Bonfiglioli
Vectron

Active Cube
Active Next Generation

Application manual
Parallel Connection
400 V / 525 V / 690 V
400 kW ... 1200 kW

Bonfiglioli
Forever Forward

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1 General Information about the Documentation

The present **document** is valid for devices of the Active Next Generation series (ANG) and Active Cube series (ACU410).

1.1 Instruction manuals

For better clarity, the documentation is structured according to the customer-specific requirements made on the frequency inverter.

Quick start guide

The Quick Start Guide describes the basic steps required for mechanical and electrical installation of the frequency inverter. The guided commissioning supports you in the selection of necessary parameters and the configuration of the frequency inverter by the software.

Operating instructions

The Operating Instructions describe all functions of the frequency inverter. The parameters required for adapting the frequency inverter to specific applications and the numerous additional functions are described in detail.

Application manual

The application manual supplements the documentation for purposeful installation and commissioning of the frequency inverter. Information on various subjects connected with the use of the frequency inverter is described specific to the application.

If you need a copy of the documentation or additional information, contact your local representative of BONFIGLIOLI.

The following instructions/manuals are available:

Operating Instructions ACU	Function of frequency inverter.
Operating Instructions ANG	
Application manual VEC1120 Complement to the operating instructions for liquid-cooled devices	Setup, installation, commissioning and operating liquid-cooled devices.
Quick Start Guide ACU	Installation and commissioning. Supplied with the device.
Quick Start Guide ANG	
Safe Torque Off (STO) manual	STO safety function (for ACU 201, 401, 501, 601).
Application manual "Functional Safety"	STO safety function (for ACU/ANG 210, 410, 510, 610).
PLC application manual	Logic linking of digital signals. Functions for analog signals such as comparisons and mathematical functions. Graphical support for programming with function blocks.
Application manual Positioning	Positioning functions of Configurations x40.
Application manual Electronic gear	Linking of at least 2 drives as electronic gear with Secondary drive in Configuration x15 or x16.
Application manual Hoist unit drives	Advanced brake control for hoist unit drives.

The present documentation was prepared with great care and was subjected to extensive and repeated reviews. For reasons of clarity, it was not possible to include all details of all types of the product in the documentation. Neither was it possible to consider all conceivable installation, operation or maintenance situations. If you require further information or if you encounter specific problems which are not dealt with in sufficient detail in the documentation, contact your local BONFIGLIOLI agent.
The present document was created in German. Other language versions are translations.

1.2 This document

This application manual describes the parallel connection of two or three frequency inverters of the device series mentioned above.
The application manual contains important information about installation and configuration of parallel-connected frequency inverters. Compliance with these instructions contributes to avoiding risks, minimizing repair cost and downtimes and increasing the reliability and service live of the frequency inverters.
For this reason, make sure you read the application manual carefully.

IMPORTANT:

Compliance with the documentation is required to ensure safe operation of the frequency inverter. Bonfiglioli Vectron MDS GmbH shall not be held liable for any damage caused by any non-compliance with the documentation.

In case any problems occur which are not covered by the documentation sufficiently, please contact the manufacturer.

For safe commissioning and operation of the inverters, comply with the following documentation:

- Operating Instructions
- Application manual "Functional Safety"

This documentation applies to parallel connection of the following frequency inverter series:

Type ACU (ACTIVE Cube), size 8

- ACU 410
- ACU 510
- ACU 610

Type ANG (ACTIVE Next Generation), size 8

- ANG 410
- ANG 510
- ANG 610

For easier reading, the general term "Frequency Inverter" is used for all frequency inverters of the series mentioned.

1.3 Warranty and liability

Bonfiglioli Vectron MDS GmbH (hereinafter referred to as "manufacturer") notes that the contents of this document do not form part of any previous or existing agreement, assurance or legal relationship between the manufacturer and the user of these Operating Instructions (hereinafter referred to as the "User"). Neither are they intended to supplement or replace such agreements, assurances or legal relationships. Any obligations of the manufacturer shall solely be based on the relevant purchase agreement which also includes the complete and solely valid warranty stipulations. These contractual warranty provisions are neither extended nor limited by the specifications contained in this documentation. The manufacturer reserves the right to correct or amend the specifications, product information and omissions in these operating instructions without prior notice. The manufacturer assumes no responsibility to update these Operating Instructions. The manufacturer shall not be liable for any damage, injuries or costs which may be caused by the aforementioned reasons.
In addition, the manufacturer excludes any warranty and disclaims all liability, including without limitation direct, indirect, special, punitive, incidental, exemplary or consequential damages arising out of or in connection with one or more of the following causes:

- inappropriate use of the frequency inverter,
- non-compliance with the instructions, warnings and prohibitions contained in the documentation,
- unauthorized modifications of the solar inverter,
- insufficient monitoring of parts of the machine/plant which are subject to wear,
- repair work at the machine/plant not carried out properly or in time,
- catastrophes by external impact and Force Majeure.

1.4 Obligation

Read this document before commissioning and comply with it. Anybody entrusted with tasks in connection with the

- transport,
- assembly,
- installation of the frequency inverter and
- operation of the frequency inverter

must have read and understood the document and, in particular, the safety instructions in order to prevent personal and material losses.

1.5 Copyright

1.6 Storage

The documentation forms an integral part of the frequency inverter. It must be stored such that it is accessible to operating staff at all times. If the frequency inverter is sold on to other users, then this document must also be handed over.

2 General safety instructions and information on use

Chapter 2 "General safety instructions and information on use" contains general safety instructions for the Operator and the Operating Staff. At the beginning of certain main chapters, some safety instructions are included which apply to all work described in the relevant chapter. Special work-specific safety instructions are provided before each safety-relevant work step.

2.1 Terminology

According to the documentation, different activities must be performed by certain persons with certain qualifications.
The groups of persons with the required qualification are defined as follows:

Operator
This is the entrepreneur/company who/which operates the frequency inverter and uses it as per the specifications or has it operated by qualified and instructed staff.

Operating staff
The term Operating Staff covers persons instructed by the Operator of the frequency inverter and assigned the task of operating the frequency inverter.

Skilled Personnel
The term Skilled Personnel covers staff that are assigned special tasks by the Operator of the frequency inverter, e.g. installation, maintenance and service/repair and troubleshooting. Based on their qualification and/or know-how, Skilled Personnel must be capable of identifying defects and assessing functions.

Qualified electrician
The term Qualified Electrician covers qualified and trained staff who has special technical know-how and experience with electrical installations. In addition, Qualified Electricians must be familiar with the applicable standards and regulations, they must be able to assess the assigned tasks properly and identify and eliminate potential hazards.

Instructed person
The term Instructed Person covers staff who was instructed and trained about/in the assigned tasks and the potential hazards that might result from inappropriate behavior. In addition, instructed persons must have been instructed in the required protection provisions, protective measures, the applicable directives, accident prevention regulations as well as the operating conditions and verified their qualification.

Expert
The term Expert covers qualified and trained staff who has special technical know-how and experience relating to frequency inverter. Experts must be familiar with the applicable government work safety directives, accident prevention regulations, guidelines and generally accepted rules of technology in order to assess the operationally safe condition of the frequency inverter.

2.2 Designated use

The product is a frequency inverter. It is designed for

- installation in machines and electrical equipment
- industrial environments

The frequency inverters are electrical drive components intended for installation in industrial plants or machines. Commissioning and start of operation is not allowed until it has been verified that the machine meets the requirements of the EC Machinery Directive 2006/42/EC and DIN EN 60204-1.
The frequency inverters meet the requirements of the low voltage directive 2006/95/EEC and DIN EN 61800-5-1. CE-labeling is based on these standards. Responsibility for compliance with the EMC Directive 2004/108/EC lies with the operator. Frequency inverters are only available at specialized dealers and are exclusively intended for commercial use as per EN 61000-3-2.
No capacitive loads may be connected to the frequency inverter.
The technical data, connection specifications and information on ambient conditions are indicated on the rating plate and in the documentation and must be complied with in any case.

2.3 Misuse

Any use other than that described in "Designated use" shall not be permissible and shall be considered as misuse.
For example, the machine/plant must not be operated

- by uninstructed staff,
- when the equipment is not in perfect condition,
- without protection enclosure (e.g. covers),
- without safety equipment or with safety equipment deactivated,
- when general requirements, such as operating conditions and technical data, are not met.

The manufacturer shall not be held liable for any damage resulting from such misuse. The sole risk shall be borne by the operator.

2.3.1 Explosion protection

The frequency inverter is an IP 20 ingress protection rating device. For this reason, use of the device in explosive atmospheres is not permitted.

2.4 Residual risks

Residual risks are special hazards involved in handling of the frequency inverter which cannot be eliminated despite the safety-compliant design of the device. Residual risks are not obviously identifiable and can be a potential source of injury or health hazard.
Typical residual hazards include:

Electrical hazard

Danger of contact with energized components due to a defect, opened covers or enclosures or improper working on electrical equipment.
Danger of contact with energized components inside of the frequency inverter if no external disconnection device was installed by the operator.

Electrostatic charging

Touching electronic components bears the risk of electrostatic discharges.

Thermal hazards

Risk of accidents by hot machine/plant surfaces, e.g. heat sink, transformer, fuse or sine filter.

Charged capacitors in DC link

The DC link may have dangerous voltage levels even up to three minutes after shutdown.

Danger of equipment falling down/over, e.g. during transport

Center of gravity is not the middle of the electric cabinet modules.

2.5 Safety and warning signs on frequency inverter

- Comply with all safety instructions and danger information provided on the frequency inverter.
- Safety information and warnings on the frequency inverter must not be removed.

2.6 Warning information and symbols used in the user documentation

2.6.1 Hazard classes

The following hazard identifications and symbols are used to mark particularly important information:

DANGER

Identification of immediate threat holding a **high** risk of death or serious injury if not avoided.

WARNING

Identification of immediate threat holding a **medium** risk of death or serious injury if not avoided.

CAUTION

Identification of immediate threat holding a **low** risk of minor or moderate physical injury if not avoided.

NOTICE

Identification of a threat holding a risk of material damage if not avoided.

2.6.2 Hazard symbols

Symbol	Meaning	Symbol	Meaning
	General hazard		Suspended load
	Electrical voltage		Hot surfaces
	Danger of crushing		

2.6.3 Prohibition signs

Symbol	Meaning
	No switching; it is forbidden to switch the machine/plant, assembly on

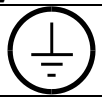
2.6.4 Personal safety equipment

Symbol	Meaning
	Wear body protection
	Wear ear protectors

2.6.5 Recycling

Symbol	Meaning
	Recycling, to avoid waste, collect all materials for reuse

2.6.6 Grounding symbol

Symbol	Meaning
	Ground connection

2.6.7 ESD symbol

Symbol	Meaning
	ESD: Electrostatic Sensitive Devices, i.e. components and assemblies sensitive to electrostatic energy

2.6.8 Information signs

Symbol	Meaning
	Tips and information making using the frequency inverter easier.

2.6.9 Font style in documentation

Example	Font style	Use
1234	bold	Representation of parameter numbers
Parameter	inclined, font: Times New Roman	Representation of parameter names
P.1234	bold	Representation of parameter numbers without name, e.g. in formulas
Q.1234	bold	Representation of source numbers

2.7 Directives and guidelines to be adhered to by the operator

The operator must follow the following directives and regulations:

- Ensure that the applicable workplace-related accident prevention regulations as well as other applicable national regulation are accessible to the staff.
- An authorized person must ensure, before using the frequency inverter, that the device is used in compliance with its designated use and that all safety requirements are met.
- Additionally, comply with the applicable laws, regulations and directives of the country in which the frequency inverter is used.
- Any additional guidelines and directives that may be required additionally shall be defined by the operator of the machine/plant considering the operating environment.

2.8 Operator's general plant documentation

- In addition to the Operating Instructions, the operator should issue separate internal user manuals for the frequency inverter. The Operating Instructions of the frequency inverter must be included in the Operating Instructions of the whole plant.

