Translation of the original operating instructions / Project planning manual

Inverters

i950 cabinet servo inverter

0.37 kW ... 250 kW
0.5 hp ... 320 hp

Contents

About this document

⚠ WARNING!

Read this documentation carefully before starting any work.

► Please observe the safety instructions!

This document applies to all devices with the order code I95**B**xxx.

Document description

This documentation is aimed primarily at the following target groups:

- **Project planners:** All persons who wish to plan machines with the products described. This documentation supports you in the design and selection of your product.
- **Installation technicians and commissioning engineers:** Qualified personnel who wish to install and connect the product.

  IEC 60364 and CENELEC HD 384 define the qualifications of these persons:
  - They are familiar with installing, mounting, commissioning, and operating the product.
  - They have the corresponding qualifications for their work.
  - They know and can apply all regulations for the prevention of accidents, directives, and laws applicable at the place of use.

Further documents

For certain tasks, information is available in further documents.

Document	Contents/topics
Mounting sheet	General safety instructions and important UL/CSA instructions, connection diagram and technical data. The mounting sheet is included in the delivery of the product.
Commissioning manual	Detailed information on setting and parameterizing the product.
Brochure "Accessories for VFDs and servo drives"	Product overviews, project planning information and selection tables for the following accessories: • Brake resistors • Brake switches • Mains chokes • RFI and mains filters • Sine filter • Electrical protection devices and busbars • Mounting • Operation and diagnostics • Power supply units • System cables
"Cybersecurity" manual	There is separate cybersecurity documentation for this product, which applies to this product and is an integral part of the information provided with the product.

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. Example: 1 234.56
Warnings		
UL Warnings	UL	Are used in English and French.
UR warnings	UR	
Text		
Engineering Tools	" "	Software Example: "EASY Starter", "PLC Designer"
Icons		
Page reference		Reference to another page with additional information. Example: 16 = see page 16
Documentation reference		Reference to other documentation with additional information. 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 i950 servo inverter is an expansion for our automation platform and can easily be integrated into servo drive systems.

- The i950 servo inverter is a high-quality servo inverter.
- The i950 servo inverter is based on the standards of IEC 61131-3, PLCopen, and CiA 402, and can be employed for a comprehensive range of machine tasks.
  - This future-proof platform architecture ensures maximum reusability.
  - This guarantees the security of investment in engineering.
- Highly user-friendly
  - Innovative interaction options enable better commissioning times than ever.
- Using an SD card as a storage medium makes it easy to transfer data from and to the device.
  - Backup of the firmware version running on the device.
  - Copy of device settings and/or application data.
  - Rapid restoration if a device replacement becomes necessary.
- Standard onboard EtherCAT connection
  - for connecting the i950 as Distributed Clocks (DC)-capable EtherCAT slave for process and safety data under a standard EtherCAT motion control

    or
  - for connecting the i950 to the EtherCAT system bus.

    Via the onboard EtherCAT connection, an EtherCAT system bus offers the simple possibility to synchronize up to 16 servo inverters of the i950 inverter series without additional motion control. One i950 acts as an EtherCAT master and sends identical master values to the other connected i950 devices, which have a "slave" function. The connection is made automatically without configuration effort (plug-and-play). The preset device profile CiA 402 and the technology application "CiA 402 Advanced" are not supported.

Centralized control (controller-based automation) or decentralized control (drive-based automation)

- Both control types are possible, as previous limitations have been lifted.
- i950 servo inverters can easily be employed in multi-axis systems with controllers.
- Integration and commissioning with a Lenze control unit take place according to a similar principle.
- This promotes the trend towards autonomous machine modules.

Preferred applications:

- Conveying drives
- Traveling drives
- Winding drives
- Hoist drives
- Handling
- Robotics
- Packaging technology
- Drives for forming processes
- Drives in machine tools

Other features:

- Power range of 0.37 ... 250 kW
- A DC-bus group with feedback operation is possible.
- The i950 servo inverter can be used to extend the power of multi-axis systems, for example in systems with controller and i750 servo inverter.
- All diagnostics tasks can be performed with the Lenze software »EASY Starter«. The "engineering port" interface is provided by default for this purpose.
- Space-saving design saves space in the control cabinet. ▶ Dimensions 🕮 161

The i950 servo inverter is equipped with the following interfaces by default:

- Control connections 🕮 93
- onboard EtherCAT 🕮 102
- Engineering Port (Standard Ethernet) for operation and diagnostics

Product expansions can be used to adapt the technical features to the needs of the applications:

▶ Motor encoder evaluation 🕮 188

▶ Load encoder/master encoder evaluation 🕮 192

▶ Networks 🕮 193

▶ Accessories 🕮 293

▶ Memory modules (SD card) 🕮 295

The i950 servo inverter supports the CiA 402 device profile by default. In addition, prepared technology applications can be adjusted.

- The technology applications are selected and parameterized with Easy Starter.
- The technology applications for the i950 servo inverter use similar processes as the technology modules for Lenze controllers.
- For the use of the technology applications, licensing is necessary. Lenze SD cards with various scopes for our licensing model are available.
  ▶ Memory modules 🕮 295
- Description of the available technology applications:
  ▶ Technology applications (TA) 🕮 32

Product variants

Two variants enable a wide range of applications for integrated "functional safety":

> Devices with a power rating of 132 kW or higher are available only in the "Extended Safety" version.
>
> All devices with the order code I95**B**xxxare always shipped with firmware version 2.0 or higher.

- i950 with Basic Safety - STO
  - STO is the only applicable safety function here.
- i950 with Extended Safety
  - Numerous security functions are available here.

▸ Functional safety 📖 204

i950 - Version with Basic Safety - STO (Up to 110 kW)

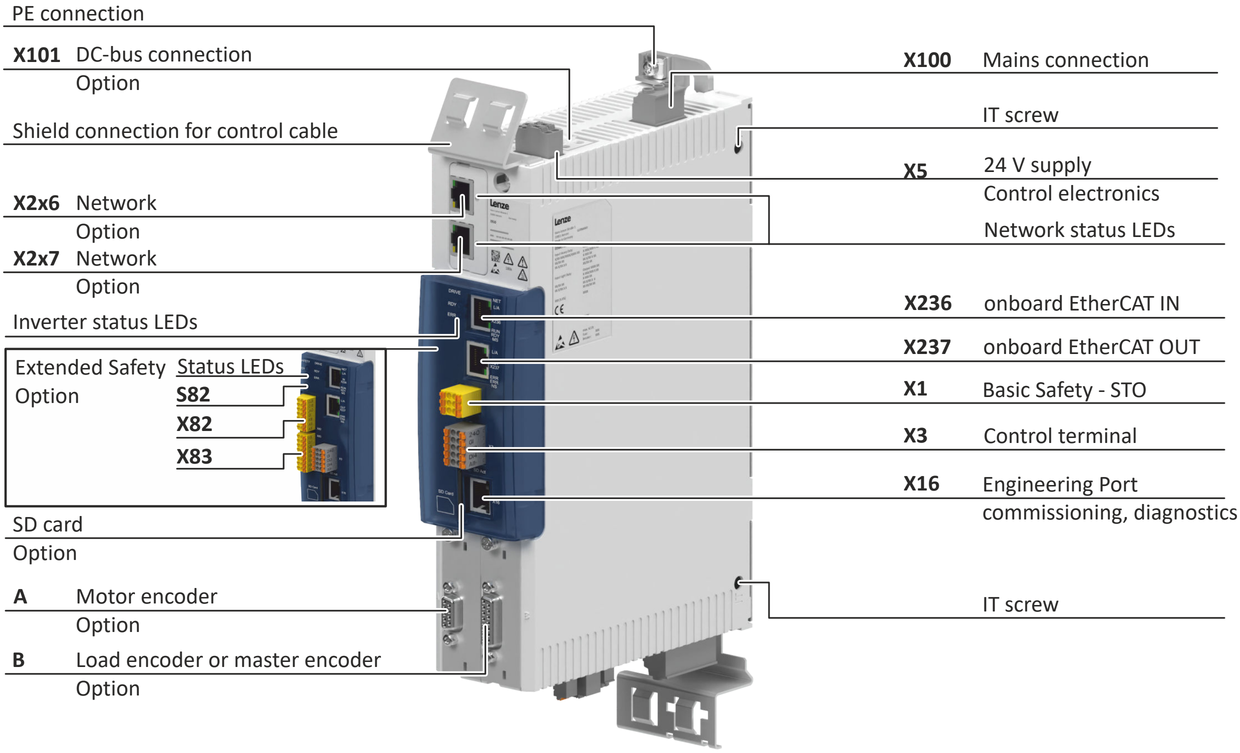
i950 - Extended Safety version

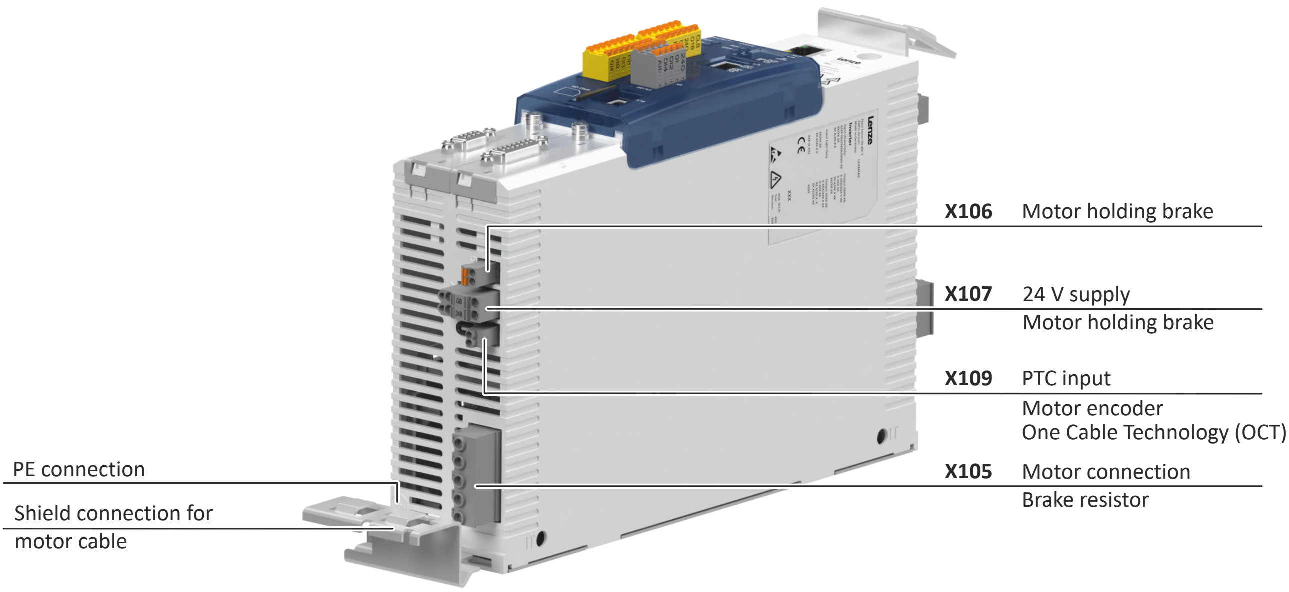
Features

The following figures give an overview of the elements and connections on the devices. Position, size and appearance of elements and connections may vary depending on the capacity and size of the equipment.

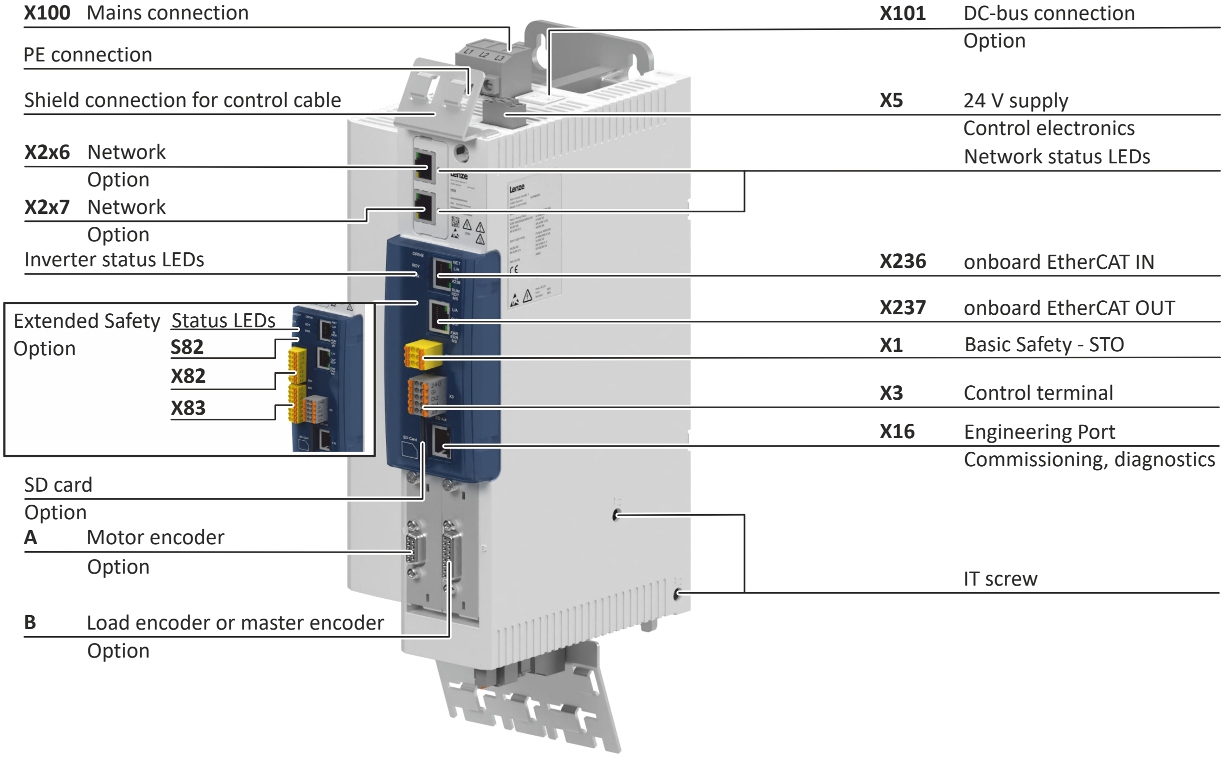
Some equipment may be optional.

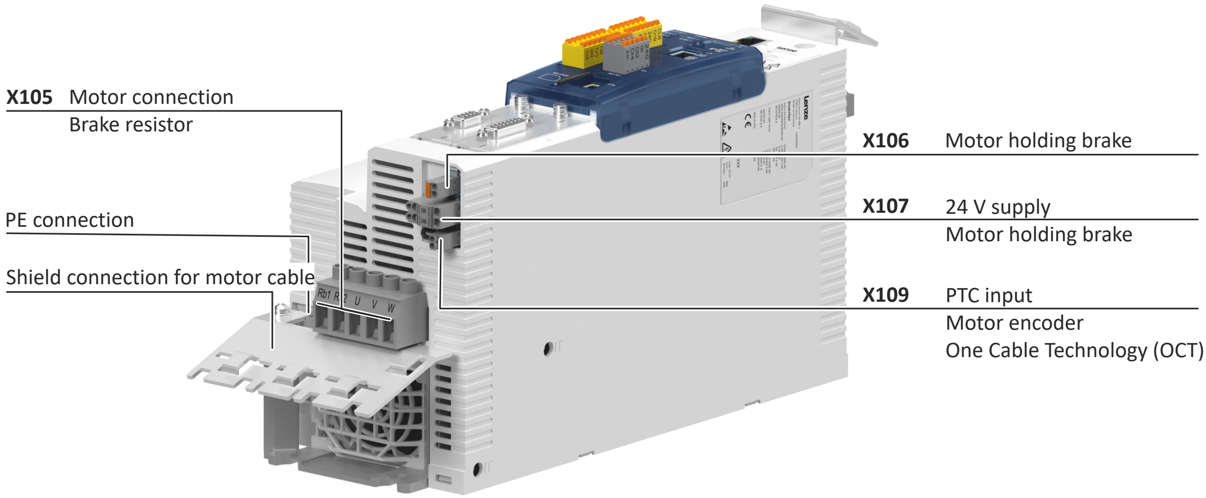
Leistungsbereich 0.37 kW ... 4 kW



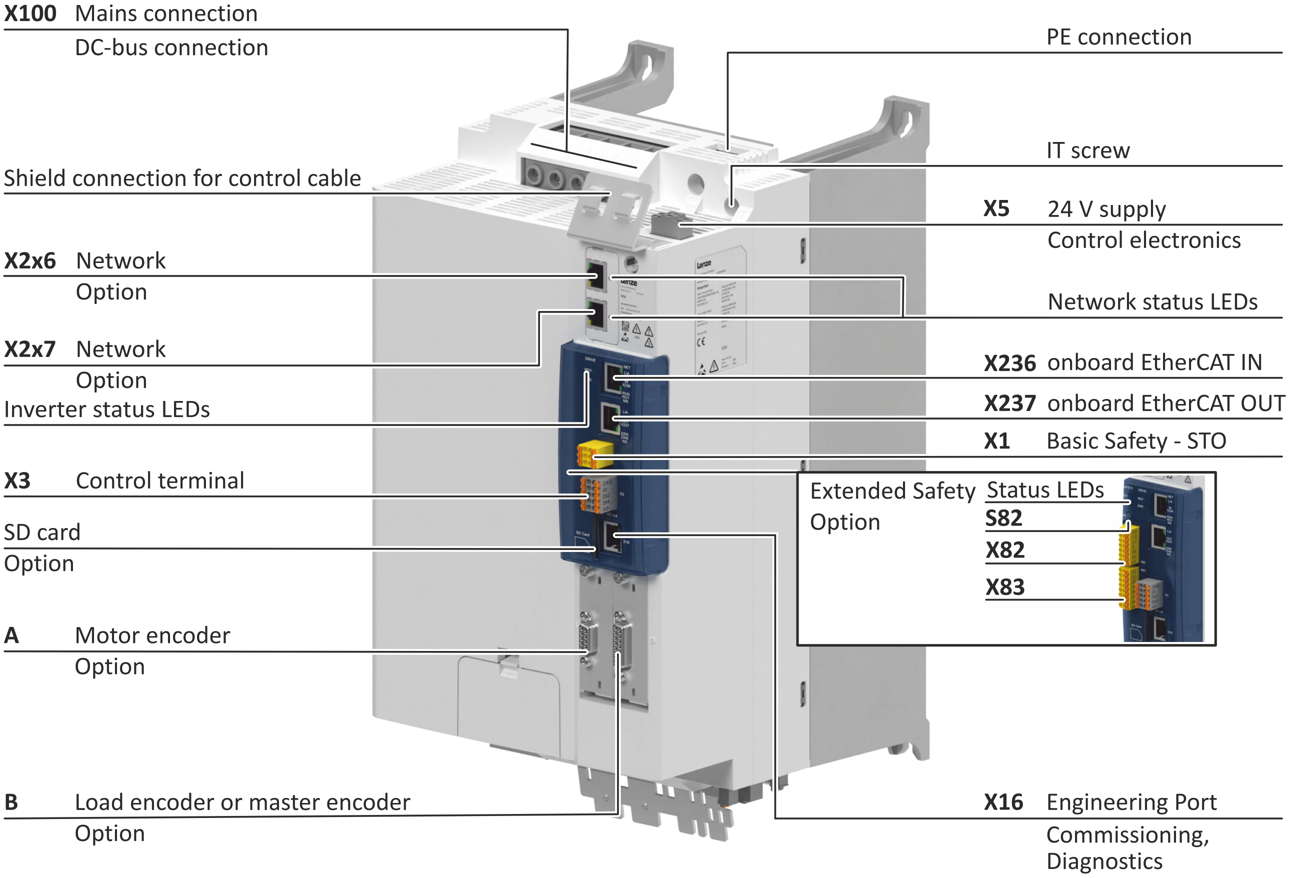


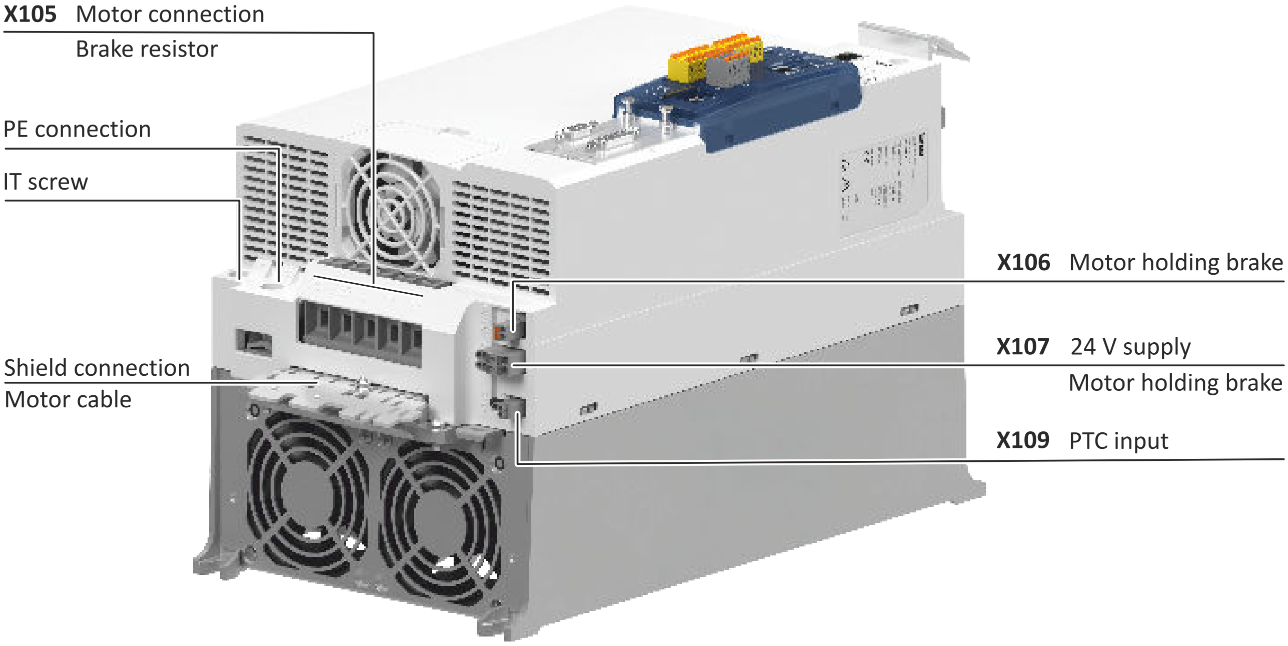
Power range 5.5 kW ... 15 kW



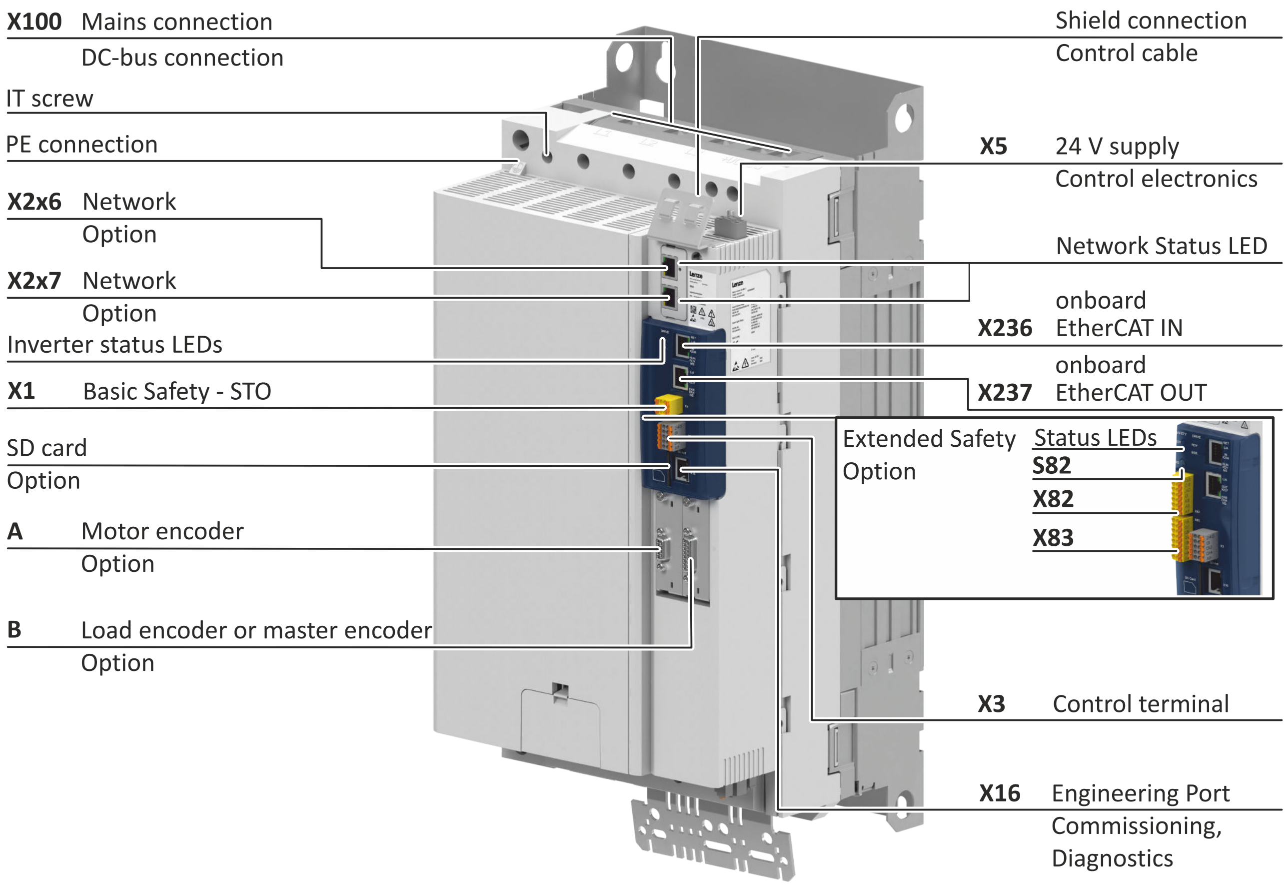


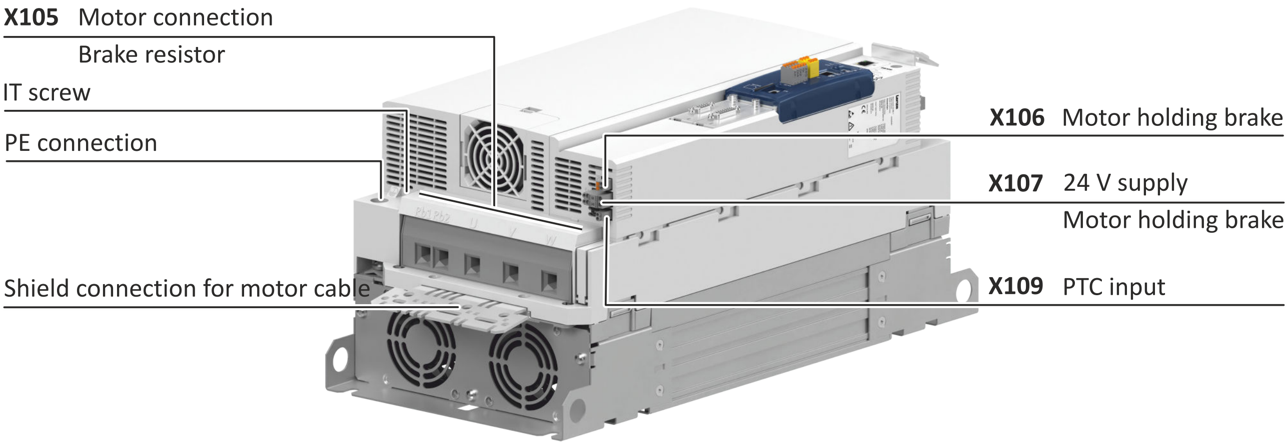
Power range 22 kW



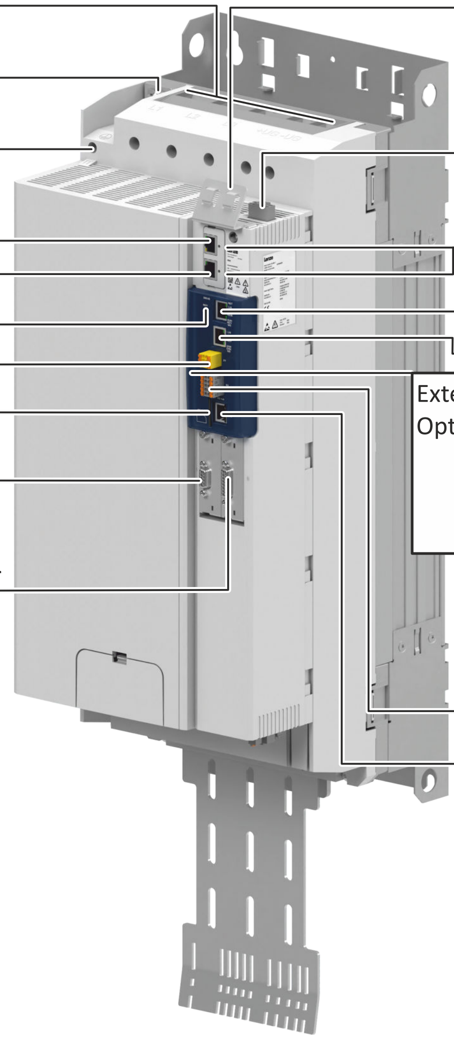


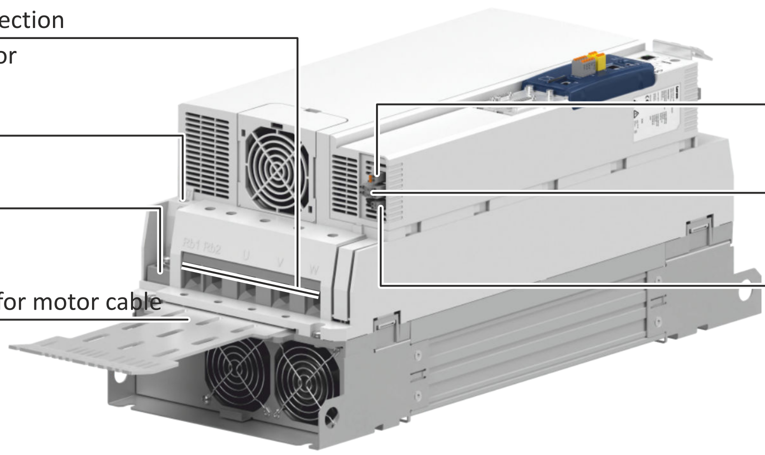
Power range 30 kW ... 45 kW



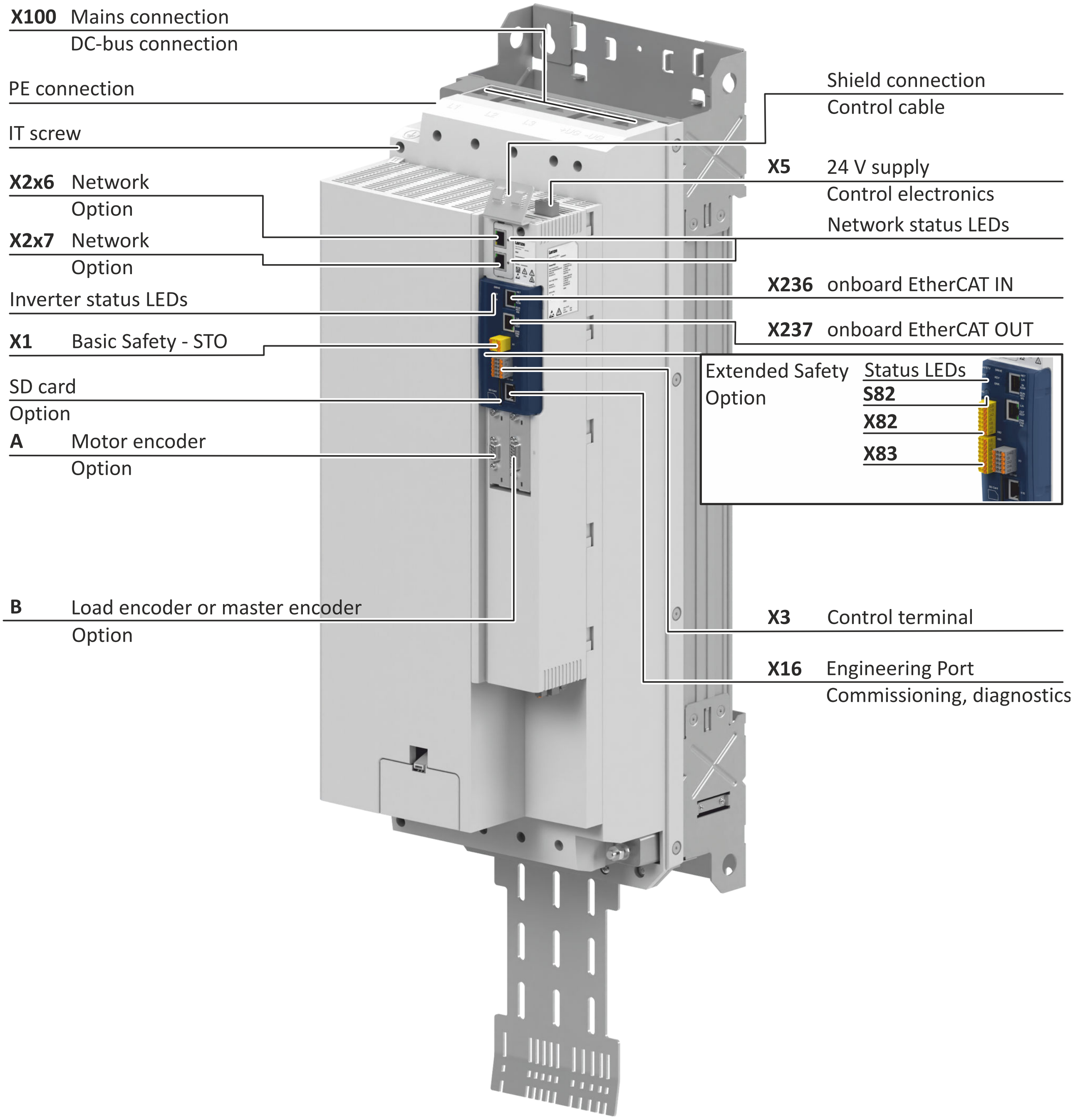


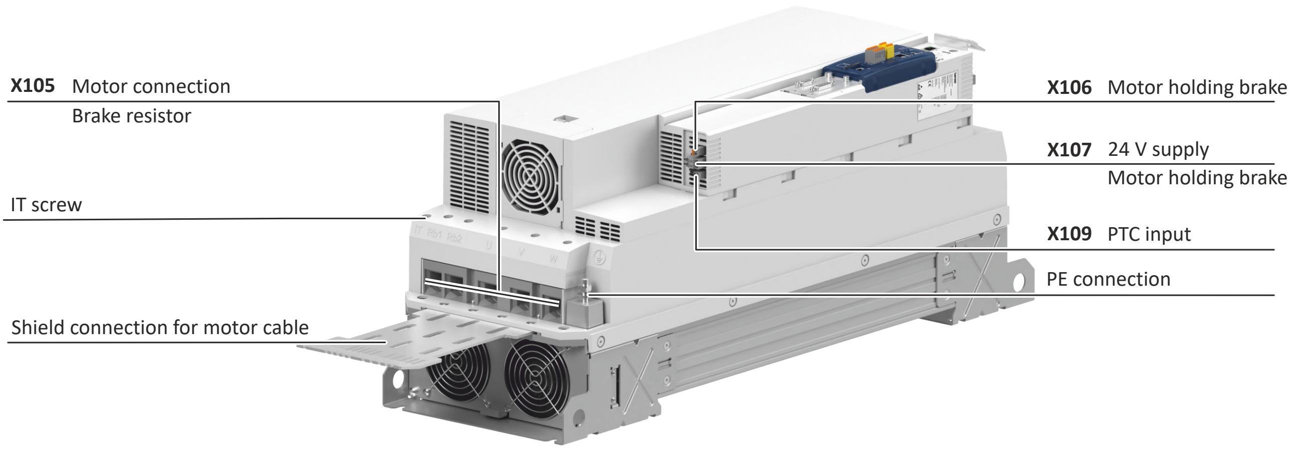
Power range 55 kW ... 75 kW



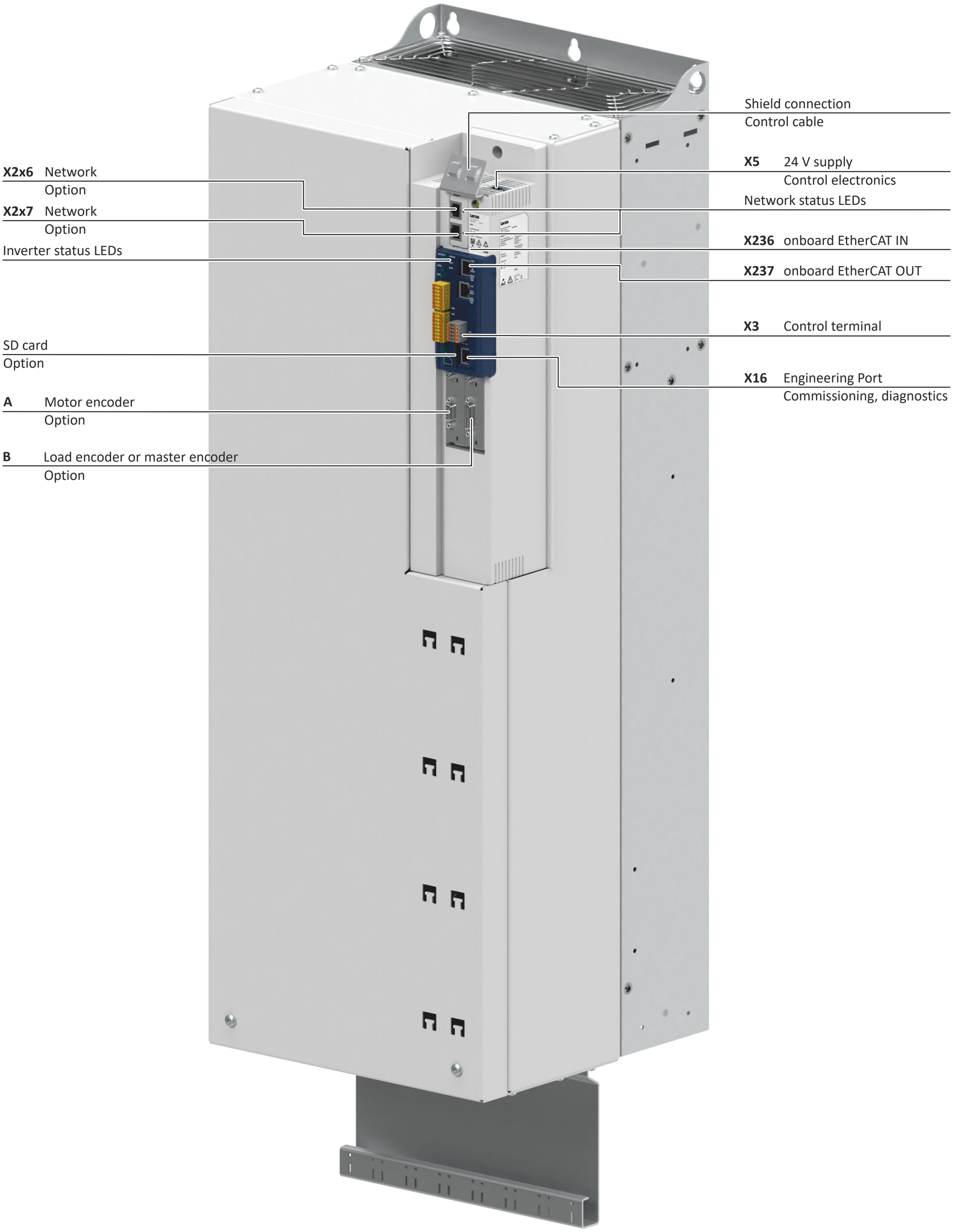


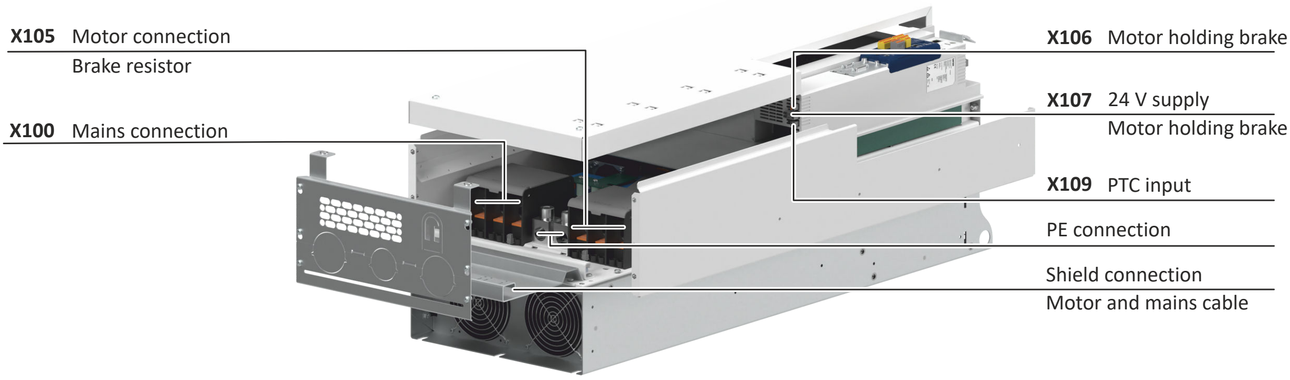
Power range 90 kW ... 110 kW



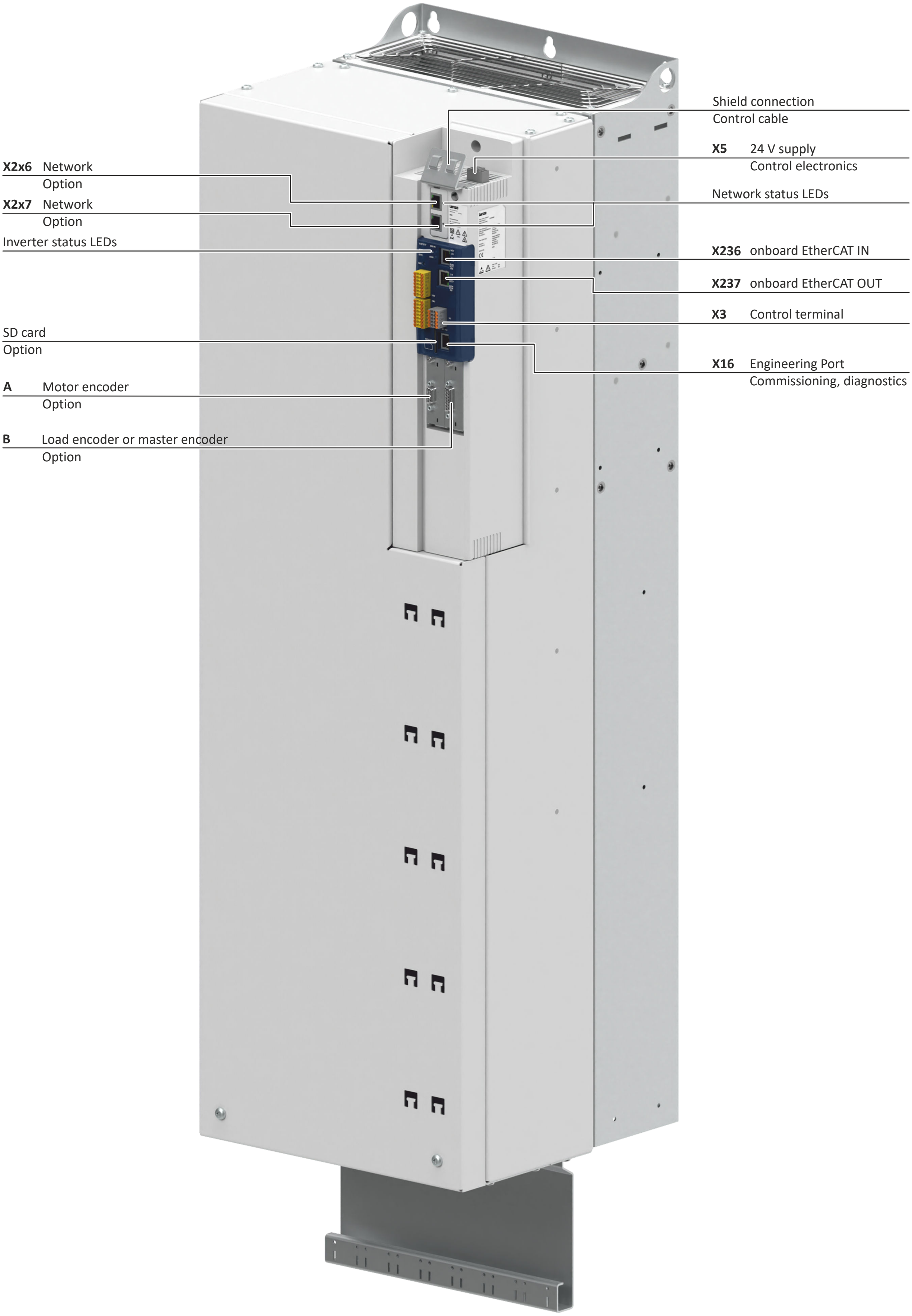


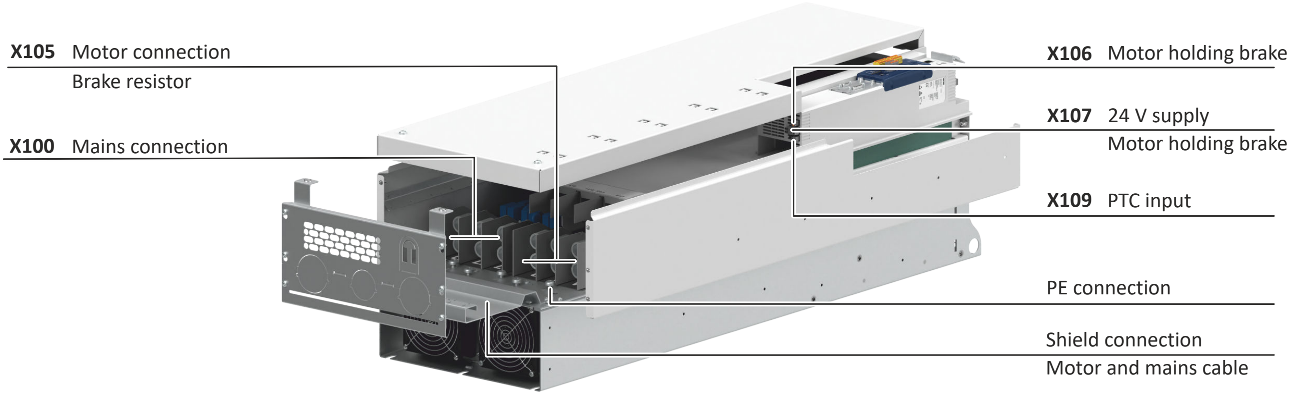
Power range 132 kW




X105 Motor connection
Brake resistor
X100 Mains connection
X106 Motor holding brake
X107 24 V supply
Motor holding brake
X109 PTC input
PE connection
Shield connection
Motor and mains cable

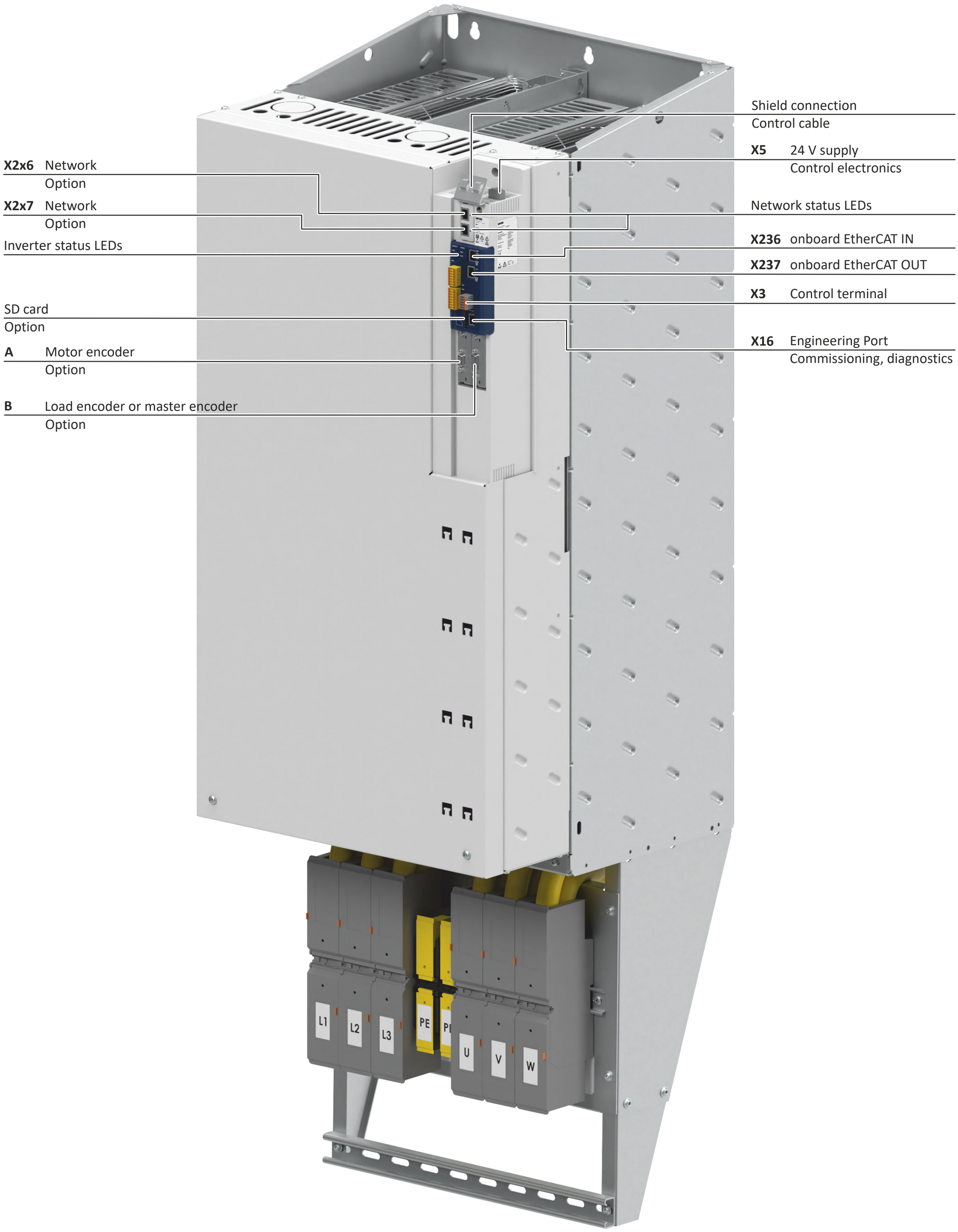
Power range 160 kW

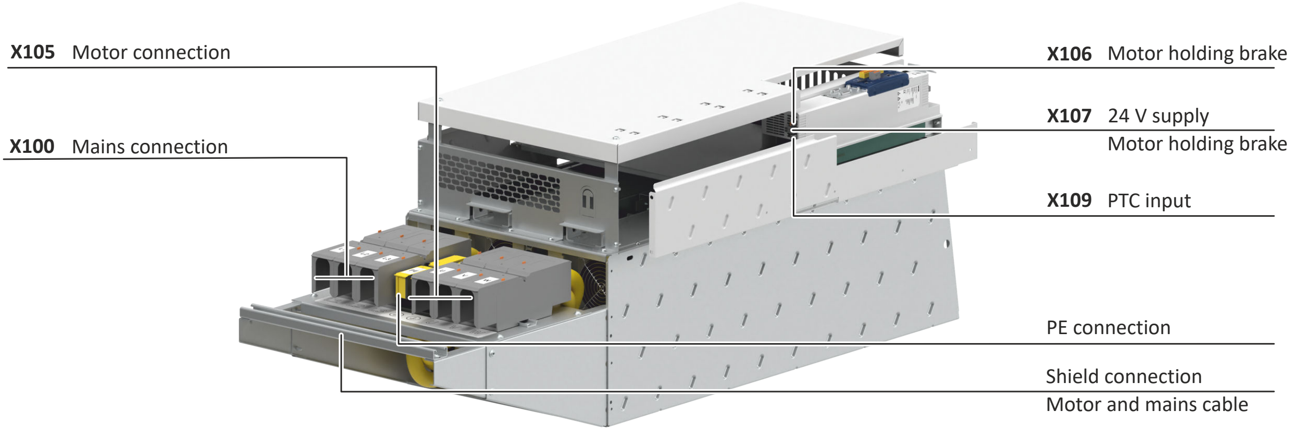




X105 Motor connection
Brake resistor
X100 Mains connection
X106 Motor holding brake
X107 24 V supply
Motor holding brake
X109 PTC input
PE connection
Shield connection
Motor and mains cable

Power range 200 kW ... 250 kW




X105 Motor connection
X100 Mains connection
X106 Motor holding brake
X107 24 V supply
Motor holding brake
X109 PTC input
PE connection
Shield connection
Motor and mains cable

One cable technology (OCT)

One Cable Technology (OCT) is supported by two motor feedback protocols:

- HIPERFACE DSL®
- EnDat 3

Advantages

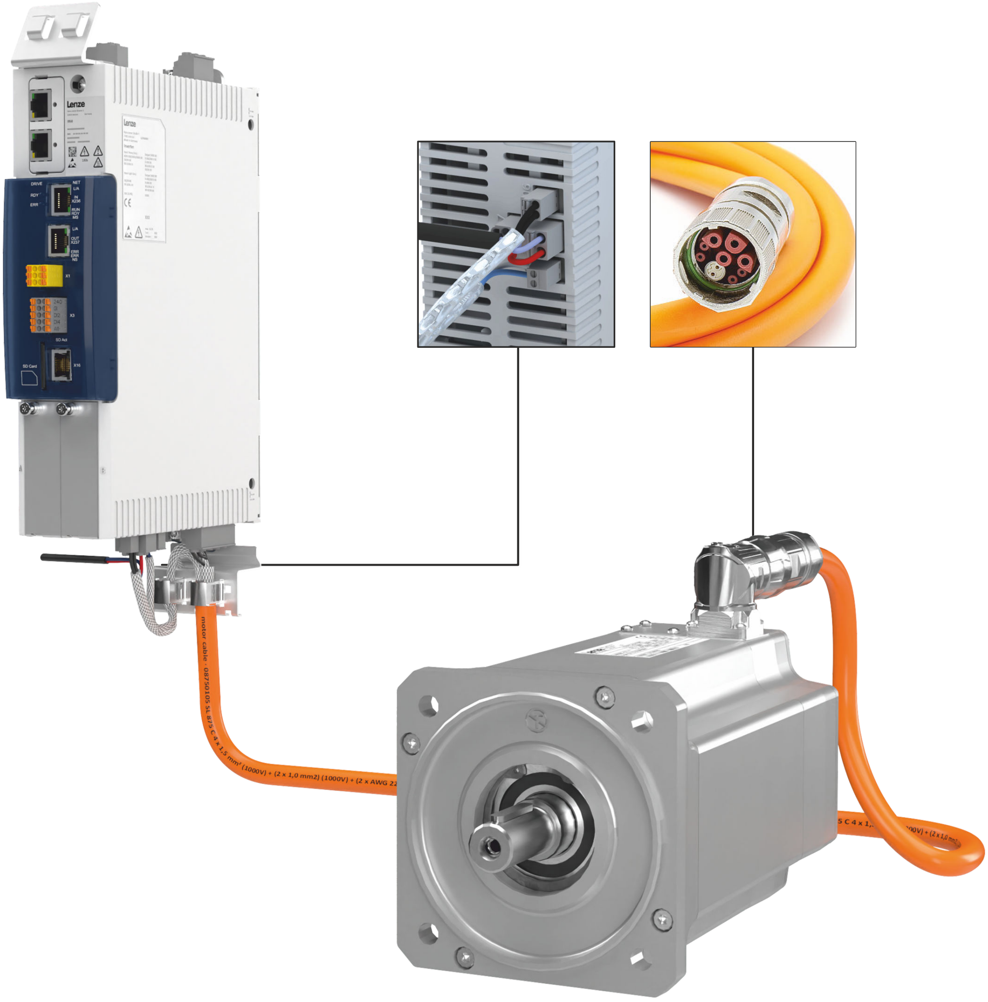
- The use of hybrid cables allows for combined servo and rotary transducer cables.
- This intelligently minimizes connecting cables, cable variants, and connection costs.
- The motor temperature is digitally transferred together with the encoder signal. There is no need for an additional connection of a thermal motor sensor.
- HIPERFACE DSL® is characterized by a high degree of fault resistance and the efficient detection and remedy of faults.

Preconditions

- One Cable Technology (OCT) is available only on <22 kW devices.
- The One Cable Technology (OCT) is possible with MCS and m850 servo motors.
- The motor must be equipped with an encoder. It must support the protocol being used.
- Make sure that no motor encoder module is plugged in slot A.
- System cable:
  - The OCT motor cable EYP008xxxxxxM11A00 or EYP008xxxxxxM12A00 must be used.
  - Different lengths up to 100 m are available. ▶ System cables 🕮 303
  - The hybrid cables have only basic insulation to the performance electronics.

Application range

- HIPERFACE DSL®:
  - Until device firmware V1.5.x: Only together with the "Basic Safety - STO" device variant.
  - From device firmware V1.6.x: Together with the "Basic Safety - STO" and "Extended Safety" device variants.
- EnDat 3:
  - Starting with device firmware V2.0.x; only when used with the "Basic Safety - STO" device variant



Status LEDs

The "RDY" and "ERR" LED status displays on the front of the inverter provide some quick information about certain operating states.

LED "RDY" (blue)	LED "ERR" (red)	State/meaning
off	off	Supply voltage not available.
on	on	Initialization in progress (inverter is starting up).
blinking (1 Hz)	off	Inverter disabled; no error detected. Safe torque off (STO) active. The inverter was disabled by the integrated safety technology. ▸ Safe torque off (STO) 📖 228
blinking (1 Hz)	on	Inverter disabled; error detected.
on	off	Inverter enabled. The motor rotates according to the specified setpoint, or the quick-stop function is active.
Both LEDs flash rapidly in alternation		Firmware update active.
Both LEDs flash very quickly in sync		"Optical Device Detection" function is enabled.

For the meaning of the status LEDs for the network, see the commissioning document.

For the meaning of the status LEDs for Safety see 📖 282.

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. CANopen® is a registered community trademark of the CAN user organisation CiA® (CAN in Automation e. V.). Device descriptions for the download: EDS files for Lenze devices
PROFI BUS®	PROFIBUS® (Process Field Bus) is a widely-used fieldbus system for the automation of machines and production plants. PROFIBUS® is a registered trademark and patented technology licensed by the PROFIBUS & PROFINET International (PI) user organisation. Device descriptions for the download: GSD files for Lenze devices
EtherCAT®	EtherCAT® (Ethernet for Controller and Automation Technology) is an Ethernet-based fieldbus system meeting the application profile for industrial real-time systems. EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany. Device descriptions for the download: XML/ESI files for Lenze devices
Safety over EtherCAT®	Fail-safe-over-EtherCAT (FSoE) enables the transmission of safe information via FSoE protocol according to ETG.5100 S specification, version 1.2.0 of the EtherCAT user organisation (ETG). Safety over EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
EtherNet/IP ODVA CONFORMANT	EtherNet/IP™ (EtherNet Industrial Protocol) is an Ethernet-based fieldbus system that uses Common Industrial Protocol™ (CIP™) to exchange data. EtherNet/IP™ and Common Industrial Protocol™ (CIP™) are trademarks and patented technologies, licensed by the user organization ODVA (Open DeviceNet Vendor Association), Inc., USA. Device descriptions for the download: EDS files for Lenze devices
PROFI NET®	PROFINET® (Process Field Network) is a real-time capable fieldbus system based on Ethernet. PROFINET® is a registered trademark and patented technology licensed by the PROFIBUS & PROFINET International (PI) user organisation. Device descriptions for the download: GSDML files for Lenze devices
PROFIsafe	The certified safety protocol for the transfer of safety-related data via PROFINET®.

Technology applications (TA)

Overview

The i950 servo inverter supports the CiA 402 device profile by default. In addition, prepared technology applications can be adjusted.

- Device profile CiA 402 Advanced ("CiA 402 Advanced")
- AC Drive Profile ("AC Drive Profile")
- Speed control ("Speed Control")
- Table positioning ("Table Positioning")
- Electronic gearbox ("Electronic Gearbox")
- Synchronism with mark correction ("Sync and Correction")
- Winder with dancer control ("Winder Dancer")
- Winder with tension control ("Winder Tension")

The basic movement functions can be used independently of the technology application.

The basic movement functions can be used to perform the following actions:

- Homing(Homing)
  - Movement of reference markers to determine the measurement system of the machine within the physically possible travel range.
  - Referencing is generally only necessary once during commissioning and during a restart of the machine.
- Manual movement (Jogging)
  - Manual control of the drive.
- Normal stop and quick stop (QSP)
  - The drive will be brought to a standstill regardless of the specified setpoint. Deceleration takes place at the value set for normal stop or quick stop.
  - A switch is made to the device state "Normal stop active" or "Quick stop active".
- Restriction of torque
  - This function limits the motor torque during ongoing operation, e. g. as overload protection for the mechanical transmission path and transmission elements from the motor shaft onwards.
- Limitation of kinematics via hardware and software
  - This function limits the speed, the rotational speed, and where applicable, the position of kinematics or a motor.

"CiA 402 Advanced" technology application

The technology application CiA 402 Advanced expands the CiA 402 functions of the i950 servo inverter. This enables the i950 to be optimally operated as a CiA device with controllers of other manufacturers.

