Project planning EN

# Inverter

## i510 protec frequency inverter

0.37 kW ... 5.5 kW
0.5 hp ... 7.5 hp

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# About this document

## Document description

This document is intended for all persons who want to configure inverters with the products described.

This document assists you with the configuration and selection of your product. It contains information on mechanical and electrical installation, on product expansions, and on accessories.

## Further documents

For certain tasks, information is available in further documents.

| Document | Contents/topics |
|---|---|
| Commissioning document | Setting and parameterising the inverters |
| Mounting and switch-on instructions | Basic information on mounting and initial switch-on of the product<br>• Is supplied with each component. |

### More information

For certain tasks, information is available in other media.

| Medium | Contents/topics |
|---|---|
| Engineering Tools | For commissioning |
| AKB articles | Additional technical information for users in the Application Knowledge Base |
| CAD data | Download in different formats from the EASY Product Finder |
| EPLAN macros | Project planning, documentation and management of projects for EPLAN P8. |
| Device descriptions | Standardized files for network configuration |

Information and tools with regard to the Lenze products can be found on the Internet:
www.Lenze.com → Downloads

## Notations and conventions

Conventions are used in this document to distinguish between different types of information.

| | | |
|---|---|---|
| Numeric notation | | |
| Decimal separator | Point | Generally shown as a decimal point.<br>Example: 1 234.56 |
| Warnings | | |
| UL Warnings | UL | Are used in English and French. |
| UR warnings | UR | |
| Text | | |
| Engineering Tools | " " | Software<br>Example: "Engineer", "EASY Starter" |
| Icons | | |
| Page reference | 🕮 | Reference to another page with additional information.<br>Example: 🕮 16 = see page 16 |
| Documentation reference | ⓚ | Reference to other documentation with additional information.<br>Example: ⓚ EDKxxx = see documentation EDKxxx |

**Layout of the safety instructions**

**⚠DANGER!**

Indicates an extremely hazardous situation. Failure to comply with this instruction will result in severe irreparable injury and even death.

**⚠WARNING!**

Indicates an extremely hazardous situation. Failure to comply with this instruction may result in severe irreparable injury and even death.

**⚠CAUTION!**

Indicates a hazardous situation. Failure to comply with this instruction may result in slight to medium injury.

**NOTICE**

Indicates a material hazard. Failure to comply with this instruction may result in material damage.



# Product information

## Product description

The frequency inverters from the i500 protec series use the same tried-and-tested technology used in control cabinet inverters and only differ functionally in terms of a higher degree of housing protection with an adapted design. If your machine requires a lot of space, has a modular design, or the space in the control cabinet is limited, we recommend a decentralized installation close to the motor. The latest connection systems are available as accessories and offer a great deal of flexibility during installation, while maintaining compliance with the degree of protection. The inverters comply with the future EN 50598-2 standard.

### Highlights

- 0.37 ... 5.5 kW with NEMA protection 1 (IP20)
- Versions with keypad, USB module or WLAN module for easy commissioning
- Industry standard fieldbus network options: ▸ Topologies / network 🕮 10
- The "Light Duty" load characteristic enables a higher output current
- High internal functional range: ▸ Overview 🕮 11

### Application ranges

- Pumps and fans
- Conveying and travelling drives
- Forming and tool drives

### Load characteristics

The inverters have two different load characteristics: "Light Duty" and "Heavy Duty".

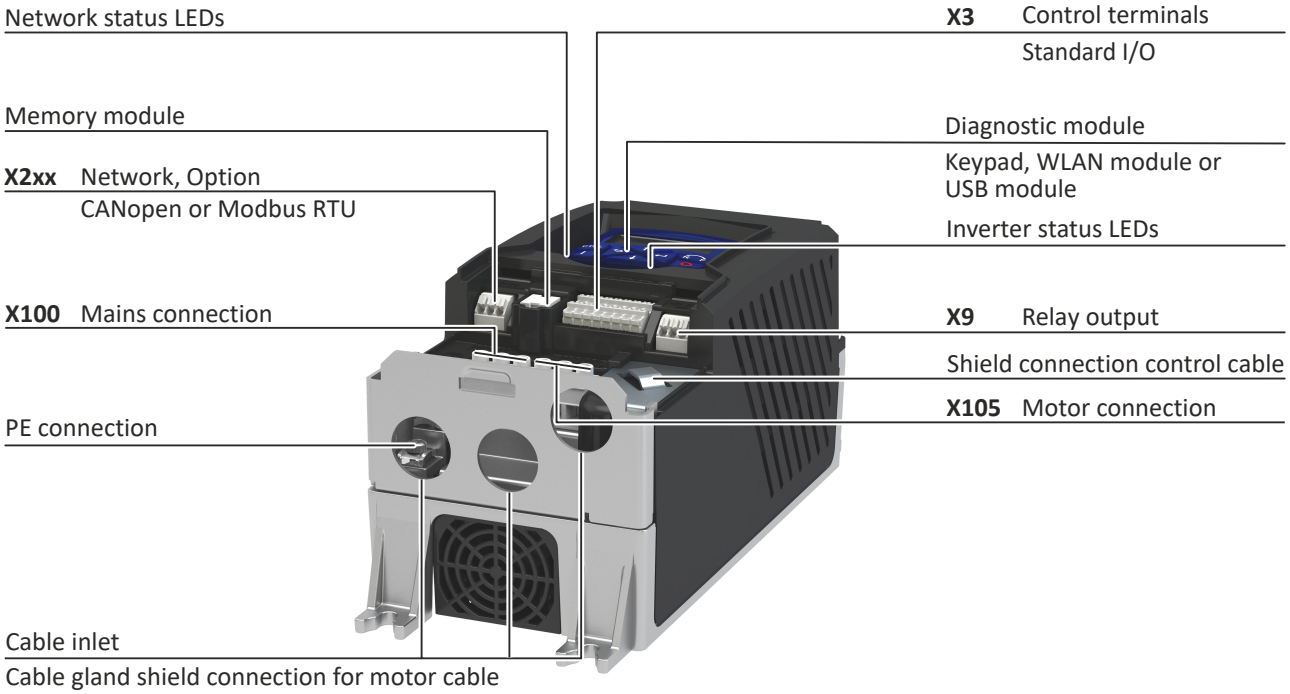
The "Light Duty" load characteristic allows for a higher output current with restrictions regarding overload capacity, ambient temperature and switching frequency. This allows the motor required for the application to be driven by a less powerful inverter. Select the load characteristic according to the application.

| | **Heavy Duty** | **Light Duty** |
|---|---|---|
| Characteristic | High dynamic requirements | Low dynamic requirements |
| Typical applications | Main tool drives, travelling drives, hoist drives, winders, forming drives and conveyors | Pumps, fans, general horizontal materials handling technology and line drives |
| Overload capacity | 3 s/200 %, 60 s/150 %<br>See technical data | Restricted<br>See technical data |

## Features

### Connections and interfaces

The following figure gives an overview of the elements and connections on the devices. Position, size and appearance of elements and connections may vary depending on the performance and size of the equipment.




The i510 protec frequency inverters have these interfaces:

- Standard I/O:
  - 5x digital input
  - 1x digital output
  - 2x analog input
  - 1x analog output
  - PNP/NPN logic
  - Cycle time: 1 ms
- Frequency input: 0 ... 100 kHz
- 1x NO/NC relay (DC 24 V max. 2 A; AC 240 V max. 3 A)
- External 24 V supply and internal 24 V power supply unit
- Spring terminals
- Diagnostic interface (USB module or WLAN module required)

### Topologies / network

The inverters can be equipped with different fieldbus networks.

The topologies and protocols typical for the prevailing networks are supported.

Currently available networks:

| | |
|---|---|
| CANopen | CANopen® is a communication protocol based on CAN.<br>CANopen® is a registered community trademark of the CAN user organisation CiA® (CAN in Automation e. V.).<br>Device descriptions for the download: EDS files for Lenze devices |
| Modbus | The Modbus protocol is an open communication protocol based on a client/server architecture and developed for the communication with programmable logic controllers.<br>Further development is carried out by the international user organisation Modbus Organization, USA. |



# Functions

## Overview

The functions of the frequency inverters i510 protec are adapted to extensive applications.

| Functions | | |
|---|---|---|
| **Motor control** | | **Monitoring** |
| V/f characteristic control linear/square-law (VFC plus) | | Short circuit |
| V/f characteristic control (VFC closed loop) | | Earth fault |
| Energy-saving function (VFC-Eco) | | Device overload (ixt) |
| Sensorless vector control (SLVC) | | Motor overload ($i^2xt$) |
| Sensorless control for synchronous motors (SL-PSM/SLSM-PSM) | | Mains phase failure |
| Servo control for asynchronous motors (SC-ASM) | | Stall protection |
| **Motor functions** | | Motor current limit |
| Flying restart circuit | | Maximum torque |
| Slip compensation | | Ultimate motor current |
| DC braking | | Motor speed |
| Oscillation damping | | Load loss detection |
| Skip frequencies | | Motor temperature |
| Automatic identification of the motor data | | **Diagnostics** |
| Brake energy management | | Error history buffer |
| Holding brake control | | Logbook |
| "Voltage add" function | | LED status displays |
| Rational Energy Ride Through (RERT) | | Keypad language selection German, English |
| Speed feedback (HTL encoder) | | **Network** |
| Brake resistor control (brake chopper integrated) | | CANopen |
| Frequency setpoint | | Modbus RTU |
| DC-bus connection (400V devices) | | IO-Link |
| **Application functions** | | EtherCAT |
| Process controller | | EtherNet/IP |
| Access protection | | Modbus TCP |
| Process controller - sleep mode and rinse function | | PROFINET |
| Freely assignable favorite menu | | **Safety functions** |
| Parameter change-over | | Basic Safety - STO |
| S-shaped ramps for smooth acceleration | | |
| Motor potentiometer | | |
| Flexible I/O configuration | | |
| Automatic restart | | |
| OEM parameter set | | |
| Complete control with 8-key keypad | | |
| UPS operation | | |
| Frequency output via digital output DO1 | | |
| Cascade function for pumps and fans | | |
| "Light Duty" load characteristic can be adjusted for selected inverters. | | |

### Motor control types

The following table contains the possible control types with Lenze motors.

| Motors | V/f characteristic control<br>VFCplus | Sensorless vector control<br>SLVC | ASM servo control<br>SC ASM |
|---|---|---|---|
| Three-phase AC motors | | | |
| MD | • | • | • |
| MF | • | • | • |
| mH | • | • | • |
| m500 | • | • | • |

Lenze synchronous servo motors are not suitable for use with inverters, e.g. the types MCS, MCM or m850.

### Motor functions

### Motor setting range

#### Rated point 120 Hz

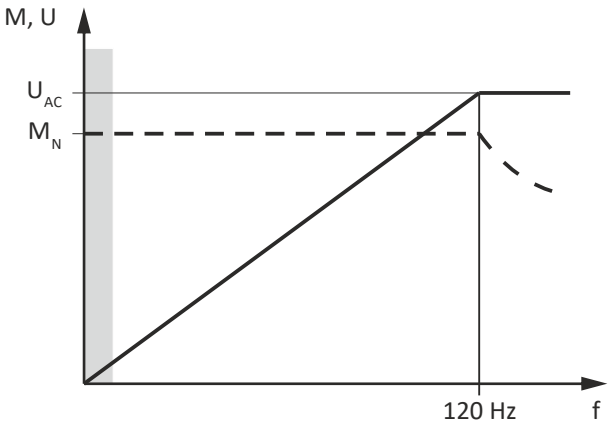
Only possible with Lenze MF motors.

The rated motor torque is available up to 120 Hz.

Compared to the 50-Hz operation, the setting range increases by 2.5 times.

Thus, a smaller motor can be selected at the same rated power.

#### V/f at 120 Hz




| | | | |
|---|---|---|---|
| V | Voltage | $V_{AC}$ | Mains voltage |
| M | Torque | $M_N$ | Rated torque |
| f | Frequency | | |

**Rated point 87 Hz**

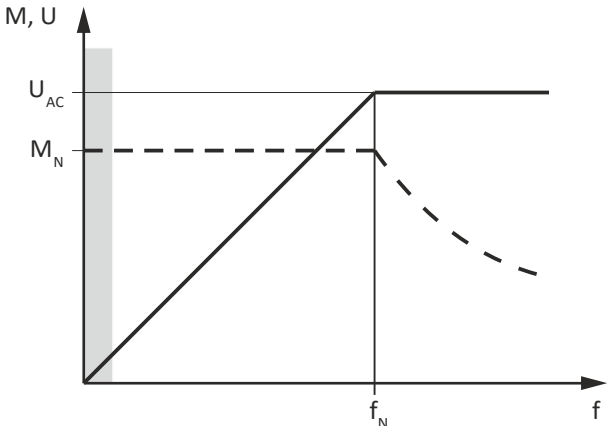
The rated motor torque is available up to 87 Hz.

Compared to the 50-Hz operation, the setting range increases by 1.74 times.

For this purpose, a motor with 230/400 V in a triangle is driven by a 400 V inverter.

The inverter must be dimensioned for a rated motor current of 230 V.

**V/f at 87 Hz**

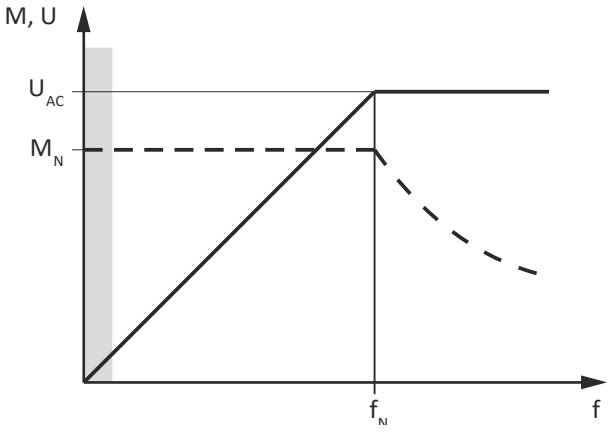



| | | | |
|---|---|---|---|
| V | Voltage | $U_{AC}$ | Mains voltage |
| M | Torque | $M_{rated}$ | Rated torque |
| f | Frequency | $f_{rated}$ | Rated frequency |

**Rated point 50 Hz**

The rated motor torque is available up to 50 Hz.

**V/f at 50 Hz**




| | | | |
|---|---|---|---|
| V | Voltage | $U_{AC}$ | Mains voltage |
| M | Torque | $M_{rated}$ | Rated torque |
| f | Frequency | $f_{rated}$ | Rated frequency |

## Identification of the products

### Product name

The product name is used when listing the technical data of the various product variants and for the assignment of accessories. You can find the assignment of product names to order codes in chapter ▸ Purchase order 🕮 100.

The product name contains:

- the designation of the product range – e.g. i5xx
- the type – "P" for "protec" = inverter for decentralized mounting locations
- its power rating – in kW for the load characteristic "Heavy Duty"
- the mains voltage class – e.g. 120 V, 230 V or 400 V
- the number of mains phases – the 1/3-phase inverters are labelled with "-2".

| Device series | Type | Rated power | | Rated mains voltage | No. of phases | Inverter | Protection class |
|---|---|---|---|---|---|---|---|
| | | Light Duty | Heavy Duty | | | | |
| | | kW | kW | V | | | |
| i510 | P | - | 0.37 | 120 | 1 | i510-P0.37/120-1 | IP20 NEMA 1 |
| | | | 0.75 | | | i510-P0.75/120-1 | |

| Device series | Type | Rated power | | Rated mains voltage | No. of phases | Inverter | Protection class |
|---|---|---|---|---|---|---|---|
| | | Light Duty | Heavy Duty | | | | |
| | | kW | kW | V | | | |
| i510 | P | 0.55 | 0.37 | 230 | 1/3 | i510-P0.37/230-2 | IP20 NEMA 1 |
| | | 1.1 | 0.75 | | | i510-P0.75/230-2 | |
| | | 1.5 | 1.1 | | | i510-P1.1/230-2 | |
| | | 2.2 | 1.5 | | | i510-P1.5/230-2 | |
| | | 3 | 2.2 | | | i510-P2.2/230-2 | |

| Device series | Type | Rated power | | Rated mains voltage | No. of phases | Inverter | Protection class |
|---|---|---|---|---|---|---|---|
| | | Light Duty | Heavy Duty | | | | |
| | | kW | kW | V | | | |
| i510 | P | 0.55 | 0.37 | 240 | 1/3 | i510-P0.37/230-2 | IP20 NEMA 1 |
| | | 1.1 | 0.75 | | | i510-P0.75/230-2 | |
| | | 1.5 | 1.1 | | | i510-P1.1/230-2 | |
| | | 2.2 | 1.5 | | | i510-P1.5/230-2 | |
| | | 3 | 2.2 | | | i510-P2.2/230-2 | |
| | | 4 | 3 | | 3 | i510-P3.0/230-3 | |
| | | 5.5 | 4 | | | i510-P4.0/230-3 | |

| Device series | Type | Rated power | | Rated mains voltage | No. of phases | Inverter | Protection class |
|---|---|---|---|---|---|---|---|
| | | Light Duty | Heavy Duty | | | | |
| | | kW | kW | V | | | |
| i510 | P | 1.1 | 0.75 | 400 | 3 | i510-P0.75/400-3 | IP20 NEMA 1 |
| | | 1.5 | 1.1 | | | i510-P1.1/400-3 | |
| | | 2.2 | 1.5 | | | i510-P1.5/400-3 | |
| | | 3 | 2.2 | | | i510-P2.2/400-3 | |
| | | 4 | 3 | | | i510-P3/400-3 | |
| | | 5.5 | 4 | | | i510-P4/400-3 | |
| | | 7.5 | 5.5 | | | i510-P5.5/400-3 | |



| Device series | Type | Rated power | | Rated mains voltage | No. of phases | Inverter | Protection class |
|---|---|---|---|---|---|---|---|
| | | Light Duty | Heavy Duty | | | | |
| | | kW | kW | V | | | |
| i510 | P | 1.1 | 0.75 | 480 | 3 | i510-P0.75/400-3 | IP20 NEMA 1 |
| | | 1.5 | 1.1 | | | i510-P1.1/400-3 | |
| | | 2.2 | 1.5 | | | i510-P1.5/400-3 | |
| | | 3 | 2.2 | | | i510-P2.2/400-3 | |
| | | 4 | 3 | | | i510-P3/400-3 | |
| | | 5.5 | 4 | | | i510-P4/400-3 | |
| | | 7.5 | 5.5 | | | i510-P5.5/400-3 | |

## Product code

| | | | I | 5 | 1 | A | P | □□□ | □ | □ | □ | □ | □ | □ | □ | □□□ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product type | Inverter | | I | | | | | | | | | | | | | |
| Product family | i500 | | | 5 | | | | | | | | | | | | |
| Product | i510 | | | | 1 | | | | | | | | | | | |
| Product generation | Generation 1 | | | | | A | | | | | | | | | | |
| Mounting type | Wall mounting | | | | | | P | | | | | | | | | |
| Rated power (Examples) | 0.37 kW | 0.5 hp | | | | | | 137 | | | | | | | | |
| | 0.75 kW | 1.0 hp | | | | | | 175 | | | | | | | | |
| | 2.2 kW | 3.0 hp | | | | | | 222 | | | | | | | | |
| Mains voltage and connection type | 1/N/PE AC 120 V | | | | | | | | A | | | | | | | |
| | 3/PE AC 230/240 V | | | | | | | | C | | | | | | | |
| | 1/N/PE AC 230/240 V<br>3/PE AC 230/240 V | | | | | | | | D | | | | | | | |
| | 3/PE AC 400 V<br>3/PE AC 480 V | | | | | | | | F | | | | | | | |
| Product variant | Standard | | | | | | | | | 0 | | | | | | |
| Integrated functional safety | Without safety function | | | | | | | | | | 0 | | | | | |
| Degree of protection | NEMA 1 (IP20), uncoated | | | | | | | | | | | 0 | | | | |
| Interference suppression | Without | | | | | | | | | | | | 0 | | | |
| Application area | Default parameter setting: Region EU (50-Hz networks) | | | | | | | | | | | | | 0 | | |
| | Default parameter setting: Region US (60-Hz networks) | | | | | | | | | | | | | 1 | | |
| Product extension | Standard I/O: ... | | | | | | | | | | | | | | 0 | |
| | Keypad- module with Standard I/O ... | | | | | | | | | | | | | | K | |
| | WLAN module with Standard I/O ... | | | | | | | | | | | | | | W | |
| | | ... without network | | | | | | | | | | | | | | 00S |
| | | ... with CANopen | | | | | | | | | | | | | | 02S |
| | | ... with Modbus RTU | | | | | | | | | | | | | | 03S |

## Ways of commissioning

There are three ways to commission the inverter quickly and easily.

Thanks to Lenze's engineering philosophy, the high functionality is still easy to grasp. Parameterization and commissioning are a breeze thanks to clear structure and simple dialogs, leading to the desired outcome quickly and reliably.

### Keypad

If it's only a matter of setting a few key parameters such as acceleration and deceleration time, this can be done quickly on the keypad.


### »EASY Starter«

If functions such as the holding brake control or sequencer need to be set, it's best to use the »EASY Starter« engineering tool.

### SMART Keypad App

The Lenze SMART Keypad App for Android or iOS allows you to diagnose and parameterize an inverter. A WLAN module on the inverter is required for communication.

- Ideal for the parameterization of simple applications such as a conveyor belt.
- Ideal for the diagnostics of the inverter.

The app can be found in the Google Play Store or in the Apple App Store.

