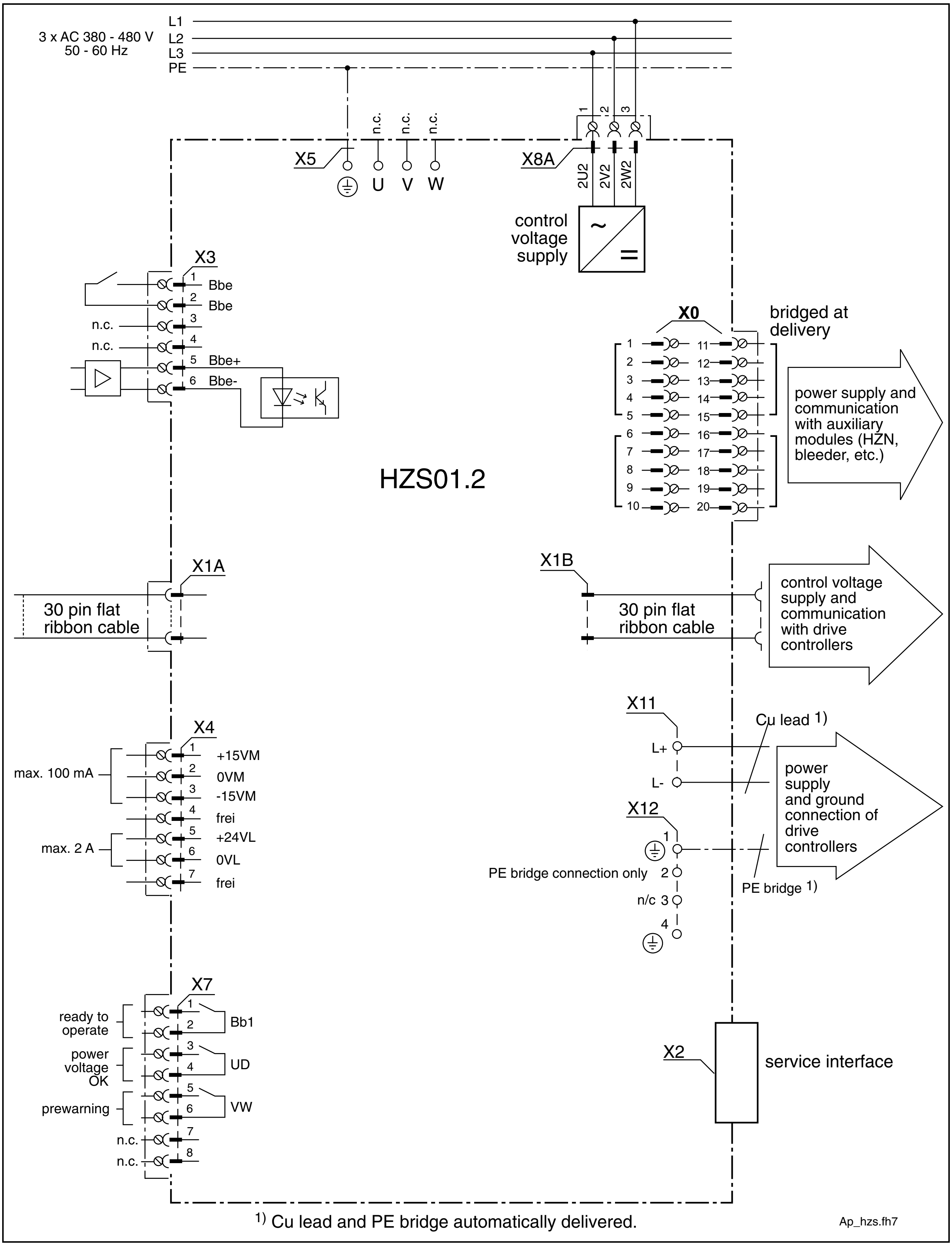


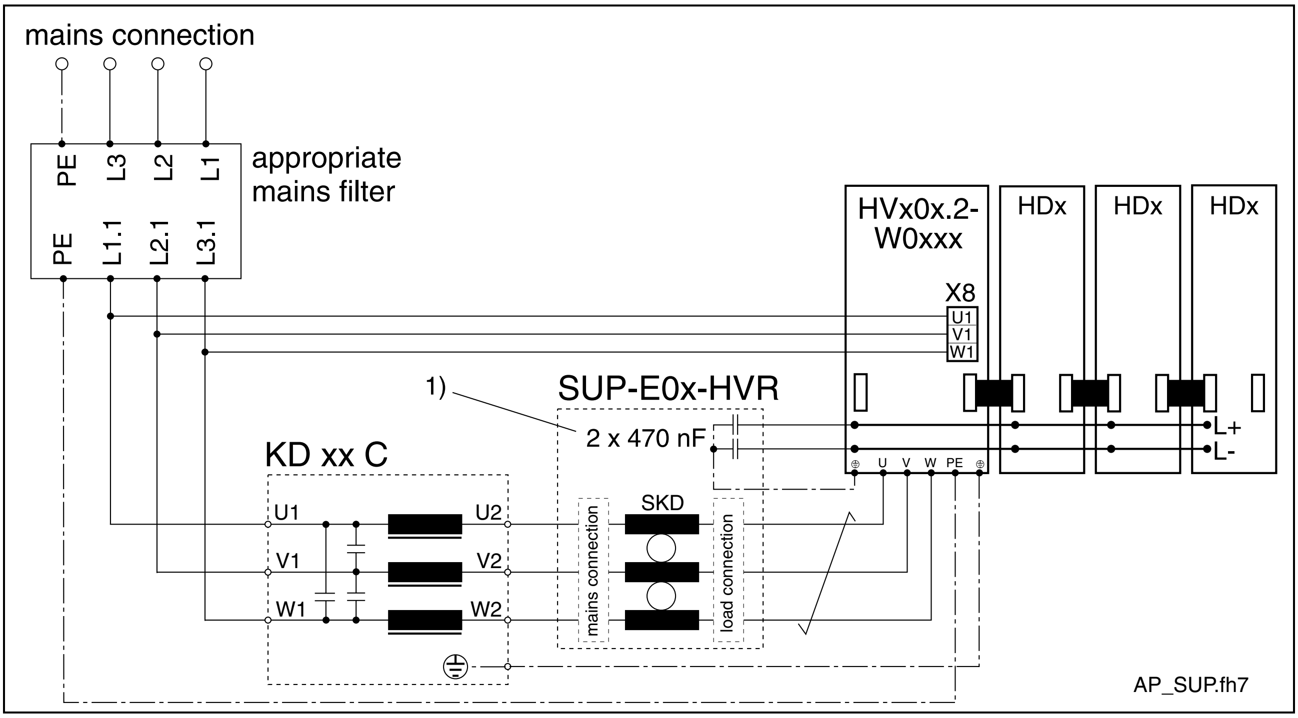
Fig. 6-40: Overall connection diagram HZS01.2

6.6 Additional components SUP-E0x

Application The additional components "SUP-E0x-HVR" can be used together with power supply units of the HVR and HVE series.

It is necessary to use "SUP-E0x-HVR"

- when a specific characteristic value is exceeded with multi-axis operation (only with HVE). See chapter 8.11 "Applications with HVE0x.2-W0xx power supply unit".
- for reducing the leakage current when using residual-current-operated protective devices
- when the HVR is operated on asymmetric mains, e.g. in the case of outer conductor ground connection In this case, HZF are not allowed for reducing interference emission.
- in order to reduce distortion of the mains voltage due to leakage currents



1) e.g. NFD03.1 for symmetric mains
2) The two capacitors are not required for SUP-E08-HVR and aren't contained in the scope of supply either.

Fig. 6-41: Example of connection SUP-E0x with HVR
(when HVE is used, KD xx – C is not required)

Technical data

Designation	Symbol	Unit	SUP-			
			E05-HVR	E06-HVR	E07-HVR	E08-HVR
Nominal current	I_{nenn}	A	18	45	80	140
Nominal voltage	U_{nenn}	V	system voltage DIAX04 or 380 - 480 (±10%)			
Frequency	f	Hz	50...60 (±2%)			
Power loss						
Power loss at maximum continuous power and maximum number of axes	P_v	W	150	200	300	500
Connection of current compensated choke						
Type	-	-	connector sleeve			ring cable lug 50 mm^2/M10
Length of strands	l	mm	600			250
Voltage stability of strands	U	V	600			
Connection cross section	A	mm^2	4 / AWG 10	10 / AWG 6	25 / AWG 4	50 / AWG 2
Weight	m	kg	10	12	14	16
Capacitor						
Capacity	C_{nenn}	nF	470			not contained
Nominal voltage	U_{nenn}	V	900			
Weight	m	g	40 each			
Connections	-	-	to L+ resp. L- via flat push-on connector 6,3 x 0,8; to ground via stud M8			
Connection cross section	A	mm^2	2,5			
Required dielectric strength of strands	U	V	600			

Fig. 6-42: Technical data SUP-E0x-HVR

Current compensated choke

Connection

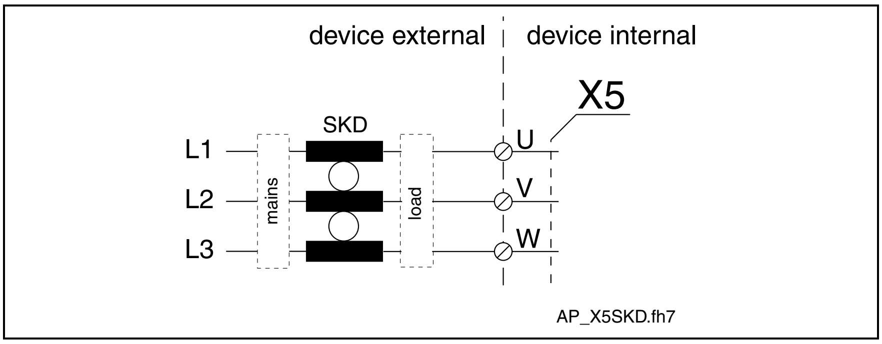


Fig. 6-43: Connection of current compensated choke

Component	Mains connection			Load connection		
SUP-E05-HVR SUP-E06-HVR SUP-E07-HVR	22	24	26	21	23	25
SUP-E08-HVR	L1	L2	L3	L1.1	L2.1	L3.1

Fig. 6-44: Connection designation of current compensated choke

Dimensions

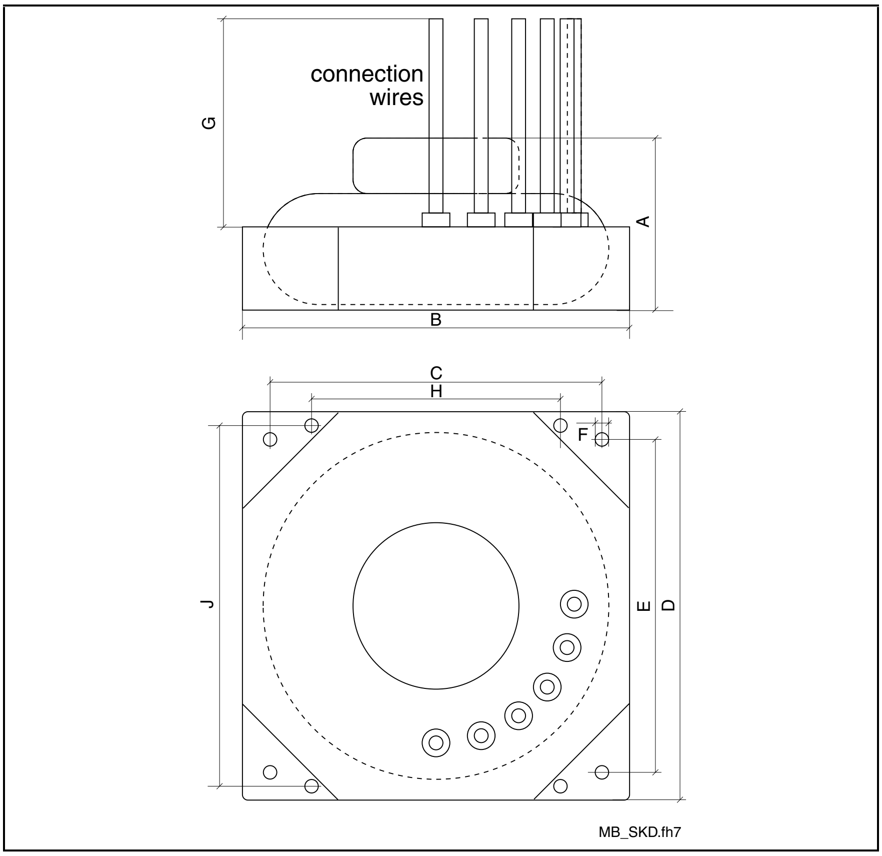


Fig. 6-45: Dimensional drawing

Choke	A	B	C	D	E	F	G	H	J
SUP-E05-HVR	100	230	200	230	200	6,5	600	--	--
SUP-E06-HVR	140	250	200	250	200	6,5	600	--	--
SUP-E07-HVR	170	250	200	250	200	6,5	600	--	--
SUP-E08-HVR	210	300	280	240	180	6,5	250	150	220

Fig. 6-46: Dimensions

Capacitor

Capacitor connection

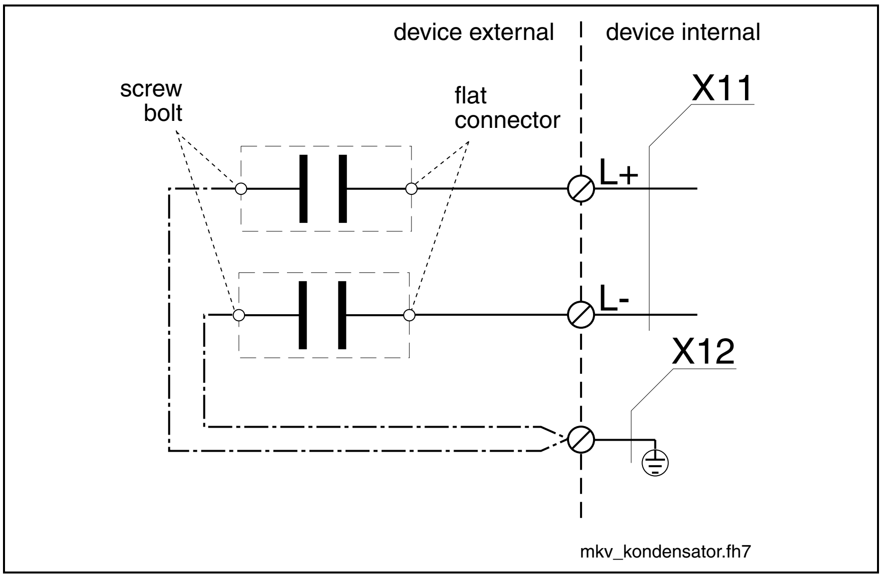


Fig. 6-47: Capacitor connection

Dimensional drawing

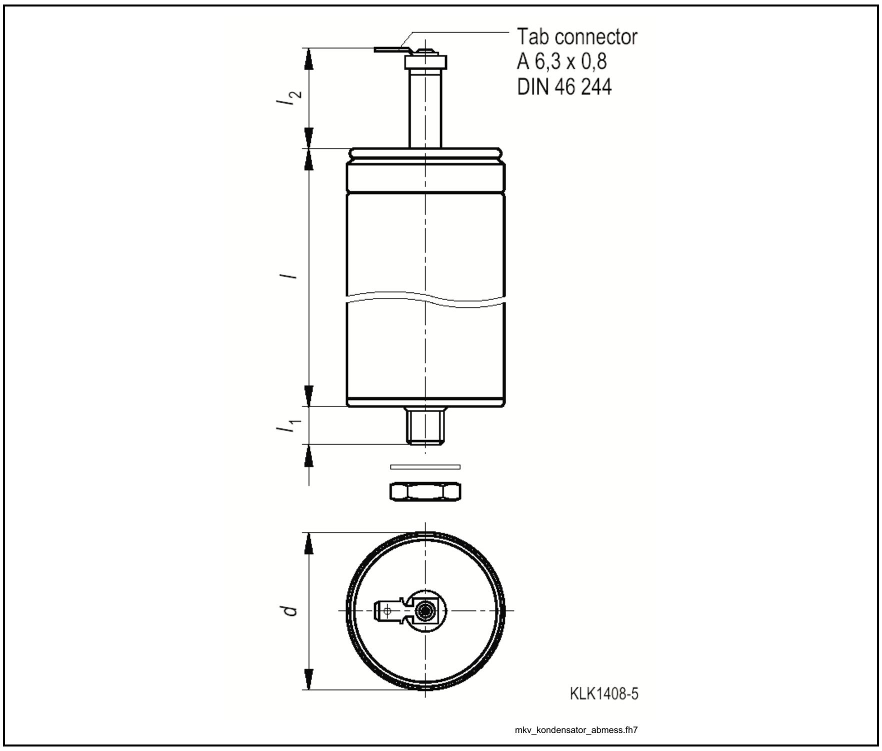


Fig. 6-48: Dimensional drawing

	d	l	l_1	l_2
Dimensions [mm]	25	57	8	15

Fig. 6-49: Dimensions

Fixing

Fixing the capacitor:

- screw M8
- tightening torque: 4 Nm

Scope of supply

The additional components SUP-E0x-HVR are supplied with:

- 1 piece current compensated choke
- 2 pieces capacitor 470nF/900V (except for SUP-E08-HVR)
- accompanying note with connection diagram

7 Mounting

7.1 Control cabinet planning

Conditions of use

Ambient temperature and installation elevation

The nominal data for the power supply units (see chapter 4) and additional components (see chapter 6 "Additional modules and components") apply to

- ambient temperature range of +5 °C to +45 °C and
- installation elevation of 0 to 1000 m above sea level.

Note: All components are built-in devices and only suited for installation in a control cabinet or housing.

Note: If the power supply unit or additional components are used in situations that exceed this range, then the "load factors" must be taken into account. This derates the power data.

Note: The derating begins with elevations of more than 1000 m. With elevations of more than 2000 m, additional external components must be provided for voltage limitation (1.5 kV). Depending on the applicable regulation (DIN 0110, CSA, NEMA), an isolating transformer is possibly required to limit the mains voltage.

CAUTION

Damage to the units due to operation outside of the specified conditions of use!

⇒ Those power supply units or additional components operated outside of the specified conditions of use can be damaged. Doing so also means that the guarantee will be forfeited!

CAUTION

Damage to the units due to overloaded power supply unit!

⇒ If you want to use power supply units or additional components outside of the specified conditions of use, please check first, whether the performance data are sufficient. Please check by reading the load factor(s) from the diagrams in Fig. 7-1 and follow the instructions below!

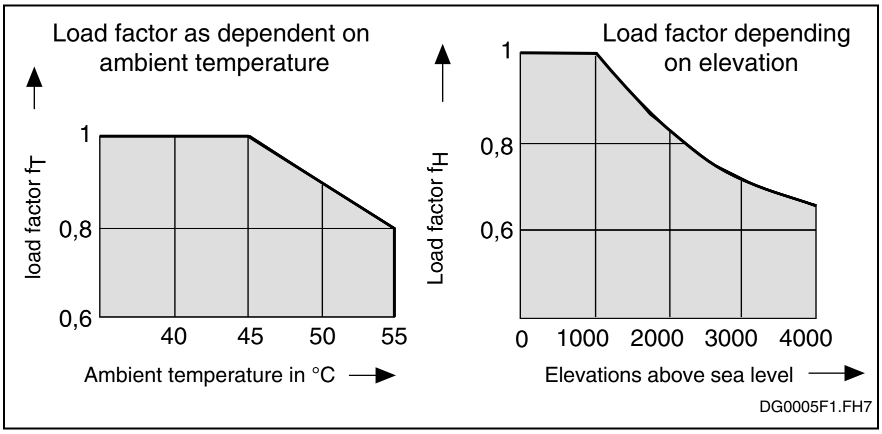


Fig. 7-1: Load factor as dependent on ambient temperature and elevation

Case 1:

The ambient temperature exceeds the nominal data

- or -

the elevation exceeds the nominal data:

1. Determine the load factor from the figure above.
2. Multiply the nominal data listed in the technical data with the load factor which has been determined.
3. Ensure that the derated nominal data is not exceeded by your application.

Case 2:

The ambient temperature exceeds the nominal data

- and -

the elevation exceeds the nominal data:

1. Determine the load factors from the figure above.
2. Multiply the determined load factors.
3. Multiply the nominal data indicated in the technical data by the load factor calculated in step 2.
4. Ensure that the derated nominal data is not exceeded by your application.

Protection category

The power supply unit and the additional components meet the requirements as specified for protection category IP10, as per IEC 529.

Mounting of the power supply unit

The power supply unit and the additional components have been designed for mounting into a control cabinet or closed housing (as per EN 50 178, edition dated 4/98).

Note: Take the safety directives governing protection upon contact into account when laying out the control cabinet. For industrial applications, also see EN 60 204.

Loss of heat in the control cabinet

With HVE and HVR types and additional components, basic losses due to control voltages, power losses and probable bleeder losses arise. Basic, power and bleeder losses produce a loss of heat in the control cabinet and might not be carried off over the control cabinet surface. They need to be carried off by an air conditioning unit.

The bleeder power loss depends on the rotary drive energy, the potential energy of non balanced masses and the programmed machine cycle (see chapter 5.5).

In the following you'll find the calculation of a heat loss in the control cabinet. The data for the calculation stem from this documentation except for the motor data and the drive and control system data.

Example calculation

The arising losses of heat shall be calculated for the following drive equipment:

Units in the control cabinet

Power supply unit	**HVR02.2-W010N**, DC bus continuous power 10 kW; calculated load 8 kW
Combining filter and commutation choke	Combining filter **HZF01.1-W010N**, Commutation choke **KD30**
Drive 1	Motor **2AD104B-...-CS** with drive controller **HDS02.2-W040N** Continuous power 5 kW; Motor constant current 12 A
Drive 2	Motor **MHD093C-035** with drive controller **HDS02.2-W040N** Constant torque 23 Nm; Motor constant current 18,5 A
Drive 3	Motor **MHD093C-035** with drive controller **HDS03.2-W075N** Constant torque 23 Nm; Motor constant current 12 A
Drive 4	Motor **MHD112B-024** with drive controller **HDS03.2-W100N** Constant torque 28 Nm; Motor constant current 21,9 A

Basic losses and load dependent losses arise in the power supply unit, the choke, the combining filter and in the drive and control systems.

Basic losses

Type of unit	Designation	Basic loss [W]
Power supply unit	HVR02.2-W010N	150
Combining filter	HZF01.1-W010N	100
Commutation choke	KD30	150
Drive controller	HDS02.2-W040N	45*
Drive controller	HDS02.2-W040N	45*
Drive controller	HDS03.2-W075N	55*
Drive controller	HDS03.2-W100N	70*
	Sum	**615 W**

*: Basic losses consist of the losses for the control voltage and the basic losses of the power supply.

Fig. 7-2: Basic losses of the units installed in the control cabinet

Load dependent losses

The calculation of load dependent losses is based on the fact that the DC bus is loaded with 8 kW (constant load) and the motor load corresponds to the respective motor constant torque or motor continuous power.

Note: It is advisable for main drive applications to start from each motor constant torque/motor continuous power.

If the calculated effective torque for the feeding application is smaller than the motor constant torque, the motor current can be reduced proportionally.

Type of unit	Designation	Load dependent losses [W]
Power supply unit	HVR02.2-W010N	8 kW * 15 W/kW = 120 W
Combining filter	HZF01.1-W010N	8 kW * 10 W/kW = 80 W
Commutation choke	KD30	8 kW * 15 W/kW = 120 W
Drive controller	HDS02.2-W040N	12 A * √2 * 5 W/A ≈ 85 W *1
Drive controller	HDS02.2-W040N	18,5 A * 5 W/A ≈ 93 W
Drive controller	HDS03.2-W075N	18,5 A * 4,625 W/A ≈ 86 W
Drive controller	HDS03.2-W100N	21,9 A * 4,6 W/A ≈ 101 W
	Sum	**685 W**

*1: With regard to asynchronous motors, the technical data include the effective value of the phase-to-phase current as motor nominal current. The loss factor (W/A) indicated in the technical data of the control units refers however to the peak value so that the motor nominal current is multiplied by √2.

Fig. 7-3: Load dependent losses of the units installed in the control cabinet

Total power loss

The total power loss in the drive package is:

Basic losses + load dependent losses =

615 W + 685 W = 1300 W = P_{vGes}

As a rule, only part of the power loss may be carried off over the control cabinet surface. Then, it is necessary to use a cooling unit so that the remaining power loss may be carried off:

$$P_{Klima} = P_{vGes} - P_{surf} = P_{vGes} - [A * K * (45^\circ - T_{max})]$$

P_{vGes}: Total power
P_{Klima}: Power to be carried off via cooling unit [W]
P_{surf}: Power carried off over control cabinet surface [W]
A: Isolated control cabinet surface [m²]
K: Heat transmission coefficient (approx. 5 ... 6 W/m²)
T_{max}: Maximum ambient temperature

Fig. 7-4: Calculation of the power loss to be carried off via cooling unit

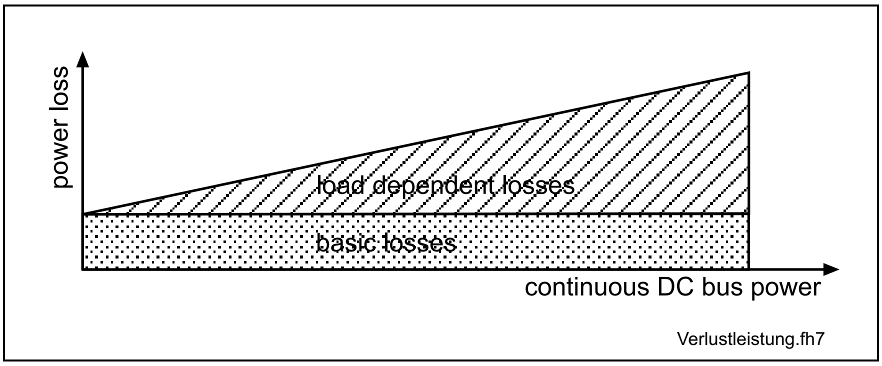


Fig. 7-5: Power loss depending on the DC bus continuous power

The use of cooling units

The power supply unit without reduced nominal data may only be operated up to an ambient temperature of 45 °C. This means that it may be necessary to use a cooling unit.

Avoid dripping and spraying water

The use of cooling units always means that condensation will occur!

CAUTION

When using cooling units, damages to the power supply unit may be caused by condensation water!

⇒ Always arrange the cooling units so that condensation cannot drip into or onto electronic equipment.

⇒ Position cooling units so that the cooling unit blower does not blow condensation which has possibly collected onto electronic equipment.

Note: For the arrangement of a cooling unit please see the following figures too.

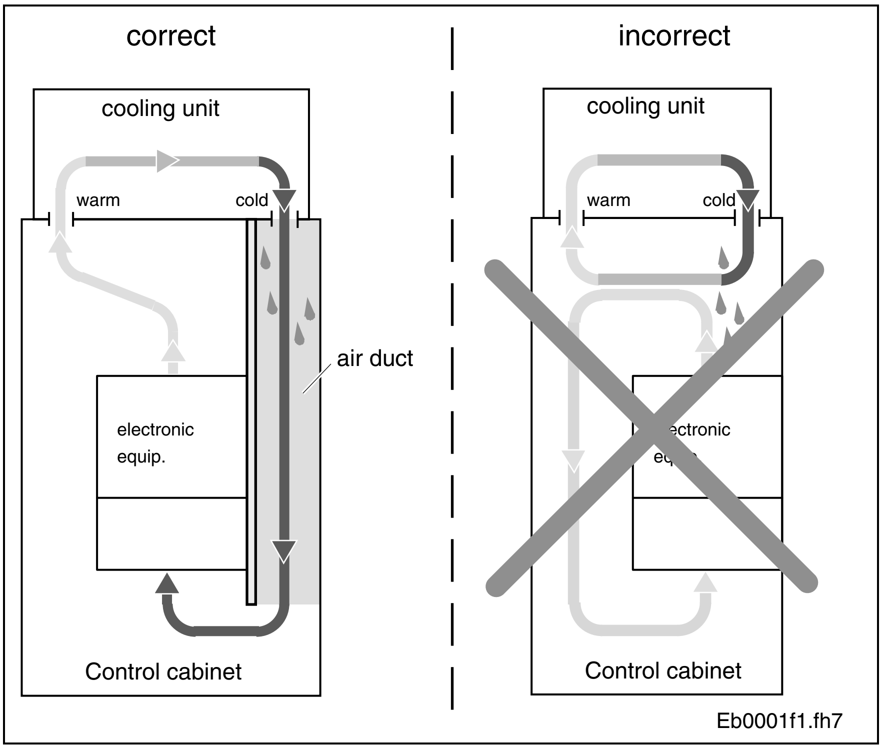


Fig. 7-6: Cooling unit arrangement on the control cabinet

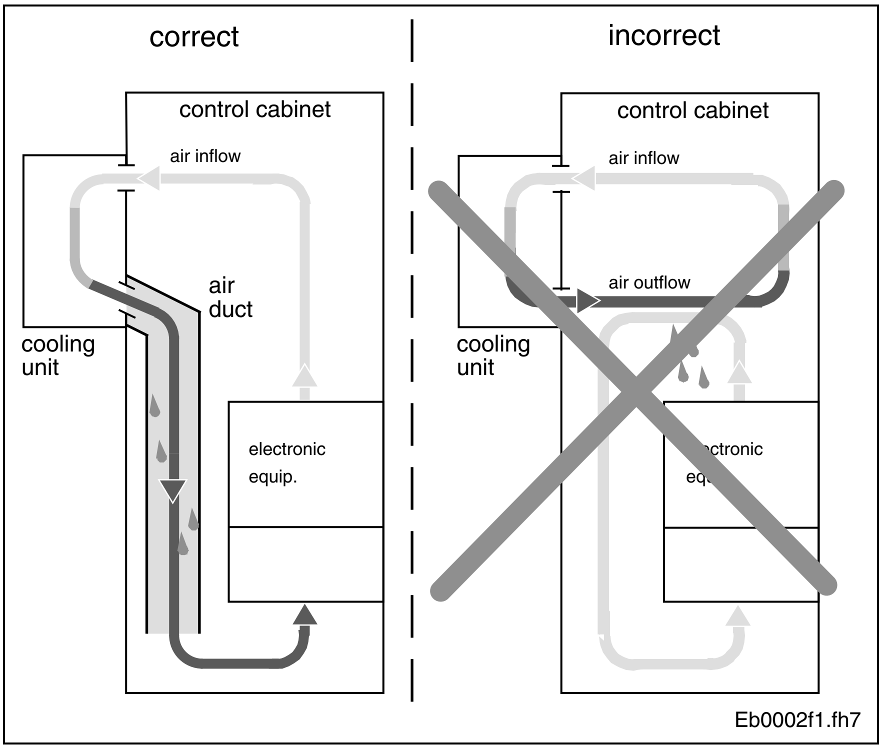


Fig. 7-7: Cooling unit arrangement on the front of the control cabinet

Avoiding condensed water

CAUTION

When using cooling units, damages to the power supply unit may be caused by condensed water!

⇒ Set the cooling units at 40 °C and no lower!

⇒ Set cooling units with follow-up temperature in such a way that the inside temperature of the control cabinet does not drop below the outside temperature. Set the temperature limit to 40 °C!

⇒ Use only well sealed control cabinets in order to avoid condensed water due to incoming humid outside air.

⇒ If the control cabinets are operated with open doors (during servicing or start ups), then ensure that the controllers are never cooler than the air within the control after the doors are closed as otherwise condensate could form. For this reason, continue to run the cooling unit even when the machine is shutdown until the temperature of the air in the control cabinet and that of the installed units is the same.

Construction of uncooled control cabinets

During operation of the units, power losses occur which heat the surrounding air in the control cabinet. If a power supply unit is operated in an uncooled and unventilated control cabinet, sufficient clearance must be provided around the unit or the drive package (at least 300 mm to the top and 100 mm to the sides). This clearance is necessary in order to produce an air circulation in the control cabinet (see also the next figure).

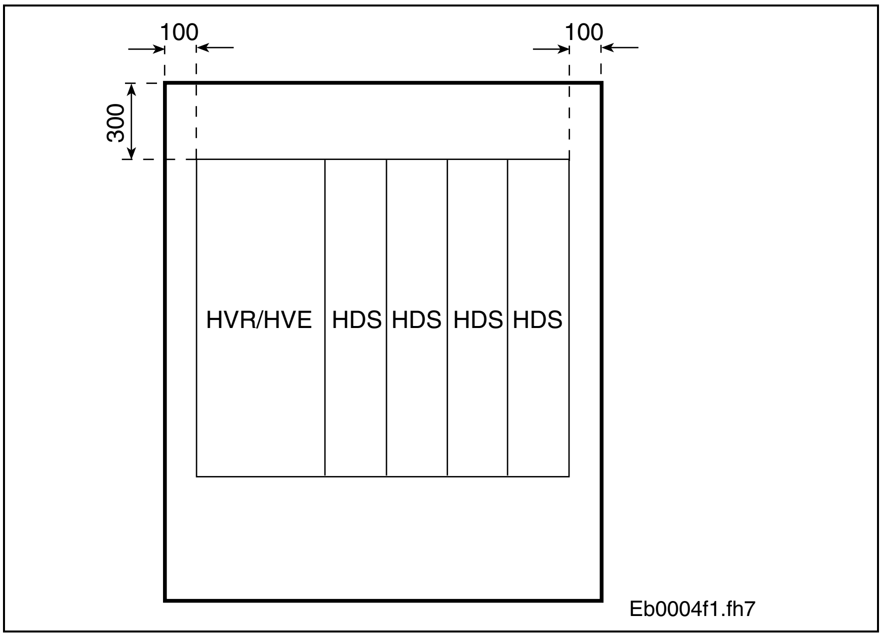


Fig. 7-8: Control cabinet (uncooled, unventilated) with drive package

CAUTION

Damage to the units due to too high temperatures!

⇒ Ensure air circulation within the control cabinet air by means of a circulation system. If circulation within the cabinet is not forced, then layers of air are generated within the cabinet the temperature of which depends on how close the layer is to the top of the cabinet, i.e., the closer the hotter. Without air circulation the air near the source of the heat continues to grow hotter to the point where extreme temperatures could occur. These temperatures can then damage the unit permanently.

Note: The cooling units inside the unit only cool internally. They do not have enough power to generate air circulation within the cabinet.

