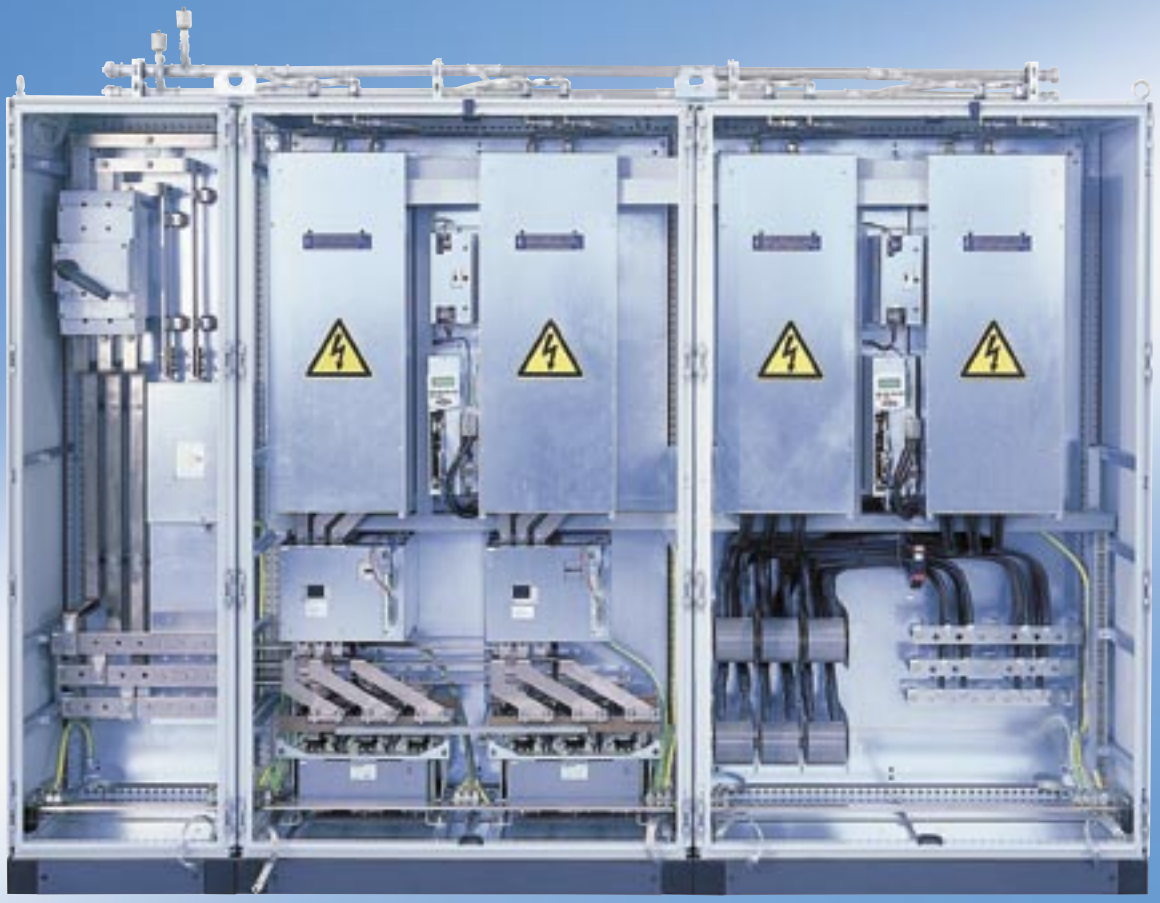
Rexroth
Bosch Group

Rexroth RD 500 SFT
Drive Control Devices
Sinus Frontend Technology

R911201409
Edition 01

Application Manual



Title Rexroth RD500 SFT
Drive Control Devices
Sinus frontend technology

Type of Documentation Application Manual

Document Typecode DOK-RD500*-SFT********-IB01-EN-P

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Purpose of Documentation This documentation describes:

- the mechanical and electrical design of the unit
- the connection requirements
- putting the unit into operation
- starting parameters of the unit
- the error messages with notes on their causes and remedies

Record of Revisions

Description	Release Date	Notes
DOK-RD500*-SFT********-IB01-EN-P	10.2004	First edition

Validity The data specified above only serve to describe the product. No statements concerning a certain condition or suitablility for a certain application can be derived from our information. The given information does not release the user from the obligation of own judgement and verification. It must be remembered that our products are subject to a natural process of wear and aging.

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Note This document has been printed on chlorine-free bleached paper.

Contents

1 Overview of Documents

Information regarding the individual components are located in the various documents.

Contents of operating instructions for SFT
DOK-RD500*-SFT******-IB0x-EN-P**

- arrangement
- assembly
- complete wiring
- firmware of power inverter
- Commisioning (complete)
- troubleshooting

Figure 1-1: Operating instructions of SFT

Contents of planning of the SFT
DOK-RD500*-SFT******-PR0x-EN-P:**

- power inverter
- input filter
- power contactor
- input choke
- controller box
- power supply
- liquid cooling
- sine power filters (HNL and HNP)

Figure 1-2: Planning of the SFT

Contents of operating instructions for RD52:
DOK-RD500*-RD52*****-IB0x-EN-P**

- motor inverter RD52

Figure 1-3: Operating instructions of RD52

Contents of description of functions of the RD52:
DOK-RD500*-RD52*****-FK0x-EN-P**

- function plans and description of parameters of the RD 52

Figure 1-4: Description of functions of the RD52

Contents of operating instructions for RD51:
DOK-RD500*-RD51*****-IB0x-EN-P**

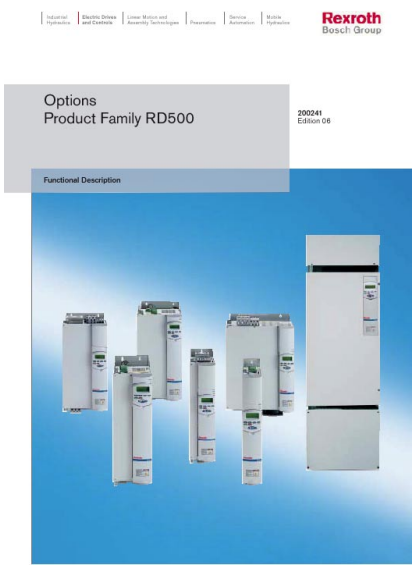
- motor inverter RD51

Figure 1-5: Operating instructions of RD51

Contents of description of functions of the RD51:
DOK-RD500*-RD51*****-FK0x-EN-P**

- function plans and description of parameters of the RD 51

Figure 1-6: Description of functions of the RD51



Contents of planning of accessories of the SFT: DOK-RD500*-OPTIONS**-FK0x-EN-P**

- Description Options

Figure 1-7: Description of options RD 500

2 Safety Instructions for Electric Servo Drives and Controls

2.1 Introduction

Read these instructions before the equipment is used and eliminate the risk of personal injury or property damage. Follow these safety instructions at all times.

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

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

WARNING

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

2.2 Explanations

The safety warnings in this documentation describe individual degrees of hazard seriousness in compliance with ANSI:

Warning symbol with text	Degree of hazard seriousness The degree of hazard seriousness describes the consequences resulting from non-compliance with the safety guidelines:
 **DANGER**	Bodily harm or product damage will occur.
 **WARNING**	Death or severe bodily harm may occur.
 **CAUTION**	Death or severe bodily harm may occur.

Fig. 2-1:Classes of danger according to ANSI

2.3 Hazards due to inappropriate 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 motor movements!

WARNING

High electrical voltage due to wrong connections! Danger to life, severe electrical shock and severe bodily injury!

WARNING

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

CAUTION

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

CAUTION

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

CAUTION

Risk of injury due to inappropriate handling of batteries!

2.4 General information

- Bosch Rexroth is not liable for damages resulting from failure to observe the warnings given in these documentation.
- Read all of the operating, maintenance and safety instructions in your language before starting up the machine. If you find that due to a translation error you can not completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this equipment.
- Trained and qualified personnel in electrical equipment:
  Only trained and qualified personnel may work on this equipment or in its proximity. Personnel are qualified if they have sufficient knowledge of the assembly, installation and operation of the product as well as an understanding 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 and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The equipment is designed for installation on commercial machinery.

European countries: see directive 89/392/EC (Machinery Directive)

- The ambient conditions specified in the product documentation must be observed.
- Use only safety features that are clearly and explicitly approved in the Project Planning manual.
  For example, the following areas of use are not allowed: Cranes and hoisting equipment, elevators used for people or freight, devices and vehicles to transport people, medical applications, refinery plants, the transport of hazardous goods, radioactive or nuclear applications, applications sensitive to high frequency, mining, control of protection equipment (also in a machine).
- Start-up is only permitted once it is ensured that the machine, in which the product is installed, complies with the requirements of national safety regulations and safety specifications of the application.
- Operation is only permitted if the national EMC regulations for the application are met.

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

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

US.: Refer to the National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA), and local building codes. The user of this equipment must observe the above noted items at all times.

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

2.5 Protection against contact with electrical parts

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

Making contact with parts at voltages above 50 Volts could be dangerous to personnel and cause an electrical shock. When operating electrical equipment, it is unavoidable that some parts of the unit conduct dangerous voltages.

DANGER

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

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

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

⇒ Before powering-up, the productive conductor must be permanently connected to all electrical units according to the connection diagram.

⇒ Do not operate electrical equipment at any time if the protective conductor is not permanently connected, even for brief measurements or tests.

⇒ Before working with electrical parts with voltage potentials higher than 50 V, the equipment must be disconnected from the line supply or power supply.

⇒ The following should be observed with electrical drives, power supplies, and filter components:

Wait five (30) minutes after switching off power to allow capacitors to discharge before beginning work. Measure the voltage at 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.

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

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

⇒ Equipment that is built into machines must be se-

cured against direct contact. Use appropriate housings, for example a control cabinet.

European countries: according to EN 50178/1998, section 5.3.2.3.

US: Refer to the National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA) and local building codes. The user of this equipment must observe the above noted instructions at all times.

To be observed for electric drives and filter components:

DANGER

High voltage! High leakage current! Danger to life, danger of injury and bodily harm from electrical shock!

⇒ Before powering-up all housings and motors must be permanently grounded according to the connection diagram. This applies even for brief tests.

⇒ The protective conductor of the electrical equipment must be permanently connected to the line supply. The leakage current is greater than 3.5 mA.

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

⇒ 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 / 1998, Section 5.3.2.1.

US: Refer to the National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA), and local building codes. The user of this equipment must observe the above noted instructions at all times.

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

All connections and terminals with voltages between 5 and 50 Volts on Bosch Rexroth products are protective low voltages designed in accordance with the following Standards:

- International: IEC 60364-4-41
- EU countries: Refer to EN 50178/1998, Section 5.2.8.1.

WARNING

High voltage due to wrong connections! Danger to life, severe electrical shock and severe bodily injury!

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

⇒ Only safely isolated voltages and electrical circuits may be connected. Safe isolation is achieved, for example, with an isolating transformer, a safe opto-electronic coupler or when battery-operated.

2.7 Protection against dangerous movements

Dangerous movements can be caused by faulty control or the connected motors. There are various causes:

- unclean or wrong wiring of cable connections
- inappropriate or wrong operation of equipment
- malfunction of sensors, encoders and monitoring circuits
- defective components
- software errors

Dangerous movements can occur immediately after equipment has been powered-up or even after an unspecified time of trouble-free operation.

The monitors in the drive components make faulty operation almost impossible. Regarding personnel safety, especially the danger of bodily harm and property damage, this alone should not be relied upon to ensure complete safety. Until the built-in monitors become active and effective, it must be assumed in any case that some faulty drive movements will occur. The extent of these faulty drive movements depends on the type of control and the state of operation.

DANGER

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

⇒ Personnel protection must be secured for the above listed reason by means of superordinate monitors or measures.

These are implemented in accordance with the specific situation of the plant/system and a danger and fault analysis conducted by the manufacturer of the plant/system. All the safety regulations that apply to this plant/system are included. By switching off, circumventing or if safety devices have simply not been activated, then random machine movements or other types of faults can occur.

Avoiding accidents, injury 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 or light barriers

⇒ Fences must be strong enough to withstand maximum possible momentum.

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

⇒ Isolate the drive power connection by means of an emergency stop circuit or use a start-inhibit system to prevent unintentional start-up.

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

⇒ Secure vertical axes against falling or slipping after switching off the motor power by, for example:

- Mechanically securing the vertical axes
- Adding an external brake / clamping mechanism
- Balancing and thus compensating for the vertical axes weight and the gravitational force

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

⇒ Disconnect electrical power to the equipment using a master switch and lock-out the switch against reclosure:

- for maintenance and repair work
- for cleaning of equipment
- if the equipment is not used for long periods of time

⇒ Avoid operating high-frequency, remote control and radio equipment near electronic circuits and feeder cables. If use of such equipment cannot be avoided, verify the system and the plant for possible malfunctions at all possible positions of normal use before the first start-up. If necessary, perform a special electromagnetic compatibility (EMC) test on the plant.

2.8 Protection against magnetic and electromagnetic fields during operations and mounting

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

WARNING

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

⇒ Persons with pacemakers, metal implants and hearing aids are not permitted to enter following areas:

- Areas in which electrical equipment and parts are mounted, being operated or started up.
- Areas in which parts of motors with permanent magnets are being stored, operated, repaired or mounted.

⇒ If it is necessary for a person with a pacemaker to enter such an area, then a physician must be consulted prior to doing so. Pacemakers, that are already implanted or will be implanted in the future, have a considerable deviation in their immunity to interference. Due to the unpredictable behavior there are no generally valid rules.

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

2.9 Protection against contact with hot parts

CAUTION

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

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

⇒ Wait ten (10) minutes before you access any hot unit. Allow the unit to cool down.

⇒ Do not touch hot parts of the equipment, such as housings, heatsinks or resistors. Danger of burns!

2.10 Protection during handling and installation

Under certain conditions inappropriate handling and installation of parts and components may cause injuries.

CAUTION

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

- ⇒ Observe general instructions and safety regulations during handling installation.
- ⇒ Use only appropriate lifting or moving equipment.
- ⇒ Take precautions to avoid pinching and crushing.
- ⇒ Use only appropriate tools. If specified by the product documentation, special tools must be used.
- ⇒ Use lifting devices and tools correctly and safely.
- ⇒ Wear appropriate protective clothing, e.g. safety glasses, safety shoes and safety gloves.
- ⇒ Never stay under suspended loads.
- ⇒ Clean up liquids from the floor immediately to prevent personnel from slipping.

2.11 Battery safety

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

CAUTION

Risk of injury through incorrect handling!

- ⇒ Do not attempt to re-activate discharged batteries by heating or other methods (danger of explosion and corrosion).
- ⇒ Never charge batteries (danger from leakage and explosion).
- ⇒ Never throw batteries into a fire.
- ⇒ Do not dismantle batteries.
- ⇒ Handle with care. Incorrect withdrawal or installation of a battery can damage equipment.

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

2.12 Protection against pressurized systems

Certain Motors (ADS, ADM, 1MB etc.) and drives, corresponding to the information in the Project Planning manual, must be provided with various media at a high pressure such as compressed air, hydraulic oil, cooling fluid or coolant. In these cases, improper handling of the supply of the pressurized systems or connections of the fluid or air under pressure can lead to injuries or accidents.

CAUTION

Danger of injury when pressurized systems are handled by untrained personnel!

⇒ Do not attempt to disassemble, to open or to cut a pressurized system.

⇒ Observe the operation restrictions of the respective manufacturer.

⇒ Before the disassembly of pressurized systems, lower pressure and drain off the fluid or gas.

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

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

Note: Environmental protection and disposal! The fluids used in the operation of the pressurized system equipment is not environmentally compatible. Fluid that is damaging to the environment must be disposed of separately from normal waste. Observe the national specifications of the country of installation.

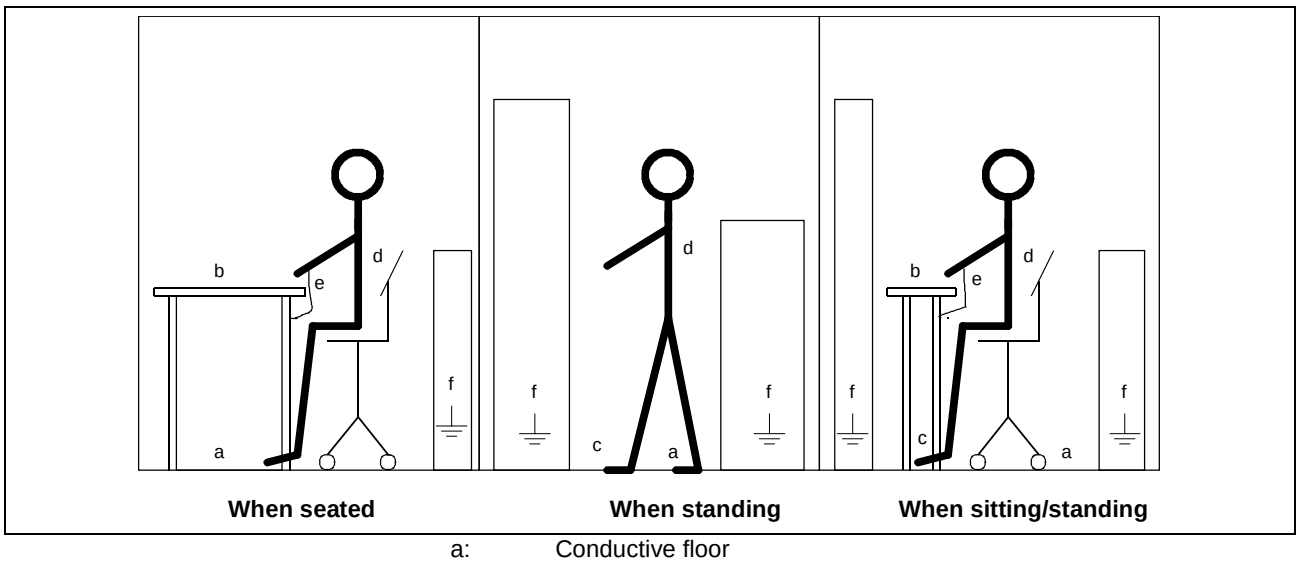
2.13 Precautionary measures when handling components which can be destroyed by electrostatic discharge (ESDS)

The drive units contain components and parts which can be destroyed by electrostatic discharge. Please observe the following when working with electronic modules and boards:

- Electronic modules and boards should only be touched if absolutely necessary.
- Before touching an electronic module/board, the human body must first be electrically discharged.
- Electronic modules/boards may not come into contact with highly-insulating materials (e.g. plastic foils, insulating work surfaces, articles of clothing manufactured from man-made fiber).
- Electronic modules/boards may only be placed on conductive surfaces.
- The soldering iron tip must be grounded when carrying-out soldering work on electronic modules/boards.

- Electronic modules/boards and components may only be stored and shipped in conductive packaging (e.g. metalized plastic or metal containers).
- If the packaging is not conductive, electronic modules/boards must be wrapped in a conductive material. In this case, e.g. conductive foam rubber or household aluminum foil can be used.

The necessary ESDS protective measures are clearly shown in the following diagram:



a: Conductive floor
b: ESDS table
c: ESDS shoes
d: ESDS overall
e: ESDS bracelet
f: Grounding connection of the cabinets

Fig. 2-2: ESDS protective measures

3 Description of the RD 500 SFT

3.1 Inverter System RD 500 SFT

RD 500 SFT (Sinus Frontend Technology) is a modern, universal, regenerative, 3-phase drive system for synchronous and asynchronous motors. Depending on the controls used at the motor side, SFT can either be used as an efficient frequency inverter or as a servo drive regulator. A forward- and reverse feed module allows four-quadrant operation and generates sinusoidal power currents with a low level of power feedbacks. Due to the regulated intermediate circuit voltage, the SFT even maintains full motor power when there is a network undervoltage. Due to the modular design of the hardware and software, the system can be flexibly adapted to the required drive task.

It can be used both for single-axle applications and servicer applications. The system is comprised of components that are supplied singly or as a combination / set completely wired and installed in the cabinet. It can have the degrees of protection IP23 and IP54.
The power sections 3 – 18.5 kW are air-cooled and the power sections 30 – 110 kW can be obtained either air-cooled or liquid-cooled. The 160 kW to 650 kW power sections are liquid-cooled and can be delivered with heat exchangers, depending on requirements.

DANGER

Impairment to hearing due to very high noise emissions!

⇒ Wear noise protection

Handling

Particular attention has been paid to simple handling/operation, e.g. automatic motor adjustment by means of parameter identification. Putting into operation is controlled via a control panel with graphic display or with the highest level of comfort using a PC equipped with the powerful RDwin software package.

Electromagnetic Compatibility (EMC)

RD 500 SFT completely fulfils the EMC regulations regarding immunity to interference and unwanted emissions according to EMC product standards EN 61800-3 / (IEC 61800-3) and EN 55011 Kl. A2 for electrical drives. RD 500 SFT conforms to the immunity to interference standard EN 50082-2.

Physical Characteristics

- Connectable motor inverters situated within a performance range reaching from 3 kW to 650 kW
- Sinusoidal negative feeder of power inverters with DC link power between 185 and 770 kW.
- forced air-cooling or liquid-cooling (selectable)
- removable control panel with copying function
- 4-line graphic display

- various interfaces that connect to the drive system,
- monitoring and parameterization (configuring) allows („download“ – parameterization):
- Sercos
- Profibus DP
- Interbus S
- CAN Bus
- RS 232 / RS 485
- peer-to-peer connection or synchrolink for faster transversal communication between several drives or between the power- and motor inverter to buffer the intermediate circuit power in case of power failure.
- expanded technology functions that can be linked as required
- PID-, PI controller, AND, O,R, XOR, RS flip-flop and D latch
- mathematic control sections
- time function elements, differential elements, integrator-transmitters
- free characteristic curve (only RD52)
- additional signal processor (32-bit floating point) for highly dynamic applications and servo-assisted applications (only RD52)
- moment settling times of 0.3 ms (only RD52)
- current cycle times of 0.1 ms (only RD52)

Block diagram of the Components for 160 kW

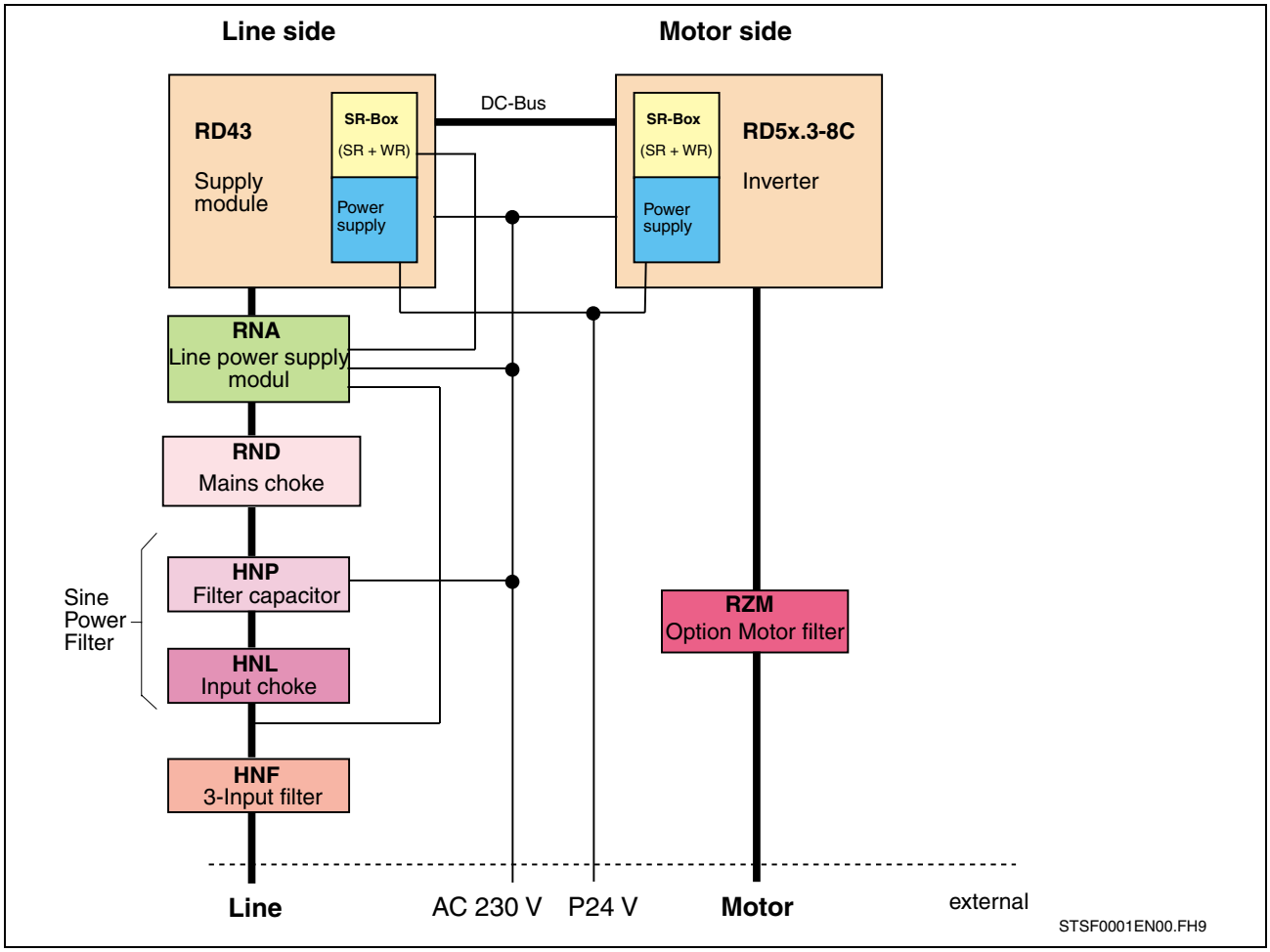


Figure 3-1: Block diagram of the components of SFT 160 kW

Block diagram of the Components of SFT 250 kW / 350kW

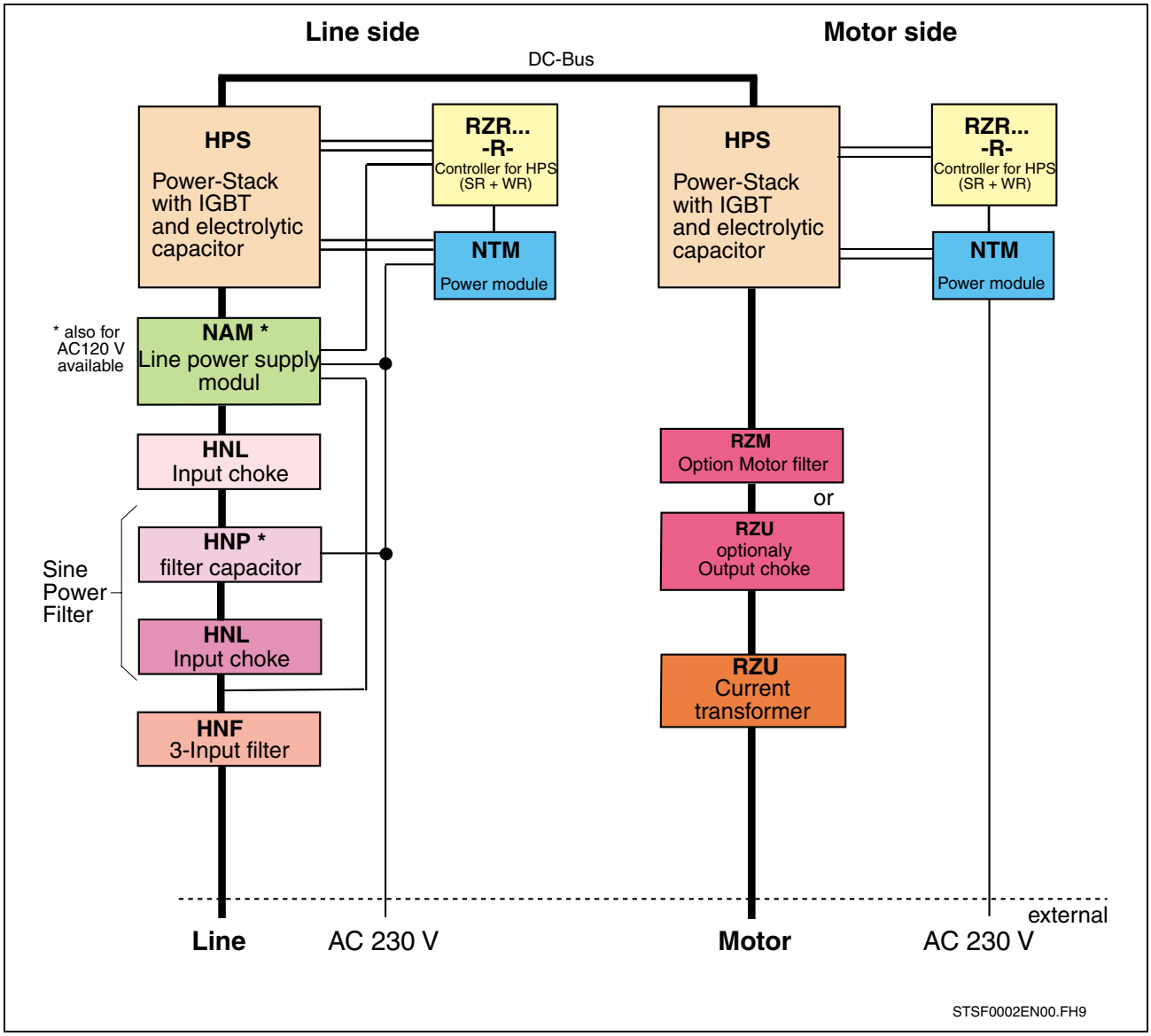


Figure 3-2: Block diagram of the Components of SFT 250 kW / 350 kW

Block diagram of the Components of SFT 450 kW / 350kW

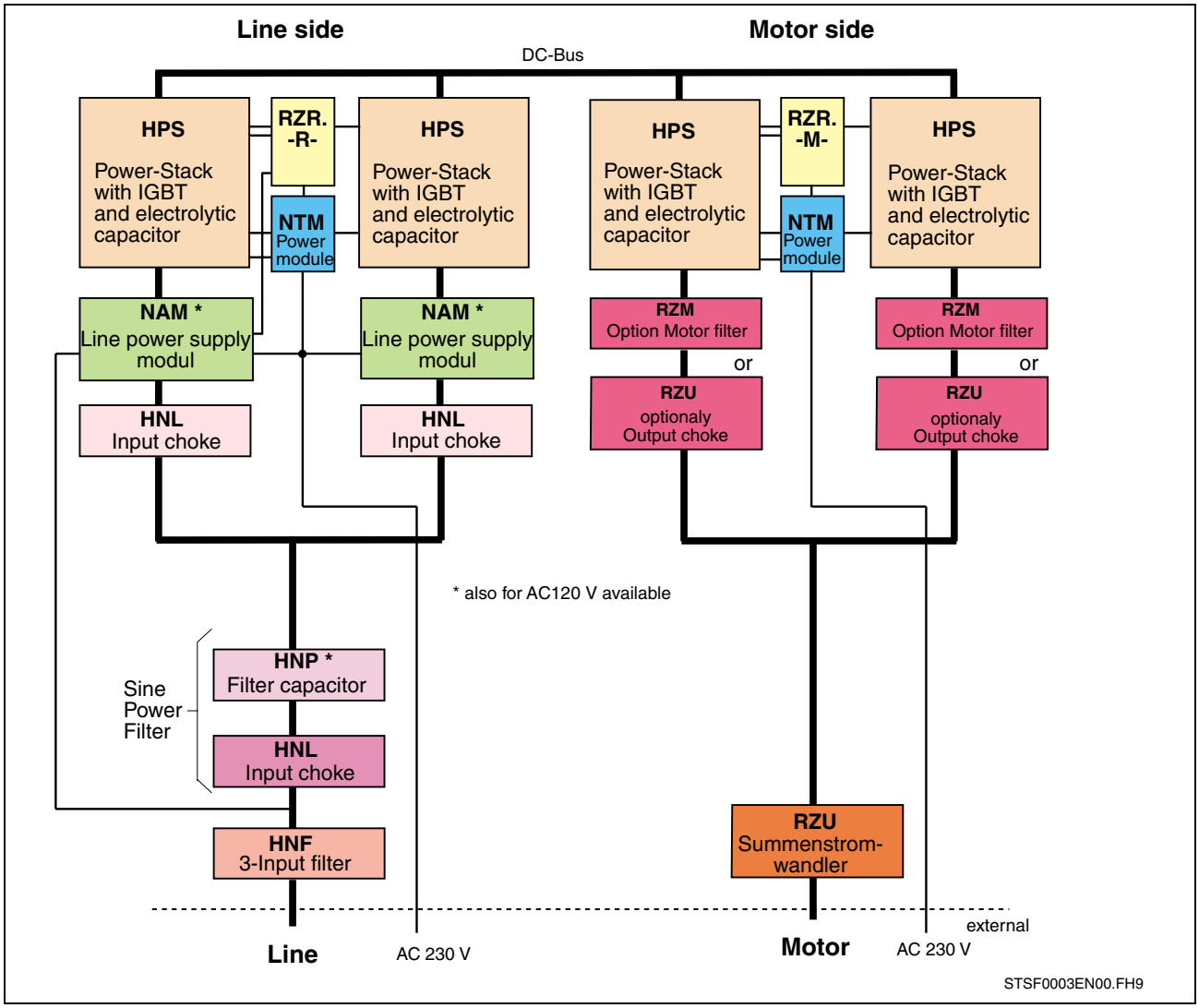


Figure 3-3: Block diagram of the Components of 450 kW / 650 kW

Use for the Intended Purpose

Introduction

Bosch Rexroth products are developed and manufactured according to the appropriate state of technology of each product. Their operational reliability is checked before delivery.

The products may only be used for their intended purpose. If they are not used for their intended purpose then situations may arise that result in the damage to goods and/or to persons.

Note: In cases where the products are not used for their intended purposes, Bosch Rexroth, as manufacturer of the products, does not provide any guarantee, liability or indemnification; any risks arising from incorrect use of the products that is not for their intended purposes lies solely with the user.

Before using Bosch Rexroth products, you must meet the following requirements in order to ensure that the products are used for their intended purposes:

- Anyone working with any of our products in any way must read and understand the relevant safety regulations and the regulations regarding the intended purpose of the product.
- If the product in question is hardware, then the product must be left in its original condition, i.e. no physical changes to the hardware must be made. Software products must not be de-compiled and their source code must not be changed.
- Damaged or faulty products must not be installed or put into operation.
- You must ensure that the products are installed according to the regulations stipulated in the documentation.

Range of use and application

Drive control units from Bosch Rexroth have been designed for regulating electrical motors and for monitoring their operation.

To regulate and monitor the motor it may be necessary to connect additional sensors and actuators.

Note: The drive control units may only be used with the accessories and attachments listed in the documentation for the RD 500. Components not expressly named must neither be installed nor connected. This also applies to cables and lines.

The equipment may only be operated in the configuration and combination of components expressly indicated and only using the software and firmware that has been indicated and specified in the respective functional description.

Every drive control unit must be programmed before putting into operation to ensure that the motor runs the functions that are specific to the application.

There are models with different drive powers and different interfaces to ensure that the drive control units are used for the specific applications.

The typical range of applications of the units is:

- test stands
- presses
- chemical and process technology,
- machine tools,
- hoisting and conveying,
- handling and assembly systems
- packaging/wrapping and foodstuff machines.

The drive control units may only be operated under the assembly and installation requirements stipulated in this manual and only in the positions indicated while fully observing the stipulated environmental conditions (temperature, type of enclosure, humidity, EMC etc.).

Usage not in Accordance with the Intended Purpose

Using drive control units outside of the stipulated range of application or under other operating conditions than those described in this manual, or using other technical specifications, is determined to be "not in accordance with the intended purpose“.

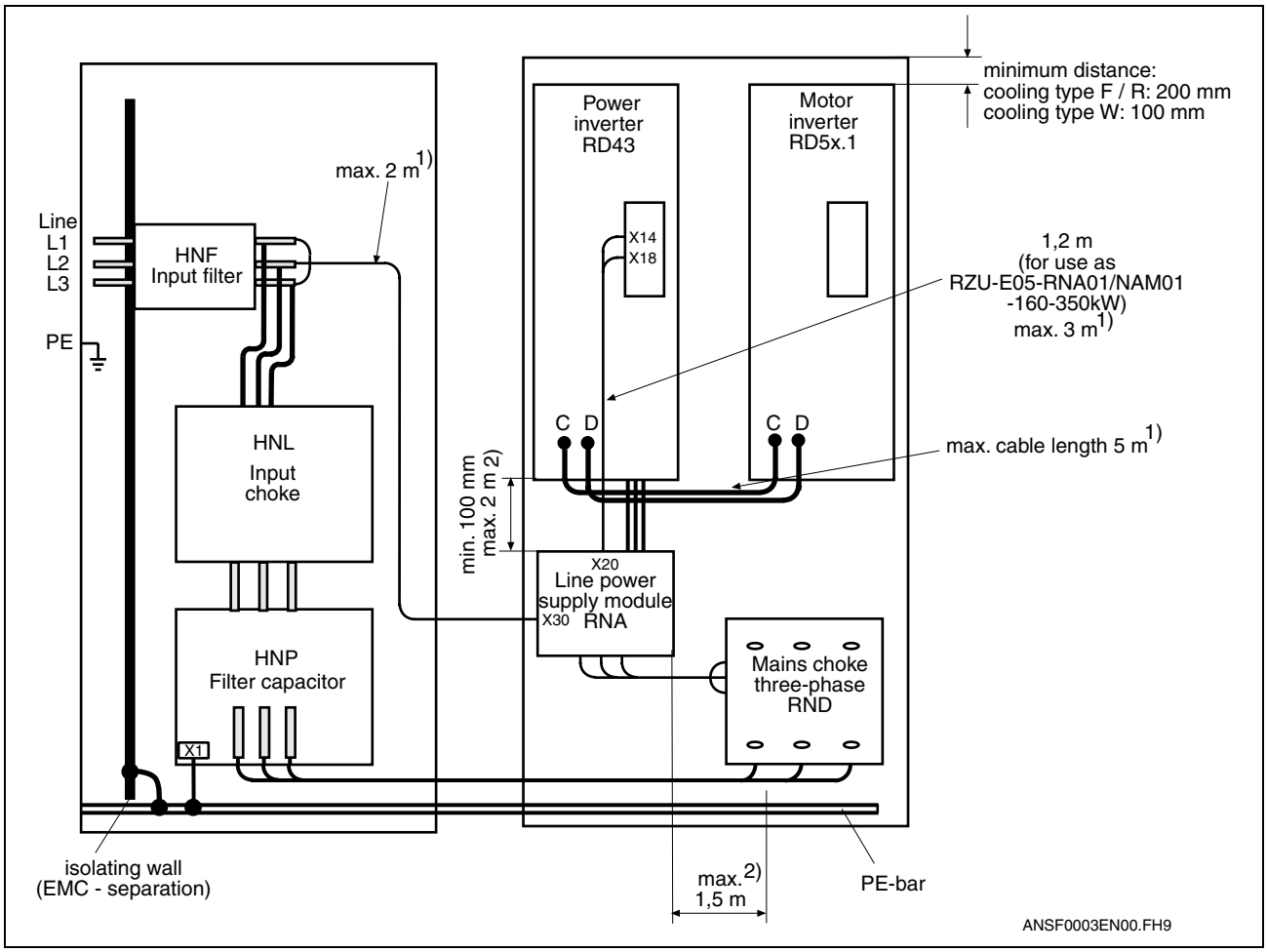
The drive control units may not be used when they are ...

- ... subjected to operating conditions that do not accord to the stipulated environmental conditions. This means that, e.g. operation under water, under extreme variations in temperature or under extreme maximum temperatures is forbidden.
- Furthermore, the drive control units may not be used for applications for which they have not been expressly released by Bosch Rexroth. In this regard, please always observe the statements made in the general safety instructions!

4 Arrangement and Wiring of the Components SFT 160 kW

The Rules for Installation of Drives According to must be respected. Chapter (7.5).

4.1 Arrangement Example of the Components SFT 160 kW



1): Maximum cable lengths (observe planning instructions)
2): Maximum assembly distance

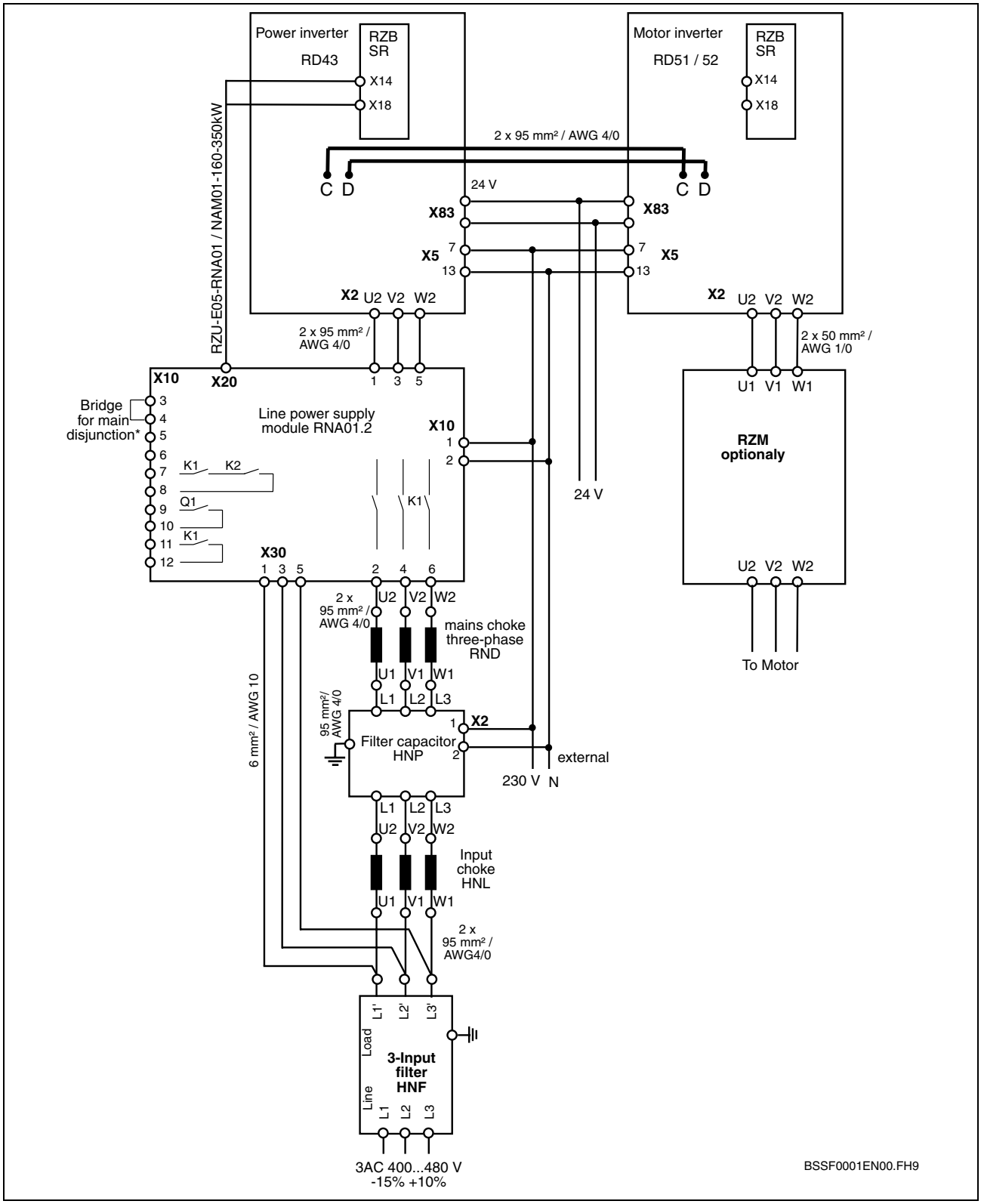
Figure 4-1: Arrangement of components SFT 160 kW

Note: Minimum clearances (for air inlets and outgoing air) or maximum clearances (cable lengths) must be observed. The project planer of the control cabinet has to make sure that the quantity of air specified in the project planning manual is respected for the respective components.