Android

iOS



# Information on project planning

## Project planning process

### Dimensioning

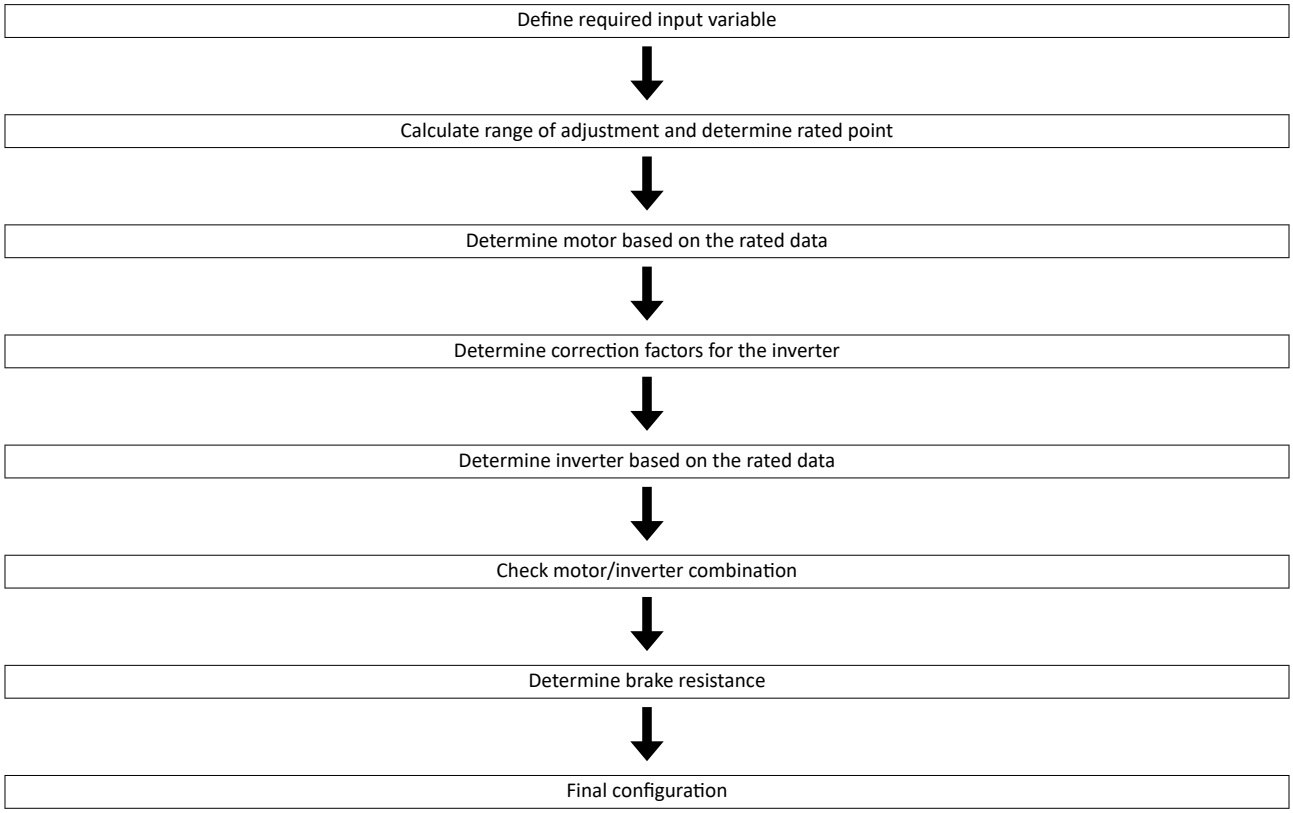
**3 methods for dimensioning**

**Fast:** Selection of the inverter based on the motor data of a 4-pole asynchronous motor.

**Detailed:** In order to optimize the selection of the inverter and all drive components, it is worthwhile to execute the detailed system dimensioning based on the physical requirements of the application. For this purpose, Lenze provides the Drive Solution Designer (DSD) design program.

**Manual:** The following chapter guides you step by step through the selection of a drive system.

**Workflow of a configuration process**




**Define required input variables**

| | | | |
|---|---|---|---|
| Operating mode | | | S1 or S6 |
| Max. load torque | $M_{L,max}$ | Nm | |
| Max. load speed | $n_{L,max}$ | rpm | |
| Min. load speed | $n_{L,min}$ | rpm | |
| Site altitude | H | m | |
| Ambient temperature (inverter) | $T_U$ | °C | |

## Calculate range of adjustment and determine rated point

| | Calculation |
|---|---|
| Setting range | $V = \frac{n_{L,max}}{n_{L,min}}$ |

| | Setting range | Rated point |
|---|---|---|
| Motor with integral fan | ≤ 2.50 (20 - 50 Hz)<br>≤ 4.35 (20 - 87Hz)<br>≤ 6 (20 - 120Hz) | 50 Hz<br>87 Hz<br>120 Hz |
| Motor with blower | ≤ 10.0 (5 - 50 Hz)<br>≤ 17.4 (5 - 87Hz)<br>≤ 24 (5 - 120Hz) | 50 Hz<br>87 Hz<br>120 Hz |
| Motor with integral fan (reduced torque) | | |

## Determine motor based on the rated data

| | | | Check |
|---|---|---|---|
| Rated torque | | | |
| Operating mode S1 | $M_{rated}$ | Nm | $M_N \geq \frac{M_{L,max}}{T_{H,Mot} \times T_{U,Mot}}$ |
| Operating mode S6 | $M_{rated}$ | Nm | $M_N \geq \frac{M_{L,max}}{2 \times T_{H,Mot} \times T_{U,Mot}}$ |
| Rated speed | $n_{rated}$ | rpm | $n_{rated} \geq n_{L,max}$<br>$\frac{n_n}{V} \leq n_{L,min}$ |

| | | | Note |
|---|---|---|---|
| Rated torque | $M_{rated}$ | Nm | → Rated motor data |
| Rated speed | $n_{rated}$ | rpm | |
| Rated point at | | Hz | → setting range |
| Power factor | cos φ | | → Rated motor data |
| Rated current | $I_{N,MOT}$ | A | |
| Rated power | $P_{rated}$ | kW | |
| Correction factor - site altitude | $T_{H,MOT}$ | | → Technical motor data |
| Correction factor - ambient temperature | $T_{U,MOT}$ | | |
| Select motor | | | |

## Correction factors for the inverter

| Site altitude Amsl | | H | | | |
|---|---|---|---|---|---|
| | [m] | ≤ 1000 | ≤ 2000 | ≤ 3000 | ≤ 4000 |
| $k_{H,INV}$ | | 1.00 | 0.95 | 0.90 | 0.85 |

| Temperature in the control cabinet | | $T_U$ | | | |
|---|---|---|---|---|---|
| | [°C] | ≤ 40 | ≤ 45 | ≤ 50 | ≤ 55 |
| Switching frequency | | | | | |
| 2 or 4 kHz | $k_{TU,INV}$ | 1.00 | 1.00 | 0.875 | 0.750 |
| 8 or 16 kHz | | 1.00 | 0.875 | 0.750 | 0.625 |
| Switching frequency with the "Light Duty" load characteristic | | | | | |
| 2 or 4 kHz | $k_{TU,INV}$ | 1.00 | 0.875 | 0.750 | - |
| 8 or 16 kHz | | - | - | - | - |

## Determine the inverter based on the rated data

| | | | Check |
|---|---|---|---|
| Output current | | | |
| Continuous operation | $I_{out}$ | A | $I_{out} \geq I_{N,Mot} / (k_{H,INV} \times k_{TU,INV})$ |
| Overcurrent operation cycle 15 s | $I_{out}$ | A | $I_{out} \geq I_{N,Mot} \times 2 / (k_{H,INV} \times k_{TU,INV})$ |
| Overcurrent operation cycle 180 s | $I_{out}$ | A | $I_{out} \geq I_{N,Mot} \times 1.5 / (k_{H,INV} \times k_{TU,INV})$ |



### Determine the inverter based on the rated data for the "Light Duty" load characteristic

| | | | Check |
|---|---|---|---|
| Output current | | | |
| Continuous operation | $I_{out}$ | A | $I_{out} \geq I_{N,Mot} / (k_{H,INV} \times k_{TU,INV})$ |
| Overcurrent operation cycle 15 s | $I_{out}$ | A | $I_{out} \geq I_{N,Mot} \times 1.65 / (k_{H,INV} \times k_{TU,INV})$ |
| Overcurrent operation cycle 180 s | $I_{out}$ | A | $I_{out} \geq I_{N,Mot} \times 1.25 / (k_{H,INV} \times k_{TU,INV})$ |

### Check motor/inverter combination

| | | | Calculation |
|---|---|---|---|
| Motor torque | M | Nm | $M = \sqrt{\left(\frac{I_{out,INV}}{I_{N,MOT}}\right)^2 - \left(1 - \cos\varphi^2\right)} \times \frac{M_N}{\cos\varphi}$ |

| | | Check |
|---|---|---|
| Inverter overload capacity | | $\frac{M_{L,max}}{M} \leq 1.5$ |

### Braking operation without additional measures

To decelerate small masses, the "DC injection brake DCB" function can be parameterised. DC-injection braking enables a quick deceleration of the drive to standstill without the need for an external brake resistor.

- A code can be used to select the braking current.
- The maximum braking torque to be realised by the DC braking current amounts to approx. 20 ... 30 % of the rated motor torque. It is lower compared to braking action in generator mode with external brake resistor.
- Automatic DC-injection braking (Auto-DCB) improves the starting performance of the motor when the operation mode without speed feedback is used.

### Final configuration

Product extensions and accessories can be found here:

▸ Product extensions 📖 89

▸ Accessories 📖 97

### Operation in motor and generator mode

The energy analysis differs between operation in motor mode and generator mode.

During operation in motor mode, the energy flows from the supplying mains via the inverter to the motor which converts electrical energy into mechanical energy (e. g. for lifting a load).

During operation in generator mode, the energy flows back from the motor to the inverter. The motor converts the mechanical energy into electrical energy - it acts as a generator (e. g. when lowering a load).

The drive brakes the load in a controlled manner.

The energy recovery causes a rise in the DC-bus voltage. If this voltage exceeds an upper limit, the output stage of the inverter will be blocked to prevent the device from being destroyed.

The drive coasts until the DC-bus voltage reaches the permissible value range again.

**Overcurrent operation**

The inverters can be driven at higher amperages beyond the rated current if the duration of this overcurrent operation is time limited.

Two utilisation cycles of 15 s and 180 s are defined. Within these utilisation cycles, an overcurrent is possible for a certain time if afterwards an accordingly long recovery phase takes place.

Cycle 15 s

During this operation, the inverter may be loaded for 3 s with up to 200 % of the rated current if afterwards a recovery time of 12 s with max. 75 % of the rated current is observed. A cycle corresponds to 15 s.

Cycle 180 s

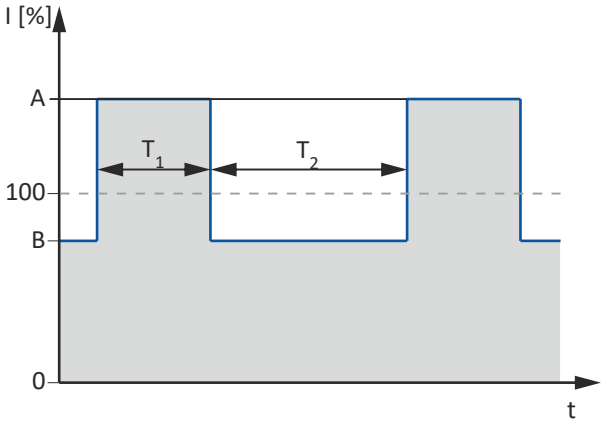
During this operation, the inverter may be loaded for 60 s with up to 150 % of the rated current if afterwards a recovery time of 120 s with max. 75 % of the rated current is observed. A cycle corresponds to 180 s.

The monitoring of the device utilization (Ixt) triggers an error if the utilization value exceeds a threshold of 100 %.

The maximum output currents correspond to the switching frequencies and the overload behaviour of the inverters are given in the rated data.

In case of rotating frequencies < 10 Hz, the time-related overload behaviour may be reduced.

The graphics shows a cycle. The basic conditions given in the table (graphics field highlighted in grey) have to be complied with in order that the inverter will not be overloaded. Both cycles can be combined with each other.




| Cycle | Max. output current | Max. overload time | Max. output current during the Recovery time | Min. recovery time |
|---|---|---|---|---|
| | A | $T_1$ | B | $T_2$ |
| s | % | s | % | s |
| 15 | 200 | 3 | 75 | 12 |
| 180 | 150 | 60 | 75 | 120 |



## Safety instructions

Disregarding the following basic safety measures and safety information may lead to severe personal injury and damage to property!

Observe all specifications of the corresponding documentation supplied. This is the precondition for safe and trouble-free operation and for obtaining the product features specified.

Please observe the specific safety information in the other sections!

### Basic safety instructions

**⚠ DANGER!**

Dangerous electrical voltage

Possible consequences: Death or severe injuries from electric shock

- ▶ Any work on the device must only be carried out in a deenergized state.
- ▶ After switching off the mains voltage, observe the signs on the product.

**Product**

- The product must only be used as directed.
- Never commission the product in the event of visible damage.
- The product must never be technically modified.
- Never commission the product before assembly has been completed.
- The product must never be operated without required covers.
- Connect/disconnect all pluggable terminals only in de-energized condition.
- Only remove the product from the installation in the de-energized state.

**Personnel**

Only qualified and skilled personnel are allowed to work with the product. IEC 60364 and/or CENELEC HD 384 define the qualifications of these persons as follows:

- They are familiar with the installation, mounting, commissioning, and operation of the product.
- They possess the appropriate qualifications for their tasks.
- They are familiar with all regulations for the prevention of accidents, directives, and laws applicable at the location and are able to apply them.

**Process engineering**

The procedural notes and circuit details described are only proposals. It is up to the user to check whether they can be adapted to the particular applications. Lenze does not take any responsibility for the suitability of the procedures and circuit proposals described.

**Device protection**

- The maximum test voltage for insulation tests between a control potential of 24 V and PE must not exceed 110 V DC (EN 61800−5−1).

**Application as directed**

- The product serves as a component for the control of three-phase AC motors and servo motors.
- The product must only be actuated with motors that are suitable for the operation with inverters.
- The product is not a household appliance, but is only designed as electrical equipment for commercial or professional use in terms of EN 61000−3−2.
- The product can be mounted in control cabinets or outside, depending on the protection class.
- The product must only be operated under the operating conditions prescribed in this documentation.
- The product meets the protection requirements of 2014/35/EU: Low-Voltage Directive.
- The product is not a machine in terms of 2006/42/EU: Machinery Directive.
- Commissioning or starting the operation as directed of a machine with the product is not permitted until it has been ensured that the machine meets the regulations of the EC Directive 2006/42/EU: Machinery Directive; observe EN 60204−1.
- Commissioning or starting operation as directed is only permissible if the EMC Directive 2014/30/EU is complied with.
- As the product may cause EMC interferences in residential areas, the operator is responsible for taking interference suppression measures.

**Additional information for the intended use in North America:**

The cables must be installed in accordance with US National Electrical Code NFPA 70 or Canadian Electrical Code C22.1.

**Use of explosion-protected motors**

Explosion-protected motors that are not designed for use with an inverter lose their approval if they are used for variable speed applications. Due to the many areas of liability that may arise when handling these applications, the following policy statement applies:

Lenze inverters are sold without warranty of suitability for use with explosion-protected motors. Lenze assumes no responsibility for direct, incidental or consequential damages, costs or losses that may result from the use of AC inverters with explosion-protected motors. Buyer expressly agrees to assume any risk of loss, expense or damage that may result from such application.

**Foreseeable misuse**

Inverters are not to be operated with DC motors.



## Handling

### Transport, storage

Observe the notes regarding transport, storage and correct handling. Ensure proper handling and avoid mechanical stress. Do not bend any components and do not change any insulation distances during transport or handling. Do not touch any electronic components and contacts. Inverters contain electrostatically sensitive components which can easily be damaged by inappropriate handling. Do not damage or destroy any electrical components since thereby your health could be endangered!

### Installation

The technical data and supply conditions can be obtained from the nameplate and the documentation. They must be strictly observed.

The inverters must be installed and cooled according to the instructions given in the corresponding documentation. Observe the climatic conditions according to the technical data. The ambient air must not exceed the degree of pollution 2 according to EN 61800−5−1.

### Electrical connection

When working on energized inverters, comply with the applicable national accident prevention regulations.

The electrical installation must be carried out according to the appropriate regulations (e. g. cable cross-sections, fuses, PE connection). Additional information can be obtained from the documentation.

The documentation contains information about installation according to EMC regulations (shielding, grounding, filters and cable routing). Please also observe this information for CE-marked inverters. The manufacturer of the system or machine is responsible for adherence to the limit values required in connection with EMC legislation. The inverters must be installed in housings (e. g. control cabinets) to meet the limit values for radio interferences valid at the site of installation. The housings must enable an EMC-compliant installation. Observe in particular that e.  the control cabinet doors should have a circumferential metal connection to the housing. Reduce housing openings and cutouts to a minimum.

### Protection in the event of short circuit or earth fault

To ensure protection in accordance with IEC 61800-5-1 in the event of an electrical short circuit or earth fault (protection against electric shock, thermal hazards and fire), the following must be taken into account in the installation:

- Use fuses according to the technical data.
- The installation must comply with the requirements of the IEC/HD 60364 (DIN VDE 0100; VDE 0100).
- The continuity of all associated protective conductors and equipotential bonding conductors including all connection points must be ensured.
- If the maximum permissible switch-off time according to IEC 60364-4-41 is exceeded with a high system impedance (especially with TT mains) or a high loop impedance with the prescribed fuses, a residual current device (RCD) can be used. Alternatively, other protective measures can be used, e. g. isolation from the environment by means of double or reinforced insulation, or isolation from the supply system by using a transformer.
- If a residual current device (RCD) is connected upstream of the inverter for protection in the event of an earth fault, only type B/B+ is permitted for 3-phase devices.

### Operation

If necessary, systems including inverters must be equipped with additional monitoring and protection devices. Also comply with the safety regulations and provisions valid at the installation site.

After the inverter has been disconnected from the supply voltage, all live components and power terminals must not be touched immediately because capacitors can still be charged. Please observe the corresponding stickers on the inverter.

All protection covers and doors must be shut during operation.

You may adapt the inverters to your application by parameter setting within the limits available. For this, observe the notes in the documentation.

**Maintenance and servicing**

The inverters do not require any maintenance if the prescribed operating conditions are observed.

**Disposal**

In accordance with the current provisions, Lenze products and accessories have to be disposed of by means of professional recycling. Lenze products contain contain recyclable raw material such as metal, plastics and electronic components.



**Residual hazards**

Even if notes given are taken into consideration and protective measures are implemented, the occurrence of residual risks cannot be fully prevented.

The user must take the residual hazards mentioned into consideration in the risk assessment for his/her machine/system.

If the above is disregarded, this can lead to severe injuries to persons and damage to property!

**Product**

Observe the warning labels on the product!

**Dangerous electrical voltage:**
Before working on the product, make sure there is no voltage applied to the power terminals!
After mains disconnection, the power terminals will still carry the hazardous electrical voltage for the time given next to the symbol!

**Electrostatic sensitive devices:**
Before working on the product, the staff must ensure to be free of electrostatic charge!

**High leakage current:**
Carry out fixed installation and PE connection in compliance with:
EN 61800−5−1 / EN 60204−1

**Hot surface:**
Use personal protective equipment or wait until the device has cooled down!

**Degree of protection - protection of persons and device protection**

- Information applies to the mounted and ready-for-use state.

**Protection of persons**

Before working on the inverter, check if no voltage is applied to the power terminals.

- Depending on the device, the power terminals X105 remain live for up to 3 ... 20 minutes.
- The power terminals X100 and X105 remain live even when the motor is stopped.

**Motor protection**

With some settings of the inverter, the connected motor can be overheated.

- E. g. by longer operation of self-ventilated motors at low speed.
- E. g. by longer operation of DC-injection braking.

**Protection of the machine/system**

Drives can reach dangerous overspeeds.

- E. g. by setting high output frequencies in connection with motors and machines not suitable for this purpose.
- The inverters do not provide protection against such operating conditions. For this purpose, use additional components.

Switch contactors in the motor cable only if the controller is inhibited.

- Switching while the inverter is enabled is only permissible if no monitoring functions are activated.

**Motor**

If there is a short circuit of two power transistors, a residual movement of up to 180°/number of pole pairs can occur at the motor! (e. g. 4-pole motor: residual movement max. 180°/2 = 90°).

## Decentralized topologies

The i510 protec frequency inverters support decentralized concepts for machines and electrical installation in particular.

**Advantages**

- Saves installation costs
  - Less expensive shielded motor cables, no EMC collective filters
  - Fewer circuit breakers, protection devices and mains cables
  - Fewer I/O gateways and cabling thanks to decentralized I/Os
  - Smaller control cabinet
- New solutions when less space is available
- Combination of functionally independent machine modules
- Less cooling units, higher efficiency

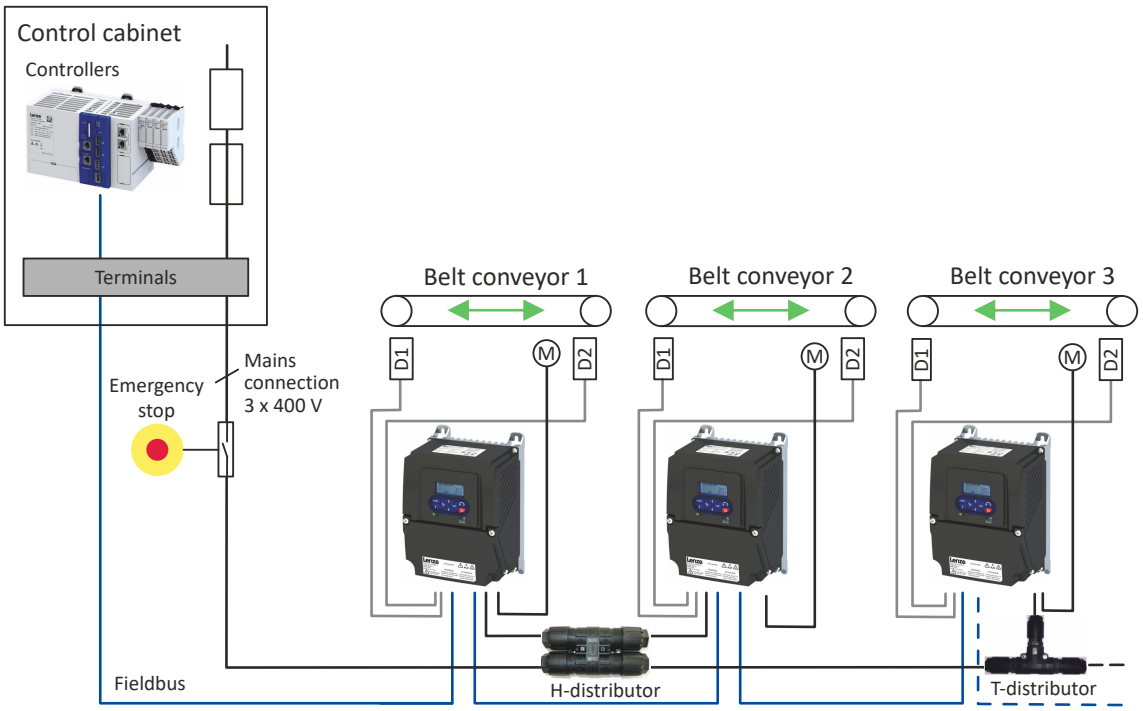



Fig. 1: Sample configuration

**Cables**

Requirements

- The cables used must correspond to the requirements at the location (e. g. EN 60204−1, UL).
- The cable cross-section must be dimensioned for the assigned fusing. Observe national and regional regulations.
- You must observe the regulations for minimum cross-sections of PE conductors. The cross-section of the PE conductor must be at least as large as the cross-section of the power connections.

