DIAX04

HVE and HVR

Power Supply Units

Applications

DOK-POWER*-HVE+HVR****-ANW3-EN-P

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This documentation serves to assist

- in the selection and calculation of power supply units
- in the control cabinet construction
- when mounting the power supply unit

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Contents

1 The modular INDRAMAT AC drive system 1-1

1.1 The main functions of the HVE and HVR ... 1-2

2 Safety Guidelines for Electrical Drives 2-1

2.1 Introduction ... 2-1
2.2 Hazards due to improper use ... 2-2
2.3 General ... 2-3
2.4 Protection against contact with electrical parts ... 2-4
2.5 Protection by protective low voltage (PELV) against electrical shock ... 2-5
2.6 Protection against dangerous movements ... 2-6
2.7 Protection against magnetic and electromagnetic fields during operations and mounting ... 2-8
2.8 Protection against contact with hot parts ... 2-8
2.9 Protection during handling and installation ... 2-9
2.10 Battery safety ... 2-9

3 Applications 3-1

3.1 Power features of the HVE and HVR power supply units ... 3-2
3.2 HVE - power data ... 3-3
3.3 Short-term operating power of the HVE ... 3-4
3.4 HVR - power data ... 3-4
3.5 HVR - short-term operating power ... 3-5
3.6 HVE - technical data ... 3-6
3.7 HVR - technical data ... 3-7
3.8 Conditions of use ... 3-8

4 Project planning - Sizing 4-1

4.1 DC bus continuous power ... 4-1
4.2 Peak DC bus power ... 4-4
4.3 Regenerated energy ... 4-4
4.4 Continuous regenerated power ... 4-6
4.5 Peak regenerated power ... 4-7
4.6 Incoming power of the power supply ... 4-8
4.7 Checking control voltage supply ... 4-8

5 Mounting 5-1

5.1 Mounting the HVE and HVR in a control cabinet ... 5-1
5.2 Safety clearances of the bleeder resistor ... 5-2
The Use of Cooling Units within the Control Cabinet ... 5-2

Steps to Take with Non-Cooled Control Cabinets........ 5-4
5.3 Dimensional data - HVE........ 5-6
5.4 Dimensional data - HVR........ 5-7
5.5 Mounting the unit........ 5-8

6 Electrical connections - Installation instructions 6-1

6.1 Terminal connecting plan - HVE02.1 and HVE03.1........ 6-2
6.2 Terminal connecting plan - HVR02.1 and HVR03.1........ 6-3
6.3 Mains connection - power section........ 6-4
Direct mains connection HVE........ 6-4
Mains connections HVE via a transformer........ 6-5
Direct Mains Connection HVR........ 6-5
Connecting the Mains HVR via a Transformer........ 6-6
6.4 Fusing with direct mains supply........ 6-8
6.5 Grounding the power supply system........ 6-9
6.6 Commutation chokes for an HVR........ 6-10
6.7 DC bus choke GLD for the HVE........ 6-11
6.8 Dimensional Data of SUP - E01 - HVR........ 6-11
6.9 Dimensional Data of SUP - E02 - HVR........ 6-12
6.10 Dimensional Data of SUP - E03 - HVR........ 6-13
6.11 Dimensional Data of SUP - E04 - HVR........ 6-14
6.12 Connecting drive controllers to the power supply unit........ 6-15
6.13 Additional DC bus capacitance........ 6-16
6.14 HZB auxiliary bleeder module........ 6-16
6.15 Loading device for the additional capacitor........ 6-16
6.16 Control voltage supply........ 6-17
6.17 Fault current protective device........ 6-18
6.18 Earth leakage monitor........ 6-19
6.19 Control cabinet check........ 6-19
6.20 Heat loss in the control cabinet........ 6-19
6.21 Front view - HVE........ 6-20
6.22 Front view - HVR........ 6-21
6.23 Interference elimination........ 6-22

7 Control of the mains contactor in the supply unit 7-1

7.1 Control options........ 7-1
7.2 Controlling the power supply unit with emergency stop relays with DC bus dynamic braking........ 7-2
7.3 Controlling the power supply unit without DC bus dynamic brake........ 7-4
7.4 Controlling the power supply unit with a position-controlled shutdown of the drives........ 7-6

8 Control interfaces of installation 8-1

8.1 DC bus dynamic brake........ 8-1
8.2 Power OFF........ 8-2
8.3 Power ON........ 8-2
8.4 Control voltages........ 8-2
8.5 Acknowledge Power ON........ 8-3
8.6 Acknowledge power OFF........ 8-4

8.7 Ready to operate........ 8-4
8.8 Power supply in order 8-5
8.9 Temperature prewarning........ 8-5
8.10 Excessive regenerated power........ 8-5
8.11 Serial interfaces on the HVR........ 8-5

9 Fault Clearance 9-1

9.1 Overview of diagnostic displays........ 9-2
9.2 Position of diagnostic display and reset key 9-3
9.3 Diagnoses - Definition and causes 9-3
9.4 Replacing the unit 9-7

10 Order information 10-1

10.1 Available options........ 10-1

11 Index 11-1

1 The modular INDRAMAT AC drive system

The modular construction of INDRAMAT's AC drive system makes it possible to operate several drive controllers with only one power supply unit. Each drive package needs only one supply connection.

Both the performance and the functionalities of the drives are oriented towards the application.

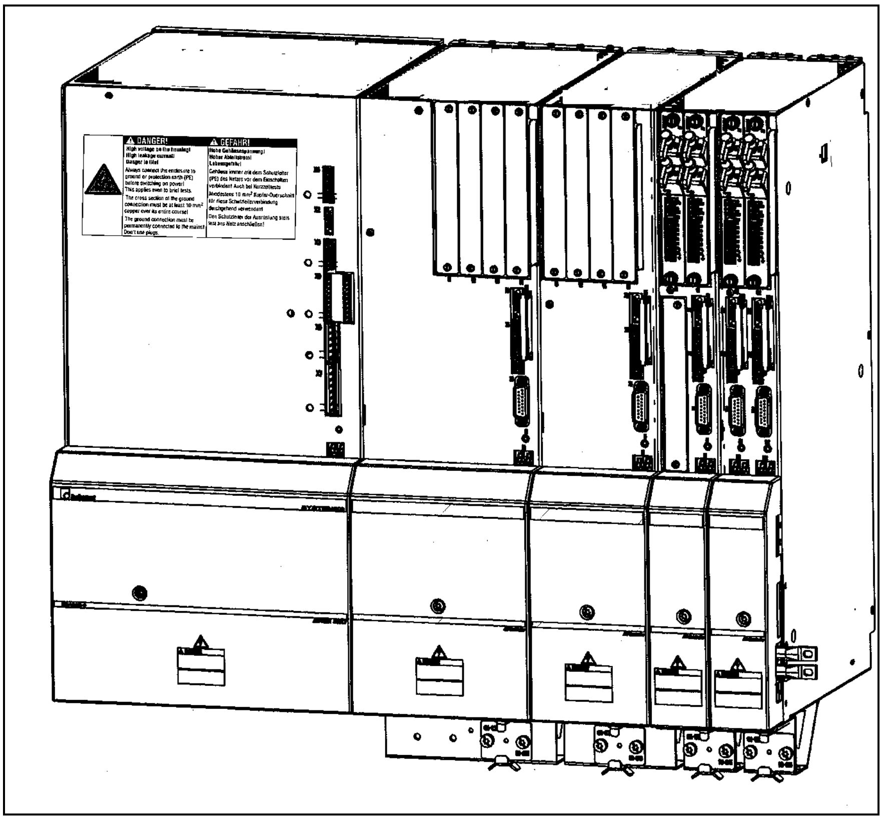


Fig. 1-1: Modular INDRAMAT AC drive system

1.1 The main functions of the HVE and HVR

HVE supplies power to the drives

The power rectifier rectifies the three-phase a.c. supply voltage and makes available an unregulated DC bus voltage as power source to the drives.

When operating the drives regeneratively, the energy fed back is absorbed by the bleeder and transformed into heat. Using the DC bus dynamic brake it is possible to shutdown drives with permanent magnet excitation even when the electronics have failed.

The internal power contactor switches off the drives from the mains.

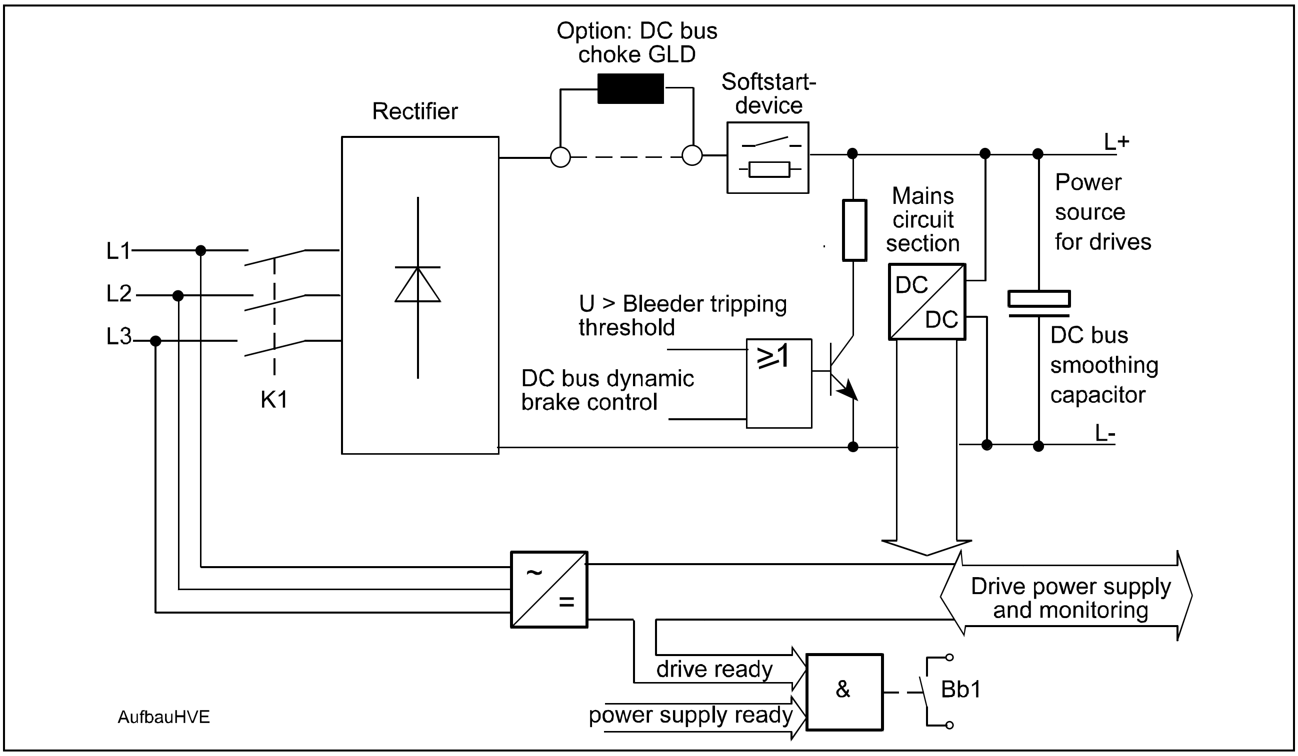


Fig. 1-2: How the HVE power supply unit is constructed

HVR supplies power to the drives

The power rectifier rectifies the three-phase a.c. supply voltage and makes available an regulated DC bus direct voltage as power source to the drives. When regeneratively operating the drives, the HVR works as a power inverter and stores the generated energy back into the mains.

In the event of mains failure or power shutdown, the drives are braked controlled via the bleeder resistor in the HVR. Using the DC bus dynamic brake it is possible to shutdown drives with permanent magnet excitation even when the electronics have failed.

The internal power contactor switches off the drives from the mains.

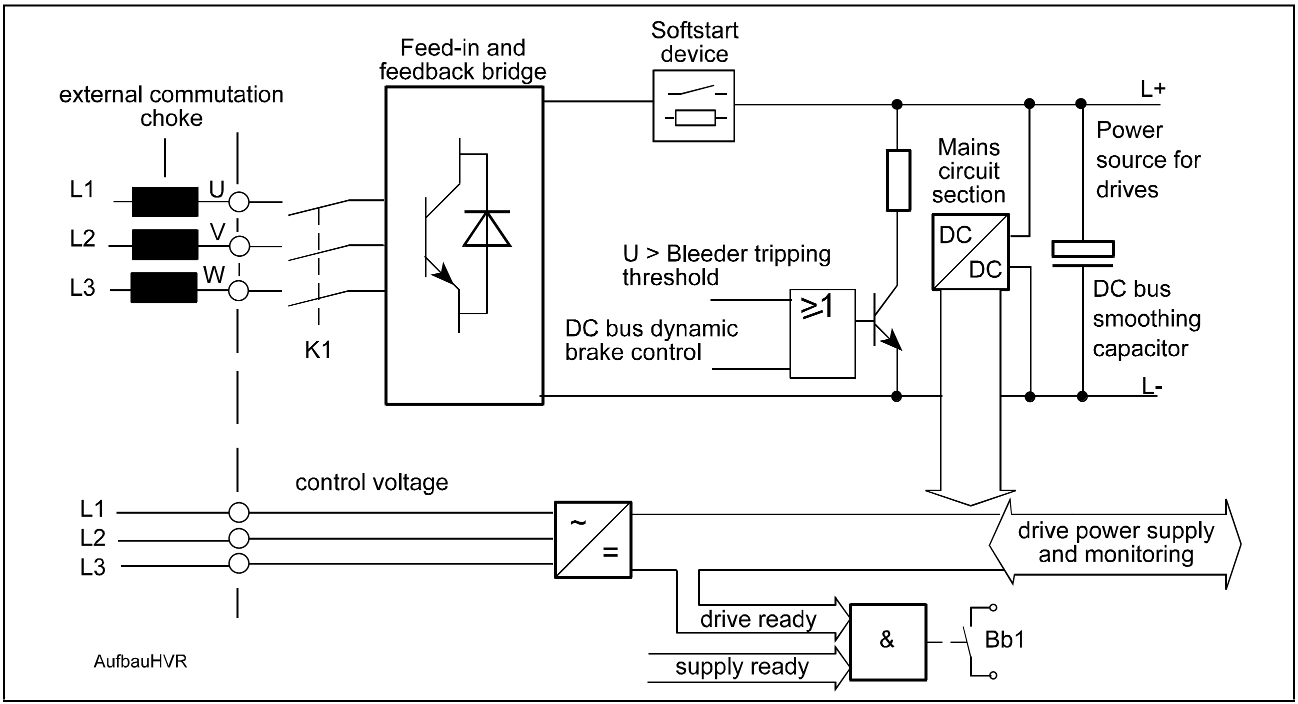


Fig. 1-3: How the HVR power supply unit is constructed

Control voltage supply

The HVE and HVR make available the control voltage for all connected drive controllers.

In the event of power failure, the control voltages are supplied by the DC bus. This means that when the drives are operating regeneratively the drive electronics remain functional.

Monitoring the drive system

The HVE and HVR are equipped with extensive monitoring functions. These communicate with the drive modules via the control voltage bus.

The Bb1 contact is of utmost importance to the operational readiness of the drive system. Not until it is closed can the internal power contact be switched on.

2 Safety Guidelines for Electrical Drives

2.1 Introduction

These instructions must be read and understood before the equipment is used to minimize the risk of personal injury and / or property damage. Follow these safety instructions at all times.

Do not attempt to install, use or service this equipment without first reading all the documentation that comes with the product. Please read and understand these safety instructions, and all user documents for the equipment, prior to working with the equipment at any time. You must contact your local Indramat representative if you cannot locate the user document for your equipment. A listing of Indramat offices is supplied in the back of this manual. Request that your representative send the document needed immediately to the person or persons responsible for the safe operation of this equipment.

If the product is resold, rented and / or otherwise transferred or passed on to further parties, then these safety instructions must accompany it.

WARNING

Improper use of this equipment, failure to follow the attached safety instructions, or tampering with the product, including disabling of safety devices, may result in personal injury, severe electrical shock, death or property damage.

2.2 Hazards due to improper use

DANGER

High voltage and high discharge current!

Danger to life, risk of severe electrical shock and risk of injury!

DANGER

Dangerous movements!

Danger to life and risk of injury or equipment damage by unintentional movements of the motor!

WARNING

High electrical voltages due to incorrect connections!

Danger to life and limb, severe electrical shock and serious bodily injury!

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids when 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 incorrect handling!

Bodily injury caused by crushing, shearing, cutting and thrusting movements!

CAUTION

Risk of injury due to incorrect handling of batteries!

2.3 General

- INDRAMAT GmbH is not liable for damages resulting from failure to observe the warnings given in these instructions.
- Operating, maintenance and safety instructions in the local language must be ordered and received before initial start-up, if the instructions in the language provided are not understood perfectly.
- 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.
- For qualified personnel trained on electrical equipment:

  Only trained and qualified personnel may work on this equipment or in its vicinity. Personnel are qualified if they have sufficient knowledge of the assembly, installation, and operation of the product as well as of all warnings and precautionary measures noted in these instructions.

  Furthermore, they should be trained, instructed, and qualified to switch electrical circuits and equipment on and off, to ground them, and to mark them according to the requirements of safe work practices and common sense. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts approved by the manufacturer.
- All safety regulations and requirements for the specific application must be followed as practiced in the country of use.
- The equipment is designed for installation in commercial machinery.
- Start-up is only permitted once it is certain that the machine in which the products have been installed complies with the requirements of national safety regulations and safety specifications of the application. European countries: see Directive 89/392/EEC (Machine Guideline).
- 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 INDRAMAT document "EMC in Drive and Control Systems“.

  The machine builder is responsible for compliance with the limit values as prescribed in the national regulations and specific regulations for the application concerning EMC.

  European countries: see Directive 89/336/EEC (EMC Guideline).

  U.S.A.: See National Electrical Codes (NEC), National Electrical Manufacturers Association (NEMA), and local building codes. The user of this equipment must consult the above noted items at all times.
- Technical data, connections, and operational conditions are specified in the product documentation and must be followed.

2.4 Protection against contact with electrical parts

Note: This section pertains to equipment and drive components with voltages over 50 volts.

Touching live parts conducting potentials of 50 volts and higher or touching enclosures that are not grounded can be dangerous and cause severe electrical shock. In order for electrical equipment to be operated, certain parts must have dangerous voltages applied to them.

DANGER

High Voltage!
Danger to life, severe electrical shock and risk of injury!

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

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

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

⇒ At no time may electrical equipment be operated if the ground wire is not permanently connected, even for brief measurements or tests.

⇒ Before beginning any work on units having a voltage exceeding 50 volts, disconnect mains or the voltage source from the equipment. Lock the equipment against being switched on while work is being performed.

⇒ Wait five (5) minutes after switching off power to allow capacitors to discharge before beginning work. Measure the voltage on the capacitors before beginning 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.

⇒ Before switching the equipment on covers and guards provided with the equipment must be installed to prevent contact with live parts. Cover and guard live parts properly before operating so they cannot be touched.

⇒ A residual-current-operated protective device (r.c.d.) must not be used in an AC drive! Indirect contact must be prevented by other means, for example, by an overcurrent protective device.

European countries: according to EN 50178/ 1994; section 5.3.2.3.

⇒ Electrical components with exposed live parts must be installed in a control cabinet to prevent direct contact.

European countries: according to EN 50178/ 1994; section 5.3.2.3.

U.S.A: See National Electrical Codes (NEC), National Electrical Manufacturers Association (NEMA), and local building codes. The user of this equipment must consult the above noted items at all times.

DANGER

High housing voltage! High leakage current!
Danger to life and limb, danger of injury from electric shock!

⇒ Prior to powering up, connect the electrical equipment, the housing of all electrical units and motors to the protective conductor at the grounding points or ground them. This applies even to brief tests.

⇒ The protective conductor of the electrical equipment and units must always be connected to the supply network. Leakage current exceeds 3.5 mA.

⇒ Use at least a 10 mm^2 copper conductor cross section for this protective connection over its entire course!

⇒ Prior to startups, even for brief tests, always connect the protective conductor or connect with ground wire. High voltage levels can occur on the housing that could lead to severe electrical shock and personal injury.

European countries: EN 50178 / 1994, section 5.3.2.3.

USA: See National Electrical Codes (NEC), National Electrical Manufacturers Association (NEMA), and local building codes. The user of this equipment must consult the above noted items at all times.

2.5 Protection by protective low voltage (PELV) against electrical shock

All connections and terminals with voltages ranging between 5 and 50 volts on INDRAMAT products are protective low voltages designed in accordance with the following standards on contact safety:

- International: IEC 364-4-411.1.5
- European countries within the EU: see EN 50178/1994, section 5.2.8.1.

WARNING

High electrical voltages due to incorrect connections!

Danger to life and limb, severe electrical shock and/or serious bodily injury!

⇒ Only that equipment or those electrical components and cables may be connected to all terminals and clamps with 0 to 50 volts if these are of the protective low voltage type (PELV = Protective Extra Low Voltage).

⇒ Only connect those voltages and electrical circuits that are safely isolated. Safe isolation is achieved, for example, with an isolating transformer, an optoelectronic coupler or when battery-operated.

2.6 Protection against dangerous movements

Dangerous movements can be caused when units have bad interfaces or motors are connected incorrectly.

There are various causes of dangerous movements:

- Improper or incorrect wiring or cable connections
- equipment is operated incorrectly
- probe or signal encoders not correctly set
- malfunctioning components
- errors in software

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

Although the monitoring circuits in the drive components make improper operation almost impossible, personnel safety requires that proper safety precautions be taken to minimize the risk of personal injury and/or property damage. This means that unexpected motion must be anticipated since safety monitoring built into the equipment might be defeated by incorrect wiring or other faults.

DANGER

Dangerous movements!
Danger to life and risk of injury or equipment damage!

⇒ In the drive component monitoring units, every effort is made to avoid the possibility of faulty operation in connected drives. What monitoring devices or measures are used depend on the specific circumstances of the installation and are instituted after a danger and fault analysis has been completed by the manufacturer of the installation. The safety directives and regulations which are applicable are included in such an analysis. By switching off or bypassing an activation or if such an activation should simply be missing, it is possible that unintended machine motion or other malfunctions can occur if monitoring units are disabled, bypassed or not activated.

⇒ Safe requirements of each individual drive application must be considered on a case-by-case basis by users and machine builders.

Avoiding accidents, injury to personnel and/or property damage:

⇒ Keep free and clear of the machine's range of motion and moving parts. Prevent people from accidentally entering the machine's range of movement:
- use protective fences
- use protective railings
- install protective coverings
- install light curtains

⇒ Fences should be strong enough to withstand maximum possible force.

⇒ Mount the Emergency Stop (E-Stop) switch in the immediate reach of the operator. Verify that the Emergency Stop works before startup. Do not use if not working.

⇒ Isolate the drive power connection by means of an Emergency Stop circuit or use a safe lock-out system to prevent unintentional start-up.

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

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

⇒ Avoid operating high-frequency, remote control, and radio equipment near equipment electronics and supply leads. If use of such equipment cannot be avoided, check the system and the plant for possible malfunctions at all possible points and in all possible positions of normal use before the first start-up. If necessary, perform a special Electromagnetic Compatibility (EMC) test on the plant.

2.7 Protection against magnetic and electromagnetic fields during operations and mounting

Magnetic and electromagnetic fields in the vicinity of current-carrying conductors and permanent motor magnets 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 and metal implants are not permitted to have access to the following areas:
  – Areas in which electrical equipment and parts are mounted, operating or are being commissioned.
  – Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.

⇒ If it is necessary for a person wtih a pacemaker to enter into such an area, then a physician must be consulted prior to doing so. The resistance to interference of already implanted heart pacemakers or those implanted in the near future varies considerably making an overall, general rule not possible.

⇒ Persons with metal implants or hearing aids must take care prior to entering into areas described above. It is assumed that metal implants or hearing aids will be affected: A physician must be consulted beforehand.

2.8 Protection against contact with hot parts

CAUTION

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

⇒ Do not touch housing surface near the source of heat! Danger of burns!