Efficiency factor of the air circulation system

The greatest affect is achieved if the air channel is conducted along an outside wall of the control cabinet so that the outside surface is used as a cooling surface. The blowers must blow upward. This may counter natural convection and the blowers internal blower, but it effects the rapid movement of cooler air out of the lower part of the cabinet into the upper, hotter layer of air thus countering pockets of heat very effectively.

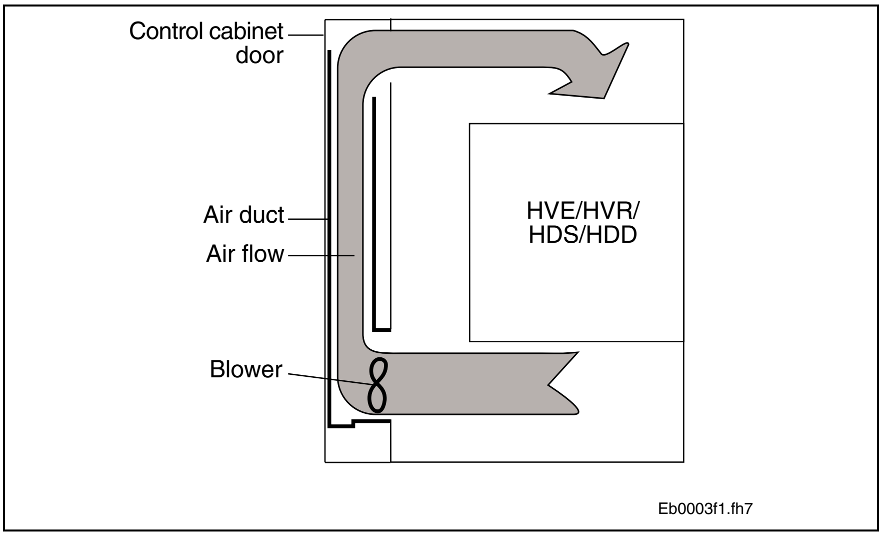


Fig. 7-9: Control cabinet with air circulation system

7.2 Mounting an HVE or HVR into the control cabinet

Mounting conditions

The power supply units HVE and HVR and their controllers are designed to be mounted into a control cabinet or closed housing. They meet the demands of protection category IP 10, as per IEC 529; i. e. the unit is protected against the ingress of objects with a diameter exceeding 50 mm.

It is not protected against

- water and
- intentional accessing, e.g., with a hand, but will keep larger body parts and surfaces out.

Mounting position

The unit is to mount in such a way that the mains connection is located at the bottom.

CAUTION

Damage to the units due to faulty mounting!

⇒ Install the unit as it is shown in the front views (chapter 7.4) so that the unit is prevented from overheating and damage due to faulty mounting.

Controller arrangement

Place those drives with high power and high currents as close to the supply unit as possible. Ideally, the axes should be distributed symmetrically on the left and right.

Given a total power of $P_{mges} > 36$ kW the axes must be arranged in accordance with their power equally on both the left and right sides (exception: single axis with $P_m > 36$ kW).

Maximum number of axes

The maximum number of axes is limited by the drive power of the control signals at X1

- and/or -

by the maximum power of the control voltage outputs of the unit (X8).

- Driver power of control signals: max. 12 axes
  (additional components, such as HZB are considered to be axes)
- Power of control voltage output: 300 W

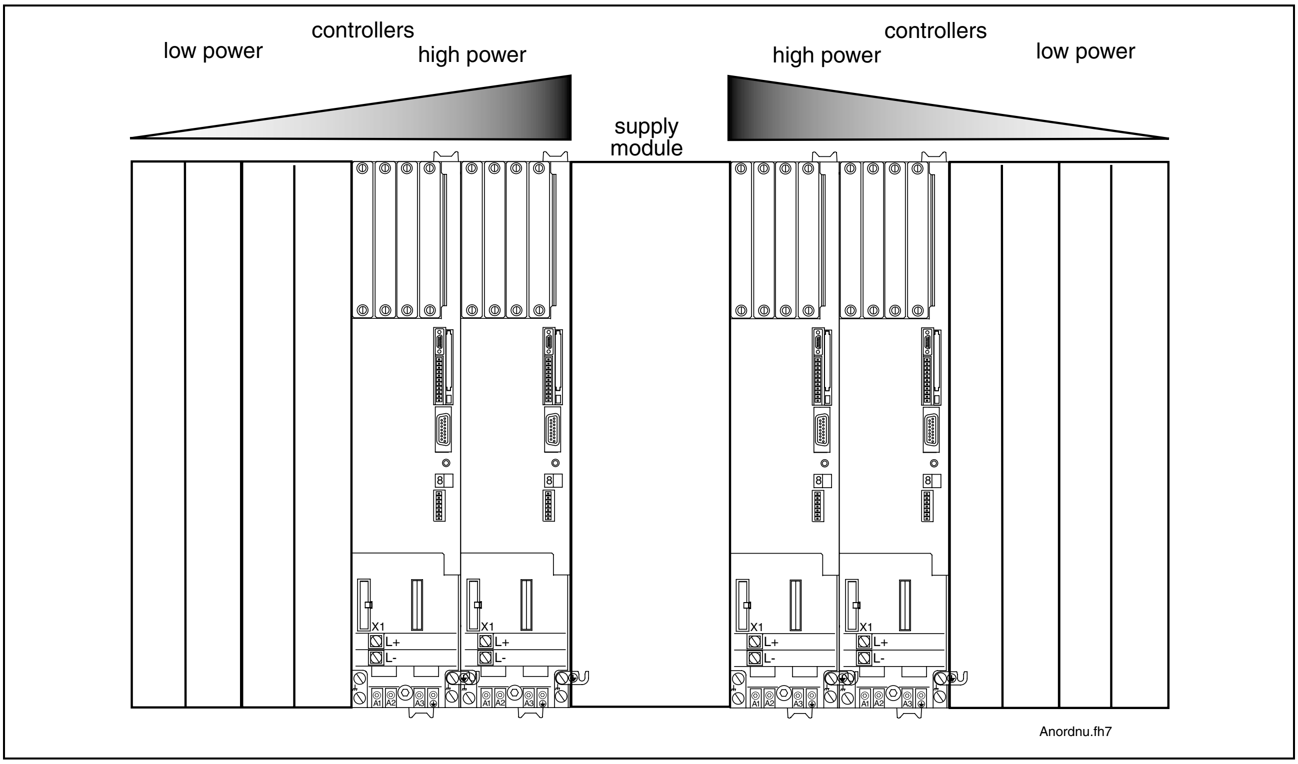


Fig. 7-10: Recommended unit arrangement within the control cabinet

Safety distance of the bleeder resistor

The bleeder resistor in the HVE heats up during operation, in the HVR after power shutdowns. Materials which could be damaged by heat, such as lines and cable ducts, must have a minimum clearance of 300 mm to the top and 40 mm to the aid and front.

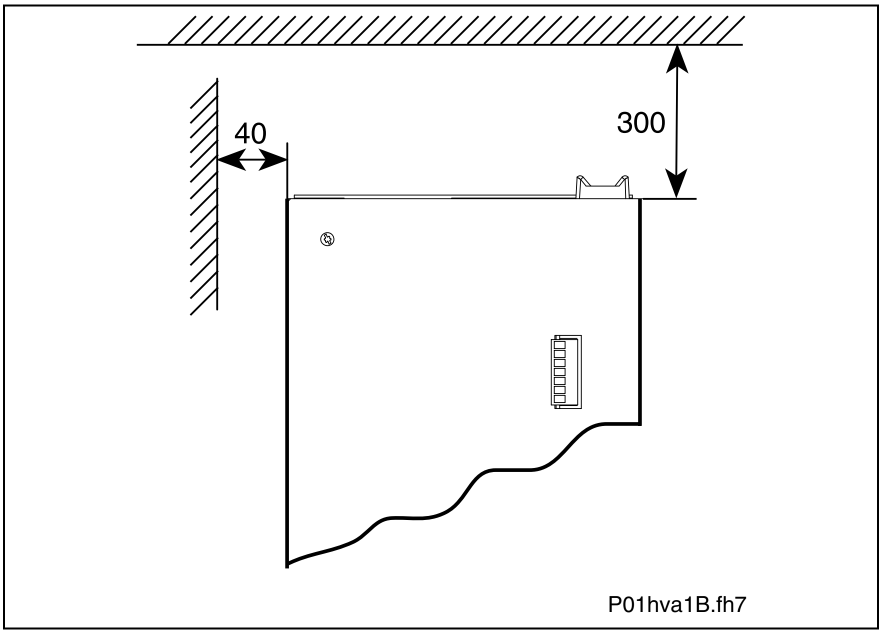


Fig. 7-11: Safety distance of the bleeder resistor

7.3 Optimal EMC installation

With regard to an optimal EMC installation, a spatial separation of the interference-free area (mains connection) and the interference susceptible area (drive components) is advisable. See the next figure in this respect.

Note: For an optimal EMC installation see also the connection hints (chapter 8.9).

HVE

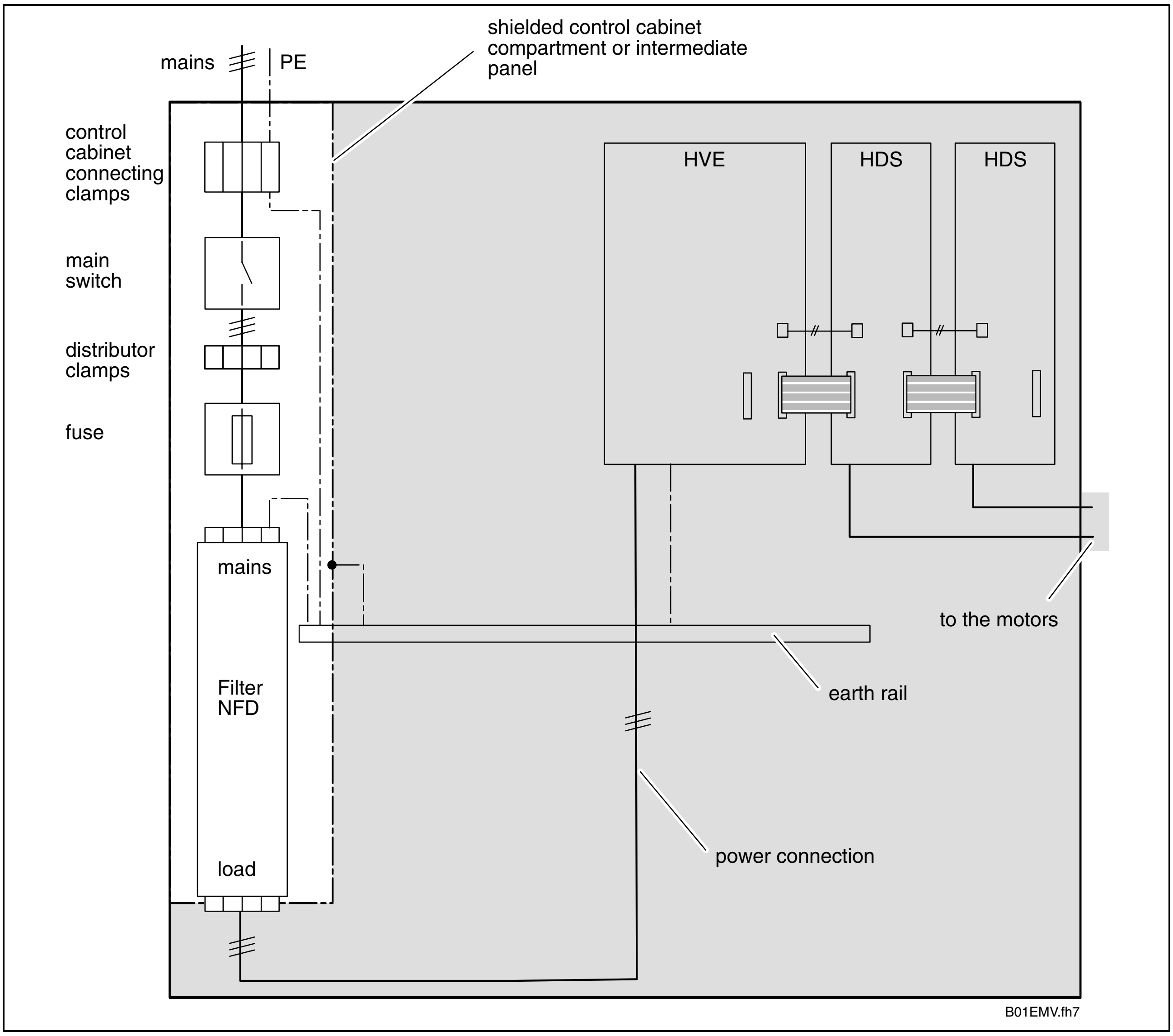


Fig. 7-12: HVE - Separation of interference-free and interference susceptible areas

HVR

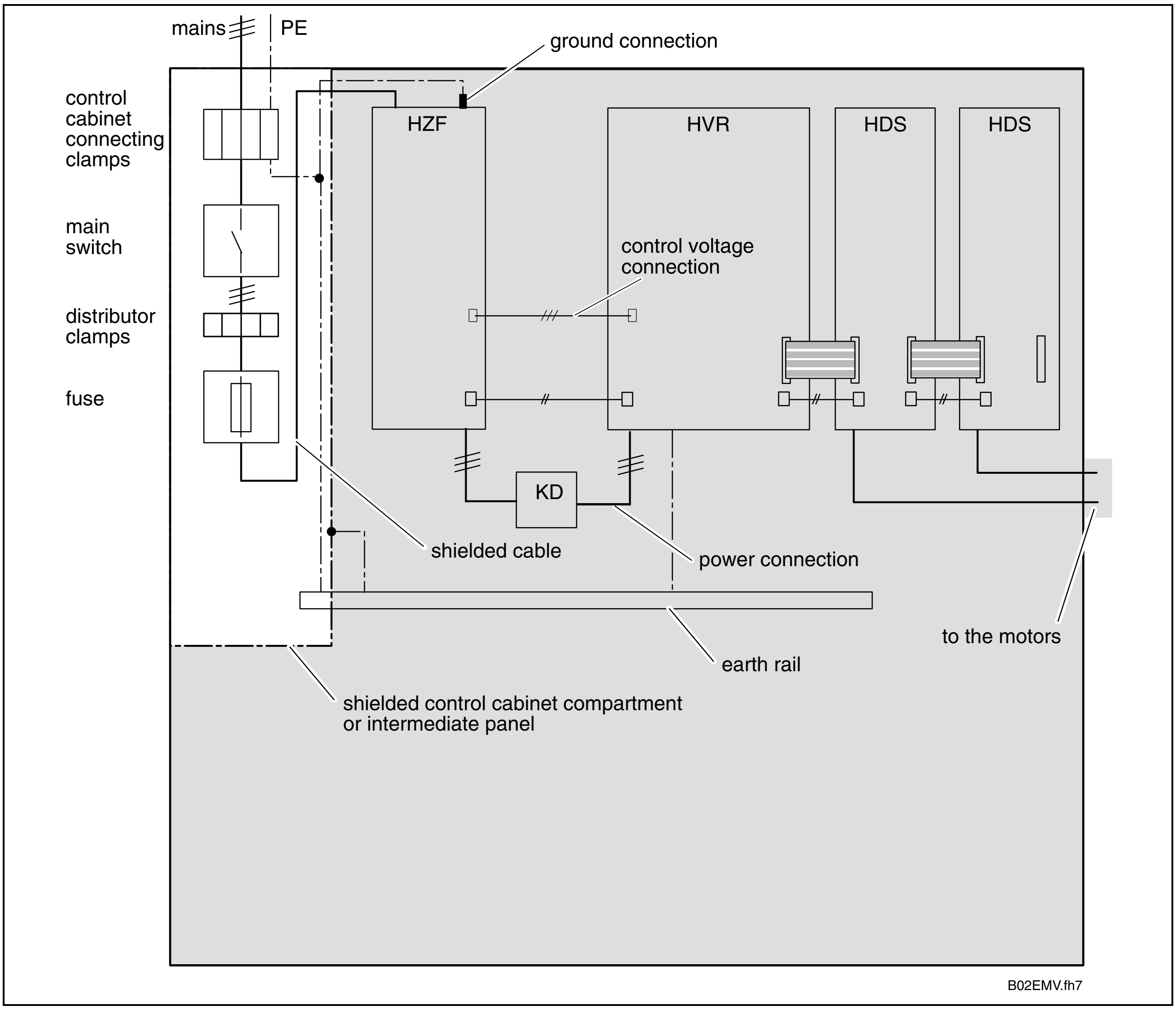


Fig. 7-13: HVR - Separation of interference-free and interference susceptible areas

7.4 Dimensional data

HVE02.2and HVE03.2

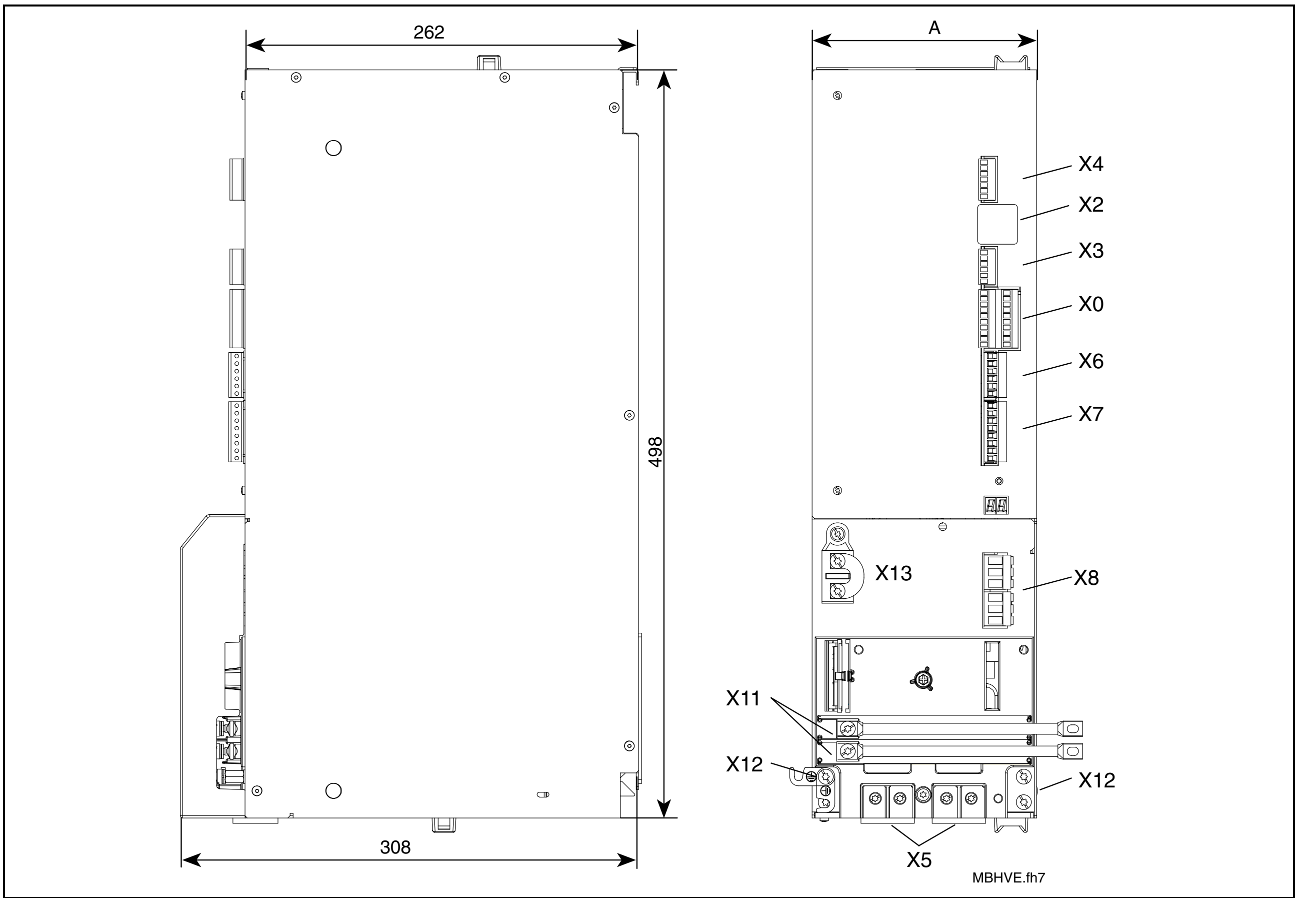


Fig. 7-14: Dimension drawings HVE02.2 and HVE03.2

Unit width A Unit types HVE02.2 have a width of 100 mm;
Unit types HVE03.2 have a width of 150 mm

Terminal designations see chapter 10

HVE04.2

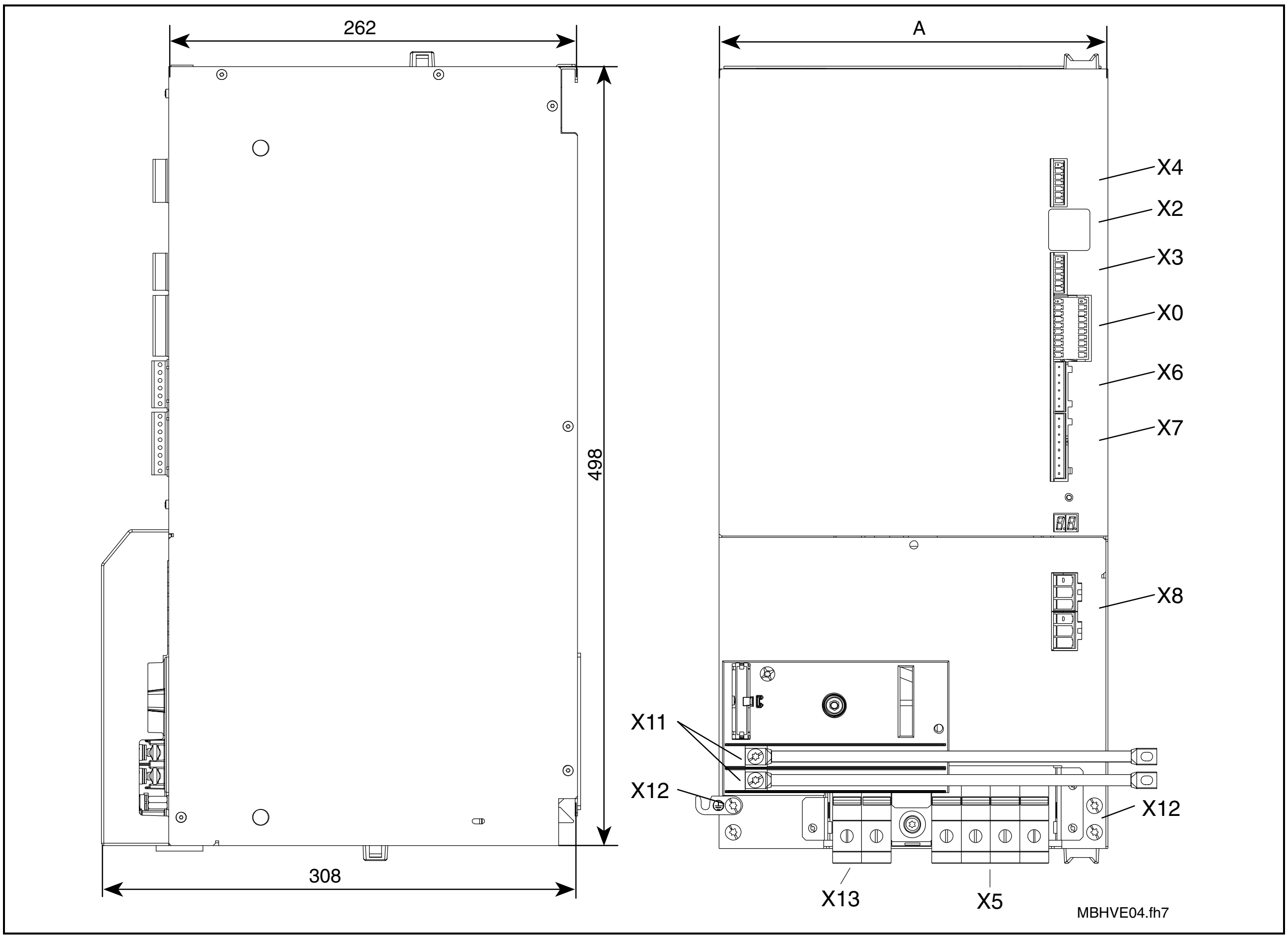


Fig. 7-15: Dimension drawing HVE04.2

Unit width A Unit types HVE04.2 have a width of 250 mm.

Terminal designations see chapter 10

HVR

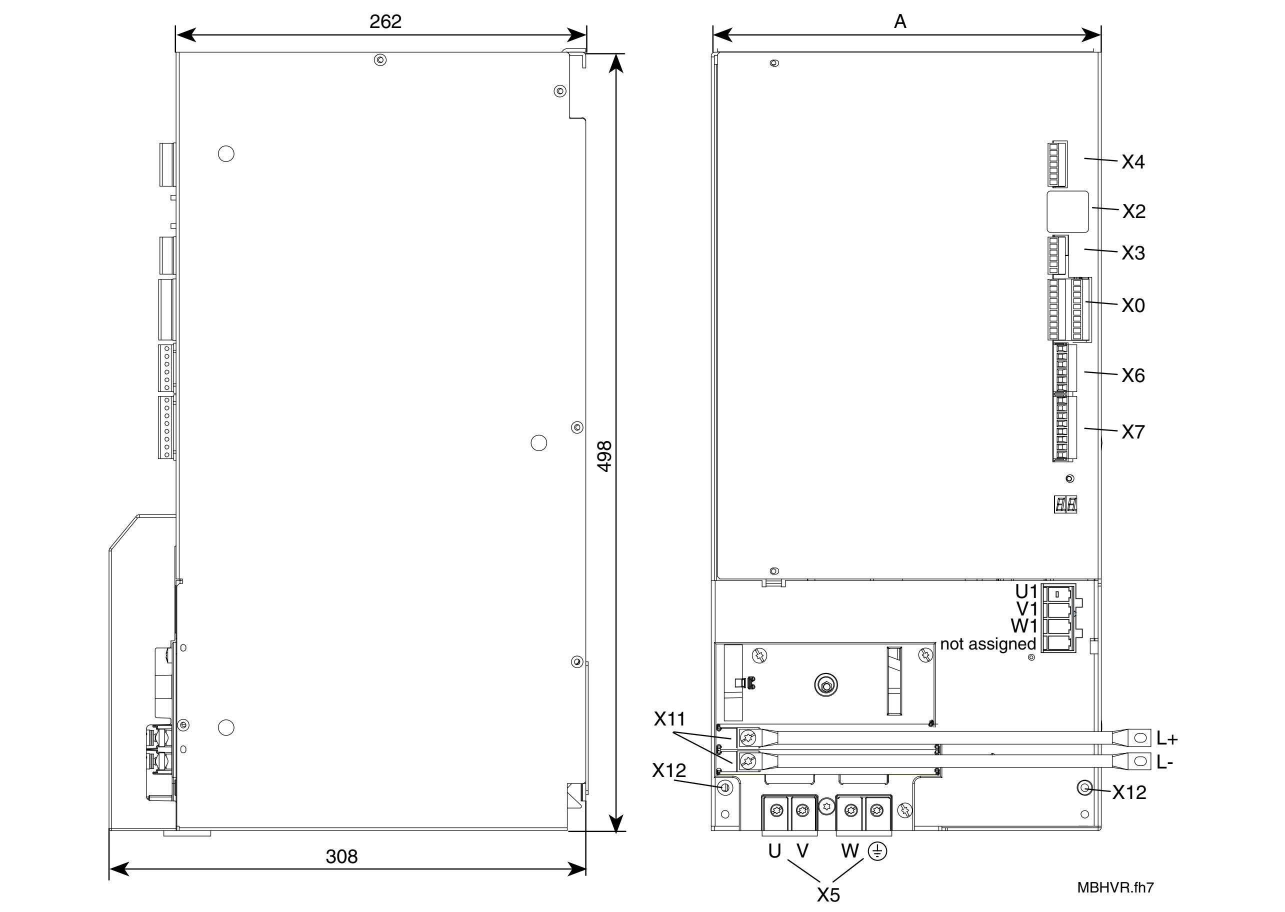


Fig. 7-16: Dimension drawing HVR

Unit width A Unit types HVR02.2 have a width of 175 mm;
Unit types HVR03.2 have a width of 250 mm

Terminal designations see chapter 10

HZF01.1-W010N

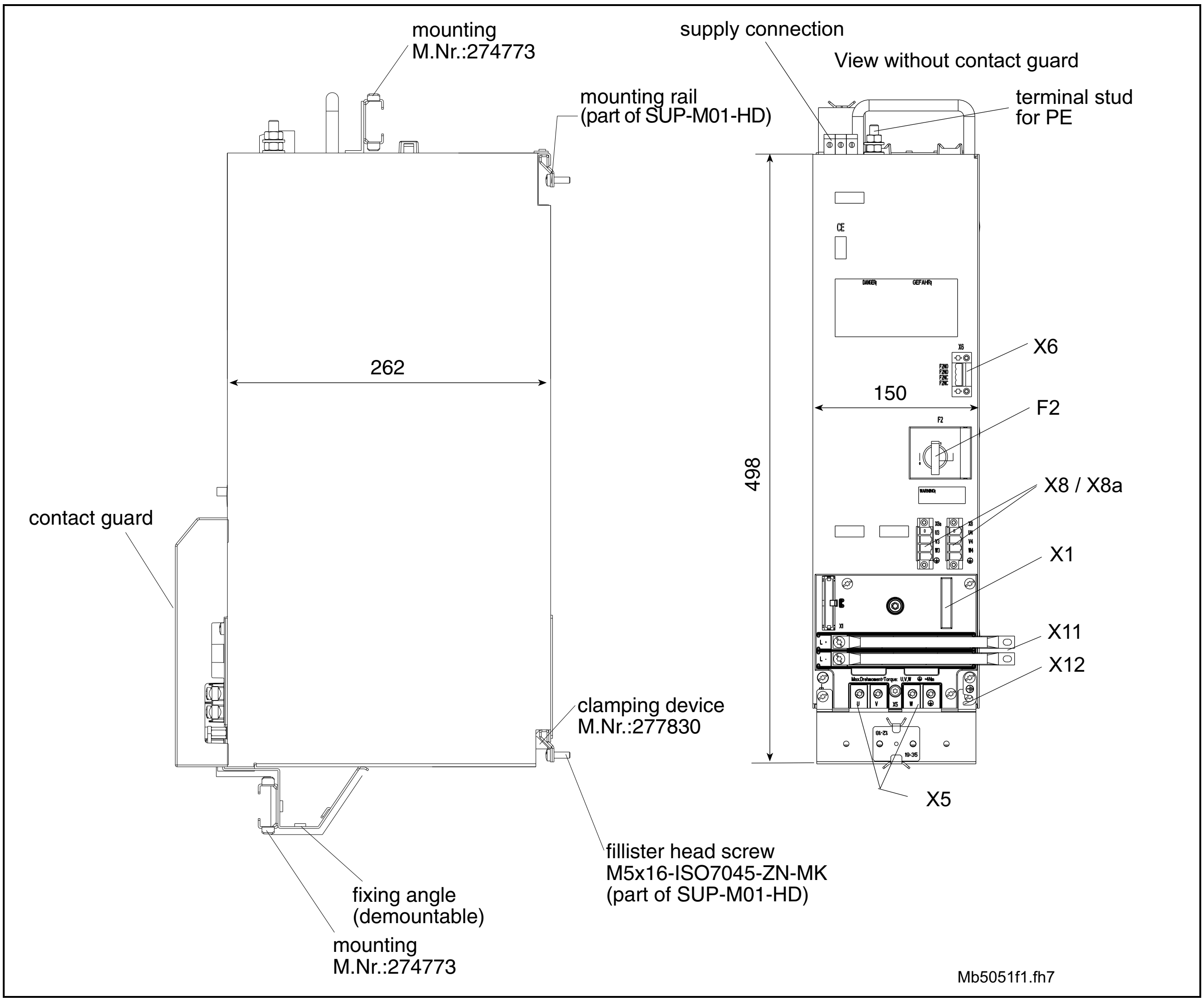


Fig. 7-17: HZF01.1-W010N

Terminal designations						
Supply connection	**X1**	**X5**	**X6**	**X8**	**X11**	**X12**
4	*1	6	2,5	1,5	*2	*2

*1: Flat cable firmly connected to the unit and/or free multiple contact strip for looping through the X1-connections

*2: This wiring material will be supplied

Fig. 7-18: Maximum cross sections for connection [mm²]

