Inverter

i950 cabinet inverter 0.55 … 110 kW

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About this document

Document description

This document is aimed at all persons who want to project inverters with the described products.

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

Further documents

For certain tasks, information is available in further documents.

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

For certain tasks, information is available in other media.

Form	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.

These media can be found here: Lenze.com

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

Notations and conventions

This document uses the following conventions to distinguish different types of information:

Numeric notation			
	Decimal separator	Point	The decimal point is always used. Example: 1 234.56
Warning			
	UL warning	UL	Are used in English and French.
	UR warning	UR	
Text			
	Engineering tools	» «	Software Example: »Engineer«, »EASY Starter«
Icons			
	Page reference	🕮	Reference to another page with additional information Example: 🕮 16 = see page 16
	Documentation reference	ⓚ	Reference to another 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 Servo Inverter i950 is an expansion for our automation platform and can easily be integrated into servo drive systems.

- The Servo Inverter provides a high-quality servo inverter.
  - Already today, the standard for efficiency classes (IE) in accordance with EN 50598-2, which will apply in the future, has been met.
- The 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.
- The EtherCAT-based Lenze system bus makes it possible to synchronise multiple axes at high speed.
  - Easy commissioning with the aid of plug-and-play mechanisms.
  - Significantly higher bandwidth and cable lengths as compared to older system bus technologies.
  - Easy diagnosis even for larger axis groups.

Centralised control (controller-based automation) or decentralised control (drive-based automation)

- Both control types are possible, as previous limitations have been lifted.
- The Servo Inverter i950 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
- Propulsion drives
- Winder drives
- Lift drives
- Handling
- Robotics
- Packaging technology
- Drives for forming processes
- Drives in machine tools

Other properties:

- The servo inverters are available in a wide power range.
  - 0.55 kW ... 110 kW
  - A DC-bus connection at the DC voltage level is possible.
- The servo inverters can be used to enhance performance in controller-based multi-axis systems.
  - E. g. systems with controllers and Multi-Axis Servo i700
- Space-saving design saves space in the control cabinet.

▸ Dimensions 📖 86

The servo inverters are outfitted with the following interfaces by default:

▸ Control connections 📖 58

▸ EtherCAT system bus 📖 61

▸ Operation and diagnostics 📖 162

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

▸ Motor encoder connection 📖 102

▸ Load encoder/master encoder connection 📖 104

▸ Networks 📖 105

▸ Accessories 📖 162

▸ Memory modules (SD card) 📖 163

Information on the available technology applications:

▸ Technology applications (TA) 📖 22

- The technology applications for the Servo Inverter i950 are selected and parameterized with Easy Starter.
- The technology applications in inverters utilize procedures comparable to technology modules in our control units.
  - For the use of the technology applications, licensing is necessary.
  - Lenze SD cards with various scopes for our licensing model are available.

▸ Memory modules 📖 163

i950 variants

Two variants allow for a wide scope of use of the integrated "functional safety":

- i950 with basic safety - STO
  - In this case, STO is the only usable safety function.
- i950 with extended safety
  - Numerous safety functions are available here.

▸ Functional safety 🕮 109

i950 - variant with basic safety - STO

i950 - variant with extended safety

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 at:

▸ Purchase order 📖 169

The product name contains the power in kW, mains voltage class 400 V, and the number of phases.

"C" marks the "Cabinet" version = inverter for the installation into the control cabinet.

Inverter series	Type	Rated power	Rated line voltage	No. of phases	Inverter
		kW	V		
i950 cabinet inverter	C	0.55	400	3	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

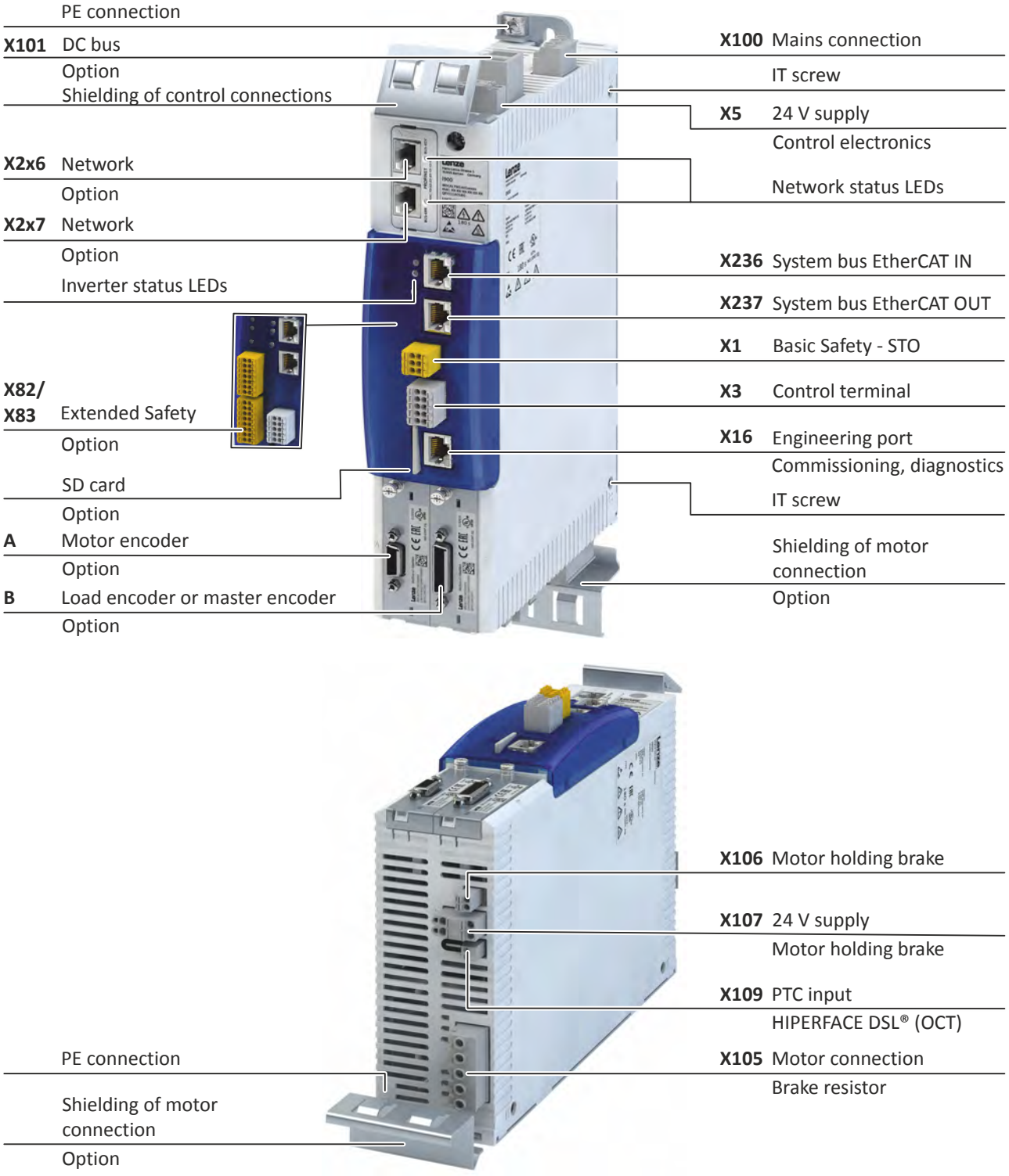
Inverter series	Type	Rated power	Rated line voltage	No. of phases	Inverter
		kW	V		
i950 cabinet inverter	C	0.55	480	3	i950-C0.55/400-3
		0.75			i950-C0.75/400-3
		2.2			i950-C2.2/400-3
		4			i950-C4.0/400-3
		7.5			i950-C7.5/400-3
		11			i950-C11/400-3
		15			i950-C15/400-3
		22			i950-C22/400-3
		30			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

Features

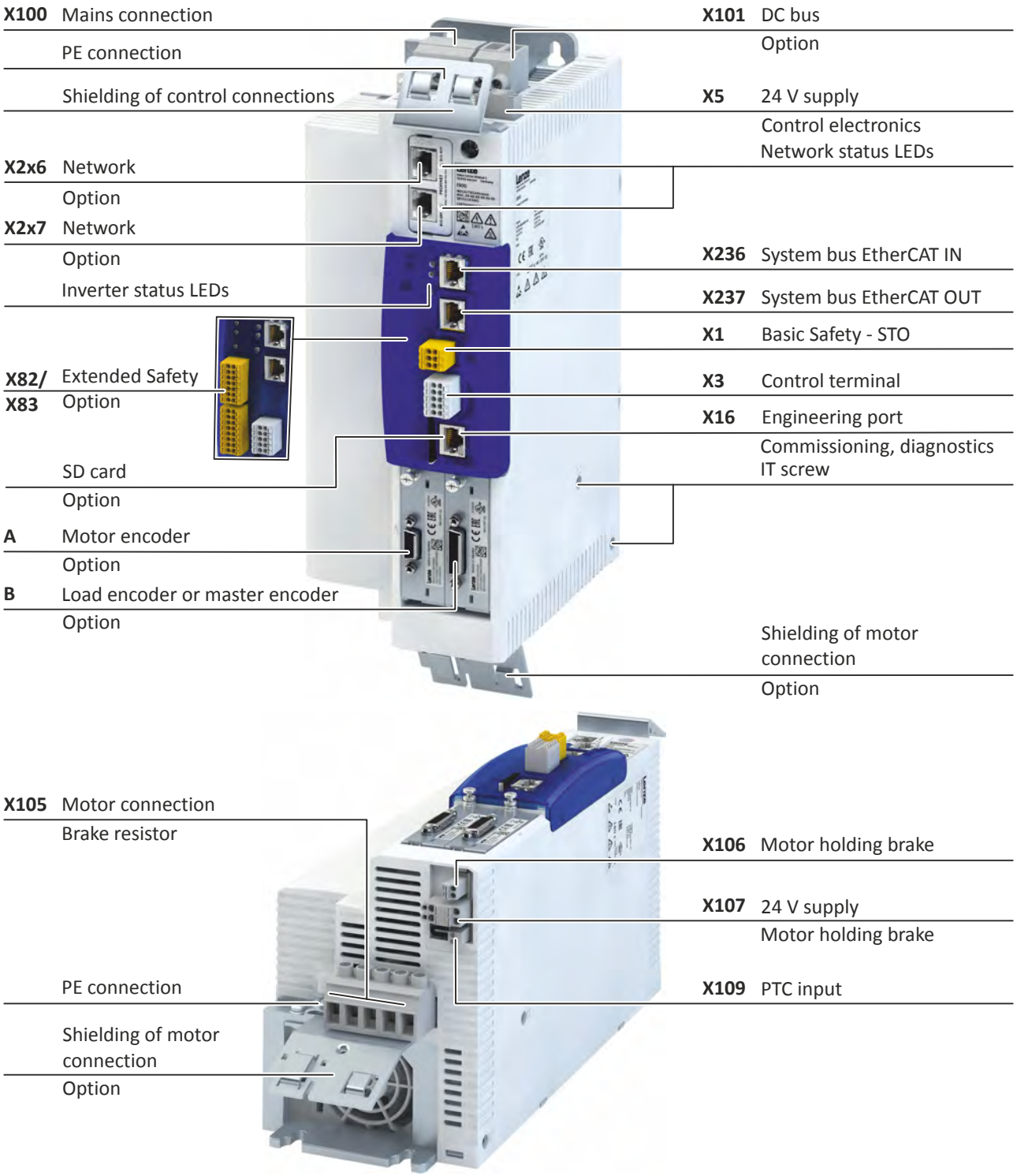
The following figures give an overview of the elements and connections on the devices. Position, size and appearance of elements and connections may vary depending on the capacity and size of the equipment.

Some equipment may be optional.

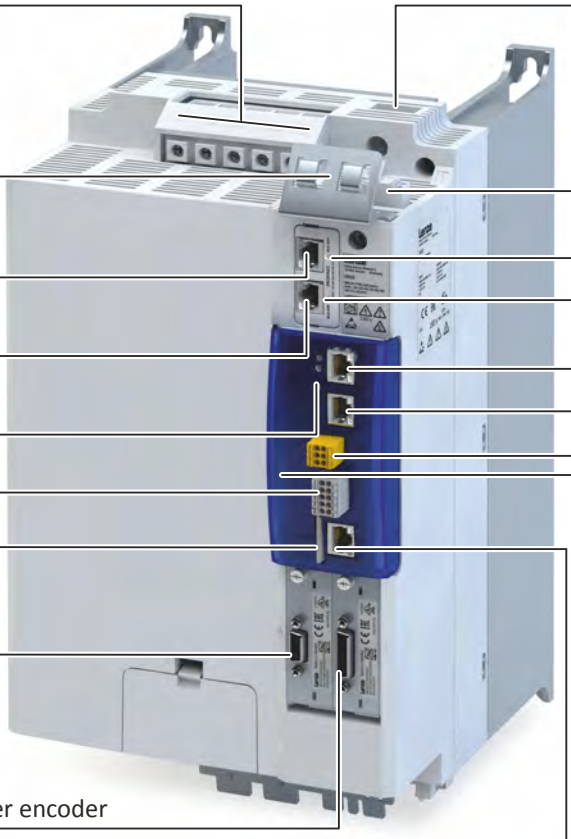
Power range 0.55 kW ... 4 kW



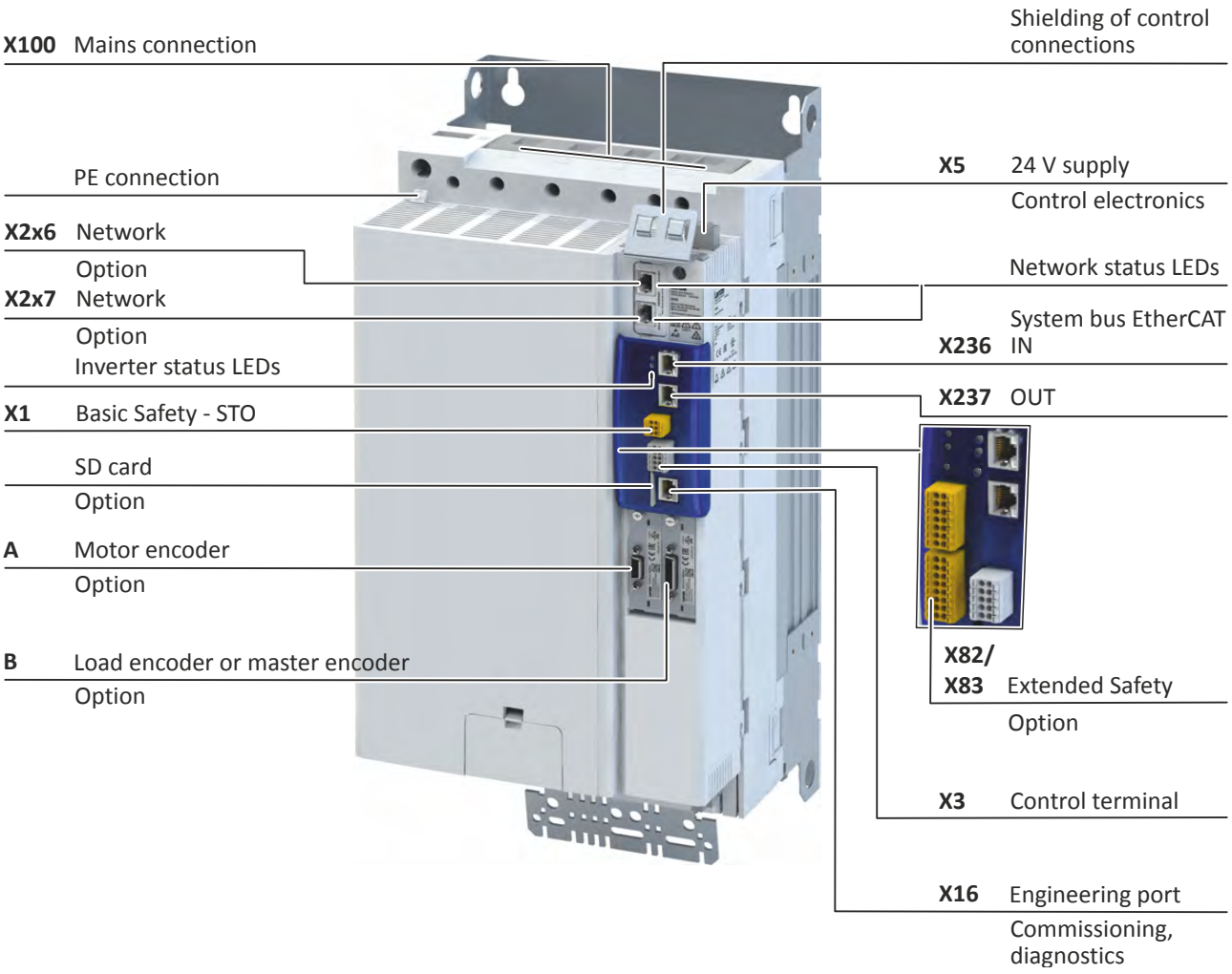
Power range 7.5 kW ... 15 kW



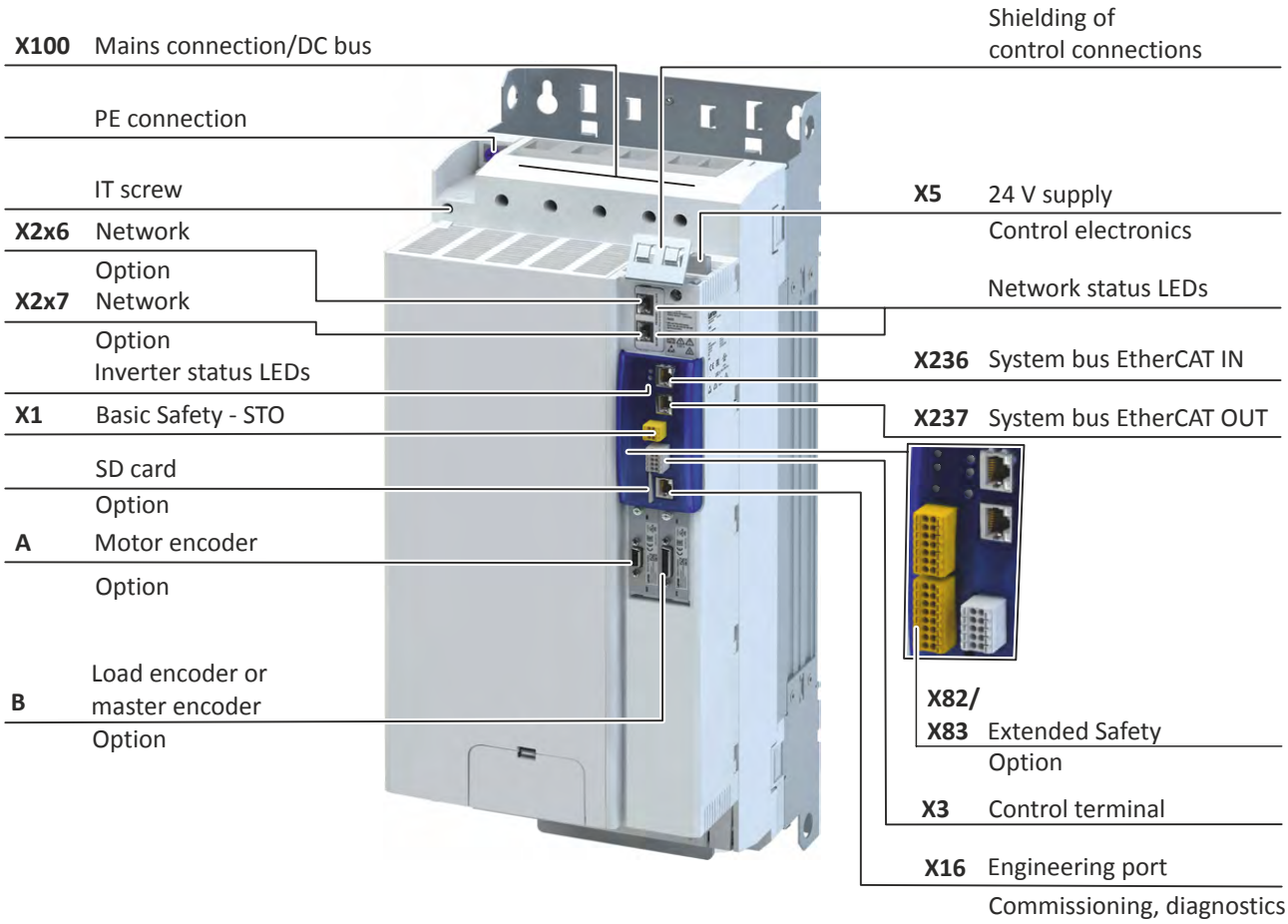
Power range22 kW

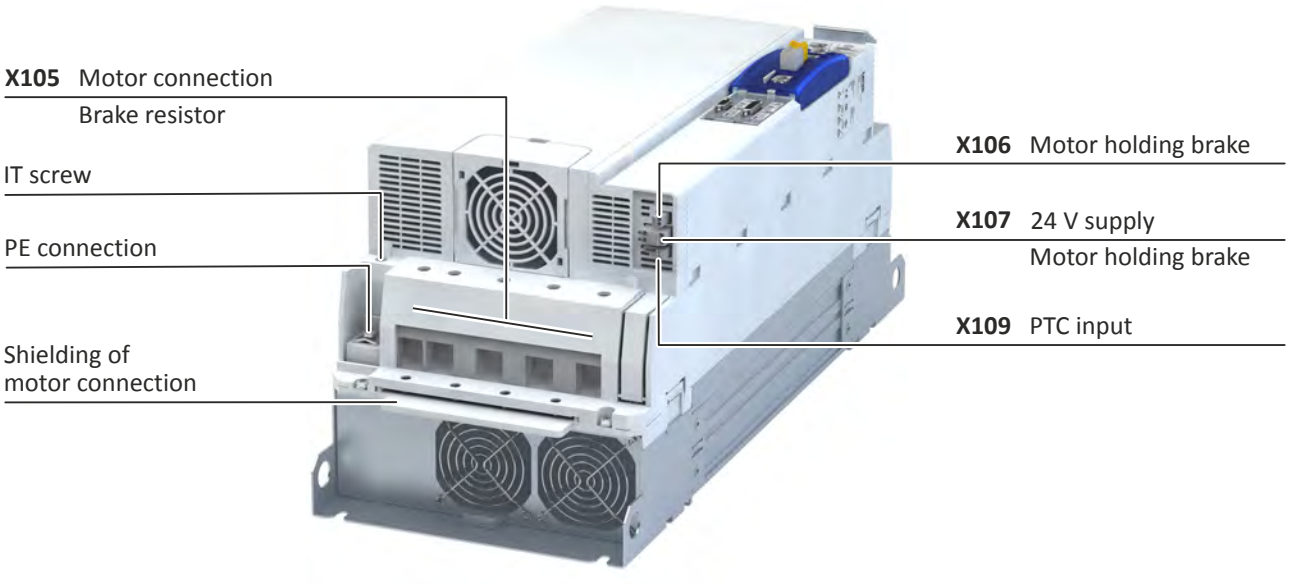


Power range 30 kW ... 45 kW

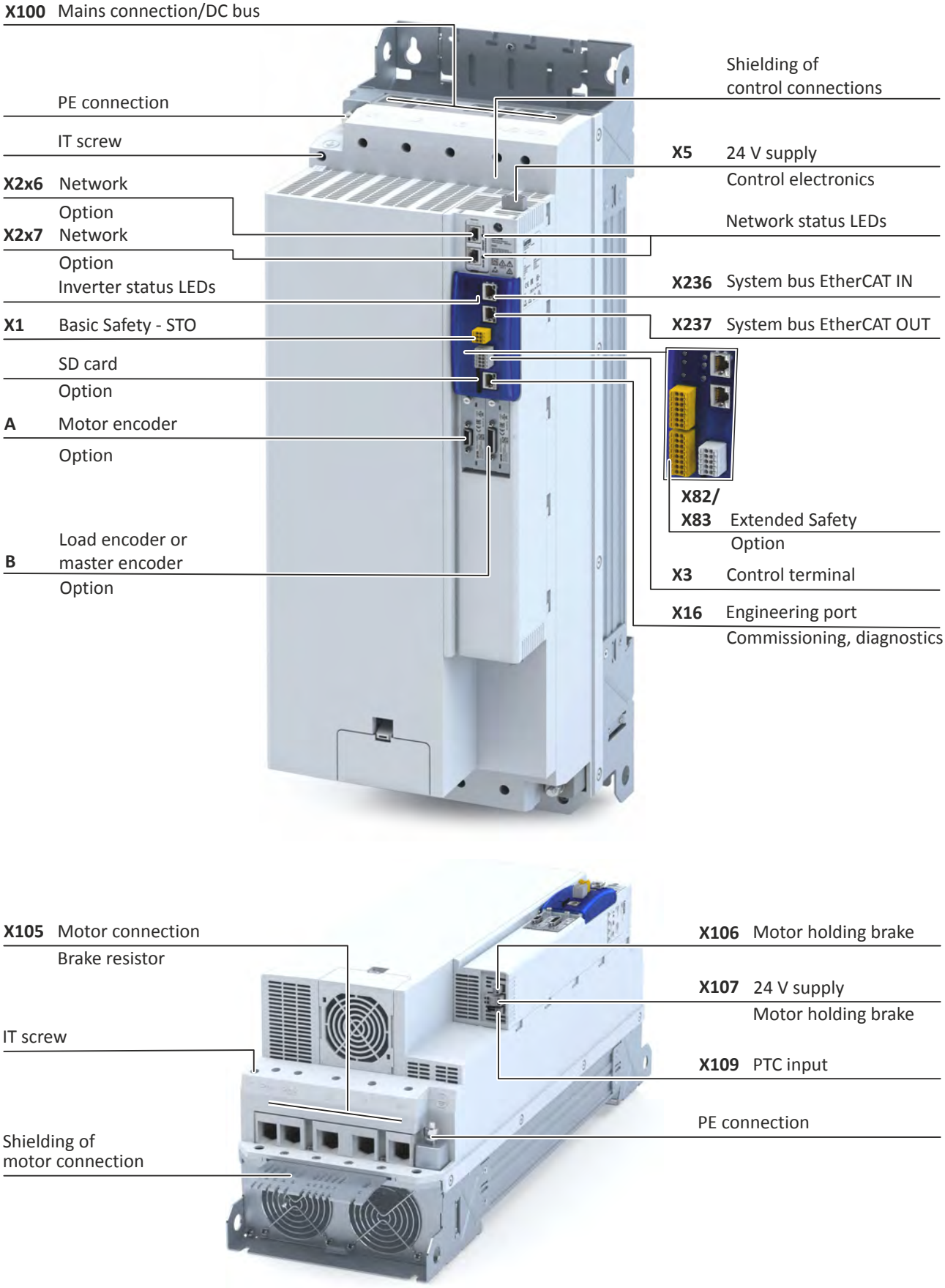


Power range 55 kW ... 75 kW





Power range 90 kW ... 110 kW



The modular system

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:

EtherCAT®	EtherCAT® (Ethernet for Controller and Automation Technology) is an Ethernet-based fieldbus system which fulfils the application profile for industrial realtime 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
PROFINET®	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
Safety over EtherCAT®	Fail-safe-over-EtherCAT (FSoE) enables the transmission of safe information via FSoE protocol in compliance with the "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.
PROFIsafe	The certified safety protocol for the transfer of safety-related data via PROFINET®.

More information on the supported networks can be found at:

http://www.lenze.com

Technology applications (TA)

Overview

The i950 helps to simplify the realisation of complex applications via technology applications.

The following technology applications are available as standard:

- Device profile CiA 402 Advanced ("CiA 402 Advanced")
- Electronic gearbox ("Electronic Gearbox")
- Synchronism with mark correction ("Sync and Correction")
- Speed control ("Speed Control")
- Table positioning ("Table Positioning")
- 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. The following additional functions are implemented in the technology application CiA 402 Advanced:

- 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

This technology application enables the i950 to be optimally operated as a Cia device with control units of other manufacturers.

"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

"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

"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

"Table Positioning" technology application

For discontinuously running conveying, lifting, 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

"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

One cable technology (OCT) via HIPERFACE DSL®

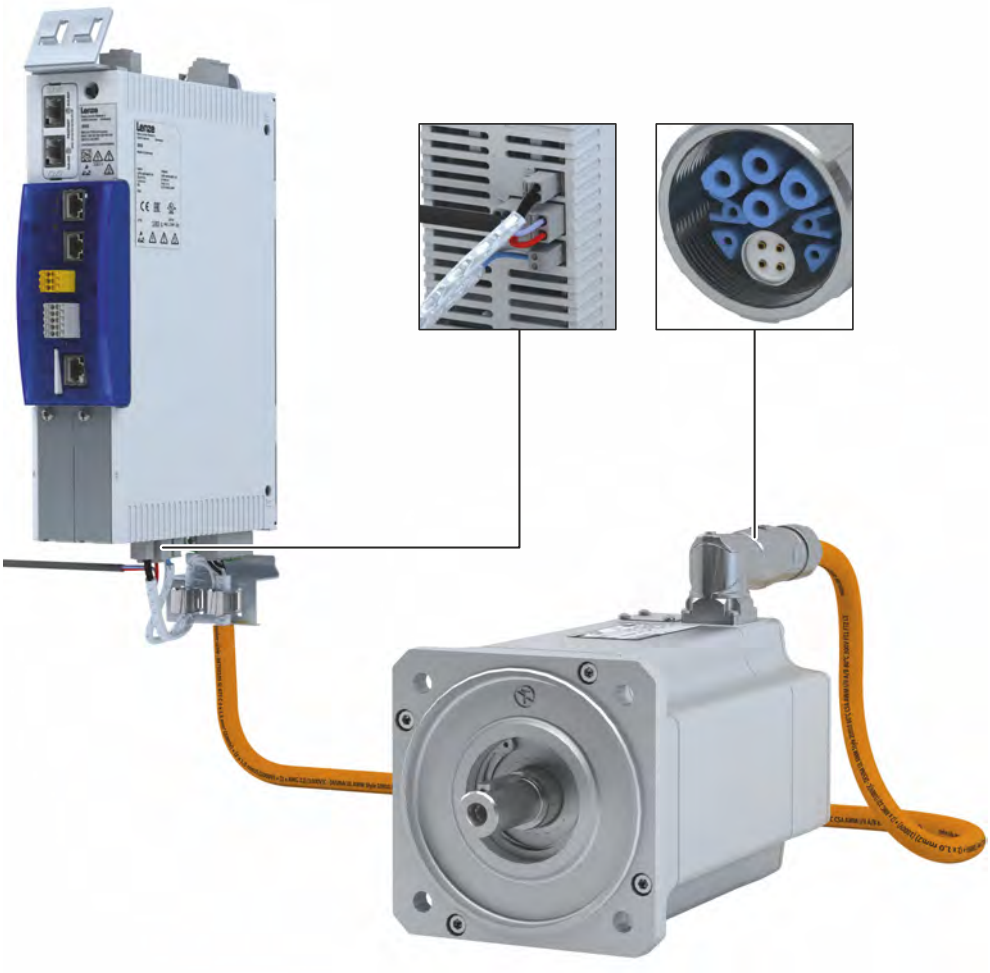
With the aid of the open motor feedback protocol HIPERFACE DSL®, the i950 allows for the use of future-oriented One Cable Technology.

Advantages

- The use of hybrid cables allows for combined servo and rotary transducer cables.
- This intelligently minimises 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.

Conditions

- The One Cable Technology (OCT) is possible with Lenze MCS and m850 servo motors.
- The motor must be equipped with a HIPERFACE DSL® encoder.
- The Lenze hybrid cable EYP0080AxxxxM11A00 must be used as connection cable.
- No motor encoder module must be plugged in slot A.
- The One Cable Technology can only be used together with the "Basic Safety - STO" version.



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

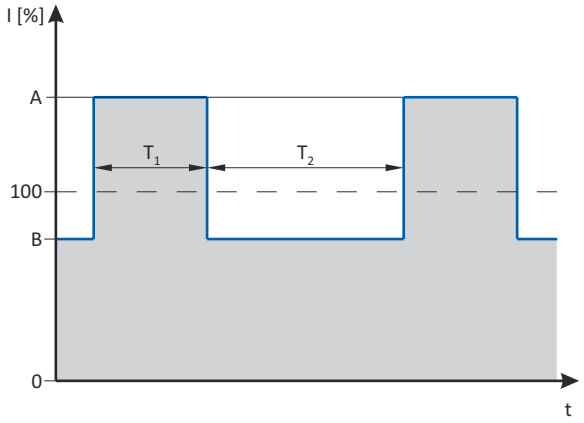
During this operation, the inverter may be loaded for 60 s with up to 150 % of the rated current if afterwards a recovery time of 120 s with max. 75 % of the rated current is observed. A cycle corresponds to 180 s.

Monitoring of the device utilization (I x t) activates the set error response if the utilization value exceeds the 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.



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

Safety instructions

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

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

Please observe the specific safety information in the other sections!

Basic safety instructions

Personnel

The product must only be used by qualified personnel. IEC 60364 or CENELEC HD 384 define the skills 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.

Process engineering

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

Application as directed

- The product must only be operated under the operating conditions prescribed in this documentation.
- The product meets the protection requirements of 2014/35/EU: Low-Voltage Directive.
- Commissioning or starting the operation as directed of a machine with the product is not permitted until it has been ensured that the machine meets the regulations of the EC Directive 2006/42/EU: Machinery Directive; observe EN 60204−1.
- Commissioning or starting operation as directed is only permissible if the EMC Directive is complied with 2014/30/EU.
- Applied standards and regulations: EN 61800−5−1 and EN 61800−3 .
- The product is not a household appliance, but is only designed as a component for commercial or professional use in terms of EN 61000−3−2.
- Drive systems comply with categories according to EN 61800−3, if the product is used in accordance with the technical data.
- In residential areas, the product may cause EMC interferences. The operator is responsible for taking interference suppression measures.
- The product must only be actuated with motors that are suitable for the operation with inverters.
  - Lenze L-force motors meet the requirements
  - Exception: m240 motors are designed for mains operation only.

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

Electrical connection

When working on live inverters, observe the applicable national regulations for the prevention of accidents.

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 notes about installation according to EMC regulations (such as shielding, grounding, filters and cable routing). Also observe these notes for CE-marked inverters. The manufacturer of the system or machine is responsible for adherence to the limits 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 have to enable an EMC-compliant installation. In particular observe that e. g. control cabinet doors preferably have a circumferential metallic connection to the housing. Reduce openings or cutouts through the housing to a minimum.

Inverters may cause a DC current in the PE conductor. If a residual current device (RCD) is used for protection against direct or indirect contact for an inverter with three-phase supply, only a residual current device (RCD) of type B is permissible on the supply side of the inverter. If the inverter has a single-phase supply, a residual current device (RCD) of type A is also permissible. Apart from using a residual current device (RCD), other protective measures can be taken as well, e. g. electrical isolation by double or reinforced insulation or isolation from the supply system by means of a transformer.

