

i750 cabinet servo inverter



1.1 ... 30 kW
1.5 ... 40 hp

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About this document

Document description

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

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



Further documents

For certain tasks, information is available in further documents.

Document	Contents/topics
Mounting sheet	General safety instructions and important UL/CSA instructions, connection diagram and technical data. • The mounting sheet is included in the delivery of the product.
Commissioning manual	Detailed information on setting and parameterizing the product.

More information

For certain tasks, information is available in other media.

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



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



Notations and conventions

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

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

Layout of the safety instructions

DANGER!

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

WARNING!

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

CAUTION!

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

NOTICE

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



Product information

Components of Lenze's automation system include controllers and a broad portfolio of inverters with matching standard three-phase AC motors, synchronous servo motors and asynchronous servo motors. The motors can each be combined with gearboxes in various designs. Decentralized I/O systems and HMIs complete the Lenze automation system.



Product description

The i750 cabinet servo inverter offers everything for precise and dynamic motion control in complex multi-axis applications. Extended safety functions and one cable technology reduce wiring and control complexity. Intelligent data-based functions and IIoT enable innovative motion control concepts.

As a single or double axis, the i750 cabinet with matching supplier fits seamlessly into the Lenze automation system. The strengths can be seen in numerous applications in a network with Lenze controllers and the FAST Application Software Toolbox. The scalable range of hardware, software, engineering services and digital services supports the realization of end-to-end automation systems from the cloud to the drive shaft.

As a power extension of the i750 cabinet servo inverter in the range of 22 ... 110 kW, the i950 cabinet servo inverter can be used.

Highlights

- Integrated DC-bus connection
- Small overall width from 50 mm for the double axis
- Axis modules capable of multiple overloads
 - Peak output currents for single axes: 5 A ... 109 A (1.1 kW ... 30 kW)
 - Peak output currents for double axes: 5 A ... 32 A (1.1 kW ... 7.5 kW)
- One Cable Technology (OCT)
- Excellent controller performance
- Autotuning function for quick and easy controller adjustment
- Integrated functional safety
 - "Basic Safety - STO" variant: Safety function Safe torque off (STO), activation via terminal
 - "Advanced Safety" variant: Safety functions Safe torque off (STO), Safe stop 1 (SS1), Safe brake control (SBC), activation via safety bus
 - "Extended Safety" variant: Numerous safety functions, activation via safety bus

Preferred applications

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

Product information

Product description
The concept



The concept

The i750 servo inverter is a multi-axis inverter, i.e. the axes are interconnected via an integrated DC bus. The supplier connected to the AC system feeds the DC bus.

A controller programmed according to IEC 61131 controls the axes via the CiA 402 device profile.

The Lenze engineering tool "PLC Designer" is available for programming the controller. The FAST function library enables the rapid creation of applications.

EtherCAT® is used for real-time communication.

Required components for a basic i750 system

For a basic system for central motion control you need these components:

- A controller
 - e.g. c550 controller
 - [More information on the product page](#)
- i750 axes
 - Data for mains voltage 230 / 240 V ▶ [Axes data](#) 97
 - Data for mains voltage 400 V ▶ [Axes data](#) 106
 - Data for mains voltage 480 V ▶ [Axes data](#) 115
- A supplier for the axes
 - Data for mains voltage 230 / 240 V ▶ [Supplier data](#) 94
 - Data for mains voltage 400 V ▶ [Supplier data](#) 103
 - Data for mains voltage 480 V ▶ [Supplier data](#) 112
- Servo motors for the application
 - e.g. MCS synchronous servo motors
 - [More information on the product page](#)
- System cables
 - e.g. for connecting motors
 - Data for system cables ▶ [System cables](#) 218
- The Lenze Engineering Tool »PLC Designer«
 - [Download »PLC Designer«](#)
- A Windows® PC
- Additionally when using a product variant with Advanced Safety or Extended Safety
 - A c250-S safety controller
 - [More information on the product page](#)

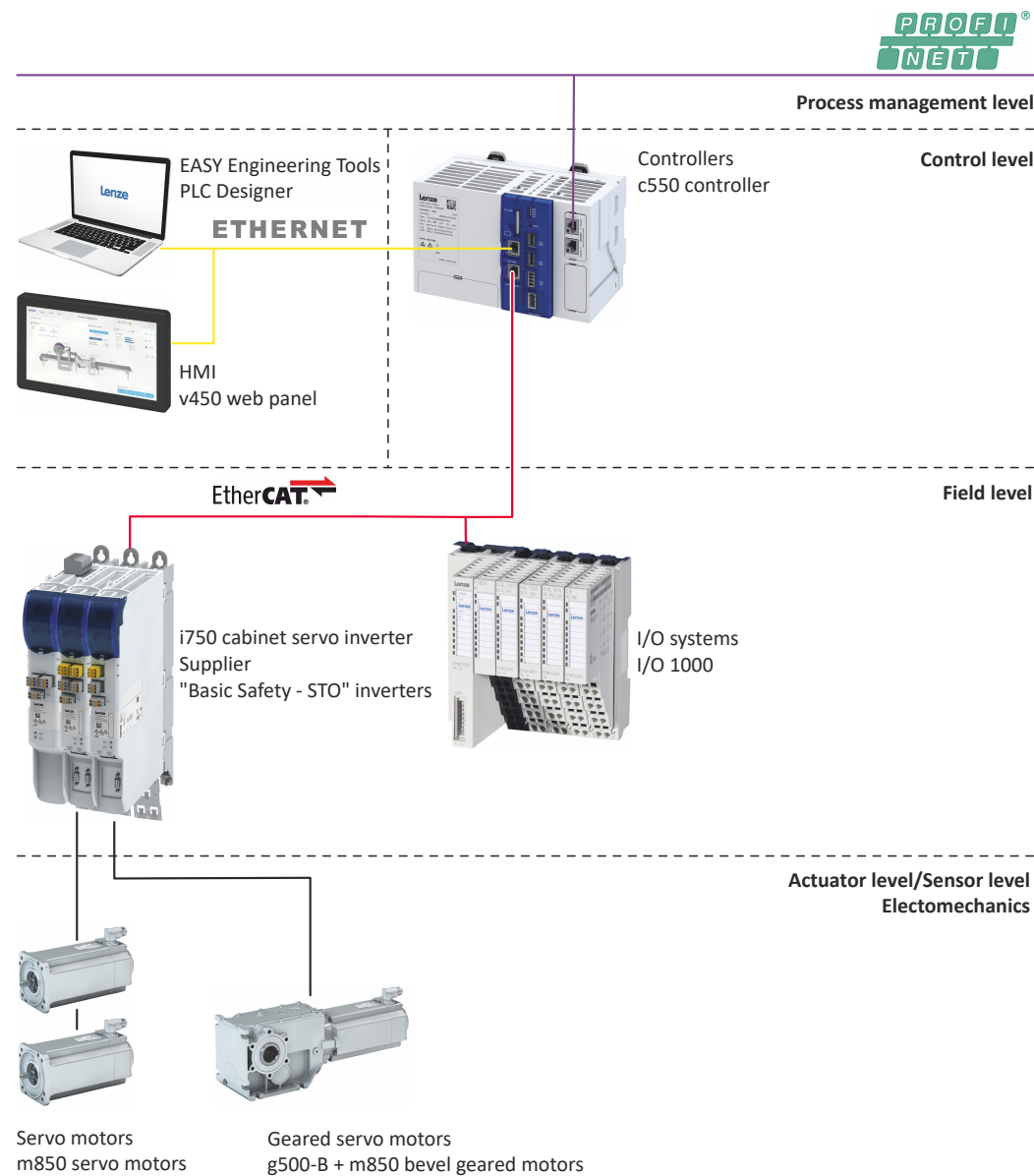


i700/i750 tutorials are available for easy commissioning.

[i700 servo inverter - Start-up tutorials](#)

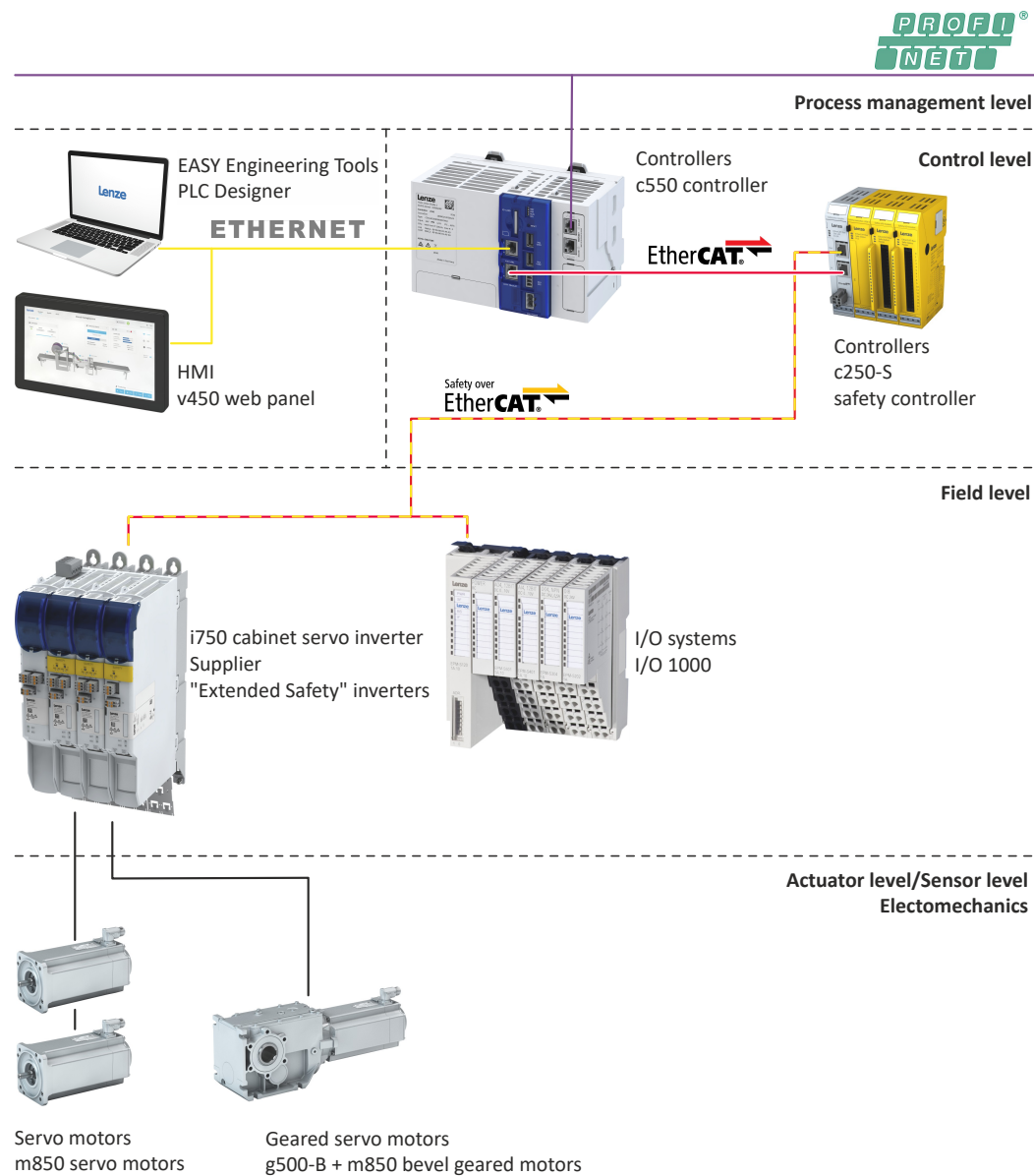


Automation with central motion control
Example: Topology for Basic Safety - STO





Automation with central motion control
Example: Topology for Advanced Safety/Extended Safety





Product information

Product description

Product variants

Axes

Product variants

Axes



The axes are available in 3 designs for functional safety and in 3 designs for motor encoder evaluation.

The designs can be freely combined into product variants.

"Functional safety" designs

Design i750 "Basic Safety - STO"

- Safety function: Safe torque off (STO)
- Activation via terminal X1

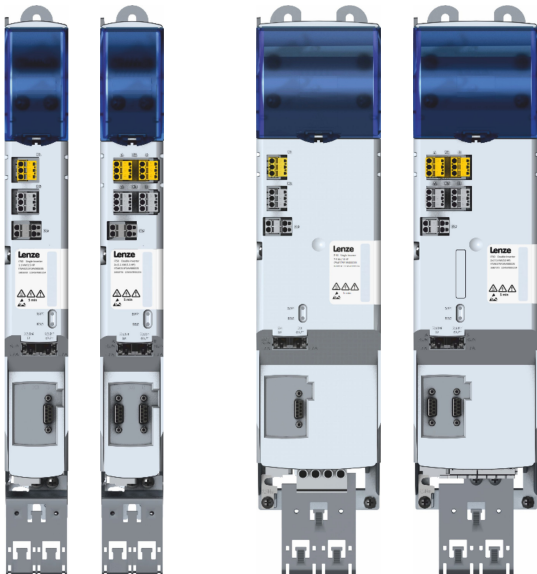
Design i750 "Advanced Safety"

- Safety functions:
 - Safe torque off (STO)
 - Safe stop 1 (SS1)
 - Safe brake control (SBC)
- Without safe encoder evaluation
- Activation via safety bus
- Details: [► Functional safety 139](#)

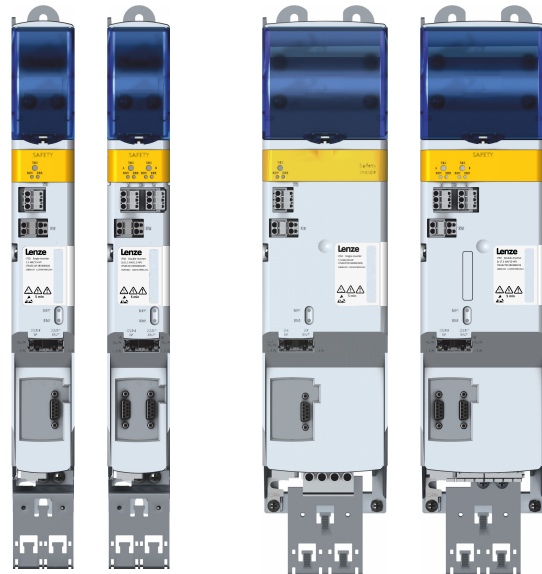
Design i750 "Extended Safety"

- Numerous additional safety functions for speed monitoring and position monitoring
- With safe encoder evaluation
- Activation via safety bus
- Details: [► Functional safety 139](#)

Example: Single axes and double axes 1.1 kW ... 15 kW



i750 "Basic Safety - STO" version



i750 "Advanced Safety" version
i750 "Extended Safety" version

Product information

Product description

Product variants

Axes



Designs "Feedback systems"

Design i750 "Hiperface DSL® (OCT)/PTC"

Function can be selected via parameters

One Cable Technology (OCT) via Hiperface DSL®

- Encoder connection on X109
- Digital motor temperature evaluation via sensor cable
- Usable Lenze motors with Hiperface DSL® encoder:
 - Servo motors m850, MCS

PTC

- PTC connection on X109
- Motor encoder evaluation is not possible
- Suitable Lenze motors with PTC/thermal contact:
 - Three-phase AC motors m550, m540, MF

Design i750 "Resolver"

- Encoder connection on 9-pin Sub-D
- Hiperface DSL® (OCT)/PTC connection X109 without function
- Motor temperature evaluation via encoder cable
- Usable Lenze motors with resolver:
 - Servo motors m850, MCS, MCA, MQA
 - Three-phase AC motors m550, m540, MF

Design i750 "Multi-Encoder"

- Encoder connection on 15-pin Sub-D
- Hiperface DSL® (OCT)/PTC connection X109 without function
- Motor temperature evaluation via encoder cable
- Supported incremental encoders: SinCos, TTL
- Supported absolute value encoders: HIPERFACE®, SSI, SinCos+SSI, EnDat 2.1/2.2
- Usable Lenze motors with encoder:
 - Servo motors m850, MCS, MCA, MQA
 - Three-phase AC motors m550, m540, MF



Product information
Product description
Product variants
Axes

Example: Single axes 1.1 kW ... 4 kW



Design i750 "Hiperface DSL® (OCT)/PTC"



Design i750 "Resolver"



Design i750 "Multi-Encoder"

Example: Double axes 1.1 kW ... 4 kW



Design i750 "Hiperface DSL® (OCT)/PTC"



Design i750 "Resolver"



Design i750 "Multi-Encoder"