Implemented additional functions:

- Homing according to CiA 402
- Position control for application encoder Slot B
- Separate application quick stop
- Interface to the fieldbus and use of the safety functions via PROFIsafe or FSoE

"Speed Control" technology application

For conveyor drives and traveling drives

- Operation at constant speed with high concentricity factor
- High control performance with speed stability
- Start-up and deceleration profiles
- Process control/torque control
- Speed control with and without feedback

"Table Positioning" technology application

For discontinuously running conveying, hoist, and handling drives

- Dynamic positioning processes
- Profile generation and position at target
- Profile generator and motion control
- Management of profile data sets
- Sequence profile control
- Override function
- Residual path positioning on marks

"Electronic Gearbox" technology application

For precise speed- and position-synchronized drives in a network

- Continuous transport of continuous materials such as paper, films, or textiles
- High concentricity factor
- Synchronism in drive network
- Precise control technology via the master
- Speed trimming

"Sync and Correction" technology application

For precise speed- and position-synchronized drives in a network

- Continuous material transport of continuous and arch-shaped materials or piece goods
- Concentricity and synchronism in the drive network
- Fiducial control
- Intermittent operation
- Phase trimming

"Winder Dancer" technology application

For speed-controlled drives for the storage or dispensing of continuous materials such as paper, film, or textiles

- DC-bus operation as electronic gearbox
- Large speed and torque setting range
- High concentricity factor
- Good disturbance behaviour
- Operation in field weakening range
- Process control/dancer control
- Reading in of sensors

"Winder Tension" technology application

Tension-controlled (open loop or closed loop) drives for the storage or dispensing of continuous materials such as paper, film, or textiles

- DC-bus operation as electronic gearbox
- Large speed and torque setting range
- High concentricity factor
- Good disturbance behaviour
- Operation in field weakening range
- Process control/tension control
- Reading in of sensors

Identification of the products

When listing the technical data of the various variants, the easily legible product name is used. This also applies for the categorisation of accessories.

- You can find the corresponding product names and order codes here: ▸ Purchase order 📖 304
- The product name contains the power in kW, the mains voltage class, and the number of phases.
- "C" marks the "Cabinet" version = inverter for the installation into the control cabinet.

Device series	Type	Rated power	Rated mains voltage	Product name
		kW		
i950	C	0.37	1/3 AC 230/240 V	i950-C0.37/230-2
		0.55		i950-C0.55/230-2
		0.75		i950-C0.75/230-2
		1.5		i950-C1.5/230-2

Device series	Type	Rated power	Rated mains voltage	Product name
		kW		
i950	C	0.37	1/3 AC 230/240 V	i950-C0.37/230-2
		0.55		i950-C0.55/230-2
		0.75		i950-C0.75/230-2
		1.5		i950-C1.5/230-2
		2.2	3 AC 230/240 V	i950-C2.2/230-3
		4		i950-C4.0/230-3
		5.5		i950-C5.5/230-3

Device series	Type	Rated power	Rated mains voltage	Product name
		kW		
i950	C	0.55	3 AC 400/480 V	i950-C0.55/400-3
		0.75		i950-C0.75/400-3
		2.2		i950-C2.2/400-3
		4		i950-C4.0/400-3
		7.5		i950-C7.5/400-3
		11		i950-C11/400-3
		15		i950-C15/400-3
		22		i950-C22/400-3
		30		i950-C30/400-3
		45		i950-C45/400-3
		55		i950-C55/400-3
		75		i950-C75/400-3
		90		i950-C90/400-3
		110		i950-C110/400-3
		132		i950-C130/400-3
		160		i950-C160/400-3
		200		i950-C200/400-3
		250		i950-C250/400-3

License information

Open Source

Lenze software may contain software components that are licensed as Free Software or Open Source. The licensing terms of the open source software components used in this product are stored in the product.

The license terms of the open source software components are available as of firmware 1.3.5.1185.

Display licence information

1. Connect product to PC via Ethernet.
2. Read out IP address of the product via »EASY Starter« engineering tool.
3. Open browser and enter **http://"IP address of the product"/index.html**.

The licences used are displayed in the browser.

PROFINET

The PROFINET firmware is optional.

The PROFINET firmware uses the following open source software packages under a modified GPL license: eCos Operating System. These components are used at the operating system level of the firmware. The protocol stack does not use source code under a GPL license.

View license: https://ecos.sourceware.org/license-overview.html

Cyber security information

There is separate cybersecurity documentation for this product, which applies to this product and is an integral part of the information provided with the product.

The cybersecurity documentation describes the product's security-related features, functions, configuration requirements, and operational requirements. It contains guidelines for safe installation, commissioning, operation, maintenance, and decommissioning.

You can find the cybersecurity documentation online:

www.Lenze.com → Online Tools → Online Documentation → Cybersecurity

This documentation may be updated separately from the product documentation to address newly identified threats, vulnerabilities, or regulatory requirements.

The product was developed in accordance with a secure development lifecycle based on IEC and offers security functions in accordance with IEC . Achieving a specific system security level depends on proper system integration, configuration, and operation by the system integrator and the operator.

The client and the system operator are responsible for:

- the implementation of the recommended security configurations, based on the risk analysis of the machine or system,
- the integration of the product into an appropriately secured system environment,
- the application of security updates and patches, as well as
- maintaining appropriate organizational and technical safety measures throughout the entire product lifecycle.

The operation of the product outside the assumptions described in the cybersecurity documentation or in environments with a higher threat level (e.g., open or public networks) may require additional protective measures.

Safety instructions

Current safety instructions for known error patterns

Important information on the safe output in conjunction with the "SOS monitored" signal for i950 Extended Safety

With safety firmware versions ≤ V1.3.6.0, the following malfunction of the safe digital output SD-Out1 (terminal X82, O1A, O1B) in connection with the "SOS monitored" signal was detected in the "Safe operating stop (SOS)" safety function:

Contrary to the intended behavior, the signal of the safe digital output does not follow the status signal "SOS monitored" when leaving the SOS tolerance limits.

The affected safety function is located in all i950 cabinet inverters with "Extended Safety" (type code I95AExxxxx**C**xxxxxxxxx).

The malfunction can be rectified by updating the safety firmware free of charge, which can only be carried out by Lenze technical support.

Measures required:

- If the "SOS monitored" signal is used via the safe digital output or is to be used in future, the correction must be made by means of a firmware update. The function must be deactivated until the firmware update has been carried out.
- Please contact your regional technical support to carry out the firmware update required to rectify the malfunction.

From safety firmware version V1.3.8.11485, the safe output SD-Out1 correctly displays the monitoring status of the SOS function. If the SOS position limits are violated, the safe digital output SD-Out1 changes its status.

Basic safety instructions

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

- Only use the product as directed.
- Never commission the product in the event of visible damage.
- Never modify the product technically.
- Never commission the product before assembly has been completed.
- Never operate the product without the required covers.
- Connect/disconnect all pluggable connections only in deenergized condition!
- Only remove the product from the installation in the deenergized state.
- The product can – depending on their degree of protection – have live, movable or rotating parts during or after operation. Surfaces can be hot.
- Observe the specifications of the corresponding documentation. This is the condition for safe and trouble-free operation and the achievement of the specified product features.
- The procedural notes and circuit details given in the associated documentation are suggestions and their transferability to the respective application has to be checked. The manufacturer of the product does not take responsibility for the suitability of the process and circuit proposals.
- All work with and on the product may only be carried out by qualified personnel.
  IEC 60364 and CENELEC HD 384 define the qualifications of these persons:
  - They are familiar with installing, mounting, commissioning, and operating the product.
  - They have the corresponding qualifications for their work.
  - They know and can apply all regulations for the prevention of accidents, directives, and laws applicable at the place of use.

Please observe the specific safety information in the other sections!

Application as directed

- The product is a professional equipment intended for use by trades, specific professions or industry and not for sale to the general public. IEC 60050 [IEV 161-05-05]
- To prevent personal injury and damage to property, higher-level safety and protection systems must be used!
- All transport locks must be removed.
- The product may only be operated under the specified operating conditions and in the specified mounting positions.
- The product is exclusively suitable for installation in control cabinets and, depending on the protection class and design, for wall and motor mounting.
- The product must only be actuated with motors that are suitable for the operation with inverters.
- The product must not be operated in private areas, in potentially explosive atmospheres and in areas with harmful gases, oils, acids and radiation.

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.

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.

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 according to EN 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 meet the requirements of the IEC 60364.
- 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 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 is permitted for three-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.

Safety functions

Certain inverter versions support safety functions (e. g. ”safe torque off”, formerly ”safe standstill”) according to the requirements of the EC Machinery Directive 2006/42/EC [UKCA: S.I. 2008/1597] . The notes on the integrated functional safety provided in this documentation must be observed.

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.
- Information does not apply to the wire range of the terminals.
  - Terminals that are not wired have low protection against physical contact.
  - Terminals for large cable cross-sections have lower classes of protection, e. g. from 15 kW IP10 only.

Protection of persons

Before working on the product, check that all power connections are de-energized.

- After switching off the power supply, the power connections (X100, X101, X105) may still carry dangerous electrical voltage for a certain period of time!

  The exact time is indicated on the product next to the symbol !
- Even when the motor is stopped, the power connections (X100, X101, X105) may carry dangerous electrical voltage.

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).

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.

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°).

Commissioning

If you use the Application Loader as a download tool for safety-related parameter sets, validate the parameter sets after the download.

Exchange of devices

Test the compatibility of the devices before exchanging.

Information on project planning

Project planning process

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.

In order that the excessive energy can be dissipated, a brake resistor or a regenerative module is required.

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

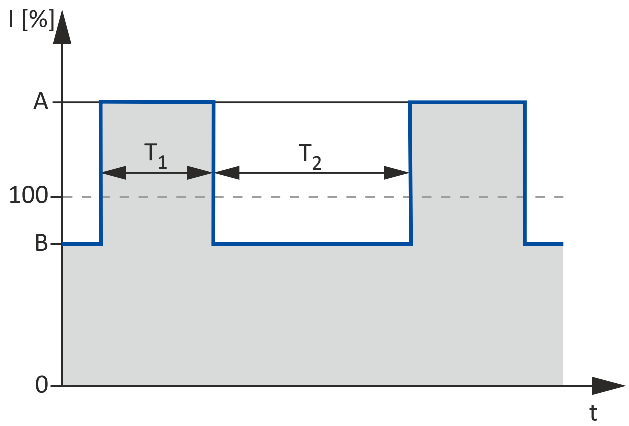
During this operation, the inverter may be loaded for 60 s with up to 150 % of the rated current if afterwards a recovery time of 120 s with max. 75 % of the rated current is observed. A cycle corresponds to 180 s.

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.



Overcurrent cycle	Max. output current	Overload time	Max. output current during the recovery time	Recovery time
	A	T_1	B	T_2
s	%	s	%	s
Overcurrent cycle 15 s	200	3	75	12
Overcurrent cycle 180 s	150	60	75	120

Control cabinet structure

Control cabinet requirements

- Protection against electromagnetic interferences
- Compliance with the ambient conditions of the installed components

Mounting plate requirements

- The mounting plate must be electrically conductive.
  - Use zinc-coated mounting plates or mounting plates made of V2A.
  - Varnished mounting plates are unsuitable, even if the varnish is removed from the contact surfaces.
- When using several mounting plates, make a conductive connection over a large surface (e. g. using grounding strips).

Arrangement of components

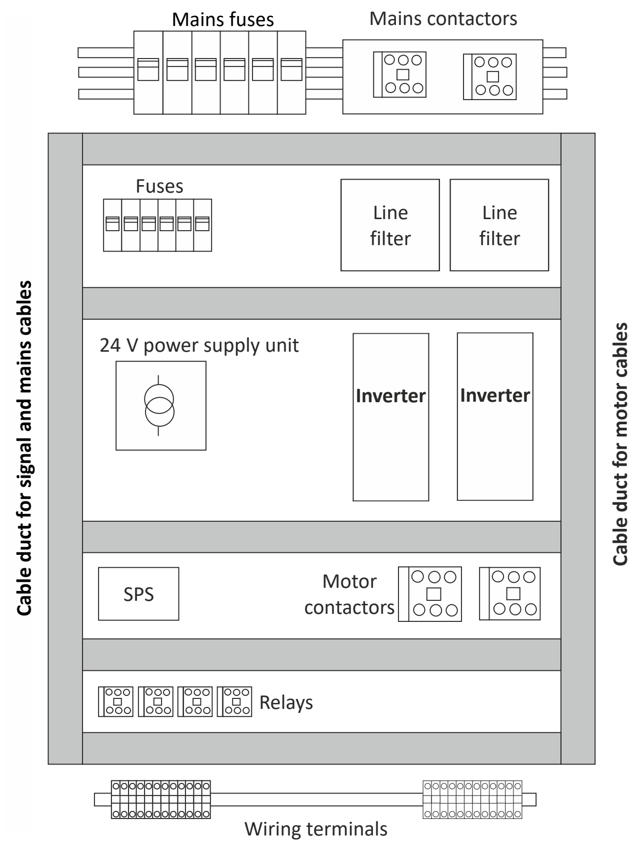


Fig. 1: Example for the ideal arrangement of components in the control cabinet

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.

Installation inside the control cabinet

- Always install cables close to the mounting plate (reference potential), as freely suspended cables act like antennas.
- Use separated cable ducts for motor cables and control cables. Do not mix up different cable types in one cable duct.
- Route cables so that they are straight-lined to the terminals (do not form cable bundles).
- Minimize coupling capacities and coupling inductances by avoiding unnecessary cable lengths and reserve loops.
- Short-circuit unused cores to the reference potential.
- Install the cables of a 24 V DC supply (positive and negative cable) close to each other or twisted over the entire length to avoid loops.
- Before leaving the control cabinet, connect the shield of the fieldbus cable to the mounting plate in accordance with EMC requirements.

Installation outside the control cabinet

- In the case of greater cable lengths, a greater cable distance between the cables is required.
- In the case of parallel routing (cable trays) of cables with different types of signals, the degree of interference can be minimized by using a metallic cable separator or isolated cable ducts.

Earthing concept

- Set up the earthing system with a star topology.
- Connect all components (inverters, filters, chokes) to a central earthing point (PE rail).
- Comply with the corresponding minimum cross-sections of the cables.
- When using several mounting plates, make a conductive connection over a large surface (e. g. using grounding strips).

Mechanical installation

Important notes

Measures for cooling during operation

- Ensure unimpeded ventilation of cooling air and outlet of exhaust air.
- If the cooling air is polluted (fluff, (conductive) dust, soot, grease, aggressive gases), take adequate countermeasures.
  - Install filters.
  - Arrange for regular cleaning of the filters.
  - Use air conditioners with hermetic separation of the inside and outside air of the control cabinet.
- If required, implement a separate air guide.

Preparation

Further data and information for mechanical mounting:

▶ Control cabinet structure 📖 48

▶ Dimensions 📖 161

Mounting positions

- Standard for all devices
  - Installation vertically on the rear panel of the control cabinet
  - Mains connections at the top, motor connections at the bottom
- Other mounting positions for i950 0.55 kW ... 15 kW (400/480 V) and 0.37 kW ... 5.5 kW (230 V)
  - Installation rotated ±90° from the vertical on the rear panel of the control cabinet
  - Installation on a horizontal mounting plate - heat sink at the bottom, front of the device at the top

The same technical data and approvals apply as for the standard mounting position.

The same free spaces apply as for the standard mounting position.

Installation clearances

- Maintain the specified installation clearances above and below to the other installations.
- Several devices of the same series can be lined up directly, regardless of the device size. No installation clearance is required between the devices.

Mechanical fastening

- The mounting location and material must ensure a durable mechanical connection.
- Do not mount the inverter on a DIN rail!
  (Except for inverters, for which a suitable mounting kit is available as an accessory.)
- In case of continuous vibrations or shocks use vibration dampers. When using non-conductive vibration dampers, an EMC-compliant design must be ensured.

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

M5 x ≥ 10 mm for devices up to and including 2.2 kW

M5 x ≥ 12 mm for devices up to and including 11 kW

M6 x ≥ 16 mm for devices up to and including 22 kW

M8 x ≥ 16 mm for devices up to and including 110 kW

Mounting inverter

How to mount the inverter on the mounting plate

Preconditions:

- Mounting plate with conductive surface

Required:

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

1. Prepare the mounting plate with the 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 plate via keyhole suspension.
5. Only tighten the screws hand-tight.
6. Pre-assemble additional units if necessary.
7. Adjust the units.
8. Screw the units to the mounting plate.

The inverter and any other units are mounted on the mounting plate. You can start wiring.

Mounting brake resistor

⚠WARNING!

Possible overheating of the brake resistor during operation

Insufficient heat dissipation and incorrect connection of the thermal contact can cause the brake resistor to overheat during operation.

Possible consequences: The brake resistor becomes very hot or is destroyed. The drive is not braked but coasts down. Sensitive components can be overheated by the brake resistor.

► Mount the brake resistor on a fire-proof mounting surface.
► Do not mount any flammable objects closer than 1 m to the brake resistor.
► Do not place any flammable objects below the brake resistor.
► Observe the mounting clearances according to the data and dimension sheets, which can be found under Lenze Support.

Further information on brake resistors and their design can be found in the brochure "Accessories for frequency inverters and servo inverters".

This brochure also contains references to further information (e.g., data sheet with dimensions, mounting clearances, and connection data) for the respective brake resistor.

How to mount the brake resistor:

1. Select a suitable mounting location.

   The mounting location must always guarantee the operating conditions specified in the technical data.
2. Screw the brake resistor into place at the mounting location.

   The mounting location and mounting materials must ensure a permanent mechanical connection.

The brake resistor is installed. You can start wiring.

▸ Brake resistor connection 🕮 90

Electrical installation

Important notes

DANGER!

Dangerous electrical voltage

Dangerous electrical voltages may be present at the product's connections during operation!

After switching off the power supply, the power connections (X100, X101, X105) may still carry dangerous electrical voltage for a certain period of time!

The exact time is indicated on the product next to the symbol ⚠ !

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

Possible consequences: Death or serious injuries from electric shock

- ▶ Any work on the product must only be carried out in a deenergized state.
- ▶ Check that no voltage is present!
- ▶ Observe the warning signs on the product.
- ▶ After switching off, wait until the drive is at a standstill.
- ▶ Implement the measures required in EN 61800-5-1 or EN 60204-1, i.e., fixed installation and standard-compliant PE connection.

DANGER!

Use of the inverter on a phase earthed mains with a rated mains voltage ≥ 300 V

The protection against accidental contact is not ensured without external measures.

Possible consequences: Death or severe injuries

- ▶ If protection against accidental contact according to EN 61800-5-1 is required for the control terminals of the inverters and the connections of the plugged device modules, ...
- ▶ an additional basic insulation has to be provided.
- ▶ the components to be connected have to come with a second basic insulation.

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 and no. of phases = 1 or 1/3

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

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.

NOTICE

Use of mains filters and RFI filters in IT systems

Mains filters and RFI filters from Lenze contain components that are interconnected against PE.

Possible consequences: The filters may be destroyed when an earth fault occurs.

Possible consequences: Monitoring of the IT system may be triggered.

▶ Do not use mains filters and RFI filters from Lenze in IT systems.

▶ Before using the inverter in the IT system, remove the IT screws.

NOTICE

Overvoltage at components

In case of an earth fault in IT systems, intolerable overvoltages may occur in the plant.

Possible consequences: Destruction of the device

▶ Before using the inverter in the IT system, the contact screws must be removed.

▶ Positions and number of the contact screws depend on the device.

NOTICE

Vibrations at the connections

Possible consequences: Damage to the connections

▶ Relieve all connections on the devices so that no vibrations can be transmitted to the connections.

You have to install the devices into housings (e. g. control cabinets) to comply with valid regulations.

Stickers with warning notes must be displayed prominently and close to the device.

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".

Electrical isolation

Ensure a trouble-free operation:

Carry out the total wiring so that the separation of the separate potential areas is preserved.

X100	L1, L2, L3	Mains connection	X216	CH, CL, CG	CANopen (option)
X101	+UG, -UG	DC-bus connection	X226	Sub-D, 9-pole	PROFIBUS (option)
X104	+UG, -UG, Rb1, Rb2	DC-bus connection/brake resistor connection (>110 kW)			
X105	U, V, W, Rb1, Rb2	Motor connection/brake resistor connection	X246/X247	RJ45	EtherCAT (option)
X106	BD1, BD2	Motor holding brake connection	X256/X257	RJ45	PROFINET (option)
X107	24B, GB	24 V supply for motor holding brake	X266/X267	RJ45	EtherNet/IP (option)
X109	T1, T2	PTC input/motor encoder One Cable Technology (OCT)	X82	CLA, CLB, OxA, OxB, AIS, AIE, IRS, IRL, 24S, GS, GSI	Extended Safety (option)
X1	SIA, SIB, GS	Basic Safety - STO	X83	IxA, IxB, GS, GIx	Extended Safety (option)
X3	DIx, GDI, DOx, GDO, 24O, AI1+, AI1-	Control terminals	A: X7	Sub-D, 9-pole	Motor encoder - resolver (option)
X5	24E, GE	24 V supply for control electronics	A: X8	Sub-D, 15-pole	Motor encoder - encoder (option)
X16	RJ45	Engineering Port	A: X17	DIx, GI, DOx, 24O, GO	Digital-I/O (option)
X236 IN	RJ45	onboard EtherCAT IN	A: X4	DIx, GDI, DOx, 24O, GDO AI2+, AI2-, AO, GA, +10V, 24V, G24	Extended-I/O (option)
X237 OUT	RJ45	onboard EtherCAT OUT	B: X7	Sub-D, 9-pole	Load encoder - resolver (option)
			B: X8	Sub-D, 15-pole	Load encoder - encoder (option)
			B: X17	DIx, GI, DOx, 24O, GO	Digital I/O (option)
			B: X4	DIx, GDI, DOx, 24O, GDO AI2+, AI2-, AO, GA, +10V, 24V, G24	Extended I/O (option)
			B: X6.1	Sub-D 9-pole	Digital frequency input (option)
			B: X6.2	Sub-D 9-pole	Digital frequency output (option)

Automatic disconnection of the supply according to IEC/HD 60364-4-41

IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410) requires fault protection for the output circuits.

Preconditions

Installation in TN network and TT network

- The inverters are installed according to the specifications in the documentation.
- The system complies with the requirements of the applicable standards of the series IEC/HD 60364 (DIN VDE 0100; VDE 0100).
- The continuity of all associated PE conductors and equipotential bonding conductors is ensured including the bonding and connection points.
- Additional measures in the TT network:
    - Use of earth-leakage circuit breakers or the additional protective grounding according to IEC 60361-4-41, section 415.

Under these conditions, the inverters meet the protective measure "automatic disconnection of the supply" according to IEC/HD 60364-4-41
(DIN VDE 0100-410; VDE 0100-410):2007-06, section 411.3.2.5.

This means that in the event of a short circuit with negligible impedance to a protective conductor or to earth, the inverters reduce the output voltage within the time required in table 41.1 of IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410):2007-06.

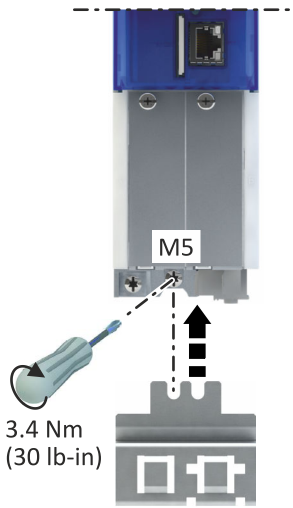
Preparation

Installation of shield connection sheet for control cable up to 15 kW

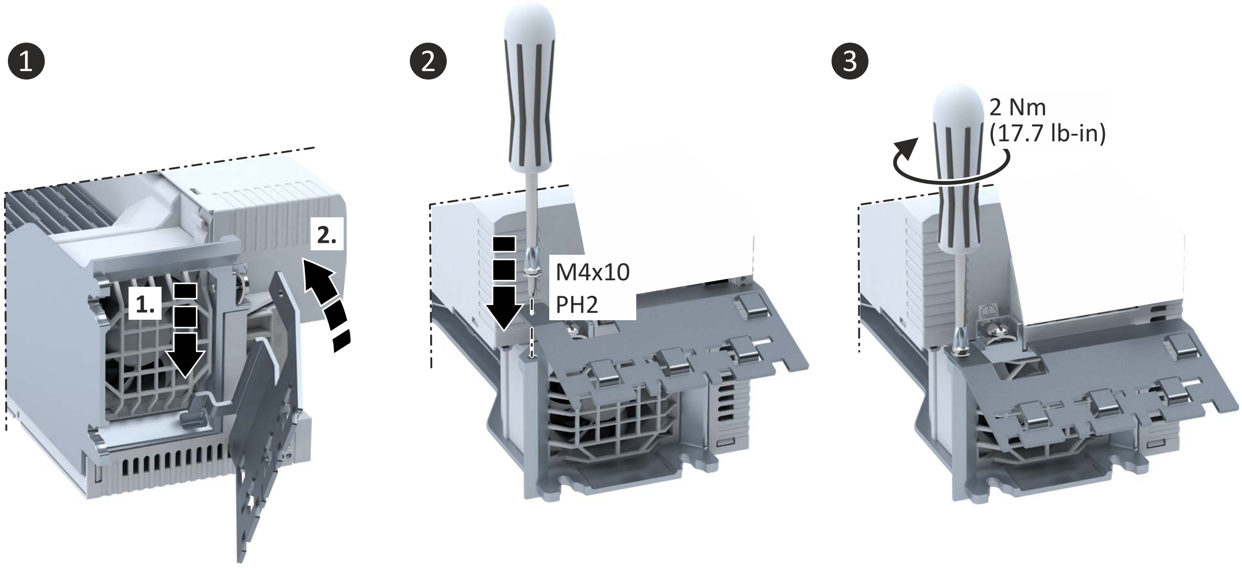
From 22 kW onwards, the shield sheet is pre-assembled.

Installation of shield connection sheet for motor cable 0.37 kW to 4 kW

Together with the inverter, the shield connection sheet is screwed onto the mounting plate.

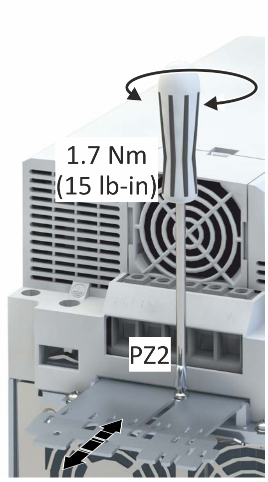


Installation of shield connection sheet for the motor cable 5.5 kW ... 15 kW

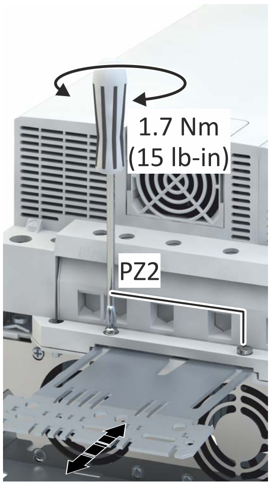


Installation of shield connection sheet for motor cable 22 kW to 45 kW

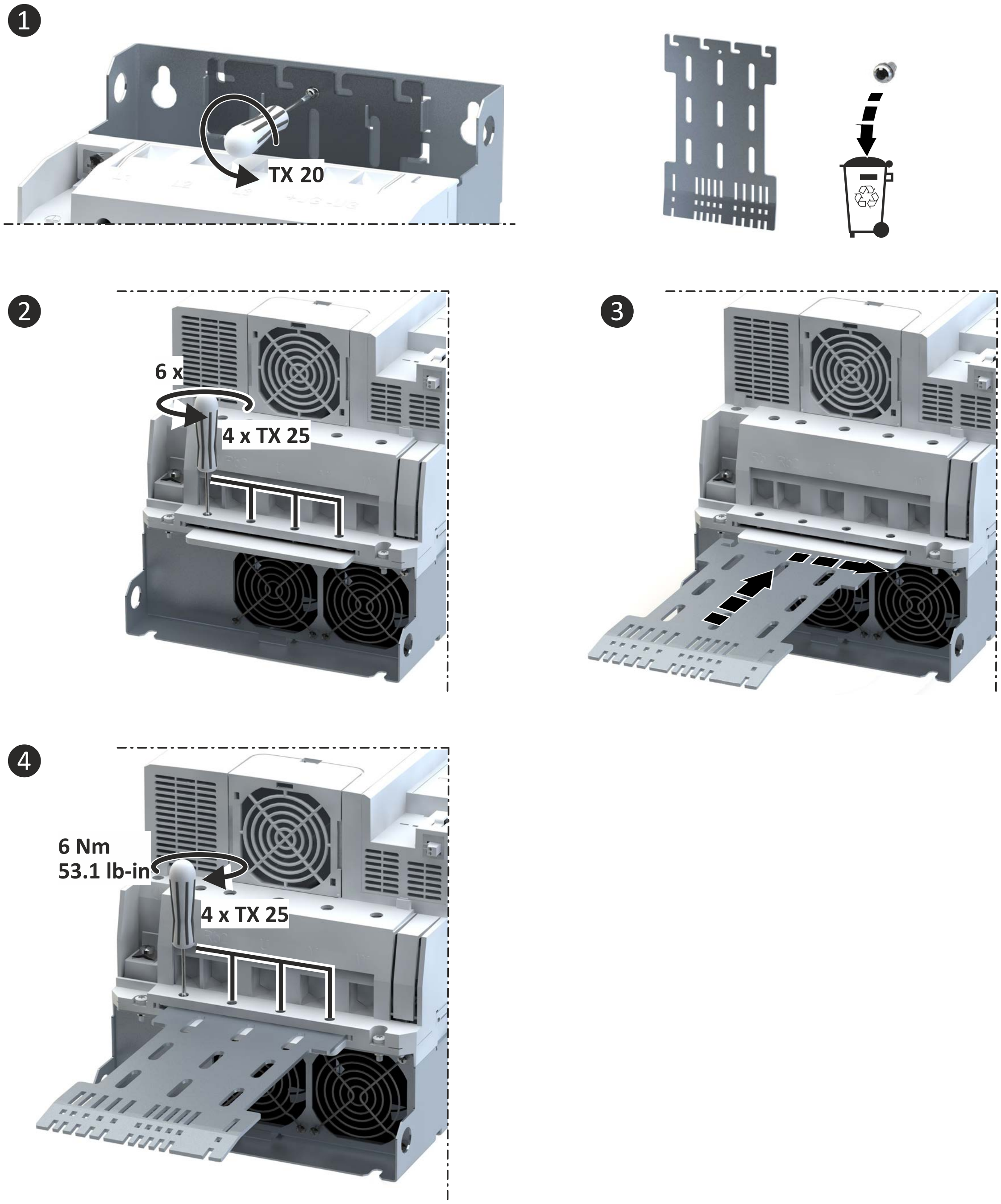
22 kW



30 kW to 45 kW



Installation of shield connection sheet for motor cable 55 kW to 110 kW



Further data and information

▶ Standards and operating conditions 📖 111

EMC-compliant installation

The drive system (inverter and drive) only complies with the directive 2014/30/EU: EMC Directive [UKCA: S.I. 2016/1091 - The Electromagnetic Compatibility Regulations 2016] if it is installed according to the guidelines for CE-typical drive systems.

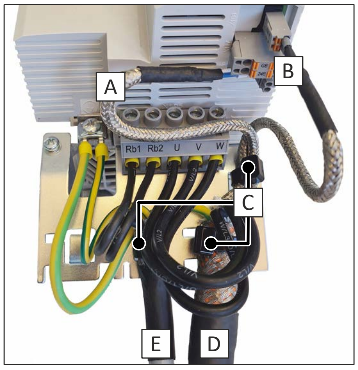
These guidelines should also be followed in installations requiring FCC Part 15 or ICES 001 compliance.

The structure in the control cabinet must support the EMC-compliant installation with shielded motor cables.

- Please use sufficiently conductive shield connections.
- Contact the inverter and accessories (e.g. mains filter) with a large surface area to the grounded mounting plate.

Matching accessories makes effective shielding easier. Shield mounting kit 301

Example: Effective motor-side wiring for one cable technology (OCT)



A	Connecting cable for transferring the OCT protocol
B	Connecting cable for the motor holding brake
C	Shield mounting with cable binders
D	Hybrid cable for motor connection with OCT
E	Connecting cable for the brake resistor

Mains connection

- Inverters, mains chokes, or mains filters may be connected to the mains via unshielded single cores or unshielded cables.
- Cable between line filter and inverter:

	Cable length	
	≤ 300 mm	**> 300 mm**
Type	unshielded twisted option	always shielded

- In DC-bus operation or DC supply, use shielded cables.

DC supply

- In DC-bus operation or DC supply, use shielded cables.

Motor cable

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

Suitable motor cables can be obtained directly from Lenze.

Capacitance per unit length

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

Braid

- Only use motor cables with braids made of tinned or nickel-plated copper.
- Shields made of steel braids are not suitable.
- The overlap rate of the braid must be at least 70 % with an overlap angle of 90 °.

Shield connection

- Apply the shielding to a large surface of the motor shield plate.
- Inverter 0.37 kW ... 15 kW:
  - Shield mounting with cable binders, fixing clips, or wire clamps.
  - Motor shield plate and cable binders are included in the scope of supply.
  - Fixing clips or wire clamps: Shield mounting kit 301.
- Inverter from 22 kW:
  - The motor shield plate is integrated in the inverter.
  - Shield mounting with fixing clips or wire clamps Shield mounting kit 301

Cable for motor temperature monitoring

- Shield the cable for motor temperature monitoring (PTC or thermal contact) and install it separately from the motor cable.
- In Lenze system cables, the shielded cores for the brake control are integrated into the motor cable. If these cores are not used for the brake control, they can also be used to connect the motor temperature monitoring up to max. 50 m system cable length.

Measures on the motor

- Connect the shield with PE over a large area at the terminal box of the motor, e.g. via a metallic EMC cable gland.
- For motors with plug connectors, the large-area shield connection is ensured via the plug connection.

Further supporting measures

- Route the motor cable separately from the mains cables and control cables.
- Lay the motor cable so that it only crosses mains cables and control cables at right angles.
- Do not disconnect the motor cable.
- If the motor cable must be disconnected (e.g. by chokes, contactors, or terminals):
  - Install the shield of the motor cable directly before and behind the point of separation to the mounting plate with a large surface.
  - The unshielded cable ends must not be longer than 100 mm.
  - Mount the separating component at least 100 mm away from other components.

Control cables

- Install the cables so that no induction-sensitive loops arise.
- Distance of shield connections of control cables to shield connections of motor cables and DC cables:
  - At least 50 mm
- Control cables for analog signals:
  - Must always be shielded
  - Connect the shield on one side of the inverter
- Control cables for digital signals:

	Cable length		
	< ca. 5 m	**ca. 5 m ... ca. 30 m**	**> ca. 30 m**
Type	unshielded option	unshielded twisted option	always shielded connected on both sides

Fieldbus cables, networks

Please observe the following recommendations for trouble-free operation, especially in the event of Ethernet-based networks.

- Cables and wiring must meet the specifications and requirements of the network being used to allow reliable operation of the network in typical installations. In this context, also observe the recommendations for action of the respective user organization.
- Lay network cables separately from power cables. Maintain as large a distance as possible to the motor cables which are subject to interference.
- To avoid compensating currents via the shielding of the network cable, install an independent, low-resistance equipotential bonding over the shortest possible distance parallel to the network cable. This applies in particular to long cables.
- Observe bending radii according to manufacturer information. Guide values for minimum bending radii:
  - 10 x cable diameter
  - 20 x cable diameter with frequent movement of the cable
- Fix longer cables 30 cm after the connection point.
- Before leaving the control cabinet, connect the shield of the network cable with the equipotential bonding system (e. g. mounting plate) on a large surface.

Patch cable/CAT5 cables:

- Cables must comply with CAT5 and be suitable for ≥ 10 Mbps.
- CAT5 cables according to specification establish the shield connection via the RJ45 plug connection. Additional shield connections are not required.
- Patch cables of 25 cm length are suitable for the network connection of inverters ≤ 4 kW installed side by side. When wiring from right to left, a sufficient bending radius can be maintained.
- Only certified, tested and fully assembled patch cables from well-known manufacturers are recommended.

RJ45 plug connections:

- RJ45 plug connections only function properly if they are not subjected to mechanical stress or lateral forces.
- For all communication modules of the i-series, the connection of the cable shielding at the RJ45 sockets is carried out as follows:
  - At the first RJ45 socket, the shielding is directly connected to functional earth (FE).
  - At the second RJ45 socket, the shielding is connected to functional earth (FE) via an RC element.

  This measure prevents potential equalization currents and the resulting interference effects (see also IEC 61158-2, section 11.8.7).

  Note: High-frequency interference is dissipated via the low-impedance capacitor to functional earth (FE), but for low-frequency signals this system has a high loop impedance. Measuring systems that use low impedance test signals therefore indicate too high impedance values for the shielding at the second RJ45 socket

Detecting and eliminating EMC interferences

Trouble	Cause	Remedy
Interferences of analog setpoints of your own or other devices and measuring systems	Unshielded motor cable has been used	Use shielded motor cable
	Shield contact is not extensive enough	Carry out optimal shielding as specified
	Shield of the motor cable is interrupted, e. g. by terminal strips, switches etc.	• Separate components from other component parts with a minimum distance of 100 mm • Use motor chokes or motor filters
	Additional unshielded cables inside the motor cable have been installed, e. g. for motor temperature monitoring	Install and shield additional cables separately
	Too long and unshielded cable ends of the motor cable	Shorten unshielded cable ends to max. 40 mm
Conducted interference level is exceeded on the supply side	Terminal strips for the motor cable are directly located next to the supply terminals	Spatially separate the terminal strips for the motor cable from mains terminals and other control terminals with a minimum distance of 100 mm
	Mounting plate varnished	Optimize PE connection: • Remove varnish • Use zinc-coated mounting plate
	HF short circuit	Check cable routing
Malfunctions of the fieldbus communication or exceedance of the permissible interference levels	Shield contact is not extensive enough	Before leaving the control cabinet, connect the shield of the fieldbus cable with the equipotential bonding system (e. g. mounting plate) on a large surface.
	Shield connection on the inverter only	
	Shield of fieldbus cable connected on one side only	Shield connection on both sides

Connection according to UL

Important notes

⚠ WARNING!

- **UL/CSA marking**
- Secondary circuit shall be supplied from an external isolating source.
- Maximum surrounding air temperature is 45 °C.
- Maximum surrounding air temperature with derating is 55 °C.
- **Marquage UL/CSA**
- Le circuit auxiliaire doit être alimenté par une source de tension externe isolée galvaniquement.
- Température ambiante maximale : 45 °C.
- Température ambiante maximale avec dèclassement : 55 °C.

⚠ WARNING!

- **UL marking**
- The supply shall be derived from a non-corner grounded type TN AC source not exceeding 277 V phase to earth.
- **Marquage UL**
- L’alimentation triphasée doit provenir d’une source de type TN ne dépassant pas 277 V entre phase et terre.

⚠ WARNING!

- **UL marking**
- Drives with a rated power of 15kW or more shall be used with line reactor connected in series with AC mains.
- Lenze type designation see table below.
- **Marquage UL**
- Les variateurs ayant une puissance nominale de 15 kW ou plus doivent être utilisés avec une inductance de ligne branchée en série avec le réseau CA.
- Se reporter au tableau ci-dessous pour connaître les désignations de type Lenze.

Inverter	Operating conditions	Line reactor - Lenze type designation		
I95AE315F	400 V 480 V	EZAELN3040 EZAELN3035 EZAELN3025 EZAELN3020	E84AZESR1834	I0FAE315F
I95AE322F	400 V -	EZAELN3063 EZAELN3050 EZAELN3045 EZAELN3040 EZAELN3035	E84AZESM2234	I0FAE322F
I95AE330F	400 V -	EZAELN3080 EZAELN3063 EZAELN3050 EZAELN3045 EZAELN3040	E84AZESM3034	I0FAE330F
I95AE345F	400 V 480 V	EZAELN3100 EZAELN3090 EZAELN3080 EZAELN3063 EZAELN3050	E84AZESM4534	I0FAE345F
I95AE355F	400 V 480 V	EZAELN3125 EZAELN3100 EZAELN3090 EZAELN3080 EZAELN3063	-	I0FAE355F
I95AE375F	400 V 480 V	EZAELN3160 EZAELN3125 EZAELN3100 EZAELN3090	-	I0FAE375F
I95AE390F	400 V 480 V	EZAELN3180 EZAELN3160	-	IOFAE411F
I95AE411F	400 V 480 V	EZAELN3200 EZAELN3180	-	IOFAE411F

⚠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.

⚠WARNING!

- **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 défault. 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) with Standard Fuses or Circuit Breaker

Standard Fault Short Circuit Current Ratings (SCCR)

(Tested per UL 61800-5-1, reference UL file E132659)

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

Inverter				Standard fuses (UL 248)			Circuit breaker (UL 489)			
	Mains	Rated power		SCCR	Max. rated current	Class	SCCR	Max. rated current	Min. cabinet dimensions	
		kW	hp	kA	A		kA	A	m^3	ft^3
i950-C0.37/230-2	230 V, 1/3-ph	0.37	0.5	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C0.55/230-2	230 V, 1/3-ph	0.55	0.75	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C0.75/230-2	230 V, 1/3-ph	0.75	1	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C1.5/230-2	230 V, 1/3-ph	1.5	2	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C2.2/230-3	230 V, 3-ph	2.2	3	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C4.0/230-3	230 V, 3-ph	4	5	65	60	CC, CF, J, T	65	60	0.042	1.48
i950-C5.5/230-3	230 V, 3-ph	5.5	7.5	65	60	CC, CF, J, T	65	60	0.042	1.48
i950-C0.55/400-3	480 V, 3-ph	0.55	0.75	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C0.75/400-3	480 V, 3-ph	0.75	1	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C2.2/400-3	480 V, 3-ph	2.2	3	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C4.0/400-3	480 V, 3-ph	4	5	65	35	CC, CF, J, T	65	25	0.042	1.48
i950-C7.5/400-3	480 V, 3-ph	7.5	10	65	60	CC, CF, J, T	65	60	0.042	1.48
i950-C11/400-3	480 V, 3-ph	11	15	65	60	CC, CF, J, T	65	60	0.042	1.48
i950-C15/400-3	480 V, 3-ph	15	20	65	60	CC, CF, J, T	65	60	0.042	1.48
i950-C22/400-3	480 V, 3-ph	22	30	65	70	CC, CF, J, T	65	70	0.17	6
i950-C30/400-3	480 V, 3-ph	30	40	22	125	CC, CF, J, T	35	125	0.57	20
i950-C45/400-3	480 V, 3-ph	45	60	22	125	CC, CF, J, T	35	125	0.57	20
i950-C55/400-3	480 V, 3-ph	55	75	22	200	CC, CF, J, T	35	200	0.57	20
i950-C75/400-3	480 V, 3-ph	75	100	22	200	CC, CF, J, T	35	200	0.57	20
i950-C90/400-3	480 V, 3-ph	90	125	22	300	CC, CF, J, T	10	300	0.57	20
i950-C110/400-3	480 V, 3-ph	110	150	22	300	CC, CF, J, T	10	300	0.57	20
i950-C130/400-3	480 V, 3-ph	132	180	100	200	CC, CF, J, T	10	350	0.57	20
i950-C160/400-3	480 V, 3-ph	160	200	100	200	CC, CF, J, T	35	200	0.57	20
i950-C200/400-3	480 V, 3-ph	200	250	100	300	CC, CF, J, T	10	300	0.57	20
i950-C250/400-3	480 V, 3-ph	250	320	100	300	CC, CF, J, T	10	300	0.57	20

Branch Circuit Protection (BCP) with Semiconductor Fuses

High Fault Short Circuit Current Ratings (SCCR)

(Tested per UL 61800-5-1, reference UL file E132659)

These devices are suitable for single motor installation when used with Semiconductor Fuses.

Inverter				Alternate fuse (semiconductor fuse)	
	Mains	Rated power		SCCR	Max. rated current
		kW	hp	kA	A
i950-C0.37/230-2	230 V, 1/3-ph	0.37	0.5	100	6
i950-C0.55/230-2	230 V, 1/3-ph	0.55	0.75	100	10
i950-C0.75/230-2	230 V, 1/3-ph	0.75	1	100	16
i950-C1.5/230-2	230 V, 1/3-ph	1.5	2	100	25
i950-C2.2/230-3	230 V, 3-ph	2.2	3	100	35
i950-C4.0/230-3	230 V, 3-ph	4	5	100	63
i950-C5.5/230-3	230 V, 3-ph	5.5	7.5	100	80
i950-C0.55/400-3	480 V, 3-ph	0.55	0.75	100	6
i950-C0.75/400-3	480 V, 3-ph	0.75	1	100	6
i950-C2.2/400-3	480 V, 3-ph	2.2	3	100	20
i950-C4.0/400-3	480 V, 3-ph	4	5	100	35
i950-C7.5/400-3	480 V, 3-ph	7.5	10	100	63
i950-C11/400-3	480 V, 3-ph	11	15	100	80
i950-C15/400-3	480 V, 3-ph	15	20	100	80
i950-C22/400-3	480 V, 3-ph	22	30	100	100
i950-C30/400-3	480 V, 3-ph	30	40	100	125
i950-C45/400-3	480 V, 3-ph	45	60	100	125
i950-C55/400-3	480 V, 3-ph	55	75	100	200
i950-C75/400-3	480 V, 3-ph	75	100	100	200
i950-C90/400-3	480 V, 3-ph	90	125	100	350
i950-C110/400-3	480 V, 3-ph	110	150	100	350
i950-C130/400-3	480 V, 3-ph	132	180	100	200
i950-C160/400-3	480 V, 3-ph	160	200	100	200
i950-C200/400-3	480 V, 3-ph	200	250	100	350
i950-C250/400-3	480 V, 3-ph	250	320	100	350

Approved Manufacturers for Semiconductor Fuses

Manufacturer	Max. rated current	Designation
	A	
Eaton / Cooper Bussmann	6	FWC-6A10F
		FWP-5A14Fa, FWP-5B
	10	FWC-10A10F
		FWP-10A14Fa, FWP-10B
		170M1308, 170M1358, 170M1408
	16	FWC-16A10F
		FWP-15A14Fa, FWP-15B
		170M1309, 170M1359, 170M1409
	20	FWC-20A10F
		FWP-20A14Fa, FWP-20A22F, FWP-20B
		170M1310, 170M1360, 170M1410
	25	FWC-25A10F
		FWP-25A14Fa, FWP-25A22F, FWP-25B
		170M1311, 170M1361, 170M1411
	35	FWC-32A10F
		FWP-32A14Fa, FWP-32A22F, FWP-35B
		170M1312, 170M1362, 170M1412
	63	FWP-63A22F, FWP-60B
		170M1315, 170M1365, 170M1415
	80	FWP-80A22F, FWP-80B
		170M1316, 170M1366, 170M1416
	100	FWP-100A22F, FWP-100B
		170M1317, 170M1367, 170M1417
	125	FWP-125A
		170M1318, 170M1368, 170M1418
	200	FWP-350A, FWP-200A
		170M1320, 170M1370, 170M1420
	350	FWP-350A
Littelfuse	35	L70QS035
	63	L70QS060
	80	L70QS080
	100	L70QS100
	125	L70QS125
	200	L70QS350, L70QS200
	350	L70QS350
Mersen	6	A70QS6-14F, A70QS6-14FI
	10	A70QS10-14F, A70QS10-14FI, A70QS10-22F, A70QS10-22FI
	16	A70QS16-14F, A70QS16-14FI, A70QS15-22F, A70QS15-22FI
	20	A70QS20-14F, A70QS20-14FI, A70QS20-22F, A70QS20-22FI
	25	A70QS25-14F, A70QS25-14FI, A70QS25-22F, A70QS25-22FI
	35	A70QS32-14F, A70QS32-14FI, A70QS32-22F, A70QS32-22FI, A70QS35-4
	63	A70QS63-22F, A70QS63-22FI, A70QS60-4
	80	A70QS80-22F, A70QS80-4, A70QS80-22FI
	100	A70QS100-4, A70QS100-22F, A70QS100-22FI
	125	A70QS125-4, A70QS125-4K
	200	A70QS350-4, A70QS200-4, A70QS200-4K
	350	A70QS350-4

DC Circuit Protection with Semiconductor Fuses

Short Circuit Current Ratings (SCCR) with Semiconductor Fuses

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

Inverter				Alternate fuse (semiconductor fuse)	
	Mains	Rated power		SCCR	Max. rated current
		kW	hp	kA	A
i950-C0.37/230-2	230 V, 1/3-ph	0.37	0.5	50	50
i950-C0.55/230-2	230 V, 1/3-ph	0.55	0.75	50	50
i950-C0.75/230-2	230 V, 1/3-ph	0.75	1	50	50
i950-C1.5/230-2	230 V, 1/3-ph	1.5	2	50	50
i950-C2.2/230-3	230 V, 3-ph	2.2	3	50	50
i950-C4.0/230-3	230 V, 3-ph	4	5	50	100
i950-C5.5/230-3	230 V, 3-ph	5.5	7.5	50	100
i950-C0.55/400-3	480 V, 3-ph	0.55	0.75	50	50
i950-C0.75/400-3	480 V, 3-ph	0.75	1	50	50
i950-C2.2/400-3	480 V, 3-ph	2.2	3	50	50
i950-C4.0/400-3	480 V, 3-ph	4	5	50	50
i950-C7.5/400-3	480 V, 3-ph	7.5	10	50	100
i950-C11/400-3	480 V, 3-ph	11	15	50	100
i950-C15/400-3	480 V, 3-ph	15	20	50	100
i950-C22/400-3	480 V, 3-ph	22	30	50	200
i950-C30/400-3	480 V, 3-ph	30	40	50	250
i950-C45/400-3	480 V, 3-ph	45	60	50	250
i950-C55/400-3	480 V, 3-ph	55	75	50	315
i950-C75/400-3	480 V, 3-ph	75	100	50	315
i950-C90/400-3	480 V, 3-ph	90	125	50	350
i950-C110/400-3	480 V, 3-ph	110	150	50	350

Approved Manufacturers for Semiconductor Fuses

Manufacturer	Max. rated current	Designation
	A	
Eaton / Cooper Bussmann	50	FWP-50A14Fa, FWP-50A22F, FWP-50B
		170M1314, 170M1364, 170M1414, 170M1733, 170M1753
	100	FWP-100A22F, FWP-100B
		170M1317, 170M1367, 170M1417, 170M1736, 170M1756
	200	FWP-200A
		170M1320, 170M1370, 170M1420, 170M1739, 170M1759
	250	FWP-250A
		170M1321, 170M1371, 170M1421, 170M1740, 170M1760
	315	170M1322, 170M1372, 170M1422, 170M1741, 170M1761
	350	FWP-350A
		170M1742, 170M1762
Littelfuse	50	L70QS050
	100	L70QS100
	200	L70QS200
	250	L70QS250
	350	L70QS350
Mersen	50	A70QS50-22F, A70QS50-14F, A70QS50-14FI, A70QS50-22FI, A70QS50-4
	100	A70QS100-4, A70QS100-22F, A70QS100-22FI
	200	A70QS200-4, A70QS200-4K
	250	A70QS250-4
	350	A70QS350-4

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.

In a **DC-system**, several inverters are operated in a network. This enables an energy exchange between motor and generator driven single drives.

▶ DC-bus connection 📖 79

1-phase mains connection 230/240 V

The connection plan is valid for the inverters i950-Cxxx/230-2.

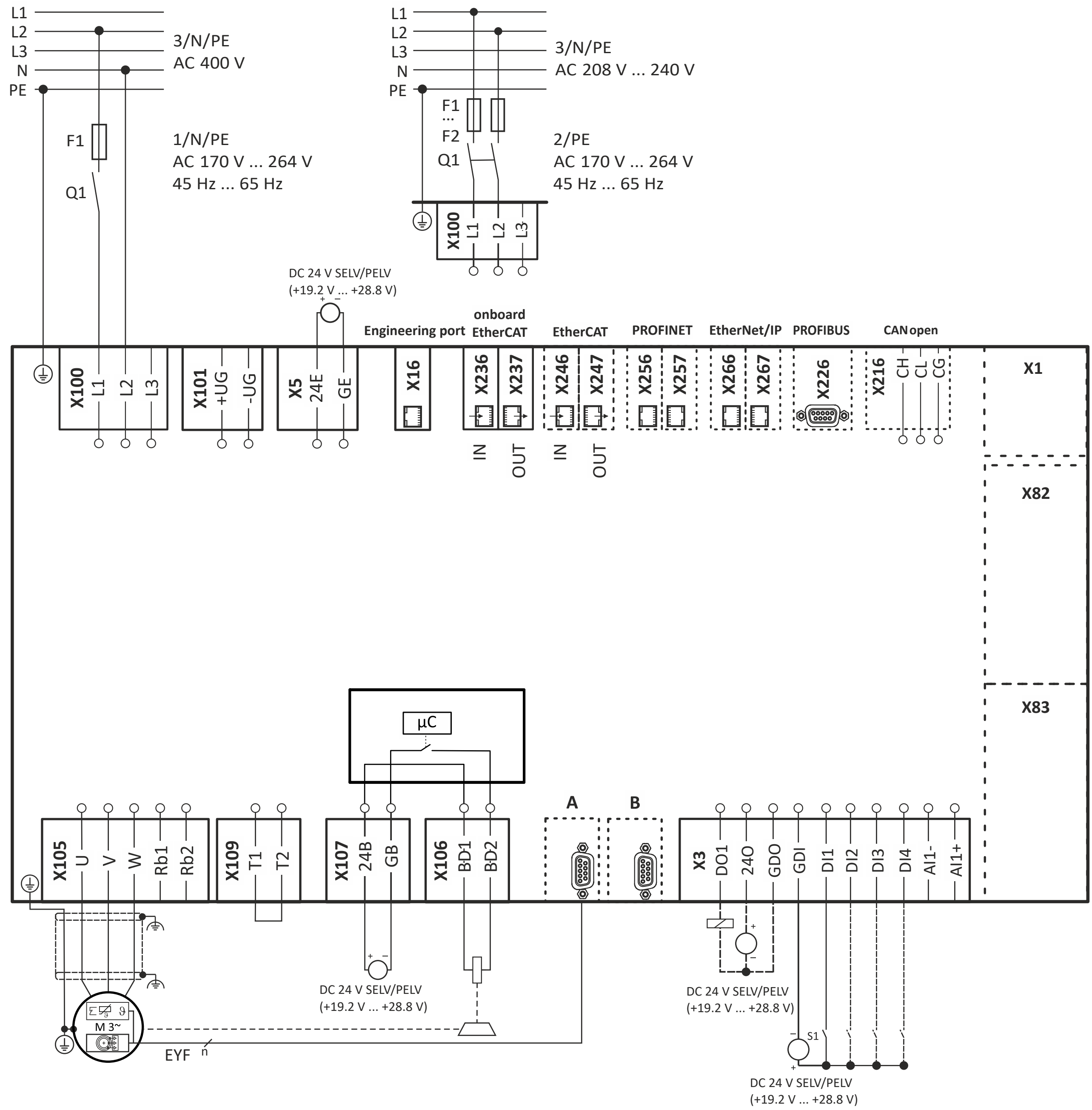


Fig. 2: Wiring example

S1	Start/stop	EYF	Lenze system cable
Fx	Fuses	---	Dashed line = options
Q1	Mains contactor		

A connection diagram for the terminal X1 can be found under: ▸ Basic Safety - STO 📖 105

A connection plan for the terminals X82 and X83 can be found under: ▸ Extended Safety 📖 108

3-phase mains connection 230/240 V

The connection plan is valid for the inverters i950-Cxxx/230-3 and i950-Cxxx/230-2.

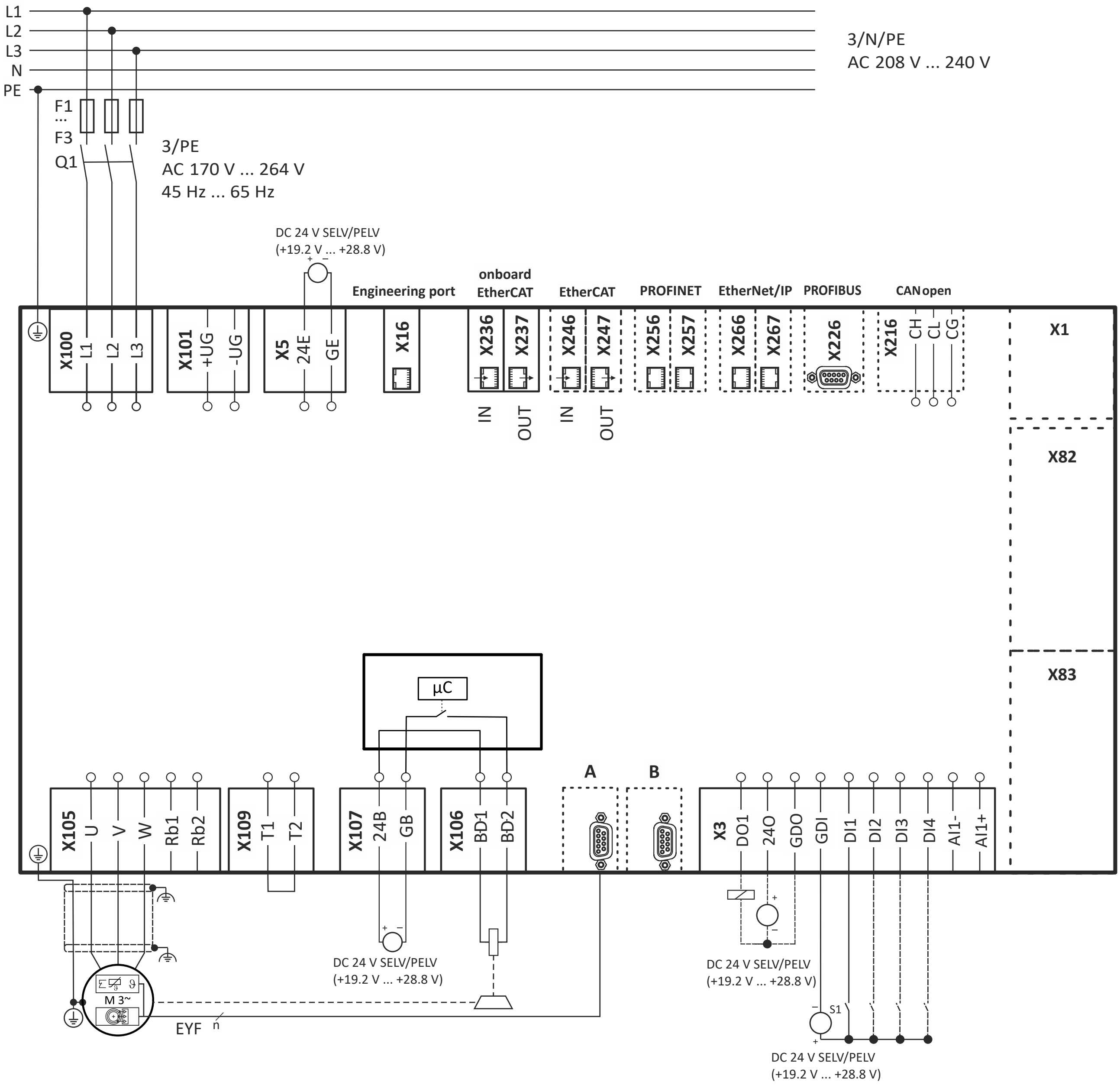


Fig. 3: Wiring example

S1	Start/Stop	EYF	Lenze system cable
Fx	Fuses	---	Dashed line = options
Q1	Mains contactor		

A connection diagram for the terminal X1 can be found under: ▶ Basic Safety - STO 🕮 105

A connection plan for the terminals X82 and X83 can be found under: ▶ Extended Safety 🕮 108

3-phase mains connection 400 V

A mains choke is required for the operation of inverters ≥ 15 kW.

The connection plan is valid for the inverters i950-Cxxx/400-3.

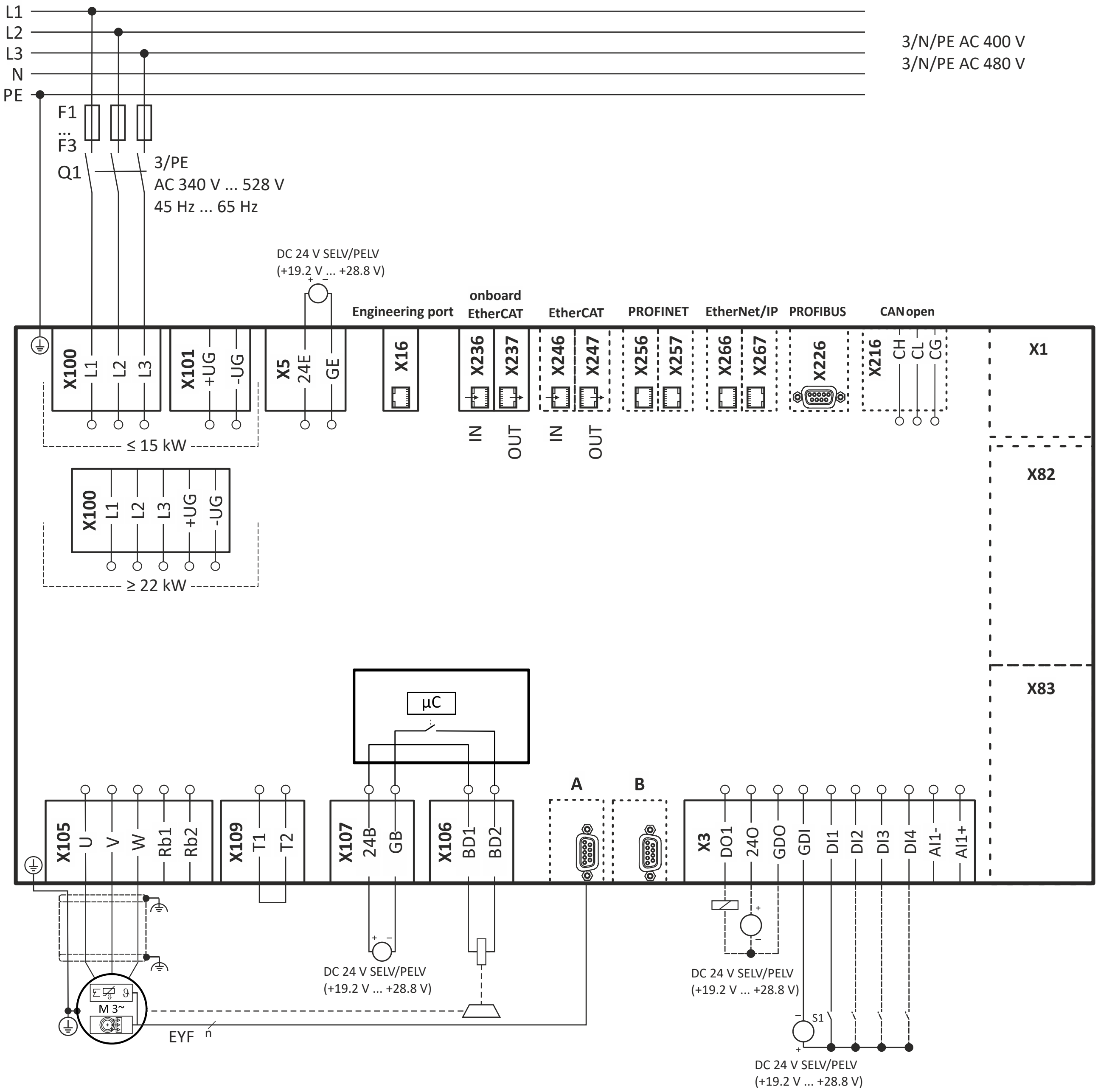


Fig. 4: Wiring example

S1	Start/Stop	EYF	Lenze system cable
Fx	Fuses	---	Dashed line = options
Q1	Mains contactor		

A connection diagram for the terminal X1 can be found under: ▶ Basic Safety - STO 📖 105

A connection plan for the terminals X82 and X83 can be found under: ▶ Extended Safety 📖 108

3-phase mains connection 480 V

A mains choke is required for the operation of inverters ≥ 15 kW.