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/EU. The notes on the integrated 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!

Protection of persons

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

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

Motor protection

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

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

⚠WARNING!

Dangerous electrical voltage

Error on device leads to overvoltage in the system.

► For a voltage supply with 24 V DC (± 25 %), use a safely separated power supply unit according to the applicable SELV/PELV requirements.

► All components connected to USB and RJ45 must be electrically isolated from the mains according to class III.

NOTICE

Short circuit at the device due to electrostatic discharge.

Destruction of the device.

► The personnel must be free of electrostatic charge prior to working on the device.

Protection of the machine/system

Drives can reach dangerous overspeeds.

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

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

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

NOTICE

High input voltage at the device.

Destruction of the device.

► Observe maximum permissible input voltage.

► Fuse device at the input against too high input voltage.

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°).

Parameter set transfer

During the parameter set transfer, control terminals of the inverters can adopt undefined states.

- Thus, the control terminal of the digital input signals have to be removed before the transfer.
- This ensures that the inverter is inhibited. The control terminals are in a defined state.

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.

Commissioning

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

Device exchange without tool

Exchange a maximum of one safe device before recommissioning.

Exchange of devices

Test the compatibility of the devices before exchanging.

Risks when exchanging devices

⚠WARNING!

Incorrect handling of devices.

Device damage.

► Check the compatibility of the devices before exchanging.

► Check the memory cards of the devices before exchanging.

► Set the safety address.

► Undertake a functional check after the exchange.

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

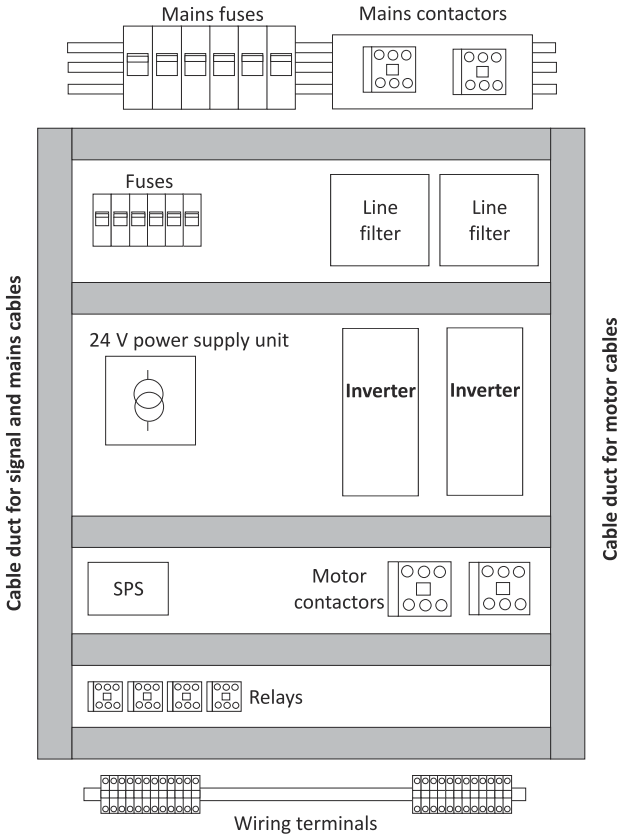


Fig. 1: Example for the ideal arrangement of components in the control cabinet

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 aerials.
- Use separated cable channels for motor cables and control cables. Do not mix up different cable types in one cable channel.
- Lead the cables to the terminals in a straight line (avoid tangles of cables).
- Minimise 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.

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 minimised 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).

EMC-compliant installation

Structure of a CE-typical drive system

The drive system (frequency inverter and drive) corresponds to 2014/30/EU: EMC Directive if it is installed according to the specifications of the CE-typical drive system.

Mains connection, DC supply

- Inverters, mains chokes, or mains filters may only be connected to the mains via unshielded single cores or unshielded cables.
- When a line filter is used, shield the cable between mains filter or RFI filter and inverter if its length exceeds 300 mm. Unshielded cores must be twisted.
- In DC-bus operation or DC supply, use shielded cables.

Motor cable

- Only use low-capacitance and shielded motor cables with braid made of tinned or nickel-plated copper.
  - The overlap rate of the braid must be at least 70 % with an overlap angle of 90 °.
  - Shields made of steel braids are not suitable.
- Shield the cable for motor temperature monitoring (PTC or thermal contact) and install it separately from the motor cable.
  - In Lenze system cables, the cable for brake control is integrated into the motor cable. If this cable is not required for brake control, it can also be used to connect the motor temperature monitoring up to a length of 50 m.
  - Only certain inverters are provided with this connection facility.
- Connect the shield with a large surface and fix it with metal cable binders or conductive clamp. The following is suitable for the connection of the shield:
  - The mounting plate
  - A central grounding rail
  - A shielding plate, if necessary, optional
- This is optimal:
  - The motor cable is separated from the mains cables and control cables.
  - The motor cable only crosses mains cables and control cables at right angles.
  - The motor cable is not interrupted.
- If the motor cable must be opened all the same (e. g. by chokes, contactors, or terminals):
  - The unshielded cable ends must not be longer than 100 mm (depending on the cable cross-section).
  - Install chokes, contactors, terminals etc. spatially separated from other components (with a minimum distance of 100 mm).
  - Install the shield of the motor cable directly before and behind the point of separation to the mounting plate with a large surface.
- Connect the shield with a large surface to PE in the terminal box of the motor at the motor housing.
  - Metal EMC cable glands at the motor terminal box ensure a large surface connection of the shield with the motor housing.

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

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 maximally 40 mm
Conducted interference level is exceeded on the supply side	Terminal strips for the motor cable are directly located next to the mains 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	Optimise PE connection: • Remove varnish • Use zinc-coated mounting plate
	HF short circuit	Check cable routing

Information on 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.
- If required, implement a separate air guide.

Preparation

Further data and information for mechanical mounting:

▸ Control cabinet structure 📖 32

▸ Dimensions 📖 86

The scope of supply of the inverter comprises mounting instructions. They describe technical data and information on mechanical and electrical installation.

Mounting position

- Vertical alignment - all mains connections are at the top and the motor connections at the bottom.

Free spaces

- Maintain the specified free spaces above and below to the other installations.

Mechanical installation

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

How to mount the inverters onto 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 mounting plate with corresponding threaded holes.
2. Fit screws and washers (if applicable).
3. Do not yet tighten the screws.
4. Mount the inverter on the prepared mounting plate via keyhole suspension.
5. Only tighten the screws hand-tight.
6. Pre-assemble further units if necessary.
7. Align the units with each other.
8. Screw the units onto the mounting plate.

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

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

Functional safety

Reliable speed and position analysis

⚠ DANGER!

Slip, shaft break etc. between the motor and encoder system interfere with the reliability of speed analysis.

The functions dependent on speed and/or direction of rotation are performed with errors.

► Reliably exclude functional errors via design measures.

► Utilize motors and encoder systems with guaranteed characteristics. Your Lenze contact will be glad to provide you with a list of suitable systems.

For the reliable analysis of speed and position values, you will need to connect an integrity-rated Sin-Cos-encoder or a resolver.

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

Motor encoder [%]	Max. speed [min^{-1}]	Synchronism	Response time of encoder monitoring [ms]	Encoder error response
Encoder	±16000	1.5	50	Error stop STO
			Parameterizable 12 / 50 / 100	
Resolver	±10000 / Number of pole pairs Resolver	1	50	
			Parameterizable 12 / 50 / 100	

Motor-encoder combinations

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

The permissible motor-encoder combinations to be used for safe speed monitoring are listed in the following tables.

Synchronous servo motors	Encoder type	Encoder product code	Risk mitigation
MCS 06 ... 19 MDXKS 56 / 71	Sin-Cos absolute value, single-turn	AS1024−8V−K2	PL d / SIL 2
	Sin-Cos absolute value, multi-turn	AM1024−8V−K2	
MCS 06 ... 19 m850S120 ... m850S190	Sin-Cos absolute value, multi-turn	AM128−8V−K2	
MCS 06 ... 19 MDXKS 56 / 71 m850S120 ... m850S190	Resolver	RV03	PL e / SIL 3

Asynchronous servo motors	Encoder type	Encoder product code	Risk mitigation
MCA 10 ... 26 MQA 20 ... 26	Sin-Cos incremental	IG1024-5V-V3	PL e / SIL 3
MCA 10 ... 26 MQA 20 ... 26	Resolver	RV03	PL e / SIL 3

Three-phase AC motors	Encoder type	Encoder product code	Risk mitigation
MDxMA063 ... MDxMA225 MHxMA063 ... MHxMA225 MFxMA063 ... MFxMA132 m550P080 ... m550P225	Sin-Cos incremental	IG2048-5V-V2 IG2048-5V-V3 IG1024-5V-V2	PL e / SIL 3

In the case of feedback systems for safety functions, please observe the manufacturer's documentation.

2-encoder concept

Safe speed monitoring can always be achieved with a 2-encoder concept.

A 2-encoder concept is a machine combination which usually utilizes the following components:

- Motor encoder: Resolver
- Position/load encoder: absolute value encoder (Sin-Cos), incremental encoder (TTL), or digital encoder (SSI/Bus)

For systems affected by slip, please refer to the chapter ▸ Slip compensation 📖 113

Operation with resolvers

When using a feedback system with only one encoder in the environment of safety applications, the standard EN 61800−5−2 has specific requirements for safety equipment when it comes to the connection between the feedback system and motor shaft. The overly large design prevents operational failure caused by a break of the encoder shaft or a slip of the encoder on the motor shaft. The acceleration limit values in the drive solutions with a resolver must not 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/s^2	1.9 ms
MCS 09 ... 19			19,000 rad/s^2	5.5 ms
MDXKS 56 / 71			17,000 rad/s^2	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/s^2	4.8 ms
MCA 20 ... 26				
MQA 20 ... 26				

Information on electrical installation

Important notes

⚠ DANGER!

Danger to life due to electric shock!

Death or serious injury

- ► Any work on the inverter must only be carried out in the deenergized state.
- ► Inverter up to 45 kW: After switching off the mains voltage, wait for at least 5 min before you start working.
- ► Inverter above 55 kW: After switching off the mains voltage, wait for at least 20 min before you start working.

⚠ DANGER!

Dangerous electrical voltage

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

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

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

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.

⚠ DANGER!

Use of the inverter on a phase earthed mains with a rated mains voltage ≥ 400 V

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

- ► 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

Error on device leads to overvoltage in the system.

► For a voltage supply with 24 V DC (± 25 %), use a safely separated power supply unit according to the applicable SELV/PELV requirements.

► All components connected to USB and RJ45 must be electrically isolated from the mains according to class III.

NOTICE

Overvoltage at devices with 230-V mains connection

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

Possible consequences: Destruction of the device

► Provide for the use of isolating transformers.

NOTICE

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

Pluggable terminal strips or plug connections

Plugging or removing the terminal strips or plug connections during operation may cause high voltages and arcing.

Possible consequences: Damage of the devices

► Switch off device.

► Only plug or remove the terminal strips or plug connections in deenergised status.

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.

Ensure a trouble-free operation:

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

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".

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.

Preparation

Further data and information for electrical installation:

- EMC-compliant installation 📖 34
- Standards and operating conditions 📖 69

The scope of supply of the inverter comprises mounting instructions. They describe technical data and information on mechanical and electrical installation.

Connection according to UL

⚠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 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.

NOTICE

- **UL marking**
- The opening of the Branch Circuit Protective Device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, current-carring 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.

⚠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.

Branch Circuit Protection (BCP) with Short Circuit Current Ratings (SCCR) with Standard Fuses and Circuit Breaker. (Tested per UL61800-5-1, reference UL file E132659)

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

Inverter			Standard Fuses (UL248)			Circuit Breaker (UL489)			
Line voltage	Rated power	Rated power	SCCR	Max. rated current	Class	SCCR	Max. rated current	Min. cabinet dimensions	Min. cabinet dimensions
	kW	hp	n/a	A		n/a	A	m³	ft³
480 V, 3-ph	0.55	0.75	65	35	CC,CF,J,T	65	25	0.042	1.48
480 V, 3-ph	0.75	1	65	35	CC,CF,J,T	65	25	0.042	1.48
480 V, 3-ph	2.2	3	65	35	CC,CF,J,T	65	25	0.042	1.48
480 V, 3-ph	4	5	65	35	CC,CF,J,T	65	25	0.042	1.48
480 V, 3-ph	7.5	10	65	60	CC,CF,J,T	65	60	0.042	1.48
480 V, 3-ph	11	15	65	60	CC,CF,J,T	65	60	0.042	1.48
480 V, 3-ph	15	20	65	60	CC,CF,J,T	65	60	0.042	1.48
480 V, 3-ph	22	30	65	70	CC,CF,J,T	65	70	0.17	6
480 V, 3-ph	30	40	22	125	CC,CF,J,T	35	125	0.57	20
480 V, 3-ph	45	60	22	125	CC,CF,J,T	35	125	0.57	20
480 V, 3-ph	55	75	22	200	CC,CF,J,T	35	200	0.57	20
480 V, 3-ph	75	100	22	200	CC,CF,J,T	35	200	0.57	20
480 V, 3-ph	90	125	22	300	CC,CF,J,T	10	300	0.57	20
480 V, 3-ph	110	150	22	300	CC,CF,J,T	10	300	0.57	20

Branch Circuit Protection (BCP) with Short Circuit Current Rating (SCCR) for Semiconductor Fuses. (Tested per UL61800-5-1, reference UL file E132659)

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

Inverter			Alternate Fuse (Semiconductor Fuse)	
Line voltage	**Rated power**	**Rated power**	**SCCR**	**Max. rated current**
	kW	**hp**	**n/a**	**A**
480 V, 3-ph	0.55	0.75	100	6
480 V, 3-ph	0.75	1	100	6
480 V, 3-ph	2.2	3	100	20
480 V, 3-ph	4	5	100	50
480 V, 3-ph	7.5	10	100	63
480 V, 3-ph	11	15	100	80
480 V, 3-ph	15	20	100	80
480 V, 3-ph	22	30	100	100
480 V, 3-ph	30	40	100	125
480 V, 3-ph	45	60	100	125
480 V, 3-ph	55	75	100	200
480 V, 3-ph	75	100	100	200
480 V, 3-ph	90	125	100	350
480 V, 3-ph	110	150	100	350

Manufacturer	Max. rated current	Designation
	A	
Eaton/Bussmann	6	FWC-6A10F
		FWP-5A14Fa
	20	FWC-20A10F
		FWP-20A14Fa, FWP-20A22F, FWP-20B
		170M1310, 170M1360, 170M1410
	50	FWP-50A14Fa, FWP-50A22F, FWP-50B
		170M1314, 170M1364, 170M1414
	63	FWP-60B, FWP-63A22F
		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-200A
		170M1320, 170M1370, 170M1420
	350	FWP-350A
Littelfuse	50	L70QS050
	63	L70QS060
	80	L70QS080
	100	L70QS100
	125	L70QS125
	200	L70QS200
	350	L70QS350
Mersen	6	A70QS6-14F, A70QS6-14FI
	20	A70QS20-14F, A70QS20-14FI, A70QS20-22F, A70QS20-22FI
	50	A70QS50-14F, A70QS50-14FI, A70QS50-22F, A70QS50-22FI, A70QS50-4
	63	A70QS60-4, A70QS63-22F, A70QS63-22FI
	80	A70QS80-22F, A70QS80-22FI, A70QS80-4
	100	A70QS100-22F, A70QS100-22FI, A70QS100-4
	125	A70QS125-4, A70QS125-4K
	200	A70QS200-4, A70QS200-4K
	350	A70QS350-4

Mains connection

The following should be considered for the mains connection of inverters:

Single inverters are either directly connected 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.

Inverter groups are connected to the **DC system** with the DC bus. For this purpose, the inverters have to be provided with a connection for the DC link, e. g. terminals +UG/-UG.

This enables the energy exchange in phases with operation in generator and motor mode of several drives in the network.

The DC system can be provided by power supply modules (AC/DC converters) or inverters with a power reserve.

The technical data informs about the possible applications in the given groups. In the dimensioning, data and further notes have to be observed.

The following examples contain the connection options for the variant Basic Safety - STO.

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.

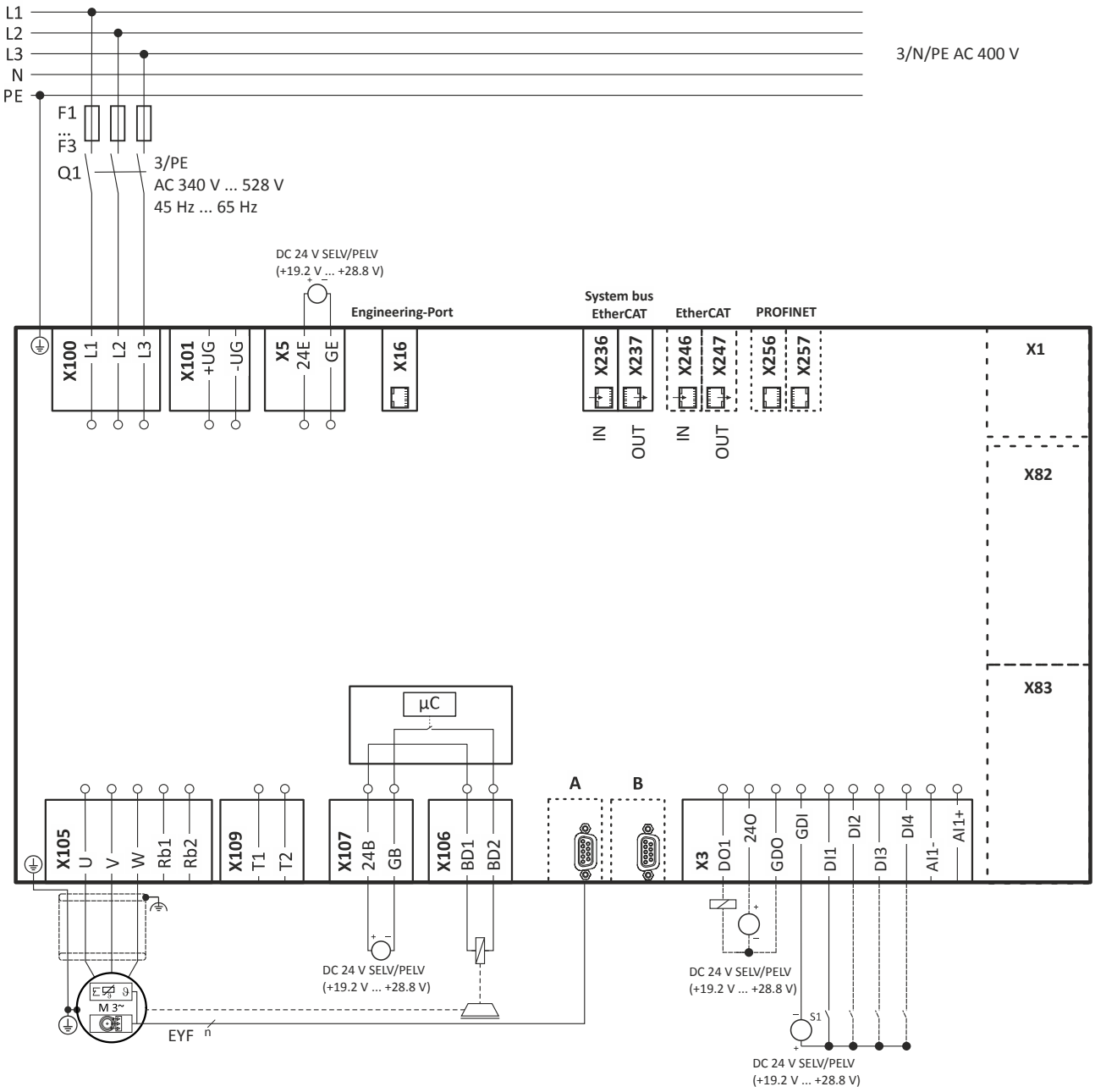


Fig. 2: Wiring example

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 63

A connection plan for the terminals X82 and X83 can be found under: ▸ Extended Safety 66

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.

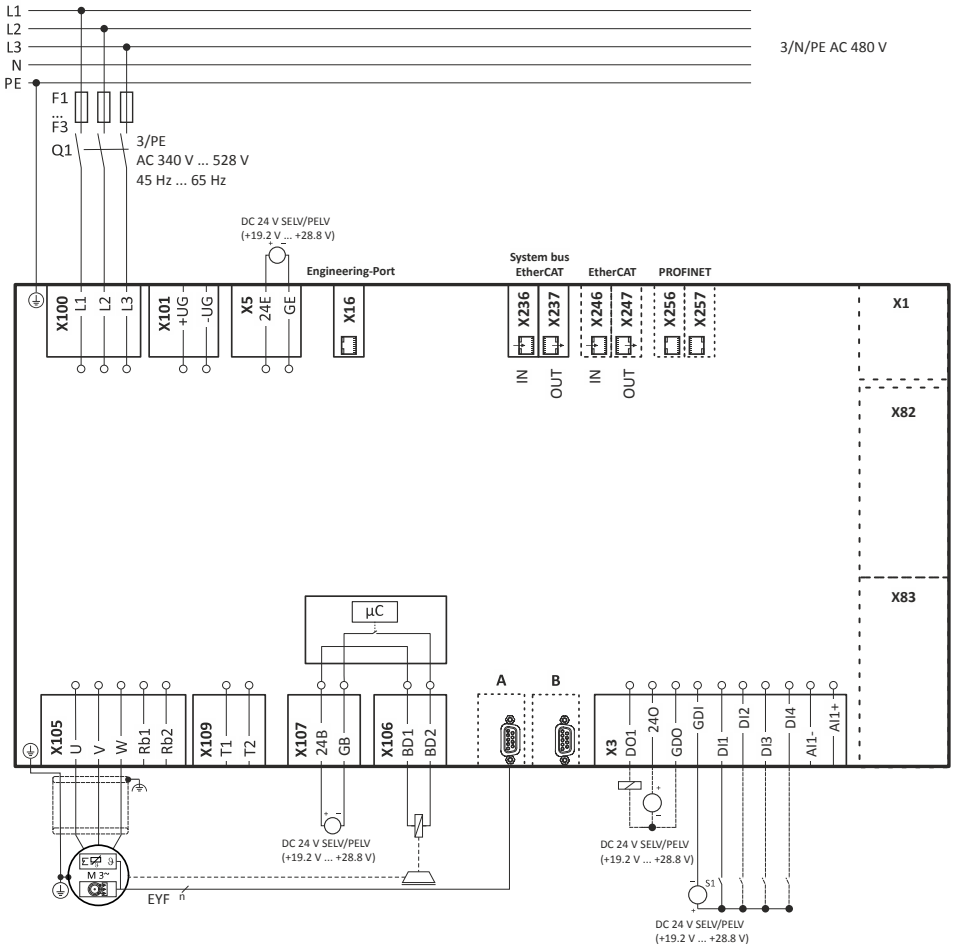


Fig. 3: Wiring example

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 📖 63

A connection plan for the terminals X82 and X83 can be found under: ▸ Extended Safety 📖 66

Motor connection

Switching in the motor cable

Switching on the motor side of the inverter is permissible:

For safety shutdown (emergency stop).

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

Please note the following:

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

Motor cable lengths

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

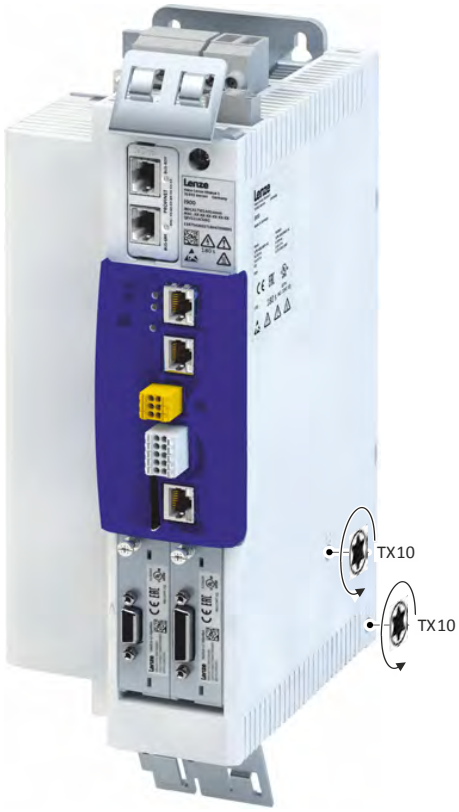
Connection to the IT system

NOTICE

Internal components have earth/ground potential if the IT screws are not removed.

The monitoring devices of the IT system will be triggered.

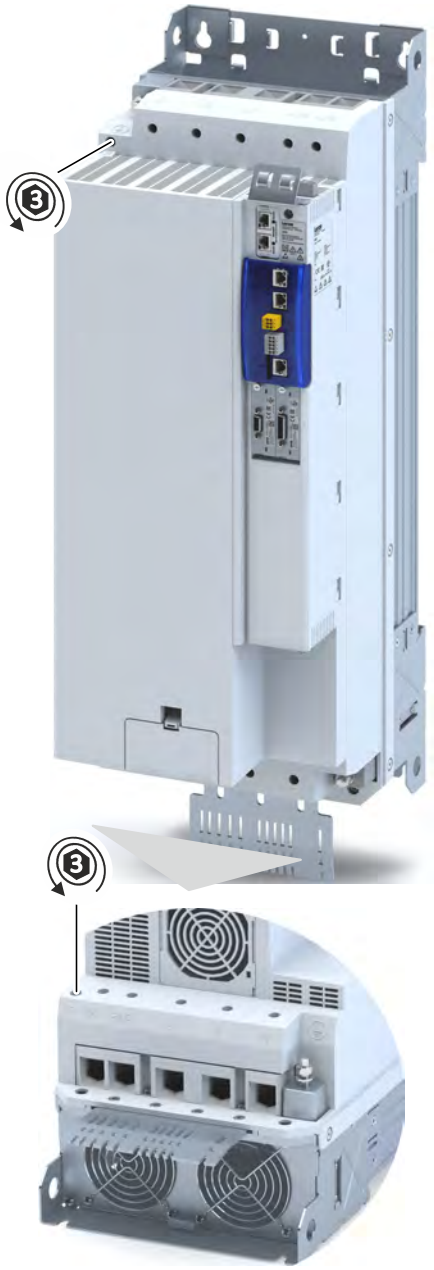
► Before connection to an IT system be absolutely sure to remove the IT screws.

I95AE155F, I95AE175F, I95AE222F, I95AE240F	I95AE275F, I95AE311F, I95AE315F
	

I95AE322F

I95AE330F, I95AE345F	I95AE355F, I95AE375F
	

I95AE390F, I95AE411F



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.

⚠ DANGER!

A common power supply unit for X107 and X5 removes the safe isolation of the control card from the mains potential - even if a SELV/PELV power supply unit is used.

Possible consequences: Electric shock in the event of an error.

► Always supply X107 and X5 via separate SELV/PELV power supply units.

Connection of motor temperature monitoring

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

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!

A common power supply unit for X107 and X5 removes the safe isolation of the control card from the mains potential - even if a SELV/PELV power supply unit is used.

Possible consequences: Electric shock in the event of an error.

► Always supply X107 and X5 via separate SELV/PELV power supply units.

Functions for controlling motor holding brakes:

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

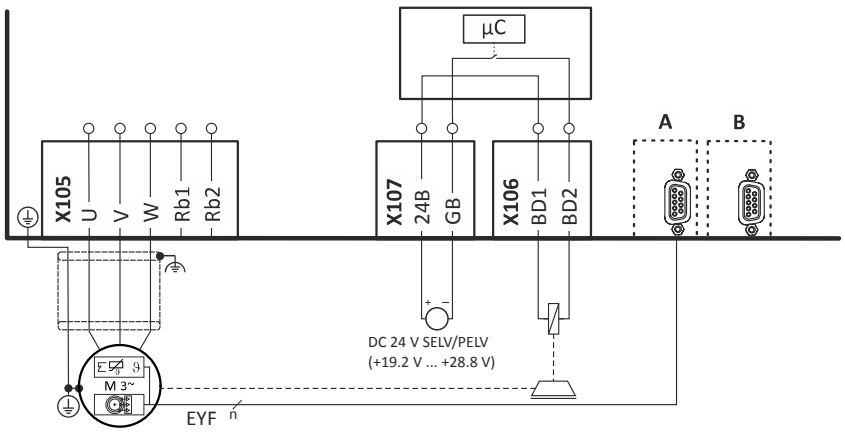


Fig. 4: Connection diagram - motor holding brake

Motor holding brake connection

Terminal			X106: BD1, BD2	Controlling a motor holding brake with or without brake voltage reduction
Level		V	LOW: < +5, HIGH: > +15	
Max. output current	0.55 ... 15 kW	A	2.5	
	22 ... 110 kW		5.0	
Cycle time		ms	1	
Short-circuit-proof			Unlimited period	
Suppressor circuit			Freewheeling diode and spark suppressor are integrated	
Max. breaking energy	0.55 ... 15 kW	Ws	5	
	22 ... 110 kW	Ws	20	
Max. operating frequency			6/min at max. output current	Depending on the output current: Doubling the operating frequency while halving the output current
Insulation			Basic insulation	

24 V supply of motor holding brake

Terminal			X107: 24B, GB	DC supply of X106
Specification of external power supply unit			SELV/PELV	
Rated input voltage		V	+24 ± 20 %	
Max. input current	0.55 ... 15 kW	A	2.5	Typical: according to the load at X106
	22 ... 110 kW	A	5.0	
Polarity reversal protection			Yes	
Suppressor circuit			Yes	Suppressor diode 30 V, bidirectional

Connection description		**Motor brake connection**	**24 V supply for motor brake**
Connection		X106	X107
Connection type		Pluggable spring terminal	Pluggable double spring terminal
Max. cable cross-section	mm²	1.5	2.5
Max. cable cross-section	AWG	16	12
Stripping length	mm	9	10
Stripping length	inch	0.35	0.39
Tightening torque	Nm	-	-
Tightening torque	lbf·in	-	-
Required tool		0.4 x 2.5	

Brake resistor connection

Short connecting cables up to 0.5 m

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.

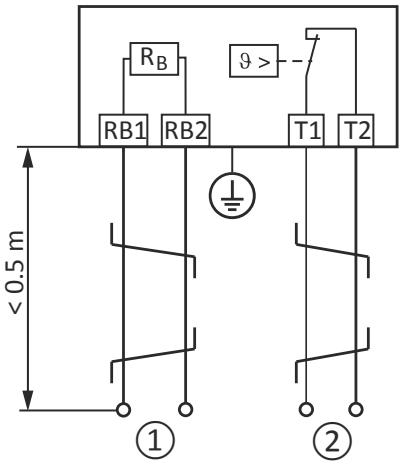


Fig. 5: Connection plan - brake resistor with a cable length of up to 0.5 m

① Wiring to the "brake resistor" connection on the inverter or another component with brake chopper.

② Wiring to a control contact, e. g. a digital input that is set to monitor the thermal contact. If the thermal contact responds, the voltage supply of the inverter must be disconnected (e. g. switch off the control of the mains contactor).

Long connecting cables up to max. 5 m

The brake resistor cable must be shielded. The maximum length is 5 m.

For the temperature monitoring cable, twisting is sufficient.

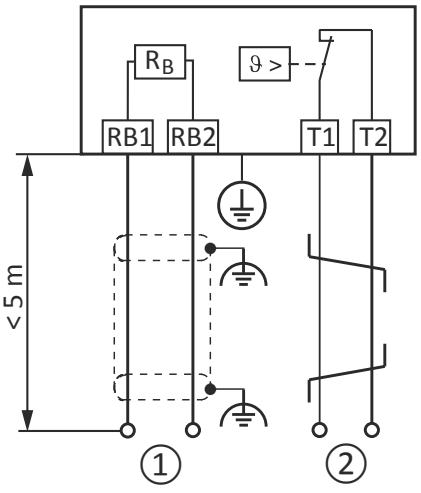


Fig. 6: Connection plan - brake resistor with a cable length of up to 5 m

① Wiring to the "brake resistor" connection on the inverter or another component with brake chopper.

② Wiring to a control contact, e. g. a digital input that is set to monitor the thermal contact. If the thermal contact responds, the voltage supply of the inverter must be disconnected (e. g. switch off the control of the mains contactor).

DC-bus connection

If multiple drives are operated in a group, energy exchange between individual drives working as motors and generators is possible.

To do so, inverter groups are connected to the DC link. For this purpose, the inverters have to be provided with a connection for the DC link, e.g. terminal X101 (+UG/-UG).

The DC system can be provided by power supply modules (AC/DC converters) or inverters with a power reserve. The technical data provide information on possible applications.

Error-free operation of the inverters in a group is only possible with meticulous design.

Rated line voltage	DC voltage range
V	
400	DC 450 V - 0 % ... 750 V + 0 %
480	

Control connections

Connection description		PTC input	24 V supply of control electronics	Control terminals
Connection		X109	X5	X3
Connection type		Pluggable screw terminal	Pluggable double spring terminal	Pluggable spring terminal
Max. cable cross-section	mm²	1.5	2.5	1.5
Max. cable cross-section	AWG	14	12	16
Stripping length	mm	6	10	9
Stripping length	inch	0.24	0.39	0.35
Tightening torque	Nm	0.2	-	-
Tightening torque	lbf·in	1.8	-	-
Required tool		0.4 x 2.5		

Motor encoder connection

The servo inverter can optionally be outfitted with a module for motor feedback (motor encoder).

Prefabricated system cables are recommended.

Available modules:

▸ Product extensions, Motor encoder connection 🕮 102

Load encoder/master encoder connection

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

Prefabricated system cables are recommended.

Available modules:

▸ Product extensions, Load encoder/master encoder connection 🕮 104

Connection of one cable technology (OCT) via HIPERFACE DSL®

Conditions

- The One Cable Technology (OCT) is possible with Lenze MCS and m850 servo motors.
- The motor must be equipped with a HIPERFACE DSL® encoder.
- The Lenze hybrid cable EYP0080AxxxxM11A00 must be used as connection cable.
- No motor encoder module must be plugged in slot A.
- The One Cable Technology can only be used together with the "Basic Safety - STO" version.