2.9 Operator’s/operating staff’s duties

2.9.1 Selection and qualification of staff

- Any work on the frequency inverter may only be carried out by Skilled Personnel. The staff must not be under the influence of any drugs. Note the minimum age required by law. Define the staff's responsibility pertaining to all work on the frequency inverter clearly.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering.
- The operating staff must be trained for the relevant work to be performed.

2.9.2 General work safety

- In addition to the Operating Instructions of the machine/plant, any applicable legal or other regulations relating to accident prevention and environmental protection must be complied with. The staff must be instructed accordingly.
  Such regulations and/or requirements may include, for example, handling of hazardous media and materials or provision/use of personal protective equipment.
- In addition to these Operating Instructions, issue any additional directives that may be required to meet specific operating requirements, including supervision and reporting requirements, e.g. directives relating to work organization, workflow and employed staff.
- Unless approved of expressly by the manufacturer, do not modify the frequency inverter in any way, including addition of attachments or retrofits.
- Only use the frequency inverter if the nominal connection and setup values specified by the manufacturer are met.
- Provide appropriate tools as may be required for performing all work on the frequency inverter properly.

2.9.3 Ear protectors

- The frequency inverter produces noise. For this reason it should be installed in areas where people normally don't stay.
- Noise emission in operation is approx. 86 dB(A) in the case of size 8. Ear protectors must be used when staying near the frequency inverter

2.10 Organizational measures

2.10.1 General

- Train your staff in the handling and use of the frequency inverter and the machine/plant as well as the risks involved.
- Use of any individual parts or components of the frequency inverter in other parts of the operator's machine/plant is prohibited.
- Optional components for the frequency inverter must be used in accordance with their designated use and in compliance with the relevant documentation.

2.10.2 Use in combination with third-party products

- Please note that Bonfiglioli Vectron MDS GmbH will not accept any responsibility for compatibility with third-party products (e.g. motors, cables or filters).
- In order to enable optimum system compatibility Bonfiglioli Vectron MDS GmbH offers components facilitating commissioning and providing optimum synchronization of the machine/plant parts in operation.
- If you use the frequency inverter in combination with third-party products, you do so at your own risk.

2.10.3 Handling and installation

- Do not commission any damaged or destroyed components.
- Prevent any mechanical overloading of the frequency inverter. Do not bend any components and never change the isolation distances.
- Do not touch any electronic construction elements and contacts. The frequency inverter is equipped with components which are sensitive to electrostatic energy and can be damaged if handled improperly. Any use of damaged or destroyed components will endanger the machine/plant safety and result in non-compliance with the applicable standards.
- Only install the frequency inverter in a suitable operating environment. The frequency inverter is exclusively designed for installation in industrial environments.
- If seals are removed from the case, this can result in the warranty becoming null and void.

2.10.4 Electrical connections

- The five safety rules must be complied with.
- Never touch live terminals. The DC-link may have dangerous voltage levels even up to 10 minutes after shutdown.
- When performing any work on/with the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants of the country in which the frequency inverter is used.
- The cables connected to the frequency inverters may not be subjected to high-voltage insulation tests unless appropriate circuitry measures are taken before.
- Only connect the frequency inverter to suitable supply mains. The frequency inverter may be operated in TN, TT and IT grid types. Precautions must be taken for operation in IT grids, see Chapter 7 "Electrical Installation" of the Operating Instructions. Operation in a corner-grounded TN grid shall not be permissible.

2.10.4.1 The five safety rules

When working on/in electrical plants, always follow the five safety rules:

1 Isolate
2 Secure to prevent restarting
3 Check isolation
4 Earth and short-circuit
5 Cover or shield neighboring live parts

2.10.5 Safe operation

- During operation of the frequency inverter, always comply with the applicable national and international regulations/laws on work on electrical equipment/plants.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to the applicable national and international safety directives.
- During operation, all covers must be installed correctly, and all electrical cabinet doors must be closed. During operation, never open the machine/plant.
- No connection work shall be carried out while power supply is on.
- The machine/plant holds high voltage levels during operation, is equipped with rotating parts (fan) and has hot surfaces. Any unauthorized removal of covers, improper use, wrong installation or operation may result in serious injuries or material damage.
- Some components, e.g. the heat sink or braking resistor, may be hot even some time after the machine/plant was shut down. Do not touch any surfaces directly after shutdown. Wear safety gloves where necessary.
- The frequency inverter may hold dangerous voltage levels until the capacitor in the DC link is discharged. Wait for at least 10 minutes after shutdown before starting electrical or mechanical work on the frequency inverter. Even after this waiting time, make sure that the equipment is deenergized in accordance with the safety rules before starting the work.
- In order to avoid accidents or damage, only qualified staff and electricians may carry out the work such as installation, commissioning or setup.
- In the case of a defect of terminals and/or cables, immediately disconnect the frequency inverter from mains supply.
- Persons not familiar with the operation of the frequency inverter and children must not have access to the device.
- Do not bypass nor decommission any protective devices.
- The frequency inverter may be connected to power supply every 60 s. This must be considered when operating a mains contactor in jog operation mode. For commissioning or after an emergency stop, a non-recurrent, direct restart is permissible.
- After a failure and restoration of the power supply, the motor may start unexpectedly if the Auto-Start function is activated.
  If staff are endangered, restarting the motor must be prevented by means of external circuitry.
- Before commissioning and the start of the operation, make sure to fix all covers and check the terminals. Check the additional monitoring and protective devices according to EN 60204 and applicable the safety directives (e.g. Working Machines Act or Accident Prevention Directives).

2.10.6 Maintenance and service/troubleshooting

- Visually inspect the frequency inverter when carrying out the required maintenance work and inspections at the machine/plant.
- Perform the maintenance work and inspections prescribed for the machine carefully, including the specifications on parts/equipment replacement.
- Work on the electrical components may only be performed by a qualified electrician according to the applicable rules of electrical engineering. Only use original spare parts.
- Unauthorized opening and improper interventions in the machine/plant can lead to personal injury or material damage. Any repair work may only be carried out by the manufacturer or persons approved/licensed by the manufacturer. Any repair work must be carried out by qualified electricians. Check protective equipment regularly.
- Before performing any maintenance work, the machine/plant must be disconnected from mains supply and secured against restarting. The five safety rules must be complied with.

2.10.7 Final decommissioning

Unless separate return or disposal agreements were made, recycle the disassembled frequency inverter components:

- Scrap metal materials
- Recycle plastic elements
- Sort and dispose of other component materials

Electric scrap, electronic components, lubricants and other utility materials must be treated as special waste and may only be disposed of by specialized companies.

In any case, comply with any applicable national disposal regulations as regards environmentally compatible disposal of the frequency inverter. For more details, contact the competent local authorities.

2.11 Safety instructions on Function "Safe Torque Off" (STO)

The function "Safe Torque Off" (STO) is a functional safety provision, i.e. it protects staff from damage, provided that projecting, installation and operation are performed properly. This function does not disconnect the plant from power supply.
In order to disconnect the plant from power supply (e.g. for maintenance work), an "Emergency Stop" provision as per EN 60204 must be installed.

WARNING

Uncontrolled starting of drive
Improper installation of the safety technique can cause an uncontrolled starting of the drive. This may cause death, serious injuries and significant material damage.

- Safety functions may only be installed and commissioned by skilled personnel.
- The STO function is not suitable for emergency switch off as per EN 60204. Implement an emergency switch-off by installing a mains contactor.

  An emergency stop according to EN 60204 must be functioning in all operation modes of the frequency inverter. Resetting of an emergency stop must not result in uncontrolled starting of the drive.
- The drive starts again when the function STO is no longer triggered. In order to comply with EN 60204, ensure that the drive does not start without prior confirmation by taking external measures.
- Without a mechanical brake, the drive might not stop immediately but coast to a standstill. If this may result in personal or material damage, take additional safety measures.
- If persons may be endangered after disconnection of the motor control by STO, access to the hazard areas must be prevented until the drive has stopped.
- Check the safety function at regular intervals according to the results of your risk assessment. Bonfiglioli Vectron recommends that the check is performed after one year, at the latest.
- The STO function is one-fault fail-safe. However, on rare occasions, the occurrence of component defects may cause jerking of the motor shaft (max. 180°/pole pair, e. g. jerk by 90° with 4-pole motor, 180°/2). Check if this causes a dangerous movement of the machine.
- If the STO function is used, the special safety, installation and instructions on use shall be complied with.

The application manual "Safe Torque Off STO" must be complied with, particularly if the safety function described there is used.

WARNING!

Dangerous voltage!
After disconnection of an external DC 24 V power supply, the DC link of the frequency inverter is still connected to mains supply. Even if power supply to the motor is disconnected, and the motor is coasting to a standstill or has already stopped, high voltages may still be present at the motor terminals. When the function "Safe Torque Off" is triggered, the motor is not disconnected from the DC link of the frequency inverter. High voltage levels may be present at the motor. Working with live terminals may cause death, serious injuries and significant material damage.

- Only use the safety function "Safe Torque Off" if mechanical work is to be performed on the driven machines, not for work on live components.
- Before working (e.g. maintenance) on live parts, the plant must always be disconnected from mains supply (main switch). This must be documented on the plant.
- Do not touch live terminals.

3 Features

Parallel connection extends the power range of the frequency inverters up to an output power of 1200 kW. The required power level is obtained by symmetrical parallel connection of 2 or more frequency inverters with the same nominal power.
The parallel-connectable device types are listed in Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** "**Fehler! Verweisquelle konnte nicht gefunden werden.**".
In parallel connection, the main inverter is responsible for controlling the parallel-connected frequency inverters. This function makes configuration of the frequency inverters to the application much easier, since only the main inverter is parameterized to the application-specific configuration (e. g. U/f control, field-oriented control, etc.). Additional parameters are used to adjust the control to the overall system.

3.1 Device identification

The device series can be recognized by its name plate and the identification on the cover. An example for an ANG type device is shown in the illustration.

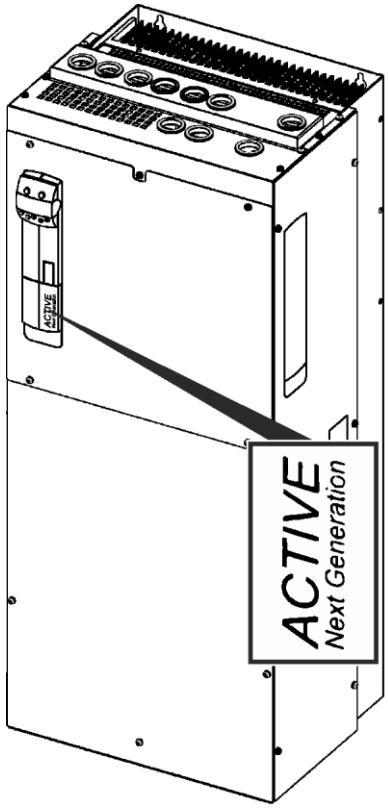


Figure 1-1: Device identification

For an example of the name plate, see Operating Instructions of frequency inverter.