HZF01.1-W025N / HZF01.1-W045N

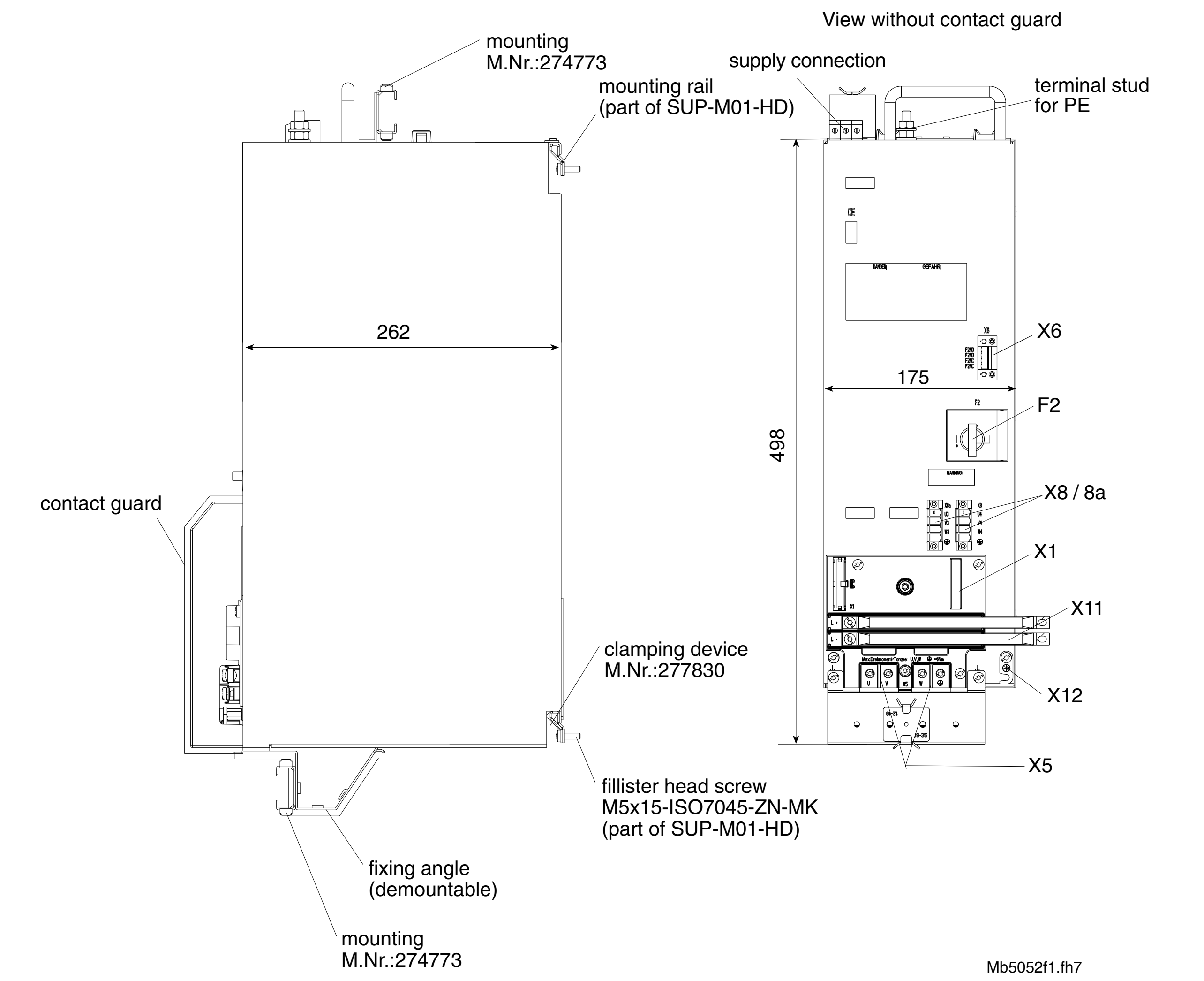


Fig. 7-19: HZF01.1-W025N / HZF01.1-W045N

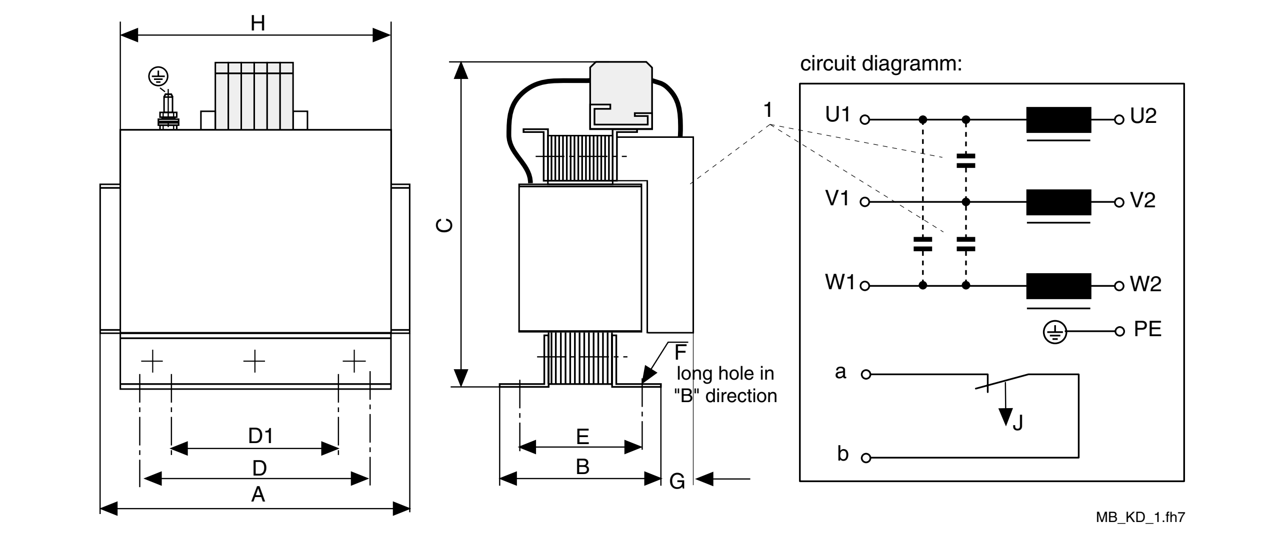
Terminal designations							
Type	**Supply connection**	**X1**	**X5**	**X6**	**X8**	**X11**	**X12**
HZF01.1-W025N	16	*1	16	2,5	1,5	*2	*2
HZF01.1-W045N	25	*1	25	2,5	1,5	*2	*2

*1: Flat cable firmly connected to the unit and/or free multiple contact strip for looping through the X1-connections

*2: This wiring material will be supplied

Fig. 7-20: Maximum cross sections for connection [mm²]

Commutation choke KD xx



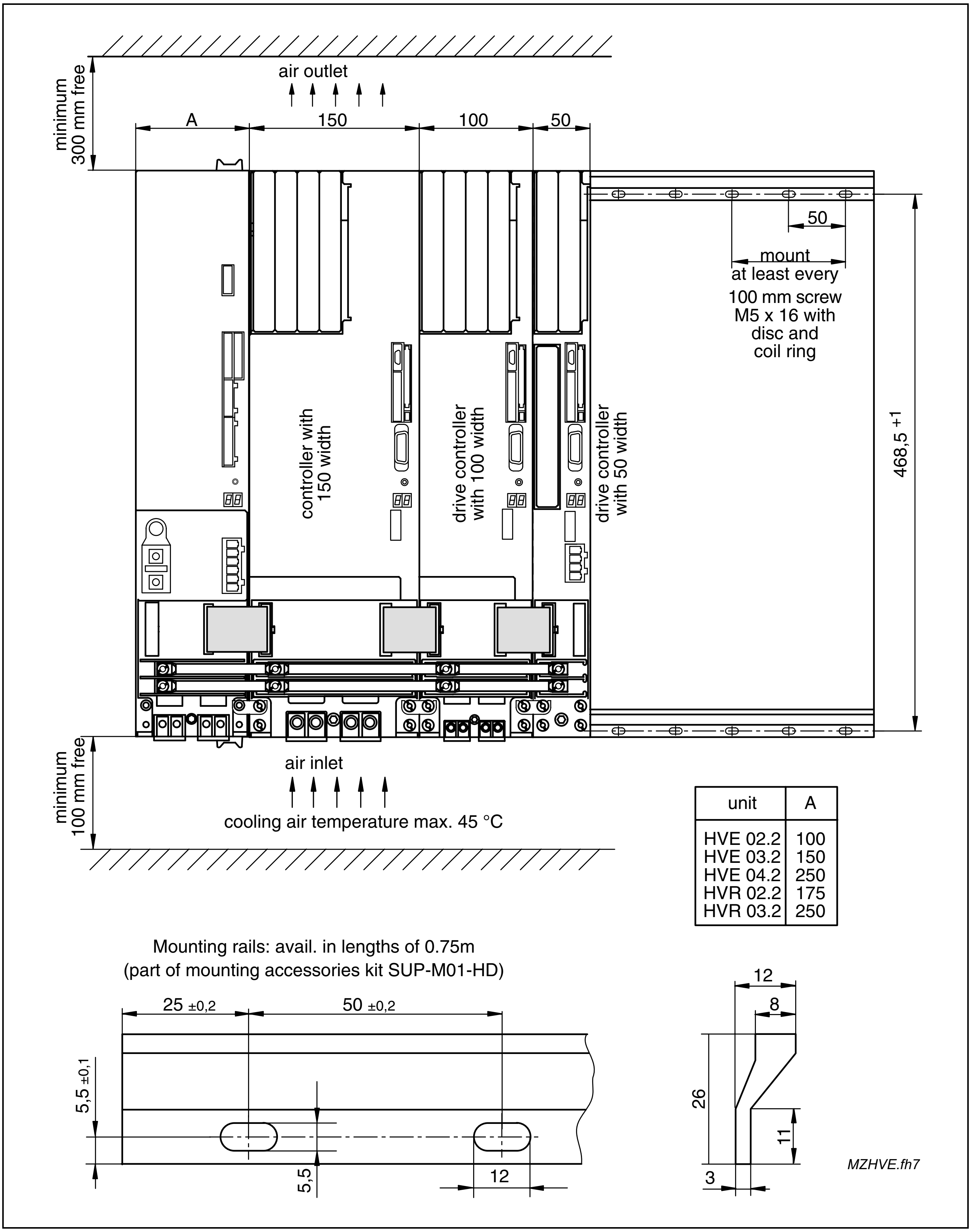
1) Capacitors are only available for the KD xx C type.

Type	Dimensions [mm²]									⏚	Terminal cross section [mm²]	Weight [kg]
	A	B	C	D	D1	E	F	G*	H*			
KD 30 / D 30 C	180	101/ 173*	205	125	-	76/ 148*	7 x 15	-	150	M5	10	8
KD 27 / D 27 C	285	138	280	170	110	108	11 x 18	50	285	M6	16	22
KD 28 / D 28 C	330	160	390	230	180	130	10 x 18	55	250	M8	35	42

*: KD xx C only

Fig. 7-21: Dimension drawing commutation choke KD xx / KD xx C

7.5 Mounting the unit



unit	A
HVE 02.2	100
HVE 03.2	150
HVE 04.2	250
HVR 02.2	175
HVR 03.2	250

Fig. 7-22: Mounting the unit

Notes

8 Electrical connection

8.1 Introduction

Note: This chapter includes recommendations of how to install the unit (by Rexroth as the manufacturer).

The manufacturer's circuit diagram is decisive for the installation of the unit!

Note: For the maximum cross sections of the connection lines please see the following chapters:

HVE, HVR, HZF, KD: chapter 7.4

GLD, HZB, HZK: chapter 6

8.2 Front view and terminal diagram

HVE

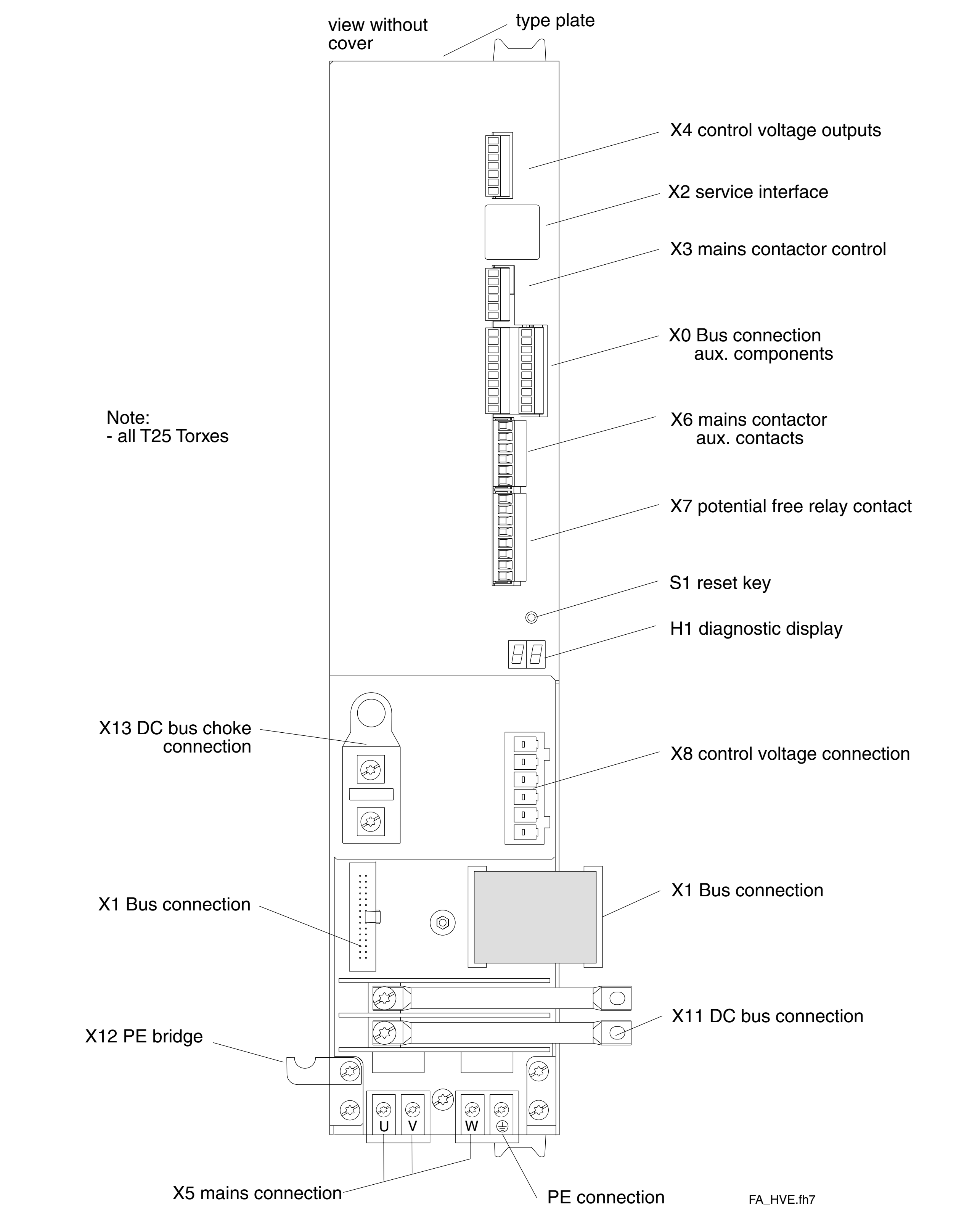


Fig. 8-1: Front views HVE02.2 and HVE03.2

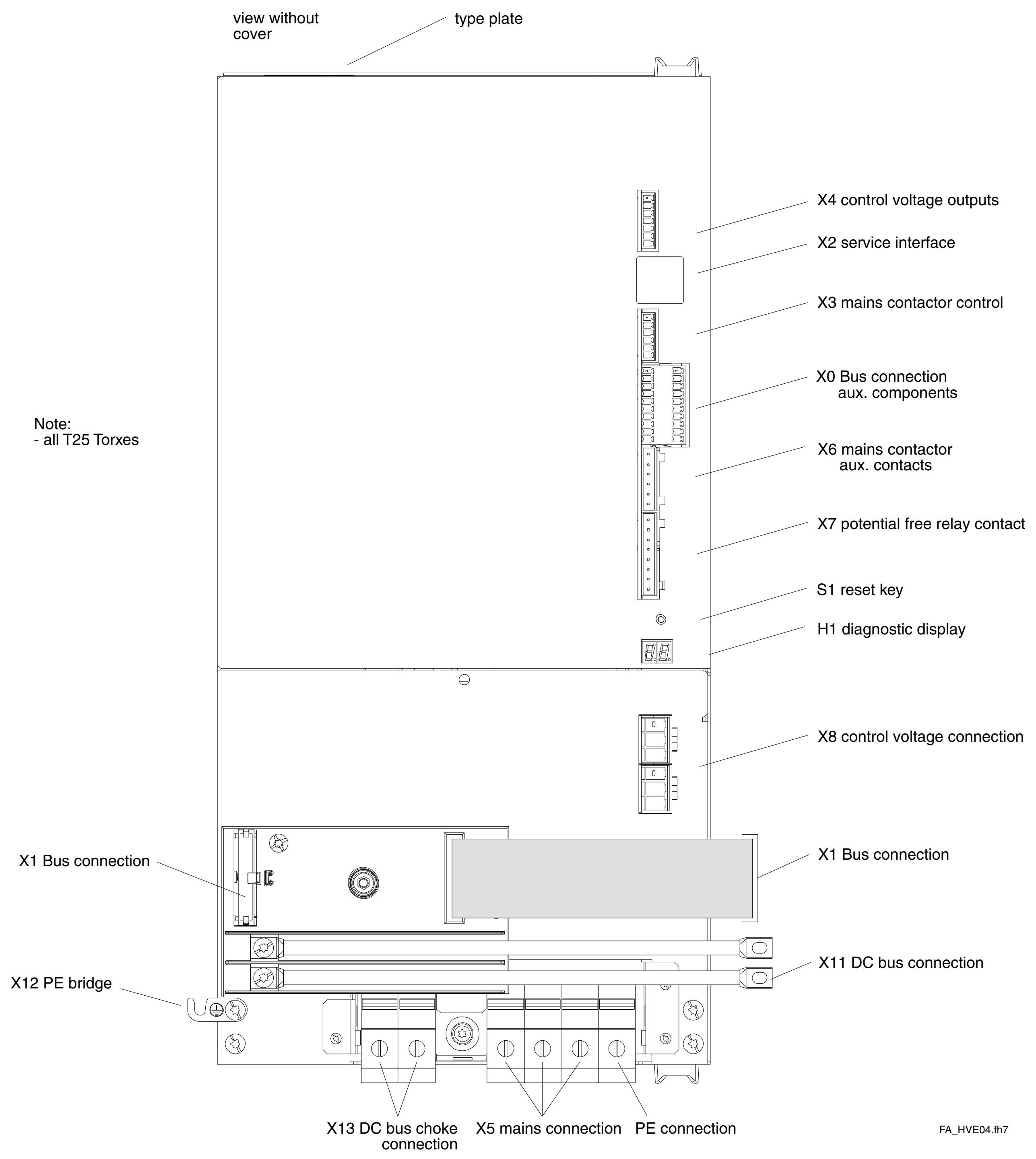


Fig. 8-2: Front view HVE04.2

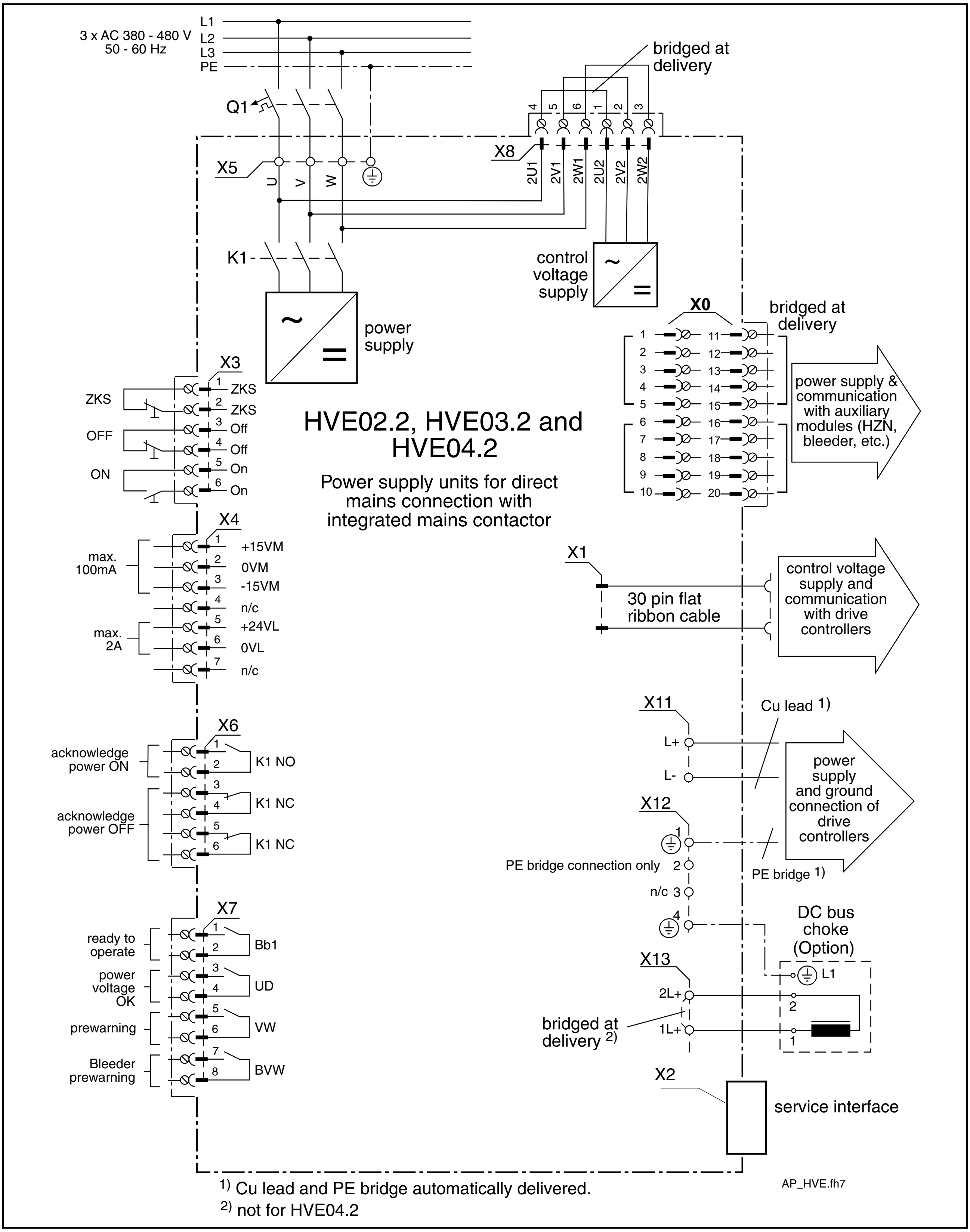


Fig. 8-3: Terminal diagram HVE02.2, HVE03.2 and HVE04.2

Note: Only for HVE04.2: If you do not use a DC choke, you have to establish a jumper from terminal X13.1L+ to X13.2L+. The cross section of the jumper must be at least AWG06 (10 mm²). Make sure there is sufficient shock protection.

HVR

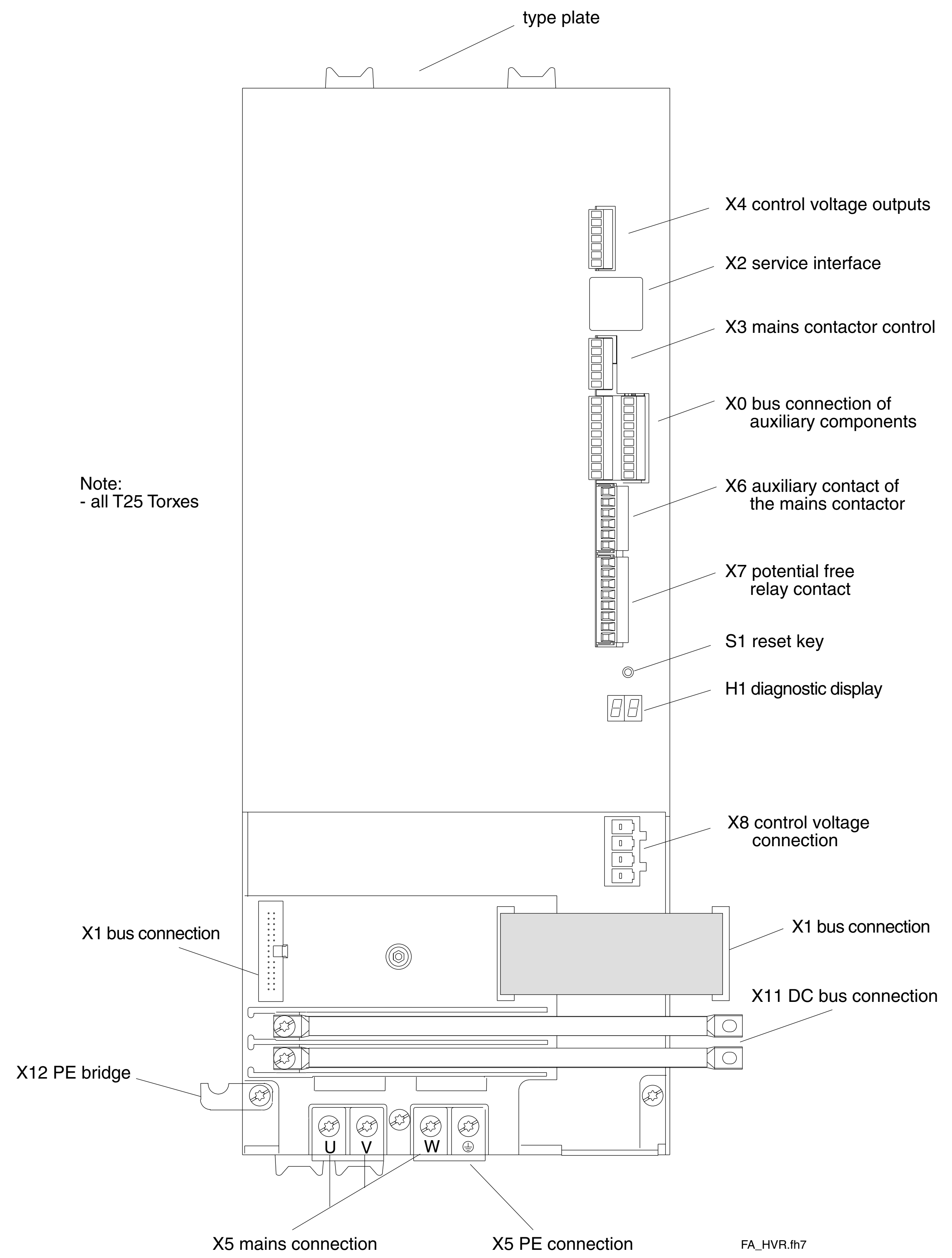


Fig. 8-4: Front view HVR

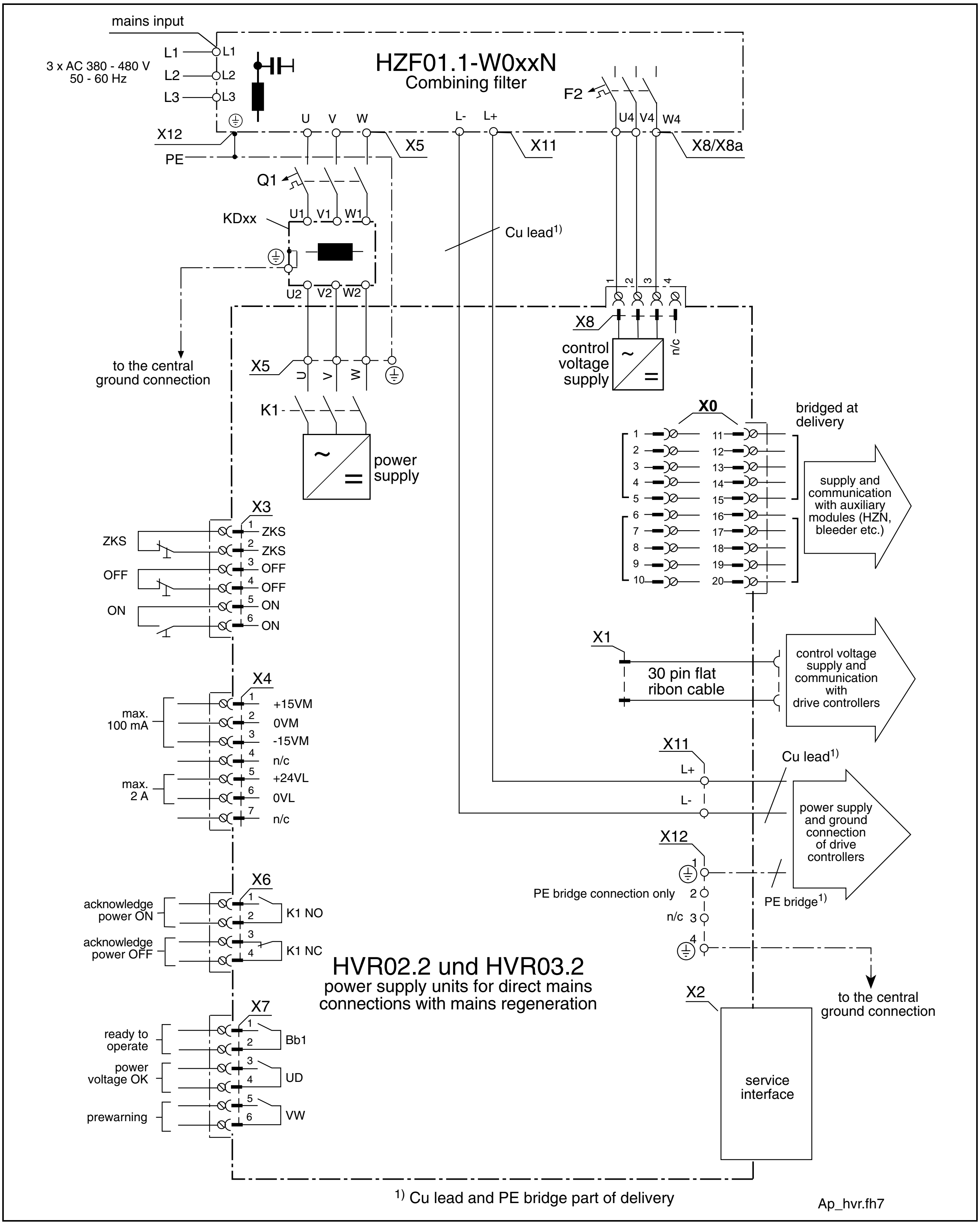
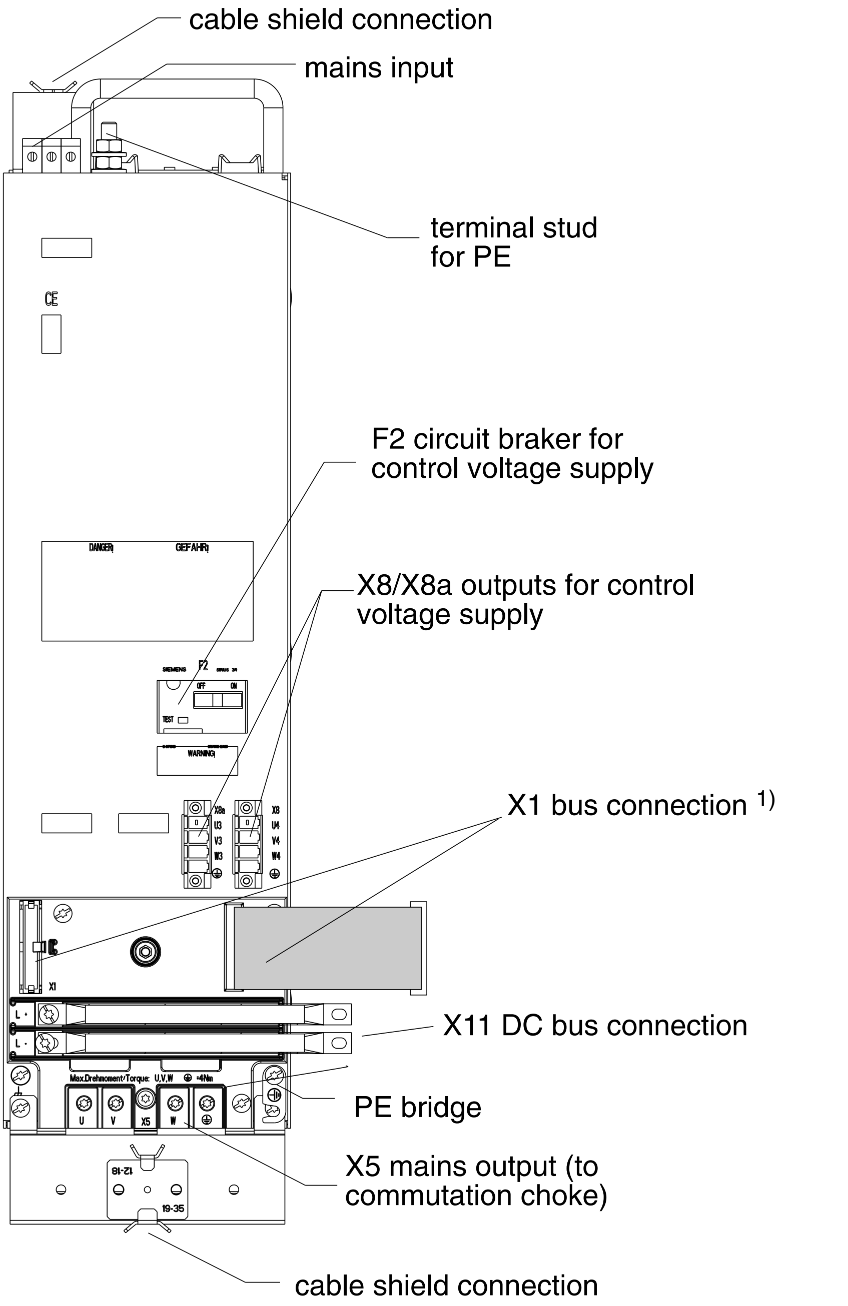


Fig. 8-5: Terminal diagram for HVR02.2 and HVR03.2

Note: Use a twisted cable for the wiring of the commutation choke!

HZF



1) only required, if drive components are mounted on both sides of the HZF (loop-through function)

Fa5120f1.fh7

Fig. 8-6: Front view HZF

Note: For the connection of the combining filter HZF see the terminal diagram of the HVR power supply units.

8.3 Mains connection

General

DANGER

High electrical voltage on the housing!
High leakage current! Danger to life, danger of injury by electric shock!

⇒ Connect the electrical equipment, the housings of all electrical units and motors permanently with the safety conductor at the ground points before power is switched on. Look at the connection diagram. This is even necessary for brief tests.

⇒ Connect the safety conductor of the electrical equipment always permanently and firmly to the supply mains. Leakage current exceeds 3.5 mA in normal operation.

⇒ Use a copper conductor with at least 10 mm² cross section over its entire course for this safety conductor connection!

⇒ Prior to startups, even for brief tests, always connect the protective conductor or connect with ground wire. Otherwise, high voltages can occur on the housing that lead to electric shock.

Direct mains connection

Power supply units of the HVE and HVR line can be connected to grounded three-phase mains with 3 x AC 380 ... 480 V (±10 %); 50 ... 60 Hz (±2 Hz) without the need of a transformer.

Mains fuse protection with direct mains connection

For more information about the subject "Mains fuse protection with direct mains connection" read the recommendations in chapter 8.4.

Connecting the mains via a transformer

A transformer is needed if the mains voltage is smaller than 380 V or greater than 480 V.

The required transformers power must be equal to or greater than the incoming power (see chapter 5.7).

The isolating transformer must have a short-circuit voltage of U_K < 2.5%.

Note: The mains inductance (leakage inductance) of transformers varies dependent upon power and type.

(Mains) voltage cutoff

If no additional capacitance is used, the supply voltage can be cut off for 3 ms in case of nominal load and 3 x AC 380 V mains voltage. More than 1 second should have passed between successive voltage cutoffs.

(Mains) voltage drop-outs

With 3 x AC 380 V mains voltage, the supply voltage may drop-out by 20% of the peak voltage for a maximum of 10 ms (in case of higher supply voltages proportionally more). More than 1 second should have passed between successive voltage drop-outs.