Connection diagram

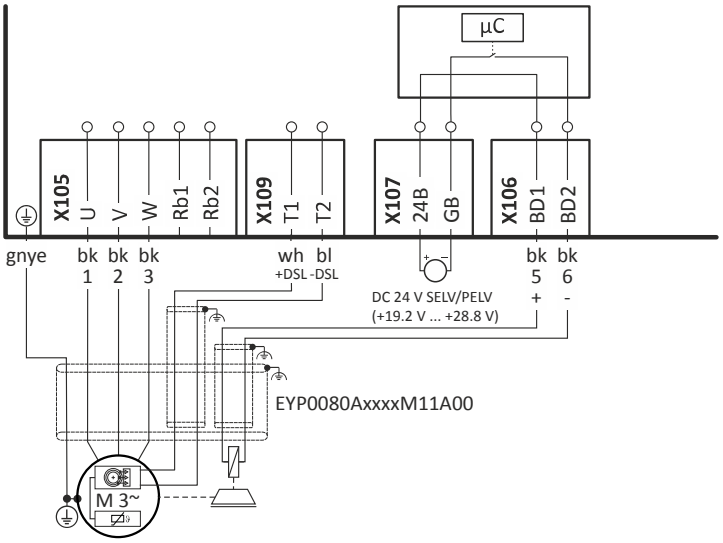


Fig. 7: Connection diagram HIPERFACE DSL® (OCT)

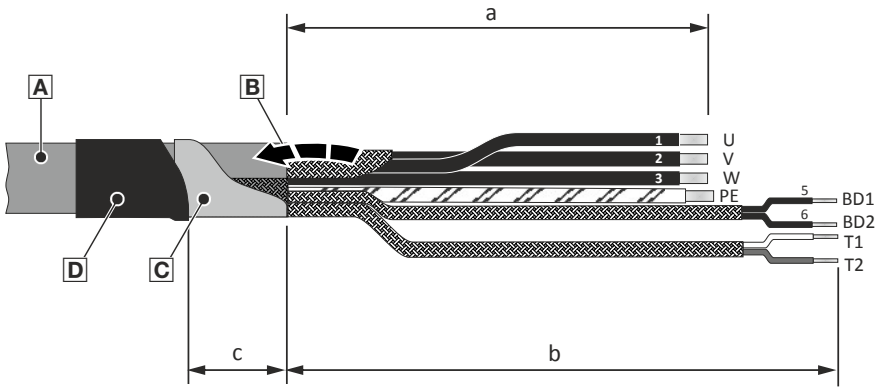


Fig. 8: Cable assembly

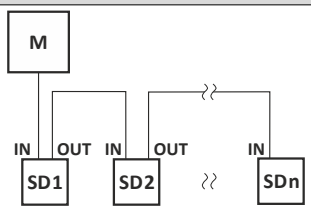
A	Hybrid cable	C	Conductive foil
B	Shield	D	Heat-shrinkable tube

Inverter	a [mm]	b [mm]	c [mm]
I95AE155F I95AE175F I95AE222F I95AE240F	100	200	25
I95AE275F I95AE311F I95AE315F	140	220	30

Networks

EtherCAT

Typical topologies

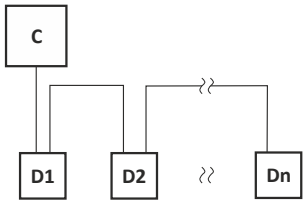
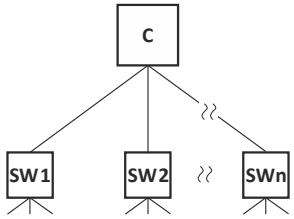
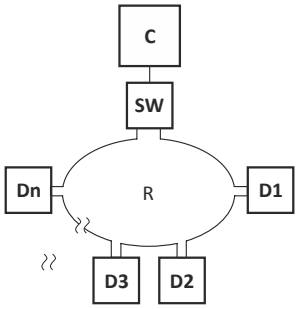
Line


M Master
SD Slave Device

Bus-related information			
Name		EtherCAT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connected as EtherCAT slave	
Status display		2 LEDs (RUN, ERR)	

PROFINET

Typical topologies

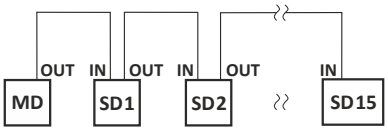
Line	Tree	Ring
		

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

Bus-related information			
Name		PROFINET RT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection as PROFINET IO Device	
Connection system		RJ45	
Status display		2 LEDs	
Connection designation		X256 X257	

EtherCAT system bus

Typical topologies

Line


MD Master device
SD Slave Device

Bus-related information			
Name		EtherCAT system bus	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection of the inverter to the system bus cross communication or as standard EtherCAT slave	
Status display		1 LED (RUN)	

Functional safety

⚠ DANGER!

Improper installation of the safety engineering system can cause an uncontrolled starting action of the drives.

Possible consequence: Death or severe injuries

- ► Safety engineering systems may only be installed and commissioned by qualified personnel.
- ► All control components (switch, relay, PLC, ...) must comply with the requirements of EN ISO 13849−1 and the EN ISO 13849−2.
- ► Switches, relays with at least IP54 enclosure.
- ► Control cabinet with at least IP54 enclosure.
- ► The wiring must be shielded.
- ► 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.
- ► If an external force acts upon the drive axes, additional brakes are required. Please observe that hanging loads are subject to the force of gravity!
- ► For safety-related braking functions, use safety-rated brakes only.
- ► The user has to ensure that the inverter will only be used in its intended application within the specified environmental conditions. This is the only way to comply with the declared safety-related characteristics.

⚠ DANGER!

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

Possible consequences: Death or severe injuries

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

NOTICE

Excessively high humidity or condensation

Malfunction or destruction of the safety component

- ► Only commission the safety component when it has acclimatised.

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.

Identification of the components

Safety components and the respective terminals are yellow.

Basic Safety - STO

Basic Safety - STO is part of the product version i95AExxxF1A.

⚠ DANGER!

With the "Safe torque off" (STO) function, no “emergency-stop" can be executed according to EN 60204−1 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 stop" requires electrical isolation, e. g. via a central mains contactor.

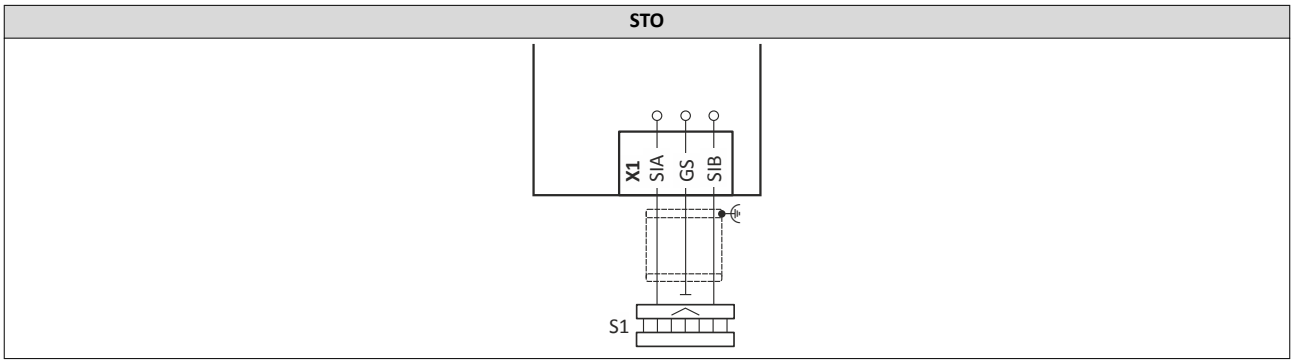
Safe state

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.

The following parameter is entered into the logbook. ▸ Safe torque off (STO) 🕮 116

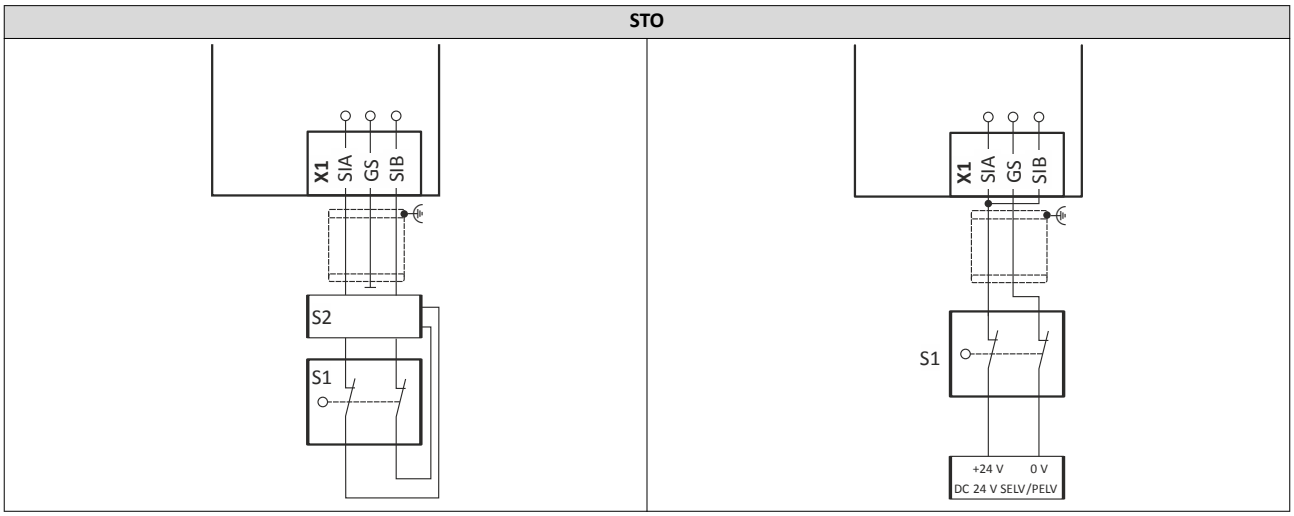
Connection diagram

Active sensors



S1 Active sensor - example of lightgrid

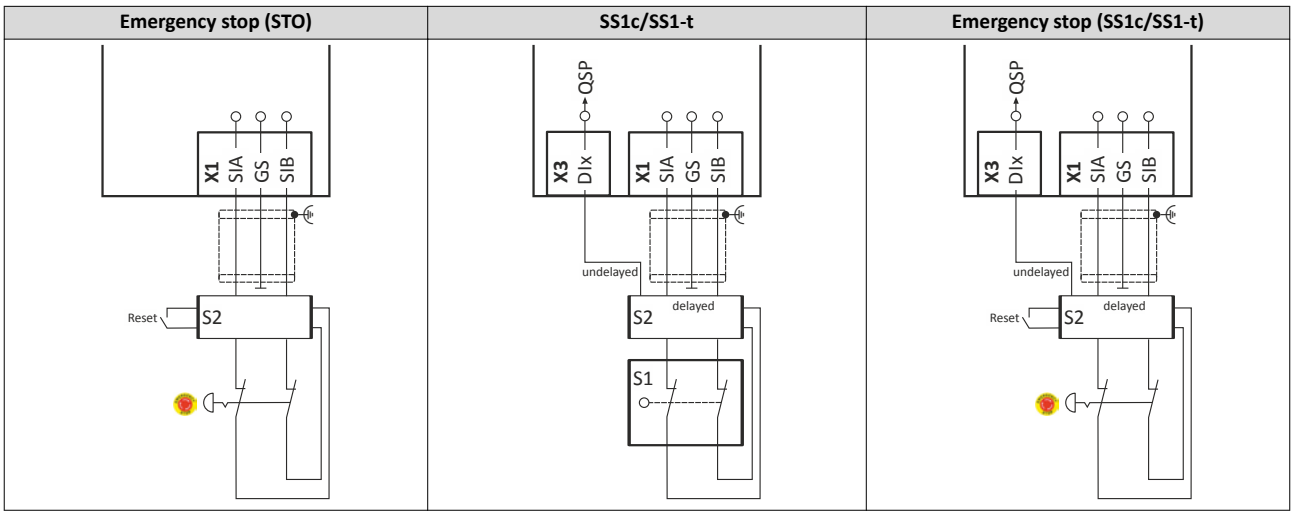
Passive sensors



S1 Passive sensor
S2 Safety switching device

S1 Passive sensor

Passive sensors - further examples



S2 Safety switching device

S1 Passive sensor
S2 Safety switching device with delayed contacts

S2 Safety switching device with delayed contacts

Terminal data

X1	Specification	Unit	min.	typ.	max.
SIA, SIB	LOW signal	V	-3	0	+5
	HIGH signal	V	+15	+24	+30
	Running 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 description		Basic Safety STO
Connection		X1
Connection type		Pluggable double spring terminal
Max. cable cross-section	mm²	1.5
Max. cable cross-section	AWG	16
Stripping length	mm	9
Stripping length	inch	0.35
Tightening torque	Nm	-
Tightening torque	lbf·in	-
Required tool		0.4 x 2.5

Extended Safety

Extended safety is part of the product version i950AExxxF1A.

⚠ 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.

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

Connection diagram

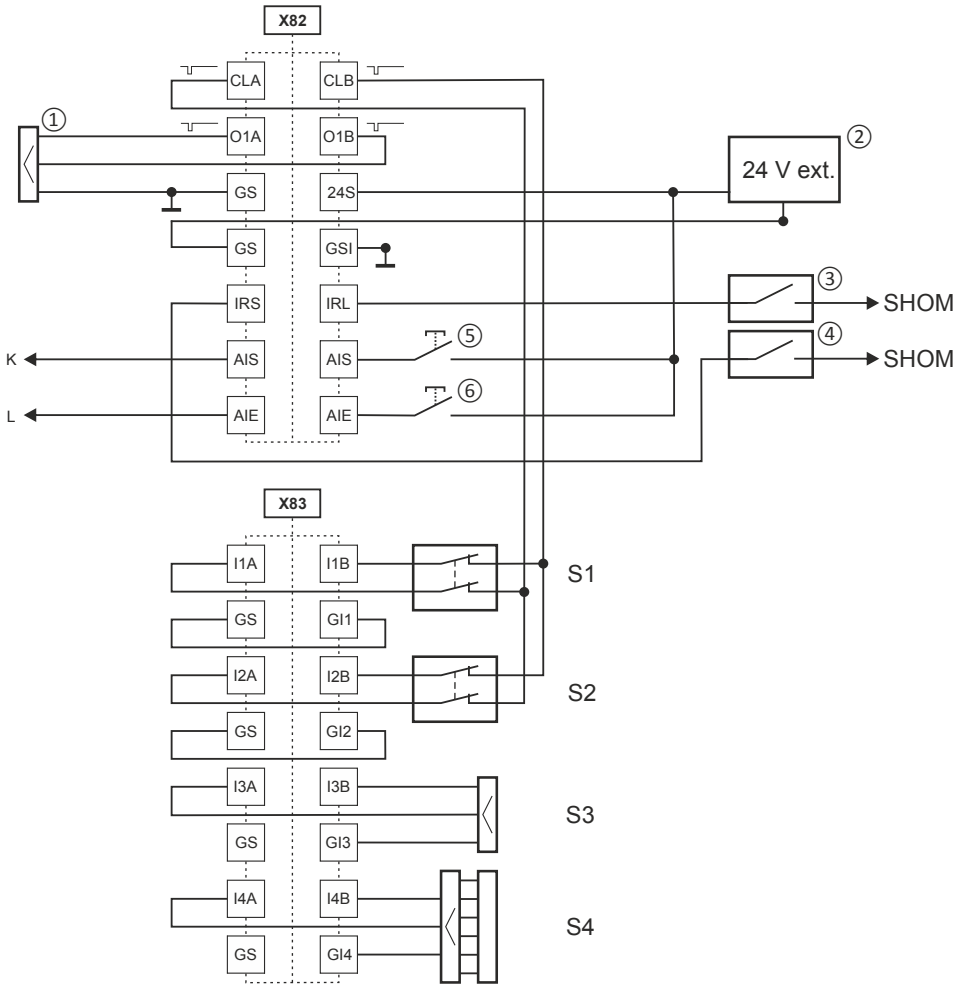


Fig. 9: Sample circuit

Name	Meaning
S1	Passive sensor with channel A and B Protected laying for category 4 according to EN ISO 13849-2 necessary
S2	
S3	Active sensor: upstream safety control
S4	Active sensor: light curtain
①	Safe output to upstream safety control
②	External 24 V voltage 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

Terminal data

X82	Specification	Unit	min.	typ.	max.
CLA, CLB	PLC output, IEC-61131-2, 24 V DC, 50 mA				
	Low signal output voltage	V		0	+0,8
	High signal 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 signal output voltage	V		0	0,8
	High signal 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 through a safely separated power supply unit (SELV/PELV)	V	18	24	30
	Input current	mA			1100
GSI	Reference potential of terminal IRS/IRL/AIS/IRS				
IRS IRL AIS AIE	PLC input, IEC-61131-2, 24 V, type 1				
	Low signal input voltage	V	-3	0	5
	High signal input voltage	V	15	24	30
	Input current	mA	2		15
	Input capacitance	nF			3,5
	Input delay (duration of actuation) for AIE and AIS	s	0,3		10
The inputs and outputs must be wired with shielded cables.					

X83	Specification	Unit	min.	typ.	max.
I1A, I1B I2A, I2B I3A, I3B I4A, I4B	PLC input, IEC-61131-2, 24 V, type 1				
	Low signal input voltage	V	-3	0	5
	High signal input voltage	V	15	24	30
	Input current	mA	2		15
	Input capacitance	nF			3.5
	Repetition rate of the test pulses	ms	50		
GI1 GI2 GI3 GI4	Reference potential for terminals • I1A ... I4B				
The inputs and outputs must be wired with shielded cables.					

Connection description		Extended Safety	
Connection		X82	X83
Connection type		Pluggable spring terminal	
Max. cable cross-section	mm²	1.5	1.5
Max. cable cross-section	AWG	16	16
Stripping length	mm	9	9
Stripping length	inch	0.35	0.35
Tightening torque	Nm	-	-
Tightening torque	lbf·in	-	-
Required tool		0.4 x 2.5	

Technical data

Standards and operating conditions

Conformities and approvals

Conformity		
CE	2006/42/EC	Machinery Directive
	2014/30/EU	EMC Directive (reference: CE-typical drive system)
EAC	TR CU 004/2011	Eurasian conformity: Safety of low voltage equipment
	TR CU 020/2011	Eurasian conformity: Electromagnetic compatibility of technical means
RoHS	2011/65/EU	Restrictions on the use of certain hazardous substances in electrical and electronic devices
Approval		
UL	UL 61800-5-1	For USA and Canada (requirements of the CSA 22.2 No. 274)
		File no. E132659

Protection of persons and device protection

Degree of protection		
IP20	EN 60529	Data applies for operationally ready mounted state and not in wire range of terminals
Type 1	UL 50	Only protection against accidental contact
Open type	UL 61800-5-1	Only in UL-approved systems
Insulation resistance		
Overvoltage category III	EN 61800-5-1	0 ... 6562 ft (0 ... 2000 m) amsl
Overvoltage category II	EN 61800-5-1	Above 6562 ft (2000 m) amsl
Isolation of control circuits		
Safe line voltage isolation via double/reinforced insulation	EN 61800-5-1	
Leakage current		
> 3.5 mA AC, > 10 mA DC	EN 61800-5-1	Please observe regulations and safety instructions!
Starting current		
≤ 3 x rated line voltage current		
Protective measures against		
Short circuit		
Ground fault		Ground-fault protected depending on operating status
Overtemperature of motor		PTC or thermal contact, I^2xt monitoring
Overvoltage		
Motor stalling		

EMC data

Noise emission		
Category C2	EN 61800-3	See rated data
Category C3	EN 61800-3	See rated data
Noise immunity		
Fulfills requirements according to	EN 61800-3	
Operation on public supply systems		
Take measures to limit the expected radio interference:		The machine or system manufacturer is responsible for compliance with the requirements for the machine/system!
< 1.34 Hp (1 kW): With choke	EN 61000-3-2	
> 1.34 Hp (1 kW) for line voltage current ≤ 16 A: Without additional measures		
Line current > 16 A: With choke or line voltage filter, with dimensioning for rated power.	EN 61000-3-12	

Motor connection

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

Environmental conditions

Energy efficiency		
Class IE2	EN 50598-2	
Climate		
1K3 (-13 ... +140°F) (-25 ... +60°C)	EN 60721-3-1	Storage
2K3 (-13 ... +158°F) (-25 ... +70°C)	EN 60721-3-2	Transport and handling
3K3 (14 ... 131 °F) (-10 ... +55°C)	EN 60721-3-3	Operation
		Operation at a switching frequency of 2 or 4 kHz: Above +113°F (+45°C): reduce rated output current by 1.389 %/°F (2.5 %/°C)
		Operation at a switching frequency of 8 or 16 kHz: Above +104°F (+40°C): reduce rated output current by 1.389 %/°F (2.5 %/°C)
Site altitude		
0 ... 3281 ft (0 … 1000 m) amsl		
3281 ... 13,123 ft (1000 … 4000 m) amsl		Reduce rated output current by 5 %/3281 ft (1000 m)
Pollution		
Degree of pollution 2	EN 61800-5-1	
	UL 61800-5-1	
Vibration resistance		
Transport and handling		
2M2 (sine, shock)	EN 60721-3-2	In original packaging
		up to 60.3 Hp (45 kW)
Operation		
Amplitude 0.039 in (1 mm)	Germanischer Lloyd	5 ... 13.2 Hz
Acceleration resistant up to 0.7 g		13.2 ... 100 Hz
		up to 20.1 Hp (15 kW)
amplitude 0.00295 in (0.075 mm)	EN 61800-5-1	10 ... 57 Hz
Acceleration resistant up to 1 g		57 ... 150 Hz

Electrical supply conditions

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

The following is supported:

- 3-phase mains connection 400 V 📖 72
- 3-phase mains connection 480 V 📖 79

Permissible power systems		
TT		Voltage to ground : max. 300 V
TN		Voltage to ground : max. 300 V
IT		Apply the measures described for IT systems!
		IT systems not relevant for UL-approved systems

Certification of the integrated safety

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

- EN ISO 13849−1: Safety of machinery − safety-related parts of control systems − Part 1
- EN ISO 13849−2: Safety of machinery − safety-related parts of control systems − Part 2
- EN 60204−1: Safety of machinery − electrical equipment of machines − Part 1
- EN 61508, Part 1−7: Safety of machinery Functional safety of electrical/electronic/ programmable electronic safety-related systems
- EN 61800−3: Electric variable-speed drives − Part 3: EMC requirements including specific test procedures
- EN 61800−5−1: Adjustable speed electrical power drive systems − Part 5−1: Safety requirements − electrical, thermal and energy requirements
- EN 61800−5−2: Adjustable speed electrical power drive systems − Part 5−2: Safety requirements − functional safety
- EN 62061: Safety of machinery − functional safety of safety-related electrical/electronic/ programmable electronic systems

Declarations of Conformity and certificates can be found on the internet at http://www.Lenze.com

3-phase mains connection 400 V

Rated data

Inverter		i950-C0.55/400-3	i950-C0.75/400-3	i950-C2.2/400-3	i950-C4.0/400-3
Rated power	**kW**	**0.55**	**0.75**	**2.2**	**4**
Rated power	**hp**	**0.75**	**1**	**3**	**5**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		3 AC 0-400 V			
Rated line current					
Without choke	A	2.5	3.3	7.8	12.5
With 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					
2 kHz	W	38	44	76	116
4 kHz	W	39	46	80	122
8 kHz	W	45	54	99	154
16 kHz	W	45	54	99	154
For controller inhibit	W	20	20	20	20
Overcurrent cycle 180 s					
Max. output current	A	2.7	3.6	8.4	14.3
Overload time	s	60	60	60	60
Recovery time	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	A	3.6	4.8	11.2	19
Overload time	s	3	3	3	3
Recovery time	s	12	12	12	12
Max. output current during the recovery time	A	1.4	1.8	4.2	7.1
Cyclic line voltage switching		3 times per minute			
Brake chopper					
Max. output current	A	2	2	5.2	16.6
Min. brake resistance	Ω	390	390	150	47
Max. shielded motor cable length					
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	35	35	35	35
Without EMC category	m	50	50	50	50
Weight	kg	1.6	1.6	1.6	1.6
Weight	lb	3.5	3.5	3.5	3.5

Inverter		i950-C7.5/400-3	i950-C11/400-3	i950-C15/400-3	i950-C22/400-3
Rated power	**kW**	**7.5**	**11**	**15**	**22**
Rated power	**hp**	**10**	**15**	**20**	**30**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		3 AC 0-400 V			
Rated line current					
Without choke	A	20	28.4	-	-
With 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	23.5	47
16 kHz	A	11	12	11	31.3
Power loss					
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
For controller inhibit	W	20	20	20	32
Overcurrent cycle 180 s					
Max. output current	A	25	35	48	71
Overload time	s	60	60	60	60
Recovery time	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	A	33	47	64	94
Overload time	s	3	3	3	3
Recovery time	s	12	12	12	12
Max. output current during the recovery time	A	12.4	17.6	24	35
Cyclic line voltage switching		3 times per minute			
Brake chopper					
Max. output current	A	29	29	43	52
Min. brake resistance	Ω	27	27	18	15
Max. shielded motor cable length					
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	35	35	35	35
Without EMC category	m	100	100	100	100
Weight	kg	3.9	3.9	3.9	10.7
Weight	lb	8.6	8.6	8.6	23.6

Technical data

3-phase mains connection 400 V
Rated data

Inverter		i950-C30/400-3	i950-C45/400-3	i950-C55/400-3	i950-C75/400-3
Rated power	**kW**	**30**	**45**	**55**	**75**
Rated power	**hp**	**40**	**60**	**75**	**100**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		3 AC 0-400 V			
Rated line current					
Without choke	A	-	-	-	-
With 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					
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
For controller inhibit	W	39	39	44	44
Overcurrent cycle 180 s					
Max. output current	A	92	134	165	225
Overload time	s	60	60	60	60
Recovery time	s	120	120	120	120
Max. output current during the recovery time	A	46	67	83	113
Overcurrent cycle 15 s					
Max. output current	A	122	178	220	300
Overload time	s	3	3	3	3
Recovery time	s	12	12	12	12
Max. output current during the recovery time	A	46	67	83	113
Cyclic line voltage switching		3 times per minute		Once per minute	
Brake chopper					
Max. output current	A	104	104	166	166
Min. brake resistance	Ω	7.5	7.5	4.7	4.7
Max. shielded motor cable length					
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	35	35	100	100
Without EMC category	m	100	100	200	200
Weight	kg	16.7	16.7	24	24
Weight	lb	37	37	53	53

Inverter		**i950-C90/400-3**	**i950-C110/400-3**
Rated power	**kW**	**90**	**110**
Rated power	**hp**	**125**	**150**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz	
Output voltage		3 AC 0-400 V	
Rated line current			
Without choke	A	-	-
With choke	A	168	198
Apparent output power	kVA	121	142
Rated output current			
2 kHz	A	180	212
4 kHz	A	180	212
8 kHz	A	162	191
16 kHz	A	99	106
Power loss			
2 kHz	W	1855	2177
4 kHz	W	1975	2319
8 kHz	W	2326	2731
16 kHz	W	2326	2731
For controller inhibit	W	44	44
Overcurrent cycle 180 s			
Max. output current	A	270	318
Overload time	s	60	60
Recovery time	s	120	120
Max. output current during the recovery time	A	135	159
Overcurrent cycle 15 s			
Max. output current	A	360	424
Overload time	s	3	3
Recovery time	s	12	12
Max. output current during the recovery time	A	135	159
Cyclic line voltage switching		Once per minute	
Brake chopper			
Max. output current	A	275	275
Min. brake resistance	Ω	2.4	2.4
Max. shielded motor cable length			
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	100	100
Without EMC category	m	200	200
Weight	kg	35.6	35.6
Weight	lb	78.5	78.5

Fusing data

EN 60204-1

Inverter	Fuse		Circuit breaker		Earth-leakage circuit breaker
	Characteristic	Max. rated current	Characteristic	Max. rated current	
		A		A	
i950-C0.55/400-3	gG/gL or gRL	10	B	10	≥ 30 mA, type B
i950-C0.75/400-3	gG/gL or gRL	10	B	10	≥ 30 mA, type B
i950-C2.2/400-3	gG/gL or gRL	16	B	16	≥ 30 mA, type B
i950-C4.0/400-3	gG/gL or gRL	16	B	16	≥ 30 mA, type B
i950-C7.5/400-3	gG/gL or gRL	50	B	40	≥ 300 mA, type B
i950-C11/400-3	gG/gL or gRL	50	B	40	≥ 300 mA, type B
i950-C15/400-3	gG/gL or gRL	50	B	40	≥ 300 mA, type B
i950-C22/400-3	gG/gL or gRL	63	B	63	≥ 300 mA, type B
i950-C30/400-3	gG/gL or gRL	80	B	80	≥ 300 mA, type B
i950-C45/400-3	gG/gL or gRL	125	B	125	≥ 300 mA, type B
i950-C55/400-3	gR	160	-	-	≥ 300 mA, type B
i950-C75/400-3	gR	160	-	-	≥ 300 mA, type B
i950-C90/400-3	gR	300	-	-	≥ 300 mA, type B
i950-C110/400-3	gR	300	-	-	≥ 300 mA, type B

The connection data according to UL can be found under: ▸ Connection according to UL 📖 43

Terminal data

		i950-Cxxxx/400-3					
Inverter	**kW**	**0.55 ... 4.0**	**7.5 ... 15**	**22**	**30 ... 45**	**55 ... 75**	**90 ... 110**
Connection		Line voltage connection X100					
Connection type		Pluggable screw terminal		Screw terminal			
Max. cable cross-section	mm²	2.5	16	35	50	95	150
Stripping length	mm	8	14	18	19	22	28
Tightening torque	Nm	0.5	1.8	3.8	4	10	18
Required tool		0.5 x 3.0	0.8 x 4.0	0.8 x 5.5	Hexagon socket 5	Hexagon socket 6	Hexagon socket 8

		i950-Cxxxx/400-3					
Inverter	**kW**	**0.55 ... 4.0**	**7.5 ... 15**	**22 ... 75**	**90 ... 110**	**0.55 ... 4.0**	**7.5 ... 15**
Connection		PE connection				Motor connection X105	
Connection type		PE screw			PE bolt	Pluggable screw terminal	
Max. cable cross-section	mm²	6	16	25	150	2.5	16
Stripping length	mm	10	11	16	-	8	14
Tightening torque	Nm	2	3.4	4	10	0.5	1.8
Required tool		Torx 20	PZ2		Width AF 13	0.5 x 3.0	0.8 x 4.0

		i950-Cxxxx/400-3			
Inverter	**kW**	**22**	**30 ... 45**	**55 ... 75**	**90 ... 110**
Connection		Motor connection X105			
Connection type		Screw terminal			
Max. cable cross-section	mm²	35	50	95	150
Stripping length	mm	18	19	22	28
Tightening torque	Nm	3.8	4	10	18
Required tool		0.8 x 5.5	Hexagon socket 5	Hexagon socket 6	Hexagon socket 8

The terminal data for the terminal X1 can be found under: ▸ Basic Safety - STO 📖 63

The terminal data for the terminals X82 and X83 can be found under: ▸ Terminal data 📖 68

Brake resistors

Inverter	Brake resistor					
	Order code	Rated resistance	Rated power	Thermal capacity	Dimensions (h x w x d)	Weight
		Ω	W	kWs	mm	kg
i950-C0.55/400-3	ERBM390R100W	390	100	15	235 x 21 x 40	0.37
i950-C0.75/400-3						
i950-C2.2/400-3	ERBP180R300W	180	300	45	320 x 41 x 122	1.4
	ERBP180R200W		200	30	240 x 41 x 122	1
i950-C4.0/400-3	ERBP047R200W	47			320 x 41 x 122	
	ERBS047R400W		400	60	400 x 110 x 105	2.3
	ERBS047R800W		800	120	710 x 110 x 105	4
i950-C7.5/400-3	ERBP027R200W	27	200	30	320 x 41 x 122	1
	ERBS027R600W		600	90	550 x 110 x 105	3.1
	ERBS027R01K2		1200	180	1020 x 110 x 105	5.6
i950-C11/400-3	ERBP027R200W		200	30	320 x 41 x 122	1
	ERBS027R600W		600	90	550 x 110 x 105	3.1
	ERBS027R01K2		1200	180	1020 x 110 x 105	5.6
i950-C15/400-3	ERBS018R800W	18	800	120	710 x 110 x 105	3.9
	ERBS018R01K4		1400	210	1110 x 110 x 105	6.2
	ERBS018R02K8		2800	420	1110 x 200 x 105	12
	ERBG018R04K3		4300	645	486 x 426 x 302	13.5
	ERBP018R300W		300	45	320 x 41 x 122	1.4
i950-C22/400-3	ERBS015R800W	15	800	120	710 x 110 x 105	3.9
	ERBS015R01K2		1200	180	1020 x 110 x 105	5.6
	ERBS015R02K4		2400	420	1020 x 200 x 105	10
	ERBG015R06K2		6200	930	486 x 526 x 302	17
	ERBG015R03K3		3300	495	486 x 326 x 302	12.6
i950-C30/400-3	ERBG075D01K9	7.5	1900	285	486 x 236 x 302	9.5
i950-C45/400-3						
i950-C55/400-3	ERBG005R02K6	5	2600	390	486 x 326 x 302	11
i950-C75/400-3						
i950-C90/400-3	ERBG028D04K1	2.8	4100	615	486 x 426 x 302	12.8
i950-C110/400-3						

Mains chokes

Inverter	Choke					
	Order code	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 115	1.31
i950-C2.2/400-3	EZAELN3006B492		6	4.9	69 x 95 x 120	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		5.85
i950-C22/400-3	EZAELN3045B651		45	0.65	112 x 185 x 200	8.25
i950-C30/400-3	EZAELN3063B471		63	0.47	122 x 185 x 210	9.65
i950-C45/400-3	EZAELN3080B371		80	0.37	125 x 210 x 240	12.5
i950-C55/400-3	EZAELN3100B301		100	0.3	139 x 267 x 205	16.5
i950-C75/400-3	EZAELN3160B191		160	0.19	149 x 291 x 215	22.5
i950-C90/400-3	EZAELN3180B171		180	0.17	164 x 316 x 235	26
i950-C110/400-3	EZAELN3200B151		200	0.15	144 x 352 x 265	25

RFI filters / Mains filters

Basic information on RFI filters, mains filters and EMC: 📖 164

EMC filters can be used both in the side structure and in the substructure.