Note: The EMC requirements are only met for the arrangement example stipulated.

If deviations are made to the arrangement of the components from the assembly instructions provided then the instructions regarding a design of the cabinet that conforms to EMC requirements must be observed. The EMC requirements must also be observed.

4.2 Complete Wiring of the Components SFT 160 kW



*): Bridge for mains disjunction: Removing the bridge prevents K1 and K2 from being switched on. Thus the power section of the inverter remains disconnected from the mains.

Figure 4-2: Wiring of the 160 kW component

Wiring of Power connections SFT160 kW

Note: Current-bearing have to be guarded against unauthorized access by means of a protective hood.

Note: Parallel connected cable (same phase) must have the same length. Please lead the cables as close as possible and prevent them from forming loops. You are expected to observe the minimal radius of bend.

Note: Please pay particular attention to the description of the components in the project planning manual.

3-phase input filter HNF – Input choke HNL

3-phase input filter – Input choke HNL		
Recommended cable	Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section	2 x 95 mm²	AWG 4/0 (194 °F)
Connection on HNF	Bore hole for screw M10	
Connection on HNL	2 x threaded hole tightening M10 torque 35 Nm	

Figure 4-3: Connection 3-phase input filter HNF – Input choke HNL

You are invited to take care of the minimum voltage distance towards the housing when connecting the conductors with the terminal bars of the HNF.

For reasons of EMC, the filter has to be mounted to one of the isolating wall by its line side. Therefore please use the existing tapped bores. In addition to this, the separating wall is in charge of the filter's low-inductive ground connection.

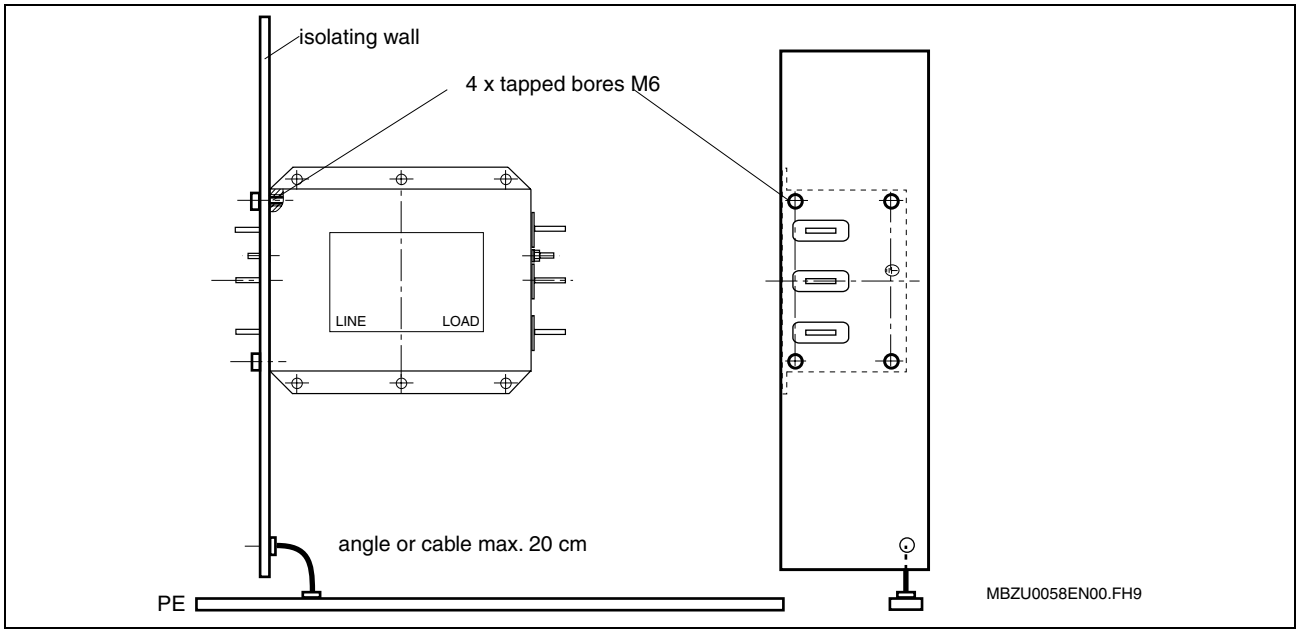


Figure 4-4: Mounting isolation plate

PE – Connection 3-phase input filter

For safety reasons, the protective wire between the isolating wall and the PE bar must have

- at least half of the cross-section of the outer conductor.
- **It must be permanently fixed**. (It may only be loosened using tools).
- be kept within a length of 20 cm

The reason for this is the high leakage current of the input filter in the ground conductor that can arise due to an imbalance in the three-phase AC system or during a phase failure. Input filters must therefore always be grounded before switching them on for the first time. There are suitable connections for this in the machine, in the system and in the control cabinet.

Note: For reasons of EMC, the notes given in the preceding paragraphs must be observed in any case. A ground connection via a line tap to the PE terminal bar is not sufficient.

Input choke HNL- Filter capacitor HNP

You are obliged to use the assigned terminal bars contained in the HNP. It is impossible to wire the components. The mounting distance of these components are fixed.

Connection HNL – HNP SFT 160 kW	Cross section
Phase L1 – L3	6 x 60 mm²

Figure 4-5: Connection HNL – HNP SFT 160 kW

Dimension drawing assembly HNL - HNP

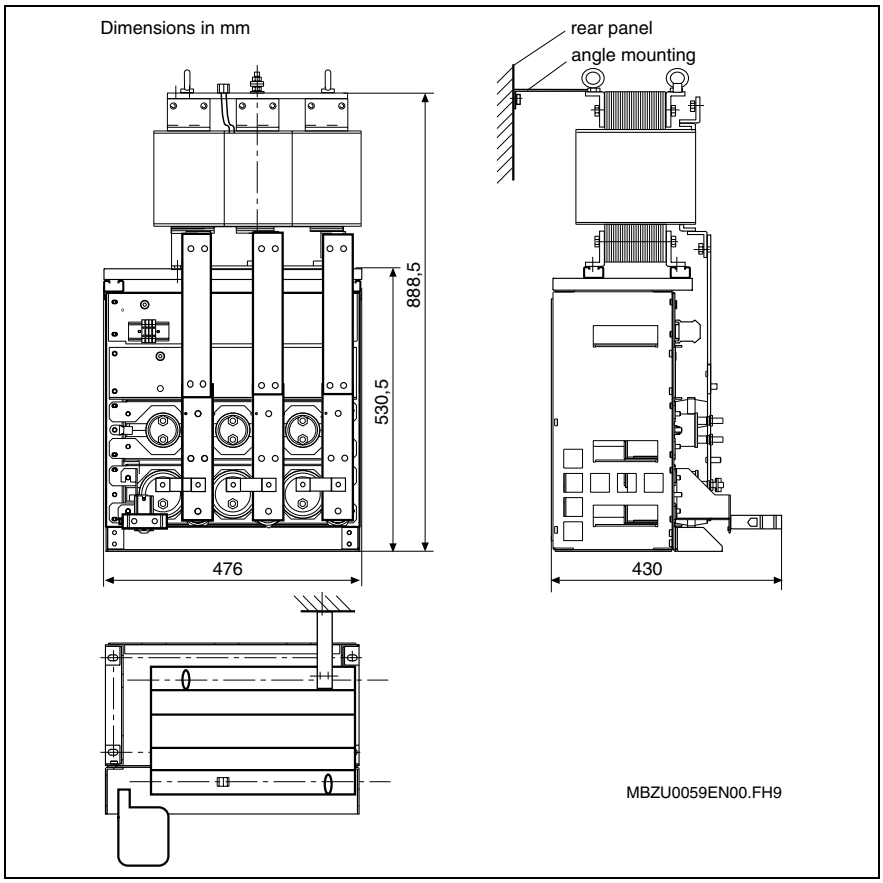


Figure 4-6: Dimension drawing assembly HNL - HNP

At mounting in control cabinet, the input choke must fixed inside the cabinet.

Sine Power filter HNP – Mains choke three-phase RND

Sine Power filter HNP – Mains choke three-phase RND		
Recommended cable	Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section	2 x 95 mm²	AWG 4/0 (194 °F)
Connection on HNP	2 x stud bolt M10 tightening torque 35 Nm	
Connection on RNA	Bore hole for screw M10	

Figure 4-7: Connection Sine Power filter HNP – Mains choke three-phase RND

Note: The Sine Power Filter (HNL01.1 + HNP01.1) can only be run in combination with the 4.2 kHz mains inverter pulse frequency adjusted at works. If it becomes necessary to modify the pulse frequency, you are expected to have this operation executed by our service staff.

Mains choke three-phase RND – Line power supply module RNA

Mains choke three-phase RND – Line power supply module RNA		
Recommended cable	Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section	2 x 95 mm²	AWG 4/0 (194 °F)
Connection on RND	Bore hole for screw M10	
Connection on RNA	2 x stud bolt M10 tightening torque 35 Nm	

Figure 4-8: Connection RND – RNA SFT 160 kW

Line power supply module RNA – Power inverter RD43

Line power supply module RNA – Power inverter RD43		
Recommended cable	Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section	2 x 95 mm²	AWG 4/0 (194 °F)
Connection on RNA	stud bolt M10 tightening torque 35 Nm	
Connection on RD43	High current terminal 240 mm² / 500MCM	

Figure 4-9: Connection RNA – RD43 SFT 160 kW

DC – Link connection (C / D)

The cable used to connect the inverter DC link must be as short as possible and should be bunched together. Correct polarity of the connection (C - C, D - D) must be observed at all times.

Note: If the lines are routed outside of the control cabinet then a fuse must be attached at both poles. This fuse must be suitable for a DC voltage of 750 V.

DC – Link connection SFT 160 kW			
Recommended cable		Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section		2 x 95 mm²	AWG 4/0 (194 °F)
Max. cable length	m	5	
Max. DC fuse type gL	A	400	
Connection to C – D -bar		Bolt connection M12 Torque 50 Nm	

Figure 4-10: DC – Link connection SFT 160 kW

Motor inverter – Motor connection

See application manual DOK-RD500*-RD52*******-IB0x-EN-P and DOK-RD500*-RD51*******-IB0x-EN-P.

Wiring of Controller connections SFT160 kW

Voltage synchronization line power supply module RNA – input filter HNF

The cable used to connect the RNA X30 power connection module with the connections of the HNF input filter at the load end must be as short as possible and bunched together and connected using a reinforced insulation cable.

Recommendation Industrial cable, type DLO, dielectric strength 2 kV, 90 °C, UL1581, AWG 10 (6 mm^2), or Pirelli rubber insulated wire NSGAFÖU 6 mm², short-circuit proof acc. to DIN VDE0250 TEIL602.

Note: As the phase sequence of the mains voltage is decisive for operation of the power inverter, you must make sure that the phases are connected to the input filter at terminal X30 in accordance to the terminal description. The phase sequence L1-L2-L3 must be a clockwise phase sequence.

Connection RNA X30 to HNF U1, V1, W1 SFT 160 kW		
Recommended cable	6 mm²	AWG 10
Max. cable length m	1.5	
Conductor cross sections that can be connected in mm²	0.5 – 16	
Connection of line filter at load end	Cable clips M10 x 4 – 6 mm²	

Figure 4-11: Connection of RNA X30 to HNF SFT 160 kW

Line power supply module RNA – Power inverter RD43 Control cable RZU-E05-RNA01/NAM01

The 120 cm cable RZU-E05-RNA01/NAM01 (delivered with the unit) from the RNA Line power supply module (connection X20) to the mains - WR RD43 (connection X14 / X18) is equipped on both ends with screening braiding. This braiding must be connected to the metal surfaces (conductive) using the screening attachments supplied for this purpose.

Note: The cable must not be laid parallel to the power cables or only a short distance from them.

To fabricate the cables yourself, please observe the description in Figure 5-30 The lengths of the cables must not exceed 300 cm.

Filter Capacitor HNP – Input choke HNL – Input inverter choke RND - Power Inverter RD43

The HNP ad HNL components are equipped with thermal switches in order to detect overtemperature.

The thermal switches are wired in series and should be connected with terminals X15.1 and X15.2 of the control unit.

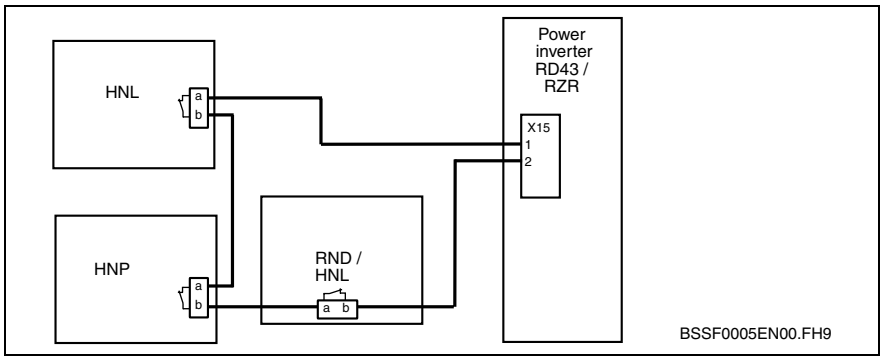


Figure 4-12: Schematic circuit diagram of the wiring of the thermal switches

Note: If overtemperature occurs then the power inverter shuts-off (fault shut-off). The Parameterization of Power inverter have to be linked at Figure 12-38 (status delivery).

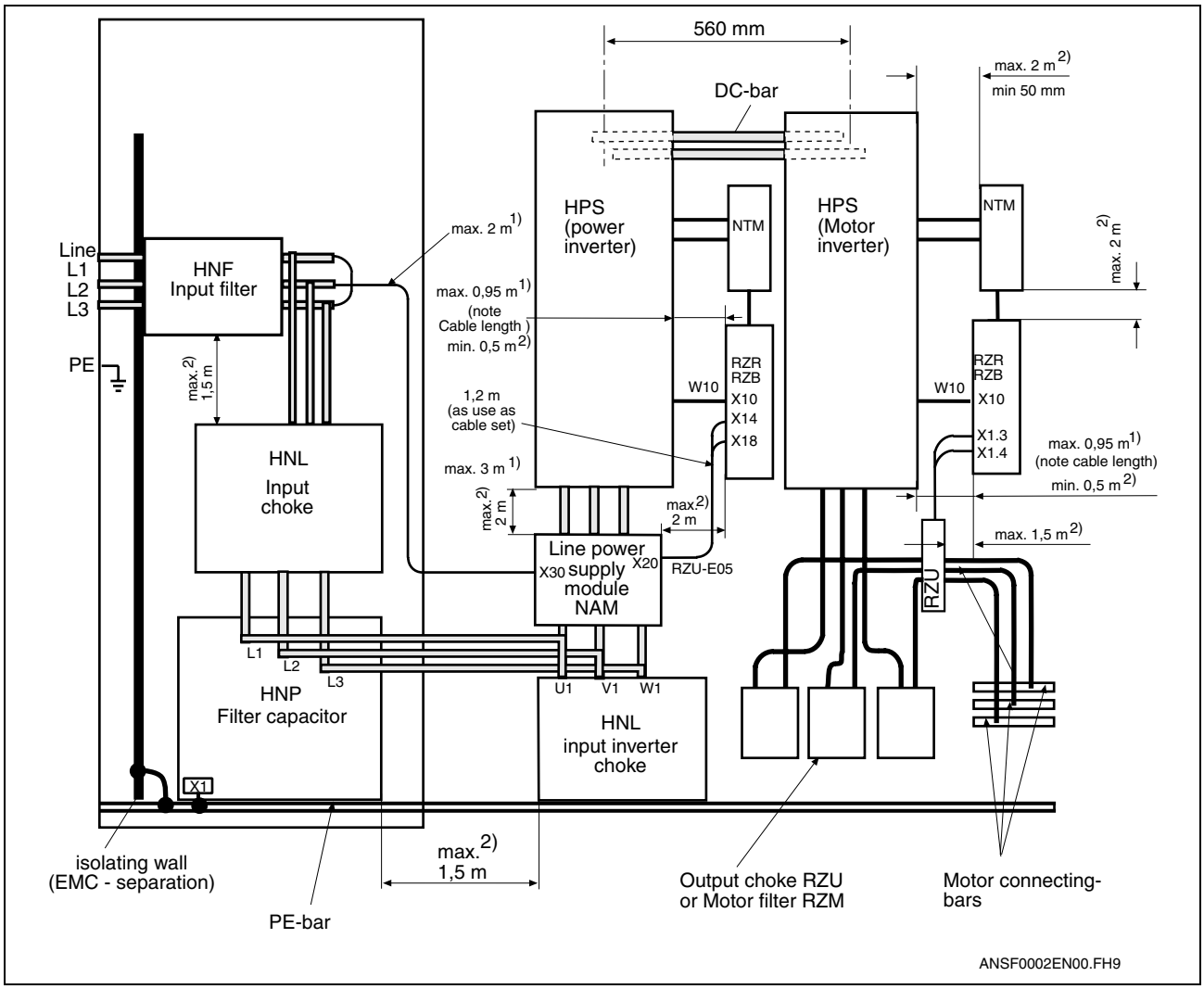
The minimum cross-section for the cable is 1.5 mm² (AWG 16)

For additional information, see operating instructions DOK-RD500*-SFT********-PR-0x-EN-P.

5 Arrangement and Wiring of the Components SFT 250 kW / 350 kW

The Rules for Installation of Drives According to must be respected. Chapter 7.5.

5.1 Arrangement Example of the Components SFT 250 kW / 350 kW



1): Maximum cable lengths (observe planning instructions)
2): Maximum assembly distance

Figure 5-1: Component arrangement of the SFT 250 kW / 350 kW

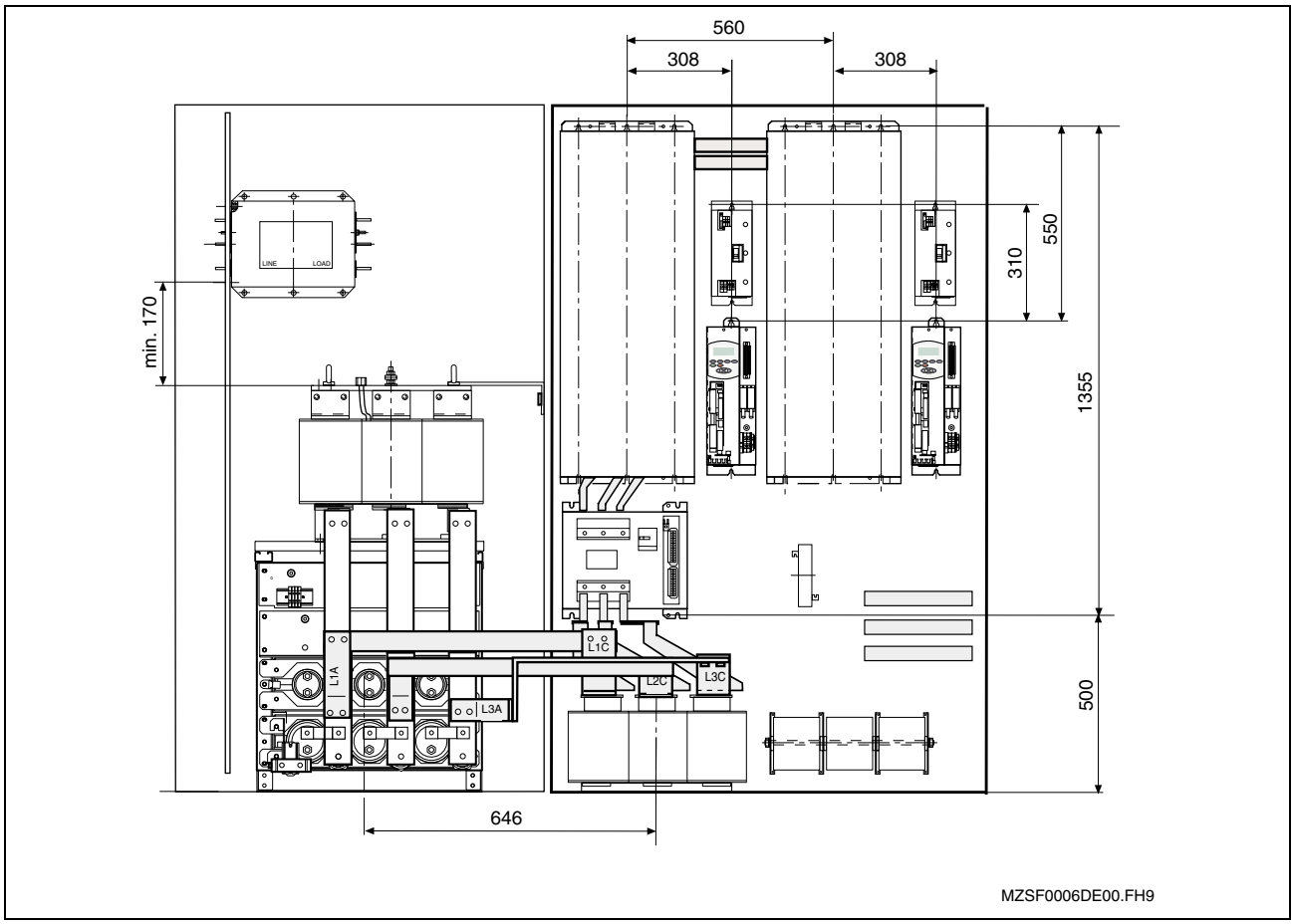
Note: Minimum clearances (for air inlets and outgoing air) or maximum clearances (cable lengths) must be observed. The project planer of the control cabinet has to make sure that the quantity of air specified in the project planning manual is respected for the respective components.

Note: The EMC requirements are only met for the arrangement example stipulated.

If deviations are made to the arrangement of the components from the assembly instructions provided then the instructions regarding a design of the cabinet that conforms to EMC requirements must be observed. The EMC requirements must also be observed.

5.2 Mounting Clearances of the Individual Components when using the associated Bars

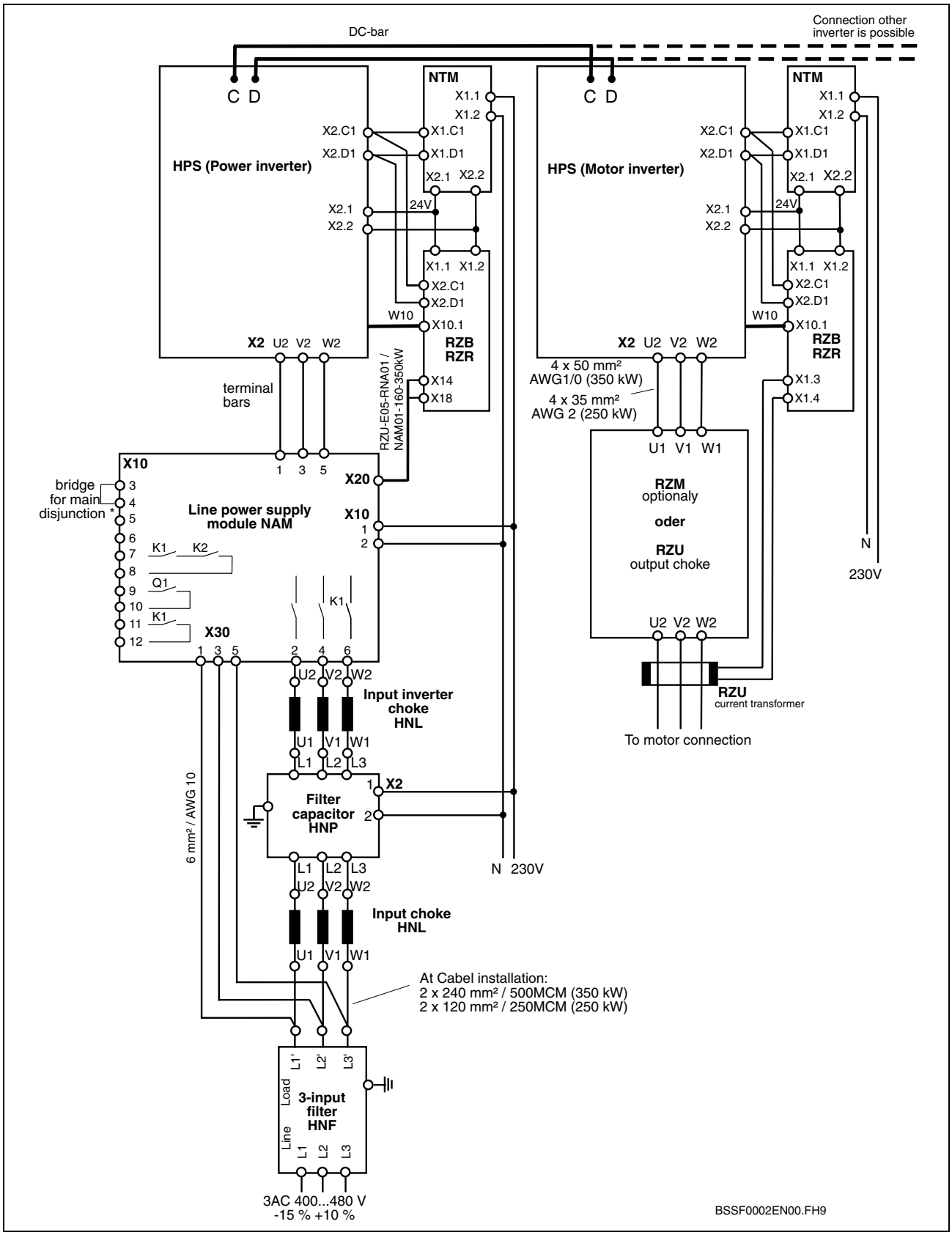
It is recommendable when use the associated bars. The mounting clearance distances must be observed!



Dimension in mm

Figure 5-2: Mounting distances of the components SFT 250 kW / 350 kW

5.3 Complete Wiring of the Components SFT 250 / 350 kW



*): Bridge for mains disjunction: Removing the bridge prevents K1 and K2 from being switched on. Thus the power section of the inverter remains disconnected from the mains.

Figure 5-3: Wiring of the Components SFT 250 kW / 350 kW

Wiring of Power connections SFT 250 kW / 350 kW

Note: Current-bearing have to be guarded against unauthorized access by means of a protective hood.

Note: Parallel connected cable (same phase) must have the same length. Please lead the cables as close as possible and prevent them from forming loops. You are expected to observe the minimal radius of bend.

Note: Please pay particular attention to the description of the components in the project planning manual.

3-phase input filter HNF – Input choke HNL

3-phase input filter – Input choke HNL SFT 250 kW		
Cu – terminal bars	Recommended min. cross section 2 x 30 x 5 mm²	
Recommended cable	Single - core cable PVC isolated (min. 90 °C)	
Recommended min. cross section	2 x 120 mm²	2 x 250MCM (194 °F)
Connection on HNF	Bore hole for screw M10	
Connection on HNL	2 x threaded hole M10 tightening torque 35 Nm	
3-phase input filter – Input choke HNL SFT 350 kW		
Cu – terminal bars	Recommended min. cross section 2 x 40 x 5 mm²	
Recommended cable	Single - core cable PVC isolated (min. 90 °C)	
Recommended min. cross section	2 x 240 mm²	2 x 500MCM (194 °F)
Connection on HNF	Bore hole for screw M12	
Connection on HNL	2 x threaded hole M10 tightening torque 35 Nm	

Figure 5-4: Connection 3-phase input filter HNF – Input choke HNL

You are invited to take care of the minimum voltage distance towards the housing when connecting the conductors with the terminal bars of the HNF.

For reasons of EMC, the filter has to be mounted to one of the isolating wall by its line side. Therefore please use the existing tapped bores. In addition to this, the separating wall is in charge of the filter's low-inductive ground connection.

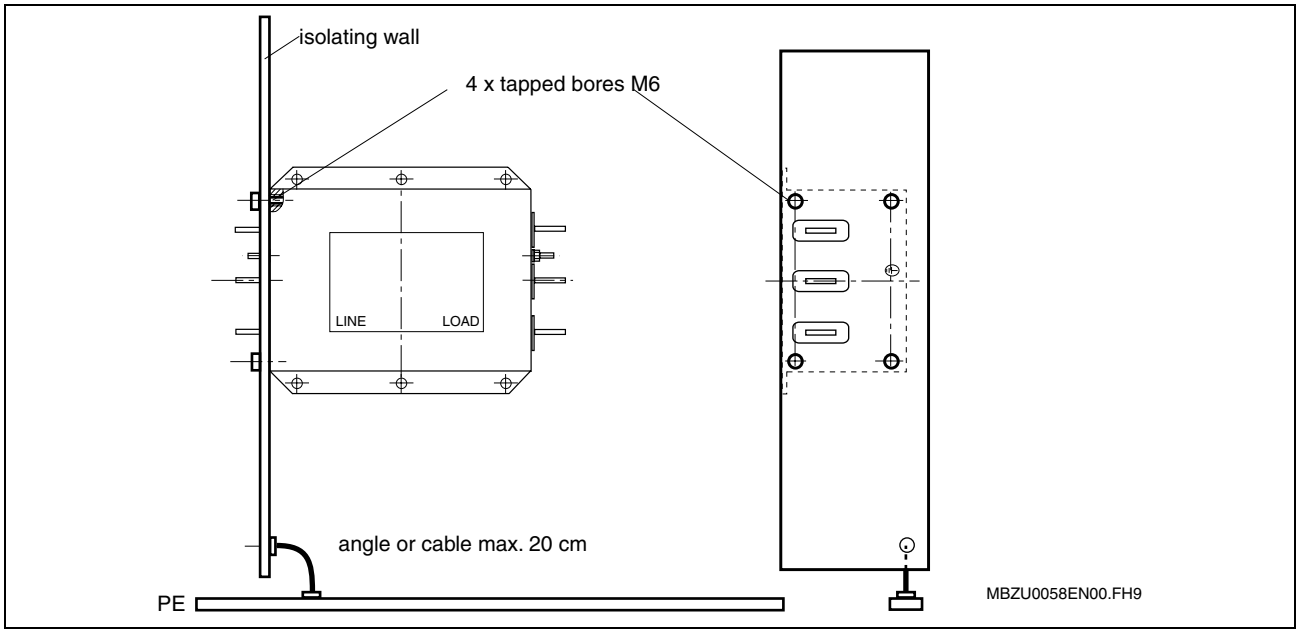


Figure 5-5: Mounting isolation wall

PE – Connection 3-input filter

For safety reasons, the protective wire between the isolating wall and the PE bar must have

- at least half of the cross-section of the outer conductor.
- **It must be permanently fixed**. (It may only be loosened using tools).
- be kept within a length of 20 cm

The reason for this is the high leakage current of the input filter in the ground conductor that can arise due to an imbalance in the three-phase AC system or during a phase failure. Input filters must therefore always be grounded before switching them on for the first time. There are suitable connections for this in the machine, in the system and in the control cabinet.

Note: For reasons of EMC, the notes given in the preceding paragraphs must be observed in any case. A ground connection via a line tap to the PE terminal bar is not sufficient.

Input choke HNL - Filter capacitor HNP

You are obliged to use the assigned terminal bars contained in the HNP. It is impossible to wire the components. The mounting distance of these components are fixed.

Connection HNL – HNP SFT 250 kW / 350 kW	Cross section
Recommended min. cross section	6 x 60 mm²
Connection	2 x bore hole M10

Figure 5-6: Connection HNL – HNP SFT 250 kW / 350 kW

Dimension drawing assembly HNL - HNP

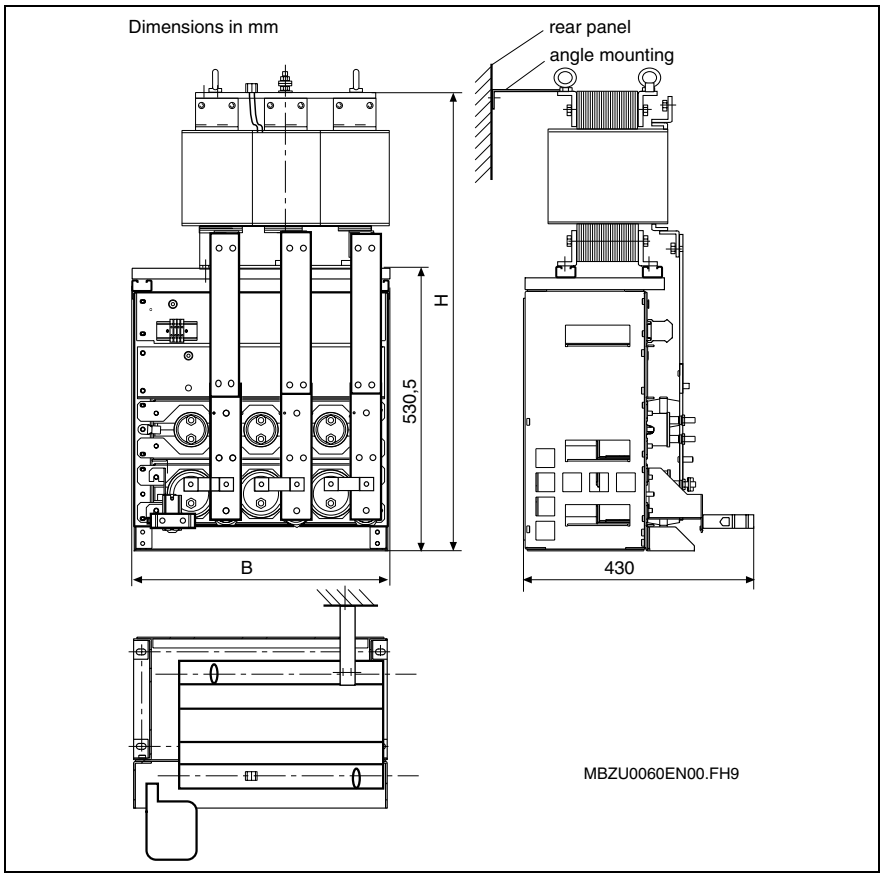


Figure 5-7: Dimension drawing assembly HNL - HNP

HNP01.1-04K2-Rxxxx-A-480-NNNN		
xxxx	**B**	**H**
0450	476	893,5
0650	506	958,5

Dimension in mm

Figure 5-8:: Drawing assembly HNL - HNP

At mounting in control cabinet, the input choke must fixed inside the cabinet.

Note: The Sine Power Filter (HNL01.1 + HNP01.1) can only be run in combination with the 4.2 kHz mains inverter pulse frequency adjusted at works. If it becomes necessary to modify the pulse frequency, you are expected to have this operation executed by our service staff.

Filter capacitor HNP – Input inverter choke HNL

The connection is made with terminal bars in the assembly example provided.

Terminal connection HNP – HNL SFT 250 kW / 350 kW	
Recommended min. cross section	60 x 6 mm²
Connection on HNP	2 x stud bolt M10
Connection on HNL	2 x threaded hole M10

Figure 5-9: Terminal connection HNP – HNL SFT 250 kW / 350 kW

The following terminal bars are associated:

Order number RZU-E07-SFT-250-350kW (terminal bar set)

Terminal bars
1 x HNP350-HNL L1 A
1 x HNP350-HNL L1 B
1 x HNP350-HNL L1 C
1 x HNP350-HNL L2 A
1 x HNP350-HNL L2 B
1 x HNP350-HNL L2 C
1 x HNP350-HNL L3 A
1 x HNP350-HNL L3 B
1 x HNP350-HNL L3 C

Figure 5-10: Terminal bars

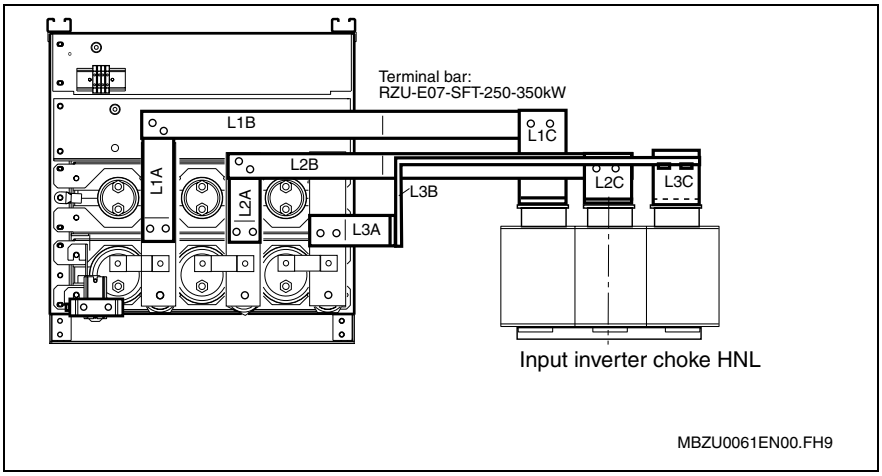


Figure 5-11: Location diagram terminal bars HNL - HNP

Cable connection HNP – HNL SFT 250 kW / 350 kW			
		SFT 250 kW	SFT 350 kW
Recommended min. cross section	mm²	2 x 120 / 2 x 250MCM	2 x 240 / 2 x 500MCM
Max. cable length	m	2	
Conductor cross sections that can be connected		terminal bar connection	
Connection		Per 2 x stud M10	

Figure 5-12: Cable connection HNP – HNL SFT 250 kW / 350 kW

Input inverter choke HNL – Line Power supply module NAM

The connection is made with terminal bars in the assembly example provided. The respectively three terminal bars designed to be connected between the NAM Line Power supply module and the HNL Input inverter choke can then be directly routed to the copper surfaces of the choke.

Order number RZU-E07-SFT-250-350kW (terminal bar set)

Terminal connection HNL - NAM SFT 250 kW / 350 kW	
Terminal bar NAM choke	HNL to NAM

Terminal bars L1, L2, L3

Figure 5-13: Terminal connection HNP – NAM SFT 250 kW / 350 kW

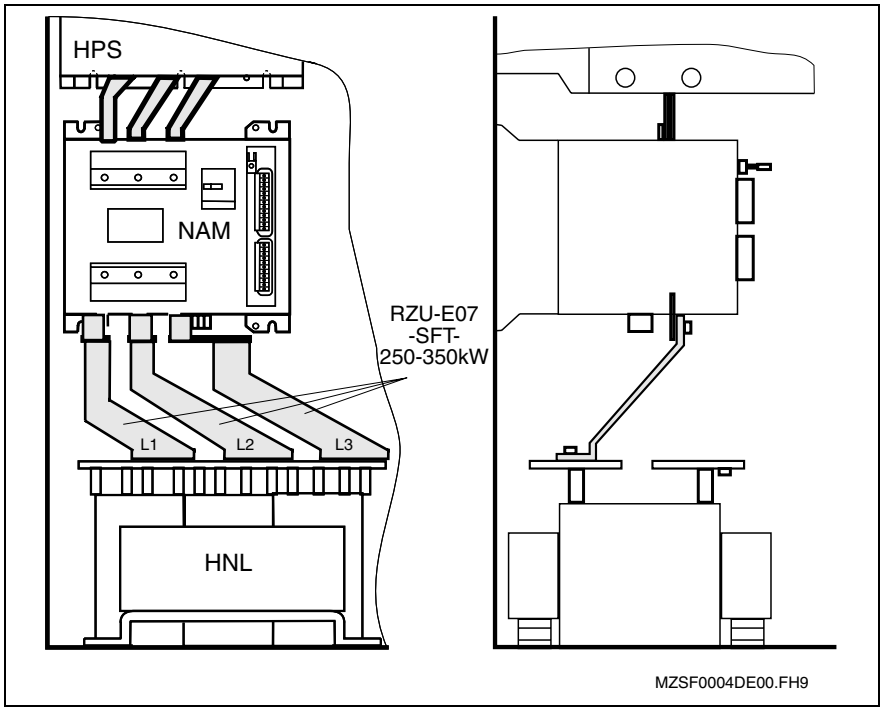


Figure 5-14: Location diagram terminal bars HNL - NAM

If the connection is to be made by cable then cable lugs connections must be used.

Cable connection HNL – NAM SFT 250kW / 350 kW				
	SFT 250kW		SFT 350kW	
Conductor cross sections that can be connected in [1] mm²	2 x 120	2 x 250MCM	2 x 240	2 x 500MCM
Max. cable length m	2			
Connection on HNL	2 x threaded hole M10			
Connection on NAM	1 x threaded hole M10			

1): as use as Single - core cable

Figure 5-15: cable connection HNP – NAM SFT 250 kW / 350 kW

Line Power supply module NAM – Power stack HPS

The connection is made with terminal bars in the assembly example provided.

Order number RZU-E07-SFT-250-350kW (terminal bar set)

Terminal connection NAM - HPS SFT 250 kW / 350 kW	
Terminal bar SFT PST - NAM	NAM to HPS

Terminal bars L1, L2, L3

Figure 5-16: Terminal connection NAM – HPS SFT 250 kW / 350 kW

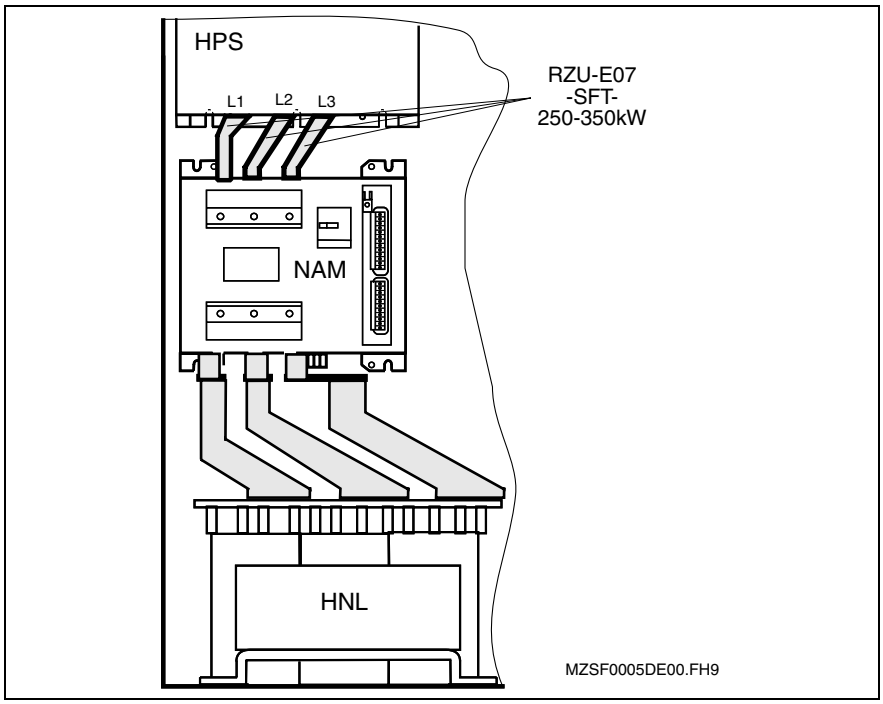


Figure 5-17: Location diagram terminal bars NAM - HPS

Note: To achieve an extensive seating for the terminal bars, the enclosed prismatic, self-sealing inlay profiles must be used.