⇒ Prior to accessing a unit, wait 10 minutes to allow the unit to cool off.

⇒ If hot parts of the equipment such as unit housing in which heatsink and resistor are located, then this can cause burns.

2.9 Protection during handling and installation

Handling and mounting certain drive components in an inappropriate way can, under unfavorable circumstances, lead to injuries.

CAUTION

Risk of injury due to incorrect handling!
Bodily injury caused by crushing, shearing, cutting and thrusting movements!

⇒ Observe installation instructions and safety regulations before handling and working on the product.
⇒ Use suitable lifting or moving equipment. Refer to the user manual of the product.
⇒ Take precautions to avoid pinching and crushing.
⇒ Only use suitable tools specified in the manuals and use them according to instructions.
⇒ Use lifting devices and tools correctly and safely.
⇒ Wear appropriate protective clothing, e.g., protective goggles, safety shoes, protective gloves.
⇒ Never stand under suspended loads.
⇒ Immediately wipe up liquids from the floor to prevent slipping.

2.10 Battery safety

Batteries are made up of active chemicals contained within a casing. Incorrect handling can result in injury or equipment damage.

CAUTION

Risk of injury due to incorrect handling!

⇒ Do not attempt to reactivate dead batteries by heating or other methods (danger of explosion and caustic burns).
⇒ Never charge batteries as they could leak or explode.
⇒ Never throw batteries into a fire.
⇒ Do not take batteries apart.
⇒ Handle carefully. Incorrect extraction or installation of a battery can damage equipment.

Note: **Environmental protection and disposal!** The batteries contained in the product should be considered hazardous waste for land, air and sea transport as legally defined (Danger of explosion). Dispose of batteries separately of other waste. Observe the legal requirements in the country of installation.

3 Applications

Power supply units of the HV* line support the power and control voltage supply of INDRAMAT drive modules of the HD* line. They are using a mains voltage of 3 x AC 380 ... 480 V.

The HVE line

INDRAMAT drives with a continuous mechanical output up to 28 kW can be used. A regenerative operation of the drives means that the fed back energy is absorbed by a bleeder resistor.

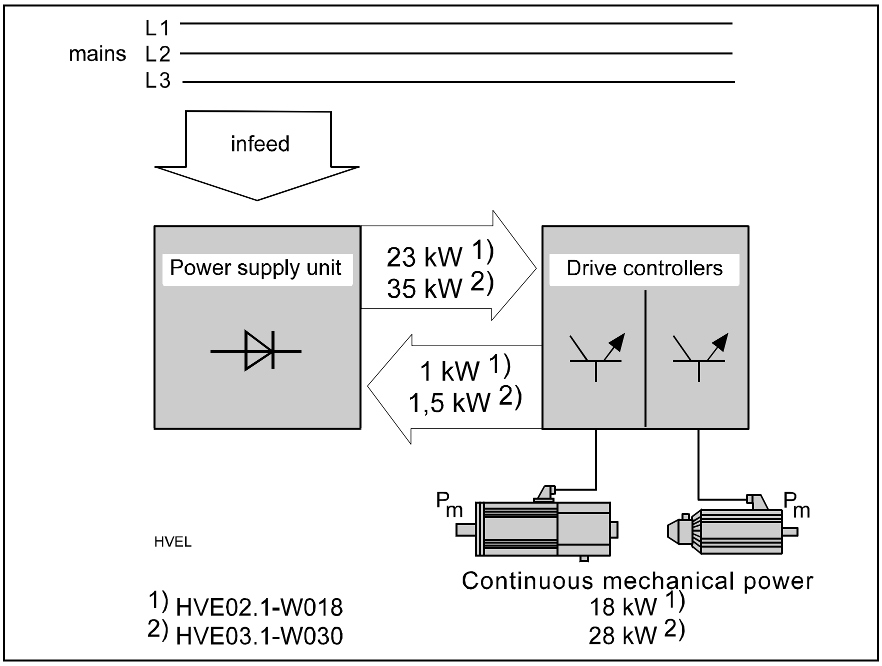


Fig. 3-1: Areas of application of the HVE power supply units

The HVR line

INDRAMAT drives with a continuous mechanical output of 36 kW can be used. The HVR implements current regeneration and regulated DC bus voltage.

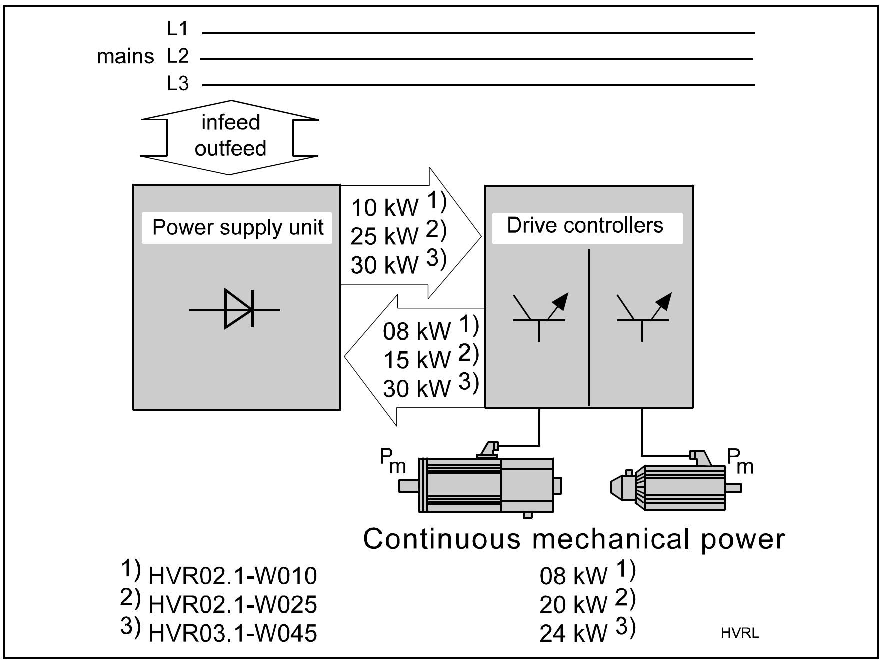


Fig. 3-2: Areas of application of HVR power supply units

3.1 Power features of the HVE and HVR power supply units

- **Direct mains connection**

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

- **Optimal matching of the power requirements of an application**

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

- **HVR power supply units implement regulated DC bus voltage**

Drive dynamics do not drop in the case of undervoltage.

- **High short-term operating load**

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

- **Integrated DC bus dynamic brake**

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

- **Charging current limits of the DC bus capacitors**

The making current need not be taken into consideration when selecting switchgears for the power supply. The lifespan of the switchgears is increased.

- **High load capabilities of the control voltage**

Several drive modules can be connected to one drive controller.

- **Service friendly**

  - signal lines connected via plugin clamps
  - extensive diagnotics and fault clearance via numeric display

3.2 HVE - power data

A bleeder resistor absorbs the energy regenerated by the HVE power supply units. Indramat drives with a continuous mechanical power of 28 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 rated mains voltages of 3x AC 380V, 400V, 440V and 480V are listed.

The power supply units of the HVE type are available in two variations. They can, if necessary, be combined with a DC bus choke GLD. This makes an optimum adjusting to the power requirements of the application possible.

P_{DC}	P_{KB30}	P_{KB03}	P_{BD}	P_{BM}	W_{max}	P_m	P_{mKB30}	P_{mKB03}	**Mains supply components**	
kW	kW	kW	kW	kW	kWs	kW	kW	kW	**HVE power supply unit**	**DC bus choke**
HVE power data when connected to 3 x AC 380V										
12	19	36	1	100	70	9.6	15.2	28.8	02.1-W018N	-----
18	29	54	1	100	70	14.4	23.2	43.2	02.1-W018N	GLD 13
18	36	54	1,5	100	100	14.4	28.8	43.2	03.1-W030N	-----
28	56	84	1,5	100	100	22.4	44.8	67.2	03.1-W030N	GLD 12
HVE Power data when connected to 3 x AC 400V										
13	20	39	1	100	70	10.4	16	31.2	02.1-W018N	-----
19	30	57	1	100	70	15.2	24	45.6	02.1-W018N	GLD 13
19	38	57	1,5	100	100	15.2	30.4	45.6	03.1-W030N	-----
30	60	90	1,5	100	100	24	48	72	03.1-W030N	GLD 12
HVE Power data when connected to 3 x AC 440V										
14	22	42	1	100	70	11.2	17.6	33.6	02.1-W018N	-----
21	33	63	1	100	70	16.8	26.4	50.4	02.1-W018N	GLD 13
21	42	63	1,5	100	100	16.8	33.6	50.4	03.1-W030N	-----
32	64	96	1,5	100	100	25.6	51.2	76.8	03.1-W030N	GLD 12
HVE Power data when connected to 3 x AC 480V										
15	24	45	1	100	70	12	19.2	36	02.1-W018N	-----
23	36	69	1	100	70	18.4	28.8	55.2	02.1-W018N	GLD 13
23	46	69	1,5	100	100	18.4	36.8	55.2	03.1-W030N	-----
35	70	105	1,5	100	100	28	56	84	03.1-W030N	GLD 12

P_{DC} = continuous DC bus power
P_{KB30} =short-term DC bus power for 30s
P_{KB03} = peak DC bus power for 0,3s
P_{BD} = continuous bleeder power
P_{BM} = peak bleeder power
W_{max} = maximum regenerated energy
P_m = continuous mechanical power (ED > 48 or 60 s) (see chap. 3.4)
P_{mKB30} = short-term mechanical power for 30s
P_{mKB03} = peak mechanical power for 0.3s

Fig. 3-3: HVE power data

3.3 Short-term operating power of the HVE

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

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

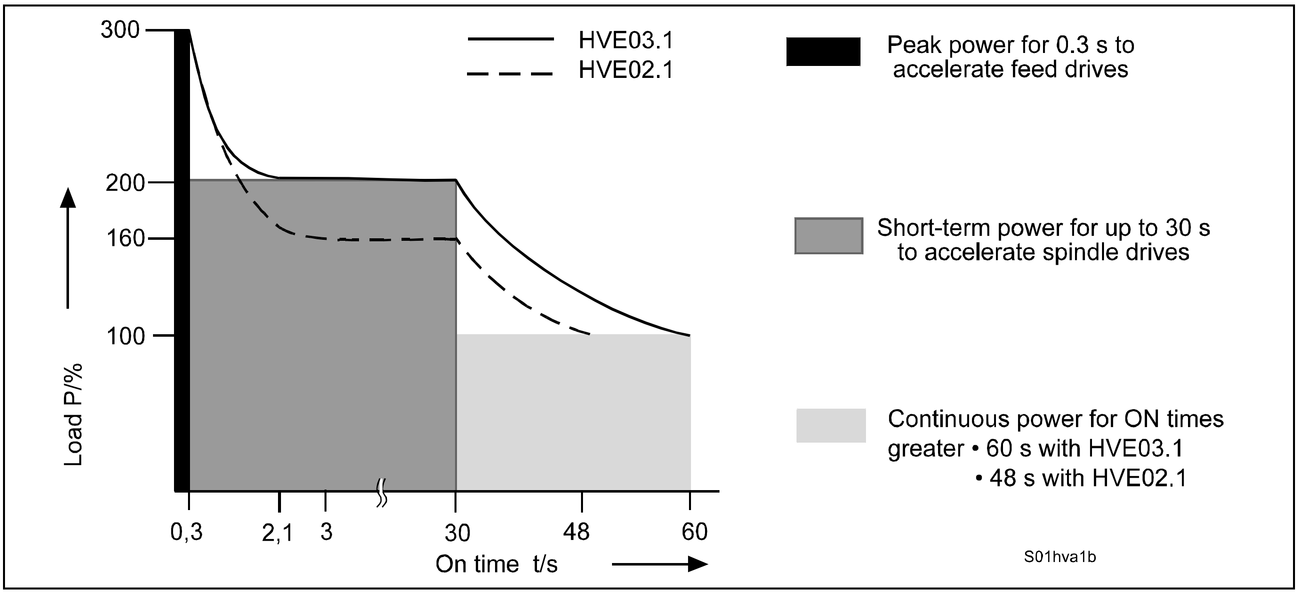


Fig. 3-4: Short-term HVE power

3.4 HVR - power data

HVR power supply units operate with regulated DC bus voltage. They can use mains voltages of 3x AC 380 ... 480V ±10%. The usable unit power depends on the supply voltage.

Three variations are available. This means that the power requirements of the application can be optimally met.

P_{DC} kW	P_{KB3} kW	P_{KB03} kW	P_{RD} kW	P_{RSp} kW	P_{BM} kW	W_{max} kWs	P_m kW	P_{mKB3} kW	P_{mKB03} kW	HVR supply unit	Choke
10	25	30	8	18	80	100	8	20	24	02.1-W010N	KD30-D
25	60	75	15	45	80	100	20	48	60	02.1-W025N	KD27-D
30	105	135	30	90	80	100	24	84	108	03.1-W045N	KD28-D

P_{DC} = continuous DC bus power
P_{KB3} =short-term DC bus power for 3s
P_{KB03} = peak DC bus power for 0,3s
P_{RD} = continuous regenerated power
P_{RSp} = peak regenerated power
P_{BM} = peak bleeder power
W_{max} = maximum regenerated energy
P_m = continuous mechanical power (ED > 10s)
P_{mKB30} = short-term mechanical power for 3s
P_{mKB03} = peak mechanical power for 0.3s

Fig. 3-5: Power data - HVR

3.5 HVR - short-term operating power

To accelerate feed and main drives, the HVR can be operated short-term as illustrated below.

Note: The maximum short-term operating loads must be taken into account during the project planning phase and may not be exceeded.

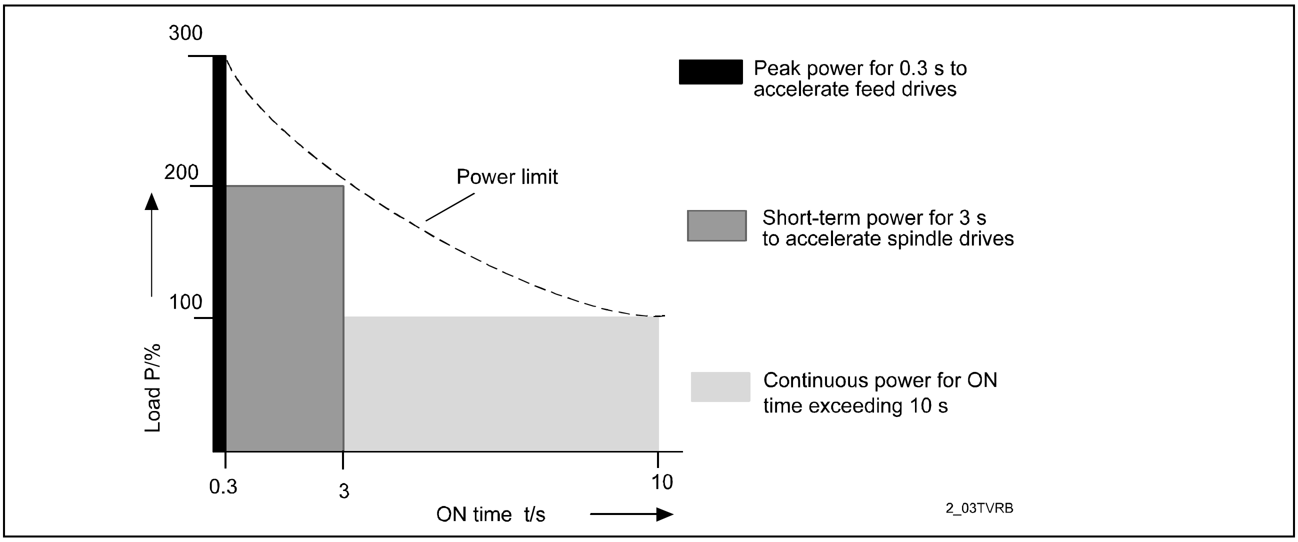


Fig. 3-6: Short-term operating loads of the HVR

3.6 HVE - technical data

Designation	Symbol	Unit	HVE02.1-W018N	HVE03.1-W030N
Power supply				
Input voltage	U(ACN)	(V)	3 x 380...480 (± 10%)	
Frequency	f(N)	(Hz)	50...60Hz (± 2 Hz)	
DC bus voltage	U(DC)	(V)	530 ...670 (± 10%)	
Output power				
DC bus continuous output	P(DC)	(kW)	See 3.2 HVE - power data	
DC bus peak output (for 0.3s)	P(KB-03)	(kW)		
Regenerated power (Bleeder power)				
continuous bleeder power	P(BD)	(kW)	1	1,5
peak bleeder power	P(BM)	(kW)	100	100
Maximum regenerated energy	W(max)	(kWs)	70	100
Power loss				
Power loss at max. continuous output (without bleeder losses)	P(V)	(W)	250	355
Basic losses	P(VG)	(W)	125	175
Power loss per kW DC bus continuous power	P(V/kW)	(W/kW)	7	6
Weight	m	(kg)	13	16
Control voltage supply				
Input voltage	U(AC)	(V)	3 x 380...480 (± 10%)	
Frequency	f(N)	(Hz)	50...60Hz (± 2 Hz)	
Power draw at maximum load	S(el)	(VA)	500	850
Control voltage output	P(St)	(W)	300	500
Conditions of use				
Permissible ambient temperature with rated data	T(amb)	(^{o}C)	+5...+45	
Maximum permissible ambient temperature with derated data	T(m.amb)	(^{o}C)	+55	
Storage and transport temperature	T(L)	(^{o}C)	-30...+85	
Installation elevation without power reduction			max. 1000m above sea level	
Permissible relative humidity			max. 95%	
Permissible absolute humidity			25g water / m^3 air	
Protection category			IP 10 per DIN 40 050	
Degree of dirt contamination			non-conductive dirt contamination; no condensate	

Fig. 3-7: Data sheet - HVE

3.7 HVR - technical data

Designation	Symbol	Unit	02.1-W010N	02.1-W025N	03.1-W045N
Power supply					
Input voltage	U(ACN)	(V)	3 x 380...480 (± 10%)		
Frequency	f(N)	(Hz)	50...60Hz (± 2 Hz)		
DC bus voltage	U(DC)	(V)	750		
DC bus power (infeed/regeneration)					
DC bus continuous output	P(DC)	(kW)	10/8	25/15	30/30
DC bus peak output (for 0.3s)	P(KB-03)	(kW)	30/18	60/45	135/90
Bleeder power					
Continuous bleeder power	P(BD)	(kW)	0 (bleeder only for Emergency stop shutdowns)		
Peak bleeder power	P(BM)	(kW)	80		
Maximum regenerated energy	W(max)	(kWs)	100		
Power loss					
Power loss at max. continuous output	P(V)	(W)	245	425	625
Basic losses	P(VG)	(W)	125	175	175
Power loss per kW DC bus continuous power	P(V/kW)	(W/kW)	15	24	24
Weight	m	(kg)	21	21	24
Control voltage supply					
Input voltage	U(AC)	(V)	3 x 380...480 (± 10%)		
Frequency	f(N)	(Hz)	50...60Hz (± 2 Hz)		
Power draw at maximum load	S(el)	(VA)	850		
Control voltage output	P(St)	(W)	500		
Conditions of use					
Permissible ambient temperature with rated data	T(amb)	(^{o}C)	+5...+45		
Maximum permissible ambient temperature with derated data	T(m.amb)	(^{o}C)	+55		
Storage and transport temperature	T(L)	(^{o}C)	-30...+85		
Installation elevation without power reduction			max. 1000m above sea level		
Permissible relative Humidity			max. 95%		
Permissible absolute Humidity			25g water / m^3 air		
Protection category			IP 10 per DIN 40 050		
Degree of dirt contamination			non-conductive dirt contamination; no condensate		

Fig. 3-8: Data sheet - HVR

3.8 Conditions of use

Higher ambient temperatures

The power and loads listed in the data sheet apply to an ambient temperature range of +5 ... +45°C. The maximum permissible ambient temperature may equal +55 °C. The power data in this, however, are derated as illustrated in the diagram below.

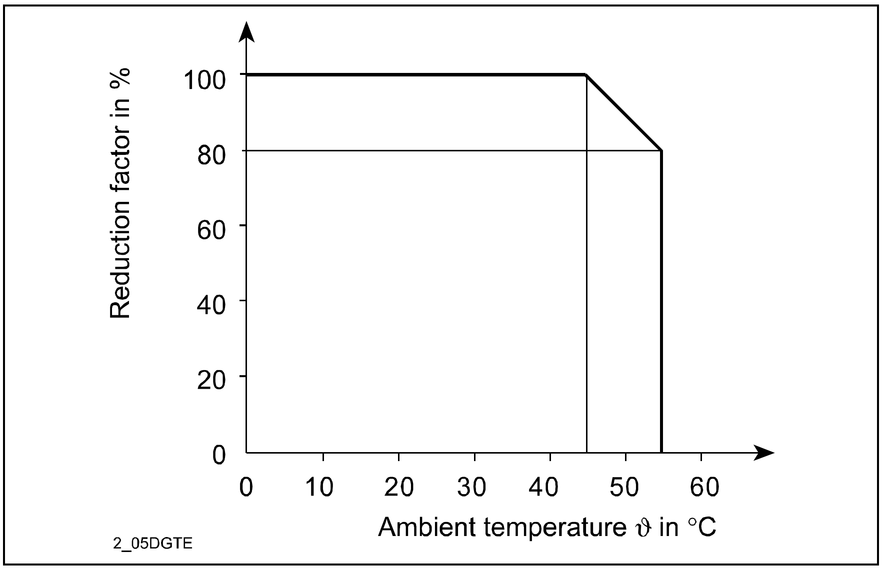


Fig. 3-9: Power data reduction with increased ambient temperatures

Installation elevation higher than 1000 m

Given installation elevations higher than 1000 meters above sea level, the power data are derated as illustrated in the diagram below.

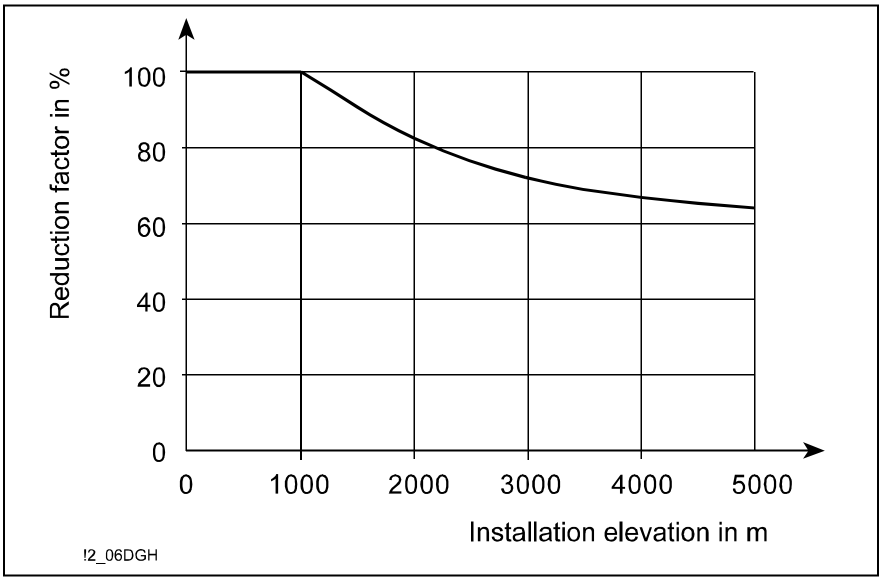


Fig. 3-10: Power data derated with installation elevations higher than 1000 m.

4 Project planning - Sizing

The power supply of an AC drive system primarily 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, possibly, transformers.

The mains supply must make available to the drives the continuous power and the 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.

To ensure a correct lay out of the mains supply, calculations as recommended in Figures 4.1...4.7 should be conducted.

4.1 DC bus continuous power

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

Mechanical power

$$P_m = M \cdot \omega = \frac{M \cdot 2\pi n}{60}$$

P_m = mechanical power in W
M = torque in Nm
ω = angular speed in rad/s
n = speed in min^{-1}

or $$P_m = \frac{M \cdot n}{9550}$$

P_m = mechanical power in kW

Fig. 4-1: 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.

