# ACOPOSinverter P96

User's manual
1.01 (December 2024)
MAACPIP96-ENG

Translation of the original documentation

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# 1 Safety information

Read through these instructions carefully and familiarize yourself with the device before installing, operating or servicing it. The warning notices listed below are included in all documentation and on the device itself and indicate potential risks and hazards or specific information that illustrates or simplifies a procedure.

**Notes**

## Danger!

**DANGER indicates a direct hazard that will result in death or serious injury if not avoided.**

## Warning!

**WARNING indicates a potential hazard that can result in death, serious injury and/or material damage if not avoided.**

## Caution!

**CAUTION indicates a potential hazard that can result in personal injury and/or material damage if not avoided.**

## Note:

**NOTE without the use of the danger symbol indicates a possible hazard that can result in material damage if not avoided.**

The term "inverter" in the context of this manual refers to the control unit of the frequency inverter as defined by the NEC.
Only qualified personnel are permitted to install, operate, service and repair electrical devices. B&R assumes no responsibility for possible consequences resulting from the use of this product.

**PLEASE NOTE**

Only qualified personnel are permitted to install, operate, control and service electrical devices. B&R is not liable for any damage resulting from the use of this material.
Qualified personnel are employees who have skills and knowledge regarding the design and operation of this electrical equipment and installations and who have completed training to recognize and avoid potential hazards.

### Personnel qualifications

Work on and with this product is only permitted to be carried out by appropriately trained and authorized personnel who are familiar with the contents of this manual and all associated product documentation. In addition, such personnel must have participated in safety training to recognize and avoid the hazards associated with the use of this product. Personnel must have sufficient technical training, know-how and experience and be able to foresee and identify potential hazards that may arise from the use of the product, the changing of settings and the mechanical, electrical and electronic equipment of the entire system. All personnel working on and with the product must be familiar with all applicable standards, guidelines and accident prevention regulations.

### Intended use

This product is an inverter for three-phase synchronous and induction motors and designed for industrial use according to the specifications and instructions in this manual. When using the product, all relevant safety regulations and guidelines as well as the specified requirements and technical data must be observed. The product must be installed outside the ATEX zone. Before use, a risk assessment must be carried out with regard to the intended application. Based on the results of this analysis, appropriate safety

measures must be implemented. Since the product is used as a component of a complete system, personal safety must be ensured by appropriate design of the complete system (for example, appropriate machine design). Any use other than that expressly permitted is prohibited and may present hazards. Only qualified personnel are permitted to install, operate, control and service electrical devices.

**Product-related information**

## Danger!

**RISK OF ELECTRIC SHOCK OR ARC AND RISK OF EXPLOSION**

- **Work on and with this drive system is only permitted to be carried out by appropriately trained and authorized personnel who are familiar with the contents of this manual and all associated product documentation and who have completed safety training to recognize and avoid the hazards involved. Installation, adjustment, repair and servicing must be carried out by qualified personnel.**
- **The system integrator is responsible for compliance with all relevant local and national electrical engineering requirements and any other applicable regulations regarding the protective grounding of all equipment.**
- **Many components of the product, including the printed circuits, are supplied by the mains voltage.**
- **Only use electrically insulated tools and measuring instruments with the correct rated voltage.**
- **Do not touch any unshielded components or terminals when voltage is applied.**
- **Motors can generate voltage when the shaft is rotated. Before performing any work on the drive system, secure the motor shaft against being driven by an external source.**
- **With AC voltage, voltage can be coupled out to unused conductors in the motor cable. Insulate unused conductors in the motor cable at both ends.**
- **Do not short-circuit the DC bus terminals, the DC bus capacitors or the braking resistor terminals.**
- **Before performing any work on the drive system:**
  - **Disconnect all power supplies, including any external voltage to the control unit. Note that the circuit breaker or main power disconnect switch does not de-energize all circuits.**
  - **Affix a DO NOT SWITCH ON sign to all circuit breakers connected to the inverter system.**
  - **Lock all circuit breakers in the open position.**
  - **Wait 15 minutes to allow the DC bus capacitors to discharge.**
  - **Follow the instructions included in section "Checking for the absence of voltage" in the product installation instructions.**
- **Before switching on the power supply to the inverter system:**
  - **Ensure that work is completed and that there are no hazards resulting from installation.**
  - **If the mains input terminals and motor output terminals are grounded and shorted, remove the grounding and shorts circuits from the main input terminals and motor output terminals.**
  - **Ensure that all devices are properly grounded.**
  - **Ensure that all protective equipment such as covers, doors and screens are installed or closed.**
- **Install and close all covers before switching on the power supply.**

**Failure to follow these instructions will result in death or life-threatening injury.**

Inverter systems can cause unexpected movements due to incorrect wiring, incorrect settings, incorrect data other errors.

## Warning!

**UNINTENDED OPERATION OF THE EQUIPMENT**

- **All EMC requirements must be strictly observed during wiring.**
- **Operating the product using unknown or unsuitable settings or data is not permitted.**
- **Perform a comprehensive commissioning test.**

**Failure to follow these instructions can result in serious bodily injury and even death or damage to the material.**

Damaged products and accessories may cause electric shock or unexpected operation of the equipment.

## Danger!

**ELECTRIC SHOCK OR UNEXPECTED OPERATION OF THE EQUIPMENT**

**The use of damaged products or accessory products is not permitted.**

**Failure to follow these instructions will result in death or life-threatening injury.**

In the event of damage, contact your local B&R sales representative.

## Warning!

**LOSS OF CONTROL**

- **When developing a control plan, it is necessary to take into account possible error states of the control paths and provide means for certain critical control functions through which a safe state can be achieved after path failure. Examples of critical control functions include emergency switch-off, overrun stop, power failure and restart.**
- **Separate or redundant control paths must be provided for critical control functions.**
- **System control paths can include communication connections. The effects of unforeseen transfer delays or connection disruptions must be taken into account.**
- **All accident prevention regulations and local safety codes[1)] must be followed.**
- **Each implementation of the product must be individually and carefully tested for proper operation before being put into service.**

**Failure to follow these instructions can result in serious bodily injury and even death or damage to the material.**

## Note:

**IRREPARABLE DAMAGE DUE TO INCORRECT MAINS VOLTAGE**

- **Before switching on and configuring the product, it must be ensured that it is approved for the existing mains voltage.**

**Failure to follow these instructions can result in bodily injury or damage to devices.**

During operating, the products described in these instructions can reach temperatures above 80°C.

[1)] For the USA: For additional information, see NEMA ICS 1.1 (latest edition), "Safety guidelines for the application, installation and maintenance of solid-state control" and NEMA ICS 7.1 (latest edition), "Safety standards for construction and guide for selection, installation and operation of adjustable-speed drive systems".

## Warning!

**HOT SURFACES**

- **Avoid all contact with hot surfaces.**
- **Keep flammable or heat-sensitive parts away from the immediate vicinity of hot surfaces.**
- **Before handling the product, ensure that it has cooled down sufficiently.**
- **Ensure that there is sufficient heat dissipation by performing a test run at maximum load.**

**Failure to follow these instructions can result in serious bodily injury and even death or damage to the material.**

The product is approved for use outside danger zones (explosive atmospheres). Install the device only in areas free of hazardous atmospheres.

## Danger!

**RISK OF EXPLOSION**

**Install and use this device only outside danger zones.**

**Failure to follow these instructions will result in death or serious injury.**

Machines, controllers and associated devices are usually integrated into the network. Unauthorized persons and malware can gain access to the machine or other devices on the machine's network/fieldbus and connected networks via insufficiently secured access to software and networks.

## Warning!

**UNAUTHORIZED ACCESS TO THE MACHINE VIA SOFTWARE AND NETWORK**

**In your hazard and risk analysis, take into account all dangers that may arise by accessing and operating the network/fieldbus and develop a suitable cybersecurity concept.**

**Ensure that the hardware and software infrastructure into which the machine will be integrated, as well as the organizational policies and guidelines, cover access to this infrastructure by taking into account the results of the hazard and risk analysis, that they are implemented according to best practices and standards and that they address IT and cybersecurity concerns (e.g. ISO/IEC 27000 for common criteria for assessing the security of information technology systems, ISO/IEC 15408, IEC 62351, ISA/IEC 62443, NIST Cybersecurity Framework, Information Security Forum - "Standard of good practice for information security").**

**Ensure the effectiveness of your IT and cybersecurity system by using appropriate, proven methods.**

**Failure to follow these instructions can result in death, serious injury or damage to property.**

## Warning!

**LOSS OF CONTROL**

**Perform a comprehensive commissioning test to ensure that the communication monitoring system properly detects communication interruptions.**

**Failure to follow these instructions can result in death, serious injury or damage to property.**

# 2 General information

This chapter describes the manual. It contains a workflow with the steps for checking the content of delivery as well as installing and commissioning the frequency inverter. The workflow refers to chapters and sections in this and other manuals.

## 2.1 Audience

This manual is intended for persons responsible for the installation planning, installation, commissioning, operation and servicing of the frequency inverter. Read this manual carefully before working on and with the frequency inverter. The reader must have knowledge of electrical engineering, wiring, electrical components and the use of symbols in circuit diagrams.

This manual is used worldwide. SI and American/British unit of measurement are specified.

## 2.2 Contents of this manual

This manual contains instructions and information for the basic configuration of the frequency inverter. The contents of the chapters of this manual are briefly described below.

"Safety information" contains the safety guidelines for the installation, commissioning, operation and servicing of the frequency inverter.

"General information" contains an introduction to this manual.

"Operating principle and hardware description" contains a description of the frequency inverter.

"Mechanical installation" contains a description of how to mechanically install the frequency inverter with its standard features.

"Planning the electrical installation" contains instructions for connecting the motor and selecting cables as well as protective measures and cable routing.

"Electrical installation" contains instructions for wiring the frequency inverter.

"Installation checklist" contains a list for checking the mechanical and electrical installation of the frequency inverter.

"Commissioning" contains the description of the procedure for commissioning the frequency inverter.

"Warning and fault messages" contains a description of troubleshooting the frequency inverter.

"Servicing" contains instructions for preventive maintenance.

"Technical data" contains the technical specifications of the frequency inverter, e.g. nominal data, dimensions, dimensional drawings, technical requirements and conditions for meeting the requirements for CE and other marks.

"Function "Safe Torque Off"" describes function "Safe Torque Off" and provides instructions for its implementation.

"Rheostatic braking" explains the selection, protection and wiring of brake choppers and resistors. This chapter also contains technical data.

## 2.3 Classification according to size and options

The instructions, technical data and dimensional drawings concerning only certain frequency inverter sizes are marked with the frame size designation (R1, R2, etc.). The size is specified on the nameplate of the frequency inverter. Selectable options are listed in section "Order key" on page 19.

## 2.4 Workflow for installation, commissioning and operation

| Procedure | Task | Note |
|---|---|---|
| 1 | Plan the electrical installation and obtain the necessary accessories (cables, fuses, etc.).<br>Check the nominal data, required cooling air volume, mains connection, compatibility of the motor, motor connection and other technical data. | See section "Planning the electrical installation" on page 173 and chapter "Technical data" on page 20. |
| 2 | Check the installation site. | See section "Ambient conditions" on page 35. |
| 3 | Unpack and check the devices. (Only properly functioning devices are permitted to be put into operation.)<br>Check whether all required optional modules and devices are complete and in a properly functioning state.<br>Install the frequency inverter. | See section "Mechanical installation" on page 163.<br>If the frequency inverter has not been in operation for more than one year, the capacitors of the DC bus must be reformed ("Capacitors" on page 360). |
| 4 | Route the cables. | See section "Routing the cables" on page 179. |
| 5 | Check the insulation of the mains connection cables, motor and motor cable. | See section "Checking the insulation of the assembly" on page 187. |
| 6 | Connect the power cables.<br>Connect the control cables. | See section "Connecting the power cables" on page 189.<br>See section "Connecting the control cables" on page 203. |
| 7 | Check the installation. | See section "Installation checklist" on page 209. |
| 8 | Switch on the frequency inverter. | See section "Commissioning" on page 211. |
| 9 | Check the functions of the frequency inverter: "Start", "Stop", "Speed control", etc. | See the enclosed quick guide for commissioning and "The drive" on page 228. |

## 2.5 Terminology and abbreviations

| Term/Abbreviation | Description |
|---|---|
| EMC | Electromagnetic compatibility |
| EMI | Electromagnetic interference |
| EMT | Metal cable tube |
| Size | Physical size of the frequency inverter |
| IGBT | Insulated gate bipolar transistor, a voltage-controlled power semiconductor type used in frequency inverters because of its easy controllability and high switching frequency. |
| I/O | Input/Output |
| ZCON | Control and I/O unit with the control program. |
| ZCU | Control and I/O unit built into a housing. The external I/O control signals are connected to the control unit, or the optional I/O expansion modules are installed on it. |
| ZGAB | Brake chopper adapter card in sizes R6 to R7 |
| ZGAD | Gate driver adapter card in sizes R6 to R7 |
| ZINT | Main electronic board |
| ZMU | Memory unit in the control unit of the frequency inverter |
| R1...R7 | Size designation of the frequency inverter |

## 2.6 Operating principle and hardware description

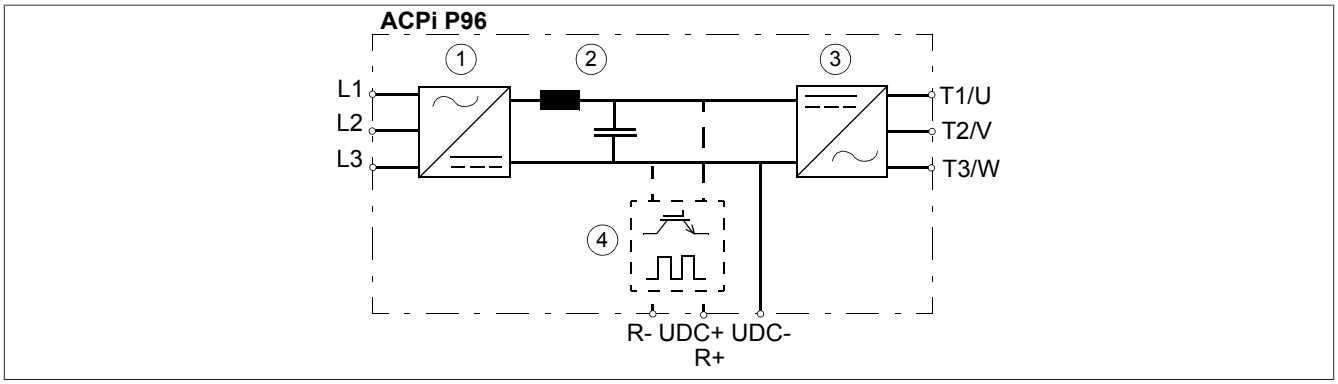
This chapter contains the description of the operating principle and structure of the frequency inverter.

### 2.6.1 Product overview

The ACOPOSinverter P96 is a frequency inverter for controlling induction motors, permanent magnet synchronous motors and induction servo motors. The main fan of the frequency inverter is speed-controlled, and the auxiliary fan has on/off control.

#### 2.6.1.1 Main circuit

The following figure shows the main circuit of the frequency inverter:



| Number | Description |
|---|---|
| 1 | The rectifier converts alternating current and voltage into direct current and voltage. |
| 2 | DC bus between rectifier and inverter. |
| 3 | The inverter converts direct current and voltage into alternating current and voltage. |
| 4 | If required, the brake chopper routes the excess energy from the DC bus of the frequency inverter to the braking resistor. The chopper operates if the DC bus voltage exceeds a certain maximum value. The voltage rise is normally caused by the braking of a motor with a high mass moment of inertia. The braking resistors are installed by the user if required. |

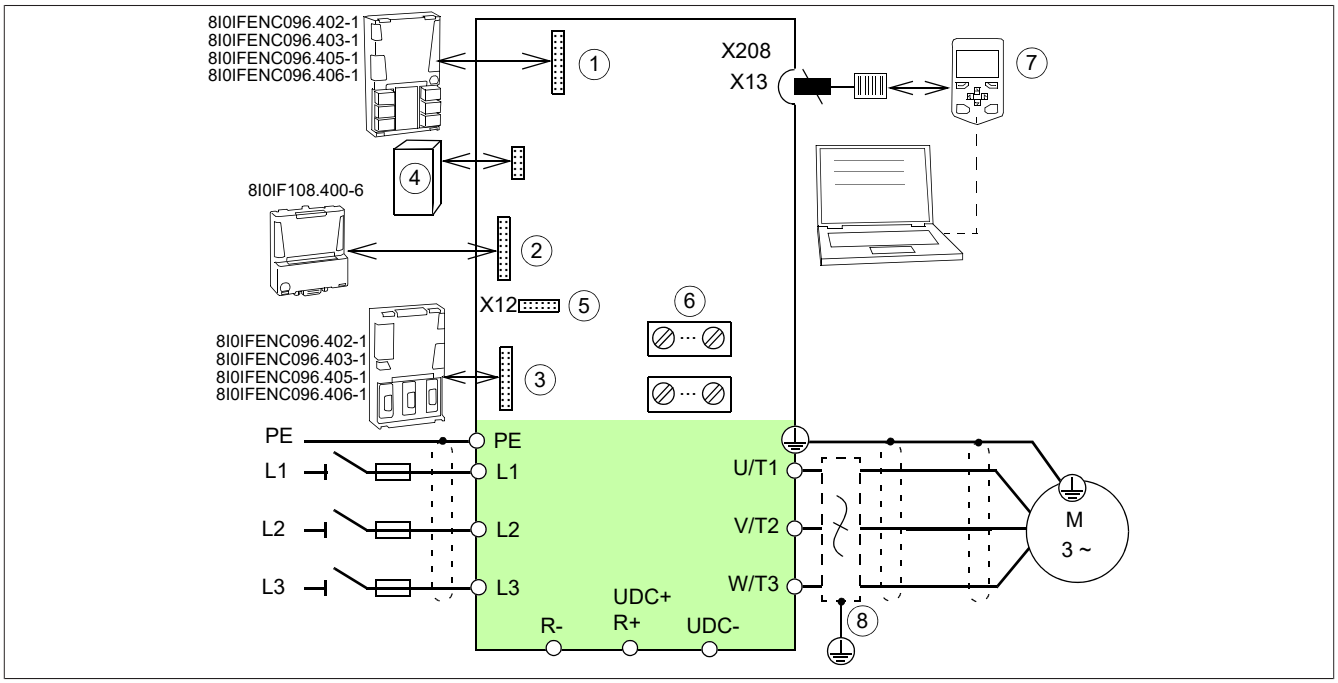
### 2.6.1.2 Design

The figure shows the components of the ACOPOSinverter P96 (view of size R5).

1 Control panel (optional)
2 Front cover
3 Four mounting points on the back of the device
4 Heat sink
5 Lifting lugs

### 2.6.1.3 Overview of power and control connections

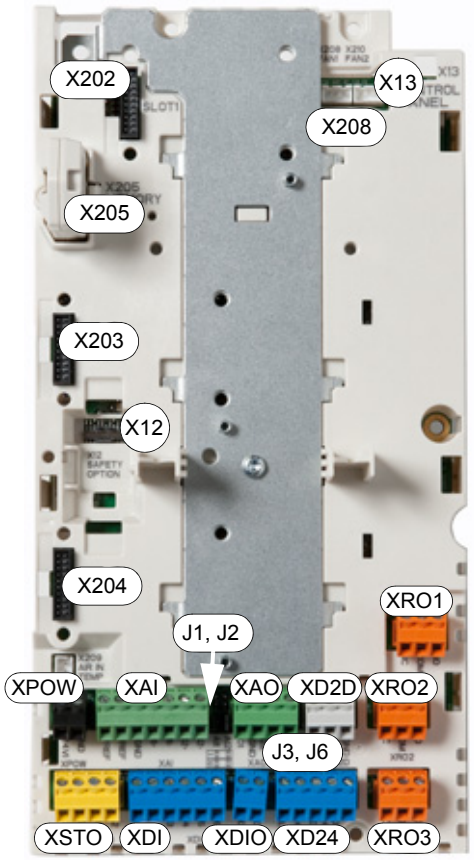
The figure shows the power connections and control interfaces of the frequency inverter.



| Number | Description |
|---|---|
| 1 - 3 | Analog and digital I/O expansion modules, rotary encoder interface modules and fieldbus communication modules can be connected to slots 1, 2 and 3.<br>Fieldbus communication module 8I0IF108.400-6 is only permitted to be connected in slot 2! |
| 4 | Memory Unit (included with delivery) |
| 5 | Connection for safety function modules |
| 6 | See sections "External control connections" on page 17, "Default I/O connection diagram" on page 203 and "Connection data of the control unit (ZCU-12)" on page 34. |
| 7 | See section "Optional control panel" on page 18. |
| 8 | dv/dt filter, common mode filter or sine wave filter (optional) |

### 2.6.1.3.1 External control connections

The following figure shows the arrangement of the external control connections for the frequency inverter.




| Name | Description |
|---|---|
| XPOW | External voltage input |
| XAI | Analog inputs |
| XAO | Analog outputs |
| XD2D | Inverter-to-inverter connection (D2D) |
| XRO1 | Relay output 1 |
| XRO2 | Relay output 2 |
| XRO3 | Relay output 3 |
| XD24 | Start inhibition connection (DIIL) and +24 V output |
| XDIO | Digital inputs/outputs |
| XDI | Digital inputs |
| XSTO | Safe Torque Off (STO) |
| X12 | Connection for safety function modules (optional) |
| X13 | Control panel connection |
| X202 | Slot 1 |
| X203 | Slot 2 |
| X204 | Slot 3 |

| Name | Description |
|---|---|
| X205 | Connection for memory unit |
| X208 | Auxiliary fan connection |
| J1, J2 | Jumpers (J1, J2) for selecting the voltage/current on the analog inputs |
| J3, J6 | Jumper (J3) for the terminating resistor of the inverter-to-inverter connection (D2D), jumper (J6) for selecting the common ground of the digital inputs |

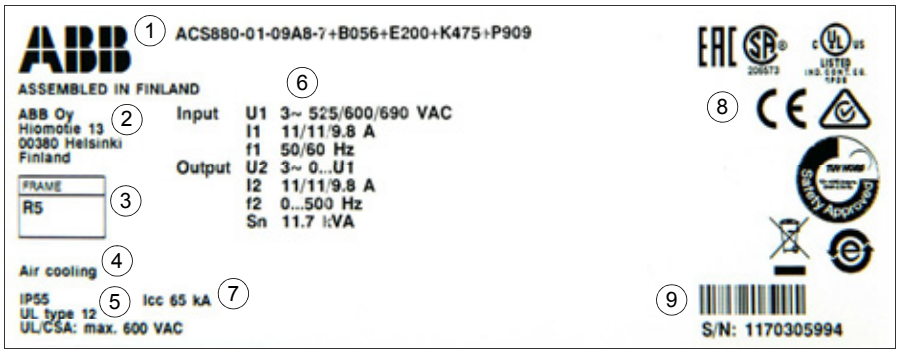
### 2.6.1.4 Optional control panel

By default, delivery is made without a control panel and the control panel bracket is covered. The LED status indicators on the bracket are visible through the protective cover.

The optionally available control panel can be removed from the front and reconnected in the reverse order. For use of the control panel, see "The drive" on page 228 or "8I0XD096.40x-1 control panels" on page 74.

## 2.6.2 Nameplate

The nameplate contains IEC and NEMA specifications, corresponding marks, type designation and a serial number that makes it possible to identify each individual unit. The nameplate is located on the front cover. The following figure shows an example of a nameplate.




| Number | Description |
|---|---|
| 1 | Type designation, see section "Order key" on page 19. |
| 2 | Manufacturing address |
| 3 | Size |
| 4 | Cooling method |
| 5 | Degree of protection |
| 6 | Nominal data in the input voltage range, see section "Nominal data" on page 24. |
| 7 | Short-circuit resistance, see section "Specification of the electrical network" on page 33. |
| 8 | Valid marks |
| 9 | Serial number. The first digit of the serial number specifies the manufacturing plant. The next four digits specify the year and week the units was manufactured. The last digits complete the serial number so that there are no two devices with the same number. |

## 2.6.3 Order key

| Product range | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | | | | | | | | | | | | | Motion product group |
| | Product family | | | | | | | | | | | | |
| | I | | | | | | | | | | | | ACOPOSinverter |
| | | Model | | | | | | | | | | | |
| | | 96 | | | | | | | | | | | ACOPOSinverter P96 |
| | | | Number of phases | | | | | | | | | | |
| | | | T | | | | | | | | | | 3-phase |
| | | | | Voltage range | | | | | | | | | |
| | | | | 4 | | | | | | | | | 380 to 500 V |
| | | | | | Nominal power | | | | | | | | |
| | | | | | 0-9 | | | | | | | | W x $10^5$ |
| | | | | | | 0-9 | | | | | | | W x $10^4$ |
| | | | | | | | 0-9 | | | | | | W x $10^3$ |
| | | | | | | | | 0-9 | | | | | W x $10^2$ |
| | | | | | | | | | 0-9 | | | | W x 10 |
| | | | | | | | | | | | Interface | | |
| | | | | | | | | | | . | 00 | | Without interface module |
| | | | | | | | | | | | | Version | |
| | | | | | | | | | | | | - | 000 Version |
| Examples | | | | | | | | | | | | | |
| 8 | I | 96 | T | 4 | 0 | 0 | 0 | 7 | 5 | . | 00 | - | 000 ACOPOSinverter P96, 3x 380 to 500 V, 0.75 kW, EMC filter and brake chopper integrated |

# 3 Technical data

This chapter contains the technical specifications of the frequency inverter, e.g. nominal data, dimensions, technical requirements and conditions for meeting the requirements for CE and other marks.

## 3.1 ACOPOSinverter P96 frequency inverter 8I96

### 3.1.1 Order data

#### Size R1 (0.75 to 5.5 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T400075.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 0.75 kW, EMC filter and brake chopper integrated | |
| 8I96T400110.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 1.1 kW, EMC filter and brake chopper integrated | |
| 8I96T400150.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 1.5 kW, EMC filter and brake chopper integrated | |
| 8I96T400220.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 2.2 kW, EMC filter and brake chopper integrated | |
| 8I96T400300.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 3 kW, EMC filter and brake chopper integrated | |
| 8I96T400400.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 4 kW, EMC filter and brake chopper integrated | |
| 8I96T400550.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 5.5 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR080.000-1 | ACOPOSinverter P96 Bremswiderstand 80 Ohm, kontinuierliche Bremsleistung 0,14kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.004-1 | 4 A sine filter for ACOPOSinverter P96 3-phase. | |
| 8I0ST096.006-1 | 6 A sine filter for ACOPOSinverter P96 3-phase. | |
| 8I0ST096.011-1 | 11 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.016-1 | 16 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 1: 8I96T400075.00-000, 8I96T400110.00-000, 8I96T400150.00-000, 8I96T400220.00-000, 8I96T400300.00-000, 8I96T400400.00-000, 8I96T400550.00-000 - Order data

## Size R2 (7.5 to 11 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T400750.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 7.5 kW, EMC filter and brake chopper integrated | |
| 8I96T401100.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 11 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR044.000-1 | ACOPOSinverter P96 Bremswiderstand 44 Ohm, kontinuierliche Bremsleistung 1 kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.016-1 | 16 A sine filter for ACOPOSinverter P96 3-phase. | |
| 8I0ST096.025-1 | 25 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.030-1 | 30 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 2: 8I96T400750.00-000, 8I96T401100.00-000 - Order data

## Size R3 (15 to 18.5 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T401500.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 15 kW, EMC filter and brake chopper integrated | |
| 8I96T401850.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 18.5 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR022.000-1 | ACOPOSinverter P96 Bremswiderstand 22 Ohm, kontinuierliche Bremsleistung 2 kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.033-1 | 33 A sine filter for ACOPOSinverter P96 3-phase. | |
| 8I0ST096.050-1 | 50 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.070-1 | 70 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 3: 8I96T401500.00-000, 8I96T401850.00-000 - Order data

## Size R4 (22 to 30 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T402200.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 22 kW, EMC filter and brake chopper integrated | |
| 8I96T403000.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 30 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR013.000-1 | ACOPOSinverter P96 Bremswiderstand 13 Ohm, kontinuierliche Bremsleistung 2 kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.050-1 | 50 A sine filter for ACOPOSinverter P96 3-phase. | |
| 8I0ST096.066-1 | 66 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.070-1 | 70 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 4: 8I96T402200.00-000, 8I96T403000.00-000 - Order data

## Size R5 (37 to 45 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T403700.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 37 kW, EMC filter and brake chopper integrated | |
| 8I96T404500.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 45 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR008.003-1 | ACOPOSinverter P96 Bremswiderstand 8 Ohm, kontinuierliche Bremsleistung 4,5 kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.066-1 | 66 A sine filter for ACOPOSinverter P96 3-phase. | |
| 8I0ST096.075-1 | 75 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.120-1 | 120 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 5: 8I96T403700.00-000, 8I96T404500.00-000 - Order data

### Size R6 (55 to 75 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T405500.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 55 kW, EMC filter and brake chopper integrated | |
| 8I96T407500.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 75 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Common mode filters** | |
| 8I0CF096.406-1 | Common Mode Filter für ACOPOSinverter P96 Baugröße R6 55kW - 75kW. | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR006.000-1 | ACOPOSinverter P96 Bremswiderstand 6 Ohm, kontinuierliche Bremsleistung 6 kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.130-1 | 130 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.120-1 | 120 A dv/dt filter for ACOPOSinverter P96 3-phase. | |
| 8I0DT096.260-1 | 260 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 6: 8I96T405500.00-000, 8I96T407500.00-000 - Order data

### Size R7 (90 to 110 kW)

| Order number | Short description | Figure |
|---|---|---|
| | **ACOPOSinverter P96 - 3-phase 380 to 500 V** | |
| 8I96T409000.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 90 kW, EMC filter and brake chopper integrated | |
| 8I96T411000.00-000 | ACOPOSinverter P96, 3x 380 to 500 V, 110 kW, EMC filter and brake chopper integrated | |
| | **Required accessories** | |
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |
| | **Optional accessories** | |
| | **Common mode filters** | |
| 8I0CF096.407-1 | Common Mode Filter für ACOPOSinverter P96 Baugröße R7 90kW - 110kW. | |
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |
| | **Optional braking resistors** | |
| 8I0BR004.001-1 | ACOPOSinverter P96 Bremswiderstand 4 Ohm, kontinuierliche Bremsleistung 9 kW, 3x 380 bis 500V | |
| | **Sine filters** | |
| 8I0ST096.162-1 | 162 A sine filter for ACOPOSinverter P96 3-phase. | |
| | **dU/dT filters** | |
| 8I0DT096.260-1 | 260 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 7: 8I96T409000.00-000, 8I96T411000.00-000 - Order data

## 3.1.2 Dimensions, weight and space requirements

### Device dimensions

| Size | IP20 | | | | UL open type | | | |
|---|---|---|---|---|---|---|---|---|
| | Height mm | Width mm | Depth mm | Weight kg | Height in. | Width in. | Depth in. | Weight lb |
| R1 | 376 | 155 | 226 | 6.1 | 14.8 | 6.1 | 8.91 | 13 |
| R2 | 376 | 155 | 249 | 7.6 | 14.8 | 6.1 | 9.82 | 17 |
| R3 | 436 | 173 | 261 | 9.9 | 17.17 | 6.81 | 10.29 | 22 |

| Size | IP20 | | | | UL open type | | | |
|---|---|---|---|---|---|---|---|---|
| | Height mm | Width mm | Depth mm | Weight kg | Height in. | Width in. | Depth in. | Weight lb |
| R4 | 563 | 203 | 274 | 16.8 | 22.17 | 7.99 | 10.8 | 37 |
| R5 | 653 | 203 | 274 | 20.2 | 25.70 | 7.99 | 10.77 | 45 |
| R6 | 593 | 252 | 357 | 39.8 | 22.35 | 9.92 | 14.07 | 88 |
| R7 | 645 | 284 | 365 | 48.6 | 25.39 | 11.18 | 14.35 | 107 |

**Note:**

**For additional information about dimensions, see section "Dimensional drawings" on page 41.**

### 3.1.2.1 Required spacing

200 mm (7.87 in.) Installation clearance is required on the top of the frequency inverter.

300 mm (11.81 in.) Installation clearance (measured from the bottom of the frequency inverter without cable connection box) is required on the bottom of the frequency inverter.

### Package dimensions

| Size | Packaging | | |
|---|---|---|---|
| | Length mm | Width mm | Height mm |
| R1 | 574 | 256 | 281 |
| R2 | 574 | 256 | 304 |
| R3 | 624 | 256 | 316 |
| R4 | 691 | 290 | 329 |
| R5 | 896 | 293 | 329 |
| R6 | 870 | 325 | 580 |
| R7 | 992 | 400 | 568 |

## 3.1.3 Nominal data

The nominal data of the frequency inverters is valid for nominal frequencies of 50 Hz ... 60 Hz and an ambient temperature of 40°C (104°F).

### $U_N$ = 400 V

| Frequency inverters | Size | IEC nominal data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Nominal input current | Nominal output data | | | | | | | |
| | | | Normal operation | | | | Light over-load operation | | Overload operation | |
| | | $I_1$ | $I_{max}$ | $I_2$ | $P_N$ | $S_N$ | $I_{Ld}$ | $P_{Ld}$ | $I_{Hd}$ | $P_{Hd}$ |
| | | A | A | A | kW | kVA | A | kW | A | kW |
| 8I96T400075.00-000 | R1 | 2.1 | 3.1 | 2.1 | 0.75 | 1.8 | 2 | 0.55 | 1.7 | 0.55 |
| 8I96T400110.00-000 | R1 | 3 | 4.1 | 3 | 1.1 | 2.6 | 2.8 | 1.1 | 2.1 | 0.75 |
| 8I96T400150.00-000 | R1 | 3.4 | 5.6 | 3.4 | 1.1 | 2.9 | 3.2 | 1.1 | 3 | 1.1 |
| 8I96T400220.00-000 | R1 | 4.8 | 6.8 | 4.8 | 1.5 | 4.2 | 4.6 | 1.5 | 3.4 | 1.1 |
| 8I96T400300.00-000 | R1 | 5.2 | 9.5 | 5.2 | 2.2 | 4.5 | 5 | 2.2 | 4.8 | 1.5 |
| 8I96T400400.00-000 | R1 | 7.6 | 12.2 | 7.6 | 3 | 6.6 | 7.2 | 3 | 5.2 | 2.2 |
| 8I96T400550.00-000 | R1 | 11 | 16 | 11 | 4 | 9.5 | 10.4 | 4 | 7.6 | 3 |
| 8I96T400750.00-000 | R2 | 14 | 21 | 14 | 5.5 | 12 | 13 | 5.5 | 11 | 4 |
| 8I96T401100.00-000 | R2 | 21 | 29 | 21 | 7.5 | 18 | 19 | 7.5 | 14 | 5.5 |
| 8I96T401500.00-000 | R3 | 27 | 42 | 27 | 11 | 23 | 26 | 11 | 21 | 7.5 |
| 8I96T401850.00-000 | R3 | 34 | 54 | 34 | 15 | 29 | 32 | 15 | 27 | 11 |
| 8I96T402200.00-000 | R4 | 40 | 64 | 40 | 18.5 | 35 | 38 | 18.5 | 34 | 15 |
| 8I96T403000.00-000 | R4 | 52 | 76 | 52 | 22 | 45 | 49 | 22 | 40 | 18.5 |
| 8I96T403700.00-000 | R5 | 65 | 104 | 65 | 30 | 56 | 62 | 30 | 52 | 22 |
| 8I96T404500.00-000 | R5 | 77 | 122 | 77 | 37 | 67 | 73 | 37 | 65 | 30 |
| 8I96T405500.00-000 | R6 | 96 | 148 | 96 | 45 | 83 | 91 | 45 | 77 | 37 |
| 8I96T407500.00-000 | R6 | 124 | 178 | 124 | 55 | 107 | 118 | 55 | 96 | 45 |
| 8I96T409000.00-000 | R7 | 156 | 247 | 156 | 75 | 135 | 148 | 75 | 124 | 55 |
| 8I96T411000.00-000 | R7 | 180 | 287 | 180 | 90 | 156 | 171 | 90 | 156 | 75 |

$U_N$ Nominal voltage of the frequency inverter
$I_1$ Nominal input current (eff.)
$I_2$ Nominal output current (continuous operation, without overload)
$P_N$ Typical motor power without overload
$I_{LD}$ Continuous output current (RMS value). 10% overload permitted every 5 minutes for a duration of one minute.
$P_{Ld}$ Typical motor power during light overload operation
$I_{max}$ Maximum output current. Possible for 10 seconds during startup, then as long as the frequency inverter temperature allows.
$I_{Hd}$ Continuous output current (RMS value). 50% overload permitted every 5 minutes for a duration of one minute.
$P_{Hd}$ Typical motor power during overload operation.

## $U_N$ = 500 V

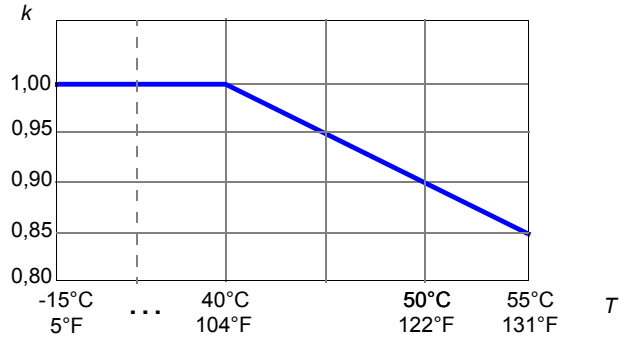
| Frequency inverters | Size | Nominal input current | IEC nominal data | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nominal output data | | | | | | | |
| | | | Normal operation | | | | Light over-load operation | | Overload operation | |
| | | $I_1$ | $I_{max}$ | $I_2$ | $P_N$ | $S_N$ | $I_{Ld}$ | $P_{Ld}$ | $I_{Hd}$ | $P_{Hd}$ |
| | | A | A | A | kW | kVA | A | kW | A | kW |
| 8I96T400075.00-000 | R1 | 2.1 | 3.1 | 2.1 | 0.75 | 1.8 | 2 | 0.75 | 1.7 | 0.55 |
| 8I96T400110.00-000 | R1 | 3 | 4.1 | 3 | 1.1 | 2.6 | 2.8 | 1.1 | 2.1 | 0.75 |
| 8I96T400150.00-000 | R1 | 3.4 | 5.6 | 3.4 | 1.5 | 2.9 | 3.2 | 1.5 | 3 | 1.1 |
| 8I96T400220.00-000 | R1 | 4.8 | 6.8 | 4.8 | 2.2 | 4.2 | 4.6 | 2.2 | 3.4 | 1.1 |
| 8I96T400300.00-000 | R1 | 5.2 | 9.5 | 5.2 | 3 | 4.5 | 5 | 3 | 4.8 | 1.5 |
| 8I96T400400.00-000 | R1 | 7.6 | 12.2 | 7.6 | 4 | 6.6 | 7.2 | 4 | 5.2 | 2.2 |
| 8I96T400550.00-000 | R1 | 11 | 16 | 11 | 5.5 | 9.5 | 10.4 | 5.5 | 7.6 | 3 |
| 8I96T400750.00-000 | R2 | 14 | 21 | 14 | 7.5 | 12 | 13 | 7.5 | 11 | 4 |
| 8I96T401100.00-000 | R2 | 21 | 29 | 21 | 11 | 18 | 19 | 11 | 14 | 5.5 |
| 8I96T401500.00-000 | R3 | 27 | 42 | 27 | 15 | 23 | 26 | 15 | 21 | 7.5 |
| 8I96T401850.00-000 | R3 | 34 | 54 | 34 | 18.5 | 29 | 32 | 18.5 | 27 | 11 |
| 8I96T402200.00-000 | R4 | 40 | 64 | 40 | 22 | 35 | 38 | 22 | 34 | 15 |
| 8I96T403000.00-000 | R4 | 52 | 76 | 52 | 30 | 45 | 49 | 30 | 40 | 18.5 |
| 8I96T403700.00-000 | R5 | 65 | 104 | 65 | 37 | 56 | 62 | 37 | 52 | 22 |
| 8I96T404500.00-000 | R5 | 77 | 122 | 77 | 45 | 67 | 73 | 45 | 65 | 30 |
| 8I96T405500.00-000 | R6 | 96 | 148 | 96 | 55 | 83 | 91 | 55 | 77 | 37 |
| 8I96T407500.00-000 | R6 | 124 | 178 | 124 | 75 | 107 | 118 | 75 | 96 | 45 |
| 8I96T409000.00-000 | R7 | 156 | 247 | 156 | 90 | 135 | 148 | 90 | 124 | 55 |
| 8I96T411000.00-000 | R7 | 180 | 287 | 180 | 110 | 156 | 171 | 110 | 156 | 75 |

$U_N$ Nominal voltage of the frequency inverter
$I_1$ Nominal input current (eff.)
$I_2$ Nominal output current (continuous operation, without overload)
$P_N$ Typical motor power without overload
$I_{LD}$ Continuous output current (RMS value). 10% overload permitted every 5 minutes for a duration of one minute.
$P_{Ld}$ Typical motor power during light overload operation
$I_{max}$ Maximum output current. Possible for 10 seconds during startup, then as long as the frequency inverter temperature allows.
$I_{Hd}$ Continuous output current (RMS value). 50% overload permitted every 5 minutes for a duration of one minute.
$P_{Hd}$ Typical motor power during overload operation.

## 3.1.4 Derating

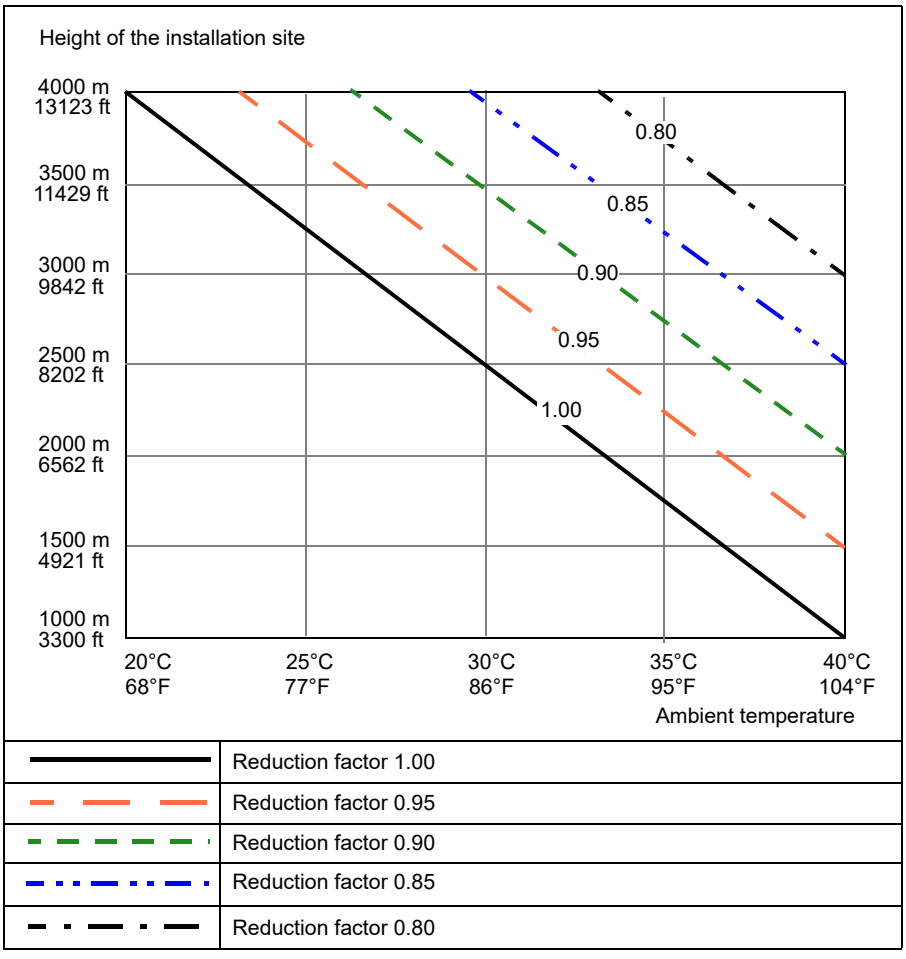
### 3.1.4.1 Derating depending on ambient temperature

In the temperature range 40 - 55°C (104 - 131°F), the output current must be reduced by 1% per 1°C (1.8°F) higher temperature. The output current can be calculated by multiplying the current specified in the nominal data table by the derating factor (k):




### 3.1.4.2 Derating at higher installation elevations

At installation elevations of 1000 to 4000 m (3300 to 13123 ft) above sea level, the reduction is 1% per additional 100 m (328 ft). If the ambient temperature is below 40°C (104°F), derating can be reduced by 1.5% for each 1°C (1.8°F) reduction in temperature. Some curves for elevation-based derating are shown below.




Derating based on installation elevation can be reduced at ambient temperatures below 40°C. At a temperature of 30°C, for example, the derating factor is 1-1.5% · 10 = 0.85. At 4000 meters above sea level, the output current can be reduced by 35% instead of 40%.

### 3.1.4.3 Current reduction with specific settings in the control program of the frequency inverter

When selecting specific settings in the control program of the frequency inverter, it may be necessary to reduce the output current.

#### 3.1.4.3.1 High speed mode

High speed mode is enabled at the factory. The max. output frequency possible is 500 Hz.

The following current reductions result from output frequencies between 120 and 500 Hz:

| Frequency inverters | Nominal output data in high speed mode | | | |
|---|---|---|---|---|
| | Max. output frequency | Normal operation | Light overload | Overload operation |
| | $f_{max}$ | $I_N$ | $I_{Ld}$ | $I_{Hd}$ |
| | Hz | A | A | A |
| 8I96T400075.00-000 | 500 | 1.8 | 1.7 | 1.4 |
| 8I96T400110.00-000 | 500 | 2.6 | 2.5 | 1.8 |
| 8I96T400150.00-000 | 500 | 2.9 | 2.8 | 2.6 |
| 8I96T400220.00-000 | 500 | 4.1 | 3.9 | 2.9 |
| 8I96T400300.00-000 | 500 | 4.4 | 4.2 | 4.1 |
| 8I96T400400.00-000 | 500 | 6.5 | 6.2 | 4.4 |
| 8I96T400550.00-000 | 500 | 9.4 | 8.9 | 6.5 |
| 8I96T400750.00-000 | 500 | 12 | 11.4 | 9.4 |
| 8I96T401100.00-000 | 500 | 18 | 17.1 | 12 |
| 8I96T401500.00-000 | 500 | 23 | 21.9 | 18 |
| 8I96T401850.00-000 | 500 | 29 | 28 | 23 |
| 8I96T402200.00-000 | 500 | 29 | 28 | 23 |
| 8I96T403000.00-000 | 500 | 37 | 35 | 29 |
| 8I96T403700.00-000 | 500 | 39 | 37 | 33 |
| 8I96T404500.00-000 | 500 | 46 | 44 | 39 |
| 8I96T405500.00-000 | 500 | 58 | 55 | 46 |
| 8I96T407500.00-000 | 500 | 74 | 70 | 58 |
| 8I96T409000.00-000 | 500 | 122 | 116 | 74 |
| 8I96T411000.00-000 | 500 | 140 | 133 | 122 |

$f_{max}$ Maximum output frequency in high speed mode
$U_N$ Nominal voltage of the frequency inverter
$I_N$ Continuous output current (RMS value). No overload operation at 40°C (104°F).
$I_{Ld}$ Continuous output current (RMS value). 10% overload permitted every 5 minutes for a period of one minute.
$I_{Hd}$ Continuous output current (RMS value). 50% overload permitted every 5 minutes for a period of one minute.

### 3.1.5 Fuses (IEC)

The gG and aR fuses for short-circuit protection of the power cable or frequency inverter are listed below. Other fuse types can also be used for sizes R1 to R7 if their response time is sufficiently short. The response time depends on the network impedance and the cross section, material and length of the supply cables.

B&R recommends high-speed (aR) fuses for sizes R7, see section "Quick guide for selecting alternative gG and aR fuses" on page 29.

**Note:**

**See also "Implementing thermal overload and short-circuit protection" on page 180.**

**Note:**

**Fuses with a higher nominal current than recommended are not permitted to be used. Fuses with a lower nominal current are permitted to be used.**

**Note:**

**Fuses from other manufacturers can be used if they comply with the characteristic values and the melting curve of the other fuse does not exceed the melting curve of the fuses specified in the table.**

#### 3.1.5.1 aR fuses

| High-speed fuses (aR) (one fuse per phase) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency inverters | Size | Min. short-circuit current [1] | Input current | Fuse | | | | | |
| | | A | A | A | $A^2s$ | V | Manufacturer | Type | Type IEC 60269 |
| 8I96T400075.00-000 | R1 | 65 | 2.1 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400110.00-000 | R1 | 65 | 3 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400150.00-000 | R1 | 65 | 3.4 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400220.00-000 | R1 | 65 | 4.8 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400300.00-000 | R1 | 65 | 5.2 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400400.00-000 | R1 | 65 | 7.6 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400550.00-000 | R1 | 65 | 11 | 25 | 130 | 690 | Bussmann | 170M1561 | 000 |
| 8I96T400750.00-000 | R2 | 120 | 14 | 40 | 460 | 690 | Bussmann | 170M1563 | 000 |
| 8I96T401100.00-000 | R2 | 120 | 21 | 40 | 460 | 690 | Bussmann | 170M1563 | 000 |
| 8I96T401500.00-000 | R3 | 170 | 27 | 63 | 1450 | 690 | Bussmann | 170M1565 | 000 |
| 8I96T401850.00-000 | R3 | 170 | 34 | 63 | 1450 | 690 | Bussmann | 170M1565 | 000 |
| 8I96T402200.00-000 | R4 | 280 | 40 | 80 | 2550 | 690 | Bussmann | 170M1566 | 000 |
| 8I96T403000.00-000 | R4 | 300 | 52 | 100 | 4650 | 690 | Bussmann | 170M1567 | 000 |
| 8I96T403700.00-000 | R5 | 480 | 65 | 125 | 8500 | 690 | Bussmann | 170M1568 | 000 |
| 8I96T404500.00-000 | R5 | 480 | 77 | 160 | 16000 | 690 | Bussmann | 170M1569 | 000 |
| 8I96T405500.00-000 | R6 | 1000 | 96 | 250 | 28500 | 690 | Bussmann | 170M3816 | 1 |
| 8I96T407500.00-000 | R6 | 1280 | 124 | 315 | 46500 | 690 | Bussmann | 170M3817 | 1 |
| 8I96T409000.00-000 | R7 | 1610 | 156 | 400 | 74000 | 690 | Bussmann | 170M5808 | 2 |
| 8I96T411000.00-000 | R7 | 2210 | 180 | 500 | 155000 | 690 | Bussmann | 170M5810 | 2 |

1) Minimum short-circuit current of the installation.

#### 3.1.5.2 gG fuses

Using the time-current curve of the fuse, check whether the response time is less than 0.5 seconds. Follow local regulations.

| gG fuses (one fuse per phase) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency inverters | Size | Min. short-circuit current [1] | Input current | Fuse | | | | | |
| | | A | A | A | $A^2s$ | V | Manufacturer | Type | IEC size |
| 8I96T400075.00-000 | R1 | 17 | 2.1 | 4 | 53 | 500 | ABB | OFAF000H4 | 000 |
| 8I96T400110.00-000 | R1 | 40 | 3 | 6 | 110 | 500 | ABB | OFAF000H6 | 000 |
| 8I96T400150.00-000 | R1 | 40 | 3.4 | 6 | 110 | 500 | ABB | OFAF000H6 | 000 |
| 8I96T400220.00-000 | R1 | 80 | 4.8 | 10 | 355 | 500 | ABB | OFAF000H10 | 000 |
| 8I96T400300.00-000 | R1 | 80 | 5.2 | 10 | 355 | 500 | ABB | OFAF000H10 | 000 |
| 8I96T400400.00-000 | R1 | 120 | 7.6 | 16 | 700 | 500 | ABB | OFAF000H16 | 000 |
| 8I96T400550.00-000 | R1 | 120 | 11 | 16 | 700 | 500 | ABB | OFAF000H16 | 000 |
| 8I96T400750.00-000 | R2 | 200 | 14 | 25 | 2500 | 500 | ABB | OFAF000H25 | 000 |

| gG fuses (one fuse per phase) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Frequency inverters | Size | Min. short-circuit current [1] | Input current | Fuse | | | | | |
| | | A | A | A | $A^2s$ | V | Manufacturer | Type | IEC size |
| 8I96T401100.00-000 | R2 | 250 | 21 | 32 | 4500 | 500 | ABB | OFAF000H32 | 000 |
| 8I96T401500.00-000 | R3 | 350 | 27 | 40 | 7700 | 500 | ABB | OFAF000H40 | 000 |
| 8I96T401850.00-000 | R3 | 400 | 34 | 50 | 15400 | 500 | ABB | OFAF000H50 | 000 |
| 8I96T402200.00-000 | R4 | 500 | 40 | 63 | 21300 | 500 | ABB | OFAF000H63 | 000 |
| 8I96T403000.00-000 | R4 | 800 | 52 | 80 | 37000 | 500 | ABB | OFAF000H80 | 000 |
| 8I96T403700.00-000 | R5 | 1000 | 65 | 100 | 63600 | 500 | ABB | OFAF000H100 | 000 |
| 8I96T404500.00-000 | R5 | 1000 | 77 | 100 | 63600 | 500 | ABB | OFAF000H100 | 000 |
| 8I96T405500.00-000 | R6 | 1300 | 96 | 125 | 103000 | 500 | ABB | OFAF00H125 | 00 |
| 8I96T407500.00-000 | R6 | 1700 | 124 | 160 | 185000 | 500 | ABB | OFAF00H160 | 00 |
| 8I96T409000.00-000 | R7 | 3300 | 156 | 250 | 600000 | 500 | ABB | OFAF0H250 | 0 |
| 8I96T411000.00-000 | R7 | 5500 | 180 | 315 | 710000 | 500 | ABB | OFAF1H315 | 1 |

1) Minimum short-circuit current of the installation.

### 3.1.5.3 Quick guide for selecting alternative gG and aR fuses

The combinations (cable size, cable length, transformer size and fuse type) in this table meet the minimum requirements for proper functionality of the fuse. Use this table to select between gG and aR fuses, or calculate the short-circuit current of the installation according to the description in "Calculating the short-circuit current of the installation" on page 30.

| Frequency inverters | Cable type | | Infeed transformer - Minimum apparent power $S_N$ (kVA) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Copper | Aluminum | Maximum cable length for gG fuses | | | Maximum cable length for aR fuses | | |
| | $mm^2$ | $mm^2$ | 10 m | 50 m | 100 m | 10 m | 100 m | 200 m |
| 8I96T400075.00-000 | 3×1.5 | - | 1 | 1 | 1 | 3.9 | 4.1 | 5 |
| 8I96T400110.00-000 | 3×1.5 | - | 2.4 | 2.4 | 2.4 | 3.9 | 4.1 | 5 |
| 8I96T400150.00-000 | 3×1.5 | - | 2.4 | 2.4 | 2.4 | 3.9 | 4.1 | 5 |
| 8I96T400220.00-000 | 3×1.5 | - | 4.8 | 4.9 | 5.2 | 3.9 | 4.1 | 5 |
| 8I96T400300.00-000 | 3×1.5 | - | 4.8 | 4.9 | 5.2 | 3.9 | 4.1 | 5 |
| 8I96T400400.00-000 | 3×1.5 | - | 7.2 | 7.5 | 8.9 | 3.9 | 4.1 | 5 |
| 8I96T400550.00-000 | 3×1.5 | - | 7.2 | 7.5 | 8.9 | 3.9 | 4.1 | 5 |
| 8I96T400750.00-000 | 3×6 | - | 12 | 12 | 12 | 7.2 | 7.3 | 7.6 |
| 8I96T401100.00-000 | 3×6 | - | 15 | 15 | 16 | 7.2 | 7.3 | 7.6 |
| 8I96T401500.00-000 | 3×10 | - | 21 | 21 | 22 | 10 | 10 | 1 |
| 8I96T401850.00-000 | 3×10 | - | 24 | 24 | 25 | 10 | 10 | 11 |
| 8I96T402200.00-000 | 3×16 | 3×35 | 30 | 30 | 31 | 17 | 17 | 18 |
| 8I96T403000.00-000 | 3×25 | 3×35 | 48 | 49 | 51 | 18/ | 18 | 19 |
| 8I96T403700.00-000 | 3×35 | 3×50 | 60 | 61 | 63 | 29 | 29 | 30 |
| 8I96T404500.00-000 | 3×35 | 3×70 | 60 | 61 | 63 | 42 | 43 | 46 |
| 8I96T405500.00-000 | 3×50 | 3×70 | 78 | 80 | 83 | 60 | 63 | 67 |
| 8I96T407500.00-000 | 3×95 | 3×120 | 103 | 105 | 108 | 77 | 80 | 85 |
| 8I96T409000.00-000 | 3×120 | 3×150 | 200 | 209 | 224 | 97 | 102 | 109 |
| 8I96T411000.00-000 | 3×150 | 3×240 | 335 | 362 | 411 | 133 | 143 | 156 |

### 3.1.5.4 Calculating the short-circuit current of the installation

Check that the short-circuit current of the installation is at least equal to the value contained in the fuse table.

The short-circuit current of the installation can be calculated as follows:

$$I_{k2-ph} = \frac{U}{2.\sqrt{R_C{}^2 + (Z_k + X_C)^2}}$$

| Formula symbols | Description |
|---|---|
| $I_{k2-ph}$ | Short-circuit current for symmetrical two-phase short circuit |
| U | Mains line-to-line voltage (V) |
| $R_c$ | Cable resistance (ohm) |
| $Z_k$ | $Z_k = z_k \cdot U_N^2/S_N$ = Impedance of the transformer (ohm) |
| $z_k$ | Impedance of the transformer (%) |
| $U_N$ | Nominal voltage of the transformer (V) |
| $S_N$ | Nominal apparent power of the transformer (kVA) |
| $X_c$ | Cable resistance (ohm) |

**Calculation example**

**Frequency inverter:**

- 8I96T407500.00-000
- Supply voltage = 410 V

**Transformer:**

- Nominal power $S_N$ = 600 kVA
- Nominal voltage (supply voltage of the frequency inverter) $U_N$ = 430 V
- Transformer impedance $z_k$ = 7.2%

**Supply cable:**

- Length = 170 m
- Resistance/Length = 0.398 ohm/km
- Reactance/Length = 0.082 ohm/km

$$Z_k = z_k \,.\, \frac{U_N{}^2}{S_N} = 0.072 \,.\, \frac{(430\ V)^2}{600\ kVA} = 22.19\ mOhm$$

$$R_c = 170\ m \,.\, 0.398\ \frac{Ohm}{km} = 67.66\ mOhm$$

$$X_c = 170\ m \,.\, 0.082\ \frac{Ohm}{km} = 13.94\ mOhm$$

$$I_{k2-ph} = \frac{410\ V}{2 \,.\, \sqrt{(67.66\ mOhm)^2 + (22.19\ mOhm + 13.94\ mOhm)^2}} = 2.7\ kA$$

The calculated short-circuit current of 2.7 kA is higher than the minimum short-circuit current of gG fuse type OFAF00H160 (1700 A) of the frequency inverter. The 500 V gG type fuse can be used.

### 3.1.6 Fuses (UL)

UL class T fuses for branch circuit protection are listed below. Fast-acting T or faster fuses are required in the USA. **Using the time-current curve of the fuse, check whether the response time is under 0.5 seconds for devices of sizes R1 to R6 and for devices of sizes R7, under 0.1 seconds. Follow local regulations.**

**Note:**

**See also section "Implementing thermal overload and short-circuit protection" on page 180.**

**Note:**

**Fuses with a higher nominal current than recommended are not permitted to be used. Fuses with a lower nominal current are permitted to be used.**

**Note:**

**Fuses from other manufacturers can be used if they comply with the characteristic values and the melting curve of the other fuse does not exceed the melting curve of the fuses specified in the table.**

| Frequency inverters | Size | Input current | Fuse (one fuse per phase) | | | | |
|---|---|---|---|---|---|---|---|
| | | A | A | V | Manufacturer | Type | UL class |
| $U_N$ = 460 V | | | | | | | |
| 8I96T400075.00-000 | R1 | 2.1 | 3 | 600 | Bussmann | JJS-3 | T |
| 8I96T400110.00-000 | R1 | 3 | 6 | 600 | Bussmann | JJS-6 | T |
| 8I96T400150.00-000 | R1 | 3.4 | 6 | 600 | Bussmann | JJS-6 | T |
| 8I96T400220.00-000 | R1 | 4.8 | 10 | 600 | Bussmann | JJS-10 | T |
| 8I96T400300.00-000 | R1 | 5.2 | 10 | 600 | Bussmann | JJS-10 | T |
| 8I96T400400.00-000 | R1 | 7.6 | 15 | 600 | Bussmann | JJS-15 | T |
| 8I96T400550.00-000 | R1 | 11 | 20 | 600 | Bussmann | JJS-20 | T |
| 8I96T400750.00-000 | R2 | 14 | 25 | 600 | Bussmann | JJS-25 | T |
| 8I96T401100.00-000 | R2 | 21 | 35 | 600 | Bussmann | JJS-35 | T |
| 8I96T401500.00-000 | R3 | 27 | 40 | 600 | Bussmann | JJS-40 | T |
| 8I96T401850.00-000 | R3 | 34 | 50 | 600 | Bussmann | JJS-50 | T |
| 8I96T402200.00-000 | R4 | 40 | 60 | 600 | Bussmann | JJS-60 | T |
| 8I96T403000.00-000 | R4 | 52 | 80 | 600 | Bussmann | JJS-80 | T |
| 8I96T403700.00-000 | R5 | 65 | 90 | 600 | Bussmann | JJS-90 | T |
| 8I96T404500.00-000 | R5 | 77 | 110 | 600 | Bussmann | JJS-110 | T |
| 8I96T405500.00-000 | R6 | 96 | 150 | 600 | Bussmann | JJS-150 | T |
| 8I96T407500.00-000 | R6 | 124 | 200 | 600 | Bussmann | JJS-200 | T |
| 8I96T409000.00-000 | R7 | 156 | 225 | 600 | Bussmann | JJS-225 | T |
| 8I96T411000.00-000 | R7 | 180 | 300 | 600 | Bussmann | JJS-300 | T |

1) Minimum short-circuit current of the installation.

### 3.1.7 Power dissipation, cooling data and noise level

| Frequency inverters | Size | Airflow | | Power dissipation | Noise |
|---|---|---|---|---|---|
| | | $m^3/h$ | $ft^3/min$ | W | dB(A) |
| 8I96T400075.00-000 | R1 | 44 | 26 | 30 | 46 |
| 8I96T400110.00-000 | R1 | 44 | 26 | 40 | 46 |
| 8I96T400150.00-000 | R1 | 44 | 26 | 52 | 46 |
| 8I96T400220.00-000 | R1 | 44 | 26 | 73 | 46 |
| 8I96T400300.00-000 | R1 | 44 | 26 | 94 | 46 |
| 8I96T400400.00-000 | R1 | 44 | 26 | 122 | 46 |
| 8I96T400550.00-000 | R1 | 44 | 26 | 172 | 46 |
| 8I96T400750.00-000 | R2 | 88 | 52 | 232 | 51 |
| 8I96T401100.00-000 | R2 | 88 | 52 | 337 | 51 |
| 8I96T401500.00-000 | R3 | 134 | 79 | 457 | 57 |
| 8I96T401850.00-000 | R3 | 134 | 79 | 562 | 57 |
| 8I96T402200.00-000 | R4 | 134 | 79 | 667 | 62 |
| 8I96T403000.00-000 | R4 | 280 | 165 | 907 | 62 |
| 8I96T403700.00-000 | R5 | 280 | 165 | 1117 | 62 |
| 8I96T404500.00-000 | R5 | 280 | 165 | 1120 | 62 |
| 8I96T405500.00-000 | R6 | 435 | 256 | 1295 | 67 |
| 8I96T407500.00-000 | R6 | 435 | 256 | 1440 | 67 |
| 8I96T409000.00-000 | R7 | 450 | 265 | 1940 | 67 |
| 8I96T411000.00-000 | R7 | 450 | 265 | 2310 | 67 |

## 3.1.8 Terminal sizes and cable diameters for power cables

### 3.1.8.1 IEC

The sizes of the connecting bars for the supply, motor, resistor and DC cables, the permissible cable size (per phase) and tightening torques (T) are specified below. l indicates the stripped length in the terminal.

| Size | Cable grommets | | L1, L2, L3, T1/U, T2/V, T3/W | | | | Ground terminals | |
|---|---|---|---|---|---|---|---|---|
| | | Ø[1] | Wire cross section | T (wire terminal screw) | | l | Max. wire cross section | T |
| | St. | mm | mm² | M... | Nm | mm | mm² | Nm |
| R1 | 2 | 17 | 0.75…6 | - | 0.6 | 8 | 25 | 1.8 |
| R2 | 2 | 17 | 0.75…6 | - | 0.6 | 8 | 25 | 1.8 |
| R3 | 2 | 21 | 0.5…16 | - | 1.7 | 10 | 25 | 1.8 |
| R4 | 2 | 24 | 0.5…35 | - | 3.3 | 18 | 25 | 2.9 |
| R5 | 2 | 32 | 6…70 | M8 | 15 | 18 | 35 | 2.9 |
| R6 | 2 | 45 | 25…150 | M10 | 30 | 30 | 185 | 9.8 |
| R7 | 2 | 54 | 95…240 (25…150) | M10 | 40 | 30 | 185 | 9.8 |

1) Maximum permissible cable diameter. For the diameter of cable grommets, see section "Dimensional drawings" on page 41.

**Note:** When using a cable diameter less than the diameter provided for the terminals, the terminals must be removed and suitable cable lugs used to connect the cable directly under the bolt head.

| Size | Cable grommets | | Terminals R-, R+/UDC+ and UDC- | | | |
|---|---|---|---|---|---|---|
| | | Ø[1] | Wire cross section | T (wire terminal screw) | | l |
| | St. | mm | mm² | M... | Nm | mm |
| R1 | 1 | 17 | 0.75…6 | - | 0.6 | 8 |
| R2 | 1 | 17 | 0.75…6 | - | 0.6 | 8 |
| R3 | 1 | 21 | 0.5…16 | - | 1.7 | 10 |
| R4 | 1 | 24 | 0.5…35 | - | 3.3 | 18 |
| R5 | 1 | 32 | 6…70 | M8 | 15 | 18 |
| R6 | 1 | 35 | 25…95 | M8 | 20 | 30 |
| R7 | 1 | 43 | 25…150 | M10 | 30 | 30 |

1) Maximum permissible cable diameter. For the diameter of cable grommets, see section "Dimensional drawings" on page 41.

**Note:** When using a cable diameter less than the diameter provided for the terminals, the terminals must be removed and suitable cable lugs used to connect the cable directly under the bolt head.

### 3.1.8.2 USA

The sizes of the connecting bars for the supply, motor, resistor and DC cables, the permissible cable size (per phase) and tightening torques (T) in US units of measurement are specified below. l denotes the stripped length in the terminal.

| Size | Cable grommets | | L1, L2, L3, T1/U, T2/V, T3/W | | | | Ground terminals | |
|---|---|---|---|---|---|---|---|---|
| | | Ø[1] | Wire cross section | T (wire terminal screw) | | l | Max. wire cross section | T |
| | St. | in. | kcmil/AWG | M... | lbf·ft | in. | AWG | lbf·ft |
| R1 | 2 | 0.67 | 18…10 | - | 0.44 | 0.31 | 4 | 1.3 |
| R2 | 2 | 0.67 | 18…10 | - | 0.44 | 0.31 | 4 | 1.3 |
| R3 | 2 | 0.83 | 20…6 | - | 1.25 | 0.39 | 4 | 1.3 |
| R4 | 2 | 0.94 | 20…2 | - | 2.4 | 0.70 | 4 | 2.1 |
| R5 | 2 | 1.26 | 10…2/0 | M8 | 11 | 0.70 | 4 | 2.1 |
| R6 | 2 | 1.77 | 4...300 MCM | M10 | 22.1 | 1.18 | 350 MCM | 7.2 |
| R7 | 2 | 2.13 | 3/0…400 MCM (4…300 MCM) | M10 | 29.5 | 1.18 | 350 MCM | 7.2 |

1) Maximum permissible cable diameter. Inner diameter of the cable clamps: 3/4" (sizes R1 and R2), 1" (R3). For the diameter of cable grommets, see section "Dimensional drawings" on page 41.

| Size | Cable grommets | | Terminals R-, R+/UDC+ and UDC- | | | |
|---|---|---|---|---|---|---|
| | | Ø[1] | Wire cross section | T (wire terminal screw) | | l |
| | St. | in. | kcmil/AWG | M... | lbf·ft | in. |
| R1 | 1 | 0.67 | 18…10 | - | 0.44 | 0.31 |
| R2 | 1 | 0.67 | 18…10 | - | 0.44 | 0.31 |
| R3 | 1 | 0.83 | 20…6 | - | 1.25 | 0.39 |
| R4 | 1 | 0.94 | 20…2 | - | 2.4 | 0.70 |
| R5 | 1 | 1.26 | 10…2/0 | M8 | 11 | 1.18 |
| R6 | 1 | 1.38 | 4…3/0 | M8 | 14.8 | 1.18 |
| R7 | 1 | 1.69 | 4...300 MCM | M10 | 22.1 | 1.18 |

1) Maximum permissible cable diameter. For the diameter of cable grommets, see section "Dimensional drawings" on page 41.

**Note:** When using a cable diameter less than the diameter provided for the terminals, the terminals must be removed and suitable cable lugs used to connect the cable directly under the bolt head.

### 3.1.8.2.1 UL listed cable lugs and tools

| Wire cross section | Crimp/Cable lug | | Crimping tool | | |
|---|---|---|---|---|---|
| kcmil/AWG | Manufacturer | Type | Manufacturer | Type | No. of crimps |
| 6 | Thomas & Betts | E10731<br>54136 | Thomas & Betts | TBM4S<br>TBM45S | 1 |
| | Burndy | YAV6C-L2 | Burndy | MY29-3 | 1 |
| | Ilsco | CCL-6-38 | Ilsco | ILC-10 | 2 |
| 4 | Thomas & Betts | 54140 | Thomas & Betts | TBM4S | 1 |
| | Burndy | YA4C-L4BOX | Burndy | MY29-3 | 1 |
| | Ilsco | CCL-4-38 | Ilsco | MT-25 | 1 |
| 2 | Thomas & Betts | 54143TB<br>54142TB | Thomas & Betts | TBM4S<br>TBM4S | 1 |
| | Burndy | YA2C-L4BOX | Burndy | MY29-3 | 2 |
| | Ilsco | CRC-2 | Ilsco | IDT-12 | 1 |
| | Ilsco | CCL-2-38 | Ilsco | MT-25 | 1 |
| 1 | Thomas & Betts | 54148 | Thomas & Betts | TBM-8 | 3 |
| | Burndy | YA1C-L4BOX | Burndy | MY29-3 | 2 |
| | Ilsco | CRA-1-38 | Ilsco | IDT-12 | 1 |
| | Ilsco | CCL-1-38 | Ilsco | MT-25 | 1 |
| 1/0 | Thomas & Betts | 54109 | Thomas & Betts | TBM-8 | 3 |
| | Burndy | YA25-L4BOX | Burndy | MY29-3 | 2 |
| | Ilsco | CRB-0 | Ilsco | IDT-12 | 1 |
| | Ilsco | CCL-1/0-38 | Ilsco | MT-25 | 1 |
| 2/0 | Thomas & Betts | 54110 | Thomas & Betts | TBM-8 | 3 |
| | Burndy | YAL26T38 | Burndy | MY29-3 | 2 |
| | Ilsco | CRA-2/0 | Ilsco | IDT-12 | 1 |
| | Ilsco | CCL-2/0-38 | Ilsco | MT-25 | 1 |

## 3.1.9 Terminal data for the control cables

See section "Connection data of the control unit (ZCU-12)" on page 34.

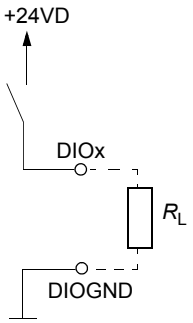
## 3.1.10 Specification of the electrical network

| | |
|---|---|
| **Voltage ($U_1$)** | 380 ... 500 V AC 3-phase 10%...-15%<br>This is specified on the nameplate as input voltage 3 ~ 400/480/500 V AC. |
| **Network type** | TN power systems (grounded) |
| **Conditional rated short-circuit current (IEC 61439-1)** | 65 kA when using the fuses listed in the fuse table |
| **Short-circuit current protection (UL 508C, CSA C22.2 No. 14-05)** | USA and Canada: The frequency inverter can be used in networks supplying a maximum symmetrical current of 100 kA (RMS) at a maximum of 600 V if fuse protection is provided in accordance with the specifications in the fuse table. |
| **Frequency** | 50/60 Hz, change by ±5%, maximum rate of change 17%/s |
| **Asymmetry** | Max. ±3% of the nominal input voltage phase-to-phase. |
| **Power factor of the fundamental frequency (cos phi$_1$)** | 0.98 (at nominal load) |

## 3.1.11 Motor connection data

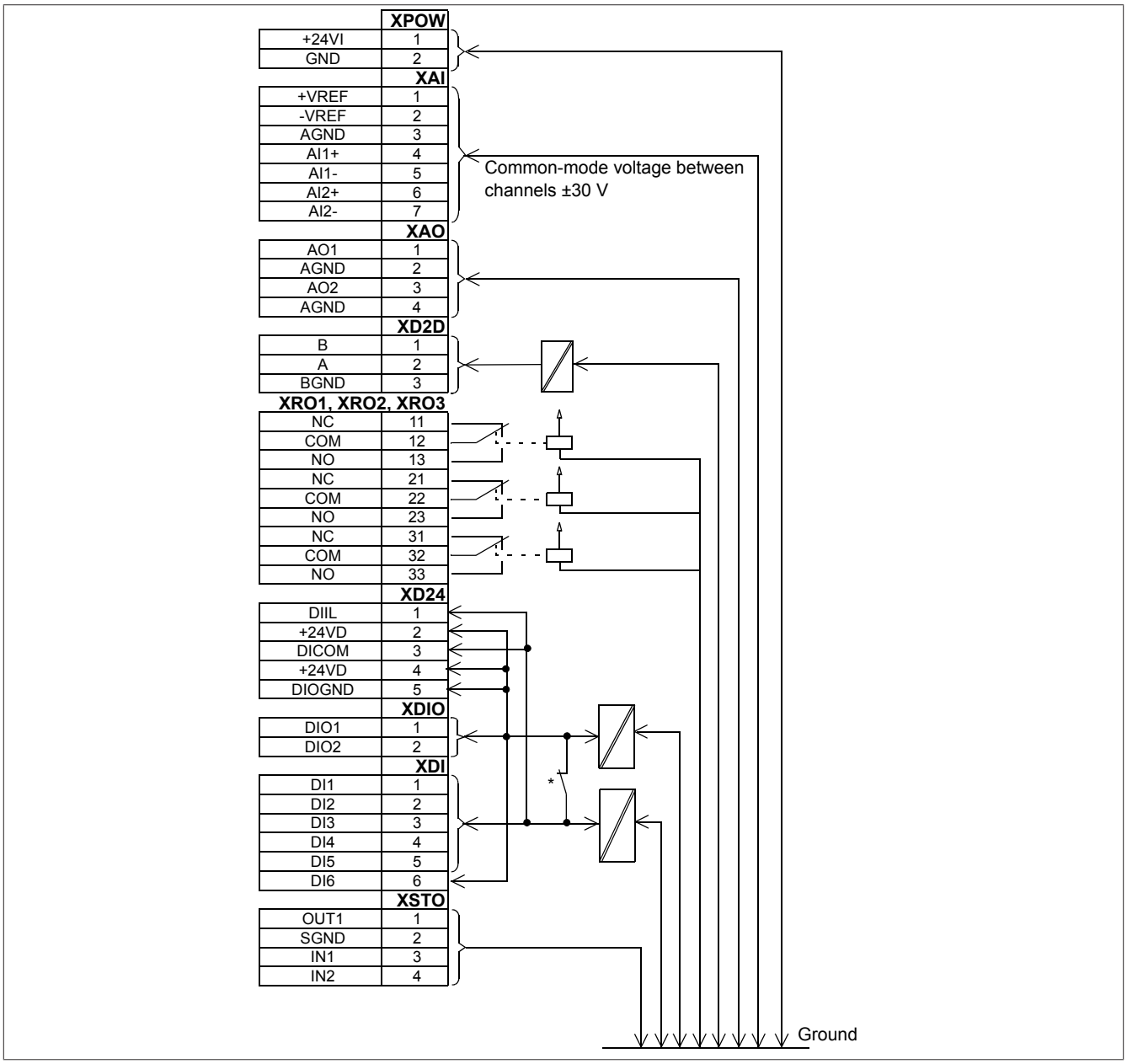
| | |
|---|---|
| **Motor types** | Induction motors, permanent magnet synchronous motors and induction servo motor |
| **Voltage ($U_2$)** | 0 to $U_1$, 3-phase symmetrical, $U_{max}$ at the field weakening point |
| **Frequency** | 0...500 Hz |
| **Current** | See section "Nominal data" on page 24. |
| **Switching frequency** | 2.7 kHz (typical) |
| **Recommended max. motor cable length** | For sizes R1 to R3: 150 m (492 ft)<br>For sizes R4 to R7: 300 m (984 ft).<br>**Note:**<br>**For motor cables longer than 150 m (492 ft) or switching frequencies higher than the standard switching frequencies, the requirements of the EMC Directive may not be met.** |

## 3.1.12 Connection data of the control unit (ZCU-12)

| | |
|---|---|
| **Power supply (XPOW)** | 24 V (±10%) DC, 2 A<br>Power supply via the power unit of the frequency inverter or externally via connection XPOW (pitch 5 mm, wire cross section 2.5 mm²). |
| **Relay outputs RO1...RO3 (XRO1...XRO3)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>250 VAC / 30 VDC, 2 A<br>Protected by varistors. |
| **+24 V output (XD24:2 and XD24:4)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>The total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the energy consumed by DIO1 and DIO2. |
| **Digital inputs DI1...DI6 (XDI:1...XDI:6)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>24 V logical thresholds: "0" < 5 V, "1" > 15 V<br>$R_{in}$: 2.0 kΩ input type: NPN/PNP (DI1...DI5), NPN (DI6)<br>Hardware filtering: 0.04 ms, digital filter up to 8 ms<br>DI6 (XDI:6) can alternatively be used as an input for 1...3 PTC sensors.<br>"0" > 4 kΩ, "1" < 1.5 kΩ<br>$I_{max}$: 15 mA (5 mA for DI6) |
| **Start inhibit input DIIL (XD24:1)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>24 V logical thresholds: "0" < 5 V, "1" > 15 V<br>$R_{in}$: 2.0 kΩ<br>Input type: NPN/PNP<br>Hardware filtering: 0.04 ms, digital filter up to 8 ms |
| **Digital inputs/outputs DIO1 and DIO2 (XDIO:1 and XDIO:2)**<br>Input/Output mode selectable by parameter setting. DIO1 can be configured as a frequency input (0...16 kHz with hardware filter of 4 microseconds) for 24 V square wave signal (sine wave or another waveform not possible). DIO2 can be configured as a 24 V square wave frequency output. See "The drive", parameter group 11. | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>As inputs:<br>24 V logical thresholds: "0" < 5 V, "1" > 15 V<br>$R_{in}$: 2.0 kΩ<br>Filter: 0.25 ms<br>As outputs:<br>Total output current of +24 VD is limited to 200 mA.<br>  <br> |
| **Reference voltage for analog inputs +VREF and -VREF (XAI:1 and XAI:2)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>10 V ±1% and -10 V ±1%, $R_{Load}$ 1…10 kΩ |
| **Analog inputs AI1 and AI2 (XAI:4...XAI:7)**<br>Selection of the current/voltage input mode by jumpers. See 205. | Voltage input: -10…10 V, $R_{in}$: >200 kΩ<br>Differential inputs, common mode ±30 V<br>Sampling interval per channel: 0.25 ms<br>Hardware filtering: 0.25 ms, digital filter up to 8 ms<br>Resolution: 11-bit + sign bit<br>Accuracy: 1% of full scale range<br>Accuracy for Pt100 sensors: 10°C (50°F) |
| **Analog outputs AO1 and AO2 (XAO)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>0…20 mA, $R_{Load}$ < 500 ohm<br>Frequency range: 0...300 Hz<br>Resolution: 11-bit + sign bit<br>Accuracy: 2% of full scale range |
| **Inverter-to-inverter connection (D2D) (XD2D)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>Physical connection: RS485<br>Termination by switch |
| **Connection for Safe Torque Off (XSTO)** | Terminal block pitch 5 mm, wire cross section 2.5 mm²<br>Input voltage range: -3...30 VDC<br>Logical thresholds: "0" < 5 V, "1" > 17 V<br>Current consumption for sizes R1 to R7: 30 mA<br>(24 VDC, continuous) per STO channel<br>Maximum output current on OUT1: 100 mA<br>(24 VDC, continuous)<br>To start up the frequency inverter, both connections (OUT1 with IN1 and IN2) must be closed.<br>EMC (immunity) per IEC 61326-3-1 |
| **Control panel / PC connection** | Connector: RJ45<br>Cable length < 3 m |

The connections on the board meet the requirements of "protective extra-low voltage" (PELV). The PELV requirements of a relay output are not met if the relay is used with a voltage higher than 48 V.

### Insulation and grounding diagram




### Ground selection settings for J6:

| | |
|---|---|
| | All digital inputs have the same ground connection (DICOM connected to DIOGND). This is the default setting. |
| | The ground of digital inputs DI1...DI5 and DIIL (DICOM) is isolated from the DIO signal ground (DIOGND). Insulation voltage 50 V. |

## 3.1.13 Efficiency

| | |
|---|---|
| **Efficiency** | Approximately 98% at nominal power |

## 3.1.14 Protection classes

| | |
|---|---|
| **Degree of protection (IEC/EN 60529)** | IP20 |
| **Housing types (UL 508C)** | Open UL type.<br>For indoor use only. |
| **Overvoltage category (IEC 60664-1)** | III |
| **Protection class (IEC/EN 61800-5-1)** | I |

## 3.1.15 Ambient conditions

The limit values of the ambient conditions for the frequency inverter are specified below. The frequency inverter is only permitted to be operated in heated and monitored indoor areas.

| | Stationary operation | Storage in the protective packaging | Transport in the protective packaging |
|---|---|---|---|
| **Installation elevation** | 0 to 4000 m (13123 ft) above sea level.[1)]<br>0 to 2000 m (6562 ft) above sea level.[2)]<br>Above 1000 m [3281 ft], see "Derating at higher installation elevations" on page 26. | - | - |
| **Air temperature** | -15 to 55°C<br>(5 to 131°F)<br>Ice formation not permitted. See section "Nominal data". | -40 to 70°C<br>(-40 to 158°F) | -40 to 70°C<br>(-40 to 158°F) |
| **Relative humidity** | 5 to 95% | Max. 95% | Max. 95% |
| | Condensation not permitted. Maximum permissible relative humidity 60% if corrosive gases are present. | | |
| **Contamination level** (IEC 60721-3-3, IEC 60721-3-2, IEC 60721-3-1) | Conductive dust not permitted. | | |
| | Chemical gases:<br>Class 3C2.<br>Solids:<br>Class 3S2 | Chemical gases:<br>Class 1C2<br>Solid particles:<br>Class 1S3 | Chemical gases:<br>Class 2C2<br>Solid particles:<br>Class 2S2 |
| **Atmospheric pressure** | 70 to 106 kPa<br>0.7 to 1.05 atmospheres | 70 to 106 kPa<br>0.7 to 1.05 atmospheres | 60 to 106 kPa<br>0.6 to 1.05 atmospheres |
| **Vibration** (IEC 60068-2) | Max. 1 mm (0.04 in.)<br>(5 to 13.2 Hz), max. 7 m/s² (23 ft/s²)<br>(13.2 to 100 Hz)<br>Sinusoidal | Max. 1 mm (0.04 in.)<br>(5 to 13.2 Hz), max. 7 m/s² (23 ft/s²)<br>(13.2 to 100 Hz)<br>Sinusoidal | Max. 3.5 mm (0.14 in)<br>(2 to 9 Hz), max. 15 m/s² (49 ft/s²)<br>(9 to 200 Hz)<br>Sinusoidal |
| **Shock** (IEC 60068-2-27) | Not permitted | Max. 100 m/s² (330 ft./s²), 11 ms | Max. 100 m/s² (330 ft./s²), 11 ms |
| **Free fall** | Not permitted | 100 mm (4 in.) for weight over 100 kg (220 lbs) | 100 mm (4 in.) for weight over 100 kg (220 lbs) |

1) For TN and TT power systems with star point grounding and non-asymmetrically grounded IT power system.
2) For asymmetrically grounded TN, TT and IT power system.

## 3.1.16 Materials used

### Frequency inverter housing

- PC/ABS 3 mm, color NCS 1502-Y (RAL 9002 / PMS 1C cold gray) and RAL 9017
- PC+10% GF 3.0 mm, color RAL 9017 (only for sizes R1 to R3)
- Hot-dip galvanized steel sheet 1.5 to 2.5 mm, thickness of coating 100 micrometers, color NCS1502-Y

### Packaging

Plywood and cardboard. Foam damping elements PP-E, tapes PP.

| Frequency inverters | Size | Packaging | | |
|---|---|---|---|---|
| | | Length [mm] | Width (mm) | Height (mm) |
| 8I96T400075.00-000<br>8I96T400110.00-000<br>8I96T400150.00-000<br>8I96T400220.00-000<br>8I96T400300.00-000<br>8I96T400400.00-000 | R1 | 574 | 256 | 281 |
| 8I96T400550.00-000<br>8I96T400750.00-000 | R2 | 574 | 256 | 304 |
| 8I96T401100.00-000<br>8I96T401500.00-000 | R3 | 624 | 256 | 316 |
| 8I96T401850.00-000<br>8I96T402200.00-000 | R4 | 691 | 290 | 329 |
| 8I96T403000.00-000<br>8I96T403700.00-000 | R5 | 896 | 293 | 329 |
| 8I96T404500.00-000<br>8I96T405500.00-000 | R6 | 870 | 325 | 580 |
| 8I96T407500.00-000<br>8I96T409000.00-000 | R7 | 992 | 400 | 568 |

### Disposal

The main components of the frequency inverter can be recycled to conserve natural resources and save energy. Parts and materials of this product should be disassembled and separated.

In general, all metals such as steel, aluminum, copper and alloys as well as precious metals can be recycled. Plastics, rubber, cardboard and other packaging materials can be used for energy recovery. Electronic boards and DC capacitors (C1-1 to C1-x) must be handled separately per IEC 62635 guidelines. To simplify recycling, plastic parts are marked with an appropriate code.

Recycling after the end of the service life must be carried out in accordance with international and country-specific regulations.

## 3.1.17 Standards and certifications

### 3.1.17.1 Applicable standards

The frequency inverter complies with the following standards. Compliance with the European Low Voltage Directive was confirmed per standard EN 61800-5-1.

| Standard | Name |
|---|---|
| IEC/EN 61800-3:2004<br>+ A1:2012 | Adjustable speed electrical power drive systems<br>Part 3: EMC requirements and specific test methods |
| IEC/EN 61800-5-1:2007 | Adjustable speed electrical power drive systems<br>Part 5-1: Safety requirements - Electrical, thermal and energy |
| IEC 61800-5-2:2016<br>EN 61800-5-2:2007 | Adjustable speed electrical power drive systems<br>Part 5-2: Safety requirements - Functional |
| IEC 61800-9-2:2017 | Adjustable speed electrical power drive systems<br>Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications - Energy efficiency indicators for power drive systems and motor starters |
| IEC 61508-1:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements |
| IEC 61508-2:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems |
| EN 62061:2005<br>+ AC:2010<br>+ A1:2013<br>+ A2:2015 | Safety of machinery. Functional safety of safety-related electrical, electronic and programmable electronic control systems |
| EN/ISO 13849-1:2015 | Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design |
| EN/ISO 13849-2:2012 | Safety of machinery - Safety-related parts of control systems - Part 2: Validation |
| IEC 60146-1-1:2009<br>EN 60146-1-1:2010 | Semiconductor converters - General requirements and line commutated converters - Part 1-1: Specification of basic requirements |
| EN 60204-1:2006<br>+ A1:2009<br>+ AC:2010 | Safety of machinery. Electrical equipment of machines. Part 1: General requirements. EN 60204-1:2006 + A1:2009 + AC:2010<br>Prerequisite for compliance: The person performing the final assembly of the machine is responsible for installing the following equipment:<br>• Emergency stop device<br>• Mains disconnect device |
| EN 60529:1991<br>+ A2:2013 | Degrees of protection provided by enclosures (IP code) |
| IEC 60664-1:2007 | Insulation coordination for equipment within low-voltage supply systems. Part 1: Principles, requirements and tests |
| EN 50581:2012 | Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances |
| IEC/EN 63000:2018 | Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances |
| UL 61800-5-1: First Edition | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy |
| CSA C22.2 No. 274-17 | Adjustable speed drive systems |
| CSA C22.2 No. 22-10 | General requirements - Canadian electrical code, part II |

### 3.1.17.2 CE marking

A CE marking is placed on the frequency inverter. This confirms that the frequency inverter meets the requirements of the European Low Voltage Directive as well as the EMC and RoHS Directives. The CE marking also confirms that the frequency inverter complies with the Machinery Directive with regard to its safety functions (such as "Safe Torque Off") as a safety component.

#### 3.1.17.2.1 Compliance with the European Low Voltage Directive

Compliance with the European Low Voltage Directive was verified according to standards EN 60204-1 and EN 61800-5-1.

#### 3.1.17.2.2 Compliance with the European EMC Directive

The EMC Directive defines the requirements for immunity and emissions of electrical equipment operating within the territory of the European Union. The EMC product standard [EN 61800-3 (2004)] contains the requirements for frequency inverters. See the following section: "Compliance with EN 61800-3" on page 38.

#### 3.1.17.2.3 Compliance with the European RoHS Directive

RoHS = Restriction of hazardous substances in electrical and electronic equipment.

#### 3.1.17.2.4 Compliance with the European Machinery Directive

The frequency inverter is an electronic product subject to the European Low Voltage Directive. However, the frequency inverter has function "Safe Torque Off" and can be equipped with other safety functions for machines that are included as safety components within the scope of the Machinery Directive. These functions of the frequency inverter are compliant with European harmonized standards such as 61800-5-2.

### 3.1.17.3 Compliance with EN 61800-3

#### 3.1.17.3.1 Definitions

EMC stands for "electromagnetic compatibility". This refers to the ability of electrical/electronic equipment to operate without interference in an electromagnetic environment. Likewise, the device is not permitted to interfere with or influence other devices or systems located in the vicinity of where it is used.

The first environment includes residential areas as well as facilities directly connected without an intermediate transformer to a low-voltage network that supplies buildings in residential areas.

The second environment includes facilities that are not directly connected to a low-voltage network that supplies buildings in residential areas.

Frequency inverters in category C2: Frequency inverters with a nominal voltage below 1000 V and intended for installation and commissioning in the first environment.

**Note:**

**Qualified personnel (person or organization) have the necessary knowledge and skills to install and/or commission electrical drive systems, including their EMC aspects.**

Frequency inverters in category C3: Drives with a nominal voltage below 1000 V intended for use in the second environment and not in the first environment.

Frequency inverters in category C4: Drives with a nominal voltage of 1000 V or higher, a nominal current of 400 A or higher or intended for use in complex systems in the second environment.

#### 3.1.17.3.2 Category C2

The frequency inverter meets the requirements of the standard under the following conditions:

- The frequency inverter is equipped with an EMC filter.
- The motor and control cables were selected and used according to the instructions contained in the hardware manual.
- The frequency inverter was installed according to the instructions in the hardware manual.
- The maximum motor cable length is 150 m.

**Warning!**

**The frequency inverter can cause high-frequency interferences when used in residential areas. The user may be required to take additional measures to prevent interference in addition to the CE requirements above.**

**Note:**

**Frequency inverters equipped with an EMC filter are not permitted to be connected to an IT power system (ungrounded). The supply network is connected to the ground potential via the EMC filter capacitors. This may cause hazards or damage the devices.**

#### 3.1.17.3.3 Category C3

The frequency inverter meets the requirements of the standard under the following conditions:

- The frequency inverter is equipped with an EMC filter.
- The motor and control cables were selected and used according to the instructions contained in the hardware manual.
- The frequency inverter was installed according to the instructions in the hardware manual.
- The maximum motor cable length is 150 m.

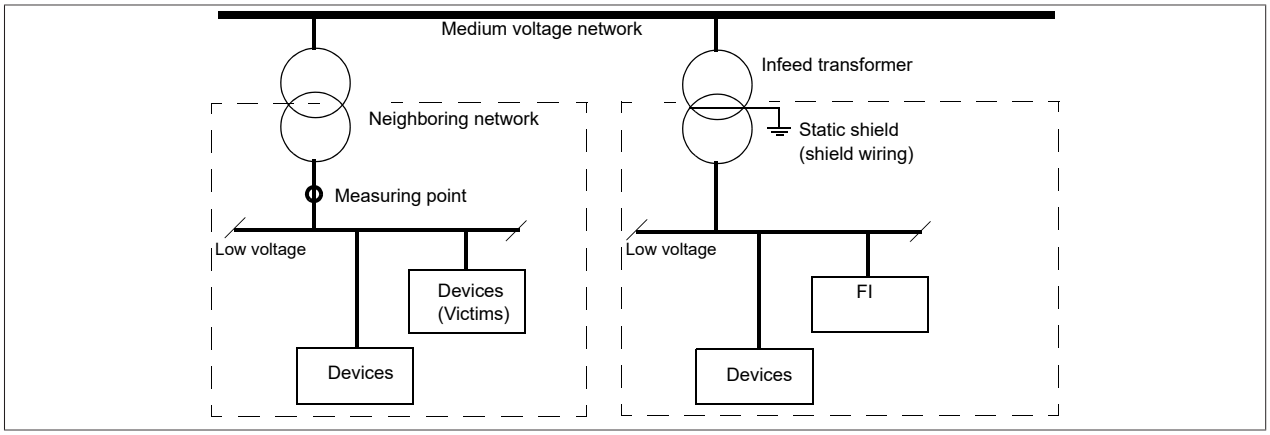
## Warning!

**A category C3 frequency inverter is not intended for connection to a public low-voltage network to which residential buildings are also connected. Radio frequency interference must be expected when connecting the frequency inverter to this type of network.**

#### 3.1.17.3.4 Category C4

If the conditions under category C3 cannot be met, the requirements of the standard can also be observed as follows:

1. It must be ensured that no excessive emissions affect neighboring low-voltage networks. In some cases, natural emission suppression in transformers and cables is sufficient. If in doubt, a mains transformer with static shielding should be used between the primary and secondary windings.




2. Installation is described with the measures for suppressing interference in an EMC plan. You can request a sample template from your B&R representative.
3. The motor and control cables were selected and used according to the instructions contained in the hardware manual.
4. The frequency inverter was installed according to the instructions in the hardware manual.

## Warning!

**A category C4 frequency inverter is not intended for connection to a public low-voltage network to which residential buildings are also connected. Radio frequency interference must be expected when connecting the frequency inverter to this type of network.**

### 3.1.17.4 UL mark

The frequency inverter is cULus listed.

#### 3.1.17.4.1 UL checklist

- The frequency inverter must be installed in clean air according to the enclosure classification. The cooling air must be clean, free of corrosive materials and electrically conductive dust.
- The maximum ambient air temperature at the nominal current is 40°C (104°F). The current must be reduced at 40 to 55°C (104 to 122°F).
- The frequency inverter can be used in networks supplying a maximum symmetrical current of 100 kA (RMS) at maximum 600 V. The ampere specification is based on tests performed per UL 508C.
- Cables within the motor circuit must be rated for a minimum of 75°C (167°F) in UL-compliant installations.
- The input cable must be protected by suitable fuses. Circuit breakers are not permitted to be used in the USA without fuses. Suitable fuses per IEC (classes gG and aR) are listed in section "Fuses (IEC)" on page 28; suitable fuses per UL (class T) are listed in section "Fuses (UL)" on page 31. Please contact your B&R representative for information about suitable circuit breakers.
- For installation in the United States, branch circuit protection must comply with the National Electrical Code (NEC) and all applicable local directives. Use UL-rated fuses to meet this requirement.

- For installations in Canada, branch circuit protection must be installed per the Canadian Electrical Code and applicable provincial regulations. Use UL-rated fuses to meet this requirement.
- The frequency inverter provides overload protection per the National Electrical Code (NEC).

#### 3.1.17.5 WEEE mark

The frequency inverter is marked with the waste container symbol. It specifies that at the end of its service life, the frequency inverter should be taken to an appropriate collection point for recycling and not disposed of as normal waste. See section "Disposal" on page 36.

### 3.1.18 Disclaimer

The manufacturer shall not be liable with respect to any product that (i) was improperly repaired or altered; (ii) was subjected to misuse, abuse, negligence or accident; (iii) was used in violation of the manufacturer's instructions; or (iv) has failed due to normal wear and tear.

### 3.1.19 Cybersecurity disclaimer

B&R products communicate via a network interface and were developed for secure connection with internal and, if necessary, other networks such as the Internet.

**Information:**

**In the following, B&R products are referred to as "product" and all types of networks (e.g. internal networks and the Internet) are referred to as "network".**

It is the sole responsibility of the customer to establish and continuously ensure a secure connection between the product and the network. In addition, appropriate security measures must be implemented and maintained to protect the product and entire network from any security breaches, unauthorized access, interference, digital intrusion, data leakage and/or theft of data or information.

B&R Industrial Automation GmbH and its subsidiaries are not liable for damages and/or losses in connection with security breaches, unauthorized access, interference, digital intrusion, data leakage and/or theft of data or information.

The aforementioned appropriate security measures include, for example:

- Segmentation of the network (e.g. separation of the IT network from the control network[2)])
- Use of firewalls
- Use of authentication mechanisms
- Encryption of data
- Use of anti-malware software

Before B&R Industrial Automation GmbH releases products or updates, they are subjected to appropriate functional testing. Independently of this, we recommend that our customers develop their own test processes in order to be able to check the effects of changes in advance. Such changes include, for example:

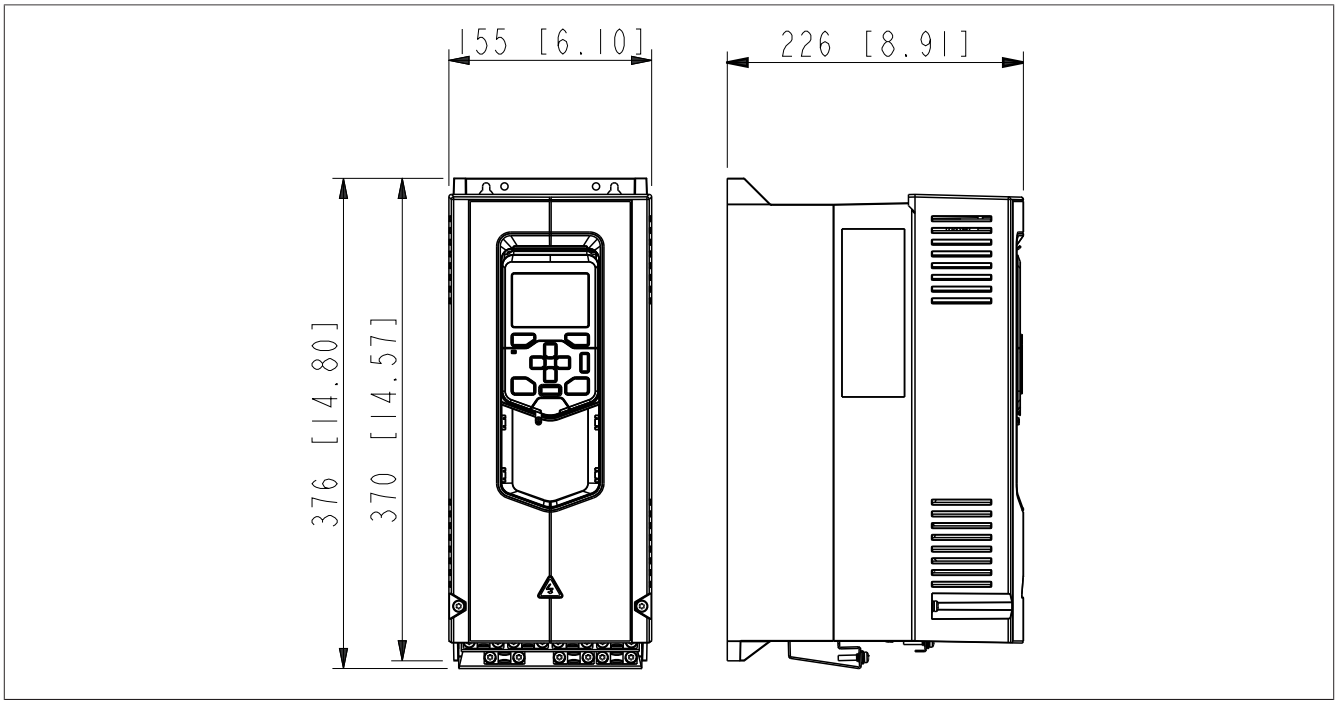
- Installation of product updates
- Significant system modifications such as configuration changes
- Deployment of updates or patches for third-party software (non-B&R software)
- Hardware replacement

These tests should ensure that implemented security measures remain effective and that systems in the customer's environment behave as expected.

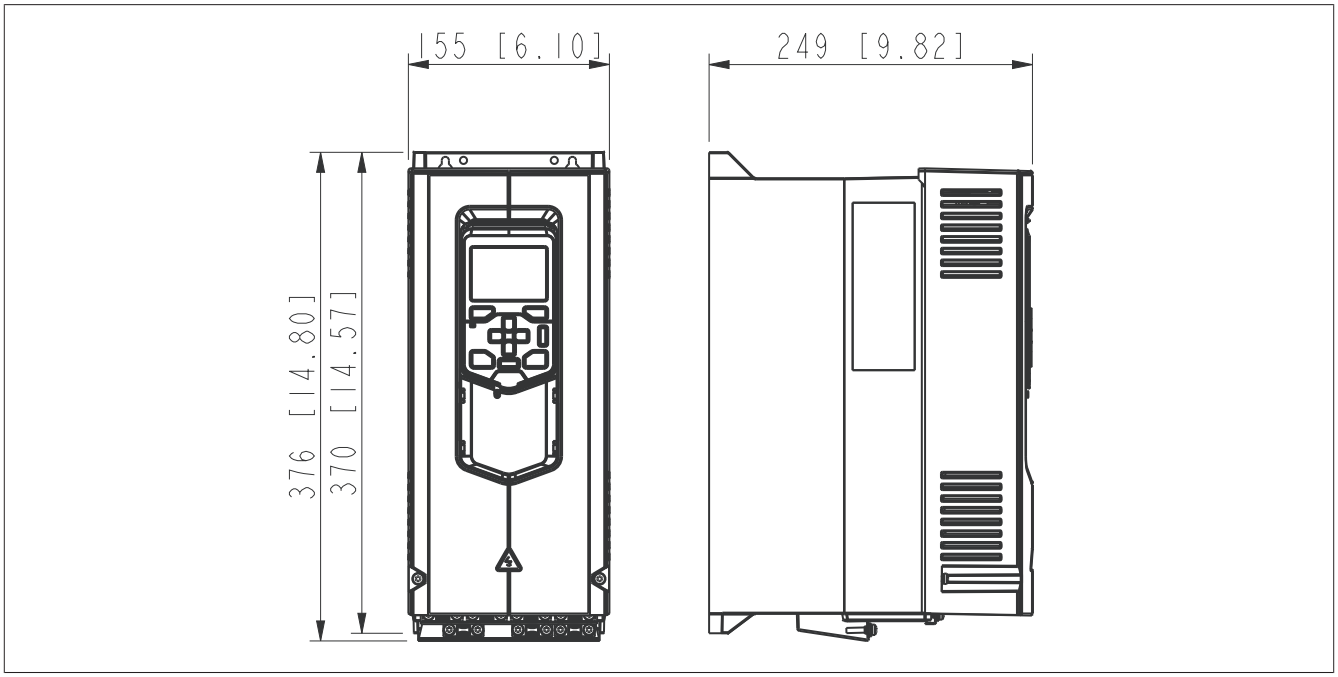
[2)] The term "control network" refers to computer networks used to connect control systems. The control network can be divided into zones, and there can be several separate control networks within a company or site. The term "control systems" refers to all types of B&R products such as controllers (e.g. X20), HMI systems (e.g. Power Panel T30), process control systems (e.g. APROL) and supporting systems such as engineering workstations with Automation Studio.

## 3.1.20 Dimensional drawings

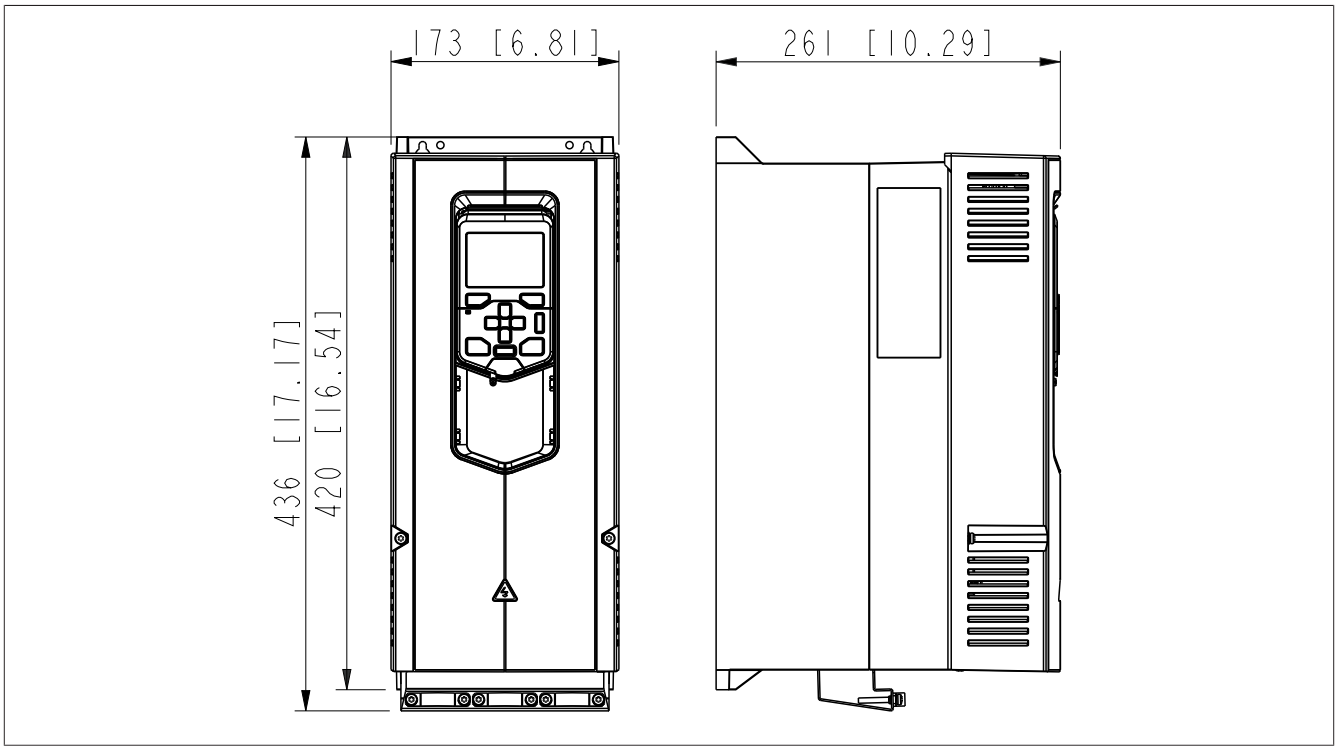
### 3.1.20.1 Size R1



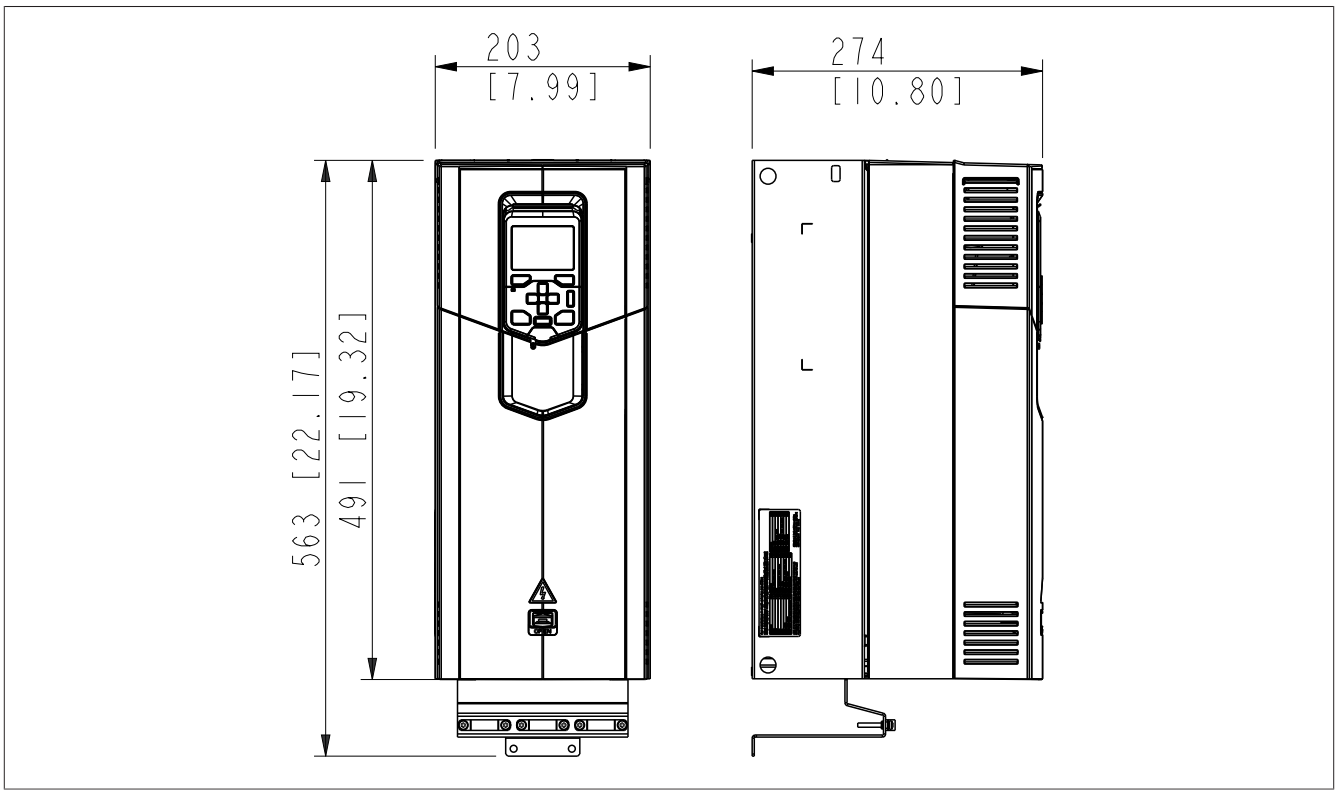

### 3.1.20.2 Size R2



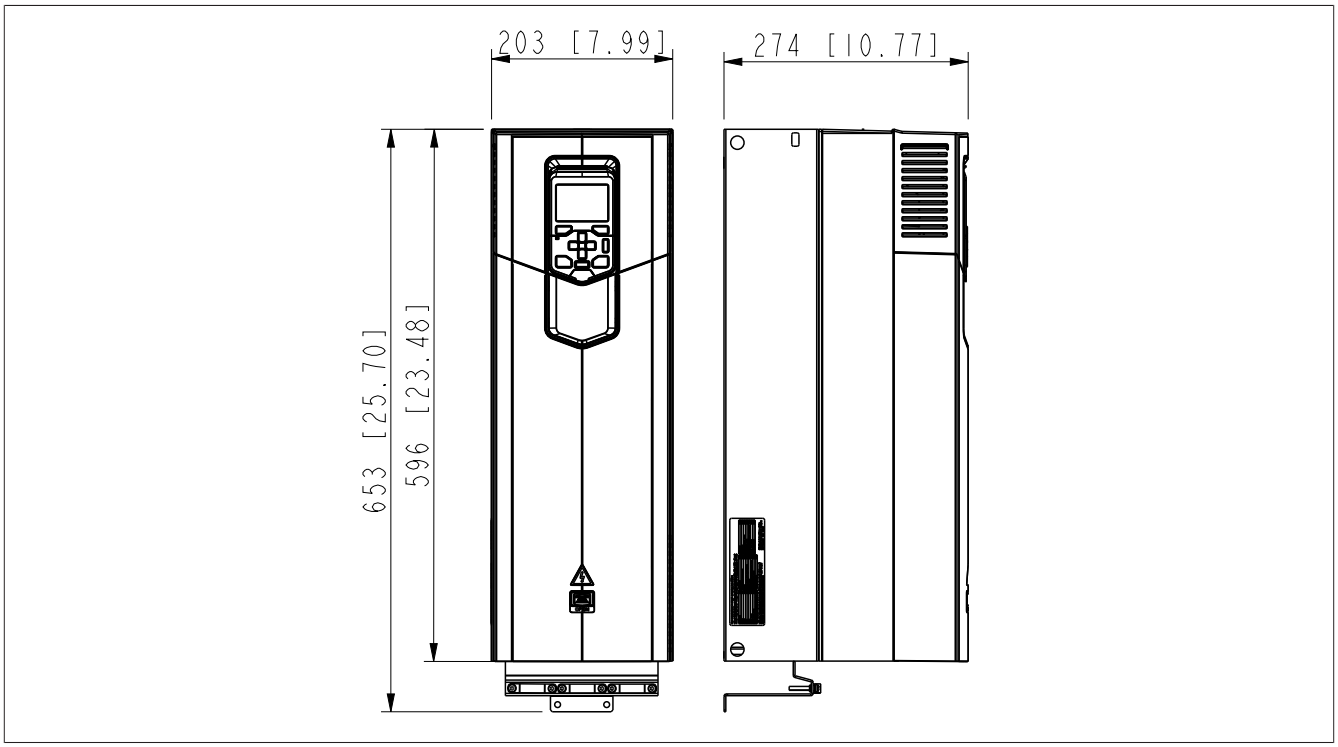
### 3.1.20.3 Size R3



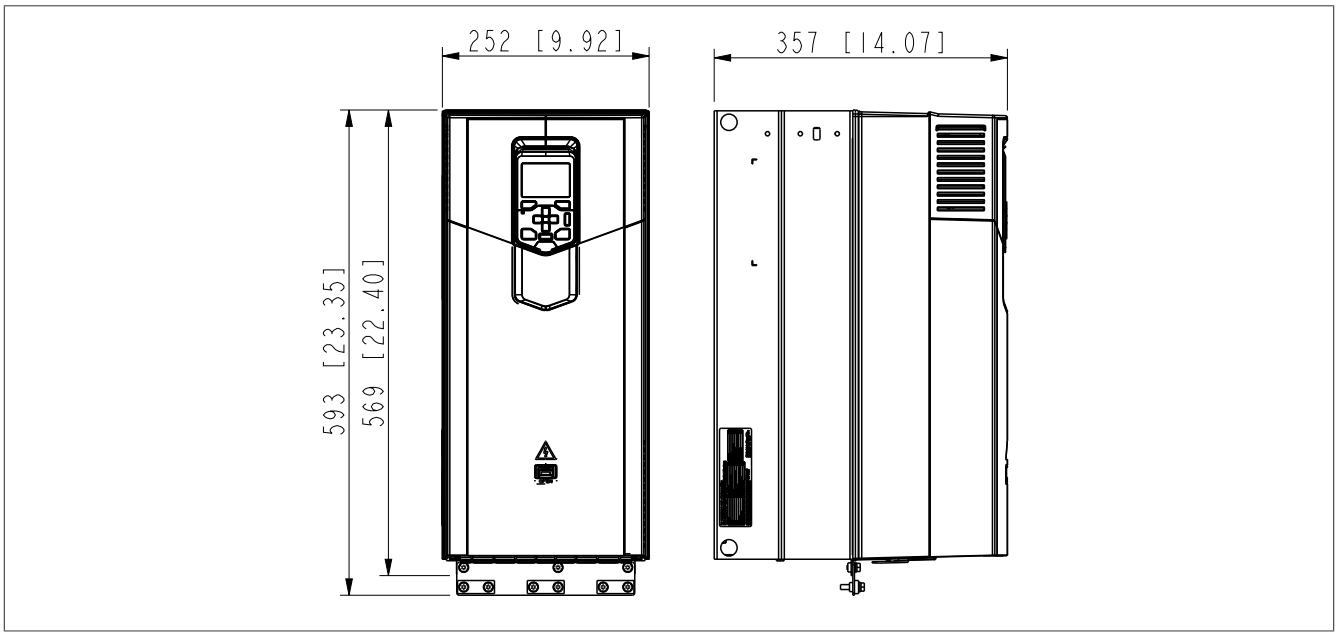

### 3.1.20.4 Size R4



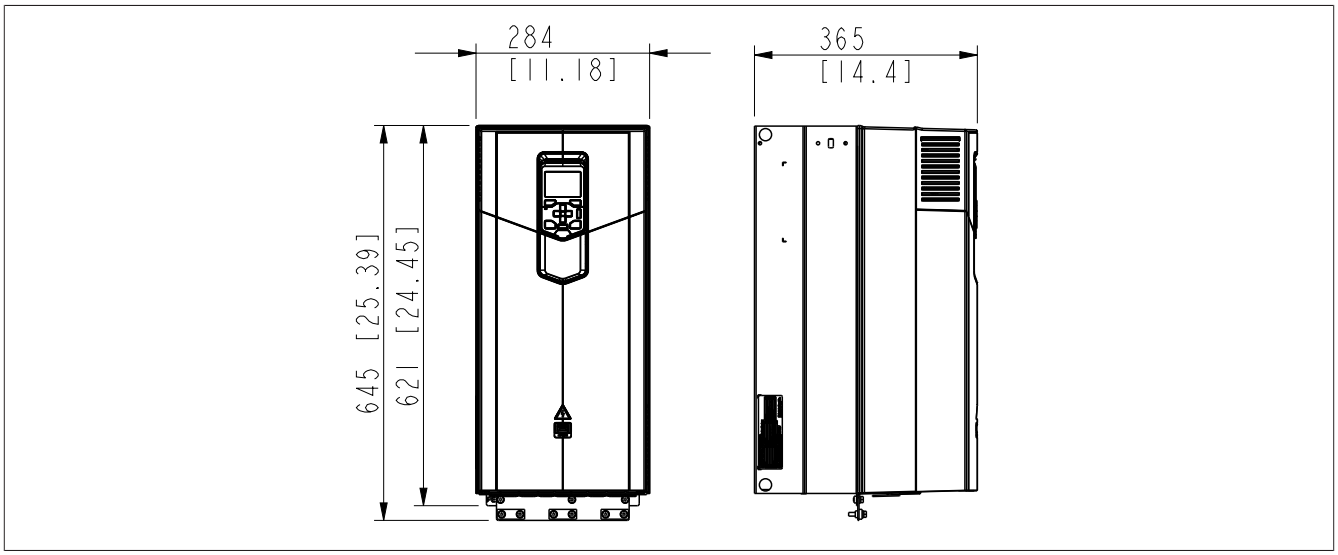
### 3.1.20.5 Size R5




### 3.1.20.6 Size R6



### 3.1.20.7 Size R7



# 3.2 Accessories

## 3.2.1 Interface cards

### 3.2.1.1 8I0IF108.400-6

#### 3.2.1.1.1 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Interface modules** | |
| 8I0IF108.400-6 | 2x POWERLINK interface, POWERLINK V2, interface module for ACOPOSinverter P96 | |

Table 8: 8I0IF108.400-6 - Order data

#### 3.2.1.1.2 Technical data

| Order number | 8I0IF108.400-6 |
|---|---|
| **General information** | |
| B&R ID code | 2173 |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using LED status indicator and software |
| Bus function | Yes, using LED status indicator and software |
| Certifications | |
| CE | Yes |
| UKCA | Yes |
| **Interfaces** | |
| Fieldbus | POWERLINK (V1/V2) controlled node |
| Type | Type 2 [1)] |
| Variant | 2x shielded RJ45 (hub) |
| Line length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | No |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Hub propagation delay | 0.96 to 1 µs |
| Min. cycle time [2)] | |
| Fieldbus | 200 µs |
| Synchronization between bus systems possible | Yes |
| **Operating conditions** | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 9: 8I0IF108.400-6 - Technical data

**Technical data**

| Order number | 8I0IF108.400-6 |
|---|---|
| **Ambient conditions** | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| **Mechanical properties** | |
| Dimensions | |
| Width | 63 mm |
| Height | 65 mm |
| Depth | 26 mm |

Table 9: 8I0IF108.400-6 - Technical data

1) For additional information, see section "Communication / POWERLINK / General information / Hardware - CN" in Automation Help.
2) The minimum cycle time specifies how far the bus cycle can be reduced without communication errors occurring.

### 3.2.1.1.3 Dimension diagram and installation dimensions

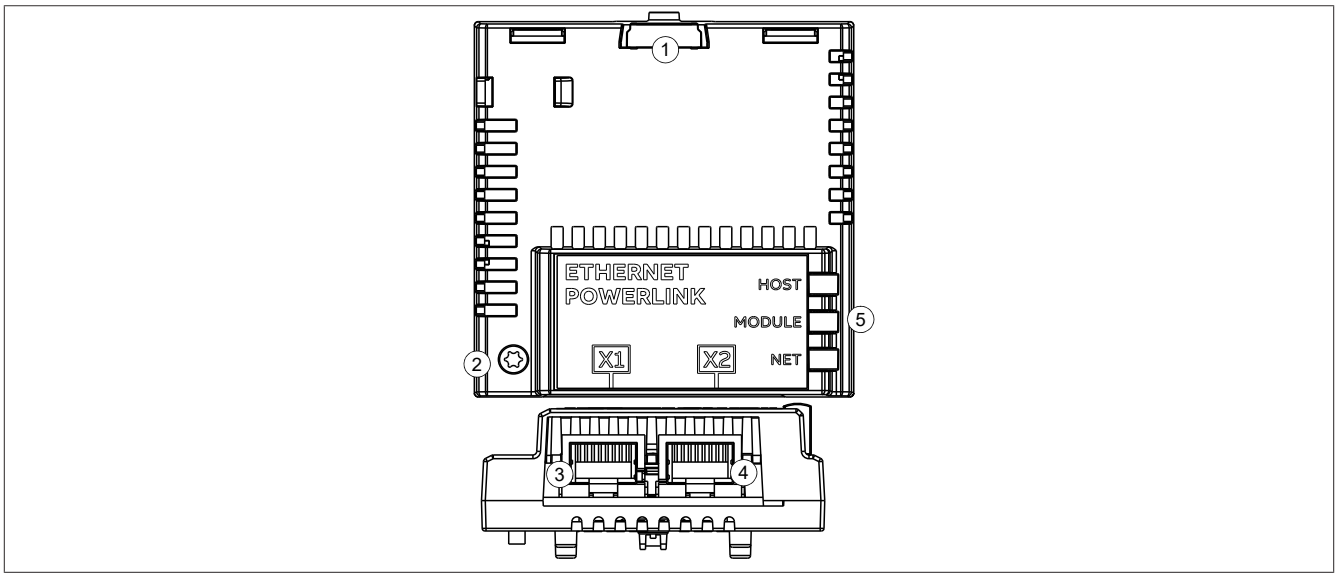



Figure 1: 8I0IF108.400-6 - Design

1 Interlocking device
2 Mounting screw
3 Connector X1
4 Connection X2
5 Diagnostic LEDs

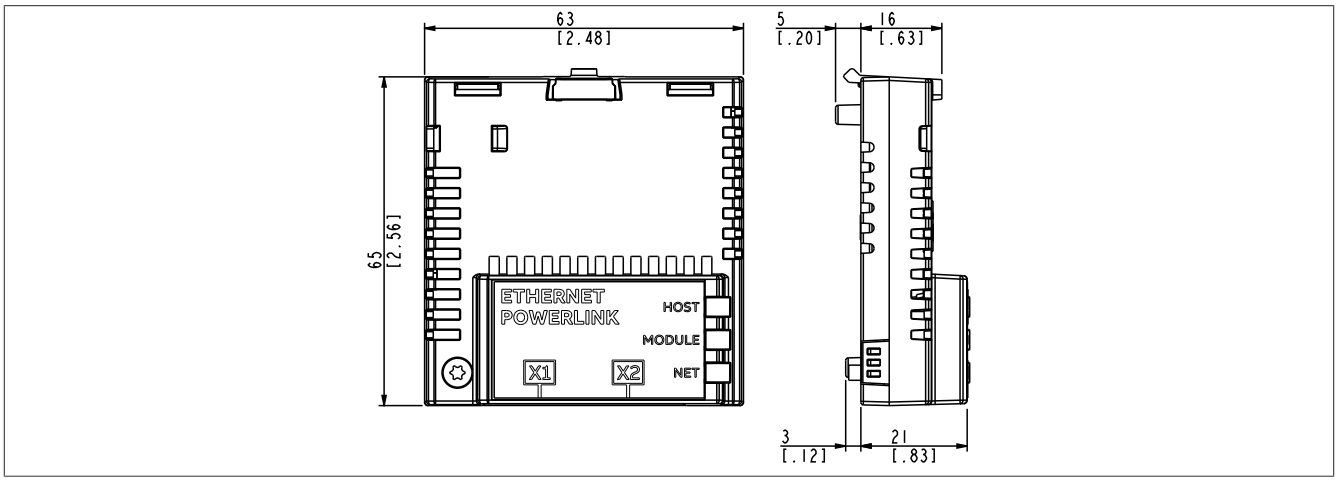



Figure 2: 8I0IF108.400-6 - Dimension diagram

### 3.2.1.2 8I0IFENC096.402-1

#### 3.2.1.2.1 General information

Interface card 8I0IFENC096.402-1 can be used in an ACOPOSinverter P96 and contains a connection for TTL incremental encoders as well as a connection for resolvers with PTC/KTY support. The module also has a TTL incremental encoder output for emulation and two digital reference signal inputs for position referencing.

##### 3.2.1.2.1.1 Compatibility

**Resolver**

8I0IFENC096.402-1 is compatible with resolvers whose rotor winding is excited by a sinusoidal voltage and that generate sine and cosine signals proportional to the rotor angle with respect to the stator windings. Amplitude and frequency of the excitation signal can be set in the range 4 ... 12 Veff, 1 ... 20 kHz. The transformation ratio of the resolver must be selected so that the sine and cosine signals remain in the range 2 ... 7 Veff.

**TTL incremental encoder**

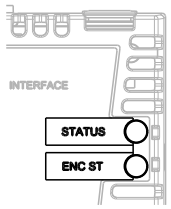
8I0IFENC096.402-1 is compatible with TTL incremental encoders with 1...65535 pulses / revolution and supports the reference / zero pulse.

**Programming**

The module is programmed via the drive parameters. These parameters must be checked and set according to the incremental encoder and resolver data sheets.

**Diagnostic LEDs**

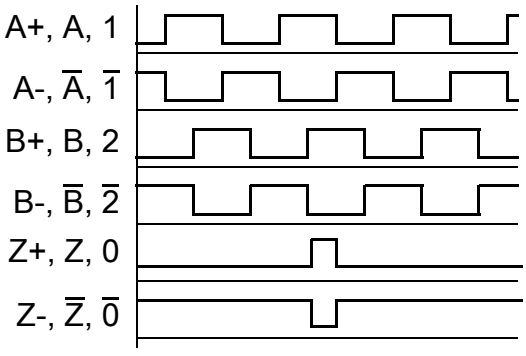
The module is equipped with two diagnostics LEDs. LED STATUS indicates the status of the interface card, and LED ENC1 ST indicates the status of the rotary encoder.

| Figure | LED | Color | Description |
|---|---|---|---|
|  | STATUS | Green | OK |
| | | Orange | Not initialized or communication with ACOPOSinverter P96 disrupted |
| | | Red | Not used |
| | ENC ST | Green | Rotary encoder OK |
| | | Red | TTL incremental encoder (X51) fault |
| | | Orange | Resolver (X52) fault |
| | | Blinking red/orange | TTL incremental encoder (X51) and resolver (X52) fault |
| | | Blinking red | TTL incremental encoder (X51) warning |
| | | Blinking orange | Resolver (X52) warning |

#### 3.2.1.2.2 Phase setting

If the TTL incremental encoder is connected correctly, a positive incremental encoder feedback signal must be generated when the drive is running forward.

The two output channels in incremental encoders, usually designated 1 and 2 or A and B, are rotated 90° (electrically). With clockwise rotation, channel 1 leads channel 2 for most but not all pulse encoders (see the following figure). See the documentation for the incremental encoder or use an oscilloscope to determine which channel is leading.



The incremental encoder output channel that leads when the drive/frequency inverter runs in the forward direction must be connected to input A of 8I0IFENC096.402-1; the lagging output channel must be connected to input B of 8I0IFENC096.402-1.

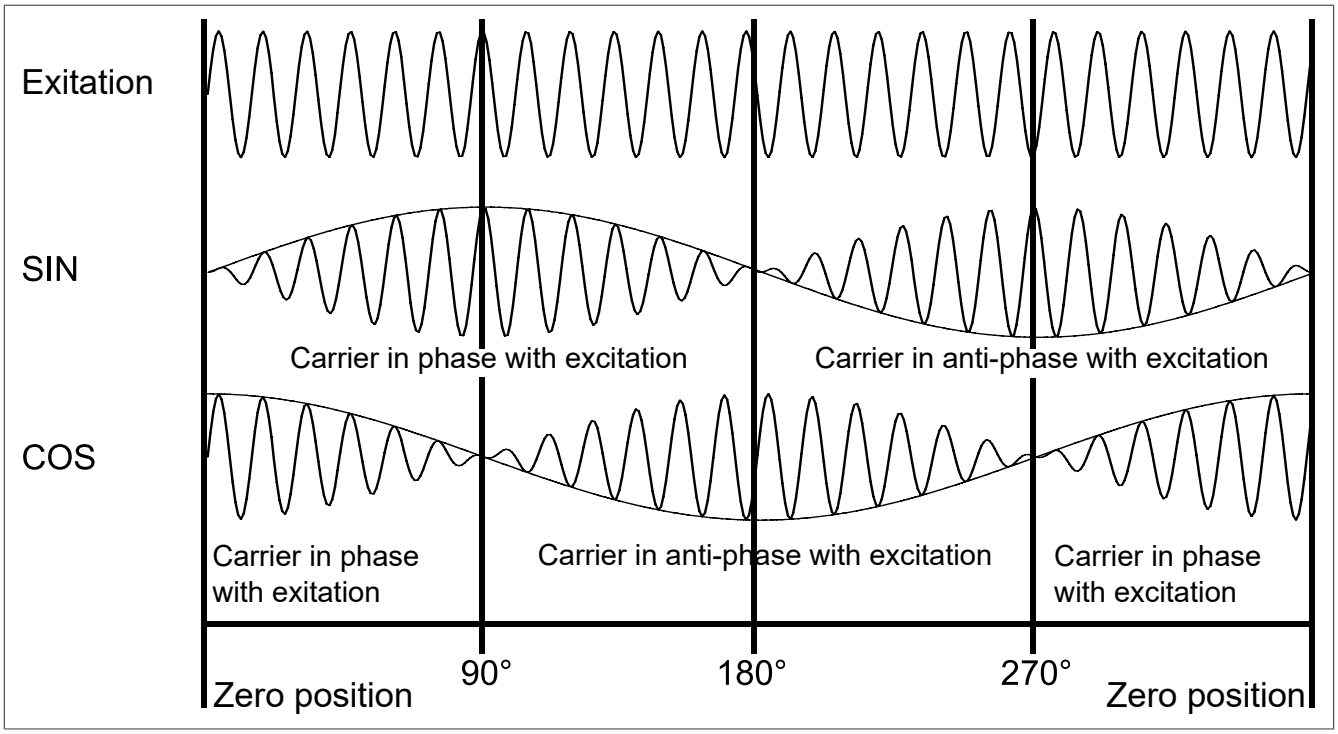
The zero pulse output channel (normally designated 0, N or Z) only needs to be connected for positioning applications.

### Excitation signal

Module 8I0IFENC096.402-1 supplies the resolver differentially with an excitation signal. The amplitude and frequency can be configured within the following limits with the software:

| Excitation signal | Amplitude | Frequency | Max. current |
|---|---|---|---|
| | 4 ... $12_{eff}$ | 1 ... 20 kHz | 100 $mA_{eff}$ |

The following image shows SIN and COS outputs and the excitation signal.




### 3.2.1.2.3 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Interface modules** | |
| 8I0IFENC096.402-1 | ACPi P96 A/B, resolver interface card | |



Table 10: 8I0IFENC096.402-1 - Order data

### 3.2.1.2.4 Technical data

| | 8I0IFENC096.402-1 |
|---|---|
| **General information** | |
| Max. power consumption | 350 mA at 24 VDC (max. total current consumption of incremental encoders, referencing and cables 5 W) |
| Degree of protection | IP20 |
| Connections | 1x 9-pin female DSUB connector<br>1x 9-pin male DSUB connector<br>1x 15-pin female DSUB connector<br>1x 6-pin terminal block, max. 1.5 mm², tightening torque 0.3 Nm [3 lbf in] |
| **TTL incremental encoder input (X51)** | |
| Output voltage | +5.5 VDC -5%, -8%, 180 mA<br>+24 VDC ±15%, 150 mA with digital inputs<br>+5.5 V and +24 V combined max. total power 3.6 W |
| CH A, CH B, CH Z | RS422/RS485, differential, 500 kHz (max.) |
| Maximum cable length | 30 m with a 5 V incremental encoder (0.5 mm² cable for power supply)<br>60 m with a 5 V incremental encoder (two pairs of wires in parallel, 0.5 mm² for power supply)<br>100 m with a 10 to 30 V TTL incremental encoder |
| Performance | Rotation speed range: -32768 to 32767<br>Speed resolution: 0.04 rpm (24 bits)<br>Position resolution: 16 M / revolution (24 bits)<br>Position accuracy: 4x pulse count / revolution |
| Electrical isolation | Together with the digital inputs |
| **Resolver interface (X42)** | |
| Output voltage | (AC) 4 ... 12$V_{Eff}$, 100 mA max. |
| PTC thermistor or KTY84 input | Yes |
| Sine/Cosine inputs | 2 ... 7 $V_{rms}$ each |
| Maximum cable length | 100 m |
| Performance | Position resolution: 24 bits<br>Speed resolution: 24 bits |
| Electrical isolation | With the emulation output of the TTL incremental encoder |
| **Emulation output for a TTL incremental encoder (X43)** | |
| Support | Emulation of a TTL incremental encoder, 1 to 65535 pulses / revolution, reference / zero pulse |
| Channels CH A, CH B, CH Z | RS422/RS485, 500 kHz (max.) |
| Maximum cable length | 100 m |
| Performance | Rotation speed range: -32768 to 32767<br>Position resolution: 4x pulse count / revolution |
| Electrical isolation | Together with the TTL incremental encoder input |
| **Digital inputs for position referencing (X44)** | |
| Output voltage | +24 VDC ±15%, short-circuit proof |
| Signal level | <5 V = 0, >15 V = 1 |
| Electrical isolation | Together with the TTL incremental encoder input |

Table 11: 8I0IFENC096.402-1 - Technical data

### 3.2.1.2.5 Dimension diagram

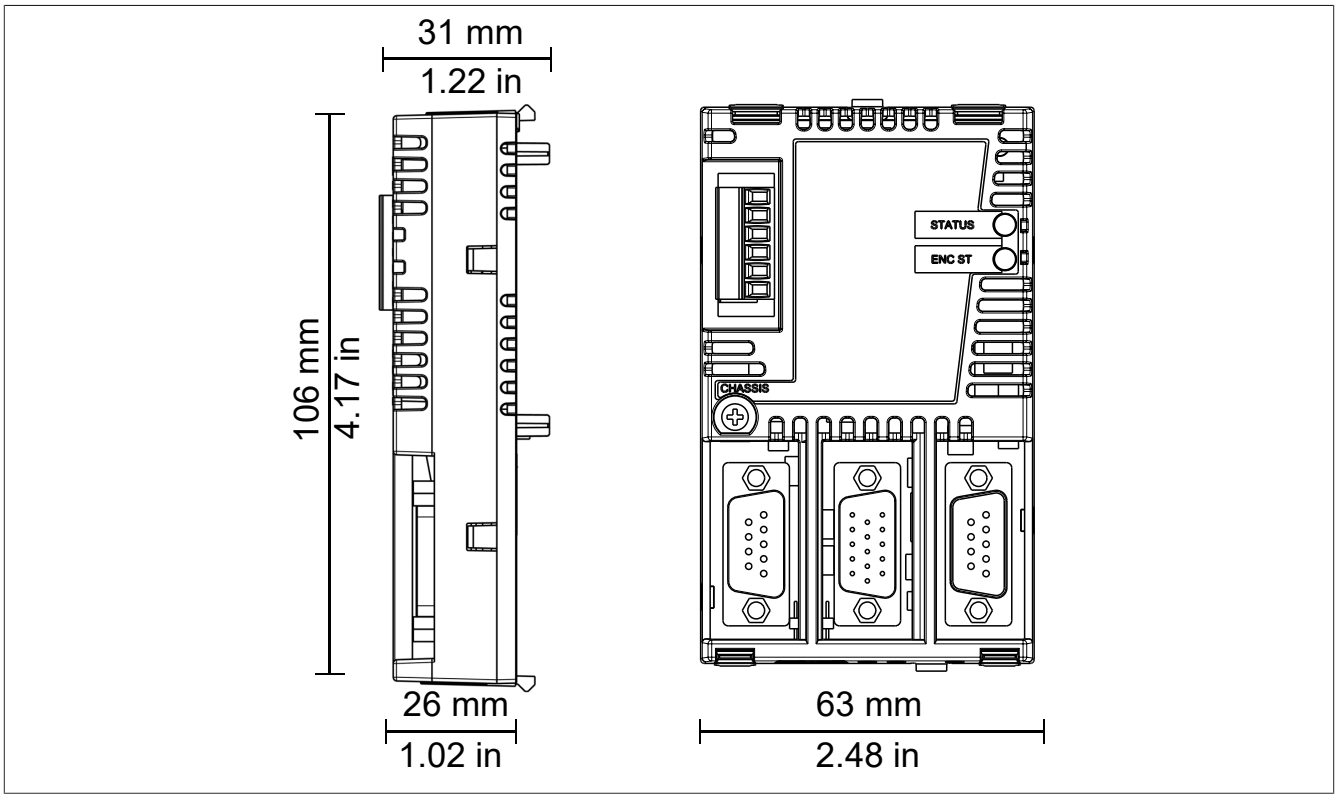



Figure 3: 8I0IFENC096.402-1 - Dimension diagram

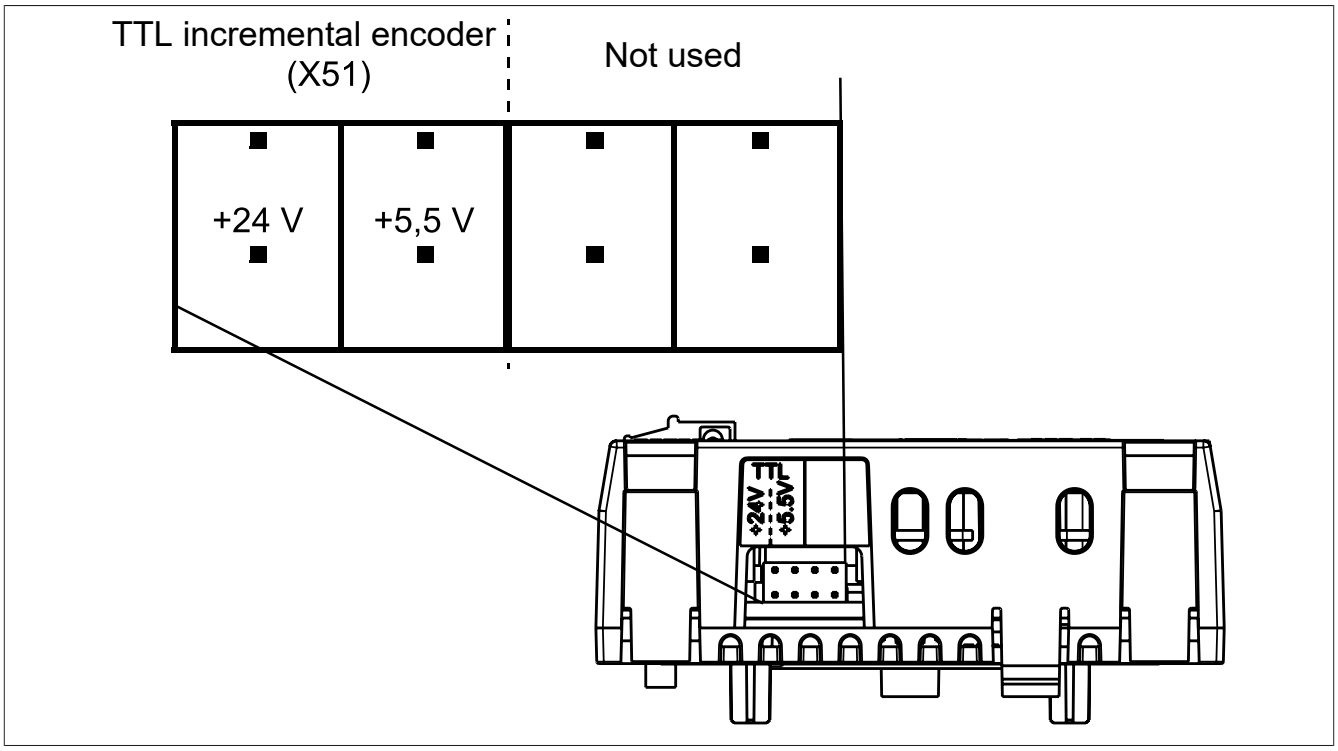
### 3.2.1.2.6 Installation

**Setting the supply voltage**

**Warning!**

**An incorrectly set supply voltage can damage the encoder.**

A supply voltage can be selected for the absolute encoder and TTL incremental encoder input. A +5.5 V or +24 V voltage for a TTL incremental encoder and a +5.5 V or +8 V voltage for an absolute encoder can be set with the vertically arranged jumpers (see the following figure).




## Note:

**When using an external power supply, the corresponding jumper must be removed.**

## Note:

**If the TTL emulation output of another interface card is connected to the TTL input, the corresponding jumper must be removed.**

**Installation**

## Warning!

**Switch off the power supply to the frequency inverter before beginning installation. Wait five minutes to ensure that the frequency inverter capacitors have discharged. Disconnect all dangerous voltages from external control circuits applied to the inputs and outputs of the frequency inverter.**

## Note:

**Before installing the module, connect the jumpers for setting the supply voltage.**

The module must be inserted into the slot for option modules in the frequency inverter.

The module is held by plastic clips and a screw. The screw is also used to ground the cable shields connected to the module and connects the GND signals of the module and the frequency inverter.

After installing the module, the connection of the signals and the voltage to the frequency inverter is made via a 20-pin connector automatically.

**Procedure**

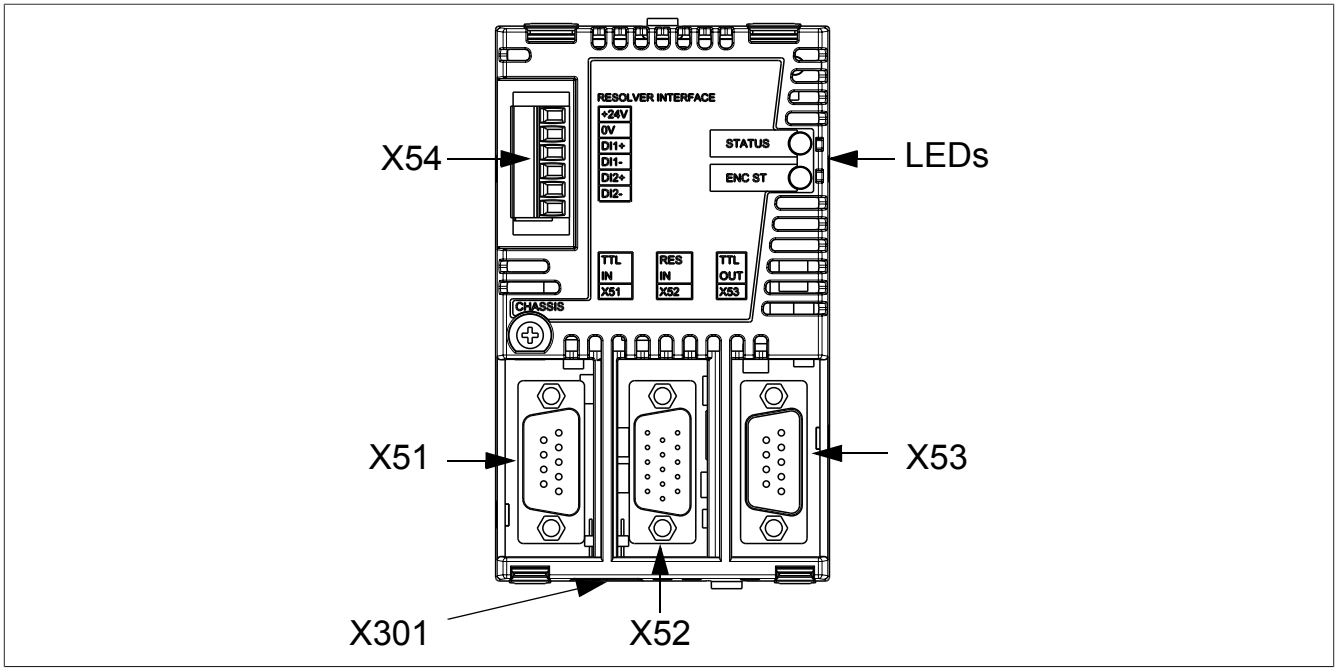
- Carefully push the module into the option slot until the module's retaining clips snap into place.
- Tighten the screw (provided).

## Note:

**Correct tightening of the screw is crucial for meeting EMC requirements and for trouble-free operation of the module.**

### 3.2.1.2.7 Wiring

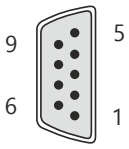
#### Overview




## Note:

**Placement of the incremental encoder cables parallel to power cables (e.g. motor cables) is not permitted.**

#### TTL incremental encoder input (X51)

| X51 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | A+ | Channel A+ |
| | 2 | B+ | Channel B+ |
| | 3 | Z | Channel Z+ |
| | 4 | COM_C | Common reference potential |
| | 5 | VCC_ENC_1 | Supply voltage (5.5 V or 24 V) |
| | 6 | A- | Channel A- |
| | 7 | B- | Channel B- |
| | 8 | Z- | Channel Z- |
| | 9 | COM_C | Common reference potential |

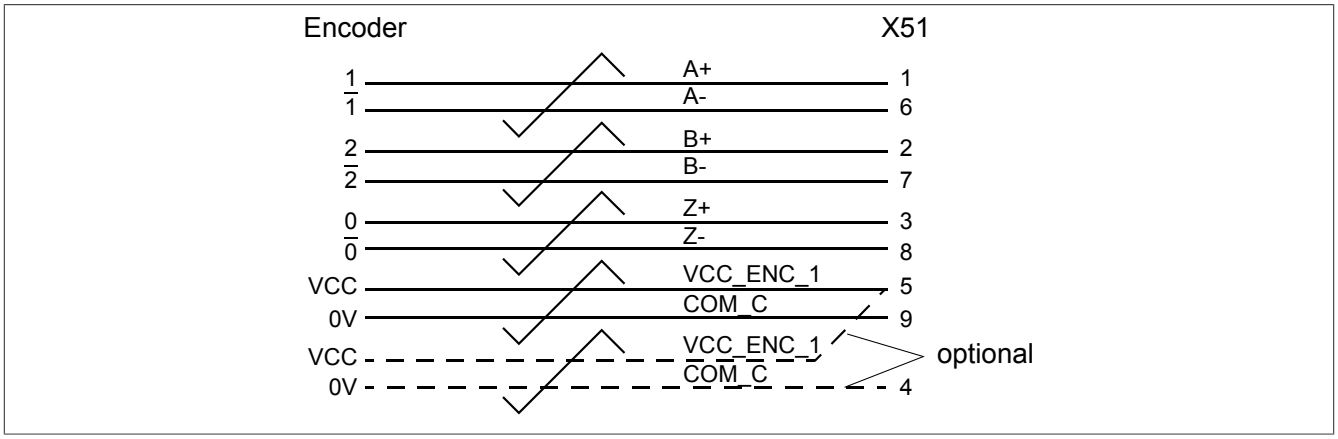
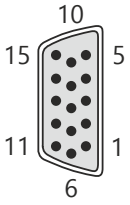



Figure 4: X51 wiring

## Resolver input (X52)

| X52 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | SIN- | Sine ref. |
| | 2 | COS- | Cosine ref. |
| | 3 | PTC/KTY | Temperature sensor |
| | 4 | COM_B | Common reference potential, reserved for temperature sensor |
| | 5 | EXCITATION+ | Excitation signal+ |
| | 6 | SIN+ | Sine signal |
| | 7 | COS+ | Cosine signal |
| | 8 | GND | Chassis, reserved for the shield of a twisted-pair cable |
| | 9 | COM_B | Common reference potential |
| | 10 | EXCITATION- | Excitation signal- |
| | 11 | GND | Chassis, reserved for the shield of a twisted-pair cable |
| | 12 | COM_B | Common reference potential |
| | 13 | COM_B | Common reference potential |
| | 14 | GND | Chassis, reserved for the shield of a twisted-pair cable |
| | 15 | GND | Chassis, reserved for the shield of a twisted-pair cable |



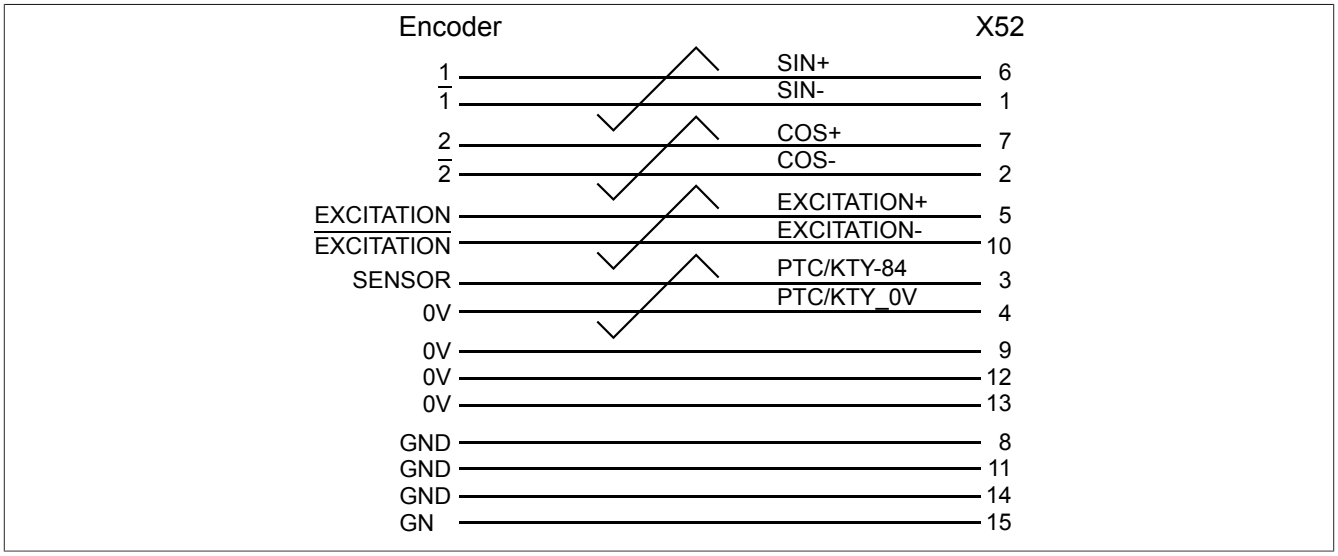
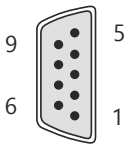



Figure 5: X52 wiring

## Emulation output of the TTL incremental encoder (X53)

| X53 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | EM_A+ | Channel A+ |
| | 2 | EM_B+ | Channel B+ |
| | 3 | EM_Z+ | Channel Z+ |
| | 4 | COM_B | Common reference potential |
| | 5 | COM_B | Common reference potential |
| | 6 | EM_A- | Channel A- |
| | 7 | EM_B- | Channel B- |
| | 8 | EM_Z- | Channel Z- |
| | 9 | COM_B | Common reference potential |



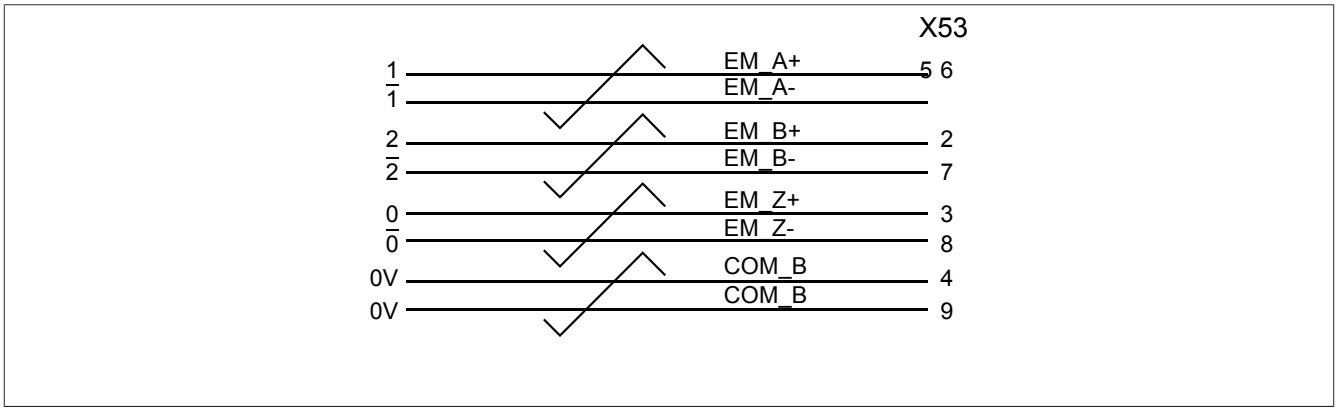
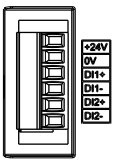



Figure 6: X53 wiring

## Digital inputs for position referencing (X54)

| X54 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | +24V_C | Supply voltage |
| | 2 | COM_C | Common reference potential |
| | 3 | DI_1+ | Reference signal 1 |
| | 4 | DI_1- | Reference signal 1 feedback |
| | 5 | DI_2+ | Reference signal 2 |
| | 6 | DI_2- | Reference signal 2 feedback |

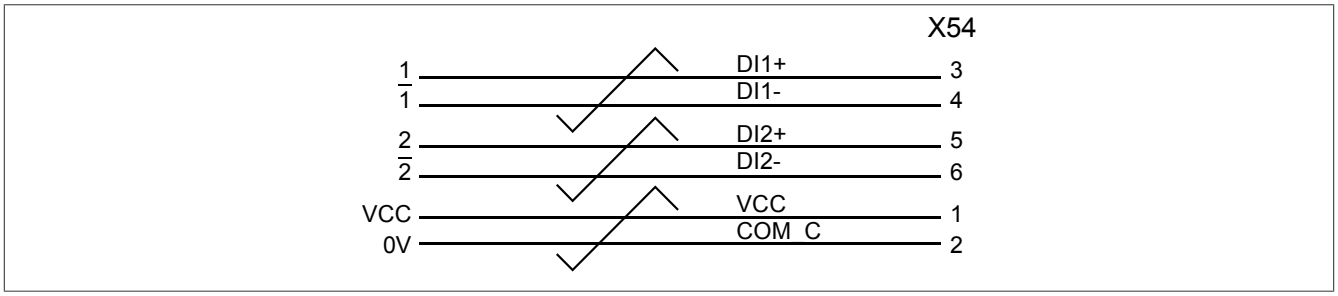



Figure 7: X54 wiring

### 3.2.1.3 8I0IFENC096.403-1

#### 3.2.1.3.1 General information

Interface card 8I0IFENC096.403-1 can be used in an ACOPOSinverter P96. It supports different types of HTL incremental encoders. A PTC or KTY temperature sensor can be connected to one of the ports on the interface board.

The module is also equipped with an RS422-compatible TTL incremental encoder output for emulation and two digital inputs. Open-circuit monitoring is supported for some types of HTL encoders.

**Compatibility**

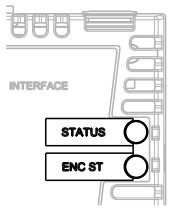
- Differential push-pull HTL incremental encoder
- Single-ended push-pull HTL incremental encoder
- Open collector HTL incremental encoder
- Open emitter HTL incremental encoder

**Programming**

The module is programmed via the drive parameters. These parameters must be checked and set according to the incremental encoder and resolver data sheets.

**Diagnostic LEDs**

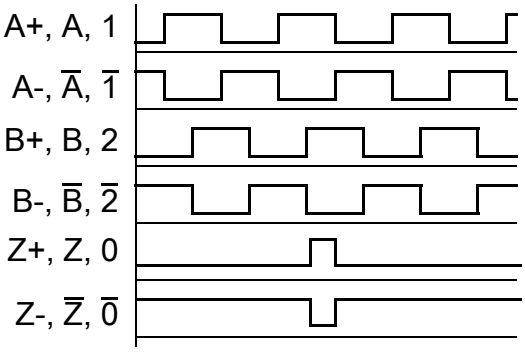
The module is equipped with two diagnostics LEDs. LED STATUS indicates the status of the interface card, and LED ENC1 ST indicates the status of the rotary encoder.

| Figure | LED | Color | Description |
|---|---|---|---|
|  | STATUS | Green | OK |
| | | Orange | Not initialized or communication with ACOPOSinverter P96 disrupted |
| | | Red | Not used |
| | ENC ST | Green | Rotary encoder OK |
| | | Orange | Rotary encoder fault |

#### 3.2.1.3.2 Phase setting

If the HTL incremental encoder is connected correctly, a positive incremental encoder feedback signal must be generated when the drive is running forward.

The two output channels in incremental encoders, usually designated 1 and 2 or A and B, are rotated 90° (electrically). With clockwise rotation, channel 1 leads channel 2 for most but not all pulse encoders (see the following figure). See the documentation for the incremental encoder or use an oscilloscope to determine which channel is leading.




That incremental encoder output channel that leads when the drive/frequency inverter runs in the forward direction, must be connected to input A of 8I0IFENC096.403-1 and the lagging output channel, to input B of 8I0IFENC096.403-1.

The zero pulse output channel (normally designated 0, N or Z) only needs to be connected for positioning applications.

### 3.2.1.3.3 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Interface modules** | |
| 8I0IFENC096.403-1 | ACPi P96 A/B & HTL interface card | |

Table 12: 8I0IFENC096.403-1 - Order data

### 3.2.1.3.4 Technical data

| | 8I0IFENC096.403-1 |
|---|---|
| **General information** | |
| Max. power consumption | 350 mA at 24 VDC (max. total current consumption of incremental encoders, referencing and cables 5 W) |
| Degree of protection | IP20 |
| Connections | 2x 7-pin terminal block, max. 2.5 mm², tightening torque 0.5 Nm [5 lbf in]<br>1x 9-pin male DSUB connector<br>1x 6-pin terminal block, max. 1.5 mm², tightening torque 0.3 Nm [3 lbf in] |
| **HTL incremental encoder inputs (X81, X82)** | |
| Supply voltages | +15 VDC ±20% 200 mA (max.)<br>+15 VDC ±20% 200 mA (max.)<br>External power supply, voltage range 10 ... 24 VDC |
| CH A, CH B, CH Z | Signal frequencies up to 300 kHz can be detected<br>Signal level: "0" <3.5 V, "1" > 7.5 V |
| Supported encoder types | Differential push-pull HTL incremental encoder, supply voltage 10 ... 24 V<br>Single-ended push-pull HTL incremental encoder, supply voltage 15 ... 24 V<br>Open collector HTL incremental encoder, supply voltage 15 ... 24 V.<br>Open emitter HTL incremental encoder, supply voltage 15 ... 24 V |
| Maximum cable length | Differential push-pull HTL incremental encoder: 300 m<br>Single-ended push-pull HTL incremental encoder: 200 m<br>Open collector / Open emitter HTL incremental encoder: 100 m |
| Performance | Rotation speed range: -32768 to 32767<br>Speed resolution: 0.04 rpm (24 bits)<br>Position resolution: 16 M / revolution (24 bits)<br>Position accuracy: 4x pulse count / revolution |
| Electrical isolation | Together with the digital inputs |
| **Emulation output for a TTL incremental encoder (X83)** | |
| Support | Emulation of a TTL incremental encoder, 1 to 65535 pulses / revolution, reference / zero pulse |
| Channels CH A, CH B, CH Z | RS422/RS485, 500 kHz (max.) |
| Maximum cable length | 100 m |
| Performance | Rotation speed range: -32768 to 32767<br>Position resolution: 4x pulse count / revolution |
| Electrical isolation | Together with the TTL incremental encoder input |
| **Digital inputs for position referencing (X84)** | |
| Output voltage | +24 VDC ±15%, short-circuit proof |
| Signal level | <5 V = 0, >15 V = 1 |
| Electrical isolation | Together with the TTL incremental encoder input |

Table 13: 8I0IFENC096.403-1 - Technical data

### 3.2.1.3.5 Dimension diagram

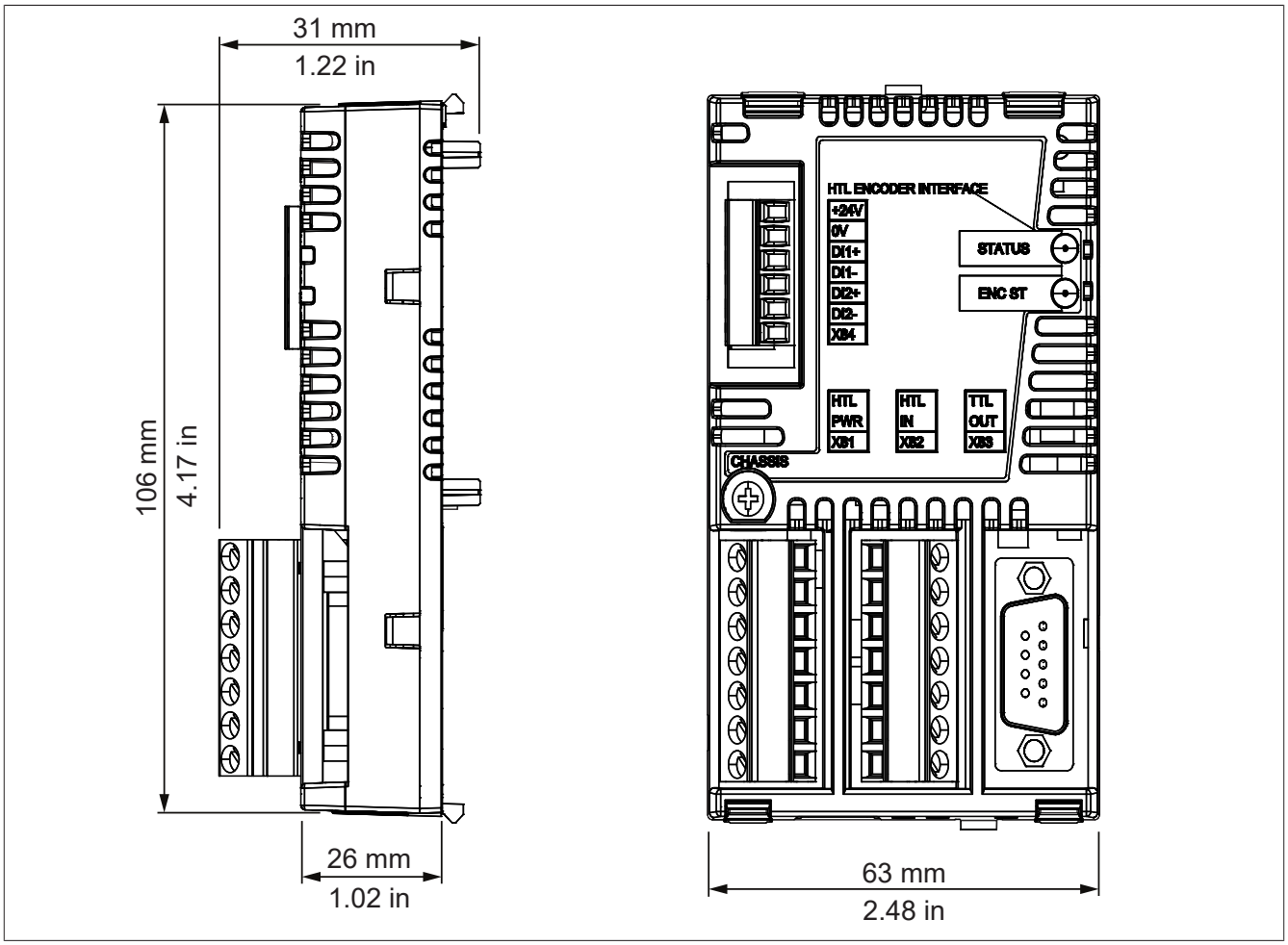



Figure 8: 8I0IFENC096.403-1 - Dimension diagram

Weight: 0.17 kg

### 3.2.1.3.6 Installation

**Setting the supply voltage**

**Warning!**

**An incorrectly set supply voltage can damage the encoder.**

The supply voltage is set using a jumper in terminal strip X81. The jumper is used to set either +15 V (default) or +24 V for the incremental encoder. If the jumper is not installed, an external voltage source can be connected.

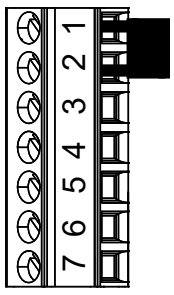
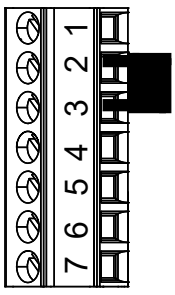
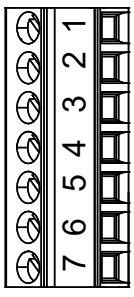
| +15 V | +24 V | External power supply |
|---|---|---|
|  |  |  |



Table 14: Setting the supply voltage

### Installation

**Warning!**

**Switch off the power supply to the frequency inverter before beginning installation. Wait five minutes to ensure that the frequency inverter capacitors have discharged. Disconnect all dangerous voltages from external control circuits applied to the inputs and outputs of the frequency inverter.**

**Note:**

**Before installing the module, connect the jumpers for setting the supply voltage.**

The module must be inserted into the slot for option modules in the frequency inverter.