The prismatic, self-adhesive screwless spring cage clamp terminals are enclosed and must match (i.e. compensate for) the V-form of the case base of the terminal when using terminal bars. They must therefore be inserted accordingly. The three terminal bars designed to be connected between the NAM line power supply module and the HPS can then be directly routed in the terminal.

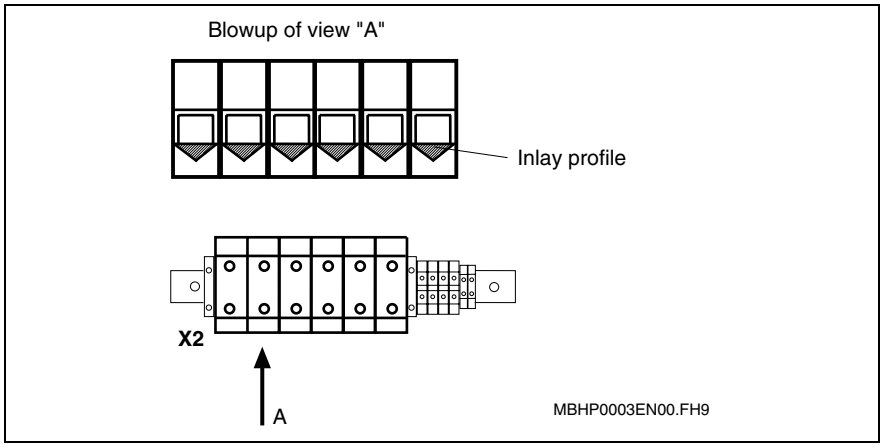


Figure 5-18: Inlay profiles (screwless spring-cage type) when using terminal bars

If the connection is to be made by cable then the prisms (V blocks) must not be used.

Cable connection NAM - HPS SFT 250 kW / 350 kW				
	SFT 250kW		**SFT 350kW**	
Recommended min. cross section [1] mm²	2 x 120	2 x 250MCM	2 x 240	2 x 500MCM
Max. cable length m	2			
Connection on NAM	1 x threaded hole M10			
Connection on HPS [2]	2 x clamp 240 mm² (500MCM)			

1): as use as Single - core cable
2): both clamp must be assigned

Figure 5-19: cable connection NAM - HPS SFT 250 kW / 350 kW

If self-fabricated terminal bars are to be used when assembling the components in a manner not as described in the assembly example, then the following instructions must be observed:

- ensure sufficient minimum code distance between bars
- sufficient dimensioning with respect to the electrical load
- use only untreated or tin-coated copper terminal bars

DC – link connection HPS - HPS

To connect the HPS01.1 power section in a control panel, tin-coated terminal bars must be used for the C and D potential. The length of the bars is indicated in the table.

Note: No untreated copper bars may be screwed onto the aluminum bars of the HPS power section.

Order number RZU-E07-SFT-250-350kW (terminal bar set)

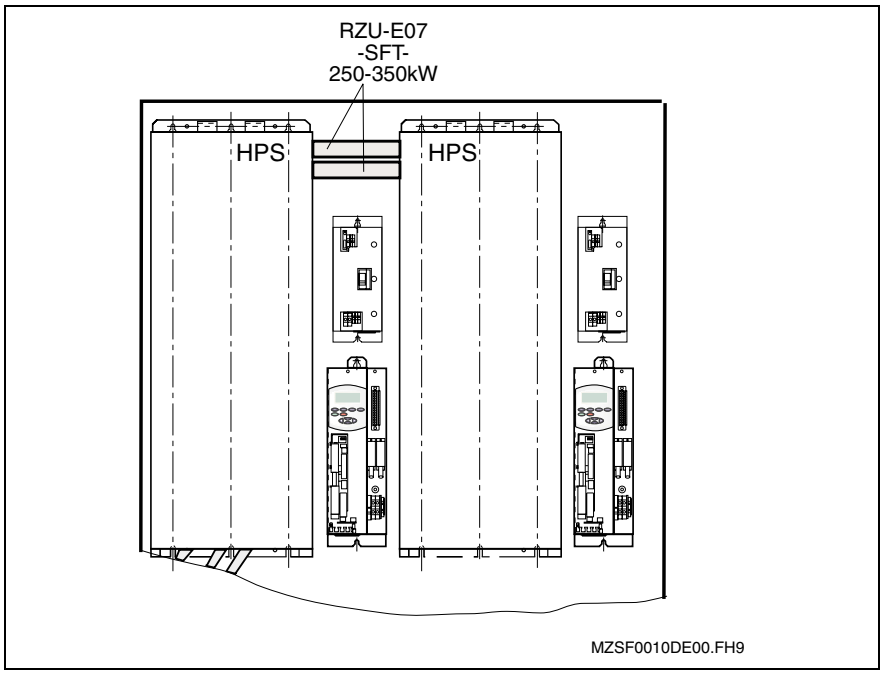


Figure 5-20: Location diagram terminal bars HPS - HPS

Bars – DC-coupling of two HPS Power Stacks in the cabinet (1200 mm wide)				
	Recommended minimum cross section of the copper bar mm²	Length of copper bar designed mm	Connection to C and D bar	Max. DC fuse type gL A
SFT 250 kW	400	670	3 x M10 threaded hole	600
SFT 350 kW	400	670	3 x M10 threaded hole	800

Figure 5-21: DC – coupling with bars

To connect the terminal bars to the HPS, the lid off the unit must be removed by releasing the four screw-and-washer assemblies on the front side. The terminal bars must be screwed to the C and D bars of the HPS at all three screws. The stipulated torque is 35 Nm.

HPS – Motor circuit (when using output chokes and current transformer)

Unit	Balancing Chokes	Aggregate Current Transformer
SFT 250	3 x RZU-E03-HPS01.1-F0610	1 x RZU-E01-HPS01.1-F0610 / F0880
SFT 350	3 x RZU-E04-HPS01.1-F0880	1 x RZU-E01-HPS01.1-F0610 / F0880

Figure 5-22: HPS – motor circuit

The output chokes are connected with the long cable ends to terminals U2, V2, W2 of the HPS01.1M power section at the motor end. Both terminals of a phase must be connected each time with the same number of power cables. The short cable ends are routed through the current transformer (RZU-E01-HPS01.1M-F0610/F0880 and connected to the motor bars. Make sure that the phases are not confused!

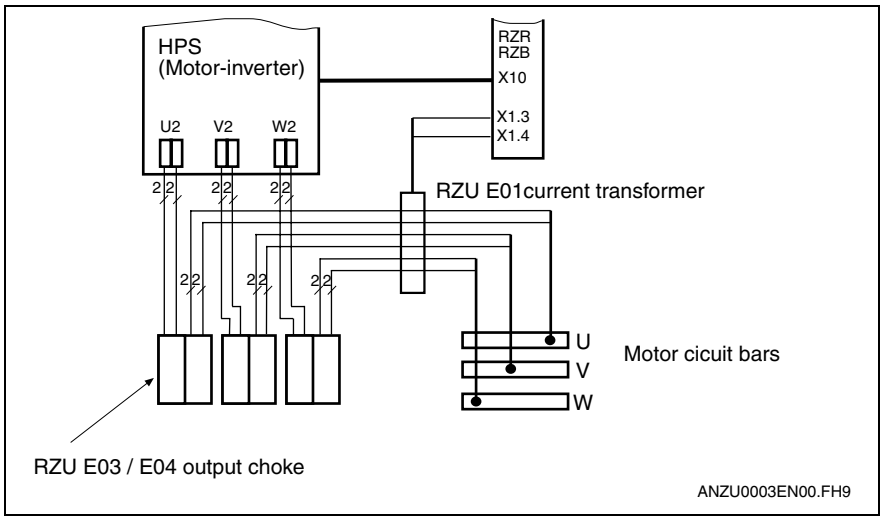


Figure 5-23: Connection HPS – Motor circuit

Wiring of controller connections SFT 250 kW / 350 kW

Voltage synchronization line power supply module NAM – input filter HNF

The cable used to connect the NAM X30 line power supply module with the connections of the HNF input filter at the load end must be as short as possible and bunched together and connected using a reinforced insulation cable.

Recommendation Industrial cable, type DLO, dielectric strength 2 kV, 90 °C, UL1581, AWG 10 (6 mm^2), or Pirelli rubber insulated wire NSGAFÖU 6 mm², short-circuit proof acc. to DIN VDE0250 TEIL602.

Note: As the phase sequence of the mains voltage is decisive for operation of the power inverter, you must make sure that the phases are connected to the input filter at terminal X30 in accordance to the terminal description. The phase sequence L1-L2-L3 must be a clockwise phase sequence.

Connection NAM X30 to HNF L1´, L2´, L3´ SFT 250 kW / 350 kW		
	SFT 250 kW	**SFT 350 kW**
Recommended min. cross section	6 mm² / AWG 10	
Max. cable length m	2	
Conductor cross sections that can be connected in mm²	0.5 – 16 AWG 20 - 4	
Connection of line filter at load end	Cable clips M10 x 6 mm²	Cable clips M12 x 6 mm²

Figure 5-24: Connection of NAM X30 to HNF SFT 250 kW / 350 kW

Line power supply module NAM – controller for HPS RZR Control cable RZU-E05-RNA01/NAM01

The 120 cm cable RZU-E05-RNA01/NAM01 (delivered with the unit) from the NAM Line power supply module (connection X20) to the controller for HPS RZR (connection X14 / X18) is equipped on both ends with screening braiding. This braiding must be connected to the metal surfaces (conductive) using the screening attachments supplied for this purpose.

Note: The cable must not be laid parallel to the power cables or only a short distance from them.

To fabricate the cables yourself, please observe the description in Figure 5-31. The lengths of the cables must not exceed 300 cm.

Note: The cords have to be linked only at the mains side of RZR.

Controller for HPS RZR – current transformer RZU

The connector cables of the current transformer are connected to the RZR01.1 controller box (X1.3, X1.4) of the corresponding motor inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	300 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)
design	twisted with mesh size max. 2 cm

Figure 5-25: Recommended cable Controller for HPS RZR – current transformer RZU

Note: The connector cables of the aggregate current transformer must not be routed along the power wiring. The cables have to be twist.

CAREFUL

Damage to property due to component overload!

⇒ The inverter may only be switched on when the current transformer is connected to the controller box RZR.

Controller for HPS RZR – Power section HPS

1. Cable W10 for IGBT – control signals. This connection of the RZR (X10) controller box to the HPS power section is a fixed element of the HPS01.1 Power-Stack.
2. Connection RZR X2.C1 to HPS X2.C1 (DC+) and RZR X2.D1 to HPS X2.D1 (DC-).

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	1000 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure 5-26: Recommended cable Controller for HPS RZR – power section HPS

CAREFUL

Voltage until 1000 V !

Note: Cords with a reinforced isolation layer are not necessary, since the lines are fused by 4A at the HPS.

Controller for HPS RZR – Power module NTM

The power module NTM02.1-230-024-15 must be arranged for both motor and mains side inverters. In the stand-by mode, the current supply takes place by means of AC230 V. During operation, the power is drawn from DC link.

Power module NTM – Power section HPS

1. Connection NTM X1.C1 to HPS X2.C1 (DC+) and from NTM X1.D1 to HPA X2.D1 (DC-).

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	1000 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure 5-27: Recommended cable Power module NTM – Power section HPS

CAREFUL

Voltage until 1000 V !

Note: Cords with a reinforced isolation layer are not necessary, since the lines are fused by 4A at the HPS.

2. 24 V supply for indoor fan HPS on X2.1 (24 V) and X2.2 (0 V).

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	300 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure 5-28: Recommended cable 24 V – indoor fan HPS

Power module NTM – controller for HPS RZR

24 V supply for Controller RZR

NTM X2.1 – RZR X1.1 / NTM X2.2 – RZR X1.2.

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	300 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure 5-29: Recommended cable 24 V – supply for controller for HPS RZR

Filter Capacitor HNP – Input choke HNL – Input inverter choke HNL – Controller for HPS RZR

The HNP and HNL components are equipped with thermal switches in order to detect overtemperature.

The thermal switches are wired in series and should be connected with terminals X15.1 and X15.2 of the control unit.

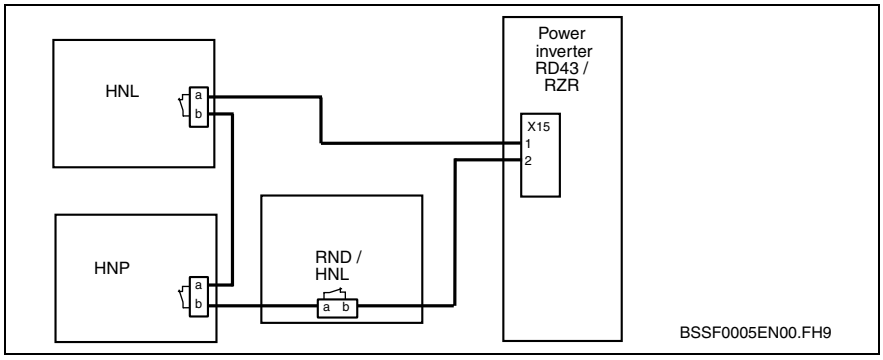


Figure 5-30: Schematic circuit diagram of the wiring of the thermal switches

Note: If overtemperature occurs then the power inverter shuts-off (fault shut-off). The Parameterization of Power inverter have to be linked at Figure 12-38 (status delivery).

The minimum cross-section for the cable is 1.5 mm² (AWG 16).

More wiring

For the connection of the external supply voltages of components NAM, HNP and NTM, please consult the project planning manual DOK-RD500*-SFT********-PR-0x-EN-P.

5.4 Control cable RZU-E05-RNA01/NAM01-160-350kW

The connection from the line power supply module to the controller box is established using a prefabricated cable for the SFT 160kW - SFT 350kW.

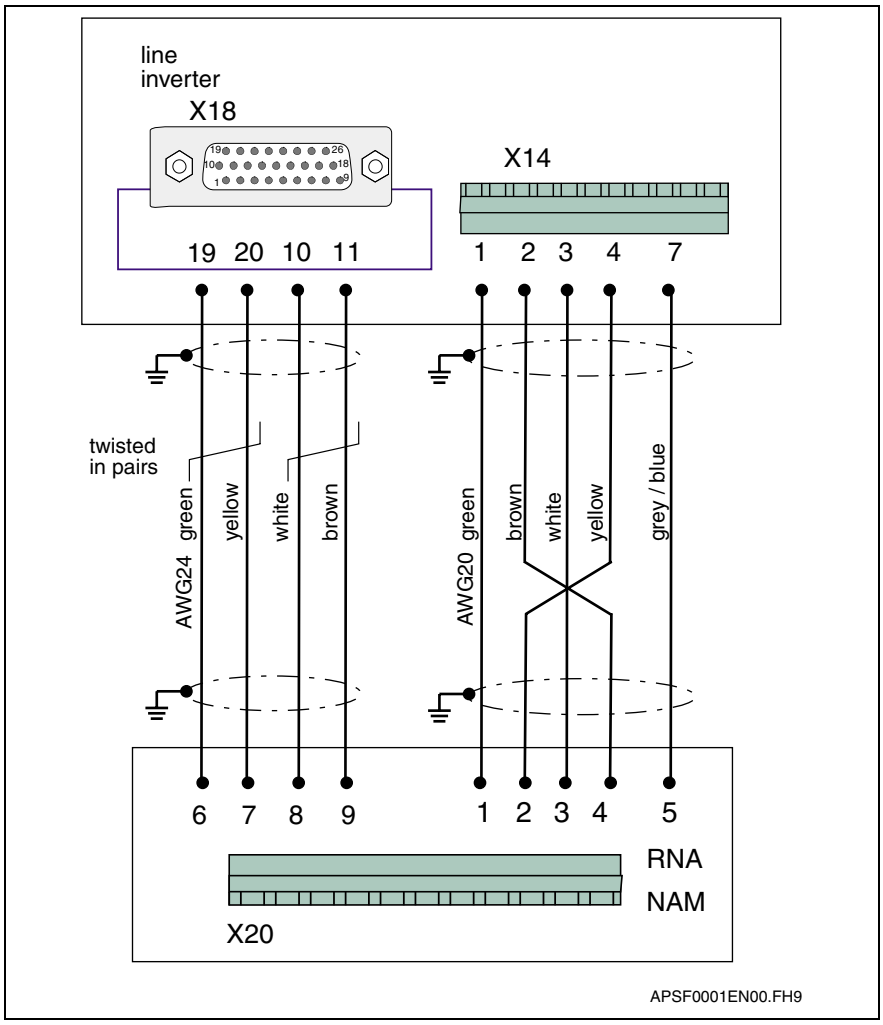
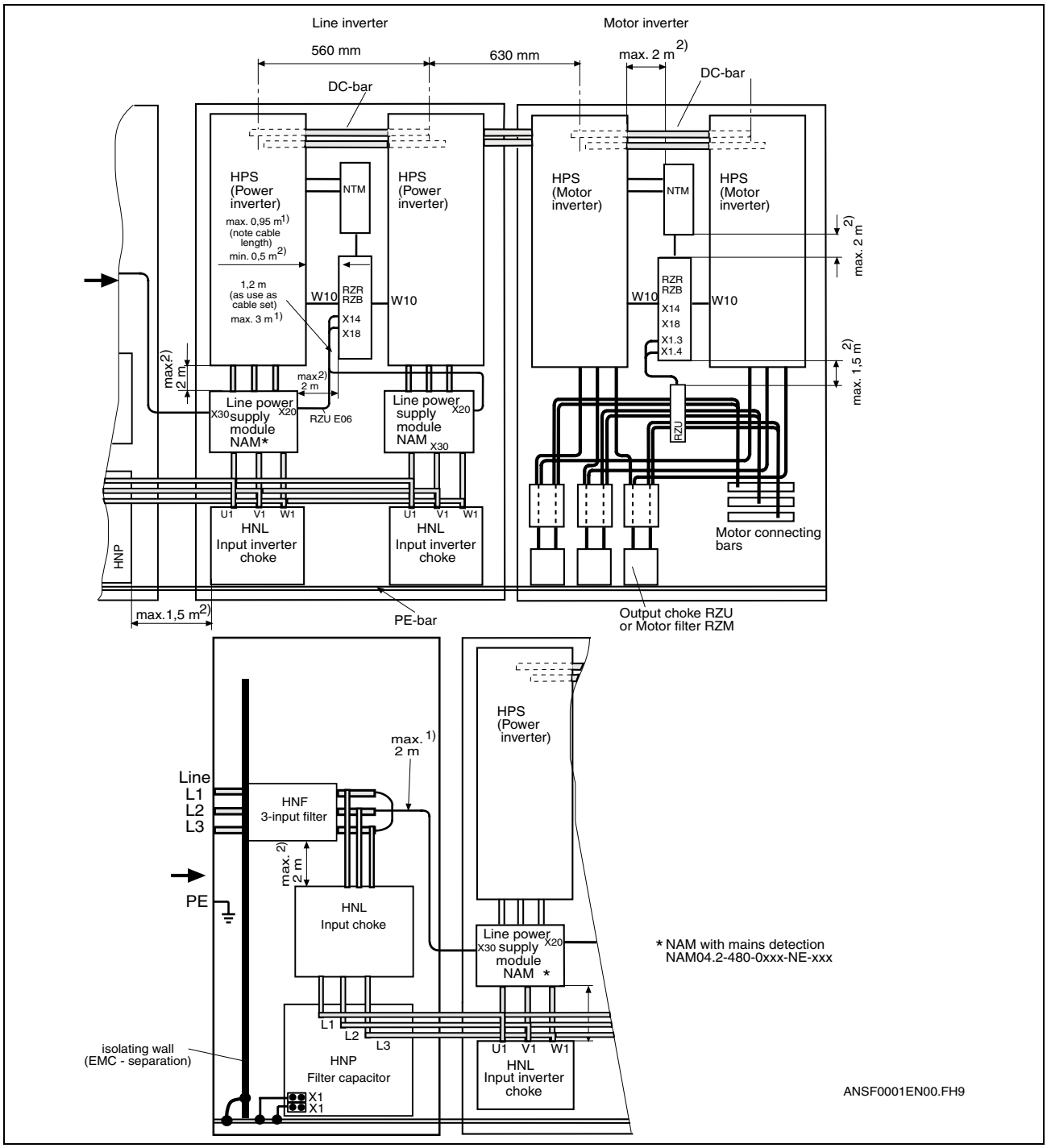


Figure 5-31: Control cable 160 / 250 / 350 kW (RZU-E05-RNA01/NAM01-160-350kW)

6 Arrangement and Wiring of the Components SFT 450 kW / 650 kW

The Rules for Installation of Drives According to must be respected chapter 7.5.

6.1 Arrangement Example of the Components SFT 450 / 650



1): Maximum cable lengths (observe planning instructions)
2): Maximum assembly distance

Figure: 6-1: Arrangement of components SFT 450 kW / 650 kW

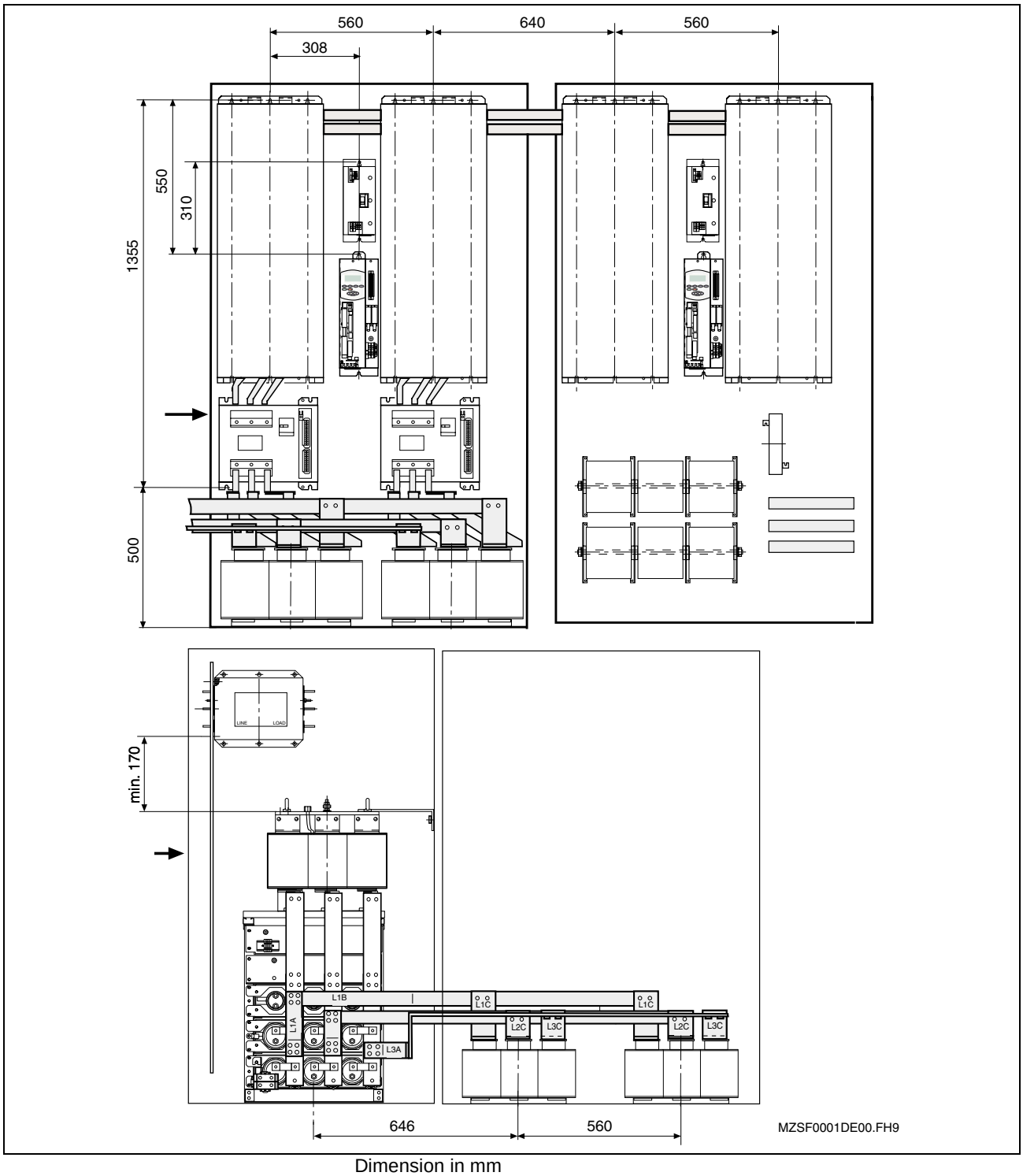
Note: Minimum clearances (for air inlets and outgoing air) or maximum clearances (cable lengths) must be observed. The project planer of the control cabinet has to make sure that the quantity of air specified in the project planning manual is respected for the respective components.

Note: The EMC requirements are only met for the arrangement example stipulated.

If deviations are made to the arrangement of the components from the assembly instructions provided then the instructions regarding a design of the cabinet that conforms to EMC requirements must be observed. The EMC requirements must also be observed.

6.2 Mounting Clearances of the Individual Components when using the associated Bars

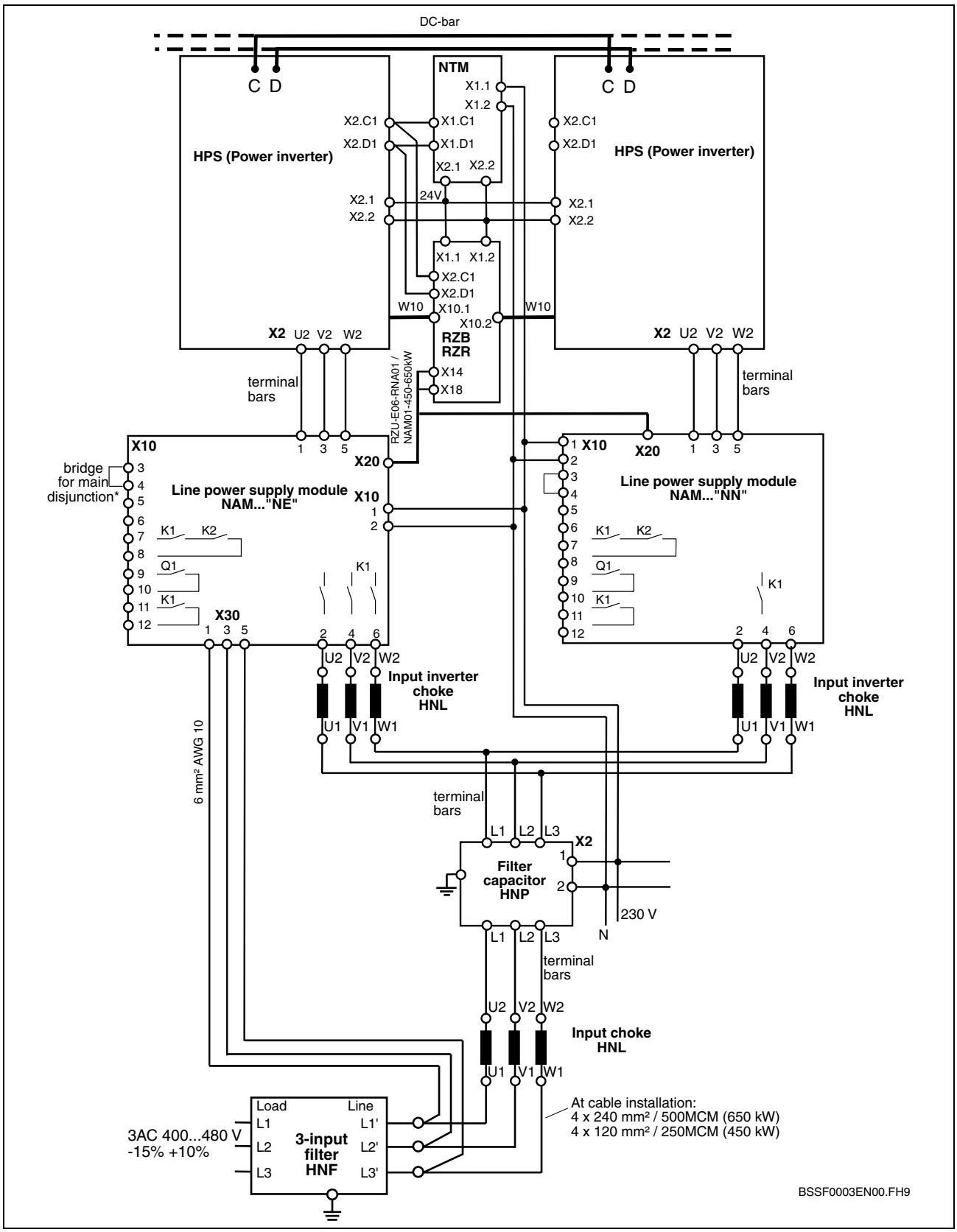
It is recommendable when use the associated bars. The mounting clearance distances must be observed!



Dimension in mm

Figure: 6-2: Mounting distances of the components SFT 450 kW / 650 kW

6.3 Complete Wiring of the Components SFT 450 kW / 650 kW



*): Bridge for mains disjunction: Removing the bridge prevents K1 and K2 from being switched on. Thus the power section of the inverter remains disconnected from the mains.

Figure: 6-3: Wiring of the Components SFT 450 kW / 650 kW (Line inverter)

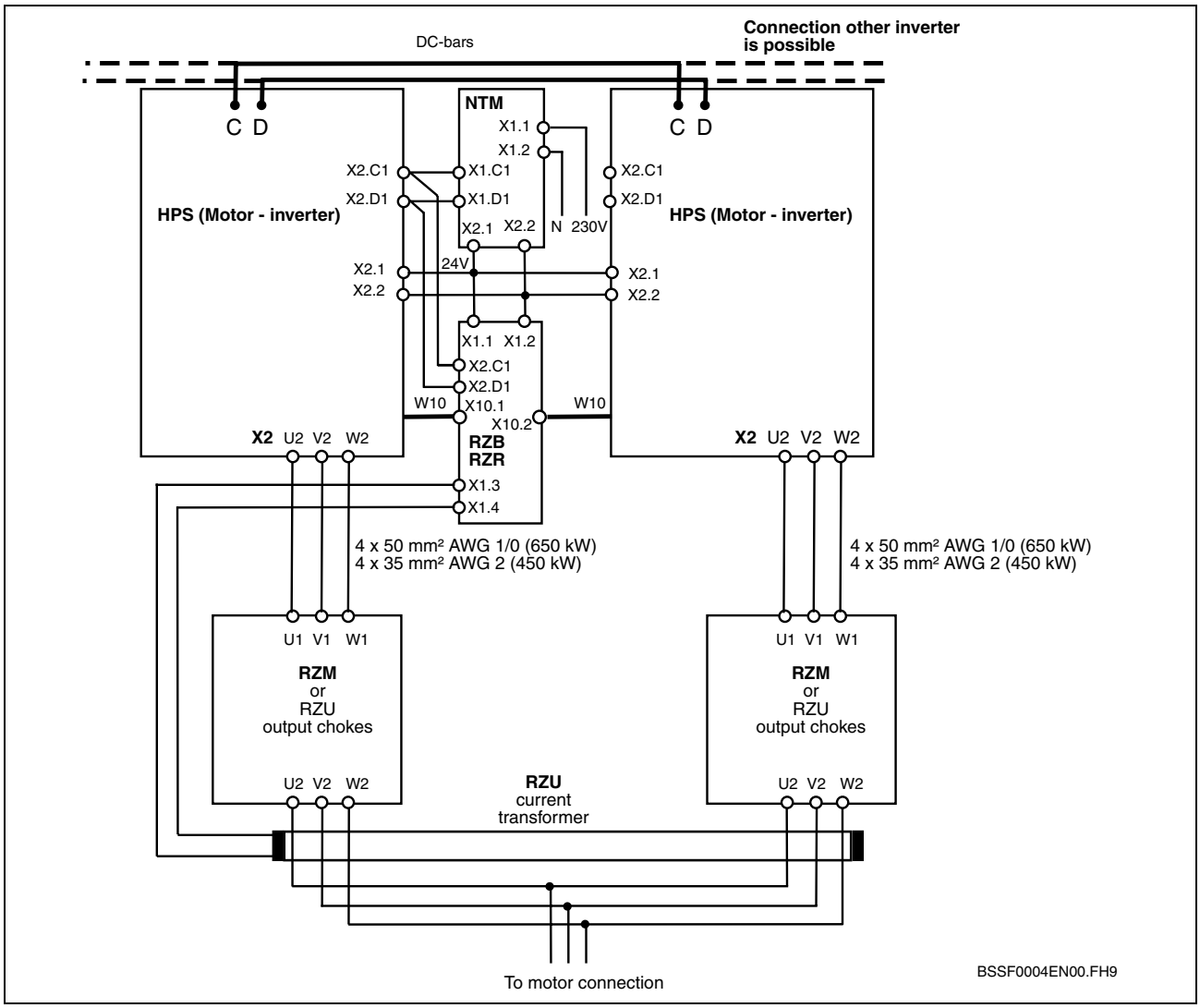


Figure: 6-4: Wiring of the Components SFT 450 kW / 650 kW (Motor inverter)

Wiring of Power connections SFT 450 kW / 650 kW

Note: Current-bearing have to be guarded against unauthorized access by means of a protective hood.

Note: Parallel connected cable (same phase) must have the same length. Please lead the cables as close as possible and prevent them from forming loops. You are expected to observe the minimal radius of bend.

Note: Please pay particular attention to the description of the components in the project planning manual.

3-phase input filter HNF – Input choke HNL

3-phase input filter – Input choke HNL SFT 450 kW		
Cu – terminal bars	Recommended min. cross section 40 x 10 mm²	
Recommended cable	Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section	4 x 120 mm²	4 x 250MCM (194 °F)
Connection on HNF	Bore hole for screw M12	
Connection on HNL	2 x threaded hole M12 tightening torque 50 Nm	
3-phase input filter – Input choke HNL SFT 650 kW		
Cu – terminal bars	Recommended min. cross section 60 x 10 mm²	
Recommended cable	Single - core cable PVC isolated (min. 90°C)	
Recommended min. cross section	4 x 240 mm²	4 x 500MCM (194 °F)
Connection on HNF	Bore hole for screw M12	
Connection on HNL	2 x threaded hole M12 tightening torque 50 Nm	

Figure: 6-5: Connection 3-phase input filter HNF – Input choke HNL

You are invited to take care of the minimum voltage distance towards the housing when connecting the conductors with the terminal bars of the HNF.

For reasons of EMC, the filter has to be mounted to one of the isolating wall by its line side. Therefore please use the existing tapped bores. In addition to this, the separating wall is in charge of the filter's low-inductive ground connection.

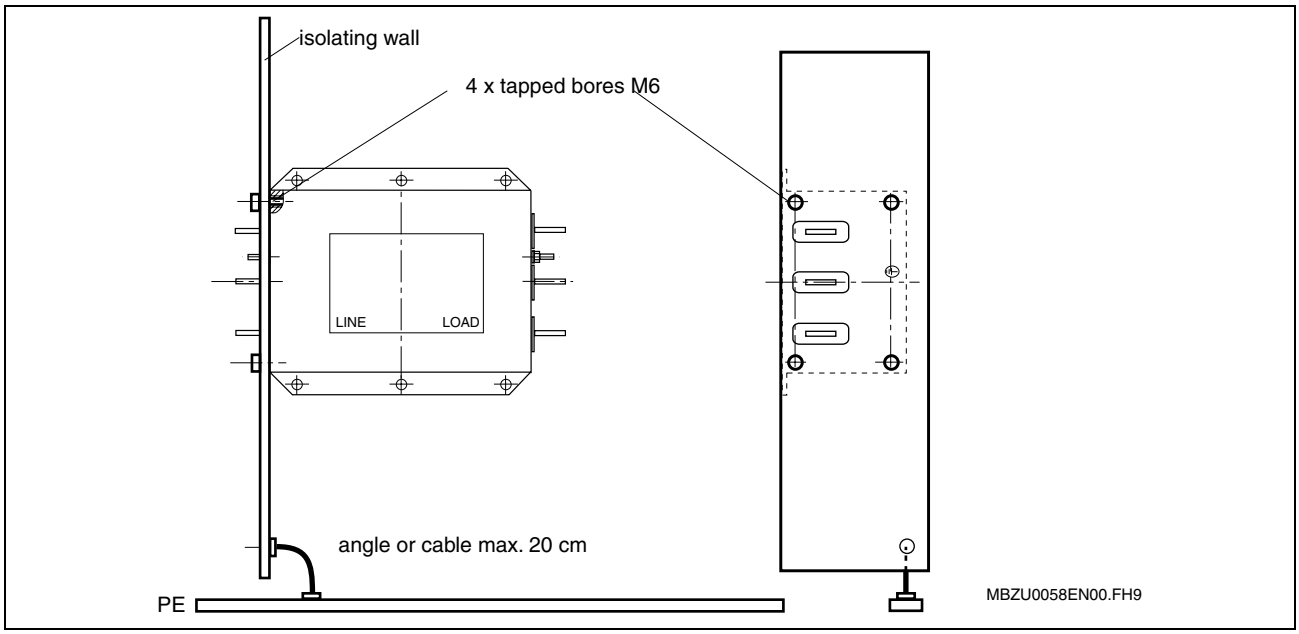


Figure: 6-6: Mounting isolation wall

PE – Connection 3-input filter

For safety reasons, the protective wire between the isolating wall and the PE bar must have

- at least half of the cross-section of the outer conductor.
- **It must be permanently fixed**. (It may only be loosened using tools).
- be kept within a length of 20 cm

The reason for this is the high leakage current of the input filter in the ground conductor that can arise due to an imbalance in the three-phase AC system or during a phase failure. Input filters must therefore always be grounded before switching them on for the first time. There are suitable connections for this in the machine, in the system and in the control cabinet.

Note: For reasons of EMC, the notes given in the preceding paragraphs must be observed in any case. A ground connection via a line tap to the PE terminal bar is not sufficient.

Input choke HNL - Filter capacitor HNP

You are obliged to use the assigned terminal bars contained in the HNP. It is impossible to wire the components. The mounting distance of these components are fixed.

Connection HNL – HNP SFT 450 kW / 650 kW	Cross section
Recommended min. cross section	10 x 60 mm²
Connection	2 x bore hole M12

Figure: 6-7: Connection HNL – HNP SFT 450 kW / 650 kW

Dimension drawing assembly HNL - HNP

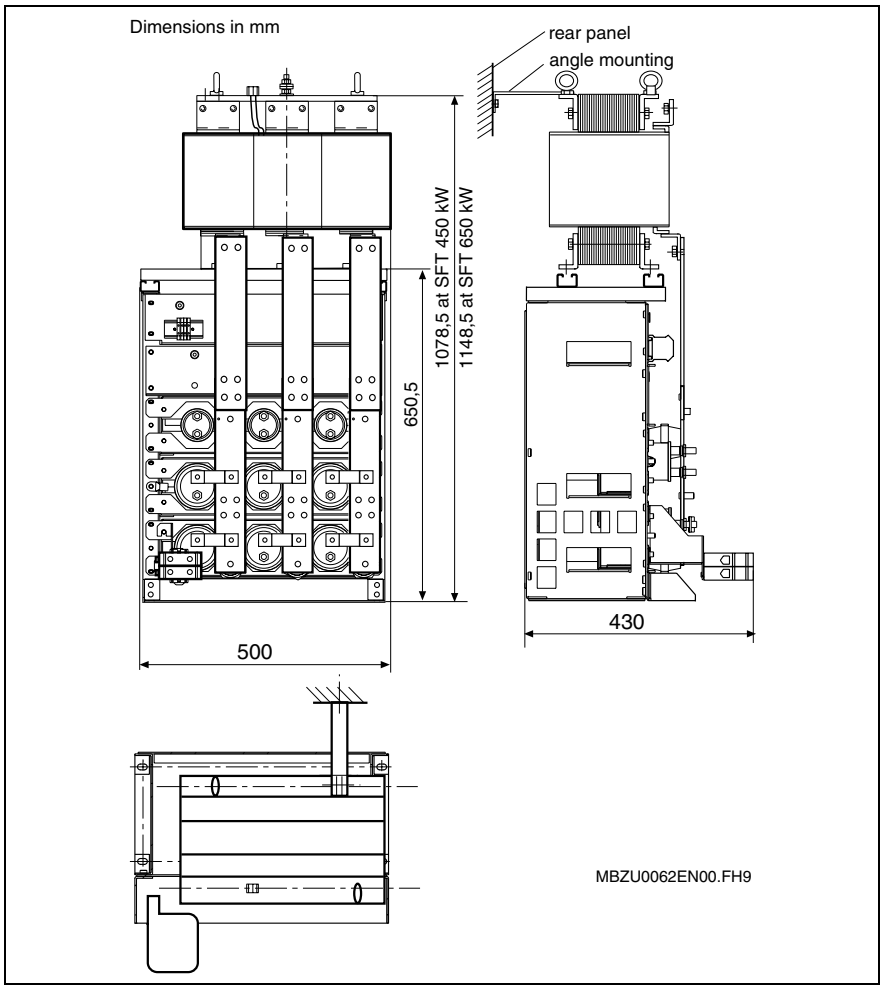


Figure: 6-8: Dimension drawing assembly HNL - HNP

At mounting in control cabinet, the input choke must fixed inside the cabinet.

Note: The Sine Power Filter (HNL01.1 + HNP01.1) can only be run in combination with the 4.2 kHz mains inverter pulse frequency adjusted at works. If it becomes necessary to modify the pulse frequency, you are expected to have this operation executed by our service staff.

Filter capacitor HNP – Input inverter choke HNL

The connection is made with terminal bars in the assembly example provided. The three terminal bars intended for this purpose that are routed from the HNL power inverter choke to the filter capacitor unit are fixed at the studs constructed for this purpose.