Mains requirements

Connected load Depending on the connected load, specific short-circuit powers are required for the mains when using HVx devices.

Connected load [kVA]	Required short-circuit power S_K [MVA]	Example of application
6 ... 50	0,6 ... 5	HVx02.2; HVE03.2
50 ... 150	5 ... 15	HVR03.2; HVE04.2
500 ... 2000	50 ... 200	several devices at one phase

Fig. 8-7: Connected load

These data are taken from the guidelines of the German power supply industry and are only valid for European power supply systems. If data for other power supply systems are required, ask the responsible power supply company for the specific information.

Mains interruption Power supply units of the HVE and HVR series tolerate mains interruptions up to a duration of 10 ms.

When mains voltage falls below its minimum value (see technical data) for more than 10 ms or a phase fails for more than 10 ms, the power supply unit switches off with the device-specific error message.

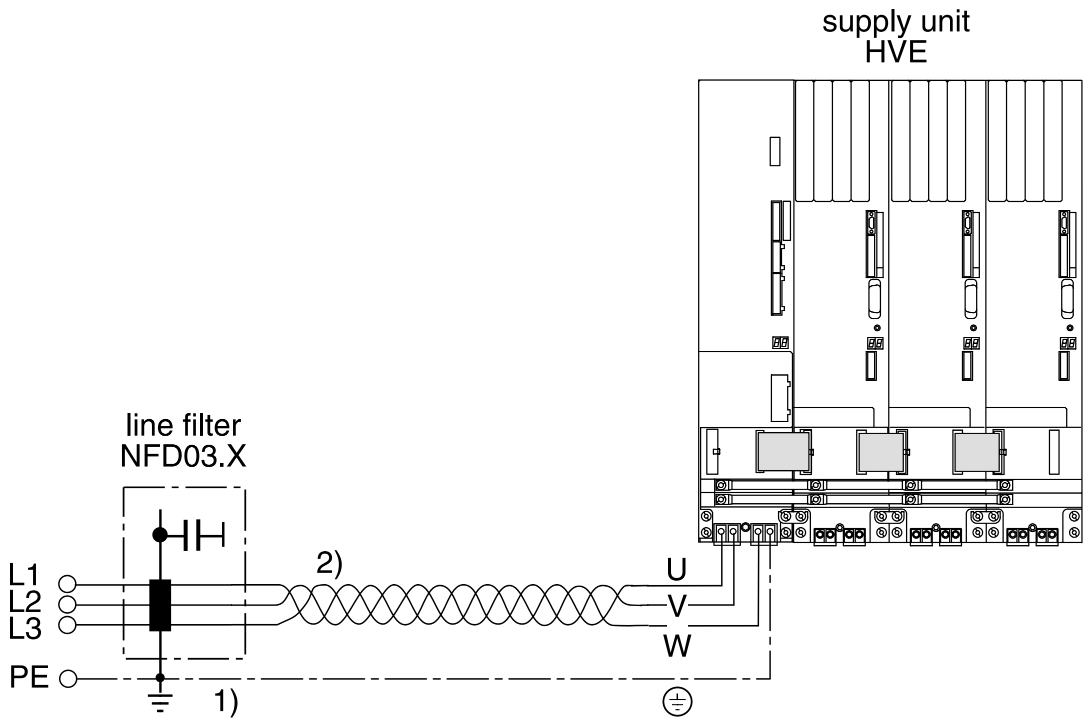
HVE

Power supply

Direct mains connection [with 3 x AC 380 ... 480 V (±10 %)]

In case of mains voltages with 3 x AC 380 ... 480 V (±10 %) the power supply unit can be connected directly to the mains; no other components are necessary.

Note: For interference suppression we recommend a line filter NFD03.x.



1) Like main wires, but not smaller than 10 mm²

2) Twist main wires - cable selections according to EN 60 204

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Fig. 8-8: Direct mains connection via line filter NFD03.x

Connecting the mains via autotransformer (with mains voltages < 3 AC x 380 V e.g. > 3 AC x 480 V)

If mains voltages are smaller than 3 AC x 380 V respectively greater than 3 AC x 480 V, it is necessary to use a transformer. To avoid earth leakage currents by system perturbations, high heat losses and autotransformer overvoltages, three capacitors (available as SUP-E01-HVR accessories set) in wye connection must be mounted as shown in the next figure.

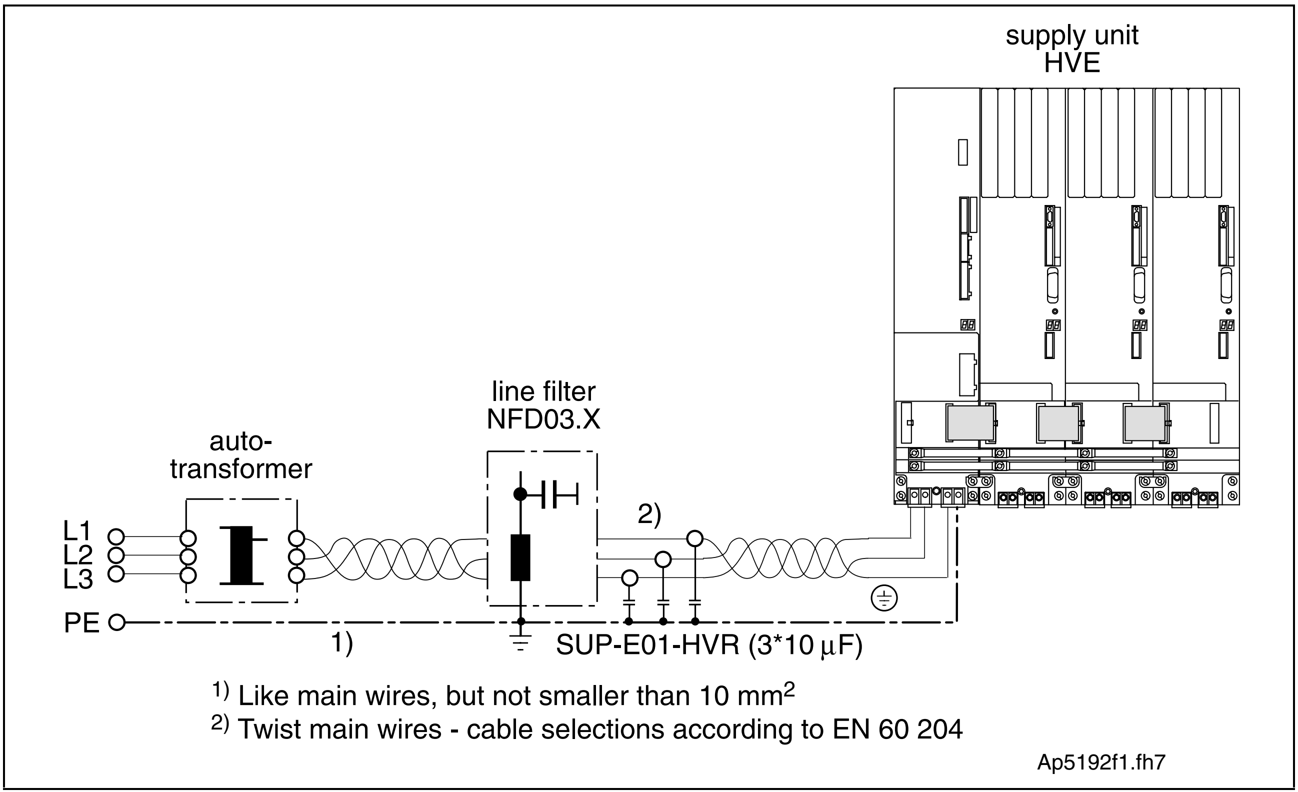


Fig. 8-9: Mains connection via autotransformer

Control voltage supply

Note: When the units are delivered, the mains connections of the power and control voltage supply are jumpered. Therefore no additional mains connection is required for the control voltage supply.

If special cases of application require a separate control voltage supply (e.g. to be able to save the diagnosis of the HVE upon shutdown of the power supply), the jumpers between power and control voltage supply must be removed. The voltage of the power and control voltage supply **must be the same**!

It is necessary to provide a short-circuit protection for the connection line of the control voltage supply (e.g. power circuit breaker 3VU1300-.MJ00, 2,6 ... 4 A; Siemens).

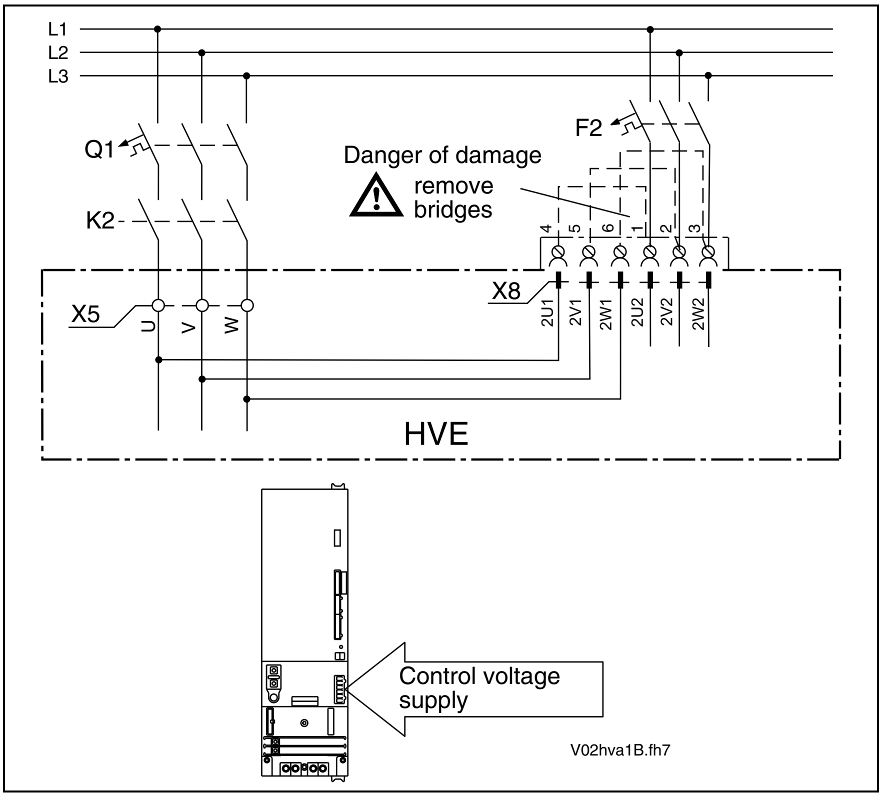


Fig. 8-10: Separate control voltage sources for the HVE

HVR

Power supply

Mains connection with 3 x AC 380 ... 480 V (±10 %)

As the power part of the HVR power supply units consists of a clocked 3-phase IGBT jumper, a commutation choke KDxx will always be needed for the mains connection. In addition, a so-called combining filter HZF01.1-W0xxN will be required.

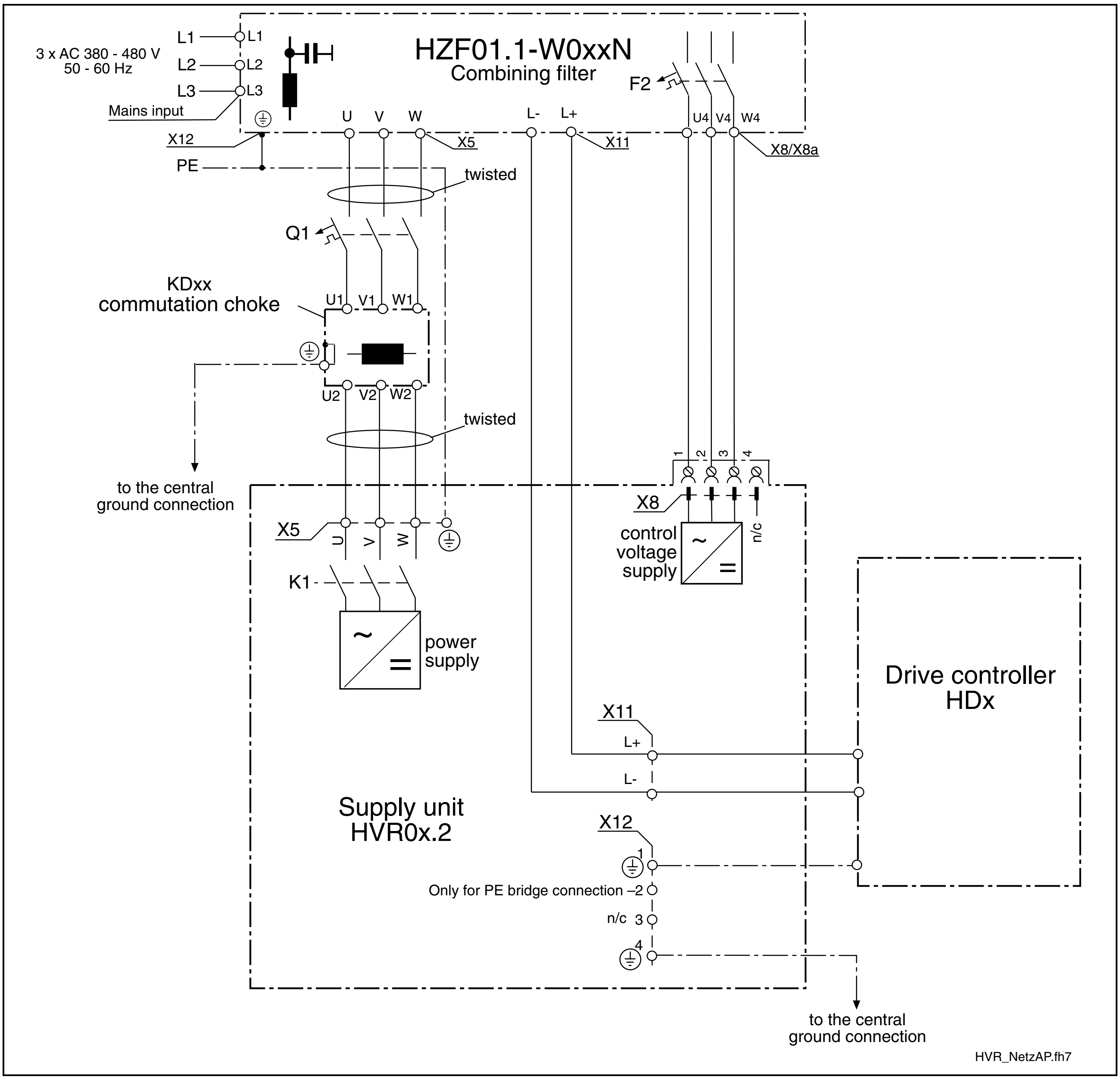


Fig. 8-11: HVR: Mains connection via commutation choke and combining filter

Basically, the HZF combining filters to be provided for the mains connection of the power supply units have two tasks:

- to suppress the current leakages from parasitic capacities of the construction (motor cable, winding capacities) and
- to ensure a sufficient interference suppression.

The combining filters are exclusively provided for the operation with HVR supply modules. On the filter outlet side no other devices may be connected. If other components in the control cabinet are to be suppressed, it is necessary to employ an appropriate interference suppression (e.g. a line filter NFD03.x) which should preferably be installed at the control cabinet entry (see chapter 8.9 "Interference elimination").

Note:

- It is not advisable to switch an additional interference suppression with the HZF in series, as non-linear procedures in the interference suppression filter (saturation of the chokes) could affect the combining filters' effect.
- Make sure there aren't any circuits with resonance produced, for example, by compensating capacitors, transformers, lines or capacitive contents of the filters that are not matching.
- Exceeding the allowed limit values for the high-frequency voltage contents at the filter can damage or destroy the filters.
- Rexroth does not supply HZF filters for asymmetric mains. If required, the appropriate HZF filters must be selected for the specific installation.

It is only allowed to operate combining filters within the allowed mains voltage range. Harmonics (f_n) on the mains voltage will lead to a temperature rise of the dielectric material of the capacitors built in the filters.

You can calculate the temperature rise using the following formula:

$$\Delta T_n = \frac{10 \times (U_{Mn})^2}{(U_{Gn})^2} [K]$$

U_{Mn}: measured voltage value at frequency f_n
U_{Gn}: voltage limit value for frequency f_n
ΔT_n: calculated temperature rise of the dielectric material for frequency f_n

Fig. 8-12: Calculating the temperature rise of the dielectric material

The temperature rises have to be added up for all frequencies $f_n \geq f_k$ (f_k: frequency at which the voltage derating starts; see Fig. 8-14):

$$\Delta T_{ges} = \sum_{v=1}^{m} \Delta T_v = \sum_{v=1}^{m} \frac{10 \times (U_{Mv})^2}{(U_{Gv})^2} [K] \leq 10 [K]$$

U_{Mv}: voltage value at frequency f_v
U_{Gv}: voltage limit value for frequency f_v
ΔT_{ges}: calculated temperature rise of the dielectric material for all frequencies

Fig. 8-13: Calculating the temperature rise of the dielectric material for all frequencies

By means of the above formulas and the measured voltages it is possible to determine the real load of a filter with voltages of higher frequencies. To do this, it is necessary to measure by means of Fourier analysis, for all combinations of line/line and line/PE, the r.m.s. value of the voltage on the mains side of the filter with all occurring frequencies (higher than f_k). You always have to measure the voltages under conditions of operation at the nominal working point, the filter having been installed. By means of the measured values it is then possible to calculate the temperature rise. To do this, the limit values of the following diagram are read at the respective frequency and used in the formula together with the measured value.

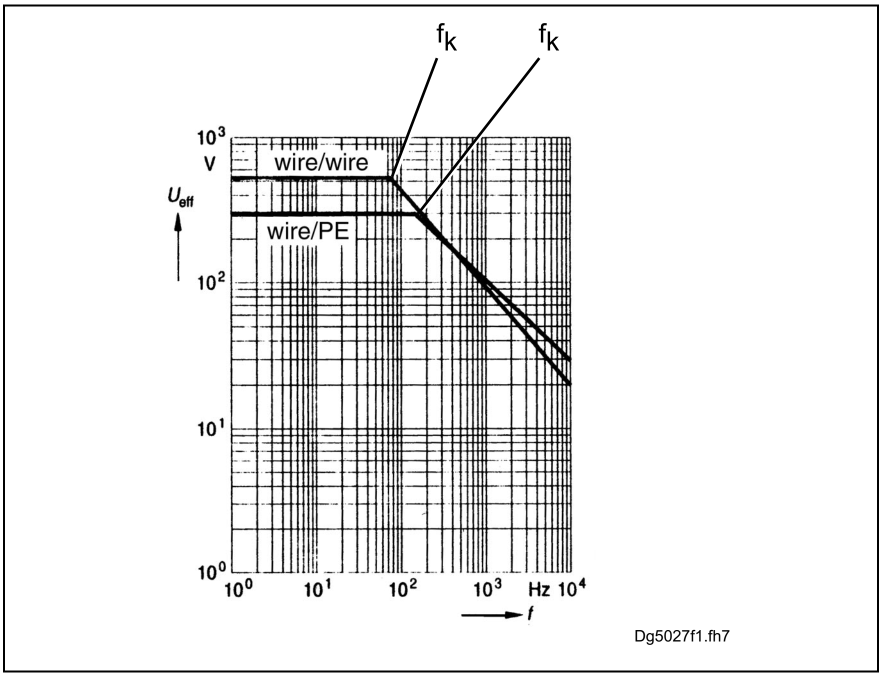


Fig. 8-14: Derating

If the total of the temperature values is greater than 10 K, the harmonics have to be reduced by means of appropriate measures.

The combining filters are located in a(n) (attachable) housing suitable for the DIAX04 family. They must be mounted directly next to the supply module (on the right or left).

The supply line to the HZF must be shielded in order to avoid guided interference emissions.

The connection cables of the commutation choke have a connected voltage of high amplitude and frequency. This can result in a possible interference of sensitive units in the control cabinet. Therefore, the connection cables need to be kept as short as possible and absolutely twisted (here it would also be better to use shielded cables).

Mains connection via transformer (with mains voltages < 3 x AC 380 V or > 3 x AC 480 V)

If a transformer is used, it is possible to connect HVR supply modules to networks with mains voltages smaller than 3 x AC 380 V or greater than 3 x AC 480 V.

Here, it is also required to use a commutation choke KDxx and a combining filter HZF01.1-W0xxN just as for the direct mains connection of the HVR supply modules.

DC bus connection and bus connection

Note: The DC bus connection must **always** be connected to the HZF for proper functioning.

The X1 bus connection is looped through and must only be connected, if there are units arranged on both sides of the HZF.

Control voltage supply

A separate control voltage connection is necessary that the HVR may be operated synchronously to the mains. The control voltage must be tapped before the commutation choke KDxx. Power and control voltage connection must be in phase.

As illustrated in the next figure, the combining filter HZF is equipped with two control voltage outlets. The control voltage outlet X8 must be connected to the control voltage inlet of the HVR.

A protection switch for the control voltage is integrated in the HZF (F2).

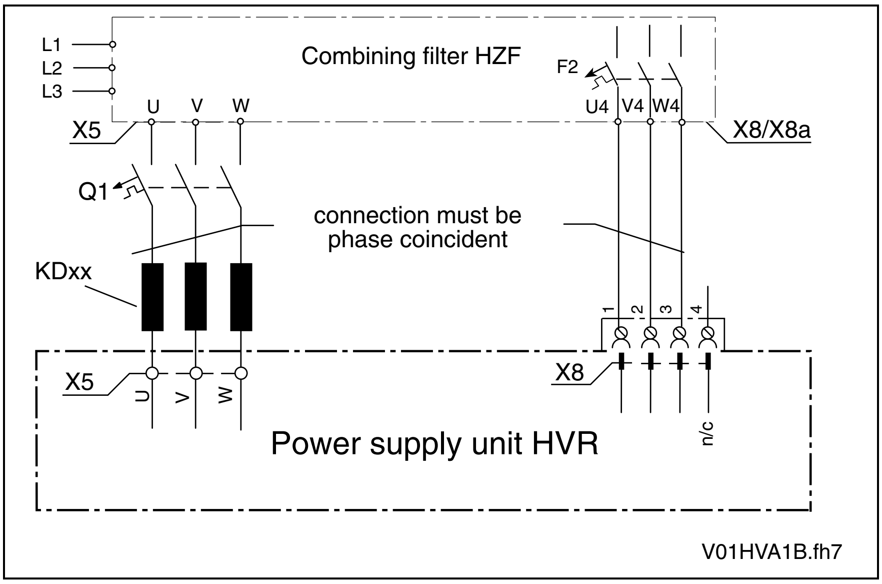


Fig. 8-15: HVR control voltage

Details of the commutation choke

The commutation chokes are equipped with a temperature contact which opens at T = 150 °C (connections a - b). The contact can be evaluated by a controller and is used for example for a regulated shutdown of the unit, should the control cabinet cooling fail.

Note: You'll find the technical data in chapter 4. The dimension drawing as well as terminal diagram can be found on page 7-18.

Details of the combining filter

Note: You'll find the technical data in chapter 4.5.

When operating combining filters at grounded IT mains, the type of construction causes leakage currents that may cause possibly existing circuit breakers or voltage monitors to trip. Remedy: Install an isolating transformer.

8.4 Fusing with direct mains supply

Fusing the mains supply for the power section of the power supply units HVE and HVR can implement, with direct mains connection, power circuit breakers or slow-blow fuses of the gL type (semiconductor fuses are not needed).

Note: Select the fusing according to the mains current too (see chapter 5.7.

The maximum fusing for the different power supply units (HVR and HVE) is listed in the following table.

Power supply unit	Fuse maximum	
	in accordance with EN50178 resp. EN60204	**in accordance with UL508C**
HVE02.2-W018N	35 A	30 A
HVE03.2-W030N/L	63 A	60 A
HVE04.2-W075N/L	160 A	150 A
HVR02.2-W010N	25 A	20 A
HVR02.2-W025N	50 A	45 A
HVR03.2-W045N	80 A	70 A

Fig. 8-16: Maximum fusing

If the fusing is effected with power protective switches, the following recommendations apply.

Power supply unit	Mains current at		Setting value	Mains connected load at 400 V connected voltage [1)]
	400 V	480 V		
HVE02.2-W018N (without GLD 13)	28 A	28 A	28 A	6 mm²
HVE02.2-W018N (with GLD 13)	28 A	28 A	28 A	6 mm²
HVE03.2-W030N (without GLD 12)	46 A	46 A	46 A	16 mm²
HVE03.2-W030N (with GLD 12)	46 A	46 A	46 A	16 mm²
HVE04.2-W075N (without GLD 20)	80 A	80 A	80 A	25 mm²
HVE04.2-W075N (with GLD 20)	120 A	120 A	120 A	50 mm²
HVR02.2-W010N	15 A	13 A	18 A	2,5 mm²
HVR02.2-W025N	38 A	32 A	38 A	10 mm²
HVR03.2-W045N	68 A	57 A	68 A	25 mm²

1) Line cross section per EN 60204 – installation type B1 – without accounting for corrections factors

Fig. 8-17: Recommended fusing

Note: The indications made herein apply to the operation with full continuous power. If fewer continuous currents are required, the fusing and thus the connection cross section can be reduced. It should however be taken into account that the bus is loaded according to the soft start with each unit peak current (3-fold continuous power). The period of time during which the current flows, depends on the bus capacity to be loaded and is 33 ms in the most unfavorable case with the 45 kW unit, 57 ms with the 25 kW unit and 142 ms with the 10 kW unit. The fuses to be installed or the power protection switches shall be dimensioned such that faulty releases do not occur.

8.5 Grounding the power supply system

Grounded three-phase mains

HVE and HVR can be operated from three-phase systems with grounded neutral points or phases without control-to-load isolation.
On mains with grounded phases you have to regard the measures described in chapter 8.12.

Ungrounded three-phase mains

With ungrounded mains (IT mains) there is the increased danger that unacceptably high overvoltages could occur between the phase and the housing. Both the HVE and HVR can be protected against unacceptable overvoltages,

- if they are connected via an isolating transformer (the star point of the output side and the PE connection of the power supply unit are connected over one grounding rail)

- or -

- if the unit is protected by **overvoltage suppressors**.

Note: Connecting the HVE and HVR via an isolating transformer offers the best protection against overvoltage and the greatest operating safety.

8.6 Connecting drive controllers to the power supply unit

Note: For the connection of the drive and control system to the power supply unit it is necessary to distinguish between the arrangement of the units one below the other and one above the other.

The following descriptions are visualized in "Fig. 8-20: Connecting the drive controller".

Arranging the units horizontally

Power connection

If the units in the control cabinet are arranged horizontally, use the copper strands and PE jumpers, included in the scope of supply, for the power connection of the drive and control systems.

Connection to the control voltage supply

Use the flat cable for the connection to the control voltage bus (terminal X1). One side of the flat cable is firmly connected to the unit on one side. Plug the connector of the free end onto terminal X1 of the next unit.

If the units are not arranged directly horizontally, you will need a longer cable for the connection of the X1 terminals:

Cable	Length	Item / Part number
INB648/0250	250 mm	292519
INB648/0800	800 mm	282398
INB648/1000	1000 mm	288731

Fig. 8-18: Cable

Arranging the units vertically

Note: With a combined unit arrangement, it is absolutely necessary that between the two rows of drive units a baffle is mounted, in order to prevent the blowers of the upper row from sucking in the warm air of the bottom row.

CAUTION

Property damages due to overheated units!

⇒ Mount a baffle between the two unit rows. Otherwise the performance data of the units can decrease and the units can be damaged with undiminished performance requirement.

Mains connection

If the units in the control cabinet are arranged vertically, you need to use twisted single conductors for the power connection of the drive and control systems (terminal X11) instead of the supplied copper strands. The single conductors for the power connection of the drive and control systems may have a maximum length of 1 m.

The ground connections of units (unit rows) that are vertically arranged must be connected by a separate cord. The minimum cross section for this cord is 10 mm^2.

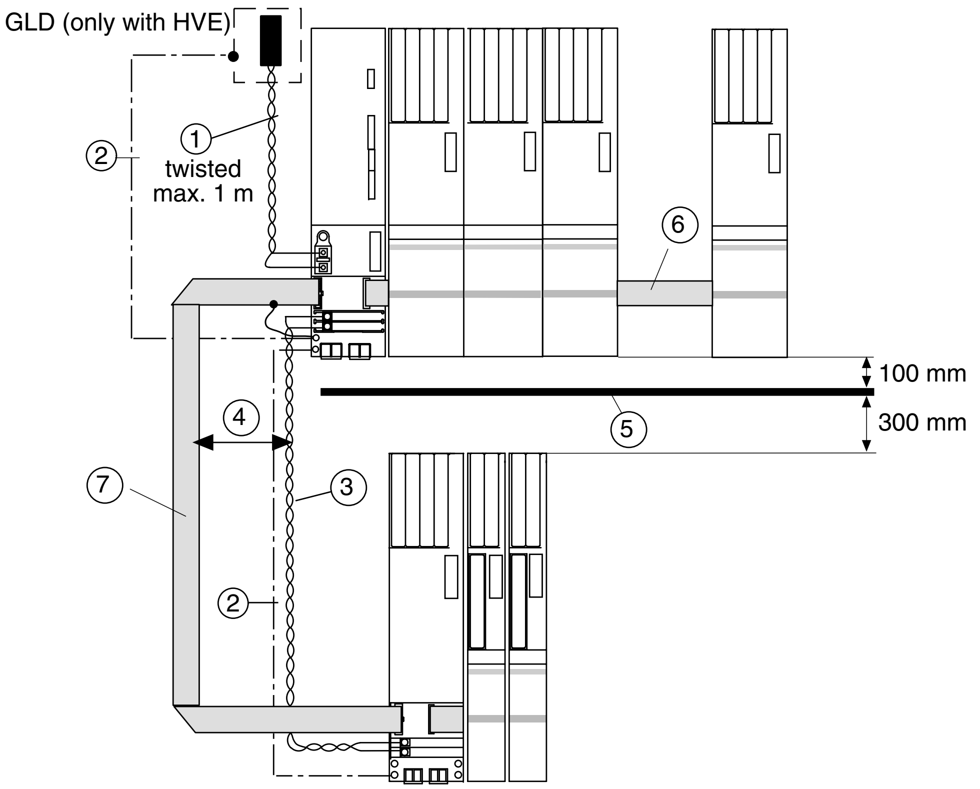
Connection to the control voltage bus

The control voltage bus must be connected with the designed Rexroth cable (designation: INB0647). Lay the shield of this cable to the unit grounding bolt (terminal X12) on the supply module.

The cable lengths listed below are available:

Cable length [mm]	Item / Part number
800	282 300
1000	287 677

Fig. 8-19: Shielded flat cable for the control voltage bus



Line cross section	HVR02.2-W010N	HVR02.2-W025N	HVR03.2-W045N	HVE02.2-W018N	HVE03.2-W030N	HVE04.2-W075N
①	---	---	---	10 mm²	16 mm²	50 mm²
②	10 mm²	10 mm²	16 mm²	10 mm²	16 mm²	25 mm²
③	10 mm²	10 mm²	16 mm²	10 mm²	16 mm²	35 mm²

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③ Lênghth: 1,2 m; designation: INB730/1200

④ Minimum clearance 0,1m

⑤ Baffle. Prevents the blowers of the upper row from sucking in the warm air of the bottom row.

⑥ Flat cable designated INB648. This cable will be necessary, if units are not arranged directly next to each other.

⑦ Flat cable designated INB647. This cable will be necessary, if units are arranged one below the other or vertically.

Fig. 8-20: Connecting the drive controller

8.7 Fault current protective device

DANGER

High electrical voltage! Danger to life, severe bodily harm by electric shock!

⇒ A residual-current-operated protective device (RCD) must not be used on electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.

- In clocked drive controllers, capacitive leakage currents primarily flow to earth. The extent of this current depends on
  - the number of drive controllers used,
  - the length of the motor power cable and
  - the grounding conditions at the installation.
- If measures are taken to improve the electromagnetic compatibility (EMC) of the installation (mains filters, shielded lines, etc.), then the current leakage is inevitably also increased. In order to avoid faulty releases when inductive loads and capacitance (interference suppression filters, transformers, contactors, magnetic valves) are switched on, it is necessary to provide an isolating transformer in the mains supply line ahead of the power supply unit of the drive system. The over current protective device must be matched to the impedance of the fault loop so that a shutdown is effected if a fault occurs. The star point of the secondary winding must be connected to the protective circuit of the installation.

8.8 Earth leakage monitor

Earth leakage monitors are often used in IT mains. Spurious releases can occur when operating electronic equipment.

Experience has shown that electronic drive controllers can only be operated on systems with earth leakage monitors if an isolating transformer is situated ahead of the supply unit for the drive system. The star point of the isolating transformer and the PE connection of the power supply unit must be applied to the same potential.

8.9 Interference elimination

Note: The subject interference elimination and electromagnetic compatibility (EMC) is described in detail in a separate documentation. It is absolutely necessary to read this documentation for the proper operation of AC-drives!

The document is titled "Electromagnetic compatibility (EMC) for AC drives". The item number is 259 740.

Note: The control cabinet construction is also important for shielding the interference emission. For further information please see the chapter 7.3.

Note: As the HVR power supply unit must be operated together with the combining filter HZF, the indications concerning the NFD mains filter arrangement apply above all to the HVE. (The line filter is already included in the combining filter HZF).

Interference emission

To maintain class B limit values (interference suppression N) as per EN 55011 / 3.91 at the machine (required in residential and light industrial areas), suitable interference suppression filters must be installed in the mains supply line in the machine. The motor power cable should be routed in a shielded manner or a shielded motor power cable should be used.

Resistance to interference

Rexroth drives are characterized by an extensive resistance to mains and circuit interference. Nonetheless, during installation the following should be noted to preclude interference affects.

- Always route signal lines shielded.
- With analog signals, connect the shield at one end, over the greatest possible surface on the unit to mass or housing. With digital signals, apply shield to both cable ends, over the greatest possible surface to mass or housing.
- Signal and control lines should be routed at least 10 cm away from the power cables. Routing in a separate cable duct is recommended.
- Signal and control lines should cross power cables at an angle of 90° only.
- Inductive loads such as contactors, relays, magnetic valves should only be operated with overvoltage limiters.
- Ground drive controllers as per Rexroth guidelines.

8.10 Control cabinet check

CAUTION

Property damages due to overloaded electronic components!

⇒ Prior to a high-voltage check of the control cabinet, disconnect all power supply unit connections. Only connect those voltages permitted by data sheets or interface descriptions.