Average motor speed:

Note: The average motor speed equals approximately 25% of the rapid motion speed - in the case of servo drive tasks in conventional NC machine tools.

Some cases require a precise calculation of the average motor speed.

Calculating average motor speed:

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

$$n_{av} = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 + \ldots + n_n \cdot t_n}{t_1 + t_2 + \ldots + t_n}$$

n_{av} = average motor speed in min^{-1}
$n_1 \ldots n_n$ = motor speed in min-1
$t_1 \ldots t_n$ = ON time in s

Fig. 4-2: Average speed without accel. and decel. times

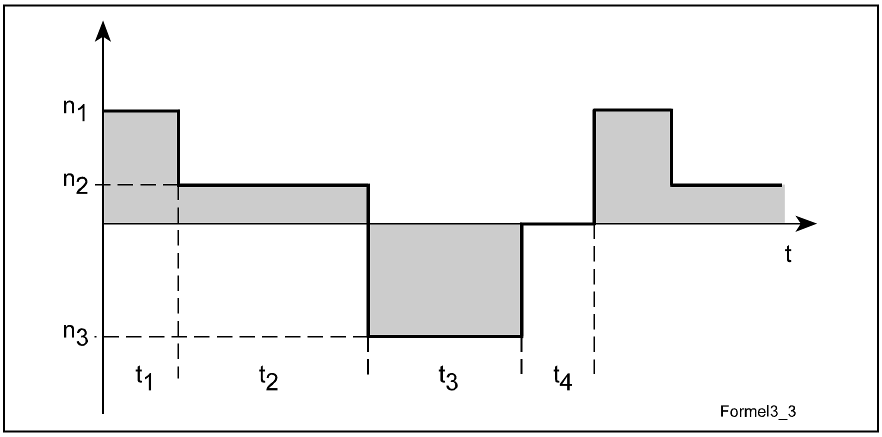


Fig. 4-3: Speed curve without accel and decel time

Accel and decel times with short cycle times must be taken into consideration in such dynamic applications as is the case with feedrollers and nibbling machines.

Average speed with accel and decel times

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

n_{av} = average motor speed in min^{-1}
n = motor speed in min^{-1}
t = time in s
t_H = accel time in s
t_B = decel time in s

Fig. 4-4: Average speed with accel and decel time

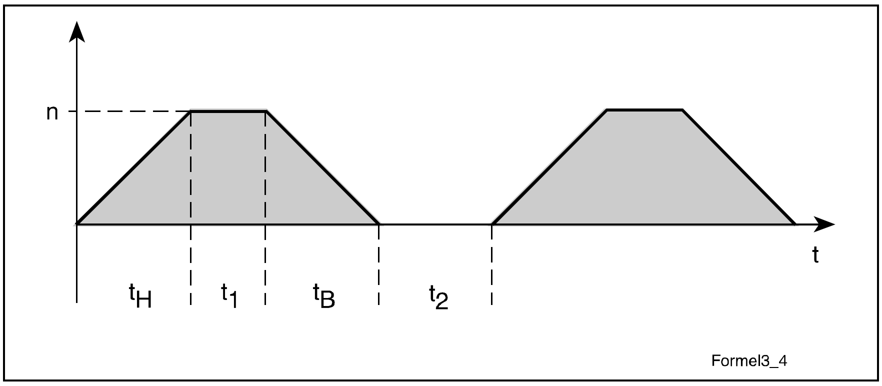


Fig. 4-5: Speed curve with accel and decel time

Mechanical power for servo drives

$$P_{mS} = \frac{M_{eff} \cdot n_{av}}{9550}$$

P_{mS} = continuous mech. power for servo drives in kW
M_{eff} = effective motor torque in Nm
n_{av} = average motor speed in min^{-1}

Fig. 4-6: Mechanical power for servo drives

Mechanical power for spindle drives

Spindle 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 spindle drives is illustrated in the operating characteristics or it can be calculated using nominal speed and torque.

$$P_{mH} = \frac{M_n \cdot n_n}{9550}$$

P_{mH} = mechanical nominal power for spindle drives (shaft output) in kW
M_n = nominal torque in Nm
n_n = motor nominal speed in min^{-1}

Fig. 4-7: Mechanical power for spindle drives

DC bus continuous power for servo drives

The power supply unit must make the DC bus power available to all servo drives. All drives are operated simultaneously in only a few applications so only the simultaneously occurring output needs to be considered.

Coincidence factor

Experience has shown that for **typical NC feed axes in machine tools,** the following coincidence factors have proven to be valuable.

Number of axes	1	2	3	4	5	6
Coincidence factor	1	1.15	1.32	1.75	2.0	2.25

Fig. 4-8: Coincidence factors

$$P_{DCS} = \frac{(P_{mS1} + P_{ms2} + \ldots + P_{mSn}) \cdot 1{,}25}{F_G}$$

P_{DCS} = continuous DC bus power for servo drives in kW
P_{mSn} = cont. mech. power for servo drives (n) in kW
F_G = coincidence factor
1.25 = constants for motor and controller efficiency

Fig. 4-9: DC bus continuous power for servo drives

DC bus continuous power for spindle drives

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

$$P_{DCH} = (P_{mH1} + P_{mH2} + \ldots + P_{mHn}) \cdot 1{,}25$$

P_{DCH} = DC bus continuous power forspindle drives in kW
P_{mHn} = mech. cont. power for main drives (n) in kW
1.25 = constants for motor and controller efficiency

Fig. 4-10: DC bus continuous power for spindle 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. When selecting the power supply unit make sure that the DC bus continuous power does not limit the short-term power of the spindle drives.

DC bus continuous power for spindle and servo drives

Add the simultaneously required power!

In machine tools

It is the spindle drive in a NC machine tool that primarily determines the DC bus power needed.

$$P_{DC} = [P_{mH} + 0{,}3(P_{mS1} + P_{mS2} + ... + P_{mSn})] \cdot 1{,}25$$

0.3 = experimental value for standard machine tools
1.25 = constants for motor and controller efficiency
P_{DC} = DC bus continuous power in kW
P_{mSn} = continuous mech. servo drive output (n) in kW
P_{mH} = nominal power for spindle drives (shaft output) in kW

Fig. 4-11: DC bus continuous power for spindle and servo drives in machine tools

4.2 Peak DC bus power

The sum of the peak power of all drives that accelerate simultaneously may not be greater than the peak output of the power supply unit.

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.

DC bus peak power per drive

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

Sum of DC bus peak power

$$\Sigma P_{peak} \leq P_{KB03}$$

1.25 = constants for motor and controller efficiency
M_{NC} = acceleration torque in NC mode in Nm
M_G = weight torque in vertical axes in Nm
n_{eil} = speed in rapid traverse in min^{-1}
P_{peak} = DC bus peak power in kW
P_{KB03} = DC bus peak power of the power supply unit in kW

Fig. 4-12: DC bus peak power

4.3 Regenerated energy

The energy content of all spindle 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 layout stage, then there could be thermal damage to the bleeder resistor in the power supply unit!

Regenerated energy per drive

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

Sum of regenerated energy

$$\Sigma W_{rot} \leq W_{max}$$

W_{rot} = rotatory energy in Ws
W_{max} = max. permisible regenerated energy of the power supply module in kWs
n_{eil} = rapid traverse speed in min^{-1}
J_g = inertia of motor and load inertia reduced to shaft in kgm^2

Fig. 4-13: Rotary regenerated energy

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. 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.

$$W_{ZW} = \frac{C_{ZW}}{2} \cdot (U_B^2 - U_{DC}^2)$$

W_{ZW} = energy stored in the DC bus in Ws
C_{ZW} = DC bus capacitor in F
U_B = bleeder actuation threshold approx. 820 V
U_{DC} = DC bus nominal voltage
in the HVR: U_{DC} = 750V
in the HVE: U_{DC} = 1.41• U_N + 10% (overvoltage)
U_N = nominal mains voltage (380 ... 480V)

Fig. 4-14: Storable energy in the DC bus

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

$$C_{Zu} \geq \frac{2W_{rot}}{(U_B^2 - U_{DC}^2)} \cdot 1000 - 1mF$$

C_{Zu} = auxiliary capacitor in mF
W_{rot} = rotatory energy in Ws

Fig. 4-15: Required auxiliary capacitance

Note: In power supply units with **regulated** DC bus voltage, e.g., HVR, up to 55 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 3x AC	380V	400V	440V	480V
storable energy per mF auxilliary capacitance	163Ws	144Ws	103Ws	59Ws

Fig. 4-16: Storable energy with auxiliary capacitance on an HVE

4.4 Continuous regenerated power

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

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 (see 4.5) is not exceeded.

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

- servo drive drive applications with numerous accel / decel procedures such as is the case in nibble machines and rollers
- machine tools with module main drives
- applications in which excessive masses must be lowered as is the case in overhead gantries of the 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.

Rotary energy

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

W_{rot} = rotary energy in Ws
n_{eil} = speed in rapid traverse in min^{-1}
J_g = moment of inertia (motor + load) in kgm^2
z = number of decels per cycle

Fig. 4-17: Rotary energy to calculate the continuous regenerated power

Potential energy

$$W_{pot} = m \cdot g \cdot h \cdot z$$

m = load mass in kg
g = gravity constant = $9{,}81 m/s^2$
h = drop height in m
W_{pot} = potential energy in Ws
z = number of drops per cycle

Fig. 4-18: Potential energy to calculate the continuous regenerated power

Continuous regenerated power

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

P_{RD} = continuous regenerated power in kW
t_z = cycle time in s
W_{potg} = sum of potential energy in kWs
W_{rotg} = sum of rotary enery in kWs

Fig. 4-19: Continuous regenerated energy

Lowering loads

If a load is lowered over a period of time exceeding 10s, then the regenerated power may not exceed the permissible continuous regenerated power of the power supply unit.

$$\frac{W_{pot}}{t_{ab}} = F \cdot v \le P_{RD}$$

Fig. 4-20: Regenerated continuous power when lowering of loads exceeds 10s

In lowering processes shorter than 10s, the regenerated power can be greater. The time average of 10s may not be exceeded by the regenerated continuous power of the power supply unit.

$$\frac{W_{pot}}{10s} = F \cdot v \cdot \frac{t_{ab}}{10s} \le P_{RD}$$

F	=	weight in N
v	=	speed in m/s
t_{ab}	=	lowering time in s
P_{RD}	=	continuous regenerated power in W W_{pot}
	=	potential energy in Ws

Fig. 4-21: Continuous regenerated power if lowering time is less than 10s

4.5 Peak regenerated power

The peak regenerated power generally drops if an E-stop is actuated and all axes are simultaneously shutdown.

CAUTION

Extended decel times and paths

Machine damage is possible!

⇒ The sum of peak regenerated outputs of all drives that, in an extreme case, brake simultaneously, may not exceed peak bleeder 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:

$$P_{RS} = \frac{M_{max} \cdot n_{max}}{9550 \cdot 1{,}25}$$

$$\sum P_{RS} \le P_{BM}$$

1,25	= constants for motor and controller efficiency
M_{max}	= max. drive torque in Nm
n_{max}	= max. NC usable speed in min^{-1}
P_{RS}	= peak regenerated power in kW
P_{BM}	= peak bleeder power in kW

Fig. 4-22: Peak regenerated power

4.6 Incoming power of the power supply

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

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

Incoming power of the HVE

without DC choke GLD

$$S_{An} = P_{DC} \cdot 1{,}6$$

with DC choke GLD

$$S_{An} = P_{DC} \cdot 1{,}07$$

P_{DC} = DC bus continuous power in kW
S_{An} = incoming power in kVA

Fig. 4-23: Incoming power of the HVE

Incoming power of the HVR

$$S_{An} = P_{DC} \cdot 1{,}05$$

P_{DC} = DC bus continuous power in kW
S_{An} = incoming power load in kVA

Fig. 4-24: Incoming power of the HVR

Mains current

$$I_N = \frac{S_{An} \cdot 1000}{\sqrt{3} \cdot U_N}$$

S_{An} = incoming power in kVA
I_N = Mains current
U_N = Mains voltage

Fig. 4-25: Mains current

4.7 Checking control voltage supply

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.

Power supply unit	Control voltage load capacities
HVE02.1-W018N	350W
HVE03.1-W030N	500W
HVR02.1-W010N	500W
HVR02.1-W025N	500W
HVR03.1-W045N	500W

Fig. 4-26: Control voltage load capacities

5 Mounting

5.1 Mounting the HVE and HVR in a control cabinet

Mounting conditions

The power supply units HVE and HVR and their controllers are designed to be built into a control cabinet or closed housing. They meet the demands of protection category IP 10, as per DIN 40050.

The unit is protected against the penetration of extrinsic objects with a diameter exceeding 50 mm.

It is not protected against

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

CAUTION

Overheating

The unit can be damaged if incorrectly mounted!

⇒ Mount the unit only in the specified mounting orientation.

Controller arrangement

Place the drives with greater power and higher unit currents as close to the power supply unit as possible.

Maximum number of controllers

No more than six to the right and to the left (12 total). Do not exceed the load capacities of the control voltage power of either the HVE or HVR.

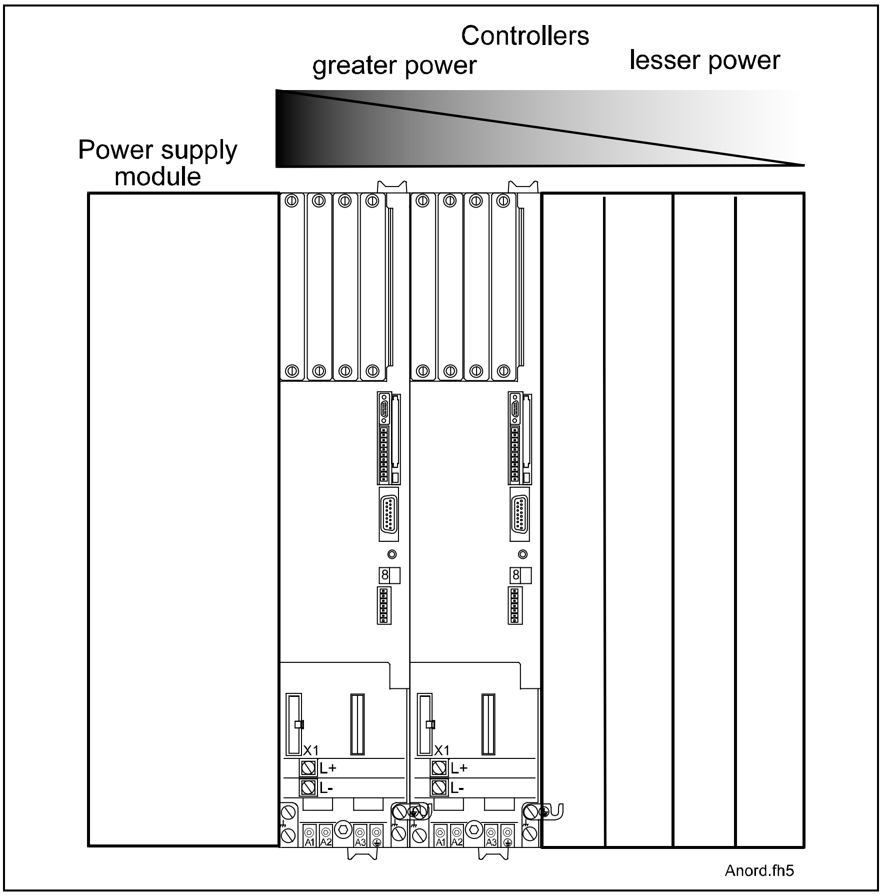


Fig. 5-1: Recommended unit arrangement within the control cabinet

5.2 Safety clearances 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 the heat, such as lines and cable ducts, must have a minimum clearance of 300mm to the top and 40mm to the side and front.

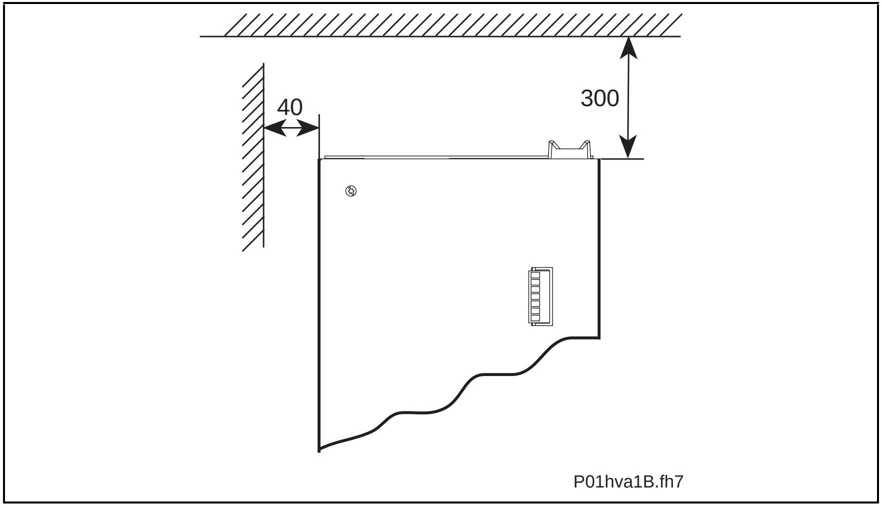


Fig. 5-2: Safety clearances to the bleeder resistor

The Use of Cooling Units within the Control Cabinet

The power supply unit with 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.

WARNING

Damage to the unit is possible!
The operation of the machine is endangered.
⇒ Please note the following instructions!

Avoiding dripping and spraying water

The use of cooling units always means that condensation will occur. Therefore, note the following:

- 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.

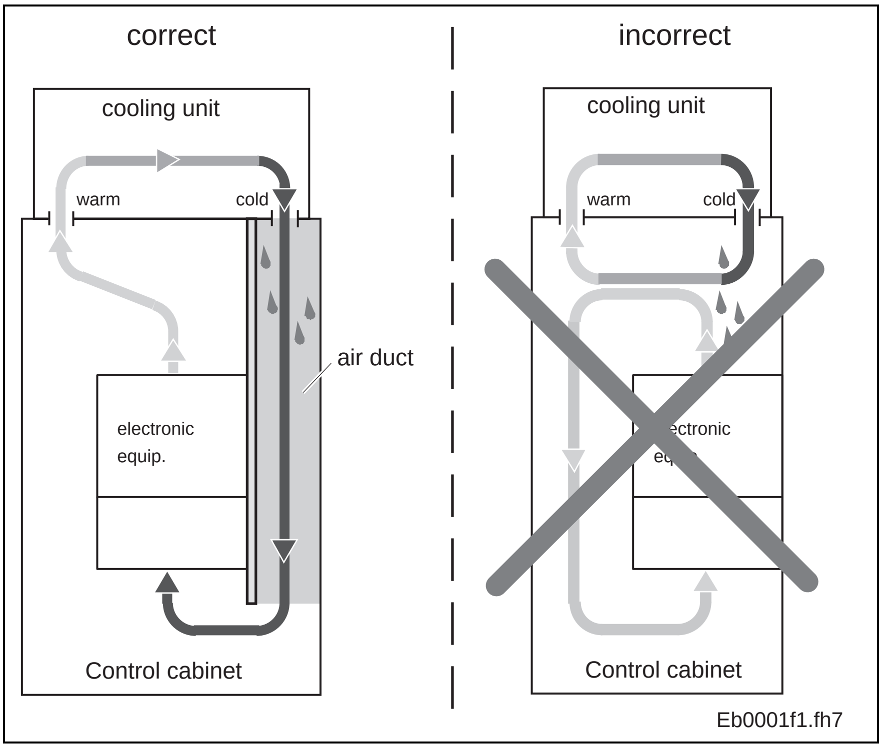


Fig. 5-3: Cooling unit arrangement on the control cabinet

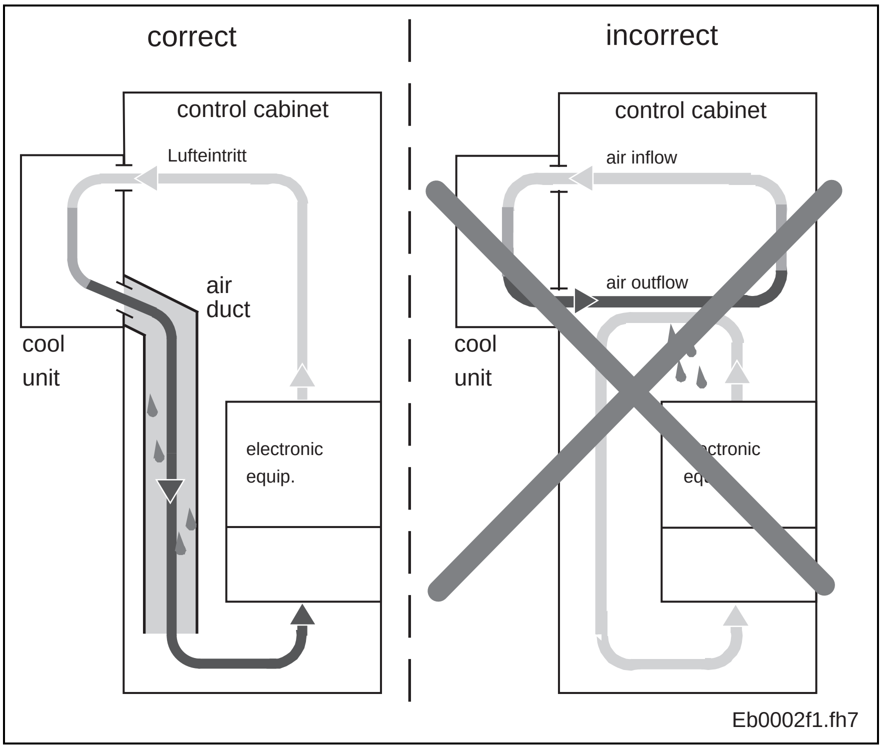


Fig. 5-4: Cooling unit situated on the front of the control cabinet

Avoiding condense 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.
- Only use well-insulated cabinets so that condense water cannot form because no humid air can escape.
- 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.

Steps to Take with Non-Cooled Control Cabinets

If a power supply unit is to be operated in an uncooled and unventillated cabinet, then the unit and/or drive package must have enough space so that air circulation within the cabinet can be generated.

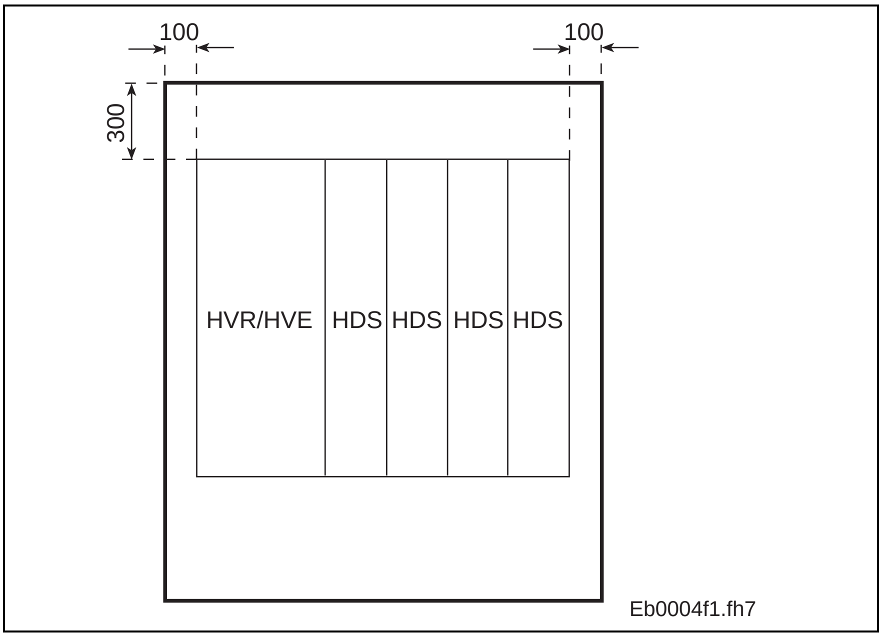


Fig. 5-5: Control cabinet (uncooled, unventillated) with drive package

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

When operating the unit there is some power loss which heats up the surrounding air in the control cabinet. 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 ponit where extreme temperatures could occur. These temperatures can then damage the unit permanently.