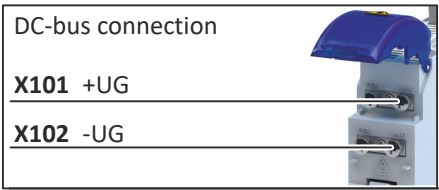
Features

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 supply

30 A



X20.1 Digital inputs

Brake chopper control/
Error reset/Slave activation

X21 External 24 V supply

Electronics

Supplier status LEDs

X100 Mains connection

X20.2 Digital outputs

Brake chopper status/Error active

X103 Brake resistor

Integrated shield mounting
Brake resistor

PE connection

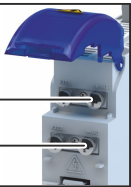


60 A

DC-bus connection

X101 +UG

X102 -UG



X100 Mains connection

X20.1 Digital inputs

Brake chopper control/
Error reset/Slave activation

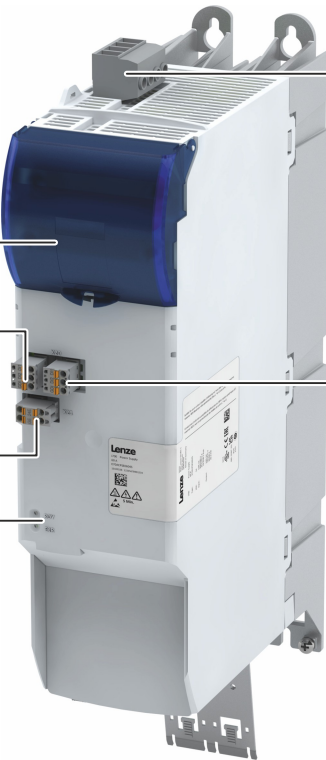
X21 External 24 V supply

Electronics

Supplier status LEDs

X20.2 Digital outputs

Brake chopper status/Error active

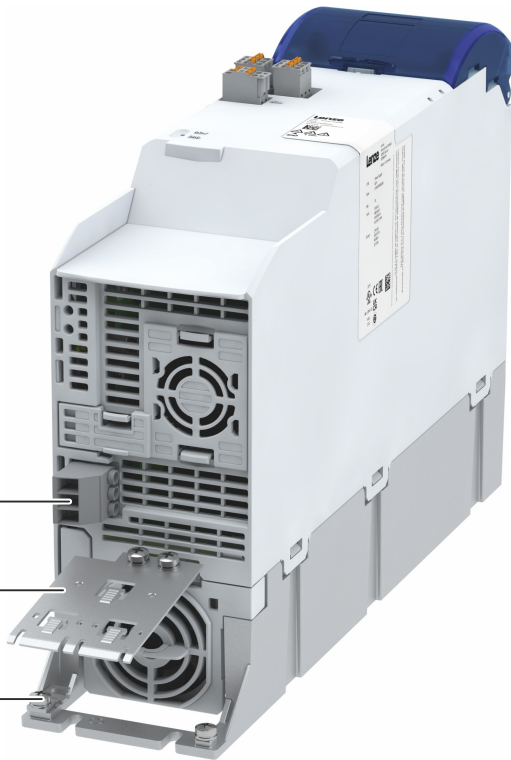


X103 Brake resistor

Integrated shield mounting

Brake resistor

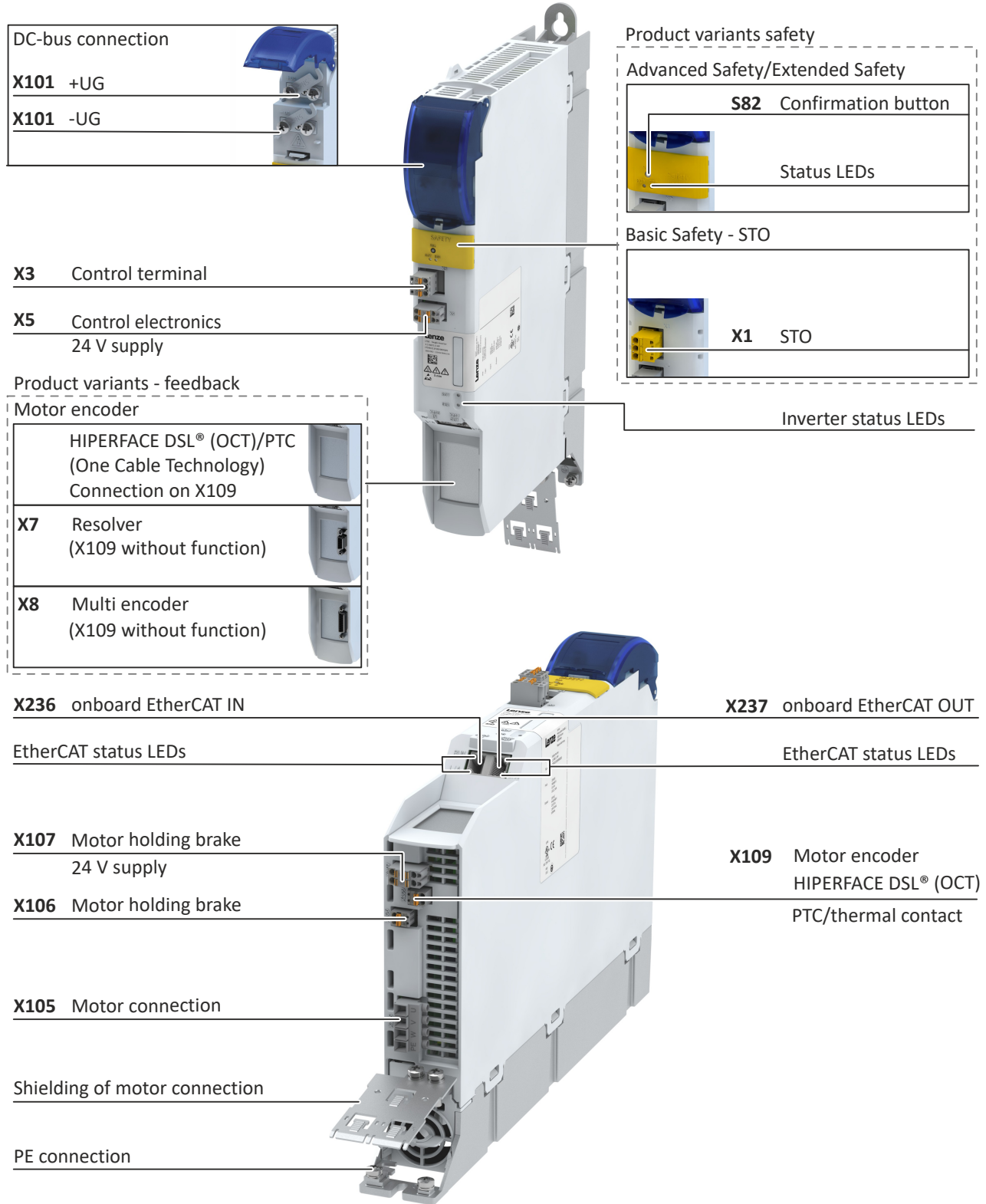
PE connection





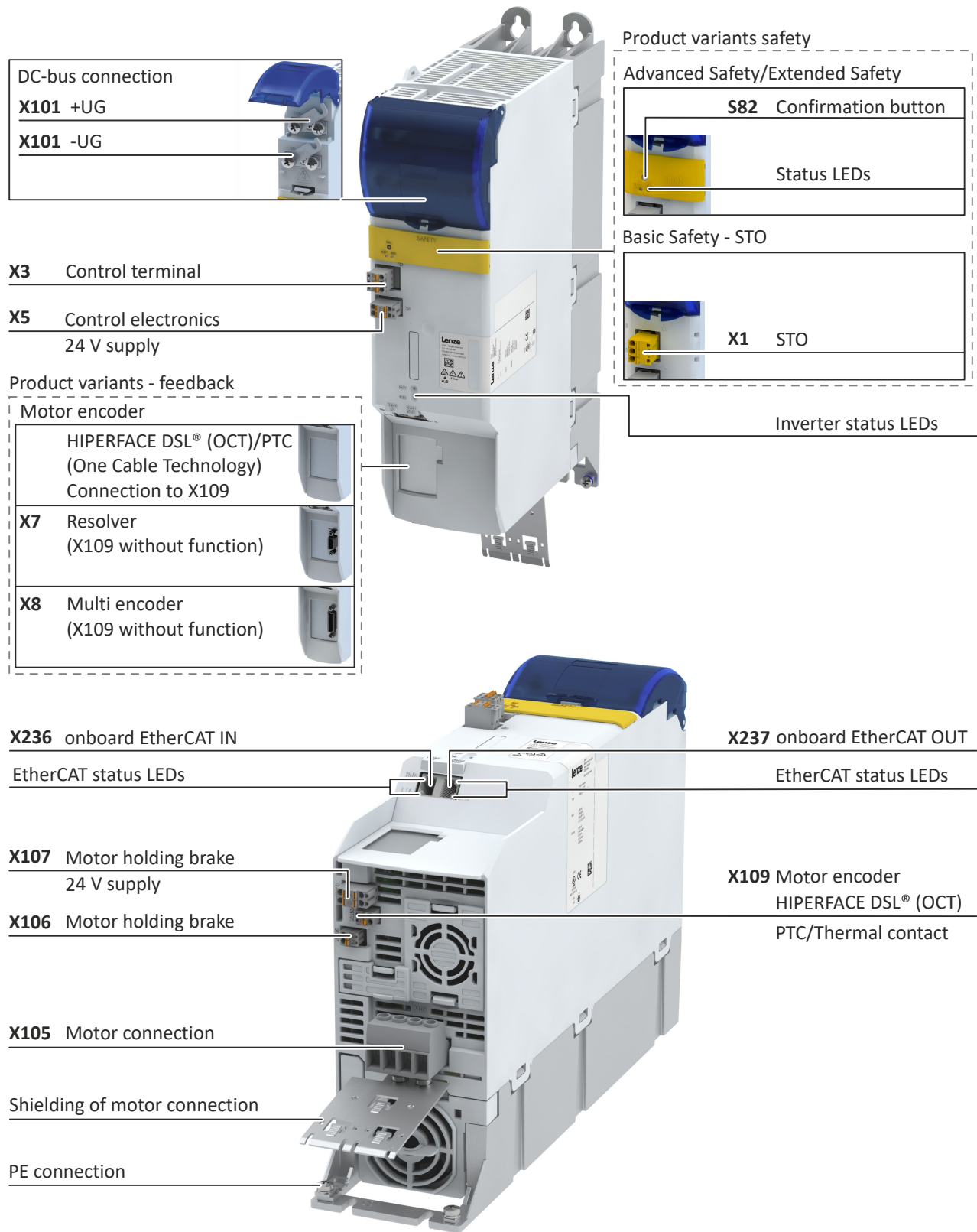
Single axes

1.1 kW ... 4 kW



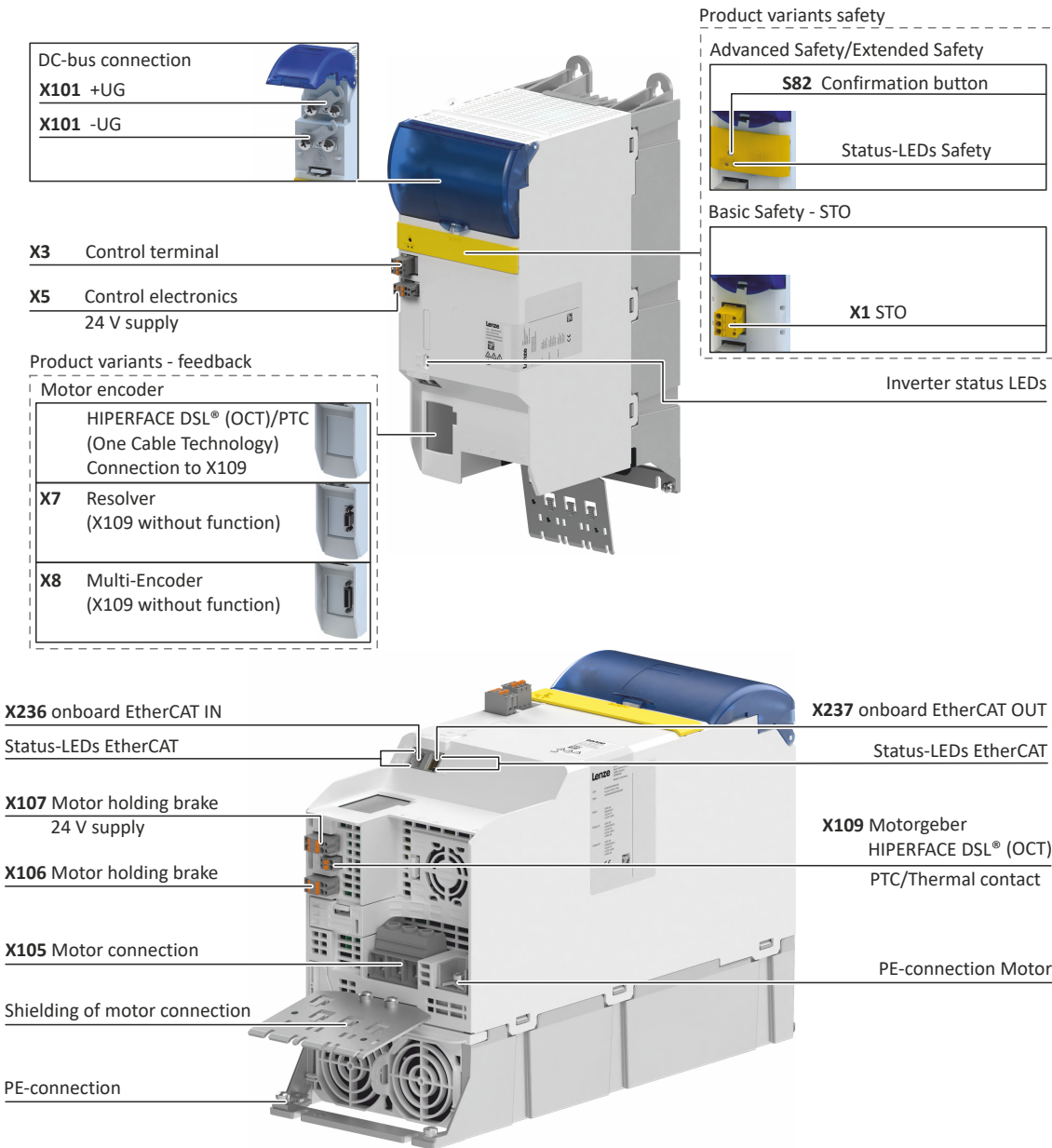


7.5 kW ... 15 kW





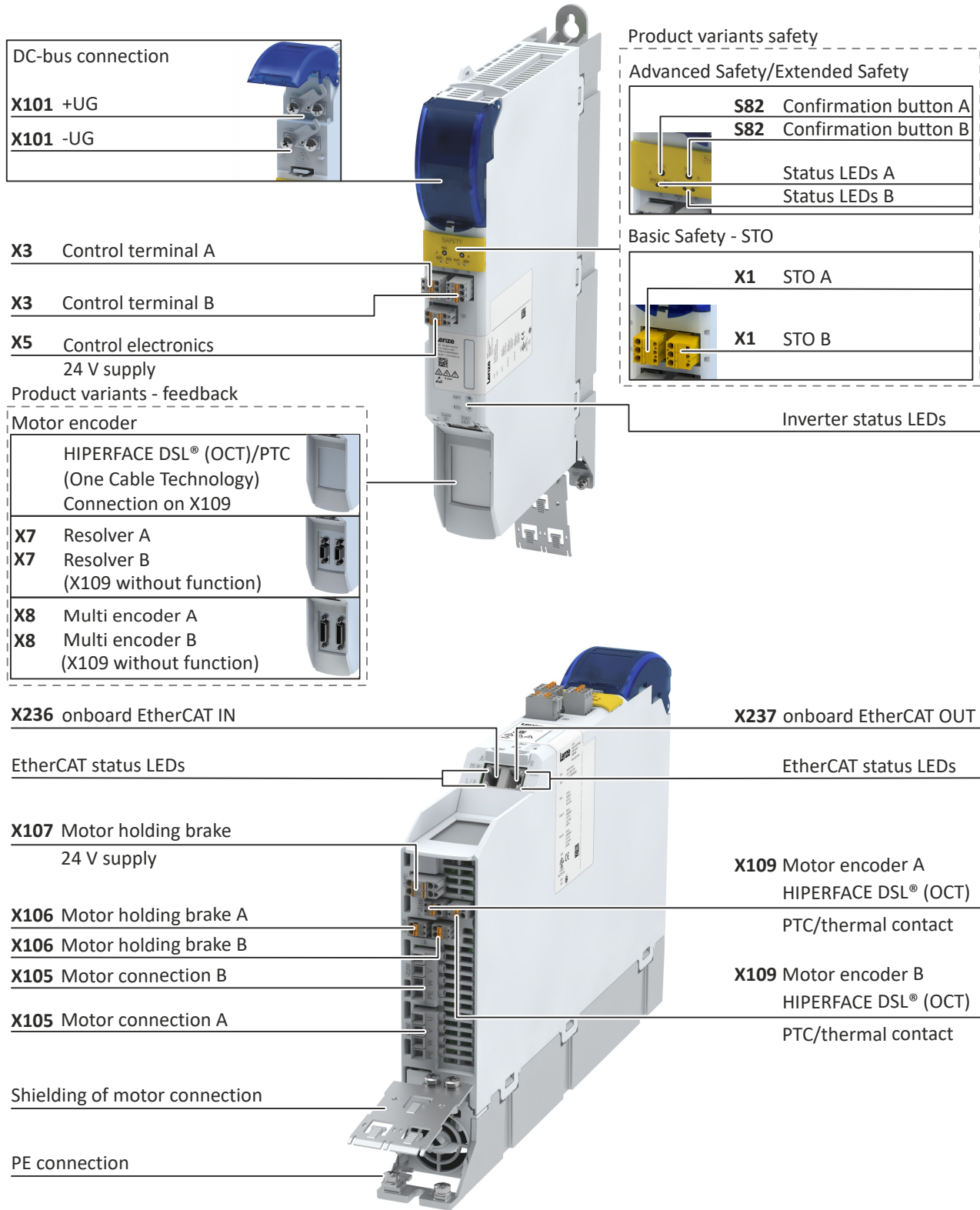
22 kW ... 30 kW





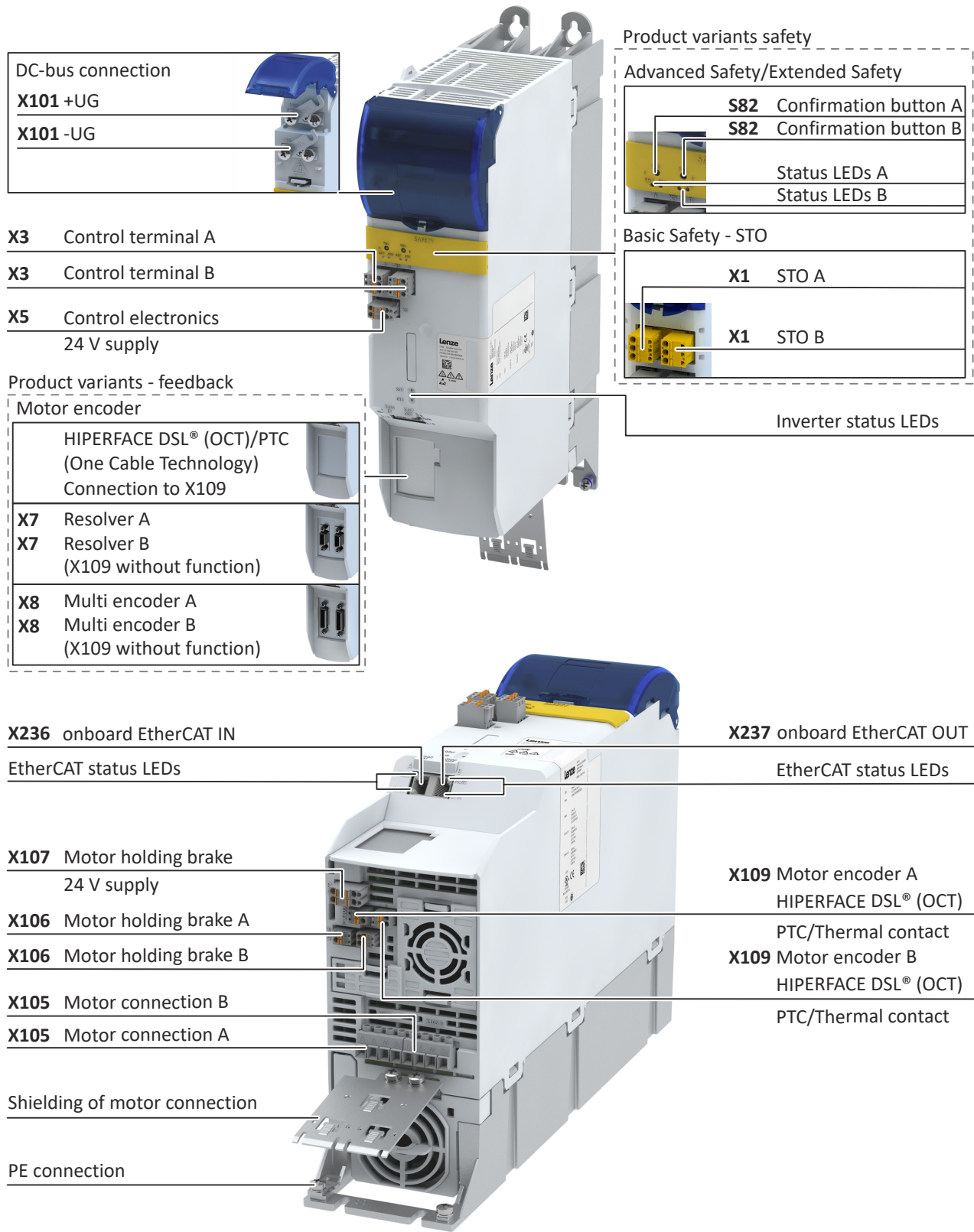
Double axes

2 x 1.1 kW ... 2 x 2.2 kW





2 x 4 kW ... 2 x 7.5 kW



Product information

Features
One cable technology (OCT) via HIPERFACE DSL®



One cable technology (OCT) via HIPERFACE DSL®

The future-oriented One Cable Technology is supported by means of the open motor feedback protocol HIPERFACE DSL®.