8.11 Applications with HVE0x.2-W0xx power supply unit

Multi-axis operation

In order to reduce the effects of the leakage currents (increased power dissipation, mains pollution), it may be necessary, depending on the application, to connect additional components (SUP kit) to the HVE power supply units. By means of the following formula and table you can determine whether it is necessary to connect additional components or not.

$$K = \frac{n^2}{2} * l$$

K: specific value
n: number of connected axes
l: average lengths of the motor cables used of all connected axes
$[\ \sum(l_1 \dots l_n)/n\ ]$

	HVE02.2-W018N		HVE03.2-W030x		HVE04.2-W075x	
K	< 100	> 100	< 200	> 200	< 400	> 400
SUP kit necessary?	no	yes	no	yes	no	yes

Fig. 8-21: SUP kits for HVE power supply units

Note: In the case of mains with a high degree of inductance (so-called "non-rigid" supply systems), heavy mains pollution can occur even if the above conditions are complied with. It is then necessary to use SUP kits although this may not be required according to the formula and table.

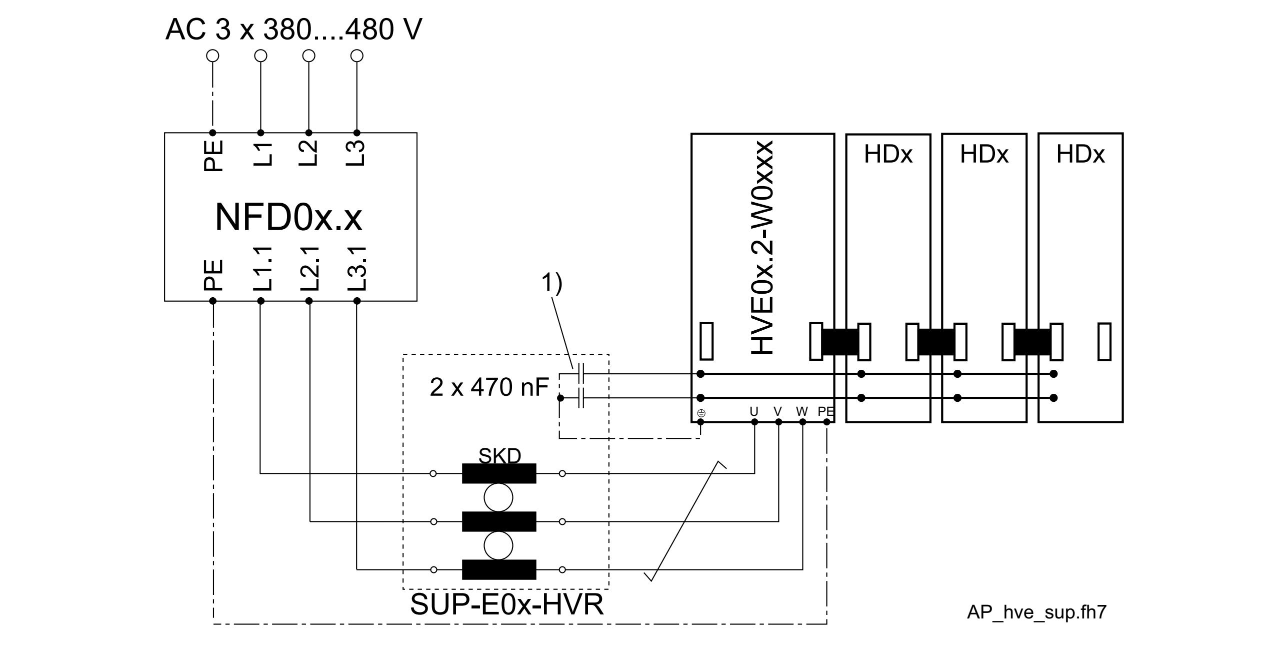

Fig. 8-22: HVE0x.2-W0xxx with SUP kit

Component	NFD	SUP-E0x
HVE02.2-W018N	NFD03.1	SUP-E06-HVR
HVE03.2-W030x	NFD03.1	SUP-E07-HVR
HVE04.2-W075x	NFD03.1	SUP-E08-HVR (without capacitor 2 x 470 nF) (as an alternative, two SUP-E07-HVR can be connected in parallel for existing installations)

Fig. 8-23: Combination of power supply unit, NDF and SUP-E0x

Note: An HZF mustn't be operated at HVE power supply units.

Parallel connection of two HVE04

To increase the available DC bus continuous power it is possible to connect two HVE04 in parallel. To do this it is necessary to operate the two HVE04.2 in a master-slave mode.

Required components

2 x HVE04.2-W075x
Both HVE devices have to be of the same type. Operating devices of different types implies the danger of malfunction in bleeder balancing. The individual device types can be identified by their serial number.

The following types can be combined:

Master	Slave
type N: SN 284285-0xxxx	type N: SN 284285-0xxxx
type N: SN 291914-0xxxx SN 295191-0xxxx	type N: SN 291914-0xxxx SN 295191-0xxxx
type L: SN 294601-0xxxx	type L: SN 294601-0xxxx

Fig. 8-24: Combinations

- **2 x GLD20 smoothing choke**

- **2 x balancing choke KD 0,1mH / 160A [MN00261805]**
  Installed at the power input of each HVE04.2-W075x. This choke is always required as the inductance of the supply feeder does not only depend on cable cross section and length, but also on the kind of cable laying (twisted, parallel, straight or in loops).

Additional module HZB

When two HVE04 are connected in parallel, it is not allowed to use the additional module HZB.

Additional capacities on the DC bus

It is possible to connect 10 mF for type N and 200 mF for type L to the DC bus of the HVE04 power supply units. Even if two HVE04 are connected in parallel, it is not allowed to connect higher capacity values than 10 or 200 mF to their common DC bus.

Number of axes

The number of axes in the entire package is limited to 12. In order to reduce the effects of leakage currents, it can be necessary to connect additional SUP-E08-HVR components to the power supply units. See also chapter "Multi-axis operation" on page 8-25.

If the necessity of using a SUP kit results from the determination of the characteristic value K – for which all axes of the entire package have to be taken into account – the SUP kit has to be installed before the two HVE devices.

Wiring of emergency stop circuit

In order to have an troublefree soft start (charging process of the DC bus), it is necessary to operate both HVE04.2 in a master-slave mode. This operating mode has to be established by means of an appropriate emergency stop circuit.

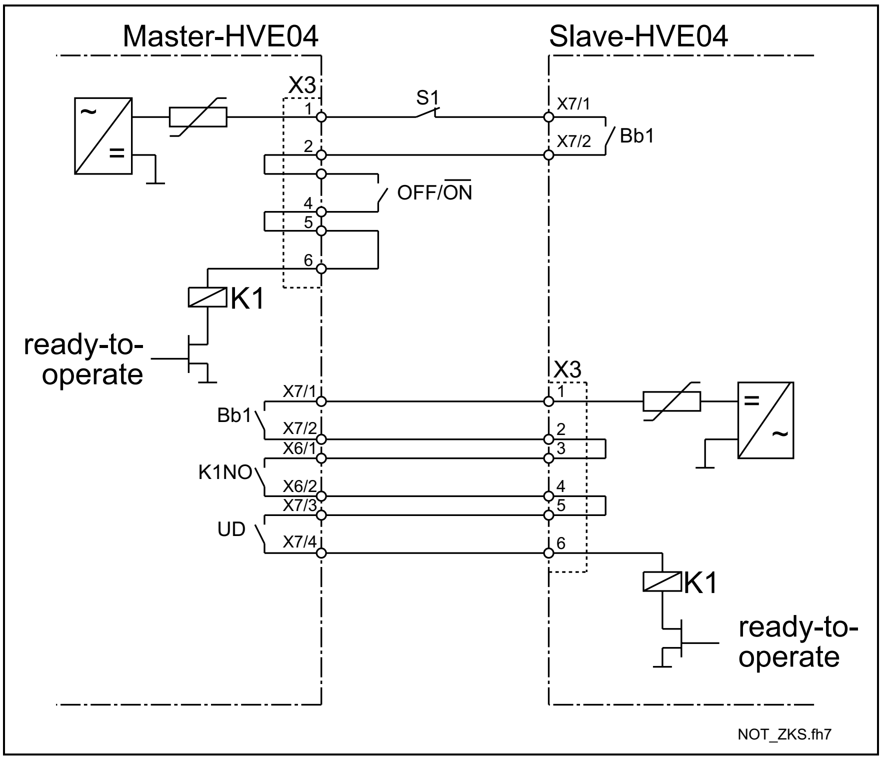

Fig. 8-25: Wiring of emergency stop circuit for master-slave operation with DC bus short circuit

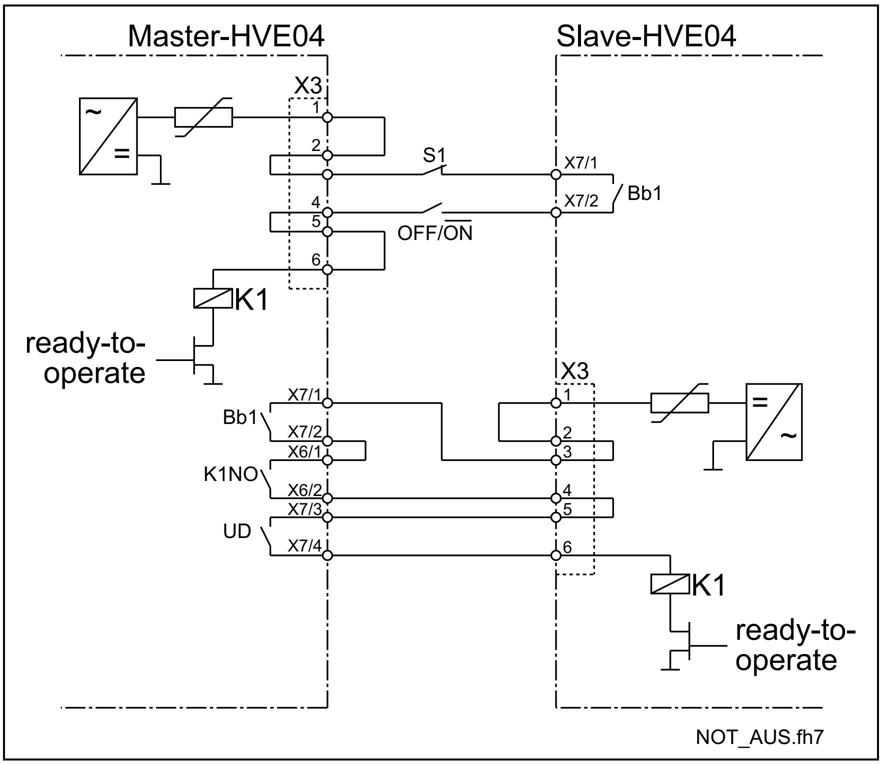

Fig. 8-26: Wiring of emergency stop circuit for master-slave operation without DC bus short circuit

Note: The maximum Ohmic resistance of the emergency stop circuit for the HVE04.2-W075N is **350 mΩ**, with higher resistance values it is no longer guaranteed that the internal load contactor will pick up safely. The supply unit might then be switched off with the error message "16 – soft start error".

The maximum possible connection cross section for the emergency stop wiring is 1,5mm^2 / AWG16. This type of wiring has an Ohmic resistance of approx. 13mΩ/m at 20 °C. The resulting maximum cable length for the emergency stop circuit is 27 m.

Establishing the master-slave connection of the two emergency stop circuits between the devices requires 6 wire connections. The maximum distance between the devices therefore is 4,50 m.

In order to realize bigger distances between the HVE devices, it is necessary to route the connection of the two emergency stop circuits via special emergency stop relays.

Arrangement of the devices

The DIAX04 DC bus connection (35mm^2 / AWG2) has been designed for a maximum of 75 kW. In order to avoid an overload of this connection in the case of parallel connection of two HVE04.2 devices, the two **HVE power supply modules** connected in parallel have to be obligatorily arranged **at the outer positions** in the drive package.

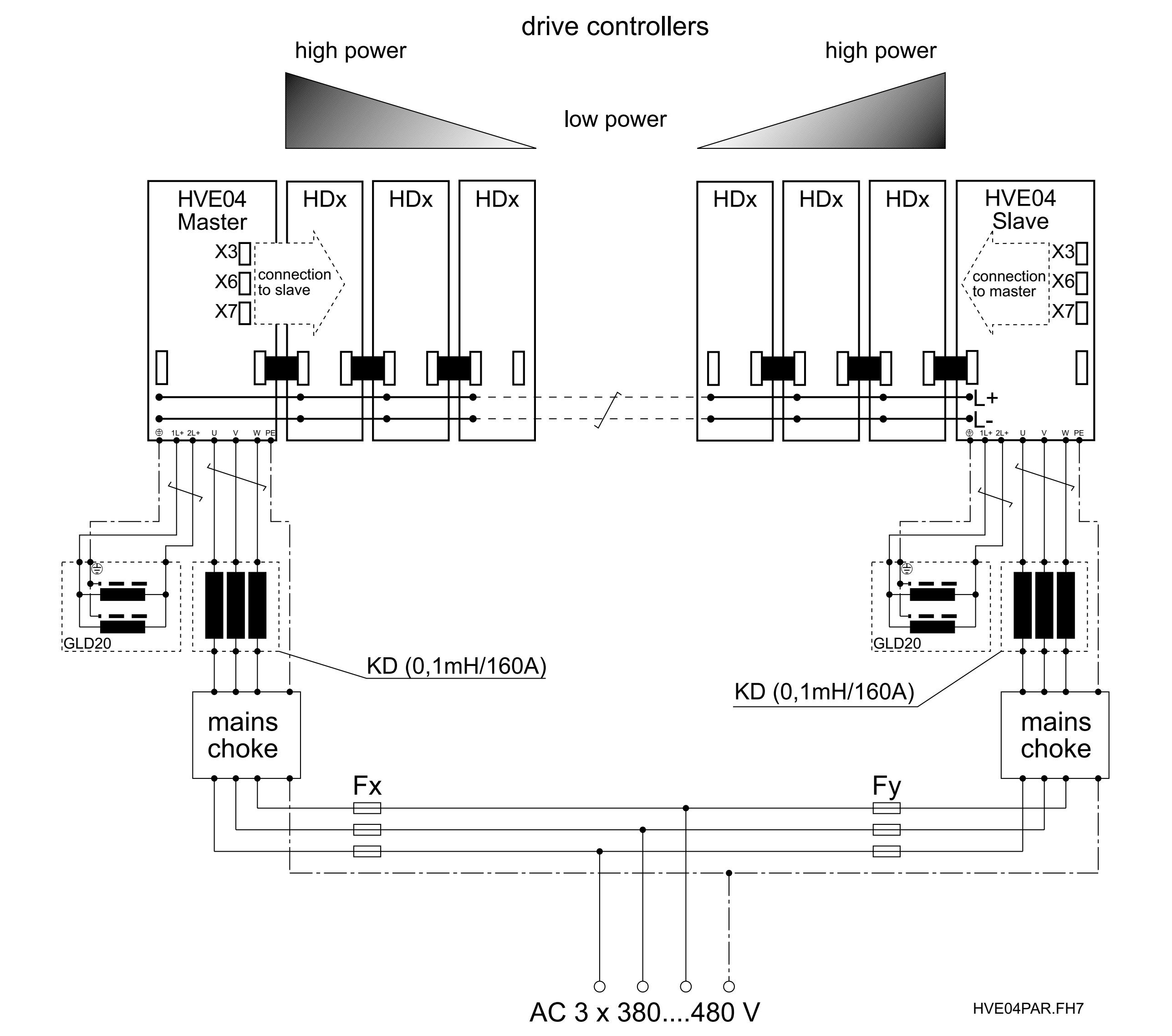

Fig. 8-27: Position of the devices with parallel connection of two HVE04

Fusing the DC bus connection between the two drive packages is not required because in the case of an error both packages will always be switched off due to the interconnection of the two emergency stop circuits.

The fusing of the two HVE devices corresponds to the fusing used for operating one device.

Due to increased interference suppression capacity, the EMC filters (NFDxx) should be positioned of the mains side of the KD balancing chokes. The position of the filters does not affect the function of the parallel connection. With regard to their influence on balancing, the filter-internal components of the Schaffner and LGF filters provided by Rexroth (current-compensated chokes, Y capacitors) can be neglected.

In order to improve the emission of interference of the entire arrangement, make sure the DC bus connection and the power wiring between the device and choke connections are twisted.

Available DC bus power with two HVE04.2-W075 connected in parallel

Due to inevitable unbalances of device-internal components, system impedances etc., the total DC bus power won't be distributed over the two power supply units in equal shares. Depending on the application, it is therefore necessary to take a reduction of power (derating) into account.

Derating due to "internal" unbalance

The tolerances of the device-internal power semiconductors and of the inductances used (GLD20, KD) cause internal unbalance due to system that will result in a derating of the parallel connection, related to the calculated total continuous power P_{ZWsum}, even with optimum "external" conditions in the installation.

This "basic derating" is approx. 10% of the possible total continuous power. Therefore, the available maximum continuous power in ideal cases is

$$P_{ZWmax} = P_{ZWsum} - 10\% = (P_{ZW/HVE1} + P_{ZW/HVE2}) - 10\%$$

The available DC bus power P_{ZW} of the power supply units depends on the mains connection voltage. The respective values cam be taken from the table of Fig. 4-4.

Derating due to unbalance in the mains connection wiring

Further reduction of power is caused by different impedances of both mains connection phases which are due to different lengths of lines, kind of routing etc.

- 0% unbalance ≙ 10% derating (basic derating)
- 100% unbalance ≙ 50% derating (power of an individual HVE)

Derating due to unbalance in DC bus

Additional impedances between both drive packages are caused by the DC bus connection. This causes further reduction of the available total power.

The length of the DC bus connection between the two drive packages is a parameter of the derating function:
with a line cross section of 35mm^2 / AWG2 to be maintained, every meter of DC bus connection corresponds to a further derating of 2% of the total continuous power.

Note: This derating factor does not apply when the wiring is carried out via a central DC bus rail with identical outgoing circuits (length of line and cross section) to the individual drive packages.

The derating then is a function resulting from the unbalance in the supply feeder with the parameter l_{ZK} (length of DC bus connection).

$$P_{ZWges} = f(\text{unbal.}_{mains\_connection}) \text{ with parameter } l_{ZK}$$

$$P_{ZWges} = P_{ZWsum} * (0{,}9 - x * 0{,}4 - l_{ZK} * 0{,}02)$$

with:
0,9 – basic derating (corresponding to 10%)
x – relative unbalance of mains connections (1 = 100% unbal.)
l_{ZK} – length of DC bus connection in meters

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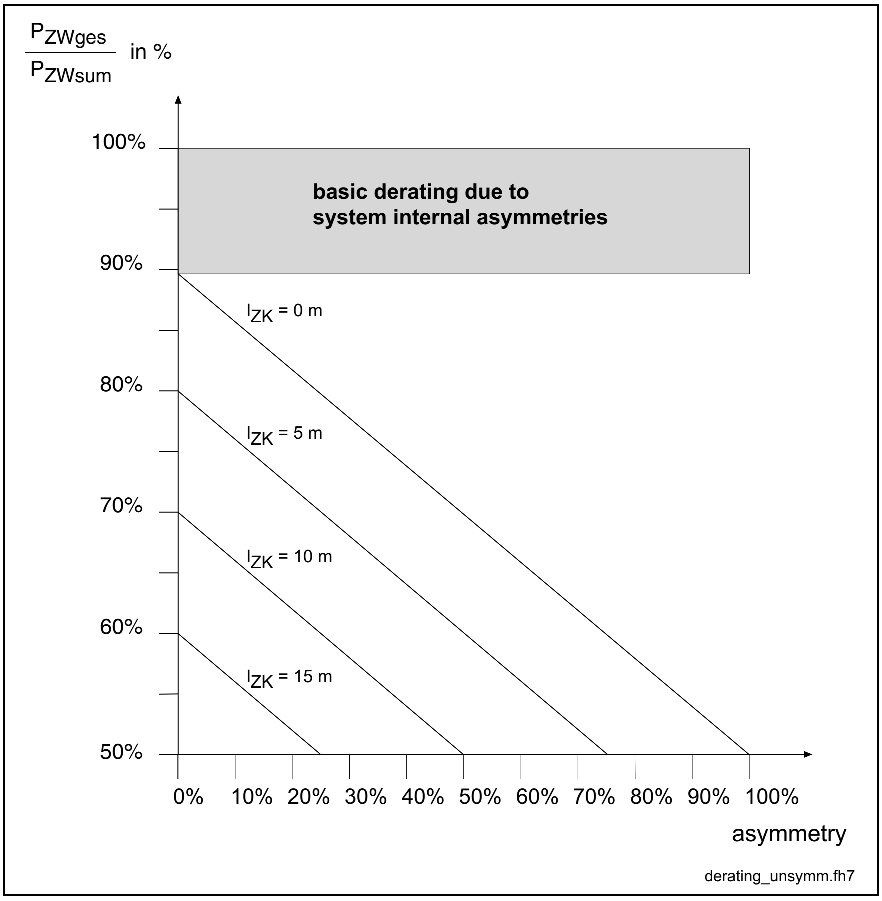

P_{ZWges} available DC bus continuous power
P_{ZWsum} maximum DC bus continuous power (total power of both HVE)
l_{ZK} length of DC bus connection between the two drive packages
unbalance: relative unbalance in the mains connection from the device terminals via choke (KD) and EMC filter (NFD) to the mains supply point

Fig. 8-28: Basic derating due to system-internal unbalance

Regenerative operation

When you operate two HVE04 together at one DC bus the following relations are valid.

Regenerated continuous power

$$\sum P_{BD} \leq 0{,}8 * 2 * P_{BD,HVE}$$

ΣP_{BD}: Regenerated continuous power of complete system [kW]
$P_{BD,HVE}$: Regenerated continuous power of one HVE [kW]

Fig. 8-29: Regenerated continuous power

Regenerated peak power

$$\sum P_{BS} \leq 0{,}8 * 2 * P_{BS,HVE}$$

ΣP_{BS}: Regenerated peak power of complete system [kW]
$P_{BS,HVE}$: Regenerated peak power of one HVE [kW]

Fig. 8-30: Regenerated peak power

Regenerated energy

$$\sum W_{ROT,MAX} + \sum W_{POT,MAX} \leq 0{,}8 * 2 * W_{MAX,HVE}$$

$W_{ROT,MAX}$: Rotary energy [Ws]
$W_{POT,MAX}$: Potential energy [Ws]
$W_{MAX,HVE}$: Regenerated energy of one HVE [Ws]

Fig. 8-31: Regenerated energy

Data of commutation choke KD (0,1mH/160A)

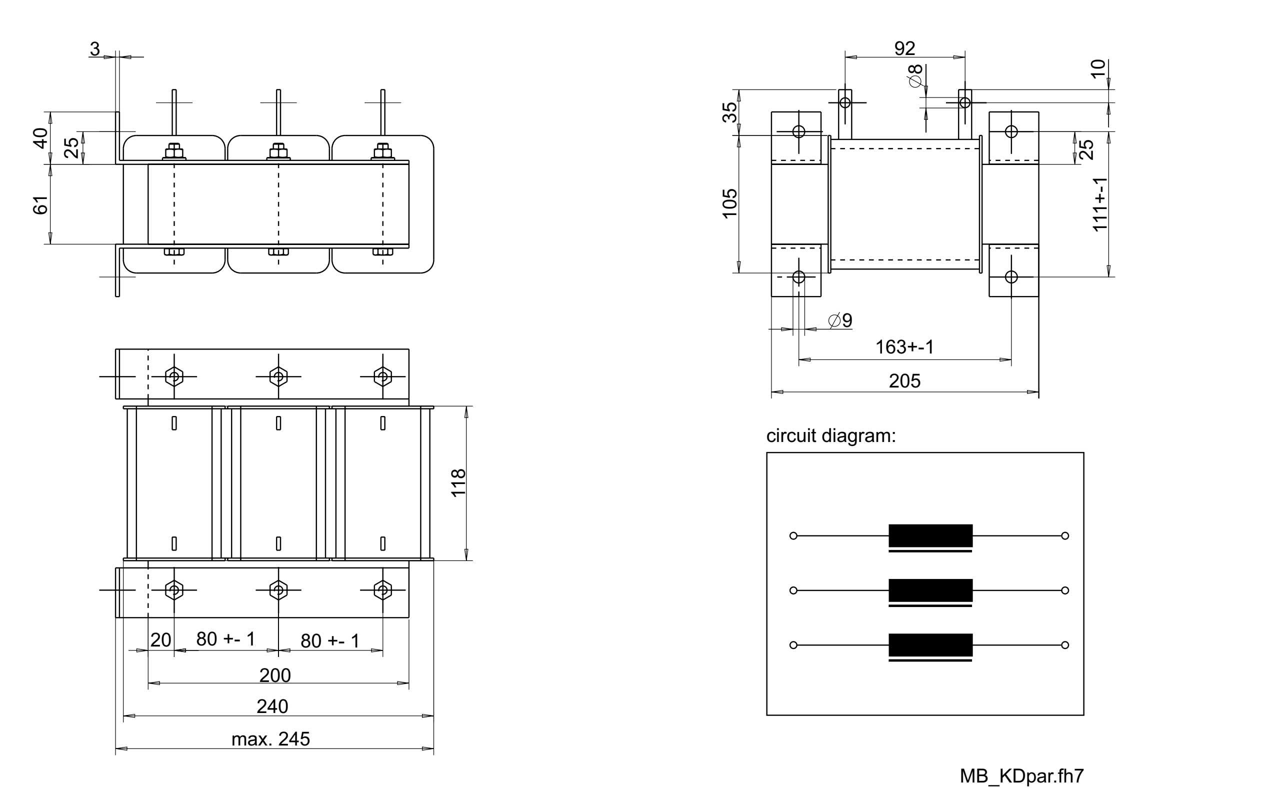

Fig. 8-32: Dimensional drawing KD 160A

Designation	**Symbol**	**Unit**	**Commutation choke KD 0,1 mH / 160 A**
part number	--	--	261805
nominal continuous current	I_{nenn}	A	160
inductance at I_{nenn}	L_{nenn}	mH	0,1
Connection			
type			ring cable lug M8
connection cross section	A	mm^2	according to the connection cross section of the power supply unit
weight	m	kg	21

Fig. 8-33: Technical data

HVE-L with external capacities

The HVE of the "L" type allows connecting external capacities of up to 200 mF. This means that the following characteristics can be fulfilled.

Reducing heat loss

In installations with cyclical reversing duty of the drive axes the regenerative power is converted to heat via the bleeder. This causes a high degree of heat loss in the control cabinet. The regenerative power can be buffered in the additional capacities on the DC bus and used for cyclical short-time loads. This allows reducing the continuous bleeder power and therefore the heat loss.

Mains failure; emergency stop strategy

In order to be able to move over a certain distance even if the mains has failed, energy has to be stored in the DC bus. Additional capacities on the DC bus can increase the energy to be stored.

Storable energy W_C

The storable energy can be calculated with the formula below.

$$W_C = \frac{(U_{Bmin}{}^2 - U_{ZW}{}^2)}{2} * C$$

W_C:	storable energy [Ws]
U_{Bmin}:	lower bleeder trigger level 800V
U_{ZW}:	DC bus nominal voltage U_{ZW} = 1,41 * U_{N1} +10% [V]
U_{N1}:	nominal mains voltage 3 x AC 380...480 V
C:	additional capacity [F]

Fig. 8-34: Storable energy W_C

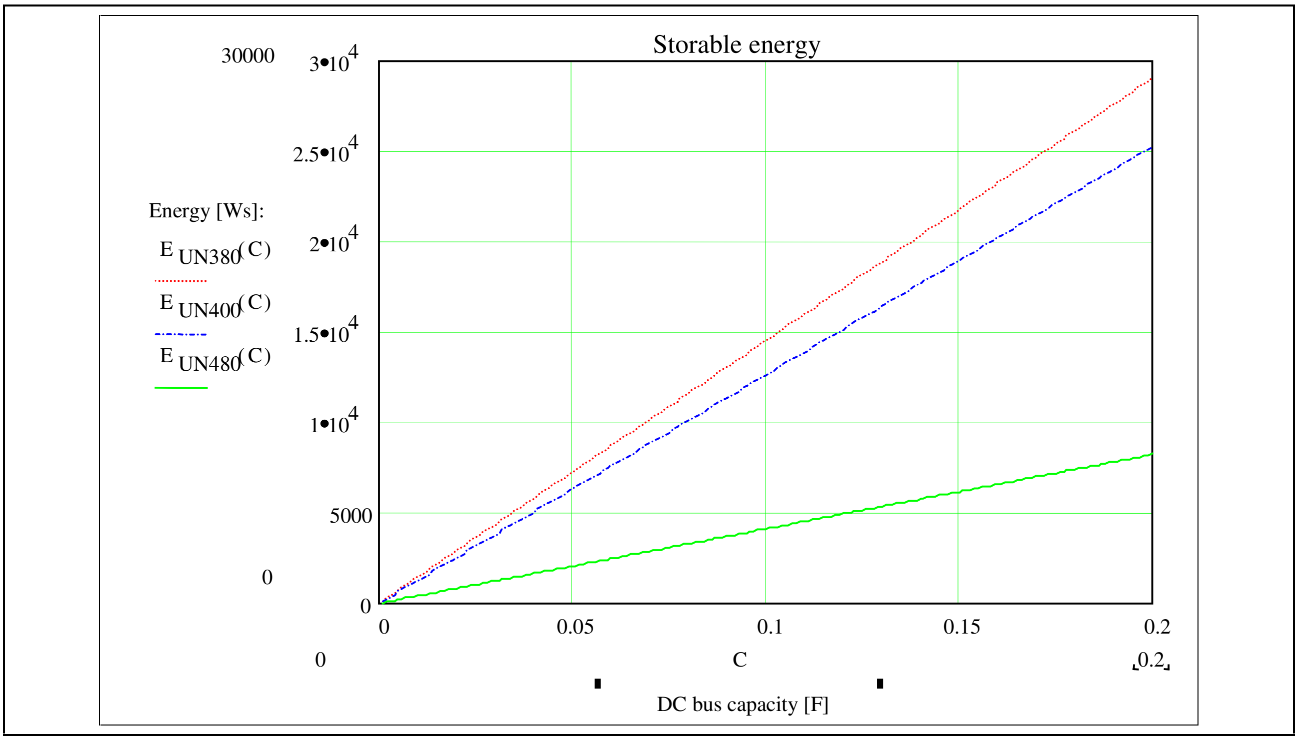

Fig. 8-35: Storable DC bus energy depending on mains voltage and additional capacity

Allowed voltage range

For dimensioning the additional capacity the allowed voltage range U_{SS} on the DC bus of the power supply unit has to be taken into account.

$$U_{SS} = U_{B\,min} - U_{ZW}$$

U_{SS}: voltage range [V]
U_{Bmin}: lower bleeder trigger level 800V
U_{ZW}: DC bus nominal voltage U_{ZW} = 1,41 * U_{N1} +10% [V]
U_{N1}: nominal mains voltage 3 x AC 380...480 V

Fig. 8-36: Allowed voltage range

This voltage range and the repetition rate are decisive for the service life of the capacitors. The interdependence of voltage range and allowed repetition rate at constant service life is illustrated in the figure below.

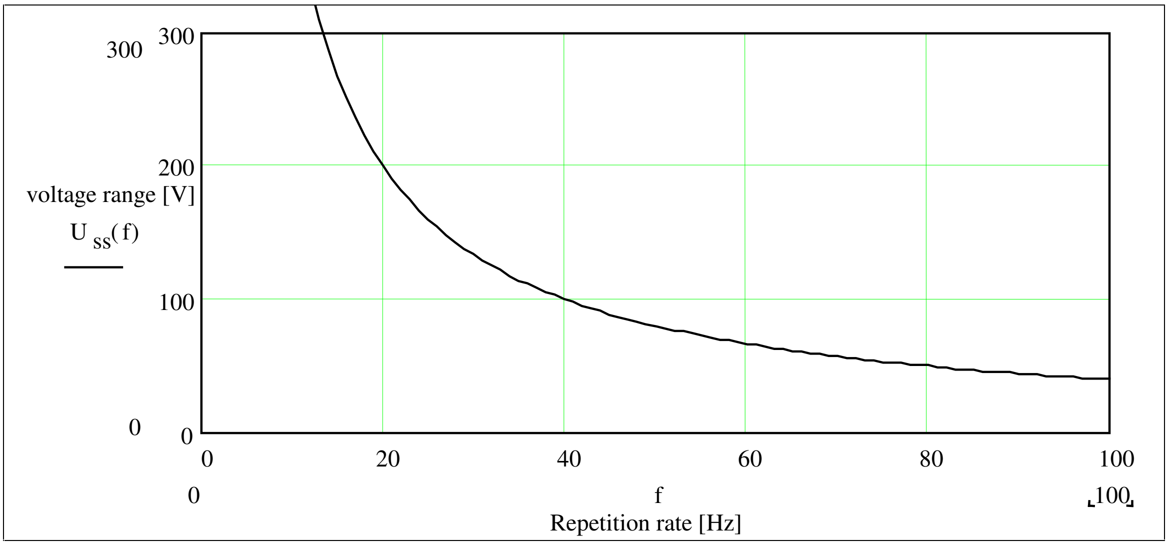

Fig. 8-37: Allowed voltage range U_{SS} on DC bus for load cycles smaller than mains frequency

Note: Exceeding the allowed voltage range reduces the service life of the device-internal DC bus capacitors.

Dimensioning the capacitors

The voltage range on the DC bus voltage caused by the application and its repetition rate are affecting the service life of the capacitors.

Note: For dimensioning the additional capacity, the tolerance and the decrease of the capacity due to age have to be taken into account. With the voltage ripple and the repetition rate it is possible to estimate the service life by means of the data of the capacitor manufacturer.

Due to the dielectric strength of the available capacitors (in most cases a maximum of 450 V) and the system DC voltage of DIAX04, it is necessary to connect 2 ore more capacitors in series.

Note: The dielectric strength of the capacitor battery must be at least 900 V.

Note: Observe the manufacturer's instructions for the balancing of capacitors that are connected in series.
The discharge time of the DC voltage DC bus can be strongly increased if there aren't any sufficiently low-resistance balancing or discharge resistors connected.

Discharge time of capacitors

Increasing the DC bus capacity also increases the discharge time if there aren't any appropriate measures taken.

DANGER

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

⇒ Wait at least 5 minutes after switching off power to allow capacitors to discharge before beginning work at the devices. Always measure voltage of capacitors before starting work.

Note: In order to make sure that the DC voltage DC bus is discharged within 5 minutes and to discharge the capacitors to a sufficiently low voltage value, Rexroth recommends "controlling the mains contactor with DC bus dynamic brake" (see chapter 9).
Observe the allowed frequency of the switch-on/switch-off cycles according to the data in Fig. 10-13: Number of switching actuations with aux. capacitance and rotating motor.