3.2 Wiring variants

The power outputs of the frequency inverters can be circuited as follows:

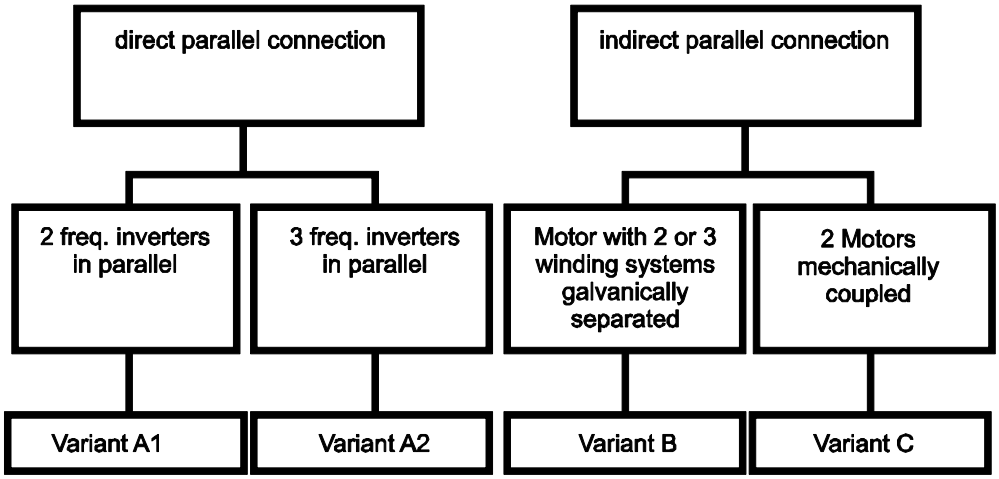
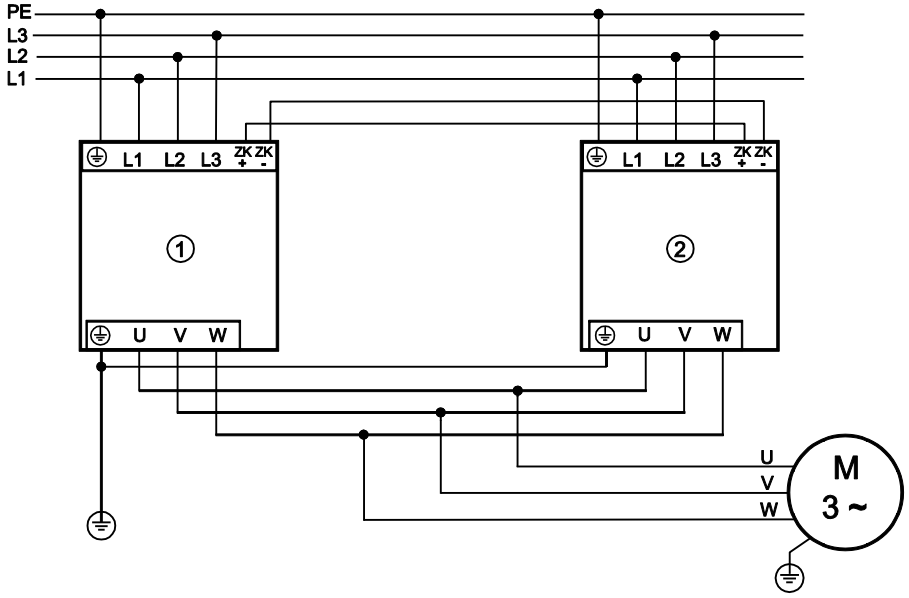


Figure 3-1: Wiring variants

Variant A1:

The following illustration shows parallel connection of two frequency inverters. Lines U, V and W of the devices are parallel-connected directly in correct phase sequence. The outputs of the two inverters should be parallel-connected as close as possible to the motor, e. g. in the motor terminal box.



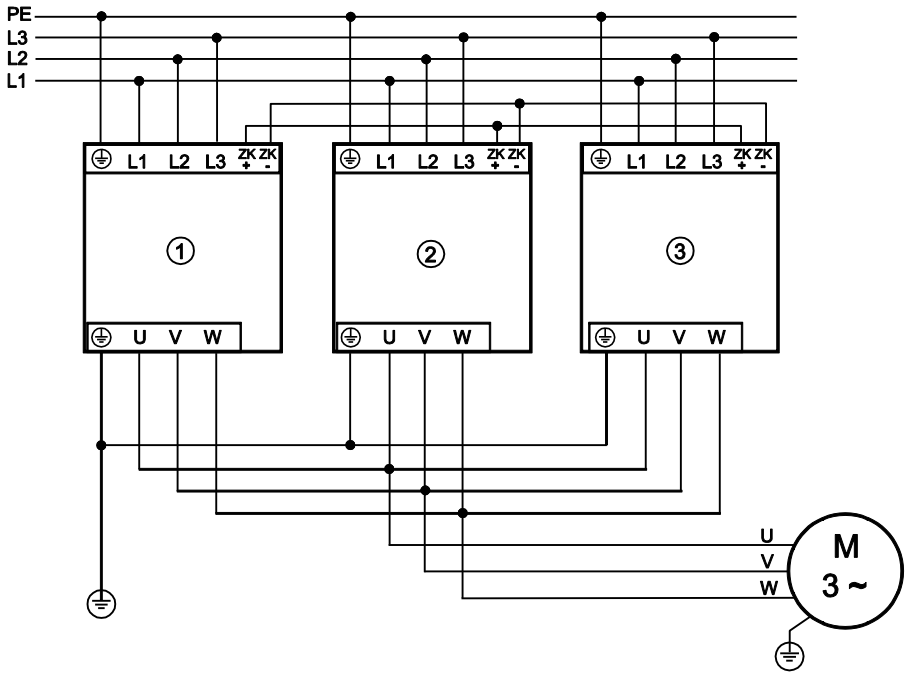
(1), (2): Frequency inverter

Figure 3-2: Wiring variant A1

Variant A2:

The following illustration shows parallel connection of three frequency inverters. Outputs U, outputs V and outputs W of the frequency inverters are parallel-connected directly in correct phase sequence. The outputs of the three inverters should be parallel-connected as close as possible to the motor, e.g. in the motor terminal box.

When three frequency inverters are parallel-connected, the main inverter should be placed in the middle.



(2): Main inverter; (1), (3): Secondary inverter

Figure 3-3: Wiring variant A2

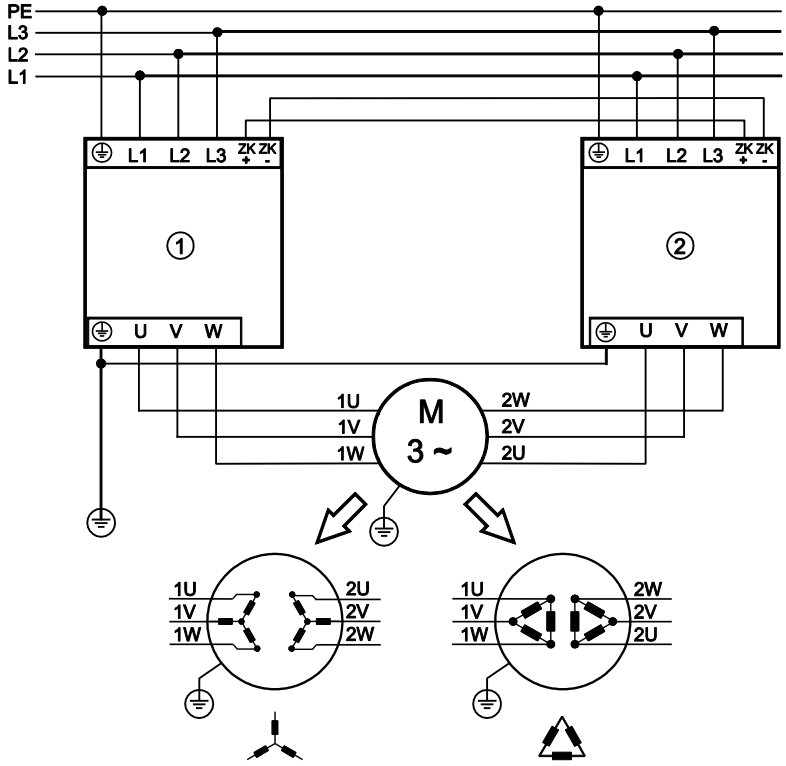
Variant B:

Outputs U, V and W of the frequency inverters are connected to a motor with two or three galvanically isolated winding systems. The number of frequency inverters that can be parallel-connected corresponds to the number of winding systems. The outputs of the frequency inverters are galvanically decoupled.

NOTICE

In any case, it must be verified that the sense of rotation and phase sequence are correct.

The following illustration shows the parallel connection of two frequency inverters with a motor featuring two galvanically isolated winding systems.



(1), (2): Frequency inverter

Figure 3-4: Wiring variant B

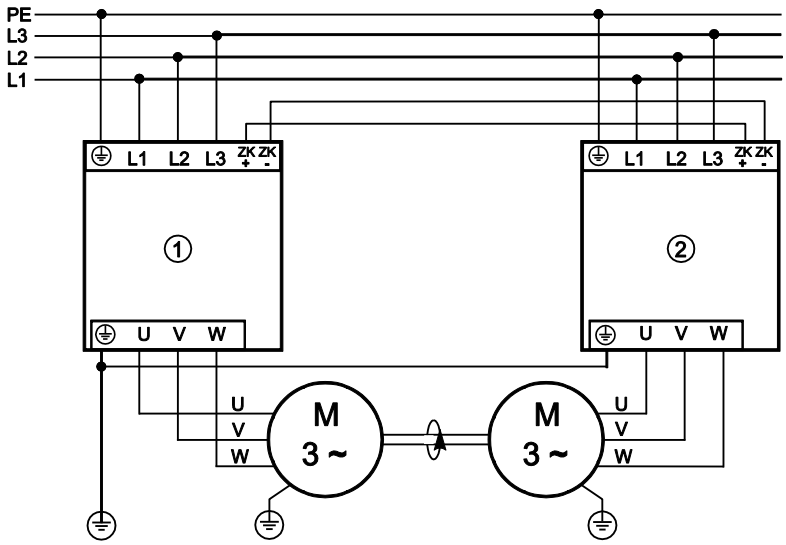
Variant C:

The circuitry of this variant corresponds to Variant B. Instead of one motor with isolated winding systems, two motors are coupled mechanically in this example via a shaft or gear.

NOTICE

The motors must be identical in design.

- In any case, it must be verified that the sense of rotation and phase sequence are correct.
- For synchronous motors, the orientation of the motors must be synchronized first. This must be done before mechanical coupling.

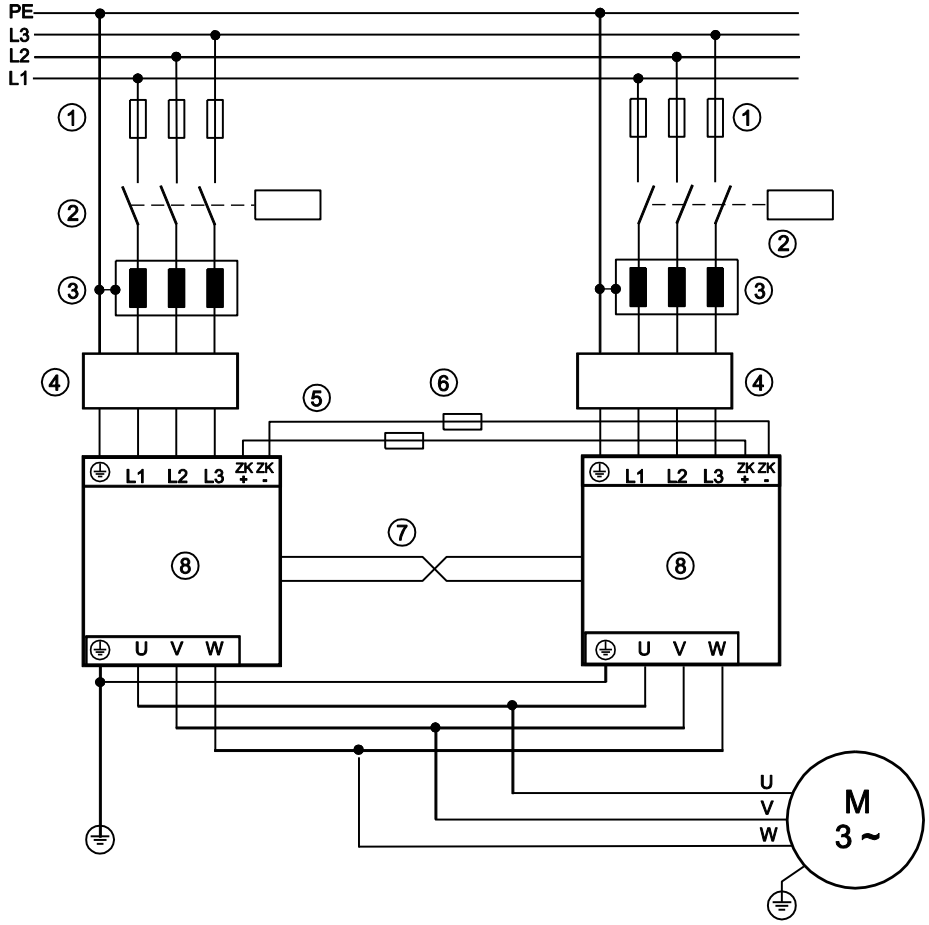


(1), (2): Frequency inverter

Figure 3-5: Wiring variant C

Components for parallel connection

The following circuit diagram shows how two frequency inverters are parallel-connected to one motor (Variant A1):



(1) Mains fuses
(2) Mains contactor
(3) Line choke
(4) EMC filter
(5) DC-interlinking
(6) Line protection
(7) Interlink cable
(8) Frequency inverter(s)

Figure 3-6: Parallel connection components

The frequency inverters (8) are connected to the input and output at the same phase sequence.