# Information on mechanical installation

## Important notes

**Measures for cooling during operation**

- Ensure unimpeded ventilation of cooling air and outlet of exhaust air.

## Preparation

Mounting instructions are included in the scope of supply of the inverter. They describe technical data and information on mechanical and electrical installation.

**Mounting position**

- Vertical alignment - do not interfere with free airflow from bottom to top of heatsink fins.

  Other mounting positions require a reduction of the rated output values by approx. 1/3.
  Your Lenze contact will help you with a precise assessment.

**Free spaces**

- Maintain the specified free spaces above and below to the other installations.
- A distance of 10 mm to the next device must be maintained at the sides.

**Mechanical fastening**

- The mounting location and material must ensure a durable mechanical connection.
- Do not mount onto DIN rails!
- In case of continuous vibrations or shocks use vibration dampers.

How to mount the inverters at a mounting location.

Required:

- Tool for drilling and thread cutting
- Screwdriver
- Screw and washer assemblies or hexagon socket screws with washers.

1. Prepare mounting area with corresponding threaded holes.
2. Fit screws and washers (if applicable).
3. Do not yet tighten the screws.
4. Mount the inverter on the prepared mounting area via keyhole suspension.
5. Only tighten the screws hand-tight.
6. Pre-assemble other devices if necessary.
   a) Adjust the devices.
   b) Screw the devices onto the mounting area.

The inverters are mounted on the mounting area. You can begin with the wiring.

Screw and washer assemblies or hexagon socket screws with washers are recommended..

M5 x ≥ 10 mm

**Further data and information**

▸ Decentralized topologies 📖 26

▸ Dimensions 📖 84

# Information on electrical installation

## Important notes

**⚠ DANGER!**

Electrical voltage

Possible consequences: Death or severe injuries

- Any work on the inverter must only be carried out in the de-energized state.
- After switching off the mains voltage, wait for at least 3 min before you start working.

**⚠ DANGER!**

Dangerous electrical voltage

The leakage current against earth (PE) is > 3.5 mA AC or > 10 mA DC.

Possible consequences: Death or severe injuries when touching the device in the event of an error.

- Implement the measures requested in EN 61800−5−1 or EN 60204−1. Especially:
- Fixed installation
- The PE connection must comply with the standards (PE conductor diameter ≥ 10 $mm^2$ or use a double PE conductor)

**⚠ WARNING!**

Dangerous electrical voltage

Device error causes an overvoltage in the system.

- For a voltage supply with DC 24 V (± 20 %), use only a safely separated power supply unit according to the valid SELV/PELV requirements.

**NOTICE**

No protection against excessively high mains voltage

The mains input is not fused internally.

Possible consequences: Destruction of the product in the event of excessively high mains voltage.

- Take note of the maximum permissible mains voltage.
- On the mains supply side, use fuses to adequately protect the product against mains fluctuations and voltage peaks.

**NOTICE**

Overvoltage at devices with 230-V mains connection

An impermissible overvoltage may occur if the central supply of the N conductor is interrupted if the devices are connected to a TN three-phase system.

Possible consequences: Destruction of the device

- Provide for the use of isolating transformers.

**NOTICE**

Mounting not according to protection class

Possible consequences: Material damage due to penetrating humidity and foreign bodies.

- All cable glands and mounting parts must at least correspond to the protection class of the inverter.
- All openings in the housing must be closed according to the protection class.
- The cover must be screwed on with the specified tightening torque.

**NOTICE**

The product contains electrostatic sensitive devices.

Possible consequences: Destruction of the device

- Before working in the connection area, the personnel must be free of electrostatic charge.

When implementing machines and systems for the use in the UL/CSA scope, you have to observe the relevant special notes.

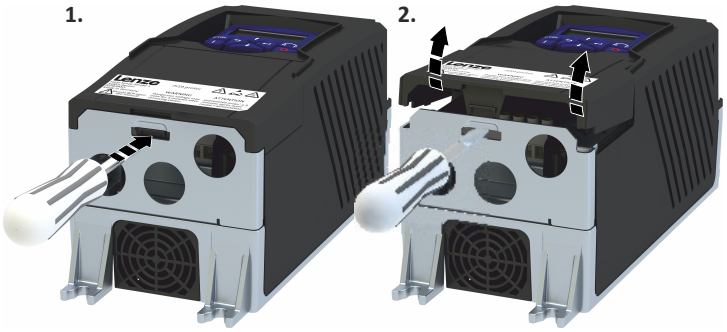
These notes are marked with "UL marking".

## Preparation

Mounting instructions are included in the scope of supply of the inverter. They describe technical data and information on mechanical and electrical installation.

### Remove housing cover and remount

For wiring, the housing cover must be removed and then remounted.




Remove housing cover

1. Press a screwdriver into the housing slot on the bottom of the device.
2. Remove housing cover

The terminals are exposed for wiring.

Mount housing cover

1. Carefully press on the housing cover until it clicks into place.

The housing cover is mounted.

### Cable glands and connection area

Bore holes are provided for mounting the cable glands for the mains cable and motor cable.

The cable gland of the motor cable must be EMC-compatible. The housing wall for the cable gland is reinforced and well conductive to avoid EMC interference.

### Bore holes for cable glands

| Power range | i510 protec |
|---|---|
| 0.75 ... 11 kW | 3 x ½" Conduit hub / 3 x M20 |

### Further data and information

- EMC-compliant installation 📖 31
- Standards and operating conditions 📖 44

## EMC-compliant installation

The drive system (inverter and drive) only complies with the EMC Directive 2014/30/EU if it is installed according to the guidelines for CE-typical drive systems.

These guidelines should also be followed in installations requiring FCC Part 15 or ICES 001 compliance.

**NOTICE**

**Electromagnetic interferences**

Product and peripheral devices may be affected during operation.

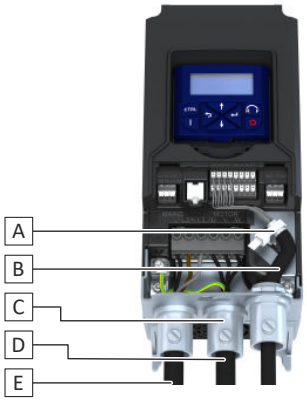
- ▸ Use integrated conductive shield connections for control lines and motor lines.
- ▸ Use central earthing points.

These inverters do not have an integrated RFI filter in the AC mains supply.

In order to meet the EMC requirements according to EN 61800−3, an external EMC filter according to IEC EN 60939 must be used.

The user must verify that the conformity with EN 61800−3 is fulfilled.

The example below shows the effective wiring:




| | | | |
|---|---|---|---|
| A | Shield connection for control connections | C | EMC cable gland / Conduit hub |
| B | Control cable | D | Motor cable with low capacity |
| | | E | Mains cable |

EMC-compliant installation must be carried out with shielded low-capacitance motor cables.

Capacitance per unit length:

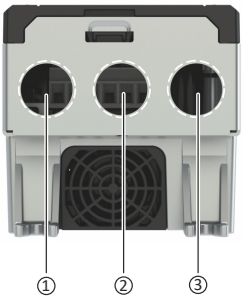
- C-core-core/C-core-shield: <75/150 pF/m ≤ 2.5 mm² (≥ AWG 14);
- C-core-core/C-core-shield: <150/300 pF/m ≤ 4 mm² (≥ AWG 12);

When using electrically conductive conduits, unshielded motor cables or single cores can also be used.

### Example 1: Application without network

≤ 2.2 kW


≥ 3 kW

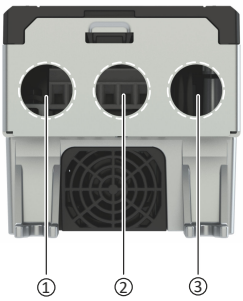



| ① ½" Conduit hub | ② ½" Conduit hub | ③ ½" Conduit hub |
|---|---|---|
| Mains cable at X100 | Motor cable at X105 | Shielded control cable at X3 and X9 |

### Example 2: Application with three-wire network

≤ 2.2 kW


≥ 3 kW




| ① ½" Conduit hub | ② ½" Conduit hub | ③ ½" Conduit hub |
|---|---|---|
| Mains cable at X100 | Motor cable at X105 | Fieldbus cable at X2xx<br>(The figure on the left shows two fieldbus cables to the previous/next device). |



## Connection according to UL

### Important notes

**⚠WARNING!**

- **UL marking**
- The integral solid state short circuit protection included in the inverter does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code / Canadian Electrical Code and any additional local codes.
- **Marquage UL**
- La protection statique intégrée contre les courts-circuits n'offre pas la même protection que le dispositif de protection du circuit de dérivation. Un tel dispositif doit être fourni, conformément au National Electrical Code / Canadian Electrical Code et aux autres dispositions applicables au niveau local.

**⚠WARNING!**

- **UL marking**
- Use 75 °C copper wire only, except for control circuits.
- **Marquage UL**
- Utiliser exclusivement des conducteurs en cuivre 75 °C, sauf pour la partie commande.

**⚠WARNING!**

- **UL marking**
- Suitable for motor group installation or use on a circuit capable of delivering not more than the RMS symmetrical amperes (SCCR) of the drive at its rated voltage.
- Approved fusing is specified in SCCR tables below.
- **Marquage UL**
- Convient pour l'utilisation sur une installation avec un groupe de moteurs ou sur un circuit capable de fournir au maximum une valeur de courant efficace symétrique en ampères à la tension assignée de l'appareil.
- Les dispositifs de protection adaptés sont spécifiés dans les SCCR tableaux suivants.

**NOTICE**

- **UL marking**
- The opening of the Branch Circuit Protective Device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, current carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.
- **Marquage UL**
- Le déclenchement du dispositif de protection du circuit de dérivation peut être dû à une coupure qui résulte d'un courant de défaut. Pour limiter le risque d'incendie ou de choc électrique, examiner les pièces porteuses de courant et les autres éléments du contrôleur et les remplacer s'ils sont endommagés. En cas de grillage de l'élément traversé par le courant dans un relais de surcharge, le relais tout entier doit être remplacé.

## NOTICE

- **UL marking**
- Internal overload protection rated for 125 % of the rated FLA.
- **Marquage UL**
- Protection contre les surcharges conçue pour se déclencher à 125 % de l'intensité assignée à pleine charge.

### Fusing data

### Branch Circuit Protection (BCP)

**Short Circuit Current Ratings (SCCR) with Standard Fuses and Circuit Breaker**

(Tested per UL61800-5-1, reference UL file E132659)

These devices are suitable for motor group installation when used with Standard Fuses or Circuit Breaker. For single motor installation, if the fuse value indicated is higher than 400 % of the motor current (FLA), the fuse value has to be calculated. If the value of the fuse is below two standard ratings, the nearest standard ratings less than the calculated value shall apply.

| Inverter | | | Standard Fuses (UL248) | | | Circuit Breaker (UL489) | |
|---|---|---|---|---|---|---|---|
| Mains | Rated power | | Max. SCCR | Max. rated current | Class | Max. SCCR | Max. rated current |
| | kW | hp | kA | A | | kA | A |
| 120 V, 1-ph | 0.37 | 0.5 | 5 | 30 | CC, CF, J, T | 5 | 30 |
| 120 V, 1-ph | 0.75 | 1 | 5 | 30 | CC, CF, J, T | 5 | 30 |
| 230 V, 1/3-ph | 0.37 | 0.5 | 42 | 25 | CC, CF, J, T | 5 | |
| 230 V, 1/3-ph | 0.75 | 1 | 42 | 25 | CF, J, T | 5 | |
| 230 V, 1/3-ph | 1.1 | 1.5 | 42 | 25 | CF, J, T | 5 | |
| 230 V, 1/3-ph | 1.5 | 2 | 42 | 25 | CF, J, T | 5 | |
| 230 V, 1/3-ph | 2.2 | 3 | 42 | 50 | CF, J, T | 5 | 30 |
| 230 V, 3-ph | 3 | 4 | 42 | 60 | CF, J, T | 5 | 30 |
| 230 V, 3-ph | 4 | 5 | 42 | 60 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 0.75 | 1 | 65 | 50 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 1.1 | 1.5 | 65 | 50 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 1.5 | 2 | 65 | 50 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 2.2 | 3 | 65 | 50 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 3 | 4 | 5 | 40 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 4 | 5 | 5 | 40 | CF, J, T | 5 | 30 |
| 480 V, 3-ph | 5.5 | 7.5 | 5 | 40 | CF, J, T | 5 | 30 |



## Mains connection

Single inverters are connected directly to the **AC system** or via upstream filters. RFI filters are already integrated in many inverters. Depending on the requirements, mains chokes or mains filters can be used.

**1-phase mains connection 120 V**

The connection plan is valid for the inverters i510-Pxxx/**120-1**.

Inverter i510-Pxxx/**120-1** do not have an integrated RFI filter in the AC mains supply.

In order to meet the EMC requirements according to EN 61800−3, an external EMC filter according to IEC EN 60939 must be used.

The user must verify that the conformity with EN 61800−3 is fulfilled.

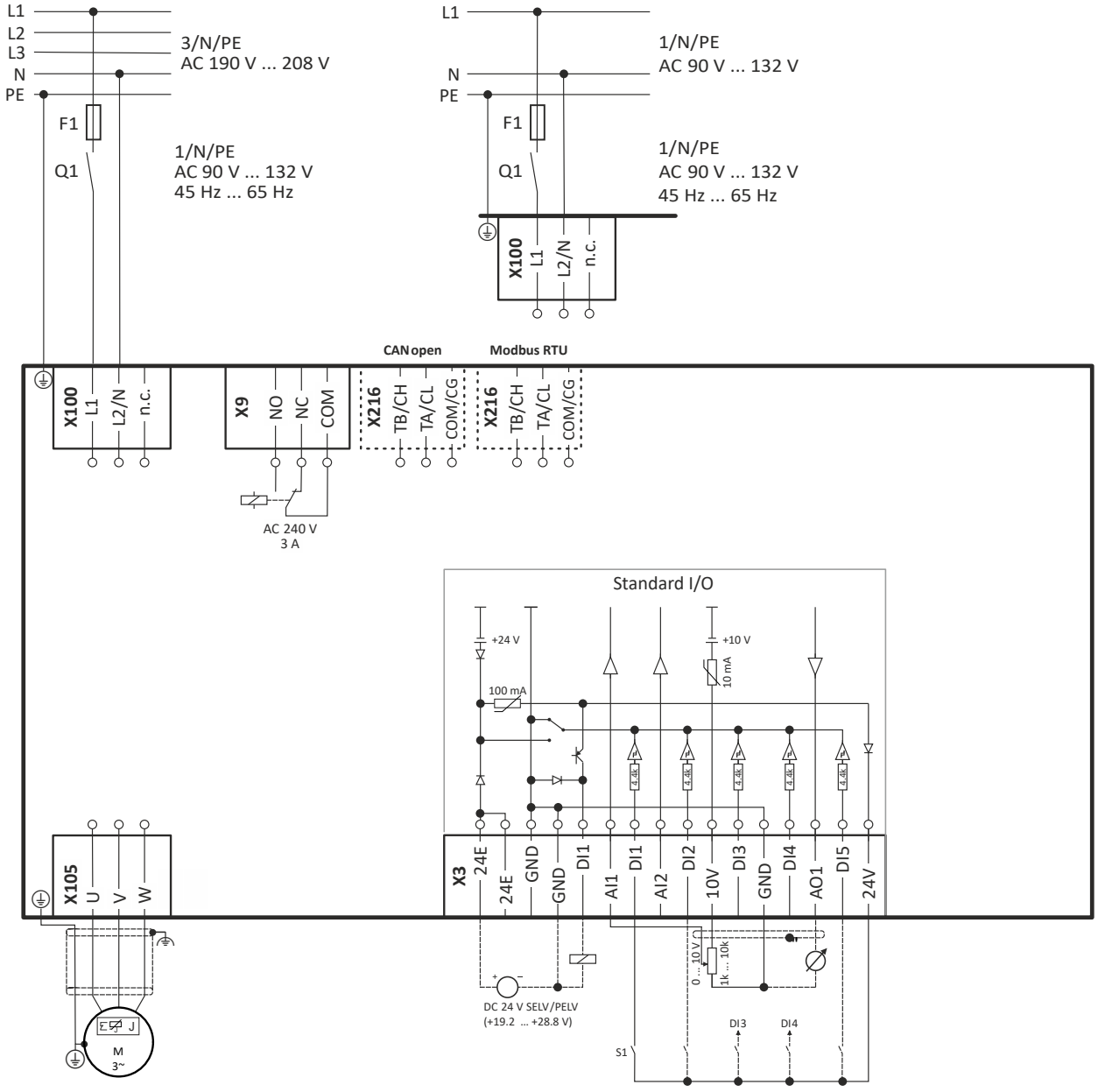



Fig. 2: Wiring example

| | | | |
|---|---|---|---|
| S1 | Start/Stop | Q1 | Mains contactor |
| Fx | Fuses | --- | Dashed line = options |

**1-phase mains connection 230/240 V**

The connection plan is valid for the inverters i510-Pxxx/**230-2**.

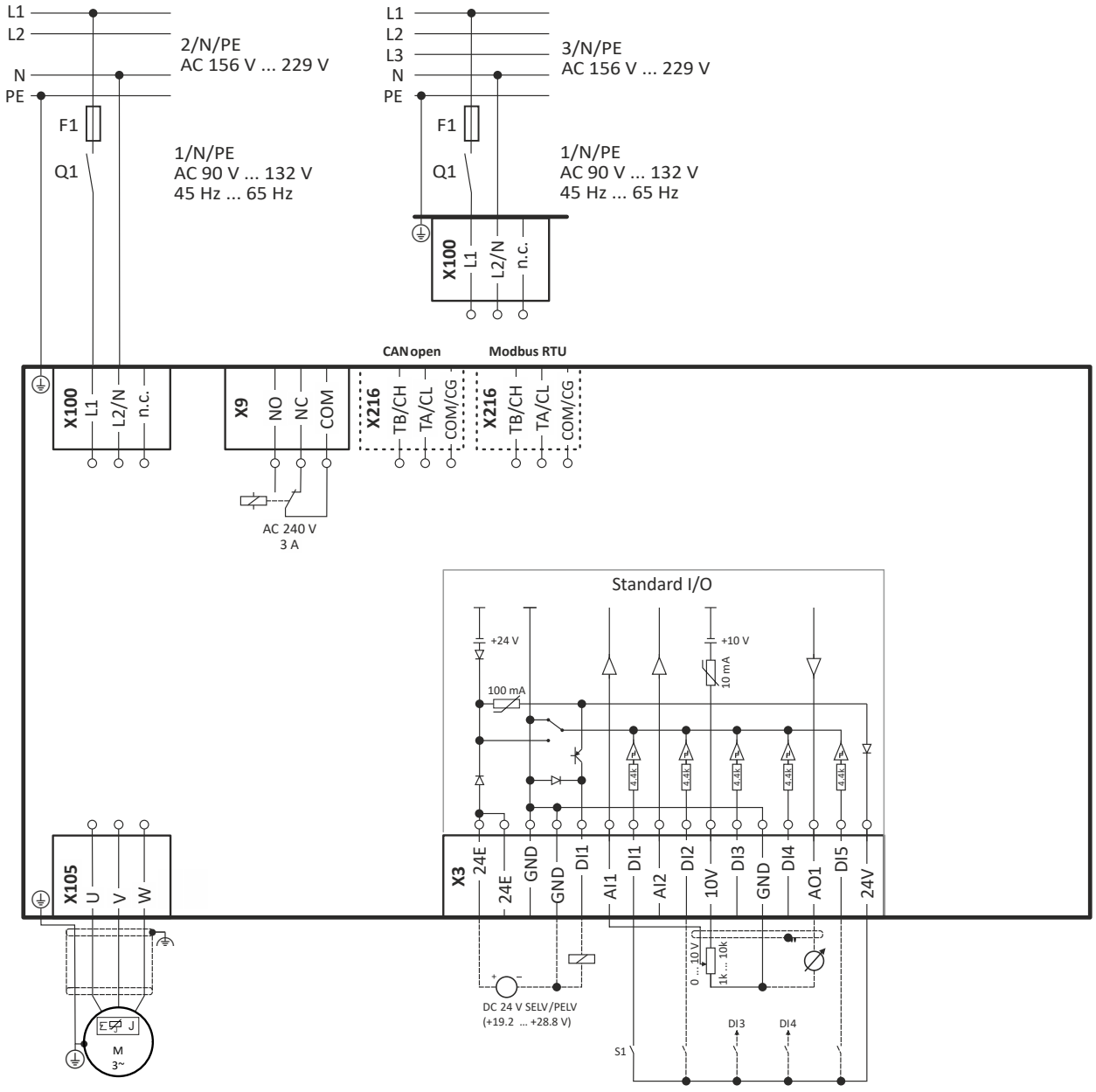



Fig. 3: Wiring example

| | | | |
|---|---|---|---|
| S1 | Start/Stop | Q1 | Mains contactor |
| Fx | Fuses | --- | Dashed line = options |

### 3-phase mains connection 230/240 V

The connection plan is valid for the inverters i510-Pxxx/**230-3** and i510-Pxxx/**230-2**.

Inverter i510-Pxxx/**230-3** and i510-Pxxx/**230-2** do not have an integrated RFI filter in the AC mains supply.

In order to meet the EMC requirements according to EN 61800−3, an external EMC filter according to IEC EN 60939 must be used.

The user must verify that the conformity with EN 61800−3 is fulfilled.