To prevent this, Indramat recommends the use of a ventilating system within the control cabinet.

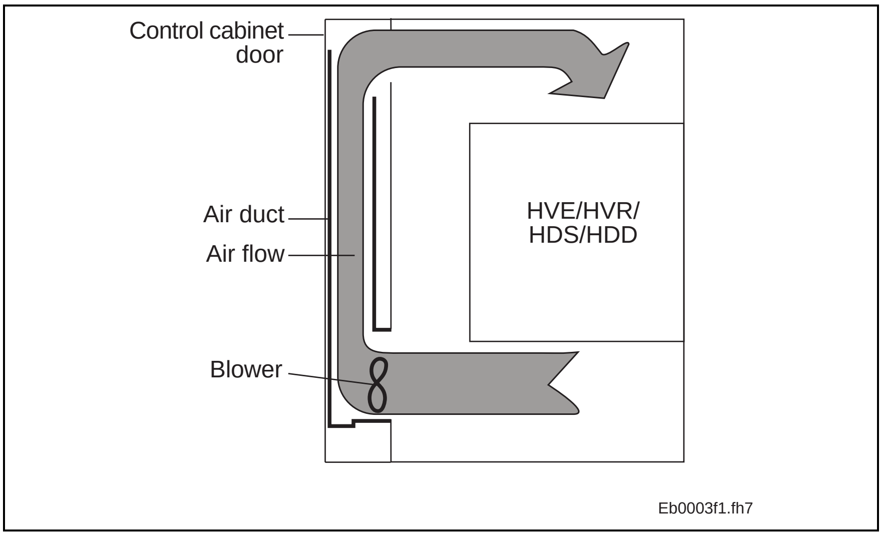
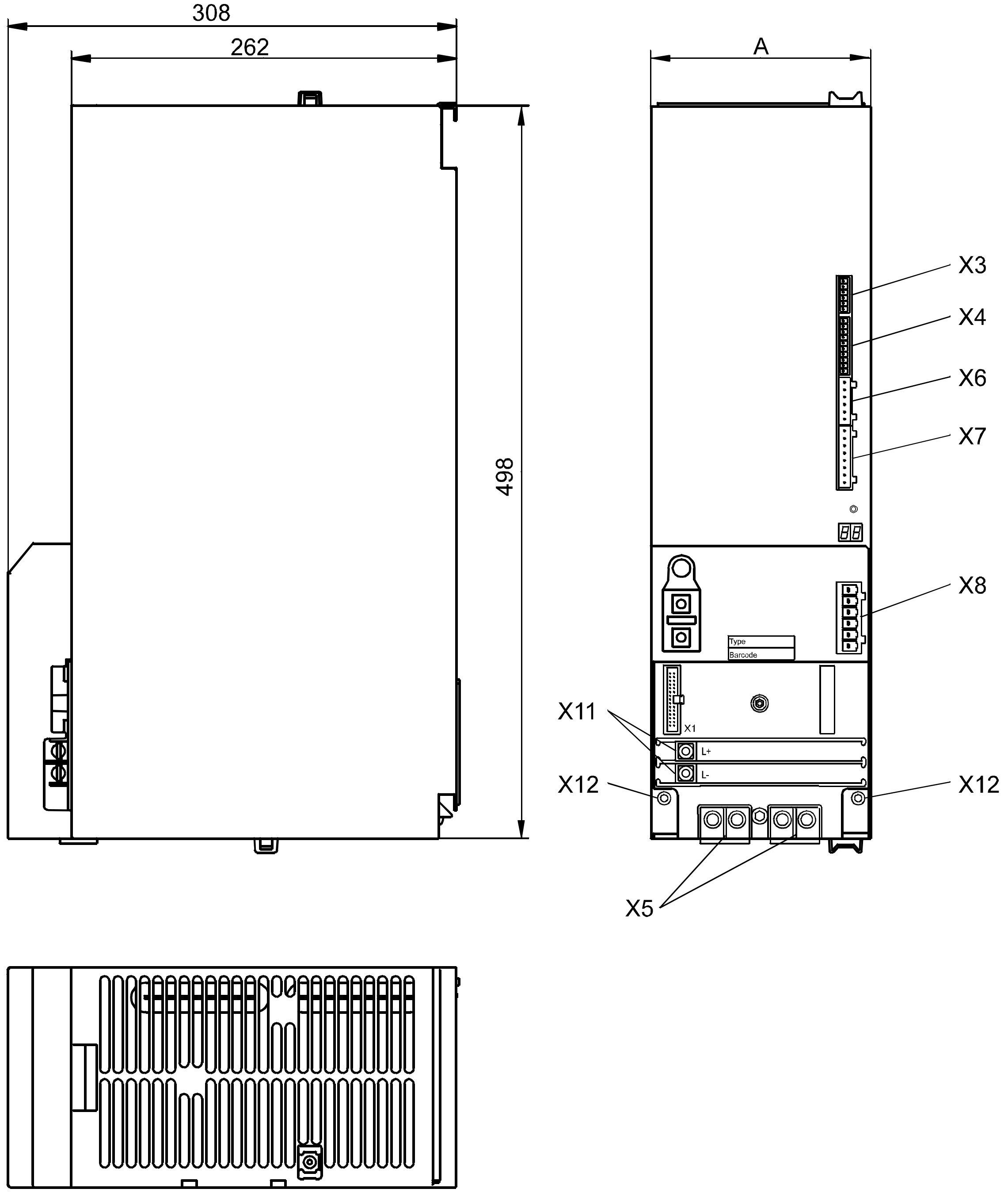


Fig. 5-6: Control cabinet with air circulation

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.

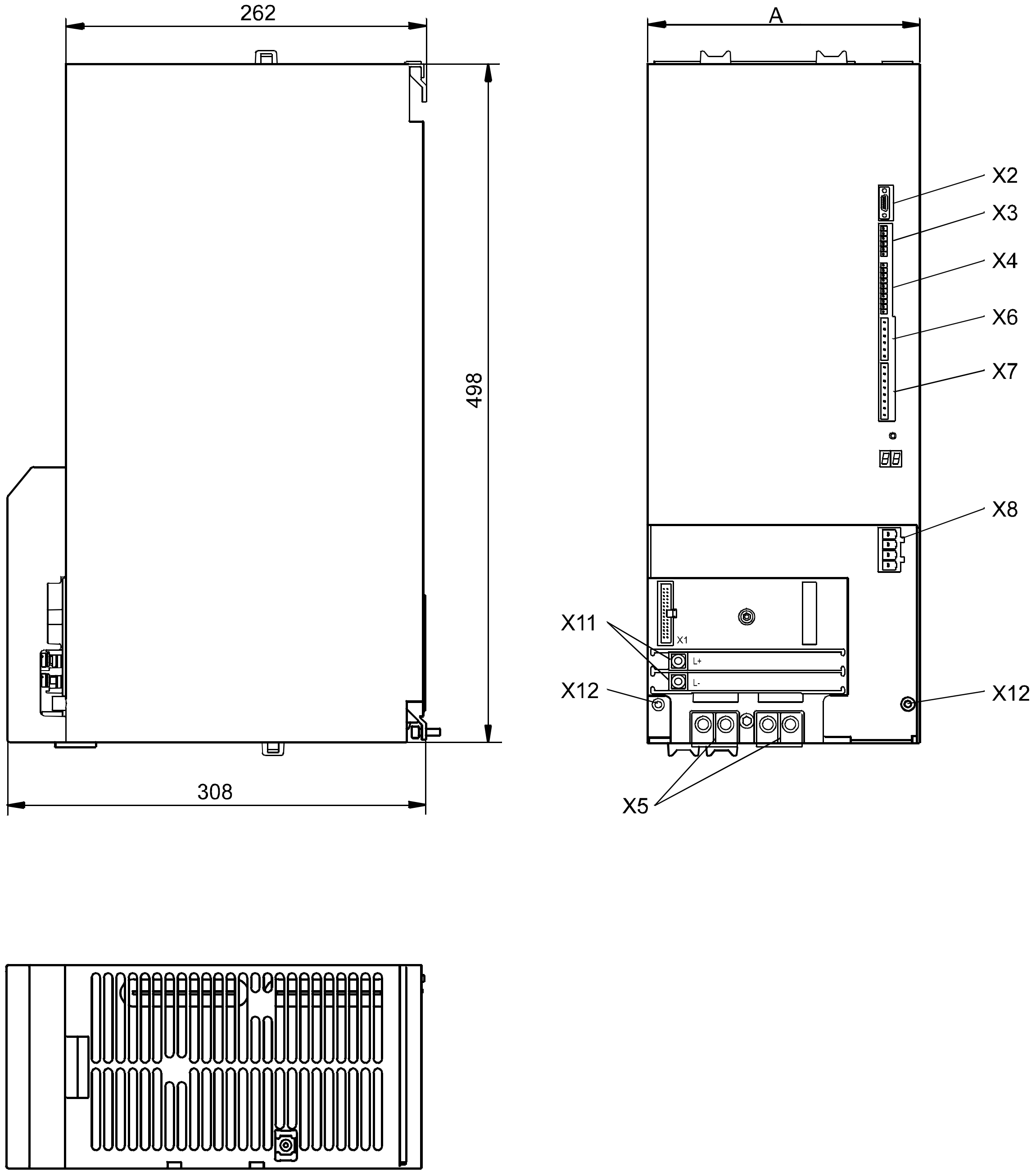
5.3 Dimensional data - HVE



		Max. conn. cross section in mm²							
Unit	A	X3	X4	X5	X6	X7	X8	X11	X12
HVE 02.1	100	1.5	1.5	16	2.5	2.5	4		
HVE 03.1	150	1.5	1.5		2.5	2.5	4		

Fig. 5-7: Dimensional sheet - HVE

5.4 Dimensional data - HVR



		Max. conn. cross section in mm²						
Unit	A	X3	X4	X5	X6	X7	X8	X11	X12
HVR 02.1	175	1.5	1.5		2.5	2.5	4		
HVR 03.1	200	1.5	1.5	35	2.5	2.5	4		

Fig. 5-8: Dimensional sheet - HVR

5.5 Mounting the unit

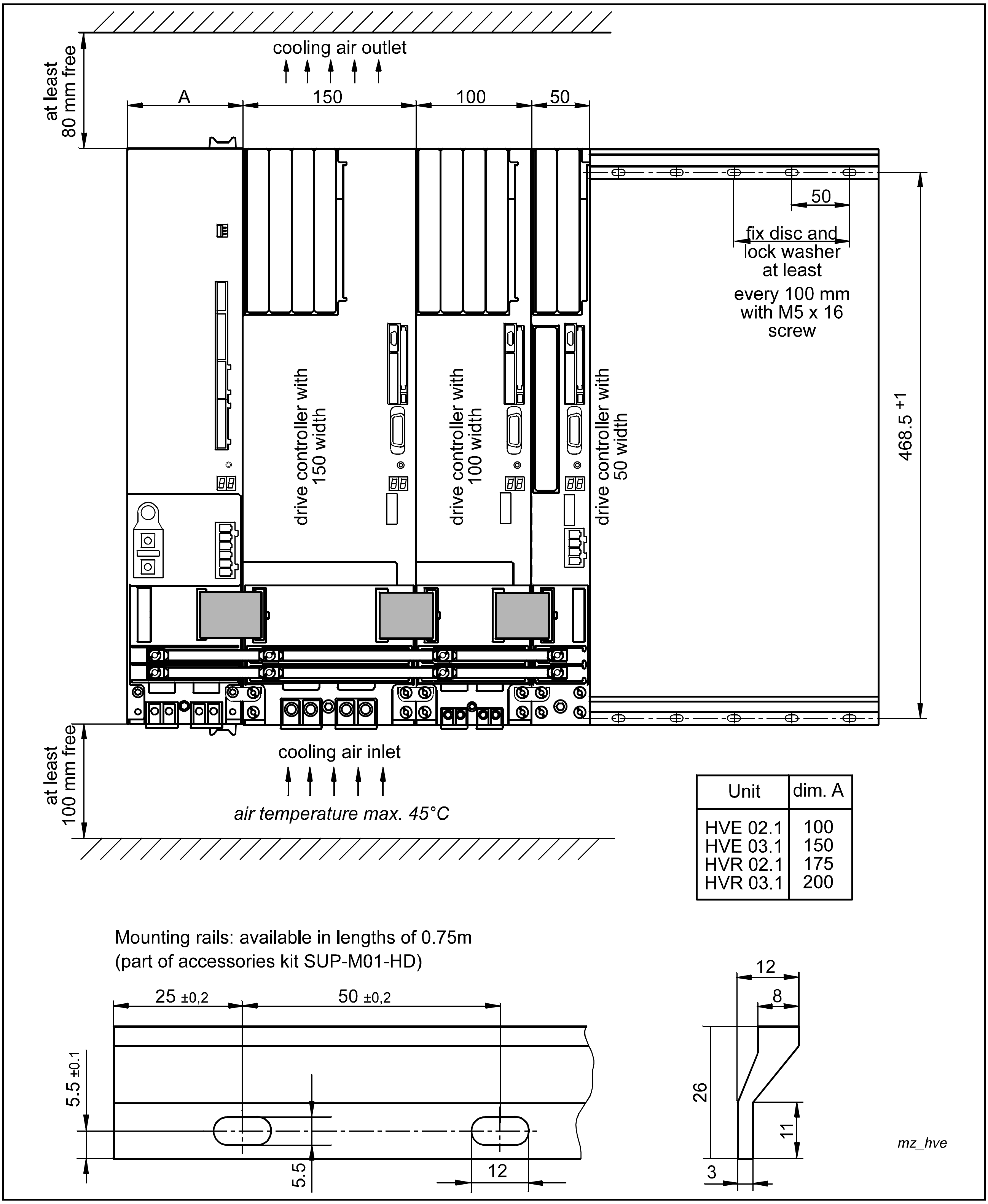


Fig. 5-9: Mounting the unit

6 Electrical connections - Installation instructions

Note: The connection diagrams shown in the document are recommendations of the manufacturer of the unit. Determinative for the mounting within the installation is the circuit diagram of the machine manufacturer.

6.1 Terminal connecting plan - HVE02.1 and HVE03.1

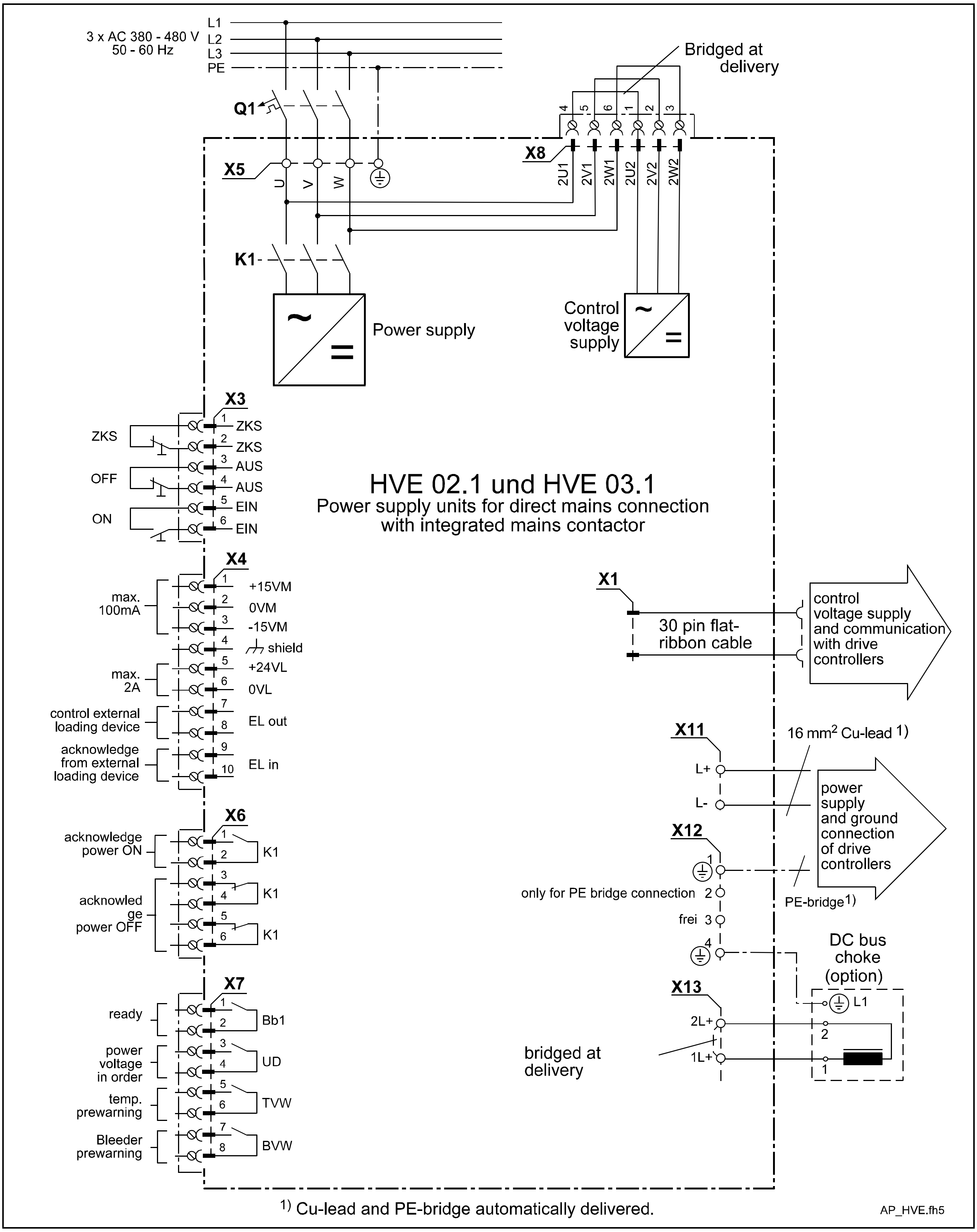


Fig. 6-1: Terminal connecting plan - HVE02.1 and HVE03.1

6.2 Terminal connecting plan - HVR02.1 and HVR03.1

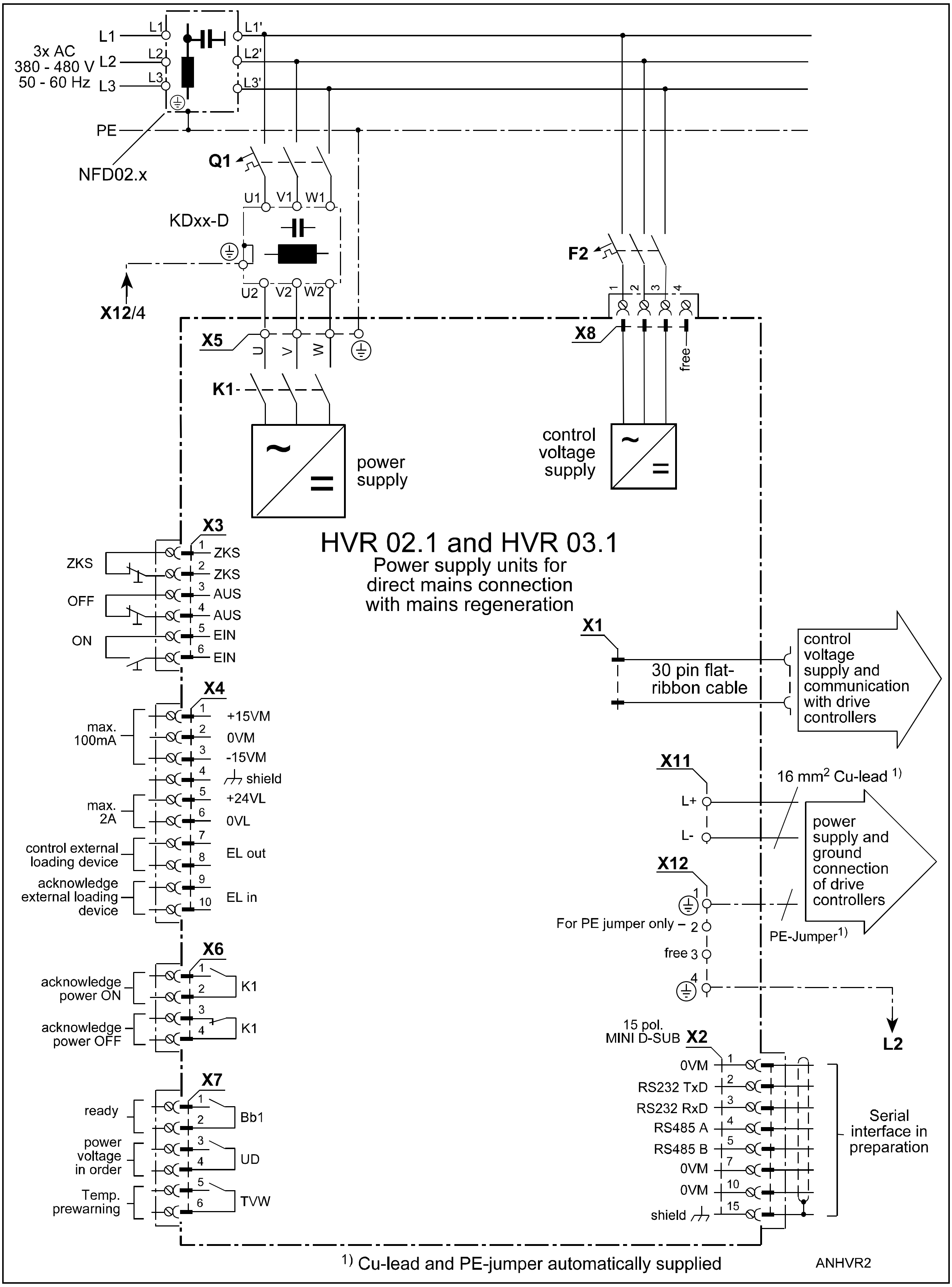


Fig. 6-2: Terminal connecting plan - HVR02.1 and HVR03.1

6.3 Mains connection - power section

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...480V,50...60Hz without the need for a transformer.