Short distance filter

Filter type: RFI filter

- C1 to 25 m
- C2 to 50 m
- Reduced leakage current, operation with 30 mA residual current circuit breaker is possible

Inverter	Filters			
	Order code	rated current	Dimensions (h x w x d)	Weight
		A	mm	kg
i950-C0.55/400-3	I0FAE175F100S0000S	3.3	276 x 60 x 50	0.9
i950-C0.75/400-3				
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.1
i950-C7.5/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4
i950-C11/400-3				
i950-C15/400-3				

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)

- C1 to 50 m
- C2 to 100 m
- Operation with 300 mA residual current circuit breaker

Inverter	Filters			
	Order code	rated current	Dimensions (h x w x d)	Weight
		A	mm	kg
i950-C0.55/400-3	I0FAE175F100D0000S	3.3	276 x 60 x 50	0.9
i950-C0.75/400-3				
i950-C2.2/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.1
i950-C4.0/400-3	I0FAE240F100D0000S	12.5		1.35
i950-C7.5/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1
i950-C11/400-3				
i950-C15/400-3				
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 205 x 90	18.5
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23
i950-C45/400-3	I0FAE345F100D0001S	100		32
i950-C55/400-3	I0FAE355F100D0001S	120	700 x 250 x 105	36
i950-C75/400-3	I0FAE375F100D0001S	162		41.5
i950-C90/400-3	I0FAE411F100D0001S	240	855 x 250 x 130	63
i950-C110/400-3				

3-phase mains connection 480 V

Rated data

Inverter		i950-C0.55/400-3	i950-C0.75/400-3	i950-C2.2/400-3	i950-C4.0/400-3
Rated power	**kW**	**0.55**	**0.75**	**2.2**	**4**
Rated power	**hp**	**0.75**	**1**	**3**	**5**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		3 AC 0-480 V			
Rated line current					
Without choke	A	2.1	2.8	6.5	10.5
With 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					
2 kHz	W	38	44	76	116
4 kHz	W	39	46	80	122
8 kHz	W	45	54	99	154
16 kHz	W	45	54	99	154
For controller inhibit	W	20	20	20	20
Overcurrent cycle 180 s					
Max. output current	A	2.4	3.2	7.2	12.3
Overload time	s	60	60	60	60
Recovery time	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	A	3.2	4.2	9.6	16.4
Overload time	s	3	3	3	3
Recovery time	s	12	12	12	12
Max. output current during the recovery time	A	1.2	1.6	3.6	6.2
Cyclic line voltage switching		3 times per minute			
Brake chopper					
Max. output current	A	2	2	5.2	16.6
Min. brake resistance	Ω	390	390	150	47
Max. shielded motor cable length					
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	35	35	35	35
Without EMC category	m	50	50	50	50
Weight	kg	1.6	1.6	1.6	1.6
Weight	lb	3.5	3.5	3.5	3.5

Technical data

3-phase mains connection 480 V

Rated data

Inverter		i950-C7.5/400-3	i950-C11/400-3	i950-C15/400-3	i950-C22/400-3
Rated power	**kW**	**7.5**	**11**	**15**	**22**
Rated power	**hp**	**10**	**15**	**20**	**30**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		3 AC 0-480 V			
Rated line current					
Without choke	A	16.6	23.7	-	47.4
With 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	7.8	7.2	26.9
Power loss					
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
For controller inhibit	W	20	20	20	32
Overcurrent cycle 180 s					
Max. output current	A	21	31.5	40.5	61
Overload time	s	60	60	60	60
Recovery time	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	A	28	42	54	81
Overload time	s	3	3	3	3
Recovery time	s	12	12	12	12
Max. output current during the recovery time	A	10.5	15.8	20.3	30
Cyclic line voltage switching		3 times per minute			
Brake chopper					
Max. output current	A	29	29	43	52
Min. brake resistance	Ω	27	27	18	15
Max. shielded motor cable length					
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	35	35	35	35
Without EMC category	m	100	100	100	100
Weight	kg	3.9	3.9	3.9	10.7
Weight	lb	8.6	8.6	8.6	23.6

Inverter		i950-C30/400-3	i950-C45/400-3	i950-C55/400-3	i950-C75/400-3
Rated power	**kW**	**30**	**45**	**55**	**75**
Rated power	**hp**	**40**	**60**	**75**	**100**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage		3 AC 0-480 V			
Rated line current					
Without choke	A	-	-	-	-
With 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					
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
For controller inhibit	W	39	39	44	44
Overcurrent cycle 180 s					
Max. output current	A	78	116	144	186
Overload time	s	60	60	60	60
Recovery time	s	120	120	120	120
Max. output current during the recovery time	A	39	58	72	93
Overcurrent cycle 15 s					
Max. output current	A	104	154	192	248
Overload time	s	3	3	3	3
Recovery time	s	12	12	12	12
Max. output current during the recovery time	A	39	58	72	93
Cyclic line voltage switching		3 times per minute		Once per minute	
Brake chopper					
Max. output current	A	104	104	166	166
Min. brake resistance	Ω	7.5	7.5	4.7	4.7
Max. shielded motor cable length					
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	35	35	100	100
Without EMC category	m	100	100	200	200
Weight	kg	16.7	16.7	24	24
Weight	lb	37	37	53	53

Technical data

3-phase mains connection 480 V
Rated data

Inverter		i950-C90/400-3	i950-C110/400-3
Rated power	**kW**	**90**	**110**
Rated power	**hp**	**125**	**150**
Line voltage range		3/PE AC 340 V ... 528 V, 45 Hz ... 65 Hz	
Output voltage		3 AC 0-480 V	
Rated line current			
Without choke	A	-	-
With choke	A	146	168
Apparent output power	kVA	121	142
Rated output current			
2 kHz	A	156	180
4 kHz	A	156	180
8 kHz	A	140	162
16 kHz	A	85.8	90
Power loss			
2 kHz	W	1855	2177
4 kHz	W	1975	2319
8 kHz	W	2326	2731
16 kHz	W	2326	2731
For controller inhibit	W	44	44
Overcurrent cycle 180 s			
Max. output current	A	234	270
Overload time	s	60	60
Recovery time	s	120	120
Max. output current during the recovery time	A	117	135
Overcurrent cycle 15 s			
Max. output current	A	312	360
Overload time	s	3	3
Recovery time	s	12	12
Max. output current during the recovery time	A	117	135
Cyclic line voltage switching		Once per minute	
Brake chopper			
Max. output current	A	275	275
Min. brake resistance	Ω	2.4	2.4
Max. shielded motor cable length			
Category C2 (2 kHz, 4 kHz, 8 kHz)	m	20	20
Category C3 (2 kHz, 4 kHz, 8 kHz)	m	100	100
Without EMC category	m	200	200
Weight	kg	35.6	35.6
Weight	lb	78.5	78.5

Fusing data

EN 60204-1

Inverter	Fuse		Circuit breaker		Earth-leakage circuit breaker
	Characteristic	Max. rated current	Characteristic	Max. rated current	
		A		A	
i950-C0.55/400-3	gG/gL or gRL	10	B	10	≥ 30 mA, type B
i950-C0.75/400-3	gG/gL or gRL	10	B	10	≥ 30 mA, type B
i950-C2.2/400-3	gG/gL or gRL	16	B	16	≥ 30 mA, type B
i950-C4.0/400-3	gG/gL or gRL	16	B	16	≥ 30 mA, type B
i950-C7.5/400-3	gG/gL or gRL	50	B	40	≥ 300 mA, type B
i950-C11/400-3	gG/gL or gRL	50	B	40	≥ 300 mA, type B
i950-C15/400-3	gG/gL or gRL	50	B	40	≥ 300 mA, type B
i950-C22/400-3	gG/gL or gRL	63	B	63	≥ 300 mA, type B
i950-C30/400-3	gG/gL or gRL	80	B	80	≥ 300 mA, type B
i950-C45/400-3	gG/gL or gRL	125	B	125	≥ 300 mA, type B
i950-C55/400-3	gR	160	-	-	≥ 300 mA, type B
i950-C75/400-3	gR	160	-	-	≥ 300 mA, type B
i950-C90/400-3	gR	300	-	-	≥ 300 mA, type B
i950-C110/400-3	gR	300	-	-	≥ 300 mA, type B

The connection data according to UL can be found under: ▸ Connection according to UL 📖 43

Terminal data

		i950-Cxxxx/400-3					
Inverter	**kW**	**0.55 ... 4.0**	**7.5 ... 15**	**22**	**30 ... 45**	**55 ... 75**	**90 ... 110**
Connection		Line voltage connection X100					
Connection type		Pluggable screw terminal		Screw terminal			
Max. cable cross-section	mm²	2.5	16	35	50	95	150
Stripping length	mm	8	14	18	19	22	28
Tightening torque	Nm	0.5	1.8	3.8	4	10	18
Required tool		0.5 x 3.0	0.8 x 4.0	0.8 x 5.5	Hexagon socket 5	Hexagon socket 6	Hexagon socket 8

		i950-Cxxxx/400-3					
Inverter	**kW**	**0.55 ... 4.0**	**7.5 ... 15**	**22 ... 75**	**90 ... 110**	**0.55 ... 4.0**	**7.5 ... 15**
Connection		PE connection				Motor connection X105	
Connection type		PE screw			PE bolt	Pluggable screw terminal	
Max. cable cross-section	mm²	6	16	25	150	2.5	16
Stripping length	mm	10	11	16	-	8	14
Tightening torque	Nm	2	3.4	4	10	0.5	1.8
Required tool		Torx 20	PZ2		Width AF 13	0.5 x 3.0	0.8 x 4.0

		i950-Cxxxx/400-3			
Inverter	**kW**	**22**	**30 ... 45**	**55 ... 75**	**90 ... 110**
Connection		Motor connection X105			
Connection type		Screw terminal			
Max. cable cross-section	mm²	35	50	95	150
Stripping length	mm	18	19	22	28
Tightening torque	Nm	3.8	4	10	18
Required tool		0.8 x 5.5	Hexagon socket 5	Hexagon socket 6	Hexagon socket 8

The terminal data for the terminal X1 can be found under: ▸ Basic Safety - STO 📖 63

The terminal data for the terminals X82 and X83 can be found under: ▸ Terminal data 📖 68

Brake resistors

Inverter	Brake resistor					
	Order code	Rated resistance	Rated power	Thermal capacity	Dimensions (h x w x d)	Weight
		Ω	W	kWs	mm	kg
i950-C0.55/400-3	ERBM390R100W	390	100	15	235 x 21 x 40	0.37
i950-C0.75/400-3						
i950-C2.2/400-3	ERBP180R300W	180	300	45	320 x 41 x 122	1.4
	ERBP180R200W		200	30	240 x 41 x 122	1
i950-C4.0/400-3	ERBP047R200W	47			320 x 41 x 122	
	ERBS047R400W		400	60	400 x 110 x 105	2.3
	ERBS047R800W		800	120	710 x 110 x 105	4
i950-C7.5/400-3	ERBP027R200W	27	200	30	320 x 41 x 122	1
	ERBS027R600W		600	90	550 x 110 x 105	3.1
	ERBS027R01K2		1200	180	1020 x 110 x 105	5.6
i950-C11/400-3	ERBP027R200W		200	30	320 x 41 x 122	1
	ERBS027R600W		600	90	550 x 110 x 105	3.1
	ERBS027R01K2		1200	180	1020 x 110 x 105	5.6
i950-C15/400-3	ERBS018R800W	18	800	120	710 x 110 x 105	3.9
	ERBS018R01K4		1400	210	1110 x 110 x 105	6.2
	ERBS018R02K8		2800	420	1110 x 200 x 105	12
	ERBG018R04K3		4300	645	486 x 426 x 302	13.5
	ERBP018R300W		300	45	320 x 41 x 122	1.4
i950-C22/400-3	ERBS015R800W	15	800	120	710 x 110 x 105	3.9
	ERBS015R01K2		1200	180	1020 x 110 x 105	5.6
	ERBS015R02K4		2400	420	1020 x 200 x 105	10
	ERBG015R06K2		6200	930	486 x 526 x 302	17
	ERBG015R03K3		3300	495	486 x 326 x 302	12.6
i950-C30/400-3	ERBG075D01K9	7.5	1900	285	486 x 236 x 302	9.5
i950-C45/400-3						
i950-C55/400-3	ERBG005R02K6	5	2600	390	486 x 326 x 302	11
i950-C75/400-3						
i950-C90/400-3	ERBG028D04K1	2.8	4100	615	486 x 426 x 302	12.8
i950-C110/400-3						

Mains chokes

Inverter	Choke					
	Order code	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 115	1.31
i950-C2.2/400-3	EZAELN3006B492		6	4.9	69 x 95 x 120	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	112 x 185 x 200	6.8
i950-C30/400-3	EZAELN3050B591		50	0.59	112 x 185 x 210	8.35
i950-C45/400-3	EZAELN3080B371		80	0.37	125 x 210 x 240	12.5
i950-C55/400-3	EZAELN3090B331		90	0.33	115 x 267 x 205	11.5
i950-C75/400-3	EZAELN3125B241		125	0.24	139 x 291 x 215	17.5
i950-C90/400-3	EZAELN3160B191		160	0.19	149 x 291 x 215	22.5
i950-C110/400-3	EZAELN3180B171		180	0.17	164 x 316 x 235	26

RFI filters / Mains filters

Basic information on RFI filters, mains filters and EMC: 📖 164

EMC filters can be used both in the side structure and in the substructure.

Short distance filter

Filter type: RFI filter

- C1 to 25 m
- C2 to 50 m
- Reduced leakage current, operation with 30 mA residual current circuit breaker is possible

Inverter	Filters			
	Order code	rated current	Dimensions (h x w x d)	Weight
		A	mm	kg
i950-C0.55/400-3	I0FAE175F100S0000S	3.3	276 x 60 x 50	0.9
i950-C0.75/400-3				
i950-C2.2/400-3	I0FAE222F100S0000S	7.8	346 x 60 x 50	1.1
i950-C7.5/400-3	I0FAE311F100S0000S	29	371 x 120 x 60	2.4
i950-C11/400-3				
i950-C15/400-3				

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)

- C1 to 50 m
- C2 to 100 m
- Operation with 300 mA residual current circuit breaker

Inverter	Filters			
	Order code	rated current	Dimensions (h x w x d)	Weight
		A	mm	kg
i950-C0.55/400-3	I0FAE175F100D0000S	3.3	276 x 60 x 50	0.9
i950-C0.75/400-3				
i950-C2.2/400-3	I0FAE222F100D0000S	7.8	346 x 60 x 50	1.1
i950-C4.0/400-3	I0FAE240F100D0000S	12.5		1.35
i950-C7.5/400-3	I0FAE311F100D0000S	29	371 x 120 x 60	2.1
i950-C11/400-3				
i950-C15/400-3				
i950-C22/400-3	I0FAE322F100D0000S	43	436 x 205 x 90	18.5
i950-C30/400-3	I0FAE330F100D0000S	55	590 x 250 x 105	23
i950-C45/400-3	I0FAE345F100D0001S	100		32
i950-C55/400-3	I0FAE355F100D0001S	120	700 x 250 x 105	36
i950-C75/400-3	I0FAE375F100D0001S	162		41.5
i950-C90/400-3	I0FAE411F100D0001S	240	855 x 250 x 130	63
i950-C110/400-3				

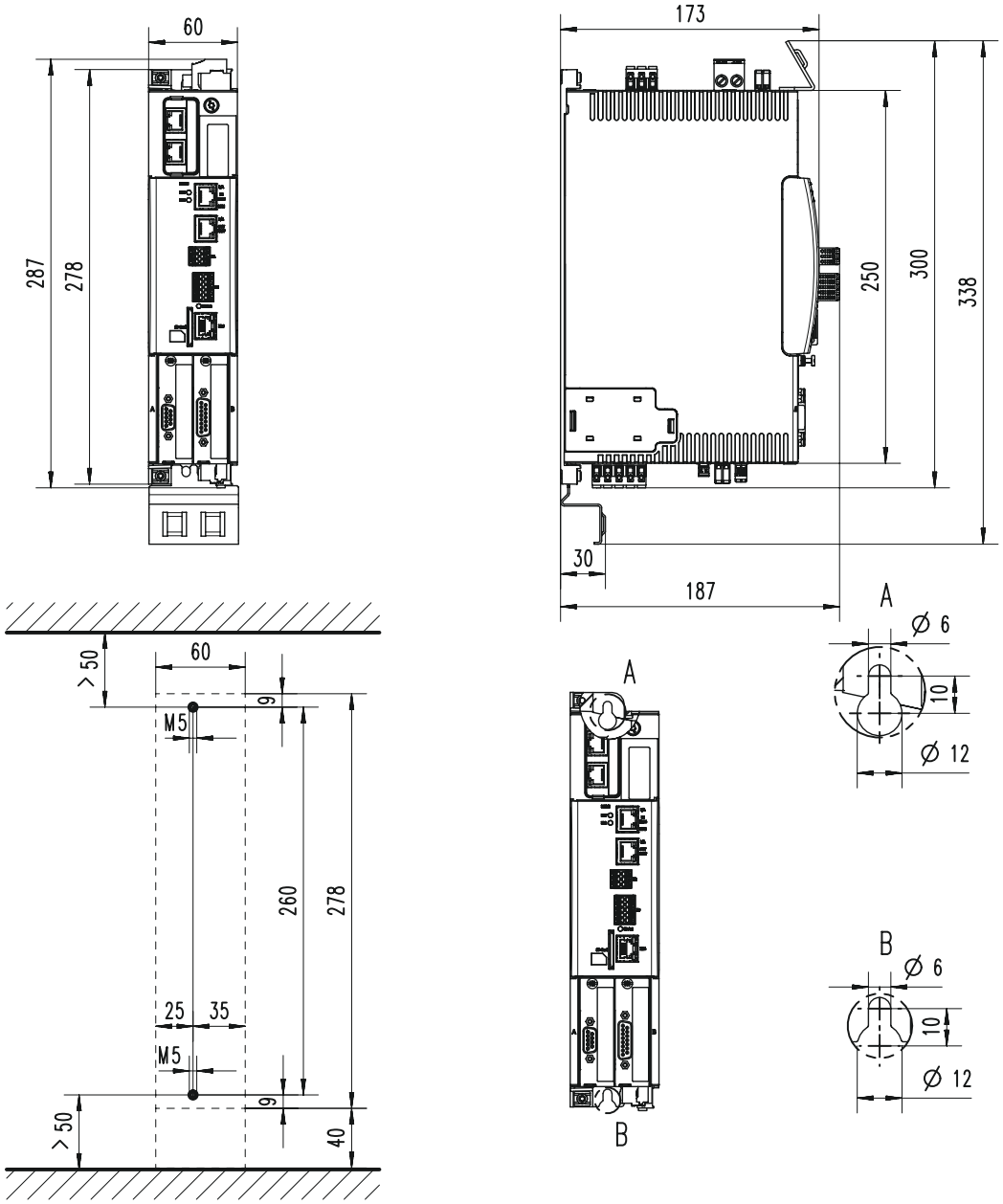
Dimensions

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

0.55 kW ... 4 kW

The dimensions in mm apply to:

0.55 kW	i950-C0.55/400-3
0.75 kW	i950-C0.75/400-3
2.2 kW	i950-C2.2/400-3
4 kW	i950-C4.0/400-3

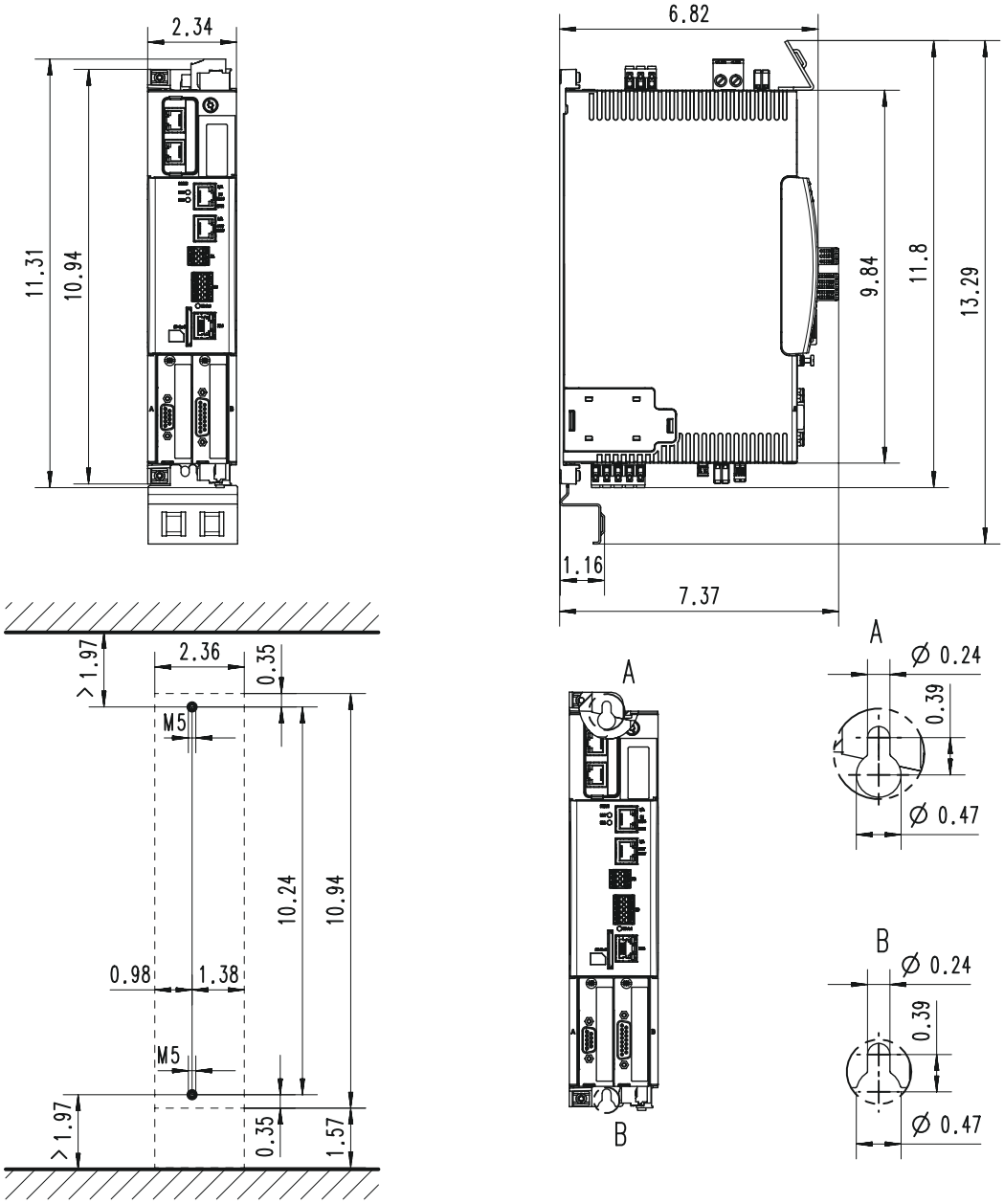


8800508

0.75 hp ... 5.5 hp

The dimensions in inch apply to:

0.75 hp	i950-C0.55/400-3
1 hp	i950-C0.75/400-3
3 hp	i950-C2.2/400-3
5.5 hp	i950-C4.0/400-3

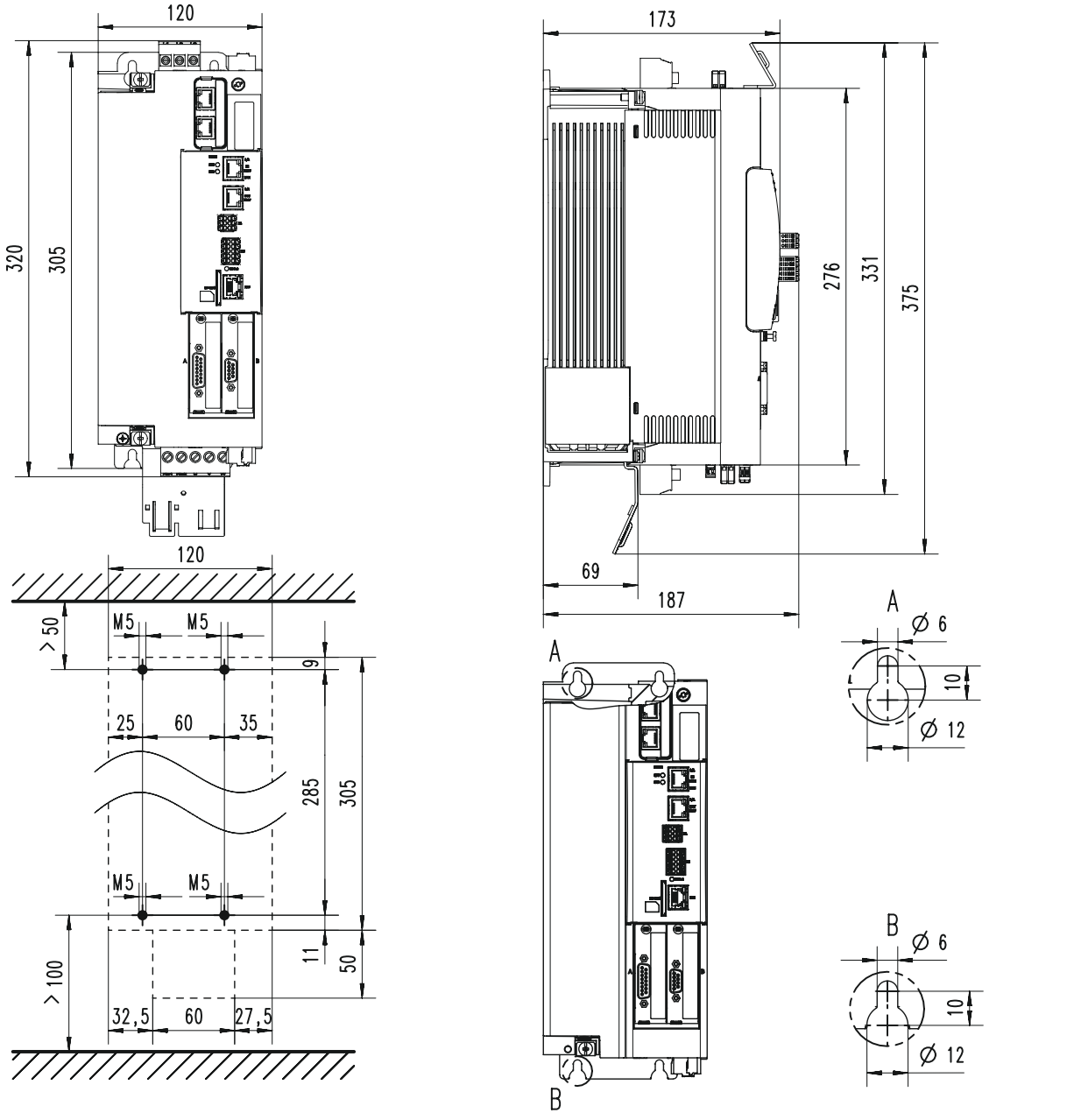


8800538

7.5 kW ... 15 kW

The dimensions in mm apply to:

7.5 kW	i950-C7.5/400-3
11 kW	i950-C11/400-3
15 kW	i950-C15/400-3

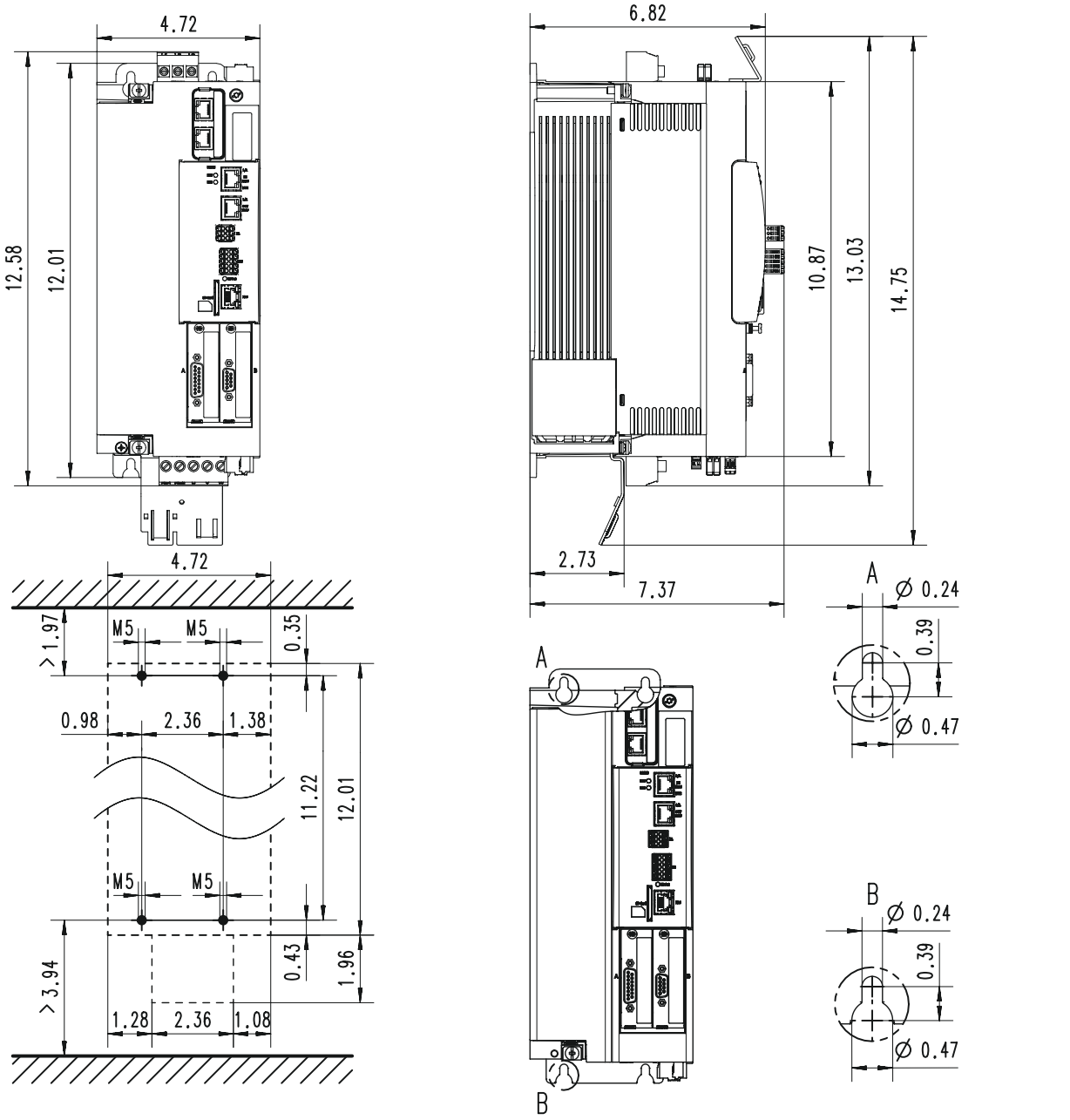


8800509

10 hp ... 20 hp

The dimensions in inch apply to:

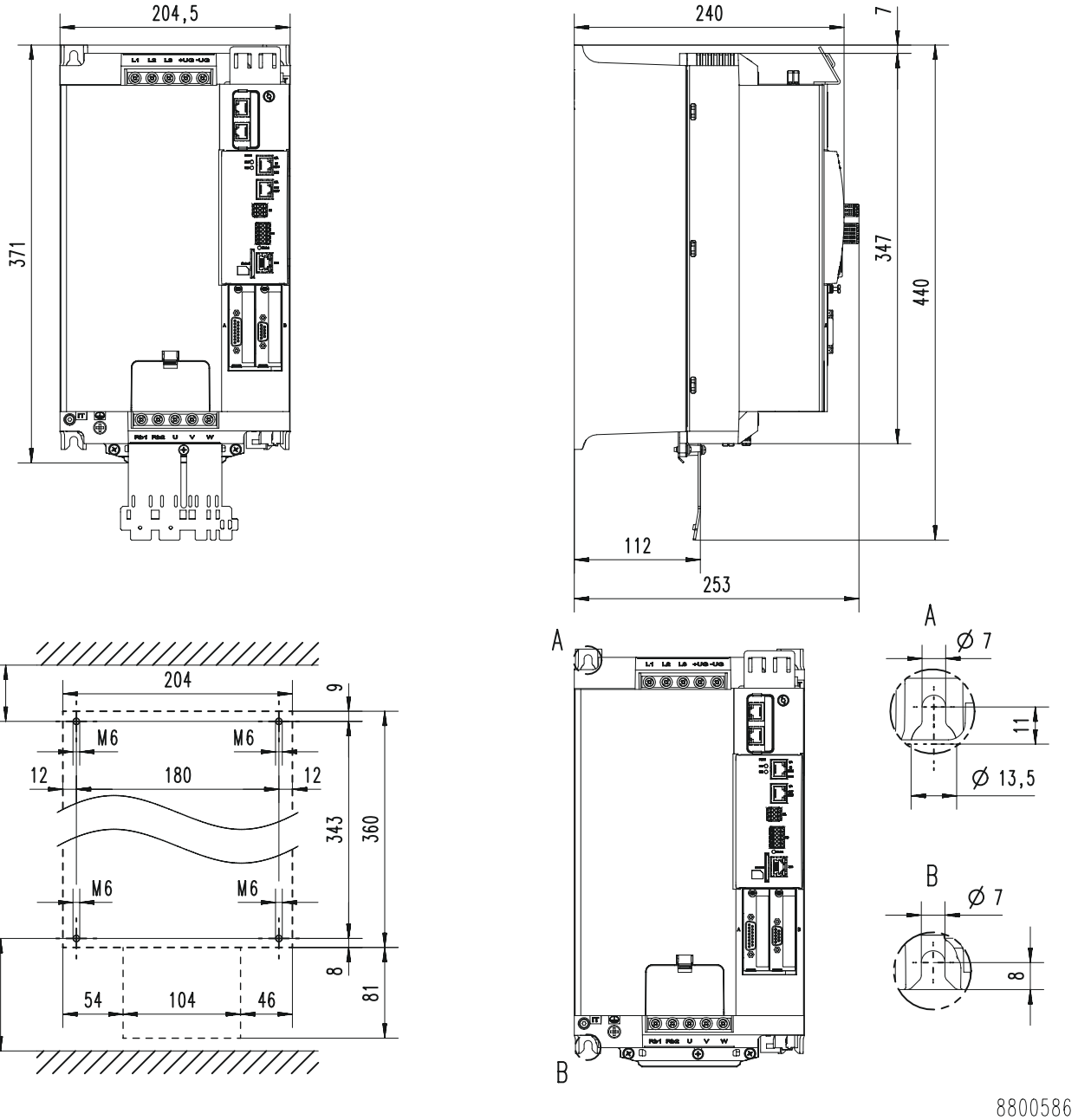
10 hp	i950-C7.5/400-3
15 hp	i950-C11/400-3
20 hp	i950-C15/400-3



22 kW

The dimensions in mm apply to:

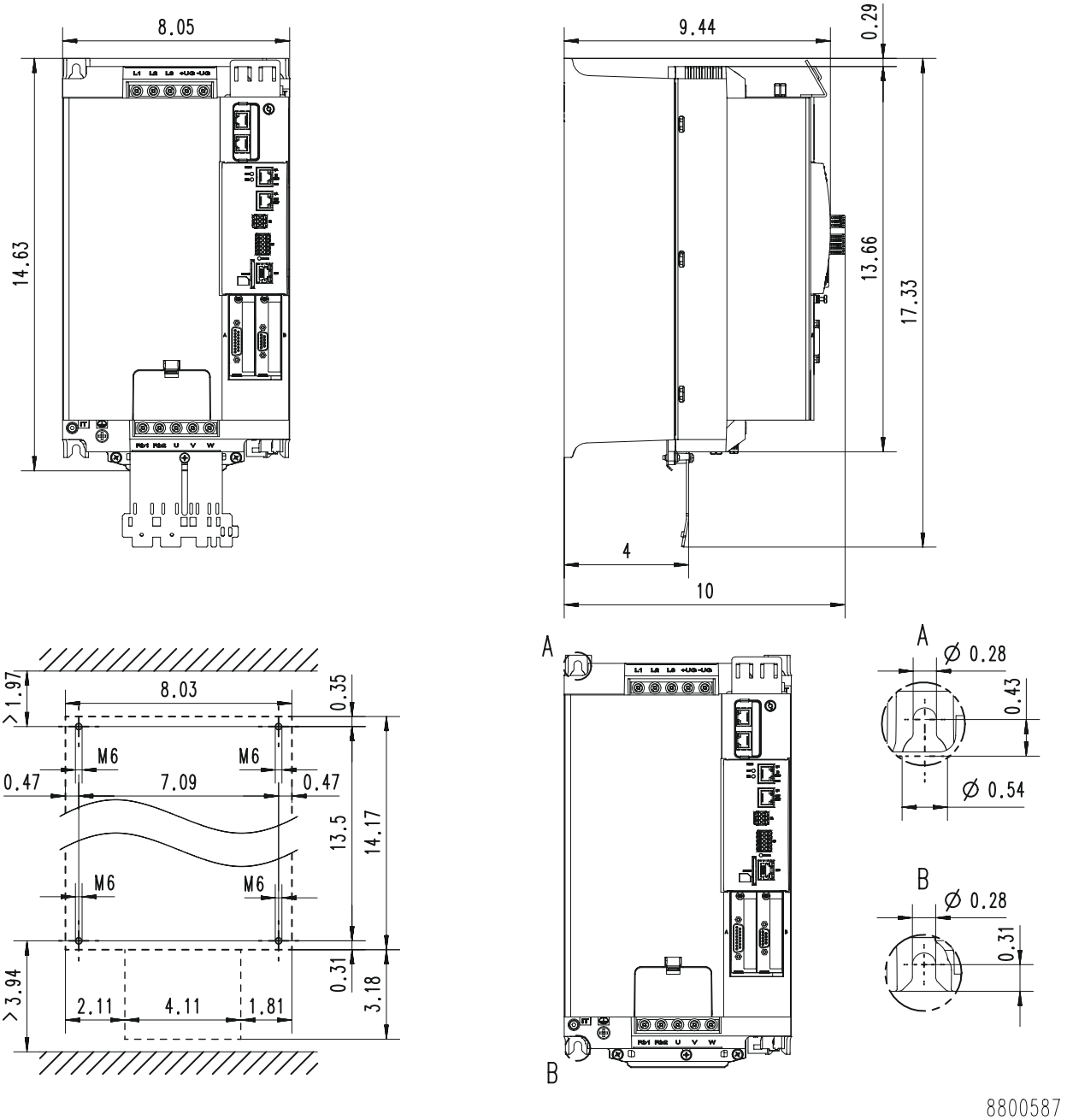
22 kW	i950-C22/400-3



30 hp

The dimensions in inch apply to:

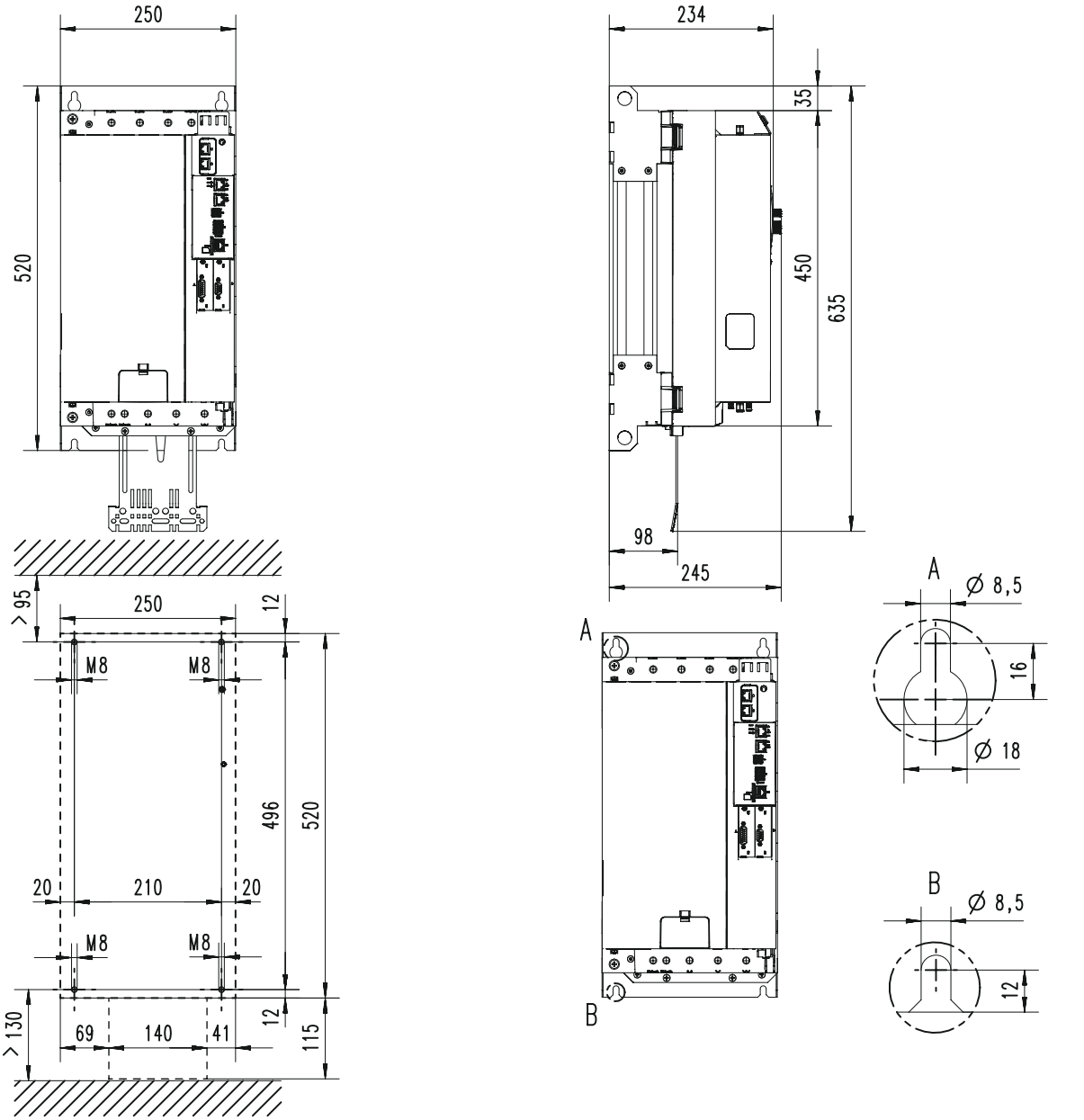
30 hp	i950-C22/400-3



30 kW ... 45 kW

The dimensions in mm apply to:

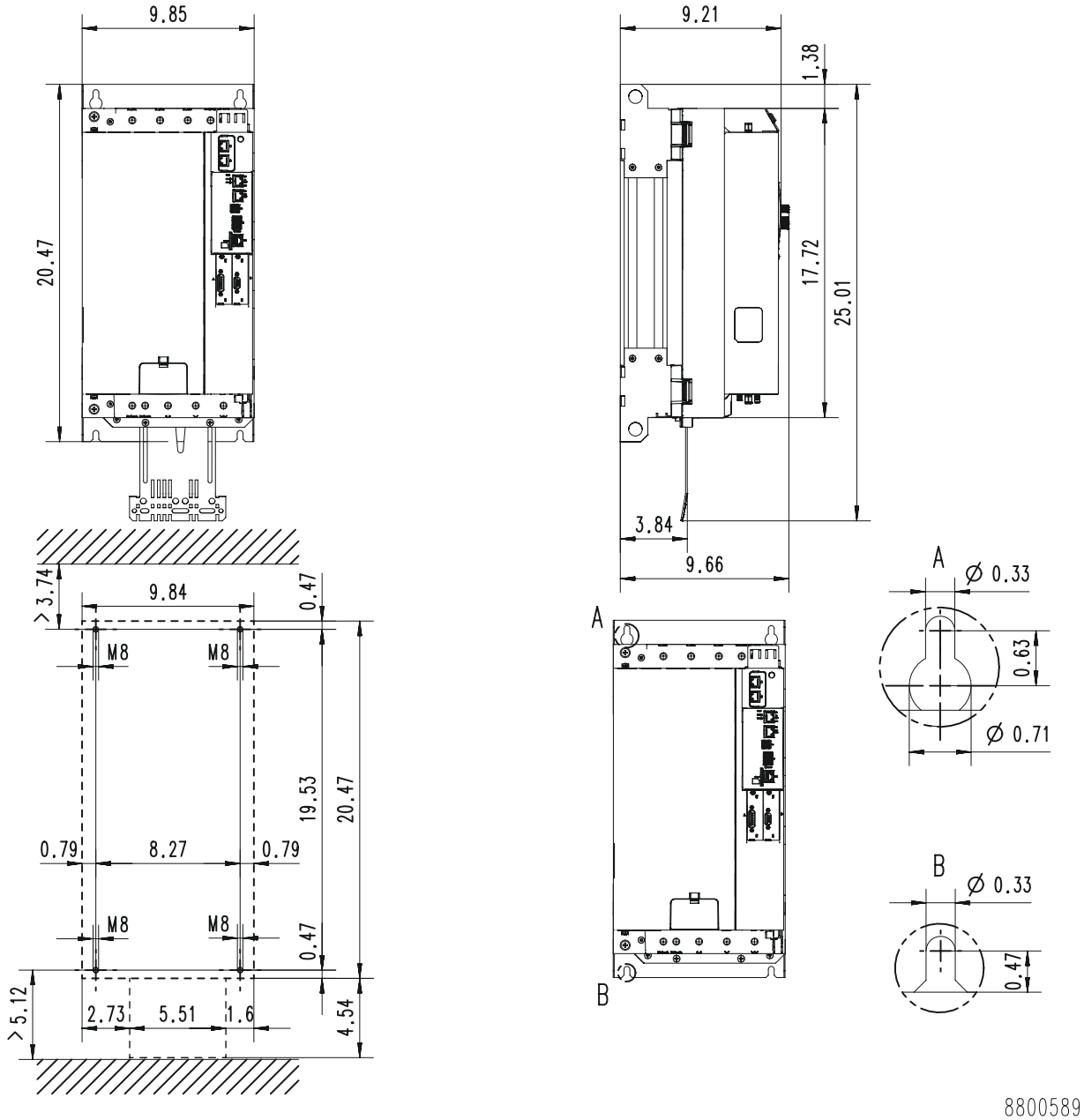
30 kW	i950-C30/400-3
45 kW	i950-C45/400-3



40 hp ... 60 hp

The dimensions in inch apply to:

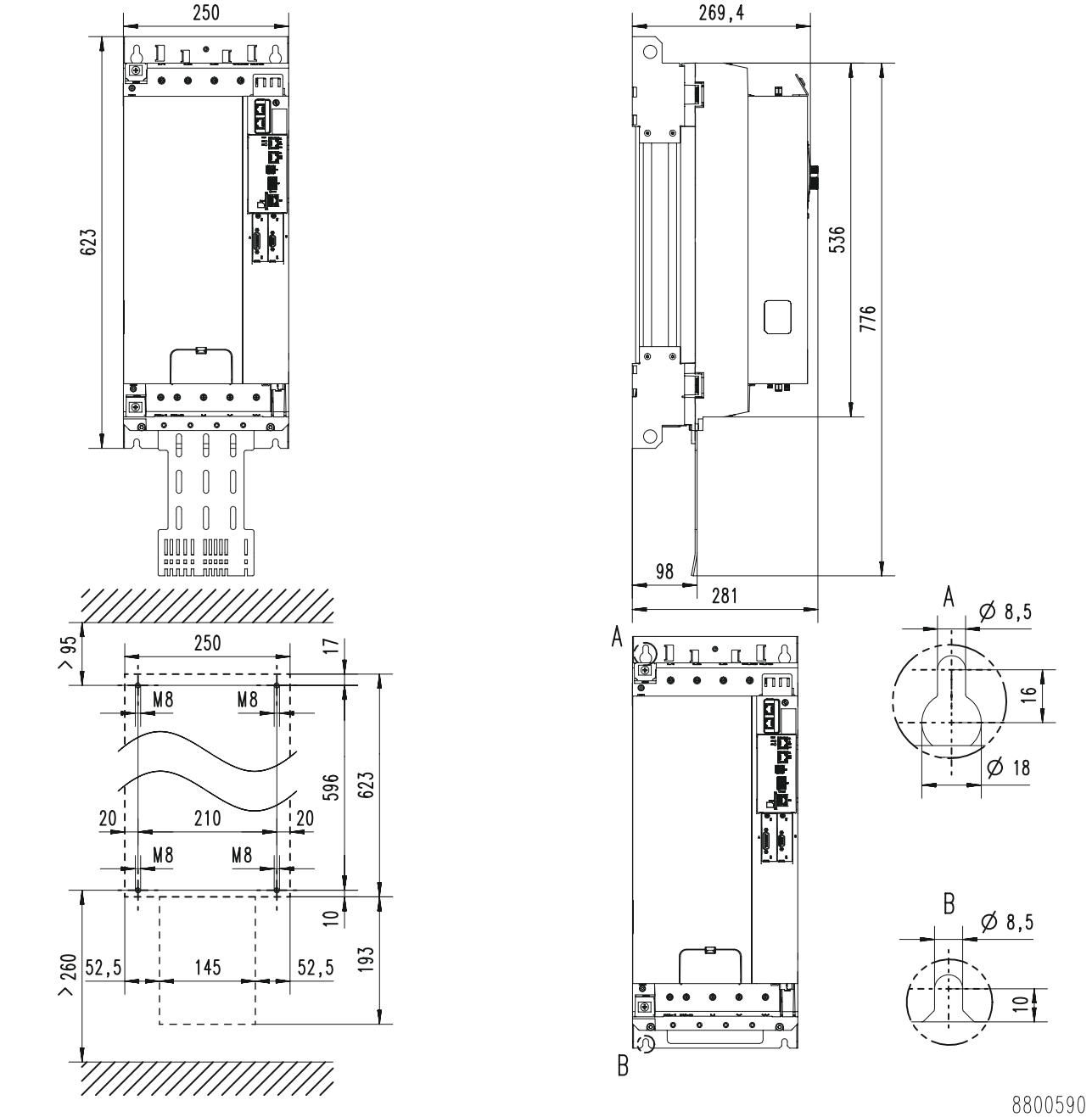
40 hp	i950-C30/400-3
60 hp	i950-C45/400-3



55 kW ... 75 kW

The dimensions in mm apply to:

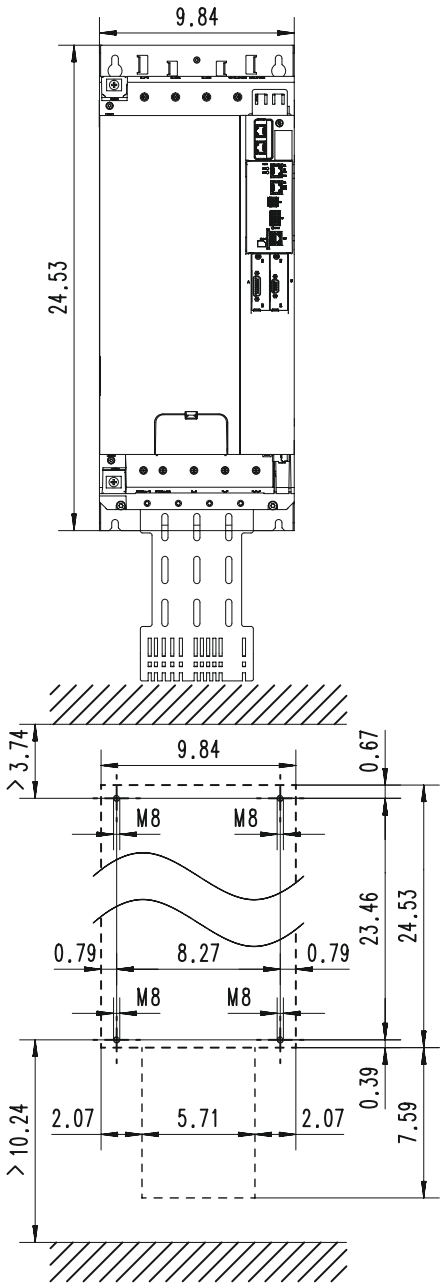
55 kW	i950-C55/400-3
75 kW	i950-C75/400-3

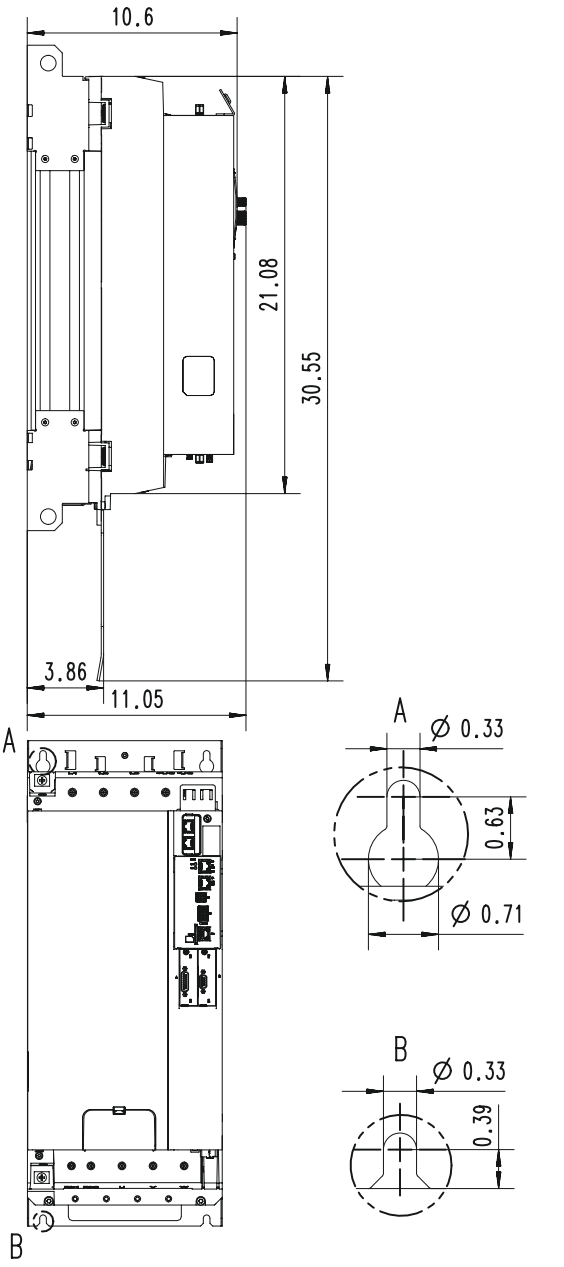


75 hp ... 100 hp

The dimensions in inch apply to:

75 hp	i950-C55/400-3
100 hp	i950-C75/400-3



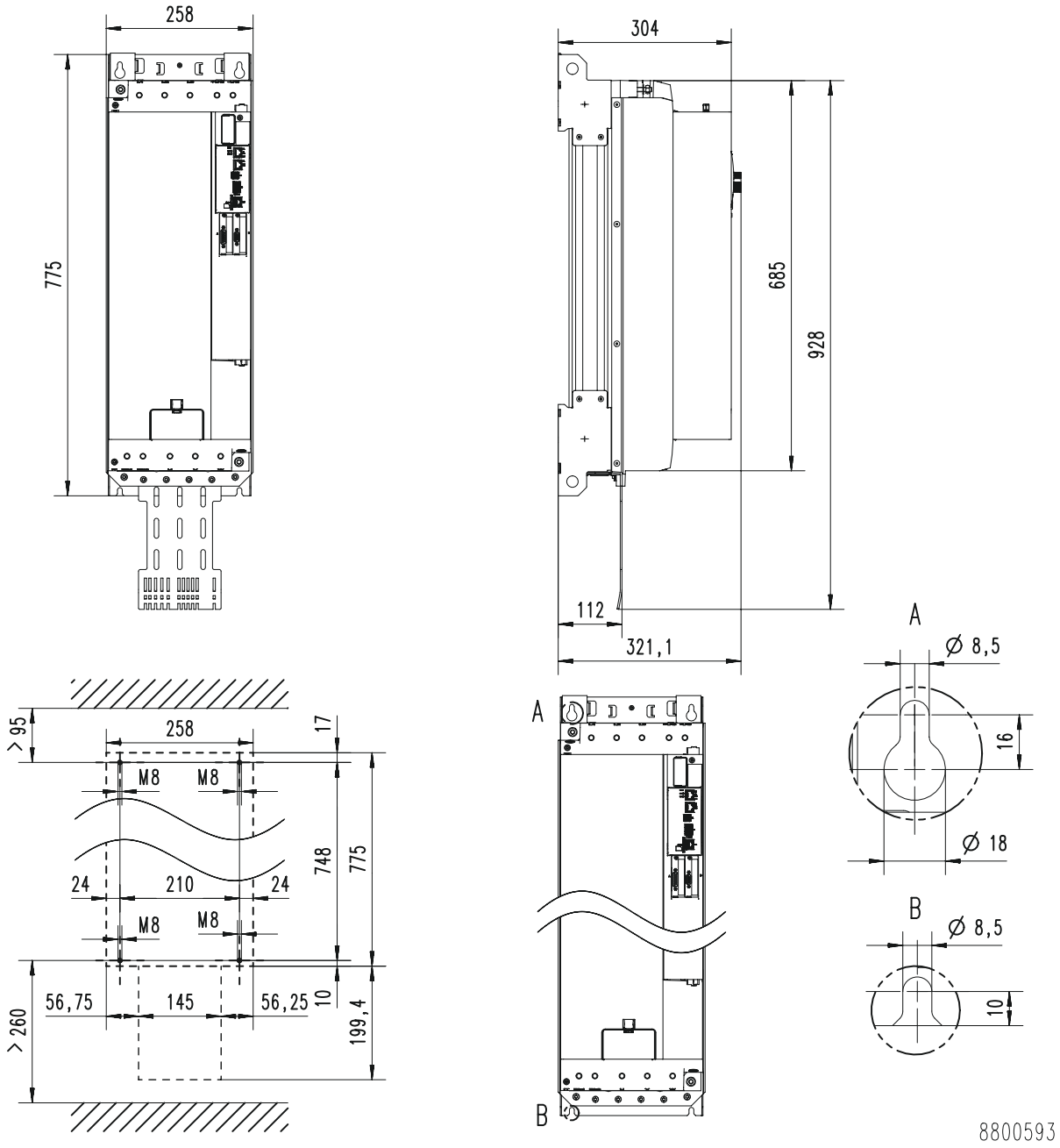


8800591

90 kW ... 110 kW

The dimensions in mm apply to:

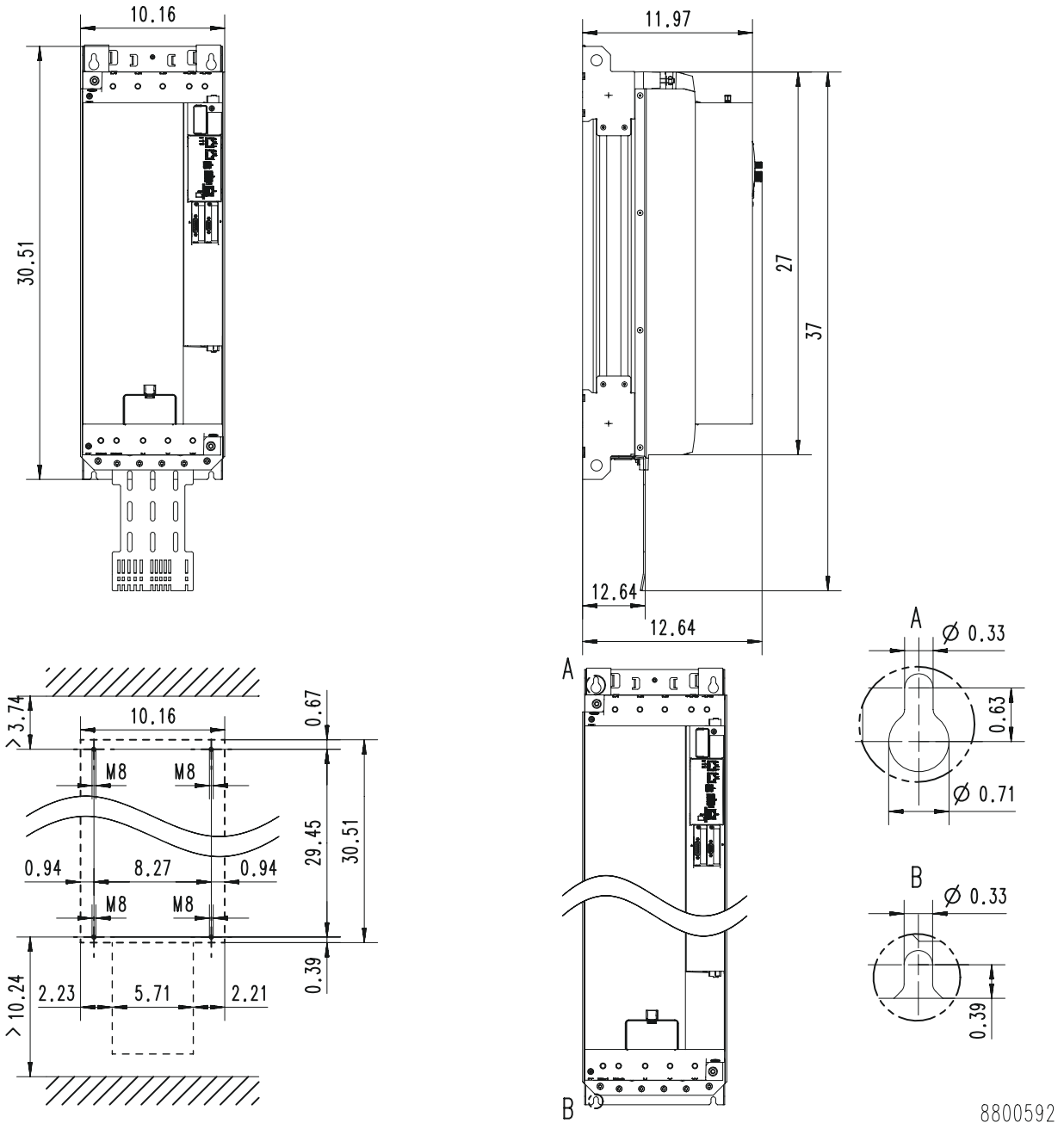
90 kW	i950-C90/400-3
110 kW	i950-C110/400-3



120 hp ... 150 hp

The dimensions in inch apply to:

120 hp	i950-C90/400-3
150 hp	i950-C110/400-3



Product extensions

Overview

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

I/O extensions

Data of control connections

Digital inputs

X3: DI1, DI2, DI3, DI4 / GI			
Switching type		PNP	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

X3: AI1+ / AI1-			
Sampling frequency	kHz	4	
Resolution of A/D converter	Bit	10	
Operation as voltage input			
Connection designation		X3/AI1+, X3/AI1-	
Input voltage DC	V	0 … 10	
Input resistance	kΩ	> 100	
Accuracy	mV	± 100	Typical
Input voltage in case of open circuit	V	- 0.2 … 0.2	Display "0"
Electric strength of external voltage	V	± 30	
Operation as current input			
Connection designation		X3/AI1+, X3/AI1-	
Input current	mA	0 ... 20	
		4 … 20	Open-circuit monitored
Accuracy	mA	± 0.4	Typical
Input current in case of open circuit	mA	2	
Input resistance	Ω	250	
Electric strength of external voltage	V	± 7.5	

24-V input

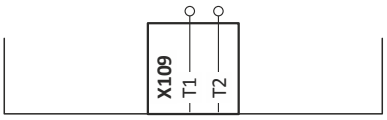
X5: 24E / GE			
Used for...		Input for mains-independent DC supply of the control electronics (incl. communication)	
Input voltage DC			
Typical	V	24	IEC 61131-2
Area	V	19.2 … 28.8	
Input power			
Typical	W	20	
Max.	W	45	Depending on the use and state of inputs and outputs.
Input current			
Typical	A	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.

Further control connections

PTC input

In the Lenze setting, motor temperature monitoring is activated! There is a wire jumper between the terminals T1 and T2 by default. Before connecting a thermal sensor, remove the wire jumper. In case of inverters up to and including i950-C15/400-3, the PTC evaluation can only be applied if the One Cable Technology (OCT) is used.

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



Motor encoder connection

The i950 can optionally be outfitted with a module for motor feedback (motor encoder).

Two modules are available:

- Resolver module
- Multi encoder module

Resolver module

Resolvers are connected to X7 (9-pole Sub-D socket).

Electrical data		
General	Cable length	Max. 150 m
Vcc, GND	Supply voltage, max. output current	5 V, 150 mA
+REF, -REF	Excitation voltage and carrier frequency	8 kHz, fixed
±COS, ±SIN	Sine and cosine track	

The operation of resolvers of other manufacturers permissible. For this purpose, the number of pole pairs of the resolver must be adapted to the resolver used. When the reference track is excited with 8 kHz, the apparent impedance of the connected resolver must not fall below 90 Ohms. When lower impedances are connected, the overload protection integrated in the resolver output limits the output current and may blur the resolver evaluation.

Multi encoder module

Encoders are connected to X8 (15-pole Sub-D socket). Absolute and incremental encoders are supported:

- SinCos incremental encoder 1 Vss
- SinCos absolute value encoder 1 Vss with Hiperface protocol
- SSI encoder
- SinCos SSI absolute value encoder

HTL encoders are not supported.

Electrical data		
General	Cable length	Max. 150 m
	Encoder types	1Vss
	Protocols	Hiperface SSI
	Number of increments	1 ... 16383
	Input frequency	Max. 500 kHz
Vcc, GND	Supply voltage	5 V
	Max. output current	330 mA to 9 V 250 mA for +12 V

SinCos encoders are open-circuit monitored, SSI encoders are not.

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-

Pin assignment of multi encoder connection

Connection	Connection description	Connection type	Pin	Encoder type			
				SinCos	Hiperface	SSI encoder	SinCos+SSI
				incremental	absolute	absolute	absolute
X8	Encoder	Sub-D, 15-pin	1	COS	COS	n.c.	COS
			2	GND	GND	GND	GND
			3	SIN	SIN	n.c.	SIN
			4	Vcc	Vcc	Vcc	Vcc
			5	Z	DATA+	DATA+	DATA+
			6	n.c.	n.c.	n.c.	n.c.
			7	TEMP-	TEMP-	TEMP-	TEMP-
			8	n.c.	n.c.	CLOCK+	CLOCK+
			9	REFCOS	REFCOS	n.c.	REFCOS
			10	n.c.	n.c.	n.c.	n.c.
			11	REFSIN	REFSIN	n.c.	REFSIN
			12	n.c.	n.c.	n.c.	n.c.
			13	/Z	DATA-	DATA-	DATA-
			14	TEMP+	TEMP+	TEMP+	TEMP+
			15	n.c.	n.c.	CLOCK-	CLOCK-

Feedback	Order code	
Resolver	I9MAG2V000000S	

Feedback	Order code	
SinCos incremental SinCos Hiperface absolute SSI SinCos + SSI absolute	I9MAG3V000000S	

Load encoder/master encoder connection

The i950 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 connection 🕮 102

Networks

The i950 can optionally be outfitted with a network module. It is used to realize communication at the "fieldbus" level.

Modules are available for connecting the following:

- EtherCAT®
- PROFINET®

For configuration and diagnosis via software, the i950 is equipped with the following:

- Engineering-Port (Ethernet)

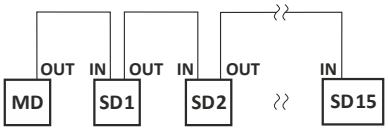
EtherCAT

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

The EtherCAT communication module

Typical topologies

Line



MD Master device
SD Slave Device

Connection description		EtherCAT	
Connection		X246	X247
Connection type		RJ45	

Bus-related information			
Name		EtherCAT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connected as EtherCAT slave	
Status display		2 LEDs (RUN, ERR)	

Technical data			
Communication profile		EtherCAT	
		CANopen over EtherCAT (CoE)	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line, tree, star	
With repeater		-	
Node			
Type		EtherCAT slave	
Max. Number		65535	In the entire network
Address		Automatically allocated by the master	
Max. cable length	m	Not limited	The length between the nodes is decisive.
Max. cable length between two nodes	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	

Modules for network

Network (fieldbus)	Order code
EtherCAT	I9MAFT0000000S

PROFINET

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

PROFINET communication module

Connection description		PROFINET	
Connection		X256	X257
Connection type		RJ45	

Technical data			
Communication profile		PROFINET RT	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Tree, star and line	
With repeater		-	
Node			
Type		I/O device with real time (RT) communication properties Conformance Class B	
Max. number		255	Per subnetwork
Address		Station name	
Max. cable length	m	Not limited	The length between the nodes is decisive.
Max. cable length between two nodes	m	100	
Process data	Bytes	4, 8, 12, 16, 20, 24, 28, 32, ... 64	
Cycle time	ms	1, 2, 4, 8, 16	
Switching method		Cut-through	
Other data		Additional TCP/IP channel	

Modules for network

Network (fieldbus)	Order code
PROFINET	I9MAFR0000000S

EtherCAT system bus

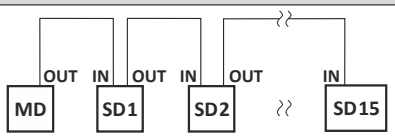
The EtherCAT system bus is the standard “on-board” bus system of the i950.

Thanks to the integrated synchronization mechanism, the "Distributed clocks" and the short cycle times, it offers excellent real-time properties. Thus it enables a high-precision synchronization of the connected nodes.

The system bus can either be used as standard EtherCAT slave or as participant of the system bus cross-communication.

Typical topologies

Line



MD Master device
SD Slave Device

Connection description		EtherCAT system bus	
Connection		X236	X237
Connection type		RJ45	

Bus-related information			
Name		EtherCAT system bus	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection of the inverter to the system bus cross communication or as standard EtherCAT slave	
Status display		1 LED (RUN)	

Technical data			
Communication profile		EtherCAT	
		CANopen over EtherCAT (CoE)	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line, tree, star	
With repeater		-	
Node			
Type		EtherCAT slave	
Max. number		65535	In the entire network
Address		Automatically allocated by the master	
Max. cable length	m	Not limited	The length between the nodes is decisive.
Max. cable length between two nodes	m	100	
Process data			
Transmit PDOs		0-100 words	200 bytes per direction (standard and safety PDOs)
Receive PDOs		0-100 words	
Cycle time	ms	250ms, 250µs, 1ms or an integer multiple of 1ms, max. 10ms	

Functional safety

General information and basics

The 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 malfunctions.