The module is held by plastic clips and a screw. The screw is also used to ground the cable shields connected to the module and connects the GND signals of the module and the frequency inverter.

After installing the module, the connection of the signals and the voltage to the frequency inverter is made via a 20-pin connector automatically.

**Procedure**

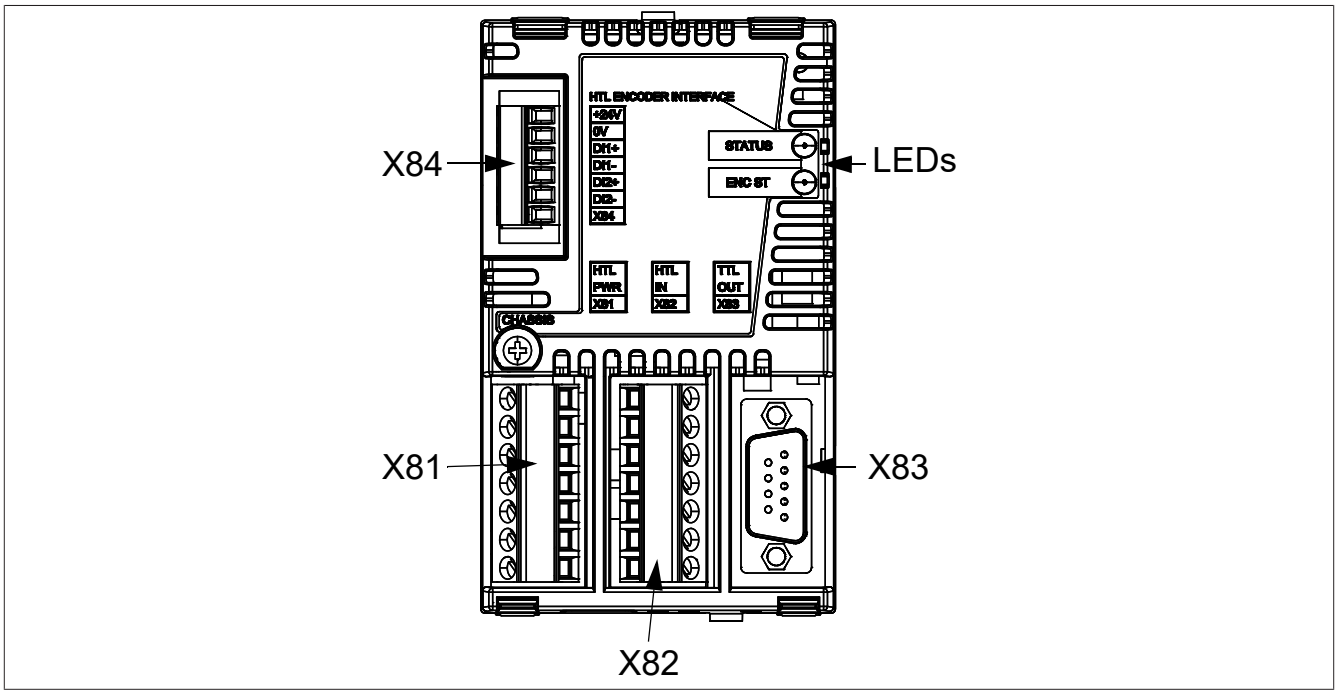
- Carefully push the module into the option slot until the module's retaining clips snap into place.
- Tighten the screw (provided).

**Note:**

**Correct tightening of the screw is crucial for meeting EMC requirements and for trouble-free operation of the module.**

#### 3.2.1.3.7 Wiring

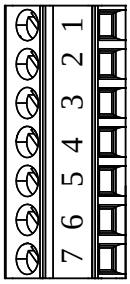
**Overview**



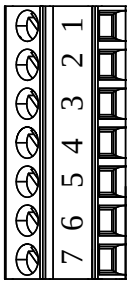

**Note:**

**Placement of the incremental encoder cables parallel to power cables (e.g. motor cables) is not permitted.**

### HTL rotary encoder supply voltage (X81)

| X81 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | +15V_B | Supply voltage +15 V |
| | 2 | VCC | External encoder power supply |
| | 3 | +24V_B | Supply voltage +24 V |
| | 4 | VCC | External encoder power supply |
| | 5 | COM_B | 0 V, temperature sensor 0 V |
| | 6 | PTC/KTY-84 | Temperature sensor |
| | 7 | GND | Shield |

### HTL rotary encoder input (X82)

| X82 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | A+ | Channel A |
| | 2 | A- | Channel A inverted |
| | 3 | B+ | Channel B |
| | 4 | B- | Channel B inverted |
| | 5 | Z | Zero pulse |
| | 6 | Z- | Zero pulse inverted |
| | 7 | GND | Shield |

### Wiring diagrams

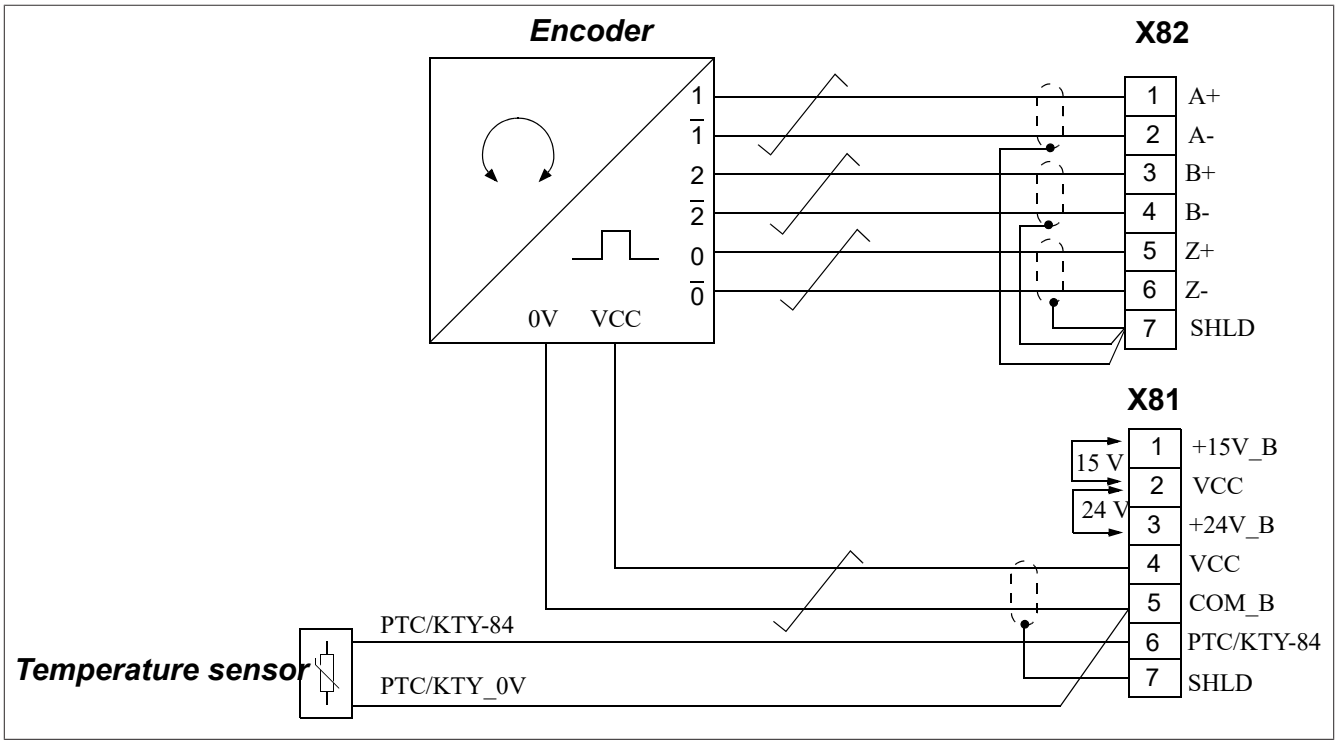



Figure 9: Wiring diagram for differential push-pull HTL incremental encoder

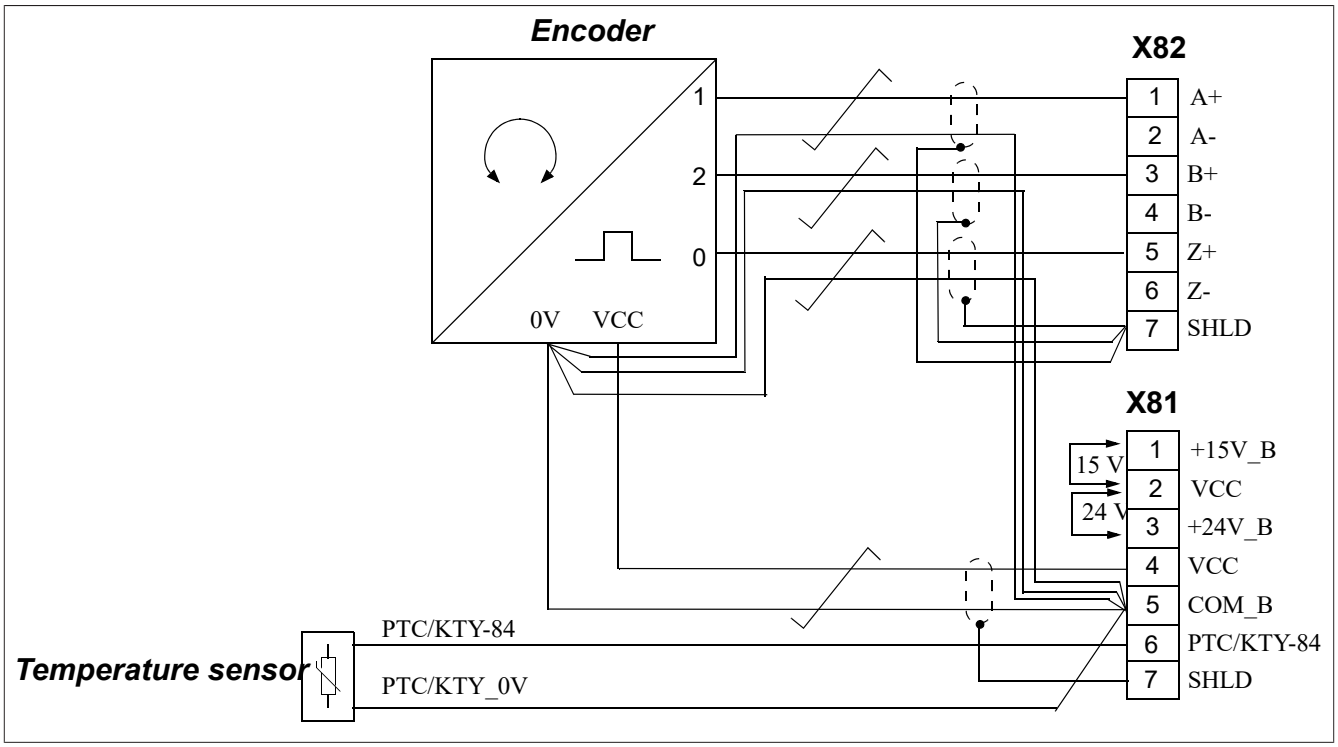



Figure 10: Wiring diagram for single-ended push-pull HTL incremental encoder

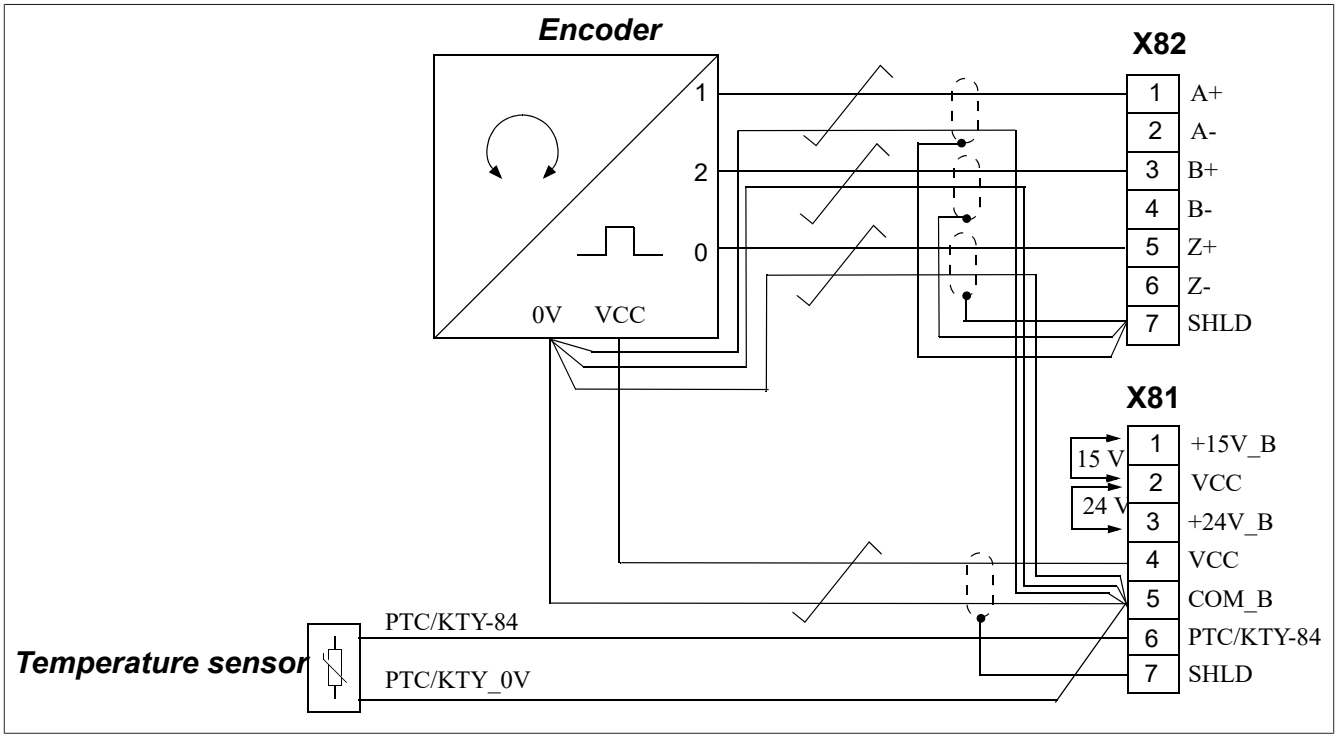



Figure 11: Wiring diagram for single-ended open collector HTL incremental encoder and single-ended open emitter HTL incremental encoder

For using single-ended open collector and single-ended open emitter HTL incremental encoders, pull-up resistors must be configured on the module:

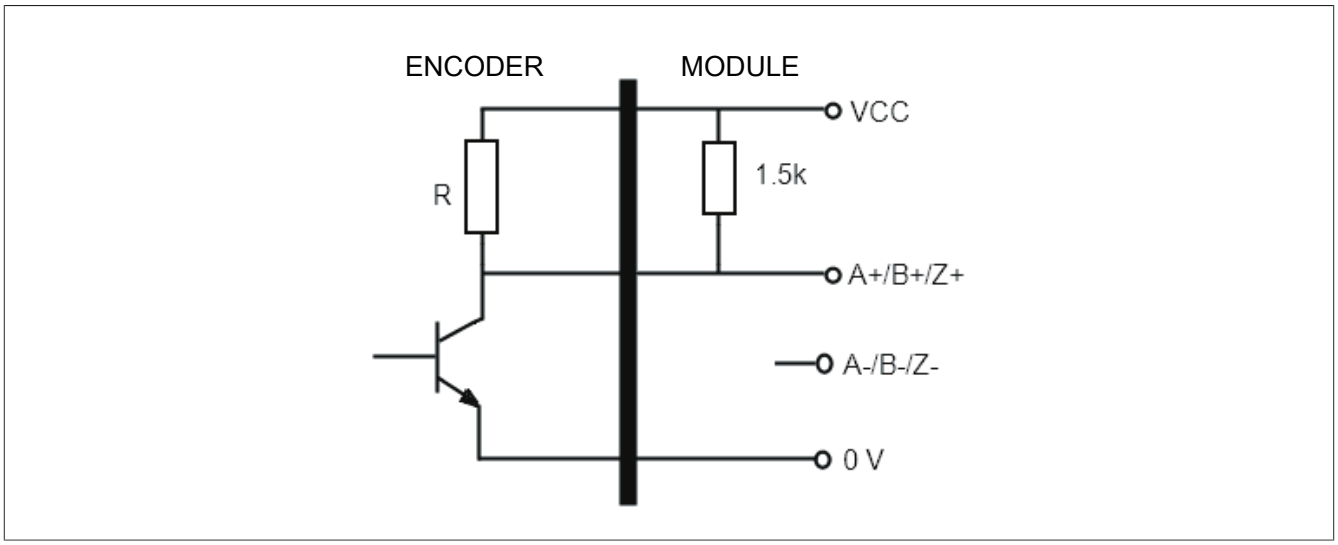



Figure 12: Resistor configuration for open collector HTL incremental encoder

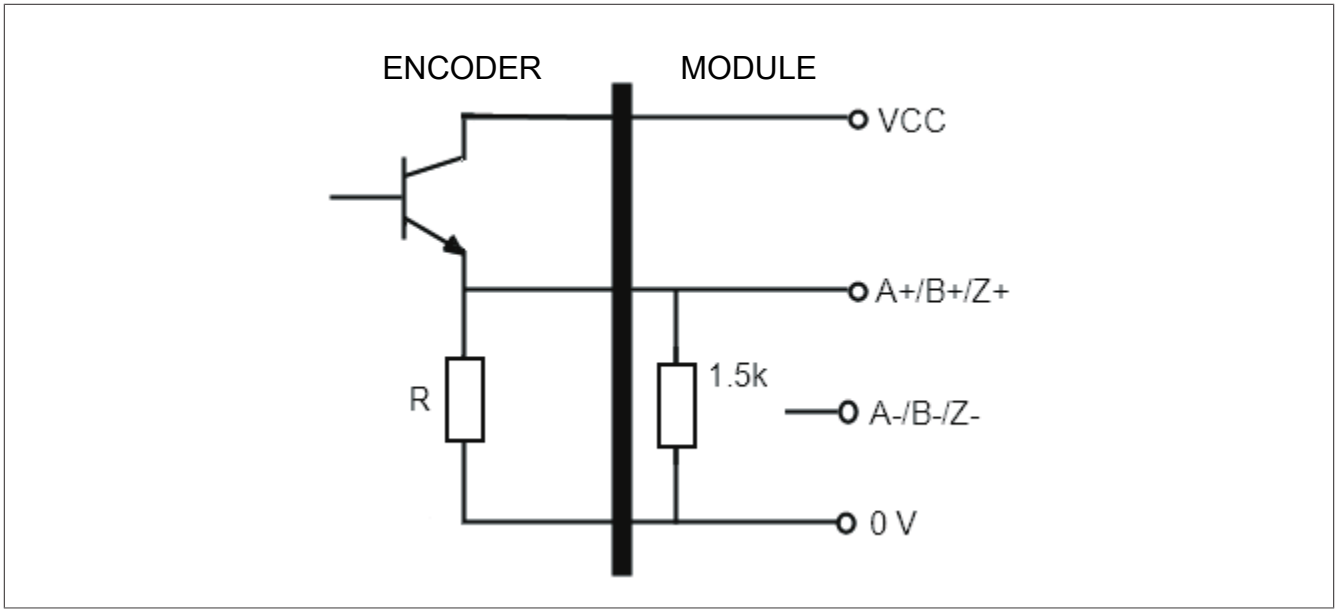



Figure 13: Resistor configuration for open emitter HTL incremental encoder

To configure the pull-up resistors using the DIP switches, the module cover must be removed.

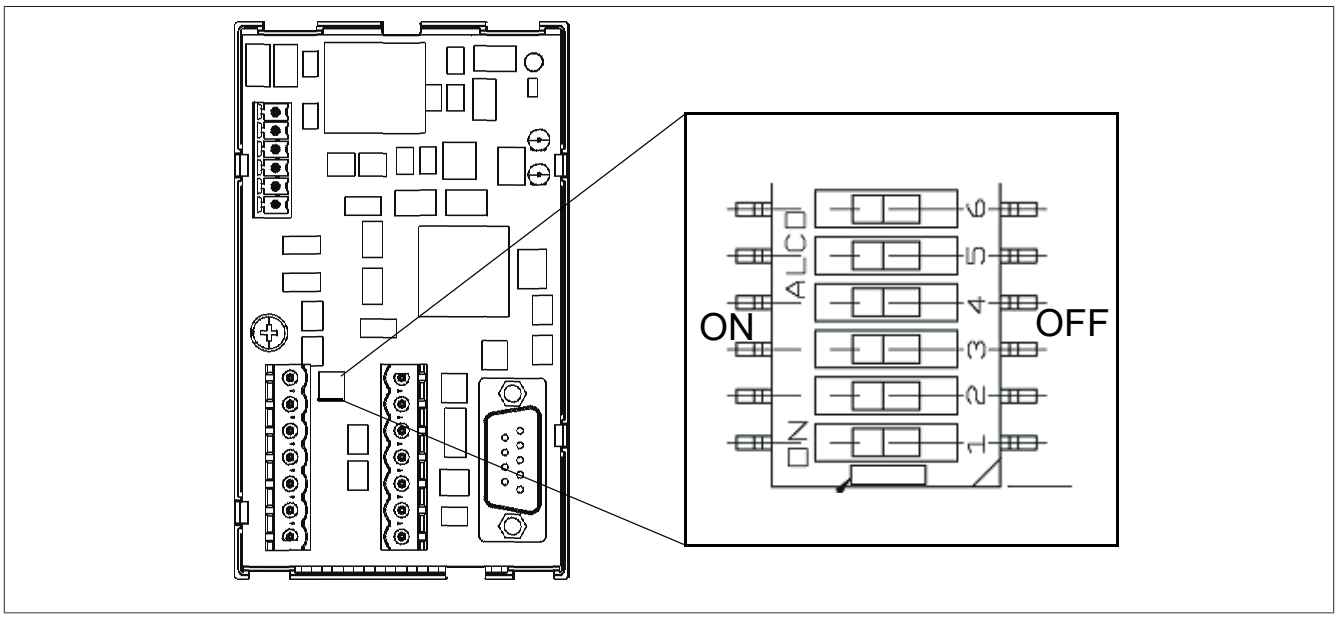



Figure 14: DIP switch arrangement

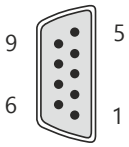
| Encoder type | DIP switch 1 | DIP switch 2 | DIP switch 3 | DIP switch 4 | Note |
|---|---|---|---|---|---|
| Differential push-pull | OFF | OFF | OFF | OFF | Default setting |
| Single-ended push-pull | OFF | OFF | OFF | OFF | Default setting |
| Open collector. | ON | ON | ON | OFF | Pull-up (A+, B+, Z+) |
| Open emitter. | ON | ON | ON | ON | Pull-down (A+, B+, Z+) |

Table 15: Configuration of the pull-up resistors using DIP switches

## Information:

**The default setting of the DIP switches is OFF.**

### TTL emulation output (X53)

| X53 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | EM_A+ | Channel A+ |
| | 2 | EM_B+ | Channel B+ |
| | 3 | EM_Z+ | Channel Z+ |
| | 4 | COM_B | Common reference potential |
| | 5 | COM_B | Common reference potential |
| | 6 | EM_A- | Channel A- |
| | 7 | EM_B- | Channel B- |
| | 8 | EM_Z- | Channel Z- |
| | 9 | COM_B | Common reference potential |



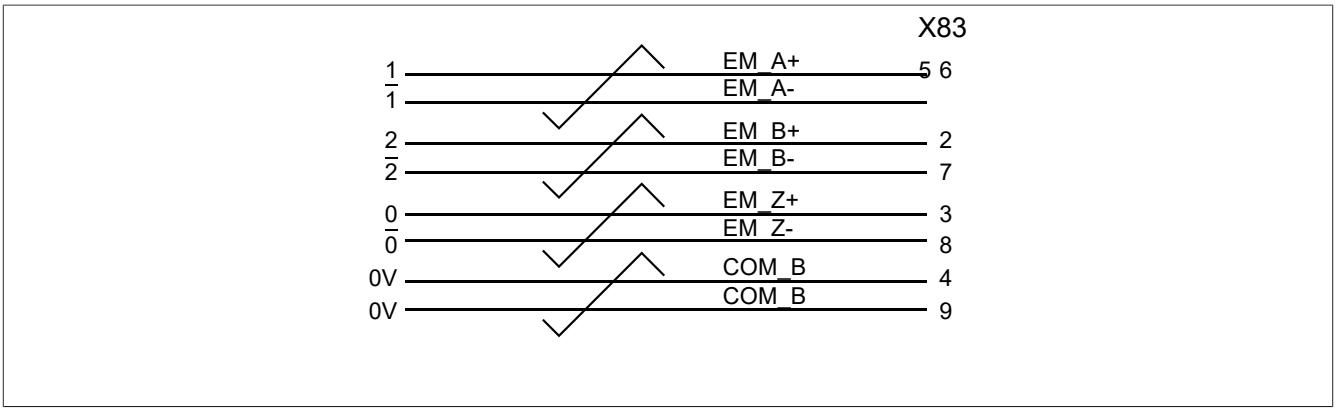
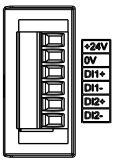



Figure 15: X53 wiring

### Digital inputs for position referencing (X84)

| X54 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | +24V_C | Supply voltage |
| | 2 | COM_C | Common reference potential |
| | 3 | DI_1+ | Reference signal 1 |
| | 4 | DI_1- | Reference signal 1 feedback |
| | 5 | DI_2+ | Reference signal 2 |
| | 6 | DI_2- | Reference signal 2 feedback |

### 3.2.1.4 8I0IFENC096.405-1

#### 3.2.1.4.1 General information

The interface card 8I0IFENC096.405-1 can be used in an ACOPOSinverter P96 and contains a connection for TTL incremental encoders, as well as for absolute encoders with PTC/KTY support. The module also has a TTL incremental encoder output for emulation and two digital reference signal inputs for position referencing.

**Compatibility**

8I0IFENC096.405-1 is compatible with the following encoders:

**Absolute encoder**

- The sin/cos encoder, 1 ... 65535 pulses / revolution, supports reference / zero pulse and sin/cos commutation signals.
- Endat 2.1 with Sin/Cos signals (partially without Sin/Cos signals)
- Endat 2.2 with Sin/Cos signals (partially without Sin/Cos signals)
- SSI with sin/cos signals (partly without sin/cos signals). Check the compatibility.

**TTL incremental encoder**

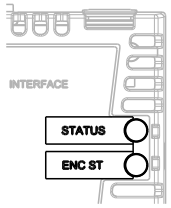
- TTL incremental encoder, 1 ... 65535 pulses / revolution, supports reference / zero pulse.

**Programming**

The module is programmed via the drive parameters. These parameters must be checked and set corresponding to the rotary encoder data sheets.

**Diagnostic LEDs**

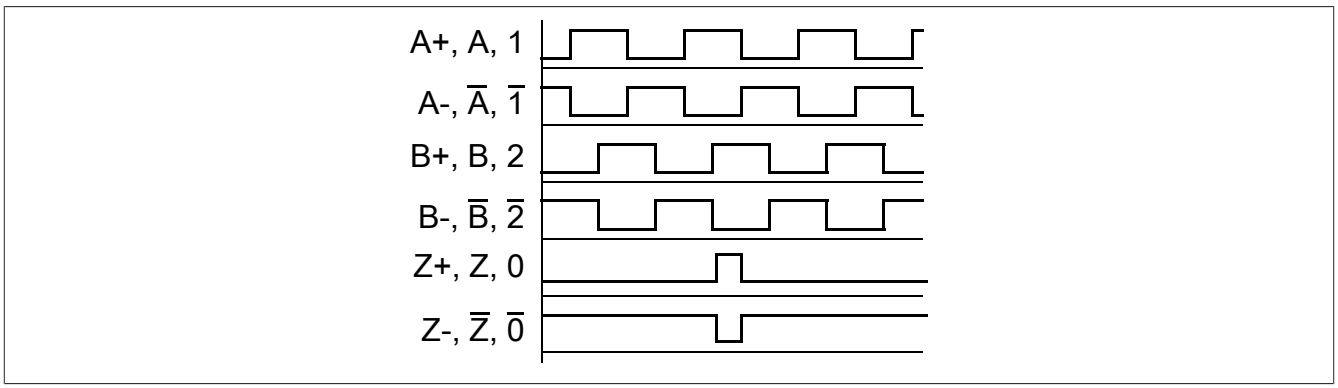
The module is equipped with two diagnostics LEDs. The STATUS LED indicates the status of the interface card and the ENC1 ST LED indicates the status of the encoder.

| Figure | LED | Color | Description |
|---|---|---|---|
|  | STATUS | Green | OK |
| | | Orange | Not initialized or communication with ACOPOSinverter P96 disrupted |
| | | Red | Not used |
| | ENC ST | Green | Rotary encoder OK |
| | | Red | TTL incremental encoder (X41) fault |
| | | Orange | Absolute encoder (X42) fault |
| | | Blinking red/orange | TTL incremental encoder (X41) and absolute encoder (X32) fault |
| | | Blinking red | TTL incremental encoder (X41) warning |
| | | Blinking orange | Absolute encoder (X32) warning |

#### 3.2.1.4.2 Phase setting

If the TTL incremental encoder is connected correctly, a positive incremental encoder feedback signal must be generated when the drive is running forward.

The two output channels in incremental encoders, usually designated 1 and 2 or A and B, are rotated 90° (electrically). With clockwise rotation, channel 1 leads channel 2 for most but not all pulse encoders (see the following figure). See the documentation for the incremental encoder or use an oscilloscope to determine which channel is leading.



### EnDat and serial SSI connection

The following diagrams show the incremental signals from each supported sine/cosine encoder type when the drive is rotating forward.

### EnDat/SSI/Incremental encoder

- The output channel leading when the drive rotates in the forward direction should be connected to the COS input of the FEN-11 and the lagging output channel to the SIN input of the module. See also, the following note.

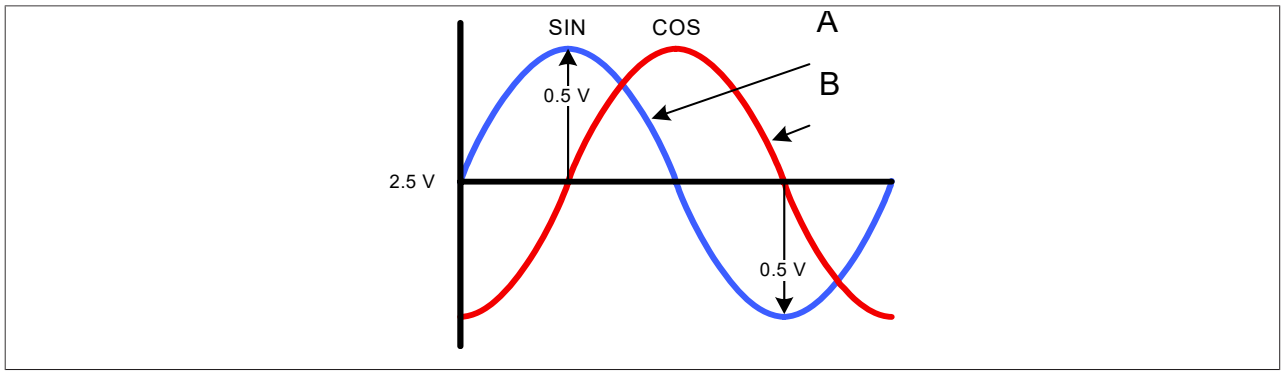



Figure 16: Incremental signals with a serial EnDat connection, with serial SSI connection and if the serial connection is not configured.

### Serial Hiperface connection

### Hiperface rotary encoder

- The output channel leading when the drive rotates in the forward direction should be connected to the SIN input of the module and the trailing output channel to the COS input of the module.

> **Note:**
>
> **If an SSI rotary encoder provides incremental signals corresponding to the SIN and COS of the HIPERFACE rotary encoder (shown in the diagram below), the cosine channel should be inverted to meet the conditions for incremental signals of the SSI serial link (diagram above).**

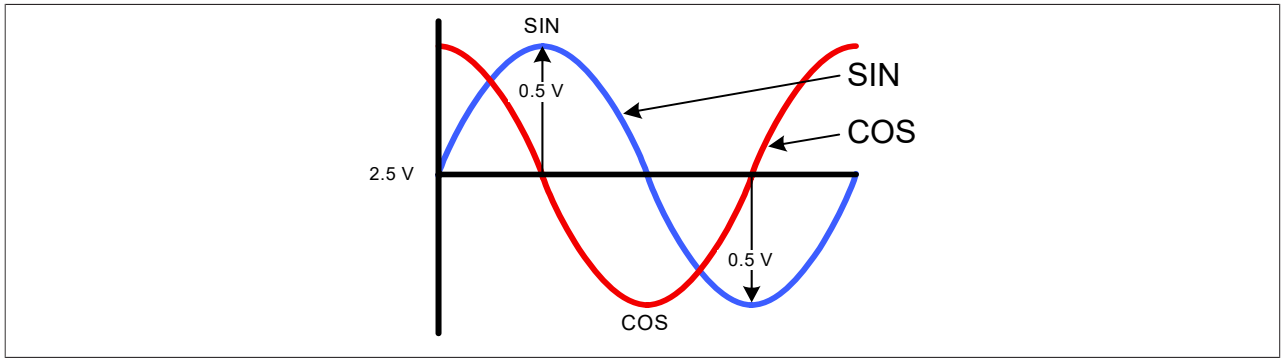



Figure 17: Incremental signals with a serial Hiperface connection

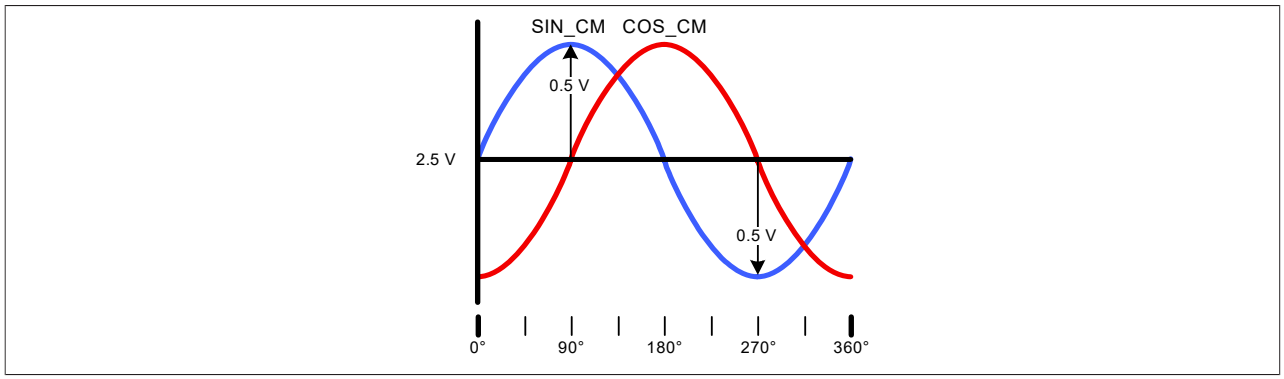



Figure 18: Shaft angle of the rotary encoder (0° ... 360°)

### Rotary encoder commutation signals

Rotary encoder commutation signals (one sine/cosine period per revolution) should be connected (if these signals are available) to inputs SIN_CM and COS_CM of the module as shown above.

The output channel of the zero pulse/reference point (normally marked 0, N or Z) only needs to be connected for positioning applications.

### 3.2.1.4.3 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Interface modules** | |
| 8I0IFENC096.405-1 | ACPi P96 EnDat, HiFace, SSI, AB, SinCos interface card | |



Table 16: 8I0IFENC096.405-1 - Order data

### 3.2.1.4.4 Technical data

| | 8I0IFENC096.405-1 |
|---|---|
| **General information** | |
| Max. power consumption | 350 mA at 24 VDC |
| Degree of protection | IP20 |
| Connections | 1x 9-pin female DSUB connector<br>1x 9-pin male DSUB connector<br>1x 15-pin female DSUB connector<br>1x 6-pin terminal block, max. 1.5 mm², tightening torque 0.3 Nm [3 lbf in] |
| **TTL incremental encoder input (X41)** | |
| Output voltage | +5.5 VDC -5%, -8%, 180 mA<br>+24 VDC ±15%, 150 mA with digital inputs<br>+5.5 V and +24 V combined max. total power 3.6 W |
| CH A, CH B, CH Z | RS422/RS485, differential, 500 kHz (max.) |
| Maximum cable length | 30 m with a 5 V incremental encoder (0.5 mm² cable for power supply)<br>60 m with a 5 V incremental encoder (two pairs of wires in parallel, 0.5 mm² for power supply)<br>100 m with a 10 to 30 V TTL incremental encoder |
| Performance | Rotation speed range: -32768 to 32767<br>Speed resolution: 0.04 rpm (24 bits)<br>Position resolution: 16 M / revolution (24 bits)<br>Position accuracy: 4x pulse count / revolution |
| Electrical isolation | Together with the digital inputs |
| **Absolute encoder input (X42)** | |
| Output voltage | +5.5 VDC +2.5%, -1%, 250 mA<br>Output voltage 2: +8 VDC +20%, -5%, 130 mA |
| PTC thermistor or KTY84 input | Yes |

Table 17: 8I0IFENC096.405-1 - Technical data

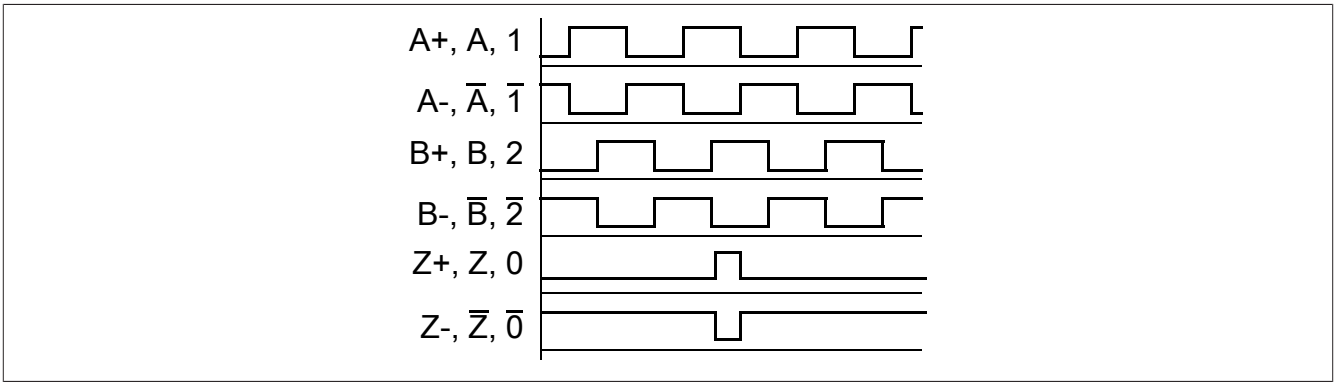
| | 8I0IFENC096.405-1 |
|---|---|
| Sine/Cosine signals | 1 Vpp (nom.), 1.2 Vpp (max.), 500 kHz (max.) |
| Serial connection | Signals corresponding to RS422/RS485 |
| Maximum cable length | 25 m (cable 0.5 mm² for power supply)<br>50 m (two pairs of wires in parallel, 0.5 mm² for power supply)<br>75 m with an external power supply of the absolute encoder |
| Performance | Rotation speed range: -32768 to 32767<br>Speed resolution: 0.04 rpm (24 bits)<br>Position resolution: 16 M / revolution (24 bits) |
| Electrical isolation | With the emulation output of the TTL incremental encoder |
| **Emulation output for a TTL incremental encoder (X43)** | |
| Support | Emulation of a TTL incremental encoder, 1 to 65535 pulses / revolution, reference / zero pulse |
| Channels CH A, CH B, CH Z | RS422/RS485, 500 kHz (max.) |
| Maximum cable length | 100 m |
| Performance | Rotation speed range: -32768 to 32767<br>Position resolution: 4x pulse count / revolution |
| Electrical isolation | Together with the TTL incremental encoder input |
| **Digital inputs for position referencing (X44)** | |
| Output voltage | +24 VDC ±15%, short-circuit proof |
| Signal level | <5 V = 0, >15 V = 1 |
| Electrical isolation | Together with the TTL incremental encoder input |

Table 17: 8I0IFENC096.405-1 - Technical data

### 3.2.1.4.5 Phase setting

If the TTL incremental encoder is connected correctly, a positive incremental encoder feedback signal must be generated when the drive is running forward.

The two output channels in incremental encoders, usually designated 1 and 2 or A and B, are rotated 90° (electrically). With clockwise rotation, channel 1 leads channel 2 for most but not all pulse encoders (see the following figure). See the documentation for the incremental encoder or use an oscilloscope to determine which channel is leading.




**EnDat and serial SSI connection**

The following diagrams show the incremental signals from each supported sine/cosine encoder type when the drive is rotating forward.

### EnDat/SSI/Incremental encoder

- The output channel leading when the drive rotates in the forward direction should be connected to the COS input of the FEN-11 and the lagging output channel to the SIN input of the module. See also, the following note.

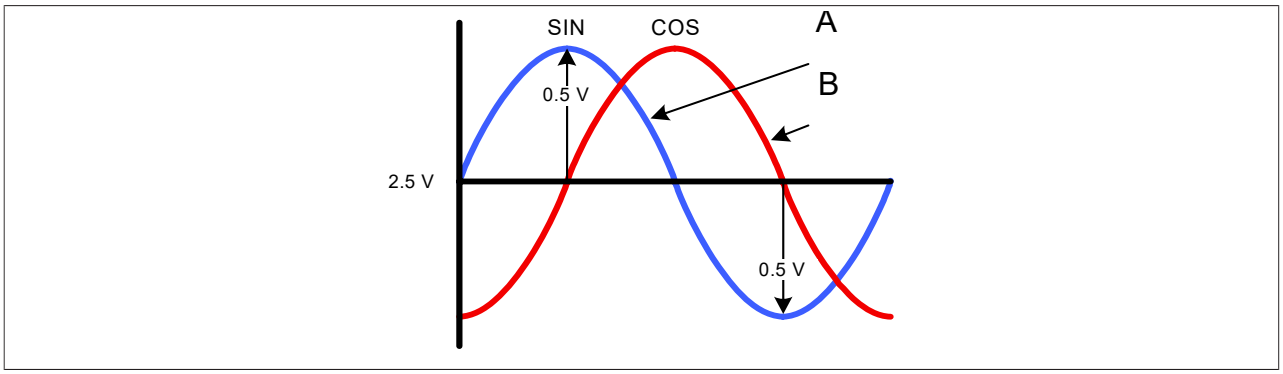



Figure 19: Incremental signals with a serial EnDat connection, with serial SSI connection and if the serial connection is not configured.

### Serial Hiperface connection

### Hiperface rotary encoder

- The output channel leading when the drive rotates in the forward direction should be connected to the SIN input of the module and the trailing output channel to the COS input of the module.

> **Note:**
>
> **If an SSI rotary encoder provides incremental signals corresponding to the SIN and COS of the HIPERFACE rotary encoder (shown in the diagram below), the cosine channel should be inverted to meet the conditions for incremental signals of the SSI serial link (diagram above).**

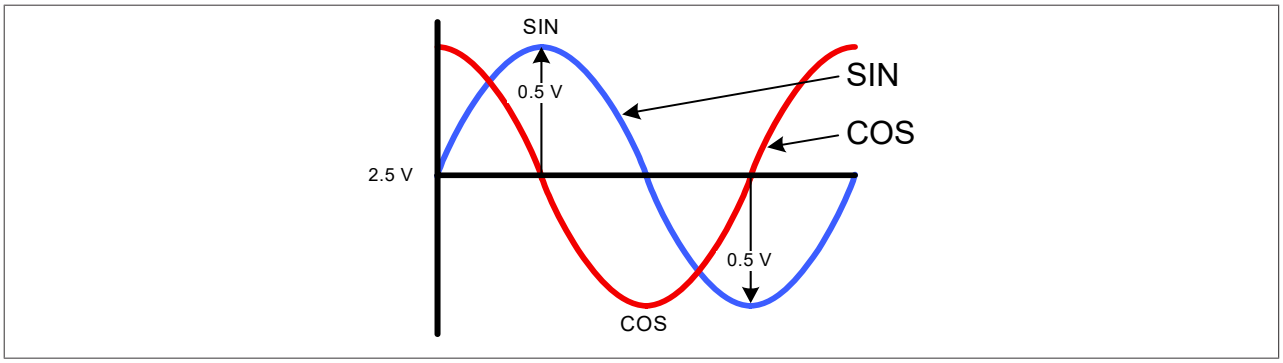



Figure 20: Incremental signals with a serial Hiperface connection

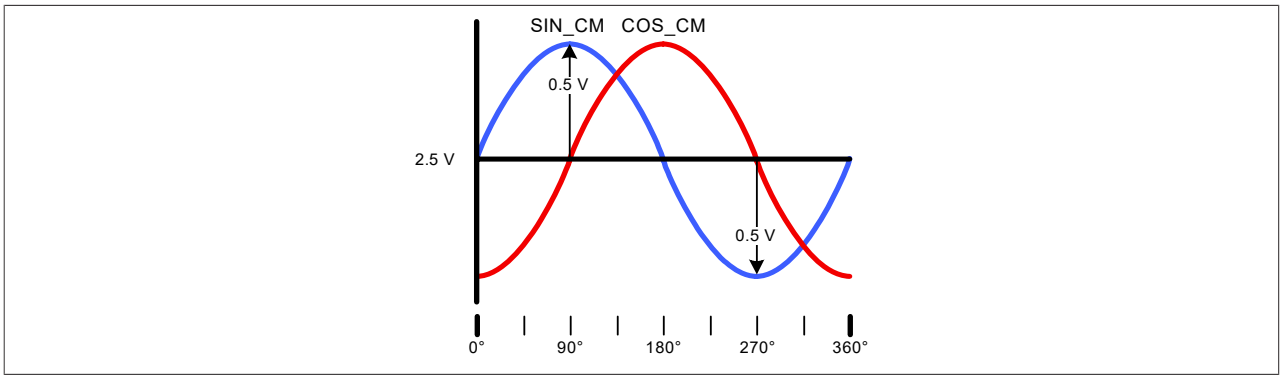



Figure 21: Shaft angle of the rotary encoder (0° ... 360°)

### Rotary encoder commutation signals

Rotary encoder commutation signals (one sine/cosine period per revolution) should be connected (if these signals are available) to inputs SIN_CM and COS_CM of the module as shown above.

The output channel of the zero pulse/reference point (normally marked 0, N or Z) only needs to be connected for positioning applications.

### 3.2.1.4.6 Dimension diagram

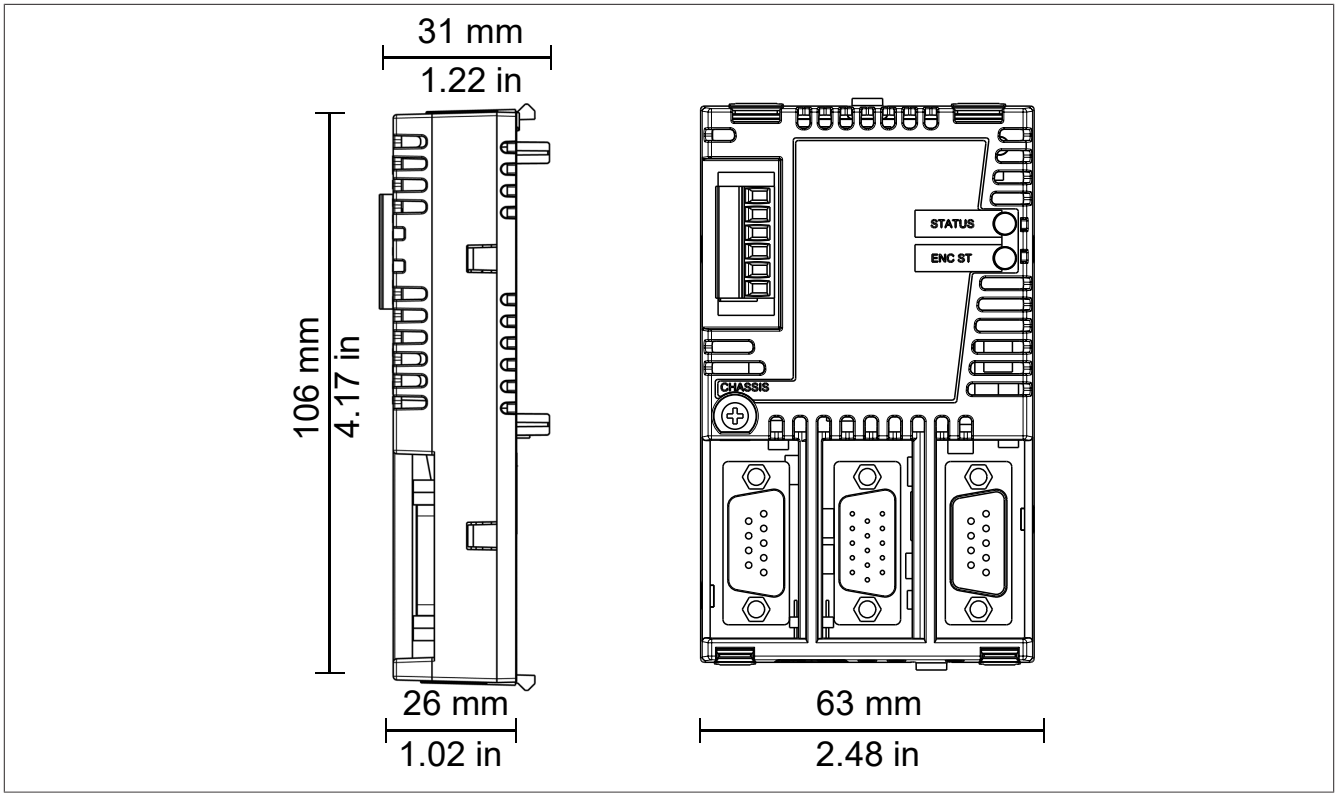



Figure 22: 8I0IFENC096.405-1 - Dimension diagram

Weight: 0.1 kg

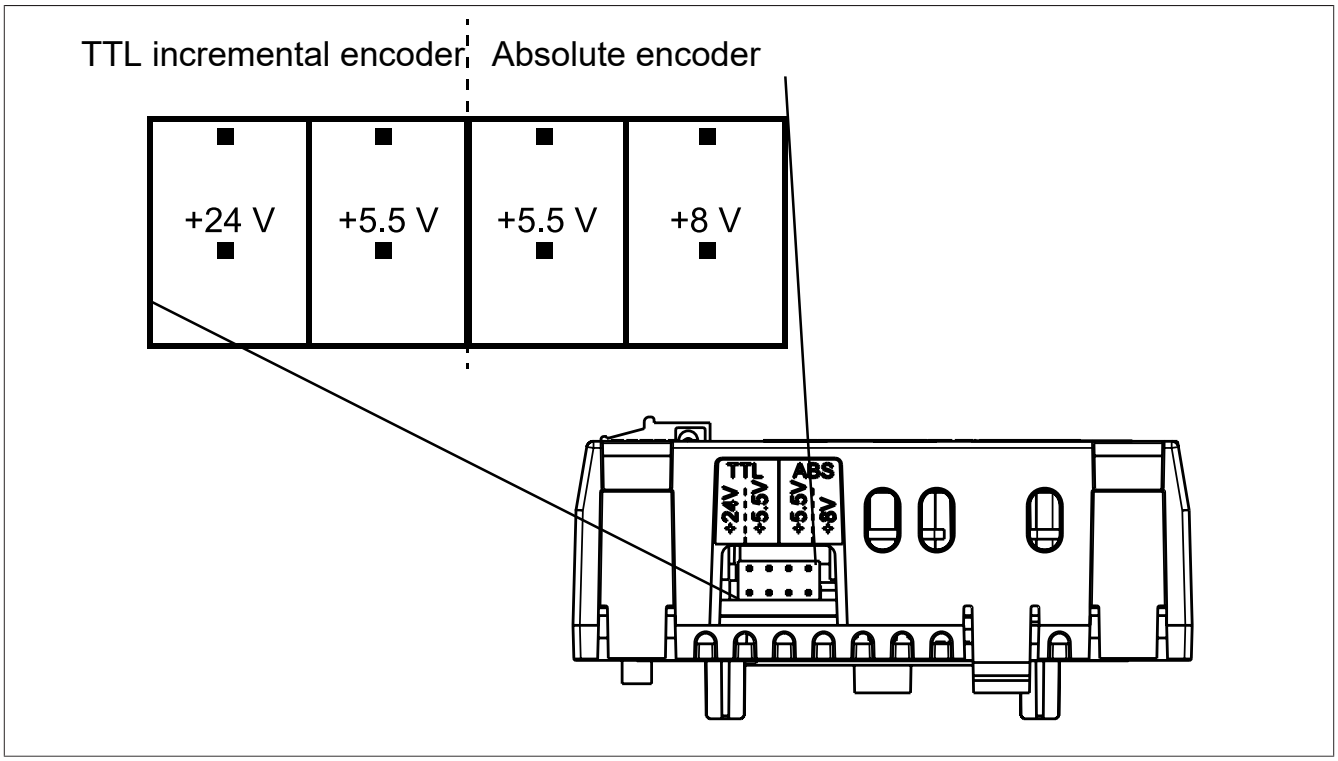
### 3.2.1.4.7 Installation

#### Setting the supply voltage

**Warning!**

**An incorrectly set supply voltage can damage the encoder.**

A supply voltage can be selected for the absolute encoder and TTL incremental encoder input. A +5.5 V or +24 V voltage for a TTL incremental encoder and a +5.5 V or +8 V voltage for an absolute encoder can be set with the vertically arranged jumpers (see the following figure).




## Note:

**When using an external power supply, the corresponding jumper must be removed.**

## Note:

**If the TTL emulation output of another interface card is connected to the TTL input, the corresponding jumper must be removed.**

**Installation**

## Warning!

**Switch off the power supply to the frequency inverter before beginning installation. Wait five minutes to ensure that the frequency inverter capacitors have discharged. Disconnect all dangerous voltages from external control circuits applied to the inputs and outputs of the frequency inverter.**

## Note:

**Before installing the module, connect the jumpers for setting the supply voltage.**

The module must be inserted into the slot for option modules in the frequency inverter.

The module is held by plastic clips and a screw. The screw is also used to ground the cable shields connected to the module and connects the GND signals of the module and the frequency inverter.

After installing the module, the connection of the signals and the voltage to the frequency inverter is made via a 20-pin connector automatically.

**Procedure**

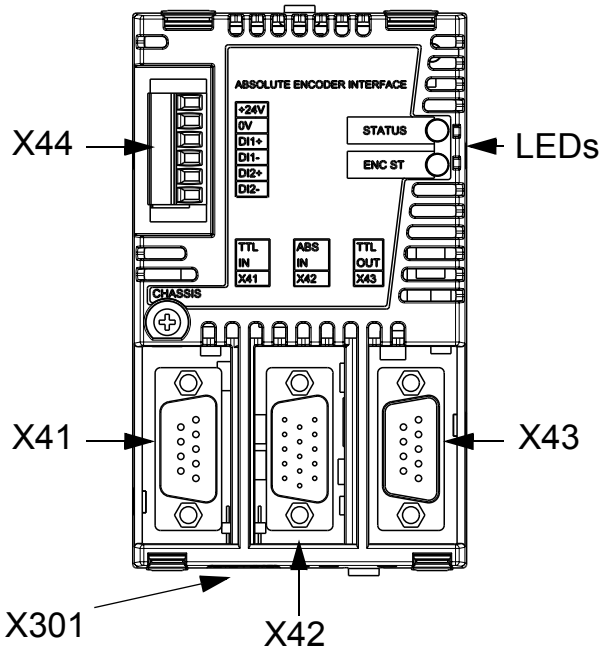
- Carefully push the module into the option slot until the module's retaining clips snap into place.
- Tighten the screw (provided).

## Note:

**Correct tightening of the screw is crucial for meeting EMC requirements and for trouble-free operation of the module.**

### 3.2.1.4.8 Wiring

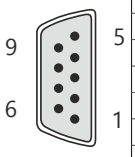
#### Overview




## Note:

**Placement of the incremental encoder cables parallel to power cables (e.g. motor cables) is not permitted.**

#### TTL incremental encoder input (X41)

| X41 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | A+ | Channel A+ |
| | 2 | B+ | Channel B+ |
| | 3 | Z | Channel Z+ |
| | 4 | COM_C | Common reference potential |
| | 5 | VCC_ENC_1 | Supply voltage (5.5 V or 24 V) |
| | 6 | A- | Channel A- |
| | 7 | B- | Channel B- |
| | 8 | Z- | Channel Z- |
| | 9 | COM_C | Common reference potential |



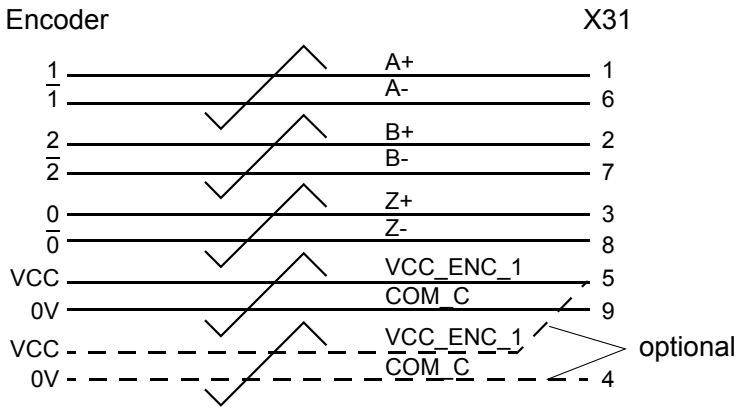



Figure 23: X41 wiring

## Absolute encoder input (X42)

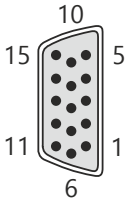
| X42 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | SIN- | Sine ref. |
| | 2 | COS- | Cosine ref. |
| | 3 | PTC/KTY | Temperature sensor |
| | 4 | PTC/KTY_0V | Common reference potential, 0 V, reserved for temperature sensor |
| | 5 | CLOCK (SIN_CM+)[1] | Clock or sine commutation signal |
| | 6 | SIN+ | Sine signal |
| | 7 | COS+ | Cosine signal |
| | 8 | COM_B | Common reference potential, 0 V |
| | 9 | NC (COS_CM+)[1] | Cosine commutation signal |
| | 10 | \CLOCK (SIN_CM-)[1] | Inverted clock signal or sine commutation signal, inverted |
| | 11 | VCC_ENC_2 | Supply voltage (5.5 V or 8 V) |
| | 12 | COM_B | Common reference potential, 0 V |
| | 13 | NC (COS_CM-)[1] | Cosine commutation signal, inverted |
| | 14 | DATA (Z+)[1] | Data line or reference/zero pulse |
| | 15 | \DATA (Z-)[1] | Inverted data line or reference/zero pulse, inverted |



Table 18: Absolute encoder input - General pinout

1 Specification in brackets: Optional function

| Pin | Designation/function depending on encoder type | | | |
|---|---|---|---|---|
| | EnDat 2.1 / 2.2 | HIPERFACE | SIN/COS | SSI |
| 1 | SIN- | | | |
| 2 | COS- | | | |
| 3 | PTC/KTY | | | |
| 4 | PTC/KTY_0V | | | |
| 5 | CLOCK | NC | SIN_CM+ | CLOCK |
| 6 | SIN+ | | | |
| 7 | COS+ | | | |
| 8 | COM_B | | | |
| 9 | NC | | COS_CM+ | NC |
| 10 | \CLOCK | NC | SIN_CM- | \CLOCK |
| 11 | VCC_ENC_2 | | | |
| 12 | COM_B | | | |
| 13 | NC | | COS_CM- | NC |
| 14 | DATA | | Z | DATA |
| 15 | \DATA | | Z- | \DATA |

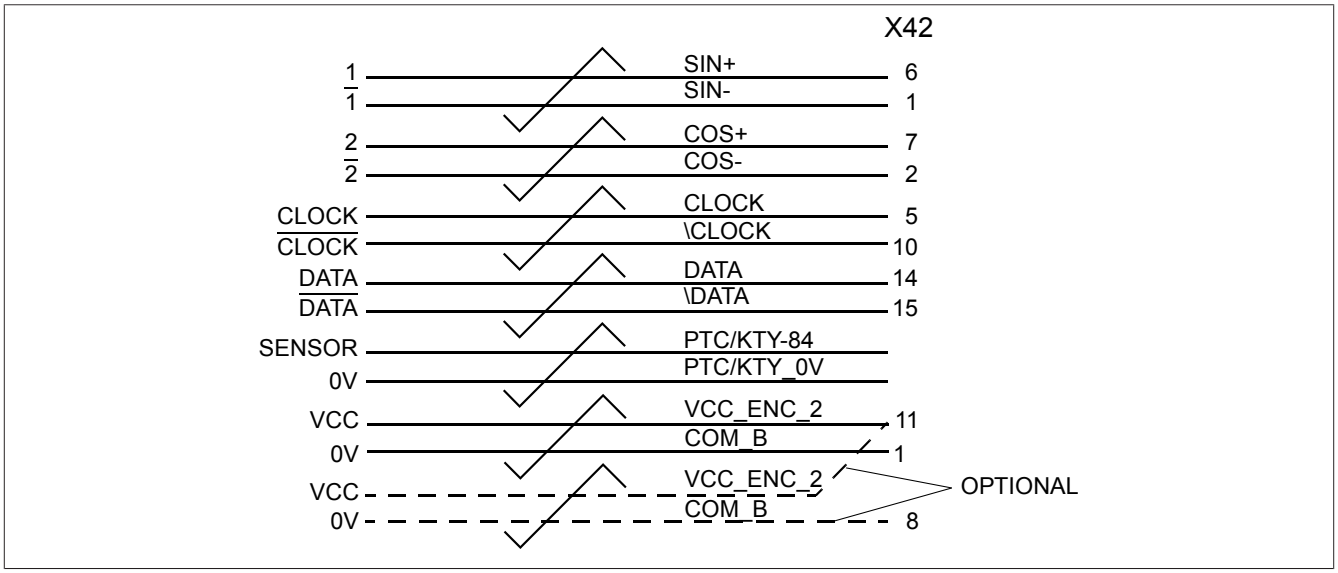



Figure 24: Wiring X42 (EnDat 2.1 / 2.2)

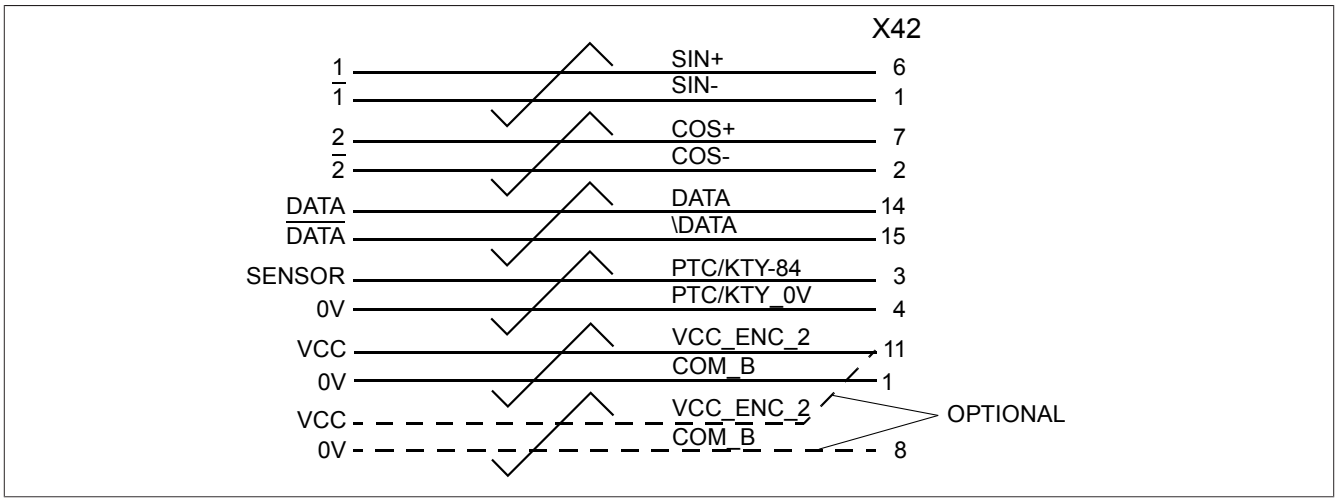



Figure 25: Wiring X42 (HIPERFACE)

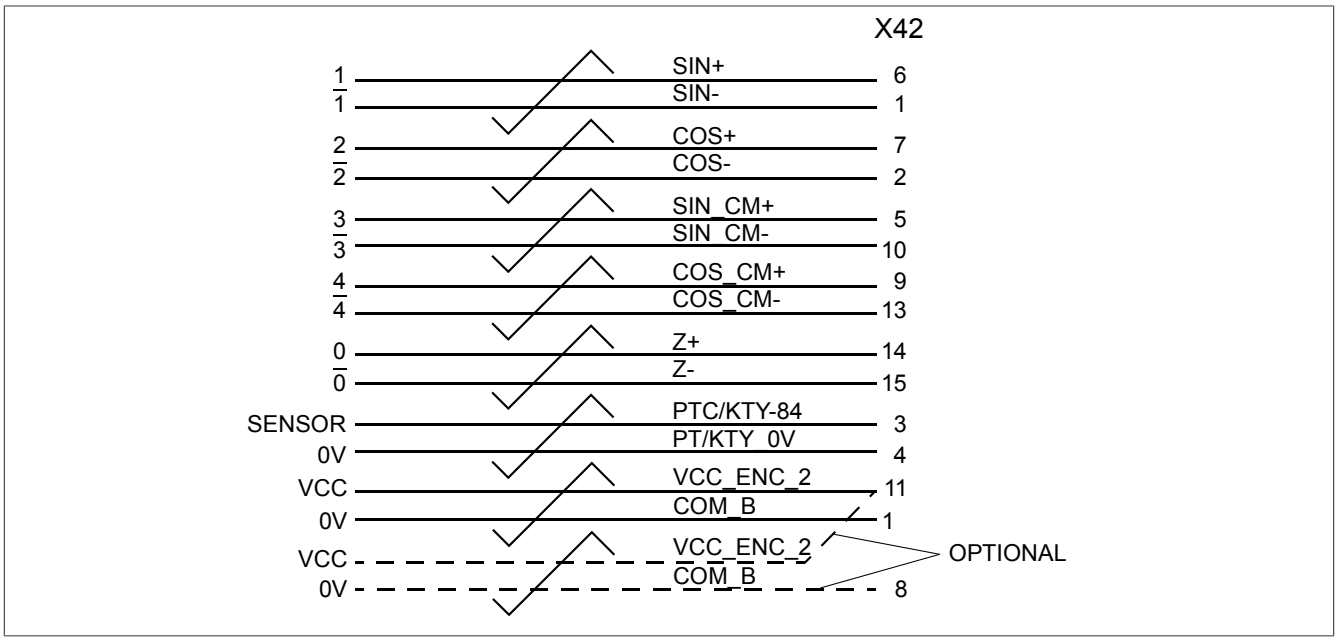



Figure 26: Wiring X42 (SIN/COS)

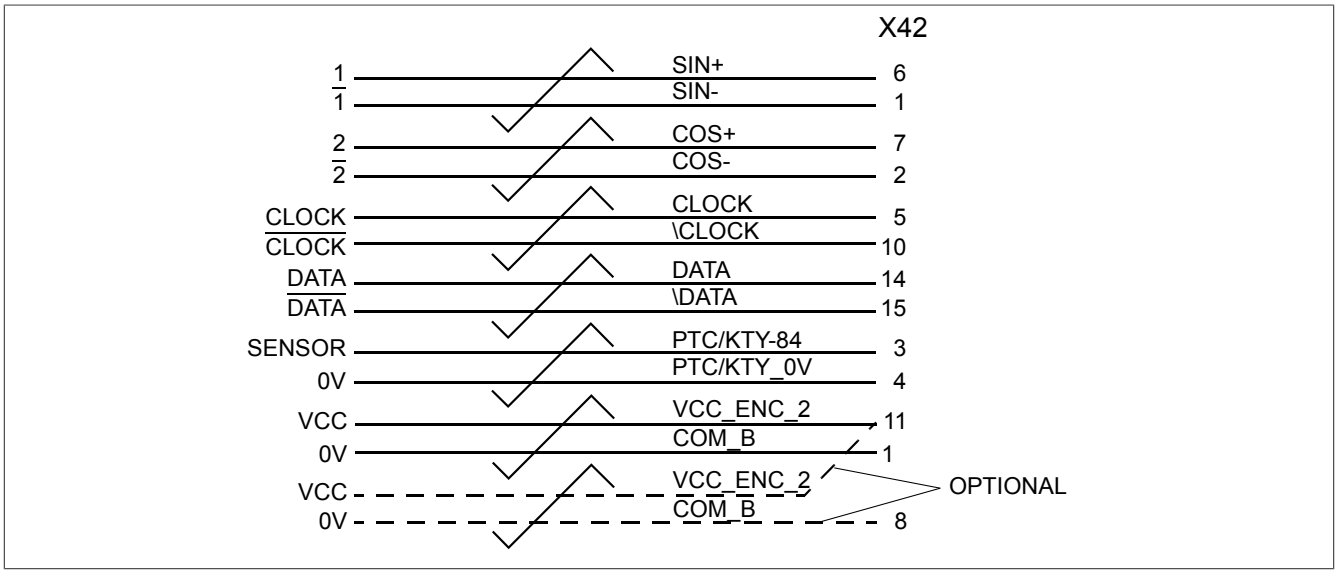
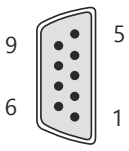



Figure 27: Wiring X42 (SSI)

## Emulation output of the TTL incremental encoder (X43)

| X43 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | EM_A+ | Channel A+ |
| | 2 | EM_B+ | Channel B+ |
| | 3 | EM_Z+ | Channel Z+ |
| | 4 | COM_B | Common reference potential |
| | 5 | COM_B | Common reference potential |
| | 6 | EM_A- | Channel A- |
| | 7 | EM_B- | Channel B- |
| | 8 | EM_Z- | Channel Z- |
| | 9 | COM_B | Common reference potential |



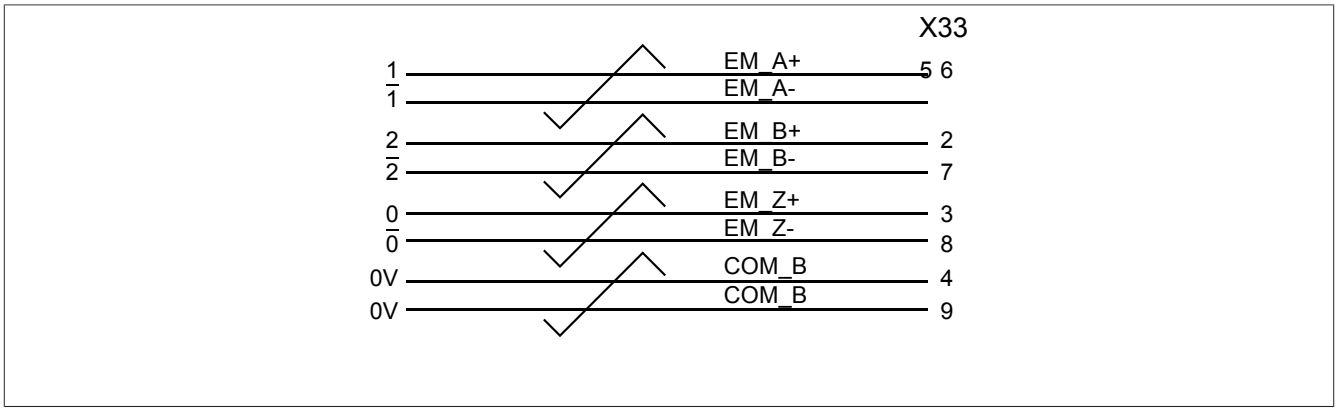
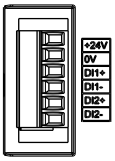



Figure 28: X43 wiring

## Digital inputs for position referencing (X44)

| X44 | Pin | Name | Function |
|---|---|---|---|
|  | 1 | +24V_C | Supply voltage |
| | 2 | COM_C | Common reference potential |
| | 3 | DI_1+ | Reference signal 1 |
| | 4 | DI_1- | Reference signal 1 feedback |
| | 5 | DI_2+ | Reference signal 2 |
| | 6 | DI_2- | Reference signal 2 feedback |



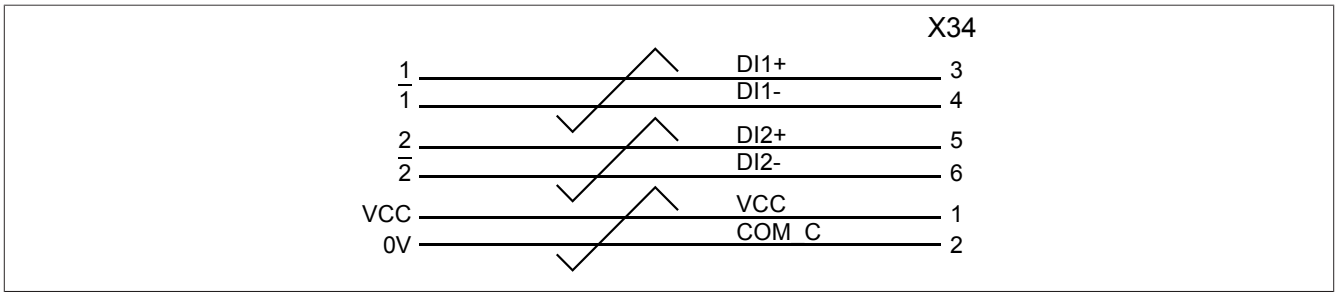



Figure 29: X44 wiring

## 3.2.2 8I0XD096.40x-1 control panels

### 3.2.2.1 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Graphic display** | |
| 8I0XD096.400-1 | ACPi P96 display terminal industrial | |
| 8I0XD096.401-1 | ACPi P96 display terminal Bluetooth | |
| | **Optional accessories** | |
| | **Feed-through mounting kits** | |
| 8I0PT096.400-1 | Pass-through mounting kit for P96 IP54 | |
| 8I0PT096.401-1 | Pass-through mounting kit for P96 IP65 | |
| 8I0PT096.402-1 | Pass-through mounting kit for P96 IP66 | |

Table 19: 8I0XD096.400-1, 8I0XD096.401-1 - Order data

### 3.2.2.2 Installation and commissioning

**Installation**

Install the control panel directly onto the frequency inverter or use a separate installation kit (for example, door mounting kit for control cabinets).

**Attaching the control panel**

1) Insert the lower edge into the recess of the frequency inverter (A).
2) Tilt the control panel back until the upper edge (B) audibly latches in.

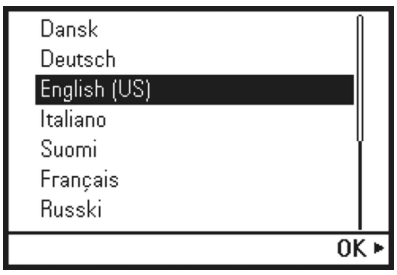
**Removing the control panel**

1) Press the clip to unlock the control panel (B).
2) Pull the upper end of the control panel out of the recess in the frequency inverter.

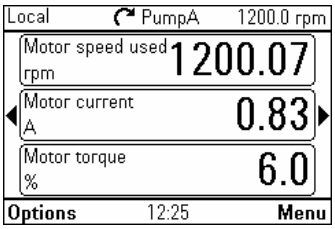
### Initial commissioning

To start up the control panel for the first time, please follow the instructions below:

1) Follow all drive-specific safety precautions.
2) Insert the control panel (see Installation).
3) Switch on the frequency inverter.
   The commissioning of the control panel starts automatically. Wait until the control panel displays the screen for selecting the language.
4) Use keys ▲ or ▼ to select the language.
5) Confirm your selection with key ↵.
   Wait until the control panel has finished reading the language file. Progress is indicated by a progress bar.

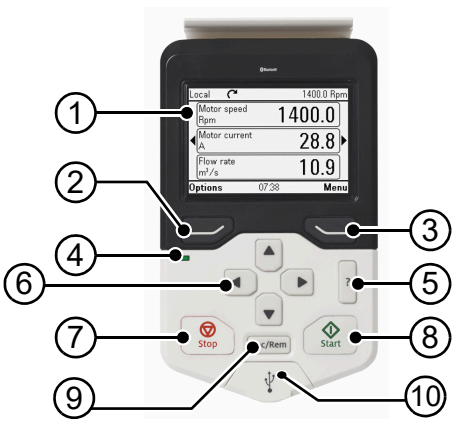


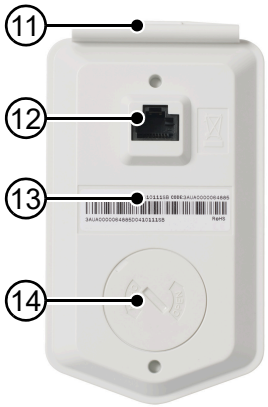
When the control panel displays the **start screen**, it is ready for operation.




### 3.2.2.3 Overview

#### 3.2.2.3.1 Display, keys and components

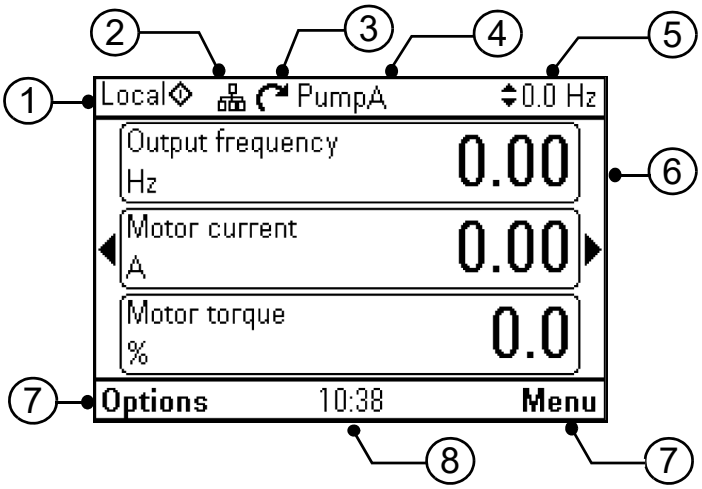



| | |
|---|---|
| 1 | Display |
| 2 | Left function key |
| 3 | Right function key |
| 4 | LED status indicator |
| 5 | Help documentation |
| 6 | Arrow keys |
| 7 | Stop (see Start and stop) |
| 8 | Start (see Start and stop) |
| 9 | Local/Remote control (see Loc/Rem) |
| 10 | USB connection |
| 11 | Clip |
| 12 | RJ45 connection |
| 13 | Serial number label |
| 14 | Battery compartment cover |

#### 3.2.2.3.1.1 Display

The following elements are shown on the control panel display on most screens:




| No. | Control panel element | Function |
|---|---|---|
| 1 | Control location and associated icons | Displays how the drive is controlled:<br><br>**No text:** The frequency inverter is in local control but being controlled by another device. The icons in the upper field indicate which actions are permitted:<br>**Local:** The frequency inverter is in local control and being controlled with this control panel.<br>**Remote:** The frequency inverter is in remote control and being controlled via I/O or fieldbus. |
| 2 | Control panel bus | Indicates that more than one frequency inverter is connected to this control panel. Open menu "Options > Select drive" to switch to another frequency inverter. |
| 3 | Status indicators | Displays the status of the frequency inverter and motor. The arrow direction indicates the active reference direction, forward (clockwise) or backward (counterclockwise).<br><br>For non-rotating equipment, digits 1 and 0 indicate whether the frequency inverter is running or stopped. |

| Status symbol | Animation | Drive status |
|---|---|---|
| | - | Stopped |
| | - | Stopped and start locked |
| | Flashes | Stopped, start command active but start locked. |
| | Flashes | Fault |
| | Flashes | Running with setpoint, but the setpoint is 0. |
| | Turning | Running, setpoint not reached |
| | Turning | Running with setpoint |

| | | |
|---|---|---|
| 4 | Drive name | If a name has been defined, it is displayed at the top of the window. By default, no name is displayed. You can change the name in the Basic settings or menu Settings. |
| 5 | Setpoint | Speed, frequency, etc. is displayed with the unit. |
| 6 | Information area | The current content of the screens is displayed in this area. The content differs for the various screens. The example screen above is the main screen of the control panel, the home screen. |
| 7 | Selection via function keys | Displays the function of the key (soft key) ( and ) in the respective context. |
| 8 | Clock | Displays the current time. The time can be changed in the Basic settings or menu Settings. |

You can adjust the contrast of the display and backlight in the Basic settings or menu Settings.

### 3.2.2.3.1.2 Keys

#### Left function key

The left function key ( ) is normally used to exit or cancel.

Its function in a particular situation is shown in the lower left corner of the display as a selection for that function.

If is pressed and held, the respective screen is closed until the home screen is reached. The key has a different function on some specific screens.

**Right function key**

The right function key ( ) is normally used to select, apply and confirm. The function of the right function key in a particular situation is shown in the lower right corner of the display as a selection for this function.

**Arrow keys**

The arrow keys ( and ) are used to highlight options in menus and selection lists, to scroll up and down text pages and to set values (e.g. time), enter passwords or change parameter values.

The left and right arrow keys ( and ) are used to move the cursor left and right during parameter editing and forward and backward in the wizards. In the menus, and have the same function as and , respectively.

**Help documentation**

Pressing the help key ( ) opens the help page. The help page is context-sensitive. This means the content of the page is based on the menu or screen that is currently open. For additional information about the help page, see "Help documentation" (page 28).

**Start and stop**

With local control, the frequency inverter is started with keys Start ( ) and Stop ( ).

**Loc/Rem**

Key Loc/Rem has no function with the ACOPOSinverter P96.

**Keyboard shortcuts**

The following table lists shortcuts and key combinations. Pressing keys simultaneously is marked with a plus sign (+).

| Shortcut | Available in... | Effect |
|---|---|---|
| + , + | Every screen | Sets the background brightness. |
| + , + | Every screen | Sets the display contrast. |
| or | Start screen | Sets the setpoint. |
| + | Parameter editing screens | Sets an adjustable parameter to its default value. |
| or | Every screen | Displays/Hides the parameter index and parameter group numbers. |
| (hold down) | Every screen | Returns to the home screen by pressing and holding the key until the start screen is displayed. |

### 3.2.2.3.1.3 LED status indicator

The control panel has an LED status indicator that indicates whether fault or warning messages are pending. The following table describes the meaning of the display forms of the LED status indicator.

| | | |
|---|---|---|
| Green, continuous display | | The drive is functioning normally. |
| Green, blinking | | Active warning message in the frequency inverter. |
| Red, continuous display | | Active fault message in the frequency inverter. |

**8I0XD096.401-1 only:**

| | | |
|---|---|---|
| Blue, flashing | | The Bluetooth interface has been enabled, can be detected by other devices and is ready to establish a connection. |
| Blue, blinking | | Data is being transferred via the Bluetooth interface of the control panel. |

For additional information about fault and warning messages, see Identifying warning and fault messages.

### 3.2.2.3.1.4 USB connection

The USB connection is used to connect the control panel to a PC.

#### 3.2.2.3.1.5 RJ45 connection

The control panel is electrically connected to the frequency inverter via the RJ45 connection. The mechanical connection is made via the clip on the upper edge of the control panel.

#### 3.2.2.3.1.6 Battery compartment cover

The battery compartment for the battery supplying power to the control panel real-time clock is located under the battery compartment cover.

#### 3.2.2.3.1.7 Wireless interface

Control panel 8I0XD096.401-1 with Bluetooth interface allows a wireless connection with ACOPOSinverter P96 frequency inverters and has a powerful processor and memory for faster communication.

The functions of control panel 8I0XD096.401-1 are identical to those of control panel 8I0XD096.400-1.

### 3.2.2.4 Basic functions

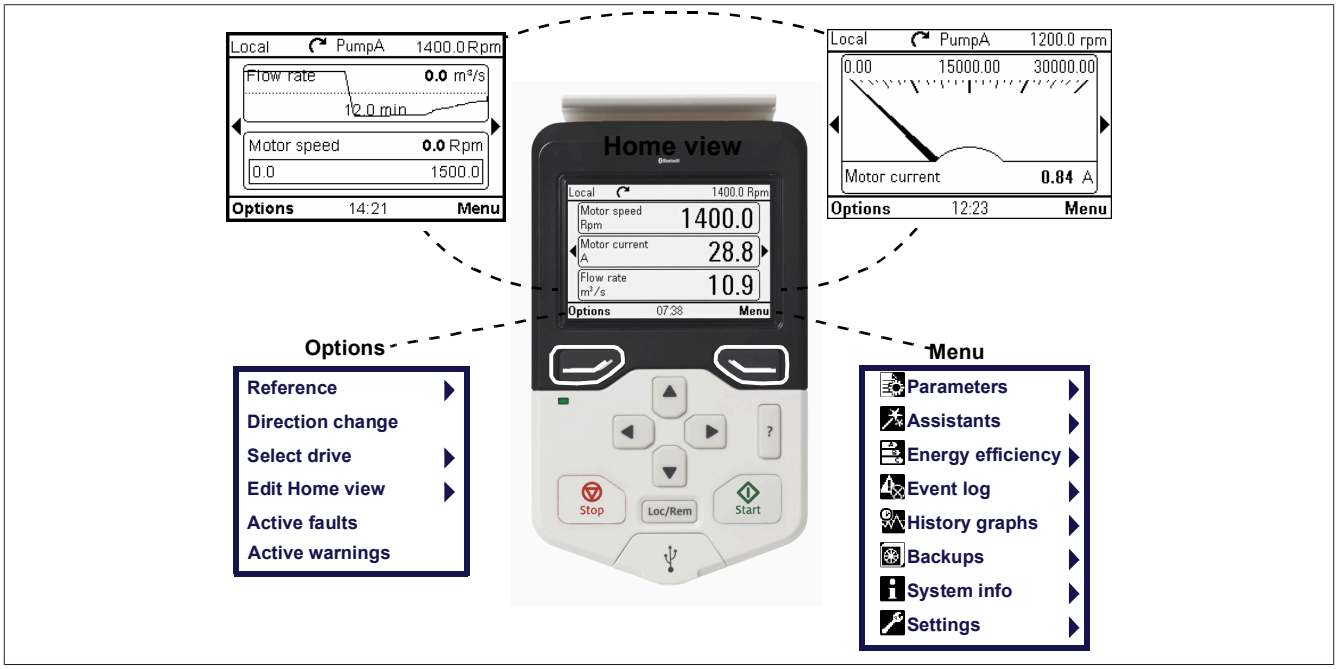
#### 3.2.2.4.1 User interface - Overview

The user interface has the following main components:

| Component | Description |
|---|---|
| Home screen | Used for monitoring signals. See start screen (page 22). |
| Menu | Access to most of the control panel functions. For a detailed description, see chapter Functions in the main menu. |
| Options | Used for setting a setpoint, changing the direction of motor rotation, selecting the drive, editing the start screen pages, and displaying the status of fault and warning messages. For a detailed description, see chapter Functions in menu Options. |
| Help documentation | Provides additional information about the current screen or menu or about possible problems related to it. See "Help documentation" (page 22). |
| Faults and warnings | Displays fault and warning messages when the frequency inverter or the control panel detects a fault. See Warning and fault messages. |

#### 3.2.2.4.2 Control panel navigation

The arrow and function keys on the control panel are used for navigation. Follow the selection options that appear on the display.




## Note:

**The menu shown serves only as an example. The menu differs depending on the frequency inverter / device to which the control panel is connected.**

### Navigation memory

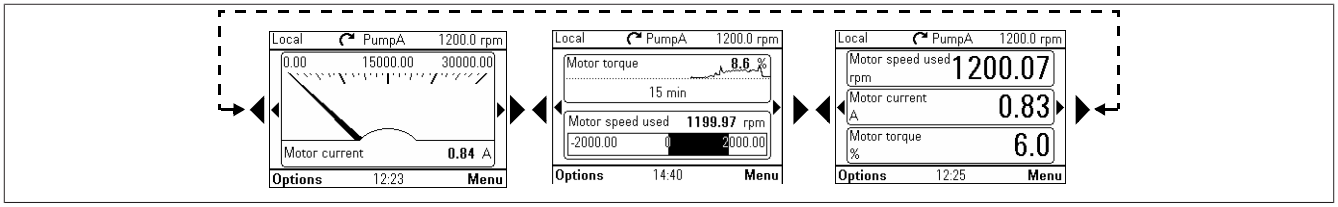
The comfort control panel has a navigation memory that can be used on the user interface with arrow keys ◄ and ► to retrace your steps. The path of your last menu steps will be saved for 10 minutes.

- The left arrow key (◄) returns you to the menu structure. Pressing key ◄ repeatedly returns you to the start screen.
- The right arrow key (►) moves you through the menu structure. Pressing key ► repeatedly moves you through the menu structure you have open previously.

### 3.2.2.4.3 Start screen

The main screen of the control panel is the **start screen**. In the **start screen**, you can monitor the state of the drive, such as its speed, torque or power. The **start screen** has one or more pages, each of which can display up to three signals.

The number of pages and the signals displayed on each page can be adjusted, and the start screen configuration is saved in the frequency inverter each time it is changed. The maximum total number of signals that can be displayed varies depending on the frequency inverter type. The following example uses three start screen pages that have different display formats.




When selecting an application macro or loading a parameter set, the respective start screen is enabled. There is a default configuration of the start screen for each frequency inverter, which can be restored in the menu Basic settings or Settings.

After the power supply of the frequency inverter is switched on, the **start screen** is displayed automatically. The **start screen** is opened via menu **Options** or the **main menu** if no key has been pressed for 10 minutes.

The start screen can be opened from any screen (except special displays) by holding down left function key ⊏.

### Navigating in the start screen

- You can use keys ◄ and ► to switch between the different pages of the **start screen**. When scrolling through the pages, the page numbers are displayed.
- You can change the setpoint (displayed in the upper right corner) using key ▲ or ▼.
- Press ⊂ (**Menu**) to open the **main menu** (see Functions in the main menu).
- Key ⊏ (**Options**) opens menu **Options** (see Functions in menu Options).

### 3.2.2.4.4 Help documentation

You can open context-sensitive help documentation from all menus and screens by pressing key ?. Provides additional information about the current screen or menu, or possible problems related to it.

On the help page, press key ? again or press ⊏ (**Exit**) to leave the page again.

### 3.2.2.4.5 General user functions

The following tables describe general user functions and their required control steps on the control panel. For a detailed description of the functions in the individual menus, see chapters Functions in the main menu and Functions in menu Options.

## Parameters

| Function | Actions |
|---|---|
| Selecting parameters that are displayed in the favorites list. | Open menu → Parameters → Favorites → Edit. See also Editing favorites. |
| Displaying/Editing (changing) parameters | Parameters can be displayed using menu → Parameter → Complete list.<br>For instructions on how to change parameters, see Editing parameters. |
| Adding parameters to the start screen. | See Editing the contents of the start screen. |
| Displaying/Hiding the parameter index and group numbers. | Press ◄ + ►. |
| Restoring the parameter default setting. | Press ▲ + ▼ in edit mode. Press (**Save**) to save the default value. |
| Displaying parameters that differ from the default setting. | Open **Menu** → **Parameters** → **Changed**. |

## Faults and warnings

For detailed information about faults and warnings, see Warning and fault messages.

| Function | Actions |
|---|---|
| Hiding/Displaying an active fault. | Faults are displayed automatically. If you hide a fault by pressing (**Hide**), it will automatically reappear if no key has been pressed after 60 seconds. You can also display the fault via **Options > Active faults**. |
| Opening the help page for a fault. | Press ? to open the help page. |
| Acknowledging an active fault. | Press (**Reset**) to acknowledge a pending fault. |
| Displaying faults with shutdown. | Open **Menu** → **Event log** → **Faults**. |
| Hiding/Displaying an active warning. | Warnings are displayed automatically. If you hide a warning by pressing (**Hide**), a warning will automatically reappear if no key is pressed after 60 seconds. |
| Opening the help page for a warning. | Press (**How to fix**) or ? to open the help page. |
| Acknowledging an active warning. | The warning message will automatically disappear when the condition that triggered it no longer exists. |
| Displaying the last warnings and faults. | Open **Menu** → **Event log** → **Other events**. |

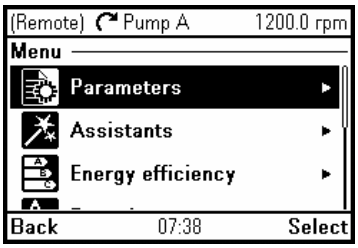
## Basic settings

| Function | Actions |
|---|---|
| Setting the background brightness. | Press and hold key and press ▲ or ▼. |
| Setting the display contrast. | Press and hold key and press ▲ or ▼. |
| Changing the language. | Open **Menu** → **Settings** → **Language**. |
| Changing the time, date and associated settings. | Open **Menu** → **Settings** → **Date & Time**. |

### 3.2.2.5 Functions in the main menu

#### 3.2.2.5.1 Menu

All control panel functions are opened via the **menu** that is the main menu for the user interface. The submenus of **Menu** are listed below and described in detail in the following sections. The submenus depend on which product is being controlled using the control panel.




The following submenus vary depending on the drive/device to which the control panel is connected.

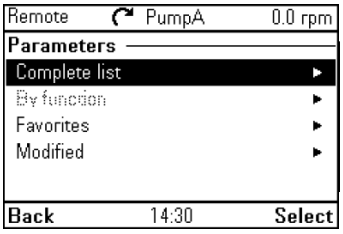
| Submenu | Function |
|---|---|
| Parameters | Displaying and editing parameters. |
| Wizards | Opening a wizard. |
| Energy efficiency | Using functions for saving energy. |
| Event log | Displaying information about faults and warnings. |
| Saved curves | Displaying the load profile. |
| System info | Displaying information about the frequency inverter and options. |
| Settings | Displaying and changing settings for time and date, language, display as well as other settings and changing texts. |
| Basic settings | Displaying and changing settings for the motor, PID, fieldbus, advanced functions, clock, region and display. |
| I/O | Contains I/O terminal designations, numbers, electrical status and functions for the drive. |
| Diagnostics | Contains fault and warning messages and helps to solve potential problems. |

**Navigating the menu**

- Pressing key ▲ or ▼ selects a menu option.
- Pressing ◄ or (**Exit**) returns to the **start screen**.
- Press ► or (**Select**) to open the desired submenu.

#### 3.2.2.5.2 Parameters

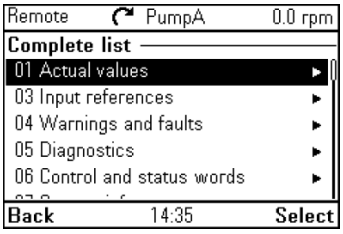
Parameters can be displayed and edited in menu **Parameters**. There are four submenus that you can use to call parameters. The grouping principle of parameters is different in each submenu.




In each submenu, you can edit a parameter by highlighting it and then pressing right function key (**Edit**). Counter parameters and certain numeric, text and bit field parameters are read-only and can be displayed by pressing (**screen**).

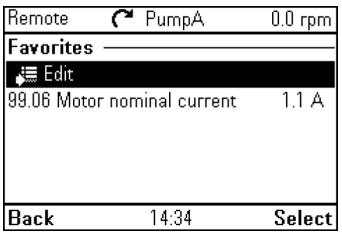
**Complete list**

In submenu **Complete list**, all parameter groups are listed in numerical order. When you select a parameter group, all parameters in the group are listed and can be displayed and edited. The parameter numbers are always displayed in this submenu.



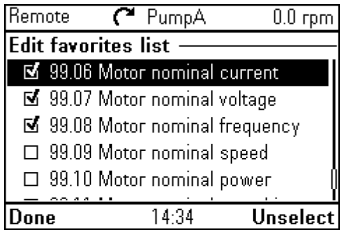
### Favorites

In submenu **Favorites**, only the parameters selected by the user are listed. The parameter number determines the sequence.



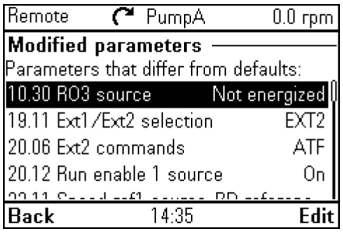

Editing the favorites list

1. Select **Edit**.
2. Use right function key (**Select**) to mark the parameters that should be displayed in the list.
3. Use key (**Done**) to exit the submenu and save the changes.




### Changed parameters

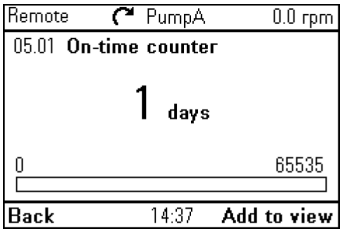
In submenu **Changed parameters**, only the parameters whose settings differ from the default settings are listed. The parameter number determines the sequence.




### Adding parameters to the start screen

If you display a read-only parameter in menu **Parameters**, it can be added to the **start screen**.

- Press (**Add display**) to open the start screen in edit mode. The parameter can then be entered in an empty display field or an existing parameter replaced.
- Press (Back) to return to the parameter screen.




Editing start screen functions is described in more detail in Editing the contents of the start screen.

### Editing parameters

Parameter values can be changed using the arrow keys.

1. Press (**Select**) to select the desired parameter from the list.
2. Then press key (**Edit**).
3. Use keys and to change the setting value.
4. Press (**Save**) to save the value, or press (**Cancel**) to exit the parameter screen and discard the changes.
5. Restore the default value of the parameter with keys + (will not be saved, however).

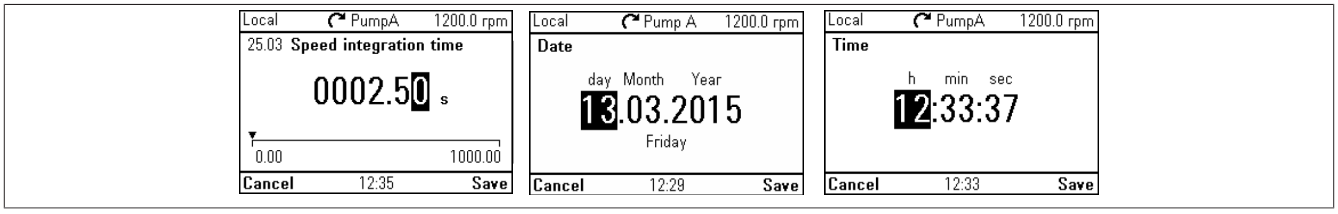
The following sections contain further information about editing special parameter types.

### Editing numerical parameters

Numerical parameters include parameters with linear numerical values, time and date parameters, time periods and exception days. For numeric parameters with linear values, the minimum and maximum values are displayed in the lower left and right corners of the content area of the display, respectively.

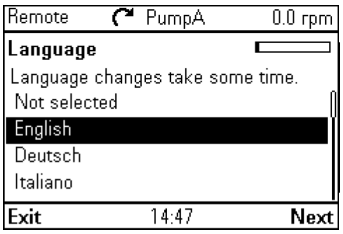
- You can mark digits with and .
- You can change the value with and .

- Press (**Save**) to save the value and exit the screen.
- Press (**Cancel**) to cancel the operation and exit.




**Editing the parameters on the selection list**

A selection list consists of specifically defined options, such as the list for Selecting Language.

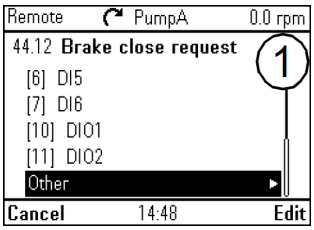


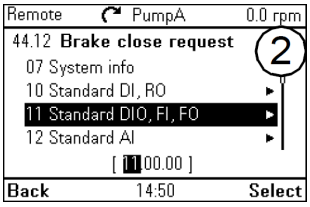

- You can move the cursor with and .
- Press (**Save**) to select and save the highlighted option.
- Press (**Cancel**) to cancel the operation and exit.

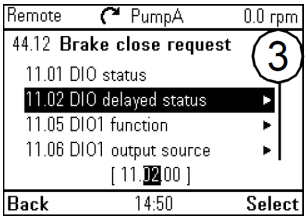
Some selection list parameters allow accepting a different parameter than their values. In addition to a given list of options, you can select a parameter that will be displayed in the list by selecting the position **Other**.

Follow the instructions to select a parameter:

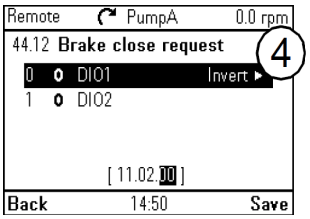
1. Selecting **Other** opens a list of parameter groups.
2. Selecting a parameter group opens a list of parameters.
3. Depending on the parameter to be edited, you must select a parameter, a single bit or one of the two.
   - If the right function key provides **Select**, a single bit must be selected as the value of the parameter being edited. Press (**Select**) to open a bit selection list.
   - If the right function key provides **Save** , you can select the parameter as the value of the parameter being edited. Press (**Save**) to save the selection.
   - If the right function key provides **Save** and an arrow is displayed to the right of the selection, either a single bit can be selected or all bits in the parameter. Press to open a bit selection list. If you want to select all bits of the parameter, press (**Save**) instead.
4. Select a bit, if possible (see previous step). Press to invert the selected bit and press (**Save**) to save the selection.

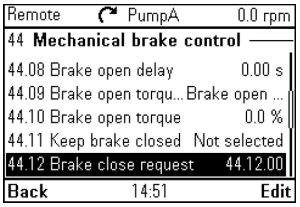


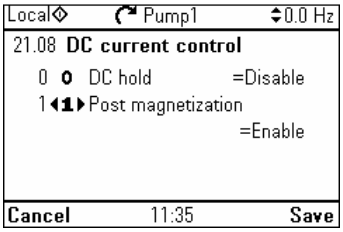

This selects the parameter or bit as the parameter value.



### Editing bit field parameters

A bit-field parameter is a bit word whose individual bits can be edited. The labels describe the function of each bit, and the current status of the bit is displayed as 1 or 0 (set or not set).

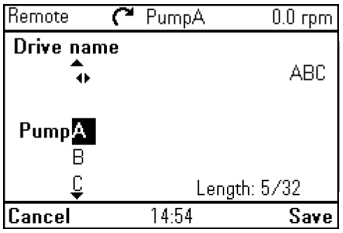



- Select a bit with ▲ and ▼.
- Press ◄ or ► to change a bit value.
- Press (**Save**) to save the bit values and finish the process.
- Press (**Cancel**) to cancel the operation and exit.

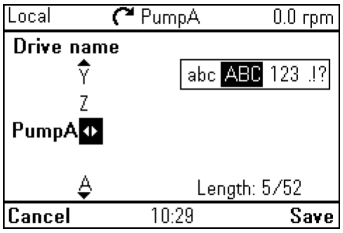
### Editing texts

The texts that you can edit with the control panel include the displayed parameter names on the start screen and their unit designations, drive names, designations of the fault and warning messages and other customizable messages, notes or names.

A bit-field parameter is a bit word whose individual bits can be edited. The labels describe the function of each bit, and the current status of the bit is displayed as 1 or 0 (set or not set).




- To select the character mode (uppercase/lowercase / numbers / special characters) press ▲. Unit symbol ◆ is marked, and then select the mode using ◄ and ►. You can now start entering characters. The character type remains the same until you select another one.
- To add a character, mark it with ▲ ▼ and then press ►.
- To remove a character, press ◄.
- Press (**Save**) to apply the new setting or (**Cancel**) to return to the previous screen without making any changes.




> **Note:**
>
> **Only the English character set (a...z) is supported in the current software version.**

### Resetting counters

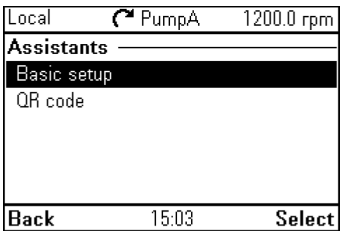
Counters are parameters that measure increments related to operation, such as hours of operation or energy consumption. Counters are automatically updated and cannot be edited, but a counter can be reset to zero when (**Reset**) is pressed for three seconds.

> **Note:**
>
> **If an indicator value is set for the counter, the progression of the counter values from zero to the indicator value can be displayed graphically as a progress bar.**

#### 3.2.2.5.3 Wizards

A wizard can be opened in menu **Wizards**. It consists of several steps to help you perform a task, such as setting up the control panel for use with the frequency inverter and motor or correcting a fault.

**Starting a wizard**




1. You can mark the desired wizard with ▲ and ▼.
2. Then press key (**Select**).
3. Then follow the instructions on the display provided by the wizard to perform the task:
   - Select the settings with keys ▲ and ▼.
   - To edit a setting, press key (**Edit** or **Select**).
   - Use keys ▶ and ◀ to navigate between the pages of the wizard. The progress bar in the upper right corner of the display shows the progress.
   - Exit the wizard by pressing key (**Exit**).

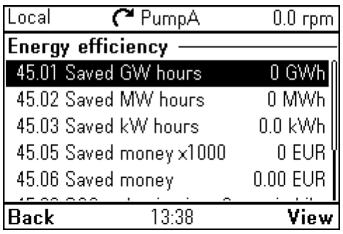
Most of the settings accessed in a wizard can also be accessed from the **main menu** or menu **Parameters**, but the steps in the wizards are more user-friendly.

## Note:

**If you use menu Wizards menu, you must follow all the steps to save the changes. Otherwise, the changes will not be applied.**

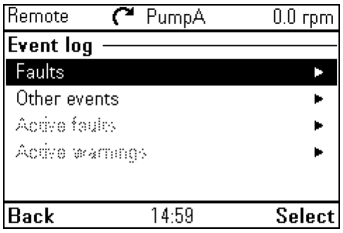
### 3.2.2.5.4 Energy efficiency

The parameters related to energy savings, such as kWh counters, can be displayed and configured in menu "Energy efficiency".




### 3.2.2.5.5 Event log

Information recorded in the faults and warnings can be displayed in menu **Event log**. Event messages are logged automatically.
For additional information about faults and warnings, see Warning and fault messages (page 57).




- Submenu **Faults** displays the fault messages that were used to switch off the frequency inverter.
- Submenu **Other events** displays all other fault and warning messages with the relevant detailed information.
- Submenus **Active faults** and **Active warnings** display all active fault and warning messages.

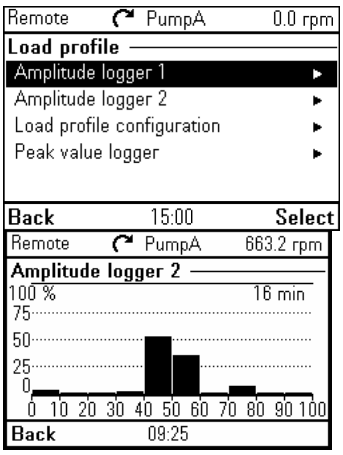
### 3.2.2.5.6 Saved curves

Submenu **Saved curves** contains load profiles.

### Load profile

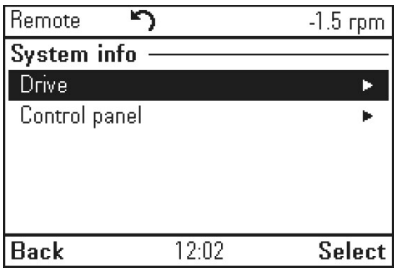
Load profiles can be displayed and configured in submenu **Load profile**. The menu contains the following submenus:

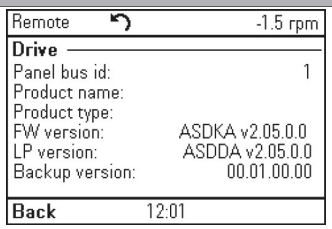
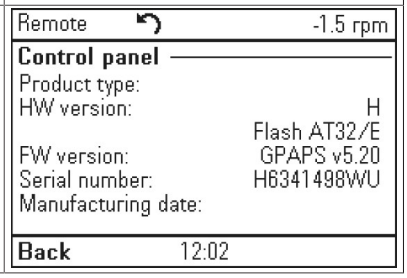
- **Amplitude memory 1**: Opens a histogram screen that displays the motor current as a histogram distribution. This memory cannot be reset.
- **Amplitude memory 2**: Opens a histogram screen that displays the contents of amplitude memory 2 as a histogram distribution. You can select the signal that should be monitored.
- **Load profile configuration**: Selection of the signal to monitor with amplitude memory 2.
- **Peak value memory**: Selection of the signal to store in the peak value memory.




### 3.2.2.5.7 System info

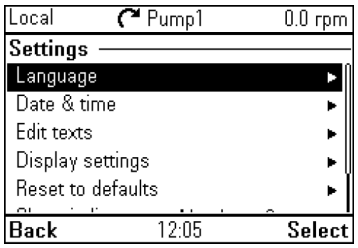
In menu "System info", you can display information about the frequency inverter, control panel, fieldbus and any installed optional modules.




| Submenu | Function | |
|---|---|---|
| Frequency inverters | Displays information about the selected component, such as the firmware version, serial number, type code, device ID number or date of manufacture.<br>**Note:**<br>**The content of the displays differs for the various types of frequency inverters.** |  |
| Control panel | Displays information about the hardware and software version of the control panel. |  |

### 3.2.2.5.8 Settings

Menu **Settings** has the following submenus:

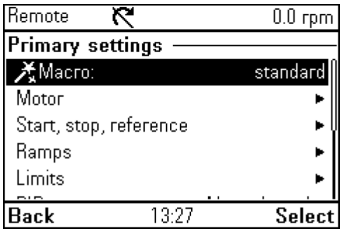



| Submenu | Function |
|---|---|
| Language | Select a different language for the control panel. |
| Date & Time | Set the date and time, select the display settings and specify whether the control panel should automatically set the summer/winter time changeover. The display formats of the date and time also determine the formatting of the time-stamps of the stored messages. |
| Editing texts | Customize editable user interface texts such as the frequency inverter name. |

| Submenu | Function |
|---|---|
| Display settings | Switch the power saving mode for the backlight on/off and set the contrast and brightness of the display. |
| Restore factory settings | Reset the settings to their default values.<br>**Reset start screen layout**: Restores the default start screen layout. |
| Display in lists | Display or hide the numeric IDs:<br>• Parameters and groups<br>• Entries in option lists<br>• Bits<br>• Devices in **Options** → **Select inverter**. |
| Password | Enter passwords in this parameter to enable further access levels (e.g. additional parameters). |

### 3.2.2.5.9 Basic settings

Menu **Basic settings** has the following submenus.



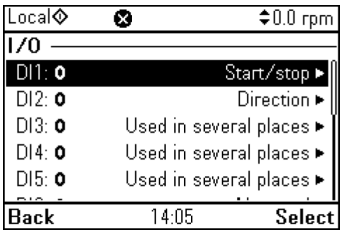

**Note:**

**The displayed content differs depending on the frequency inverter to which the control panel is connected. The menu shown serves only as an example.**

| Submenu | Function |
|---|---|
| Macro | Use submenu Macro to quickly set drive control and setpoint sources by selecting a set of preset wiring configurations. |
| Frequency inverters | Frequency inverter specific settings such as control location, operating releases, ramps, limit values, constant speeds, setpoints for flying start. |
| Motor | Motor-specific settings, such as the operating mode, nominal data, ID run or thermal motor protection. Note that the settings displayed depend on other selections, such as vector or scalar operating mode, motor type or the selected start method. |
| Controller | Loop controller settings and actual values. The loop controller is only used with remote control. |
| Pump and fan control | Controls a motor connected to the frequency inverter and three other auxiliary motors. |
| Communication | Control of the drive over a fieldbus. |
| Start/Stop, setpoint | The start, stop and setpoint submenu is used to set the start/stop commands, setpoint and related features such as constant speeds or permissions for operation. |
| Ramps | Acceleration and deceleration ramp settings. |
| Limit values | Setting the limits for the permitted operating range. This function protects the motor, connected hardware and mechanics. The drive maintains the configured limits, regardless of setpoint specifications. |
| PID | Submenu PID contains settings and actual values for process control. PID / Process control is only used with remote control. |
| Fieldbus | Help for the configuring the fieldbus protocols. |
| Additional options/functions | Submenu "Advanced options" contains settings for advanced functions, such as triggering or acknowledging faults via I/O or switching between different sets of settings. |
| Clock, region, display | Submenu "Clock, region, display" contains the settings for selecting the language and date and time as well as display settings (e.g. brightness) and a setting for displaying information on the display. |
| Restore factory settings | The submenu enables resetting the start screen to factory settings. |

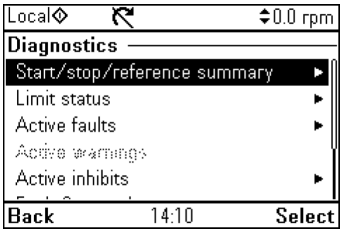
### 3.2.2.5.10 I/O

In menu **I/O**, each line contains a port name, number, electrical status and function for the drive. For each line, there is a submenu with more information about the menu items and possible changes made to the I/O connections.




### 3.2.2.5.11 Diagnostics

Menu **Diagnostics** contains diagnostic information, such as faults and warnings, and helps you solve possible problems. Use this menu to ensure that the drive is working correctly.




**Note:**

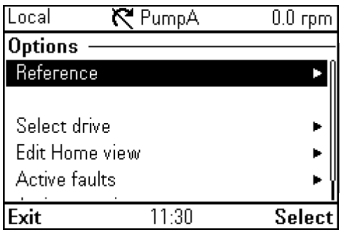
**The menus vary depending on the frequency inverter/device to which the control panel is connected. The menus shown here are examples only.**

| Submenu | Function |
|---|---|
| Start, stop, setpoint, summary | Indicates from where the frequency inverter currently receives its start and stop commands as well as the setpoint. The screen is updated in real time. If the drive does not start or stop as expected or does not run at the correct speed, this screen can be used to determine from which sources the control commands are coming. |
| Limit value status | This screen the limits that currently apply to the operation. If the drive is not running at the desired speed, this screen can be used to determine which limit values are active. |
| Active faults | This screen shows the active faults and provides information about how to correct and acknowledge them. |
| Active warnings | This screen shows the active warnings and provides information about how to correct and acknowledge them. |
| Active locks | Displays the currently active locks. The frequency inverter cannot start. The frequency inverter is not configured correctly. |
| Fault and event log | This screen contains a list of faults, warnings and other events that have occurred in the drive. |
| Fieldbus | This screen contains status information and data sent to and received from the fieldbus for troubleshooting. |
| Load profile | This screen contains status information about the load balancing (i.e. the duration of the drive runtime at each load level) and peak load levels. |

### 3.2.2.6 Functions in menu Options

#### 3.2.2.6.1 Menu Options

Menu **Options** is used to modify the start screen settings.




> **Note:**
>
> **The displayed content differs depending on the frequency inverter/device to which the control panel is connected. The menu shown serves only as an example.**

Menu **Options** contains the following submenus:

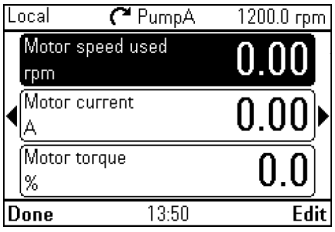
| Submenu | Function |
|---|---|
| Setpoint | The setpoint is configured with keys ▲ and ▼. The modified settings are applied when they are saved with function key ⌴. |
| Selecting an inverter | Enable or disable the panel bus. When it is enabled, the status of the drives in the panel bus is displayed and the drive to control via the control panel is selected. See chapter Controlling multiple drives (page 53). |
| Edit start screen | Edit the contents of the start screen. See "Editing the contents of the start screen" (page 50). |
| Active faults | Display an active fault message. See chapter Warning and fault messages (page 57). |
| Active warnings | Display an active warning message. See chapter Warning and fault messages (page 57). |

#### 3.2.2.6.2 Editing the contents of the start screen

1. In menu **Options**, select row **Edit start screen**. This opens the **start screen** for editing.
2. Parameters of the start screen can be added, edited and deleted in edit mode.

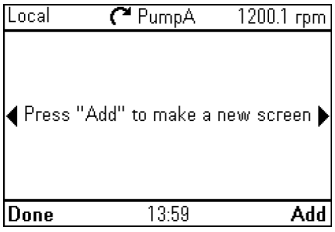
   After editing, press key ⌴ (**Done**) to confirm the changes, exit edit mode and return to the **start screen**.

Two-signal page in edit mode

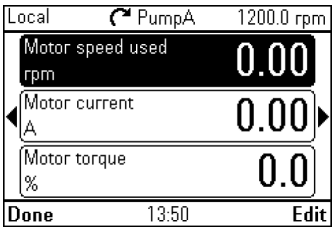



The function key assignment and a flashing cursor indicate that the control panel is in edit mode.

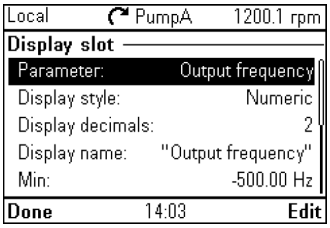
Blank page in edit mode




3. In edit mode, keys ◀ and ▶ are used to switch between the different pages of the **start screen**.
   - To add a new page, navigate to the page where Add is displayed above the right function key and press function key **Add** to create a new page.
   - Go to the respective page to edit, add or delete parameters existing pages.
4. You can use keys ▲ and ▼ to move the cursor for marking and selecting.
   - To add a parameter to an existing page, select an area above, between or below displayed parameters.
   - Select a displayed parameter to edit or delete it.




5. You can open menu **Display area** with key ⌴ (**Edit**).
6. Then select a parameter, its display settings and its scaling.

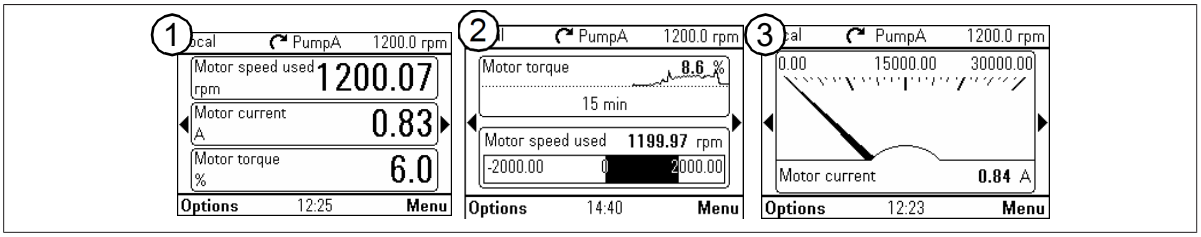



> **Note:**
>
> **Parameters that are displayed as text (like the bit status names) or that contain characters that are not numbers (like date or time duration) are automatically displayed as text. For these parameters, the display mode for numerical parameters and a corresponding selection is not available.**

- **Parameter:** The parameter selection displays the selected area. The most frequently used parameters are listed as default settings. For bit field parameters, either a single bit or the entire bit field can be selected to add to the **start screen**. For individual bits, the bit status is displayed. Full bit fields are displayed in either hexadecimal or binary format.

> **Note:**
>
> **When Empty is selected, the parameter is removed from the start screen.**

- **Display type:** Select the display type of signal values. Different display types can be used on one page.
  - **Numeric:** The parameter values are displayed as numbers (see image 1). If there is only one parameter on the page, a bar display is also shown.
  - **Measured values/bars:** If there is only one parameter on the page, the parameter value is also displayed as a pointer (see Image 3). If two or three parameters are on the same page, the value is displayed as a bar (see areas in Image 2).
  - **Curve:** 15 minutes, 30 minutes, 1 hour or 24 hours: The parameter value is displayed as a curve within the selected time period (see upper display area in image 2).




> **Note:**
>
> **The data displayed as a curve is not stored in the drive memory, which means that if you remove or restart the control panel, the data will be lost.**

- **Display decimal places:** Specify how many decimal places are displayed.
- **Display name:** Enter a unique name that will be displayed in the **start screen** instead of the parameter name.
- **Min** and **Max**: The function depends on whether **scaling range of values** was selected:
  - **Scaling range of values** was not selected: Select the minimum and maximum signal values to display on curves.
  - **Scaling range of values** was selected: Select the actual values of the parameter corresponding to **Display min. signal as** and **Display max. signal as** (see below).
- **Scaling range of values:** Selection for setting the scaling range of values.
  - **Display min. signal as** and **Display max. signal as**: Selection for setting the minimum and maximum values displayed in the **start screen**. This setting option allows the use of application-specific scaling.

    If the parameter value goes below the minimum or above the maximum, the text message Out of scale is displayed. In the curve display, small arrows are displayed instead of the values outside the scaling range.

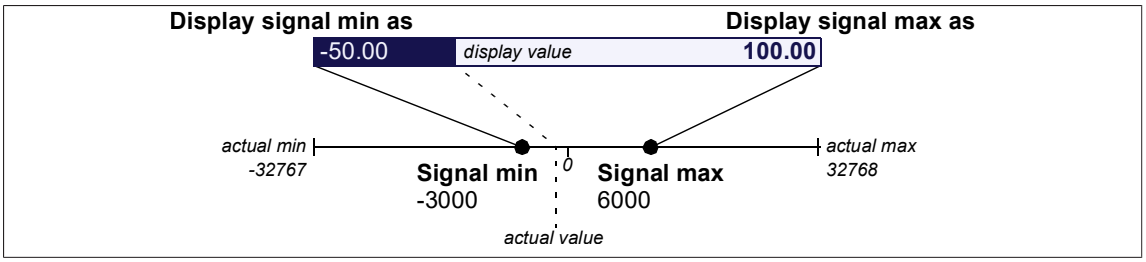



Figure 30: Scaling with "Display min/max signal as" and "Min/Max signal"

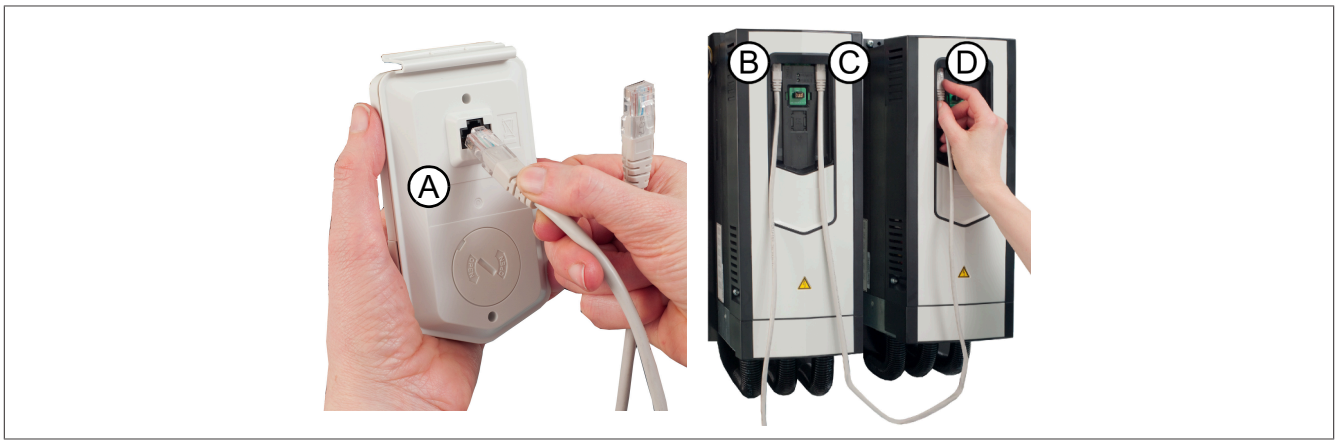
- **Display unit**: Customized adjustment of the unit displayed in the start screen when scaling is used.

### 3.2.2.7 Controlling multiple drives

#### 3.2.2.7.1 Connecting multiple frequency inverters to one control panel

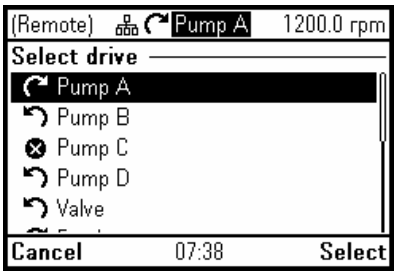
1. Connect the control panel (A) to the first frequency inverter (B) on the panel bus.
2. Connect the first frequency inverter (C) to the second (D), the second to the third and so on using RJ45 cables.

> **Note:**
>
> **For each frequency inverter, a node ID must be set with parameter** 49.01 Node ID number**.**




#### 3.2.2.7.2 Selecting menu Drive

In menu **Options**, selection **Select drive** provides a list of all frequency inverters connected to the panel bus with the display of their current status. If the panel bus has not been enabled, only one frequency inverter is displayed.




If the connection to the currently selected frequency inverter is disrupted in the panel bus, menu option **Select drive** is displayed with the other drive list.

In menu **Select drive**, all drives to which there is no connection are displayed with dimmed (pale) text.

**Selecting a drive**

If several drives are connected to the same panel bus, the drive with which to connect the control panel can be selected, i.e. the drive to control.

1. In menu **Options**, use **Select drive** to open a list of connected drives.
2. You can use keys ▲ and ▼ to move the cursor. When a drive is highlighted, the green LED of the drive blinks for one second.
3. You can switch to the controller of the marked drive with function key ⌴ (**Select**).

#### 3.2.2.7.3 Control panel functions for multiple drives

**Control panel screens**

In a panel bus configuration, the control panel communicates with only one drive at a time. All information displayed on the control panel, such as status bars or signals on the **start screen**, is for the currently selected drive only. The control panel only stores the data from the currently selected drive it its memory accordingly.

Changes to the **start screen** configuration and all parameter changes are saved in the drive. They can be transferred to other drives using the backup function.

In the panel bus, you can display information about other drives and change to a different drive in menu **Select drive**.

**The help page**

The content of the help page is drive-specific and always depends on the drive currently selected.

**Curve display data**

The data for the curve format in the **start screen** is saved in the control panel for the selected drive only. When the selected drive is changed, the stored curve data is deleted and curve data for the newly selected drive is collected.

Stored curves and the corresponding settings (signal selection, horizontal time axis) are stored in the frequency inverter and the curves for the currently selected drive are always displayed in menu **Stored curves**. Each drive stores data independently.

**Drive-specific content**

Each drive in the panel bus has its own specific content since all changes to the default values are stored in the drive.

**Wizards**

Wizards have drive-specific functions, which means that different drives in the panel bus can also have different wizards. However, the principle of operation of the wizards is the same for all drives.

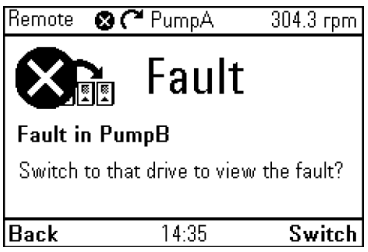
### 3.2.2.7.4 Faults and warnings for multiple drives

**Faults and warnings in the currently selected drive**

Faults and warnings in the currently selected drive are displayed normally.

**Faults and warnings in the other drives**

Faults and warnings in the other drives in the panel bus are displayed as "Fault in...".
Faults that require a restart look similar. Faults are displayed normally when you switch the control panel to the drive in which the fault was detected.




The keys have the following functions on the **Fault** screen:

- Press (**Hide**) to return to the previous screen. As in the case of regular faults, the fault display does not reappear.
- Press (**Switch**) to establish a connection to the disrupted frequency inverters.

The warning messages are only displayed by the selected drive with a connected control panel. To display warning messages from other drives, you must **select the other drive** in the menu.

### 3.2.2.8 Warning and fault messages

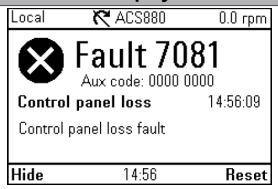
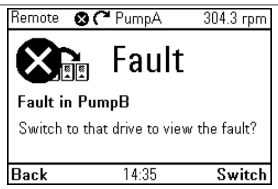
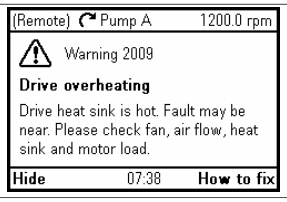
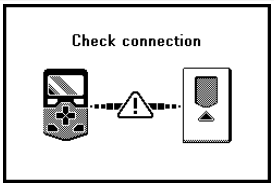
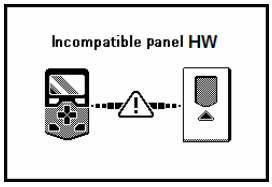
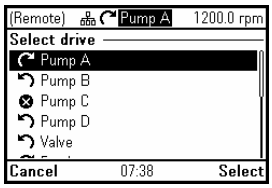
#### 3.2.2.8.1 Identifying warning and fault messages

Faults and warnings are drive states that are reported when the drive detects a problem during operation. Message display, backlight and LED indicators help to identify the problem.

Some of the fault and warning symbols and their descriptions are listed in the table.

| Message | Symbol |
|---|---|
| Fault generated | |
| Fault acknowledgment | |
| Warning generated | |
| Warning disabled | |
| Pure message enabled | |
| Pure message disabled | |

The following table provides more information about fault and warning messages.

| Display | LED | Type |
|---|---|---|
|  | Red, continuous light | See Faults . |
| | Red, blinking light | Faults of this type require the drive to be stopped and restarted before normal operation can be resumed.<br>See Faults . |
|  | Red, continuous light | A fault has occurred in another drive on the panel bus. |
|  | Green, blinking light | See Warnings. |
|  | Green, continuous light | The connection between the control panel and drive is faulty.<br>Check if the connection cable is installed correctly. |
|  | Green, continuous light | The type of control panel is not compatible with the drive to which it should be connected. |
|  | Green, continuous light | The connection between the control panel and the drive has been interrupted.<br>Check all control panel network connections.<br>Select a different drive. |

#### 3.2.2.8.2 Faults

Faults are problems that require attention before you restart the drive.

Follow the steps below to corrects faults:

1. Identify and eliminate the cause of the fault. The fault code is displayed on the **Fault** screen. For additional information about the fault, see the drive manual.
2. Acknowledge the fault with right function key (Reset) on the fault screen.

The keys have the following functions on the **Fault** screen:

- You can temporarily hide the fault message and return to the previous screen with key (**Hide**) or any arrow key. If a warning is also active, the warning message is now displayed at the position. The fault message reappears if no key has been pressed for 60 seconds.
- The fault message is acknowledged, and the previous screen is reopened with key (**Reset**).
- Press key to open the context-sensitive help documentation. The help page has a keyboard shortcut to the wizard for fault diagnostics, which provides assistance in correcting the causes of faults.

#### 3.2.2.8.3 Warnings

Warnings mean that a potential problem has been detected and requires attention, but the drive is still operating. A warning message is disabled when the condition that triggered it no longer exists.

- You can hide the warning message and return to the previous screen using key (**Hide**). If the cause of the warning message persists, the **Warning** screen will automatically reappear after 60 seconds if no key has been pressed.
- Press key to open the context-sensitive help documentation.

> **Note:**
>
> **If multiple alerts are active, the total number of active alerts is displayed. Use can use keys and to scroll through the warning messages.**

### 3.2.2.9 Service and maintenance

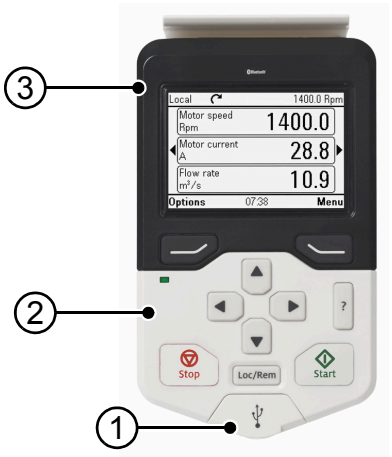
#### 3.2.2.9.1 Removing the control panel cover

The control panel cover can be removed to remove dust from the inside of the cover or replace the cover with a customized version.

The cover consists of two parts, both of which can be removed. No tools are required to remove the cover.

1. Open the USB port cover.
2. Remove the lower part of the control panel cover.
3. Remove the upper part of the control panel cover.

Replace the covers in reverse order.



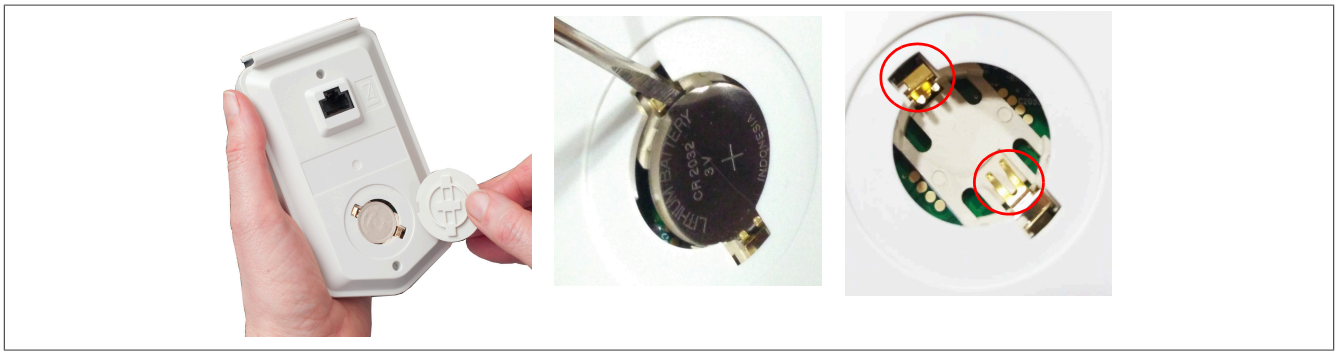

#### 3.2.2.9.2 Cleaning the connections

The control panel has two connectors, the RJ45 connector (on the back of the control panel) and the USB connector (on the front of the control panel). Clean the surface/area around the connectors with a suitable cleaning solution (e.g. an isopropyl alcohol solution). The cleaning solution is not permitted for cleaning the inside of the connectors.

#### 3.2.2.9.3 Replacing the battery

The following instructions describe how to replace the battery that supplies power to the control panel real-time clock.

1. Turn the battery compartment cover on the back of the control panel counterclockwise until the latch in the recesses is released, then remove the cover.
2. Carefully remove the battery.
3. Replace the battery with a new CR2032 battery. The battery holder has claws. Slide the battery in first and then press the other side. The battery then snaps into place.
4. Ensure that the positive terminal of the battery is on top.
5. Replace the lid and lock it by turning it clockwise.
6. Dispose of the old battery in accordance with regulations.



### 3.2.2.10 Degree of protection

| Type of connection/installation | Degree of protection |
|---|---|
| Separate | IP20 |
| Control panel connected to an RJ45 cable | IP20 |
| Control panel connected to a USB cable | IP20 |
| Control panel installed in 8I0PT096.400-1 pass-through mounting kit | IP54 |
| Control panel installed in 8I0PT096.401-1 push-through mounting kit | IP65 |
| Control panel installed in through-hole mounting kit 8I0PT096.402-1 | IP66 |

A control panel mounted on a frequency inverter has the same degree of protection as the frequency inverter itself.

### 3.2.2.11 Technical data

#### 3.2.2.11.1 Connections

The control panel has the following connections:

| Connection | Purpose |
|---|---|
| Female RJ45 connector | For connecting the control panel to the frequency inverter.<br>• The maximum length permitted for the cable used is 100 m (328 ft.).<br>• On the panel bus, the combined maximum length of the panel bus cables is 100 m (328 ft).<br>• The panel bus can have a maximum of 32 nodes. |
| USB port type B mini | For connecting the control panel to the PC. It is intended as a temporary service port (USB 2.0, MTP protocol). The maximum cable length is three meters (9.8 ft.). |

#### 3.2.2.11.2 Display

The control panel has a monochrome LCD display, resolution 240 x 160 pixels, with adjustable backlight and contrast.

See Basic settings.

#### 3.2.2.11.3 Battery

At an ambient temperature of 25°C (77°F), the replacement interval for the real-time clock battery is approximately 10 years.

Battery type: CR2032

#### 3.2.2.11.4 Dimensions and weight

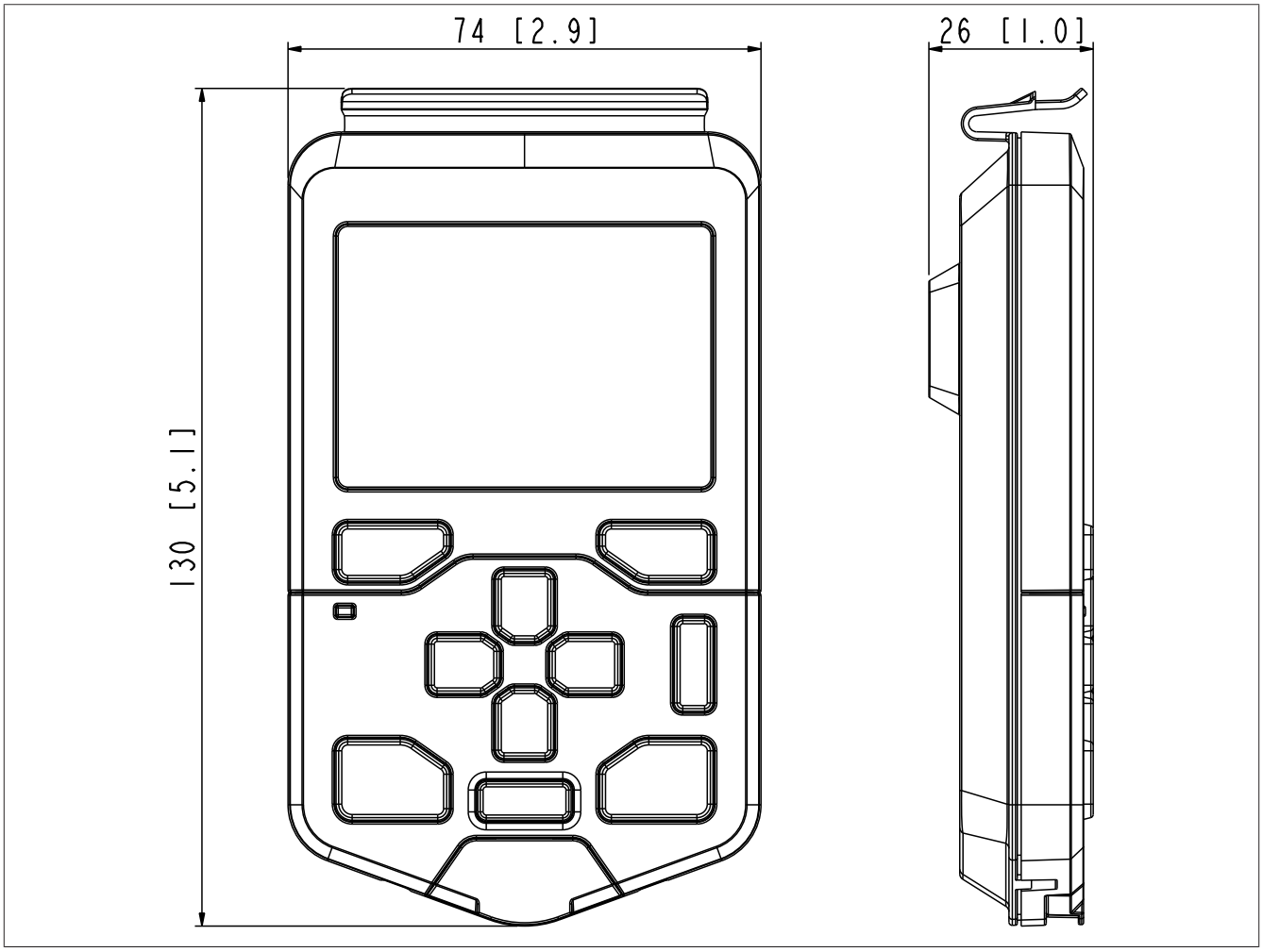



Figure 31: Dimensions in millimeters [in.]

Weight: 130 g

### 3.2.2.11.5 Materials used

| | |
|---|---|
| Housing | PC/ABS |
| Packaging | Cardboard |
| Display window / Display | Polycarbonate |
| Disposal | Disposing of the control panel with normal waste is not permitted.<br>Observe the locally applicable regulations for the disposal of electronic devices.<br>See the recycling instructions and environmental information provided with the frequency inverter. |

### 3.2.2.11.6 Ambient condition limits

| | Operation | Storage | Transport |
|---|---|---|---|
| Installation site / Elevation above sea level | 4000 m (13123 ft.) | - | - |
| Air temperature | -20°C to +55°C<br>(-4°F to 131°F) | -40°C to +70°C<br>(-40°F to 158°F) | -40°C to +70°C<br>(-40°F to 158°F) |
| Relative humidity | 95%, non-condensing | | |
| Temperature inside the control panel | -20°C to +70°C<br>(-4°F to 158°F) | -25°C to +70°C<br>(-13°F to 158°F) | - |

## Note:

**The accuracy of the real-time clock deteriorates at very high and very low temperatures.**

### 3.2.2.11.7 IEC conformity

| | Operation | Transport |
|---|---|---|
| Contamination levels<br>(IEC 60721-3-3, IEC 60721-3-2, IEC 60721-1-3-1) | 3C3 | |
| Sinusoidal oscillations | 61800-5-1 output 2.<br>EN 60082-2-6 Test Fc (1g) | Class 2M3 per EN 60082-2-6 |
| Shock | Class 3M4 per EN 60062-2-27 | Class 2M2 per to EN 60082-2-27 |
| Free fall | IEC-60068-2-32, drop height 1 m. (3.3 ft.) | - |
| EMV conformity<br>(EN 61800-3: 2004 +A1: 2012) | IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-6 | - |

### 3.2.2.11.8 Bluetooth encryption (8I0XD096.401-1 only)

| | Bluetooth classic | Bluetooth LE (low energy) |
|---|---|---|
| **Encryption algorithm** | Individual algorithms are based on:<br>• SAFER + for key derivation (called E21 and E22)<br>• Authentication as message authentication codes (called E1)<br>• Payload data encryption (called E0) | AES |
| **Encryption protocol** | E0, E1, E21, E22/ SAFER+ | AES |
| **Type** | Symmetrical | |
| **Key length** | 128 | |
| **Function** | Key derivation, authentication and payload data encryption | |

### 3.2.2.11.9 LCD specification

| LCD type | FSTN, negative passband |
|---|---|
| Operating temperature | -20°C to +70°C (-4°F to 158°F) |
| Storage temperature | -40°C to +80°C (-40°F to 176°F) |
| Transport temperature | -40°C to +80°C (-40°F to 176°F) |
| Driver IC | UC1698U |
| RoHS | Met |
| General tolerance | ±0.2 |

## Note:

**The LCD display responds slowly at 0°C (32°F) and below.**

### 3.2.2.11.10 Bluetooth interface (8I0XD096.401-1 only)

| | |
|---|---|
| Bluetooth standard | Bluetooth 4.0 Dual mode (smart ready), Bluetooth classic, Bluetooth LE (low energy) |
| Certificate | Bluetooth® qualified design |
| Antenna type | Internally inverted-F on PCB |
| Operating frequency | 2.4000 ... 2.4835 GHz |
| Antenna gain | Maximum 1.7 dBi |

### 3.2.2.11.11 Bluetooth encryption (8I0XD096.401-1 only)

| | Bluetooth classic | Bluetooth LE (low energy) |
|---|---|---|
| **Encryption algorithm** | Individual algorithms are based on:<br>• SAFER + for key derivation (called E21 and E22)<br>• Authentication as message authentication codes (called E1)<br>• Payload data encryption (called E0) | AES |
| **Encryption protocol** | E0, E1, E21, E22/ SAFER+ | AES |
| **Type** | Symmetrical | |
| **Key length** | 128 | |
| **Function** | Key derivation, authentication and payload data encryption | |

### 3.2.2.12 Accessories

### 3.2.2.12.1 8I0PT096.400-1

### 3.2.2.12.1.1 General information

Pass-through mounting kit 8I0PT096.400-1 is designed for flush mounting in a control cabinet door and has IP54 protection. [3)]

### 3.2.2.12.1.2 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Feed-through mounting kits** | |
| 8I0PT096.400-1 | Pass-through mounting kit for P96 IP54 | |

Table 20: 8I0PT096.400-1 - Order data

### 3.2.2.12.1.3 Technical data

| Order number | 8I0PT096.400-1 |
|---|---|
| **Operating conditions** | |
| Degree of protection per EN 60529 | IP54 [1)] |
| **Mechanical properties** | |
| Dimensions | |
| Width | 125 mm |
| Height | 261.8 mm |
| Depth | 50.5 mm |
| Weight | 0.3 kg |

Table 21: 8I0PT096.400-1 - Technical data

1) With a mounted control panel. With an unmounted control panel: IP20.

3) When the control panel is installed. When the control panel is not installed: IP20.

### 3.2.2.12.1.4 Dimension diagram

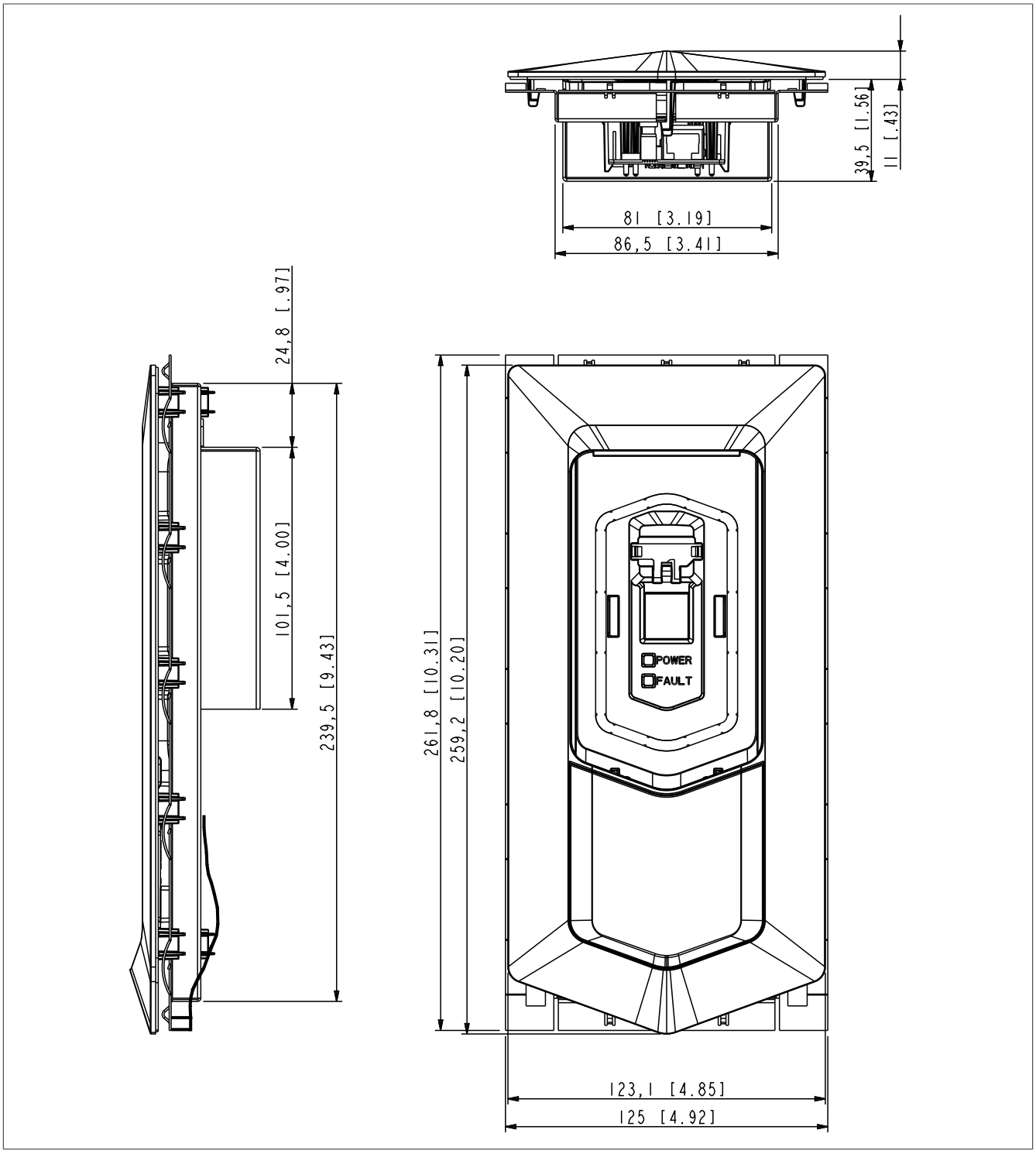
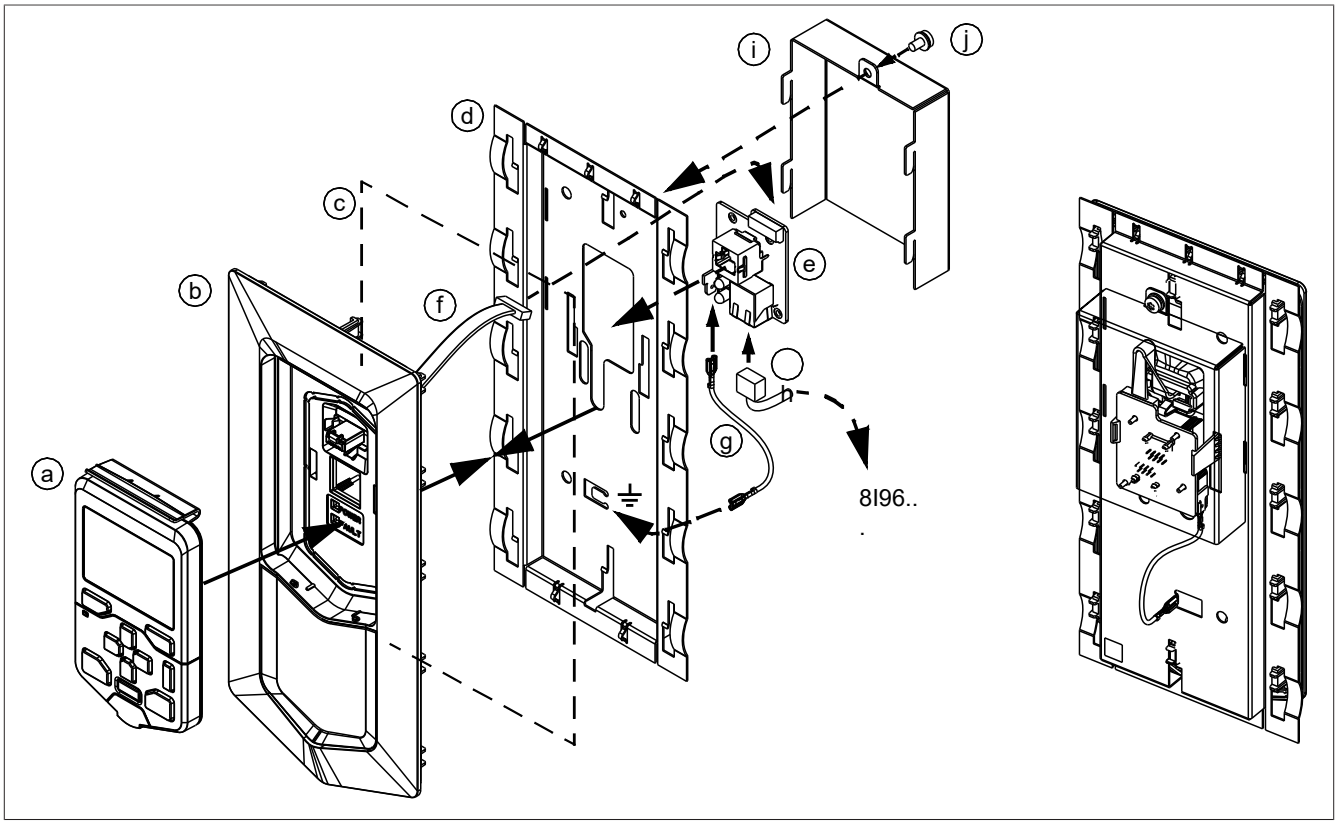



Figure 32: 8I0PT096.400-1 - Dimension diagram

Recess in control cabinet door: 109 mm × 223 mm (4.29 in. × 8.78 in.)

Thickness of the cabinet door: 1.5...2.5 mm (0.059...0.098 in.)

### 3.2.2.12.1.5 Assembly and installation




a Control panel (not included in delivery)
b Mounting plate
c Recess in the control cabinet door
d EMC plate
e Interface module
f Ribbon cable
g Ground cable
h Connection cable to ACOPOSinverter P96
i Module cover
j M4x8 screw

**Procedure**

1) Cut a recess into the control cabinet door (c). See also Dimension diagram.
2) Insert the mounting plate (b) into the recess (c). Hold the mounting plate in position.
3) Push the ribbon cable (f) through the EMC plate (d) on the other side of the control cabinet door. Attach the EMC plate: Align the holes in the EMC plate with the guides in the mounting plate and slide the EMC plate downward.
4) Connect the ribbon cable (f) to the interface module (e) and snap the interface module under the plastic clips.
5) Bend the grounding lug open and connect the ground cable (g).
6) Connect the connection cable (h) to the interface board (e) and the ACOPOSinverter P96.
7) Hook the module cover (i) into the EMC plate (d) and screw it in place (j).
8) Attach the control panel (a).

### 3.2.2.12.2 8I0PT096.401-1

#### 3.2.2.12.2.1 General information

Pass-through mounting kit 8I0PT096.401-1 is intended for surface mounting and has IP54 protection.[4)].

[4)] When the control panel is installed. When the control panel is not installed: IP20

### 3.2.2.12.2.2 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Feed-through mounting kits** | |
| 8I0PT096.401-1 | Pass-through mounting kit for P96 IP65 | |

Table 22: 8I0PT096.401-1 - Order data

### 3.2.2.12.2.3 Technical data

| Order number | 8I0PT096.401-1 |
|---|---|
| **Operating conditions** | |
| Degree of protection per EN 60529 | IP65 [1] |
| **Mechanical properties** | |
| Dimensions | |
| Width | 85.9 mm |
| Height | 152.2 mm |
| Depth | 67 mm |
| Weight | 0.3 kg |

Table 23: 8I0PT096.401-1 - Technical data

1) When the control panel is installed. When the control panel is not installed: IP20.

### 3.2.2.12.2.4 Dimension diagram

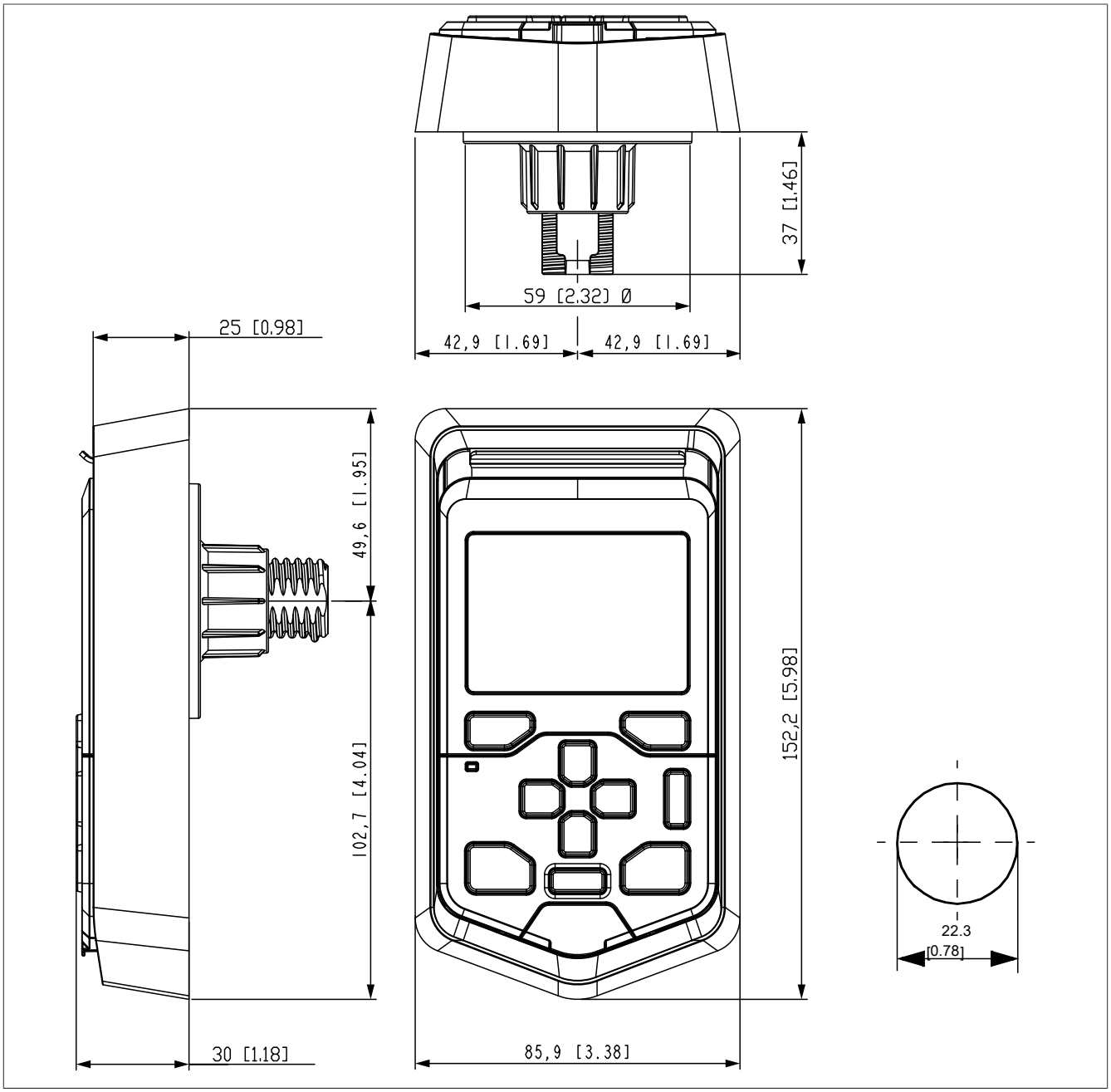
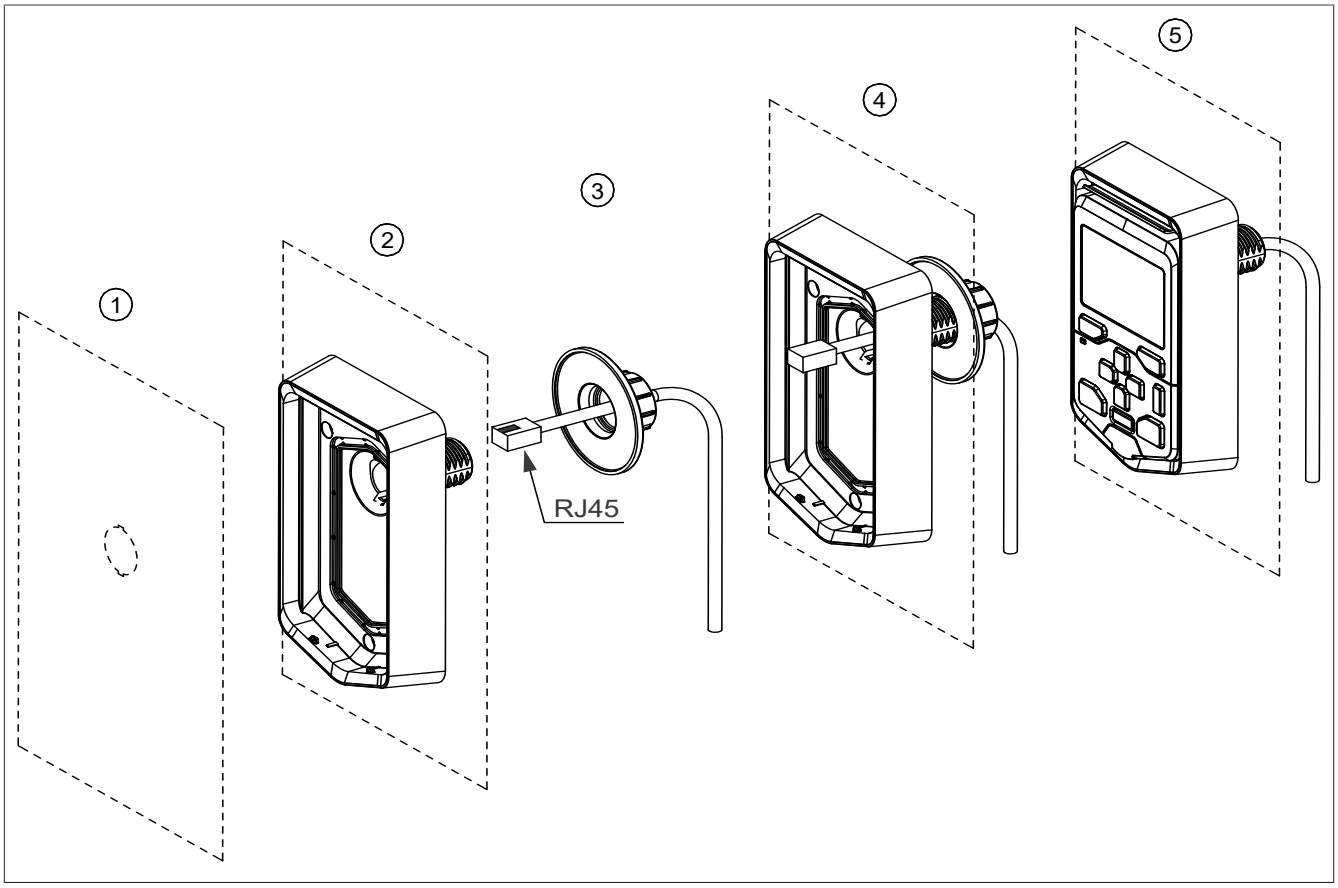



Figure 33: 8I0PT096.401-1 - Dimension diagram

Thickness of the control cabinet door: 1.5 ... 30 mm (0.059...1.18 in.)

#### 3.2.2.12.2.5 Assembly and installation




**Procedure**

1) Cut a hole in the control cabinet door. See Dimension diagram.
2) Remove locking the nut and insert installation frame into the hole.
3) Guide the attachment cable through the locking nut and the hole in the installation frame.
4) Turn the locking nut clockwise to tighten it.
5) Connect the attachment cable to the control panel and insert the control panel into the installation frame.
6) Secure the attachment cable, with a cable tie for example, to prevent tensile stress on the connector plug. Provide sufficient cable length for opening the control cabinet door or removing the control panel from the installation frame.
7) Connect the other end of the attachment cable to the ACOPOSinverter P96.

### 3.2.2.12.3 8I0PT096.402-1

#### 3.2.2.12.3.1 General information

The pass-through mounting kit 8I0PT096.402-1 is designed for surface mounting in harsh environments and has IP66 protection. [5)].

[5)] When the cover is closed

### 3.2.2.12.3.2 Order data

| Order number | Short description | Figure |
|---|---|---|
| | **Feed-through mounting kits** | |
| 8I0PT096.402-1 | Pass-through mounting kit for P96 IP66 | |

Table 24: 8I0PT096.402-1 - Order data

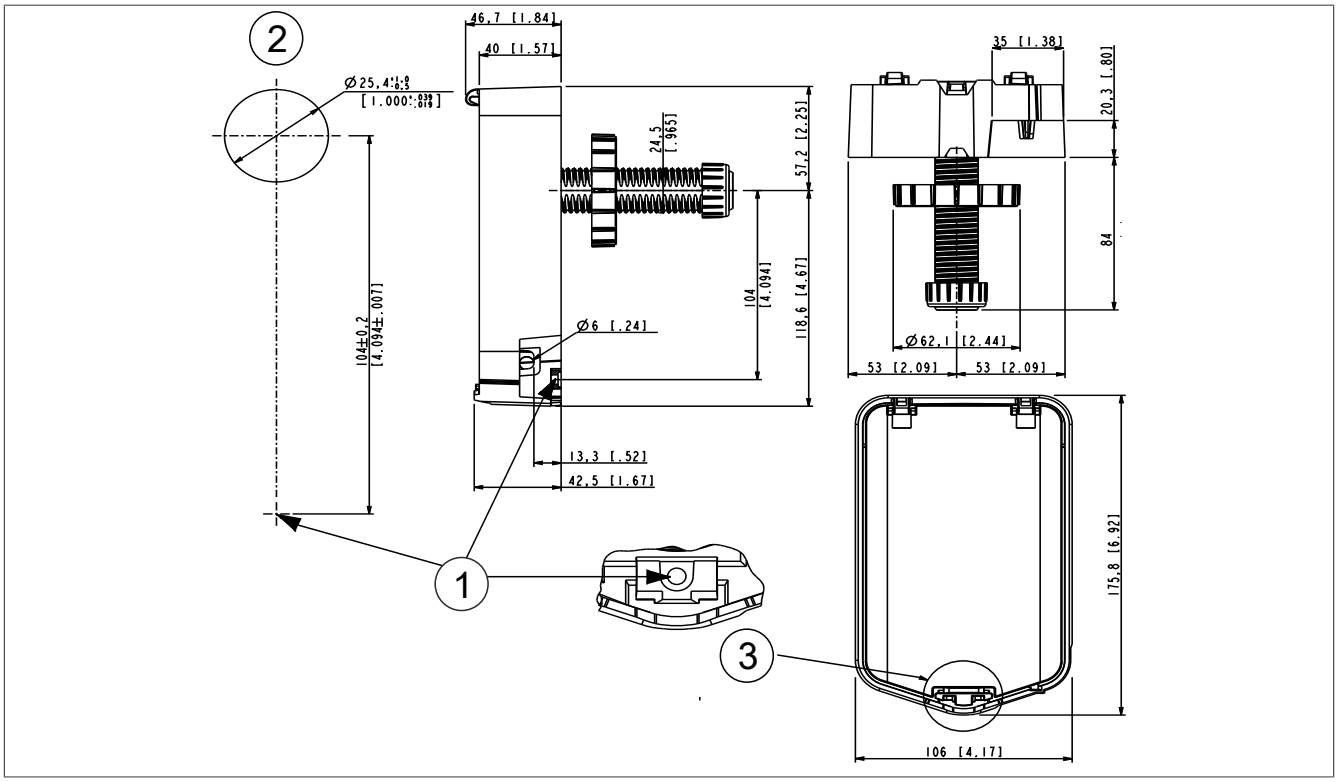
### 3.2.2.12.3.3 Technical data

| Order number | 8I0PT096.402-1 |
|---|---|
| **Operating conditions** | |
| Degree of protection per EN 60529 | IP66 [1)] |
| **Mechanical properties** | |
| Dimensions | |
| Width | 106 mm |
| Height | 175.8 mm |
| Depth | 130.7 mm |
| Weight | 0.25 kg |

Table 25: 8I0PT096.402-1 - Technical data

1) With the cover closed.