Demands made of the supply network

Mains voltage: 3x AC 380 ... 480; ± 10 %

Mains frequency 50 ... 60 Hz; ± 2 Hz

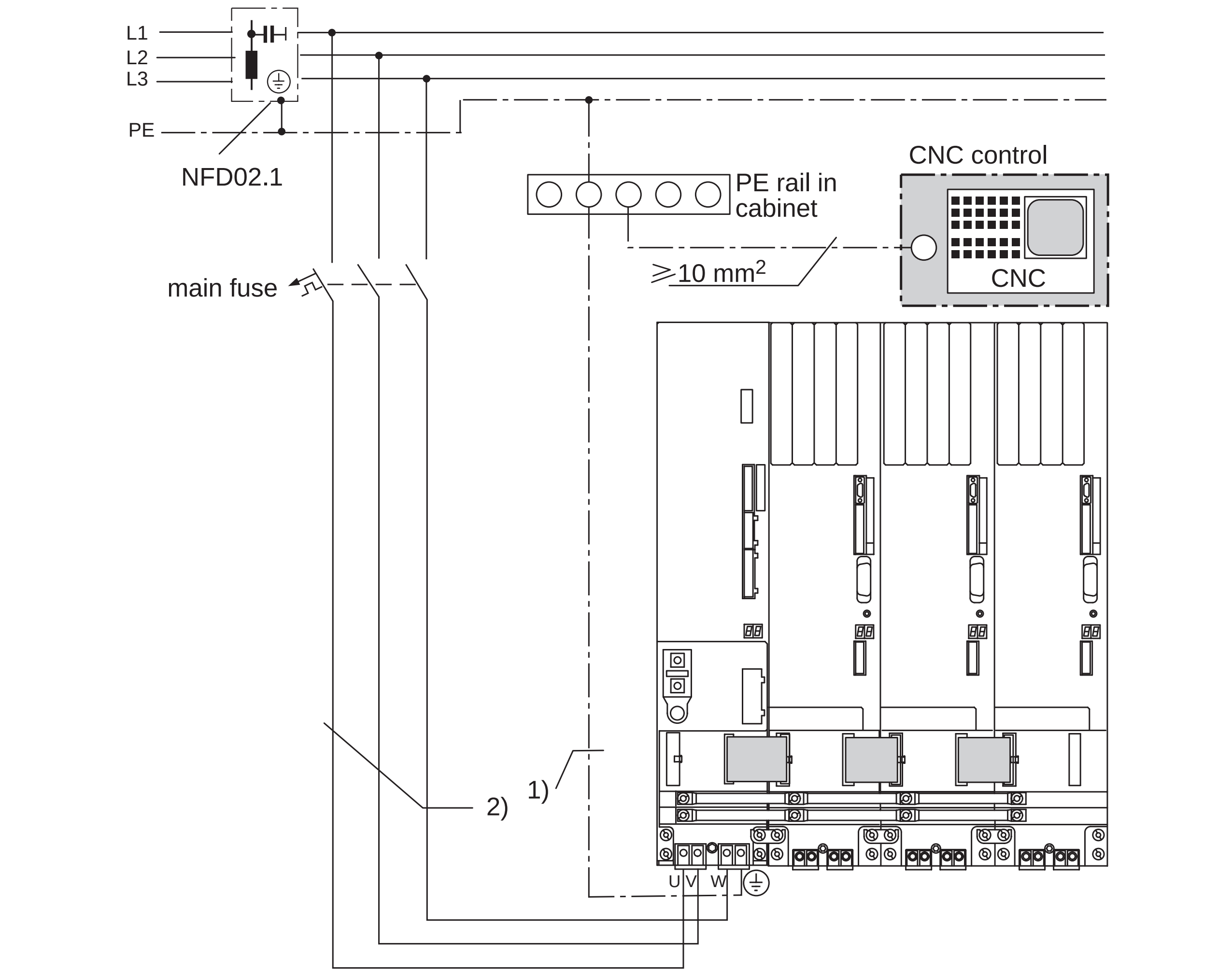
Voltage break

Max. 3 ms at nominal load and 380 V mains voltage; without additional capacitance. There must be a duration of > 1s between sequential breaks.

Voltage breaks

20 % of the peak voltage for a maximum of one period (with 3 x 380V; with higher supply voltages a corresponding per cent more). There must be a duration of > 1s between sequential breaks.

Direct mains connection HVE



1) As main line, but smaller than 10 mm²
2) Twist main line - line cross section per EN 60 204

Fig. 6-3: Power connection of the power supply units HVE

Note: When operating modular drives in residential or light industrial areas, it may be necessary to mount an interference suppression filter in the power line in order to be able to maintain the limits for interference transmission (interference suppression).

WARNING

Leakage current via the protective circuit > 3.5 mA
Electrical shock upon contact.
⇒ Operate the unit only with attached mains connection and never without a protective circuit.

Mains connections HVE via a transformer

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

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

The required transformers power: Transformer power must be equal to or greater than the incoming power (see 4.6).

Direct Mains Connection HVR

Connection using mains filter NFD02.x and commutation choke KDxx-D

Given the technical circumstances, the commutation chokes, KD27-D, KD28-D and KD30-D, are equipped with additional capacitors in order to avoid system perturbations and excessive heat dissipation.

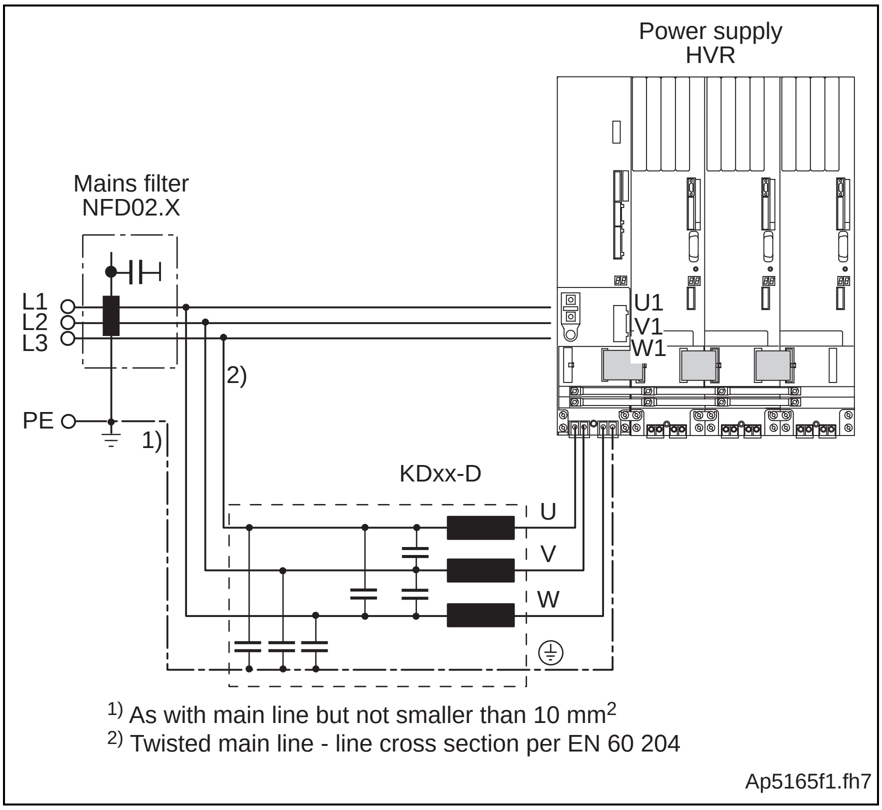


Fig. 6-4: Direct mains connection via mains filter NFD02.x and commutation choke KDxx-D

Connecting the Mains HVR via a Transformer

A commutation choke and a mains filter is always needed with a mains connection which uses a transformer.

Connection with mains filter NFD02.x and commutation choke KDxx-D

It is also necessary to mount three capacitors in a star connection between transformer and the NFD mains filter (available as accessory kit SUP-E01-HVR). This helps avoid system perturbations. The star connection must be grounded.

To avoid excessive heat dissipation and overvoltage of the transformer, a current-compensated choke (see Figs. 6-6 and 6-7) are used. The accessory kit with the current-compensated choke also includes two MKV capacitors (470 nF/900V). These must be connected to the DC bus, so that one goes rom L+ to ground and one from L- to ground.

Unit	Appropriate accessories kit
HVR02.2-10	SUP-E02-HVR
HVR02.2-25	SUP-E03-HVR
HVR03.2-45	SUP-E04-HVR

Fig. 6-5: Selecting the accessory kit with current-compensated choke and auxiliary capacitors for the DC bus

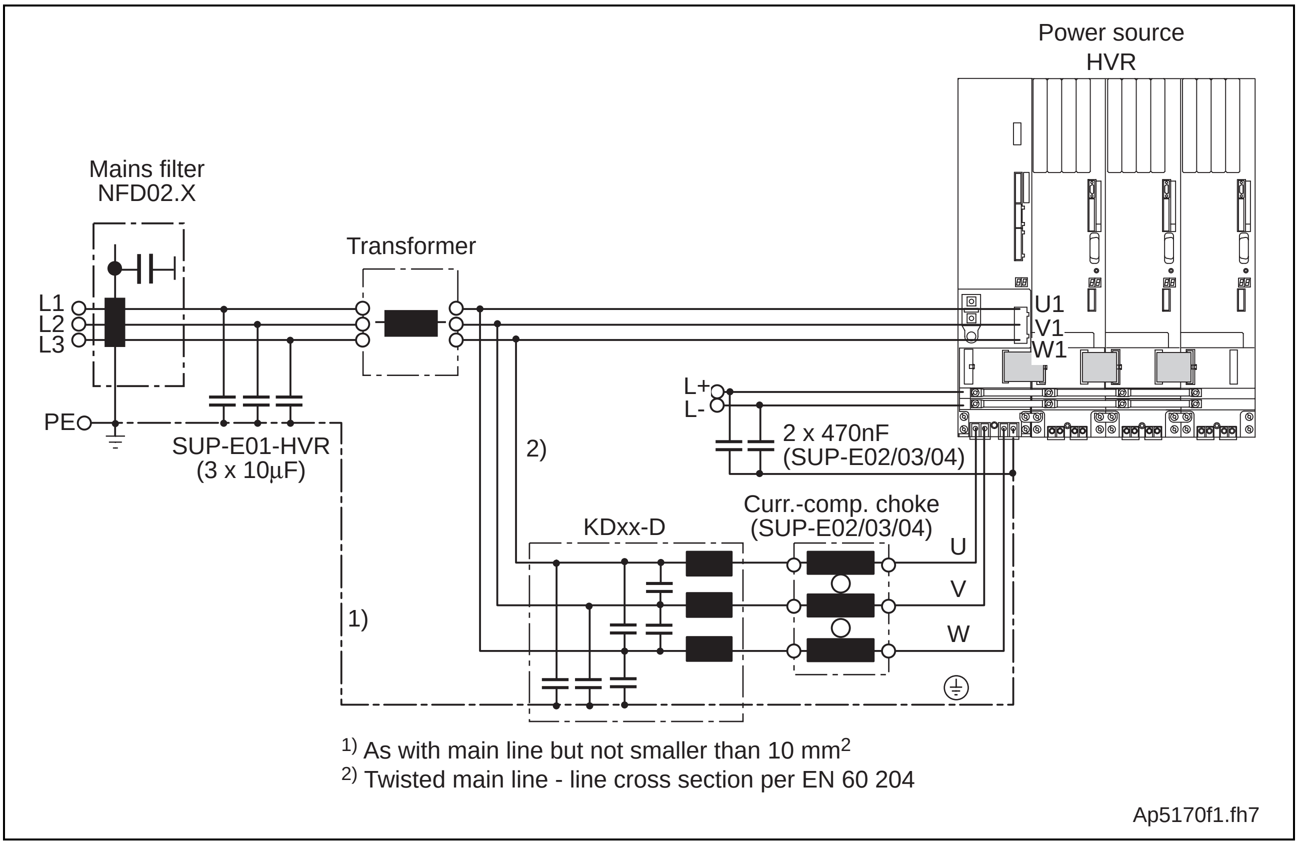


Fig. 6-6: Connection via transformer mains filter NFD02.x and commutation choke KDxx-D

Note: The layout of the transformer must pay special attention to the use of a low loss transformer core (suitable for frequencies > 10 kHz) and insulation that is especially voltage resistant. This is due to the HVR specific load of the transformer with a current ripple of 10 kHz. The insulation of the winding in terms of the ground potential must equal > 3kV. Indramat recommends the "DIF" transformers made by Karl A. Gass GmbH & Co. KG (Hersfelder Strasse 54, D-36304 Alsfeld, Phone: 06631-4071 / fax: 06631 - 6544.

6.4 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.

Maximum fusing

Power supply unit	Fuse maximum
HVE02.1-W018N	35A
HVE03.1-W030N	63A
HVR02.1-W010N	25A
HVR02.1-W025N	50A
HVR03.1-W045N	80A

Fig. 6-7: Maximum fusing

With a direct main connection, the following recommendations apply when using power circuit breakers.

If slow-blow fuses are used, then the gL type should be used. Semiconductor fuses are not needed. Select the fuse to suit the mains current (see Fig. 4-25: Mains current).

Power supply unit	Mains current at		Power circuit breaker (Siemens)	Setting value	Mains connected load at 400V connected voltage 1)
	400V	480V			
HVE02.1-W018N (without GLD 13)	28A	23A	3VU1600-.MQ00 2)	28A	$6mm^2$
HVE02.1-W018N (with GLD 13)	28A	23A	3VU1600-.MQ00 2)	28A	$6mm^2$
HVE03.1-W030N (without GLD 13)	46A	39A	3VF3111-5DN71-....	46A	$16mm^2$
HVE03.1-W030N (with GLD 13)	46A	39A	3VF3111-5DN71-....	46A	$16mm^2$
HVR02.1-W010N	15A	13A	3VU1300-.MM00 3)	15A	$2{,}5mm^2$
HVR02.1-W025N	38A	32A	3VU1600-.MQ00 2)	38A	$10mm^2$
HVR03.1-W045N	68A	57A	3VF3111-5DN71-....	68A	$25mm^2$

1) Line cross section as per EN60204 - B1 installation type - without accounting for correction factors

2) Max. back-up fuse as manufacturer: 200 A (gL) with connected voltage up to 500 V

3) Max. back-up fuse as manufacturer: 80 A (gL) with connected voltage up to 500 V

Fig. 6-8: Recommended fusing of the power supply line

6.5 Grounding the power supply system

Grounded three-phase mains

HVEs and HVRs can be operated from three-phase systems with grounded neutral points or phases without control-to-load isolation.

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 transformer and the PE connection of the power supply unit are connected over one grounding rail)

- or -

- if the installation is overvoltage protected.

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

Overvoltage

Periodic overvoltage of the HVE and HVR between phase (1U1, 1V1, 1W1, 2U1, 2V1, 2W1) and housing may not exceed 1000 V (peak value).

Non-periodic overvoltage as per VDE 0160 between phase and phase and housing are permissible in terms of the following diagrams.

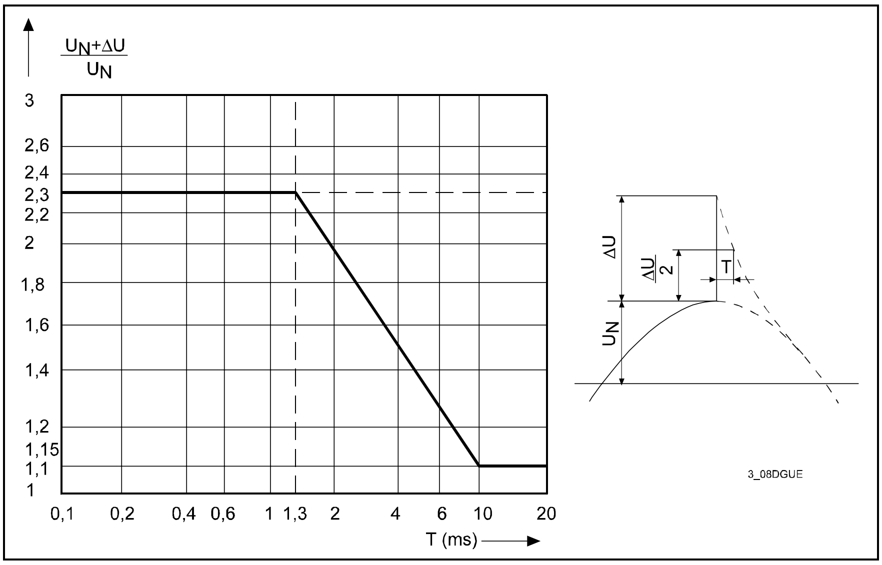


Fig. 6-9: Permissible non-periodic overvoltage as per VDE 0160

HVE and HVR can be connected to 3 x 480 V.

The maximum permissible overvoltage is thus:

$$480\text{V} \cdot \sqrt{2} \cdot 2{,}3 = 1560\text{V}$$

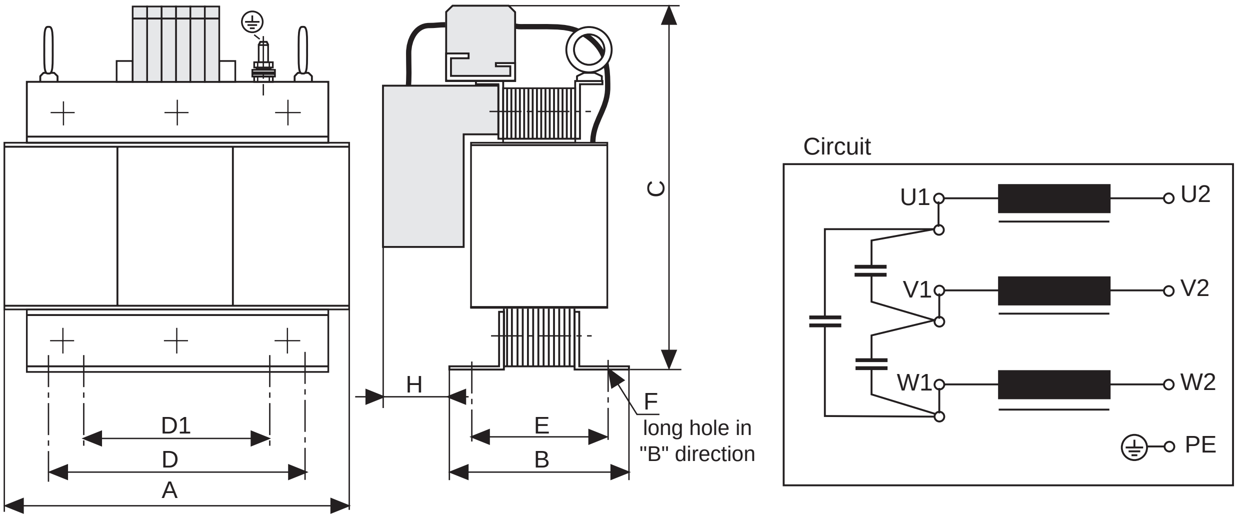
Fig. 6-10: Maximum permissible overvoltage

6.6 Commutation chokes for an HVR

Power supply units of the HVR line are generally operated with commutation choke KD **and** interference suppression filter NFD

HVR	Commutation chokes
02.1-W010N	KD 30-D
02.1-W025N	KD 27-D
03.1-W045N	KD 28-D

For suppression filters see “ Electromagnetic Compatibility (EMC) in AC Drives“; doc. type. DOK-GENEREL-EMV********-PRJ1-EN-P.



Dimensions:

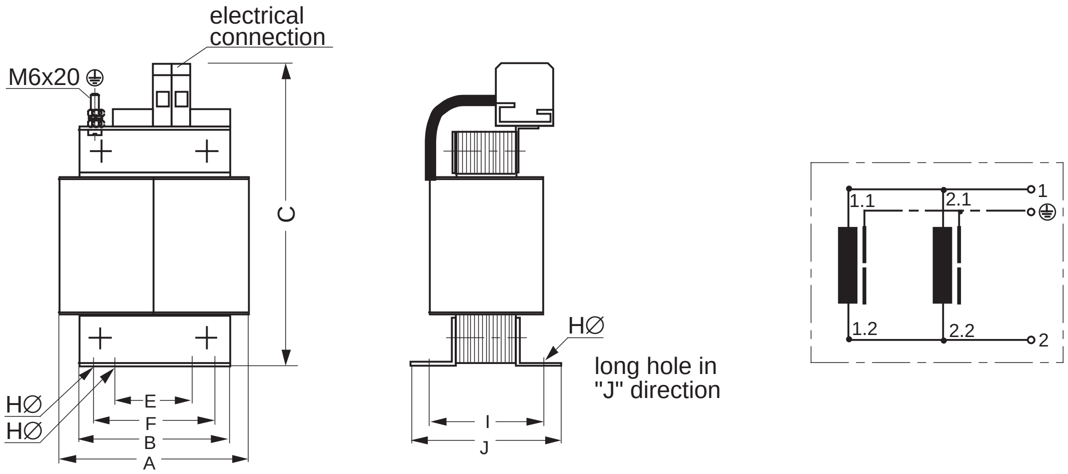
Type	Induc-tance/ mH	curr./ A	Dimensions in mm A	B	C	D	D1	E	F	H	⏚	clamps /mm^2	weight/ kg	power loss/ W
KD30-D	1,0	18	180	225	205	125	-	200	7 x 15	-	M5	10	10	400
KC27-D	0,7	45	285	138	280	170	110	108	11 x 18	100	M6	16	24	550
KD28-D	0,5	80	335	155	380	230	160	125	11 x 18	105	M8	35	44	750

Fig. 6-11: Commutation choke KD ..

6.7 DC bus choke GLD for the HVE

To increase the usable DC bus continuous power DC bus choke GLD can be connected to the HVE power supply unit.

For a selection, see 3.2.



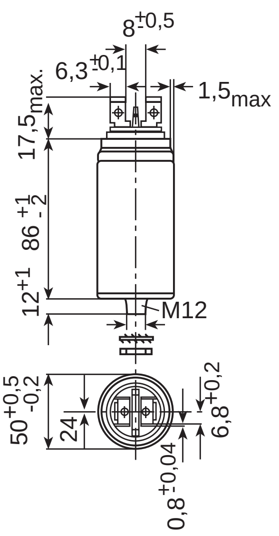
Type	mH/A	Dimensions in mm								max. conn. cross sec.	Weight	power loss
		A	B	C	E	F	HØ	I	J		kg	W
GLD 12	1,0/100	160	121	285	60	100	7x14	97	121	35mm²	13,5	100
GLD 13	1,0/50	122	90	225	--	60	6x10	66	82	16mm²	4,8	50