Protective devices prevent any human access to danger 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 safety

The integrated safety technology fulfils the control and drive conditions for implementing the protective functions. The expenses for planning and installation decrease. Integrated safety equipment increases machine functionality and availability. The integrated safety system can be used for the protection of persons working on machines in accordance with the Machinery Directive.

The motion functions continue to be executed by the inverter. The integrated safety system monitors the safe compliance with the limit values and provides the safe inputs and outputs. If monitored limit values are exceeded, the integrated safety system in the inverter reacts with safety functions according to EN 61800−5−2.

Identification of the components

Safety components and the respective terminals are yellow.

Safety address

The safety address is set using the 0xF980 parameter (safety address). Via the parameter, addresses in the range of 1 ... 65534 can be set.

Stop functions

The Stop functions include:

▸ Safe stop emergency (SSE) 🕮 118
▸ Safe stop 1 (SS1) 🕮 119
▸ Safe stop 2 (SS2) 🕮 121
▸ Safe operating stop (SOS) 🕮 125

The Stop functions differ according to how they are triggered:

- Normal stop (simple stop)
  - Triggered by a safe input with the parameterised functions Safe Torque Off, Safe Stop 1, or Safe Stop 2.
  - Triggered by the activated bits Safe Torque Off, Safe Stop 1, or Safe Stop 2 via the safety bus.
- Emergency stop
  - Triggered by a safe input with the parameterised function SSE.
  - Triggered by the activated bits SSE via the safety bus.
  - STO or SS1 can be configured as the function to be executed via the parameter "SSE: Emergency stop function".
- Fault stop
  - Triggered as a response to a fault.
- Repair Mode Select

Prioritisation

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

Hierarchy:

1. Safe torque off (STO) The function STO has the highest priority and hence precedence over all other functions. Functions that have already been initiated (e. g. SS1 or SS2) are aborted and the drive is switched off.
2. Safe stop 1 (SS1) The function SS1 has precedence over SS2. Observing the defined stop time for SS1 and SS2 as well as the SS1 mode, the drive is rendered torqueless.
3. Monitoring functions The monitoring functions have equal priorities and can be executed simultaneously with the stop function.

Restart

The restart sets the drive in motion after it was previously brought to a standstill via a stop function.

Whether the restart needs to be acknowledged or if it launches automatically can be parameterised in a manner dependent on the preceding stop function:

- Restart behaviour according to STO / SS1 (0x2892:001)
- Restart behaviour according to SS2 / SOS (0x289F:002)

⚠ DANGER!

The requirement for the safety function is lifted.

The drive may automatically restart when the requirement for the safety function is lifted!

► In the case of automatic restart, you must take external measures to ensure that the drive only restarts after a confirmation in accordance with EN ISO 13849–1.

The restart behaviour after an emergency stop corresponds to that for the restart behaviour parameterised for the stop function STO / SS1.

Prerequisites for restart

- Setting "Acknowledged restart"
  - After a normal stop, a restart acknowledgement (AIS) via a terminal or safety bus is necessary.
  - After a fault stop, a fault acknowledgement (AIE) is first necessary before the restart can be acknowledged with AIS.
- Setting "Automatic restart"

When the safety function "Safe cascading" is active, the plausibility check rejects the automatic restart after STO.

  - The drive must be in a stopped state (see status bit STO or SOS).
  - The superposed controller must ensure that the drive only restarts after a confirmation.

Safety sensors

Kontaktfunktionstest

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

Safe input in the ON state
- A LOW level at one channel puts the input in the OFF state. The discrepancy monitoring starts simultaneously.
- A LOW level must be detected at both channels within the discrepancy time, otherwise a discrepancy error will be reported.
- To be able to acknowledge the discrepancy error, a LOW level must be detected before at both channels.

Safe input in the OFF state
- A HIGH level at one channel starts the discrepancy monitoring.
- A HIGH level must be detected at both channels within the discrepancy time, otherwise a discrepancy error will be reported.
- To be able to acknowledge the discrepancy error, a HIGH level must be detected before at both channels.

General

For the sensors on the inverter, the following applies:
- Sensor type and sensor function are parameterisable.
- A local evaluation is conducted when a corresponding parameter setting has been performed.
- If a safety bus is activated, the sensor signals will be sent as status information to the upstream controller.
- Deactivated sensor inputs are not to be connected. The status of an unconnected input is in an OFF state.
- If a signal to deactivated sensor inputs is detected during initialisation, the drive remains blocked (STO).
- Erroneous inputs are evaluated as an OFF state.

Specification	Passive sensor type	Active sensor type
Discrepancy time	parameterisable 0 ... 30,000 ms (step size: 2 ms)	
Input delay	parameterisable 0 ... 100 ms (step size: 2 ms)	
Input filter time for test pulses	fixed, 2 ms	
Repeat rate of test pulses	defined by the clock outputs CLA and CLB	> 50 ms
Error response	Sensor input is evaluated as an OFF state. Acknowledgement via safety bus or 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 equipment 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 chatter from contact components.
- Input filter time

  Time during which noise pulses and test pulses from e.g. switched-on active sensors are not recognised.

The time of the input delay and the time of the input filters influence the response time.

Connection of active sensors

The safe sensor inputs X83 / I1A ... I4B are suitable for active sensors.

P/M-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.

This fault is detected:

Antivalent input signals after discrepancy time has elapsed.

Connection of passive sensors

The safe sensor inputs X83/I1A ... I4B are suitable for equivalent switching passive sensors.

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.

Please note the following:

- The clock outputs are only suitable for monitoring passive sensors.
- Always connect
  - X82/CLA via the sensor with X83/IxA (channel A of sensor input).
  - X82/CLB via the sensor with X83/IxB (channel B of sensor input).
  - X82/GS with X83/GIx of the sensor input.
- The sensor inputs are tested cyclically via a short switching to LOW.

  The channels A and B are tested with a time offset, in cycles of approx. 2s, with test pulses of < 1ms.

These errors are detected:

- Short circuit with supply voltage.
- Short circuit between the input signals when different clock outputs are used.
- Antivalent input signals after discrepancy time has elapsed.

This error is not detected:

Short circuit between the input signals, if the same clock outputs are used

⚠ DANGER!

Loss of the safety function in case of a short circuit of the input signals.

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

► Lay the cables in a protective manner according to the category 4, EN ISO 13849-2.

Slip compensation

When an operational slip occurs between the load and motor encoders, the slip is evaluated and compensated for via the function.

⚠WARNING!

The slip compensation may not be suitable for the application.

Serious injuries when exceeding the travel path.

► Ensure that the application is suitable for the 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.

Via parameter setting in the PDSS function, the slip compensation for the areas between the diagnostics positions and the end of the travel path can be deactivated. ▸ Position-dependent safe speed (PDSS) 🕮 133

The maximum slip compensated must be activated by the user (0x2885:001 > 0). This function is intended for the travel areas outside the buffer zones in conjunction with the function PDSS.

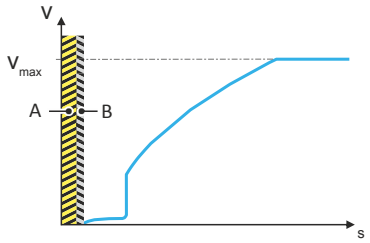


Fig. 10: Areas of the travel path

A Prohibited area B Buffer end zone

When the application is used, the boundary to the prohibited area may not be traversed. The buffer end zone must be enlarged by the maximum permissible slip.

The following parameters can be configured		
Parameter name	**Index**	**Explanation**
Maximum slip compensated	0x2885:001	Configuration of maximum slip compensated/ motor rotation. The value 0 deactivates slip compensation.
Slip compensation in end zone	0x2885:002	Activate/deactivate slip compensation in the end zones outside of the diagnostics positions.

Activating slip compensation

In order to activate slip compensation, the diagnostics markers ① and ② are required. The diagnostics markers provide a cyclic indication of the accuracy of the position encoder. In order for a sufficient braking distance to be available in the case of a fault, the diagnostic markers must be arranged such that a fault in the range of the maximum permissible speed is recognised. The cycle in which the diagnostics markers are traversed is controlled by the application. The cycle must be monitored by the safety controller.

Fig. 11: Position of diagnostics markers

When slip compensation is active, a cyclic position comparison between motor encoder and position encoder is performed between the diagnostics markers ① and ②. The diagnostics markers are located before the buffer areas. When the diagnostics positions are traversed, the parameterised diagnostics markers are compared to the absolute encoder position. If the difference lies outside a tolerance window (to be parameterised), the parameterised error response is triggered.

The following parameters can be configured		
Parameter name	**Index**	**Explanation**
SHOM Diag-In	0x2883	Configuration of input source for SHOM diagnostics position.
SHOM diagnostics position detection	0x2884:001	Configuration of level for detection of a SHOM diagnostics position.
SHOM: lower diagnostics position	0x2884:002	Configuration of lower diagnostics position for SHOM.
SHOM: upper diagnostics position	0x2884:003	Configuration of upper diagnostics position for SHOM.
SHOM: diagnostics position tolerance	0x2884:004	Configuration of permissible tolerance when traversing the diagnostics positions for SHOM.

Safety functions

Supported safety functions for "Basic Safety-STO"

Supported safety functions for "Extended Safety"

Safe torque off (STO)

The motor cannot generate torque and movements of the drive.

⚠ DANGER!

With the "Safe torque off" (STO) function, no “emergency-stop" can be executed according to EN 60204−1 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 stop" requires electrical isolation, e. g. via a central mains contactor.

⚠ DANGER!

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

Possible consequences: Death or severe injuries

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

⚠ DANGER!

The power supply is not safely disconnected.

Death or serious injury due to electrical voltage.

► Turn off the power supply.

Preconditions

Motion caused by external forces must be prevented by additional measures such as mechanical braking.

The restart must be set. See chapter ▸ Restart. 🕮 110

Functional description

How to safely disconnect the drive:

1. A safety sensor requests the safety function.
2. The transmission of the pulse width modulation is safely switched off by the safety unit. The power drivers do not generate a rotating field anymore.
3. The inverter switches to the STO active device status (status word 0x6041, Bit15 = 0).

The motor is safely switched to torqueless operation (STO).

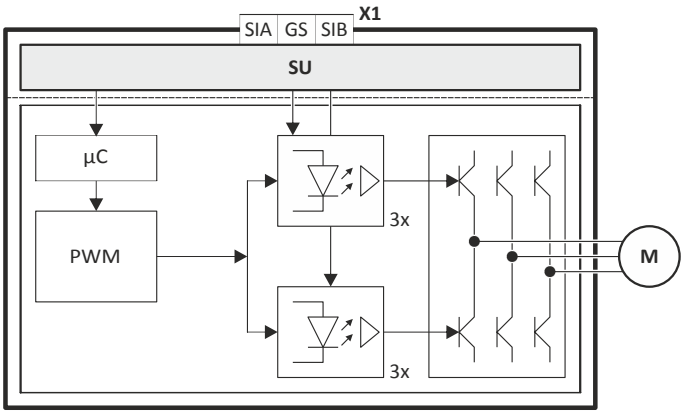


Fig. 12: Functional principle: Basic Safety - STO

X1	Control terminals of the safety unit	PWM	Pulse width modulation
SU	Hardware interface	M	Motor
µC	Microcontroller		

Functional description

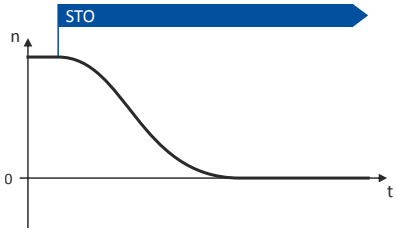


Fig. 13: Safety function STO

Functional sequence and error response have no adjustable parameters.

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces". 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

In response to the error stop request.

In response to the emergency stop request.

Parameter Extended-Safety

Parameter	Source	Information
0x2890	STO: SD-In	Function source of the safe inputs for requesting the STO function
0x2891	STO: S-bus	Activation/deactivation of the STO control bit via the safety bus.
0x2893	STO active: S-bus	Influence of the status bit "STO active" on the control of existing outputs.

Safe stop emergency (SSE)
The safety function SSE has the highest priority. The safety function SSE is controlled primarily from all states, operating modes or safety functions. Depending on the parameter setting in 0x28A3:001, SSE activates one of these functions:

- Safe torque off (STO)
- Safe stop 1 (SS1)

Exception
One exception is the tripping source parameterized with SSE that can be deactivated by the "Safe Muting" function. In this case, the SSE function is not effective.

NOTICE

Emergency stop buttons must not be overruled by a special operation.

Otherwise the functional safety of the system cannot be guaranteed anymore.

► Please observe the notes in the section ▸ Stop functions. 📖 109

► Please observe the notes regarding the special operation (OMS) in the section ▸ Operation mode selector (OMS). 📖 139

Preconditions
The emergency stop buttons are connected to the emergency stop function.

Activation of the function
A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces".📖 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

Safe stop 1 (SS1)

The safety function monitors the parameterized stopping time of the drive (n = 0).

In the SS1 function, the drive switches to torqueless state via the parameterized mode. 0x2897:001

Preconditions

The drive is brought to standstill via the application.

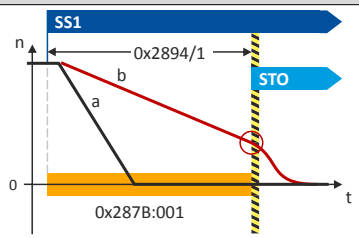
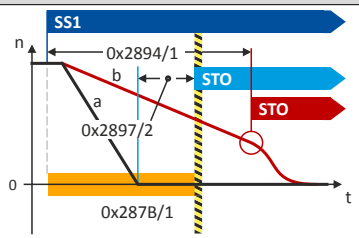
Movements caused by external forces require additional measures. When the stopping time is defined, the application time of the brake must be taken into consideration.

The restart is possible after the stopping time has completely elapsed. An exception from this is the special operation.

Functional description

n = 0 means that the motor speed is lower then the motor speed parameterized in the tolerance window. 0x287B:001

The deceleration ramp can be parameterized and monitored for the SS1 stop function.

SS1-t **0x2897:001 = 0 (STO after stopping time)**	**SS1-t** **0x2897:001 = 1 (STO at n = 0)**
	
The SS1 safety function switches the inverter to STO if the set stopping time has elapsed. 0x2894:001 The switching operation is triggered irrespective of whether or not the motor is at standstill!	This parameter setting stops the motor. The deceleration n = 0 is parameterized in the following parameter: 0x2897:002
Curve (a): The motor comes to a standstill within the parameterized stopping time.	Curve (a): The deceleration parameterized in 0x2897:002 starts when the speed is lower than the tolerance window of the motor speed parameterized in 0x287B:001. After the parameterized stopping time has elapsed, the inverter switches to STO. 0x2894:001
Curve (b): At the moment of STO, the motor is not yet at standstill. Switching off with STO lets the motor coast down.	Curve (b): If the deceleration ramp is set too long, it is switched to STO after the stopping time has elapsed. In the case shown here, the motor coasts down.

Notes on how the set the stopping time

Please observe the following dependency when setting der stopping time 0x2894:001:

- If an encoder is available:
  - The speed is calculated from the encoder data.
  - In 0x2897:001, selection “1”: STO at n = 0, a waiting time 0x2897:002can be set which determines when the STO status is adopted. This deceleration indicates the time between the motor standstill and the activation of STO.
- If no encoder is available:
  - The function evaluates the speed status n= = 0 from the inverter.
  - The stopping time monitored by the safety device 0x2894:001 must be 0.5 s higher than the stopping time parameterized in the inverter.

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces".📖 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

In response to the error stop request.

In response to the emergency stop request.

Parameter Extended-Safety

Parameter	Source	Information
0x2890	STO: SD-In	Function source of the safe inputs for requesting the STO function
0x2891	STO: S-bus	Activation/deactivation of the STO control bit via the safety bus.
0x2893	STO active: S-bus	Influence of the status bit "STO active" on the control of existing outputs.

Response of the function under normal circumstances

When the stopping time has elapsed (0x2894:001or after falling below the tolerance window (0x287B:001) a standard stop is activated.

The power supply for generating the rotating field is safely interrupted (STO). The motor cannot generate torque and movements of the drive.

Response of the function in the event of an error

An error message and an error stop are triggered if:

- Standstill could not be reached when the stopping time has elapsed (0x2894:001.
- The activated ramp monitoring exceeds the parameterized deceleration ramp.

The power supply for generating the rotating field is safely interrupted (STO). The motor cannot generate any torque and movements of the drive.

A premature cancelation of the Safe Stop request does not stop the error stop function.

Safe stop 2 (SS2)

The safety function monitors whether the drive has reached the set tolerance window (n = 0) within the parameterised stopping time.

After the stopping time has elapsed or the value has fallen below the tolerance window, the monitoring function switches to safe operational stop (SOS) or activates the safety function (STO).

In the safe operational stop, the drive is not switched to torque-free operation. All control functions remain active for maintaining the reached position.

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

Preconditions

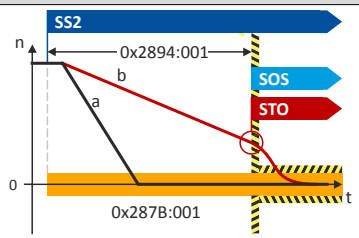
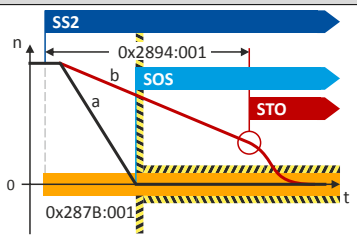
The drive is brought to standstill via the application.

Movements caused by external forces require additional measures. When the stopping time is defined, the application time of the brake must be taken into consideration.

The restart is possible after the stopping time has completely elapsed. An exception from this is the special operation.

Functional description

The deceleration ramp can be parameterized and monitored for the SS2 stop function.

SS2-t **0x289B:001 = 0 (SOS after stopping time)**	**SS2-t** **0x289B:001 = 1 (SOS at n = 0)**
	
The safe operating stop is activated if the stopping time parameterized in 0x2894:001 has elapsed and the motor speed is lower than the value parameterized in 0x287B:001. Safe operating stop (SOS)	Curve (a): For details see Safe operating stop (SOS). 📖 125.
Curve (a): For details see Safe operating stop (SOS).📖 125.	Curve (b): STO is also activated if, after the stopping time 0x2894:001 has elapsed, the speed is not lower than the value parameterized in 0x287B:001.
Curve (b): STO is also activated if, after the stopping time 0x2894:001 has elapsed, the speed is not lower than the value parameterized in 0x287B:001.	

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces".📖 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

In response to the error stop request.

Response of the function under normal circumstances

When the stopping time has elapsed (0x2894:001or after falling below the tolerance window (0x287B:001), the safety function📖 125 is activated.

Response of the function in the event of an error

An error message and an error stop are triggered if:

- Standstill could not be reached when the stopping time has elapsed (0x2894:001.
- The activated ramp monitoring exceeds the parameterized deceleration ramp.

The power supply for generating the rotating field is safely interrupted (STO). The motor cannot generate any torque and movements of the drive.

A premature cancelation of the Safe Stop request does not stop the error stop function.

Ramp monitoring

In addition, the deceleration ramp can be parameterised and monitored for the stop functions SS1 and SS2. If the parameterised ramp is not exceeded, it is then switched to the parameterised stop function STO or SOS.

Condition

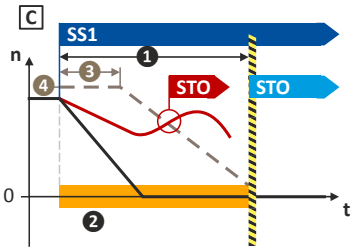
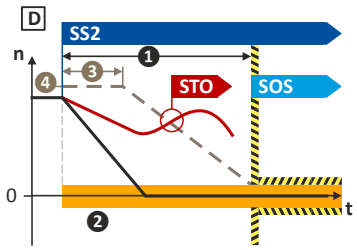
- Safe speed evaluation via the parameterised encoder system.
- Ramp monitoring is activated. 0x2894:005

Functional description

Monitoring the deceleration process guarantees a higher safety level.

- The application leads the drive to a standstill.
- If the ramp monitoring is active, the starting value of the ramp and the smoothing time must be defined as percentage value.

If the speed exceeds the deceleration ramp parameterised within the stopping time or before the tolerance window (n = 0) is reached, an error message is triggered and an error stop is initiated.

Safe ramp monitoring for SS1-r and SS2-r
C  D 
1. 0x2894:001 SS1, SS2: Stopping time
2. 0x287B:001 Tolerance window (n=0)
3. 0x2894:003 SS1, SS2: Ramp smoothing time
4. 0x2894:005 SS1, SS2: start offset ramp

The parameterized monitoring ramp considers the parameters of the deceleration ramp in the application.

0...30 % of the actual speed are added to the actual speed as start offset. The sum is used as constant starting value.

Alternative: An absolute value can be parameterized as start offset. 0x2894:006.

The following parameter determines whether the relative or the absolute offset value is to be used. 0x2894:004

In the Lenze setting of the start offset, the tolerance window (n=0) is considered as the offset.0x2894:005

The monitoring ramp starts after an internal deceleration time has elapsed. The internal deceleration time depends on “SS1, SS2”: smoothing time” and “SS1, SS2”: stopping time”.

Activation

- If the stop functions SS1/SS2 are requested, a monitoring ramp is calculated and placed over the current speed characteristic.

Normal behaviour

While the stopping time elapses or before the tolerance window (n = 0) is reached, the parameterised speed ramp is not exceeded. When the stopping time has elapsed or the parameterised speed ramp has been exceeded, the parameterised stop function STO or SOS is activated.

Error behaviour

An error message and an error stop are triggered if:

- the current speed exceeds the stopping time of the speed ramp parameterised.
- the current speed exceeds the parameterised speed ramp before the tolerance window is reached.

The power supply for generationg the rotating field is safely interrupted ▸ Safe torque off (STO). The motor cannot generate torques and movements of the drive.

Safe operating stop (SOS)
In the safe operational stop, the drive is not switched to torque-free operation. All control functions are maintained. The reached position remains active.

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

Preconditions
The drive is brought to standstill via the application.

Functional description

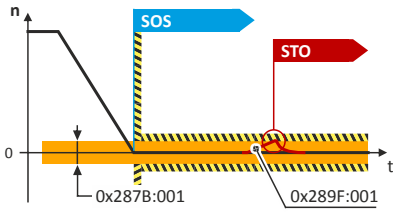


Fig. 14: SOS function

SOS is activated if the motor speed is lower than the tolerance window parameterised in 0x287B:001, tolerance window (n=0),.

In the SOS state, relative position changes are added and saved in 0x289F:003. The value in 0x289F:003 is continuously compared to the permissible value in 0x289F:001.

If one of the two states occurs during a safe operational stop (SOS):

- Position is outside the tolerance window safely monitored in 0x289F:001

an error message is generated and STO is activated:

When the SOS state is left, the maximum relative positioning is displayed in 0x289F:003.

The 0x289F:002 parameter defines the restart behaviour after SOS has been deactivated.

If the SOS state is requested again, the sum of the last position changes in 0x289F:003 is reset to zero.

Example: The "SS2 active" state is interrupted by an STO request. If the STO request is reset, the transition to the SOS state will follow. The position deviation is reset to p = 0.

Activation of the function
The following options are available to activate the function:

- The Safe stop 2 (SS2) function📖 121
- The safety bus, see section "Safety bus".
- A safe input, see section "Safe inputs"

Behaviour of the function in the event of an error
In the final state "Safe operational stop (SOS)", an error message is triggered if:

- the speed exits the tolerance window set 0x287B:001 (n=0).
- the position exits the tolerance window set 0x289F:001 (p=0).

Safe maximum speed (SMS)

The safety function monitors the compliance with the safe maximum motor speed set.

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

Functional description

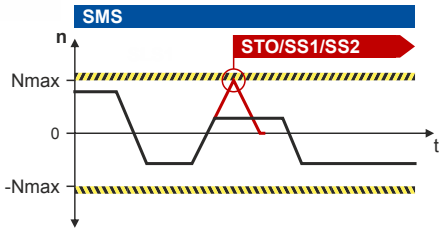


Fig. 15: SMS function

Activation of the function

The function can only be activated via parameterisation.

The function is activated by a value > 0 in 0x28B0:001.

Behaviour of the function in the event of an error

An error message is triggered if:

- The speed exceeds the maximum speed Nmax set in 0x28B0:001.

One of the error stops parameterised in (0x28B0:002) is initiated:

- Safe torque off (STO)📖 116
- Safe stop 1 (SS1)📖 119
- Safe stop 2 (SS2)📖 121

Safely-limited speed (SLS)

The safety function monitors the parameterized speed Nlim if the following states are reached:

- The values have fallen below the parameterized speed.
- The set braking time has elapsed.

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

Preconditions

The drive must be braked by the application.

If the SLS function is combined with the Safe direction (SDI) function, the values for the delay times (0x28C4:001 ... 0x28C4:004) must be coordinated. The Nlim braking time (0x28C3:001 ... 0x28C3:004) starts at the same time as the SDI delay time. See ▸ Safe direction (SDI) function. 🕮 131

Functional description

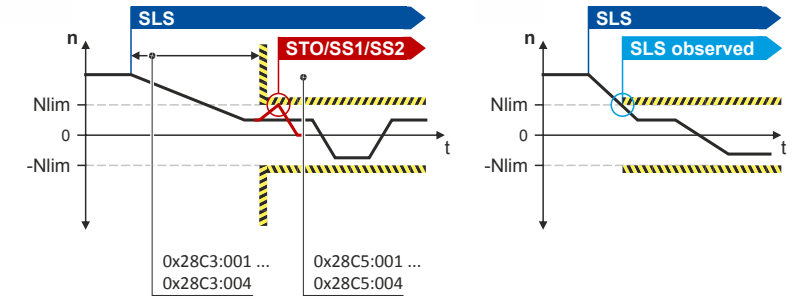


Fig. 16: SLS function

For operation within the limit values the "SLS1...4 monitored" status is set in 0x2870:002.

The status can be

- assigned to the safe output as a safe speed monitor.
- reported via the safety bus.

The permissible direction of movement is set via 0x28C4:001 ... 0x28C4:004.

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces". 🕮 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

Via internal status signals. (From safety firmware V1.1 with parameter set version V1.1)

Behaviour of the function in the event of an error

If the speed is exceeded in the monitored state, an error message is triggered. For the SLS safety function, the following error responses can be parameterised as safe stop:

▸ Safe torque off (STO) 🕮 116

▸ Safe stop 1 (SS1) 🕮 119

▸ Safe stop 2 (SS2) 🕮 121

Safe speed monitor (SSM)

The function monitors the limited speed set.

The function is activated if:

- the monitoring limits are parameterised, or
- the values are non-zero.

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

NOTICE

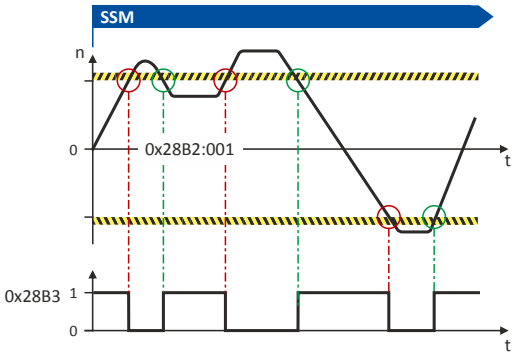
The SSM function does not feature any hysteresis.

Oscillating response of the safe output during operation in the proximity of the speed limit parameterised.

Oscillating response of the safe output when slowly passing the speed limit parameterised.

► Avoid continuous operation at the speed limit parameterised.

Functional description



During operation within the limit values, the SSM status is set on the safety bus within the limits 0x2870:002.

The SSM status is assigned to the safe output as safe speed monitor (amount) 0x28B2:001.

If the amount of the safe speed adopts the value "0", the SSM function is deactivated.

The status bit in 0x28B3 influences the control of available outputs.

Safely-limited increment (SLI)

With this function, a maximum permissible position change [incr] can be set.

Within the position window, the increments parameterised can be traversed in positive and negative directions. There is no time limit for executing this function. If the increment limits parameterised are exceeded, an error stop is initiated.

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

Functional description

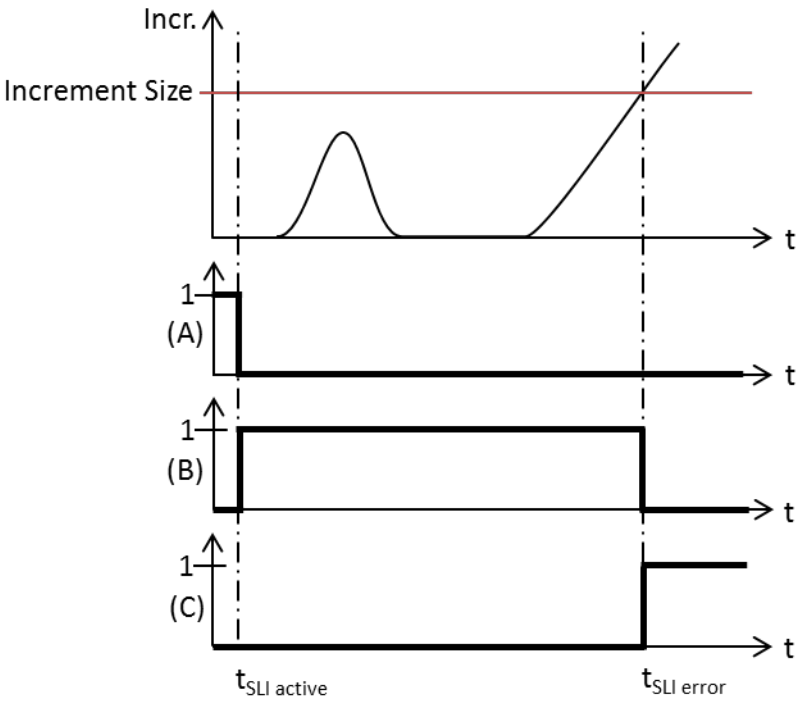


Fig. 17: SLI function

A	Triggering of the function	C	Error status
B	Monitoring active		

If the drive exceeds the increment parameterised in 0x28CA:001 (normal operation) or 0x28CA:003 (special operation), the stop function set in 0x28CA:002 is excecuted.

Activation of the function

The function cannot be activated if the drive is in Safe operating stop (SOS).

The function can be activated during operation.

The function is activated

- via the safety bus. For this purpose, a data telegram is sent to the inverter, see safety bus.
- as a function of the operating mode changeover (OMS) by activation of the special operation, Operation mode selector (OMS). 📖 139
- by the OFF state on a safe input. For the OFF state, a function is parameterised. See safe inputs.

Behaviour of the function in the event of an error

If the maximum permissible position change is exceeded, an error stop is initiated. The following functions can be set as safe stop:

- Safe torque off (STO) 📖 116
- Safe stop 1 (SS1) 📖 119
- Safe stop 2 (SS2) 📖 121

When exceeding the position change in the OMS mode, the error stop set there is used. See chapter " ▸ Operation mode selector (OMS)". 📖 139

Safe direction (SDI)

The function monitors the direction of rotation of the motor. A parameterisable tolerance threshold ensures that the drive does not change the permissible direction of rotation. Within the limits parameterised, the drive can rotate in the impermissible direction of rotation.

NOTICE

The delay in 0x28BA:002 is parameterised with a value > 0.

Machine parts and parts of the facility can be destroyed if this setting is not taken into consideration for the calculation of the safety distance.

► Only utilise this function if the safety distance has been calculated previously, taking the delay set into consideration.

► If necessary, the "SDIpos observed" or "SDIneg observed" feedback must be evaluated (via the safety bus or via a safe output).

⚠WARNING!

A safety-rated encoder system must be used.

Without an encoder, this safety function cannot be used.

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

Condition

- The risk analysis must ensure that the deceleration presents no danger.
- The application leads the drive into the permissible direction of movement.

Conditions

- The risk analysis must ensure that the delay does not pose any hazard.
- The application leads the drive to the permissible direction of rotation.

Functional description

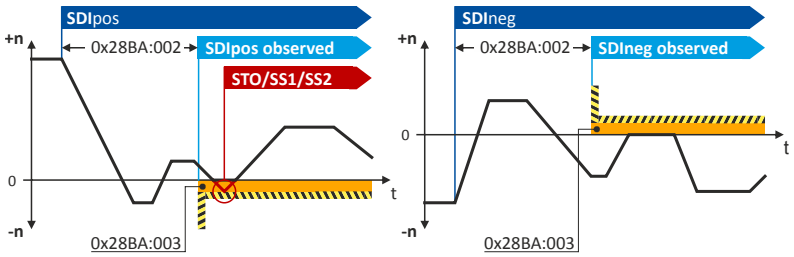


Fig. 18: SDI configuration modes

For operation within the limit values, the SDIpos observed (0x28BB:001) or SDIneg observed (0x28BB:002) status is set.

The status can

- be assigned to the safe output (0x28BB:001 or 0x28BB:002) or
- can be reported via the safety bus (0x28B9:001 or 0x28B9:002).

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces". 📖 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

For normal operation, the safe direction can be set via a safe parameter.

The safe direction can be combined with the Safely-limited speed (SLS) function. 📖 127

If the tolerance threshold for the SDIpos or SDIneg direction set (0x28BA:003) is exceeded after the delay time has elapsed (0x28BA:002), an error message is triggered and the stop function set in 0x28BA:S004 is activated.

Safely-limited position (SLP)

The function monitors the lower and upper position limit.

Preconditions

The following function must be executed:

- Set upper position value.
- Set lower position value.
- Safe homing (SHOM)

Functional description

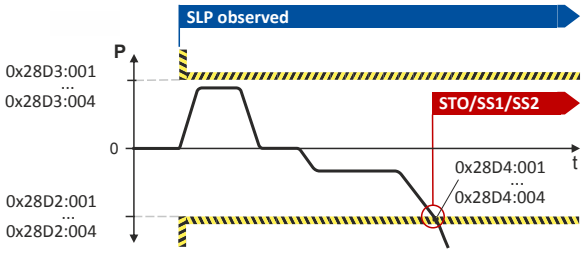


Fig. 19: SLP function

For operation within the upper limit value, the SLPpos observed status is used. 0x28D3:000
For operation within the lower limit value, the SLPneg observed status is used. 0x28D2:000

The upper and lower position limits parameterised are monitored at the time of the request, see SLPx observed status bit.

The status can

- be assigned to the safe output (0x28BB:001 or 0x28BB:002).
- be reported via the safety bus (0x28B9:001 or 0x28B9:002).

This function can be executed during normal operation and special operation. See
▸ Operation mode selector (OMS) . 🕮 139

Up to four absolute position setpoint pairs can be parameterised and monitored at the same time.

In connection with this function, please also observe the information with regard to safe homing in chapter Safe homing (SHOM).

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces".🕮 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

Behaviour of the function in the event of an error

If the Plim position limit is exceeded during the monitoring process,

- an error message is triggered.
- a stop function for the parameters set
  - 0x28D2:001 ... 0x28D2:004 the lower absolute position limit set
  - 0x28D3:001 ... 0x28D3:004 the upper absolute position limit set

  is triggered.