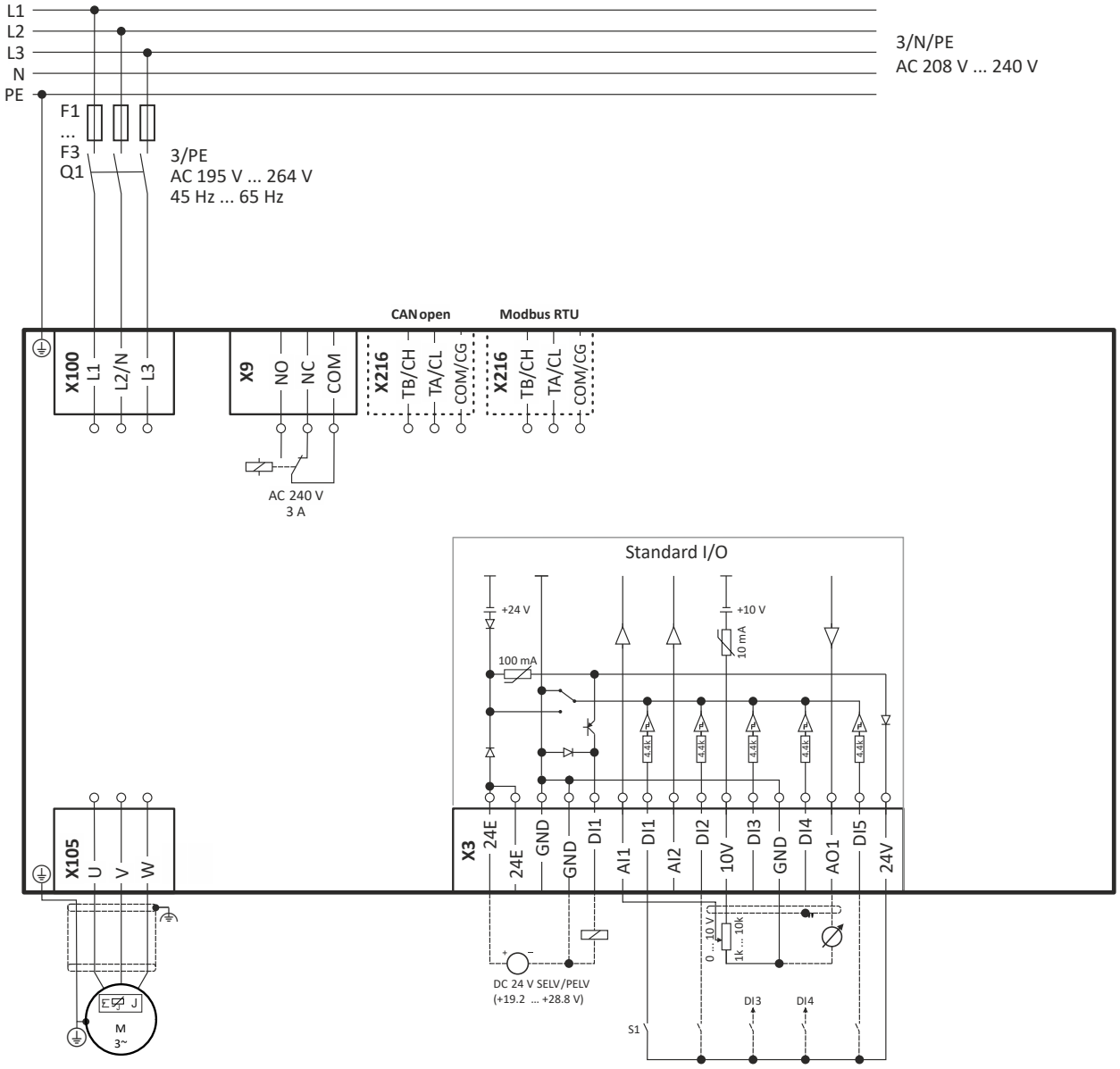



Fig. 4: Wiring example

| | | | |
|---|---|---|---|
| S1 | Start/Stop | Q1 | Mains contactor |
| Fx | Fuses | --- | Dashed line = options |

**3-phase mains connection 400 V**

The connection plan is valid for the inverters i510-Pxxx/**400-3**.

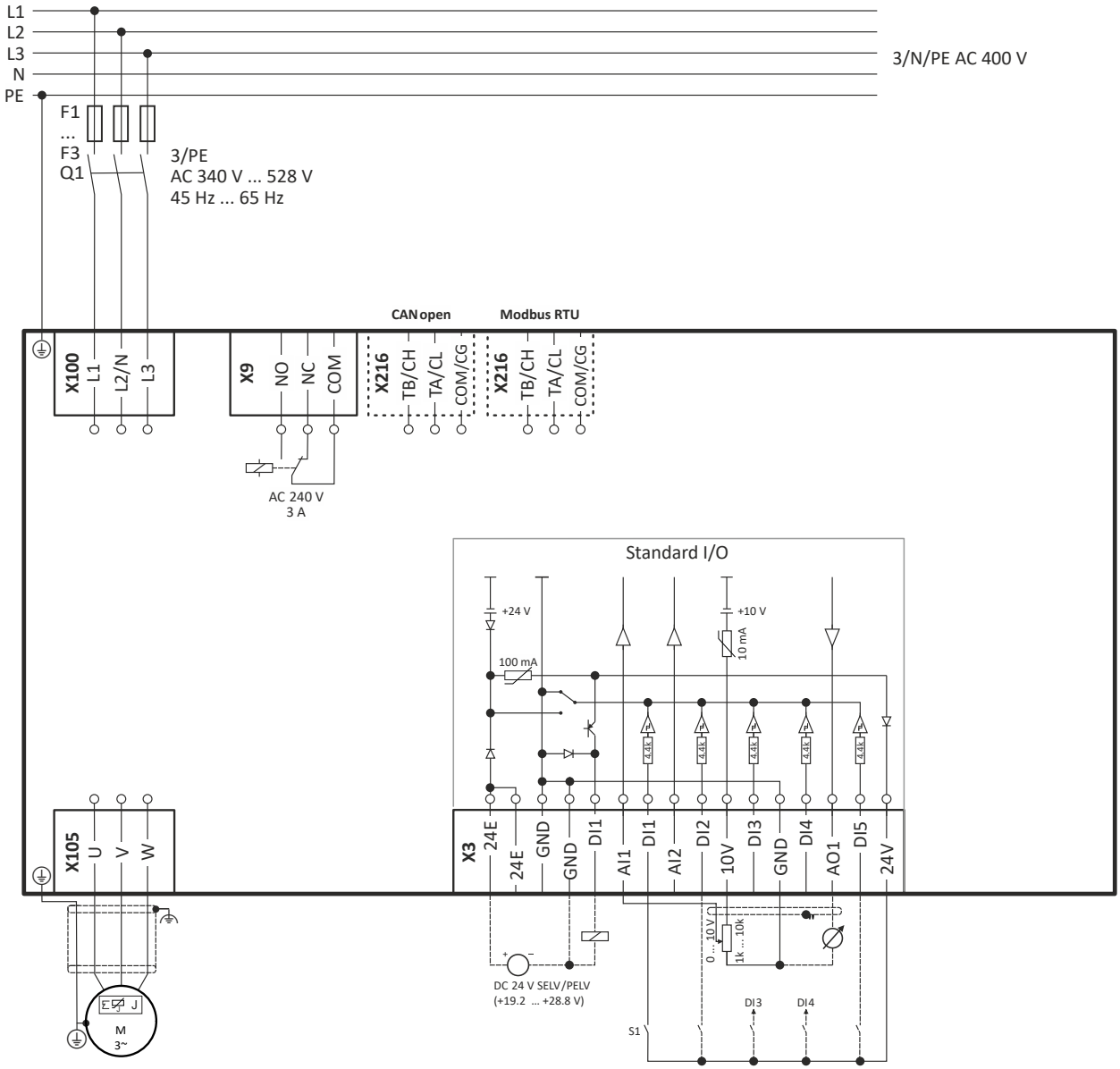



Fig. 5: Wiring example

| | | | |
|---|---|---|---|
| S1 | Start/Stop | Q1 | Mains contactor |
| Fx | Fuses | --- | Dashed line = options |

### 3-phase mains connection 480 V

The connection plan is valid for the inverters i510-Pxxx/**400-3**.

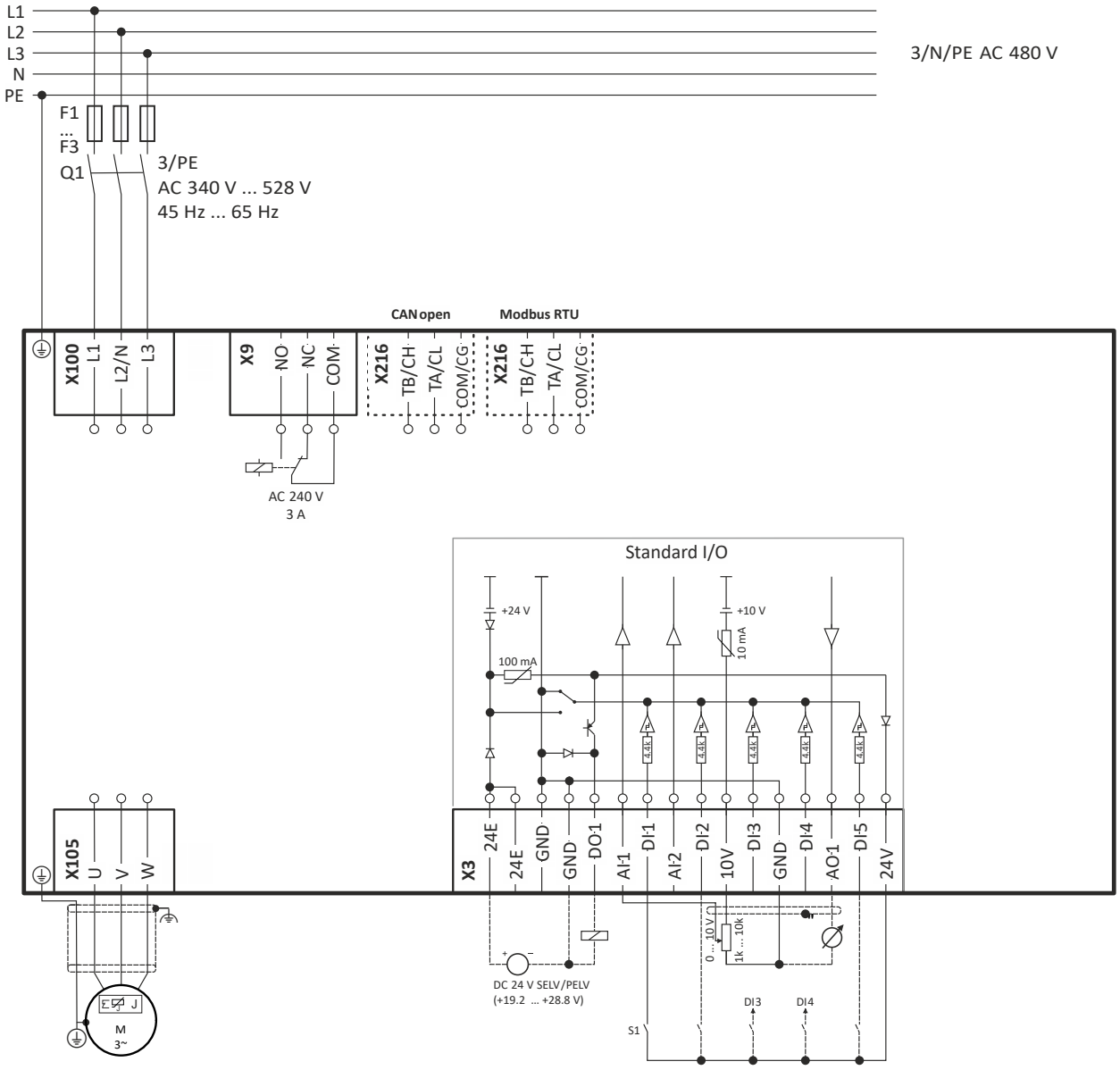



Fig. 6: Wiring example

| | | | |
|---|---|---|---|
| S1 | Start/Stop | Q1 | Mains contactor |
| Fx | Fuses | --- | Dashed line = options |

## Motor connection

### Switching in the motor cable

Switching on the motor side of the inverter is permissible:

For safety shutdown (emergency stop).

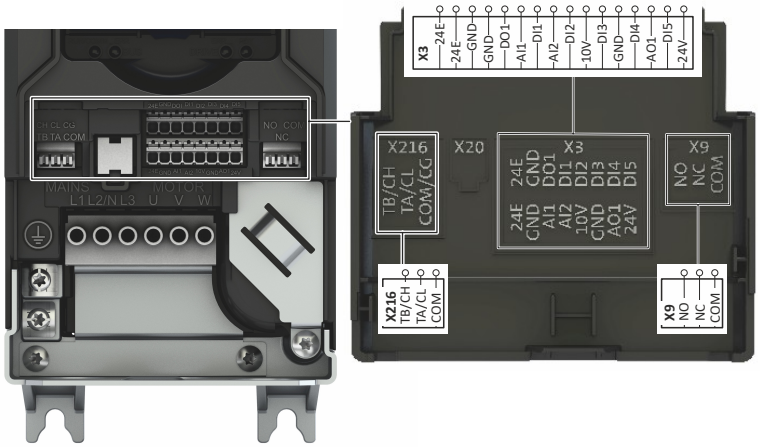
In case several motors are driven by one inverter (only in V/f operating mode).

Please note the following:

The switching elements on the motor side must be dimensioned for with the maximum occurring load.

## Control connections

In case of long cables and/or high interference the effect of the shielding can be improved. To do this, connect the shield of cables for the analog inputs and outputs at one end of the cable via a capacitor with PE potential (e. g. 10 nF/ 250 V).




The designations of the terminals X216, X3 and X9 are located on the inside of the cover.

| Connection description | | | Control terminals | Relay output |
|---|---|---|---|---|
| **Connection** | | | **X3** | **X9** |
| Connection type | | | Non-pluggable | Non-pluggable |
| Max. cable cross-section | | mm² | 1.5 | 1.5 |
| Max. cable cross-section | | AWG | 16 | 16 |
| Stripping length | | mm | 9 | 9 |
| Stripping length | | in | 0.35 | 0.35 |
| Required tool | | | Screwdriver 0.4 x 2.5 | |

## Networks

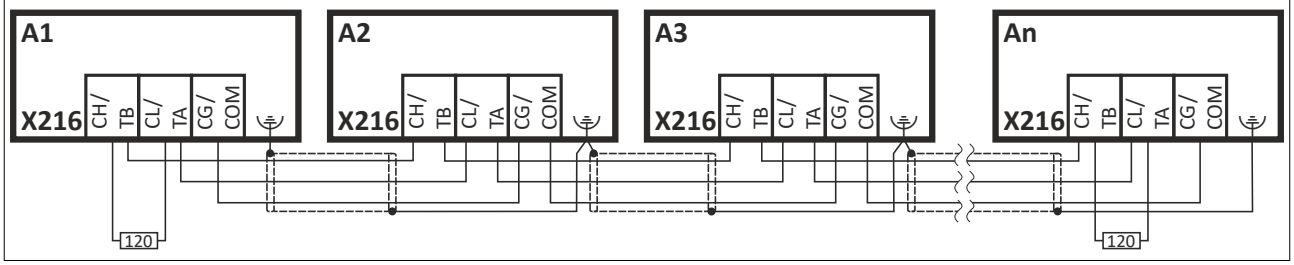
### CANopen

The network must be terminated with a 120 Ω resistor at the physically first and last node.

Connect the resistor to terminals TB/CH and TA/CL.

### Typical topologies

**Line**




| Connection description | | | CANopen |
|---|---|---|---|
| **Connection** | | | **X216** |
| Connection type | | | Non-pluggable |
| Max. cable cross-section | | mm² | 1.5 |
| Max. cable cross-section | | AWG | 16 |
| Stripping length | | mm | 9 |
| Stripping length | | in | 0.35 |
| Required tool | | | Screwdriver 0.4 x 2.5 |



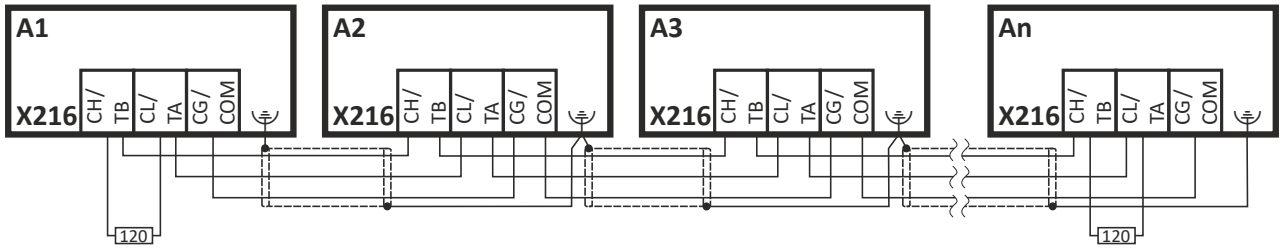
## Modbus RTU

The network must be terminated with a 120 Ω resistor at the physically first and last node.

Connect the resistor to terminals TB/CH and TA/CL.

## Typical topologies

**Line**




| **Connection description** | | | **Modbus RTU** |
|---|---|---|---|
| **Connection** | | | **X216** |
| Connection type | | | Non-pluggable |
| Max. cable cross-section | | mm² | 1.5 |
| Max. cable cross-section | | AWG | 16 |
| Stripping length | | mm | 9 |
| Stripping length | | in | 0.35 |
| Required tool | | | Screwdriver 0.4 x 2.5 |

# Technical data

## Standards and operating conditions

### Conformities and approvals

| | | | |
|---|---|---|---|
| Conformities | | | |
| CE | 2014/30/EU | | EMC Directive (reference: CE-typical drive system) |
| | 2014/35/EU | | Low-Voltage Directive |
| EAC | TP TC 020/2011 | | Eurasian conformity: Electromagnetic compatibility of technical means |
| | TP TR 004/2011 | | Eurasian conformity: Safety of low voltage equipment |
| RoHS | 2011/65/EU | | Restrictions on the use of certain hazardous substances in electrical and electronic devices |
| Approvals | | | |
| UL | UL 61800-5-1 | | File No. E132659 |
| | | | for USA and Canada (requirements of the CSA 22.2 No. 274) |

### Protection of persons and device protection

| | | | |
|---|---|---|---|
| Degree of protection | | | Information applies to the mounted and ready-for-use state |
| EN | EN 60529 | IP20 | |
| NEMA | NEMA 250 | Type 1 | |
| UL | UL 50 | | |
| Insulation resistance | | | |
| Overvoltage category | EN 61800-5-1 | II | > 2000 m ü. NN |
| | | III | 0 … 2000 m ü. NN |
| Insulation of control circuits | | | |
| | EN 61800-5-1 | Safe mains isolation | double/reinforced insulation |
| Leakage current | | | |
| AC | EN 61800-5-1 | > 3.5 mA | Please observe regulations and safety instructions! |
| DC | | > 10 mA | |
| Starting current | | | |
| | | ≤ 3 x rated mains current | |
| Protective measures | | | |
| Earth fault resistance | | | Earth-fault protected depending on operating status |
| Motor stall protection | | | |
| Short-circuit strength | | | |
| Overvoltage resistance | | | |
| Overtemperature of motor | | | $I^2xt$ monitoring |

### EMC data

| | | | |
|---|---|---|---|
| Operation on public supply systems | | | The machine or system manufacturer is responsible for compliance with the requirements for the machine/system! |
| > 1 kW, mains current ≤ 16 A | EN 61000-3-2 | no additional measures | |
| < 1kW | | with mains choke | |
| Mains current > 16 A | EN 61000-3-12 | With mains choke or mains filter | When designed for rated power. |
| Noise emission | | | |
| Category C1 | EN 61800-3 | | See rated data |
| Category C2 | | | |
| Category C3 | | | |
| Noise immunity | | | |
| | EN 61800-3 | Requirements fulfilled | |



## Motor connection

| Requirements for the shielded motor cable | | | |
|---|---|---|---|
| Capacitance per unit length | | < 150/300 pF/m | C core-core/C core-shield ≤ 4 mm² / AWG 12 |
| | | < 75/150 pF/m | C core-core/C core-shield ≤ 2.5 mm² / AWG 14 |
| Electric strength | | Uo/U = 0.6/1.0 kV | U = r.m.s. value from external conductor to external conductor |
| | | | Uo = r.m.s. value external conductor to PE |
| | UL | U ≥ 600 V | U = r.m.s. value from external conductor to external conductor |

## Environmental conditions

| Energy efficiency | | | |
|---|---|---|---|
| High Efficiency | EN 50598-2 | Class IE2 | |
| Climate | | | |
| Storage | EN 60721-3-1 | 1K3 (-30 ... +60 °C) | |
| Transport | EN 60721-3-2 | 2K3 (-30 ...+70 °C) | |
| Operation | EN 60721-3-3 | 3K3 (-30 ... +55 °C) | Operation at a switching frequency of 2 or 4 kHz: Above +45°C: reduce rated output current by 2.5 %/°C |
| | | | Operation at a switching frequency of 8, 12 or 16 kHz: Above +40°C: reduce rated output current by 2.5 %/°C |
| Site altitude | | | |
| 0 … 1000 m ü. NN | | | |
| 1000 … 4000 m ü. NN | | | Reduce rated output current by 5 %/1000 m |
| Pollution | | | |
| | EN 61800-5-1 | Degree of pollution 2 | |
| | UL 61800-5-1 | | |
| Vibration resistance | | | |
| Transport | EN 60721-3-2 | 2M2 (sine, shock) | in original packaging |
| Operation | EN 61800-5-1 | Amplitude 0.075 mm | 10 ... 57 Hz |
| | | acceleration resistant up to 1 g | 57 ... 150 Hz |
| | German Lloyd | Amplitude 1 mm | 5 ... 13.2 Hz |
| | | acceleration resistant up to 0.7 g | 13.2 ... 100 Hz |

## Electrical supply conditions

| Power systems | | | |
|---|---|---|---|
| TN | | | Voltage to earth: max. 300 V |
| TT | | | |

The connection to different supply forms enables a worldwide application of the inverters.

The following is supported:


- 1-phase mains connection 120 V 📖 46
- 1-phase mains connection 230/240 V 📖 50
- 1-phase mains connection 230/240 V "Light Duty" 📖 55
- 3-phase mains connection 230/240 V 📖 59
- 3-phase mains connection 230/240 V "Light Duty" 📖 65
- 3-phase mains connection 400 V 📖 69
- 3-phase mains connection 400 V "Light Duty" 📖 74
- 3-phase mains connection 480 V 📖 77
- 3-phase mains connection 480 V "Light Duty" 📖 82

## 1-phase mains connection 120 V

**EMC filters** are **not integrated** in inverters for this mains connection.



**Rated data**

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 45 °C (113 °F).
- At switching frequency 8 kHz, 12 kHz or 16 kHz: Ambient temperature max. 40 °C (104 °F).