Terminal connection HNP – HNL SFT 450 kW / 650 kW	
Recommended min. cross section	60 x 10 mm²
rail length	740 mm
Connection on HNP	4 x stud bolt M10
Connection on HNL	Per 2 x threaded hole M10

Figure: 6-9: Terminal connection HNP – HNL SFT 450 kW / 650 kW

The following terminal bars are associated:

Order number RZU-E08-SFT-450-650kW (terminal bar set)

Terminal bars
1 x HNP350-HNL L1 A
1 x HNP350-HNL L1 B
2 x HNP350-HNL L1 C
1 x HNP350-HNL L2 A
1 x HNP350-HNL L2 B
2 x HNP350-HNL L2 C
1 x HNP350-HNL L3 A
1 x HNP350-HNL L3 B
2 x HNP350-HNL L3 C

Figure: 6-10: Terminal bars

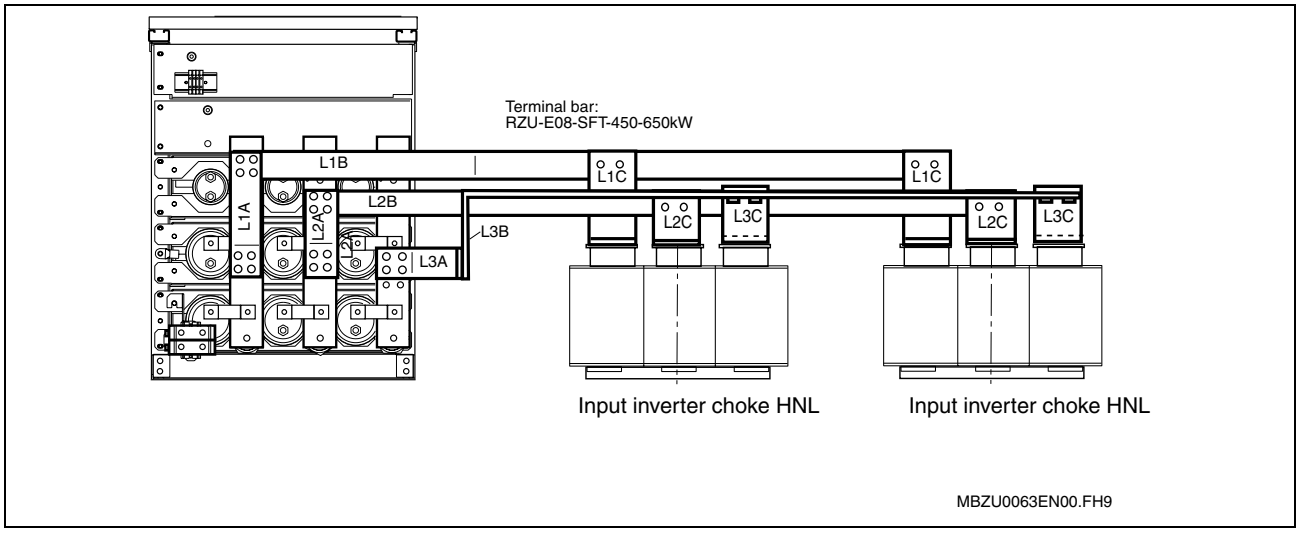


Figure: 6-11: Location diagram terminal bars HNL - HNP

Cable connection HNP – HNL SFT 2450 kW / 650 kW		
	SFT 450 kW	**SFT 650 kW**
Recommended min. cross section mm²	2 x 2 x 120 / 2 x 2 x 250MCM	2 x 2 x 240 / 2 x 2 x 500MCM
Max. cable length m	2 at a distance to choke	
Conductor cross sections that can be connected	terminal bar connection	
Connection HNP	Per 4 x stud M10	
Connection HNL	Per 2 x threaded hole M10	

Figure: 6-12: Cable connection HNP – HNL SFT 450 kW / 650 kW

Input inverter choke HNL – Line power supply module NAM

The connection is made with terminal bars in the assembly example provided. The respectively three terminal bars designed to be connected between the NAM Line Power supply module and the HNL Input inverter choke can then be directly routed to the copper surfaces of the choke.

Order number RZU-E08-SFT-450-650kW (terminal bar set)

Terminal connection HNL - NAM SFT 450 kW / 650 kW	
Terminal bar NAM choke	HNL to NAM

Terminal bars L1, L2, L3

Figure: 6-13: Terminal connection HNP – NAM SFT 450 kW / 650 kW

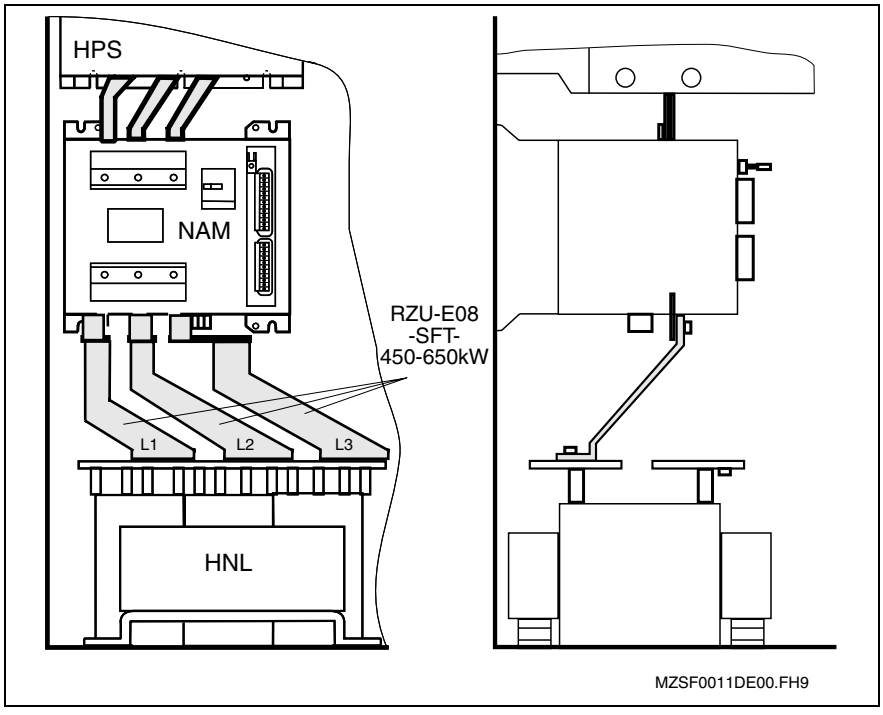


Figure: 6-14: Location diagram terminal bars HNL - NAM

If the connection is to be made by cable then cable lugs connections must be used.

Cable connection HNL – NAM SFT 450kW / 650 kW		
	SFT 450kW	**SFT 650kW**
Conductor cross sections that can be connected in [1] mm²	20 x 120 / 2 x 250MCM	2 x 240 / 2 x 500MCM
Max. cable length m	2	
Connection on HNL	2 x threaded hole M10	
Connection on NAM	1 x threaded hole M10	

1): as use as Single - core cable

Figure: 6-15: cable connection HNP – NAM SFT 450 kW / 650 kW

Line Power supply module NAM – Power stack HPS

The connection is made with terminal bars in the assembly example provided.

Order number RZU-E08-SFT-450-650kW (terminal bar set).

Terminal connection NAM - HPS SFT 450 kW / 650 kW	
Terminal bar SFT PST - NAM	NAM - HPS

Terminal bars L1, L2, L3

Figure: 6-16: Terminal connection NAM – HPS SFT 450 kW / 650 kW

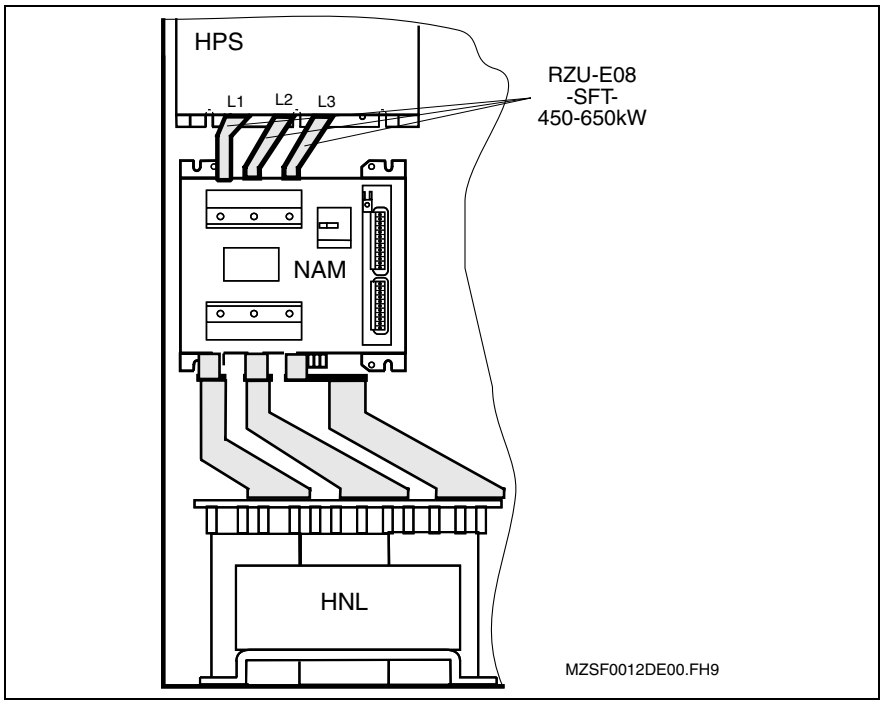


Figure: 6-17: Location diagram terminal bars NAM - HPS

Note: To achieve an extensive seating for the terminal bars, the enclosed prismatic, self-sealing inlay profiles must be used.

The prismatic, self-adhesive screwless spring cage clamp terminals are enclosed and must match (i.e. compensate for) the V-form of the case base of the terminal when using terminal bars. They must therefore be inserted accordingly. The three terminal bars designed to be connected between the NAM line power supply module and the HPS can then be directly routed in the terminal.

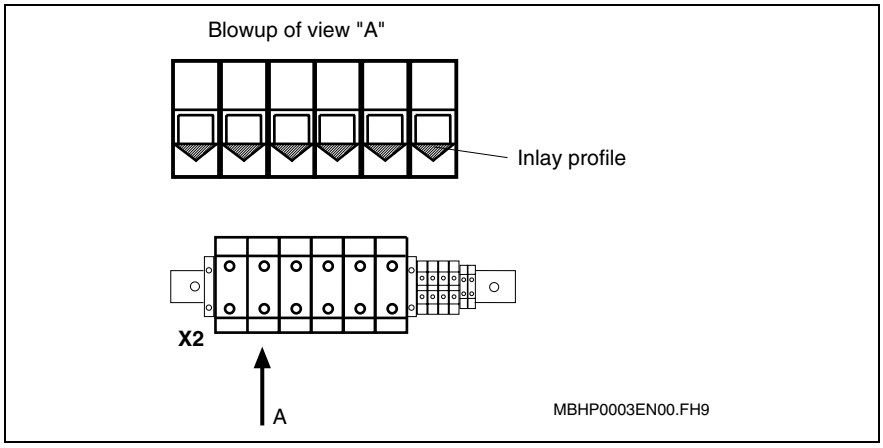


Figure: 6-18: Inlay profiles (screwless spring-cage type) when using terminal bars

If the connection is to be made by cable then the prisms (V blocks) must not be used.

Cable connection NAM - HPS SFT 450 kW / 650 kW		
	SFT 450 kW	**SFT 650 kW**
Recommended min. cross section [1] mm²	2 x 120 / 2 x 250MCM	2 x 240 / 2 x 500MCM
Max. cable length m	2	
Connection on NAM	1 x threaded hole M10	
Connection on HPS [2]	2 x clamp 240 mm² (500MCM)	

1): as use as Single - core cable
2): both clamp must be assigned

Figure: 6-19: cable connection NAM - HPS SFT 450 kW / 650 kW

If self-fabricated terminal bars are to be used when assembling the components in a manner not as described in the assembly example, then the following instructions must be observed:

- ensure sufficient minimum code distance between bars
- sufficient dimensioning with respect to the electrical load
- use only untreated or tin-coated copper terminal bars

DC – link connection HPS - HPS

To connect the HPS01.1 power section in a control panel, tin-coated terminal bars must be used for the C and D potential. The length of the bars is indicated in the table.

Note: No untreated copper bars may be screwed onto the aluminum bars of the HPS power section.

Order number RZU-E08-SFT-450-650kW (terminal bar set).

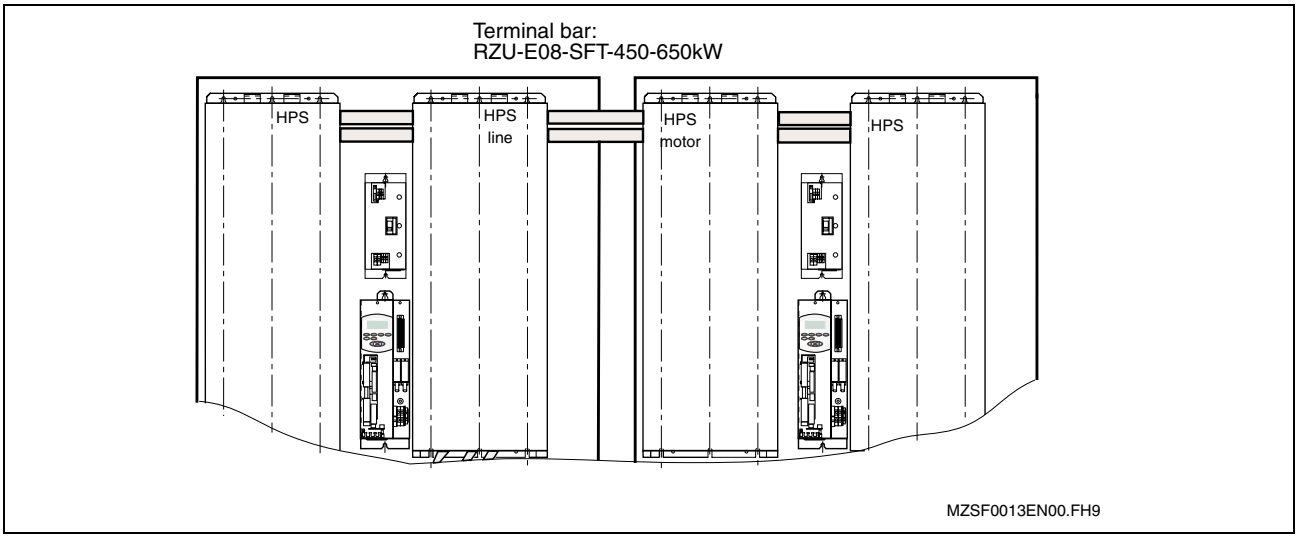


Figure: 6-20: Location diagram terminal bars

Bars – DC-coupling of two HPS Power Stacks in the cabinet (1200 mm wide)			
	Recommended minimum cross section of the copper bar mm²	Length of copper bar designed mm	Connection to C and D bar
SFT 450 kW	400	670	3 x M10 threaded hole
SFT 650 kW	400	670	3 x M10 threaded hole

Figure: 6-21: DC – coupling with bars

To connect the terminal bars to the HPS, the lid off the unit must be removed by releasing the four screw-and-washer assemblies on the front side. The terminal bars must be screwed to the C and D bars of the HPS at all three screws. The stipulated torque is 35 Nm.

DC – link connection HPS power inverter– Motor HPS Motor inverter

To connect the HPS01.1 power section in a control panel, terminal bars must be used for the C and D potential. The length of the bars is indicated in the table.

Order number RZU-E08-SFT-450-650kW (terminal bar set) see Figure: 6-20.

Bars – DC-coupling of two HPS Power inverter to HPS motor inverter				
	Recommended minimum cross section of the copper bar mm²	Length of copper bar designed mm	Connection to C and D bar	Max. DC fuse type gL A
SFT 450 kW	500	760	3 x M10 screws	1000
SFT 650 kW	500	760	3 x M10 screws	1500

Figure: 6-22: DC – coupling with bars

To connect the terminal bars to the HPS, the lid off the unit must be removed by releasing the four screw-and-washer assemblies on the front side. The terminal bars must be screwed to the C and D bars of the HPS at all three screws. The stipulated torque is 35 Nm.

HPS – Motor circuit (when using output chokes and current transformer)

Unit	**Output Chokes**	**Current Transformer**
SFT 450	6 x RZU-E03-HPS01.1-F0610	1 x RZU-E02-HPS01.1-F0610 / F0880
SFT 650	6 x RZU-E04-HPS01.1-F0880	1 x RZU-E02-HPS01.1-F0610 / F0880

Figure: 6-23: HPS – motor circuit

The output chokes are connected with the long cable ends to terminals U2, V2, W2 of the HPS01.1M power section at the motor end. Both terminals of a phase must be connected each time with the same number of power cables. The short cable ends are routed through the current transformer (RZU-E02-HPS01.1M-F0610/F0880 and connected to the motor bars. Make sure that the phases are not confused!

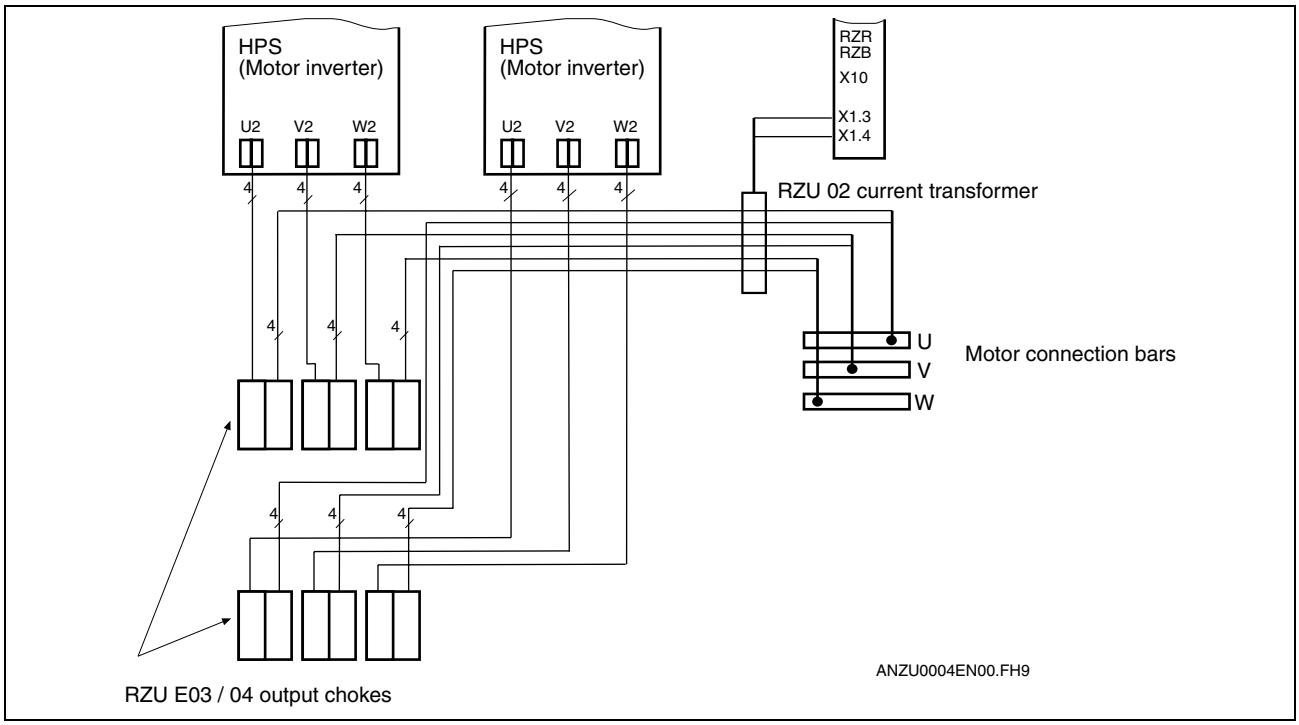


Figure: 6-24: Connection HPS – motor connecting bars

Wiring of controller connections SFT 450 kW / 650 kW

Voltage synchronization line power supply module NAM – input filter HNF

The cable used to connect the NAM X30 line power supply module with the connections of the HNF input filter at the load end must be as short as possible and bunched together and connected using a reinforced insulation cable.

Recommendation Industrial cable, type DLO, dielectric strength 2 kV, 90 °C, UL1581, AWG 10 (6 mm^2), or Pirelli rubber insulated wire NSGAFÖU 6 mm², short-circuit proof acc. to DIN VDE0250 TEIL602.

Note: Only **one** NAM Line power supply module is equipped with mains detection. (see type code of the line power supply module in the planning instructions, Chapter 11).

Note: As the phase sequence of the mains voltage is decisive for operation of the power inverter, you must make sure that the phases are connected to the input filter at terminal X30 in accordance to the terminal description. The phase sequence L1-L2-L3 must be a clockwise phase sequence.

Connection NAM X30 to HNF L1´, L2´, L3´ SFT 450 kW / 650 kW		
	SFT 450 kW	**SFT 650 kW**
Recommended min. cross section	6 mm² / AWG 10	
Max. cable length m	2	
Conductor cross sections that can be connected in mm²	0.5 – 16 / AWG 20 - 4	
Connection of line filter at load end	Cable clips M12 x 6 mm²	

Figure: 6-25: Connection of NAM X30 to HNF SFT 450 kW / 650 kW

Line power supply modules NAM – controller for HPS RZR Control cable RZU-E06-RNA01/NAM01

The 120 cm cable RZU-E06-RNA01/NAM01 (delivered with the unit) from the NAM Line power supply modules (per connection X20) to the controller for HPS RZR (connection X14 / X18) is equipped on both ends with screening braiding. This braiding must be connected to the metal surfaces (conductive) using the screening attachments supplied for this purpose.

Note: The cable must not be laid parallel to the power cables or only a short distance from them.

To fabricate the cables yourself, please observe the description in Figure: 6-32. The lengths of the cables must not exceed 300 cm.

Note: Only execute the connection by the closed loop control box RZR disposed at the mains side. Plug X 20 of the control cord bearing pins 1 – 9 must be connected with NAM04.2-480-0xxx-NE-xxx (NAM at the left). Plug X 20 bearing pins 1 – 5 has to be connected with NAM04.2-480-0xxx-NN-xxx (NAM at the right)

Controller for HPS RZR – current transformer RZU.

The connector cables of the current transformer are connected to the RZR01.1 controller box (X1.3, X1.4) of the corresponding motor inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	300 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)
design	twisted with mesh size max. 2 cm

Figure: 6-26: Recommended cable Controller for HPS RZR – current transformer RZU

Note: The connector cables of the aggregate current transformer must not be routed along the power wiring. The cables have to be twist.

CAREFUL

Damage to property due to component overload!

⇒ The inverter may only be switched on when the current transformer is connected to the controller box RZR.

Controller for HPS RZR – Power section HPS

1. Cable W10 for IGBT – control signals. This connection of the RZR (X10) controller box to the HPS power section is a fixed element of the HPS01.1 Power-Stack.
2. Connection RZR X2.C1 to HPS left X2.C1 (DC+) and RZR X2.D1 to HPS left X2.D1 (DC-). **Remark:** The connections of the HPS right are not occupied.

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	1000 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure: 6-27: Recommended cable Controller for HPS RZR – power section HPS

CAREFUL

Voltage until 1000 V !

Note: Cords with a reinforced isolation layer are not necessary, since the lines are fused by 4 A at the HPS.

Controller for HPS RZR – Power Module NTM

The Power module NTM02.1-230-024-15 must be arranged for both motor and power side inverters. In the standby mode, the current supply takes place by means of AC230V. During operation, the power is drawn from the DC -Link.

Power Module NTM – Power section HPS

1. Connection NTM X1.C1 to HPS left X2.C1(DC+) and NTM X1.D1 to HPS left X2.D1 (DC-). **Remark:** The connections of the HPS right X2.C1 – D1 are not occupied.

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	1000 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure: 6-28: Recommended cable power module NTM – power section HPS

CAREFUL

Voltage until 1000 V !

Note: Cords with a reinforced isolation layer are not necessary, since the lines are fused by 4 A at the HPS.

2. 24 V supply for indoor fan HPS on X2.1 (24 V) and X2.2 (0 V).

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	300 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure: 6-29: Recommended cable 24 V – supply indoor fan HPS

Power module NTM – controller for HPS RZR

24 V supply for Controller RZR

NTM X2.1 – RZR X1.1 / NTM X2.2 – RZR X1.2.

Note: The cords have to be linked both at the mains **and** the motor side of the inverter.

Recommended cable

Kind of cable	Litz wire Cu
electric strength	300 V
Temperature strength	75 °C
Cross section	1.5 mm² (AWG 16)

Figure: 6-30: Recommended cable 24 V – supply for controller for HPS RZR

Filter Capacitor HNP – Input choke HNL – Input inverter choke HNL – Controller for HPS RZR

The HNP and HNL components are equipped with thermal switches in order to detect overtemperature.

The thermal switches are wired in series and should be connected with terminals X15.1 and X15.2 of the control unit.

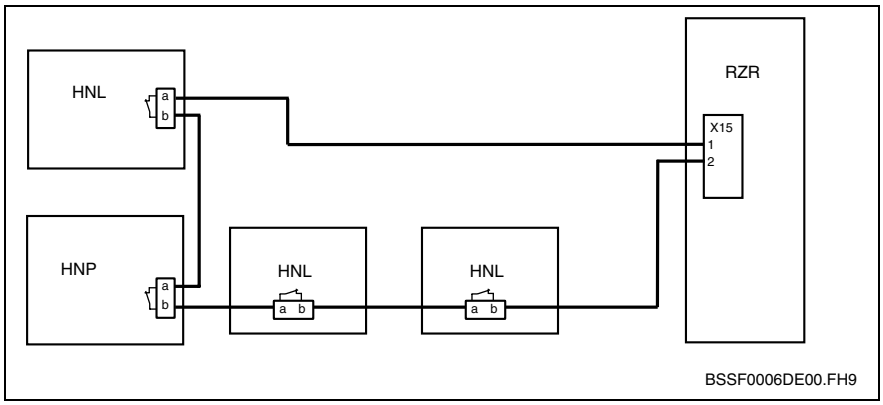


Figure: 6-31: Schematic circuit diagram of the wiring of the thermal switches

Note: If overtemperature occurs then the power inverter shuts-off (fault shut-off). The Parameterization of Power inverter have to be linked at Figure 12-38 (status delivery).

The minimum cross-section for the cable is 1.5 mm² (AWG 16).

More wiring

For the connection of the external supply voltages of components NAM, HNP and NTM, please consult the project planning manual DOK-RD500*-SFT********-PR-0x-EN-P.

6.4 Control cable RZU-E06.RNA01/NAM01-450-650kW

The connection from the line power supply modules to the controller box is established using a prefabricated cable for the SFT 460kW - SFT 650 kW.

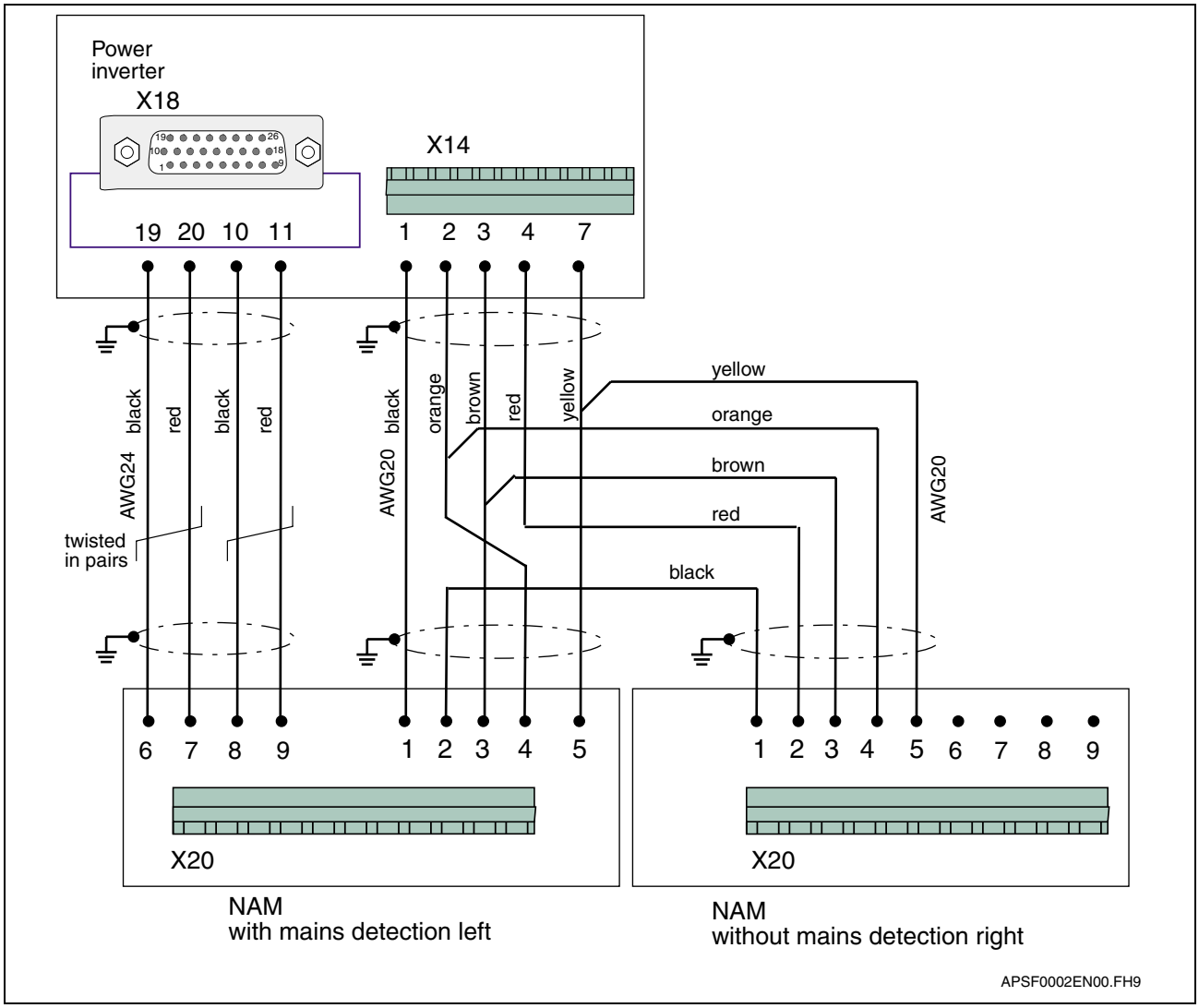


Figure: 6-32: Control cable 460 / 650 kW (RZU-E06.RNA01/NAM01-450-650kW)

7 Requirements for Mains Connection and EMC

7.1 Supply Voltage Range, Equipment Power

The rated value of the mains connection voltage when operating the unit is 3 AC 400 ... 480 V (-15 % +10 %), 50 / 60 Hz (± 2 %). No hardware switching or re-plugging at the described SFT components is required for the stipulated voltage range.

Please note that the input voltage of the inverter is influenced due to the drop in voltage at the mains impedance caused by the inverter mains supply. These voltage changes must not depart from the specified voltage range of the unit. The feed-in transformers must be equipped with tapped coils on the primary side for voltage adjustment (±2.5...5%...7.5%) .

In case of mains voltages < 360 V, the permissible continuous output of the intermediate circuit is reduced by 1% for each 4 V. The minimum operating voltage is 3AC 340 V. A fault switch-off is made for voltages under this value .

In case of mains voltages > 400 V, the permissible maximum continuous current for 400 V must be reduced by 1 % for every 4 V in order to achieve a constant power consumption from the mains.

7.2 Mains Voltage Changes and Changes in the Mains Phase Angle

- max. dynamic voltage change: max. 30 V per 10 ms (average value)
- max. dynamic phase-angle change: max. 5° per 10 ms (average value)

7.3 Types of Supply and Short Circuit Capacity

Units belonging to the SFT series my only be operated at grounded networks (TT, TN). At IT networks, the isolation transformer must be equipped with secondary grounding of the neutral (common) point. Bosch Rexroth provides specific notes on design on enquiry.

Note: The harmonics at operating frequency contained in the sinusoidal incoming and regenerative currents generate strong distortions of the mains voltage if there is no additional filter. This is especially the case where there are high levels of impedance in the network, i.e. where the networks are weak. This can result in hindrances to consumers that are connected to the same low-voltage distribution network. Sinus Frontend Technology inverters are therefore equipped with a sine power filter that even allows for connections to relatively weak networks.

We recommend to let our service staff give you support when the unit is put into service initially. Thereby, the best usage of our Sine Power Filter possible at the mains conditions prevailing at the site of mounting is guaranteed.

A minimum ratio of mains short circuit capacity to the rated connected load of

$$R_{SCE} = \frac{S_{SC}}{S_N} \geq 20$$

Figure 7-1: Minimum ratio of mains short circuit capacity / rated connected load

must be maintained at the connection point of the SFT inverter. This requirement also applies to limited operating conditions (e.g. when a redundant transformer is switched off). Normal power transformers can be used as supply transformers. The transformers must be equipped with tapped coils on the primary side for voltage adjustment (±2.5...5 %...7.5 %) .

Example Operation of 2 SFT 650 kW at one external power supply : The inverters have a mains power input of 2 x 811 kVA = 1622 kVA. Required min. mains short circuit capacity:

S_{SC} = 20 x 1622 kVA = 32,4 MVA; for example by using 2 transformers 1000 kVA, u_k = 6 %, or 2 x 900 kVA, u_k = 4 %.

7.4 Grounding Design and Consumers operated in Parallel at Connection Points within the System

- If several power inverters and additional consumers are operated at the same external power supply then these must be started from the supply transformer (and spread out in a star-shaped pattern). The grounding design intends that isolated PE conductors be isolated from any metal parts (e.g. control cabinets, etc.) from the mains to the motor end. An extraneous grounding of systems over lightning protection ground or grounded system housings should be avoided.
- Single-phase consumers that contain input filters or switched-mode power supplies must not be connected to the same low-voltage distribution network.
- The connection of consumers that cause commutator ripples may require that the input filter of the SFT be adjusted. Corresponding network data should therefore be passed on to Bosch Rexroth.
- The capacitors from compensation plants should be connected in series with chokes.
- Sinus-Frontend-Technology frequency inverters are also compliant to the pulse-frequency noise voltages of the line-led interference level according to DIN 61000-2-4. Consumers that cause harmonics outside of these limit values at the common connection point must not be connected to the same low-voltage distribution system.

In case of low short-circuit capacity ratios of Rsce < 20, the harmonics limit values of pulse-frequency noise voltages and multiples thereof are not compliant to DIN EN 61000-2-4.

7.5 10 Rules for Installation of Drives According to EMC

The following 10 rules are the basics for designing drive systems in compliance with EMC.

Rules 1 to 7 are generally valid. Rules 8 to 10 are especially important to limit noise emission.

Rule 1 All metal parts of the switch cabinet should be connected with one another through the largest possible surface area so that the best electrical connection is established (no paint on paint!). If necessary, use contact or scraper discs. The cabinet door should be connected to the cabinet using the shortest possible grounding straps.

Rule 2 Signal, line supply, motor and power cables should be routed away from another (this eliminates mutual interference!). The minimum clearance is 20 cm. Barriers should be provided between power and signal cables. These barriers should be grounded at several locations.

Rule 3 Contactors, relays, solenoid valves, electromechanical operating hour counters etc. in the cabinet must be provided with noise suppression devices, e.g. using RC elements, diodes, varistors. These devices must be connected directly at the coil.

Rule 4 Non-shielded cables belonging to the same circuit (feeder and return cables) should be twisted with the smallest possible distance between them. Cores which are not used must be grounded at both ends.

Rule 5 Generally, noise which is coupled in can be reduced by routing cables as closely as possible to grounded sheet steel panels. For this reason, cables and wires should not be routed freely in the cabinet, but as closely as possible to the cabinet itself and the mounting panels. This is also true for reserve cables.

Rule 6 Incremental encoders must be connected using shielded cables. The shield must be connected at the incremental encoder and at the AC drive converter through the largest possible surface area. The shield may not be interrupted, e.g. using intermediate terminals.

Rule 7 The shields of signal cables must be connected to ground at both ends through the largest possible surface area to establish a good electrical connection (transmitter and receiver). If the potential bonding between the screen connections is poor, an additional potential bonding conductor with a cross-section of at least 10 mm² (AWG 6) should be connected in parallel with the shield to reduce the shield current. The shields can be connected to ground at several locations, e.g. on the cabinet housing and on cable trays. Foil shields are not recommended. Braided screens provide a better shielding effect (factor of 5).

If the potential bonding is poor, analog signal cables may only be grounded to the converter at one end in order to prevent low-frequency noise being radiated into the screen (50 Hz).

Rule 8 Always place a radio interference suppression filter close to the noise source. The filter is to be connected flush with the cabinet housing, mounting plate, etc. The best solution is a bare metal mounting panel (e.g. stainless steel, galvanized steel), because the complete mounting surface can be used to establish good electrical contact.

The incoming and outgoing cables of the radio interference suppression filter should be separated.

Rule 9 All variable-speed motors should be connected using shielded cables, whereby the shield is connected at both ends to the housings through the largest possible surface area to minimize the inductance. The motor feeder cables should also be shielded outside the cabinet, or at least screened using barriers.

Cables with steel shields are not suitable.

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

Rule 10 The shield between the motor and the frequency converter may not be interrupted by installing components such as output reactors, sinusoidal filters, motor filters, fuses, contactors, etc. The components must be mounted on mounting panels which also simultaneously serve as the shield connection for the incoming and outgoing motor cables. Metal barriers may be required to shield the components

8 Lengths of motor lines

8.1 Peak values for the strain of the motor isolation

If you use the internal output chokes with the of 160 kW unit and the external output chokes RZU in case of 250 - 650 kW versions, the following indications are valid:

- du / dt max. 2000 V / µs
- u_{max}: max. 1500 V

8.2 SFT motor line lengths 1 : 1 drives (160 - 650 kW)

	4 kHz		**8 kHz**	
	unshielded	shielded	unshielded	shielded
Without motor filter 1)	75 m	50 m	50 m	30 m
Motor filter mounted	300 m	150 m	180 m	90 m

1): containing internal output chokes in case of the 160 kW version and 650 kW as far as 160 - 650 kW models are concerned

Figure. 8-1: Lengths of SFT motor lines for 1 : 1 drives

SFT overall motor line lengths as enumeration for several motor inverters (1 : x drives)

	4 kHz		**8 kHz**	
	unshielded	**shielded**	**unshielded**	**shielded**
160 kW	-	750 m	-	450 m
250 kW	-	1000 m	-	600 m
350 kW	-	1000 m	-	600 m
450 kW	-	2000 m	-	1200 m
650 kW	-	2000 m	-	1200 m

Figure. 8-2: SFT overall motor line lengths specified for several kinds of motor inverters

Note: The motor lines which match with the respective motor inverter must not exceed the maximum length permitted.

Note: For the set up of 1: x plants, you are obliged to choose shielded motor lines. Furthermore, we wish you to observe the project planning notices referring to 1: x devices.

9 Connecting several motor inverters to one power inverter

9.1 Short description

In addition to the 1:1 combination of power inverter and motor inverter, units from the SFT Series provide the possibility of operating several motor inverters with smaller powers via a central feeder and negative feeder module.

9.2 Type of units that can be connected

Components that can be connected to the intermediate circuit terminal of the power inverter:

• RD51.3-8C-xxx	xxxx 003-018 kW	GK A , B
• RD51.3-8C-xxx	xxx: 030-160 kW	GK C , D, E, G
• RD52.3-8C-xxx	xxx: 003-018 kW	GK A , B
• RD52.3-8C-xxx	xxx: 030-160 kW	GK C , D, E, G
		Gk = Size classes

- NTM02.1-230-024-15
- RZR01.1-RD5x-0xxx-x-x-FW
- HPS01.1M-F0xxx-N-08-NNNN
- Bosch Rexroth DIAX04 drive control units HDS02.2-W040N and HDS05.2-W300N, connectable via auxiliary module HZS01.2-W300N
- Bosch Rexroth additional capacity module HZK02.1-W003N

Note: The operating and planning instructions of the corresponding unit must be observed.

When using DIAX04 control units, additional capacity modules must be assigned that supply the reactive power for their motors and, in case of a power failure, also provide short power surges (motor-driven, generative). The total required capacity is determined when planning the system. Every control unit must at least be assigned one HZK02.1-W003N additional capacity module.

9.3 Number of units that can be connected

The following AND criteria must be fulfilled by the SFT 1 : x system selected by the project manager:

- The type of the units corresponds to the types listed in the previous chapter
- The max. number of selected units (refer to the following table) must not be exceeded
- The installed intermediate circuit power of the power inverter is greater at all times than the actual intermediate circuit power that must be provided for the motor inverter

- When connecting the additional capacities, the values listed in the following table must not be exceeded. Furthermore, a load amplification circuit must be built-in and controlled by the power module.

DC link power kW	max. capacity of DC link that can be connected mF
185	150
300	150
420	150
530	300
770	300

Figure 9-1: DC link power / max. capacity of DC link that can be connected

- All additional planning regulations stipulated in this chapter for wiring, fuse-protection, EMC, etc. must be observed.

Number of connectable components (without charge amplification)

The power module NTM02.1-230-024-15 of power inverter must not account at the number of connectable components.

Maximal number connectable SFT – components at minimum line voltage 400 V –15 %

Power inverter DC link kW	Inverter Size classes A, B, C	Inverter Size classes E, D	Inverter Size classes G	HPS01.1 / NTM02.1-230-024-15
185	3	1	10	3 / 2
300	3	1	10	2 / 2
420	3	1	10	2 / 2
530	6	3	20	5 / 4 or 6 / 3
770	6	3	20	5 / 4 or 6 / 3

Figure 9-2: Maximal number connectable SFT – components at minimum line voltage 400 V –15 %

Maximal number connectable DIAX04 – components at minimum line voltage 400 V –15 %

Power inverter DC link power kW	HZS with max. 4 x DIAX04-W040 / W300 and 4 x HZK
185	-
300	-
420	-
530	5*
770	5*

*): 2 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

Figure 9-3: Maximal number connectable DIAX04 – components at minimum line voltage 400 V –15 %

Maximal number connectable SFT – components at minimum line voltage 400 V –105 %

Power inverter DC link power kW	Inverter Size classes A, B, C	Inverter Size classes E, D	Inverter Size classes G	HPS01.1 / NTM02.1-230-024-15
185	6	3	10	4 / 3
300	4	2	10	4 / 2
420	4	2	10	4 / 2
530	8	4	20	6 / 5 or 7 / 4
770	8	4	20	6 / 5 or 7 / 4

Figure 9-4: Maximal number connectable SFT – components at minimum line voltage 400 V –10 %

Maximal number connectable DIAX04 – components at minimum line voltage 400 V –10 %

Power inverter DC link power kW	HZS with max. 4 x DIAX04-W040 / W300 and 4 x HZK
185	5*
300	5*
420	5*
530	11**
770	11**

*): 1 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

**): 2 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

Figure 9-5: Maximal number connectable DIAX04 – components at minimum line voltage 400 V –10 %

Maximal number connectable SFT – components at minimum line voltage 480 V –10 %

Power inverter DC link power kW	Inverter Size classes A, B, C	Inverter Size classes E, D	Inverter Size classes G	HPS01.1 / NTM02.1-230-024-15
185	7	4	10	4 / 4
300	6	4	10	4 / 3
420	6	4	10	4 / 3
530	12	8	20	6 / 6 or 7 / 5
770	12	8	20	6 / 6 or 7 / 5

Figure 9-6: Maximal number connectable SFT – components at minimum line voltage 480 V –10 %

Maximal number connectable DIAX04 – components at minimum line voltage 480 V –10 %

Power inverter DC link power kW	HZS with max. 4 x DIAX04-W040 / W300 and 4 x HZK
185	6*
300	6*
420	6*
530	13**
770	13**

*): 1 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

**): 2 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

Figure 9-7: Maximal number connectable DIAX04 – components at minimum line voltage 400 V –10 %

Number of connectable component with charge amplification RZL04.1-0900

The charge amplification RZL04.1-0900 appropriate the precharging connection in line power supply modules RNA01.2 and NAM04.2. Per RNA01.2 and NAM04.2 is only one RZL01.1-0900 parallel switched. For min. line voltage ≥ 480 V –10 % a charge amplification is not available.

The power module NTM02.1-230-024-15 of power inverter must not account at the number of connectable components.