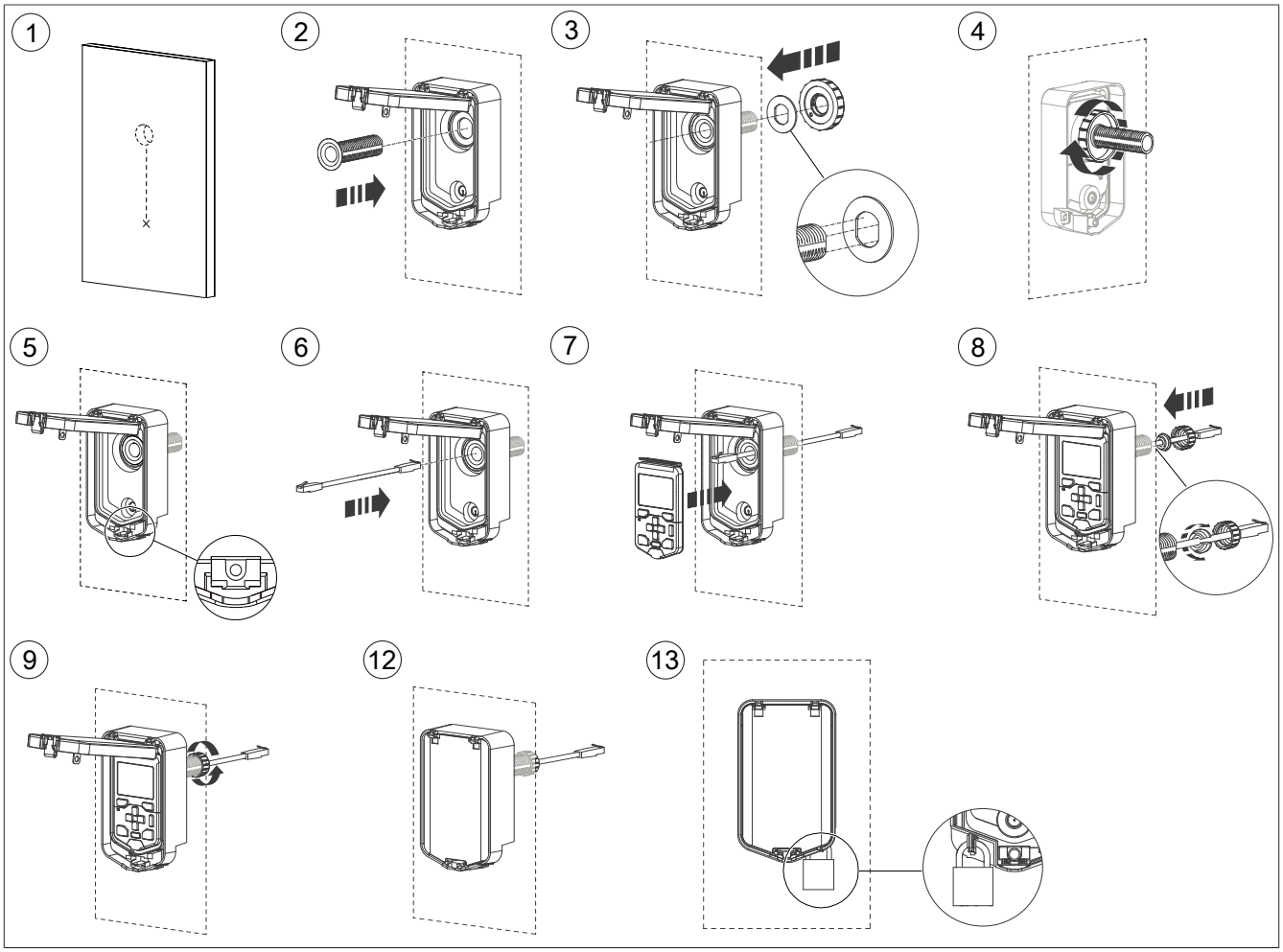
### 3.2.2.12.3.4 Dimension diagram




1 Hole diameter in the wall / control cabinet door
2 Position of the stabilizing screw. Max. screw diameter 4 mm [#8].
3 Detail A - Cover open

Wall thickness / Panel door thickness: Max. 60 mm (2.36 in), smooth parallel surfaces on both sides.

### 3.2.2.12.3.5 Assembly and installation




**Procedure**

1) Cut a hole in the control cabinet door. Placing mark for stabilizing screw. See Dimension diagram.
2) Align the holes in the installation frame and control cabinet door. Insert the locking bar into the hole.
   Note: The locking bar can be shortened to a suitable length (minimum length: thickness of the control cabinet door + 30 mm [1.18 in.]).
3) Slide the seal and locking nut onto the locking bar. Align the seal with the locking rod.
4) Tighten the locking nut.
5) If the installation frame can still be moved:
   Use a locking screw[6]. Drill hole at the position for the locking screw. Ensure that the seal is in the correct position. Screw in the locking screw.
6) Push the attachment cable through the locking bar.
7) Connect the attachment cable to the control panel and insert the control panel into the installation frame.
8) Attach the cable seal to the attachment cable. Slide the locknut for the cable seal onto the attachment cable.
9) Secure the cable seal with the locknut.
10) Secure the attachment cable, with a cable tie for example, to prevent tensile stress on the connector plug. Provide sufficient cable length for opening the control cabinet door or removing the control panel from the installation frame.
11) Connect the other end of the attachment cable to the ACOPOSinverter P96.
12) Control panel mounting bracket in assembled state.
13) If necessary, secure the control panel mounting bracket using a padlock[7].

[6] not included in scope of delivery
[7] Not included.

## 3.2.3 Filter

### 3.2.3.1 dv/dt filters

#### 3.2.3.1.1 8I0DT096.016-1

##### 3.2.3.1.1.1 General information

dv/dt filter 8I0DT096.016-1 is used to reduce bearing currents and to protect the insulation of motors connected to ACOPOSinverter P96.

##### 3.2.3.1.1.2 Order data

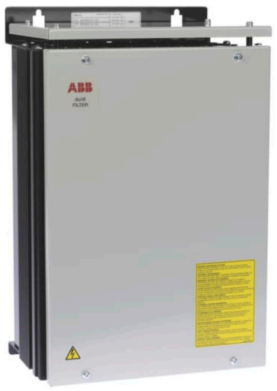
| Order number | Short description | Figure |
|---|---|---|
| | **dU/dT filters** |  |
| 8I0DT096.016-1 | 16 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 26: 8I0DT096.016-1 - Order data

##### 3.2.3.1.1.3 Technical data

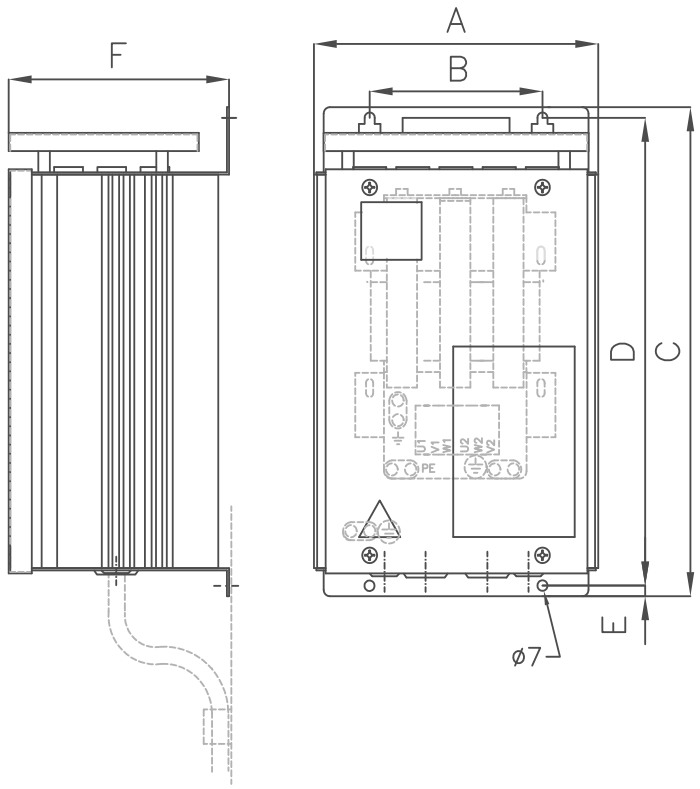
| Order number | 8I0DT096.016-1 |
|---|---|
| **Mains connection** | |
| Mains input voltage | 380 to 690 V ±10% |
| Max. assumed short-circuit current (Isc) (short-circuit current at connection point) | 50 kA (1 s) |
| **Ambient conditions** | |
| Temperature | |
| Operation | -15 to +50°C |
| Derating | 1%/°C from 40°C |
| Storage | -40 to +70°C |
| Transport | -40 to +70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | <95%, non-condensing |
| Transport | <95%, non-condensing |
| **Mechanical properties** | |
| Dimensions | |
| Width | 199 mm |
| Height | 323 mm |
| Depth | 154 mm |
| Weight | 6 kg |

Table 27: 8I0DT096.016-1 - Technical data

### 3.2.3.1.1.4 Dimension diagram and installation dimensions

**Dimension diagram**

All specifications in millimeters.




| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 8I0DT096.016-1 | 199 | 120 | 323 | 309 | 7 | 154 |
| 8I0DT096.030-1 | 249 | 160 | 348 | 334 | 7 | 172 |
| 8I0DT096.070-1 | 279 | 180 | 433 | 419 | 7 | 202 |

Figure 34: 8I0DT096.0xx-1 - Dimension diagram

**Installation dimensions**

300 mm clearance on each side.

Exception: 500 mm above the filter if installed under an ACOPOSinverter P96.

**Mechanical installation**

- Lift the filter into the installation position using the lifting lugs.
- Secure the filter with four screws (tightening torque for screws M6: 9 Nm) to the mounting points in the mounting brackets.

### 3.2.3.1.1.5 Wiring

**Overview**

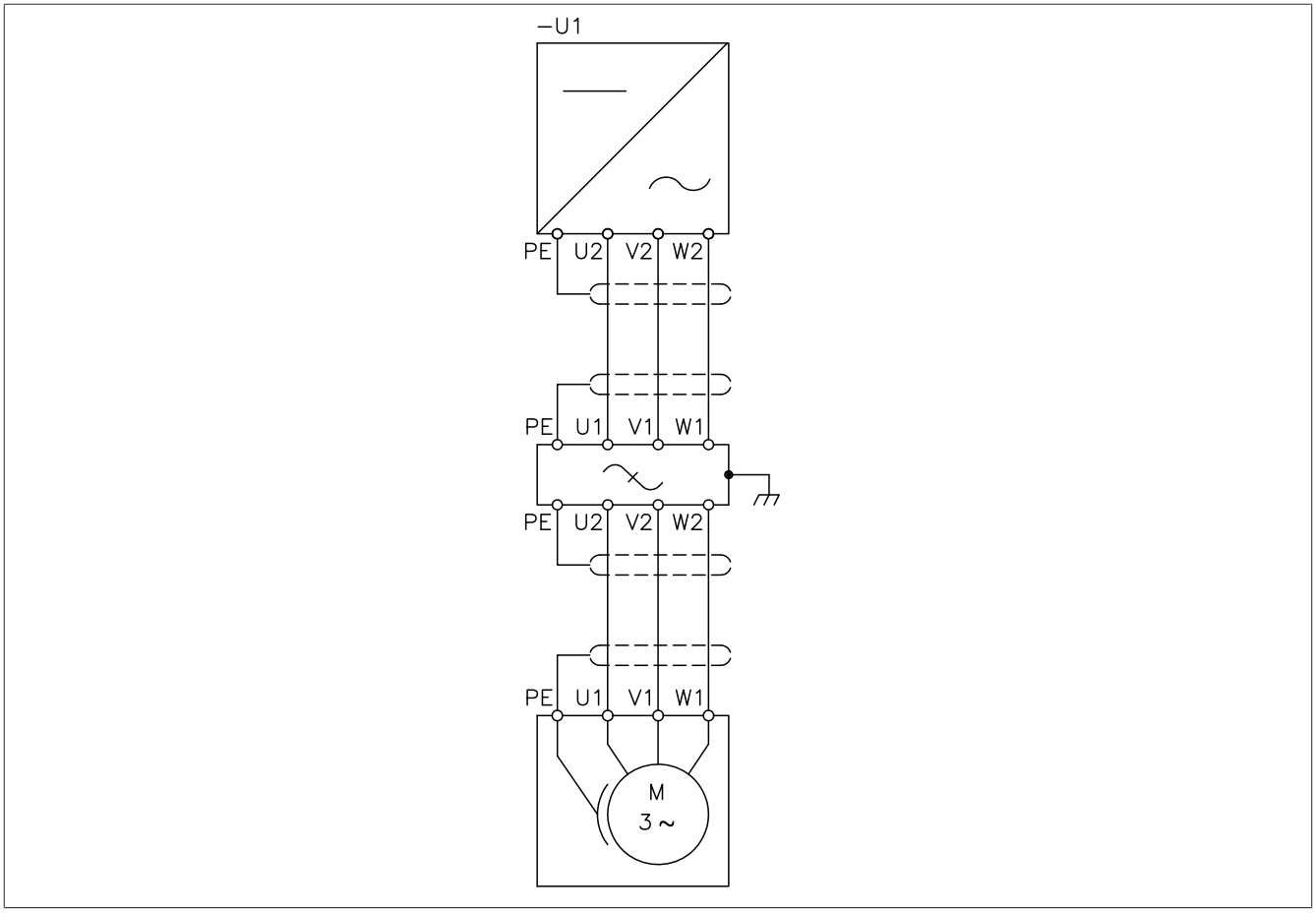



Figure 35: Overview 8I0DT096.0xx-1

**Input/Output circuit diagram**

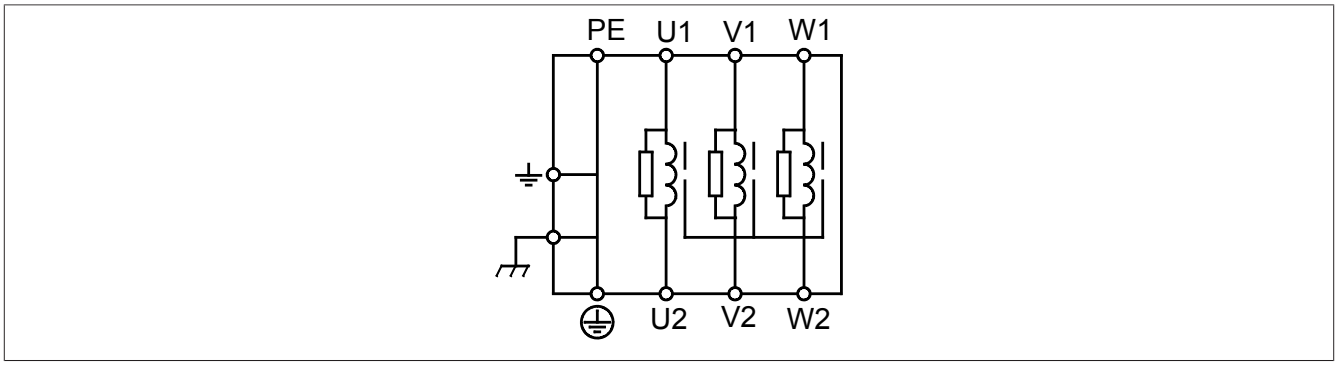



Figure 36: 8I0DT096.0xx-1 - Input/Output circuit diagram

### 3.2.3.1.2 8I0DT096.030-1

#### 3.2.3.1.2.1 General information

dv/dt filter 8I0DT096.030-1 is used to reduce bearing currents and to protect the insulation of motors connected to ACOPOSinverter P96.

#### 3.2.3.1.2.2 Order data

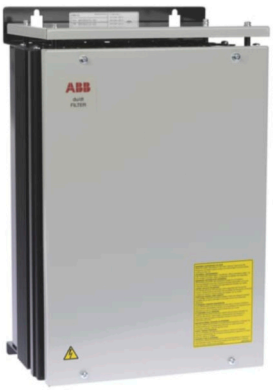
| Order number | Short description | Figure |
|---|---|---|
| | **dU/dT filters** |  |
| 8I0DT096.030-1 | 30 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 28: 8I0DT096.030-1 - Order data

#### 3.2.3.1.2.3 Technical data

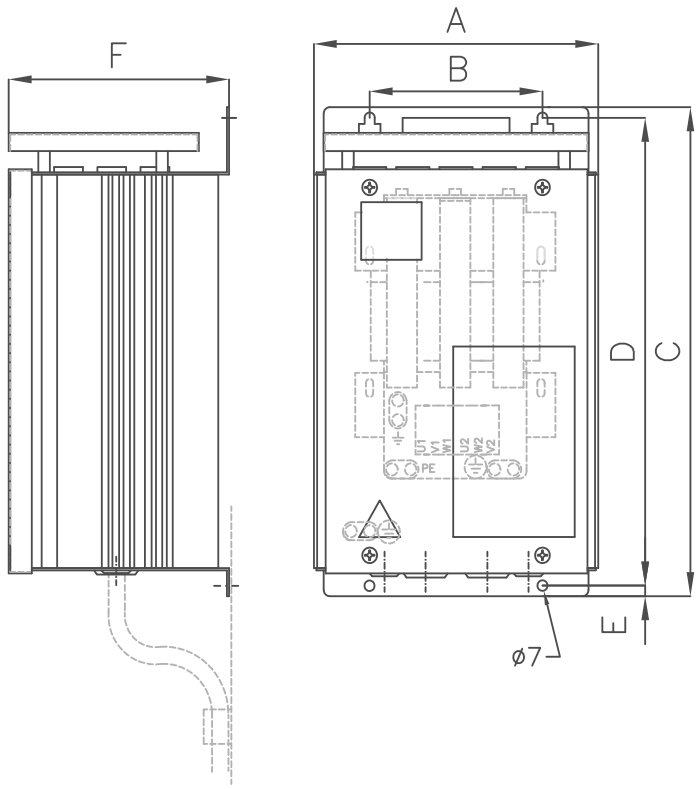
| Order number | 8I0DT096.030-1 |
|---|---|
| **Mains connection** | |
| Mains input voltage | 380 to 690 V ±10% |
| Max. assumed short-circuit current (Isc) (short-circuit current at connection point) | 50 kA (1 s) |
| **Ambient conditions** | |
| Temperature | |
| Operation | -15 to +50°C |
| Derating | 1%/°C from 40°C |
| Storage | -40 to +70°C |
| Transport | -40 to +70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | <95%, non-condensing |
| Transport | <95%, non-condensing |
| **Mechanical properties** | |
| Dimensions | |
| Width | 249 mm |
| Height | 348 mm |
| Depth | 160 mm |
| Weight | 9 kg |

Table 29: 8I0DT096.030-1 - Technical data

### 3.2.3.1.2.4 Dimension diagram and installation dimensions

**Dimension diagram**

All specifications in millimeters.




| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 8I0DT096.016-1 | 199 | 120 | 323 | 309 | 7 | 154 |
| 8I0DT096.030-1 | 249 | 160 | 348 | 334 | 7 | 172 |
| 8I0DT096.070-1 | 279 | 180 | 433 | 419 | 7 | 202 |

Figure 37: 8I0DT096.0xx-1 - Dimension diagram

**Installation dimensions**

300 mm clearance on each side.

Exception: 500 mm above the filter if installed under an ACOPOSinverter P96.

**Mechanical installation**

- Lift the filter into the installation position using the lifting lugs.
- Secure the filter with four screws (tightening torque for screws M6: 9 Nm) to the mounting points in the mounting brackets.

### 3.2.3.1.2.5 Wiring

**Overview**

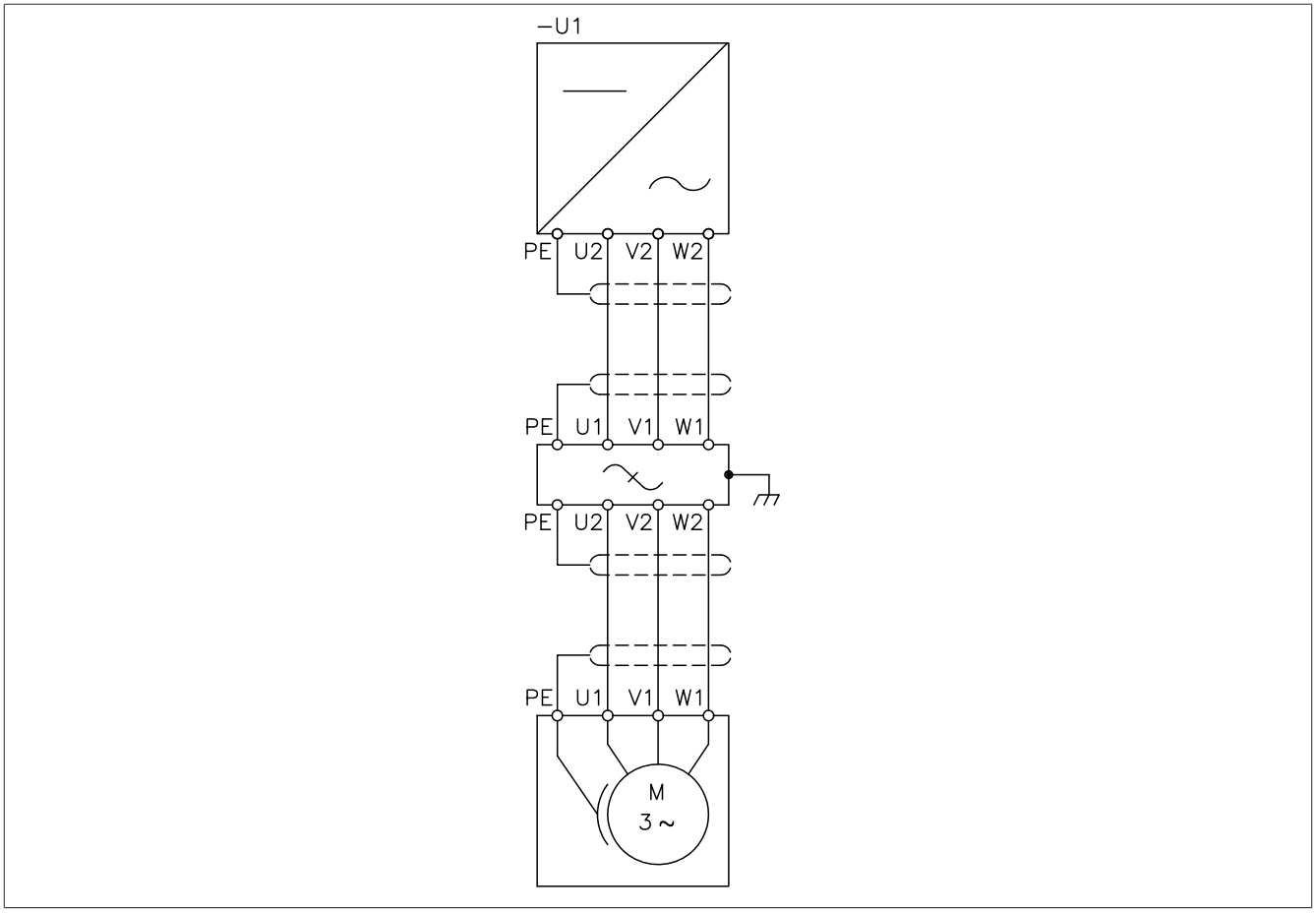



Figure 38: Overview 8I0DT096.0xx-1

**Input/Output circuit diagram**

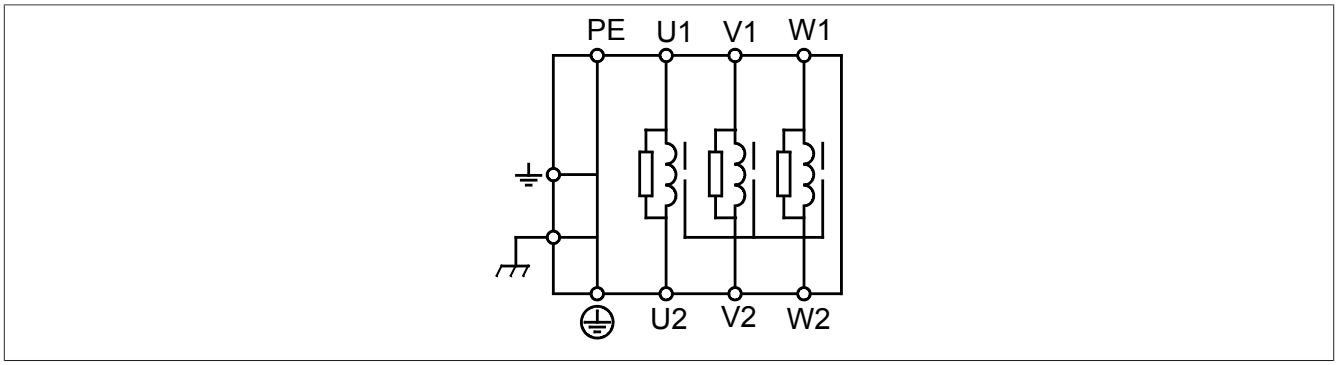



Figure 39: 8I0DT096.0xx-1 - Input/Output circuit diagram

### 3.2.3.1.3 8I0DT096.070-1

#### 3.2.3.1.3.1 General information

dv/dt filter 8I0DT096.070-1 is used to reduce bearing currents and to protect the insulation of motors connected to ACOPOSinverter P96.

#### 3.2.3.1.3.2 Order data

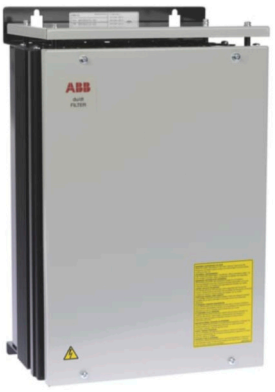
| Order number | Short description | Figure |
|---|---|---|
| | **dU/dT filters** |  |
| 8I0DT096.070-1 | 70 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 30: 8I0DT096.070-1 - Order data

#### 3.2.3.1.3.3 Technical data

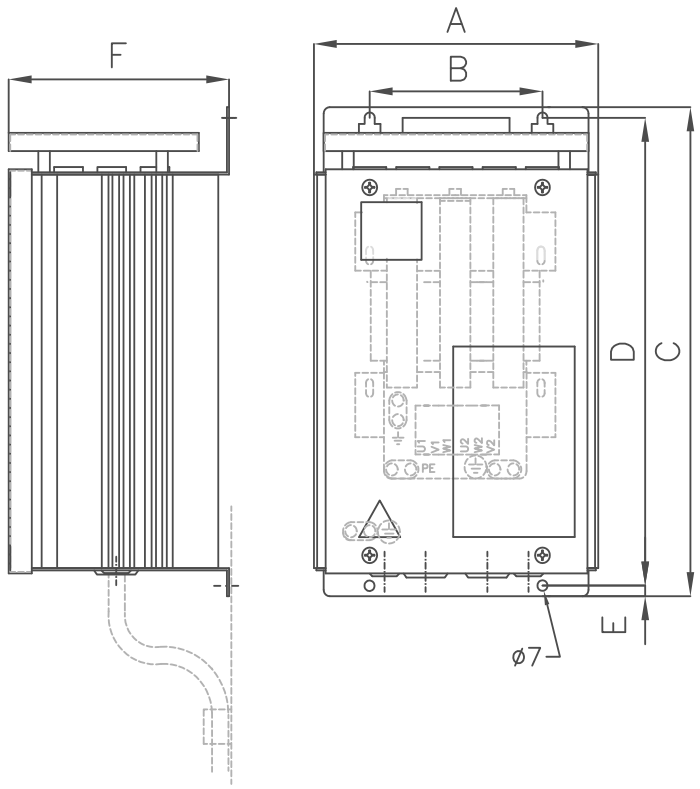
| Order number | 8I0DT096.070-1 |
|---|---|
| **Mains connection** | |
| Mains input voltage | 380 to 690 V ±10% |
| Max. assumed short-circuit current (Isc) (short-circuit current at connection point) | 50 kA (1 s) |
| **Ambient conditions** | |
| Temperature | |
| Operation | -15 to +50°C |
| Derating | 1%/°C from 40°C |
| Storage | -40 to +70°C |
| Transport | -40 to +70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | <95%, non-condensing |
| Transport | <95%, non-condensing |
| **Mechanical properties** | |
| Dimensions | |
| Width | 279 mm |
| Height | 433 mm |
| Depth | 180 mm |
| Weight | 15.5 kg |

Table 31: 8I0DT096.070-1 - Technical data

### 3.2.3.1.3.4 Dimension diagram and installation dimensions

**Dimension diagram**

All specifications in millimeters.




| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 8I0DT096.016-1 | 199 | 120 | 323 | 309 | 7 | 154 |
| 8I0DT096.030-1 | 249 | 160 | 348 | 334 | 7 | 172 |
| 8I0DT096.070-1 | 279 | 180 | 433 | 419 | 7 | 202 |

Figure 40: 8I0DT096.0xx-1 - Dimension diagram

**Installation dimensions**

300 mm clearance on each side.

Exception: 500 mm above the filter if installed under an ACOPOSinverter P96.

**Mechanical installation**

- Lift the filter into the installation position using the lifting lugs.
- Secure the filter with four screws (tightening torque for screws M6: 9 Nm) to the mounting points in the mounting brackets.

### 3.2.3.1.3.5 Wiring

**Overview**

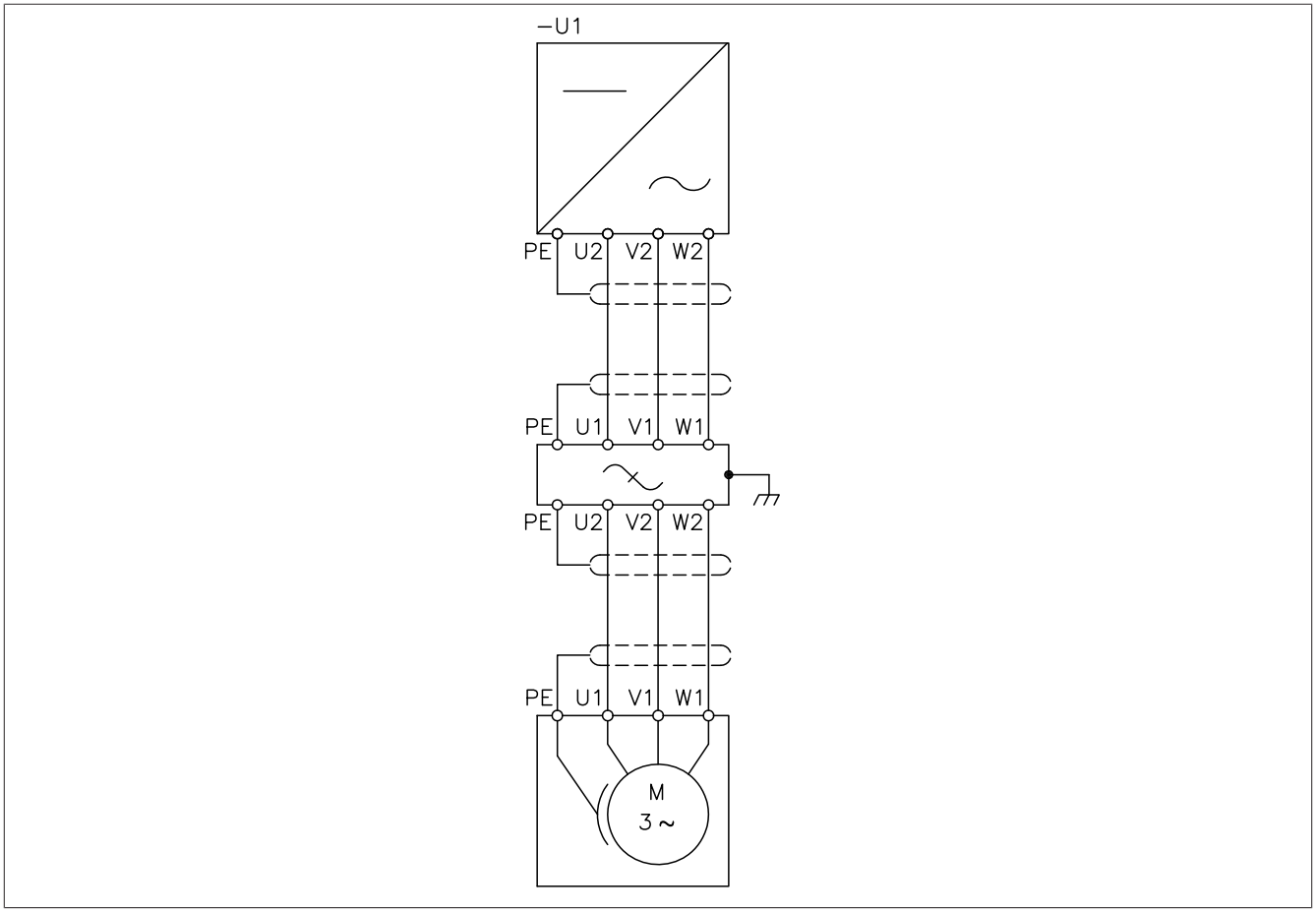



Figure 41: Overview 8I0DT096.0xx-1

**Input/Output circuit diagram**

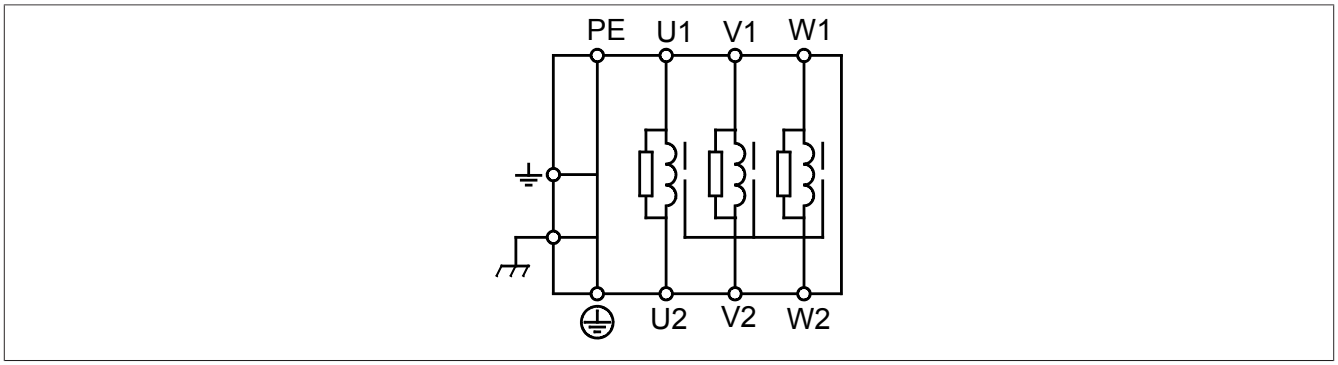



Figure 42: 8I0DT096.0xx-1 - Input/Output circuit diagram

### 3.2.3.1.4 8I0DT096-120-1

#### 3.2.3.1.4.1 General information

dv/dt filter 8I0DT096.120-1 is used to reduce bearing currents and to protect the insulation of motors connected to ACOPOSinverter P96.

#### 3.2.3.1.4.2 Order data

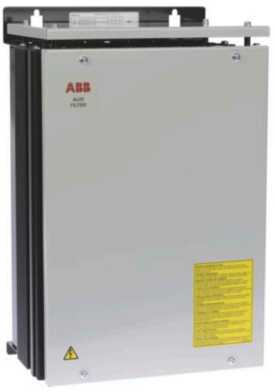
| Order number | Short description | Figure |
|---|---|---|
| | **dU/dT filters** |  |
| 8I0DT096.120-1 | 120 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 32: 8I0DT096.120-1 - Order data

#### 3.2.3.1.4.3 Technical data

| Order number | 8I0DT096.120-1 |
|---|---|

Table 33: 8I0DT096.120-1 - Technical data

### 3.2.3.1.4.4 Dimension diagram and installation dimensions

**Dimension diagram**

All specifications in millimeters.

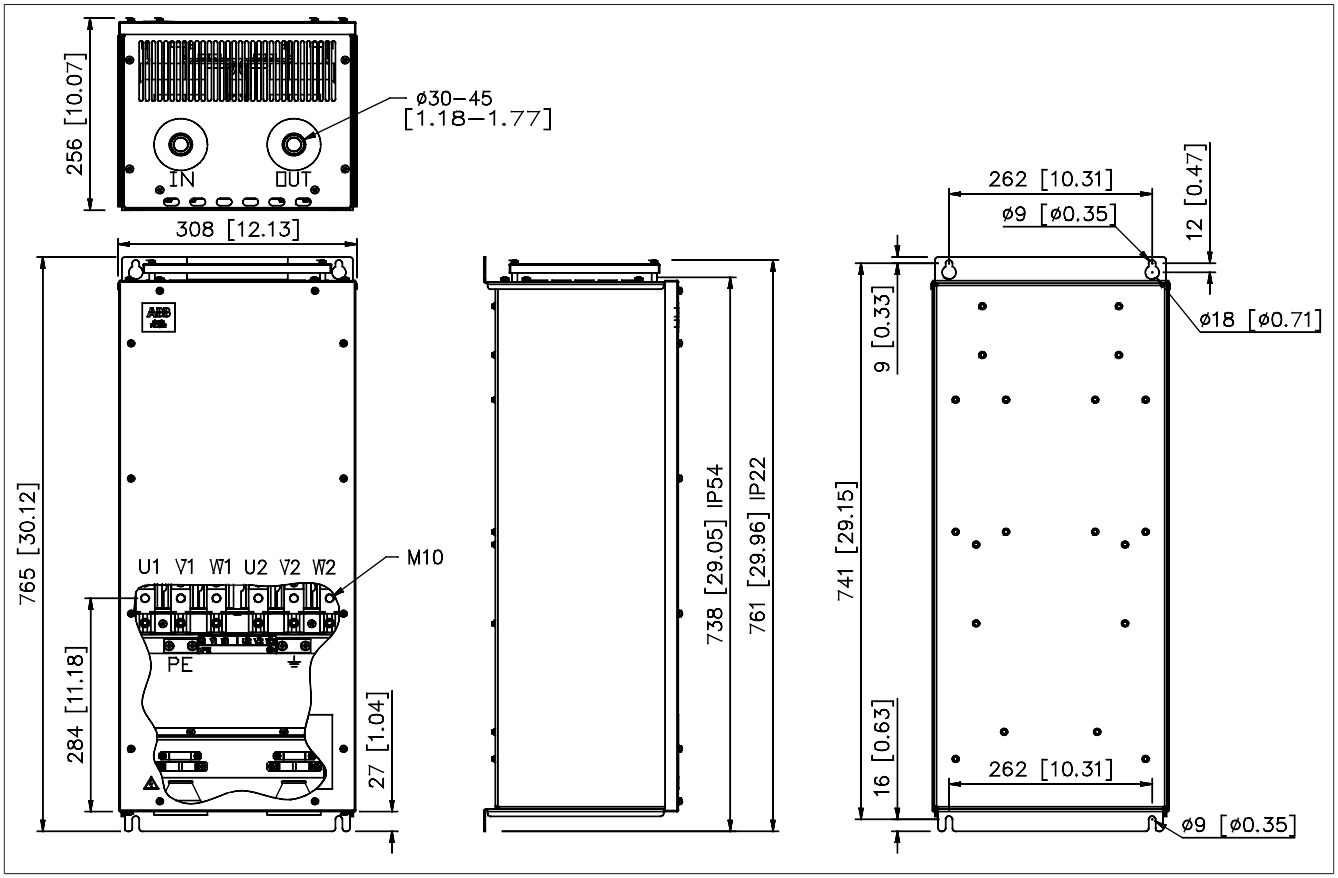



Figure 43: 8I0DT096.120-1 - Dimension diagram

**Installation dimensions**

300 mm clearance on each side.

Exception: 500 mm above the filter if installed under an ACOPOSinverter P96.

**Mechanical installation**

- Lift the filter into the installation position using the lifting lugs.
- Secure the filter with four screws (tightening torque for screws M8: 20 Nm) to the mounting points in the mounting brackets.

### 3.2.3.1.4.5 Wiring

**Overview**

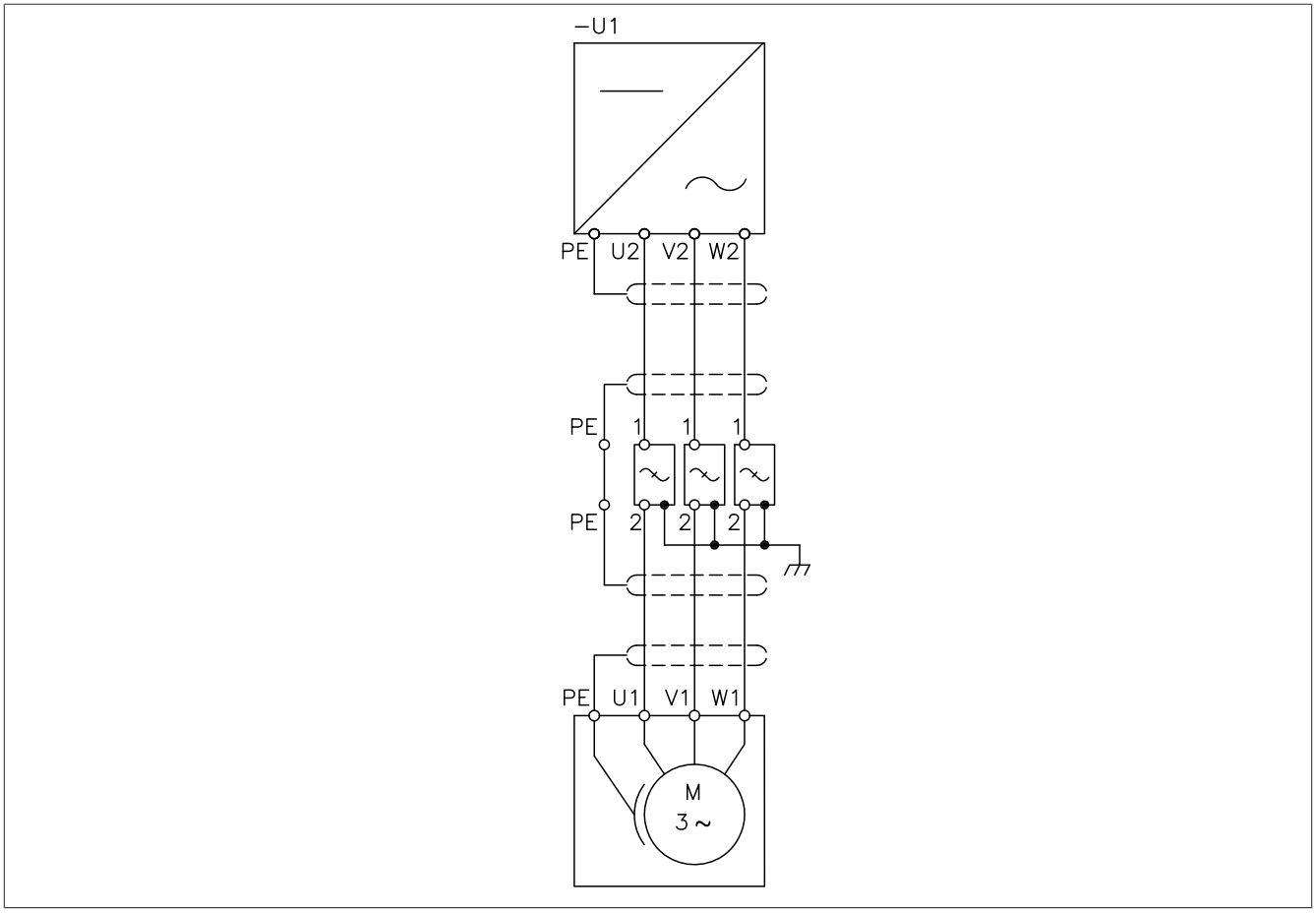



Figure 44: Overview 8I0DT096.120-1

**Input/Output circuit diagram**

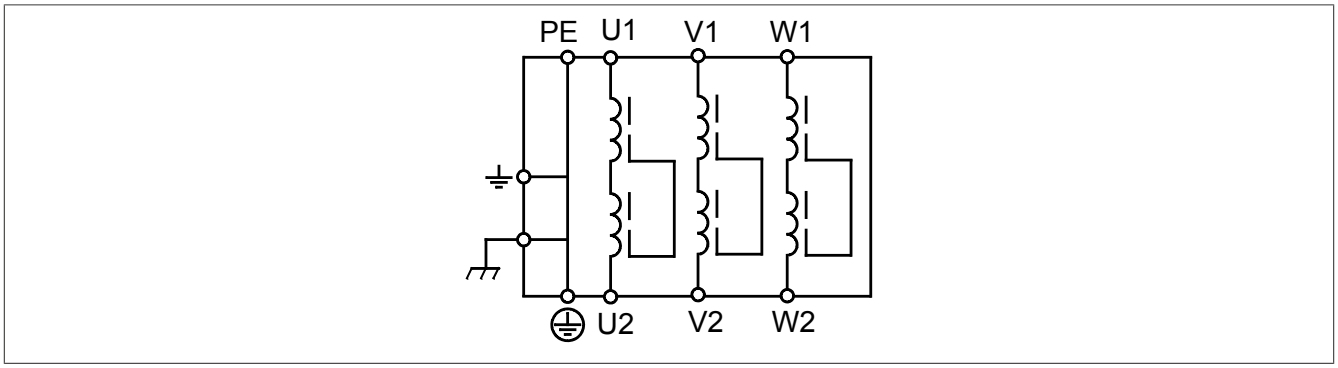



Figure 45: 8I0DT096.120-1 - Input/Output circuit diagram

### 3.2.3.1.5 8I0DT096.260-1

#### 3.2.3.1.5.1 General information

dv/dt filter 8I0DT096.260-1 is used to reduce bearing currents and to protect the insulation of motors connected to ACOPOSinverter P96.

#### 3.2.3.1.5.2 Order data

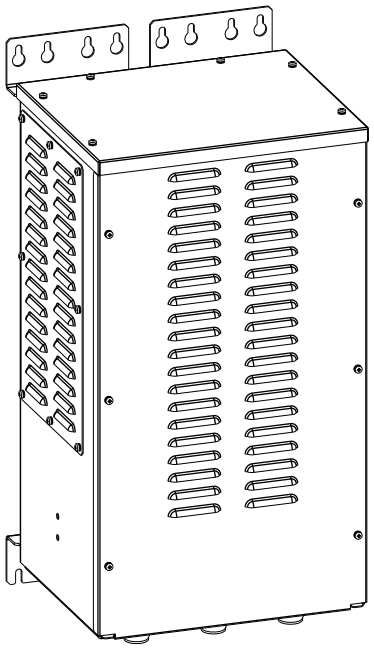
| Order number | Short description | Figure |
|---|---|---|
| | **dU/dT filters** |  |
| 8I0DT096.260-1 | 260 A dv/dt filter for ACOPOSinverter P96 3-phase. | |

Table 34: 8I0DT096.260-1 - Order data

#### 3.2.3.1.5.3 Technical data

| Order number | 8I0DT096.260-1 |
|---|---|
| **Mains connection** | |
| Mains input voltage | 380 to 690 V ±10% |
| **Ambient conditions** | |
| Temperature | |
| Operation | -15 to +50°C |
| Derating | 1%/°C starting at 40°C |
| Storage | -40 to +70°C |
| Transport | -40 to +70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | <95%, non-condensing |
| Transport | <95%, non-condensing |
| **Mechanical properties** | |
| Dimensions | |
| Width | 396 mm |
| Height | 772 mm |
| Depth | 376 mm |
| Weight | 74 kg |

Table 35: 8I0DT096.260-1 - Technical data

## 3.2.3.2 Sine filter

### 3.2.3.2.1 8I0ST096.004-1

#### 3.2.3.2.1.1 General information

#### 3.2.3.2.1.2 Order data

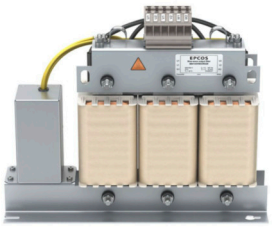
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** | |
| 8I0ST096.004-1 | 4 A sine filter for ACOPOSinverter P96 3-phase. |  |

Table 36: 8I0ST096.004-1 - Order data

#### 3.2.3.2.1.3 Technical data

| Order number | 8I0ST096.004-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 235 mm |
| Height | 200 mm |
| Depth | 96 mm |
| Weight | 5 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.004-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 4 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 390 mΩ |
| Rated inductance $L_R$ | 12 mH |
| Rated capacity $C_R$ | 2.2 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 60 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ in operation at ACOPOSinverter P96 at $f_{P\ min}$.

### 3.2.3.2.1.4 Dimension diagram and installation dimensions

**Dimension diagram**

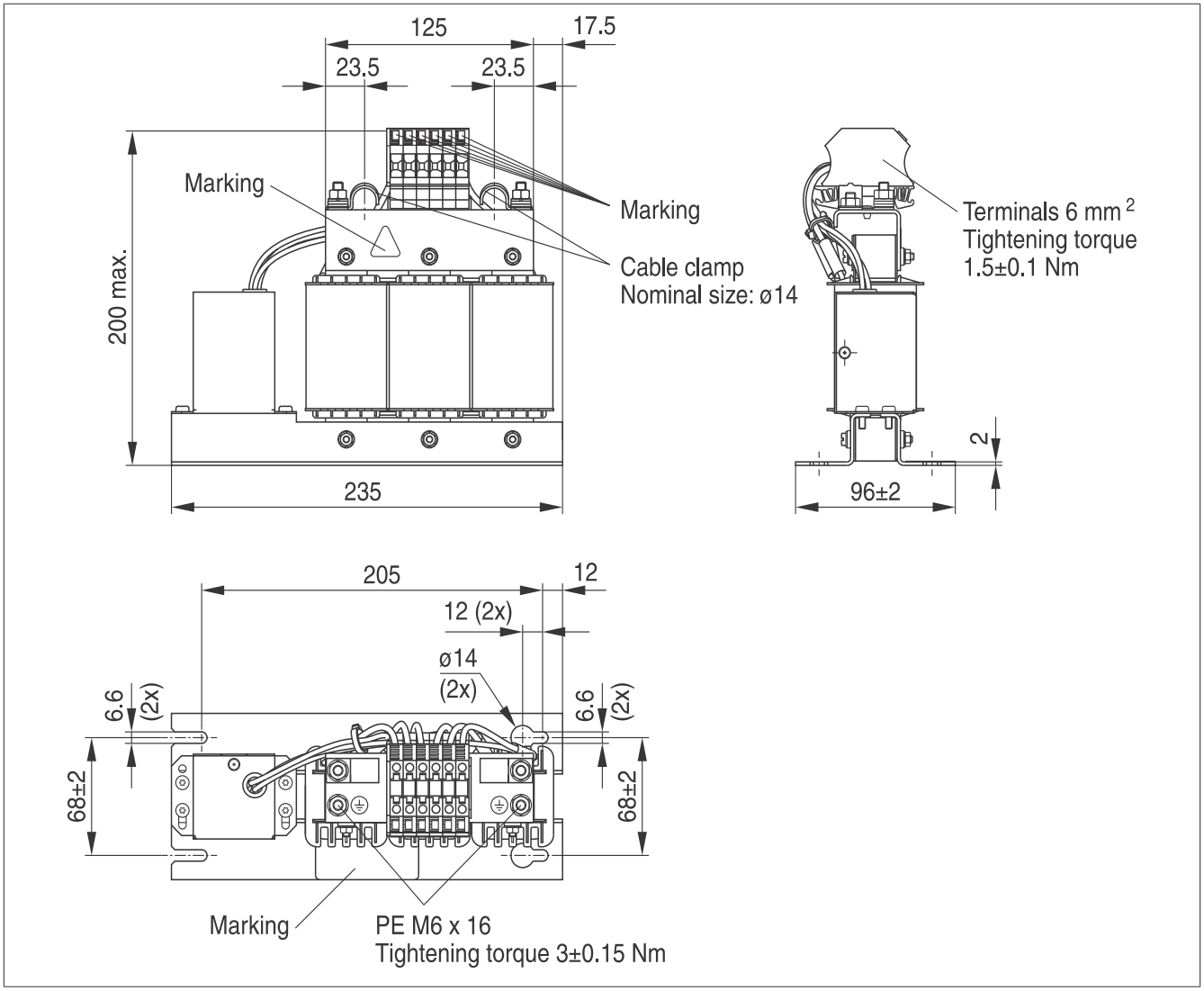



Figure 46: 8I0ST096.004-1 - Dimension diagram

## Installation dimensions

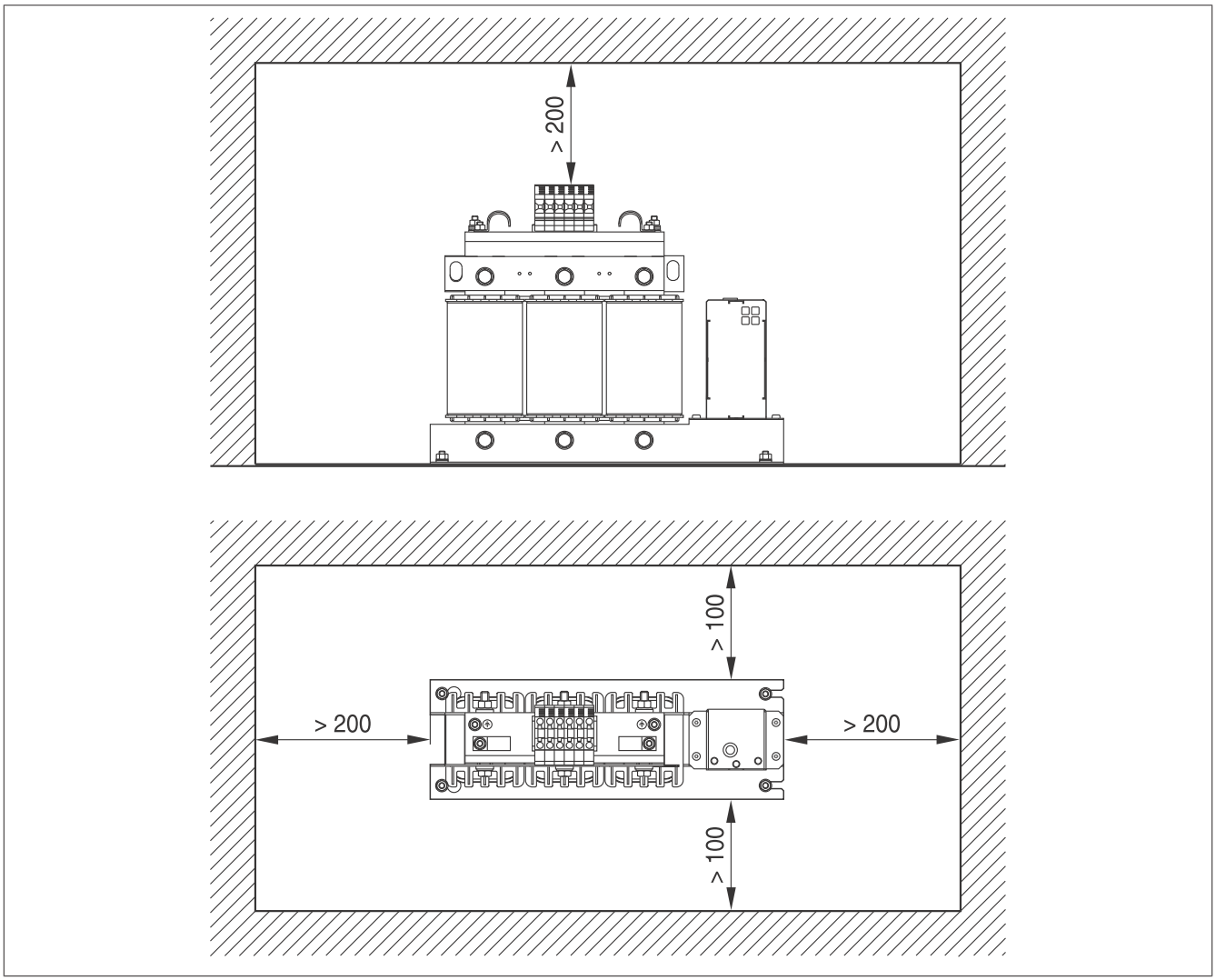
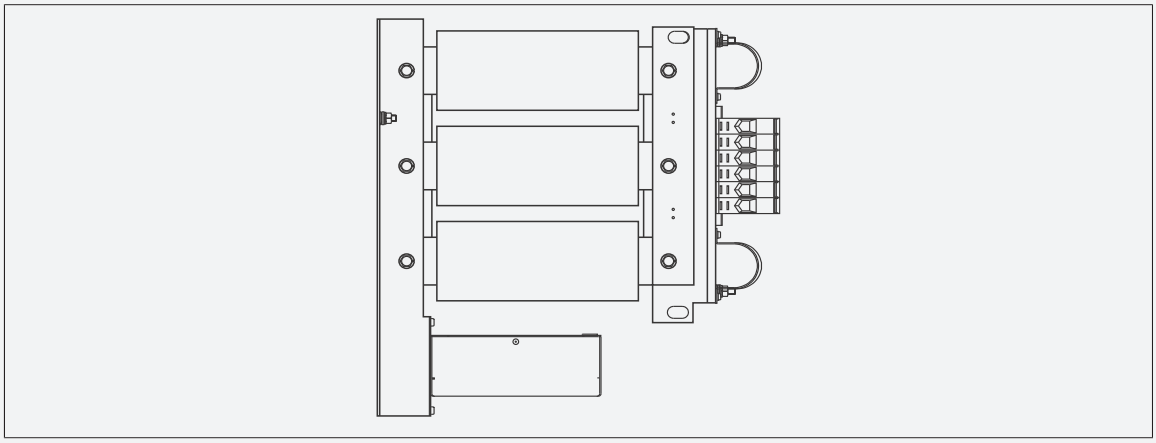


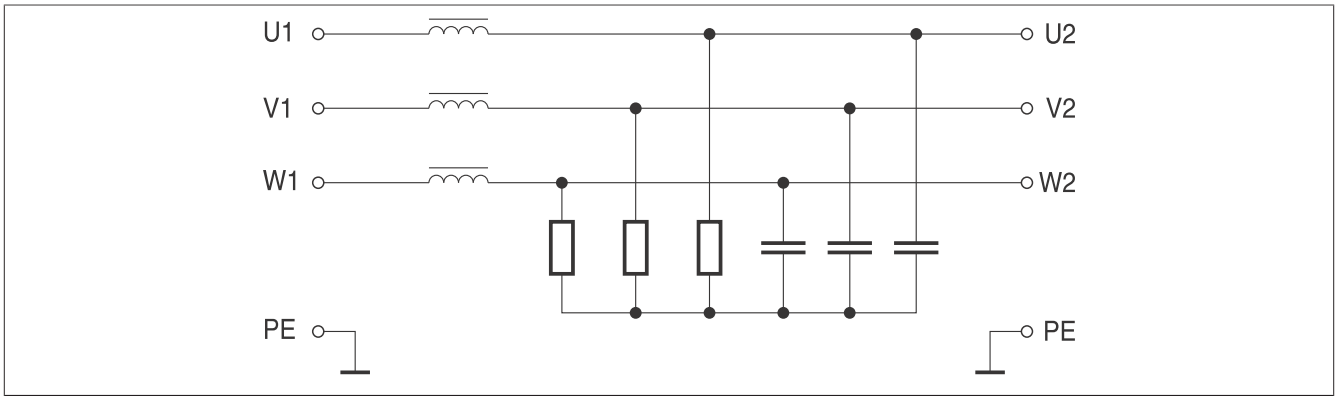

Figure 47: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.1.5 Input/Output circuit diagram



### 3.2.3.2.2 8I0ST096.006-1

#### 3.2.3.2.2.1 General information

#### 3.2.3.2.2.2 Order data

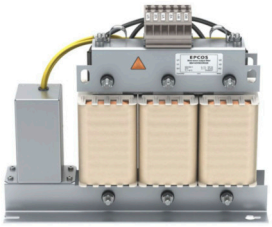
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** | |
| 8I0ST096.006-1 | 6 A sine filter for ACOPOSinverter P96 3-phase. |  |

Table 37: 8I0ST096.006-1 - Order data

#### 3.2.3.2.2.3 Technical data

| Order number | 8I0ST096.006-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 235 mm |
| Height | 200 mm |
| Depth | 96 mm |
| Weight | 5 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.006-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 6 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 290 mΩ |
| Rated inductance $L_R$ | 8.5 mH |
| Rated capacity $C_R$ | 2.2 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 100 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ in operation at ACOPOSinverter P96 at $f_{P\ min}$.

### 3.2.3.2.2.4 Dimension diagram and installation dimensions

**Dimension diagram**

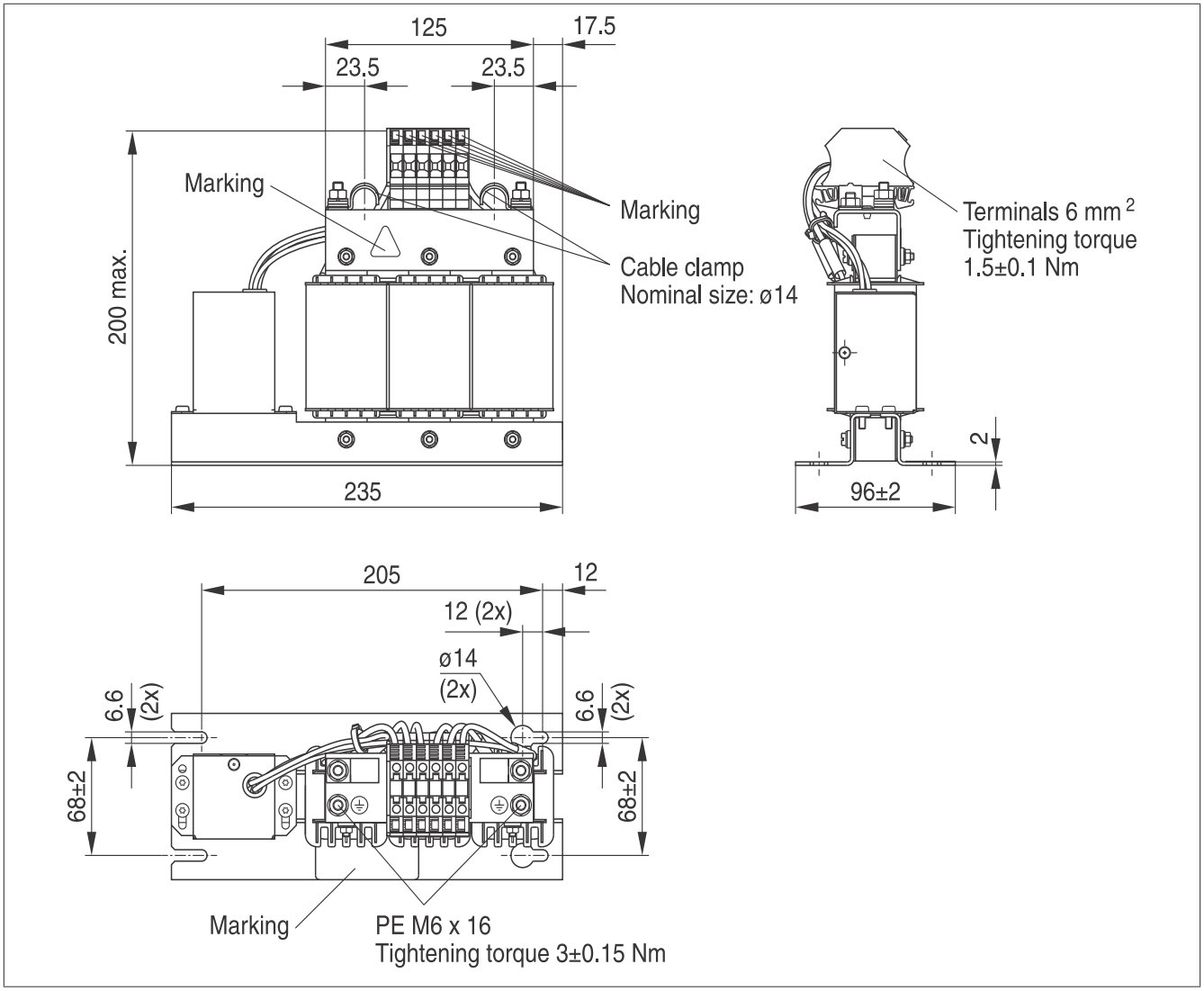



Figure 48: 8I0ST096.006-1 - Dimension diagram

## Installation dimensions

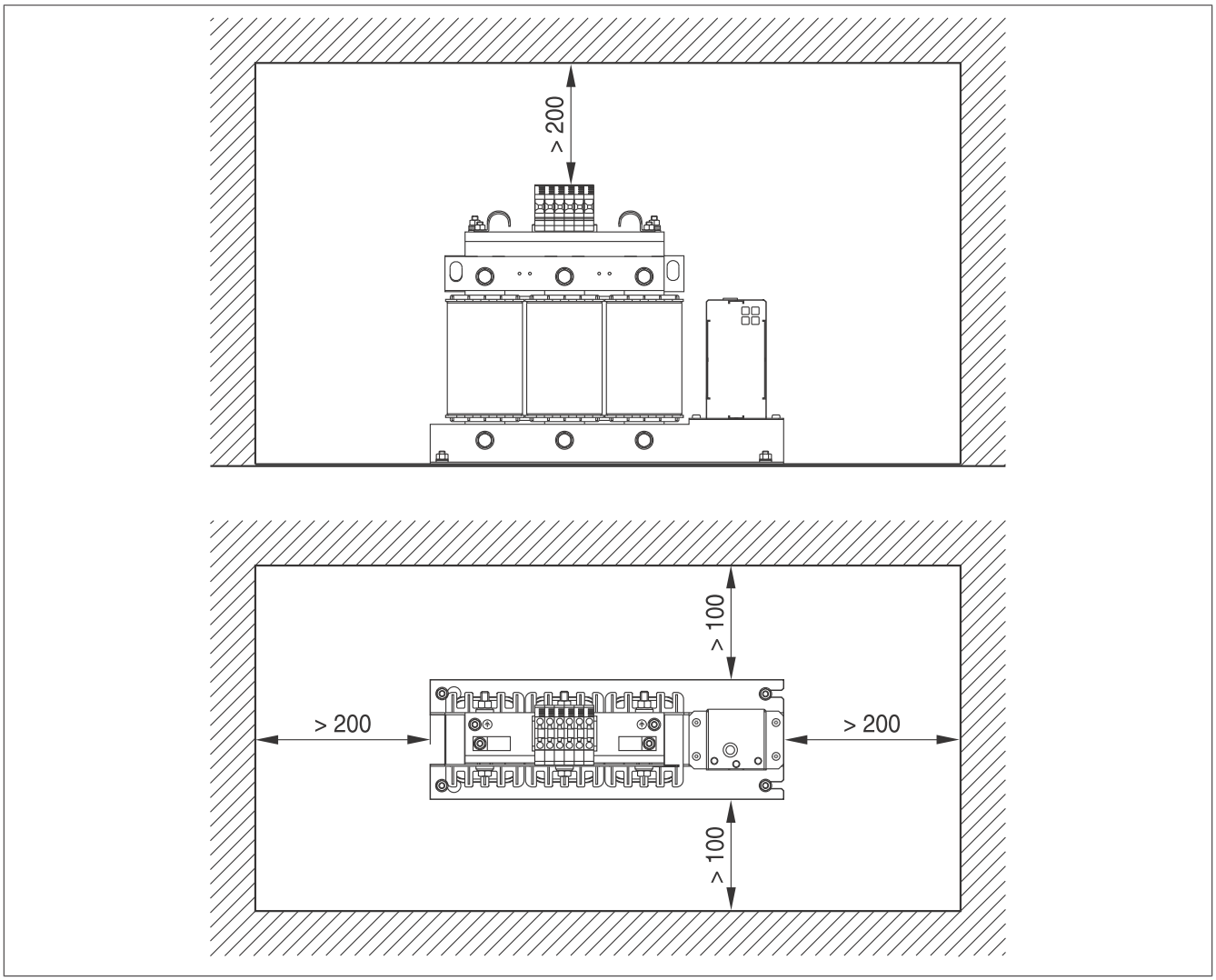
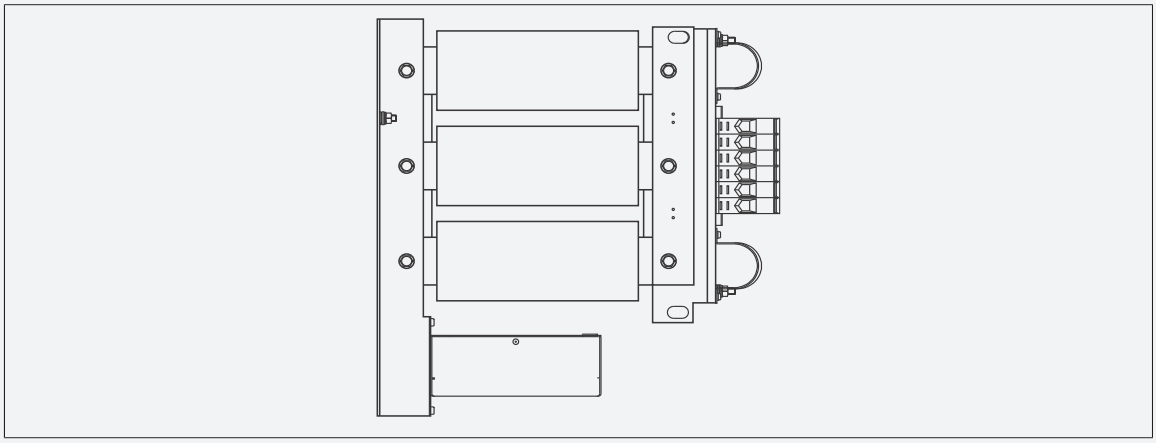


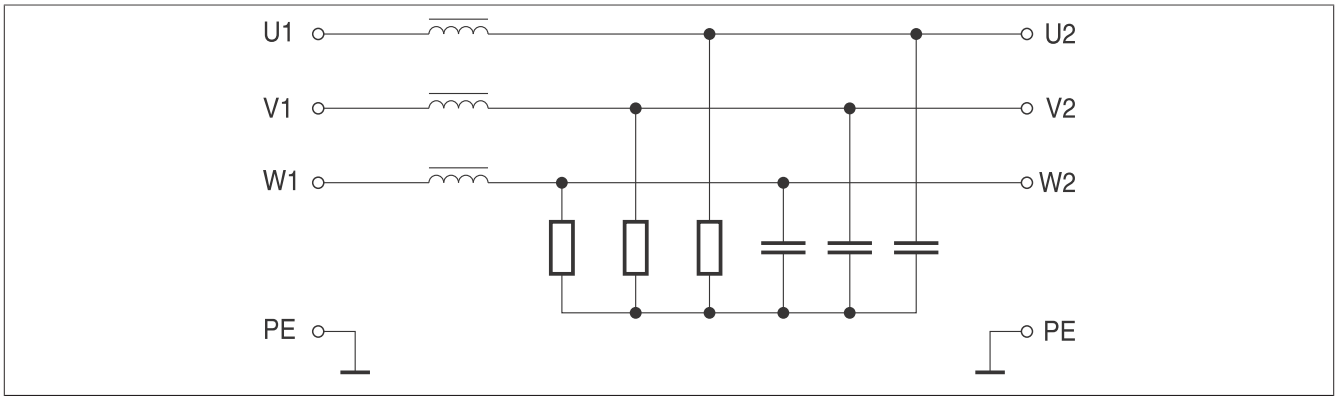

Figure 49: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.2.5 Input/Output circuit diagram



### 3.2.3.2.3 8I0ST096.011-1

#### 3.2.3.2.3.1 General information

#### 3.2.3.2.3.2 Order data

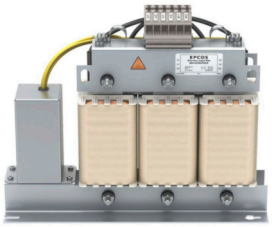
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** |  |
| 8I0ST096.011-1 | 11 A sine filter for ACOPOSinverter P96 3-phase. | |

Table 38: 8I0ST096.011-1 - Order data

#### 3.2.3.2.3.3 Technical data

| Order number | 8I0ST096.011-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 235 mm |
| Height | 200 mm |
| Depth | 110 mm |
| Weight | 7 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.011-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 11 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 67 mΩ |
| Rated inductance $L_R$ | 4.5 mH |
| Rated capacity $C_R$ | 3.3 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 90 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ in operation at ACOPOSinverter P96 at $f_{P\ min}$.

### 3.2.3.2.3.4 Dimension diagram and installation dimensions

**Dimension diagram**

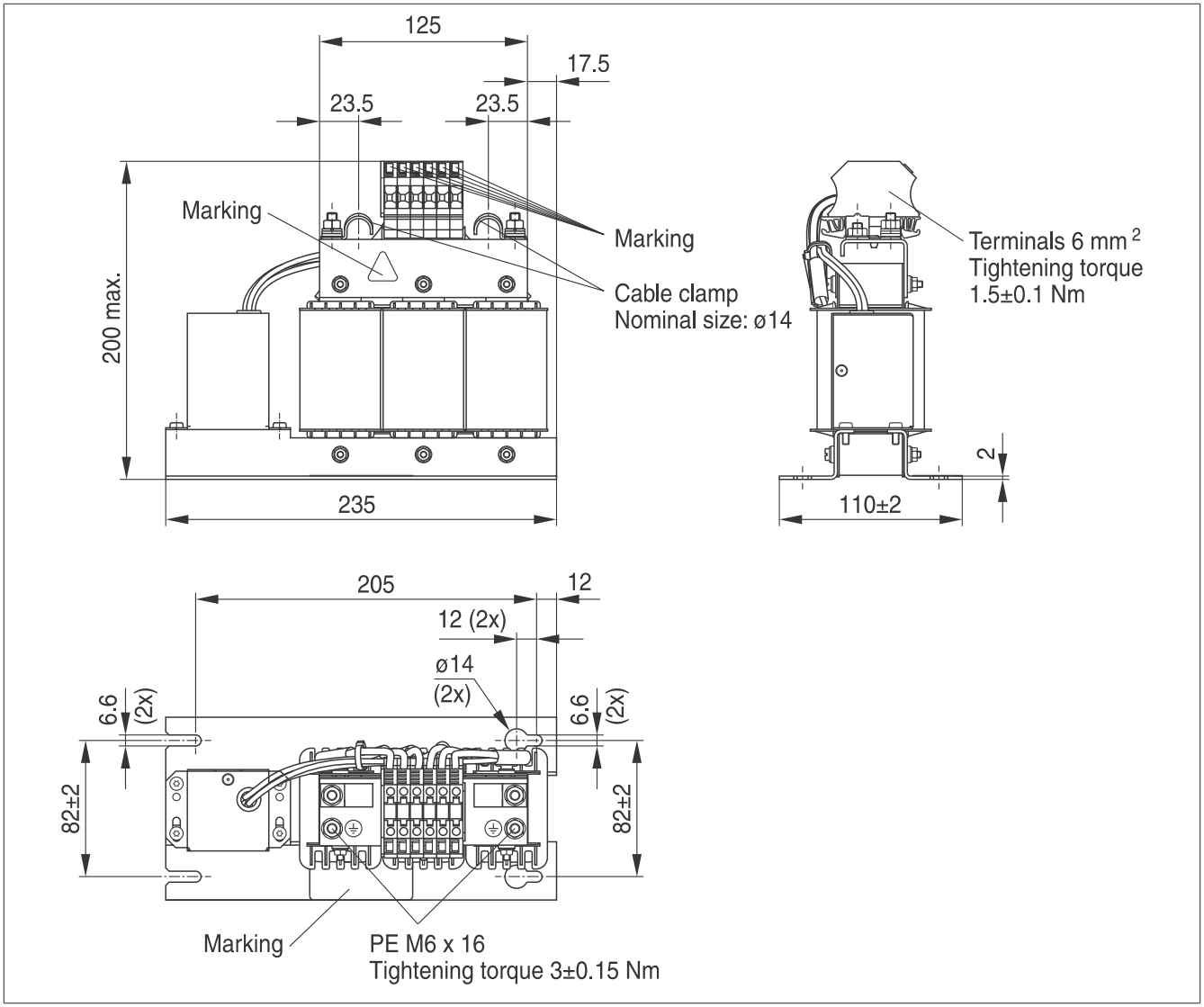



Figure 50: 8I0ST096.011-1 - Dimension diagram

## Installation dimensions

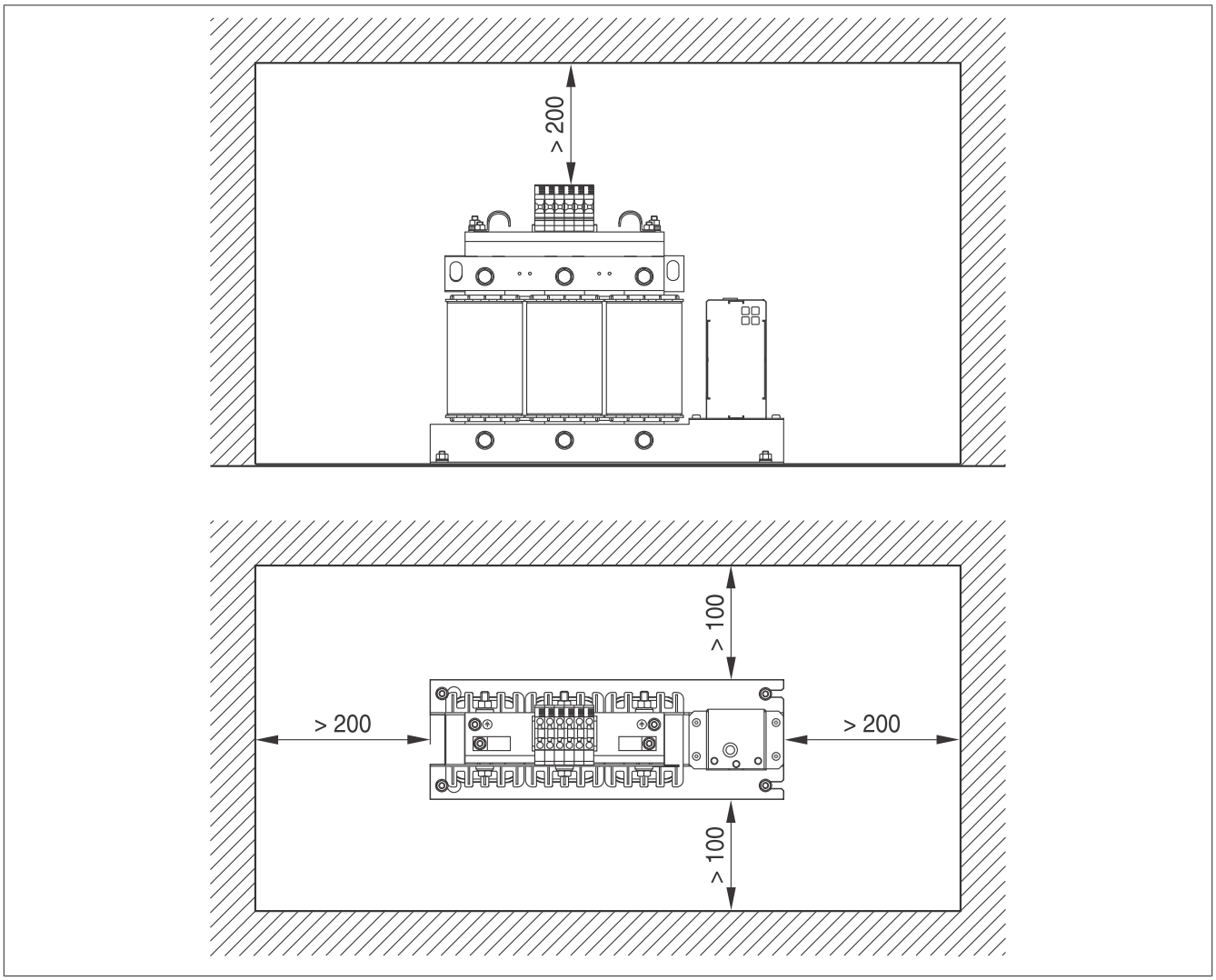
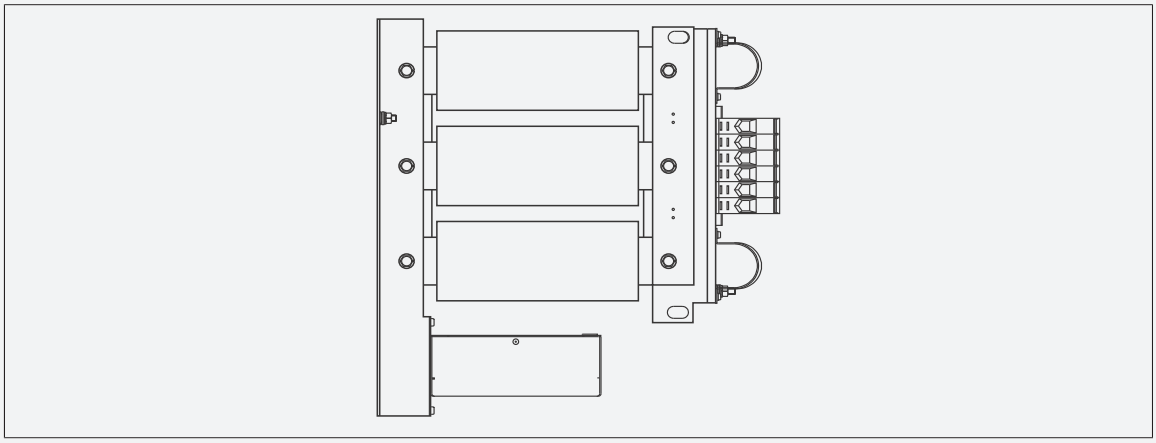


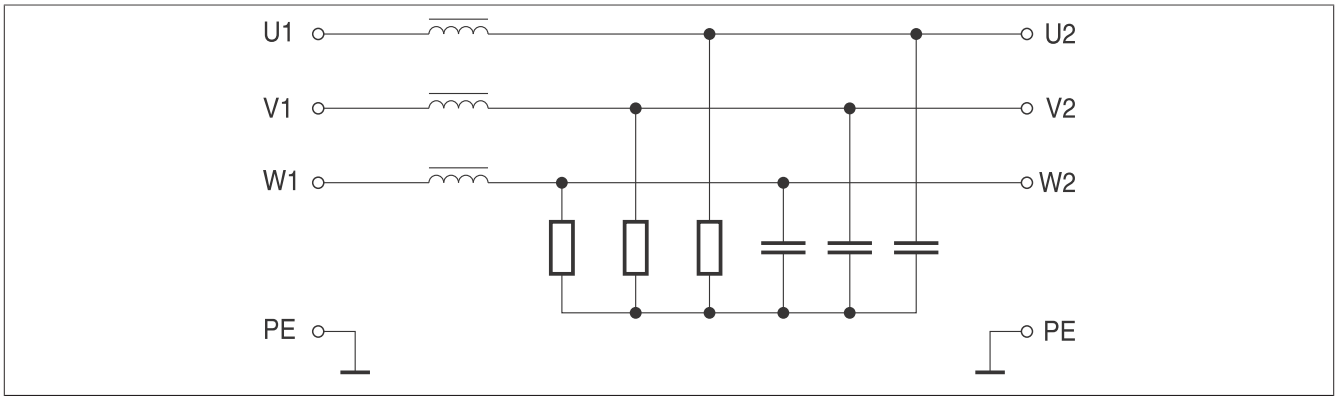

Figure 51: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.3.5 Input/Output circuit diagram



### 3.2.3.2.4 8I0ST096.016-1

### 3.2.3.2.4.1 General information

### 3.2.3.2.4.2 Order data

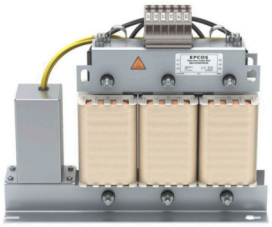
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** |  |
| 8I0ST096.016-1 | 16 A sine filter for ACOPOSinverter P96 3-phase. | |

Table 39: 8I0ST096.016-1 - Order data

### 3.2.3.2.4.3 Technical data

| Order number | 8I0ST096.016-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 275 mm |
| Height | 235 mm |
| Depth | 122 mm |
| Weight | 12 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.016-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 16 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 31 mΩ |
| Rated inductance $L_R$ | 3 mH |
| Rated capacity $C_R$ | 5.6 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 80 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ in operation at ACOPOSinverter P96 at $f_{P\ min}$.

### 3.2.3.2.4.4 Dimension diagram and installation dimensions

**Dimension diagram**

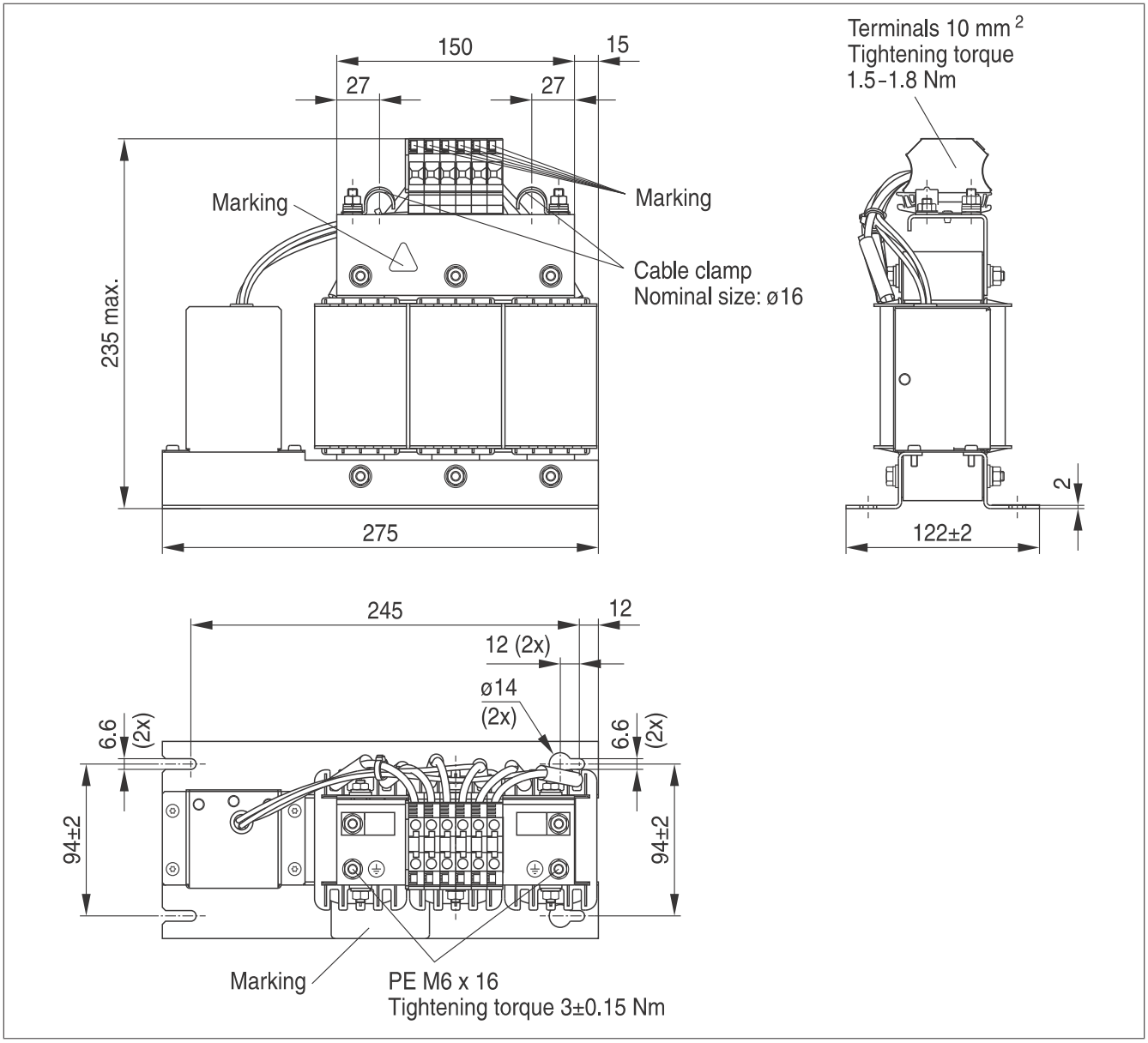



Figure 52: 8I0ST096.016-1 - Dimension diagram

## Installation dimensions

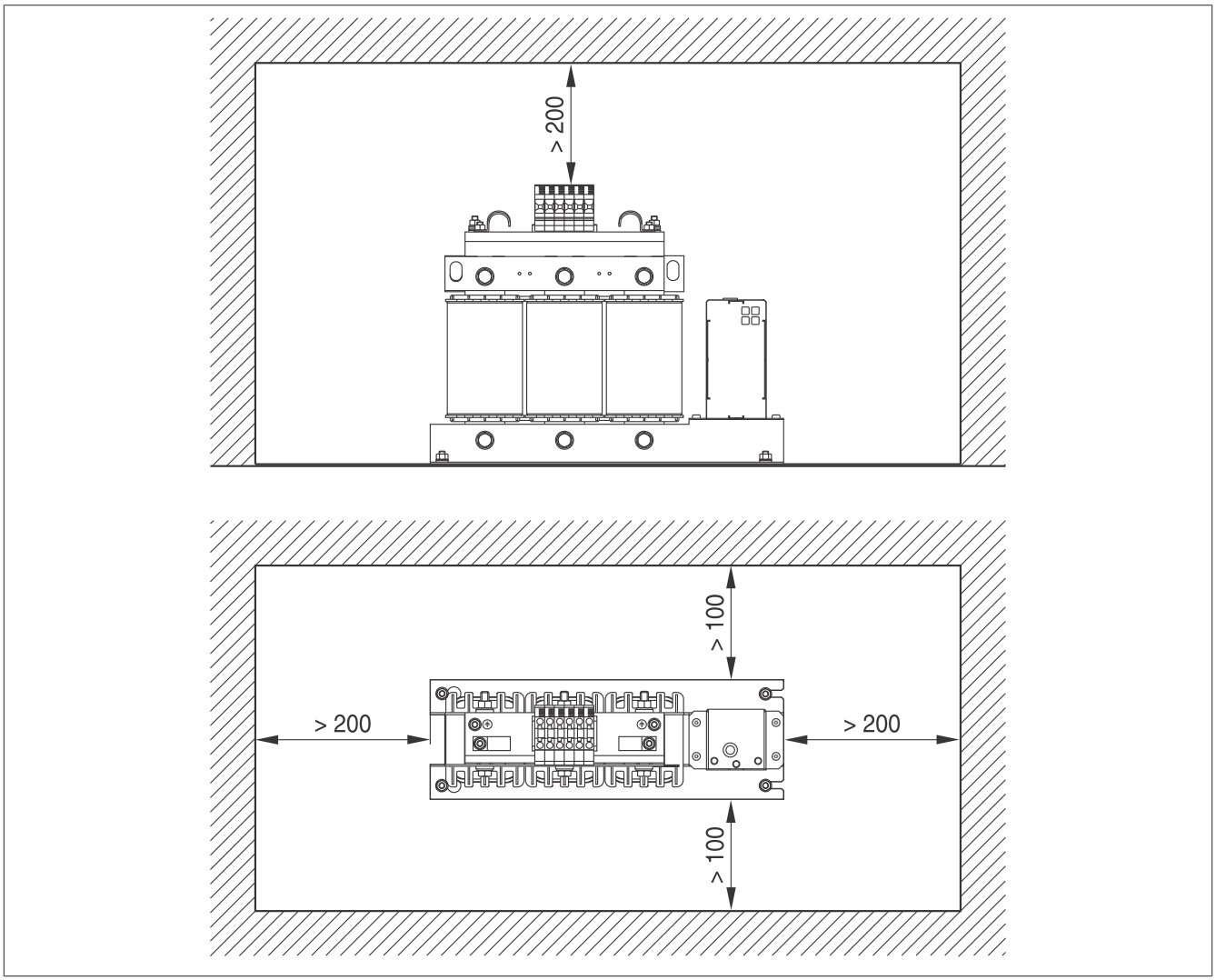
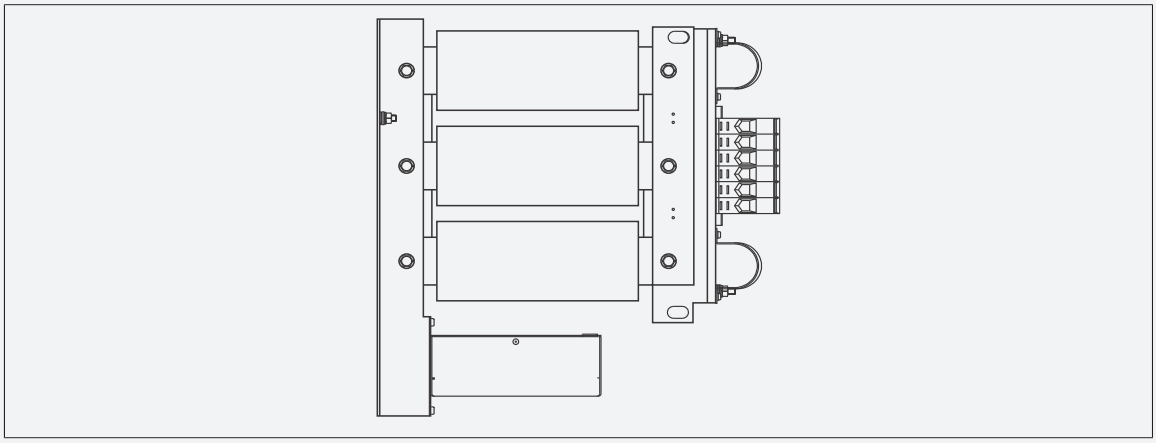


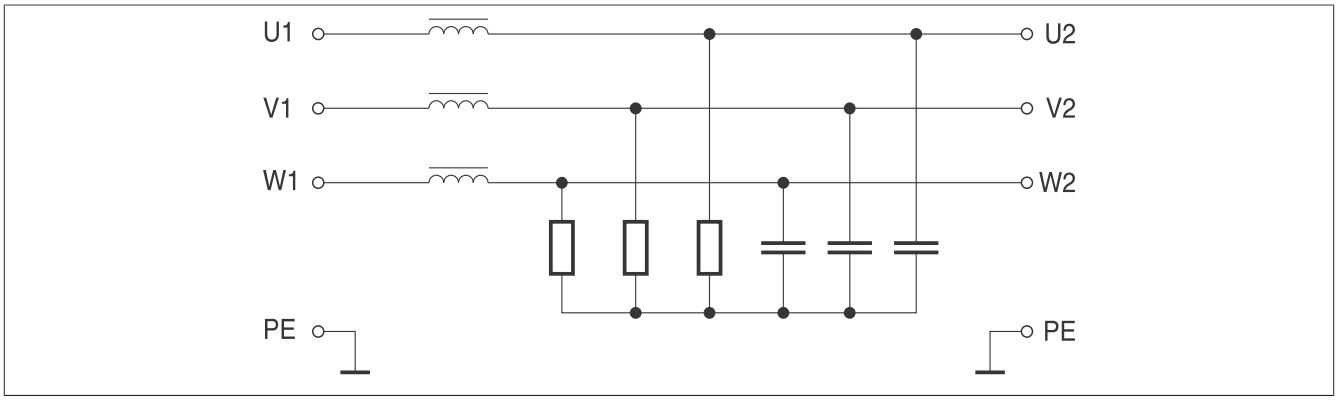

Figure 53: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.4.5 Input/Output circuit diagram



### 3.2.3.2.5 8I0ST096.025-1

#### 3.2.3.2.5.1 General information

#### 3.2.3.2.5.2 Order data

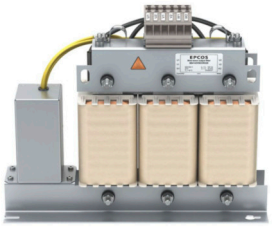
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** | |
| 8I0ST096.025-1 | 25 A sine filter for ACOPOSinverter P96 3-phase. |  |

Table 40: 8I0ST096.025-1 - Order data

#### 3.2.3.2.5.3 Technical data

| Order number | 8I0ST096.025-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 355 mm |
| Height | 285 mm |
| Depth | 120 mm |
| Weight | 20 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.025-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 25 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 25 mΩ |
| Rated inductance $L_R$ | 2.5 mH |
| Rated capacity $C_R$ | 10 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 140 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ in operation at ACOPOSinverter P96 at $f_{P\ min}$.

### 3.2.3.2.5.4 Dimension diagram and installation dimensions

**Dimension diagram**

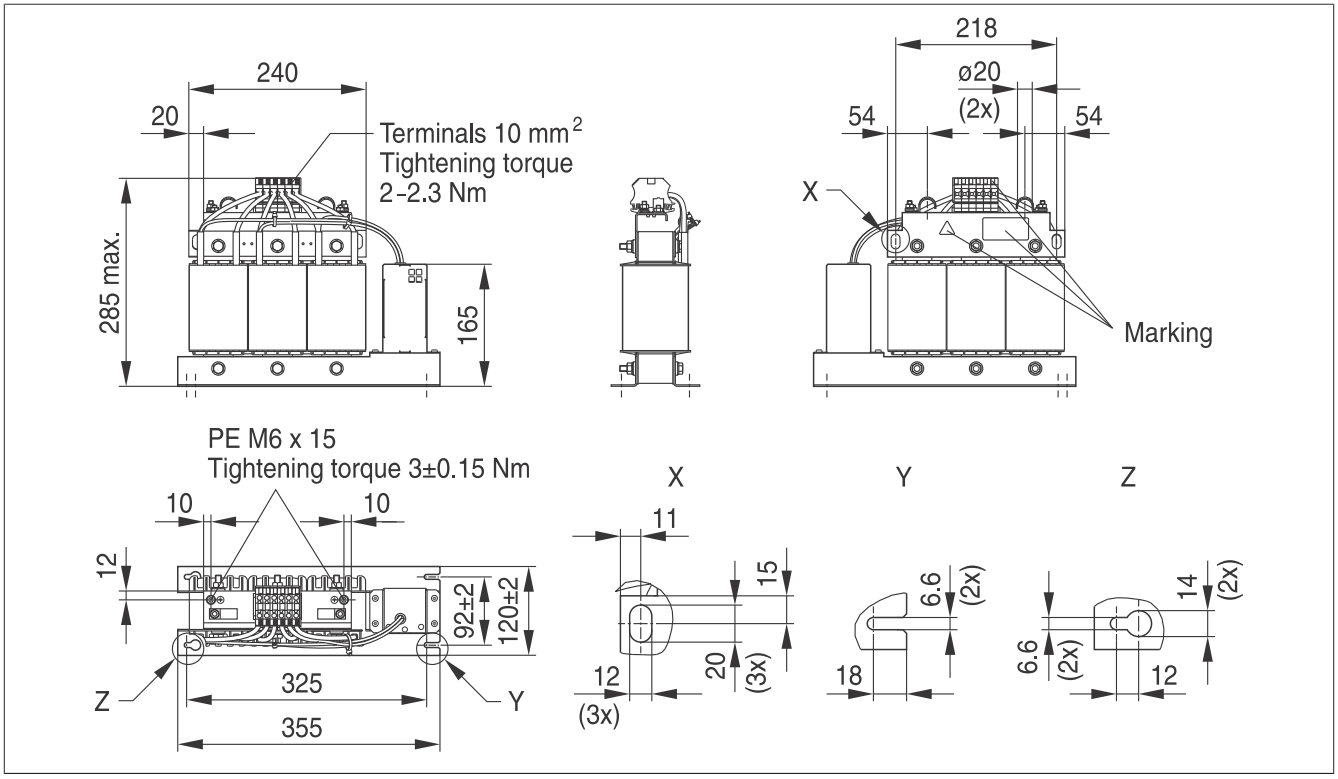



Figure 54: 8I0ST096.025-1 - Dimension diagram

## Installation dimensions

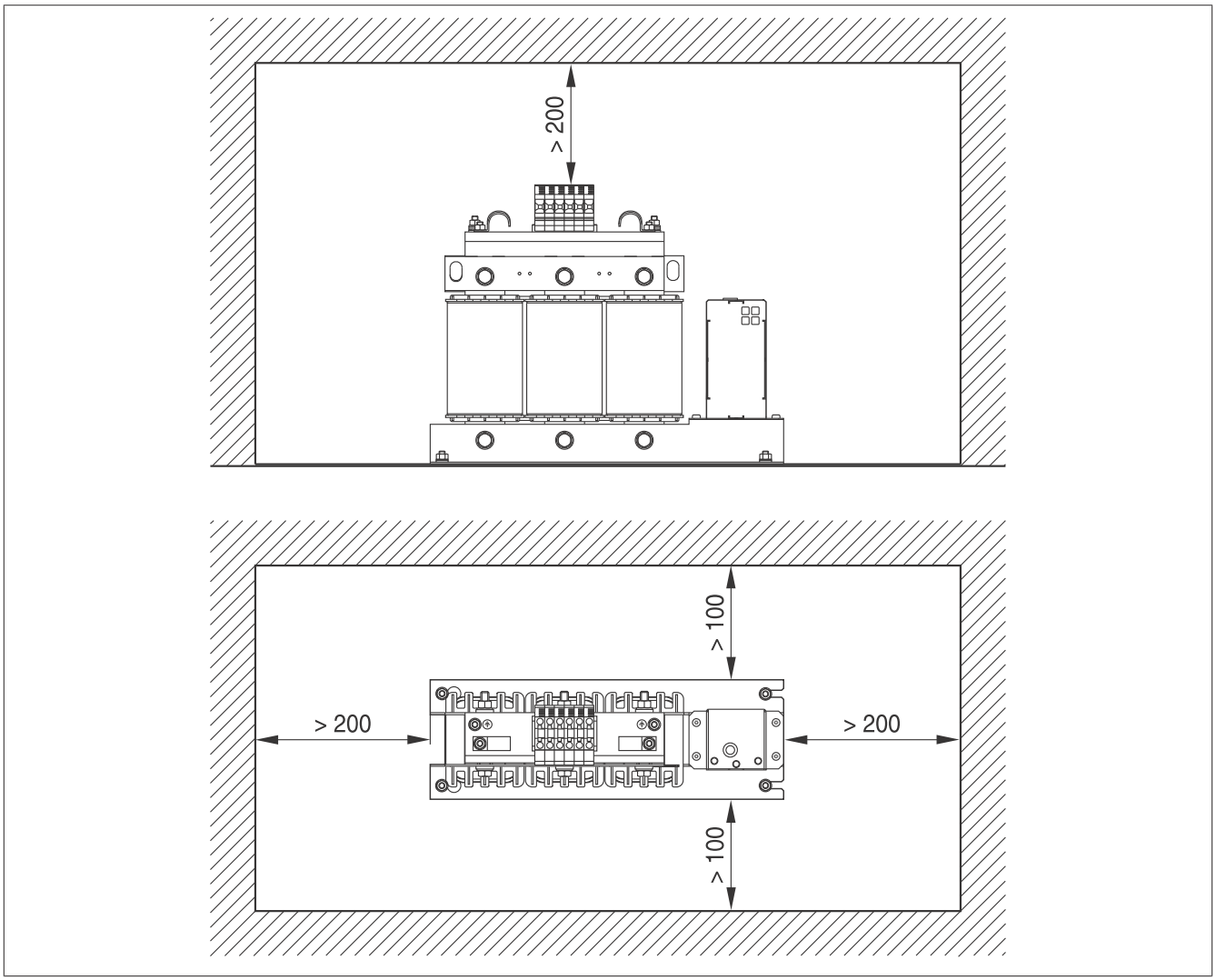
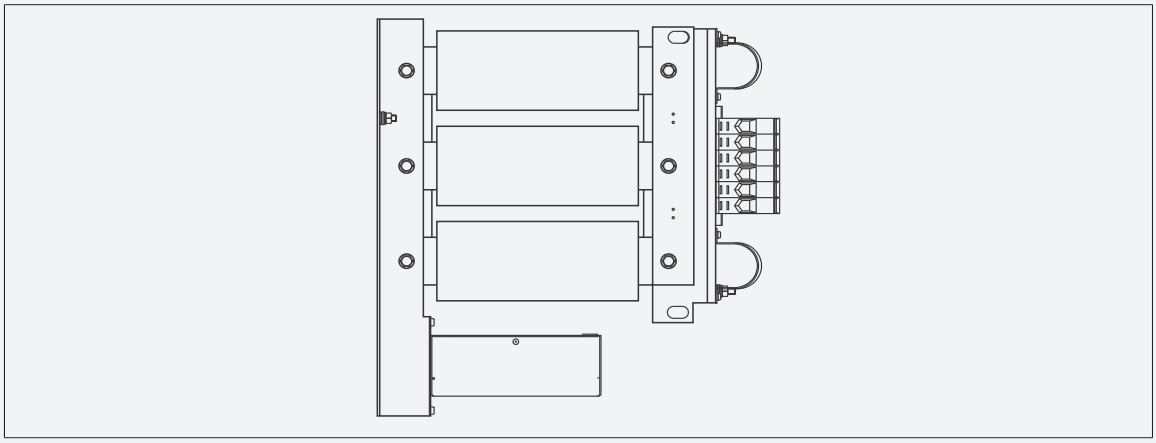


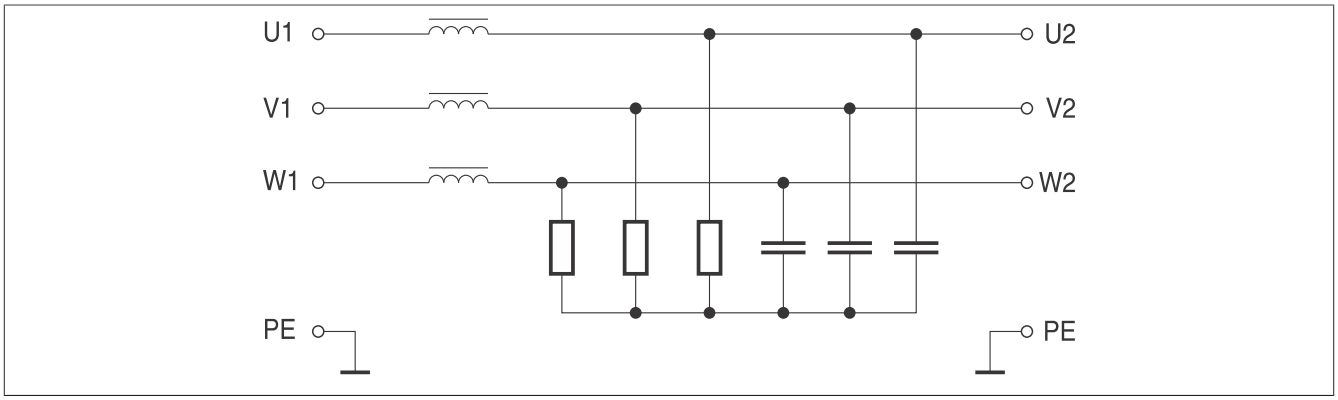

Figure 55: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.5.5 Input/Output circuit diagram



### 3.2.3.2.6 8I0ST096.033-1

### 3.2.3.2.6.1 General information

### 3.2.3.2.6.2 Order data

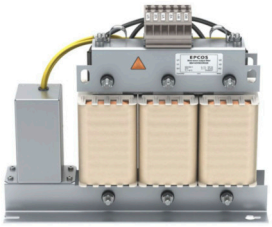
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** |  |
| 8I0ST096.033-1 | 33 A sine filter for ACOPOSinverter P96 3-phase. | |

Table 41: 8I0ST096.033-1 - Order data

### 3.2.3.2.6.3 Technical data

| Order number | 8I0ST096.033-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 380 mm |
| Height | 285 mm |
| Depth | 141 mm |
| Weight | 24 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.004-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 33 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 16 mΩ |
| Rated inductance $L_R$ | 1.8 mH |
| Rated capacity $C_R$ | 10 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 160 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ in operation at ACOPOSinverter P96 at $f_{P\ min}$.

### 3.2.3.2.6.4 Dimension diagram and installation dimensions

**Dimension diagram**

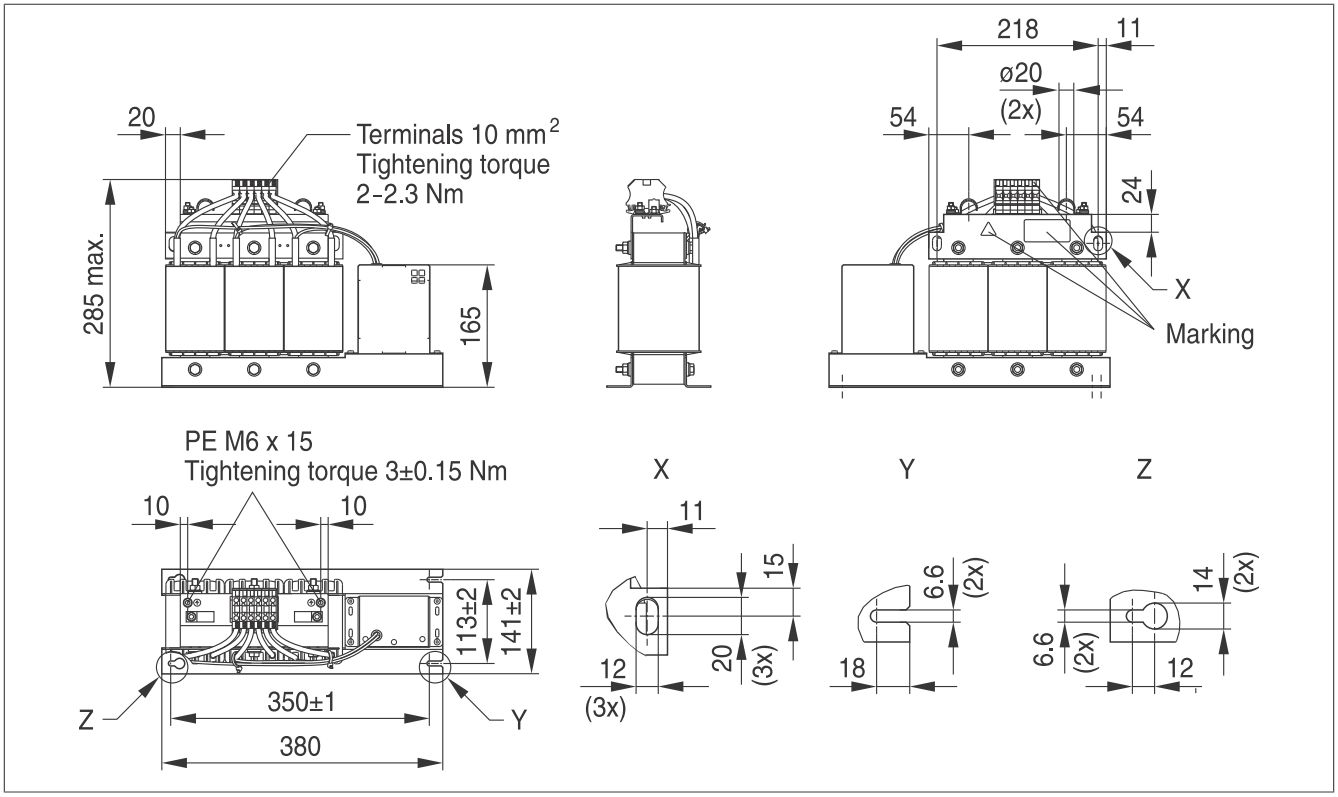



Figure 56: 8I0ST096.033-1 - Dimension diagram

## Installation dimensions

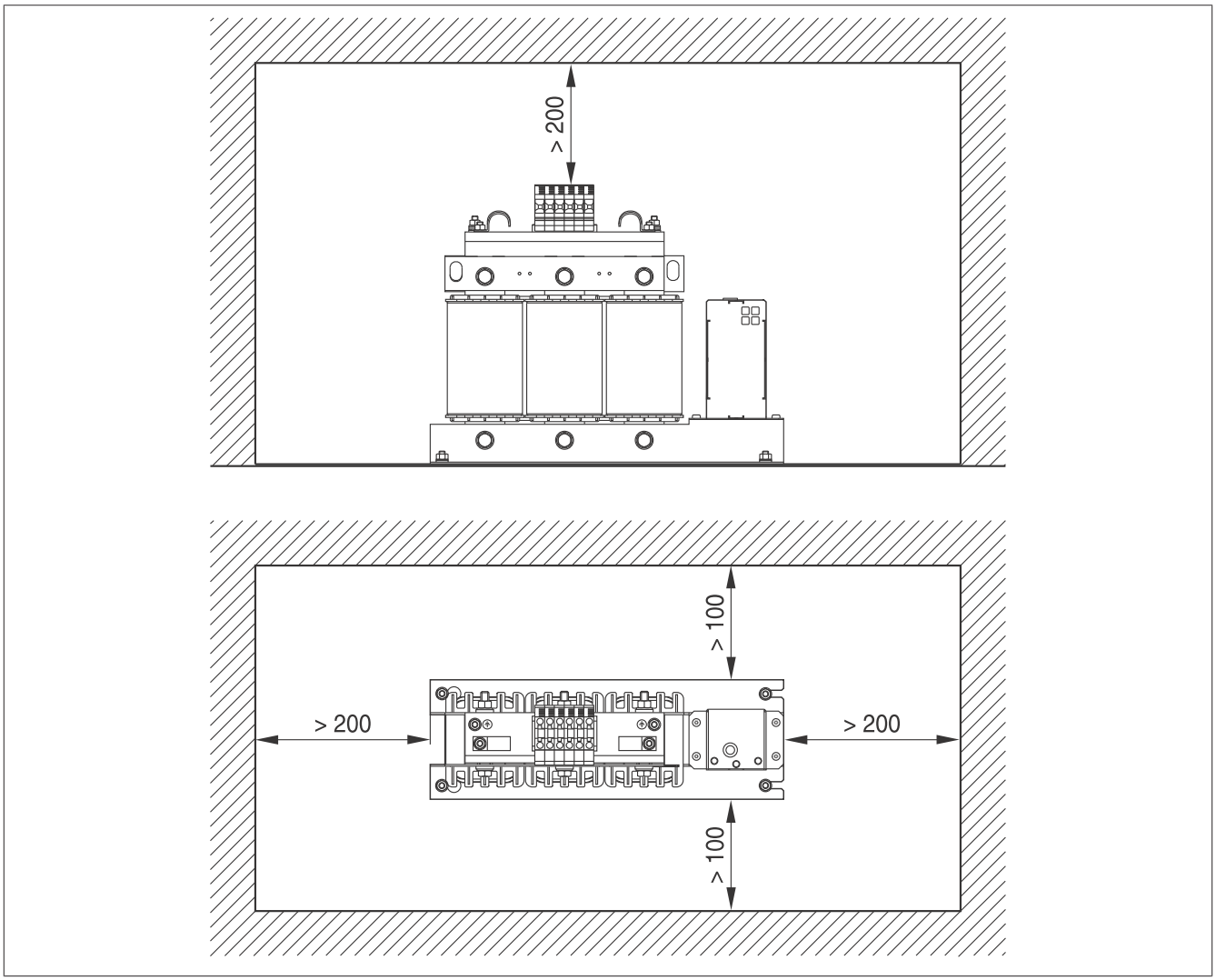
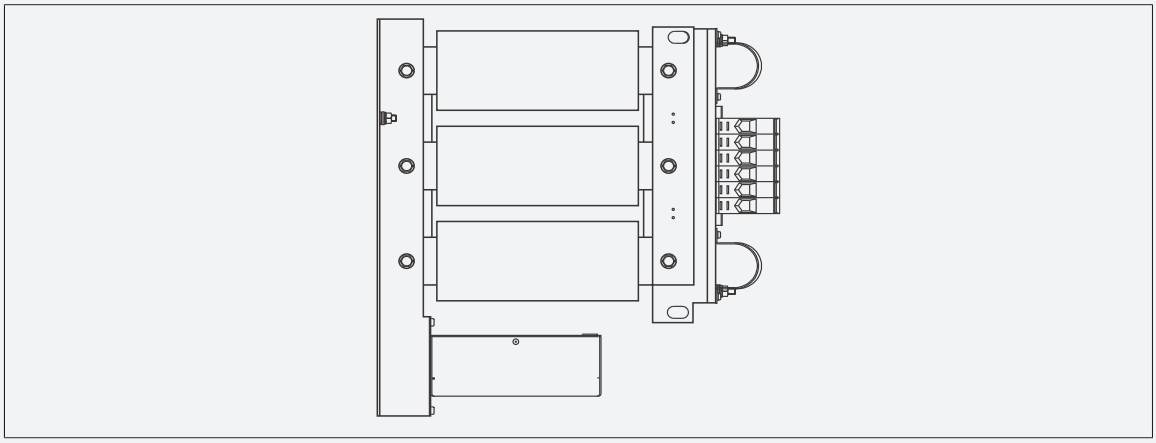


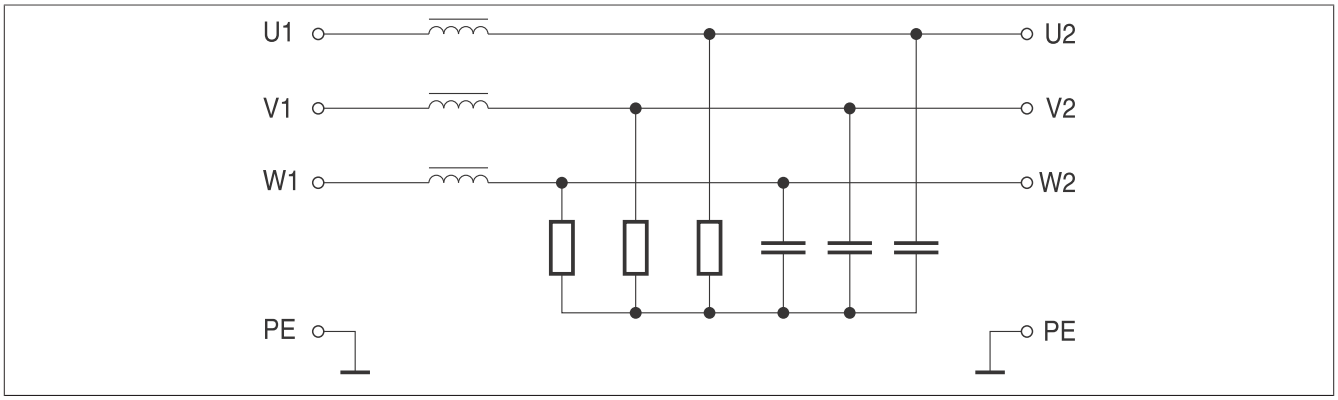

Figure 57: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.6.5 Input/Output circuit diagram



### 3.2.3.2.7 8I0ST096.050-1

### 3.2.3.2.7.1 General information

### 3.2.3.2.7.2 Order data

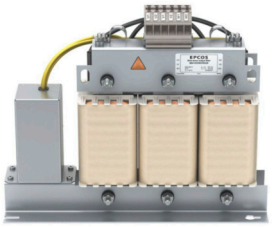
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** |  |
| 8I0ST096.050-1 | 50 A sine filter for ACOPOSinverter P96 3-phase. | |

Table 42: 8I0ST096.050-1 - Order data

### 3.2.3.2.7.3 Technical data

| Order number | 8I0ST096.050-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP10 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 440 mm |
| Height | 375 mm |
| Depth | 138 mm |
| Weight | 41 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.050-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 50 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 8.9 mΩ |
| Rated inductance $L_R$ | 1.2 mH |
| Rated capacity $C_R$ | 15 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 10 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 220 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ when operated on ACOPOSinverter P96 at $f_{P\,min}$.

### 3.2.3.2.7.4 Dimension diagram and installation dimensions

**Dimension diagram**

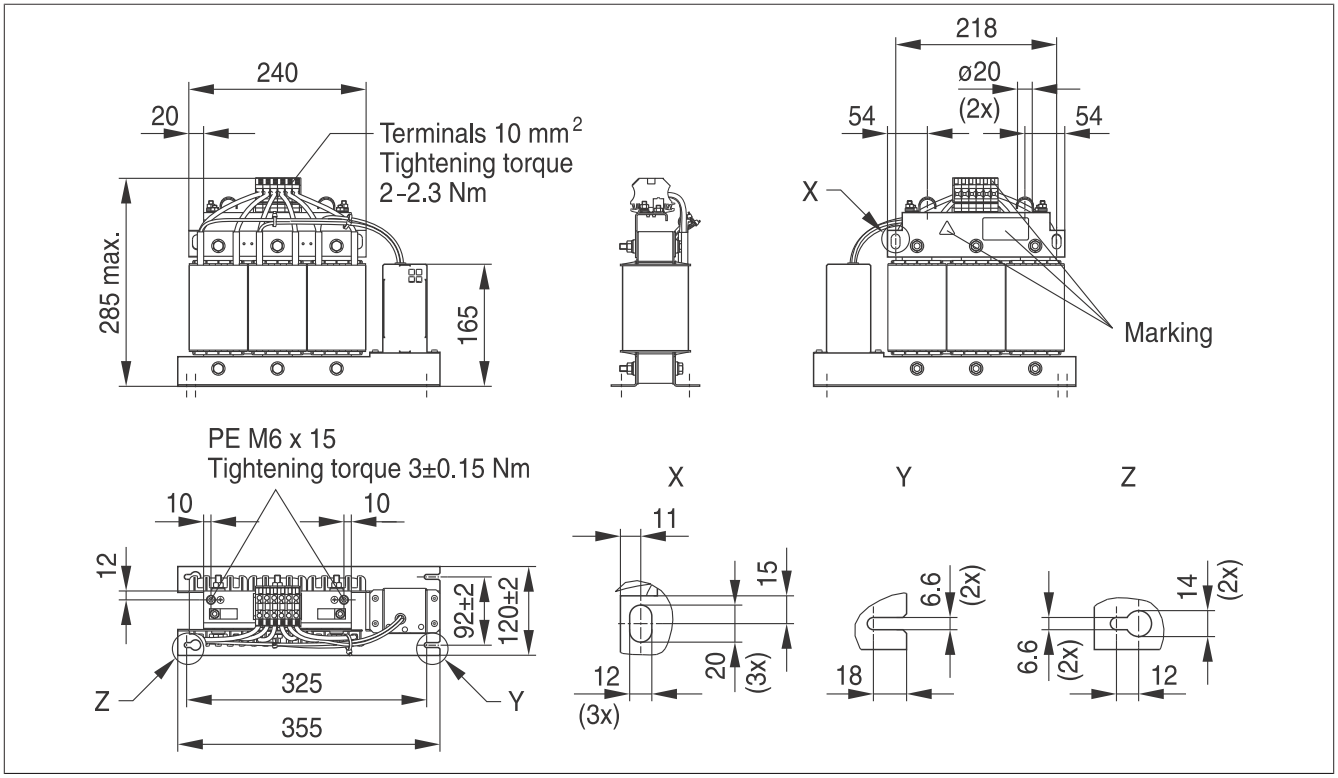



Figure 58: 8I0ST096.050-1 - Dimension diagram

## Installation dimensions

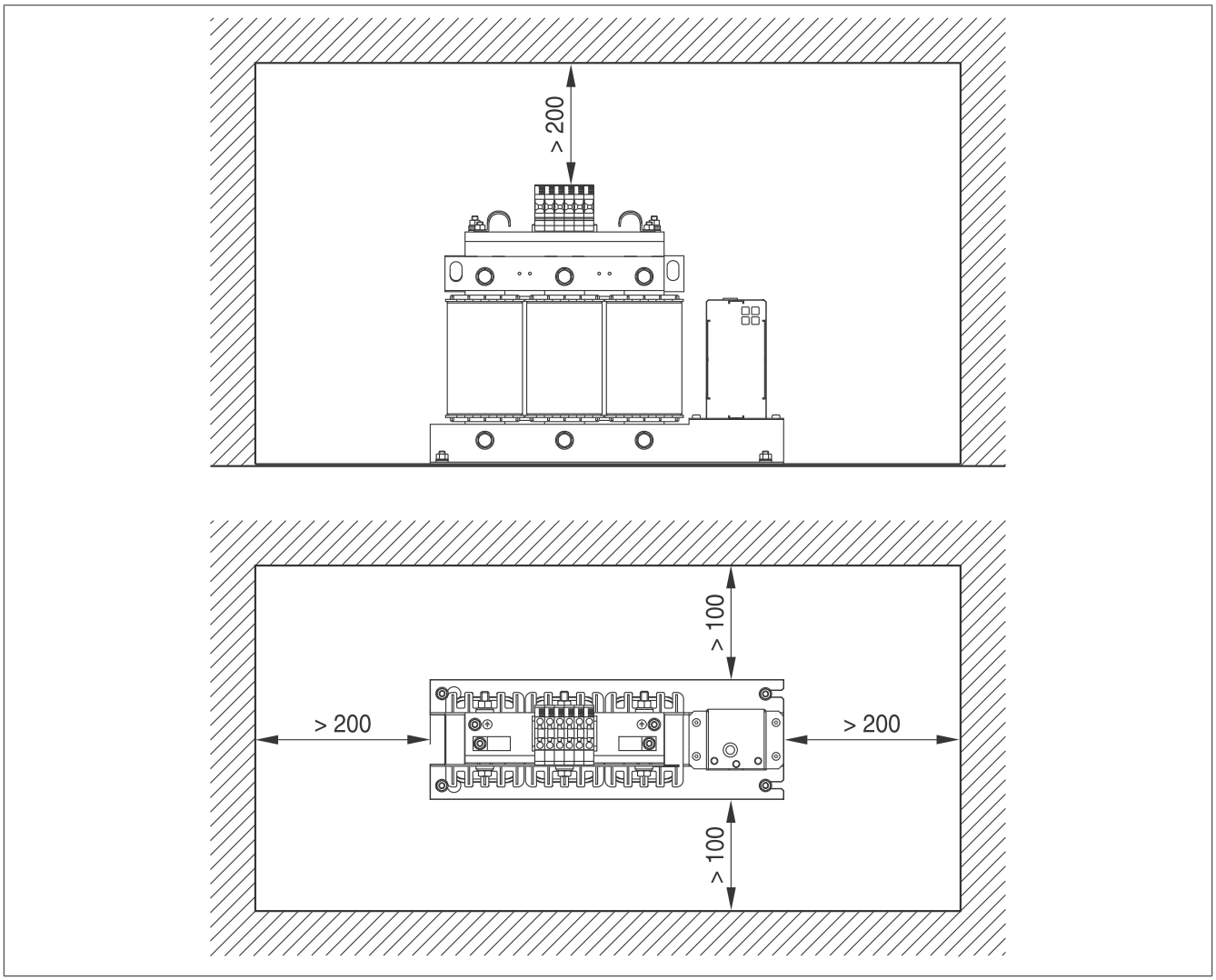
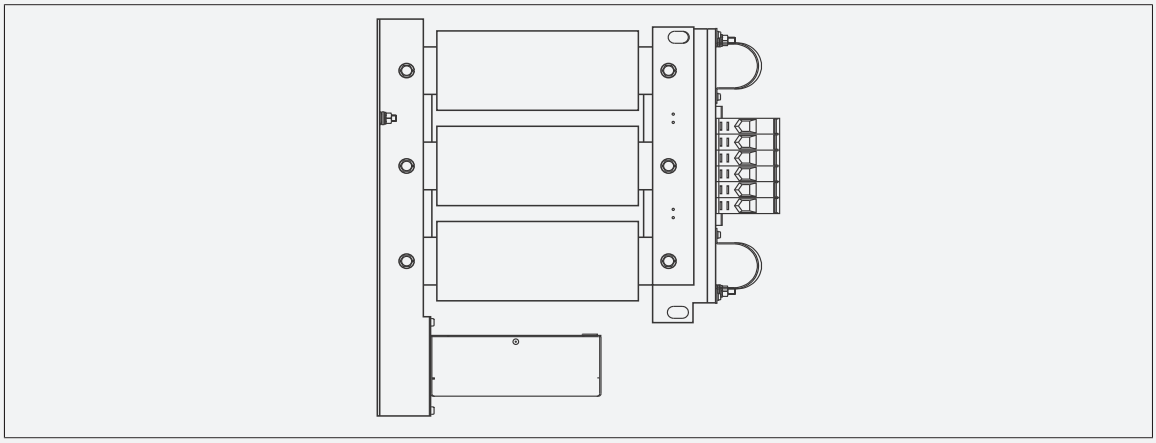


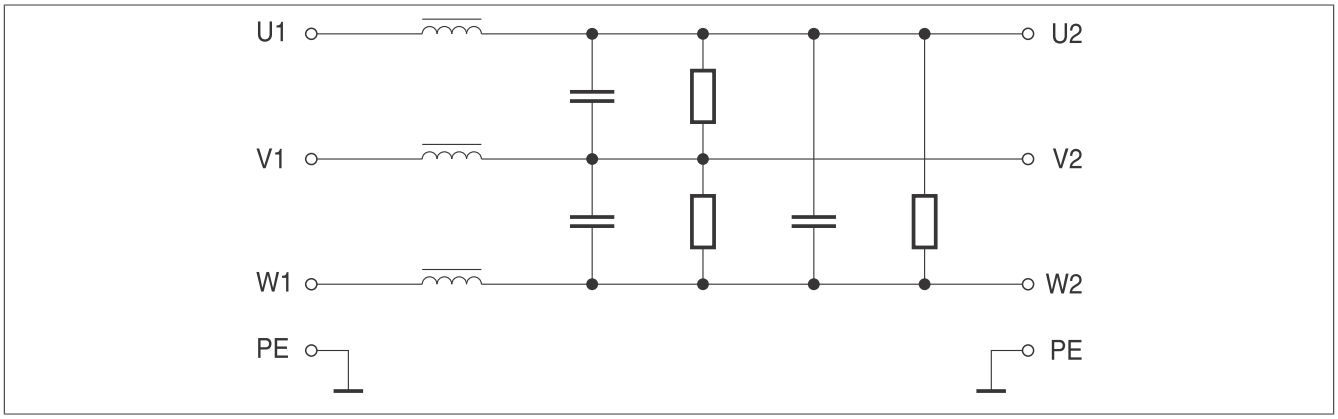

Figure 59: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.7.5 Input/Output circuit diagram



### 3.2.3.2.8 8I0ST096.066-1

### 3.2.3.2.8.1 General information

### 3.2.3.2.8.2 Order data

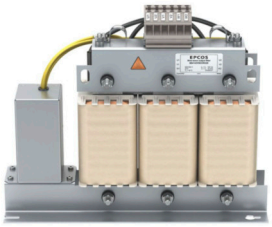
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** |  |
| 8I0ST096.066-1 | 66 A sine filter for ACOPOSinverter P96 3-phase. | |

Table 43: 8I0ST096.066-1 - Order data

### 3.2.3.2.8.3 Technical data

| Order number | 8I0ST096.066-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP20 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 440 mm |
| Height | 355 mm |
| Depth | 146 mm |
| Weight | 43 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.066-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 66 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 5.5 mΩ |
| Rated inductance $L_R$ | 0.95 mH |
| Rated capacity $C_R$ | 30 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 8 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 250 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ when operated on ACOPOSinverter P96 at $f_{P\,min}$.

### 3.2.3.2.8.4 Dimension diagram and installation dimensions

**Dimension diagram**

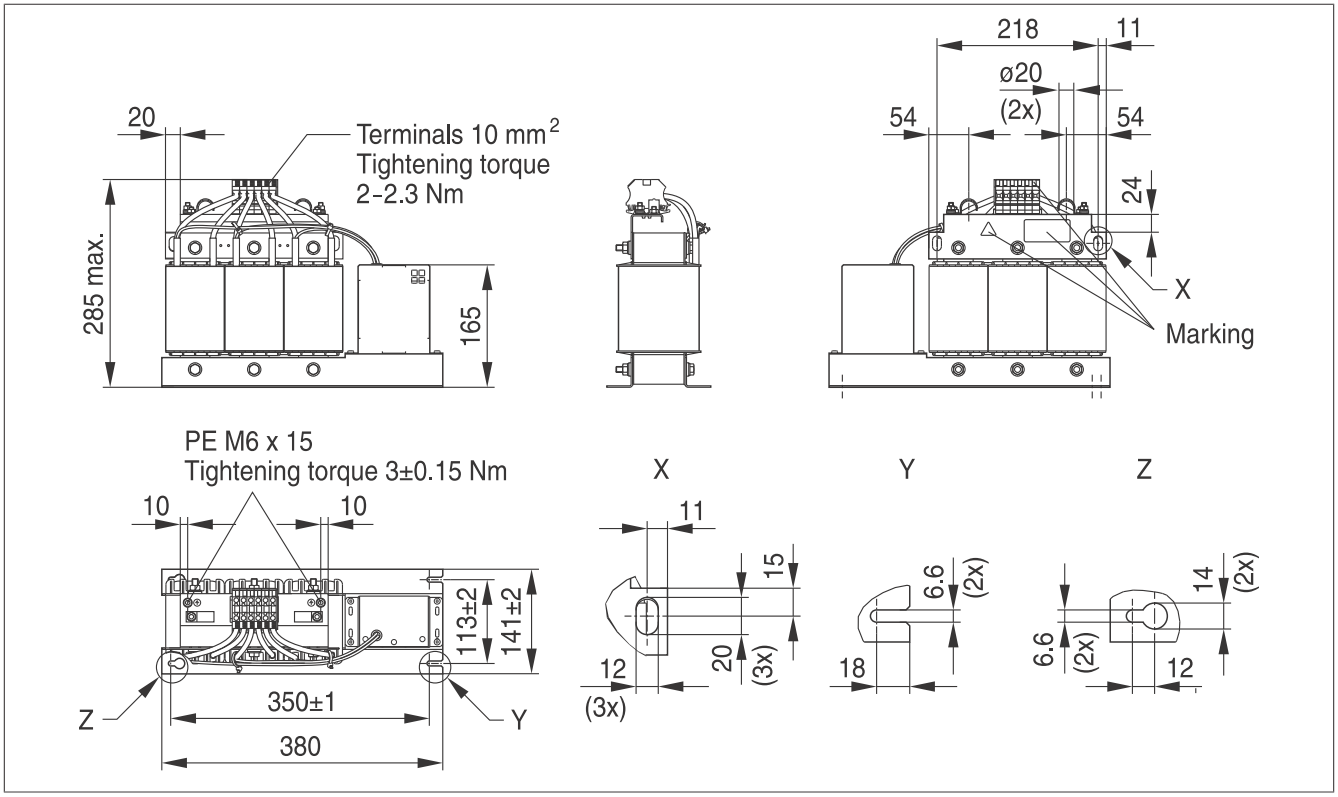



Figure 60: 8I0ST096.066-1 - Dimension diagram

## Installation dimensions

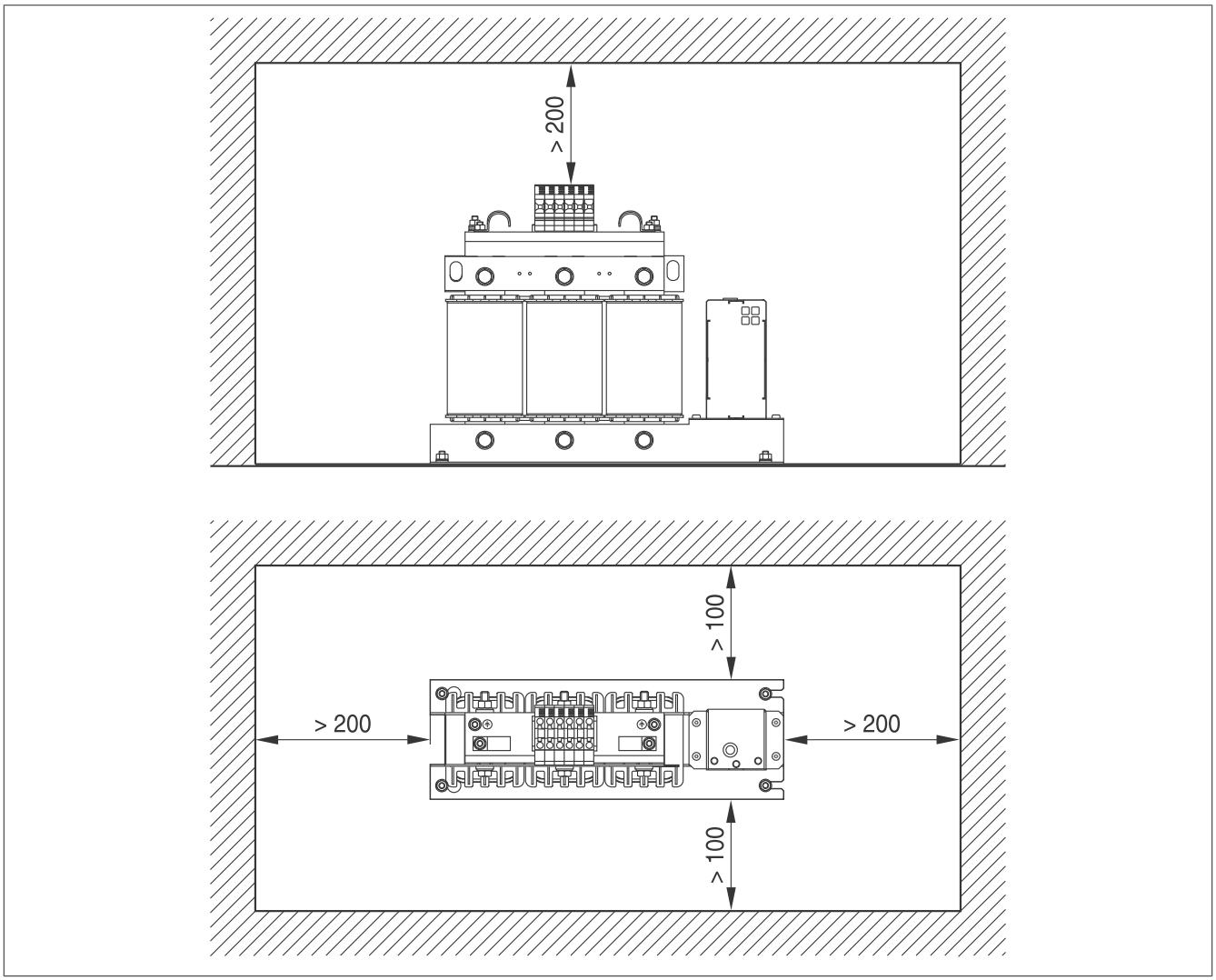
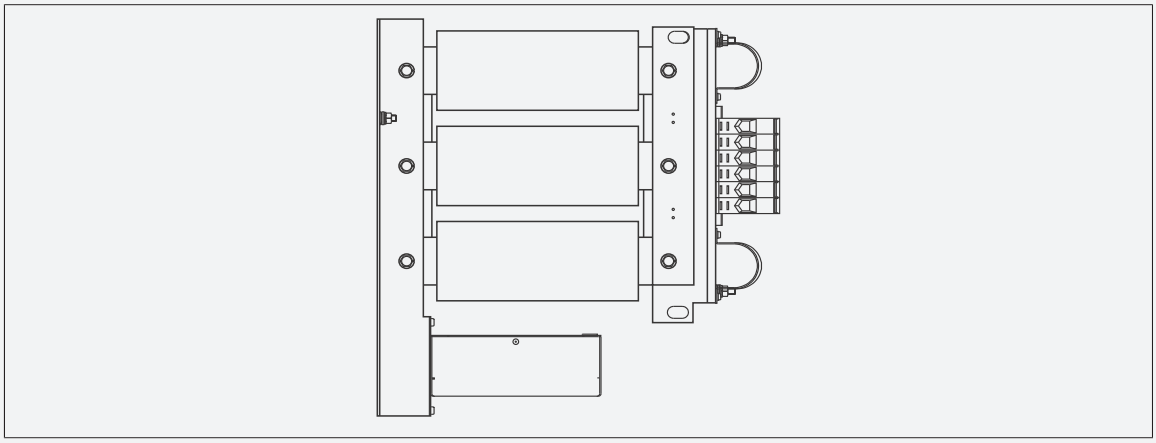


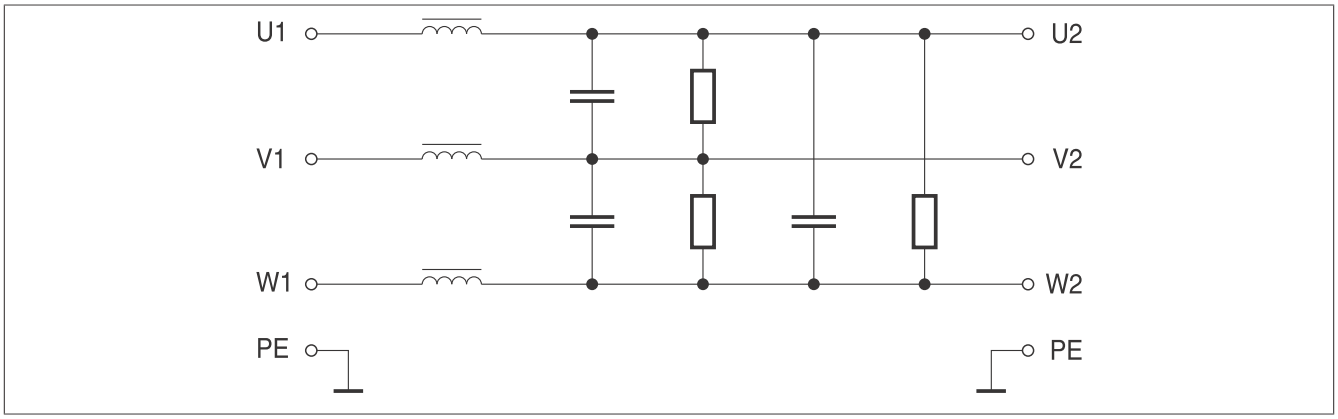

Figure 61: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.8.5 Input/Output circuit diagram



### 3.2.3.2.9 8I0ST096.075-1

#### 3.2.3.2.9.1 General information

#### 3.2.3.2.9.2 Order data

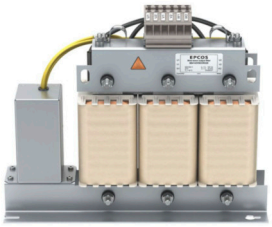
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** |  |
| 8I0ST096.075-1 | 75 A sine filter for ACOPOSinverter P96 3-phase. | |

Table 44: 8I0ST096.075-1 - Order data

#### 3.2.3.2.9.3 Technical data

| Order number | 8I0ST096.075-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical [1] | Yes |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP10 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 440 mm |
| Height | 380 mm |
| Depth | 198 mm |
| Weight | 62 kg |

1) In a vertical mounting orientation, the capacitors must be at the bottom!

| Order number | 8I0ST096.075-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 75 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 5.5 mΩ |
| Rated inductance $L_R$ | 0.86 mH |
| Rated capacity $C_R$ | 30 µF |
| Pulse frequency $f_p$ | Min. 3 kHz<br>Max. 8 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1] | 310 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ when operated on ACOPOSinverter P96 at $f_{P\,min}$.

### 3.2.3.2.9.4 Dimension diagram and installation dimensions

**Dimension diagram**

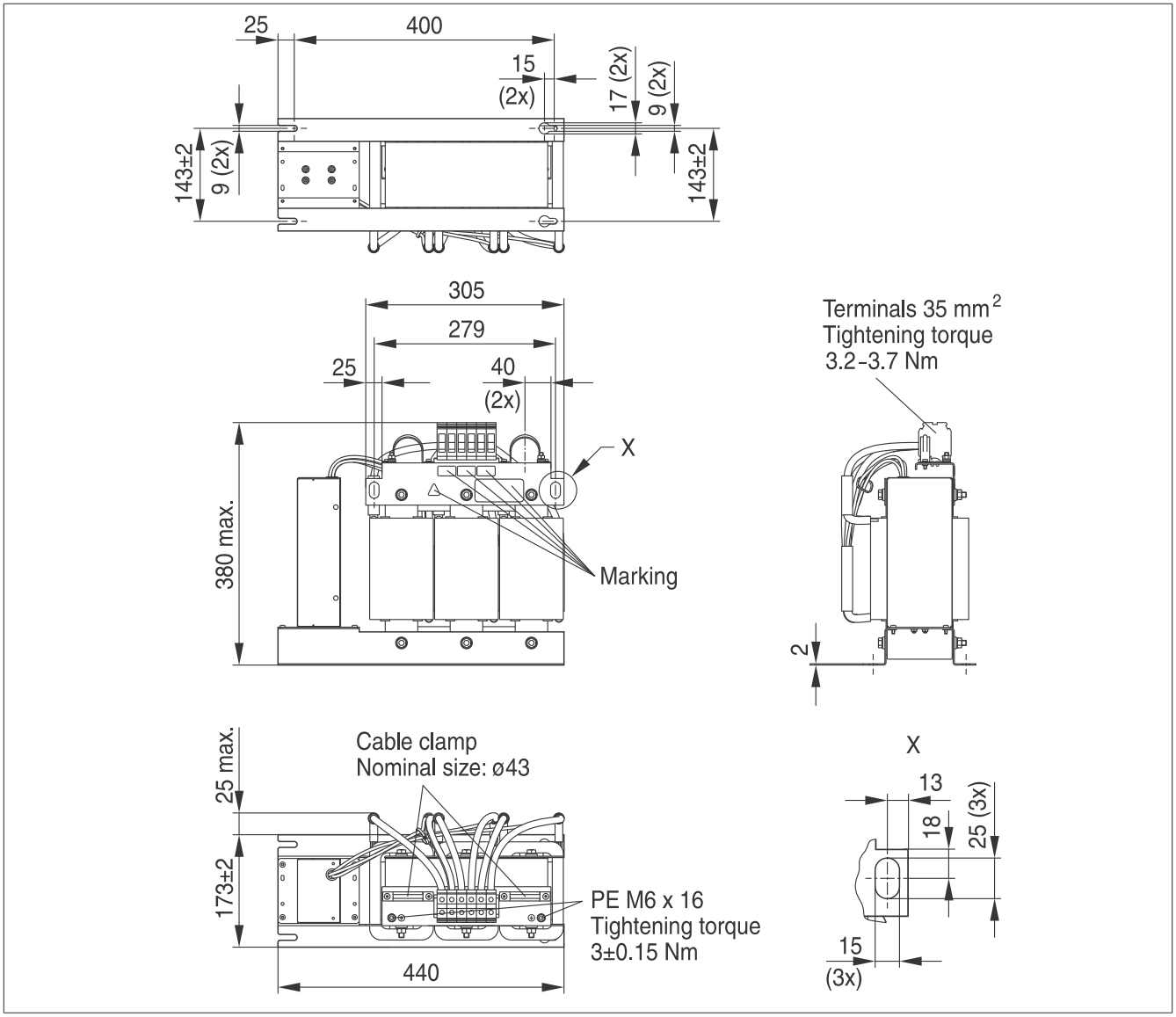



Figure 62: 8I0ST096.075-1 - Dimension diagram

## Installation dimensions

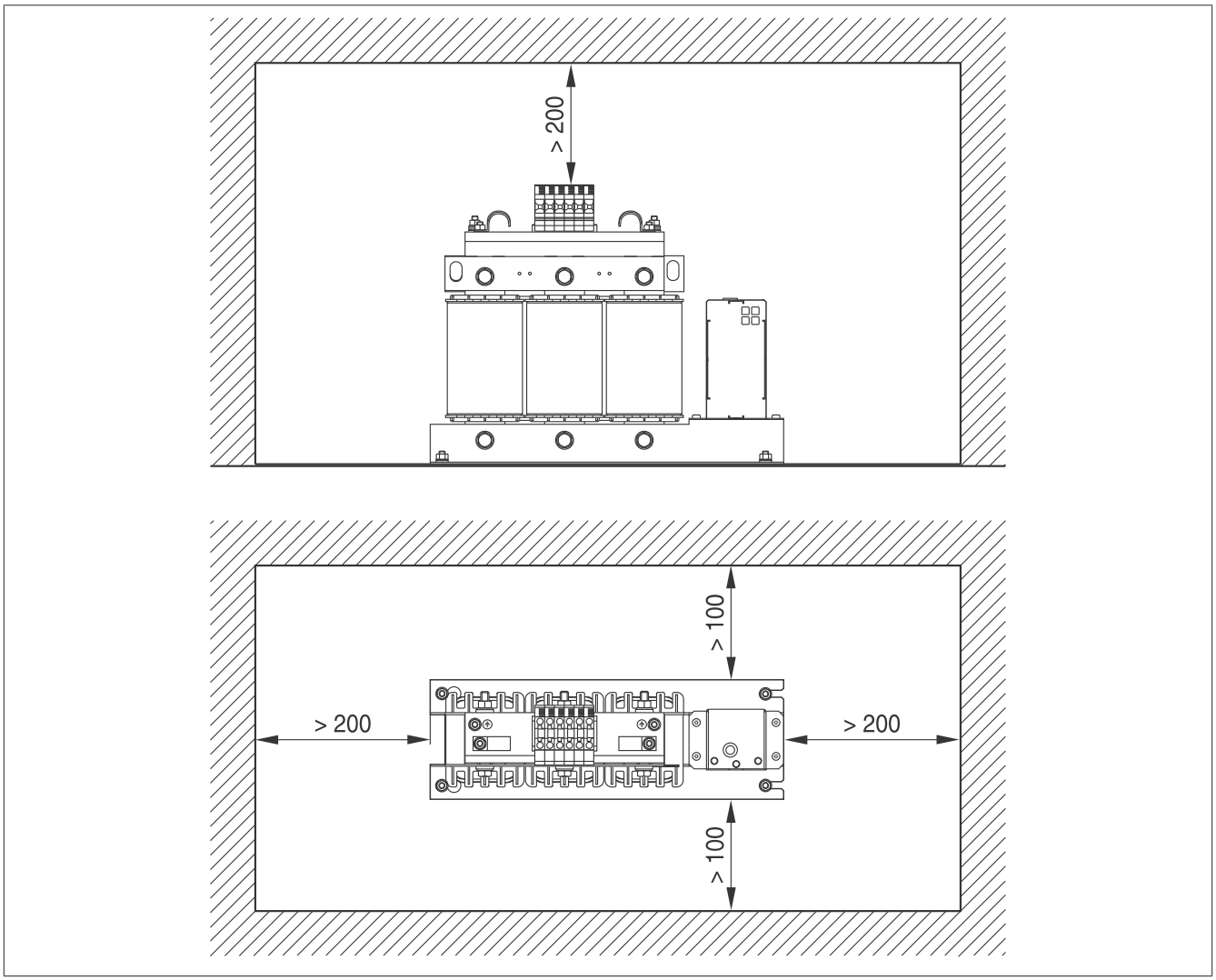
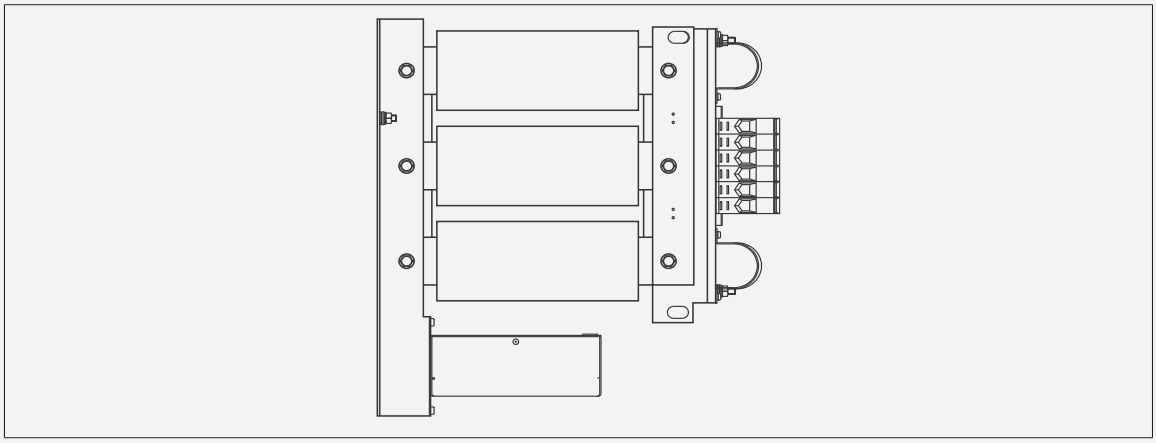


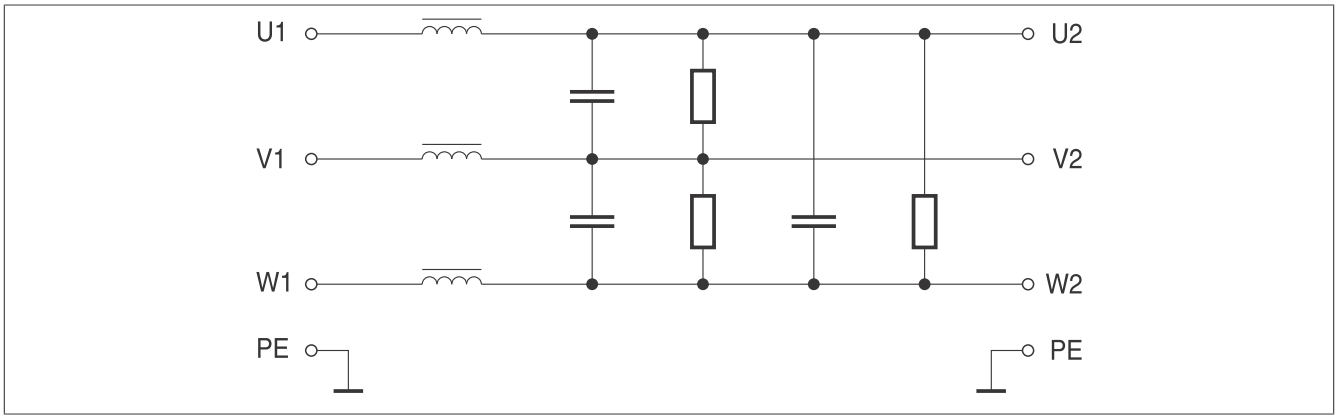

Figure 63: Installation dimensions 8I0ST096.xxx-1

## Note:

**In a vertical mounting orientation, the capacitors must be at the bottom!**



### 3.2.3.2.9.5 Input/Output circuit diagram



### 3.2.3.2.10 8I0ST096.130-1

### 3.2.3.2.10.1 General information

### 3.2.3.2.10.2 Order data

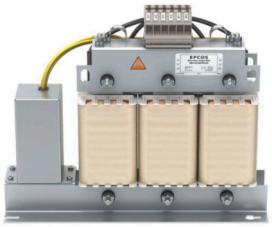
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** | |
| 8I0ST096.130-1 | 130 A sine filter for ACOPOSinverter P96 3-phase. |  |

Table 45: 8I0ST096.130-1 - Order data

### 3.2.3.2.10.3 Technical data

| Order number | 8I0ST096.130-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical | No |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP00 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 540 mm |
| Height | 420 mm |
| Depth | 231 mm |
| Weight | 110 kg |

| Order number | 8I0ST096.130-1 |
|---|---|
| Rated voltage $U_R$ | 400/690 VAC (50/60 Hz) |
| Rated current $I_R$ | 130 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 3.2 mΩ |
| Rated inductance $L_R$ | 0.54 mH |
| Rated capacity $C_R$ | 70 µF |
| Pulse frequency $f_p$ | Min. 2.4 kHz<br>Max. 8 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1)] | 630 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ when operated on ACOPOSinverter P96 at $f_{P\,min}$.

### 3.2.3.2.10.4 Dimension diagram and installation dimensions

**Dimension diagram**

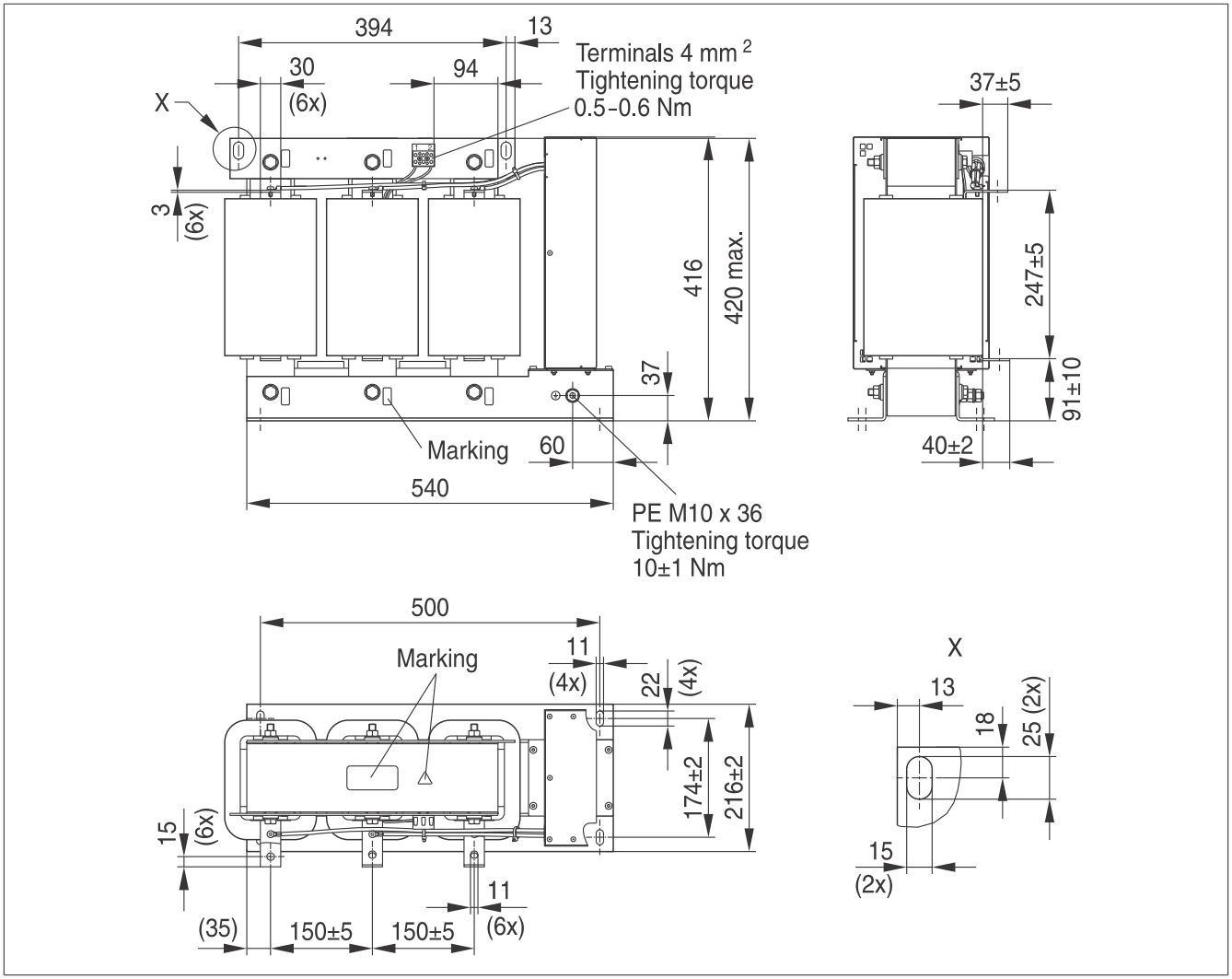



Figure 64: 8I0ST096.130-1 - Dimension diagram

### Installation dimensions

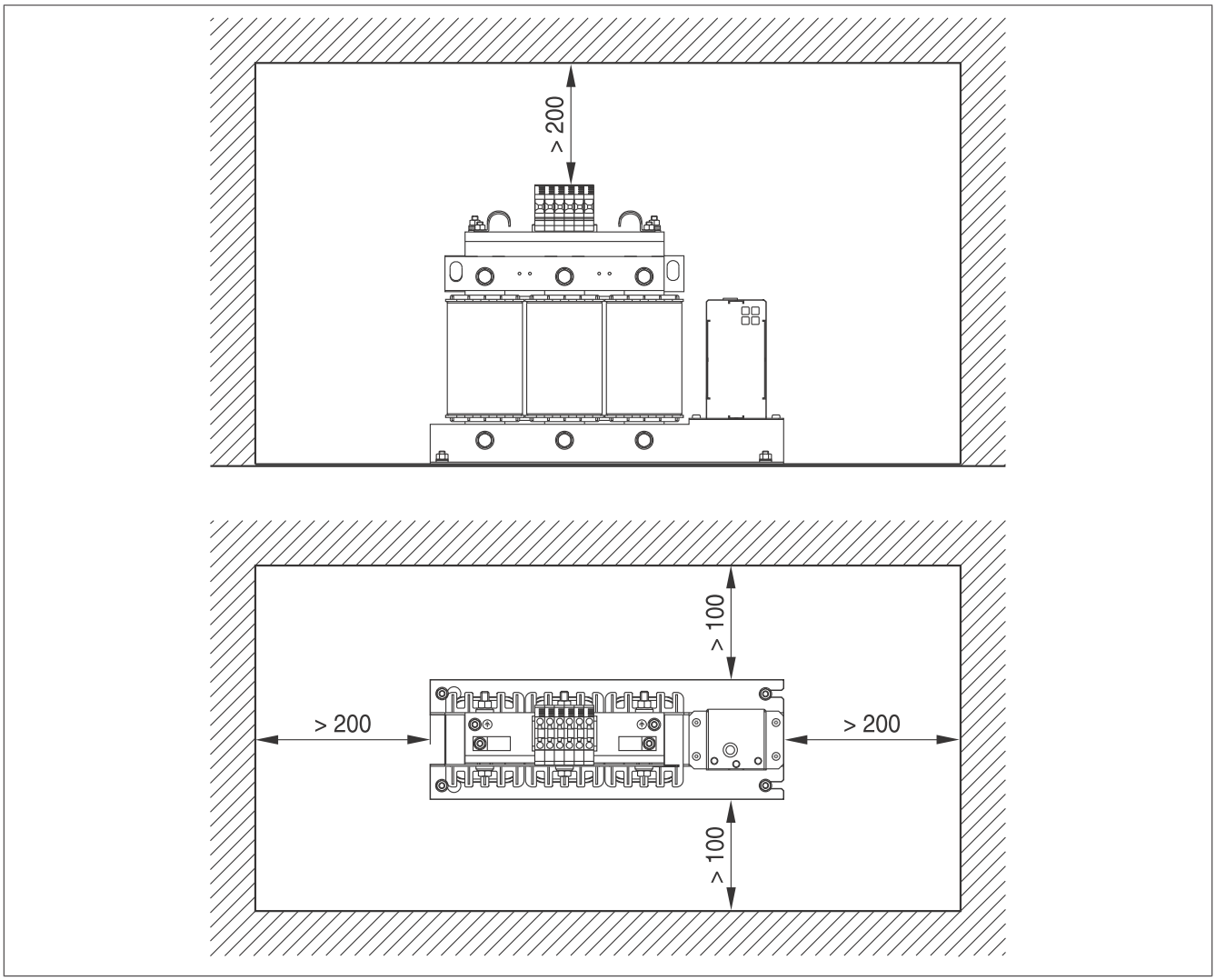
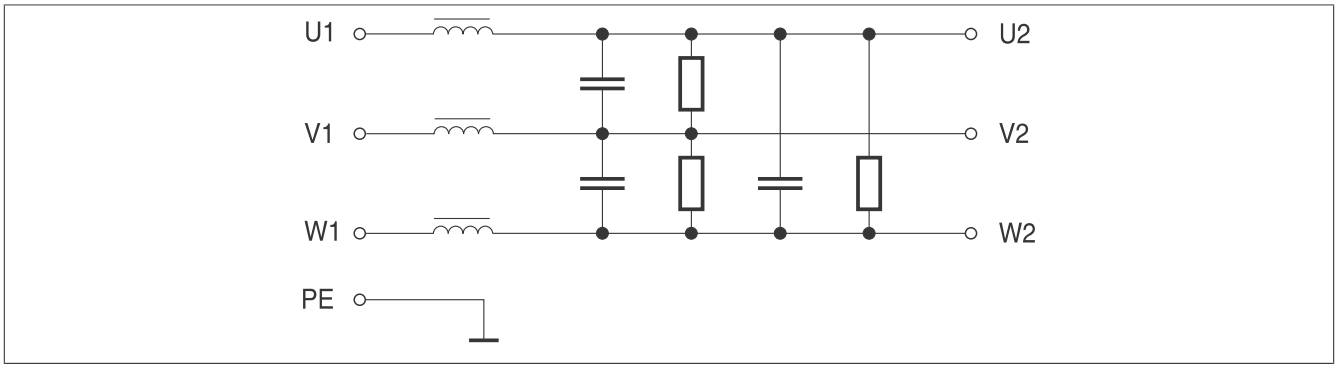



Figure 65: Installation dimensions 8I0ST096.xxx-1

### 3.2.3.2.10.5 Input/Output circuit diagram



## 3.2.3.2.11 8I0ST096.162-1

### 3.2.3.2.11.1 General information

### 3.2.3.2.11.2 Order data

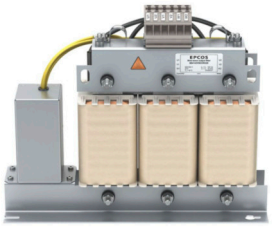
| Order number | Short description | Figure |
|---|---|---|
| | **Sine filters** | |
| 8I0ST096.162-1 | 162 A sine filter for ACOPOSinverter P96 3-phase. |  |

Table 46: 8I0ST096.162-1 - Order data

### 3.2.3.2.11.3 Technical data

| Order number | 8I0ST096.162-1 |
|---|---|
| **Operating conditions** | |
| Mounting orientation | |
| Vertical | No |
| Vertical | Yes |
| Degree of protection per EN 60529 | IP00 |
| **Mechanical properties** | |
| Dimensions | |
| Width | 500 mm |
| Height | 380 mm |
| Depth | 298 mm |
| Weight | 112 kg |

| Order number | 8I0ST096.162-1 |
|---|---|
| Rated voltage $U_R$ | 300/520 VAC (50/60 Hz) |
| Rated current $I_R$ | 162 A |
| Overload capacity (thermal) | 1.5 x $I_R$ for 1 min per hour |
| DC resistance $R_{type}$ | Typ. 1.53 mΩ |
| Rated inductance $L_R$ | 0.4 mH |
| Rated capacity $C_R$ | 90 µF |
| Pulse frequency $f_p$ | Min. 2.4 kHz<br>Max. 6 kHz |
| Motor frequency $f_M$ | 0 to 100 Hz |
| Power dissipation $P_V$ [1)] | 550 W |
| dv/dt on the filter input | Max. 5 kV/µs |

1) Estimated power dissipation at $I_R$ and $U_R$ when operated on ACOPOSinverter P96 at $f_{P\,min}$.