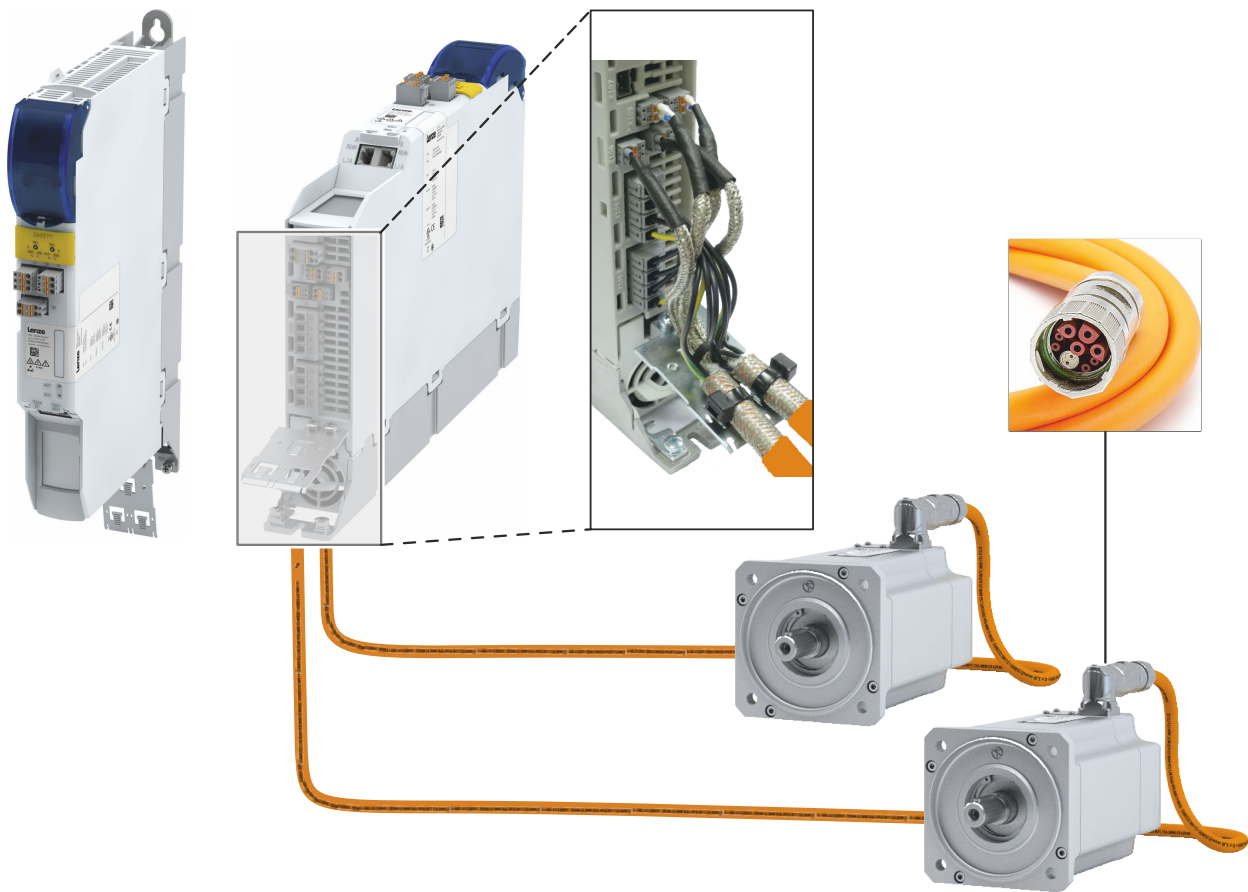
Advantages

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

Preconditions

- The motor must be provided with a HIPERFACE DSL® encoder.
- Connection cable
 - The EYP008xxxxxxM11A00 or EYP008xxxxxxM12A00 hybrid cable must be used.
 - Different lengths up to 100 m are available. ▶ [System cables](#) 218
 - The hybrid cables have only basic insulation to the power electronics.

Example setup - double axis





Status LEDs

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

"RDY" LED (blue)	"ERR" LED (red)	Status/meaning
off	off	Supply voltage not available.
		Initialisation in progress (inverter is being started).
on	on	
 blinks (1 Hz)	off	Safe torque off (STO) active. The inverter has been inhibited by the integrated safety system. ▶ Safe torque off (STO)  155
 blinks (1 Hz)		Inverter inhibited, error active.
	off	Inverter enabled. Motor rotates according to the specified setpoint or quick stop is active.
 Both LEDs are blinking in a rapidly alternating mode		Firmware update active.
 Both LEDs are blinking in a very rapidly synchronous mode		"Visual tracking" function is active.

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

For the meaning of the status LEDs for Safety see  198.

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® (Ethernet for Controller and Automation Technology) is an Ethernet-based fieldbus system meeting the application profile for industrial real-time systems. EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany. Device descriptions for the download: XML/ESI files for Lenze devices
	Fail-safe-over-EtherCAT (FSoE) enables the transmission of safe information via FSoE protocol according to ETG.5100 S specification, version 1.2.0 of the EtherCAT user organisation (ETG). Safety over EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

More information on the supported networks can be found at:

www.Lenze.com



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.

- The product name of the suppliers contains:
 - The DC rated output current, the mains voltage class, and the number of phases
 - "C" marks the "Cabinet" version = For installation into the control cabinet.
- The product name of the axes contains:
 - The rated power in kW, the mains voltage class, and the number of phases.
 - Double axes are additionally marked with "/2".
 - "C" marks the "Cabinet" version = For installation into the control cabinet.
- You can find the corresponding product names and order codes here: Purchase order 220

Device series	Type	DC rated output current	Rated mains voltage	No. of phases	Supplier
		A	V		
i700	C	30	240	3	i700-CV30/400-3
		60	400 480		i700-CV60/400-3

Device series	Type	Rated power	Mains voltage	No. of phases	Single axis
		kW	V		
i750	C	1.1	400 480 230	3	i750-C1.1/400-3
		2.2			i750-C2.2/400-3
		4			i750-C4/400-3
		7.5			i750-C7.5/400-3
		11			i750-C11/400-3
		15			i750-C15/400-3
		22			i750-C22/400-3
		30			i750-C30/400-3

Device series	Type	Rated power	Mains voltage	No. of phases	Double axis
		kW	V		
i750	C	1.1	400 480 230	3	i750-C1.1/400-3/2
		2.2			i750-C2.2/400-3/2
		3			i750-C3/400-3/2
		4			i750-C4/400-3/2
		7.5			i750-C7.5/400-3/2



License information

Open Source



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

To display the license information of the open source software components, an EoE connection (Ethernet over EtherCAT) must be established between PC and product.

Display licence information

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

The licences used are displayed in the browser.



Safety instructions

Basic safety instructions

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

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

Please observe the specific safety information in the other sections!



Application as directed

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

Additional information for the intended use in North America:

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

Safety instructions

Foreseeable misuse



Foreseeable misuse

Inverters are not to be operated with DC motors.



Handling

Transport, storage

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

Installation

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

The inverters must be installed and cooled according to the instructions given in the corresponding documentation. Observe the climatic conditions according to the technical data.

Electrical connection

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

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

The documentation contains information about installation according to EMC regulations (shielding, grounding, filters and cable routing). Please also observe this information for CE-marked inverters. The manufacturer of the system or machine is responsible for adherence to the limit values required in connection with EMC legislation.

The inverters must be installed in housings (e. g. control cabinets) to meet the limit values for radio interferences valid at the site of installation. The housings must enable an EMC-compliant installation. Observe in particular that e. the control cabinet doors should have a circumferential metal connection to the housing. Reduce housing openings and cutouts to a minimum.

Protection in the event of short circuit or earth fault

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

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

Operation

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

Safety instructions

Handling



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

All protection covers and doors must be shut during operation.

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

Safety functions

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

Maintenance and servicing

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

Disposal

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



Residual hazards

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

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

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

Product

Observe the warning labels on the product!



Dangerous electrical voltage:

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



Electrostatic sensitive devices:

Before working on the product, the staff must ensure to be free of electrostatic charge!



High leakage current:

Carry out fixed installation and PE connection in compliance with:
EN 61800-5-1 / EN 60204-1



Hot surface:

Use personal protective equipment or wait until the device has cooled down!

Degree of protection - protection of persons and device protection

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

Protection of persons

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

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

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

- Even when the motor is stopped, the power connections (X100, X101, X105) may carry dangerous electrical voltage.

Device protection

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

Motor protection

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

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

Safety instructions

Residual hazards



Protection of the machine/system

Drives can reach dangerous overspeeds.

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

Motor

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

Commissioning

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



Information on project planning

Project planning process

Overcurrent operation

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

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

Cycle 15 s

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

Cycle 180 s

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

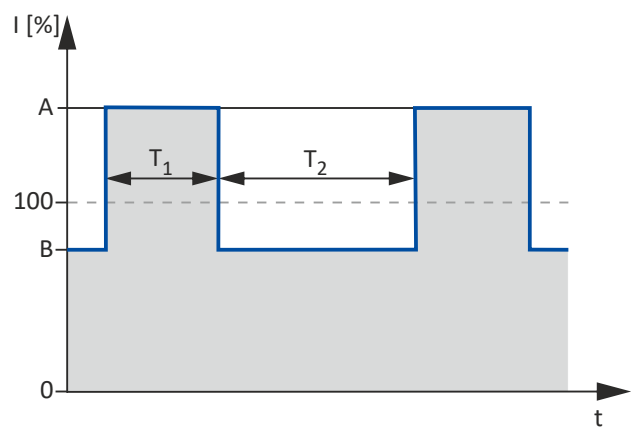
The monitoring of the device utilization (Ixt) triggers an error if the utilization value exceeds a threshold of 100 %.



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

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

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



Overcurrent cycle	Max. output current	Overload time	Max. output current during the recovery time	Recovery time
	A	T ₁	B	T ₂
s	%	s	%	s
Overcurrent cycle 15 s	200	3	75	12
Overcurrent cycle 180 s	150	60	75	120

Information on project planning

Control cabinet structure
Cables



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).

Cables

Requirements

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

Installation inside the control cabinet

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

Installation outside the control cabinet

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

Earthing concept

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



DC-bus group

The inverters are designed for DC link interconnection with a central AC system feed point.

Suppliers with various services are available for this purpose.

Parallel operation of suppliers to increase supply power or braking power is permitted.

Advantages of a DC-bus group

- Energy exchange between the inverters in motor operation and in generator operation.
 - Reduced supply power from the AC system
 - Design of the supply modules with lower rated power
 - Reduced braking losses in regenerative operation
- Only one AC mains connection
- Reduced wiring effort due to integrated busbar system

Important notes

The inverters in the DC-bus group may only start operation when the DC bus is fully charged. This means that all inverters must be supplied with 24 V.

NOTICE

The 24 V supply is not switched on for all inverters in the DC-bus group.

Possible consequences: Charging relay or charging hybrid can be destroyed.

- ▶ Feed all inverters in the DC-bus group via a common and stable 24 V supply.
- ▶ With split 24 V supply and fuse protection: If a fuse responds, shut down the entire drive train if possible to avoid cyclical voltage strokes in the DC bus.

Preconditions for trouble-free operation in the DC-bus connection

- The rated values of the mains voltage and the DC-bus voltage must be the same for all inverters in the DC-bus connection.
- The total DC power P_{DC} must be provided by the supplier. ▶ [Dimensioning](#) 51
- The busbar system must not be overloaded:
 - Max. continuous current: 200 A
 - Max. overload: 300 A for 60 s
 - Unloading phase after overload: Max. 150 A for 120 s
- Braking operation with suppliers connected in parallel:
 - The switching thresholds of the brake choppers must be set to the same value.
 - The control of the brake chopper must be synchronized by master-slave connection.
 - ▶ [Braking operation](#) 45

Preconditions for operation from other sources

The inverter can also be supplied from a source other than an i700 supplier without losing UL certification.

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

DC-bus group
DC-bus group with one supplier



A supplier with AC mains connection feeds into the DC-bus group consisting of several inverters.

A brake resistor can be connected to the supplier's brake chopper.

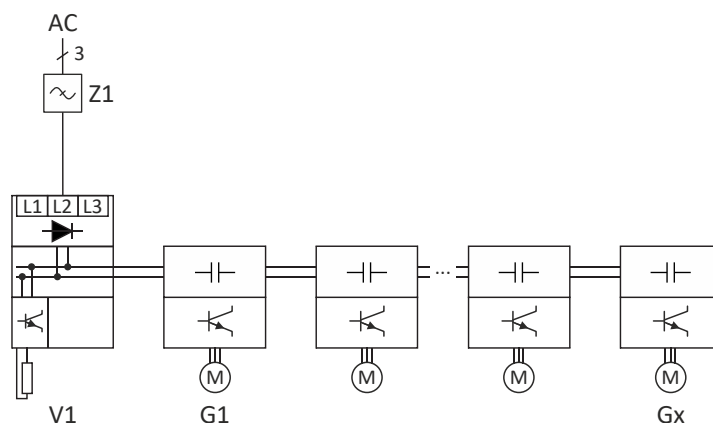


Fig. 1: Basic circuit diagram: DC-bus group with one supplier

Z1	Mains filter or RFI filter	G1...	Inverter
V1	Supplier	Gx	

Supplier	Mains-side components		DC output current $I_{DC\ 100\%}$ [A]	DC-supply power $P_{DC\ 100\%}$ [kW]	
	Mains filter	RFI filter		400 V	480 V
E70ACPSx0304x	–	E94AZRP0084	9.8	3.4	4.1
E70ACPSx0304x	E94AZMP0084	–		5.1	6.2
E70ACPSx0304x	–	E94AZRP0294	30	10.3	12.3
E70ACPSx0304x	E94AZMP0294	–		15.4	18.5
E70ACPSx0604x	–	E94AZRP0824	60	20.6	24.7
E70ACPSx0604x	E94AZMP0494	–		30.9	37.0



DC-bus group with suppliers operated in parallel

Suppliers can be operated in parallel to increase DC supply power and/or increase braking power.

The suppliers operated in parallel are connected to the AC mains via an RFI filter or a mains filter.

 Parallel operation of suppliers is **not** permitted in UL-approved facilities.

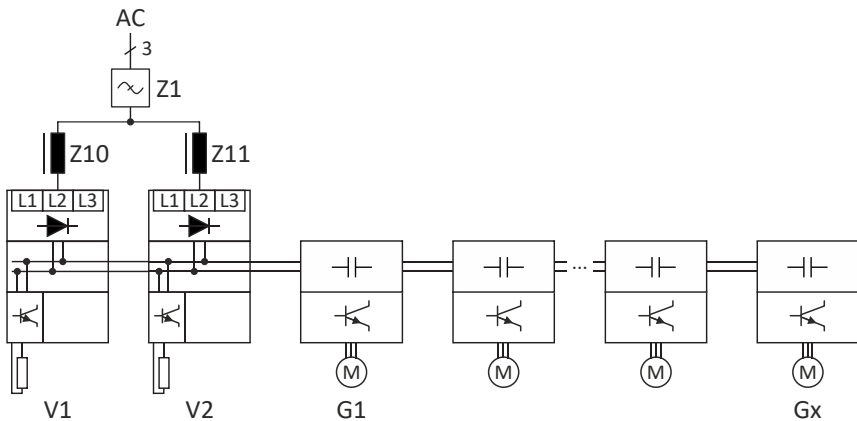


Fig. 2: Basic circuit diagram: DC-bus group with suppliers connected in parallel

Z1 Mains filter or RFI filter V1, V2 Supplier
Z10, Mains choke G1... Inverter
Z11 Gx

Typical combinations

Supplier	Mains-side components			DC output current I _{DC 100%} [A]	DC-supply power P _{DC 100%} [kW]	
	Collective filter		Mains choke			
	Mains filter	RFI filter			400 V	480 V
E70ACPSx0304x	-	E94AZRP0824	EZAELN3025B122	90	46.3	55.5
E70ACPSx0604x			EZAELN3050B591			
E70ACPSx0304x	E94AZMP0824	-	EZAELN3025B122	90	46.3	55.5
E70ACPSx0604x			EZAELN3050B591			
E70ACPSx0604x	-	E94AZRP0824	EZAELN3050B591	100	51.5	61.7
E70ACPSx0604x			EZAELN3050B591			
E70ACPSx0604x	E94AZMP0824	-	EZAELN3050B591	100	51.5	61.7
E70ACPSx0604x			EZAELN3050B591			
E70ACPSx0604x	-	E94AZRP2004	EZAELN3050B591	120	61.8	74
E70ACPSx0604x			EZAELN3050B591			
E70ACPSx0604x	E94AZMP2004	-	EZAELN3050B591	120	61.8	74
E70ACPSx0604x			EZAELN3050B591			



DC-bus group with regenerative power supply module

If regenerative energy is to be fed back into the AC system from a DC-bus group, a regenerative power supply module can be used.

The DC power supply adapter E70AZEVE001 is required to connect the DC cable from the DC output of the regenerative power supply module to the DC busbar system of i750.

A brake resistor can additionally be connected to the brake chopper of the regenerative power supply module.

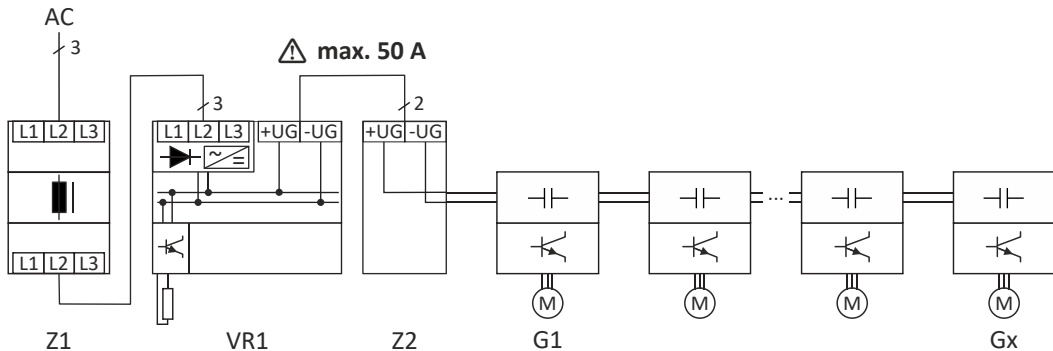


Fig. 3: Basic circuit diagram: DC-bus group with regenerative power supply module E94ARNExxxx

- Z1

Mains filter E94AZMRxxxxxxx
- Z2

DC power supply adapter E70AZEVE001
- VR1

Regenerative power supply module E94ARNExxxx
- G1...

Inverter
- Gx

Typical combinations

Regenerative power supply module	Mains-side components		Supply			Power recovery		
	Mains filter		DC output current $I_{DC\ 100\%}$ [A]	DC-supply power $P_{DC\ 100\%}$ [kW]		DC output current $I_{DC\ 100\%}$ [A]	DC regenerative power $P_{DC\ 100\%}$ [kW]	
	Short distance	Long distance		400 V	480 V		400 V	480 V
E94ARNE0134	E94AZMR0264SDB	-	32	15	18	16	7.5	9
E94ARNE0134	-	E94AZMR0264LDB						
E94ARNE0244	E94AZMR0474SDB	-	57	27	32.4	28.5	13.5	16.2
E94ARNE0244	-	E94AZMR0474LDB						



Braking operation

If more regenerative power is generated in an inverter in the DC-bus group than can be stored in the DC-bus of the inverter, the other inverters in the DC-bus group can use this excess energy.

If there are operating states in which excess regenerative energy is generated for the entire DC-bus group, an additional brake resistor must be used at the supplier. This avoids the disconnection of the DC-bus group due to too high DC-bus voltage. The excess energy is converted into heat in the brake resistor.

NOTICE

Overheating of the brake resistor due to overload

Possible consequences: Destruction of the brake resistor or the supplier.

- ▶ If you use non-intrinsically safe brake resistors: If the thermal contact responds, the voltage supply to the supplier must be disconnected (e.g. switch off the control of the mains contactor).
- ▶ Use intrinsically safe brake resistors.

NOTICE

The brake chopper is not monitored internally. Excessively high currents flow via the connection terminal of the brake resistor due to excessively long switch-on times.

Possible consequences: The connection terminal and the supply cable to the brake resistor can be destroyed.

- ▶ The user must ensure that the max. permissible "switch-on time to rest time" ratio of the brake chopper is not exceeded.

Preconditions for trouble-free braking operation

- Check whether sufficient braking power is available from the brake chopper in the supplier for the maximum regenerative power occurring in all operating states.
- When designing for continuous braking power in the DC-bus group, the limiting monitors must be included:
 - Monitoring the brake chopper
 - Monitoring the brake resistor

Information on project planning

DC-bus group
Braking operation



Increasing the braking power

To increase the braking power, you can use several suppliers with brake chopper and brake resistor in parallel.

This is how you connect several suppliers with brake chopper and brake resistor in parallel:

- One supplier must be defined as "master", all other suppliers as "slave".
- Adjust the wiring of the control terminals to ensure simultaneous switching of all brake choppers on request of the master:
 - Connect the digital input DI3 of each slave to GND potential.
 - Connect the digital output DO1 of the master with DI1 of the slaves.

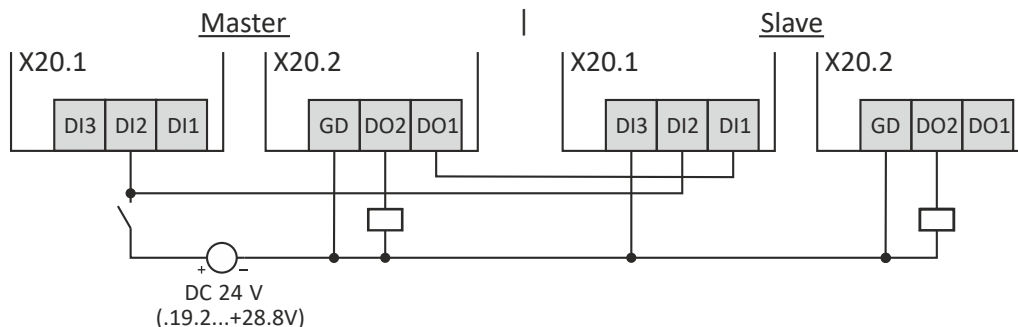


Fig. 4: Master-slave wiring of the brake chopper with suppliers connected in parallel

Recommended brake resistors

- ▶ 3-phase mains connection 400 V, Brake resistors [105](#)
- ▶ 3-phase mains connection 480 V, Brake resistors [114](#)



Compliance with EMC category C3 (industrial premises)

Applications for the "second environment" in the industrial sector must comply with EMC category C3.