# Technical data

1-phase mains connection 120 V
Rated data

| **Inverter** | | | **i510-P0.37/120-1** | **i510-P0.75/120-1** |
|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **0.37** | **0.75** |
| **Rated power** | **$P_{rated}$** | **hp** | **0.5** | **1** |
| Mains voltage range | | | 1/PE AC 90 V ... 132 V, 45 Hz ... 65 Hz | |
| Output voltage | | | 3 AC 0 - 230/240 V | |
| Rated mains current | | | | |
| without mains choke | | A | 9.6 | 16.8 |
| with mains choke | | A | - | |
| Apparent output power | | kVA | 0.9 | 1.6 |
| Rated output current | | | | |
| 2 kHz | | A | 2.4 | 4.2 |
| 4 kHz | | A | 2.4 | 4.2 |
| 8 kHz | | A | 2.4 | 4.2 |
| 12 kHz | | A | 2.2 | 3.8 |
| 16 kHz | | A | 1.6 | 2.8 |
| Power loss | | | | |
| 2 kHz | | W | 19 | 30 |
| 4 kHz | | W | 20 | 32 |
| 8 kHz | | W | 24 | 40 |
| 12 kHz | | W | 23 | 38 |
| 16 kHz | | W | 22 | 35 |
| Overcurrent cycle 180 s | | | | |
| Max. output current | | A | 3.6 | 6.3 |
| Overload time | $T_1$ | s | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 |
| Overcurrent cycle 15 s | | | | |
| Max. output current | | A | 4.8 | 8.4 |
| Overload time | $T_1$ | s | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 |
| Cyclic mains switching | | | 3 times per minute | |
| Brake chopper | | | | |
| Max. output current | | | - | |
| Min. brake resistance | | | - | |
| Max. motor cable length shielded | | | | |
| without EMC category | | m | 30 | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | |
| Max. motor cable length unshielded | | | | |
| without EMC category | | m | 60 | |



## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.37/120-1 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P0.75/120-1 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |

## Terminal data

| Rated power | $P_{rated}$ | kW | 0.37 ... 0.75 |
|---|---|---|---|
| Connection description | | | Mains connection |
| Connection | | | X100 |
| Connection type | | | Pluggable |
| Max. cable cross-section | | mm² | 4 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 8 |
| Stripping length | | in | 0.3 |
| Tightening torque | | Nm | 0.6 |
| Tightening torque | | lb-in | 5.3 |
| Required tool | | | Screwdriver 0.5 x 3.0 |

| Rated power | $P_{rated}$ | kW | 0.37 ... 0.75 |
|---|---|---|---|
| Connection description | | | PE connection |
| | | | - |
| Max. cable cross-section | | mm² | 6 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 10 |
| Stripping length | | in | 0.4 |
| Tightening torque | | Nm | 2 |
| Tightening torque | | lb-in | 18 |
| Required tool | | | Torx key 20 |

| Rated power | $P_{rated}$ | kW | 0.37 ... 0.75 |
|---|---|---|---|
| Connection description | | | Motor connection |
| Connection | | | X105 |
| Connection type | | | Pluggable |
| Max. cable cross-section | | mm² | 4 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 8 |
| Stripping length | | in | 0.3 |
| Tightening torque | | Nm | 0.6 |
| Tightening torque | | lb-in | 5.3 |
| Required tool | | | Screwdriver 0.5 x 3.0 |

## 1-phase mains connection 230/240 V

**EMC filters** are **not integrated** in inverters of the type "i550-Px.xx/230-2".



**Rated data**

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 45 °C (113 °F).
- At switching frequency 8 kHz, 12 kHz or 16 kHz: Ambient temperature max. 40 °C (104 °F).

# Technical data

1-phase mains connection 230/240 V
Rated data

| Inverter | | | i510-P0.37/230-2 | i510-P0.75/230-2 | i510-P1.1/230-2 | i510-P1.5/230-2 |
|---|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **0.37** | **0.75** | **1.1** | **1.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **0.5** | **1** | **1.5** | **2** |
| Mains voltage range | | | 1/PE AC 170 V ... 264 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 230/240 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 5.7 | 10 | 14.3 | 16.7 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 0.9 | 1.6 | 2.3 | 2.6 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.4 | 4.2 | 6 | 7 |
| 4 kHz | | A | 2.4 | 4.2 | 6 | 7 |
| 8 kHz | | A | 2.4 | 4.2 | 6 | 7 |
| 12 kHz | | A | 2.2 | 3.8 | 5.4 | 6.3 |
| 16 kHz | | A | 1.6 | 2.8 | 4 | 4.7 |
| Power loss | | | | | | |
| 2 kHz | | W | 19 | 30 | 38 | 45 |
| 4 kHz | | W | 20 | 32 | 40 | 48 |
| 8 kHz | | W | 24 | 40 | 51 | 61 |
| 12 kHz | | W | 23 | 38 | 54 | 65 |
| 16 kHz | | W | 22 | 35 | 49 | 58 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.6 | 6.3 | 9 | 10.5 |
| Overload time | $T_1$ | s | 60 | | | |
| Recovery time | $T_2$ | s | 120 | | | |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.8 | 8.4 | 12 | 14 |
| Overload time | $T_1$ | s | 3 | | | |
| Recovery time | $T_2$ | s | 12 | | | |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | | 80 | |



| **Inverter** | | | **i510-P2.2/230-2** |
|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **2.2** |
| **Rated power** | **$P_{rated}$** | **hp** | **3** |
| Mains voltage range | | | 1/PE AC 170 V ... 264 V, 45 Hz ... 65 Hz |
| Output voltage | | | 3 AC 0 - 230/240 V |
| Rated mains current | | | |
| without mains choke | | A | 22.5 |
| with mains choke | | A | - |
| Apparent output power | | kVA | 3.6 |
| Rated output current | | | |
| 2 kHz | | A | 9.6 |
| 4 kHz | | A | 9.6 |
| 8 kHz | | A | 9.6 |
| 12 kHz | | A | 8.6 |
| 16 kHz | | A | 6.4 |
| Power loss | | | |
| 2 kHz | | W | 62 |
| 4 kHz | | W | 66 |
| 8 kHz | | W | 85 |
| 12 kHz | | W | 91 |
| 16 kHz | | W | 81 |
| Overcurrent cycle 180 s | | | |
| Max. output current | | A | 14.4 |
| Overload time | $T_1$ | s | 60 |
| Recovery time | $T_2$ | s | 120 |
| Max. output current during the recovery time | | A | 7.2 |
| Overcurrent cycle 15 s | | | |
| Max. output current | | A | 19.2 |
| Overload time | $T_1$ | s | 3 |
| Recovery time | $T_2$ | s | 12 |
| Max. output current during the recovery time | | A | 7.2 |
| Cyclic mains switching | | | 3 times per minute |
| Brake chopper | | | |
| Max. output current | | | - |
| Min. brake resistance | | | - |
| Max. motor cable length shielded | | | |
| without EMC category | | m | 30 |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - |
| Max. motor cable length unshielded | | | |
| without EMC category | | m | 80 |

## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.37/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P0.75/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.1/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.5/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P2.2/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |

## Terminal data

| **Rated power** | **$P_{rated}$** | **kW** | **0.37 ... 1.5** | **2.2** |
|---|---|---|---|---|
| **Connection description** | | | **Mains connection** | |
| **Connection** | | | **X100** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

| **Rated power** | **$P_{rated}$** | **kW** | **0.37 ... 2.2** |
|---|---|---|---|
| **Connection description** | | | **PE connection** |
| | | | - |
| Max. cable cross-section | | mm² | 6 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 10 |
| Stripping length | | in | 0.4 |
| Tightening torque | | Nm | 2 |
| Tightening torque | | lb-in | 18 |
| Required tool | | | Torx key 20 |

| **Rated power** | **$P_{rated}$** | **kW** | **0.37 ... 1.5** | **2.2** |
|---|---|---|---|---|
| **Connection description** | | | **Motor connection** | |
| **Connection** | | | **X105** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

## 1-phase mains connection 230/240 V "Light Duty"

**EMC filters** are **not integrated** in inverters of the type "i550-Px.xx/230-2".

## Rated data

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 40 °C (104 °F).

| **Inverter** | | | **i510-P0.37/230-2** | **i510-P0.75/230-2** | **i510-P1.1/230-2** | **i510-P1.5/230-2** |
|---|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **0.55** | **1.1** | **1.5** | **2.2** |
| **Rated power** | **$P_{rated}$** | **hp** | **0.75** | **1.5** | **2** | **3** |
| Mains voltage range | | | 1/PE AC 170 V ... 264 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 230/240 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 6.9 | 12 | 17.1 | 20 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 1.2 | 2.2 | 2.6 | 3.6 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.9 | 5 | 7.2 | 8.4 |
| 4 kHz | | A | 2.9 | 5 | 7.2 | 8.4 |
| Power loss | | | | | | |
| 2 kHz | | W | 30 | 38 | 45 | 62 |
| 4 kHz | | W | 32 | 40 | 48 | 66 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.6 | 6.3 | 9 | 10.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.8 | 8.4 | 12 | 14 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | | 80 | |



| **Inverter** | | | **i510-P2.2/230-2** |
|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **3** |
| **Rated power** | **$P_{rated}$** | **hp** | **4** |
| Mains voltage range | | | 1/PE AC 170 V ... 264 V, 45 Hz ... 65 Hz |
| Output voltage | | | 3 AC 0 - 230/240 V |
| Rated mains current | | | |
| without mains choke | | A | 27.4 |
| with mains choke | | A | - |
| Apparent output power | | kVA | 4.9 |
| Rated output current | | | |
| 2 kHz | | A | 11.5 |
| 4 kHz | | A | 11.5 |
| Power loss | | | |
| 2 kHz | | W | 79 |
| 4 kHz | | W | 84 |
| Overcurrent cycle 180 s | | | |
| Max. output current | | A | 14.4 |
| Overload time | $T_1$ | s | 60 |
| Recovery time | $T_2$ | s | 120 |
| Max. output current during the recovery time | | A | 7.2 |
| Overcurrent cycle 15 s | | | |
| Max. output current | | A | 19.2 |
| Overload time | $T_1$ | s | 3 |
| Recovery time | $T_2$ | s | 12 |
| Max. output current during the recovery time | | A | 7.2 |
| Cyclic mains switching | | | 3 times per minute |
| Brake chopper | | | |
| Max. output current | | | - |
| Min. brake resistance | | | - |
| Max. motor cable length shielded | | | |
| without EMC category | | m | 30 |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - |
| Max. motor cable length unshielded | | | |
| without EMC category | | m | 80 |

## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.37/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P0.75/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.1/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.5/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P2.2/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |

## Terminal data

▸ Terminal data 📖 54



## 3-phase mains connection 230/240 V

**EMC filters** are **not integrated** in inverters for this mains connection.

**Rated data**

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 45 °C (113 °F).
- At switching frequency 8 kHz, 12 kHz or 16 kHz: Ambient temperature max. 40 °C (104 °F).



| **Inverter** | | | **i510-P0.37/230-2** | **i510-P0.75/230-2** | **i510-P1.1/230-2** | **i510-P1.5/230-2** |
|---|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **0.37** | **0.75** | **1.1** | **1.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **0.5** | **1** | **1.5** | **2** |
| Mains voltage range | | | 3/PE AC 195 V ... 264 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 230/240 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 3.9 | 6.4 | 7.8 | 9.5 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 0.9 | 1.6 | 2.3 | 2.6 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.4 | 4.2 | 6 | 7 |
| 4 kHz | | A | 2.4 | 4.2 | 6 | 7 |
| 8 kHz | | A | 2.4 | 4.2 | 6 | 7 |
| 12 kHz | | A | 2.2 | 3.8 | 5.4 | 6.3 |
| 16 kHz | | A | 1.6 | 2.8 | 4 | 4.7 |
| Power loss | | | | | | |
| 2 kHz | | W | 19 | 30 | 38 | 45 |
| 4 kHz | | W | 20 | 32 | 40 | 48 |
| 8 kHz | | W | 24 | 40 | 51 | 61 |
| 12 kHz | | W | 23 | 38 | 54 | 65 |
| 16 kHz | | W | 22 | 35 | 49 | 58 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.6 | 6.3 | 9 | 10.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.8 | 8.4 | 12 | 14 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | | 80 | |

# Technical data

3-phase mains connection 230/240 V
Rated data

| **Inverter** | | | **i510-P2.2/230-2** | **i510-P3.0/230-3** | **i510-P4.0/230-3** |
|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **2.2** | **3** | **4** |
| **Rated power** | **$P_{rated}$** | **hp** | **3** | **4** | **5** |
| Mains voltage range | | | 3/PE AC 195 V ... 264 V, 45 Hz ... 65 Hz | | |
| Output voltage | | | 3 AC 0 - 230/240 V | | |
| Rated mains current | | | | | |
| without mains choke | | A | 13.6 | 15 | 20.6 |
| with mains choke | | A | - | | |
| Apparent output power | | kVA | 3.6 | 4.5 | 6.2 |
| Rated output current | | | | | |
| 2 kHz | | A | 9.6 | 12 | 16.5 |
| 4 kHz | | A | 9.6 | 12 | 16.5 |
| 8 kHz | | A | 9.6 | 12 | 16.5 |
| 12 kHz | | A | 8.6 | 10.8 | 14.9 |
| 16 kHz | | A | 6.4 | 8 | 11 |
| Power loss | | | | | |
| 2 kHz | | W | 62 | 79 | 102 |
| 4 kHz | | W | 66 | 84 | 108 |
| 8 kHz | | W | 85 | 109 | 140 |
| 12 kHz | | W | 91 | 104 | 133 |
| 16 kHz | | W | 81 | 104 | 133 |
| Overcurrent cycle 180 s | | | | | |
| Max. output current | | A | 14.4 | 18 | 24.8 |
| Overload time | $T_1$ | s | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 7.2 | 9 | 12.4 |
| Overcurrent cycle 15 s | | | | | |
| Max. output current | | A | 19.2 | 24 | 33 |
| Overload time | $T_1$ | s | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 7.2 | 9 | 12.4 |
| Cyclic mains switching | | | 3 times per minute | | |
| Brake chopper | | | | | |
| Max. output current | | | - | | |
| Min. brake resistance | | | - | | |
| Max. motor cable length shielded | | | | | |
| without EMC category | | m | 30 | 50 | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Max. motor cable length unshielded | | | | | |
| without EMC category | | m | 80 | 100 | |



## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.37/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P0.75/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.1/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.5/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P2.2/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P3.0/230-3 | gG/gL, gRL | 80 | B | 32 | ≥30 | Typ B |
| i510-P4.0/230-3 | gG/gL, gRL | 80 | B | 32 | ≥30 | Typ B |

## Terminal data

| Rated power | $P_{rated}$ | kW | 0.37 ... 1.5 | 2.2 ... 4 |
|---|---|---|---|---|
| **Connection description** | | | **Mains connection** | |
| **Connection** | | | **X100** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

| Rated power | $P_{rated}$ | kW | 0.37 ... 4 |
|---|---|---|---|
| **Connection description** | | | **PE connection** |
| | | | - |
| Max. cable cross-section | | mm² | 6 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 10 |
| Stripping length | | in | 0.4 |
| Tightening torque | | Nm | 2 |
| Tightening torque | | lb-in | 18 |
| Required tool | | | Torx key 20 |

| Rated power | $P_{rated}$ | kW | 0.37 ... 1.5 | 2.2 ... 4 |
|---|---|---|---|---|
| **Connection description** | | | **Motor connection** | |
| **Connection** | | | **X105** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

## 3-phase mains connection 230/240 V "Light Duty"

**EMC filters** are **not integrated** in inverters for this mains connection.

## Rated data

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 40 °C (104 °F).

| **Inverter** | | | **i510-P0.37/230-2** | **i510-P0.75/230-2** | **i510-P1.1/230-2** | **i510-P1.5/230-2** |
|---|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **0.55** | **1.1** | **1.5** | **2.2** |
| **Rated power** | **$P_{rated}$** | **hp** | **0.75** | **1.5** | **2** | **3** |
| Mains voltage range | | | 3/PE AC 195 V ... 264 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 230/240 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 4.7 | 7.7 | 9.4 | 11.4 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 1.2 | 2.2 | 2.6 | 3.6 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.9 | 5 | 7.2 | 8.4 |
| 4 kHz | | A | 2.9 | 5 | 7.2 | 8.4 |
| Power loss | | | | | | |
| 2 kHz | | W | 30 | 38 | 45 | 62 |
| 4 kHz | | W | 32 | 40 | 48 | 66 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.6 | 6.3 | 9 | 10.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.8 | 8.4 | 12 | 14 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.8 | 3.2 | 4.5 | 5.3 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | | 80 | |



| Inverter | | | i510-P2.2/230-2 | i510-P3.0/230-3 | i510-P4.0/230-3 |
|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **3** | **4** | **5.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **4** | **5** | **7.5** |
| Mains voltage range | | | 3/PE AC 195 V ... 264 V, 45 Hz ... 65 Hz | | |
| Output voltage | | | 3 AC 0 - 230/240 V | | |
| Rated mains current | | | | | |
| without mains choke | | A | 16.4 | 17.3 | 23.8 |
| with mains choke | | A | - | | |
| Apparent output power | | kVA | 4.9 | 6.2 | 8.7 |
| Rated output current | | | | | |
| 2 kHz | | A | 11.5 | 14.4 | 19.8 |
| 4 kHz | | A | 11.5 | 14.4 | 19.8 |
| Power loss | | | | | |
| 2 kHz | | W | 79 | 102 | 137 |
| 4 kHz | | W | 84 | 108 | 145 |
| Overcurrent cycle 180 s | | | | | |
| Max. output current | | A | 14.4 | 18 | 24.8 |
| Overload time | $T_1$ | s | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 7.2 | 9 | 12.4 |
| Overcurrent cycle 15 s | | | | | |
| Max. output current | | A | 19.2 | 24 | 33 |
| Overload time | $T_1$ | s | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 7.2 | 9 | 12.4 |
| Cyclic mains switching | | | 3 times per minute | | |
| Brake chopper | | | | | |
| Max. output current | | | - | | |
| Min. brake resistance | | | - | | |
| Max. motor cable length shielded | | | | | |
| without EMC category | | m | 30 | 50 | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Max. motor cable length unshielded | | | | | |
| without EMC category | | m | 80 | 100 | |

## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.37/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P0.75/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.1/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P1.5/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P2.2/230-2 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P3.0/230-3 | gG/gL, gRL | 80 | B | 32 | ≥30 | Typ B |
| i510-P4.0/230-3 | gG/gL, gRL | 80 | B | 32 | ≥30 | Typ B |

## Terminal data

▸ Terminal data 📖 64



## 3-phase mains connection 400 V

### Rated data

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 45 °C (113 °F).
- At switching frequency 8 kHz, 12 kHz or 16 kHz: Ambient temperature max. 40 °C (104 °F).

# Technical data

3-phase mains connection 400 V
Rated data

| Inverter | | | i510-P0.75/400-3 | i510-P1.1/400-3 | i510-P1.5/400-3 | i510-P2.2/400-3 |
|---|---|---|---|---|---|---|
| **Rated power** | $P_{rated}$ | **kW** | **0.75** | **1.1** | **1.5** | **2.2** |
| **Rated power** | $P_{rated}$ | **hp** | **1** | **1.5** | **2** | **3** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 3.3 | 4.4 | 5.4 | 7.8 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 1.6 | 2.1 | 2.6 | 3.8 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.4 | 3.2 | 3.9 | 5.6 |
| 4 kHz | | A | 2.4 | 3.2 | 3.9 | 5.6 |
| 8 kHz | | A | 2.4 | 3.2 | 3.9 | 5.6 |
| 12 kHz | | A | 1.9 | 2.9 | 3.5 | 5 |
| 16 kHz | | A | 1.4 | 2.1 | 2.6 | 3.7 |
| Power loss | | | | | | |
| 2 kHz | | W | 30 | 38 | 45 | 62 |
| 4 kHz | | W | 32 | 40 | 48 | 66 |
| 8 kHz | | W | 40 | 51 | 61 | 85 |
| 12 kHz | | W | 38 | 54 | 65 | 91 |
| 16 kHz | | W | 35 | 49 | 58 | 81 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.6 | 4.8 | 5.9 | 8.4 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.8 | 2.4 | 2.9 | 4.2 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.8 | 6.4 | 7.8 | 11.2 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.8 | 2.4 | 2.9 | 4.2 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | 80 | | |



| Inverter | | | i510-P3/400-3 | i510-P4/400-3 | i510-P5.5/400-3 |
|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **3** | **4** | **5.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **4** | **5** | **7.5** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | |
| Rated mains current | | | | | |
| without mains choke | | A | 9.6 | 12.5 | 17.2 |
| with mains choke | | A | - | | |
| Apparent output power | | kVA | 4.9 | 6.4 | 8.7 |
| Rated output current | | | | | |
| 2 kHz | | A | 7.3 | 9.5 | 13 |
| 4 kHz | | A | 7.3 | 9.5 | 13 |
| 8 kHz | | A | 7.3 | 9.5 | 13 |
| 12 kHz | | A | 5.8 | 7.6 | 10.4 |
| 16 kHz | | A | 4.9 | 6.3 | 8.7 |
| Power loss | | | | | |
| 2 kHz | | W | 79 | 102 | 137 |
| 4 kHz | | W | 84 | 108 | 145 |
| 8 kHz | | W | 109 | 140 | 189 |
| 12 kHz | | W | 104 | 133 | 180 |
| 16 kHz | | W | 104 | 133 | 180 |
| Overcurrent cycle 180 s | | | | | |
| Max. output current | | A | 11 | 14.3 | 19.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 5.5 | 7.1 | 9.8 |
| Overcurrent cycle 15 s | | | | | |
| Max. output current | | A | 14.6 | 19 | 26 |
| Overload time | $T_1$ | s | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 5.5 | 7.1 | 9.8 |
| Cyclic mains switching | | | 3 times per minute | | |
| Brake chopper | | | | | |
| Max. output current | | | - | | |
| Min. brake resistance | | | - | | |
| Max. motor cable length shielded | | | | | |
| without EMC category | | m | 50 | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Max. motor cable length unshielded | | | | | |
| without EMC category | | m | 100 | | |

## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.75/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.1/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.5/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P2.2/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P3/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P4/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P5.5/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |



## Terminal data

| **Rated power** | $P_{rated}$ | **kW** | **0.75 ... 2.2** | **3 ... 5.5** |
|---|---|---|---|---|
| **Connection description** | | | **Mains connection** | |
| **Connection** | | | **X100** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

| **Rated power** | $P_{rated}$ | **kW** | **0.75 ... 5.5** |
|---|---|---|---|
| **Connection description** | | | **PE connection** |
| **Connection** | | | **PE** |
| Max. cable cross-section | | mm² | 6 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 10 |
| Stripping length | | in | 0.4 |
| Tightening torque | | Nm | 2 |
| Tightening torque | | lb-in | 18 |
| Required tool | | | Torx key 20 |

| **Rated power** | $P_{rated}$ | **kW** | **0.75 ... 2.2** | **3 ... 5.5** |
|---|---|---|---|---|
| **Connection description** | | | **Motor connection** | |
| **Connection** | | | **X105** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

## 3-phase mains connection 400 V "Light Duty"

### Rated data

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 40 °C (104 °F).

| **Inverter** | | | **i510-P0.75/400-3** | **i510-P1.1/400-3** | **i510-P1.5/400-3** | **i510-P2.2/400-3** |
|---|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **1.1** | **1.5** | **2.2** | **3** |
| **Rated power** | **$P_{rated}$** | **hp** | **1.5** | **2** | **3** | **4** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 4.5 | 5 | 6.1 | 8.7 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 2.1 | 2.6 | 3.6 | 4.9 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.9 | 3.8 | 4.7 | 6.7 |
| 4 kHz | | A | 2.9 | 3.8 | 4.7 | 6.7 |
| Power loss | | | | | | |
| 2 kHz | | W | 38 | 45 | 62 | 79 |
| 4 kHz | | W | 40 | 48 | 66 | 84 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.6 | 4.8 | 5.9 | 8.4 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.8 | 2.4 | 2.9 | 4.2 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.8 | 6.4 | 7.8 | 11.2 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.8 | 2.4 | 2.9 | 4.2 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | 80 | | |



| **Inverter** | | | **i510-P3/400-3** | **i510-P4/400-3** | **i510-P5.5/400-3** |
|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **4** | **5.5** | **7.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **5** | **7.5** | **10** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | |
| Rated mains current | | | | | |
| without mains choke | | A | 10.3 | 14 | 18.3 |
| with mains choke | | A | - | | |
| Apparent output power | | kVA | 6.4 | 8.7 | 11 |
| Rated output current | | | | | |
| 2 kHz | | A | 8.8 | 11.9 | 15.6 |
| 4 kHz | | A | 8.8 | 11.9 | 15.6 |
| Power loss | | | | | |
| 2 kHz | | W | 102 | 137 | 172 |
| 4 kHz | | W | 108 | 145 | 183 |
| Overcurrent cycle 180 s | | | | | |
| Max. output current | | A | 11 | 14.3 | 19.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 5.5 | 7.1 | 9.8 |
| Overcurrent cycle 15 s | | | | | |
| Max. output current | | A | 14.6 | 19 | 26 |
| Overload time | $T_1$ | s | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 5.5 | 7.1 | 9.8 |
| Cyclic mains switching | | | 3 times per minute | | |
| Brake chopper | | | | | |
| Max. output current | | | - | | |
| Min. brake resistance | | | - | | |
| Max. motor cable length shielded | | | | | |
| without EMC category | | m | 50 | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Max. motor cable length unshielded | | | | | |
| without EMC category | | m | 100 | | |

## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.75/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.1/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.5/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P2.2/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P3/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P4/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P5.5/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |

## Terminal data

▸ Terminal data 📖 73



## 3-phase mains connection 480 V

### Rated data

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 45 °C (113 °F).
- At switching frequency 8 kHz, 12 kHz or 16 kHz: Ambient temperature max. 40 °C (104 °F).

# Technical data

3-phase mains connection 480 V
Rated data

| Inverter | | | i510-P0.75/400-3 | i510-P1.1/400-3 | i510-P1.5/400-3 | i510-P2.2/400-3 |
|---|---|---|---|---|---|---|
| **Rated power** | $P_{rated}$ | **kW** | **0.75** | **1.1** | **1.5** | **2.2** |
| **Rated power** | $P_{rated}$ | **hp** | **1** | **1.5** | **2** | **3** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 2.8 | 3.7 | 4.5 | 6.5 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 1.7 | 2.4 | 2.8 | 3.9 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.1 | 3 | 3.5 | 4.8 |
| 4 kHz | | A | 2.1 | 3 | 3.5 | 4.8 |
| 8 kHz | | A | 2.1 | 3 | 3.5 | 4.8 |
| 12 kHz | | A | 1.7 | 2.7 | 3.2 | 4.3 |
| 16 kHz | | A | 1.3 | 2 | 2.3 | 3.2 |
| Power loss | | | | | | |
| 2 kHz | | W | 30 | 38 | 45 | 62 |
| 4 kHz | | W | 32 | 40 | 48 | 66 |
| 8 kHz | | W | 40 | 51 | 61 | 85 |
| 12 kHz | | W | 38 | 54 | 65 | 91 |
| 16 kHz | | W | 35 | 49 | 58 | 81 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.2 | 4.5 | 5.3 | 7.2 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.6 | 2.3 | 2.6 | 3.6 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.2 | 6 | 7 | 9.6 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.6 | 2.3 | 2.6 | 3.6 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | 80 | | |



| Inverter | | | i510-P3/400-3 | i510-P4/400-3 | i510-P5.5/400-3 |
|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **3** | **4** | **5.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **4** | **5** | **7.5** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | |
| Rated mains current | | | | | |
| without mains choke | | A | 8 | 10.5 | 14.3 |
| with mains choke | | A | - | | |
| Apparent output power | | kVA | 5.1 | 6.6 | 8.9 |
| Rated output current | | | | | |
| 2 kHz | | A | 6.3 | 8.2 | 11 |
| 4 kHz | | A | 6.3 | 8.2 | 11 |
| 8 kHz | | A | 6.3 | 8.2 | 11 |
| 12 kHz | | A | 5 | 6.6 | 8.8 |
| 16 kHz | | A | 4.2 | 5.5 | 7.3 |
| Power loss | | | | | |
| 2 kHz | | W | 79 | 102 | 137 |
| 4 kHz | | W | 84 | 108 | 145 |
| 8 kHz | | W | 109 | 140 | 189 |
| 12 kHz | | W | 104 | 133 | 180 |
| 16 kHz | | W | 104 | 133 | 180 |
| Overcurrent cycle 180 s | | | | | |
| Max. output current | | A | 9.5 | 12.3 | 16.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 4.7 | 6.2 | 8.3 |
| Overcurrent cycle 15 s | | | | | |
| Max. output current | | A | 12.6 | 16.4 | 22 |
| Overload time | $T_1$ | s | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 4.7 | 6.2 | 8.3 |
| Cyclic mains switching | | | 3 times per minute | | |
| Brake chopper | | | | | |
| Max. output current | | | - | | |
| Min. brake resistance | | | - | | |
| Max. motor cable length shielded | | | | | |
| without EMC category | | m | 50 | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Max. motor cable length unshielded | | | | | |
| without EMC category | | m | 100 | | |

## Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.75/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.1/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.5/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P2.2/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P3/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P4/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P5.5/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |



## Terminal data

| **Rated power** | $P_{rated}$ | **kW** | **0.75 ... 2.2** | **3 ... 5.5** |
|---|---|---|---|---|
| **Connection description** | | | **Mains connection** | |
| **Connection** | | | **X100** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

| **Rated power** | $P_{rated}$ | **kW** | **0.75 ... 5.5** |
|---|---|---|---|
| **Connection description** | | | **PE connection** |
| **Connection** | | | **PE** |
| Max. cable cross-section | | mm² | 6 |
| Max. cable cross-section | | AWG | 10 |
| Stripping length | | mm | 10 |
| Stripping length | | in | 0.4 |
| Tightening torque | | Nm | 2 |
| Tightening torque | | lb-in | 18 |
| Required tool | | | Torx key 20 |

| **Rated power** | $P_{rated}$ | **kW** | **0.75 ... 2.2** | **3 ... 5.5** |
|---|---|---|---|---|
| **Connection description** | | | **Motor connection** | |
| **Connection** | | | **X105** | |
| Connection type | | | Pluggable | |
| Max. cable cross-section | | mm² | 4 | 6 |
| Max. cable cross-section | | AWG | 10 | 10 |
| Stripping length | | mm | 8 | 8 |
| Stripping length | | in | 0.3 | 0.3 |
| Tightening torque | | Nm | 0.6 | 0.7 |
| Tightening torque | | lb-in | 5.3 | 6.2 |
| Required tool | | | Screwdriver 0.5 x 3.0 | Screwdriver 0.6 x 3.5 |

## 3-phase mains connection 480 V "Light Duty"

### Rated data

The output currents apply to these operating conditions:

- At switching frequency 2 kHz or 4 kHz: Ambient temperature max. 40 °C (104 °F).

| **Inverter** | | | **i510-P0.75/400-3** | **i510-P1.1/400-3** | **i510-P1.5/400-3** | **i510-P2.2/400-3** |
|---|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **1.1** | **1.5** | **2.2** | **3** |
| **Rated power** | **$P_{rated}$** | **hp** | **1.5** | **2** | **3** | **4** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | | |
| Rated mains current | | | | | | |
| without mains choke | | A | 3.9 | 4.2 | 5.1 | 7.3 |
| with mains choke | | A | - | | | |
| Apparent output power | | kVA | 2.4 | 2.8 | 3.9 | 5.1 |
| Rated output current | | | | | | |
| 2 kHz | | A | 2.5 | 3.6 | 4.2 | 5.8 |
| 4 kHz | | A | 2.5 | 3.6 | 4.2 | 5.8 |
| Power loss | | | | | | |
| 2 kHz | | W | 38 | 45 | 62 | 79 |
| 4 kHz | | W | 40 | 48 | 66 | 84 |
| Overcurrent cycle 180 s | | | | | | |
| Max. output current | | A | 3.2 | 4.5 | 5.3 | 7.2 |
| Overload time | $T_1$ | s | 60 | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 1.6 | 2.3 | 2.6 | 3.6 |
| Overcurrent cycle 15 s | | | | | | |
| Max. output current | | A | 4.2 | 6 | 7 | 9.6 |
| Overload time | $T_1$ | s | 3 | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 1.6 | 2.3 | 2.6 | 3.6 |
| Cyclic mains switching | | | 3 times per minute | | | |
| Brake chopper | | | | | | |
| Max. output current | | | - | | | |
| Min. brake resistance | | | - | | | |
| Max. motor cable length shielded | | | | | | |
| without EMC category | | m | 30 | | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | | |
| Max. motor cable length unshielded | | | | | | |
| without EMC category | | m | 60 | 80 | | |



| **Inverter** | | | **i510-P3/400-3** | **i510-P4/400-3** | **i510-P5.5/400-3** |
|---|---|---|---|---|---|
| **Rated power** | **$P_{rated}$** | **kW** | **4** | **5.5** | **7.5** |
| **Rated power** | **$P_{rated}$** | **hp** | **5** | **7.5** | **10** |
| Mains voltage range | | | 3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz | | |
| Output voltage | | | 3 AC 0 - 400/480 V | | |
| Rated mains current | | | | | |
| without mains choke | | A | 8.6 | 11.2 | 15.3 |
| with mains choke | | A | - | | |
| Apparent output power | | kVA | 6.6 | 8.9 | 11.3 |
| Rated output current | | | | | |
| 2 kHz | | A | 7.6 | 9.8 | 13.2 |
| 4 kHz | | A | 7.6 | 9.8 | 13.2 |
| Power loss | | | | | |
| 2 kHz | | W | 102 | 137 | 172 |
| 4 kHz | | W | 108 | 145 | 183 |
| Overcurrent cycle 180 s | | | | | |
| Max. output current | | A | 9.5 | 12.3 | 16.5 |
| Overload time | $T_1$ | s | 60 | 60 | 60 |
| Recovery time | $T_2$ | s | 120 | 120 | 120 |
| Max. output current during the recovery time | | A | 4.7 | 6.2 | 8.3 |
| Overcurrent cycle 15 s | | | | | |
| Max. output current | | A | 12.6 | 16.4 | 22 |
| Overload time | $T_1$ | s | 3 | 3 | 3 |
| Recovery time | $T_2$ | s | 12 | 12 | 12 |
| Max. output current during the recovery time | | A | 4.7 | 6.2 | 8.3 |
| Cyclic mains switching | | | 3 times per minute | | |
| Brake chopper | | | | | |
| Max. output current | | | - | | |
| Min. brake resistance | | | - | | |
| Max. motor cable length shielded | | | | | |
| without EMC category | | m | 50 | | |
| Category C1 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C2 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Category C3 (2 kHz, 4 kHz, 8 kHz) | | m | - | | |
| Max. motor cable length unshielded | | | | | |
| without EMC category | | m | 100 | | |

### Fusing data

A residual current device (RCD) is optional.

Fusing data for UL/NEC compliant installations: ▸ Fusing data 📖 34

| Inverter | Fuse | | Circuit breaker | | RCD | |
|---|---|---|---|---|---|---|
| | Characteristic | Max. rated current | Characteristic | Max. rated current | | Type |
| | | A | | A | mA | |
| i510-P0.75/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.1/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P1.5/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P2.2/400-3 | gG/gL, gRL | 32 | B | 32 | ≥30 | Typ B |
| i510-P3/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P4/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |
| i510-P5.5/400-3 | gG/gL, gRL | 40 | B | 32 | ≥30 | Typ B |

### Terminal data

▸ Terminal data 📖 81

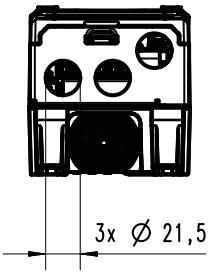
## Dimensions

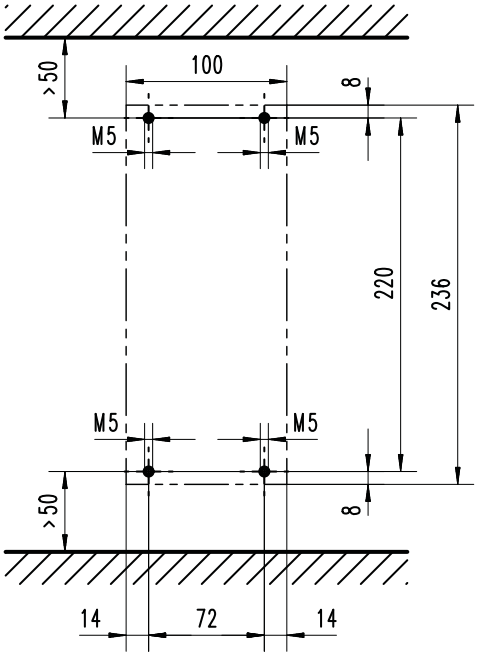
The specified installation clearances are minimum dimensions to ensure a sufficient air circulation for cooling purposes. They do not consider the bend radiuses of the connecting cables.

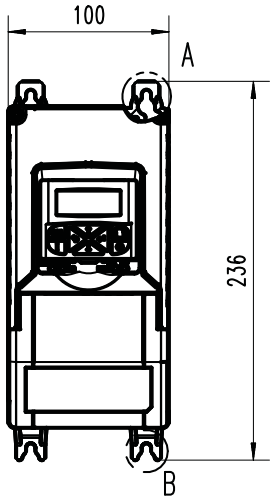
**0.37 kW ... 2.2 kW**

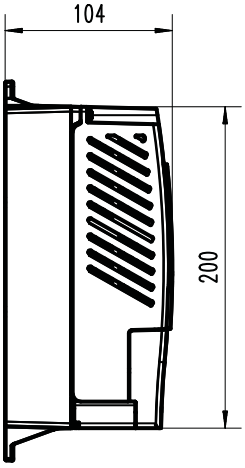
The dimensions in mm apply to:

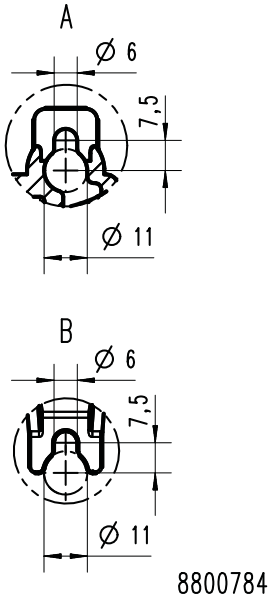
| | | | | | |
|---|---|---|---|---|---|
| 0.37 kW | i510-P0.37/120-1 | i510-P0.37/230-2 | | | |
| 0.75 kW | i510-P0.75/120-1 | i510-P0.75/230-2 | | i510-P0.75/400-3 | |
| 1.1 kW | | | i510-P1.1/230-2 | | i510-P1.1/400-3 |
| 1.5 kW | | | i510-P1.5/230-2 | | i510-P1.5/400-3 |
| 2.2 kW | | | | | i510-P2.2/400-3 |
| Weight | 1.4 kg | 1.4 kg | 1.5 kg | 1.4 kg | 1.5 kg |



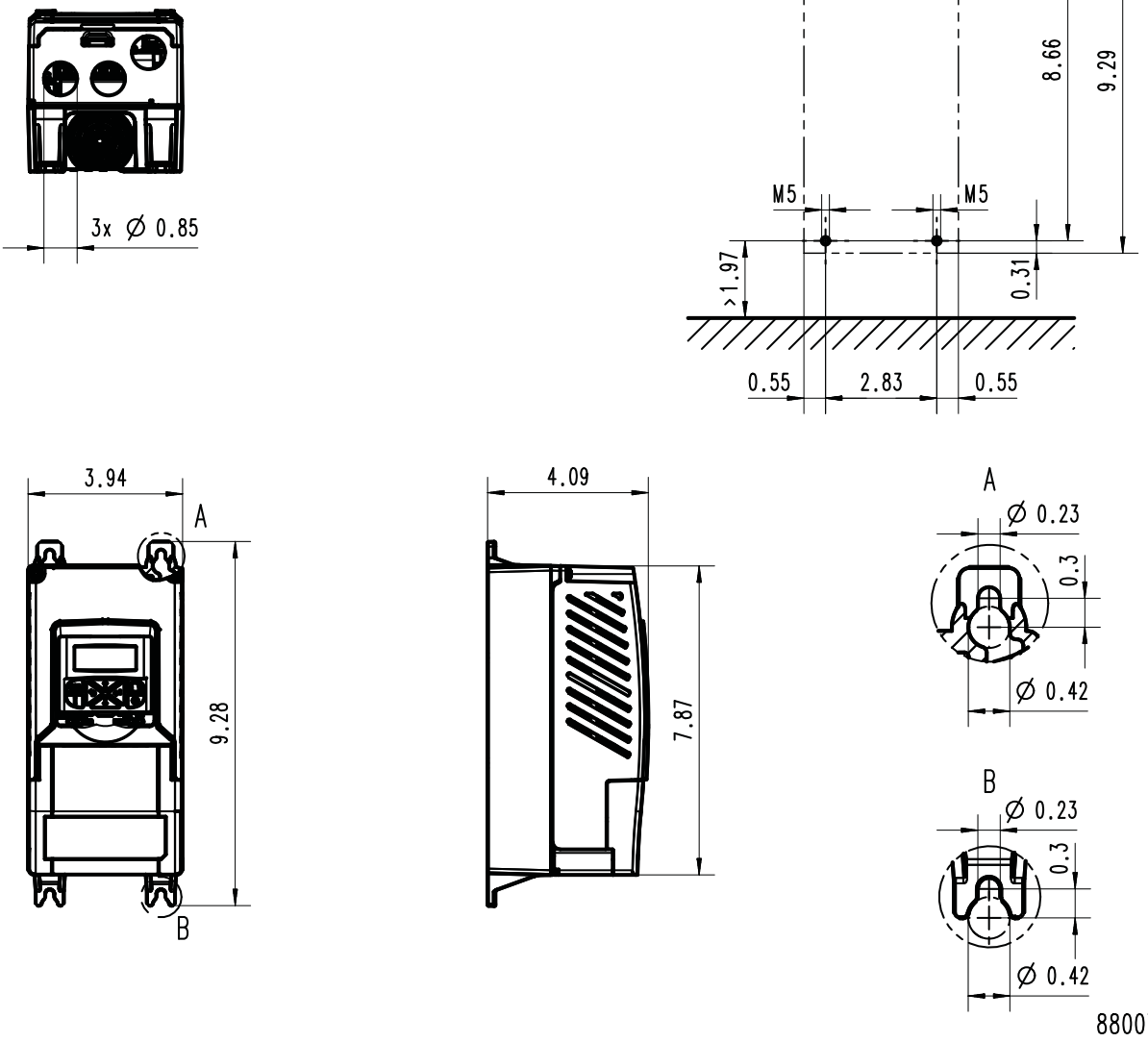



**0.5 hp ... 3 hp**

The dimensions in inch apply to:

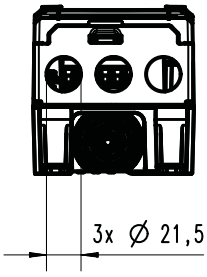
| | | | | | |
|---|---|---|---|---|---|
| 0.5 hp | i510-P0.37/120-1 | i510-P0.37/230-2 | | | |
| 1 hp | i510-P0.75/120-1 | i510-P0.75/230-2 | | i510-P0.75/400-3 | |
| 1.5 hp | | | i510-P1.1/230-2 | | i510-P1.1/400-3 |
| 2 hp | | | i510-P1.5/230-2 | | i510-P1.5/400-3 |
| 3 hp | | | | | i510-P2.2/400-3 |
| Weight | 3.1 lb | 3.1 lb | 3.3 lb | 3.1 lb | 3.3 lb |

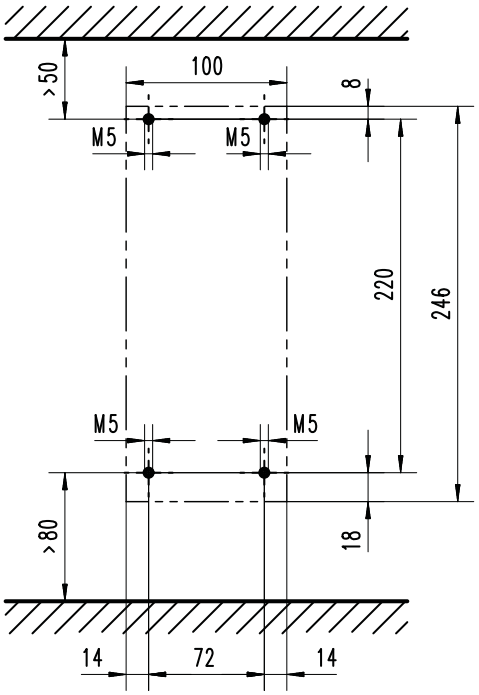


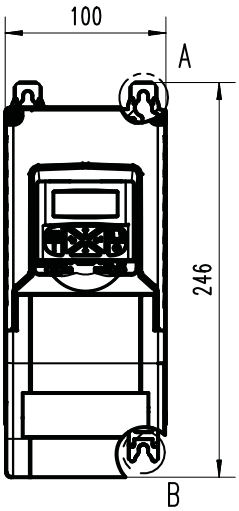
**2.2 kW ... 5.5 kW**

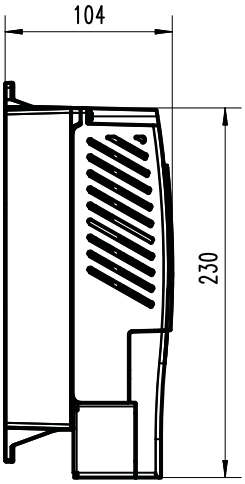
The dimensions in mm apply to:

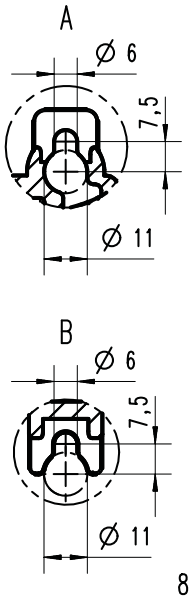
| | | | |
|---|---|---|---|
| 2.2 kW | i510-P2.2/230-2 | | |
| 3 kW | | i510-P3.0/230-3 | i510-P3/400-3 |
| 4 kW | | i510-P4.0/230-3 | i510-P4/400-3 |
| 5.5 kW | | | i510-P5.5/400-3 |
| Weight | 1.5 kg | 1.6 kg | 1.6 kg |

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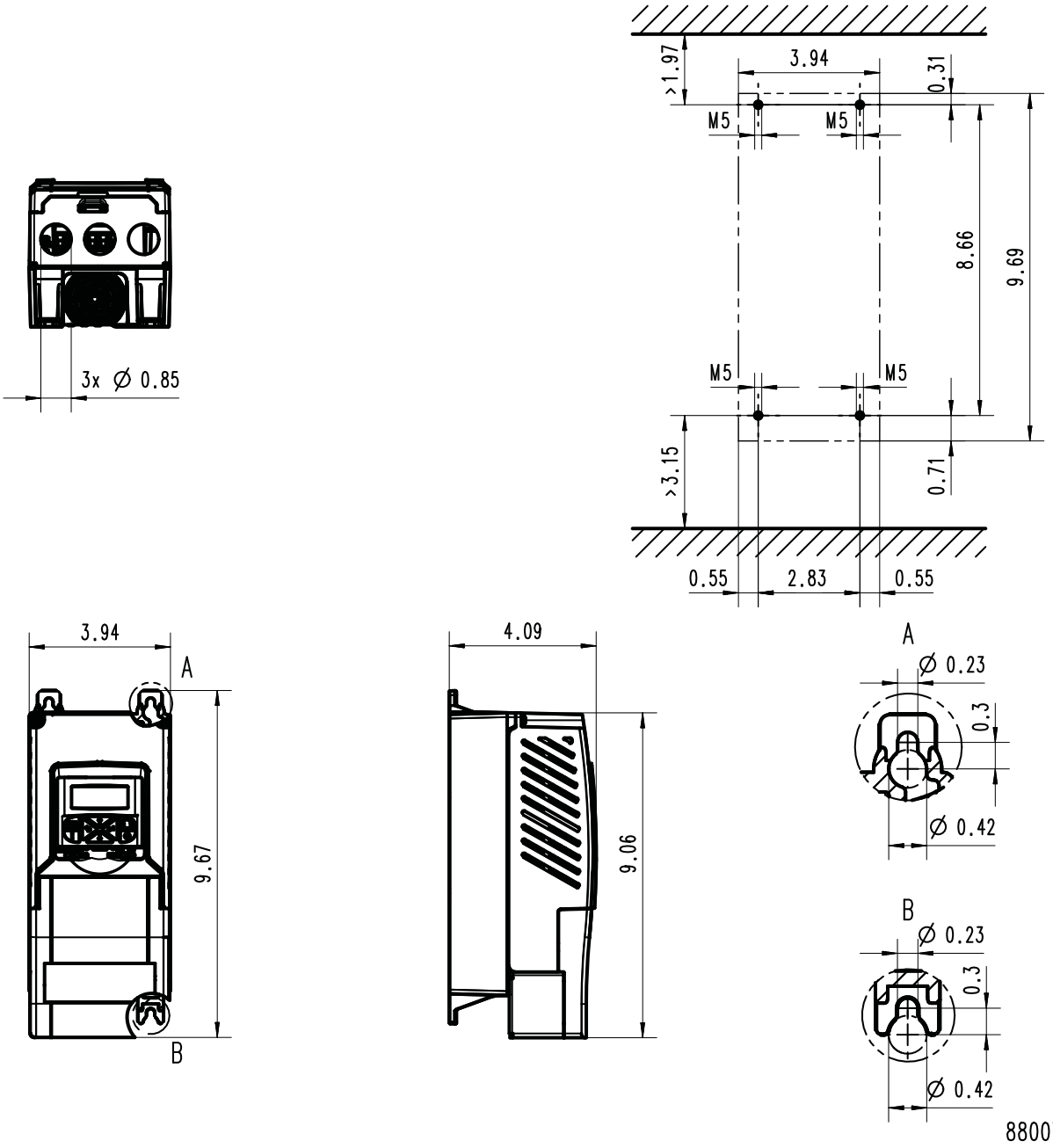
**3 hp ... 7.5 hp**

The dimensions in inch apply to:

| | | | |
|---|---|---|---|
| 3 hp | i510-P2.2/230-2 | | |
| 4 hp | | i510-P3.0/230-3 | i510-P3/400-3 |
| 5 hp | | i510-P4.0/230-3 | i510-P4/400-3 |
| 7.5 hp | | | i510-P5.5/400-3 |
| Weight | 3.3 lb | 3.5 lb | 3.5 lb |





# Product extensions

## Overview

Integrated standard interfaces:

- Standard I/O (analog and digital inputs and outputs)
- Relay output

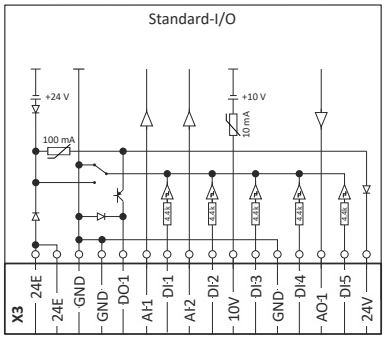
These **optional** product extensions provide further interfaces for the functions required for your application:

- Networks:
  - CANopen
  - Modbus RTU

## I/O extensions

### Standard I/O

The Standard I/O provides the inverter with analog and digital inputs and outputs and is designed for standard applications. The Standard I/O is available with different network options. ▸ Networks 🕮 95




| Control terminal X3 | | |
|---|---|---|
| **Inputs/outputs** | **Terminal** | **Description** |
| Digital inputs | DI1, DI2, DI3, DI4, DI5 | DI3/DI4 can be optionally used as frequency or encoder input. HIGH-active/LOW-active switchable. |
| Digital outputs | DO1 | |
| Analog inputs | AI1, AI2 | Can be optionally used as voltage or current input. |
| Analog outputs | AO1 | Can be optionally used as voltage or current output. |
| 24-V input | 24E | Mains-independent DC supply of the control electronics (incl. communication) |
| 10-V output | 10 V | Reference voltage for setpoint potentiometer |
| 24-V output | 24 V | |
| Reference potential | GND | |
| Connection system | | Spring terminal, not pluggable |



## Data of control connections

### Digital inputs

| | | | |
|---|---|---|---|
| Switching type | | PNP, NPN | Parameterisable |
| PNP switching level | | | |
| LOW | V | < +5 | IEC 61131−2, type 1 |
| HIGH | V | > +15 | |
| NPN switching level | | | |
| LOW | V | > +15 | |
| HIGH | V | < +5 | |
| Input resistance | kΩ | 4.6 | |
| Cycle time | ms | 1 | |
| Electric strength of external voltage | V | ± 30 | |

| | | | |
|---|---|---|---|
| Frequency input | | | |
| Connection | | X3/DI3, X3/DI4 | |
| Frequency range | kHz | 0 … 100 | |

| | | | |
|---|---|---|---|
| Encoder input | | | |
| Type | | Incremental HTL encoder | |
| Two-track connection | | X3/DI3<br>X3/DI4 | Track A<br>Track B |
| Frequency range | kHz | 0 … 100 | |

### Digital outputs

| | | | |
|---|---|---|---|
| Switching level | | | |
| LOW | V | < +5 | IEC 61131−2, type 1 |
| HIGH | V | > +15 | |
| max. output current | mA | 100 | Total current for DO1 and 24V |
| Cycle time | ms | 1 | |
| Short-circuit strength | | Unlimited period | |
| Electric strength of external voltage | V | ± 30 | |
| Polarity reversal protection | | Integrated freewheeling diode for switching the inductive load | |
| Overload behaviour | | Reduced voltage or periodic switch-off/on | |
| Reset or switch-on behaviour | | Output is switched off | LOW |

## Analog inputs

| | | | |
|---|---|---|---|
| Cycle time | ms | 1 | |
| Resolution of A/D converter | Bit | 12 | |
| Operation as voltage input | | | |
| Connection designation | | X3/AI1, X3/AI2 | |
| Input voltage DC | V | 0 … 10 | |
| Input resistance | kΩ | 70 | |
| Accuracy | mV | ± 50 | Typical |
| Input voltage in case of open circuit | V | - 0.2 … 0.2 | Display "0" |
| Electric strength of external voltage | V | ± 24 | |
| Operation as current input | | | |
| Connection designation | | X3/AI1, X3/AI2 | |
| Input current | mA | 0 ... 20 | |
| | | 4 … 20 | open-circuit monitored |
| Accuracy | mA | ± 0.1 | Typical |
| Input current in case of open circuit | mA | < 0.1 | Display "0" |
| Input resistance | Ω | < 250 | |
| Electric strength of external voltage | V | ± 24 | |

## Analog inputs

| | | | |
|---|---|---|---|
| Cycle time | ms | 1 | |
| Resolution of A/D converter | Bit | 12 | |
| Operation as voltage input | | | |
| Connection designation | | X3/AI1, X3/AI2 | |
| Input voltage DC | V | -10 … 10 | |
| Input resistance | kΩ | 70 | |
| Accuracy | mV | ± 50 | Typical |
| Input voltage in case of open circuit | V | - 0.2 … 0.2 | Display "0" |
| Electric strength of external voltage | V | ± 24 | |
| Operation as current input | | | |
| Connection designation | | X3/AI1, X3/AI2 | |
| Input current | mA | 0 ... 20 | |
| | | 4 … 20 | open-circuit monitored |
| Accuracy | mA | ± 0.1 | Typical |
| Input current in case of open circuit | mA | < 0.1 | Display "0" |
| Input resistance | Ω | < 250 | |
| Electric strength of external voltage | V | ± 24 | |



### Analog outputs

| | | | |
|---|---|---|---|
| Short-circuit strength | | Unlimited period | |
| Electric strength of external voltage | V | + 24V | |
| Operation as voltage output | | | |
| Resolution of D/A converter | Bit | 12 | |
| Output voltage DC | V | 0 ... 10 | |
| max. output current | mA | 5 | |
| min. load resistance | kΩ | ≥ 2.2 | |
| max. capacitive load | µF | 1 | |
| Accuracy | mV | ± 100 | Typical |
| Operation as current output | | | |
| Output current | mA | 0 ... 20 | |
| | | 4 … 20 | open-circuit monitored |
| Accuracy | mA | ± 0.3 | Typical |

### 10-V output

| | | | |
|---|---|---|---|
| Use | | Primarily for the supply of a potentiometer (1 ... 10 kΩ) | |
| Output voltage DC | | | |
| Typical | V | 10 | |
| Accuracy | mV | ± 100 | |
| Max. output current | mA | 10 | |
| Max. capacitive load | µF | 1 | |
| Short-circuit strength | | Unlimited period | |
| Electric strength of external voltage | V | + 24 | |

### 24-V input

| | | | |
|---|---|---|---|
| Use | | Input for mains-independent DC supply of the control electronics (incl. communication) | |
| Input voltage DC | | | |
| Typical | V | 24 | IEC 61131-2 |
| Area | V | 19.2 … 28.8 | |
| Input power | | | |
| Typical | W | 3.6 | |
| Max. | W | 6 | Depending on the use and state of inputs and outputs. |
| Input current | | | |
| Typical | A | 0.150 | |
| Max. | A | 1.0 | When switching on for 50 ms |
| Capacity to be charged | µF | 440 | |
| Polarity reversal protection | | When polarity is reversed: No function and no destruction | |
| Suppression of voltage pulses | | Suppressor diode 30 V, bidirectional | |
| Power supply unit | | SELV/PELV | Externally to create a mains-independent DC supply |
| Max. current | A | 8.0 | While looping-through |

### 24-V output

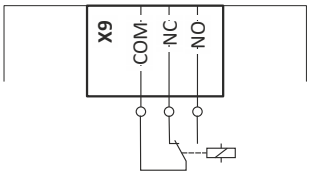
| | | | |
|---|---|---|---|
| Use | | Primarily for the supply of digital inputs | |
| Output voltage DC | | | |
| Typical | V | 24 | |
| Area | V | 16 … 28 | |
| max. output current | mA | 100 | Total current for DO... and 24V |
| Short-circuit strength | | Unlimited period | |
| Electric strength of external voltage | V | + 30 | |
| Excess current release | | Automatically resettable | |

## Further control connections

### Relay output

Use a corresponding suppressor circuit in case of an inductive or capacitive load!

| | | | | |
|---|---|---|---|---|
| Connection | | | Terminal X9: COM | Common contact (Common) |
| | | | Terminal X9: NC | Normally closed contact |
| | | | Terminal X9: NO | Normally open contact |
| Minimum DC contact load | | | | |
| | Voltage | V | 10 | A correct switching of the relay contacts needs both values to be exceeded simultaneously. |
| | Current | mA | 10 | |
| Switching voltage/switching current | | | | |
| Maximum | AC 240 V | A | 3 | According to UL: General Purpose |
| | 24 V DC | A | 2 | According to UL: Resistive |
| | 240 V DC | A | 0.16 | |





## Networks

### CANopen

CANopen is an internationally approved communication protocol which is designed for commercial and industrial automation applications. High data transfer rates in connection with efficient data formatting provide for the coordination of motion control devices in multi-axis applications.

| Bus-related information | | | |
|---|---|---|---|
| Name | | CANopen CiA 301 V4.2.0 | |
| Communication medium | | CAN cable in accordance with ISO 11898-2 | |
| Use | | Connection of inverter to a CANopen network | |
| Connection system | | Pluggable double spring terminal | |
| Status display | | 2 LEDs | |
| Connection designation | | X216: CH, CL, CG | |

| Technical data | | | |
|---|---|---|---|
| Bus terminating resistor | Ω | 120 | Terminated on both sides |
| Integrated bus terminating resistor | | No | |
| Network topology | | | |
| Without repeater | | Line | |
| With repeater | | Line or tree | |
| Device | | | |
| Type | | Slave | |
| Max. number without repeater | | 127 | Per bus segment, incl. host system |
| Address | | 1 ... 127 | Adjustable via code |
| Baud rate | kbps | 20, 50, 125, 250, 500, 800 or 1000 | Adjustable via code |
| Max. bus length | m | 2500, 1000, 500, 250, 100, 50 or 25 | Total cable length depends on the baud rate |
| Max. cable length between two devices | | Not limited, the max. bus length is decisive | |
| Process data | | | |
| Transmit PDOs | | 3 TPDOs with 1 … 8 Byte (adjustable) | |
| Receive PDOs | | 3 RPDOs with 1 … 8 bytes (adjustable) | |
| Transmission mode for TPDOs | | | |
| With change of data | | Yes | |
| Time-controlled, multiple of | ms | 10 | |
| After reception | | 1 … 240 sync telegrams | |
| Parameter data | | | |
| SDO channels | | Max. 2 servers | |

| Processing time of process data | | | |
|---|---|---|---|
| Update cycle | ms | 10 | In inverter |
| Processing time | ms | 0 ... 1 | |
| Application task runtime of the technology application used (tolerance) | ms | 1 ... x | |

## Modbus RTU

Modbus is an internationally approved, asynchronous, serial communication protocol, designed for commercial and industrial automation applications.

| Bus-related information | | | |
|---|---|---|---|
| Name | | Modbus RTU | |
| Communication medium | | RS485 (EIA) | |
| Use | | Connection of inverter to a Modbus network | |
| Connection system | | Pluggable double spring terminal | |
| Status display | | 2 LEDs | |
| Connection designation | | X216: TA, TB, COM | |

| Technical data | | | |
|---|---|---|---|
| Communication profile | | Modbus RTU | |
| Bus terminating resistor | Ω | 120 | Terminated on both sides |
| Integrated bus terminating resistor | | No | |
| Network topology | | | |
| Without repeater | | Line | |
| Device | | | |
| Type | | Slave | |
| Max. number without repeater | | 32 | Per bus segment, incl. host system |
| Max. number with repeater | | 90 | |
| Address | | 1 ... 247 | Adjustable via code |
| Baud rate | kbps | 4.8 … 115 | Adjustable via code |
| Max. cable length | m | 12 ... 600 | Per bus segment, depending on the baud rate and the used cable type |
| Max. cable length between two devices | | Not limited, the max. bus length is decisive | |
| Data channel | | | |
| SDO channels | | Max. 2 servers, with 1 … 8 bytes | Supported functions:<br>Read Holding Registers<br>Preset Single Register<br>Preset Multiple Registers<br>Read/Write 4 x registers |



# Accessories

## Operation and diagnostics

The inverter can be configured and ordered with keypad module or WLAN module. The inverter is then delivered with the module mounted.

### Keypad

Parameter setting and diagnostics

Thanks to the intuitive operating structure, the navigation keys allow a quick and easy access to the most important parameters, either to configure functions or to query current values. Parameters and actual values are indicated on the easy-to-read display.


### USB module

Interface to the PC

Connect the inverter via a USB 2.0 connection cable to a PC on which the Lenze "EASY Starter" engineering tool is installed. Configure the inverter with the "EASY Starter" using graphical user interfaces. You can create diagnostics with trend functions or observe parameter values.

Parameterising without supplying the inverter with voltage: in many cases, the USB interface of the PC is sufficient for the voltage supply if you connect the inverter directly to the PC without a hub.


| USB module | |
|---|---|
| **Order code** | **Version** |
| I5MADU0000000S | Parameterization without voltage supply of the inverter is possible.<br>USB 2.0 connecting cable required |

| Connecting cable | | |
|---|---|---|
| **Order code** | **Length** | **Type** |
| EWL0085/S | 3 m | USB 2.0-connecting cable (A-plug to micro B-plug) |
| EWL0086/S | 5 m | |

### WLAN module

Communicate wirelessly with the inverter, via a PC using the Lenze Engineering Tool "EASY Starter" or the Lenze "SMART Keypad App" for Android and iOS smartphones.


**⚠WARNING!**

- This product contains FCC ID: QOQWF121/IC: 5123A-BGTWF121
- To comply with FCC and Industry Canada RF radiation exposure limits for general population, the transmitter with its antenna must be installed such that a minimum separation distance of 20 cm is maintained between the radiator (antenna) and all persons at all times.
- This product must not be collocated or operated in conjunction with any other antenna or transmitter.
- ----------
- Le produit contient un module transmetteur certifié FCC ID: QOQWF121/IC: 5123A-BGTWF121
- Afin de se conformer aux réglementations de la FCC et d'Industry Canada relatives aux limites d'exposition aux rayonnements RF pour le grand public, le transmetteur et son antenne doivent être installés de sorte qu'une distance minimale de 20 cm soit constamment maintenue entre le radiateur (antenne) et toute personne.
- Le produit ne doit pas être utilisé en combinaison avec d'autres antennes ou transmetteurs.

The module can be used if the certification is recognized in a country according to one of these standards.

| **Conformity and approvals** | | |
|---|---|---|
| CE | RED | EN 301489-1 V2.1.1:2016 |
| | | EN 301489-17 V3.1.1:2016 |
| | | EN 300328 V2.1.1:2016 |
| FCC | Part 15.107/15.109<br>ICES-003 | |

Additional conformities and approvals:

- IC
- CMIIT

| **LED status displays** | | | |
|---|---|---|---|
| **LED 1** | **LED 2** | **LED 3** | **Meaning** |
| **Power (green)** | **TX/RX (yellow)** | **WLAN (green)** | |
| **Supply voltage status** | **Communication status** | **WLAN status** | |
| OFF | OFF | OFF | No voltage |
| ON | ON | ON | Self-test (approx. 1 s) |
| ON | OFF | OFF | Ready for operation<br>No active WLAN connection |
| ON | Flashing | ON | Communication active |
| ON | OFF | Blinking | Client Mode<br>Waiting for connection |
| Blinking | OFF | OFF | Trouble |



| Connection data (default setting) | |
|---|---|
| IP address | 192.168.178.1 |
| SSID | <Product type>_<10-digit identifier> |
| Password | password |

## Memory modules

For standard set-up, Lenze offers its customers multipacked, unwritten memory modules (EPM). In combination with the EPM copier, the EPMs can be duplicated at any location.

A memory module is included in the scope of supply of the inverter.

| Memory module | | |
|---|---|---|
| **Order code** | **Type** | **VPE** |
| | | **Piece** |
| I0MAPA0000000M | Easily pluggable<br>Duplicate data set with memory module copier | 12 |

## Memory module copier

For duplicating data on memory modules for a faster standard set-up.

The memory module copier is a copying system for all memory modules from Lenze. With the help of simple optical user guidance, the data of a module is copied quickly and reliably to another memory module.


| Memory module copiers | |
|---|---|
| **Order code** | **Type** |
| EZAEDE1001 | Data set copier for memory modules |

# Purchase order

## Notes on ordering

You can order the frequency inverter i510 protec in the protection class NEMA 1 (IP20).

Additional feature options can be optionally configured during order placement.

- Rated power
- Mains voltage
- Application area (default parameter setting)
- Product extension (keypad module, WLAN module, fieldbus network CANopen or Modbus RTU)

The inverters are supplied as a complete device in the selected configuration.

Subsequent modification of the configured inverter is not possible. Only in this way can the compact design and the protection class be achieved and assured.