The connection plan is valid for the inverters i950-Cxxx/400-3.

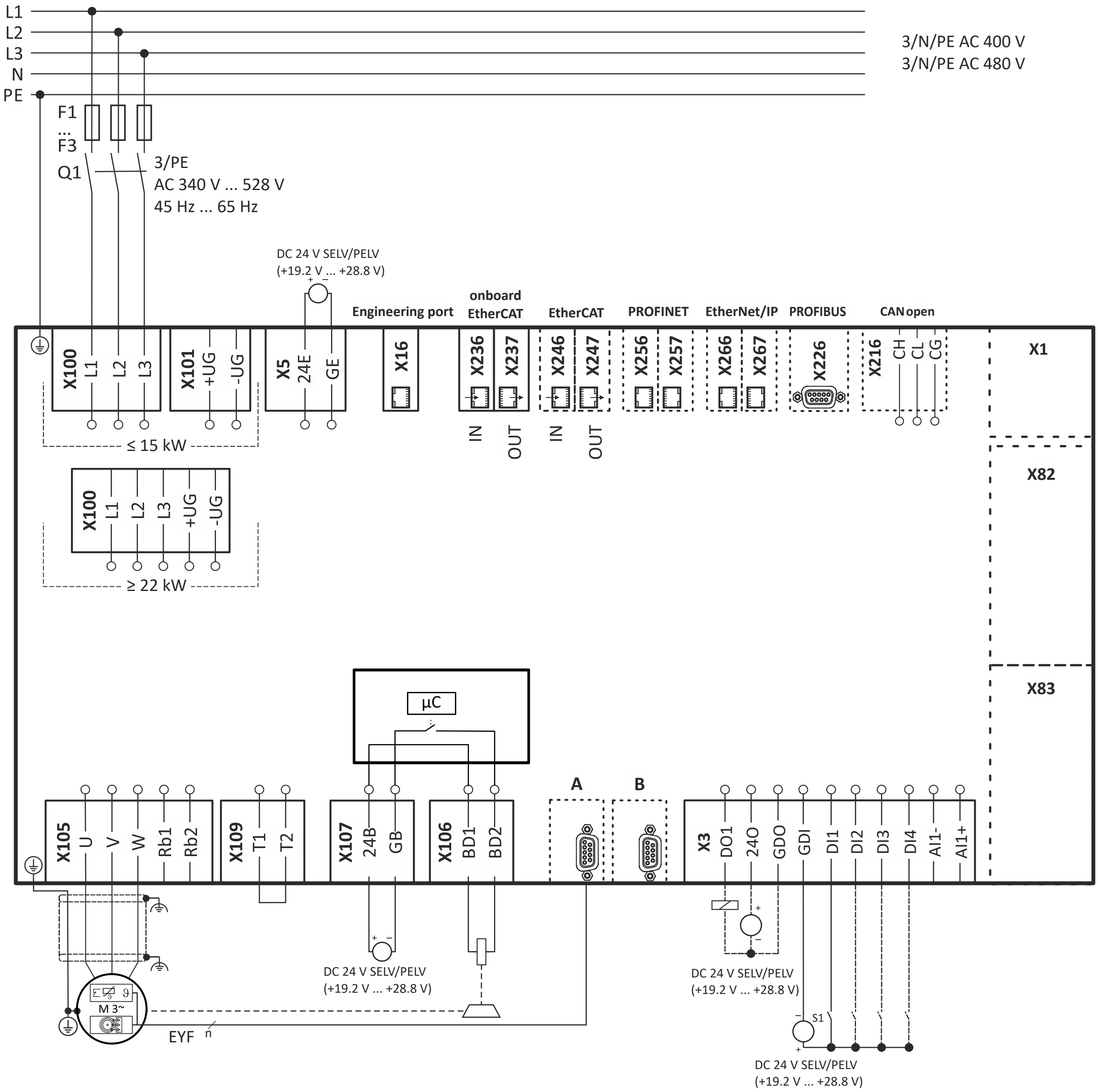


Fig. 5: Wiring example

S1	Start/Stop	EYF	Lenze system cable
Fx	Fuses	---	Dashed line = options
Q1	Mains contactor		

A connection diagram for the terminal X1 can be found under: ▶ Basic Safety - STO 📖 105

A connection plan for the terminals X82 and X83 can be found under: ▶ Extended Safety 📖 108

The wiring diagram for terminal X104 applies to the inverters i950-Cxxx/400-3 in the power range of 132 kW ... 160 kW.

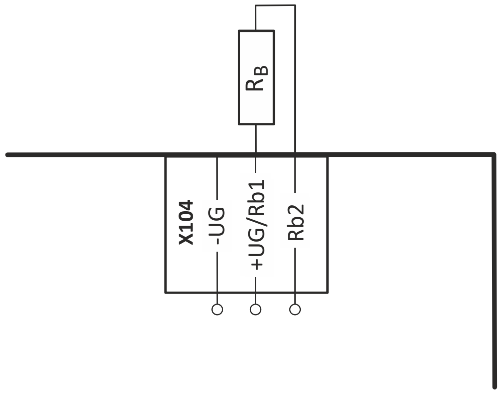


Fig. 6: Wiring example

The wiring diagram for terminal X104 applies to the inverters i950-Cxxx/400-3 in the power range of 200 kW ... 250 kW.

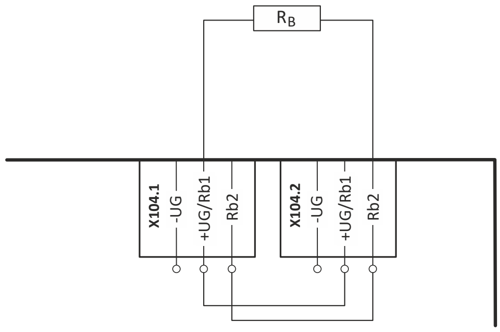


Fig. 7: Wiring example

On the I95xE42xF device, terminal X104 is located in the upper section under the protection cover.

The unit comes from the factory with bridges installed for the operation of a brake resistor. If the device is to be operated in a DC bus connection, the -UG bridge must still be set.

DC-bus connection

If several inverters are operated in a DC bus network, energy can be exchanged between single drives operating in motor mode and generator mode. Groups of inverters are connected to the DC bus.

Preconditions:

- The inverters must have a suitable connection option, e.g., terminal +UG/-UG.
- The inverters connected to the DC bus must be designed for the same DC-bus voltage and have the same number of phases on the mains side.
- The cables for the DC-bus wiring (+UG/–UG) must be selected so that, in the event of a fault (short circuit, earth fault), upstream fuses interrupt the supply voltage. Alternatively, short-circuit-proof wiring in accordance with DIN VDE 0100-520:2013-06 must be ensured in order to prevent short circuits or earth faults.

The DC network can be provided by power supply modules (AC/DC inverters) or inverters with power reserve. The technical data provides information about the possible applications.

Only careful design will enable trouble-free operation of the inverters in the DC-bus network.

Further information can be found in the Application Knowledge Base.

AKB article "Information on i950 interconnected operation"

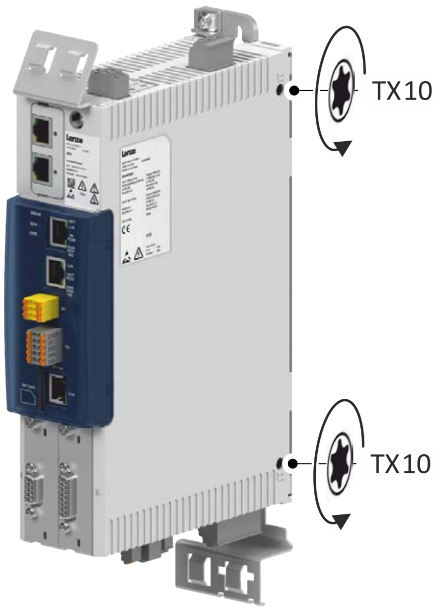
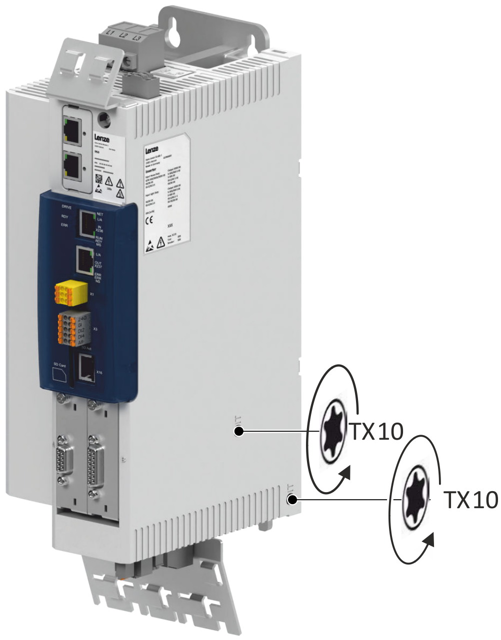
Connection to the IT system

NOTICE

Internal components have earth/ground potential

Possible consequences: The monitoring devices of the IT system will be triggered.

- ▶ Upstream an isolation transformer.
- ▶ Before connection to an IT system be absolutely sure to remove the screws labeled with "IT" on the product.

I95xE137D, I95xE155x, I95xE175x, I95xE215D, I95xE222x, I95xE240F	I95xE240C, I95xE255C, I95xE275F, I95xE311F, I95xE315F
	

I95xE322F

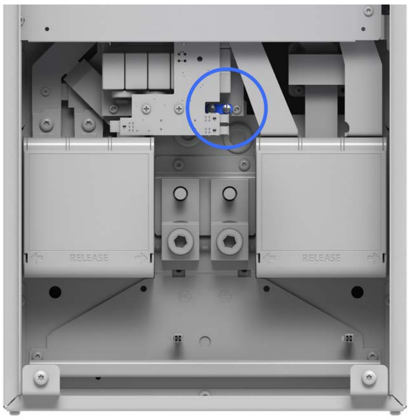

I95xE330F, I95xE345F	I95xE355F, I95xE375F
	

I95xE390F, I95xE411F

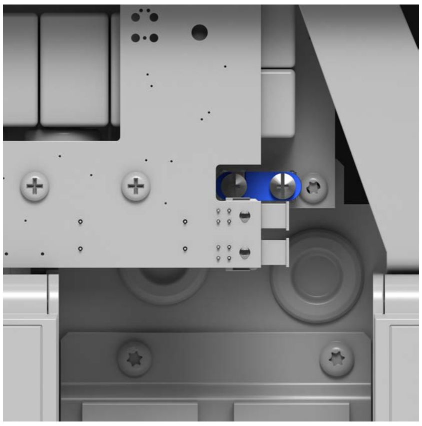

I95xE413F

This disconnects the internal connection between the filter and the protective earth.

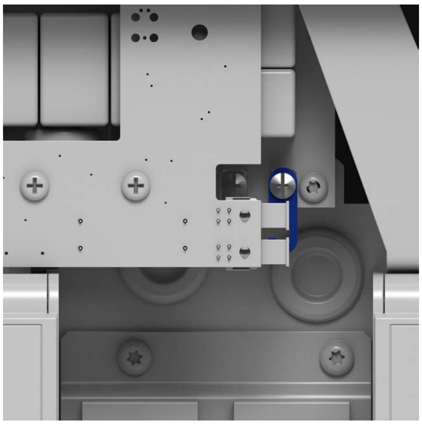
- The bridge is located in the center, above the mains and motor cable terminals.



- Loosen both screws with a Phillips screwdriver (PH2). (Do not remove them.)



- Fold the bridge down 90 degrees counterclockwise.



- Tighten both screws again.
  - Tightening torque: 3.4 Nm (30 lb-in)

I95xE416F, I95xE420F

This disconnects the internal connection between the filter and the protective earth.

- The bridge is located to the left, upstream from the mains connection.

- Loosen both screws using a Phillips screwdriver (PH2). (Do not remove them.)

- Fold the bridge upward 180 degrees in a clockwise direction.

- Tighten both screws again.
  - Tightening torque: 3.4 Nm (30 lb-in)

I95xE425F

If devices of this size are to be used in IT networks, appropriate measures must be taken at the factory. Please keep this in mind when placing your order and contact your sales representative for more information.

Motor connection

Only use motors suitable for the inverter operation.

Insulation resistance (EN 60034): max. û ≥ 1.5 kV, max. du/dt ≥ 5 kV/µs

Motor cable lengths

- The rated data for the length of the motor cable must be observed .
- Keep the motor cable as short as possible, as this has a positive effect on drive performance and EMC.

Switching in the motor cable

Some applications require switching on the motor side of the inverter. Switching on the motor side of the inverter is permitted if you observe the following basic conditions.

Preconditions:

- The switching elements on the motor side must be dimensioned for with the maximum occurring loads.
- Connect the shield of the motor cable to the mounting plate immediately before and after the switching element in an EMC-compliant manner.

Possible applications:

- Galvanic isolation of the motor from the inverter
  - A controller must ensure that the switching element in the motor cable does not switch until the inverter is inhibited.
- Operation of several motors on one inverter in V/f characteristic control mode
  - Monitoring functions of the inverter for motor protection (e.g. i²xt) cannot be used.
  - Ensure temperature monitoring of all motors by external measures.
  - Disable the inverter when overload protection and cable protection in the individual motor cables respond. Do not disconnect the motor circuit.

Please note the following:

- If switching is performed on the motor side when the inverter is enabled, error messages can be triggered.
- It is not possible to predict whether an error message will be triggered or not. This can only be determined by testing under real operating conditions.
- Error messages to be expected:
  - Overcurrent
  - Motor phase failure

Rated power	**shielded**	**unshielded**
P_{rated}		
0.37 ... 4 kW	50 m	100 m
7.5 ... 15 kW	100 m	200 m
22 ... 45 kW	100 m	200 m
55 ... 110 kW	200 m	400 m
The maximum length of the motor cable when using HIPERFACE DSL® (OCT) is 100 m.		

Connection of motor temperature monitoring

In the default setting, the motor temperature monitoring is active! By default, a wire jumper is installed between the terminals T1 and T2. Before connecting a thermal sensor, remove the wire jumper.

Terminal X109 can be used with inverters < 22 kW either for temperature monitoring with PTC/thermal contact or for One Cable Technology (OCT).

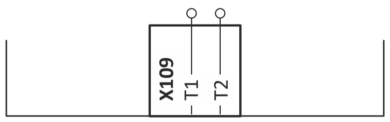
▶ One Cable Technology (OCT) 🕮 97

The inverter can optionally be outfitted with a module for motor feedback (motor encoder). In this case, it is not necessary to connect an external PTC thermistor (PTC) or a thermal contact, since temperature monitoring is already integrated in the motor feedback module.

▶ Product extensions, Motor encoder evaluation 🕮 188

If the terminal X109 is used, e. g. to connect an external PTC thermistor (PTC) or a thermal contact, ensure at least one basic insulation to the potentials of motor, mains and control terminals to not restrict the safe separation of the control terminals.

Use	Connection of PTC or thermal contact
Connection	Terminal X109: T1 Terminal X109: T2
Sensor types	PTC single sensor (DIN 44081) PTC triple sensor (DIN 44082) Thermal contact



Connection			**PTC, thermal contact, OCT**
Connection designation			**X109**
Connection system			Screw terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	6
Stripping length		in	0.24
Required tools			Screwdriver 0.4 x 2.5

Motor holding brake connection

The inverter is designed for 24 V brakes. A motor holding brake is connected to X106 and supplied via X107.

⚠ DANGER!

Loss of the safe isolation

Safe isolation of the control card from the mains potential is deactivated when the motor and motor holding brake are connected via a system cable AND X5 and X107 are supplied by a common power supply unit. This also applies when using a SELV/PELV power supply unit.

Possible consequences: Electric shock in the event of a fault.

► Supply X107 and X5 by separate SELV/PELV power supply units if the motor and motor holding brake are connected via a system cable.

X107 and X5 can be supplied by a common SELV/PELV power supply unit if the motor and motor holding brake are connected via safely isolated installed cables.

When the motor holding brake is open, a slight knocking sound can be noticed in the motor. This stems from test pulses for monitoring the motor brake control.

Functions for controlling motor holding brakes:

- Recognition of the brakes
- Default setting of motor torque
- Manual mode
- Automatic mode
- Logical inversion

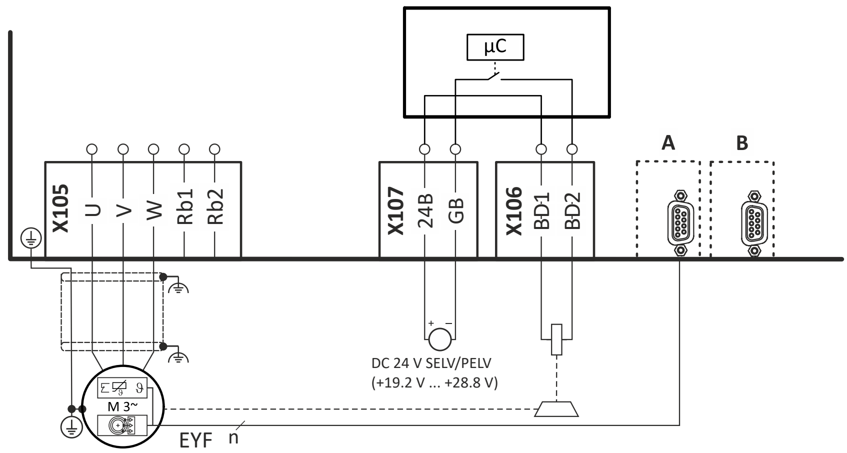


Fig. 8: Connection diagram - motor holding brake

Connection data

Motor holding brake

Connection			Motor holding brake	
Connection designation			**X106**	
Pin designation			BD1, BD2	Controlling a motor holding brake with or without brake voltage reduction
Level		V	LOW: < +5, HIGH: > +15	
Max. output current ≤ 15 kW		A	2.5	
> 15 kW		A	5.0	
Cycle time		ms	1	
Short-circuit-proof			Unlimited period	
Suppressor circuit			Integrated freewheeling diode and spark suppressor	
Max. breaking energy ≤ 15 kW		Ws	5	
> 15 kW		Ws	20	
Max. Switching rate			6/min. at max. output current	Depending on the output current: Switching frequency doubles if the output current is halved
Insulation			Basic insulation	Connection via system cable
			Double/reinforced insulation	Connection via separated cable

24 V supply for motor holding brake

Connection			24 V supply for motor holding brake	
Connection designation			**X107**	
Pin designation			24B, GB	DC supply of X106
External power supply unit specification			SELV/PELV	
Rated input voltage		V	+24 ± 20 %	
Max. Input current ≤ 15 kW		A	2.5	Typical: according to the load at X106
> 15 kW		A	5.0	
Polarity reversal protection			Yes	
Suppressor circuit			Yes	Suppressor diode 30 V, bidirectional

Connection			Motor holding brake	24 V supply for motor holding brake
Connection designation			**X106**	**X107**
Connection system			Spring terminal	Spring terminal
Connection type			Pluggable	Pluggable
Double (Daisy Chain)			No	Yes
Max. cable cross-section		mm²	1.5	2.5
Max. cable cross-section		AWG	16	14
Min. cable cross-section		mm²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	10	12
Stripping length		in	0.4	0.47
Required tools			Screwdriver 0.4 x 2.5	Screwdriver 0.6 x 3.5

Brake resistor connection

⚠WARNING!

Possible overheating of the brake resistor during operation

Insufficient heat dissipation and incorrect connection of the thermal contact can cause the brake resistor to overheat during operation.

Possible consequences: The brake resistor becomes very hot or is destroyed. The drive is not braked but coasts down. Sensitive components can be overheated by the brake resistor.

- ► Always connect the thermal contact of the brake resistor and integrate it into the system monitoring so that the mains supply (e.g. mains contactor) of the inverter is switched off if the brake resistor overheats.
- ► The shutdown by the built-in thermal contact must be provided with an acknowledgement function that prevents the drive from restarting automatically.
- ► Before acknowledging and recommissioning, check that the brake resistor is in perfect condition!
- ► Do not recommission brake resistors damaged by thermal overload! If you are unsure about the condition, please contact the Lenze Service.
- ► Do not place any flammable objects below the brake resistor.

NOTICE

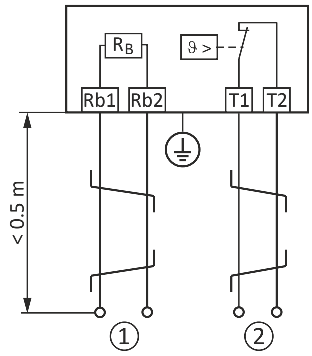
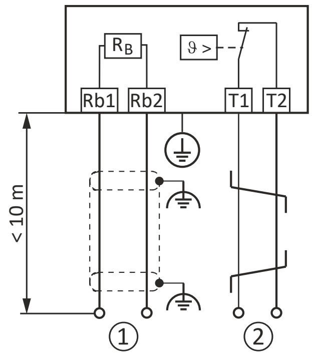
Use of intrinsically safe brake resistors

In the case of brake resistors that are not unsafe in the event of thermal overload, i.e. whose behavior is “intrinsically safe”, no separate temperature monitoring (thermal contact) and no control of the mains contactor is required.
The intrinsically safe brake resistor can be destroyed in the event of thermal overload (e.g. short circuit of the brake transistor). This interrupts the energy flow. If it is permanently energized (due to a fault), there is no danger, provided it has been installed in accordance with the mounting instructions.

Preconditions

- The cables for connecting the brake resistor (Rb1/Rb2) must be selected so that upstream fuses interrupt the supply voltage in the event of an error (short circuit or earth fault). Or there must be short-circuit-proof wiring in accordance with DIN VDE 0100-520:2013-06, which excludes a short circuit or earth fault.

General connection diagram for brake resistors with thermal contact and for intrinsically safe brake resistors

<table>
<tr><th>Short connection cables up to 0.5 m</th><th>Long connection cables up to max. 10 m</th></tr>
<tr><td>Up to a cable length of 0.5 m, the cable for the brake resistor and that of the temperature monitoring can be twisted. Doing so reduces problems due to EMC interference.

</td><td>The cable of the brake resistor must be shielded.
The maximum length is 10 m.
Twisting is sufficient for the temperature monitoring cable.

</td></tr>
<tr><td colspan="2">① Wiring to the "brake resistor" connection on the component with brake chopper.
② Wiring to a control contact that is set to monitor the thermal contact.
If the thermal contact responds, the voltage supply to the component with brake chopper must be disconnected (e.g. switch off the control of the mains contactor).</td></tr>
</table>

To connect the brake resistor:

1. Disconnect the basic device from the power supply and check that all power terminals are free of voltage.
2. Depending on the type of brake resistor:
   a) Remove the terminal cover on the brake resistor.
   b) Pull cables through cable glands.
3. Connection variant 1: **Short connection cables up to 0.5 m**
   a) Use twisted cable.
   b) For brake resistors with pre-assembled cables, twist the connecting cable.
4. Connection variant 2: **Long connection cables up to max. 10 m**
   a) Use shielded cable.
   b) For brake resistors with pre-assembled cables, shorten the connection cable to ≤ 10 cm and connect it to external terminals. Lay shielded cables from there.
5. Connect cores to the brake resistor at terminals RB1 and RB2.
   a) Observe the tightening torque according to the data and dimension sheets, which can be found under Lenze Support.
   b) In the case of shielded cables and cable glands, the shield must be firmly connected to the cable gland over a large area.
6. Connect cores to the inverter at terminals X105/Rb1 and X105/Rb2. For shielded cables, connect the shield to the inverter.
7. Connect thermal contact for safety shutdown:
   a) Use twisted cable and connect the cores to the terminals T1 and T2 on the brake resistor. Observe the tightening torque according to the data and dimension sheets, which can be found under Lenze Support.
   b) Integrate the thermal contact into the system monitoring in such a way that the power supply is switched off if the brake resistor overheats.
8. Perform PE connection in accordance with EN 61800-5-1.
9. Depending on the type of brake resistor:
   a) Mount the terminal cover on the brake resistor.
   b) Tighten cable glands.
   c) Apply a sticker with the safety note “Hot surface” in a clearly visible location near the device.

Supply voltage connection

An external 24 V supply voltage to X5:24E/GE is necessary for supplying the control electronics.

If the control electronics are supplied independently of the AC grid of the inverter, the inverter can also be configured when the AC grid is turned off. Communication via existing networks also remains available.

An external 24 V supply voltage to X5:24E/GE is necessary for supplying the control electronics.

⚠ DANGER!

Loss of the safe isolation

Safe isolation of the control card from the mains potential is deactivated when the motor and motor holding brake are connected via a system cable AND X5 and X107 are supplied by a common power supply unit. This also applies when using a SELV/PELV power supply unit.

Possible consequences: Electric shock in the event of a fault.

► Supply X107 and X5 by separate SELV/PELV power supply units if the motor and motor holding brake are connected via a system cable.

Device series			**I950**
Connection			**24 V supply for control electronics**
Connection designation			**X5**
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			Yes
Max. cable cross-section		mm²	2.5
Max. cable cross-section		AWG	14
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	12
Stripping length		in	0.47
Required tools			Screwdriver 0.6 x 3.5

Control connections

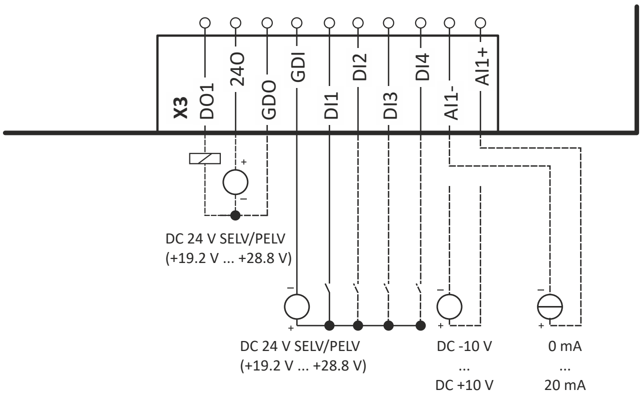


Fig. 9: Wiring diagram of control connections

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).

Connection			**Control signals (I/O)**		
Connection designation			**X3**	**X4**	**X17**
Connection system			Spring terminal	Spring terminal	Spring terminal
Connection type			Pluggable	Pluggable	Pluggable
Double (Daisy Chain)			No	No	No
Max. cable cross-section		mm²	1.5	1.5	1.5
Max. cable cross-section		AWG	16	16	16
Min. cable cross-section		mm²	0.25	0.25	0.25
Min. cable cross-section		mm²	22	22	22
Stripping length		mm	10	10	10
Stripping length		in	0.4	0.4	0.4
Required tools			Screwdriver 0.4 x 2.5		

Motor encoder connection

The maximum permissible lengths for feedback cables must be observed:
- Resolver: 150 m
- Encoder: 100 m

Resolver

The inverter can optionally be equipped with a module for resolver evaluation.

Prefabricated system cables are available for the connection between motor and inverter.

Details:

▶ Product extensions, Resolver 📖 192

Pin assignment of resolver connection

Connection	Connection description	Connection type	Pin	Resolver
X7	Resolver	Sub-D, 9-pole	1	+REF
			2	- REF
			3	n.c.
			4	+COS
			5	-COS
			6	+SIN
			7	-SIN
			8	TEMP+
			9	TEMP-

Incremental encoders and absolute value encoders

The inverter can optionally be equipped with a module for evaluating various encoders.

Prefabricated system cables are available for the connection between motor and inverter.

Details:

▶ Product extensions, Incremental encoders and absolute value encoders 🕮 189

Pin assignment of incremental encoder

Connection designation	Connection	Connection system	Pin	Type	
				SinCos	TTL
				incremental	incremental
X8	Incremental encoder	Sub-D, 15-pole	1	COS	A
			2	GND	GND
			3	SIN	B
			4	Vcc	Vcc
			5	Z	Z
			6	n.c.	n.c
			7	TEMP-	TEMP-
			8	n.c.	n.c.
			9	REFCOS	/A
			10	n.c.	n.c.
			11	REFSIN	/B
			12	n.c.	n.c.
			13	/Z	/Z
			14	TEMP+	TEMP+
			15	n.c.	n.c.

An HTL encoder can be connected to the Extended-IO extension module.

▶ Product extensions, I/O extensions, Extended I/O 🕮 185

Pin assignment - absolute value encoder

Connection designation	Connection	Connection system	Pin	Type		
				HIPERFACE®	SSI	SinCos+SSI
				absolute	absolute	absolute
X8	Absolute value encoder	Sub-D, 15-pole	1	COS	n.c	COS
			2	GND	GND	GND
			3	SIN	n.c	SIN
			4	Vcc	Vcc	Vcc
			5	DATA+	DATA+	DATA+
			6	n.c.	n.c.	n.c.
			7	TEMP-	TEMP-	TEMP-
			8	n.c.	CLOCK+	CLOCK+
			9	REFCOS	n.c.	REFCOS
			10	n.c.	n.c.	n.c.
			11	REFSIN	n.c.	REFSIN
			12	n.c.	n.c.	n.c.
			13	DATA-	DATA-	DATA-
			14	TEMP+	TEMP+	TEMP+
			15	n.c.	CLOCK-	CLOCK-

Pin assignment - absolute value encoder EnDat

Connection designation	Connection	Connection system	Pin	Type	
				EnDat 2.1	EnDat 2.2
				absolute	absolute
X8	Absolute value encoder	Sub-D, 15-pole	1	A+	n.c.
			2	GND	GND
			3	B+	n.c.
			4	Vcc	Vcc
			5	DATA+	DATA+
			6	n.c.	n.c.
			7	TEMP-	TEMP-
			8	CLOCK+	CLOCK+
			9	A-	n.c.
			10	GND	GND
			11	B-	n.c.
			12	Vcc	Vcc
			13	DATA-	DATA-
			14	TEMP+	TEMP+
			15	CLOCK-	CLOCK-

One Cable Technology (OCT)

Preconditions

- One Cable Technology (OCT) is available only on <22 kW devices.
- The One Cable Technology (OCT) is possible with MCS and m850 servo motors.
- The motor must be equipped with an encoder. It must support the protocol being used.
- Make sure that no motor encoder module is plugged in slot A.
- System cable:
  - The OCT motor cable EYP008xxxxxxM11A00 or EYP008xxxxxxM12A00 must be used.
  - Different lengths up to 100 m are available. System cables 303
  - The hybrid cables have only basic insulation to the performance electronics.

Application range

- HIPERFACE DSL®:
  - Until device firmware V1.5.x: Only together with the "Basic Safety - STO" device variant.
  - From device firmware V1.6.x: Together with the "Basic Safety - STO" and "Extended Safety" device variants.
- EnDat 3:
  - Starting with device firmware V2.0.x; only when used with the "Basic Safety - STO" device variant

Cable preparation

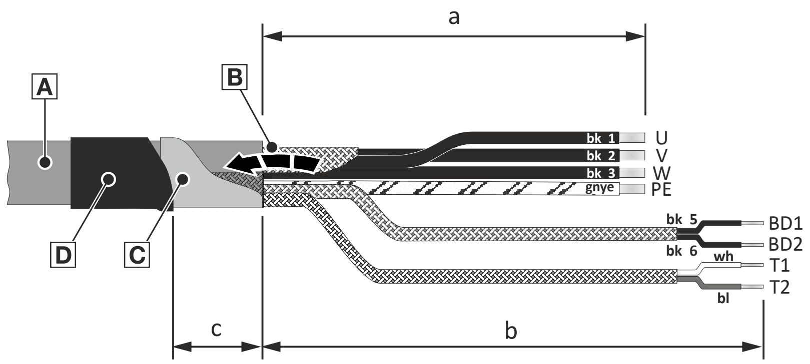


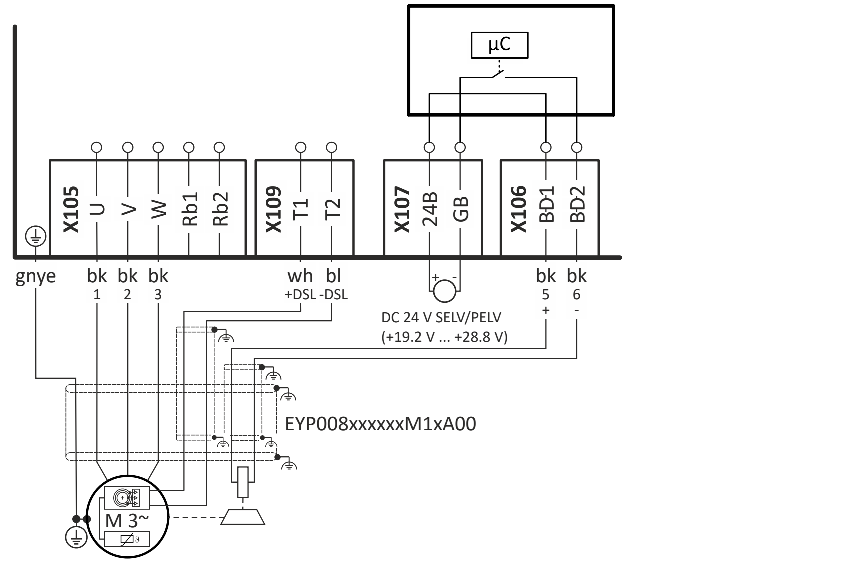
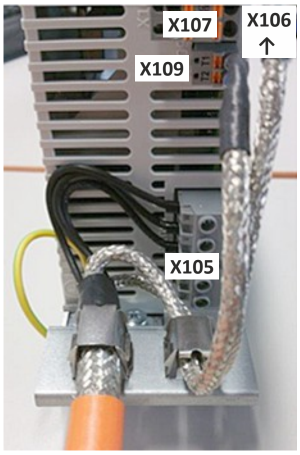
Fig. 10: Cable assembly

A	Hybrid cable	C	Conductive foil
B	Shield	D	Heat-shrinkable tube

Inverter			**I95AE**									
			137D	**155D**	**175D**	**215D**	**222C**	**240C**	**255C**			
				155F	**175F**		**222F**	**240F**		**275F**	**311F**	**315F**
Rated power	P_N	**kW**	**0.37**	**0.55**	**0.75**	**1.5**	**2.2**	**4**	**5.5**	**7.5**	**11**	**15**
Rated power	P_N	**HP**	**0.5**	**0.75**	**1**	**2**	**3**	**5**	**7.5**	**10**	**15**	**20**
Stripping length	a	mm	100						140			
	b	mm	200						220			
	c	mm	25						30			

Connection diagram and shield connection

Connect all shields with a large surface and fix it with cable ties or fixing clips.

Connection diagram One Cable Technology (OCT)	Shield connection
	

Connection			PTC, thermal contact, OCT
Connection designation			**X109**
Connection system			Screw terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	6
Stripping length		in	0.24
Required tools			Screwdriver 0.4 x 2.5

Load encoder/master encoder connection

The inverter can optionally be outfitted with a module for position feedback. This is used to realize application feedback via a load encoder or master encoder.

Prefabricated system cables are available for the connection between motor and inverter.

Available modules:

The same modules are used for the load encoder/master encoder as for the motor encoder.

▶ Product extensions, Motor encoder evaluation 📖 188

Networks connection

When planning networks, consider the recommendations listed in the chapter "EMC-compliant installation" for low-interference operation, especially of Ethernet-based networks.

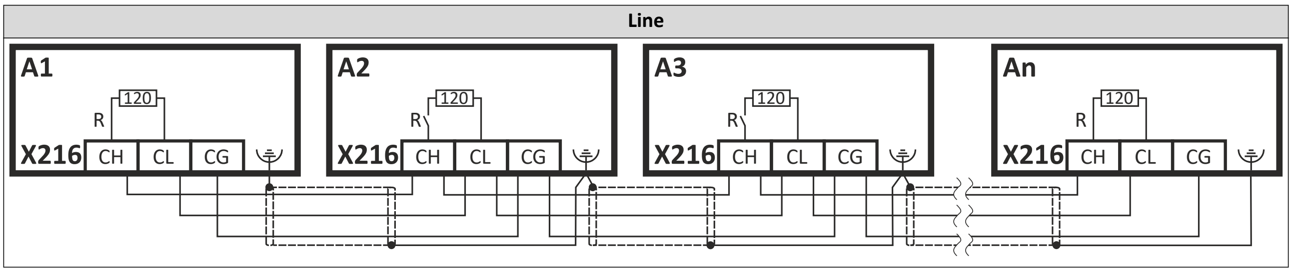
EMC-compliant installation → Fieldbus cables, networks 64

CANopen

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

To do this, set the jumper to the "R" position on the plug connector.

Typical topologies



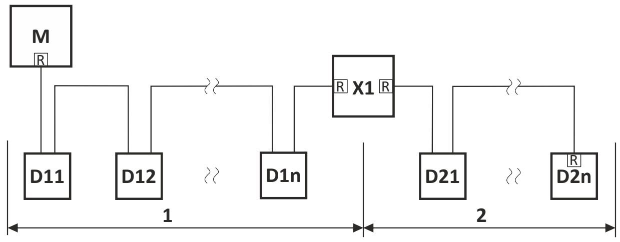
Connection			CANopen
Connection designation			**X216**
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			Yes
Max. cable cross-section		mm²	2.5
Max. cable cross-section		AWG	14
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	24
Stripping length		mm	12
Stripping length		in	0.47
Required tools			Screwdriver 0.6 x 3.5

PROFIBUS

The network must be terminated with a resistor at the physically first and last node.
Activate the bus terminating resistor at these nodes in the bus connection plug.

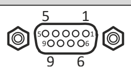
Typical topologies

Line with repeater



M	Master	X	Repeater
D	Device	R	Activated bus terminating resistor

Sub-D socket, 9-pole - X226

View	Pin	Assignment	Description
	1	n.c.	
	2	n. c.	
	3	RxD/TxD-P	Data line-B (received data/transmitted data +)
	4	RTS	Request To Send (received data/transmitted data, no differential signal)
	5	M5V2	Reference potential (bus terminating resistor -)
	6	P5V2	5 V DC / 30 mA (bus terminating resistor +, OLM, OLP)
	7	n. c.	
	8	RxD/TxD-N	Data line-A (received data/transmitted data -)
	9	n. c.	

onboard EtherCAT

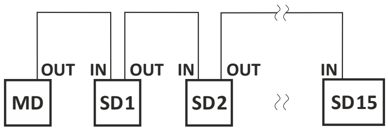
The standard onboard EtherCAT connection provides EtherCAT as the standard bus system of the inverter. Due to the synchronization mechanism, the "distributed clocks" and the short cycle times, it offers excellent real-time properties. This enables highly accurate synchronization of the connected devices.

Typical use:

- Connecting the inverter as Distributed Clocks (DC)-capable EtherCAT slave for process and safety data (FSoE) under a standard EtherCAT motion control
- Connecting the inverter to the EtherCAT system bus.

Typical topologies

Line



M Master
SD Slave Device

Connection			onboard EtherCAT	
Connection designation			**X236**	**X237**
Connection type			RJ45	

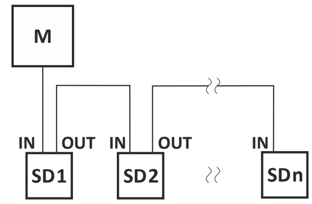
Bus-related information			
Name		onboard EtherCAT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection as EtherCAT slave	
Status display		1 LED (RUN)	
Connection designation		IN: X236 OUT: X237	

Technical data			
Communication profile		EtherCAT	
		CANopen over EtherCAT	
		File over EtherCAT (FoE)	
		Ethernet over EtherCAT (EoE)	
		Distributed Clocks (DC)	
Safety over EtherCAT (FSoE)		Yes	Advanced Safety und Extended Safety
Device profile		CiA 402	
Vendor ID [hex]		0x3B	
Network topology		Line, tree, star	
Device			
Type		EtherCAT slave	
Max. number		65535	In the entire network
Address		Automatically assigned by the master	
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data			
Transmit PDOs		0 ... 100 words	200 bytes per direction (standard and safety PDOs)
Receive PDOs		0 ... 100 words	
Cycle time		250 µs, 500 µs, 1 ms, and an integer multiple of 1 ms, max. 10 ms	

EtherCAT

Typical topologies

Line



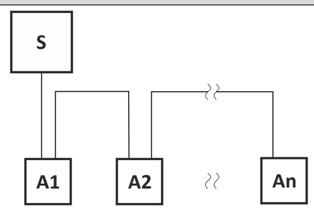
M Master
SD Slave Device

Connection			EtherCAT	
Connection designation			**X246**	**X247**
Connection type			RJ45	

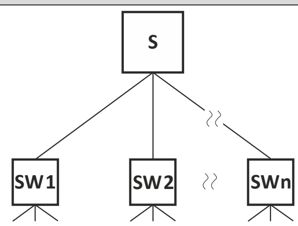
EtherNet/IP

Typical topologies

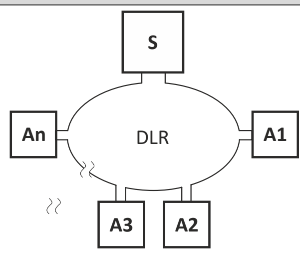
Line



Tree



Ring



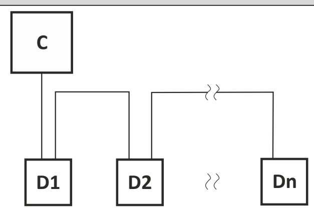
S Scanner
A Adapter
SW Switch

Connection			EtherNet/IP	
Connection designation			**X266**	**X267**
Connection type			RJ45	

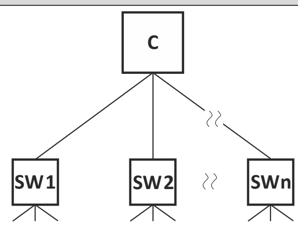
PROFINET

Typical topologies

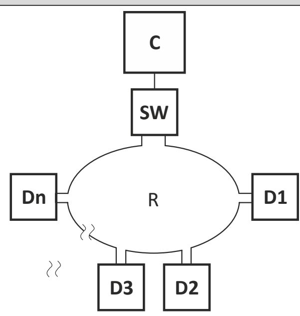
Line



Tree



Ring



C IO controller
D IO device
SW Switch SCALANCE (MRP capable)
R Redundant domain

Connection			PROFINET	
Connection designation			**X256**	**X257**
Connection type			RJ45	

Functional safety connection

⚠ DANGER!

If the safety components are not installed correctly, drives may start up in an uncontrolled manner.

Possible consequences: Death or severe injuries

- ► Only qualified personnel may install and commission safety components.
- ► All wiring must be EMC-compliant.
- ► All control components (switch, relay, PLC, ...) must comply with the requirements of EN ISO 13849-1 and the EN ISO 13849-2.
- ► Switches and relays must have a protection class of at least IP54.
- ► Always mount inverters, controllers, and other safety components with a protection class of less than IP54 in a control cabinet with a protection class of at least IP54.
- ► The wiring at the interface X1 (Basic Safety), X82/X83 (Extended Safety) must be shielded if the cable length exceeds 30 m.
- ► It is essential to use insulated wire end ferrules for wiring.
- ► All safety relevant cables outside the control cabinet must be protected, e.g. by means of a cable duct.
- ► Ensure that no short circuits can occur according to the specifications of the EN ISO 13849-2.
- ► All further requirements and measures can be obtained from the EN ISO 13849-1 and the EN ISO 13849-2.
- ► In the case of an external force effect on the drive axes, additional brakes are necessary. In particular, please observe the effect of gravitational force on hanging loads!
- ► For safety-related braking functions, use safety-rated brakes only.
- ► The user must ensure that the inverter is only operated within the specified environmental conditions in its intended application. Only by doing so can the specified safety-related characteristics be adhered to.

NOTICE

Overvoltage

Destruction of the safety component

- ► Make sure that the maximum voltage (maximum rated) at the safe inputs does not exceed 30 V DC.

Basic Safety - STO

Part of the product variant "Basic Safety - STO" ▸ Order details 📖 305

⚠ DANGER!

With the "Safe torque off" (STO) function, no "emergency switching off" in terms with EN 60204-1 can be executed without additional measures. There is no electrical isolation between the motor and inverter and no service switch or maintenance switch!

Possible consequences: Death or severe injuries

► "Emergency switching off" requires electrical isolation, e. g. by a central mains contactor.

Safe state

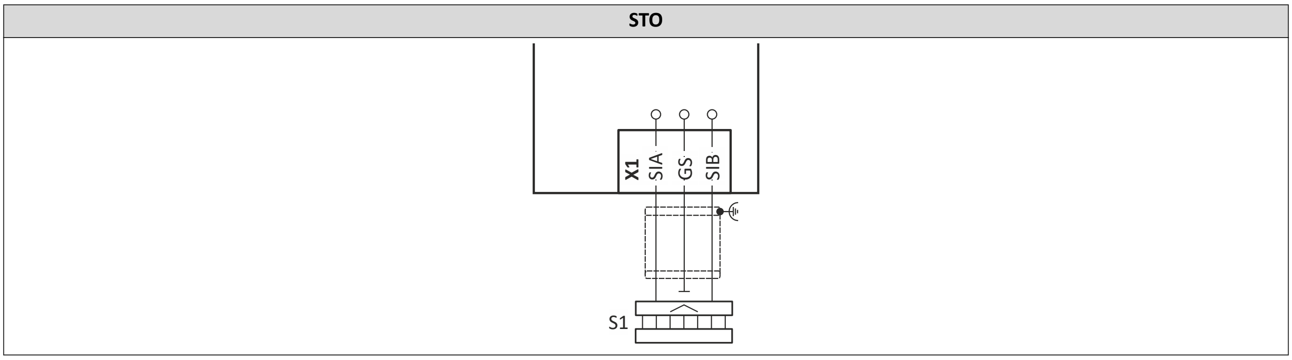
When the pulse width modulation of the inverter is switched off by the safety equipment, the motor is rendered free of torque. The inverter switches to the device state "STO active".

▸ Safe torque off (STO) 📖 228

Connection diagram

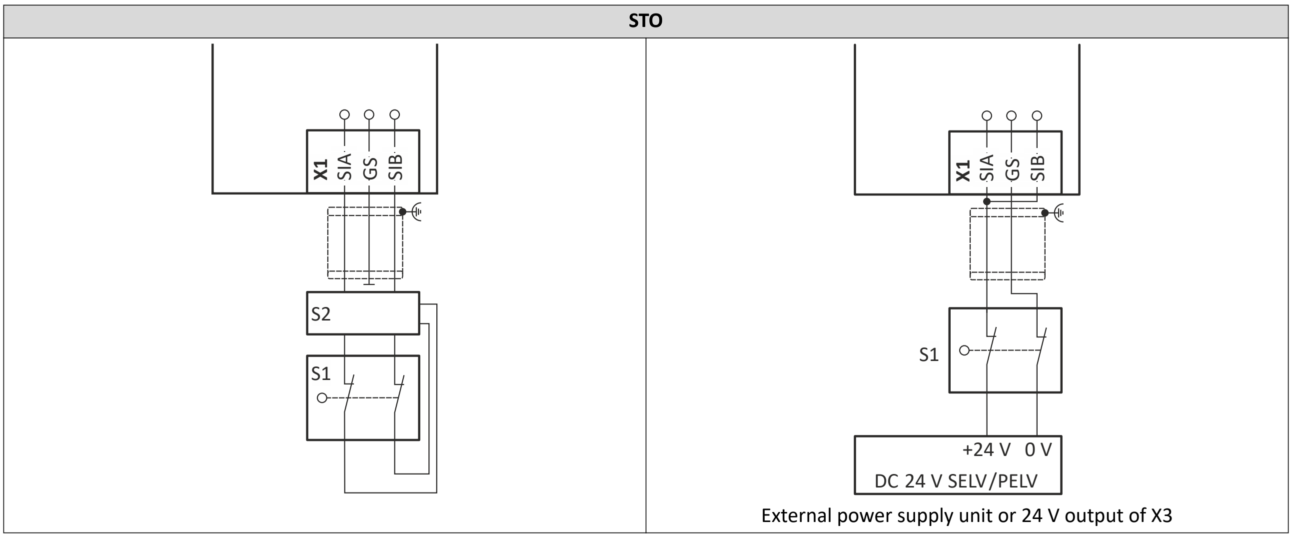
The connection diagrams shown are only example circuits. The user is responsible for the correct safety-related design and selection of the components!

Active sensors



S1 Active sensor - example of lightgrid

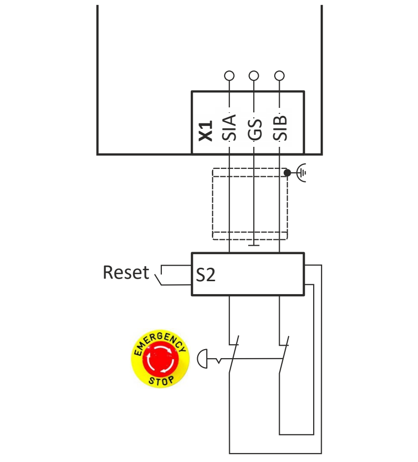
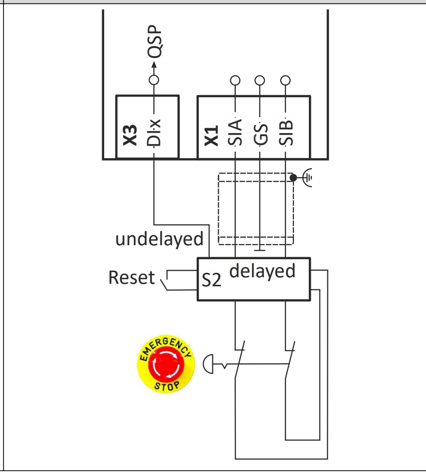
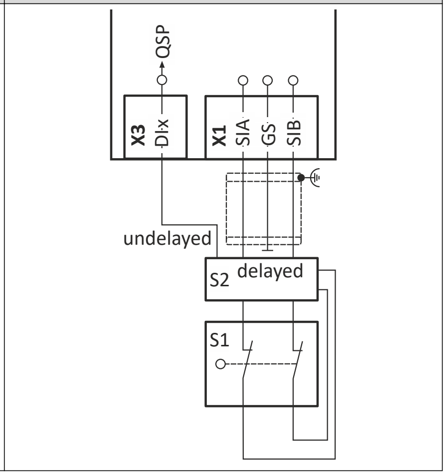
Passive sensors



S1 Passive sensor
S2 Safety switching device

S1 Passive sensor

Passive sensors - further examples

Emergency stop (STO)	Emergency stop (SS1-t)	SS1-t
		

S2 Safety switching device

S2 Safety switching device with delayed contacts
QSP "Quick stop" function

S1 Passive sensor
S2 Safety switching device with delayed contacts
QSP "Quick stop" function

Connection data

X1	Specification	Unit	min.	typ.	max.
SIA, SIB	LOW signal	V	-3	0	+5
	HIGH signal	V	+15	+24	+30
	Switch-on time	ms		10	
	Clear time	ms		15	30
	Input current	mA		8	12
	Input peak current	mA		400	
	Input capacitance SIA	µF		5	
	Input capacitance SIB				
	Test pulse duration	ms			1
	Test pulse interval	ms	10		
GS	Reference potential for SIA and SIB				

Runtime = Start of rising edge at SIA, SIB until internal HIGH signal is detected.

Switch-off time = Start of falling edge at SIA, SIB until internal LOW signal is detected.

Connection			Basic Safety - STO
Connection designation			**X1**
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			Yes
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length			10
Stripping length			0.39
Required tools			Screwdriver 0.4 x 2.5

Extended Safety

Part of the product variant "Extended Safety" ▶ Order details 📖 305

⚠ DANGER!

Loss of the safety function.

A loss of the safety function causes an unsafe condition of the machine. The machine condition cannot be controlled via the safety function.

Possible consequences: Death or severe injuries

► Always install the cables S1 and S2 in a protective manner according to category 4 of EN ISO 13849-2.

Connection diagram

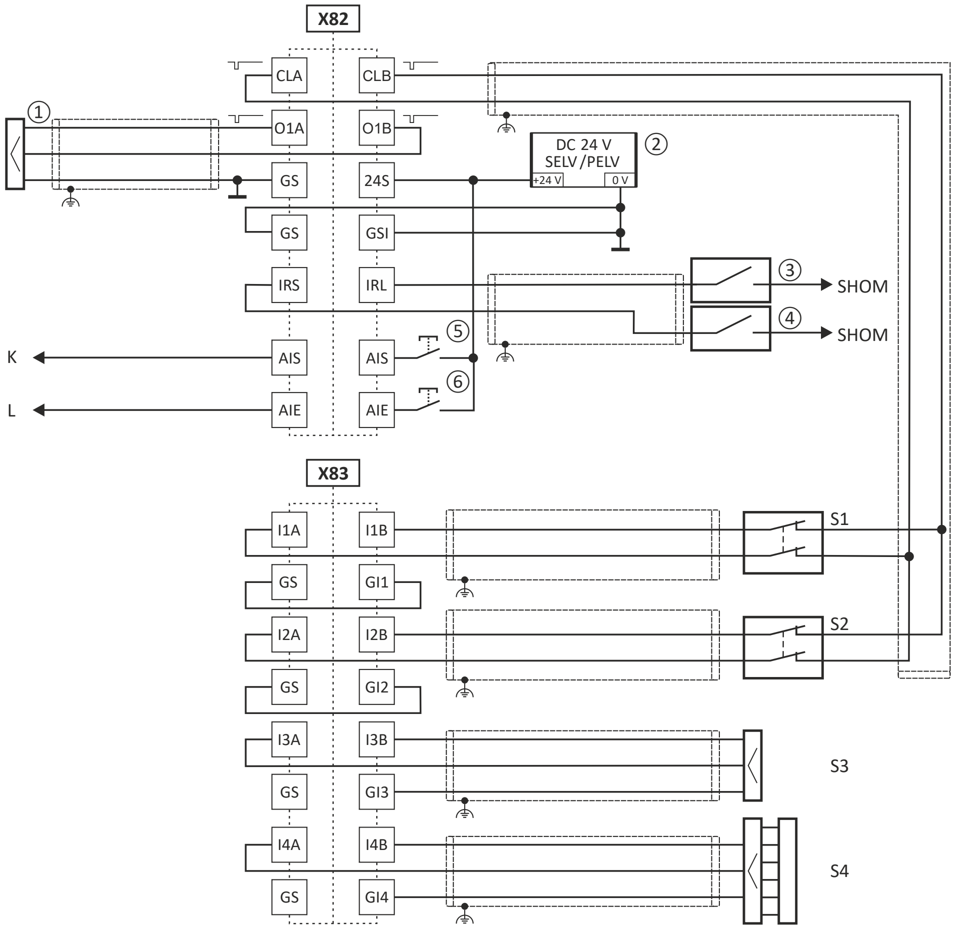


Fig. 11: Sample circuit

Name	Meaning
S1	Passive sensor with channel A and B Protected installation required for category 4 according to EN ISO 13849-2.
S2	
S3	Active sensor: Higher-level safety controller
S4	Active sensor: Lightgrid
①	Safe output to upstream safety control
②	External 24-V-supply of the safe output and the clock outputs (SELV/PELV)
③	Reference switch; see function "SHOM"
④	Reference switch; see function "SHOM"
⑤	Button for restart acknowledgement
⑥	Button for fault acknowledgement
K	To "AIS" connection of next device
L	To "AIE" connection of next device

Connection data

X82	Specification	Unit	Min.	Typ.	Max.
CLA, CLB	PLC output, IEC-61131-2, 24 V DC, 50 mA				
	LOW level output voltage	V		0	+0.8
	HIGH level output voltage	V	+17	+24	+30
	Output current	mA			60
	Cable capacity	nF			100
	Cable resistance of a passive sensor	Ω			200
O1A, O1B	PLC output, IEC-61131-2, 24 V DC				
	LOW level output voltage	V		0	0.8
	HIGH level output voltage	V	17	24	30
	Output current	mA			500
	Cable capacity	nF			100
	Cable resistance	Ω			200
GS	Reference potential for terminals • CLA, CLB • O1A, O1B • 24S				
24S	Supplies the clock outputs and the safe output via a safely separated power supply unit (SELV/PELV)	V	18	24	30
	Input current	mA			1100
GSI	Reference potential terminals IRS/IRL/AIS/AIE				
IRS IRL AIS AIE	PLC input, IEC-61131-2, 24 V, type 1				
	LOW level input voltage	V	-3	0	5
	HIGH level input voltage	V	15	24	30
	Input current	mA	2		15
	Input capacitance	nF			3.5
	Input delay (operating time) for AIE and AIS	s	0.3		10

X83	Specification	Unit	Min.	Typ.	Max.
I1A, I1B I2A, I2B I3A, I3B I4A, I4B	PLC input, IEC-61131-2, 24 V, type 1				
	LOW level input voltage	V	-3	0	5
	HIGH level input voltage	V	15	24	30
	Input current	mA	2		15
	Input capacitance	nF			3.5
	Repeat rate of test pulses	ms	50		
GI1 GI2 GI3 GI4	Reference potential for terminals • I1A ... I4B				

Connection			Extended Safety	
Connection designation			**X82**	**X83**
Connection system			Spring terminal	Spring terminal
Connection type			Pluggable	Pluggable
Double (Daisy Chain)			No	No
Max. cable cross-section		mm²	1.5	1.5
Max. cable cross-section		AWG	16	16
Min. cable cross-section		mm²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	10	10
Stripping length		in	0.4	0.4
Required tools			Screwdriver 0.4 x 2.5	

Technical data

Standards and operating conditions

Conformities and approvals

Conformities			
CE	2006/42/EC		Machinery Directive only relevant for safety components
	2009/125/EC		Ecodesign Directive
	2011/65/EU		RoHS Directive
	2014/30/EU		EMC Directive
UKCA	S.I. 2008/1597		The Supply of Machinery (Safety) Regulations 2008
	S.I. 2012/3032		The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
	S.I. 2016/1091		The Electromagnetic Compatibility Regulations 2016
	S.I. 2021/745		The Ecodesign for Energy-Related Products and Energy Information Regulations 2021
Approvals			
cULus	UL 61800-5-1		File No. E132659
			For USA and Canada

Declarations of conformity, certificates and approvals can be found on the Internet:

www.Lenze.com → Products → Inverters → Servo inverters
→ i950 cabinet servo inverter

(Section "Product support")

Protection of persons and device protection

Degree of protection			Information applies to the mounted and ready-for-use state.
EN	EN IEC 60529	IP20	In the area of the power connections, size-dependent IP10
UL	UL 50E	Type 1	Protection against accidental contact
			UL 50E Type 1 comparable to NEMA 1
	UL 61800-5-1	Open type	In UL-approved systems
Protection against electric shock			
Isolation of control circuits	EN IEC 61800-5-1	Safe mains isolation	Double/reinforced insulation
Overvoltage category		II	2000 … 4000 m amsl
		III	0 … 2000 m amsl
Degree of pollution		2	
Leakage current			
AC	EN IEC 61800-5-1	> 3.5 mA	Observe regulations and safety instructions!
DC		> 10 mA	
Starting current			
		≤ 3 x rated mains current	
Protective measures			
Earth fault strength			Earth-fault protected depending on operating status
Motor stall protection			
Short-circuit strength			
Overvoltage resistance			
Motor overtemperature			PTC or thermal contact, I²xt monitoring

EMC data

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

Motor connection

Requirements for the shielded motor cable			
Capacitance per unit length		C-core-core/C-core-shield < 150/300 pF/m	≥ 4 mm² / AWG 12
		C-core-core/C-core-shield < 75/150 pF/m	≤ 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			
Efficiency level	EN IEC 61800-9-2	Energy efficiency class IE2	according to REGULATION (EU) 2019/1781
Climate			
Storage	EN 60721-3-1:1997	1K3 (-25 ... +60°C)	
Transport	EN 60721-3-2:1997	2K3 (-25 ... +70 °C)	
Operation	EN 60721-3-3:1995 + A2:1997	3K3 (-10 ... +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 or 16 kHz: Above +40°C: reduce rated output current by 2.5%/°C
Installation altitude			
0 … 1000 m amsl			Without current derating
1000 … 4000 m amsl			Reduce rated output current by 5%/1000 m
Vibration resistance			
Transport	EN 60721-3-2:1997	2M2 (sine, shock)	In original packaging
Operation	DNV-CG-0339		Amplitude 1 mm (5 ... 13.2 Hz)
			Acceleration-resistant up to 0.7 g (13.2 ... 100 Hz)
		Acceleration resistant up to 0.7 g	Specifications apply to devices up to 15 kW
	EN IEC 61800-5-1		Amplitude 0.075 mm (10 ... 57 Hz)
			Acceleration-resistant up to 1 g (57 ... 150 Hz)

Electrical supply conditions

Permitted power systems			
IT			Apply the measures described for IT systems!
TN			Voltage to earthed neutral point: 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 230/240 V 📖 114
- 3-phase mains connection 230/240 V 📖 119
- 3-phase mains connection 400 V 📖 125
- 3-phase mains connection 480 V 📖 140

Certification of the integrated functional safety

The certification of the integrated safety is based on these test fundamentals:

EN ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems – Part 1
EN 61508, Part 1-7:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
EN 61800-5-1:2007 + A1:2017 + A11:2021	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy requirements
EN 61800-5-2:2007 EN 61800-5-2:2017	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional safety

Declarations of conformity, certificates and approvals can be found on the Internet:

www.Lenze.com → Products → Inverters → Servo inverters
→ i950 cabinet servo inverter

(Section "Product support")

1-phase mains connection 230/240 V

Rated data

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

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

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

Product name			**i950-C0.37/230-2**	**i950-C0.55/230-2**	**i950-C0.75/230-2**	**i950-C1.5/230-2**
Rated power	P_{rated}	**kW**	**0.37**	**0.55**	**0.75**	**1.5**
Rated power	P_{rated}	**hp**	**0.5**	**0.75**	**1**	**2**
Mains voltage range			1 AC 170 V ... 264 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 230/240			
Rated mains current						
without mains choke		A	5.7	7.6	10	-
with mains choke		A	4.8	7.1	8.8	13.9
Apparent output power		kVA	0.9	1.2	1.6	2.6
Rated output current						
2 kHz		A	2.4	3.2	4.2	7
4 kHz		A	2.4	3.2	4.2	7
8 kHz		A	2.4	3.2	4.2	7
16 kHz		A	1.6	2.1	2.8	4.7
Power loss						
On standby		W	15	15	15	15
2 kHz		W	34	39	48	73
4 kHz		W	35	42	53	81
8 kHz		W	40	47	61	98
16 kHz		W	40	47	61	98
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	3.6	4.8	6.3	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	2.4	3.2	5.3
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	4.8	6.4	8.4	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	2.4	3.2	5.3
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	-			
Category C3 (≤ 8 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			

Brake chopper						
Product name			**i950-C0.37/230-2**	**i950-C0.55/230-2**	**i950-C0.75/230-2**	**i950-C1.5/230-2**
Switch-on threshold		V	390			
Min. brake resistance		Ω	100			33
Rated output current		A	3.9			12
Max. output current		A	3.9			12
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Fusing data (EN 60204-1)

- A residual current device (**RCD**) is optional.
- **Icc** = Rated conditional short-circuit current
- Fusing data for UL/NEC compliant installations:
  ▶ Connection according to UL, Fusing data 📖 69

Inverters	Fuse			Circuit breaker			RCD	
	Icc	**Characteristic**	**Max. rated current**	**Icc**	**Characteristic**	**Max. rated current**		**Type**
	kA		**A**	**kA**		**A**	**mA**	
i950-C0.37/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.37/230-2	65	gG	16	65	B, C	16	≥ 30	Typ F
i950-C0.55/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.55/230-2	65	gG	16	65	B, C	16	≥ 30	Typ F
i950-C0.75/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.75/230-2	65	gG	16	65	B, C	16	≥ 30	Typ F
i950-C1.5/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C1.5/230-2	65	gG	16	65	B, C	16	≥ 30	Typ F

Connection data

Rated power	P_{rated}	kW	0.37 ... 1.5
Connection			**Netz**
Connection designation			**X100**
Connection system			Screw terminal
Connection type			Pluggable
Max. cable cross-section		mm²	2.5
Max. cable cross-section		AWG	12
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	8
Stripping length		in	0.32
Tightening torque		Nm	0.6
Tightening torque		lb-in	5.3
Required tools			Screwdriver 0.5 x 3.0

Rated power	P_{rated}	kW	0.37 ... 1.5
Connection			**Protective earth (PE)**
Connection designation			**Symbol for protective earth (PE)**
Connection system			Screw
Max. cable cross-section		mm²	6
Max. cable cross-section		AWG	10
Min. cable cross-section		mm²	1.5
Min. cable cross-section		AWG	16
Stripping length		mm	10
Stripping length		in	0.4
Tightening torque		Nm	2
Tightening torque		lb-in	18
Required tools			Torx key 20

Rated power	P_{rated}	kW	0.37 ... 1.5
Connection			**Motor**
Connection designation			**X105**
Connection system			Screw terminal
Connection type			Pluggable
Max. cable cross-section		mm²	2.5
Max. cable cross-section		AWG	12
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	8
Stripping length		in	0.32
Tightening torque		Nm	0.6
Tightening torque		lb-in	5.3
Required tools			Screwdriver 0.5 x 3.0

The terminal data for the terminal X1 can be found under: ▶ Basic Safety - STO 📖 105

The terminal data for the terminals X82 and X83 can be found under: ▶ Connection data 📖 110

Brake resistors

Lenze provides selection tables for easy and quick selection of a brake resistor.