DC-bus group with one supplier or suppliers connected in parallel

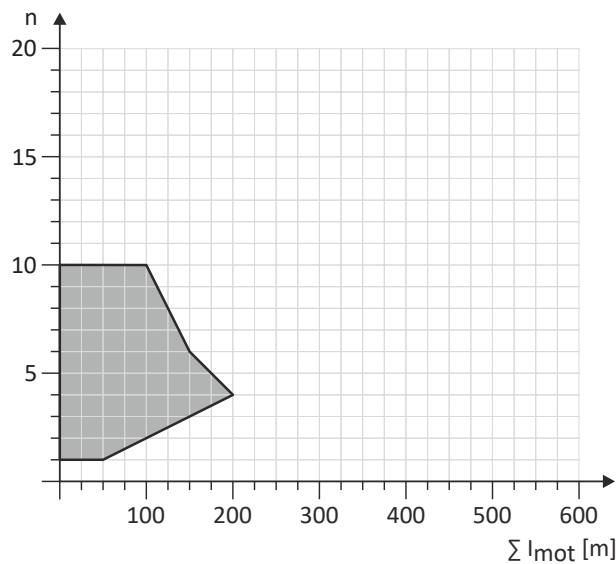
Preconditions

- The maximum sum of all motor cable lengths $\sum l_{\text{mot}}$ must be observed.
- Max. motor cable length per inverter: 50 m.

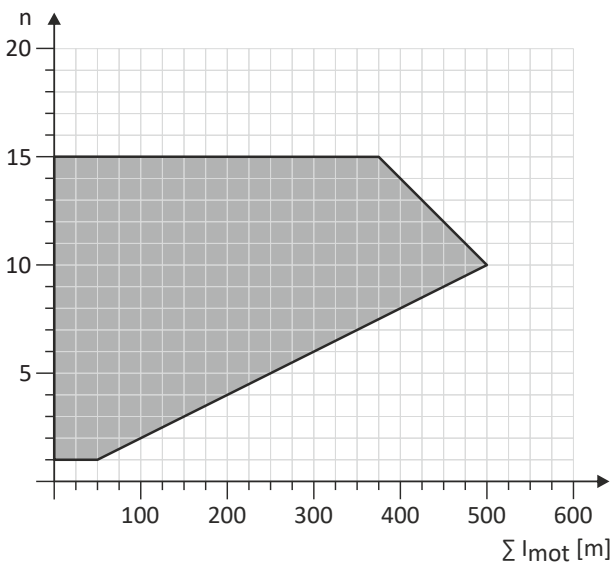
DC-bus group with i700-CVxx/400-3 suppliers

For operation without mains choke: Compliance with EMC category C3 only for switching frequencies 4 kHz and 8 kHz.

Operation without filter/mains choke



Operation with mains choke



$\sum l_{\text{mot}}$ Max. sum of all motor cable lengths
Max. motor cable length per inverter: 50 m

Number of inverters

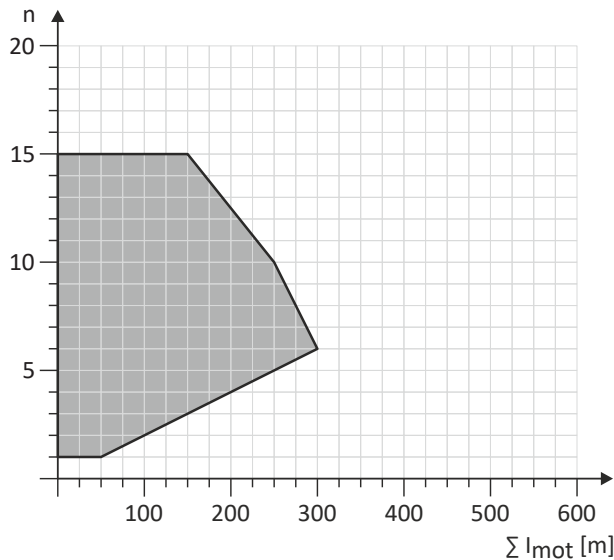
Recommended mains chokes

- ▶ 3-phase mains connection 400 V, Mains chokes [105](#)
- ▶ 3-phase mains connection 480 V, Mains chokes [114](#)



DC-bus group with i700-CVxx/400-3 suppliers

Operation with E94AZRPxxxx RFI filter

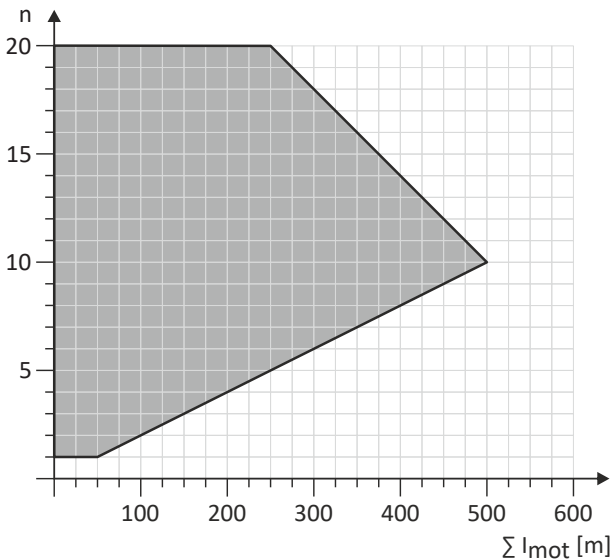


Σ l_{mot} Max. sum of all motor cable lengths
 Max. motor cable length per inverter: 50 m

Recommended filters

- ▶ 3-phase mains connection 400 V, RFI filters / Mains filters [105](#)
- ▶ 3-phase mains connection 480 V, RFI filters / Mains filters [114](#)

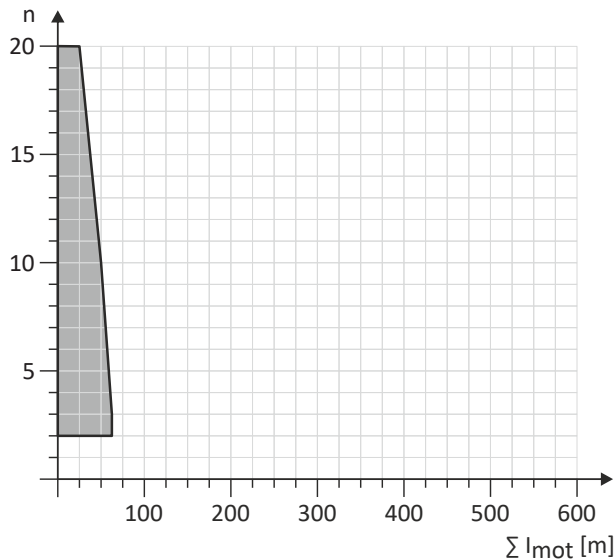
Operation with E94AZMPxxxx mains filter



n Number of inverters

DC-bus group with E94ARNExxxx regenerative power supply module

Operation with E94AZMRxxxxSDB mains filter (short distance)

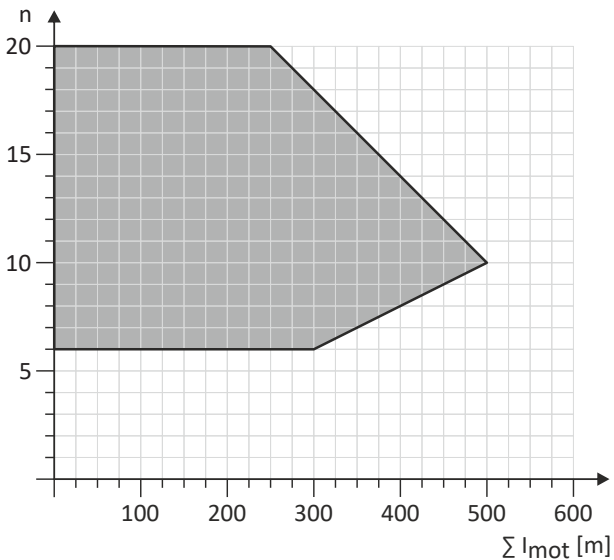


Σ l_{mot} Max. sum of all motor cable lengths
 Max. motor cable length per inverter: 50 m

Recommended filters

- ▶ 3-phase mains connection 400 V, RFI filters / Mains filters [105](#)
- ▶ 3-phase mains connection 480 V, RFI filters / Mains filters [114](#)

Operation with E94AZMRxxxxLDB mains filter (long distance)



n Number of inverters



Compliance with EMC category C2 (residential areas)

Applications for the "first environment" in residential areas must comply with EMC category C2.

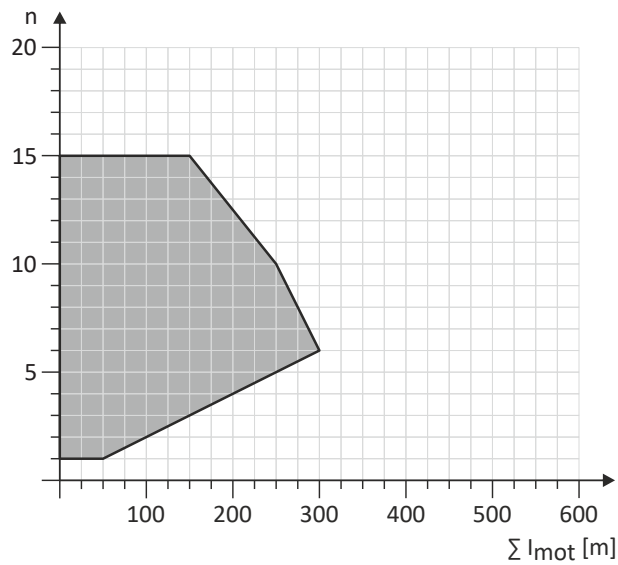
DC-bus group with one supplier or suppliers connected in parallel

Preconditions

- The maximum sum of all motor cable lengths $\sum l_{\text{mot}}$ must be observed.
- Max. motor cable length per inverter: 50 m.

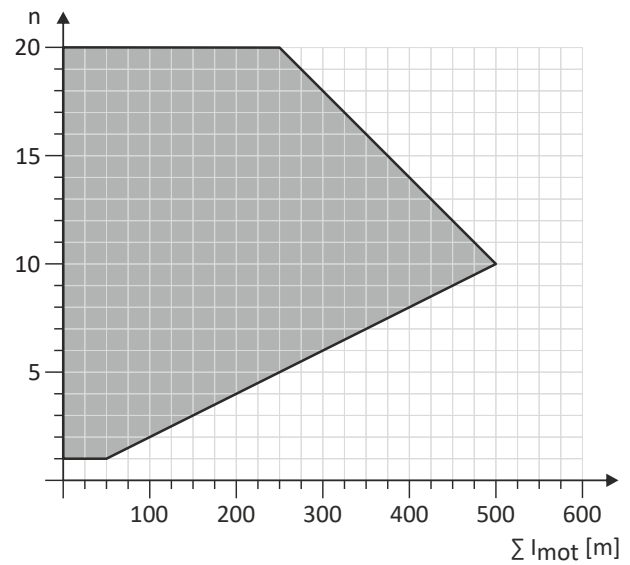
DC-bus group with i700-CVxx/400-3 suppliers

Operation with E94AZRPxxxx RFI filter



$\sum l_{\text{mot}}$ Max. sum of all motor cable lengths
Max. motor cable length per inverter: 50 m

Operation with E94AZMPxxxx mains filter



n Number of inverters

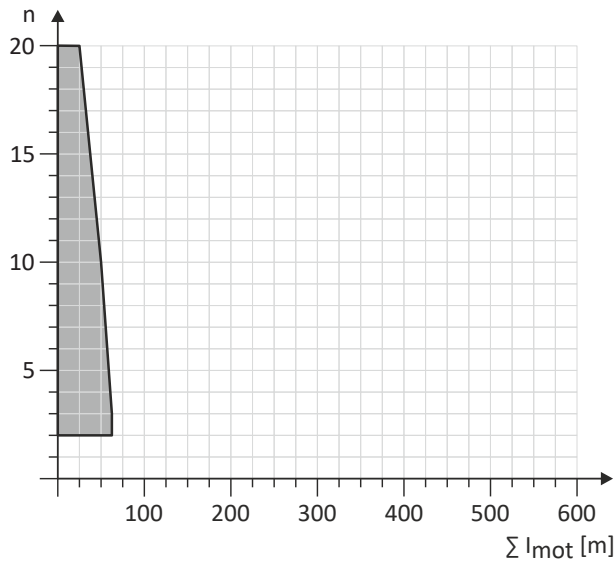
Recommended filters

- ▶ 3-phase mains connection 400 V, RFI filters / Mains filters [105](#)
- ▶ 3-phase mains connection 480 V, RFI filters / Mains filters [114](#)



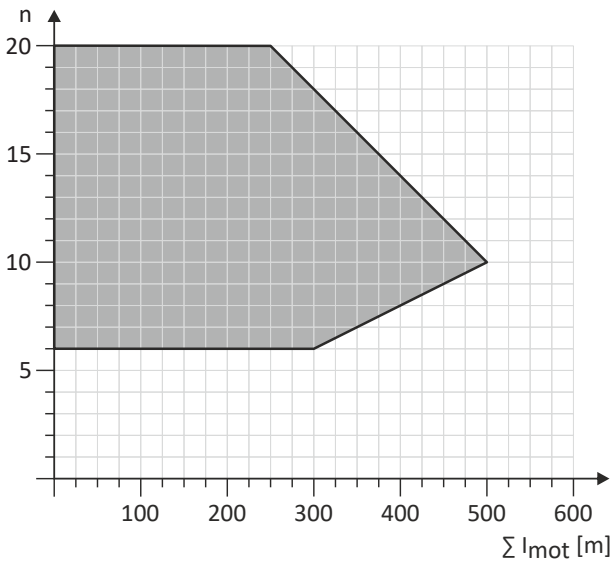
DC-bus group with E94ARNExxxx regenerative power supply module

Operation with E94AZMRxxxxSDB mains filter (short distance)



Σl_{mot} Max. sum of all motor cable lengths
Max. motor cable length per inverter: 50 m

Operation with E94AZMRxxxxLDB mains filter (long distance)



n Number of inverters

Recommended filters

- ▶ 3-phase mains connection 400 V, RFI filters / Mains filters [105](#)
- ▶ 3-phase mains connection 480 V, RFI filters / Mains filters [114](#)



Dimensioning



The free engineering tool "EASY System Designer" provides support for designing a DC-bus connection.

[EASY System Designer](#)

Preconditions

To calculate the total power of the DC bus manually, you need a time/power diagram of all inverters for a complete machine cycle. The power balance of the DC bus can be determined from the addition of the simultaneous individual power outputs:

- Positive values correspond to the supply power from the AC system, which determines the selection of the supplier.
- Negative values correspond to the braking power that must be dissipated via a brake resistor or a regenerative power supply module.

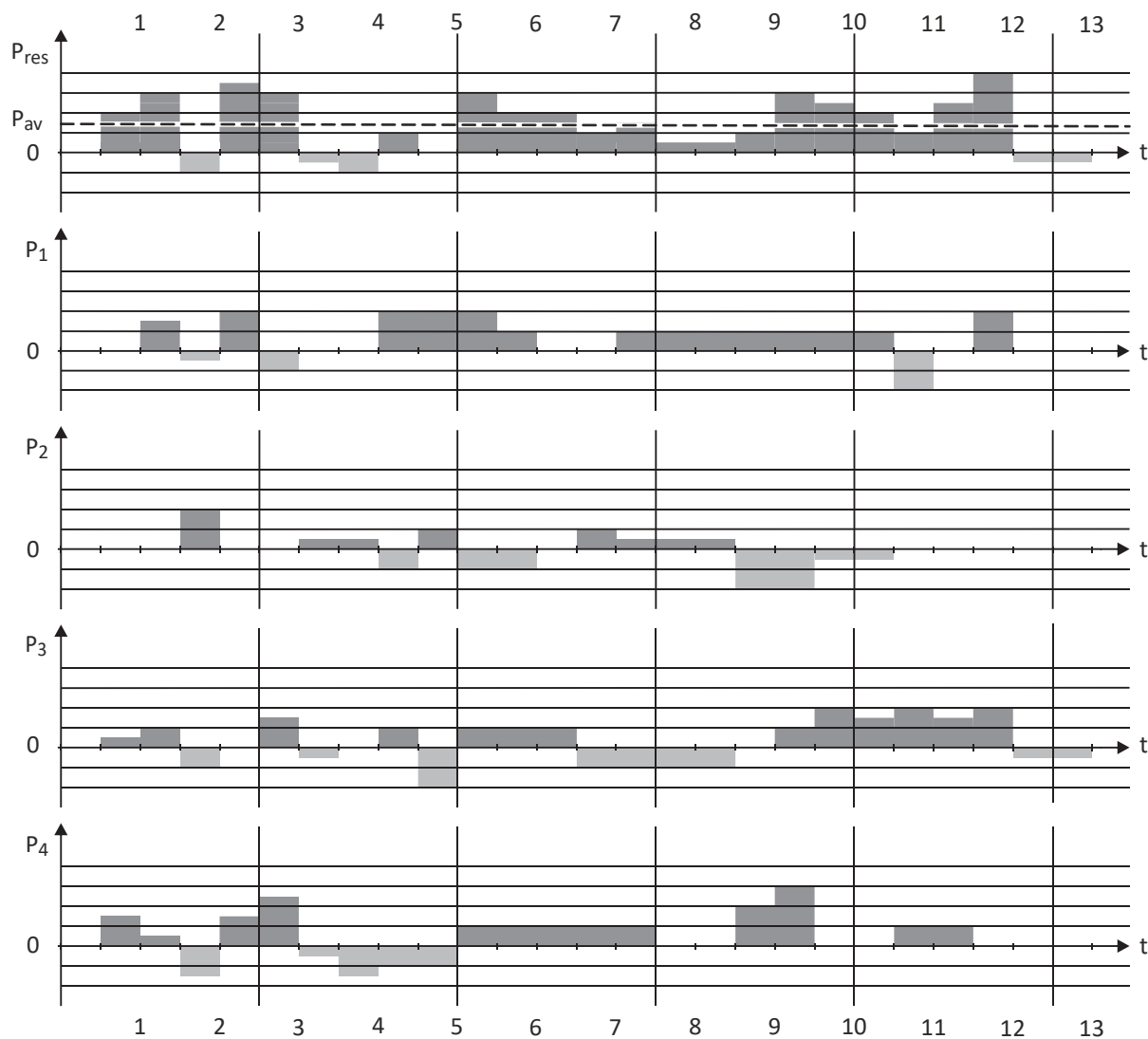


Fig. 5: Example time/power diagram

P1 ... Individual power outputs of
P4 inverters 1 ... Inverter 4
Pres Sum of the individual power outputs

Pav Mean value of the individual power
outputs

Information on project planning

DC-bus group
Dimensioning



Requirements for the supplier

The supplier must be able to provide the mean value of the individual P_{av} power outputs on a permanent basis.

The overload requirements must be within the permissible range:

- 3-min cycle: 1 min overload with 150% and 2 min recovery time with 75%.
- 15-s cycle: 3 s overload with 200% and 12 s recovery time with 75%.

Determining the power requirement

Determine the motor mode power requirement of the DC-bus group based on the rated power of the motors, their efficiencies and the power losses of the inverters:

$$P_{DC} = \sum_{i=1}^n \left\{ \frac{(P_{Mot})_i}{\eta_i} + (P_v)_i \right\}$$

P_{DC}	Total motor mode power requirement of the DC-bus group
P_v	Power loss of an inverter
n	Number of inverters in the DC-bus group
P_{Mot}	Rated power of a connected motor
η	Motor efficiency



Mechanical installation

Important notes

Measures for cooling during operation

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

Mounting of the suppliers and axes

- Standard mounting: Mount the supplier to the left of the axis system.