The selection can be made with the "EASY Product Finder" on the Lenze homepage.

**»EASY Product Finder«**

The »EASY Product Finder« helps you to configure your required product in next to no time. In addition, you can retrieve all important technical details such as data sheets, CAD data, and EPLAN data.

The link and the QR code lead directly to the "EASY Product Finder": EASY Product Finder



## Order code

The following is a list of the information required to order an i510 protec frequency inverter.

### Order example

| Description of the component | Order code |
|---|---|
| Complete inverter | I51A P 222 F 0 0 0 0 1 002S |
| Rated power 2.2 kW (i510-P2.2/400-3) | |
| Three-phase mains connection 400 V | |
| Product version: Standard | |
| Safety technology: Without safety function | |
| Degree of protection: IP20 / NEMA 1 | |
| Interference suppression: Without interference suppression | |
| Default parameter setting: Region US (60-Hz networks) | |
| Product extension: Standard I/O with CANopen | |

### Assignment of product name and order code

When listing the technical data of the various variants, the easily legible product name is used.

The product name contains the power in kW, mains voltage class and the number of phases.
This information results in the first 9 characters of the order code:

| Complete inverter | | | |
|---|---|---|---|
| Power | | Inverter | Order code |
| kW | hp | | |
| Single-phase mains connection 120 V | | | |
| 0.37 | 0.5 | i510-P0.37/120-1 | I51AP137A |
| 0.75 | 1.0 | i510-P0.75/120-1 | I51AP175A |
| Single/three-phase mains connection 230/240 V | | | |
| 0.37 | 0.5 | i510-P0.37/230-2 | I51AP137D |
| 0.75 | 1.0 | i510-P0.75/230-2 | I51AP175D |
| 1.1 | 1.5 | i510-P1.1/230-2 | I51AP211D |
| 1.5 | 2.0 | i510-P1.5/230-2 | I51AP215D |
| 2.2 | 3.0 | i510-P2.2/230-2 | I51AP222D |
| Three-phase mains connection 230/240 V | | | |
| 3.0 | 4.0 | i510-P3.0/230-3 | I51AP230C |
| 4.0 | 5.0 | i510-P4.0/230-3 | I51AP240C |
| Three-phase mains connection 400/480 V | | | |
| 0.75 | 1.0 | i510-P0.75/400-3 | I51AP175F |
| 1.1 | 1.5 | i510-P1.1/400-3 | I51AP211F |
| 1.5 | 2.0 | i510-P1.5/400-3 | I51AP215F |
| 2.2 | 3.0 | i510-P2.2/400-3 | I51AP222F |
| 3.0 | 4.0 | i510-P3.0/400-3 | I51AP230F |
| 4.0 | 5.0 | i510-P4.0/400-3 | I51AP240F |
| 5.5 | 7.5 | i510-P5.5/400-3 | I51AP255F |

The other positions of the order code indicate options and design variants. The following table shows the structure of the complete order code.

# Purchase order
Order code

## Order code structure

| | | | I | 5 | 1 | A | P | □□□ | □ | □ | □ | □ | □ | □ | □□□ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Product type | Inverter | | I | | | | | | | | | | | | |
| Product family | i500 | | | 5 | | | | | | | | | | | |
| Product | i510 | | | | 1 | | | | | | | | | | |
| Product generation | Generation 1 | | | | | A | | | | | | | | | |
| Mounting type | Wall mounting | | | | | | P | | | | | | | | |
| Rated power (Examples) | 0.37 kW | 0.5 hp | | | | | | 137 | | | | | | | |
| | 0.75 kW | 1.0 hp | | | | | | 175 | | | | | | | |
| | 2.2 kW | 3.0 hp | | | | | | 222 | | | | | | | |
| Mains voltage and connection type | 1/N/PE AC 120 V | | | | | | | | A | | | | | | |
| | 3/PE AC 230/240 V | | | | | | | | C | | | | | | |
| | 1/N/PE AC 230/240 V<br>3/PE AC 230/240 V | | | | | | | | D | | | | | | |
| | 3/PE AC 400 V<br>3/PE AC 480 V | | | | | | | | F | | | | | | |
| Product variant | Standard | | | | | | | | | 0 | | | | | |
| Integrated functional safety | Without safety function | | | | | | | | | | 0 | | | | |
| Degree of protection | NEMA 1 (IP20), uncoated | | | | | | | | | | | 0 | | | |
| Interference suppression | Without | | | | | | | | | | | | 0 | | |
| Application area | Default parameter setting: Region EU (50-Hz networks) | | | | | | | | | | | | | 0 | |
| | Default parameter setting: Region US (60-Hz networks) | | | | | | | | | | | | | 1 | |
| Product extension | Standard I/O: ... | | | | | | | | | | | | | | 0 |
| | Keypad module with Standard I/O ... | | | | | | | | | | | | | | K |
| | WLAN module with Standard I/O ... | | | | | | | | | | | | | | W |
| | | ... without network | | | | | | | | | | | | | 00S |
| | | ... with CANopen | | | | | | | | | | | | | 02S |
| | | ... with Modbus RTU | | | | | | | | | | | | | 03S |

## Environmental notes and recycling

Lenze has been certified to the worldwide DIN EN ISO 14001 environmental management standard for many years. As part of our environmental policy and the associated climate responsibility, please note the following information on hazardous ingredients and the recycling of Lenze products and their packaging:

CE — Lenze products are partly subject to the EU Directive 2011/65/EU on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS). This is documented accordingly in the EU declaration of conformity and with the CE mark.

Lenze products are not subject to EU Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), but some contain batteries/rechargeable batteries in accordance with EU Directive 2006/66/EC (Battery Directive). The disposal route, which is separate from household waste, is indicated by corresponding labels with the "crossed-out trash can".
Any batteries/rechargeable batteries included are designed to last the life of the product and do not need to be replaced or otherwise removed by the end user.

21 PAP — Lenze products are usually sold with cardboard or plastic packaging. This packaging complies with EU Directive 94/62/EC on packaging and packaging waste (Packaging Directive). The required disposal route is indicated by material-specific labels with the "recycling triangle".
Example: "21 - other cardboard"

REACH — Lenze products are subject to the European Regulation EC No. 1907/2006 (REACH Chemicals Regulation). When used as intended, exposure of substances to humans, animals and the environment is excluded.

Lenze products are industrial electrical and electronic products and are disposed of professionally. Both the mechanical and electrical components such as electric motors, gearboxes or inverters contain valuable raw materials that can be recycled and reused. Proper recycling and thus maintaining the highest possible level of recyclability is therefore important and sensible from an economic and ecological point of view.

- Coordinate professional disposal with your waste disposal company.
- Separate mechanical and electrical components, packaging, hazardous waste (e.g. gear oils) and batteries/rechargeable batteries wherever possible.
- Dispose of the separated waste in an environmentally sound and proper manner (no household waste or municipal bulky waste).

| What? | Material | Disposal instructions |
|---|---|---|
| Pallets | Wood | Return to manufacturers, freight forwarders or reusable materials collection system |
| Packaging material | Paper, cardboard, pasteboard, plastics | Collect and dispose of separately |
| Products | | |
| Electronic devices | Metal, plastics, circuit boards, heatsinks | As electronic waste give to professional disposer for recycling |
| Gearbox | Oil | Drain oil and dispose of separately |
| | Casting, steel, aluminium | Dispose as metal scrap |
| Motors | Casting, copper, rotors, magnets, potting compound | As engine scrap give to professional disposer for recycling |
| Dry-cell batteries/rechargeable batteries | | As used batteries give to professional disposer for recycling |

Further information on Lenze's environmental and climate responsibility and on the topic of energy efficiency can be found on the Internet:

www.Lenze.com → search word: "Sustainability"

# Appendix

## Good to know

### Approvals and directives

| | |
|---|---|
| CCC | China Compulsory Certification<br>documents the compliance with the legal product safety requirements of the PR of China - in accordance with Guobiao standards. |
| $_{C}CSA_{US}$ | CSA certificate, tested according to US and Canada standards |
| UE | Union Européenne<br>documents the declaration of the manufacturer that EU Directives are complied with. |
| CEL | China Energy Label<br>documents the compliance with the legal energy efficiency requirements for motors, tested according to the PR of China and Guobiao standards |
| CSA | CSA Group (Canadian Standards Association)<br>CSA certificate, tested according to Canada standards |
| $UL^{Energy}{}_{US\ CA}$ | Energy Verified Certificate<br>Determining the energy efficiency according to CSA C390 for products within the scope of energy efficiency requirements in the USA and Canada |
| $_{C}UL_{US}$ | UL certificate<br>for products, tested according to US and Canada standards |
| $_{C}UR_{US}$ | UL certificate<br>for components, tested according to US and Canada standards |
| EAC | Customs union Russia / Belarus / Kazakhstan certificate<br>documents the declaration of the manufacturer that the specifications for the Eurasian conformity (EAC) required for placing electronic and electromechanical products on the market of the entire territory of the Customs Union (Russia, Belarus, Kazakhstan, Armenia and Kyrgyzstan) are complied with. |
| UL | Underwriters Laboratory Listed Product |
| $UL_{LISTED}$ | UL Listing approval mark<br>as proof that the product has been tested and the applicable safety requirements have been confirmed by UL (Underwriters Laboratory). |
| UR | UL Recognized Component approval mark<br>as proof that the UL approved component can be used in a product or system bearing the UL Listing approval mark. |



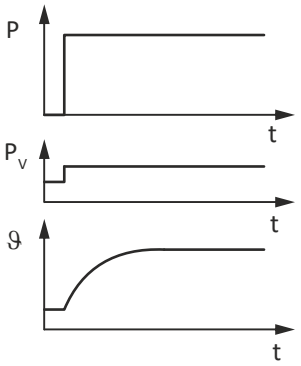
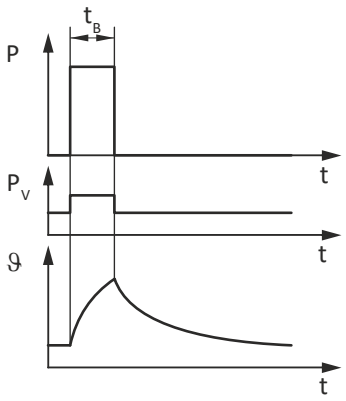
### Operating modes of the motor

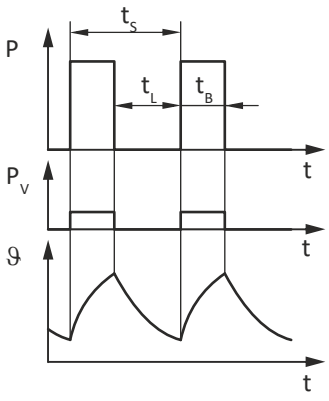
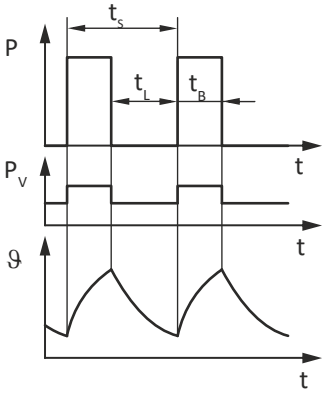
Operating modes S1 ... S10 as specified by EN 60034-1 describe the basic stress of an electrical machine.

In continuous operation a motor reaches its permissible temperature limit if it outputs the rated power dimensioned for continuous operation. However, if the motor is only subjected to load for a short time, the power output by the motor may be greater without the motor reaching its permissible temperature limit. This behaviour is referred to as overload capacity.

Depending on the duration of the load and the resulting temperature rise, the required motor can be selected reduced by the overload capacity.

### The most important operating modes

| Continuous operation S1 | Short-time operation S2 |
|---|---|
|  |  |
| Operation with a constant load until the motor reaches the thermal steady state. The motor may be actuated continuously with its rated power. | Operation with constant load; however, the motor does not reach the thermal steady state. During the following standstill, the motor winding cools down to the ambient temperature again. The increase in power depends on the load duration. |

| Intermittent operation S3 | Non-intermittent periodic operation S6 |
|---|---|
|  |  |
| Sequence of identical duty cycles comprising operation with a constant load and subsequent standstill. Start-up and braking processes do not have an impact on the winding temperature. The steady-state is not reached. The guide values apply to a cycle duration of 10 minutes. The power increase depends on the cycle duration and on the load period/ downtime ratio. | Sequence of identical duty cycles comprising operation with a constant load and subsequent no-load operation. The motor cools down during the no-load phase. Start-up and braking processes do not have an impact on the winding temperature. The steady-state is not reached. The guide values apply to a cycle duration of 10 minutes. The power increase depends on the cycle duration and on the load period/idle time ratio. |

| | | | |
|---|---|---|---|
| P | Power | $P_V$ | Power loss |
| t | Time | $t_B$ | Load period |
| $t_L$ | Idle time | $t_S$ | Cycle duration |
| $\vartheta$ | Temperature | | |

**Motor control types**

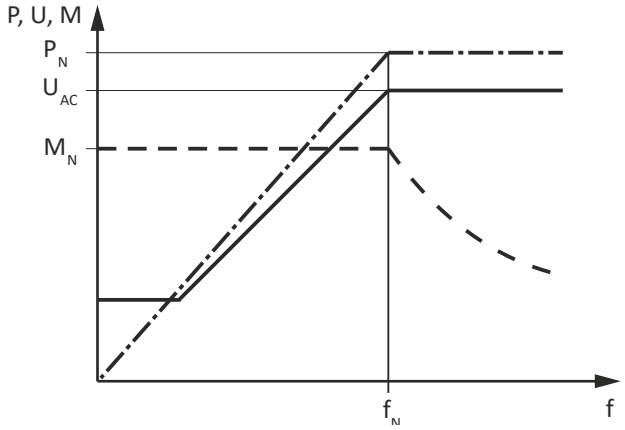
The inverter provides various motor control types.

**Linear V/f characteristic control**

The output voltage is increased proportionately to the output frequency.

In case of low output frequencies, the motor voltage can be increased to ensure a minimum current for the breakaway torque. In the field weakening range, the output voltage of the inverter is constant (mains voltage) and the frequency can be further increased depending on the load. The maximum torque of the motor is reduced proportionately to the square of the frequency increase, the maximum output power of the motor being constant.

Application areas are for instance: Single drives with constant load.




| | | | |
|---|---|---|---|
| P | Power | $M_{rated}$ | Rated torque |
| V | Voltage | $f_{rated}$ | Rated frequency |
| M | Torque | $M_{rated}$ | Rated torque |
| f | Frequency | $f_{rated}$ | Rated frequency |

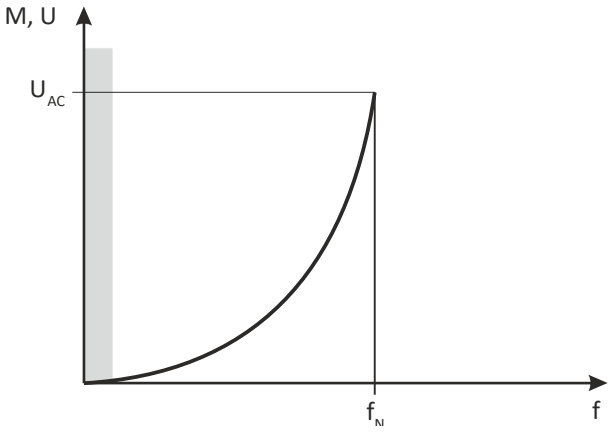
**Square-law V/f characteristic control**

The output voltage is increased squarely to the output frequency.

In case of low output frequencies, the motor voltage can be increased to ensure a minimum current for the breakaway torque. In the field weakening range, the output voltage of the inverter is constant (mains voltage) and the frequency can be further increased depending on the load. The maximum torque of the motor is reduced squarely to the frequency increase, the maximum output power of the motor being constant.

Application areas are for instance:

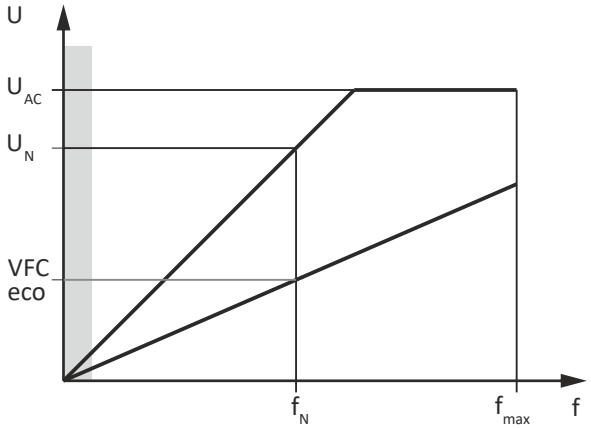
- Pumps
- Fans
- Ventilators




| | | | |
|---|---|---|---|
| V | Voltage | $U_{AC}$ | Mains voltage |
| f | Frequency | $f_{rated}$ | Rated frequency |
| M | Torque | | |

**VFCeco**

The VFCeco mode has a special effect in the partial load operational range. Usually, three-phase AC motors are supplied there with a higher magnetising current than required by the operating conditions. The VFCeco mode reduces the losses in the partial load operational range so that savings up to 30 % are possible.



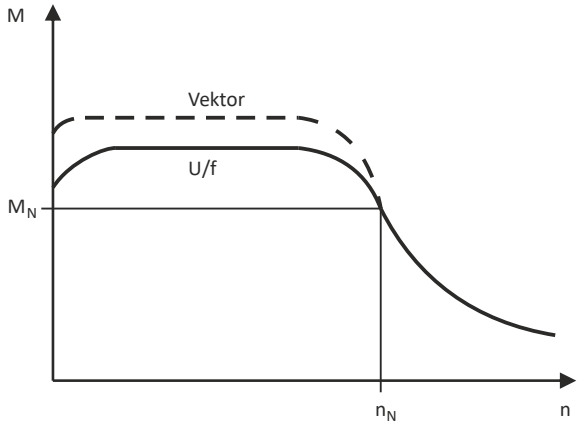

| | | | |
|---|---|---|---|
| V | Voltage | f | Frequency |
| $U_{AC}$ | Mains voltage | $f_{rated}$ | Rated frequency |
| $U_{rated}$ | Rated voltage | $f_{max}$ | Max. frequency |

**Sensorless vector control (SLVC)**

In vector control, an inverted voltage model is used for calculation. The parameters are detected via a parameter identification. The inverter determines the angle between current and voltage. This imposes a current on the motor”.

Compared to the V/f characteristic control, the vector control serves to achieve improved drive characteristics thanks to:

- higher torque throughout the entire speed range
- higher speed accuracy and higher concentricity factor
- higher efficiency




| | | | |
|---|---|---|---|
| M | Torque | $M_{rated}$ | Rated torque |
| n | Speed | $n_{rated}$ | Rated speed |

Application areas are for instance:

- Single drives with changing loads
- Single drives with high starting duty
- Sensorless speed control of three-phase AC motors

**Switching frequencies**

On an inverter, the term "switching frequency" is understood to mean the frequency with which the input and outputs of the output module (inverter) are switched. On an inverter, the switching frequency can generally be set to values between 2 and 16 kHz, whereby the selection is based on the respective power output.

As switching the modules cause heat losses, the inverter can provide higher output currents at low switching frequencies than at high frequencies. Additionally, it is distinguished between the operation at a permanently set switching frequency and a variably set switching frequency. Here, the switching frequency is automatically reduced as a function of the device utilization.

At a higher switching frequency, the noise generation is less.

Options for the switching frequency:

- 2 kHz
- 4 kHz
- 8 kHz
- 12 kHz
- 16 kHz
- variable (automatic adaptation)



### Enclosures

The degree of protection indicates the suitability of a motor for specific ambient conditions with regard to humidity as well as the protection against contact and the ingress of foreign particles. The degrees of protection are classified by EN 60529.

The first code number after the code letters IP indicates the protection against the ingress of foreign particles and dust. The second code number refers to the protection against the ingress of humidity.

| Code number 1 | Degree of protection | Code number 2 | Degree of protection |
|---|---|---|---|
| 0 | No protection | 0 | No protection |
| 1 | Protection against the ingress of foreign particles d > 50 mm. No protection in case of deliberate access. | 1 | Protection against vertically dripping water (dripping water). |
| 2 | Protection against medium-sized foreign particles, d > 12 mm, keeping away fingers or the like. | 2 | Protection against diagonally falling water (dripping water), 15 ° compared to normal service position. |
| 3 | Protection against small foreign particles d > 2.5 mm. Keeping away tools, wires or the like. | 3 | Protection against spraying water, up to 60 ° from vertical. |
| 4 | Protection against granular foreign particles, d > 1 mm, keeping away tools, wire or the like. | 4 | Protection against spraying water from all directions. |
| 5 | Protection against dust deposits (dust-protected), complete protection against contact. | 5 | Protection against water jets from all directions. |
| 6 | Protection against the ingress of dust (dust-proof), complete protection against contact. | 6 | Protection against choppy seas or heavy water jets (flood protection). |

## Glossary

| Abbreviation | Meaning |
|---|---|
| AIE | Acknowledge In Error, error acknowledgement |
| AIS | Acknowledge In Stop, restart acknowledgement |
| OFF state | Triggered signal status of the sensors |
| CCF | Common Cause Error (also β-value) |
| EC_FS | Error Class Fail Safe |
| EC_SS1 | Error-Class Safe Stop 1 |
| EC_SS2 | Error-Class Safe Stop 2 |
| EC_STO | Error-Class Safe Torque Off Stop 0 |
| ON state | Signal status of the safety sensor in normal operation |
| FIT | Failure In Time, 1 FIT = 10-9 Error/h |
| FMEA | Failure Mode and Effect Analysis |
| FSoE | FailSafe over EtherCAT |
| GSDML | Device description file with PROFINET-specific data to integrate the configuring software of a PROFINET controller. |
| HFT | Hardware Failure Tolerance |
| Cat. | Category in accordance with EN ISO 13849-1 |
| OSSD | Output Signal Switching Device, tested signal output |
| PELV | Protective Extra Low Voltage, extra-low voltage with safe isolation |
| PL | Performance Level according to EN ISO 13849-1 |
| PM | Plus−Minus − switched signal paths |
| PP | Plus−Plus − switched signal paths |
| PS | PROFIsafe |
| PWM | Pulse width modulation |
| SCS | Safe crawling speed |
| SD−In | Safe Digital Input |
| SD−Out | Safe Digital Output |
| SELV | Safety Extra Low Voltage |
| SFF | Safe Failure Fraction |
| SIL | Safety Integrity Level in accordance with IEC 61508 |