### 3.2.3.2.11.4 Dimension diagram and installation dimensions

**Dimension diagram**

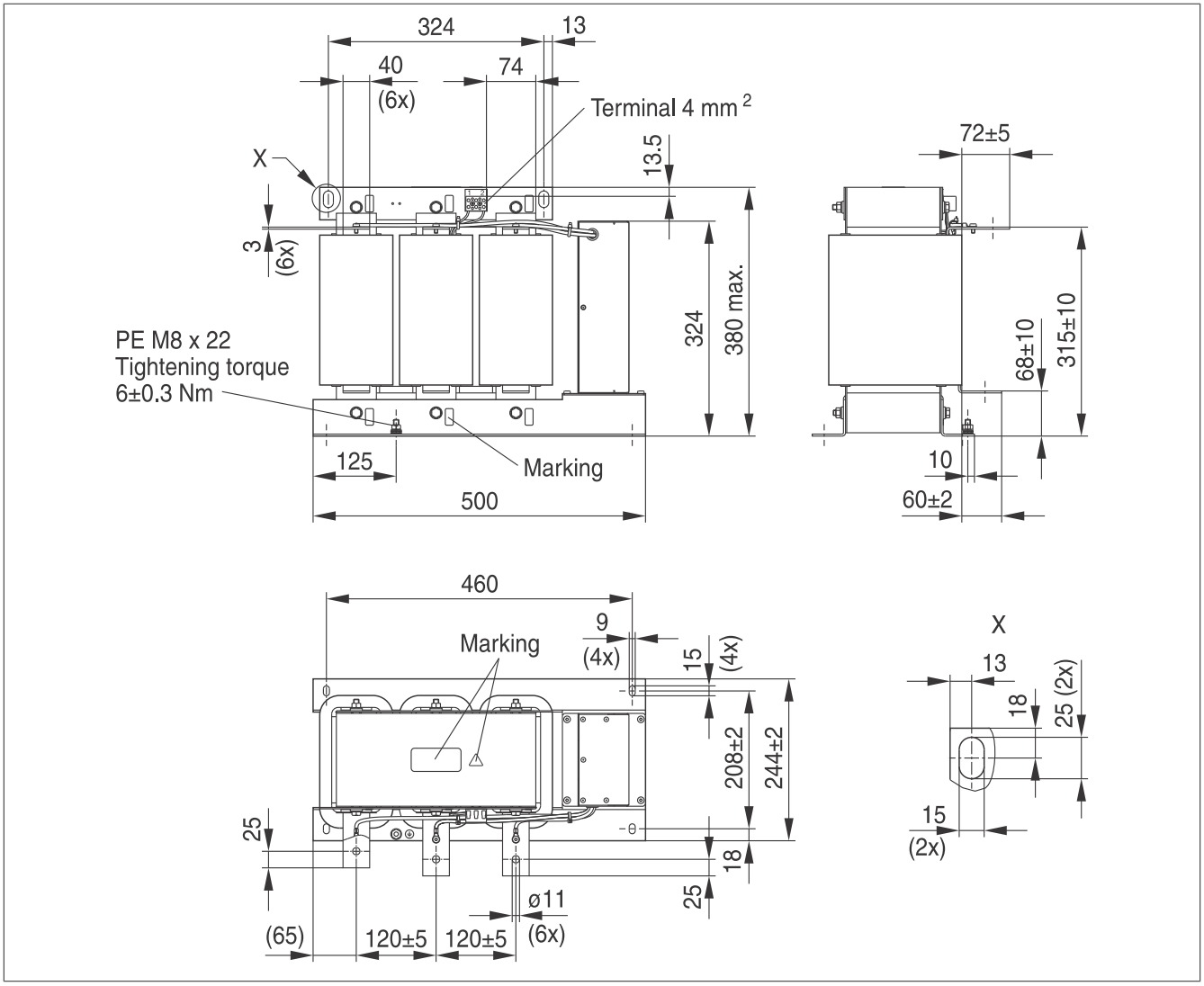



Figure 66: 8I0ST096.162-1 - Dimension diagram

## Installation dimensions

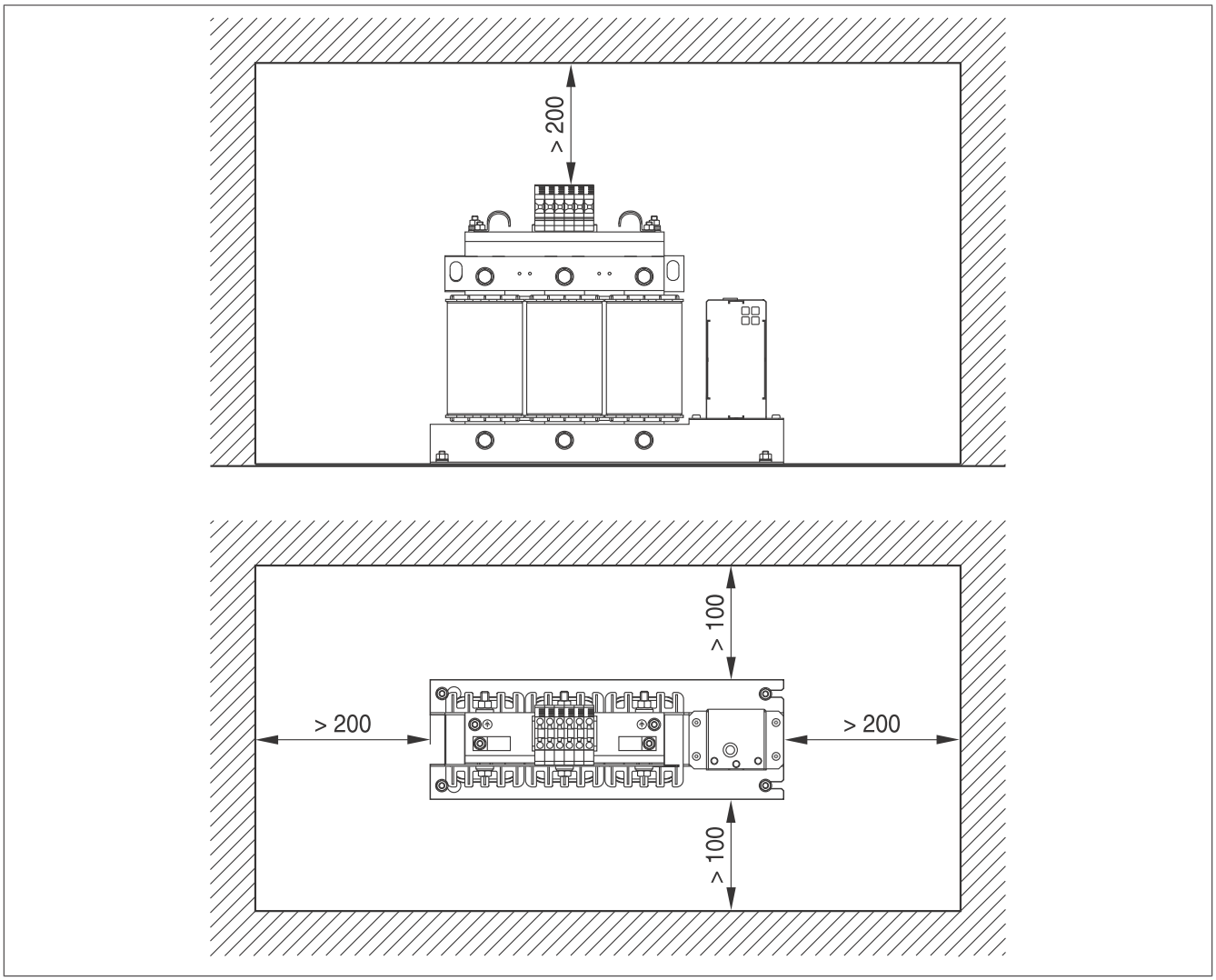
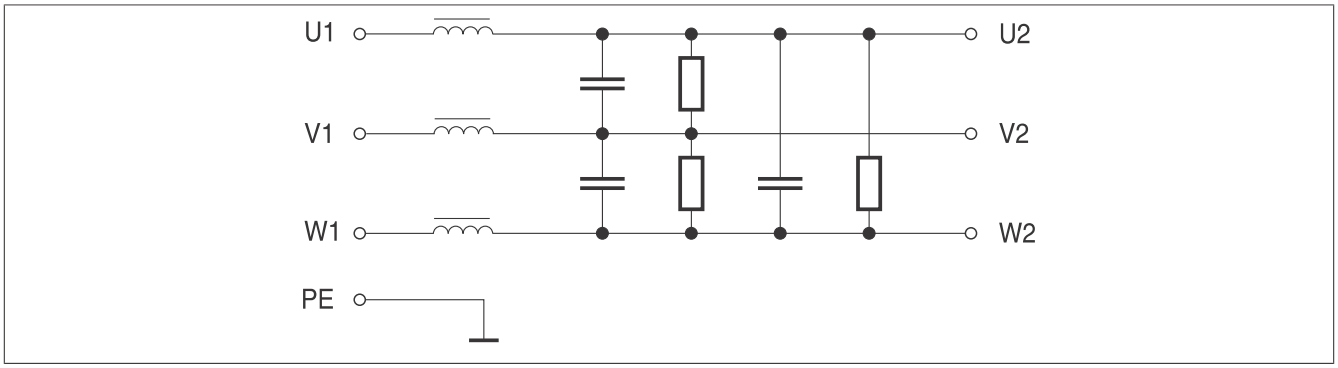



Figure 67: Installation dimensions 8I0ST096.xxx-1

### 3.2.3.2.11.5 Input/Output circuit diagram



# 4 Installation

## 4.1 Mechanical installation

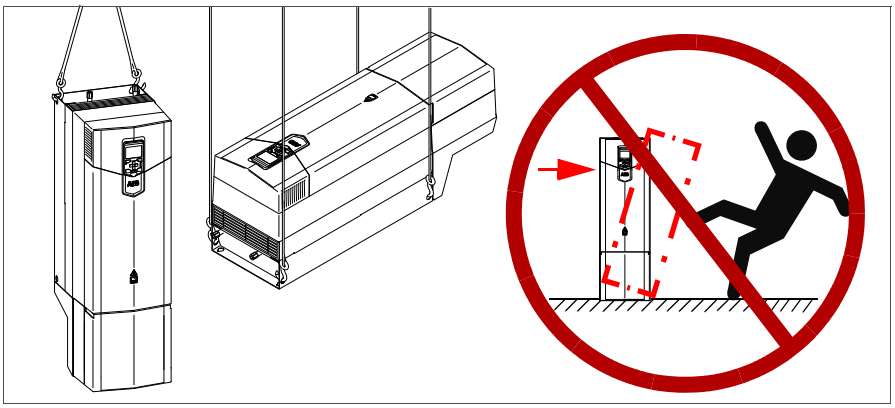
This chapter describes the mechanical installation of the frequency inverter.

### 4.1.1 Safety

**Warning!**

**For sizes R6 and R7:**

**Use the lifting lugs of the frequency inverter for lifting. The frequency inverter is not permitted to be tilted. The frequency inverter is heavy and has a high center of gravity. If it falls over, it can cause serious injuries.**

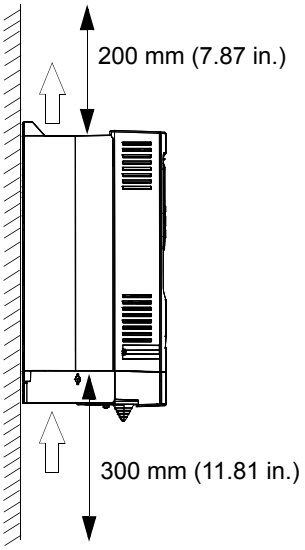


### 4.1.2 Checking the installation site

The frequency inverter must be installed upright with the heat sink facing the wall. All frequency inverters in sizes R1 to R3 can be installed close together. For frequency inverters in sizes R4 to R7, spacing of 100 mm (4 in) must be left between the front covers.

Ensure that the installation site meets the following requirements:

- The installation site is sufficiently ventilated to prevent the frequency inverter from overheating. See section "Power dissipation, cooling data and noise level" on page 31.
- The operating conditions of the frequency inverter correspond to the specifications in section "Ambient conditions" on page 35.
- The wall is vertical, made of non-flammable material and is strong enough to support the weight of the devices. See section "Dimensions, weight and space requirements" on page 23.
- The material underneath the device is not flammable.
- There is sufficient space above and below the frequency inverter for the cooling air flow, as well as for service and maintenance tasks. See section "Dimensions, weight and space requirements" on page 23. There is sufficient space in front of the frequency inverter for the cooling air flow during operation, as well as for service and maintenance tasks.
- Ensure that there are no sources of strong magnetic fields near the frequency inverter, such as high-current single-core conductors or contactor coils. A strong magnetic field can cause interference or inaccuracies in the operation of the inverter.




### 4.1.3 Required tools

- Drill and suitable drill bits
- Screwdriver and/or wrench with suitable inserts. The cover of the frequency inverter is secured with Torx screws.

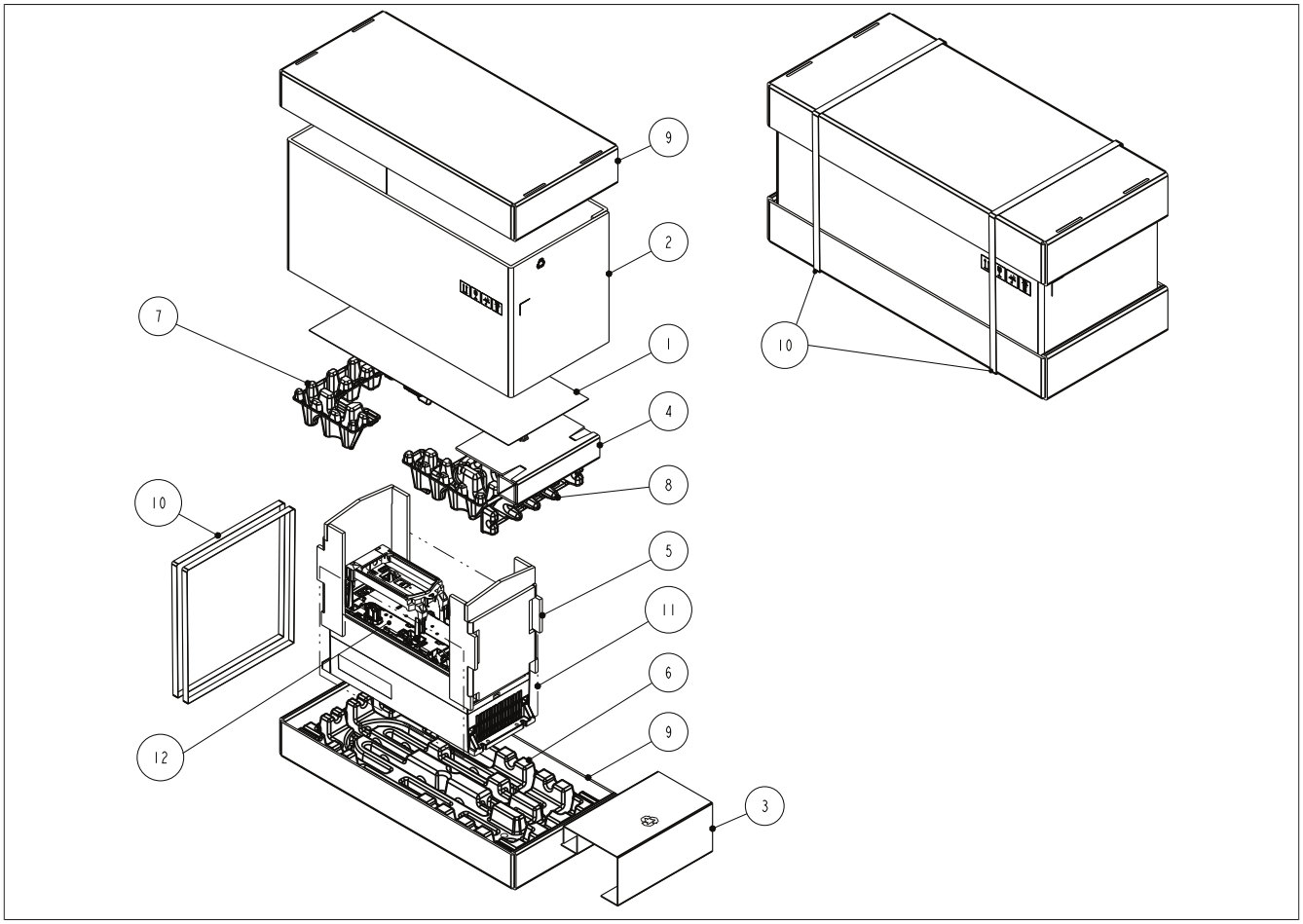
### 4.1.4 Transporting the frequency inverter

Transport the package to the installation site using a pallet truck.

### 4.1.5 Unpacking and checking the delivery

The following figures show the structure of the transport package. Check whether all parts are present and whether there is visible damage. Read the specifications on the nameplate of the frequency inverter to ensure that the type of the device is correct.

#### 4.1.5.1 Sizes R1 and R2

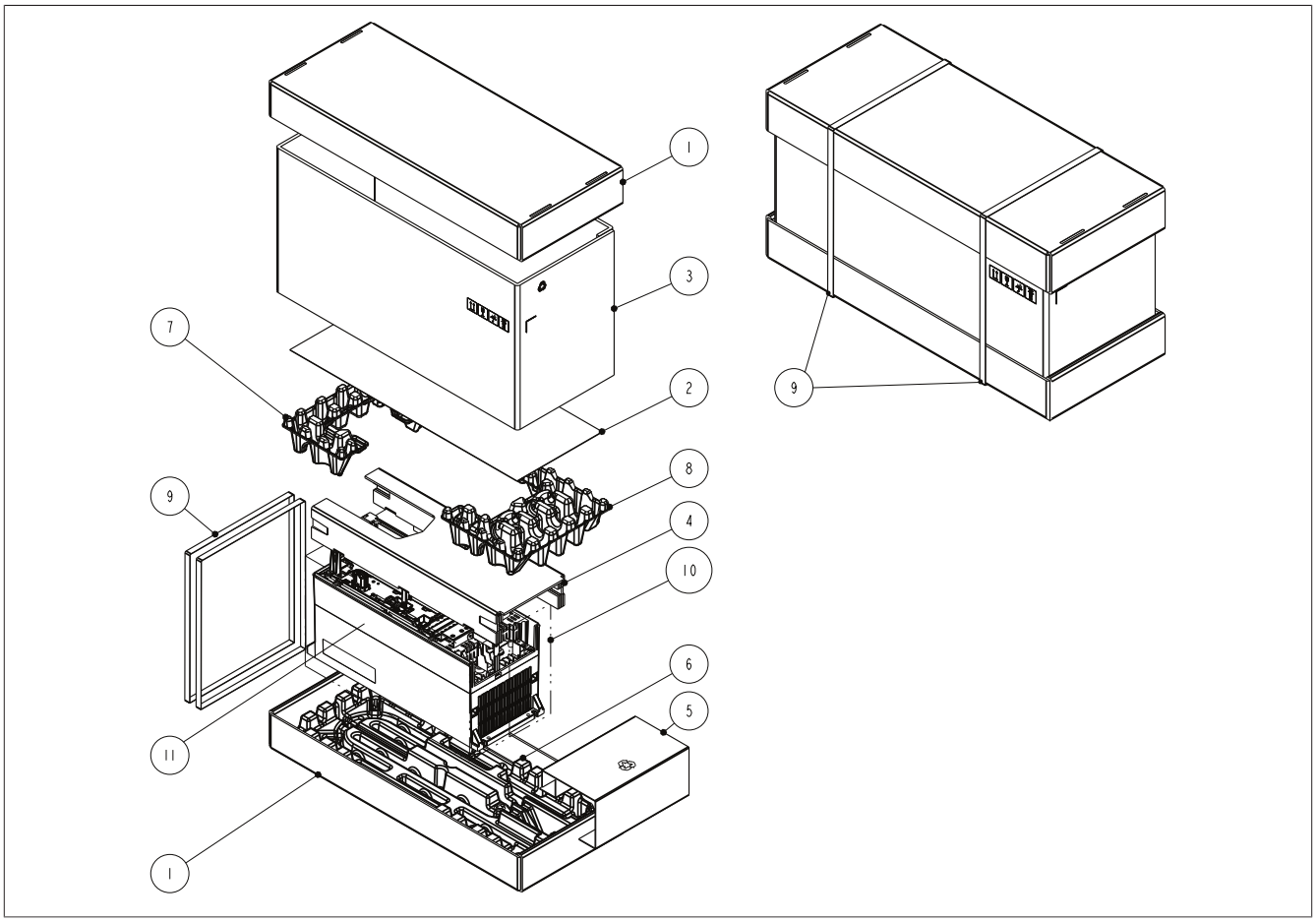



| Item | Description |
|---|---|
| 1 | Securing plate |
| 2 | Cardboard cover |
| 3...5 | Cardboard reinforcement |
| 6...8 | Packaging cushioning elements |
| 9 | Cardboard top |
| 10 | PET ribbons |
| 11 | Plastic bag |
| 12 | Frequency inverter with factory-installed options |

Unpack the frequency inverter as follows:

- Cut the ribbons (10).
- Remove the cardboard top (9), securing plate (1), cardboard reinforcement (4) and cushioning elements (7 and 8).
- Remove the cardboard cover (2).
- Remove the cardboard reinforcement (5).
- Lift the frequency inverter clear.

### 4.1.5.2 Size R3

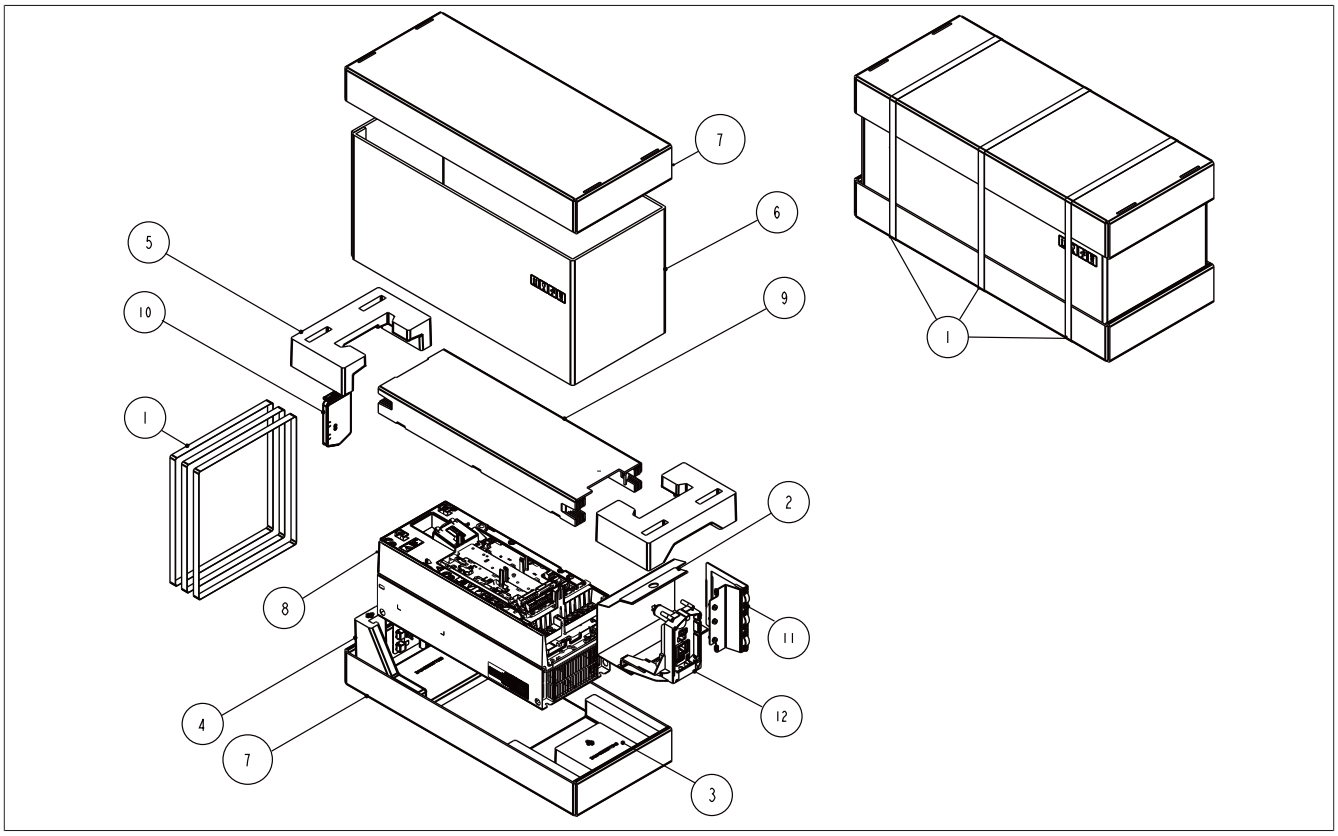



| Item | Description |
|---|---|
| 1 | Cardboard bottom and cardboard top |
| 2 | Securing plate |
| 3 | Cardboard cover |
| 4 | Cardboard spacer |
| 5 | Cardboard reinforcement |
| 6...8 | Packaging cushioning elements |
| 9 | PET ribbons |
| 10 | Plastic bag |
| 11 | Frequency inverter with factory-installed options |

Unpack the frequency inverter as follows:

- Cut the ribbons (9).
- Remove the cardboard top (1), securing plate (2) and cushioning elements (7 and 8).
- Remove the cardboard cover (3).
- Remove the cardboard spacer (4).
- Lift the frequency inverter clear.

### 4.1.5.3 Size R4

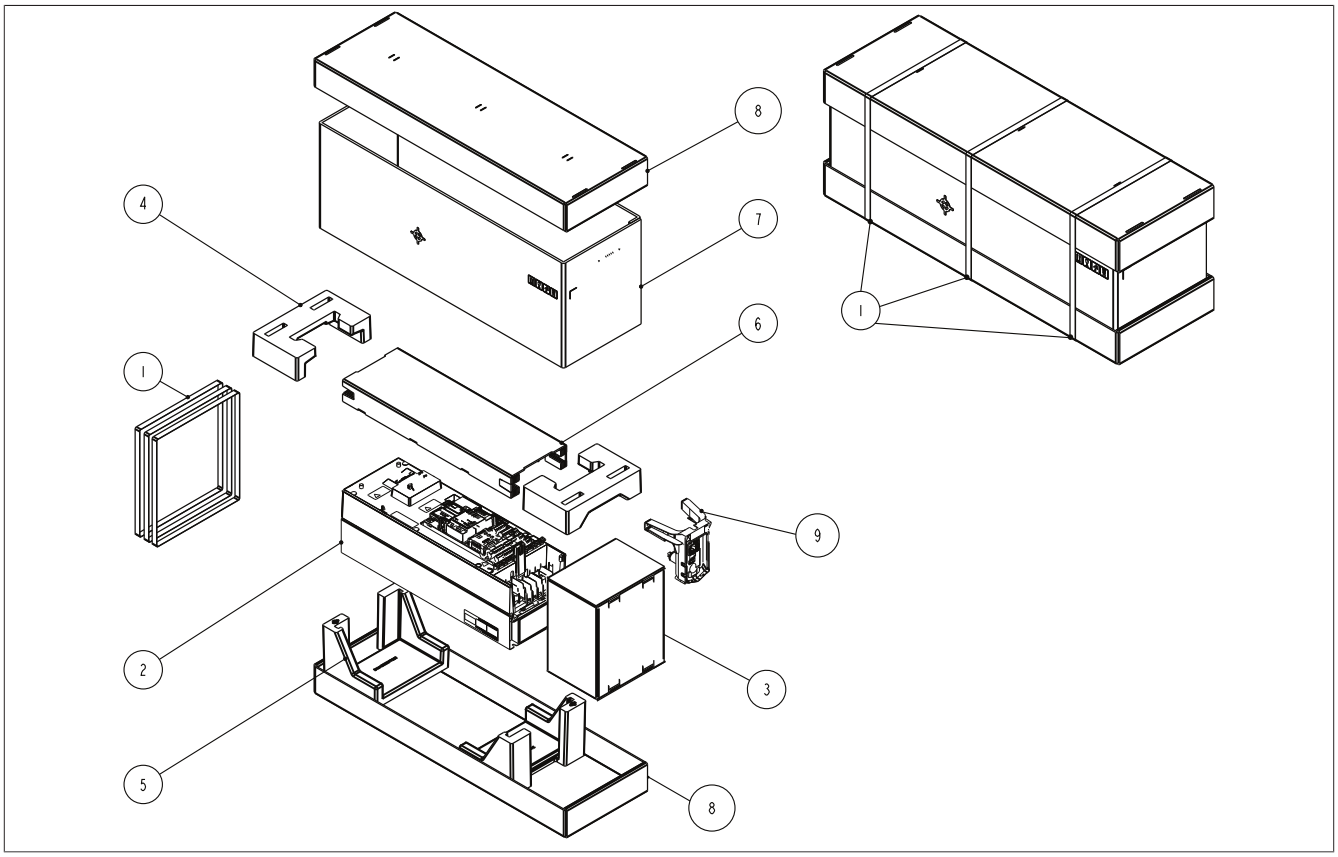



| Item | Description |
|---|---|
| 1 | PET ribbons |
| 2 | Cardboard reinforcement |
| 3...5 | Packaging cushioning elements |
| 6 | Cardboard cover |
| 7 | Cardboard bottom and cardboard top |
| 8 | Frequency inverter with factory-installed options |
| 9 | Cardboard spacer |
| 10 | Installation kit |
| 11 | Main cable clamp set |
| 12 | Panel holder |

Unpack the frequency inverter as follows:

- Cut the ribbons (1).
- Remove the cardboard top (7).
- Remove the spacer (9), cushioning elements (5), cardboard reinforcement (2), panel holder (12) and main cable clamp set (11).
- Remove the cardboard cover (6).
- Attach hooks to the lifting lugs of the frequency inverter. Lift the frequency inverter with a hoist.

### 4.1.5.4 Size R5

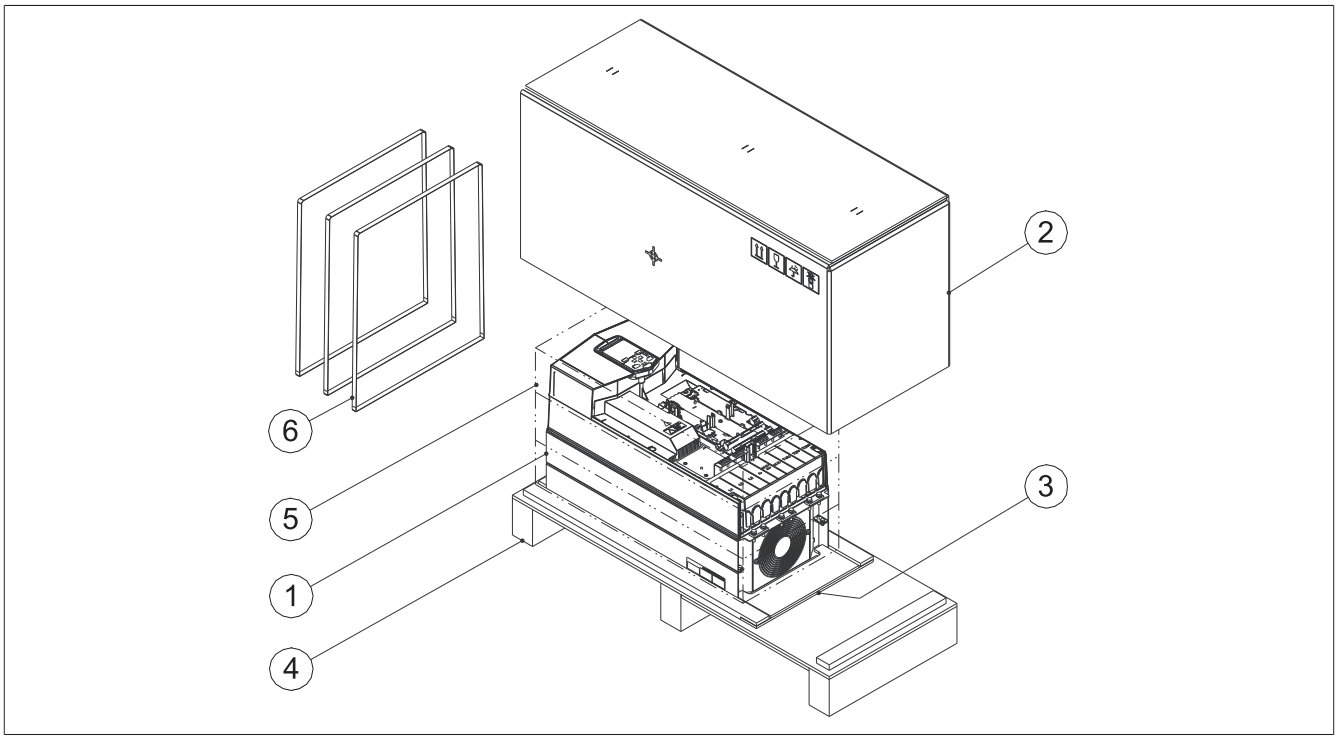



| Item | Description |
|---|---|
| 1 | PET ribbons |
| 2 | Frequency inverter with factory-installed options |
| 3 | Cardboard for panel holder |
| 4...5 | Packaging cushioning elements |
| 6 | Cardboard spacer |
| 7 | Cardboard cover |
| 8 | Cardboard bottom and cardboard top |
| 9 | Panel holder |

Unpack the frequency inverter as follows:

- Cut the ribbons (1).
- Remove the cardboard top (8), cushioning elements (4), spacers (6) and the cardboard for the panel holder (3).
- Remove the cardboard cover (7).
- Attach hooks to the lifting lugs of the frequency inverter. Lift the frequency inverter with a hoist.

### 4.1.5.5 Sizes R6 and R7




| Item | Description |
|---|---|
| 1 | Frequency inverter with factory-installed options |
| 2 | Packaging lid |
| 3 | Stopper |
| 4 | Pallet |
| 5 | Packaging cushioning element |
| 6 | PET ribbons |

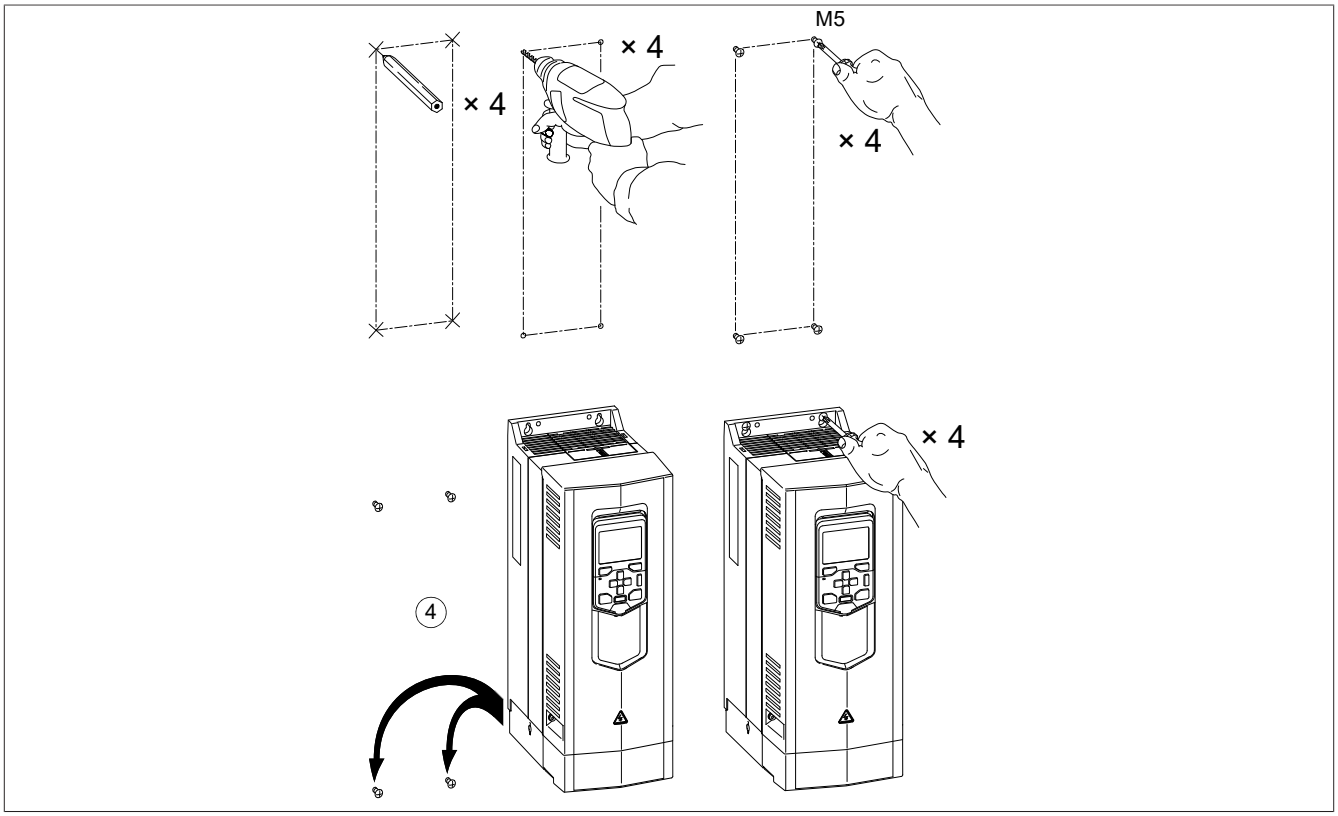
Unpack the frequency inverter as follows:

- Cut the ribbons (6).
- Remove the packaging lid (2).
- Remove the stopper (3).
- Attach hooks to the lifting lugs of the frequency inverter. Lift the frequency inverter with a hoist.

### 4.1.6 Installing the frequency inverter

This section describes how to install the frequency inverter on a wall without vibration dampers.

1. See the dimensions in section "Dimensional drawings" on page 41. Mark the locations for the four mounting holes.
2. Drill the holes.
3. Insert anchors or dowels into the holes and screw/insert the screws or bolts into the anchors or dowels. Screw the screws into the wall far enough to support the weight of the frequency inverter.
4. Place the frequency inverter on the screws/anchors in the wall.
5. Tighten the screw connection to the wall.

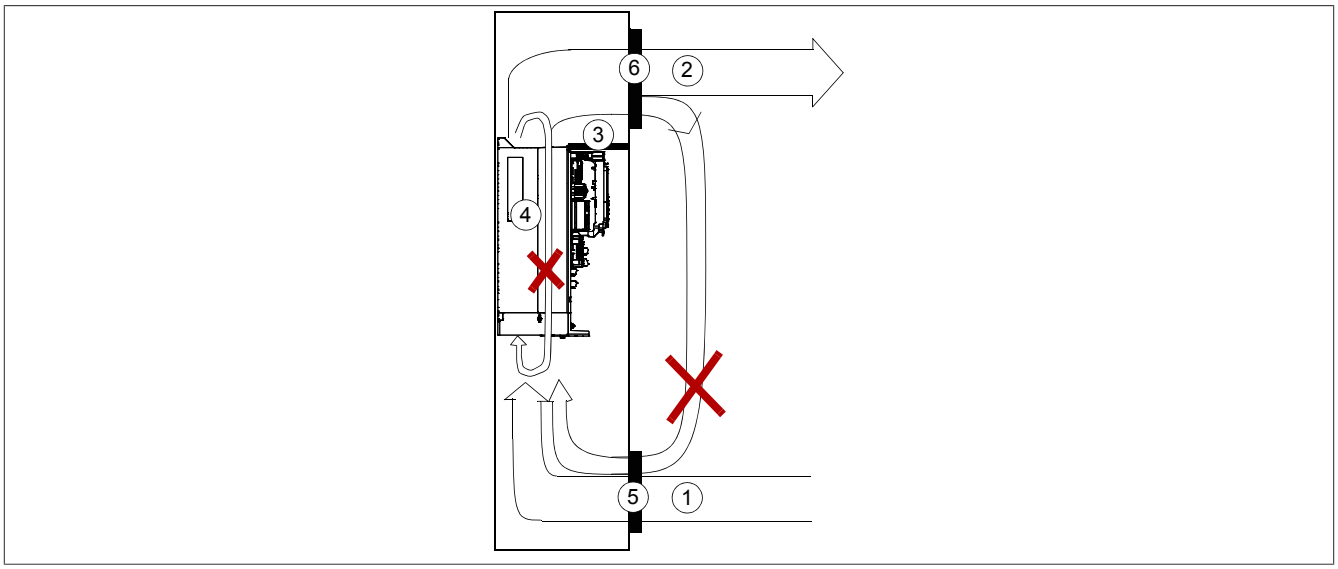


### 4.1.7 Cabinet installation

This section contains the basic instructions for installing the frequency inverter in a control cabinet.

#### 4.1.7.1 Cooling

- Ensure that sufficient cooling is provided.
- Ensure that the temperature of the cooling air flowing into the frequency inverter does not exceed 40°C (104°F).
- Prevent heated cooling air from flowing back into the control cabinet. You can use air deflectors or an external fan at the inlet or outlet of the control cabinet. If you use a fan, we recommend an inlet fan with filter. This type of fan creates overpressure in the control cabinet that ensures that no dust penetrates.
- Prevent the heated exhaust air from re-entering from outside the control cabinet. Direct the exhaust air away from the air inlet – to the other side of the control cabinet or upwards.
- Ensure that the room in which the control cabinet is installed has adequate cooling/ventilation.




1 Intake of the main air flow
2 Outlet of the main air flow
3 Air deflector
4 Frequency inverters
5 Intake air filter
6 Exhaust air filter

**Note:**

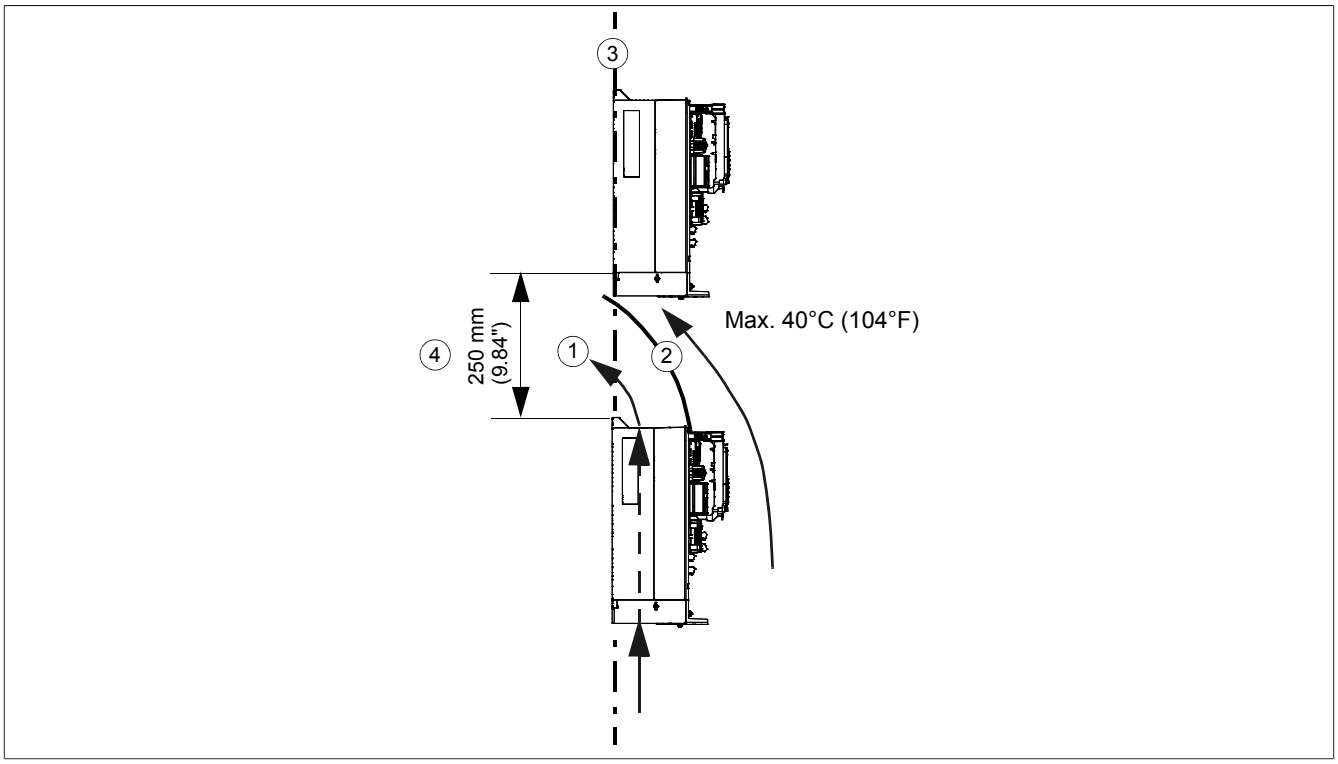
**You can remove the front cover of the frequency inverter module to improve the cooling effect.**

#### 4.1.7.2 Grounding in the control cabinet

Leave the contact surfaces of the mounting points uncoated (direct metal-to-metal contact). The housing of the frequency inverter is grounded to the PE rail of the control cabinet via mounting surfaces, screws and the control cabinet frame. Alternatively, use a separate ground conductor between the PE connection of the frequency inverter and the PE rail of the control cabinet.

#### 4.1.7.3 Installing frequency inverters one above the other

Ensure that the heated cooling air of the lower frequency inverter is directed away from the frequency inverter installed above it.




1 Airflow through the frequency inverter
2 Air deflector
3 Mounting plate with cutout for airflow
4 Minimum distance between the frequency inverters

## 4.2 Planning the electrical installation

This section contains instructions for planning the electrical installation of the frequency inverter. Some instructions must be followed for every installation; others contain useful information that only applies to specific applications.

### 4.2.1 Limitation of liability

Applicable laws and local regulations must always be observed when planning and carrying out installation. B&R accepts no liability for installations that have not been planned and carried out in accordance with local laws and regulations. If the recommendations provided by B&R are not observed, problems may occur during operation of the frequency inverter that are not covered by the warranty.

### 4.2.2 Selecting the mains disconnect device

Install a manually operated input disconnect device between the AC supply and frequency inverter. The disconnect device must be such that it can be locked in the open position for installation and maintenance tasks.

#### European Union

To meet the EU Machinery Directive per EN 60204-1 "Safety of machinery", one of the following disconnect devices must be used:

- Switch-disconnector for utilization category AC-23B (EN 60947-3)
- Disconnector with an auxiliary contact that in every case causes switching devices to cut off the load before opening the main contacts of the disconnector (EN 60947-3)
- Circuit breaker suitable for disconnection per EN 60947-2

#### Other regions

The disconnect device must comply with applicable safety regulations.

### 4.2.3 Selecting and dimensioning the main contactor

If a main contactor is used, its utilization category (number of switching operations under load) must be AC-1 per IEC 60947-4 "Low-voltage switchgear and controlgear". Dimension the contactor according to the nominal voltage and current of the frequency inverter.

### 4.2.4 Checking the compatibility of the motor and frequency inverter

The frequency inverter is designed for controlling induction motors, permanent magnet synchronous motors or induction servo motors. Several induction motors can be connected to the frequency inverter simultaneously under certain conditions.

The size of the motor and type of frequency inverter must be selected using the characteristic tables in chapter "Technical data" based on the AC mains voltage and motor load.

Ensure that the motor can withstand the maximum peak voltage at the motor terminals. See "Requirements table" on page 174. For the basics of protecting motor insulation and bearings in drive systems, see section "Protecting the motor insulation and bearings" on page 174 below.

**Note:**

- **Contact the motor manufacturer before using a motor where the nominal motor voltage differs from the AC mains voltage.**
- **The voltage peaks at the motor terminals are relative to the supply voltage of the frequency inverter, not to the output voltage of the frequency inverter.**
- **If the motor and frequency inverter are not the same size, the following operating limits of the frequency inverter control program must be observed:**
  - **Nominal voltage range of the motor 1/6... 2 · $U_N$**
  - **Nominal current of the motor 1/6... 2 · $I_N$ of the frequency inverter with direct torque control (DTC) and 0... 2 · $I_N$ with scalar control. The control mode is selected with a frequency inverter parameter.**

#### 4.2.4.1 Protecting the motor insulation and bearings

Modern IGBT inverter technology is used on the frequency inverter. On the output of the frequency inverter – independent of the output frequency – pulses are generated that correspond approximately to the DC bus voltage with very short rise times. The voltage of the pulses can nearly double at the motor terminals according to the damping and reflection properties of the motor cable. This can result in additional stress on the motor and motor cable insulation.

Modern frequency inverter with their fast-rising voltage pulses and high switching frequencies can generate current pulses that run through the motor bearings. This can result in gradual irreparable damage to the bearing raceways.

Optional dv/dt filters protect the motor insulation and reduce bearing currents. Optional common mode filters are mainly used to reduce bearing currents. Insulated bearings on the B-side (non-drive side) protect the motor bearings.

#### 4.2.4.2 Requirements table

The following table lists how to select motor insulation and when optional dv/dt, common mode filters and insulated B-side motor bearings (non-drive side) are required. Failure to follow these requirements or improper installation may shorten the service life of the motor or damage motor bearings as well as void the warranty.

| Motor type | Nominal AC mains voltage | Requirement for | | |
|---|---|---|---|---|
| | | Motor insulation | dv/dt filter and common mode filter, insulated B-side motor bearings | |
| | | | $P_N$ < 100 kW and size < IEC 315 | 100 kW ≤ $P_N$ < 350 kW or IEC 315 ≤ Size < IEC 400 |
| | | | $P_N$ < 134 hp and size < NEMA 500 | 134 hp ≤ $P_N$ < 469 hp or NEMA 500 ≤ Size ≤ NEMA 580 |
| Random- and form-wound windings | $U_N$ ≤ 420 V | Standard: $\hat{U}_{LL}$ = 1300 V | - | + N or CMF |
| | 420 V < $U_N$ ≤ 500 V | Standard: $\hat{U}_{LL}$ = 1300 V | +dv/dt | + dv/dt + (N or CMF) |
| | | Reinforced: ÛLL = 1600 V, rise time 0.2 microseconds | - | + N or CMF |

Explanation of the abbreviations used in the table:

| Abbreviation | Definition |
|---|---|
| $U_N$ | Nominal mains voltage |
| $\hat{U}_{LL}$ | Peak line-to-line voltage at the motor terminals that the motor insulation must withstand. |
| $P_N$ | Motor nominal power |
| dv/dt | dv/dt filter at the frequency inverter output. Available from B&R on request. |
| CMF | Common mode filter. Depending on the frequency inverter type, the common mode filter is available from B&R upon request. |
| N | Insulated B-side motor bearing |
| N/A | Motors in this power range are not offered as standard motors. Contact the motor manufacturer. |

##### 4.2.4.2.1 Additional requirements for applications with braking operation

If the motor brakes the machine, the voltage in the DC bus of the frequency inverter increases, which corresponds to an increase in the motor supply voltage of up to 20 percent. Consider this voltage increase when defining the motor insulation requirements if the motor will be braking for much of its operating time.

**Example:**

The motor insulation required for an application with 400 V AC mains voltage must be selected as if the frequency inverter were supplied with 480 V.

#### 4.2.4.2.2 Additional requirements for high-power motors and motors with IP23 protection

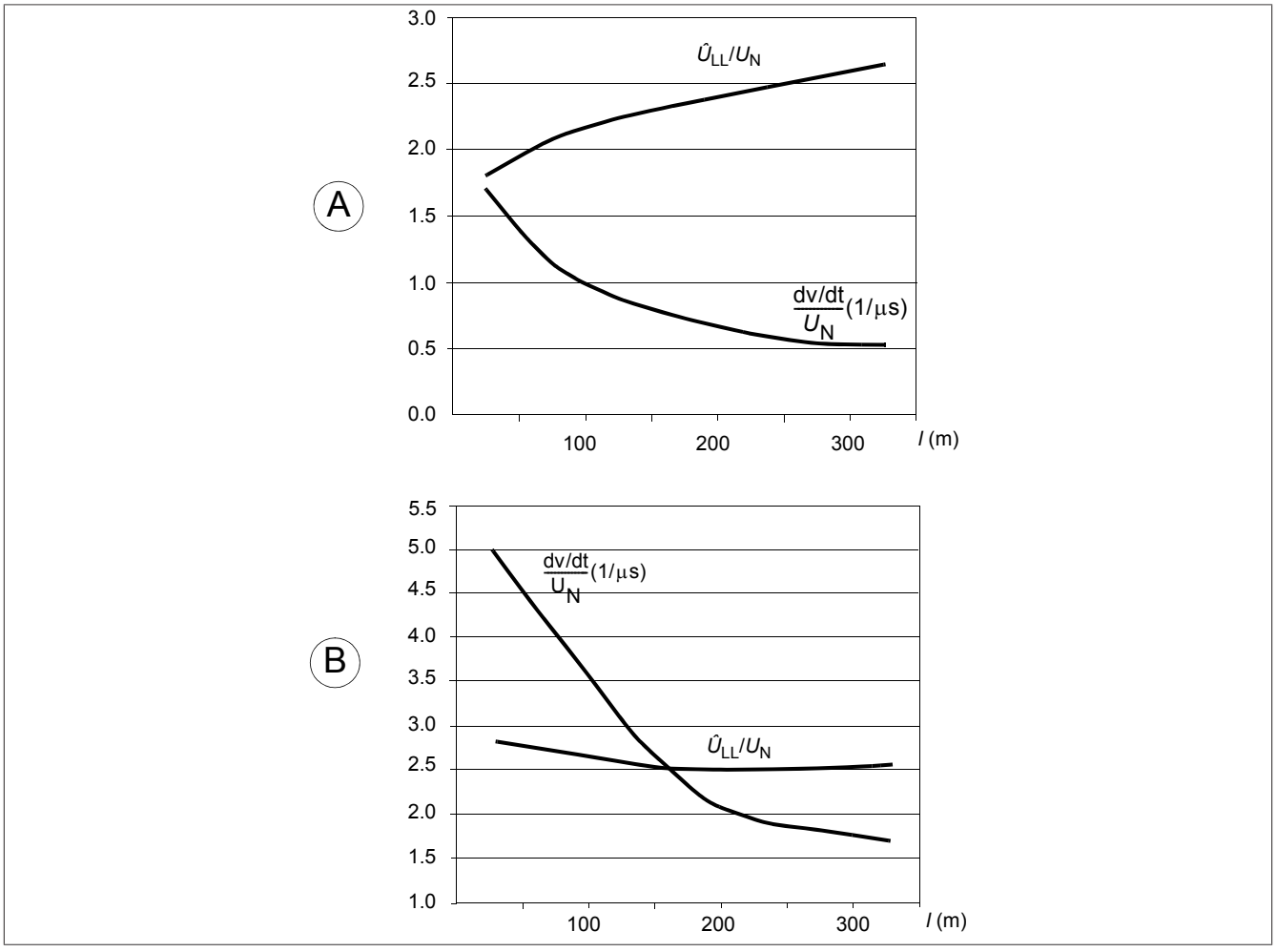
The rated power of high-power motors is higher than that specified for the relevant size in EN 50347 (2001). The table shows the requirements for motors with random-wound winding and form-wound winding.

| Nominal mains voltage (AC mains voltage) | Motor insulation | Requirement for dv/dt filter and common mode filter, insulated B-side motor bearings | |
|---|---|---|---|
| | | $P_N$ < 100 kW or size < IEC 315 | 100 kW ≤ $P_N$ < 350 kW or IEC 315 ≤ Size < IEC 400 |
| | | $P_N$ < 134 hp or size < NEMA 500 | 134 hp ≤ $P_N$ < 469 hp or NEMA 500 ≤ Size ≤ NEMA 580 |
| $U_N$ ≤ 420 V | Standard: $\hat{U}_{LL}$= 1300 V | + N or CMF | + N + CMF |
| 420 V < $U_N$ ≤ 500 V | Standard: $\hat{U}_{LL}$= 1300 V | + dv/dt + (N or CMF) | + dv/dt + N + CMF |
| | Reinforced: $\hat{U}_{LL}$ = 1600 V, rise time 0.2 microseconds | + N or CMF | + N + CMF |

#### 4.2.4.2.3 Additional data for calculating the rise time and peak line-to-line voltage

If you need to calculate the actual peak voltage and voltage rise time taking into account the cable length, proceed as follows:

- Peak line-to-line voltage: Read the relative value for $\hat{U}_{LL}/U_N$ from the corresponding diagram below and multiply this value with the nominal supply voltage ($U_N$).
- Voltage rise time: Read the relative values for $\hat{U}_{LL}/U_N$ and $(dv/dt)/U_N$ from the corresponding diagram below. Multiply these values with the nominal supply voltage ($U_N$) and include the result in the equation $t = 0.8 \times \hat{U}_{LL}/(dv/dt)$.



| Abbreviation | Definition |
|---|---|
| A | Frequency inverter with dv/dt filter |
| B | Frequency inverter without dv/dt filter |
| I | Motor cable length |
| $\hat{U}_{LL}/U_N$ | Relative peak line-to-line voltage |
| $(dv/dt)/U_N$ | Relative dv/dt value |

**Note:**

**The values for $\hat{U}_{LL}$ and dv/dt are approximately 20% higher with rheostatic braking.**

#### 4.2.4.2.4 Additional note for sine wave filters

Sine wave filters protect the motor insulation. dv/dt filters can therefore be replaced by a sine wave filter. With a sine wave filter, the peak line-to-line voltage is approximately 1.5 x $U_N$.

### 4.2.5 Selecting the power cables

#### 4.2.5.1 General rules

Select the power and motor cables according to local regulations:

- Select a cable that is designed for the nominal current of the frequency inverter. Nominal currents are specified in section "Nominal data" on page 24.
- Select a cable rated for at least 70°C maximum permissible temperature of the conductor during continuous operation.
  For the USA: See section "Additional US requirements" on page 178.
- The inductance and impedance of the PE conductor/cable (ground conductor) must be designed according to the permissible touch voltage that occurs under fault conditions (so that the fault voltage does not rise too high when a ground fault occurs).
- 600 VAC cables are permitted up to 500 VAC. 750 VAC cables are permitted up to 600 VAC. For devices with 690 VAC, the cables should be designed for a nominal voltage of at least 1 kV.

For frequency inverters size R5 and larger or motors with more than 30 kW (40 hp), a symmetrical shielded motor cable must be used (see section "Alternative power cable types" on page 177). A 4-wire system can be used up to size R4 and motors up to 30 kW (40 hp), but symmetrical shielded motor cables are always recommended. Provide motor cable shields with 360° grounding at both ends. The motor cable and the twisted shield (PE) must be kept as short as possible to reduce electromagnetic emissions.

**Note:**

**If a continuous metal cable conduit is used, a shielded cable is not required. The cable conduit must be grounded at both ends.**

Although a four-conductor system is permitted as the mains connection cable, a symmetrical shielded cable is recommended.

Compared to four-conductor cables, the use of symmetrical shielded cables reduces electromagnetic emissions from the entire drive system as well as bearing currents and wear.

The protective ground conductor must always have sufficient conductivity.

Unless otherwise specified, the cross section of the protective ground conductor must comply with the conditions requiring automatic cut off of the supply per section 411.3.2. of IEC 60364-4-41:2005. It must also withstand the rated fault current during the switch-off time of the protective equipment.

The cross section of the protective ground conductor can either be selected using the table below or calculated per section 543.1 of IEC 60364-5-54.

The following table specifies the minimum cross section in relation to the phase conductor size per IEC 61800-5-1 when the phase conductor and protective ground conductor are made of the same metal. If this is not the case, the cross section of the protective ground conductor must be determined so that conductivity is provided that corresponds to that resulting from the application of this table.

| Cross section of phase conductor S ($mm^2$) | Minimum cross section of associated protective ground conductor $S_p$ ($mm^2$) |
|---|---|
| $S \leq 16$ | S |
| $16 < S \leq 35$ | 16 |
| $35 < S$ | S/2 |

### 4.2.5.2 Typical power cable sizes

The following table specifies the types of copper and aluminum cables with concentric copper shield for frequency inverters with nominal current.

| Frequency inverters | Size | IEC [1] | | US [2] | |
|---|---|---|---|---|---|
| | | Copper cable type | Aluminum cable type | Copper cable type | Aluminum cable type |
| | | mm² | mm² | AWG/kcmil | AWG/kcmil |
| **$U_N$ = 500 V** | | | | | |
| 8I96T400075.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400110.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400150.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400220.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400300.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400400.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400550.00-000 | R2 | 3×6 | - | 10 | - |
| 8I96T400750.00-000 | R2 | 3×6 | - | 10 | - |
| 8I96T401100.00-000 | R3 | 3×10 | - | 8 | - |
| 8I96T401500.00-000 | R3 | 3×10 | - | 8 | - |
| 8I96T401850.00-000 | R4 | 3×16 | 3×25 | 6 | - |
| 8I96T402200.00-000 | R4 | 3×25 | 3×25 | 4 | - |
| 8I96T403000.00-000 | R5 | 3×35 | 3×35 | 3 | - |
| 8I96T403700.00-000 | R5 | 3×35 | 3×50 | 3 | - |
| 8I96T404500.00-000 | R6 | 3×50 | 3×70 | 1 | - |
| 8I96T405500.00-000 | R6 | 3×95 | 3×95 | 2/0 | - |
| 8I96T407500.00-000 | R7 | 3×120 | 3×150 | 3/0 | - |
| 8I96T409000.00-000 | R7 | 3×150 | 3×185 | 250 MCM | - |

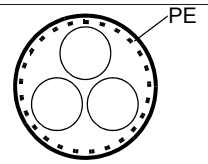
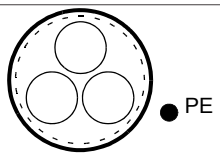
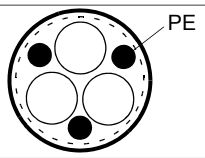
1) Cable sizing is based on max. 9 cables routed side by side on a cable tray, ambient temperature of 30°C, PVC insulation and a surface temperature of 70°C (EN 60204-1 and IEC 60364-5-52/2001). Under other conditions, the cables must be adapted to the local safety regulations, corresponding input voltage and the load current of the frequency inverter. For permissible cable sizes of the frequency inverter, see also section "Terminal sizes and cable diameters for power cables" on page 32.

2) The cable cross section is based on NEC table 310-16 for copper wires, 75°C (167°F) wire insulation at 40°C (104°F) ambient temperature. No more than three current-carrying conductors are permitted to be routed in a cable duct, conduit or in the ground (directly buried). Under other conditions, the cables must be adapted to the local safety regulations, corresponding input voltage and the load current of the frequency inverter. For permissible cable sizes of the frequency inverter, see also section "Terminal sizes and cable diameters for power cables" on page 32.

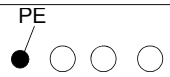
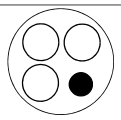
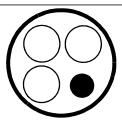
### 4.2.5.3 Alternative power cable types

The recommended as well as non-permissible power cable types that can be used with the frequency inverter are shown below.

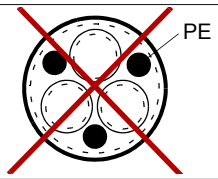
#### 4.2.5.3.1 Recommended power cable types

| | |
|---|---|
|  | Symmetrical shielded cable with three-phase conductors and a concentric PE conductor as shield. The shield must meet the requirements of IEC 61800-5-1, see section "General rules" on page 176. Please check regarding applicable local and country-specific electrical regulations. |
|  | Symmetrical shielded cable with three-phase conductors and a concentric PE conductor as shield. A separate PE conductor is required if the shield does not meet the requirements of IEC 61800-5-1, see section "General rules" on page 176. |
|  | Symmetrical shielded cable with three phase conductors, symmetrically constructed PE conductor and shield. The PE conductor must meet the requirements of IEC 61800-5-1. |

#### 4.2.5.3.2 Power cable types for restricted use

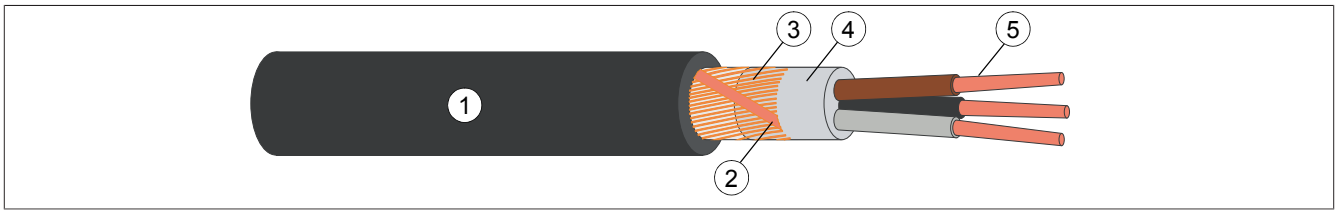
| | |
|---|---|
|  | A 4-conductor system (three phase conductors and a protective ground conductor on a cable tray) is **not permitted for motor wiring** (permitted for input wiring). |
|  | A 4-conductor system (three phase conductors and a PE conductor in a PVC cable conduit) is **permitted for input and motor wiring if the cross section of the phase conductor is less than 10 mm² (8 AWG) or for motors ≤ 30 kW (40 hp)**. This is not permitted in the USA. |
|  | Corrugated armored or EMT cable with three phase conductors and one protective ground conductor is permitted for motor wiring if the phase conductor cross section is less than 10 mm² (8 AWG) or the motors have a power output ≤ 30 kW (40 hp). |

#### 4.2.5.3.3 Impermissible power cable types

| | |
|---|---|
|  | Symmetrical shielded cables of any size with individual shields for each phase conductor are not permitted as input and motor cables. |

### 4.2.5.4 Motor cable shield

If the motor cable shield is used as the sole protective ground conductor of the motor, it must be ensured that the conductivity of the shield is sufficient. See section "General rules" on page 176 or IEC 61800-5-1. To effectively suppress radiated and conducted high-frequency emissions, the shield conductivity load must be at least 1/10 of the phase conductivity. These requirements are easily met by a copper or aluminum shield. The minimum requirements for the motor cable shield of the frequency inverter are shown below. It consists of a concentric layer of copper wires with a spiral layer of copper strip. The better and tighter the shield, the lower the emissions and bearing currents.




1 Insulation jacket
2 Spiral layer of copper wire
3 Spiral layer of copper strip
4 Inner insulation
5 Cable core

### 4.2.5.5 Additional US requirements

The motor cable must be type MC continuous corrugated aluminum armor cable with symmetrical protective conductors or, if a protective conduit is not used, a shielded power cable must be used as the motor cable. In North America, 600 VAC cables are permitted up to 500 V AC. 1000 V AC cables are required for voltages above 500 VAC (below 600 VAC). For drives with nominal current over 100 amperes, the power cables must be designed for 75°C (167°F).

#### 4.2.5.5.1 Protective conduit

Connect separate parts of the protective conduit in an electrically conductive manner: Ground bridges must be made at the connection points, firmly connected to both ends of the conduit. A connection must also be made to the frequency inverter and motor housing. Use separate protective conduits for the mains connection and the motor, braking resistor and control cables. If a protective conduit is used, a type MC continuous corrugated aluminum armor cable or shielded power cable is not required. A special ground cable is always required.

**Note:**

**Motor cables for more than one frequency inverter are not permitted to be routed in the same protective conduit.**

#### 4.2.5.5.2 Armored cables / Shielded power cables

A six-conductor (3 phase conductors and 3 symmetrical ground conductors) type MC cable with continuous corrugated aluminum conduit with symmetrical ground conductors can be obtained from the following suppliers (trade names in parentheses):

- Anixter Wire & Cable (Philsheath)
- BICC General Corp. (Philsheath)
- Rockbestos Co. (Gardex)
- Oaknite (CLX)

Shielded power cables can be purchased from Belden, LAPPKABEL (ÖLFLEX), Pirelli, etc.

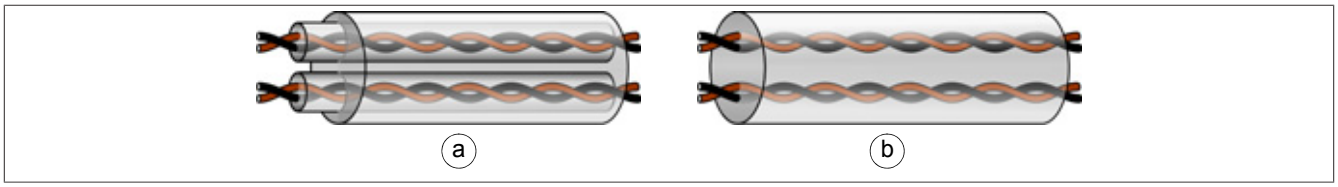
### 4.2.6 Selecting the control cables

#### 4.2.6.1 Shield

All control cables must be shielded.

Use a double-shielded twisted pair for analog signals. This cable type is also recommended for the incremental encoder signals. An individually shielded pair must be used for each signal. A common return line is not permitted to be used for different analog signals.

A double-shielded cable (figure "a" below) is best for low-voltage digital signals, but a single-shielded cable with pairs of wires can also be used.




#### 4.2.6.2 Signals in separate cables

Route analog and digital signals in separate, shielded cables.

Signals with 24 VDC and 115/230 VAC are not permitted to be transferred in the same cable.

#### 4.2.6.3 Signals that can be routed in the same cable

Relay-controlled signals can be routed via the same cables as digital input signals, provided their voltage does not exceed 48 V. The relay-controlled signals should be routed via twisted wire pairs.

#### 4.2.6.4 Length and type of the control panel cable

The cable from the control panel to the frequency inverter is not permitted to be longer than 3 meters (10 ft). The cable type is a shielded Cat 5e or better Ethernet patch cable with RJ45 ends.

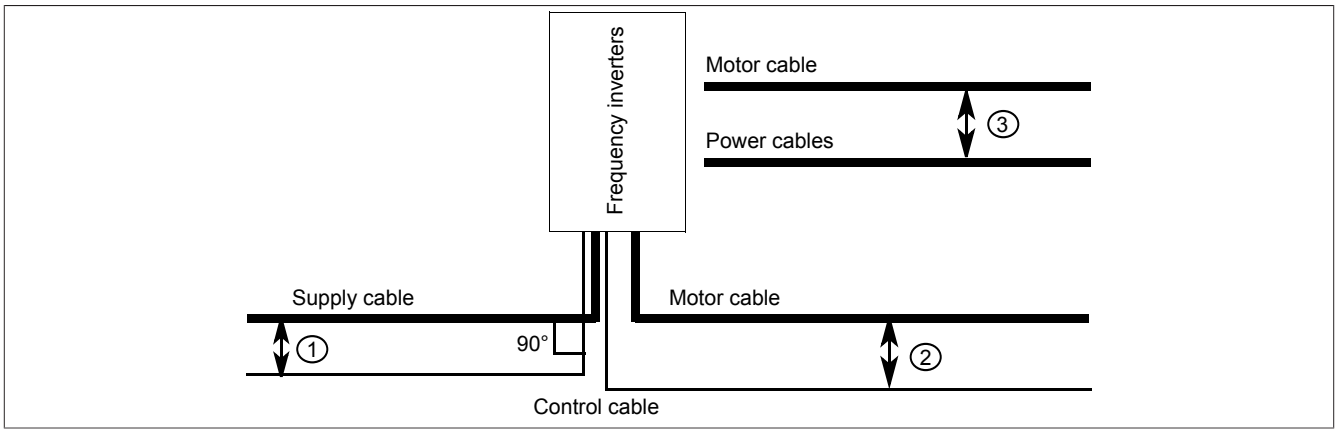
### 4.2.7 Routing the cables

The motor cable must be routed separately from other cables. The motor cables of several frequency inverters can run parallel to each other. The motor, mains and control cables must be routed on separate cable trays. Cables running in parallel over long distances must be avoided in order to keep electromagnetic interference caused by rapid changes in the output voltage of the frequency inverter low.

If control cables must be routed over power cables, this must be done at an angle as close to 90° as possible. Do not route any additional cables through the frequency inverter cabinet.

The cable trays must have a good electrical connection to each other and to ground. Aluminum support systems can be used to ensure good equipotential bonding.

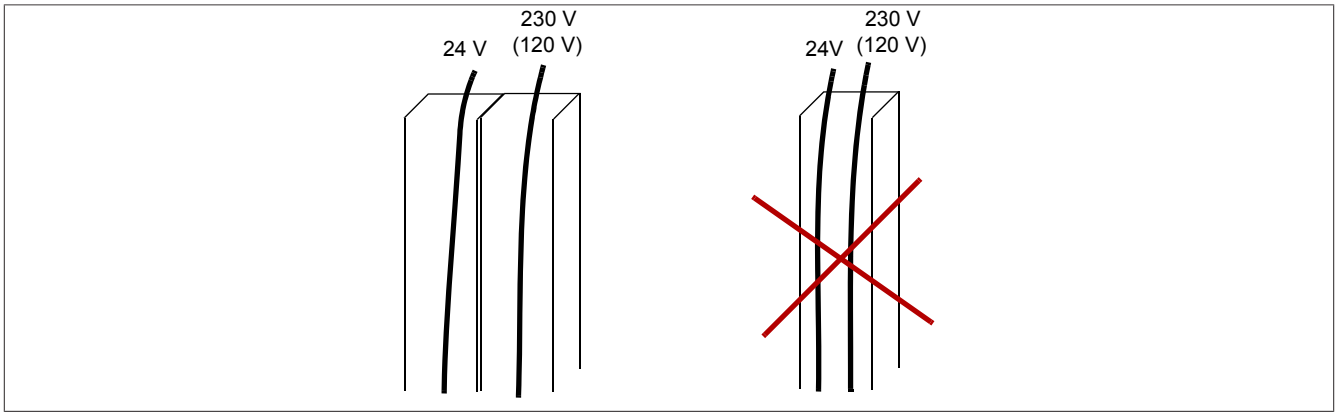
The cable routing is shown below.




1 Spacing min. 200 mm (8 in.)
2 Spacing min. 500 mm (20 in.)
3 Spacing min. 300 mm (12 in.)

#### 4.2.7.1 Separate control cable ducts

Route 24 V and 230 V (120 V) control cables in separate cable ducts unless the 24 V cable has insulation for 230 V (120 V) or an insulation jacket for 230 V (120 V).




#### 4.2.7.2 Continuous motor cable shield or channel for equipment on the motor cable

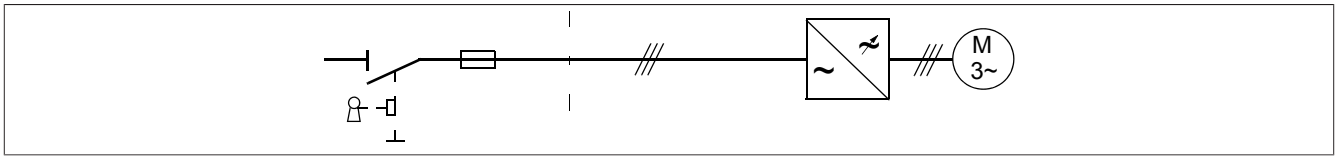
To reduce the noise level when circuit breakers, contactors, cable connection boxes or similar devices are installed on the motor cable (i.e. between the frequency inverter and motor):

- European Union: Install the devices in a metal enclosure with 360° grounding of the input and motor cable shields or otherwise connect the cable shields together.
- US: Install the devices in a metal enclosure and route cables so that the cable conduits or motor cable shields are continuous without interruption from the frequency inverter to the motor.

### 4.2.8 Implementing thermal overload and short-circuit protection

#### 4.2.8.1 Protecting the frequency inverter and supply cable in the event off short circuits

Protect the frequency inverter and supply cable with fuses as follows:




Size the fuses on the distribution board according to the instructions in chapter "Technical data" on page 20. The fuses protect the supply cable in the event of a short circuit, limit damage to the frequency inverter and prevent damage to connected devices in the event of a short circuit in the frequency inverter.

**Circuit breakers**

The protective characteristics of circuit breakers depend on the type, construction and settings of the breaker. There are also limitations on the short-circuit capacity of the supply network.

## Warning!

**Due to the operating principle and construction of circuit breakers, regardless of the manufacturer, hot ionized gases can escape from the housing of the breaker in the event of a short circuit. For safe operation, the installation and placement of the breakers require special attention. Follow the manufacturer's instructions.**

You are permitted to use the circuit breakers listed below. Other circuit breakers can be used for the frequency inverter, provided they have the same electrical characteristics. B&R assumes no liability for the correct function and protective effect of circuit breakers that are not listed below. If the recommendations provided by B&R are not followed, problems may occur when using the frequency inverter that are not covered by the warranty.

## Note:

**In the USA, circuit breakers are not permitted to be without fuses.**

| Frequency inverter type | Size | Circuit breaker | | Compact circuit breaker ($T_{max}$) | |
|---|---|---|---|---|---|
| | | Type | kA [1] | Type | kA [1] |
| **$U_N$ = 500 V** | | | | | |
| 8I96T400075.00-000 | R1 | S 803 S-B/C 6 | 10 | - | - |
| 8I96T400110.00-000 | R1 | S 803 S-B/C 6 | 10 | - | - |
| 8I96T400150.00-000 | R1 | S 803 S-B/C 10 | 10 | - | - |
| 8I96T400220.00-000 | R1 | S 803 S-B/C 13 | 10 | - | - |
| 8I96T400300.00-000 | R1 | S 803 S-B/C 13 | 10 | - | - |
| 8I96T400400.00-000 | R1 | S 803 S-B/C 20 | 10 | - | - |
| 8I96T400550.00-000 | R2 | S 803 S-B/C 25 | 10 | - | - |
| 8I96T400750.00-000 | R2 | S 803 S-B/C 32 | 10 | - | - |
| 8I96T401100.00-000 | R3 | S 803 S-B/C 50 | 10 | - | - |
| 8I96T401500.00-000 | R3 | S 803 S-B/C 63 | 10 | - | - |
| 8I96T401850.00-000 | R4 | S 803 S-B/C 63 | 10 | - | - |
| 8I96T402200.00-000 | R4 | S 803 S-B/C 75 | 10 | - | - |
| 8I96T403000.00-000 | R5 | S 803 S-B/C 125 | 10 | 1SDA067918R1 | 65 |
| 8I96T403700.00-000 | R5 | S 803 S-B/C 125 | 10 | 1SDA067918R1 | 65 |
| 8I96T404500.00-000 | R6 | - | - | 1SDA068555R1 | 65 |
| 8I96T405500.00-000 | R6 | - | - | 1SDA068555R1 | 65 |
| 8I96T407500.00-000 | R7 | - | - | 1SDA068555R1 | 65 |
| 8I96T409000.00-000 | R7 | - | - | 1SDA054141R1 | 65 |

1) Maximum permissible conditional rated short-circuit current (IEC 61800-5-1) from the mains.

### 4.2.8.2 Protecting the motor and motor cable in the event of short circuits

The frequency inverter protects the motor cable and motor in the event of a short circuit if the motor cable is rated according to the nominal current of the frequency inverter. Additional protective devices are not required.

### 4.2.8.3 Protecting the frequency inverter, supply and motor cables against thermal overload

The frequency inverter protects itself as well as the supply and motor cables against thermal overload if the cables are rated according to the nominal current of the frequency inverter. Additional equipment for thermal protection is not required.

## Warning!

**If the frequency inverter is connected to multiple motors, a separate disconnector or fuses must be used to protect each motor cable and motor from overload. The overload protection of the frequency inverter is set to the total motor load. It may not trip due to an overload in only one motor circuit.**

#### 4.2.8.4 Protecting the motor against thermal overload

The motor must be protected against overheating in accordance with the regulations, and the current must be switched off if an overload of the motor is detected. The frequency inverter is equipped with a thermal protection function that protects the motor and cuts off the current when necessary. Depending on the setting of a frequency inverter parameter, the function monitors either a calculated temperature value (based on a thermal motor protection model) or a temperature value measured by motor temperature sensors. The user can set the thermal model more precisely by entering additional motor and load data.

Section "The drive" on page 228 contains additional information about thermal motor protection as well as the connection and use of temperature sensors.

### 4.2.9 Protecting the frequency inverter against ground faults

The frequency inverter is equipped with an internal ground fault protection function to protect the unit from ground faults in the motor and motor cables. This is not meant to protect personnel and is not a fire protection feature. The ground fault protection function can be disabled by a parameter setting, see section "The drive" on page 228.

#### 4.2.9.1 Compatibility with residual current protective devices

The frequency inverter is suitable for use with type B residual current protective device.

**Note:**

**The EMC filter of the frequency inverter includes capacitors connected to the main circuit and the frame. These capacitors and long motor cables increase the ground fault current and can cause residual-current circuit breakers to trip.**

### 4.2.10 Implementing the emergency stop function

For safety reasons, install emergency stop devices at each operator station and at other stations where an emergency stop may be necessary. You can use function "Safe Torque Off" to implement the emergency stop function. See section "Function "Safe Torque Off"" on page 211.

**Note:**

**Pressing the stop button on the control panel of the frequency inverter does not result in an emergency stop of the motor or disconnection of the frequency inverter from dangerous potential.**

### 4.2.11 Using function "Safe Torque Off"

See section "Function "Safe Torque Off"" on page 211.

### 4.2.12 Using the power failure bypass function

The power failure bypass function is implemented as follows:

- Check whether the power failure bypass function of the frequency inverter is enabled with parameter 30.31 Undervoltage control (Page 292).
- If the installation is equipped with a main contactor, prevent it from shutting down during an input voltage failure. For example, use a time-delay relay (hold) in the control circuit of the main contactor.

**Warning!**

**Prevent the on-the-fly restart from resulting in a hazard. If you are not sure, do not use the power failure bypass function.**

### 4.2.13 Using power factor correction capacitors

Power factor correction capacitors are not required for use with frequency inverters. If a frequency inverter should be connected to a system with power factor correction capacitors, however, observe the following limitations.

## Warning!

**Do not connect power factor correction capacitors or harmonic filters to the motor cables (between the frequency inverter and motor). They are not intended for use with frequency inverters and may cause permanent damage to the frequency inverter or be damaged themselves.**

Note the following when power factor correction capacitors are connected in parallel with the three-phase input of the frequency inverter:

1. Do not connect high-power capacitors to the supply while the frequency inverter is connected. Switching on causes voltage fluctuations that can switch off the frequency inverter or even damage it.
2. If the capacitor load is increased/decreased step by step while the frequency inverter is connected to the supply: The change steps should be small enough so that no voltage fluctuations are caused that would cause the frequency inverter to switch off.
3. Check whether the power factor correction unit is suitable for use in systems with frequency inverters, i.e. harmonic-generating loads. In such systems, the compensation unit should typically be equipped with a blocking reactor or harmonic filter.

### 4.2.14 Using a contactor between the frequency inverter and motor

The control of an output contactor depends on which operating mode of the frequency inverter is set. See also section "Using a bypass connection" on page 183.

With DTC control of the motor and motor ramp stop, the contactor must be opened as follows:

1. Give a stop command to the frequency inverter.
2. Wait until the frequency inverter has decelerated the motor to zero speed.
3. Open the contactor.

With DTC control of the motor and motor stop with coasting or scalar control, the contactor must be opened as follows:

1. Give a stop command to the frequency inverter.
2. Open the contactor.

## Warning!

**If the DTC motor control mode is set, you are not permitted under any circumstances to open the contactor while the frequency inverter is controlling the motor. DTC motor control works extremely fast. It works much faster than the contactor needs to open its contacts. If the contactor starts opening the contacts while the frequency inverter is controlling the motor, DTC control tries to hold the load current and therefore immediately increases the output voltage of the frequency inverter to the maximum. This results in the contactor being damaged or the contacts melting.**

### 4.2.15 Using a bypass connection

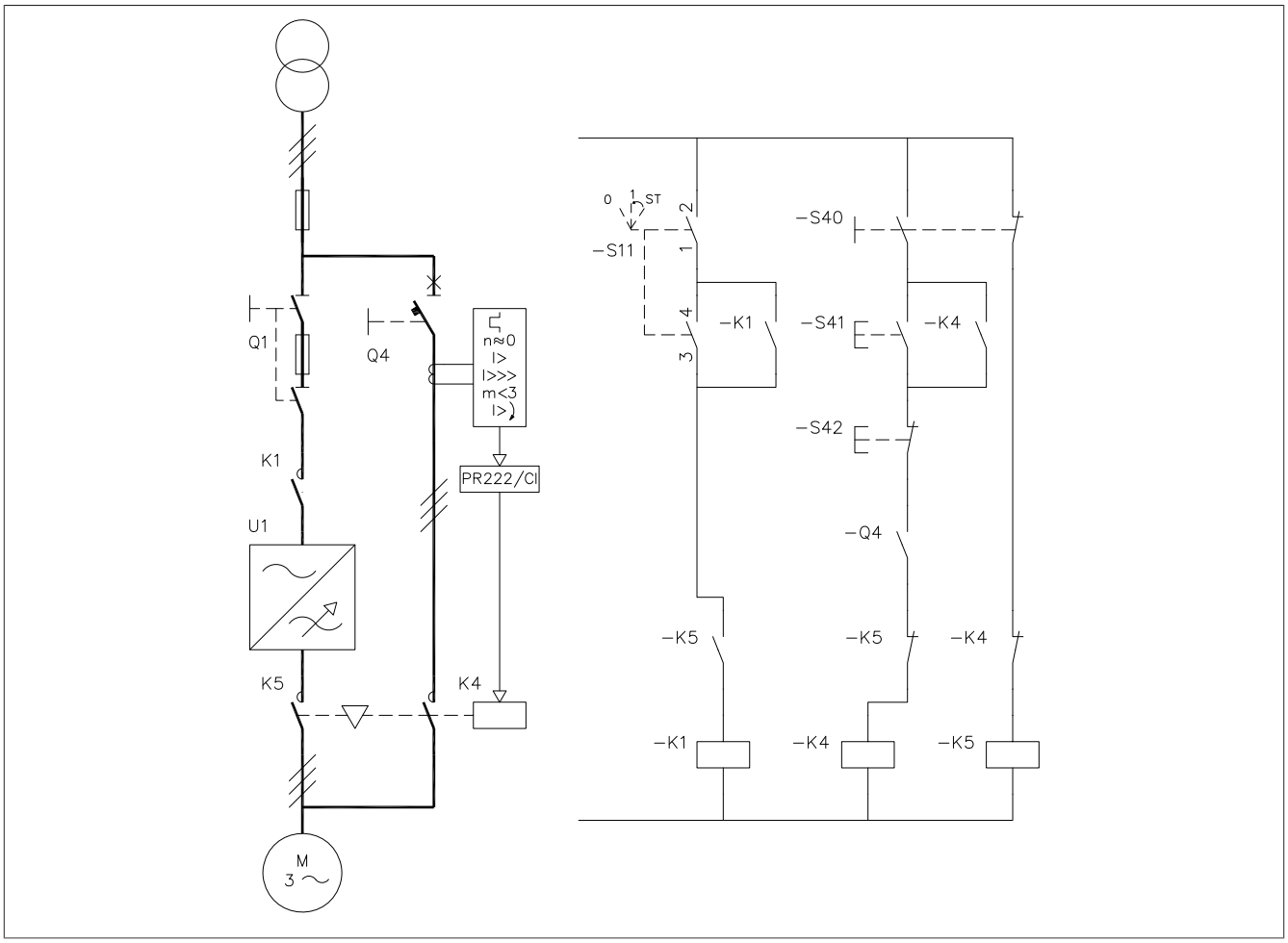
If bypass operation is necessary, use mechanically or electrically interlocked contactors between the motor and frequency inverter and between the motor and mains connection. Use the interlock to ensure that the contactors cannot be closed simultaneously. The equipment must be clearly marked per subsection 6.5.3 of IEC/EN 61800-5-1, for example "THIS MACHINE STARTS AUTOMATICALLY".

## Warning!

**Never connect the frequency inverter output to the power grid. This can damage the frequency inverter.**

#### Example bypass connection

An example bypass connection is shown below.




Q1 Main switch of the frequency inverter
Q4 Bypass circuit breaker
K1 Main contactor of the frequency inverter
K4 Bypass contactor
K5 Output contactor of the frequency inverter
S11 On/Off controller of the frequency inverter main contactor
S40 Selects the motor power supply (frequency inverter or direct mains connection)
S41 Start if the motor is directly connected to the mains
S42 Stop if the motor is directly connected to the mains

### 4.2.15.1 Switching the motor power supply from the frequency inverter to direct power supply from the mains

1. Stop the frequency inverter and the motor using the frequency inverter control panel (frequency inverter in local control mode) or external stop signal (frequency inverter in remote control mode).
2. Open the main contactor of the frequency inverter with S11.
3. Switch the motor power supply from the frequency inverter to direct mains connection with S40.
4. Wait 10 seconds to allow the magnetization of the motor to subside.
5. Start the motor with S41.

### 4.2.15.2 Switching the motor power supply from direct mains connection to the frequency inverter

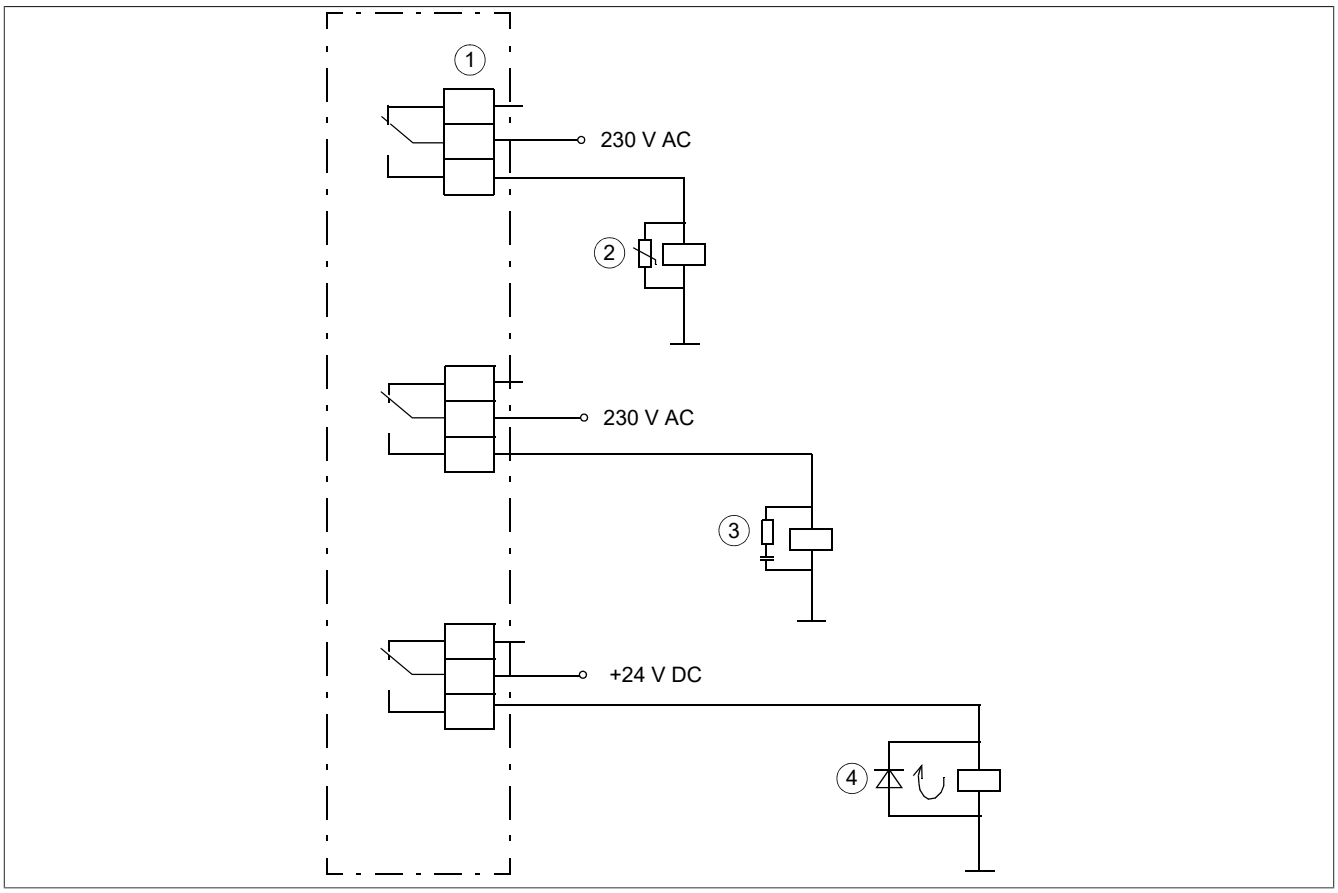
1. Stop the motor with S42.
2. Switch the motor power supply from direct mains connection to frequency inverter supply with S40.
3. Close the frequency inverter's main contactor with switch S11 (→ turn to position ST for 2 seconds, then leave in position 1).
4. Start the frequency inverter and motor with the control panel of the frequency inverter (frequency inverter in local control mode) or with the external start signal (frequency inverter in remote control mode).

### 4.2.16 Protecting the relay output contacts

Inductive loads (relays, contactors, motors) cause brief overvoltages when switched off.

The relay contacts on the frequency inverter control board are protected against overvoltage peaks by varistors (250 V). Nevertheless, it is strongly recommended to equip inductive loads with noise-attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to reduce EMC emissions that occur during switch-off. If not suppressed, the interference can be capacitively or inductively transferred to other conductors in the control cable, creating a risk of malfunction in other parts of the system.

Install the protective equipment as close to the respective inductive load as possible. Do not install the protective equipment on the relay outputs.




1 Relay outputs
2 Varistor
3 RC filter
4 Diode

### 4.2.17 Implementing a motor temperature sensor connection

**Warning!**

**IEC 60664 requires double or reinforced insulation between live parts and the surface of accessible parts of electrical equipment that are non-conductive but not connected to protective ground.**

There are four alternatives for connecting a motor temperature sensor and other similar components to the frequency inverter:

1. If there is double or reinforced insulation between the sensor and the live parts of the motor, you can connect the sensor directly to the inputs of the frequency inverter.
2. If there is basic insulation between the sensor and the live parts of the motor, you can connect the sensor to the inputs of the frequency inverter if all circuits connected to the frequency inverter's digital and analog inputs (normally circuits with functional extra-low voltage) are protected against contact and separated from other low-voltage circuits by basic insulation. The insulation must be designed for the same voltage as the main circuit of the frequency inverter. Note that circuits with functional extra-low voltage (such as 24 VDC) usually do not meet these requirements.
3. You can connect a sensor to an external thermistor relay whose insulation is designed for the main circuit voltage of the frequency inverter.

#### 4.2.17.1 Frequency inverter I/O and rotary encoder interface modules

See the following sections:

- "AI1 and AI2 as Pt100, Pt1000, PTC and KTY84 sensor inputs (XAI, XAO)" on page 205
- DI6 (XDI_:6) as a PTC sensor input

> **Note:**
>
> **The deviation of temperature measurement with Pt100 sensors via the analog inputs of the frequency inverter is 10°C (18°F).**

## 4.3 Electrical installation

This chapter contains instructions for wiring the frequency inverter.

### Warning!

**The work described in this chapter is only permitted to be carried out by qualified personnel. The "Safety information" in the first chapter of this manual must be followed. Failure to observe the safety guidelines can result in injuries and fatal accidents.**

### 4.3.1 Checking the insulation of the assembly

#### 4.3.1.1 Frequency inverters

Voltage tolerance tests or insulation resistance tests are not permitted to be performed on any part of the frequency inverter, as this may damage the frequency inverter. For each frequency inverter, the insulation between the main circuit and the housing was tested at the factory. In addition, the frequency inverter is equipped with voltage-limiting circuits that automatically limit the test voltage.

#### 4.3.1.2 Supply cable

Check the insulation of supply cables according to local regulations before connecting them to the frequency inverter.

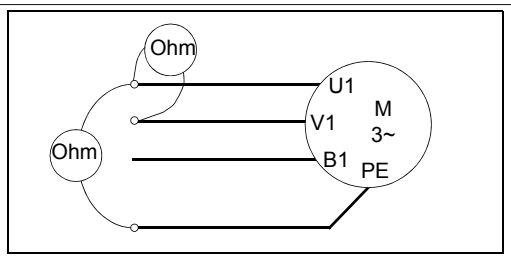
#### 4.3.1.3 Motor and motor cable

Check the insulation of the motor and motor cable as specified below.

1. Check whether the motor cable is disconnected from frequency inverter output terminals T1/U, T2/V and T3/W.
2. Check the insulation resistances between all phase conductors and each phase conductor and the PE conductor (protective ground) with a measuring voltage of 1000 VDC. The insulation resistance of a motor must exceed 100 MΩ (reference value at 25°C or 77°F). For the insulation resistances of other motors, please see the manufacturer's instructions.

### Note:

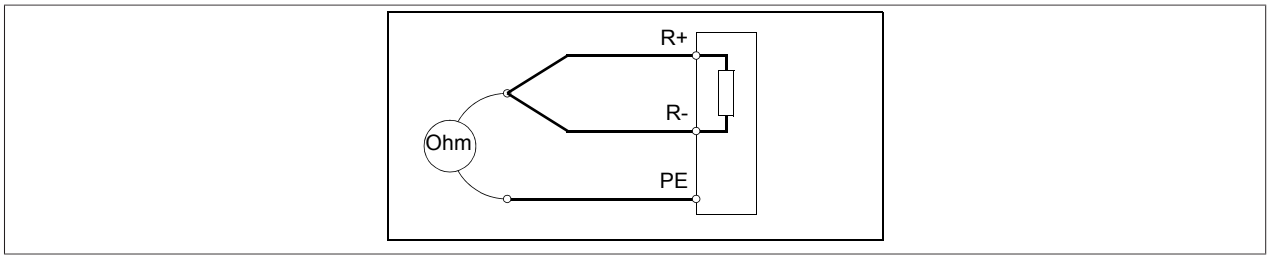
**Moisture inside the motor housing reduces the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.**




#### 4.3.1.4 Braking resistor unit

Check the insulation of the braking resistor unit (if present) as follows:

1. Ensure that the resistor cable is connected to the resistor and disconnected from frequency inverter output terminals R+ and R-.
2. On the frequency inverter side, connect terminals R+ and R- of the resistor cable. Measure the insulation resistance between the connected terminals and protective ground with a measuring voltage of 1 kV DC. The insulation resistance must be more than 1 MΩ.




### 4.3.2 Checking the compatibility with IT (ungrounded) and asymmetrically grounded TN power systems

**Warning!**

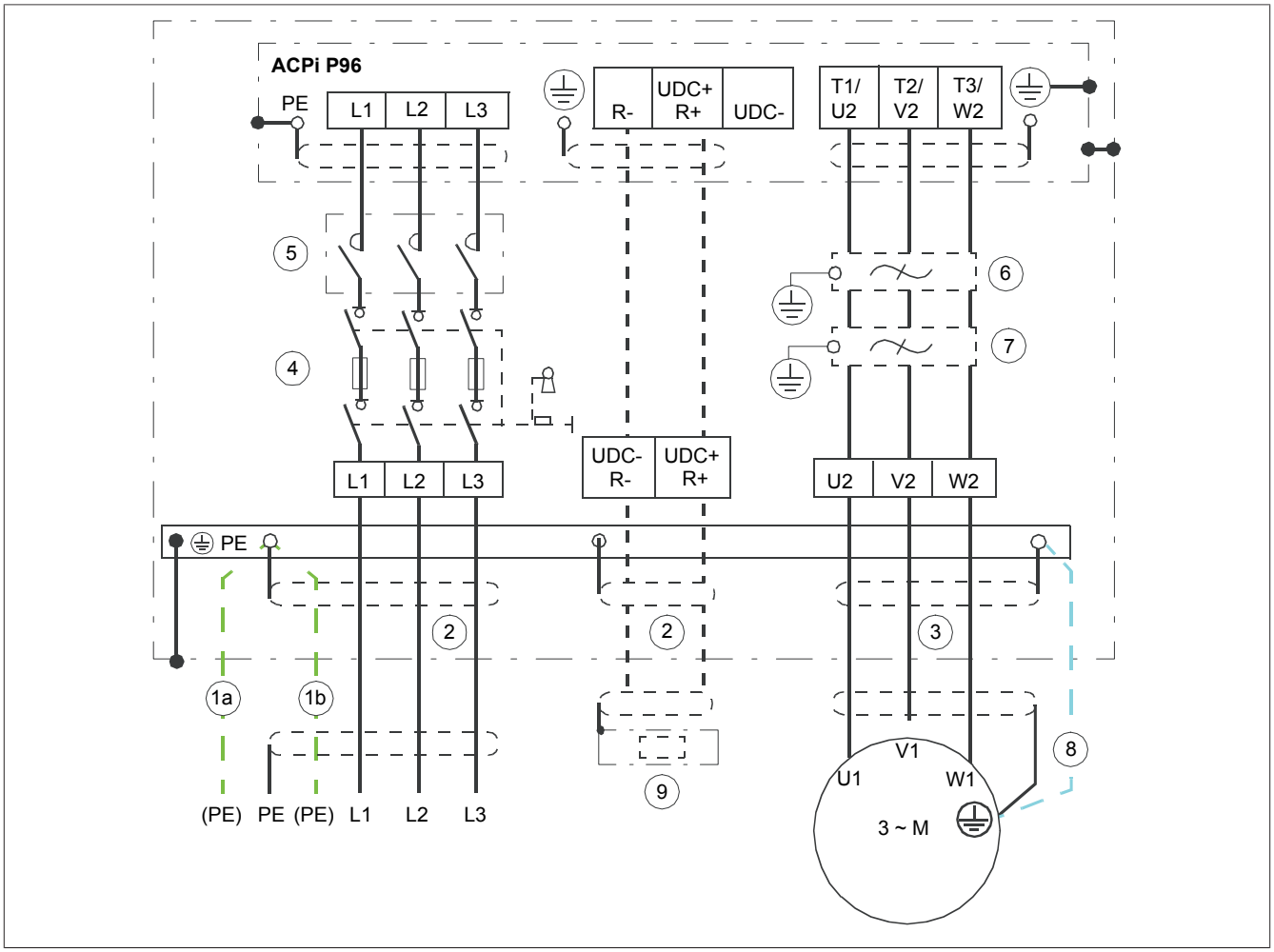
**Do not connect the frequency inverter to an IT power network (an ungrounded or high-impedance grounded network [over 30 ohm]); otherwise, the network will be connected to ground potential via the EMC filter capacitors of the frequency inverter. This may result in danger to persons or damage to the frequency inverter.**

**EMC filter**

ACOPOSinverter P96 devices are not permitted to be used with IT power networks (ungrounded).

## 4.3.3 Connecting the power cables

### 4.3.3.1 Connection diagram




| Item | Description |
|---|---|
| 1 | Use a separate PE ground cable (1a) or cable with a separate PE conductor (1b) if the conductivity of the shield does not meet the requirements for the PE conductor (see section "General rules" on page 176). |
| 2 | When using a shielded cable, 360° grounding is recommended. Ground the other end of the cable shield or PE conductor to the distribution board. |
| 3 | 360° grounding necessary. |
| 4 | Switch-disconnectors and fuses. Observe the notes on selecting the mains disconnect device in the manual. |
| 5 | Main contactor (optional) |
| 6 | Common mode filter (optional) |
| 7 | dv/dt filter or sine wave filter (optional) |
| 8 | Use a separate ground cable if the shield does not meet the requirements of IEC 61800-5-1 (see section "General rules" on page 176) and the cable does not have a symmetrically constructed ground conductor (see "Motor cable shield" on page 178). |
| 9 | External braking resistor |

**Note:**

**If there is a symmetrically constructed ground conductor in the motor cable in addition to the shield, the ground conductors must be connected to the ground terminals of the frequency inverter and the motor.**

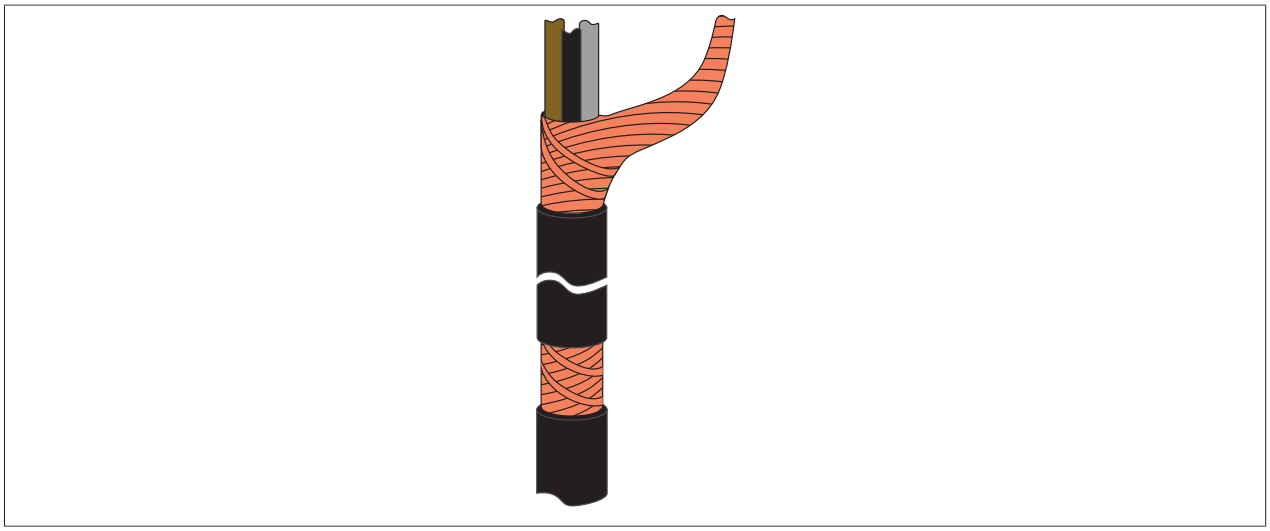
**An asymmetrically constructed motor cable is not permitted to be used for motors over 30 kW (see "General rules" on page 176). Connecting the fourth conductor on the motor side results in an increase in bearing currents and additional wear.**

### 4.3.3.2 Procedure for connecting cables

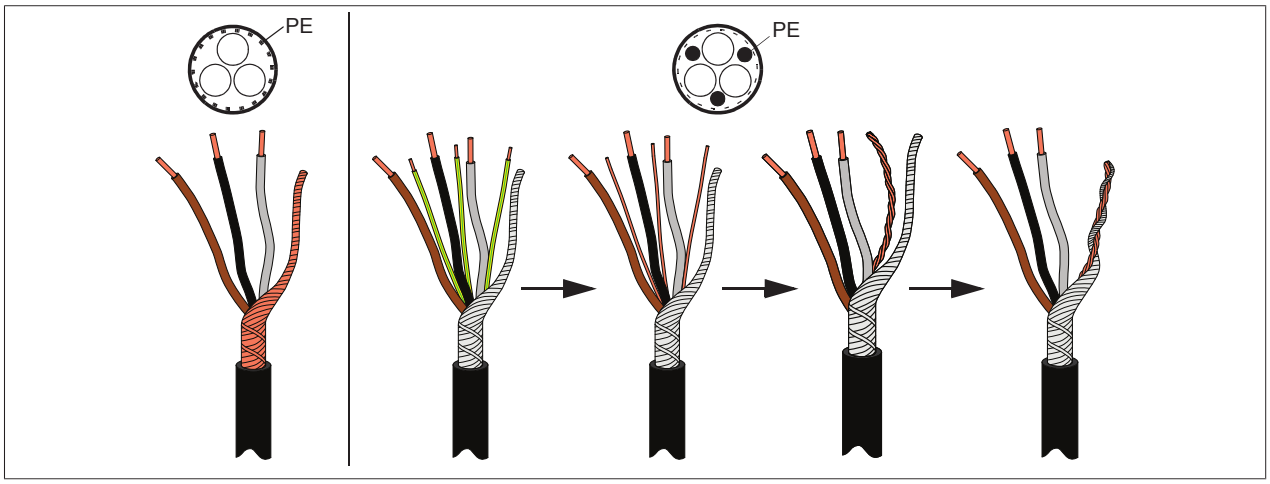
This section provides instructions about how to connect the power cables. For US cabling instructions, see the quick guide for installation.

#### 4.3.3.2.1 Preparing the cable ends for connection and establishing 360-degree grounding at the cable entry plate

1. Peel off 3 - 5 cm (1 1/4 - 2 in) of the outer insulation of the cables at the cable entries with the conductive sleeves for the 360° high-frequency grounding.



2. Prepare the ends of the cables.

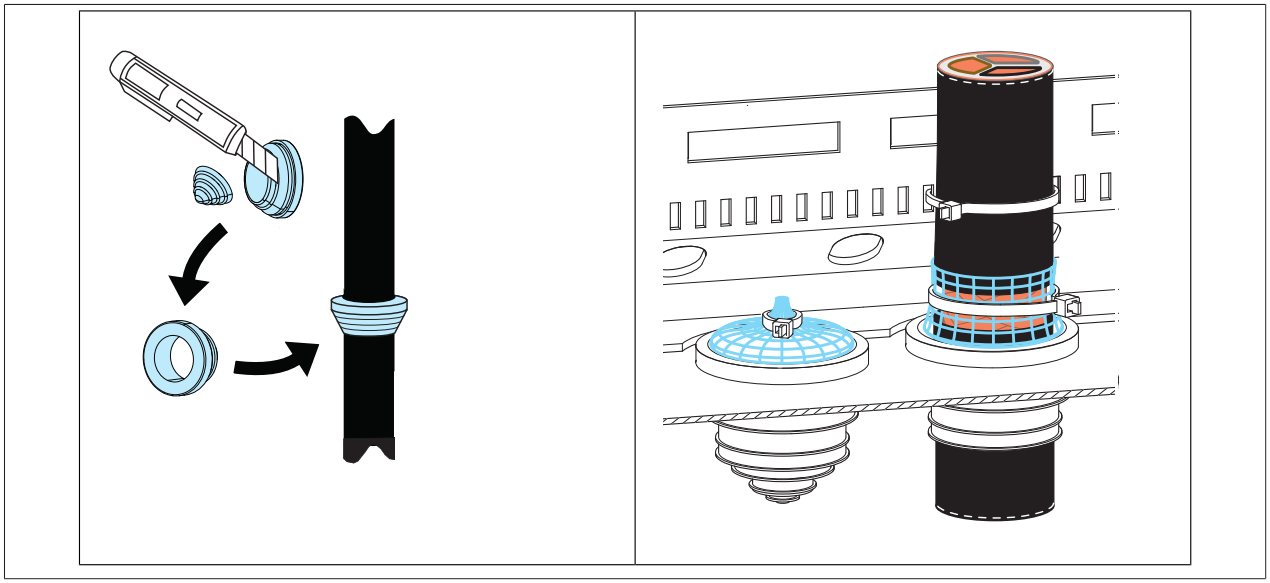



**Warning!**

**Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Follow the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.**

3. If fire insulation is used, make an opening in the mineral wool sheet according to the diameter of the cable.
4. Route the cables through the entry plate.
5. Remove the rubber grommets from the entry plate for the cables to be connected. Cut suitable holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables through the entry plate and attach the grommets to the holes.

6. Attach the conductive sleeves to the cable shields with cable ties. Tie up the unused conductive sleeves with cable ties. An example of bottom entry is shown below. For top entry, place the grommet upwards.



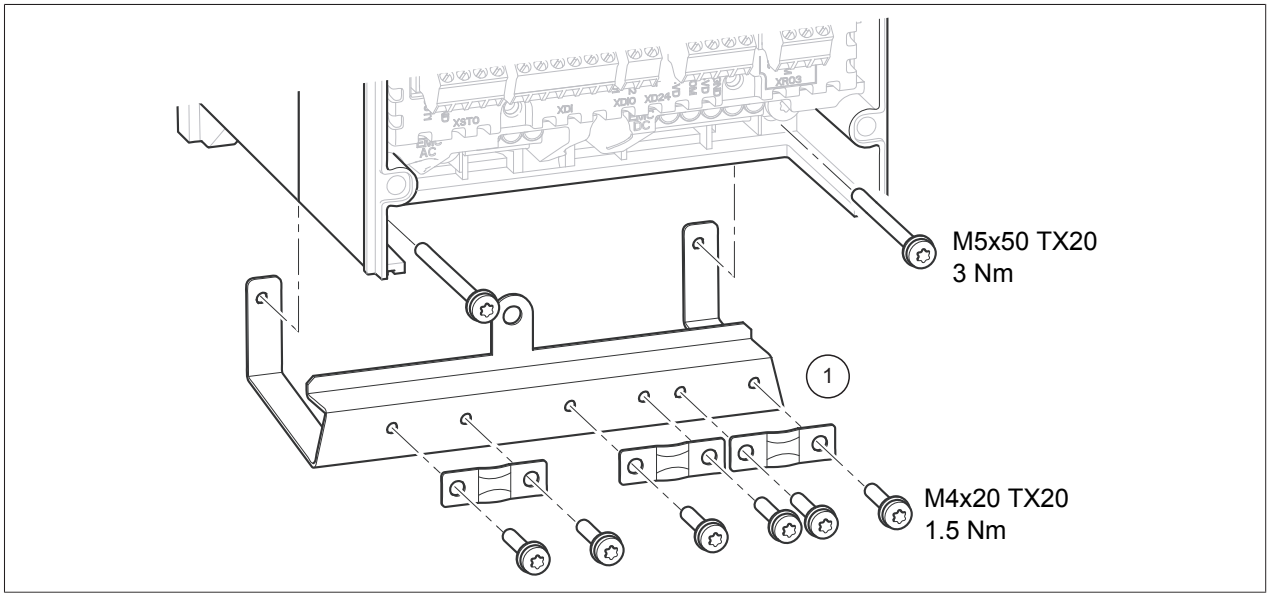
### 4.3.3.2.2 Connecting the twisted shields and phase conductors of the power cables

| Size | Description |
|---|---|
| R1...R2 | "Sizes R1 and R2" on page 192 |
| R3 | "Size R3" on page 194 |
| R4...R5 | "Sizes R4 and R5" on page 197 |
| R6...R7 | "Sizes R6 and R7" on page 201 |

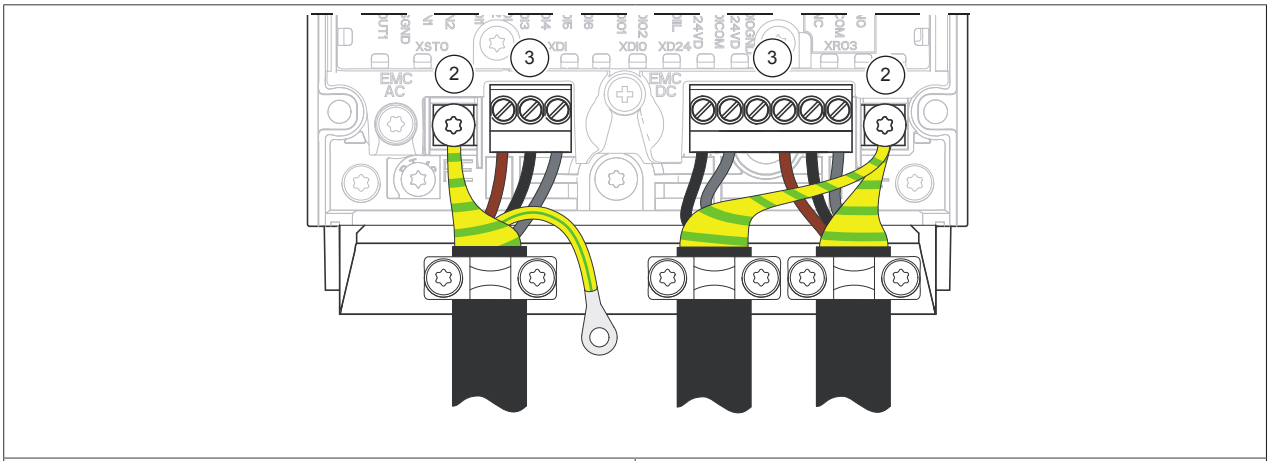
### 4.3.3.3 Installing the drive module shelves and connecting the cables

#### 4.3.3.3.1 Sizes R1 and R2

1. Attach the mechanical support shelf for the power cables to the frequency inverter module.

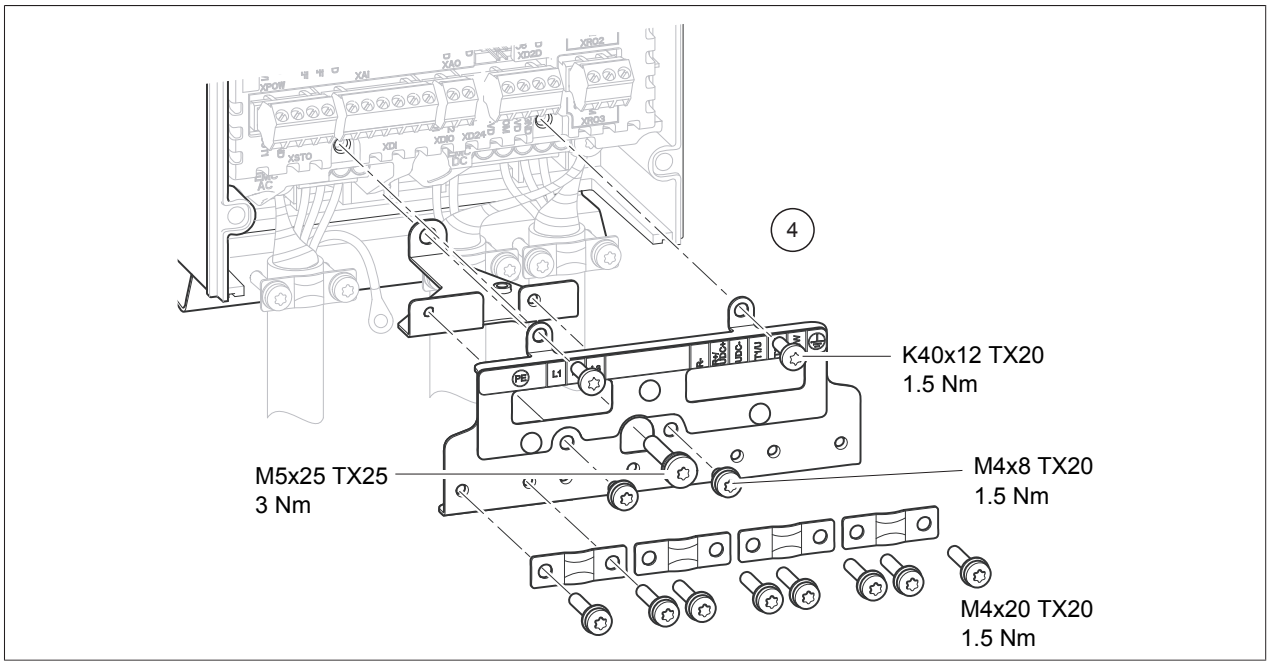



2. Connect the twisted shields of the power cables to the ground terminals.
3. Connect the phase conductors of the supply cable to terminals L1, L2 and L3 and the phase conductors of the motor cable to terminals T1/U, T2/V and T3/W. Connect the braking resistor conductors (if present) to terminals R+ and R-. Tighten the screws to the torque specified in the figure below.

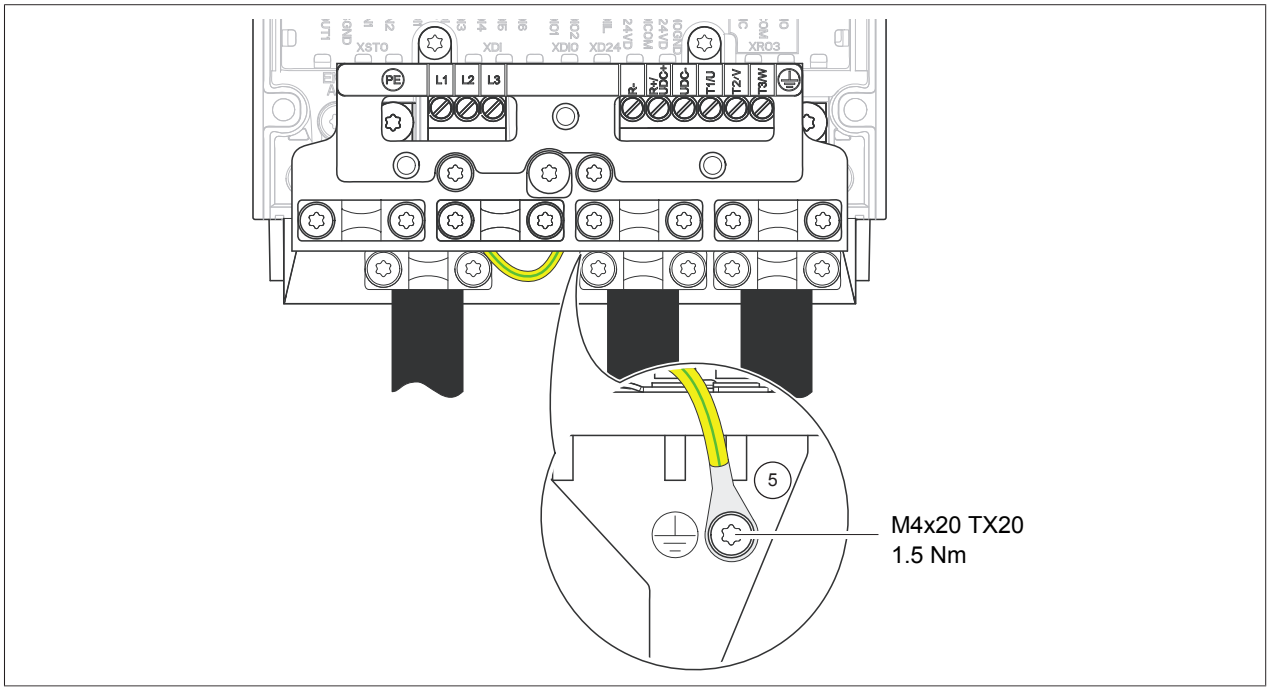



| L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+, UDC | Grounding |
|---|---|
| 0.6 Nm | 1.8 Nm |

4. Install the shelves for grounding the additional PE conductor of the supply cable and the pair-cable shields and grounding wires of the control cables.




5. Connect the additional PE conductor of the supply cable to the grounding shelf.

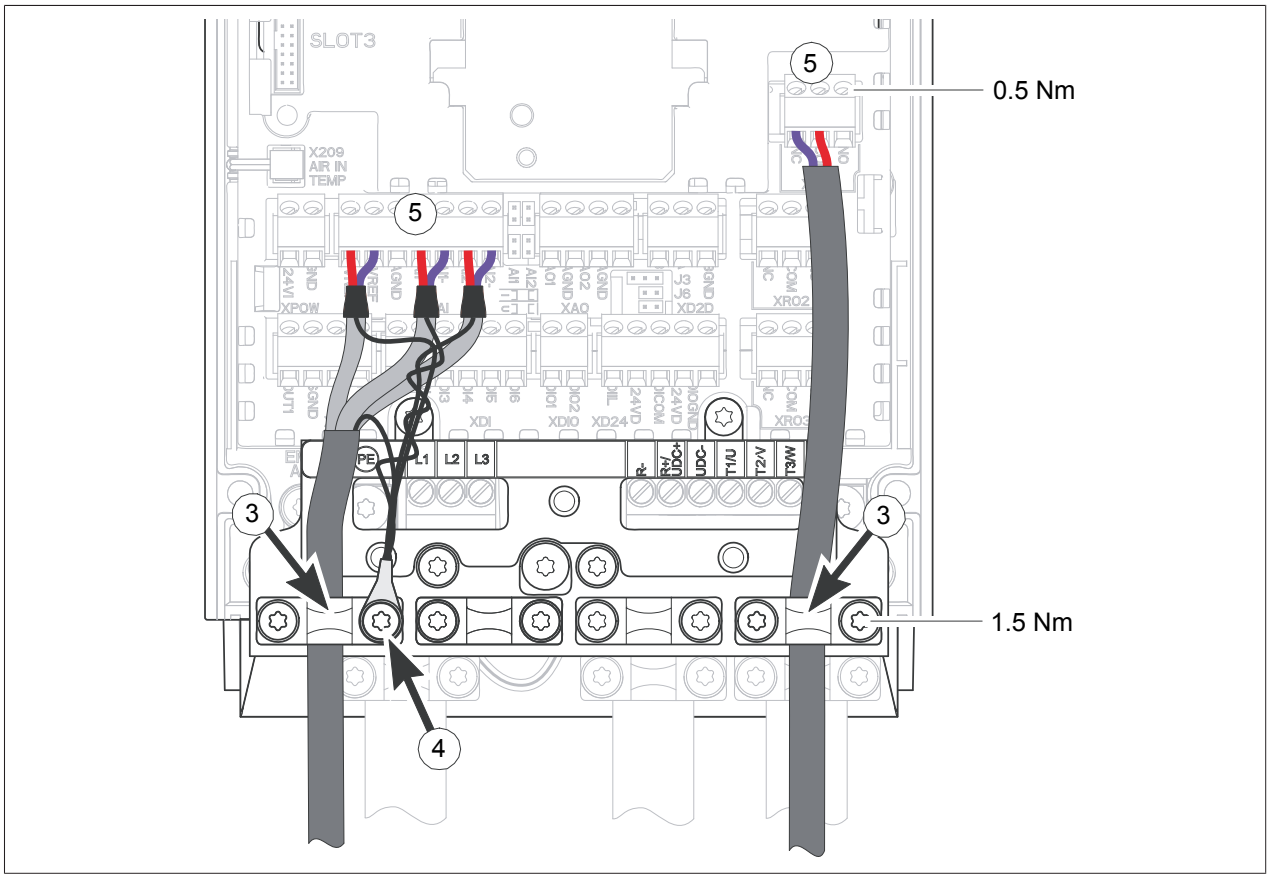



6. Proceed to section "Control cable connections: Sizes R1 and R2" on page 193.

#### 4.3.3.3.1.1 Control cable connections: Sizes R1 and R2

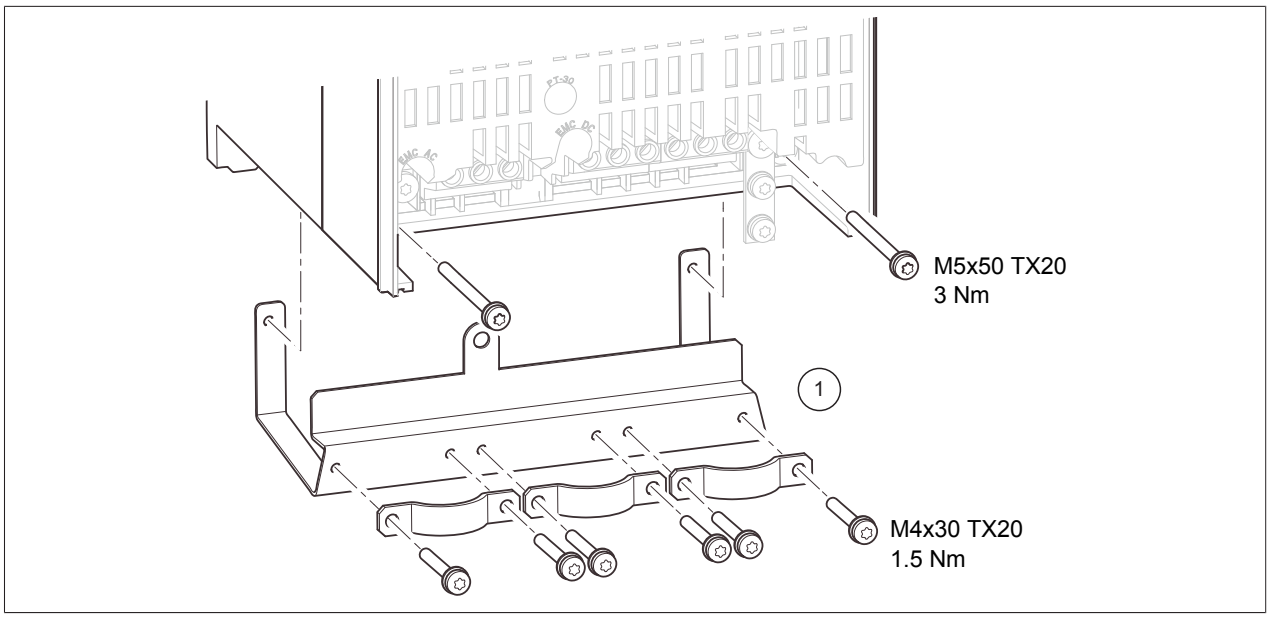
1. Strip the cable ends and cut them to a suitable length (note the extra length of the ground conductors).
2. Ground the outer shields of all control cables 360 degrees at the cabinet entry.
3. Secure the cables mechanically at the clamps.
4. Ground the pair-cable shields to the clamps. Leave the other end of the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, e.g. 3.3 nF / 630 V.
5. Connect the conductors to the corresponding terminals of the control unit (see Default I/O connection diagram).

6. Wire the optional modules if included in delivery.

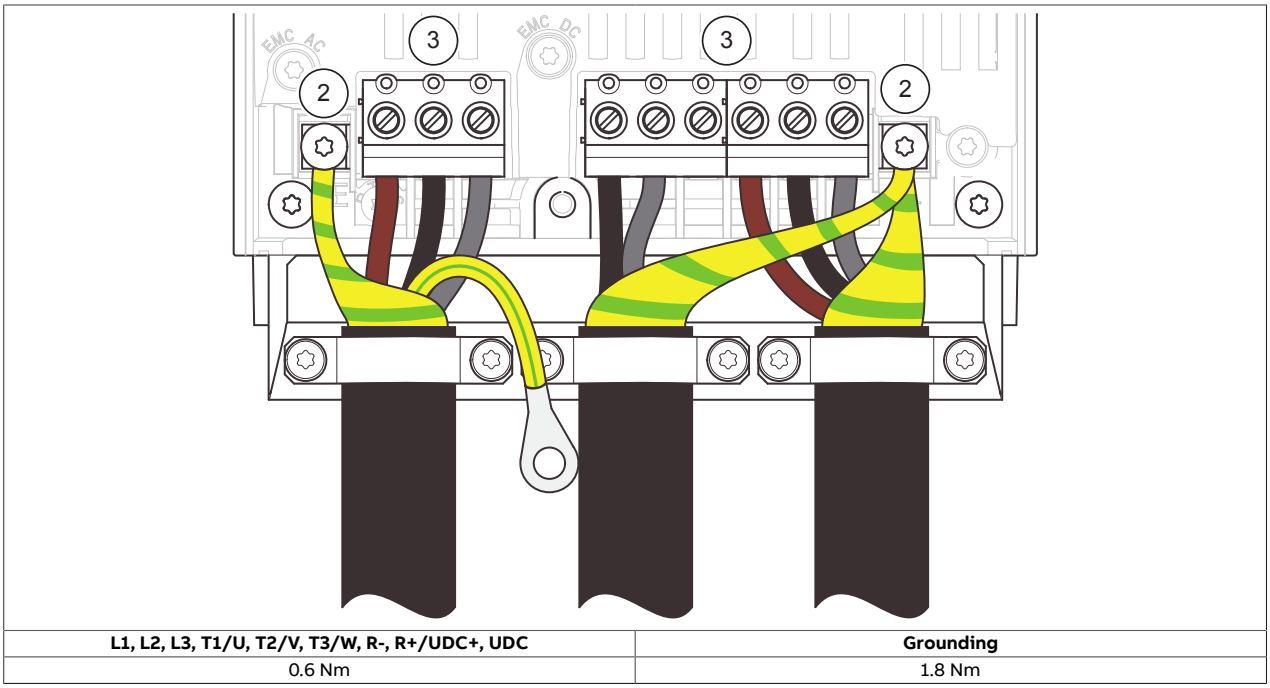



#### 4.3.3.3.2 Size R3

1. Attach the mechanical support shelf for the power cables to the frequency inverter module.

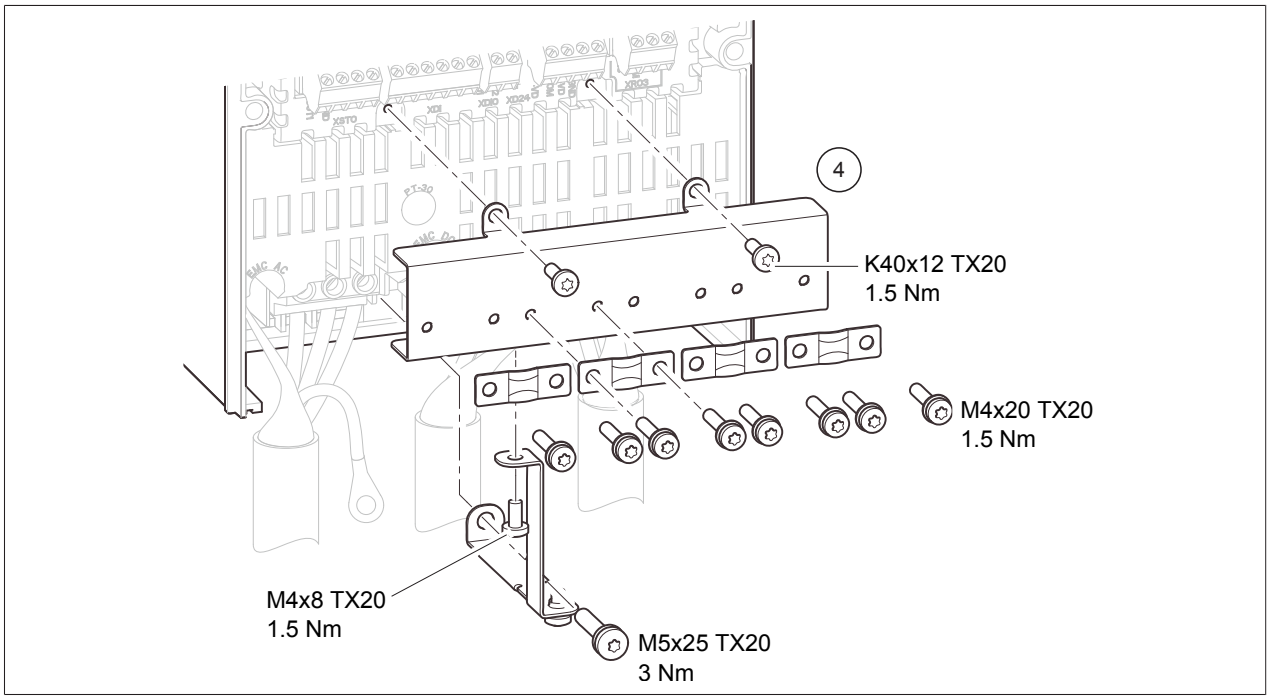



2. Connect the twisted shields of the power cables to the ground terminals.
3. Connect the phase conductors of the supply cable to terminals L1, L2 and L3 and the phase conductors of the motor cable to terminals T1/U, T2/V and T3/W. Connect the braking resistor conductors (if present) to terminals R+ and R-. Tighten the screws to the torque specified in the figure below.

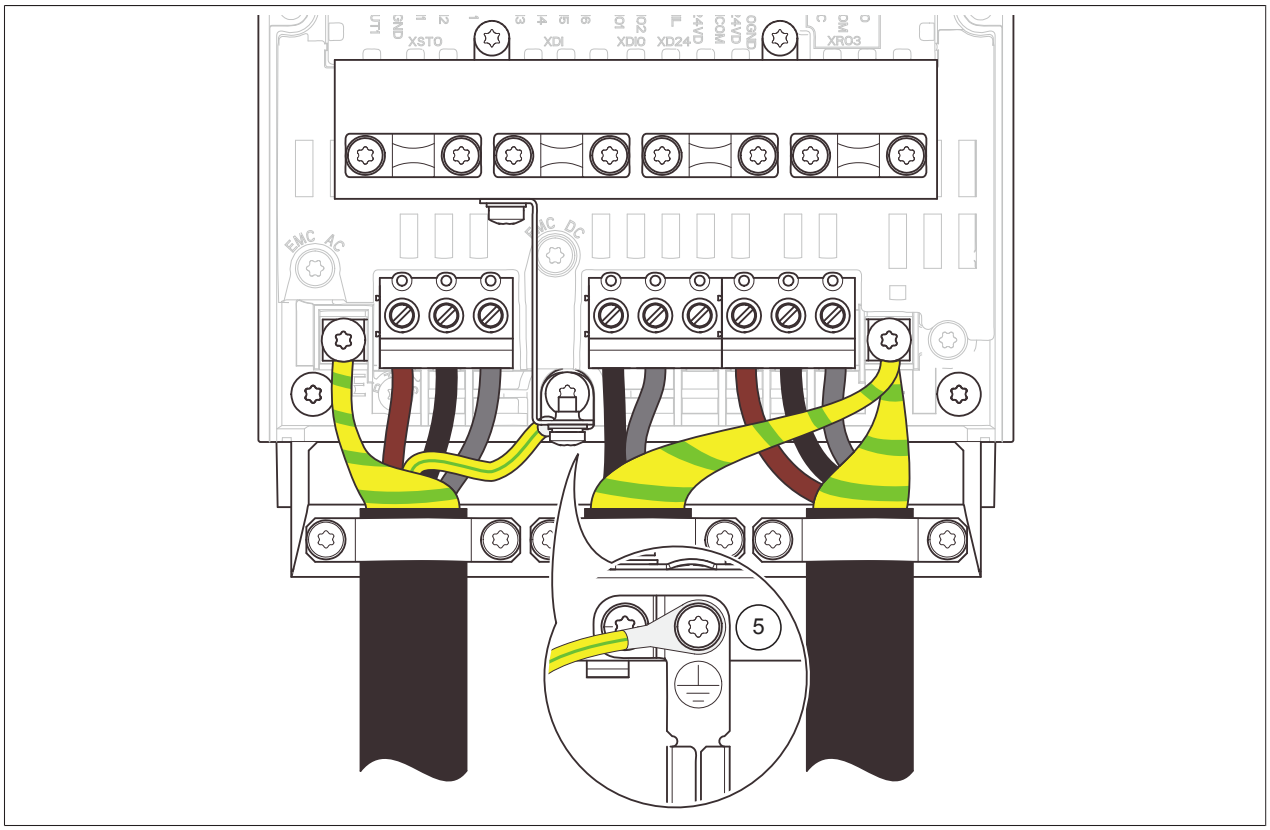



| L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+, UDC | Grounding |
|---|---|
| 0.6 Nm | 1.8 Nm |

4. Install the shelves for grounding the additional PE conductor of the supply cable and the pair-cable shields and grounding wires of the control cables.




5. Connect the additional PE conductor of the supply cable to the grounding shelf.

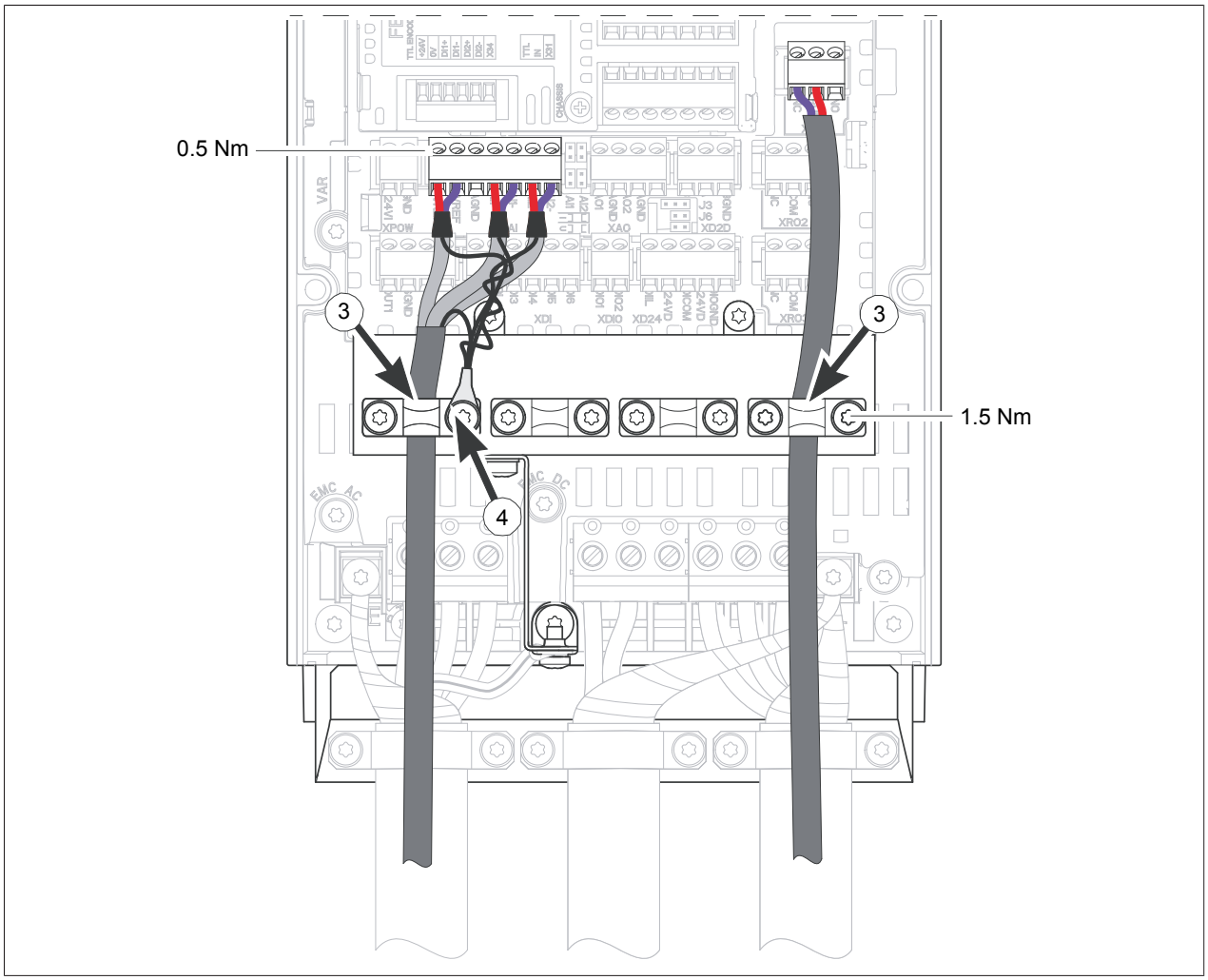



6. Proceed to section "Control cable connection: Size R3" on page 196.

#### 4.3.3.3.2.1 Control cable connection: Size R3

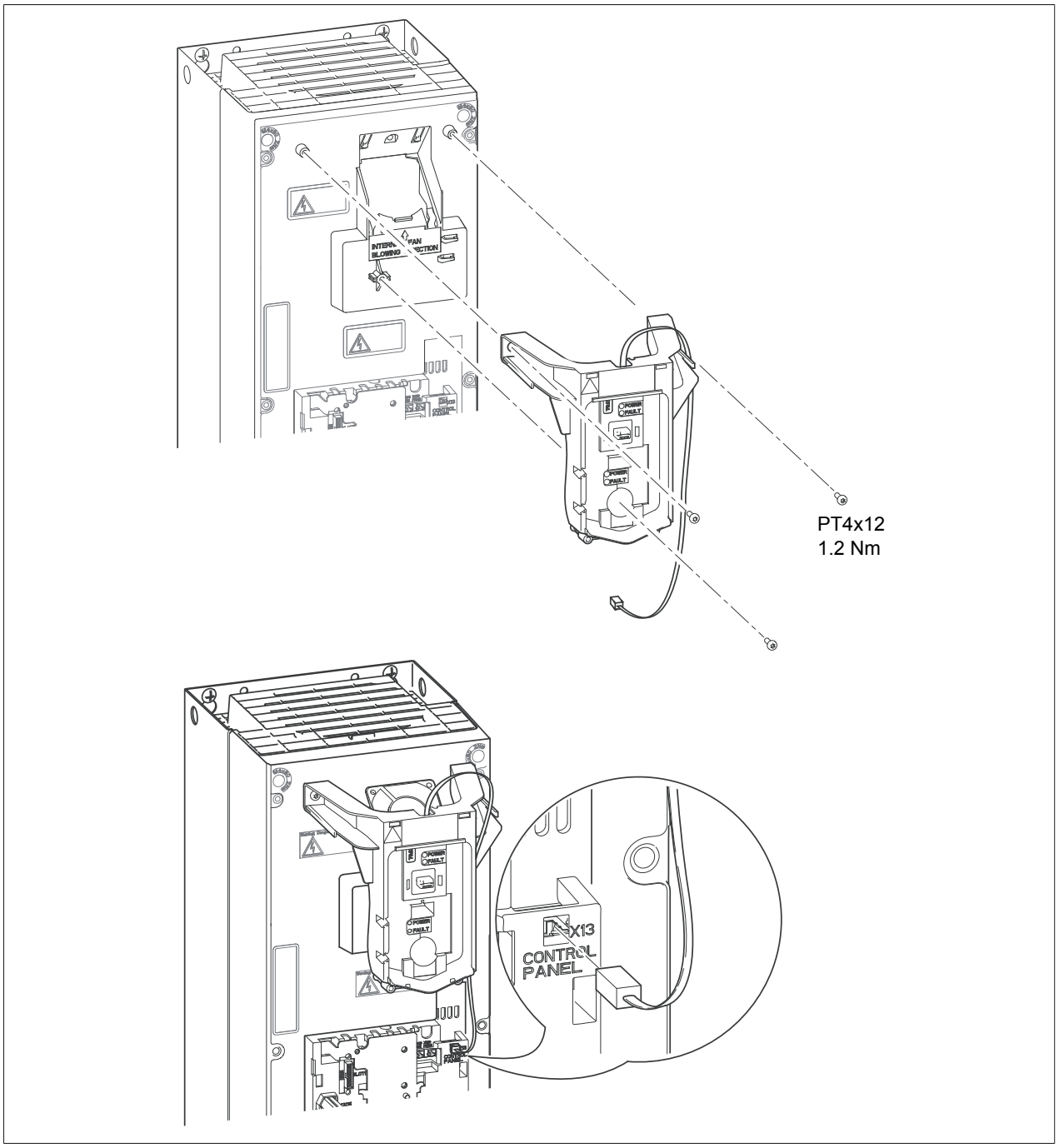
1. Strip the cable ends and cut them to a suitable length (note the extra length of the ground conductors).
2. Ground the outer shields of all control cables 360 degrees at the cabinet entry.
3. Secure the cables mechanically at the clamps.
4. Ground the pair-cable shields to the clamps. Leave the other end of the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, e.g. 3.3 nF / 630 V.
5. Connect the conductors to the corresponding terminals of the control unit (see Default I/O connection diagram).

6. Wire the optional modules if included in delivery.

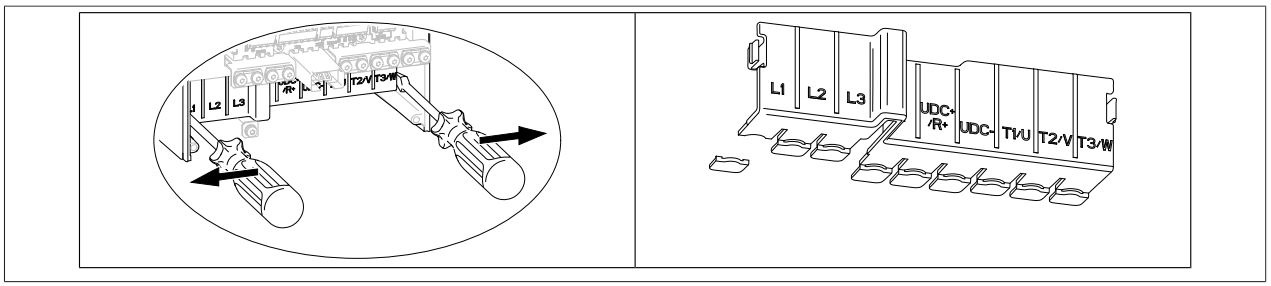



#### 4.3.3.3.3 Sizes R4 and R5

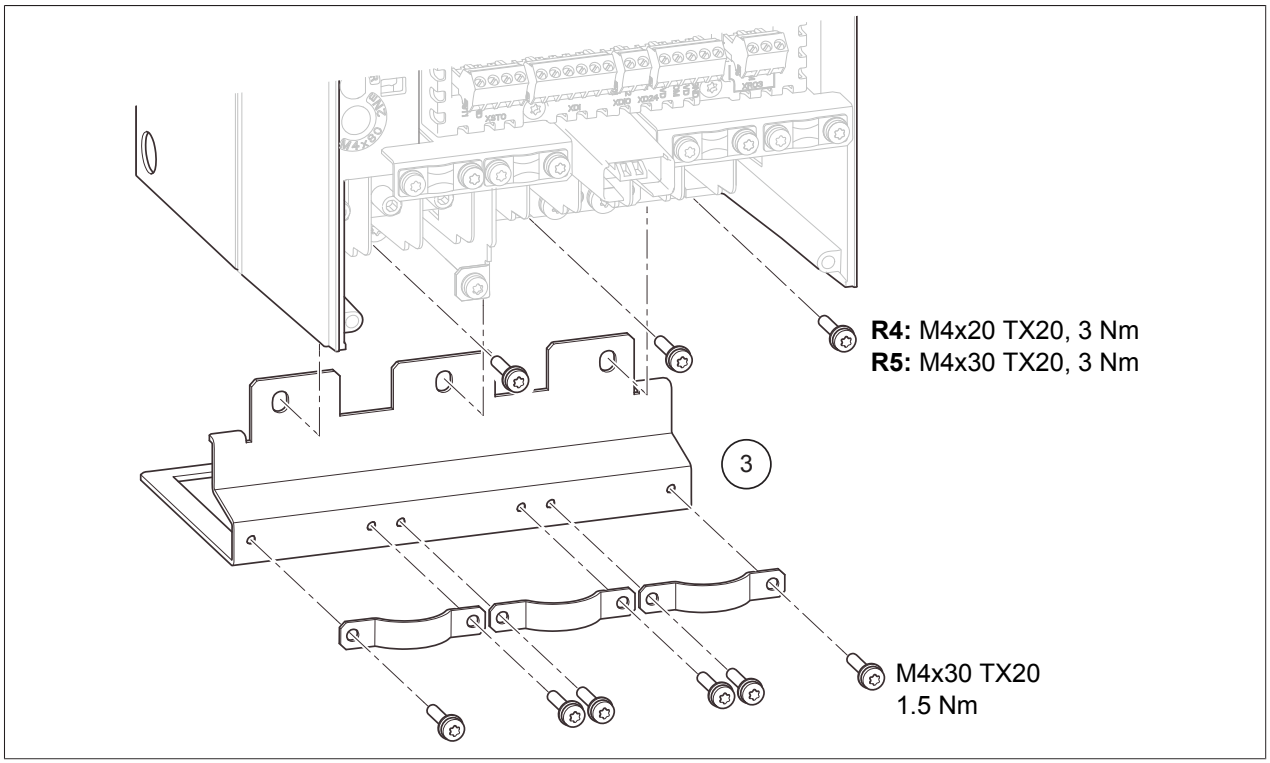
1. Install the operator panel holder. Connect the wire.



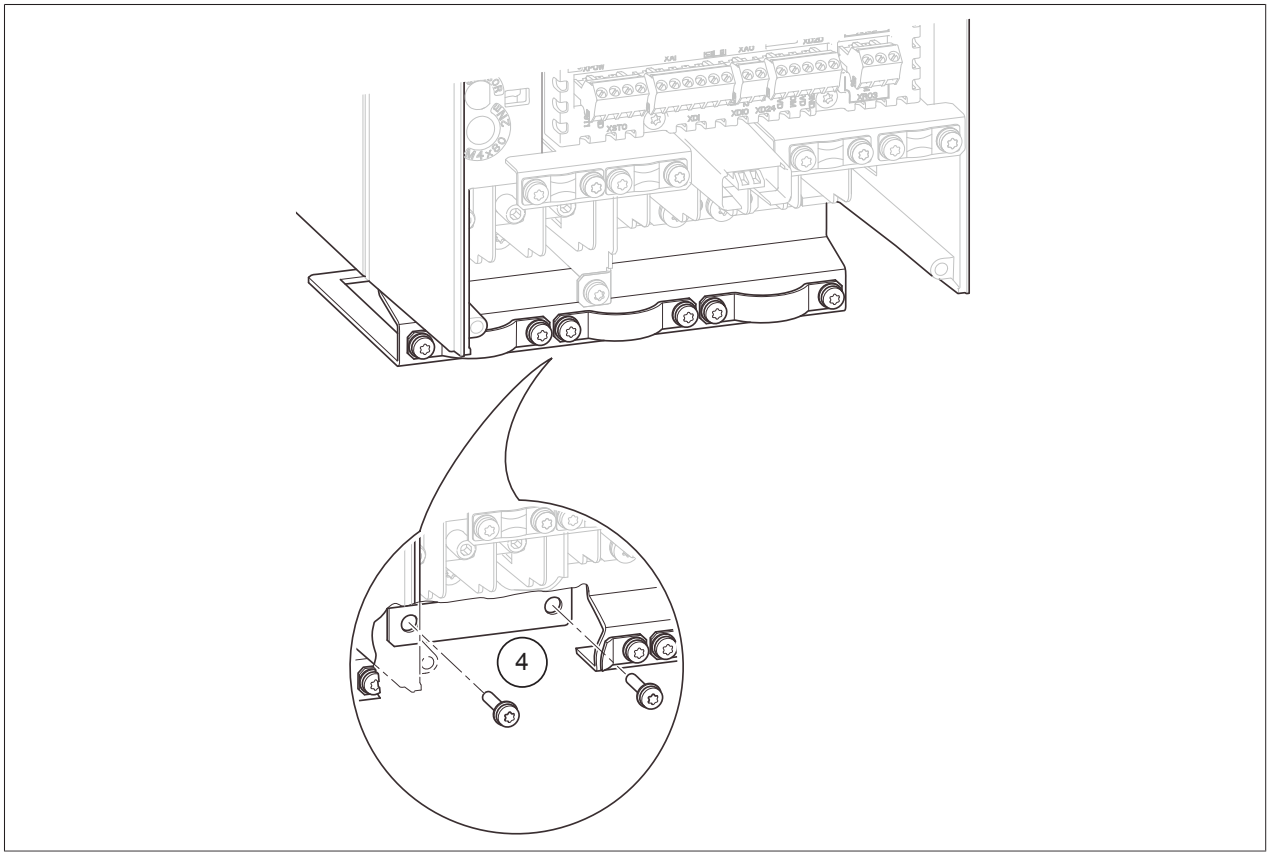

2. Remove the cover on the power cable terminals by releasing the clips and lifting the cover up from the sides with a screwdriver. Create holes in the cover for the cables to be installed.



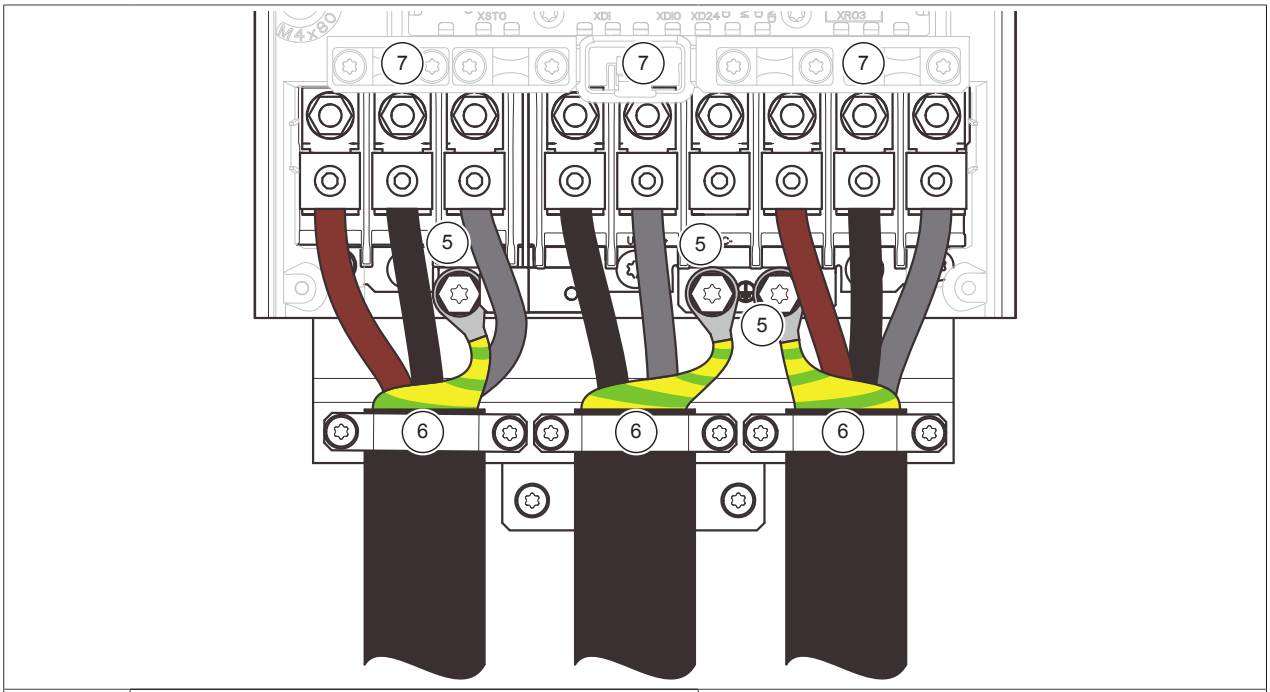

3. Attach the mechanical support shelf for the power cables to the frequency inverter module.




4. Attach the mechanical support shelf for the power cables to the mounting plate.

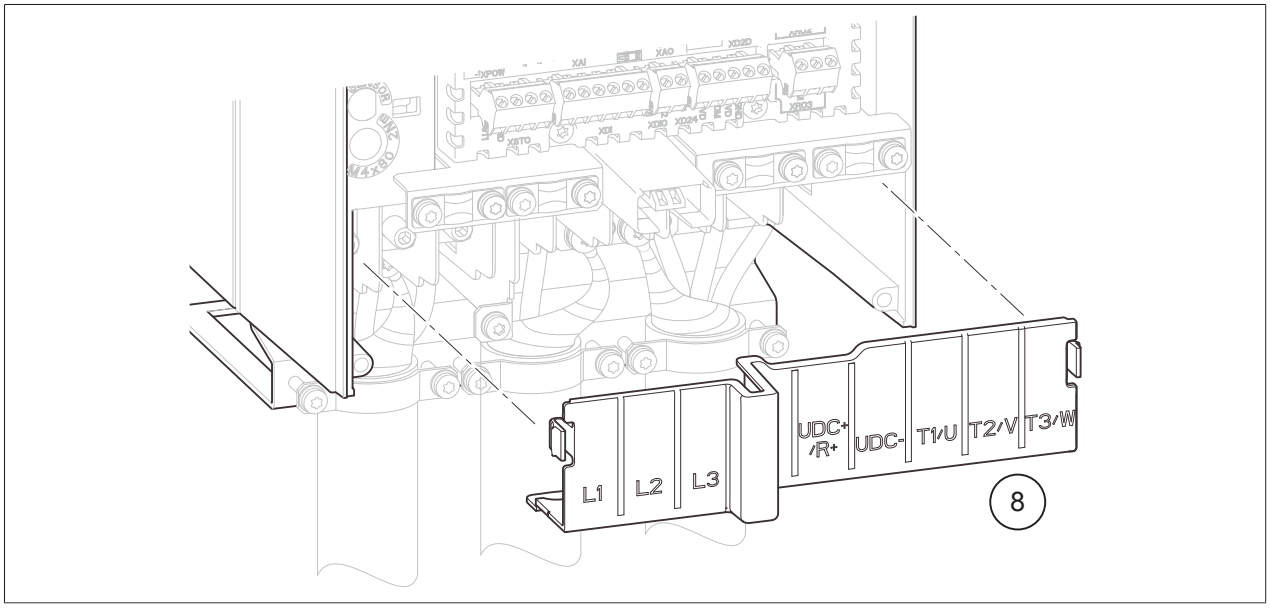



5. Connect the twisted shields of the power cables to the ground terminals.
6. Attach the power cables with the clamps to the power cable support shelf.
7. Connect the phase conductors of the supply cable to terminals L1, L2 and L3 and the phase conductors of the motor cable to terminals T1/U, T2/V and T3/W. Connect the braking resistor conductors (if present) to terminals R+ and R-. Tighten the screws to the torque specified in the figure below.




| | L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+, UDC | Grounding |
|---|---|---|
| R4 | 3.3 Nm | 2.9 Nm |
| R5 | 5.6 Nm | 2.9 Nm |

8. Reinstall the cover on the power terminals.

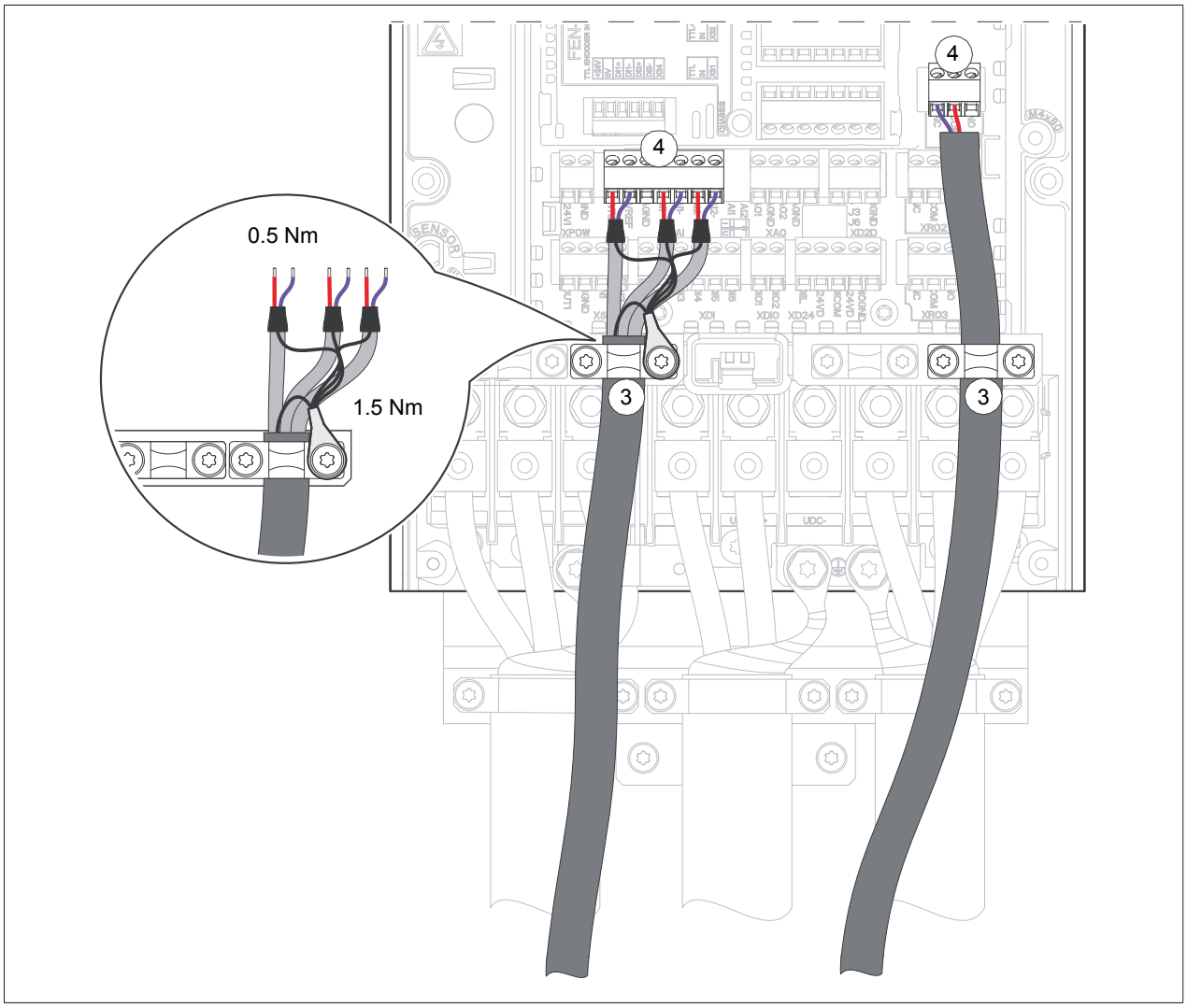



9. Proceed to section "Control cable connections: Sizes R4 and R5" on page 200.

#### 4.3.3.3.3.1 Control cable connections: Sizes R4 and R5

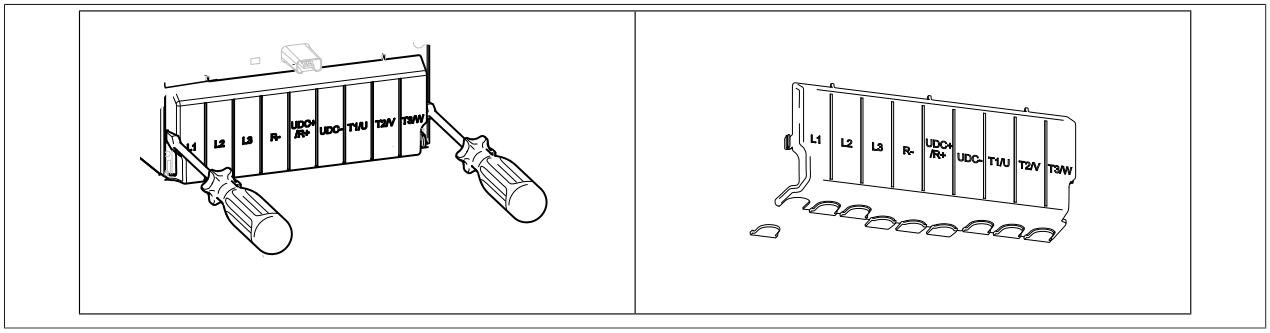
1. Strip the cable ends and cut them to a suitable length (note the extra length of the ground conductors).
2. Ground the outer shields of all control cables 360 degrees at the cabinet entry.
3. Secure the cables mechanically at the clamps.
4. Ground the pair-cable shields to the clamps. Leave the other end of the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, e.g. 3.3 nF / 630 V.
5. Connect the conductors to the corresponding terminals of the control unit (see Default I/O connection diagram).