For mounting to the right of the axis system, the swivel hooks for the busbar system must be relocated.
- The DC infeed adapter i700 E70AZEVE001 can be connected to the left or right side of suppliers or axes.



Preparation

Further data and information for mechanical mounting:

▶ [Control cabinet structure](#) 40

▶ [Dimensions](#) 121

Installation clearances

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

Mechanical fastening

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

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

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

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

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

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



Mounting inverter

How to mount the inverter on the mounting plate

Preconditions:

- Mounting plate with conductive surface

Required:

- Tool for drilling and thread cutting
 - Screwdriver
 - Screw and washer assemblies or hexagon socket screws with washers.
1. Prepare the mounting plate with the corresponding threaded holes.
 2. Fit screws and washers (if applicable).
 3. Do not yet tighten the screws.
 4. Mount the inverter on the prepared mounting plate via keyhole suspension.
 5. Only tighten the screws hand-tight.
 6. Pre-assemble additional units if necessary.
 7. Adjust the units.
 8. Screw the units to the mounting plate.

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



Mounting brake resistor

WARNING!

Possible overheating of the brake resistor during operation

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

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

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



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

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

How to mount the brake resistor:

1. Select a suitable mounting location.

The mounting location must always guarantee the operating conditions specified in the technical data.

2. Screw the brake resistor into place at the mounting location.

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

The brake resistor is installed. You can start wiring.

▶ [Brake resistor connection](#)  76



Electrical installation

Important notes

DANGER!

Dangerous electrical voltage

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

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

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

The leakage current to earth (PE) is $> 3.5 \text{ mA AC}$ or $> 10 \text{ mA DC}$.

Possible consequences: Death or serious injuries from electric shock

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

DANGER!

Use of the inverter on a phase earthed mains with a rated mains voltage $\geq 300 \text{ V}$

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

Possible consequences: Death or severe injuries

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

WARNING!

Dangerous electrical voltage

Device error causes an overvoltage in the system.

- ▶ For a voltage supply with DC $24 \text{ V} (\pm 20 \%)$, use only a safely separated power supply unit according to the valid SELV/PELV requirements.

NOTICE

No protection against excessively high mains voltage

The mains input is not fused internally.

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

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



NOTICE

Overvoltage at devices with 230-V mains connection and no. of phases = 1 or 1/3

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

Possible consequences: Destruction of the device

- Provide for the use of isolating transformers.

NOTICE

The product contains electrostatic sensitive devices.

Possible consequences: Destruction of the device

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

NOTICE

Use of mains filters and RFI filters in IT systems

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

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

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

- Do not use mains filters and RFI filters from Lenze in IT systems.
- Before using the inverter in the IT system, remove the IT screws.

NOTICE

Overvoltage at components

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

Possible consequences: Destruction of the device

- Before using the inverter in the IT system, the contact screws must be removed.
- Positions and number of the contact screws depend on the device.

NOTICE

Vibrations at the connections

Possible consequences: Damage to the connections

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



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

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



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

These notes are marked with "UL marking".



Electrical installation

Important notes
Electrical isolation

Electrical isolation



Ensure a trouble-free operation:

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

Electrical installation

Important notes
Electrical isolation



Supplier

X100 X101 X102 X103 X20.1 X20.2 X21 Hazardous mains potential No insulation Simply insulated from the mains potential Isolation by basic insulation Safely isolated from the mains potential Isolation by double or reinforced insulation Protection against accidental contact is guaranteed without any further measures. ----- Isolation by functional insulation					
X100	L1, L2, L3, PE	Mains connection	X20.1	DI1, DI2, DI3	Digital inputs
X101	+UG	DC-bus connection	X20.2	DO1, DO2, GD	Digital outputs
X102	-UG	DC-bus connection	X21	24E, GE	24 V supply for control electronics
X103	Rb1, Rb2, PE	Brake resistor connection			

Inverter

X101 X105 X1 X3 X5 X236 IN X237 OUT X7 X8 X106 X107 X109 Hazardous mains potential No insulation Simply insulated from the mains potential Isolation by basic insulation Safely isolated from the mains potential Isolation by double or reinforced insulation Protection against accidental contact is guaranteed without any further measures. ----- Isolation by functional insulation					
X101	+UG, -UG	DC-bus connection	X1	SIA, SIB, GS	Basic Safety - STO (Option)
X105	U, V, W, PE	Motor connection	X3	DI1, DI2, GDI	Control terminals
X106	BD1, BD2	Motor holding brake connection	X5	24E, GE	24 V supply for control electronics
X107	24B, GB	24 V supply for motor holding brake	X7	Sub-D, 9-pole	Motor encoder - resolver (option)
X109	T1, T2	PTC input/motor encoder HIPERFACE DSL® (OCT)	X8	Sub-D, 15-pole	Motor encoder - encoder (option)
X236 IN	RJ45	onboard EtherCAT IN			
X237 OUT	RJ45	onboard EtherCAT OUT			



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

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

Preconditions

Installation in TN network and TT network

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

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

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



Preparation

After the mechanical assembly, the wiring begins with making the integrated electrical connections.

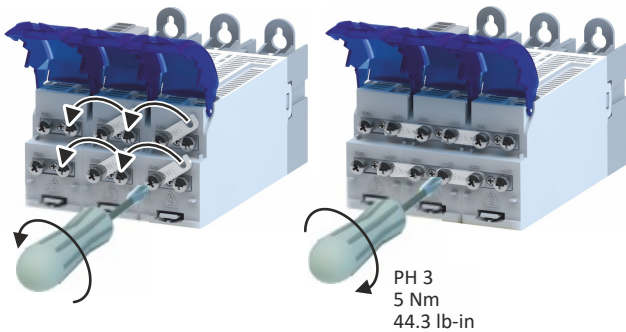
This is how you establish the integrated DC-bus connection.

Required tools

- Screwdriver PH 3

1. Loosen screws.
2. Turn the swivel hook into position.
3. Tighten the screws.

The DC-bus connection from the supplier to the last inverter in the DC-bus group is established.



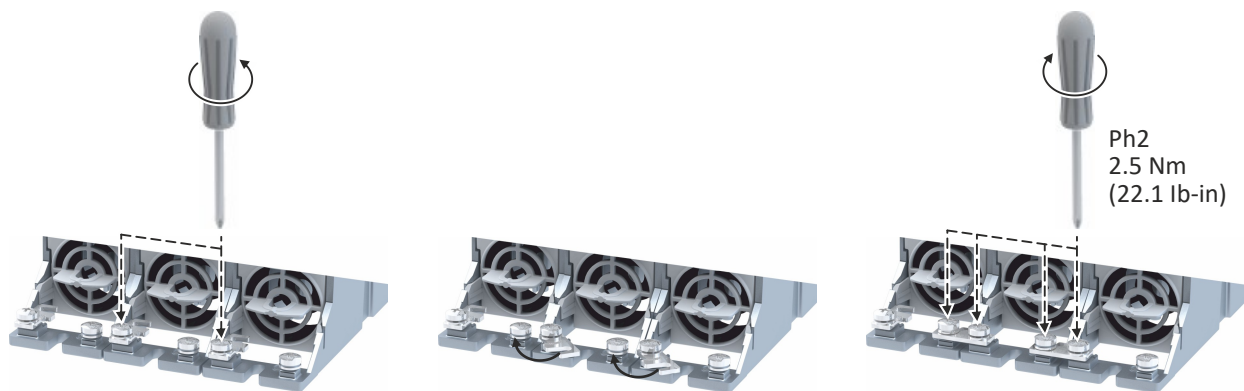
This is how you establish the integrated protective earth connection.

Required tools

- Screwdriver PH 2

1. Loosen screws.
2. Turn the swivel hook into position.
3. Tighten the screws.
4. Double the PE connection on the left and right product of a network in accordance with the standard.
5. Mount the shield connection sheet.

The protective earth connection from the supplier to the last inverter in the network has been established.



Further data and information

► [Standards and operating conditions](#) 91



EMC-compliant installation

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

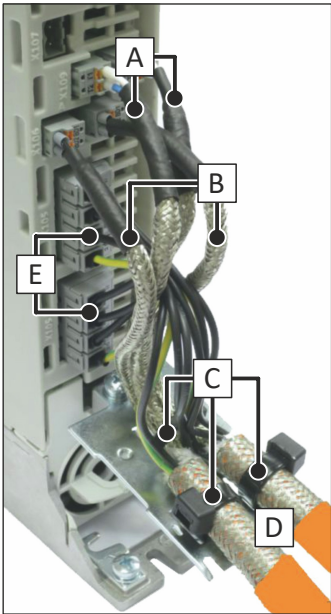
These guidelines should also be followed in installations requiring FCC Part 15 or ICES 001 compliance.

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

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

Matching accessories makes effective shielding easier. ▶ [Shield mounting kit](#) 216

Example: Motor-side wiring of a double axis for one cable technology (OCT)



- A Connection cable for the transmission of the Hiperface DSL® protocol.
- B Connection cable for the motor holding brake
- C Shield mounting with cable ties
- D Hybrid cable for motor connection with one cable technology (OCT)
- E Motor connection

Mains connection

Mains cable

- Suppliers, mains chokes or mains-side filters may be connected to the mains via unshielded single wires or unshielded cables.
- Cable between mains-side filter and supplier:

	Cable length	
	≤ 300 mm	> 300 mm
Design	unshielded twisted option	always shielded



Motor cable

EMC-compliant installation must be carried out with shielded low-capacitance motor cables.
Suitable motor cables can be obtained directly from Lenze.

Capacitance per unit length

- Cable cross-section $\leq 2.5\text{ mm}^2$ ($\geq$ AWG 14): C-core-core/C-core-shield $<75/150\text{ pF/m}$
- Cable cross-section $\leq 4\text{ mm}^2$ ($\geq$ AWG 12): C-core-core/C-core-shield $<150/300\text{ pF/m}$

Braid

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

Cable for motor temperature monitoring

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

Measures on the motor

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

Further supporting measures

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

Control cables

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

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



Fieldbus cables, networks

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

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

Patch cable/CAT5 cables:



The appropriate patch cable for the EtherCAT connection of the axes is included in the scope of supply.

RJ45 plug connections:

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

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

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



Detecting and eliminating EMC interferences

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



Connection according to UL

Important notes

WARNING!

- ▶ **UL/CSA marking**
 - ▶ Secondary circuit shall be supplied from an external isolating source.
 - ▶ Maximum surrounding air temperature is 40 °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 : 40 °C.
 - ▶ Température ambiante maximale avec déclassement : 55 °C.
-

WARNING!

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

WARNING!

- ▶ **UL marking**
 - ▶ Drives shall be used with line reactor connected in series with AC mains, all rated min. 480 V.
 - ▶ **Marquage UL**
 - ▶ Les variateurs avec une tension assignée mini de 480 V doivent être utilisés avec une inductance de ligne raccordée en série à un réseau électrique triphasé.
-

WARNING!

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

WARNING!

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

Electrical installation

Connection according to UL
Fusing data
Branch Circuit Protection (BCP) with Standard Fuses or Circuit Breaker



 WARNING!

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

NOTICE

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

Fusing data

Branch Circuit Protection (BCP) with Standard Fuses or Circuit Breaker

Short Circuit Current Ratings (SCCR)

(Tested per UL 508C, reference UL file E132659)

Suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 480Y/277V maximum:

- When protected by fuses rated as given in tables below.
- When protected by a circuit breaker having an interrupt rating not less than 100,000 rms symmetrical amperes, 480Y/277V maximum rated as given in tables below.
- No further common DC-bus protection is required when common DC-bus wires or DC-bus tap wires have an adequate ampacity.

Supplier	Standard Fuses (UL248)			Circuit Breaker (UL489)			
	SCCR	Max. rated current	Class	SCCR	Max. rated current	Min. cabinet dimensions	
	kA	A		kA	A	m ³	ft ³
i700-CV30/400-3	100	80	CC, CF, G, J, T	100	40	-	-
i700-CV60/400-3	100	125	CC, CF, G, J, T	100	80	-	-

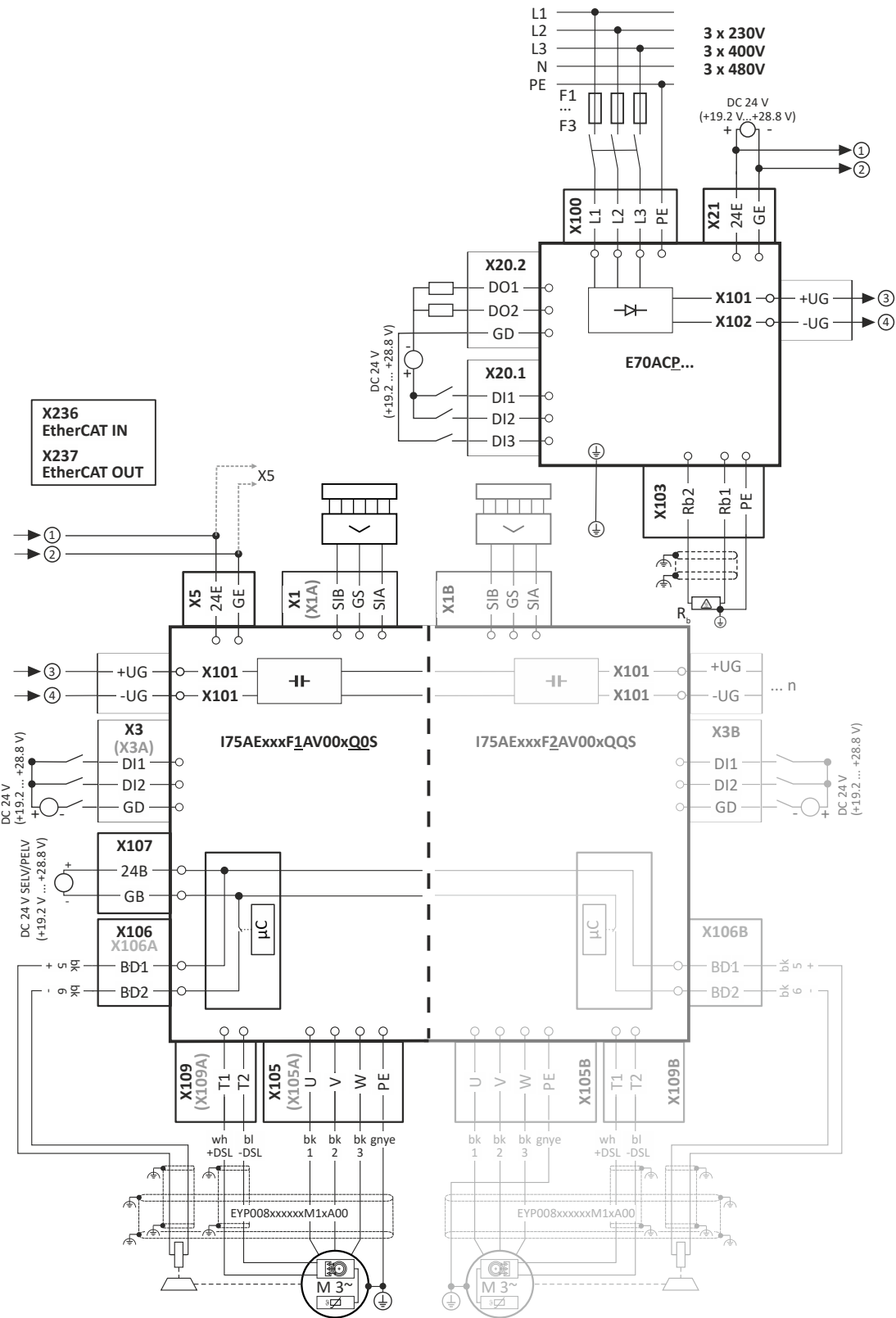


Mains connection

The connection diagrams are considered exemplary for all voltage and power classes.

Connection diagram Basic Safety with OCT version

The connection diagram is valid for suppliers E70ACP... with single axes I75AExxxFxAV00xQ0S and double axes I75AExxxFxAV00xQQS.





DC-bus connection

 Detailed information on the DC-bus group can be found here: [▶ Information on project planning, DC-bus group](#)  41

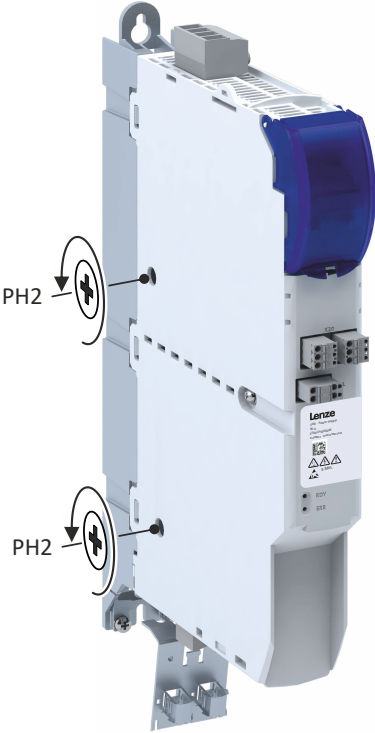


Connection to the IT system

NOTICE

Internal components have earth/ground potential
Possible consequences: The monitoring devices of the IT system will be triggered.
► Upstream an isolation transformer.
► Before connection to an IT system be absolutely sure to remove the screws labeled with "IT" on the product.

 The IT screws are on the supplier.

E70ACPSE0304x	E70ACPSE0604x
	



Motor connection

Only use motors that are suitable for inverter operation.
Insulation resistance (EN 60034): max. $\hat{u} \geq 1.5 \text{ kV}$, min. $du/dt \geq 5 \text{ kV}/\mu\text{s}$

Motor cable lengths

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

Switching in the motor cable

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

Preconditions:

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

Possible applications:

- Galvanic isolation of the motor from the inverter
 - A controller must ensure that the switching element in the motor cable does not switch until the inverter is inhibited.
- Operation of several motors on one inverter in V/f characteristic control mode
 - Monitoring functions of the inverter for motor protection (e.g. i^2xt) cannot be used.
 - Ensure temperature monitoring of all motors by external measures.
 - Disable the inverter when overload protection and cable protection in the individual motor cables respond. Do not disconnect the motor circuit.

Please note the following:

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

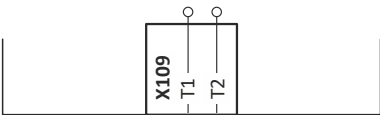
Rated power	shielded	unshielded
P _{rated}		
0.37 ... 15 kW	50 m	100 m
22 ... 30 kW	100 m	200 m
The maximum length of the motor cable when using HIPERFACE DSL® (OCT) is 100 m.		



Connection of motor temperature monitoring

- Terminal X109 can be used on inverters either for temperature monitoring with PTC/thermal contact or for One Cable Technology (OCT).
[▶ HIPERFACE DSL® encoder \(OCT\)](#)
- If the terminal X109 is used, e. g. to connect an external PTC thermistor (PTC) or a thermal contact, ensure at least one basic insulation to the potentials of motor, mains and control terminals to not restrict the safe separation of the control terminals.

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



Connection			PTC, thermal contact, OCT
Connection designation			X109
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	10
Stripping length		in	0.4
Required tools			Screwdriver 0.4 x 2.5



Motor holding brake connection

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

 **DANGER!**

Loss of the safe isolation

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

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

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



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



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

Functions for controlling motor holding brakes:

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

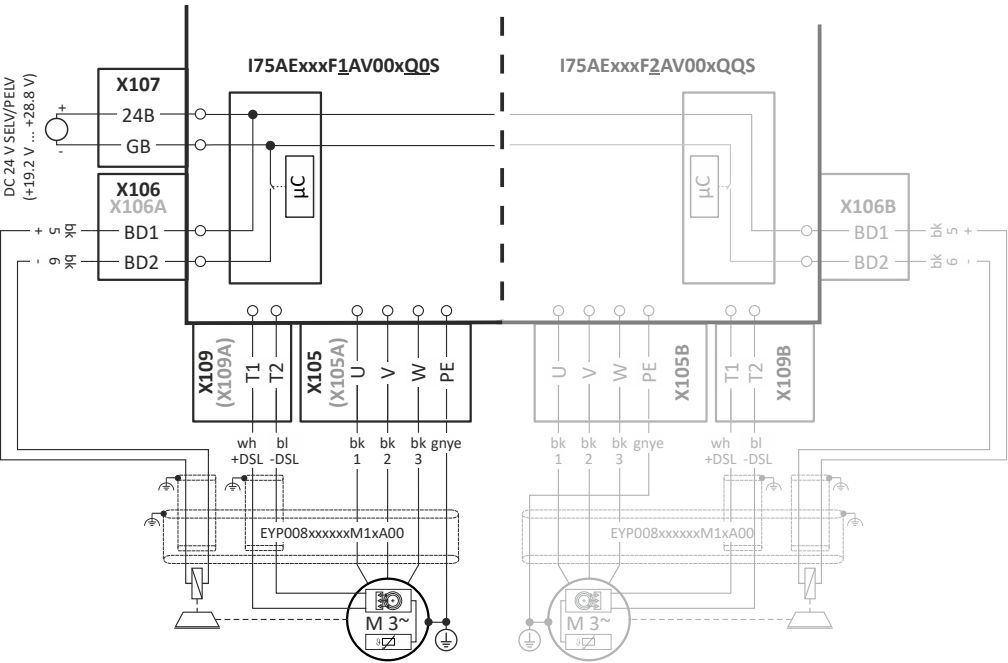


Fig. 6: Connection diagram for motor holding brake - i750 OCT/PTC version



Connection data

Motor holding brake

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

24 V supply for motor holding brake

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

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



Brake resistor connection

The brake resistor is connected to terminal X103 on the supplier.