The mains fuses (1) at the input are dimensioned to correspond to the nominal current of the frequency inverter.
The mains contactors (2) connect the individual frequency inverters to mains at the same time. For details, refer to Chapter 6.1.3 "Switching devices (mains contactor)". Use one main contactor for both frequency inverters where possible. In this case, the mains fuses should be installed downstream the main contactor.
The line chokes (3) are required for connection of the frequency inverters to the public supply mains. They absorb mains disturbances from the frequency inverters. To ensure that the total current is evenly distributed to the frequency inverters, the line chokes must have the same impedance.
The optional downstream EMC filters (4) limit, where required, high-frequency radio interference voltages on the mains cable.
Interlinking of the DC-links (5) is important. The fuses (6) are used for line protection and protect the frequency inverters against overloading.
The interlink connection (7) is used for synchronization between the frequency inverters.

3.3 Data exchange

Via the interlink connections, the secondary inverters report the following error bits to the main inverter:

- Overcurrent
- Overcurrent at brake chopper
- General error signals

The main inverter represents the average current and phase values of the parallel-connected frequency inverters as actual values.
The main displays the highest values measured at the parallel-connected frequency inverters as the heat sink and interior temperature.

WARNING

Different device behavior!
The "Safe Torque Off (STO)" function is disabled in secondary inverters. The function is solely implemented by addressing the main inverter.

- Do not connect extension or communication modules to the secondary inverters.
- Only use the control of the main inverter.

Do not connect any signals to the signal terminals (e. g. X210, X410) of the secondary inverter(s).

4 Technical data

NOTICE

Only frequency inverters with the same power ratings may be parallel-connected.

Output, motor side												
Recommended Motor shaft output	P	kW	400	450	500	560	630	710	800	945	1065	1200
Total output current	I	A										
at 400 V[1)]			760	950	950	1190	1190	1290	1470	1785	1935	2205
at 525 V[2)]			580	720	720	900	900	980	1120	1350	1470	1680
at 690 V[3)]			460	560	560	700	700	800	900	1050	1200	1350
Input, mains side												
Mains voltage	U	V										
ANG 410...[1)]			320 … 528									
ANG 510...[2)]			525									
ANG 610...[3)]			690									
Mains frequency	f	Hz	50 (-10 %) … 60 (+10 %)									
Mechanical												
Number of devices, power output and type [1) 2) 3)]	–	–	2x 200 kW -53	2x 250 kW -55	2x 250 kW -55	2x 315 kW -57	2x 315 kW -57	2x 355 kW -59	2x 400 kW -61	3x 315 kW -57	3x 355 kW -59	3x 400 kW -61
Number of Interlink cables	–	–	1	1	1	1	1	1	1	2	2	2
Options and accessories												
Line choke (u_k=4 %)	–	–	External									
mains filter	–	–	Optional external									
brake chopper transistor	–	–	Optional internal									
Digital control unit	–	–	Optional									

1) applies also to ACU 410
2) applies also to ACU 510
3) applies also to ACU 610

For more technical data and ambient conditions, see Operating Instructions of frequency inverter.

5 Mechanical installation

During installation, follow the instructions on mechanical installation included in the Operating Instructions of the frequency inverter. For dimensions and installation distances, refer to the relevant chapters. The frequency inverters are designed, as a standard, for installation in electrical cabinets. When choosing the electrical cabinet dimensions, consider the space requirements of additional components installed in the direct vicinity of the frequency inverter.
For each frequency inverter, these are

- 3 x mains fuses, single-phase
- 1 x mains contactor, 3-phase
- 1 x line choke, 3-phase
- 1 x EMC filter, 3-phase (optional)

In addition, consider the heat production of all components in operation.

For information, refer to the Operating Instructions of the frequency inverter.

WARNING

Inappropriate installation may result in severe damages or in personal injury.
Unprotected DC-interlinking may result in severe damages of the device or personal injury.

- Use line fuses for DC-interlinking.

For the dimensions and installation dimensions of the required components, please contact BONFIGLIOLI.
The frequency inverters must be installed close to one another since the length of the interlinking cables is limited.

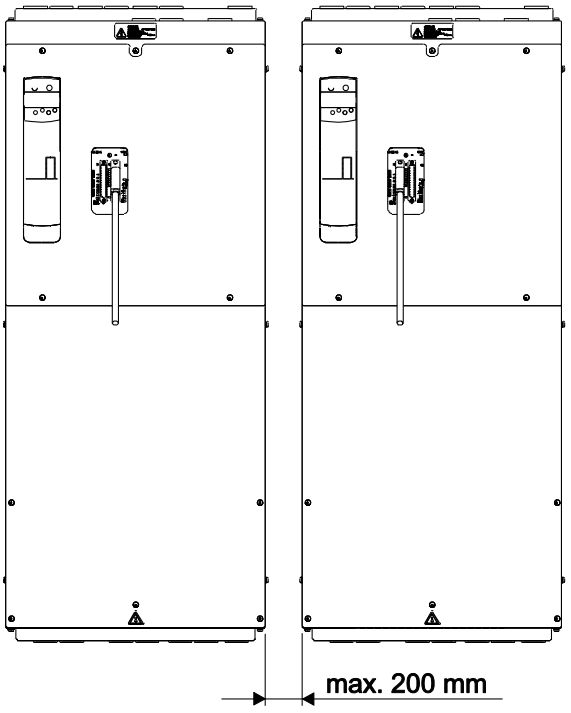


Figure 5-1: Inverter positioning

NOTICE

- Only use the BONFIGLIOLI interlinking cable. The interlinking cable must not be extended.

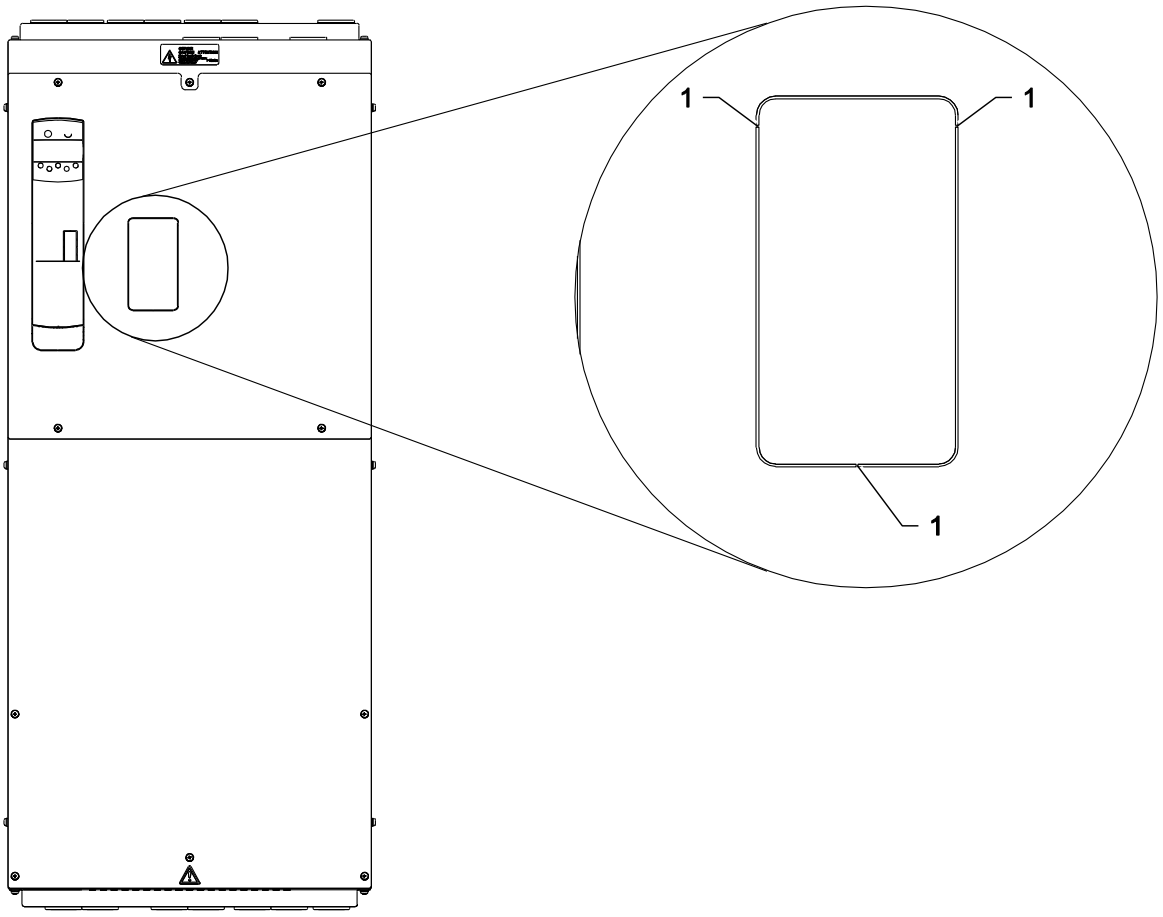
5.1 Preparation of the device front panels

For interlinking, a cutout must be made in the front panels of the parallel-connected frequency inverters.

NOTICE

- In order to prevent the device from being damaged, remove the front panel from the device before making the cutout.

- Remove the front panel from the device.
- Make the required cutout in the removed front panel.
- Install the front panel again.



(1): Cutout

Figure 5-2: Cutout

6 Electrical installation

During electrical installation, follow the Operating Instructions of the frequency inverter.

WARNING

Inappropriate installation!

Inappropriate installation may result in severe damages or in personal injury.

The electrical installation must be carried out by qualified electricians according to the general and regional safety and installation directives.

- Comply with documentation and device specifications during installation.
- Before any assembly or connection work, discharge the frequency inverter.
- Check for absence of voltage.

WARNING

Inappropriate installation!

Inappropriate installation may result in severe damages or in personal injury.

Once all DC-links of the frequency inverters are connected, all parallel-connected frequency inverters must be disconnected from power supply.

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work on the device may only be started once the DC link capacitors have discharged. The discharge time is at least 10 minutes in the case of size 8 devices.

- Do not connect inappropriate voltage sources. The nominal voltage of the frequency inverter must correspond to the supply voltage.

The frequency inverter must be connected to ground potential.

- Do not remove any covers of the frequency inverter while power supply is on.

6.1 Mains connection

WARNING

Live contacts!

Working on live terminals may result in severe damages or in personal injury.

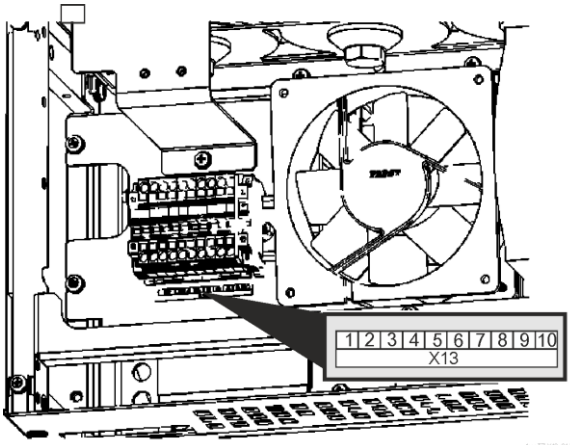
- Switch off power supply before connecting or disconnecting the mains cable to terminals L1, L2 and L3.