Application class	Meaning	Examples
Dynamic load	Compensation of low, sporadic voltage peaks	Overshoot due to backlash-affected mechanics at the end of the acceleration phase Transfer of conveyed material to downstream conveyor line
Emergency stop	Compensation of regenerative energy during an emergency stop	Braking after pressing the emergency stop button
Passive load	Compensation of regenerative energy during horizontal movement	Braking of slides on machine tools or rotary tables
Active load	Compensation of regenerative energy during vertical movement	Braking hoists

Inverters	Brake resistor			
	Dynamic load	Emergency stop	Passive load	Active load
i950-C0.37/230-2	ERBU150R035WUQN000	ERBM100R086W	ERBM100R086W	ERBM100R100W
i950-C0.55/230-2	ERBU150R035WUQN000	ERBM100R086W	ERBM100R086W	ERBM100R150W
i950-C0.75/230-2	ERBM100R086W	ERBM100R086W	ERBM100R086W	ERBM100R150W
i950-C1.5/230-2	ERBP033R200W	ERBP033R200W	ERBP033R200W	ERBP033R300W

The assignment via the mains voltage and the rated power of the inverter is a non-binding recommendation. This recommended assignment of the brake resistors is electrically protected via the assigned mains fuses of the inverters. For other assignments, the assignment of the mains fuses to the brake resistors must be checked.

Brake resistor								
Type designation	R_B	P_D	Q_B	V_{Max}	Degree of protection	Thermal protection	m	H x W x D
	Ω	W	kWs	V			kg	mm
ERBU150R035WUQN000	150	35	0.418	800	IP20	eigensicher	0.38	278 x 60 x 27.5
ERBP033R200W	33	200	30	800	IP23	Thermokontakt	1	240 x 42 x 122
ERBP033R300W	33	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBM100R086W	100	86	3.4	800	IP23	Thermokontakt	0.49	110 x 80 x 28
ERBM100R100W	100	100	15	850	IP54	Thermokontakt	0.37	235 x 20.6 x 40
ERBM100R150W	100	150	22.5	800	IP20	Thermokontakt	0.54	238 x 80 x 59

For more information on brake resistors and their design, please refer to the brochure ": Accessories for VFDs and servo drives"".

Mains chokes

Inverters	Netzdrossel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i950-C0.37/230-2	ELN1-0900H005	1	5	9	82 x 66 x 75	1.1
i950-C0.55/230-2	ELN1-0500H009		9	5		
i950-C0.75/230-2						
i950-C1.5/230-2	ELN1-0250H018		18	2.5	90 x 96 x 96	2.1

RFI filters / Mains filters

Basic information on RFI filters, mains filters and EMC: 298

Short distance filter

- Filter type: RFI filter
- Operation with 300 mA residual current circuit breaker possible

i950-C1.5/230-2

In addition to the RFI filter, the ELN1-0250H018 mains choke must be connected.

Inverters	Filter				Max. motor cable length shielded					
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1		C2		C3	
		A	mm	kg			m	kHz	m	kHz
i950-C0.37/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	2	50	2
i950-C0.37/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	4	50	4
i950-C0.37/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	8	50	8
i950-C0.37/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	16	50	16
i950-C0.55/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	2	50	2
i950-C0.55/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	4	50	4
i950-C0.55/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	8	50	8
i950-C0.55/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	16	50	16
i950-C0.75/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	2	50	2
i950-C0.75/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	4	50	4
i950-C0.75/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	8	50	8
i950-C0.75/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	50	16	50	16
i950-C1.5/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	-	-	50	2
i950-C1.5/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	-	-	50	4
i950-C1.5/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	-	-	50	8
i950-C1.5/230-2	I0FAE222B100S0000S	22.5	346 x 60 x 50	1.02	-	-	-	-	50	16

3-phase mains connection 230/240 V

Rated data

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

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

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

Product name			**i950-C0.37/230-2**	**i950-C0.55/230-2**	**i950-C0.75/230-2**	**i950-C1.5/230-2**
Rated power	P_{rated}	**kW**	**0.37**	**0.55**	**0.75**	**1.5**
Rated power	P_{rated}	**hp**	**0.5**	**0.75**	**1**	**2**
Mains voltage range			3 AC 170 V ... 264 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 230/240			
Rated mains current						
without mains choke		A	3.9	4.8	6.4	9.5
with mains choke		A	3	3.8	5.1	6.8
Apparent output power		kVA	0.9	1.2	1.6	2.6
Rated output current						
2 kHz		A	2.4	3.2	4.2	7
4 kHz		A	2.4	3.2	4.2	7
8 kHz		A	2.4	3.2	4.2	7
16 kHz		A	1.6	2.1	2.8	4.7
Power loss						
On standby		W	15	15	15	15
2 kHz		W	34	39	48	73
4 kHz		W	35	42	53	81
8 kHz		W	40	47	61	98
16 kHz		W	40	47	61	98
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	3.6	4.8	6.3	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	2.4	3.2	5.3
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	4.8	6.4	8.4	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	2.4	3.2	5.3
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	-			
Category C3 (≤ 8 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			

Product name			i950-C2.2/230-3	i950-C4.0/230-3	i950-C5.5/230-3
Rated power	P_{rated}	**kW**	**2.2**	**4**	**5.5**
Rated power	P_{rated}	**hp**	**3**	**5**	**7.5**
Mains voltage range			3 AC 170 V ... 264 V, 45 Hz ... 65 Hz		
Output voltage		V	3 AC 0 ... 230/240		
Rated mains current					
without mains choke		A	-	20.6	28.8
with mains choke		A	9.8	15.7	21.9
Apparent output power		kVA	3.6	6.2	8.7
Rated output current					
2 kHz		A	9.6	16.5	23
4 kHz		A	9.6	16.5	23
8 kHz		A	9.6	16.5	23
16 kHz		A	6.4	11	15.3
Power loss					
On standby		W	15	15	15
2 kHz		W	96	151	207
4 kHz		W	107	172	235
8 kHz		W	130	211	293
16 kHz		W	130	211	293
Overcurrent cycle 180 s					
Max. output current (≤ 8 kHz)		A	14.4	24.8	34.5
Overload time	T_1	s	60	60	60
Recovery time	T_2	s	120	120	120
Max. output current during the recovery time		A	7.2	12.4	17.3
Overcurrent cycle 15 s					
Max. output current (≤ 8 kHz)		A	19.2	33	46
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	12.4	17.3
Cyclic mains switching			3-mal pro Minute		
Max. motor cable length shielded					
without EMC category		m	50	100	
Category C1 (≤ 8 kHz)		m	-		
Category C2 (≤ 8 kHz)		m	-		
Category C3 (≤ 8 kHz)		m	-		
Max. motor cable length unshielded					
without EMC category		m	100	200	

Brake chopper						
Product name			**i950-C0.37/230-2**	**i950-C0.55/230-2**	**i950-C0.75/230-2**	**i950-C1.5/230-2**
Switch-on threshold		V	390			
Min. brake resistance		Ω	100			33
Rated output current		A	3.9			12
Max. output current		A	3.9			12
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper					
Product name			**i950-C2.2/230-3**	**i950-C4.0/230-3**	**i950-C5.5/230-3**
Switch-on threshold		V	390		
Min. brake resistance		Ω	33	15	
Rated output current		A	12	26	
Max. output current		A	12	26	
Switch-on time (I_{max})			-		
Recovery time (I = 0 A)			-		
Max. cable length					
shielded		m	10		
unshielded		m	0.5		

Fusing data (EN 60204-1)

- A residual current device (**RCD**) is optional.
- **Icc** = Rated conditional short-circuit current
- Fusing data for UL/NEC compliant installations:
  ▶ Connection according to UL, Fusing data 📖 69

Inverters	Fuse			Circuit breaker			RCD	
	Icc	Characteristic	Max. rated current	Icc	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
i950-C0.37/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.55/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.75/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C1.5/230-2	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C2.2/230-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C4.0/230-3	65	gG	50	65	B, C	50	≥ 30	Typ B
i950-C5.5/230-3	65	gG	50	65	B, C	50	≥ 30	Typ B

Connection data

Rated power	P_{rated}	kW	0.37 ... 2.2	4 ... 5.5
Connection			**Mains**	
Connection designation			**X100**	
Connection system			Screw terminal	
Connection type			Pluggable	
Max. cable cross-section		mm²	2.5	16
Max. cable cross-section		AWG	12	6
Min. cable cross-section		mm²	0.25	0.5
Min. cable cross-section		AWG	22	20
Stripping length		mm	8	12
Stripping length		in	0.32	0.47
Tightening torque		Nm	0.6	1.8
Tightening torque		lb-in	5.3	16
Required tools			Screwdriver 0.5 x 3.0	Screwdriver 0.8 x 4.0

Rated power	P_{rated}	kW	0.37 ... 2.2	4 ... 5.5
Connection			**Protective earth (PE)**	
Connection designation			**Symbol for protective earth (PE)**	
Connection system			Screw	
Max. cable cross-section		mm²	6	16
Max. cable cross-section		AWG	10	6
Min. cable cross-section		mm²	1.5	2.5
Min. cable cross-section		AWG	16	14
Stripping length		mm	10	12
Stripping length		in	0.4	0.47
Tightening torque		Nm	2	3.4
Tightening torque		lb-in	18	30
Required tools			Torx key 20	Crosstip screwdriver PZ2

Rated power	P_{rated}	kW	0.37 ... 2.2	4 ... 5.5
Connection			**Motor**	
Connection designation			**X105**	
Connection system			Screw terminal	
Connection type			Pluggable	
Max. cable cross-section		mm²	2.5	16
Max. cable cross-section		AWG	12	6
Min. cable cross-section		mm²	0.25	0.5
Min. cable cross-section		AWG	22	20
Stripping length		mm	8	12
Stripping length		in	0.32	0.47
Tightening torque		Nm	0.6	1.8
Tightening torque		lb-in	5.3	16
Required tools			Screwdriver 0.5 x 3.0	Screwdriver 0.8 x 4.0

The terminal data for the terminal X1 can be found under: ▶ Basic Safety - STO 105

The terminal data for the terminals X82 and X83 can be found under: ▶ Connection data 110

Brake resistors

Lenze provides selection tables for easy and quick selection of a brake resistor.

Application class	Meaning	Examples
Dynamic load	Compensation of low, sporadic voltage peaks	Overshoot due to backlash-affected mechanics at the end of the acceleration phase Transfer of conveyed material to downstream conveyor line
Emergency stop	Compensation of regenerative energy during an emergency stop	Braking after pressing the emergency stop button
Passive load	Compensation of regenerative energy during horizontal movement	Braking of slides on machine tools or rotary tables
Active load	Compensation of regenerative energy during vertical movement	Braking hoists

Inverters	Brake resistor			
	Dynamic load	Emergency stop	Passive load	Active load
i950-C0.37/230-2	ERBU150R035WUQN000	ERBM100R086W	ERBM100R086W	ERBM100R100W
i950-C0.55/230-2	ERBU150R035WUQN000	ERBM100R086W	ERBM100R086W	ERBM100R150W
i950-C0.75/230-2	ERBM100R086W	ERBM100R086W	ERBM100R086W	ERBM100R150W
i950-C1.5/230-2	ERBP033R200W	ERBP033R200W	ERBP033R200W	ERBP033R300W
i950-C2.2/230-3	ERBP033R200W	ERBP033R200W	ERBP033R200W	ERBP033R300W
i950-C4.0/230-3	ERBP018R300W	ERBS015R800W	ERBS015R800W	ERBS015R01K2
i950-C5.5/230-3	ERBS015R800W	ERBS015R800W	ERBS015R800W	ERBS015R01K2

The assignment via the mains voltage and the rated power of the inverter is a non-binding recommendation. This recommended assignment of the brake resistors is electrically protected via the assigned mains fuses of the inverters. For other assignments, the assignment of the mains fuses to the brake resistors must be checked.

Brake resistor								
Type designation	R_B	P_D	Q_B	V_{Max}	Degree of protection	Thermal protection	m	H x W x D
	Ω	W	kWs	V			kg	mm
ERBU150R035WUQN000	150	35	0.418	800	IP20	eigensicher	0.38	278 x 60 x 27.5
ERBS015R800W	15	800	120	800	IP66	Thermokontakt	4	710 x 114 x 105
ERBS015R01K2	15	1200	180	800	IP66	Thermokontakt	5.6	1020 x 114 x 105
ERBP018R300W	18	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBP033R200W	33	200	30	800	IP23	Thermokontakt	1	240 x 42 x 122
ERBP033R300W	33	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBM100R086W	100	86	3.4	800	IP23	Thermokontakt	0.49	110 x 80 x 28
ERBM100R100W	100	100	15	850	IP54	Thermokontakt	0.37	235 x 20.6 x 40
ERBM100R150W	100	150	22.5	800	IP20	Thermokontakt	0.54	238 x 80 x 59

For more information on brake resistors and their design, please refer to the brochure ": Accessories for VFDs and servo drives"".

Mains chokes

Inverters	Netzdrossel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i950-C0.37/230-2	EZAELN3004B742	3	4	7.35	60 x 95 x 117	1.31
i950-C0.55/230-2						
i950-C0.75/230-2	EZAELN3006B492		6	4.9	69 x 95 x 117	1.45
i950-C1.5/230-2	EZAELN3008B372		8	3.68	85 x 120 x 140	1.9
i950-C2.2/230-3	EZAELN3010B292		10	2.94		2
i950-C4.0/230-3	EZAELN3016B182		16	1.84	95 x 120 x 140	2.7
i950-C5.5/230-3	EZAELN3025B122		25	1.18	110 x 155 x 170	5.8

3-phase mains connection 400 V

Rated data

Product name			**i950-C0.55/400-3**	**i950-C0.75/400-3**	**i950-C2.2/400-3**	**i950-C4.0/400-3**
Rated power	P_{rated}	**kW**	**0.55**	**0.75**	**2.2**	**4**
Rated power	P_{rated}	**hp**	**0.75**	**1**	**3**	**5**
Mains voltage range			3 AC 340 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 400			
Rated mains current						
without mains choke		A	2.5	3.3	7.8	12.5
with mains choke		A	2	2.6	5.3	9
Apparent output power		kVA	1.2	1.6	3.8	6.4
Rated output current						
2 kHz		A	1.8	2.4	5.6	9.5
4 kHz		A	1.8	2.4	5.6	9.5
8 kHz		A	1.8	2.4	5.6	7.1
16 kHz		A	1.2	1.6	2.6	2.9
Power loss						
On standby		W	15	15	15	15
2 kHz		W	33	39	71	111
4 kHz		W	34	41	75	117
8 kHz		W	40	49	94	149
16 kHz		W	40	49	94	149
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	2.7	3.6	8.4	14.3
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	1.4	1.8	4.2	7.1
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	3.6	4.8	11.2	19
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	1.4	1.8	4.2	7.1
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20			
Category C3 (≤ 8 kHz)		m	35			
Max. motor cable length unshielded						
without EMC category		m	100			

Product name			i950-C7.5/400-3	i950-C11/400-3	i950-C15/400-3	i950-C22/400-3
Rated power	P_{rated}	**kW**	**7.5**	**11**	**15**	**22**
Rated power	P_{rated}	**hp**	**10**	**15**	**20**	**30**
Mains voltage range			3 AC 340 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 400			
Rated mains current						
without mains choke		A	20	28.4	-	
with mains choke		A	15.7	22.3	28.8	42
Apparent output power		kVA	11	16	22	32
Rated output current						
2 kHz		A	16.5	23.5	32	47
4 kHz		A	16.5	23.5	32	47
8 kHz		A	16.5	23.5		47
16 kHz		A	11	12	11	31.3
Power loss						
On standby		W	20	20	20	32
2 kHz		W	186	256	342	505
4 kHz		W	197	272	363	536
8 kHz		W	252	351	471	694
16 kHz		W	252	351	471	694
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	25	35	48	71
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	12.4	17.6	24	35
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	33	47	64	94
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	12.4	17.6	24	35
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	100			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20			
Category C3 (≤ 8 kHz)		m	35			
Max. motor cable length unshielded						
without EMC category		m	200			

Product name			**i950-C30/400-3**	**i950-C45/400-3**	**i950-C55/400-3**	**i950-C75/400-3**
Rated power	P_{rated}	**kW**	**30**	**45**	**55**	**75**
Rated power	P_{rated}	**hp**	**40**	**60**	**75**	**100**
Mains voltage range			3 AC 340 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 400			
Rated mains current						
without mains choke		A	-			
with mains choke		A	54.9	80	99	135
Apparent output power		kVA	41	60	75	100
Rated output current						
2 kHz		A	61	89	110	150
4 kHz		A	61	89	110	150
8 kHz		A	61	89	110	150
16 kHz		A	40.6	59.3	76.6	95
Power loss						
On standby		W	39	39	44	44
2 kHz		W	653	934	1151	1553
4 kHz		W	694	994	1224	1654
8 kHz		W	898	1292	1593	2157
16 kHz		W	898	1292	1593	2157
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	92	134	165	225
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	46	67	83	113
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	122	178	220	300
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	46	67	83	113
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	100		200	
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20			
Category C3 (≤ 8 kHz)		m	35		100	
Max. motor cable length unshielded						
without EMC category		m	200		400	

Product name			i950-C90/400-3	i950-C110/400-3	i950-C130/400-3	i950-C160/400-3
Rated power	P_{rated}	**kW**	**90**	**110**	**132**	**160**
Rated power	P_{rated}	**hp**	**125**	**150**	**180**	**200**
Mains voltage range			3 AC 340 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 400			
Rated mains current						
without mains choke		A	-		236	285
with mains choke		A	168	198	-	
Apparent output power		kVA	121	142	164	196
Rated output current						
2 kHz		A	180	212	245	292
4 kHz		A	180	212	209	250
8 kHz		A	162	191	160	191
16 kHz		A	99	106	-	
Power loss						
On standby		W	44	44	44	44
2 kHz		W	1855	2177	3300	4100
4 kHz		W	1975	2319	3300	4100
8 kHz		W	2326	2731	3300	4100
16 kHz		W	2326	2731	-	-
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	270	318	314	375
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	135	159	157	188
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	360	424	418	500
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	135	159	157	188
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	200			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20		-	
Category C3 (≤ 8 kHz)		m	100		150	
Max. motor cable length unshielded						
without EMC category		m	400			

Product name			**i950-C200/400-3**	**i950-C250/400-3**
Rated power	P_{rated}	**kW**	**200**	**250**
Rated power	P_{rated}	**hp**	**250**	**320**
Mains voltage range			3 AC 340 V ... 440 V, 45 Hz ... 65 Hz	
Output voltage		V	3 AC 0 ... 400	
Rated mains current				
without mains choke		A	349	436
with mains choke		A	-	
Apparent output power		kVA	245	308
Rated output current				
2 kHz		A	366	460
4 kHz		A	313	368
8 kHz		A	210	260
16 kHz		A	-	
Power loss				
On standby		W	44	44
2 kHz		W	4900	6200
4 kHz		W	4900	6200
8 kHz		W	4900	6200
16 kHz		W	-	-
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	470	552
Overload time	T_1	s	60	60
Recovery time	T_2	s	120	120
Max. output current during the recovery time		A	235	276
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	626	736
Overload time	T_1	s	3	3
Recovery time	T_2	s	12	12
Max. output current during the recovery time		A	235	276
Cyclic mains switching			3-mal pro Minute	
Max. motor cable length shielded				
without EMC category		m	200	
Category C1 (≤ 8 kHz)		m	-	
Category C2 (≤ 8 kHz)		m	-	
Category C3 (≤ 8 kHz)		m	150	
Max. motor cable length unshielded				
without EMC category		m	400	

Brake chopper						
Product name			**i950-C0.55/400-3**	**i950-C0.75/400-3**	**i950-C2.2/400-3**	**i950-C4.0/400-3**
Switch-on threshold		V	725			
Min. brake resistance		Ω	390		150	47
Rated output current		A	1.9		4.8	15.4
Max. output current		A	1.9		4.8	15.4
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper						
Product name			**i950-C7.5/400-3**	**i950-C11/400-3**	**i950-C15/400-3**	**i950-C22/400-3**
Switch-on threshold		V	725			
Min. brake resistance		Ω	27		18	15
Rated output current		A	27		40	48
Max. output current		A	27		40	48
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper						
Product name			**i950-C30/400-3**	**i950-C45/400-3**	**i950-C55/400-3**	**i950-C75/400-3**
Switch-on threshold		V	725			
Min. brake resistance		Ω	7.5		4.7	
Rated output current		A	97		154	
Max. output current		A	97		154	
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper						
Product name			**i950-C90/400-3**	**i950-C110/400-3**	**i950-C130/400-3**	**i950-C160/400-3**
Switch-on threshold		V	725			
Min. brake resistance		Ω	2.3		2.8	2.3
Rated output current		A	275		259	315
Max. output current		A	275		259	315
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper				
Product name			**i950-C200/400-3**	**i950-C250/400-3**
Switch-on threshold		V	725	
Min. brake resistance		Ω	1.8	1.4
Rated output current		A	414	518
Max. output current		A	414	518
Switch-on time (I_{max})			-	
Recovery time (I = 0 A)			-	
Max. cable length				
shielded		m	10	
unshielded		m	0.5	

Fusing data (EN 60204-1)

- A residual current device (**RCD**) is optional.
- **Icc** = Rated conditional short-circuit current
- Fusing data for UL/NEC compliant installations:
  ▶ Connection according to UL, Fusing data 69

Inverters	Fuse			Circuit breaker			RCD	
	Icc	**Characteristic**	**Max. rated current**	**Icc**	**Characteristic**	**Max. rated current**		**Type**
	kA		**A**	**kA**		**A**	**mA**	
i950-C0.55/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.75/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C2.2/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C4.0/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C7.5/400-3	65	gG	50	65	B, C	50	≥ 300	Typ B
i950-C11/400-3	65	gG	50	65	B, C	50	≥ 300	Typ B
i950-C15/400-3	65	gG	50	65	B, C	50	≥ 300	Typ B
i950-C22/400-3	65	gG	63	65	B, C	63	≥ 300	Typ B
i950-C30/400-3	22	gG	80	35	B, C	125	≥ 300	Typ B
i950-C45/400-3	22	gG	125	35	B, C	125	≥ 300	Typ B
i950-C55/400-3	22	gR	160	35	B, C	160	≥ 300	Typ B
i950-C75/400-3	22	gR	160	35	B, C	160	≥ 300	Typ B
i950-C90/400-3	22	gR	300	10	B, C	300	≥ 300	Typ B
i950-C110/400-3	22	gR	300	10	B, C	300	≥ 300	Typ B
i950-C130/400-3	100	gR	350	-	-		≥ 300	Typ B
i950-C160/400-3	100	gR	400	-	-		≥ 300	Typ B
i950-C200/400-3	100	gR	450	-	-		≥ 300	Typ B
i950-C250/400-3	100	gR	450	-	-		≥ 300	Typ B

Connection data

Rated power	P_{rated}	**kW**	**0.55 ... 4**	**7.5 ... 15**	**22**	**30 ... 45**	**55 ... 75**	**90 ... 110**	**132**	**160**	**200 ... 250**
Connection			**Mains**								
Connection designation			**X100**								
Connection system			Screw terminal						Screw		
Connection type			Pluggable		Non-pluggable				-		
Max. cable cross-section		mm²	2.5	16	35	50	95	150	-	-	-
Max. cable cross-section		AWG	12	6	2	1/0	4/0	300 kcmil	-	-	-
Min. cable cross-section		mm²	0.25	0.5	1.5	10	25	35	-	-	-
Min. cable cross-section		AWG	22	20	16	6	2	1	-	-	-
Stripping length		mm	8	12	18	22	32	41	-	-	-
Stripping length		in	0.32	0.47	0.7	0.87	1.25	1.6	-	-	-
Tightening torque		Nm	0.6	1.8	3.8	4	10	18	-	47	35
Tightening torque		lb-in	5.3	16	34	35	90	160	-	416	315
Required tools			Screwdriver 0.5 x 3.0	Screwdriver 0.8 x 4.0	Screwdriver 1.0 x 5.5	Hex key 5.0	Hex key 6.0	Hex key 8.0	Hex key 10.0	Wrench size 17	Wrench size 24

Rated power	P_{rated}	**kW**	**0.55 ... 4**	**7.5 ... 15**	**22**	**30 ... 75**	**90 ... 110**	**132 ... 160**	**200 ... 250**
Connection			**Protective earth (PE)**						
Connection designation			**Symbol for protective earth (PE)**						
Connection system			Screw				Bolt	Screw	Bolt
Max. cable cross-section		mm²	6	16	25	35	150	120	150
Max. cable cross-section		AWG	10	6	4	2	300 kcmil	4/0	300
Min. cable cross-section		mm²	1.5	2.5	4	4	4	-	-
Min. cable cross-section		AWG	16	14	12	12	12	-	-
Stripping length		mm	10	12	16	16	-	-	-
Stripping length		in	0.4	0.47	0.63	0.63	-	-	-
Tightening torque		Nm	2	3.4	4	4	10	8	20
Tightening torque		lb-in	18	30	35	35	90	71	180
Required tools			Torx key 20	Crosstip screwdriver PZ2			Wrench size 13	-	Wrench size 17

Rated power	P_{rated}	**kW**	**0.55 ... 4**	**7.5 ... 15**	**22**	**30 ... 45**	**55 ... 75**	**90 ... 110**	**132**	**160**	**200 ... 250**
Connection			**Motor**								
Connection designation			**X105**								
Connection system			Screw terminal						Screw		
Connection type			Pluggable		Non-pluggable				-		
Max. cable cross-section		mm²	2.5	16	35	50	95	150	-	-	-
Max. cable cross-section		AWG	12	6	2	1/0	4/0	300 kcmil	-	-	-
Min. cable cross-section		mm²	0.25	0.5	1.5	10	25	35	-	-	-
Min. cable cross-section		AWG	22	20	16	6	2	1	-	-	-
Stripping length		mm	8	12	18	22	32	41	-	-	-
Stripping length		in	0.32	0.47	0.7	0.87	1.25	1.6	-	-	-
Tightening torque		Nm	0.6	1.8	3.8	4	10	18	-	47	35
Tightening torque		lb-in	5.3	16	34	35	90	160	-	416	315
Required tools			Screwdriver 0.5 x 3.0	Screwdriver 0.8 x 4.0	Screwdriver 1.0 x 5.5	Hex key 5.0	Hex key 6.0	Hex key 8.0	Hex key 10.0	Wrench size 17	Wrench size 24

The terminal data for the terminal X1 can be found under: ▶ Basic Safety - STO 📖 105

The terminal data for the terminals X82 and X83 can be found under: ▶ Connection data 📖 110

Brake resistors

Lenze provides selection tables for easy and quick selection of a brake resistor.

Application class	Meaning	Examples
Dynamic load	Compensation of low, sporadic voltage peaks	Overshoot due to backlash-affected mechanics at the end of the acceleration phase Transfer of conveyed material to downstream conveyor line
Emergency stop	Compensation of regenerative energy during an emergency stop	Braking after pressing the emergency stop button
Passive load	Compensation of regenerative energy during horizontal movement	Braking of slides on machine tools or rotary tables
Active load	Compensation of regenerative energy during vertical movement	Braking hoists

Inverters	Brake resistor			
	Dynamic load	Emergency stop	Passive load	Active load
i950-C0.55/400-3	ERBU390R035WUQN000	ERBU390R035WUQN000	ERBM390R100W	ERBM390R100W
i950-C0.75/400-3	ERBU390R035WUQN000	ERBU390R035WUQN000	ERBM390R100W	ERBM390R100W
i950-C2.2/400-3	ERBU150R035WUQN000	ERBP180R200W	ERBP180R300W	ERBS180R350WNQN000
i950-C4.0/400-3	ERBU150R035WUQN000	ERBM047R135W	ERBS047R400W	ERBS047R800W
i950-C7.5/400-3	ERBP027R200W	ERBP027R200W	ERBS027R600W	ERBS027R01K4
i950-C11/400-3	ERBP027R200W	ERBS027R600W	ERBS027R01K2	ERBS027R01K4
i950-C15/400-3	ERBP018R300W	ERBP018R300W	ERBS018R01K4	ERBG018R04K3
i950-C22/400-3	ERBS015R800W	ERBS015R800W	ERBS015R02K4	ERBG015R06K2
i950-C30/400-3	ERBG075D01K9	ERBG075D01K9	ERBG075D04K5WBN000	ERBG075D15K0WBN000
i950-C45/400-3	ERBG075D01K9	ERBG075D01K9	ERBG075D04K5WBN000	ERBG075D15K0WBN000
i950-C55/400-3	ERBG005R02K6	ERBG005R02K6	ERBG005R10K0WBN000	ERBG005R22K0WBN000
i950-C75/400-3	ERBG005R02K6	ERBG005R02K6	ERBG005R10K0WBN000	ERBG005R22K0WBN000
i950-C90/400-3	ERBG028D04K1	ERBG028D04K1	ERBG028D11K0WBN000	ERBG028D34K0WBN000
i950-C110/400-3	ERBG028D04K1	ERBG028D04K1	ERBG028D11K0WBN000	ERBG028D34K0WBN000
i950-C130/400-3		ERBG028D04K1		
i950-C160/400-3		ERBG023D05K6		
i950-C200/400-3		ERBG035D03K3		
i950-C250/400-3		ERBG028D04K1		

The assignment via the mains voltage and the rated power of the inverter is a non-binding recommendation. This recommended assignment of the brake resistors is electrically protected via the assigned mains fuses of the inverters. For other assignments, the assignment of the mains fuses to the brake resistors must be checked.

Brake resistor								
Type designation	R_B	P_D	Q_B	V_{Max}	Degree of protection	Thermal protection	m	H x W x D
	Ω	W	kWs	V			kg	mm
ERBU150R035WUQN000	150	35	0.418	800	IP20	eigensicher	0.38	278 x 60 x 27.5
ERBU390R035WUQN000	390	35	0.418	800	IP20	eigensicher	0.38	278 x 60 x 27.5
ERBS015R800W	15	800	120	800	IP66	Thermokontakt	4	710 x 114 x 105
ERBS015R02K4	15	2400	360	800	IP66	Thermokontakt	10	1020 x 204 x 105
ERBS018R01K4	18	1400	210	800	IP66	Thermokontakt	6.3	1110 x 114 x 105
ERBS027R600W	27	600	90	800	IP66	Thermokontakt	3.1	550 x 114 x 105
ERBS027R01K2	27	1200	180	800	IP66	Thermokontakt	5.6	1020 x 114 x 105
ERBS027R01K4	27	1400	210	800	IP66	Thermokontakt	6.3	1110 x 114 x 105
ERBS047R400W	47	400	60	800	IP66	Thermokontakt	2.3	400 x 114 x 105
ERBS047R800W	47	800	120	800	IP66	Thermokontakt	4	710 x 114 x 105
ERBS180R350WNQN000	180	350	53	850	IP66	Thermokontakt	2.1	382 x 124 x 122
ERBP018R300W	18	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBP027R200W	27	200	30	800	IP23	Thermokontakt	1	240 x 42 x 122
ERBP180R200W	180	200	30	800	IP23	Thermokontakt	1	240 x 42 x 122
ERBP180R300W	180	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBM047R135W	47	135	6.3	800	IP23	Thermokontakt	0.67	216 x 80 x 28
ERBM390R100W	390	100	15	850	IP54	Thermokontakt	0.37	235 x 20.6 x 40
ERBG023D05K6	2.3	5600	840	1000	IP20	Thermokontakt	15.9	302 x 486 x 426
ERBG028D04K1	2.8	4100	615	1000	IP20	Thermokontakt	12.8	302 x 486 x 426
ERBG028D11K0WBN000	2.8	11000	1650	1000	IP20	Thermokontakt	28	302 x 486 x 736
ERBG028D34K0WBN000	2.8	34000	5100	1000	IP20	Thermokontakt	90	1020 x 486 x 736
ERBG035D03K3	3.5	3300	495	1000	IP20	Thermokontakt	12.6	302 x 486 x 326
ERBG005R02K6	5	2600	390	1000	IP20	Thermokontakt	11	302 x 486 x 326
ERBG005R10K0WBN000	5	10000	1500	1000	IP20	Thermokontakt	27	302 x 486 x 736
ERBG005R22K0WBN000	5	22000	3300	1000	IP20	Thermokontakt	54	600 x 486 x 736
ERBG075D01K9	7.5	1900	285	1000	IP20	Thermokontakt	9.5	302 x 486 x 236
ERBG075D04K5WBN000	7.5	4500	675	1000	IP20	Thermokontakt	15	302 x 486 x 426
ERBG075D15K0WBN000	7.5	15000	2250	1000	IP20	Thermokontakt	38	600 x 486 x 526
ERBG015R06K2	15	6200	930	1000	IP20	Thermokontakt	17	302 x 486 x 526
ERBG018R04K3	18	4300	645	1000	IP20	Thermokontakt	13.5	302 x 486 x 426

For more information on brake resistors and their design, please refer to the brochure ": Accessories for VFDs and servo drives"".

Mains chokes

Inverters	Netzdrossel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i950-C0.55/400-3	EZAELN3002B153	3	2	14.7	56 x 77 x 100	0.53
i950-C0.75/400-3	EZAELN3004B742		4	7.35	60 x 95 x 117	1.31
i950-C2.2/400-3	EZAELN3006B492		6	4.9	69 x 95 x 117	1.45
i950-C4.0/400-3	EZAELN3010B292		10	2.94	85 x 120 x 140	2
i950-C7.5/400-3	EZAELN3016B182		16	1.84	95 x 120 x 140	2.7
i950-C11/400-3	EZAELN3025B122		25	1.18	110 x 155 x 170	5.8
i950-C15/400-3	EZAELN3030B981		30	0.98	111 x 155 x 170	5.9
i950-C22/400-3	EZAELN3045B651		45	0.65	112 x 185 x 200	8.3
i950-C30/400-3	EZAELN3063B471		63	0.47	122 x 185 x 210	9.7
i950-C45/400-3	EZAELN3080B371		80	0.37	125 x 210 x 240	12.5
i950-C55/400-3	EZAELN3100B301		100	0.3	154 x 267 x 205	16.3
i950-C75/400-3	EZAELN3160B191		160	0.19	189 x 291 x 215	22
i950-C90/400-3	EZAELN3180B171		180	0.17	184 x 316 x 235	25
i950-C110/400-3	EZAELN3200B151		200	0.15	160 x 352 x 265	

RFI filters / Mains filters

Basic information on RFI filters, mains filters and EMC: 298

RFI filters/mains filters can be used both in the side structure and in the substructure.

Short distance filter

- Filter type: RFI filter
- Operation on 300-mA residual current circuit breaker possible

i950-C15/400-3

In addition to the RFI filter, the EZAELN3025B122 mains choke must be connected.

i950-C4.0/400-3

To meet the EMC requirements of EN IEC 61800-3, when using the I0FAE240F100S0001S filter, the lower screw marked "IT" on the product must be removed.

Inverters	Filter				Max. motor cable length shielded					
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1		C2		C3	
		A	mm	kg	m	kHz	m	kHz		
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	2	50	2	-	-
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	4	50	4	-	-
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	8	50	8	-	-
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	16	50	16	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	2	50	2	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	4	50	4	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	8	50	8	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	16	50	16	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	2	50	2	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	4	50	4	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	8	50	8	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	16	50	16	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	2	50	2	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	4	50	4	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	8	50	8	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	16	50	16	-	-
i950-C7.5/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	4	50	4	-	-
i950-C7.5/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	8	50	8	-	-
i950-C11/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	4	50	4	-	-
i950-C11/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	8	50	8	-	-
i950-C15/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	4	50	4	-	-
i950-C15/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	8	50	8	-	-

Long distance filter

- Filter type up to 15 kW: RFI filter
- Filter type from 22 kW: Mains filter (combination of RFI filter and mains choke)
- Operation with 300 mA residual current circuit breaker possible

i950-C15/400-3

In addition to the RFI filter, the EZAELN3025B122 mains choke must be connected.

Inverters	Filter				Max. motor cable length shielded					
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1		C2		C3	
		A	mm	kg	m	kHz	m	kHz		
i950-C0.55/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	4	50	4	-	-
i950-C0.55/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	8	50	8	-	-
i950-C0.75/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	4	50	4	-	-
i950-C0.75/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	8	50	8	-	-
i950-C2.2/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	4	50	4	-	-
i950-C2.2/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	8	50	8	-	-
i950-C4.0/400-3	I0FAE240F100D0001S	14	346 x 60 x 50	1.42	50	4	100	4	-	-
i950-C4.0/400-3	I0FAE240F100D0001S	14	346 x 60 x 50	1.42	50	8	100	8	-	-
i950-C7.5/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	4	100	4	-	-
i950-C7.5/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	8	100	8	-	-
i950-C11/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	4	100	4	-	-
i950-C11/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	8	100	8	-	-
i950-C15/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	4	100	4	-	-
i950-C15/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	8	100	8	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	2	100	2	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	4	100	4	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	8	100	8	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	16	100	16	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	2	100	2	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	4	100	4	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	8	100	8	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	16	100	16	-	-
i950-C45/400-3	I0FAE345F100D0001S	100	590 x 250 x 105	32	50	2	100	2	-	-
i950-C45/400-3	I0FAE345F100D0001S	100	590 x 250 x 105	32	50	4	100	4	-	-
i950-C55/400-3	I0FAE355F100D0001S	120	700 x 250 x 105	36	50	4	100	4	-	-
i950-C55/400-3	I0FAE355F100D0001S	120	700 x 250 x 105	36	50	8	100	8	-	-
i950-C75/400-3	I0FAE375F100D0001S	162	700 x 250 x 105	42	50	4	100	4	-	-
i950-C75/400-3	I0FAE375F100D0001S	162	700 x 250 x 105	42	50	8	100	8	-	-
i950-C90/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	4	-	-
i950-C90/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	8	-	-
i950-C110/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	4	-	-
i950-C110/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	8	-	-
i950-C130/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C130/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C130/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-
i950-C160/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C160/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C160/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-
i950-C200/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C200/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C200/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-
i950-C250/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C250/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C250/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-

3-phase mains connection 480 V

Rated data

Product name			**i950-C0.55/400-3**	**i950-C0.75/400-3**	**i950-C2.2/400-3**	**i950-C4.0/400-3**
Rated power	P_{rated}	**kW**	**0.55**	**0.75**	**2.2**	**4**
Rated power	P_{rated}	**hp**	**0.75**	**1**	**3**	**5**
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 480			
Rated mains current						
without mains choke		A	2.1	2.8	6.5	10.5
with mains choke		A	1.7	2.2	4.4	7.5
Apparent output power		kVA	1.2	1.6	3.8	6.4
Rated output current						
2 kHz		A	1.6	2.1	4.8	8.2
4 kHz		A	1.6	2.1	4.8	8.2
8 kHz		A	1.6	2.1	4.8	6.2
16 kHz		A	1.1	1.4	2.2	2.5
Power loss						
On standby		W	15	15	15	15
2 kHz		W	33	39	71	111
4 kHz		W	34	41	75	117
8 kHz		W	40	49	94	149
16 kHz		W	40	49	94	149
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	2.4	3.2	7.2	12.3
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	1.2	1.6	3.6	6.2
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	3.2	4.2	9.6	16.4
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	1.2	1.6	3.6	6.2
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20			
Category C3 (≤ 8 kHz)		m	35			
Max. motor cable length unshielded						
without EMC category		m	100			

Product name			i950-C7.5/400-3	i950-C11/400-3	i950-C15/400-3	i950-C22/400-3
Rated power	P_{rated}	**kW**	**7.5**	**11**	**15**	**22**
Rated power	P_{rated}	**hp**	**10**	**15**	**20**	**30**
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 480			
Rated mains current						
without mains choke		A	16.6	23.7	-	
with mains choke		A	13.1	18.6	24	35.3
Apparent output power		kVA	11	16	22	32
Rated output current						
2 kHz		A	14	21	27	40.4
4 kHz		A	14	21	27	40.4
8 kHz		A	14	21	19.8	40.4
16 kHz		A	7.8		7.2	26.9
Power loss						
On standby		W	20	20	20	32
2 kHz		W	186	256	342	505
4 kHz		W	197	272	363	536
8 kHz		W	252	351	471	694
16 kHz		W	252	351	471	694
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	21	31.5	40.5	61
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	10.5	15.8	20.3	30
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	28	42	54	81
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	10.5	15.8	20.3	30
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	100			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20			
Category C3 (≤ 8 kHz)		m	35			
Max. motor cable length unshielded						
without EMC category		m	200			

Product name			i950-C30/400-3	i950-C45/400-3	i950-C55/400-3	i950-C75/400-3
Rated power	P_{rated}	**kW**	**30**	**45**	**55**	**75**
Rated power	P_{rated}	**hp**	**40**	**60**	**75**	**100**
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 480			
Rated mains current						
without mains choke		A	-			
with mains choke		A	45.7	66.7	83	113
Apparent output power		kVA	41	60	75	100
Rated output current						
2 kHz		A	52	77	96	124
4 kHz		A	52	77	96	124
8 kHz		A	52	77	96	124
16 kHz		A	34.6	51.3	66.8	78.5
Power loss						
On standby		W	39	39	44	44
2 kHz		W	653	934	1151	1553
4 kHz		W	694	994	1224	1654
8 kHz		W	898	1292	1593	2157
16 kHz		W	898	1292	1593	2157
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	78	116	144	186
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	39	58	72	93
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	104	154	192	248
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	39	58	72	93
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	100		200	
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20			
Category C3 (≤ 8 kHz)		m	35		100	
Max. motor cable length unshielded						
without EMC category		m	200		400	

Product name			i950-C90/400-3	i950-C110/400-3	i950-C130/400-3	i950-C160/400-3
Rated power	P_{rated}	**kW**	**90**	**110**	**132**	**160**
Rated power	P_{rated}	**hp**	**125**	**150**	**180**	**200**
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		V	3 AC 0 ... 480			
Rated mains current						
without mains choke		A	-		236	285
with mains choke		A	146	168	-	
Apparent output power		kVA	121	142	164	196
Rated output current						
2 kHz		A	156	180	245	292
4 kHz		A	156	180	209	250
8 kHz		A	140	162	140	167
16 kHz		A	85.8	90	-	
Power loss						
On standby		W	44	44	44	44
2 kHz		W	1855	2177	3300	4100
4 kHz		W	1975	2319	3300	4100
8 kHz		W	2326	2731	3300	4100
16 kHz		W	2326	2731	-	-
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	234	270	314	375
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	117	135	157	188
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	312	360	418	500
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	117	135	157	188
Cyclic mains switching			3-mal pro Minute			
Max. motor cable length shielded						
without EMC category		m	200			
Category C1 (≤ 8 kHz)		m	-			
Category C2 (≤ 8 kHz)		m	20		-	
Category C3 (≤ 8 kHz)		m	100		150	
Max. motor cable length unshielded						
without EMC category		m	400			

Product name			i950-C200/400-3	i950-C250/400-3
Rated power	P_{rated}	**kW**	**200**	**250**
Rated power	P_{rated}	**hp**	**250**	**320**
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz	
Output voltage		V	3 AC 0 ... 480	
Rated mains current				
without mains choke		A	349	436
with mains choke		A	-	
Apparent output power		kVA	245	308
Rated output current				
2 kHz		A	366	460
4 kHz		A	313	368
8 kHz		A	240	228
16 kHz		A	-	
Power loss				
On standby		W	44	44
2 kHz		W	4900	6200
4 kHz		W	4900	6200
8 kHz		W	4900	6200
16 kHz		W	-	-
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	470	552
Overload time	T_1	s	60	60
Recovery time	T_2	s	120	120
Max. output current during the recovery time		A	235	276
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	626	736
Overload time	T_1	s	3	3
Recovery time	T_2	s	12	12
Max. output current during the recovery time		A	235	276
Cyclic mains switching			3-mal pro Minute	
Max. motor cable length shielded				
without EMC category		m	200	
Category C1 (≤ 8 kHz)		m	-	
Category C2 (≤ 8 kHz)		m	-	
Category C3 (≤ 8 kHz)		m	150	
Max. motor cable length unshielded				
without EMC category		m	400	

Brake chopper						
Product name			**i950-C0.55/400-3**	**i950-C0.75/400-3**	**i950-C2.2/400-3**	**i950-C4.0/400-3**
Switch-on threshold		V	780			
Min. brake resistance		Ω	390		150	47
Rated output current		A	2		5.2	16.6
Max. output current		A	2		5.2	16.6
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper						
Product name			**i950-C7.5/400-3**	**i950-C11/400-3**	**i950-C15/400-3**	**i950-C22/400-3**
Switch-on threshold		V	780			
Min. brake resistance		Ω	27		18	15
Rated output current		A	29		43	52
Max. output current		A	29		43	52
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper						
Product name			**i950-C30/400-3**	**i950-C45/400-3**	**i950-C55/400-3**	**i950-C75/400-3**
Switch-on threshold		V	780			
Min. brake resistance		Ω	7.5		4.7	
Rated output current		A	104		166	
Max. output current		A	104		166	
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper						
Product name			**i950-C90/400-3**	**i950-C110/400-3**	**i950-C130/400-3**	**i950-C160/400-3**
Switch-on threshold		V	780			
Min. brake resistance		Ω	2.3		2.8	2.3
Rated output current		A	275		279	339
Max. output current		A	275		279	339
Switch-on time (I_{max})			-			
Recovery time (I = 0 A)			-			
Max. cable length						
shielded		m	10			
unshielded		m	0.5			

Brake chopper				
Product name			**i950-C200/400-3**	**i950-C250/400-3**
Switch-on threshold		V	780	
Min. brake resistance		Ω	1.8	1.4
Rated output current		A	446	557
Max. output current		A	446	557
Switch-on time (I_{max})			-	
Recovery time (I = 0 A)			-	
Max. cable length				
shielded		m	10	
unshielded		m	0.5	

Fusing data (EN 60204-1)

- A residual current device (**RCD**) is optional.
- **Icc** = Rated conditional short-circuit current
- Fusing data for UL/NEC compliant installations:
  ▶ Connection according to UL, Fusing data 📖 69

Inverters	Fuse			Circuit breaker			RCD	
	Icc	Characteristic	Max. rated current	Icc	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
i950-C0.55/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C0.75/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C2.2/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C4.0/400-3	65	gG	16	65	B, C	16	≥ 30	Typ B
i950-C7.5/400-3	65	gG	50	65	B, C	50	≥ 300	Typ B
i950-C11/400-3	65	gG	50	65	B, C	50	≥ 300	Typ B
i950-C15/400-3	65	gG	50	65	B, C	50	≥ 300	Typ B
i950-C22/400-3	65	gG	63	65	B, C	63	≥ 300	Typ B
i950-C30/400-3	22	gG	80	35	B, C	125	≥ 300	Typ B
i950-C45/400-3	22	gG	125	35	B, C	125	≥ 300	Typ B
i950-C55/400-3	22	gR	160	35	B, C	160	≥ 300	Typ B
i950-C75/400-3	22	gR	160	35	B, C	160	≥ 300	Typ B
i950-C90/400-3	22	gR	300	10	B, C	300	≥ 300	Typ B
i950-C110/400-3	22	gR	300	10	B, C	300	≥ 300	Typ B
i950-C130/400-3	100	gR	350	-	-		≥ 300	Typ B
i950-C160/400-3	100	gR	400	-	-		≥ 300	Typ B
i950-C200/400-3	100	gR	450	-	-		≥ 300	Typ B
i950-C250/400-3	100	gR	450	-	-		≥ 300	Typ B

Connection data

Rated power	P_{rated}	kW	0.55 ... 4	7.5 ... 15	22	30 ... 45	55 ... 75	90 ... 110	132	160	200 ... 250
Connection			**Mains**								
Connection designation			**X100**								
Connection system			Screw terminal						Screw		
Connection type			Pluggable		Non-pluggable				-		
Max. cable cross-section		mm²	2.5	16	35	50	95	150	-	-	-
Max. cable cross-section		AWG	12	6	2	1/0	4/0	300 kcmil	-	-	-
Min. cable cross-section		mm²	0.25	0.5	1.5	10	25	35	-	-	-
Min. cable cross-section		AWG	22	20	16	6	2	1	-	-	-
Stripping length		mm	8	12	18	22	32	41	-	-	-
Stripping length		in	0.32	0.47	0.7	0.87	1.25	1.6	-	-	-
Tightening torque		Nm	0.6	1.8	3.8	4	10	18	-	47	35
Tightening torque		lb-in	5.3	16	34	35	90	160	-	416	315
Required tools			Screwdriver 0.5 x 3.0	Screwdriver 0.8 x 4.0	Screwdriver 1.0 x 5.5	Hex key 5.0	Hex key 6.0	Hex key 8.0	Hex key 10.0	Wrench size 17	Wrench size 24

Rated power	P_{rated}	kW	0.55 ... 4	7.5 ... 15	22	30 ... 75	90 ... 110	132 ... 160	200 ... 250
Connection			**Protective earth (PE)**						
Connection designation			**Symbol for protective earth (PE)**						
Connection system			Screw				Bolt	Screw	Bolt
Max. cable cross-section		mm²	6	16	25	35	150	120	150
Max. cable cross-section		AWG	10	6	4	2	300 kcmil	4/0	300
Min. cable cross-section		mm²	1.5	2.5	4	4	4	-	-
Min. cable cross-section		AWG	16	14	12	12	12	-	-
Stripping length		mm	10	12	16	16	-	-	-
Stripping length		in	0.4	0.47	0.63	0.63	-	-	-
Tightening torque		Nm	2	3.4	4	4	10	8	20
Tightening torque		lb-in	18	30	35	35	90	71	180
Required tools			Torx key 20	Crosstip screwdriver PZ2			Wrench size 13	-	Wrench size 17

Rated power	P_{rated}	kW	0.55 ... 4	7.5 ... 15	22	30 ... 45	55 ... 75	90 ... 110	132	160	200 ... 250
Connection			**Motor**								
Connection designation			**X105**								
Connection system			Screw terminal						Screw		
Connection type			Pluggable		Non-pluggable				-		
Max. cable cross-section		mm²	2.5	16	35	50	95	150	-	-	-
Max. cable cross-section		AWG	12	6	2	1/0	4/0	300 kcmil	-	-	-
Min. cable cross-section		mm²	0.25	0.5	1.5	10	25	35	-	-	-
Min. cable cross-section		AWG	22	20	16	6	2	1	-	-	-
Stripping length		mm	8	12	18	22	32	41	-	-	-
Stripping length		in	0.32	0.47	0.7	0.87	1.25	1.6	-	-	-
Tightening torque		Nm	0.6	1.8	3.8	4	10	18	-	47	35
Tightening torque		lb-in	5.3	16	34	35	90	160	-	416	315
Required tools			Screwdriver 0.5 x 3.0	Screwdriver 0.8 x 4.0	Screwdriver 1.0 x 5.5	Hex key 5.0	Hex key 6.0	Hex key 8.0	Hex key 10.0	Wrench size 17	Wrench size 24

The terminal data for the terminal X1 can be found under: ▶ Basic Safety - STO 📖 105

The terminal data for the terminals X82 and X83 can be found under: ▶ Connection data 📖 110

Brake resistors

Lenze provides selection tables for easy and quick selection of a brake resistor.

Application class	Meaning	Examples
Dynamic load	Compensation of low, sporadic voltage peaks	Overshoot due to backlash-affected mechanics at the end of the acceleration phase Transfer of conveyed material to downstream conveyor line
Emergency stop	Compensation of regenerative energy during an emergency stop	Braking after pressing the emergency stop button
Passive load	Compensation of regenerative energy during horizontal movement	Braking of slides on machine tools or rotary tables
Active load	Compensation of regenerative energy during vertical movement	Braking hoists

Inverters	Brake resistor			
	Dynamic load	Emergency stop	Passive load	Active load
i950-C0.55/400-3	ERBU390R035WUQN000	ERBU390R035WUQN000	ERBM390R100W	ERBM390R100W
i950-C0.75/400-3	ERBU390R035WUQN000	ERBU390R035WUQN000	ERBM390R100W	ERBM390R100W
i950-C2.2/400-3	ERBU150R035WUQN000	ERBP180R200W	ERBP180R300W	ERBS180R350WNQN000
i950-C4.0/400-3	ERBU150R035WUQN000	ERBM047R135W	ERBS047R400W	ERBS047R800W
i950-C7.5/400-3	ERBP027R200W	ERBP027R200W	ERBS027R600W	ERBS027R01K4
i950-C11/400-3	ERBP027R200W	ERBS027R600W	ERBS027R01K2	ERBS027R01K4
i950-C15/400-3	ERBP018R300W	ERBP018R300W	ERBS018R01K4	ERBG018R04K3
i950-C22/400-3	ERBS015R800W	ERBS015R800W	ERBS015R02K4	ERBG015R06K2
i950-C30/400-3	ERBG075D01K9	ERBG075D01K9	ERBG075D04K5WBN000	ERBG075D15K0WBN000
i950-C45/400-3	ERBG075D01K9	ERBG075D01K9	ERBG075D04K5WBN000	ERBG075D15K0WBN000
i950-C55/400-3	ERBG005R02K6	ERBG005R02K6	ERBG005R10K0WBN000	ERBG005R22K0WBN000
i950-C75/400-3	ERBG005R02K6	ERBG005R02K6	ERBG005R10K0WBN000	ERBG005R22K0WBN000
i950-C90/400-3	ERBG028D04K1	ERBG028D04K1	ERBG028D11K0WBN000	ERBG028D34K0WBN000
i950-C110/400-3	ERBG028D04K1	ERBG028D04K1	ERBG028D11K0WBN000	ERBG028D34K0WBN000
i950-C130/400-3		ERBG028D04K1		
i950-C160/400-3		ERBG023D05K6		
i950-C200/400-3		ERBG035D03K3		
i950-C250/400-3		ERBG028D04K1		

The assignment via the mains voltage and the rated power of the inverter is a non-binding recommendation. This recommended assignment of the brake resistors is electrically protected via the assigned mains fuses of the inverters. For other assignments, the assignment of the mains fuses to the brake resistors must be checked.

Brake resistor								
Type designation	R_B	P_D	Q_B	V_{Max}	Degree of protection	Thermal protection	m	H x W x D
	Ω	W	kWs	V			kg	mm
ERBU150R035WUQN000	150	35	0.418	800	IP20	eigensicher	0.38	278 x 60 x 27.5
ERBU390R035WUQN000	390	35	0.418	800	IP20	eigensicher	0.38	278 x 60 x 27.5
ERBS015R800W	15	800	120	800	IP66	Thermokontakt	4	710 x 114 x 105
ERBS015R02K4	15	2400	360	800	IP66	Thermokontakt	10	1020 x 204 x 105
ERBS018R01K4	18	1400	210	800	IP66	Thermokontakt	6.3	1110 x 114 x 105
ERBS027R600W	27	600	90	800	IP66	Thermokontakt	3.1	550 x 114 x 105
ERBS027R01K2	27	1200	180	800	IP66	Thermokontakt	5.6	1020 x 114 x 105
ERBS027R01K4	27	1400	210	800	IP66	Thermokontakt	6.3	1110 x 114 x 105
ERBS047R400W	47	400	60	800	IP66	Thermokontakt	2.3	400 x 114 x 105
ERBS047R800W	47	800	120	800	IP66	Thermokontakt	4	710 x 114 x 105
ERBS180R350WNQN000	180	350	53	850	IP66	Thermokontakt	2.1	382 x 124 x 122
ERBP018R300W	18	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBP027R200W	27	200	30	800	IP23	Thermokontakt	1	240 x 42 x 122
ERBP180R200W	180	200	30	800	IP23	Thermokontakt	1	240 x 42 x 122
ERBP180R300W	180	300	45	800	IP23	Thermokontakt	1.4	320 x 42 x 122
ERBM047R135W	47	135	6.3	800	IP23	Thermokontakt	0.67	216 x 80 x 28
ERBM390R100W	390	100	15	850	IP54	Thermokontakt	0.37	235 x 20.6 x 40
ERBG023D05K6	2.3	5600	840	1000	IP20	Thermokontakt	15.9	302 x 486 x 426
ERBG028D04K1	2.8	4100	615	1000	IP20	Thermokontakt	12.8	302 x 486 x 426
ERBG028D11K0WBN000	2.8	11000	1650	1000	IP20	Thermokontakt	28	302 x 486 x 736
ERBG028D34K0WBN000	2.8	34000	5100	1000	IP20	Thermokontakt	90	1020 x 486 x 736
ERBG035D03K3	3.5	3300	495	1000	IP20	Thermokontakt	12.6	302 x 486 x 326
ERBG005R02K6	5	2600	390	1000	IP20	Thermokontakt	11	302 x 486 x 326
ERBG005R10K0WBN000	5	10000	1500	1000	IP20	Thermokontakt	27	302 x 486 x 736
ERBG005R22K0WBN000	5	22000	3300	1000	IP20	Thermokontakt	54	600 x 486 x 736
ERBG075D01K9	7.5	1900	285	1000	IP20	Thermokontakt	9.5	302 x 486 x 236
ERBG075D04K5WBN000	7.5	4500	675	1000	IP20	Thermokontakt	15	302 x 486 x 426
ERBG075D15K0WBN000	7.5	15000	2250	1000	IP20	Thermokontakt	38	600 x 486 x 526
ERBG015R06K2	15	6200	930	1000	IP20	Thermokontakt	17	302 x 486 x 526
ERBG018R04K3	18	4300	645	1000	IP20	Thermokontakt	13.5	302 x 486 x 426

For more information on brake resistors and their design, please refer to the brochure ": Accessories for VFDs and servo drives"".

Mains chokes

Inverters	Netzdrossel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i950-C0.55/400-3	EZAELN3002B153	3	2	14.7	56 x 77 x 100	0.53
i950-C0.75/400-3	EZAELN3004B742		4	7.35	60 x 95 x 117	1.31
i950-C2.2/400-3	EZAELN3006B492		6	4.9	69 x 95 x 117	1.45
i950-C4.0/400-3	EZAELN3008B372		8	3.68	85 x 120 x 140	1.9
i950-C7.5/400-3	EZAELN3016B182		16	1.84	95 x 120 x 140	2.7
i950-C11/400-3	EZAELN3020B152		20	1.47	95 x 155 x 165	3.8
i950-C15/400-3	EZAELN3025B122		25	1.18	110 x 155 x 170	5.8
i950-C22/400-3	EZAELN3040B741		40	0.74	102 x 185 x 195	6.8
i950-C30/400-3	EZAELN3050B591		50	0.59	112 x 185 x 210	8.4
i950-C45/400-3	EZAELN3080B371		80	0.37	125 x 210 x 240	12.5
i950-C55/400-3	EZAELN3090B331		90	0.33	130 x 267 x 205	11
i950-C75/400-3	EZAELN3125B241		125	0.24	160 x 291 x 215	17.1
i950-C90/400-3	EZAELN3160B191		160	0.19	189 x 291 x 215	22
i950-C110/400-3	EZAELN3180B171		180	0.17	184 x 316 x 235	25

RFI filters / Mains filters

Basic information on RFI filters, mains filters and EMC: 298

RFI filters/mains filters can be used both in the side structure and in the substructure.