6. Wire the optional modules if included in delivery.

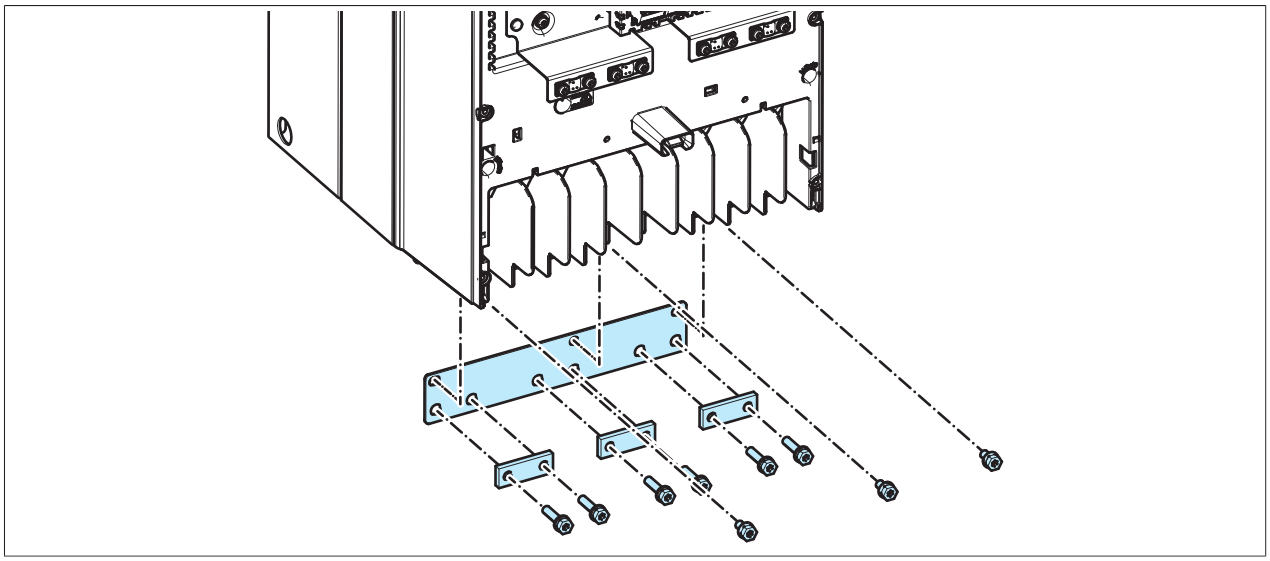



#### 4.3.3.3.4 Sizes R6 and R7

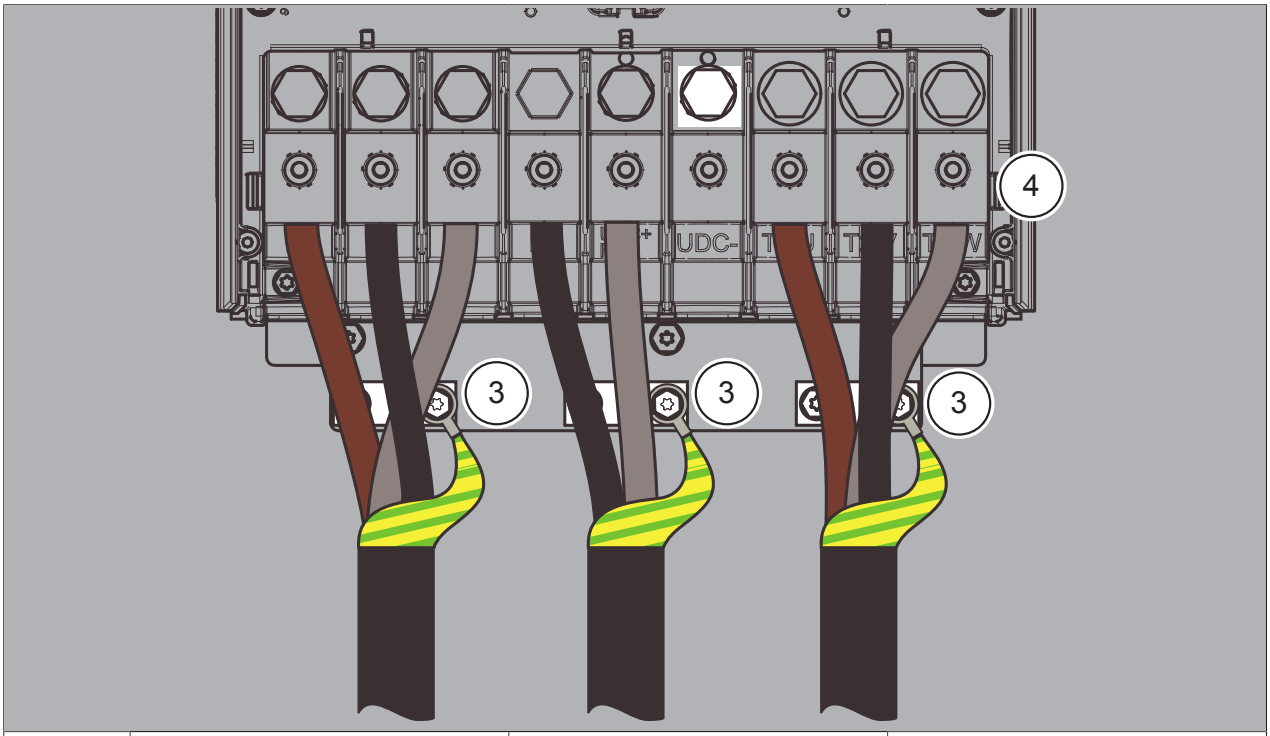
1. Remove the cover on the power cable terminals by releasing the clips and lifting the cover up from the sides with a screwdriver. Create holes in the cover for the cables to be installed.




2. Attach the power cable shield grounding shelf to the frequency inverter module.

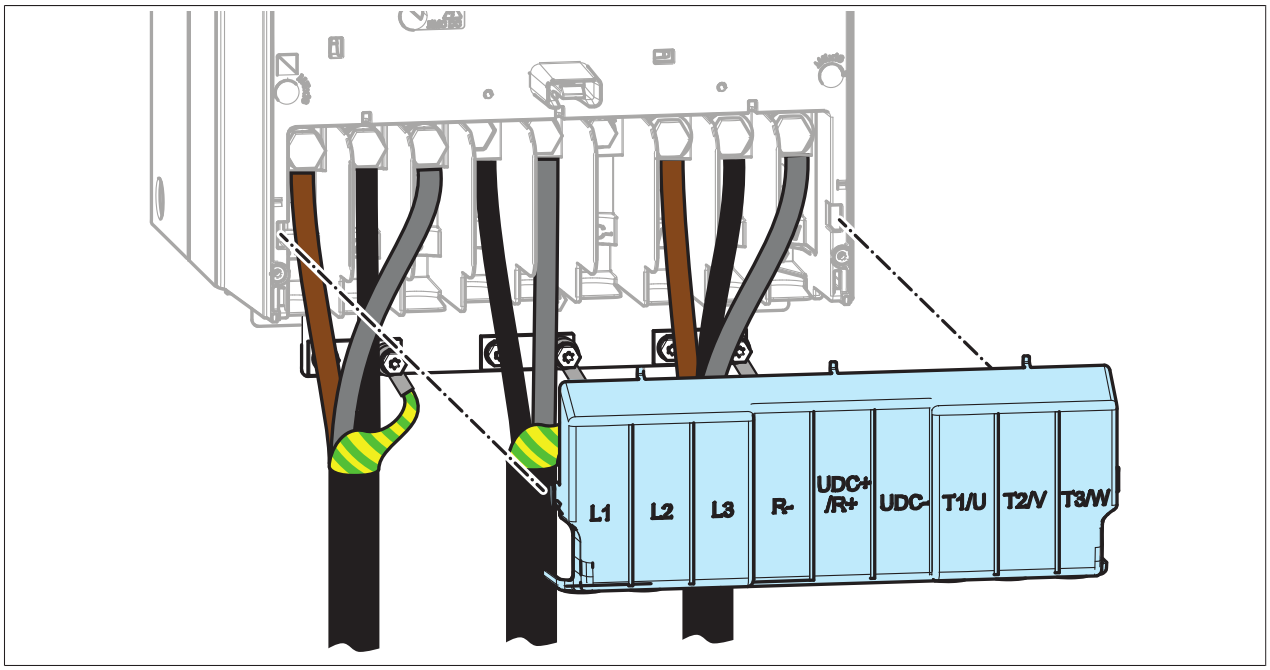


3. Connect the twisted shields of the power cables under the grounding clamps or with cable lugs under the clamp screws.
4. Connect the phase conductors of the supply cable to terminals L1, L2 and L3 and the phase conductors of the motor cable to terminals T1/U, T2/V and T3/W. Connect the braking resistor conductors (if present) to terminals R+ and R-. Tighten the screws to the torque specified in the figure below.




| | L1, L2, L3, T1/U, T2/V, T3/W | R-, R+/UDC+, UDC- | R-, R+/UDC+, UDC- |
|---|---|---|---|
| R6 | 30 Nm | 20 Nm | 9.8 Nm |
| R7 | 40 Nm | 30 Nm | 9.8 Nm |

5. Reinstall the cover on the power cable terminals.




6. Proceed to section "Control cable connections: Sizes R6 and R7" on page 203.

#### 4.3.3.3.4.1 Control cable connections: Sizes R6 and R7

1. Strip the cable ends and cut them to a suitable length (note the extra length of the ground conductors).
2. Ground the outer shields of all control cables 360 degrees at the cabinet entry.
3. Secure the cables mechanically at the clamps.
4. Ground the pair-cable shields to the clamps. Leave the other end of the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, e.g. 3.3 nF / 630 V.
5. Connect the conductors to the corresponding terminals of the control unit (see Default I/O connection diagram).
6. Wire the optional modules if included in delivery.

### 4.3.4 DC connection

The UDC+ and UDC- terminals can be used for configurations with a DC power grid for multiple frequency inverter modules. This allows energy regenerated from one module to be used by another module in motor operation.

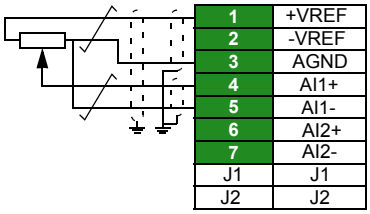
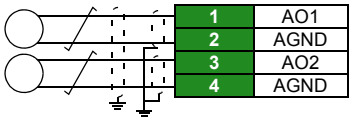
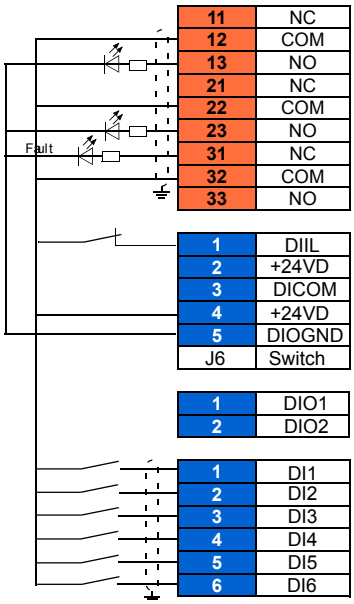
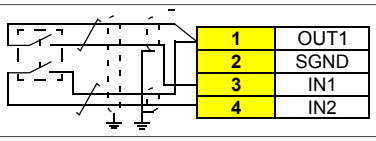
### 4.3.5 Connecting the control cables

For the default I/O connections for the factory macro of the ACOPOSinverter P96 main control program, see section "Default I/O connection diagram" on page 203. For other macros and control programs, see "The drive" on page 228. Connect the cables according to the description in section "Procedure for connecting control cables" on page 207.

#### 4.3.5.1 Default I/O connection diagram

Conductor sizes: 0.5 ... 2.5 mm² (24...12 AWG), tightening torques: 0.5 Nm (5 lbf in) for stranded wire and single-core conductors.

| Figure | I/O | Description |
|---|---|---|
| | **XPOW** | **Input for external power supply** |
| | 1 | 24 VDC, 2 A |
| | 2 | |

| Figure | I/O | Description |
|---|---|---|
|  | **XAI** | **Reference voltage and analog inputs** |
| | 1 | 10 VDC, $R_L$ 1…10 kΩ |
| | 2 | -10 VDC, $R_L$ 1…10 kΩ |
| | 3 | Ground |
| | 4 | **Speed setpoint** 0(2)…10 V, $R_{in}$ > 200 kΩ [1] |
| | 5 | |
| | 6 | Not used by default. |
| | 7 | 0(4)…20 mA, $R_{in}$ = 100 ohm [2] |
| | J1 | AI1 jumper selection |
| | J2 | AI2 jumper selection |
|  | **XAO** | **Analog outputs** |
| | 1 | **Motor speed rpm** 0…20 mA, $R_L$ 500 ohm |
| | 2 | |
| | 3 | **Motor current** 0…20 mA, $R_L$ 500 ohm |
| | 4 | |
| | **XD2D** | **Inverter-to-inverter connection (D2D)** |
| | 1 | Inverter-to-inverter connection (D2D) |
| | 2 | |
| | 3 | |
| | J3 | D2D link termination switch |
|  | **XRO1, XRO2, XRO3** | **Relay outputs** |
| | 11 | **Ready to start**<br>250 VAC / 30 VDC<br>2 A |
| | 12 | |
| | 13 | |
| | 21 | **In operation**<br>250 VAC / 30 VDC<br>2 A |
| | 22 | |
| | 23 | |
| | 31 | **Fault (-1)**<br>250 VAC / 30 VDC<br>2 A |
| | 32 | |
| | 33 | |
| | **XD24** | **Digital start interlock** |
| | 1 | Start interlock |
| | 2 | +24 VDC 200 mA [3] |
| | 3 | Digital input ground |
| | 4 | +24 VDC 200 mA [3] |
| | 5 | Digital input/output ground |
| | J6 | Ground selection switch |
| | **XDIO** | **Digital inputs/outputs** |
| | 1 | Output: Ready to start |
| | 2 | Output: In operation |
| | **XDI** | **Digital inputs** |
| | 1 | Stop (0) / Start (1) |
| | 2 | Forward (0) / Reverse (1) |
| | 3 | Fault acknowledgment |
| | 4 | Ramp selection [4] |
| | 5 | Constant speed 1 (1 = On) |
| | 6 | Not used by default |
|  | **XSTO** | **Safe Torque Off** |
| | 1 | Safe Torque Off (STO). Both circuits must be closed for the frequency inverter to start. |
| | 2 | |
| | 3 | |
| | 4 | |
| | **X12** | **Connection for safety function module** |
| | **X13** | **Connection for control panel** |
| | **X205** | **Connection for memory unit** |

1) Current [0(4)…20 mA, $R_{in}$ = 100 ohm] or voltage [ 0(2)…10 V, $R_{in}$ > 200 kΩ]:
Input selection with jumper J1. Changing the setting requires the control unit to be restarted.
2) Current [0(4)…20 mA, $R_{in}$ = 100 ohm] or voltage [ 0(2)…10 V, $R_{in}$ > 200 kΩ]:
Input selection with jumper J2. Changing the setting requires the control unit to be restarted.
3) The total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the energy consumed by DIO1 and DIO2.
4) 0 = Open, 1 = Closed

## Notes:

1. Current [0(4)…20 mA, $R_{in}$ = 100 ohm] or voltage [ 0(2)…10 V, $R_{in}$ > 200 kΩ]:
Input selection with jumper J1. Changing the setting requires the control unit to be restarted.
2. Current [0(4)…20 mA, $R_{in}$ = 100 ohm] or voltage [ 0(2)…10 V, $R_{in}$ > 200 kΩ]:
Input selection with jumper J2. Changing the setting requires the control unit to be restarted.
3. The total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the energy consumed by DIO1 and DIO2.
4. 0 = Open, 1 = Closed

| DI4 | Ramp times according to |
|---|---|
| 0 | Parameters 23.12 and 23.13 |
| 1 | Parameters 23.14 and 23.15 |

For additional information about using the connectors and jumpers, see the following sections. See also section "Connection data of the control unit (ZCU-12)" on page 34.

#### 4.3.5.1.1 Jumpers and switches

| Jumper/ Switch | Description | Position | |
|---|---|---|---|
| J1 (AI1) | Defines whether analog input AI1 is used as a current or voltage input. | | Current (I) |
| | | | Voltage (U) |
| J2 (AI2) | Defines whether analog input AI2 is used as a current or voltage input. | | Current (I) |
| | | | Voltage (U) |
| J3 | Inverter-to-inverter communication termination. Must be set to the termination position if the frequency inverter is the last unit in the D2D connection. | | Bus is terminated. |
| | | | Bus is not terminated. |
| J6 | Selector switch for common ground of digital inputs. Defines whether DICOM is separated from DIOGND (no common reference for digital inputs). See "Insulation and grounding diagram" on page 35. | | DICOM and DIOGND connected (default). |
| | | | DICOM and DIOGND separated. |

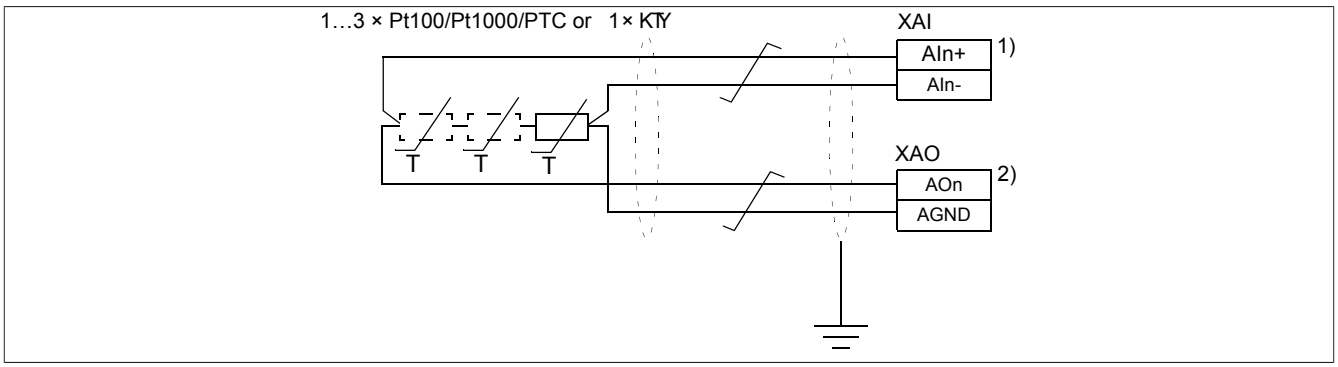
#### 4.3.5.1.2 External power supply for the control unit (XPOW)

External +24 V power supply (2 A) for the control unit can be connected to terminal block XPOW. An external 24 V power supply is recommended if the following applies:

- The control unit must remain operational during interruptions in the mains voltage supply, for example to ensure continuous fieldbus communication.
- An immediate restart is required after an interruption of the mains voltage supply. A delay is not permitted to be caused by switching on the control unit.

#### 4.3.5.1.3 AI1 and AI2 as Pt100, Pt1000, PTC and KTY84 sensor inputs (XAI, XAO)

As shown below, three Pt100, Pt1000 and PTC sensors or one KTY84 sensor for measuring motor temperature can be connected between an analog input and output. The other end of the shield should be left open or indirectly grounded via capacitors with a few nanofarads suitable for high frequency and high voltage, for example 3.3 nF / 630 V. The shield can also be grounded directly at both ends without significant voltage drop if they are connected to the same ground.




1) Set the input type to voltage with switch J1 for analog input AI1 or with J2 for analog input AI2. Set the corresponding unit of the analog input to V (volts) in parameter group **12 Standard AI**.
2) Select the excitation mode in parameter group **13 Standard AO**.

## Warning!

**Since the inputs shown above are not insulated per IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between live parts of the motor and the sensor. If the design does not meet these requirements, the I/O board terminals must be protected against contact and are not permitted to be connected to other devices, or the temperature sensor must be isolated from the I/O terminals.**

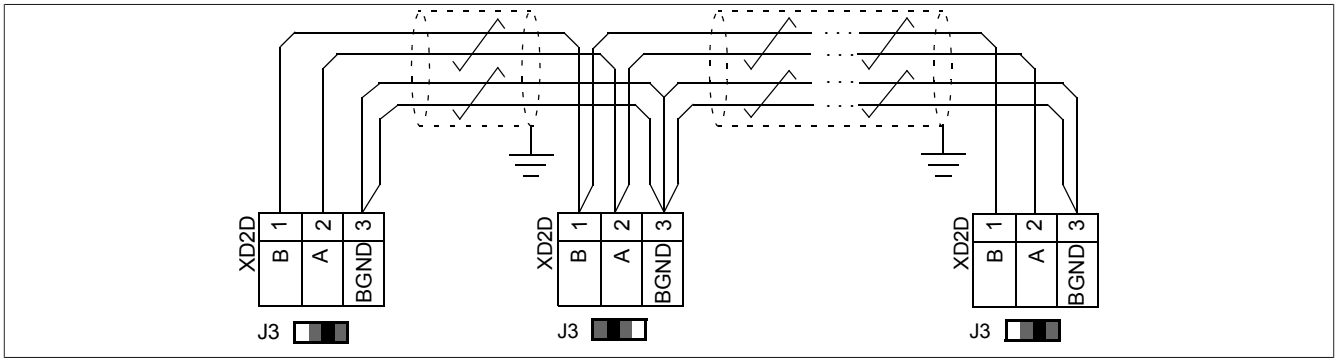
#### 4.3.5.1.4 Connection between frequency inverters (XD2D)

The connection between frequency inverters (drive-to-drive link or D2D) is a connected-through (daisy-chained) RS485 transfer line that allows basic master/follower communication with one master frequency inverter and multiple followers.

Set the jumper for activating the terminating resistor J3 (see Jumpers and switches) next to this terminal block on the frequency inverters at the ends of the inverter-to-inverter connection to the ON position. For intermediate frequency inverters, set the jumper to the OFF position.

Use a shielded twisted pair cable (~100 ohm, e.g. PROFIBUS-compatible cable) for the wiring. High-quality cables provide the best immunity. Keep the cable as short as possible. The maximum length of the connection is 50 meters (164 ft). Avoid unnecessary loops and routing next to power cables (such as motor cables).

The following wiring diagram shows the inverter-to-inverter wiring.

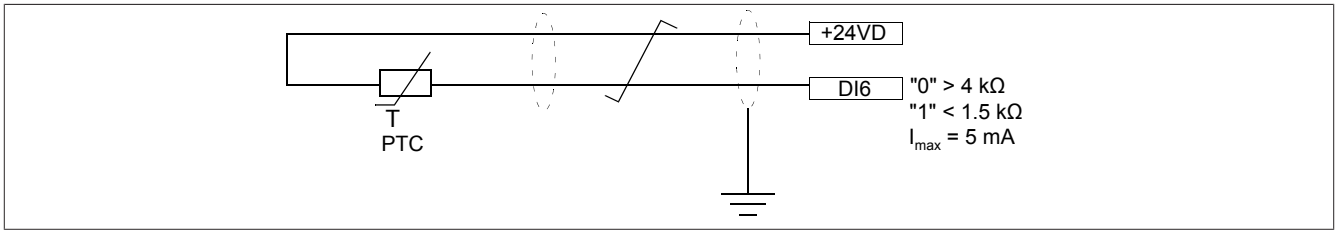



#### 4.3.5.1.5 DIIL input (XD24:1)

The DIIL input can be selected, for example, as a signal for an emergency stop command or external event. For additional information, see chapter "The drive" on page 228.

#### 4.3.5.1.6 DI6 (XDI_:6) as a PTC sensor input

A PTC sensor can be connected to this input for motor temperature measurement as follows. The sum of the sensor resistance is not permitted to exceed the threshold resistance of the digital input at the normal operating temperature of the motor. Do not connect both ends of the cable shield directly to ground. The other end of the shield should be left open or indirectly grounded via capacitors with a few nanofarads suitable for high frequency and high voltage, for example 3.3 nF / 630 V. The shield can also be grounded directly at both ends without significant voltage drop if they are connected to the same ground. For parameter settings, see chapter "The drive" on page 228.



## Warning!

**Since the inputs shown above are not insulated per IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between live parts of the motor and the sensor. If the design does not meet these requirements, the I/O board terminals must be protected against contact and are not permitted to be connected to other devices, or the temperature sensor must be isolated from the I/O terminals.**

#### 4.3.5.1.7 Safe Torque Off (XSTO)

To start up the frequency inverter, both connections (OUT1 with IN1 and IN2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting an external Safe Torque Off circuit to the frequency inverter. See "Function "Safe Torque Off"" on page 211.

### 4.3.5.2 Procedure for connecting control cables

## Warning!

**The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Remove the front cover(s). See section "Connecting the power cables" on page 189.
3. Cut a suitable opening in the rubber cable grommets and slide the cable grommets onto the cables. Insert the cables through the openings of the lower end plate and press the cable grommets into the openings.
4. Route the cables as shown in figure "Routing the cables" on page 208.
5. Establish 360-degree grounding on a grounding clamp for the outer shields of all control cables in the cable connection box, see "Routing the cables" on page 208. Tighten the clamp to 1.5 Nm (13 lbf in). Keep the shields continuous as close as possible to the terminals of the control unit. Mechanically secure the cables to the clamps below the control unit.
   Sizes R1 to R3: Connect the shields of the wire pairs and the ground cables to the grounding clamp of the cable connection box.
6. Sizes R4 to R7: Ground the cable shields and all grounding cables via the clamp below the control unit, see "Routing the cables" on page 208.
7. Connect the conductors to the corresponding terminals (see "Default I/O connection diagram" on page 203) of the control unit and tighten to 0.5 Nm (5 lbf in).
8. For connecting fieldbus cables, see the Quick guide for installation.

## Note:

**The other ends of the control cable shields should be left open or indirectly grounded via capacitors suitable for high frequencies with a few nanofarads, e.g. 3.3 nF / 630 V. The shield can also be grounded directly at both ends without significant voltage drop if they are connected to the same ground.**

## Note:

**Keep signal line pairs twisted as close to the terminals as possible. Twisting the signal lines with the return line reduces faults caused by inductive coupling.**

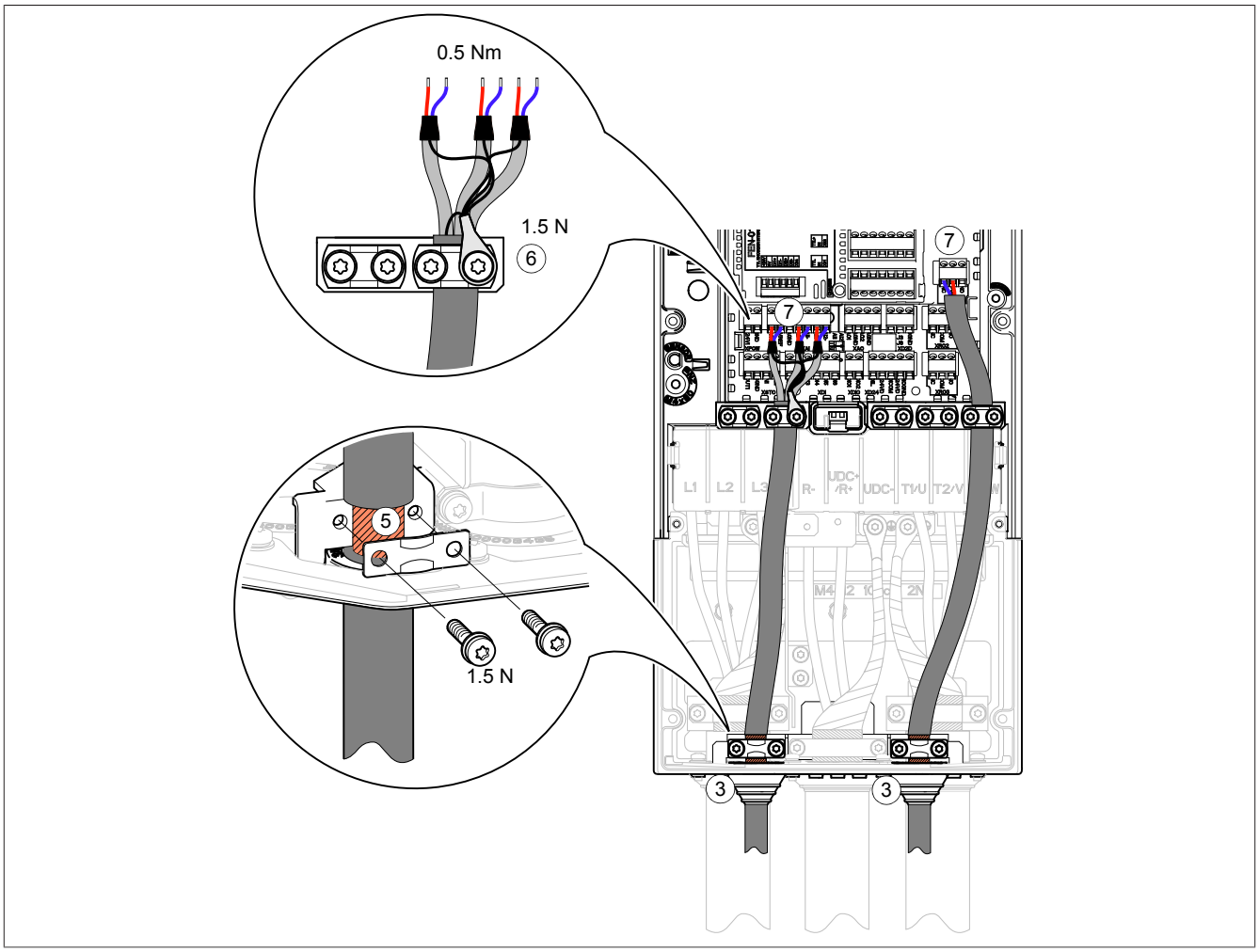



Figure 68: Routing the cables

### 4.3.6 Installing optional modules

**Note:**

**Sizes R1 and R2 cannot use a 90° connector in slot 1. For other sizes, there is a space of 50 to 55 mm for the connector and the cable available on slots 1, 2 and 3.**

#### 4.3.6.1 Mechanical installation of fieldbus adapter and incremental encoder interface modules

For available slots for each module, see "Overview of power and control connections" on page 16. The optional modules are installed as follows:

**Warning!**

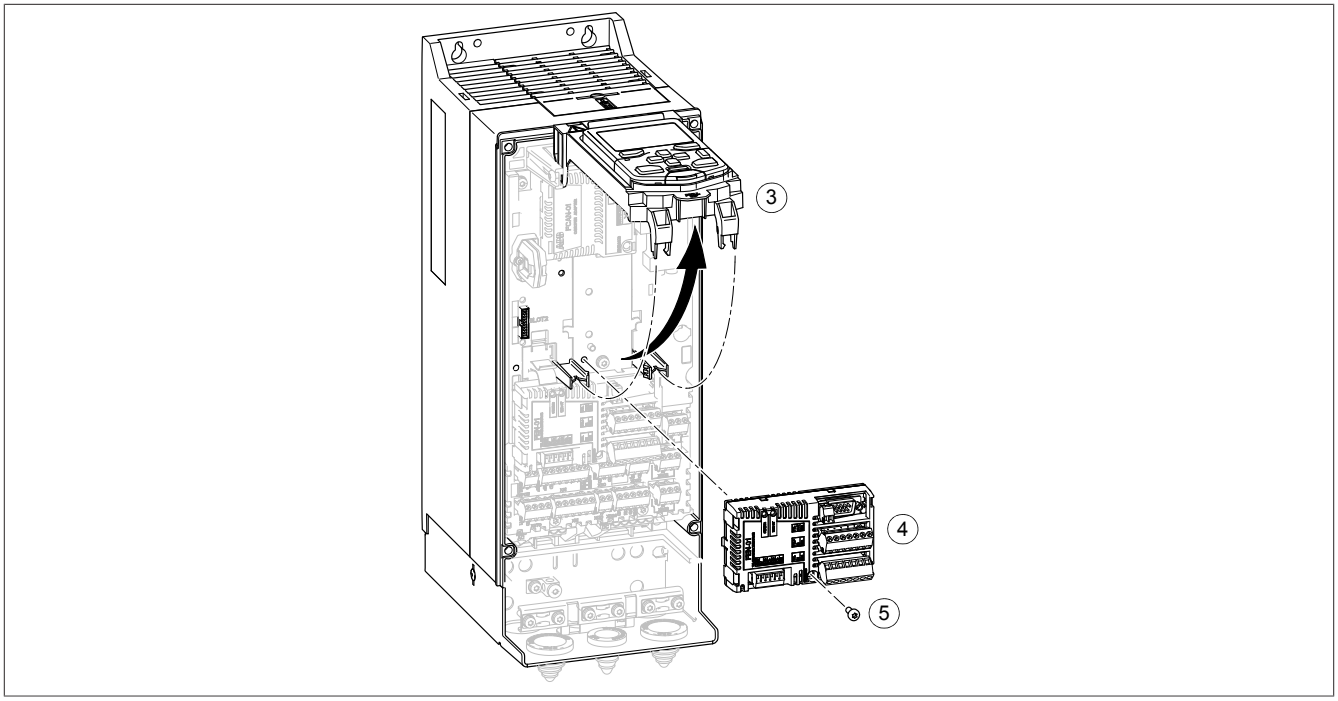
**The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Remove the front cover (see section "Connecting the power cables" on page 189).
3. Sizes R1 to R3: Swivel the control panel bracket upwards to make the slots for the optional modules accessible.
4. Carefully insert the optional module into the slot on the control unit.

5. Tighten the mounting screw to 0.8 Nm.

**Note:**

**The screw secures the connections and grounds the module. It is important for meeting EMC requirements and for proper functionality of the module.**




#### 4.3.6.2 Wiring the fieldbus adapter and encoder interface modules

See section Interface cards.

For routing the cables, see "Routing the cables" on page 208.

## 4.4 Installation checklist

This section contains a list for checking the mechanical and electrical installation of the frequency inverter.

Check the mechanical and electrical installation of the frequency inverter before commissioning. Go through the checklist with another person.

**Warning!**

**All work described below is only permitted to be carried out by qualified personnel. Observe all safety guidelines of the frequency inverter. Failure to observe the safety guidelines can result in injuries and fatal accidents. Open the main power disconnect switch of the frequency inverter and lock it in the open position. Ensure that there is no voltage on the frequency inverter by measuring.**

| ☑ | Check the following... |
|---|---|
| ☐ | The ambient conditions during operation correspond to the specification in chapter "Technical data" on page 20. |
| ☐ | If the frequency inverter has not been in operation for over a year: The electrolytic capacitors in the DC bus have been reformed. See "Capacitors" on page 360. |
| ☐ | There is a sufficiently dimensioned protective ground conductor (grounding) between the frequency inverter and the control cabinet or distribution board. |
| ☐ | There is a sufficiently dimensioned protective ground conductor (grounding) between the motor and frequency inverter. |
| ☐ | All protective ground conductors (grounding) have been connected to the appropriate terminals and the terminals have been tightened (pull on the conductors to check). |
| ☐ | The supply voltage corresponds to the nominal input voltage of the frequency inverter. Check on the nameplate. |
| ☐ | The power cable was connected to the correct terminals, the phase sequence is correct and the terminals have been tightened (pull on the conductors to check). |
| ☐ | Appropriate supply fuses and main power disconnect switches have been installed. |

**Installation**

| ☑ | Check the following... |
|---|---|
| ☐ | The motor cable was connected to the correct terminals, the phase sequence is correct and the terminals have been tightened (pull on the conductors to check). |
| ☐ | The braking resistor cable (if present) was connected to the correct terminals, and the terminals have been tightened (pull on the conductors to check). |
| ☐ | The motor cable (and braking resistor cable, if present) is routed separately from other cables. |
| ☐ | There are no power factor correction capacitors on the motor cable. |
| ☐ | The control cables (if any) have been connected to the control unit. |
| ☐ | If a bypass connection is used for the frequency inverter: The contactor for direct mains operation of the motor and the output contactor of the frequency inverter are either mechanically or electrically interlocked (this prevents both from being closed at the same time). |
| ☐ | There are no tools, foreign objects or drilling dust in the frequency inverter. |
| ☐ | All covers in the frequency inverter, motor terminal box, etc. are reinstalled. |
| ☐ | The motor and the driven machine are ready to start. |

# 5 Commissioning

This chapter contains the description of the procedure for commissioning the frequency inverter.

## 5.1 Procedure for commissioning

1. Configure the frequency inverter control program per chapter "The drive" on page 228.
   - For frequency inverters with braking resistor, see also section "Commissioning" on page 223.
2. Check function "Safe Torque Off" according to the instructions in section "Function "Safe Torque Off"" on page 211.

## 5.2 Warning and fault messages

This section contains a description of frequency inverter troubleshooting.

### LEDs

| Where | LED | Color | When the LED lights up |
|---|---|---|---|
| Operator panel mounting platform | POWER | Green | The control unit is switched on, and the control panel is supplied with +15 V. |
| | FAULT | Red | Fault in the frequency inverter. |

### Warning and fault messages

Descriptions, causes and corrective actions related to warning and fault messages of the control program are included in section "The drive" on page 228.

## 5.3 Function "Safe Torque Off"

This section contains a description of the frequency inverter's "Safe Torque Off" (STO) function as well as instructions for using this function.

### 5.3.1 Description

Function "Safe Torque Off" can be used, for example, to set up safety or monitoring circuits that stop the frequency inverter in the event of danger (e.g. with an emergency stop circuit). Another possible application is a circuit to prevent unexpected startup that can be used to perform short-term work (such as cleaning) and/or maintenance tasks on non-electrical parts of the machine without switching off the power supply to the frequency inverter.

When enabled, function "Safe Torque Off" switches off the control voltage of the power semiconductors of the frequency inverter output stage (A, see diagram below) and prevents the torque required for motor rotation from being generated. If the motor is running and function "Safe Torque Off" is enabled, the motor coasts to a stop.

Function "Safe Torque Off" has a redundant structure; this means that both channels must be used when implementing the safety function. The safety data specified in this manual was calculated for redundant use and only applies when both channels are used.

Function "Safe Torque Off" of the frequency inverter complies with the following standards:

| Standard | Name |
|---|---|
| IEC 60204-1:2016<br>EN 60204-1:2018 | Safety of machinery - Electrical equipment of machines - Part 1: General requirements |
| IEC 61000-6-7:2014 | Electromagnetic compatibility (EMC) - Part 6-7: Generic standards - Immunity requirements for devices and equipment intended to perform functions in safety-related systems (functional safety) at industrial sites |
| IEC 61326-3-1:2017 | Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications |
| IEC 61508-1:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements |
| IEC 61508-2:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems |
| IEC 61511-1:2017 | Functional safety - Safety instrumented systems for the process industry sector |

| Standard | Name |
|---|---|
| IEC 61800-5-2:2016<br>EN 61800-5-2:2007 | Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional |
| IEC 62061:2021<br>EN 62061:2021 | Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems |
| EN ISO 13849-1:2015 | Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design |
| EN ISO 13849-2:2012 | Safety of machinery - Safety-related parts of control systems - Part 2: Validation |

The function also complies with "Prevention of unexpected startup" per EN 1037:1995 + A1:2008 and "uncontrolled stop" (stop category 0) per EN 60204-1:2006 + AC:2010.

#### 5.3.1.1 Compliance with the European Machinery Directive

Additional information is included in section "Compliance with the European Machinery Directive" on page 38.

### 5.3.2 Wiring

The following diagrams show wiring examples of function "Safe Torque Off" for the following applications:

- Single frequency inverter (see page 213)
- Multiple frequency inverters (see page 214)
- Multiple frequency inverters with external 24 VDC power supply (see page 215)

#### 5.3.2.1 Safety switch

In the circuit diagrams below, the safety switch has the designation (K). It stands for a component such as a manually operated switch, emergency stop button or contacts of a safety relay or safety PLC.

- If a manually operated switch is used, a switch type that can be locked in the open position must be selected.
- The contacts of the switch or relay must open/close with a time offset to each other of max. 200 ms.

#### 5.3.2.2 Cable types and lengths

- If possible, use double-shielded cables with twisted pairs of wires.
- Maximum cable lengths:
  - 300 m (984 ft) between the safety switch [K] and control unit of the frequency inverter.
  - 60 m (200 ft) between multiple frequency inverters.
  - 60 m (200 ft) between external power supply and the first frequency inverter.

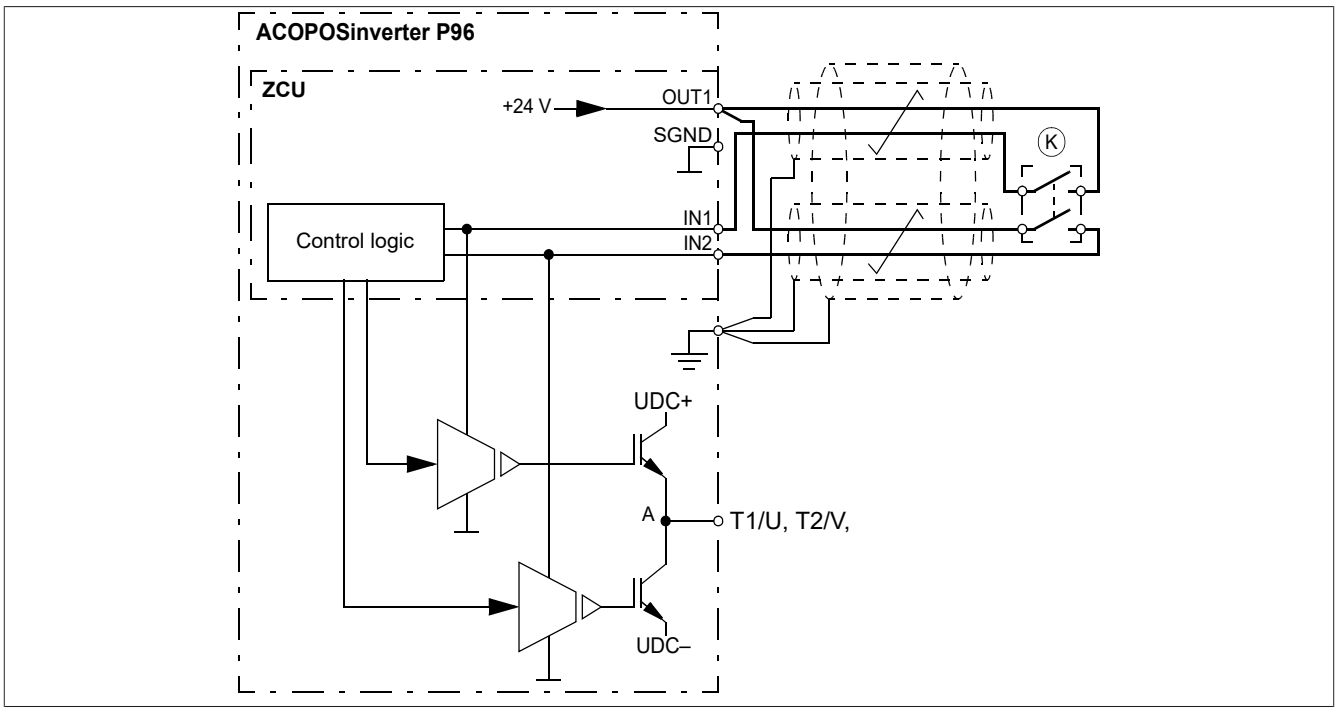
> **Note:**
>
> **The voltage on the INx terminals of individual frequency inverters must be at least 17 VDC to be interpreted as "1".**

#### 5.3.2.3 Grounding cable shields

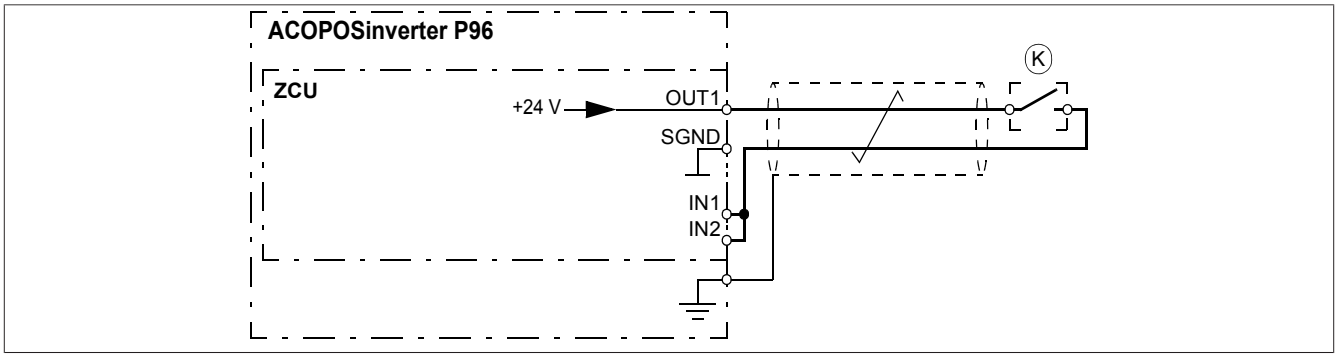
- Ground the shielding of the wiring between the activation switch and control unit at the control unit.
- Ground the shielding of the wiring between two control units only at one control unit.

### 5.3.2.4 Single frequency inverter with internal power supply

#### 5.3.2.4.1 Dual-channel connection



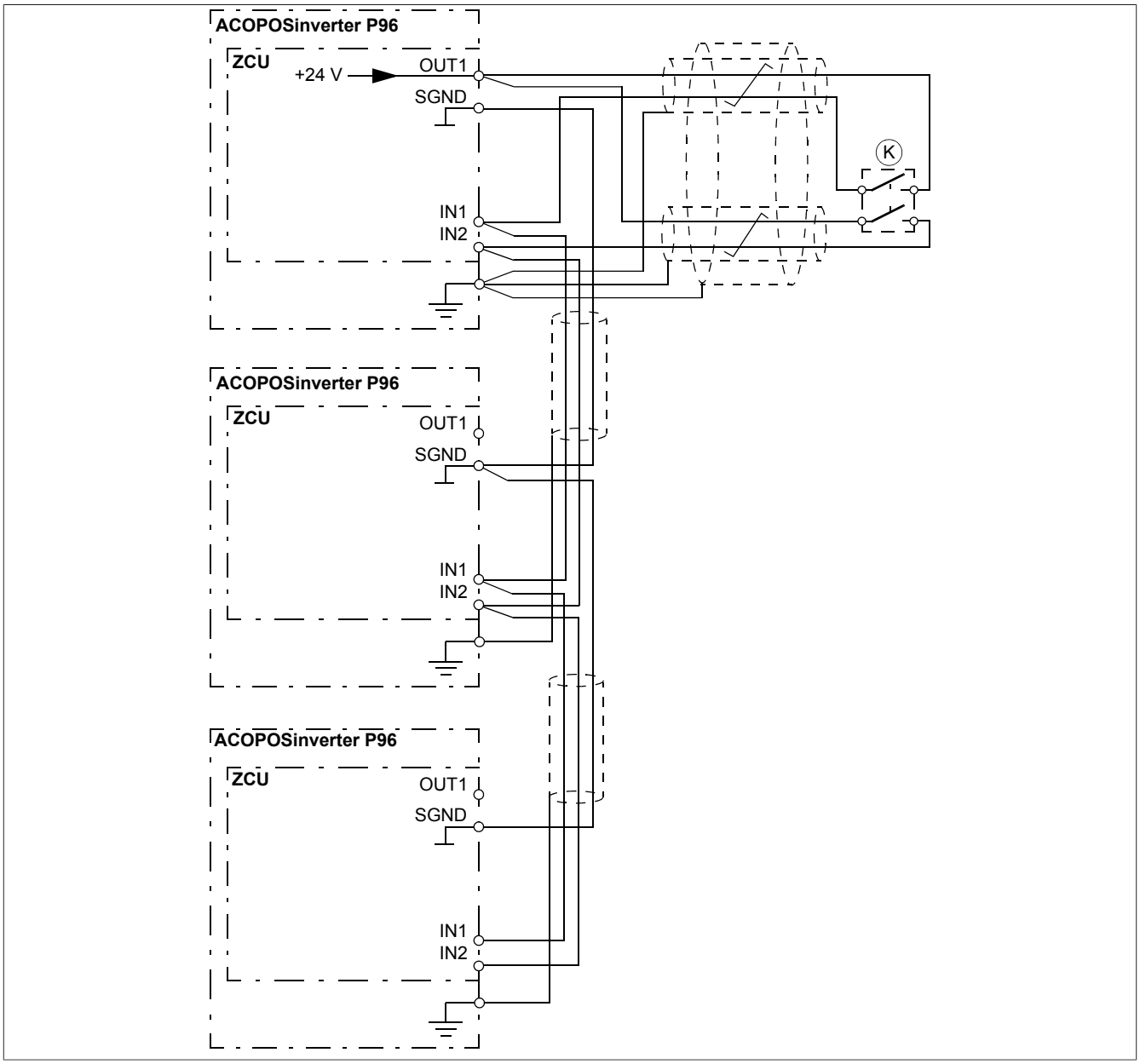

#### 5.3.2.4.2 Single-channel connection



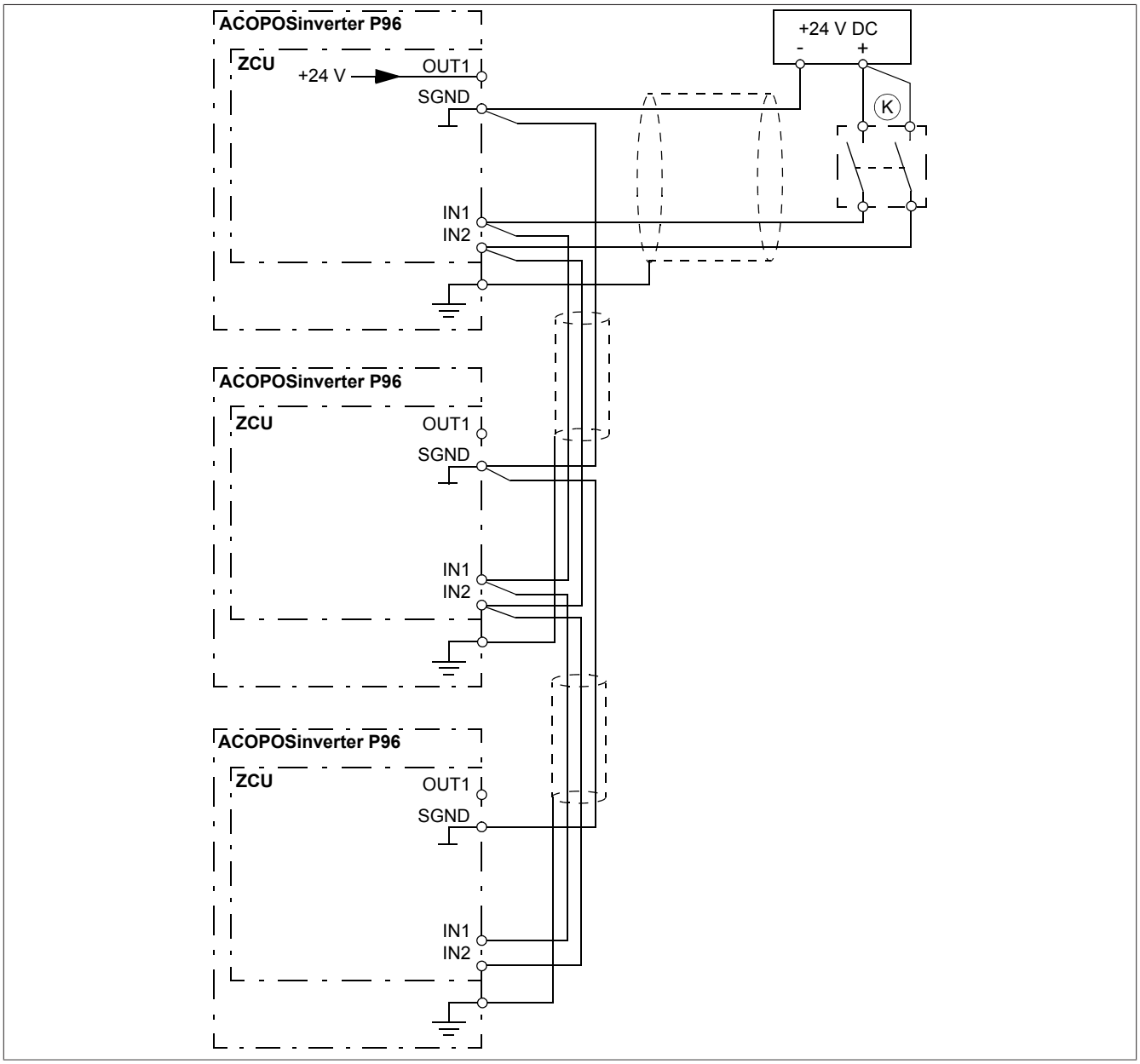

## Note:

- **Both STO inputs (IN1, IN2) must be connected to the activation switch. Otherwise, there is no SIL/PL classification.**
- **It is essential to avoid potential errors when wiring. Therefore, use shielded cables. For measures on how to avoid errors during wiring, see e.g. EN ISO 13849-2:2012, table D.4.**

### 5.3.2.5 Multiple frequency inverters with internal power supply



#### 5.3.2.6 Multiple frequency inverters with external power supply




### 5.3.3 Operating principle

1. Function "Safe Torque Off" is enabled (the safety switch is opened or the contacts of the safety relay open).
2. The STO inputs on the inverter control unit switch off.
3. The control unit switches off the control voltage of the IGBTs of the frequency inverter.
4. The control program generates an indicator defined according to parameter 31.22 (see "The drive" on page 228).
5. The motor coasts to a stop (if rotating). The frequency inverter cannot be restarted if the safety switch or the contacts of the safety relay are open. After the contacts close, a new start command is required to start the frequency inverter.

### 5.3.4 Commissioning including acceptance test

A check is required to ensure the reliability of function "Safe Torque Off". The person responsible for final assembly of the machine must ensure the reliability of the function during an acceptance test.

The acceptance test must be performed in the following cases:

- When commissioning the safety functions for the first time
- After any changes related to the safety function (electronic boards, wiring, components, settings, etc.)
- After any maintenance tasks related to the safety function
- After updating the frequency inverter firmware

#### 5.3.4.1 Competence

The acceptance test of the safety function must be performed by a competent person who has the appropriate expertise and knowledge of the safety function and functional safety as required by section 6 of the IEC 61508-1 standard. The competent/authorized person must document the test procedure and prepare and sign the test report.

#### 5.3.4.2 Acceptance test reports

Signed acceptance test reports must be included with the machine's service booklet/documents. The report must contain documentation of commissioning activities and test results as well as references to failure reports and the correction of malfunctions. Any new acceptance test performed due to modifications or servicing activities must be recorded in the service booklet/documents.

#### 5.3.4.3 Procedure for the acceptance test

After wiring function "Safe Torque Off", it must be checked as follows.

| ☑ | Measure |
|---|---|
| ☐ | **Warning!** **The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.** |
| ☐ | Ensure sure that the drive can be started, rotated and stopped without a hazard during commissioning. |
| ☐ | Stop the drive (if in operation), switch off the power supply and disconnect the frequency inverter from the mains using a disconnector. |
| ☐ | Check the wiring of function "Safe Torque Off" (STO) using the circuit diagram. |
| ☐ | Close the disconnector and switch on the power supply. |

| ☑ | Measure |
|---|---|
| ☐ | Check function STO with the motor stopped:<br>• Give a stop command to the frequency inverter (if in operation) and wait until the motor shaft is at standstill.<br>Ensure sure that the frequency inverter operates as follows:<br>• Open the STO circuit. The frequency inverter generates a message if one was defined for state "Stopped" using parameter 31.22 (see "The drive" on page 228).<br>• Give a start command to check that function STO is blocking operation of the frequency inverter. The motor is not permitted to start up.<br>• Close the STO circuit.<br>• Acknowledge all active faults. Restart the drive and check whether the motor runs normally. |
| ☐ | Check function STO function with the motor running:<br>• Start the drive and ensure that the motor is running.<br>• Open the STO circuit. The motor must stop. The frequency inverter generates a message if one was defined for state "In operation" using parameter 31.22 (see "The drive" on page 228).<br>• Acknowledge all active faults and try to start the frequency inverter.<br>• Ensure that the motor remains at standstill and the inverter behaves as described above when the motor is stopped.<br>• Close the STO circuit.<br>• Acknowledge all active faults. Restart the drive and check whether the motor runs normally. |
| ☐ | Check operation of the frequency inverter fault detection. The motor can be stopped or running.<br>• Open the first channel of the STO circuit (wire from IN1). If the motor was running, let it coast to a stop. The frequency inverter generates fault message FA81 Safe torque off 1 loss (see "The drive" on page 228).<br>• Issue a start command to check whether the STO function blocks operation of the frequency inverter. The motor is not permitted to start up.<br>• Close the STO circuit.<br>• Acknowledge all active faults. Restart the drive and check whether the motor runs normally.<br>• Open the second channel of the STO circuit (wire from IN2). If the motor was running, let it coast to a stop. The frequency inverter generates fault message FA82 Safe torque off 2 loss (see "The drive" on page 228).<br>• Issue a start command to check whether the STO function blocks operation of the frequency inverter. The motor is not permitted to start up.<br>• Close the STO circuit.<br>• Acknowledge all active faults. Restart the drive and check whether the motor runs normally. |
| ☐ | Create and sign the acceptance test report confirming that the safety function operates reliably and without malfunctions. |

### 5.3.5 Use/Function

1. Open the safety switch or activate the safety function wired to the STO port.
2. STO inputs on the control unit of the frequency inverter become de-energized, and the control unit cuts off the control voltage from the inverter IGBTs.
3. The control program generates an indicator defined according to parameter 31.22 (see section "The drive" on page 228).
4. The motor coasts to a stop (if rotating). The frequency inverter does not start if the safety switch or the contacts of the safety relay are open.
5. Disable the STO function by closing the safety switch or resetting the safety function wired to the STO connection.
6. Acknowledge all faults before restarting.

**Warning!**

**Function "Safe Torque Off" does not switch off the power supply to the main and auxiliary circuits of the frequency inverter. Maintenance tasks on electrical parts of the frequency inverter or motor is therefore only permitted to be carried out after the frequency inverter has been disconnected from the power supply.**

Function "Safe Torque Off" function is supported by every ACOPOSinverter inverter or frequency inverter firmware.

## Warning!

**(Applies only to permanent magnet motors or speed-controlled synchronous motors [Syn-RM].) In the event of multiple faults in the IGBT power semiconductors, the system can generate a torque that rotates the motor shaft up to a maximum of 180/p degrees (for permanent magnet motors) or 180/2p degrees (for speed-controlled synchronous motors [Syn-RM]) regardless of whether function "Safe Torque Off" is enabled. "p" denotes the number of pole pairs.**

## Note:

- **If the frequency inverter is stopped during operation by function "Safe Torque Off", it cuts off the power supply to the motor and the motor coasts to a stop. If this poses a hazard or cannot be permitted, stop the frequency inverter and driven machine with the correct stop function before using this function.**
- **Function "Safe Torque Off" has priority over all other functions of the frequency inverter.**
- **Function "Safe Torque Off" is ineffective against sabotage or deliberate misuse.**
- **Function "Safe Torque Off" was developed to reduce known hazardous conditions. Nevertheless, it is not always possible to eliminate all potential hazards. The person responsible for installing the machine must inform the end user about the residual risks.**

### 5.3.6 Servicing

After the functionality of the STO circuit has been checked during commissioning, function "Safe Torque Off" (STO) must be tested regularly. With an operating mode with a high demand rate, the maximum test interval is 20 years. With a low demand mode of operation, the maximum interval of retesting is 10 years, see section "Safety data (SIL, PL)" on page 219. It is assumed that all dangerous faults of the STO circuit are detected during the repeat test. To perform the repeat test, see "Procedure for the acceptance test" on page 216.

## Note:

**See also "Recommendation of Use CNB/M/11.050" published by the European Coordination of Notified Bodies regarding two-channel, safety-related systems with electromechanical outputs:**

- **If the safety requirement level for the safety function is SIL 3 or PL e (Cat. 3 or 4), functional testing must take place at least monthly.**
- **If the safety requirement level for the safety function is SIL 2 (HFT = 1) or PL d (Cat. 3), functional testing must take place at least annually.**

Function STO of the frequency inverter does not contain any electromechanical components.

In addition to the test, it is recommended to check the functions when performing other routine servicing of the machine.

Include the check of function "Safe Torque Off" described in this chapter in the routine servicing program of the machine driven by the frequency inverter.

If wiring or components have been replaced or parameters have been restored after commissioning, the test described in section "Procedure for the acceptance test" on page 216 must be performed again.

Use only replacement parts approved by B&R.

Log all maintenance tasks and activities regarding functional testing in the machine logbook.

#### 5.3.6.1 Competence

Maintenance tasks and activities regarding the testing of the safety function must be performed by a competent person who has the appropriate expertise and knowledge of the safety function and functional safety as required by section 6 of the IEC 61508-1 standard.

### 5.3.7 Warning and fault messages

The indicators output during normal operation of function "Safe Torque Off" are selected by frequency inverter parameter 31.22.

Diagnostics of function "Safe Torque Off" function is performed by aligning the status of the two STO channels. If the channels do not have the same status, the frequency inverter will shut down due to a fault in the STO hardware. Attempting to use function STO non-redundantly, for example by activating only one channel, will result in the same reaction.

For the indicators generated by the frequency inverter as well as a description of the procedure for assigning fault and warning indicators to the respective output on the control unit during external diagnostics, see the frequency inverter's firmware manual.

Any failures of function "Safe Torque Off" must be reported to B&R.

### 5.3.8 Safety data (SIL, PL)

The safety data for function "Safe Torque Off" is provided below.

**Note:**

**The safety data is calculated for redundant use and only applies if both STO channels are used.**

| Size | SIL / SIL CL | SC | PL | SFF (%) | PFH (T1 = 20 a) (1/h) | $PFD_{avg}$ | | | MTTF D (a) | DC (%) | Cat. | HFT | CCF | Service life (a) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Complete test | | Simplified test | | | | | | |
| | | | | | | T1 = 5 a | T1 = 10 a | T1 = 5 a or 10 a | | | | | | |
| **$U_N$ = 500 V** | | | | | | | | | | | | | | |
| R1 | 3 | 3 | e | >99 | 2.84E-09 | 5.91E-05 | 1.19E-04 | 2.37E-05 | 10530 | ≥90 | 3 | 1 | 80 | 20 |
| R2 | 3 | 3 | e | >99 | 2.84E-09 | 5.91E-05 | 1.19E-04 | 2.37E-05 | 10529 | ≥90 | 3 | 1 | 80 | 20 |
| R3 | 3 | 3 | e | >99 | 2.84E-09 | 5.91E-05 | 1.19E-04 | 2.37E-05 | 10489 | ≥90 | 3 | 1 | 80 | 20 |
| R4 | 3 | 3 | e | >99 | 2.89E-09 | 6.02E-05 | 1.21E-04 | 2.41E-05 | 10442 | ≥90 | 3 | 1 | 80 | 20 |
| R5 | 3 | 3 | e | >99 | 2.89E-09 | 6.02E-05 | 1.21E-04 | 2.41E-05 | 10240 | ≥90 | 3 | 1 | 80 | 20 |
| R6 | 3 | 3 | e | >99 | 2.89E-09 | 6.02E-05 | 1.21E-04 | 2.41E-05 | 10340 | ≥90 | 3 | 1 | 80 | 20 |
| R7 | 3 | 3 | e | >99 | 2.89E-09 | 6.02E-05 | 1.21E-04 | 2.41E-05 | 10340 | ≥90 | 3 | 1 | 80 | 20 |

- This temperature profile is used to calculate the safety values:
  - 670 on/off cycles per year with ΔT = 71.66°C
  - 1340 on/off cycles per year with ΔT = 61.66°C
  - 30 on/off cycles per year with ΔT = 10.0°C
  - 32°C board temperature at 2.0% of the time
  - 60°C board temperature at 1.5% of the time
  - 85°C board temperature at 2.3% of the time
- Function STO is a type A safety component per the definition in IEC 61508-2.
- Relevant failure types:
  - Function STO trips incorrectly (safe failure).
  - Function STO is not enabled when requested.

  Fault exclusion of failure mode "Short circuit on electronic board" was performed (EN 13849-2, table D.5). The analysis is based on the assumption that only one malfunction occurs at a time. Multiple malfunctions occurring simultaneously have not been analyzed.
- STO response time (shortest detectable interruption): 1 ms
- STO response time: 2 ms (typical), 5 ms (maximum)
- Fault response time: Channels in different operating states for longer than 200 ms
- Fault response time: Fault response time + 10 ms
- Delay of STO fault indicator (parameter 31.22): <500 ms
- Delay of STO warning indicator (parameter 31.22): <1000 ms

#### 5.3.8.1 Abbreviations

| Abbr. | Standard | Description |
|---|---|---|
| Cat. | EN ISO 13849-1 | Classification of the safety-related parts of a control system in terms of their immunity to disturbances and subsequent response in the event of disturbances and that is achieved by the structural arrangement of the parts, disturbance detection and/or by their reliability. The categories are B, 1, 2, 3 and 4. |
| CCF | EN ISO 13849-1 | Common cause failure (%) |
| DC | EN ISO 13849-1 | Diagnostic coverage |
| FIT | IEC 61508 | Failure in time: 1E-9 hours |
| HFT | IEC 61508 | Hardware fault tolerance |
| $MTTF_d$ | EN ISO 13849-1 | Mean time to dangerous failure: (Total number of life units) / (Number of dangerous undetected failures) during a particular measurement interval under specified conditions. |
| $PFD_{avg}$ | IEC 61508 | Average probability of dangerous failure on demand |
| PFH | IEC 61508 | Average frequency of dangerous failures per hour |
| PL | EN ISO 13849-1 | Performance level, levels a...e. Comparable to SIL level. |
| SC | IEC 61508 | Systematic capability |
| SFF | IEC 61508 | Safe failure fraction (%) |
| SIL | IEC 61508 | Safety integrity level (1...3) |
| SILCL | IEC 62061 | Maximum SIL (level 1...3) that can be specified for a safety function or subsystem |
| SS1 | IEC/EN 61800-5-2 | Safe stop 1 |
| STO | IEC/EN 61800-5-2 | Safe Torque Off (STO) |
| T1 | IEC 61508-6 | Proof test interval T1 is a parameter used to define the probability of failure rate (PFH or PFD) for the safety function or a subsystem. Performing a test with a maximum interval of T1 is required to obtain the SIL rating. The same interval must be used to obtain the PL rating (EN ISO 13849). Note that specified T1 values do not constitute a guarantee or warranty. See also section "Servicing" on page 218. |

## 5.4 Rheostatic braking

This section describes the selection, protection and wiring of brake choppers and resistors. The section also contains technical data.

### 5.4.1 Operating principle and hardware description

The ACOPOSinverter P96 has integrated brake choppers. Braking resistors are available as optional accessories.

The brake chopper processes the energy generated by a braking motor. The brake chopper always switches the braking resistors to the DC bus when the DC bus voltage exceeds the limit value set in the control program. The energy conversion by the losses of the braking resistors reduces the voltage until the resistors can be switched off again.

### 5.4.2 Planning the rheostatic braking system

#### 5.4.2.1 Selecting the components for the brake circuit

1. Calculate the maximum power ($P_{max}$) generated by the motor during operation.
2. Select a suitable combination of frequency inverter and braking resistor for the application according to the table in section "Nominal data" on page 224. The braking power of the chopper must be greater than or equal to the maximum braking power generated by the motor.
3. Check the selection of the resistor. The energy generated by the motor within 400 seconds is not permitted to exceed heat dissipation capacity $E_R$ of the resistor.

**Note:**

**If value $E_R$ is not sufficient, four resistors can be used with two standard resistors connected in parallel and two connected in series. Value $E_R$ of the unit consisting of four resistors is four times the value defined for the single resistor.**

#### 5.4.2.2 Selecting a customized braking resistor

If you use a braking resistor other than the standard resistor, ensure the following:

1. The resistance value of the customized resistor is greater than or equal to the resistance value of the standard resistor according to the table in section"Nominal data" on page 224:
   $R \geq R_{min}$

| | |
|---|---|
| R | Resistance value of the customized resistor.<br> <br>**Warning!**<br>**Never use a braking resistor with a lower resistance value than $R_{min}$. The frequency inverter and chopper cannot withstand the overcurrent caused by a resistance value that is too low.** |
| $R_{min}$ | Resistance value of the standard resistor |

2. The load capacitance of the customized resistor is higher than the instantaneous maximum power consumption of the resistor when it is connected to the DC bus voltage of the frequency inverter via the switched-on brake chopper:

$$P_r < \frac{U_{DC}^2}{R}$$

| | |
|---|---|
| $P_r$ | Load capacity of the customized resistor |
| $U_{DC}$ | DC bus voltage of the frequency inverter.<br>1.35 · 1.25 · 415 VDC (with supply voltage from 380 to 415 VAC)<br>1.35 · 1.25 · 500 VDC (with supply voltage from 440 to 500 VAC)<br>1.35 · 1.25 · 690 VDC (with supply voltage from 525 to 690 VAC) |
| R | Resistance value of the customized resistor |

### 5.4.2.3 Selecting and routing the braking resistor cables

To ensure that the input fuses also protect the resistor cables, use resistor cables with the same design as the input cables of the frequency inverter. Alternatively, a shielded two-conductor cable with the same cross section can be used.

#### Minimizing electromagnetic interference

Observe the following rules to minimize electromagnetic interference due to the rapid current changes in the resistor cables:

- The resistor cables must be completely shielded, either by using shielded cables or by using a metal cable conduit (cable duct). Unshielded single-core cables are only permitted to be used inside a cabinet that effectively suppresses radiated emissions.
- Resistance cables must be routed separately from other cables.
- Cables running in parallel over long distances should be avoided. The minimum distance between parallel cables must be 0.3 meters.
- The other cables must be crossed at right angles.
- The cables must be as short as possible to minimize radiated emissions and stress on the chopper IGBTs. The longer the cables, the higher the radiated emissions, inductive load and voltage peaks over the IGBT semiconductors of the brake chopper.

#### Maximum cable length

The maximum length of the resistor cable is 10 m (33 ft).

#### EMC conformity of the complete installation

**Note:**

**B&R cannot confirm compliance with EMC requirements when using external user-specific braking resistors and cables. Compliance with EMC requirements of the complete installation must be ensured by the customer.**

### 5.4.2.4 Placing the braking resistors

All resistors must be installed outside the frequency inverter in a place where they are cooled.

Resistors must be installed as follows with regard to cooling requirements:

- Any danger of overheating of the resistor or the material in the immediate vicinity is not permitted.
- The temperature of the room in which the resistor is installed is not permitted to exceed the permissible maximum value.

Cool resistors with sufficiently cool air / coolant according to the resistor manufacturer's instructions.

## Warning!

**The materials used in the vicinity of the braking resistor are not permitted to be flammable. The surface temperature of the resistor is high. The exhaust air of the resistor is several hundred degrees. If cooling is provided by a fan system, it must be ensured that the material can withstand high temperatures. Protect the resistor against contact.**

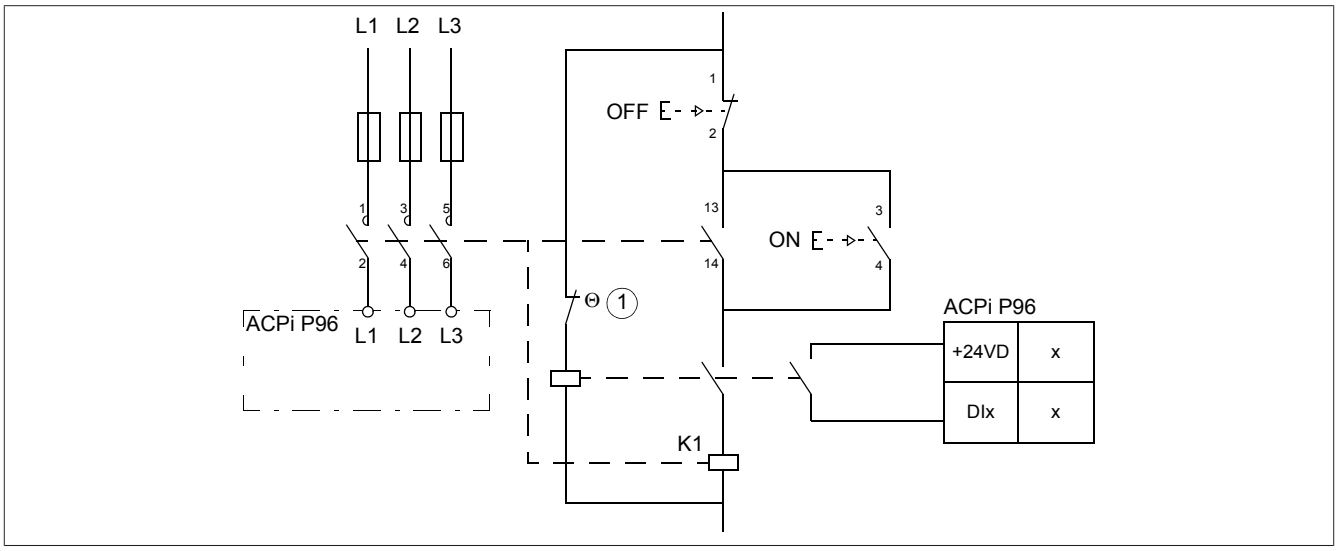
#### 5.4.2.5 Protecting the system against thermal overload

The brake chopper and resistor cables are protected against thermal overload if the cables are sufficiently dimensioned for the nominal current of the frequency inverter. The control program of the frequency inverter includes a protection function against thermal overload of the resistors and resistor cables that can be set by the user. See section "The drive" on page 228.

##### 5.4.2.5.1 Sizes R1 to R4

For safety purposes, the frequency inverter can be equipped with a main contactor. The contactor must be wired to open in the event the braking resistor overheats, which enables the frequency inverter to interrupt the mains supply if the braking chopper remains conductive when a fault occurs. An example circuit diagram is shown below.

We recommend also wiring the thermal switch to a digital input of the frequency inverter.




##### 5.4.2.5.2 Sizes R5 to R7

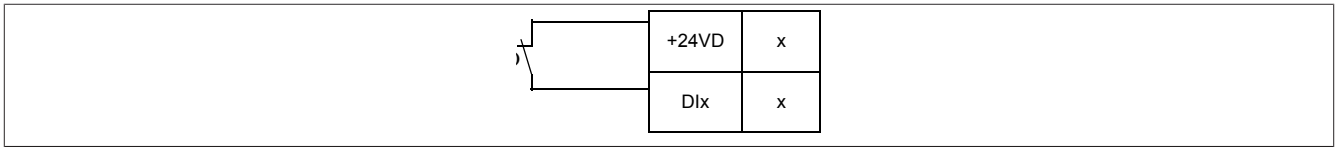
If the resistor is dimensioned according to specifications and an internal brake chopper is used, a main contactor is not required to protect the resistor from overheating. If the brake chopper remains conductive in the event of a fault, the frequency inverter protects the braking resistor by blocking the energy flow through the input bridge.

It should be noted that the charging resistor is also heavily loaded and can fail.

## Note:

**If an external brake chopper (outside the frequency inverter module) is used, a main contactor is always required.**

For safety reasons, a temperature-controlled switch is required. The cable for the thermal switch must be shielded and is not permitted to be longer than the cable of the resistor. Wire the switch to a digital input on the control unit of the frequency inverter as shown in the figure below.



#### 5.4.2.6 Protecting the resistor cable against short circuits

The input fuses also protect the resistor's cable if it is identical to the supply cable.

### 5.4.3 Electrical installation

#### Checking the insulation of the assembly

Follow the instructions in section "Braking resistor unit" on page 187.

#### Connection diagram

Additional information is included in section "Connection diagram" on page 189.

#### Procedure for connection work

- Connect the resistor cables to the R+ and R- terminals in the same way as the other power cables. When using a three-conductor cable, cut off the third conductor, insulate it and ground the twisted cable shield (protective ground conductor of the resistor) at both ends.
- Close the temperature-controlled switch of the braking resistor as described above in section "Sizes R1 to R4" or "Sizes R5 to R7".

### 5.4.4 Commissioning

**Note:**

**When used for the first time, the protective oil film on the braking resistors will burn off. Sufficient airflow must be ensured.**

Set the following parameters (P96 main control program):

- Disable overvoltage control of the frequency inverter with parameter **30.30 Overvoltage control**.
- Set parameter **31.01 External event 1 source** to the digital input to which the thermal switch of the braking resistor is connected.
- Set parameter **31.02 External event 1 type** to **Fault**.
- Enable the brake chopper function with parameter **43.06 Brake chopper function**. If **Enabled with thermal model** is selected, parameters 43.08 and 43.09 for the overload protection of the braking resistor must also be set according to the application.
- Sizes R5 to R7: Set parameter **43.07 Brake chopper run enable** to **Other [bit]** and use parameter **10.01 DI status** to select the digital input to which the braking resistor thermal switch is connected.
- Check the setting of the resistance value of parameter **43.10 Brake resistance**.

With these parameter settings, the frequency inverter stops in the event of overtemperature of the braking resistor and the drive coasts to a stop.

**Warning!**

**If the frequency inverter is equipped with a brake chopper but the chopper is not enabled by parameter setting, there is no internal protection of the frequency inverter against overheating of the resistor. In this case, the braking resistor must be disconnected.**

For instructions about the settings for other control programs, see the corresponding section in "The drive" on page 228.

## 5.4.5 Technical data

### 5.4.5.1 Nominal data

The specified data applies to an ambient temperature of 40°C (104°F).

| Frequency inverter type | Internal brake chopper | | Braking resistors (examples) | | | |
|---|---|---|---|---|---|---|
| | $P_{brcont}$ [1] | $R_{min}$ [2] | Type | R [3] | $E_R$ [4] | $P_{Rcont}$ [5] |
| | kW | Ohm | | Ohm | kJ | kW |
| $U_N$ = 500 V | | | | | | |
| 8I96T400075.00-000 | 1.1 | 78 | 8I0BR080.000-1 | 80 | 40 | 0.14 |
| 8I96T400110.00-000 | 1.5 | 78 | 8I0BR080.000-1 | 80 | 40 | 0.14 |
| 8I96T400150.00-000 | 2.2 | 78 | 8I0BR080.000-1 | 80 | 40 | 0.14 |
| 8I96T400220.00-000 | 3.0 | 78 | 8I0BR080.000-1 | 80 | 40 | 0.14 |
| 8I96T400300.00-000 | 4.0 | 78 | 8I0BR080.000-1 | 80 | 40 | 0.14 |
| 8I96T400400.00-000 | 5.5 | 78 | 8I0BR080.000-1 | 80 | 40 | 0.14 |
| 8I96T400550.00-000 | 7.5 | 39 | 8I0BR044.000-1 | 44 | 210 | 1 |
| 8I96T400750.00-000 | 11 | 39 | 8I0BR044.000-1 | 44 | 210 | 1 |
| 8I96T401100.00-000 | 15 | 19 | 8I0BR022.000-1 | 22 | 420 | 2 |
| 8I96T401500.00-000 | 18.5 | 19 | 8I0BR022.000-1 | 22 | 420 | 2 |
| 8I96T401850.00-000 | 22 | 13 | 8I0BR013.000-1 | 13 | 435 | 2 |
| 8I96T402200.00-000 | 22 | 13 | 8I0BR013.000-1 | 13 | 435 | 2 |
| 8I96T403000.00-000 | 37 | 8 | 8I0BR008.003-1 | 8 | 1800 | 4.5 |
| 8I96T403700.00-000 | 45 | 8 | 8I0BR008.003-1 | 8 | 1800 | 4.5 |
| 8I96T404500.00-000 | 55 | 5.4 | 8I0BR006.000-1 | 6 | 2400 | 6 |
| 8I96T405500.00-000 | 75 | 5.4 | 8I0BR006.000-1 | 6 | 2400 | 6 |
| 8I96T407500.00-000 | 90 | 3.3 | 8I0BR004.001-1 | 4 | 3600 | 9 |
| 8I96T409000.00-000 | 110 | 3.3 | 8I0BR004.001-1 | 4 | 3600 | 9 |

1) Maximum continuous braking power. The braking procedure is considered continuous if the braking time exceeds 30 seconds.
2) The minimum permissible resistance value of the braking resistor.
3) Resistance value for the listed resistor unit.
4) Short energy pulse that the resistor unit withstands every 400 seconds.
5) Continuous (heat) power of the resistor that it can dissipate when properly installed.

### 5.4.5.2 Degree of protection and thermal constant of the resistors

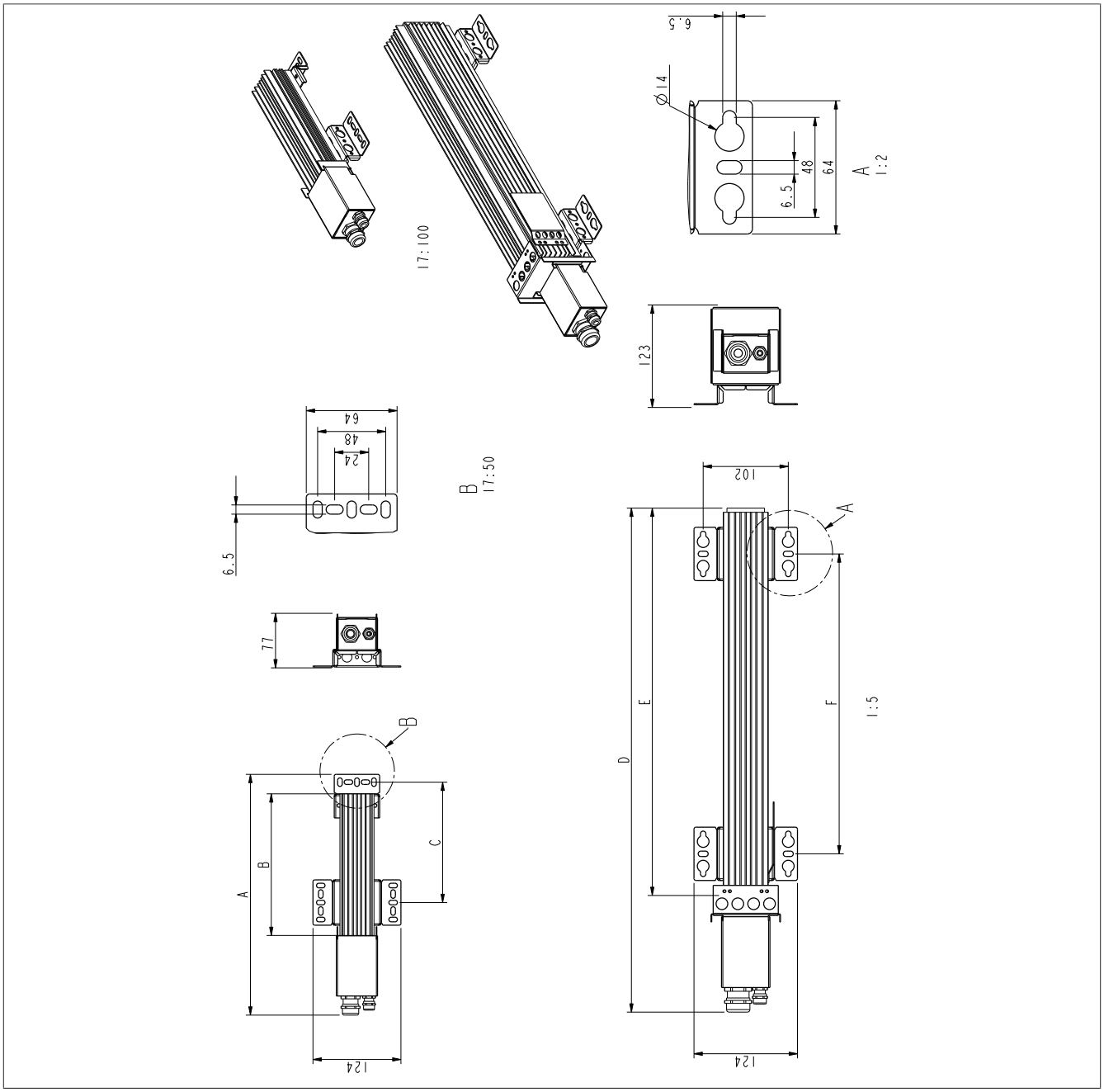
| Resistor type | Degree of protection | Thermal constant(s) |
|---|---|---|
| 8I0BR080.000-1 | IP20 | |
| 8I0BR044.000-1<br>8I0BR022.000-1<br>8I0BR013.000-1 | IP21 | 200 |
| 8I0BR008.003-1<br>8I0BR006.000-1<br>8I0BR004.001-1 | IP00 | 555 |

### 5.4.5.3 Terminal sizes and cable diameters

Additional information is included in section "Terminal sizes and cable diameters for power cables" on page 32.

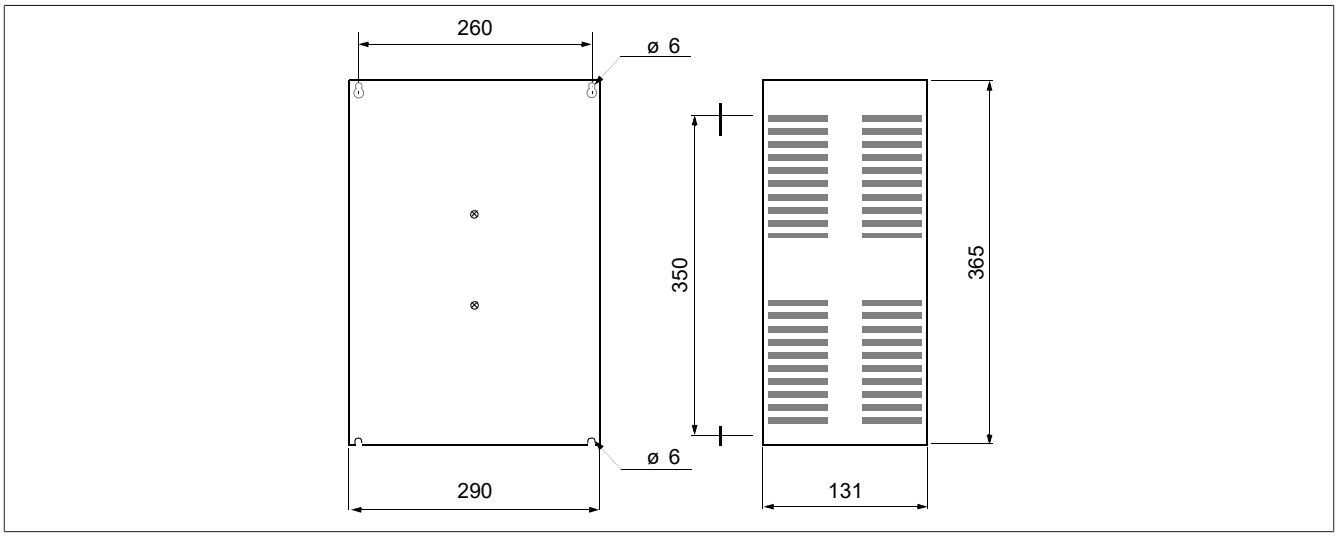
## 5.4.6 Dimensions and weights of external resistors

### 5.4.6.1 8I0BR080.000-1



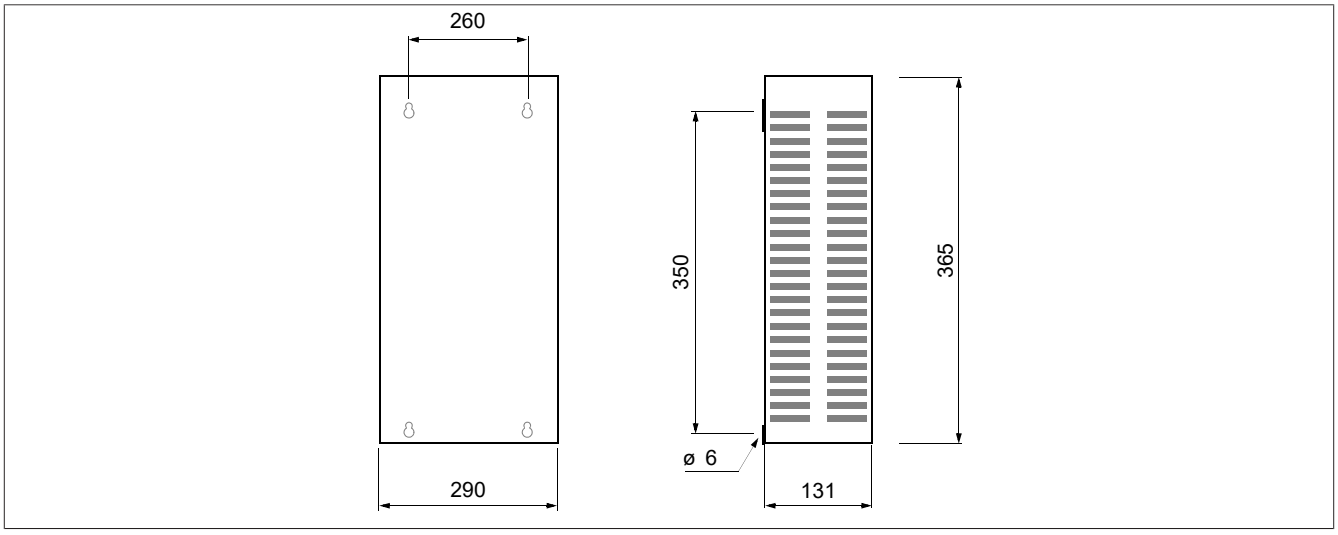

| | |
|---|---|
| Dimension A | 340 mm (13.39 in.) |
| Dimension B | 200 mm (7.87 in.) |
| Dimension C | 170 mm (6.69 in.) |
| Weight | 0.8 kg (1.8 lb) |
| Maximum wire cross section of main terminals | 10 mm² (6 AWG) |
| Tightening torques of main clamps | 1.5 … 1.8 Nm (13 … 16 lbf·in) |
| Max. wire cross section of terminals for overtemperature switch | 4 mm² (12 AWG) |
| Tightening torque of terminals for overtemperature switch | 0.6 … 0.8 Nm (5.3 … 7.1 lbf·in) |

### 5.4.6.2 8I0BR044.000-1



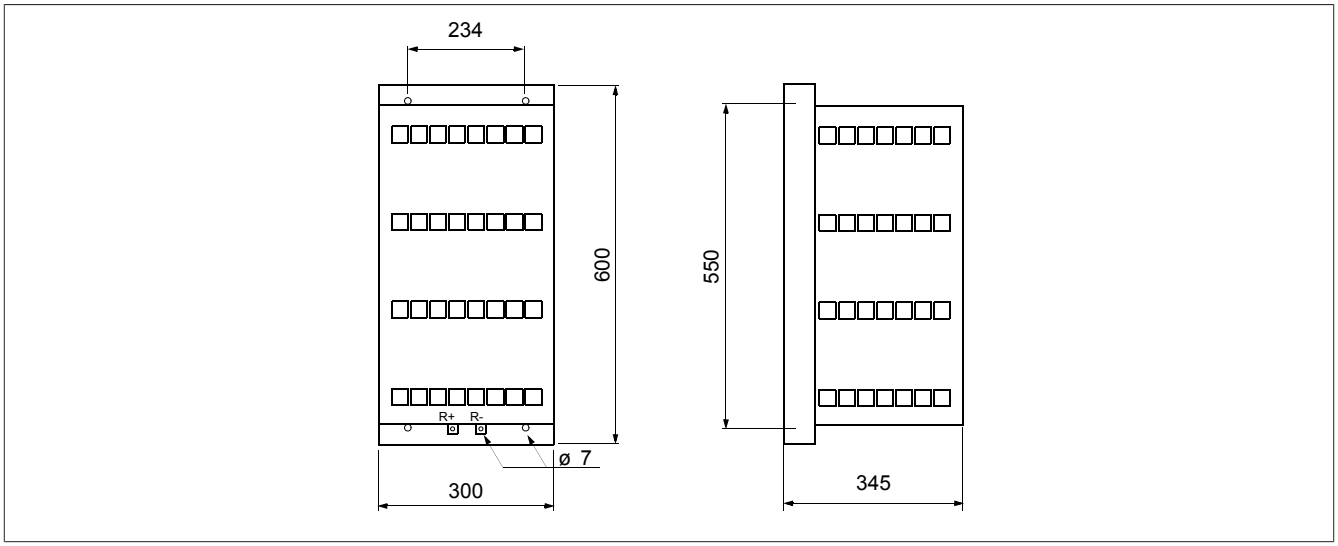

| | |
|---|---|
| Weight | 6 kg (13 lb) |

### 5.4.6.3 8I0BR022.000-1 and 8I0BR013.000-1



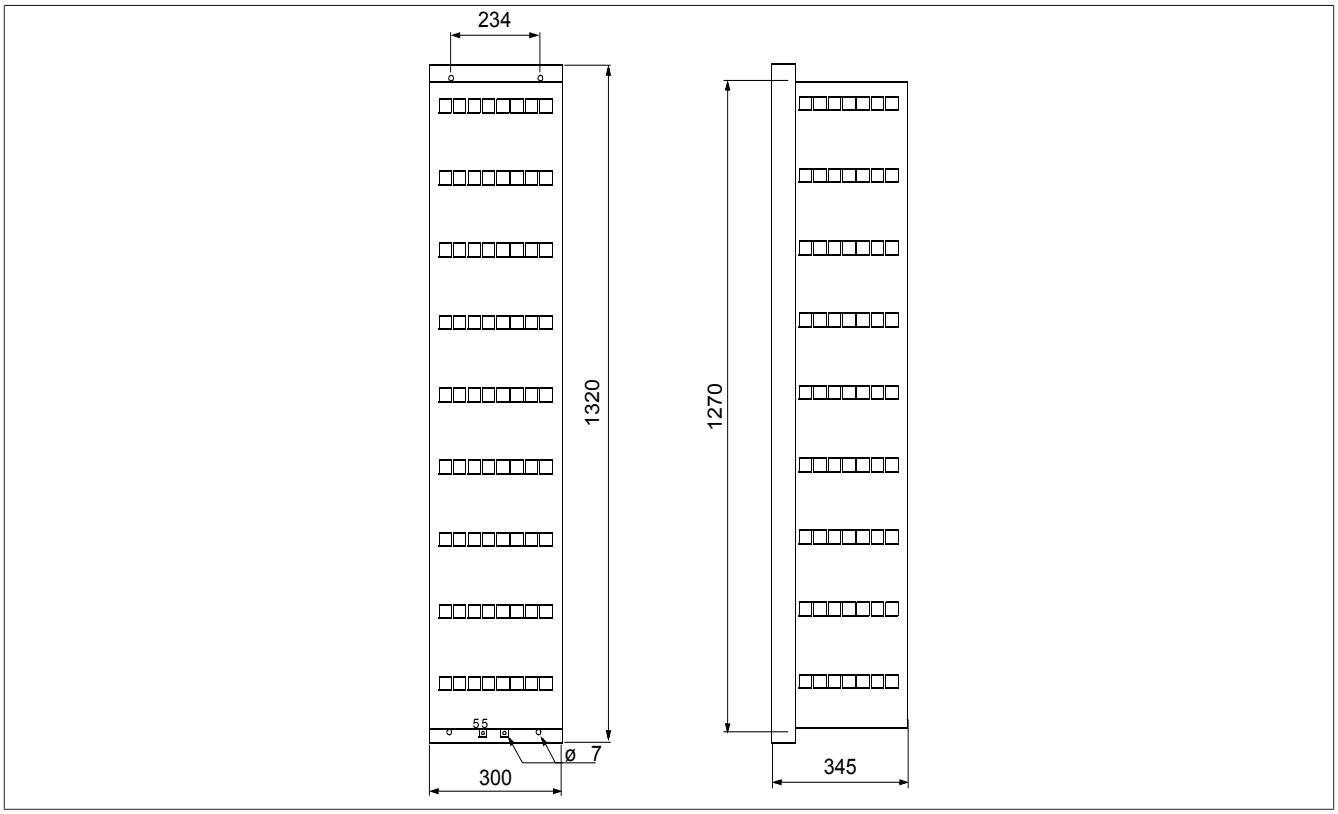

| | |
|---|---|
| Weight | 6 kg (13 lb) |

### 5.4.6.4 8I0BR006.000-1 and 8I0BR008.003-1




| Braking resistor type | Weight |
|---|---|
| 8I0BR006.000-1 | 14 kg (31 lb) |
| 8I0BR008.003-1 | 12 kg (26 lb) |

### 5.4.6.5 8I0BR004.001-1 and 8I0BR002.002-1




| Braking resistor type | Weight |
|---|---|
| 8I0BR004.001-1 | 25 kg (55 lb) |
| 8I0BR002.002-1 | 30 kg (66 lb) |

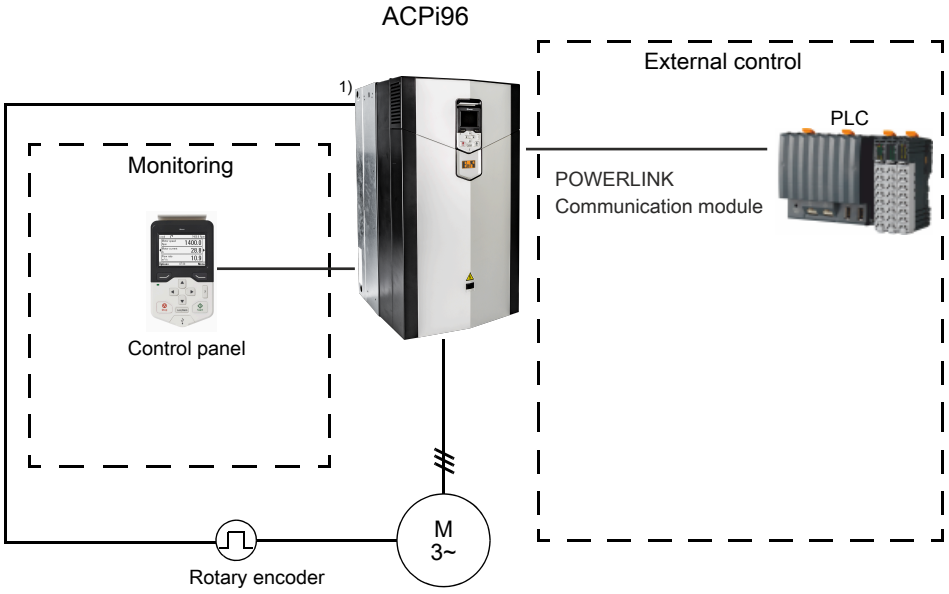
# 6 The drive

## 6.1 Control and operating modes

This chapter contains the description of the control and operating modes supported by the control program.

### 6.1.1 Controller

The ACOPOSinverter P96 (ACPi P96 for short) can be configured using B&R Automation Studio and controlled via POWERLINK. The optional control panel can be used for supervision or device-related supervision.




1) Incremental encoder or resolver interface module(s) in the frequency inverter slots.

#### 6.1.1.1 Local mode

Reconfiguring individual parameters is possible but is explicitly not recommended. Local control is also not intended. For this reason, the "LOC/REM" key on the control panel was disabled.

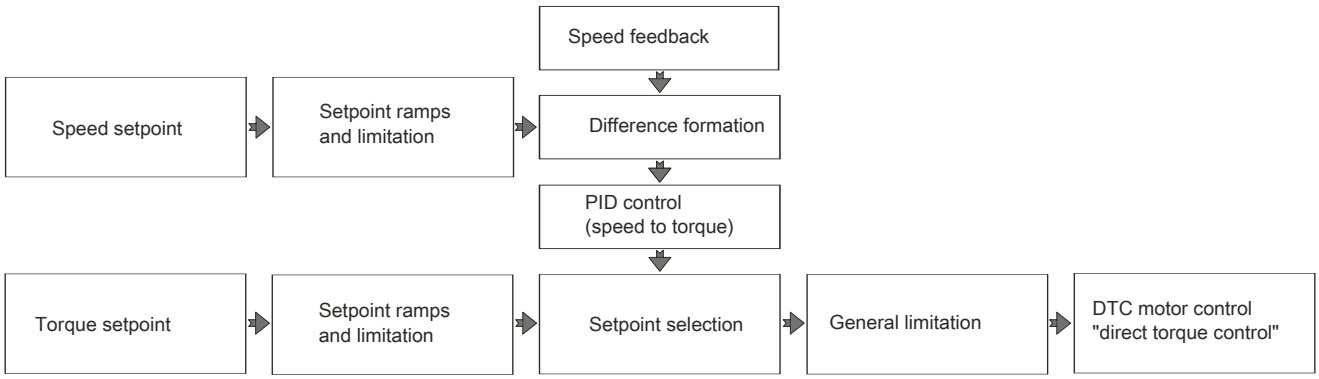
#### 6.1.1.2 External control

With external control via the POWERLINK communication module, the control commands are provided by the PLC in compliance with DS402.

Parameter groups 19. 20. 22. and 26. are configured automatically.

### 6.1.2 Operating modes of the frequency inverter

The frequency inverter can work in different operating modes with different setpoint types. The following figure is a general representation of the setpoint types and open-loop/closed-loop control chains. It refers to detailed diagrams in chapter Open-loop/Closed-loop control block diagrams .




#### 6.1.2.1 Speed control

The motor follows a speed setpoint specified to the drive. This operating mode can be used with either a calculated speed as the feedback value or with incremental encoder or resolver feedback for more accurate motor speed control.

#### 6.1.2.2 Torque control

The motor follows a torque setpoint specified for the drive. Torque control is possible without feedback, but it is more dynamic and accurate when rotary encoders such as incremental encoders or resolvers are used. The use of rotary encoders is recommended for controlling cranes, winches or hoist drives / elevators.

## 6.2 Local management

The control program contains all parameters (including the actual value signals) of the frequency inverter. This chapter presents some important functions of the control program. It describes how they are programmed and used for operation.

**Warning!**

**Ensure that the system in which the frequency inverter is integrated complies with accident prevention and safety regulations. Note that the frequency inverter (a complete drive module or basic drive module per IEC 61800-2) is not defined as a safety device according to the European Machinery Directive and corresponding harmonized standards. According to this, the safety equipment for persons of the complete machine and the operational safety are not permitted to be based on a specific frequency inverter feature; this must be ensured in accordance with the provisions in the application-specific regulations.**

### 6.2.1 Control interfaces

#### 6.2.1.1 Programmable analog inputs

The drive has two programmable analog inputs. Each input can be used independently as a voltage input (0/2...10 V or -10...10 V) or a current input (0/4...20 mA) with jumpers set on the control unit. Each input can be filtered, inverted and scaled.

**Information:**

**Analog inputs are read using a time interval of 0.5 ms.**

The frequency inverter can be set to perform an action (e.g. generate a warning or fault message) as soon as the value of an analog input is outside the predefined range.

**Settings**

Parameter group "12 Standard AI" on page 263.

#### 6.2.1.2 Programmable analog outputs

The drive provides two analog outputs whose control signals can be defined by the user. The signals can be filtered, inverted and scaled. Analog outputs are updated using a time interval of 0.5 ms.

**Settings**

Parameter group "13 Standard AO" on page 266.

#### 6.2.1.3 Programmable digital inputs and outputs

The control unit has six digital inputs, one digital start inhibit input and two digital inputs/outputs (I/O that can be set as either input or output).

**Information:**

**Digital inputs are read using a time interval of 0.5 ms. If digital inputs/outputs are configured as standard I/Os, they are updated at 0.5 ms intervals. If DIO1 is used as a frequency input, frequencies with up to 16 kHz can be read in. If DIO2 is used as a frequency output, frequencies with up to 16 kHz can be generated.**

Digital input DI6 can be used as PTC thermistor input. See section "Thermal motor protection" on page 243.

Digital input/output DIO1 can be used as a frequency input, and DIO2 can be used as a frequency output.

**Settings**

Parameter groups "10 Standard DI, RO" on page 258 and "11 Standard DIO, FI, FO" on page 261.

#### 6.2.1.4 Programmable relay outputs

The drive provides two relays whose control signals can be defined by the user.

**Information:**

**The relays are updated using a time interval of 0.5 ms. The third relay is preconfigured as an error relay.**

**Settings**

Parameter group "10 Standard DI, RO" on page 258.

### 6.2.2 Motor control

#### 6.2.2.1 Direct torque control (DTC)

The motor control of the ACPi96 is based on direct torque control (DTC). The output semiconductor circuits are controlled to achieve the required stator flux and motor torque. The switching frequency is only changed if the actual torque and stator flux values deviate from their setpoints by a higher value than the permissible hysteresis. The setpoint for the torque controller comes from the speed controller or directly from an external torque setpoint source.

Motor control requires measurement of the DC bus voltage and two motor phase currents. The stator flux is calculated by integrating the motor voltage in vector space. The motor torque is calculated as the cross product of stator flux and rotor current. the Calculation of the stator flux is improved by using the identified motor model (motor ID run). The actual speed of the motor shaft is not required for motor control.

The main difference between conventional control and DTC is that the torque controller operates with the same fast time interval as power semiconductor control. There is no separate voltage- and frequency-controlled pulse width modulator (PWM); the output stage circuit is based solely on the electromagnetic state of the motor.

**Settings**

Parameter 99.13 ID run requested.

#### 6.2.2.2 Setpoint ramps

The acceleration and deceleration ramp times can be set for speed and torque setpoints. The POWERLINK communication card is able to process the corresponding DS402 objects and to generate the device-specific parameter values.

The ramps can be defined in compliance with DS402 via the corresponding POWERLINK objects.

##### 6.2.2.2.1 Specific acceleration/deceleration ramps

A separate deceleration ramp can be set for the emergency stop ("OFF3").

#### 6.2.2.3 Suppressing critical speeds

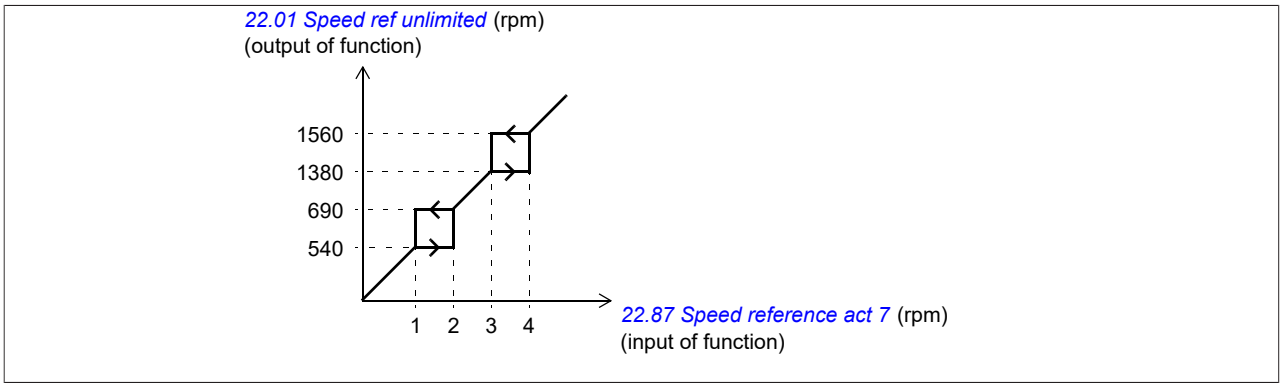
The speed suppression function is available for applications where certain motor speeds or speed ranges must be avoided due to mechanical vibration problems.

The speed suppression function prevents the setpoint from oscillating in a critical speed range for extended periods. When a changing setpoint (22.87 Speed reference act 7) enters a critical range, the output of the function freezes at this value (22.01 Speed ref unlimited) until the setpoint leaves the range again. Any rapid change of the output is damped by the ramp function of the setpoint chain.

**Example**

A fan exhibits vibrations in the ranges 540 to 690 rpm and 1380 to 1560 rpm. To make the frequency inverter skip the speed ranges that cause vibration, make the following settings:

- Enable the speed suppression function by enabling bit 0 of parameter 22.51 Critical speed function.
- Set the problematic speed ranges as follows:




1 Par. 22.52 = 540 rpm
2 Par. 22.53 = 690 rpm
3 Par. 22.54 = 1380 rpm
4 Par. 22.55 = 1560 rpm

**Settings**

- Critical speeds: Parameter 22.51 ...22.57 on page 276.

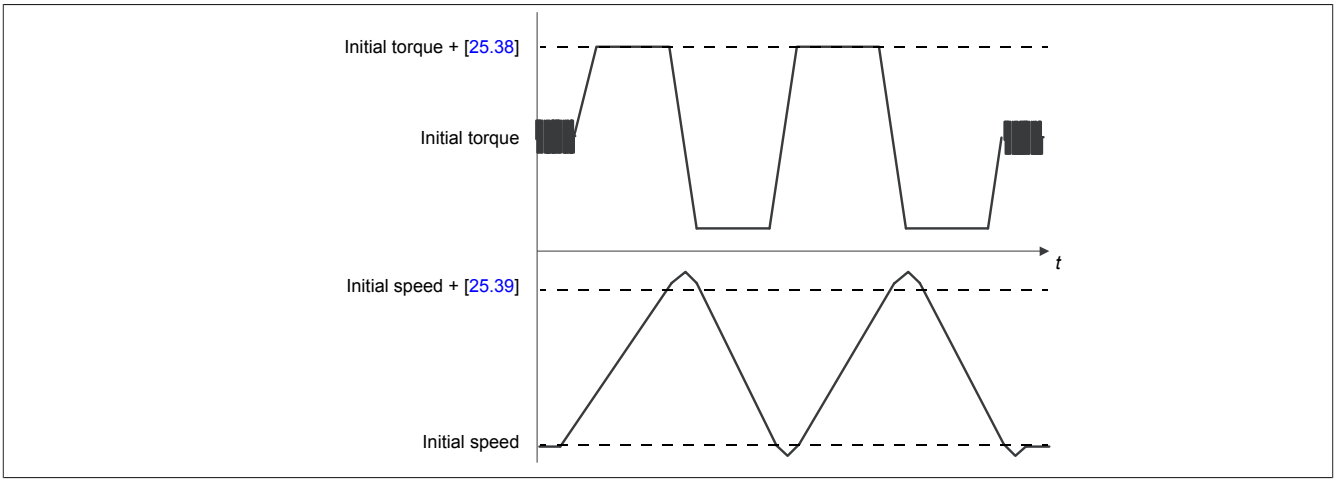
#### 6.2.2.4 Speed controller autotune

The speed controller of the frequency inverter can be set automatically with the autotuning function. Autotuning is based on a calculation of the mechanical time constant (mass moment of inertia) of the motor and machine.

The controller autotuning routine causes the motor to run through a series of acceleration/deceleration cycles, the number of which can be adjusted with parameter 25.40 Autotune repeat times. A higher number gives more accurate results, especially if the difference between the initial and maximum speed is small.

The maximum torque setpoint used during controller tuning is the initial torque (i.e. the torque when the routine is enabled) plus 25.38 Autotune torque step, unless it is limited by the maximum torque limit (parameter group 30 Limits) or nominal motor torque (99 Motor data). The calculated maximum speed during the routine is the initial speed (i.e. the speed when the routine is enabled) plus 25.39 Autotune speed step, unless it is limited by 30.12 Maximum speedor 99.09 Motor nominal speed.

Controller autotuning routine. In this example, 25.40 Autotune repeat times is set to 2.




## Note:

- **If the drive cannot generate the required braking power during the routine, the results will only be based on the acceleration phases and will not be as accurate as with full braking power.**
- **The motor slightly exceeds the calculated maximum speed at the end of each acceleration phase.**

#### 6.2.2.4.1 Before enabling the controller autotuning routine

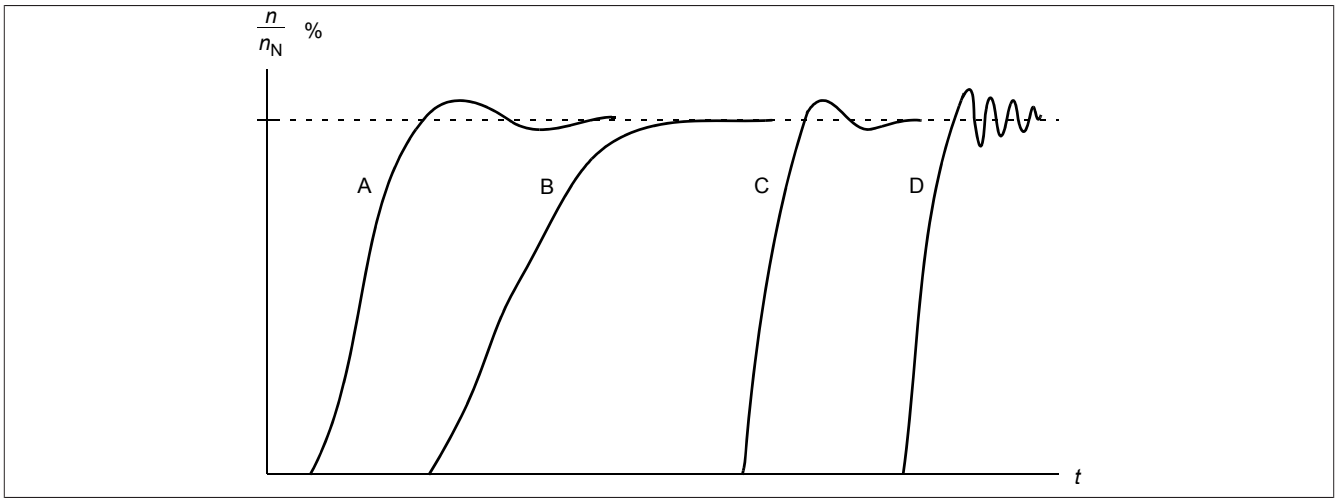
Preconditions for performing controller autotuning:

- Successful execution of the motor ID run.
- Speed and torque limits are set (parameter group 30 Limits).
- Supervision of speed feedback for noise, vibration and other faults generated by the mechanical components of the system was set to prevent these faults.
  - Filtering of the speed feedback (parameter group 90 Feedback selection)
  - Filtering of the speed deviation (24 Speed reference conditioning)
  - Zero speed (parameters 21.06 and 21.07)
- The drive was started and is running in speed control mode.

If these conditions are met, controller autotuning can be enabled with parameter 25.33 Speed controller autotune (or the signal source selected by it).

#### 6.2.2.4.2 Controller autotuning modes

Controller autotuning can take place in three different steps depending on the setting of parameter 25.34 Speed controller autotune mode. The levels Smooth, Normal and Tight define how the torque setpoint reacts after controller autotuning. Selection Smooth results in a slow but clear response; Tight results in a fast response, but also gain values that are too high for some applications. The following figure shows the transient behavior of the speed after a change to the speed setpoint (typically 1 to 20%).




A Undercompensated
B Tuned normally (self-optimization)
C Tuned normally (manual). Better, more dynamic control behavior than with B.
D Overcompensated (integration time too short and controller gain too high)

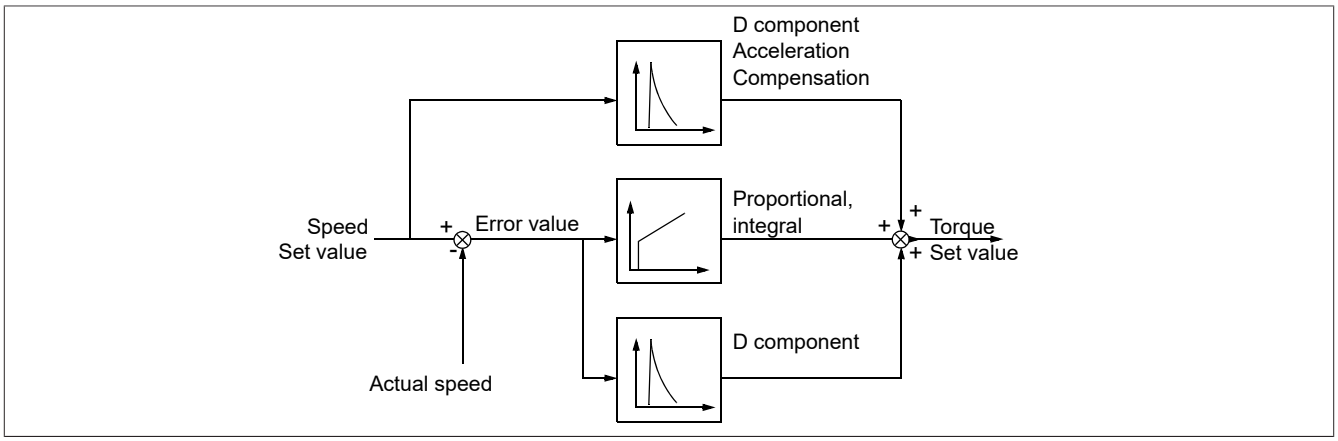
#### 6.2.2.4.3 Results of the controller autotuning

The results of controller autotuning in the following parameters are saved automatically:

- 25.02 Speed proportional gain (relative gain of the speed controller)
- 25.03 Speed integration time (integration time of the speed controller)
- 25.37 Mechanical time constant (mechanical time constant of motor and machine).

However, it is also possible to set the controller gain, integration time and derivative time manually.

The following figure represents a simplified block diagram of the speed control. The controller output is the setpoint for torque control.




#### 6.2.2.4.4 Warning messages

Warning message AF90 Speed controller autotuning is generated if the tuning routine has not been fully completed. For additional information, see chapter "Warning and fault messages" on page 331.

#### 6.2.2.4.5 Settings

Parameters 25.33 … 25.40.

### 6.2.2.5 Eliminating resonant frequencies

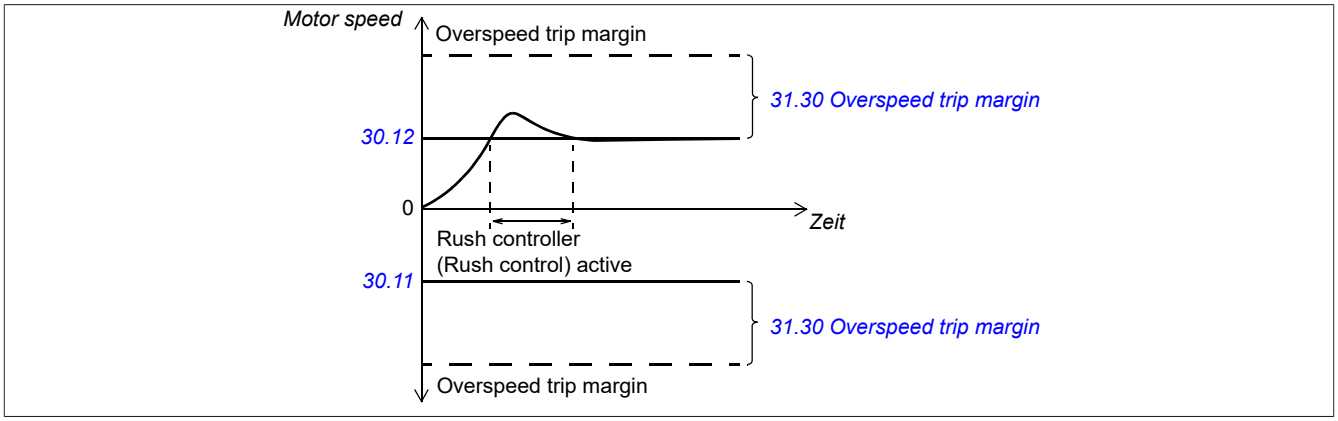
The control program contains a blocking filter function for eliminating resonant frequencies from the speed error signal.

#### 6.2.2.5.1 Settings

Parameters 24.13 … 24.17.

### 6.2.2.6 Limit control

With torque control, the motor speed could potentially increase sharply if the load is suddenly absent. The control program has a limit control function that reduces the torque setpoint when the motor speed exceeds the values set with 30.11 Minimum speed or 30.12 Maximum speed.




The function works with PI control. The proportional gain and integration time can be set using parameters. Setting these two values to zero disables limit control.

#### 6.2.2.6.1 Settings

Parameters 26.81 Rush control gain and 26.82 Rush control integration time.

### 6.2.2.7 Encoder support

The drive can be equipped with a rotary encoder or resolver. The following optional interface modules are available:

- Resolver interface module 8I0IFENC096.402-1:
  Resolver input, TTL input, TTL output (for rotary encoder emulation and echo) and two digital inputs.
- HTL incremental encoder interface module 8I0IFENC096.403-1:
  HTL input, TTL output (for rotary encoder emulation and echo) and two digital inputs.
- Absolute encoder interface module 8I0IFENC096.405-1:
  Absolute encoder input, TTL input, TTL output (for rotary encoder emulation and echo) and two digital inputs.
- TTL incremental encoder interface module 8I0IFENC096.406-1:
  2x TTL input, TTL output (for rotary encoder emulation and echo) and two digital inputs.

#### 6.2.2.7.1 Motor feedback

The speed of the motor axis can be determined directly using an encoder/resolver or indirectly via the output motor current.

A detailed description of the motor signal connections is provided in the block diagram "Configuration of the motor feedback" on page 353.

To maintain compatibility with mapp Motion, it is recommended that to not enter any mechanical gearboxes or other gear ratios on the drive. This information should instead be calculated directly on the PLC.

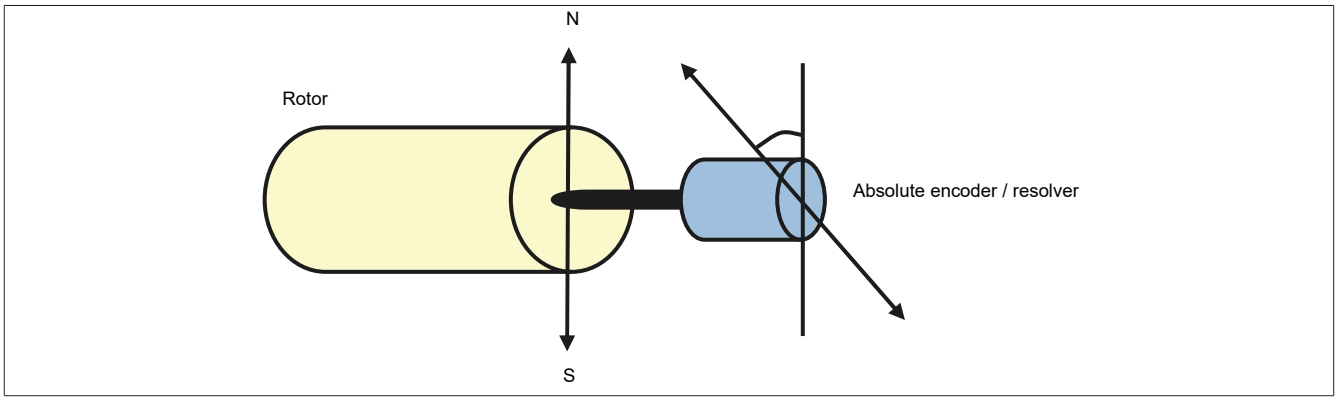
### 6.2.2.8 Autophasing

Autophasing is an automatic measurement routine for determining the angular position of the magnetic flux of a permanent magnet synchronous motor or the magnetic axis of a synchronous reluctance motor. Motor control requires the absolute position of the rotor flux to accurately control the motor torque.

Encoders such as absolute encoders and resolvers always show the rotor position after the offset between the zero angle of the rotor and the angular position of the encoder. In contrast, an incremental encoder determines the rotor position when it rotates, but the initial position is not known. However, an incremental encoder can be used as an absolute encoder if it is equipped with Hall sensors, albeit with coarse accuracy of the initial position. Hall sensors generate commutation pulses that change their state six times during one revolution, so it is only known in which 60° sector of a complete revolution the initial position is located.

Many encoders give one zero pulse (also called Z-pulse) per revolution. The position of the zero pulse is fixed. If this position is known in relation to the zero position used by the motor control, the rotor position at the moment of the zero pulse is also known.

Using the zero pulse increases the robustness of the rotor position measurement. The rotor position must be determined during startup since the value given by the encoder is zero. The autophasing routine determines the position, but there is a risk of a position error. If the zero pulse position is known in advance, the position determined by autophasing can be corrected when the zero pulse is detected for the first time after startup.




Rotor position detection is performed on permanent magnet synchronous motors and synchronous reluctance motors in the following cases:

1) One-time measurement of the rotor and encoder position difference when using an absolute encoder, resolver or encoder with commutation signal
2) Each time the power supply is switched on when an incremental encoder is being used.
3) With motor control without feedback to repeat the measurement of the rotor position on each startup.
4) If the position of the zero pulse must be measured before the first startup after switching on.

## Note:

**For motor control with feedback, autophasing is performed automatically after the motor ID run. Autophasing is also performed automatically before startup, if necessary.**

With motor control without feedback, the zero angle of the rotor is determined before startup. With motor control with feedback, the current angle of the rotor is determined with autophasing if the encoder indicates the zero angle. The offset of the angle must be determined because the zero angles of the encoder and rotor normally do not match. Autophasing determines how the rotor position is detected during control with and without feedback.

The user can also set an offset of the rotor position for the motor control, see parameter 98.15 Position offset user. Note that the autophasing routine also writes its result to this parameter. The results are also updated if user settings are not enabled with 98.01 User motor model mode.

## Note:

**With control without feedback, the motor always rotates when it is started because the motor shaft is rotated in the direction of the remanence flux.**

Bit 4 of 06.21 Drive status word 3 indicates when the rotor position has already been determined.

#### 6.2.2.8.1 Autophasing methods

Several methods of rotor position detection are available (see parameter 21.13 Autophasing mode).

Method "Turning" (Turning) is especially recommended for case 1 (see list above), as it is the most robust and accurate method. With this method, the motor shaft is rotated backward and forward (±360/pole pairs)° to determine the rotor position. In case 3 (open-loop control), the shaft is rotated in one direction only and the angle is smaller.

Another method of type "Turning", Turning with Z-pulse, can be used if there are problems when using the normal "Turning" method, e.g. due to high friction. With this method, the rotor is rotated slowly until the rotary encoder detects a zero pulse. When the zero pulse is first detected, its position is stored in Parameter 98.15 Position offset user, where fine-tuning can take place. This method does not necessarily have to be used with a zero pulse encoder. For motor control without feedback, the two "Turning" methods are identical.

If the motor cannot be rotated (for example with a coupled load), the standstill methods (Standstill 1, Standstill 2) can be used. Since the characteristics of motors and loads are different, it is necessary to test which is the most suitable standstill method.

The frequency inverter can determine the rotor position when starting on a rotating motor with or without rotary encoder feedback. In this situation, setting 21.13 Autophasing mode has no meaning.

Since the autophasing routine may fail, it is recommended to perform the routine several times and check the value of parameter 98.15 Position offset user.

An autophasing error (3385 Autophasing mode) can occur with a rotating motor if the calculated angle of the motor deviates too much from the measured angle. This could have the following causes, for example:

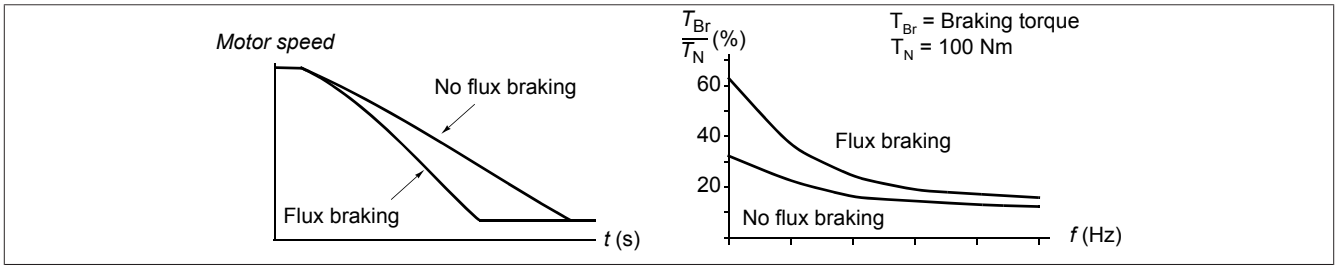
- The encoder slips on the motor shaft.
- An incorrect value was entered in 98.15Position offset user.
- The motor was already turning before autophasing was started.
- Method Turning was selected in 21.13 Autophasing mode, but the motor shaft is blocked.
- Method Turning with Z-pulse was selected in 21.13 Autophasing mode, but no zero pulse was detected during a motor rotation.
- An incorrect motor type was selected for 99.03Motor type.
- The motor ID run failed.

#### 6.2.2.8.2 Settings

Parameters 06.21 Drive status word 3 (Page 256), 21.13 Autophasing mode, 98.15 Position offset and 99.13 ID run requested.

### 6.2.2.9 Flux braking

By increasing magnetization of the motor, the frequency inverter can provide faster braking deceleration of the drive. When the motor flux is increased, the energy generated by the motor during braking is converted into thermal energy.




The frequency inverter constantly monitors the state of the motor, even during flux braking. Flux braking can therefore be used both for braking the motor and for changing the speed. Other advantages of flux braking:

- The braking procedure starts immediately after the stop command. To execute the function, it is not necessary to wait for the flux reduction before starting the braking procedure.
- Cooling of the induction motor is efficient. The stator current of the motor increases during flux braking, not the rotor current. Cooling of the stator is more efficient than that of the rotor.
- Flux braking can be used with induction motors and permanent magnet synchronous motors.

Two brake strengths are available:

- Moderate braking provides faster deceleration than with flux braking disabled. The flux level of the motor is limited to prevent overheating of the motor.
- With full braking, all available current is used to convert the mechanical energy into thermal energy. The braking time is shorter than with moderate braking. During cyclic operation, the motor can become very hot.

## Warning!

**The motor must be sized large enough to absorb the thermal energy of flux braking.**

#### 6.2.2.9.1 Settings

Parameter "97.05 Flux braking" on page 323

### 6.2.2.10 DC magnetization

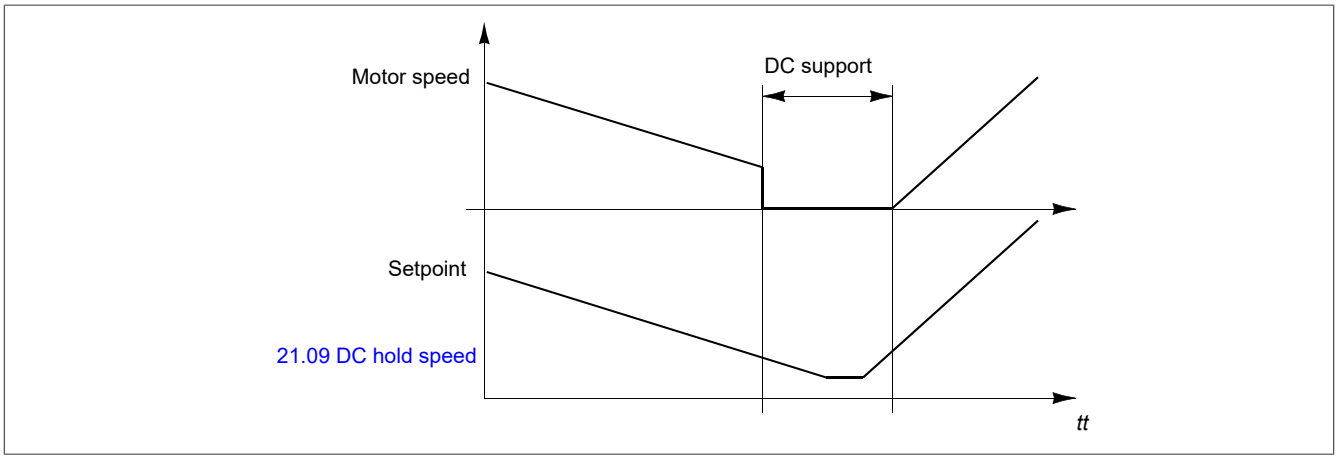
DC magnetization can be applied to the motor to keep the motor at or near zero speed.

#### 6.2.2.10.1 Premagnetization

Premagnetization is DC magnetization before startup. Depending on the selected start method (21.01 Start method), the premagnetization can be used to ensure the highest possible starting torque, up to 200% of the rated motor torque. Startup of the motor and, for example, releasing a mechanical brake can be synchronized by setting the premagnetization time (21.02 Magnetization time).

#### 6.2.2.10.2 DC hold

This function makes it possible to keep the rotor at (near) zero speed during normal operation. DC hold is enabled with parameter 21.08 DC current control. When both the setpoint and the motor speed fall below a certain value (parameter 21.09 DC hold speed), the frequency inverter stops generating a sinusoidal current and supplies the DC holding current to the motor. The current is set with parameter 21.10 DC current reference. If the speed setpoint exceeds the value of parameter 21.09 DC hold speed, normal operation is resumed.




## Note:

- **DC hold is only available with speed control in DTC motor control mode (see Operating modes of the frequency inverter).**
- **The function affects only one phase of the AC current and depends on the rotor position. The return current is distributed to the other phases.**

#### 6.2.2.10.3 Post-magnetization

This function maintains the motor magnetization for a certain time (21.11 Post magnetization time) after stopping. This prevents the machine from being moved by a load, e.g. before a mechanical brake can be applied. Premagnetization is enabled with parameter 21.08 DC current control. The magnetizing current value is set in 21.10 DC current reference.

## Note:

**Post-magnetization is only available with speed control in DTC motor control mode (see Operating modes of the frequency inverter) and only if stop with ramp was set (see parameter 21.03 Stop mode).**

## 6.2.3 Application control

### 6.2.3.1 Controlling a mechanical brake

The mechanical brake has the task of keeping the motor and the driven machines at zero speed when the drive stops or is not supplied with voltage. The brake control logic checks the settings of parameter group 44 Mechanical brake control and various external signals and changes the states accordingly, see diagram "Brake state sequence" on page 239. The tables below the status diagram describe the states and transitions in detail. The timing diagram shows an example of a engage-release braking sequence.

#### 6.2.3.1.1 Brake control logic inputs

The start command of the frequency inverter (bit 5 of 06.16 Drive status word 1) is the main control source of the brake control logic. An external release/engage signal can optionally be selected with 44.12 Brake close request. The two signals interact as follows:

- Start command = 1 **AND** signal selected with 44.12 Brake close request = 0 → Request brake to **release**
- Start command = 0 **OR** signal selected with 44.12 Brake close request = 1 → Request for **engaging** the brake

Another external signal – from a control system, for example – can be used via parameter 44.11 Keep brake closed to prevent the brake from being released.

Other signals affecting the state of the brake control logic:

- Brake state acknowledgment (optional, parameter setting 44.07 Brake acknowledge selection)
- Bit 2 of 06.11 Main status word (indicates whether the frequency inverter is ready to follow the specified setpoint)
- Bit 6 of 06.16 Drive status word 1 (indicates whether the frequency inverter is modulating)

#### 6.2.3.1.2 Brake control logic outputs

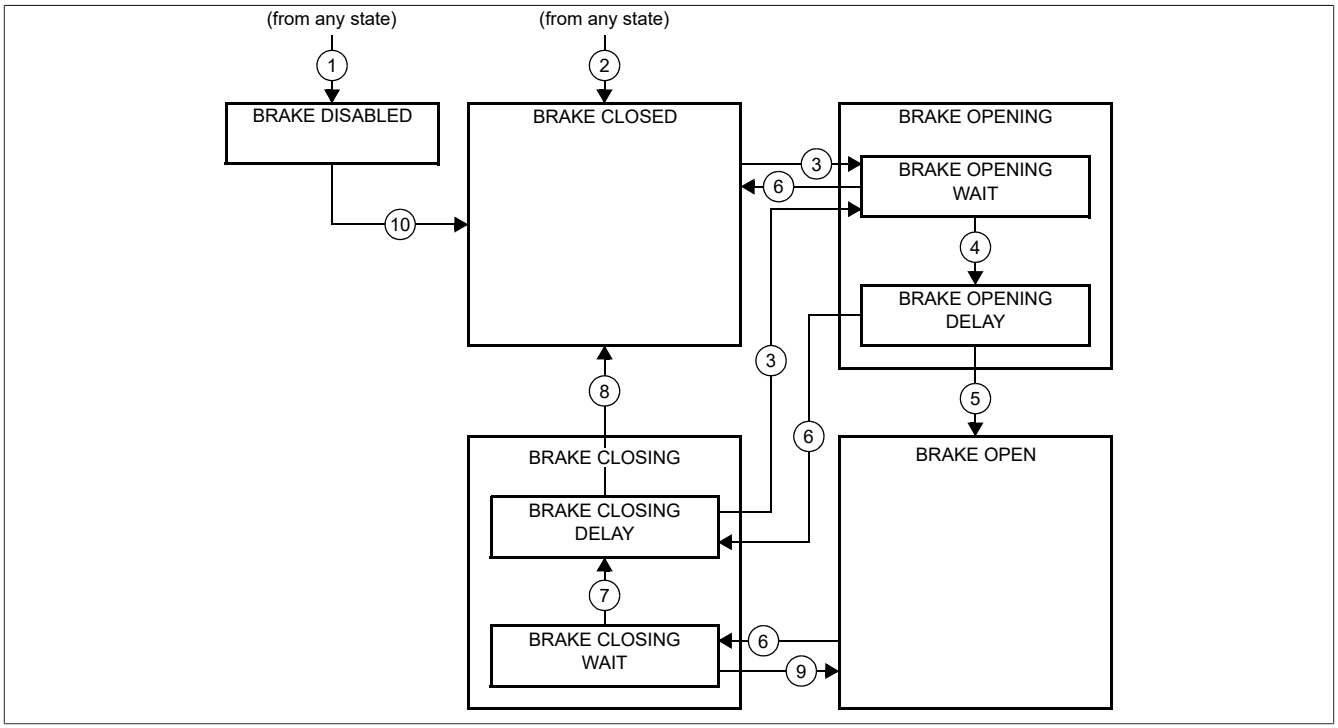
The mechanical brake must be controlled by bit 0 of parameter 44.01 Brake control status. This bit should be selected as the source of a relay output (or digital input/output in output mode) that is then wired to the brake via a contactor. See "Connection example" on page 240.

In the various states, the brake control logic requests the drive control to hold the motor, increase the torque or reduce the speed at the ramp. These requirements are visible in parameter 44.01 Brake control status.

#### 6.2.3.1.3 Settings

Parameter group "44 Mechanical brake control" on page 308.

### 6.2.3.1.4 Brake state sequence




State descriptions

| State name | Description |
|---|---|
| BRAKE DISABLED | Brake control is disabled (parameter 44.06 Brake control enable = 0 and 44.01 Brake control status B4 = 0). The brake is closed (44.01 Brake control status b0 = 0). |
| BRAKE OPENING: | |
| BRAKE OPENING WAIT | "Release brake" was requested. Drive control receives the command to increase the torque to the value for releasing the brake so that the load can be held (44.01 Brake control status b1 = 1 and b2 = 1). The state of 44.11 Keep brake closed is checked; if it is not 0 within the required time, the frequency inverter switches off* with fault message 71A5 Mechanical brake opening not allowed. |
| BRAKE OPENING DELAY | The conditions for releasing the brake are met and the release signal is enabled (44.01 Brake control status b0 is set). The request for releasing the brake is deleted (44.01 Brake control status b1 → 0). The load is held by the speed control of the frequency inverter 44.08 Brake open delay.<br>At this point, if 44.07 Brake acknowledge selection is set to No acknowledge, the brake control enters state BRAKE OPEN. If a source for the acknowledgment signal was selected, its status is checked; if this is not "Brake open", the frequency inverter switches off* with fault message 71A3 Mechanical brake opening failed. |
| BRAKE OPEN | The brake is released (44.01 Brake control status B0 = 1). The hold request is cleared (44.01 Brake control status B2 = 0) and the drive can follow the setpoint again. |
| BRAKE CLOSING: | |
| BRAKE CLOSING WAIT | "Engage brake" was requested. The drive control receives the request to ramp down the speed to a stop (44.01 Brake control status B3 = 1). The release signal remains active (44.01 Brake control status B0 = 1). The brake control remains in this state until the speed remains below 44.14 Brake close level for the time set with 44.15 Brake close level delay. |
| BRAKE CLOSING DELAY | The conditions for closing the brake are met. The release signal is disabled (44.01 Brake control status b0 → 0) and the torque value for engaging the brake was written to 44.02 Brake torque memory. The request to decelerate via ramp remains enabled (44.01 Brake control status B3 = 1). The brake control remains in this state until the time set with 44.13 Brake close delay has elapsed.<br>At this point, if 44.07 Brake acknowledge selection is set to No acknowledge, the brake control enters state BRAKE CLOSED. If a source for the acknowledgment signal was selected, its status is checked; if it is not "Brake closed", the frequency inverter outputs warning message A7A1 Mechanical brake closing failed.<br>If 44.17 Brake fault function = Fault, the frequency inverter switches off with fault message 71A2 Mechanical brake closing failed after delay time 44.18 Brake fault delay. |
| BRAKE CLOSED | The brake is closed (44.01 Brake control status B0 = 0). The frequency inverter is not necessarily modulating.<br>**Note for applications without encoder feedback (encoderless):** If the brake is held engaged by a brake engage request (parameter 44.12) against a modulating frequency inverter for more than five seconds, the brake is forced to state "Closed" and the frequency inverter switches off with fault 71A5 Mechanical brake opening not permitted. |
| *A warning message can alternatively be selected with 44.17 Brake fault function; the frequency inverter then continues to modulate and remains in this state. | |

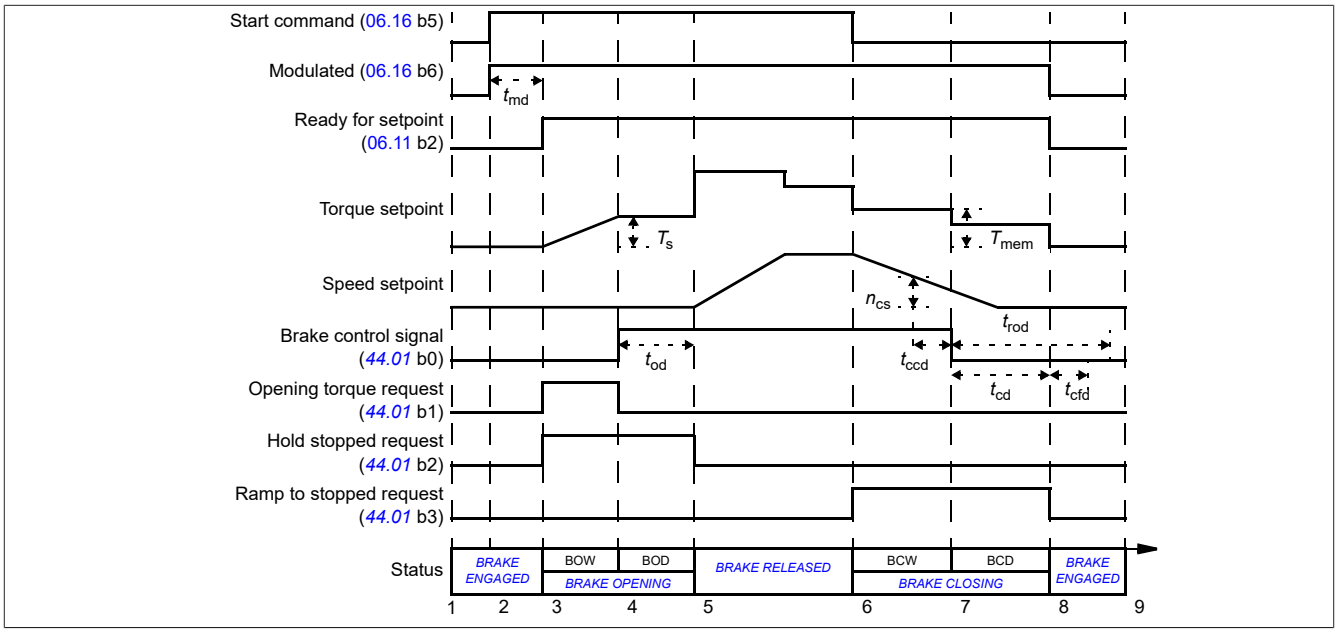
State change conditions

1. Brake control disabled (44.06 Brake control enable → 0).
2. 06.11 Main status word,, bit 2 = 0.
3. Request to engage the brake and 44.16 Brake reopen delay has expired.

4. Conditions for releasing the brake (e.g 44.10 Brake open torque) are met and 44.11 Keep brake closed = 0.
5. 44.08 Brake open delay has expired and acknowledgment for releasing the brake (if selected with 44.07 Brake acknowledge selection) was received.
6. Brake was requested to close.
7. Motor speed has remained below the speed for brake closing 44.14 Brake close level for the time set with 44.15 Brake close level delay.
8. 44.13 Brake close delay has expired and acknowledgment for closing the brake (if selected with 44.07 Brake acknowledge selection) was received.
9. "Release brake" was requested.
10. Brake control enabled (parameter 44.06 Brake control enable → 1).

### 6.2.3.1.5 Timing diagram

The simplified time lapse diagram illustrates the operation of the brake control function. See the state diagram above.




$T_s$ Start torque when brake is released (parameter 44.03 Brake open torque reference)
$T_{mem}$ Stored torque value when brake closed (44.02 Brake torque memory)
$t_{md}$ Motor magnetization delay
$t_{od}$ Delay when releasing the brake (parameter 44.08 Brake open delay)
$n_{cs}$ Speed at which the brake closes (parameter 44.14 Brake close level)
$t_{ccd}$ Delay of the command for closing the brake (parameter 44.15 Brake close level delay)
$t_{cd}$ Brake close delay (parameter 44.13 Brake close delay)
$t_{cfd}$ Delay time for fault during brake closing (parameter 44.18 Brake fault delay)
$t_{rod}$ Delay for releasing the brake (parameter 44.16 Brake reopen delay)
BOW BRAKE OPENING WAIT
BOD BRAKE OPENING DELAY
BCW BRAKE CLOSING WAIT
BCD BRAKE CLOSING DELAY

### 6.2.3.1.6 Wiring example

The following figure shows a wiring example for brake control. The provision and installation of the hardware and wiring of the brake must be carried out by the user.

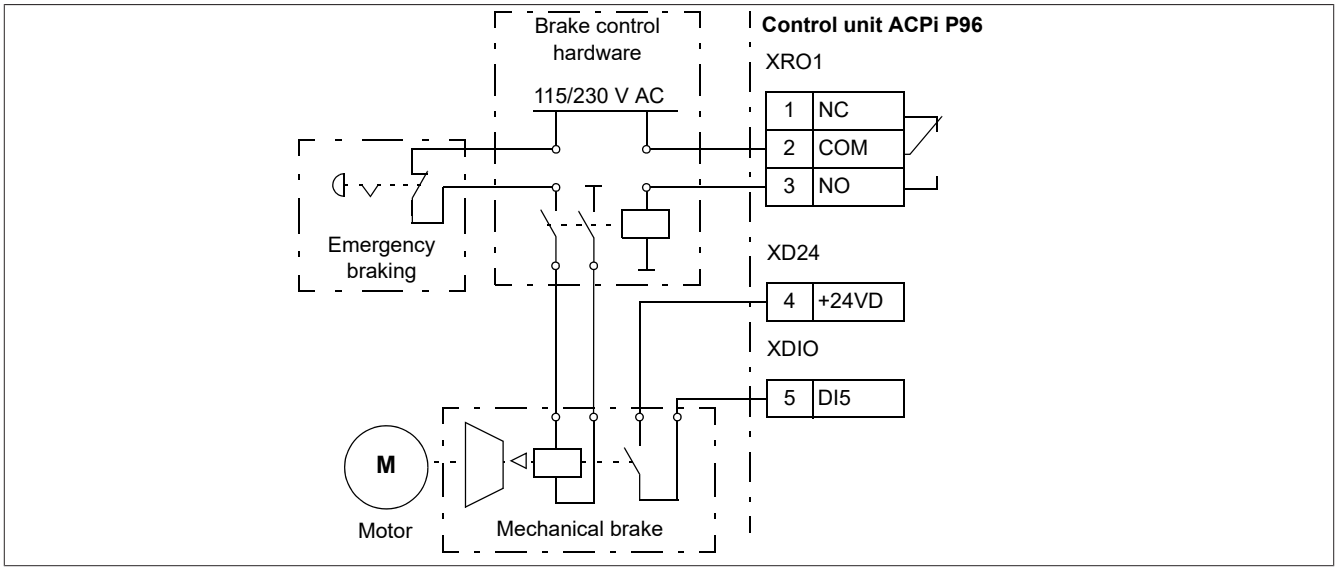
## Warning!

**Ensure that the system in which the frequency inverter with brake control function is integrated complies with accident prevention and safety regulations. It is important to note that the frequency inverter (a complete drive module or basic drive module per IEC 61800-2) is not defined as a safety device according to the EU Machinery Directive and associated harmonized standards. According to this, the safety equipment for persons of the complete drive equipment and the operational safety are not permitted to be based on a specific frequency inverter feature (such as the brake control function); this must be ensured in accordance with the provisions in the application-specific regulations.**

The brake is controlled by bit 0 of parameter 44.01 Brake control status. The source for the brake acknowledgment (status monitoring) is selected with parameter 44.07 Brake acknowledge selection.

In this example, the following parameters are set:

- Parameter 10.24 RO1 source to Open brake command (i.e. bit 0 of 44.01 Brake control status)
- Parameter 44.07 Brake acknowledge selection on DI5




### 6.2.4 DC voltage control

#### 6.2.4.1 Overvoltage control

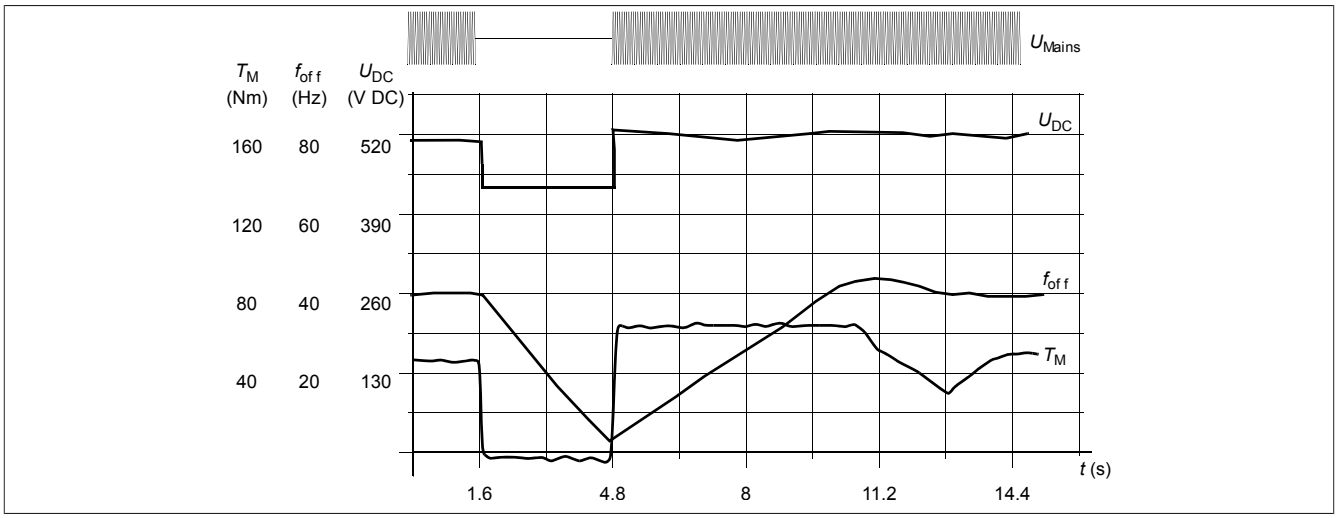
DC bus overvoltage control is typically required when the motor is running in regenerative mode. The motor can generate energy when decelerating or when the load is actively rotating the motor shaft and trying to accelerate the motor above the set speed. To prevent the DC voltage from exceeding the overvoltage limit, the overvoltage controller automatically reduces the regenerative torque when the DC voltage limit is reached. The overvoltage control also increases the programmed delay times; a brake chopper and brake resistors are required for shorter delay times.

#### 6.2.4.2 Undervoltage control (power failure control)

In the event of supply voltage failure, the frequency inverter continues operation by using the kinetic energy of the rotating motor. The frequency inverter operates as long as the motor rotates and supplies energy to the frequency inverter. The frequency inverter can resume operation after a failure when the power supply is restored, if the main contactor (if available) remains closed.

## Note:

**Units equipped with a main contactor must be equipped with a holding circuit (e.g. UPS) that keeps the contactor control circuit closed during a short power supply failure.**




$U_{DC}$ DC bus voltage of the frequency inverter
$f_{Off}$ Output frequency of the frequency inverter
$T_M$ Motor torque voltage failure at rated load ($f_{Out}$ = 40 Hz)

The DC bus voltage drops to the lower limit value. Control keeps the voltage constant as long as the power supply has failed. The driven machine and motor act generatively. The motor speed drops, but the frequency inverter remains operational as long as the motor can deliver sufficient kinetic energy.

### 6.2.4.3 Voltage control and switch-off limit values

The control and switch-off limits of the DC bus voltage control depend on the supply voltage and type of frequency inverter. The DC voltage is approximately 1.35 times the line-to-line supply voltage and is displayed with parameter 01.11 Supply voltage.

All levels are relative to the supply voltage range set in parameter 95.01 Supply voltage. The following table shows the values of the selected DC voltage levels in volts and as a percentage of $U_{DCmax}$ (the DC voltage at the upper limit of the supply voltage range).

| | Supply voltage range [V AC] (see 95.01 Supply voltage) | | |
|---|---|---|---|
| **Level [V DC (% of $U_{DCmax}$)]** | **380...415** | **440...480** | **500** |
| Overcurrent fault limit | 800 | 878 | 880 |
| Overvoltage control limit | 700 (125) | 810 (125) | 810 (120) |
| Internal brake chopper at 100% pulse width | 697 (124) | 806 (124) | 806 (119) |
| Internal brake chopper at 0% pulse width | 648 (116) | 749 (116) | 780 (116) |
| Overvoltage warning limit | 644 (115) | 745 (115) | 776 (115) |
| $U_{DCmax}$ = DC voltage at the upper limit of the supply voltage range | 560 (100) | 648 (100) | 675 (100) |
| DC voltage at the lower limit of the supply voltage range | 513 | 594 | 675 |
| Undervoltage control and warning limit | 436 (85) | 505 (85) | 574 (85) |
| Charging activation/standby limit | 410 (80) | 475 (80) | 540 (80) |
| Undervoltage fault limit | 308 (60) | 356 (60) | 405 (60) |

#### 6.2.4.3.1 Settings

Parameters 01.11 DC voltage, 30.30 Overvoltage control, 30.31 Undervoltage control, "95.01 Supply voltage" on page 320 and 95.02 Adaptive voltage limits.

### 6.2.4.4 Brake chopper

A brake chopper can be used to dissipate the energy generated by a braking motor. If the DC voltage rises too high, the chopper switches the DC bus to external braking resistors. The chopper works with the principle of pulse width modulation.

The brake chopper of the frequency inverter dissipates excess energy when the DC bus voltage reaches 1.156 × $U_{DCmax}$. 100% pulse width is reached at about 1.2 x $U_{DCmax}$, depending on the supply voltage range.

$U_{DCmax}$ corresponds to the maximum of the AC supply voltage range, see table in section Voltage control and switch-off limit values.

**Note:**

**Overvoltage control (parameter 30.30 Overvoltage control) must be disabled to use the brake chopper.**

#### 6.2.4.4.1 Settings

Parameters 01.11 DC voltage and 30.30 Overvoltage control. parameter group "43 Brake chopper" on page 307.

### 6.2.5 Safety and protection functions

#### 6.2.5.1 Emergency stop

The emergency stop signal is connected to the input selected with parameter 21.05 Emergency stop source. An emergency stop can also be triggered via fieldbus (parameter 06.01 Main control word, bits 0...2).

The mode of the emergency stop is selected with parameter 21.04 Emergency stop mode.
The following stop types are available:

- Off1: Stop with the standard deceleration ramp of the respective setpoint type used
- Off2: Coast to a stop
- Off3: Stop with the emergency stop ramp set with parameter 23.23 Emergency stop time.

For stop modes Off1 and Off3, the ramp-controlled motor speed can be monitored with parameters 31.32 Emergency ramp supervision and 31.33 Emergency ramp supervision delay.

**Note:**

- **The installer of the equipment is responsible for installing the emergency stop devices and all additional equipment required for the emergency stop to meet the requirements of the emergency stop categories.**
- **After an emergency stop signal has been detected, the emergency stop function cannot be disabled even if the signal was disabled.**
- **If the minimum (or maximum) torque limit is set to 0%, the emergency stop function may not be able to stop the frequency inverter.**
- **Additions to speed and torque setpoint, as well as setpoint ramp shapes (23.16 ... 23.19) are ignored with emergency stop ramps.**

#### 6.2.5.1.1 Settings

Parameters 06.17 Drive status word 2, 06.18 Start inhibit status word, 21.04 Emergency stop mode, 21.05 Emergency stop source, 23.23 Emergency stop time, 25.13 Min torque sp ctrl em stop, 25.14 Max torque sp ctrl em stop, 25.15 Proportional gain em stop, 31.32 Emergency ramp supervision and 31.33 Emergency ramp supervision delay.

#### 6.2.5.2 Thermal motor protection

The control program provides two separate motor temperature monitoring functions. The temperature data sources and warning/switch-off limit values can be set separately for each function.

The motor temperature can be monitored as follows:

- With the thermal motor protection model (temperature calculated internally in the frequency inverter).
- Or with the sensors installed in the motor windings. This results in higher accuracy of the motor model.

In addition to temperature monitoring, a protection function is available for EX motors installed in a potentially explosive atmosphere.

#### 6.2.5.2.1 Thermal motor protection model

The frequency inverter calculates the temperature of the motor based on the following assumptions:

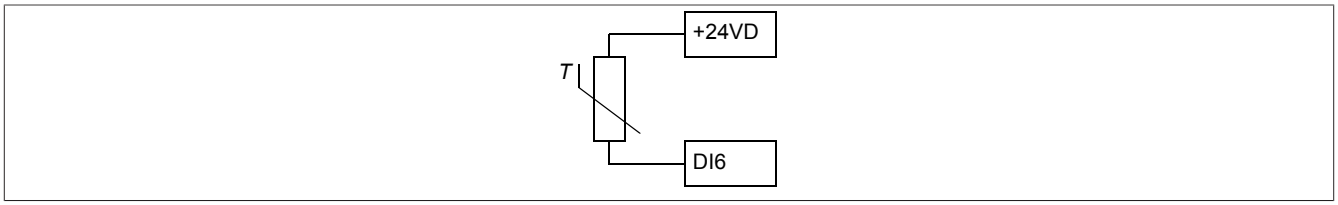
1) When the power supply of the frequency inverter is switched on for the first time, it is assumed that the motor is at ambient temperature (setting of parameter 35.50 Motor ambient temperature). After that, the calculated motor temperature is assumed when the power supply of the frequency inverter is switched on.
2) The motor temperature is calculated from the user-adjustable thermal motor time curve and motor load characteristic curve. The motor load characteristic curve should be adjusted at an ambient temperature above 30°C.

**Note:**

**The thermal motor model can only be used if only one motor is connected to the inverter.**

#### 6.2.5.2.2 Temperature monitoring with PTC sensors

One PTC sensor can be connected to digital input DI6.

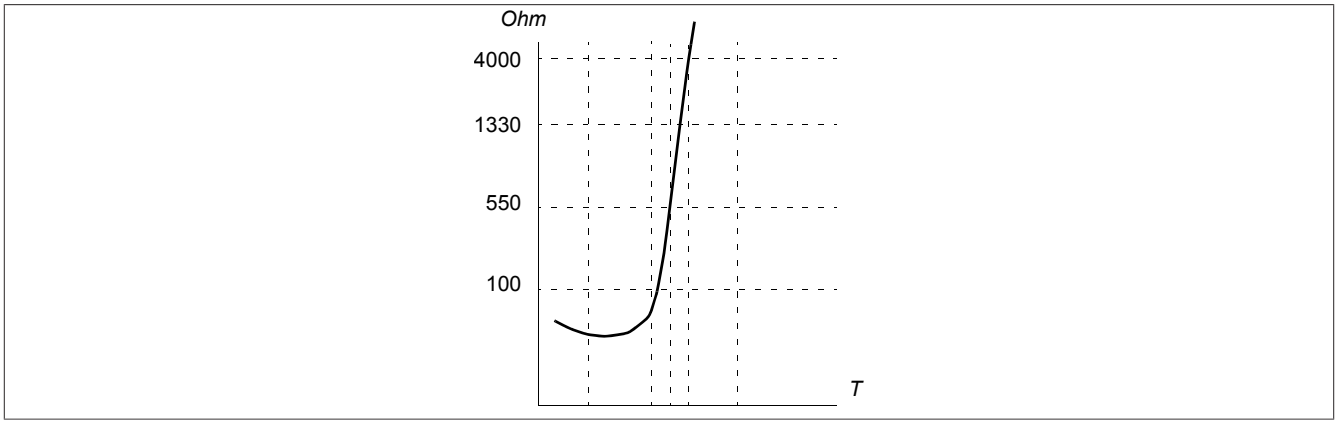



The resistance value of the PTC sensor increases as its temperature rises. The rising resistance value of the sensor lowers the voltage at the digital input and eventually the state of DI6 changes from 1 to 0, thus reporting the overtemperature.

1...3 PTC sensors can also be connected in series to an analog input and an analog output. The analog output supplies the sensor with a constant excitation current of 1.6 mA. The resistance of the sensor increases with the motor temperature to the same extent as the voltage applied to the sensor. The temperature measurement function calculates the resistance of the sensor and generates an indication if overtemperature is detected.

For information about the sensor wiring, see DI6 (XDI_:6) as a PTC sensor input.

The figure shows typical resistance values of a PTC sensor depending on the temperature.




In addition to the above, optional 8I0IFENC encoder interface modules have connections for PTC sensors. For additional information, see the module-specific documentation.

#### 6.2.5.2.3 Temperature monitoring with Pt100 or Pt1000 sensors

1...3 Pt100 or Pt1000 sensors can be connected in series to an analog input and an analog output.

The analog output supplies the sensor with a constant excitation current of 9.1 mA (Pt100) or 1 mA (Pt1000). The resistance of the sensor increases with the motor temperature to the same extent as the voltage applied to the sensor. The temperature measurement function measures the voltage with the analog input and converts it to degrees Celsius.

The fault and warning limits can be set with parameters.

For information about wiring the temperature sensor, see AI1 and AI2 as Pt100, Pt1000, PTC and KTY84 sensor inputs (XAI, XAO).

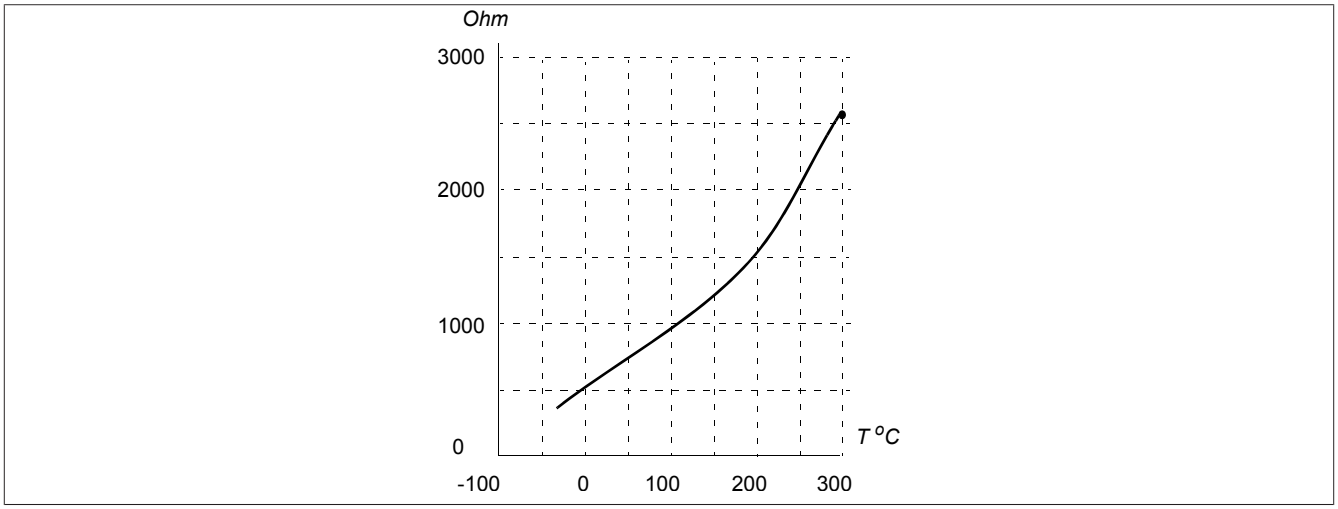
#### 6.2.5.2.4 Temperature monitoring with KTY84 sensors

One KTY84 sensor can be connected to an analog input and an analog output of the control unit.

The analog output supplies the sensor with a constant current of 2.0 mA. The resistance of the sensor increases with the motor temperature to the same extent as the voltage applied to the sensor. The temperature measurement function measures the voltage with the analog input and converts it to degrees Celsius.

The 8I0IFENC encoder interface modules also have a KTY84 sensor connection.

The figure and table below show typical resistance values of a KTY84 sensor depending on the operating temperature of the motor.




**KTY84 scaling:**

90°C = 936 ohms
110°C = 1063 ohms
130°C = 1197 ohms
150°C = 1340 ohms

The fault and warning limits can be set with parameters.

For information about wiring the temperature sensor, see AI1 and AI2 as Pt100, Pt1000, PTC and KTY84 sensor inputs (XAI, XAO).

#### 6.2.5.2.5 Motor fan control logic (parameters 35.100 ... 35.106)

If the motor is equipped with an external fan, a drive signal (for example, running/stopping) can be used to control the fan via a relay or digital output. A digital input can be selected for the fan feedback signal. A failure of the feedback signal can optionally trigger a warning or fault message.

Start and stop delay times can be set for the fan. In addition, a feedback delay time can be set within which the frequency inverter expects feedback after the fan starts.

#### 6.2.5.2.6 Settings

Parameter groups "35 Motor thermal protection" on page 299 and "91 Encoder module settings" on page 315.

### 6.2.5.3 Thermal motor cable protection

The control program has a thermal protection function for the motor cable. This function should be used, for example, if the nominal current of the frequency inverter exceeds the current-carrying capacity of the motor cable.

The program calculates the temperature of the cable based on the following data:

- Measured output current (parameter 01.07 Motor current)
- Nominal continuous current of the cable, set with 35.61 Cable nominal current
- Thermal time constant of the cable, set with 35.62 Cable thermal rise time

If the calculated cable temperature reaches 102% of the maximum nominal temperature, warning A480 Motor cable overload is generated. The frequency inverter switches off with fault message 4000 Motor cable overload when 106% is reached.

#### 6.2.5.3.1 Settings

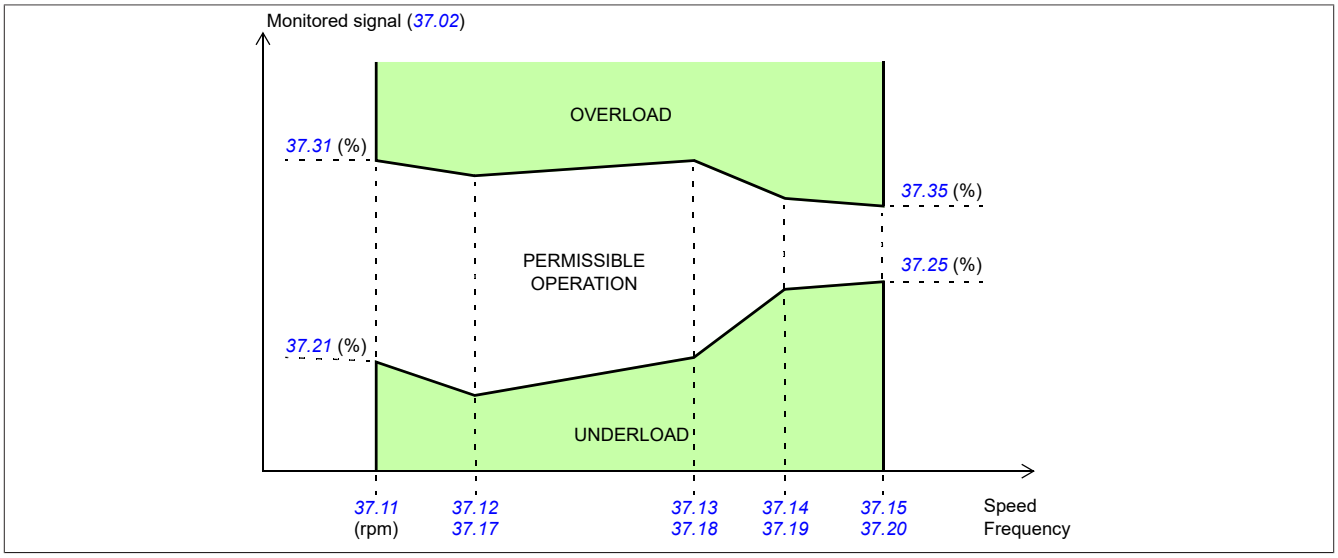
Parameters 35.60 … 35.62.

### 6.2.5.4 User load curve

The user load curve provides a function that monitors an input signal (for example, motor torque or motor current) as a function of the drive's output speed or output frequency. The function includes monitoring of both the upper limit value (overload) and lower limit value (underload). Overload monitoring can be used, for example, to detect when a pump is clogged or a saw blade is hitting a snag. Underload monitoring can detect that the load was lost, for example due to the breakage of a transmission belt.