NOTICE

In order to supply the control circuits of ANG 510 and ANG 610 devices, an external 400 V power supply or 400 V from a power source is required for the inverter. This also applies for ANG 410 devices without Y-capacitors.

- Connect 3x400 V at X13 terminal of the inverter.

The illustration below shows the X13 terminal as an example.



Auxiliary voltage terminal X13	
1 … 6	Not used
7	⏚ PE
8	L1
9	L2
10	L3

Connection	
Connected load	≥ 1.2 kW
Supply voltage	400 V +- 10 %
Supply frequency	50 / 60 Hz

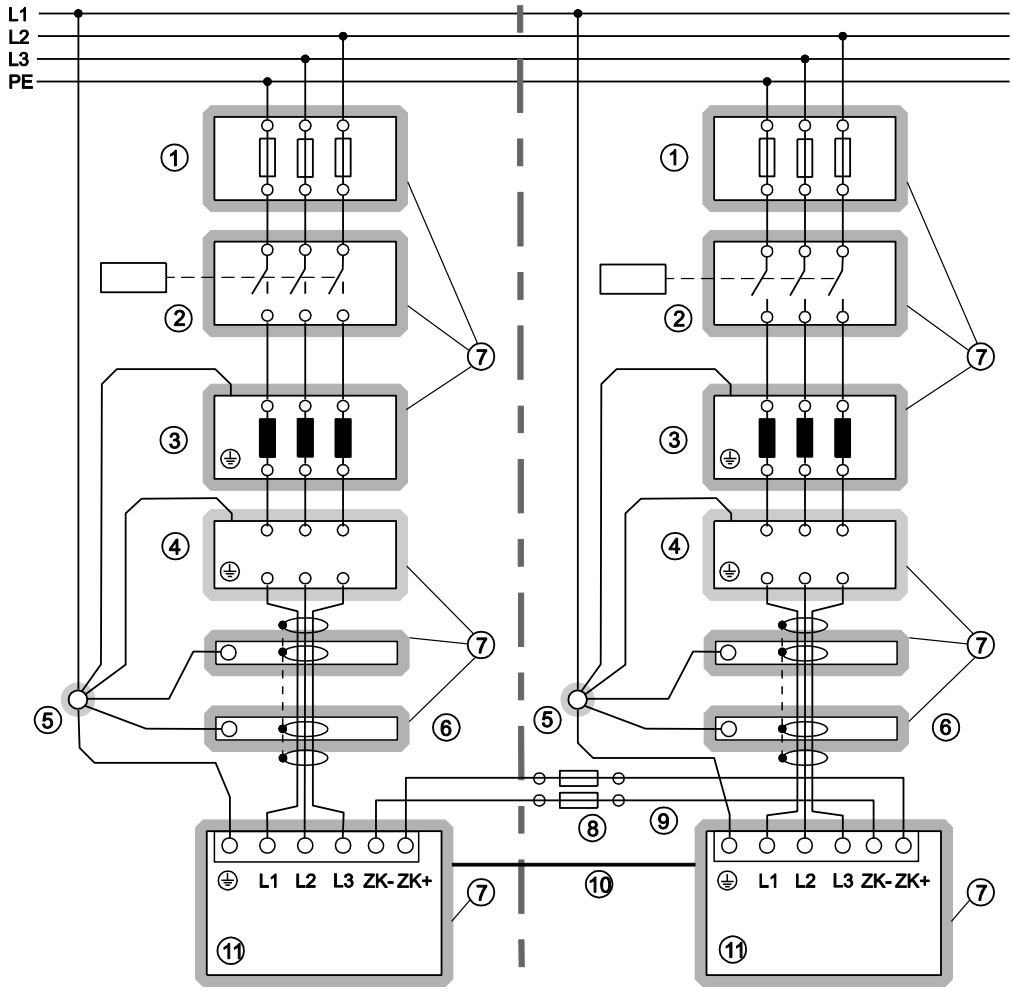
Figure 6-2: Connection of external 400 V power supply

6.1.1 Installation Diagram

NOTICE

Only frequency inverters with the same power ratings may be parallel-connected.

The following illustration shows the mains-side installation diagram of two parallel-connected frequency inverters:



(1) Mains fuses
(2) Mains contactor
(3) Line choke
(4) EMC filter
(5) PE star point
(6) PE busbar
(7) Unpainted metal surface
(8) Line protection
(9) DC-interlinking
(10) Interlink cable
(11) Frequency inverter(s)

Figure 6-1: Mains-side installation

6.1.2 Mains fuses and conductor cross-sections

The connecting cables must be protected externally, considering the maximum voltage and current values of the fuses. The mains fuses and cable cross-sections are to be selected according to EN 602041 and DIN VDE 0298 Part 4 for the nominal operating point of the frequency inverter.

NOTICE

The fuses to be used are to be selected depending on the specific application. The safety recommendations in the Technical Data are valid for continuous operation without overload.

The following tables provide an overview of typical cable cross-sections (copper cable with PVC insulation, 30 °C ambient temperature, continuous mains current max. 100% nominal input current, installation variant C). Actual mains cable cross-section requirements may deviate from these values depending on actual operating conditions.

400V: Three-phase connection (L1/L2/L3)

401/410		Mains cable	PE-conductor
-51	*160 kW*	150 mm²	95 mm²
-53	*200 kW*	240 mm²	120 mm²
-55	*250 kW*	2x120 mm²	120 mm²
-57	*315 kW*	2x150 mm²	150 mm²
-59	*355 kW*	2x185 mm²	185 mm²
-61	*400 kW*	2x240 mm²	240 mm²

525V: Three-phase connection (L1/L2/L3)

501/510		Mains cable	PE-conductor
-51	*160 kW*	95 mm²	70 mm²
-53	*200 kW*	150 mm²	95 mm²
-55	*250 kW*	185 mm²	120 mm²
-57	*315 kW*	2x120 mm²	120 mm²
-59	*355 kW*	2x120 mm²	120 mm²
-61	*400 kW*	2x150 mm²	150 mm²

690V: Three-phase connection (L1/L2/L3)

601/610		Mains cable	PE-conductor
-51	*160 kW*	70 mm²	At least 35 mm²
-53	*200 kW*	95 mm²	70 mm²
-55	*250 kW*	120 mm² or 2x70 mm²	95 mm²
-57	*315 kW*	185 mm² or 2x70 mm²	120 mm²
-59	*355 kW*	240 mm² or 2x95 mm²	120 mm²
-61	*400 kW*	2x120 mm²	120 mm²

The conductor cross-sections are valid for each frequency inverter and for connection of the mains terminals L1, L2 and L3 to the frequency inverter. The cable between the EMC filter and frequency inverter must be shielded as from a length of 30 cm.
PE installation and connection of cable shields must be done as per the instructions in the Operating Instructions.

6.1.3 Switching devices (mains contactor)

For each frequency inverter, a 3-phase mains contactor with auxiliary contacts is required. The mains contactors must disconnect the frequency inverters from the mains safely and connect/disconnect mains supply synchronously (max. time difference 20 ms). This must be implemented by choosing an appropriate design of the contactor circuitry and addressing, e. g. by interlocking the contactors in the release

circuit. Alternatively, one single large contactor can be used for all parallel-connected frequency inverters.

NOTICE

Inching mode of the mains contactors is permissible only if the time between switching off and on is at least 60 s. Note the relevant instructions in the Operating Instructions!

6.1.4 Line chokes

In the case of parallel-connected frequency inverters, a line choke is required for each frequency inverter between the mains input and mains supply. The line chokes must have the same short-circuit impedance in order to distribute the total current across the individual frequency inverters symmetrically.

- The line choke must be installed between the mains contactor and the EMC filter.
- Connect the case of the line choke to the PE star point in the electrical cabinet.

Suitable line chokes with a relative short-circuit voltage of u_k = 4% are available at BONFIGLIOLI.

6.1.5 EMC filter

- The EMC filter should be installed in direct vicinity of the frequency inverter.
- Connect the case of the EMC filter to the PE star point in the electrical cabinet.

The cable between the EMC filter and frequency inverter must be shielded if it is longer than 30 cm.
The cable between the EMC filter and the line choke can be unshielded.
Suitable EMC filters are available at BONFIGLIOLI.

6.2 Motor connection

WARNING

Inappropriate installation!
Inappropriate installation may result in severe damages or in personal injury.
The electrical installation must be carried out by qualified electricians according to the general and regional safety and installation directives.

- Comply with documentation and device specifications during installation.
- Before any assembly or connection work, discharge the frequency inverter.
- Check for absence of voltage.

WARNING

Inappropriate installation!
Inappropriate installation may result in severe damages or in personal injury.
Once all DC-links of the frequency inverters are connected, all parallel-connected frequency inverters must be disconnected from power supply.
When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work on the device may only be started once the DC link capacitors have discharged. The discharge time is at least 10 minutes in the case of size 8 devices.

- Do not connect inappropriate voltage sources. The nominal voltage of the frequency inverter must correspond to the supply voltage.

  The frequency inverter must be connected to ground potential.
- Do not remove any covers of the frequency inverter while power supply is on.
- Switch off power supply before connecting or disconnecting the motor cables to terminals U, V and W.

WARNING

Inappropriate installation!

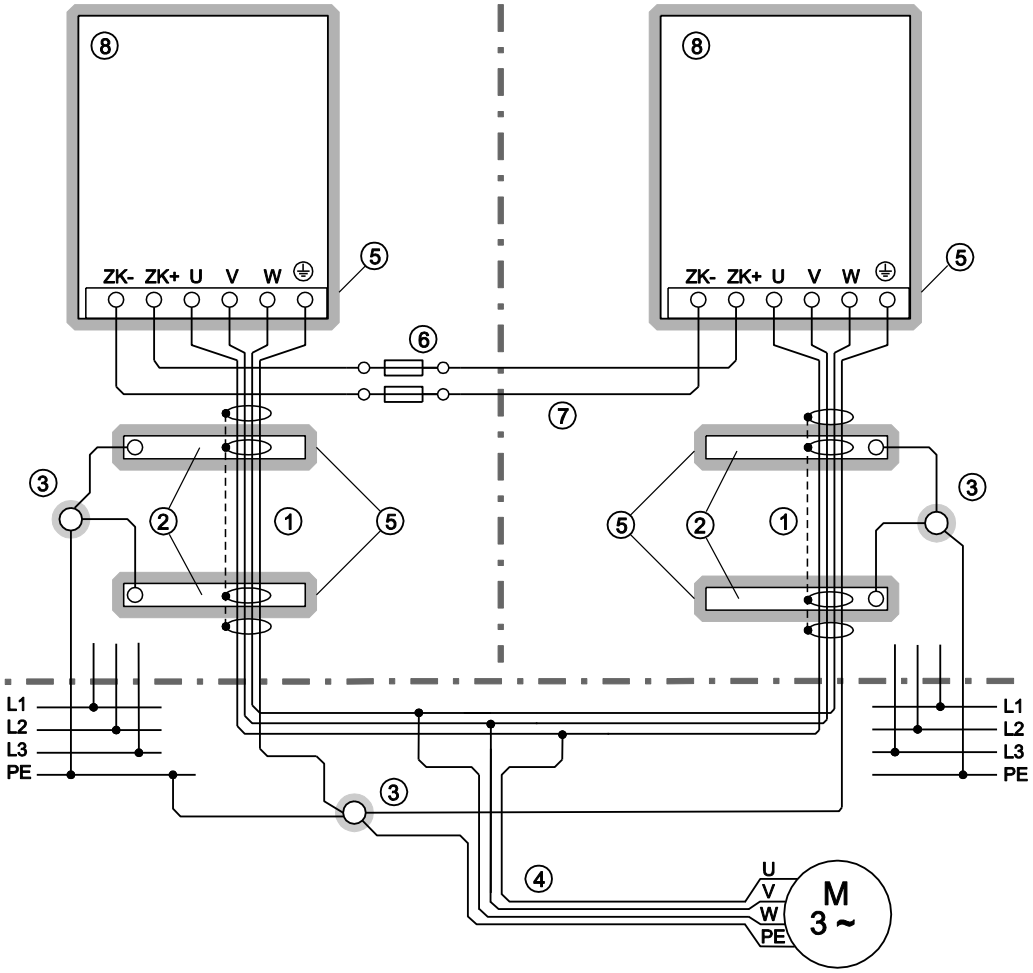
Inappropriate installation may result in severe damages or in personal injury.