If "controlling the mains contactor with DC bus dynamic brake" cannot be used (e.g. emergency stop strategy in the case of mains failure), calculate the discharge time approximately according to the formula below:

$$t_{entlade} \approx 5 * R_{Sym} * C$$

$t_{entlade}$ discharge time [sec.]
R_{Sym} resulting total resistance of the balancing resistances [Ohm]
C capacity value of the entire capacitor battery [F]

Fig. 8-38: Discharge time

Connecting lines of the capacitor battery

Load capacity of the DC bus connection at the power supply unit

max. voltage	DC 900 V
voltage against ground	provided mains voltage
max. continuous current	150 A_{eff}

Fig. 8-39: Load capacity of the DC bus connection at the power supply unit

Line

line length	max. 10 m
line cross section	not smaller than cross section of supply feeder to power supply unit
line routing	with low inductance, twisted routing when capacitor battery is mounted externally, line routing in the pipe is recommended
dielectric strength of single strand against ground	≥ 750 V (e.g.: strand type – H07)
shielding	recommended

Fig. 8-40: Line

According to standard, there isn't any separate fusing of the capacitor battery required when the capacitor battery is mounted together with the HVE-L in the same control cabinet. Rexroth nevertheless recommends fusing the capacitor battery according to the respectively valid standards EN50178, EN 60204 and/or UL 508C.

Note: **DC voltage!**
The fuses used have to be suited for operation with direct voltage or direct current.

DC bus charging currents with additional capacities

When power is switched on the DC bus is charged via a current-limiting circuit. The generated peak values of the charging current pulses depend, among other things, on the mains voltage and the additional capacity.

If the HVE-L is operated with nominal load, the DC bus charging currents do not have to be taken into account for fusing the devices. In the case of low device load and fusing, the charging current possibly has to be taken into account for dimensioning the mains circuit breaker.

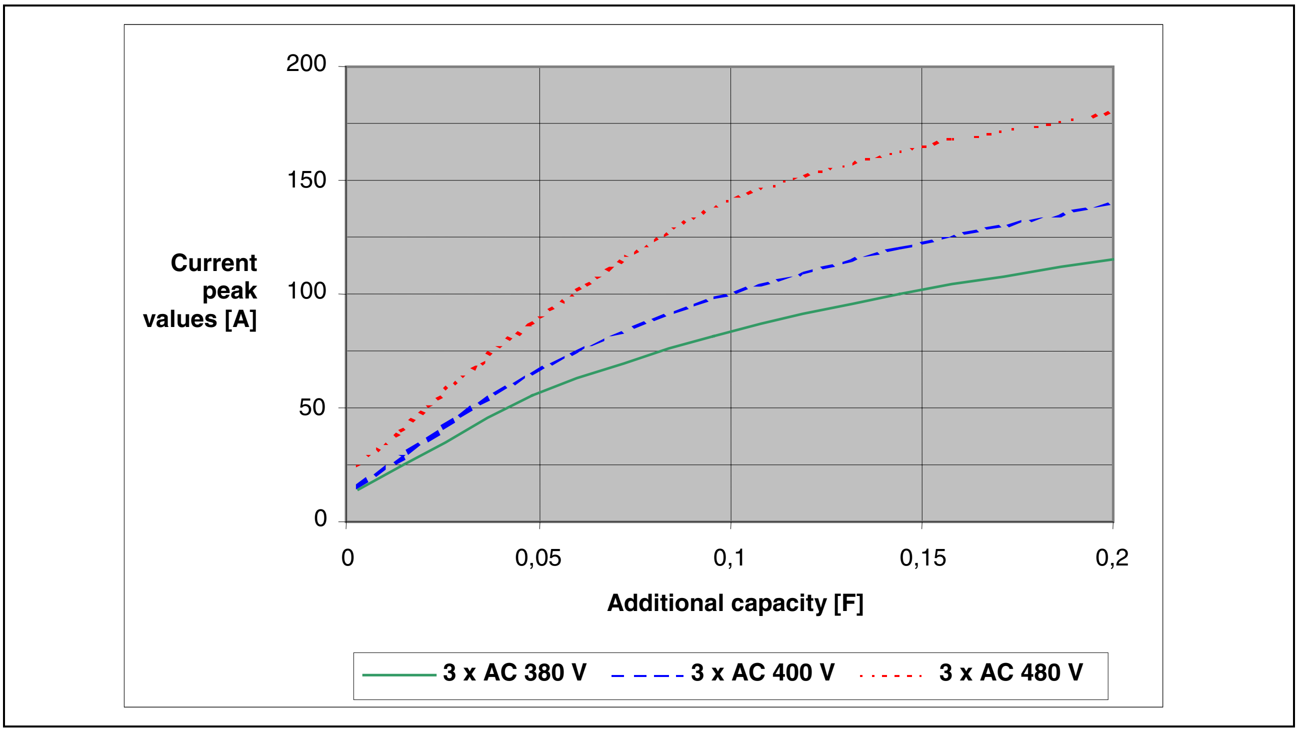

Fig. 8-41: Peak values of charging current pulses at soft start with HVE-L depending on mains voltage and additional capacity

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The duration of the soft start with HVE-L is approx. 6 seconds. The resulting average value of the charging current is illustrated in the diagram below.

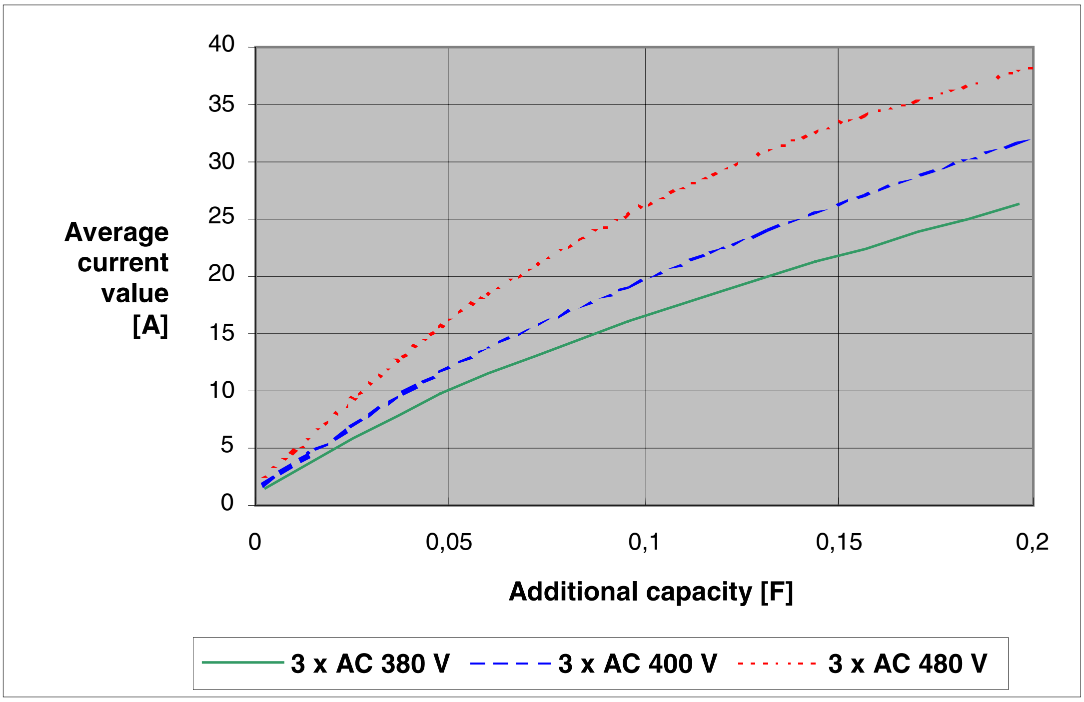


Fig. 8-42: Average current value at soft start with HVE-L depending on mains voltage and additional capacity

Operating HVE04 with GLD12

For applications that require lower power (in range between applications without and with GLD20) it is possible to use the GLD12. This choke, compared to GLD20, is of clearly smaller size.

The power data below are valid for operating a HVE04 with GLD12.

Mains voltage [V AC]	P_{ZW} [kW]	P_{KB30} [kW]	P_{KB03} [kW]	Power supply unit	DC bus choke
3 x 380	42	84	126	HVE04.2-W075x	GLD12
3 x 400	45	90	135		
3 x 440	50	100	150		
3 x 480	55	110	165		

P_{ZW} DC bus continuous power
P_{KB30} DC bus short-time power (for 30s)
P_{KB03} DC bus peak power (for 0,3s)

Fig. 8-43: Power data HVE04 with GLD12

The values for bleeder continuous power and peak power, as well as for the maximum regenerative power do not change when the GLD12 is used.

The technical data and dimensions of the GLD12 can be taken from chapter 6.2.

8.12 Operation on mains with outer conductor ground connection (asymmetric mains)

There are two ways of operating power supply units on asymmetric mains:

- connecting an isolating transformer before the power supply unit
- direct operation on the mains

Connecting an isolating transformer before the power supply unit

The neutral point of the isolating transformer must be connected as a ground reference.

The isolating transformer must have a short-circuit voltage of U_K < 2.5%.

Direct operation on the mains

It is only with additional components that the power supply units can be operated on asymmetric mains:

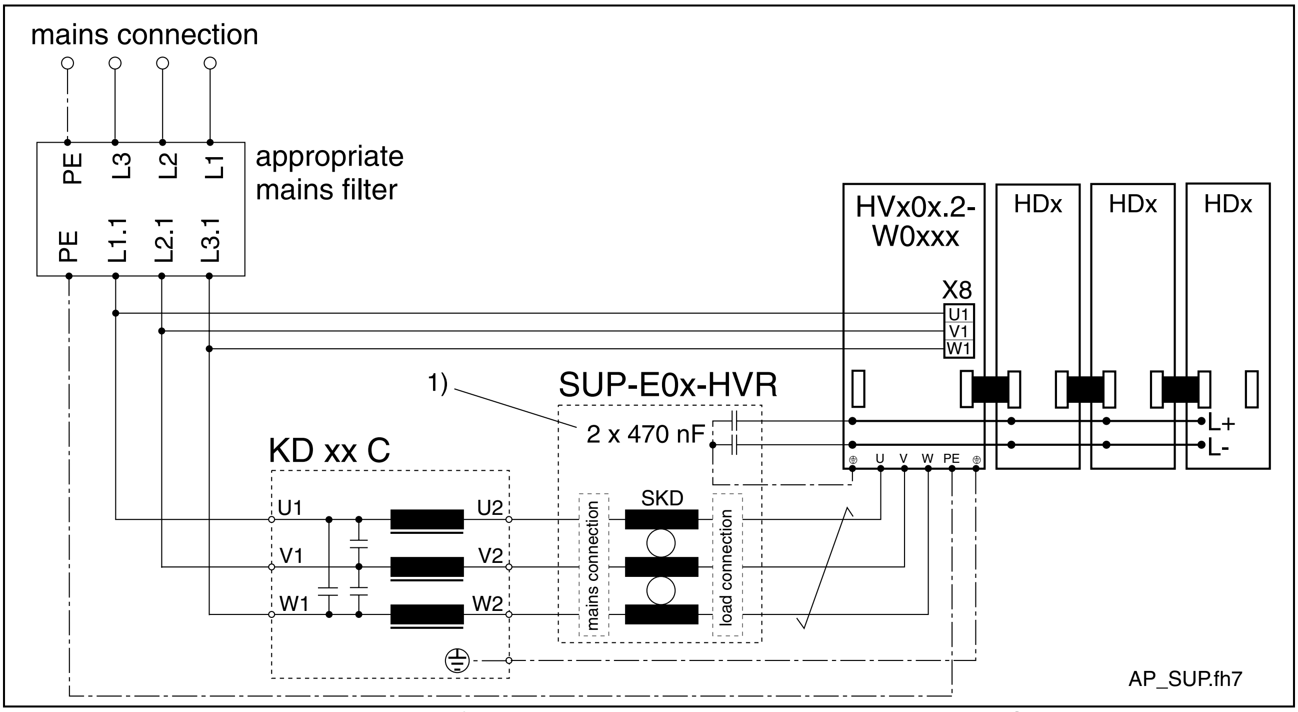
- HVR:
commutation choke with filter unit (KDxx-C) and another current compensated choke with Y capacitors (SUP-E0x-HVR)
- HVE:
current compensated choke with two Y capacitors on the DC bus (SUP-E0x-HVR)

Note: For direct operation on mains with outer conductor ground connection the outer conductor voltage of the mains mustn't exceed a maximum of 400V +10%!

Note: HZF are not suited for operation on asymmetric mains! The modules risk heating up unduly! Therefore, alternatively use SUP-E0x.

Note: Residual current operation of the HVE power supply unit on an asymmetric mains requires an isolating transformer with grounded neutral point. Direct operation on the asymmetric mains would cause false tripping of the residual-current-operated circuit-breaker.

Recommended connections for phase-grounded mains



1) The two capacitors are not required for SUP-E08-HVR and aren't contained in the scope of supply either.

Fig. 8-44: Connection power supply units on asymmetric mains

Note: NFD03.1 filters are not suited for asymmetric mains!

Component	Commutation choke	SUP-E0x
HVR02.2-W010N	KD30-C	SUP-E05-HVR
HVR02.2-W025N	KD27-C	SUP-E06-HVR
HVR03.2-W045N	KD28-C	SUP-E07-HVR
HVE02.2-W018N	no KD	SUP-E06-HVR
HVE03.2-W030x	no KD	SUP-E07-HVR
HVE04.2-W075x	no KD	SUP-E08-HVR (as an alternative, two SUP-E07-HVR can be connected in parallel for existing installations)

Fig. 8-45: Combination of the components

Note: Using SUP with HVR on mains with outer conductor ground connection requires commutation chokes of the KD xx C type!

8.13 Reducing interference emissions

Note: Rexroth does not supply EMC filters for asymmetric mains. If required, the appropriate EMC filters must be selected for the specific installation.

Frequency range	10 – 80 kHz		50 – 150 kHz		150 kHz – 30 MHz	
Kind of mains	**asymm.**	**TT, TN or IT**	**asymm.**	**TT, TN or IT**	**asymm.**	**TT, TN or IT**
HVE02.2-W018N	-	-	SUP-E06-HVR	SUP-E06-HVR	other appropriate mains filter	NFD03.1
HVE03.2-W030x	-	-	SUP-E07-HVR	SUP-E07-HVR		
HVE04.2-W075x	-	-	SUP-E08-HVR	SUP-E08-HVR		
HVR02.2-W010N	no measure required		SUP-E05-HVR	HZF01.1-W010N		no measure required, because NFD integrated in HZF
HVR02.2-W025N			SUP-E06-HVR	HZF01.1-W025N		
HVR03.2-W045N			SUP-E07-HVR	HZF01.1-W045N		

Fig. 8-46: Overview for reducing interference emissions

Reachable limit values for TN, TT and IT systems (frequency range: 150 kHz – 30 MHz)

For Rexroth drive systems, the following limit values can be reached with regard to line-based emission (according to EN 61800-3):

1. Industrial area/second environment, connection I > 100 A

Reachable limit value	Type of drive	Filter measures
limit value **class A**, group 2, I > 100 A (diagram line 1.1, 1.2)	all drive types	without additional filters

2. Industrial area/second environment, connection I > 100 A

Reachable limit value	Type of drive	Filter measures	max. motor cable length (1)
limit value **class A**, group 2, I < 100 A (diagram line 2.1, 2.2)	HVR+HZF01.1	without additional filters	200 m
	HDC 1.1		25 m
	all others	with NFD03.1 filter	180 m per filter

3. Industrial estate and residential area/first environment, restricted distribution

Reachable limit value	Type of drive	Filter measures	max. motor cable length (1)
limit value **class A**, group 2, I < 100 A (diagram line 3.1, 3.2)	HVR+HZF01.1	without additional filters	125 m
	HDC 1.1		25 m
	all others	with NFD03.1 filter	125 m per filter, 200 m with filters of more than 130 A

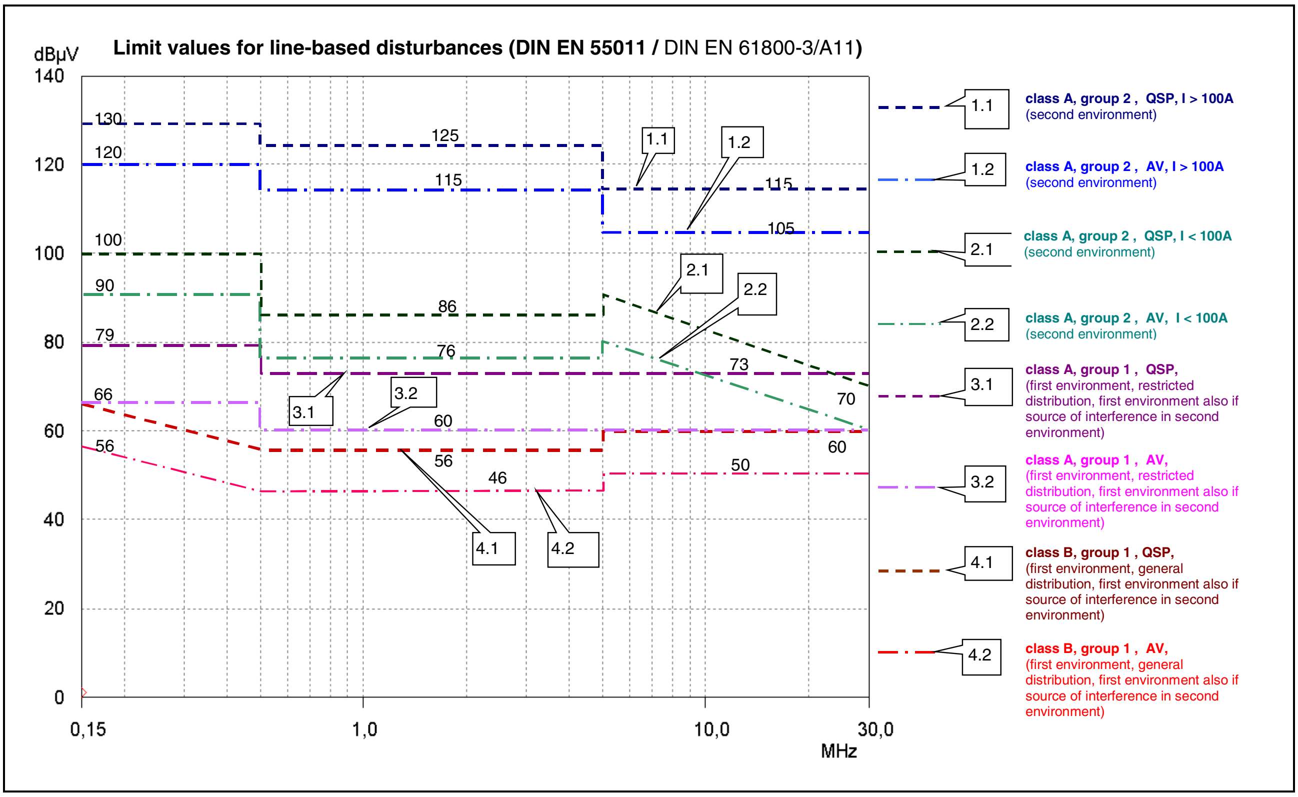
Note: According to IEC 61800-3, the drive controllers are products of the restricted distribution class In a residential area this product can cause high-frequency interference. If this happens, the user can be requested to take appropriate measures, in order to comply with class B, group 1.

4. Industrial estate and residential area/first environment, general distribution

Reachable limit value	Type of drive	Filter measures	max. motor cable length (1)
limit value **class B**, group 2, I < 100 A (diagram line 4.1, 4.2)	HDC 1.1	with NFD03.1 filter	25 m
	all other drives except for HDC and HVR	with NFD03.1 filter	50 m per filter
	HVR with HZF1.1: only class A can be reached	no NFD03.1 filter possible	-

Explanatory notes:

- (1) motor cable length: total length of all motor cables of all connected axes
- The classification according to classes A and B and groups 1 and 2 is defined in the basic technical standard EN 55011.
- diagram with limit values see following page
- The values apply to mains with neutral grounding at a 4 kHz clock rate of the drive controllers.



QSP: quasi peak value
AV: average value

Fig. 8-47: Limit values for line-based disturbances (DIN 55011/DIN 61800-3/A11)

Phase-grounded mains (example Japan)

Frequency range 50 kHz to 150 kHz

Reduction of the leakage current with phase-grounded mains due to RCD.

Frequency range 150 kHz to 30 MHz

Interference emission that can be reached with filters in the case of phase-grounded mains:

The NFD03.1 filters are not suited for phase-grounded mains where low leakage current is required. Due to the higher asymmetric load with reference to ground, the mains would be enough to produce a higher leakage current of typically 150 mA in this case.

For phase-grounded mains we therefore recommend filters with low ground capacitances, FN 258L-x-29 types, for example, with currents according to the wild card character "x" = 7, 16, 30, 55, 75, 130, 180 A, (manufacturer: Schaffner EMV GmbH). With this mains, these filters have a leakage current of typically 7.5 mA, max. 9 mA.

The interference emission to be obtained in this case has a higher noise level than with the NFD03.1 filters and depends on the installation parameters. The interference emission can therefore only be determined by measurement in the installation.

9 Control mains contactor

9.1 Control possibilities

The controls of the mains contactor and of the DC bus dynamic brake in the power supply unit, that are suggested in this documentation, explain the function principles. In this chapter, several control options are discussed and explained.

Note: Which control and functions are selected ultimately depend on the extent of functions required and the range of actions of the entire installation and is primarily the responsibility of the manufacturer.

Shutdowns with faulty drive electronics

An additional safety for braked shutdowns of the drives in case of faulty drive electronics is to short-circuit the DC bus voltage.

If the DC bus voltage is short-circuited, the motors with permanent energized magnet will always be shut down to a braked condition. This is the case whether the drive electronics is operative or not.

Note: Asynchronous drives do not brake when DC bus voltage is short circuited!

If the drive electronics is interfered and the DC bus voltage is not short-circuited, then the motors with energized permanent magnet will slow down uncontrolled.

Braking with emergency stop or power failure

In an emergency stop or power failure situation, drives are generally shutdown by the drive control.

Given an emergency stop or with actuation of the drive-internal monitor, the drive control command value is set to go to zero and the drives brake controlled at maximum torque.

In some applications, however, e.g., electronically-coupled gear cutting machines, it is necessary to bring the drives, given an emergency stop or power failure, to a standstill controlled by the CNC. In an emergency stop situation or given the actuation of the drive-internal monitor, the drives are shutdown position-controlled by the NC control.

9.2 Controlling the power supply unit with emergency stop relays

With DC bus dynamic brake

If the mains contactor in the power supply unit is controlled via the emergency stop relay and the DC bus is short-circuited, you will reach maximum safety possible thus with very little expenditure. The drive system monitors are most effectively used. The drive system monitors are most effectively used.

Applications

You should use this mode, if

- only motors with permanent magnetic excitation have been mounted,
- or if motors with permanent magnetic excitation and asynchronous motors (induction machines) have been mounted,
- or if the emergency stop circuit must be duplicated or if e.g. a protection door monitor is required,
- or if your drive system includes an extended and substantial emergency stop chain.

Note: As the energizing current of the mains contactor flows via the emergency stop chain, the voltage drop must not become too great. To ensure a reliable energizing, the total resistance of the emergency stop chain which comes into effect between the connections X3/1 and X3/6 must be under 1.3 Ω (HVE02.2, HVE03.2 and HVR0x.2-xx) or 350 mΩ (HVE04.2)!

Features

The DC bus dynamic brake can shutdown motors with permanent magnetic excitation even with a fault in the drive electronics. A prerequisite, however, is a pertinent programming of the drive controller (parameter "Shutting down power in the event of a fault"). The DC bus dynamic brake is only active in the event of drive errors. If the emergency stop is actuated, asynchronous drives will also brake.

In an emergency stop situation or with actuation of the monitor in the power supply unit (e.g., power failure), the drives are shutdown by the drive electronics in the manner set for the specific error reaction.

WARNING

Property damages due to uncontrolled axis movements!

The DC bus dynamic brake protects machines against drive errors. It alone cannot assume the function of protecting personnel. Given faults in the drive and power supply unit, uncontrolled drive movements are still possible even if the DC bus dynamic brake is activated (X3/2 = 0).

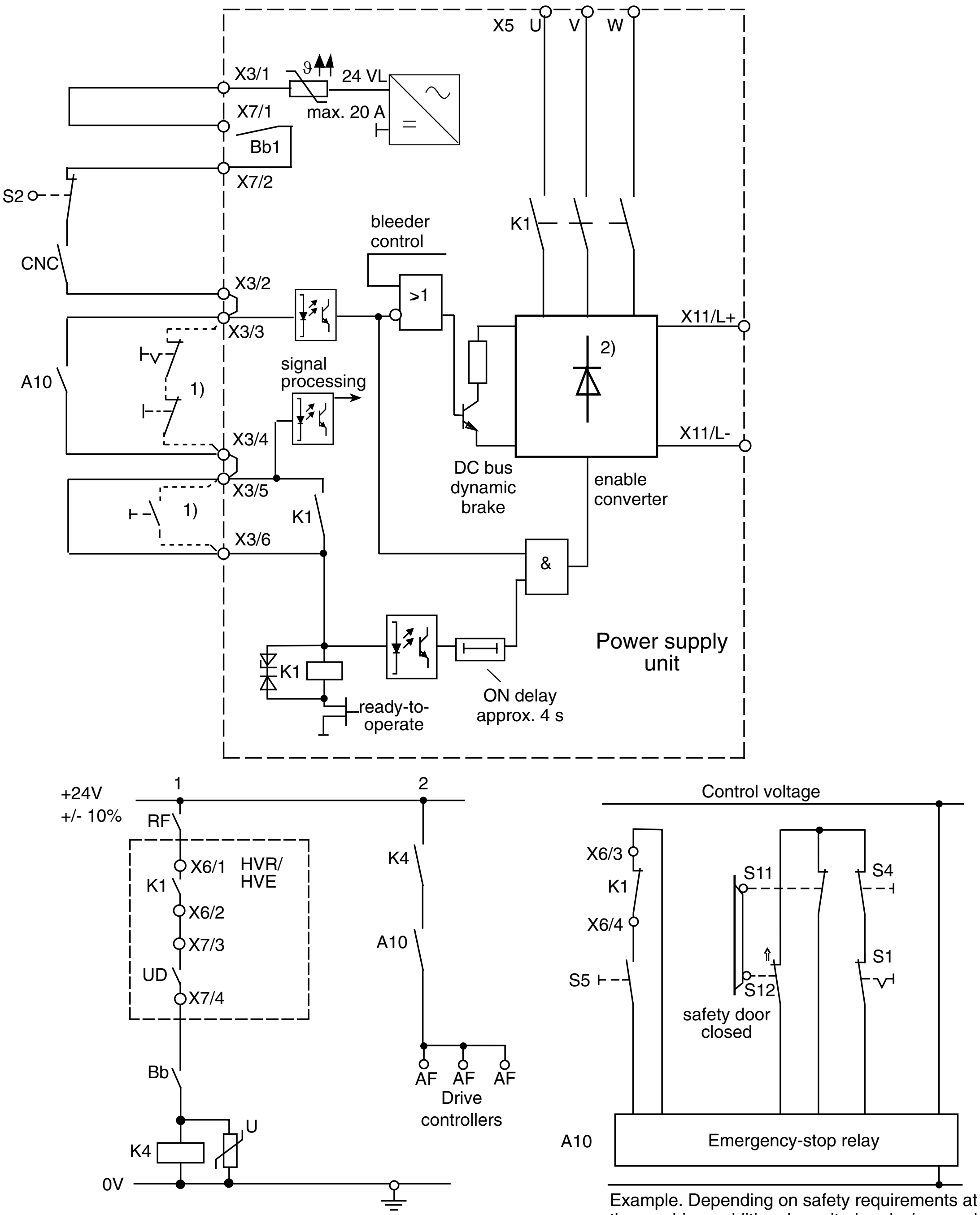
Asynchronous machines do not brake if the DC bus is short-circuited. Depending on the type of machine, injury to personnel is possible.

⇒ Additional monitoring and protective devices should be installed in the installation.

Function

When actuating the emergency stop key, the mains contactor in the power supply unit immediately falls off. Drive enables are shut off by the emergency stop relay or an auxiliary contact of the mains contactor. The drives are shutdown as per the error reaction set in the drive controller.

A drive error message from the supply module (Bb1-contact), an error message by the NC control (servo error) or the overtravelling of the end limit switch causes the mains contactor to be switched off and the DC bus dynamic brake to be actuated.



Example. Depending on safety requirements at the machine, additional monitoring devices and locks may be necessary!

A10 = Emergency-stop relay
AF = drive enable of the drive controllers
Bb1 = power supply module ready (drive system)
Bb = drive controllers ready
CNC = lag error message of control (use only contacts that do not open with E-stop switch is open)
K1 = mains contactor in power supply module
K4 = drive enable signal control
RF = drive enable signal of the control
S1 = Emergency-stop
S2 = axis end position
S4 = power OFF
S5 = power ON
S11/S12 = safety door monitor

1) K1 control if no emergency-stop switch is used
2) unregulated rectifier in HVE; regulated one in HVR

SS2HVR.fh7

Fig. 9-1: Control of the power supply unit with DC bus dynamic brake in the event of faulty drive electronics

Without DC bus dynamic brake

Application

- If an uncontrolled running out of the drives cannot damage the installation.
- If only asynchronous drives are connected to the power supply unit.
- If the end positions of the feed axes are sufficiently attenuated.

Features

The DC bus voltage is not short-circuited.

In an emergency stop situation, or if the monitors of the power supply unit are actuated (e.g., power failure), then the drives are shutdown by the drive electronics as per the set error reaction.

Function

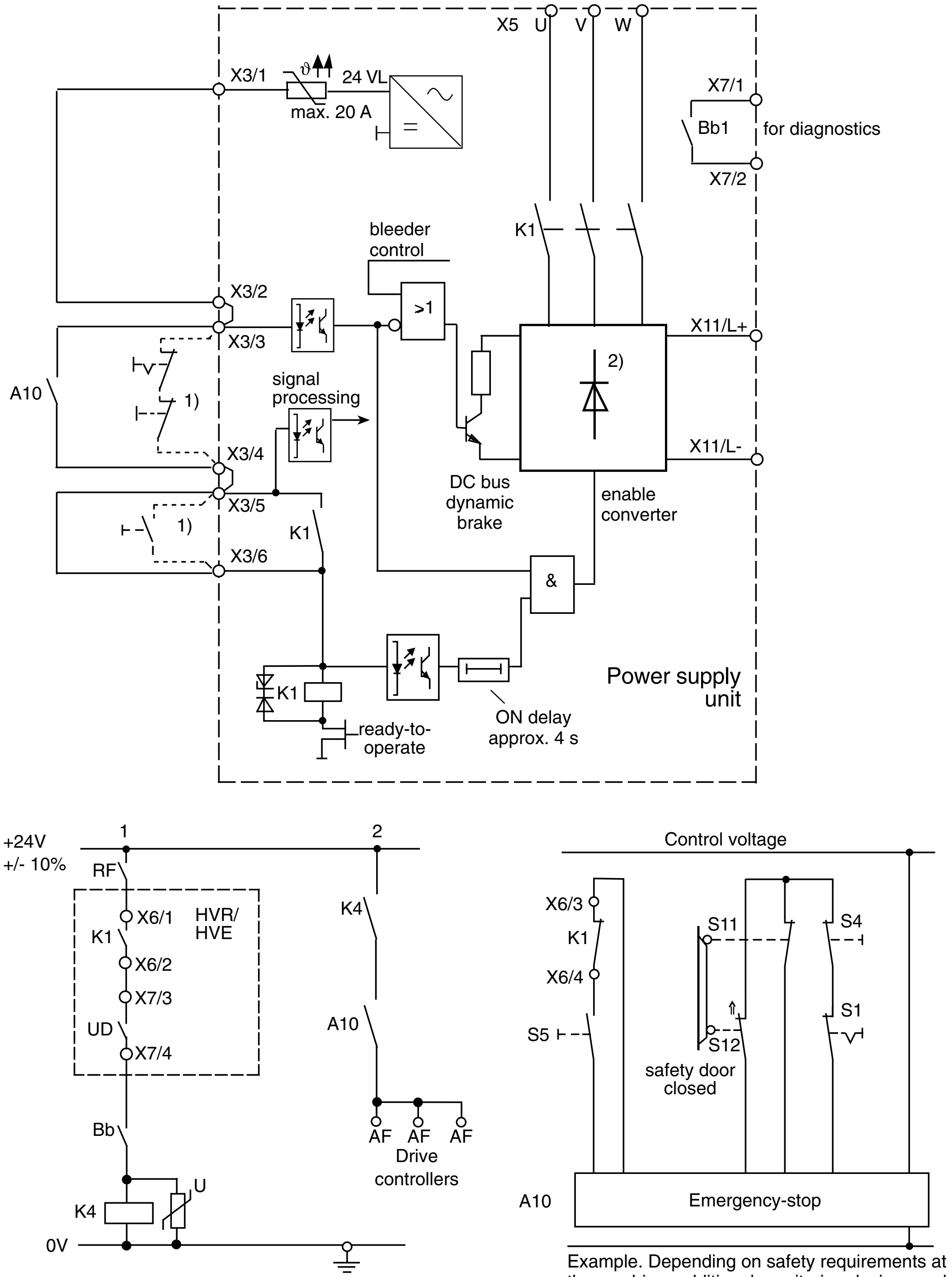
The mains contactor in the power supply unit immediately falls off when the emergency stop sequence is initiated. The drive enable is removed by the emergency stop relay or by an auxiliary contact of the mains contactor. The drives are shutdown depending on the set error reaction.

CAUTION

Machine damages due to brakeless slowing down of the drives in the event of faulty drive electronics!

⇒ Use motors with mechanical brakes (a holding brake must not be used as operating brake).

⇒ End positions of feed axes must be sufficiently attenuated.



Example. Depending on safety requirements at the machine, additional monitoring devices and locks may be necessary!