WARNING!

Possible overheating of the brake resistor during operation

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

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

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

NOTICE

Use of intrinsically safe brake resistors

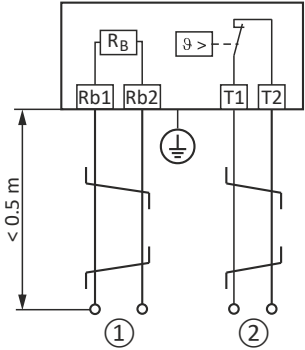
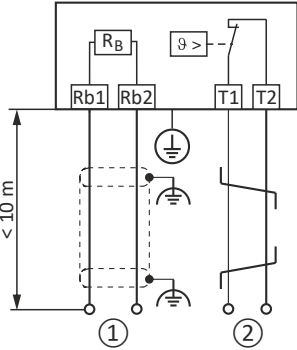
In the case of brake resistors that are not unsafe in the event of thermal overload, i.e. whose behavior is “intrinsically safe”, no separate temperature monitoring (thermal contact) and no control of the mains contactor is required.

The intrinsically safe brake resistor can be destroyed in the event of thermal overload (e.g. short circuit of the brake transistor). This interrupts the energy flow. If it is permanently energized (due to a fault), there is no danger, provided it has been installed in accordance with the mounting instructions.

Preconditions

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



Short connection cables up to 0.5 m	Long connection cables up to max. 10 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. 	The cable of the brake resistor must be shielded. The maximum length is 10 m. Twisting is sufficient for the temperature monitoring cable. 
① Wiring to the "brake resistor" connection on the component with brake chopper. ② Wiring to a control contact that is set to monitor the thermal contact. If the thermal contact responds, the voltage supply to the component with brake chopper must be disconnected (e.g. switch off the control of the mains contactor).	

To connect the brake resistor:

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



Supply voltage connection

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

 **DANGER!**

Loss of the safe isolation

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

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

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

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



Control connections

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

Connection			Control signals (I/O)
Connection designation			X3
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	2.5
Max. cable cross-section		AWG	14
Min. cable cross-section		mm²	0.25
Min. cable cross-section		mm²	22
Stripping length		mm	10
Stripping length		in	0.4
Required tools			Screwdriver 0.4 x 2.5



Motor encoder connection



The maximum permissible lengths for feedback cables must be observed:

- Resolver: 150 m
- Encoder: 100 m

The motor encoder type is determined by the selected variant of the axis:

▶ [Product extensions](#), [Motor encoder evaluation](#) 134

Prefabricated system cables are recommended.

Details on the connection of the one cable technology (OCT):

▶ [HIPERFACE DSL® encoder \(OCT\)](#) 83

Resolver

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-



Electrical installation

Motor encoder connection
Incremental encoders and absolute value encoders

Incremental encoders and absolute value encoders

Pin assignment of incremental encoder

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

Pin assignment - absolute value encoder

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



Pin assignment - absolute value encoder EnDat

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



HIPERFACE DSL® encoder (OCT)

Preconditions

- The One Cable Technology (OCT) is possible with MCS and m850 servo motors.
- The motor must be provided with a HIPERFACE DSL® encoder.
- The inverter can only be equipped with one motor feedback per axis; a combination of motor encoder and load/position encoder is not possible.
- Connection cable
 - The EYP008xxxxxxM11A00 or EYP008xxxxxxM12A00 hybrid cable must be used.
 - Different lengths up to 100 m are available. ▶ [System cables](#) 218
 - The hybrid cables have only basic insulation to the power electronics.

Preparation of the cable

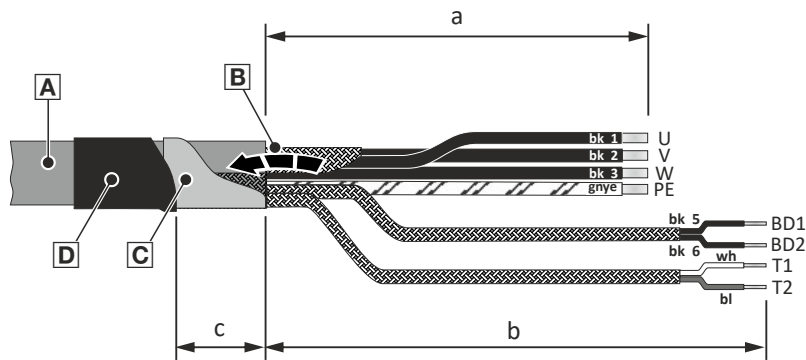


Fig. 7: Cable assembly

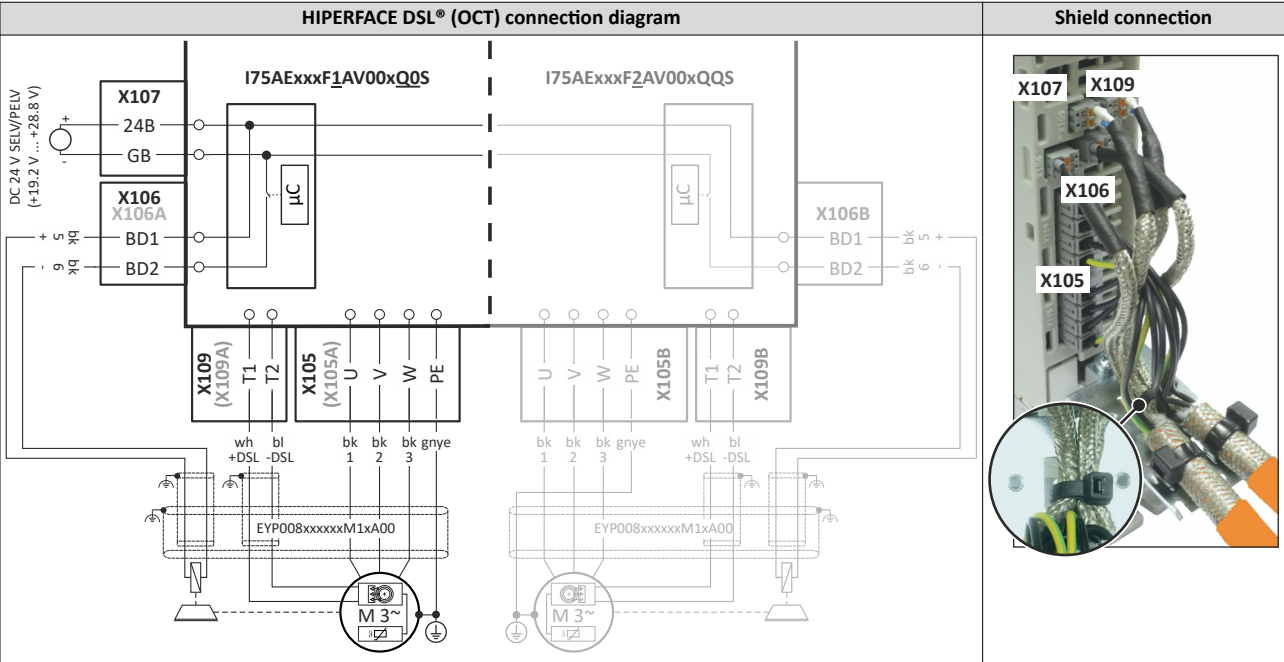
- A Hybrid cable
B Shield
C Conductive foil
D Heat-shrinkable tube

Inverter			I75AE							
			211F1	222F1	240F1	275F1	311F1	315F1	322F1	330F1
			211F2	222F2	240F2	275F2				
Rated power	P _{rated}	kW	1.1	2.2	4	7.5	11	15	22	30
Rated power	P _{rated}	HP	1.5	3	5	10	15	20	30	40
Stripping length	a	mm	130				130		160	
	b	mm	180				180		230	
	c	mm	25				30		30	



Connection diagram and shield sheet

Lay out all shields over a large area and fasten with cable ties or fixing clips.



Connection			PTC, thermal contact, OCT
Connection designation			X109
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	1.5
Max. cable cross-section		AWG	16
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length		mm	10
Stripping length		in	0.4
Required tools			Screwdriver 0.4 x 2.5



Networks



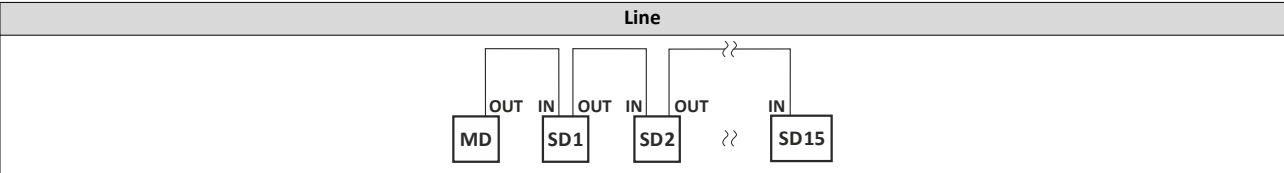
When planning networks, consider the recommendations listed in the chapter "EMC-compliant installation" for low-interference operation, especially of Ethernet-based networks.

EMC-compliant installation → [Fieldbus cables, networks](#)  65

onboard EtherCAT

The inverter has an integrated EtherCAT connection for real-time communication on the fieldbus side. The interface supports the EtherCAT Distributed Clocks (DC) mechanism and short cycle times, enabling deterministic real-time communication and high-precision time synchronization of all connected EtherCAT devices, which is particularly advantageous for motion control applications.

Typical topologies



M Master
SD Slave Device

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

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



Functional safety

DANGER!

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

Possible consequences: Death or severe injuries

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

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 acclimated.



Basic Safety - STO

Basic Safety - STO is part of the i75AExxxFxA product variant.

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.

DANGER!

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

Possible consequences: Death or severe injuries

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

Safe state

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

- [Safe torque off \(STO\)](#)  155

Electrical installation

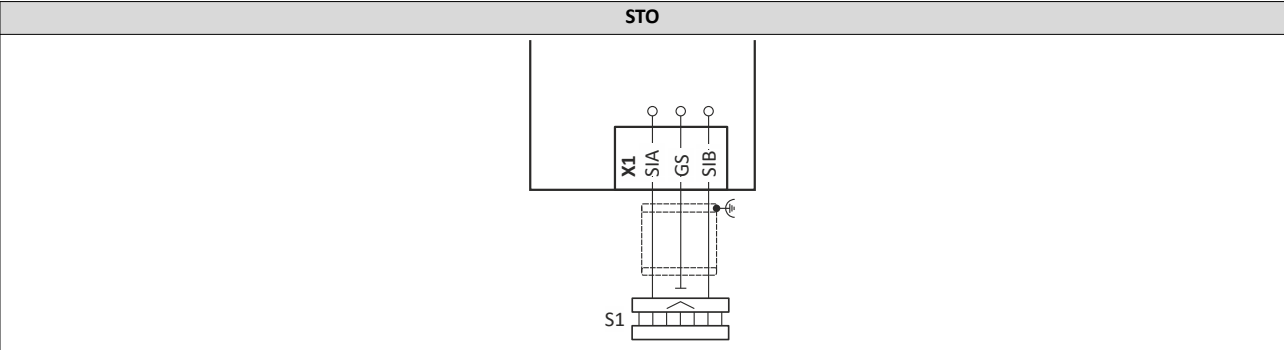
Functional safety
Basic Safety - STO
Connection diagram



Connection diagram

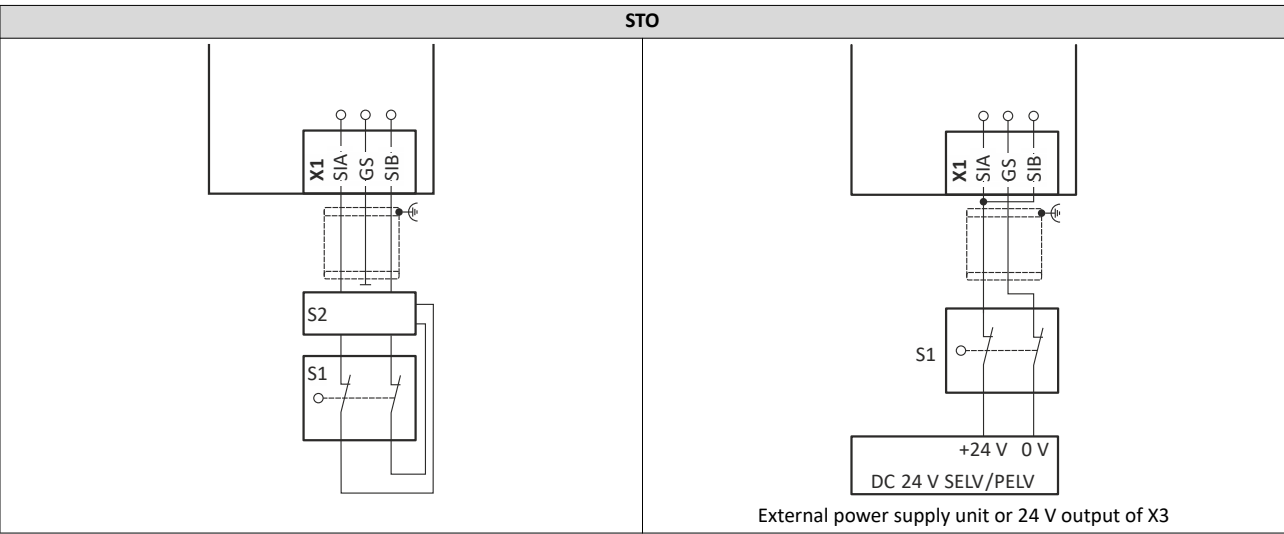
 The connection diagrams shown are only example circuits. The user is responsible for the correct safety-related design and selection of the components!

Active sensors



S1 Active sensor - example of lightgrid

Passive sensors

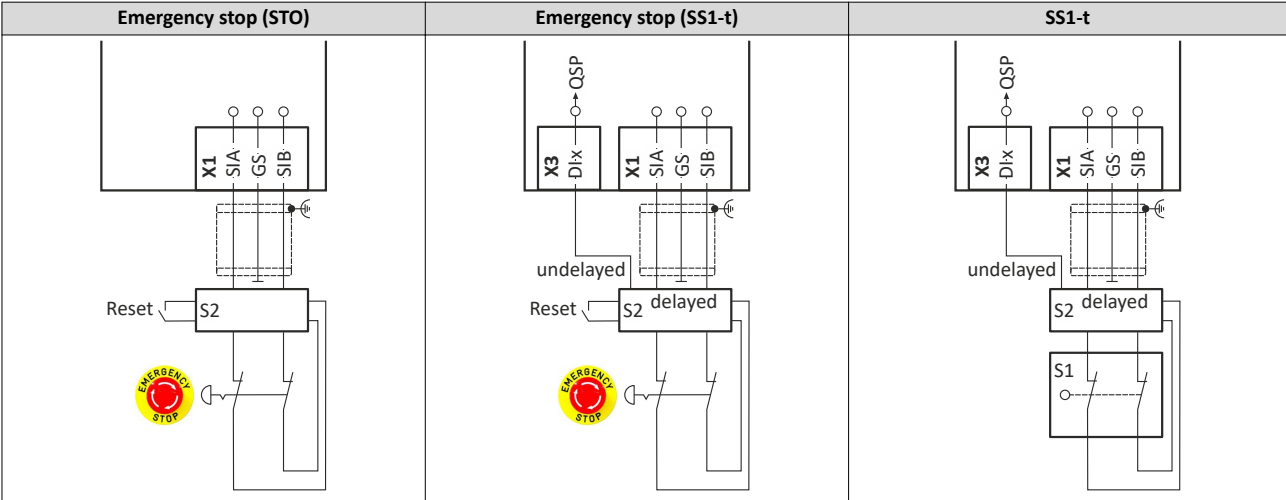


S1 Passive sensor
S2 Safety switching device

S1 Passive sensor



Passive sensors - further examples



- S2

Safety switching device
- S2

Safety switching device with delayed contacts
- S1

Passive sensor
- QSP

"Quick stop" function
- S2

Safety switching device with delayed contacts
- QSP

"Quick stop" function

Connection data

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

i

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			STO
Connection designation			X1
Connection system			Spring terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	2.5
Max. cable cross-section		AWG	14
Min. cable cross-section		mm²	0.25
Min. cable cross-section		AWG	22
Stripping length			10
Stripping length			0.4
Required tools			Screwdriver 0.4 x 2.5

Electrical installation

Functional safety
Advanced Safety



Advanced Safety

Advanced Safety is part of the i75AExxxFxF product variant.



The i75AExxxFxF product variant has no terminals for controlling the safety functions.

The safety functions are controlled exclusively via the safety bus.

▶ [Safety functions](#)  154

▶ [Safe network interfaces](#)  148

Extended Safety

Extended Safety is part of the i75AExxxFxB product variant.



The i75AExxxFxB product variant has no terminals for controlling the safety functions.

The safety functions are controlled exclusively via the safety bus.

▶ [Safety functions](#)  154

▶ [Safe network interfaces](#)  148



Technical data

Standards and operating conditions

Conformities and approvals

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

Supplier

UL	UL 508C		File No. E132659
			For USA and Canada (requirements of the CSA 22.2 No. 14)



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

www.Lenze.com → Products → Inverters → Servo inverters
→ [i750 cabinet servo inverter](#)
(Section "Product support")

Protection of persons and device protection

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



EMC data

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

Motor connection

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

Environmental conditions

Climate			
Storage	EN 60721-3-1:1997	1K3 (-25 ... +60°C)	
Transport	EN 60721-3-2:1997	2K3 (-25 ... +70 °C)	
Operation	EN 60721-3-3:1995 + A2:1997	3K3 (-10 ... +55°C)	Above +40°C: reduce rated output current by 2.5 %/°C
Site altitude			
0 ... 1000 m amsl			Without current derating
1000 ... 4000 m amsl			Reduce rated output current by 5 %/1000 m
Vibration resistance			
Transport	EN 60721-3-2:1997	2M2 (sine, shock)	In original packaging
Operation	DNV-CG-0339	Amplitude ±1 mm	5 ... 13.2 Hz
		Acceleration resistant up to 0.7 g	13.2 ... 100 Hz
	EN IEC 61800-5-1	Amplitude 0.075 mm	10 ... 57 Hz
		Acceleration resistant up to 1 g	57 ... 150 Hz

Electrical supply conditions

Power systems			
IT			Apply the measures described for IT systems!
TN			Voltage against earth: max. 300 V
TT			

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

The following is supported:

- 3-phase mains connection 400 V 103
- 3-phase mains connection 480 V 112



Certification of the integrated functional safety

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

EN ISO 13849-1:2015 EN ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems – Part 1
EN 61508, Part 1-7:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
EN 61800-5-1:2007 + A1:2017 + A11:2021	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy requirements
EN 61800-5-2:2007 EN 61800-5-2:2017	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional safety



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

www.Lenze.com → Products → Inverters → Servo inverters

→ [i750 cabinet servo inverter](#)

(Section "Product support")

Technical data

3-phase mains connection 230/240 V

Supplier data

Rated data



3-phase mains connection 230/240 V

Supplier data

Rated data

Supplier			i700-CV30/400-3	i700-CV60/400-3
Mains voltage range			3 AC 170 V ... 264 V, 45 Hz ... 65 Hz	
Rated mains current				
without mains choke		A	24.5	49
with mains choke		A	24.5	49
Cyclic mains switching			5-mal in 5 Minuten	
DC output voltage range			DC 235 V ... 370 V	
DC rated output current				
without mains choke		A	30	60
with mains choke		A	30	60
Power loss				
without mains choke		W	60	110
with mains choke		W	80	160
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	45	90
Overload time	T_1	s	60	60
Recovery time	T_2	s	120	120
Max. output current during the recovery time		A	22.5	45
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	60	120
Overload time	T_1	s	3	3
Recovery time	T_2	s	12	12
Max. output current during the recovery time		A	19.8	39.6
DC rated output power				
without mains choke		kW	5.9	11.8
with mains choke		kW	8.9	17.7

Supplier			i700-CV30/400-3	i700-CV60/400-3
Brake chopper				
Switch-on threshold		V	765	
Min. brake resistance		Ω	18	9
Rated output current		A	6.5	13.1
Max. output current		A	42.5	85
Switch-on time (I_{max})		s	15	
Recovery time ($I = 0$ A)		s	82	
Max. cable length				
shielded		m	10	
unshielded		m	0.5	



Fusing data

Inverters	Fuse			Circuit breaker			RCD	
	SCCR	Characteristic	Max. rated current	SCCR	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
E70ACPSE0604	100	gG/gL, gRL	63	100	C	63	≥ 300	Typ B
E70ACPSE0304	100	gG/gL, gRL	40	100	C	40	≥ 300	Typ B



If the I75AE322F1 and I75AE330F1 devices are supplied with a power supply module not supplied by Lenze (i700-CV30/400-3 or i700-CV60/400-3), semiconductor fuses must be used to limit the short-circuit current to I_{cc}= 5 kA.