MB_GLD.fh7

Fig. 6-12: DC bus choke GLD

6.8 Dimensional Data of SUP - E01 - HVR

SUP-E01-HVR contains:
3 capacitors each 10 µF



MBSUPE01.fh7

Fig. 6-13: Dimensional data for 10µF capacitors

6.9 Dimensional Data of SUP - E02 - HVR

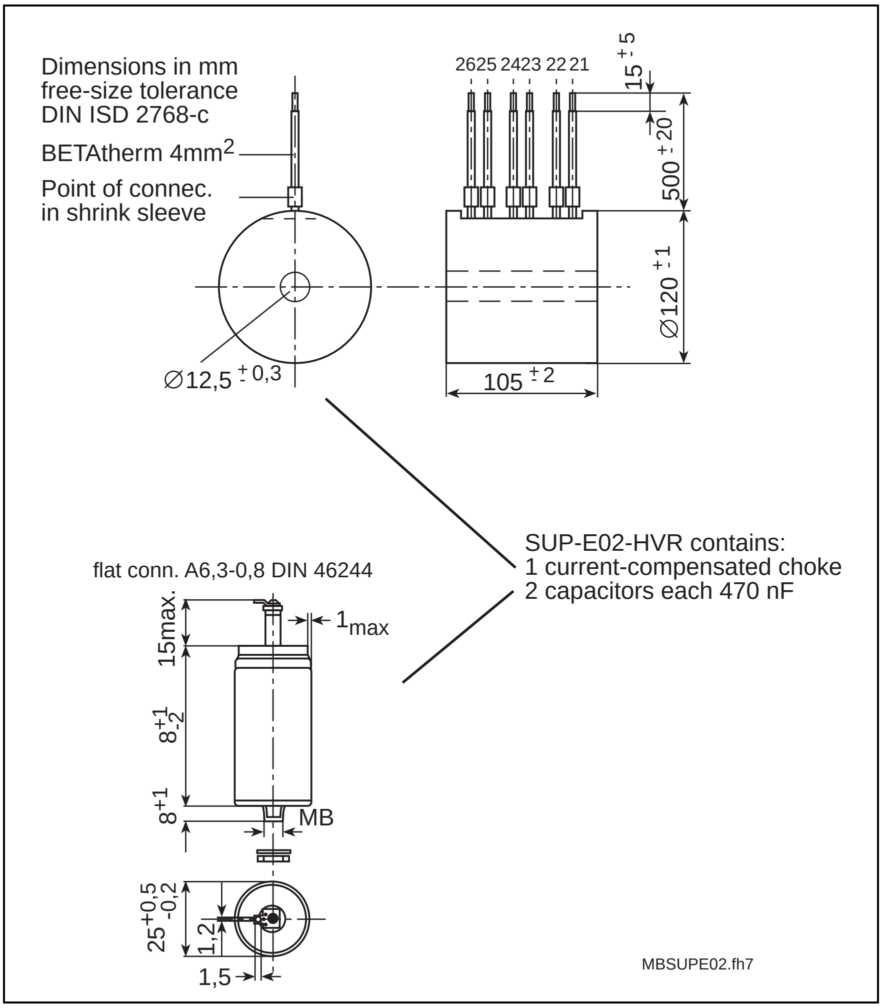


Fig. 6-14: Dimensional sheet of current-compensating choke and 470nF capacitors

6.10 Dimensional Data of SUP - E03 - HVR

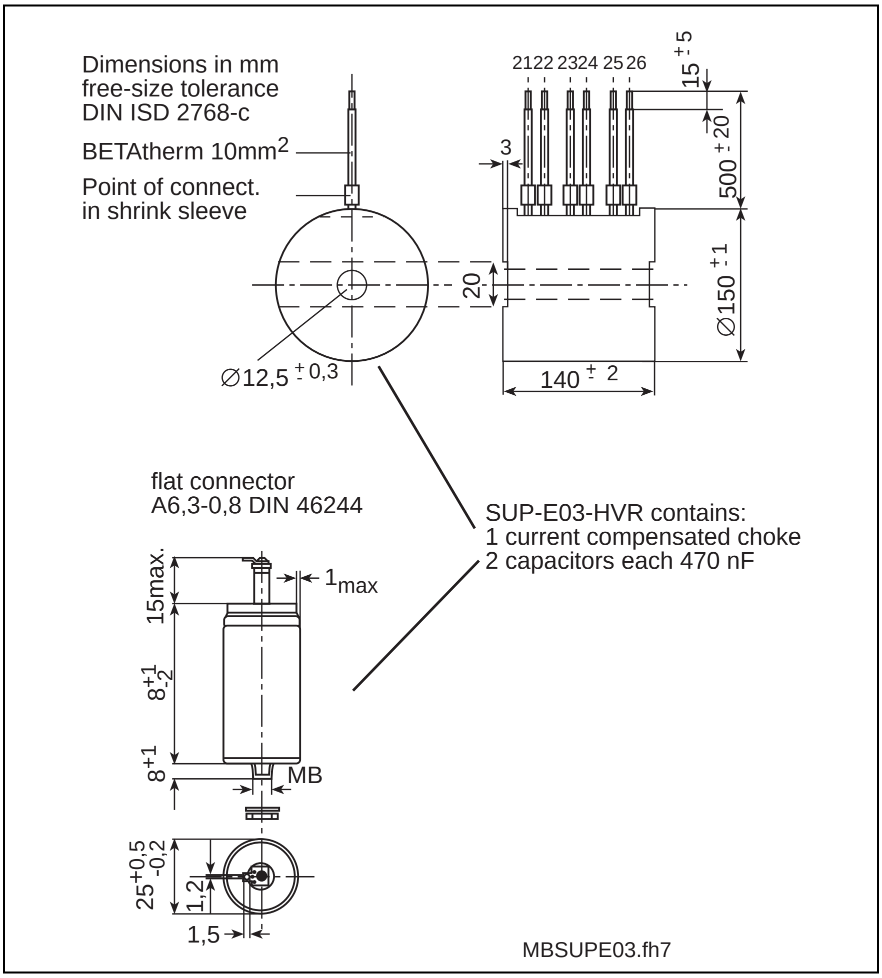


Fig. 6-15:: Dimensional sheet of current-compensating choke and 470nF capacitors

6.11 Dimensional Data of SUP - E04 - HVR

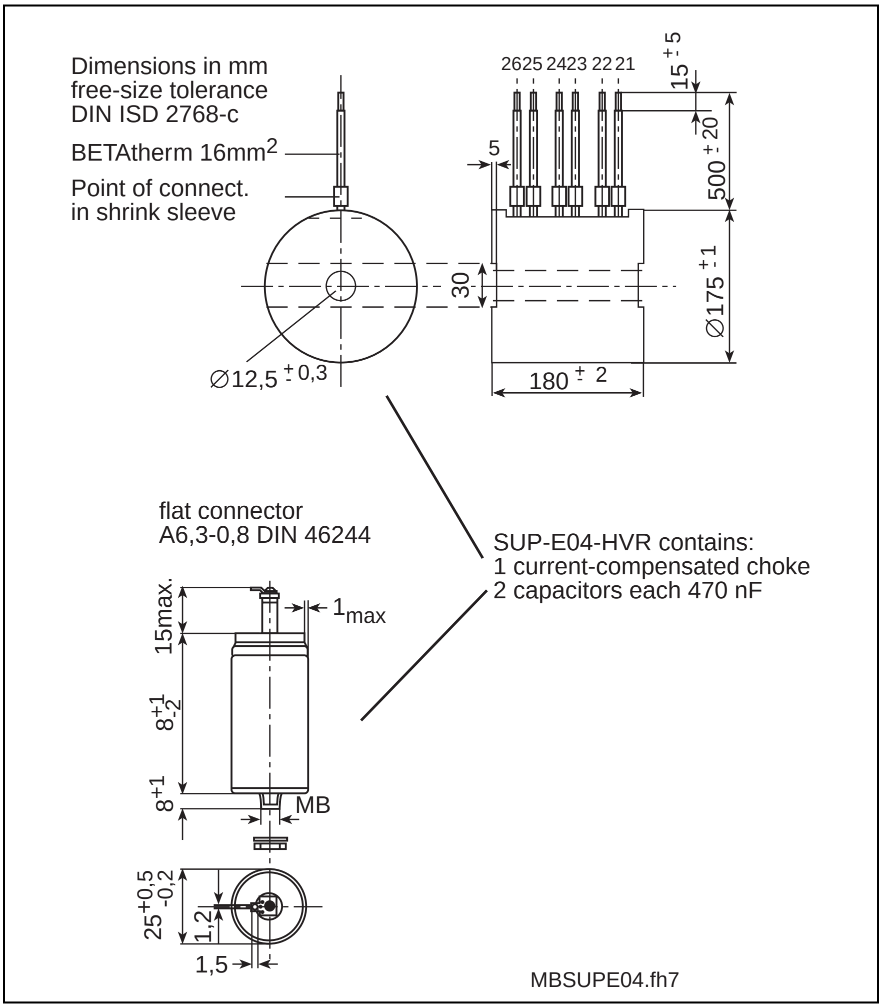


Fig. 6-16:: Dimensional sheet of current-compensating choke and 470nF capacitors

6.12 Connecting drive controllers to the power supply unit

Arranging the units horizontally

The power connections of the drive controller at the DC bus implements copper conductors and PE bridges which are generally automatically supplied.

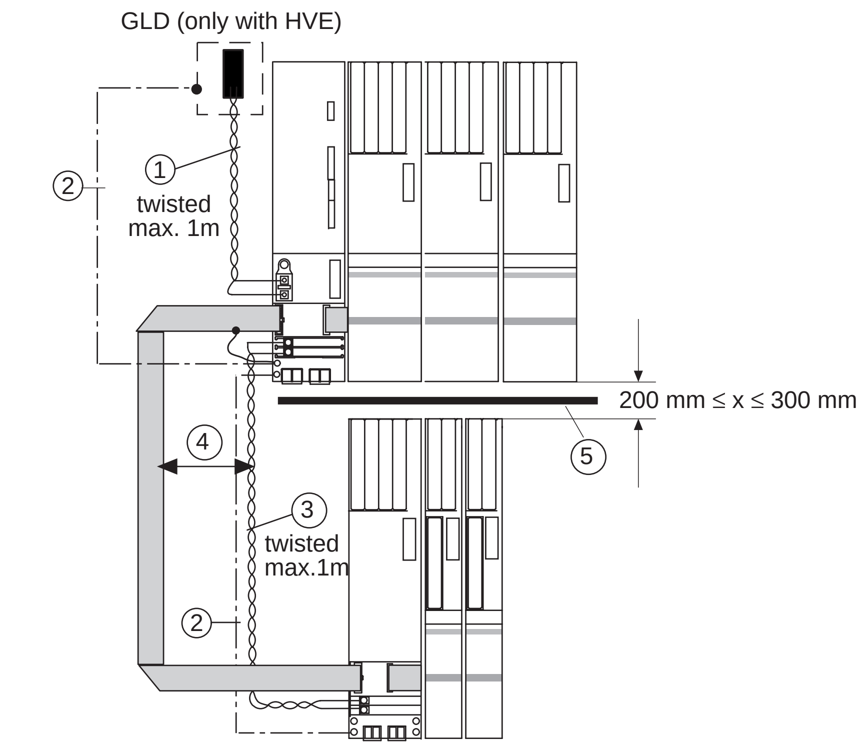
The flat-ribbon cable for the control voltage bus is permanently mounted to the units at one end. The non-mounted end is inserted into the next unit.

Arranging the units vertically

Use twisted single strands for the power connections of the drive controllers (maximum one meter length).

The ground connections of both types of units must be connected via a separate line (minimum cross section equals 10 mm^2).

The control voltage bus must be connected using INDRAMAT readymade cable INB 0647 (Length: 800 mm, Mat.No. 282300).



Line cross section	HVR02.1-W010N	HVR02.1-W025N	HVR03.1-W045N	HVE02.1-W018N	HVE03.1-W030N
1	---	---	---	10 mm^2	16 mm^2
2	10 mm^2	10 mm^2	16 mm^2	10 mm^2	16 mm^2
3	10 mm^2	10 mm^2	16 mm^2	10 mm^2	16 mm^2

4 Minimum clearance 0.1m

V04hva1b.fh7

5 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.

Fig. 6-17: Connecting the drive controllers

6.13 Additional DC bus capacitance

Reducing heat loss in the control cabinet

In installations where the feed axes must rapidly and sequentially accel and decel (e.g., nibble machines, flange grinding machines, rollers and so on), it is possible to reduce dissipated heat by using an auxiliary capacitor at the DC bus.

Traversing path after power failure

It can be advantageous to the application if, after a power failure, a specific traversing path or return action is conducted. The energy stored in the DC bus can be used for this purpose. The auxiliary capacitor increases the energy stored in the DC bus.

Maximum possible additional capacitance

Without an additional loading device, 10mF can be connected to the HVE and 20mF additional capacitance to the HVR.

6.14 HZB auxiliary bleeder module

If necessary select units form DIAX04 2nd Generation.

6.15 Loading device for the additional capacitor

If necessary select units form DIAX04 2nd Generation.

6.16 Control voltage supply

Connected voltage:	3x AC 380 ... 480 V; 50 ... 60 Hz	
Connected load:	HVE02.1-W018N	500 VA
	HVE03.1-W030N	850 VA
	HVR02.1-W010N	850 VA
	HVR02.1-W025N	850 VA
	HVR03.1-W045N	850 VA

HVE control voltage supply

The mains connections of power and control voltage supply are bridged at the time the units are delivered. As such, the control voltage supply needs no additional mains connection.

Some special cases need a separate control voltage supply (e.g., to store HVE diagnostics when powering down). This means that the bridges between the power and control voltage supply must be released. Use a short-circuit protector for the connected load of the control voltage supply (e.g. power circuit breaker 3 VU 1300 -.MJ00, 2,6 ... 4A, Siemens).

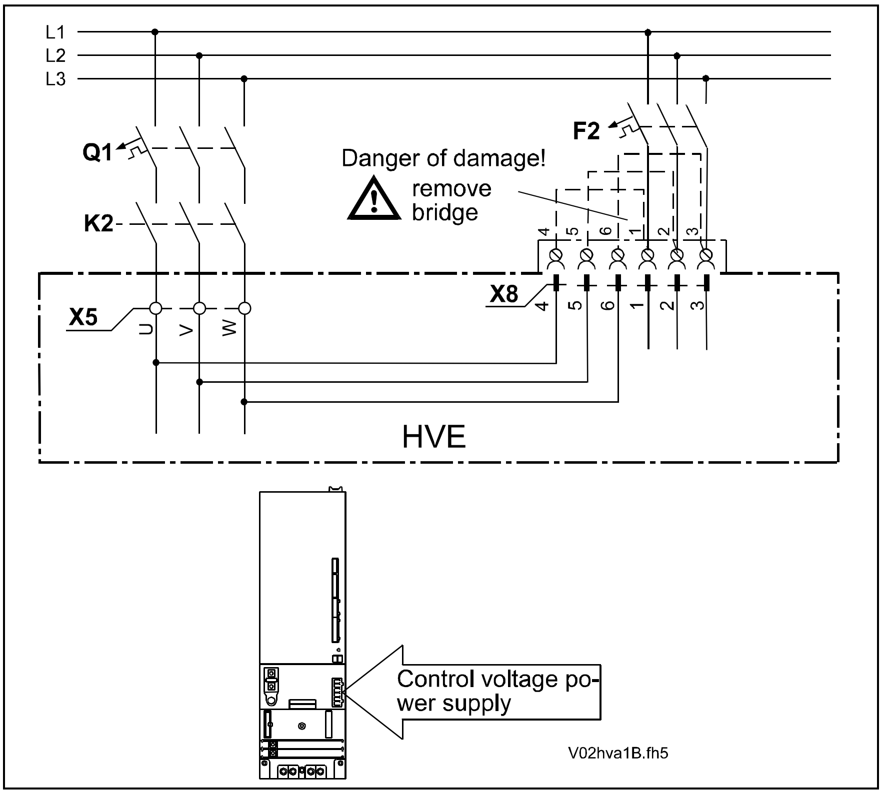


Fig. 6-18: Separate control voltage supply for the HVE

HVR control voltage supply

A separate control voltage connection is required to operate the HVR with mains hold. The control voltage must be tapped off ahead of the commutation link HZN. Power and control voltage connections must be phase coincident. Make sure that the connected load of the control voltage supply is outfitted with short-circuit protection (e.g., power circuit 3 VU 1300 -.MJ00, 2,6 ... 4A, Siemens).

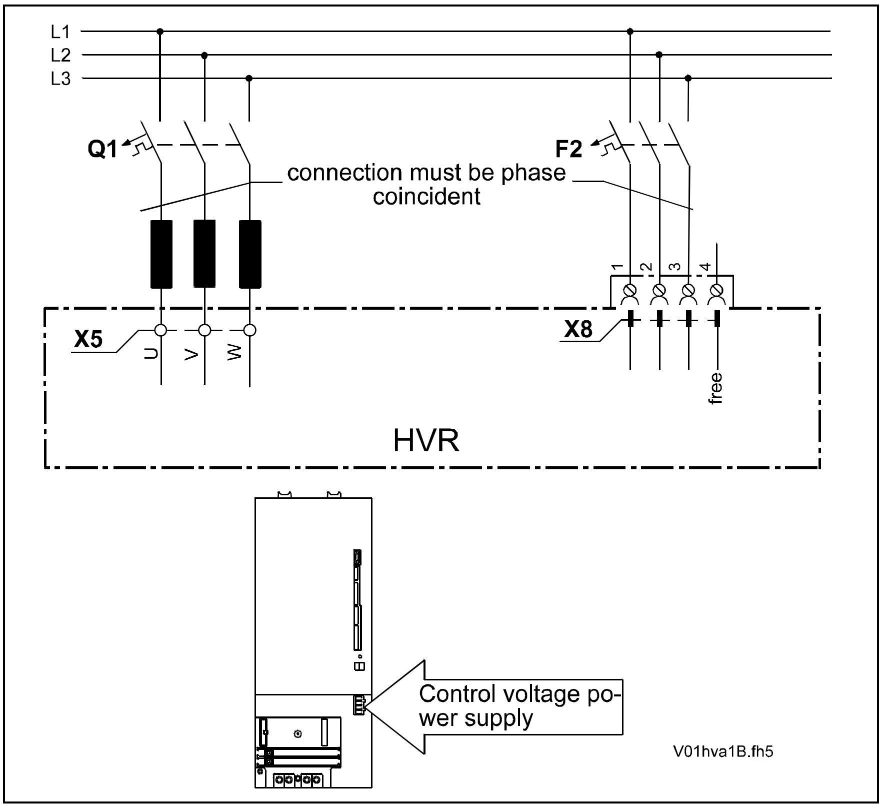


Fig. 6-19: Control voltage supply HVR

6.17 Fault current protective device

Preferrably, the overcurrent fuse (fuse, protective circuit breaker) of the installation should shutdown in the event of a casing short. If, for example, in **TT mains** a current fault protection device is urgently needed due to the excessive earth resistance, then the following should be noted.

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
- the grounding conditiions at the installation

If measures are taken to improve the electromagnetic compatibility (EMC) of the installation (mains filters, shielded lines, etc.), then the leakage currently is inevitably also increased. Fault current protective devices with nominal fault currents under 0.5 A can therefore generally **not** be used!

Note: When switching on inductances and capacitances (interference suppression filters, transformers, contactors, magnetic valves) spurious releases can occur.

⚠ **WARNING**

Commercial, pulse-current sensitive, fault current protective devices do not sufficiently guarantee the protection of electronic equipment with three-phase bridge circuits (e.g., the HVE and HVR). The protection of electrical equipment, connected with other equipment via a three-phase bridge circuit to a fault current protective device is impaired. Pulse-current sensitive, fault current protective devices only recognize a.c. and pulsating d.c. fault currents which periodically go to zero**.**

Electrical shock in the event of a fault is possible!

⇒ Use either fault current protective devices that also shutdown with d.c. fault current as well or install an isolating transformer in the power supply line.

Use isolating transformers that match the overcurrent protective device to the impedance of the fault loop that can initiate a shutdown with a fault. The star point of the secondary winding must be connected to the protective circuit of the installation.

6.18 Earth leakage monitor

Note: 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 inserted. The star point of the isolating transformer and the PE connection of the power supply unit must be applied to the same potential.

6.19 Control cabinet check

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.

6.20 Heat loss in the control cabinet

Heat losses occur in the HVE and HVR due to control voltages, power loss and bleeder loss, in some cases.

Basic losses

Basic losses equal:

125 W	in the	HVE02.1-W018N
175 W	in the	HVE03.1-W030N
175 W	in the	HVR...

Power losses

Per kW continuous DC bus power:

HVE02.1-W018N	HVE03.1-W030N	HVR02.1-W010N	HVR02.1-W025N	HVR03.1-W045N
7W/kW	6W/kW	15W/kW	24W/kW	24W/kW

Bleeder losses in the HVE

Bleeder loss is dependent on the rotary drive energy, the potential energy of uncompensated masses and the machine cycle which has been programmed (see 4.4).

6.21 Front view - HVE

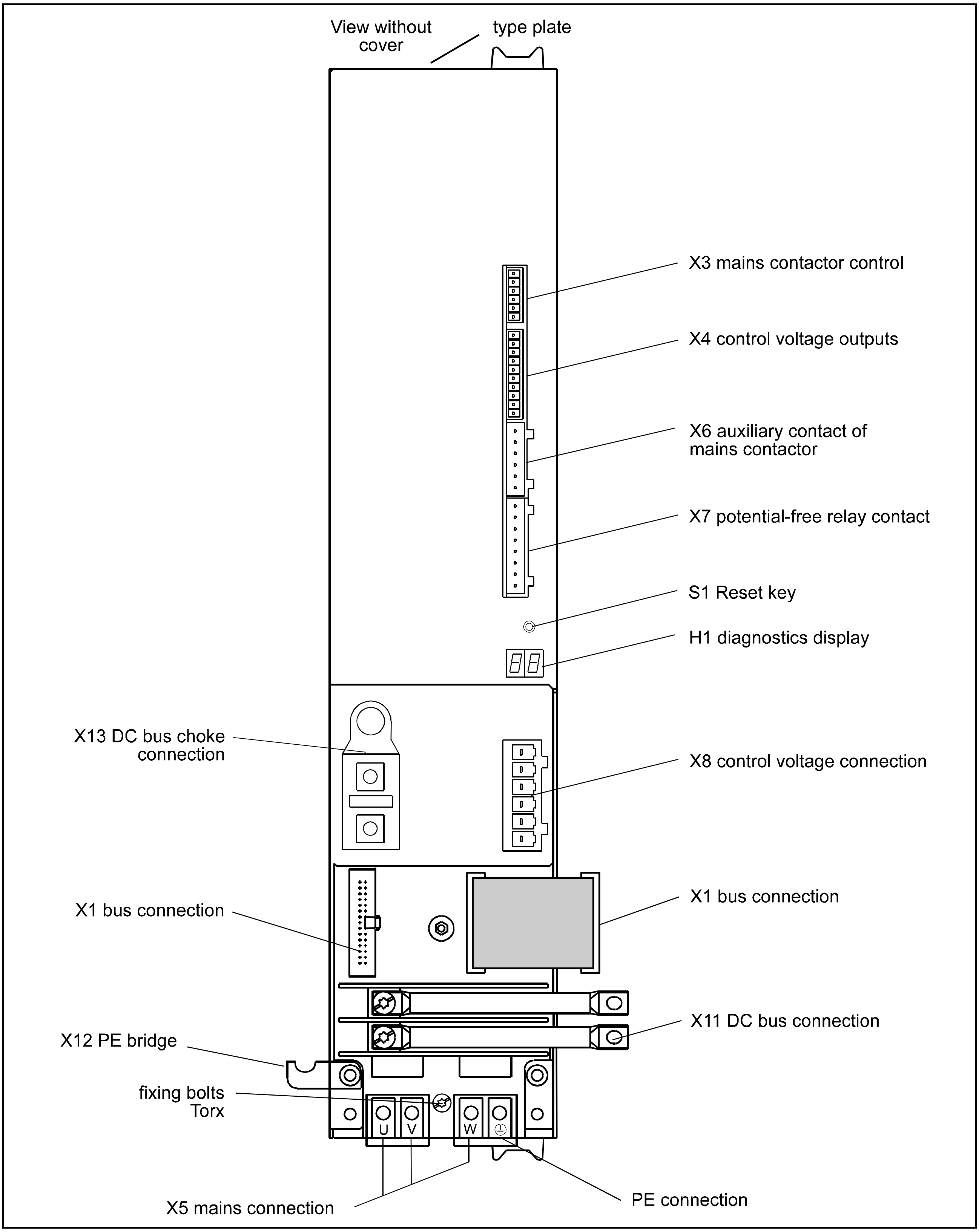


Fig. 6-20: Front view - HVE

6.22 Front view - HVR

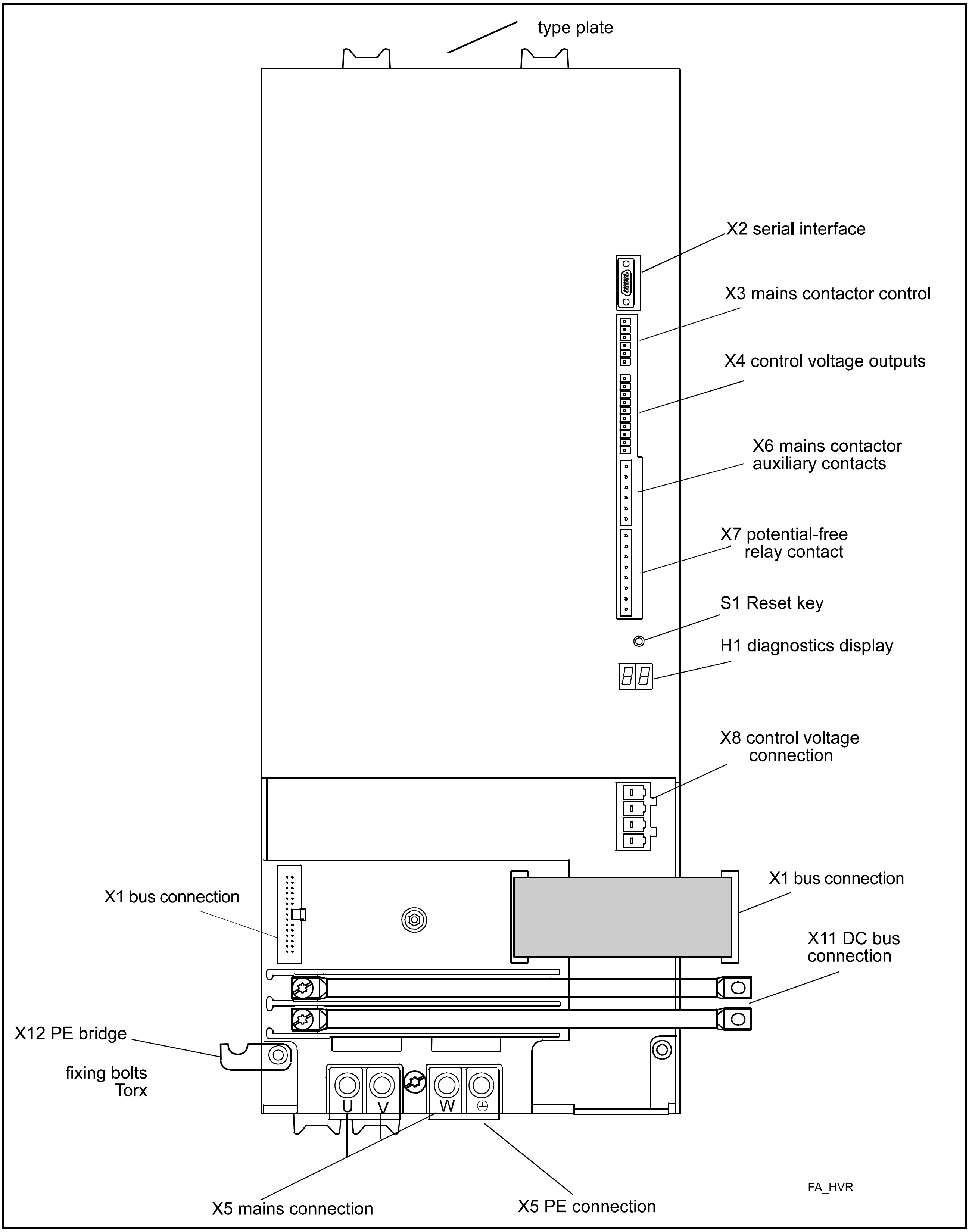


Fig. 6-21: Front view - HVR

6.23 Interference elimination

Interference emission

To maintain class B limit values (interference suppression N) as per EN 55011 / 3.91 and table 1 per DIN EN 55014, 1987 edition 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.