Short distance filter

- Filter type: RFI filter
- Operation on 300-mA residual current circuit breaker possible

i950-C15/400-3

In addition to the RFI filter, the EZAELN3025B122 mains choke must be connected.

i950-C4.0/400-3

To meet the EMC requirements of EN IEC 61800-3, when using the I0FAE240F100S0001S filter, the lower screw marked "IT" on the product must be removed.

Inverters	Filter				Max. motor cable length shielded					
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1		C2		C3	
		A	mm	kg	m	kHz	m	kHz		
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	2	50	2	-	-
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	4	50	4	-	-
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	8	50	8	-	-
i950-C0.55/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	16	50	16	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	2	50	2	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	4	50	4	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	8	50	8	-	-
i950-C0.75/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	16	50	16	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	2	50	2	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	4	50	4	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	8	50	8	-	-
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.01	25	16	50	16	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	2	50	2	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	4	50	4	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	8	50	8	-	-
i950-C4.0/400-3	I0FAE240F100S0001S	14	346 x 60 x 50	1.42	25	16	50	16	-	-
i950-C7.5/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	4	50	4	-	-
i950-C7.5/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	8	50	8	-	-
i950-C11/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	4	50	4	-	-
i950-C11/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	8	50	8	-	-
i950-C15/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	4	50	4	-	-
i950-C15/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4	25	8	50	8	-	-

Long Distance filter

- Filter type up to 15 kW: RFI filter
- Filter type from 22 kW: Mains filter (combination of RFI filter and mains choke)
- Operation with 300 mA residual current circuit breaker possible

i950-C15/400-3

In addition to the RFI filter, the EZAELN3025B122 mains choke must be connected.

Inverters	Filter				Max. motor cable length shielded					
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1		C2		C3	
		A	mm	kg	m	kHz	m	kHz		
i950-C0.55/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	4	50	4	-	-
i950-C0.55/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	8	50	8	-	-
i950-C0.75/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	4	50	4	-	-
i950-C0.75/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	8	50	8	-	-
i950-C2.2/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	4	50	4	-	-
i950-C2.2/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.03	50	8	50	8	-	-
i950-C4.0/400-3	I0FAE240F100D0001S	14	346 x 60 x 50	1.42	50	4	100	4	-	-
i950-C4.0/400-3	I0FAE240F100D0001S	14	346 x 60 x 50	1.42	50	8	100	8	-	-
i950-C7.5/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	4	100	4	-	-
i950-C7.5/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	8	100	8	-	-
i950-C11/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	4	100	4	-	-
i950-C11/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	8	100	8	-	-
i950-C15/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	4	100	4	-	-
i950-C15/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1	50	8	100	8	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	2	100	2	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	4	100	4	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	8	100	8	-	-
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 202 x 90	14	50	16	100	16	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	2	100	2	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	4	100	4	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	8	100	8	-	-
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23	50	16	100	16	-	-
i950-C45/400-3	I0FAE345F100D0001S	100	590 x 250 x 105	32	50	2	100	2	-	-
i950-C45/400-3	I0FAE345F100D0001S	100	590 x 250 x 105	32	50	4	100	4	-	-
i950-C55/400-3	I0FAE355F100D0001S	120	700 x 250 x 105	36	50	4	100	4	-	-
i950-C55/400-3	I0FAE355F100D0001S	120	700 x 250 x 105	36	50	8	100	8	-	-
i950-C75/400-3	I0FAE375F100D0001S	162	700 x 250 x 105	42	50	4	100	4	-	-
i950-C75/400-3	I0FAE375F100D0001S	162	700 x 250 x 105	42	50	8	100	8	-	-
i950-C90/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	4	-	-
i950-C90/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	8	-	-
i950-C110/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	4	-	-
i950-C110/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	100	8	-	-
i950-C130/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C130/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C130/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-
i950-C160/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C160/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C160/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-
i950-C200/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C200/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C200/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-
i950-C250/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	2	-	-
i950-C250/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	4	-	-
i950-C250/400-3	I0FAE411F100D0001S	234	855 x 250 x 130	63	-	-	150	8	-	-

Ecodesign Directive

Product information acc. to REGULATION (EU) 2019/1781 (ANNEX I, Section 4)

Legend

Operating point (f; I)	f = relative motor stator frequency; I = relative torque-producing current
Power losses	The power losses at the operating points (f; I) and in the standby state refer to the rated apparent output power. The power losses for options (e.g. for diagnostics) and for accessories can be found in the additional product documentation on the Internet.

Performance losses										
0; 25	f; I	%	2.9	2.5	1.6	1.1	1.0	1.2	0.8	4.2
0; 50	f; I	%	2.9	2.5	1.7	1.2	1.1	1.3	1.0	4.2
0; 100	f; I	%	3.1	2.7	2.0	1.5	1.5	1.7	1.5	4.5
50; 25	f; I	%	2.9	2.5	1.6	1.2	1.1	1.2	0.9	4.3
50; 50	f; I	%	3.0	2.6	1.8	1.3	1.3	1.4	1.1	4.3
50; 100	f; I	%	3.3	2.9	2.2	1.7	1.7	2.0	1.8	4.6
90; 50	f; I	%	3.1	2.7	1.9	1.4	1.4	1.5	1.2	4.4
90; 100	f; I	%	3.4	3.1	2.4	2.0	2.1	2.2	2.0	4.8
In standby mode		%	1.5	1.3	0.9	0.5	0.3	0.2	0.2	1.3
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY							
Commercial register number			Hannover HRB 204803							
Model identifier of the product			I95BE137D	I95BE155D	I95BE175D	I95BE215D	I95BE222C	I95BE240C	I95BE255C	I95BE155F
Apparent output power		kVA	0.9	1.2	1.6	2.6	3.6	6.2	8.7	1.2
Indicative rated output power of the motor		kW	0.37	0.55	0.75	1.5	2.2	4	5.5	0.55
Rated output current		A	2.4	3.2	4.2	7	9.6	16.5	23	1.8
Maximum operating temperature		°C	45							
Rated input frequency		Hz	50							
Rated input voltage		V	230							400
Switching frequency		kHz	4							
Rated apparent output power		kVA	0.977	1.19	1.71	3.3	4.44	7.38	9.95	1.19

Performance losses										
0; 25	f; I	%	2.5	1.3	1.3	0.8	0.6	0.7	0.6	0.6
0; 50	f; I	%	2.7	1.5	1.4	0.9	0.8	0.9	0.8	0.8
0; 100	f; I	%	2.9	1.8	1.8	1.3	1.1	1.4	1.2	1.2
50; 25	f; I	%	2.6	1.4	1.3	0.8	0.7	0.7	0.6	0.6
50; 50	f; I	%	2.7	1.6	1.5	1.0	0.8	0.9	0.8	0.8
50; 100	f; I	%	3.1	2.0	1.9	1.5	1.3	1.5	1.4	1.4
90; 50	f; I	%	2.8	1.7	1.6	1.1	0.9	1.0	0.9	0.9
90; 100	f; I	%	3.2	2.4	2.1	1.7	1.6	1.8	1.6	1.7
In standby mode		%	0.9	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY							
Commercial register number			Hannover HRB 204803							
Model identifier of the product			I95BE175F	I95BE222F	I95BE240F	I95BE275F	I95BE311F	I95BE315F	I95BE322F	I95BE330F
Apparent output power		kVA	1.6	3.8	6.4	11	16	22	32	41
Indicative rated output power of the motor		kW	0.75	2.2	4	7.5	11	15	22	30
Rated output current		A	2.4	5.6	9.5	16.5	23.5	32	47	61
Maximum operating temperature		°C	45							
Rated input frequency		Hz	50							
Rated input voltage		V	400							
Switching frequency		kHz	4							
Rated apparent output power		kVA	1.71	4.44	7.38	14.4	19.5	23.9	38.2	47

Performance losses										
0; 25	f; I	%	0.5	0.5	0.5	0.5	0.4	0.6	0.7	0.9
0; 50	f; I	%	0.7	0.6	0.7	0.7	0.5	0.7	0.9	1.2
0; 100	f; I	%	1.2	1.1	1.2	1.3	1.0	1.1	1.4	1.9
50; 25	f; I	%	0.5	0.5	0.6	0.6	0.4	0.5	0.8	1.0
50; 50	f; I	%	0.7	0.7	0.8	0.8	0.6	0.8	1.0	1.3
50; 100	f; I	%	1.3	1.2	1.5	1.5	1.2	1.4	1.6	2.2
90; 50	f; I	%	0.8	0.8	0.9	0.9	0.7	1.0	1.1	1.5
90; 100	f; I	%	1.6	1.5	1.9	1.8	1.5	1.7	2.0	2.6
In standby mode		%	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY							
Commercial register number			Hannover HRB 204803							
Model identifier of the product			I95BE345F	I95BE355F	I95BE375F	I95BE390F	I95BE411F	I95BE413F	I95BE416F	I95BE420F
Apparent output power		kVA	60	75	100	121	142	164	196	242
Indicative rated output power of the motor		kW	45	55	75	90	110	132	160	200
Rated output current		A	89	110	150	180	212	245	292	366
Maximum operating temperature		°C	45							
Rated input frequency		Hz	50							
Rated input voltage		V	400							
Switching frequency		kHz	4				2			
Rated apparent output power		kVA	68.4	92.8	111	135	162	196	196	228

Performance losses			
0; 25	f; I	%	0.8
0; 50	f; I	%	0.9
0; 100	f; I	%	1.5
50; 25	f; I	%	0.8
50; 50	f; I	%	1.1
50; 100	f; I	%	1.8
90; 50	f; I	%	1.2
90; 100	f; I	%	2.2
In standby mode		%	0.0
Efficiency level			IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY
Commercial register number			Hannover HRB 204803
Model identifier of the product			I95BE425F
Apparent output power		kVA	302
Indicative rated output power of the motor		kW	250
Rated output current		A	460
Maximum operating temperature		°C	45
Rated input frequency		Hz	50
Rated input voltage		V	400
Switching frequency		kHz	2
Rated apparent output power		kVA	287

Control connections

Digital inputs

X3: DI1, DI2, DI3, DI4 / GI			
Switching type		Positive/negative logic (parameterizable)	
Use case 1		Standard digital input	
Use case 2		Touch probe input	Maximum of 8 markers per ms detectable with a temporal resolution of 10 ns.
Switching level PNP			
LOW	V	< + 5	IEC 61131-2, type 1
HIGH	V	> + 15	
Input resistance	kΩ	4.6	
Sampling frequency of digital inputs	kHz	4	When used as standard digital input.
	MHz	100	When used as touch probe.
External-voltage protection	V	± 30	

Digital outputs

X3: DO1 / 24O / GO			
Switching level			
LOW	V	< + 5	IEC 61131-2, type 1
HIGH	V	> + 15	
Max. output current, DO1	mA	50	
Cycle time	ms	0.25	
Short-circuit strength		No time limit	
External-voltage protection	V	± 30	
Suppressor circuit		Integrated varistor	
Overload behavior		Voltage reduction or switching off and on periodically	
Time response	µs	250	LOW - HIGH / HIGH - LOW
Reset or switch-on behavior		Output is switched off	LOW

Analog inputs

Connection designation		X3/AI1+, X3/AI1-	
Sampling frequency	kHz	4	
Resolution of A/D converter	Bit	10	
Operation as voltage input			
Input voltage DC	V	0 ... 10	
		-10 ... +10	
Input resistance	kΩ	> 100	
Accuracy	mV	± 100	Typical
External-voltage protection	V	± 30	Differential
		± 50	Common mode against GND
Operation as current input			
Input current	mA	0 ... 20	
		4 ... 20	Open-circuit monitored
		2	Tripping "open-circuit"
Input resistance	Ω	250	
Accuracy	mA	± 0.4	Typical
External-voltage protection	V	± 7.5	
	V	± 30	If an overcurrent is detected, the input is switched to a voltage input.

24-V input

X5: 24E / GE			
Used for...		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	20	
Max.	W	45	Depending on the use and state of inputs and outputs.
Input current			
Typical	A	0.8	
Max.	A	2	When switching on for 50 ms
Capacity to be charged	µF	5500	
Polarity reversal protection		When polarity is reversed: No function and no irreparable damage.	
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	12.0	While looping-through.

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.

Mounting positions

- Standard for all devices
  - Installation vertically on the rear panel of the control cabinet
  - Mains connections at the top, motor connections at the bottom
- Other mounting positions for i950 0.55 kW ... 15 kW (400/480 V) and 0.37 kW ... 5.5 kW (230 V)
  - Installation rotated ±90° from the vertical on the rear panel of the control cabinet
  - Installation on a horizontal mounting plate - heat sink at the bottom, front of the device at the top

The same technical data and approvals apply as for the standard mounting position.

The same free spaces apply as for the standard mounting position.

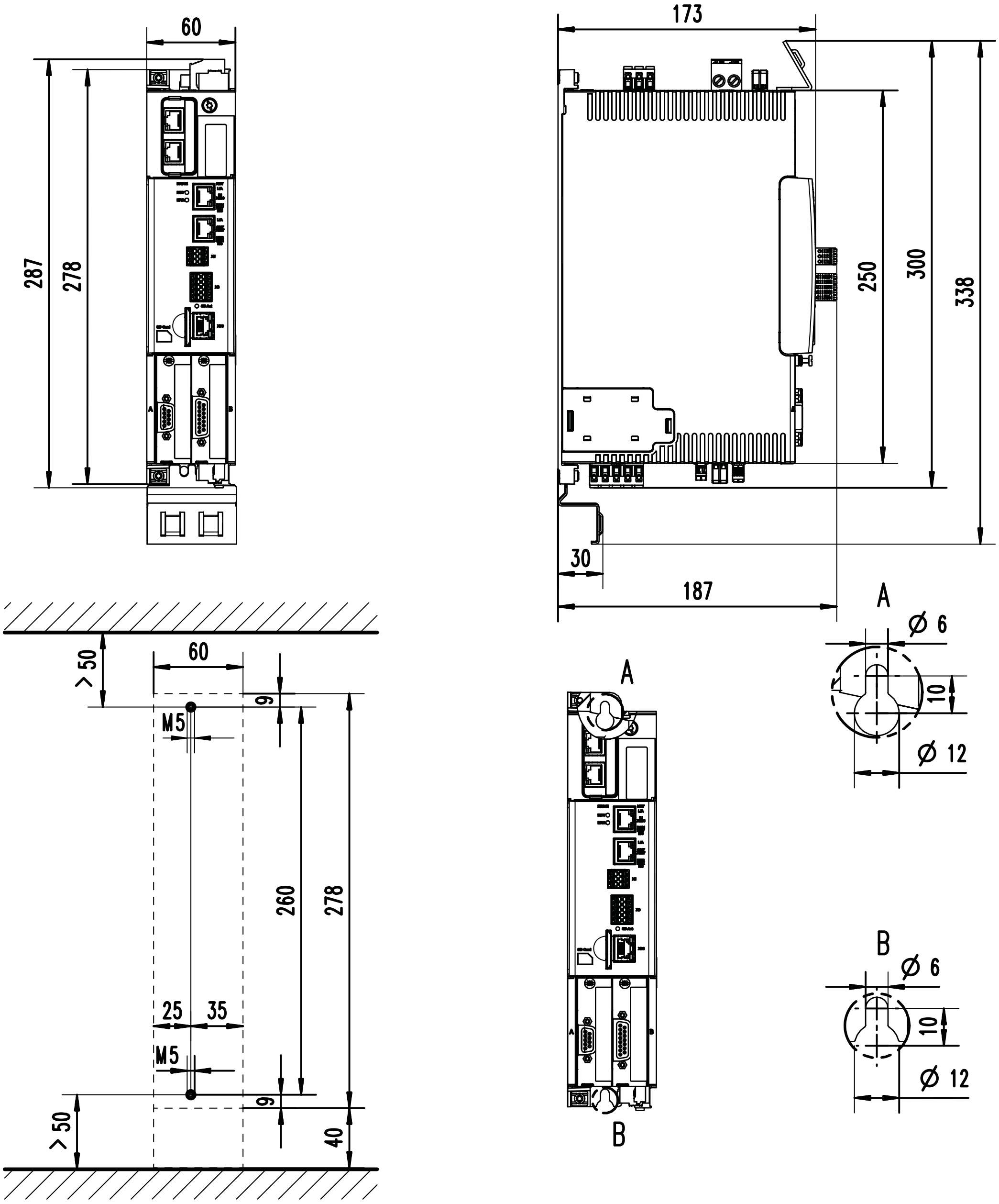
Installation clearances

- Maintain the specified installation clearances above and below to the other installations.
- Several devices of the same series can be lined up directly, regardless of the device size. No installation clearance is required between the devices.

0.37 kW ... 4 kW

The dimensions in mm apply to:

0.37 kW	i950-C0.37/230-2		
0.55 kW	i950-C0.55/230-2		i950-C0.55/400-3
0.75 kW	i950-C0.75/230-2		i950-C0.75/400-3
1.5 kW	i950-C1.5/230-2		
2.2 kW		i950-C2.2/230-3	i950-C2.2/400-3
4 kW			i950-C4.0/400-3
Weight	1.6 kg	1.6 kg	1.6 kg

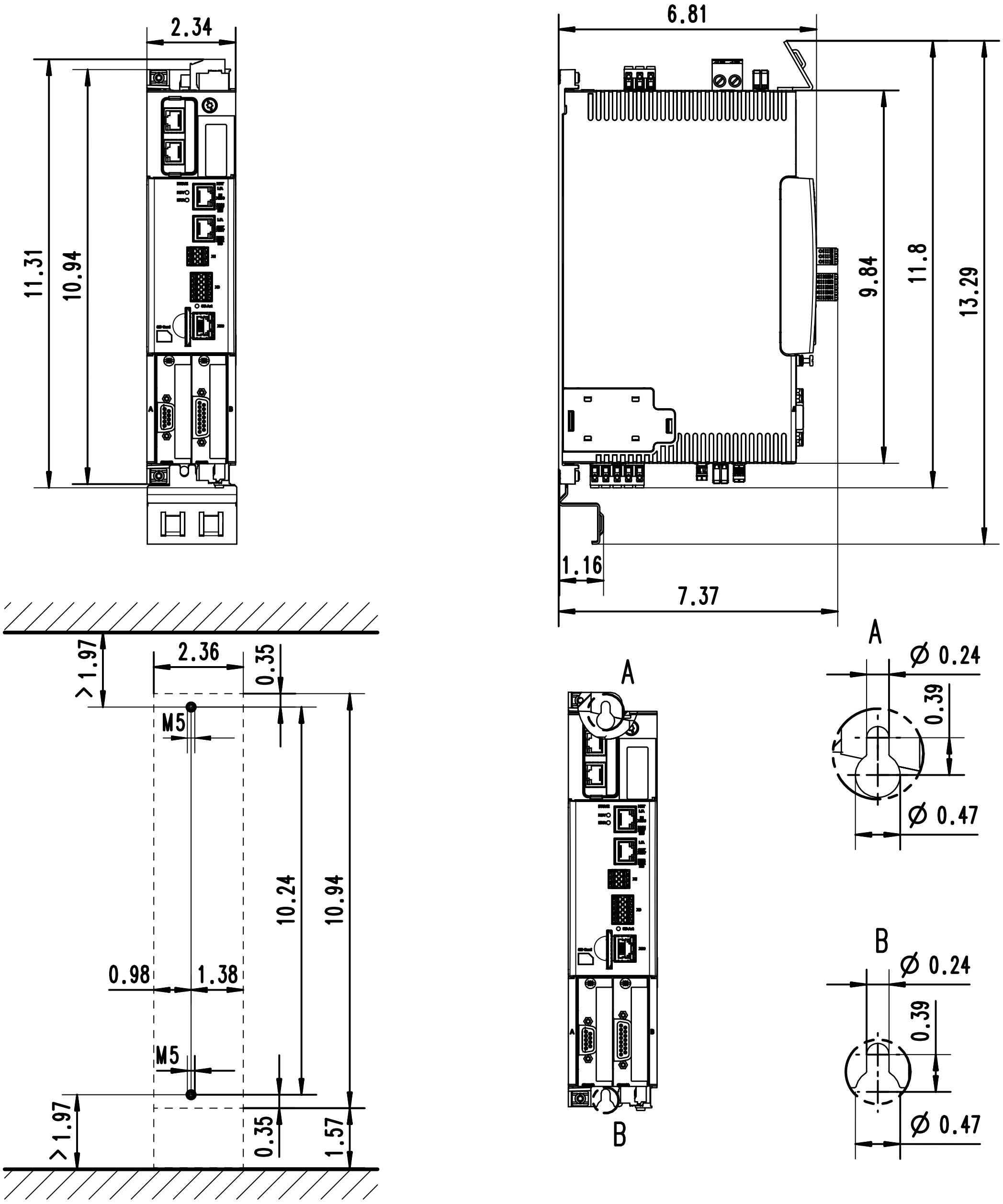


8800508

0.5 hp ... 5 hp

The dimensions in inch apply to:

0.5 hp	i950-C0.37/230-2		
0.75 hp	i950-C0.55/230-2		i950-C0.55/400-3
1 hp	i950-C0.75/230-2		i950-C0.75/400-3
2 hp	i950-C1.5/230-2		
3 hp		i950-C2.2/230-3	i950-C2.2/400-3
5 hp			i950-C4.0/400-3
Weight	3.5 lb	3.5 lb	3.5 lb

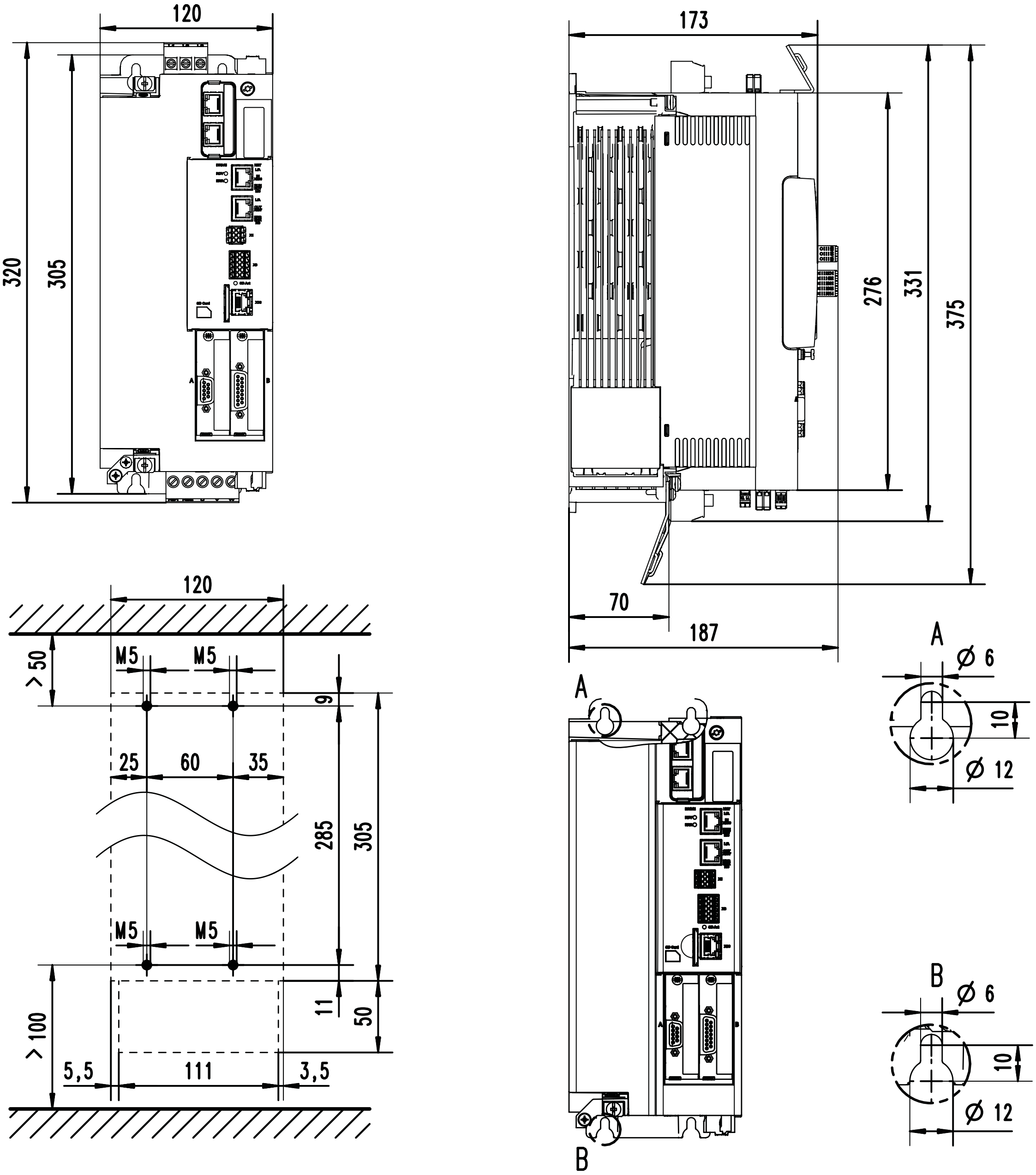


8800538

4 kW ... 15 kW

The dimensions in mm apply to:

4 kW	i950-C4.0/230-3	
5.5 kW	i950-C5.5/230-3	
7.5 kW		i950-C7.5/400-3
11 kW		i950-C11/400-3
15 kW		i950-C15/400-3
Weight	3.9 kg	3.9 kg

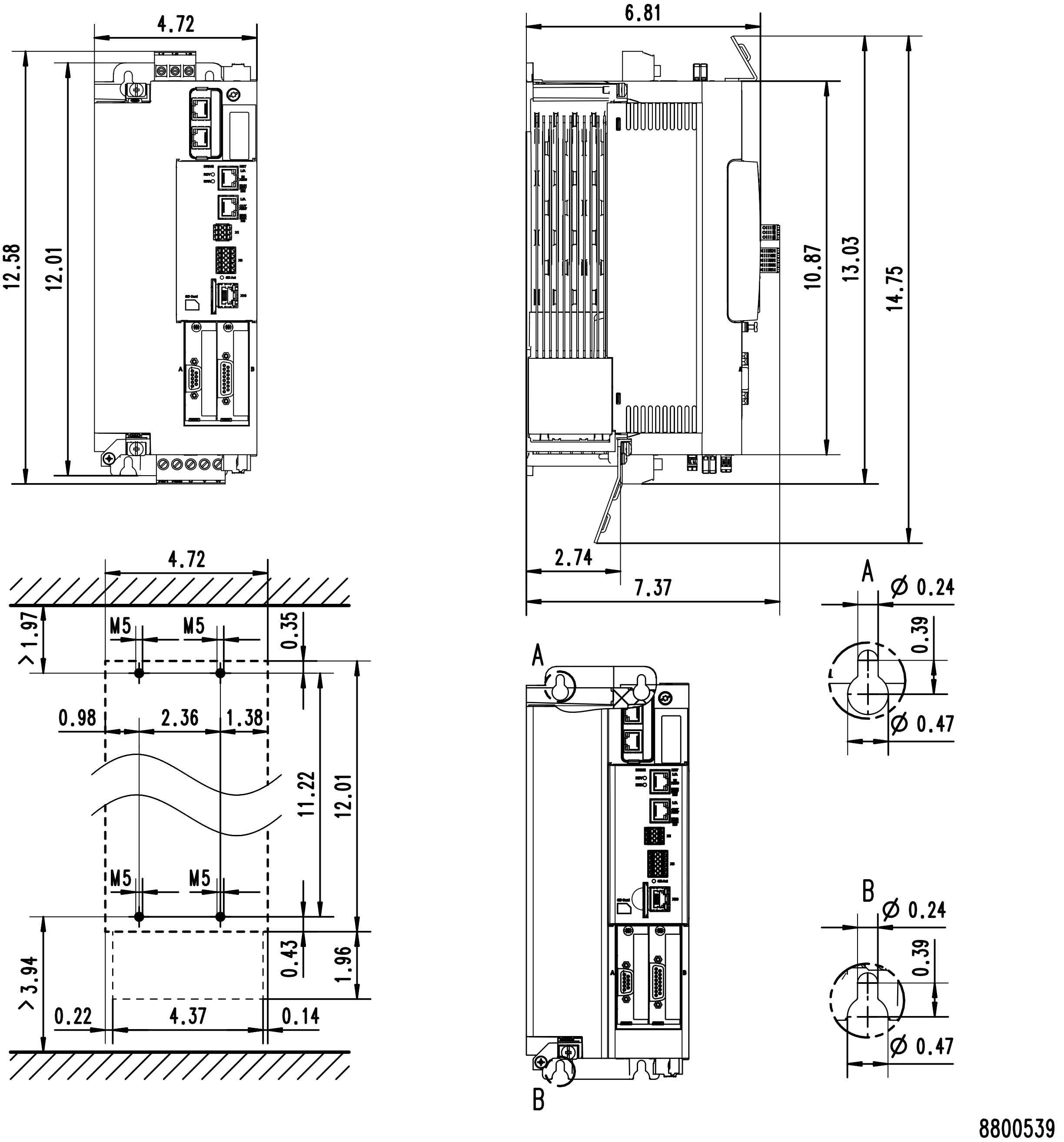


8800509

5 hp ... 20 hp

The dimensions in inch apply to:

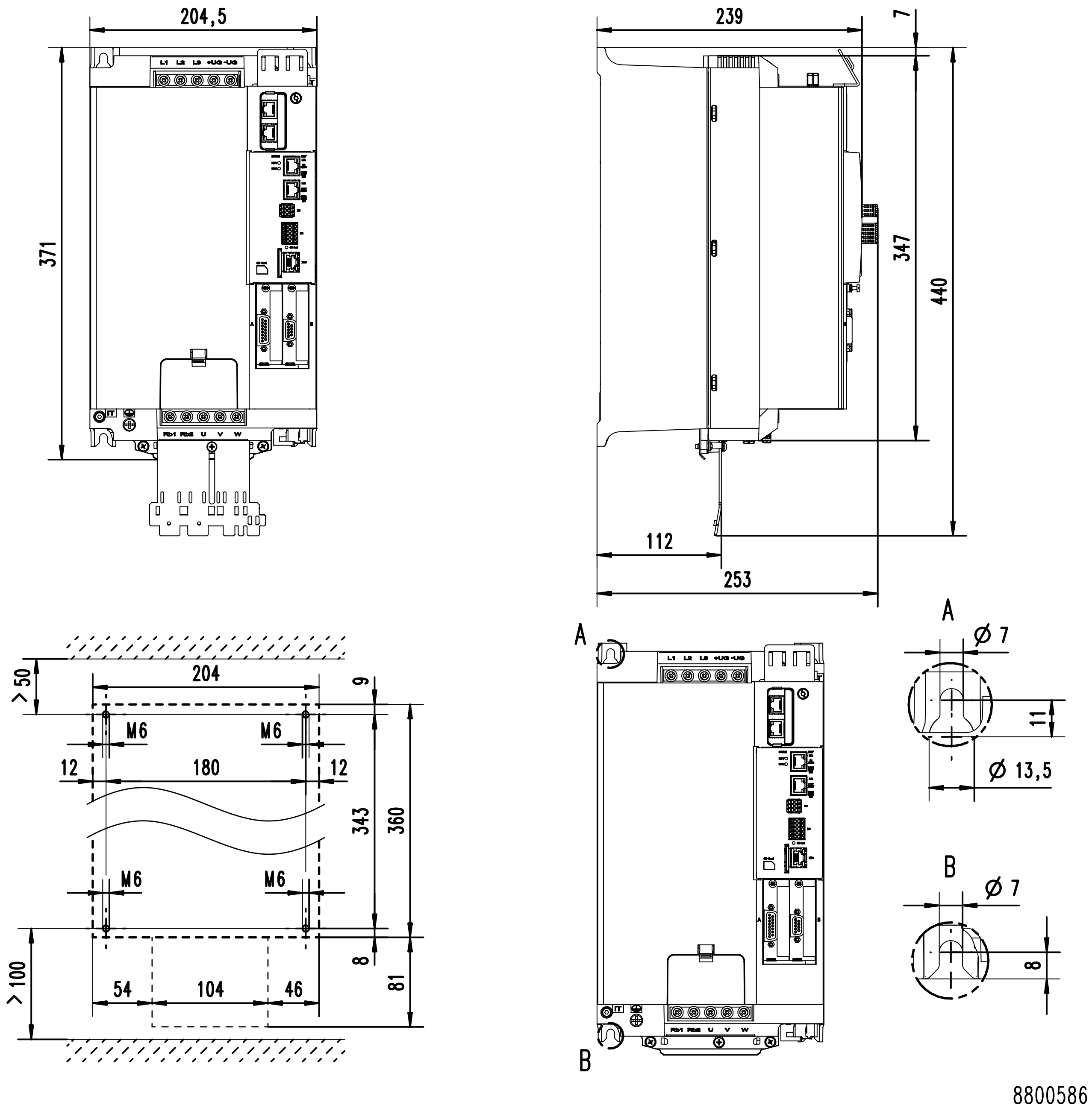
5 hp	i950-C4.0/230-3	
7.5 hp	i950-C5.5/230-3	
10 hp		i950-C7.5/400-3
15 hp		i950-C11/400-3
20 hp		i950-C15/400-3
Weight	8.6 lb	8.6 lb



22 kW

The dimensions in mm apply to:

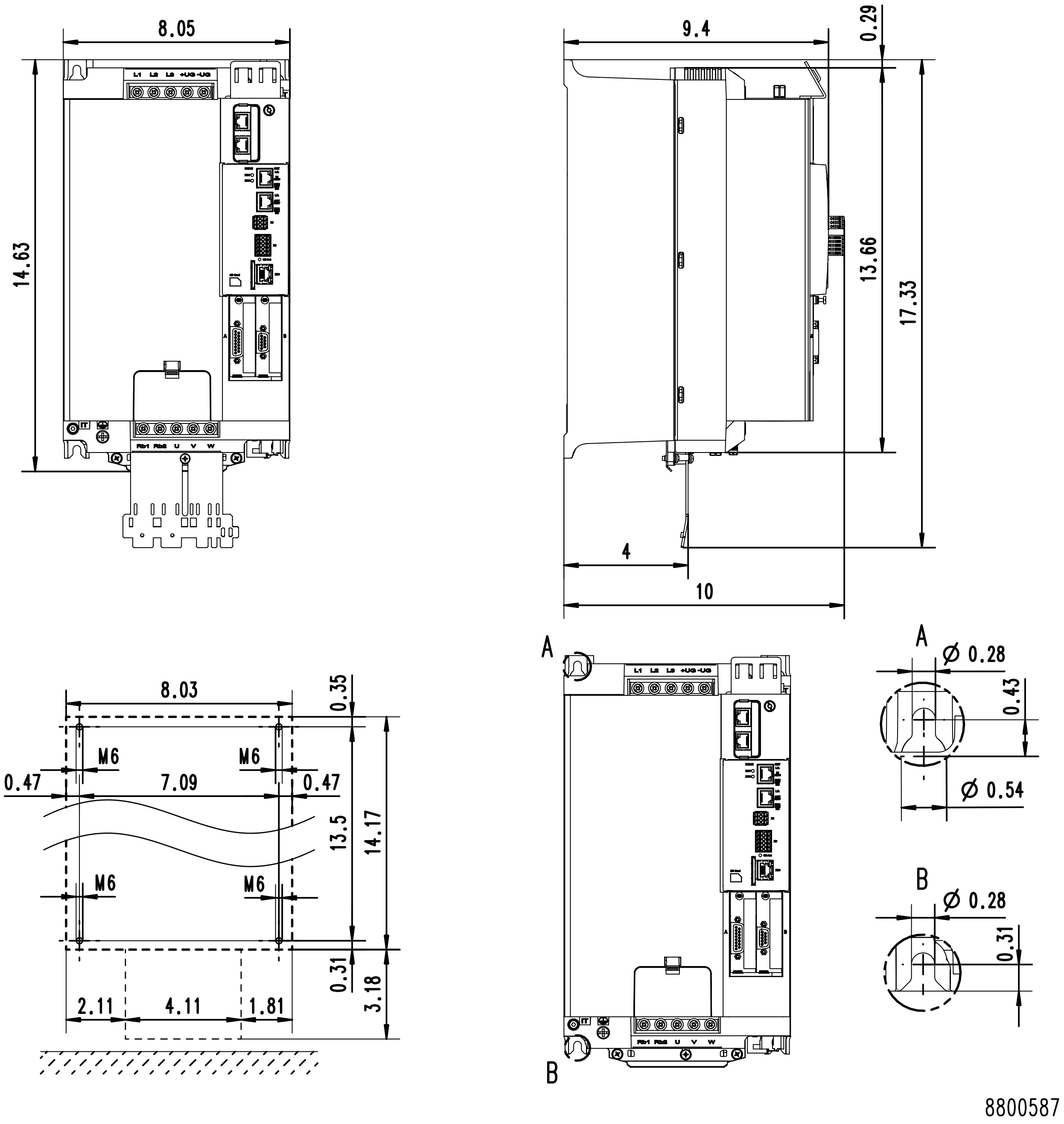
22 kW	i950-C22/400-3
Weight	10.7 kg



30 hp

The dimensions in inch apply to:

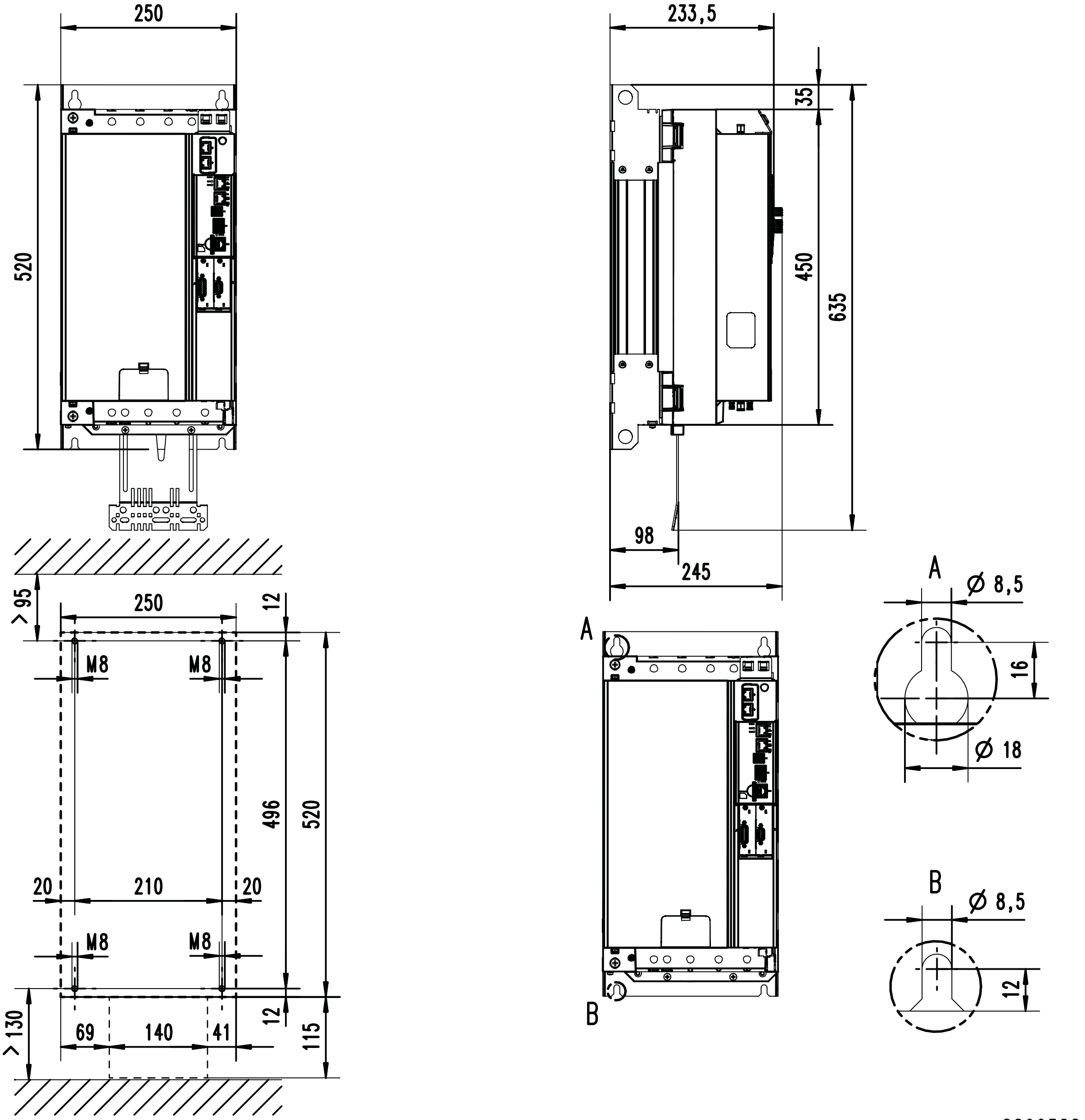
30 hp	i950-C22/400-3
Weight	24 lb



30 kW ... 45 kW

The dimensions in mm apply to:

30 kW	i950-C30/400-3
45 kW	i950-C45/400-3
Weight	16.7 kg

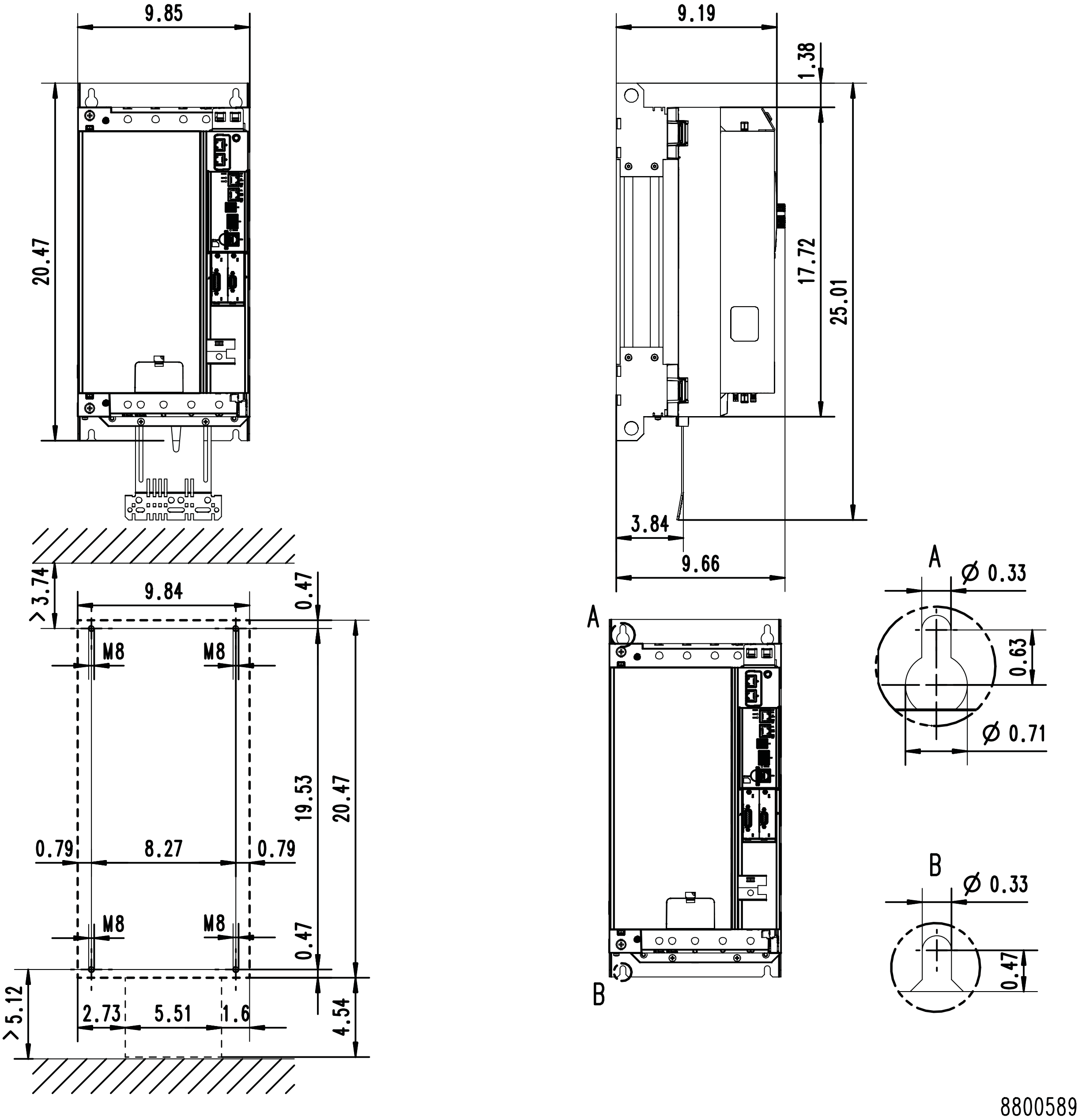


8800588

40 hp ... 60 hp

The dimensions in inch apply to:

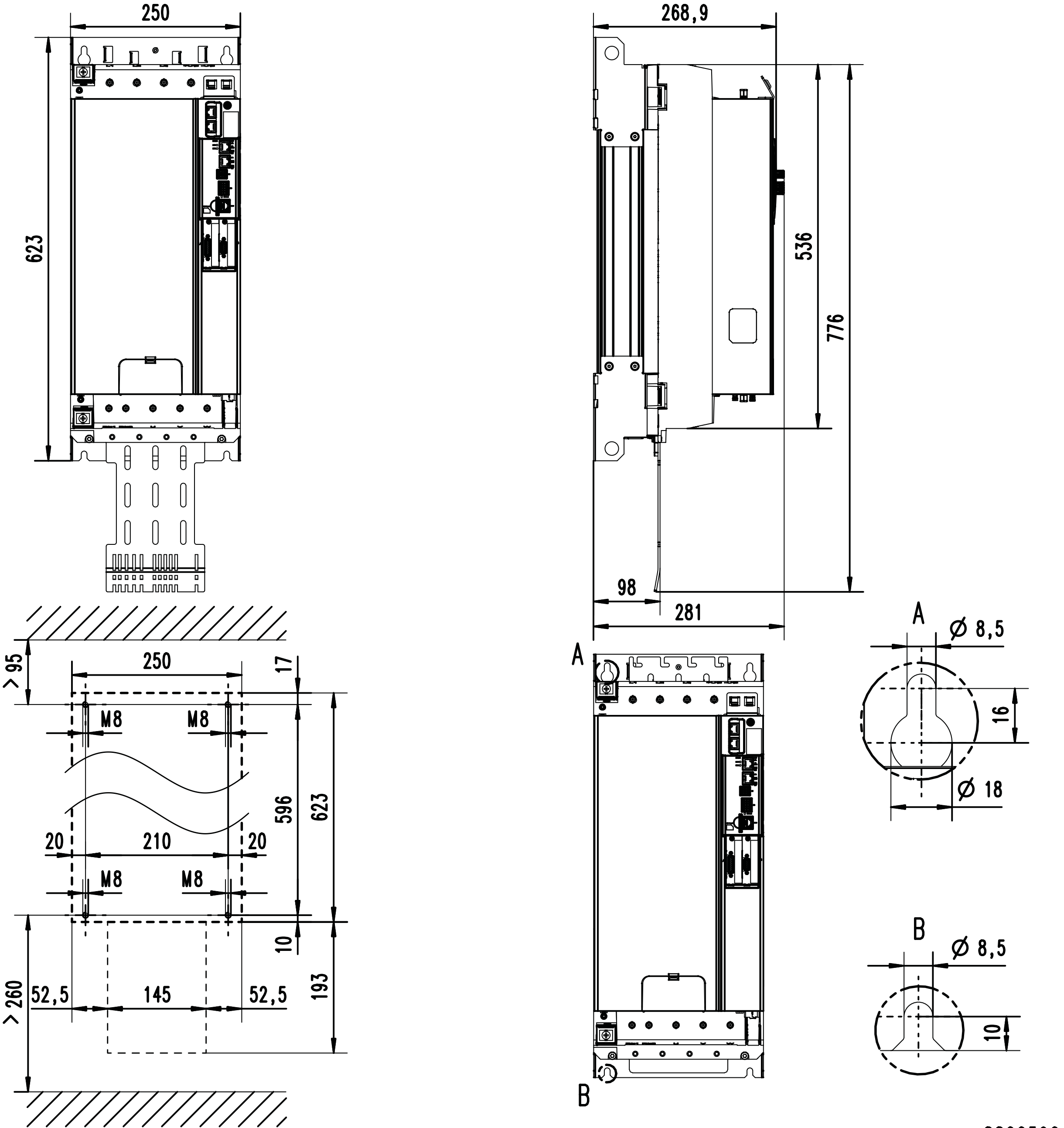
40 hp	i950-C30/400-3
60 hp	i950-C45/400-3
Weight	37 lb



55 kW ... 75 kW

The dimensions in mm apply to:

55 kW	i950-C55/400-3
75 kW	i950-C75/400-3
Weight	24 kg

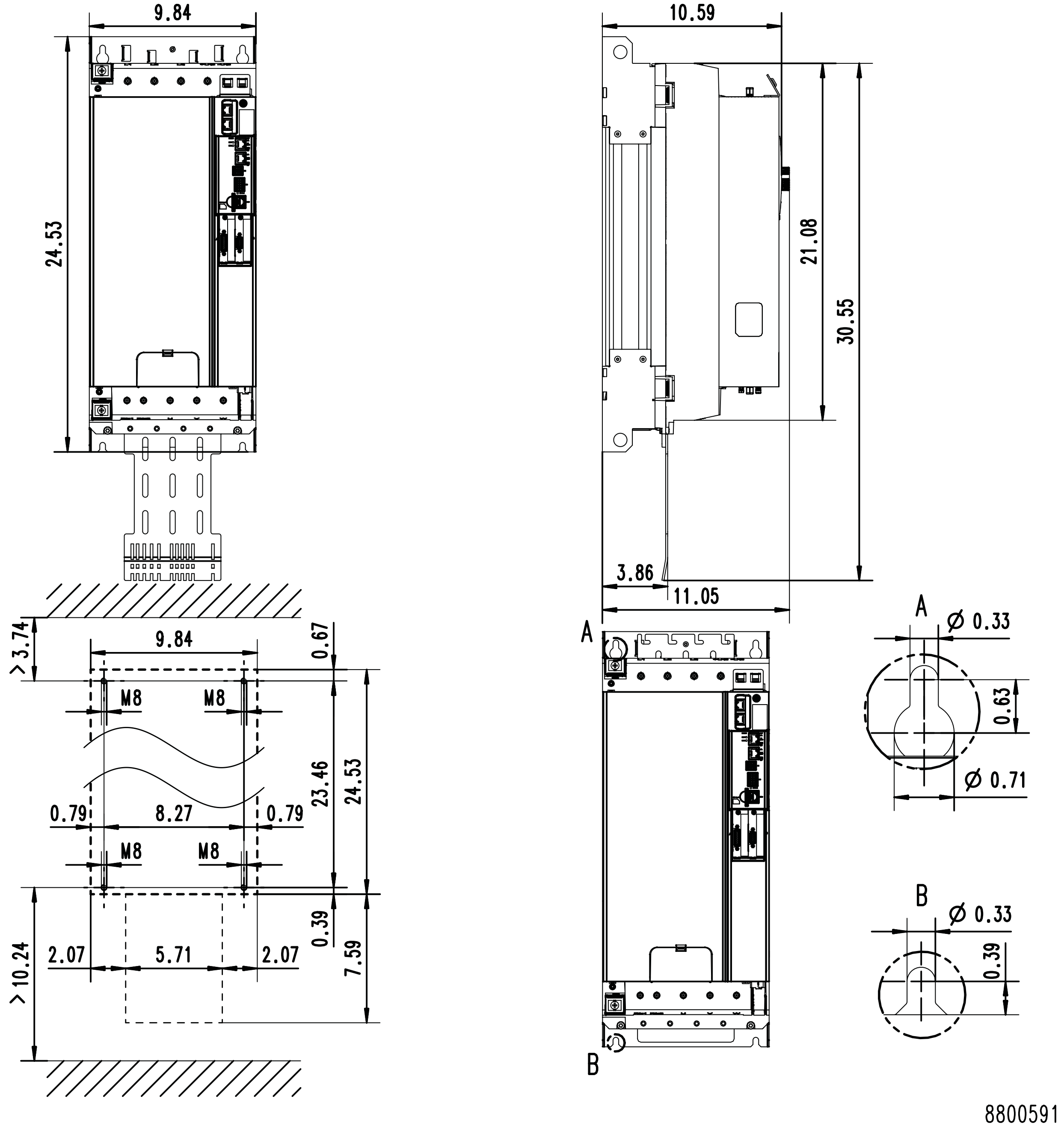


8800590

75 hp ... 100 hp

The dimensions in inch apply to:

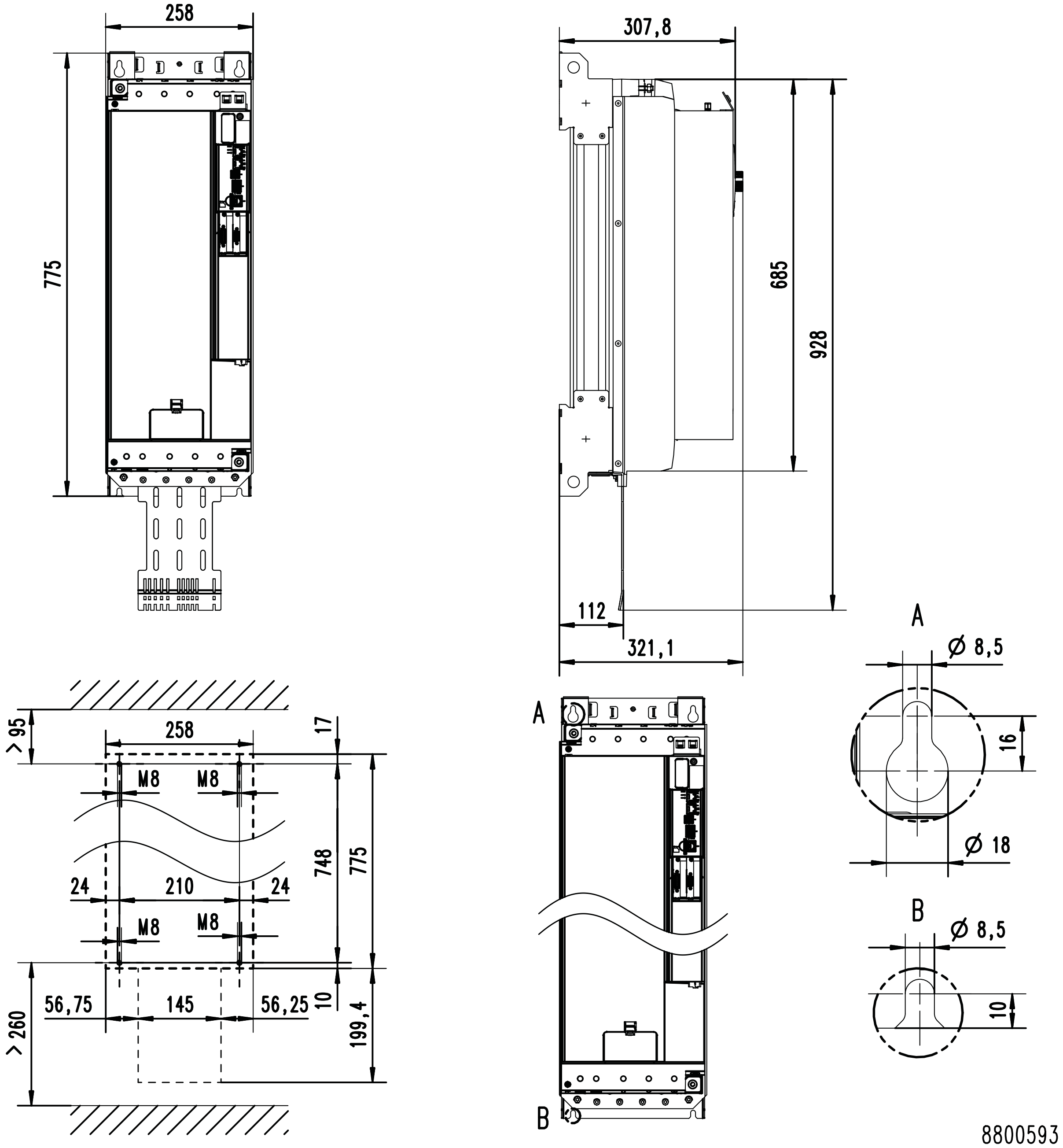
75 hp	i950-C55/400-3
100 hp	i950-C75/400-3
Weight	53 lb



90 kW ... 110 kW

The dimensions in mm apply to:

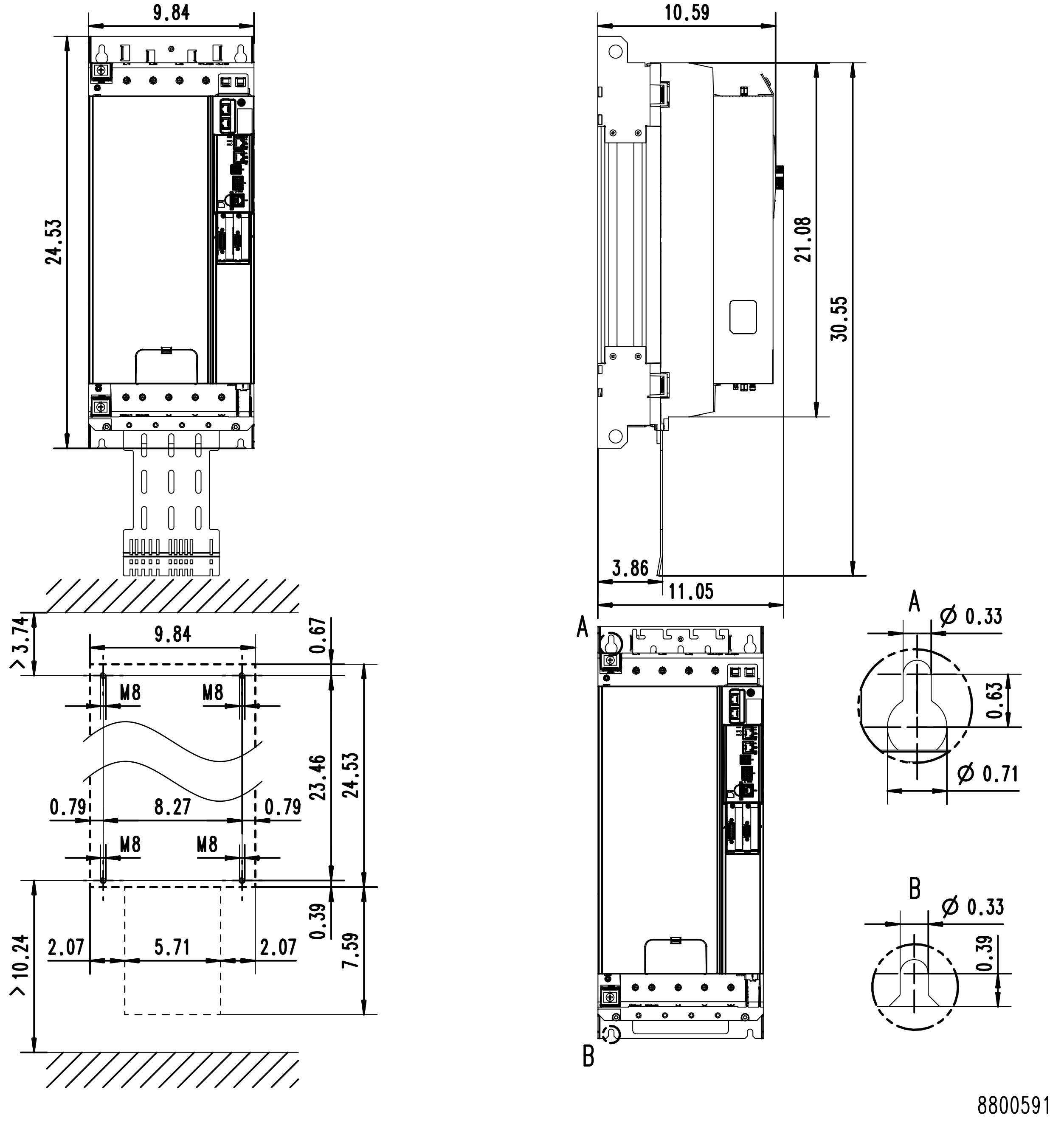
90 kW	i950-C90/400-3
110 kW	i950-C110/400-3
Weight	36 kg



125 hp ... 150 hp

The dimensions in inch apply to:

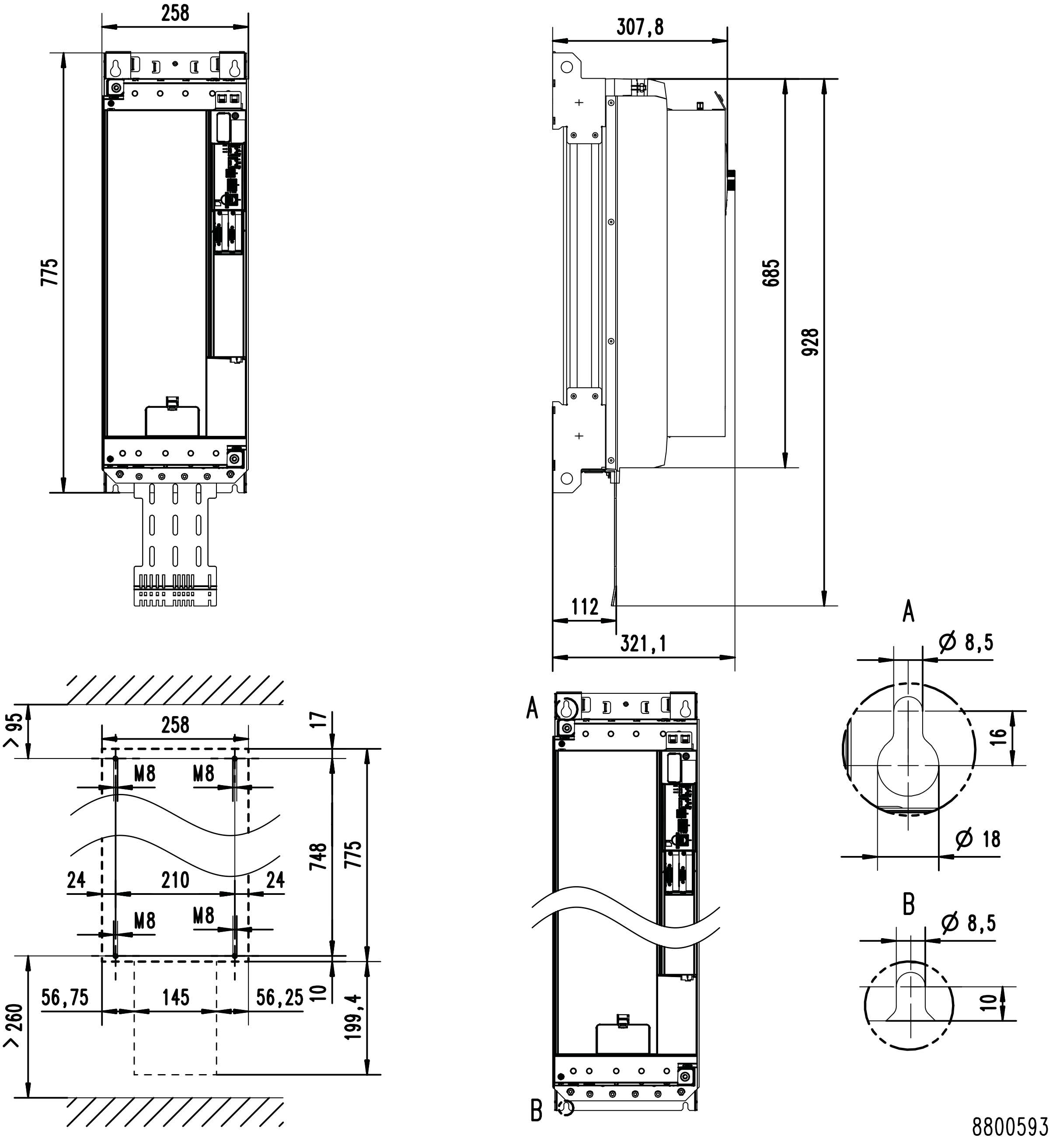
125 hp	i950-C90/400-3
150 hp	i950-C110/400-3
Weight	79 lb



132 kW

The dimensions in mm apply to:

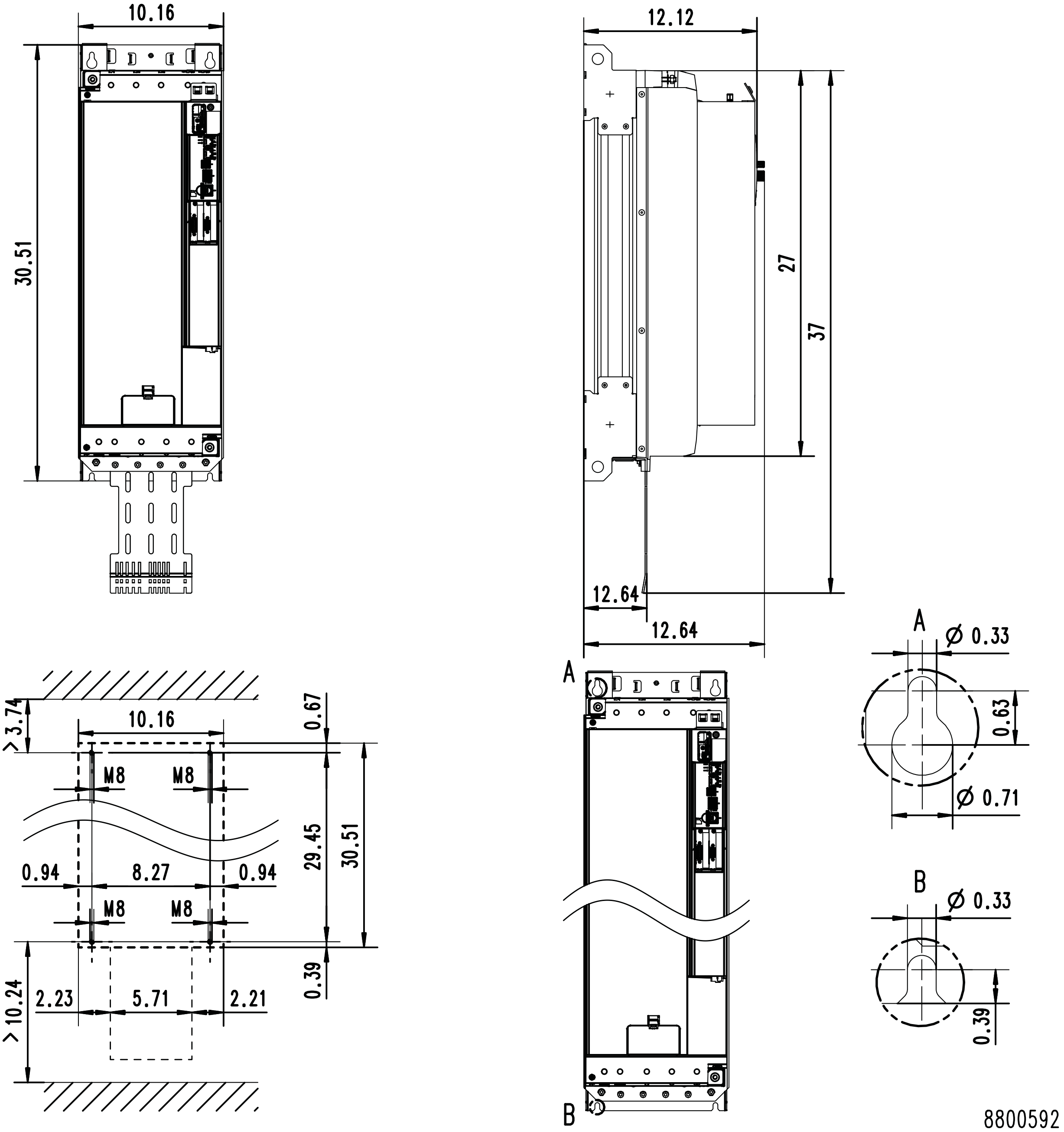
132 kW	i950-C130/400-3
Weight	74 kg



180 hp

The dimensions in inch apply to:

180 hp	i950-C130/400-3
Weight	163 lb



160 kW

The dimensions in mm apply to:

160 kW	i950-C160/400-3
Weight	77 kg

200 hp

The dimensions in inch apply to:

200 hp	i950-C160/400-3
Weight	170 lb

200 kW ... 250 kW

The dimensions in mm apply to:

200 kW	i950-C200/400-3
250 kW	i950-C250/400-3
Weight	180 kg

250 hp ... 320 hp

The dimensions in inch apply to:

250 hp	i950-C200/400-3
320 hp	i950-C250/400-3
Weight	397 lb

Performance indicators motor control

Functionality	Key figures	Data
Torque control	Repeat accuracy	<0.1 %
	Internal resolution	30 bit ≡ 100 % M_{max}
	Setting range (tolerance range 5 % M_n and 5 % M_{set})	1:60 (without field weakening range)
	Linearity (temperature-compensated)	<3 % (without field weakening range)
	Cycle time for the control	16 kHz (62.5 µs)
	Rise time	62.5 µs
	Temperature compensation of the magnets (PSM)	Available
Current control	Settling time (5 % tolerance range)	62.5 µs
	Internal resolution	30 bits = 100 % I_{max}
	Absolute resolution	14 bits
	Bandwidth	6 kHz
	Cycle time for the control	16 kHz (62.5 µs)
Speed control	Repeat accuracy	<<0.1 %
	Internal resolution	30 bits = 240 000 rpm 1 LSB = 0.000224 rpm
	Cycle time for the control	16 kHz (62.5 µs)
Position control	Resolver accuracy	<5 angular minutes (resolver-dependent)
	SinCos encoder accuracy	0.6 angular seconds (1024 SinCos encoder)
	Internal resolution	32 bits ≡ 1 revolution 1 LSB = 83.3 * 10^{-9} degree
	Resolution to one revolution	CiA parameter 0x608F:001 (16 to 30 bits)
	Cycle time for the control	16 kHz (62.5 µs)
Dynamics	Maximum acceleration 0-N_{Rated}	6000 rpm in 7 ms
	Shortest response time to a fault	62.5 µs
Modulation	Voltage resolution of the PWM	100 MHz
	Switching frequencies	2, 4, 8, 16 kHz (fixed, drive-optimized)
Phase voltage measurement		from 22 kW

Product extensions

Overview

Product expansions allow you to flexibly tailor the inverter to your application.