The monitoring covers a motor speed range. The range is set with five speed values (parameters 37.11 .. 37.15). The values are positive, but the monitoring is symmetrically active in the negative direction to indicate that the monitored signal is ignored. Outside the speed/frequency range, monitoring is disabled.

An underload (37.21 .. 37.25) and overload limit value (37.31 .. 37.35) is set for each of the five speed points. Between these points, the limit values are linearly interpolated to form overload and underload curves.




The action (none, warning or fault) taken when the signal leaves the permissible operating range can be selected separately for overload and underload conditions (parameter 37.03 or 37.04). For each state, there is also an optional timer to delay the selected action (37.41 and 37.42).

#### 6.2.5.4.1 Settings

Parameter group "37 User load curve" on page 306.

### 6.2.5.5 Automatic acknowledgment of faults

The frequency inverter itself can automatically acknowledge overvoltage, undervoltage and external faults. The user can also specify a fault (except faults related to function "Safe Torque Off") that is automatically acknowledged.

By default, automatic acknowledgment is disabled and must be enabled by the user.

**Warning!**

**Before enabling this function, ensure that no dangerous situations can occur. The function automatically restarts the frequency inverter and resumes operation after a fault.**

#### 6.2.5.5.1 Settings

Parameters 31.12 … 31.16.

#### 6.2.5.6 Other programmable protection functions

##### 6.2.5.6.1 External events (parameters 31.01 .. 31.10)

Five different process event signals can be connected to selected inputs to generate warning messages and fault shutdowns of the drive. If the signal drops, the external event (fault, warning or a log entry) is generated. The contents of the messages can be edited with the control panel by selecting **Menu - Settings - Edit texts**.

##### 6.2.5.6.2 Detecting the failure of a motor phase (parameter 31.19)

This parameter sets the response of the frequency inverter when detecting the failure of a motor phase.

##### 6.2.5.6.3 Detecting a ground fault (parameter 31.20)

The ground fault detection function is based on the measurement of the total current.
Note the following:

- A ground fault in the supply cable does not enable protection.
- The protection responds within 2 milliseconds in a grounded supply network.
- The supply network capacitance must be 1 microfarad or more in an ungrounded supply network.
- The capacitive currents caused by shielded motor cables up to 300 meters do not enable protection.
- Protection is disabled when the drive was stopped.

##### 6.2.5.6.4 Detecting the loss failure of a supply phase (parameter 31.21)

The parameter is used to select the response of the frequency inverter when the failure of a supply phase is detected.

##### 6.2.5.6.5 Detecting Safe Torque Off (parameter 31.22)

The frequency inverter monitors the state of the Safe Torque Off (STO) input. This parameter is used to select which indications are output when the signals are lost. (The parameter itself has no effect on the functionality of Safe Torque Off.) For additional information about the function of the safely switched off torque, see Safe Torque Off.

##### 6.2.5.6.6 Swapped supply and motor cables (parameter 31.23)

The frequency inverter detects if the supply and motor cables have been accidentally swapped (if the supply cable was connected to the motor terminals, for example). The parameter is used to select whether a fault message is generated. Note that this protection function must be disabled if the frequency inverter / inverter is supplied from a DC voltage source in the DC bus.

##### 6.2.5.6.7 Stall protection (parameters 31.24 .. 31.28)

The frequency inverter protects the motor in the event of a stall. The monitoring limit values (current, frequency and time) can be set, and the response of the frequency inverter when a stall condition is detected can be selected.

##### 6.2.5.6.8 Overspeed protection (parameter 31.30)

The user can set overspeed (and overfrequency) limits that are a certain range above/below the currently set maximum and minimum speed (or frequency) limits.

##### 6.2.5.6.9 Ramp stop monitoring (parameters 31.32, 31.33, 31.37 and 31.38)

The control program has a monitoring function for both normal ramps and emergency stop ramps. The user can define either a maximum time for the stop or a maximum deviation from the expected deceleration rate. If the drive does not stop as expected, a fault message is generated and the drive coasts to a stop.

##### 6.2.5.6.10 Supervision of the main fan (parameter 31.35)

This parameter is used to set how the drive responds if the main fan fails.

#### 6.2.5.6.11 Customized motor current fault limit (parameter 31.42)

The control program sets a motor current limit based on the drive hardware. In most cases, the default value is suitable. However, a lower limit value can be set manually by the user, for example to protect a permanent magnet motor from demagnetization.

#### 6.2.5.6.12 Detecting local control failure

The user can use a parameter to set the drive response in the event communication with the control panel is lost.

### 6.2.6 Diagnostics

#### 6.2.6.1 Fault and warning messages, data storage

See chapter "Warning and fault messages" on page 331.

#### 6.2.6.2 Signal supervision

Three signals can be selected for monitoring with this function. If a monitored signal rises above / falls below a preset limit value, a bit in 32.01 Supervision status is enabled and a warning or fault message is triggered. The contents of the messages can be edited with the control panel by selecting **Menu - Settings - Edit texts**.

The monitored signals are low-pass filtered.

##### 6.2.6.2.1 Settings

Parameter group "32 Supervision" on page 298.

#### 6.2.6.3 Maintenance times and counters

The program has six different time functions or counters for the maintenance tasks to be performed. They can be configured to output a warning message when a predefined message size is reached. The contents of the messages can be edited with the control panel by selecting **Menu - Settings - Edit texts**.

Time functions/counters can be used to monitor any parameter. The counters are useful as a reminder for service work.

There are three types of counters:

- Switch-on time. Measures the time that a binary source is enabled (for example, a bit in a status word).
- Signal edge counter. The counter is incremented by 1 when the monitored binary source changes its state.
- Value counter. The counter measures the monitored parameter by integration. A warning message is output if the integrated value reaches a set limit value.

# 6.3 Parameters

This chapter describes the parameters including the actual value signals of the control program.

## 6.3.1 Terminology and abbreviations

| Term | Explanation |
|---|---|
| Actual signal | Type of a parameter that is the result of a measurement or calculation by the frequency inverter or that contains status information. Most actual signals can only be read, but some can be reset (for example, counter actual values). |
| Def (factory setting) | (Shown in the following parameter table on the same row as the parameter name)<br>Default value of a parameter for macro "Factory settings". For additional information about macro-specific parameter values, see chapter "Application macros" on page .<br>**Note:**<br>**Certain configurations or optional devices may require specific default values.** |
| FbEq16 | (Shown in the following parameter table on the same row as the parameter range or for the respective setting.)<br>16-bit fieldbus equivalent: The scaling between the value displayed on the control panel and the integer value used in fieldbus communication when a 16-bit value is selected for transfer to an external system. A dash (-) indicates that the parameter is not accessible in 16-bit format. The corresponding 32-bit scalings are listed in chapter "Additional parameter data" on page . |
| Other | The value of another parameter is used.<br>When "Other" is selected, a parameter list is displayed where the user can specify the source parameter.<br>**Note:**<br>**The source parameter must be a 32-bit floating-point number. To use a 16-bit integer value (e.g. received from an external device in data sets) as a source, data storage parameters can be used.** |
| Other [bit] | The value of a specific bit in another parameter.<br>When "Other" is selected, a parameter list is displayed where the user can specify the source parameter and bit. |
| Parameter | Either an operating instruction for the drive configured by the user or an actual signal. |
| p.u. | Per unit (per unit) |

## 6.3.2 Overview of parameter groups

| Group | Contents |
|---|---|
| 01 Actual values | Basic signals for monitoring the frequency inverter/drive. |
| 04 Warnings and faults | Information about warnings and faults that have occurred recently. |
| 05 Diagnostics | Various operating time counters and measured values for drive maintenance. |
| 06 Control and status words | Control and status words of the drive |
| 07 System info | Information about the hardware and firmware of the frequency inverter as well as the application program. |
| 10 Standard DI, RO | Configuration of digital inputs and relay outputs. |
| 11 Standard DIO, FI, FO | Configuration of digital inputs/outputs and frequency inputs/outputs. |
| 12 Standard AI | Configuration of standard analog inputs. |
| 13 Standard AO | Configuration of standard analog outputs. |
| 20 Start/stop/direction | Selection of signal sources for start/stop/direction of rotation, controller/start/tap enable, selection of signal sources for positive/negative setpoint enabling. |
| 21 Start/stop mode | Start and stop modes, emergency stop and signal source selection, DC magnetization settings, selection of rotor position detection mode. |
| 22 Speed reference selection | Speed setpoint selection, motor potentiometer settings. |
| 23 Speed reference ramp | Sets the speed setpoint ramps (programming the acceleration and deceleration rates of the drive). |
| 24 Speed reference conditioning | Calculates the speed control deviation, speed control deviation window configuration, speed deviation steps. |
| 25 Speed control | Settings for speed control. |
| 26 Torque reference chain | Settings for the torque setpoint chain. |
| 30 Limits | Limit values for frequency inverter operation. |
| 31 Fault functions | Configuration of external events, selection of the drive's behavior in the event of disturbances. |
| 32 Supervision | Configuration of the signal supervision functions 1...3. |
| 35 Motor thermal protection | Settings of the thermal motor protection such as configuration of the temperature measurement and the fan control as well as definition of the load curve. |
| 37 User load curve | Settings for the user load curve (ULC). |
| 43 Brake chopper | Settings for the internal brake chopper. |
| 44 Mechanical brake control | Configuration of the mechanical brake control. |
| 46 Monitoring/scaling settings | Speed monitoring settings, actual signal filtering and general scaling settings. |
| 51 FBA A settings | Configuration of fieldbus adapter A. |
| 90 Feedback selection | Configuration of the motor and load feedback. |
| 91 Encoder module settings | Configuration of encoder interface modules. |
| 92 Encoder 1 configuration | Settings for rotary encoder 1. |
| 95 HW configuration | Various hardware-specific settings. |

| Group | Contents |
|---|---|
| 96 System | Language selection, access levels, macro selection, save and restore parameters, control unit restart, user parameter sets, unit selection, data storage triggering, parameter checksum calculation, user/parameter lock. |
| 97 Motor control | Motor model settings. |
| 98 User motor parameters | The motor data entered by the user is used in the motor model. |
| 99 Motor data | Motor configuration settings. |

## 6.3.3 Parameter list

### 01 Actual values

| No. | Name/Value | Description | Clear all / FbEq16 |
|---|---|---|---|
| 01 | Actual values | Basic signals for monitoring the frequency inverter/drive.<br>All parameters in this group are read-only unless otherwise specified. | |
| 01.01 | Motor speed used | Measured or calculated motor speed depending on the type of feedback (see parameter 90.41 Motor feedback selection). A filter time constant for this signal can be set with parameter 46.11 Filter time motor speed. | - |
| | -30000.00 … 30000.00 rpm | Measured or calculated motor speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 01.02 | Motor speed estimated | Calculated motor speed in rpm. A filter time constant for this signal can be set with parameter 46.11 Filter time motor speed. | - |
| | -30000.00 … 30000.00 rpm | Calculated motor speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 01.03 | Motor speed % | Displays the value of 01.01 Motor speed used as a percentage of the synchronous speed of the motor. | 100 = 1% |
| | -1000.00 … 1000.00% | Measured or calculated motor speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 01.04 | Encoder 1 speed filtered | Speed of rotary encoder 1 in rpm. A filter time constant for this signal can be set with parameter 46.11 Filter time motor speed. | - |
| | -30000.00 … 30000.00 rpm | Encoder 1 speed | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 01.05 | Encoder 2 speed filtered | Speed of rotary encoder 2 in rpm. A filter time constant for this signal can be set with parameter 46.11 Filter time motor speed. | - |
| | -30000.00 … 30000.00 rpm | Encoder 2 speed | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 01.06 | Output frequency | Calculated frequency inverter output frequency in Hz. A filter time constant for this signal can be set with parameter 46.12 Filter time output frequency. | - |
| | -500.00 … 500.00 Hz | Calculated output frequency. | |
| 01.07 | Motor current | Measured (absolute) motor current in A. | - |
| | 0.00 … 30000.00 A | Motor current. | 1 = 0.01 A (DS402 mode), see par. 46.05. (native mode) |
| 01.08 | Motor current % of motor nom | Motor current (frequency inverter output current) as a percentage of the nominal motor current. | - |
| | 0.0...1000.0% | Motor current. | 10 = 1% |
| 01.10 | Motor torque | Motor torque as a percentage of the nominal motor torque.<br>A filter time constant for this signal can be set with parameter 46.13 Filter time motor torque. | - |
| | -1600.0 ... 1600.0% | Motor torque. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 01.11 | DC voltage | Measured DC bus voltage. | - |
| | 0.00 … 2000.00 V | DC bus voltage. | 100 = 1 V |
| 01.13 | Output voltage | Calculated motor voltage in V AC. | - |
| | 0…2000 V | Motor voltage. | 1 = 1 V |
| 01.14 | Output power | Frequency inverter output power. The unit is selected with parameter 96.16 Unit selection. A filter time constant for this signal can be set with parameter 46.14 Filter time power out. | - |
| | -32768.00 … 32767.00 kW | Output power. | 100 = 1 kW |
| 01.15 | Output power % of motor nom | Displays the value of 01.14 Output power as a percentage of the nominal motor power. | - |
| | -300.00 ... 300.00% | Output power. | 100 = 1% |
| 01.17 | Motor shaft power | Calculated mechanical power at the motor shaft. The unit is selected with parameter 96.16 Unit selection. A filter time constant for this signal can be set with parameter 46.14 Filter time power out. | - |
| | -32768.00 … 32767.00 kW | Motor shaft power. | 100 = 1 kW |
| 01.21 | U-phase current | Measured U-phase current. | - |
| | -30000.00 … 30000.00 A | U-phase current. | 1 = 0.01 A (DS402 mode), see par. 46.05. (native mode) |
| 01.22 | V-phase current | Measured V-phase current. | - |
| | -30000.00 … 30000.00 A | V phase current. | 1 = 0.01 A (DS402 mode), see par. 46.05. (native mode) |
| 01.23 | W-phase current | Measured W phase current. | - |
| | -30000.00 … 30000.00 A | W phase current | 1 = 0.01 A (DS402 mode), see par. 46.05. (native mode) |

| No. | Name/Value | Description | Clear all / FbEq16 |
|---|---|---|---|
| 01.24 | Flux actual % | Used flux setpoint as a percentage of the nominal flux of the motor. | - |
| | 0…200% | Flux setpoint. | 1 = 1% |
| 01.29 | Speed change rate | Actual speed change rate. Positive values mean acceleration; negative values mean deceleration.<br>See also parameters 31.32 Emergency ramp supervision, 31.33 Emergency ramp supervision delay, 31.37 Ramp stop supervision and 31.38 Ramp stop supervision delay. | - |
| | -15000 … 15000 rpm/s | Speed change rate. | 1 = 1 (rpm)/s |
| 01.31 | Ambient temperature | Measured temperature of the incoming cooling air. The unit is selected with parameter 96.16 Unit selection. | - |
| | -40 … 120°C | Cooling air temperature. | 1 = 1°C |
| 01.61 | Abs motor speed used | Absolute value of 01.01 Motor speed used. | - |
| | 0.00 = 30000.00 rpm | Measured or calculated motor speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 01.62 | Abs motor speed % | Absolute value from 01.03 Motor speed %. | - |
| | 0.00 ... 1000.00% | Measured or calculated motor speed. | 100 = 1% |
| 01.63 | Abs output frequency | Absolute encoder of 01.06 Output frequency:. | - |
| | 0.00 … 500.00 Hz | Calculated output frequency. | 1 = 0.01 Hz (DS402 mode), see par. 46.02 (native mode) |
| 01.64 | Abs motor torque | Absolute value of 01.10 Motor torque. | - |
| | 0.0...1600.0% | Motor torque. | 1 = 0.1% (DS402 mode), see par. 46.03 (native mode) |
| 01.65 | Abs output power | Absolute value of 01.14 Output power. | - |
| | 0.00… 32767.00 kW | Output power. | 1 = 1 unit |
| 01.66 | Abs output power % motor nom | Absolute value of 01.15 Output power % of motor nom. | - |
| | 0.00 ... 300.00% | Output power. | 100 = 1% |
| 01.68 | Abs motor shaft power | Absolute value from 01.17 Motor shaft power. | - |
| | 0.00… 32767.00 kW | Motor shaft power. | 1 = 1 unit |

## 03 Input references

| No. | Name/Value | Description | Clear all / FbEq16 |
|---|---|---|---|
| 03 | Input references | Values of setpoints received from different sources.<br>All parameters in this group are read-only unless otherwise specified. | |
| 03.05 | FB A reference 1 | Setpoint 1 received via fieldbus adapter A. | - |
| | -100000.00 … 100000.00 | Setpoint 1 from fieldbus adapter A. | 100 = 1.00 |
| 03.06 | FB A reference 2 | Setpoint 2 received via fieldbus adapter A. | - |
| | -100000.00 … 100000.00 | Setpoint 2 from fieldbus adapter A. | 100 = 1.00 |

## 04 Warnings and faults

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 04 | Warnings and faults | Information about warnings and faults that have occurred recently.<br>For a description of individual warning and fault codes, see chapter Warning and fault messages.<br>All parameters in this group are read-only unless otherwise specified. | |
| 04.01 | Tripping fault | Code of the 1st active fault (fault that caused the current shutdown). | - |
| | 0000h…FFFFh | 1st active fault. | 1 = 1 |
| 04.02 | Active fault 2 | Code of the second-to-last active fault. | - |
| | 0000h…FFFFh | Second-to-last active fault. | 1 = 1 |
| 04.03 | Active fault 3 | Code of the third-to-last active fault. | - |
| | 0000h…FFFFh | Third-to-last active fault. | 1 = 1 |
| 04.04 | Active fault 4 | Code of the fourth-to-last active fault. | - |
| | 0000h…FFFFh | Fourth-to-last active fault. | 1 = 1 |
| 04.05 | Active fault 5 | Code of the fifth-to-last active fault. | - |
| | 0000h…FFFFh | Fifth-to-last active fault. | 1 = 1 |
| 04.06 | Active warning 1 | Code of the last active warning. | - |
| | 0000h…FFFFh | Last active warning. | 1 = 1 |
| 04.07 | Active warning 2 | Code of the second-to-last active warning. | - |
| | 0000h…FFFFh | Second-to-last active warning. | 1 = 1 |
| 04.08 | Active warning 3 | Code of the third-to-last active warning. | - |
| | 0000h…FFFFh | Third-to-last active warning. | 1 = 1 |
| 04.09 | Active warning 4 | Code of the fourth-to-last active warning. | - |
| | 0000h…FFFFh | Fourth-to-last active warning. | 1 = 1 |
| 04.10 | Active warning 5 | Code of the fifth-to-last active warning. | - |
| | 0000h…FFFFh | Fifth-to-last active warning. | 1 = 1 |
| 04.11 | Latest fault | Code of the last stored (non-active) fault. | - |
| | 0000h…FFFFh | Last stored fault. | 1 = 1 |
| 04.12 | 2nd latest fault | Code of the second-to-last stored (non-active) fault. | - |
| | 0000h…FFFFh | Second-to-last stored fault. | 1 = 1 |
| 04.13 | 3rd latest fault | Code of the third-to-last stored (non-active) fault. | - |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | 0000h...FFFFh | Third-to-last stored fault. | 1 = 1 |
| 04.14 | 4th latest fault | Code of the fourth-to-last stored (non-active) fault. | - |
| | 0000h...FFFFh | Fourth-to-last stored fault. | 1 = 1 |
| 04.15 | 5th latest fault | Code of the fifth-to-last stored (non-active) fault. | - |
| | 0000h...FFFFh | Fifth-to-last stored fault. | 1 = 1 |
| 04.16 | Latest warning | Code of the last stored (non-active) warning. | - |
| | 0000h...FFFFh | Last stored warning. | 1 = 1 |
| 04.17 | 2nd latest warning | Code of the second-to-last stored (non-active) warning. | - |
| | 0000h...FFFFh | Second-to-last stored warning. | 1 = 1 |
| 04.18 | 3rd latest warning | Code of the third-to-last stored (non-active) warning. | - |
| | 0000h...FFFFh | Third-to-last stored warning. | 1 = 1 |
| 04.19 | 4th latest warning | Code of the fourth-to-last stored (non-active) warning. | - |
| | 0000h...FFFFh | Fourth-to-last stored warning. | 1 = 1 |
| 04.20 | 5th latest warning | Code of the fifth-to-last stored (non-active) warning. | - |
| | 0000h...FFFFh | Fifth-to-last warning saved. | 1 = 1 |
| 04.21 | Fault word 1 | ACPi P96-compatible fault word 1<br>The bit assignments of this word correspond to the fault word 1 of the ACPi P96.<br>Each bit can indicate different events of the ACPi P96 according to the following list.<br>This parameter can only be read. | - |

| Bit | ACPi P96 fault name | ACPi P96 event indicated by this bit (see Warning and fault messages on page 331) |
|---|---|---|
| | - | |
| 0 | SHORT CIRC | 2340 |
| 1 | OVERCURRENT | 2310 |
| 2 | DC OVERVOLT | 3210 |
| 3 | ACS800 TEMP | 2381, 4210, 4290, 42F1, 4310, 4380 |
| 4 | EARTH FAULT | 2330, 2392, 3181 |
| 5 | MOTOR TEMP M | 4981 |
| 6 | MOTOR TEMP | 4982 |
| 7 | SYSTEM_ FAULT | 6481, 6487, 64A1, 64A2, 64A3, 64B1, 64E1, 6881, 6882, 6883, 6885 |
| 8 | UNDERLOAD | - |
| 9 | OVERFREQ | 7310 |
| 10 | MPROT SWITCH | 9081 |
| 11 | CH2 COMM LOSS | 7582 |
| 12 | SC (INU1) | 2340 (XXYY YY01) |
| 13 | SC (INU2) | 2340 (XXYY YY02) |
| 14 | SC (INU3) | 2340 (XXYY YY03) |
| 15 | SC (INU4) | 2340 (XXYY YY04) |

| | | | |
|---|---|---|---|
| | 0000h...FFFFh | ACPi P96-compatible fault word 1 | 1 = 1 |
| 04.22 | Fault word 2 | ACPi P96-compatible fault word 2<br>The bit assignments of this word correspond to the fault word 2 of the ACPi P96.<br>Each bit can indicate different events of the ACPi P96 according to the following list. This parameter can only be read. | - |

| Bit | ACPi P96 fault name | | ACPi P96 event indicated by this bit (see Warning and fault messages on page 331) |
|---|---|---|---|
| 0 | SUPPLY PHASE | SUPPLY PHASE | 3130 |
| 1 | NO MOT DATA | NO MOTOR DATA | - |
| 2 | DC UNDERVOLT | DC UNDERVOLT | 3220 |
| 3 | Reserved | CABLE TEMP | 4000 |
| 4 | RUN ENABLE | RUN DISABLE | AFEB |
| 5 | ENCODER ERR | ENCODER ERR | 7301, 7380, 7381, 73A0, 73A1 |
| 6 | I/O COMM | IO COMM ERR | 7080, 7082 |
| 7 | CTRL B TEMP | CTRL B TEMP | - |
| 8 | EXTERNAL FLT | SELECTABLE | 9082 |
| 9 | OVER SWFREQ | OVER SWFREQ | - |
| 10 | AI < MIN FUNC | AI<MIN FUNC | 80A0 |
| 11 | PPCC LINK | PPCC LINK | 5681, 5682, 5690, 5691, 5692, 5693, 5694, 5695 |
| 12 | COMM MODULE | COMM MODULE | 6681, 7510, 7520, 7581 |
| 13 | PANEL LOSS | PANEL LOSS | 7081 |
| 14 | MOTOR STALL | MOTOR STALL | 7121 |
| 15 | MOTOR PHASE | MOTOR PHASE | 3381 |

| | | | |
|---|---|---|---|
| | 0000h...FFFFh | ACPi P96-compatible fault word 2 | 1 = 1 |
| 04.31 | Warning word 1 | ACPi P96-compatible warning word 1.<br>The bit assignments of this word correspond to the warning word 1 of the ACPi P96.<br>Each bit can indicate different ACPi P96 warnings according to the following list.<br>This parameter can only be read. | - |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|

| Bit | ACPi P96 fault name | | ACPi P96 event indicated by this bit (see Warning and fault messages on page 331) |
|---|---|---|---|
| 0 | START INHIBIT | START INHIBI | A5A0 |
| 1 | Reserved | EM STOP | AFE1, AFE2 |
| 2 | THERMISTOR | MOTOR TEMP M | A491 |
| 3 | MOTOR TEMP | MOTOR TEMP | A492 |
| 4 | ACS800 TEMP | ACS800 TEMP | A2BA, A4A9, A4B0, A4B1, A4F6 |
| 5 | ENCODER ERR | ENCODER ERR | A797, A7B0, A7B1, A7E1 |
| 6 | T MEAS ALM | T MEAS CIRC | A490, A5EA, A782, A8A0 |
| 7 | Reserved | Digital IO | - |
| 8 | Reserved | ANALOG IO | - |
| 9 | Reserved | EXT DIGITAL IO | - |
| 10 | Reserved | EXT ANALOG IO | A6E5, A7AA, A7AB |
| 11 | Reserved | CH2 COMM LOSS | A7CB, AF80 |
| 12 | COMM MODULE | MPROT SWITCH | A981 |
| 13 | Reserved | EM STOP DEC | - |
| 14 | EARTH FAULT | EARTH FAULT | A2B3 |
| 15 | Reserved | SAFETY SWITC | A983 |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | ACPi P96-compatible warning word 1. | 1 = 1 |
| 04.32 | Warning word 2 | ACPi P96-compatible warning word 2.<br>The bit assignments of this word correspond to the warning word 2 of the ACPi P96.<br>Each bit can display different warnings of the ACPi P96 according to the following list.<br>This parameter can only be read. | - |

| Bit | ACPi P96 fault name | | ACPi P96 event indicated by this bit (see Warning and fault messages on page 331) |
|---|---|---|---|
| 0 | Reserved | MOTOR FAN | A781 |
| 1 | UNDERLOAD | UNDERLOAD | - |
| 2 | Reserved | INV OVERLOAD | - |
| 3 | Reserved | CABLE TEMP | A480 |
| 4 | ENCODER | ENCODER A<>B | - |
| 5 | Reserved | FAN OVERTEMP | A984 |
| 6 | Reserved | Reserved | - |
| 7 | POWFAIL FILE | POWFAIL FILE | - |
| 8 | ALM (OS_17) | POWDOWN FILE | - |
| 9 | MOTOR STALL | MOTOR STALL | A780 |
| 10 | AI < MIN FUNC | AI<MIN FUNC | A8A0 |
| 11 | Reserved | COMM MODULE | A6D1, A6D2, A7C1, A7C2, A7CA, A7CE |
| 12 | Reserved | BATT FAILURE | - |
| 13 | PANEL LOSS | PANEL LOSS | A7EE |
| 14 | Reserved | DC UNDERVOLT | A3A2 |
| 15 | Reserved | RESTARTED | - |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | ACS800-compatible warning word 2. | 1 = 1 |

## 05 Diagnostics

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 05 | Diagnostics | Various operating time counters and measured values for drive maintenance. All parameters in this group are read-only unless otherwise specified. | |
| 05.01 | On-time counter | Frequency inverter switch-on time. The counter runs when the frequency inverter is switched on. | - |
| | 0…65535 d | Frequency inverter switch-on time | 1 = 1 d |
| 05.02 | Run-time counter | Motor operating time counter. The counter runs when the frequency inverter is modulating. | - |
| | 0…65535 d | Motor operating time counter. | 1 = 1 d |
| 05.04 | Fan on-time counter | Operating time of the frequency inverter fan. Can be reset with the control panel by pressing the reset button for more than three seconds. | - |
| | 0…65535 d | Fan operating time counter. | 1 = 1 d |
| 05.09 | Time since power on | Ticks of 500 microseconds have elapsed since the last booting of the control unit. | - |
| | 0…4294967295 | Ticks of 500 microseconds have elapsed since the last boot. | 1 = 1 |
| 05.11 | Inverter temperature | Calculated inverter temperature as a percentage of the fault limit value. The switch-off limit value varies depending on the type of frequency inverter.<br>0.0% = 0°C (32°F)<br>94% approx. = Warning limit<br>100.0% = Fault limit | - |
| | -40.0 ... 160.0% | Inverter temperature in percent. | 10 = 1% |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 05.22 | Diagnostic word 3 | Diagnostic word 3. | - |
| | Bit / Name / Value | | |
| | 0…10 / Reserved | | |
| | 11 / Fan command | 1 = Frequency inverter fan rotating above idle speed | |
| | 12 / Fan service counter | 1 = Maintenance counter of the frequency inverter fan has reached its limit value. | |
| | 13…15 / Reserved | | |
| | 0000h…FFFFh | Diagnostic word 3. | 1 = 1 |
| 05.41 | Main fan service counter | Displays the age of the main fan as a percentage of the calculated service life. The calculation is based on the load, operating conditions and other fan operating parameters. If the counter reaches 100%, a warning (A8C0 Fan service counter) is generated.<br>Can be reset with the control panel by pressing the reset button for more than three seconds. | - |
| | 0…150% | Age of the main fan. | 1 = 1% |
| 05.42 | Aux. fan service counter | Displays the age of the auxiliary fan as a percentage of the calculated service life. The calculation is based on the load, operating conditions and other fan operating parameters. If the counter reaches 100%, a warning (A8C0 Fan service counter) is generated.<br>Can be reset with the control panel by pressing the reset button for more than three seconds. | - |
| | 0…150% | Age of the auxiliary fan. | 1 = 1% |
| 05.111 | Line converter temperature | (Only visible if the IGBT supply unit control has been activated) Calculated rectifier unit temperature as a percentage of the fault limit. 0.0% = 0°C (32°F) 94% approx. = Warning limit 100.0% = Fault limit value | - |
| | -40.0…160.0% | Rectifier unit temperature as a percentage. | 10 = 1% |
| 05.121 | MCB closing counter | (Only visible if the IGBT supply unit control has been activated) Counts the closing operations of the circuit breaker or main contactor of the rectifier unit. | - |
| | 0…4294967295 | Counter value of the closing operations of the circuit breaker or main contactor of the rectifier unit. | 1 = 1 |

## 06 Control and status words

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 06 | Control and status words | Control and status words of the drive | |
| 06.01 | Main control word | The main control word of the drive. This parameter shows the control signals received from the selected sources (such as digital inputs, fieldbus interfaces and control program).<br>**Note:**<br>**Bits 12...15 can be used with additional control data and as signal source from any binary source selection parameter. This parameter can only be read.** | |
| | 0000h…FFFFh | Main control word | 1 = 1 |
| 06.03 | FBA A transparent control word | Displays the unchanged control word received from the PLC via fieldbus adapter A when a transparent communication profile, in parameter group 51 FBA A settings for example, was selected.<br>This parameter can only be read. | - |
| | 00000000h … FFFFFFFFh | Control word received via fieldbus adapter A. | - |
| 06.11 | Main status word | Main status word of the drive.<br>This parameter can only be read. | - |
| | 0000h…FFFFh | Main status word. | 1 = 1 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 06.16 | Drive status word 1 | Drive status word 1<br>This parameter can only be read. | - |

| Bit | Name | Description |
|---|---|---|
| 0 | Enabled | 1 = Both the controller enable signal (see par. 20.12) and the start enable signal are present and function "Safe Torque Off" has not been activated.<br>**Note:**<br>• **For I/O control or local control, clearing this bit causes the frequency inverter to change to status SWITCH-ON INHIBITED.**<br>• **This bit is inactive in the event of a fault.** |
| 1 | Suspended | 1 = Starting is locked. See parameters 06.18 and 06.25 for the source of the blocked signal. |
| 2 | DC charged | 1 = The DC bus is charged. If present, the DC switch is closed and the charging switch is open.<br>0 = Charging procedure not completed. |
| 3 | Ready to start | 1 = Frequency inverter is ready to receive the start command. |
| 4 | Following the setpoint | 1 = Drive is ready to follow the setpoint value. |
| 5 | Started | 1 = The drive is started. |
| 6 | Modulated | 1 = The inverter is modulating (output stage is controlled) |
| 7 | Limited | 1 = An operating limit value (speed, torque, etc.) is active. |
| 8 | Local control | 1 = Drive in local control |
| 9 | Network control | 1 = Drive is in network control (see page 15). |
| 10 | Ext1 active | 1 = Control location EXT1 is active. |
| 11 | Ext2 active | 1 = Control location EXT2 is active. |
| 12 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Frequency inverter status word 1. | 1 = 1 |
| 06.17 | Drive status word 2 | Drive status word 2<br>This parameter can only be read. | - |

| Bit | Name | Description |
|---|---|---|
| 0 | Identification run done | 1 = The motor identification run (ID) was performed. |
| 1 | Magnetized | 1 = Motor was magnetized |
| 2 | Torque control | 1 = Torque control is active. |
| 3 | Speed control | 1 = Speed control is active. |
| 4 | Power control | 1 = Power control is active. |
| 5 | Safe setpoint active | 1 = A "safe" setpoint is being used by functions. |
| 6 | Last speed active | 1 = A "last speed" setpoint is being used by functions. |
| 7 | Setpoint lost | 1 = Setpoint signal has failed. |
| 8 | Emergency stop fault | 1 = Emergency stop failed (see parameters 31.32 and 31.33) |
| 9 | Jogging active | 1 = The enable signal for jogging is active. |
| 10 | Above limit value | 1 = Actual speed, frequency or torque is equal to or above the limit value (according to parameters 46.31...46.33). This applies to both directions of rotation. |
| 11 | Emergency stop is active. | 1 = An emergency stop command signal is active, or the frequency inverter is stopping after receiving an emergency stop command. |
| 11 | Reduced operation | 1 = Reduced operation is active (see section Reduced operation (redundant operation) on page Reduzierter Betrieb (Redundanzbetrieb)) |
| 13 | Reserved | |
| 14 | Stop failed | 1 = Stop failed (see parameters 31.37 and 31.38) |
| 15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Inverter status word 2. | 1 = 1 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 06.18 | Start inhibit status word | Start inhibit status word. This status word specifies the source of the inhibit signal that is blocking the drive from starting.<br>The conditions marked with an asterisk (*) require that the start command be updated. In all other cases, the inhibit condition must be reset first.<br>See also parameters 06.25 Drive inhibit status word 2 and 06.16 Drive status word 1, bit 1.<br>This parameter can only be read. | - |

| Bit | Name | Description | |
|---|---|---|---|
| 0 | Not ready | 1 = DC voltage missing or the drive was not configured correctly. Check the parameters in groups 95 and 99. | a |
| 1 | Control location changed | * 1 = The control location was changed. | a,c |
| 2 | SSW inhibit | 1 = The control program is keeping itself in an inhibited state. | a |
| 3 | Fault acknowledgment | * 1 = Fault was acknowledged | a,c |
| 4 | Start enable missing | 1 = The start enable signal is missing. | a |
| 5 | Controller enable missing | 1 = The controller enable signal is missing. | a |
| 6 | --- | --- | --- |
| 7 | STO | 1 = Function "Safe torque off" active | b |
| 8 | Current calibr. ended | * 1 = The current calibration routine is ended. | b,c |
| 9 | ID run ended | * 1 = The motor identification run is ended. | b,c |
| 10 | Rotor pos. detection ended | * 1 = Autophasing is ended. | b,c |
| 11 | Stop Off1 | 1 = Emergency stop signal (mode Off1) | b |
| 12 | Stop Off2 | 1 = Emergency stop signal (mode Off2) | b |
| 13 | Stop Off3 | 1 = Emergency stop signal (mode Off3) | b |
| 14 | Auto reset inhibit | 1 = The automatic acknowledgment function is blocking operation. | |
| 15 | Jogging active | 1 = Signal "Jogging enable" is blocking normal operation. | b |

| Notes | |
|---|---|
| a | If bit 1 of 06.16 Drive status word 1 is still set after resetting the inhibit condition and triggering is selected according to an edge for the active external control location, a new start signal with rising edge is required. |
| b | If bit 1 of 06.16 Drive status word 1 is still set after resetting the inhibit condition, a new start signal with rising edge is required. |
| c | Informational bit. The inhibit condition does not need to be reset by the user. |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Start inhibit status word. | 1 = 1 |
| 06.19 | Speed control status word | Speed control status word.<br>This parameter can only be read. | - |

| Bit | Name | Description |
|---|---|---|
| 0 | Zero speed | 1 = The drive is running at zero speed, i.e. the absolute value of par 90.01 Motor speed for control 90.01 Motor speed for control remained below 21.06 Zero speed limitfor a longer time than 21.07 Zero speed delay.<br>**Note:**<br>• **This bit is not updated if control of the mechanical brake was enabled with par. 44.06 and the frequency inverter is modulating.**<br>• **During a ramp stop in the forward direction of rotation, the delay time counter runs if [90.01] < [21.06]. From the reverse direction of rotation, the delay time counter runs if 90.01 > -21.06.** |
| 1 | Forward | 1 = The drive is running in the forward direction of rotation above the zero speed limit, i.e. 90.01 > +21.06. |
| 2 | Back | 1 = The drive is running in the reverse direction above the zero speed limit, i.e 90.01 < -21.06. |
| 4 | Internal speed feedback | 1 = The calculated actual speed value is being used for motor control, i.e. the calculated speed was set with par. 90.41 or 90.46, or the selected encoder has a fault (par. 90.45).<br>0 = Encoder 1 or 2 is being used for speed feedback. |
| 5 | Encoder 1 feedback | 1 = Encoder 1 is being used for speed feedback during motor control.<br>0 = Encoder 1 is faulty or not selected as the source of speed feedback (see par. 90.41 and 90.46). |
| 10…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Speed control status word | 1 = 1 |
| 06.20 | Constant speed status word | Constant speed/frequency status word. Indicates which constant speed or frequency is active (if selected). See also parameter 06.19 Speed control status word, bit 7.<br>This parameter can only be read. | - |
| | 0000h…FFFFh | Constant speed/frequency status word | 1 = 1 |
| 06.21 | Drive status word 3 | Drive status word 3<br>This parameter can only be read. | - |

| Bit | Name | Description |
|---|---|---|
| 0 | DC hold active | 1 = DC hold is active (see par. 21.08). |
| 1 | Post-magnetization active | 1 = Post-magnetization is active (see par. 21.08). |
| 3 | Smooth start enabled | Reserved. |
| 4 | Rotor position known | 1 = The rotor position was determined (rotor position detection not required). See section Autophasing (page 234). |
| 5…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Drive status word 3 | 1 = 1 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 06.25 | Drive inhibit status word 2 | Frequency inverter inhibit status word 2. This status word specifies the source of the inhibit signal that is blocking the drive from starting.<br>See also parameters 06.18 Start inhibit status word and 06.16 Drive status word 1, bit 1.<br>This parameter can only be read. | - |

| Bit | Name | Description | Note |
|---|---|---|---|
| 3 | Encoder feedback | 1 = The configuration of the encoder feedback is preventing the drive from starting. | a |
| 4 | Setpoint source 1 configuration | 1 = A conflict of the setpoint source configuration is preventing the drive from starting. See warning A6DA Reference source parameterization (page 337). | b |
| 5…15 | Reserved | | |

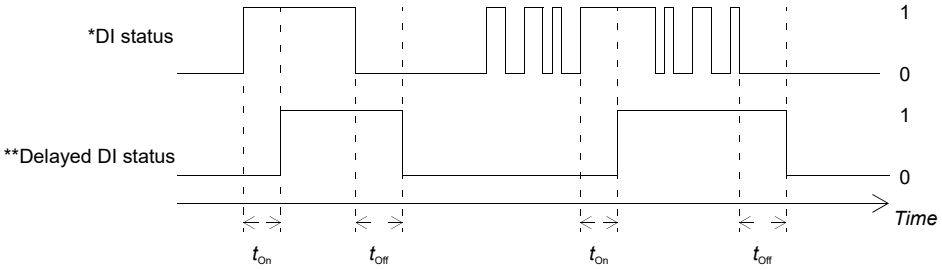
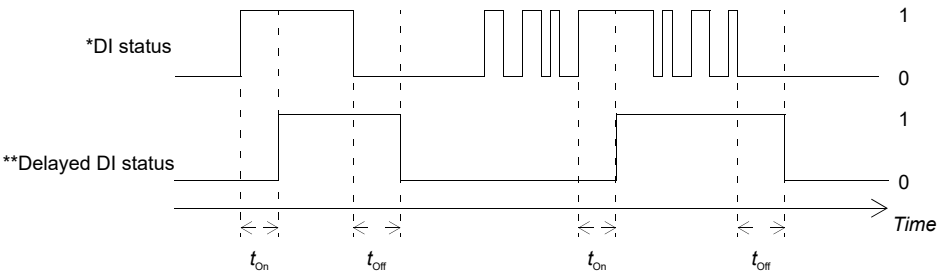
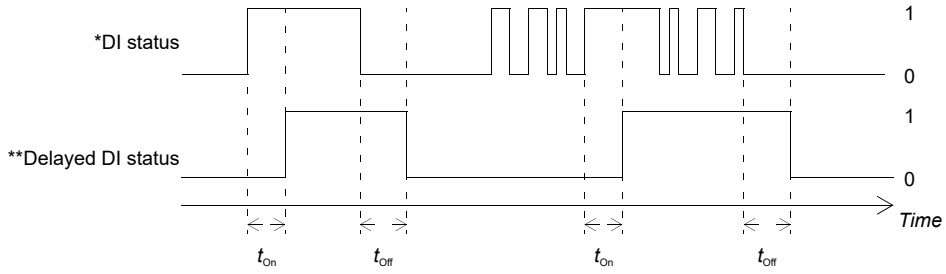
| Notes: | |
|---|---|
| a | If bit 1 of 06.16 Drive status word 1 is still set after resetting the inhibit condition and triggering is selected according to an edge for the active external control location, a new start signal with rising edge is required. |
| b | If bit 1 of 06.16 Drive status word 1 is still set after resetting the inhibit condition, a new start signal with rising edge is required. |

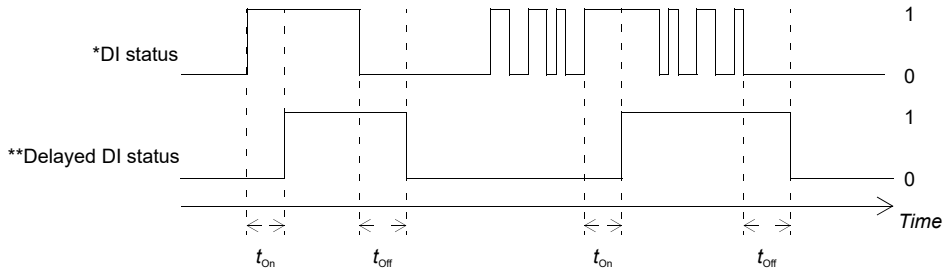
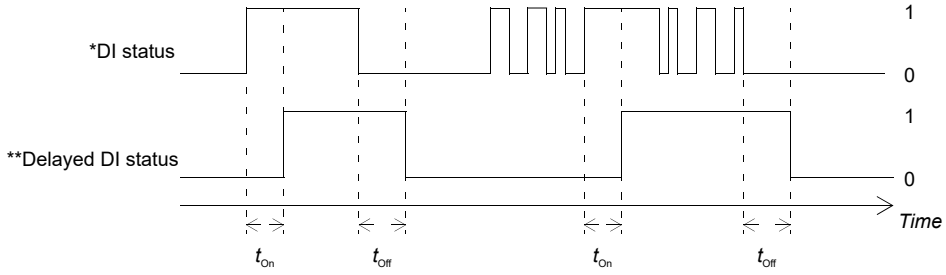
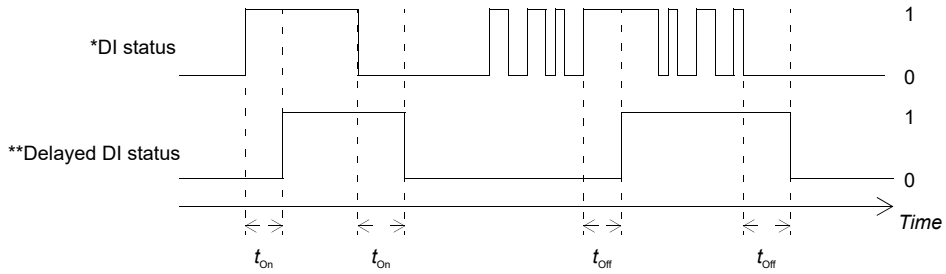
| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Start inhibit status word. | 1 = 1 |
| 06.29 | MSW bit 10 sel | Selects a binary source whose status is transmitted as bit 10 of 06.11 Main status word. | Above limit |
| | False | 0. | 0 |
| | True | 1. | 1 |
| | Above limit value | Bit 10 of 06.17 Drive status word 2 (see page 138). | 2 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 06.30 | MSW bit 11 sel | Selects a binary source whose status is transmitted as bit 11 of 06.11 Main status word. | Ext ctrl loc |
| | False | 0. | 0 |
| | TRUE | 1. | 1 |
| | Ext ctrl loc | Bit 11 of 06.01 Main control word (see page 06 Control and status words). | 2 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 06.31 | MSW bit 12 sel | Selects a binary source whose status is transmitted as bit 12 of 06.11 Main status word. | Ext run enable |
| | False | 0. | 0 |
| | TRUE | 1. | 1 |
| | Ext run enable | Inverted bit 5 of 06.18 Start inhibit status word (see page 256). | 2 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 06.32 | MSW bit 13 sel | Selects a binary source whose status is transmitted as bit 13 of 06.11 Main status word. | False |
| | False | 0. | 0 |
| | TRUE | 1. | 1 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 06.33 | MSW bit 14 sel | Selects a binary source whose status is transmitted as bit 14 of 06.11 Main status word. | False |
| | False | 0. | 0 |
| | TRUE | 1. | 1 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |

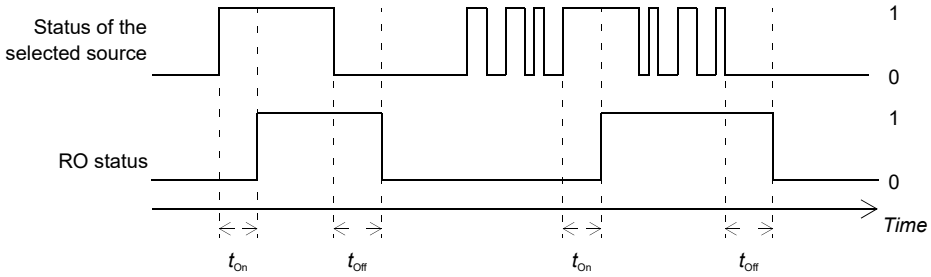
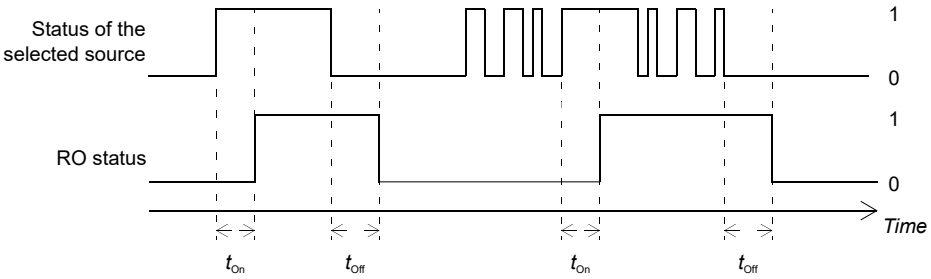
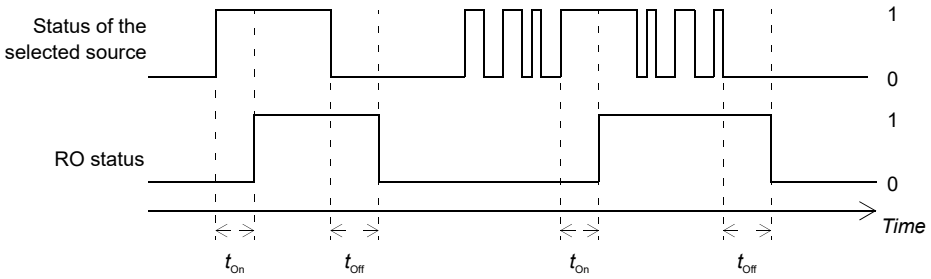
## 07 System info

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 07 | System info | Information about the hardware and firmware of the frequency inverter as well as the application program. All parameters in this group can only be read (read-only). | |
| 07.03 | Drive rating id | Type of drive/inverter unit. | - |
| 07.04 | Firmware name | Firmware identification. The format is AINFX, where X denotes the type of control unit (2 = BCU-x2, 6 = ZCU-12/14). | - |
| 07.05 | Firmware version | Version number of the firmware.<br>The format is A.BB.C.D, where A = Major version, B = Minor version, C = Patch (i.e. firmware variant code), D = 0. | - |
| 07.06 | Loading package name | Name of the firmware program version<br>The format is AINLX, where X denotes the type of control unit (2 = BCU-x2, 6 = ZCU-12/14). | - |
| 07.07 | Loading package version | Name of the firmware program version. See parameter 07.05. | - |
| 07.08 | Bootloader version | Version number of the firmware bootloader. | - |
| 07.11 | Cpu usage | Utilization of the microprocessor in percent. | - |
| | 0…100% | Utilization of the microprocessor. | 1 = 1% |
| 07.13 | PU logic version number | Version number of the power unit logic.<br>Value FFFF indicates that the version numbers of power units connected in parallel are different. See the frequency inverter data on the control panel. | - |

## 10 Standard DI, RO

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 10 | Standard DI, RO | Configuration of digital inputs and relay outputs. | |
| 10.01 | DI status | Displays the electrical status of digital inputs DIIL and DI6...DI1. The on/off delays of the inputs (if specified) are ignored. A filter time can be set with parameter 10.51 DI filter time.<br>Bits 0...5 indicate the status of DI1...DI6; bit 15 indicates the status of input DIIL. Example: 1000000000010011b = DIIL, DI5, DI2 and DI1 are enabled, DI3, DI4 and DI6 are not enabled.<br>This parameter can only be read. | - |
| | 0000h...FFFFh | Status of the digital inputs. | 1 = 1 |
| 10.02 | DI delayed status | Displays the status of digital inputs DIIL and DI6...DI1. This word is updated only after on/off delays (if applicable).<br>Bits 0...5 indicate the status after delay of DI1...DI6; bit 15 indicates the status after delay of input DIIL.<br>This parameter can only be read. | - |
| | 0000h...FFFFh | Status of the digital inputs after delay. | 1 = 1 |
| 10.05 | DI1 ON delay | Sets the enabling delay for digital input DI1. | 0.0 s |
| |  <br>tOn = 10.05 DI1 ON delay<br>tOff = 10.06 DI1 OFF delay<br>*Electrical status of the digital input. Indicated by 10.01 DI status.<br>**Indicated by 10.02 DI delayed status. | | |
| | 0.0 ... 3000.0 s | Enabling delay for DI1. | 10 = 1 s |
| 10.06 | DI1 OFF delay | Sets the disabling delay for digital input DI1. See parameter 10.05 DI1 ON delay. | 0.0 s |
| | 0.0 ... 3000.0 s | Disabling delay for DI1. | 10 = 1 s |
| 10.07 | DI2 ON delay | Sets the enabling delay for digital input DI2. | 0.0 s |
| |  | | |
| | 0.0 ... 3000.0 s | Enabling delay for DI2. | 10 = 1 s |
| 10.08 | DI2 OFF delay | Sets the enabling delay for digital input DI2. See parameter 10.07 DI2 ON delay. | 0.0 s |
| | 0.0 ... 3000.0 s | Disabling delay for DI2. | 10 = 1 s |
| 10.09 | DI3 ON delay | Sets the enabling delay for digital input DI3. | 0.0 s |
| |  | | |
| | 0.0 ... 3000.0 s | Enabling delay for DI3. | 10 = 1 s |
| 10.10 | DI3 OFF delay | Sets the disabling delay for digital input DI3. See parameter 10.09 DI3 ON delay. | 0.0 s |
| | 0.0 ... 3000.0 s | Disabling delay for DI3. | 10 = 1 s |

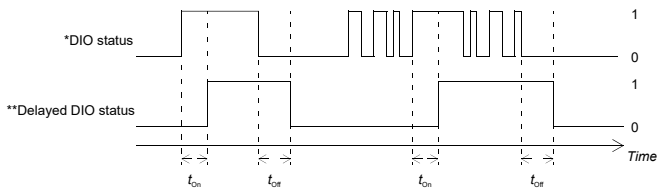
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 10.11 | DI4 ON delay | Sets the enabling delay for digital input DI4. | 0.0 s |
| | |  | |
| | 0.0 … 3000.0 s | Enabling delay for DI4. | 10 = 1 s |
| 10.12 | DI4 OFF delay | Sets the disabling delay for digital input DI4. See parameter 10.11 DI4 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for DI4. | 10 = 1 s |
| 10.13 | DI5 ON delay | Sets the enabling delay for digital input DI5. | 0.0 s |
| | |  | |
| | 0.0 … 3000.0 s | Enabling delay for DI5. | 10 = 1 s |
| 10.14 | DI5 OFF delay | Sets the disabling delay for digital input DI5. See parameter 10.13 DI5 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for DI5. | 10 = 1 s |
| 10.15 | DI6 ON delay | Sets the enabling delay for digital input DI6 | 0.0 s |
| | |  | |
| | 0.0 … 3000.0 s | Enabling delay for DI6. | 10 = 1 s |
| 10.16 | DI6 OFF delay | Sets the disabling delay for digital input DI6. See parameter 10.15 DI6 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for DI6. | 10 = 1 s |
| 10.21 | RO status | Status of relay outputs RO8...RO1. Example: 00000001b = RO1 is enabled, RO2...RO7 are not enabled. | - |
| | 0000h…FFFFh | Status of the relay outputs. | 1 = 1 |
| 10.24 | RO1 source | Selects a drive signal for the connection to relay output RO1. | Ready run |
| | Not energized | Output is not energized. | 0 |
| | Energized | Output is energized. | 1 |
| | Ready run | Bit 1 of 06.11 Main status word (see page 254). | 2 |
| | Enabled | Bit 0 of 06.16 Drive status word 1 (see page 255). | 4 |
| | Started | Bit 5 of 06.16 Drive status word 1 (see page 255). | 5 |
| | Magnetized | Bit 1 of 06.17 Drive status word 2 (see page 255). | 6 |
| | Running | Bit 6 of 06.16 Drive status word 1 (see page 255). | 7 |
| | Ready ref | Bit 2 of 06.11 Main status word (see page 254). | 8 |
| | At setpoint | Bit 8 of 06.11 Main status word (see page 254). | 9 |
| | Back | Bit 2 of 06.19 Speed control status word (see page 256). | 10 |
| | Zero speed | Bit 0 of 06.19 Speed control status word (see page 256). | 11 |
| | Above limit value | Bit 10 of 06.17 Drive status word 2 (see page 255). | 12 |
| | Warning | Bit 7 of 06.11 Main status word (see page 254). | 13 |
| | Fault | Bit 3 of 06.11 Main status word (see page 254). | 14 |
| | Fault (-1) | Inverted bit 3 of 06.11 Main status word (see page 254). | 15 |
| | Open brake command | Bit 0 of 44.01 Brake control status (see page 308). | 22 |
| | Ext2 active | Bit 11 of 06.16 Drive status word 1 (see page 255). | 23 |
| | Remote control | Bit 9 of 06.11 Main status word (see page 254). | 24 |
| | Supervision 1 | Bit 0 of 32.01 Supervision status (see page 298). | 33 |
| | Supervision 2 | Bit 1 of 32.01 Supervision status (see page 298). | 34 |
| | Supervision 3 | Bit 2 of 32.01 Supervision status (see page 298). | 35 |
| | RO/DIO control word bit0 | Bit 0 of 10.99 RO/DIO control word (see page 260). | 40 |
| | RO/DIO control word bit1 | Bit 1 of 10.99 RO/DIO control word (see page 260). | 41 |
| | RO/DIO control word bit2 | Bit 2 of 10.99 RO/DIO control word (see page 260). | 42 |
| | RO/DIO control word bit8 | Bit 8 of 10.99 RO/DIO control word (see page 260). | 43 |

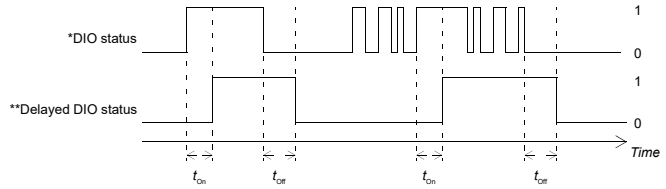
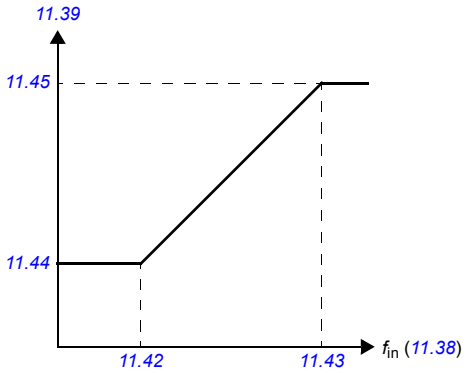
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | RO/DIO control word bit9 | Bit 9 of 10.99 RO/DIO control word (see page 260). | 44 |
| | Other [bit] | Source selection (see "Terms and abbreviations" on page 118). | - |
| 10.25 | RO1 ON delay | Defines the enabling delay for relay output RO1. | 0.0 s |
| |  | | |
| | 0.0 … 3000.0 s | Enabling delay for RO1. | 10 = 1 s |
| 10.26 | RO1 OFF delay | Defines the disabling delay for relay output RO1. See parameter 10.25 RO1 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for RO1. | 10 = 1 s |
| 10.27 | RO2 source | Selects a drive signal for the connection to relay output RO2.<br>For available choices, see parameter 10.24 RO1 source. | |
| 10.28 | RO2 ON delay | Defines the enabling delay for relay output RO2. | 0.0 s |
| |  | | |
| | 0.0 … 3000.0 s | Enabling delay for RO2. | 10 = 1 s |
| 10.29 | RO2 OFF delay | Defines the disabling delay for relay output RO2. See parameter 10.28 RO2 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for RO2. | 10 = 1 s |
| 10.30 | RO3 source | Selects a drive signal for connection to relay output RO3.<br>For available choices, see parameter 10.24 RO1 source. | Fault (-1) |
| 10.31 | RO3 ON delay | Defines the enabling delay for relay output RO3. | 0.0 s |
| |  | | |
| | 0.0 … 3000.0 s | Enabling delay for RO3. | 10 = 1 s |
| 10.32 | RO3 OFF delay | Defines the disabling delay for relay output RO3. See parameter 10.31 RO3 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for RO3. | 10 = 1 s |
| 10.51 | DI filter time | Sets a filter time for parameter 10.01 DI status. | 10.0 ms |
| | 0.3 … 100.0 ms | Filter time for 10.01. | 10 = 1 ms |
| 10.99 | RO/DIO control word | Storage parameter for controlling the relay outputs and digital inputs/outputs via the integrated fieldbus interface.<br>To control the relay outputs (RO) and digital inputs/outputs (DIO) of the frequency inverter, a control word is transmitted with the bit assignments shown below as Modbus I/O data. Set the target selection parameter of this specific data (58.101...58.124) to RO/DIO control word. Then select the corresponding bit of this word in the source selection parameter of the desired output. | 0000h |

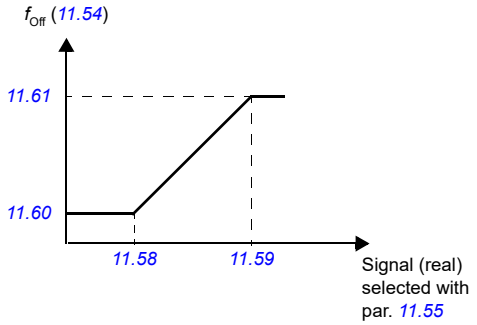
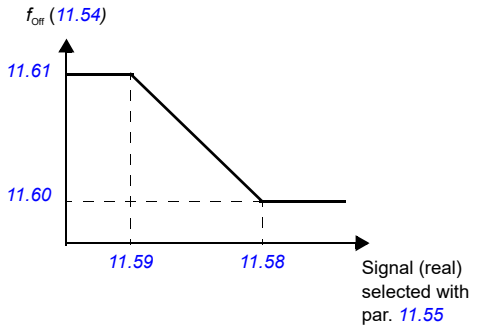
| Bit | Name | Description |
|---|---|---|
| 0 | RO1 | Source bits for relay outputs RO1...RO3 (see parameters 10.24, 10.27 and 10.30). |
| 1 | RO2 | |
| 2 | RO3 | |
| 3…7 | Reserved | |
| 8 | DIO1 | Source bits for digital inputs/outputs DIO1...DIO3 (see parameters 11.06 and 11.10). |
| 9 | DIO2 | |
| 10…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | RO/DIO control word | 1 = 1 |

## 11 Standard DIO, FI, FO

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 11 | Standard DIO, FI, FO | Configuration of digital inputs/outputs and frequency inputs/outputs. | |
| 11.01 | DIO status | Displays the electrical status of digital inputs/outputs DIO2 and DIO1. The on/off delays of the inputs (if specified) are ignored. A filter time (for the input mode) can be set with parameter 10.51 DI filter time.<br>**Example:** 0010 = DIO2 is on, DIO1 is off. This parameter can only be read. | - |
| | 0000b…0011b | Status of the digital inputs/outputs. | 1 = 1 |
| 11.02 | DIO delayed status | Displays the delayed status of digital inputs/outputs DIO2 and DIO1. This word is updated only after on/off delays (if applicable).<br>**Example:** 0010 = DIO2 is enabled, DIO1 is disabled. This parameter can only be read. | - |
| | 0000b…0011b | Status of the delay of the digital inputs/outputs. | 1 = 1 |
| 11.05 | DIO1 function | Selects whether DIO1 is used as a digital output, digital input or frequency input. | Output |
| | Output | DIO1 is used as a digital output. | 0 |
| | Input | DIO1 is used as a digital input. | 1 |
| | Frequency | DIO1 is used as a frequency input. | 2 |
| 11.06 | DIO1 output source | Selects a drive signal for the connection to digital input/output DIO1 if parameter 11.05 DIO1 function is set to "Output". | Ready run |
| | Not energized | The output is off / not energized. | 0 |
| | Energized | The output is on/energized. | 1 |
| | Ready run | Bit 1 of 06.11 Main status word (see page 254). | 2 |
| | Enabled | Bit 0 of 06.16 Drive status word 1 (see page 255). | 4 |
| | Started | Bit 5 of 06.16 Drive status word 1 (see page 255). | 5 |
| | Magnetized | Bit 1 of 06.17 Drive status word 2 (see page 255). | 6 |
| | Running | Bit 6 of 06.16 Drive status word 1 (see page 255). | 7 |
| | Ready ref | Bit 2 of 06.11 Main status word (see page 254). | 8 |
| | At setpoint | Bit 8 of 06.11 Main status word (see page 254). | 9 |
| | Back | Bit 2 of 06.19 Speed control status word (see page 256). | 10 |
| | Zero speed | Bit 0 of 06.19 Speed control status word (see page 256). | 11 |
| | Above limit value | Bit 10 of 06.17 Drive status word 2 (see page 255). | 12 |
| | Warning | Bit 7 of 06.11 Main status word (see page 254). | 13 |
| | Fault | Bit 3 of 06.11 Main status word (see page 254). | 14 |
| | Fault (-1) | Inverted bit 3 of 06.11 Main status word (see page 254). | 15 |
| | Open brake command | Bit 0 of 44.01 Brake control status (see page 308). | 22 |
| | Ext2 active | Bit 11 of 06.16 Drive status word 1 (see page 255). | 23 |
| | Remote control | Bit 9 of 06.11 Main status word (see page 254). | 24 |
| | Supervision 1 | Bit 0 of 32.01 Supervision status (see page 298). | 33 |
| | Supervision 2 | Bit 1 of 32.01 Supervision status (see page 298). | 34 |
| | Supervision 3 | Bit 2 of 32.01 Supervision status (see page 298). | 35 |
| | RO/DIO control word bit0 | Bit 0 of 10.99 RO/DIO control word (see page 260). | 40 |
| | RO/DIO control word bit1 | Bit 1 of 10.99 RO/DIO control word (see page 260). | 41 |
| | RO/DIO control word bit2 | Bit 2 of 10.99 RO/DIO control word (see page 260). | 42 |
| | RO/DIO control word bit8 | Bit 8 of 10.99 RO/DIO control word (see page 260). | 43 |
| | RO/DIO control word bit9 | Bit 9 of 10.99 RO/DIO control word (see page 260). | 44 |
| | Other [bit] | Source selection (see "Terms and abbreviations" on page 118). | - |
| 11.07 | DIO1 ON delay | Defines the enabling delay for digital input/output DIO1 (if used as a digital output or digital input).<br>  | 0.0 s |
| | 0.0 … 3000.0 s | Enabling delay for DIO1. | 10 = 1 s |
| 11.08 | DIO1 OFF delay | Defines the disabling delay for digital input/output DIO1 (if used as a digital output or digital input). See parameter 11.07 DIO1 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for DIO1. | 10 = 1 s |
| 11.09 | DIO2 function | Selects whether DIO2 is used as a digital output, digital input or frequency output. | Output |
| | Output | DIO2 is used as a digital output. | 0 |
| | Input | DIO2 is used as a digital input. | 1 |
| | Frequency | DIO2 is used as a frequency output. | 2 |
| 11.10 | DIO2 output source | Selects a drive signal for the connection to digital input/output DIO2 if parameter 11.09 DIO2 function is set to "Output".<br>For available selections, see parameter 11.06 DIO1 output source. | Running |

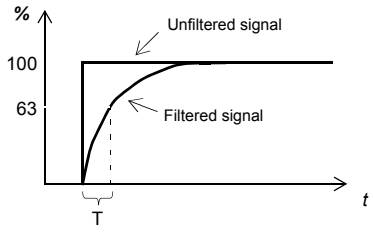
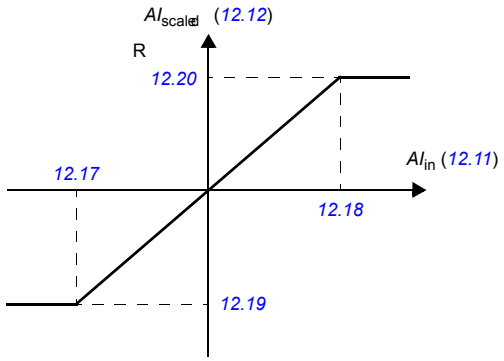
| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 11.11 | DIO2 ON delay | Defines the enabling delay for digital input/output DIO2 (if used as a digital output or digital input).<br>  | 0.0 s |
| | 0.0 … 3000.0 s | Enabling delay for DIO2. | 10 = 1 s |
| 11.12 | DIO2 OFF delay | Defines the disabling delay for digital input/output DIO2 (if used as a digital output or digital input). See parameter 11.11 DIO2 ON delay. | 0.0 s |
| | 0.0 … 3000.0 s | Disabling delay for DIO2. | 10 = 1 s |
| 11.38 | Freq in 1 actual value | Displays the value of frequency input 1 (via DIO1 if used as a frequency input) before scaling. See parameter 11.42 Freq in 1 min.<br>This parameter can only be read. | - |
| | 0 … 16000 Hz | Unscaled value of frequency input 1. | 1 = 1 Hz |
| 11.39 | Freq in 1 scaled | Displays the value of frequency input 1 (via DIO1 if used as a frequency input) after scaling. See parameter 11.42 Freq in 1 min.<br>This parameter can only be read. | - |
| | -32768.000 … 32767.000 | Scaled value of frequency input 1. | 1 = 1 |
| 11.42 | Freq in 1 min | Sets the minimum input frequency for frequency input 1 (DIO1 if used as a frequency input).<br>The incoming frequency signal ((11.38 Freq in 1 actual value) is scaled into an internal signal (11.39 Freq in 1 scaled) with parameters 11.42...11.45 as follows:<br>  | 0 Hz |
| | 0 … 16000 Hz | Minimum frequency of frequency input 1 (DIO1). | 1 = 1 Hz |
| 11.43 | Freq in 1 max | Sets the maximum input frequency for frequency input 1 (DIO1 if used as a frequency input). See parameter 11.42 Freq in 1 min. | 16000 Hz |
| | 0 … 16000 Hz | Maximum frequency of frequency input 1 (DIO1). | 1 = 1 Hz |
| 11.44 | Freq in 1 at scaled min | Sets the value that must correspond to the minimum input frequency according to parameter 11.42 Freq in 1 min. See diagram at parameter 11.42 Freq in 1 min. | 0.000 |
| | -32768.000 … 32767.000 | Value corresponds to the minimum of frequency input 1. | 1 = 1 |
| 11.45 | Freq in 1 at scaled max | Sets the value that must internally correspond to the maximum input frequency according to parameter 11.43 Freq in 1 max. See diagram at parameter 11.42 Freq in 1 min. | 1500.000,<br>1800.000<br>(95.20 b0) |
| | -32768.000 … 32767.000 | Value corresponds to the maximum of frequency input 1. | 1 = 1 |
| 11.54 | Freq out 1 actual value | Displays the value of frequency output 1 after scaling. See parameter 11.58 Freq out 1 src min. This parameter can only be read. | - |
| | 0 … 16000 Hz | Value of frequency output 1. | 1 = 1 |
| 11.55 | Freq out 1 source | Selects a signal to be connected to frequency output 1. | Motor speed used |
| | None | Not selected. | 0 |
| | Motor speed used | 01.01 Motor speed used (page 250). | 1 |
| | Output frequency | 01.06 Output frequency: (page 250). | 3 |
| | Motor current | 01.07 Motor current (page 250). | 4 |
| | Motor torque | 01.10 Motor torque (page 250). | 6 |
| | DC voltage | 01.11 DC voltage (page 250). | 7 |
| | Power inu out | 01.14 Output power (page 250). | 8 |
| | Speed ref ramp in | 23.01 Speed ref ramp input (page 23 Speed reference ramp). | 10 |
| | Speed ref ramped | 23.02 Speed ref ramp output (page 277). | 11 |
| | Speed ref used | 24.01 Used speed reference. (page 279) | 12 |
| | Torq ref used | 26.02 Torque reference used (page 287). | 13 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |

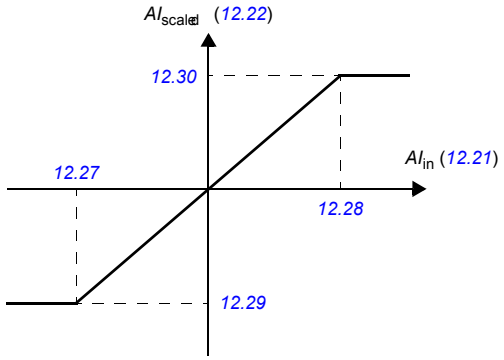
| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 11.58 | Freq out 1 src min | Sets the real value of the signal (selected with parameter 11.55 Freq out 1 source and displayed by parameter 11.54 Freq out 1 actual value) that corresponds to the minimum value of frequency output 1 (according to the setting of parameter 11.60 Freq out 1 at src min).<br>  <br>  | 0.000 |
| | -32768.000 … 32767.000 | Real signal value corresponding to the minimum value of frequency output 1. | 1 = 1 |
| 11.59 | Freq out 1 src max | Sets the real value of the signal (selected with parameter 11.55 Freq out 1 source and displayed by parameter 11.54 Freq out 1 actual value) that corresponds to the maximum value of frequency output 1 (according to the setting of parameter 11.61 Freq out 1 at src max). See parameter 11.58 Freq out 1 src min. | 1500.000, 1800.000 (95.20 B0) |
| | -32768.000 … 32767.000 | Real signal value corresponding to the maximum value of frequency output 1. | 1 = 1 |
| 11.60 | Freq out 1 at src min | Sets the minimum value of frequency output 1. See diagram at parameter 11.58 Freq out 1 src min. | 0 Hz |
| | 0…16000 Hz | Minimum value of frequency output 1. | 1 = 1 Hz |
| 11.61 | Freq out 1 at src max | Sets the maximum value of frequency output 1. See diagram at parameter 11.58 Freq out 1 src min. | 16000 Hz |
| | 0…16000 Hz | Maximum value of frequency output 1. | 1 = 1 Hz |
| 11.81 | DIO filter time | Sets a filter time for parameter 11.01 DIO status. The filter time applies only to DIOs in input mode. | 10.0 ms |
| | 0.3 … 100.0 ms | Filter time for 11.01. | 10 = 1 ms |

## 12 Standard AI

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 12 | Standard AI | Configuration of standard analog inputs. | |
| 12.01 | AI tune | Enables the analog input tuning function.<br>Connect the signal to the input and select the appropriate tuning function. | |
| | No action | Tuning of AI is not enabled. | 0 |
| | AI1 min tune | The signal value of analog input AI1 is set as the minimum value of AI1 in parameter 12.17 AI1 min. The value is set back to No action automatically. | 1 |
| | AI1 max tune | The signal value of analog input AI1 is set as the maximum value of AI1 in parameter 12.18 AI1 max. The value is set back to No action automatically. | 2 |
| | AI2 min tune | The signal value of analog input AI2 is set as the minimum value of AI2 in parameter 12.27 AI2 min. The value is set back to No action automatically. | 3 |
| | AI2 max tune | The signal value of analog input AI2 is set as the maximum value of AI2 in parameter 12.28 AI2 max. The value is set back to No action automatically. | 4 |

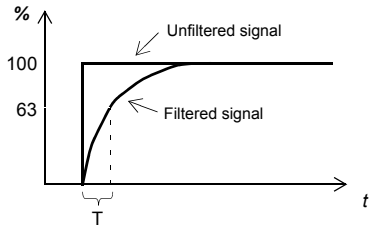
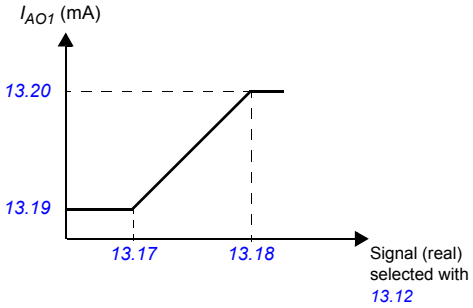
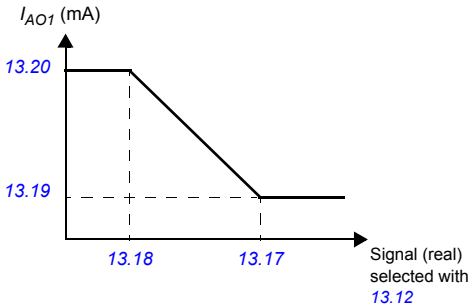
<table>
<tr><th>No.</th><th>Name/Value</th><th>Description</th><th>Clear all/<br>FbEq16</th></tr>
<tr><td>12.03</td><td>AI supervision function</td><td>Sets the response of the frequency inverter when an analog input signal exceeds the minimum and/or maximum limits set for the input.<br>With supervision, a tolerance range of 0.5 V or 1.0 mA applies to the limit values. For example, if the maximum limit for the input is 7.000 V, supervision will respond at 7.000 V.<br>The inputs and limits to be monitored are selected with parameter 12.04 AI supervision selection.<br>Note:<br>Analog input signal supervision is only active in the following cases:<br>• If the analog input is set as source in parameter 22.11, 22.12, 26.11, 26.12, 26.16, 26.25, 30.21, 30.22, or 44.09 is set and is used as the active source.<br>• Or if supervision is set using parameter 12.05 AI supervision force.</td><td>No action</td></tr>
<tr><td></td><td>No action</td><td>No reaction.</td><td>0</td></tr>
<tr><td></td><td>Fault</td><td>The frequency inverter switches off with fault message 80A0 AI supervision.</td><td>1</td></tr>
<tr><td></td><td>Warning</td><td>The frequency inverter generates warning message A8A0 AI supervision.</td><td>2</td></tr>
<tr><td></td><td>Last speed</td><td>The frequency inverter outputs a warning (A8A0 AI supervision) and fixes the speed (or frequency) at the value at which the frequency inverter last operated. The speed/frequency is determined on the basis of the actual speed with 850 ms low-pass filtering.<br>Warning!<br>Ensure that operation can resume without hazards if the communication fails.</td><td>3</td></tr>
<tr><td></td><td>Speed ref safe</td><td>The frequency inverter generates warning message A8A0 AI supervision.<br>Warning!<br>Ensure that operation can resume without hazards if the communication fails.</td><td>4</td></tr>
<tr><td>12.04</td><td>AI supervision selection</td><td>Sets the analog input limits to be monitored. See parameter 12.03 AI supervision function.</td><td>0000b</td></tr>
<tr><td></td><td colspan="3"><table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>AI1 < MIN</td><td>1 = Supervision of the minimum limit of AI1 is active.</td></tr>
<tr><td>1</td><td>AI1 > MAX</td><td>1 = Supervision of the maximum limit of AI1 is active.</td></tr>
<tr><td>2</td><td>AI2 < MIN</td><td>1 = Supervision of the minimum limit of AI2 is active.</td></tr>
<tr><td>3</td><td>AI2 > MAX</td><td>1 = Supervision of the maximum limit of AI2 is active.</td></tr>
<tr><td>4…15</td><td>Reserved</td><td></td></tr>
</table></td></tr>
<tr><td></td><td>0000b…1111b</td><td>Enables analog input supervision.</td><td>1 = 1</td></tr>
<tr><td>12.05</td><td>AI supervision force</td><td>Enables analog input supervision separately for each control location (see section "Controller" on page 228).<br>The parameter is primarily intended for analog input supervision when the input is connected to the application program and has not been selected as a control source by drive parameters.</td><td>0000 0000b</td></tr>
<tr><td></td><td colspan="3"><table>
<tr><th>Bit</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td>AI1 Ext1</td><td>1 = AI1 supervision active when EXT1 is used.</td></tr>
<tr><td>1</td><td>AI1 Ext2</td><td>1 = AI1 supervision active when EXT2 is used.</td></tr>
<tr><td>2</td><td>AI1 Local</td><td>1 = AI1 supervision active when local control is used.</td></tr>
<tr><td>3</td><td>Reserved</td><td></td></tr>
<tr><td>4</td><td>AI2 Ext1</td><td>1 = AI2 supervision active when EXT1 is used.</td></tr>
<tr><td>5</td><td>AI2 Ext2</td><td>1 = AI2 supervision active when EXT2 is used.</td></tr>
<tr><td>6</td><td>AI2 Local</td><td>1 = AI2 supervision active when local control is used.</td></tr>
<tr><td>7…15</td><td>Reserved</td><td></td></tr>
</table></td></tr>
<tr><td></td><td>0000 0000b … 0111 0111b</td><td>Selects analog input supervision.</td><td>1 = 1</td></tr>
<tr><td>12.11</td><td>AI1 actual value</td><td>Displays the value of analog input AI1 in mA or V (depending on whether the input is set as a current or voltage input with a hardware setting).<br>This parameter can only be read.</td><td>-</td></tr>
<tr><td></td><td>-22.000 … 22.000 mA or V</td><td>Value of analog input AI1.</td><td>1000 = 1 mA or V</td></tr>
<tr><td>12.12</td><td>AI1 scaled value</td><td>Displays the value of analog input AI1 after scaling. See parameters 12.19 AI1 scaled at AI1 min and 12.20 AI1 scaled at AI1 max.<br>This parameter can only be read.</td><td>-</td></tr>
<tr><td></td><td>-32768.000 … 32767.000</td><td>Scaled value of analog input AI1.</td><td>1 = 1</td></tr>
</table>

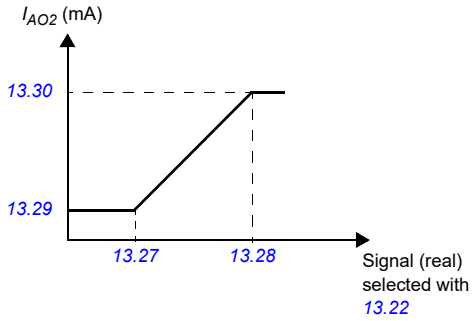
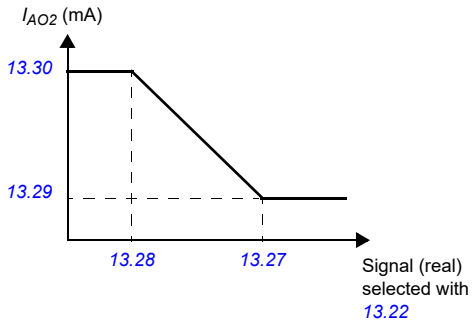
| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 12.15 | AI1 unit selection | Selects the unit for reading and setting analog input AI1.<br>**Note:**<br>**This setting must match the corresponding hardware setting on the control unit of the frequency inverter (see the hardware manual of the frequency inverter). Changes to the hardware settings only take effect after the power supply of the control unit has been switched off and on again or with the corresponding setting of parameter 96.08 Control board boot.** | V |
| | V | Volts. | 2 |
| | mA | Milliamperes. | 10 |
| 12.16 | AI1 filter time | Sets the filter time constant for analog input AI1.<br>  <br>**Note:**<br>**The signal is also filtered by the signal interface hardware (approximately 0.25 ms time constant). The hardware filter cannot be changed via parameter settings.** | 0.100 s |
| | 0.000 … 30.000 s | Filter time constant. | 1000 = 1 s |
| 12.17 | AI1 min | Defines the minimum value of the system for analog input AI1. Setting of the value that is actually transmitted to the frequency inverter when the analog signal from the system is set to its minimum setting.<br>See also parameter 12.01 AI tune. | 0.000 mA or V |
| | -22.000 … 22.000 mA or V | Minimum value of AI1. | 1000 = 1 mA or V |
| 12.18 | AI1 max | Defines the maximum value of the system for analog input AI1. Setting of the value that is actually transmitted to the frequency inverter when the analog signal from the system is set to its maximum setting.<br>See also parameter 12.01 AI tune. | 20.000 mA or 10.000 V |
| | -22.000 … 22.000 mA or V | Maximum value of AI1. | 1000 = 1 mA or V |
| 12.19 | AI1 scaled at AI1 min | Sets the real internal value corresponding to the minimum value of analog input AI1 according to parameter 12.17 AI1 min. (Changing the polarity setting of 12.19 and 12.20 can invert the analog input.)<br>  | 0.000 |
| | -32768.000 … 32767.000 | Real value corresponding to the minimum value of AI1. | 1 = 1 |
| 12.20 | AI1 scaled at AI1 max | Sets the real internal value corresponding to the maximum value of analog input AI1 according to parameter 12.18 AI1 max. See diagram for parameter 12.19 AI1 scaled at AI1 min. | 1500.000, 1800.000 |
| | -32768.000 … 32767.000 | Real value corresponding to the maximum value of AI1. | 1 = 1 |
| 12.21 | AI2 actual value | Displays the value of analog input AI2 in mA or V (depending on whether the input is set as a current or voltage input with a hardware setting).<br>This parameter can only be read. | - |
| | -22.000 … 22.000 mA or V | Value of analog input AI2. | 1000 = 1 mA or V |
| 12.22 | AI2 scaled value | Displays the value of analog input AI2 after scaling. See parameters 12.29 AI2 scaled at AI2 min and 12.30 AI2 scaled at AI2 max.<br>This parameter can only be read. | - |
| | -32768.000 … 32767.000 | Scaled value of analog input AI2. | 1 = 1 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 12.25 | AI2 unit selection | Selects the unit for reading and setting analog input AI2.<br>**Note:**<br>**This setting must match the corresponding hardware setting on the control unit of the frequency inverter (see the hardware manual of the frequency inverter). Changes to the hardware settings only take effect after the power supply of the control unit has been switched off and on again or with the corresponding setting of parameter 96.08 Control board boot.** | mA |
| | V | Volts. | 2 |
| | mA | Milliamperes. | 10 |
| 12.26 | AI2 filter time | Sets the filter time constant for analog input AI2.<br>See parameter 12.16 AI1 filter time. | 0.100 s |
| | 0.000 … 30.000 s | Filter time constant. | 1000 = 1 s |
| 12.27 | AI2 min | Sets the minimum value of the system for analog input AI2.<br>Setting of the value that is actually transmitted to the frequency inverter when the analog signal from the system is set to its minimum setting.<br>See also parameter 12.01 AI tune. | 0.000 mA or V |
| | -22.000 ... 22.000 mA or V | Minimum value of AI2. | 1000 = 1 mA or V |
| 12.28 | AI2 max | Sets the maximum value of the system for analog input AI2.<br>Setting of the value that is actually transmitted to the frequency inverter when the analog signal from the system is set to its maximum setting.<br>See also parameter 12.01 AI tune. | 20.000 mA or 10.000 V |
| | -22.000 ... 22.000 mA or V | Maximum value of AI2. | 1000 = 1 mA or V |
| 12.29 | AI2 scaled at AI2 min | Sets the real value corresponding to the minimum value of analog input AI2 according to parameter 12.27 AI2 min. (Changing the polarity setting of 12.29 and 12.30 can invert the analog input.)<br>  | 0.000 |
| | -32768.000 … 32767.000 | Real value corresponding to the minimum value of AI2. | 1 = 1 |
| 12.30 | AI2 scaled at AI2 max | Sets the real value corresponding to the maximum value of analog input AI2 according to parameter 12.28 AI2 max. See diagram for parameter 12.29 AI2 scaled at AI2 min. | 100.000 |
| | -32768.000 … 32767.000 | Real value corresponding to the maximum value of AI2. | 1 = 1 |

## 13 Standard AO

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 13 | Standard AO | Configuration of standard analog outputs. | |
| 13.11 | AO1 actual value | Displays the value of AO1 in mA.<br>This parameter can only be read. | - |
| | 0.000…22.000 mA | Value of AO1. | 1000 = 1 mA |
| 13.12 | AO1 source | Selects a signal for the connection to analog output AO 1. Alternatively, sets the output to constant current to supply power to a temperature sensor. | Motor speed used |
| | Zero | No value selected. | 0 |
| | Motor speed used | 01.01 Motor speed used (page 250). | 1 |
| | Output frequency | 01.06 Output frequency (page 250). | 3 |
| | Motor current | 01.07 Motor current (page 250). | 4 |
| | Motor torque | 01.10 Motor torque (page 250). | 6 |
| | DC voltage | 01.11 DC voltage (page 250). | 7 |
| | Power inu out | 01.14 Output power (page 250). | 8 |
| | Speed ref ramp in | 23.01 Speed ref ramp input (page 277). | 10 |
| | Speed ref ramp output | 23.02 Speed ref ramp output (page 277). | 11 |
| | Speed ref used | 24.01 Used speed reference (page 279). | 12 |
| | Torq ref used | 26.02 Torque reference used (page 287). | 13 |
| | Freq ref used | 28.02 Frequency ref ramp output (page 28 Frequenz-Sollwertkette). | 14 |
| | Process PID out | 40.01 Process PID output actual (page 40 Prozessregler Satz 1). | 16 |
| | Process PID fbk | 40.02 Process PID feedback actual (page 40 Prozessregler Satz 1). | 17 |
| | Process PID act | 40.03 Setpoint actual (page 40 Prozessregler Satz 1). | 18 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | Process PID dev | 40.04 Process PID deviation actual (page 40 Prozessregler Satz 1). | 19 |
| | Force Pt100 excitation | The output is used to supply 1...3 Pt100 sensors with an excitation current. See section Thermal motor protection (page 243). | 20 |
| | Force KTY84 excitation | The output is used to supply a KTY84 sensor with a constant current. See section Thermal motor protection (page 243). | 21 |
| | Force PTC excitation | The output is used to supply 1...3 PTC sensors with a constant current. See section Thermal motor protection (page 243). | 22 |
| | Force Pt1000 excitation | The output is used to supply 1...3 Pt1000 sensors with a constant current. See section Thermal motor protection (page 243). | 23 |
| | AO1 data storage | 13.91 AO1 data storage (page 267). | 37 |
| | AO2 data storage | 13.92 AO2 data storage (page 267). | 38 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 13.16 | AO1 filter time | Defines the filter time constant for analog output AO1.<br>  | 0.100 s |
| | 0.000 … 30.000 s | Filter time constant. | 1000 = 1 s |
| 13.17 | AO1 source min | Sets the real minimum value of the signal (selected with parameter 13.12 AO1 source) corresponding to the minimum output value of AO1 (according to the setting of parameter 13.19 AO1 out at AO1 src min).<br>  <br>Programming 13.17 as the maximum value and 13.18 as the minimum value inverts the output.<br>  | 0.0 |
| | -32768.0 … 32767.0 | Real signal value corresponding to the minimum output value of AO1. | 1 = 1 |
| 13.18 | AO1 source max | Sets the real maximum value of the signal (selected with parameter 13.12 AO1 source) corresponding to maximum minimum output value of AO1 (according to the setting of parameter 13.20 AO1 out at AO1 src max).<br>See parameter 13.17 AO1 source min. | 1500.0, 1800.0 |
| | -32768.0 … 32767.0 | Real signal value corresponding to the maximum output value of AO1. | 1 = 1 |
| 13.19 | AO1 out at AO1 src min | Sets the minimum output value for analog output AO1.<br>See also the diagram for parameter 13.17 AO1 source min. | 0.000 mA |
| | 0.000…22.000 mA | Minimum output value of AO1. | 1000 = 1 mA |
| 13.20 | AO1 out at AO1 src max | Sets the maximum output value for analog output AO1.<br>See also the diagram for parameter 13.17 AO1 source min. | 20.000 mA |
| | 0.000…22.000 mA | Maximum output value of AO1. | 1000 = 1 mA |
| 13.21 | AO2 actual value | Displays the value of AO2 in mA.<br>This parameter can only be read. | - |
| | 0.000…22.000 mA | Value of AO2. | 1000 = 1 mA |
| 13.22 | AO2 source | Selects a signal for the connection to analog output AO2. Alternatively, sets the output to constant current to supply power to a temperature sensor.<br>For selection options, see parameter 13.12 AO1 source. | Motor current |
| 13.26 | AO2 filter time | Sets the filter time constant for analog output AO2.<br>See parameter 13.16 AO1 filter time. | 0.100 s |
| | 0.000 … 30.000 s | Filter time constant. | 1000 = 1 s |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 13.27 | AO2 source min | Sets the real minimum value of the signal (selected with parameter 13.22 AO2 source) corresponding to the minimum output value of AO2 (according to the setting of parameter 13.29 AO2 out at AO2 src min).<br>  <br>Programming 13.27 as the maximum value and 13.28 as the minimum value inverts the output.<br>  | 0.0 |
| | -32768.0 … 32767.0 | Real signal value corresponding to the minimum output value of AO2. | 1 = 1 |
| 13.28 | AO2 source max | Sets the real maximum value of the signal (selected with parameter 13.22 AO2 source) corresponding to maximum minimum output value of AO2 (according to the setting of parameter 13.30 AO2 out at AO2 src max).<br>See parameter 13.27 AO2 source min. | 100.0 |
| | -32768.0 … 32767.0 | Real signal value corresponding to the maximum output value of AO2. | 1 = 1 |
| 13.29 | AO2 out at AO2 src min | Sets the minimum output value for analog output AO2.<br>See also the diagram for parameter 13.27 AO2 source min. | 0.000 mA |
| | 0.000…22.000 mA | Minimum output value of AO2. | 1000 = 1 mA |
| 13.30 | AO2 out at AO2 src max | Sets the maximum output value for analog output AO2.<br>See also the diagram for parameter 13.27 AO2 source min. | 20.000 mA |
| | 0.000…22.000 mA | Maximum output value of AO2. | 1000 = 1 mA |
| 13.91 | AO1 data storage | Storage parameters for controlling analog output AO1, e.g. via the fieldbus.<br>In 13.12 AO1 source, select setting AO1 data storage. Then set this parameter as the target of the incoming signal data.<br>Simply set the target selection parameter of the specified data (58.101…58.124) to AO1 data storage via the integrated fieldbus interface. | 0.00 |
| | -327.68 … 327.67 | Storage parameter for AO1. | 100 = 1 |
| 13.92 | AO2 data storage | Storage parameters for controlling analog output AO2, e.g. via the fieldbus.<br>In 13.22 AO2 source, select setting AO2 data storage. Then set this parameter as the target of the incoming signal data.<br>Simply set the target selection parameter of the specified data 58.101…58.124) to AO2 data storage. | 0.00 |
| | -327.68 … 327.67 | Storage parameter for AO2. | 100 = 1 |

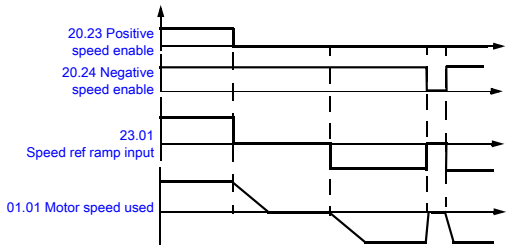
## 19 Operation mode

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 19 | Operation mode | Selects the control sources for local control and external control and operating modes.<br>See also section "Operating modes of the frequency inverter" (page 23). | |
| 19.01 | Actual operation mode | Displays the current operating mode.<br>This parameter can only be read. | - |
| | Zero | No value selected. | 1 |
| | Speed | Speed control (with DTC motor control). | 2 |
| | Torque | Torque control (with DTC motor control). | 3 |
| | Min | The torque selector compares the torque setpoint from the speed controller output (25.01 Torque reference speed control) with the torque setpoint after the torque ramp (26.74 Torque ref ramp out) and the smaller of the two is used. | 4 |
| | Max | The torque selector compares the torque setpoint from the speed controller output (25.01 Torque reference speed control) with the torque setpoint after the torque ramp (26.74 Torque ref ramp out) and the larger of the two is used. | 5 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | Add | The torque setpoint from the speed controller output is added to the torque setpoint after the torque ramp. | 6 |
| | Scalar (Hz) | Frequency control with scalar motor control. | 10 |
| | Scalar (rpm) | Speed control with scalar motor control. | 11 |
| | Forced magn. | The motor is magnetized. | 20 |
| 19.12 | Ext1 control mode | Automatically managed by the DS402 profile registers. | Speed |
| | Zero | No value selected. | 1 |
| | Speed | Speed control. The torque setpoint used is 25.01 Torque reference speed control (output of the speed setpoint chain). | 2 |
| | Torque | Torque control. The torque setpoint used is 26.74 Torque ref ramp out (output of the torque setpoint chain). | 3 |
| | Minimum | Combination of selections Speed and Torque: The torque selector compares the torque setpoint from the speed controller output (25.01 Torque reference speed control) and the torque setpoint after the ramp (26.74 Torque ref ramp out) and selects the smaller value of the two.<br>If the speed difference becomes negative, the frequency inverter follows the speed controller output until the speed difference becomes positive again. The drive therefore does not accelerate uncontrollably if the load drops during torque control. | 4 |
| | Maximum | Combination of selections Speed and Torque: The torque selector compares the torque setpoint from the speed controller output (25.01 Torque reference speed control) with the torque setpoint after the torque ramp (26.74 Torque ref ramp out) and selects the larger value of the two.<br>If the speed difference becomes positive, the frequency inverter follows the speed controller output until the speed difference becomes negative again. The drive therefore does not accelerate uncontrollably if the load drops during torque control. | 5 |
| | Add | Combination of the settings of Speed and Torque: The torque selector adds the torque setpoint from the speed controller output to the torque setpoint after the torque ramp. | 6 |

## 20 Start/stop/direction

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 20 | Start/stop/direction | Selection of signal sources for start/stop/direction of rotation, controller/start/job enable, selection of signal sources for positive/negative setpoint enable.<br>For additional information about control locations, see section "Local control and external control" (page 19). | |
| 20.01 | Ext1 commands | Selects the source of the start, stop and direction of rotation commands for external control location 1 (EXT1). | Fieldbus A |
| | None | No sources for start or stop commands selected. | 0 |
| | Fieldbus A | The start and stop commands are received via fieldbus adapter A. | 12 |
| 20.11 | Run enable stop mode | Selects how the motor is stopped when the enable signal goes out.<br>The source of the enable signal is selected with parameter 20.12 Run enable 1 source. | Coast |
| | Coast | Stop by switching off the output semiconductors of the frequency inverter. The motor coasts to a stop.<br>**Warning!**<br>**If a mechanical brake is used, it must be ensured that no hazards are caused by coasting the drive to a stop.** | 0 |
| | Ramp | Stops according to the active deceleration ramp. See parameter group 23 Speed reference ramp on page 277. | 1 |
| | Torque limit | Stop according to the torque limit values (parameters 30.19 and 30.20). | 2 |
| 20.12 | Run enable 1 source | Selects the source for the external controller enable signal. If the enable signal is switched off, the frequency inverter will not start. If it is already running, it stops according to the setting of parameter 20.11 Run enable stop mode.<br>1 = Enable signal active.<br>**Note:**<br>**Warning can be suppressed in the event of a missing signal.** | Selected |
| | None | 0. | 0 |

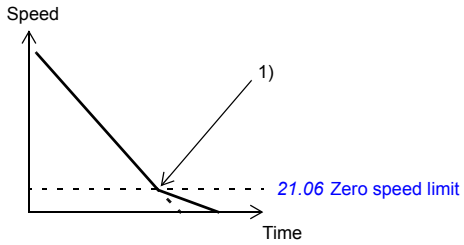
| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | FBA A MCW bit 3 | Control word bit 3, received via fieldbus adapter A.<br>**Note:**<br>• **Switching off bit 3 resets the start and controller enable signals. In this case, the stop method is defined by 20.11 Run enable stop mode or 21.03 Stop mode depending on the priority of the methods. The precedence of stop methods from highest to lowest is coast to a stop – torque limit – ramp.** | 30 |
| 20.23 | Positive speed enable | Sets the signal source for enabling the positive speed setpoint.<br>1 = Positive speed enabled.<br>0 = Positive speed interpreted as zero speed setpoint.<br>In the following diagram, 23.01 Speed ref ramp input is set to zero after the enable signal of the positive speed has been cleared.<br>Behavior with different types of control:<br>Speed control: The speed setpoint is set to zero and the motor is stopped with the set deceleration ramp. Overspeed control (limiting controller) prevents additional torque and the motor does not rotate in the positive direction.<br>Torque control: The limiting controller monitors the direction of rotation of the motor.<br>  <br><br>**Example:** The motor is rotating in the forward direction. To stop the motor, the positive speed enable signal is disabled with a hardware limit switch (e.g. via digital input). If the positive speed enable signal remains disabled and the negative speed enable signal is enabled, only motor operation in the reverse direction of rotation is permitted. | Selected |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see "Terms and abbreviations" on page 118). | - |
| 20.24 | Negative speed enable | Selects the source of the enable command for the negative speed setpoint. See parameter 20.23 Positive speed enable. | Selected |

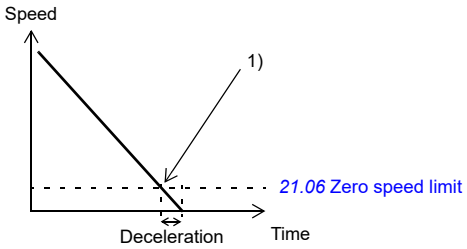
## 21 Start/stop mode

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 21 | Start/stop mode | Start and stop modes, emergency stop and signal source selection, DC magnetization settings, autophasing mode selection. | |
| 21.01 | Start mode | Selects the motor start function for DTC motor control, i.e. if 99.04 Motor control mode was set to DTC.<br>**Note:**<br>• **Starting on a rotating motor is not possible if DC magnetization is selected (Fast or Constant time).**<br>• **For permanent magnet motors and synchronous reluctance motors, start method Automatic must be used.**<br>• **This parameter setting cannot be changed when the drive is running.**<br>See also section DC magnetization (page 237). | Automatic |
| | Fast | The frequency inverter magnetizes the motor before starting. The premagnetization time is set automatically and is 200 ms to 2 s depending on the motor size. This mode should be set if a high starting torque is required. | 0 |

<table>
<tr><th>No.</th><th>Name/Value</th><th>Description</th><th>Def (factory setting)/<br>FbEq16</th></tr>
<tr><td></td><td>Constant time</td><td>The frequency inverter magnetizes the motor before starting. The premagnetization time is set with parameter 21.02 Magnetization time. This mode should be selected if a constant premagnetization time is required (i.e. if motor startup must be synchronized with the releasing of a mechanical brake). This setting also guarantees the highest possible starting torque if the premagnetization time was set long enough.<br><br>Warning!<br>The drive starts after the set magnetization time has elapsed, even if motor magnetization has not yet been completed.<br><br>For applications requiring full starting torque, the constant magnetization time must be set long enough to achieve full magnetization and full torque.</td><td>1</td></tr>
<tr><td></td><td>Automatic</td><td>The automatic start ensures optimal starting of the motor under all conditions. This setting includes the flying start function (starting on a rotating motor) and the automatic restart function (a stopped motor can be restarted immediately without needing to reduce the motor flux). Motor control detects both the flux and the mechanical state of the motor and starts the motor without delay under all operating conditions.</td><td>2</td></tr>
<tr><td></td><td>Flying start</td><td>This method is intended for induction motors only and optimized for applications where the frequency inverter must be started on a rotating motor at high frequencies (above 150 Hz).</td><td>3</td></tr>
<tr><td>21.02</td><td>Magnetization time</td><td>Setting the premagnetization time:<br>• If parameter 21.01 Start mode is set to Constant time (for DTC motor control).<br><br>After the start command, the frequency inverter automatically performs premagnetization of the motor during the set time. To ensure full magnetization, this parameter must be set to the same or higher value than the rotor time constant of the motor. In case of doubt, the rule of thumb value listed in the following table can be used:<br><table><tr><th>Nominal motor power</th><th>Constant magnetization time</th></tr><tr><td><1 kW</td><td>>50 to 100 ms</td></tr><tr><td>1 to 10 kW</td><td>>100 to 200 ms</td></tr><tr><td>10 to 200 kW</td><td>>200 to 1000 ms</td></tr><tr><td>200 to 1000 kW</td><td>>1000 to 2000 ms</td></tr></table><br>Note:<br>This parameter setting cannot be changed when the drive is running.</td><td>500 ms</td></tr>
<tr><td></td><td>0 … 10000 ms</td><td>Constant DC magnetization time.</td><td>1 = 1 ms</td></tr>
<tr><td>21.03</td><td>Stop mode</td><td>Selects the method used to stop the motor when a stop command is received. Additional braking is possible by selecting flux braking (see parameter 97.05 Flux braking).<br><br>Note:<br>This parameter has no effect in the follower drive in a master/follower configuration.</td><td>Coast</td></tr>
<tr><td></td><td>Coast</td><td>Stop by switching off the output semiconductors of the frequency inverter. The motor coasts to a stop.<br><br>Warning!<br>If a mechanical brake is used, it must be ensured that no hazards are caused by coasting the drive to a stop.</td><td>0</td></tr>
<tr><td></td><td>Ramp</td><td>Stops according to the active deceleration ramp. See parameter group 23 Speed reference ramp on page 277.</td><td>1</td></tr>
<tr><td></td><td>Torque limit</td><td>Stop according to the torque limit values (parameters 30.19 and 30.20).</td><td>2</td></tr>
<tr><td>21.04</td><td>Emergency stop mode</td><td>Selects the method used to stop the motor when an emergency stop command is received.<br>The source of the emergency stop signal is selected with parameter 21.05 Emergency stop source.</td><td>Eme ramp stop (Off3)</td></tr>
<tr><td></td><td>Ramp stop (Off1)</td><td>With the drive running:<br>• 1 = Normal operation.<br>• 0 = Normal stop according to the standard deceleration ramp set for the specific setpoint type (see section Setpoint ramps [page 231]). After the drive has been stopped, it can be restarted by acknowledging the emergency stop signal and switching the start signal from 0 to 1.<br><br>With the drive stopped:<br>• 1 = Starting permitted.<br>• 0 = Starting not permitted.</td><td>0</td></tr>
</table>

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | Coast stop (Off2) | With the drive running:<br>• 1 = Normal operation.<br>• 0 = Stop by coasting. The drive can be restarted by acknowledging the start interlock signal and switching the start signal from 0 to 1.<br>With the drive stopped:<br>• 1 = Starting permitted.<br>• 0 = Starting not permitted. | 1 |
| | Eme ramp stop (Off3) | With the drive running:<br>• 1 = Normal operation.<br>• Stop with ramp according to the emergency stop ramp set with parameter 23.23 Emergency stop time. After the drive has been stopped, it can be restarted by acknowledging the emergency stop signal and switching the start signal from 0 to 1.<br>With the drive stopped:<br>• 1 = Starting permitted.<br>• 0 = Starting not permitted. | 2 |
| 21.05 | Emergency stop source | Selects the source for emergency stop signal OFF3. The stop mode is set with parameter 21.04 Emergency stop mode.<br>0 = Emergency stop active<br>1 = Normal operation<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | Inactive (true), DI4 |
| | Active (false) | 0. | 0 |
| | Inactive (true) | 1. | 1 |
| | DIIL | DIIL input (10.02 DI delayed status, bit 15). | 2 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 3 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 4 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 5 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 6 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 7 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 8 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 11 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 12 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 21.06 | Zero speed limit | Sets the zero speed limit. The motor is stopped along a speed ramp until the zero speed limit is reached. After the zero speed delay, the motor coasts to a stop. | 30.00 rpm |
| | 0.00 … 30000.00 rpm | Zero speed limit value. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |

<table>
<tr><th>No.</th><th>Name/Value</th><th>Description</th><th>Def (factory setting)/ FbEq16</th></tr>
<tr><td>21.07</td><td>Zero speed delay</td><td>Defines the delay for the zero speed delay function. The function is suitable for applications where a smooth and fast restart is important. During the delay, the frequency inverter knows the position of the rotor exactly.<br><br>No zero speed delay:<br>The frequency inverter receives a stop command and decelerates along a ramp. If the current motor speed falls below the value of parameter 21.06 Zero speed limit, modulation of the inverter is stopped and the motor coasts to a stop.<br><br> 

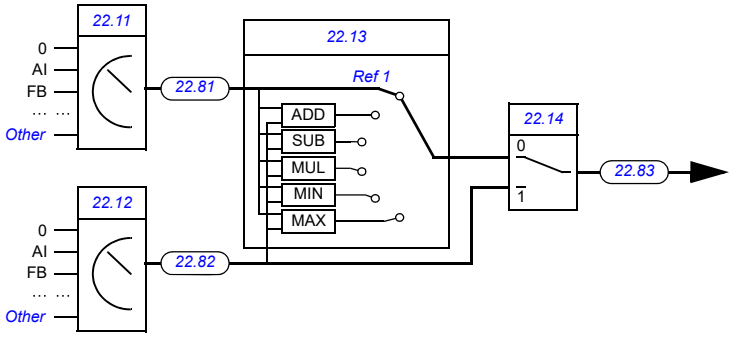
<br><br>1) Speed control switched off: Motor coasts to a stop.<br><br>With zero speed delay:<br>The frequency inverter receives a stop command and decelerates along a ramp. If the actual motor speed falls below the value of parameter 21.06 Zero speed limit, the zero speed delay is enabled. During the delay, the function keeps the speed controller active: The inverter modulates, the motor magnetizes and the frequency inverter is ready for a quick restart. Zero speed delay can be used for the jog function, for example.<br><br> 

<br><br>1) The speed controller remains active. The motor decelerates to true zero speed.</td><td>0 ms</td></tr>
<tr><td></td><td>0 … 30000 ms</td><td>Zero speed delay time.</td><td>1 = 1 ms</td></tr>
<tr><td>21.08</td><td>DC current control</td><td>Enables/Disables the DC hold and post-magnetization functions. See section DC magnetization (page 237).<br><br>Note:<br>• These functions are only available with speed control in DTC motor control mode (see page 228).<br>• DC magnetization heats up the motor. For applications with long DC magnetization time, externally cooled motors should be used. If the DC magnetization time is long, DC magnetization cannot prevent the motor shaft from rotating if a constant load is applied to the motor.</td><td>0000b</td></tr>
<tr><td></td><td colspan="2"><table>
<tr><th>Bit</th><th>Value</th></tr>
<tr><td>0</td><td>1 = Enables DC holding. See section DC hold (page 237).<br><br>Note:<br>The DC hold has no effect if the start signal is switched off.</td></tr>
<tr><td>1</td><td>1 = Enables post-magnetization. See section Post-magnetization (page 237).<br><br>Note:<br>Post-magnetization is available only if stop with ramp was set (see parameter 21.03 Stop mode).</td></tr>
<tr><td>2…15</td><td>Reserved</td></tr>
</table></td><td></td></tr>
<tr><td></td><td>0000b…0011b</td><td>Selects DC magnetization.</td><td>1 = 1</td></tr>
<tr><td>21.09</td><td>DC hold speed</td><td>Sets the DC hold speed. See parameter 21.08 DC current control and section DC hold (page 237).</td><td>5.00 rpm</td></tr>
</table>

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | 0.00 … 1000.00 rpm | DC hold speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 21.10 | DC current reference | Sets the DC hold current as a percentage of the nominal motor current. See parameter 21.08 DC current control and section DC magnetization (page 237). | 30.0% |
| | 0.0...100.0% | DC hold current. | 10 = 1% |
| 21.11 | Post magnetization time | Sets the length of time that post-magnetization is active after stopping the motor. The magnetizing current value is set in parameter 21.10 DC current reference. See parameter 21.08 DC current control. | 0 s |
| | 0…3000 s | Post magnetization time | 1 = 1 s |
| 21.12 | Continuous magnetization command | Enables/Disables permanent magnetization (or selects a source with which permanent magnetization is enabled/disabled).<br>The magnetizing current is calculated based on the flux setpoint (see parameter group 97 Motor control).<br>**Note:**<br>• **This function is only available if "Ramp" is the selected stop method (see parameter 21.03 Stop mode) and only with speed control in DTC motor control mode (see page 228).**<br>• **Permanent magnetization heats up the motor. For applications with long magnetization time, externally cooled motors should be used.**<br>• **Permanent magnetization cannot prevent the motor shaft from rotating for a long time when a constant load is applied to the motor.**<br>0 = Normal operation<br>1 = Magnetization active | Off |
| | Off | 0. | 0 |
| | On | 1. | 1 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 21.13 | Autophasing mode | Selects how autophasing is performed.<br>See section Autophasing on page 234. | Turning |
| | Turning | This mode gives the most accurate result of autophasing. This mode can be used and is recommended when it is permissible for the motor to rotate and commissioning is not time critical.<br>**Note:**<br>**The motor rotates in this mode. The load torque must be less than 5%.** | 0 |
| | Standstill 1 | Faster than mode Turning but not as accurate. The motor does not rotate. | 1 |
| | Standstill 2 | An alternative mode for autophasing at standstill that can be used when mode Turning cannot be used and mode Standstill 1 delivers incorrect results. However, this mode is significantly slower than Standstill 1. | 2 |
| | Turning with Z-pulse | This mode should be used if the zero pulse signal of the pulse generator must be monitored and other modes do not deliver a result. The motor continues to rotate until a zero pulse is detected. | 3 |
| 21.14 | Pre-heating input source | Selects the signal source for the on/off command of the motor heater (preheating). See section Preheating (page 237).<br>**Note:**<br>**The preheat function is not enabled in the following cases:**<br>• **If STO function "Safe Torque Off" is enabled.**<br>• **If a fault message is active.**<br>• **If less than one minute has passed since the stop.**<br>• **If the PID sleep function is active.**<br>Preheating is disabled when the drive starts, and premagnetization, post-magnetization or permanent magnetization have priority.<br>0 = Preheating not active<br>1 = Preheating active | Off |
| | Off | 0. Preheating is permanently disabled. | 0 |
| | On | 1. Preheating is always enabled when the drive is stopped (except for the conditions mentioned above). | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | Supervision 1 | Supervision 1 active (32.01 Supervision status, bit 0). | 8 |
| | Supervision 2 | Supervision 2 active (32.01 Supervision status, bit 1). | 9 |
| | Supervision 3 | Supervision 3 active (32.01 Supervision status, bit 2). | 10 |
| | Other [bit] | Source selection (see "Terms and abbreviations" on page 118). | - |
| 21.16 | Pre-heating current | Sets the motor preheating current that is supplied to the motor if the source selected with parameter 21.14 Pre-heating input source is enabled. Value as a percentage of the nominal motor current. | 0.0% |
| | 0.0 ... 30.0% | Pre-heating current | 10 = 1% |

## 22 Speed reference selection

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 22 | Speed reference selection | Speed setpoint selection, motor potentiometer settings.<br>See the setpoint chain diagram on page 353. | |
| 22.01 | Speed ref unlimited | Displays the output of the speed setpoint selection block. See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 ... 30000.00 rpm | Value of the selected speed setpoint. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.11 | Speed ref1 source | Selects source 1 for the speed setpoint.<br>Two signal sources can be set with this parameter and 22.12 Speed ref2 source. A digital source selected with 22.14 Speed ref1/2 selection can be used to switch between the two sources, or a mathematical function calculates the setpoint from to two signals. | FB A ref1 |
| |  | | |
| | Zero | Not selected. | 0 |
| | FB A ref1 | 03.05 FB A reference 1 (see page 251). | 4 |
| | FB A ref2 | 03.06 FB A reference 2 (see page 251). | 5 |
| 22.12 | Speed ref2 source | Selects source 2 for the speed setpoint.<br>For the selection options and a diagram of the setpoint source selection, see parameter 22.11 Speed ref1 source. | Zero |
| 22.14 | Speed ref1/2 selection | Configures the selection between speed setpoints 1 and 2. See diagram for 22.11 Speed ref1 source.<br>0 = Speed reference 1<br>1 = Speed reference 2 | Speed reference 1 |
| | Speed reference 1 | 0. | 0 |
| | Speed reference 2 | 1. | 1 |
| 22.51 | Critical speed function | Enables/Disables the speed suppression function. It also defines whether the set ranges apply to both directions of rotation. See also section Suppressing critical speeds/frequencies (page 231). | 0000 |

| Bit | Name | Information |
|---|---|---|
| 0 | Enabled | 1 = Enable: Speed suppression enabled. |
| | | 0 = Disable: Speed suppression not enabled. |
| 1 | Sign mode | 1 = With sign: The signs of the parameters 22.52...22.57 are observed. |
| | | 0 = Absolute: Parameters 22.52..22.57 are processed as absolute values. The ranges apply to both directions of rotation. |
| 2...15 | Reserved | |

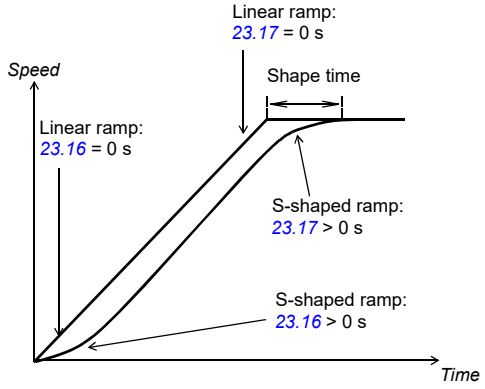
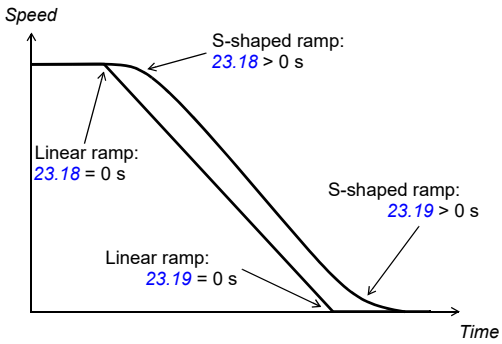
| | | | |
|---|---|---|---|
| | 0000b...0011b | Configuration word of the critical speeds. | 1 = 1 |
| 22.52 | Critical speed 1 low | Defines the lower limit for speed suppression range 1.<br>**Note:**<br>**This value must be less than or equal to the value of 22.53 Critical speed 1 high.** | 0.00 rpm |
| | -30000.00 ... 30000.00 rpm | Lower value for speed suppression range 1. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 22.53 | Critical speed 1 high | Defines the upper limit for speed suppression range 1.<br>**Note:**<br>**This value must be greater than or equal to the value of 22.52 Critical speed 1 low.** | 0.00 rpm |
| | -30000.00 … 30000.00 rpm | Upper value for speed suppression range 1. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.54 | Critical speed 2 low | Defines the lower limit for speed suppression range 2.<br>**Note:**<br>**This value must be less than or equal to the value of 22.55 Critical speed 2 high.** | 0.00 rpm |
| | -30000.00 … 30000.00 rpm | Lower value for speed suppression range 2. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.55 | Critical speed 2 high | Defines the upper limit for speed suppression range 2.<br>**Note:**<br>**This value must be greater than or equal to the value of 22.54 Critical speed 2 low.** | 0.00 rpm |
| | -30000.00 … 30000.00 rpm | Upper value for speed suppression range 2. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.56 | Critical speed 3 low | Defines the lower limit for speed suppression range 3.<br>**Note:**<br>**This value must be less than or equal to the value of 22.57 Critical speed 3 high.** | 0.00 rpm |
| | -30000.00 … 30000.00 rpm | Lower value for speed suppression range 3. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.57 | Critical speed 3 high | Defines the upper limit for speed suppression range 3.<br>**Note:**<br>**This value must be greater than or equal to the value of 22.56 Critical speed 3 low.** | 0.00 rpm |
| | -30000.00 … 30000.00 rpm | Upper value for speed suppression range 3. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.81 | Speed reference act 1 | Shows the value of speed setpoint source 1 (selected with parameter 22.11 Speed ref1 source). See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Value of setpoint source 1. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.82 | Speed reference act 2 | Shows the value of speed setpoint source 2 (selected with parameter 22.12 Speed ref2 source). See the setpoint chain diagram on page 353. | - |
| | -30000.00 … 30000.00 rpm | Value of setpoint source 2. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.83 | Speed reference act 3 | Shows the value of the speed setpoint after calculation and selection of set-point 1/2 (22.14 Speed setpoint selection 1/2). See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Speed setpoint after source selection. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.84 | Speed reference act 4 | Shows the value of the speed setpoint after applying the 1st additional speed value. See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Speed setpoint after additional value 1. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.85 | Speed reference act 5 | Shows the value of the speed setpoint after applying the speed weighting. See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | -30000.00 … 30000.00 rpm | Speed setpoint after speed weighting. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.86 | Speed reference act 6 | Shows the value of the speed setpoint after applying the 2nd additional speed value. See the setpoint block diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Speed setpoint after additional value 2. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 22.87 | Speed reference act 7 | Shows the value of the speed setpoint before applying the speed suppression ranges. See the setpoint chain diagram on page 353.<br>The value is received from 22.86 Speed reference act 6 unless it is overwritten by one of the following:<br>• A constant speed<br>• A jog mode setpoint<br>• The network control setpoint<br>• The control panel setpoint<br>• The speed setpoint of the safe speed.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Speed setpoint before applying the speed suppression ranges. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |

## 23 Speed reference ramp

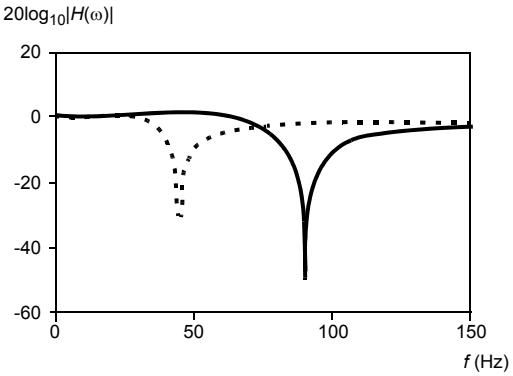
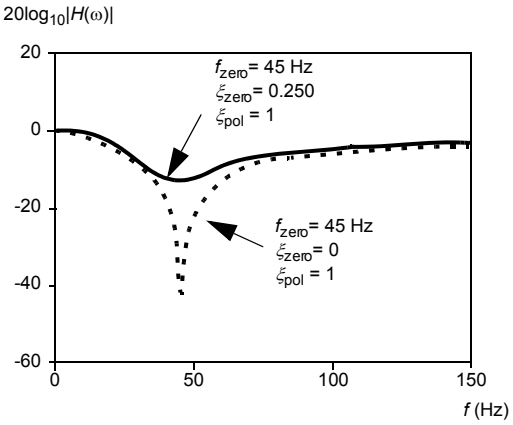
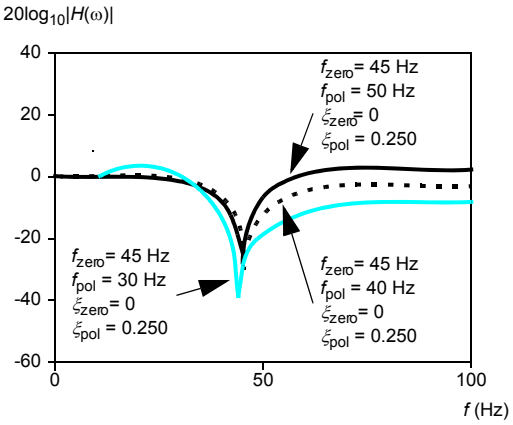
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 23 | Speed reference ramp | Sets the speed setpoint ramps (programming the acceleration and deceleration rates of the drive).<br>See the setpoint chain diagram on page 353. | |
| 23.01 | Speed ref ramp input | Displays the speed setpoint used (in rpm) before entry to the ramp and ramp shaping functions. See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Speed setpoint before ramping and ramp shaping. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 23.02 | Speed ref ramp output | Displays the speed setpoint in rpm with ramp time and ramp shape. See the setpoint chain diagram on page 353.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Speed setpoint after ramping and ramp shaping. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 23.11 | Ramp set selection | Selects the source that switches between two sets of acceleration/deceleration ramp times according to the settings of parameters 23.12...23.15.<br>0 = Acceleration time 1 and deceleration time 1 are active.<br>1 = Acceleration time 2 and deceleration time 2 are active. | Acc/Dec time 1 |
| | Acc/Dec time 1 | 0. | 0 |
| | Acc/Dec time 2 | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 23.12 | Acceleration time 1 | Sets acceleration time 1, in which the drive is accelerated from zero speed to the speed value according to the setting of parameter 46.01 Speed scaling (**not** according to parameter 30.12 Maximum speed).<br>If the speed setpoint is increased faster than the set acceleration ramp, the motor speed follows the acceleration ramp.<br>If the speed setpoint is increased slower than the set acceleration ramp, the motor speed follows the setpoint.<br>If the acceleration time is set too short, the frequency inverter automatically extends the acceleration so that the drive torque limits are not exceeded. | 20.000 s |
| | 0.000 … 1800.000 s | Acceleration time 1. | 1000 = 1 s |

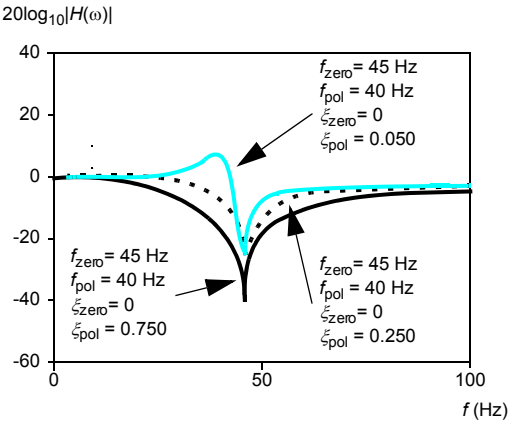
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 23.13 | Deceleration time 1 | Sets deceleration time 1, in which the drive is decelerated from the speed value according to the setting of parameter 46.01 Speed scaling (**not** according to parameter 30.12 Maximum speed) to zero.<br>If the speed setpoint is decreased slower than the set deceleration ramp, the motor speed follows the setpoint.<br>If the speed setpoint is reduced faster than the set deceleration ramp, the motor speed follows the deceleration ramp.<br>If the deceleration time is set too short, the frequency inverter automatically extends the deceleration so that the drive torque limits (or a safe DC bus voltage) are not exceeded. Ensure that DC overvoltage control is enabled if there is any doubt whether the delay time is too short (parameter 30.30 Overvoltage control).<br>**Note:**<br>**If a short deceleration time is required in an application with a high mass moment of inertia, the frequency inverter should be equipped with a braking device, e.g. a brake chopper and a braking resistor.** | 20.000 s |
| | 0.000 … 1800.000 s | Deceleration time 1. | 1000 = 1 s |
| 23.14 | Acceleration time 2 | Sets acceleration time 2. See parameter 23.12 Acceleration time 1. | 60.000 s |
| | 0.000 … 1800.000 s | Acceleration time 2 | 1000 = 1 s |
| 23.15 | Deceleration time 2 | Sets deceleration time 2. See parameter 23.13 Deceleration time 1. | 60.000 s |
| | 0.000 … 1800.000 s | Deceleration time 2. | 1000 = 1 s |
| 23.16 | Shape time acc 1 | Sets the shape of the acceleration ramp at the beginning of acceleration.<br>0.000 s: Linear ramp. Suitable for steady acceleration or deceleration and for slow ramps.<br>0.001...1000.000 s: The ramp is S-shaped. S-curve ramps are ideal for lifting applications. The S-curve consists of symmetrical curves at both ends of the ramp and a linear part in between.<br>**Note:**<br>**For safety reasons, curve forming times are not applicable for emergency stop ramp times.**<br>**Acceleration:**<br>  <br><br>**Deceleration:**<br>  <br> | 0.000 s |
| | 0.000 … 1800.000 s | Ramp shape at the start of acceleration. | 1000 = 1 s |
| 23.17 | Shape time acc 2 | Sets the shape of the acceleration ramp at the end of acceleration. See parameter 23.16 Shape time acc 1. | 0.000 s |
| | 0.000 … 1800.000 s | Ramp shape at the end of acceleration. | 1000 = 1 s |
| 23.18 | Shape time dec 1 | Sets the shape of the acceleration ramp at the beginning of the deceleration. See parameter 23.16 Shape time acc 1. | 0.000 s |
| | 0.000 … 1800.000 s | Ramp shape at the start of deceleration. | 1000 = 1 s |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 23.19 | Shape time dec 2 | Sets the shape of the deceleration ramp at the end of deceleration. See parameter 23.16 Shape time acc 1. | 0.000 s |
| | 0.000 … 1800.000 s | Ramp shape at the end of deceleration. | 1000 = 1 s |
| 23.23 | Emergency stop time | In speed control mode, this parameter sets the deceleration rate for emergency stop OFF3 as the required time for the speed to decelerate from the value of parameter 46.01 Speed scaling to zero. This applies equally to torque control since the drive switches to speed control when it receives an emergency stop OFF3 command.<br>In frequency control mode, this parameter defines the required time for the frequency to decelerate from the value of parameter 46.01 Speed scaling to zero.<br>The emergency stop method and enabling source are set with parameters 21.04 Emergency stop mode and 21.05 Emergency stop source. The emergency stop can also be enabled via the fieldbus.<br>**Note:**<br>**Emergency stop OFF1 uses the standard deceleration ramp defined with parameters 23.11..23.19 (speed and torque control).** | 3.000 s |
| | 0.000 … 1800.000 s | Delay time for emergency stop method OFF 3. | 1000 = 1 s |

## 24 Speed reference conditioning

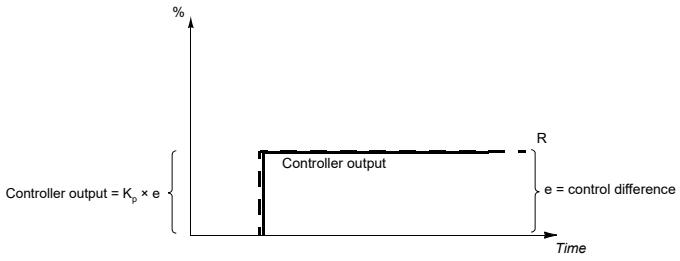
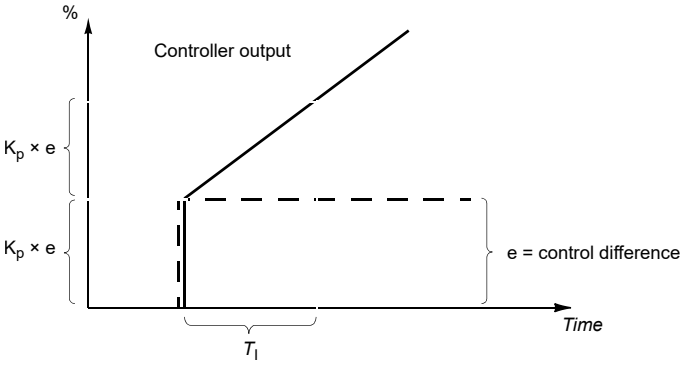
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 24 | Speed reference conditioning | Calculates the speed control deviation, speed control deviation window configuration, speed deviation steps.<br>See the setpoint chain diagrams on pages 354 and 354. | |
| 24.01 | Used speed reference | Displays the corrected speed setpoint after ramp (before calculation of the speed deviation). See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Used speed setpoint for calculation of the speed deviation | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 24.02 | Used speed feedback | Displays the speed feedback for the calculation of the speed deviation. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.00 … 30000.00 rpm | Used actual speed value for calculating the speed deviation | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 24.03 | Speed error filtered | Displays the filtered speed deviation. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 … 30000.0 rpm | Filtered speed deviation. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 24.04 | Speed error inverted | Displays the inverted (unfiltered) speed deviation. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 … 30000.0 rpm | Inverted speed deviation. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 24.12 | Speed error filter time | Sets the time constant of the speed deviation low-pass filter.<br>If the speed setpoint used changes quickly, disturbances of the speed measurement can be filtered out with the speed deviation filter. However, ripple reduced with these filters can cause speed controller problems. A long filter time constant and fast acceleration time contradict each other. A very long filter time results in unstable control. | 0 ms |
| | 0...10000 ms | Filter time constant for the speed deviation. 0 = Filter not enabled. | 1 = 1 ms |
| 24.13 | RFE speed filter | Enables/Disables the resonant frequency filter. The filter is configured with parameters 24.13...24.17.<br>The speed deviation signal routed to the speed controller is filtered by a second-order general notch filter to eliminate the amplification of mechanical resonant frequencies.<br>**Note:**<br>**Fine tuning of the resonant frequency filter requires basic knowledge of frequency filters. Incorrect fine tuning can amplify mechanical oscillations and damage the frequency inverter hardware. To ensure the stability of the speed controller, stop the frequency inverter or disable the filter function before changing parameter values.**<br>• **0 = Resonant frequency filter disabled.**<br>• **1 = Resonant frequency filter enabled.** | Off |
| | Off | 0. | 0 |

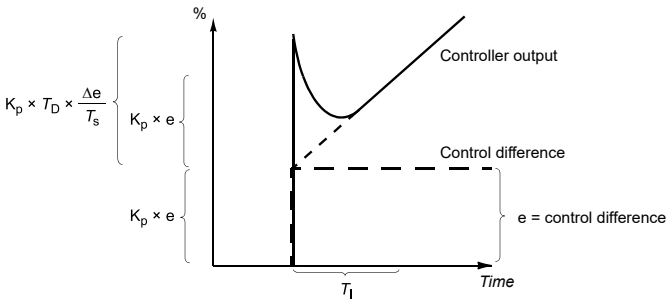
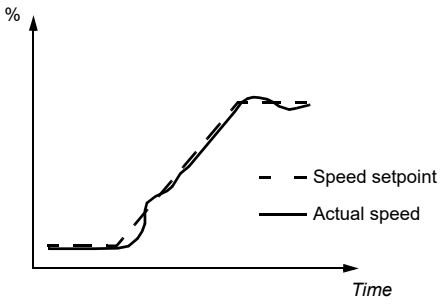
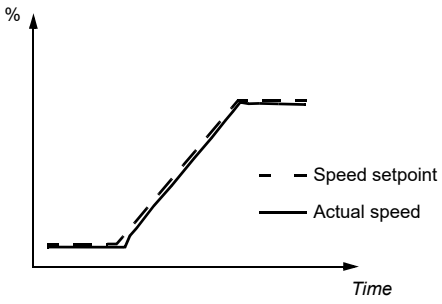
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | On | 1 | 1 |
| 24.14 | Frequency of zero | Defines the zero frequency of the resonant frequency filter. The value must be set close to the resonant frequency that is filtered out before the speed controller.<br>The diagram shows the frequency response.<br>  | 45.00 Hz |
| | 0.50 … 500.00 Hz | Frequency of zero | 100 = 1 Hz |
| 24.15 | Damping of zero | Defines the damping coefficient for parameter 24.14. Value 0 corresponds to the maximum suppression of the resonance frequency.<br>  <br>**Note:**<br>**To ensure that the resonant frequency band is filtered (and not amplified), the value of 24.15 must be less than 24.17.** | 0.000 |
| | -1.000 … 1.000 | Damping coefficient. | 1000 = 1 |
| 24.16 | Frequency of pole | Defines the pole frequency of the resonant frequency filter.<br>  <br>**Note:**<br>**If this value is very different from that of 24.14, the frequencies close to the pole frequency are amplified, which can cause damage to the driven machines.** | 40.00 Hz |
| | 0.50 … 500.00 Hz | Frequency of pole | 100 = 1 Hz |

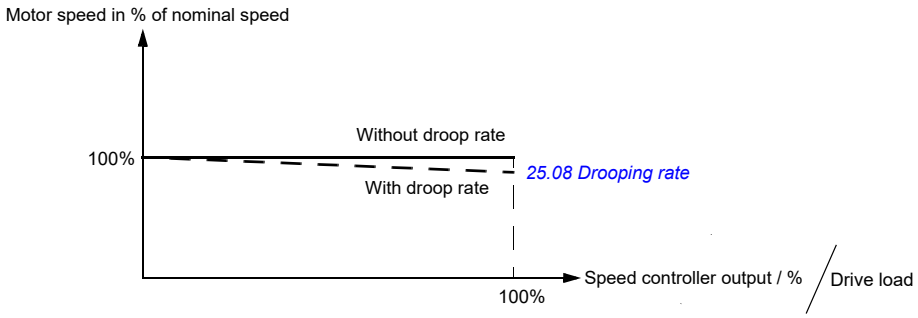
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 24.17 | Damping of pole | Defines the damping coefficient for parameter 24.16. The coefficient determines the frequency response of the resonant frequency filter. A narrower bandwidth results in better dynamic properties. Setting this parameter value to 1 eliminates the effect of the pole.<br>  <br><br>**Note:**<br>**To ensure that the resonant frequency band is filtered (and not amplified), the value of 24.15 must be less than 24.17.** | 0.250 |
| | -1.000 … 1.000 | | 1000 = 1 |
| 24.46 | Speed error step | Sets a speed deviation jump that is added to the input of the speed controller (and added to the speed deviation value). This function can be used in large drive systems for dynamic correction of the speed.<br>**Warning!**<br>**Ensure that the value of the deviation jump is cleared before the stop command is given.** | 0.00 rpm |
| | -3000.00 ... 3000.00 rpm | Speed deviation jump. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |

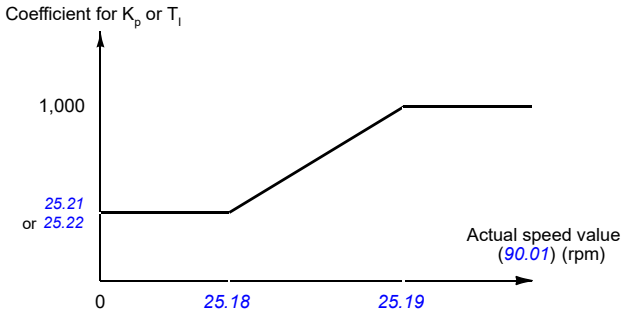
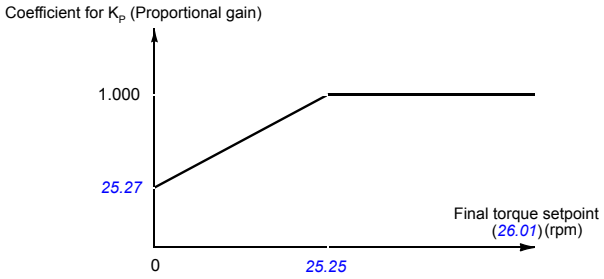
## 25 Speed control

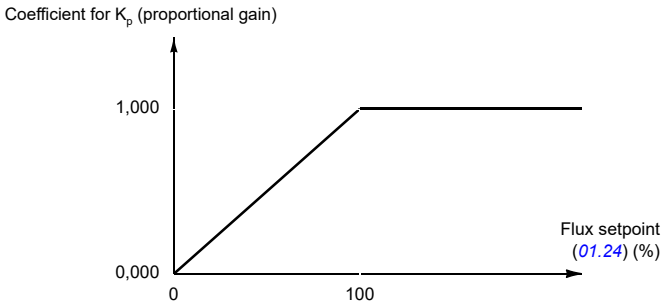
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25 | Speed control | Settings for speed control.<br>See the setpoint chain diagrams on pages 354 and 354. | |
| 25.01 | Torque reference speed control | Displays the speed controller output that is transferred to the torque controller. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Limited speed controller output torque. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25.02 | Speed proportional gain | Sets the proportional gain ($K_p$) of the speed controller. Too high a gain can cause speed oscillations. The following diagram displays the speed controller output after a step increase when the control difference remains constant.<br>  <br><br>Gain = $K_p$ = 1<br>$T_I$ = Integration time = 0<br>$T_D$= Derivative time = 0<br><br>If the gain is set to 1.00, a deviation (Setpoint - Actual value) of 10% of the motor synchronous speed generates a proportional correction value of 10%.<br><br>**Note:**<br>**This parameter is automatically set by the autotuning function of the speed control. See section Speed controller autotune (page 231).** | 10.00, 5.00 (95.21 b1/b2) |
| | 0.00 … 250.00 | Proportional gain of the speed controller. | 100 = 1 |
| 25.03 | Speed integration time | Sets the integration time of the speed controller. The integration time is defined as the rate at which the controller output changes when the control deviation is constant and the proportional gain of the speed controller is 1. The shorter the integration time, the faster the constant control difference is compensated.<br>Setting the integration time to zero disables the I-component of the controller. This is useful when tuning the proportional gain; first set the proportional gain, then the integration time. The integral component has an anti-integration saturation function for operation at a torque or current limit. The following diagram displays the speed controller output after a step increase when the control difference remains constant.<br>  <br><br>Gain = $K_p$ = 1<br>$T_I$ = Integration time > 0<br>$T_D$= Derivative time = 0<br><br>**Note:**<br>**This parameter is automatically set by the autotuning function of the speed control. See section Speed controller autotune (page 231).** | 2.50 s: 5.00 (95.21 b1/b2) |
| | 0.00 … 1000.00 s | Integration time for the speed controller. | 100 = 1 s |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25.04 | Speed derivation time | Sets the D time of the speed controller. The derivative increases the output signal of the controller when the control deviation changes. The longer the D time, the more the speed controller output is amplified when a change occurs. If the D time is set to zero, the controller operates as a PI controller; otherwise, it operates as a PID controller. Because of the derivative, the control is more responsive to disturbances. For simpler applications (especially without an incremental encoder), normally no D-time is required and should remain zero.<br>The following diagram displays the speed controller output after a step increase when the control difference remains constant. The derivative of the speed deviation must be filtered with a low-pass filter to avoid external disturbances.<br>  <br><br>Gain = $K_p$ = 1<br>$T_I$ = Integration time > 0<br>$T_D$= Derivative time = 0<br>$T_s$= Query time interval = 500 µs<br>δe = Changes of the control deviation between two queries | 0.000 s |
| | 0.000 … 10.000 s | D time for the speed controller. | 1000 = 1 s |
| 25.05 | Derivation filter time | Sets the filter time constant of the D time. See parameter 25.04 Speed derivation time. | 8 ms |
| | 0...10000 ms | Derivative filter time constant. | 1 = 1 ms |
| 25.06 | Acc comp derivation time | Sets the D time for acceleration (deceleration) compensation. A high mass moment of inertia of the load is compensated during acceleration by adding the setpoint derivative (D component) to the speed controller output. The principle of D component tuning is described under parameter 25.04 Speed derivation time.<br>**Note:**<br>**As a rule of thumb, a value between 50 and 100% of the sum of the mechanical time constants of the motor and driven machine should be set for this parameter.**<br>The following figure shows the speed responsiveness during ramped acceleration of a load with high inertia.<br>**Without acceleration compensation:**<br>  <br><br>**With acceleration compensation:**<br>  <br> | 0.00 s |
| | 0.00 … 1000.00 s | Filter time of the derivative function of the acceleration compensation. | 100 = 1 s |

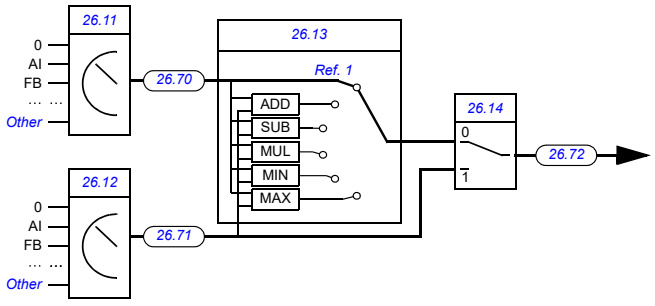
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25.07 | Acc comp filter time | Sets the filter time constant of acceleration (or deceleration) compensation. See parameters 25.04 Speed derivation time and 25.06 Acc comp derivation time. | 8.0 ms |
| | 0.0 … 1000.0 ms | Filter time for acceleration/deceleration time. | 10 = 1 ms |
| 25.08 | Drooping rate | Sets the droop rate as a percentage of the nominal motor speed. The droop rate slightly reduces the speed of the drive when the drive load increases. The reduction of the actual speed at a certain operating point depends on the setting of the droop rate and the drive load (i.e. torque setpoint / speed controller output). At 100% speed controller output, the drooping function reduces the speed by the set droop rate. The droop rate decreases linearly to zero along with the decreasing load.<br>The droop rate can be used, for example, to adjust the load distribution in a master/follower application with several frequency inverters. In a master/follower application, the motor shafts are coupled to each other.<br>The correct droop rate of a process must be determined for each application on a case-by-case basis in practice. | 0.00% |
| | **Speed reduction** = Speed controller output × Drooping × Nominal speed<br>**Example:** The speed controller output is 50%, the droop rate is 1%, the maximum speed of the drive is 1500 rpm.<br>Speed reduction = 0.50 × 0.01 × 1500 rpm = 7.5 rpm<br>  <br> | | |
| | 0.00 ... 100.00% | Droop rate | 100 = 1% |
| 25.09 | Speed ctrl balancing enable | Selects the source for enabling compensation of the speed controller output. This function creates a smooth, bumpless transition from motor torque or tension control back to speed control. If compensation is enabled, the output of the speed controller is set to the value of 25.10 Speed ctrl balancing ref Set value.<br>The ramp generator can also be used for compensation.<br>0 = Disabled<br>1 = Enabled | Not selected |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 25.10 | Speed ctrl balancing ref | Sets the used set value of the speed controller output. The output of the speed controller is set to this value if the function is enabled with parameter 25.09 Speed ctrl balancing enable. | 0.0% |
| | -300.0 ... 300.0% | Set value of the speed controller output. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.11 | Speed control min torque | Sets the minimum torque of the speed controller output. | -300.0% |
| | -1600.0 ... 0.0% | Minimum torque of the speed controller output. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.12 | Speed control max torque | Sets the maximum torque of the speed controller output. | 300.0% |
| | 0.0...1600.0% | Maximum torque of the speed controller output. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.13 | Min torq sp ctrl em stop | Sets the minimum torque of the speed controller output in case of an emergency stop with ramp (OFF1 or OFF3). | -400.0% |
| | -1600.0 ... 0.0% | Minimum torque of the speed controller output for an emergency stop with ramp. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.14 | Max torq sp ctrl em stop | Sets the maximum torque of the speed controller output in case of an emergency stop with ramp (OFF1 or OFF3). | 400.0% |
| | 0.0...1600.0% | Maximum torque of the speed controller output for an emergency stop with ramp. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.15 | Proportional gain em stop | Sets the proportional gain for the speed controller when an emergency stop is enabled. See parameter 25.02 Speed proportional gain. | 10.00, 5.00 (95.21 b1/b2) |
| | 1.00 … 250.00 | Proportional gain during an emergency stop. | 100 = 1 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25.18 | Speed adapt min limit | Minimum actual speed for speed controller adjustment. The speed controller gain and integration time can be adjusted according to the actual speed (90.01 Motor speed for control). This is done by multiplying the gain (25.02 Speed proportional gain) and integration time (25.03 Speed integration time) with coefficients at certain speeds. The coefficients are set individually for gain and integration time. If the actual speed is less than or equal to 25.18 Speed adapt min limit, the gain and integration time are multiplied with 25.21 Kp adapt coef at min speed or 25.22 Ti adapt coef at min speed.<br>If the actual speed is greater than or equal to 25.19 Speed adapt max limit, no adjustment takes place (the coefficient is 1).<br>If the actual speed is between 25.18 Speed adapt min limit and 25.19 Speed adapt max limit, the coefficients for gain and integration time are calculated linearly based on the breakpoints.<br>See also the block diagram on page 354.<br>  <br>$K_p$ = Proportional gain<br>$T_i$ = Integration time | 0 rpm |
| | 0…30000 rpm | Minimum actual speed for speed controller adjustment. | 1 = 1 rpm |
| 25.19 | Speed adapt max limit | Maximum actual speed for speed controller adjustment.<br>See parameter 25.18 Speed adapt min limit. | 0 rpm |
| | 0…30000 rpm | Maximum actual speed for speed controller adjustment. | 1 = 1 rpm |
| 25.21 | Kp adapt coef at min speed | Proportional gain coefficient at the minimum actual speed.<br>See parameter 25.18 Speed adapt min limit. | 1.000 |
| | 0000 … 10000 | Proportional gain coefficient at the minimum actual speed. | 1000 = 1 |
| 25.22 | Ti adapt coef at min speed | Integration time coefficient at the minimum actual speed.<br>See parameter 25.18 Speed adapt min limit. | 1.000 |
| | 0000 … 10000 | Integration time coefficient at the minimum actual speed. | 1000 = 1 |
| 25.25 | Torque adapt max limit | Maximum torque setpoint for speed controller adjustment.<br>The gain of the speed controller can be adjusted according to the final unlimited torque setpoint (26.01 Torque reference to TC). This can be used to smooth out fluctuations due to a small load or backlashes.<br>The function involves multiplying the gain (25.02 Speed proportional gain) with a coefficient within a certain torque range.<br>If the torque setpoint is 0%, the gain is multiplied by the value of parameter 25.27 Kp adapt coef at min torque.<br>If the torque setpoint greater than or equal to 25.25 Torque adapt max limit, no adjustment takes place (the coefficient is 1).<br>Between 0% and 25.25 Torque adapt max limit, the coefficient for the gain is calculated linearly based on the breakpoints.<br>The torque setpoint can be filtered with parameter 25.26 Torque adapt filt time.<br>See also the block diagram on page 354.<br>  | 0.0% |
| | 0.0...1600.0% | Maximum torque setpoint for speed controller adjustment. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.26 | Torque adapt filt time | Sets a filter time constant for adjusting the rate of change of the gain.<br>See parameter 25.25 Torque adapt max limit. | 0.000 s |
| | 0.000 … 100.000 s | Filter time for the adjustment. | 1000 = 1 s |
| 25.27 | Kp adapt coef at min torque | Coefficient of the proportional gain at 0% torque setpoint.<br>See parameter 25.25 Torque adapt max limit. | 1.000 |
| | 0000 … 10000 | Coefficient of the proportional gain at 0% torque setpoint. | 1000 = 1 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25.30 | Flux adaption enable | Enables/Disables the speed controller adjustment based on the motor flux setpoint (01.24 Flux actual %).<br>The proportional gain of the speed controller is multiplied by a coefficient of 0...1 or 0...100% flux setpoint.<br>See also the block diagram on page 354.<br>  | Enabled |
| | Disabled | Speed controller adjustment based on the flux setpoint disabled. | 0 |
| | Enabled | Speed controller adjustment based on the flux setpoint enabled. | 1 |
| 25.33 | Speed controller autotune | Enables (or selects a source to enable) the speed control autotuning function. See section Speed controller autotune (page 231).<br>The autotuning function automatically sets parameters 25.02 Speed proportional gain, 25.03 Speed integration time and 25.37 Mechanical time constant.<br>Preconditions for performing controller autotuning:<br>• Successful execution of the motor ID run<br>• Setting the speed and torque limits (parameter group 30 Limits)<br>• Setting the filtering of the speed feedback (parameter group 90 Feedback selection), filtering of the speed deviation (24 Speed reference conditioning) and the zero speed (21 Start/stop mode)<br>• Successful start of the drive and operation in speed control mode<br>**Warning!**<br>**The motor and the machine reach the torque and speed limits during the autotuning routine. ENSURE THAT THE NECESSARY REQUIREMENTS FOR SAFETY ARE MET FOR THE AUTOTUNING FUNCTION!**<br>The routine can be aborted by stopping the drive.<br>0 → 1 = Enables autotuning of the speed control<br>**Note:**<br>**The value is not automatically reset to zero (0).** | Off |
| | Off | 0. | 0 |
| | On | 1. | 1 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 25.34 | Speed controller autotune mode | Preset for speed controller tuning. This setting determines how the torque setpoint responds to a change in the speed setpoint. | Normal |
| | Smooth | Slow but robust response | 0 |
| | Normal | Normal setting. | 1 |
| | Tight | Fast response. May result in too high a gain for some applications. | 2 |
| 25.37 | Mechanical time constant | Mechanical time constant of the drive and the driven machine determined by the autotuning function. The value can be adjusted manually. | - |
| | 0.00 … 1000.00 s | Mechanical time constant. | 100 = 1 s |
| 25.38 | Autotune torque step | Sets an additional torque value used by the autotuning function. This value is scaled to the nominal motor torque.<br>Note that the torque used by the autotuning function can also be limited by the torque limits (in parameter group 30 Limits) and the nominal motor torque. | 10.00% |
| | 0.00...100.00% | Autotune torque step | 100 = 1% |
| 25.39 | Autotune speed step | Sets a speed value that is added to the initial speed for the autotuning function. The initial speed (used when autotuning is enabled) plus the value of this parameter is the calculated maximum speed used by the autotuning routine. The maximum speed can also be limited by the speed limits (in parameter group 30 Limits) and the nominal motor speed.<br>The value is scaled to the nominal motor speed.<br>**Note:**<br>**The motor slightly exceeds the calculated maximum speed at the end of each acceleration phase.** | 10.00% |
| | 0.00...100.00% | Autotune speed step | 100 = 1% |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 25.40 | Autotune repeat times | Sets the number of acceleration/deceleration cycles performed during the autotuning routine. Increasing the value improves the accuracy of the autotuning function and allows the use of smaller torque or speed change values. | 10 |
| | 1…10 | Number of cycles during the autotuning routine. | 1 = 1 |
| 25.53 | Torque prop reference | Displays the output of the proportional (P) component of the speed controller. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 ... 30000.0% | P component of the speed controller output. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.54 | Torque integral reference | Displays the output of the integral (I) component of the speed controller. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 ... 30000.0% | I component of the speed controller output. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.55 | Torque deriv reference | Displays the output of the derivative (D) component of the speed controller. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 ... 30000.0% | D component of the speed controller output. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.56 | Torque acc compensation | Displays the output of the acceleration compensation function. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 ... 30000.0% | Output of the acceleration compensation function. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 25.57 | Torque reference unbalanced | Displays the acceleration compensated output of the speed controller. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -30000.0 ... 30000.0% | Acceleration-compensated output of the speed controller. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |

## 26 Torque reference chain

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 26 | Torque reference chain | Settings for the torque setpoint chain.<br>See the setpoint chain diagrams on pages 354 and 355. | |
| 26.01 | Torque reference to TC | Displays the final torque setpoint as an input of the torque controller in percent. The setpoint is then affected by various final limiters, such as power, torque, load, etc.<br>See the setpoint chain diagrams on pages 355 and 356.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque setpoint for torque control. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.02 | Torque reference used | Displays the final torque setpoint (as a percentage of the nominal motor torque) for the DTC logic and after frequency, voltage and torque limitation.<br>See the setpoint chain diagram on page 356.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque setpoint for torque control. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.08 | Minimum torque ref | Sets the minimum value of the torque setpoint. Allows local limiting of the torque setpoint before it is passed to the torque ramp controller. Because of an absolute torque limiting, see parameter 30.19 Minimum torque 1. | -300.0% |
| | -1000.0 ... 0.0% | Minimum torque setpoint. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.09 | Maximum torque ref | Sets the maximum value of the torque setpoint. Allows local limiting of the torque setpoint before it is passed to the torque ramp controller. Because of an absolute torque limiting, see parameter 30.20 Maximum torque 1. | 300.0% |
| | 0.0...1000.0% | Maximum torque setpoint. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.11 | Torque ref1 source | Selects the source for torque setpoint 1.<br>Two signal sources can be set with this parameter and 26.12 Torque ref2 source. A digital source selected with 26.14 Torque ref1/2 selection can be used to switch between the two sources, or a mathematical function calculates the setpoint from the two signals.<br>  | Zero |
| | Zero | Not selected. | 0 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | FB A ref1 | 03.05 FB A reference 1 0 (see page 251). | 4 |
| | FB A ref2 | 03.06 FB A reference 2 (see page 251). | 5 |
| 26.12 | Torque ref2 source | Selects the source for torque setpoint 2.<br>For the selection options and a diagram of the setpoint source selection, see parameter 26.11 Torque ref1 source. | Zero |
| 26.14 | Torque ref1/2 selection | Configures the selection between torque setpoints 1 and 2. See diagram for 26.11 Torque ref1 source.<br>0 = Torque reference 1<br>1 = Torque reference 2 | Torque reference 1 |
| | Torque reference 1 | 0. | 0 |
| | Torque reference 2 | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 3 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 4 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 5 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 6 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 7 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 8 |
| | Other [bit] | Source selection (see "Terms and abbreviations" on page 118). | - |
| 26.17 | Torque ref filter time | Sets a low-pass filter time constant for the torque setpoint. | 0.000 s |
| | 0.000 … 30.000 s | Filter time constant for the torque setpoint. | 1000 = 1 s |
| 26.18 | Torque ramp up time | Sets the ramp-up time for the torque setpoint, i.e. the rise time in which the setpoint rises from zero to the nominal motor torque. | 0.000 s |
| | 0.000 … 60.000 s | Torque setup ramp-up time. | 1000 = 1 s |
| 26.19 | Torque ramp down time | Sets the ramp time for reducing the torque setpoint, i.e. the time in which the setpoint is returned to zero from the nominal motor torque. | 0.000 s |
| | 0.000 … 60.000 s | Torque setpoint ramp time down to zero. | 100 = 1 s |
| 26.70 | Torque reference act 1 | Displays the value of speed setpoint source 1 (selected with parameter 26.11 Torque ref1 source). See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Value of torque setpoint source 1. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.71 | Torque reference act 2 | Displays the value of speed setpoint source 2 (selected with parameter 26.12 Torque ref2 source). See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Value of torque setpoint source 2. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.72 | Torque reference act 3 | Displays the torque setpoint after calculation according to parameter 26.13 Torque ref1 function (if used) and after selection (26.14 Torque ref1/2 selection). See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque reference after selection. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.73 | Torque reference act 4 | Displays the torque setpoint after applying torque additive setpoint 1. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque setpoint after applying torque additive setpoint 1. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.74 | Torque ref ramp out | Displays the torque setpoint after limits and ramps. See the setpoint chain diagram on page 354.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque setpoint after limits and ramps. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.75 | Torque reference act 5 | Displays the torque setpoint after selecting the control mode. See the setpoint chain diagram on page 355.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque setpoint after selecting the control mode. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.76 | Torque reference act 6 | Displays the torque setpoint after applying torque additive setpoint 2. See the setpoint chain diagram on page 355.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Torque setpoint after applying torque additive setpoint 2. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 26.81 | Rush control gain | Rush controller gain value. See section Rush control (page 234). | 10.0 |
| | 0.0 … 10000.0 | Rush controller gain (0.0 = Disabled). | 10 = 1 |
| 26.82 | Rush control integration time | Rush controller integration time value. | 2.0 s |
| | 0.0 … 10.0 s | Rush controller integration time (0.0 = Disabled). | 10 = 1 s |

## 30 Limits

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 30 | Limits | Limit values of frequency inverter operation (see note at FBA A MCW bit 3). | |
| 30.01 | Limit word 1 | Displays limit word 1.<br>This parameter can only be read. | - |

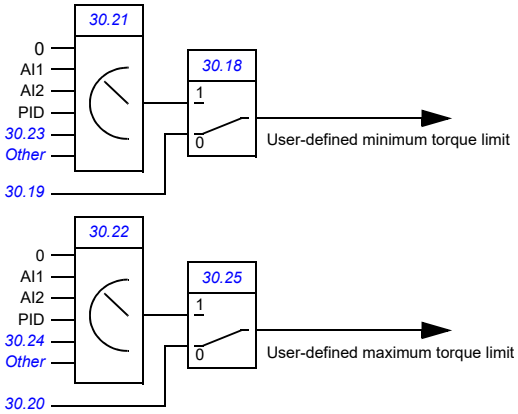
| Bit | Name | Description |
|---|---|---|
| 0 | Torq lim | 1 = The drive torque is limited by the motor control (undervoltage control, current control, load angle control or pull-out control) or by the torque limits set with parameters. |
| 1 | Spd ctl tlim min | 1 = The speed controller output is limited by 25.11 Speed control min torque. |
| 2 | Spd ctl tlim max | 1 = The speed controller output is limited by 25.12 Speed control max torque. |
| 3 | Torq ref max | 1 = The torque setpoint ramp is limited by 26.09 Maximum torque ref, source of 30.25 Maximum torque sel, 30.26 Power motoring limit or 30.27 Power generating limit. See diagram on page 356. |
| 4 | Torq ref min | 1 = The torque setpoint ramp input is limited by 26.08 Minimum torque ref, source of 30.18 Minimum torque sel, 30.26 Power motoring limit or 30.27 Power generating limit. See diagram on page 356. |
| 5 | Tlim max speed | 1 = The torque setpoint is limited by the rush controller because of the maximum speed limit (30.12 Maximum speed). |
| 6 | Tlim min speed | 1 = The torque reference is limited by the rush controller because of the minimum speed limit (30.11 Minimum speed). |
| 7 | Max speed ref lim | 1 = The speed setpoint is limited by 30.12Maximum speed. |
| 8 | Min speed ref lim | 1 = The speed setpoint is limited by 30.11Minimum speed. |
| 9 | Max freq ref lim | 1 = The frequency setpoint is limited by the maximum frequency. |
| 10 | Min freq ref lim | 1 = The frequency setpoint is limited by the minimum frequency. |
| 11 | Reserved | |
| 12 | Sw freq ref lim | 1 = The requested output frequency cannot be reached due to limiting of the switching frequency (due to output filter or e.g. ATEX-related protection). |
| 13…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Limit word 1 | 1 = 1 |
| 30.02 | Torque limit status | Displays the status word of torque controller limitation.<br>This parameter can only be read. | - |

| Bit | Name | Description |
|---|---|---|
| 0 | Undervoltage | *1 = Undervoltage in the DC bus. |
| 1 | Overvoltage | *1 = Overvoltage in the DC bus. |
| 2 | Minimum torque | *1 = Torque is limited by 30.26 Power motoring limit, 30.27 Power generating limit or the source of 30.18 Minimum torque sel.<br>See diagram on page 356. |
| 3 | Maximum torque | *1 = Torque is limited by 30.26 Power motoring limit, 30.27 Power generating limit or the source of 30.25 Maximum torque sel.<br>See diagram on page 356. |
| 4 | Internal current | 1 = An inverter current limit (identified with bits 8...11) is active. |
| 5 | Load angle | (Only for permanent magnet motors and synchronous reluctance motors) 1 = The load angle limit is enabled, i.e. the motor cannot generate more torque. |
| 6 | Motor pullout | (Only for induction motors)<br>1 = The motor pull-out limit is enabled, i.e. the motor cannot generate more torque. |
| 7 | Reserved | |
| 8 | Thermal | 1 = The input current is limited by the thermal limit of the main circuit. |
| 9 | Maximum current | *1 = The maximum output current ($I_{MAX}$) is limited. |
| 10 | User current | *1 = The output current is limited by 30.17Maximum current. |
| 11 | Thermal IGBT | *1 = The output current is limited by a calculated thermal current value. |
| 12 | IGBT overtemperature | *1 = The output current is limited due to the calculated IGBT temperature. |
| 13 | IGBT overload | *1 = The output current is limited due to the IGBT junction temperature. |
| 4…15 | Reserved | |
| *Only one of the bits 0...3 and one of the bits 9...13 can be set simultaneously. The bit of the limit value that is exceeded first is indicated. | | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Torque limiting status word. | 1 = 1 |
| 30.11 | Minimum speed | Defines the permissible minimum speed.<br>**Warning!**<br>**This value is not permitted to be higher than 30.12 Maximum speed.**<br>**Warning!**<br>**This limit value has no effect with scalar/frequency control. Ensure that the frequency limits are set correctly when scalar/frequency control is used.**<br>**Warning!**<br>**In a master/follower configuration, the maximum and minimum speed limits of the follower drive are not permitted to have the same sign. See section Master/Follower functionality (page Master/Follower-Funktionalität).** | -1500.00 rpm, -1800.00 rpm (b0) |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | -30000.00 … 30000.00 rpm | Permissible minimum speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 30.12 | Maximum speed | Defines the permissible maximum speed.<br> <br>**Warning!**<br>**This value is not permitted to be lower than 30.11 Minimum speed.**<br> <br>**Warning!**<br>**This limit value has no effect with scalar/frequency control. Ensure that the frequency limits are set correctly when scalar/frequency control is used.**<br> <br>**Warning!**<br>**In a master/follower configuration, the maximum and minimum speed limits of the follower drive are not permitted to have the same sign. See section Master/Follower functionality (page Master/Follower-Funktionalität).** | 1500.00 rpm, 1800.00 rpm n (b0) |
| | -30000.00 … 30000.00 rpm | Maximum speed. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 30.15 | Maximum start current enable | A temporary motor current limit specifically for starting can be set with the parameter and 30.16 Maximum start current.<br>If this parameter is set to Enabled, the frequency inverter will use the current limit at startup according to the setting of 30.16 Maximum start current. The limit is effective for 2 seconds after initial magnetization (of an induction motor) or autophasing (of a permanent magnet motor), but not more frequently than once every 7 seconds. Otherwise, the limit according to 30.17 Maximum current is in effect.<br>**Note:**<br>**The availability of a higher starting current than the general limit depends on the frequency inverter hardware.** | Disabled |
| | Disabled | The current limit for startup is disabled. | 0 |
| | Enabled | The current limit for startup is enabled. | 1 |
| 30.16 | Maximum start current | A maximum motor current limit specifically for startup can be set with parameter 30.15 Maximum start current enable. | - |
| | 0.00 … 30000.00 A | Maximum motor current for startup. | 100 = 1 A |
| 30.17 | Maximum current | Sets the maximum permissible motor current. | 0.00 A |
| | 0.00 … 30000.00 A | Maximum motor current. | 100 = 1 A |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 30.18 | Minimum torque sel | Selects a source used to switch between two different preset minimum torque limits.<br>0 = The minimum torque limit according to parameter 30.19 is active.<br>1 = The minimum torque limit according to parameter 30.21 is active.<br>The user can define two different sets of torque limits and switch between the sets with a binary source such as a digital input. The selection of the minimum limit (30.18) is independent of the selection of the maximum limit (30.25).<br>The first set of limit values is set with parameters 30.19 and 30.20. The second set has selector parameters for the minimum (30.21) and maximum limit (30.22), which permit the selection of an analog source (like an analog input).<br>  <br>**Note:**<br>**In addition to user-defined limits, torque can be limited for other reasons (such as power limits). See the block diagram on page 356.** | Minimum torque 1 |
| | Minimum torque 1 | 0 (the minimum torque limit according to parameter 30.19 is active). | 0 |
| | Minimum torque 2 source | 1 (the minimum torque limit according to parameter 30.21 is active). | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 118). | - |
| 30.19 | Minimum torque 1 | Sets the minimum torque limit for the drive (as a percentage of the nominal motor torque). See the diagram under parameter 30.18 Minimum torque sel.<br>The limit takes effect in the following cases:<br>• If the source selected with 30.18 Minimum torque sel is 0.<br>• If 30.18 is set to Minimum torque 1. | -300.0% |
| | -1600.0 ... 0.0% | Minimum torque limit 1. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 30.20 | Maximum torque 1 | Sets the maximum torque limit for the drive (as a percentage of the nominal motor torque). See the diagram under parameter 30.18 Minimum torque sel.<br>The limit takes effect in the following cases:<br>• If the source selected with 30.25 Maximum torque sel is 0.<br>• If 30.25 is set to Maximum torque 1. | 300.0% |
| | 0.0...1600.0% | Maximum torque limit 1. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 30.21 | Minimum torque 2 source | Defines the source of the minimum torque limit for the drive (as a percentage of the nominal motor torque)<br>• The source selected with parameter 30.18 Minimum torque sel is 1, or<br>• 30.18 is set to Minimum torque 2 source.<br>See the diagram for 30.18 Minimum torque sel.<br>**Note:**<br>**Positive values received from the selected source are inverted.** | Minimum torque 2 |
| | Zero | Not selected. | 0 |
| | AI1 scaled | 12.12 AI1 scaled value (see page 264). | 1 |
| | AI2 scaled | 12.22 AI2 scaled value (see page 265). | 2 |
| | Minimum torque 2 | 30.23 Minimum torque 2. | 6 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 30.22 | Maximum torque 2 source | Defines the source of the maximum torque limit for the drive (as a percentage of the nominal motor torque) in the following cases:<br>• The source selected with parameter 30.25 Maximum torque sel is 1, or<br>• 30.25 is set to "Maximum torque 2 source".<br>See the diagram for 30.18 Minimum torque sel.<br>**Note:**<br>**Negative values received from the selected source are inverted.** | Maximum torque 2 |
| | Zero | Not selected. | 0 |
| | AI1 scaled | 12.12 AI1 scaled value (see page 264). | 1 |
| | AI2 scaled | 12.22 AI2 scaled value (see page 265). | 2 |
| | Maximum torque 2 | 30.24 Maximum torque 2* | 6 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 30.23 | Minimum torque 2 | Sets the minimum torque limit for the drive (as a percentage of the nominal motor torque).<br>• The source selected with parameter 30.18 Minimum torque sel is 1, and<br>• 30.21 is set to "Minimum torque 2".<br>See the diagram for 30.18 Minimum torque sel. | -300.0% |
| | -1600.0 ... 0.0% | Minimum torque limit 2. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 30.24 | Maximum torque 2 | Sets the maximum torque limit for the drive (as a percentage of the nominal motor torque).<br>• The source selected with parameter 30.25 Maximum torque sel is 1, and<br>• 30.22 is set to Maximum torque 2.<br>See the diagram for 30.18 Minimum torque sel. | 300.0% |
| | 0.0...1600.0% | Maximum torque limit 2. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 30.25 | Maximum torque sel | Selects a source used to switch between two different preset maximum torque limits.<br>0 = The maximum torque limit 1 according to parameter 30.20 is active.<br>1 = The maximum torque limit according to parameter 30.22 is active.<br>See also parameter 30.18 Minimum torque sel. | Maximum torque 1 |
| | Maximum torque 1 | 0. | 0 |
| | Maximum torque 2 source | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 30.26 | Power motoring limit | Defines the maximum shaft power in motor mode, i.e. when drive power is transferred from the motor to the machine. The value is specified as a percentage of the nominal motor power. | 300.00% |
| | 0.00...600.00% | Maximum shaft power in motor mode. | 100 = 1% |
| 30.27 | Power generating limit | Defines the maximum shaft power in generator mode, i.e. when drive power is transferred from the machine to the motor. The value is specified as a percentage of the nominal motor power. | -300.00% |
| | -600.00 ... 0.00% | Maximum shaft power in generator mode. | 100 = 1% |
| 30.30 | Overvoltage control | Enables overvoltage control of the DC bus. During fast braking of a load with high mass moment of inertia, the voltage rises to the limit value of overvoltage control. To prevent the DC bus voltage from exceeding the limit value, the overvoltage controller automatically reduces the braking torque.<br>**Note:**<br>**If the drive is equipped with a brake chopper and brake resistors or a regenerative rectifier unit, overvoltage control must be switched off.** | Enabled |
| | Disabled | Overvoltage control is disabled. | 0 |
| | Enabled | Overvoltage control is enabled. | 1 |
| 30.31 | Undervoltage control | Enables undervoltage control of the DC bus. If the DC voltage drops due to power failure, the undervoltage controller automatically lowers the motor torque to keep the voltage above the lower limit. By reducing the motor torque, the inertia of the load causes energy to be regenerated to the frequency inverter, thus maintaining the charge of the DC bus and preventing an undervoltage shutdown until the motor coasts to a stop. This acts like a power failure control in systems with high mass moment of inertia, such as centrifuges or fans. | Enabled |
| | Disabled | Undervoltage control is disabled. | 0 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | Enabled | Undervoltage control is enabled. | 1 |
| 30.35 | Thermal current limitation | Activates/deactivates the temperature-based limiting of the output current. Disabling the limitation is only permitted if the application requires it. | Enabled |
| | Disabled | Thermal current limiting disabled. | 0 |
| | Enabled | Thermal current limiting enabled. | 1 |