Position-dependent safe speed (PDSS)

The function

- monitors the speed of a drive as a function of of the absolute position along a motion range.
- allows for the utilisation of a physically limited motion range without the use of mechanical buffers and limit switches.
- can be parameterised as permanently active.

NOTICE

If the slip compensation is used, the diagnostic marks must be overtravelled cyclically.

Machine parts and parts of the facility may be destroyed if the slip compensation described is not taken into consideration for the respective application.

► Check the slip compensation for the respective application.

► Ensure a diagnostic interval test by a higher-level control component.

Functional description

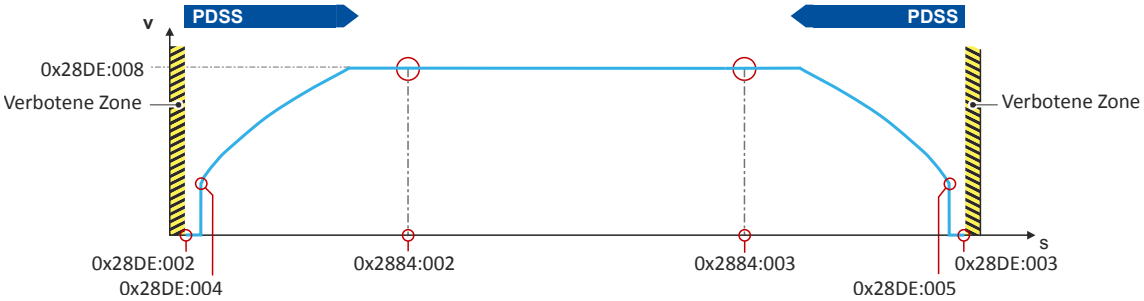
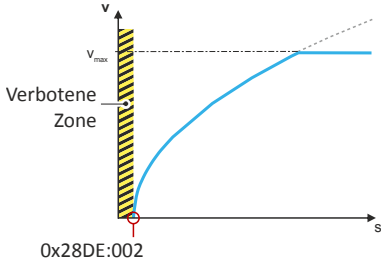
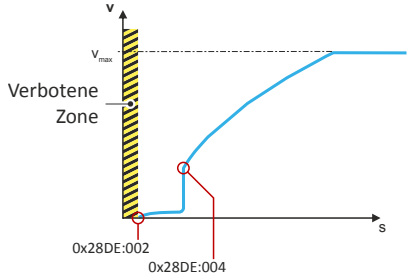


Fig. 20: PDSS function, representation of the key parameters

For this function, please also observe the description relating to the slip compensation in section Information on mechanical installation. 📖 36

Safe creeping speed (SCS)	
	
It depends on the application whether the drive approaches the position limit (0x28DE:002) with the limited speed v_{max} (0x28DE:008). The limited speed is predefined by the monitoring function.	By parameterising a safe creeping speed (SCS), the prohibited zone can nearly be approached. The distance to the position limit (0x28DE:002) and the tolerance parameterised must be selected extensively enough to rule out a collision. The speed changeover depending on the direction of rotation makes it possible for the drive to move away from the prohibited zone at maximum speed.

In connection with this function, please also observe the information with regard to safe homing. See chapter Safe homing (SHOM). 📖 135

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces". 📖 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

Error behaviour

If the envelope curve is exceeded or when the absolute position limits are exited, an error message is triggered and an error stop with the function set in the 0x28DE:011 parameter is initiated.

Safe homing (SHOM)

This function supplements the position evaluation of the encoder systems used. See Information on mechanical installation. 📖 36

⚠WARNING!

In the switched-off state, the motor position must not be changed by external forces.

A change in the motor position causes injuries and may even result in death.

► Ensure that the motor position does not change.

Preconditions

In applications with only one position switch, this switch must be connected in parallel to the inputs X82/IRS and X82/IRL.

Functional description

The start of the homing process does not cause the drive to execute a homing process. The initialisation and motion control are both executed autonomously by the drive.

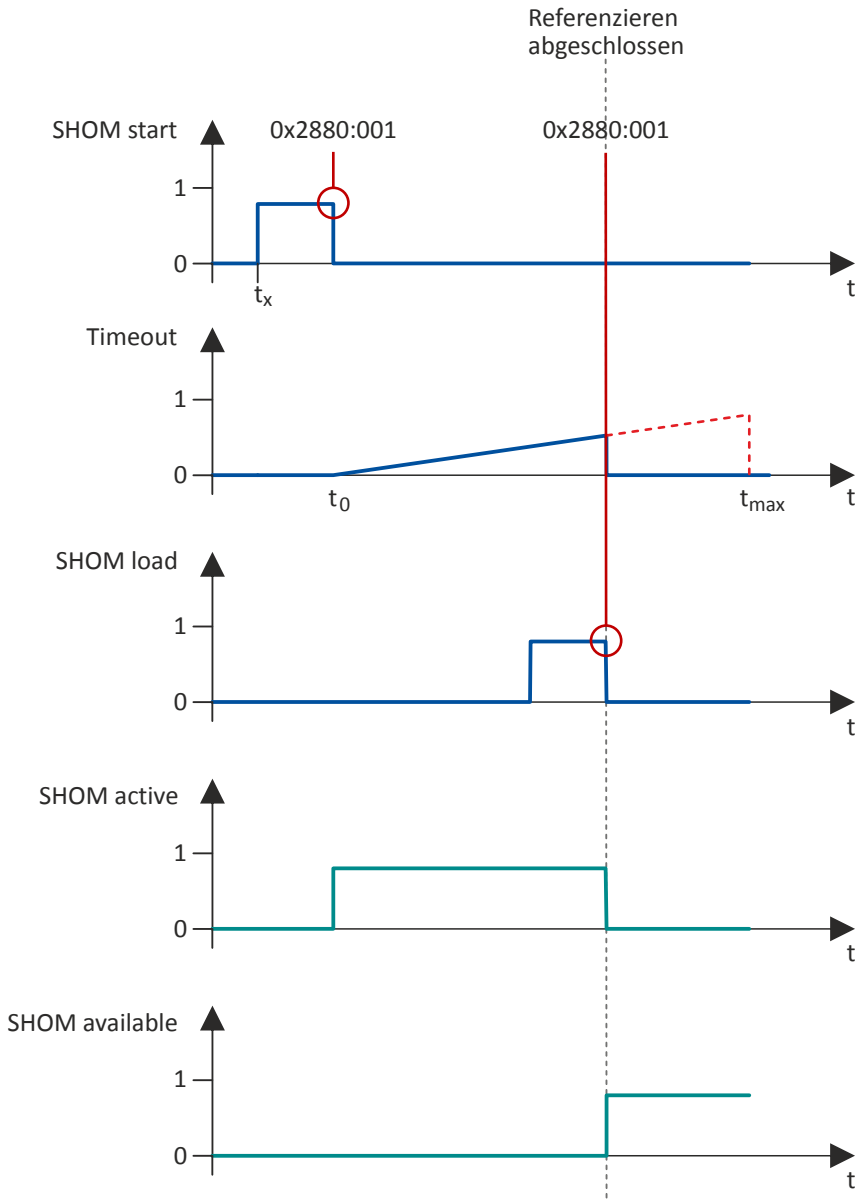


Fig. 21: Timing of the SHOM function

The homing process is for example started via the IRS signal (source can be set in 0x2880:001).

The safely limited speed (SLS) is always activated. ▸ Safely-limited speed (SLS) 🕮 127.

Within a time period defined in 0x2882:002 (timeout), the 0x2881:001 reference signal is expected via the input X82/IRL (SHOM-Load). The reference signal defines the safe reference point 0x2882:001 (home position) in the absolute area.

When the reference point has been defined, homing is completed. A changeover to normal operation will follow.

The home position parameterised is the absolute reference point for these safety functions:

- Safely-limited position (SLP) 📖 132
- Position-dependent safe speed (PDSS) 📖 133
- Safe cam (SCA) 📖 138

The following states are shown:

- The "SHOM active" state is reset (display in 0x2882:006).
- The "SHOM available" state is set (display in 0x2882:006)

Mini-homing

The mini-homing process serves to reach plausibility of the safety function's absolute position values. The mini-homing process is carried out via the Safely-limited speed (SLS) function and is monitored by the safety function.

Prerequisites

- The safely limited speed Nlim must have been parameterised. C28C2:001
- The distance of the mini reference run must ≥ the 4-fold value of the parameter to be configured. C287C:001

Completion of the mini-homing process

After the mini-homing, the status bit is set. C2882:006

After returning from the above-mentioned states, with a parameterised safe home position, the path of motion control can generally adopt the motion in the direction of the home position.

Safe cam (SCA)

The function monitors the lower and upper position limit.

Preconditions

The following function must be executed:

- Set upper position value.
- Set lower position value.
- Safe homing (SHOM)

Functional description

In connection with this function, please also observe the information with regard to safe homing in chapter Safe homing (SHOM).📖 135

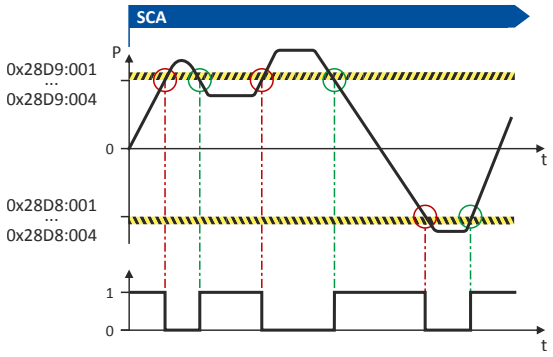


Fig. 22: SCA function

When this function is executed, the current absolute position is compared to the position limits parameterised.

- Upper position limit parameterised (0x28D9:001 ... 0x28D9:004)
- Lower position limit parameterised (0x28D8:001 ... 0x28D8:004)

The status of the position comparison is specified in a binary fashion in 0x2870:002, bit12 ... bit15.

The status is transmitted to the safety and standard application.

Activation of the function

The function is activated by entry of a parameter value (≠ 0) for the upper and lower position limit.

Operation mode selector (OMS)

This function serves to switch between normal operation and special operation of the drive.

If the OMS safety function is requested via a HIGH signal, the safety function is switched off in the case of an open circuit. In this case, there exists no safety function in the case of an open circuit.

⚠ DANGER!

When returning to normal operation, automatic restart is not permissible.

Severe injuries and death.

► Parameterise manual restart.

⚠ WARNING!

Operating mode changeover (OMS) is activated via the safety bus.

If safe communication fails, the OMS function is deactivated.

► Configure at least one stop function (STO, SS1 or SS2).

Functional description

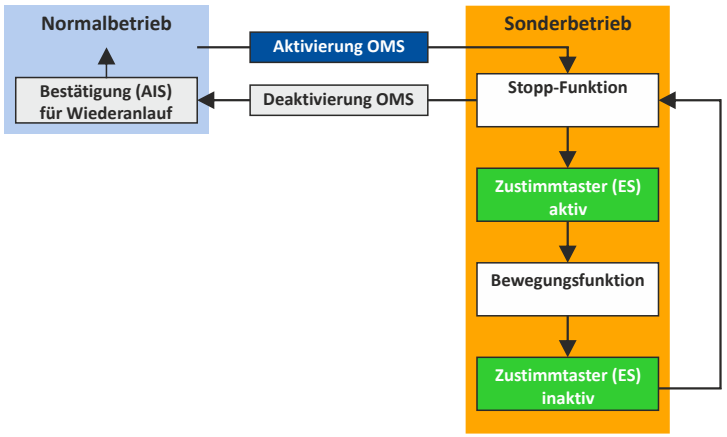


Fig. 23: OMS function

Special operation (OMS) provides for overwriting a normal stop STO, SS1 and SS2 by activating the enable switch (ES), see Enable switch (ES) function. 📖 141

A detected error in special operation activates the stop function that is correspondingly parameterised there (Safe torque off (STO), Safe stop 1 (SS1) or Safe stop 2 (SS2)). The stop function can be parameterised in special operation as stop function.

If a request for special operation is pending ("OMS activation"), the stop function that is parameterised for special operation in 0x28A9:001 (Safe torque off (STO), Safe stop 1 (SS1) or Safe stop 2 (SS2)) is started.

Via Safely-limited increment (SLI), the motion function (SLS or retracting) parameterised for special operation in 0x28A9:002 can be executed.

Furthermore, 0x28CA:003 can be used to switch on the monitoring function (Safely-limited increment (SLI)) for the motion function parameterised.

The setting "0" deactivates the SLI monitoring function.

Activation of special operation

By means of the "Operation mode selector" function, special operation is activated by an "ON state" on a safe input. The function Enable switch (ES) must have been assigned to the corresponding input by parameterisation.

Only if no safe input is utilised, the function can be activated via the safety bus. Via the safety bus, a data telegram with a corresponding content is sent to the inverter, see safety bus .

Deactivation of special operation

- A changeover from special operation to normal operation can only be effected when the drive is at a standstill, see Safe torque off (STO), Safe stop 1 (SS1) or Safe stop 2 (SS2) .
- In the case of a restart, the restart (AIS) must be acknowledged via the terminals or safety bus.
- An automatic restart is not permissible.
  - If "Automatic restart" is parameterised, this has to be prevented by special measures, e.g. programming in the master control.

Behaviour of the function in the event of an error

- The monitoring functions Safe maximum speed (SMS) and Safely-limited speed (SLS) can be activated in both operating modes (normal operation / special operation). In the event of an error, the stop function paramterised (STO, SS1 or SS2) is triggered.
- With an activated monitoring function Safely-limited increment (SLI), exceeding the position window triggers the stop function parameterised for special operation.

The "Emergency stop" function can be triggered in normal operation and in special operation and has the highest priority.

Enable switch (ES)

This function makes it possible to override the normal stop functions

- Safe torque off (STO),
- Safe stop 1 (SS1) and
- Safe stop 2 (SS2)

in special operation.

Preconditions

A safe input or the safety bus can be used for connecting an enable switch. If the safe input is used, the **ES** bit of the safety bus must be deactivated. If no safe input is parameterised, the safety bus can be used for activation.

- Activate special operation Operation mode selector (OMS).
- Activate special operation Repair mode selector (RMS).

The plausibility check rejects ambiguous settings until they are parameterised correctly.

Functional description

The enable switch activates the motion function parameterised during special operation (OMS) and the repair mode (RMS). The drive can be traversed.

The stop times assigned to the stop functions are directly deactivated or stopped.

Activation of the function

The function is activated by the ON state of a safe input.

The Functional safety function must have been assigned to the corresponding input by parameterisation.

If no safe input is utilised, the function can be activated via the safety bus. Via the safety bus, a data telegram with a corresponding content is sent to the inverter, seesafety bus.

Repair mode selector (RMS)

This function moves the drive from a situation that is blocking it ("Deadlock").

In the safety concept, this state is taken into consideration as a special case for actuating an axis connected. The encoders connected are not evaluated in a safety-oriented fashion.

⚠WARNING!

Repair mode select (RMS) is activated via the safety bus.

If the safe communication fails, the RMS function will be deactivated.

► Configure at least one stop function (STO, SS1 or SS2).

⚠DANGER!

In the RMS operating mode unexpected movements with an unexpected speed may occur.

In the RMS operating mode, the permissible motion limits of the axis may be violated.

► The use of the RMS function is exclusively permissible to release an axis from a "deadlock". If possible, the OMS function should be used!

► In the RMS operating mode, exclusively the enable switch is effective. Ensure, if necessary by additional safety measures, that no persons can be endangered.

In the repair mode, the safety functions are solely restricted to the parameterisable STO and SS1 stop functions (without ramp monitoring) and the effectiveness of the enable switch.

⚠DANGER!

When returning to normal operation, automatic restart is not permissible.

Severe injuries and death.

► Parameterise manual restart.

Functional description

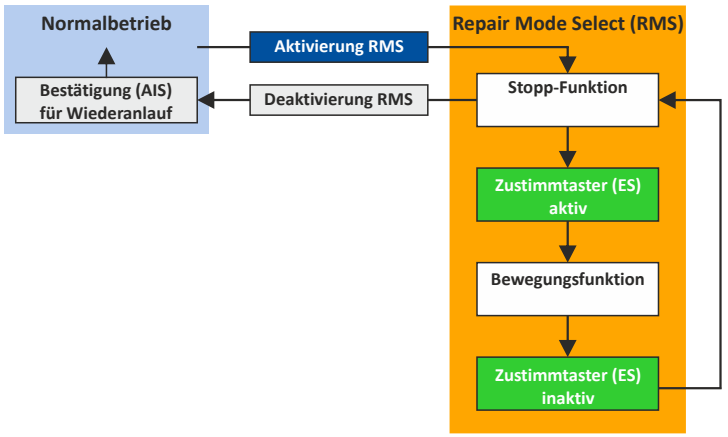


Fig. 24: RMS function

In the repair mode, speed functions and absolute position functions are deactivated. The SHOM status is reset. ▸ Safe homing (SHOM) 🕮 135

Request of the repair mode

The repair mode is requested by the "ON state" on a safe input. The function must have been assigned to the corresponding input by parameterisation.

Only if no safe input is utilised, the function can be activated via the safety bus. Via the safety bus, a data telegram with a corresponding content is sent to the inverter, see safety bus .

Behaviour of the function in the event of an error

If the position values of the motor encoder and the load encoder do not comply after the repair mode has been exited, the following error states are displayed if absolute position monitoring is active:

- Exit position window
- Slip error
- Deactivation of Safe homing (SHOM). 📖 135

STO cascading (CAS)

This function allows for the synchronised shutdown of an entire drive network.

Preconditions

- As source for the cascading request, the SD-In4 input must be parameterised. 0x2124, 4: SD-In4
- As an active input for the "Emergency stop" function and the input delay, a value ≤ 10 ms must be parameterised for SD-In4. Safe inputs
- As executing stop function, the "Safe torque off (STO)" function must be parameterised. Safe stop emergency (SSE) 0x28A3:001 🕮 118
- As restart behaviour of the drive after executing Safe torque off (STO), "Acknowledged restart" must be parameterised. 0x2892:001
- The control of the SD-Out1 output via a parameterised safety bus must be inhibited. Safety bus

The plausibility check rejects other settings until the plausibility check is parameterised correctly.

- If the cascading safety function is used in connection with special operation, "SS2" must be parameterised as stop function in the operation mode selector (OMS).

The STO stop function will trigger the "Cascading" function. Activation by means of the enable switch (ES) is not possible.

Description of the principle

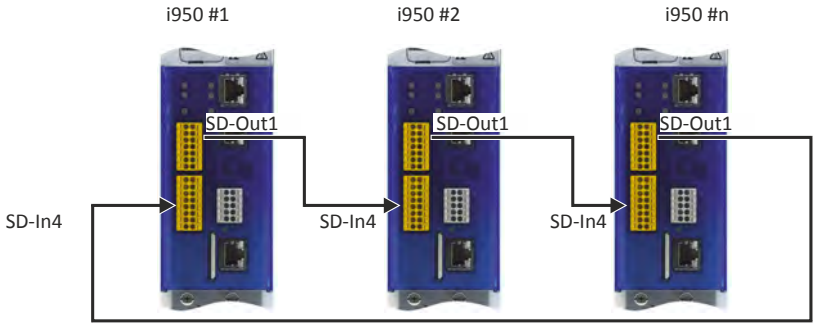


Fig. 25: CAS function

With 0x2125:001, the time period is shown, which elapses from switching the SD-Out1 output to the OFF state to recording the OFF state at the SD-In4 input.

- If, after a stop, the time period "0 ms" is shown, another safety function has triggered the stop via the cascade.
- The time period is shown until the next system acknowledgement takes place.

Activation of the function

The function is activated by parameterisation of the SD-In4 input as source for a cascading request (0x2124, 4: SD-In4).

Safe brake control (SBC)

(From standard device firmware V1.3, safety firmware V1.1 with parameter set version V1.1)

The SBC function provides for a safe brake control by the inverter.

The internal test rate of the brake output (X106) restricts the request rate to max. 1 brake request/10 seconds.

An application-dependent test rate of the connected brake reduces the request rate accordingly.

Conditions

In order to use the SBC function, the following conditions must be fulfilled:

- The brake is connected to X106.
- Brake function and monitoring of the brake control are controlled via X106 ▸ Motor holding brake connection 🕮 55.
- Parameter 0x2820:023 and 0x2820:005:
  - Both parameters must be set to "0".
  - Other settings are not compatible with the SBC function.

    The warning "Incompatible SBC device configuration – 0x6187" is output.

    STO stop function is activated.

⚠ DANGER!

Use of non-safety-rated brakes

Severe injuries or death.

► Only use safety-rated brakes with suitable safety-related parameters according to EN ISO13849-1 and/or EN 62061 or IEC 61508.

Functional description

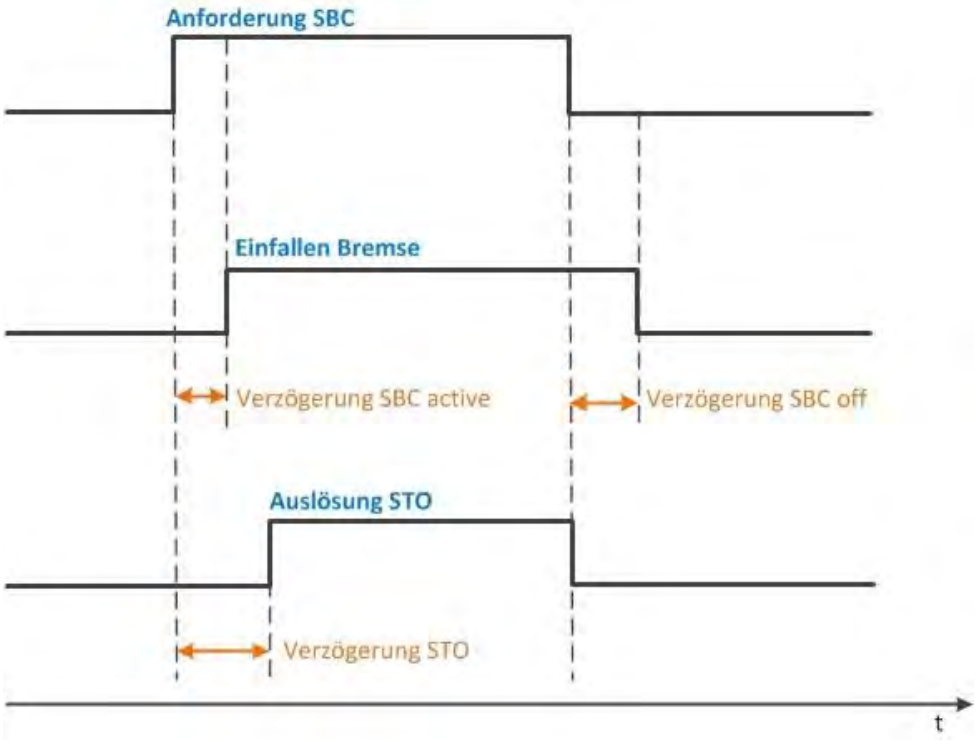


Fig. 26: SBC function

Activation of the function

A data telegram is sent to the inverter via the safety bus. See chapter "Safe network interfaces". 148

Via a safe input, if the corresponding parameter is assigned to the safe input.

Response of the function in the event of an error

If an error is detected, the control of the brake is switched off.

If 0x28E6:001 = 1 (SBC without STO) is parameterized, no stop function is activated in the event of an error.

Safe muting (MUT)
(From standard device firmware V1.3, safety firmware V1.1 with parameter set version V1.1)

The “safe muting” safety function may only be used during commissioning or maintenance work.

It serves to move the motor even if the inverter is in a safety state.

The safe muting function deactivates selected safe inputs and all functions of the safety bus.

The safe muting function can only be activated via the LSPE (Lenze Safety Parameter Editor). For this purpose, a special muting password must be entered.

Within a network, the safe muting function can always only be activated for one inverter.

The safe muting function is maximally active for 30 minutes. It can be interrupted or stopped anytime.

Please note the following:

If the safe muting function is stopped or interrupted by an error, the inverter automatically changes to the monitored state.

All safety functions that have been deactivated before become active again.

⚠ DANGER!

Activating the safe muting function deactivates safety functions!

This may result in severe injuries or death!

► Only authorized personnel is permitted to activate the safe muting function.

► One input must be parameterized as emergency stop. This input must not be deactivated by safe muting.

Conditions

In order to activate the safe muting function, you need the following:

- A PC with »Easy Starter« (1.16 or higher) or »PLC Designer« with LSPE (Lenze Safety Parameter Editor).
- A permanent communication link between LSPE and inverter.

  If the connection is interrupted during safe muting, safe muting is aborted immediately with an error message. The inverter changes to the monitored operation where all safety functions are active again.
- A valid parameter set that contains the settings for safe muting:
  - The sources to be hidden. 0x213A
  - The muting password. 0x213B:001

Activation of the function

Activate safe muting

1. Go to the »Easy Starter« and open the **Safety parameter list** tab.
2. Select safe muting.
3. Enter password.
4. Check information in the window and ensure that the correct device has been selected.
   The optical device detection is activated automatically. The blinking blue LED indicates the inverter with activated safe muting.
5. **Start** activates the safe muting function.

The safe muting function is active now.

Deactivation of the function

Deactivate safe muting

1. **Close** deactivates the safe muting function for the input.

The safe muting function is inactive now.

Safe network interfaces

PROFIsafe connection

This function makes it possible to perform the synchronised shutdown of an entire drive group.

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 organisation (PNO). The inverter forwards the PROFIsafe information to the function for secure evaluation.

PROFIsafe	The certified safety protocol for the transfer of safety-related data via PROFINET®.

PROFIsafe connection	Inverter	Safety bus: configuration 0x2128:000
PROFINET	i950	PROFIsafe/PROFINET

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.

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 • 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.

PROFIsafe output data

The PROFIsafe output data (control data) is transmitted from the control.

The value of a bit in the table indicates the active bit state:

- 0 = the function is LOW-active.
- 1 = the function is HIGH-active.
- 0↗1 = a LOW-HIGH edge activates the function.

Bit	Name	Value	Information
0	STO	0	The STO function is activated.
1	SS1	0	The SS1 function is activated.
2	SS2	0	The SS2 function is activated.
3	SLS1	0	The SLS1 function is activated.
4	SLS2	0	The SLS2 function is activated.
5	SLS3	0	The SLS3 function is activated.
6	SLS4	0	The SLS4 function is activated.
7	SDIpos	0	The SDIpos function is activated.
8	SDIneg	0	The SDIneg function is activated.
9	ES	1	Confirmation is active: During special operation, motion functions are possible.
10	SLI	0	The SLI function is activated.
11	OMS	0	Normal operation = OMS is deactivated.
		1	Special operation = OMS is activated.
12	SLP1	0	The SLP1 function is activated.
13	SLP2	0	The SLP2 function is activated.
14	SLP3	0	The SLP3 function is activated.
15	SLP4	0	The SLP4 function is activated.
16	AIS	0↗1	Activate restart acknowledgement. The bit must be set for at least one S bus cycle.
17	AIE	0↗1	Activation of error acknowledgement. The bit must be set for at least one S bus cycle.
18	SOS	0	The SOS function is activated.
19	RMS	0	Repair mode select = RMS is deactivated.
		1	Repair mode select = RMS is activated.
20	SHOM Start	0↗1	Starts the homing process.
21	SHOM load	0↗1	Acceptance of the absolute home position parameterized.
22	PDSS	0	The PDSS function is activated.
23	SSE	0	The SSE function is activated.
24	SD-Out1	1	The SD-Out1 output is set to ON state.
25	SBC	0	The SBC function is activated.
26	Reserved		

The parameter S-bus: display control data displays the control data. 0x2874:000.

PROFIsafe input data

The PROFIsafe input data (status information) is transmitted to the control.

The value of a bit in the table indicates the active bit state:

Bit	Name	Value	Information
0	STO active	1	The STO function is active and the drive is safely switched to torqueless operation. • This bit is also set by SS1 after the stopping time has elapsed.
1	SS1 active	1	The SS1 function is active. • At the end of the function the bit 0 (STO active) is set.
2	SS2 active	1	The SS2 function is active. • At the end of the function bit 16 (SOS monitored) is set.
3	SLS1 active	1	The SLS1 function is active. • After the Nlim1 braking time has elapsed, bit 17 (SLS1 monitored) is set in addition.
4	SLS2 active	1	The SLS2 function is active. • After the Nlim2 braking time has elapsed, bit 18 (SLS2 monitored) is set in addition.
5	SLS3 active	1	The SLS3 function is active. • After the Nlim3 braking time has elapsed, bit 19 (SLS3 monitored) is set in addition.
6	SLS4 active	1	The SDIpos function is active. • After the Nlim4 braking time has elapsed, bit 20 (SLS4 monitored) is set in addition.
7	SDIpos active	1	The SDIpos function is active. • After the delay time has elapsed, bit 21 (SDIpos monitored) is set in addition.
8	SDIneg active	1	The SDIneg function is active. • After the delay time has elapsed, bit 22 (SDIneg monitored) is set in addition.
9	ES active	1	ES function is active during special operation: Motion function
		0	ES function is not active during special operation: Stop function
10	SLI active	1	The SLI function is active.
11	SOS active	1	The SOS function is active. In an error-free state, bit 16 (SOS monitored) is set in addition.
12	SLP1 monitored	1	The SLP1 function is active. Compliance with the parameterized absolute position limits is monitored.
13	SLP2 monitored	1	The SLP2 function is active. Compliance with the parameterized absolute position limits is monitored.
14	SLP3 monitored	1	The SLP3 function is active. Compliance with the parameterized absolute position limits is monitored.
15	SLP4 monitored	1	The SLP4 function is active. Compliance with the parameterized absolute position limits is monitored.
16	SOS monitored	1	The SOS function is active. The safe operating stop is monitored.
17	SLS1 monitored	1	The SLS1 function is active. Compliance with the limited speed 1 is monitored.
18	SLS2 monitored	1	The SLS2 function is active. Compliance with the limited speed 2 is monitored.
19	SLS3 monitored	1	The SLS3 function is active. Compliance with the limited speed 3 is monitored.
20	SLS4 monitored	1	The SLS4 function is active. Compliance with the limited speed 4 is monitored.
21	SDIpos monitored	1	The SDIpos function is active. Compliance with the safe direction SDIpos is monitored.
22	SDIneg monitored	1	The SDIneg function is active. Compliance with the safe direction SDIneg is monitored.
23	SSE monitored	1	The SSE function is monitored. • When the emergency stop function STO is parameterized, bit 0 (STO active) is set as well. • When the emergency stop function SS1 is parameterized, first bit 1 (SS1 active) is set and at the end of the function bit 0 (STO active) is set.
24	SD-In1	1	Sensor at I1A and I1B: Channels A and B are in the ON state.
25	SD-In2	1	Sensor at I2A and I2B: Channels A and B are in the ON state.
26	SD-In3	1	Sensor at I3A and I3B: Channels A and B are in the ON state.
27	SD-In4	1	Sensor at I4A and I4B: Channels A and B are in the ON state.

Bit	Name	Value	Information
28	RMS active	1	Repair mode select is activated.
		0	Repair mode select is deactivated.
29	OMS active	1	The OMS function is active. Special operation • In contrast to bit 11 (OMS), this bit remains set until the special operation is canceled and the change-over to normal operation has taken place via the stop function.
		0	The OMS function is not active Normal operation.
30	SMS monitored	1	The SMS function is active. Compliance with the maximum limited speed SMS is monitored.
31	Error active	1	Error status is active (fault or warning).
32	SHOM active	1	Homing / mini-homing is active.
33	SHOM available	1	Homing / mini-homing is has been completed. Safe reference is known.
34	PDSSpos monitored	1	For position-dependent speed monitoring, the positive direction of movement is monitored.
35	PDSSneg monitored	1	For position-dependent speed monitoring, the negative direction of movement is monitored.
36	SCA1 within the limits	1	Safe cam 1 has been parameterized and is complied with.
37	SCA2 within the limits	1	Safe cam 2 has been parameterized and is complied with.
38	SCA3 within the limits	1	Safe cam 3 has been parameterized and is complied with.
39	SCA4 within the limits	1	Safe cam 4 has been parameterized and is complied with.
40	SSM within the limits	1	Safe speed monitoring SSM has been parameterized and is complied with.
41	Safe speed OK	1	"Safe speed" status signal • The speed value displayed is valid. • Value = 0: The speed value displayed is invalid.
42	n = 0	1	The safe speed is within the tolerance window parameterized. 0x287B:001 • Value = 0: n ≠ 0
43	Positive direction of movement	1	Status signal for showing the direction of movement • Value = 0: Negative direction of movement
44	SD-Out1	1	Safe output 1 (feedback output) in the ON state.
45	SBC active	1	The SBC function is active. After the delay time has elapsed, bit 46 (SBC monitored) is set in addition.
46	SBC activated	1	The SBC function is active. The brake control is safely switched off.
47	MUT active	1	Safe muting is active. The parameterized safety functions are hidden.
48-55	n safe, byte 0	Safe speed in rpm, byte 0	
56-63	n safe, byte 1	Safe speed in rpm, byte 1	
64-71	p safe, byte 0	Safe position in increments, byte 0	
72-79	p safe, byte 1	Safe position in increments, byte 1	
80-87	p safe, byte 2	Safe position in increments, byte 2	
88-95	p safe, byte 3	Safe position in increments, byte 3	

FSoE connection

Safety over EtherCAT	Fail-safe-over-EtherCAT (FSoE) enables the transmission of safe information via FSoE protocol in compliance with the "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.

Description

Safe transmission of information via EtherCAT.

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.

FSoE frame

Range	Values
FSoE data	Safety outputs: 11 bytes
	Safety inputs: 31 bytes

ESI file

The ESI file contains the information required to configure the EtherCAT.

You will find the current ESI file for this Lenze product on the Internet in the "Downloads" area under **http://www.Lenze.com**.

FSoE output data

The FSoE output data (control data) is transmitted from the control.

	Bit offset							
Byte offset	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Byte 0	Command (CMD)							
Byte 1	AIE	SDIneg	SDIpos	-	SOS	SS2	SS1	STO
Byte 2	SSE	SLI	ES	RMS	OMS	SHOM load	SHOM start	AIS
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	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)							

FSoE input data

The FsoE input data (status information) is transmitted to the control.

	Bit offset							
Byte 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 withinLimit	SCA3 withinLimit	SCA2 withinLimit	SCA1 withinLimit	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 obs.	PDSSpos obs.	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)							

Acceptance

If parameters of the safety functions are changed, the inspector must repeat the test and record the results in the test report.

Description

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

Inspector

The machine manufacturer must authorize a person with expertise and knowledge of the safety functions to carry out the test.

Inspection report

The test result of every safety function must be documented and signed by the inspector.