I/O extensions

Two different I/O extensions are possible in the inverter. These provide additional control terminals.

Details:

Digital I/O 🕮 183

Extended I/O 🕮 185

Preconditions

- Only one I/O extension module can be used.
- The I/O extension module occupies either slot A for the motor encoder or slot B for the load encoder.
- When using One Cable Technology (OCT), slot A must be empty. The motor encoder is connected to X109.

Possible combinations of the I/O extension module with motor encoder and load encoder			
I/O extension module	Motor encoder	Motor encoder (OCT)	Load encoder
Slot A	-	-	Slot B
Slot B	Slot A	-	-
Slot B	-	X109	-

Digital I/O

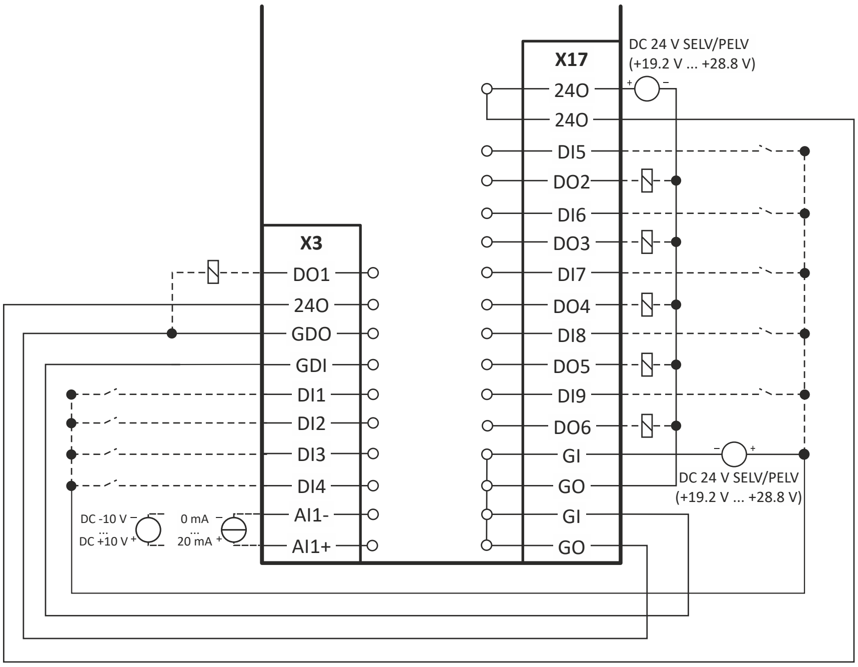
The digital I/O module provides additional digital inputs and digital outputs.

The control terminals are available in the technology applications.

Digital I/O equipment

- 5 digital inputs
- 5 digital outputs

Digital I/O connection diagram



Connection data

Connection data - digital inputs

Connection			Control signals (I/O)	
Connection designation			**X17**	
Pin name			DI5, DI6, DI7, DI8, DI9	Standard digital inputs
Switching level		V	LOW: < +5, HIGH: > +15	IEC 611311-2, type 1
Input resistance		kΩ	4.6	
Sampling frequency of digital inputs		kHz	4	When used as standard digital inputs
External-voltage protection		V	±30	

Connection data - digital outputs

Connection			Control signals (I/O)	
Connection designation			**X17**	
Pin name			DO2, DO3, DO4, DO5, DO6	
Switching level		V	LOW: < +5, HIGH: > +15	IEC 611311-2, type 1
Output current		mA	50	per digital output
Cycle time		ms	0.25	
Short-circuit strength				Unlimited period
External-voltage protection				Integrated varistor
Suppressor circuit				
Overload behavior				Voltage reduction or periodic switch-off and switch-on
Time response		µs	250	LOW - HIGH / HIGH - LOW
Behavior when reset or switched on			Output is switched off	LOW

Connection			Control signals (I/O)
Connection designation			**X17**
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length			10
Stripping length			0.4
Required tools			Screwdriver 0.4 x 2.5

I/O extension	Order code	
Digital I/O	I9MAGBV000000S	

Extended I/O

The extended I/O module provides additional control terminals.

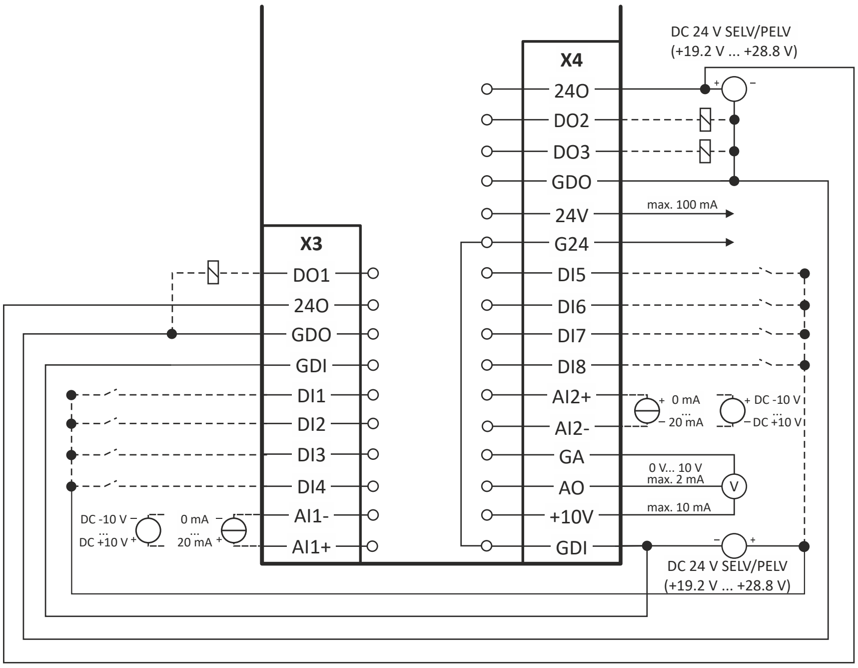
The digital inputs can be configured as encoder evaluation.

The control terminals are available in the technology applications.

Extended I/O equipment

- 4 digital inputs
  - Switchable as HTL encoder input
  - Adjustable for both double and four-fold evaluation
- 2 digital outputs
- 1 analog input (current or voltage, selectable)
- 1 analog output 0-10 V
- 24 V output, max. 100 mA for encoder supply
- 10 V output for potentiometer control

Extended-I/O connection diagram



Connection data

Connection data - digital inputs

Connection			Control signals (I/O)	
Connection designation			**X4**	
Pin name			DI5, DI6, DI7, DI8	Standard digital inputs
Switching level		V	LOW: < +5, HIGH: > +15	IEC 611311-2, type 1
Input resistance		kΩ	4.6	
Sampling frequency of digital inputs		kHz	200	When used as standard digital inputs
External-voltage protection		V	±30	

Digital encoder inputs

Encoder input			Incremental HTL encoder	
Type			**X4**	
Two-track connection			DI5 DI6	Track A Track B
Four-track connection			DI5 DI6 DI7 DI8	Track A Track B Track A- Track B-
Frequency range		kHz	0 … 200	

Connection data - digital outputs

Connection			Control signals (I/O)	
Connection designation			**X4**	
Pin name			DO2, DO3	
Switching level		V	LOW: < +5, HIGH: > +15	IEC 611311-2, type 1
Output current		mA	50	per digital output
Cycle time		ms	0.25	
Short-circuit strength				Unlimited period
External-voltage protection				Integrated varistor
Suppressor circuit				
Overload behavior				Voltage reduction or periodic switch-off and switch-on
Time response		µs	250	LOW - HIGH / HIGH - LOW
Behavior when reset or switched on			Output is switched off	LOW

Connection data - analog outputs

Connection			Control signals (I/O)	
Connection designation			**X4**	
Pin name			AO	Voltage output
Resolution		Bit	10	
Value range		V	0-10 V	

Connection data - analog inputs

Connection			Control signals (I/O)	
Connection designation			X4	
Pin name			AI2+, AI2-	
Sampling frequency		kHz	4	
Resolution of A/D converter		Bit	10	
Operation as voltage input				
DC input voltage		V	0 ... 10	
			-10 ... +10	
Input resistance		kΩ	>100	
Accuracy		mV	±100	Typical
External-voltage protection		V	±30	Differential
			±50	Common mode against GND
Operation as current input				
Input current		mA	0 ... 20	
			4 ... 20	Open-circuit monitoring
			2	Wire breakage” triggering
Input resistance		Ω	250	
Accuracy		mA	±0.4	
External-voltage protection		V	±7.5	
			±30	If an overcurrent is detected, the input is switched to a voltage input.

Connection			Control signals (I/O)
Connection designation			X4
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length			10
Stripping length			0.4
Required tools			Screwdriver 0.4 x 2.5

I/O extension	Order code	
Extended I/O	I9MAGCV000000S	

Motor encoder evaluation

The inverter can optionally be outfitted with a module for motor encoder evaluation.
Modules are available for the evaluation of various motor encoders:

- Resolver
- Incremental encoder and absolute value encoder
- HTL encoder via Extended I/O

Resolver

Resolver module

Resolvers are connected to the 9-pin Sub-D socket X7.

Operation of resolvers of other manufacturers is permissible.

- The number of resolver pole pairs must be adapted to the resolver used.
- If the reference track is excited at 8 kHz, the apparent impedance of the connected resolver must not fall below 90 Ω.
- If smaller impedances are connected, the overload protection integrated in the resolver output limits the output current and may blur the resolver evaluation.

Connection data

Electrical data		
General	Cable length	max. 150 m
TEMP+, TEMP-	Temperature sensor connection (PT1000)	
+REF, -REF	Excitation voltage and carrier frequency	8 kHz, fixed
±COS, ±SIN	Sine and cosine track	

Pin assignment of resolver connection

Connection	Connection description	Connection type	Pin	Resolver
X7	Resolver	Sub-D, 9-pole	1	+REF
			2	- REF
			3	n.c.
			4	+COS
			5	-COS
			6	+SIN
			7	-SIN
			8	TEMP+
			9	TEMP-

Feedback	Order code	
Resolver	I9MAG2V000000S	

Incremental encoders and absolute value encoders

The module for evaluating incremental encoders and absolute encoders supports rotary encoders and linear encoders. These are connected to the 15-pin Sub-D socket X8.

- Incremental encoder
  - SinCos
  - TTL
  - HTL encoder via Extended I/O
- Absolute value encoder
  - HIPERFACE®
  - SSI encoder
  - SinCos+SSI
  - EnDat 2.1
  - EnDat 2.2

- Encoders with SinCos tracks are monitored for wire breakage.
- SSI encoders and TTL encoders are not monitored for wire breakage.

Connection data

Electrical data		
General	Cable length	max. 100 m
	Protocols	HIPERFACE® SSI TTL EnDat 2.1 EnDat 2.2
	Number of increments	1 ... 131072
	Input frequency	Max. 500 kHz
Vcc, GND	Supply voltage	5 ... 12 V
	Max. output current	330 mA to 9 V 250 mA at 12 V
	Max. output power	3 W

Pin assignment of incremental encoder

Connection designation	Connection	Connection system	Pin	Type	
				SinCos	TTL
				incremental	incremental
X8	Incremental encoder	Sub-D, 15-pole	1	COS	A
			2	GND	GND
			3	SIN	B
			4	Vcc	Vcc
			5	Z	Z
			6	n.c.	n.c
			7	TEMP-	TEMP-
			8	n.c.	n.c.
			9	REFCOS	/A
			10	n.c.	n.c.
			11	REFSIN	/B
			12	n.c.	n.c.
			13	/Z	/Z
			14	TEMP+	TEMP+
			15	n.c.	n.c.

Pin assignment - absolute value encoder

Connection designation	Connection	Connection system	Pin	Type		
				HIPERFACE®	SSI	SinCos+SSI
				absolute	absolute	absolute
X8	Absolute value encoder	Sub-D, 15-pole	1	COS	n.c	COS
			2	GND	GND	GND
			3	SIN	n.c	SIN
			4	Vcc	Vcc	Vcc
			5	DATA+	DATA+	DATA+
			6	n.c.	n.c.	n.c.
			7	TEMP-	TEMP-	TEMP-
			8	n.c.	CLOCK+	CLOCK+
			9	REFCOS	n.c.	REFCOS
			10	n.c.	n.c.	n.c.
			11	REFSIN	n.c.	REFSIN
			12	n.c.	n.c.	n.c.
			13	DATA-	DATA-	DATA-
			14	TEMP+	TEMP+	TEMP+
			15	n.c.	CLOCK-	CLOCK-

Pin assignment - absolute value encoder EnDat

Connection designation	Connection	Connection system	Pin	Type	
				EnDat 2.1	EnDat 2.2
				absolute	absolute
X8	Absolute value encoder	Sub-D, 15-pole	1	A+	n.c.
			2	GND	GND
			3	B+	n.c.
			4	Vcc	Vcc
			5	DATA+	DATA+
			6	n.c.	n.c.
			7	TEMP-	TEMP-
			8	CLOCK+	CLOCK+
			9	A-	n.c.
			10	GND	GND
			11	B-	n.c.
			12	Vcc	Vcc
			13	DATA-	DATA-
			14	TEMP+	TEMP+
			15	CLOCK-	CLOCK-

Feedback	Order code	
SinCos incremental SinCos HIPERFACE absolute SSI TTL SinCos + SSI absolute	I9MAG3V000000S	

Load encoder/master encoder evaluation

The inverter can optionally be outfitted with a module for application feedback (load encoder or master encoder).

The modules used for the load encoder/master encoder and the motor encoder are the same. The data can be found under: ▶ Product extensions, Motor encoder evaluation 📖 188

Digital frequency

The inverter can be optionally equipped with a digital frequency module.

The digital frequency module may only be inserted and used in slot B of the inverter.

Connection data

Electrical data for digital frequency module			-
DC supply			Internally from DC supply of control electronics
Max. cable length between inverter and feedback		m	100
Maximum number of slave drives at 250 kHz			20
Maximum number of slave drives at 500 kHz			10
Max. cable length between digital frequency modules		m	100
Max. voltage level of the output signals VOL at IO=20mA		V	0.4
Min. voltage level of the output signals VOH at IO=-20mA		V	2.4
Max. output frequency of incremental signals		MHz	2
Max. output current		mA	30
Min. load resistance		Ω	90

	Order code	
Digital frequency module	I9MAGLV000000S	

Networks

The i950 can optionally be equipped with a network module to realize communication at the "fieldbus" level.

Available network modules:

- CANopen®
- PROFIBUS®
- EtherCAT®
- EtherNet/IP™
- PROFINET®

The i950 is equipped with an engineering port (standard Ethernet) for setting and diagnostics via software.

Notes on ordering

Which network module the i950 servo inverter should be equipped with can be optionally configured when ordering. The delivery takes place as a complete device.

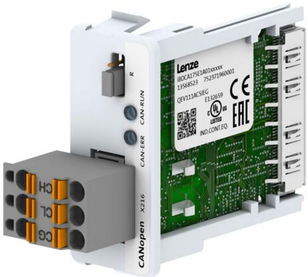
Network modules can also be ordered separately as replacement components.

Network (fieldbus)	Order code for replacement component
CANopen	I9MAFC0000000S
PROFIBUS	I9MAFP0000000S
EtherCAT	I9MAFT0000000S
EtherNet/IP	I9MAFG0000000S
PROFINET	I9MAFR0000000S

CANopen

CANopen is an internationally approved communication protocol which is designed for commercial and industrial automation applications.

CANopen network module



General information			
Design		Optional module	
DC supply		Internally via the inverter	

Bus-related information			
Name		CANopen CiA 301 V4.2.0	
Communication medium		CAN cable in accordance with ISO 11898-2	
Use		Connection of the inverter to a CANopen network	
Connection system		Pluggable 3-pole 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		Yes	Activation via "R” jumper
Network topology			
Without repeater		Line	
With repeater		Line or tree	
Device			
Type		Slave, mini master	Adjustable via parameter
Max. number without repeater		127	Per bus segment, incl. host system
Address		1 ... 127	Adjustable via parameter
Baud rate	kbps	20, 50, 125, 250, 500, 800 or 1000	Adjustable via parameter
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		Max. 4 TPDOs with 8 bytes each	
Receive PDOs		Max. 4 RPDOs with 8 bytes each	
Cycle time	ms	Integer multiple of 1 ms	Adjustable via parameter
Application synchronization by sync telegrams		Yes	
Transmission mode for TPDOs			
With change of data		Yes	
Time-controlled, multiple of	ms	10	
After reception of		1 ... 240 sync telegrams	
Parameter data			
SDO channels		Max. 2 servers	

Communication time			
Communication time depends on		Processing time in the inverter	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

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

Other data
Note: There are no interdependencies between parameter data and process data.

PROFIBUS

PROFIBUS is a common fieldbus for the connection of inverters to different control systems in plants.

PROFIBUS network module

General information			
Design		Optional module	
DC supply		Internally via the inverter	

Bus-related information			
Name		PROFIBUS-DP	
Communication medium		RS485	
Use		Connection as PROFIBUS-DP device	
Connection system		9-pole Sub-D socket	
Status display		2 LEDs	
Connection designation		X226: Pin 1 ... 9	

Technical data			
Communication profile		PROFIBUS-DP-V0	I/O cyclic
		PROFIBUS-DP-V1	PROFIdrive parameter data channel
Bus terminating resistor	Ω	120	Terminated on both sides
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line	
With repeater		-	
Device			
Type		Device	
Max. number without repeater		32	Per bus segment, incl. host system
Max. number with repeater		125	
Address		1 ... 126	Adjustable via parameter
Transmission rate	kbps	9.6 ... 12000	Automatic detection for cable type A (EN 50170)
Max. bus length	m	1200	Per bus segment, depending on the transmission rate and the cable type used
Max. cable length between two devices		Not limited, max. bus length is decisive	
Process data			
PZD		1 ... 32 words (16 bits/word) per direction	
Transmission mode			
Identification number		0x0E950	
Parameter data			
Acyclic (DP-V1)		Max. 240 bytes	

Communication time			
Communication time depends on		Processing time in the inverter	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

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

Other data
Note: There are no interdependencies between parameter data and process data.

EtherCAT

EtherCAT® (Ethernet for Controller and Automation Technology) is an Ethernet-based fieldbus system which fulfils the application profile for industrial plant systems.

EtherCAT network module

General information			
Design		Optional module	
DC supply		Internally via the inverter	

Bus-related information			
Name		EtherCAT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection as EtherCAT slave	
Status display		2 LEDs (RUN, ERR)	
Connection designation		IN: X246 OUT: X247	

Technical data			
Communication profile		EtherCAT	
		CANopen over EtherCAT	
Safety over EtherCAT (FSoE)		Yes	
Vendor ID [hex]		0x3B	
Network topology		Line, tree ring	
Device			
Type		EtherCAT slave	
Max. number		65535	In the entire network
Address		Automatically assigned by the master	
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data			
Transmit PDOs		0 ... 16 double words	Max. 64 bytes
Receive PDOs		0 ... 16 double words	
Cycle time	ms	Integer multiple of 1 ms	

Communication time			
Communication time depends on		Processing time in the inverter	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

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

Other data
Note: There are no interdependencies between parameter data and process data.

EtherNet/IP

EtherNet/IP is a common fieldbus for the connection of inverters to different control systems in plants.

EtherNet/IP network module

General information			
Design		Optional module	
DC supply		Internally via the inverter	

Bus-related information			
Name		EtherNet/IP	
Communication medium		Ethernet 10 Mbps, 100 Mbps, half duplex, full duplex	
Use		Connection as EtherNet/IP adapter	
Status display		2 LEDs (CIP Module Status, CIP Network Status)	
Connection designation		X266, X267	

Technical data			
Communication profile		EtherNet/IP	
Vendor ID		587	
Device type		0x2 (AC Drive)	
Product code		951	
Network topology		Line, tree, ring	
Device			
Type		Adapter (slave)	
Max. number		254	Per subnetwork
Address		IP address is assigned by the scanner or via Lenze engineering tools	
Max. cable length	m	-	Not limited The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data	Byte	4, 8, 12, 16, 20, 24, 28, 32, ..., 64	
Cycle time/RPI	ms	≥ 1	
Switching method		Cut-Through	
CIP features			
"Exclusive Owner" connection		1	
I/O connection type		Cyclic	
DLR (redundancy protocol)		Beacon-based Ring Node	
More features		Support for multicast messages, UCMM, ACD, DHCP, DSCP	
Other data		TCP/IP socket connections	For communication with the Lenze tools »EASY Starter«, »EASY Firmware Loader« and »PLC Designer«

Communication time			
Communication time depends on		Processing time in the inverter	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

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

Other data
Note: There are no interdependencies between parameter data and process data.

PROFINET

PROFINET is a common fieldbus for the connection of inverters to different control systems in plants.

PROFINET network module

General information			
Design		Optional module	
DC supply		Internally via the inverter	

Bus-related information			
Name		PROFINET RT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Integration as PROFINET IO-Device	
Status display		2 LEDs (Ready, Error)	
Connection designation		X256, X257	

Technical data			
Communication profile		PROFINET	
PNO identification number		0x0106	
Device identification (Device ID)		0x0900	
Network topology		Line, tree, ring	
Device			
Type		IO device with real time (RT) communication properties	Conformance Class B, NetloadClass III
Max. number		255	Per subnetwork
Address		Station name	
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data	Byte	4, 8, 12, 16, 20, 24, 28, 32, ..., 64	
Cycle time	ms	1, 2, 3, 4, ...	
Switching method		Cut-through	
Optional functions		PROFIsafe PROFIenergy Class 3 Shared device MRP (Media Redundancy Protocol)	
Other data		Additional TCP/IP channel	

Communication time			
Communication time depends on		Processing time in the inverter	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

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

Other data
Note: There are no interdependencies between parameter data and process data.

Functional safety

The i950 cabinet servo inverter is available in the following functional safety versions:

- Basic Safety - STO
- Extended Safety - LT

Function overview

	Functional safety design	
	Basic Safety - STO	**Extended Safety - LT**
Safe inputs and outputs		
Sensor inputs	1 (STO)	4
Homing inputs	-	IRS + IRL
Acknowledgement inputs	-	AIS + AIE
Safe output	-	1
Safety bus		
PROFIsafe connection	-	●
FSoE connection	-	●
Safe stop functions		
Safe torque off (STO)	●	●
Safe stop 1 (SS1)	-	●
Safe stop emergency (SSE)	-	●
Safe stop 2 (SS2)	-	●
Safe operating stop (SOS)	-	●
Safe brake control (SBC)	-	●
STO cascading (CAS)	-	●
Safe monitoring functions		
Safe maximum speed (SMS)	-	●
Safely-limited speed (SLS)	-	●
Position-dependent safe speed (PDSS)	-	●
Safe speed monitor (SSM)	-	●
Safely-limited position (SLP)	-	●
Safely-limited increment (SLI)	-	●
Safe direction (SDI)	-	●
Safe cam (SCA)	-	●
Auxiliary and maintenance functions for functional safety		
Safe homing (SHom)	-	●
Operation mode selector (OMS)	-	●
Repair mode selector (RMS)	-	●
Enable switch (ES)	-	●
Safe Muting (MUT)	-	●

General information and basics

Functional safety describes the necessary measures that need to be taken by means of electrical or electronic equipment to prevent or eliminate dangers due to functional errors.

Protective devices prevent any human access to dangerous areas during normal operation. However, persons may have to be in the danger areas in certain operating modes. The machine operator is protected by internal drive and control measures in these operating modes.

Integrated functional safety

Integrated functional safety provides the conditions in the controls and drives to implement protective functions. Planning and installation expenditure is reduced. Using integrated functional safety increases machine functionality and availability. Integrated functional safety can be used for the protection of persons working on machines in accordance with the Machinery Directive.

Safety component

The safety component in the inverter provides the safe interfaces (e.g. safe inputs or safe network interfaces). If the STO safety function is requested, the safety component immediately brings about the torque-free state according to EN 61800-5-2.

In the "Advanced Safety" or "Extended Safety" version, the safety component also monitors safe compliance with the limit values. If monitored limit values are exceeded, the safety component reacts with safety functions according to EN 61800-5-2.

Identification of the components

The functional safety components and the associated connections are usually marked in yellow. Since the functional safety standards do not prescribe color coding, the components and terminals can also be designed in other colors.

NOTICE

Excessive humidity or condensation

Malfunction or irreparable damage to safety component

► Only commission the safety component when it has acclimatized.

Standards

Safety regulations are confirmed by laws and other governmental guidelines and measures and the prevailing opinion among experts, e.g. by technical regulations.

The regulations and rules to be applied must be observed in accordance with the application.

Risk assessment

This documentation can only accentuate the need for a risk assessment. The user of the integrated functional safety must read up on standards and the legal situation.

Before a machine can be put into circulation, the manufacturer of the machine has to conduct a risk assessment according to the 2006/42/EC: Machinery Directive [UKCA: S.I. 2008/1597 - The Supply of Machinery (Safety) Regulations 2008] to determine the hazards associated with the use of the machine.

The Machinery Directive refers to three basic principles for the highest possible level of safety:

- Hazard elimination / minimisation by the construction itself.
- Taking the protective measures required against hazards that cannot be removed.
- Existing residual hazards must be documented and the user must be informed of them.

Detailed information on the risk assessment is provided in the DIN EN ISO 12100:2013-08: Safety of machinery − General principles for design − Risk assessment and risk reduction. The result of the risk assessment determines the category for safety-related control systems according to EN ISO 13849-1. Safety-oriented parts of the machine control must be compliant.

Mission time

The mission time of the used components must be complied with.

In case of a defect or when the mission time of a component has expired, the complete component must be replaced. Continued operation is not permitted!

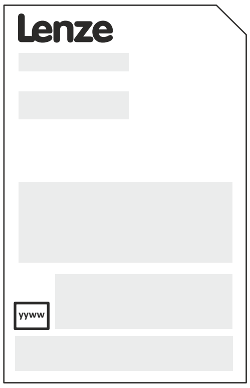
> The mission time for the safety functions cannot be reset by a special proof test.

The specified mission time starts at the date of manufacture.

Mission time ▶ Safety-related data 284

Manufacturing date

- The manufacturing date is permanently stored in the device. You can read it out using the »EASY Starter«. (Parameter 0x2000:003)
- The manufacturing date can be found on the nameplate as well.



yyww Year of manufacture and week of manufacture (1841 = KW 41 2018)

Stop functions

The stop functions differ according to how they are triggered:

- Normal stop (simple stop)
  - Triggering via a safe input (if available) with the parameterized stop function (e.g. STO or SS1).
  - Triggering via a safety bus by activating the corresponding bit (e.g. STO or SS1) in the control data.
- Emergency stop
  - The "Safe emergency stop (SSE)" safety function is required for an emergency stop.
  - Triggering via a safe input (if available) with the parameterized SSE function.
  - Triggering via a safety bus by activating the corresponding SSE bit in the control data.
  - STO or SS1 can be configured as the function to be executed via the parameter "SSE: Emergency stop function".
- Error stop
  - Triggered as a response to an error.

Prioritisation

Stop functions with higher priority influence the flow of lower-order functions which have already been initiated.

Hierarchy:

1. Safe torque off (STO)
   - STO has the highest priority and hence precedence over all other functions.
   - Functions that have already been initiated (e.g. SS1 or SS2) are canceled and the drive is switched off.
2. Safe stop 1 (SS1)
   - SS1 has priority over SS2.
   - Observing the defined stop time for SS1 and SS2 as well as the SS1 mode, the drive is rendered torqueless.

Notes:

- Safe stop 2 (SS2) is only supported by devices with safe feedback.
- The monitoring functions have equal priorities and can be executed simultaneously with the stop function.

Acceptance

The machine manufacturer must check and prove the operability of the safety functions used.

- The machine manufacturer must authorize a person as an inspector who can carry out the test on the basis of their technical training and knowledge of the safety functions.
- The inspector must document and sign the result of the test of each safety function in a test report.

A complete test includes:

- Document the installation including the safety functions:
  - Create an overview image of the installation.
  - Describe the installation.
  - Describe safety devices.
  - Document the safety functions used.
  - Complete validation of the safety functions used.
    (The validation must also include tests under fault conditions.)
- Create test report:
  - Document the functional test.
  - Check parameters.
  - Sign test report.
- Create an annex with test records:
  - Protocols for the installation.
  - External recordings

As of »EASY Starter« version 1.25, the »Safety-Validation Tool« is available. It accelerates the approval processes for safety applications:

- Guides the user through the test steps - no paper checklists.
- Saves test results - no copying and pasting of files created during the approval process.
- Avoids errors through automation - no manual work.
- Automatically generates all documents and files required for approval.

Video instructions for the "Safety Validation Tool"

Periodic inspections

After installation and after every modification, the user must check and validate the safety function.

The user must document these tests.

Check the operational flow of the safety-related functions at regular intervals. The risk assessment or prevailing regulations determine the time intervals between the inspections.

Device exchange

⚠WARNING!

When replacing secure devices, please note the following:

- ► Exchange a maximum of one safe device before recommissioning.
- ► It is important to ensure that the connected sensors and actuators are assigned to the correct device.

How to replace a safe device:

1. Check the compatibility of the devices.
2. Check the memory cards of the devices.
3. Set the safety address.
4. Carry out a functional test.

Safe parameter setting

Safety parameters can only be set and transferred in the »EASY Starter« and »PLC Designer« via a special parameterization dialog. This parameterization dialog is available when you select a device with integrated safety technology or a safety module.

Open parameterization dialog for safety parameters:

- »EASY Starter«: Open the **Safety parameter list** tab.
- »PLC Designer«: Open the **Safety parameter set** object under the axis in the device tree.

The safe parameterization is checked for plausibility.

The plausibility check rejects ambiguous or contradictory settings until they have been parameterized correctly. Only then can the parameters be saved.

Parameter set acceptance from the SD card

Safe parameter set acceptance is supported by means of a safe parameter set saved in the device.

Safety address

The unambiguousness of an axis with safety functions in a drive system can be achieved by means of the safety address. The parameter set is saved in the safety option (and, depending on the device, on the SD card) with a unique safety address. When initializing the safety option, i.e. when loading the safe parameter set, the safety address is checked for conformity. If no compliance exists, an initialization error is reported.

- In drive systems with activated PROFIsafe or FSoE safety bus, the safety address is also used as the safety bus target address. The unique assignment of the safety address must be configured in the safety PLC.
- In drive systems without activated safety bus or with CIP Safety™ safety bus, unambiguousness and correct assignment of the safety address must be checked. For this purpose, use the »EASY Starter« or the »PLC Designer«.

Clearly define the safety address in a drive system or plant.

Document the safety address in circuit diagrams and markings.

If the device detects a changed safety address during initialization, the device requests an acknowledgement with confirmation button S82.

Acknowledgement with confirmation button S82

If the device detects a modified parameter set or a changed safety address during initialization, for example, the device requests an acknowledgement with confirmation button S82.

Confirmation is also required after a firmware update (e.g., after a device replacement) to activate the newly installed safety-related software component.

Display for requested acknowledgement

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
on	off	Restart acknowledgement requested	The device is working correctly.
	blinking 2 Hz		During startup, a modified parameter set was detected in the "Init" state.
	blinking 4 Hz		During startup, a changed safety address was detected in the "Init" state.
	blinking		During startup, a changed assignment between OCT encoder and inverter was detected in the "Init" state.
The detection of a firmware update is signaled by the subsequent flashing of the safety LEDs.			
on	1 second ascending	SW confirmation requested	A changed safety-relevant SW component (safety firmware or safety bootloader) was detected during start-up.

All requests are acknowledged with the same steps.

The acknowledgement procedure is aborted if the reaction time of 2.5 seconds is exceeded. The acknowledgement procedure must be repeated.

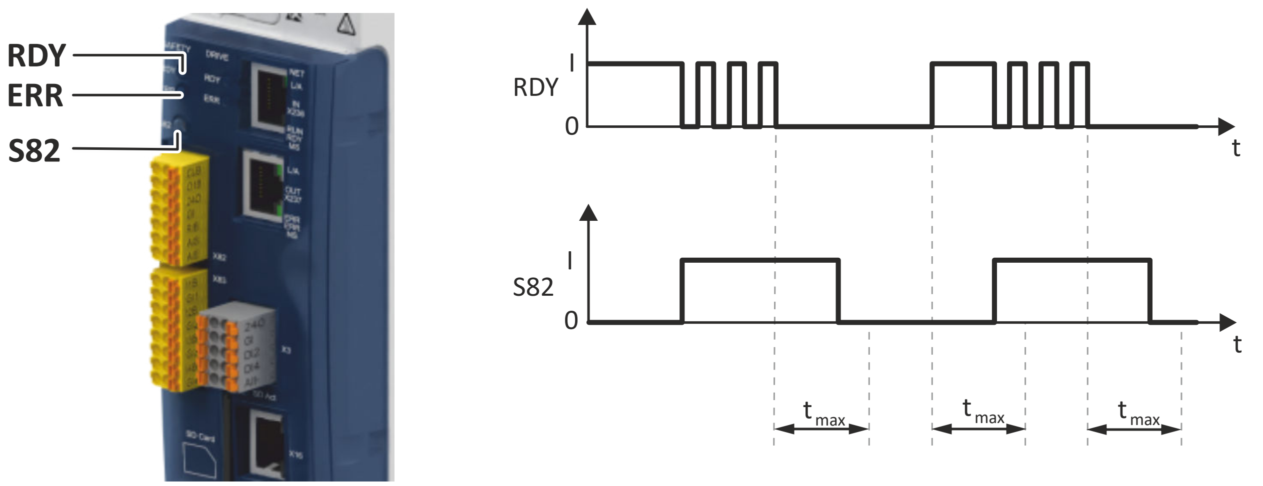


Fig. 12: Sequence of the acknowledgment procedure

RDY	LED "RDY"	tmax	Maximum permissible response time
S82	Confirmation button S82		
t	Time axis		

To acknowledge the request with the S82 confirmation button:

Precondition:

- The "RDY" LED is lit.
- The "ERR" LED is blinking.

1. Press and hold the S82 button.
   The "RDY" LED starts blinking.
2. The "RDY" LED goes off after 3 seconds.
3. Release the S82 button after a maximum of 2.5 seconds.
   The "RDY" LED is lit.
4. Press and hold the S82 button after a maximum of 2.5 seconds.
   The "RDY" LED starts blinking.
5. The "RDY" LED goes off after 3 seconds.
6. Release the S82 button after a maximum of 2.5 seconds.
   The acknowledgement is successfully completed.

   The action is recorded in the inverter logbook.
7. Use a function test to ensure that the acknowledgement has led to the correct result.

If the parameter set is invalid, an error is reported and the "ERR" LED starts blinking.

Safe interfaces

Safe inputs

Sensor inputs

Safety sensors can be connected to the safe inputs on terminal X83. The sensor inputs I1A/I1B ... I4A/I4B are suitable for active and passive sensors.

- Sensor type and sensor function are parameterizable.
- The inverter evaluates the sensors according to the parameterization.
- If a safety bus is activated, the sensor signals are sent to the higher-level control as status information.
- Deactivated sensor inputs must not be connected. An input that is not connected is in the "OFF state".
- If a signal is detected at a deactivated sensor input during initialization, the drive remains disabled (STO).
- Faulty input signals set the input to the "OFF state".

Monitoring modes

Specification	Passive sensor	Active sensor
Discrepancy time	parameterizable 0 ... 30000 ms (increment: 2 ms)	
Input delay	parameterizable 0 ... 100 ms (increment: 2 ms)	
Input filter time for test pulses	fixed, 2 ms	
Repetition rate of test pulses	defined by the clock outputs CLA and CLB	> 50 ms
Error response	Sensor output is switched to "OFF state". Acknowledgement via safety bus or the AIE input	

Explanations of the information:

- Discrepancy time 0x2119:
  - Maximum time within which both channels of a safe input are permitted to be in antivalent states without the safety technology triggering an error response.
- Input delay 0x211A:
  - Time between the detection of the signal change and the effective evaluation of an input signal. This does not take into account multiple and short signal changes due to bouncing of contact components.
  -
  - The input delay time affects the response time.
- Input filter time:
  - Time during which interference pulses and test pulses from e.g. switched-on active sensors are not recognized.
  - The input filter time affects the response time.

Connection of active sensors

- For connection diagram, see ▸ Extended Safety 108
- PN-switched input signals are permissible.
- The circuit monitoring must correspond to the requirements of category 3 or category 4. No circuit monitoring takes place via the integrated safety equipment.
- Detected errors:
  - Antivalent input signals after discrepancy time has elapsed.

Connection of passive sensors

- For connection diagram, see ▶ Extended Safety 📖 108
- The safe sensor inputs are suitable for equivalent switching passive sensors.
- Channels A and B are tested cyclically with a time delay by briefly switching LOW.
  - Cycle time approx. 2 s, test pulses < 1 ms
- In order to monitor passive sensors according to EN ISO 13849-1, cat. 3 or cat. 4, you will need to wire the clock outputs X82/CLA and X82/CLB:
  - The clock outputs are only suitable for monitoring passive sensors.
  - Connect X82/CLA via the sensor with X83/IxA (channel A of sensor input).
  - Connect X82/CLB via the sensor with X83/IxB (channel B of sensor input).
  - Connect X82/GS with X83/GIx of the sensor input.
  - X82/24S and X82/GS must be connected to an external 24 V supply.
- Detected errors:
  - Short circuit to the supply voltage.
  - Short circuit between the input signals when different clock outputs are used.
  - Antivalent input signals after discrepancy time has elapsed.
- Undetected errors:
  - Short circuit between the input signals, if the same clock outputs are used

⚠ DANGER!

Loss of safety function when input signals are short-circuited.

The loss of the safety function leads to an unsafe condition of the machine. The machine status cannot be controlled via the safety function.

► Lay the cables protected according to category 4 of EN ISO 13849-2.

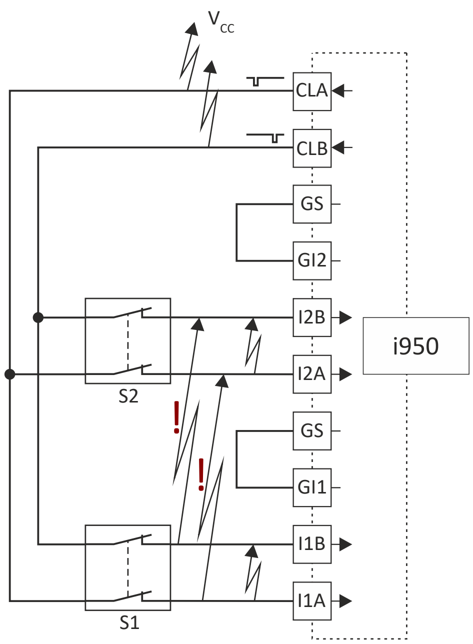


Fig. 13: Ways to detect errors

! Undetectable errors

Contact function test

An internal contact function test is carried out at the safe inputs.

Safe input in the ON state

- A LOW level on a channel sets the input to the OFF state; discrepancy monitoring starts at the same time.
- A LOW level must be detected on both channels within the discrepancy time; if it is not, a discrepancy error is reported.
- In order to be able to acknowledge a discrepancy error, a LOW level must previously have been detected on both channels.

Safe input in the OFF state

- A HIGH level on a channel triggers discrepancy monitoring.
- A HIGH level must be detected on both channels within the discrepancy time; if it is not, a discrepancy error is reported.
- To be able to acknowledge the discrepancy error, a HIGH level must be detected before at both channels.

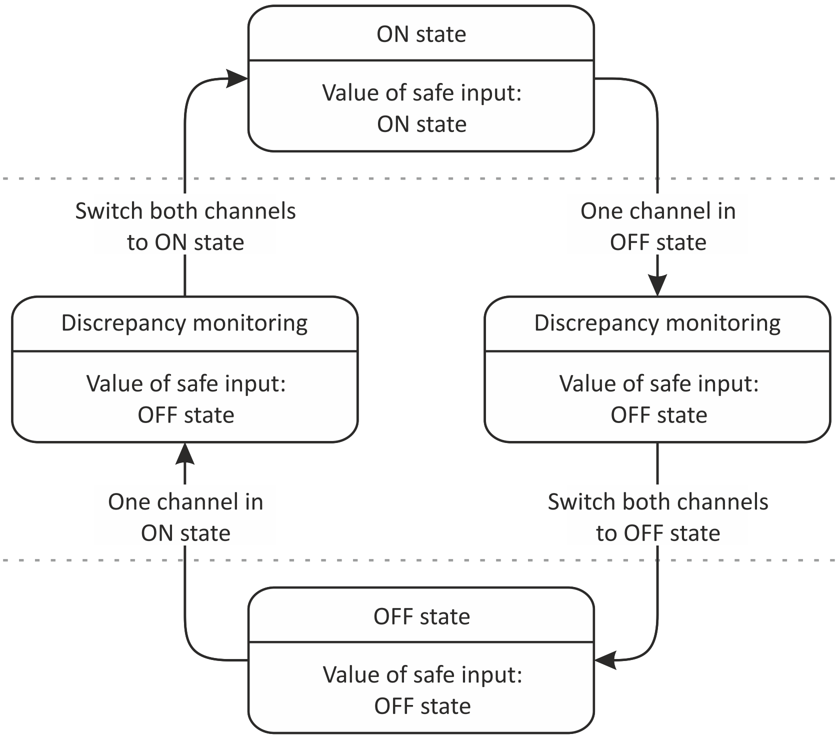


Fig. 14: Contact function test – state behavior

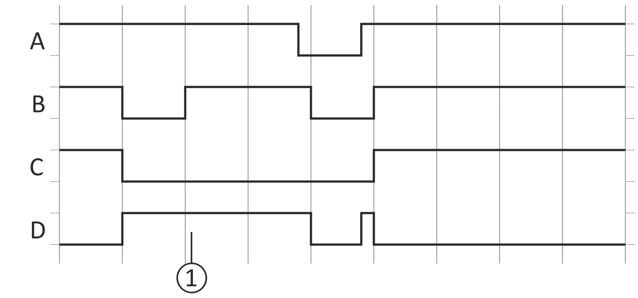


Fig. 15: Contact function test – error-free input signals

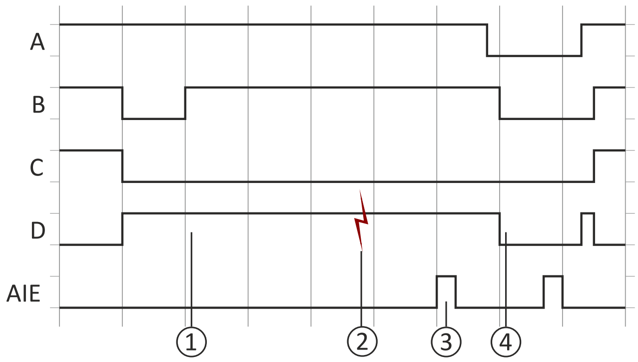


Fig. 16: Contact function test – faulty input signals

A, B	Safe input, channel A and channel B
C	Internal valuation of the safe input
D	Discrepancy monitoring
AIE	Error acknowledgement
①	Discrepancy monitoring active
②	Discrepancy monitoring time-out
③	Error acknowledgement impermissible
④	Error acknowledgement permissible

Homing inputs

Before the execution of safety functions that require an absolute reference point, a safety evaluated reference point must be available in the system.

The input signals IRS and IRL are available for generating a safe reference point.

Reference input IRS

An action at the reference input IRS starts safe homing.

- Activation of reference input IRS: 0x2880:001
- Definition of the signal edge that starts the homing process: 0x2880:002

Reference input IRL

An action at reference input IRL sets the safe reference point and ends safe homing.

- Activation of reference input IRL: 0x2881:001
- Definition of the signal edge that sets the safe reference point: 0x2881:002

Further information

- Connection diagram: ▸ Extended Safety 🕮 108
- Activation via the safety bus: ▸ Acknowledgement signals 🕮 224
- Safe homing: ▸ Safe homing (SHom) 🕮 268

Acknowledgement inputs

Error acknowledgement (AIE)

Errors require acknowledgement with the AIE signal.

Error acknowledgement via the safe input AIE:

- Positive signal pulse from 0.3 ... 10 s.
- Acknowledgement with the negative edge.

Restart acknowledgement (AIS)

After a stop function has been executed, the restart requires an acknowledgement with the AIS signal if "acknowledged restart" is set:

Restart acknowledgement via the safe input AIS:

- Positive signal pulse from 0.3 ... 10 s.
- Acknowledgement with the negative edge.

Further information

- Connection diagram: ▶ Extended Safety 📖 108
- Acknowledgement via the safety bus: ▶ Acknowledgement signals 📖 224

Safe output

Via the safe output O1A/O1B information can be output to a higher-level unit (e .g. safety PLC) or external switching elements (actuators) can be controlled.

> For an application according to category 3 or category 4, the use of both output channels (O1A and O1B) is required.

- The status of the safe output is controlled by two ways:
  - directly from the integrated safety technology (parameterization required)
  - via a safety bus
- The safe output is not potential-free.
- The safe output is PP switching, i e. two plus channels are switched.
- The safe output in ON state is cyclically tested by quick LOW switching.
  - The channels A and B are tested with a time offset, in cycles of approx. 2 s, with test pulses of < 1 ms.
  - When selecting the downstream control elements, ensure that the test pulses will not be detected as LOW level.
- Through parameterization, the status of the safety functions can be assigned to the safe output.

These errors will be detected and set the output to OFF state:

- Short circuit to the supply voltage.
- In the ON state: Short circuit between the output signals.
- In the ON state: Missing 24-V voltage supply at terminal 24S is detected as "Stuck-at-Low" error.

These errors are not detected:

- In the OFF state: Short circuit between the output signals.

Further information

> Information on the electrical connection can be found in the corresponding project planning document in the chapter "Electrical installation → Functional safety".

Further information on the connection

Electrical installation ▶ Functional safety connection 📖 104

Safety bus

Function included in variant:			Extended Safety

PROFIsafe ist das zertifizierte Safety-Protokoll zur Übertragung von sicherheitsgerichteten Daten über PROFINET®.

▸ PROFIsafe connection 📖 218

Fail-safe-over-EtherCAT (FSoE) ermöglicht die Übertragung von sicheren Informationen über das FSoE–Protokoll nach Spezifikation ETG.5100 S, Version 1.2.0 der EtherCAT Nutzerorganisation (ETG).
Safety over EtherCAT® ist eine eingetragene Marke und patentierte Technologie, lizenziert durch die Beckhoff Automation GmbH, Deutschland.

▸ FSoE connection 📖 221

PROFIsafe connection

PROFIsafe is the certified safety protocol for the transmission of safety-related data via PROFINET®.

The function supports the transfer of secure information via the PROFIsafe protocol according to the specification "PROFIsafe Profile for Safety Technology", Version 2.0, of the PROFIBUS user organization (PNO). The inverter forwards the PROFIsafe information to the function for secure evaluation.

Preconditions

Operation with PROFIsafe via PROFINET is only permitted according to the specification PROFIsafe Profile for Safety Technology Version 2.x!

Addressing

In order to ensure that a data telegram reaches the right node, a unique PROFIsafe destination address is necessary. If PROFIsafe has been chosen as the safety bus, the safety address will be used as the PROFIsafe destination address. This address must match the corresponding configuration of the safety PLC.

Definition of the PROFIsafe address

The PROFIsafe address (code name according to IEC 61784-3-3:2010) is used to uniquely identify the source and destination. Therefore, a distinction is made between two parts of an address: the source address and the target address. One or both addresses are used for protection.

PROFIsafe address type 1

- The uniqueness of the PROFIsafe address is guaranteed solely by the destination address.
- The target address must be unique on the network and should then be verified in the security report.
- If there are multiple safety PLCs, their target address ranges must not overlap.
- The source address has no effect on the uniqueness of the PROFIsafe address.
- The target and source addresses are contained in the CRC value of the safety program in the safety PLC.

PROFIsafe address type 2

- The uniqueness of the PROFIsafe address is ensured by the combination of the source address and the target address.
- The source address used for the safety components (F-peripherals) of a safety PLC must be unique on the network.
- The target address must be unique within the network and must differ from all PROFIsafe Address Type 1 target addresses on the same network.
- The target and source addresses are contained in the CRC value of the safety program in the safety PLC.

PROFIsafe Frame

The PROFIsafe data is transmitted in the second slot of a PROFINET data telegram. This must be taken into account during the hardware configuration of the safety PLC.

PROFINET data telegram			
Header	**Slot 1**	**Slot 2**	**Trailer**
	Data	PROFIsafe data	

PROFIsafe data

In the PROFIsafe data, a bit is used to control a safety function. The structure of the PROFIsafe data is described in the PROFIsafe profile. The length of the PROFIsafe data (or PROFIsafe message) is 16 bytes.

PROFIsafe message V2 mode								
Bit offset								
Byte offset	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0...11	PROFIsafe process data (PROFIsafe output data/PROFIsafe input data)							
12	Control byte or status byte							
13...15	CRC2 Signature from PROFIsafe process data, the PROFIsafe parameters and the running numbers.							

The meaning of the PROFIsafe process data is described separately in the following chapters according to PROFIsafe output data and PROFIsafe input data.

Extended Safety

Structure of the PROFIsafe output data

The safety PLC transmits PROFIsafe output data (control commands) to the inverter:

- Data length: 16 bytes
- Control commands are LOW-active, the bit state "0" activates the function.
- Exceptions: See details in the table.

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	SDIpos	SLS4	SLS3	SLS2	SLS1	SS2	SS1	STO
Byte 1	SLP4	SLP3	SLP2	SLP1	OMS (HIGH-active)	SLI	ES (HIGH-active)	SDIneg
Byte 2	SSE	PDSS	SHom load (0↗1)	SHom start (0↗1)	RMS (HIGH-active)	SOS	AIE (0↗1)	AIS (0↗1)
Byte 3	-	-	-	-	-	-	SBC	SD-Out1 (HIGH-active)
Byte 4	-	-	-	-	-	-	-	-
Byte 5	-	-	-	-	-	-	-	-
Byte 6	-	-	-	-	-	-	-	-
Byte 7	-	-	-	-	-	-	-	-
Byte 8	-	-	-	-	-	-	-	-
Byte 9	-	-	-	-	-	-	-	-
Byte 10	-	-	-	-	-	-	-	-
Byte 11	-	-	-	-	-	-	-	-
Byte 12	Status byte							
Byte 13	CRC2 (consecutive number)							
Byte 14								
Byte 15								

Structure of the PROFIsafe input data

The inverter transmits PROFIsafe input data (status information) to the safety PLC:

- Data length: 16 bytes
- Status information is HIGH-active, the bit status "1" indicates the active status information.

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	SDIpos active	SLS4 active	SLS3 active	SLS2 active	SLS1 active	SS2 active	SS1 active	STO active
Byte 1	SLP4 observed	SLP3 observed	SLP2 observed	SLP1 observed	SOS active	SLI active	ES active	SDIneg active
Byte 2	SSE active	SDIneg observed	SDIpos observed	SLS4 observed	SLS3 observed	SLS2 observed	SLS1 observed	SOS observed
Byte 3	Error active	SMS observed	OMS active	RMS active	SD-In4	SD-In3	SD-In2	SD-In1
Byte 4	SCA4 within limits	SCA3 within limits	SCA2 within limits	SCA1 within limits	PDSSneg observed	PDSSpos observed	SHom available	SHom active
Byte 5	MUT active	SBC activated	SBC active	SD-Out1	Positive direction	n = 0	Safe speed OK	SSM within limits
Byte 6	Actual speed n_safe, byte 0							
Byte 7	Actual speed n_safe, byte 1							
Byte 8	Actual position p_safe, byte 0							
Byte 9	Actual position p_safe, byte 1							
Byte 10	Actual position p_safe, byte 2							
Byte 11	Actual position p_safe, byte 3							
Byte 12	Status byte							
Byte 13	CRC2 (consecutive number)							
Byte 14								
Byte 15								

FSoE connection

Safety over EtherCAT

Fail-safe-over-EtherCAT (FSoE) enables the transmission of safe information via FSoE protocol according to ETG.5100 S specification, version 1.2.0 of the EtherCAT user organisation (ETG).

Safety over EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

FSoE availability

i950 Extended Safety Technology application		FSoE via onboard EtherCAT		FSoE via EtherCAT module I9MAFT0000000S	
		From safety firmware V1.1 with parameter set version V1.1		From safety firmware V1.2 with parameter set version V1.2	
		With Lenze components	With Beckhoff components	With Lenze components	With Beckhoff components
	EtherCAT master	Lenze Controller	Beckhoff PLC	Lenze Controller	Beckhoff PLC
	FSoE master	Lenze c250-S	TwinSAFE	Lenze c250-S	TwinSAFE
Device profile CiA 402 (0x4000 = 0)		From device firmware V01.04.01 Without SD card	-	-	
CiA 402 Advanced (0x4000 = 1)		From device firmware V01.04.01 With SD card	From device firmware V01.03.07 With SD card	-	
All other technology applications (0x4000 > 1)				From device firmware V01.04.01 With SD card	

Preconditions

ESI file

The ESI file can be used to integrate Lenze EtherCAT devices into the EtherCAT configuration software of PLC manufacturers.

The ESI file is NOT required for Lenze controllers with EtherCAT master functionality. For Lenze controllers, all device description files are installed with Lenze PLC Designer and Lenze Package Manager.

Download of the current ESI file → www.lenze.com

Addressing

A definite FsoE address ensures that a data frame reaches the correct node. If "FSoE" has been selected as safety bus, the safety address is at the same time accepted as the FSoE target address. This address must match the corresponding configuration of the safety PLC.

The checksums (CRC) of a parameter set are calculated via the set safety parameters. The calculated checksums of the safety parameter set must match the corresponding configuration of the safety PLC.