A10 = Emergency-stop relay
AF = drive enable of the drive controllers
Bb1 = power supply module ready (drive system)
Bb = drive controllers ready
CNC = lag error message of control (use only contacts that do not open with E-stop switch is open)
K1 = mains contactor in power supply module
K4 = drive enable signal control
RF = drive enable signal of the control
S1 = Emergency-stop
S2 = axis end position
S4 = power OFF
S5 = power ON
S11/S12 = safety door monitor

1) K1 control if no emergency-stop switch is used
2) unregulated rectifier in HVE; regulated one in HVR

SS3HVR.fh7

Fig. 9-2: Control of the power supply unit without DC bus dynamic brake

9.3 Control via NC controller

If the mains contactor is controlled via NC controller, it is possible to provide a position controlled shutdown of the drive via the NC controller in the event of an emergency stop or as reaction of the internal monitoring of the drive.

Application

This kind of mains contactor control is mostly used with drives which are electronically coupled and shutdown synchronously when a power failure occurs.

Features

The DC bus voltage is not short-circuited so that power for a position-controlled shutdown of the drives is available.

Note: The energy stored in the DC bus or the regenerated energy must be greater than the energy needed to excite asynchronous machines or for the return motion.

The parameter "Activating NC reactions with a fault" must be programmed in the drive controller (P-0-0117, bit 0 = 1).

Given an emergency stop or the actuation of the power supply unit monitor (e.g., power failure), the drives are shutdown position-controlled by the position controller.

Function

Upon initiating the emergency stop sequence, or with the actuation of the monitor in the power supply unit (e.g., power failure), the mains contactor in the supply unit falls off.

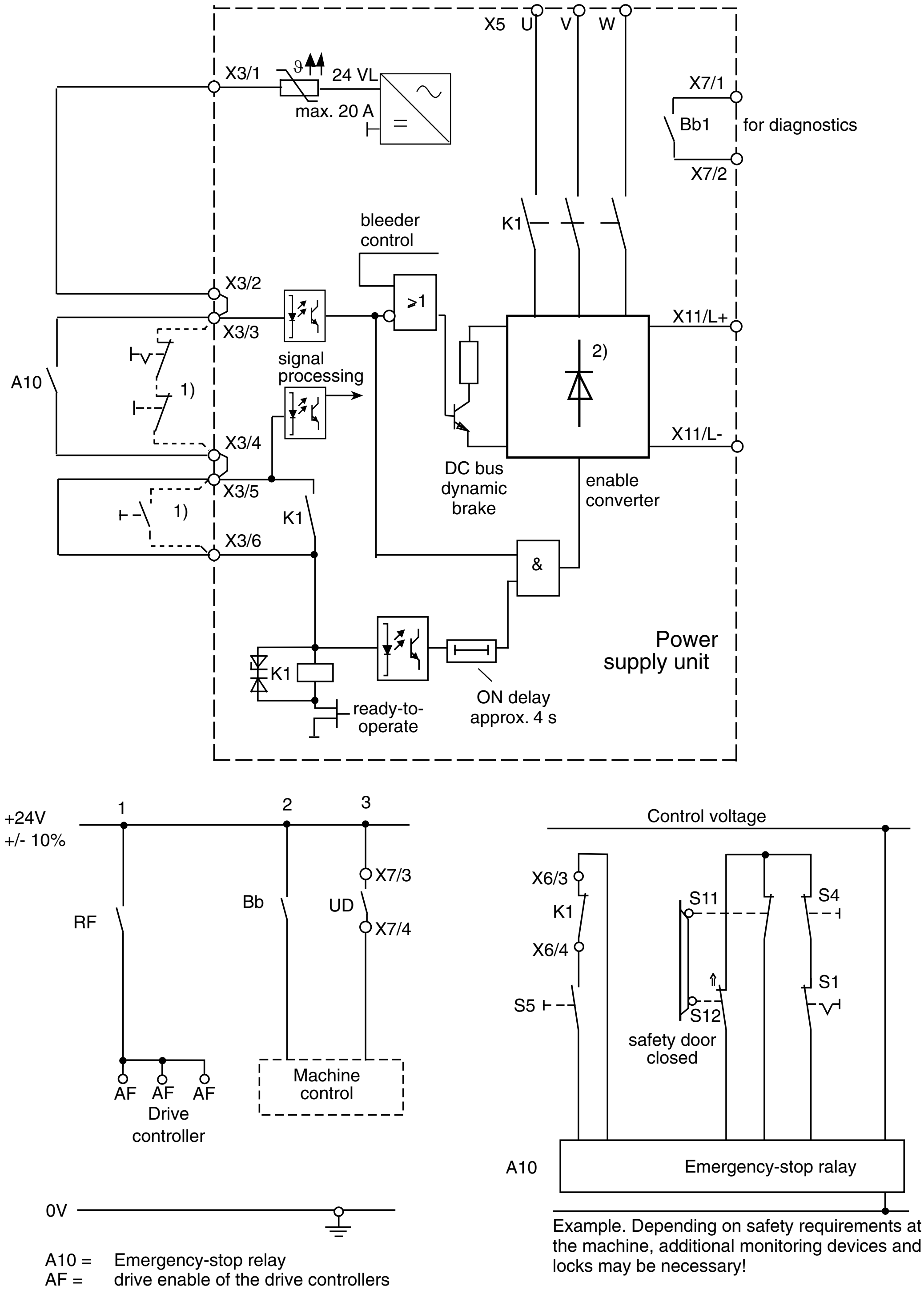
Drives with SERCOS interface signal the error to the NC control, meaning that the drives can be shutdown position controlled.

Drives without SERCOS interface require the control to evaluate the UD contact. If the UD contact is actuated, then the NC control must shut down the drives.

CAUTION

Machine damages due to brakeless slowing down of the drives in case of too little DC bus voltage!

⇒ The controller should evaluate the UD contact and shut down the drives, when the contact reacts.



A10 = Emergency-stop relay
AF = drive enable of the drive controllers
Bb1 = power supply module ready (drive system)
Bb = drive controllers ready
CNC = lag error message of control (use only contacts that do not open with E-stop switch is open)
K1 = mains contactor in power supply module
K4 = drive enable signal control
RF = drive enable signal of the control
S1 = Emergency-stop
S2 = axis end position
S4 = power OFF
S5 = power ON
S11/S12 = safety door monitor

1) K1 control if no emergency-stop switch is used
2) unregulated rectifier in HVE; regulated one in HVR

SS4HVR.fh7

Fig. 9-3: Control for position controlled shutdown of the drives via NC-controller (without DC bus voltage brake)

10 System control

10.1 Interfaces

X0, Additional component bus

Terminal X0

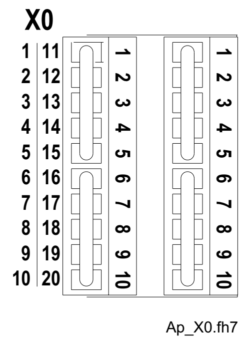


Fig. 10-1: Terminal X0 (condition as supplied with connectors)

Design

Type	Number of poles	Type of design
screw terminal	2 x 10	bushing at connector

Fig. 10-2: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No:
0,14...1,5	0,25 - 1,5	28...16

Fig. 10-3: Connection cross section

Tightening torque 0,22 Nm

Terminal assignment

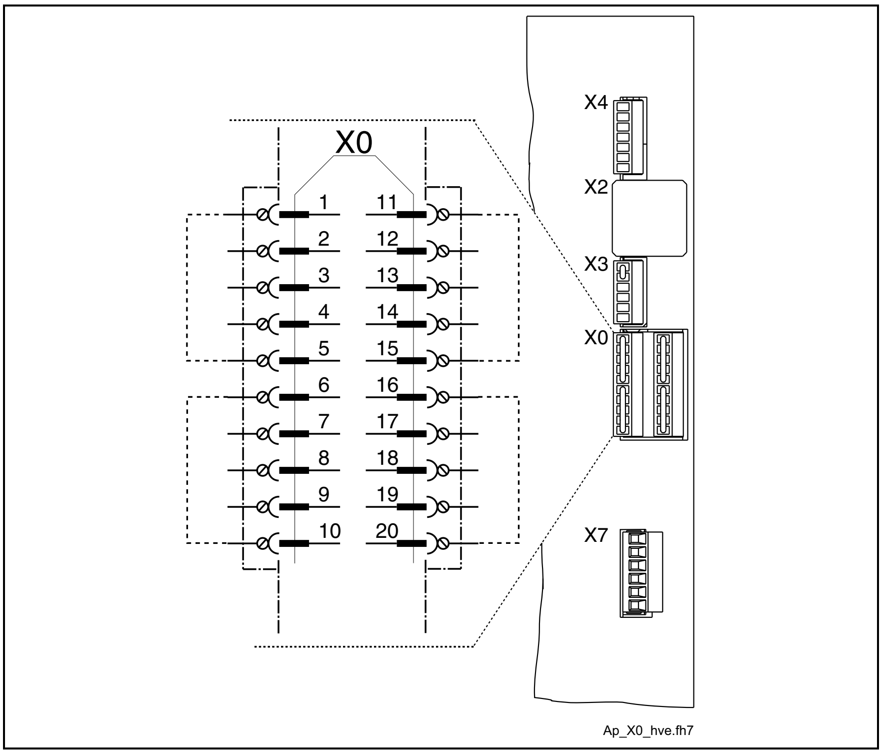


Fig. 10-4: Terminal X0 at the additional component HZS

Note: At delivery, terminal 1 is jumpered with 5, 6 with 10, 11 with 15 and 16 with 20. If there aren't any additional components HZB used, the HVx power supply unit has to be operated with these jumpers.

For further information on X0 see the respective chapters of the additional components.

X1, Connection for integrated bus connections from neighboring device

Terminal X1

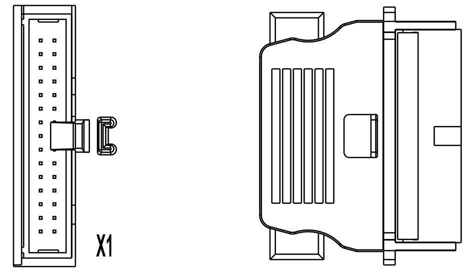


Fig. 10-5: Terminal X1

Design

Type	Number of poles	Type of design
ribbon cable connector	30	pins at device
ribbon cable bushing	30	bushing at ribbon cable

Fig. 10-6: Design

The control electronics of the neighboring drive controllers is supplied via connector X1. The connection is made starting from the power supply unit to the drive controllers, by means of the ribbon cables integrated in the devices. The maximum length of the ribbon cable is 1 m (when using extensions)!

Note: This is an internal connection between power supply unit and drive controller.

X2, Service interface

The X2 interface is only used for service purposes. Therefore this manual does not contain any further information on this interface.

X3, Emergency stop circuit

Terminal X3

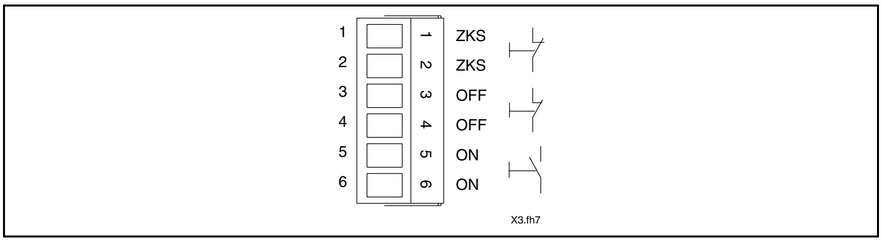


Fig. 10-7: Terminal X3

Design

Type	Number of poles	Type of design
screw terminal	1 x 6	bushing at connector

Fig. 10-8: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,14...1,5	0,25 - 1,5	28...16

Fig. 10-9: Connection cross section

Tightening torque 0,22 Nm

Terminal assignment

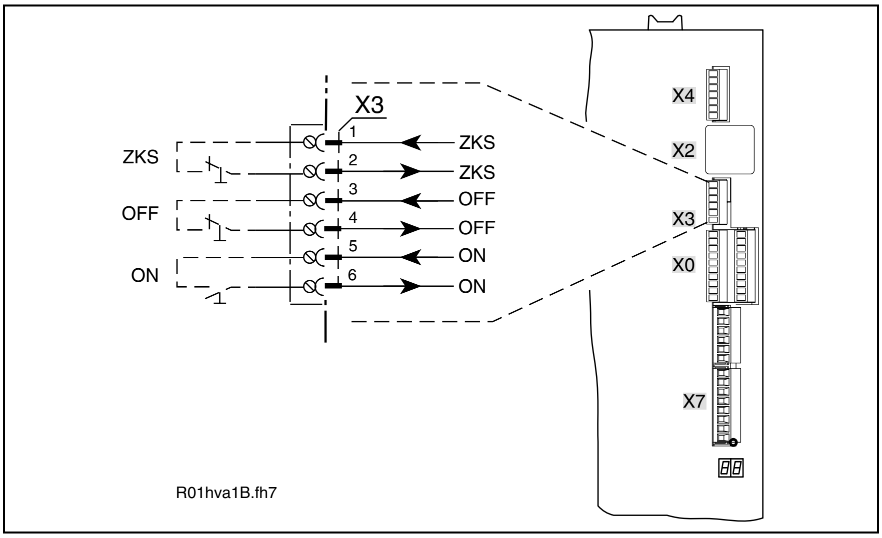


Fig. 10-10: Terminal assignment X3

The DC bus brake switching is activated via plug-in terminal X3 and the mains contactor in the power supply unit is switched:

Input "ZKS" If input “ZKS" is open, the DC bus short circuit is activated.

Input "OFF" Only with closed input (Power) "OFF" can the power contactor in the power supply unit be switched on. If input "OFF" is open, the power contactor in the power supply unit is immediately switched off.

Input "ON" If the inputs "ZKS" and "OFF" are closed and the unit is internally ready for operation, the power contactor in the power supply unit is switched on while the input "ON" is closed.

The ON impulse must be applied for at least 4 s.

Power supply unit	Voltage (DC) [V]	Break-away starting current [A]	Holding current [A]
HVE02 / 03	24	8	0,45
HVE04	24	20	1
HVR	24	8	1

Fig. 10-11: Technical data of the DC bus

As an additional installation protection in the event of drive electronic problems, the DC bus is short-circuited with an open DC bus input. Motors with permanent magnet excitation can, in this case, still be shutdown in a controlled manner.

WARNING

Injury to the personnel due to uncontrolled drive movements!

⇒ In the event of faults in the drive and supply unit, uncontrolled drive motions are still possible even if the DC bus circuit is activated. Therefore provide additional monitoring and protective equipment to the system.

Note: As the energizing current of the mains contactor flows via the emergency stop chain, the voltage drop must not become too great. To ensure a reliable energizing, the total resistance of the emergency stop chain, which comes into effect between the connections X3/1 and X3/6 must be under 1.3 Ω (HVE02.2, HVE03.2, and HVR0x.2-xx) or 350 mΩ (HVE04.2)!

Number of switching actuations

The power of the DC bus brake resistor is needed for the calculation of the permissible number of switching actuations:

HVE02	HVE03	HVE04	HVR02 and HVR03
1000 W	1500 W	2500 W	400 W

Fig. 10-12: Power of the DC bus brake resistor (P_{ZKS})

$$z = \frac{2 * P_{ZKS}}{2C_{ZU} * U_B^2 + J_g * \omega^2} * 60$$

U_B: bleeder actuating threshold [V] (820 V)
C_{ZU}: DC bus capacitance [F]
J_g: total moment of inertia [kgm²]
P_{ZKS}: power of the DC bus brake resistor
ω: angular speed [rad/s]
z: number of switching actuations per minute

Fig. 10-13: Number of switching actuations with aux. capacitance and rotating motor

Note: A maximum number of 16 switching actuations per minute applies to the internal contactors K1 and K2.

The number of switching actuations (service life of the contact elements) is 1 million for HVR and HVE units, however only if the contactor is switched current less. If switched in loaded condition (e.g. when emergency stop is released), the number of switching actuations for both unit families and types of contactors is 400.000.

X4, Control voltages

Terminal X4

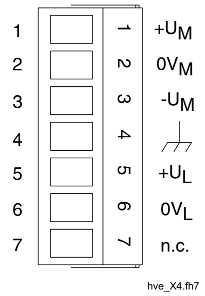


Fig.. 10-14: Terminal X4

Design

Type	Number of poles	Type of design
screw terminal	1 x 7	bushing at connector

Fig. 10-15: Design

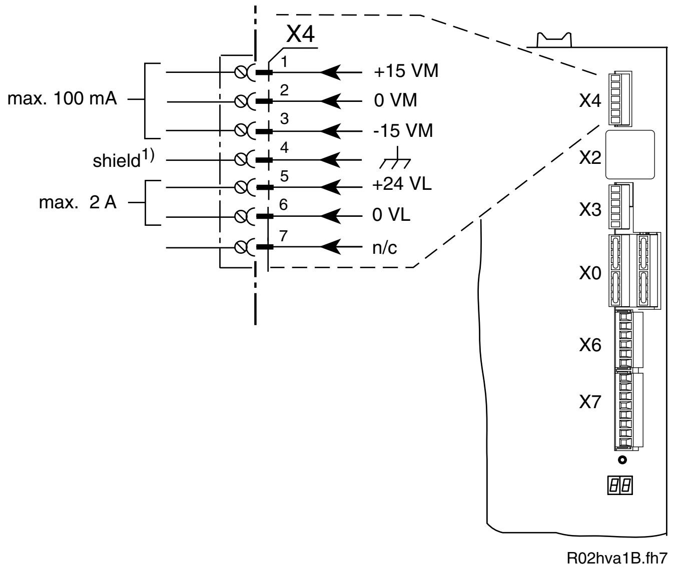
Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,14...1,5	0,25 - 1,5	28...16

Fig. 10-16: Connection cross section

Tightening torque 0,22 Nm

Terminal assignment



1) only for HVE

Fig. 10-17: Terminal assignment X4

Control voltages 24 VL and ±15 VM can be tapped off of terminal strips X4/1 ... X4/6. These terminals are intended for measuring and test purposes.

If these voltages are used outside of the drive system, then make sure that no interference voltages are coupled in (short, shielded lines). The load carrying ability of the control voltages is correspondingly reduced by the drive controllers.

The control voltage outputs are short-circuit proof. The maximum permissible load must not be exceeded in order not to endanger the functions of the drives.

X5, Mains connection

Terminal X5

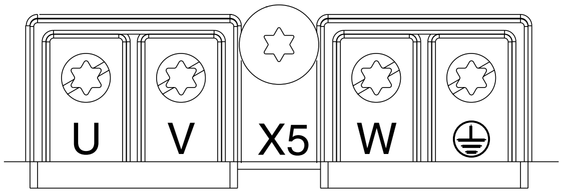


Fig. 10-18: Terminal X5 with HVx02.2 and HVx03.2

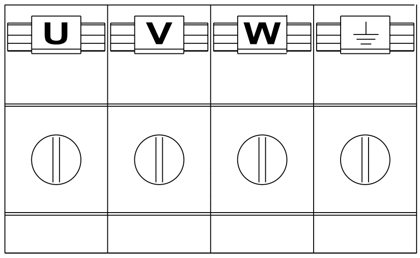


Fig. 10-19: Terminal X5 with HVE04.2

Design

Type	Number of poles	Type of design
screw terminal	1 x 4	bushing at device

Fig. 10-20: Design

Connection cross section

Device	Cross section single-core [mm²]	Cross section multi-core with connector sleeve [mm²]	Cross section in AWG gauge No.:
HVR02.2-W10N HVR02.2-W25N HVE02.2-W18N	2,5...10	2,5...16	12...6
HVR03.2-W45N HVE03.2-W30N	2,5...16	2,5...35	12...2
HVE04.2-W75N	16...50	16...50	6...0

Fig. 10-21: Connection cross section

Tightening torque

Device	Tightening torque
HVR02.2-W10N HVR02.2-W25N HVE02.2-W18N	2 Nm
HVR03.2-W45N HVE03.2-W30N	4 Nm
HVE04.2-W75N	6 Nm

Fig. 10-22: Tightening torques

Terminal assignment

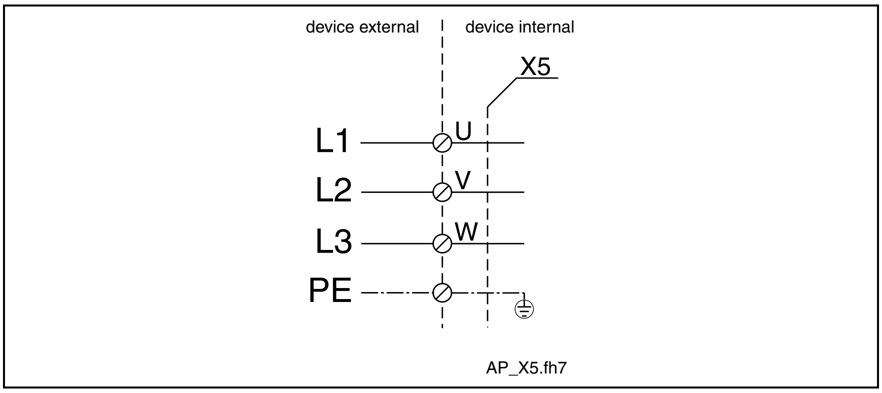


Fig. 10-23: Terminal assignment

X6, Acknowledging the power supply unit mains contactor

Terminal X6

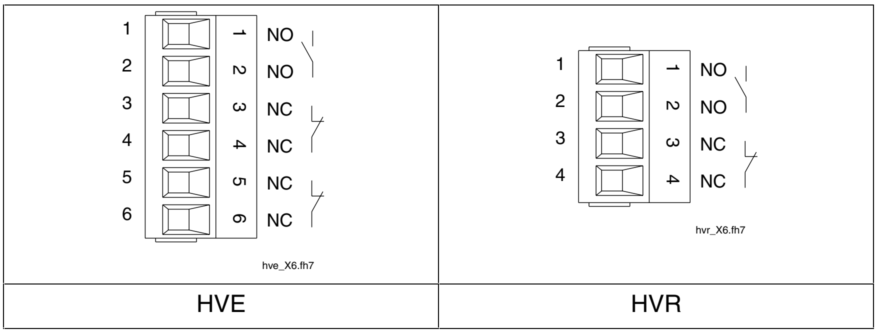


Fig. 10-24: Terminal X6

Design

Type	Number of poles	Type of design
screw terminal	1 x 4 for HVR 1 x 6 for HVE	bushing at connector

Fig. 10-25: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,2...2,5	0,25 - 2,5	24...12

Fig. 10-26: Connection cross section

Tightening torque 0,5 Nm

The acknowledge outputs are on terminal X6.

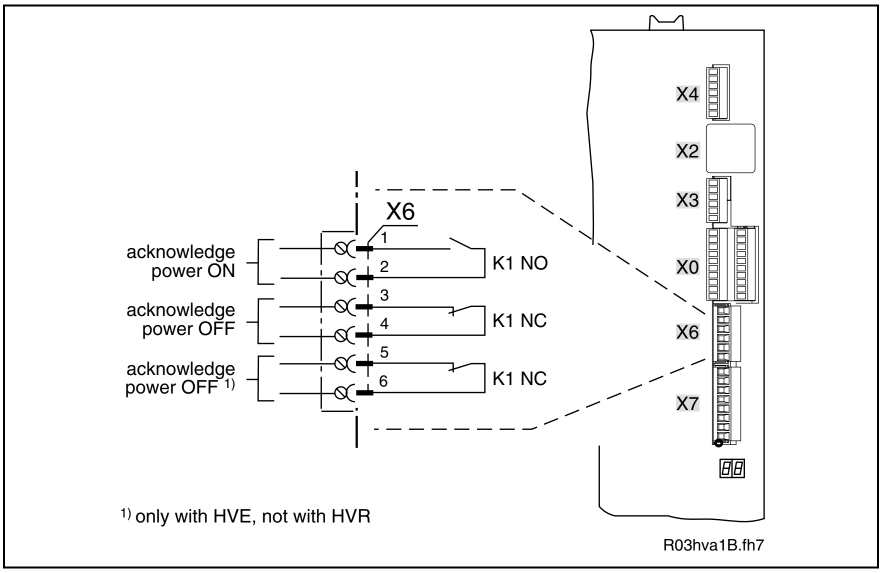


Fig. 10-27: Terminal assignment X6

Continuous current	Starting current
DC 24 V/1 A	DC 24 V/1 A
AC 220 V/1 A	AC 220 V/1 A

Fig. 10-28: Maximum contact load

Note: The indicated voltages have to refer to potential ground.

"Acknowledge power ON"

At output acknowledge power ON it can be queried as to whether the mains contactor in the supply unit is on or not. The contact is closed if the mains contactor is on. It can be used as a precondition for the drive enable signal.

"Acknowledge power OFF"

At output acknowledge power OFF it can be queried as to whether the mains contactor in the supply unit has dropped off or not. If it has, then the contact is closed. This can be used as a precondition to enable the safety door lock.

There is restricted guidance between the acknowledge power OFF contact and the main contacts of the mains contactor in the power supply unit.

On the HVE power supply unit, there are two brake contacts labeled as "Acknowledge power Off" led to the outside of the unit.

X7, Ready-to-operate and other messages

Terminal X7

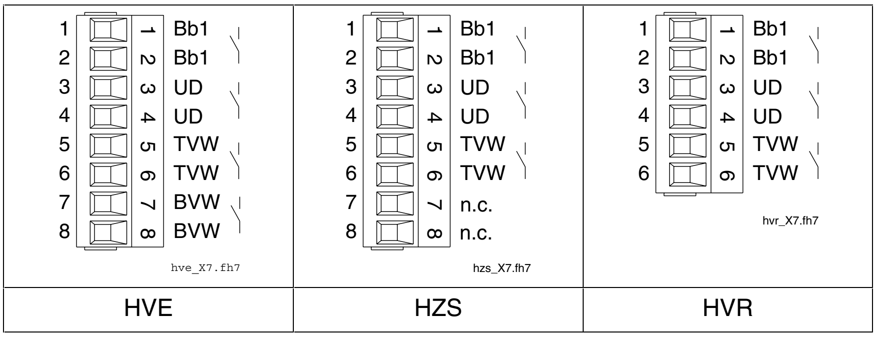


Fig. 10-29: Terminal X7

Design

Type	Number of poles	Type of design
screw terminal	1 x 6 for HVR 1 x 8 for HVE	bushing at connector

Fig. 10-30: Design

Connection cross section

Cross section single-core [mm²]	Cross section multic-core [mm²]	Cross section in AWG gauge No.:
0,2...2,5	0,25 - 2,5	24...12

Fig. 10-31: Connection cross section

Tightening torque 0,5 Nm

Terminal assignment

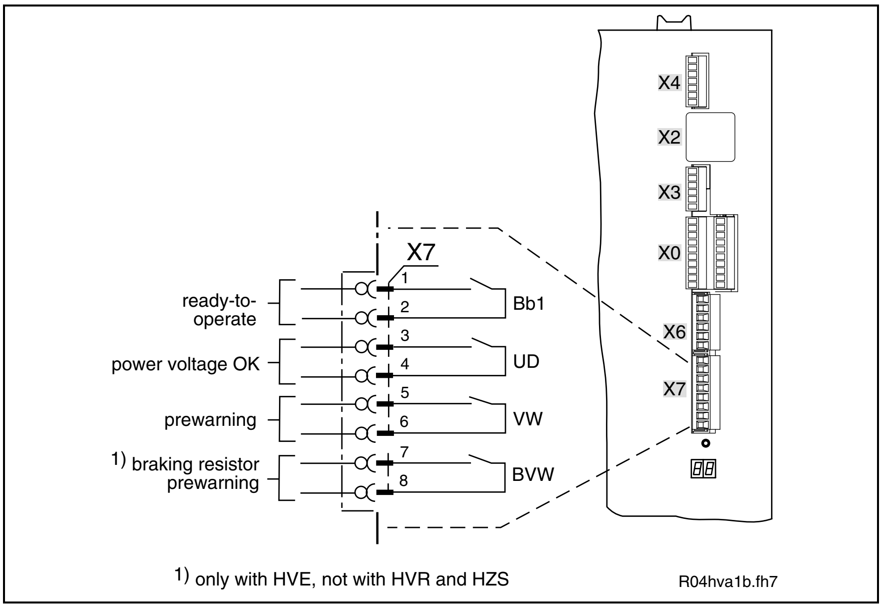


Fig. 10-32: Terminal assignment X7

Description

The terminal X7 contains outputs

- signalizing that the drive systems are ready for operation,
- acknowledging the proper power supply,
- warning that the device is overheated, and
- warning that the regenerated power is too great.

	HVE		HVR
Continuous current	DC 24 V/1 A	AC 250 V/1 A	DC 24 V/1 A
Starting current	DC 24 V/1 A	AC 250 V/1 A	DC 24 V/1 A

Fig. 10-33: Maximum contact load

Note: The indicated voltages have to refer to potential ground.

Ready-to-operate (Bb1)

The Bb1 contact of the power supply unit is of higher-ranking significance. It signals that the drive is ready to receive power. Only if closed, the locks within the unit allow switching the mains contactor to the power supply unit.

In the event of a fault, the power contactor is shut off and the Bb1 contact opens. If this contact opens, then there will probably not be a controlled shutdown of the drives. It can, therefore, be used as a precondition for letting the DC bus dynamic brake drop in.

The Bb1 contact opens with the following faults:

- faults in the power supply unit and
- faults in the drive controller (power off must be parameterized in the drive controller).
- faults in additional components.

The Bb1 contact closes if the control voltage at terminal X8 is applied and no error is pending.

Power supply in order (UD)

The UD contact acknowledges that the power supply is in working order.

It opens in the event of the following faults:

- mains fault
- DC bus voltage is smaller than the permissible minimum value (HVR: 680 V, HVE: 80% of U_{Netz})
- when switching off K1

If the installation requires that the drives be shutdown with position control in the event of a mains fault, then the installation control must evaluate the UD contact and shut down the drives in a controlled fashion.

Pre-warning (VW)

The pre-warning contact is opened, if the cooling unit temperature in the power supply unit is too high or a critical value is reached in an additional component. The mains contactor in the power supply unit interrupts the power supply after 30 seconds and the Bb1 contact opens.

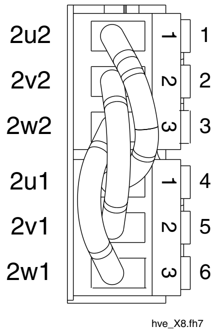
Note: If the installation requires that the drives are shut down in a position controlled fashion if there is a fault in the unit, then the drives must be shutdown within 30 seconds.

Bleeder pre-warning contact (BVW)

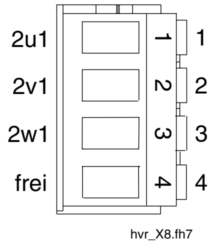
The bleeder pre-warning contact only exists in the HVE power supply units. The bleeder pre-warning contact opens if continuous regenerated power exceeds 80% of the continuous bleeder power. If the bleeder power continues to rise, then the mains contactor stops the HVE power supply unit and the Bb1 contact opens.

X8, Control voltage supply

Terminal X8



HVE



HVR

Fig. 10-34: Terminal X8

Design

Type	Number of poles	Type of design
screw terminal	1 x 4 for HVR 1 x 6 for HVE	bushing at connector

Fig. 10-35: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
0,2...4,0	0,25 - 4,0	24...10

Fig. 10-36: Connection cross section

Tightening torque

0,5 Nm

Terminal assignment

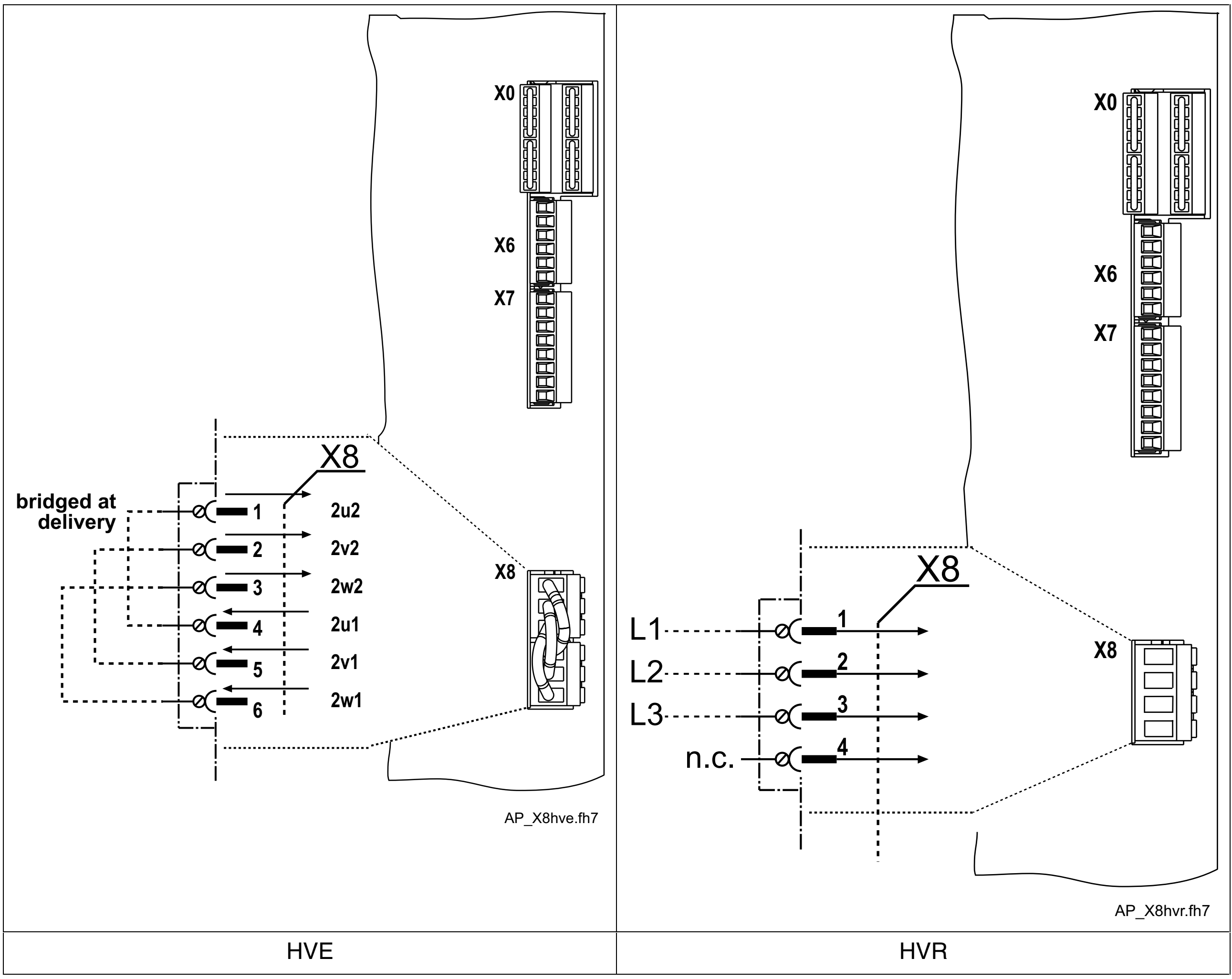


Fig. 10-37: Terminal assignment X8

X11, DC bus connection

Terminal X11

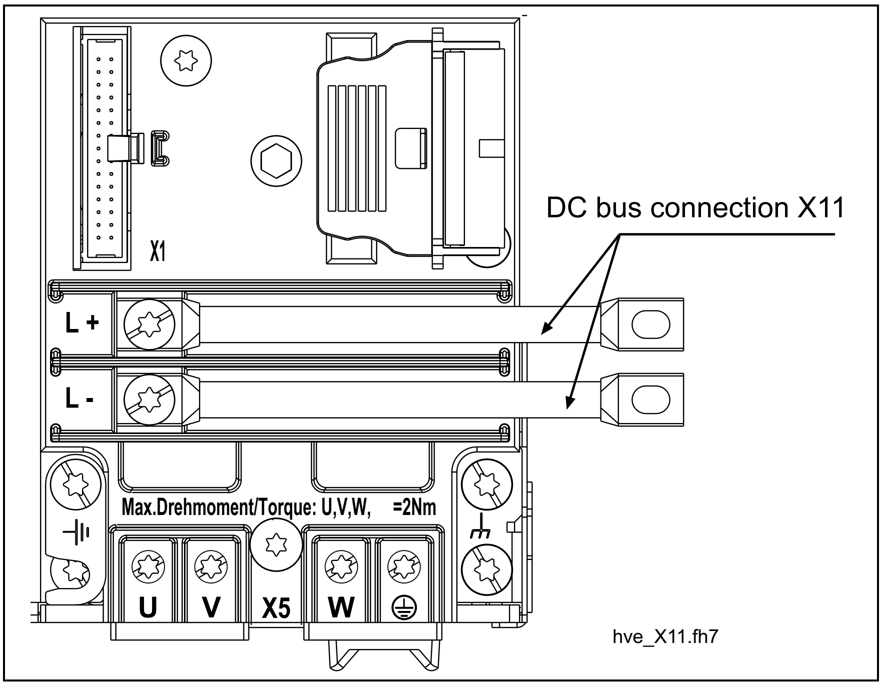


Fig. 10-38: Terminal X11

Design

Type	Number of poles	Type of design
terminal block	2	screw terminal for ring cable lug M5

Fig. 10-39: Design

Connection cross section

Cross section single-core [mm²]	Cross section multi-core [mm²]	Cross section in AWG gauge No.:
--	35	--

Fig. 10-40: Connection cross section

Tightening torque 3 Nm

CAUTION

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

⇒ When connecting the DC bus make sure the polarity is correct.