Connection data

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			Mains connection
Connection designation			X100
Connection system			Screw terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	16
Max. cable cross-section		AWG	6
Min. cable cross-section		mm²	0.5
Min. cable cross-section		AWG	20
Stripping length		mm	12
Stripping length		in	0.47
Tightening torque		Nm	1.5
Tightening torque		lb-in	13
Required tools			Screwdriver 1.0 x 5.5

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			DC bus
Connection designation			X101
Connection system			Busbar system
Tightening torque		Nm	5
Tightening torque		lb-in	44
Required tools			Crosstip screwdriver PH3

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			Protective earth (PE)
Connection designation			Symbol for protective earth (PE)
Connection system			Busbar system
Tightening torque		Nm	2.5
Tightening torque		lb-in	22
Required tools			Crosstip screwdriver PH2

Technical data

3-phase mains connection 230/240 V
Supplier data
Brake resistors



Brake resistors

Supplier	Brake resistor					
	Type designation	Rated resistance	Rated power	Thermal capacity	Dimensions (H x W x D)	Weight
		Ω	W	kWs	mm	kg
i700-CV30/400-3	ERBP018R300W	18	300	45	320 x 42 x 122	1.4
i700-CV30/400-3	ERBS018R01K9	18	1900	285	825 x 204 x 105	8.7
i700-CV30/400-3	ERBG018R04K3	18	4300	645	302 x 486 x 426	13.5
i700-CV60/400-3	ERBG012R01K9	12	1900	285	302 x 486 x 236	9.5
i700-CV60/400-3	ERBG012R05K2	12	5200	780	302 x 486 x 426	15.1

Mains chokes

Supplier	Netzdrössel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i700-CV30/400-3	EZAELN3025B122	3	25	1.18	110 x 155 x 170	5.8
i700-CV60/400-3	EZAELN3050B591		50	0.59	112 x 185 x 210	8.4

RFI filters / Mains filters

The max. permissible motor cable length for the EMC categories depends on the sum of the motor cable lengths in the DC-bus group:

- ▶ Compliance with EMC category C3 (industrial premises) 47
- ▶ Compliance with EMC category C2 (residential areas) 49

Supplier	Filter				Max. motor cable length shielded		
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1	C2	C3
		A	mm	kg			
i700-CV30/400-3	E94AZRP0294	29	485 x 60 x 261	4.5	-	-	-
i700-CV30/400-3	E94AZMP0084	8	485 x 90 x 261	8.6	-	-	-
i700-CV30/400-3	E94AZRP0084	8	485 x 60 x 261	4.2	-	-	-
i700-CV30/400-3	E94AZMP0294	29	485 x 120 x 261	16	-	-	-
i700-CV60/400-3	E94AZRP0824	82	490 x 209 x 272	18.5	-	-	-
i700-CV60/400-3	E94AZMP0494	49	485 x 150 x 264	25.5	-	-	-



Technical data

3-phase mains connection 230/240 V

Axes data

Rated data

Axes data

Rated data

The max. permissible motor cable length for the EMC categories depends on the sum of the motor cable lengths in the DC-bus group:

- ▶ Compliance with EMC category C3 (industrial premises)  47
- ▶ Compliance with EMC category C2 (residential areas)  49



The specified currents for the i750-C.../2 double axes apply per axis.

Technical data

3-phase mains connection 230/240 V
Axes data
Rated data



Axis			i750-C1.1/400-3	i750-C1.1/400-3/2	i750-C2.2/400-3	i750-C2.2/400-3/2
Rated power	P _{rated}	kW	0.37		1.1	
Rated power	P _{rated}	hp	0.5		1.5	
DC input voltage range			DC 235 V ... 370 V			
DC rated input current						
without mains choke		A	5	9.3		18.7
with mains choke		A	3	6.4		12.5
DC rated input power						
without mains choke		kW	0.9	1.9		3.7
with mains choke		kW	0.9	1.9		3.7
Output voltage		V	3 AC 0 ... 230/240			
Apparent output power		kVA	0.9		1.8	
Rated output current						
4 kHz		A	2.5		5	
8 kHz		A	2.5		5	
16 kHz		A	1.5		3	
Power loss						
4 kHz		W	45	80	75	125
8 kHz		W	50	90	80	140
16 kHz		W	60	110	80	160
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	3.8	3.8	7.5	7.5
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	1.9	1.9	3.8	3.8
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	5	5	10	10
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	1.9	1.9	3.8	3.8
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data
3-phase mains connection 230/240 V
Axes data
Rated data

Axis			i750-C3/400-3/2	i750-C4/400-3	i750-C4/400-3/2	i750-C7.5/400-3
Rated power	P _{rated}	kW	1.5	2.2		4
Rated power	P _{rated}	hp	2.2	3		5
DC input voltage range			DC 235 V ... 370 V			
DC rated input current						
without mains choke		A	27.7	18.7	37	29.8
with mains choke		A	18.6	12.5	25	20
DC rated input power						
without mains choke		kW	5.5	3.7	7.4	5.9
with mains choke		kW	5.5	3.7	7.4	5.9
Output voltage		V	3 AC 0 ... 230/240			
Apparent output power		kVA	5.6	3.6		5.7
Rated output current						
4 kHz		A	7.5	10		16
8 kHz		A	6	10		12.8
16 kHz		A	3	6		9.6
Power loss						
4 kHz		W	160	115	230	185
8 kHz		W	180	130	260	190
16 kHz		W	180	140	260	200
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	11.3	15	15	24
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	5.6	6	7.5	12
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	15	20	20	32
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	5.6	6	7.5	12
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 230/240 V
Axes data
Rated data



Axis			i750-C7.5/400-3/2	i750-C11/400-3	i750-C15/400-3	i750-C22/400-3
Rated power	P _{rated}	kW	4	5.5	7.5	11
Rated power	P _{rated}	hp	5	7.5	10	15
DC input voltage range			DC 235 V ... 370 V			
DC rated input current						
without mains choke		A	59.2	44.6	59.2	81.1
with mains choke		A	39.9	30.1	39.9	54
DC rated input power						
without mains choke		kW	11.8	8.9	11.8	16.1
with mains choke		kW	11.8	8.9	11.8	16.1
Output voltage		V	3 AC 0 ... 230/240			
Apparent output power		kVA	5.7	8.6	11.5	17.2
Rated output current						
4 kHz		A	16	24	32	48
8 kHz		A	12.8	19.2	25.6	30.4
16 kHz		A	9.6	14.4	19.2	14.7
Power loss						
4 kHz		W	325	255	345	395
8 kHz		W	330	250	330	450
16 kHz		W	370	280	360	450
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	24	36	48	72
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	12	18	24	36
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	32	48	64	96
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	12	18	24	36
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data

3-phase mains connection 230/240 V

Axes data

Rated data

Axis			i750-C30/400-3
Rated power	P _{rated}	kW	15
Rated power	P _{rated}	hp	22
DC input voltage range			DC 235 V ... 370 V
DC rated input current			
without mains choke		A	103.3
with mains choke		A	69
DC rated input power			
without mains choke		kW	20.5
with mains choke		kW	20.5
Output voltage		V	3 AC 0 ... 230/240
Apparent output power		kVA	21.9
Rated output current			
4 kHz		A	54.9
8 kHz		A	33.6
16 kHz		A	16.3
Power loss			
4 kHz		W	550
8 kHz		W	630
16 kHz		W	630
Overcurrent cycle 180 s			
Max. output current (≤ 8 kHz)		A	82.4
Overload time	T ₁	s	60
Recovery time	T ₂	s	120
Max. output current during the recovery time		A	45.8
Overcurrent cycle 15 s			
Max. output current (≤ 8 kHz)		A	109.8
Overload time	T ₁	s	3
Recovery time	T ₂	s	12
Max. output current during the recovery time		A	45.8
Max. motor cable length shielded			
without EMC category		m	50
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-
Max. motor cable length unshielded			
without EMC category		m	100

Technical data

3-phase mains connection 230/240 V
Axes data
Connection data



Connection data

Single axis			i750-C1.1/400-3 ... i750-C30/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			DC bus
Connection designation			X101
Connection system			Busbar system
Tightening torque		Nm	5
Tightening torque		lb-in	44
Required tools			Crosstip screwdriver PH3

Single axis			i750-C1.1/400-3 ... i750-C4/400-3	i750-C1.1/400-3 ... i750-C4/400-3	i750-C1.1/400-3 ... i750-C4/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			Motor connection	Motor connection	Motor connection
Connection designation			X105	X105	X105
Connection system			Screw terminal	Screw terminal	Screw terminal
Connection type			Pluggable	Pluggable	Non-pluggable
Double (Daisy Chain)			No	No	No
Max. cable cross-section		mm²	4	16	35
Max. cable cross-section		AWG	12	6	2
Min. cable cross-section		mm²	0.25	0.5	1.5
Min. cable cross-section		AWG	22	20	16
Stripping length		mm	8	12	18
Stripping length		in	0.32	0.47	0.7
Tightening torque		Nm	0.5	1.5	3.8
Tightening torque		lb-in	4.4	13	34
Required tools			Screwdriver 0.6 x 3.5	Screwdriver 1.0 x 5.5	Screwdriver 1.0 x 5.5

Single axis			i750-C1.1/400-3 ... i750-C30/400-3	i750-C1.1/400-3 ... i750-C30/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			Protective earth (PE)	Protective earth (PE)
Connection designation			Symbol for protective earth (PE)	Symbol for protective earth (PE)
Connection system			Busbar system	Screw
Tightening torque		Nm	2.5	4
Tightening torque		lb-in	22	35
Required tools			Crosstip screwdriver PH2	Crosstip screwdriver PZ2



3-phase mains connection 400 V

Supplier data

Rated data

Supplier			i700-CV30/400-3	i700-CV60/400-3
Mains voltage range			3 AC 340 V ... 440 V, 45 Hz ... 65 Hz	
Rated mains current				
without mains choke		A	24.5	49
with mains choke		A	24.5	49
Cyclic mains switching			5 times in 5 minutes	
DC rated output power				
without mains choke		kW	10.3	20.6
with mains choke		kW	15.4	30.9
DC output voltage range			DC 460 V ... 620 V	
DC rated output current				
without mains choke		A	30	60
with mains choke		A	30	60
Power loss				
without mains choke		W	60	110
with mains choke		W	80	160
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	45	90
Overload time	T_1	s	60	60
Recovery time	T_2	s	120	120
Max. output current during the recovery time		A	22.5	45
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	60	120
Overload time	T_1	s	3	3
Recovery time	T_2	s	12	12
Max. output current during the recovery time		A	19.8	39.6

Supplier			i700-CV30/400-3	i700-CV60/400-3
Brake chopper				
Switch-on threshold		V	765	
Min. brake resistance		Ω	18	9
Rated output current		A	6.5	13.1
Max. output current		A	42.5	85
Switch-on time ($I_{\max}$)		s	15	
Recovery time ($I = 0$ A)		s	82	
Max. cable length				
shielded		m	10	
unshielded		m	0.5	

Technical data

3-phase mains connection 400 V
Supplier data
Fusing data



Fusing data



- A residual current device (RCD) is optional.
- **I_{cc}** = Rated conditional short-circuit current
- Fusing data for UL/NEC compliant installations:
 - ▶ [Connection according to UL](#), [Fusing data](#) 68



If the I75AE322F1 and I75AE330F1 devices are supplied with a power supply module not supplied by Lenze (i700-CV30/400-3 or i700-CV60/400-3), semiconductor fuses must be used to limit the short-circuit current to I_{cc}= 5 kA.

Supplier	Fuse			Circuit breaker			RCD	
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
i700-CV30/400-3	100	gG/gL, gRL	40	100	C	40	≥ 300	Typ B
i700-CV60/400-3	100	gG/gL, gRL	63	100	C	63	≥ 300	Typ B

Connection data

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			Mains connection
Connection designation			X100
Connection system			Screw terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm²	16
Max. cable cross-section		AWG	6
Min. cable cross-section		mm²	0.5
Min. cable cross-section		AWG	20
Stripping length		mm	12
Stripping length		in	0.47
Tightening torque		Nm	1.5
Tightening torque		lb-in	13
Required tools			Screwdriver 1.0 x 5.5

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			DC bus
Connection designation			X101
Connection system			Busbar system
Tightening torque		Nm	5
Tightening torque		lb-in	44
Required tools			Crosstip screwdriver PH3

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			Protective earth (PE)
Connection designation			Symbol for protective earth (PE)
Connection system			Busbar system
Tightening torque		Nm	2.5
Tightening torque		lb-in	22
Required tools			Crosstip screwdriver PH2



Technical data
3-phase mains connection 400 V
Supplier data
Brake resistors

Brake resistors

Supplier	Brake resistor					
	Type designation	Rated resistance	Rated power	Thermal capacity	Dimensions (H x W x D)	Weight
		Ω	W	kWs	mm	kg
i700-CV30/400-3	ERBP018R300W	18	300	45	320 x 42 x 122	1.4
i700-CV30/400-3	ERBS018R01K9	18	1900	285	825 x 204 x 105	8.7
i700-CV30/400-3	ERBG018R04K3	18	4300	645	302 x 486 x 426	13.5
i700-CV60/400-3	ERBG012R01K9	12	1900	285	302 x 486 x 236	9.5
i700-CV60/400-3	ERBG012R05K2	12	5200	780	302 x 486 x 426	15.1

Mains chokes

Supplier	Netzdrossel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i700-CV30/400-3	EZAELN3025B122	3	25	1.18	110 x 155 x 170	5.8
i700-CV60/400-3	EZAELN3050B591		50	0.59	112 x 185 x 210	8.4

RFI filters / Mains filters

The max. permissible motor cable length for the EMC categories depends on the sum of the motor cable lengths in the DC-bus group:

- ▶ Compliance with EMC category C3 (industrial premises) [47](#)
- ▶ Compliance with EMC category C2 (residential areas) [49](#)

Supplier	Filter				Max. motor cable length shielded		
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1	C2	C3
		A	mm	kg			
i700-CV30/400-3	E94AZRP0294	29	485 x 60 x 261	4.5	-	-	-
i700-CV30/400-3	E94AZMP0084	8	485 x 90 x 261	8.6	-	-	-
i700-CV30/400-3	E94AZRP0084	8	485 x 60 x 261	4.2	-	-	-
i700-CV30/400-3	E94AZMP0294	29	485 x 120 x 261	16	-	-	-
i700-CV60/400-3	E94AZRP0824	82	490 x 209 x 272	18.5	-	-	-
i700-CV60/400-3	E94AZMP0494	49	485 x 150 x 264	25.5	-	-	-

Regenerative power supply module	Filter				Max. motor cable length shielded		
	Order code	rated current	Dimensions (H x W x D)	Weight	C1	C2	C3
		A	mm	kg			
E94ARNE0134	E94AZMR0264SDB	26	485 x 149 x 272	25	-	-	-
E94ARNE0134	E94AZMR0264LDB	26	485 x 149 x 272	26	-	-	-
E94ARNE0244	E94AZMR0474SDB	47	485 x 209 x 272	36	-	-	-
E94ARNE0244	E94AZMR0474LDB	47	485 x 209 x 272	37	-	-	-

Technical data

3-phase mains connection 400 V

Axes data

Rated data



Axes data

Rated data

The max. permissible motor cable length for the EMC categories depends on the sum of the motor cable lengths in the DC-bus group:

- ▶ [Compliance with EMC category C3 \(industrial premises\)](#) 47
- ▶ [Compliance with EMC category C2 \(residential areas\)](#) 49



The specified currents for the i750-C.../2 double axes apply per axis.



Technical data
3-phase mains connection 400 V
Axes data
Rated data

Axis			i750-C1.1/400-3		i750-C1.1/400-3/2		i750-C2.2/400-3		i750-C2.2/400-3/2	
Rated power	P _{rated}	kW	1.1				2.2			
Rated power	P _{rated}	hp	1.5				3			
DC input voltage range			DC 460 V ... 620 V							
DC rated input current										
without mains choke		A	5		9.3			18.7		
with mains choke		A	3.1		6.2			12.4		
DC rated input power										
without mains choke		kW	1.6		3.2			6.4		
with mains choke		kW	1.6		3.2			6.4		
Output voltage		V	3 AC 0 ... 400							
Apparent output power		kVA	1.6				3.1			
Rated output current										
4 kHz		A	2.5				5			
8 kHz		A	2.5				5			
16 kHz		A	1.5				3			
Power loss										
4 kHz		W	50		90		80		140	
8 kHz		W	50		90		80		140	
16 kHz		W	60		110		80		160	
Overcurrent cycle 180 s										
Max. output current (≤ 8 kHz)		A	3.8		3.8		7.5		7.5	
Overload time	T ₁	s	60		60		60		60	
Recovery time	T ₂	s	120		120		120		120	
Max. output current during the recovery time		A	1.9		1.9		3.8		3.8	
Overcurrent cycle 15 s										
Max. output current (≤ 8 kHz)		A	5		5		10		10	
Overload time	T ₁	s	3		3		3		3	
Recovery time	T ₂	s	12		12		12		12	
Max. output current during the recovery time		A	1.9		1.9		3.8		3.8	
Max. motor cable length shielded										
without EMC category		m	50							
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-							
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-							
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-							
Max. motor cable length unshielded										
without EMC category		m	100							

Technical data

3-phase mains connection 400 V
Axes data
Rated data



Axis			i750-C3/400-3/2	i750-C4/400-3	i750-C4/400-3/2	i750-C7.5/400-3
Rated power	P _{rated}	kW	3	4		7.5
Rated power	P _{rated}	hp	4	5		10
DC input voltage range			DC 460 V ... 620 V			
DC rated input current						
without mains choke		A	27.7	18.7	37	29.8
with mains choke		A	18.5	12.4	24.7	19.8
DC rated input power						
without mains choke		kW	9.5	6.4	12.7	10.2
with mains choke		kW	9.5	6.4	12.7	10.2
Output voltage		V	3 AC 0 ... 400			
Apparent output power		kVA	5.6	6.2		10
Rated output current						
4 kHz		A	7.5	10		16
8 kHz		A	6	10		12.8
16 kHz		A	3	6		9.6
Power loss						
4 kHz		W	180	130	260	210
8 kHz		W	180	130	260	190
16 kHz		W	180	140	260	200
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	11.3	15	15	24
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	5.6	6	7.5	12
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	15	20	20	32
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	5.6	6	7.5	12
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data
3-phase mains connection 400 V
Axes data
Rated data