Maximal number connectable SFT – components at minimum line voltage 400 V –15 %

Power inverter DC link power kW	Inverter Size classes A, B, C	Inverter Size classes E, D	Inverter Size classes G	HPS01.1 / NTM02.1-230-024-15
185	6	2	15	6 / 4
300	6	2	15	5 / 4
420	6	2	15	5 / 4
530	12	6	30	10 / 8 or 12 / 6
770	12	6	30	10 / 8 or 12 / 6

Figure 9-8: Maximal number connectable SFT – components at minimum line voltage 400 V –15 %

Maximal number connectable DIAX04 – components at minimum line voltage 400 V –15 %

Power inverter DC link power kW	HZS with max. 4 x DIAX04-W040 / W300 and 4 x HZK
185	4*
300	4*
420	4*
530	8**
770	8**

*): 1 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

**): 2 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

Figure 9-9: Maximal number recommended DIAX04 – components at minimum line voltage 400 V –15 %

Maximal number connectable SFT – components at minimum line voltage 400 V –10 %

Power inverter DC link power kW	Inverter Size classes A, B, C	Inverter Size classes E, D	Inverter Size classes G	HPS01.1 / NTM02.1-230-024-15
185	12	6	15	8 / 6
300	8	4	15	8 / 4
420	8	4	15	8 / 4
530	16	8	30	12 / 10 or 14 / 8
770	16	8	30	12 / 10 or 14 / 8

Figure 9-10: Maximal number connectable SFT – components at minimum line voltage 400 V –10 %

Maximal number connectable DIAX04 – components at minimum line voltage 400 V –10 %

Power inverter DC link power kW	HZS with max. 4 x DIAX04-W040 / W300 and 4 x HZK
185	8*
300	8*
420	8*
530	17**
770	17**

*): 1 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

**): 2 x HPS01.1 and 1 x NTM02.1-230-024-15 may be additionally connected

Figure 9-11: Maximal number connectable DIAX04 – components at minimum line voltage 400 V –10 %

9.4 Connecting to an external precharging circuit (charge amplification)

The internal precharging circuit has been designed for connecting DC-link capacitors of up to 150 mF. An 18 Ohm / 300 W resistor is used for this in every phase of the network.

To operate larger intermediate circuit capacities (loads), the precharging circuit can be amplified by externally connected components. To achieve this, an external precharging unit (precharging protection circuit and three resistors) is connected in the power entry module RNA or NAM parallel to terminal bar power connections U1, V1, W1 and U2, V2, W2.

Calculating the precharge resistances:

In order to distribute the losses of the internal and external precharge evenly, the charging-time constant must remain the same.

Determining the external charging resistance R_{ext}: where R_{int} = 18 Ω and C_{int} = 150 mF

$$R_{ext} = \frac{R_{\text{int}}}{\frac{C_{ges}}{C_{\text{int}}} - 1}$$

C_{ges}: total capacitance

Figure 9-12: Determining the external charging resistance R_{ext}

Determining the nominal power of the external charging resistance R_{ext}:

$$P_{\text{Re}\,xt} = 300W \; x \; \frac{R_{\text{int}}}{R_{ext}}$$

Figure 9-13: Determining the nominal power of the external charging resistance R_{ext}

The pulse loading capacity of the resistor must be checked.

Recommended resistor type: KRAH-RWI power resistor series VHPR

Peak current for designing the circuit protection and wiring:

$$\hat{i}_{\text{Re}\,xt} = \frac{\hat{u}_{Netz}}{2 \; x \; R_{ext}}$$

where $\hat{u}_{Netz}$ = max. amplitude of the line voltage

Figure 9-14: Peak current for designing the circuit protection and wiring

The SIEMENS 3RT1016-1AP02 contactor is used for the internal precharging circuit.

Note: The above-mentioned typical values for dimensioning the system also contain protection in case of a fault. Possible faults: short-circuit in the intermediate circuit due to incorrectly connected inverters (reverse voltage protection). This ensures that the intermediate circuit voltage does not increase. There is a risk that the resistor and the contactor are overloaded. This fault is only recognized and switched off by the control electronics after a few seconds.

Control voltage connection and response signals:

There is an AC 230 V output at terminals X10.5 (L) and .6 (N) of power entry modules RNA and NAM (alternative: AC 120 V). This is used for controlling the external precharging protective circuit. This output is also floated when using the function „Disconnecting the Protective Supply Voltages".

Designation RNA / NAM	Meaning	
X10.5	L (AC 230 V or AC 120 V, depending on the design of the RNA / NAM)	Control voltage output for preload amplification; neutral conductor is connected during the precharging phase and can be loaded with max. 1 A
X10.6	N	

Figure 9-15: Terminal X10.5 / X10.6 on RNA and NAM

Designation RNA / NAM	Meaning	
X10.7	max. DC 24 V / 1 A	response from main contactor and precharging contactor OFF (break contact from K1 and K2 in series)
X10.8	AC 230 V / 1 A	

Figure 9-16: Terminal X10.7 / X10.8 on RNA and NAM

Note: If the response signals X10.7 and .8 are evaluated then the response signal contact of the external precharging relay must be looped in.

9.5 Planning regulations

Maximum line lengths

DC link connections:

DC link power kW	max. DC line lengths m
185 – 770	100

Figure 9-17: DC link power / max. DC line lengths

The maximum allowed terminal bar or cable lengths of the DC link circuit connections is 100 m. The resulting cable lengths are calculated from the sum of the lengths of the single cables that are connected in parallel. In case of long intermediate circuit lines, a copper terminal bar must be used. The DC connections must be made in accordance to the following planning instructions.

Motor cable

In general, the motor cables should be kept as short as possible.

Motor cables must be shielded. To keep leakage currents to a minimum, only high-quality, low-loss cable must be used. The motor inverters should be operated with as low a pulse frequency as possible.

Total length of the motor cable to motor inverters at one power inverter:

DC link power kW	Line length m
185	750
300	1000
420	1000
530	2000
770	2000

Figure 9-18: DC link power / Line length

On this occasion, the lengths of each single motor line mentioned in chapter 8.2 must not be exceeded.

Design of the DC connection

- The cables must always be laid on as short a path as possible. The potentials of the intermediate circuit must be laid at a minimum distance of 40 cm to the power, motor and control lines and should not be parallel to these. If cables with different interference potentials are crossed then this should always be at right angles.
- Within a control cabinet, the DC terminal bars or wiring should be end-to-end connections.
- If the total length of the DC connection is more than 15 m then a third bar should be introduced between the C and D bar as a PE conductor. The connected motor inverters must be grounded at the PE connector. On the mains end, the PE conductor must be connected to the HNF and HNP components as well as to the PE connection on the mains end.
- 3-way terminal bars can be used. In EMC-critical areas outside of the control cabinets, the terminal bars must be laid in a metal, multi-grounded cable duct at a minimum clearance distance of 50 m from the duct wall to the bar.
- If the drive control units are outside of the control cabinet of the power inverter, then a star-shaped wiring to the individual motor inverters or to the individual groups of motor inverters must be used if the maximum total length of the DC lines is less than 100 m. Within the motor inverter groups, make sure that the powerful motor inverters are arranged nearer to the power inverter.
- If the star-shaped wiring exceeds the maximum possible DC size then the size can be reduced by using an end-to-end DC connection. In this case, a 3-way bar (C, D, PE) or the star quad cable must always be used.
- If the total length of the DC line exceeds 15 m then the cable must be designed as star quad cable (unshielded, as described in the following):

Star quad cable for DC wiring

Star quad: 4-wire cable, unshielded

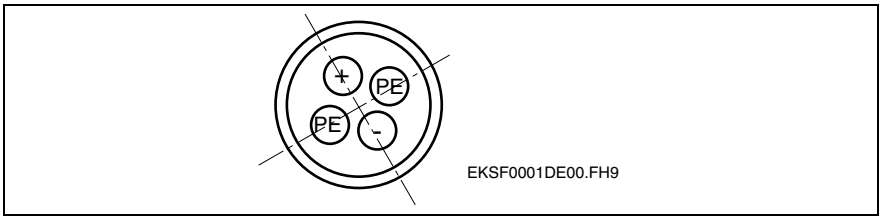


Figure 9-19: 4-wire cable, unshielded

Two opposed wires must be used for the positive and negative intermediate circuit potential. The two remaining wires should be laid onto the PE terminal bar of the control cabinet as protective wires (via the shortest possible path and without looping).

- In case of star-shaped wiring to the motor inverters, the following applies: The PE conductors of all DC supplies of the motor inverters must be laid onto the PE conductor in the cabinet of the power inverter.
- In EMC-critical areas outside of the control cabinets, the cable must be laid in a metal, multi-grounded cable duct at a minimum clearance distance of 50 m from the duct wall to the cable.

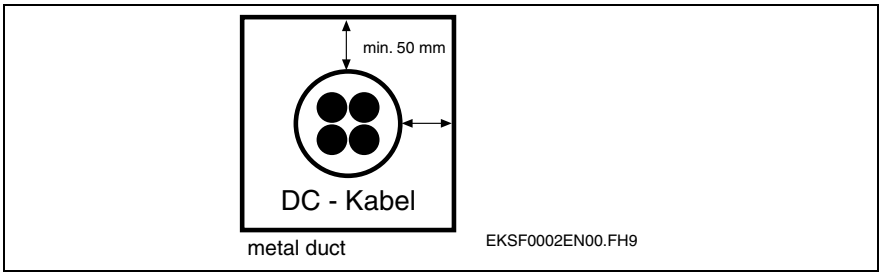


Figure 9-20: cable duct

DC fuse protection

The protective equipment described here protect the circuit against short-circuits. Overload protection is not required. For additional information, please refer to DIN VDE 0100 Section 430.

Protecting the DC link distribution line at the power inverter:

No protection against short-circuiting is required if

- the wiring of the DC link is not near flammable components
- the danger of short-circuit has been reduced to a minimum (enhanced circuit protection)

If the DC link voltage is laid externally and if the above-mentioned points (1-9) can not be observed then a **bipolar** protection line that accords to the protection values in the planning instructions is required in the field of the DC output.

Protecting the DC link distribution line at the motor inverters:

No protection against short-circuiting is required if

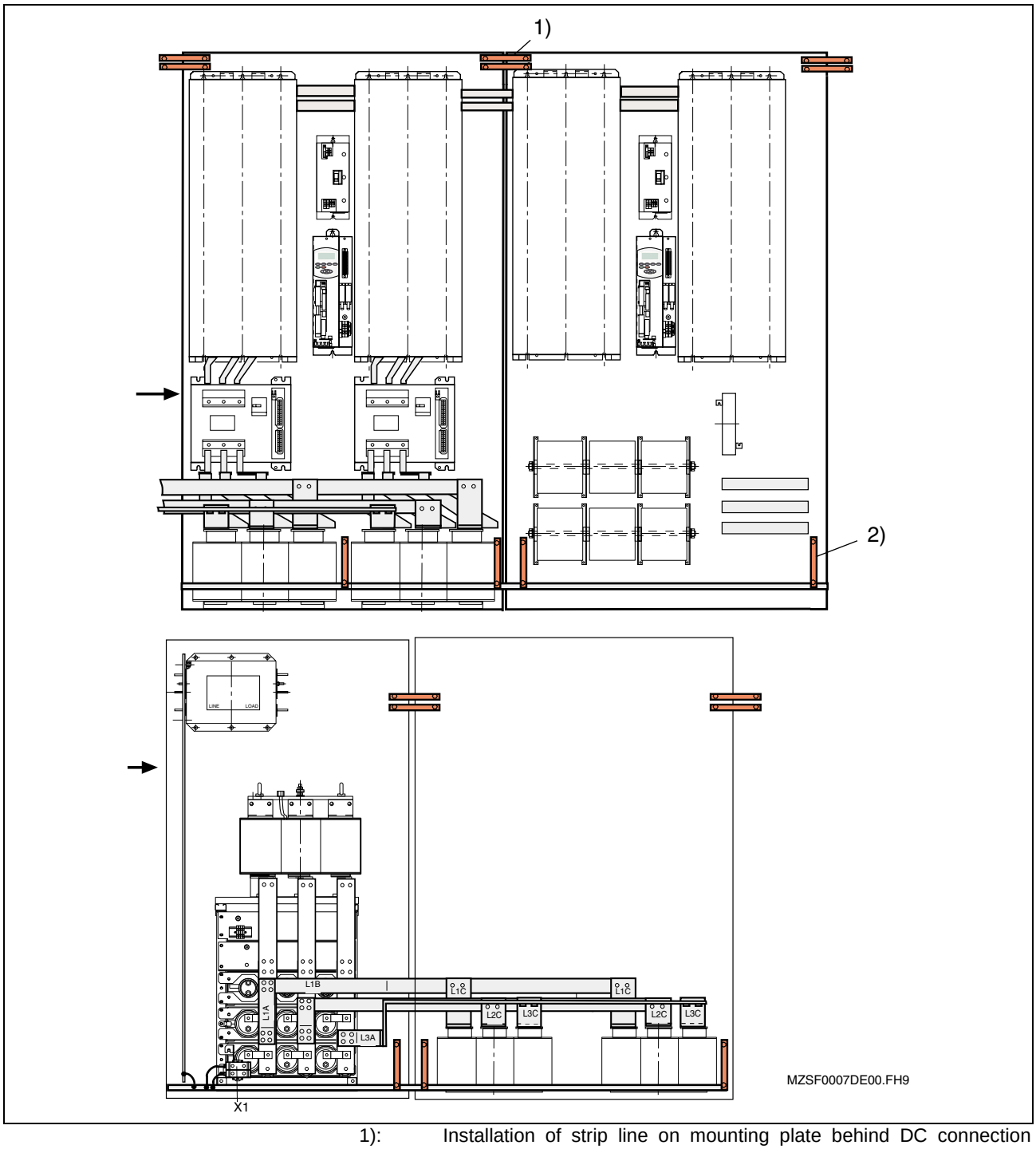
- the wiring of the DC link is not near flammable components
- the danger of short-circuit has been reduced to a minimum (enhanced circuit protection)

If one of these conditions is not fulfilled then blowout fuses must be used in the DC link at outlets for motor inverters where there is a reduction of area of the cross section. A **bipolar** protection is required that accords to the protection values in the planning instructions.

Measures in order to avoid stray leakage currents

The leakage currents caused by frequency inverters in connection with long lines must always be led back to the interference source. The SFT Sine Power Filter couples in these leakage currents at the mains side and then leads them via the DC bus back to their source. To ensure that the leakage currents take the path via the Sine Power Filter, the following planning instructions **must** be observed. Non-observance of these instructions may result in damage to components as well as the occurrence of EMC problems:

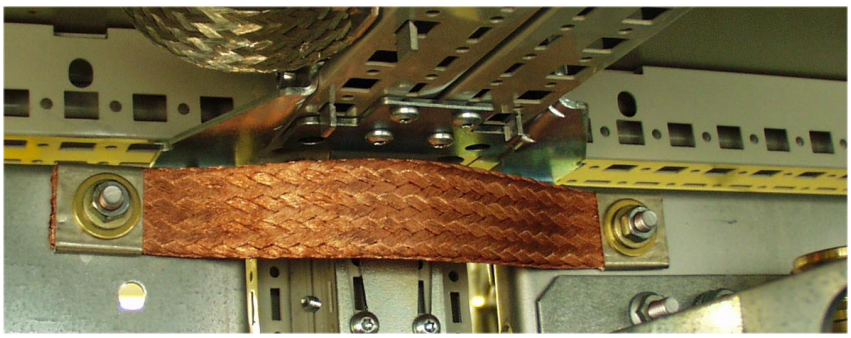
- DC-wiring as star quad or with a 3-way terminal bar
- Motor lines must be kept as short as possible. In cases where there is doubt, then longer DC bus wiring should be used to the motor inverters and not longer motor lines. The PE conductor of the motor cables should be connected to the PE terminal bar via the shortest path without looping. The screening braiding must be applied extensively to the mounting plate or on well-grounded areas intended for this purpose.
- 2 x field grounding of fitting panels at the PE terminal bar (see Figure 9-21). If the cross section is suitably dimensioned then the strip conductors also act (quasi) as protective wire connections.



1): Installation of strip line on mounting plate behind DC connection (length appr. 200 mm

2): Installation of strip line on rear panel to PE bar (length appr. depth of the cabinet)

Figure 9-21: earthing arrangements on mounting plate to PE bar

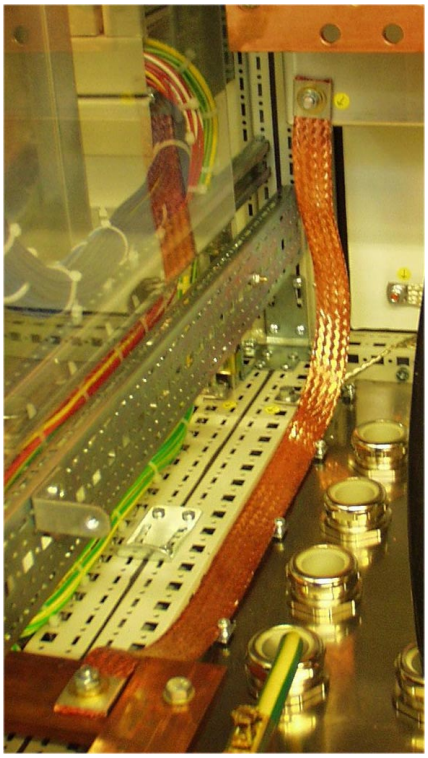


1): to legend 1 Fig. 9.21

Figure 9-22: earthing strip over HPS Power stack

Suitable earthing strips: Druseidt Order No. 15290, Type B2, length are matched.

- Equipotential bonding of adjacent fields – connection with earthing strips always in the immediate vicinity of the DC link terminal bars (see Figure).



2): to legend 2 Fig. 9.22

Figure 9-23: earthing strip rear panel to PE - bar

- Separating wall of EMC filter – low-inductive ground connection

The separating wall is in charge of the filter's low-inductive ground connection.

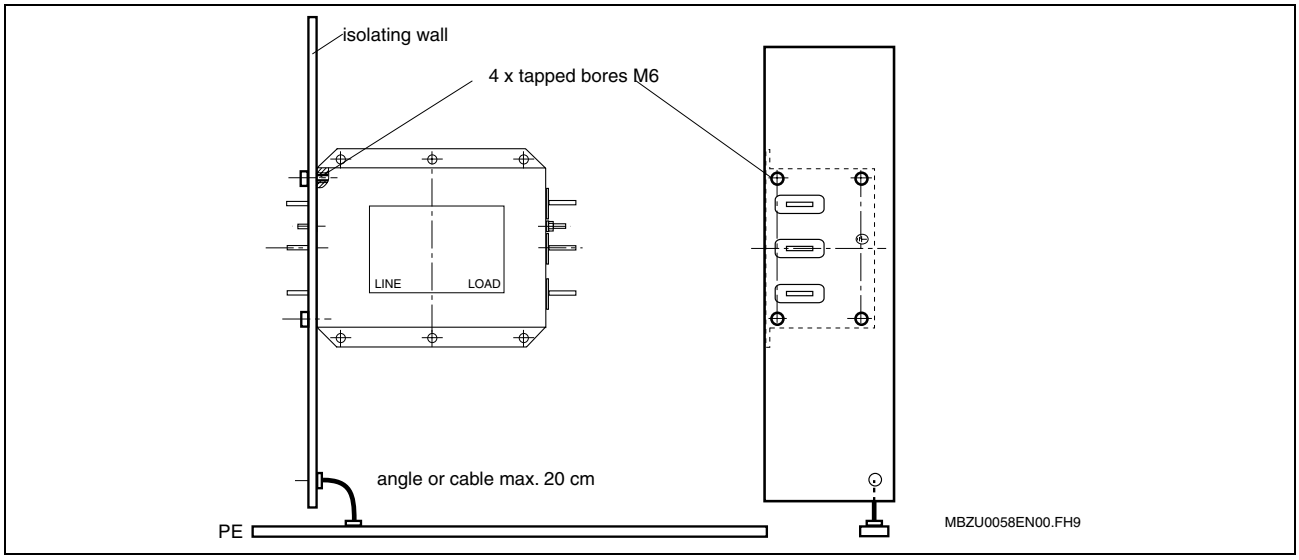


Figure 9-24: Mounting isolation wall

- short PE connections of the HNP capacitor filter unit (terminal X1) to the PE terminal bar
- Reduction of magnetic leakages by using narrow line paths, including the protective wire. No spreading of areas!

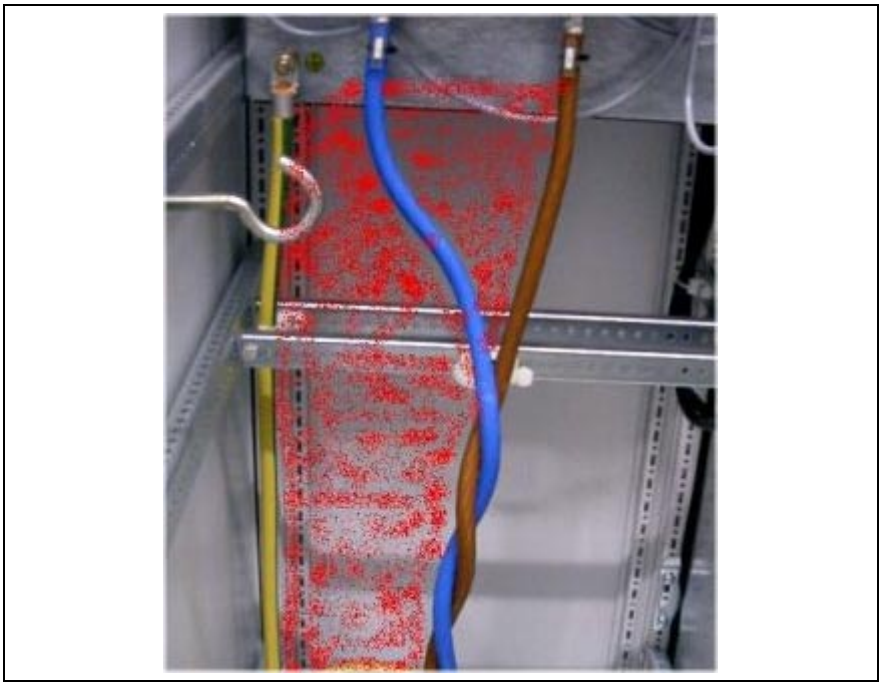


Figure 9-25: magnetic leakages are presence

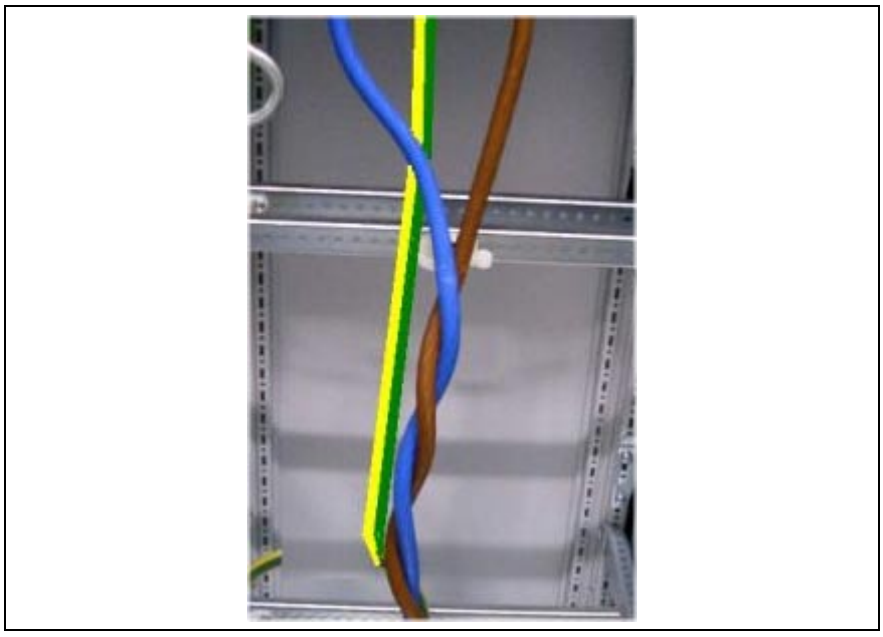


Figure 9-26: narrow line paths => no magnetic leakages

- In case of very extensive system with extraneous grounding by lightning protection ground, etc., the DC connection lines may have to be choked with ferrite toroids. This then forces (by induction of a boost voltage) the return flow of the leakage current into the PE conductors designed for this purpose. The number of rings required is projected by the BRC. To determine this, the motor cable lengths of all axles must be known.
- Components may not be changed and must be used in accordance to the regulations stipulated in the planning instructions.

Example configurations

1. Power inverter 770 kW (2 x HPS 01.1M-F0880-N-08-NNNN)

connected motor inverters:

2 x HPS 01.1M-F0610-N-08-NNNN (450 kW)

2 x HPS 01.1M-F0610-N-08-NNNN (450 kW)

1 x HPS 01.1M-F0610-N-08-NNNN (250 kW)

1 x HPS 01.1M-F0610-N-08-NNNN (250 kW)

1 x HPS 01.1M-F0610-N-08-NNNN (250 kW)

connected auxiliary components:

6 x NTM02.1-230-024-15

Construction: lined up control cabinet fields with end-to-end DC terminal bar

This configuration can only be operated with charging amplification (internal precharging circuit = external precharging circuit). The DC link power of the power inverter is not exceeded at any time as it has been ensured that the motor powers are never motor-driven and degenerative at the same time.

2. Power inverter 185 kW (RD43.1-4R-185)

connected motor inverters:

3 x RD52.3-8C-018 (18,5 kW)

3 x RD52.3-8C-030 (30 kW)

1 x RD52.3-8C-075 (75 kW)

connected auxiliary components:

1 x NTM02.1-230-024-15

Construction: lined up control cabinet fields with end-to-end DC - terminal bar

This configuration can be operated without charging amplification. A host controller ensures that the motor inverters are never operated simultaneously at full power.

10 Operator Control and Visualization

10.1 Possibilities of Operator Control

The user panel (option), the RDwin PC user interface and several other interfaces are available to operate, visualize and parameterize RD 500 units.

Serial interfaces RS232 and RS485 are installed as standard on the logic and control board. In addition, the optional interface cards Sercos, Profibus DP, Interbus S and CAN bus are available for setting parameters.

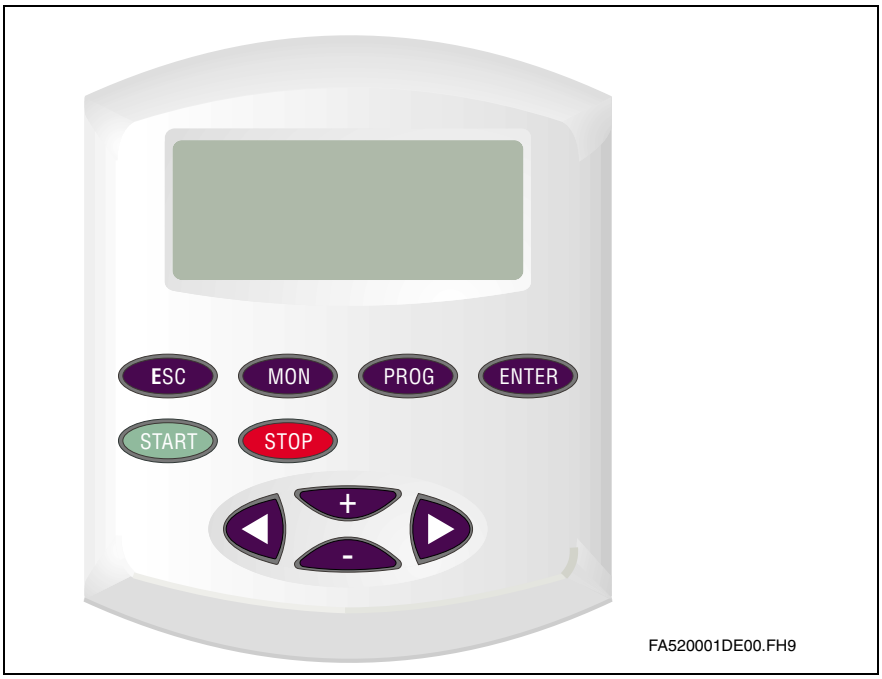


Figure. 10-1: User panel with graphics display (accessory)

10.2 Operator Control with the User Panel

Visualization (Monitor) with the User Panel

Key	Menu level
Esc	Return to previous menu item
Mon	Changes to monitor
Prog	Changes to parameterization
Enter	Accepts the selected menu item
+	To previous menu item
-	To next menu item

Figure. 10-2: Key functions of the user panel in monitor mode

Operation with the operator panel

When supplied (standard values of the basic parameterization are set), the start / stop key and the plus / minus key (for the motorized potentiometer function) are active.

Key	Function	Conditions
Start	Starts the drive	The On / Off command must be set to “Terminal steady-state + operator panel” or “Operator panel, dynamic”.
Stop	Stops the drive	
+	Motorized potentiometer setpoint increases	The setpoint must be set to “Motorized potentiometer” and the ON/OFF logic must be set to “Terminal steady-state + operator panel” or “Operator panel, dynamic”.
−	Motorized potentiometer setpoint decreases	
+	Toggles between the NORMAL and TEST modes	Password level 2 must be selected and the inverter must be inhibited

Figure 10-3: Function of the operator panel in “Operation”

Normal and test operation (local / remote)

The two operating modes are intended for setting-up or for service purposes (test mode) and for normal operation (normal mode). The On / Off commands and the setpoint input can be separately set for each mode. For example, the normal mode can be set-up for terminal operation (P0870 = terminal, steady-state) and the test mode for operator control using the operator panel (P0871 = operator panel, steady-state).

Parameterization Using the User Panel

Key	Menu level	Parameterizing level
Esc	Return to previous menu item	Cancels the changed value
Mon	Changes to monitor	
Prog	Changes to parameterization	Value is temporarily accepted. All of the values are accepted only after pressing the “Enter” key.
Enter	Accepts selected menu item	Accepts the changed value
+	To previous menu item	Increases value
−	To next menu item	Decreases value
▶	Jump to end of list	Cursor position to right
◀	Jump to beginning of list	Cursor position to left

Figure 10-4: Key functions of user panel when parameterizing

Fast Parameterization using Key Combinations

Key	Response
+ + −	If these keys are simultaneously pressed: – the complete parameter number is set to zero (numerical list). – the complete parameter value is set to zero (for numerical parameters).
◀ + ▶	If these two keys are pressed simultaneously, the factory setting of the active value is set.
Mon + Prog	If these keys are simultaneously pressed, the system changes from the monitor or prog. area into a temporary actual value display. When the ESC key is pressed again, the display goes back to the selected menu. In order for the user to be able to differentiate between the standard operating display and the temporary actual value display, the temporary actual value display has a flashing frame.

Figure 10-5: Key combinations

Load Standard Values (only motor inverter)

When the drive converter or inverter is supplied, the parameters are set to standard values. The “Load factory setting” function can also be activated by parameter P0071.

SET PARAMETERS

Prompted parameterization

Unit setting

P0071 Load factorySetting

No action

Standard values

Sercos applic. free

Note: All of the parameters of the selected password level are reset using the “Load factory setting” function.

Depending on the application, the user must adapt the following parameters after the standard values have been set.

Application/output frequency	Option	Firmware	Pulse frequency
-200 Hz	Without filter		4 – 8 kHz

Figure 10-6: P0026 pulse frequency

CAUTION

Damage caused by parameterizing errors!

⇒ The filter or motor could be damaged if the pulse frequency (P0026) is incorrectly selected.

CAUTION

As consequence of activating the function “loading standard values” , all parameters are deleted!

⇒ When this happens, the corresponding set of parameters which you are in need of for running the mains converter has to be loaded once more.

Fault Messages when Parameterizing

Fault message	Cause	Solution
Parameter inhibited	Device is operational.	Inhibit the inverter and then change the parameter.
Data conflict (general)	Some parameter settings are dependent on others. If a parameter value is changed and acknowledged with Enter, this can result in a data conflict.	
Data conflict, e.g. P0109.00 with P0046	The specified current limit in P0109.00 is too high for this device for the selected pulse frequency (P0026).[1]	The value of the first parameter change is temporarily accepted with Prog; after the second parameter change, acknowledge both values with Enter - they are then saved.

1: For parameters which are dependent on the motor data set changeover (P0070), both data sets (indexes 0 and 1) are monitored. This includes the parameter set which isn’t active.

Figure 10-7: Fault messages when parameterizing

Copy Function

A copy function is integrated in the user panel. This allows a parameter set to be saved in the user panel (P0733) and then transferred quickly into another unit (P0732). In this case, only those parameters which are accessible with the selected password level are transferred to the unit.

Note: The parameter set can be saved in the operator panel after start-up and after the drive has been optimized. This means that when the AC drive converter is replaced, it can be quickly recommissioned.

Password level 3 must be used to transfer (download) data into the drive.

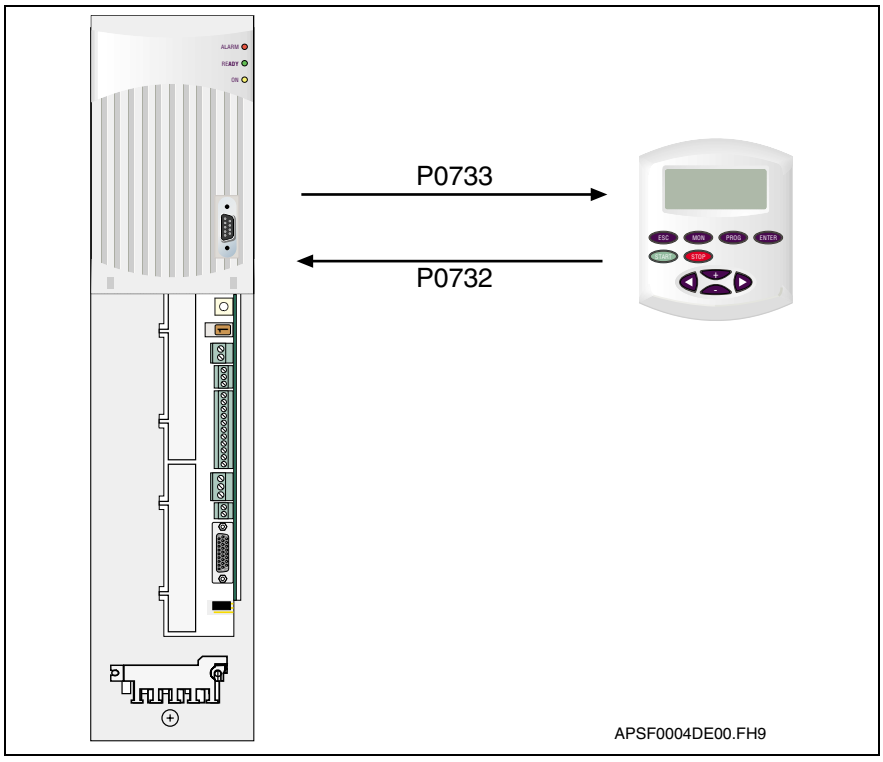


Figure 10-8: Copy function

Note: After Copy, can be checked over Monitor copy-Status if faults be arise at the transmission

Fault Acknowledgement

After a fault occurs, “Fault” is displayed in the operating display. The cause of the fault and the fault time are displayed below this. After the cause of the fault has been removed, it can be acknowledged using the Esc key of the user panel.

10.3 Visualization

Monitor

Monitor Structure

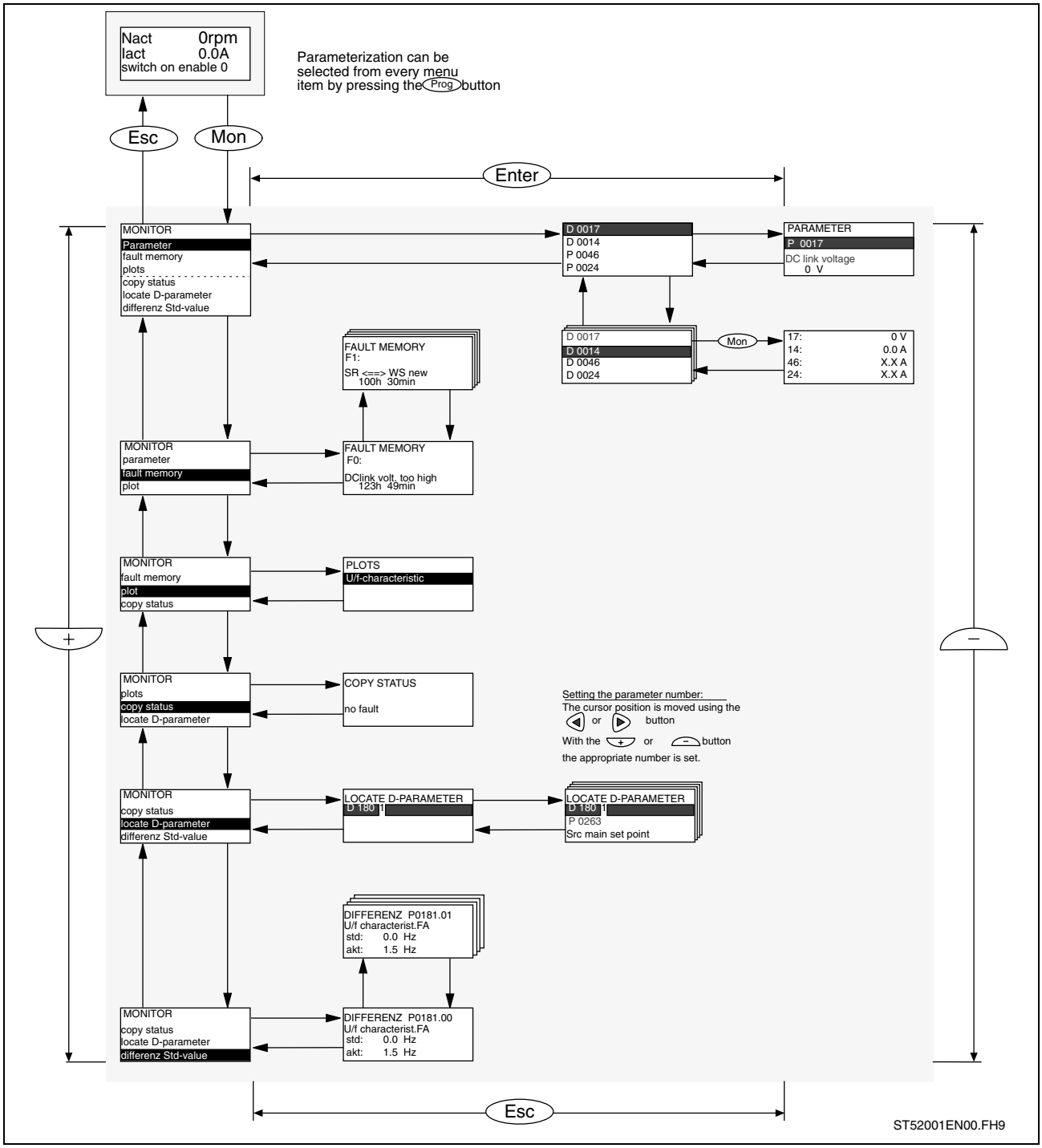


Figure 10-9: Monitor program structure

Monitor Functions

Parameter Four selectable parameters are simultaneously displayed. The parameter monitor can be used to support commissioning, e.g. the speed setpoint route can be tracked using the parameterizable functions of the converter. In this case, use the D parameters from the function charts.

Fault memory The last 10 faults are saved in the fault memory. The most recent fault is in memory location S0, the oldest in S9. A new fault is always saved in memory location S0. All of the older faults are always shifted one position upwards in the memory. This means the fault in memory location S9 is lost.

Graphic display The existing V/f (V/Hz) characteristic is graphically displayed in this menu. (This characteristic is only relevant in operating mode P0189 = voltage-controlled.)

Copy status Faults and irregularities which occur when copying a data set from the operator field in the converter are displayed in this menu. The copy status is lost when the drive converter is shut down.

Search for D parameters A list of “Parameter sources” in which the selected D parameter is connected is displayed using “Search for D parameters”. The list can be scrolled using the Enter key. If the selected D parameter is not linked with a “Parameter source”, the following is displayed: “is not linked”. Refer to the function charts with legend for additional information on this subject.

Operating Display

From ten display values, three can be selected to be displayed in the operating display; refer to P0037.0x.

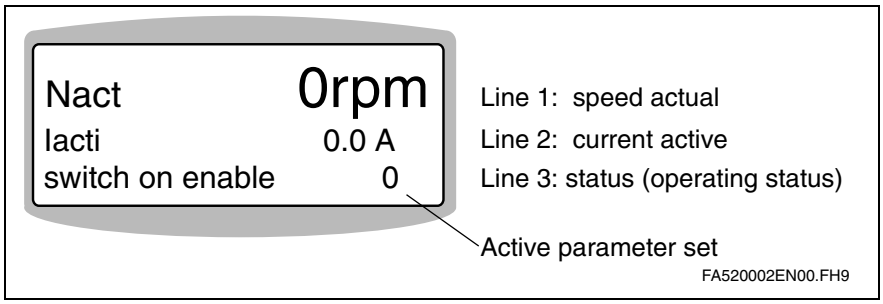


Figure 10-10: Operating display

Warning Display

If a critical operating condition develops, a warning message and operating display are displayed alternatingly until this critical condition has been resolved.

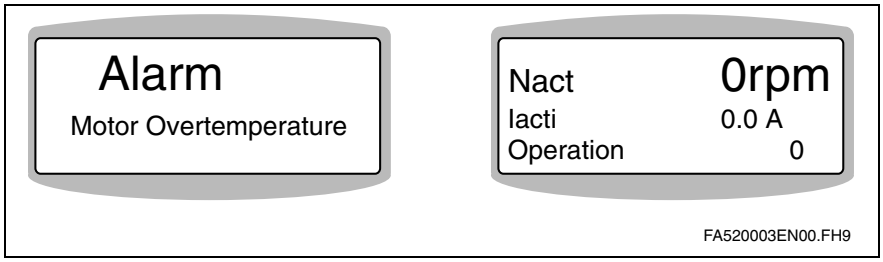


Figure 10-11: Warning display

Fault Display

If an operating condition which initiates a fault occurs, the fault display replaces the operating display.

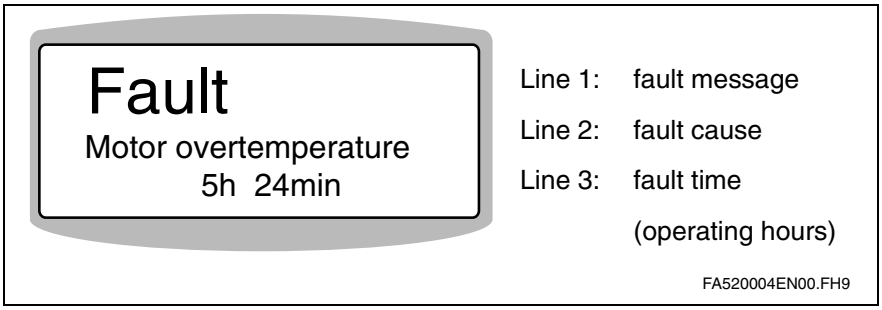


Figure 10-12: Fault display

LED Display

LED display		Meaning
○ ○ ○	No LED lit	Operating condition, power-on inhibitor not ready to power-up
○ ● green ○	Green LED lit	Operating condition, ready to power-up
○ ● green ● yellow	Green LED lit Yellow LED lit	Operating condition, ready
○ ○ ● yellow	Yellow LED lit	Operating condition, operation (run)
● red ○	Red LED lit	Operating condition, fault

Figure 10-13: LEDs

11 Firmware of the SFT Power Inverter (sinusoidal reverse feeding)

11.1 Preliminary Remarks

This operating mode is a sinusoidal reverse feed that is operated at regulated voltages. The output voltage must thereby be synchronized to a reference voltage.