Every frequency inverter must be connected to the motor or line switching devices via individual lines.

- Refer to Chapter "Wiring variants" for applicable motor connection configurations.

6.2.1 Installation Diagram

Variant A:



(1) Cable, shielded
(2) PE busbar
(3) PE star point
(4) Motor cable
(5) Unpainted metal surface
(6) Line protection
(7) DC-interlinking
(8) Frequency inverter(s)

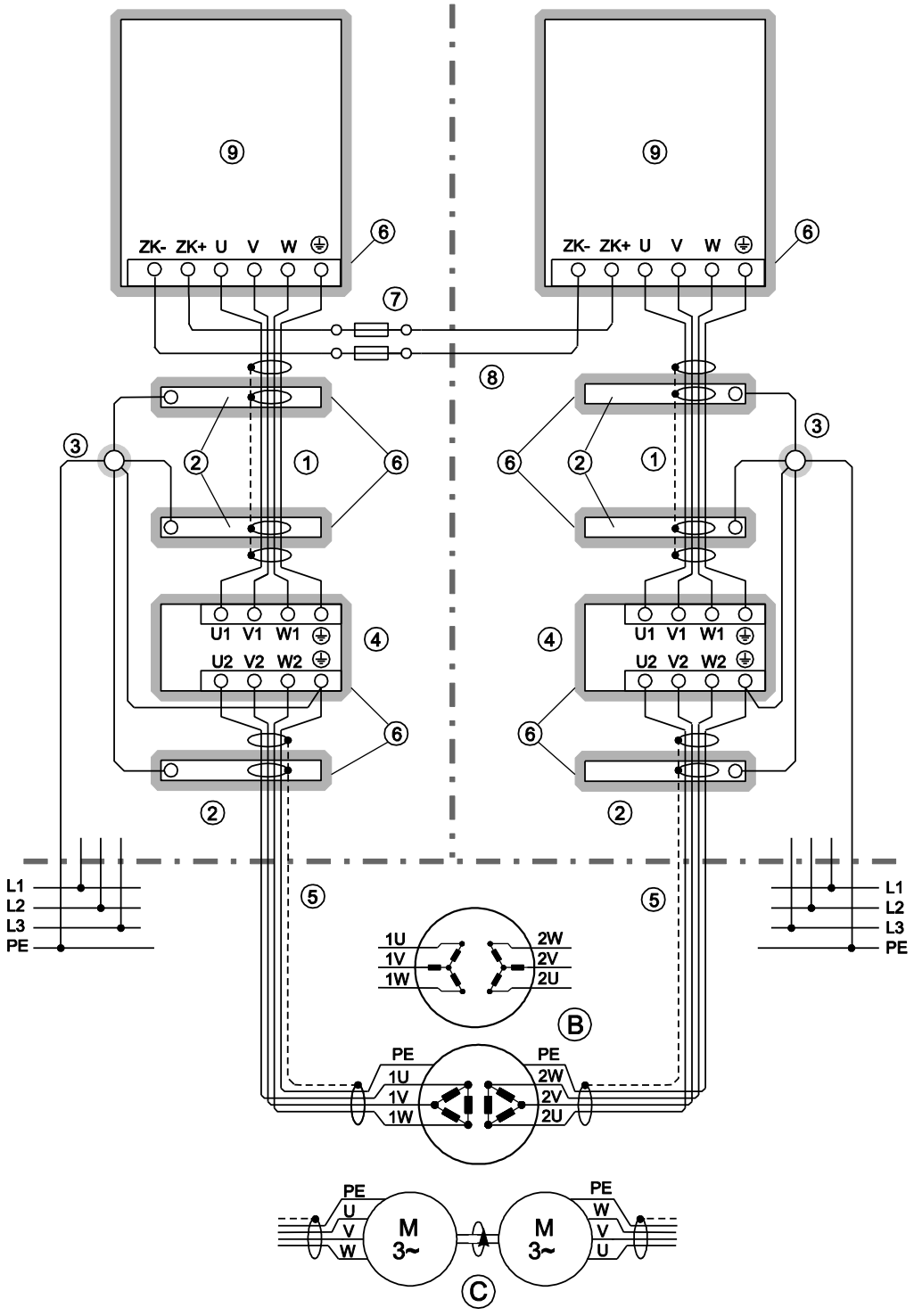
Figure 6-2: Motor connection Variant A

NOTICE

During installation, note the following:

- The cables leading to the motor should not exceed an appropriate conductor cross-section. The conductor inductance and resistance are important!
- The frequency inverters should be parallel-connected in the motor terminal box if possible.
- For DC-interlinking, use the same cross-section as for the supply cables.

Variants B and C:



(1) Cable, shielded
(2) PE busbar
(3) PE star point
(4) Output filter
(5) Motor cable
(6) Unpainted metal surface
(7) Line protection
(8) DC-interlinking
(9) Frequency inverter(s)
(B) Motor connection Variant B
Star or delta connection
(C) Motor connection Variant C

Figure 6-3: Motor connection Variants B and C

NOTICE

In the case of motors with isolated windings (Variant B) strictly note the following:

- The test voltage between the winding systems must be at least 2 kV.
- The galvanically isolated winding systems must not be connected to one another electrically.

6.2.2 Output filter

- In Variants B and C, install output filters, if long cables are used.
- Choose an output filter suitable for the relevant output currents and frequencies of the frequency inverter and install it in close vicinity to the frequency inverter.
- Shield the cable if the cable between the output filter and frequency inverter is longer than 30 cm.
- Connect the housing of the output filter to the PE star-point in the electrical cabinet.
- If output filters are used, the devices can be connected to one another directly downstream of the output filter. Only one set of cables must be routed to the motor. (In applications without output filters, cables leading from each frequency inverter to the motor must be routed separately.)

Suitable output filters are available at BONFIGLIOLI.

6.2.3 Cables

NOTICE

- All cables between the frequency inverter and motor must be shielded.
- If output filters are used, the cables between the output filter and motor must be installed as per the user's requirements and local conditions. Depending on the application, the cable must be shielded or unshielded.
- Connect the cable shields to PE potential properly, i.e. with good conductivity, on both sides.

The cable cross-sections are to be selected according to EN 602041-1 and DIN VDE 0298 Part 4 for the nominal operating point of the frequency inverter.
The following tables provide an overview of typical cable cross-sections (copper cable with PVC insulation, 30 °C ambient temperature, continuous mains current max. 100% nominal input current, installation variant C). Actual mains cable cross-section requirements may deviate from these values depending on actual operating conditions.

400V: Three-phase connection (L1/L2/L3)

401/410		Motor cable	PE-conductor
-51	*160 kW*	185 mm²	95 mm²
-53	*200 kW*	240 mm²	120 mm²
-55	*250 kW*	2x120 mm²	120 mm²
-57	*315 kW*	2x150 mm²	150 mm²
-59	*355 kW*	2x185 mm²	185 mm²
-61	*400 kW*	2x240 mm²	240 mm²

525V: Three-phase connection (L1/L2/L3)

501/510		Motor cable	PE-conductor
-51	*160 kW*	120 mm²	70 mm²
-53	*200 kW*	150 mm²	95 mm²
-55	*250 kW*	240 mm²	120 mm²
-57	*315 kW*	2x120 mm²	120 mm²
-59	*355 kW*	2x120 mm²	120 mm²
-61	*400 kW*	2x150 mm²	150 mm²

690V: Three-phase connection (L1/L2/L3)

601/610		Motor cable	PE-conductor
-51	*160 kW*	70 mm²	At least 35 mm²
-53	*200 kW*	120 mm²	70 mm²
-55	*250 kW*	150 mm² or 2x70 mm²	95 mm²
-57	*315 kW*	240 mm² or 2x95 mm²	120 mm²
-59	*355 kW*	240 mm² or 2x95 mm²	120 mm²
-61	*400 kW*	2x120 mm²	120 mm²

6.2.4 Maximum cable lengths

Permissible length of motor cable without output filter		
Frequency inverter	**unshielded cable**	**shielded cable**
160.0 kW … 400.0 kW	150 m	100 m
Motor cable length with output filter		
Frequency inverter	**unshielded cable**	**shielded cable**
160.0 kW … 400.0 kW	300 m	200 m

Upon request and provided that appropriate technical measures are taken, the motor cable lengths listed in the tables can be extended, e. g. if low-capacity cables are used.

6.3 Connection of braking resistor

In generator mode, the motor feeds electrical energy back into the frequency inverter which results in an increase of the DC-link voltage. If such situations occur during operation, we recommend providing the parallel-connected frequency inverters with an external braking resistor. The brake chopper transistor included in the standard frequency inverter design connects the external braking resistor once the voltage in the DC-link exceeds an adjustable limit.

WARNING

Inappropriate installation!

Inappropriate installation may result in severe damages or in personal injury.

The electrical installation must be carried out by qualified electricians according to the general and regional safety and installation directives.

- Comply with documentation and device specifications during installation.
- Before any assembly or connection work, discharge the frequency inverter.
- Check for absence of voltage.

WARNING

Inappropriate installation!

Inappropriate installation may result in severe damages or in personal injury.

Once all DC-links of the frequency inverters are connected, all parallel-connected frequency inverters must be disconnected from power supply.

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work on the device may only be started once the DC link capacitors have discharged. The discharge time is at least 10 minutes in the case of size 8 devices.

- The unit may only be connected with the power supply switched off.
- Switch off power supply before connecting or disconnecting the cables to terminals Zk+ and Rb2.
- Verify safe isolation from power supply.

CAUTION

Overheating of components

The braking resistor may reach high temperatures during operation. High temperatures may lead to dangerous situations.

- The braking resistor must be equipped with a temperature monitor (temperature switch).
- The temperature monitor must be included in the safety circuitry of the external control. Once the maximum temperature is reached, the frequency inverter must be disconnected from mains safely. In this process, no dangerous situations may occur.

External braking resistors can only be used if the frequency inverter is provided with a brake chopper transistor.
Brake chopper transistors are installed per default ex factory. Retrofitting is not possible.
All brake chopper transistors are addressed at the same time. For this reason, we recommend connecting braking resistors to all frequency inverters.

The number of braking resistors required depends on the application. It must be checked in each case how much regenerative energy must be converted into braking energy.
The Operating Instructions of the frequency inverter contains:

- Technical data of the brake chopper transistor
- Information on dimensioning and selection of the braking resistors
- Information on conductor cross-sections

Depending on the application, the cables between the frequency inverters and braking resistors may be shielded or unshielded. If shielded cables are used, connect the cable shields to PE potential properly, i.e. with good conductivity, on both sides.

NOTICE

- The cables must have an electric strength corresponding to the permissible maximum DC-link voltage of the frequency inverter (see Operating Instructions of frequency inverter).
- The conductor cross-section must be chosen as per the current carrying capacity of the permitted connection cable as per DIN VDE 0100 Part 430, DIN VDE 0298 Part 4 and EN 60204-1.

6.4 Connection of DC-links

Connection of DC-links (interlinking) is required for all variants.

WARNING

Inappropriate installation!

Inappropriate installation may result in severe damages or in personal injury.

The electrical installation must be carried out by qualified electricians according to the general and regional safety and installation directives.

- Comply with documentation and device specifications during installation.
- Before any assembly or connection work, discharge the frequency inverter.
- Check for absence of voltage.

WARNING

Inappropriate installation!

Inappropriate installation may result in severe damages or in personal injury.

Once all DC-links of the frequency inverters are connected, all parallel-connected frequency inverters must be disconnected from power supply.