Extended Safety

Structure of the FSoE output data

The safety PLC transmits FSoE output data (control commands) to the inverter:

- Data length: 11 bytes
- Control commands are LOW-active, the bit state "0" activates the function.
- Exceptions: See details in the table.

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Command (CMD)							
Byte 1	AIE (0↗1)	SDIneg	SDIpos	-	SOS	SS2	SS1	STO
Byte 2	SSE	SLI	ES (HIGH-active)	RMS (HIGH-active)	OMS (HIGH-active)	SHom load (0↗1)	SHom start (0↗1)	AIS (0↗1)
Byte 3	CRC_0 (low-byte)							
Byte 4	CRC_0 (high-byte)							
Byte 5	SLP4	SLP3	SLP2	SLP1	SLS4	SLS3	SLS2	SLS1
Byte 6	-	-	-	-	-	SBC	SD-Out1 (HIGH-active)	PDSS
Byte 7	CRC_1 (Low-Byte)							
Byte 8	CRC_1 (High-Byte)							
Byte 9	Connection-ID (low-byte)							
Byte 10	Connection-ID (high-byte)							

Structure of the FSoE input data

The inverter transmits FSoE input data (status information) to the safety PLC:

- Data length: 31 bytes
- Status information is HIGH-active, the bit status "1" indicates the active status information.

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Command (CMD)							
Byte 1	Error active	SDIneg active	SDIpos active	-	SOS active	-	-	STO active
Byte 2	SSE active	SLI active	ES active	RMS active	OMS active	SOS observed	SS2 active	SS1 active
Byte 3	CRC_0 (low-byte)							
Byte 4	CRC_0 (high-byte)							
Byte 5	SLS4 observed	SLS3 observed	SLS2 observed	SLS1 observed	SLS4 active	SLS3 active	SLS2 active	SLS1 active
Byte 6	SCA4 within limits	SCA3 within limits	SCA2 within limits	SCA1 within limits	SLP4 observed	SLP3 observed	SLP2 observed	SLP1 observed
Byte 7	CRC_1 (low-byte)							
Byte 8	CRC_1 (high-byte)							
Byte 9	SSM within limits	SMS observed	PDSSneg observed	PDSSpos observed	SDIneg observed	SDIpos observed	SHom available	SHom active
Byte 10	-	-	-	-	MUT active	Positive direction	n=0	Safe speed OK
Byte 11	CRC_2 (low-byte)							
Byte 12	CRC_2 (high-byte)							
Byte 13	-	-	-	-	SD-In4	SD-In3	SD-In2	SD-In1
Byte 14	-	-	-	-	-	SBC activated	SBC active	SD-Out1
Byte 15	CRC_3 (low-byte)							
Byte 16	CRC_3 (high-byte)							
Byte 17	Actual speed n_safe, byte 0							
Byte 18	Actual speed n_safe, byte 1							
Byte 19	CRC_4 (low-byte)							
Byte 20	CRC_4 (high-byte)							
Byte 21	Actual position p_safe, byte 0							
Byte 22	Actual position p_safe, byte 1							
Byte 23	CRC_5 (low-byte)							
Byte 24	CRC_5 (high-byte)							
Byte 25	Actual position p_safe, byte 2							
Byte 26	Actual position p_safe, byte 3							
Byte 27	CRC_6 (low-byte)							
Byte 28	CRC_6 (high-byte)							
Byte 29	Connection-ID (low-byte)							
Byte 30	Connection-ID (high-byte)							

Homing signals

Before the execution of safety functions that require an absolute reference point, a safety evaluated reference point must be available in the system.

The input signals IRS and IRL are available for generating a safe reference point.

IRS (SHom_Start)

Start safe homing via the safety bus with the "SHom_Start" bit:

- Start with bit change 0↗1.
- The bit must be set for at least one safety bus cycle.

IRL (SHom_Load)

Set safe reference point via the safety bus with the "SHom_Load" bit:

- Set reference point with bit change 0↗1.
- The bit must be set for at least one safety bus cycle.
- The safe reference run is terminated.

Further information

- Safety bus: ▶ Safety bus 217
- Safe homing: ▶ Safe homing (SHom) 268
- Activation via safe inputs: ▶ Homing inputs 215

Acknowledgement signals

Error acknowledgement (AIE)

Errors require acknowledgement with the AIE signal.

Error acknowledgement via the safety bus with the "AIE" bit:

- Acknowledgement with bit change 0↗1.
- The bit must be set for at least one safety bus cycle.

Restart acknowledgement (AIS)

After a stop function has been executed, the restart requires an acknowledgement with the AIS signal if "acknowledged restart" is set:

Restart acknowledgement via the safety bus with the "AIS" bit:

- Acknowledgement with bit change 0↗1.
- The bit must be set for at least one safety bus cycle.

Safe speed and position analysis

Drive systems which are outfitted with Lenze inverters of the "Extended Safety" variant provide speed-dependent safety functions for reliable speed monitoring and for reliable position monitoring.

For safe speed and position detection, you must connect a safety-rated motor/encoder combination.

Alternatively, you can connect a 2-encoder system consisting of a motor encoder and load encoder.

For drive systems with slip between motor encoder and load encoder: ▸ Encoder slip compensation

Important notes

⚠ DANGER!

Slip, shaft fracture etc. between the motor and encoder system interfere with the reliability of speed and position detection.

Speed-dependent and direction-dependent functions are executed incorrectly.

► Reliably exclude functional errors via design measures.

► Utilize motors and encoder systems with guaranteed features.

In order to enable the reavailability of the absolute position after mains switching without a new reference run (load stored reference), encoders with absolute value information that covers the entire traversing range must be used.

If you use a 2-encoder system, the load encoder must provide the absolute value information.

Operation with 2-encoder system

A 2-encoder system is a machine configuration that typically uses the following components:

- Motor encoder: Resolver
- Load encoder Absolute value encoder (SinCos), incremental encoder (TTL) or digital encoder (SSI/Bus)

Preconditions

- The inverter must be parameterized so that the position values of the load encoder are transmitted to the safety system.

  The parameter depends on the selected technology application.
- The preset device profile CiA 402 cannot evaluate a 2-encoder system.
- The status and value of the load encoder position can be read out.

Parameterizable settings:

- The motor encoder position and load encoder position can be adjusted using gearbox factors.
- Error response in the event of an error from an external load encoder.

Detailed information on setting and parameterizing the product is described in the commissioning manual.

Operation with 1-encoder system with resolver

When using only one encoder in safety applications, theEN 61800-5-2 standard places separate requirements on the connection between the feedback system and the motor shaft. The oversized design prevents operational failures caused by encoder shaft fracture or encoder slippage on the motor shaft. The acceleration limit values in the drive solutions with a resolver are not to be exceeded.

Limit values

Synchronous servo motors	Encoder type	Encoder product code	Maximum permissible angular acceleration	Minimum time per 1,000 1/min speed stroke
MCS 06	Resolver	RV03	56,000 rad/s²	1.9 ms
MCS 09 ... 19			19000 rad/s²	5.5 ms
MDXKS 56 / 71			17000 rad/s²	6.2 ms

Asynchronous servo motors	Encoder type	Encoder product code	Maximum permissible angular acceleration	Minimum time per 1,000 1/min speed stroke
MCA 10 ... 19	Resolver	RV03	22000 rad/s²	4.8 ms
MCA 20 ... 26				
MQA 20 ... 26				

Motor-encoder combinations

The achievable risk reductions (PL/SIL) also depend on the safety function used.

Match the values specified here with the values for the safety functions:

▶ Safety-related characteristics Extended Safety 📖 285

Also observe the supplied documentation of the encoder manufacturer.

Permissible motor-encoder combinations for safe speed and position monitoring

Synchronous servo motors	Safety-rated encoder			
	Encoder type	Encoder product code	Max. speed [rpm]	Risk mitigation
MCS 06 ... 19 MDXKS 56 / 71	SinCos absolute value, single-turn	AS1024–8V–K2	±16000	PL d / SIL 2
	SinCos absolute value, multi-turn	AM1024–8V–K2		
MCS 06 ... 19 m850S120 ... m850S190	SinCos absolute value, multi-turn	AM128–8V–K2		
	HIPERFACE DSL® (OCT)	AM20-8V-D2	±15000	
		AM20-8V-D2-1	±9000	
MCS 06 ... 19 MDXKS 56 / 71 m850S120 ... m850S190	Resolver	RV03	±10000/number of pole pairs	PL e / SIL 3

Asynchronous servo motors	Safety-rated encoder			
	Encoder type	Encoder product code	Max. speed [rpm]	Risk mitigation
MCA 10 ... 26 MQA 20 ... 26	SinCos incremental	IG1024-5V-V3	±16000	PL e / SIL 3
MCA 10 ... 26 MQA 20 ... 26	Resolver	RV03	±10000/number of pole pairs	PL e / SIL 3
m850AS 040 ... 080	HIPERFACE DSL® (OCT)	AM17-8V-D2	±12000	PL d / SIL 2

Three-phase AC motors	Safety-rated encoder			
	Encoder type	Encoder product code	Max. speed [rpm]	Risk mitigation
MDxMA063 ... MDxMA225 MHxMA063 ... MHxMA225 MFxMA063 ... MFxMA132 m550P080 ... m550P225	SinCos incremental	IG2048-5V-V2 IG1024-5V-V2	±16000	PL d / SIL 2
		IG2048-5V-V3		PL e / SIL 3

Safety functions

Safe torque off (STO)

The "Safe Torque Off (STO)" safety function safely switches off the drive. The drive coasts down.

STO corresponds to an uncontrolled shutdown according to EN 60204-1, category 0.

With STO, additional measures are required for an "emergency switching off" according to EN 60204-1.

Basic Safety - STO

Function included in variant:	Basic Safety - STO		

Preconditions

- Additional measures are required to prevent movement caused by external forces.
- When assessing risk, also take into account overtravel distances.

Important notes

⚠ DANGER!

No "emergency switching off" in terms with EN 60204-1

With the "Safe torque off" (STO) function, no "emergency switching off" in terms with EN 60204-1 can be executed without additional measures. There is no electrical isolation between the motor and inverter and no service switch or maintenance switch!

Possible consequences: Death or severe injuries

► "Emergency switching off" requires electrical isolation, e. g. by a central mains contactor.

⚠ DANGER!

The power supply is not safely disconnected.

Possible consequences: Death or severe injuries due to electrical voltage.

► Turn off the power supply.

⚠ DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

► Set the motor to standstill mechanically.

⚠ DANGER!

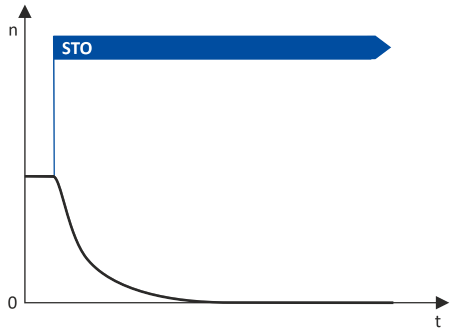
Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

► You must provide additional measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

Functional description

STO



- The transmission of the pulse width modulation is safely switched off by STO. The power drivers do not generate a rotating field anymore.
- The motor is safely switched to torqueless operation.

Activation

STO is activated via the safe input X1 with the channels SIA and SIB:

Safe input X1		Inverter device state
SIA	SIB	
LOW	LOW	STO active
LOW	HIGH	Inverter disabled (safety)
HIGH	LOW	
HIGH	HIGH	Drive enabled

If the GS connection is interrupted, or in case of a short circuit/cross-circuit of GS to SIA/SIB, STO is active.

Advanced Safety/Extended Safety

Function included in variant:			Extended Safety

Preconditions

- Additional measures are required to prevent movement caused by external forces.
- When assessing risk, also take into account overtravel distances.

Important notes

⚠ DANGER!

No "emergency switching off" in terms with EN 60204-1

With the "Safe torque off" (STO) function, no "emergency switching off" in terms with EN 60204-1 can be executed without additional measures. There is no electrical isolation between the motor and inverter and no service switch or maintenance switch!

Possible consequences: Death or severe injuries

▶ "Emergency switching off" requires electrical isolation, e. g. by a central mains contactor.

⚠ DANGER!

The power supply is not safely disconnected.

Possible consequences: Death or severe injuries due to electrical voltage.

▶ Turn off the power supply.

⚠ DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

▶ Set the motor to standstill mechanically.

⚠ DANGER!

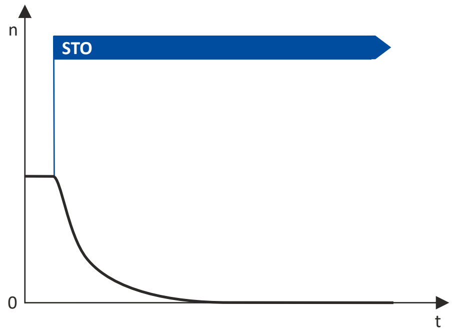
Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

▶ You must provide additional measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

Functional description

STO



- The transmission of the pulse width modulation is safely switched off by STO. The power drivers do not generate a rotating field anymore.
- The motor is safely switched to torqueless operation.

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Indirectly:

- As a possible error response

Automatically by activating the safety functions:

- Safe stop emergency (SSE)

Automatically after the safety functions have expired:

- Safe stop 1 (SS1)

Automatically when transferring the safe parameter set

As a result of errors in the stop functions:

- Safe Operating Stop (SOS)

As a result of errors in the safety functions for speed monitoring:

- Safe maximum speed (SMS)
- Safely limited speed (SLS)
- Safe position-dependent speed (PDSS)

As a result of errors in the safety functions for position monitoring:

- Safely limited increment (SLI)
- Safe direction (SDI)
- Safely limited position (SLP)

Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Whether the restart must be acknowledged or whether it starts automatically can be set in the "STO: Restart" parameter.

Safe stop 1 (SS1)

Function included in variant:			Extended Safety

The "Safe Stop 1 (SS1)" safety function monitors whether a deceleration ramp in the application causes the drive to come to a standstill.

SS1 corresponds to a controlled stop according to EN 60204-1, stop category 1.

Safe stop 1 time controlled (SS1-t)

Function included in variant:			Extended Safety

SS1-t triggers the normal stop STO after the stop time has elapsed or after reaching standstill.

Preconditions

- A deceleration ramp in the application guides the drive to standstill.
- Additional measures are required to prevent movement caused by external forces.

Important notes

⚠ DANGER!

The power supply is not safely disconnected.

Possible consequences: Death or severe injuries due to electrical voltage.

► Turn off the power supply.

⚠ DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

► Set the motor to standstill mechanically.

⚠ DANGER!

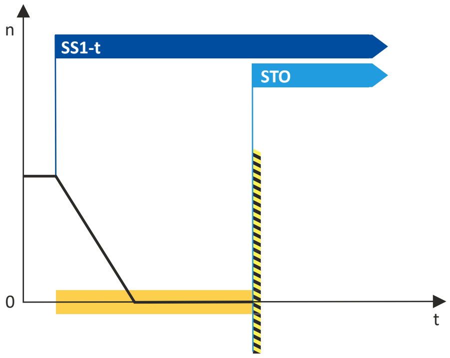
Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

► You must provide additional measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

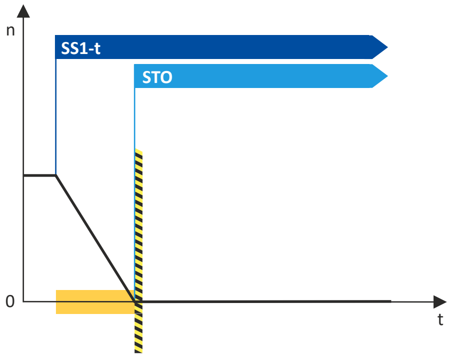
Functional description

SS1-t (STO after stop time)



- SS1-t activates the normal stop STO when the parameterized stop time has elapsed.
- If standstill has not yet been reached, the motor coasts down.

SS1-t (STO at standstill)



- SS1-t activates the normal stop STO when standstill is detected.
- A waiting time can also be parameterized.
  - The waiting time starts when the standstill is detected.
  - SS1-t activates the normal stop STO when the waiting time has elapsed.
- Detection of standstill:
  - For applications without encoder: n ≤ 5 rpm
  - For applications with encoder: n is within the parameterized tolerance window

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Indirectly:

- As a possible error response

Automatically by activating the safety functions:

- Safe stop emergency (SSE)

As a result of errors in the safety functions for speed monitoring:

- Safe maximum speed (SMS)
- Safely limited speed (SLS)
- Safe position-dependent speed (PDSS)

As a result of errors in the safety functions for position monitoring:

- Safely limited increment (SLI)
- Safe direction (SDI)
- Safely limited position (SLP)

Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Restarting is only possible after the stop time has elapsed completely. Exception: STO is activated even while the stop time is still elapsing.
- Whether the restart must be acknowledged or whether it starts automatically can be set in the "STO: Restart" parameter.

Error behavior

States that trigger an event and an error stop:

- The drive does not stop after the stop time has elapsed.
  - Event: SS1/SS2 - Stop time exceeded (0x2A00FF88)
  - Error stop STO

Safe stop 1 ramp monitored (SS1-r)

Function included in variant:			Extended Safety

SS1-r triggers the normal stop STO after the stop time has elapsed or after reaching standstill.

SS1-r also monitors the deceleration ramp of the application.

Preconditions

- A deceleration ramp in the application guides the drive to standstill.
- Additional measures are required to prevent movement caused by external forces.
- A safety-rated encoder system records the speed.
- Ramp monitoring is activated.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

⚠ DANGER!

The power supply is not safely disconnected.

Possible consequences: Death or severe injuries due to electrical voltage.

► Turn off the power supply.

⚠ DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

► Set the motor to standstill mechanically.

⚠ DANGER!

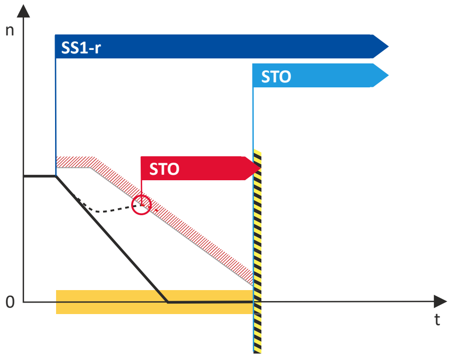
Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

► You must provide additional measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

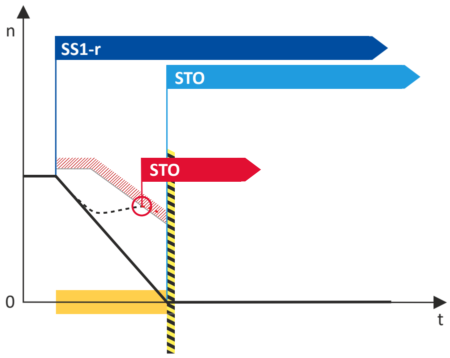
Functional description

SS1-r (STO after stop time)



- If the SS1-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- There are two options for calculating the monitoring ramp:
  1. Constant time: The monitoring ramp is calculated based on the stop time.
  2. Constant delay: The monitoring ramp is determined by setting a delay time.
- SS1-r activates the normal stop STO when the parameterized stop time has elapsed and the monitoring ramp has not been exceeded.
- If standstill has not yet been reached, the motor coasts down.

SS1-r (STO at standstill)



- If the SS1-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- There are two options for calculating the monitoring ramp:
  1. Constant time: The monitoring ramp is calculated based on the stop time.
  2. Constant delay: The monitoring ramp is determined by setting a delay time.
- SS1-r activates the normal stop STO when standstill is detected and the monitoring ramp has not been exceeded.
- Detection of standstill:
  - For applications without encoder: n ≤ 5 rpm
  - For applications with encoder: n is within the parameterized tolerance window

Activation

Directly:
- Via a safety bus
- Via a safe input (depending on the version)

Automatically by activating the safety functions:
- Safe stop emergency (SSE)

As a result of errors in the safety functions for speed monitoring:
- Safe maximum speed (SMS)
- Safely limited speed (SLS)
- Safe position-dependent speed (PDSS)

As a result of errors in the safety functions for position monitoring:
- Safely limited increment (SLI)
- Safe direction (SDI)
- Safely limited position (SLP)

Restart
- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Restarting is only possible after the stop time has elapsed completely.
- Whether the restart must be acknowledged or whether it starts automatically can be set in the "STO: Restart" parameter.

Error behavior

States that trigger an event and an error stop:
- The drive does not stop after the stop time has elapsed.
  - Event: SS1/SS2 - Stop time exceeded (0x2A00FF88)
  - Error stop STO
- The speed of the drive exceeds the monitoring ramp within the stop time.
  - Event: SS1/SS2 - Speed ramp exceeded (0x2A00FF95)
  - Error stop STO

Safe stop emergency (SSE)

Function included in variant:			Extended Safety

The "Safe emergency stop (SSE)" safety function has a higher priority for triggering the "Safe torque off (STO)" or "Safe stop 1 (SS1)" stop functions.

SSE is primarily controlled from all states, operating modes or safety functions.

SSE immediately triggers the assigned stop function.

Preconditions

- The requirements for the triggered stop function must be met.

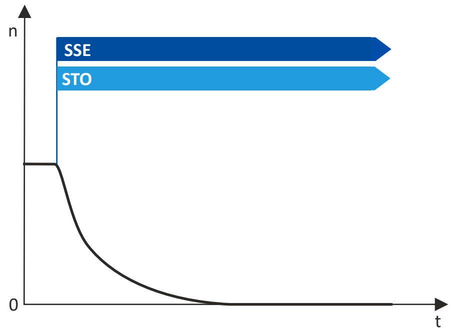
Important notes

Connect the emergency stop buttons which must not be overruled by special operation or repair mode select (RMS) to the SSE function. For this purpose, parameterize the safe input as the trigger source for the SSE function.

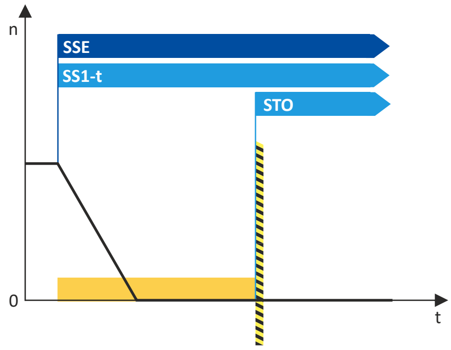
The SSE function can also be requested with the "SSE" bit via the safety bus.

Functional description

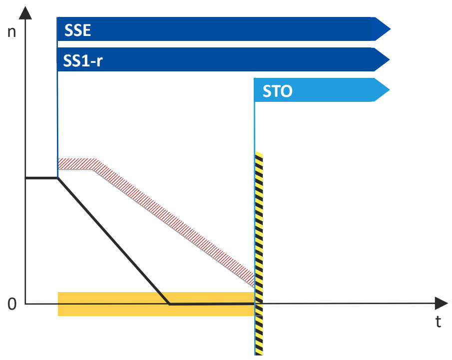
SSE (STO)



SSE (SS1-t)



SSE (SS1-r)



The SSE safety function initiates the parameterized stop function with the highest priority.

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Restarting is only possible after the stop time has elapsed completely. Exception: STO is activated even while the stop time is still elapsing.
- Whether the restart must be acknowledged or whether it starts automatically can be set in the "STO: Restart" parameter.

Error behavior

States that trigger an event and an error stop:

- The drive does not stop after the stop time has elapsed.
  - Event: SS1/SS2 - Stop time exceeded (0x2A00FF88)
  - Error stop STO

Safe stop 2 (SS2)

The "Safe Stop 2 (SS2)" safety function monitors whether a deceleration ramp in the application causes the drive to come to a standstill.

SS2 corresponds to a controlled stop according to EN 60204-1, stop category 2.

Safe stop 2 time controlled (SS2-t)

Function included in variant:			Extended Safety

SS2-t triggers the normal stop SOS after the stop time has elapsed or after reaching speed 0. The reached position is actively held and monitored.

Preconditions

- A deceleration ramp in the application guides the drive to standstill.
- A safety-rated encoder system records the speed.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

⚠ DANGER!

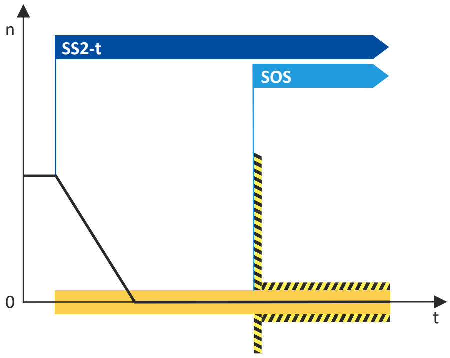
Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

► You must provide additional measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

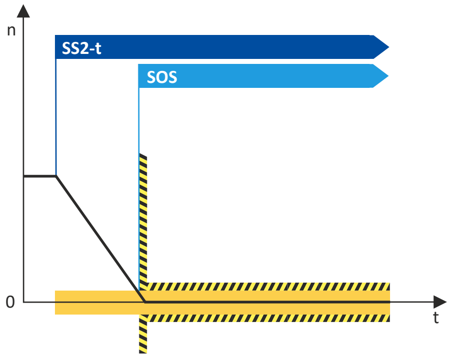
Functional description

SS2-t (SOS after stop time)



- SS2-t activates the normal stop SOS when the parameterized stop time has elapsed and the speed n = 0 has been detected.

SS2-t (SOS at n = 0)



- SS2-t activates the normal stop SOS when the speed n = 0 is detected.
- Restarting is only possible after the stop time has elapsed completely.

Activation

Directly:
- Via a safety bus
- Via a safe input (depending on the version)

As a result of errors in the safety functions for speed monitoring:
- Safe maximum speed (SMS)
- Safely limited speed (SLS)
- Safe position-dependent speed (PDSS)

As a result of errors in the safety functions for position monitoring:
- Safely limited increment (SLI)
- Safe direction (SDI)
- Safely limited position (SLP)

Error behavior

States that trigger an event and an error stop:
- The drive does not stop after the stop time has elapsed.
  - Event: SS1/SS2 - Stop time exceeded (0x2A00FF88)
  - Error stop STO

Safe stop 2 ramp monitored (SS2-r)

Function included in variant:			Extended Safety

SS2-r triggers the normal stop SOS after the stop time has elapsed or after reaching speed 0. The reached position is actively held and monitored.

SS2-r-r also monitors the deceleration ramp of the application.

Preconditions

- A deceleration ramp in the application guides the drive to standstill.
- A safety-rated encoder system records the speed.
- Ramp monitoring is activated.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

⚠ DANGER!

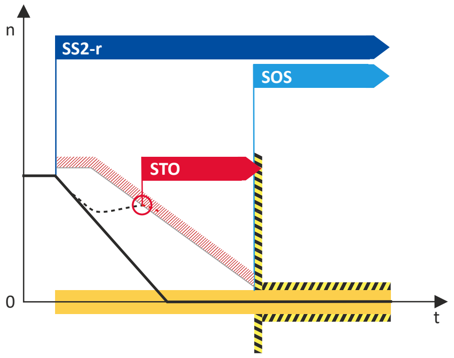
Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

► You must provide additional measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

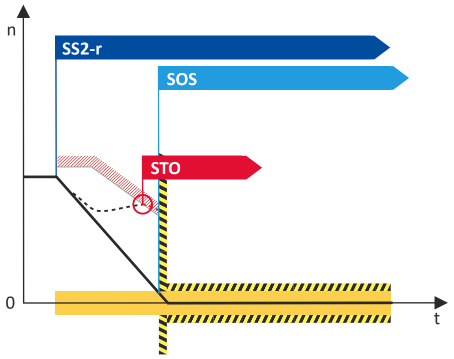
Functional description

SS2-r (SOS after stop time)



- If the SS2-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- There are two options for calculating the monitoring ramp:
  1. Constant time: The monitoring ramp is calculated based on the stop time.
  2. Constant delay: The monitoring ramp is determined by setting a delay time.
- SS2-r activates the normal stop SOS when the parameterized stop time has elapsed and the monitoring ramp has not been exceeded.

SS2-r (SOS at n = 0)



- If the SS2-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- There are two options for calculating the monitoring ramp:
  1. Constant time: The monitoring ramp is calculated based on the stop time.
  2. Constant delay: The monitoring ramp is determined by setting a delay time.
- SS2-r activates the normal stop SOS if the speed n = 0 is detected and the monitoring ramp has not been exceeded.

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

As a result of errors in the safety functions for speed monitoring:

- Safe maximum speed (SMS)
- Safely limited speed (SLS)
- Safe position-dependent speed (PDSS)

As a result of errors in the safety functions for position monitoring:

- Safely limited increment (SLI)
- Safe direction (SDI)
- Safely limited position (SLP)

Error behavior

States that trigger an event and an error stop:

- The drive does not stop after the stop time has elapsed.
  - Event: SS1/SS2 - Stop time exceeded (0x2A00FF88)
  - Error stop STO
- The speed of the drive exceeds the monitoring ramp within the stop time.
  - Event: SS1/SS2 - Speed ramp exceeded (0x2A00FF95)
  - Error stop STO

Safe operating stop (SOS)

Function included in variant:			Extended Safety

The "Safe Operating Stop (SOS)" safety function monitors the standstill of the drive. The reached position is actively held and monitored.

Preconditions

- A deceleration ramp in the application guides the drive to standstill.
- A safety-rated encoder system records speed and position.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

▶ Use a safety-rated encoder system to use this function.

⚠ DANGER!

Automatic restart can occur if the request of the safety function is deactivated.

Possible consequences: Death or severe injuries

▶ Parameterize the acknowledged restart.

▶ Take external measures according to EN ISO 13849-1 to ensure that the drive only restarts after confirmation.

⚠ DANGER!

The function for linking the safe digital output SD-Out1 (terminal X82, O1A, O1B) with the status information “SOS observed” via parameter 0x28A0 is faulty in the safety firmware versions ≤ V1.3.6.0. Contrary to the intended behavior, the signal of the safe digital output SD-Out1 does not follow the status signal “SOS observed” when leaving the SOS tolerance limits.

From safety firmware version V1.3.8.11485, the safe output SD-Out1 correctly displays the monitoring status of the SOS function. If the SOS position limits are violated, the safe digital output SD-Out1 changes its status.

Possible consequences: Death or severe injuries

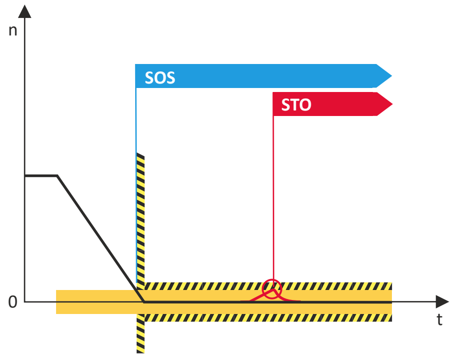
▶ The setting of the safe parameter 0x28A0 must not deviate from the default setting “Deactivated” [0] in safety firmware versions ≤ V1.3.6.0.

▶ If the "SOS observed" signal is used via the safe digital output SD-Out1 or is to be used in future, the correction must be made by means of an update of the safety firmware. The function must be deactivated until the firmware update has been carried out.

▶ Please contact your regional technical support to carry out the firmware update required to rectify the malfunction.

Functional description

SOS



- SOS is activated when the speed n = 0 is detected. The reached position is actively held and monitored.
- Relative position changes are added and saved. The value is continuously compared with the tolerance window for the position deviation.
- When the SOS state is requested again, the sum of the last position changes is reset.

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Automatically after the safety functions have expired:

- Safe stop 2 (SS2)

Error behavior

States that trigger an event and an error stop:

- The position change has exceeded the tolerance window p = 0.
  - Event: SOS - Tolerance limit exceeded (0x2A00FF91)
  - Error stop STO

Safe brake control (SBC)

Function included in variant:			Extended Safety

(From standard device firmware V1.3, safety firmware V1.1 with parameter set version V1.1)

The "Safe Brake Control (SBC)" safety function enables the safe control of a brake of the drive that is active at standstill, i.e. the brake closes when the brake voltage is switched off. To prevent the motor from working against the closed brake, STO can be activated simultaneously or with a time delay.

Preconditions

- Only use safety-rated brakes.
- The brake is connected to X106.
- Brake function and brake control monitoring are controlled via X106.

Important notes

⚠ DANGER!

Use of non-safety-rated brakes

Possible consequences: Death or severe injuries

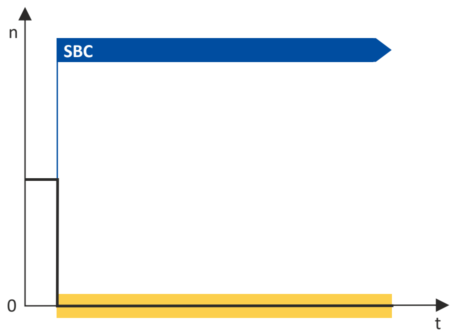
► Only use safety-rated brakes with suitable safety-related parameters according to EN ISO 13849-1 and/or EN 62061or EN IEC 61508.

The internal test rate of the brake output (X106) restricts the request rate to max. 1 brake request/10 seconds.

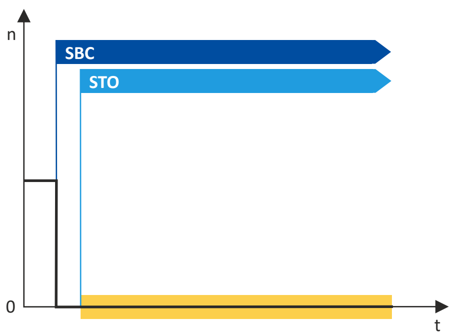
Depending on the application test rate of the connected brake to be released you must reduce the request rate accordingly.

Functional description

SBC



SBC (STO)



Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)
- Via internal status signals (Starting with Safety Firmware V2.0 and parameter set version V2.0)

Error behavior

The brake is applied when any error is detected.

States that trigger an event:

- Incompatible configuration of the brake control
  - Event: SBC - Device configuration incompatible (0x2A006187)
- Faulty test of the brake control
  - Event: SBC - Test pulse error (0x2A00508E)
- The brake control supply is switched off.
  - Event: SBC - Remains stuck at LOW (0x2A00508F)

STO cascading (CAS)

Function included in variant:			Extended Safety

The “Cascading STO (CAS)” safety function enables the synchronized shutdown of an entire drive system. CAS switches off all connected drives synchronously by triggering an STO request. The drives then coast to a halt.

Preconditions

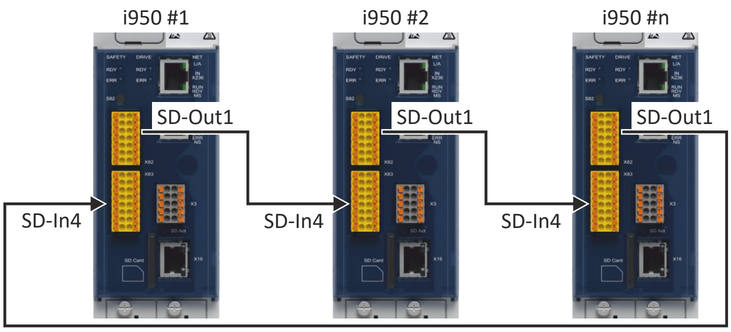
- CAS can only be activated via safe inputs and safe outputs.
- CAS cannot be activated via a safety bus.

Important notes

Please note with active cascading:

- Repair mode (RMS) is not possible as STO cannot be overridden with the enabling switch (ES).
- SS2 must be parameterized as a stop function for the operating mode selector switch (OMS).

Functional description



- The cascade triggers with every STO, regardless of which drive assumes the STO state and for what reason.
- Restart:
  - The drives in the cascade can only be restarted if all cascading inputs SD-In4 are in the OFF state.
  - The drives must receive the AIS restart acknowledgment at the same time.
  - After AIS is detected, the drives restart after 100 ms.

Activation

Via parameterization:

- The safe input SD-In4 is defined as a trigger source for CAS.

Setting

Please note when setting the parameters:

- Safe input SD-In4:
  - SD-In4 is used as a cascading input. It can no longer be parameterized as a universal input.
  - SD-In4 must be parameterized as an active input.
  - SD-In4 must be parameterized as a source for SSE.
  - The input delay for SD-In4 must be parameterized ≤ 10 ms.
- Safe output SD-Out1:
  - SD-Out1 is used as a cascading output. It can no longer be parameterized as a universal feedback output.
  - SD-Out1 must not be controlled via the safety bus.
- Safe stop emergency (SSE)
  - SD-In4 must be parameterized as a source for SSE.
  - STO must be parameterized as an emergency stop function.
- Restart:
  - The restart must be parameterized as “Acknowledged restart”.

Safe maximum speed (SMS)

Function included in variant:			Extended Safety

The "Safe maximum speed (SMS)" safety function monitors the maximum speed of the drive.

Preconditions

- A safety-rated encoder system records the speed.

Important notes

⚠ DANGER!

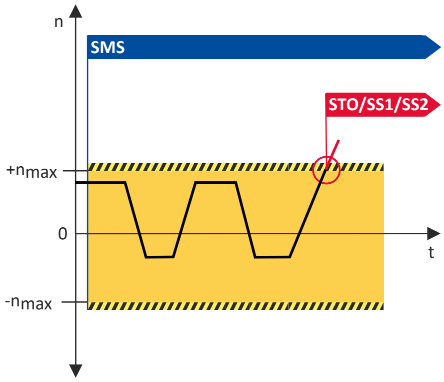
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

Functional description

SMS



This function monitors the amount of the set maximum speed of the drive.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: SMS monitored
  - In status word bit 4
  - Via a safe output (depending on the version)

Activation

Via parameterization:

- Maximum speed > 0 activates the function.

Error behavior

States that trigger an event and an error stop:

- The actual speed has exceeded the maximum speed.
  - Event: SMS - Nmax exceeded (0x2A00FF90)
  - Error stop Parameterizable

Safely-limited speed (SLS)

Function included in variant:			Extended Safety

The "Safely limited speed (SLS)" safety function monitors up to 4 arbitrary operating speeds of the drive.

Preconditions

- A deceleration ramp in the application decelerates the drive.
- A safety-rated encoder system records the speed.

Important notes

⚠ DANGER!

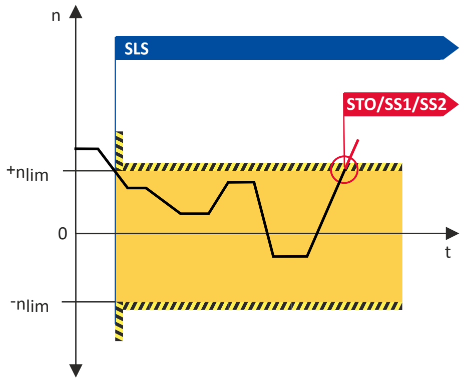
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

▶ Use a safety-rated encoder system to use this function.

Functional description

SLS



The function monitors up to 4 speed limits of the drive.

- Monitoring is activated when the set start delay has elapsed or the actual speed is within the set monitoring limits.
- In addition, the permissible direction of movement can be monitored within the monitoring limits.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: SLS1 monitored ... SLS4 monitored
  - In status word bit 0 ... Bit 3
  - Via a safe output (depending on the version)

Activation

Directly:

- Via a safe input.
- Via the safety bus. ▶ Safety bus 📖 217
- Via internal status signals. (From Safety Firmware V1.1 with parameter set version V1.1)

Error behavior

States that trigger an event and an error stop:

- The actual speed has exceeded a speed limit.
  - Event: SLS1 - Nlim1 exceeded (0x2A00FF89)
  - Event: SLS2 - Nlim2 exceeded (0x2A00FF8A)
  - Event: SLS3 - Nlim3 exceeded (0x2A00FF8B)
  - Event: SLS4 - Nlim4 exceeded (0x2A00FF8C)
  - Error stop Parameterizable
- The drive is moving in the wrong direction.
  - Event: SDIpos - Wrong direction (0x2A00FF8E)
  - Event: SDIneg - Wrong direction (0x2A00FF8F)
  - Error stop Parameterizable

Position-dependent safe speed (PDSS)

Function included in variant:			Extended Safety

The safety function "Safe position-dependent speed (PDSS) monitors the speed of a drive depending on the absolute position along a limited movement range in order to ensure timely standstill at the position limits.

As a result, mechanical buffers can be dimensioned smaller or mechanical buffers and limit switches can be dispensed with altogether. A suitable safety-rated mechanical braking system may be required.

Application examples:

- Monitoring a storage and retrieval unit between the end positions

Preconditions

- The reference run must be executed.
- A safety-rated encoder system records speed and position.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

⚠ WARNING!

When using the slip compensation: The slip compensation may not be suitable for the application.

Serious injuries when exceeding the travel path.

► As part of the risk assessment for the machine, make sure that the application is suitable for slip compensation.

► Traverse the diagnostics markers cyclically when using the slip compensation.

► Define a diagnostics interval with the help of the risk assessment. The diagnostics interval must be determined via an upstream control component.

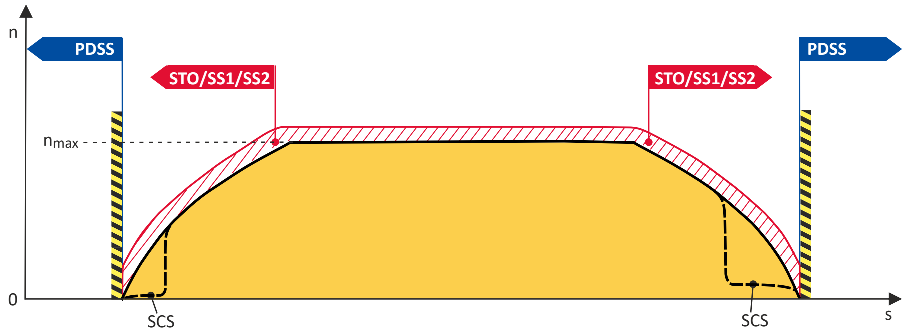
In connection with this function, please also note the information on slip compensation and safe homing:

▸ Encoder slip compensation 272

▸ Safe homing (SHom) 268

Functional description

PDSS



- PDSS uses the parameterized values for the maximum speed, for the decelerations and for the absolute end positions to calculate the maximum speed at each position in order to ensure timely standstill at the position limits.
- In addition, two creep speeds (SCS) can be parameterized to approach the position limits more slowly.
- From the end positions, the drive can travel with maximum speed.

If the motion control of the drive is within the monitoring limits:

- Output of the status message: PDSSpos monitored
  - In status word bit 16
  - Via a safe output (depending on the version)
- Output of the status message: PDSSneg monitored
  - In status word bit 17
  - Via a safe output (depending on the version)

Activation

Directly:

- Via a safe input.
- Via the safety bus.

Via parameterization:

- Function permanently active

Error behavior

States that trigger an event and an error stop:

- The actual speed has exceeded the speed limit.
  - Event: PDSS - Velocity exceeded (0x2A00FF9D)
  - Error stop Parameterizable
- The actual creep speed has exceeded the speed limit.
  - Event: PDSS - Creep velocity SCS exceeded (0x2A00FF9E)
  - Error stop Parameterizable

Safe speed monitor (SSM)

Function included in variant:			Extended Safety

The "Safe speed monitoring (SSM)" safety function monitors the amount of any operating speed of the drive.

A status message indicates compliance with the monitoring limits.

Application examples:

- Safe standstill monitoring
- Despite excessive speed, no immediate machine standstill may occur. The operating personnel is only informed safely.

Preconditions

- A safety-rated encoder system records the speed.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

NOTICE

The function has no hysteresis.

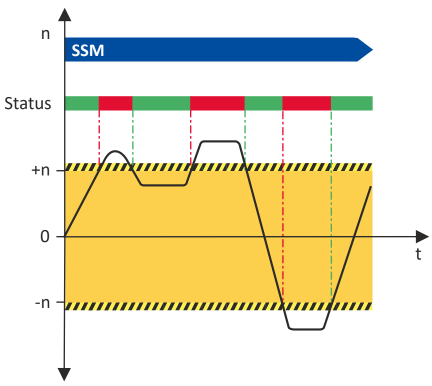
Possible consequences: The safe output can switch frequently when the speed of the drive is near the monitoring limit.

Mechanical actuators at the safe output could wear out more quickly due to frequent switching.

► In this case, avoid continuous operation at the monitoring limit.

Functional description

SSM



The function compares the actual speed with the parameterized speed limits.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: SSM within limits
  - In status word bit 5
  - Via a safe output (depending on the version)

Activation

Via parameterization:

- Monitored speed > 0 activates the function.

Error behavior

If the monitoring limits are exceeded, no error message is output and no error stop is triggered.

Only the "SSM within limits" status is reset.

Safely-limited position (SLP)

Function included in variant:			Extended Safety

The "Safely limited position (SLP)" safety function monitors up to 4 absolute position limits of a permissible movement range.

Preconditions

- The reference run must be executed.
- A safety-rated encoder system records speed and position.

Important notes

⚠ DANGER!

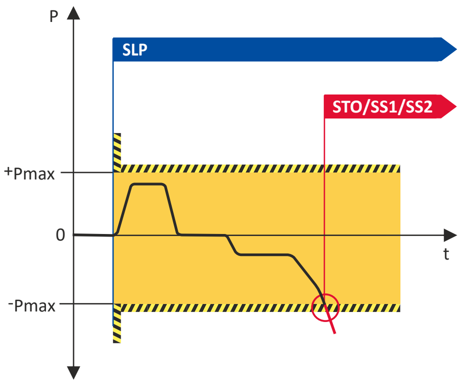
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

▶ Use a safety-rated encoder system to use this function.

Functional description

SLP



The function monitors up to 4 upper and lower position limits of the drive.

- After requesting the function, the monitoring is active immediately.

If the actual position of the drive is within the monitoring limits:

- Output of the status message: SLP1 monitored ... SLP4 monitored
  - In status word Bit 8 ... Bit 11
  - Via a safe output (depending on the version)

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Error behavior

States that trigger an event and an error stop:

- The actual position has exceeded a position limit.
  - Event: SLP1 - Position limits exceeded (0x2A00FF97)
  - Event: SLP2 - Position limits exceeded (0x2A00FF98)
  - Event: SLP3 - Position limits exceeded (0x2A00FF99)
  - Event: SLP4 - Position limits exceeded (0x2A00FF9A)
  - Error stop Parameterizable

Safely-limited increment (SLI)

Function included in variant:			Extended Safety

The "Safely limited increment (SLI)" safety function monitors the amount of a maximum permissible position change.

SLI can be set separately for normal operation and special operation.

Preconditions

- A safety-rated encoder system records speed and position.

Important notes

DANGER!

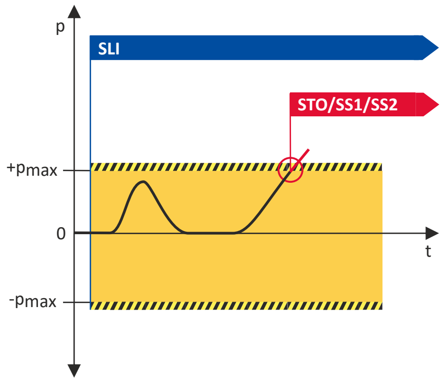
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

▶ Use a safety-rated encoder system to use this function.

Functional description

SLI



The function monitors the parameterized maximum position change.

- After requesting the function, the monitoring is active immediately.

Activation

The function cannot be activated if the drive is in the "Safe operating stop (SOS)" state.

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Error behavior

States that trigger an event and an error stop:

- The position change has exceeded the monitoring limit.
  - Event: SLI - Safely limited increment exceeded (0x2A00FF96)
  - Error stop Parameterizable

Safe direction (SDI)

Function included in variant:			Extended Safety

The "Safe direction (SDI)" safety function monitors the direction of rotation of the drive.

A tolerance window can be used to define the number of increments that the drive may move in the blocked direction.

Preconditions

- The application guides the drive in the permitted direction of movement.
- A safety-rated encoder system records speed and position.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

NOTICE

The start delay is activated.

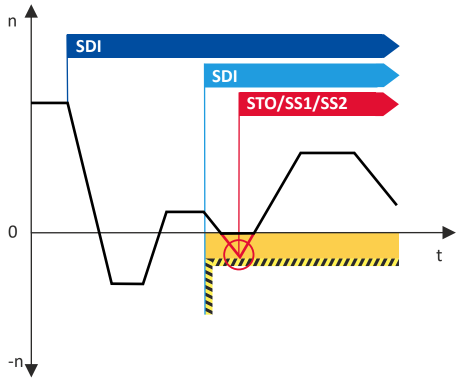
Machine and system parts can be destroyed if this setting is not taken into account when calculating the safety distance.

► Only use this function if the safety distance has been calculated beforehand, taking the set delay into account.

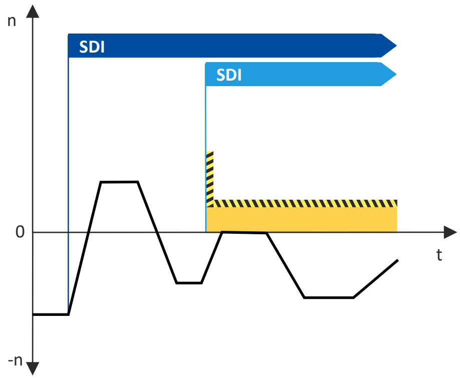
► Evaluate the feedback: "SDIpos - Wrong direction" or "SDIpos - Wrong direction".

Functional description

SDI (SDIpos)



SDI (SDIneg)



The function monitors the permissible direction of movement of the drive.

- Monitoring becomes active when the set start delay has expired.
- In addition, the number of increments that the drive may move in the blocked direction without triggering an error stop can be defined within the monitoring limits.

If the direction of rotation of the drive is within the monitoring limits:

- Output of the status message: SDIpos monitored
  - In status word bit 6
  - Via a safe output (depending on the version)
- Output of the status message: SDIneg monitored
  - In status word bit 7
  - Via a safe output (depending on the version)

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Error behavior

States that trigger an event and an error stop:

- The drive is moving in the wrong direction.
  - Event: SDIpos - Wrong direction (0x2A00FF8E)
  - Event: SDIneg - Wrong direction (0x2A00FF8F)
  - Error stop Parameterizable

Safe cam (SCA)

Function included in variant:			Extended Safety

The "Safe cam (SCA)" safety function monitors up to 4 arbitrary absolute lower and upper position limits.

A status message indicates compliance with the monitoring limits.

Application examples:

- Monitoring the parking position of a storage and retrieval machine.
- Collision avoidance for an X-Y-Z gantry when there is a fixed obstacle in the travel range.

Preconditions

- The reference run must be executed.
- A safety-rated encoder system records speed and position.

Important notes

⚠ DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

► Use a safety-rated encoder system to use this function.

NOTICE

The function has no hysteresis.

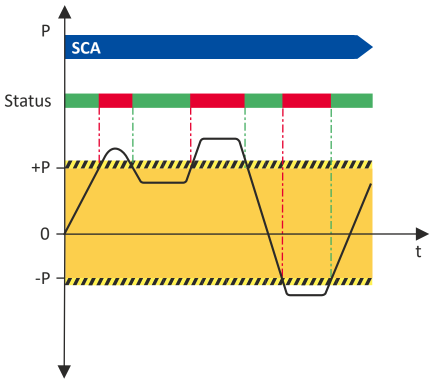
Possible consequences: The safe output can switch frequently when the speed of the drive is near the monitoring limit.

Mechanical actuators at the safe output could wear out more quickly due to frequent switching.

► In this case, avoid continuous operation at the monitoring limit.

Functional description

SCA



The function compares the absolute actual position with the parameterized position limits.

If the actual position of the drive is within the monitoring limits:

- Output of the status message: SCA1 within limits ... SCA4 within limits
  - Via a safe output
  - In status word bit 12 ... bit 15

Activation

Via parameterization:
- Lower and upper position limits ≠ 0 activate the function.

Error behavior

If the monitoring limits are exceeded, no error message is output and no error stop is triggered.

Only the "SCA1 within limits" ... "SCA4 within limits" status is reset.

Safe homing (SHom)

Function included in variant:			Extended Safety

Safety functions based on absolute positions require an absolute reference point to calculate and monitor the position.

- This reference point is defined with the complete reference run.
- The mini reference run can replace the complete reference run in certain operating states.

For the operation of a drive system with slip, consisting of motor encoder and load encoder, the slip between motor encoder and load encoder can be compensated with parameterizable diagnostic positions.

Preconditions

In applications with only one position switch, this switch must be connected in parallel to the inputs X82/IRS and X82/IRL.

Complete homing

The reference position determined with the reference run is the absolute reference point for the safety functions:

- Safely-limited position (SLP)
- Position-dependent safe speed (PDSS)
- Safe cam (SCA)

Important notes

DANGER!

When switched off, the motor position must not be changed by external forces.

Possible consequences: Death or severe injuries

► Make sure that the motor position does not change.

NOTICE

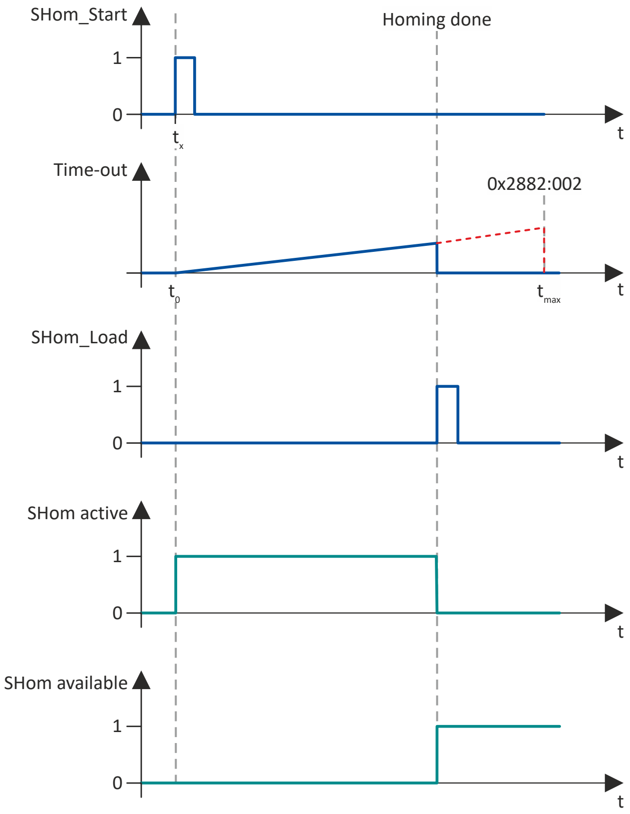
Undetected local change of the home position.

An unrecognized local change of the home position leads to incorrect values of the absolute position.

► Mount the components for detecting the reference position mechanically so that the home position cannot change due to external influences.

Functional description

SHom



Sequence of the reference run

1. The reference run process is started via the defined input source.
2. The superimposed application must start the reference run. The drive independently takes over the motion control.
3. The reference run is performed with the set safely limited speed (SLS).
4. The reference signal "SHom_Load" is expected within the defined "Timeout" period, which adopts the parameterized position value as the "Home Position" when the reference position is passed.
5. Once the reference point is set, the reference run is ended.
6. The drive changes to normal operation.

By parameterization it can be set whether the current position is stored non-volatilely when the voltage supply is switched off. If the restart conditions are fulfilled after the voltage supply is switched on again and after a mini reference run, no new reference run is performed.

Error behavior

States that trigger an event and an error stop:

- The reference run is faulty.
  - Event: SHom - Time-out (0x2A00FFA6)
  - Event: SHom - Home position deleted (0x2A00FFA7)
  - Event: SHom - Maximum slip value exceeded (0x2A00FFA8)
  - Event: SHom - Tolerance of start position exceeded (0x2A00FFA9)
  - Event: SHom - Tolerance of position comparison exceeded (0x2A00FFAA)
  - Error stop STO

Mini-homing

The mini reference run can replace the complete reference run in certain operating states.

The mini reference run is a minimum movement to check the plausibility of absolute position values.

After the reference run has been completed successfully, the drive switches to normal operation.

Preconditions

- A complete reference run was carried out before the first call.
- "Load saved reference" is set as a restart condition.

Functional description

- The drive moves at the parameterized safely limited speed SLS.
- The minimum distance for the mini reference run is calculated automatically:
  - Minimum distance ≥ 4 x tolerance window for the position comparison
- Sequence of the plausibility check during the mini reference run:
  1. Are the saved position and the current position within the parameterized tolerance window for the starting position?
  2. Are the position value currently received from the inverter and the internal position value within the parameterized tolerance window for the position comparison?
  3. If the plausibility check is successful, the status bit "SHom present" is set.
  4. The drive changes to normal operation.

If complete homing is to be performed via the home position switch despite the "SHom present" status bit being set, the status bit must be reset with the "Clear home position" command.

Only the status bit is reset via this path. The superimposed application must start the complete reference run.

Activation

Automatically in the operating states:

- After mains switching
- After acknowledgement of an SSI encoder error
- After returning from the repair mode select (RMS)

Error behavior

States that trigger an event and an error stop:

- The mini reference run is faulty.
  - Event: SHom - Tolerance of start position exceeded (0x2A00FFA9)
  - Event: SHom - Tolerance of position comparison exceeded (0x2A00FFAA)
  - Error stop STO

A complete reference run is required.

Encoder slip compensation

If slip between the motor encoder and load encoder is to be expected due to operation, e.g. in the case of a friction wheel drive, the slip can be cyclically evaluated and compensated for by this function.

The function is intended especially for the travel ranges outside the buffer zones. The function leads to a reduction in buffer end areas and serves to improve the availability of the system.

Slip compensation can also be permanently activated independently of a safety function.

It can be deactivated for the areas between the diagnostic positions and the end of the travel path by setting the appropriate parameters.

⚠WARNING!

The slip compensation may not be suitable for the application.

Serious injuries when exceeding the travel path.

► As part of the risk assessment for the machine, make sure that the application is suitable for slip compensation.

► Traverse the diagnostics markers cyclically when using the slip compensation.

► Define a diagnostics interval with the help of the risk assessment. The diagnostics interval must be determined via a master control component.

Preconditions

- It must be ensured that the boundary to the impermissible area A is not crossed.

  Therefore, the buffer end range must be increased by the maximum compensated slip (range B).
- The maximum compensated slip must be parameterized. 0x2885:001 > 0

  This setting activates the slip compensation.
- Upper and lower diagnostic position must be parameterized. 0x2884:002, 0x2884:003

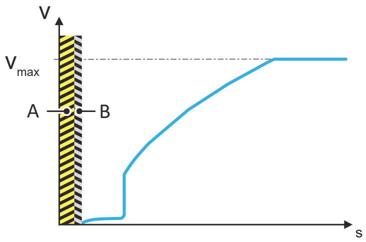


Fig. 17: End zone using the example of the PDSS safety function

A	Prohibited area	B	Buffer end zone

Functional description

- For slip compensation, the diagnostic positions ① and ② are required so that the freedom from error of the load encoder is verified cyclically.
  - To ensure that sufficient braking distance is available in the event of an error, it must be ensured that the diagnostic positions are arranged in such a way that error detection takes place in the range of the maximum permissible speed.
  - The cycle for traversing the diagnostic positions must be controlled by the application. The cycle must be monitored in terms of safety.
- Between the diagnostic positions ① and ②, a cyclic position comparison is performed between the motor encoder and load encoder in each calculation cycle of the safety function.
- The diagnostic positions must be located in front of the buffer areas at the ends of the travel path:

Fig. 18: Position of the diagnostic marks using the example of the PDSS safety function

- When traversing the diagnostic positions, the diagnostic position is compared with the current absolute value encoder position.
- If the difference is outside the parameterized tolerance window, the parameterized error reaction is triggered.
  - Definition of tolerance window: 0x2884:004
  - Definition of error response: 0x2884:005

Operation mode selector (OMS)

Function included in variant:			Extended Safety

This function can be used to switch between normal operation and special operation of the drive.

The special operation makes it possible to override a normal stop (e.g. STO or SS1) by enabling it via the enable switch (ES). The "emergency stop" function also has the highest priority in special operation.

For special operation, the motion function SLS and the monitoring function SLI can be parameterized separately.

If the monitoring function SMS is active, special operation is also monitored.

Preconditions

- A source for activating the function must be configured. 0x28A8
  - Only one safe input or the safety bus can be configured as a source.
  - If a safe input is configured as a source, the function at LOW level must be selected carefully, since according to the closed-circuit principle, no additional danger may emanate from normal operation or special operation. 0x28A9:003
- A source for the ES enable switch must be configured. 0x28AE
- A stop function for special operation must be configured. 0x28A9:001
- A motion function for special operation must be configured. 0x28A9:002

The plausibility check rejects ambiguous settings until they are parameterised correctly.

Important notes

DANGER!

When returning to normal operation, the automatic restart is not permissible.

Possible consequences: Death or severe injuries

► If "automatic restart" is parameterized, this must be prevented by special measures, e.g. by programming in the higher-level control system.

Functional description

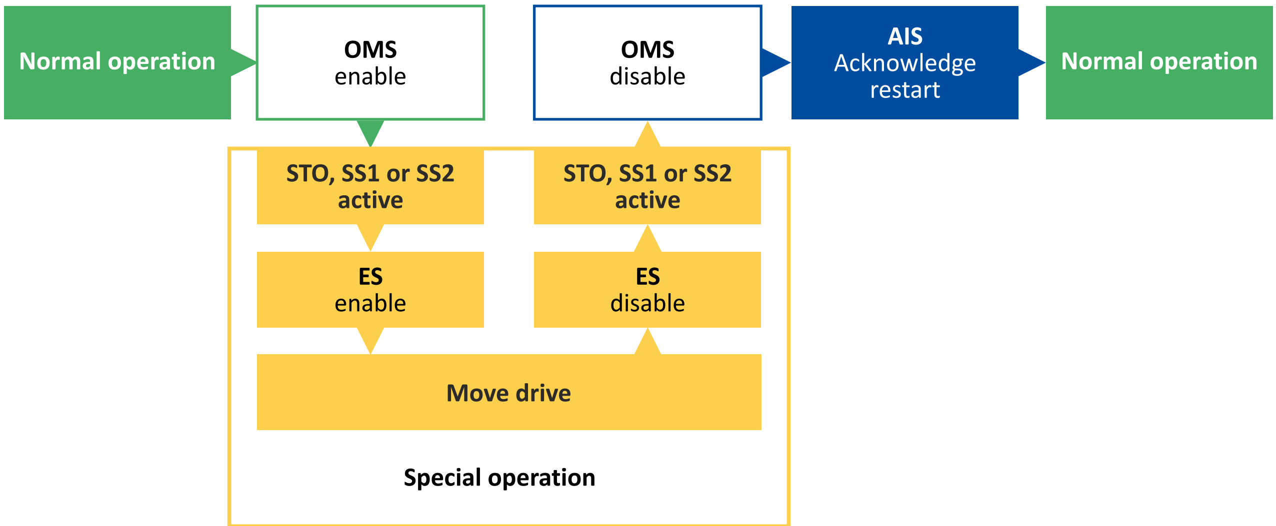


Fig. 19: OMS function

Sequence of the special operation

1. Activate OMS via the configured trigger source.
   The stop function configured for OMS is activated.
2. Activate the enable switch ES via the configured trigger source.
   The stop function is now overruled.
3. The drive can be moved with the configured motion function.