Operation

The following parameters have been newly introduced (with index 0 and 1 for 2 data records):

Parameter	Designation	Unit (with decimal places) Min. value/ Max. value / Standard	Comments
P0808	time limit for i_{sq} deviation	xxx ms 0 / 32000 / 0	States after which period of time the deviation parameterized in P0814 provokes the reset of D1186
P0809	Select stand-alone operation	D1700 (standard value)	Select stand-alone operation with state machine
P0810	Mains: rated frequency	xx Hz 45 / 65 / 50	Set value in stand-alone operation Reference value for synchronization (see FP 15b)
P0811	Mains: inductance	xxx.xx mH 0.01 / 650.00 / 1.00	Sets current controller in control operation
P0812	Mains: resistance	xx.xxx Ohm 0.001 / 10.000 / 0.100	Sets current controller in control operation
P0813	Max. frequency deviation	xx Hz 0 / Pyyy / 10	Reference for synchronization (see 15b)
P0814	Max_{sq} deviation	xxx,xx % 0,00 / 199.99 / 0,00	Established to supervise the maximum deviation of current i_{sq} admissible
P0815	Max. Output voltage	xxx,x V 0 / 199,99 / 199,99	Maximum value of output voltage (interlinked root-mean-square (RMS) value)
P0816	Mains: manual phase shift	xxx degrees -180 / 0 / +180	see FP 15b
P0817	Mains: amplitude correction Phase U	xxx.xx % 0.00 / 199.99 / 100.00	see FP 15b
P0818	Mains: amplitude correction Phase V	xxx.xx % 0.00 / 100.00 / 100.00	see FP 15b
P0819	Mains: offset correction, phase U	xxx.xx % -199.99 / 0.00 / 199.99	see FP 15b
P0820	Mains: offset correction, phase V	xxx.xx % -199.99 / 0,00 / 199.99	see FP 15b
D2027	Mains: actual frequency value	xxx.xx % 100% = P0810	Not active (for future use)

Figure. 11-1: Parameter

The parameters can be accessed in the control panel via

password level 2 (1234 = 'Esc' 'Mon' 'Prog' '+' <ENTER>)

in the "**numeric list**" selection box.

The parameters are **not** entered in the "**Quick Setup**" and also not in the "**Made Configuration**" menu.

These parameters must be entered completely; no network identification with test signals is made.

The motor type "Mains-WR" is selected via parameter P0100:

Parameter	Designation	Comments
P0100	Type of motor	Mains-WR
P0189	Operating mode	Current controlled (position 0)
P0130	Type of transmitter	3-phase mains (position 6)

Figure. 11-2: Parameter

11.2 Data Acquisition

Current, Voltage

Display of the actual values for current and voltage, including the percental parameters, as in the standard RD 500.

Except for the laboratory parameters (range D1000 ... D1099), all parameters are displayed with their **rms values** (range D1800ff).

The parameters whose units are shown directly in the control panel (P0013ff) are also displayed as rms values.

- DC link voltage

Measurement is made as in the standard RD 500

- phase currents

As in the standard RD 500, the output currents of the inverter are measured in the phases u and v. They are displayed as in the standard RD 500

They are also recalculated as active current (i_{sq}) and reactive current (i_{sd}).

- mains voltage

The mains voltage is measured in its 3 phases and then made available (floating) via the X18 inputs of the controller. Connection is as follows:

Terminal			Meaning (line)
Input NE 19562.2 (transformer on primary side)	**Output NE 19562.2 (transformer on secondary side)**	**Input SR17002**	
X1.1	X2.1	X18.19	U1
X1.2	X2.2	X18.20	V1
	X3.1	X18.10	V1
X1.3	X3.2	X18.11	W1

Figure. 11-3: Connection of the mains voltage

Temperature

Monitoring of the temperatures in the unit is as in the standard unit at stand FWC-SR1700-200-04VRS-MS

Sensors for Protective Purposes

No additional measures in the software apart from the standard functions as in the RD 500.

11.3 Software Core

Frequency Monitoring

The mains frequency is determined from the phase signals u and v that are read in. If the mains frequency falls below or rises above the value P0810 ± P0813 then synchronization bit D1186 is reset.

Note: There must be a clockwise phase sequence.

D1186 = 0	Internal phase not synchronized to mains (transition phase or no mains power, frequency outside of the tolerance P0810 ± P0813 or incorrect direction of rotation)
D1186 = 1	Internal phase is synchronized to the mains see phase diagram 25h

Mains Voltage

The mains voltage is read in by the control and made available with the following parameters:

Parameter	Designation	Standardization
P0018	Voltage V_{mains}	V (directly specified on BF) not for connecting, only display
D1998	Mains Voltage	0 x 4000 = V_{mains} standardization from the system configuration (D1036.55) = 5V at X122.25 = half modulation of the AD conversion; a 3-phase, rectified mean value is measured The display is as an rms value and is calculated as $V_{rms} = \frac{V_{mean}}{\sqrt{2} \cdot 0.955}$ Example: Standardization D1036.55 = 500 V Rectified mean value = 513 V = 5.13 V at X122.25 D1998 = 76% = 380V rms This display is only shown when mains detection is selected in the system configuration (D1036.54 = 1)

Any monitoring of the mains voltage are implemented with existing functional blocks.

11.4 Control Mode

The set value of the current is set via the normal set value paths.

Parameter	Designation
D1867	Current set value Isq (see function plan 25f)

The already existing parameters P0810ff are used to describe the supply network.

However, current control receives a different structure. Speed and position control do exist but they are not useful in their original function for the application described here. However, they can be interconnected for other superimposed tasks. See Figure 12-40.

Current Control

A digital controller is used for controlling the current; it is set to a finite setting time. The current controller is designed as a 2-phase current controller, as in the standard control. The set value of the d axis is „0“. The set value in the q axis can be set as usual. The control structure that is already in the units is used.

The measured mains voltage is servo-controlled at the output of the a axis, thereby ensuring a good switch-on reaction.

11.5 Angle of Rotation

Phase Angle Detection

The interlinked voltages V_{uv} and V_{vw} are read-in as follows. The phase angle detection adjusts the phase angle of the phase sequence (phase rotation). The angle must be processed in such a way that when connecting a current in the q axis, a phase voltage in the u phase is outputted in phase with the mains voltage phase u.

The parameters P0817ff can be stipulated as in the block diagram to correct any errors in the phase detection.

Depending on whether or not the phase angle detection was successful (parameter 1186), the system then switches to one of the following operating modes.

See function plan 15b, Figure. 11-4.

Synchronized Operation

In synchronized operation, the mains frequency determined by the phase angle detection is used.

Unsynchronized Operation

In unsynchronized operation (D1186 = 0) , the preset frequency is used; this frequency must be entered in the following parameter, unless an impulse inhibition is part of the parameterisation.

Parameter	Designation
P1319	nominal frequency in Hz

11.6 Signal Generation

All display parameters (that are meaningful for this application) are supported. The mains current i_N is designated here by i_{sq}. The field-forming current i_{sd} is not supported by the control and therefore has the value "0".

Designation	Parameter	Comments
Mains current, total current	D1882	100 % = P0374 (rms value)
	D1071	200 % = P0374 (peak value, laboratory parameter)
	D1874	100 % = P0374 (corresponds to D1882 here)
Modulation	D1075	200 % = 2 / 3 * u_{zk} (amplitude, phase voltage)
	D1077 (u_{sq})	100 % = 2 / 3 * u_{zk} (corresponds to D1075 here) (amplitude, phase voltage)

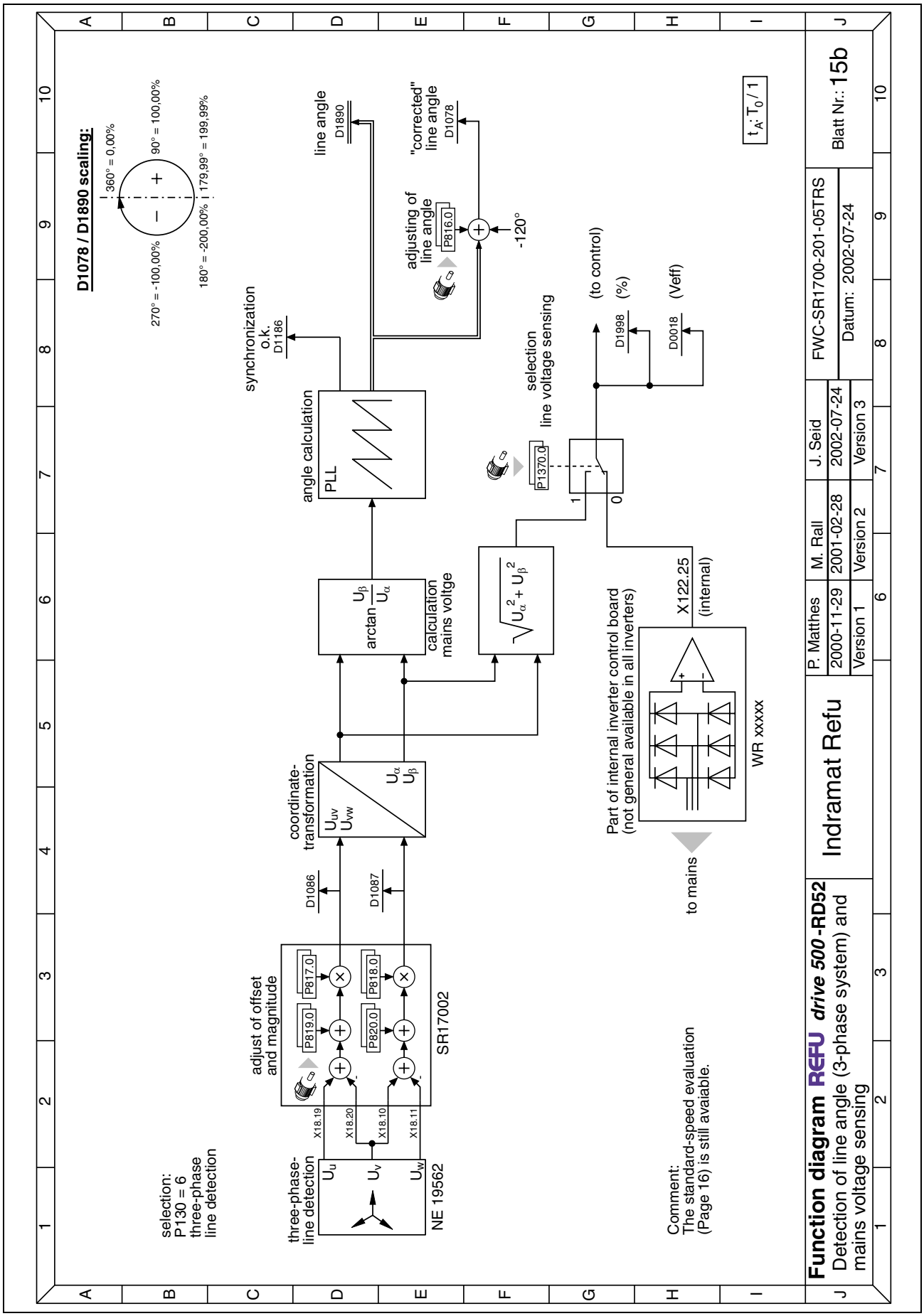


Figure. 11-4:Function diagram 15b

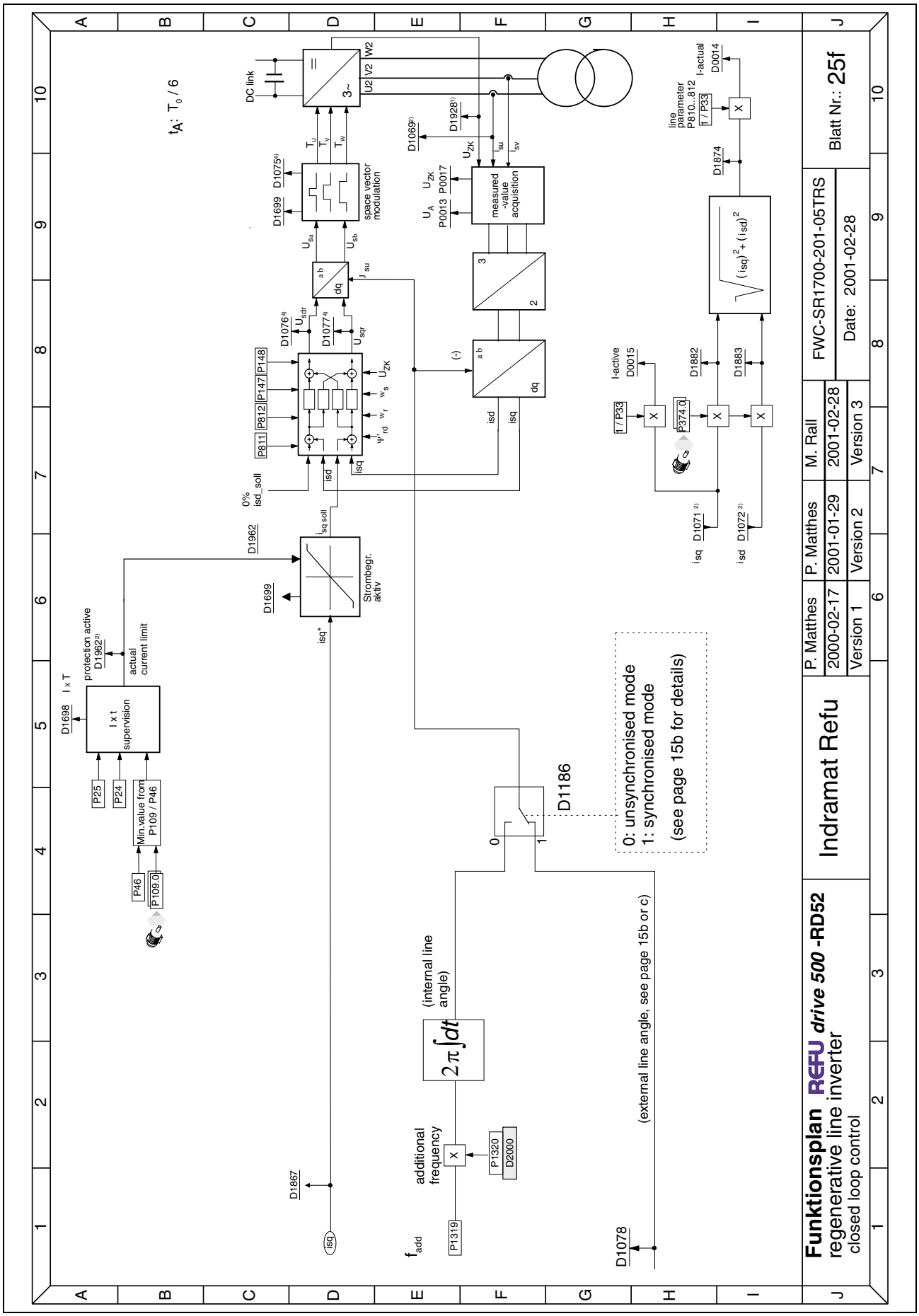


Figure. 11-5:Function diagram 25f

12 Configuring and Commissioning

12.1 Commissioning Power- and motor

Establishing the Reference Potential when Operating Several RD 500 SFT

When units from the RD 500 series are connected together with potential and/or are connected to an external control, then a central connection of the reference ground must be established to the PE. To do this, proceed as follows:

- Separate the cable connection of the reference ground X14.7 – PE (housing) to all inverters (RD51, RD52)
- Separate the bridge X14.7 to the PE housing at the supply modules (RD52, RD43)
- Terminate all RD 500 reference grounds (terminal X14.7 for each), including any existing PLC ground at a central point.
- Establish the connection from reference ground-neutral point – PE, preferably in the PLC control cabinet (set terminal if necessary)

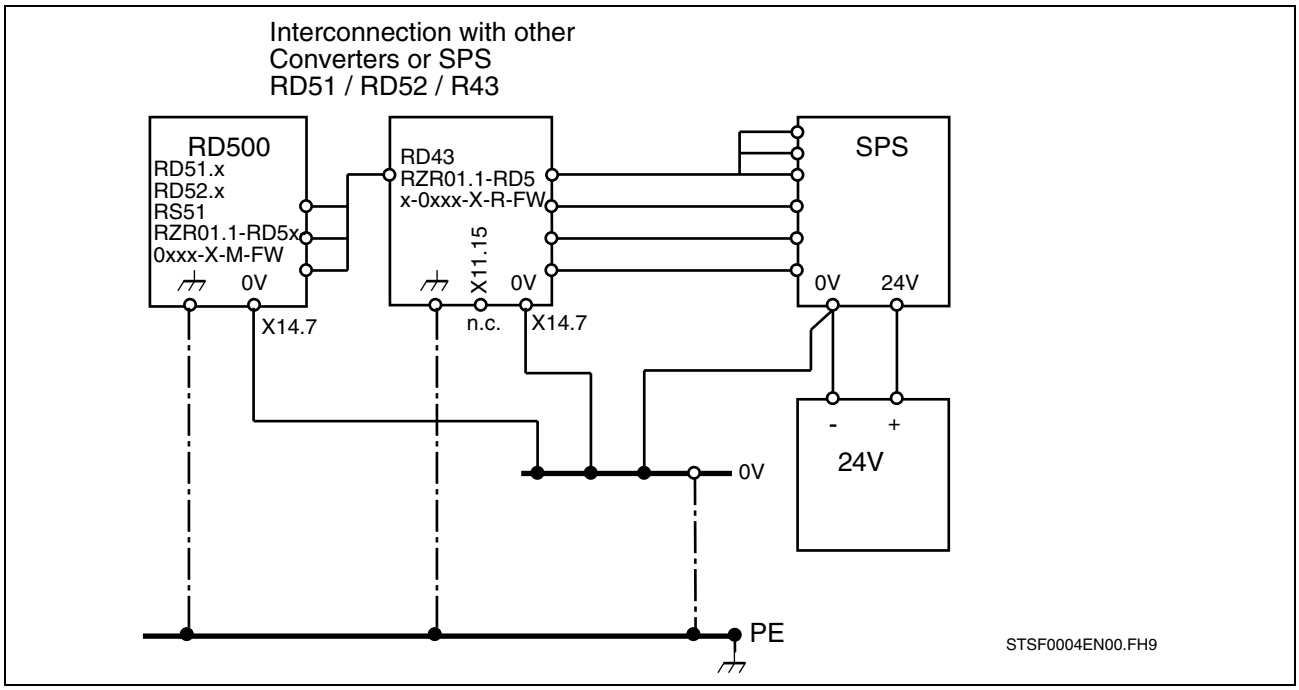


Figure 12-1: central connection of reference ground to PE

If there is no live control connection between the units (e.g. fiber-optic coupling) then the reference ground is directly connected to the PE at every unit.

Note: On delivery, there is a direct connection at RD 500 SFT units between a reference ground and the PE via cable connection X14.7 to the housing.

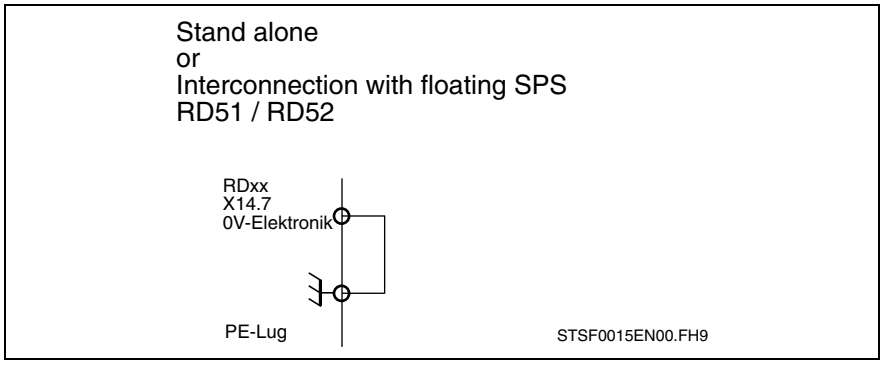


Figure 12-2: Direct connection of reference ground to PE for RD51 and RD52

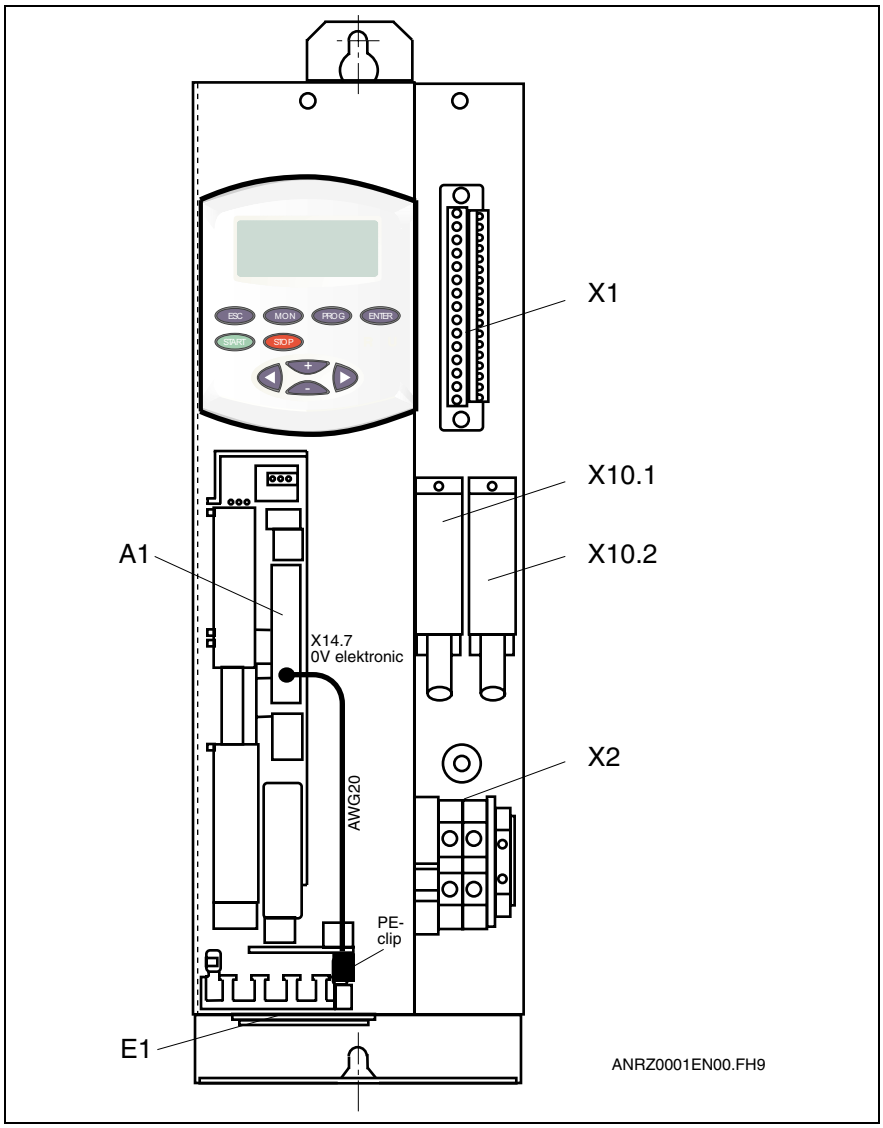


Figure 12-3: Connection of reference ground to PE

12.2 Configuring the Inverter at the Motor

A description of how to put into operation and configure the RD52 and / or RD51 inverters at the motor is contained in the respective functional descriptions of the standard units.

12.3 Encoder Connections motor inverter

The following encoder types can be connected to the RD 500 RD52 series of units:

- TTL incremental encoder, U_B = 5 V, with inverted tracks acc. to RS422
- TTL incremental encoder (Type R), U_B = 9 V, up to 30 V, with inverted tracks acc. to RS422
- TTL incremental encoder, U_B = 9 V, up to 30 V, with / without inverted tracks acc. to RS422
- Sine / Cosine encoder, U_B = 5 V, signal voltage 1 V_{pp}
- Sine / Cosine encoder, U_B = 5 V, with detection of rotor position, e.g. ERN 1387
- Resolver
- Magnetic field encoder

The encoder is connected to the control board at X18 (sub-D socket / 26-pins). The sub-D plug / 26-pin for connecting the encoder is delivered with the RD52. Prefabricated encoder cable is available for all types of encoder.

General Planning Instructions

- All encoders mentioned in the above can be used for operation with asynchronous motors.
- For synchronous motors, the sin / cos encoder with rotor position detection, e.g. ERN1387, or a resolver can be used.
- The maximum length of encoder cable that can be connected depends for the most part on the signal frequency, the cable capacity and the signal voltage and is indicated by the manufacturer of the encoder.
- Unused wires of the encoder cable must be laid onto the housing ground on the encoder and on the inverter side.
- The temperature sensor of the motor can either be incorporated into the encoder cable or can be wired in a separate line on plug X15 of the control board.

Note: The Combicon and Mini-Combicon plug components with spring connection included in the delivery require a particular length of the stripped conductor or of the used wire end-sleeve to ensure secure and permanent contact. The plug components are suitable both for stripped cable as well as for the use of wire end-sleeves.

Recommendation

Combicon headers FKC pitch 5.08 mm

X12, X16, X45

Cross section in mm²	Strip length in mm	Length of wire end sleeve in mm	Name & Number of Article Phönix Contact
2,5	10	10	Al 2.5 -10BU / 3202533

Figure 12-4: Combicon headers FKC pitch

Combicon headers FKC pitch 3.81 mm

X13, X14, X15, X17, X31, X32; X33, X34, X38, X47

Cross section in mm²	Strip length in mm	Length of wire end sleeve in mm	Name & Number of Article Phönix Contact
1.5	9	10	Al 1.5 -10BK / 3200195

Figure 12-5: Combicon headers FK - MCP pitch

Configuring the Encoder

Parameter No.:	Name:	Description / Explanation Selectable Options	Factory Setting Min ... Max Values	Pass-word
0130	Encoder selection	0 = resolver 1 = incremental encoder 2 = sin / cos & commutation 3 = sine / cosine encoder 4 = without encoder 5 = external from P0145	1 0 ... 5	2
0131	Resolver pin numbers	The pin number can be set as required between 2 and 100 pins.	2 2 ... 100	2
0132	Encoder line count	The pulse number can be set as required between 64 and 10000 pulses.	1024 64 ... 10000	2
0133	Encoder delta-Phi	Electrical encoder adjustment	0° -180 ... 180°	3
0189	Operating mode	0 = current-controlled 1 = voltage-controlled 2 = motor identification 3 = encoder optimization run	0	3

Figure 12-6: Configuring the incremental encoder

Additional explanations are contained in the documentation DOK-RD500*-RD52*06VRS*-FKxx-EN-P.

Switching-Over the Supply Voltage

The supply voltage is switched-over by Jumper S5 on the control board. Jumper 5 V is plugged on delivery. To replug the jumper, proceed as follows:

Note: Observe the warnings and instructions in Chapter 1

- Switch the unit off.
- Remove the front cover of the unit.
- To connect encoders with 15 V supply voltage, carefully move the jumper from +5 V (factory setting) to +15 V using tweezers.

CAREFUL

Damage to the units due to incorrect connection voltage!

⇒ Please observe the specifications in the documentation of the encoder manufacturer.

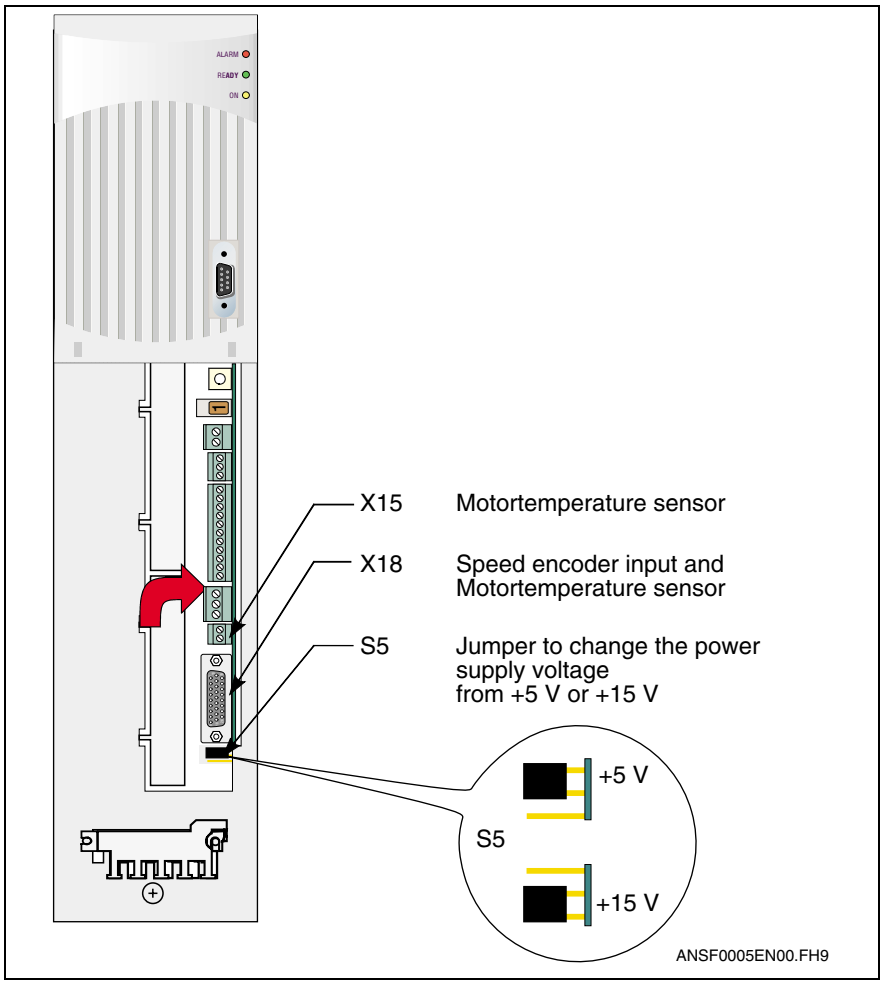


Figure 12-7: Setting the encoder supply voltage

Encoder Cable

We recommend that you use the encoder cable from Firma Bosch Rexroth to connect the encoder to the inverter. The following pictures only apply when using this cable. Raw cable number of Bosch Rexroth INK0691 (Mat.-no. R911291021) for:

- HTL and TTL incremental encoders
- Sine / Cosine encoders

Raw cable number of Bosch Rexroth INK0690 (Mat.-no. R911291101) for:

- Resolver

Ordering Example

Select the required connection (e.g. IKS5008/xxx,x). The order type must be supplemented by the length of cable. (Deliverable cable lengths: 2 ...75 m, in steps of 0.5 m).

Example text for a cable length of 5.5 m: **IKS5008/005.5**

Note: The maximum total length of the cable connection from the motor to the drive control unit with two plug locations in between is 75 m. If there are several plug locations then the maximum total length may be reduced. This must be tested by measurement.

HTL and TTL Incremental Encoders (for use with asynchronous motors)

Display of the signal for clockwise rotation on the A side of the motor shaft

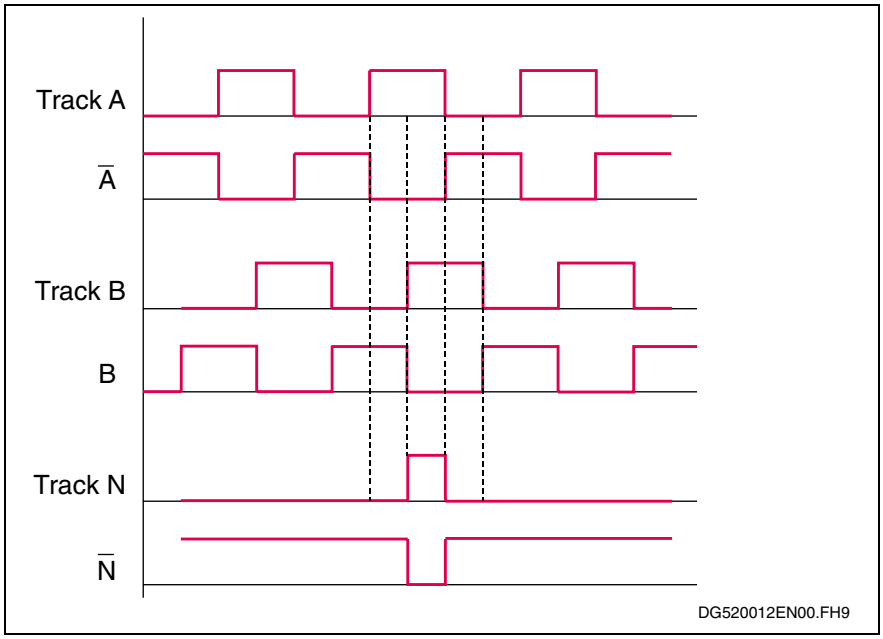


Figure 12-8: Display of signal of the HTL and TTL encoders

Connecting the HTL encoder with inverted tracks

X18	Speed Transmitter	
3	N	Reset pulse N (no evaluation)
4	$\overline{N}$	Reset pulse N inverted (no evaluation)
8	M	0 V (ground)
9	P 15 V	+15 V supply voltage (plug Jumper S5 to position +15 V (see Figure 12-7: Setting the encoder supply voltage)
10	B	Pulse track B
11	$\overline{B}$	Pulse track B inverted
19	A	Pulse track A
20	$\overline{A}$	Pulse track A inverted

Figure 12-9: Connecting the HTL encoder with inverted tracks

Note: The reset pulse is only evaluated by TTL encoders. The HTL encoder can therefore not be used for applications with positioning.

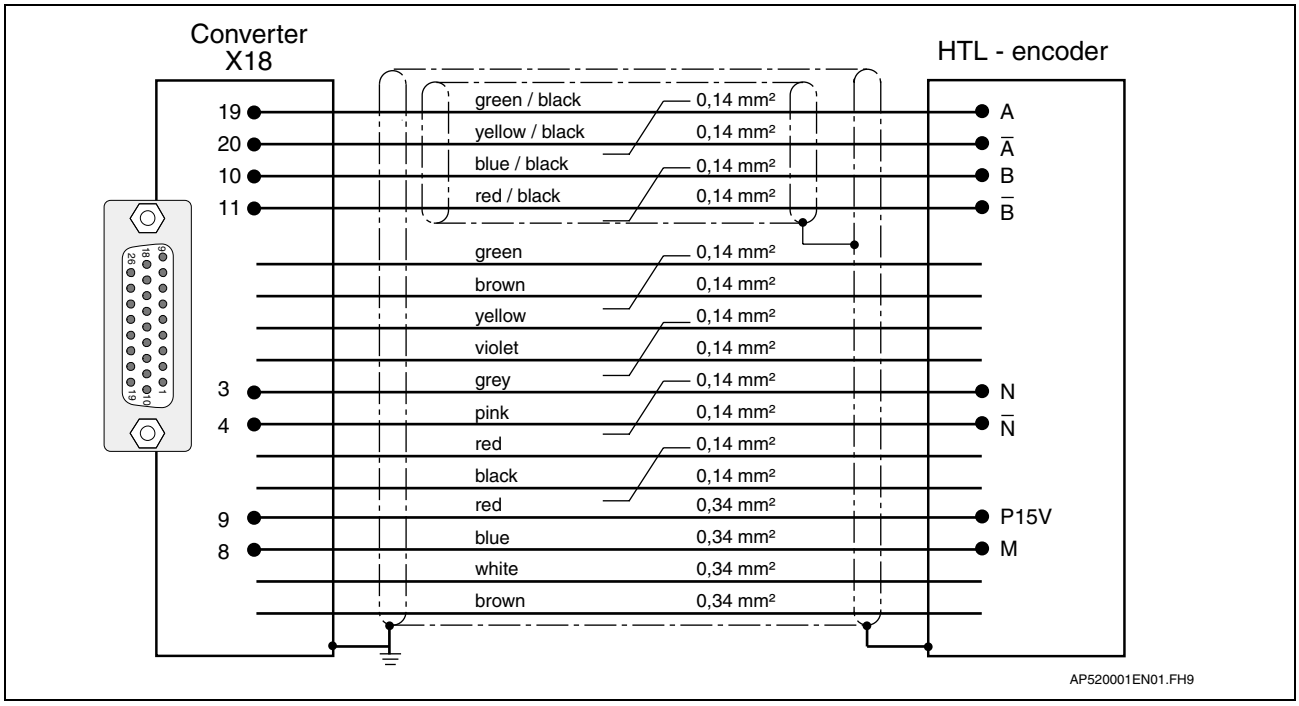


Figure 12-10: Connecting the HTL encoder with inverted tracks (e.g. IKS 5010)

Connecting the HTL encoder without inverted tracks

X18	Speed Transmitter	
3	N	Reset pulse N (no evaluation)
8	M	0 V (ground)
9	P 15 V	+15 V supply voltage (plug Jumper S5 to position +15 V (see Figure 12-7: Setting the encoder supply voltage)
10	B	Pulse track B
19	A	Pulse track A
1 20	Bridge	
11 2	Bridge	

Figure 12-11: Connecting the HTL encoder without inverted tracks

Note: The reset pulse is only evaluated by TTL encoders. The HTL encoder can therefore not be used for applications with positioning.

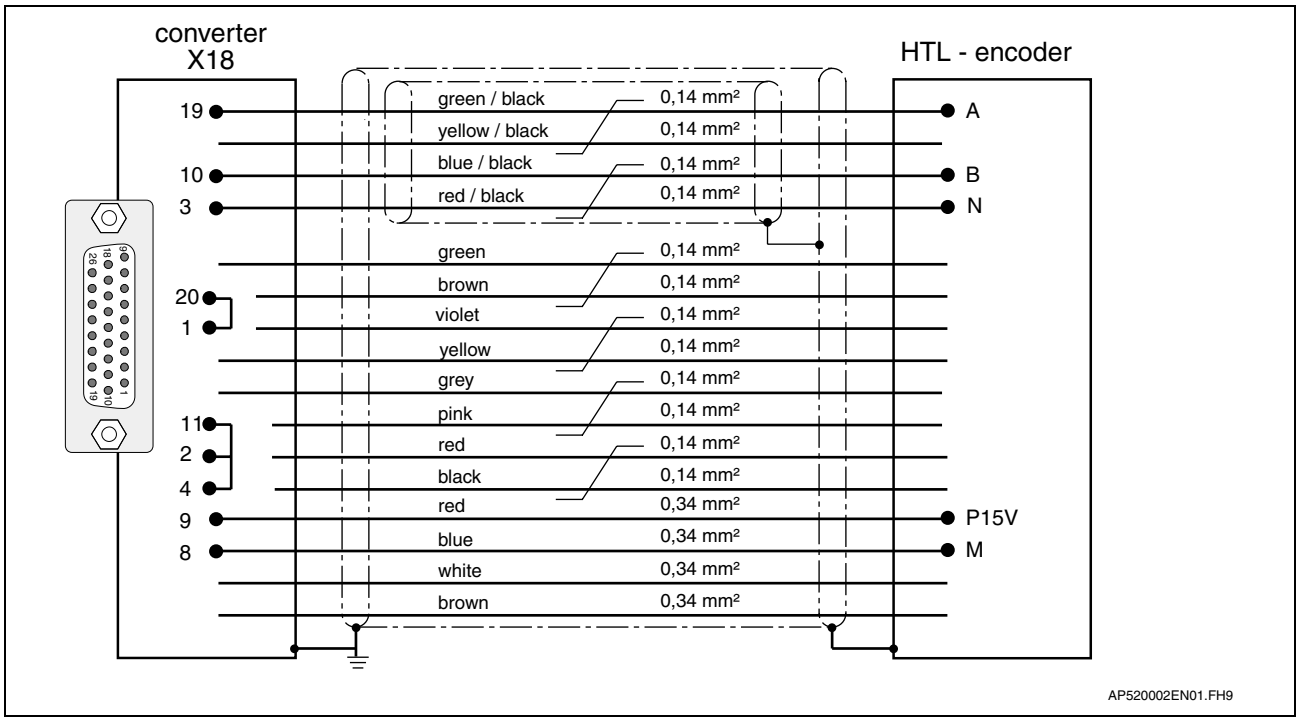


Figure 12-12: Connecting the HTL encoder without inverted tracks (e.g. IKS 5009)

Technical Specifications of the HTL Encoder Evaluation

Supply Voltage V_B (DC 15 V (Jumper S5 see Figure 12-7)

Max. Output Current I_{max} = 175 mA

Cutoff Frequency 150 kHz without inverted tracks
300 kHz with inverted tracks

Configuration P0130: incremental encoder
P0132: line count

Connecting the TTL Encoder

X18	Speed Transmitter	
7	M sense	Sensor circuit 0 V
8	M	0 V (ground)
9	P 5 V	+5 V supply voltage, see Figure 12-7
12	$\overline{A}$	Pulse track A inverted
13	A	Pulse track A
14	B	Pulse track B
15	$\overline{B}$	Pulse track B inverted
16	N	Reset pulse N
17	$\overline{N}$	Reset pulse N inverted
18	P sense	Sensor circuit +5 V

Figure 12-13: Connection assignments at the X18 for TTL encoders

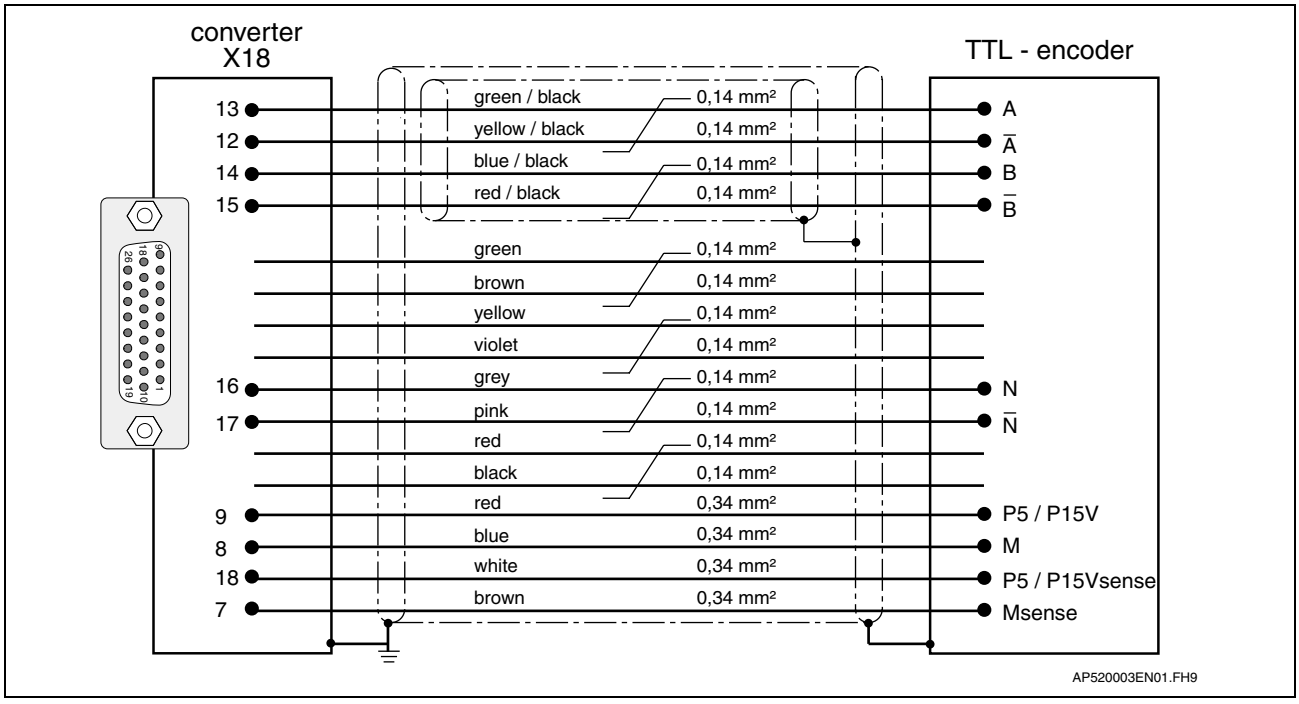


Figure 12-14: Connection Block Diagram of TTL encoder (e.g. IKS 5008)

Technical Specifications of the TTL Encoder Evaluation

Supply Voltage V_B (DC) 5 V ± 2.5 % (Jumper S5 see Figure 12-7)

Max. Output Current I_{max} = 200 mA

Cutoff Frequency 300 kHz

Input Resistance 120 Ω

Configuration P0130: incremental encoder
P0132: line count

Sine / Cosine Encoder $1V_{pp}$ and Magnetic Field Encoder

For use with asynchronous motors.