Scope of inspection

A complete test comprises the following:

- Documenting the plant including the safety functions:
  - Creating an overview of the installation
  - Describing the installation
  - Describing the safety equipment
  - Documenting the safety functions used
- Checking the function of the safety functions used.
- Preparing the test report:
  - Documenting the functional test
  - Checking the parameters
  - Signing the test report
- Preparing the appendix with test records
  - Logs from the installation
  - External recording

Periodic inspections

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

LED status display

On its front, the inverter indicates the "STO active" device state via the right "RDY" LED.

You can gather the meaning of the "RDY" and "ERR" LEDs (left side) from the following two tables:

LED "RDY" (yellow)	State	Meaning
off	-	No status message active
On (yellow)	-	Restart acknowledgement requested
Blinking yellow 2 Hz	SOS active	
Blinking yellow 1 Hz	Service state	Parameter set transfer requested.

"ERR" LED (red)	State	Meaning
off	-	The device is working correctly.
on (red)	Critical device error	The device is defective and must be replaced.
Blinking red 2 Hz	Bus error	Safety communication interrupted.
Blinking red 1 Hz	Error detection in the safety system	One of the following errors has been detected: • Speed exceeded • Discrepancy of the inputs • Acknowledgable errors

LED status during parameter set transfer

LED "RDY" (yellow)	"ERR" LED (red)	Meaning
On	Blinking 1Hz	At start-up, a modified parameter set has been detected. Acknowledge with button S82.

LED "RDY" (yellow)	"ERR" LED (red)	Meaning
on	Blinking 2 Hz	A modified safety address has been detected during the parameter set transfer in the "Init" state. Acknowledge with button S82.

Technical data

Rated data

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 ▸ Rated data 🕮 155

Basic safety - STO

Safety-related characteristics according to EN 61508, Part 1–7 and EN 62061

Specification	Value	Comment
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

Safety-related characteristics according to EN ISO 13849–1

Specification	Value	Comment
Performance level	e	
Category	4	
$MTTF_d$	High	> 100 years
Mean diagnostic coverage DC_{avg}	High	99 %

Basics of the safety-related characteristics

Basic	Value	Comment
Source of failure rates	SN 29500	When no values from the component manufacturers were available.
Average max. ambient temperature	60 °C	

Extended safety

Safety-related characteristics according to IEC 61508, Part 1–7 and EN 62061 for all safety functions except for SBC

Specification	Value	Comment
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

Safety-related characteristics according to IEC 61508, Part 1–7 and EN 62061 for SBC safety function

Specification	Value	Comment
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

Safety-related characteristics according to EN ISO 13849–1 for all safety functions except for SBC

Specification	Value	Comment
Performance level	e	
Category	4	
$MTTF_d$	High	> 250 years
Mean diagnostic coverage DC_{avg}	High	95 %

Safety-related characteristics according to EN ISO 13849–1 for SBC safety function

Specification	Value	Comment
Performance level	d	
Category	2	
$MTTF_d$	High	> 230 years
Mean diagnostic coverage DC_{avg}	High	95 %

Basics of the safety-related characteristics

Basic	Value	Comment
Source of failure rates	SN 29500	When no values from the component manufacturers were available.
Average max. ambient temperature	60 °C	

Response times

The overall system must be taken into account when determining the response time following a safety function request.

The following is essential for the response time:

- Response time of the connected safety sensors.
- Input delay of the safety inputs.
- Internal processing time.
- Delay times, braking times, and stopping times from the parameterized safety functions.
- When using a feedback system:
  - The response time of encoder monitoring.
- When using a safety bus:
  - Monitoring time for cyclic services.
  - Monitoring time in the safety PLC.
  - Processing time in the safety PLC.
- Delay times due to further components.

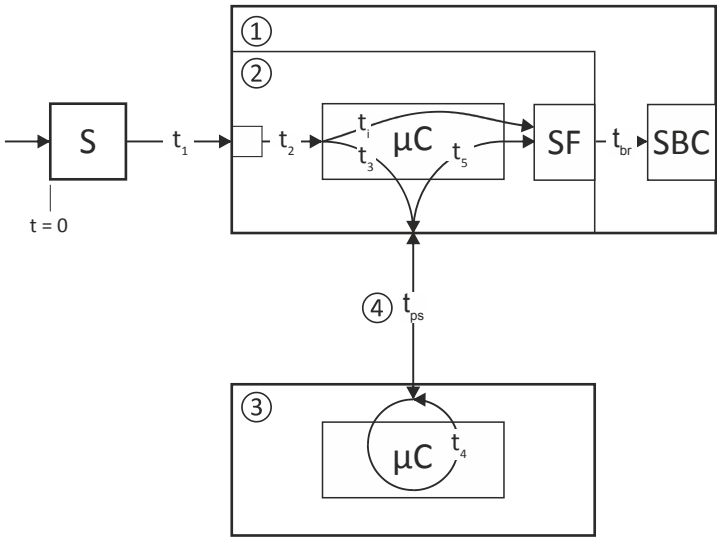


Fig. 27: Response times to the request of a safety function

1	Standard device	µC	Microcontroller
2	Integrated safety system	S	Safety sensor technology
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 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 time of encoder monitoring			[ms]
	Time required to detect faults caused by continuous signal errors at the encoder interface.		
			12
		Parameterizable via: 0x2878:004	12/50/100

It is necessary to assess the minimum response time required for the respective system. A longer response time results in a higher system availability if, for instance, short-time, process-related speed steps occur at safe operational stop during setting-up operation.

Response times of the safety bus

Response time to an event in 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 drive-based safety system		
	Cycle time - Main Task	Technology application	1
		PLC project	As set
	Internal transmission time PROFIsafe	Safety: Firmware 1.0.1 Standard device: Firmware 1.2	40
		Safety: Firmware 1.1.x Standard device: Firmware 1.3	40
	Internal transmission time PROFIsafe	Safety: Firmware 1.1.x Standard device: Firmware 1.3	8
Input data ready for transmission			$t_1 + t_2 + t_3$
t_{ps}	Cycle time PROFINET		See manufacturer information
Input data ready for processing in the safety PLC			$t_1 + t_2 + t_3 + t_{ps}$

Tab. 3: Response time to an event in the safety sensors

Response time to a control word (output data)			[ms]
t_4	Processing time in the safety PLC		Calculate
t_{ps}	Cycle time PROFINET		See manufacturer information
t_5	Processing time in drive-based safety system		
	Cycle time - Main Task	Technology application	1
		PLC project	As set
	Internal transmission time PROFIsafe	Safety: Firmware 1.0.1 Standard device: Firmware 1.2	108
		Safety: Firmware 1.1.x Standard device: Firmware 1.3	108
	Internal transmission time FsoE	Safety: Firmware 1.1.x Standard device: Firmware 1.3	16
	Cycle time Safety		4
Safety function starts after			$t_4 + t_{ps} + t_5$

Tab. 4: Response time in case of a safety bus request

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 has occurred at a safe input, the message is fed back to drive-based safety via the safety PLC.
- Drive-based safety activates a safety function.
- Hence, the maximum response time to the event is calculated as follows:
  - $t_{max} = t_1 + t + t_3 + \max (F\_WD\_Time; t_{ps} + t_4 + t_{ps} + t_5)$
  - When calculating the maximum response time, include the times of the safety functions, e.g. in case of SS1 the stopping time until STO is active. 0x2894:001

Parameter set acceptance from the SD card

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

Acknowledging the parameter set or the safety address

The parameter set and the safety address are acknowledged by the same procedure.

The parameter set transfer is aborted if the response time of 2.5 seconds is exceeded.

The parameter set transfer must be repeated.

How to acknowledge the parameter set or the safety address.

- 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 within the space of 2.5 seconds.
   The "RDY" LED is lit.
4. Press and hold the S82 button within the space of 2.5 seconds.
   The "RDY" LED starts blinking.
5. The "RDY" LED goes off after 3 seconds.
6. Release the S82 button within the space of 2.5 seconds.
   The new parameter set or new safety address has been acknowledged.

The action is recorded in the inverter logbook.

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

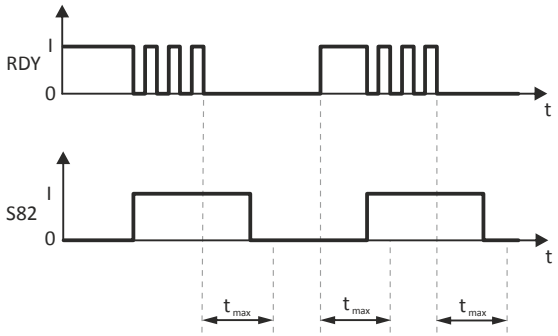


Fig. 28: Sequence of the acknowledgement procedure

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

Accessories

Purpose-built accessories support the realisation of drive tasks with the servo inverter.

Overview

For the i950, the following accessories are available:

- Memory modules 📖 163 (as SD card)
- Brake resistors 📖 163
- RFI filters / Mains filters 📖 164

(supply modules)

- Power supply units 📖 165
- Mounting 📖 166 (kits for installation)

(cables and system wires)

Operation and diagnostics

All diagnostics tasks can be performed with the Lenze software EASY-Starter.

The engineering port interface (Ethernet-based) is provided by default for this purpose.

Setpoint 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 setpoint 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.

Setpoint potentiometer		
Order code	**Name**	**Type**
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

Overview of the required Application Credit

	Technology applications	Technology modules	Required Application Credit
Actuating drive	CiA 402	-	0
	CiA 402 Advanced		50
Parameterizable	Speed control Electronic gearbox Table positioning	-	50
	Synchronism with mark correction Winder with dancer control Winder with tension control		100
Programmable	Speed control Electronic gearbox Table positioning	Speed control Electronic gearbox Table positioning Flex CAM	≥ 150
	Synchronism with mark correction Winder with dancer control Winder with tension control	Sync & correction Winder dancer Winder tension Cross cutter	≥ 200
	-	User	≥ 300

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.

The matching assignment of these accessories is specified in the technical data of the devices.

Mains chokes

- Chokes reduce the effects of the inverter on the supplying line voltage by smoothing the high-frequency interference.
- The effective line voltage current is reduced, saving energy.
- Chokes can be used without restrictions in conjunction with RFI filters.
- Please note that the use of a choke reduces the line voltage at the input of the inverter by about 4% (typical voltage drop across the choke at the rated point).

The matching assignment of these accessories is specified in the technical data of the devices.

RFI filters / Mains filters

RFI and mains filters are used to ensure compliance with the EMC requirements of European Standard EN 61800-3. This standard defines the EMC requirements for electrical drive systems 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 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 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 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 61800−3 comply with EN 55011 class A group 2.

The matching assignment of these accessories is specified in the technical data of the devices.

Power supply units

For the external supply of the control electronics of the inverter.

The parameterisation and diagnostics can be executed when the mains input at the inverter is deenergised.

Order code		EZV1200-000	EZV2400-000	EZV4800-000	EZV1200-001	EZV2400-001	EZV4800-001
Rated voltage	V	230			400		
Rated mains current	A	0.8	1.2	2.3	0.3	0.6	1.0
Input voltage	V	AC 85 - 264 DC 90 ...350			AC 320 ... 575 DC 450 ...800		
Output voltage	V	DC 22.5 - 28.5					
Rated output current	A	5.0	10.0	20.0	5.0	10.0	20.0

Mounting

Shield mounting kit

Motor cable

If the shielding of the motor cable is centrally connected to an earthing busbar in the control cabinet, no shielding is required.

For a direct connection of the shielding of the motor cable to the inverter, the optionally available accessories can be used consisting of shield sheet and fixing clips or wire clamps.

From 22 kW onwards, the shield sheet is integrated.

Inverter	Shield mounting kit			
	Order code	Packaging unit Unit	Order code	Packaging unit Unit
i950-C0.55/400-3	EZAMBHXM018/M	5x motor shield plate 5x fixing clip 5x wire clamp (cable diameter 0.157 ... 0.591 in (4 ... 15 mm))	EZAMBHXM018/S	1x motor shield plate 1x fixing clip 1x wire clamp (cable diameter 0.157 ... 0.591 in (4 ... 15 mm))
i950-C0.75/400-3				
i950-C2.2/400-3				
i950-C4.0/400-3				
i950-C7.5/400-3	EZAMBHXM016/M	5x motor shield plate 5x fixing clip 5x wire clamp (cable diameter 0.394 ... 0.787 in (10 ... 20 mm)) 5x M4x12 screw	EZAMBHXM016/S	1x motor shield plate 1x fixing clip 1x wire clamp (cable diameter 0.394 ... 0.787 in (10 ... 20 mm)) 1x M4x12 screw
i950-C11/400-3				
i950-C15/400-3				
i950-C22/400-3	EZAMBHXM004/M	10x wire clamp (cable diameter 0.591 ... 1.102 in (15 ... 28 mm))	-	-
i950-C30/400-3	EZAMBHXM004/M	10x wire clamp (cable diameter 0.591 ... 1.102 in (15 ... 28 mm))	EZAMBHXM005/M	10x wire clamp (cable diameter 0.787 ... 1.457 in (20 ... 37 mm))
i950-C45/400-3				
i950-C55/400-3	EZAMBHXM004/M	10x wire clamp (cable diameter 0.591 ... 1.102 in (15 ... 28 mm))	EZAMBHXM005/M	10x wire clamp (cable diameter 0.787 ... 1.457 in (20 ... 37 mm))
i950-C75/400-3				
i950-C90/400-3	-	-	-	-
i950-C110/400-3				

Terminal strips

For connecting the inverter, the connections are equipped with pluggable terminal strips.
Pluggable terminal strips are available separately for service purposes or if cable harnesses need to be physically separated.

Installation set

Variant		0.55 kW ... 4 kW	7.5 kW ... 15 kW	22 kW ... 110 kW	0.55 kW ... 4 kW	7.5 kW ... 15 kW	22 kW ... 110 kW
		Basic Safety STO			Extended Safety		
		Order code					
		I9ZAA0014S	I9ZAA0015S	I9ZAA0016S	I9ZAA0017S	I9ZAA0018S	I9ZAA0019S
Multipole connector	Connection	Piece	Piece	Piece	Piece	Piece	Piece
X1	Basic Safety STO	1	1	1	-	-	-
X82	Extended Safety	-	-	-	1	1	1
X83	Extended Safety	-	-	-	1	1	1
X5	24 V	1	1	1	1	1	1
X3	I/O control terminal	1	1	1	1	1	1
X100	Grid terminal	1	-	-	1	-	-
X100	Grid terminal	-	1	-	-	1	-
X105	Motor/brake resistor	1	-	-	1	-	-
X105	Motor/brake resistor	-	1	-	-	1	-
X109	PTC, bridged	1	1	1	1	1	1
X107	24 V brake	1	1	1	1	1	1
X106	Motor holding brake	1	1	1	1	1	1
-	Shielding of control connections	1	1	1	1	1	1

Inverter	0.55 kW ... 15 kW	
Connection	X101 terminal strip	
	Order code	Packaging unit
		Unit
DC bus	I9ZAA0013/M	5
DC bus, daisy chain	I9ZAA0012/M	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 0.55 kW to 4 kW on DIN rail

System cables

Hybrid cable for motor connection with One Cable Technology (OCT)

The One Cable Technology (OCT) is possible with Lenze MCS and m850 servo motors. For this purpose, you need a special hybrid cable:

Order code	Length	Description
EYP0080A0020M11A00	2 m	Motor end: M23 plug 3 power wires, 1 PE 1 pair of control wires for transmitting the Hiperface DSL® protocol 1 pair of control wires for controlling the motor holding brake
EYP0080A0035M11A00	3.5 m	
EYP0080A0050M11A00	5 m	
EYP0080A0075M11A00	7 m	
EYP0080A0100M11A00	10 m	
EYP0080A0150M11A00	15 m	
EYP0080A0200M11A00	20 m	

Information on further system cables is provided in the "System cables and system connectors" manual.

Download

▸ Connection of one cable technology (OCT) via HIPERFACE DSL® 59

Purchase order

Notes on ordering

The servo inverter is ordered as a complete device in the previously chosen "safety" variant.
Two versions are available for selection:

- Inverters with “Basic Safety - STO”
- Inverters 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 servo inverter is delivered as complete device.

Order code

The following is a list of the necessary information when ordering a servo inverter.

Order example

Description of the component	Order code
Complete inverter	i95A 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	
EMC filter: integrated	
Network: none	
Feedback: none	

Complete inverter							
Power		Inverter	Order code				
kW	HP						
Three-phase mains connection 400/480 V, EMC filter integrated							
0.55	0.75	i950-C0.55/400-3	i95AE155F1				
0.75	1	i950-C0.75/400-3	i95AE175F1				
2.2	3	i950-C2.2/400-3	i95AE222F1				
4	5	i950-C4.0/400-3	i95AE240F1				
7.5	10	i950-C7.5/400-3	i95AE275F1				
11	15	i950-C11/400-3	i95AE311F1				
15	20	i950-C15/400-3	i95AE315F1				
22	30	i950-C22/400-3	i95AE322F1				
30	40	i950-C30400-3	i95AE330F1				
45	60	i950-C45/400-3	i95AE345F1				
55	74	i950-C55/400-3	i95AE355F1				
75	100	i950-C75/400-3	i95AE375F1				
90	120	i950-C90/400-3	i95AE390F1				
110	150	i950-C110/400-3	i95AE411F1				
Safety technology							
Basic safety - STO				A			
Extended safety				C			
Type							
IP 20, painted					V		
EMC filter							
Integrated						1	
Delivery status							
Default parameter setting: Region EU (50-Hz networks)							0
Option							
Without							0000

Appendix

Declarations of Conformity

Lenze

2366856.02

EU-Konformitätserklärung

EU Declaration of Conformity

LENZE Automation GmbH, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

erklärt in alleiniger Verantwortung die Übereinstimmung der Produkte

declares under sole responsibility compliance of the products

i950 mit integrierter Sicherheitsfunktion STO / I95Axxxxx1Axxxxxxx

mit der

with the

Maschinenrichtlinie 2006/42/EG Anhang IX und VIII			**Machinery Directive** 2006/42/EC Annex IX and VIII		
Angewandte harmonisierte Normen:			**Applied harmonized standards:**		
Sicherer Halt	Stopp Kategorie 0	**EN 60204-1 + A1 + AC**	**:2006, 2018 :2009 :2010**	Stop category 0	Safe torque off
	Kategorie 4 Performance Level (PL): PL e	**EN ISO 13849-1**	**:2015**	Category 4 Performance Level (PL): PL e	
		EN 61508 1-7	**:2010**		
Sicherheitsfunktionen siehe Betriebsanleitung.	SIL 3	**EN 62061 + AC + A1 + A2**	**:2005 :2010 :2013 :2015**	SIL 3	For safety functions see manual.
		EN 61800-5-2	**:2017**		
		EN 61800-5-1 + A1	**:2007 :2017**		

Konformitätsbewertung		**Conformity assessment**	
CE 0035	**Benannte Stelle**	**notified body**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
	Zertifikate	certificates	01/205/5605.00/17
	Gültigkeit	Date of expiry	11.08.2022

EMV- Richtlinie 2014/30/EU	**EMC Directive** 2014/30/EU
Angewandte harmonisierte Normen:	**Applied harmonized standards:**
EN 61800-3:2004, 2018 + A1:2012	
RoHS- Richtline 2011/65/EU	**RoHS Directive** 2011/65/EU
EN 50581:2012	

Die Sicherheitshinweise der Betriebanleitung sind zu beachten.

The safety instructions of the manual are to be considered.

Die Produkte sind bestimmt zum Einbau in Maschinen. Die Inbetriebnahme ist solange untersagt bis festgestellt wurde, dass die Maschine, in welche diese Produkte eingebaut werden sollen, den Bestimmungen der o.g. EU-Richtlinie entsprechen.

These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned EU Directive.

Ort / Datum Place / date	**Geschäftsführer** General Manager	**Dokumentationsverantwortlicher** Responsible for documentation
Aerzen 01.07.2019	*Dipl.-Ing. Frank Maier*	*i.V. T. Wedemeyer*

Lenze

2366856.02

Déclaration UE de conformité

Dichiarazione di conformità UE

LENZE Automation GmbH, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

Déclare, sous sa seule responsabilité, que les produits

dichiara sotto la propria esclusiva responsabilità la conformità dei seguenti prodotti

i950 mit integrierter Sicherheitsfunktion STO / I95Axxxxx1Axxxxxxx

respectent la

alla

Directive Machines
2006/42/CE Annexes IX et VIII

Direttiva macchine
2006/42/CE Allegato IX e VIII

Normes harmonisées appliquées :

Standard armonizzati applicati:

Arrêt sécurisé	Catégorie d'arrêt 0	**EN 60204-1 + A1 + AC**	**:2006, 2018 :2009 :2010**	Categoria di stop 0	Arresto sicuro
	Catégorie 4 Niveau de performance(PL): PL	**EN ISO 13849-1**	**:2015**	Categoria 4 Livello di prestazioni (PL): PL	
		EN 61508 1-7	**:2010**		
Fonctions de sécurité : voir manuel d'utilisation.	SIL 3	**EN 62061 + AC + A1 + A2**	**:2005 :2010 :2013 :2015**	SIL 3	Per le funzioni di sicurezza vedere le istruzioni operative.
		EN 61800-5-2	**:2017**		
		EN 61800-5-1 + A1	**:2007 :2017**		

Évaluation de conformité

Valutazione della conformità

CE 0035

	Organisme notifié	**Ente notificato**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
	Certificats	Certificati	01/205/5605.00/17
	Date d'expiration	Validità	11.08.2022

Directive CEM
2014/30/EU

Direttiva EMC
2014/30/EU

Angewandte harmonisierte Normen:

Applied harmonized standards:

EN 61800-3:2004, 2018 + A1:2012

Directive RoHS
2011/65/EU

Direttiva RoHS
2011/65/EU

EN 50581:2012

Respecter impérativement les consignes de sécurité contenues dans le manuel d'utilisation.

Ces produits sont destinés à être installés au sein de machines. Leur mise en service est interdite tant qu'il n'a pas été attesté que la machine destinée à les accueillir respecte les dispositions de la directive UE susmentionnée.

Osservare assolutamente le informazioni sulla sicurezza riportate nelle istruzioni operative.

I prodotti elencati sono destinati all'installazione su macchine e non possono essere messi in funzione fintanto che non sia stata verificata la conformità delle macchine su cui dovranno essere installati alla suddetta direttiva UE.

Lieu / date
Luogo / data

Aerzen 01.07.2019

Gérant
Amministratore delegato

Dipl.-Ing. Frank Maier

Responsable de documentation
Responsabile della documentazione

i.V. T. Wedemeyer

i.V. T. Wedemeyer

Lenze

2366856.02

Declaración UE de conformidad

Declaracão UE de Conformidade

LENZE Automation GmbH, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

declara bajo su propia responsabilidad, que los productos

declara, sob sua exclusiva responsabilidade, a conformidade dos produtos

i950 mit integrierter Sicherheitsfunktion STO /
I95Axxxxx1Axxxxxxx

cumplen con la

com a

Directiva de Máquinas
2006/42/CE Anexo IX y VIII

Directiva de Máquinas
2006/42/CE Anexo IX e VIII

Normas harmonizadas aplicables:

Normas harmonizadas aplicadas:

Paro seguro	Categoría de paro 0	**EN 60204-1 + A1 + AC**	**:2006, 2018 :2009 :2010**	Paragem categoria 0	Paragem segura
	Categoría 4 Nivel de rendimiento (PL): PL e	**EN ISO 13849-1**	**:2015**	Categoria 4 Nível de performance (PL):	
		EN 61508 1-7	**:2010**		
Las funciones de seguridad se encuentran en el manual de instrucciones.	SIL 3	**EN 62061 + AC + A1 + A2**	**:2005 :2010 :2013 :2015**	SIL 3	Consulte as funções de segurança no manual de operação.
		EN 61800-5-2	**:2017**		
		EN 61800-5-1 + A1	**:2007 :2017**		

Evaluación de conformidad

Avaliação da conformidade

CE 0035

	Entidad notificada	**Organismo notificado**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
	Certificados	Certificados	01/205/5605.00/17
	Validez	Validade	11.08.2022

Directiva CEM
2014/30/EU

Directiva CEM
2014/30/EU

Angewandte harmonisierte Normen:

Applied harmonized standards:

EN 61800-3:2004, 2018 + A1:2012

Directiva RoHS
2011/65/EU

Directiva RoHS
2011/65/EU

EN 50581:2012

Deben tenerse en cuenta las instrucciones de seguridad del manual.

Los productos están diseñados para su instalación en máquinas. Está prohibida la puesta en marcha hasta que se pueda determinar que la máquina en la que se instale éste producto cumpla con las directivas anteriormente indicadas.

Devem ser observadas as instruções de segurança do manual de operação.

Os produtos são destinados à incorporação em máquinas. A colocação em serviço permanece proibida até que seja constatado que a máquina, na qual estes produtos devem ser incorporados, corresponde às disposições da Directiva de Máquinas UE acima citada.

Lugar / Fecha
Local / Data

Aerzen 01.07.2019

Gerencia
Gerente

Dipl.-Ing. Frank Maier

Responsable de la documentación
Responsável pela documentação

i.V. T. Wedemeyer

Lenze

2402288.02

EU-Konformitätserklärung

EU Declaration of Conformity

LENZE Automation GmbH, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

erklärt in alleiniger Verantwortung die Übereinstimmung der Produkte

declares under sole responsibility compliance of the products

i950 mit integrierter Sicherheitsfunktion Extended Safety / I95Axxxxx1Cxxxxxxx

mit der

with the

Maschinenrichtlinie
2006/42/EG Anhang IX und VIII

Machinery Directive
2006/42/EC Annex IX and VIII

Angewandte harmonisierte Normen:

Applied harmonized standards:

Sicherer Halt	Stopp Kategorie 0	**EN 60204-1 + A1 + AC**	**:2006, 2018 :2009 :2010**	Stop category 0	Safe torque off
	Kategorie 4 Performance Level (PL): PL e	**EN ISO 13849-1**	**:2015**	Category 4 Performance Level (PL): PL e	
		EN 61508 1-7	**:2010**		
Sicherheitsfunktionen siehe Betriebsanleitung.	SIL 3	**EN 62061 + AC + A1 + A2**	**:2005 :2010 :2013 :2015**	SIL 3	For safety functions see manual.
		EN 61800-5-2	**:2017**		
		EN 61800-5-1 + A1	**:2007 :2017**		

Konformitätsbewertung

Conformity assessment

CE 0035

Benannte Stelle	**notified body**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
Zertifikate	certificates	01/205/5657.00/18
Gültigkeit	Date of expiry	2023-12

EMV- Richtlinie
2014/30/EU

EMC Directive
2014/30/EU

Angewandte harmonisierte Normen:

Applied harmonized standards:

EN 61800-3:2004, 2018 + A1:2012

RoHS- Richtline
2011/65/EU

RoHS Directive
2011/65/EU

Die Sicherheitshinweise der Betriebanleitung sind zu beachten.

The safety instructions of the manual are to be considered.

Die Produkte sind bestimmt zum Einbau in Maschinen. Die Inbetriebnahme ist solange untersagt bis festgestellt wurde, dass die Maschine, in welche diese Produkte eingebaut werden sollen, den Bestimmungen der o.g. EU-Richtlinie entsprechen.

These products are intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these products are to be installed, conforms to the above mentioned EU Directive.

Ort / Datum
Place / date

Aerzen 01.07.2019

Geschäftsführer
General Manager

Dipl.-Ing. Frank Maier

Dokumentationsverantwortlicher
Responsible for documentation

i.V. T. Wedemeyer

Lenze

2402288.02

Déclaration UE de conformité

Dichiarazione di conformità UE

LENZE Automation GmbH, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

Déclare, sous sa seule responsabilité, que les produits

dichiara sotto la propria esclusiva responsabilità la conformità dei seguenti prodotti

i950 mit integrierter Sicherheitsfunktion Extended Safety / I95Axxxxx1Cxxxxxxx

respectent la

alla

Directive Machines
2006/42/CE Annexes IX et VIII

Direttiva macchine
2006/42/CE Allegato IX e VIII

Normes harmonisées appliquées :

Standard armonizzati applicati:

Arrêt sécurisé	Catégorie d'arrêt 0	**EN 60204-1 + A1 + AC**	**:2006, 2018 :2009 :2010**	Categoria di stop 0	Arresto sicuro
	Catégorie 4 Niveau de performance(PL): PL	**EN ISO 13849-1**	**:2015**	Categoria 4 Livello di prestazioni (PL): PL e	
		EN 61508 1-7	**:2010**		
Fonctions de sécurité : voir manuel d'utilisation.	SIL 3	**EN 62061 + AC + A1 + A2**	**:2005 :2010 :2013 :2015**	SIL 3	Per le funzioni di sicurezza vedere le istruzioni operative.
		EN 61800-5-2	**:2017**		
		EN 61800-5-1 + A1	**:2007 :2017**		

Évaluation de conformité

Valutazione della conformità

CE 0035

Organisme notifié	**Ente notificato**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
Certificats	Certificati	01/205/5657.00/18
Date d'expiration	Validità	2023-12

Directive CEM
2014/30/EU

Direttiva EMC
2014/30/EU

Angewandte harmonisierte Normen:

Applied harmonized standards:

EN 61800-3:2004, 2018 + A1:2012

Directive RoHS
2011/65/EU

Direttiva RoHS
2011/65/EU

Respecter impérativement les consignes de sécurité contenues dans le manuel d'utilisation.

Ces produits sont destinés à être installés au sein de machines. Leur mise en service est interdite tant qu'il n'a pas été attesté que la machine destinée à les accueillir respecte les dispositions de la directive UE susmentionnée.

Osservare assolutamente le informazioni sulla sicurezza riportate nelle istruzioni operative.

I prodotti elencati sono destinati all'installazione su macchine e non possono essere messi in funzione fintanto che non sia stata verificata la conformità delle macchine su cui dovranno essere installati alla suddetta direttiva UE.

Lieu / date
Luogo / data

Aerzen 01.07.2019

Gérant
Amministratore delegato

Dipl.-Ing. Frank Maier

Responsable de documentation
Responsabile della documentazione

i.V. T. Wedemeyer
i.V. T. Wedemeyer

Lenze

2402288.02

Declaración UE de conformidad

Declaracão UE de Conformidade

LENZE Automation GmbH, Hans-Lenze-Strasse 1, 31855 Aerzen GERMANY

declara bajo su propia responsabilidad, que los productos

declara, sob sua exclusiva responsabilidade, a conformidade dos produtos

i950 mit integrierter Sicherheitsfunktion Extended Safety / I95Axxxxx1Cxxxxxxx

cumplen con la

com a

Directiva de Máquinas
2006/42/CE Anexo IX y VIII

Normas harmonizadas aplicables:

Paro seguro	Categoría de paro 0	**EN 60204-1 + A1 + AC**	**:2006, 2018 :2009 :2010**	Paragem categoria 0	Paragem segura
	Categoría 4 Nivel de rendimiento (PL): PL e	**EN ISO 13849-1**	**:2015**	Categoria 4 Nível de performance (PL): PL e	
		EN 61508 1-7	**:2010**		
Las funciones de seguridad se encuentran en el manual de instrucciones.	SIL 3	**EN 62061 + AC + A1 + A2**	**:2005 :2010 :2013 :2015**	SIL 3	Consulte as funções de segurança no manual de operação.
		EN 61800-5-2	**:2017**		
		EN 61800-5-1 + A1	**:2007 :2017**		

Directiva de Máquinas
2006/42/CE Anexo IX e VIII

Normas harmonizadas aplicadas:

Evaluación de conformidad

Avaliação da conformidade

CE 0035

Entidad notificada		**Organismo notificac**	TÜV Rheinland Industrie Service GmbH Am Grauen Stein 51105 Köln / Germany
Certificados		Certificados	01/205/5657.00/18
Validez		Validade	2023-12

Directiva CEM
2014/30/EU

Angewandte harmonisierte Normen:

Directiva CEM
2014/30/EU

Applied harmonized standards:

EN 61800-3:2004, 2018 + A1:2012

Directiva RoHS
2011/65/EU

Directiva RoHS
2011/65/EU

Deben tenerse en cuenta las instrucciones de seguridad del manual.

Los productos están diseñados para su instalación en máquinas. Está prohibida la puesta en marcha hasta que se pueda determinar que la máquina en la que se instale éste producto cumpla con las directivas anteriormente indicadas.

Devem ser observadas as instruções de segurança do manual de operação.

Os produtos são destinados à incorporação em máquinas. A colocação em serviço permanece proibida até que seja constatado que a máquina, na qual estes produtos devem ser incorporados, corresponde às disposições da Directiva de Máquinas UE acima citada.

Lugar / Fecha
Local / Data

Aerzen 01.07.2019

Gerencia
Gerente

Dipl.-Ing. Frank Maier

Responsable de la documentación
Responsável pela documentação

i.V. T. Wedemeyer

Good to know

Approvals and directives

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

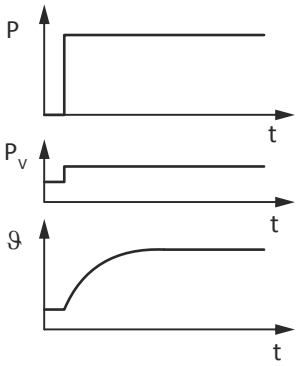
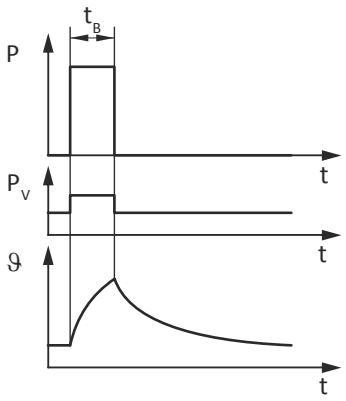
Operating modes of the motor

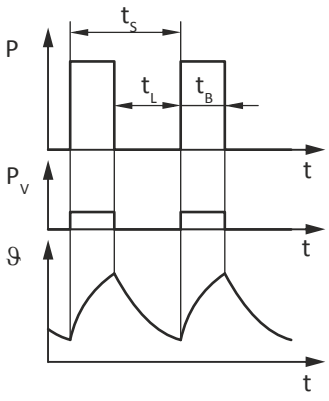
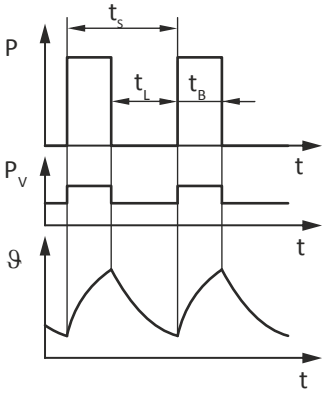
Operating modes S1 ... S10 as specified by EN 60034-1 describe the basic stress of an electrical machine.

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

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

The most important operating modes

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

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

P	Power	P_V	Power loss
t	Time	t_B	Load period
t_L	Idle time	t_S	Cycle duration
ϑ	Temperature		

Switching frequencies

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

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

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

Features	Versions
Switching frequencies	• 2 kHz • 4 kHz • 8 kHz • 16 kHz • variable (automatic adjustment)

Enclosures

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

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

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

Glossary

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

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