## 31 Fault functions

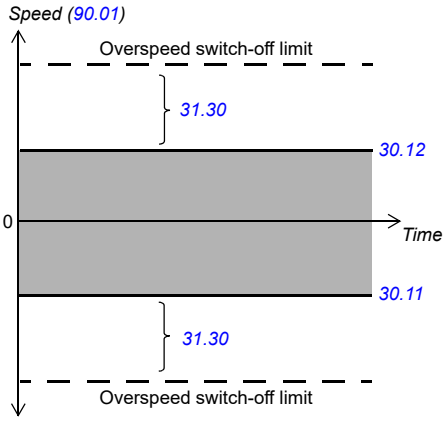
| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 31 | Fault functions | Configuration of external events, selection of the drive's behavior in the event of disturbances. | |
| 31.01 | External event 1 source | Defines the source of external event 1.<br>See also parameter 31.02 External event 1 type.<br>0 = Event triggers<br>1 = Normal operation | Inactive (true), DI6 (b8) |
| | Active (false) | 0. | 0 |
| | Inactive (true) | 1. | 1 |
| | DIIL | DIIL input (10.02 DI delayed status, bit 15). | 2 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 3 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 4 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 5 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 6 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 7 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 8 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 11 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 12 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 31.02 | External event 1 type | Selects the type of external event 1. | Fault (b8) |
| | Fault | The external event generates a fault message. | 0 |
| | Warning | The external event generates a warning message. | 1 |
| | Warning/Fault | If the drive is modulating, the external event generates a fault message. Otherwise, the external event generates a warning message. | 3 |
| 31.03 | External event 2 source | Defines the source of external event 2. See also parameter 31.04 External event 2 type.<br>For selection options, see parameter 31.01 External event 1 source. | Inactive (true), DIIL (b5) |
| 31.04 | External event 2 type | Selects the type of external event 2. | |
| | Fault | The external event generates a fault message. | 0 |
| | Warning | The external event generates a warning message. | 1 |
| | Warning/Fault | If the drive is modulating, the external event generates a fault message. Otherwise, the external event generates a warning message. | 3 |
| 31.05 | External event 3 source | Defines the source of external event 3. See also parameter 31.06 External event 3 type.<br>For selection options, see parameter 31.01 External event 1 source. | Inactive (true) |
| 31.06 | External event 3 type | Selects the type of external event 3. | |
| | Fault | The external event generates a fault message. | 0 |
| | Warning | The external event generates a warning message. | 1 |
| | Warning/Fault | If the drive is modulating, the external event generates a fault message. Otherwise, the external event generates a warning message. | 3 |
| 31.07 | External event 4 source | Defines the source of external event 4. See also parameter 31.08 External event 4 type.<br>For selection options, see parameter 31.01 External event 1 source. | Inactive (true) |
| 31.08 | External event 4 type | Selects the type of external event 4. | |
| | Fault | The external event generates a fault message. | 0 |
| | Warning | The external event generates a warning message. | 1 |
| | Warning/Fault | If the drive is modulating, the external event generates a fault message. Otherwise, the external event generates a warning message. | 3 |
| 31.09 | External event 5 source | Defines the source of external event 5. See also parameter 31.10 External event 5 type.<br>For selection options, see parameter 31.01 External event 1 source. | Inactive (true) |
| 31.10 | External event 5 type | Selects the type of external event 5. | |
| | Fault | The external event generates a fault message. | 0 |
| | Warning | The external event generates a warning message. | 1 |
| | Warning/Fault | If the drive is modulating, the external event generates a fault message. Otherwise, the external event generates a warning message. | 3 |
| 31.11 | Fault reset selection | Selects the source for an external fault acknowledgment signal. This signal is observed even if it is not the active source at the current control location (EXT1/EXT2/Local).<br>(Acknowledgment via the active source is always observed regardless of this parameter setting.)<br>0 → 1 = Acknowledge | |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | FBA A MCW bit 7 | Control word bit 7 received via fieldbus adapter A. | 30 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 31.12 | Autoreset selection | Selects the faults that are automatically acknowledged. The parameter is a 16-bit word where each bit corresponds to a fault type. If a bit is set to 1, the corresponding fault is automatically acknowledged/reset.<br>The number of acknowledgments and the interval between acknowledgments (acknowledgment attempts) can be set with parameter 31.16.<br>**Note:**<br>**Before enabling this function, ensure that no dangerous situations can occur. The function automatically restarts the frequency inverter and resumes operation after a fault.**<br>**Note:**<br>• **The automatic acknowledgment function is only available with external control, see section "Controller" (page 228).**<br>• **Faults in connection with function "Safe Torque Off" (STO) cannot be acknowledged automatically.**<br>The bits of this binary value correspond to the following faults: | 0000h |

| Bit | Fault |
|---|---|
| 0 | Overcurrent |
| 1 | Overvoltage |
| 2 | Undervoltage |
| 3 | AI monitoring fault |
| 4 | Rectifier unit |
| 5…7 | Reserved |
| 8 | Application fault 1 (set in the application program) |
| 9 | Application fault 2 (set in the application program) |
| 10 | Selectable fault (see parameter 31.13 User selectable fault) |
| 11 | External fault 1 (from the source set with parameter 31.01 External event 1 source) |
| 12 | External fault 2 (from the source set with parameter 31.03 External event 2 source) |
| 13 | External fault 3 (from the source set with parameter 31.05 External event 3 source) |
| 14 | External fault 4 (from the source set with parameter 31.07 External event 4 source) |
| 15 | External fault 5 (from the source set with parameter 31.09 External event 5 source) |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Configuration word of the automatic acknowledgment. | 1 = 1 |
| 31.13 | User selectable fault | Defines the fault that can be automatically acknowledged with parameter 31.12 Autoreset selection, bit 10.<br>The fault messages are listed in chapter Warning and fault messages on page 343. | 0000h |
| | 0000h…FFFFh | Fault code | 10 = 1 |
| 31.16 | Delay time | Sets the delay time that the frequency inverter waits after the occurrence of a fault (or a previous acknowledgment attempt) before attempting automatic acknowledgment. See parameter 31.12 Autoreset selection. | 0.0 s |
| | 0.0 … 120.0 s | Waiting time of automatic acknowledgment. | 10 = 1 s |
| 31.19 | Motor phase loss | Sets the response of the frequency inverter when the failure of a motor phase is detected. | Fault |
| | No action | No reaction. | 0 |
| | Fault | The frequency inverter switches off with fault message 3381 Output phase loss. | 1 |
| 31.20 | Earth fault | Sets the response of the frequency inverter when a ground fault or current unbalance is detected in the motor or motor cable. | Fault |
| | No action | No reaction. | 0 |
| | Warning | The frequency inverter generates warning message A2B3 Earth leakage. | 1 |
| | Fault | The frequency inverter switches off with fault message 2330 Earth leakage. | 2 |
| 31.21 | Supply phase loss | Sets the response of the frequency inverter when the failure of a line phase is detected. | Fault |

<table>
<tr><th>No.</th><th>Name/Value</th><th>Description</th><th>Clear all/<br>FbEq16</th></tr>
<tr><td>31.22</td><td>STO indication run/stop</td><td>Selects the indicators when one or both signals for Safe Torque Off (STO) are switched off or missing. The indicators also depend on whether the frequency inverter is running or stopped when this phenomenon occurs.<br>The table associated with each selection specifies the indicators associated with that setting.<br><br>Note:<br>• This parameter does not affect the functionality of STO itself. Function STO function operates independently of the setting of this parameter: A running frequency inverter stops if one or both STO signals are missing and only starts when both STO signals are restored and all faults are acknowledged.<br>• The absence of only one STO signal always generates a fault message since it is interpreted as a fault.<br><br>For additional information about function STO, see the hardware manual of the inverter.</td><td>Fault/Fault</td></tr>
<tr><td></td><td>Fault/Fault</td><td><table><tr><th colspan="2">Inputs</th><th>Indicator (running or stopped)</th></tr><tr><th>IN1</th><th>IN2</th><th></th></tr><tr><td>0</td><td>0</td><td>Fault 5091 Safe torque off</td></tr><tr><td>0</td><td>1</td><td>Faults 5091 Safe torque off and FA81 Safe torque off 1 loss.</td></tr><tr><td>1</td><td>0</td><td>Faults 5091 Safe torque off and FA82 Safe torque off 2 loss.</td></tr><tr><td>1</td><td>1</td><td>(Normal operation)</td></tr></table></td><td>0</td></tr>
<tr><td></td><td>Fault/Warning</td><td><table><tr><th colspan="2">Inputs</th><th colspan="2">Display</th></tr><tr><td>IN1</td><td>IN2</td><td>Running</td><td>Stopped</td></tr><tr><td>0</td><td>0</td><td>Fault 5091 Safe torque off</td><td>Warning A5A0 Safe torque off</td></tr><tr><td>0</td><td>1</td><td>Faults 5091 Safe torque off and FA81 Safe torque off 1 loss.</td><td>Warning A5A0 Safe torque off and fault FA81 Safe torque off 1 loss.</td></tr><tr><td>1</td><td>0</td><td>Faults 5091 Safe torque off and FA82 Safe torque off 2 loss.</td><td>A5A0 Safe torque off and fault FA82 Safe torque off 2 loss.</td></tr><tr><td>1</td><td>1</td><td colspan="2">(Normal operation)</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Fault/Event</td><td><table><tr><th colspan="2">Inputs</th><th colspan="2">Display</th></tr><tr><td>IN1</td><td>N2</td><td>Running</td><td>Stopped</td></tr><tr><td>0</td><td>0</td><td>Fault 5091 Safe torque off</td><td>Event B5A0 STO event</td></tr><tr><td>0</td><td>1</td><td>Faults 5091 Safe torque off and FA81 Safe torque off 1 loss.</td><td>Event B5A0 STO event and fault FA81 Safe torque off 1 loss.</td></tr><tr><td>1</td><td>0</td><td>Faults 5091 Safe torque off and FA82 Safe torque off 2 loss.</td><td>Event B5A0 STO event and fault FA82 Safe torque off 2 loss.</td></tr><tr><td>1</td><td>1</td><td colspan="2">(Normal operation)</td></tr></table></td><td>2</td></tr>
<tr><td></td><td>Warning/Warning</td><td><table><tr><th colspan="2">Inputs</th><th>Indicator (running or stopped)</th></tr><tr><th>IN1</th><th>IN2</th><th></th></tr><tr><td>0</td><td>0</td><td>Warning A5A0 Safe torque off</td></tr><tr><td>0</td><td>1</td><td>Warning A5A0 Safe torque off and fault FA81 Safe torque off 1 loss.</td></tr><tr><td>1</td><td>0</td><td>Warning A5A0 Safe torque off and fault FA82 Safe torque off 2 loss.</td></tr><tr><td>1</td><td>1</td><td>(Normal operation)</td></tr></table></td><td>3</td></tr>
<tr><td></td><td>Event/Event</td><td><table><tr><th colspan="2">Inputs</th><th>Indicator (running or stopped)</th></tr><tr><th>IN1</th><th>IN2</th><th></th></tr><tr><td>0</td><td>0</td><td>Event B5A0 STO event</td></tr><tr><td>0</td><td>1</td><td>Event B5A0 STO event and fault FA81 Safe torque off 1 loss.</td></tr><tr><td>1</td><td>0</td><td>Event B5A0 STO event and fault FA82 Safe torque off 2 loss.</td></tr><tr><td>1</td><td>1</td><td>(Normal operation)</td></tr></table></td><td>4</td></tr>
<tr><td></td><td>No indication/No indication</td><td><table><tr><th colspan="2">Inputs</th><th>Indicator (running or stopped)</th></tr><tr><th>IN1</th><th>IN2</th><th></th></tr><tr><td>0</td><td>0</td><td>None</td></tr><tr><td>0</td><td>1</td><td>Fault FA81 Safe torque off 1 loss.</td></tr><tr><td>1</td><td>0</td><td>Fault FA82 Safe torque off 2 loss.</td></tr><tr><td>1</td><td>1</td><td>(Normal operation)</td></tr></table></td><td>5</td></tr>
<tr><td>31.23</td><td>Wiring or earth fault</td><td>Sets the response of the frequency inverter in the event of incorrect supply and motor cable connections (i.e. supply cable to motor connections).<br><br>Note:<br>The protection function must be disabled in frequency inverters / inverters supplied via the DC bus.</td><td>Fault</td></tr>
</table>

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | No action | No response (protection disabled). | 0 |
| | Fault | The frequency inverter switches off with fault message 3181 Wiring or earth fault. | 1 |
| 31.24 | Stall function | Sets the response of the frequency inverter in the event of a motor stall.<br>A stall condition is defined as follows:<br>• The frequency inverter has reached the stall current limit (31.25 Stall current limit).<br>• And: The output frequency is below the value set with parameter 31.27 Stall frequency limit or the motor speed is below the value set with parameter 31.26 Stall speed limit.<br>• And: The conditions above lasted longer than the time set with parameter 31.28 Stall time. | Fault |
| | No action | Nothing selected (stall monitoring disabled). | 0 |
| | Warning | The frequency inverter generates warning message A780 Motor stall. | 1 |
| | Fault | The frequency inverter switches off with fault message 7121 Motor stall. | 2 |
| 31.25 | Stall current limit | Stall current limit value as a percentage of the nominal motor current.<br>See parameter 31.24 Stall function. | 200.0% |
| | 0.0...1600.0% | Stall current limit value. | - |
| 31.26 | Stall speed limit | Stall speed limit value in rpm. See parameter 31.24 Stall function. | 150.00 rpm, 180.00 rpm (b0) |
| | 0.00 … 10000.00 rpm | Stall speed limit value. | See par. 46.01. |
| 31.27 | Stall frequency limit | Stall frequency limit value. See parameter 31.24 Stall function.<br>**Note:**<br>**Setting the limit value below 10 Hz is not recommended.** | 15.00 Hz, 18.00 Hz (b0) |
| 31.28 | Stall time | Stall time. See parameter 31.24 Stall function. | 20 s |
| | 0 … 3600 s | Stall time. | - |
| 31.30 | Overspeed trip margin | Sets the maximum permissible speed of the motor (overspeed protection), together with 30.11 Minimum speed and 30.12 Maximum speed. If 90.01 Motor speed for control or the calculated speed exceeds the speed limit value according to parameter 30.11 or 30.12 by more than the value of this parameter, the frequency inverter switches off with fault message 7310 Overspeed.<br>**Example:** If the maximum speed is 1420 rpm and the tolerance for the overspeed shutdown limit is 300 rpm, the frequency inverter will shut down at 1720 rpm.<br>  <br> | 500.00 rpm |
| | 0.00 … 10000.0 rpm | Overspeed trip margin | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 31.32 | Emergency ramp supervision | Together with 01.29 Speed change rate, parameters 31.32 Emergency ramp supervision and 31.33 Emergency ramp supervision delay form a monitoring function for emergency stops OFF1 and OFF3.<br>Monitoring is based on one of the following values:<br>• Monitoring the time within which the motor stops<br>• Comparison of the actual delay value with the expected deceleration rate.<br>If this parameter is set to 0%, the maximum stop time is set directly in parameter 31.33. Otherwise, 31.32 defines the maximum permissible deviation from the expected deceleration rate calculated from parameters 23.11...23.19 (Off1) or 23.23 Emergency stop time (Off3). If the actual deceleration rate (01.29) deviates too much from the expected rate, the drive stops with fault message 73B0 Emergency ramp failed, sets bit 8 of 06.17 Drive status word 2, and coasts to a stop.<br>If 31.32 is set to 0% and 31.33 is set to 0 s, supervision of the emergency stop ramp is disabled.<br>See also parameter 21.04 Emergency stop mode. | 0% |
| | 0...300% | Maximum deviation from the expected deceleration rate. | 1 = 1% |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 31.33 | Emergency ramp supervision delay | If parameter 31.32 Emergency ramp supervision is set to 0%, this parameter defines the maximum time that an emergency stop (mode Off1 or Off3) is permitted to take. If the motor was not stopped when the time elapsed, the frequency inverter switches off with fault 73B0 Emergency ramp failed, sets bit 8 of 06.17 Drive status word 2 and the drive coasts to a stop.<br>If 31.32 is set to a value other than 0%, this parameter sets a delay between receiving the emergency stop command and enabling monitoring. It is recommended to specify a short delay to allow the speed change rate to stabilize. | 0 s |
| | 0…32767 s | Maximum ramp time (ramp down) or delay for enabling supervision. | 1 = 1 s |
| 31.35 | Main fan fault function | Sets the reaction of the frequency inverter when a fault of the main fan is detected. | Warning |
| | Fault | The frequency inverter switches off with fault message 5080 Fan. | 0 |
| | Warning | The frequency inverter generates warning message A581 Fan. | 1 |
| | No action | No reaction. | 2 |
| 31.37 | Ramp stop supervision | Together with 01.29 Speed change rate, parameters 31.37 Ramp stop supervision and 31.38 Ramp stop supervision delay form a supervision function for a normal stop with ramp (not emergency stop / OFF3).<br>Monitoring is based on one of the following values:<br>• Monitoring the time within which the motor stops<br>• Comparison of the actual delay value with the expected deceleration rate.<br>If this parameter is set to 0%, the maximum stop time is set directly in parameter 31.38. Otherwise, 31.37 defines the maximum permissible deviation from the expected deceleration rate, which is calculated using parameters 23.11...23.19. If the actual deceleration rate (01.29) deviates too much from the expected rate, the drive stops with fault message 73B1 Stop failed, sets bit 14 of 06.17 Drive status word 2 and coasts to a stop.<br>If 31.32 is set to 0% and 31.33 is set to 0 s, ramp stop supervision is disabled. | 0% |
| | 0…300% | Maximum deviation from the expected deceleration rate. | 1 = 1% |
| 31.38 | Ramp stop supervision delay | If parameter 31.37 Ramp stop supervision is set to 0%, this parameter defines the maximum time that a ramp stop is permitted to take. If the motor was not stopped when the time elapsed, the frequency inverter switches off with fault 73B1 Stop failed, sets bit 14 of 06.17 Drive status word 2 and the drive coasts to a stop.<br>If 31.37 is set to a value other than 0%, this parameter sets a delay between receiving the stop command and enabling supervision. It is recommended to specify a short delay to allow the speed change rate to stabilize. | 0 s |
| | 0…32767 s | Maximum ramp time (ramp down) or delay for enabling supervision. | 1 = 1 s |
| 31.40 | Disable warning messages | Selects the warnings to be suppressed. The parameter is a 16-bit word where each bit corresponds to a warning. If a bit is set to 1, the corresponding warning is suppressed.<br>The bits of this binary value correspond to the following warnings: | 0000b |

| Bit | Fault |
|---|---|
| 0 | Overvoltage |
| 1 | Reserved |
| 2 | Encoder 1 |
| 3 | Encoder 2 |
| 4 | CU (Control unit) battery |
| 5…15 | Reserved |

| | | | |
|---|---|---|---|
| | 0000b…1101b | Warning suppression word. | 1 = 1 |
| 31.42 | Overcurrent fault limit | Sets a user-specific motor current fault limit.<br>The frequency inverter automatically sets an internal motor current limit according to the drive hardware. The internal current limit is suitable for most applications, but this parameter can be used to set a lower current limit, for example to protect a permanent magnet motor from demagnetization.<br>**Note:**<br>**The limit value defines the maximum peak current of one phase.**<br>If this parameter is set to 0.0 A, only the automatically set internal limit is effective. | 0.00 A |
| | 0.00 … 30000.00 A | User motor current fault limit | 1 = 0.01 A (DS402 mode), see par. 46.05. (native mode) |

## 32 Supervision

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 32 | Supervision | Configuration of the signal supervision functions 1...3.<br>Three values can be selected for supervision. A warning or fault message is generated if preset limit values are exceeded.<br>See also section Signal supervision (page 248). | |
| 32.01 | Supervision status | Signal supervision status word.<br>Indicates whether the values monitored by the signal supervision function are within or outside the respective limits.<br>**Note:**<br>**This status word is independent of the reactions set via parameters 32.06, 32.16 and 32.26.** | 0000b |

| Bit | Name | Description |
|---|---|---|
| 0 | Supervision 1 | 1 = The signal selected using 32.07 is outside the limits. |
| 1 | Supervision 2 | 1 = The signal selected using 32.17 is outside the limits. |
| 2 | Supervision 3 | 1 = The signal selected using 32.27 is outside the limits. |
| 3...15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000...0111b | Signal supervision status word. | 1 = 1 |
| 32.05 | Supervision 1 function | Mode selection of signal supervision function 1. Sets how the monitored signal (see parameter 32.07) is compared with its upper and lower limits (32.09 or 32.10). If the condition is fulfilled, the reaction is selected using 32.06. | Disabled |
| | Disabled | Signal supervision 1 not enabled. | 0 |
| | Low | Reaction if the signal falls below the lower limit. | 1 |
| | High | Reaction if the signal exceeds the upper limit. | 2 |
| | Abs low | Reaction if the absolute value of the signal falls below the (absolute) lower limit. | 3 |
| | Abs high | Reaction if the absolute value of the signal exceeds the (absolute) upper limit. | 4 |
| | Both | Reaction if the signal falls below the lower limit or exceeds the upper limit. | 5 |
| | Abs both | Reaction if the absolute value of the signal falls below the (absolute) lower limit or exceeds the (absolute) upper limit. | 6 |
| 32.06 | Supervision 1 action | Selects the reaction of the frequency inverter if the value monitored by signal supervision 1 exceeds its limits.<br>**Note:**<br>**This parameter does not affect the status indicated by 32.01 Supervision status.** | No action |
| | No action | No reaction. | 0 |
| | Warning | A warning message (A8B0 Signal supervision ) is generated. | 1 |
| | Fault | The frequency inverter switches off with fault message 80B0 Signal supervision. | 2 |
| | Fault if running | If running, the frequency inverter switches off with fault message 80B0 Signal supervision. | |
| 32.07 | Supervision 1 signal | Selects the signal that is monitored with signal supervision function 1. | Zero |
| | Zero | Not selected. | 0 |
| | Speed | 01.01 Motor speed used (page 250). | 1 |
| | Frequency | 01.06 Output frequency: (page 250). | 3 |
| | Motor current | 01.07 Motor current (page 250). | 4 |
| | Torque | 01.10 Motor torque (page 250). | 6 |
| | DC voltage | 01.11 DC voltage (page 250). | 7 |
| | Output power | 01.14 Output power (page 250). | 8 |
| | AI1 | 12.11 AI1 actual value (page 264). | 9 |
| | AI2 | 12.21 AI2 actual value (page 265). | 10 |
| | Speed ref ramp in | 23.01 Speed ref ramp input (page 277). | 18 |
| | Speed ref ramped | 23.02 Speed ref ramp output (page 277). | 19 |
| | Speed ref used | 24.01 Used speed reference (page 279). | 20 |
| | Torq ref used | 26.02 Torque reference used (page 287). | 21 |
| | Process PID out | 40.01 Process PID output actual (page 40 Prozessregler Satz 1). | 24 |
| | Process PID feedback actual | 40.02 Process PID feedback actual (page 40 Prozessregler Satz 1). | 25 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 32.08 | Supervision 1 filter time | Sets a filter time constant for the signal monitored with signal supervision 1. | 0.000 s |
| | 0.000 ... 30.000 s | Signal filter time. | 1000 = 1 s |
| 32.09 | Supervision 1 low | Sets the lower limit for signal supervision 1. | 0.00 |
| | -21474830.00 ... 21474830.00 | Lower limit. | - |
| 32.10 | Supervision 1 high | Sets the upper limit for signal supervision 1. | 0.00 |
| | -21474830.00 ... 21474830.00 | Upper limit. | - |
| 32.15 | Supervision 2 function | Mode selection of signal supervision function 2. Sets how the monitored signal (see parameter 32.17) is compared with its upper and lower limits (32.19 or 32.20). If the condition is fulfilled, the reaction is selected using 32.16. | Disabled |
| | Disabled | Signal supervision 2 not enabled. | 0 |
| | Low | Reaction if the signal falls below the lower limit. | 1 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | High | Reaction if the signal exceeds the upper limit. | 2 |
| | Abs low | Reaction if the absolute value of the signal falls below the (absolute) lower limit. | 3 |
| | Abs high | Reaction if the absolute value of the signal exceeds the (absolute) upper limit. | 4 |
| | Both | Reaction if the signal falls below the lower limit or exceeds the upper limit. | 5 |
| | Abs both | Reaction if the absolute value of the signal falls below the (absolute) lower limit or exceeds the (absolute) upper limit. | 6 |
| 32.16 | Supervision 2 action | Selects the reaction of the frequency inverter if the value monitored by signal supervision 2 exceeds its limits.<br>**Note:**<br>**This parameter does not affect the status indicated by 32.01 Supervision status.** | No action |
| | No action | No reaction. | 0 |
| | Warning | A warning message (A8B1 Signal supervision 2) is generated. | 1 |
| | Fault | The frequency inverter switches off with fault message 80B1 Signal supervision 2. | 2 |
| | Fault if running | If running, the frequency inverter switches off with fault message 80B0 Signal supervision. | |
| 32.17 | Supervision 2 signal | Selects the signal that is monitored with signal supervision function 2.<br>For available selection options, see parameter 32.07 Supervision 1 signal. | Zero |
| 32.18 | Supervision 2 filter time | Sets a filter time constant for the signal monitored with signal supervision 2. | 0.000 s |
| | 0.000 … 30.000 s | Signal filter time. | 1000 = 1 s |
| 32.19 | Supervision 2 low | Sets the lower limit for signal supervision 2. | 0.00 |
| | -21474830.00 … 21474830.00 | Lower limit. | - |
| 32.20 | Supervision 2 high | Sets the upper limit for signal supervision 2. | 0.00 |
| | -21474830.00 … 21474830.00 | Upper limit. | - |
| 32.25 | Supervision 3 function | Mode selection of signal supervision function 3. Sets how the monitored signal (see parameter 32.27) is compared with its upper and lower limits (32.29 or 32.30). If the condition is fulfilled, the reaction is selected using 32.26. | Disabled |
| | Disabled | Signal supervision 3 not enabled. | 0 |
| | Low | Reaction if the signal falls below the lower limit. | 1 |
| | High | Reaction if the signal exceeds the upper limit. | 2 |
| | Abs low | Reaction if the absolute value of the signal falls below the (absolute) lower limit. | 3 |
| | Abs high | Reaction if the absolute value of the signal exceeds the (absolute) upper limit. | 4 |
| | Both | Reaction if the signal falls below the lower limit or exceeds the upper limit. | 5 |
| | Abs both | Reaction if the absolute value of the signal falls below the (absolute) lower limit or exceeds the (absolute) upper limit. | 6 |
| 32.26 | Supervision 3 action | Selects the reaction of the frequency inverter if the value monitored by signal supervision 3 exceeds its limits.<br>**Note:**<br>**This parameter does not affect the status indicated by 32.01 Supervision status.** | No action |
| | No action | No reaction. | 0 |
| | Warning | A warning message (A8B2 Signal supervision 3) is generated. | 1 |
| | Fault | The frequency inverter switches off with fault message A8B2 Signal supervision 3. | 2 |
| | Fault if running | If running, the frequency inverter switches off with fault message 80B0 Signal supervision. | |
| 32.27 | Supervision 3 signal | Selects the signal that is monitored with signal supervision function 3.<br>For available selection options, see parameter 32.07 Supervision 1 signal. | Zero |
| 32.28 | Supervision 3 filter time | Sets a filter time constant for the signal monitored with signal supervision 3. | 0.000 s |
| | 0.000 … 30.000 s | Signal filter time. | 1000 = 1 s |
| 32.29 | Supervision 3 low | Sets the lower limit for signal supervision 3. | 0.00 |
| | -21474830.00 … 21474830.00 | Lower limit. | - |
| 32.30 | Supervision 3 high | Sets the upper limit for signal supervision 3. | 0.00 |
| | -21474830.00 … 21474830.00 | Upper limit. | - |

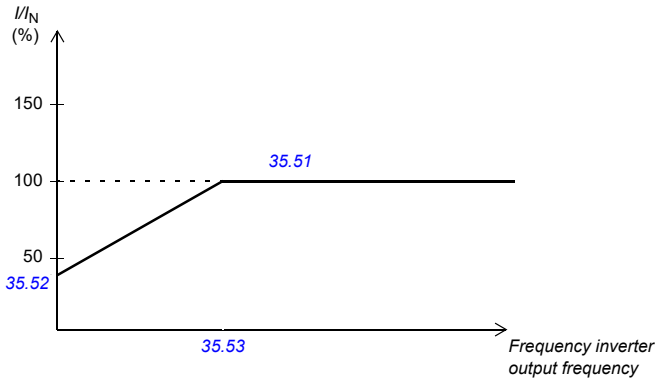
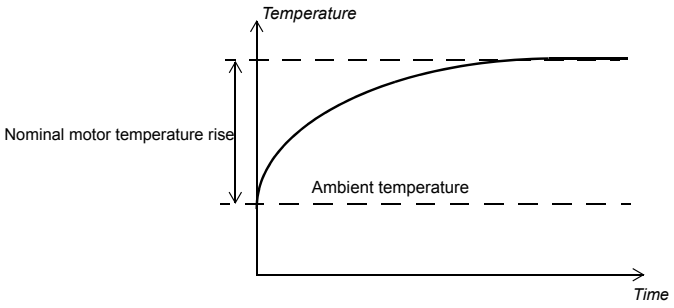
## 35 Motor thermal protection

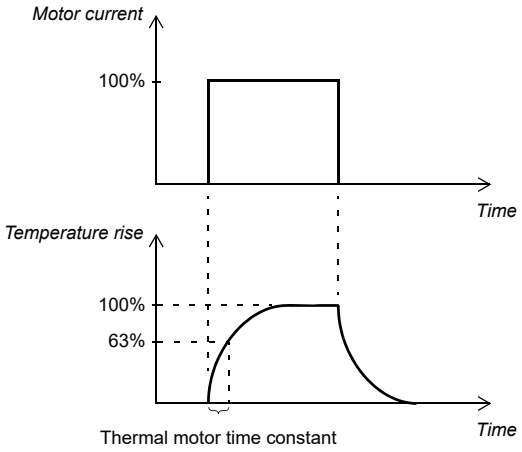
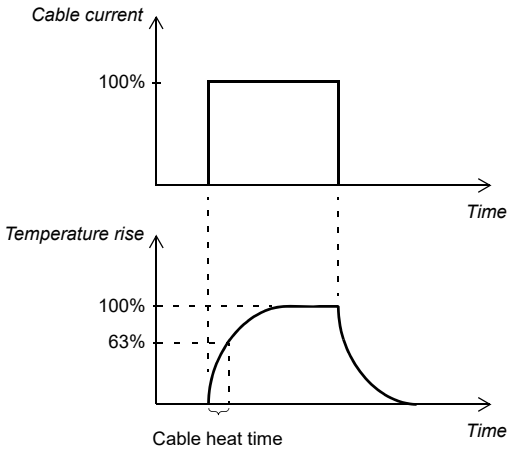
| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 35 | Thermal motor protection | Settings of the thermal motor protection such as configuration of the temperature measurement and the fan control as well as definition of the load curve.<br>See also section Motor thermal protection (page 243). | |
| 35.01 | Motor estimated temperature | Displays the motor temperature as calculated by the thermal motor protection model (see parameters 35.50...35.55). The unit is selected with parameter 96.16 Unit selection.<br>This parameter can only be read. | - |
| | -60 … 1000°C | Calculated motor temperature. | 1 = 1°C |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 35.02 | Measured temperature 1 | Displays the temperature received from the source set with parameter 35.11 Temperature 1 source. The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms.**<br>This parameter can only be read. | - |
| | -60 … 1000°C or 0…5000 Ω | Measured temperature 1. | 1 = 1 unit |
| 35.03 | Measured temperature 2 | Displays the temperature received from the source set with parameter 35.21 Temperature 2 source. The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms.**<br>This parameter can only be read. | - |
| | 60 … 1000°C or 0…5000 Ω | Measured temperature 2. | 1 = 1 unit |
| 35.11 | Temperature 1 source | Selects the source from which measured temperature 1 is read.<br>For wiring examples, see the hardware manual of the frequency inverter.<br>This source usually comes from a sensor connected to the motor that is controlled by a frequency inverter. However, this could also be used to measure and monitor a temperature of other parts of the process, as long as a suitable sensor from the selection list is used. | Disabled |
| | Disabled | Not selected. Temperature monitoring function 1 is disabled. | 0 |
| | Estimated temperature | Calculated motor temperature (see parameter 35.01 Motor estimated temperature).<br>The temperature is calculated internally by the frequency inverter. It is important to set the ambient temperature of the motor in 35.50 Motor ambient temperature. | 1 |
| | KTY84 analog I/O | KTY84 sensor is connected to an analog input selected with parameter 35.14 Temperature 1 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The following settings are required:<br>• Set the hardware jumper or switch of the analog input to U (voltage). Each change must be confirmed with a restart of the control unit.<br>• Set the unit selection parameter of the input to Volt.<br>• Set the source selection parameter of the analog output to "Force KTY84 excitation".<br>• Select the analog input in parameter 35.14. Use selection Other as a pointer to the current input value parameter if the input is on an I/O expansion module.<br>The analog output supplies the sensor with constant current. If the resistance of the sensor changes with the sensor temperature, the voltage at the sensor changes accordingly. The voltage is read from the analog input and converted to degrees. | 2 |
| | KTY84 encoder module 1 | A KTY84 sensor is connected to encoder module 1. See also parameters 91.21 Module 1 temp sensor type and 91.22 Module 1 temp filter time. | 3 |
| | KTY84 encoder module 2 | A KTY84 sensor is connected to encoder module 2. | 4 |
| | 1 × Pt100 analog I/O | Pt100 sensor is connected to the analog input selected with parameter 35.14 Temperature 1 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The required settings are the same as for KTY84 analog I/O except that the source selection parameter of the analog output must be set to Force Pt100 excitation. | 5 |
| | 2 × Pt100 analog I/O | As with 1 × Pt100 analog I/O, but with two sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 6 |
| | 3 × Pt100 analog I/O | As with 1 × Pt100 analog I/O, but with three sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 7 |
| | PTC DI6 | A PTC sensor is connected to digital input DI6 (see the connection diagram 6.2.5.2 "Thermal motor protection" on page 243).<br>**Note:**<br>**Either 0 Ohm (normal temperature) or 4000 Ohm (temperature too high) are displayed with 35.02 Measured temperature 1. If the temperature is too high, a warning message is generated by default according to parameter 35.13 Temperature 1 warning limit. If a fault message should be generated instead, set 35.12 Temperature 1 fault limit to 4000 Ohm.** | 8 |
| | PTC analog I/O | PTC sensor is connected to the standard analog input selected with parameter 35.14 Temperature 1 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The required settings are the same as for KTY84 analog I/O except that the source selection parameter of the analog output must be set to Force PTC excitation. | 20 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | PTC encoder module 1 | A PTC sensor is connected to encoder module 1. See also parameters 91.21 Module 1 temp sensor type and 91.22 Module 1 temp filter time. | 9 |
| | PTC encoder module 2 | A PTC sensor is connected to encoder module 2. | 10 |
| | Direct temperature | The temperature is read from the source defined by 35.14 Temperature 1 AI source. It is assumed that the value of the source is in the unit for temperature set with 96.16 Unit selection. | 11 |
| | 1 × Pt1000 analog I/O | Pt1000 sensor is connected to the analog input selected with parameter 35.14 Temperature 1 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The required settings are the same as for KTY84 analog I/O except that the source selection parameter of the analog output must be set to Force Pt1000 excitation. | 13 |
| | 2 × Pt1000 analog I/O | As for 1 × Pt1000 analog I/O but with two sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 14 |
| | 3 × Pt1000 analog I/O | As for 1 × Pt1000 analog I/O but with three sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 15 |
| 35.12 | Temperature 1 fault limit | Sets the fault limit value for temperature monitoring function 1. If the measured temperature 1 exceeds the limit value, the frequency inverter switches off with fault message 4981 External temperature 1.<br>The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms.** | 130°C or 4500 Ω |
| | -60 … 1000°C or 0…5000 Ω | Fault limit value for temperature monitoring function 1. | 1 = 1 unit |
| 35.13 | Temperature 1 warning limit | Sets the warning limit value for temperature monitoring function 1. If the measured temperature 1 exceeds the limit value, a warning (A491 External temperature 1) is generated.<br>The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms.** | 110°C or 4000 Ω |
| | -60 … 1000°C or 0…5000 Ω | Warning limit value for temperature monitoring function 1. | 1 = 1 unit |
| 35.14 | Temperature 1 AI source | Specifies the analog input if the setting of 35.11 Temperature 1 source requires measurement via an analog input.<br>**Note:**<br>**If the input is on an I/O expansion module, use selection Other as a pointer to the AI actual value in group 14, 15 or 16.** | Not selected |
| | None | Not selected. | 0 |
| | AI1 actual value | Analog input AI1 of the control unit. | 1 |
| | AI2 actual value | Analog input AI2 of the control unit. | 2 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 35.21 | Temperature 2 source | Selects the source from which measured temperature 2 is read.<br>For wiring examples, see the hardware manual of the frequency inverter.<br>This source usually comes from a sensor connected to the motor that is controlled by a frequency inverter. However, this could also be used to measure and monitor a temperature of other parts of the process, as long as a suitable sensor from the selection list is used. | Disabled |
| | Disabled | Not selected. Temperature monitoring function 2 is disabled. | 0 |
| | Estimated temperature | Calculated motor temperature (see parameter 35.01 Motor estimated temperature).<br>The temperature is calculated internally by the frequency inverter. It is important to set the ambient temperature of the motor in 35.50 Motor ambient temperature. | 1 |
| | KTY84 analog I/O | KTY84 sensor is connected to an analog input selected with parameter 35.24 Temperature 2 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The following settings are required:<br>• Set the hardware jumper or switch of the analog input to U (voltage). Each change must be confirmed by restarting the control unit.<br>• Set the unit selection parameter of the input to Volt.<br>• Set the source selection parameter of the analog output to "Force KTY84 excitation".<br>• Select the analog input in parameter 35.24. Use selection Other as a pointer to the current input value parameter if the input is on an I/O expansion module.<br>The analog output supplies the sensor with constant current. If the resistance of the sensor changes with the sensor temperature, the voltage at the sensor changes accordingly. The voltage is read from the analog input and converted to degrees. | 2 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | KTY84 encoder module 1 | A KTY84 sensor is connected to encoder module 1.<br>See also parameters 91.21 Module 1 temp sensor type and 91.22 Module 1 temp filter time. | 3 |
| | KTY84 encoder module 2 | A KTY84 sensor is connected to encoder module 2. | 4 |
| | 1 × Pt100 analog I/O | Pt100 sensor is connected to the analog input selected with parameter 35.24 Temperature 2 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The required settings are the same as for KTY84 analog I/O except that the source selection parameter of the analog output must be set to Force Pt100 excitation. | 5 |
| | 2 × Pt100 analog I/O | Like selection 1 × Pt100 analog I/O but with two sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 6 |
| | 3 × Pt100 analog I/O | Like selection 1 × Pt100 analog I/O but with three sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 7 |
| | PTC DI6 | A PTC sensor is connected to digital input DI6 (see connection diagram on page 243).<br>**Note:**<br>**Either 0 Ohm (normal temperature) or 4000 Ohm (temperature too high) are displayed with 35.03 Measured temperature 2. If the temperature is too high, a warning message is generated by default according to parameter 35.23 Temperature 2 warning limit. If a fault message should be generated instead, set 35.22 Temperature 2 fault limit to 4000 Ohm.** | 8 |
| | PTC analog I/O | PTC sensor is connected to the standard analog input selected with parameter 35.24 Temperature 2 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The required settings are the same as for KTY84 analog I/O except that the source selection parameter of the analog output must be set to Force PTC excitation. | 20 |
| | PTC encoder module 1 | A PTC sensor is connected to encoder module 1.<br>See also parameters 91.21 Module 1 temp sensor type and 91.22 Module 1 temp filter time. | 9 |
| | PTC encoder module 2 | A PTC sensor is connected to encoder module 2. | 10 |
| | Direct temperature | The temperature is read from the source defined by 35.24 Temperature 2 AI source. It is assumed that the value of the source is in the unit for temperature set with 96.16 Unit selection. | 11 |
| | 1 × Pt1000 analog I/O | Pt1000 sensor is connected to the analog input selected with parameter 35.24 Temperature 2 AI source and an analog output. Input and output can be located on the control unit of the frequency inverter or on an expansion module.<br>The required settings are the same as for KTY84 analog I/O except that the source selection parameter of the analog output must be set to Force Pt1000 excitation. | 13 |
| | 2 × Pt1000 analog I/O | Like selection 1 × Pt1000 analog I/O but with two sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 14 |
| | 3 × Pt1000 analog I/O | Like selection 1 × Pt1000 analog I/O but with three sensors connected in series. Using multiple sensors significantly improves measurement accuracy. | 15 |
| 35.22 | Temperature 2 fault limit | Sets the fault limit value for temperature monitoring function 2. If the measured temperature 2 exceeds the limit value, the frequency inverter switches off with fault message 4982 External temperature 2.<br>The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms.** | 130°C or 4500 Ω |
| | -60 … 1000°C or 0…5000 Ω | Fault limit value for temperature monitoring function 2. | 1 = 1 unit |
| 35.23 | Temperature 2 warning limit | Sets the warning limit value for temperature monitoring function 2. If measured temperature 2 exceeds the limit value, a warning (A492 External temperature 2) is generated.<br>The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms.** | 110°C or 4000 Ω |
| | -60 … 1000°C or 0…5000 Ω | Warning limit value for temperature monitoring function 2. | 1 = 1 unit |
| 35.24 | Temperature 2 AI source | Selects the input for parameters 35.21 Temperature 2 source, for settings KTY84 analog I/O, 1 × Pt100 analog I/O, 2 × Pt100 analog I/O, 3 × Pt100 analog I/O and Direct temperature. | Not selected |
| | None | Not selected. | 0 |
| | AI1 actual value | Analog input AI1 of the control unit. | 1 |
| | AI2 actual value | Analog input AI2 of the control unit. | 2 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 35.50 | Motor ambient temperature | Sets the ambient temperature of the motor for the thermal motor protection model. The unit is selected with parameter 96.16 Unit selection.<br>The thermal motor protection model calculates the motor temperature based on parameters 35.50...35.55. The motor temperature increases during operation if the motor runs above the load curve. It decreases during operation below the curve.<br>**Warning!**<br>**The model cannot protect the motor if the motor is not cooled properly due to dust, dirt, etc.** | 20°C |
| | -60 … 100°C | Ambient temperature. | 1 = 1°C |
| 35.51 | Motor load curve | Sets the motor load characteristic curve together with parameters 35.52 Zero speed load and 35.53 Break point. The thermal motor protection model uses the load curve to calculate the motor temperature. If the parameter is set to 100%, the maximum load is equal to the value of parameter 99.06 Motor nominal current (higher loads heat up the motor). The load curve should be set if the ambient temperature deviates from the nominal value according to 35.50 Motor ambient temperature.<br>  <br>I = Motor current<br>$I_N$ = Nominal motor current | 100% |
| | 50...150% | Maximum load for the motor load characteristic curve. | 1 = 1% |
| 35.52 | Zero speed load | Sets the motor load characteristic curve together with parameters 35.51 Motor load curve and 35.53 Break point. Sets the maximum motor load at zero speed of the load curve. If the motor has an external motor fan to improve cooling performance, a higher value can be set. See recommendations of the motor manufacturer.<br>See parameter 35.51 Motor load curve. | 100% |
| | 50...150% | Max. load zero speed for the motor load characteristic curve. | 1 = 1% |
| 35.53 | Break point | Sets the motor load characteristic curve together with parameters 35.51 Motor load curve and 35.52 Max. Zero speed load. Adjustment of the break point of the load curve, which is the point at which the motor load curve starts, from the value of parameter 35.51 Motor load curve to the value of parameter 35.52 Zero speed load.<br>See parameter 35.51 Motor load curve. | 45.00 Hz |
| 35.54 | Motor nominal temperature rise | Sets the motor temperature rise if the motor is loaded with nominal current. See recommendations of the motor manufacturer.<br>The unit is selected with parameter 96.16 Unit selection.<br>  | 80°C |
| | 0…300°C | Temperature rise. | 1 = 1°C |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 35.55 | Motor thermal time constant | Sets the thermal time constant used for the thermal motor protection model, which is defined as the time required to reach 63% of the nominal motor temperature. See recommendations of the motor manufacturer.<br>  | 256 s |
| | 100 … 10000 s | Thermal motor time constant. | 1 = 1 s |
| 35.60 | Cable temperature | Displays the calculated temperature of the motor cable. See section Thermal motor cable protection (page 245).<br>102% = Overtemperature warning (A480 Motor cable overload)<br>106% = Overtemperature fault (4000 Motor cable overload)<br>This parameter can only be read. | 0.0% |
| | 0.0...200.0% | Calculated temperature of the motor cable. | 10 = 1% |
| 35.61 | Cable nominal current | Sets the continuous current of the motor cable for thermal protection in the control program.<br>**Warning!**<br>**The value entered in this parameter must be limited according to all factors affecting the overload capacity of the cable, such as ambient temperature, type of cable laying and coverage. See the technical data of the cable manufacturer.** | 10000.00 A |
| | 0.00 … 10000.00 A | Continuous current capacity of the motor cable. | 100 = 1 A |
| 35.62 | Cable thermal rise time | Sets the time constants of the motor cable for thermal protection in the control program. This value is the time in which 63% of the nominal cable temperature is reached if the cable is loaded with nominal current (parameter 35.61 Cable nominal current).<br>0 s = Thermal motor cable protection disabled<br>See the technical data of the cable manufacturer.<br>  | 1 s |
| | 0 s | Thermal motor cable protection disabled | 1 = 1 s |
| | 1...50000 svv | Time constant of the thermal motor cable. | 1 = 1 s |
| 35.100 | DOL starter control source | Parameters 35.100...35.106 configure a monitored start/stop logic for external devices such as a contactor-controlled motor fan.<br>This parameter selects the signal for starting and stopping the fan.<br>0 = Stop<br>1 = Start<br>The output that controls the fan contactor must be connected to bit 1 of parameter 35.105. 35.101 or 35.102 can be used to set switch-on and switch-off delays for the fan. A feedback signal coming from the fan can be applied to the terminal selected with 35.103. Failure of the feedback signal optionally triggers a warning or fault (see 35.104 and 35.106). | Off,06.16 b6 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | Off | 0 (function disabled). | 0 |
| | On | 1. | 1 |
| | Running | Bit 6 of 06.16 Drive status word 1 (see page 255). | 2 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 35.101 | DOL starter on delay | Defines a start delay for the motor fan. The delay timer starts when the control source selected with parameter 35.100 is switched on. After the delay has been ended, bit 1 of 35.105 is set. | 0 s |
| | 0…42949673 s | Start delay for the motor fan | 1 = 1 s |
| 35.102 | DOL starter off delay | Defines a stop delay for the motor fan.<br>The delay timer starts when the control source selected with parameter 35.100 is switched off. After the end of the delay, bit 1 of 35.105 is reset. | 20 min. |
| | 0...715828 min. | Stop delay for the motor fan | 1 = 1 min. |
| 35.103 | DOL starter feedback source | Selects the input for the motor fan feedback signal.<br>0 = Stopped<br>1 = Running<br>After the fan has started (bit 1 of 35.105 is set), feedback is expected within the time set with 35.104. | Not selectedDI5 |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 35.104 | DOL starter feedback delay | Defines a delay of the feedback signal for the motor fan.<br>The delay timer starts when bit 1 of 35.105 is set. If no feedback was received from the fan by the time the delay has ended, the action selected with 35.106 is performed.<br>**Note:**<br>**This delay is only applied at startup. If the feedback signal fails to appear during operation, the action set with 35.106 is performed immediately.** | 0 s, 5 s |
| | 0…42949673 s | Start delay for the motor fan | 1 = 1 s |
| 35.105 | DOL starter status word | Status of the motor fan control logic.<br>Bit 1 is the control output for the fan, which is used as a source, e.g. for a digital or relay output.<br>The other bits indicate the states of the selected control and feedback sources and the fault status. This parameter can only be read. | - |

| Bit | Name | Description |
|---|---|---|
| 0 | Start command | Status of the fan control source selected with 35.100.<br>0 = Stop requested<br>1 = Start requested |
| 1 | Delayed start command | Fan control bit (delays are monitored). Select this bit as a source for the output that controls the fan.<br>0 = Stopped<br>1 = Started |
| 2 | DOL feedback | Status of fan feedback (source selected with 35.103).<br>0 = Stopped<br>1 = Running |
| 3 | DOL fault (-1) | Fault status.<br>0 = Fault (fan feedback missing). The measure selected with 35.106 is carried out.<br>1 = No fault |
| 4…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000b…1111b | Status of the motor fan control logic | 1 = 1 |
| 35.106 | DOL starter event type | Sets the measure to be performed if the motor fan control logic detects that fan feedback is missing. | Fault |
| | No action | No reaction. | 0 |
| | Warning | The frequency inverter issues a warning (A781 Motor fan). | 1 |
| | Fault | The frequency inverter switches off with fault message 71B1 Motor fan. | 2 |

## 37 User load curve

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 37 | User load curve | Settings for the user load curve (ULC).<br>See also section User load curve (page 246). | |
| 37.01 | ULC output status word | Displays the status of the monitored signal. (The status word is independent of the actions and delays set with parameters 37.03, 37.04, 37.41 and 37.42.)<br>This parameter can only be read. | - |

| Bit | Name | Information |
|---|---|---|
| 0 | Underload limit | 1 = Monitored signal below the underload curve. |
| 1 | Reserved | |
| 2 | Overload limit | 1 = Monitored signal above the overload curve. |
| 3…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 000b … 101b | Status of the monitored signal. | 1 = 1 |
| 37.02 | ULC supervision signal | Selects the signal that should be monitored. The function compares the absolute value of the signal with the load curve. | Not selected |
| | None | No signal selected (supervision not active). | 0 |
| | Motor current % | 01.07 Motor current (page 01 Actual values). | 2 |
| | Motor torque % | 01.10 Motor torque (page 250). | 3 |
| | Output power % of motor nominal | 01.15 Output power % of motor nom (See page 250.) | 4 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 37.03 | ULC overload actions | Selects the reaction of the drive if the absolute value of the monitored signal remains above the overload curve longer than the time according to the value of 37.41 ULC overload timer. | Disabled |
| | Disabled | There is no reaction. | 0 |
| | Warning | The frequency inverter issues a warning (A8BE ULC overload warning). | 1 |
| | Fault | The frequency inverter switches off with fault message 8002 ULC overload fault. | 2 |
| | Warning/Fault | The frequency inverter generates warning message A8BE ULC overload warning if the signal is above the overload curve for half the time set with parameter 37.41 ULC overload timer.<br>The frequency inverter switches off with fault message 8002 ULC overload fault if the signal remains above the overload curve for the time set with parameter 37.41 ULC overload timer. | 3 |
| 37.04 | ULC underload actions | Selects the reaction of the drive if the absolute value of the monitored signal remains longer above the underload curve than the time according to the value of 37.42 ULC underload timer. | Disabled |
| | Disabled | There is no reaction. | 0 |
| | Warning | The frequency inverter issues a warning (A8BF ULC underload warning). | 1 |
| | Fault | The frequency inverter switches off with fault message 8001 ULC underload fault. | 2 |
| | Warning/Fault | The frequency inverter generates a warning message A8BF ULC underload warning if the signal is below the underload curve for half the time set with parameter 37.42 ULC underload timer.<br>The frequency inverter switches off with fault message 8001 ULC underload fault if the signal remains below the underload curve for the time set with parameter 37.42 ULC underload timer. | 3 |
| 37.11 | ULC speed table point 1 | Sets the first speed point on the x-axis of the user load curve.<br>The speed points are used in DTC and scalar motor control mode in speed control. The five points must have an ascending sequence from the lowest to the highest value. The points are defined as positive values, but the range is symmetrically effective also in the negative direction. Monitoring is not active outside these two areas. | 150.0 rpm |
| | 0.0 … 30000.0 rpm | Speed. | 10 = 1 rpm |
| 37.12 | ULC speed table point 2 | Sets the second speed point on the x-axis of the user load curve. | 750.0 rpm |
| | 0.0 … 30000.0 rpm | Speed | 10 = 1 rpm |
| 37.13 | ULC speed table point 3 | Sets the third speed point on the x-axis of the user load curve. | 1290.0 rpm |
| | 0.0 … 30000.0 rpm | Speed. | 10 = 1 rpm |
| 37.14 | ULC speed table point 4 | Sets the fourth speed point on the x-axis of the user load curve. | 1500.0 rpm |
| | 0.0 … 30000.0 rpm | Speed. | 10 = 1 rpm |
| 37.15 | ULC speed table point 5 | Sets the fifth speed point on the x-axis of the user load curve. | 1800.0 rpm |
| | 0.0 … 30000.0 rpm | Speed. | 10 = 1 rpm |
| 37.16 | ULC frequency table point 1 | Sets the first frequency point on the x-axis of the user load curve.<br>The frequency points are used in scalar motor control mode in frequency control.<br>The five points must have an ascending sequence from the lowest to the highest value. The points are defined as positive values, but the range is symmetrically effective also in the negative direction. Monitoring is not active outside these two areas. | 5.0 Hz |
| | 0.0 … 500.0 Hz | Frequency | 10 = 1 Hz |
| 37.17 | ULC frequency table point 2 | Sets the second frequency point on the x-axis of the user load curve. | 25.0 Hz |
| | 0.0 … 500.0 Hz | Frequency | 10 = 1 Hz |
| 37.18 | ULC frequency table point 3 | Sets the third frequency point on the x-axis of the user load curve. | 43.0 Hz |
| | 0.0 … 500.0 Hz | Frequency | 10 = 1 Hz |
| 37.19 | ULC frequency table point 4 | Sets the fourth frequency point on the x-axis of the user load curve. | 50.0 Hz |
| | 0.0 … 500.0 Hz | Frequency | 10 = 1 Hz |
| 37.20 | ULC frequency table point 5 | Sets the fifth frequency point on the x-axis of the user load curve. | 60.0 Hz |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | 0.0 … 500.0 Hz | Frequency | 10 = 1 Hz |
| 37.21 | ULC underload point 1 | Sets the first point of the underload curve. Each point of the underload curve must have a lower value than the corresponding overload point. | 10.0% |
| | 0.0 ... 1600.0% | Underload point. | 10 = 1% |
| 37.22 | ULC underload point 2 | Sets the second point of the underload curve. | 15.0% |
| | 0.0 ... 1600.0% | Underload point. | 10 = 1% |
| 37.23 | ULC underload point 3 | Sets the third point of the underload curve. | 25.0% |
| | 0.0 ... 1600.0% | Underload point. | 10 = 1% |
| 37.24 | ULC underload point 4 | Sets the fourth point of the underload curve. | 30.0% |
| | 0.0 ... 1600.0% | Underload point. | 10 = 1% |
| 37.25 | ULC underload point 5 | Sets the fifth point of the underload curve. | 30.0% |
| | 0.0 ... 1600.0% | Underload point. | 10 = 1% |
| 37.31 | ULC overload point 1 | Sets the first point of the overload curve.<br>Each point of the overload curve must have a higher value than the corresponding underload point. | 300.0% |
| | 0.0...1600.0% | Overload point. | 10 = 1% |
| 37.32 | ULC overload point 2 | Sets the second point of the overload curve. | 300.0% |
| | 0.0...1600.0% | Overload point. | 10 = 1% |
| 37.33 | ULC overload point 3 | Sets the third point of the overload curve. | 300.0% |
| | 0.0...1600.0% | Overload point. | 10 = 1% |
| 37.34 | ULC overload point 4 | Sets the fourth point of the overload curve. | 300.0% |
| | 0.0...1600.0% | Overload point | 10 = 1% |
| 37.35 | ULC overload point 5 | Sets the fifth point of the overload curve. | 300.0% |
| | 0.0...1600.0% | Overload point. | 10 = 1% |
| 37.41 | ULC overload timer | Sets the time the monitored signal must remain above the overload curve before the frequency inverter performs the action per selection of 37.03 ULC overload actions. | 20.0 s |
| | 0.0 … 10000.0 s | Overload time. | 10 = 1 s |
| 37.42 | ULC underload timer | Sets the time the monitored signal must remain below the underload curve before the frequency inverter performs the action according to selection of 37.04 ULC underload actions. | 20.0 s |
| | 0.0 … 10000.0 s | Underload time. | 10 = 1 s |

## 43 Brake chopper

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 43 | Brake chopper | Settings for the internal brake chopper. | |
| 43.01 | Braking resistor temperature | Displays the calculated temperature of the braking resistor or how close the braking resistor is to the point where it is too hot.<br>The value is specified as a percentage where 100% is ultimately the temperature that the resistor will reach if it takes up its maximum rated load for long enough (43.09 Brake resistor Pmax cont).<br>Temperature calculation is based on the values of parameters 43.08, 43.09 and 43.10 as well as on the assumption that the resistor was installed according to the manufacturer's instructions (i.e. it cools down as expected).<br>This parameter can only be read. | - |
| | 0.0...120.0% | Calculated temperature of the braking resistor. | 10 = 1% |
| 43.06 | Brake chopper function | Enables brake chopper control and selects the overload protection method (calculation or measurement) for the braking resistor.<br>**Note:**<br>**Before enabling the brake chopper control, ensure that:**<br>• **A braking resistor is connected.**<br>• **The overvoltage control is switched off (parameter 30.30 Overvoltage control).**<br>• **The range of the supply voltage (parameter 95.01 Supply voltage) was correctly selected.** | Disabled |
| | Disabled | Brake chopper control is disabled. | 0 |
| | Enabled with thermal model | Brake chopper control enabled with brake resistance protection based on a thermal model. If you select this, you must also specify the values required by the model, i.e. parameters 43.08...43.12. See the data sheet of the resistor. | 1 |
| | Enabled without thermal model | Brake chopper control enabled without overload protection for the braking resistor. This setting can be used if the resistor is equipped with a temperature-controlled circuit breaker wired so that the drive is switched off if the braking resistor overheats.<br>Before using this setting, make sure that overvoltage control is disabled (parameter 30.30 Overvoltage control). | 2 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| | Overvoltage peak protection | Brake chopper control enabled during overvoltage.<br>This setting is for situations where<br>• The brake chopper is not needed during operation to dissipate the inertia energy of the motor.<br>• The motor can save a considerable part of the magnetizing energy in its windings<br>• The motor is stopped intentionally or unintentionally with coasting.<br>In such a situation, the motor releases a lot of magnetic energy to the drive, which results in damage. To protect the drive, the brake chopper can be used with a small resistor that dissipates only the magnetic energy (not the inertial energy) of the motor.<br>With this setting, the brake chopper is only enabled if the DC voltage exceeds the overvoltage limit. In normal operation, the brake chopper is not active. | 3 |
| 43.07 | Brake chopper run enable | Selects the source for switching on/off the brake chopper.<br>0 = IGBT pulses of the brake chopper switched off<br>1 = Normal IGBT modulation of the brake chopper permitted.<br>This parameter can be used to program the brake chopper so that it only operates if the supply of a drive with regenerative supply unit fails. | On |
| | Off | 0. | 0 |
| | On | 1. | 1 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 43.08 | Brake resistor thermal tc | Sets the thermal time constant of the thermal model for the braking resistor. | 0 s |
| | 0 … 10000 s | Thermal time constant of the braking resistor, i.e. the rated time in which 63% of the temperature is reached. | 1 = 1 s |
| 43.09 | Brake resistor Pmax cont | Defines the maximum continuous load of the braking resistor, which finally increases the temperature of the resistor to the maximum permissible value (continuous heat dissipation capacity of the resistor in kW), but not beyond. The value is used for overload protection of the resistor based on the thermal model. See parameter 43.06 Brake chopper function and data sheet of the braking resistor. | 0.00 kW |
| | 0.00 … 10000.00 kW | Maximum continuous load of the braking resistor. | 100 = 1 kW |
| 43.10 | Brake resistance | Sets the resistance value of the braking resistor. The value is used for protection of the brake chopper based on the thermal model. See parameter 43.06 Brake chopper function. | 0.0 Ohm |
| | 0.0 … 1000.0 Ω | Resistance value of the braking resistor. | 10 = 1 Ω |
| 43.11 | Brake resistor fault limit | Selects the fault limit value for protection of the braking resistor based on the thermal model. See parameter 43.06 Brake chopper function. The frequency inverter switches off with fault message 7183 BR excess temperature if the limit value is exceeded.<br>The value is specified as a percentage of the temperature that the resistor reaches if it must absorb the energy according to the setting of parameter 43.09 Brake resistor Pmax cont. | 105% |
| | 0...150% | Fault limit value temperature of the braking resistor. | 1 = 1% |
| 43.12 | Brake resistor warning limit | Selects the warning limit value for protection of the braking resistor based on the thermal model. See parameter 43.06 Brake chopper function. The frequency inverter issues warning A793 BR excess temperature if the limit value is exceeded. The value is specified as a percentage of the temperature that the resistor reaches if it must absorb the energy according to the setting of parameter 43.09 Brake resistor Pmax cont. | 95% |
| | 0...150% | Warning limit value temperature of the braking resistor. | 1 = 1% |

## 44 Mechanical brake control

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 44 | Mechanical brake control | Configuration of the mechanical brake control.<br>See also section Mechanical brake control (page 238). | |
| 44.01 | Brake control status | Displays the status word of the mechanical brake control.<br>This parameter can only be read. | - |

| Bit | Name | Information |
|---|---|---|
| 0 | Opening command | Command for engaging/releasing brake control (0 = engage, 1 = release). Set this bit to the desired output. |
| 1 | Opening torque request | 1 = Torque requested by drive control when brake is released. |
| 2 | Hold stopped request | 1 = Remain stopped requested by drive control |
| 3 | Ramp to stopped | 1 = Stop with ramp to speed zero requested by drive control |
| 4 | Enabled | 1 = Brake controller enabled |
| 5 | Closed | 1 = Brake control in status BRAKE CLOSED |
| 6 | Opening | 1 = Brake control in status BRAKE OPENING |
| 7 | Open | 1 = Brake control in status BRAKE OPEN |
| 8 | Closing | 1 = Brake control in status BRAKE CLOSING |
| 9…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000h…FFFFh | Status word of the mechanical brake control. | 1 = 1 |
| 44.02 | Brake torque memory | Displays the torque (in percent) at the time of the previous brake close command.<br>This value can be used as a setpoint for the torque when releasing the brake. See parameters 44.09 Brake open torque source and 44.10 Brake open torque. | - |
| | -1600.0 ... 1600.0% | Torque when closing the brake. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |

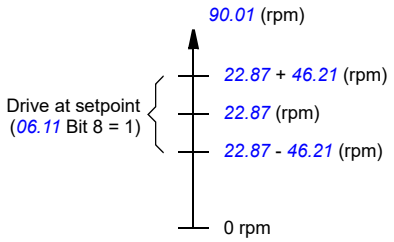
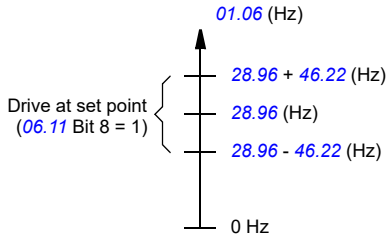
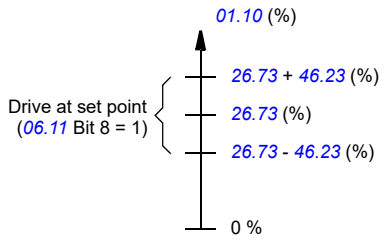
| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 44.03 | Brake open torque reference | Displays the current torque for releasing the brake.<br>See parameters 44.09 Brake open torque source and 44.10 Brake open torque.<br>This parameter can only be read. | - |
| | -1600.0 ... 1600.0% | Current torque for releasing the brake. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 44.06 | Brake control enable | Enables/Disables mechanical brake control (or selects a source that enables/disables mechanical brake control).<br>0 = Brake control disabled<br>1 = Brake control active | Not selected |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 44.07 | Brake acknowledge selection | Enables/Disables (and selects the source for) state monitoring (feedback) when releasing/engaging the brake.<br>If a brake control fault (unexpected state of the feedback signal) is detected, the frequency inverter responds according to the setting of parameter 44.17 Brake fault function.<br>0 = Brake closed<br>1 = Brake open | No acknowledge |
| | Off | 0. | 0 |
| | On | 1. | 1 |
| | No acknowledge | Monitoring of released/engaged brake is disabled. | 2 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 3 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 4 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 5 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 6 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 7 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 8 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 11 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 12 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 44.08 | Brake open delay | Defines the delay time for releasing the brake, i.e. the delay between the internal brake open command and release of the motor speed control. The delay timer starts after the frequency inverter has magnetized the motor and raised the motor torque to the value for releasing the brake (parameter 44.03 Brake open torque reference). Simultaneously with the start of the timer, the brake control enables the brake control output and the brake release starts.<br>The delay time set in this parameter must correspond to the delay for a mechanical release of the brake according to the manufacturer's specification. | 0.00 s |
| | 0.00 ... 5.00 s | Delay time when releasing the brake. | 100 = 1 s |
| 44.09 | Brake open torque source | Sets a source that is used as the torque setpoint when releasing the brake when<br>• Its absolute value is greater than the setting of parameter 44.10 Brake open torque, and<br>• Its sign is equal to the setting of 44.10 Brake open torque.<br>See parameter 44.10 Brake open torque. | Brake open torque |
| | Zero | Zero. | 0 |
| | AI1 scaled | 12.12 AI1 scaled value (see page 264). | 1 |
| | AI2 scaled | 12.22 AI2 scaled value (see page 265). | 2 |
| | FBA ref1 | 03.05 FB A reference 1 (see page 251). | 3 |
| | FBA ref2 | 03.06 FB A reference 2 (see page 251). | 4 |
| | Brake torque memory | Parameter 44.02 Brake torque memory. | 7 |
| | Brake open torque | Parameter 44.10 Brake open torque. | 8 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 44.10 | Brake open torque | Setting the sign (i.e. the direction of rotation) and the smallest absolute value of the torque for releasing the brake (requested motor torque when releasing the brake as a percentage of the nominal motor torque).<br>Using the value of the source selected with parameter 44.09 Brake open torque source only as the torque for releasing the brake if it has the same sign as this parameter and a larger absolute value.<br>**Note:**<br>**This parameter is not active for scalar motor control.** | 0.0% |
| | -1600.0 ... 1600.0% | Minimum torque when releasing the brake. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 44.11 | Keep brake closed | Selects a source that prevents the brake from being released.<br>0 = Normal operation<br>1 = Keep brake closed<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | Not selected |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 44.12 | Brake close request | Selects the source for an external request signal for closing the brake. If enabled, the signal has priority over the internal brake control and closes the brake.<br>0 = Normal operation/no external close signal connected<br>1 = Close brake<br>**Note:**<br>• **If the brake is engaged against a modulating frequency inverter for more than 5 seconds in an application without encoder feedback (encoderless) using a command for engaging the brake, the brake is forced to be engaged and the frequency inverter switches off with fault message 71A5 Mechanical brake opening not allowed.**<br>• **This parameter setting cannot be changed when the drive is running.** | Not selected |
| | None | 0. | 0 |
| | Selected | 1. | 1 |
| | DI1 | Digital input DI1 (10.02 DI delayed status, bit 0). | 2 |
| | DI2 | Digital input DI2 (10.02 DI delayed status, bit 1). | 3 |
| | DI3 | Digital input DI3 (10.02 DI delayed status, bit 2). | 4 |
| | DI4 | Digital input DI4 (10.02 DI delayed status, bit 3). | 5 |
| | DI5 | Digital input DI5 (10.02 DI delayed status, bit 4). | 6 |
| | DI6 | Digital input DI6 (10.02 DI delayed status, bit 5). | 7 |
| | DIO1 | Digital input/output DIO1 (11.02 DIO delayed status, bit 0). | 10 |
| | DIO2 | Digital input/output DIO2 (11.02 DIO delayed status, bit 1). | 11 |
| | Other [bit] | Source selection (see Terms and abbreviations on page 249). | - |
| 44.13 | Brake close delay | Sets a delay time between a brake close command (i.e. when the output signal of the brake control is disabled) and stopping the modulation of the frequency inverter. This keeps the motor magnetized and the control active until the brake actually closes.<br>Set this parameter to the same value that is specified by the brake manufacturer as the time for mechanically releasing the brake. | 0.00 s |
| | 0.00 … 60.00 s | Delay time for closing the brake. | 100 = 1 s |
| 44.14 | Brake close level | Sets the speed at which the brake closes as an absolute value.<br>After the motor speed has remained below this value for the duration of the delay time for closing the brake (44.15 Brake close level delay), a close command is issued.<br>**Note:**<br>**Check the compatibility of this setting with 21.03 Stop mode (and the delay time to be applied).** | 10.00 rpm |
| | 0.00 … 1000.00 rpm | Speed for closing the brake. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 44.15 | Brake close level delay | Sets a delay time for the threshold value for closing the brake. See parameter 44.14 Brake close level. | 0.00 s |
| | 0.00 … 10.00 s | Delay time for the threshold value for closing the brake. | 100 = 1 s |
| 44.16 | Brake reopen delay | Sets the minimum time between engaging the brake and a following release command. | 0.00 s |
| | 0.00 … 10.00 s | Delay time for releasing the brake again. | 100 = 1 s |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 44.17 | Brake fault function | Sets the reaction of the drive in the event of a fault of the mechanical brake control.<br>**Note:**<br>**If parameter 44.07 Brake acknowledge selection is set to No acknowledge, monitoring of brake feedback is completely disabled and no warning or fault messages are generated for it. The conditions for releasing the brake are always monitored.** | Fault |
| | Fault | The frequency inverter switches off with fault message 71A2 Mechanical brake closing failed / 71A3 Mechanical brake opening failed if the feedback status does not correspond to the status expected by brake control.<br>The frequency inverter switches off with fault message 71A5 Mechanical brake opening not allowed if the conditions for releasing the brake cannot be met (if the required torque for motor start is not achieved). | 0 |
| | Warning | The frequency inverter issues warning message A7A1 Mechanical brake closing failed / A7A2 Mechanical brake opening failed if the feedback status does not correspond to the status expected by brake control.<br>The frequency inverter issues warning message A7A5 Mechanical brake opening not allowed if the conditions for releasing the brake cannot be met (if the required torque for motor start is not achieved). | 1 |
| | Open fault | When the brake is requested to be closed, the frequency inverter outputs warning message A7A1 Mechanical brake closing failed if the feedback status does not correspond to the status expected by the brake control.<br>When the brake is requested to be released, the frequency inverter switches off with fault message 71A3 Mechanical brake opening failed if the feedback status does not correspond to the status expected by brake control.<br>The frequency inverter switches off with fault message 71A5 Mechanical brake opening not allowed if the conditions for releasing the brake cannot be met (if the required torque for motor start is not achieved). | 2 |
| 44.18 | Brake fault delay | Sets a delay time for the fault when engaging the brake, i.e. between engaging the brake and fault switch-off. | 0.00 s |
| | 0.00 … 60.00 s | Delay time for the fault message when the brake is closed. | 100 = 1 s |

## 46 Monitoring/scaling settings

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 46 | Monitoring/scaling settings | Speed monitoring setting, actual signal filtering and general scaling settings. | |
| 46.01 | Speed scaling | Sets the maximum speed value for defining the acceleration ramp and the initial speed for defining the deceleration ramp (see parameter group 23 Speed reference ramp). The speed acceleration and deceleration ramp times therefore refer to this value (**not** to parameter 30.12 Maximum speed). | 20000.00 rpm |
| | 20000.00 rpm | This value is not permitted to be changed. | 100 = 1 rpm |
| 46.03 | Torque scaling. | Sets 16-bit scaling of torque parameters. The value of this parameter (as a percentage of the nominal motor torque) corresponds to 10000.<br>See also parameters 46.42 Torque decimals. | 100.0% |
| | 0.1...1000.0% | Torque value that corresponds to 10000 in fieldbus communication. | 10 = 1% |
| 46.04 | Power scaling. | Output power value setting.<br>The unit is selected with parameter 96.16 Unit selection. | 1000.00 kW |
| | 0.10 … 30000.00 kW | Power value corresponds to 10000. | 1 = 1 unit |
| 46.05 | Current scaling | Sets 16-bit scaling of the current parameters. The value of this parameter corresponds to 10000. | 10000 A |
| | 0…30000 A | Current that corresponds to 10000 in fieldbus communication. | - |
| 46.11 | Filter time motor speed | Sets a filter time for signals 01.01 Motor speed used, 01.02 Motor speed estimated, 01.04 Encoder 1 speed filtered and 01.05 Encoder 2 speed filtered. | 500 ms |
| | 0...20000 ms | Filter time for motor speed signal. | 1 = 1 ms |
| 46.12 | Filter time output frequency | Sets a filter time for signal 01.06 Output frequency: | 500 ms |
| | 0...20000 ms | Filter time for output frequency signal. | 1 = 1 ms |
| 46.13 | Filter time motor torque | Sets a filter time for signal 01.10 Motor torque. | 100 ms |
| | 0...20000 ms | Filter time for motor torque signal. | 1 = 1 ms |
| 46.14 | Filter time power out | Sets a filter time for signal 01.14 Output power. | 100 ms |
| | 0...20000 ms | Filter time for output power signal. | 1 = 1 ms |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 46.21 | At speed hysteresis | Defines the "At setpoint" limits for speed control of the drive.<br>If the absolute difference between the speed setpoint (22.87 Speed reference act 7) and the actual value (90.01 Motor speed for control) is less than 46.21 At speed hysteresis, the drive is at "At setpoint". This is indicated by bit 8 of 06.11 Main status word.<br>  | 100.00 rpm |
| | 0.00 … 30000.00 rpm | Limit for displaying "At setpoint" during speed control. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 46.22 | At frequency hysteresis | Defines the "At setpoint" limits for frequency control of the drive. If the absolute difference between the setpoint (28.96 Frequency ref ramp input) and the actual frequency value (01.06 Output frequency) is less than 46.22 At frequency hysteresis, the frequency inverter is "At setpoint". This is indicated by bit 8 of 06.11 Main status word.<br>  | 10.00 Hz |
| | 0.00 … 1000.00 Hz | Limit for display "At setpoint" for frequency control. | |
| 46.23 | At torque hysteresis | Defines the "At setpoint" limits for torque control of the drive. If the absolute difference between the setpoint (26.73 Torque reference act 4) and the actual torque value (01.10 Motor torque) is less than 46.23 At torque hysteresis, "At setpoint" applies to the frequency inverter. This is displayed by bit 8 of 06.11 Main status word.<br>  | 10.0% |
| | 0.0...300.0% | Limit for displaying "At setpoint" for torque control. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 46.31 | Above speed limit | Defines the enabling threshold for "Above limit" during speed control. If the actual speed rises above the limit value, bit 10 of 06.17 Drive status word 2 is set. | 1500.00 rpm |
| | 0.00 … 30000.00 rpm | Displays enabling threshold "Above limit" for speed control. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 46.32 | Above frequency limit | Defines the enabling threshold for displaying "Above limit" during frequency control. If the actual frequency rises above the limit value, bit 10 of 06.17 Drive status word 2 is set. | 50.00 Hz |
| | 0.00 … 1000.00 Hz | Displays enabling threshold "Above limit" for frequency control. | |
| 46.33 | Above torque limit | Defines the enabling threshold for displaying "Above limit" during torque control. If the actual torque rises above the limit value, bit 10 of 06.17 Drive status word 2 is set. | 300.0% |
| | 0.0...1600.0% | Displays enabling threshold "Above limit" for torque control. | 1 = 0.1% (DS402 mode), see par. 46.03. (native mode) |
| 46.42 | Torque decimals | Sets the number of decimal places of the torque-related parameters. | 1 |
| | 0…2 | Number of decimal places of the torque parameters. | 1 = 1 |

## 50 Fieldbus adapter (FBA)

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 50 | Fieldbus adapter (FBA) | Configures fieldbus communication. | |

## 51 FBA A settings

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 51 | FBA A settings | Configuration of fieldbus adapter A. | |
| 51.01 | FBA A type | Displays the type of the connected (plugged in) fieldbus adapter module.<br>0 = Module cannot be found, is not connected correctly or disabled.<br>136 = FEPL.<br>This parameter can only be read. | - |
| 51.02 | FBA A Par2 | The settings of parameters 51.02...51.26 depend on the adapter module. For additional information, see the documentation of the fieldbus adapter module. Please note that not all of these parameters are necessarily used. | - |
| | 0…65535 | Parameter for configuring the fieldbus adapter. | 1 = 1 |
| Etc. | Etc. | Etc. | Etc. |
| 51.26 | FBA A Par26 | See parameter 51.02 FBA A Par2. | - |
| | 0…65535 | Parameter for configuring the fieldbus adapter. | 1 = 1 |
| 51.27 | FBA A par refresh | Updates changes to the parameter settings when configuring the fieldbus adapter modules. After the update, the value is automatically set back to Done.<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | Done |
| | Done | Update complete. | 0 |
| | Refresh | Refresh in progress. | 1 |
| 51.28 | FBA A par table ver | Displays the parameter table version of the fieldbus adapter module mapping file stored in the frequency inverter memory.<br>In format axyz (ax = main table revision number, yz = subordinate table revision number).<br>This parameter can only be read. | - |
| | | Parameter table version of the adapter module. | - |
| 51.29 | FBA A drive type code | Displays the frequency inverter type code of the fieldbus adapter module mapping file stored on the frequency inverter.<br>This parameter can only be read. | - |
| | 0…65535 | Frequency inverter type code stored in the mapping file. | 1 = 1 |
| 51.30 | FBA A mapping file ver | Displays the version of the mapping file of the fieldbus adapter module, which is stored in the memory of the frequency inverter in decimal format.<br>This parameter can only be read. | - |
| | 0…65535 | Version of the mapping file. | 1 = 1 |
| 51.31 | D2FBA A comm status | Displays the status of the fieldbus adapter module communication. | - |
| | Not configured | The adapter module is not configured. | 0 |
| | Initialized | The adapter module is initialized. | 1 |
| | Time out | Communication between the adapter and the frequency inverter was interrupted. | 2 |
| | Configuration error | Configuration error in the adapter: The mapping file was not found in the data system of the frequency inverter or upload of the mapping file has failed more than three times. | 3 |
| | Off-line | Fieldbus communication is offline. | 4 |
| | On-line | Fieldbus communication is online or the fieldbus adapter was configured is such a way that it does not detect communication interruption. For additional information, see the documentation of the fieldbus adapter. | 5 |
| | Reset | The adapter performs a hardware reset. | 6 |
| 51.32 | FBA A comm SW ver | Displays the patch and build version of the adapter module firmware in format xxyy (xx = patch version number, yy = build version number).<br>Example: C802 = 200.02 (patch version 200, build version 2). | |
| | | Patch and build version of the adapter module firmware. | - |
| 51.33 | FBA A appl SW ver | Displays the main version and the subordinate version of the adapter module firmware in format xyy (x = main revision number, yy = revision number of the subordinate version).<br>Example: 300 = 3.00 (major version 3, minor version 00). | |
| | | Main version and subordinate version of the adapter module firmware. | - |

## 90 Feedback selection

| No. | Name/Value | Description | Def (Clear all)/ FbEq16 |
|---|---|---|---|
| 90 | Feedback selection | Configuration of the motor and load feedback. See also sections Rotary encoder support (page 234), Position counter (page Encoder support) and the diagram on page 353. | |
| 90.01 | Motor speed for control | Displays the calculated or measured motor speed used for motor control, i.e. the final motor speed feedback according to the selection of parameter 90.41 Motor feedback selection and filtering according to parameter 90.42 Motor speed filter time. If the measured feedback is selected, it can also be scaled via the motor gear function. This parameter can only be read. | - |
| | -32768.00 … 32767.00 rpm | Motor speed used for control. | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |

| No. | Name/Value | Description | Def (Clear all)/ FbEq16 |
|---|---|---|---|
| 90.02 | Motor position | Displays the motor position (within one rotation) that is read from the source selected with parameter 90.41 Motor feedback selection. If the measured feedback is selected, it can also be scaled via the motor gear function. This parameter can only be read. | - |
| | 0.00000000 … 1.00000000 rev. | Motor position | 32767 = 1 rev. |
| 90.06 | Motor position scaled | Calculated number of axis increments. The axis mode (linear or rotary axis) and the resolution are set with parameters 90.48 Motor position axis mode or 90.49 Motor position resolution. ATTENTION: The value can only be reliably processed at standstill. When reading out this value, it must be noted that there is a time offset due to transfer of information to the PLC. | - |
| | -2147483.648 … 2147483.647 | Motor position | - |
| 90.10 | Encoder 1 speed | Displays "Encoder 1 speed" in rpm. This parameter can only be read. | - |
| | -32768.00 … 32767.00 rpm | Encoder 1 speed | 100 = 1 rpm (DS402 mode), see parameter 46.01. (native mode) |
| 90.11 | Encoder 1 position | Displays the actual position of encoder 1 within one revolution. This parameter can only be read. | - |
| | 0.00000000 … 1.00000000 rev. | Actual position of encoder 1 within one revolution. | 32767 = 1 rev. |
| 90.12 | Encoder 1 multiturn revolutions | Displays the revolutions of (multi-turn) rotary encoder 1 within its value range. This parameter can only be read. | - |
| | 0…16777215 | Encoder 1 revolutions | - |
| 90.13 | Encoder 1 revolution extension | Displays the revolution counter extension for encoder 1. With a single-turn rotary encoder, the counter is increased by 1 if the rotary encoder position (parameter 90.11) overflows in the positive direction of rotation and is decreased accordingly in the negative direction of rotation. With a multi-turn rotary encoder, the counter is increased by 1 if the revolution counter (parameter 90.12) exceeds the range of values in the positive direction of rotation and is decreased accordingly in the negative direction of rotation. This parameter can only be read. | - |
| | -2147483648 … 2147483647 | Multi-turn encoder 2 revolution counter extension. | - |
| 90.14 | Encoder 1 position raw | Displays raw measurement data of encoder 1 position within one revolution as a 24-bit unsigned integer value, received from the encoder interface. This parameter can only be read. | - |
| | 0…16777215 | Raw data of encoder 1 position within one revolution. | - |
| 90.15 | Encoder 1 revolutions raw | Displays the revolutions of (multi-turn) rotary encoder 1 within its value range as a raw measurement. This parameter can only be read. | - |
| | 0…16777215 | Encoder 1 revolutions as raw data count. | - |
| 90.41 | Motor feedback selection | Selects the motor speed feedback value for motor control.<br>**Note:**<br>**Ensure autophasing (see page Skalar-Motorregelung) is performed for a permanent magnet motor using the selected encoder. Set parameter 99.13 ID run requested to Autophasing to request a new autophasing procedure.** | Estimate |
| | Estimate | A calculated speed value is used for DTC control. | 0 |
| | Encoder 1 | Actual speed measured by encoder 1. The encoder is configured with the parameters in group 92 Encoder 1 configuration. | 1 |
| | Encoder 2 | Actual speed measured by encoder 2. | 2 |
| 90.42 | Motor speed filter time | Sets a filter time for motor speed feedback that is used for control (90.01 Motor speed for control). | 3 ms |
| | 0 … 10000 ms | Motor speed filter time. | 1 = 1 ms |
| 90.45 | Motor feedback fault | Sets the reaction of the frequency inverter in case of failure of the measured motor feedback. | Fault |
| | Fault | The frequency inverter switches off with fault message 7301 Motor speed feedback or 7381 Encoder. | 0 |
| | Warning | The frequency inverter generates warning A798 Encoder option comm loss, A7B0 Motor speed feedback or A7E1 Encoder and continues operation with the calculated feedback.<br>**Note:**<br>**Check the stability of the speed control loop with calculated feedback by operating the frequency inverter with calculated feedback before using this setting (see 90.41 Motor feedback selection).** | 1 |

| No. | Name/Value | Description | Def (Clear all)/ FbEq16 |
|---|---|---|---|
| 90.46 | Force open loop | Forces the use of the calculated motor speed as feedback for the DTC motor model. This parameter can be enabled if the encoder data is obviously unreliable, for example due to motor slip.<br>**Note:**<br>**This parameter only affects the selection of feedback for the motor model, not for the speed controller.** | No |
| | No | The motor model uses feedback according to parameter 90.41 Motor feedback selection. | 0 |
| | Yes | The motor model uses the calculated speed value (regardless of the setting of parameter 90.41 Motor feedback selection, which in this case only selects the source of the speed controller feedback). | 1 |
| 90.48 | Motor position axis mode | Selects the axis type for measuring the motor position. | Rollover |
| | Linear | Linear. | 0 |
| | Rollover | The value is between 0 and 1 revolutions and overflows at 360 degrees. | 1 |
| 90.49 | Motor position resolution | Sets the number of bits used for motor position counting within one revolution. For example, the position value for display in parameter 90.06 Motor position scaled (or for the fieldbus) is multiplied by 16777216 using setting 24. | 24 |
| | 0…31 | Motor position resolution. | - |

## 91 Encoder module settings

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 91 | Encoder module settings | Configuration of encoder interface modules. | |
| 91.01 | Encoder DI status | Displays the status of the digital inputs from the 8I0IFENC rotary encoder interface modules.<br>This parameter can only be read. | - |

| Bit | Name | Information |
|---|---|---|
| 0 | DI1 / Module 1 | DI1 of interface module 1 (see parameters 91.11 and 91.12) |
| 1 | DI2 / Module 1 | DI2 of interface module 1 (see parameters 91.11 and 91.12) |
| 6…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000 0000b … 0011 0011b | Status word of the 8I0IFENC module digital inputs. | 1 = 1 |
| 91.02 | Module 1 status | Displays the type of the interface module that was found in the slot specified by parameter 91.12 Module 1 location.<br>This parameter can only be read. | - |
| | No option | No module detected in the specified slot. | 0 |
| | No communication | A module was detected but cannot be used for communication. | 1 |
| | Unknown | The module type is unknown. | 2 |
| | FEN-01 | This module is not supported by B&R. | 16 |
| | FEN-11 | A module of type 8I0IFENC096.405-1 was detected and is active. | 17 |
| | FEN-21 | A module of type 8I0IFENC096.402-1 was detected and is active. | 18 |
| | FEN-31 | A module of type 8I0IFENC096.403-1 was detected and is active. | 21 |
| | FSE-31 | This module is not supported by B&R. | 25 |
| 91.04 | Module 1 temperature | Displays the temperature measured via the sensor input of interface module 1. The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**With a PTC sensor, the unit is ohms. This parameter can only be read.** | - |
| | 0...1000°C, °F or Ohm | Measured temperature via interface module 1. | - |
| | 0...1000°C, °F or Ohm | Measured temperature via interface module 2. | - |
| 91.10 | Encoder parameter refresh | Validates modified parameters of a rotary encoder interface module. This is necessary for changes of parameters of groups 90...93 to become effective.<br>After the update, the value is automatically set back to Done.<br>**Note:**<br>• **Only for permanent magnet motors: The frequency inverter performs a new autophasing procedure at the next startup (see page Skalar-Motorregelung) if the settings of the encoder for motor feedback were changed.**<br>• **This parameter cannot be changed while the drive is running.** | Done |
| | Done | Update complete. | 0 |
| | Refresh | Refresh in progress. | 1 |
| 91.11 | Module 1 type | Sets the module type of interface module 1. | Not selected |
| | None | None (communication is disabled). | 0 |
| | FEN-11 | 8I0IFENC096.405-1 | 2 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | FEN-21 | 8I0IFENC096.402-1 | 3 |
| | FEN-31 | 8I0IFENC096.403-1 | 4 |
| 91.12 | Module 1 location | Sets the slot (1...3) on the control unit of the frequency inverter on which the interface module is installed. | Slot 2 |
| | Slot 1 | Slot 1. | 1 |
| | Slot 2 | Slot 2.<br>Note: This slot must be used for the POWERLINK communication card 8I0IF108.400-6. | 2 |
| | Slot 3 | Slot 3. | 3 |
| | None | None | 0 |
| 91.21 | Module 1 temp sensor type | Sets the temperature sensor type connected to interface module 1. It is important to note that the module must also be enabled by parameters 91.11...91.12. | Not selected |
| | None | None. | 0 |
| | PTC | PTC (the unit is ohms). | 1 |
| | KTY-84 | KTY84. The unit is selected with parameter 96.16 Unit selection. | 2 |
| 91.22 | Module 1 temp filter time | Sets a filter time for temperature measurement via interface module 1. | 1500 ms |
| | 0...10000 ms | Filter time for temperature measurement. | - |
| 91.31 | Module 1 TTL output source | Selects the encoder input on interface module 1, whose signal is emulated to or forwarded from the TTL output.<br>See also section Encoder support (page 234). | Not selected |
| | None | TTL output not in use. | 0 |
| | Module input 1 | Input 1 is emulated to or forwarded from the TTL output. | 1 |
| | Module input 2 | Input 2 is emulated to or forwarded from the TTL output. | 2 |
| 91.32 | Module 1 emulation pulses/rev | Defines the number of TTL pulses per revolution for the output of the rotary encoder emulation of interface module 1. | 0 |
| | 0…65535 | Number of TTL pulses for emulation. | 1 = 1 |
| 91.33 | Module 1 emulated Z-pulse offset | Defines for interface module 1 when zero pulses are emulated in relation to the zero position received from the encoder.<br>For example, a zero pulse is emulated at a value of 0.50000 if the encoder position has reached 0.5 revolutions. At a value of 0.00000, a zero pulse is emulated if the encoder has reached the zero position. | 0.00000 |
| | 0.00000 ... 1.00000 rev. | Position of the emulated zero pulses. | 32767 = 1 rev. |

## 92 Encoder 1 configuration

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 92 | Encoder 1 configuration | Settings for rotary encoder 1.<br>**Note:**<br>• **The content of the parameter group varies according to the selected encoder type.** | |
| 92.01 | Encoder 1 type | Sets the type of encoder 1. | Not selected |
| | None | Not selected. | 0 |
| | TTL | TTL. Module type (input): 8I0IFENC096.405-1 (X41) or 8I0IFENC096.402-1 (X51). | 1 |
| | Absolute encoder | Absolute encoder. Module type (input): 8I0IFENC096.405-1 (X42). | 3 |
| | Resolver | Resolver. Module type (input): 8I0IFENC096.402-1 (X52). | 4 |
| | HTL | HTL. Module type (input):8I0IFENC096.403-1 (X82). | 5 |
| 92.02 | Encoder 1 source | Selection of the interface module to which the rotary encoder is connected. (The physical slots and types of the rotary encoder interface modules are configured in parameter group 91 Encoder adapter settings.) | Module 1 |
| | Module 1 | Interface module 1. | 0 |
| | Module 2 | Interface module 2. | 1 |
| 92.10 | Pulses/revolution | (Visible if a TTL, TTL+ or HTL incremental encoder is selected)<br>Sets the number of pulses per revolution. | 2048 |
| | 0…65535 | Number of pulses. | - |
| 92.10 | Excitation signal frequency | (Visible if a resolver is selected)<br>Sets the frequency of the excitation signal. | 1 kHz |
| | 1...20 kHz | Frequency of the excitation signal. | 1 = 1 kHz |
| 92.11 | Pulse encoder type | (Visible if a TTL, TTL+ or HTL incremental encoder is selected)<br>Sets the RMS amplitude of the excitation signal. | Quadrature |
| | Quadrature | Incremental encoder with two tracks (with two channels, A and B) | 0 |
| | Single track | Incremental encoder with one track (has one channel, channel A)<br>**Note:**<br>**With this setting, the measured speed value is positive regardless of the direction of rotation.** | 1 |
| 92.11 | Absolute position source | (Visible if an absolute encoder is selected)<br>Selects the source of the absolute position information. | Not selected |
| | None | Not selected. | 0 |
| | Commut signals | Commutation signals. | 1 |

<table>
<tr><th>No.</th><th>Name/Value</th><th>Description</th><th>Def (factory setting)/ FbEq16</th></tr>
<tr><td></td><td>EnDat</td><td>Serial interface: EnDat encoder.</td><td>2</td></tr>
<tr><td></td><td>HIPERFACE</td><td>Serial interface: HIPERFACE encoder.</td><td>3</td></tr>
<tr><td></td><td>SSI</td><td>Serial interface: SSI encoder.</td><td>4</td></tr>
<tr><td>92.11</td><td>Excitation signal amplitude</td><td>(Visible if a resolver is selected)<br>Sets the amplitude of the excitation signal.</td><td>4.0 V</td></tr>
<tr><td></td><td>4.0 … 12.0 V</td><td>Amplitude of the excitation signal.</td><td>10 = 1 V</td></tr>
<tr><td>92.12</td><td>Speed calculation mode</td><td>(Visible if a TTL, TTL+ or HTL incremental encoder is selected)<br>Selects the type of speed calculation.<br>*With a 1-track rotary encoder (parameter 92.11 Incremental encoder type = 1-track A), the speed is always positive.</td><td>Auto rising</td></tr>
<tr><td></td><td>A&B all</td><td>Channels A and B: Rising and falling edges are used for speed calculation.<br>*Channel B: Determines the direction of rotation.<br>Note:<br>For a 1-track rotary encoder (parameter 92.11 Incremental encoder type), this setting corresponds to the effect of A all.</td><td>0</td></tr>
<tr><td></td><td>A all</td><td>Channel A: Rising and falling edges are used for speed calculation.<br>*Channel B: Determines the direction of rotation.</td><td>1</td></tr>
<tr><td></td><td>A rising</td><td>Channel A: Rising edges are used for speed calculation.<br>*Channel B: Determines the direction of rotation.</td><td>2</td></tr>
<tr><td></td><td>A falling</td><td>Channel A: Falling edges are used for speed calculation.<br>*Channel B: Determines the direction of rotation.</td><td>3</td></tr>
<tr><td></td><td>Auto rising</td><td>One of the above calculation modes (modes) is automatically selected as follows depending on the pulse frequency:<table><tr><th>Pulse frequency of the channel(s)</th><th>Mode used</th></tr><tr><td><2442 Hz</td><td>A&B all</td></tr><tr><td>2442...4884 Hz</td><td>A all</td></tr><tr><td>>4884 Hz</td><td>A rising</td></tr></table></td><td>4</td></tr>
<tr><td></td><td>Auto falling</td><td>One of the above calculation types (modes) is automatically selected as follows depending on the pulse frequency:<table><tr><th>Pulse frequency of the channel(s)</th><th>Mode used</th></tr><tr><td><2442 Hz</td><td>A&B all</td></tr><tr><td>2442...4884 Hz</td><td>A all</td></tr><tr><td>>4884 Hz</td><td>A falling</td></tr></table></td><td>5</td></tr>
<tr><td>92.12</td><td>Zero pulse enable</td><td>(Visible if an absolute encoder is selected)<br>Enables the rotary encoder zero pulse for the absolute encoder input (X42) of interface module 8I0IFENC096.405-1.<br>Note:<br>For serial interfaces, there is no zero pulse, which means when parameter 92.11 Absolute position source is set to EnDat, Hiperface or SSI.</td><td>Disabled</td></tr>
<tr><td></td><td>Disabled</td><td>Zero pulse disabled.</td><td>0</td></tr>
<tr><td></td><td>Enabled</td><td>Zero pulse enabled.</td><td>1</td></tr>
<tr><td>92.12</td><td>Resolver polepairs</td><td>(Visible if a resolver is selected)<br>Sets the number of pole pairs of the resolver.</td><td>1</td></tr>
<tr><td></td><td>1…32</td><td>Number of pole pairs of the resolver.</td><td>1 = 1</td></tr>
<tr><td>92.13</td><td>Position estimation enable</td><td>(Visible if a TTL, TTL+ or HTL incremental encoder is selected)<br>Selects whether the position calculation with encoder 1 is used to increase the position data resolution or not.</td><td>Enabled</td></tr>
<tr><td></td><td>Disabled</td><td>Measured position is used. (The resolution is 4 pulses per revolution for quadrature rotary encoders, 2 pulses per revolution for single-track rotary encoders.)</td><td>0</td></tr>
<tr><td></td><td>Enabled</td><td>Calculated position is used (uses position interpolation; extrapolates at the time of data retrieval).</td><td>1</td></tr>
<tr><td>92.15</td><td>Transient filter</td><td>(Visible if a TTL, TTL+ or HTL incremental encoder is selected)<br>Enables transient filtering for rotary encoder evaluation (changes of the direction of rotation above the selected pulse frequency are ignored).</td><td>4880 Hz</td></tr>
<tr><td></td><td>4880 Hz</td><td>Change of rotation permissible below 4880 Hz.</td><td>0</td></tr>
<tr><td></td><td>2440 Hz</td><td>Change of rotation permissible below 2440 Hz.</td><td>1</td></tr>
<tr><td></td><td>1220 Hz</td><td>Change of rotation permissible below 1220 Hz.</td><td>2</td></tr>
<tr><td></td><td>Disabled</td><td>Change of rotation permissible at any pulse frequency.</td><td>3</td></tr>
<tr><td>92.21</td><td>Encoder cable fault mode</td><td>(Visible if a TTL, TTL+ or HTL incremental encoder is selected)<br>Selects which interface cables and reference conductors are monitored for connection errors for which channels.</td><td>A, B</td></tr>
<tr><td></td><td>A, B</td><td>A and B.</td><td>0</td></tr>
<tr><td></td><td>A, B, Z</td><td>A, B and Z.</td><td>1</td></tr>
<tr><td></td><td>A+, A-, B+, B-</td><td>A+, A-, B+ and B-.</td><td>2</td></tr>
<tr><td></td><td>A+, A-, B+, B-, Z+, Z</td><td>ZA+, A-, B+, B-, Z+ and Z-.</td><td>3</td></tr>
</table>

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 92.23 | Maximum pulse waiting time | (Visible if parameter 92.01 Encoder 1 type = TTL or HTL)<br>Sets a pulse waiting time of speed calculation via the encoder interface module. If no pulse edges are detected within this time, the encoder module sets the measured speed to zero.<br>Increasing the setting can increase the measurement accuracy, especially at low speeds close to zero.<br>**Note:**<br>• **The parameter only affects speed measurement. The position is updated if a new pulse edge is detected. If speed measured by the encoder module is zero, the frequency inverter updates the speed data based on the position changes.** | 4 ms |
| | 1...200 ms | Maximum pulse waiting time. | 1 = 1 ms |
| 92.24 | Pulse edge filtering | (Visible if parameter 92.01 Encoder 1 type = HTL)<br>Enables pulse edge filtering. Pulse edge filtering can improve the reliability of measurements, especially of encoders with single-ended connection.<br>**Note:**<br>**Pulse edge filtering reduces the maximum pulse frequency. With a filter time of 2 µs, the maximum pulse frequency is 200 kHz.** | No filtering |
| | No filtering | Filtering not enabled. | 0 |
| | 1 µs | Filter time 1 microsecond. | 1 |
| | 2 µs | Filter time 2 microseconds. | 2 |
| 92.25 | Pulse overfrequency function | (Visible if parameter 92.01 Encoder 1 type = HTL)<br>Sets the reaction of the frequency inverter if the encoder interface module detects a pulse overfrequency. | Fault |
| | Warning | The frequency inverter issues warning 7381 Encoder. The interface module continues updating the speed and position data. | 0 |
| | Fault | The frequency inverter switches off with fault message A7E1 Encoder. | 1 |
| 92.30 | Serial link mode | (Visible if an absolute encoder is selected)<br>Selects the type of serial connection for EnDat or SSI encoders. | Initial position |
| | Initial position | Single position transfer mode (initial position). | 0 |
| | Continuous | Continuous position transfer. | 1 |
| | Continuous speed and position | Continuous speed and position transfer. This setting is for EnDat 2.2 rotary encoders without sin/cos incremental signals. | 2 |
| 92.31 | EnDat max calculation time | (Visible if an absolute encoder is selected)<br>Sets the maximum rotary encoder calculation time for an EnDat rotary encoder.<br>**Note:**<br>**This parameter must only be set if an EnDat rotary encoder with continuous position transfer is used, i.e. without Sin/Cos incremental signals (only supported as encoder 1).**<br>**See also parameters 92.30 Serial link mode.** | 50 ms |
| | 10 µs | 10 microseconds. | 0 |
| | 100 µs | 100 microseconds. | 1 |
| | 1 ms | 1 millisecond. | 2 |
| | 50 ms | 50 milliseconds. | 3 |
| 92.32 | SSI cycle time | (Visible if an absolute encoder is selected)<br>Selects the transfer cycle for an SSI rotary encoder.<br>**Note:**<br>**This parameter must only be set if an SSI rotary encoder with continuous position transfer is used, i.e. without sin/cos incremental signals (only supported as rotary encoder 1).**<br>**See also parameters 92.30 Serial link mode.** | 100 µs |
| | 50 µs | 50 microseconds. | 0 |
| | 100 µs | 100 microseconds. | 1 |
| | 200 µs | 200 microseconds. | 2 |
| | 500 µs | 500 microseconds. | 3 |
| | 1 ms | 1 millisecond. | 4 |
| | 2 ms | 2 milliseconds. | 5 |

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 92.33 | SSI clock cycles | (Visible if an absolute encoder is selected)<br>Sets the length of an SSI message. The length is defined as a number of clock cycles. The number of cycles can be calculated by adding 1 to the number of bits in an SSI message frame. | 2 |
| | 2…127 | Length of the SSI message. | - |
| 92.34 | SSI position msb | (Visible if an absolute encoder is selected)<br>For an SSI rotary encoder: Sets the position of the MSB (most significant bit) of the position data within an SSI message. | 1 |
| | 1…126 | Position of the MSB (bit number) of the position data. | - |
| 92.35 | SSI revolution msb | (Visible if an absolute encoder is selected)<br>For an SSI encoder: Sets the position of the MSB (most significant bit) of the revolution count within an SSI message. | 1 |
| | 1…126 | Position of the MSB (bit number) of the revolution count. | - |
| 92.36 | SSI data format | (Visible if an absolute encoder is selected)<br>Selects the data format for an SSI rotary encoder. | Binary |
| | Binary | Binary code. | 0 |
| | Gray | Gray code. | 1 |
| 92.37 | SSI baud rate | (Visible if an absolute encoder is selected)<br>Selects the baud rate for an SSI rotary encoder. | 100 kbit/s |
| | 10 kbit/s | 10 kbit/s. | 0 |
| | 50 kbit/s | 50 kbit/s. | 1 |
| | 100 kbit/s | 100 kbit/s. | 2 |
| | 200 kbit/s | 200 kbit/s. | 3 |
| | 500 kbit/s | 500 kbit/s. | 4 |
| | 1000 kbit/s | 1000 kbit/s. | 5 |
| 92.40 | SSI zero phase | (Visible if an absolute encoder is selected)<br>Sets the phase angle within a sin/cos signal period, which corresponds to the value zero in serial SSI data connection. The parameter is used to synchronize the SSI position data and the position based on the sin/cos incremental signals. Incorrect synchronization can cause an error of ±1 incremental period.<br>**Note:**<br>**This parameter must be set only if an SSI rotary encoder is used in mode "Starting position" (see parameter 92.30 Serial link mode).** | 315-45 deg |
| | 315-45 deg | 315-45 degrees. | 0 |
| | 45-135 deg | 45-135 degrees. | 1 |
| | 135-225 deg | 135-225 degrees. | 2 |
| | 225-315 deg | 225-315 degrees. | 3 |
| 92.45 | Hiperface parity | (Visible if an absolute encoder is selected)<br>Sets the use of the parity and stop bits when using a HIPERFACE rotary encoder.<br>Typically, this parameter does not need to be set. | Odd |
| | Odd | Parity bit odd, one stop bit. | 0 |
| | Even | Even parity bit, one stop bit. | 1 |
| 92.46 | Hiperface baud rate | (Visible if an absolute encoder is selected)<br>Sets the transfer rate of the connection with a HIPERFACE rotary encoder.<br>Typically, this parameter does not need to be set. | 4800 bits/s |
| | 4800 bit/s | 4800 bit/s. | 0 |
| | 9600 bit/s | 9600 bit/s. | 1 |
| | 19200 bit/s | 19200 bit/s. | 2 |
| | 38400 bit/s | 38400 bit/s | 3 |
| 92.47 | Hiperface node address | (Visible if an absolute encoder is selected)<br>Sets the node address for a HIPERFACE rotary encoder.<br>Typically, this parameter does not need to be set. | 64 |
| | 0…255 | Node address of the HIPERFACE rotary encoder. | - |

## 95 HW configuration

| No. | Name/Value | Description | Def (factory setting)/ FbEq16 |
|---|---|---|---|
| 95 | HW configuration | Various hardware-specific settings. | |
| 95.01 | Supply voltage | Sets the supply voltage range. This parameter is used by the frequency inverter to determine the nominal voltage of the supply network. This parameter also affect the current characteristics and DC voltage control (switch-off limits for switching off and the brake chopper) of the frequency inverter.<br> <br>**Warning!**<br>**Incorrect setting can result in uncontrolled motor operation or overload of the brake chopper or resistor.**<br>**Note:**<br>**The setting options shown depend on the frequency inverter hardware. If the frequency inverter has only one voltage range, it is selected by default.** | - |
| | Not given | No voltage range selected. The frequency inverter does not start until a voltage range was selected. | 0 |
| | 208…240 V | 208…240 V | 1 |
| | 380…415 V | 380…415 V | 2 |
| | 440…480 V | 440…480 V | 3 |
| | 500 V | 500 V | 4 |
| | 525…600 V | 525…600 V | 5 |
| | 660…690 V | 660…690 V | 6 |
| 95.02 | Adaptive voltage limits | Enables the adaptive voltage limits.<br>Adaptive voltage limits can be used if the DC voltage level should be raised with an IGBT supply unit. The limits are calculated based on the measured DC voltage at the end of the pre-loading sequence.<br>This function is also useful if the AC supply voltage of the frequency inverter is high since the warning thresholds are raised accordingly. | Disable |
| | Disable | Adaptive voltage limits are disabled. | 0 |
| | Enabling | Adaptive voltage limits are enabled. | 1 |
| 95.04 | Control board supply | Sets the power supply of the control unit.<br>The default value depends on the type of control unit and the hardware configuration setting. | Internal 24V (ZCU), External 24V (BCU,b4) |
| | Internal 24V | The control unit is supplied via the power supply of the frequency inverter.<br>**Note:**<br>**If operation with restricted power (see page 98) is required, External 24 V should be selected instead.** | 0 |
| | External 24V | The control unit of the frequency inverter is connected to an external power supply. Faults in the power unit of the frequency inverter and faults in the connection to the power unit are suppressed if the frequency inverter is stopped so that the main circuit can be switched off without fault messages while the control unit is supplied with voltage. | 1 |
| | Special HW settings | Contains hardware specific settings that can be enabled and disabled by toggling the specific bits.<br>**Note:**<br>**Installation of hardware specified with this parameter may require derating of the frequency inverter output or result in other limitations. See the hardware manual of the frequency inverter.** | - |
| 95.21 | HW options word 2 | Specifies hardware-related options that require differentiated parameter default settings.<br> <br>**Warning!**<br>**After changing bits in this word, the values of the respective parameters must be checked.** | - |

| Bit | Name | Information |
|---|---|---|
| 2 | Salient PM | 1 = Salient pole permanent magnet is used. Concerns parameters 25.02, 25.03, 25.15, 99.03, 99.13. |
| 3…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000b…0011b | Configuration word 2 of the hardware options. | 1 = 1 |

## 96 System

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 96 | System | Language selection, access levels, macro selection, save and restore parameters, control unit restart, user parameter sets, unit selection, data storage triggering, parameter checksum calculation, user/parameter lock. | |
| 96.01 | Language | Selects the language of the parameter interface and other displayed information shown on the control panel.<br>**Note:**<br>• **Not all listed languages may be supported.**<br>• **This parameter does not affect the languages in PCTool Drive Composer. (These are via menu option "View"** | - |
| | Not selected | No selection. | 0 |
| | English | English. | 1033 |
| | German | German. | 1031 |
| | Italiano | Italian. | 1040 |
| | Español | Spanish. | 3082 |
| | Portugues | Portuguese. | 2070 |
| | Nederlands | Dutch. | 1043 |
| | Français | French. | 1036 |
| | Dansk | Danish. | 1030 |
| | Suomi | Finnish. | 1035 |
| | Svenska | Swedish. | 1053 |
| | Russki | Russian. | 1049 |
| | Polski | Polish. | 1045 |
| | Czech | Czech. | 1029 |
| | Chinese (Simplified, PRC) | Simplified Chinese. | 2052 |
| | Türkçe | Turkish. | 1055 |
| 96.04 | Macro select | Selects the application macro. For additional information, see chapter Application macros (page Applikationsmakros). After a selection has been made, the parameter automatically switches back to Done. | Done |
| | Done | Macro selection ended; normal operation. | 0 |
| | Factory | Macro factory setting (see page Makro Werkseinstellung). | 1 |
| 96.05 | Macro active | Displays the currently selected application macro. For additional information, see chapter Application macros (page Applikationsmakros).<br>To change the macro, use parameter 96.04 Macro select. | B&R Standard |
| | Factory | Macro factory setting (see page Makro Werkseinstellung). | 1 |
| 96.06 | Parameter restore | Restores the factory setting of the control program, i.e. default settings of the parameter values.<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | Done |
| | Done | Restoring the factory settings completed. | 0 |
| | Restore defaults | Except for the following values, all editable parameter values are reset to their default values:<br>• Motor data and ID run results<br>• Parameter 31.42 Overcurrent fault limit<br>• Settings of the control panel / PC communication<br>• Settings of the I/O expansion modules<br>• Fieldbus adapter settings<br>• Rotary encoder configuration data.<br>• Selection of the application macros and the standard parameter settings implemented by this<br>• Parameter 95.01 Supply voltage<br>• Differential default settings by parameters 95.21 HW options word 2<br>• Parameter lock configuration parameters. | 8 |
| | Clear all | Except for the following values, all editable parameter values are reset to their default values:<br>• Settings of the control panel / PC communication<br>• Fieldbus adapter settings<br>• Selection of the application macros and the standard parameter settings implemented by this<br>• Parameter 95.01 Supply voltage<br>• Differential default settings by parameters 95.21 HW options word 2<br>• Parameter lock configuration parameters<br>Communication with the PC tool is interrupted during recovery. | 62 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 96.07 | Parameter save manually | Saves the valid parameter values in the permanent memory. This parameter should be used to save the values transmit from a fieldbus or if an external power supply is used for the control unit since the power supply could have a very short rundown time after switching off.<br>**Note:**<br>**A new parameter value is automatically saved if it was changed with the PC tool or the control panel, but not if the change was made via a fieldbus adapter connection.** | Done |
| | Done | Saving completed. | 0 |
| | Save | Saving in progress. | 1 |
| 96.08 | Control board boot | Changing the value of this parameter to 1 reboots the control unit (without completely switching on or off the inverter module).<br>The value is automatically reset to zero (0). | 0 |
| | 0…1 | 1 = Restarting the control unit. | 1 = 1 |
| 96.16 | Unit selection | Selects the unit of the parameters for displaying the power, temperature and torque. | 0000 0000b |

| Bit | Name | Information |
|---|---|---|
| 0 | Power unit | 0 = kW |
| 1 | Reserved | |
| 2 | Temperature unit | 0 = C (°C) |
| 3 | Reserved | |
| 4 | Torque unit | 0 = Nm (N·m) |
| 5…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 0000 0000b … 0001 0101b | Unit selection, data word | 1 = 1 |
| 96.31 | Drive ID number | Sets the ID number of the frequency inverter. The ID can be read by an external controller via DDCS, for example for comparison with an ID that exists in the controller application. | 0 |
| | 0…32767 | ID number. | 1 = 1 |
| 96.53 | Actual checksum | Displays the checksum of the current parameter configuration. The checksum is generated if an action selected in parameter 96.54 Checksum action is performed.<br>The parameters included in the calculation have been preselected, but the selection can be edited/changed using PC tool "Drive customizer". See also section Parameter checksum calculation (page Parameter-Prüfsummenberechnung). | 0h |
| | 00000000h… FFFFFFFFh | Actual checksum. | - |
| 96.54 | Checksum action | Selects the reaction of the frequency inverter if the parameter checksum (96.53 Actual checksum) does not match any of the confirmed checksums (96.56...96.59). The active checksums are selected with 96.55 Checksum control word. | No action |
| | No action | No reaction. (The checksum function is not used.) | 0 |
| | Pure event | The frequency inverter generates an event memory entry (B686 Checksum mismatch). | 1 |
| | Warning | The frequency inverter issues a warning (A686 Checksum mismatch). | 2 |
| | Warning and prevent start | The frequency inverter issues a warning (A686 Checksum mismatch). Prevents the drive from starting. | 3 |
| | Fault | The frequency inverter switches off with fault message 6200 Checksum mismatch. | 4 |
| 96.55 | Checksum control word | Bits 0...3 define with which confirmed checksum (from 96.56...96.59) the current checksum (96.53) is compared.<br>Bits 4...7 select a (reference) checksum parameter (96.56...96.59) into which the current checksum of parameter 96.53 is copied. | 00000000b |

| Bit | Name | Description |
|---|---|---|
| 0 | Approved checksum 1 | 1 = Enabled: Checksum 1 (96.56) is used. |
| 1 | Approved checksum 1 | 1 = Enabled: Checksum 2 (96.57) is used. |
| 2 | Approved checksum 1 | 1 = Enabled: Checksum 3 (96.58) is used. |
| 3 | Approved checksum 1 | 1 = Enabled: Checksum 4 (96.59) is used. |
| 4 | Set approved checksum 1 | 1 = Set: Copies value from 96.53 to 96.56. |
| 5 | Set approved checksum 1 | 1 = Set: Copies value from 96.53 to 96.57. |
| 6 | Set approved checksum 1 | 1 = Set: Copies value from 96.53 to 96.58. |
| 7 | Set approved checksum 1 | 1 = Set: Copies value from 96.53 to 96.59. |
| 8…15 | Reserved | |

| | | | |
|---|---|---|---|
| | 00000000b… 11111111b | Checksum control word. | 1 = 1 |
| 96.56 | Approved checksum 1 | Approved checksum 1 (reference). | 0h |
| | 00000000h… FFFFFFFFh | Approved checksum 1. | - |
| 96.57 | Approved checksum 2 | Approved checksum 2 (reference). | 0h |
| | 00000000h… FFFFFFFFh | Approved checksum 2. | - |
| 96.58 | Approved checksum 3 | Approved checksum 3 (reference). | 0h |
| | 00000000h… FFFFFFFFh | Approved checksum 3. | - |
| 96.59 | Approved checksum 4 | Approved checksum 4 (reference). | 0h |
| | 00000000h… FFFFFFFFh | Approved checksum 4. | - |
| | 0000h…FFFFh | Selects actions that will be locked by the parameter lock. | - |

## 97 Motor control

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 97 | Motor control | Motor model settings. | |
| 97.03 | Slip gain | The slip gain setting is used to improve the calculated motor slip. 100% means full slip compensation gain; 0% means no slip compensation gain. The default value is 100%. Other values can be used if a static speed deviation is detected despite the setting to full slip gain.<br>**Example** (motor with nominal slip of 40 rpm at nominal load): A speed setpoint of 1000 rpm is specified for the frequency inverter. Despite full slip compensation gain (100%), a manual tachometer measurement of the motor shaft results in a speed value of 998 rpm. The static speed deviation is 1000 rpm - 998 rpm = 2 rpm. To compensate for the deviation, the slip gain should be increased to 105% (2 rpm / 40 rpm = 5%). | 100% |
| | 0...200% | Slip gain. | 1 = 1% |
| 97.04 | Voltage reserve | Sets the permissible minimum voltage reserve. After the voltage reserve has dropped to the set value, the drive switches to the field-weakening range.<br>**Note:**<br>**This is a parameter for experts, which should not be changed without the appropriate expertise. With a DC bus voltage of 550 V and a voltage reserve of 5%, the RMS value of the maximum output voltage during continuous operation is 0.95 × 550 V / square root = 369 V**<br>**The dynamic performance of the motor control in the field-weakening range can be improved by increasing the value of the voltage reserve, but the drive will then enter the field-weakening range earlier.** | -2% |
| | -4 ... 50% | Voltage reserve. | 1 = 1% |
| 97.05 | Flux braking | Sets the braking energy. (Other stop and braking modes can be configured in parameter group 21 Start/stop mode.)<br>See section Flux braking (page 236).<br>**Note:**<br>**This is a parameter for experts, which should not be changed without the appropriate expertise.** | Disabled |
| | Disabled | Flux braking is disabled. | 0 |
| | Moderate | The flux value is limited during braking. The delay time is longer in relation to full braking. | 1 |
| | Full | Maximum braking power. Almost all the available current is used in the motor to convert the mechanical braking energy into thermal energy. | 2 |
| 97.06 | Flux reference select | Selects the source of the flux setpoint.<br>**Note:**<br>**This is a parameter for experts, which should not be changed without the appropriate expertise.** | User flux reference |
| | Zero | No value selected. | 0 |
| | User flux reference | Parameter 97.07 User flux reference. | 1 |
| | Other | Source selection (see Terms and abbreviations on page 249). | - |
| 97.07 | User flux reference | Sets the flux setpoint if parameter 97.06 Flux reference select is set to User flux reference. | 100.00% |
| | 0.00 ... 200.00% | User-defined flux setpoint. | 100 = 1% |
| 97.09 | Switching freq mode | Optimization of the setting for balanced control performance and a low motor noise level.<br>**Note:**<br>**This is a parameter for experts, which should not be changed without the appropriate expertise.** | Normal |
| | Normal | Optimized control performance with long motor cables. | 0 |
| | Low noise | Minimizes the motor noise levels.<br>**Note:**<br>**Derating is required for this setting. See Derating.** | 1 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | Cyclic | The control is optimized for applications with a cyclic load.<br>**Note:**<br>**This setting is not suitable for long motor cables.** | 2 |
| | Manual | **Note:**<br>**Derating may be required for this setting. See Derating.** | 3 |
| 97.10 | Signal injection | Enables the anti-cogging function: A high-frequency alternating signal from the motor is coupled into the motor at low speeds to improve the stability of torque control. This prevents the motor from "cogging", which can occur when the rotor passes the magnetic poles. This function can be enabled with different amplitude levels.<br>**Note:**<br>• **This is a parameter for experts, which should not be changed without the appropriate expertise.**<br>• **Use the lowest possible level that provides satisfactory performance.**<br>• **Signal injection cannot be used with induction motors.** | Disabled |
| | Disabled | Anti-cogging disabled. | 0 |
| | Enabled (5 %) | Anti-cogging enabled at an amplitude level of 5%. | 1 |
| | Enabled (10 %) | Anti-cogging enabled at an amplitude level of 10%. | 2 |
| | Enabled (15 %) | Anti-cogging enabled at an amplitude level of 15%. | 3 |
| | Enabled (20 %) | Anti-cogging enabled at an amplitude level of 20%. | 4 |
| 97.11 | TR tuning | Tunes the rotor time constant.<br>This parameter can be used to improve the torque accuracy of an induction motor with rotary encoder feedback. Normally, the motor identification procedure provides sufficient accuracy, but manual fine tuning can be performed for an optimal performance especially in demanding applications.<br>**Note:**<br>**This is a parameter for experts, which should not be changed without the appropriate expertise.** | 100% |
| | 25…400% | Tunes the rotor time constant. | 1 = 1% |
| 97.15 | Motor model temperature adaptation | Selects whether the temperature-dependent parameters (such as stator or rotor resistance values) of the motor model are included in the current (measured or calculated) temperature or not.<br>See parameter group 35 Motor thermal protection for source selection of temperature measurement. | Disabled |
| | Disabled | Temperature adjustment of the motor model disabled. | 0 |
| | Estimated temperature | Calculated temperature (35.01 Motor estimated temperature) is used for adjusting the motor model. | 1 |
| | Measured temperature 1 | Measured temperature 1 (35.02 Measured temperature 1) is used to adjust the motor model. | 2 |
| | Measured temperature 2 | Measured temperature 2 (35.03 Measured temperature 2) is used to adjust the motor model. | 3 |
| 97.32 | Motor torque unfiltered. | Unfiltered motor torque as a percentage of the nominal motor torque. | - |
| | -1600.0 ... 1600.0% | Unfiltered motor torque. | 1 = 0.1% (DS402 mode),<br>see par. 46.03. (native mode) |
| 97.33 | Speed estimate filter time | Sets a filter time for the calculated speed. See diagram on page 353. | 5.00 ms |
| | 0.00 … 100.00 ms | Filter time for the calculated speed. | 100 = 1 ms |

## 98 User motor parameters

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 98 | User motor parameters | The motor data entered by the user is used in the motor model.<br>These parameters are useful for special motors or for more accurate motor control. A better motor model always improves motor control. | |
| 98.01 | User motor model mode | Enables motor model parameters 98.02...98.14 and rotor angle offset parameter 98.15.<br>**Note:**<br>• **This parameter value is automatically set to zero if the ID run is selected with parameter 99.13 ID run requested. The values of parameters 98.02...98.15 are updated with the motor characteristic data, which is determined during the ID run.**<br>• **Measurements taken directly at the motor connections during the ID run are likely to return values different from those specified in the data sheet of the motor manufacturer.**<br>• **This parameter setting cannot be changed when the drive is running.** | Not selected |
| | Not selected | Parameters 98.02...98.15 are not active. | 0 |
| | Motor parameters | The values of parameters 98.02...98.14 are used as the motor model. | 1 |
| | Position offset | The value of parameter 98.15 is used as rotor angle offset. Parameters 98.02...98.14 are not active. | 2 |
| | Motor parameters & position offset | The values of parameter 98.02...98.14 are used as the motor model, and the value of parameter 98.15 is used as the rotor angle offset. | 3 |
| 98.02 | Rs user | Sets stator resistance value $R_S$ for the motor model.<br>For a motor connected in a star connection, $R_S$ is the resistance value of one winding. For a motor connected in a delta connection, $R_S$ corresponds to one third of the resistance of one winding | 0.00000 p.u. |
| | 0.00000 ... 0.50000 p.u. | Stator resistance value in p.u. (per unit). | - |
| 98.03 | Rr user | Sets rotor resistance value $R_R$ for the motor model.<br>**Note:**<br>**This parameter only applies to induction motors.** | 0.00000 p.u. |
| | 0.00000 ... 0.50000 p.u. | Rotor resistance value in p.u. (per unit). | - |
| 98.04 | Lm user | Sets mutual inductance $L_M$ for the motor model. | |
| | 0.00000 ... 10.00000 p.u. | Mutual inductance in p.u. (per unit). | - |
| 98.05 | SigmaL user | Adjusts leakage inductance $L_S$.<br>**Note:**<br>**This parameter only applies to induction motors.** | |
| | 0.00000 ... 1.00000 p.u. | Leakage inductance in p.u. (per unit). | - |
| 98.06 | Ld user | Sets the longitudinal (synchronous) inductance.<br>**Note:**<br>**This parameter only applies to permanent magnet motors.** | 0.00000 p.u. |
| | 0.00000 ... 10.00000 p.u | Longitudinal inductance in p.u. (per unit). | - |
| 98.07 | Lq user | Sets the cross (synchronous) inductance.<br>**Note:**<br>**This parameter only applies to permanent magnet motors.** | |
| | 0.00000 ... 10.00000 p.u | Cross inductance in p.u. (per unit). | - |
| 98.08 | PM flux user | Adjusts the permanent magnet flux.<br>**Note:**<br>**This parameter only applies to permanent magnet motors.** | 0.00000 p.u. |
| | 0.00000 ... 2.00000 p.u | Permanent magnet flux in p.u. (per unit). | - |
| 98.09 | Rs user SI | Sets stator resistance value $R_S$ for the motor model. | 0.00000 Ohm |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | 0.00000 … 100.00000 Ω | Stator resistance value. | 100 = 1 mΩ |
| 98.10 | Rr user SI | Sets rotor resistance value $R_R$ for the motor model.<br>**Note:**<br>**This parameter only applies to induction motors.** | 0.00000 Ohm |
| | 0.00000 … 100.00000 Ω | Rotor resistance value. | 100 = 1 mΩ |
| 98.11 | Lm user SI | Sets mutual inductance $L_M$ for the motor model.<br>**Note:**<br>**This parameter only applies to induction motors.** | 0.00 mH |
| | 0.00 …100000.00 mH | Mutual inductance. | 100 = 1 mH |
| 98.12 | SigmaL user SI | Adjusts leakage inductance $L_S$.<br>**Note:**<br>**This parameter only applies to induction motors.** | 0.00 mH |
| | 0.00 …100000.00 mH | Leakage inductance. | 100 = 1 mH |
| 98.13 | Ld user SI | Sets the longitudinal (synchronous) inductance.<br>**Note:**<br>**This parameter only applies to permanent magnet motors.** | 0.00 mH |
| | 0.00 …100000.00 mH | Longitudinal inductance. | 100 = 1 mH |
| 98.14 | Lq user SI | Sets the cross (synchronous) inductance.<br>**Note:**<br>**This parameter only applies to permanent magnet motors.** | 0.00 mH |
| | 0.00 …100000.00 mH | Cross inductance. | 100 = 1 mH |
| 98.15 | Position offset user | Sets the angular offset between the zero position of the synchronous motor and the zero position of the position sensor.<br>This value is set as the initial value of rotor position detection if parameter 21.13 Autophasing mode is set to Turning with Z-pulse and can be adjusted later.<br>**Note:**<br>• **The value is set in electrical angular degrees. The electrical angle is equal to the mechanical angle multiplied by the number of motor pole pairs.**<br>• **This parameter only applies to permanent magnet motors.** | 0 degrees |
| | 0...360 degrees | Angle offset. | 1 = 1° |

## 99 Motor data

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 99 | Motor data | Motor configuration settings. | |
| 99.03 | Motor type | Sets the motor type.<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | Induction motor |
| | Induction motor | Standard squirrel-cage rotor induction motor (induction motor). | 0 |
| | Permanent magnet motor | Permanent magnet motor. Three-phase AC synchronous motor with permanent magnet rotor and sinusoidal counter EMF voltage. | 1 |
| 99.04 | Motor control mode | Selects the motor control mode. | DTC |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | | Direct torque control. This type of control is suitable for most applications.<br><br>**Note:**<br>**In addition to direct torque control, there is also scalar control, which should be used in the following situations:**<br>• **With multi-motor applications 1) if the load is unequally shared between the motors, 2) if the motors in a multi-motor application are of different sizes or 3) if the motor is replaced after a motor ID run.**<br>• **If the nominal current of the motor is less than 1/6 of the nominal output current of the frequency inverter.**<br>• **If the frequency inverter is used without a connected motor (e.g. for testing purposes).**<br><br>See also section Operating modes of the drive (page 228). | 0 |
| | Scalar | Scalar control. The outstanding motor control accuracy of DTC cannot be achieved with scalar control.<br>See the DTC setting above. It contains a list of applications where scalar control should be used in any case.<br><br>**Note:**<br>• **Correct motor operation requires that the magnetizing current of the motor does not exceed 90% of the nominal current of the frequency inverter.**<br>• **Some standard features are not active during scalar control.**<br><br>See also sections Scalar motor control (page Skalar-Motorregelung) and Operating modes of the frequency inverter (page 228). | |
| 99.06 | Motor nominal current | Sets the nominal motor current. This setting must correspond exactly to the value specified on the motor nameplate. When connecting several motors to the frequency inverter, the total current of the motors must be entered.<br><br>**Note:**<br>• **Correct motor operation requires that the magnetizing current of the motor does not exceed 90% of the nominal current of the inverter.**<br>• **This parameter setting cannot be changed when the drive is running.** | 0.0 A |
| | 0.0 … 32767.0 A | Nominal current of the motor. The permissible range is 1/6...2 × IN (nominal current) of the frequency inverter (0...2 × IN for scalar control). | 10 = 1 A |
| 99.07 | Motor nominal voltage | Defines the nominal motor voltage supplied to the motor. This setting must correspond exactly to the value on the motor nameplate.<br><br>**Note:**<br>• **For permanent magnet motors, the nominal voltage is the back EMF voltage at nominal speed of the motor. If the voltage is specified as voltage per rpm, e.g. 60 V per 1000 rpm, then the voltage for a nominal speed of 3000 rpm = 3 × 60 V = 180 V.**<br>• **The load on the motor insulation always depends on the supply voltage of the frequency inverter. This also applies if the nominal motor voltage is lower than that of the frequency inverter and the supply voltage.**<br>• **This parameter setting cannot be changed when the drive is running.** | 0.0 V |
| | 0.0 … 32767.0 V | Nominal voltage of the motor. The permissible range is 1/6...2 × $U_N$ (nominal voltage) of the frequency inverter. $U_N$ corresponds to the upper limit of the supply voltage range set with parameter 95.01 Supply voltage. | 10 = 1 V |
| 99.08 | Motor nominal frequency | Sets the nominal motor frequency. This setpoint must correspond exactly to the value specified on the motor nameplate.<br><br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | 50.00 Hz |
| | 0.00 … 500.00 Hz | Nominal frequency of the motor. | 100 = 1 Hz |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 99.09 | Motor nominal speed | Sets the nominal speed of the motor. This setting must correspond exactly to the value on the motor nameplate.<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | 0 rpm |
| | 0…30000 rpm | Nominal speed of the motor. | 1 = 1 rpm |
| 99.10 | Motor nominal power | Sets the nominal power of the motor. This setting must correspond exactly to the value on the motor nameplate. If no nominal power is specified on the nameplate, the torque can be entered instead in parameter 99.12.<br>If several motors are connected to the frequency inverter, the total power of the motors must be specified.<br>The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>**This parameter setting cannot be changed when the drive is running.** | 0.00 kW |
| | 0.00 … 10000.00 kW | Nominal power of the motor. | 100 = 1 kW |
| 99.11 | Motor nominal cos Φ | Sets the motor cosphi for a more accurate motor model. This value is not obligatory, but it is useful in case of an induction motor, especially in case of identification with the motor at standstill. This value is not required for a permanent magnet motor or a synchronous reluctance motor.<br>**Note:**<br>• **Do not enter an estimated value. If the exact value is not known, leave the parameter setting at zero.**<br>• **This parameter setting cannot be changed when the drive is running.** | 0.00 |
| | 0.00 … 1.00 | Cosphi of the motor. | 100 = 1 |
| 99.12 | Motor nominal torque | Sets the nominal motor shaft torque. This value can be entered instead of the nominal power (99.10) if it is written on the motor nameplate.<br>The unit is selected with parameter 96.16 Unit selection.<br>**Note:**<br>• **This setting is an alternative to the nominal power value (99.10). If both are entered, 99.12 has priority.**<br>• **This parameter setting cannot be changed when the drive is running.** | 0.000 Nm |
| | 0.000… Nm | Motor nominal torque | 1000 = 1 Nm |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| 99.13 | ID run requested | Sets the type of the motor identification routine (ID run) that is performed at the next start of the frequency inverter. With the motor identification run, the frequency inverter identifies the characteristics of the connected motor and thus enables optimum motor control.<br>If no ID run was performed yet (or if the default parameter values have been restored using parameter 96.06 Parameter restore have been restored), this parameter is automatically set to Standstill and indicates that an ID run must be performed.<br>After the ID run, the frequency inverter stops and this parameter is automatically set to None.<br>**Note:**<br>• **For ID run Advanced, the driven device must always be disconnected from the motor.**<br>• **For a permanent magnet or synchronous reluctance motor, an ID run Normal, Reduced or Standstill is necessary, where the motor shaft is NOT permitted to be blocked. The load torque must be less than 10%.**<br>• **With scalar control (99.04 Motor control mode = scalar), only ID run Current measurement calibration is possible.**<br>• **Before enabling the ID run, motor temperature measurement (if used) must be configured in parameter group 35 Motor thermal protection.**<br>• **If the ID run is enabled, it can be aborted by stopping the frequency inverter:**<br>• **The ID run must always be performed if one of the motor parameters (99.04, 99.06...99.12) was changed.**<br>• **Any Safe Torque Off and emergency stop circuits must be closed during the ID run.**<br>• **Any mechanical brake that may be present is not released by the switching logic for the ID run.**<br>• **This parameter setting cannot be changed when the drive is running.** | Standstill |
| | None | No motor ID run requested. This mode can only be selected if the ID run (Normal, Reduced, Standstill, Advanced, Advanced Standstill) has already been performed once. | 0 |
| | Normal | Normal ID run. Ensures good control accuracy for all drive applications. The ID run takes about 90 seconds. This mode should always be selected if possible.<br>**Note:**<br>• **If the load torque is higher than 20% of the nominal motor torque or if the machine is not designed for the nominal torque during the ID run, the driven machine must be disconnected from the motor for the duration of the ID run.**<br>• **The direction of rotation of the motor must be checked before starting the ID run. During the ID run, the motor rotates in the forward direction.**<br> <br>**Warning!**<br>**The motor accelerates to about 50...100% of the nominal speed during the ID run. ENSURE THAT THE MOTOR CAN BE OPERATED WITHOUT DANGER BEFORE STARTING THE ID RUN!** | 1 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | Reduced | Reduced ID run.<br>This mode should be selected instead of ID run Normal or Advanced if<br>• The mechanical losses exceed 20% (i.e. the motor cannot be decoupled from the driven equipment) or if<br>• Flux reduction is not permitted while the motor is running (i.e. for a motor with an integrated brake supplied via the motor terminals).<br>In this ID run mode, motor control in the field-weakening range or at high torques is not necessarily as accurate as in ID run "Normal". ID run "Reduced" is performed faster than ID run "Normal" (90 seconds).<br>**Note:**<br>**The direction of rotation of the motor must be checked before starting the ID run. During the ID run, the motor rotates in the forward direction.**<br>**Warning!**<br>**The motor accelerates to about 50...100% of the nominal speed during the ID run. ENSURE THAT THE MOTOR CAN BE OPERATED WITHOUT DANGER BEFORE STARTING THE ID RUN!** | 2 |
| | Stoppage | ID run "Standstill". DC current is supplied to the motor. With an induction motor (asynchronous motor), the motor shaft is not rotated. With a permanent magnet or synchronous reluctance motor, the shaft can rotate half a revolution.<br>**Note:**<br>**ID run "Standstill" should only be selected if ID run Normal, Reduced or Advanced is not possible since the coupled mechanical system does not allow this (e.g. for elevators or crane applications).**<br>See also section Advanced Standstill. | 3 |
| | Autophasing | Autophasing is used to determine the start angle of a permanent or synchronous reluctance motor (see page 234). Autophasing does not update the other motor model values.<br>Autophasing is automatically enabled as part of ID runs Normal, Reduced, Standstill, Advanced or Advanced Standstill. Autophasing can be performed separately with this setting. This is useful after changes have been made to the rotary encoder configuration, such as replacing or adding absolute encoders, resolvers or incremental encoders with commutation signals.<br>**Note:**<br>• **This setting can only be used after ID run Normal, Reduced, Standstill, Advanced or Advanced Standstill has been performed.**<br>• **Depending on the selection of the autophasing mode, the motor shaft may rotate during autophasing. See parameter 21.13 Autophasing mode.** | 4 |
| | Current measurement calibration | Requires calibration of the current measurement, i.e. identification of the offset and gain errors in the current measurement.<br>Calibration will be performed at the next start. | 5 |
| | Advanced | ID run "Advanced". The ID run ensures the best possible control accuracy. The ID run can take a few minutes. This mode should be selected if the highest control accuracy is required for the entire operating range.<br>**Note:**<br>**The operated machine must be disconnected from the motor due to the high torque and speed used temporarily.**<br>**Warning!**<br>**The motor accelerates to about 50...100% of the nominal speed during the ID run. Various accelerations and decelerations are performed. ENSURE THAT THE MOTOR CAN BE DRIVEN WITHOUT ANY HAZARDS BEFORE STARTING THE ID RUN!** | 6 |

| No. | Name/Value | Description | Clear all/ FbEq16 |
|---|---|---|---|
| | Advanced Standstill | ID run "Advanced Standstill".<br>This setting is recommended for induction motors up to 75 kW instead of ID run Standstill if:<br>• The exact nominal data of the motor is unknown or<br>• The control behavior of the motor after ID run Standstill is not satisfactory.<br>**Note:**<br>**The time required for ID run Advanced Standstill varies depending on the motor size. For a small motor, the ID run is normally finished after 5 minutes. For a large motor, it can take up to an hour.** | 7 |
| 99.14 | Last ID run performed | Displays the mode of the last performed ID run. For additional information about the different modes, see the settings of parameter 99.13 ID run requested. | Not selected |
| | None | No ID run was performed. | 0 |
| | Normal | ID run Normal. | 1 |
| | Reduced | ID run Reduced. | 2 |
| | Stoppage | ID run Standstill. | 3 |
| | Advanced | ID run Advanced. | 6 |
| | Advanced Standstill | ID run Advanced Standstill. | 7 |
| 99.15 | Motor polepairs calculated | Calculated number of pole pairs in the motor. | 0 |
| | 0...1000 | Number of pole pairs. | 1 = 1 |
| 99.16 | Motor phase order | Changes the direction of rotation of the motor. This parameter can be used if the motor rotates in the incorrect direction (for example, the motor cables are in an incorrect phase sequence) and if it is difficult to change the motor cable connection.<br>**Note:**<br>• **Changing this parameter has no effect on the polarities of the speed setpoint, i.e. if the speed setpoint is positive, the motor will rotate forward. Setting the phase sequence ensures that "forward" is the correct direction of rotation.**<br>• **After changing this parameter setting, the sign of the rotary encoder feedback signal (if used) must be checked. This can be changed by setting parameter 90.41 Motor feedback selection to Calculated and comparing the sign of 90.01 Motor speed for control with 90.10 Encoder 1 speed. If the sign of the measured value signal is incorrect, the rotary encoder cable connection must be corrected or the sign of the motor gearbox counter reversed.** | U V W |
| | U V W | Normal | 0 |
| | U W V | Reversed direction of rotation. | 1 |

## 6.4 Warning and fault messages

This chapter lists all warning and fault messages including possible causes and corrective measures. Information in this chapter can be used to identify and correct the causes of most warning and fault messages. If not, please contact your B&R service.

The warning and fault messages are listed in separate tables in this chapter. The tables are sorted by the codes of the warning and fault messages.

### 6.4.1 Safety

**Warning!**

**Installation and service/maintenance tasks on the frequency inverter/drive is only permitted to be performed by qualified personnel! Read the safety instructions on the first pages of the hardware manual before working on the frequency inverter/drive.**

## 6.4.2 Status indicators

### 6.4.2.1 Warnings and faults

Warnings and faults indicate an abnormal drive condition. The code and the name of the warning/fault message are displayed on the control panel of the frequency inverter and in PC program "Drive Composer". Only the codes of the warning/fault messages are available via the fieldbus.

Warnings do not need to be acknowledged. The display is canceled if the cause of the warning no longer exists. Warnings do not affect operation of the drive and the frequency inverter continues to control the motor.

Faults cause the frequency inverter to switch off control and the motor is stopped. After the cause of a fault has been eliminated, the fault can be acknowledged via a selectable source (see parameter 31.11 Fault reset selection) such as the control panel, PC tool drive composer, the digital inputs of the frequency inverter or the fieldbus. If the fault was acknowledged, the frequency inverter can be restarted. For some faults, it is necessary to restart the control unit. This can be done by switching it off and on again or with parameter 96.08 Control board boot.

Warning and fault messages can be forward to a relay output or a digital input/output by selecting Warning, Fault or Fault (-1). See the following sections:

- "Programmable digital inputs and outputs" on page 230
- "Programmable relay outputs" on page 230

### 6.4.2.2 Pure event messages

In addition to warning and fault messages, there are event messages that are only logged in the event memories of the frequency inverter. The codes of these events are contained in table Warning messages.

### 6.4.2.3 Editable text messages

For some warning and fault messages, the text of the messages can be changed and instructions and contact information can be added. To change these messages, select **Menu - Settings - Edit texts** on the control panel.

## 6.4.3 Storage and analysis of warning and fault messages

### 6.4.3.1 Event logs

The frequency inverter has two event logs that can be accessed via the main menu of the control panel. Access (and acknowledgment) is also possible with PC tool "Drive Composer".

One of the logs contains fault messages and fault acknowledgments. The other log lists warning messages, pure event messages and delete entries. Both logs contain the 32 most recent events. All messages are stored in the event memories with a timestamp and additional information.

#### 6.4.3.1.1 Supplementary codes

For some events, an supplementary code is generated to make identification of a problem easier. The supplementary code is displayed on the control panel together with the message. It is also stored in the event details.

**Data storage of factory settings** The frequency inverter has a data memory in which preset frequency inverter values are stored in 500 microsecond intervals (default; see parameter 96.65 Factory data logger time level). By default, about 700 query values are stored in the memory unit of the frequency inverter immediately before and after a fault. The fault data of the last five faults can be retrieved in the event log if they are displayed in PC tool "Drive Composer Pro". (The fault data cannot be retrieved via the control panel.)

The values stored in the data memory of the factory settings include 01.07 Motor current, 01.10 Motor torque, 01.11 DC voltage, 01.24 Flux actual %, 06.01 Main control word, 06.11 Main status word, 24.01 Used speed reference, 30.01 Limit word 1, 30.02 Torque limit status and 90.01 Motor speed for control. Selection of parameters cannot be changed by the user.

#### 6.4.3.2 Other data storage

##### 6.4.3.2.1 User-specific data storage

This functionality enables free selection of up to eight parameters that are queried at configurable intervals. The trigger conditions and the monitoring time can be defined for up to 8000 query values. The data memory status is shown in parameter 96.61 application data memory status word. The triggering sources are set with parameters 96.63 User data logger trigger and 96.64 User data logger start. Configuration, status and collected data are stored in the memory unit for later analysis.

#### 6.4.3.3 Parameters with warning and fault information

The frequency inverter can store a list of currently active faults that have stopped the drive at the present time. The faults are displayed in parameter group 04 Warnings and faults (page 127). The parameter group also displays a list of faults and warnings that occurred previously.

##### 6.4.3.3.1 Event word (parameters 04.40...04.72)

Parameter 04.40 Event word 1 can be configured by the user to indicate the status of 16 selectable events (i.e. faults, warnings or pure events). It is possible to specify a supplementary code for each event to filter out other supplementary codes.