Display of the signal for clockwise rotation on the A side of the motor shaft

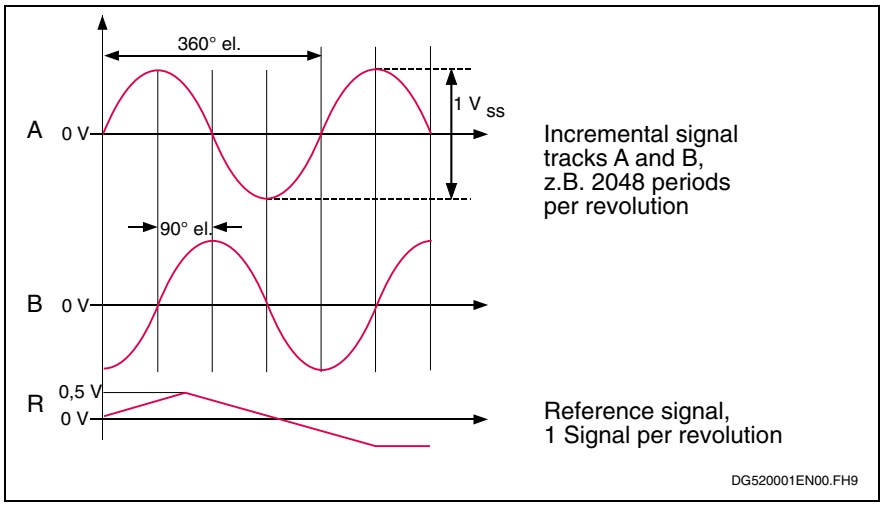


Figure 12-15: Display of the signal for clockwise rotation on the A side of the motor shaft

Sine / Cosine encoder connection

X18	Speed Transmitter and Temperature Sensor	
7	M sense	Sensor circuit 0 V
8	M	0 V (ground)
9	P 5V	+5 V supply voltage (Jumper S5 see Figure 12-7)
12	A-	Incremental signal A (sine)
13	A+	
14	B+	Incremental signal B (cosine)
15	B-	
16	R+	Reference signal R
17	R-	
18	P sense	Sensor circuit +5 V
25	Motor Temp.+	Connecting a motor temperature sensor (PTC or KTY84) Observe the correct polarity when connecting a KTY84!
26	Motor Temp. -	

Figure 12-16: Connections sine / cosine and magnetic field encoder

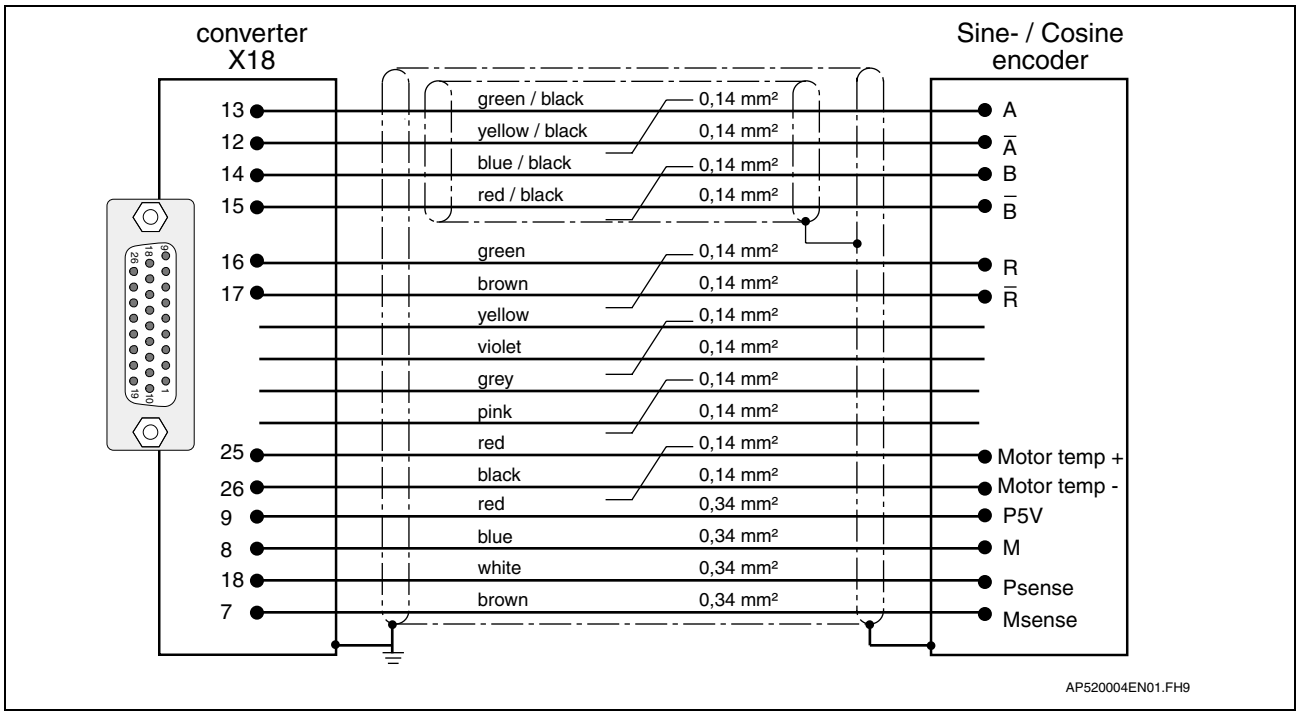


Figure 12-17: Connection Block Diagram of sine / cosine and magnetic field encoder (e.g. IKS 5001)

Technical Specifications of the Sine / Cosine Encoder Evaluation

Supply Voltage V_B (DC)	5 V ± 2.5 % (Jumper S5 see Figure 12-7)
Max. Output Current	I_{max} = 200 mA
Cutoff Frequency	300 kHz
Terminating Resistor Input	120 Ω
Configuration	P0130: Sine / Cosine encoder P0132: line count

Sine / Cosine Encoder 1 V_{pp} with Commutation (detection of rotor position)

For use with asynchronous and synchronous motors.

Display of the signal for clockwise rotation on the A side of the motor shaft

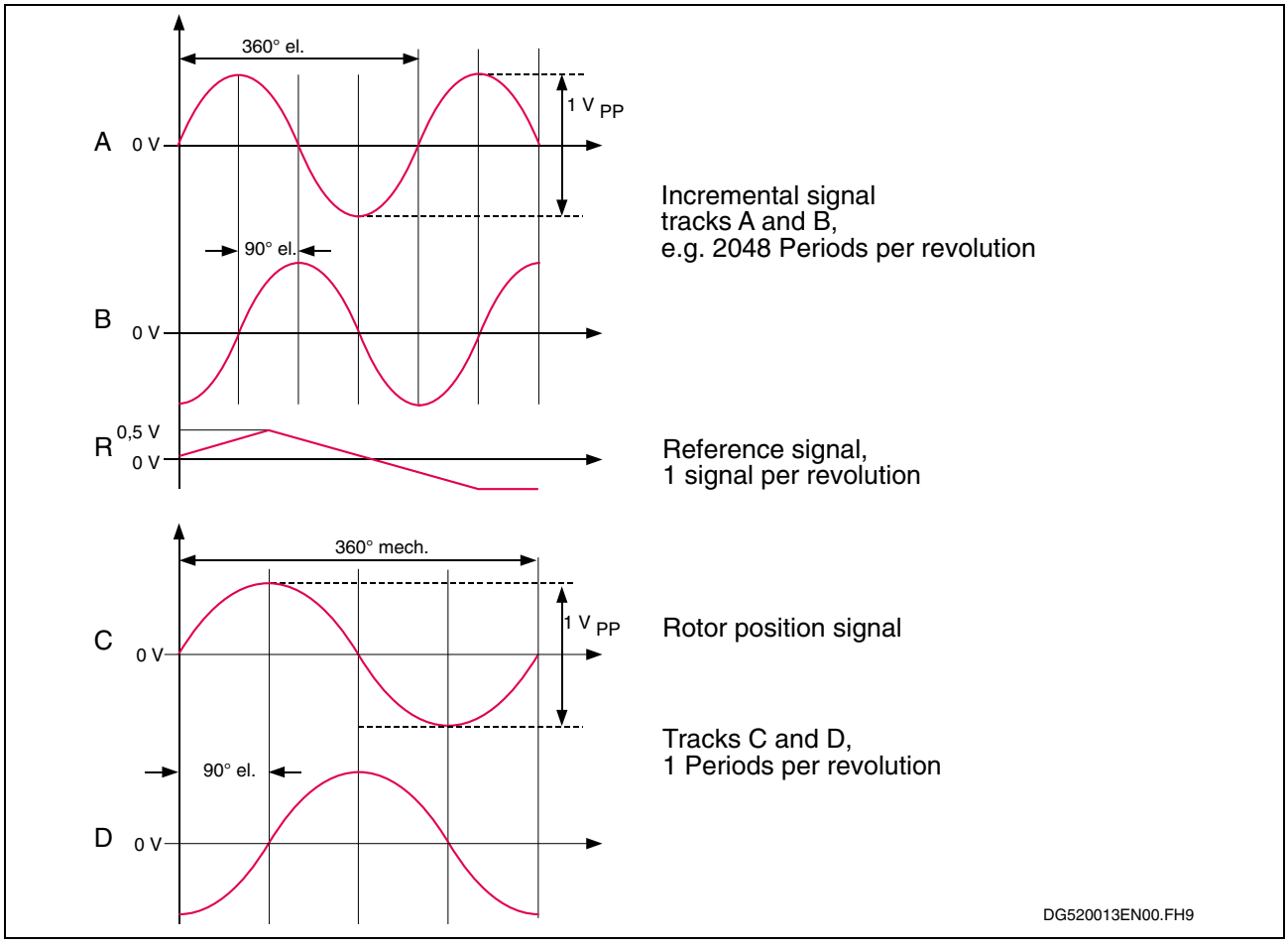


Figure 12-18: Display of signal sine / cosine encoder with detection of rotor position

Connection Assignment for Sine / Cosine Encoder 1 V_{pp} with Commutation

X18	Speed Transmitter and Temperature Sensor	
3	C+	Signal track C, rotor position
4	C-	
5	D+	Signal track D, rotor position
6	D-	
7	M sense	Sensor circuit 0 V
8	M	0 V (ground)
9	P 5 V	+ 5 V supply voltage (see Figure 12-7)
12	A+	Incremental signal A (sine)
13	A-	
14	B+	Incremental signal B (cosine)
15	B-	
16	R+	Reference signal R
17	R-	
18	P sense	Sensor circuit +5 V
25	Motor Temp.+	Connecting a motor temperature sensor (PTC or KTY84) Observe the correct polarity when connecting a KTY84!
26	Motor Temp. -	

Figure 12-19: Display of sine /cosine encoder 1 V_{pp} with commutation

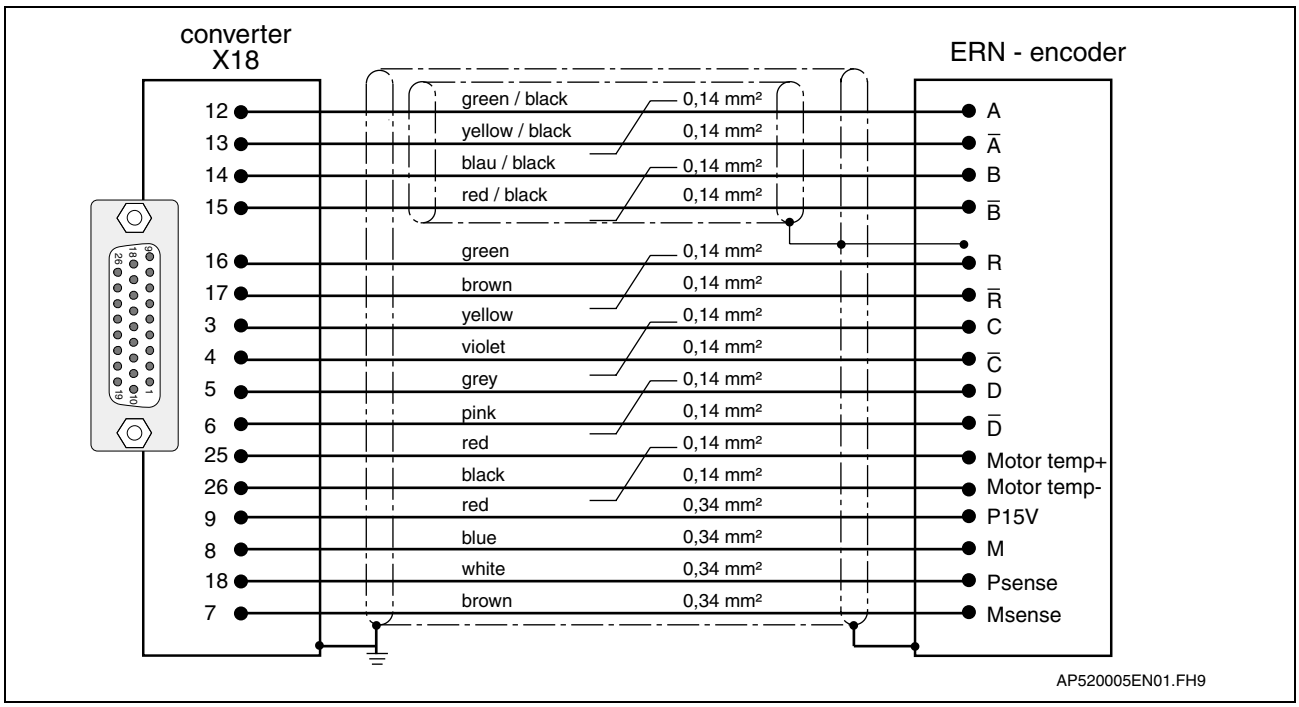


Figure 12-20: Connection Block Diagram of sine / cosine encoder 1 V_{pp} with commutation (e.g. IKS 5007)

Technical Specifications for Sine / Cosine Encoder 1 V_{pp} with Commutation

Supply Voltage V_B (DC)	5 V ± 2.5 % (Jumper S5 see Figure 12-7)
Max. Output Current	I_{max} = 200 mA
Cutoff Frequency	300 kHz
Terminating Resistor Input	120 Ω
Configuration	P0130: Sin / Cos & commutation P0132: line count

- P0130: Sin / Cos & commutation
- P0132: line count
- P0133: Encoder Delta-Pi (a mechanical fault in the encoder can be corrected using this parameter). This is only necessary when using synchronous machines.

When using a Siemens encoder or an encoder with a Siemens-compatible pole assignment of the quick disconnect plug, a prefabricated cable can be purchased from Bosch Rexroth.

Resolver (for use with asynchronous and synchronous motors)

Display of the signal for clockwise rotation on the A side of the motor shaft

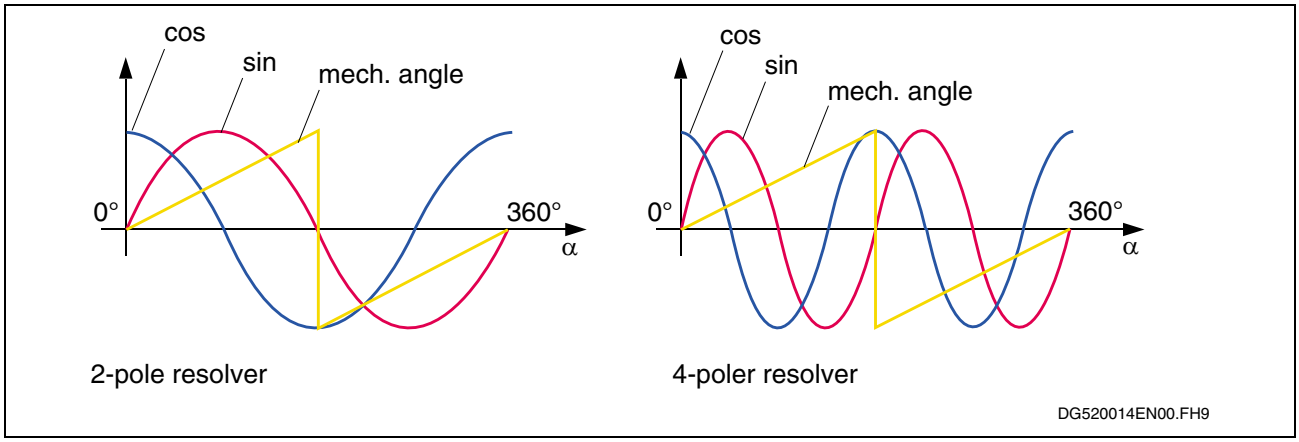


Figure 12-21: Display of signal of the resolver

The signals can be displayed using the RDwin oscilloscope function.

- Sine: D1086
- Cosine: D1087
- Mechanical angle: D1890

Connecting the Resolver

X18	Speed Transmitter and Temperature Sensor	
1	R1	Excitation voltage +
2	R2 (R3)	Excitation voltage -
10	S1	cos +
11	S3	cos -
19	S2	sin +
20	S4	sin -
25	Motor Temp.+	Connecting a motor temperature sensor (PTC or KTY84) Observe the correct polarity when connecting a KTY84!
26	Motor Temp. -	

Figure 12-22: Connection assignment of the resolver

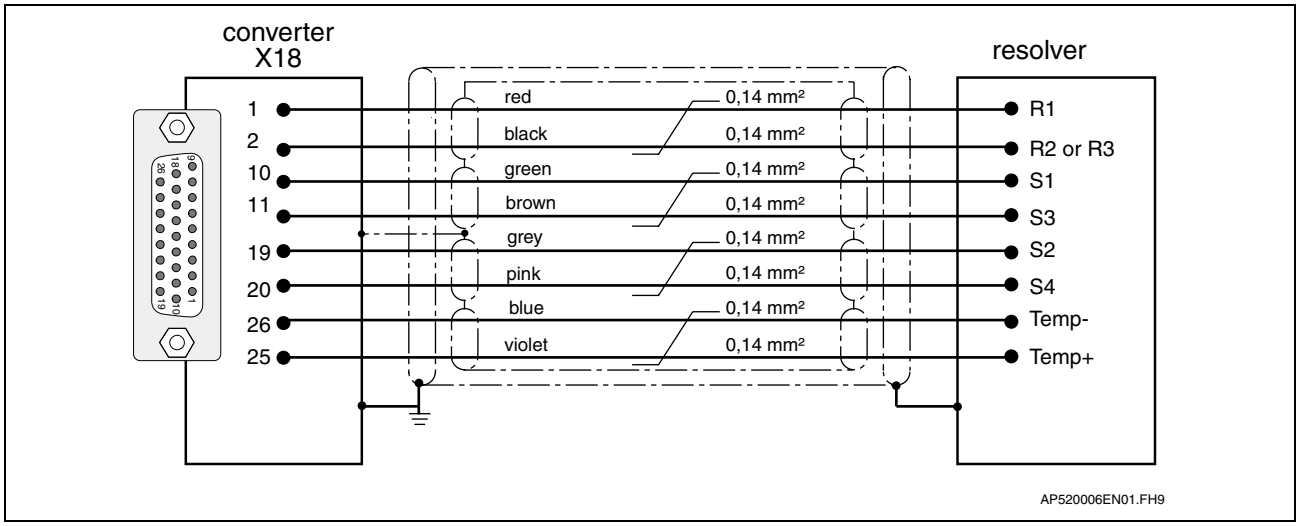


Figure 12-23: Connection block diagram of the resolver (e.g. IKS5014)

We recommend that you use an 8-pole cable that is shielded in pairs and twisted, with an additional outer shielding to connect the resolver to the inverter. The cross-section should be at least 0.14 mm^2 (raw cable number of Bosch Rexroth INK0690).

The line length of the resolver cable should be kept as short as possible and must not exceed 75 m.

Technical Specifications of the Resolver Evaluation

Supply Voltage V_B (DC) 7 V_{eff}, f_{err} (exciter frequency)

Max. Output Current I_{max} = 100 mA

Configuration

- P0130: Resolver
- P0131: No. of pins

f_p kHz	4	6	8	10	12
f_{err} kHz	8	12	8	10	12

f_p: pulse frequency (P0026)

Figure 12-24: Frequency selection

- P0133: Encoder Delta-Pi (a mechanical fault in the encoder can be corrected using this parameter). This is only necessary when using synchronous machines.

Recommended Ratings of the Resolver

Transformation ratio 0.4 ... 0.6

Max. phase shift ±15°

Max. electrical error ±10 angular minutes

Max. output impedance Z_{pp} (180 + j500) Ω

Zero voltage < 30 mV

Assembling the Resolver

Mean offset between the rotor and the stator max. 0.05 mm

Axial offset between the rotor and the stator max. ±0.25 mm

Assignment of number of motor poles – number of engine poles

The relation between the number of poles of the motor and of the resolver must always be an integer!

Number of poles = number of pole pairs ∗ 2.

Number of poles of Resolver	Number of Poles of Motor				Manufacturer	
	2	4	6	8	Siemens	Tamagawa
2	X	X	X	X	V23401-H2009-B202	TS2018 N 431 E41
4		X		X	V23401-H2012-B201	TS2018 N 532 E41
6			X		V23401-H2002-B209	TS2018 N 543 E41
8				X	V23401-H2003-B209	

Figure 12-25: Assignment of number of poles of motor – number of poles of resolver

When using a Siemens resolver or a resolver with a Siemens-compatible pole assignment of the quick disconnect plug (20° coded), a prefabricated encoder cable (IKS 5014) can be purchased from Bosch Rexroth.

First Encoder Test

Connect the motor with the encoder installed to the inverter.

If the motor has not been released then rotate the motor shaft manually in a clockwise direction (view of the A side, i.e. the drive side).

A positive speed must be displayed in the operation indicator lamp of the control panel.

When turning the motor shaft anticlockwise, a negative speed must be displayed.

12.4 Service Interface RS232 (X11)

This interface has been designed for connecting the control panel or a PC to RDwin. A standard extension cable (prefabricated) can be obtained from Bosch Rexroth to connect the units (order no.: R911200239, length 5 m).

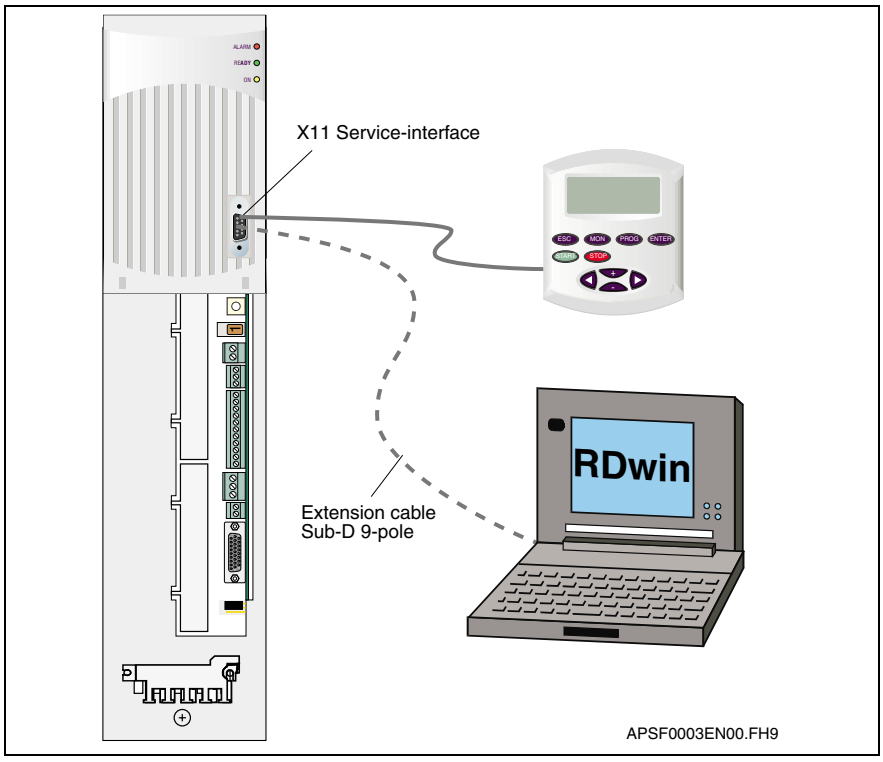


Figure 12-26: Connection possibilities to the service interface

Connecting the Control Panel

The control panel can either be plugged-in directly using the X11 plug or can be connected using the above-mentioned cable.

Connecting a PC

The cable used to connect a PC must be configured as follows:

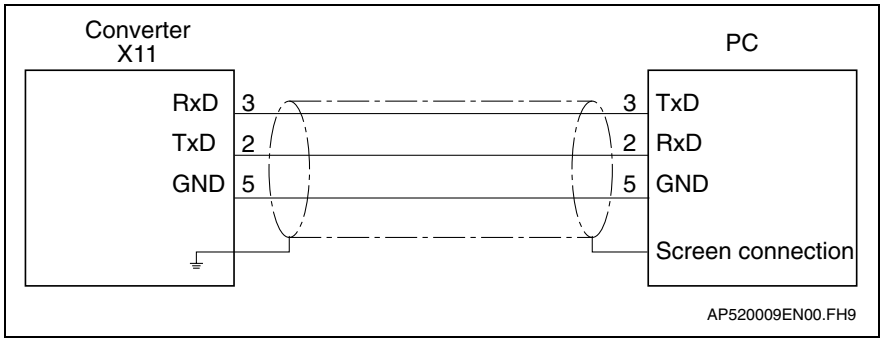


Figure 12-27: Connection cable for PC

Alternatively, the control panel cable can also be used.

Configuring the RS232 Service Interface

The service interface uses the USS protocol.

The protocol type is fixed (4 / 6 words, even parity, 1 stop bit).

Additional explanations are contained in the functional description DOK-RD500-RD52*xxVRS*-FKxx-EN-P.

The baud rate can be selected using P0499.

Parameter No.:	Name:	Description / Explanation Selectable Options	Factory Settings Min ... Max Values	Pass-word
0499	RS232 baud rate X11	Parameter value 0 = 1200 baud 1 = 2400 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud 5 = 38400 baud 6 = 57600 baud 7 = 76800 baud	9600 baud 0 ... 7	2

Figure 12-28: Parameters for RS232

The following settings should be observed:

Baud rate: selectable using P0499: 1200, 2400, 4800, **9600** (factory setting), 19200, 38400, 57600, 76800 baud

Data bits: 8

Parity: even

Stop bits: 1

Type of protocol: USS protocol, 4 / 6 words

12.5 Standard Interface RS485 (X12)

The RS485 interface supports the USS protocol, which allows the inverter to be operated via a PLC. The USS protocol (Universal Serial Interface, (*Ger.: Universelles-Serielles-Schnittstellenprotokoll*) defines an access procedure according to the master-slave principle for communication over a serial bus. Additional explanations are contained in the functional description
DOK-RD500-RD52*xxVRS*-FKxx-EN-P.

Terminal Plan of the Control Board

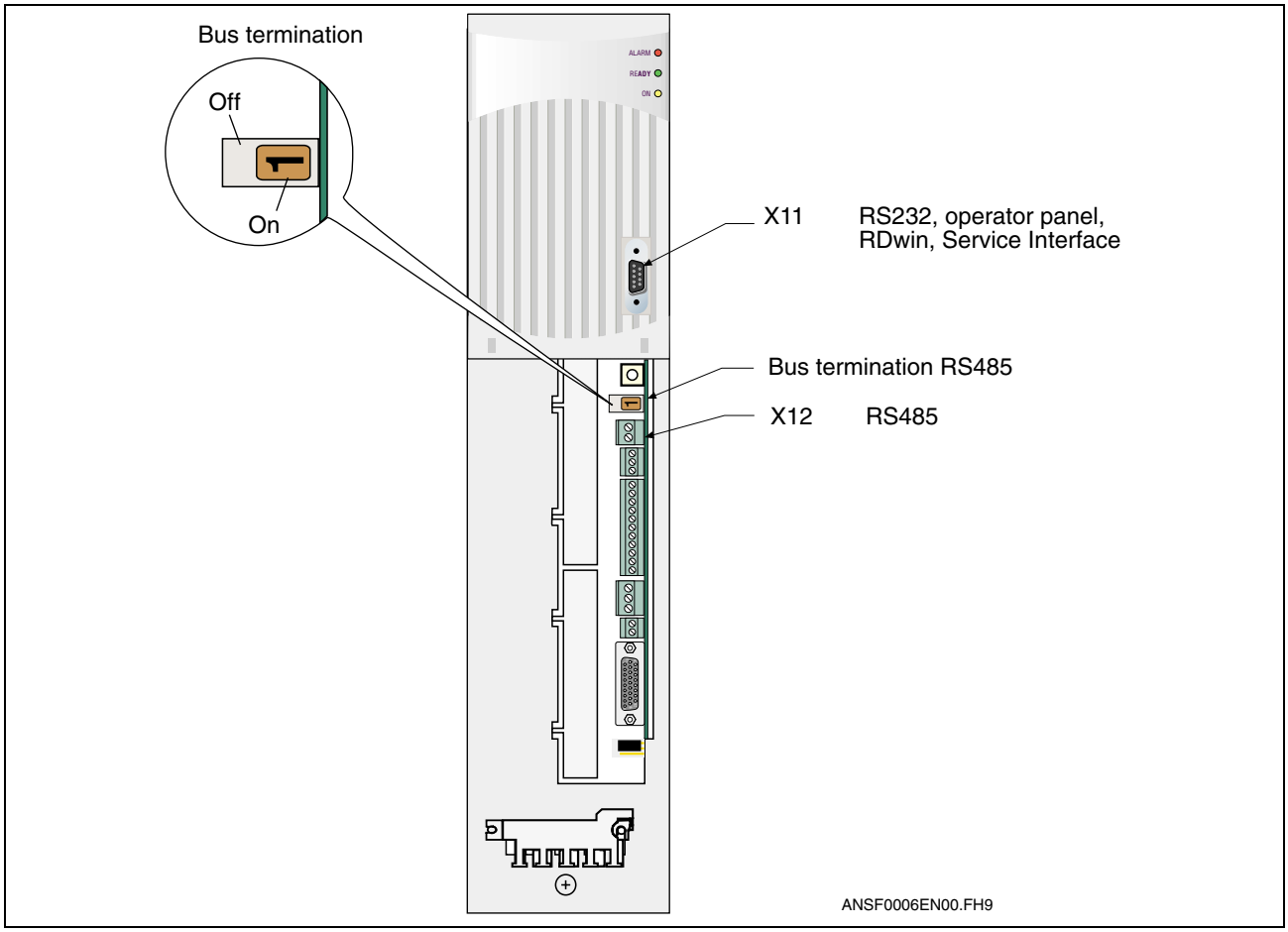


Figure 12-29: Terminal Plan SR17002

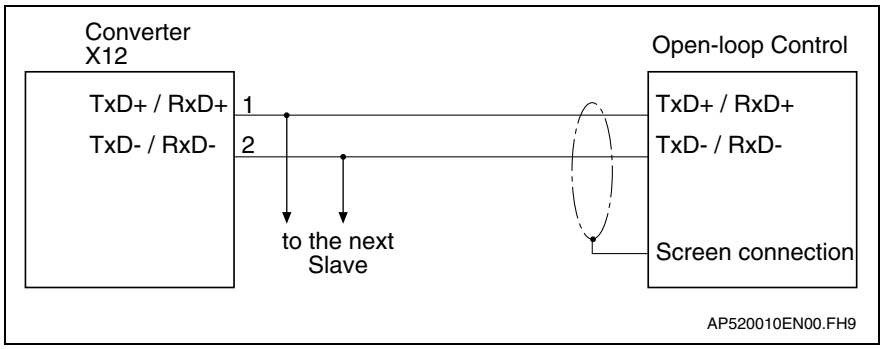


Figure 12-30: Standard interface connection

When operating with this interface, make sure that the same interface configuration is set for each bus node

Exception: "SS1 Slave Address"; here, every bus node gets its own address.

Bus Termination

The first and last nodes on the bus system must terminate the bus to protect it from interference. Bus termination is switched on and off by a switch on the control board (see Figure 12-29)

Configuring the Inverter

The standard RS485 interface is configured by setting P0500 to P0506.

The parameters can be accessed via the menu as follows:

CONFIGURATION/SET PARAMETERS/SER. COMMUNICATION

Configuring the Standard Interface

Parameter No.:	Name:	Description / Explanation Selectable Options	Factory Settings Min ... Max Values	Pass-word
0500	SS1 protocol X12	Serial interface 1 (SS1) is a RS485 interface (connection X12) Parameter value: 0 = no protocol 1 = USS 4 / 2 words 2 = USS 4 / 6 words 3 = USS 0 / 2 words 4 = USS 0 / 6 words 5 = USS 4 / 0 words	USS 4 / 6 words 0 ... 5	2
0501	SS1 baud rate X12	Parameter value 0 = no protocol 1 = 1200 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud 5 = 38400 baud 6 = 76800 baud	9600 baud 0 ... 6	2
0502	SS1 parity X12	Parameter value 0 = no parity 1 = ODD 2 = EVEN	EVEN 0 ... 2	2
0503	SS1 stop bits X12	1 or 2 stop bits can be set.	1 1 ... 2	2
0504	SS1 slave address	The address of the unit can be set between 0and 31 for the RS485 bus. **Attention:** There must be no identical addresses in the bus!	0 0 ... 31	2
0505	SS1 Rx monitoring	Parameter value 0 = no action 1 = alarm 2 = fault	Fault 0 ... 2	2
0506	SS1 Rx monitoring time	Monitoring time for the standard interface SS1. If the receiver does not receive any faultless protocol in this time then the reaction selected in P0505 is triggered.	0.1 s 0.1 ... 60.0 s	2

Figure 12-31: Parameters for RS485

12.6 Commisioning Power Inverter

Note: Switch-on is suppressed if the phase sequence of the applied mains voltage is incorrect. L1-L2-L3 must be a clockwise phase sequence.

Generating the Control Word

The units are controlled using a controlled word. The control word is comprised of 16 bits. Bits 0 to 7 are set according to VDI / VDE regulations 3689.

Bits 8 to 15 can be set via the serial interface and every bit can be freely assigned to a unit control function. The control word is formed from logical linkages of the **control word KL (terminal strip)** and the **control word MS (mask or interface)**. The MS control word can be assigned by four sources that are selected by a switch. The switch is activated by parameter P0073.

P0073, switch position 0: control panel and terminals

The control word MS is formed by a mask in which bits 1 to 15 have been firmly assigned. Only bit 0 can be set to 1 (ON command) or 0 (OUT1 - command) by the control panel.

Note: This is contained in the basic parameter set of the power inverter and corresponds to its condition on shipment.

P0073, switch position 1: bus SSX and terminals

Control word MS is from a variable parameter source. Only the process data of the serial interfaces can be used in the parameter source. The MS control word is therefore pre-assigned via the interface. Therefore, P0074 is linked with the control word associated with the serial bus.

In this configuration, bits 8 to 15 can also be set via the serial interface and every bit can be freely assigned to a unit control function. These become effective in the unit by further switching of the parameters D1768 to D1775. The corresponding basic parameter set of the power inverter must be loaded.

P0073, switch position 2: Terminals

The control word MS is formed by a mask in which bits 0 to 15 have been firmly assigned. The mask is assigned in such a way that control of the unit is only via the control word KL.

Bits 0 to 7 of the control word KL have been assigned fixed control functions.

Digital input 4 is reserved for the switch-on command. In divergence from the basic parameter set, parameter P0583.00 must be set to the value D1717. The operational release is automatically set after acknowledgement from the main contactor. If operational release is also to be controlled via the terminal strip, then parameter P0585.03 must be interconnected with the digital input being used.

P0073, switch position 3: PC (RS232) and terminals

Control word MS is from the RS232 service interface. Switch position 3 has been designed for control operation via RDwin, which transmits a control command as PZD1.

Note: To switch on the unit, a signal change is required in bit 0 from 0 to 1 when in the „Ready to Run“ operating state. Even the error acknowledgement (bit 7) is only accepted when there has been a signal change from 0 to 1. The corresponding basic parameter set of the power inverter must be loaded.

Assignment of the Control Word Bit

Bits 0 to 7 of control word 1 (D1920) are the same as those functions set in VDI/VDE regulations 3689:

- Bit 0 = ON (edge L-> H) / OFF 1 (L active)
- Bit 1 = OFF 2, voltage separation (L active)
- Bit 2 = OFF 3, fast stop (L active)
- Bit 3 = operational release (H active)
- Bit 4 = HLG reset (L active)
- Bit 5 = stop of start-up (L active)
- Bit 6 = set value release (H active)
- Bit 7 = error acknowledgement (edge L-> H)

Bits 8 to 15 can only be assigned via the control word from the serial interface . The functions for these bits can be configured as desired.

Note: More information regarding the control/state logic is contained in the Control and State Word Flow Diagram, Function Plan, Sheets 56 and 57.

12.7 Configuring the RD500 SFT Power Inverter

The parameterisation figuring in this document complies with the unit’s shipping condition.

Firmware: **On and after FWC-SR1700-201-06V42-FW**

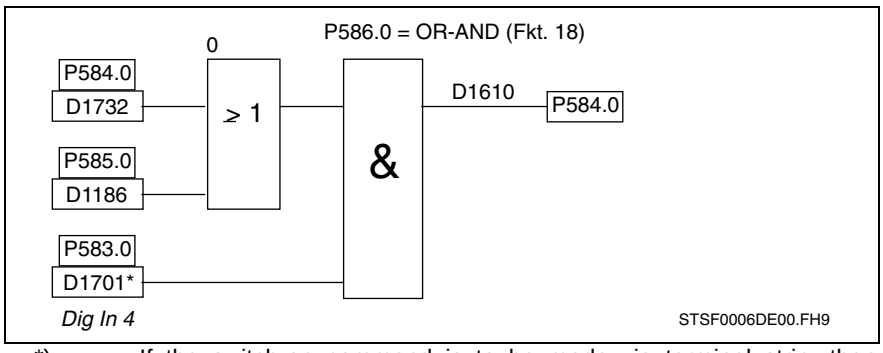
This basic configuration is absolutely necessary for the function of the inverter at the mains side.

ATTENTION

As consequence of activating the function “loading standard values” , all parameters are deleted!

⇒ When this happens, the corresponding set of parameters which you are in need of for running the mains converter has to be loaded once more.

ON - control:



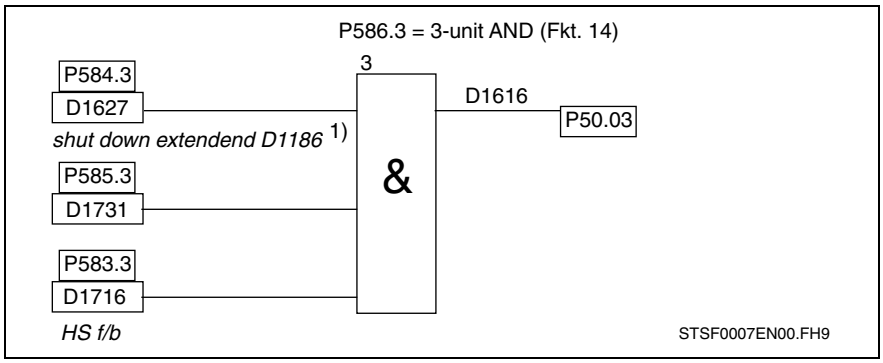
*): If the switch-on command is to be made via terminal strip, then P0583.0 = 1717 must be set and P0073 must be accordingly selected.

Figure 12-32: ON - control

P0073 = control panel + terminal strip

Switch-on is suppressed if the phase sequence is incorrect.

Operation - control:



1): see Figure 12-40

Figure 12-33: Operation - control:

The equipment is only released after the HS has answered back. The pulses are blocked if there is no synchronization with the mains voltage (D1186).

Digital inputs and outputs:

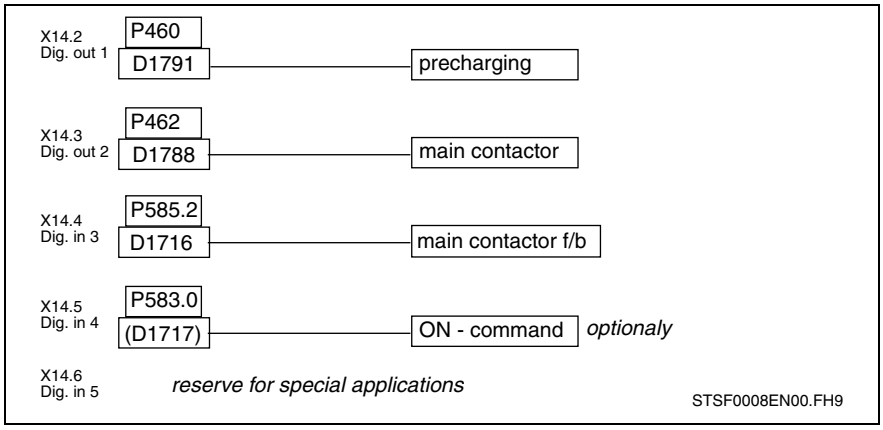


Figure 12-34: Digital inputs and outputs

Standard: P0583.0 = 1701

Precharging protection and main contactor are activated via the SR terminal strip. The HS- acknowledgement is evaluated on the configuration level.

12.8 Faults and Alarms:

External Fault 0: fault in the main contactor

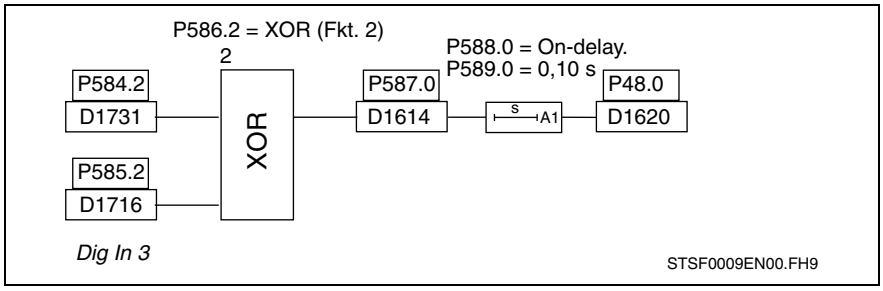
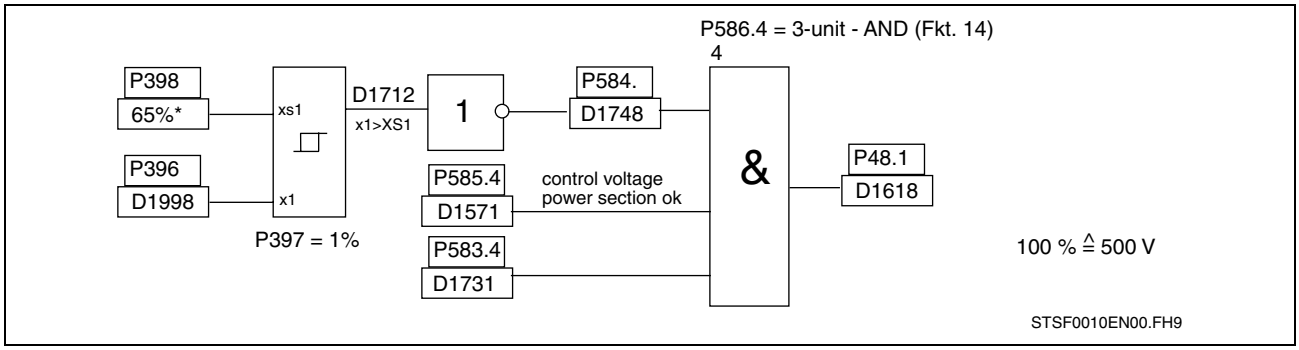


Figure 12-35: Fault in the main contactor

P1036.80 = 100 ms (HS response time) must be set in the data record of the unit.