Optimal EMC installation

A spatial separation of the interference - free area (mains connection) and areas subject to interference (drive components) is recommend as shown.

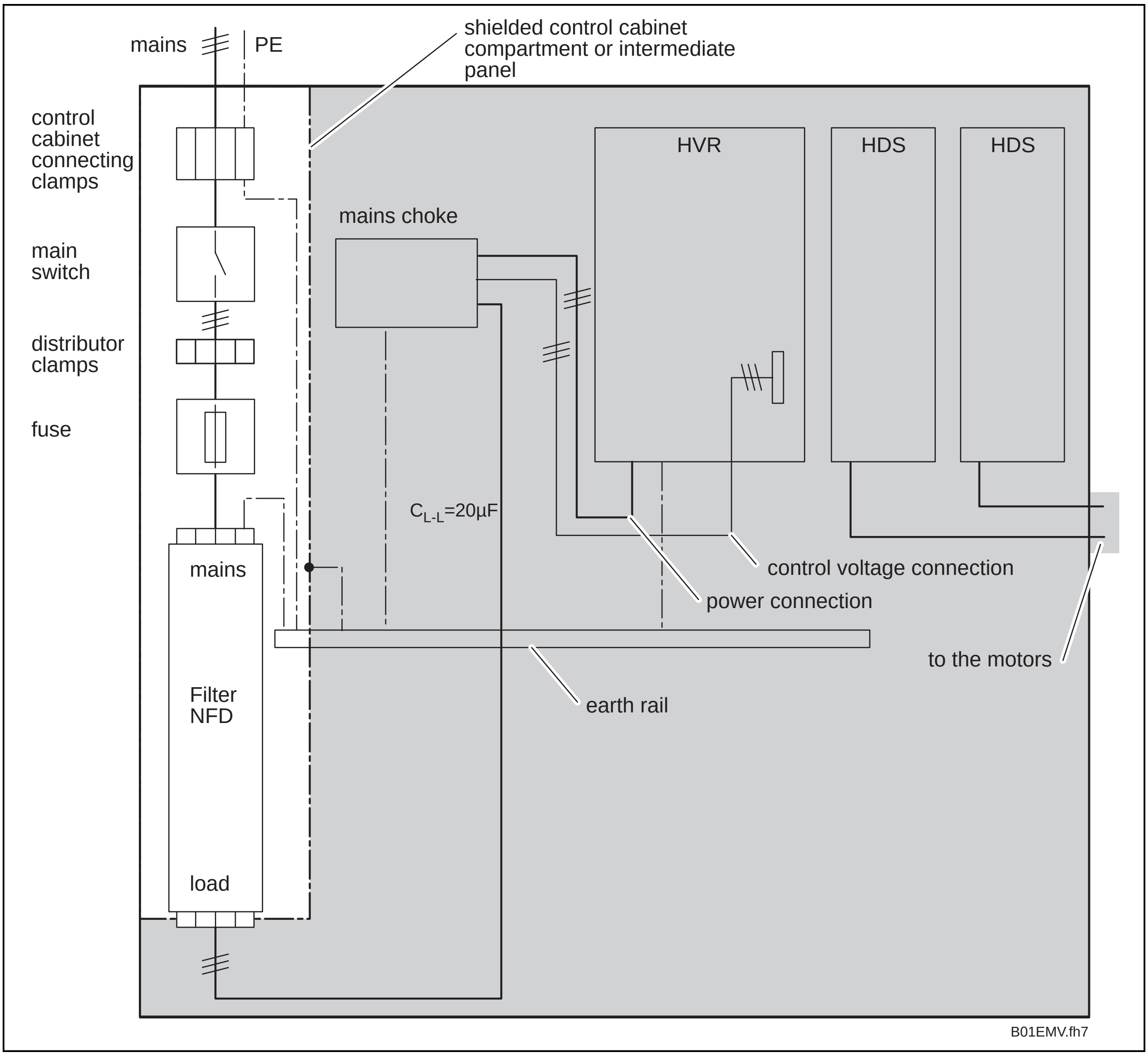


Fig. 6-22: Separation of interference - free and interference - subject areas

Resistance to interference

INDRAMAT 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 10cm 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^o only.
- Inductive loads such as contactors, relays, magnetic valves should only be operated with overvoltage limiters.
- Ground drive controllers as per INDRAMAT guidelines.

Supplementary documentation

See „Electromagnetic Compatibility (EMC) in AC Drives“, doc. type: DOK-GENEREL-EMV********-PRJ_-EN-P

7 Control of the mains contactor in the supply unit

The mains contactor and DC bus dynamic brake controls in the power supply unit recommended by INDRAMAT represent the basic functional principle. In this chapter, several control options are discussed and explained. 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.

7.1 Control options

Shutdowns with faulty drive electronics with or without DC bus dynamic brake

The DC bus voltage is short-circuited as additional safety device for shutting down drives in the event of faults in the drive electronics.

The DC bus dynamic brake always shuts down motors with permanent magnetic excitation regardless of whether the drive electronics are still functional or not.

Without DC bus dynamic brake, motors with permanent magnetic excitation will coast uncontrolled in the event of electronic problems in the drive.

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

Braking with emergency stop or power failure at maximum torque or position-controlled with NC control

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

Given an emergency stop or with actuation of the drive-internal monitor, the drive control command vaue to zero is set 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 or given the actuation of the drive-internal monitor, the drives are shutdown position-controlled by the NC control.

7.2 Controlling the power supply unit with emergency stop relays with DC bus dynamic braking

This control variant achieves a high level of safety with little effort. The drive system monitors are most effectively used.

Applications

- If the emergency stop circuit must be duplicated or if, e.g., a safety monitor is required,
- 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.

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 engaged with drive a fault. This means that if the emergency stop relay is deactivated, even asynchronous drives will 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

Danger from uncontrolled drive motions!

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.

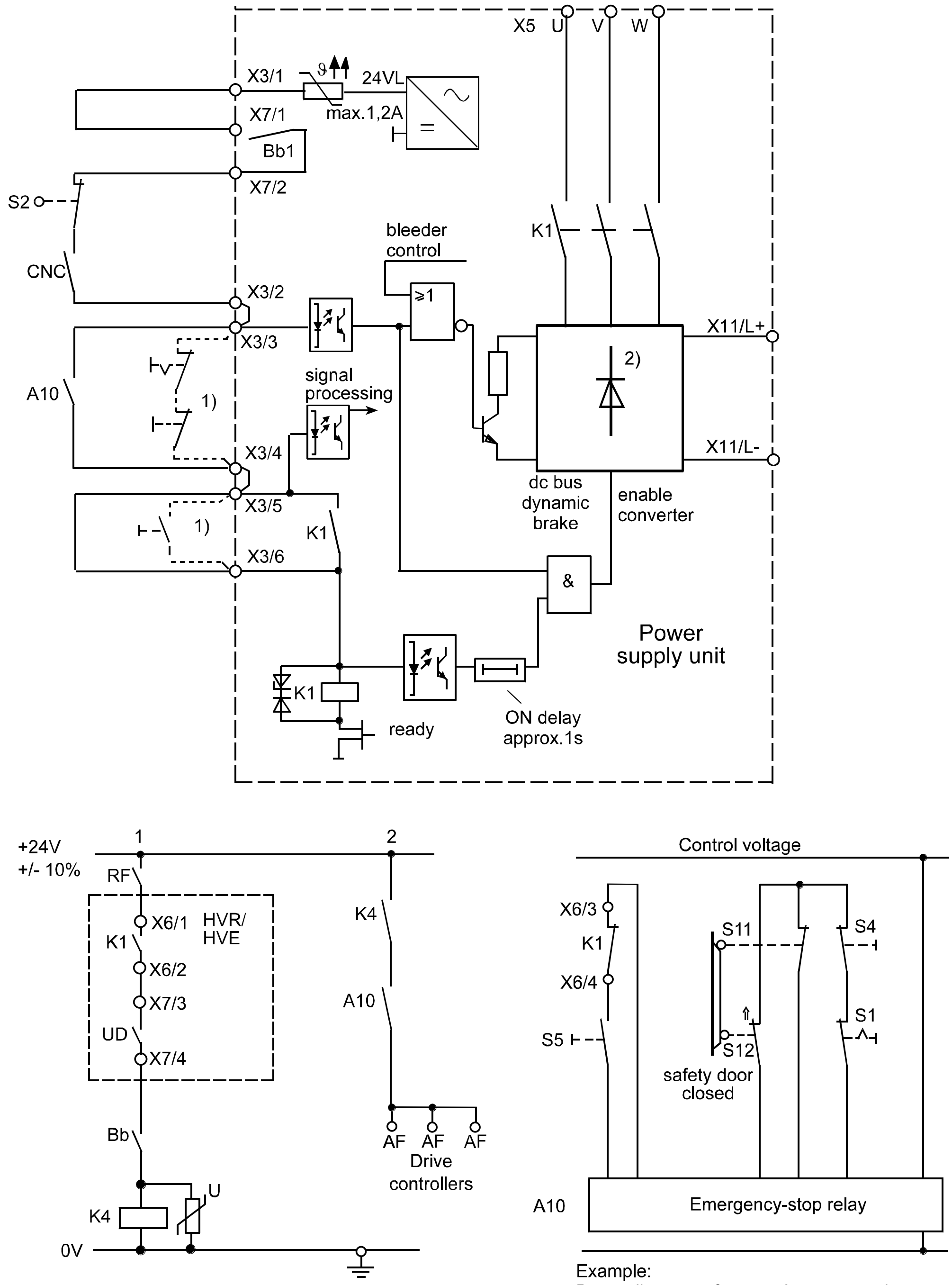
⇒ Additional monitoring and protective devices should be installed in the installation.

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.

• with DC bus dynamic brake if drive electronics fail



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 = ready - drive controllers
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 = E-stop
S2 = axis end position
S4 = power OFF
S5 = power ON

SS2HVR

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

Fig. 7-1: Power supply unit control with DC bus dynamic brake

7.3 Controlling the power supply unit without DC bus dynamic brake

Application

If an uncontrolled running out of the drives cannot damage the installation.

Typical applications:

- if only asynchronous drives are connected to the power supply unit and
- if the end positions of the feed axes is sufficiently attentuated.

Features

The DC bus voltage is **not short-circuited.** The DC bus dynamic brake has no additional braking affect in asynchronous drives given a fault in the drive electronics. Once the DC bus voltage is short-circuited, then asynchronous drives can no longer be shutdown in a controlled manner.

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

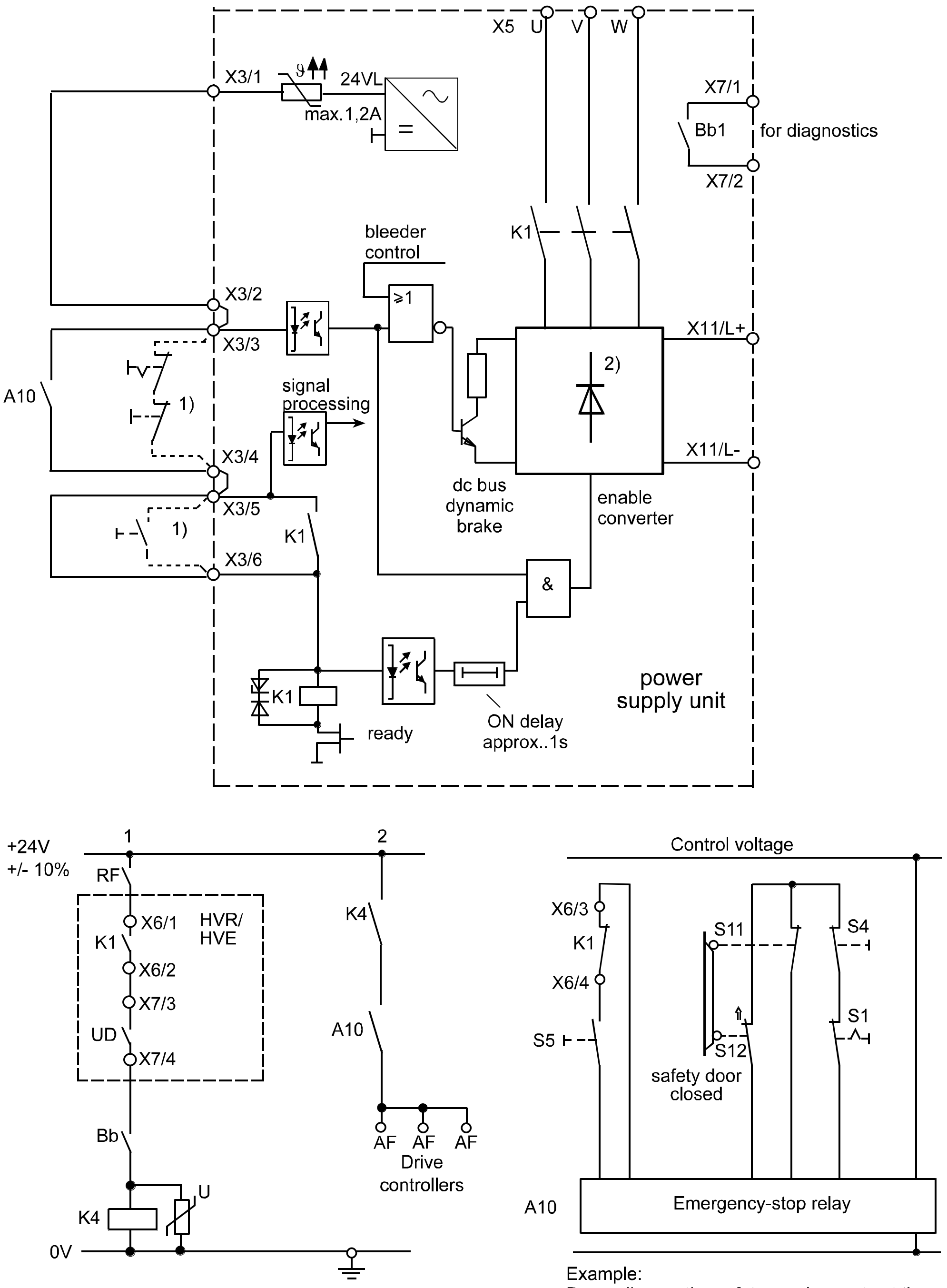
There drives run out uncontrolled if there is a fault in the drive electronics!

Machine damage is possible!

⇒ Use motors with mechanical brakes.

⇒ End positions of feed axes must be sufficiently attenuated.

• without DC bus dynamic brake



Example:
Depending on the safety requirements at the machine, additional monitors and locks may be required!

A10 = Emergency-stop relay
AF = drive enable of the drive controllers
Bb1 = power supply module ready (drive system)
Bb = drive controller ready
K1 = mains contactor in power supply
K4 = drive enable control
RF = drive enable signal of the control
S1 = E-stop
S4 = power OFF
S5 = power ON
S11/S12 = safety door monitor

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

SS3HVR

Fig. 7-2: Controlling the power supply unit without DC bus dynamic brake

7.4 Controlling the power supply unit with a position-controlled shutdown of the drives

Application

Generally with electronically-coupled drives that must be synchronously shutdown with a power failure.

Features

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

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.

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.

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

If the DC bus voltage is too low then it may not be possible to shut the drives down in a controlled manner.

Machine damage with an uncontrolled shutdown of the drives is possible.

⇒ If the UD contact is triggered then the positioning control must shut down the drives position controlled.

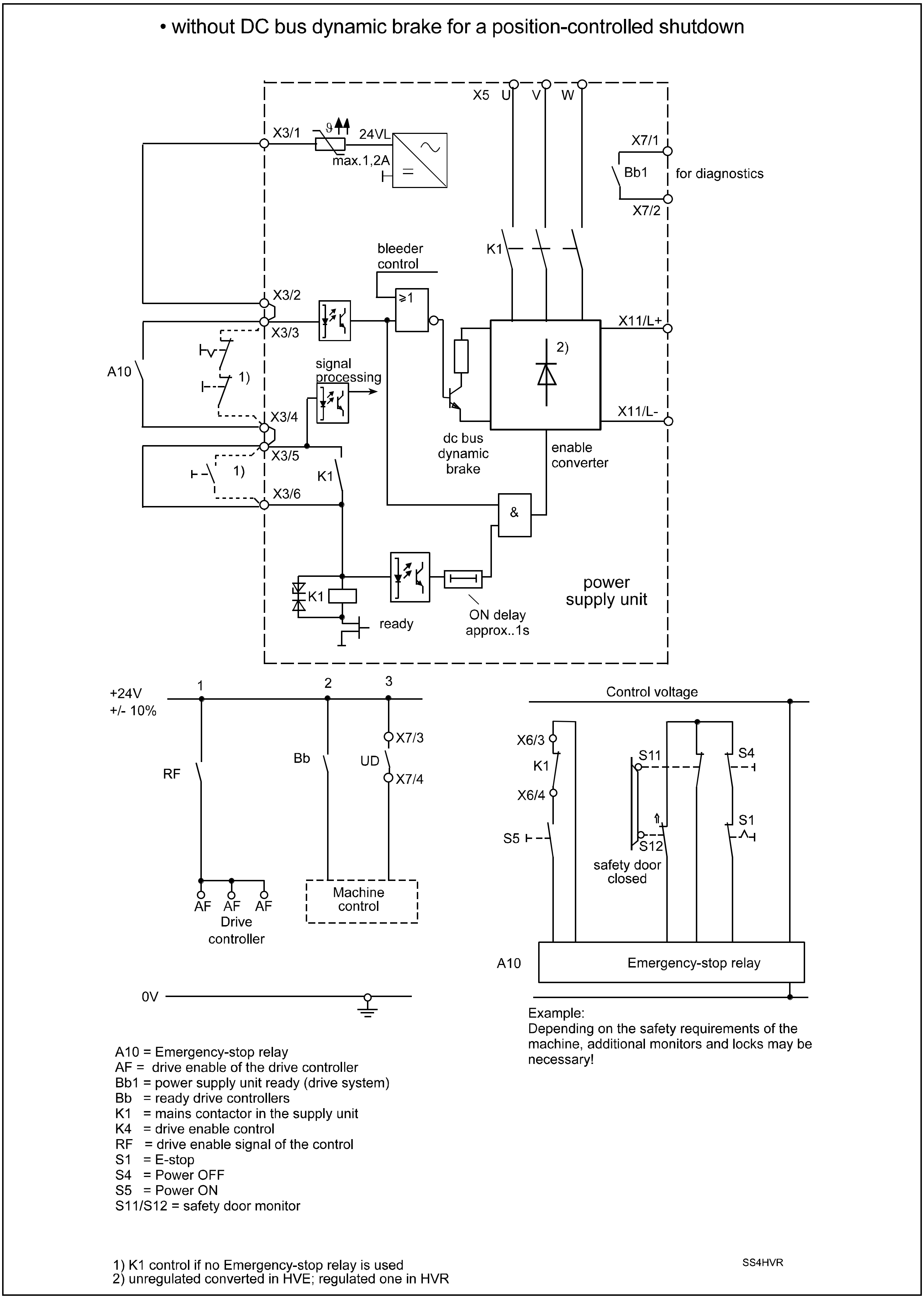


Fig. 7-3: A position-controlled shutdown of the drives

8 Control interfaces of installation

8.1 DC bus dynamic brake

The DC bus dynamic brake is activated via plugin terminal X3 and the mains contactor of the power supply unit is connected.

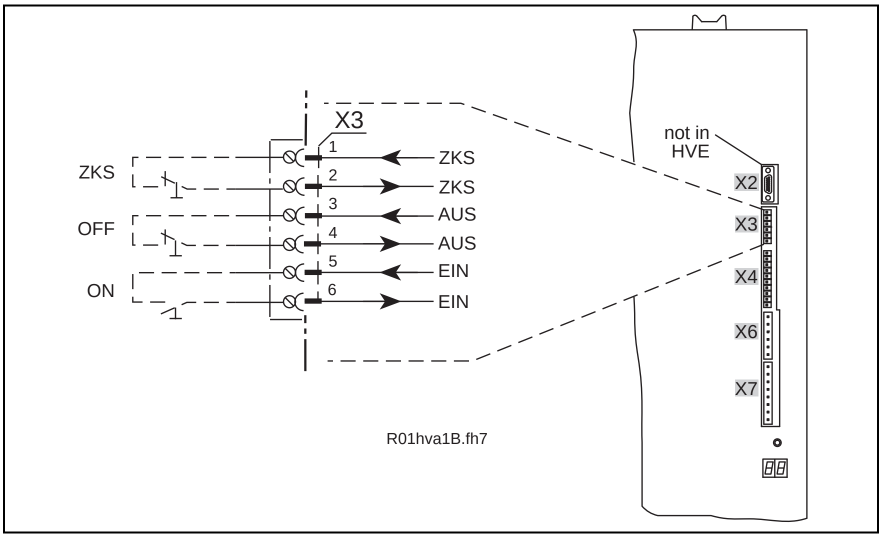


Fig. 8-1:Terminal assignment - X3

Voltage DC 24V

Current consumption **Break-away starting current**:

8 A (HVE, HVR)

Holding current:

450 mA (HVE)

1 A (HVR)

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.

Only if the DC bus input is closed can the power contactor in the power supply unit be switched on.

WARNING

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.

There is danger to personnel depending on the type of machine!

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

Number of switching actuations Maximum 16 operating cycles per minute (without auxiliary capacitance and drive speed is zero).

$$z = \frac{2 \cdot P_{ZK}}{2C_{Zu} \cdot U_B^2 + J_g \cdot \omega^2} \cdot 60$$

U_B = bleeder actuating threshold = 820V
C_{zu} = DC bus capacitance in F
J_g = total moment of inertia in kgm^2
P_{ZK} = power of the DC bus dynamic brake resistor in W 1000W in HVE02 and HVE03
400W in HVR02 and HVR03
ω = angular speed in rad/s
z = number of switching actuations per minute, but max.16/min

Fig. 8-2: Number of switching actuations with aux. capacitance and rotating motor

8.2 Power OFF

Only with closed input Power OFF can the power contactor in the power supply unit be switched on. If input Power OFF is open, then the power contactor in the power supply unit is immediately switched off.

Terminal assignment, voltage and current consumption, see 8.1.

Number of switching actuations Maximum 16 operating cycles per minute.

8.3 Power ON

With power OFF input on and unit-internal ready to operate, the power contactor in the power supply unit is switched on if input Power ON is closed. The ON impulse must be applied for at least 200 ms.