### 6.4.4 Warning messages

**Note:**

**This list also contains event messages that are only displayed in the event log.**

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A2A1 | Current calibration | At the next start, the offset and the gain of current measurement is calibrated. | Informative warning. (See parameter 99.13 ID run requested.) |
| A2B1 | Overcurrent | Output current has exceeded the internal fault limit. | Check the motor load.<br>Check the acceleration times in parameter group 23 Speed reference ramp (speed control) or 26 Torque reference chain (torque control) or 28 Frequency reference chain (frequency control). Check also parameters 46.01 Speed scaling, 46.02 Frequency scaling and 46.03 Torque scaling.<br>Check the motor and the motor cable (including phase and delta/star connection).<br>Check that no contactors in the motor cable open and close. Check whether the IBN/motor data in parameter group 99 correspond to the data on the motor plate.<br>Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed in the motor cable.<br>Check the rotary encoder cable (including phase sequence).<br>Check the supplementary code (format XXXY YYZZ). In the case of inverter modules connected in parallel, "Y YY" indicates the channel of control unit BCU through which the fault was received. "ZZ" refers to the phase that triggered the fault (0: No detailed information available, 1: U phase, 2: V phase, 4: W phase, 3/5/6/7: Multiple phases). |
| A2B3 | Earth leakage Programmable fault: 31.20 Earth fault | The frequency inverter has detected a load asymmetry typical of a ground fault in the motor or motor cable. | Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable.<br>Check for ground faults in the motor or motor cable by measuring the insulation resistance of the motor and motor cable.<br>Try to control the motor in scalar mode if permissible. (See parameter 99.04 Motor control mode..) |
| A2B4 | Short circuit | Short circuit in motor cable(s) or motor | Check the motor and motor cable for connection errors.<br>Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A2BA | IGBT overload | IGBT overtemperature between junction and housing. This warning message protects IGBT(s) and it can be triggered by a short circuit in the motor cable. | Check the motor cable.<br>Check the ambient conditions.<br>Check if there is sufficient cool air flow and fan operation.<br>Check heat sink fins for dust coating.<br>Compare the motor power with the power of the frequency inverter. |
| A3A1 | DC link overvoltage | The DC bus voltage of the frequency inverter is too high (if the drive is stopped). | Check the setting of the supply voltage (parameter 95.01 Supply voltage). Note that an incorrect setting can result in uncontrolled motor operation or overload of the brake chopper or resistor.<br>Check the supply voltage.<br>In the case of A3A1 or A3A2 in inverter modules connected in parallel, the supplementary code indicates the affected module. The format of the code is 000X XX00, where "XXX" stands for the channel on control unit BCU. |
| A3A2 | DC link undervoltage | The DC bus voltage of the frequency inverter is too low (if the drive is stopped). | |
| A3AA | DC not charged | The DC bus voltage has not yet reached the level required for operation. | |
| A480 | Motor cable overload | The calculated motor cable temperature has exceeded the warning limit. | Check the settings of parameters 35.61 and 35.62.<br>Check the dimensioning of the motor cable with regard to the required load. |
| A490 | Incorrect temperature sensor setup | Problem with motor temperature measurement. | Check the supplementary code (format 0XYY ZZZZ).<br>"X" indicates the temperature monitoring function concerned (0 = Parameter 35.11, 1 = Parameter 35.21).<br>"YY" indicates the selected temperature source, i.e. the setting of the selection parameter in hexadecimal format.<br>"ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0001 | The sensor type is incorrect. | Check parameters 35.11/35.21 against 91.21/91.24. |
| | 0002 | Temperature below limit | Check parameters 35.11...35.14/35.21...35.24 (and 91.21/91.24 if the sensor is connected to an encoder interface).<br>Check the sensor and its wiring. |
| | 0003 | Short circuit | |
| | 0004 | Circuit interruption | |
| A491 | External temperature 1 (message text that can be edited) | Measured temperature 1 has exceeded the warning limit. | Check the value of parameter 35.02 Measured temperature 1.<br>Check the motor cooling (or other devices whose temperature is measured).<br>Value of parameter 35.13 Temperature 1 warning limit. |
| A492 | External temperature 2 (message text that can be edited) | Measured temperature 2 has exceeded the warning limit. | Check the value of parameter 35.03 Measured temperature 2.<br>Check the motor cooling (or other devices whose temperature is measured).<br>Value of parameter 35.23 Temperature 2 warning limit. |
| A497 | Motor temperature 1 (message text that can be edited) | The thermistor protection module installed in slot 1 indicates overtemperature. | Check the cooling of the motor.<br>Check the motor load and the nominal data of the frequency inverter.<br>Check the wiring of the temperature sensor. If defective, repair the wiring.<br>Measure the resistance of the sensor. Replace the sensor if defective. |
| A498 | Motor temperature 2 (message text that can be edited) | The thermistor protection module installed in slot 2 indicates overtemperature. | |
| A499 | Motor temperature 3 (message text that can be edited) | The thermistor protection module installed in slot 3 indicates overtemperature. | |
| A4A0 | Control board temperature | Temperature of the control unit is too high. | Check the supplementary code. See the measures after the following specification on the codes. |
| | (None) | Temperature above warning limit | Check the ambient conditions.<br>Check if there is sufficient cool air flow and fan operation.<br>Check heat sink fins for dust coating. |
| | 1 | Thermistor defective | Replacement of the control unit required. |
| A4A1 | IGBT overtemperature | The calculated IGBT temperature of the frequency inverter is too high. | Check the ambient conditions.<br>Check if there is sufficient cool air flow and fan operation.<br>Check heat sink fins for dust coating.<br>Compare the motor power with the power of the frequency inverter. |
| A4A9 | Cooling | The temperature of the frequency inverter is too high. | Check the ambient temperature. If it is higher than 40°C (104°F), ensure that the load current does not exceed the reduced load capacity of the frequency inverter.<br>Check if there is sufficient air flow and fan operation.<br>Check the interior of the cabinet and the heat sink of the frequency inverter module for dust deposits. Clean if necessary. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A4B0 | Excess temperature | The temperature of the power unit is too high. | Check the ambient conditions.<br>Check the cooling air flow and functionality of the fan.<br>Check the heat sink fins for dust deposits.<br>Compare the motor power with the power of the frequency inverter.<br>Check the supplementary code (format XXXY YYZZ). "Y YY" stands for the channel of control unit BCU through which the fault was received. "ZZ" refers to the origin of the fault (1: U phase, 2: V phase, 3: W phase, 4: INT card, 5: Brake chopper, 6: Air inlet (sensor connected to X10 of INT card), 7: Fan of electronic card compartment or power supply card, 8: du/dt filter or temperature switch (XT) (sensor connected to X7 of INT card), 9: Sensor connected to X6 of INT card, 0FA: Ambient temperature). |
| A4B1 | Excess temperature difference | High temperature difference between IGBTs of different phases. | Check the motor cable.<br>Check the cooling of the inverter module(s).<br>Check the supplementary code (format XXXY YYZZ). "XXX" refers to the source of the difference (0: Single module, temperature difference between IGBTs of different phases, 1: Modules connected in parallel, minimum-maximum difference between all IGBTs of all modules). With modules connected in parallel, "Y YY" indicates the channel of control unit BCU through which the fault was received. "ZZ" specifies the phase (0: Single module, 1: U phase [modules connected in parallel], 2: V phase [modules connected in parallel], 3: W phase [modules connected in parallel]. |
| A4B2 | PCB space cooling | The difference between the ambient temperature and temperature of the circuit board housing is too high. | Check the fan of the circuit board housing.<br>For modules connected in parallel, check the supplementary code (format XXXY YYZZ). "Y YY" stands for the channel of control unit BCU through which the fault was received. |
| A4F6 | IGBT temperature | The IGBT temperature of the frequency inverter is too high. | Check the ambient conditions.<br>Check the cooling air flow and functionality of the fan.<br>Check the heat sink fins for dust deposits.<br>Compare the motor power with the power of the frequency inverter. |
| A580 | PU communication | Communication error between the control unit and the power unit of the frequency inverter. | Check the connections between the control unit and the power unit.<br>Check the supplementary code (format XXXY YYZZ). For modules connected in parallel, "Y YY" indicates the affected channel of control unit BCU (0: Transfer). "ZZ" specifies the error source (8: Transfer error in the PSL connection [see "XXX"], 9: Transmitter FIFO buffer warning limit reached). "XXX" specifies the direction of the transfer error and the detailed warning code (0: Rx/Communication error, 1: Tx/Reed-Solomon symbol error, 2: Tx/No synchronization error, 3: Tx/Reed-Solomon decoding error, 4: Tx/Manchester coding error). |
| A581 | Fan | Fan feedback is missing. | Check the setting of parameter 95.20 HW options word 1, bit 14.<br>Check the supplementary code to identify the fan. Code 0 denotes main fan 1. Other codes (format XYZ): "X" specifies the status code (1: ID run, 2: Normal). "Y" specifies the index that is connected to the inverter unit on control unit BCU (0...n, always 0 for ZCU control units). "Z" specifies the index of the fan (1: Main fan 1, 2: Main fan 2, 3: Main fan 3).<br>Check fan operation and the connection.<br>Replace the fan if defective. |
| A582 | Auxiliary fan not running | An auxiliary fan (connected to the fan terminals of the control unit) is blocked or is disconnected from the power supply. | The supplementary code refers to the fan (1: Auxiliary fan 1, 2: Auxiliary fan 2).<br>Check the auxiliary fan(s) and the respective connection(s). Replace the defective fan.<br>Ensure that the front cover of the frequency inverter module is installed and screwed tight. If the cover must be removed during commissioning, this warning is also generated after the corresponding fault has been eliminated. See fault 5081 Auxiliary fan not running (page 345). |
| A5A0 | Safe torque off<br>Programmable warning 31.22 STO indication run/stop | Function Safe Torque Off is enabled, i.e. safety circuit signal(s) connected to XSTO are not received. | Check the connections of the safety circuit. For additional information, see the respective hardware manual and description of parameter 31.22 STO indication run/stop (page 295). |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A5EA | Measurement circuit temperature | Problem with internal temperature measurement of the frequency inverter. | Check the supplementary code (format XXXY YYZZ). "Y YY" stands for the channel of control unit BCU through which the fault was received ("0 00" for control unit ZCU). "ZZ" refers to the origin of the fault (1: U phase, IGBT, 2: V phase IGBT, 3: W phase IGBT, 4: Power unit INT card, 5: Brake chopper, 6: Air inlet, 7: Voltage supply card, 8: du/dt filter, FAh: Air inlet temperature). |
| A5EB | PU board powerfail | Fault in the power supply to the power unit. | Contact your B&R representative. |
| A5EC | PU communication internal | Communication error between the control unit and the power unit of the frequency inverter. | Check the connections between the control unit and the power unit. |
| A5ED | Measurement circuit ADC | Problem with the measurement circuit of the power unit (analog-digital converter) | Contact your B&R representative. |
| A5EE | Measurement circuit DFF | Problem with current or voltage measurement of the power unit. | Contact your B&R representative. |
| A5EF | PU state feedback | Status response from the output phases does not match the control signals. | Contact your B&R representative. |
| A5F0 | Charging feedback | Warning message that the charging circuit is still running. | Informative warning. Wait until charging is complete before starting the inverter unit. |
| A5F3 | Switching frequency below requested | Adequate motor control with the output frequency requested cannot be achieved due to a limited switching frequency (e.g. due to parameter 95.15). | Informative warning. |
| A5F4 | Control unit battery | The battery of the control unit is low. | Replace the battery of the control unit.<br>This warning message can be suppressed with parameter 31.40. |
| A682 | Flash erase speed exceeded | The flash memory (in the memory unit) was erased too often, affecting the service life of the memory. | Avoid unnecessary saving of parameters by parameter 96.07 or cyclic writing of parameters (such as triggering user-specific data memory via parameters).<br>Check the supplementary code (format XYYY YZZZ). "X" specifies the source of the warning (1: Generic deletion of flash memory via supervision). "ZZZ" specifies the number of the flash subsector that generated the warning. |
| A683 | Data saving to power unit | Error in the data backup to the power unit. | Check the supplementary code. See the measures after the following specification on the codes. |
| | 0 | An error prevents initialization of the saving procedure. | Switch the power supply of the frequency inverter off and on again. If the control unit is supplied externally, also restart the control unit by switching it off and on again or with parameter 96.08 Control board boot. |
| | 1 | | |
| | 2. | Write error. | |
| A684 | SD card | Error in the SD card that is used for data storage (only control unit BCU). | Check the supplementary code. See the measures after the following specification on the codes. |
| | 1 | No SD card | Insert a compatible, writable SD card into the SD card slot on control unit BCU. |
| | 2 | Write-protected SD card. | |
| | 3 | SD cards not readable. | |
| A686 | Checksum mismatch<br>Programmable warning: 96.54 Checksum action | The calculated parameter checksum does not correspond to an enabled setpoint checksum. | Check whether all required confirmed (reference) checksums (96.56...96.59) in 96.55 Checksum control word are enabled.<br>Check the parameter configuration. Use 96.55 Checksum control word to enable a checksum parameter and copy the actual checksum into this parameter. |
| A687 | Checksum configuration | A measure was defined for a deviation of the parameter checksum, but the function has not been configured. | Disable function in 96.54 Checksum action. |
| A688 | Para map configuration | Too much data in the parameter mapping table created in Drive Customizer. | Please contact your local B&R representative. |
| A689 | Mapped parameter value cut | Parameter value overflows. For example, due to scaling specified in the parameter mapping table (created in Drive Customizer). | Please contact your local B&R representative. |
| A6A4 | Motor nominal value | The motor parameters are not set correctly. | Check the supplementary code. See the measures after the following specification on the codes. |
| | | The drive is not dimensioned correctly. | |
| | 1 | The slip frequency is too low. | Check the settings of the motor configuration parameters in groups 98 and 99. Check that the sizing of the frequency inverter is correct for the motor. |
| | 2 | The synchronous and nominal speed differ too much. | |
| | 3 | The nominal speed is higher than the synchronous speed with one pole pair. | |
| | 4 | The nominal current has exceeded the limits. | |
| | 5 | The nominal voltage has exceeded the limits. | |
| | 6 | The nominal power is higher than the reactive power. | |
| | 7 | The nominal power does not match the nominal speed and torque. | |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A6A5 | No motor data | Parameters in group 99 are not set. | Check whether all required parameters have been set in group 99.<br>**Note:**<br>**It is normal that this warning message is displayed during commissioning as long as the motor data has not been set.** |
| A6A6 | Supply voltage unselected | The supply voltage has not been set. | Set the supply voltage (parameter 95.01 Supply voltage). |
| A6D1 | FBA A parameter conflict | The frequency inverter does not have the function requested by a PLC or the function is not enabled. | Check the PLC programming. Check the settings of parameter group 50 Fieldbus adapter (FBA) and 51 FBA A settings. |
| A6D2 | FBA B parameter conflict | The frequency inverter does not have the function requested by a PLC or the function is not enabled. | Check the PLC programming. Check the settings of parameter group 50 Fieldbus adapter (FBA) and 54 FBA B settings. |
| A6DA | Reference source parameterization | A setpoint source is simultaneously connected to several parameters with different units. | Check the setpoint source selection parameters.<br>Check the supplementary code (format XXYY 00ZZ). "XX" and "YY" specify the two parameter sets to which the source was connected (01 = Speed reference chain [22.11, 22.12, 22.15, 22.17], 02 = Frequency reference chain [28.11, 28.12], 03 = Torque reference chain [26.11, 26.12, 26.16], 04 = Other torque-related parameters [26.25, 30.21, 30.22, 44.09], 05 = Process PID control parameters [40.16, 40.17, 40.50, 41.16, 41.17, 41.50]). "ZZ" indicates the conflict setpoint source (01...0E = Index in parameter group 3, 33 = Process PID control, 3D = Motor potentiometer, 65 = AI1, 66 = AI2, 6F = Frequency input). |
| A6E5 | AI parameterization | The hardware setting for current/voltage of an analog input does not correspond to the parameter setting. | Check the supplementary code. The code identifies the analog input whose settings are causing the conflict. Correct the hardware setting (on the control unit) or parameter 12.15/12.25.<br>**Note:**<br>**Changes to the hardware settings only take effect after the power supply of the control unit has been switched off and on again or via the corresponding setting of parameter 96.08 Control board boot.** |
| A6E6 | ULC configuration | Configuration error of the user load curve. | Check the supplementary code (format XXXX ZZZZ). "ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0000 | Speed points inconsistent. | Check whether each speed point (parameter 37.11...37.15) has a higher value than the previous point. |
| | 0001 | Frequency points inconsistent. | Check whether each frequency point (parameter 37.16...37.20) has a higher value than the previous point. |
| | 0002 | Underload point above overload point. | Check whether each overload point (37.31...37.35) has a higher value than the corresponding underload point (37.21...37.25). |
| | 0003 | Underload point below overload point. | |
| A780 | Motor stall<br>Programmable warning: 31.24 Stall function | The motor is operating in the stall range due to load that is too high or insufficient motor power, for example. | Check the motor load and the nominal data of the frequency inverter.<br>Check the parameter settings of the fault function. |
| A781 | Motor fan<br>Programmable warning: 35.106 DOL starter event type | No feedback signal received from external fan. | Check the external fan (or other controlled devices) with the logic.<br>Check the settings of parameters 35.100...35.106. |
| A782 | Temperature encoder module | Temperature measurement error with a temperature sensor (KTY or PTC) connected to interface module 8I0IF. | Check whether the parameter setting of 35.11 Temperature 1 source / 35.21 Temperature 2 source corresponds to the current encoder interface installation.<br>Check the settings of parameter 91.21and 91.24. Check whether the corresponding module is enabled in parameter 91.11...91.1291.14. Use parameter 91.10 Encoder parameter refresh to validate the changes in the settings. |
| A791 | Brake resistor | The braking resistor is defective or not connected. | Check whether a braking resistor is connected.<br>Check the state of the braking resistor. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A793 | BR excess temperature | The measured temperature of the braking resistor has exceeded the warning limit according to parameter 43.12 Brake resistor warning limit. | Stop the drive. Let the braking resistor cool down. Check the settings of the overload protective function of the resistor (parameter group 43 Brake chopper). Check the setting of the warning limit, parameter 43.12 Brake resistor warning limit.<br>Check whether the resistor was correctly dimensioned.<br>Check whether the braking cycles are within the permissible limits. |
| A794 | BR data | The braking resistor data has not been set. | One or more settings of the braking resistor data (parameter 43.08...43.10) are not correct. The parameter is specified by the supplementary code. |
| | 0000 0001 | Resistance value too low. | Check the value of parameter 43.10. |
| | 0000 0002 | The thermal time constant is not set. | Check the value of parameter 43.08. |
| | 0000 0003 | The maximum continuous power is not set. | Check the value of parameter 43.09. |
| A797 | Speed feedback configuration | The speed feedback configuration was changed. | Check the supplementary code (format XXYY ZZZZ). "XX" specifies the number of the pulse encoder interface module (01 91.11/91.12, 02: 91.13/91.14). "YY" specifies the pulse encoder (01: 92 Encoder 1 configuration, 02: 93 Encoder 2 configuration). "ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0001 | The adapter was not found in the specified slot. | Check the slot of module (91.12or 91.14). |
| | 0002 | The detected type of the interface module does not match the parameter setting. | Set the module type (91.11 or 91.13) against the status (91.02 or 91.03). |
| | 0003 | The logic version is too old. | Contact your B&R representative. |
| | 0004 | The software version is too old. | Contact your B&R representative. |
| | 0006 | The encoder type is incompatible with the interface module type. | Check the module type (91.11 or 91.13) against the encoder type (92.01 or 93.01). |
| | 0007 | The adapter is not configured. | Check the slot of module (91.12or 91.14). |
| | 0008 | The speed feedback configuration was changed. | Use parameter 91.10 Encoder parameter refresh to validate the changes in the settings. |
| | 0009 | No encoders configured for the encoder module | Configure the encoder in group 92 Encoder 1 configuration or 93 Encoder 2 configuration. |
| | 000A | The emulation input does not exist. | Check the input selection (91.31or 91.41). |
| | 000B | The echo is not supported by the selected input (e.g. resolver or absolute encoder). | Check the input selection (91.31 or 91.41), the type of interface module and the encoder type. |
| | 000C | Emulation is not supported during continuous transfer. | Check the input selection (91.31 or 91.41) and the serial transfer mode settings (92.30 or 93.30). |
| A798 | Encoder option comm loss | Encoder feedback is not used as actual feedback or measured motor feedback is interrupted (and parameter 90.45/90.55 is set to Warning). | Check whether the encoder is selected as the feedback source in parameter 90.41or 90.51.<br>Check whether the interface module is properly installed in its slot.<br>Check whether the contacts of the interface module or the slots are damaged. To isolate the problem, install the module in a different slot. Check the supplementary code (format XXXX YYYY). "YYYY" stands for the problem (see the measures for each code after this list). |
| | 0001 | No response to the encoder configuration message. | Contact your B&R representative. |
| | 0002 | No response to the disable message of the adapter watchdog. | Contact your B&R representative. |
| | 0003 | No response to the enable message of the adapter watchdog. | Contact your B&R representative. |
| | 0004 | No response to the adapter configuration message. | Contact your B&R representative. |
| | 0005 | Too many missing responses to speed and position messages. | Contact your B&R representative. |
| | 0006 | The DDCS driver failed. | Contact your B&R representative. |
| A79B | BC short circuit | Short circuit in brake chopper IGBT | Replace the brake chopper (if external). Frequency inverters with internal choppers must be tested by B&R.<br>Check that the braking resistor is connected and not damaged. |
| A79C | BC IGBT excess temperature | The brake chopper IGBT temperature has exceeded the internal warning limit value. | Let the brake chopper cool down.<br>Check whether the ambient temperature is too high.<br>Check whether the fan has failed.<br>Check whether the airflow is obstructed.<br>Check the dimensioning and cooling of the control cabinet.<br>Check the settings of the resistor overload protection function (parameter 43.06...43.10).<br>Check whether the smallest permissible resistance value for the chopper is observed.<br>Check whether the permissible limit values are observed for the braking cycle.<br>Check whether the AC supply voltage of the frequency inverter is too high. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A7A1 | Mechanical brake closing failed<br>Programmable warning: 44.17 Brake fault function | The message is enabled if the brake feedback signal is not received as expected when the brake is engaged. | Check the connection of the mechanical brake.<br>Check the settings of the mechanical brake in parameter group 44 Mechanical brake control.<br>Check whether the feedback signal corresponds to the current status of the brake. |
| A7A2 | Mechanical brake opening failed<br>Programmable warning: 44.17 Brake fault function | The message is enabled if the brake feedback signal is not received as expected when the brake is released. | Check the connection of the mechanical brake.<br>Check the settings of the mechanical brake in parameter group 44 Mechanical brake control.<br>Check whether the confirmation signal corresponds to the current status of the brake. |
| A7A5 | Mechanical brake opening not allowed<br>Programmable warning: 44.17 Brake fault function | Conditions for releasing the mechanical brake cannot be met (e.g. parameter 44.11 Keep brake closed prevents the brake from releasing). | Check the settings of the mechanical brake in parameter group 44 Mechanical brake control (in particular 44.11 Keep brake closed).<br>Check whether the confirmation signal (if used) corresponds to the current status of the brake. |
| A7AA | Extension AI parameterization | The hardware current/voltage setting of an analog input (on an I/O expansion module) does not match the parameter settings. | Check the supplementary code (format XX00 00YY). "XX" specifies the number of I/O expansion modules (01: Parameter group 14 I/O extension module 1, 02: 15 I/O extension module 2, 03: 16 I/O extension module 3). "YY" specifies the analog input of the module.<br>For example, for analog output 1 of I/O extension module 1 (supplementary code 0000 0101), the hardware current/voltage setting of parameter 14.29 is displayed. The corresponding parameter setting is 14.30. Adjust the hardware setting in the module or the parameter to resolve the mismatch.<br>**Note:**<br>**Changes to the hardware settings only take effect after the power supply of the control unit has been switched off and on again or with the corresponding setting of parameter 96.08 Control board boot.** |
| A7AB | Extension I/O configuration failure | The types and slots of the I/O expansion modules specified by the parameters do not match the detected configuration. | Check the supplementary code. The code indicates which I/O expansion module is affected.<br>Check the settings of the modules with regard to type and slot (parameters 14.01, 14.02, 15.01, 15.02, 16.01 and 16.02).<br>Check if the modules are correctly installed. |
| A7B0 | Motor speed feedback<br>Programmable warning: 90.45 Motor feedback fault | No motor speed feedback signal is received. | Check the supplementary code (format XXYY ZZZZ). "XX" specifies the number of the pulse encoder interface module (01 91.11/91.12, 02: 91.13/91.14). "YY" specifies the pulse encoder (01: 92 Encoder 1 configuration, 02: 93 Encoder 2 configuration). "ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0001 | The motor gear definition is invalid or outside the limits. | Check the motor gear settings (90.43 and 90.44). |
| | 0002 | The encoder is not configured. | Check the settings of the encoder (92 Encoder 1 configuration or 93 Encoder 2 configuration).<br>Use parameter 91.10 Encoder parameter refresh) to validate the changes in the settings. |
| | 0003 | Encoder operation stopped. | Check the encoder status. |
| | 0004 | A rotary encoder slip was detected. | Check whether there is a slip between the rotary encoder and the motor. |
| A7B1 | Load speed feedback<br>Programmable warning: 90.55 Load feedback fault | No load speed feedback signal received. | Check the supplementary code (format XXYY ZZZZ). "XX" specifies the number of the pulse encoder interface module (01 91.11/91.12, 02: 91.13/91.14). "YY" specifies the pulse encoder (01: 92 Encoder 1 configuration, 02: 93 Encoder 2 configuration). "ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0001 | The load gear definition is invalid or outside the limits. | Check the load gear settings (90.53 and 90.54). |
| | 0002 | The defined slope value is invalid or outside the limits. | Check the settings of the slope value (90.63 and 90.64). |
| | 0003 | Encoder operation stopped. | Check the encoder status. |
| A7C1 | FBA A communication<br>Programmable warning: 50.02 FBA A comm loss func | Cyclic communication between the frequency inverter and fieldbus adapter module A or between the PLC and fieldbus adapter module A is interrupted. | Check the status of the fieldbus communication. See the documentation of the fieldbus interface.<br>Check the settings of parameter groups 50 Fieldbus adapter (FBA) and 51 FBA A settings, 52 FBA A data in and 53 FBA A data out.<br>Check the cable connections.<br>Check whether the communication master can communicate. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A7C2 | FBA B communication<br>Programmable warning: 50.32 FBA B comm loss func | Cyclic communication between the frequency inverter and fieldbus adapter module B or between the PLC and fieldbus adapter module B is interrupted. | Check the status of the fieldbus communication. See the documentation of the fieldbus interface.<br>Check the settings of parameter group 50 Fieldbus adapter (FBA).<br>Check the cable connections.<br>Check whether the communication master can communicate. |
| A7CA | DDCS controller comm loss<br>Programmable warning: 60.59 DDCS controller comm loss function | DDCS communication (via fiber optic) between the frequency inverter and the external controller failed. | Check the status of the external controller. See the documentation of the external controller.<br>Check the settings of parameter group 60 DDCS communication. Check the cable connections. If necessary, replace the cables. |
| A7CB | MF comm loss<br>Programmable warning: 60.09 M/F comm loss function | The master/follower communication is interrupted. | Check the supplementary code. The code shows which node address (set with parameter 60.02 in each frequency inverter) is affected in the master/follower connection.<br>Check the settings of parameter group 60 DDCS communication.<br>On the FDCO module (if present), check that the DDCS connection switch is not set to 0 (OFF).<br>Check the cable connections. If necessary, replace the cables. |
| A7CE | EFB comm loss<br>Programmable warning: 58.14 Communication loss action | Communication failure in the integrated fieldbus (EFB). | Check the status of the fieldbus master ("Online", "Offline", "Error", etc.).<br>Check the cable connections on the XD2D connector on the control unit. |
| A7E1 | Encoder<br>Programmable warning: 90.45 Motor feedback fault | Encoder error. | Check the supplementary code (format XXYY ZZZZ). "XX" specifies the number of the pulse encoder interface module (01 91.11/91.12, 02: 91.13/91.14). "YY" specifies the pulse encoder (01: 92 Encoder 1 configuration, 02: 93 Encoder 2 configuration). "ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0001 | Cable fault | Check the order of the conductors at both ends of the pulse encoder cable. Check the grounding of the pulse encoder cable.<br>If the pulse encoder was previously in operation, check the pulse encoder, the pulse encoder cable and the pulse encoder interface module for damage.<br>See also parameter 92.21 Encoder cable fault. mode. |
| | 0002 | No encoder signal | Check the state of the pulse encoder. |
| | 0003 | Overspeed | Contact your B&R representative. |
| | 0004 | Overfrequency | Contact your B&R representative. |
| | 0005 | Resolver ID run failed | Contact your B&R representative. |
| | 0006 | Resolver overcurrent error | Contact your B&R representative. |
| | 0007 | Speed scaling error | Contact your B&R representative. |
| | 0008 | Communication error with the absolute encoder | Contact your B&R representative. |
| | 0009 | Initialization error of the absolute encoder | Contact your B&R representative. |
| | 000A | Configuration error of the SSI absolute encoder | Contact your B&R representative. |
| | 000B | Encoder reported an internal error | See the documentation of the encoder. |
| | 000C | Encoder reported a battery fault | See the documentation of the encoder. |
| | 000D | Encoder reported overspeed or reduced resolution due to overspeed | See the documentation of the encoder. |
| | 000E | Encoder reported a position counter error | See the documentation of the encoder. |
| | 000F | Encoder reported an internal error | See the documentation of the encoder. |
| A7EE | Control panel loss<br>Programmable warning: 49.05 Communication loss action | Control panel has stopped communicating. | Check control panel connection.<br>Check the connectors of the control panel.<br>Check the mounting platform used, if used.<br>Disconnect the control panel and then reconnect its connector. |
| A880 | Motor bearing<br>Programmable warnings:<br>33.14 On-time 1 warn message<br>33.24 On-time 2 warn message<br>33.55 Value counter 1 warn message<br>33.65 Value counter 2 warn message | Warning generated by a switch-on time counter or a value counter. | Check the supplementary code. Check the source of the warning using the supplementary code:<br>0: 33.13 On-time 1 source<br>1: 33.23 On-time 2 source<br>4: 33.53 Value counter 1 source<br>5: 33.63 Value counter 2 source |
| A881 | Output relay | Warning generated by an edge counter.<br>Programmable warnings:<br>33.35 Edge counter 1 warn message<br>33.45 Edge counter 2 warn message | Check the supplementary code. Check the source of the warning using the supplementary code:<br>2: 33.33 Edge counter 1 source<br>3: 33.43 Edge counter 2 source |
| A882 | Motor starts | | |
| A883 | Power ups | | |
| A884 | Main contactor | | |
| A885 | DC charge | | |
| A886 | On-time 1<br>(Message text that can be edited) Programmable warning:<br>33.14 On-time 1 warn message | The warning is generated by switch-on time timer 1. | Check the setting of the source of the warning (parameter 33.13 On-time 1 source). |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A887 | On-time 2<br>(Message text that can be edited) Programmable warning:<br>Warning: 33.24 On-time 2 warn message | The warning is generated by switch-on time timer 2. | Check the setting of the source of the warning (parameter 33.23 On-time 2 source). |
| A888 | Edge counter 1<br>(Message text that can be edited) Programmable warning:<br>33.35 Edge counter 1 warn message | The warning is generated by edge counter 1. | Check the setting of the source of the warning (parameter 33.33 Edge counter 1 source). |
| A889 | Edge counter 2<br>(Message text that can be edited) Programmable warning:<br>33.45 Edge counter 2 warn message | The warning is generated by edge counter 2. | Check the setting of the source of the warning (parameter 33.43 Edge counter 2 source). |
| A88A | Value counter 1<br>(Message text that can be edited) Programmable warning:<br>33.55 Value counter 1 warn message | The warning is generated by value counter 1. | Check the setting of the source of the warning (parameter 33.53 Value counter 1 source). |
| A88B | Value counter 2<br>(Message text that can be edited) Programmable warning:<br>33.65 Value counter 2 warn message | The warning is generated by value counter 2. | Check the setting of the source of the warning (parameter 33.63 Value counter 2 source). |
| A88C | Device clean | Warning generated by a switch-on time timer.<br>Programmable warnings:<br>33.14 On-time 1 warn message<br>33.24 On-time 2 warn message | Check the supplementary code. Check the source of the warning using the supplementary code:<br>0: 33.13 On-time 1 source<br>1: 33.23 On-time 2 source<br>10: 05.04 Fan on-time counter. |
| A88D | DC capacitor | | |
| A88E | Cabinet fan | | |
| A88F | Cooling fan | | |
| A890 | Additional cooling | | |
| A8A0 | AI supervision<br>Programmable warning:<br>12.03 AI supervision function | An analog signal has exceeded one of the limit values specified for the analog input. | Check the supplementary code (format XYY). "X" specifies the location of the input (0: AI on the control unit; 1: I/O extension module 1, etc.), "YY" specifies the input and limits (01: AI1 below minimum, 02: AI1 above maximum, 03: AI2 below minimum, 04: AI2 above maximum).<br>Check the signal level on the analog input.<br>Check the wiring to the input.<br>Check the upper and lower limit of the input in parameter group 12 Standard AI, 14 I/O extension module 1, 15 I/O extension module 2 or 16 I/O extension module 3. |
| A8B0 | Signal supervision<br>(Message text that can be edited) Programmable warning:<br>32.06 Supervision 1 action | Warning generated by signal monitoring function 1. | Check the setting of the source of the warning (parameter 32.07 Supervision 1 signal). |
| A8B1 | Signal supervision 2<br>(Message text that can be edited) Programmable warning:<br>32.16 Supervision 2 action | Warning generated by the signal monitoring function 2. | Check the setting of the source of the warning (parameter 32.17 Supervision 2 signal). |
| A8B2 | Signal supervision 3<br>(Message text that can be edited) Programmable warning:<br>32.26 Supervision 3 action | Warning generated by the signal monitoring function 3. | Check the setting of the source of the warning (parameter 32.27 Supervision 3 signal). |
| A8BE | ULC overload warning<br>Programmable fault:<br>37.03 ULC overload actions | The selected signal has exceeded the user overload curve. | Check for operating conditions that increase the monitored signal (for example, the motor load if the torque or the current is monitored).<br>Check the definition of the load curve (parameter group 37 User load curve). |
| A8BF | ULC underload warning<br>Programmable fault:<br>37.04 ULC underload actions | The selected signal has fallen below the user underload curve. | Check for operating conditions that decrease the monitored signal (for example, the load decreases if the torque or the current is monitored).<br>Check the definition of the load curve (parameter group 37 User load curve). |
| A8C0 | Fan service counter | A fan has reached the end of its calculated service life. See parameters 05.41 and 05.42. | Check the supplementary code. The code shows the fan to be replaced.<br>0: Main fan<br>1: Auxiliary fan<br>2: Auxiliary fan 2<br>3: Cabinet cooling fan<br>4: Fan of the circuit board housing<br>For instructions on how to replace the fan, see the hardware manual of the frequency inverter. |
| A981 | External warning 1<br>(Message text that can be edited) Programmable warning:<br>31.01 External event 1 source<br>31.02 External event 1 type | Fault on external device 1. | Check the external device.<br>Check the setting of parameter 31.01 External event 1 source. |
| A982 | External warning 2<br>(Message text that can be edited) Programmable warning:<br>31.03 External event 2 source<br>31.04 External event 2 type | Fault on external device 2. | Check the external device.<br>Check the setting of parameter 31.03 External event 2 source. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| A983 | External warning 3<br>(Message text that can be edited) Programmable warning:<br>31.05 External event 3 source<br>31.06 External event 3 type | Fault on external device 3. | Check the external device.<br>Check the setting of parameter 31.05 External event 3 source. |
| A984 | External warning 4<br>(Message text that can be edited) Programmable warning:<br>31.07 External event 4 source<br>31.08 External event 4 type | Fault on external device 4. | Check the external device.<br>Check the setting of parameter 31.07 External event 4 source. |
| A985 | External warning 5<br>(Message text that can be edited) Programmable warning:<br>31.09 External event 5 source<br>31.10 External event 5 type | Fault on external device 5. | Check the external device.<br>Check the setting of parameter 31.09 External event 5 source. |
| AF80 | INU-LSU comm loss<br>Programmable warning: 60.79 INU-LSU comm loss function | DDCS communication (via fiber optic) between the frequency inverter power units (e.g. the inverter unit and the rectifier unit) failed. | Check the status of other frequency inverter power units (parameters 06.36 and 06.39).<br>Check the settings of parameter group 60 DDCS communication. Check the corresponding settings in the control program of the other frequency inverter power units. Check the cable connections. If necessary, replace the cables. |
| AF85 | Line side unit warning | The rectifier unit generated a warning. | If a control panel or PC tool Drive Composer is used, connect it to the rectifier unit to read the warning code. For information about the codes, see the firmware manual of the rectifier unit. |
| AF8C | Process PID sleep mode | The drive goes into sleep mode. | Informative warning. See section "Sleep function" of process control (page 70) and parameters 40.41...40.48. |
| AF90 | Speed controller autotuning | The autotuning routine of the speed controller was not completed successfully. | Check the supplementary code (format XXXX YYYY). "YYYY" stands for the problem (see the measures for each code after this list). |
| | 0000 | The frequency inverter was stopped before the autotuning routine was completed. | Repeat autotuning until it is completed successfully. |
| | 0001 | The frequency inverter was started but was not ready to follow the autotuning command. | Ensure that the requirements for the autotuning routine are met. See section Before enabling the controller autotuning routine (page 232). |
| | 0002 | The required torque setpoint was not reached before the frequency inverter reached the maximum speed. | Decrease the torque step (parameter 25.38) or increase the speed step (25.39). |
| | 0003 | The motor could not accelerate/decelerate to the max/min speed. | Increase the torque step (parameter 25.38) or decrease the speed step (25.39). |
| | 0005 | The motor could not decelerate with the full autotuning torque. | Reduce the torque step (parameter 25.38) or the speed step (25.39). |
| AFAA | Autoreset | A fault should be acknowledged automatically. | Informative warning. See the settings in parameter group 31 Fault functions. |
| AFE1 | Emergency stop (off2) | The frequency inverter received a stop command (stop type off2). | Check whether it is safe to continue operation. Acknowledge the source of the emergency stop signal (e.g. an emergency stop button). Restart the frequency inverter.<br>If the emergency stop was unintentional, check the source of the stop signal (e.g 21.05 Emergency stop source or the control word received from an external controller). |
| | | (Follower drive in a master/follower configuration) Drive received a stop command from the master. | Informative warning. After stopping via a ramped stop command (OFF1 or OFF3), the master sends a short 10 millisecond command to the follower(s) to coast to a stop (OFF2).<br>The OFF2 stop is stored in the event log of the follower. |
| AFE2 | Emergency stop (OFF1 or OFF3) | The frequency inverter received a stop command (stop type OFF1 or OFF3). | Check whether it is safe to continue operation. Acknowledge the source of the emergency stop signal (e.g. an emergency stop button). Restart the frequency inverter.<br>If the emergency stop was unintentional, check the source of the stop signal (e.g 21.05 Emergency stop source or the control word received from an external controller). |
| AFE7 | Follower | A follower switched off with a fault message. | Check the supplementary code. Add 2 to the code to find out the node address of the faulty frequency inverter.<br>Fix the fault in the follower. |
| AFEA | Enable start signal missing<br>(Message text that can be edited) | No start enable signal received. | Check the setting (and source) of parameter 20.19 Enable start command. |
| AFEB | Run enable missing<br>(Message text that can be edited) | No controller enable signal received. | Check the setting of parameter 20.12 Run enable 1 source. Switch on the signal (e.g. in the fieldbus control word) or check the connection to the selected signal source. |

| Code (Hex) | Warning | Cause | Measure |
|---|---|---|---|
| AFEC | External power signal missing | 95.04 Control board supply is set to External 24 V, but no external power supply is connected to the XPOW connector of the control unit. | Check the external 24 V DC power supply of the control unit or change the setting of parameter 95.04. |
| AFF6 | Identification run | The motor ID run will be performed at the next start or is in progress. | Informative warning. |
| AFF7 | Autophasing | Autophasing is performed at the next start. | Informative warning. |
| B5A0 | STO event<br>Programmable event: 31.22 STO indication run/stop | Function Safe Torque Off is enabled, i.e. safety circuit signal(s) connected to XSTO are not received. | Check the connections of the safety circuits. For additional information, see the respective hardware manual and description of parameter 31.22 STO indication run/stop (page 295). |
| B5A4 | SW internal diagnostics | Unexpected restart of the control unit. | Informative event. |
| B686 | Checksum mismatch<br>Programmable event: 96.54 Checksum action | The calculated parameter checksum does not correspond to an enabled setpoint checksum. | See A686 Checksum mismatch (page 336). |

## 6.4.5 Fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 2281 | Calibration | The measured offset of the output phase current measurement or the difference between the current measurements of output phases U2 and W2 is too large (values are updated during calibration). | Try to perform current calibration again (selection of Current measurement calibration at parameter 99.13). |
| 2310 | Overcurrent | The output current exceeded the internal fault limit. | See A2B1 Overcurrent (page 333). |
| 2330 | Earth leakage<br>Programmable fault: 31.20 Earth fault | The frequency inverter detected a load asymmetry typical of a ground fault in the motor or motor cable. | Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable.<br>Check for ground faults in the motor or motor cable by measuring the insulation resistance of the motor and motor cable. |
| 2340 | Short circuit | Short circuit in motor cable(s) or motor | Check the motor and motor cable for connection errors.<br>Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable.<br>Check the supplementary code (format XXXY YYZZ). In the case of inverter modules connected in parallel, "Y YY" indicates the channel of control unit BCU through which the fault was received. "ZZ" indicates the location of the short circuit (0: No detailed information available, 1: Upper branch of U phase, 2: Lower branch of U phase, 4: Upper branch of V phase, 8: Lower branch of V phase, 10: Upper branch of W phase, 20: Lower branch of W phase, other: Combinations of the above).<br>After correcting the fault, restart the control unit by switching it off and on again or with parameter 96.08 Control board boot. |
| 2381 | IGBT overload | IGBT overtemperature between junction and housing. This fault message protects IGBT(s), and it can be enabled by a short circuit in the motor cable. | Check the motor cable.<br>Check the ambient conditions.<br>Check the ambient conditions. Check the cooling air flow and functionality of the fan.<br>Check the heat sink fins for dust deposits.<br>Compare the motor power with the power of the frequency inverter. |
| 2391 | BU current difference | The difference of the phase current between the inverter modules connected in parallel is too high. | Check the motor cable.<br>Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable.<br>Check the supplementary code (format XXXY YYZZ). "XXX" specifies the source of the first error (see "YYY"). "YYY" specifies the channel of control unit BCU in the module through which the fault was received (1: Channel 1, 2: Channel 2, 4: Channel 3, 8: Channel 4, ..., 800: Channel 12, other: Combinations of the above). "ZZ" refers to the phase (1: U, 2: V, 3: W). |
| 2392 | BU earth leakage | The sum of the ground fault current of the inverter modules is too high. | Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable.<br>Check the insulation resistance of the motor and motor cables. |
| 3130 | Input phase loss<br>Programmable fault: 31.21 Supply phase loss | The DC bus voltage oscillates due to a missing input phase or a melted fuse. | Check the fuses of the mains connection.<br>Check the power cable for loose connections.<br>Check the asymmetry of the supply network. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 3180 | Charge relay lost | No feedback received from the charging relay. | Contact your B&R representative. |
| 3181 | Wiring or earth fault<br>Programmable fault: 31.23 Wiring or earth fault | The frequency inverter hardware is powered by a common DC bus. | Switch off the protection in parameter 31.23. |
| | | Faulty input voltage connection and motor cable connection (i.e. the supply cable is connected to the motor connection terminals). | Check the power connections. |
| | | The frequency inverter detected a load asymmetry typical of a ground fault in the motor or motor cable. | Check and ensure that no power factor correction capacitors or overvoltage absorbers are installed on the motor cable.<br>Check for ground faults in the motor or motor cable by measuring the insulation resistance of the motor and motor cable. |
| 3210 | DC link overvoltage | The DC bus voltage is too high.The DC bus voltage is too low due to a missing supply phase, a melted fuse or a faulty rectifier bridge. | Check whether overvoltage control is enabled (parameter 30.30 Overvoltage control).<br>Check whether the supply voltage corresponds to the nominal input voltage of the frequency inverter.<br>Check the supply connection for static or transient overvoltage.<br>Check the brake chopper and resistor (if used).<br>Check the delay time.<br>Use the coast function (if permissible).<br>Retrofit the frequency inverter with brake choppers and resistors.<br>For modules connected in parallel, check the supplementary code (format XXXY YYZZ). "Y YY" stands for the channel of control unit BCU through which the fault was received. |
| 3220 | DC link undervoltage | The DC bus voltage is too low due to a missing supply phase, a melted fuse or a faulty rectifier bridge. | Check the supply cables, fuses and switchgear/distributor.<br>For modules connected in parallel, check the supplementary code (format XXXY YYZZ). "Y YY" stands for the channel of control unit BCU through which the fault was received. |
| 3280 | Standby timeout | Automatic restart failed (see section Automatic restart on page Undervoltage control (power failure control)). | Check the condition of the mains supply (voltage, wiring, fuses, switchgear). |
| 3291 | BU DC link difference | The difference of the DC voltages between inverter modules connected in parallel | Check the supplementary code (format XXXY YYZZ). "XXX" specifies the source of the first error (see "YYY"). "YYY" specifies the channel of control unit BCU in the module through which the fault was received (1: Channel 1, 2: Channel 2, 4: Channel 3, 8: Channel 4, ..., 800: Channel 12). |
| 3381 | Output phase loss<br>Programmable fault: 31.19 Motor phase loss | Motor connection is missing (not all three phases are connected). | Connect the motor cable. |
| 3385 | Autophasing | The autophasing routine failed (see section Autophasing on page 234). | If possible, try other autophasing types (see parameter 21.13 Autophasing mode).<br>If mode Turning with Z-pulse is selected, check the zero pulse given by the rotary encoder.<br>Check and ensure that the motor ID run was completed successfully.<br>Check parameter 98.15 Position offset user.<br>Check and ensure that the encoder does not slip on the motor shaft.<br>Check and ensure that the motor is not already rotating when autophasing starts.<br>Check the setting of parameter 99.03 Motor type. |
| 4000 | Motor cable overload | The calculated motor cable temperature has exceeded the warning limit. | Check the settings of parameters 35.61 and 35.62.<br>Check the dimensioning of the motor cable with regard to the required load. |
| 4210 | IGBT overtemperature | The calculated IGBT temperature of the frequency inverter is too high. | Check the ambient conditions.<br>Check if there is sufficient cool air flow and fan operation.<br>Check heat sink fins for dust coating.<br>Compare the motor power with the power of the frequency inverter. |
| 4290 | Cooling | The temperature of the frequency inverter is too high. | Check the ambient temperature. If it is higher than 40°C (104°F), ensure that the load current does not exceed the reduced load capacity of the frequency inverter. See the corresponding hardware manual.<br>Check if there is sufficient air flow and fan operation.<br>Check the interior of the cabinet and the heat sink of the frequency inverter module for dust deposits. Clean if necessary. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 42F1 | IGBT temperature | The IGBT temperature of the frequency inverter is too high. | Check the ambient conditions.<br>Check the cooling air flow and functionality of the fan.<br>Check the heat sink fins for dust deposits.<br>Compare the motor power with the power of the frequency inverter. |
| 4310 | Excess temperature | The power unit temperature is too high. | See A4B0 Overtemperature (page 335). |
| 4380 | Excess temperature difference | High temperature difference between IGBTs of different phases. | See A4B1 Excess temperature difference (page 335). |
| 4381 | PCB space cooling | The temperature difference between the ambient temperature and the temperature of the circuit board housing is too high. | See A4B2 PCB space cooling. (page 335) |
| 4981 | External temperature 1<br>(Message text that can be edited) | Measured temperature 1 exceeded the fault limit. | Check the value of parameter 35.02 Measured temperature 1.<br>Check the motor cooling (or other devices whose temperature is measured).<br>Check the value of parameter 35.12 Temperature 1 fault limit. |
| 4982 | External temperature 2<br>(Message text that can be edited) | Measured temperature 2 exceeded the fault limit. | Check the value of parameter 35.03 Measured temperature 2.<br>Check the motor cooling (or other devices whose temperature is measured).<br>Check the value of parameter 35.22 Temperature 2 fault limit. |
| 5080 | Fans | Fan feedback is missing. | See A581 Fan (page 335). |
| 5081 | Auxiliary fan not running | An auxiliary fan (connected to the fan terminals of the control unit) is blocked or is disconnected from the power supply. | Check the supplementary code. The supplementary code refers to the fan (1: Auxiliary fan 1, 2: Auxiliary fan 2).<br>Check the auxiliary fan(s) and the respective connection(s). Replace the defective fan.<br>Ensure that the front cover of the frequency inverter module is installed and screwed tight. If the cover must be removed during commissioning, enable the fault suppression if the auxiliary fan for two minutes after restarting the control unit to temporarily suppress the fault. |
| 5090 | STO hardware failure | Hardware fault in the circuit of function Safe Torque Off (STO). | Contact your B&R representative and state the supplementary code. The code contains information about the location of the fault, especially for inverter modules connected in parallel. If the bits of the code are converted to 32-bit binary numbers, they represent the following:<br>31...28: Number of defective inverter modules (0...11 decimal). 1111: STO_ACT states of control unit and inverter modules between which there is a conflict 27: State STO_ACT of inverter modules 26: State STO_ACT of control unit 25: STO1 of control unit 24: STO2 of control unit 23...12: STO1 of inverter modules 12...1 (bits of non-existent modules set to 1) 11...0: STO2 of inverter modules 12...1 (bits of non-existent modules set to 1) |
| 5091 | Safe torque off<br>Programmable fault: 31.22 STO indication run/stop | Function Safe Torque Off is disabled, i.e. safety circuit signal(s) connected to XSTO are interrupted at startup or during operation. | Check the connections of the circuit of function Safe Torque Off. For additional information, see the respective hardware manual and description of parameter 31.22 STO indication run/stop (page 295). |
| 5092 | PU logic error | The memory of the power unit was deleted. | Switch the power supply of the frequency inverter off and on again. If the control unit is supplied externally, also restart the control unit by switching it off and on again or with parameter 96.08 Control board boot. |
| 5093 | Rating ID mismatch | The hardware of the frequency inverter does not match the data stored in the memory unit. The error message can appear, for example, after a firmware update or memory unit replacement. | Switch the power supply of the frequency inverter off and on again.<br>Check the supplementary code. Categories of the supplementary code:<br>1 = PU and CU nominal data are not the same. Nominal data ID has changed. 2 = Nominal data ID of parallel connection changed 3 = PU types are not the same in all power units. 4 = Nominal data ID of parallel connection is enabled in a single power unit 5 = It is not possible to implement the selected nominal data with the current PUs. 6 = Nominal data ID of the PU is 0. 7 = Reading out the nominal data ID for the PU or PU type failed during PU connection. 8 = PU not supported (invalid nominal data ID).<br>In the event of disturbances of parallel connection (control unit BCU), the format of the supplementary code is 0X0Y. "Y" represents the category of the supplementary code, "X" indicates the first faulty PU channel in hexadecimal format (1...C). (For a ZCI control unit, "X" can also be 1 or 2, but this is irrelevant for the fault.) |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 5094 | Measurement circuit temperature | Problem with internal temperature measurement of the frequency inverter. | See A5EA Measurement circuit temperature (page 336). |
| 5681 | PU communication | The type of power supply to the control unit does not correspond to the parameter setting. | Check the setting of parameter 95.04 Control board supply. |
| | | Communication error between the control unit and the power unit of the frequency inverter. | Check the connections between the control unit and the power unit.<br>Check the supplementary code (format XXXY YYZZ). For modules connected in parallel, "Y YY" indicates the affected channel of control unit BCU (0: Transfer). "ZZ" specifies the source of the error (1: Transmitter side [connection error], 2: Transmitter side [no communication], 3: Receiver side [connection error], 4: Receiver side [no communication], 5: Transmitter FIFO error [see "XXX"], 6: Module [xINT card] not found, 7: BAMU card not found). "XXX" specifies the transmitter FIFO error code (1: Internal error [invalid call parameter], 2: Internal error [configuration is not supported], 3: Transfer buffer full). |
| 5682 | Power unit lost | The connection between the control unit and the power unit of the frequency inverter failed. | Check the connections between the control unit and the power unit. |
| 5690 | PU communication internal | Internal communication is disrupted. | Contact your B&R representative. |
| 5691 | Measurement circuit ADC | Measurement circuit fault | Contact your B&R representative. |
| 5692 | PU board powerfail | Fault in the power supply to the power unit. | Check the supplementary code (format ZZZY YYXX). "YY Y" specifies the affected inverter module (0...C, always 0 for ZCU control units). "XX" specifies the affected power supply (1: Power supply 1, 2: Power supply 2, 3: Both power supplies). |
| 5693 | Measurement circuit DFF | Measurement circuit fault. | Contact your B&R representative. |
| 5694 | PU communication configuration | A version check cannot find a matching FPGA logic of the power unit. | Contact your B&R representative. |
| 5695 | Reduced run | The number of detected inverter modules does not match the value of parameter 95.13 Reduced run mode. | Check whether the value of 95.13 Reduced run mode corresponds to the number of existing inverter modules. Check whether the existing modules are supplied by the DC bus and are connected to control unit BCU with fiber optic cables.<br>If all modules of the inverter unit are ready for operation (e.g. maintenance tasks completed), check whether parameter 95.13 is set to 0 (reduced operation disabled). |
| 5696 | PU state feedback | Status response from the output phases does not match the control signals. | Contact your B&R representative. |
| 5697 | Charging feedback | Charging switch and DC switch were operated in disregard of the sequence, or a start command was issued before the unit was ready for operation. | Normal switch-on sequence:<br>1. Close the charging switch.<br>2. After charging has been completed ("OK" lights up for the charging procedure), close the DC switch.<br>3. Open the charging switch. |
| | | Charging circuit fault. | Check the charging circuit.<br>For an inverter module of size R6i/R7i, supplementary code "FA" indicates that the feedback on the charging protection status does not match the control signal.<br>For modules of size R8i that are connected in parallel, supplementary code (format XX00) "XX" indicates the affected channel of control unit BCU. |
| 5698 | Unknown power unit fault | Unknown logic fault of the power unit | Check the compatibility of the power unit logic with the firmware.<br>Contact your B&R representative. |
| 6000 | Internal SW error | Internal fault. | Contact your B&R representative. |
| 6181 | FPGA version incompatible | The firmware and FPGA file version in the power unit is not compatible. | Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again. If the problem persists, contact your B&R representative. |
| | | Software update of the power unit failed. | Retry. |
| 6200 | Checksum mismatch<br>Programmable fault: 96.54 Checksum action | The calculated parameter checksum does not correspond to an enabled target checksum. | See A686 Checksum mismatch (page 336). |
| 6306 | FBA A mapping file | Read error of the mapping file of fieldbus adapter A. | Contact your B&R representative. |
| 6307 | FBA B mapping file | Read error of the mapping file of fieldbus adapter B. | Contact your B&R representative. |
| 6481 | Task overload | Internal fault. | Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again.<br>If the problem persists, contact your B&R representative. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 6487 | Stack overflow | Internal fault. | Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again.<br>If the problem persists, contact your B&R representative. |
| 64A1 | Internal file load | Data read error | Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again.<br>If the problem persists, contact your B&R representative. |
| 64A2 | Internal record load | Internal record load error. | Contact your B&R representative. |
| 64A3 | Application loading | Application file incompatible or corrupted | Check the supplementary code. See the measures after the following specification on the codes. |
| | 8006 | Not enough memory for the application. | Reduce the size of the application.<br>Reduce the number of parameter mappings.<br>See the drive-specific log generated by Automation Builder. |
| | 8007 | The application contains an incorrect system library version. | Update the system library or reinstall Automation Builder.<br>See the drive-specific log generated by Automation Builder. |
| | 8008 | The application is empty. | Output command "Clean" and reload the application in Automation Builder. |
| | 8009 | The application contains invalid tasks. | In Automation Builder, check the configuration of the application task, issue command "Clean all" and reload the application. |
| | 800A | The application contains an unknown target (system library function). | Update the system library or reinstall Automation Builder.<br>See the drive-specific log generated by Automation Builder. |
| 64A5 | Licensing fault | Starting the control program is prevented since either a restricted license is present or a required license is missing. | Record the supplementary coded of all license errors and contact the product supplier for further instructions. |
| 64A6 | Adaptive program | Error during execution of the adaptive program | Check the supplementary code (format XXXX YYYY). "XXXX" specifies the number of the function block (0000 = General fault). "YYYY" stands for the problem (see the measures for each code after this list). |
| | 000A | Program corrupted or block missing | Restore the template program or download the program to the frequency inverter. |
| | 000C | The required block input is missing. | Check the inputs of the block. |
| | 000E | Program corrupted or block missing | Restore the template program or download the program to the frequency inverter. |
| | 0011 | The program is too big. | Remove the blocks until the fault is resolved. |
| | 0012 | The program is empty. | Correct the program and load it onto the frequency inverter. |
| | 001C | A parameter or block that does not exist is used in the program. | Edit the program to correct the parameter setpoint or to use an existing block. |
| | 001D | The parameter type for the selected pin is invalid. | Edit the program to correct the parameter setpoint. |
| | 001E | Output to the parameter failed since the parameter was read-only. | Check the parameter setpoint in the program.<br>Check for other sources that affect the target parameter. |
| | 0023 | The program file is not compatible with the current firmware version. | Adapt the program to the current function block library and firmware version 0024. |
| | 0024 | | |
| | 002A | Too many blocks. | Edit the program to reduce the number of blocks. |
| | Other | - | Contact your B&R representative and state the supplementary code. |
| 64B0 | Memory unit detached | The memory unit was removed when the control unit was switched on. | Switch off the power supply to the control unit and reinstall the memory unit.<br>If the memory unit was not removed when the fault occurred, check whether the memory unit is properly positioned in the slot and the mounting screw is tight. Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again.<br>If the problem persists, contact your B&R representative. |
| 64B1 | Internal SSW fault | Internal fault. | Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again.<br>If the problem persists, contact your B&R representative. |
| 64B2 | User set fault | Loading the user parameter set failed since<br>• The requested record does not exist<br>• The set is not compatible with the control program<br>• The frequency inverter was switched off during charging. | Ensure that a valid parameter set exists. Try to load it again if you are unsure. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 64E1 | Kernel overload | Operating system error. | Reboot the control unit (using parameter 96.08 Control board boot) or perform a restart by switching the power supply off and on again. |
| 6581 | Parameter system | Loading or saving parameters failed. | Try to force saving with parameter 96.07 Parameter save manually. Retry. |
| 65A1 | FBA A parameter conflict | The frequency inverter does not have the function requested by the PLC or the function is not enabled. | Check the PLC programming.<br>Check the settings of parameter group 50 Fieldbus adapter (FBA) and 51 FBA A settings. |
| 65A2 | FBA B parameter conflict | The frequency inverter does not have the function requested by the PLC or the function is not enabled. | Check the PLC programming.<br>Check the settings of parameter group 50 Fieldbus adapter (FBA). |
| 65B1 | Setpoint source 1 configuration | A setpoint source is simultaneously connected to several parameters with different units. | See A6DA Reference source parameterization (page 337). |
| 6681 | EFB comm loss | Communication failure in the integrated fieldbus (EFB). | Check the status of the fieldbus master ("Online", "Offline", "Error", etc.).<br>Check the cable connections on the XD2D connector on the control unit. |
| 6682 | EFB config file | The configuration file of the integrated fieldbus (EFB) could not be read. | Contact your B&R representative. |
| 6683 | EFB invalid parameterization | The parameter settings of the integrated field bus (EFB) are not consistent or not compatible with the selected protocol. | Check the settings in parameter group 58 Embedded fieldbus. |
| 6684 | EFB load fault | The protocol firmware of the integrated fieldbus (EFB) could not be loaded.<br>The version of the EFB protocol firmware and the frequency inverter firmware are not compatible. | Contact your B&R representative. |
| 6881 | Text data overflow | Internal fault. | Acknowledge the fault. Contact your B&R representative if the fault persists. |
| 6882 | Text 32-bit table overflow | Internal fault. | Acknowledge the fault. Contact your B&R representative if the fault persists. |
| 6883 | Text 64-bit table overflow | Internal fault. | Acknowledge the fault. Contact your B&R representative if the fault persists. |
| 6885 | Text file overflow | Internal fault. | Acknowledge the fault. Contact your B&R representative if the fault persists. |
| 7080 | Option module comm loss | Communication between the frequency inverter and an optional module failed. | See A798 Encoder option comm loss (page 338). |
| 7081 | Control panel loss | The control panel (or PC tool) has set communication. | Check the PC tool or control panel connection.<br>Check the connectors of the control panel.<br>Disconnect the control panel and then reconnect its connector.<br>Check the supplementary code. The code specifies the I/O port as follows: 0: Control panel, 1: Fieldbus interface A, 2: Fieldbus interface B, 3: Ethernet, 4: D2D/EFB port). |
| 7082 | Ext I/O comm loss | The I/O expansion module types and locations that are parameterized do not correspond to the detected configuration. | Check the supplementary code (format XXYY YYYY). "XX" specifies the number of I/O expansion modules (01: Parameter group 14 I/O extension module 1, 02: 15 I/O extension module 2, 03: 16 I/O extension module 3). "YY YYY" represents the problem (see the measures for each code after this list). |
| | 00 0001 | Communication with the module failed. | Check whether the module is properly installed in its slot.<br>Check whether the module and the slot connector are not damaged.<br>Install the module in another slot. |
| | 00 0002 | The module was not found. | Check the settings of the modules with regard to type and slot (parameters 14.01, 14.02, 15.01, 15.02 and 16.01/16.02).<br>Check whether the module is properly installed in its slot.<br>Check whether the module and the slot connector are not damaged.<br>Install the module in another slot. |
| | 00 0003 | Configuration of the module failed. | |
| | 00 0004 | Configuration of the module failed. | |
| 7083 | Panel reference conflict | An attempt was made to use the stored control panel setpoint for several control modes. | The control panel setpoint can be saved for only one setpoint type at a time. Consider the possibility of using a copied setpoint instead of a stored setpoint (see the setpoint selection parameters). |
| 7084 | Panel version conflict | The current version of the control panel does not support a function. (For example, older control panel versions cannot be used as a source of an external setpoint.) | Update control panel. If necessary, contact your B&R representative. |
| 7085 | Optional module not compatible | The optional module is not supported. (For example, fieldbus adapter modules of type Fxxxxx- M are not supported.) | Check the supplementary code. The code specifies the interface to which the unsupported module is connected: 1: Fieldbus interface A, 2: Fieldbus interface B.<br>Replace the module with a supported type. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 7121 | Motor stall<br>Programmable fault: 31.24 Stall function | The motor is operating in the stall range due to load that is too high or insufficient motor power, for example. | Check the motor load and the nominal data of the frequency inverter.<br>Check the parameter settings of the fault function. |
| 7181 | Brake resistor | The braking resistor is defective or not connected. | Check whether a braking resistor is connected.<br>Check the state of the braking resistor.<br>Check the dimensioning of the braking resistor. |
| 7183 | BR excess temperature | The measured motor temperature exceeded the fault limit according to parameter 43.11 Brake resistor fault limit. | Stop the drive. Let the braking resistor cool down.<br>Check the settings of the overload protective function of the resistor (parameter group 43 Brake chopper).<br>Check the setting of the fault limit, parameter 43.11 Brake resistor fault limit.<br>Check whether the permissible limit values are observed with the braking cycle. |
| 7184 | Brake resistor wiring | Short circuit of the braking resistor or fault of the braking chopper controller | Check the connections of the brake chopper and the braking resistor.<br>Ensure that the braking resistor is not damaged. After correcting the fault, restart the control unit by switching it off and on again or with parameter 96.08 Control board boot. |
| 7191 | BC short circuit | Short circuit in brake chopper IGBT | Check that the braking resistor is connected and not damaged.<br>Check the electrical specification of the braking resistor using the information in the hardware manual.<br>Replace the brake chopper (if replaceable). After correcting the fault, restart the control unit by switching it off and on again or with parameter 96.08 Control board boot. |
| 7192 | BC IGBT excess temperature | The brake chopper IGBT temperature exceeded the internal fault limit. | Let the brake chopper cool down.<br>Check whether the ambient temperature is too high.<br>Check whether the fan has failed.<br>Check whether the airflow is obstructed.<br>Check the dimensioning and cooling of the control cabinet.<br>Check the settings of the overload protective function of the resistor (parameter group 43 Brake chopper).<br>Check whether the permissible limit values are observed with the braking cycle.<br>Check whether the AC supply voltage of the frequency inverter is too high. |
| 71A2 | Mechanical brake closing failed<br>Programmable fault: 44.17 Brake fault function | Mechanical brake control fault. The fault message is enabled if the brake feedback signal is not received as expected when the brake is engaged. | Check the connection of the mechanical brake.<br>Check the settings of the mechanical brake in parameter group 44 Mechanical brake control.<br>Check whether the confirmation signal corresponds to the current status of the brake. |
| 71A3 | Mechanical brake opening failed<br>Programmable fault: 44.17 Brake fault function | Mechanical brake control fault. The fault message is enabled if the brake feedback signal is not received as expected when the brake is released. | Check the connection of the mechanical brake.<br>Check the settings of the mechanical brake in parameter group 44 Mechanical brake control.<br>Check whether the confirmation signal corresponds to the current status of the brake. |
| 71A5 | Mechanical brake opening not allowed<br>Programmable fault: 44.17 Brake fault function | Conditions for releasing the mechanical brake cannot be met (e.g. parameter 44.11 Keep brake closed prevents the brake from releasing). | Check the settings of the mechanical brake in parameter group 44 Mechanical brake control (in particular 44.11 Keep brake closed).<br>Check whether the confirmation signal (if used) corresponds to the current status of the brake. |
| | | In an encoderless application, the brake is held engaged for longer than 5 seconds against a modulating frequency inverter by the request for engaging the brake (parameter 44.12 Brake close request). | Check the signal source selected with parameter 44.12 Brake close request. |
| 71B1 | Motor fan<br>Programmable fault: 35.106 DOL starter event type | No feedback signal received from external fan. | Check the external fan (or other controlled devices) with the logic.<br>Check the settings of parameters 35.100...35.106. |
| 7301 | Motor speed feedback<br>Programmable fault: 90.45 Motor feedback fault | No motor speed feedback signal was received. | See A7B0 Motor speed feedback. (page 339) |
| 7310 | Overspeed | The motor speed is above the maximum permissible speed due to an incorrect setting of the minimum/maximum speed, an insufficient braking torque or due to a change in the load when using the torque setpoint. | Check the settings for the minimum and maximum speed, parameter 30.11 Minimum speed and 30.12 Maximum speed.<br>Check whether an appropriate motor braking torque exists.<br>Check whether torque control can be used.<br>Check the need for a brake chopper and resistor/resistors. |
| | | The calculated speed is not correct. | Check the status of the motor current measurement. |
| 7380 | Encoder internal | Internal fault. | Contact your B&R representative. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 7381 | Encoder<br>Programmable fault: 90.45 Motor feedback fault | Feedback signal of the encoder is missing. | See A7E1 Encoder (page 340). |
| 73A0 | Speed feedback configuration | The speed feedback configuration is not correct. | See Warning messages. (page 338) |
| 73A1 | Load feedback | No load feedback received. | Check the supplementary code (format XXYY ZZZZ). "XX" specifies the number of the pulse encoder interface module (01 91.11/91.12, 02: 91.13/91.14). "YY" specifies the pulse encoder (01: 92 Encoder 1 configuration, 02: 93 Encoder 2 configuration). "ZZZZ" stands for the problem (see the measures for each code after this list). |
| | 0001 | The load gear definition is invalid or outside the limits. | Check the load gear settings (90.53 and 90.54). |
| | 0002 | The defined slope value is invalid or outside the limits. | Check the settings of the slope value (90.63 and 90.64). |
| | 0003 | The motor/load gear definition is invalid or outside the limits. | Check the settings of the motor/load gear (90.61 and 90.62). |
| | 0004 | The encoder is not configured. | Check the settings of the encoder (92 Encoder 1 configuration.<br>Use parameter 91.10 Encoder parameter refresh) to validate the changes in the settings. |
| | 0005 | Encoder operation stopped. | Check the encoder status. |
| 73B0 | Emergency ramp failed | The emergency stop was not completed within the designated time. | Check the settings of parameters 31.32 Emergency ramp supervision and 31.33 Emergency ramp supervision delay.<br>The preset ramp times (23.11...23.19 for mode OFF1, 23.23 for mode OFF3). |
| 73B1 | Stop failed | The ramp-guided stop was not completed within the scheduled time. | Check the settings of parameters 31.37 Ramp stop supervision and 31.38 Ramp stop supervision delay.<br>Check the defined ramp times in parameter group 23 Speed reference ramp. |
| 7510 | FBA A communication | Cyclic communication between the frequency inverter and fieldbus adapter module A or between the PLC and fieldbus adapter module A is interrupted. | Check the status of the fieldbus communication. See the documentation of the fieldbus interface.<br>Check the settings of parameter group 50 Fieldbus adapter (FBA) and 51 FBA A settings.<br>Check the cable connections.<br>Check whether the communication master can communicate. |
| 7520 | FBA B communication | Cyclic communication between the frequency inverter and fieldbus adapter module B or between the PLC and fieldbus adapter module B is interrupted. | Check the status of the fieldbus communication. See the documentation of the fieldbus interface.<br>Check the settings of parameter group 50 Fieldbus adapter (FBA).<br>Check the cable connections.<br>Check whether the communication master can communicate. |
| 7580 | INU-LSU comm loss | DDCS communication (via fiber optic) between the frequency inverter power units (e.g. the inverter unit and the rectifier unit) failed. | Check the status of other frequency inverter power units.<br>Check the corresponding settings in the control program of the other frequency inverter power units.<br>Check the cable connections. If necessary, replace the cables. |
| 7581 | DDCS controller comm loss | DDCS communication (via fiber optic) between the inverter and the external controller failed. | Check the status of the external controller. See the documentation of the external controller.<br>Check the cable connections. If necessary, replace the cables. |
| 7582 | MF comm loss | The master/follower communication is interrupted. | See A7CB MF comm loss (page 340). |
| 7583 | Line side unit faulted | The rectifier unit connected to the inverter unit (or another frequency inverter) generated a fault. | Check the fault status of the rectifier unit (or other frequency inverter). |
| 7584 | LSU charge failed | The rectifier unit was not ready within the scheduled time (i.e. Main contactor / circuit breaker could not be closed). | Check whether the rectifier unit is activated, enabled for startup and can be controlled by the inverter unit (e.g. not in local control mode). |
| 8001 | ULC underload fault<br>Programmable fault: 37.04 ULC underload actions | The selected signal has fallen below the user underload curve. | See A8BF ULC underload warning (page 341). |
| 8002 | ULC overload fault<br>Programmable fault: 37.03 ULC overload actions | The selected signal has exceeded the user overload curve. | See A8BE ULC overload actions (page 341). |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| 80A0 | AI supervision<br>Programmable fault: 12.03 AI supervision function | An analog signal has exceeded one of the limit values specified for the analog input. | Check the supplementary code (format XXXX XYZZ). "Y" specifies the location of the input (0: Control unit / Control panel, 1: I/O extension module 1, 2: I/O extension module 2, 3: I/O extension module 3). "ZZ" specifies the limit (01: AI1 below the minimum, 02: AI1 above the maximum, 03: AI2 below the minimum, 04: AI2 above the maximum). Check the signal level on the analog input. Check the wiring to the input. Check the upper and lower limit values of the input in parameter group 12 Standard AI. |
| 80B0 | Signal supervision<br>(Message text that can be edited) Programmable fault: 32.06 Supervision 1 action | Fault generated by signal monitoring function 1. | Check the source of the fault (parameter 32.07 Supervision 1 signal). |
| 80B1 | Signal supervision 2<br>(Message text that can be edited) Programmable fault: 32.16 Supervision 2 action | Fault generated by signal monitoring function 2. | Check the source of the fault (parameter 32.17 Supervision 2 signal). |
| 80B2 | Signal supervision 3<br>(Message text that can be edited) Programmable fault: 32.26 Supervision 3 action | Fault generated by signal monitoring function 3. | Check the source of the fault (parameter 32.27 Supervision 3 signal). |
| 9081 | External fault 1<br>(Message text that can be edited) Programmable fault:<br>31.01 External event 1 source<br>31.02 External event 1 type | Fault of external device 1. | Check the external device.<br>Check the setting of parameter 31.01 External event 1 source. |
| 9082 | External fault 2<br>(Message text that can be edited) Programmable fault:<br>31.03 External event 2 source<br>31.04 External event 2 type | Fault of external device 2. | Check the external device.<br>Check the setting of parameter 31.03 External event 2 source. |
| 9083 | External fault 3<br>(Message text that can be edited) Programmable fault:<br>31.05 External event 3 source<br>31.06 External event 3 type | External device fault. 3 | Check the external device.<br>Check the setting of parameter 31.05 External event 3 source. |
| 9084 | External fault 4<br>(Message text that can be edited) Programmable fault:<br>31.07 External event 4 source<br>31.08 External event 4 type | Fault of external device 4. | Check the external device.<br>Check the setting of parameter 31.07 External event 4 source. |
| 9085 | External fault 5<br>(Message text that can be edited) Programmable fault:<br>31.09 External event 5 source<br>31.10 External event 5 type | Fault of external device 5. | Check the external device.<br>Check the setting of parameter 31.09 External event 5 source. |
| FA81 | Safe torque off 1 loss | Function "Safe Torque Off" is enabled, i.e. STO circuit 1 is interrupted. | Check the connections of the safety circuit. For additional information, see the respective hardware manual and description of parameter 31.22 STO indication run/stop (page 295).<br>Check the supplementary code. The code contains information about the location of the fault, especially for inverter modules connected in parallel. If the bits of the code are converted to 32-bit binary numbers, they represent the following:<br>31...28: Number of defective inverter modules (0...11 decimal). 1111: STO_ACT states of control unit and inverter modules between which there is a conflict 27: State STO_ACT of inverter modules 26: State STO_ACT of control unit 25: STO1 of control unit 24: STO2 of control unit 23...12: STO1 of inverter modules 12...1 (bits of non-existent modules set to 1) 11...0: STO2 of inverter modules 12...1 (bits of non-existent modules set to 1) |
| FA82 | Safe torque off 2 loss | Function "Safe Torque Off" is enabled, i.e. STO circuit 2 is interrupted. | |
| FB11 | Memory unit missing | No memory unit is connected to the control unit. | Switch off the control unit. Check whether the memory unit is properly connected to the control unit. |
| | | The memory unit inserted into the control unit is empty. | Switch off the control unit. Insert a memory unit (with the appropriate firmware) into the control unit. |
| FB12 | Memory unit missing | The memory unit connected to the control unit is not compatible. | Switch off the control unit.<br>Connect a compatible memory unit. |
| FB13 | Memory unit FW incompatible | The firmware of the memory unit connected is not compatible with the frequency inverter. | Switch off the control unit.<br>Connect a memory unit with compatible firmware. |
| FB14 | Memory unit FW load failed | The firmware of the memory unit connected could not be loaded into the frequency inverter. | Switch off the control unit.<br>Check whether the memory unit is properly connected to the control unit.<br>If the problem persists, replace the memory unit. |

Table 47: Overview of fault messages

| Code (Hex) | Fault | Cause | Measure |
|---|---|---|---|
| FF61 | ID run | The motor ID run was not completed successfully. | Check the nominal motor values in parameter group 99 Motor data.<br>Check that no external controller is connected to the inverter.<br>Switch the power supply of the frequency inverter off and on again (and of the control unit, if supplied separately).<br>Check that the motor shaft is not blocked.<br>Check the supplementary code. The second digit of the code represents the problem (see the measures for each code after this list). |
| | 0001 | Maximum current limit too low. | Check the settings of parameters 99.06 Motor nominal current and 30.17 Maximum current. Ensure that 30.17 > 99.06.<br>Check the correct dimensioning of the frequency inverter using the motor data. |
| | 0002 | The maximum speed limit or calculated field weakening point is too low. | Check the settings of the following parameters.<br>• 30.11 Minimum speed<br>• 30.12 Maximum speed<br>• 99.07 Motor nominal voltage<br>• 99.08 Motor nominal frequency<br>• 99.09 Motor nominal speed.<br>Ensure the following:<br>• 30.12 > (0.55 × 99.09) > (0.50 × synchronous speed)<br>• 30.11 < 0<br>• Supply voltage > (0.66 × 99.07) |
| | 0003 | The maximum torque limit is too low. | Check the settings of parameter 99.12 Motor nominal torque and the torque limits in group 30 Limits.<br>Ensure that the selected maximum torque limit is greater than 100%. |
| | 0004 | Calibration of current measurement was not completed within an appropriate time. | Contact your B&R representative. |
| | 0005…0008 | Internal fault. | Contact your B&R representative. |
| | 0009 | (Induction motors only) Acceleration was not completed in an appropriate time. | Contact your B&R representative. |
| | 000A | (Induction motors only) Deceleration was not completed in an appropriate time. | Contact your B&R representative. |
| | 000B | (Induction motors only) The speed dropped to zero during the ID run. | Contact your B&R representative. |
| | 000C | (Permanent magnet motors only) First acceleration was not completed in an appropriate time. | Contact your B&R representative. |
| | 000D | (Permanent magnet motors only) Second acceleration was not completed in an appropriate time. | Contact your B&R representative. |
| | 000E…0010 | Internal fault. | Contact your B&R representative. |
| FF7E | Follower | A follower switched off with a fault message. | Check the supplementary code. Add to the code to find out node address 2 of the faulty frequency inverter.<br>Fix the fault in the follower. |
| FF81 | FB A force trip | A fault switch-off command was received via fieldbus adapter A. | Check the error information from the PLC. |
| FF82 | FB B force trip | A fault switch-off command was received via fieldbus adapter B. | Check the error information from the PLC. |
| FF8E | EFB force trip | A fault switch-off command was received via the integrated fieldbus interface (EFB). | Check the error information from the Modbus controller. |

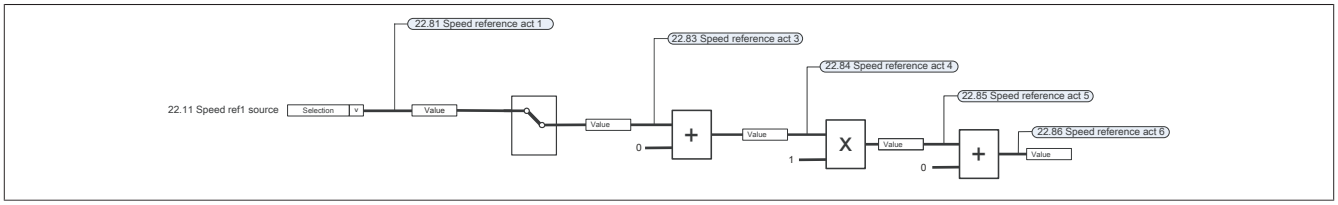
Table 47: Overview of fault messages

## 6.5 Block diagrams of closed-loop control/open-loop control

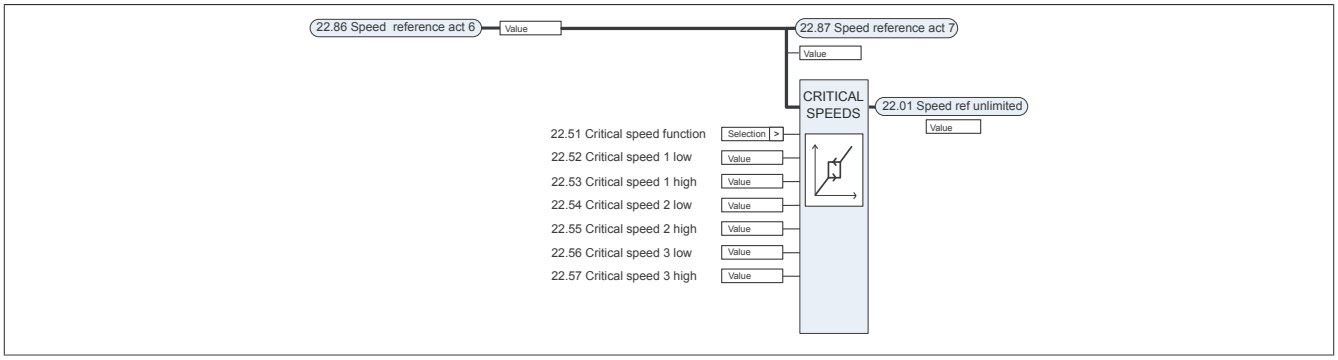
This chapter shows the block diagrams for closed-loop control and open-loop control of the frequency inverter. The closed-loop and open-loop control block diagrams show how the parameters interact and where the parameter settings have an effect within the drive parameter system.

A more general diagram is shown in section Operating modes of the frequency inverter .

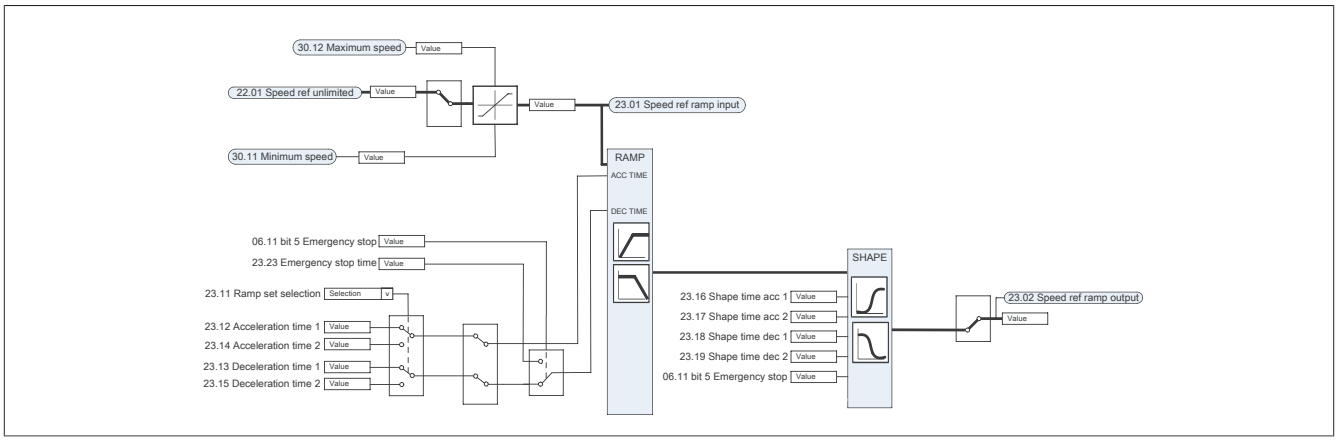
## 6.5.1 Speed setpoint - Source selection I



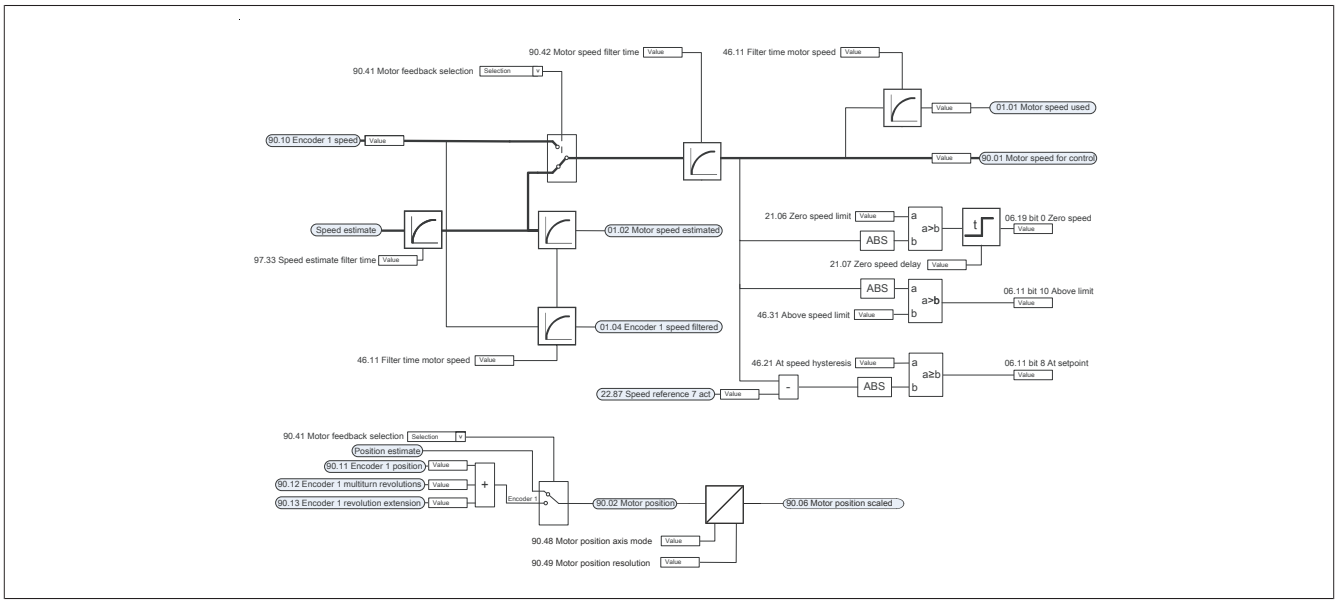

## 6.5.2 Speed setpoint - Source selection II



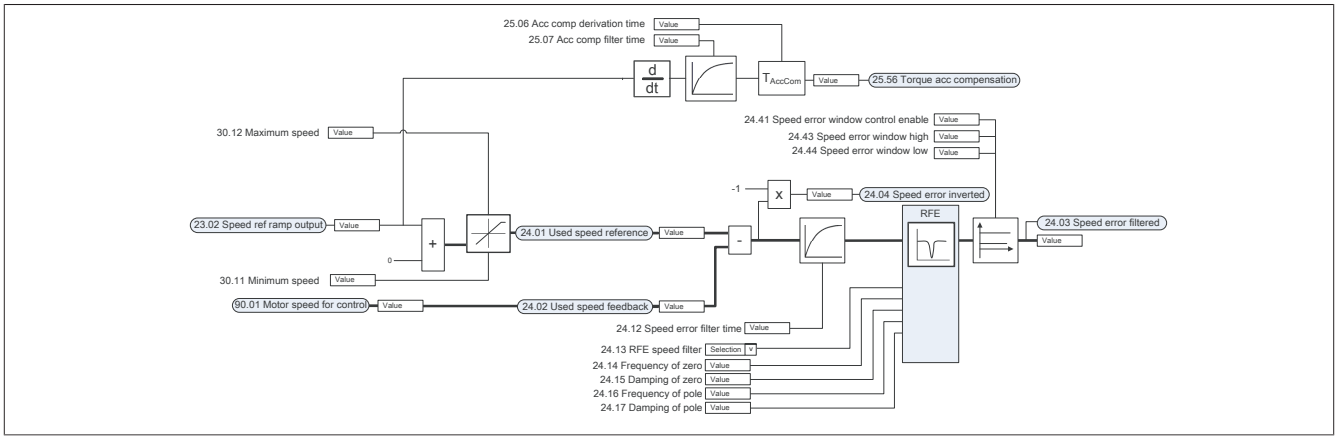

## 6.5.3 Speed setpoint - Ramp time and shape



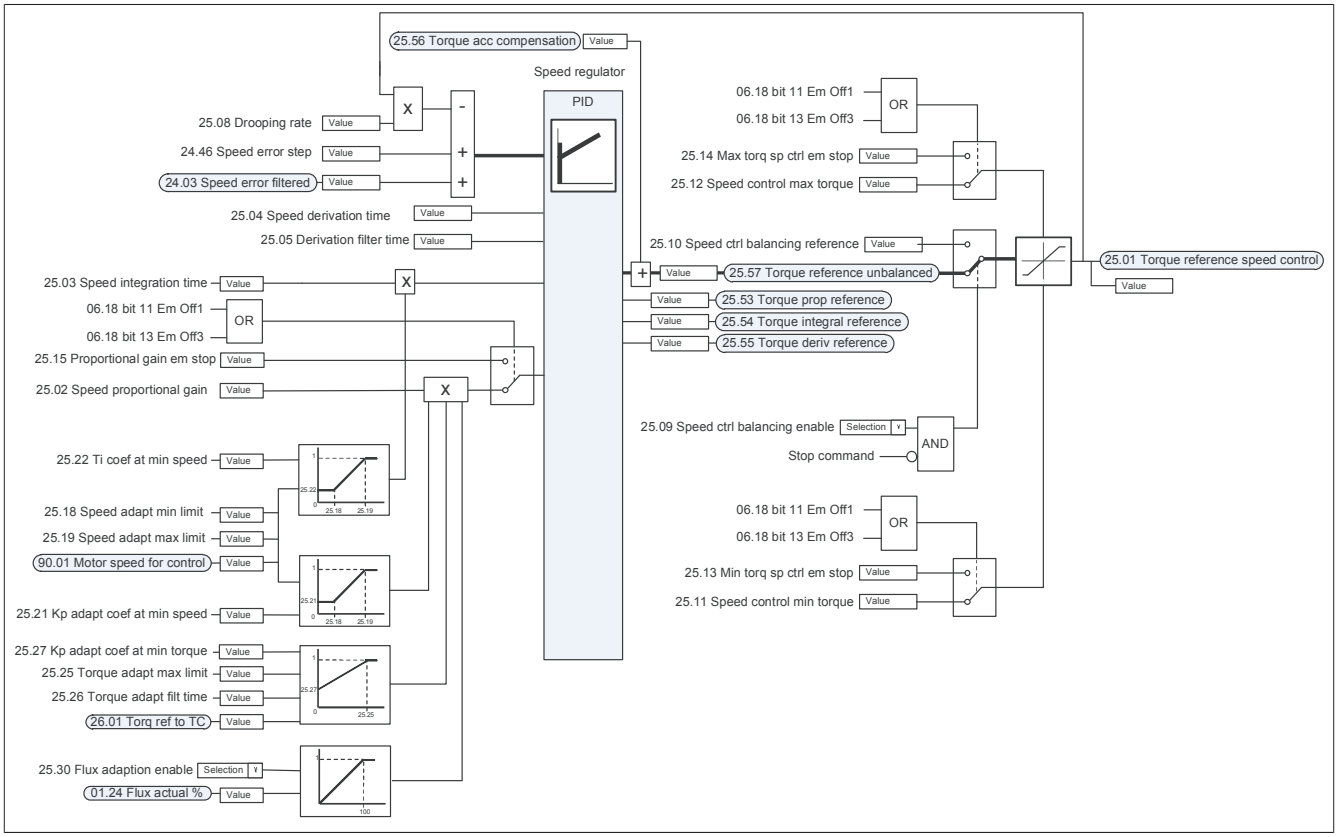

## 6.5.4 Motor feedback - Configuration



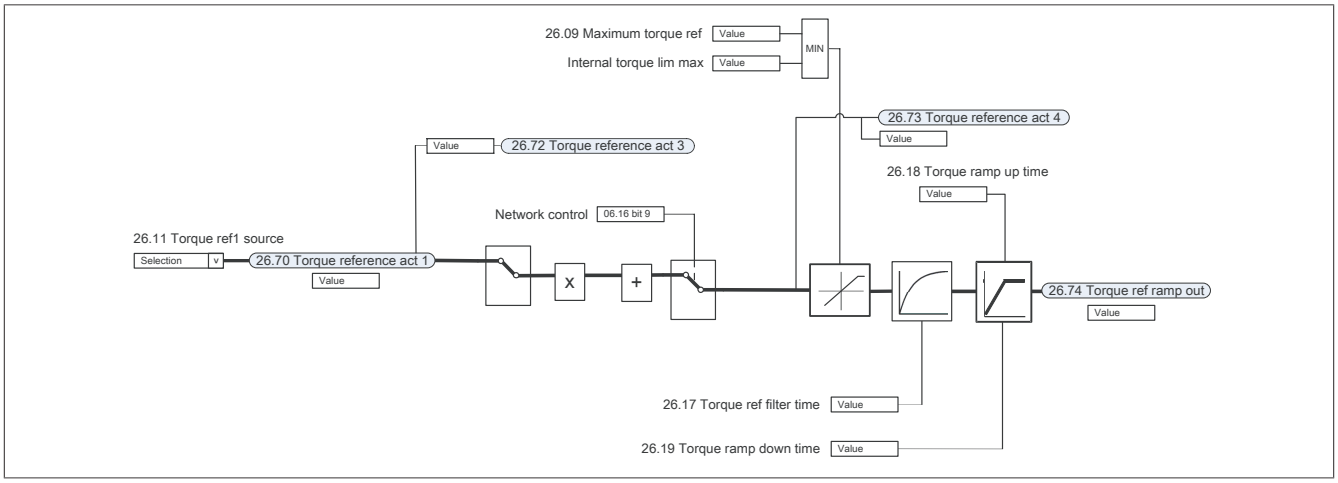
## 6.5.5 Speed difference - Calculation



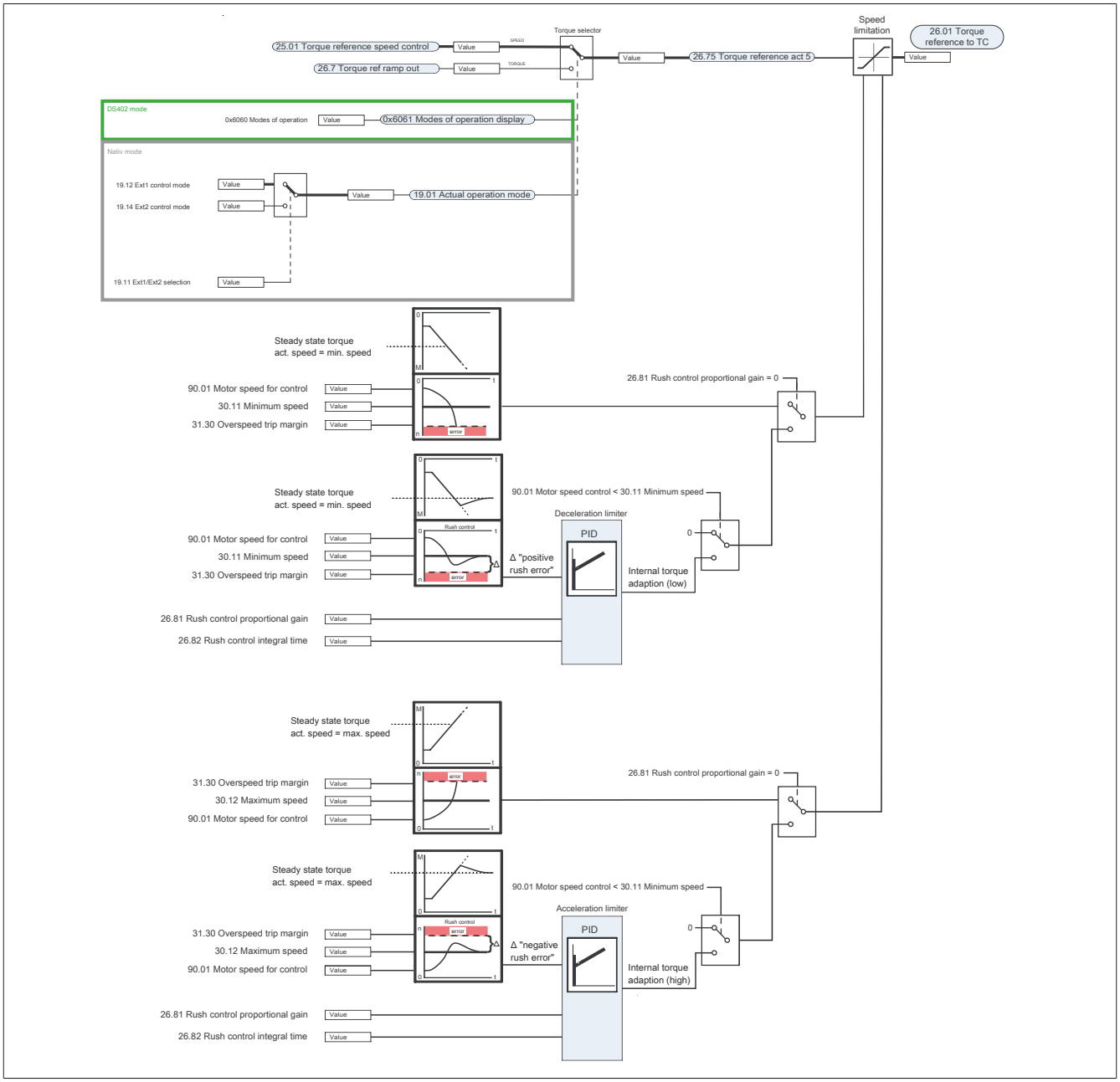

## 6.5.6 Speed control



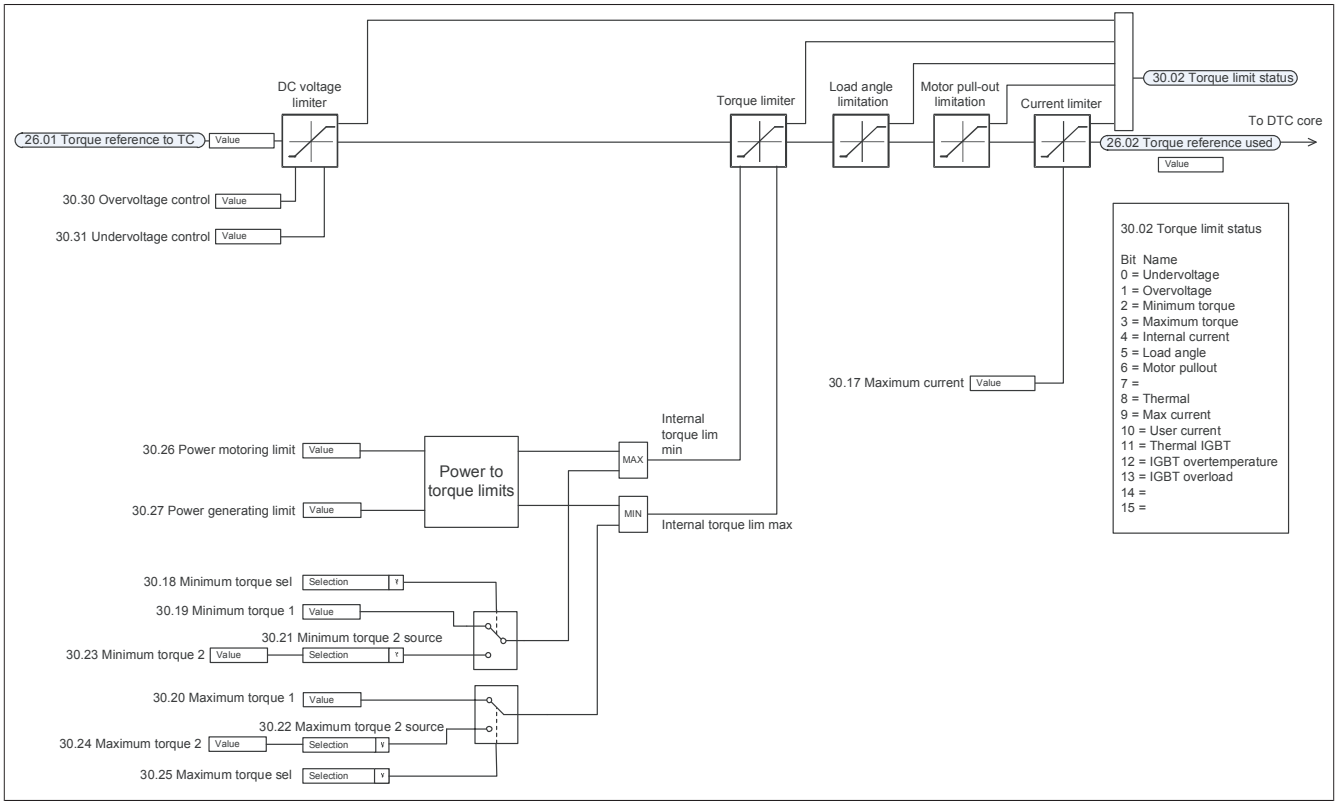

## 6.5.7 Torque setpoint - Source selection and modification



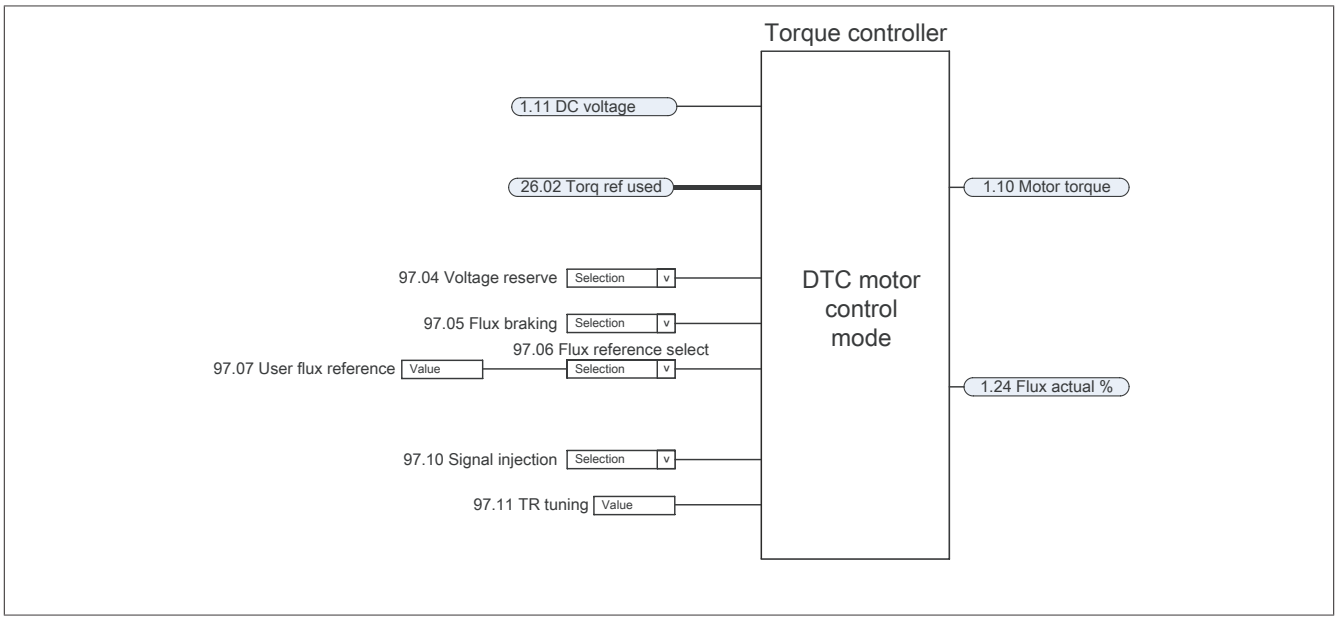
## 6.5.8 Setpoint selection for torque control



## 6.5.9 Speed limiting




## 6.5.10 Torque control



# 7 Servicing

This chapter contains instructions for preventive maintenance.

## 7.1 Service intervals

The following table shows the maintenance tasks that can be performed by the customer.

The service and replacement intervals are based on the assumption that the equipment is operated within the specified nominal data and ambient conditions. B&R recommends annual checks of the frequency inverter to ensure maximum reliability and optimal performance.

**Note:**

**In case of prolonged operation at the limit of the specified maximum nominal data or ambient limit values, shorter maintenance intervals may be required for some components.**

### 7.1.1 Description of symbols

| Measure | Description |
|---|---|
| I | Carry out visual inspection and servicing activities if necessary. |
| P | Performance of on-site or off-site work (commissioning, testing, measurements or other work) |
| R | Replacement of component |

### 7.1.2 Recommended maintenance tasks that can be performed by the user

| Measure | Component(s) |
|---|---|
| P | Quality of the supply voltage |
| I | Replacement parts |
| P | Forming the DC bus capacitors, replacement modules and replacement capacitors. |
| I | Tightening torques of the screw connections |
| I | Dust exposure, corrosion or temperature |
| I | Cleaning heat sinks |

### 7.1.3 Recommended service intervals after commissioning

| Component | Years after commissioning | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 | 6 | 9 | 12 | 15 | 18 | 20 | 21 |
| **Cooling** | | | | | | | | |
| Main fan (sizes R1 to R7) | | | R | | | R | | |
| Auxiliary fan of the electronic boards (sizes R1 to R7) | | | R | | | R | | |
| **Aging** | | | | | | | | |
| Battery for the control panel and ZCU control unit | | | R | | | R | | |

## 7.2 Heat sink

The fins of the heat sink pick up dust from the cooling air. The frequency inverter can heat up unacceptably and generate fault and warning messages if the heat sinks are not cleaned regularly. If necessary, clean the heat sink as follows.

**Warning!**

**The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

**Warning!**

**Use a vacuum cleaner with anti-static hose and nozzle. A normal vacuum cleaner can cause static discharges and thus cause irreparable damage to printed circuit boards.**

1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Remove the fan(s). See the following section: "Fans" on page 358.
3. Blow compressed air (not moist or with oil mist) from bottom to the top and simultaneously use a vacuum cleaner at the air outlet to collect the dust.

> **Note:**
>
> **If there is a risk of dust entering adjoining equipment, cleaning must be carried out in another room.**

4. Reinstall the fan.

## 7.3 Fans

The service life of the fans depends on the operating time, ambient temperature and dust concentration.

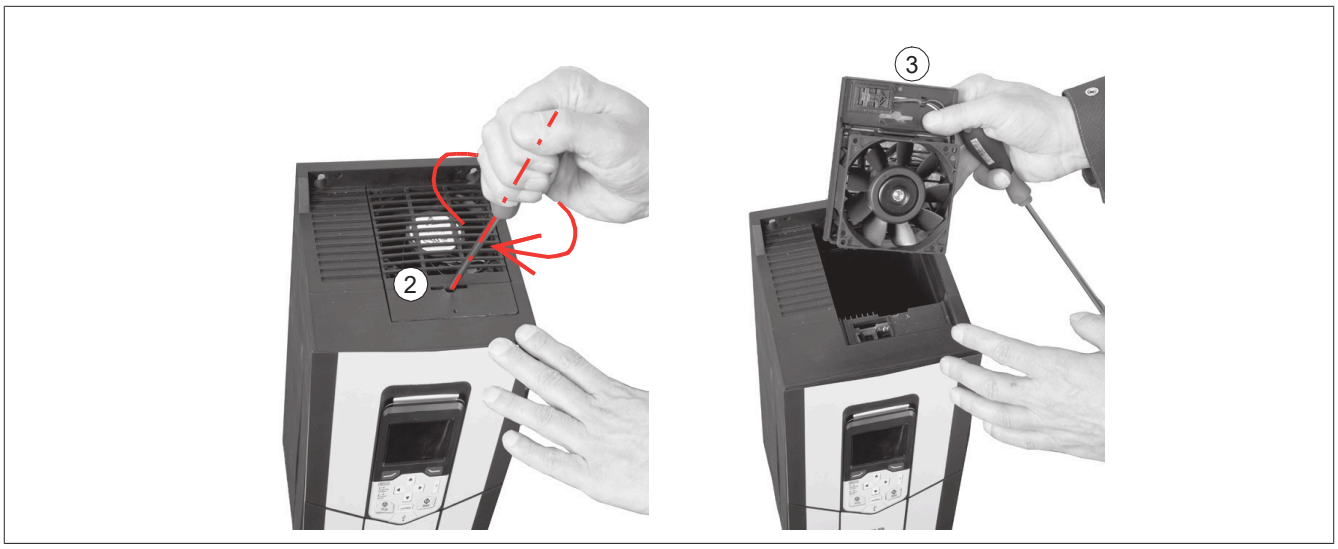
After replacing the fan, reset the operating time signal of the fan. If necessary, also reset the servicing counter.

Replacement fans are available from B&R. Use only replacement parts approved by B&R.

### 7.3.1 Replacing the main fan for sizes R1 to R3

> **Warning!**
>
> **The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Release the retaining clip by pressing against the clip with a screwdriver and turning it to the right.
3. Remove the fan assembly.
4. Install the new fan assembly in reverse order. Ensure that the fan conveys the exhaust air upwards.
5. Reset the counter (if used) in group 5 of the main control program.




### 7.3.2 Replacing the fans for sizes R4 to R5

> **Warning!**
>
> **The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

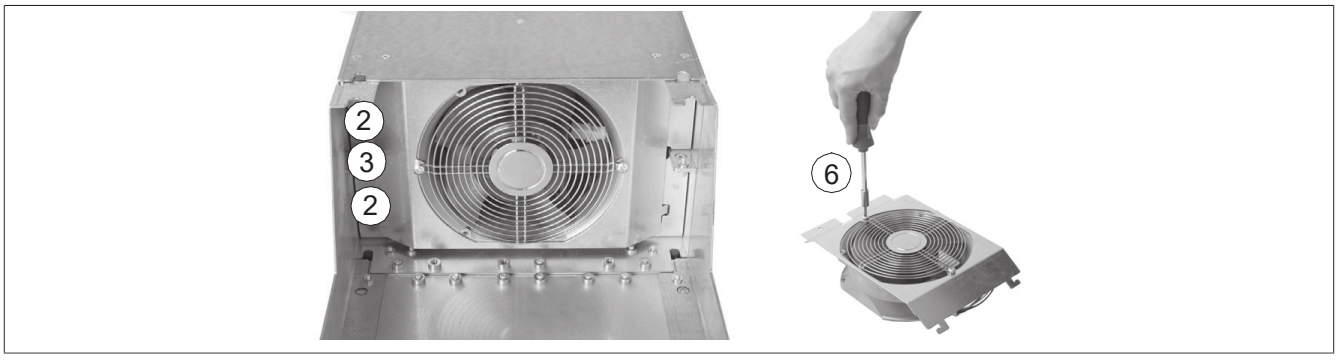
1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Lift the fan plate at the front edge.
3. Disconnect the power cables.
4. Remove the fan assembly.
5. Install the new fan assembly in reverse order. Ensure that the fan conveys the exhaust air upwards.
6. Reset the counter (if used) in group 5 of the main control program.

### 7.3.3 Replacing the main fan for sizes R6 to R7

**Warning!**

**The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Unscrew the mounting screws of the fan plate (view from below).
3. Pull down the fan plate at the side edge.
4. Disconnect the power cables.
5. Remove the fan plate.
6. Remove the fan from the mounting plate.
7. Install the new fan in reverse order. Ensure that the fan conveys the exhaust air upwards.
8. Reset the counter (if used) in group 5 of the main control program.

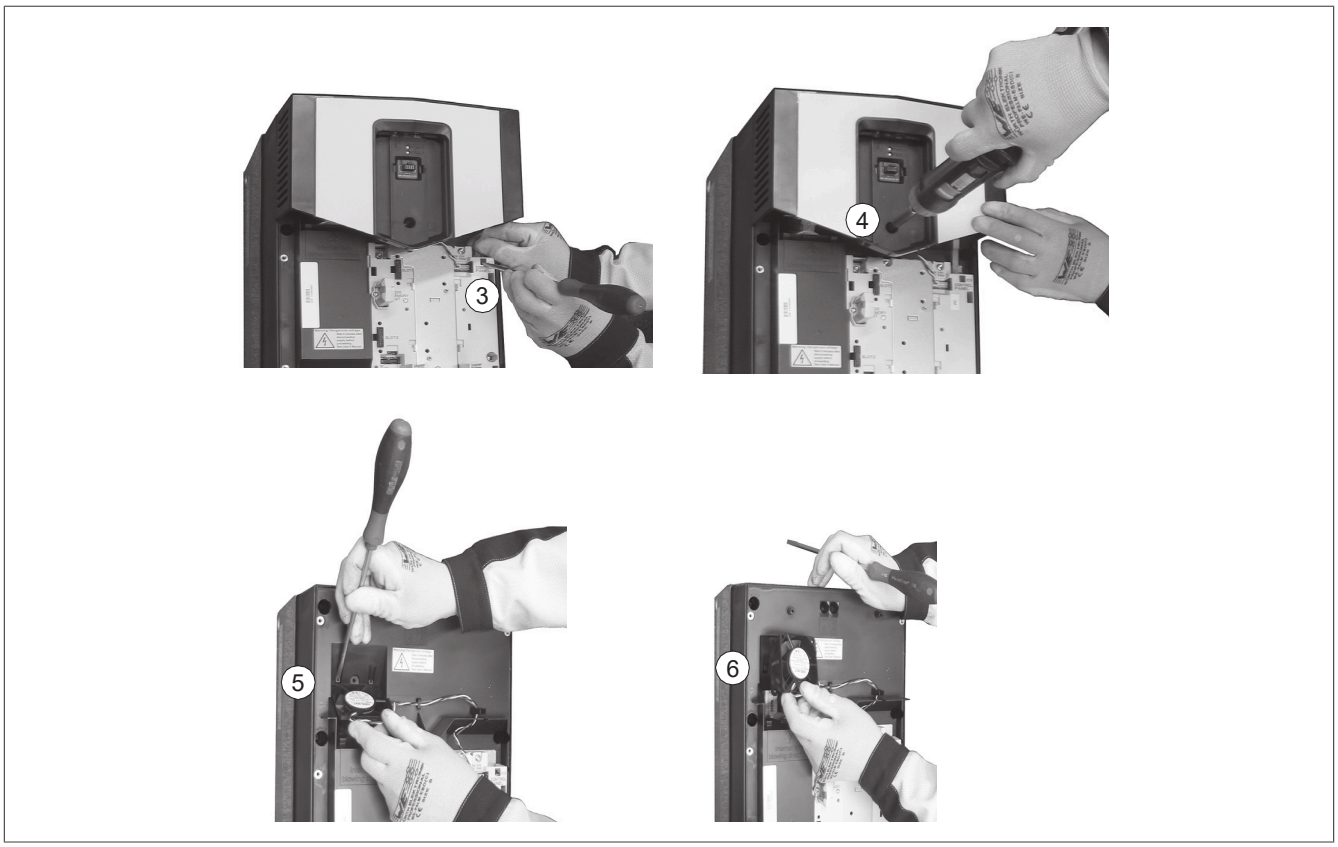



### 7.3.4 Replacing the auxiliary fan for sizes R6 to R7

**Warning!**

**The "Safety information" on page 10 must be observed. Failure to follow this information can result in injury, fatal accidents or damage to equipment.**

1. Disconnect the frequency inverter from the mains. Lock the mains disconnect device and ensure by measuring that there is no voltage.
2. Remove the lower front cover (see "Procedure for connecting cables" on page 189).
3. Disconnect the power supply cables of the control panel from connector X13 of the control unit and the power supply cables of the cooling fan from connector X208:FAN2.
4. Remove the upper front cover.
5. Release the retaining clips.
6. Lift out the fan.
7. Install the new fan in reverse order. Ensure that the arrow on the fan is pointing up.




## 7.4 Capacitors

The DC bus of the frequency inverter contains several electrolytic capacitors. Their service life depends on the operating hours of the frequency inverter, load and ambient temperature. The service life of capacitors is extended at low ambient temperature.

For sizes R1 to R3 the capacitors are integrated on the ZINT board; for sizes R4 to R5, they are integrated on the ZMAC board. For sizes R6 to R7, the capacitors are separate.

Capacitor failure is usually followed by damage to the unit and input fuse failure or fault shutdown. In the event of suspected capacitor failure, please contact B&R.

### 7.4.1 Forming capacitors

The capacitors must be reformed if the frequency inverter has not been switched on for three years or more. Reforming is performed by switching on the device without load for 60 minutes. Section "Nameplate" on page 18 describes how to determine the date of manufacture.

## 7.5 Replacing the control panel battery

The battery is located on the back of the control panel. Replace the battery with a new CR2032 battery. Dispose of the old battery in accordance with regulations.

## 7.6 Replacing the control unit battery

The battery must be replaced after 9 years. Contact B&R.

# Appendix A Quick guide for installation

This quick guide describes the installation of the frequency inverter. For additional information, planning guidelines, technical data and the complete safety instructions, see the other chapters of this user's manual.

## A.1 Follow the safety instructions

### Warning!

**Follow these instructions. Failure to follow these instruction may result in injuries, fatal accidents or damage to the equipment:**

- **Only qualified personnel are permitted to perform Installation and maintenance of the frequency inverter.**
- **No work on the frequency inverter, the motor cable or the motor is permitted as long as the mains voltage is applied. If the frequency inverter is/was already connected to the power supply, wait 5 minutes after disconnecting it from the input voltage.**
- **Do not perform any work on the control cables when voltage is applied to the frequency inverter or the external control circuits.**
- **Always ground the frequency inverter, the motor and the neighboring devices via the PE bus bar of the power supply.**
- **Ensure that drill shavings and dust do not enter the frequency inverter during installation.**
- **Do not apply a voltage to the frequency inverter that is higher than specified on the nameplate.**

The floor underneath the device must be made of non-flammable material.

## A.2 Checking whether capacitors must be reformed

The capacitors must be reformed if the frequency inverter has not been switched on (either stored or not used) for more than one year.

The date of manufacture can be determined from the serial number, which is specified on the nameplate located on the frequency inverter. The serial number format is MJJWWRXXXX. JJ and WW indicate the year and week of manufacture:

JJ: 17, 18, 19, etc. for 2017, 2018, 2019, etc.

WW: 01, 02, 03, etc. for week 1, week 2, week 3, etc.

## A.3 Ensuring sufficient cooling

The permissible operating temperature range for the frequency inverter without derating is -15 to +40°C.

| Frequency inverters | Size | Airflow | | Power dissipation |
|---|---|---|---|---|
| | | $m^3/h$ | $ft^3/min$ | W |
| **$U_N$ = 500 V** | | | | |
| 8I96T400075.00-000 | R1 | 44 | 26 | 40 |
| 8I96T400110.00-000 | R1 | 44 | 26 | 52 |
| 8I96T400150.00-000 | R1 | 44 | 26 | 73 |
| 8I96T400220.00-000 | R1 | 44 | 26 | 94 |
| 8I96T400300.00-000 | R1 | 44 | 26 | 122 |
| 8I96T400400.00-000 | R1 | 44 | 26 | 172 |
| 8I96T400550.00-000 | R2 | 88 | 52 | 232 |
| 8I96T400750.00-000 | R2 | 88 | 52 | 337 |
| 8I96T401100.00-000 | R3 | 134 | 79 | 457 |
| 8I96T401500.00-000 | R3 | 134 | 79 | 562 |
| 8I96T401850.00-000 | R4 | 134 | 79 | 667 |
| 8I96T402200.00-000 | R4 | 280 | 165 | 907 |
| 8I96T403000.00-000 | R5 | 280 | 165 | 1117 |
| 8I96T403700.00-000 | R5 | 280 | 165 | 1120 |

| Frequency inverters | Size | Airflow | | Power dissipation |
|---|---|---|---|---|
| | | m³/h | ft³/min | W |
| 8I96T404500.00-000 | R6 | 435 | 256 | 1295 |
| 8I96T405500.00-000 | R6 | 435 | 256 | 1440 |
| 8I96T407500.00-000 | R7 | 450 | 265 | 1940 |
| 8I96T409000.00-000 | R7 | 450 | 265 | 2310 |

## A.4 Protecting the frequency inverter and supply cables

| Frequency inverters | Size | Fuses (one fuse per phase) | | |
|---|---|---|---|---|
| | | Fuse | | |
| | | Manufacturer | Type | IEC size |
| $U_N$ = 500 V | | | | |
| 8I96T400075.00-000 | R1 | ABB | OFAF000H6 | 000 |
| 8I96T400110.00-000 | R1 | ABB | OFAF000H6 | 000 |
| 8I96T400150.00-000 | R1 | ABB | OFAF000H10 | 000 |
| 8I96T400220.00-000 | R1 | ABB | OFAF000H10 | 000 |
| 8I96T400300.00-000 | R1 | ABB | OFAF000H16 | 000 |
| 8I96T400400.00-000 | R1 | ABB | OFAF000H16 | 000 |
| 8I96T400550.00-000 | R2 | ABB | OFAF000H25 | 000 |
| 8I96T400750.00-000 | R2 | ABB | OFAF000H32 | 000 |
| 8I96T401100.00-000 | R3 | ABB | OFAF000H40 | 000 |
| 8I96T401500.00-000 | R3 | ABB | OFAF000H50 | 000 |
| 8I96T401850.00-000 | R4 | ABB | OFAF000H63 | 000 |
| 8I96T402200.00-000 | R4 | ABB | OFAF000H80 | 000 |
| 8I96T403000.00-000 | R5 | ABB | OFAF000H100 | 000 |
| 8I96T403700.00-000 | R5 | ABB | OFAF000H100 | 000 |
| 8I96T404500.00-000 | R6 | ABB | OFAF00H125 | 00 |
| 8I96T405500.00-000 | R6 | ABB | OFAF00H160 | 00 |
| 8I96T407500.00-000 | R7 | ABB | OFAF0H250 | 0 |
| 8I96T409000.00-000 | R7 | ABB | OFAF1H315 | 1 |

Ensure that the response time of the fuses is less than 0.5 seconds.

## A.5 Selecting the power cables

The power cables must be adequately rated for the nominal current specified on the nameplate of the frequency inverter per local regulations.

| Frequency inverters | Size | IEC [1] | | US [2] | |
|---|---|---|---|---|---|
| | | Copper cable type | Aluminum cable type | Copper cable type | Aluminum cable type |
| | | mm² | mm² | AWG/kcmil | AWG/kcmil |
| $U_N$ = 500 V | | | | | |
| 8I96T400075.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400110.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400150.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400220.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400300.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400400.00-000 | R1 | 3×1.5 | - | 14 | - |
| 8I96T400550.00-000 | R2 | 3×6 | - | 10 | - |
| 8I96T400750.00-000 | R2 | 3×6 | - | 10 | - |
| 8I96T401100.00-000 | R3 | 3×10 | - | 8 | - |
| 8I96T401500.00-000 | R3 | 3×10 | - | 8 | - |
| 8I96T401850.00-000 | R4 | 3×16 | 3×25 | 6 | - |
| 8I96T402200.00-000 | R4 | 3×25 | 3×25 | 4 | - |
| 8I96T403000.00-000 | R5 | 3×35 | 3×35 | 3 | - |
| 8I96T403700.00-000 | R5 | 3×35 | 3×50 | 3 | - |
| 8I96T404500.00-000 | R6 | 3×50 | 3×70 | 1 | - |
| 8I96T405500.00-000 | R6 | 3×95 | 3×95 | 2/0 | - |
| 8I96T407500.00-000 | R7 | 3×120 | 3×150 | 3/0 | - |
| 8I96T409000.00-000 | R7 | 3×150 | 3×185 | 250 MCM | - |

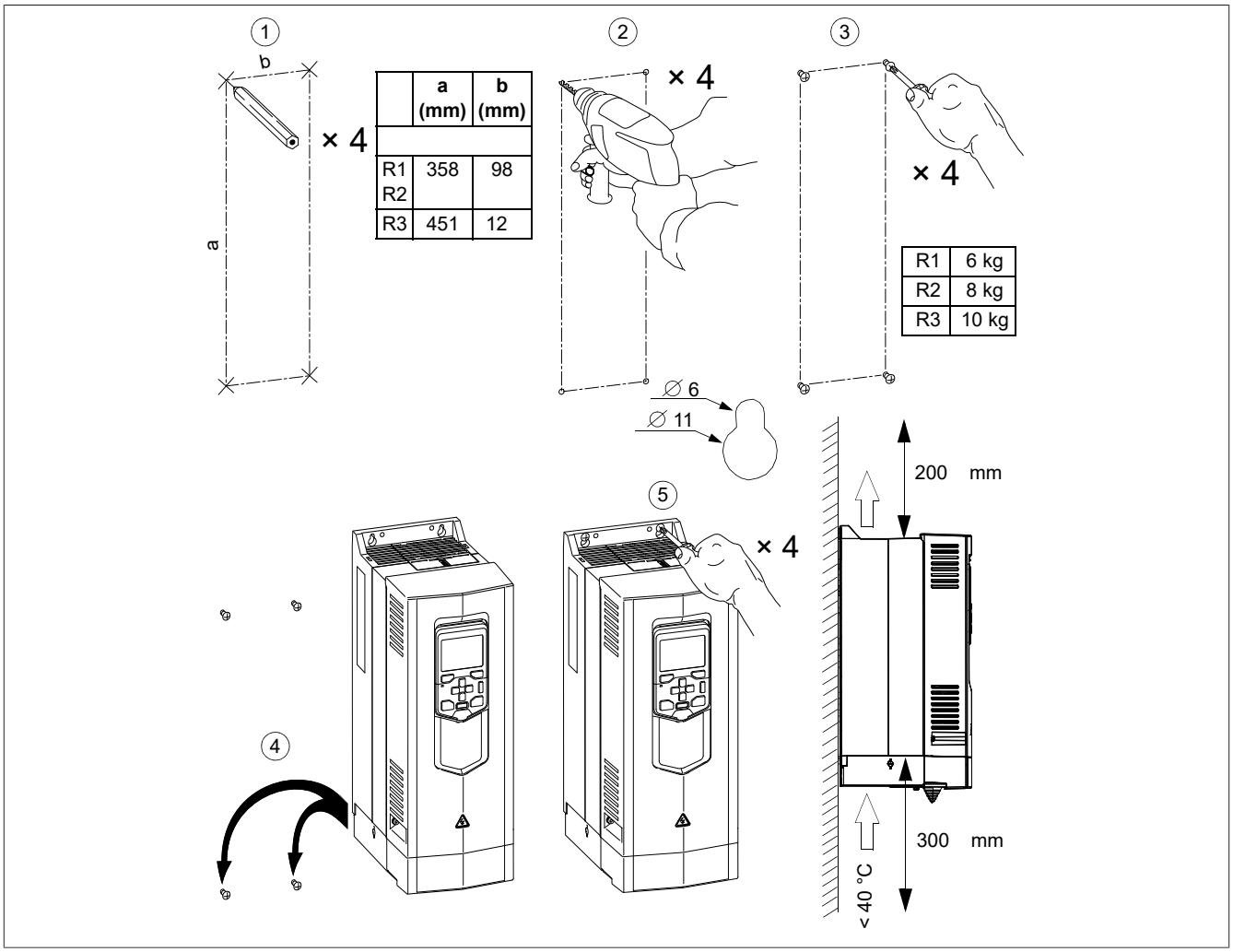
1) Cable sizing is based on max. 9 cables routed side by side on a cable tray, ambient temperature of 30°C, PVC insulation and a surface temperature of 70°C (EN 60204-1 and IEC 60364-5-52/2001). Under other conditions, the cables must be adapted to the local safety regulations, corresponding input voltage and the load current of the frequency inverter.

2) The cable cross section is based on NEC table 310-16 for copper wires, 75°C (167°F) wire insulation at 40°C (104°F) ambient temperature. No more than three current-carrying conductors are permitted to be routed in a cable duct, conduit or in the ground (directly buried). Under other conditions, the cables must be adapted to the local safety regulations, corresponding input voltage and the load current of the frequency inverter.

Dimensioning conditions, see the user's manual.

# A.6 Frequency inverter wall mounting

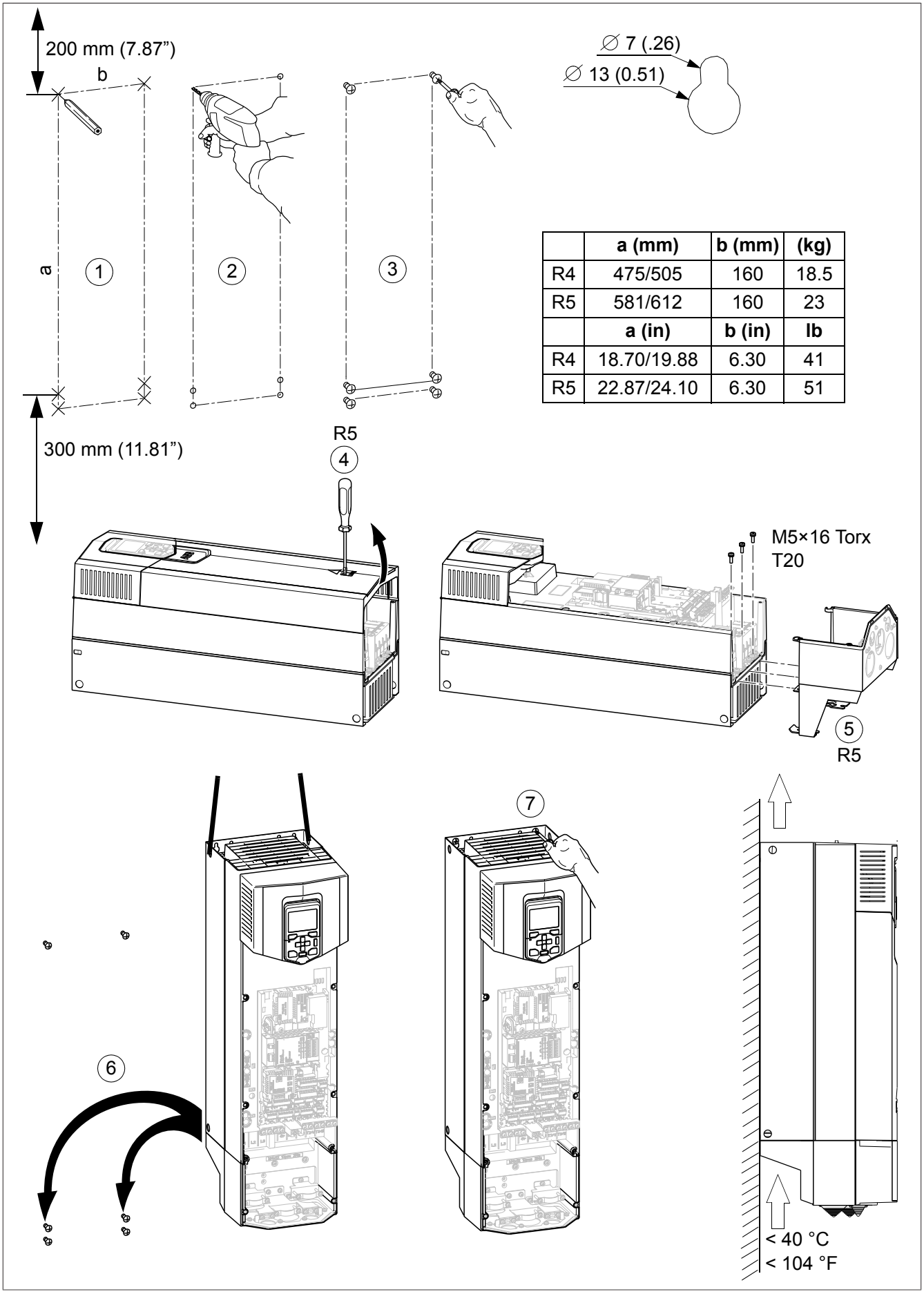
## A.6.1 Sizes R1 to R3




| | a (mm) | b (mm) |
|---|---|---|
| R1 R2 | 358 | 98 |
| R3 | 451 | 12 |

Figure 69: Wall mounting Sizes R1 to R3

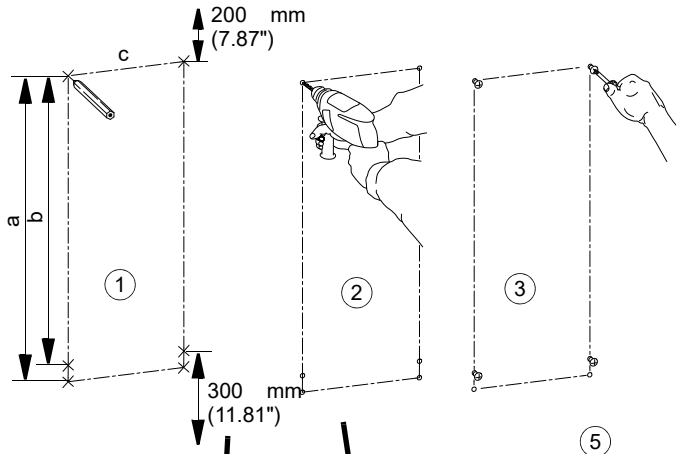
## A.6.2 Sizes R4, R5



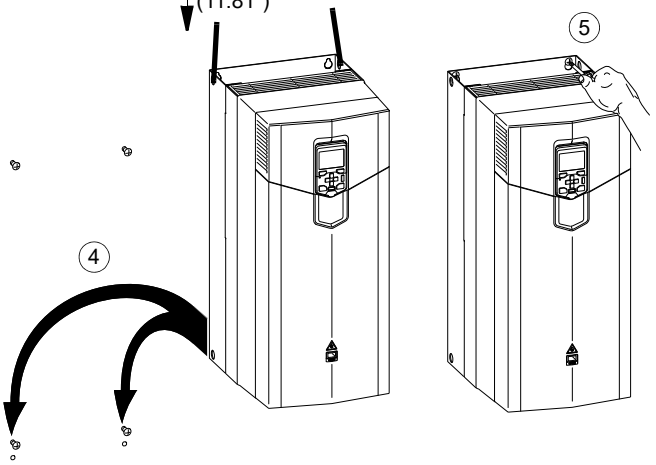

| | a (mm) | b (mm) | (kg) |
|---|---|---|---|
| R4 | 475/505 | 160 | 18.5 |
| R5 | 581/612 | 160 | 23 |
| | **a (in)** | **b (in)** | **lb** |
| R4 | 18.70/19.88 | 6.30 | 41 |
| R5 | 22.87/24.10 | 6.30 | 51 |

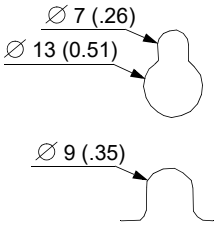
Figure 70: Wall mounting Sizes R4, R5

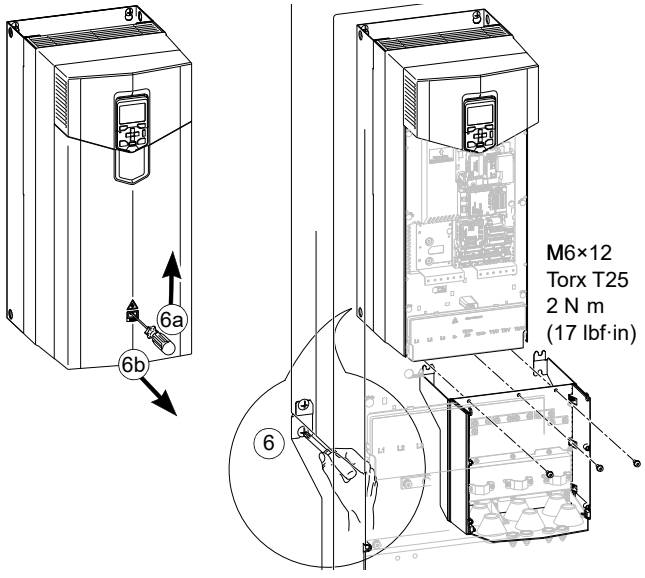
## A.6.3 Sizes R6, R7

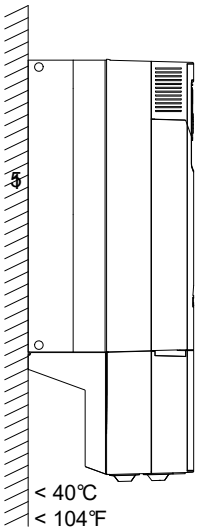



| | a (mm) | b (mm) | c (mm) | kg |
|---|---|---|---|---|
| R6 | 571 | 531 | 212.5 | 45 |
| R7 | 623 | 583 | 245 | 5 |
| | (in) | (in) | (in) | lb |
| R6 | 22.50 | 20.91 | 8.37 | 99 |
| R7 | 24.53 | 22.95 | 9.65 | 12 |



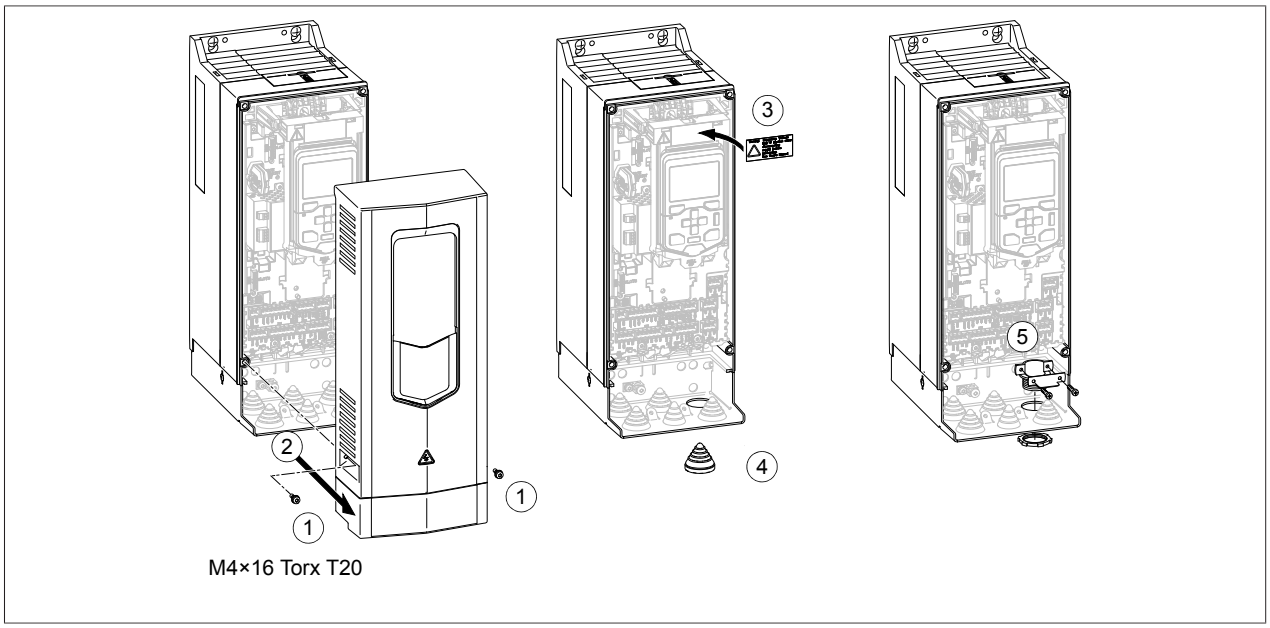



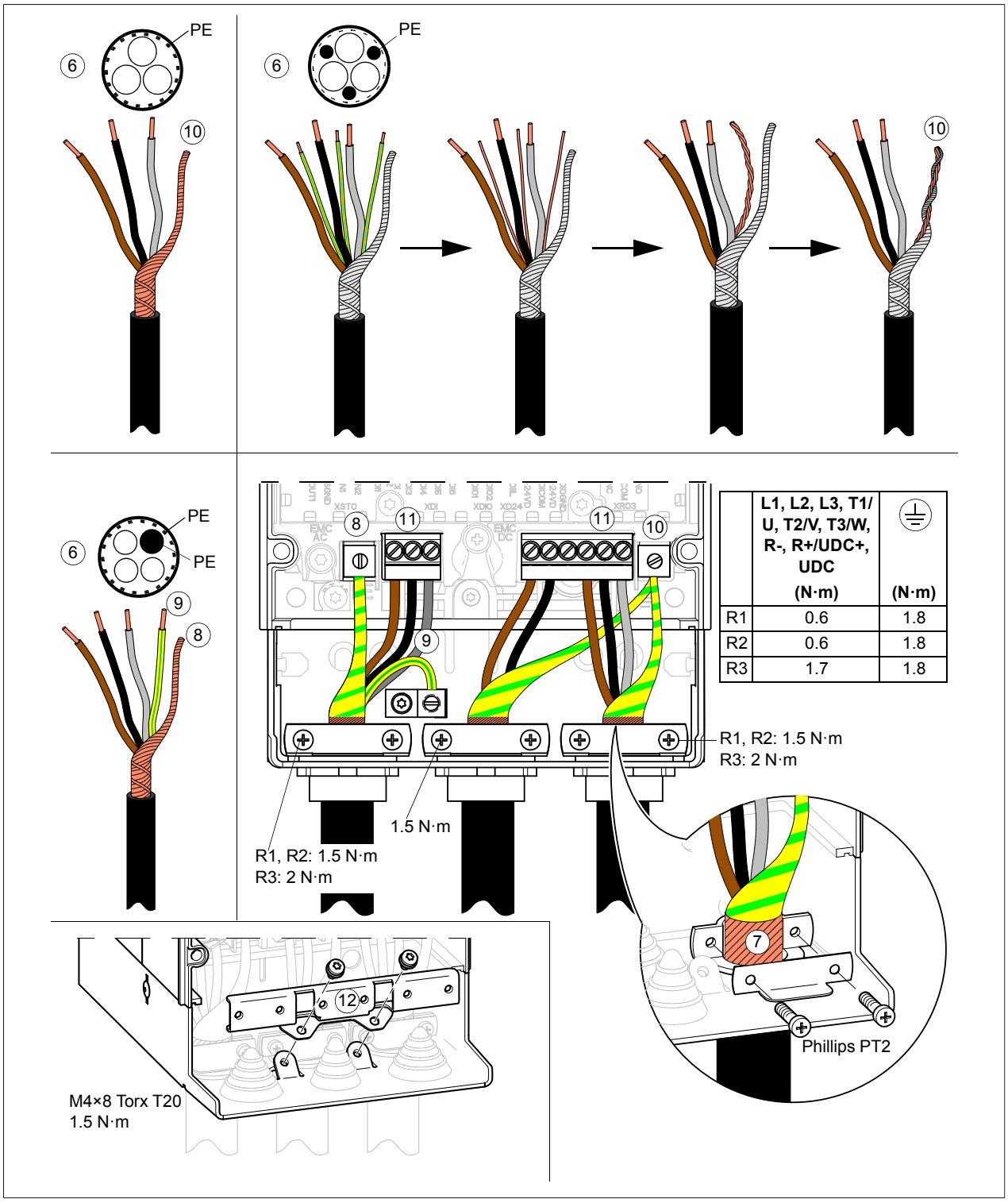
# A.7 Connecting the power cable

## A.7.1 Sizes R1, R2, R3

1. Loosen the mounting screws on the sides of the front cover.
2. Remove the cover by sliding it forward.
3. Affix the residual voltage warning label in the required local language to the control panel bracket.
4. Remove the rubber cable grommets for the cables to be connected from the grommet plate.
5. Secure the cable clamps (provided, in a plastic bag) to the holes of the grommet plate.



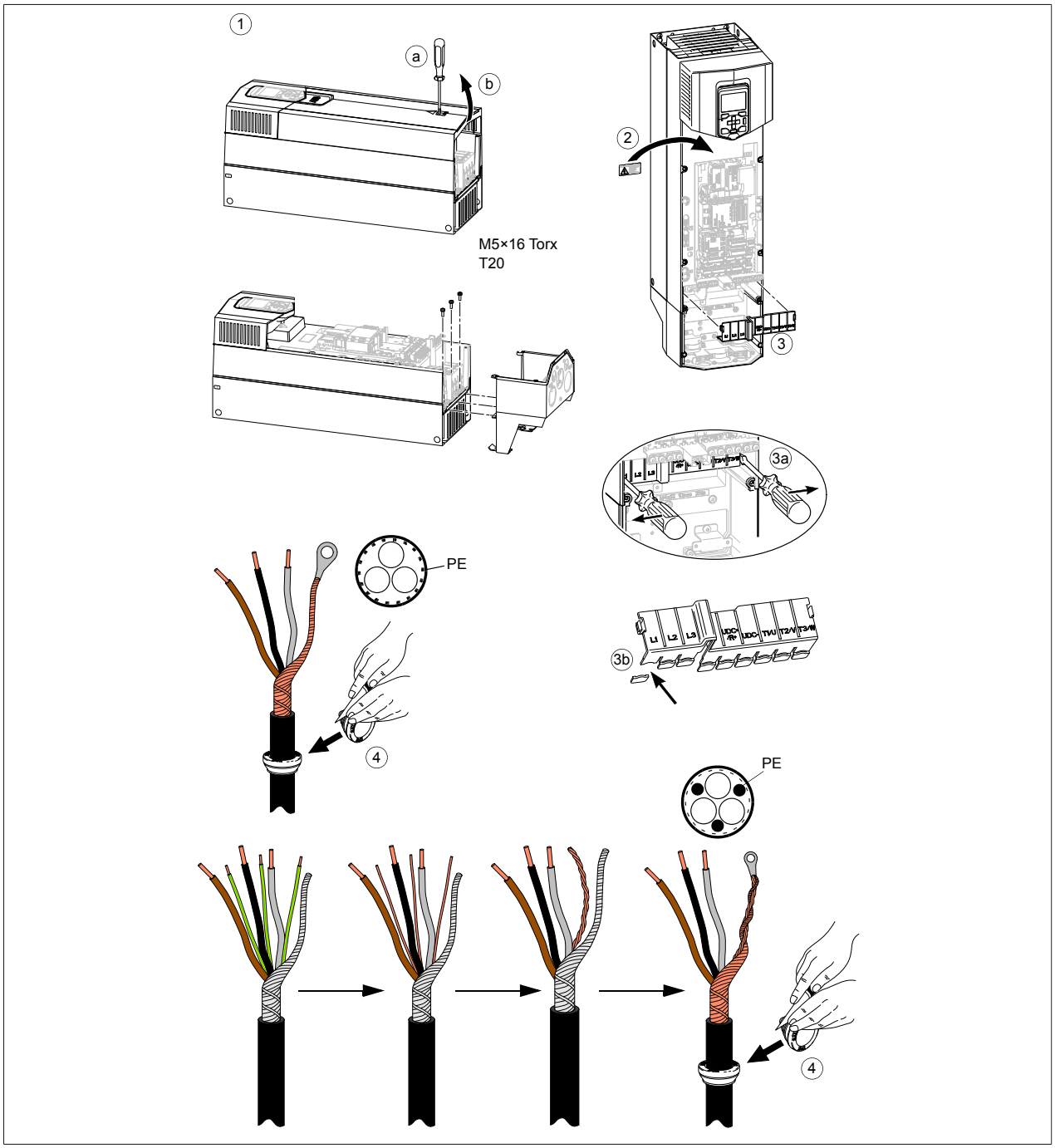

6. Prepare the ends of the supply and motor cables as shown in the figure.
7. Ground the cable shielding 360 degrees to the cable terminals.
8. Connect the twisted shielding of the feeder cable to the ground terminal.
9. Connect the grounding conductor (PE) of the feeder cable to the additional grounding terminal.
10. Connect the twisted shields of the motor and resistor cable (if available) to the ground terminal.
11. Connect the phase conductors of the supply, motor and resistor cables. Tighten the screws.
12. Install the control cable grounding clamp rail in the cable connection box.




13. Mechanically secure the cables outside the frequency inverter.
14. Connect the motor cable shields to earth/PE on the motor side. To ensure low interference, install a 360-degree grounding at the cable entry or keep the twisted shielding short.

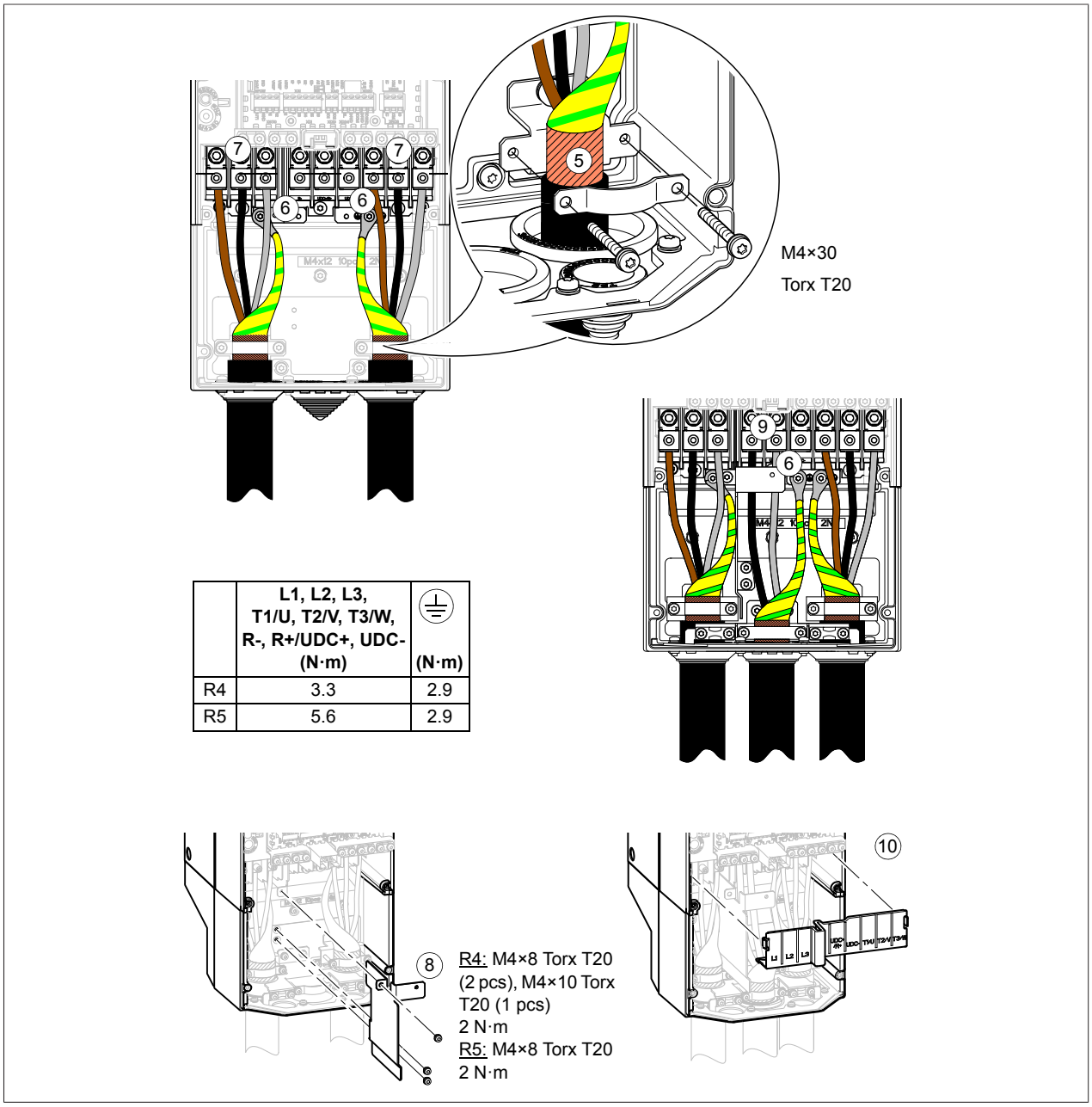
## A.7.2 Sizes R4, R5

1. Remove the front cover. Loosen the retaining clip with a screwdriver (a) and remove the cover (b) to the outside. Remove the cable connection box cover by loosening the mounting screw.
2. Apply the residual voltage warning label in the required local language on the upper part of the control unit.
3. Remove the cover from the power cable terminals by loosen the clips and pry the cover loose at the sides using a screwdriver (a). Break out openings for the cables (b) that should be connected at the respective locations to create suitable openings.
4. Cut suitable openings in the rubber cable grommets. Slide the grommets onto the cables. Prepare the cable ends. Insert the cables through the openings of the lower cover plate and press the cable grommets into the openings.




5. Ground the bare cable shields 360 degrees under the cable clamps.
6. Connect the twisted cable shields to the PE connections.
7. Connect the feeder cable conductors and the motor cable. Tighten the screws.
8. If not already done, reinstall the EMC isolation between the input and motor cables.

9. Connect the braking resistor cable conductors to terminals R+ and R-.
10. Replace the cover on the power cable terminals.

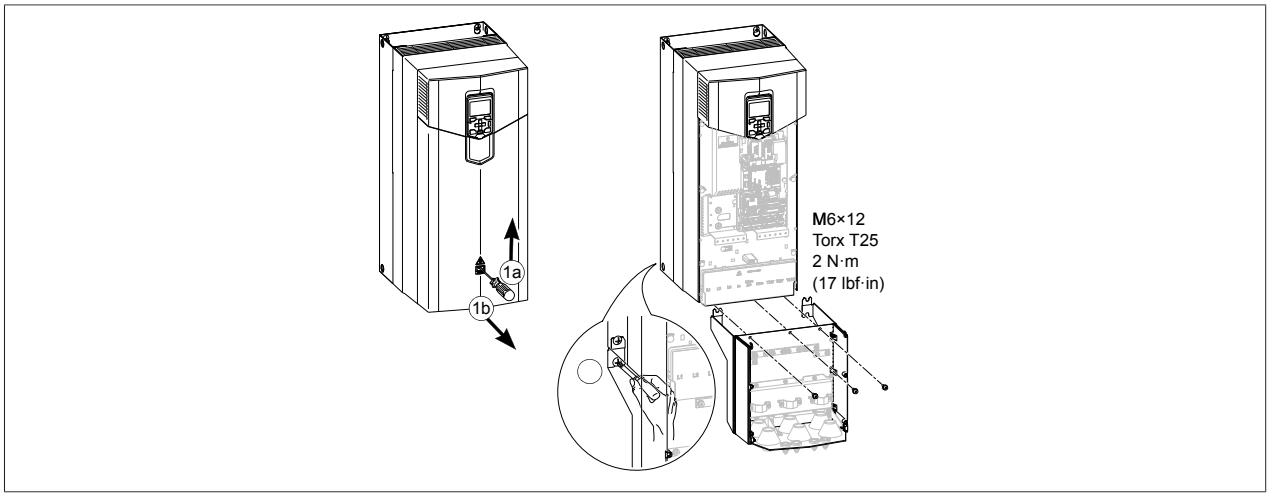



| | L1, L2, L3, T1/U, T2/V, T3/W, R-, R+/UDC+, UDC- (N·m) | ⏚ (N·m) |
|---|---|---|
| R4 | 3.3 | 2.9 |
| R5 | 5.6 | 2.9 |

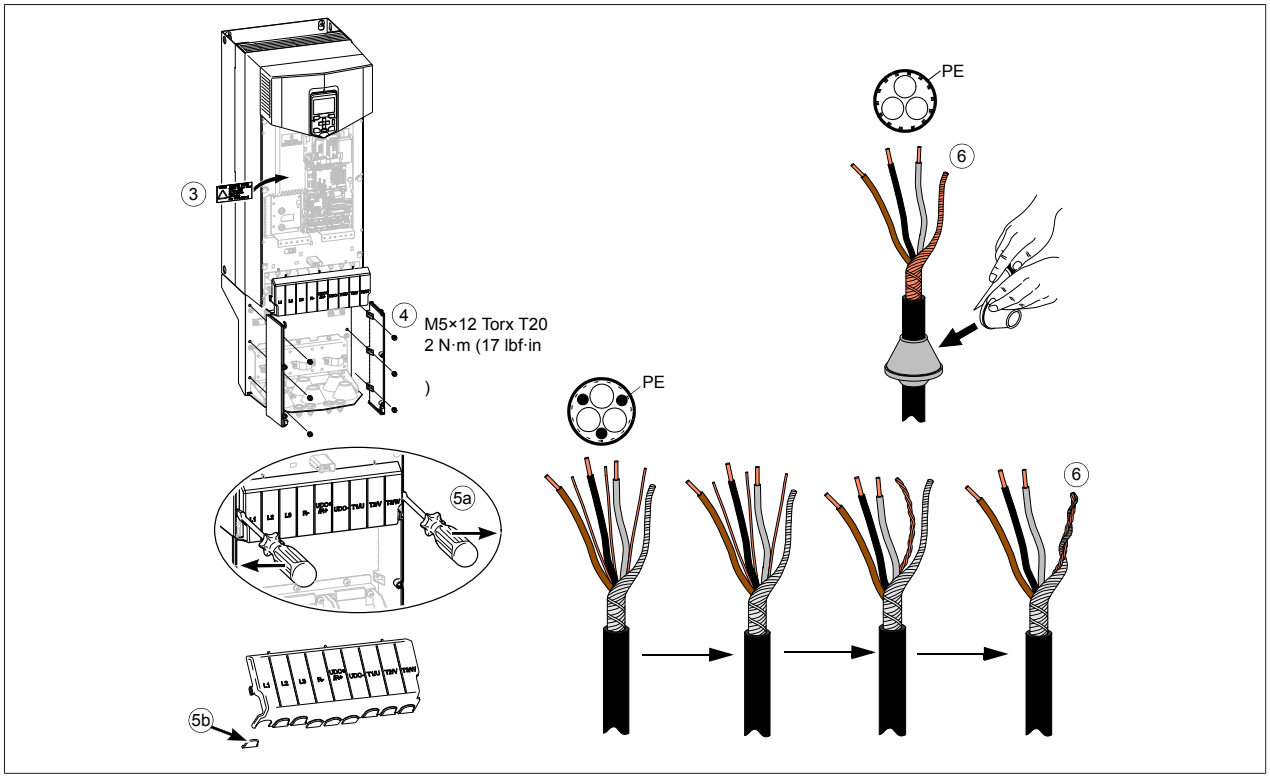
11. Mechanically secure the cables outside the unit.
12. Connect the motor cable shields to earth/PE on the motor side. To ensure low interference, install a 360-degree grounding at the cable entry or keep the twisted shielding short.

### A.7.3 Sizes R6, R7

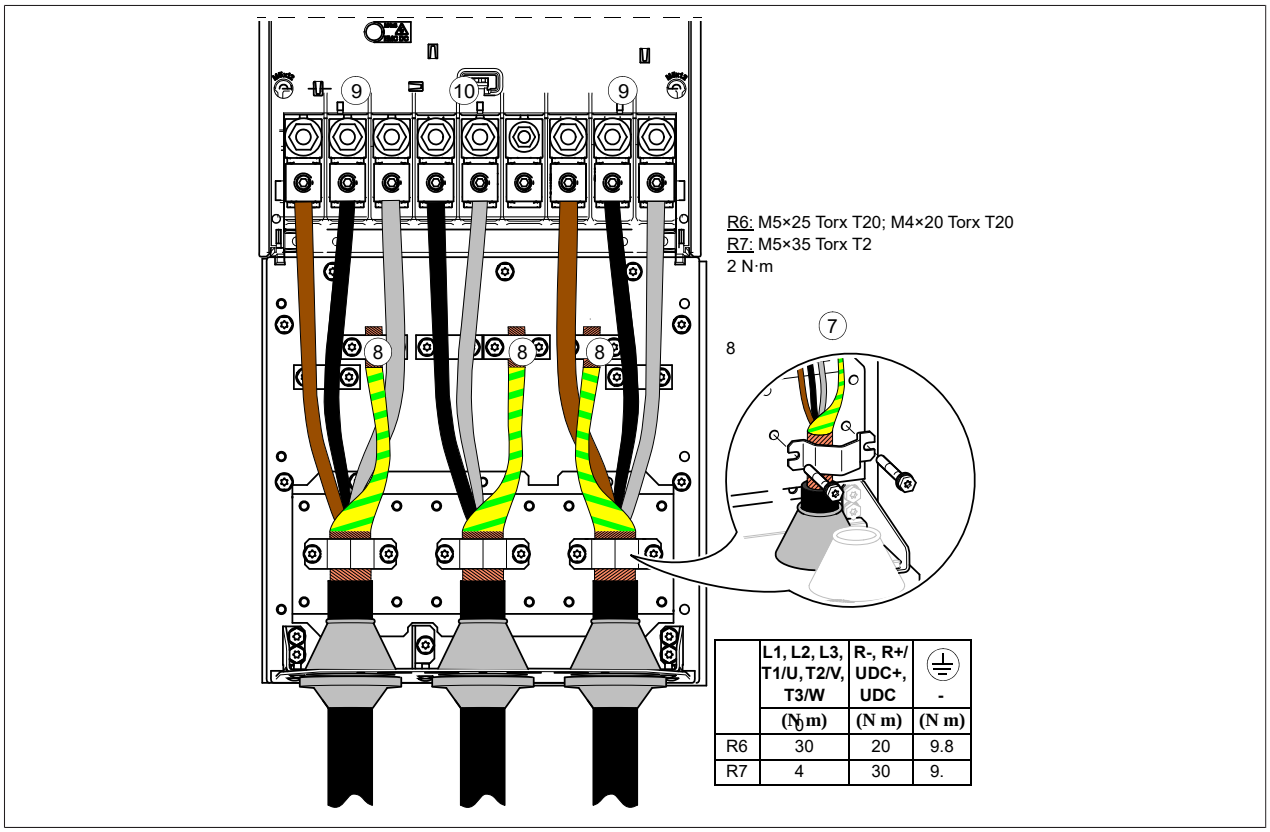
1. Remove the front cover. Loosen the retaining clip with a screwdriver (a) and remove the cover (b) to the outside.
2. Remove the cable connection box cover by loosening the mounting screws.




3. Place the residual voltage warning label in the required local language next to the control unit.
4. Remove the side panels of the cable connection box.
5. Remove the cover from the power cable terminals by loosening the clips on the sides and prying the cover loose with a screwdriver (a). Break out the openings for the cables (b).
6. Cut suitable openings in the rubber cable grommets. Slide the grommets onto the cables. Prepare the cable ends. Insert the cables through the openings of the lower cover plate and press the cable grommets into the openings.



7. Ground the bare cable shields 360 degrees under the cable clamps.
8. Connect the twisted cable shields to the PE connections.
9. Connect the feeder cable conductors and the motor cable. Tighten the screws.
10. Connect the braking resistor cable conductors to terminals R+ and R-.




| | L1, L2, L3, T1/U, T2/V, T3/W | R-, R+/ UDC+, UDC | ⏚ |
|---|---|---|---|
| | (N m) | (N m) | (N m) |
| R6 | 30 | 20 | 9.8 |
| R7 | 4 | 30 | 9. |

11. Replace the cover on the power cable terminals.
12. Replace the side panels of the cable connection box.
13. Mechanically secure the cables outside the unit.

## A.8 Connecting the control cable

1. Cut a suitable opening in the rubber cable grommets and slide the cable grommets onto the cables. Insert the cables through the openings of the lower cover plate and press the cable grommets into the openings.
2. Strip the cable ends and cut them to the appropriate length (note the additional length required for the ground conductors).
3. Establish 360-degree grounding on a grounding clamp for the outer shielding of all control cables in the cable connection box.
4. Ground the cable shielding to the ground terminal. Do not connect or indirectly ground the other end of the shields via a high frequency capacitor with a few nanofarads (e.g. 3.3 nF / 630 V).
5. Connect the conductors to the corresponding terminals of the control unit (see Standard I/O connections).
6. If included in the scope of delivery, connect the option modules.
7. Replace the front cover.

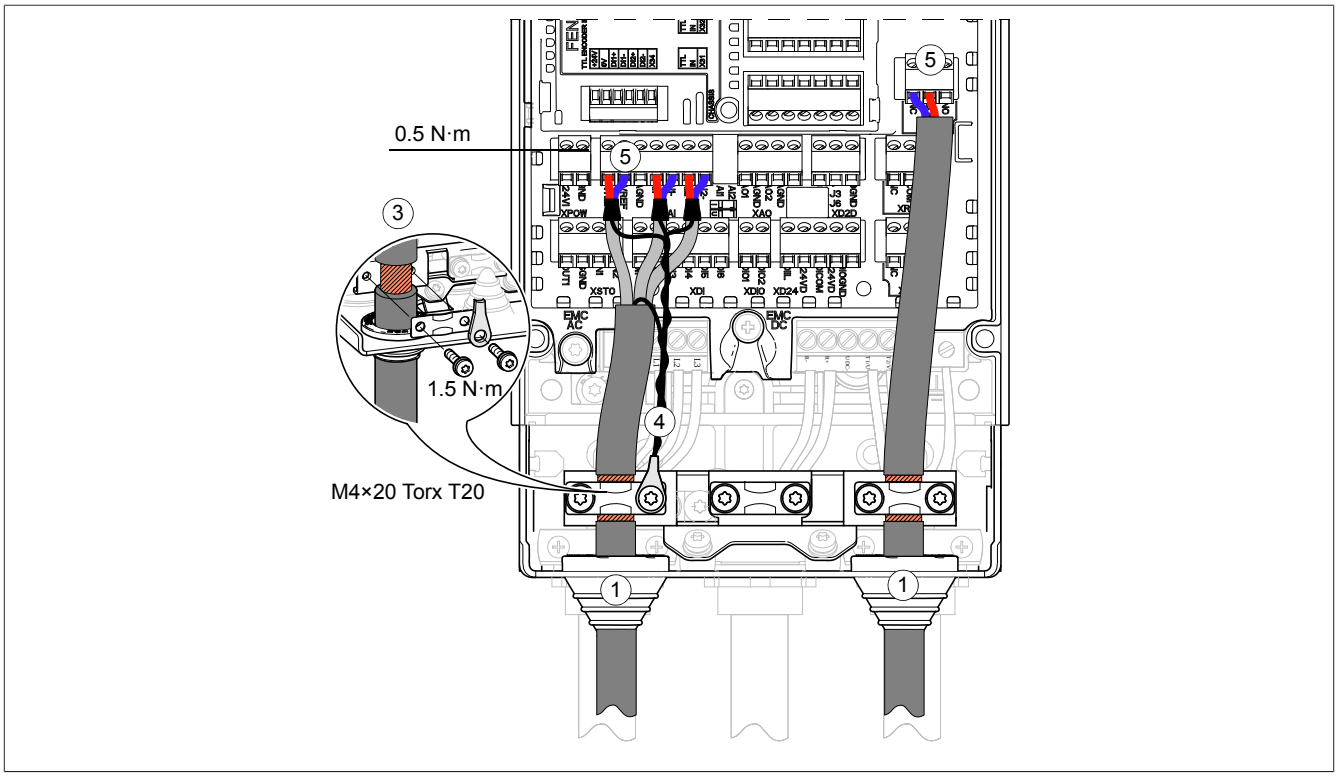



Figure 71: Sizes R1, R2, R3

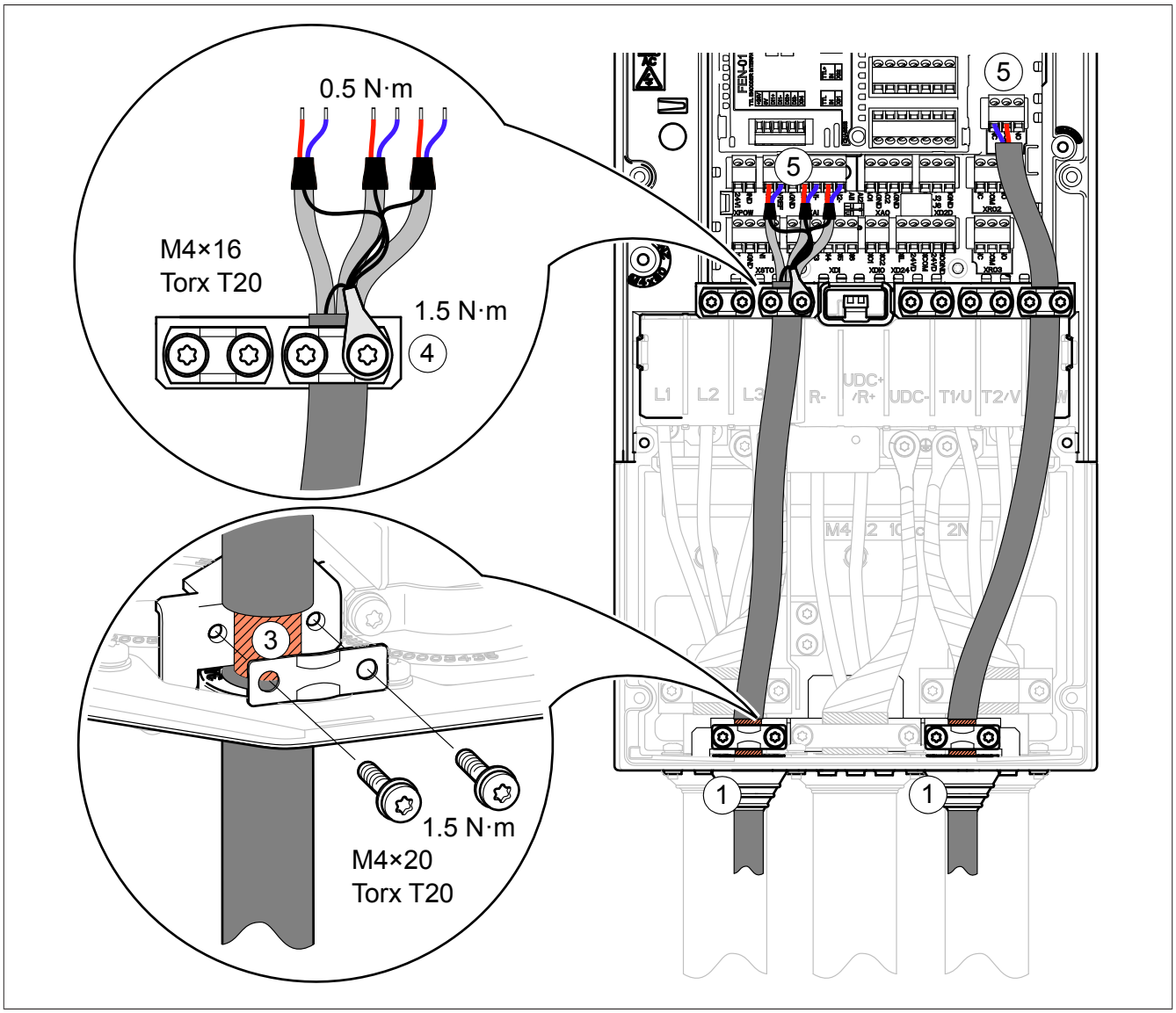



Figure 72: Sizes R4, R5

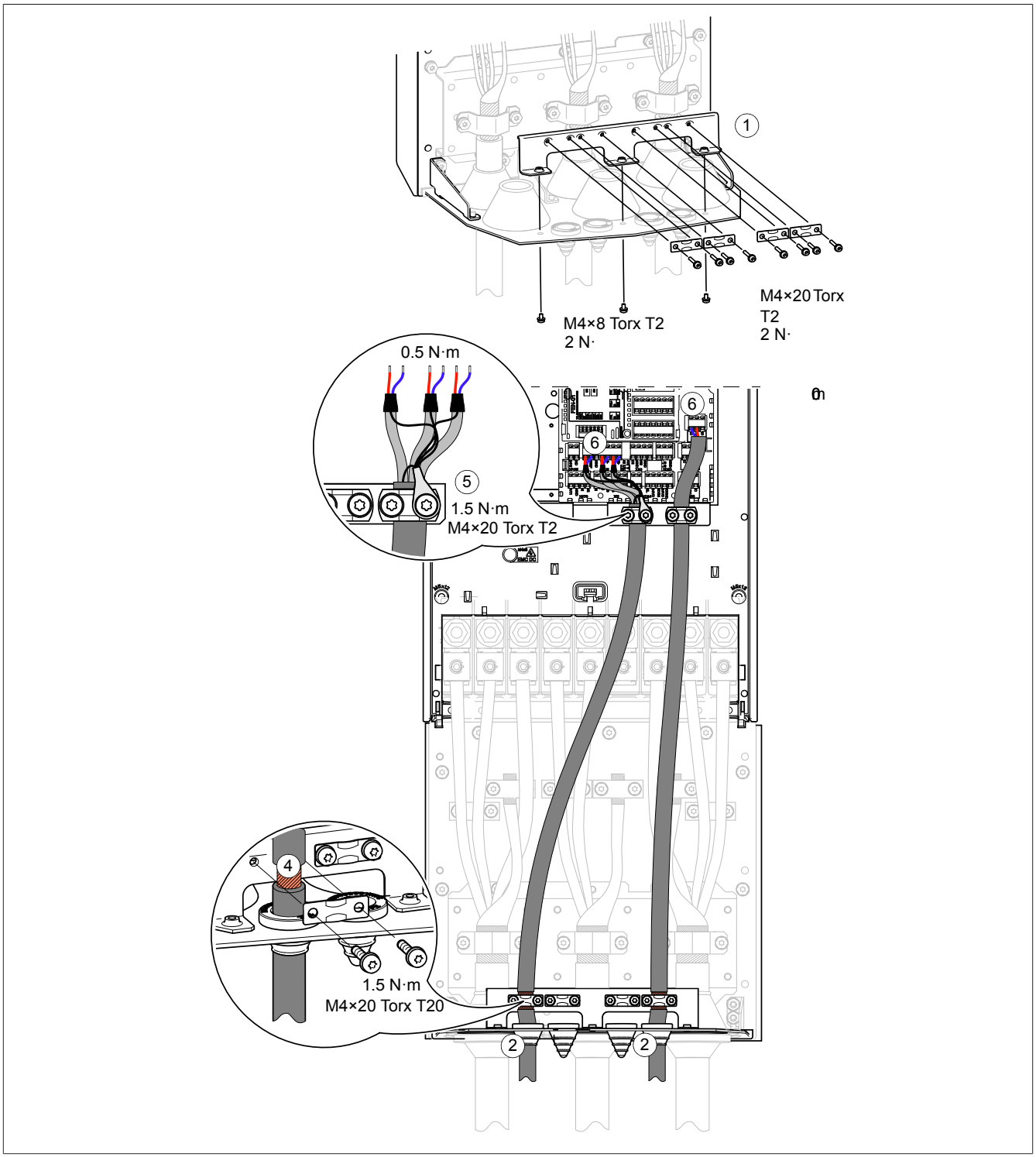



Figure 73: Sizes R6, R7

## A.8.1 Note about fieldbus cabling

1) Install the additional grounding clamp bar.
2) Ground the outer shielding of the cables 360 degrees under the grounding clamp.
3) To install the cable, break the covers from the openings in the cable connection box. Install the cable connection box cover.
4) Connect the connector to the fieldbus module.

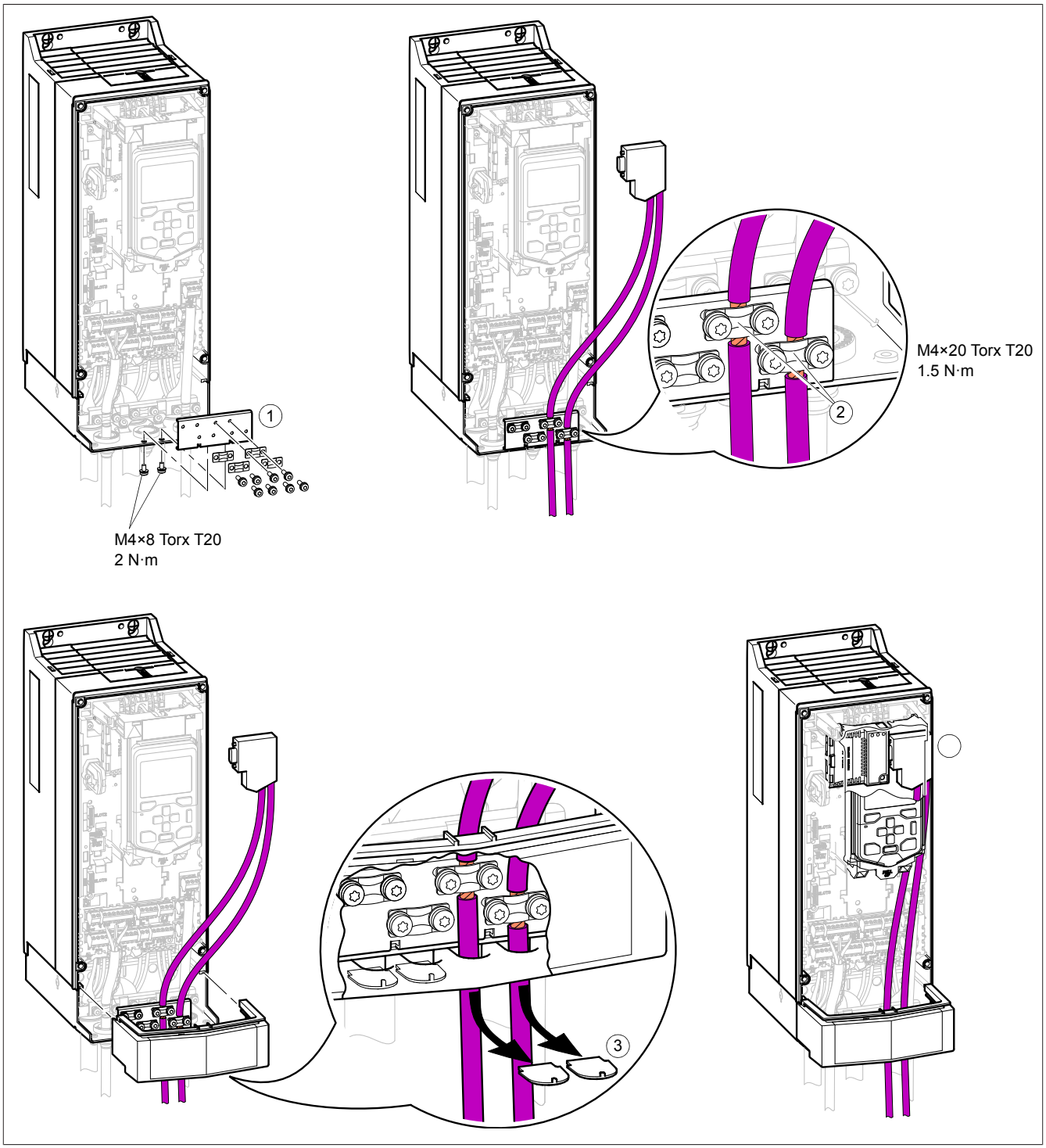



Figure 74: Sizes R1, R2, R3

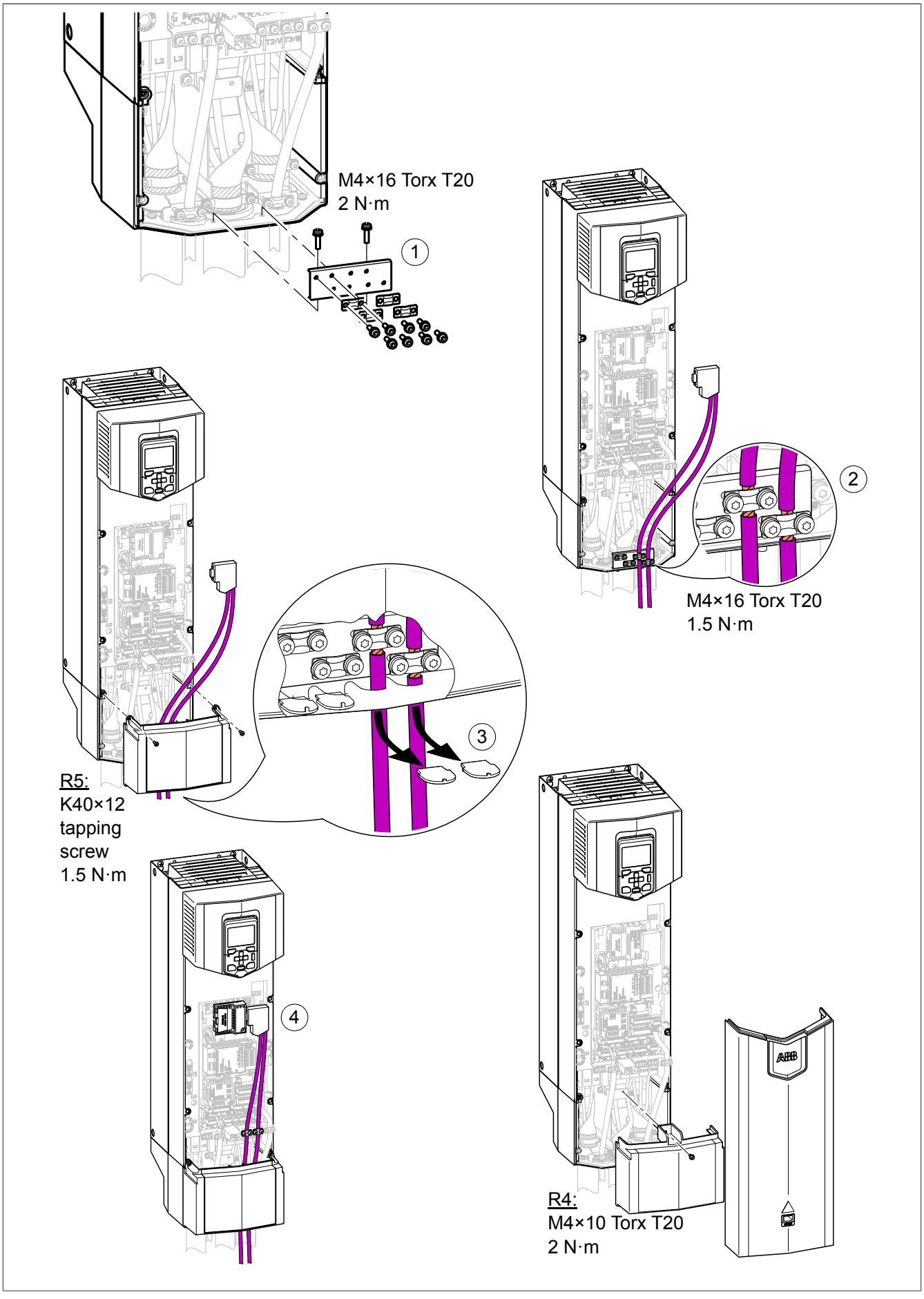



Figure 75: Sizes R4, R5

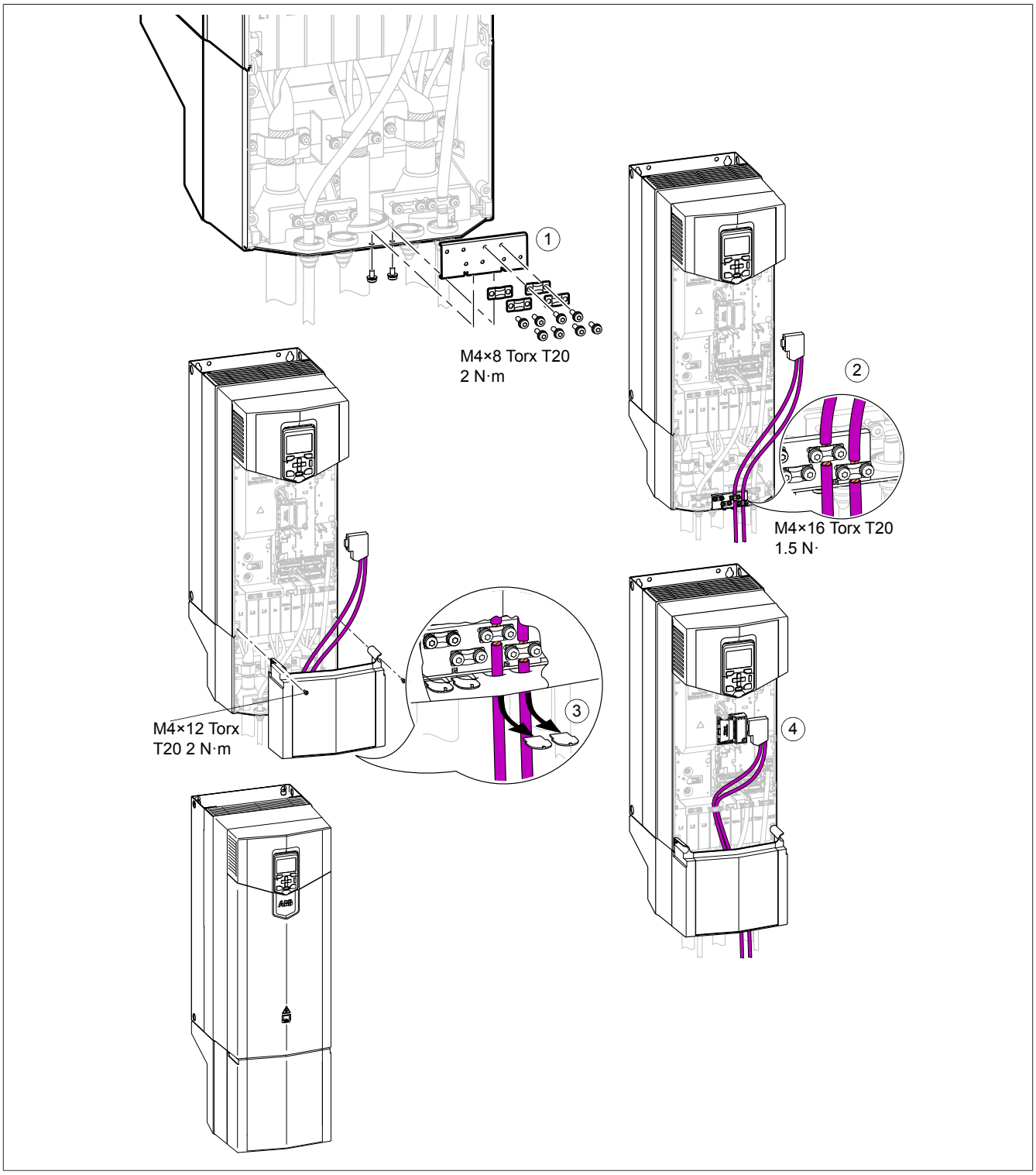
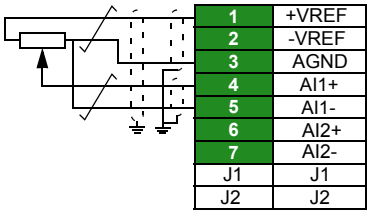
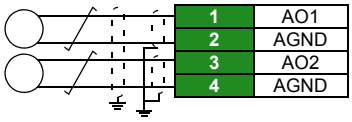
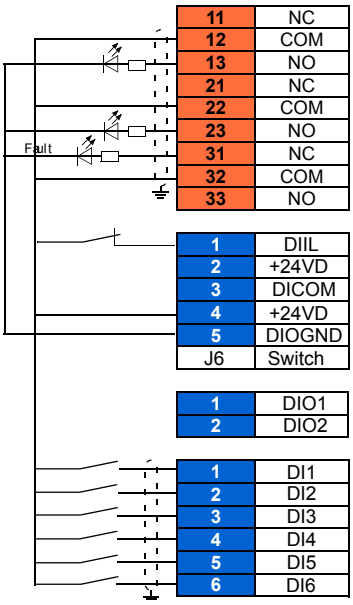
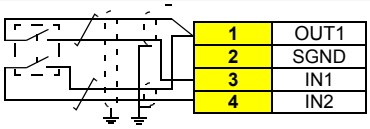



Figure 76: Sizes R6, R7

## A.9 Standard I/O connections

The default I/O connections of the factory setting macro of the ACOPOSinverter P96 main control program are shown below.

Conductor sizes: 0.5 ... 2.5 mm² (24...12 AWG), tightening torques: 0.5 Nm (5 lbf in) for stranded wire and single-core conductors.

| Figure | I/O | Description |
|---|---|---|
| | **XPOW** | **Input for external power supply** |
| | 1 | 24 VDC, 2 A |
| | 2 | |
|  | **XAI** | **Reference voltage and analog inputs** |
| | 1 | 10 VDC, $R_L$ 1…10 kΩ |
| | 2 | -10 VDC, $R_L$ 1…10 kΩ |
| | 3 | Ground |
| | 4 | **AI1** 0(2)...10 V, $R_{in}$ > 200 kΩ [1] |
| | 5 | |
| | 6 | Not used by default. |
| | 7 | 0(4)…20 mA, $R_{in}$ = 100 ohm [2] |
| | J1 | AI1 jumper selection |
| | J2 | AI2 jumper selection |
|  | **XAO** | **Analog outputs** |
| | 1 | **AO1** 0...20 $mA_{,RL}$ 500 Ohm |
| | 2 | |
| | 3 | **AO2** 0...20 $mA_{,RL\ 500}$ Ohm |
| | 4 | |
| | **XD2D** | **Inverter-to-inverter connection (D2D)** |
| | 1 | Inverter-to-inverter connection (D2D) |
| | 2 | |
| | 3 | |
| | J3 | D2D link termination switch |
|  | **XRO1, XRO2, XRO3** | **Relay outputs** |
| | 11 | **Ready to start**<br>250 VAC / 30 VDC<br>2 A |
| | 12 | |
| | 13 | |
| | 21 | **In operation**<br>250 VAC / 30 VDC<br>2 A |
| | 22 | |
| | 23 | |
| | 31 | **Fault (-1)**<br>250 VAC / 30 VDC<br>2 A |
| | 32 | |
| | 33 | |
| | **XD24** | **Digital start interlock** |
| | 1 | Not used by default |
| | 2 | +24 VDC 200 mA [3] |
| | 3 | Digital input ground |
| | 4 | +24 VDC 200 mA [3] |
| | 5 | Digital input/output ground |
| | J6 | Ground selection switch |
| | **XDIO** | **Digital inputs/outputs** |
| | 1 | Not used by default |
| | 2 | Not used by default |
| | **XDI** | **Digital inputs** |
| | 1 | Not used by default |
| | 2 | Not used by default |
| | 3 | Not used by default |
| | 4 | Not used by default |
| | 5 | Not used by default |
| | 6 | Not used by default |
|  | **XSTO** | **Safe torque off** |
| | 1 | Safe Torque Off (STO). Both circuits must be closed for the frequency inverter to start. |
| | 2 | |
| | 3 | |
| | 4 | |
| | **X12** | **Connection for safety function module** |
| | **X13** | **Connection for control panel** |
| | **X205** | **Connection for memory unit** |

1) Current [0(4)…20 mA, $R_{in}$ = 100 ohm] or voltage [ 0(2)…10 V, $R_{in}$ > 200 kΩ]:
Input selection with jumper J1. Changing the setting requires the control unit to be restarted.

2) Current [0(4)…20 mA, $R_{in}$ = 100 ohm] or voltage [ 0(2)…10 V, $R_{in}$ > 200 kΩ]:
Input selection with jumper J2. Changing the setting requires the control unit to be restarted.

3) The total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the energy consumed by DIO1 and DIO2.