   If monitoring functions are activated, the movement is monitored.
4. When the action is complete, deactivate the ES enable switch.
   The drive can no longer be moved.

   The stop function configured for OMS is activated.
5. Deactivate the trigger source for OMS.
   The special operation is finished.
6. The drive waits for the restart to be acknowledged.
7. Acknowledge the restart via terminal AIS or the safety bus.

The drive changes to normal operation.

If the movement is to be monitored in special operation, the SLI and SMS functions can be activated for this purpose.

- SLI: 0x28CA:003
- SMS: 0x28B0:001 > 0 rpm

Behavior of the function in the event of an error

Activation of OMS via a safe input

- In case of a wire breakage at the safe input when OMS is activated via HIGH level:
  - OMS is deactivated.
  - The drive changes to normal operation. No stop function is triggered.
- In the event of an error at the safe input (e.g. discrepancy error):
  - OMS is deactivated.
  - The "ERR" LED is blinking.
  - The drive changes to normal operation. No stop function is triggered.
  - Once the error has been corrected and acknowledged, the special operation can be reactivated.

Activation of OMS via the safety bus

- In case of failure of safe communication:
  - OMS is deactivated.
  - The drive changes to normal operation. No stop function is triggered.

Error when executing the movement function

- When a parameterized monitoring responds:
  - The parameterized stop function for special operation is triggered.
  - The drive does not change to normal operation.

Repair mode selector (RMS)

Function included in variant:			Extended Safety

This function moves the drive from a situation that is blocking it ("Deadlock").

Application examples

- If an encoder fails, the drive must be moved to a position in which it can be repaired.

The connected encoders are not evaluated safety-related.

Only the stop function configurable for RMS and the enable switch ES are active. All other safety functions are deactivated.

Preconditions

- A source for the ES enable switch must be configured.
- A stop function for RMS must be configured.

Important notes

DANGER!

Unexpected motions with unexpected speed.

Violation of the permissible movement limits.

Possible consequences: Death or severe injuries

► Use RMS exclusively to free an axis from a "deadlock".

► If necessary, take additional safety measures to ensure that no persons can be endangered, since all monitoring functions are deactivated except for the ES enable switch.

► Use other functions to move the drive when it is not in a "deadlock"!

DANGER!

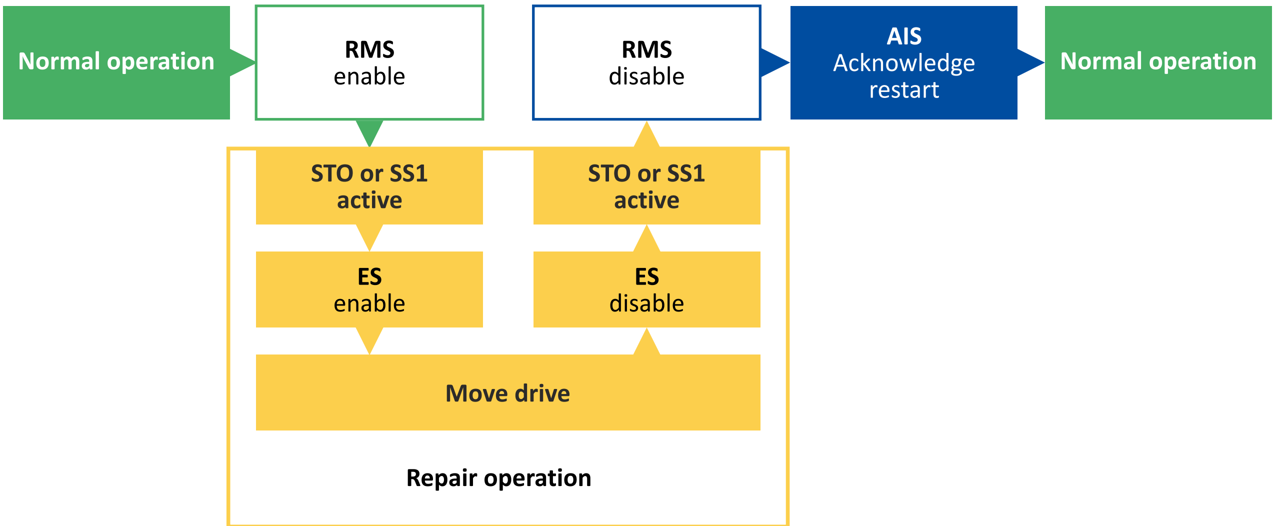
When returning to normal operation, the automatic restart is not permissible.

Possible consequences: Death or severe injuries

► If "automatic restart" is parameterized, this must be prevented by special measures, e.g. by programming in the higher-level control system.

Functional description

RMS



Repair operation procedure

1. Activate RMS via the configured trigger source.
   The stop function configured for RMS is activated.

   Speed functions and absolute position functions are deactivated.

   The SHom status is reset.
2. Activate the enable switch ES via the configured trigger source.
   The stop function is now overruled.
3. The drive can now be released from the "deadlock".
4. When the action is complete, deactivate the ES enable switch.
   The drive can no longer be moved.

   The stop function configured for RMS is activated.
5. Deactivate the trigger source for RMS.
   The encoder evaluation is switched active again.

   The repair mode is finished.
6. The minireference run starts automatically.
7. After a successful minireference run, the drive waits for the restart to be acknowledged.
8. Acknowledge the restart with the signal AIS.
   The drive changes to normal operation.

Activation

Directly:

- Via a safe input.
- Via the safety bus.

Error behavior

States that trigger an event and an error stop:

- The mini reference run is faulty.
  - Event: SHom - Tolerance of start position exceeded (0x2A00FFA9)
  - Event: SHom - Tolerance of position comparison exceeded (0x2A00FFAA)
  - Error stop STO

A complete reference run is required.

After completion of the complete reference run, the drive switches to normal operation.

Enable switch (ES)

Function included in variant:			Extended Safety

This function makes it possible to override the normal stop functions in repair mode or special mode.

Preconditions

The repair mode and/or special mode must be configured and activated.

Functional description

- The enable switch overrides the stop function active in repair mode or special mode. The stop function is deactivated without delay.
- Repair mode has higher priority within the device and overrides special mode.
- The drive can then be moved freely as long as the enable switch is active.
- If the enable switch is deactivated, the stop function for repair mode or special mode is reactivated without delay.

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Safe Muting (MUT)

Function included in variant:			Extended Safety

(From standard device firmware V1.3, safety firmware V1.1 with parameter set version V1.1)

This function deactivates selected safe inputs and all functions of the safety bus.

A typical use case for "safe muting" is during initial commissioning, when not all safety interfaces have been wired yet.

- The function may only be used during commissioning or for maintenance work.
- The function is active for a maximum of 30 minutes.
- It can be ended at any time.

Preconditions

To activate the Safe Muting function, you need:

- A PC with »EASY Starter« (1.16 or higher) or »PLC Designer«.
- A permanent communication link between engineering tool and inverter.
- In a network, the Safe Muting function can only be activated for one inverter at a time.
- The muting password was assigned via the password dialog in the **Safety parameter list**.
- The active safe parameter set in the inverter must contain the settings for safe muting:
  - The sources to be hidden.
  - The muting password.

Important notes

⚠ DANGER!

Activating the Safe Muting function deactivates safety functions!

Possible consequences: Death or severe injuries

► Only authorized personnel may activate the Safe Muting function.
► An emergency stop switch-off must be present that cannot be deactivated by Safe Muting.

Activation

To set the Safe Muting password (or change an existing password):

1. Open the parameterization dialog for safety parameters:
   a) »EASY Starter«: Open the **Safety parameter list** tab.
   b) »PLC Designer«: In the device tree, under the axis, open the object **Safety parameter set** in the device tree under the axis.
2. Click the " " button and execute the "Muting Password" command.
   The "Change Muting Password" dialog box opens.
3. Set the muting password.
4. Transfer the safety parameters to the device so that the change to the muting password takes effect.

To activate and deactivate safe muting:

1. Open parameterization dialog:
   a) »EASY Starter«: Open the **Safety parameter list** tab.
   b) »PLC Designer«: Open the **Safety parameter set** object under the axis in the device tree.
2. Click on the button (hide input signals of the device).
   The password dialog opens.
3. Enter muting password.
   The muting dialog opens.
4. Use the displayed data to ensure that the correct inverter has been selected.
   Optical device identification is activated automatically. The two LEDs "RDY" and "ERR" on the front of the selected inverter flash quickly.
5. **Start** activates the function.
   The function is now active for a maximum of 30 minutes. The remaining time is displayed.
6. End function
   a) The function is automatically ended after 30 minutes.
   b) **Stop** ends the function manually.
   c) If the connection between the engineering tool and the inverter is disconnected, the function is terminated immediately with an error message.
   Monitored operation is reactivated immediately.

   All previously deactivated safety functions are active again.

Diagnostics

Status LEDs

The LEDs "RDY" and "ERR" show the current safety status:

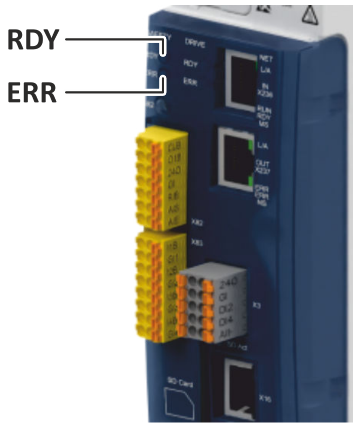


Fig. 20: Position of the RDY and ERR LEDs

DANGER!

Unreliable status information possible due to LEDs.

LEDs are not reliable status indicators. There is no guarantee that the LEDs provide accurate information.

Possible consequences: Death or severe injuries

- ► Only use LEDs for general diagnostics during commissioning or troubleshooting.
- ► Do not use LEDs as status displays.

LED "RDY" (yellow)		Status	Meaning
off		-	No status message active.
blinking 4 Hz		SOS active	
blinking 2 Hz		Service status	Transfer of parameter set requested.
Both LEDs are blinking in a rapidly alternating mode		Safety-Firmware update active.	Safety firmware update in progress.

Display for requested acknowledgement

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
on	off	Restart acknowledgement requested	The device is working correctly.
	blinking 2 Hz		During startup, a modified parameter set was detected in the "Init" state.
	blinking 4 Hz		During startup, a changed safety address was detected in the "Init" state.
	blinking		During startup, a changed assignment between OCT encoder and inverter was detected in the "Init" state.
The detection of a firmware update is signaled by the subsequent flashing of the safety LEDs.			
on	1 second ascending	SW confirmation requested	A changed safety-relevant SW component (safety firmware or safety bootloader) was detected during start-up.

Display in the event of errors

	LED "ERR" (red)	Status	Meaning
	off	-	The device is working correctly.
	blinking 1 Hz	Error	One of the following errors has been detected: • A monitoring device has been activated. • An acknowledgeable error is active. • Discrepancy of the inputs
	blinking 2 Hz	Safety bus error	Communication via the safety bus is not established: • There is no valid configuration. • The start-up has not been completed yet.

Display for critical device errors

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
From safety firmware 1.0.x			
off	on	Critical	The device is defective. It must be replaced.
From safety firmware 1.3.x			
blinking	blinking	Critical system error	• "Lock-out" (CPU stopped) • STO is active. • If the system error occurs again after switching the 24 V supply, the device is defective. It must be replaced.

For more information on diagnostics and fault elimination, refer to the inverter commissioning document.

Safety-related data

Safety-related characteristics Basic Safety - STO

<table>
<tr><td colspan="4">Basics of the safety-related characteristics</td></tr>
<tr><td rowspan="2"></td><td>Source of failure rates</td><td>SN 29500</td><td>When no values from the component manufacturers were available.</td></tr>
<tr><td>Average max. ambient temperature</td><td>60 °C</td><td></td></tr>
<tr><td colspan="4">Basic Safety - STO</td></tr>
<tr><td rowspan="5">EN IEC 61508, part 1-7
EN 62061</td><td>SFF</td><td>99 %</td><td rowspan="2"></td></tr>
<tr><td>Safety Integrity Level</td><td>SIL 3</td></tr>
<tr><td>PFH [1/h]</td><td>< 1 E-09</td><td>< 1 % of SIL 3</td></tr>
<tr><td>PFD_{avg} (T)</td><td>< 1 E-04</td><td>< 10 % of SIL 3 after T = 20 years</td></tr>
<tr><td>Proof test interval T</td><td>20 years</td><td>Mission time</td></tr>
<tr><td rowspan="4">EN ISO 13849-1</td><td>Category</td><td>4</td><td rowspan="2"></td></tr>
<tr><td>Performance Level</td><td>e</td></tr>
<tr><td>$MTTF_d$</td><td rowspan="2">High</td><td>> 100 years</td></tr>
<tr><td>Mean diagnostic coverage DC_{avg}</td><td>99 %</td></tr>
</table>

Safety-related characteristics Extended Safety

The achievable risk reductions (PL/SIL) also depend on the motor/encoder combination used.

Match the values given here with the values for the motor/encoder combinations:

▸ Motor-encoder combinations 227

Basics of the safety-related characteristics			
	Source of failure rates	SN 29500	When no values from the component manufacturers were available.
	Average max. ambient temperature	60 °C	
All safety functions except Safe Brake Control (SBC) for drive systems with motors with resolvers and SinCos encoders			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 3	
	PFH [1/h]	< 1 E-09	< 1 % of SIL 3
	PFD_{avg} (T)	< 1 E-04	< 10 % of SIL 3 after T = 20 years
	SFF	99 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	e	
	Category	4	
	$MTTF_d$	High	> 250 years
	Mean diagnostic coverage DC_{avg}		95 %
All safety functions except Safe Brake Control (SBC) for drive systems with motors with HIPERFACE DSL® encoders (OCT)			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 2	
	PFH [1/h]	< 5 E-09	< 0.5 % of SIL 2
	PFD_{avg} (T)	< 5 E-04	< 5 % of SIL 2 after T = 20 years
	SFF	> 90 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	d	
	Category	3	
	$MTTF_d$	High	> 300 years
	Mean diagnostic coverage DC_{avg}	Medium	> 90 %
Safe Brake Control (SBC) safety function independent of the parameterized motor encoder system			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 2	
	PFH [1/h]	< 1 E-08	< 1 % of SIL 2
	PFD_{avg} (T)	< 1 E-03	< 10 % of SIL 2 after T = 20 years
	SFF	99 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	d	
	Category	2	
	$MTTF_d$	High	> 230 years
	Mean diagnostic coverage DC_{avg}		95 %

Response times of the safety unit

The overall system must be taken into account when determining the response time following a safety function request.

Decisive for the reaction time are:

- Response time of the connected safety sensors.
- Input delay of the safety inputs.
- Internal processing time.
- Deceleration times, braking times, and stopping times from the parameterized safety functions.
- When a feedback system is used:
    - The response time of encoder monitoring. 0x2878:004
- When a safety bus is used:
    - Monitoring time for cyclic services.
    - Monitoring time in the safety PLC.
    - Processing time in the safety PLC.
- Delay times due to further components.

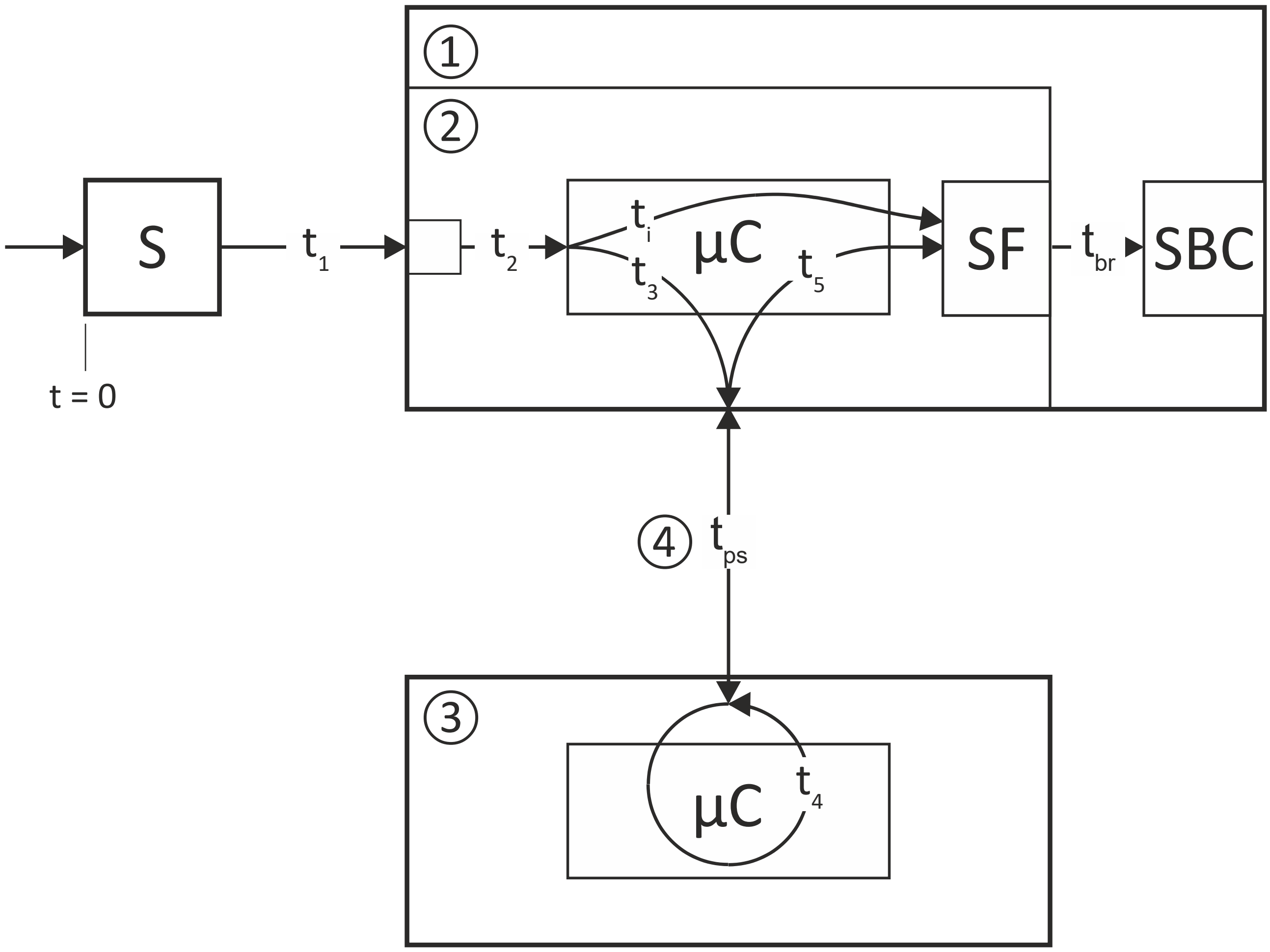


Fig. 21: Response times to the request of a safety function

1	Standard device	µC	Microcontroller
2	Integrated safety	S	Safety sensors
3	Safety PLC	SF	Activated safety function
4	Safety bus	SBC	Safe Brake Control

Response times of safe inputs

Response time to an event in the safety sensors			[ms]
t_1	Response time of the safety sensors		according to manufacturer information
t_2	Input delay of the safe inputs		
		Parameterizable via: 0x211A:001, 0x211A:002, 0x211A:003, 0x211A:004	0...100
		Input filter	2
t_i	Processing time in drive-based safety sensor technology		4
	Safety function starts after		$t_1 + t_2 + t_i$

Tab. 1: Response time to an event in the safety sensors

Response time of the safe output

Response time of the safe output to a safety function		[ms]
	Safe output SD-Out 1 switches to	4

Tab. 2: Response time - safe output

Response time of encoder monitoring

Time required to detect faults caused by continuous signal errors at the encoder interface.			[ms]
		Default setting	50
		Parameterizable via: 0x2878:004	12/50/100

It must be evaluated for each application what minimum response time is possible.

The longer the reaction time, the more the safe speed is filtered.

During dynamic processes (acceleration, deceleration), the safely evaluated speed lags behind the actual speed of the drive. This time offset must be taken into account when reaching limit values.

Response time of the load sensor monitoring

Filter time position frozen.			[ms]
		Default setting	10
		Parameterizable via: 0x2878:004	0-2000

Response times of safe SBC brake control

Response time from the detection of the SBC safety function to the switch-off of the safe brake control			[ms]
t_{br}	Delay time between request and activation of the brake control		
		Parameterizable via: 0x28E6:2	0 ... 30000
t_i	Processing time in drive-based safety sensor technology		4
	Control X106 starts after		$t_{br} + t_i$

Test pulse interval and error response time		[ms]
	Test pulse interval, brake control	100
	Error response time, min. time for error detection and error triggering	200

Response times of the safety bus

Response time to an event on the safety sensors (input data)			[ms]
t_1	Response time of the safety sensors		See manufacturer information
t_2	Input delay of the safe inputs		
		Parameterizable via: 0x211A:001, 0x211A:002, 0x211A:003, 0x211A:004	0...100
		Input filter	2
t_3	Processing time in integrated safety technology		
	Main Task cycle time	Technology application	1
		PLC project	As set
	Internal transmission time PROFIsafe	Safety: from firmware 1.0.1 Standard device: from firmware 1.2	40
	Internal transmission time FSoE	Safety: from firmware 1.1.x Standard device: from firmware 1.3	8
Input data ready for transmission			$t_1 + t_2 + t_3$
t_{ps}	PROFINET cycle time		See project planning in the PLC
	EtherCAT cycle time		
Input data ready for processing in the safety PLC			$t_1 + t_2 + t_3 + t_{ps}$

Tab. 3: Response time to an event on the safety sensors

Response time to a control word (output data)			[ms]
t_4	Processing time in the safety PLC		Calculate
t_{ps}	PROFINET cycle time		See project planning in the PLC
	EtherCAT cycle time		
t_5	Processing time in integrated safety technology		
	Main Task cycle time	Technology application	1
		PLC project	As set
	Internal transmission time PROFIsafe	Safety: from firmware 1.0.1 Standard device: from firmware 1.2	108
	Internal transmission time FSoE	Safety: from firmware 1.1.x Standard device: from firmware 1.3	16
Safety function starts after			$t_4 + t_{ps} + t_5$

Tab. 4: Response time for request via the safety bus

Information on how to calculate the processing time and transmission time of the safety bus can be found in the documentation of the safety PLC used.

When the safety bus communication is disturbed, it is changed to the fail-safe state after the safety bus monitoring time (F_WD_Time) has elapsed. The safety bus communication is passivated.

Example

- After an event at a safe input, the message is fed back to the integrated safety technology via the safety PLC.
- The integrated safety technology then triggers a safety function.
- The maximum response time to the event is then calculated to:
  - $t_{max} = t_1 + t_2 + t_3 + \max(F\_WD\_Time; t_{ps} + t_4 + t_{ps} + t_5)$
  - Include the times of the safety functions in the calculation, e.g. for SS1 the stop time until STO is active.

Calculation of the maximum response times

To determine the response time to a safety function request, the entire system must be taken into account:

- Response time of connected safety sensors
- Input delay of safety inputs
- Internal processing times
- Deceleration times, braking times, and stop times from the parameterized safety functions.
- When using a feedback system, the response time of the encoder monitoring
- When using a safety bus:
  - Monitoring time for cyclic services.
  - Monitoring time in the safety PLC.
  - Processing time in the safety PLC
- Deceleration times due to further components.

The ETG FSoE protocol specification contains formulas for calculating the maximum response time in fault-free operation and in the event of a fault.

Detailed information on setting and parameterizing the product is described in the commissioning manual.

This chapter refers to calculations using a safety bus and safety PLC.

In the "Application Knowledge Base", Lenze provides an Excel table as a calculation aid. This can be used to easily calculate the reaction times.

Link to "Application Knowledge Base"

Please note the following:

The variables for the individual response times are named differently in the documentation for the c250-S safety controller than in the FSoE protocol specification of the ETG.

In the following graphics, the differences are marked with "Lenze" and "ETG".

Definition of the single response times

Name Lenze	Name ETG	Description	Comment
T_Sensor	T_S	Processing time of the sensor until the signal is available at the interface.	See technical data of the sensor
T_InputFilter		Parameterized filter time of the safe input.	
T_Input	T_I	Processing time of the safe input.	E.g. safety I/O module, FSoE sensor or inverter. See technical data
T_WDInput	T_WD_In	Monitoring time parameterized in the safety PLC (c250-S) for the safe input module.	E.g. safety I/O module, FSoE sensor or inverter.
T_EtherCAT	T_Com	EtherCAT cycle time	
T_FSoE		Processing time of the communication, depending on the EtherCAT cycle time	The documentation of the c250-S specifies max. 3 x T_EtherCAT. The ETG FSoE protocol specification specifies max. 2 x T_Com. It depends on the application which factor can be used. Factor 3 means improved availability of secure communications.
T_SafetyPLC	T_L	Processing time of the safety PLC (c250-S).	Corresponds to the set cycle time of the safety application.
T_Output	T_O	Processing time of the safe output.	E.g. safety I/O module or inverter. See technical data
T_WDOutput	T_WD_Out	Monitoring time parameterized in the safety PLC (c250-S) for the safe output module.	E.g. safety I/O module or inverter.
T_Aktor	T_A	Processing time of the actuator.	See technical data of the actuator

Maximum response time with error-free communication

> Note the different factors for calculating the processing time of the communication:
>
> The documentation of the c250-S specifies max. 3 x T_EtherCAT.
>
> The ETG FSoE protocol specification specifies max. 2 x T_Com.
>
> It depends on the application which factor can be used. Factor 3 means improved availability of secure communications.

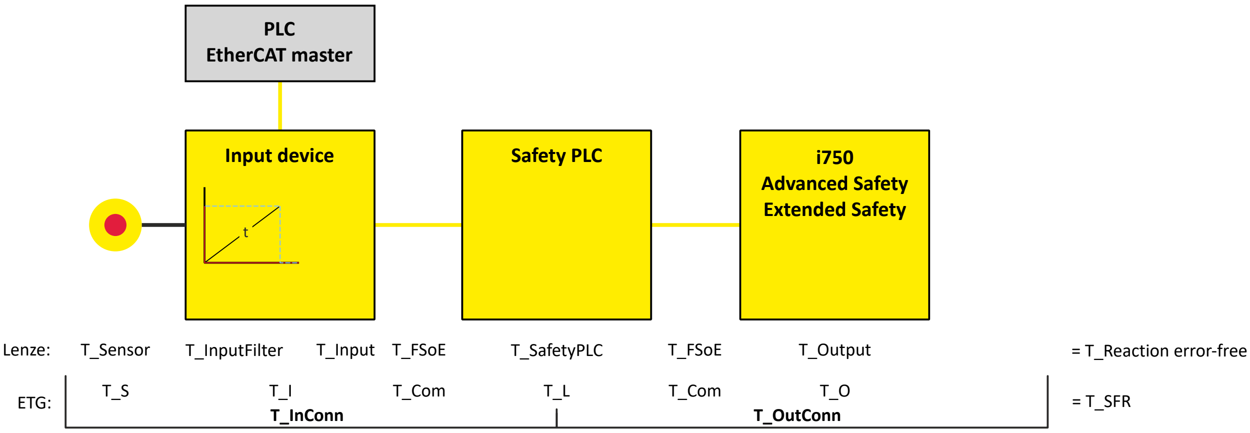


Fig. 22: Maximum response time with error-free communication **without** Safe Brake Control (SBC)

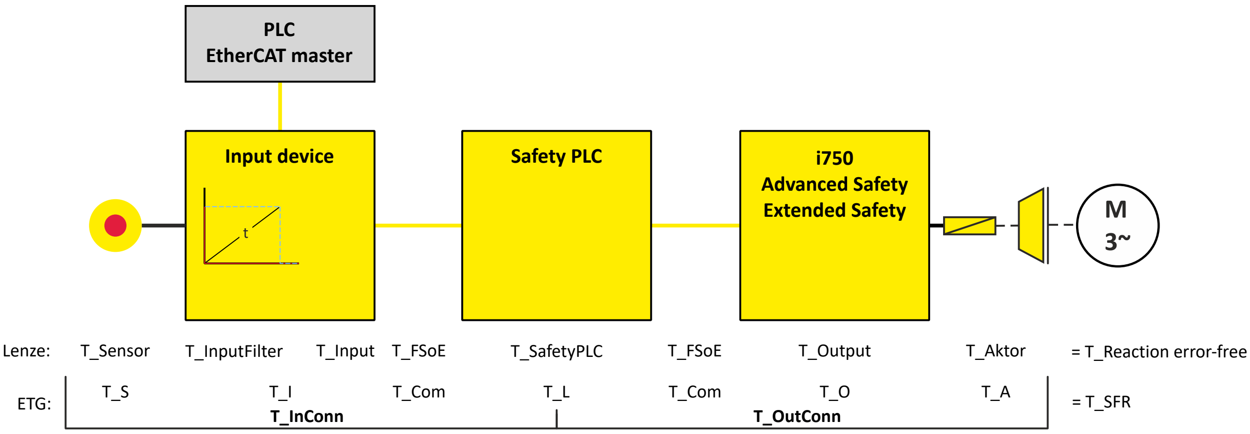


Fig. 23: Maximum response time with error-free communication **with** Safe Brake Control (SBC)

Calculation of the maximum response time with error-free communication

	Max. response time without SBC		Max. response time with SBC
T_InConn	2 × T_S + 2 × T_I + 2 × T_Com (3 × T_Com) + 2 × T_L		2 × T_S + 2 × T_I + 2 × T_Com (3 × T_Com) + 2 × T_L
T_OutConn	+ 2 × T_L + 2 × T_Com (3 × T_Com) + 2 × T_O		+ 2 × T_L + 2 × T_Com (3 × T_Com) + 2 × T_O + 2 × T_A
	= T_SFR		= T_SFR

Response time in case of communication interruption

The FSoE watchdog time T_WD is included in the calculation of the maximum response time in case of communication interruption.

The FSoE watchdog time T_WD can be calculated according to the formula in the ETG FSoE protocol specification.

The processing times in the individual subsystems and the processing time of the communication are included in this calculation. In addition, a reserve of 20% is added.

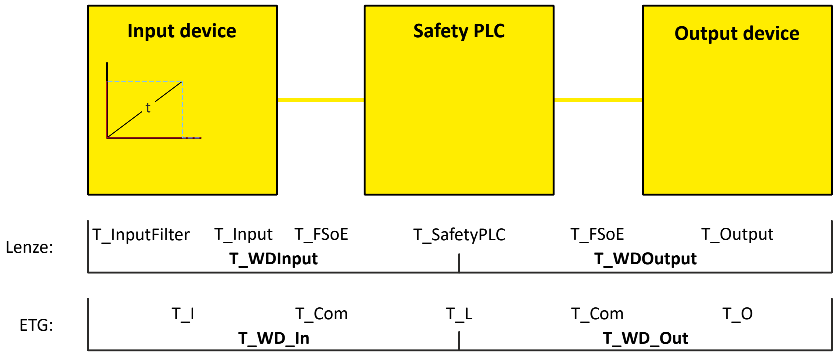


Fig. 24: FSoE watchdog time

> Depending on the input module and the output module used, the calculation may result in different values.
>
> The higher value must always be used for further calculation to improve the availability of secure communication.

Calculation of the FSoE watchdog time

	Input module		Output module
	2 × T_I + 4 × T_Com (6 × T_Com) + 2 × T_L + ΔT (20 %)		 + 4 × T_Com (6 × T_Com) + 2 × T_L + 2 × T_O + ΔT (20 %)
	= T_WD_In		= T_WD_Out

Calculation of the maximum response time in case of communication interruption in the input module

	Max. response time without SBC		Max. response time with SBC
T_InConn_wc	2 × T_S + T_WD_In		2 × T_S + T_WD_In
T_OutConn	+ 2 × T_L + 2 × T_Com (3 × T_Com) + 2 × T_O		+ 2 × T_L + 2 × T_Com (3 × T_Com) + 2 × T_O + 2 × T_A
	= T_SFR _wc (In)		= T_SFR _wc (In)

Calculation of the maximum response time in case of communication interruption in the output module

	Max. response time without SBC		Max. response time with SBC
T_InConn	2 × T_S + 2 × T_I + 2 × T_Com (3 × T_Com) + 2 × T_L		2 × T_S + 2 × T_I + 2 × T_Com (3 × T_Com) + 2 × T_L
T_OutConn_wc	2 × T_L + T_WD_Out		2 × T_L + T_WD_Out + 2 × T_A
	= T_SFR _wc (Out)		= T_SFR _wc (Out)

Calculation of the maximum response time in case of communication interruption for the entire system

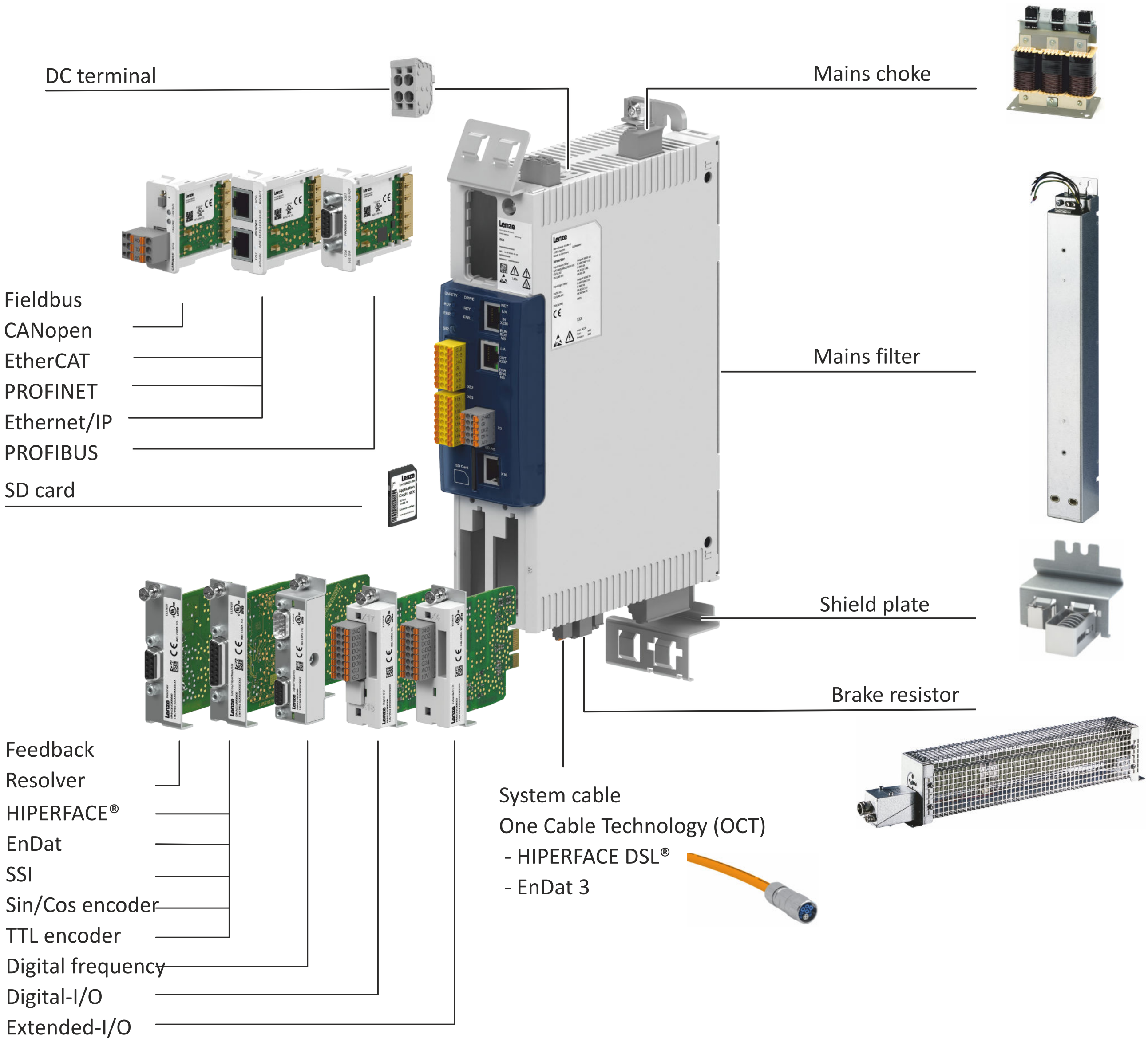
	Max. response time without SBC		Max. response time with SBC
T_SFR _wc	= max {T_SFR _wc (In); T_SFR _wc (Out)}		= max {T_SFR _wc (In); T_SFR _wc (Out)}

Accessories

Overview

For the i950 servo inverter, the following accessories are available:

- Potentiometer 📖 294
- Memory modules 📖 295 (as SD card)
- Brake resistors 📖 296
- RFI filters / Mains filters 📖 298
- Regenerative modules 📖 299
- Power supply units 📖 300
- Mounting 📖 301 (kits for installation)
- System cables 📖 303 (cable and system cables)



Operation and diagnostics

Control and display elements

Potentiometer

For the external selection of an analog setpoint.

The setpoint selection (e.g. motor speed) can be manually set via the external potentiometer.
The potentiometer is connected to the analog input terminals of the inverter.

The position is displayed on the scale via the rotary knob.

The components have to be ordered separately.

Potentiometer		
Type designation	**Type**	**Design**
ERPD0010K0001W	Potentiometer	10 kΩ/1 W
ERZ0001	Rotary knob	Diameter 36 mm
ERZ0002	Scale	Scale 0 … 100 %, Diameter 62 mm

Memory modules

All settings can be stored in a storage module.

The servo inverter uses an SD card as its storage module.

This SD card is not commercially available, as it contains Application Credit. Application Credit is required for the use of technology applications (TA).

SD card with Application Credit

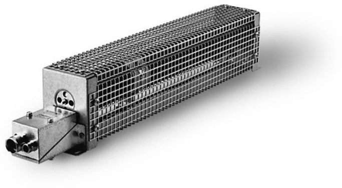
Application Credit	Order code
50	EPCZEMSD0L1005
100	EPCZEMSD0L1010
150	EPCZEMSD0L1015
200	EPCZEMSD0L1020
300	EPCZEMSD0L1030
400	EPCZEMSD0L1040
500	EPCZEMSD0L1050
600	EPCZEMSD0L1060
700	EPCZEMSD0L1070
1000	EPCZEMSD0L1100
1200	EPCZEMSD0L1120
1500	EPCZEMSD0L1150
2000	EPCZEMSD0L1200
2500	EPCZEMSD0L1250
3000	EPCZEMSD0L1300
4000	EPCZEMSD0L1400

Overview of the required Application Credit

<table>
<tr><th></th><th>Technology applications</th><th>Technology modules</th><th>Required Application Credit</th></tr>
<tr><td rowspan="2">Actuating drive</td><td>CiA 402</td><td rowspan="2">-</td><td>0</td></tr>
<tr><td>CiA 402 Advanced</td><td>50</td></tr>
<tr><td rowspan="2">Parameterizable</td><td>Speed control
Electronic gearbox
Table positioning</td><td rowspan="2">-</td><td>50</td></tr>
<tr><td>Synchronism with mark correction
Winder with dancer control
Winder with tension control</td><td>100</td></tr>
<tr><td rowspan="3">Programmable</td><td>Speed control
Electronic gearbox
Table positioning</td><td>Speed control
Electronic gearbox
Table positioning
Flex CAM</td><td>≥ 150</td></tr>
<tr><td>Synchronism with mark correction
Winder with dancer control
Winder with tension control</td><td>Sync & correction
Winder dancer
Winder tension
Cross cutter</td><td>≥ 200</td></tr>
<tr><td>-</td><td>User</td><td>≥ 300</td></tr>
</table>

Brake resistors

- To decelerate greater moments of inertia or with a longer operation in generator mode an external brake resistor is required.
- The brake resistor absorbs the produced brake energy and converts it into heat.



Assignment of these accessories to the devices depends on the mains connection:
▶ Technical data 111
Here you can also find the order codes.

Mains chokes

- Mains chokes reduce the feedback effects of the inverter on the supplying mains by their high inductive resistance reducing high-frequency interference.
- The effective mains current is reduced which saves energy.
- Mains chokes can be used without restrictions in conjunction with RFI filters.
- Please note that the use of a mains choke reduces the mains voltage at the input of the inverter by4 % (typical voltage drop across the mains choke in the rated point).

Assignment of these accessories to the devices depends on the mains connection:
▸ Technical data 111

Here you can also find the order codes.

RFI filters / Mains filters

RFI and mains filters are used to ensure compliance with the EMC requirements of EN IEC 61800-3. This standard defines the EMC requirements for electrical drive system in various categories.

- RFI filters are capacitive accessory components. RFI filters reduce conducted noise emissions. RFI filters are also called EMC filters.
- Mains filters are a combination of mains choke and RFI filter. Mains filters reduce the conducted noise emission.

Definition of the environments

(EN IEC 61800-3)

First environment

The first environment comprises residential buildings or locations that are directly connected to a low-voltage system for supplying residential areas.

Second environment

The second environment comprises facilities or locations that are not directly connected to a low-voltage system for supplying residential areas.

Category C1

Category C1 defines the requirements for drive systems that are intended for the use in the first environment at a rated voltage lower than 1000 V.

The limit values of the EN IEC 61800-3 comply with EN 55011 class B.

Category C2

Category C2 defines the requirements for permanently installed fixed drive systems that are intended for the use in the first environment at a rated voltage lower than 1000 V. Installation and commissioning may only be carried out by specialist personnel with EMC knowledge.

The limit values of the EN IEC 61800-3 comply with EN 55011 class A group 1.

Category C3

Category C3 defines the requirements for drive systems that are exclusively intended for the use in the second environment at a rated voltage lower than 1000 V.

The limit values of the EN IEC 61800-3 comply with EN 55011 class A group 2.

Assignment of these accessories to the devices depends on the mains connection:
▶ Technical data 📖 111

Here you can also find the order codes.

Regenerative modules

For feeding energy from the DC bus of a drive system back into a 3-phase AC system

r750 regenerative module
Device features:

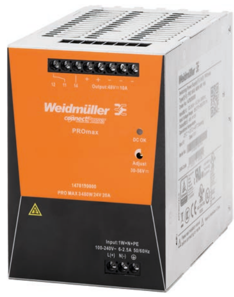
- Self-synchronizing with the AC system
- Automatic operation
  - Self-optimizing
  - Self-parameterizing
  - No parameterization of operating conditions required
- Scaling of the regenerative power by parallel operation of further regenerative modules of this series
- Controlling power peaks by parallel operation of a brake chopper is possible
- High peak regenerative power
- High efficiency
- Operation without external filters possible
- Polarity reversal protection of the device is integrated in the DC-bus connection.
- Operation without external supply voltage
  - Direct supply from the DC bus or from the AC system
- Measured value via the regenerated energy

Further information can be found in the mounting and switch-on instructions for the r750 regenerative module.

Power supply units

For the external supply of the control electronics of the inverter.

The parameterization and diagnostics can be executed when the mains input at the inverter is deenergized.



Type designation			**EZVA024**				
			005BB000000	**010BB000000**	**005FB000000**	**010FB000000**	**020FB000000**
Mains connection		V	1 AC 230/240		2 oder 3 AC 400/480		
Netzspannungsbereich		V	85 ... 277		360 ... 575		
Rated current		A	1	1.5	0.3	0.4	0.85
Rated output voltage		V	24				
Ausgangsspannungsbereich		V	22.5 ... 29.5				
Rated output current		A	5	10	5	10	20
Degree of protection			IP20				
Abmessungen (H x B x T)		mm	130 x 40 x 125	130 x 60 x 125	130 x 40 x 125	130 x 60 x 125	130 x 70 x 150
Weight	m	kg	0.86	1.05	0.78	1.32	1.6

Mounting

Shield mounting kit

Motor cable

To support the shielding of the motor cable directly on the inverter, the optional accessories that can be ordered, consisting of shield plate and fixing clips or wire clamps, can be used.

From 22 kW onwards, the shield sheet is integrated.

Inverter	Shield mounting			
	Order code	Packaging unit	Order code	Packaging unit
		Piece		Piece
i950-C0.37/230-2 i950-C0.55/230-2 i950-C0.75/230-2 i950-C1.5/230-2 i950-C2.2/230-3 i950-C0.55/400-3 i950-C0.75/400-3 i950-C2.2/400-3 i950-C4.0/400-3	EZAMBHXM018/M	5x motor shield plate 5x fixing clip 5x terminal clamp (cable diameter 4 ... 15 mm)	EZAMBHXM018/S	1x motor shield plate 1x fixing clip 1x terminal clamp (cable diameter 4 ... 15 mm)
i950-C4.0/230-3 i950-C5.5/230-3 i950-C7.5/400-3 i950-C11/400-3 i950-C15/400-3	EZAMBHXM016/M	5x motor shield plate 5x fixing clip 5x terminal clamp (cable diameter 10 ... 20 mm) 5x screw M4x12	EZAMBHXM016/S	1x motor shield plate 1x fixing clip 1x terminal clamp (cable diameter 10 ... 20 mm) 1x screw M4x12
i950-C22/400-3	EZAMBHXM003/M	10x terminal clamp (cable diameter 10 ... 20 mm)	EZAMBHXM004/M	10x terminal clamp (cable diameter 15 ... 28 mm)
i950-C30/400-3 i950-C45/400-3	EZAMBHXM004/M	10x terminal clamp (cable diameter 15 ... 28 mm)	EZAMBHXM005/M	10x terminal clamp (cable diameter 20 ... 37 mm)
i950-C55/400-3 i950-C75/400-3	EZAMBHXM004/M	10x terminal clamp (cable diameter 15 ... 28 mm)	EZAMBHXM005/M	10x terminal clamp (cable diameter 20 ... 37 mm)
i950-C90/400-3 i950-C110/400-3	-	-	-	-

Multipoint connectors

Some connections are equipped with pluggable multipoint connectors. Pluggable multipoint connectors are available individually, e.g. for service purposes or for the separate production of cable harnesses.

Inverter	Terminal strips			
	Basic Safety - STO version		Extended Safety version	
	Order code	Packaging unit	Order code	Packaging unit
		Piece		Piece
i950-C0.37/230-2	I9ZAA0014S	1x X1 (Basic Safety - STO) 1x X5 (24 V) 1x X3 (I/O control terminal) 1x X100 (supply terminal) 1x X105 (motor/brake resistor) 1x X109 (PTC, bridged) 1x X107 (24-V brake) 1x X106 (motor holding brake) 1x shield support for control connections	I9ZAA0017S	1x X82 (Extended Safety) 1x X83 (Extended Safety) 1x X5 (24 V) 1x X3 (I/O control terminal) 1x X100 (supply terminal) 1x X105 (motor/brake resistor) 1x X109 (PTC, bridged) 1x X107 (24-V brake) 1x X106 (motor holding brake) 1x shield support for control connections
i950-C0.55/230-2				
i950-C0.75/230-2				
i950-C1.5/230-2				
i950-C2.2/230-3				
i950-C0.55/400-3				
i950-C0.75/400-3				
i950-C2.2/400-3				
i950-C4.0/400-3				
i950-C4.0/230-3	I9ZAA0015S		I9ZAA0018S	
i950-C5.5/230-3				
i950-C7.5/400-3				
i950-C11/400-3				
i950-C15/400-3				
i950-C22/400-3	I9ZAA0016S	1x X1 (Basic Safety - STO) 1x X5 (24 V) 1x X3 (I/O control terminal) 1x X109 (PTC, bridged) 1x X107 (24-V brake) 1x X106 (motor holding brake) 1x shield support for control connections	I9ZAA0019S	1x X82 (Extended Safety) 1x X83 (Extended Safety) 1x X5 (24 V) 1x X3 (I/O control terminal) 1x X109 (PTC, bridged) 1x X107 (24-V brake) 1x X106 (motor holding brake) 1x shield support for control connections
i950-C30/400-3				
i950-C45/400-3				
i950-C55/400-3				
i950-C75/400-3				
i950-C90/400-3				
i950-C110/400-3				

Inverter	0.37 kW ... 15 kW	
Connection	Terminal strip X101	
	Order code	Packaging unit
		Piece
DC bus	I9ZAA0013M	5
DC-Bus, daisy chain	I9ZAA0012M	5

DIN rail

In accordance with EN 60175, the inverter can be mounted onto a DIN rail 35 mm x 7.5 mm.
For this purpose, a mounting set is available.

Order code	Description
I5ZAB0DR2S	Mounting of the inverters 0.37 kW to 4 kW on DIN rail

System cables

Hybrid cables for motor connection with One Cable Technology (OCT)

The One Cable Technology (OCT) is possible with MCS and m850 servo motors. You need a special hybrid cable for this:

Order code	Length	Description		
EYP0080A0020M13A00	2 m	Motor end M23 connector 3 power wires, 1 PE Cable cross-section 1.5 mm²	1 pair of control wires for controlling the motor holding brake Cable cross-section 0.75 mm²	1 pair of control wires for transferring the Hiperface DSL® protocol Cable cross-section 0.32 mm²
EYP0080A0035M13A00	3.5 m			
EYP0080A0050M13A00	5 m			
EYP0080A0075M13A00	7.5 m			
EYP0080A0100M13A00	10 m			
EYP0080A0150M13A00	15 m			
EYP0080A0200M13A00	20 m			
EYP0080A0500M13A00	50 m			
EYP0080A1000M13A00	100 m			
EYP0081A0020M13A00	2 m	Motor end M23 connector 3 power wires, 1 PE Cable cross-section 2.5 mm²	1 pair of control wires for controlling the motor holding brake Cable cross-section 1 mm²	
EYP0081A0035M13A00	3.5 m			
EYP0081A0050M13A00	5 m			
EYP0081A0075M13A00	7.5 m			
EYP0081A0100M13A00	10 m			
EYP0081A0150M13A00	15 m			
EYP0081A0200M13A00	20 m			
EYP0081A0500M13A00	50 m			
EYP0081A1000M13A00	100 m			
EYP0085A0020M12A00	2 m	Motor end M40 connector 3 power wires, 1 PE Cable cross-section 4 mm²		
EYP0085A0035M12A00	3.5 m			
EYP0085A0050M12A00	5 m			
EYP0085A0075M12A00	7.5 m			
EYP0085A0100M12A00	10 m			
EYP0085A0150M12A00	15 m			
EYP0085A0200M12A00	20 m			
EYP0085A0500M12A00	50 m			
EYP0085A1000M12A00	100 m			
EYP0086A0020M12A00	2 m	Motor end M40 connector 3 power wires, 1 PE Cable cross-section 6 mm²		
EYP0086A0035M12A00	3.5 m			
EYP0086A0050M12A00	5 m			
EYP0086A0075M12A00	7.5 m			
EYP0086A0100M12A00	10 m			
EYP0086A0150M12A00	15 m			
EYP0086A0200M12A00	20 m			
EYP0086A0500M12A00	50 m			
EYP0086A1000M12A00	100 m			

Information on further motor cables is provided in the "System cables and system connectors" manual (→ Download).

More information about the One Cable Technology (OCT):

▸ One Cable Technology (OCT) 🕮 97

Purchase order

Notes on ordering

The i950 servo inverter is ordered as a complete device in the previously chosen "safety" variant. The following two device variants are available:

- Inverter with "Basic Safety - STO"
- Inverter with "Extended Safety"

Additional feature options can be optionally configured during order placement.

- Modules for connecting to a network
- Modules for connecting motor encoders
- Modules for connecting load/master encoders
- SD card with Application Credit

The delivery takes place as a complete device.

»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

Aftersales Service

You can use our online support to directly request support and repairs for specific Lenze products or order spare parts and call up technical data and documentation.

www.Lenze.com → Support

Simply enter the material number or scan the nameplate with our integrated scan function. All support information is immediately available to you at a glance.

Order details

The following is a list of the information required to place the order.

Order example

Description of the component	Order code
Complete inverter	I95B E 222 F 1 A V10 0000
Three-phase mains connection 400 V	
Power 2.2 kW (i950-C2.2/400-3)	
Safety technology: Basic safety - STO	
Interference suppression: Integrated RFI filter	
Network: none	
Feedback: none	

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:

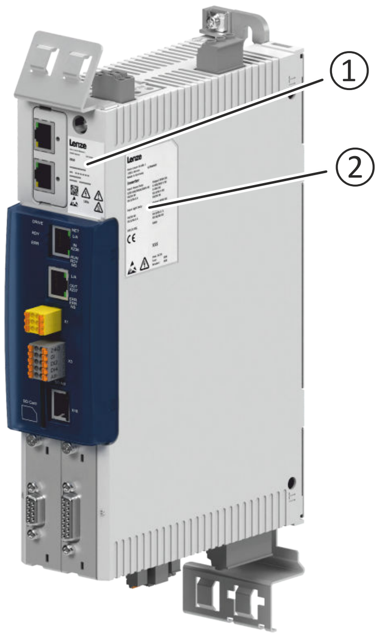
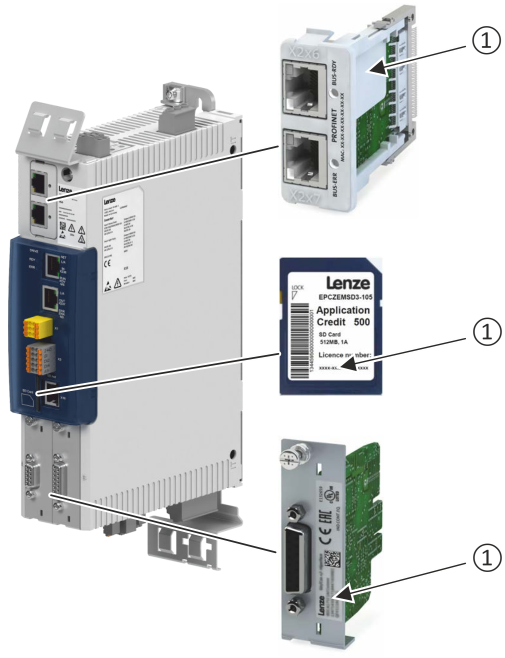
Power		Product name	Order code (only the first 9 characters)
kW	HP		
Single-phase mains connection 230 V			
0.37	0.5	i950-C0.37/230-2	I95xE137D
0.55	0.75	i950-C0.55/230-2	I95xE155D
0.75	1	i950-C0.75/230-2	I95xE175D
1.5	2	i950-C1.5/230-2	I95xE215D
Three-phase mains connection 230 V			
0.37	0.5	i950-C0.37/230-2	I95xE137D
0.55	0.75	i950-C0.55/230-2	I95xE155D
0.75	1	i950-C0.75/230-2	I95xE175D
1.5	2	i950-C1.5/230-2	I95xE215D
2.2	3	i950-C2.2/230-3	I95xE222C
4	5	i950-C4.0/230-3	I95xE240C
5.5	7.5	i950-C5.5/230-3	I95xE255C
Three-phase mains connection 400/480 V			
0.55	0.75	i950-C0.55/400-3	I95xE155F
0.75	1	i950-C0.75/400-3	I95xE175F
2.2	3	i950-C2.2/400-3	I95xE222F
4	5	i950-C4.0/400-3	I95xE240F
7.5	10	i950-C7.5/400-3	I95xE275F
11	15	i950-C11/400-3	I95xE311F
15	20	i950-C15/400-3	I95xE315F
22	30	i950-C22/400-3	I95xE322F
30	40	i950-C30/400-3	I95xE330F
45	60	i950-C45/400-3	I95xE345F
55	74	i950-C55/400-3	I95xE355F
75	100	i950-C75/400-3	I95xE375F
90	120	i950-C90/400-3	I95xE390F
110	150	i950-C110/400-3	I95xE411F
132	174	i950-C132/400-3	I95xE413F
160	200	i950-C160/400-3	I95xE416F
200	250	i950-C200/400-3	I95xE420F
250	320	i950-C250/400-3	I95xE425F

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

			I	9	5	□	E	□□□	□	1	□	□	□	□	□	□	□	□
Product type		Inverter	I															
Product family		i900		9														
Product		i950			5													
Product generation		Generation 1				A												
		Generation 2				B												
Mounting type		Control cabinet mounting					E											
Rated power (Examples)		0.55 kW						155										
		4.0 kW						240										
		30 kW						330										
		110 kW						411										
Mains voltage and connection type		3/PE AC 230/240 V							C									
		1/N/PE AC 230/240 V 3/PE AC 230/240 V							D									
		3/PE AC 400 V 3/PE AC 480 V							F									
Motor connections		Single axis								1								
Integrated functional safety		Basic Safety - STO									A							
		Extended Safety									C							
Protection class		IP20										0						
		IP20, coated										V						
Interference suppression		Without											0					
		Integrated RFI filter											1					
Design types	Dual Use	Not subject to export authorization: 0, 1, A, W												□				
		Subject to export authorization: 7, 8, E, V												□				
	SD card	Without													Z			
		0 Application Credit													0			
		50 Application Credit													1			
		100 Application Credit													2			
		150 Application Credit													3			
		200 Application Credit													4			
		300 Application Credit													5			
		400 Application Credit													6			
	Option (slot B)	Without (blanking cover)														0		
		Load encoder - resolver														2		
		Load encoder (SinCos/HIPERFACE®/SSI/TTL/EnDat)														3		
		Digital-I/O														B		
		Extended-I/O														C		
	Option (slot A)	Motor encoder HIPERFACE® DSL/EnDat 3 (OCT) bis 15 kw (Blanking cover)															Q	
		Without from 22 kW (Blanking cover)															0	
		Motor encoder - resolver															2	
		Motor encoder (SinCos/HIPERFACE®/SSI/TTL/EnDat)															3	
		Digital-I/O															B	
		Extended-I/O															C	
	Networks	Without network																0
		PROFIBUS																P
		PROFINET																R
		EtherCAT																T
		Ethernet/IP																G
		CANopen																C

Nameplate information

Position and meaning of the nameplates

Complete inverter		Component (options)	
			
①	Nameplate at the top front: Technical data, type, and serial number of the inverter	①	Type and serial number of the component
②	Nameplate on the side: Technical data of the inverter	-	-

Environmental notes and recycling

Lenze products are intended for use by companies in industrial environments. This means that they are also subject to requirements regarding recycling and disposal. Both mechanical and electrical components such as electric motors, gearboxes, and inverters contain valuable raw materials that can be recycled and reused. Proper recycling is important and sensible from both an economic and ecological perspective.

For information on the proper disposal and legal requirements of our products, please refer to the information on the respective product page on the Internet:

https://www.lenze.com/en-de/products

If you require support, please contact your local branch:

https://www.lenze.com/en-de/company/global-presence

Note: By disposing of devices and packaging properly, you are helping us to protect the environment and conserve resources.

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

https://www.lenze.com/en-de/company/sustainability

Appendix

Good to know

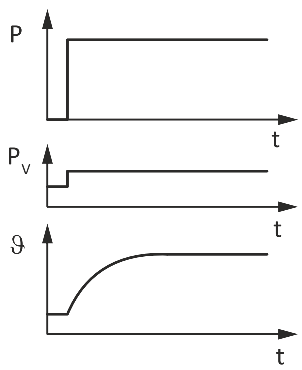
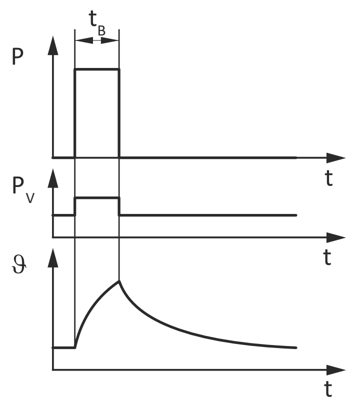
Operating modes of the motor

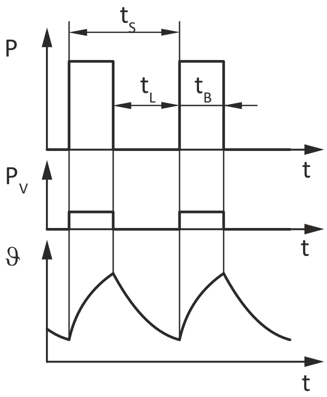
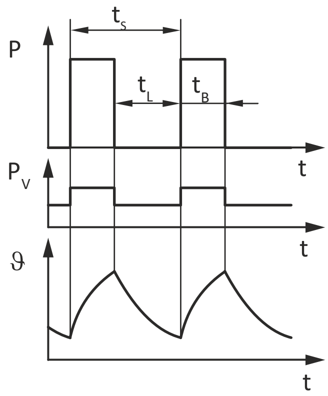
Operating modes S1 ... S10 as specified by EN 60034-1 describe the basic stress of an electrical machine.

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

<table>
<tr><th>Continuous operation S1</th><th>Short-time operation S2</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Operation with a constant load until the motor reaches the thermal steady state. The motor may be actuated continuously with its rated power.</td><td>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.</td></tr>
</table>

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
ϑ	Temperature		

Enclosures

The protection class indicates the suitability of a product for specific ambient conditions with regard to humidity as well as the protection against contact and the ingress of foreign particles. The protection classes are classified in the EN IEC 60034-5/EN IEC 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

Definitions in functional safety

Abbreviation	Meaning
AIE	Acknowledge In Error, error acknowledgement
AIS	Acknowledge In Stop, restart acknowledgement
OFF state	Triggered signal status of the safety sensors
CCF	Common Cause Error (also β-value)
CIP	Common Industrial Protocol
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 sensors 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
nBD	Speed value Base-Drive, internally determined actual speed from standard application
nSD	Safe-Drive speed value, internally determined actual speed from the safety application
n_safe	Actual speed determined from validation of nBD and nSD. Enters the further processing of the speed-dependent safety functions.
OSSD	Output Signal Switching Device, tested signal output
pBD	Base-Drive position value, internally determined actual position from standard application
pSD	Safe-Drive position value, internally determined actual position from the safety application
p_safe	Actual position determined from validation of pBD and pSD. Enters the further processing of the position-dependent safety functions.
PELV	Protective Extra Low Voltage
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 Creeping Speed
SD−In	Safe Digital Input
SD−Out	Safe Digital Output
SELV	Safety Extra Low Voltage
SFF	Safe Failure Fraction
SIL	Safety Integrity Level according to EN IEC 61508

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