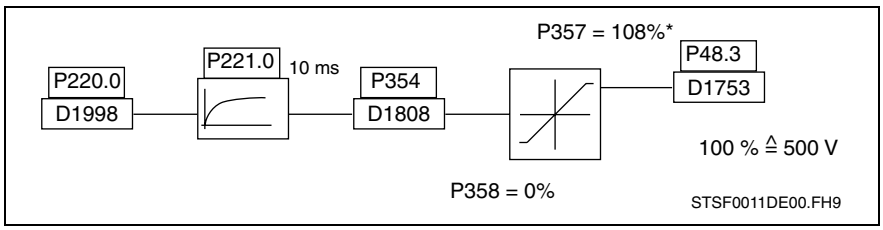
External Fault 1: power failure



*) P398 (undervoltage threshold of mains) must be adapted to the application.

Figure 12-36: Power failure

External Fault 3: power overvoltage



*): P357 (overvoltage threshold of mains) must be adapted to the application.

Figure 12-37: Power overvoltage

Fault - Overtemperature at motor: power choke temperature is too high

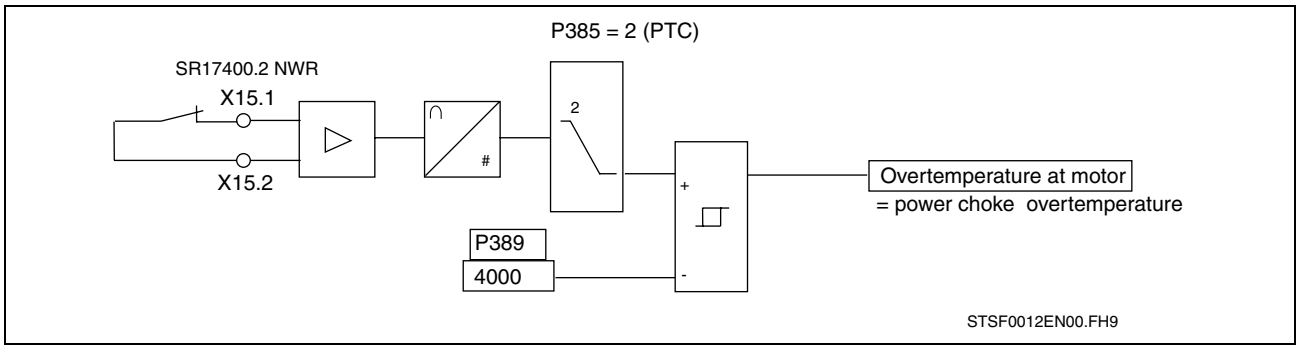


Figure 12-38: Power choke overtemperature

External Alarm: no synchronization of the mains voltage

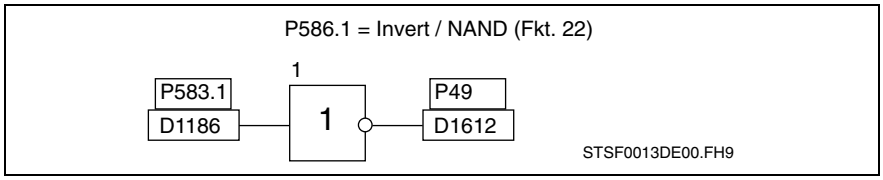


Figure 12-39: No synchronization of the mains voltage

If external alarms occur after connecting the mains voltage:

incorrect phase sequence, or the power switch of the line power supply is in off-position!

12.9 V_{ic} Control with Power-On i_{sq}* Limitation

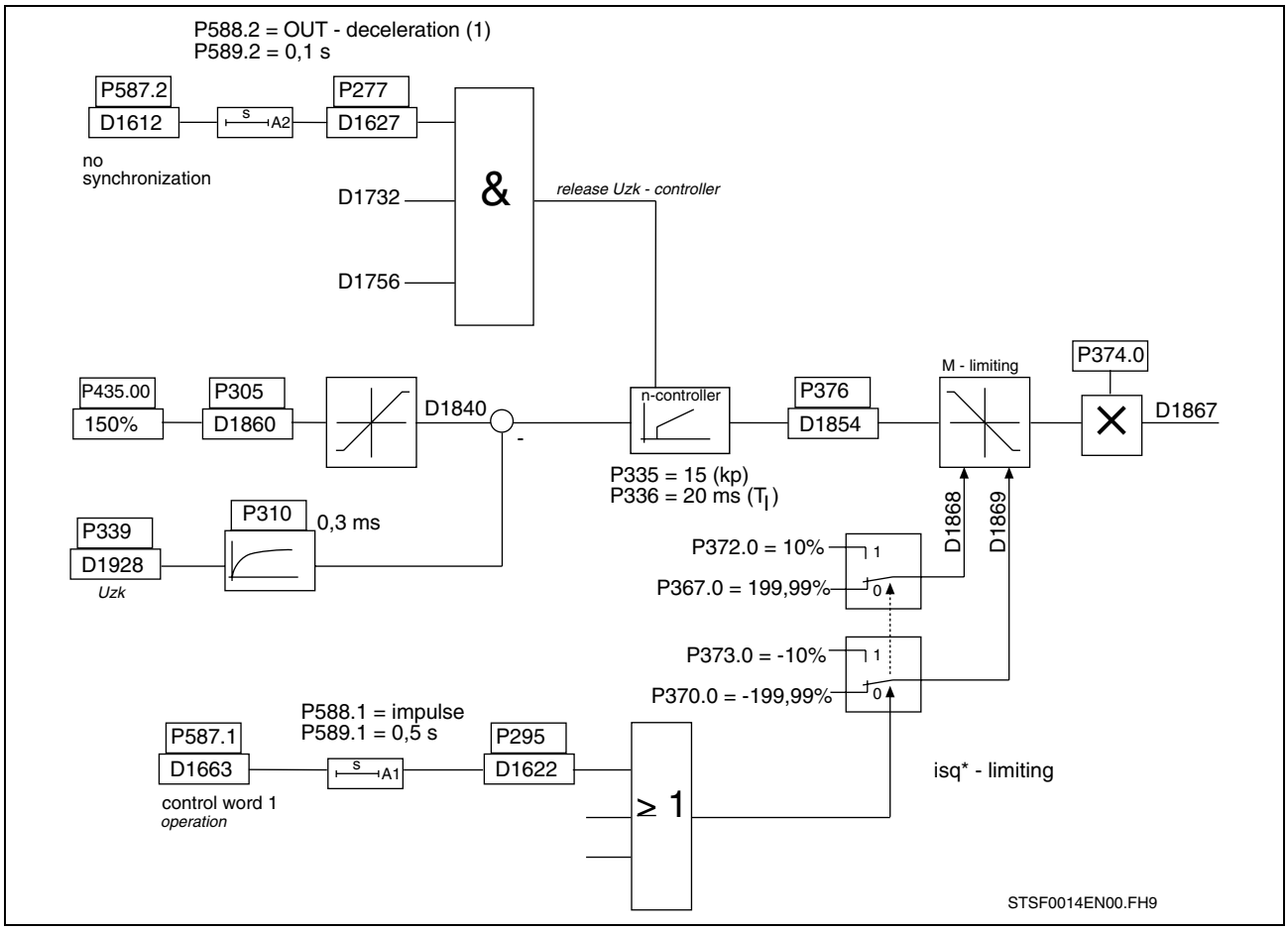


Figure 12-40: V_{ic} Control with Power-On i_{sq}* Limitation

Within 100 ms, the switch-off delay hinders a renewed release of the controls during phasic synchronization.

12.10 Device-Dependent Parameters of the Power Inverter:

For the meaning of the parameters, see DOK-RD500x-RD52A106VRS-FK01-EN-P Kap5.pdf

	185 kW (SFT 160 kW)	**300 kW (SFT 250 kW)**	**420 kW (SFT 350 kW)**	**530 kW (SFT 450 kW)**	**770 kW (SFT 650 kW)**
P100	Power inverter	Power inverter	Power inverter	Power inverter	Power inverter
P109	461 A	572 A	819 A	1040 A	1521 A
P130	3-phase network	3-phase network	3-phase network	3-phase network	3-phase network
P148	70 %	70 %	70 %	70 %	70 %
P153	1 (hexagon)	1 (hexagon)	1 (hexagon)	1 (hexagon)	1 (hexagon)
P189	Current controlled	Current controlled	Current controlled	Current controlled	Current controlled
P357*	108 %	108 %	108 %	108 %	108 %
P372.0	10 %	10 %	10 %	10 %	10 %
P373.0	-10 %	-10 %	-10 %	-10 %	-10 %
P374	300 A	400 A	600 A	800 A	1000 A

	185 kW (SFT 160 kW)	300 kW (SFT 250 kW)	420 kW (SFT 350 kW)	530 kW (SFT 450 kW)	770 kW (SFT 650 kW)
P395	4000 1 / min	4000 1 / min	4000 1 / min	4000 1 / min	4000 1 / min
P398*	65 %	65 %	65 %	65 %	65 %
P808*	5 ms	5 ms	5 ms	5 ms	5 ms
P810*	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
P811	0.39 mH	0.20 mH	0.14 mH	0.10 mH	0.07 mH
P812	0.100 Ω	0.056 Ω	0.040 Ω	0.028 Ω	0.020 Ω
P813*	10 Hz	10 Hz	10 Hz	10 Hz	10 Hz
P814*	50,00 %	50,00 %	50,00 %	50,00 %	50,00 %
P815*	530.0	530.0	530.0	530.0	530.0
P816	-135°	-135°	-135°	-135°	-135°
P817**	80 %	80 %	80 %	80 %	80 %
P818**	80 %	80 %	80 %	80 %	80 %
P819**	0 %	0 %	0 %	0 %	0 %
P820**	0 %	0 %	0 %	0 %	0 %
P1319*	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
P1370	Source X18	Source X18	Source X18	Source X18	Source X18

* depends on the application; the standard values are listed

** is adjusted when the unit is checked only standard values are mentioned

Figure 12-41: Parameter

13 Troubleshooting

13.1 Self-Test Error Messages

The system carries out a self-test after the initialization routine. During this test, the individual components of the microcomputer system such as, e.g. the EEPROM are checked and data is read in from the power control board.

13.2 Alarms / Warnings

If a warning is issued then the alarm message is displayed alternating with the programmed operation indicator lamp. The alarm bit can be outputted at a digital input. If the inverter is to be prevented from turning on then the alarm bit must be linked to the free configuration.

Note: During power inverter functions, switching on is prevented by the alarm „external alarm“ when:

- the input voltage does not correspond to any clockwise phase sequence
- the power switch of the line power supply is in off-position

13.3 Faults

During operation, both fixed and adjustable limit values are constantly monitored. To protect the power section from damage, the unit is always switched off when a limit value is exceeded and the corresponding error message is shown in the display.

In the case of RD 500 inverters with 3-phase AC feed, the main contactor is switched off when a fault occurs and the power section is disconnected. The corresponding error message is shown in the display.

The fault is displayed by the red "ALARM" LED on the front side of the unit.

Error messages are stored in the fault memory and protected against power failure. The fault memory is called-up in the monitor. The last 10 faults are stored in the fault memory. The last fault is in stored at location S0 and the oldest in S9. A new fault is always stored at location S0. All older faults are moved up one place in the memory. The fault stored at S9 is thereby lost.

Acknowledging Faults

After a switch-off due to a fault, the unit is locked and can not be switched back on until the fault is acknowledged. As long as the cause of the fault has not been remedied, acknowledgement is not possible. If the cause of the fault has been remedied then the fault can be acknowledged after a time set in the timer has expired (P0093, factory setting 1 sec.).

There are several ways of acknowledging a fault:

- Press the Esc button on the control panel.
- Press the S9 button, "fault acknowledgment" on the control board.
- Via a digital input: Connect an H signal at the digital input, and then interconnect the D parameters of the selected digital input in P0050.07.

- Via serial interface RS485; transmit the control word with bit 7 set to "high"

13.4 List of Alarms and Error Messages

No.	Messages	Warning	Fault
0	no fault, no warning	x	x
1	External (main conducter)	x	x
3	intermediate circuit voltage is too high		x
4	intermediate circuit voltage is too low	x	x
7	overtemperature at unit	x	x
8	braking resistor		x
9	main contactor		x
10	precharging circuit		x
11	new EEPROM		x
12	clock1 <==> clock2		x
13	power section		x
14	inverter		x
15	power supply		x
16	internal DSP comm. (communication)		x
17	overspeed	x	x
18	ground fault		x
19	EEPROM data	x	x
20	internal DSP ack. (reception acknowledgement)		x
21	internal WS comm.		x
22	NTC power section		x
23	motor sensor		x
24	SS1 time monitoring	x	x
25	SS2 function	x	x
26	SS2 time monitoring	x	x
27	analog input : I < 4 mA	x	x
28	Overtemperature at motor	x	x
30	SR output state		x
31	BW overload	x	x
32	overcurrent		x
34	emergency shut-down	x	x
35	motor overload	x	x
39	on during start-up lock		x
40	switching power supply		x
41	SR <==> WS new		x
44	SS4 function	x	x
45	SS4 time monitoring	x	x
47	start-up lock active	x	

No.	Messages	Warning	Fault
48	module overtemperature	x	x
49	Uzk (DC link) imbalance		x
50, 51	phase V, phase W		x
52	power undervoltage (extertnal1)		x
53	External 2 (not connected)	x	
54	power overvoltage (extertnal3)		x
55, 56, 57, 58	external 4, external 5, external 6, external 7 (not connected)	x	x
59	SS6 time monitoring	x	x
60	Syncho-Link time monitoring	x	x
59	SS6 time monitoring	x	x
61	FUS power supply		x
62	resonance		X
63	output current EN81 – for future use		
64	discharge of intermediate circuit – for future use		

Figure. 13-1: Error messages

13.5 Alarms and Error Messages – SFT Cause and Remedy / Comment

NWR = power inverter

MWR = motor inverter

No.	Designation Cause	Message Remedy / Comment
1	External	warning / fault
MWR	If a digital input has been assigned the function „no external fault“, and there is no 24 V signal at the digital input then the unit switches off with the fault "External" (fail-safe model).	Determine and remedy the cause of the signal loss in the system.
1	External	warning
NWR	No synchronization of the mains voltage	If this warning occurs when switched-off then check the mains voltage for clockwise phase sequence. Check the wiring of the mains voltage detection: RNA01/NAM04: X30 wired correctly? X20 plugged? X18 plugged at SR 17002 (RZR01 or RD43)? Q1 RNA01/NAM04 switched on? If this warning occurs when switched-on then check the mains voltage with an oscilloscope.
1	External 0	Fault
NWR	Main conducter	Check the control voltage for the main contactor. Check the auxiliary contact for the acknowledgement. Check that plug X20 is seated firmly on RNA01/NAM04. Check that plug X14 is seated firmly on RZR01 or on SR of RD43.
3	Intermediate circuit voltage is too high	Fault
MWR	Reverse feeding of the intermediate circuit in generative operation. Limit value: V_{ZKmax} (P0095) has been exceeded The time of the driving off ramp has been set too short.	If the fault occurs during dynamic braking then set the driving off ramp of the integrator-transmitter slower (P0280). Check the braking resistor (when option W is available) with the ohmmeter; use more powerful external braking resistor. Check whether the braking resistor is selected (P0036).
NWR	Reverse feed into mains not possible; mains voltage is too high, mains not able to absorb energy	Reduce the mains voltage; switch on additional consumers
4	DC link voltage is too low	warning / fault
MWR and NWR	The DC link voltage drops during operation below the limit value of V_{ZKmin} (P0094). Power loss or power failure. Contact of the main contactor interrupted. Mains-supply rectifier defective.	Check mains voltage with oscilloscope.

No.	Designation Cause	Message Remedy / Comment
7	overtemperature at unit	warning / fault
MWR and NWR	The measured temperature of the cooler of the power section or of the rectifier is too high. A warning is displayed when the cooler temperature is greater than 65 °C. Fault shut-off is initiated when the temperature is greater than 70 °C. The temperature difference between the warning and the fault shut-off can be changed in the P0086 parameter. The current cooler temperatures can be shown on the monitor (power section = D1870 and rectifier = D2029). Ambient temperature > 40 °C Fan is defective Air filter is jammed NTC (temperature sensor) is defective Fan control is set incorrectly Water cooling circuit is not in operation No skip supply voltage	Example for incorrectly set fan control in P0034: Function is on „Automatic“ and the threshold in P0035 is set too high Reduce the threshold. Check the cooling circuit Check the 24V supply
8	Braking resistor	fault
MWR	No acknowledgement on activating the braking resistor. Switching transistor or (possibly) the braking resistor is defective	Check the BW switching transistor between terminals F and D using a multimeter. If the BW switching transistor is OK then the following must be measured: from F to D: reverse voltage from D to F: diode forward voltage
9	Main contactor (irrelevant for SFT)	fault
	Main contactor does not close, drops during operation or does not respond.	Check the control voltage for the main contactor. Check the auxiliary contact for the acknowledgement.
10	Precharging circuit	fault
NWR	The temporal course of the charging of the DC link voltage is checked after switching on. If impermissible deviations occur then precharging is cancelled. Short-circuit between terminals C and D (DC link voltage) or C-PE or D-PE. Only for the W braking resistor option: Short-circuit between F and C. Only for the V electronic stand-by option: The „On“ command is applies while stand-by supply is active, but there is no mains voltage.	Check the following:, whether the mains voltage is connected whether there is a short-circuit between terminals C and D or C-PE or D-PE. Comment After acknowledging the „precharging circuit“ fault, the unit can only be turned back on after 30 seconds to protect the precharging resistors from over heating.
11	New EEPROM	fault
MWR and NWR	The bit pattern loaded into the EEPROM at the factory has not been recognized by the processor control.	Please call customer service.
12		fault
MWR and NWR	The frequency of both clock-pulse generators on the control board are checked against each other for plausibility (overspeed protection). This fault shut-off is generated in case of deviations of more than ±1 %.	One of the two clock-pulse generators is defective; replace module.
13	Power section	fault
MWR and NWR	Unspecified fault in the power section.	Please call customer service.

No.	Designation Cause	Message Remedy / Comment
14	Inverter	**fault**
MWR and NWR	This fault is triggered by the response of an overcurrent threshold and protects the transistors of the power section. **Causes outside of the unit:** defective motor; blocked or stiff motor; defective motor cable jump in set value is too fast	Disconnect motor cable; release inverter. If no other fault occurs then the cause is most probably at the motor end. Replace the motor. Measurement with RDwin „oscilloscope function“: Parameter D1981“f-I actual of standardization“.
	Cause in the configuration: Incorrect motor data configured. Only for the S sinus filter option: the pulse frequency (P0026) is at less than 8 kHz; the sinus filter can thereby resonate and transmit high currents.	Check the motor data in the quick setup. Set the pulse frequency in the quick setup (P0026) to equal or greater than 8 kHz.
	Causes within the unit: Defective transistor or power section.	
	Note on troubleshooting: In many cases, a defective power transistor in the inverter can be found very easily using a normal multimeter. To do this, proceed as follows: Disconnect the unit from the mains. Disconnect any connected motor. With the multimeter, measure each of the diode forward voltages between the output terminals and the intermediate circuit terminals. When the inverter is intact, the following is measured: from U2 to C: Diode forward voltage from U2 to D: reverse voltage from C to U2: reverse voltage from D to U2: diode forward voltage from V2 to C: Diode forward voltage from V2 to D: reverse voltage from C to V2: reverse voltage from D to V2: diode forward voltage from W2 to C: Diode forward voltage from W2 to D: reverse voltage from C to W2: reverse voltage from D to W2: diode forward voltage In blocked state, the power transistors are high impedant in both directions. The multimeter shows a diode forward voltage when the freewheeling diode connected in parallel to it is measured in the forward direction.	
NWR	Error message of the skip half bridge module Phase V faulty mains synchronization X10 to RZR01 no Skiip supply voltage **Cause in the configuration:** faulty configuration of the network model	Check the wiring of the mains voltage detection: X18 plugged at SR 17002 (RZR01 or RD43)? X10 to RZR01 plugged and secured? Check 24 V supply Configuration acc. to instructions for putting into operation
15	Power supply	fault
MWR and NWR	The voltages of the switching power supply are outside the thresholds: Threshold for +15 V = +13.5 V -15 V = -13.5 V	The switching power supply is defective or the load through a defective module is too high (see also the comment on faults 40, switching power supply)
16	Internal DSP comm. (communication)	fault
MWR and NWR	Communication with the digital signal processor on the control board is disturbed	Please call customer service.

No.	Designation Cause	Message Remedy / Comment
17	Overspeed	warning / fault
MWR	The current speed exceeds the speed limit set in the „f-limit machine“ parameter.	Check P0178 (f-limit machine) for the correct setting. The selected slip compensation is perhaps too high (P0540) . Check P0390 (frequency standardization) for the correct value and correct if necessary. In P0449 (reaction in case of overspeed), you can select between warning (alarm) and fault.
18	Ground fault	fault
MWR and NWR	Ground fault at the output terminals of the inverter (U2, V2, W2) or too high a capacity against ground due to long motor lines.	
NWR	Ground fault at intermediate circuit	
19	EEPROM data	warning / fault
MWR and NWR	**Cause in the configuration:** The control board has been replaced and detects a new power section after initialization which, e.g. is not able to deliver the currents configured; i.e. one or more parameters are outside of the tolerance range The affected parameters are reset to the standard values of the unit after acknowledgement. **Cause in the unit:** This fault can even occur when the voltage fails during operation. The power section should transmit the wrong data to the control board	The corresponding parameter numbers can be seen with P0061.XX and the faulty parameter values with P0062.XX. The fault can be remedied by means of special acknowledgement with P0060 (password level 3 [Esc], [Mon], [Prog] and [+]). You must then check whether the changed parameters fit the application. When exiting the configuration, accept values in the EEPROM. The fault may perhaps be remedied by switching the mains voltage or the stand-by supply on and off. If this measure is not successful then please contact the customer service.
20	Internal DSP ackn. (reception acknowledgment)	fault
MWR and NWR	Internal processor coupling is faulty.	Error acknowledgement; if the error continues to occur then one of the modules is faulty; replace the control board if necessary.
21	Internal WS comm.	fault
MWR and NWR	Communication between the processor board and the power section is faulty. If the error occurs immediately after switching on during the self-test then it can not be acknowledged.	Check the plug connection between the boards or replace the modules.
22	NTC power section	fault
MWR and NWR	Wire break to the NTC on the heat sink or rectifier module ; NTC defective, resistance is too high or plus has no contact.	Check the plug connection; replace plug, line or NTC.
23	Motor transmitter	fault
MWR	Incorrect transmitter data configured Jumper S5 to SR17002 is plugged incorrectly (see Figure 4-11: Control terminals on control board SR17002 The transmitter connection has been interrupted Transmitter is defective	Check correctness of transmitter data in P0130 and P0131. Check transmitter cable for throughput. Replace transmitter.
24	SS1 time monitoring	warning / fault
MWR and NWR	The control computer does not transmit any data within the configured reaction time (P0506).	Check plug connection SS1 (RS485), increase reaction time (P0506), select another type of reaction (P0505).

No.	Designation Cause	Message Remedy / Comment
25	SS2 function	warning / fault
MWR and NWR	Only for optional interface boards on optional slot 1. The inverter detects a physical error on the interface circuit from the host control computer. Incorrect data transmission on the field bus.	Check for correct type of PPO (protocol type), baud rate, parity, stop bit and slave address. If a bus error occurs as a warning or a fault, then the warning or the fault or even both messages can be suppressed using P0509, i.e. the system can still be operated!
		Only for the CAN bus option: The transmitted protocols are monitored on the CAN bus. If a bus error occurs more than 127 times then a warning is issued. If a bus error occurs more than 255 times then a fault is reported. The warning or fault, or even both messages, can be masked in parameter P0509, i.e. the system can still be operated. Only for the Profibus option: In parameter P0524, you can select between „no action“ and „fault“ on receiving clear data. Attention: P0509 should thereby be set to the function „all active“! i.e. clear data is transmitted by the control computer when there is an invalid protocol or a bus error. Only for the Interbus S option: The type of reaction can be set In parameter P0518 and the monitoring time in case of a bus error can be set in P0519. Index 0 = process data, index 1 = PKW (vehicle) range.
26	SS2 time monitoring	warning / fault
MWR and NWR	Only for optional interface boards on optional slot 1. The host control computer does not transmit any data within the configured reaction times (P0527).	Check plug connection SS2 (RS485), increase reaction time (P0527), select another type of reaction (P0526.
27	Analog input 1: I < 4 mA	warning / fault
MWR and NWR	**Causes inside the unit:** Short-circuit or wire break on the set point circuit to the analog input or to the optional analog inputs (only when in 4 - 20 mA or 2 - 10 V mode).	Check the set point circuit.
	Cause in the configuration: Incorrect type of reaction Incorrect operating mode	 Check the reaction type in P0564.0X or P0752.0X . Check the operating mode in P0201.0x or P0735.0X .

No.	Designation Cause	Message Remedy / Comment
28	Overtemperature at motor	warning / fault
MWR	The inverter detects a resistance that is too high at the terminals X15.1 and 2. The motor is overheated, the temperature sensor is defective, the sensor circuit is defective. Faulty configuration.	Replace the sensor or the sensor circuit. Check the correctness of the parameters for temperature evaluation (P0385 – P0389). On selecting KTY84, the current motor temperature in °C can be displayed by D1872; on selecting PTC, the current ohm value can be displayed by D1871.
28 NWR	Overtemperature in the following components: HNL (power chokes), HNP (filter capacitor unit) The inverter detects a resistance that is too high at the terminals X15.1 and X15.2. The power choke HNL or filter capacitor unit HNP is overheated. Fan is defective or not in operation. The ambient temperature has been exceeded. Thermal switch defective; sensor circuit defective Faulty configuration.	Check the cooling system. Check the fan Check the thermal switch and the wiring of the thermal switch Configure acc. to the instructions for putting into operation
30	SR output state?	fault
MWR and NWR	The control board and the firmware (Flash EPROM) do not match.	Please call customer service.

No.	Designation Cause	Message Remedy / Comment
31	BW overload	warning / fault
MWR	A temperature map is calculated by the inverter for the configured braking resistance. If he braking resistor is activated then the inverter calculates the assigned temperature. If the threshold is exceeded then the inverter reports an overload to the braking resistor.	
	Causes outside the unit: Only for the W braking resistor option: The connected braking resistor is high resistant. No braking resistor is connected. The connected braking resistor is too small for the energy that is regenerated in the intermediate circuit on braking.	Check the braking resistor.
	Cause in the configuration: The driving-off ramp set is too high. Incorrect braking resistance selected. Only for externally programmed braking resistance: The values for resistance, continuous output and/or thermal time contents have been incorrectly configured	Check the driving-off ramp in P0280.0X. In P0038, check whether the correct braking resistance has been selected. Note on standard: every inverter motor-power class is assigned a particular braking resistance. Check the values in P0623 to P06256. Observing of the max. braking time and the required pause times until the next brake procedure. To calculate the brake and pause times, you can use the load diagram in the instructions for the brake resistance option.
32	Overcurrent	fault
MWR and NWR	The current limit is longer than the permissible configured time.	Check the setting of P0574! The time period of the uninterrupted current limit (D1678 = 1) can be set with P0574 to between 1 second and100 seconds in 11 steps. If the current limit is interrupted before the end of the configured time (D1678 = 0), then the time counter is reset to 0 and re-starts at the next current limit. If P0574 is set to 0 (= continuous), then no „overcurrent“ fault is triggered.
34	Emergency shut-down (NAMUR)	warning / fault
MWR	The „emergency shut-down“ error message has been introduced so ensure that the inverters comply with the Namur Standard (*Normenarbeitsgemeinschalt für Mess- und Regeltechnik in der Chemischen Industrie;* Eng. Association of Users of Process Control Technology). It is activated by P0057=1. Select fault or warning with P0571. The fault is triggered by an external control signal that is laid onto the digital input of the inverted. The D parameter of the digital input is interconnected in P0050.1. The external control signal is for the forced disconnection of the drive from the power (1 = operation; 0 = disconnection).	

No.	Designation Cause	Message Remedy / Comment
35	Motor overload	warning / fault
MWR	The electronic overload relay has closed (see here the function plan „Modulation, Data Acquisition“ or in the operating instructions, Chapter 5 of the basic programming „Thermal Motor Protection“).	Check the P0566 „Overload Protection Threshold“ for the correct setting. The reaction time of the electronic overload relay can be set with P0565 to: switched off/ warning / fault
39	on during start-up lock	fault
MWR	The message only occurs when the start-up lock option is installed. Motor class A to E: Contacts X80.1 and 2 have been opened during operation or an ON command has been issued when the terminal was open. Motor classes G and H: Contacts X80.1 and 171 have been opened during operation or an ON command has been issued when the terminal was open.	
40	Switching power supply	fault
MWR and NWR	The switching power supply for the electronics supply does not report back.	Replace the defective switching power supply. Depending on the model of the unit, the switching power supply is on one of the following boards: LT (power section), WS (inverter controller) or SV (power supply)
41	SR <==> WS new	
MWR and NWR	If the control board is replaced in a unit with a larger or smaller power or unit index then this entry is made in the fault memory (the unit does not switch to fault!) A fault only occurs when the parameters are outside of the limit values (see Fault 19).	
44	SS4 function	warning / fault
MWR and NWR	Only for optional interface boards on optional slot 2. The inverter detects a physical error on the interface circuit from the host control computer. Incorrect data transmission on the field bus.	Check for correct type of PPO (protocol type), baud rate, parity, stop bit and slave address. If a bus error occurs as a warning or a fault, then the warning or the fault or even both messages can be suppressed using P0745, i.e. the system can still be operated! Only for the CAN bus option: The transmitted protocols are monitored on the CAN bus interface. If a bus error occurs more than 127 times then a warning is issued. If a bus error occurs more than 255 times then a fault is reported. The warning or fault, or even both messages, can be masked in parameter P0745, i.e. the system can still be operated. Only for the Profibus option: In parameter P0524, you can select between „no action“ and „fault“ on receiving clear data. Attention: P0745 should thereby be set to the function „all active“! i.e. clear data is transmitted by the control computer when there is an invalid protocol or a bus error. Only for the Interbus S option: The type of reaction can be set In parameter P0518 and the monitoring time in case of a bus error can be set in P0519. Index 0 = process data, index 1 = PKW (vehicle) range.
45	SS4 time monitoring	warning / fault
MWR and NWR	Only for optional interface boards on optional slot 2. The host control computer does not transmit any data within the configured reaction time.	Check plug connection SS4, increase reaction time (P0747), select another type of reaction (P0746).

No.	Designation Cause	Message Remedy / Comment
47	Start-up lock active	warning
MWR	Only for the start-up lock option: Start-up lock has been activated while the unit was not in operating state.	
48	Module overtemperature	warning / fault
MWR and NWR	The measured temperature of the module of the power transistor or of the rectifier is too high. Possible cause: Ambient temperature is too high Fan is defective Air filter is jammed Fan control is set incorrectly Water cooling circuit is not in operation No Skiip supply voltage	Example for incorrectly set fan control in P0034: Function is on „Automatic“ and the threshold in P0035 is set too high Reduce the threshold. Check the cooling circuit Check the 24 V supply
49	Uzk imbalance	warning / fault
MWR and NWR	The symmetry monitoring circuit of the DC-link capacitors has triggered.	Call the customer service

No.	Designation Cause	Message Remedy / Comment
50, 51	Phase V , Phase W	fault
MWR and NWR	This fault is triggered by the response of an overcurrent threshold and protects the transistors of the power section. **Causes outside of the unit:** Defective motor Defective motor cable. Defective motor speed transmitter or transmitter cable Incorrectly connected motor cable.	Disconnect motor cable; release inverter. If no other fault occurs then the cause is most probably at the motor end. Replace the motor. Check the transmitter signal at the display or RDwin in empty run-out or during manual movement of the motor shaft. Measurement with RDwin „oscilloscope function“: Parameter D1850 set value of the n controller.
	Cause in the configuration: Incorrect motor data configured. Incorrect current controller setting Incorrect transmitter setting (P0130) Only in case of S sinus filter option: the pulse frequency (P0026) is at less than 8 kHz; the sinus filter can thereby resonate and transmit high currents.	Check the motor data in the quick setup. Carry out a motor identification (P0189); the current controller thereby sets itself automatically (see description of the function plan) Set the pulse frequency in the quick setup (P0026) to equal or greater than 8 kHz.
	Causes within the unit: Defective transistor or power section.	
50, 51	Phase V , Phase W	
NWR	Error message of the skip half bridge module Phase V faulty mains synchronization; faulty contact from plug X10 to RZR01 no Skiip supply voltage **Cause in the configuration:** faulty configuration of the network model; incorrect current controller setting	Check the wiring of the mains voltage detection: X18 plugged at SR 17002 (RZR01 or RD43)? X10 to RZR01 plugged and secured? Check 24 V supply Configuration acc. to instructions for putting into operation
52	External 1	
MWR	If a digital input has been assigned the function „no external fault“, and there is no 24 V signal at the digital input then the unit switches off with the fault "External" (fail-safe model).	Determine and remedy the cause of the signal loss in the system.
52	External 1	
NWR	Power undervoltage	Check the wiring of the mains voltage detection: RNA01/NAM04: X30 wired correctly? X20 plugged? X18 plugged at SR 17002 (RZR01 or RD43)? Check threshold P398 (100 % = 500 V). Check mains voltage with oscilloscope.
53	External 2	
MWR and NWR	If a digital input has been assigned the function „no external fault“, and there is no 24 V signal at the digital input then the unit switches off with the fault "External" (fail-safe model).	Determine and remedy the cause of the signal loss in the system.

No.	Designation Cause	Message Remedy / Comment
54	External 3	
MWR	If a digital input has been assigned the function „no external fault“, and there is no 24 V signal at the digital input then the unit switches off with the fault "External" (fail-safe model).	Determine and remedy the cause of the signal loss in the system.
54	External 3	
NWR	Power overvoltage	Check threshold P0357 (100 % = 500 V). Check mains voltage with oscilloscope.
55, 56, 57, 58	External 4, external 5, external 6, external 7	warning / fault
MWR and NWR	If a digital input has been assigned the function „no external fault“, and there is no 24 V signal at the digital input then the unit switches off with the fault "External" (fail-safe model).	Determine and remedy the cause of the signal loss in the system.
59	SS6 time monitoring	warning / fault
MWR and NWR	The control computer does not transmit any data within the configured reaction time (P1275).	Check plug connection X13, increase reaction time (P1275), select another type of reaction (P1276).
60	Synchro-Link time monitoring	warning / fault
MWR and NWR	Only in case of Synchro-Link SS7 . No valid protocol has been received within the configured reaction time (P0497).	Check plug connection Increase reaction time (P0497), select another type of reaction (P0496).
61	FUS power supply	fault
MWR and NWR	The power supply on the interface module KB21004 is not functioning correctly	Replace KB21004 module
62	Resonance	fault
MWR and NWR	Current resonances have occurred between the motor and the output filter at an operation point (oscillations).	Set another operation point in the U/f characteristic curve or: De-select filter P1224.xx = 0 Switch-off the output filter for the corresponding parameter set (P1224.XX)
63	Output current EN81 – for future use	
MWR and NWR		
64	Discharge of intermediate circuit – for future use	
MWR and NWR		

Figure. 13-2: Alarms and Error Messages – SFT Cause and Remedy / Comment

14 Service & Support

14.1 Helpdesk

Unser Kundendienst-Helpdesk im Hauptwerk Lohr am Main steht Ihnen mit Rat und Tat zur Seite. Sie erreichen uns

Our service helpdesk at our headquarters in Lohr am Main, Germany can assist you in all kinds of inquiries. Contact us

- telefonisch - by phone: **+49 (0) 9352 40 50 60**
  über Service Call Entry Center - via Service Call Entry Center
  Mo-Fr 07:00-18:00 Mo-Fr 7:00 am - 6:00 pm
- per Fax - by fax: **+49 (0) 9352 40 49 41**
- per e-Mail - by e-mail: **service.svc@boschrexroth.de**

14.2 Service-Hotline

Außerhalb der Helpdesk-Zeiten ist der Service direkt ansprechbar unter

After helpdesk hours, contact our service department directly at

+49 (0) 171 333 88 26

oder - or **+49 (0) 172 660 04 06**

14.3 Internet

Unter **www.boschrexroth.com** finden Sie ergänzende Hinweise zu Service, Reparatur und Training sowie die **aktuellen** Adressen *) unserer auf den folgenden Seiten aufgeführten Vertriebs- und Servicebüros.

Verkaufsniederlassungen
Niederlassungen mit Kundendienst

Außerhalb Deutschlands nehmen Sie bitte zuerst Kontakt mit unserem für Sie nächstgelegenen Ansprechpartner auf.

*) Die Angaben in der vorliegenden Dokumentation können seit Drucklegung überholt sein.

At **www.boschrexroth.com** you may find additional notes about service, repairs and training in the Internet, as well as the **actual** addresses *) of our sales- and service facilities figuring on the following pages.

sales agencies
offices providing service

Please contact our sales / service office in your area first.

*) Data in the present documentation may have become obsolete since printing.

14.4 Vor der Kontaktaufnahme... - Before contacting us...

Wir können Ihnen schnell und effizient helfen wenn Sie folgende Informationen bereithalten:

1. detaillierte Beschreibung der Störung und der Umstände.
2. Angaben auf dem Typenschild der betreffenden Produkte, insbesondere Typenschlüssel und Seriennummern.
3. Tel.-/Faxnummern und e-Mail-Adresse, unter denen Sie für Rückfragen zu erreichen sind.

For quick and efficient help, please have the following information ready:

1. Detailed description of the failure and circumstances.
2. Information on the type plate of the affected products, especially type codes and serial numbers.
3. Your phone/fax numbers and e-mail address, so we can contact you in case of questions.

14.5 Kundenbetreuungsstellen - Sales & Service Facilities

Deutschland – Germany

vom Ausland: (0) nach Landeskennziffer weglassen!
from abroad: don't dial (0) after country code!

Vertriebsgebiet Mitte Germany Centre	SERVICE AUTOMATION	SERVICE AUTOMATION	SERVICE AUTOMATION
Rexroth Indramat GmbH Bgm.-Dr.-Nebel-Str. 2 / Postf. 1357 97816 Lohr am Main / 97803 Lohr **Kompetenz-Zentrum Europa** Tel.: +49 (0)9352 40-0 Fax: +49 (0)9352 40-4885	CALL ENTRY CENTER Helpdesk MO – FR von 07:00 - 18:00 Uhr from 7 am – 6 pm **Tel. +49 (0) 9352 40 50 60** **Fax +49 (0) 9352 40 49 41** service.svc@boschrexroth.de	HOTLINE 24 / 7 / 365 außerhalb der Helpdesk-Zeit out of helpdesk hours **Tel.: +49 (0)172 660 04 06** oder / or **Tel.: +49 (0)171 333 88 26**	**ERSATZTEILE / SPARES** verlängerte Ansprechzeit - extended office time - ♦ nur an Werktagen - only on working days - ♦ von 07:00 - 18:00 Uhr - from 7 am - 6 pm - **Tel. +49 (0) 9352 40 42 22**
Vertriebsgebiet Süd Germany South	Vertriebsgebiet West Germany West	Gebiet Südwest Germany South-West	
Bosch Rexroth AG Landshuter Allee 8-10 80637 München Tel.: +49 (0)89 127 14-0 Fax: +49 (0)89 127 14-490	Bosch Rexroth AG Regionalzentrum West Borsigstrasse 15 40880 Ratingen Tel.: +49 (0)2102 409-0 Fax: +49 (0)2102 409-406 +49 (0)2102 409-430	Bosch Rexroth AG Service-Regionalzentrum Süd-West Siemensstr.1 70736 Fellbach Tel.: +49 (0)711 51046–0 Fax: +49 (0)711 51046–248	
Vertriebsgebiet Nord Germany North	Vertriebsgebiet Mitte Germany Centre	Vertriebsgebiet Ost Germany East	Vertriebsgebiet Ost Germany East
Bosch Rexroth AG Walsroder Str. 93 30853 Langenhagen Tel.: +49 (0) 511 72 66 57-0 Service: +49 (0) 511 72 66 57-256 Fax: +49 (0) 511 72 66 57-93 Service: +49 (0) 511 72 66 57-783	Bosch Rexroth AG Regionalzentrum Mitte Waldecker Straße 13 64546 Mörfelden-Walldorf Tel.: +49 (0) 61 05 702-3 Fax: +49 (0) 61 05 702-444	Bosch Rexroth AG Beckerstraße 31 09120 Chemnitz Tel.: +49 (0)371 35 55-0 Fax: +49 (0)371 35 55-333	Bosch Rexroth AG Regionalzentrum Ost Walter-Köhn-Str. 4d 04356 Leipzig Tel.: +49 (0)341 25 61-0 Fax: +49 (0)341 25 61-111

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from abroad: don't dial (0) after country code, Italy: dial 0 after country code

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Hongkong Bosch Rexroth (China) Ltd. 6th Floor, Yeung Yiu Chung No.6 Ind Bldg. 19 Cheung Shun Street Cheung Sha Wan, Kowloon, Hongkong Tel.: +852 22 62 51 00 Fax: +852 27 41 33 44 alexis.siu@boschrexroth.com.hk	India - Indien Bosch Rexroth (India) Ltd. Electric Drives & Controls Plot. No.96, Phase III Peenya Industrial Area Bangalore – 560058 Tel.: +91 80 51 17 0-211...-218 Fax: +91 80 83 94 345 +91 80 83 97 374 mohanvelu.t@boschrexroth.co.in	India - Indien Bosch Rexroth (India) Ltd. Electric Drives & Controls Advance House, II Floor Ark Industrial Compound Narol Naka, Makwana Road Andheri (East), Mumbai - 400 059 Tel.: +91 22 28 56 32 90 +91 22 28 56 33 18 Fax: +91 22 28 56 32 93 singh.op@boschrexroth.co.in	India - Indien Bosch Rexroth (India) Ltd. S-10, Green Park Extension New Delhi – 110016 Tel.: +91 11 26 56 65 25 +91 11 26 56 65 27 Fax: +91 11 26 56 68 87 koul.rp@boschrexroth.co.in
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Nordamerika – North America

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