Terminal assignment, voltage and current consumption, see 8.1

Number of switching actuations Maximum 16 operating cycles per minute

Service life 1 million operating cycles in the HVE

1 million operating cycles in the HVR

8.4 Control voltages

Control voltages 24VL 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. Do not exceed maximum permisible load to not endanger the drives.

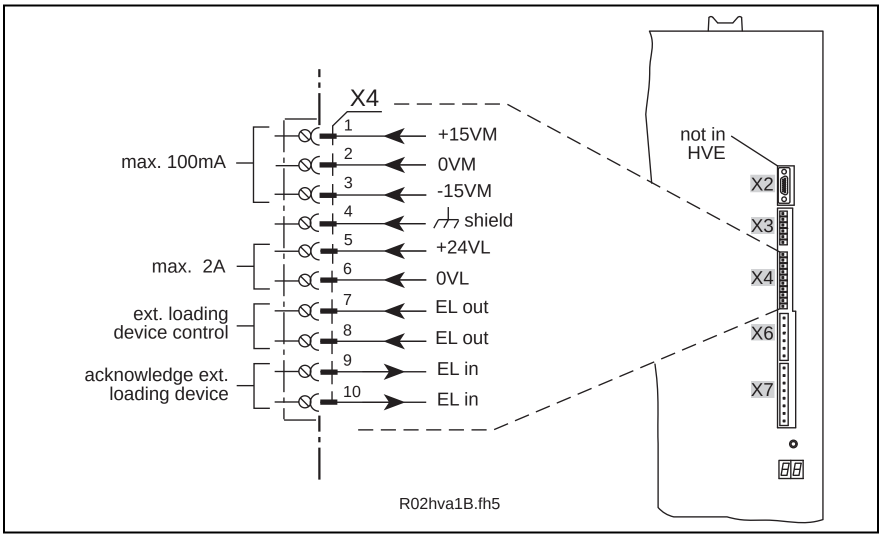


Fig. 8-3: Terminal assignment X4

8.5 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.

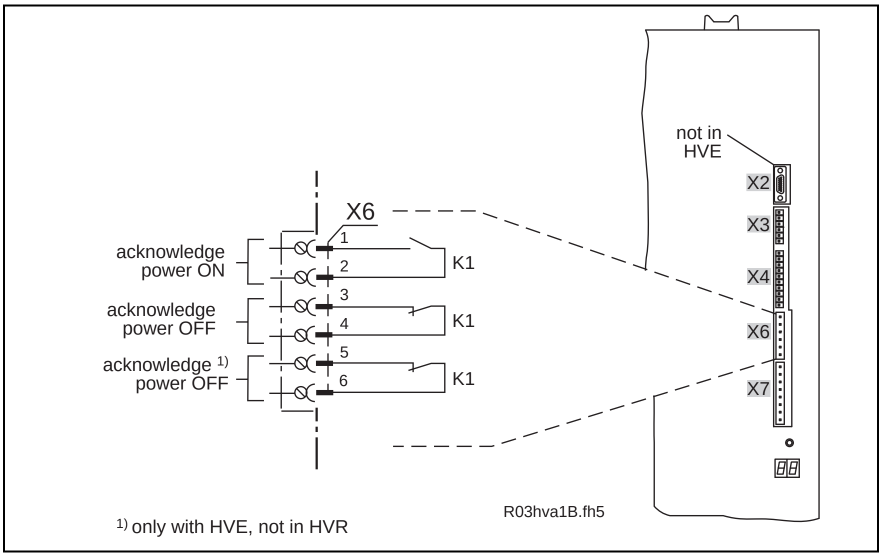


Fig. 8-4: Terminal assignment X6

Contact load

Continuous current:	DC 24V/1A	AC 220V/1A
Starting current:	DC 24V/1A	AC 220V/1A

DANGER

DANGER of voltage transmission between various potentials!

Electrical shock upon contact.

⇒ The contacts of terminals X6 and/or X7 may not be applied to different voltage potentials. Apply only identical voltages.

8.6 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.

Two N/Cs that acknowledge power OFF are conducted outwards in the HVE.

Terminal assignment and contact load, see 8.5.

8.7 Ready to operate

Output 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 after it is closed, will the internal locks permit the mains contactor in the power supply unit to be switched on.

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 closes if the control voltage at terminal X8 is applied and no error is pending.

The Bb1 contact opens with the following faults:

- faults in the power supply unit
- faults in the drive controller (power off must be parametrized)

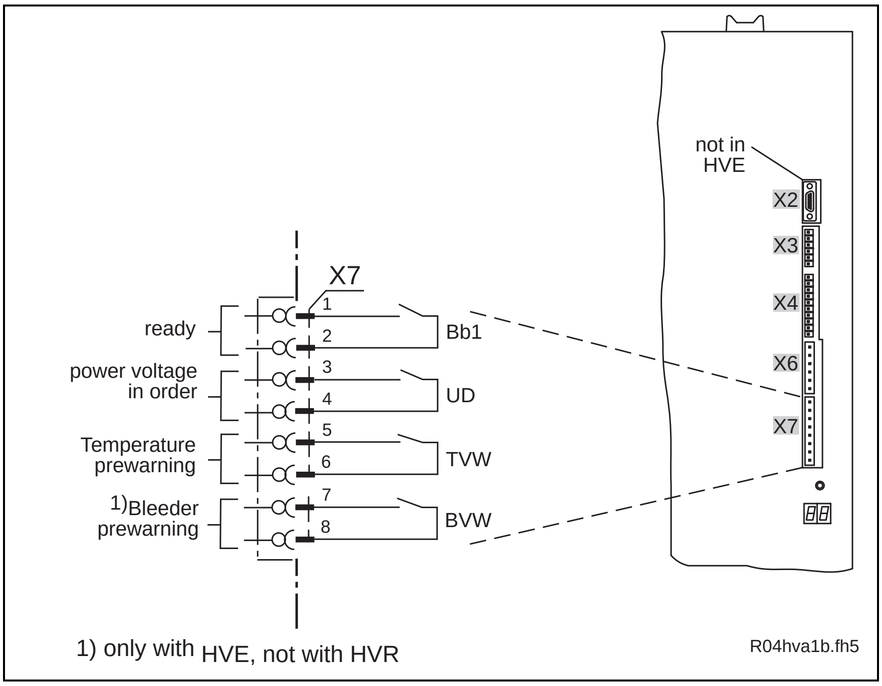


Fig. 8-5: Terminal assignment X7

Contact load

		HVE		HVR
	Continuous current:	DC 24V/1A	AC 250V/1A	DC 24V/1A
	Starting current:	DC 24V/1A	AC 250V/1A	DC 24V/1A

8.8 Power supply in order

Output 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 smaller than permissible minimum value

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.

Terminal assignment and contact load, see 8.1.

8.9 Temperature prewarning

Output TVW

The temperature prewarning contact opens if cooling temperature is too high. The mains contactor in the power supply unit interrupts the power supply after 30 seconds and the Bb1 contact opens.

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.

Terminal assignment and contact load, see 8.1.

8.10 Excessive regenerated power

Note: The message **excessive regenerated power** is only available with the HVE. In the HVR, this is signalled by the temperature prewarning contact.

Output BVW

The bleeder prewarning contact opens if continuous regenerated power exceeds 80% of the continuous bleeder power. If it continues to climb, then the mains contactor in the HVE will interrupt the power supply and the Bb1 contact will open.

Terminal assignment and contact load, see 8.1

8.11 Serial interfaces on the HVR

The serial interface on the HVR cannot presently be accessed.

9 Fault Clearance

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 INDRAMAT 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.

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 +24V, ± 15V and +5V 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
- or switching the control voltage off.

Checking and Repairing

If either checks or repairs are needed, then it applies:

- Checks and repairs may only be conducted by INDRAMAT customer service personnel or such personnel that has been trained to do so.
- Maintain safety measures when checking or repairing.
- Repairing drive components on the machine is very time consuming. Replace defective drive components completely.

WARNING

Increased danger potential with faults!
Injury to personnel and machine damage is possible.
⇒ Fault clearance should only be conducted by trained personnel.
⇒ Protective devices must not be switched off.
⇒ Note the warnings in section 2.

Contacting INDRAMAT Customer Service

In the interest of a rapid and effective processing, we would request that the following information be handy at the time of contact:

- type designations and serial numbers of units and motors
- the status of the fault
- any diagnostic displays
- software status, if necessary

Telephone number

INDRAMAT customer service can be reached Mondays through Fridays at 09352/40 -4894, -4922, -4592 or -4808.

Service Hotline

The Service Hotline can be reached at 0172/ 66 00 406 or 0171/ 33 38 826 during the following hours.

Mondays through Fridays	17.00 - 23.00
Saturday	8.00 - 20.00
Sundays and holidays	9.00 - 19.00

9.1 Overview of diagnostic displays

Anzeige DISPLAY	Bedeutung ACCEPTATION	Erläuterung EXPLANATIONS
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.
16	- Softstartfehler - - SOFTSTART-FAULT -	DC bus cannot be loaded.
17	- Leistung Aus / Zwischenkreis-Kurzschluß - - 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 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 auxiliary unit (bleeder, loading device)
25	- Rückspeise-Überlast - - REGEN. POWER OVERLOAD -	Continuous regenerated power of the drives excessive
26	- Einspeise-Überlast - - BUS POWER OVERLOAD -	The continuous feedin power of the drive excessive
50	- Kühlkörper-Übertemperatur-WARNUNG - - HEATSINK TEMP. WARNING -	Tempertaure prewarning contact is open. Power off in 30 seconds
60	- Überstrom - 1) - OVERCURRENT -	Short-circuit in supply or drive in motor or in a cable
69	- +24V / ±15V / +5V fehler - - +24V / ±15V / +5V FAULT-	Control voltages faulty
80	- Ground fault - - 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.
83	- Netzspannungsfehler - 1) - LINE VOLTAGE FAULT -	Mains voltage exceeds permissible tolerance.
84	- Anschlußfehler - 1) - MISWIRING -	No phase coincidence in power and control voltage connections
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
– –	- +5V Fehler 2) - +5V FAILURE -	+5V control voltage fault

Fig. 9-1: Overview of diagnostic displays

1) HVR only

2) HVE only

9.2 Position of diagnostic display and reset key

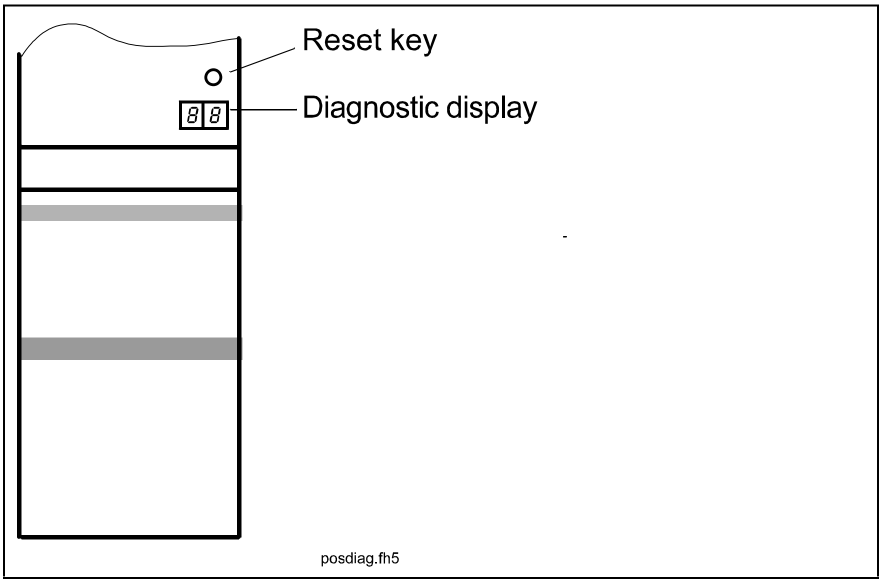


Fig. 9-2: Position of diagnostic display and reset key

9.3 Diagnoses - Definition and causes

bb

Ready to receive power

Supply unit and drive controller are ready. Power contactor has dropped off.

Possible cause: OFF or emergency stop key was actuated.

Recovery Switch power contact on.

Possible cause: Faulty control (if power can basically not be switched on).

Recovery Check control - at X3/6 for at least 200ms +24V must be applied.

Lb

Power ready

DC bus voltage within permissible range. The power supply unit is ready to supply power.

. .

Unit fault

Hardware or software error in unit

Possible cause: Processor error in HVR; circuit error in HVE

Recovery Switch control voltage off and on. If error still present, replace unit.

– –

+5V error HVE only !

+5V control voltage is faulty

Possible cause: Unit fault

Recovery Replace unit

16

Softstart error

The DC bus cannot be loaded.

Possible cause: Short-circuit in supply unit or drive controller.

Recovery Release connections to drive controller and switch power on again. Replace unit, if necessary.

Possible cause: Too many auxiliary capacitors have been connected.

Recovery Reduce the number of aux. capacitors or use a separate loading unit.

Possible cause: interrupt DC bus choke (with HVE only)

Recovery DC bus choke and lines must be check, replaced if necessary

17

Power OFF with DC bus dynamic brake

The power contactor has dropped off. The DC bus dynamic brake was activated.

Possible cause: The control of the installation has triggered a DC bus dynamic braking action.

Recovery Check the emergency stop sequence of the installation.

18

Heatsink temperature too high

Power shutdown due to excessive heatsink temperature.

Possible cause: The unit is overloaded or the ambient temperature is too high.

Recovery Load and ambient temperature must be checked. Evaluate prewarn contact of unit.

20

Bleeder overload

Power off due to excessive bleeder load

Possible cause: In the HVR, the regenerated drive energy with power off is too big.

Recovery Reduce drive speed. Switch power OFF or emergency stop in a delayed fashion.

Possible cause: In the HVE, the continuous regenerated power and/or rotary drive energy is too high.

Recovery Increase cycle time, reduce drive speed, install auxiliary bleeder.

Possible cause: Defective unit.

Recovery Replace unit

23 **Drive error:** Error not stored.

Possible cause: A drive controller has detected a fault in the unit, motor or line connections.

Recovery Diagnostic display of drive controller must be checked.

24 **Auxiliary component error**

Possible cause: An error was detected in an auxiliary component, such as auxiliary bleeder, control voltage power section or separate loading device.

Recovery Auxiliary components must be checked.

25 **Regenerated overload:** Error not stored !

Possible cause: The regenerated power of the drive is excessive.

Recovery Reduce permissible delay. Use drive controller with smaller peak current.

26 **Power feed overload :** Error only stored for 500ms!

Possible cause: The feedin power required by drive is excessive!

Recovery Reduce permissible acceleration. Use drive controllers with smaller peak current.

50 **Heatsink overtemperature-prewarning**

The permissible heatsink temperature has been reached. The temperature prewarning contact has opened. Power off in 30s!

Possible cause: Excessive load, ambient temperature too high, cooling air flow blocked, blower in the unit defective.

Recovery Reduce load, reduce control cabinet temperature, unblock cooling air flow, replace unit.

60 **Overcurrent** HVR only!

Possible cause: Short circuit in supply unit, drive controller, motor or cable.

Recovery Release power connections to the drive controllers step by step. Replace defective unit.

69

+24V / ±15V / +5V Fault

Interference in control voltages.

Possible cause: Maximum permissible load has been exceeded.

Recovery Release bus connections to drive controllers step by step.

Possible cause: Short circuit in wiring if control voltages used outside of drive system.

Recovery Release control voltage taps and check for short circuit.

Possible cause: Unit defective.

Recovery Replace unit.

80

Ground fault

Possible cause: Ground fault in power supply unit, drive controller, motor or cable.

Recovery Release power connections to the drive controllers step by step. Replace defective unit.

81

Power failure HVR only !

Possible cause: At least one phase of the mains supply is missing.

Recovery Check mains fuses and replace, if necessary.

82

Phase Fault HVE only!

Possible cause: At least one phase is missing the the mains supply.

Recovery Check mains fuse and replace, if necessary.

83

Mains voltage fault HVR only!

Possible cause: Mains voltage exceeds permissible tolerance (3x 380 ... 480V, ± 10 %)

Recovery Check mains voltage, use matching transformer if necessary.

84

Connection fault HVR only!

Possible cause: Power and control voltage connections not phase coincident

Recovery 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.

85

Mains frequency fault HVR only

Possible cause: Mains frequency exceeds permissible tolerance (± 2Hz).

87 **Control voltage supply fault** HVE only!

Possible cause: The control voltage supply of the HVE exceeds permissible tolerance (3x 380 ... 480V, ± 10 %).

Recovery Check mains fuse in control cabinet and replace, if necessary.

94 **EPROM Fault** HVR only!

Possible cause: Unit fault

Recovery Replace unit.

9.4 Replacing the unit

Replacing the unit requires, depending upon unit weight, a lifting device and an identical replacement unit.

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. Motors must be standing still. Secure vertical axes against motion.

3. Using type plate check whether both units are the same type. Replace a unit only with an identical type.

4. Release all connections from the defective unit.

5. Release the fixing bolts and remove the unit from the control cabinet. Use the lifting device, if necessary.

6. Hang replacement unit into mounting rails. Use lifting device!

7. Reconnect the unit **as per the terminal diagram of the machine manufacturer.**

8. If vertical axes have been mechanically secured prior to replacement, then remove these devices at this point.

This completes the replacement. The installation can now be restarted.

10 Order information

10.1 Available options

Unit designation / unit type	Explanations	Selection data, see section
Power supply unit HVE02.1-W018N	- 13kW continuous DC bus power at 3x AC 400V (without DC bus choke GLD) - 19kW continuous DC bus power at 3x AC 400V (with DC bus choke GLD) - without mains regeneration	3.2
Power supply unit HVE03.1-W030N	- 19kW continuous DC bus power at 3x AC 400V (without DC bus choke GLD) - 30kW continuous DC bus power at 3x AC 400V (with DC bus choke GLD) - without mains regeneration	3.2
Power supply unit HVR02.1-W010N	- 10kW continuous DC bus power (control gear HZN02.1-W010N or KD 30-D required) - with mains regeneration	3.4
Power supply unit HVR02.1-W025N	- 25kW continuous DC bus power (commutation choke KD 27-D required) - with mains regeneration	3.4
Power supply unit HVR03.1-W045N	- 30kW continuous DC bus power (commutation choke KD 28-D required) - with mains regeneration	3.4
DC bus choke GLD 13	option for HVE02.1-W018N	3.2
DC bus choke GLD 12	option for HVE03.1-W030N	3.2
commutation choke KD 30-D	accessories for HVR02.1-W010N	3.4
commutaton choke KD 27-D	accessories for HVR02.1-W025N	3.4
commutaton choke KD 28-D	accessories for HVR03.1-W045N	3.4
SUP-M01-HD	mounting parts/components	
SUP-E01-HVR	auxiliary capacitors for connecting HVR units via transformers to the mains	6.3
SUP-E02-HVR	auxiliary choke and capacitors; needed for control gears of a transformers in front of HVR02.2-10	6.3
SUP-E03-HVR	auxiliary choke and capacitors; needed for control gears of a transformers in front of HVR02.2-25	6.3
SUP-E04-HVR	auxiliary choke and capacitors; needed for control gears of a transformers in front of HVR03.2-45	6.3

11 Index

A

Acknowledge power OFF 8-4
Acknowledge power ON 8-3
Ambient temperature 3-6, 3-7, 3-8
Applications 3-1
Arrangement 5-1
Asynchronous drives 7-4
Auxiliary capacitance 4-5
Average motor speed 4-1

B

Basic losses 6-19
Bb1 contact 8-4
Bleeder 1-2
Bleeder losses 6-19
Bleeder overload 9-4
Bleeder prewarning contact 8-5
Bleeder resistor 3-1, 5-2
Break-away starting current 8-1

C

capacitance 6-16
Charging current limits 3-2
Checking 9-1
Coincidence factor 4-3
Commutation choke 6-10
Conditions of use 3-6, 3-7, 3-8
Connected load 4-8
Connection fault 9-6
Contact load 8-3, 8-5
Continuous bleeder power 4-6
Continuous power 4-1, 4-6
Continuous regenerated power 4-6, 8-5
Control 7-1
Control voltage output 3-7
Control voltage power 4-8
Control voltage supply 3-6, 3-7, 4-8, 6-17
Control voltages 8-2
Current regeneration 3-1
Customer Service 9-1

D

Data sheet - HVE 3-6
Data sheet - HVR 3-7
DC bus choke 3-3, 6-11
DC bus continuous output 3-6, 3-7
DC bus continuous power 4-1, 4-3, 4-4, 6-11
DC bus dynamic brake 1-2, 1-3, 7-1, 7-2, 8-1
DC bus peak output (for 0.3s) 3-6, 3-7
DC bus peak power 4-4
Degree of dirt contamination 3-6, 3-7
Diagnoses 9-3
Diagnotic displays 9-2
Dimensional data - HVE 5-6
Dimensional data - HVR 5-7
Drive error 9-5

E

Earth leakage monitor 6-19
Effective motor torque 4-1
Electrical connections 6-1
Emergency stop relay 7-2, 7-4
End limit switch 7-2
Energy 4-6
Energy content 4-4
Energy regenerated 3-1
Energy storage 4-5
EPROM-Fault 9-7

F

Fault current protective device 6-18
Fault diagnostics 9-1
Fault search 9-1
Frequency 3-6, 3-7
Front view - HVE 6-20
Front view - HVR 6-21
Fusing 6-8

G

GLD 3-3, 6-11
Ground fault 9-6
Grounding 6-9

H

Heat loss 6-16, 6-19
Heatsink overtemperature 9-5
High-voltage check 6-19
Holding currrent 8-1
Humidity 3-6

I

INDRAMAT Customer Service 9-1
Input voltage 3-6, 3-7
Installation elevation 3-6, 3-7, 3-8
Installation instructions 6-1
Installation protection 8-1
Interfaces 8-1
Interference elimination 6-22

Interference emission 6-22
Interference suppresion 6-22
Interference suppression filter 6-10
IT mains 6-9, 6-19

L

Layout 4-1
Leakage current 6-5
Leakage currents 6-18
Lowering 4-6

M

Mains connection power section 6-4
Mains current 4-8
Mains frequency 6-4
Mains frequency fault 9-6
Mains voltage 6-4
Mains voltage fault 9-6
Maximum number 5-1
Maximumg fusing 6-8
Mechanical power 4-1
Minimum clearance 5-2
Mounting 5-1
Mounting conditions 5-1
Mounting the unit 5-8

N

Number of switching actuations 8-2

O

ON impulse 8-2
Order information 10-1
Output Bb1 8-4
Output BVW 8-5
Output power 3-6
Output TVW 8-5
Output UD 8-5
Overcurrent 9-5
Overvoltage 6-9

P

Peak power 4-4
Peak regenerated power 4-7
Phase Fault 9-6
Potential energy 4-6
Power contactor 8-4
Power data 3-3, 3-4, 3-6
Power failure 9-6
Power features 3-2
Power feed overload 9-5
power for servo drives 4-3
power for spindle drives 4-3
Power loss 3-6, 3-7
Power losses 6-19
Power OFF 8-2
Power ON 8-2
Power rectifier 1-2, 1-3
Project planning 4-1
Protection category 3-6, 3-7, 5-1

R

Ready to operate 8-4
Regenerated energy 4-4, 4-5
Regenerated overload 9-5
Regenerated power 3-6
Repairing 9-1
RESET key 9-1, 9-3
Resistance to interference 6-23
Return action 6-16
Rotary energy 4-6

S

Safety clearances 5-2
Safety door lock 8-4
Safety guidelines 2-1
Service Hotline 9-1
Service life 8-2
Short-term operating load 3-2
Short-term operating power 3-4, 3-5
Softstart error 9-4

T

Technical data HVE 3-6
Technical data HVR 3-7
Telephone number 9-1
Temperature prewarning 8-5
Temperature prewarning contact 8-5
Terminal connecting plan - HVE 6-2
Terminal connecting plan - HVR 6-3
Transformer 6-5

U

UD contact 7-6, 8-5
Unit power 3-3
Unit replacement 9-7

V

Voltage break 6-4
Voltage breaks 6-4

W

Weight 3-6, 3-7

Kundenbetreuungsstellen - Sales & Service Facilities

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