Rexroth Bosch Group

Lines for DC bus connection

If in special cases it is impossible to use the DC bus strands provided to make the connection, the connection must be made using the shortest possible twisted wires!

line length: • within a drive package • between two drive packages • HZS application in stand-alone operation	 • max. 2 x 1 m • max. 2 x 15 m • max. 2 x 30 m
line cross section	min. 10 mm^2; but not smaller than cross section of supply feeder
line protection	by circuit breakers in the mains connection
dielectric strength of single strand against ground	≥ 750 V (e.g. strand type - H07)

Fig. 10-41: Lines for DC bus connection

X12, Ground connection

Terminal X12

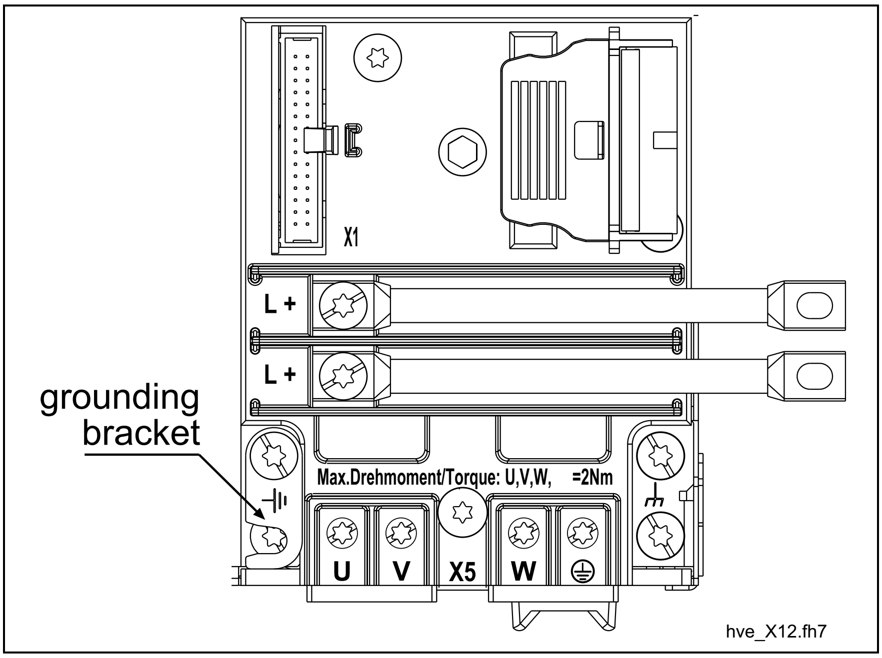


Fig. 10-42: Terminal X12

Design Screw terminal

Tightening torque 3 Nm

The ground connection to the drive controllers is double:

- rear panel of device and mounting rail
- grounding bracket on the front (see figure)

Connect the neighboring devices to both sides via the grounding brackets.

X13, Optional choke connection (only HVE)

Terminal X13

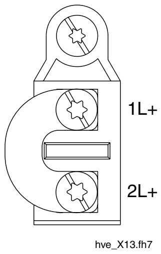
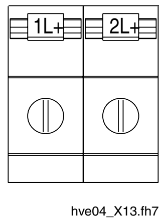
 	
HVE02 and HVE03 (jumpered at delivery)	HVE04 (not jumpered at delivery)

Fig. 10-43: Terminal X13

Design

	HVE02/HVE03	HVE04
Type	screw terminal	screw terminal
Number of poles	2	2
Type of design	screw terminal for ring cable lug M5	multi-core with connector sleeve or single-core
Cross section [mm^2]	10...25	16...50
Tightening torque	2,5...3,0	6...8

Fig. 10-44: Design

Terminal assignment

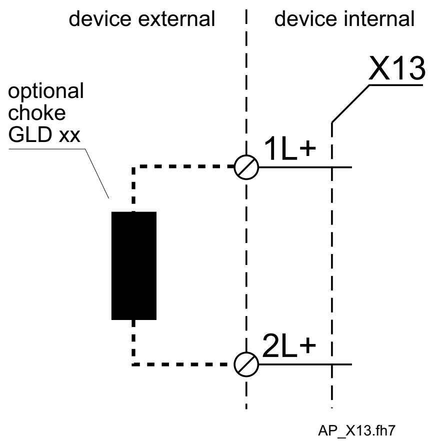


Fig. 10-45: Terminal assignment

Condition as supplied

- HVE02/HVE03: with jumper from 1L+ to 2L+
- HVE04: without jumper
  (if the optional choke is not required, a jumper has to be laid from 1L+ to 2L+; line cross section: see below)

Load capacity

max. voltage with reference to L-	DC 900 V
voltage with reference to ground	provided mains voltage
max. continuous current	• HVE02/03: 70 A • HVE04: 150 A

Fig. 10-46: Load capacity

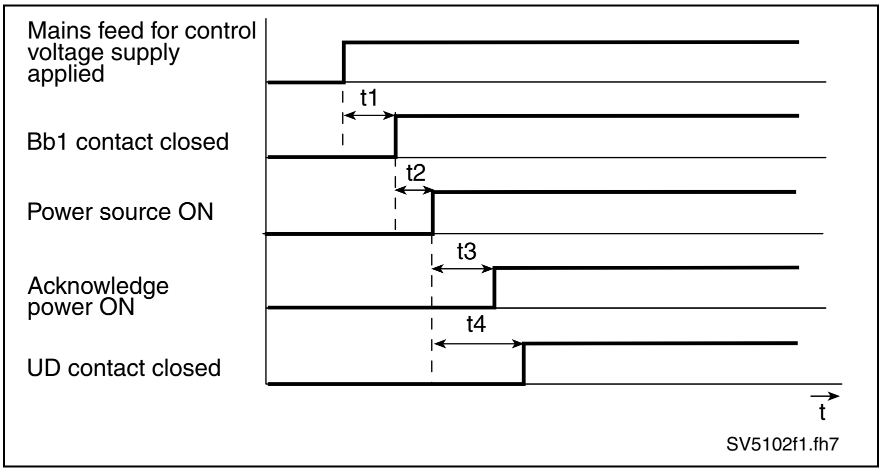
Line 1L+ and 2L+ to choke

line length	max. 10 m
line cross section	not smaller than cross section of supply feeder; minimum cross section: see data under "Design"
line routing	twisted
dielectric strength of single strand against ground	≥ 750 V (e.g.: strand type – H07)

Fig. 10-47: Line 1L+ and 2L+

10.2 Chronological sequence when switching on and off

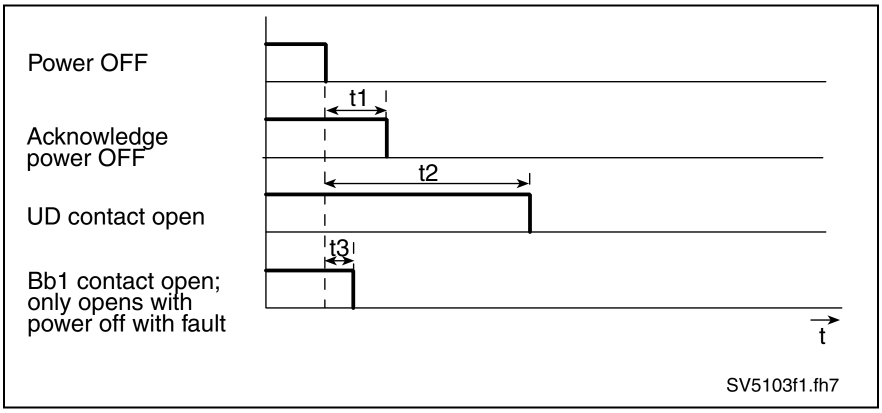
When powering up



t1:	Depends on parameterized function of the drives
t2:	Depends on the reaction time of the PLC
t3:	On-delay of the K1 mains contactor in the unit (maximum 100 ms)
t4:	Time to build up DC bus voltage - maximum 4,1 s; value applies to maximum DC bus capacitance (10 mF or 20 mF) - maximum 6,5 s; value applies to maximum DC bus capacitance (100 mF or 200 mF)

Fig. 10-48: Chronological sequence when powering unit up

When shutting down



t1:	On-delay of the K1 mains contactor in the unit (maximum 100 ms)
t2:	Depends on reduction of DC bus voltage (maximum 500 ms)
t3:	Only opens with power shutdown due to a fault (fault in supply unit, drive controller or due to mains failure); (maximum 25 ms)

Fig. 10-49: Chronological sequence when shutting down the unit

11 Troubleshooting

11.1 General

Extensive searches for faults and repair of drive components on the machine are not acceptable due to the production downtime involved.

The modular concept of Rexroth AC drives makes it possible to completely exchange drive components. Service thus means localizing problems either on the motor, drive controller or power supply unit and replacing the part. No further adjustments are needed.

11.2 Fault diagnostics and resetting faults

Fault diagnostics

The power supply unit signals operating states, warnings or faults via a two-place 7-segment display.

A prerequisite for fault diagnoses is a control voltage of +24 V, ±15 V and +5 V and processors in the supply and drive controllers that are working properly.

Resetting faults

Stored fault messages must be reset before the unit will again operate. An error can be reset by

- pressing the RESET key on the unit,
- switching the control voltage off or
- generating the reset command of the control via the control voltage bus.

CAUTION

Destruction of the power supply module, if the power is switched on to a faulty drive controller!

⇒ Upon RESET of an over current fault and after replacement of a defective supply module, the fault memories of the drive controllers must be read out prior to switching it on.

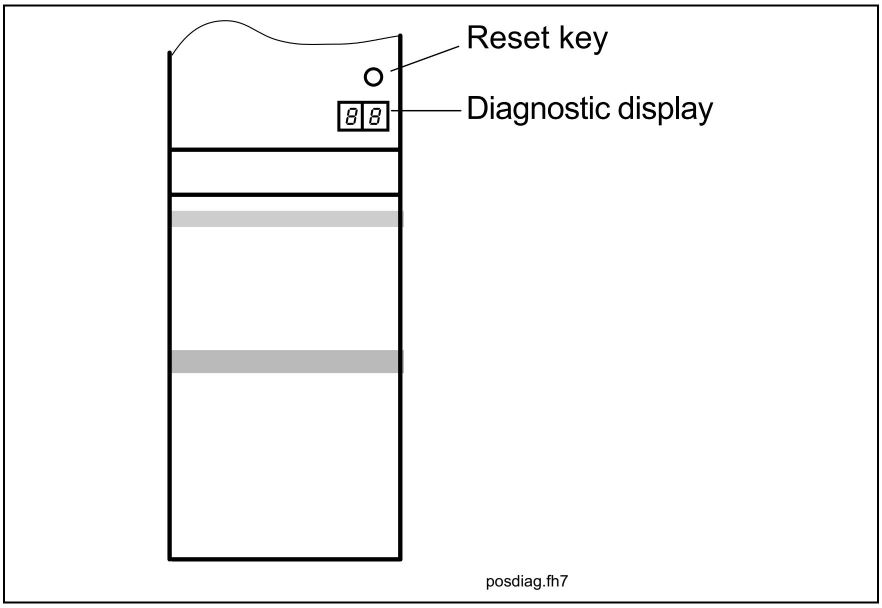


Fig. 11-1: Position of diagnostic display and reset key

If either checks or repairs are needed, then it applies:

- Checks and repairs may only be conducted by Rexroth customer service personnel or such personnel that has been trained to do so.
- Observe the applicable safety regulations when checking the unit.
- Repairing drive components on the machine is very time consuming. Replace defective drive components completely.

WARNING

When faults are cleared, damages to the machine and injury to the personnel may occur!

⇒ Fault clearance should only be conducted by trained personnel.

⇒ Protective devices must not be switched off.

⇒ Note the warnings in section 3.

11.3 Checking and repairing the unit

When contacting our service personnel we would like to ask you to provide the following information so that a quick and precise assistance can be assured:

- type designations and serial numbers of units and motors,
- the status of the fault,
- any diagnostic displays and
- software status, if necessary.

You'll find the telephone number of our service hotline in the chapter "Service & Support".

11.4 Replacing the unit

Note: Replacing the unit requires, depending upon unit weight, a lifting device and an identical replacement unit.

DANGER

Electrical shock due to voltage-containing parts of more than 50 V!

⇒ The unit may only be replaced by qualified personnel, which have been trained to perform the work on or with electrical devices.

Note: Prior to the replacement of the unit please check according to the type plates, whether these units are of the same types. Replace only units of the same types.

Proceed as follows:

1. Switch voltage to installation off and secure it against being switched back on.
2. Using an appropriate measuring device, check whether the installation is power free. Wait the discharge time.
3. Motors must be standing still.
4. Secure vertical axes against motion.
5. Release all connections from the defective unit.
6. Release the fixing bolts and remove the unit from the control cabinet. Use the lifting device, if necessary.
7. Hang replacement unit into mounting rails. Use the lifting device, if necessary.
8. Reconnect the unit as per the terminal diagram of the machine manufacturer.
9. If vertical axes have been mechanically secured prior to replacement, then remove these devices at this point.
10. While reading out the fault memories of the connected drive controllers make sure that the device fault has not been triggered by the drive controllers (see warnings in chapter 11.2 "Fault diagnostics and resetting faults").

The unit replacement is completed. The system can be put back into operation.

11.5 Diagnostic Display

Overview

Anzeige DISPLAY	Bedeutung ACCEPTATION	Erläuterung EXPLANATION
bb	- Bereit zur Leistungszuschaltung - - READY FOR POWER ON -	Supply and drives are fault-free. Power can be switched on.
Lb	- Leistung bereit - - POWER OK -	Mains contactor is ON. DC bus voltage within permissible range.
14	- Zusatzkomponenten Vorwarnung - - EXTERNAL COMPONENT WARNING -	WARNING an additional component is being applied. Power off in 30 s.
15	- Steuerspg.-Vers.-Temp.-Vorwarnung - 1) - CONTROL VOLTAGE TEMP. WARNING -	Control voltage supply is overloaded. The temperature pre-warning contact has opened.
16	- Softstartfehler - - SOFTSTART-FAULT -	DC bus cannot be loaded.
17	- Leistung Aus / Zwischenkreiskurzschluss - - POWER OFF WITH BUS SHORTING -	Power is off and DC bus dynamic brake activated.
18	- Kühlkörpertemperatur zu hoch - - HEATSINK OVERTEMP. FAULT -	Power off due to excessive heatsink or power section temperature.
20	- Bleeder Überlast - -BLEEDER OVERLOAD -	Rotary drive energy (HVR/HVE) or regenerated power (HVE) too high.
23	- Antriebsfehler - - DRIVE FAULT -	Power of due to drive error.
24	- Zusatzkomponenten-Fehler - EXTERNAL COMPONENT ERROR -	Power off due to fault in additional component (bleeder, loading device).
25	- Rückspeise-Überlast - - REGEN. POWER OVERLOAD -	Continuous regenerated power of the drives excessive.
26	- Einspeise-Überlast - - BUS POWER OVERLOAD -	The continuous feed in power of the drive excessive.
50	- Kühlkörper-Übertemperatur-Warnung - - HEATSINK TEMP. WARNING -	Temperature pre-warning contact is open. Power off after a further rise in temperature of 5 °C.
52	Bleeder Überlast-Warnung - BLEEDER OVERLOAD WARNING -	80 % of the allowable bleeder ON time has been achieved due to excessive regenerated power.
60	- Überstrom - 1) - OVERCURRENT -	Short-circuit in supply or drive in motor or in a cable.
69	- +24 V / ±15 V / +5 V Fehler - - +24 V / ±15 V / +5 V FAULT -	Control voltages faulty.
80	- Erdschluss - - SHORT TO GROUND -	Ground fault in supply or drive unit, in motor or in cable.
81	- Netzausfall - 1) - POWER FAILURE -	One or several mains phases missing.
82	- Phasenfehler - 2) -PHASELOSS FAULT -	One or several mains phases missing or the mains voltage is too low.
83	- Netzspannungsfehler - - LINE VOLTAGE FAULT -	Mains voltage exceeds permissible tolerance.
84	- Anschlussfehler - 1) - MISWIRING -	No phase coincidence in power and control voltage connections. Line contactor doesn't pick up.
85	- Netzfrequenzfehler - 1) - LINE FREQUENCY FAULT -	Mains frequency exceeds permissible tolerance.
87	- Steuerspannungsversorgungs-Fehler - 2) - CONTROL VOLTAGE SUPPLY FAILURE -	The HVE control voltage supply exceeds permissible tolerance.
94	- EPROM-Fehler - 1) - CHECKSUM ERROR -	Hardware or software error in unit.
. .	- Gerätefehler - - DEVICE FAILURE -	Hardware or software error in unit.
– –	- +5 V Fehler 2) - +5 V FAILURE -	+5 V control voltage failure.
E1...E9	- Gerätefehler - 2) - DEVICE FAILURE -	Hardware or software error in unit.

1): with HVR only
2): with HVE only

Fig. 11-2: Diagnostic display overview

Description, possible cause and troubleshooting

Display	Description	Possible cause	Troubleshooting
bb	**Ready to receive power** Supply unit and drive controller are ready.	1) Power contactor has dropped off because OFF or emergency stop key was actuated. 2) The power contactor can not be activated, as its drive is faulty (if in principle, the power cannot be switched on).	1) Release button and switch power contactor on. 2) Check control - at X3/6 for at least 200 ms +24 V must be applied.
Lb	**Power ready** DC bus voltage within permissible range. The power supply unit is ready to supply power.		
14	**Additional component pre-warning** A warning signal of an additional unit is pending. Power is shutdown after 30 s.	1) Temperature may be too high. 2) The end contactor has not been plugged to terminal X0.	1) Check additional units. 2) Plug an end contactor to terminal X0 on additional units.
15	**Control voltage supply temperature pre-warning** [1)] The control voltage supply is overloaded. A power shutdown is pending.	There may be too many drives connected.	Check the dimensioning of the power supply unit.
16	**Softstart error**	The DC bus cannot be loaded because 1) there is a short-circuit in the power supply unit or in the drive controller. 2) too many additional capacitances have been connected. 3) the DC bus choke is cutoff [2)] 4) the main contactor cannot be activated [2)] a) the permissible number of switching on and off actuations has been exceeded. b) the maximum permissible resistance in the emergency stop chain has been exceeded. [2)] 5) the jumper or DC choke at terminal X13 is missing.	1) Release connections to drive controller and switch power on again. Replace unit, if necessary. 2) Reduce the number of aux. capacitors or use a separate loading unit. 3) DC bus choke and lines must be checked, replaced if necessary. 4) a) Reduce the number of switching actuations. b) Check the contacts in the emergency stop chain for dirt and corrosion. 5) Connect jumper or DC choke.
17	**Power OFF with DC bus dynamic brake** The power contactor has dropped off. The DC bus dynamic brake was activated.	The control of the installation has triggered a DC bus dynamic braking action.	Check the emergency stop sequence of the installation.

Display	Description	Possible cause	Troubleshooting
18	**Heatsink temperature too high** Power shutdown.	Power shutdown due to excessive heatsink temperature because the unit is overloaded or the ambient temperature is too high.	Load and ambient temperature must be checked. Evaluate prewarn contact of unit.
20	**Bleeder overload** Power shutdown.	The power has been switched off due to excessive bleeder load because 1) the regenerated power on the HVR is too high with switched off power. 2) in the HVE, the continuous regenerated power and/or rotary drive energy is too high 3) the unit is defective.	1) Reduce drive speed. Switch power OFF or emergency stop in a delayed fashion. 2) Increase cycle time, reduce drive speed or install additional bleeder. 3) Replace unit.
23	**Drive error** 3)	A drive controller has detected a fault in the unit, motor or line connections.	Diagnostic displays of drive controllers must be checked.
24	**Additional component error**	1) An error was detected in an additional component, such as HZB or HZS 2) Jumpers not inserted into connector X0.	1) Additional components must be checked. 2) Jumpers must be checked.
25	**Regenerated overload** 3)	The regenerated power of the drive is excessive.	Reduce permissible delay. Use drive controller with smaller peak current.
26	**Feedin overload** 3)	The feedin power required by drive is excessive.	Reduce permissible acceleration. Use drive controllers with smaller peak current.
50	**Heatsink overtemperature-pre-warning** The permissible heatsink temperature has been reached. The temperature pre-warning contact has opened. Power off in 30 s.	1) Excessive load 2) Ambient temperature too high 3) Cooling air flow blocked 4) Blower in the unit defective	1) Reduce load 2) Reduce control cabinet temperature 3) Unblock cooling air flow 4) Replace unit
52	**Bleeder overload warning**	80 % of the allowable bleeder ON time has been achieved due to excessive regenerated power.	Reduce the allowable acceleration (delay). **- or-** Reduce drive speed **- or-** Reduce the peak current of the drive

Display	Description	Possible cause	Troubleshooting
60	**Overcurrent** [1)]	1) Short circuit in supply unit, drive controller, motor or cable. 2) Too high continuous power.	1) Release power connections to the drive controllers step by step. Replace defective unit. 2) Check machine cycle; check drive design
69	**+24 V / ±15 V / +5 V Fault**	The control voltages are faulty because: 1) the maximum permissible load has been exceeded. 2) there is a short-circuit in the wiring of the control voltage used outside the drive systems. 3) the unit is defective.	1) Release bus connections to drive controllers step by step. 2) Release control voltage taps and check for short circuit. 3) Replace unit.
80	**Ground fault**	Ground fault in power supply unit, drive controller, motor or cable.	Release power connections to the drive controllers step by step. Replace defective unit.
81	**Power failure** [1)]	At least one phase is missing of the mains supply.	Check mains fuses and replace, if necessary.
82	**Phase Fault**	1) At least one phase is missing of the mains supply. 2) The mains voltage is too low.	1) Check mains fuse and replace, if necessary. 2) Measure the mains voltage and compare it with the required data.
83	**Mains voltage fault**	**HVR:** Mains voltage exceeds permissible tolerance (3 x 380 ... 480 V (± 10 %)). **HVE:** The maximum value of the mains voltage has been exceeded.	Check mains voltage, use matching transformer if necessary.
84	**Connection fault** [1)]	1) Power and control voltage connections not phase coincident. 2) Resistance in the emergency stop chain too high; load contactor cannot close.	1) Check connection voltage. Terminals X5/U and X8/1, X5/V and X8/2, X5/W and X8/3 may not conduct voltage to each other. 2) Check the contacts in your emergency stop chain for dirt or corrosion.
85	**Mains frequency fault** [1)]	Mains frequency exceeds permissible tolerance (±2 Hz).	
87	**Control voltage fault** [2)]	The control voltage supply exceeds permissible tolerance (3 x 380 ... 480 V (± 10 %)).	Check mains fuse in control cabinet and replace, if necessary.

Display	Description	Possible cause	Troubleshooting
94	**EPROM fault** 1)	Unit fault.	Replace unit.
. .	**Unit fault**	Hardware or software error in unit. **HVR:** Processor error **HVE:** Circuit error	Switch control voltage off and on. If error still present, replace unit.
--	**+5 V error** 2)	The +5 V control voltage is faulty because of a unit fault.	Replace unit.
E1...E9	**Unit fault**	Hardware or software error in unit.	Switch control voltage off and on again. If the error occurs again during further operation, replace the device.

1): Error message exists only with HVR units
2): Error message exists only with HVE units
3): Error is not saved

Fig. 11-3: Diagnostic display; acceptance, possible cause and recovery

12 Delivery Status

12.1 Packaging

Packaging Units

The components are supplied in separate packaging units.

Packaging Materials

The packaging materials consist of cardboard, wood and polystyrene. They can be easily recycled. For ecological reasons you should not return the empty packages to us.

Packaging Labels

The content of the packed components and the order number may be identified using the adhesive barcode label on the packaging.

12.2 Scope of Delivery

Supply Units HVx
Additional Components HZx

The supply units HVx0x.2-W0xxx resp. the additional components HZS, HZB, HZK and HZF are delivered:

- with connectors plugged on
- with mounted touch guard
- with strands for DC bus connection to neighboring device
- with grounding brackets for ground connection to neighboring device
- the manual „Safety Instructions for Electrical Drives" (HVx only)

Additional Components
GLD, KD and SUP-E0x-HVR

The additional components GLD resp. KD resp. SUP-E0x-HVR are delivered without any accessories.

Notes

13 Identifying the Components

Type Plate Arrangement

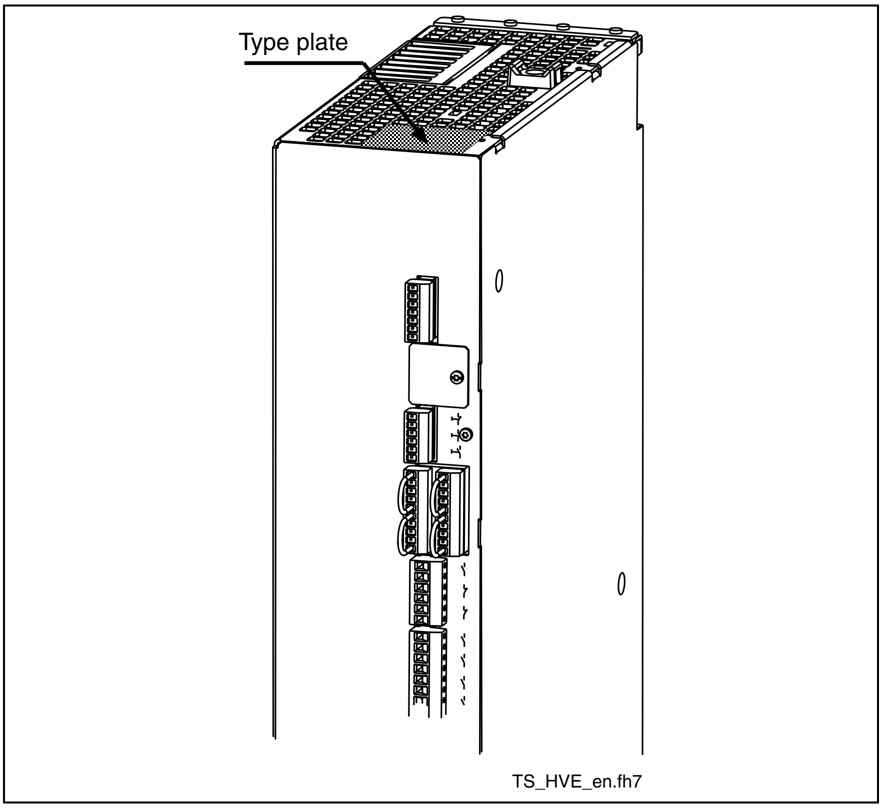


Fig. 13-1: Type plate arrangement

Type Plate Design

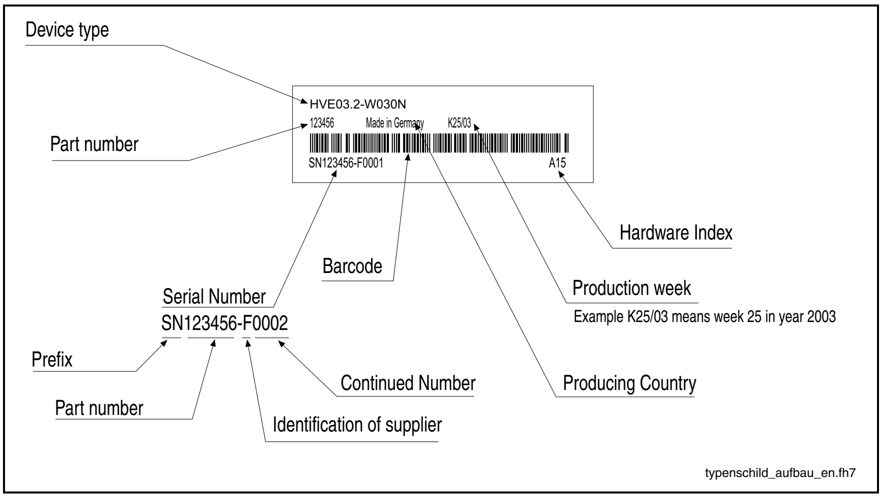


Fig. 13-2: Type plate design

Notes

14 Index

15 Service & Support

15.1 Helpdesk

Unser Kundendienst-Helpdesk im Hauptwerk Lohr am Main steht Ihnen mit Rat und Tat zur Seite. Sie erreichen uns

Our service helpdesk at our headquarters in Lohr am Main, Germany can assist you in all kinds of inquiries. Contact us

- telefonisch - by phone: **49 (0) 9352 40 50 60**
  über Service Call Entry Center Mo-Fr 07:00-18:00
  - via Service Call Entry Center Mo-Fr 7:00 am - 6:00 pm
- per Fax - by fax: **+49 (0) 9352 40 49 41**
- per e-Mail - by e-mail: **service.svc@boschrexroth.de**

15.2 Service-Hotline

Außerhalb der Helpdesk-Zeiten ist der Service direkt ansprechbar unter

After helpdesk hours, contact our service department directly at

+49 (0) 171 333 88 26
oder - or **+49 (0) 172 660 04 06**

15.3 Internet

Unter **www.boschrexroth.com** finden Sie ergänzende Hinweise zu Service, Reparatur und Training sowie die **aktuellen** Adressen *) unserer auf den folgenden Seiten aufgeführten Vertriebs- und Servicebüros.

- ☐ Verkaufsniederlassungen
- ☐ Niederlassungen mit Kundendienst

Außerhalb Deutschlands nehmen Sie bitte zuerst Kontakt mit unserem für Sie nächstgelegenen Ansprechpartner auf.

*) Die Angaben in der vorliegenden Dokumentation können seit Drucklegung überholt sein.

At **www.boschrexroth.com** you may find additional notes about service, repairs and training in the Internet, as well as the **actual** addresses *) of our sales- and service facilities figuring on the following pages.

- ☐ sales agencies
- ☐ offices providing service

Please contact our sales / service office in your area first.

*) Data in the present documentation may have become obsolete since printing.

15.4 Vor der Kontaktaufnahme... - Before contacting us...

Wir können Ihnen schnell und effizient helfen wenn Sie folgende Informationen bereithalten:

1. detaillierte Beschreibung der Störung und der Umstände.
2. Angaben auf dem Typenschild der betreffenden Produkte, insbesondere Typenschlüssel und Seriennummern.
3. Tel.-/Faxnummern und e-Mail-Adresse, unter denen Sie für Rückfragen zu erreichen sind.

For quick and efficient help, please have the following information ready:

1. Detailed description of the failure and circumstances.
2. Information on the type plate of the affected products, especially type codes and serial numbers.
3. Your phone/fax numbers and e-mail address, so we can contact you in case of questions.

15.5 Kundenbetreuungsstellen - Sales & Service Facilities

Deutschland – Germany

vom Ausland: (0) nach Landeskennziffer weglassen!
from abroad: don't dial (0) after country code!

Vertriebsgebiet Mitte Germany Centre Rexroth Indramat GmbH Bgm.-Dr.-Nebel-Str. 2 / Postf. 1357 97816 Lohr am Main / 97803 Lohr **Kompetenz-Zentrum Europa** Tel.: +49 (0)9352 40-0 Fax: +49 (0)9352 40-4885	**SERVICE** **CALL ENTRY CENTER** **MO – FR** **von 07:00 - 18:00 Uhr** **from 7 am – 6 pm** **Tel. +49 (0) 9352 40 50 60** service.svc@boschrexroth.de	**SERVICE** **HOTLINE** **MO – FR** **von 17:00 - 07:00 Uhr** **from 5 pm - 7 am** **+ SA / SO** **Tel.: +49 (0)172 660 04 06** **oder / or** **Tel.: +49 (0)171 333 88 26**	**SERVICE** **ERSATZTEILE / SPARES** verlängerte Ansprechzeit - extended office time - ♦ nur an Werktagen - only on working days - ♦ von 07:00 - 18:00 Uhr - from 7 am - 6 pm - **Tel. +49 (0) 9352 40 42 22**
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from abroad: don't dial (0) after country code, Italy: dial 0 after country code

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