When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work on the device may only be started once the DC link capacitors have discharged. The discharge time is at least 10 minutes in the case of size 8 devices.

- The unit may only be connected with the power supply switched off.
- Switch off power supply before connecting or disconnecting the cables to terminals Zk+ and Zk-.
- Verify safe isolation from power supply.

NOTICE

- The cables must have an electric strength corresponding to the permissible maximum DC-link voltage of the frequency inverter (see Operating Instructions of frequency inverter).
- The conductor cross-section must correspond to that of the supply cable.
- The cables should be as short as possible, they must not be longer than 750 mm.

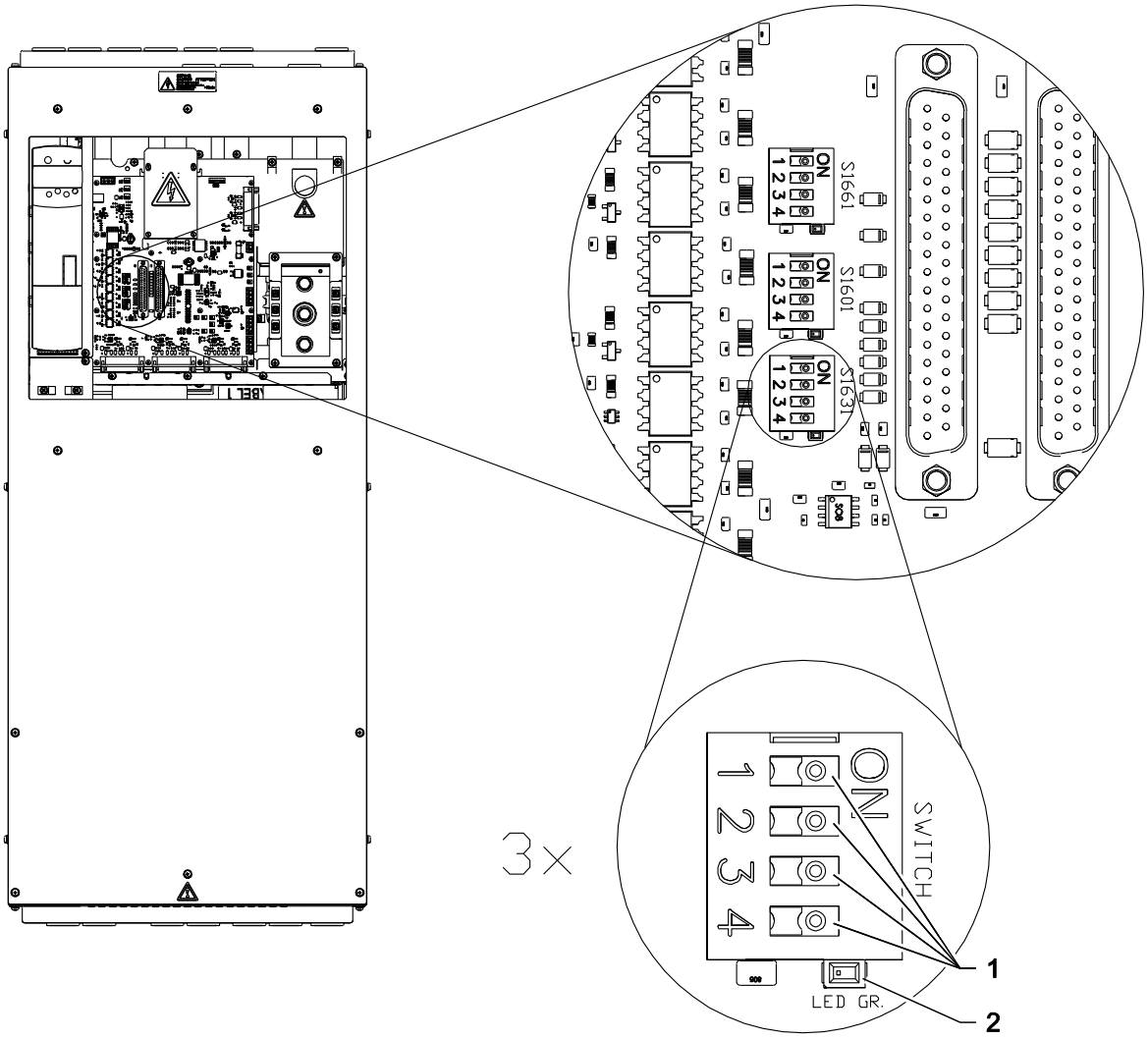
6.5 Interlink cables

When parallel-connected, data exchange between the frequency inverters is done via interlink cables, see Chapter 3.3 "Data exchange".

6.5.1 Setting of DIP switches

For configuration of the frequency inverters as main inverter or secondary inverter, they feature three DIP switch blocks with four DIP switches each. Set the DIP switches as follows:

- Main inverter: all 12 DIP switches on
- Secondary inverter: all 12 DIP switches off



(1) DIP switch
(2) LED

Figure 6-4: setting DIP switches

Upon delivery, frequency inverters are set up as main inverters, i.e. all DIP switches are on. To configure a frequency inverter as a secondary inverter, turn the DIP switches off:

- Turn the device off.
- Turn all DIP switches of those inverters to be used as secondary inverters off.

Each of the three DIP switch blocks is provided with a LED. When the device is on, the LED will light up (green) when all DIP switches of the block are on.

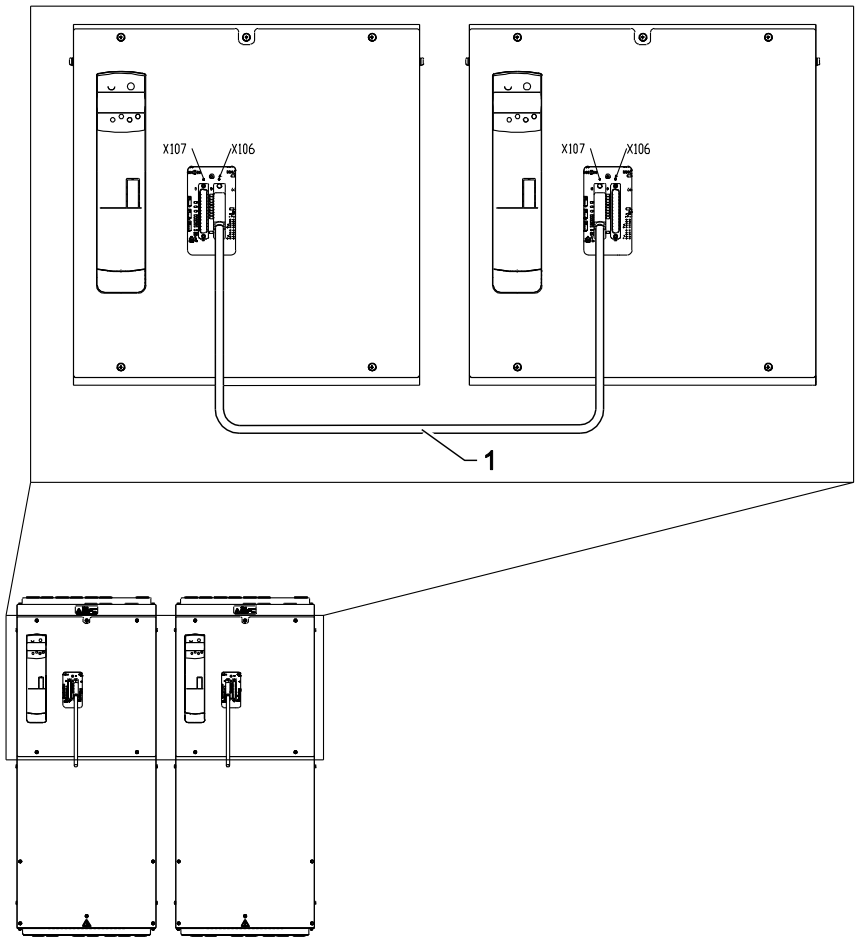
6.5.2 Connection of interlink cables

WARNING

Inappropriate installation!
Inappropriate installation may result in severe damages or in personal injury.
Once all DC-links of the frequency inverters are connected, all parallel-connected frequency inverters must be disconnected from power supply.
When the frequency inverter is disconnected from power supply, the mains, DC-link voltage and motor terminals may still be live for some time. Work on the device may only be started once the DC link capacitors have discharged. The discharge time is at least 10 minutes in the case of size 8 devices.

- The unit may only be connected with the power supply switched off.
- Switch off power supply before connecting or disconnecting the cables.
- Verify safe isolation from power supply.

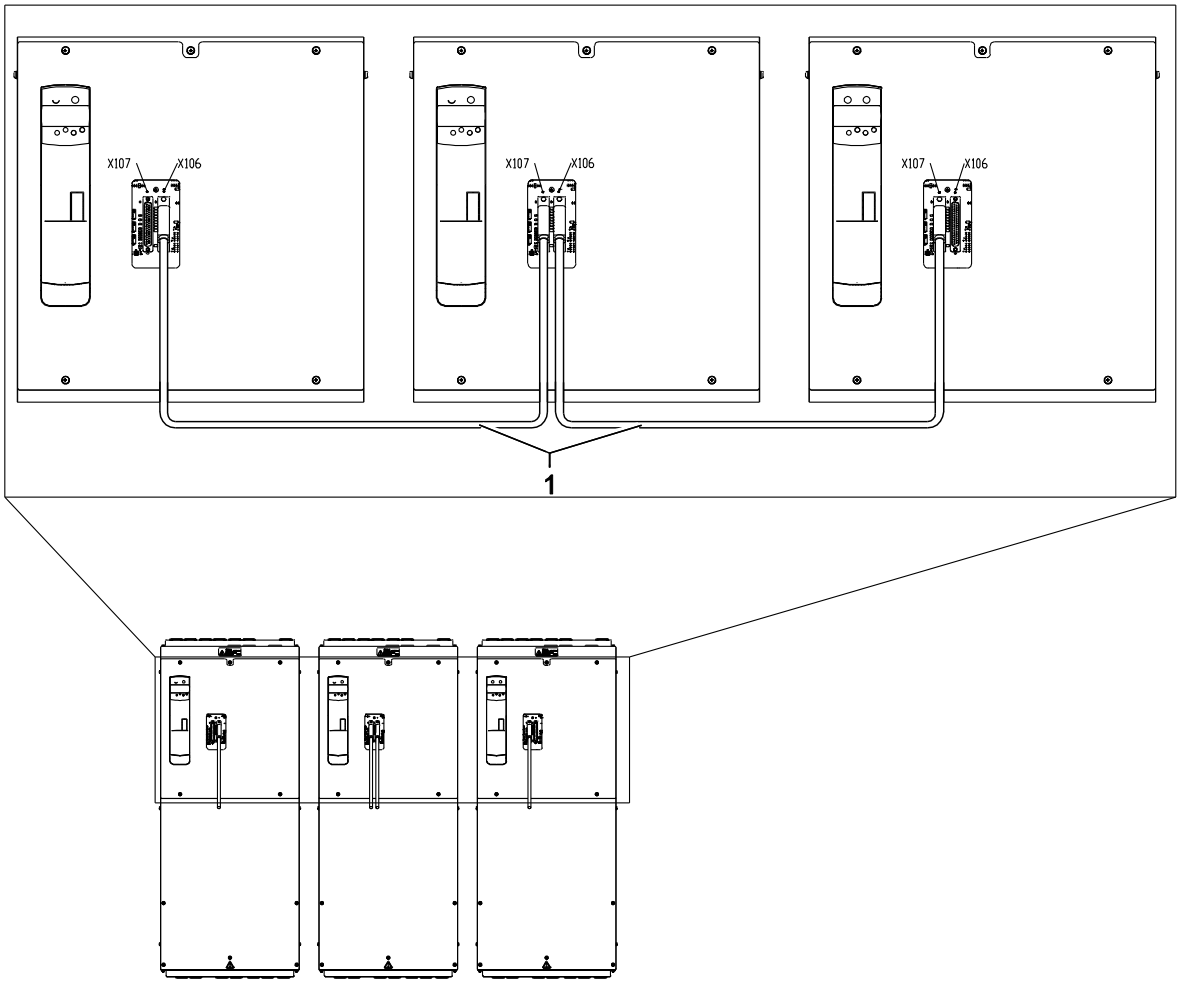
The frequency inverters are connected using ready-made interlink cables. Both device connectors can be used. Use connectors such that cable routes are as short as possible. The following illustrations show the cabling diagram for two and three parallel-connected devices.
Cabling for two frequency inverters:



(1) Interlink cable

Figure 6-5: connecting interlink cables for two inverters

Cabling for three frequency inverters:



(1) Interlink cable

Figure 6-6: connecting interlink cables for three inverters

6.6 Control connections

The Operating Instructions of the frequency inverter contain detailed information on control connection and installation of analog and digital signal cables.

6.6.1 Main inverter control signals

In the main inverter, the full functionality of the control signal inputs and outputs is available. For details, refer to the Operating Instructions of the frequency inverter.

6.6.2 Secondary inverter control signals

In secondary inverters, the functionality of the control signal inputs and outputs is not available.

WARNING

Different device behavior!

The "Safe Torque Off (STO)" function is disabled in secondary inverters. The function is solely implemented by addressing the main inverter.

- Do not connect extension or communication modules to the secondary inverters.
- Only use the control of the main inverter.

- Do not connect any signals to the signal terminals (e.g. X210, X410) of the secondary inverter(s).
- Do not connect keypads to secondary inverters. The keypad would not deliver reliable values if it were connected to secondary inverters.
- The LEDs at the controller of secondary inverters have no meaning. Lighting of the red LED on secondary inverters can be ignored.

7 Commissioning

During commissioning, follow the instructions included in the Operating Instructions of the frequency inverter. These instructions also apply to parallel connection.
Commissioning of the overall system should be performed in the following order:

1 Check interlink connection, see Chapter 6.5.2 "Connection of interlink cables"
2 Turn mains voltage on at main inverter, see Chapter 7.1 "Turn mains voltage on"
3 Check status LEDs at the DIP switch blocks of all frequency inverters, see Chapter 6.5.1 "Setting of DIP switches". For setup of main inverter, see Chapter 7.2 "Setup of main inverter"
4 Set main inverter parameters

7.1 Turn mains voltage on

After completion of the installation work, make sure to check all control and power connections again before switching on the mains voltage. If all electrical connections are correct, make sure that the main inverter is not enabled (control input STO open).

WARNING

Different device behavior!
The "Safe Torque Off (STO)" function is disabled in secondary inverters. The function is solely implemented by addressing the main inverter.

- Do not connect extension or communication modules to the secondary inverters.
- Only use the control of the main inverter.

7.2 Setup of main inverter

Setup is done as described for individual devices in the Operating Instructions for frequency inverters.

- Connect KP500 control unit, see Operating Instructions of frequency inverter.
- For Parameter *No. of Freq. Inverters* **35,** enter the total number of parallel-connected frequency inverters, i.e. 2 or 3 depending on the installation variant.
- By changing this parameter, the default settings for parallel connection are set automatically.
- Carry out setup procedure completely, see Operating Instructions of frequency inverter.

Upon completion of the setup procedure, the specific parallel connection parameters are saved in the main inverter.

7.3 Parameter identification

Parameter identification is started by the main inverter only. It is performed in the same way as the parameter identification of individual frequency inverters, see Operating Instructions of frequency inverter.

7.4 Possible configurations in parallel connection

For parallel connection, generally the same configurations can be used as in the case of standalone devices. Depending on the output circuitry, there are configurations which might involve additional commissioning requirements.

CAUTION

Risk of personal or material damage!
Incorrect configuration and parameterization can result in unexpected operating behavior of frequency inverters and machines.

- Note the correct configuration and parametrization.

NOTICE

- After commissioning, check the current values in the motor cables. The current values in the corresponding phases of main and secondary inverters must not deviate beyond permissible tolerances.

The different operation modes are set via parameter *Operation Mode* **30**.
The following table shows the available configurations for Variants A**1,** A2, B and C as described in Chapter "Wiring variants". Depending on the chosen configuration, extension modules, e.g. with speed sensor signal input may be required.

Operation Mode		Variants		
No.	**Description**	**A1/A2**	**B**	**C [1)]**
110	Sensor-less control	+	o	o
210	FOR speed control, with encoder [2)]	+	o	o
410	Sensor-less field oriented regulation	+	o	o
510	FOR synchronous machine speed control, with encoder [2)]	+	o	o
610	DMR for PMSM, speed-controlled, without encoder	+	o	o

\+ Configuration suitable for parallel connection
o Configuration possible, but higher optimization and tuning requirements (note orientation/phase sequence!).

[1)] specifications only valid if identical motors are used
[2)] encoder evaluation in main inverter only

7.5 Parameters

Specific parameters are implemented for parallel connection. They are used for tuning the control to the parallel-connected frequency inverters.

7.5.1 Number of inverters

Parameter Umrichteranzahl 35 can only be set at the main inverter. The number of inverters shows the total of all parallel-connected frequency inverters, incl. the main inverter.

Parameter		Setting		
No.	**Identifier**	**min.**	**max.**	**Factory setting**
35	No. of Freq. Inverters	1	3	1

Any changes made to Parameter 35 will also change the internal default values.

8 Extensions

WARNING

Different device behavior!
The "Safe Torque Off (STO)" function is disabled in secondary inverters. The function is solely implemented by addressing the main inverter.

- Do not connect extension or communication modules to the secondary inverters.
- Only use the control of the main inverter.

- No extension or communication modules may be connected to secondary inverters.

At the main inverter, all communication and extension modules which are compatible with the relevant type of frequency inverter can be connected, see Operating Instructions of frequency inverter.

9 Error messages

The following table shows specific parallel connection error messages.

Error message			
Display KP 500			**Meaning**
Code		**Text**	**Cause / Remedy**
F0C	21	-	General hardware error at ACU of size 8. This error will be displayed in case of overtemperature, overcurrent or short-circuits in the inverter or pre-charging area or the temperature-monitored components. Check wiring and DIP switch position of secondary inverters.

For information on other error messages, refer to the Operating Instructions of the frequency inverter.

10 List of parameters

The following table contains parameters which are relevant to parallel connection. For information on the other parameters, refer to the Operating Instructions of the frequency inverter.

Inverter data				
No	**Identifier**	**Unit**	**Setting range**	**Chapter**
35	No. of Freq. Inverters	–	Selection	7.5.1

Bonfiglioli worldwide network

Bonfiglioli Australia
2, Cox Place Glendenning NSW 2761
Locked Bag 1000 Plumpton NSW 2761
Tel. (+ 61) 2 8811 8000 - Fax (+ 61) 2 9675 6605
www.bonfiglioli.com.au

Bonfiglioli Brasil
Travessa Cláudio Armando 171
Bloco 3 - CEP 09861-730 - Bairro Assunção
São Bernardo do Campo - São Paulo
Tel. (+55) 11 4344 2323 - Fax (+55) 11 4344 2322
www.bonfigliolidobrasil.com.br

Bonfiglioli Canada
2-7941 Jane Street - Concord, Ontario L4K 4L6
Tel. (+1) 905 7384466 - Fax (+1) 905 7389833
www.bonfigliolicanada.com

Bonfiglioli China
Unit D, 8th Floor, Building D, BenQ Plaza, No.207
Songhong Road, Shanghai 200335
Tel. (+86) 21 60391118 - Fax (+86) 59702957
www.bonfiglioli.cn

Bonfiglioli Deutschland
Industrial, Mobile, Wind
Sperberweg 12 - 41468 Neuss
Tel. +49 (0) 2131 2988 0 - Fax +49 (0) 2131 2988 100
www.bonfiglioli.de
Industrial
Europark Fichtenhain B6 - 47807 Krefeld
Tel. +49 (0) 2151 8396 0 - Fax +49 (0) 2151 8396 999

Bonfiglioli España
Industrial, Mobile, Wind
Tecnotrans Bonfiglioli S.A
Pol. Ind. Zona Franca sector C, calle F, n°6
08040 Barcelona
Tel. (+34) 93 4478400 - Fax (+34) 93 3360402
www.tecnotrans.com

Bonfiglioli France
14 Rue Eugène Pottier
Zone Industrielle de Moimont II - 95670 Marly la Ville
Tel. (+33) 1 34474510 - Fax (+33) 1 34688800
www.bonfiglioli.fr

Bonfiglioli India
Industrial
Bonfiglioli Transmission PVT ltd
Survey No. 528, Perambakkam High Road
Mannur Village - Sriperumbudur Taluk 602105
www.bonfiglioli.in
Mobile, Wind
Bonfiglioli Transmission PVT ltd
PLOT AC7-AC11 Sidco Industrial Estate
Thirumudivakkam - Chennai 600 044
Tel. +91(0) 44 24781035 - 24781036 - 24781037
Fax +91(0) 44 24780091 - 24781904
www.bonfiglioli.in

Bonfiglioli Italia
Industrial, Photovoltaic
Via Sandro Pertini lotto 7b - 20080 Carpiano (Milano)
Tel. (+39) 02 985081 - Fax (+39) 02 985085817
www.bonfiglioli.it
Bonfiglioli Mechatronic Research
Via F. Zeni 8 - 38068 Rovereto (Trento)
Tel. (+39) 0464 443435/36 - Fax (+39) 0464 443439
www.bonfiglioli.it

Bonfiglioli New Zealand
88 Hastie Avenue, Mangere Bridge, Auckland
2022, New Zealand - PO Box 11795, Ellerslie
Tel. (+64) 09 634 6441 - Fax (+64) 09 634 6445
www.bonfiglioli.co.nz

Bonfiglioli Österreich
Molkereistr 4 - A-2700 Wiener Neustadt
Tel. (+43) 02622 22400 - Fax (+43) 02622 22386
www.bonfiglioli.a

Bonfiglioli South East Asia
24 Pioneer Crescent #02-08
West Park Bizcentral - Singapore, 628557
Tel. (+65) 6268 9869 - Fax. (+65) 6268 9179
www.bonfiglioli.co

Bonfiglioli South Africa
55 Galaxy Avenue,
Linbro Business Park - Sandton
Tel. (+27) 11 608 2030 OR - Fax (+27) 11 608 2631
www.bonfiglioli.co.za

Bonfiglioli Türkiye
Atatürk Organize Sanayi Bölgesi,
10044 Sk. No. 9, 35620 Çiğli - Izmir
Tel. +90 (0) 232 328 22 77 (pbx)
Fax +90 (0) 232 328 04 14
www.bonfiglioli.com.tr

Bonfiglioli United Kingdom
Industrial
Unit 7, Colemeadow Road
North Moons Moat - Redditch, Worcestershire
B98 9PB
Tel. (+44) 1527 65022 - Fax (+44) 1527 61995
www.bonfiglioli.co.u
Mobile, Wind
3 - 7 Grosvenor Grange, Woolston Warrington
- Cheshire WA1 4SF
Tel. (+44) 1925 852667 - Fax (+44) 1925 852668
www.bonfiglioli.co.uk

Bonfiglioli USA
3541 Hargrave Drive Hebron, Kentucky 41048
Tel. (+1) 859 334 3333 - Fax (+1) 859 334 8888
www.bonfiglioliusa.com

Bonfiglioli Vietnam
Lot C-9D-CN My Phuoc Industrial Park 3
Ben Cat - Binh Duong Province
Tel. (+84) 650 3577411 - Fax (+84) 650 3577422
www.bonfiglioli.vn

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Bonfiglioli has been designing and developing innovative and reliable power transmission and control solutions for industry, mobile machinery and renewable energy applications since 1956.

Bonfiglioli Riduttori S.p.A.
Via Giovanni XXIII, 7/A
40012 Lippo di Calderara di Reno
Bologna (Italy)

tel: +39 051 647 3111
fax: +39 051 647 3126
bonfiglioli@bonfiglioli.c
www.bonfiglioli.co

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