Axis			i750-C7.5/400-3/2	i750-C11/400-3	i750-C15/400-3	i750-C22/400-3
Rated power	P _{rated}	kW	7.5	11	15	22
Rated power	P _{rated}	hp	10	15	20	30
DC input voltage range			DC 460 V ... 620 V			
DC rated input current						
without mains choke		A	59.2	44.6	59.2	81.1
with mains choke		A	39.5	29.8	39.5	54
DC rated input power						
without mains choke		kW	20.3	15.3	20.3	27.8
with mains choke		kW	20.3	15.3	20.3	27.8
Output voltage			3 AC 0 ... 400			
Apparent output power			10	15	20	29.9
Rated output current						
4 kHz		A	16	24	32	48
8 kHz		A	12.8	19.2	25.6	30.4
16 kHz		A	9.6	14.4	19.2	14.7
Power loss						
4 kHz		W	370	290	390	450
8 kHz		W	330	250	330	450
16 kHz		W	370	280	360	450
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	24	36	48	72
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	12	18	24	36
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	32	48	64	96
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	12	18	24	36
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 400 V
Axes data
Rated data



Axis			i750-C30/400-3
Rated power	P _{rated}	kW	30
Rated power	P _{rated}	hp	40
DC input voltage range			DC 460 V ... 620 V
DC rated input current			
without mains choke		A	103.3
with mains choke		A	69
DC rated input power			
without mains choke		kW	35.4
with mains choke		kW	35.4
Output voltage		V	3 AC 0 ... 400
Apparent output power		kVA	38
Rated output current			
4 kHz		A	54.9
8 kHz		A	33.6
16 kHz		A	16.3
Power loss			
4 kHz		W	630
8 kHz		W	630
16 kHz		W	630
Overcurrent cycle 180 s			
Max. output current (≤ 8 kHz)		A	82.4
Overload time	T ₁	s	60
Recovery time	T ₂	s	120
Max. output current during the recovery time		A	45.8
Overcurrent cycle 15 s			
Max. output current (≤ 8 kHz)		A	109.8
Overload time	T ₁	s	3
Recovery time	T ₂	s	12
Max. output current during the recovery time		A	45.8
Max. motor cable length shielded			
without EMC category		m	50
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-
Max. motor cable length unshielded			
without EMC category		m	100



Technical data

3-phase mains connection 400 V
Axes data
Connection data

Connection data

Single axis			i750-C1.1/400-3 ... i750-C30/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			DC bus
Connection designation			X101
Connection system			Busbar system
Tightening torque		Nm	5
Tightening torque		lb-in	44
Required tools			Crosstip screwdriver PH3

Single axis			i750-C1.1/400-3 ... i750-C4/400-3	i750-C1.1/400-3 ... i750-C4/400-3	i750-C1.1/400-3 ... i750-C4/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			Motor connection	Motor connection	Motor connection
Connection designation			X105	X105	X105
Connection system			Screw terminal	Screw terminal	Screw terminal
Connection type			Pluggable	Pluggable	Non-pluggable
Double (Daisy Chain)			No	No	No
Max. cable cross-section		mm²	4	16	35
Max. cable cross-section		AWG	12	6	2
Min. cable cross-section		mm²	0.25	0.5	1.5
Min. cable cross-section		AWG	22	20	16
Stripping length		mm	8	12	18
Stripping length		in	0.32	0.47	0.7
Tightening torque		Nm	0.5	1.5	3.8
Tightening torque		lb-in	4.4	13	34
Required tools			Screwdriver 0.6 x 3.5	Screwdriver 1.0 x 5.5	Screwdriver 1.0 x 5.5

Single axis			i750-C1.1/400-3 ... i750-C30/400-3	i750-C1.1/400-3 ... i750-C30/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			Protective earth (PE)	Protective earth (PE)
Connection designation			Symbol for protective earth (PE)	Symbol for protective earth (PE)
Connection system			Busbar system	Screw
Tightening torque		Nm	2.5	4
Tightening torque		lb-in	22	35
Required tools			Crosstip screwdriver PH2	Crosstip screwdriver PZ2



3-phase mains connection 480 V

Supplier data

Rated data

Supplier			i700-CV30/400-3	i700-CV60/400-3
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz	
Rated mains current				
without mains choke		A	24.5	49
with mains choke		A	24.5	49
Cyclic mains switching			5 times in 5 minutes	
DC rated output power				
without mains choke		kW	12.3	24.7
with mains choke		kW	18.5	37
DC output voltage range			DC 590 V ... 750 V	
DC rated output current				
without mains choke		A	30	60
with mains choke		A	30	60
Power loss				
without mains choke		W	60	110
with mains choke		W	80	160
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	45	90
Overload time	T_1	s	60	60
Recovery time	T_2	s	120	120
Max. output current during the recovery time		A	22.5	45
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	60	120
Overload time	T_1	s	3	3
Recovery time	T_2	s	12	12
Max. output current during the recovery time		A	19.8	39.6

Supplier			i700-CV30/400-3	i700-CV60/400-3
Brake chopper				
Switch-on threshold		V	765	
Min. brake resistance		Ω	18	9
Rated output current		A	6.5	13.1
Max. output current		A	42.5	85
Switch-on time (I_{max})		s	15	
Recovery time ($I = 0$ A)		s	82	
Max. cable length				
shielded		m	10	
unshielded		m	0.5	



Fusing data



- A residual current device (RCD) is optional.
- **I_{cc}** = Rated conditional short-circuit current
- Fusing data for UL/NEC compliant installations:
▶ [Connection according to UL, Fusing data](#) 68



If the I75AE322F1 and I75AE330F1 devices are supplied with a power supply module not supplied by Lenze (i700-CV30/400-3 or i700-CV60/400-3), semiconductor fuses must be used to limit the short-circuit current to I_{cc} = 5 kA.

Supplier	Fuse			Circuit breaker			RCD	
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
i700-CV30/400-3	100	gG/gL, gRL	40	100	C	40	≥ 300	Typ B
i700-CV60/400-3	100	gG/gL, gRL	63	100	C	63	≥ 300	Typ B

Connection data

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			Mains connection
Connection designation			X100
Connection system			Screw terminal
Connection type			Pluggable
Double (Daisy Chain)			No
Max. cable cross-section		mm ²	16
Max. cable cross-section		AWG	6
Min. cable cross-section		mm ²	0.5
Min. cable cross-section		AWG	20
Stripping length		mm	12
Stripping length		in	0.47
Tightening torque		Nm	1.5
Tightening torque		lb-in	13
Required tools			Screwdriver 1.0 x 5.5

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection			DC bus
Connection designation			X101
Connection system			Busbar system
Tightening torque		Nm	5
Tightening torque		lb-in	44
Required tools			Crosstip screwdriver PH3

Supplier			i700-CV30/400-3 ... i700-CV60/400-3
Connection designation			Symbol for protective earth (PE)
Connection			Protective earth (PE)
Connection system			Busbar system
Tightening torque		Nm	2.5
Tightening torque		lb-in	22
Required tools			Crosstip screwdriver PH2

Technical data

3-phase mains connection 480 V
Supplier data
Brake resistors



Brake resistors

Supplier	Brake resistor					
	Type designation	Rated resistance	Rated power	Thermal capacity	Dimensions (H x W x D)	Weight
		Ω	W	kWs	mm	kg
i700-CV30/400-3	ERBP018R300W	18	300	45	320 x 42 x 122	1.4
i700-CV30/400-3	ERBS018R01K9	18	1900	285	825 x 204 x 105	8.7
i700-CV30/400-3	ERBG018R04K3	18	4300	645	302 x 486 x 426	13.5
i700-CV60/400-3	ERBG012R01K9	12	1900	285	302 x 486 x 236	9.5
i700-CV60/400-3	ERBG012R05K2	12	5200	780	302 x 486 x 426	15.1

Mains chokes

Supplier	Netzdrossel					
	Type designation	No. of phases	Rated current	Inductance	Dimensions (H x W x D)	Weight
			A	mH	mm	kg
i700-CV30/400-3	EZAELN3025B122	3	25	1.18	110 x 155 x 170	5.8
i700-CV60/400-3	EZAELN3050B591		50	0.59	112 x 185 x 210	8.4

RFI filters / Mains filters

The max. permissible motor cable length for the EMC categories depends on the sum of the motor cable lengths in the DC-bus group:

- ▶ Compliance with EMC category C3 (industrial premises) [47](#)
- ▶ Compliance with EMC category C2 (residential areas) [49](#)

Supplier	Filter				Max. motor cable length shielded		
	Type designation	Rated current	Dimensions (H x W x D)	Weight	C1	C2	C3
		A	mm	kg			
i700-CV30/400-3	E94AZRP0294	29	485 x 60 x 261	4.5	-	-	-
i700-CV30/400-3	E94AZMP0084	8	485 x 90 x 261	8.6	-	-	-
i700-CV30/400-3	E94AZRP0084	8	485 x 60 x 261	4.2	-	-	-
i700-CV30/400-3	E94AZMP0294	29	485 x 120 x 261	16	-	-	-
i700-CV60/400-3	E94AZRP0824	82	490 x 209 x 272	18.5	-	-	-
i700-CV60/400-3	E94AZMP0494	49	485 x 150 x 264	25.5	-	-	-

Regenerative power supply module	Filter				Max. motor cable length shielded		
	Order code	rated current	Dimensions (H x W x D)	Weight	C1	C2	C3
		A	mm	kg			
E94ARNE0134	E94AZMR0264SDB	26	485 x 149 x 272	25	-	-	-
E94ARNE0134	E94AZMR0264LDB	26	485 x 149 x 272	26	-	-	-
E94ARNE0244	E94AZMR0474SDB	47	485 x 209 x 272	36	-	-	-
E94ARNE0244	E94AZMR0474LDB	47	485 x 209 x 272	37	-	-	-



Technical data

3-phase mains connection 480 V

Axes data

Rated data

Axes data

Rated data

The max. permissible motor cable length for the EMC categories depends on the sum of the motor cable lengths in the DC-bus group:

- ▶ Compliance with EMC category C3 (industrial premises) [47](#)
- ▶ Compliance with EMC category C2 (residential areas) [49](#)



The specified currents for the i750-C.../2 double axes apply per axis.

Technical data

3-phase mains connection 480 V
Axes data
Rated data



Axis			i750-C1.1/400-3	i750-C1.1/400-3/2	i750-C2.2/400-3	i750-C2.2/400-3/2
Rated power	P _{rated}	kW	1.1		2.2	
Rated power	P _{rated}	hp	1.5		3	
DC input voltage range			DC 590 V ... 750 V			
DC rated input current						
without mains choke		A	4.9	9.2		18.5
with mains choke		A	3.1	6.2		12.3
DC rated input power						
without mains choke		kW	1.9	3.8		7.6
with mains choke		kW	1.9	3.8		7.6
Output voltage		V	3 AC 0 ... 480			
Apparent output power		kVA	1.9		3.7	
Rated output current						
4 kHz		A	2.5		5	
8 kHz		A	2.5		5	
16 kHz		A	1.5		2.4	
Power loss						
4 kHz		W	50	90	80	150
8 kHz		W	50	90	80	150
16 kHz		W	70	120	90	170
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	3.8	3.8	7.5	7.5
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	1.9	1.9	3.8	3.8
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	5	5	10	10
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	1.9	1.9	3.8	3.8
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data
3-phase mains connection 480 V
Axes data
Rated data

Axis			i750-C3/400-3/2	i750-C4/400-3	i750-C4/400-3/2	i750-C7.5/400-3
Rated power	P _{rated}	kW	3	4		7.5
Rated power	P _{rated}	hp	4	5		10
DC input voltage range			DC 590 V ... 750 V			
DC rated input current						
without mains choke		A	27.7	18.5	36.9	29.7
with mains choke		A	18.5	12.3	24.6	19.8
DC rated input power						
without mains choke		kW	11.4	7.6	15.2	12.2
with mains choke		kW	11.4	7.6	15.2	12.2
Output voltage		V	3 AC 0 ... 480			
Apparent output power		kVA	5.6	7.5		12
Rated output current						
4 kHz		A	7.5	10		16
8 kHz		A	4.8	10		12.8
16 kHz		A	1.6	4.8		7.68
Power loss						
4 kHz		W	200	130	260	210
8 kHz		W	200	130	260	190
16 kHz		W	200	150	280	210
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	11.3	15	15	24
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	5.6	6	6	9.6
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	15	20	20	32
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	5.6	6	6	9.6
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 480 V
Axes data
Rated data



Axis			i750-C7.5/400-3/2	i750-C11/400-3	i750-C15/400-3	i750-C22/400-3
Rated power	P _{rated}	kW	7.5	11	15	22
Rated power	P _{rated}	hp	10	15	20	30
DC input voltage range			DC 590 V ... 750 V			
DC rated input current						
without mains choke		A	59.1	44.5	59.1	69.3
with mains choke		A	39.4	29.7	39.4	46
DC rated input power						
without mains choke		kW	24.3	18.3	24.3	28.5
with mains choke		kW	24.3	18.3	24.3	28.5
Output voltage		V	3 AC 0 ... 480			
Apparent output power		kVA	12	18	23.9	30.7
Rated output current						
4 kHz		A	16	24	32	41
8 kHz		A	12.8	19.2	25.6	
16 kHz		A	7.68	11.52	15.36	11.4
Power loss						
4 kHz		W	380	300	390	450
8 kHz		W	340	260	340	450
16 kHz		W	390	290	380	450
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	24	36	48	61.5
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	9.6	14.4	19.2	30.8
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	32	48	64	82
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	9.6	14.4	19.2	30.8
Max. motor cable length shielded						
without EMC category		m	50			
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-			
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data
3-phase mains connection 480 V
Axes data
Rated data

Axis			i750-C30/400-3
Rated power	P _{rated}	kW	30
Rated power	P _{rated}	hp	40
DC input voltage range			DC 590 V ... 750 V
DC rated input current			
without mains choke		A	88
with mains choke		A	59
DC rated input power			
without mains choke		kW	36.2
with mains choke		kW	36.2
Output voltage		V	3 AC 0 ... 480
Apparent output power		kVA	38.9
Rated output current			
4 kHz		A	46.8
8 kHz		A	28.7
16 kHz		A	13.8
Power loss			
4 kHz		W	630
8 kHz		W	630
16 kHz		W	630
Overcurrent cycle 180 s			
Max. output current (≤ 8 kHz)		A	70.2
Overload time	T ₁	s	60
Recovery time	T ₂	s	120
Max. output current during the recovery time		A	39
Overcurrent cycle 15 s			
Max. output current (≤ 8 kHz)		A	93.6
Overload time	T ₁	s	3
Recovery time	T ₂	s	12
Max. output current during the recovery time		A	39
Max. motor cable length shielded			
without EMC category		m	50
Category C1 (4 kHz, 8 kHz, 16 kHz)		m	-
Category C2 (4 kHz, 8 kHz, 16 kHz)		m	-
Category C3 (4 kHz, 8 kHz, 16 kHz)		m	-
Max. motor cable length unshielded			
without EMC category		m	100

Technical data

3-phase mains connection 480 V
Axes data
Connection data



Connection data

Single axis			i750-C1.1/400-3 ... i750-C30/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			DC bus
Connection designation			X101
Connection system			Busbar system
Tightening torque		Nm	5
Tightening torque		lb-in	44
Required tools			Crosstip screwdriver PH3

Single axis			i750-C1.1/400-3 ... i750-C4/400-3	i750-C1.1/400-3 ... i750-C4/400-3	i750-C1.1/400-3 ... i750-C4/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			Motor connection	Motor connection	Motor connection
Connection designation			X105	X105	X105
Connection system			Screw terminal	Screw terminal	Screw terminal
Connection type			Pluggable	Pluggable	Non-pluggable
Double (Daisy Chain)			No	No	No
Max. cable cross-section		mm²	4	16	35
Max. cable cross-section		AWG	12	6	2
Min. cable cross-section		mm²	0.25	0.5	1.5
Min. cable cross-section		AWG	22	20	16
Stripping length		mm	8	12	18
Stripping length		in	0.32	0.47	0.7
Tightening torque		Nm	0.5	1.5	3.8
Tightening torque		lb-in	4.4	13	34
Required tools			Screwdriver 0.6 x 3.5	Screwdriver 1.0 x 5.5	Screwdriver 1.0 x 5.5

Single axis			i750-C1.1/400-3 ... i750-C30/400-3	i750-C1.1/400-3 ... i750-C30/400-3
Double axis			i750-C1.1/400-3/2 ... i750-C7.5/400-3/2	i750-C1.1/400-3/2 ... i750-C7.5/400-3/2
Connection			Protective earth (PE)	Protective earth (PE)
Connection designation			Symbol for protective earth (PE)	Symbol for protective earth (PE)
Connection system			Busbar system	Screw
Tightening torque		Nm	2.5	4
Tightening torque		lb-in	22	35
Required tools			Crosstip screwdriver PH2	Crosstip screwdriver PZ2



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.

Installation clearances

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

Dimensions
Power supply





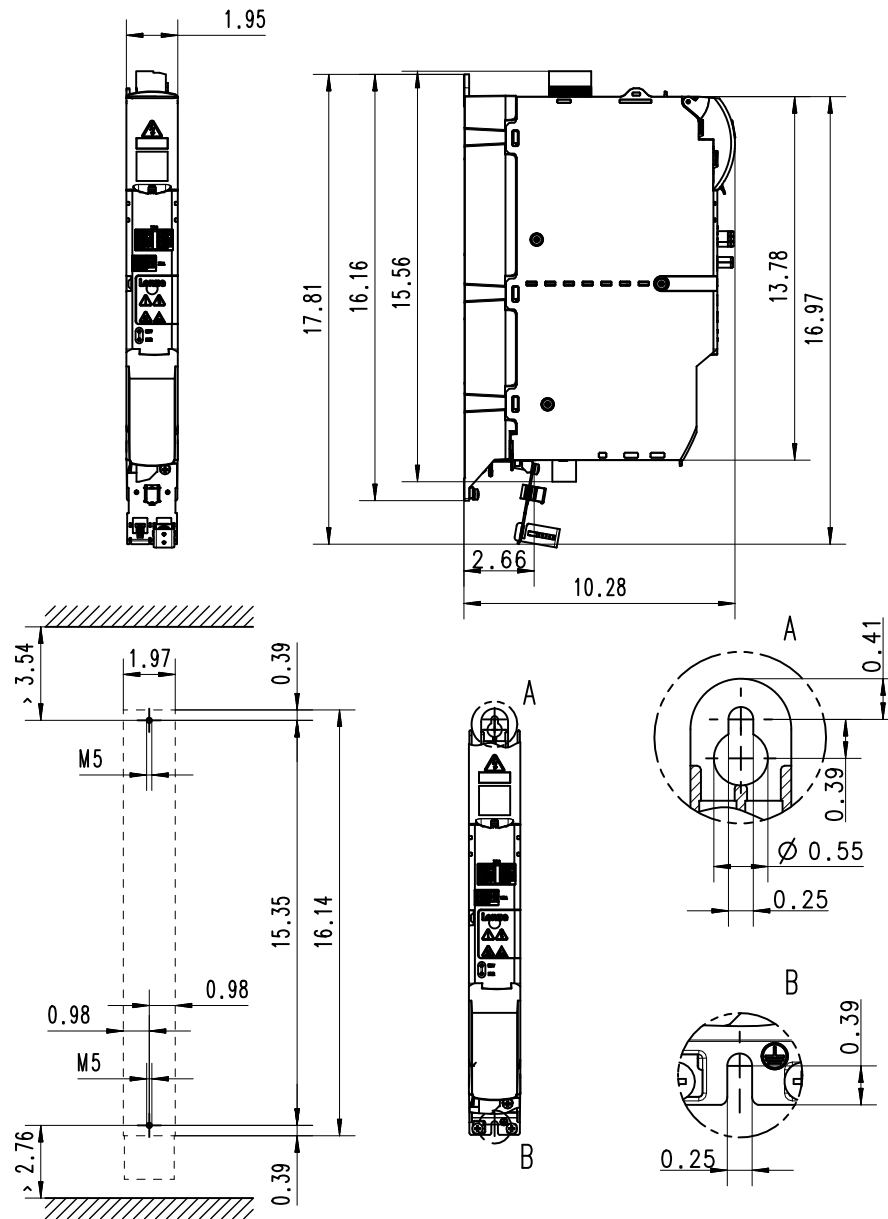
Technical data

Dimensions
Power supply

30 A

The dimensions in inch apply to:

30 A	i700-CV30/400-3
Weight	5.5 lb



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Technical data

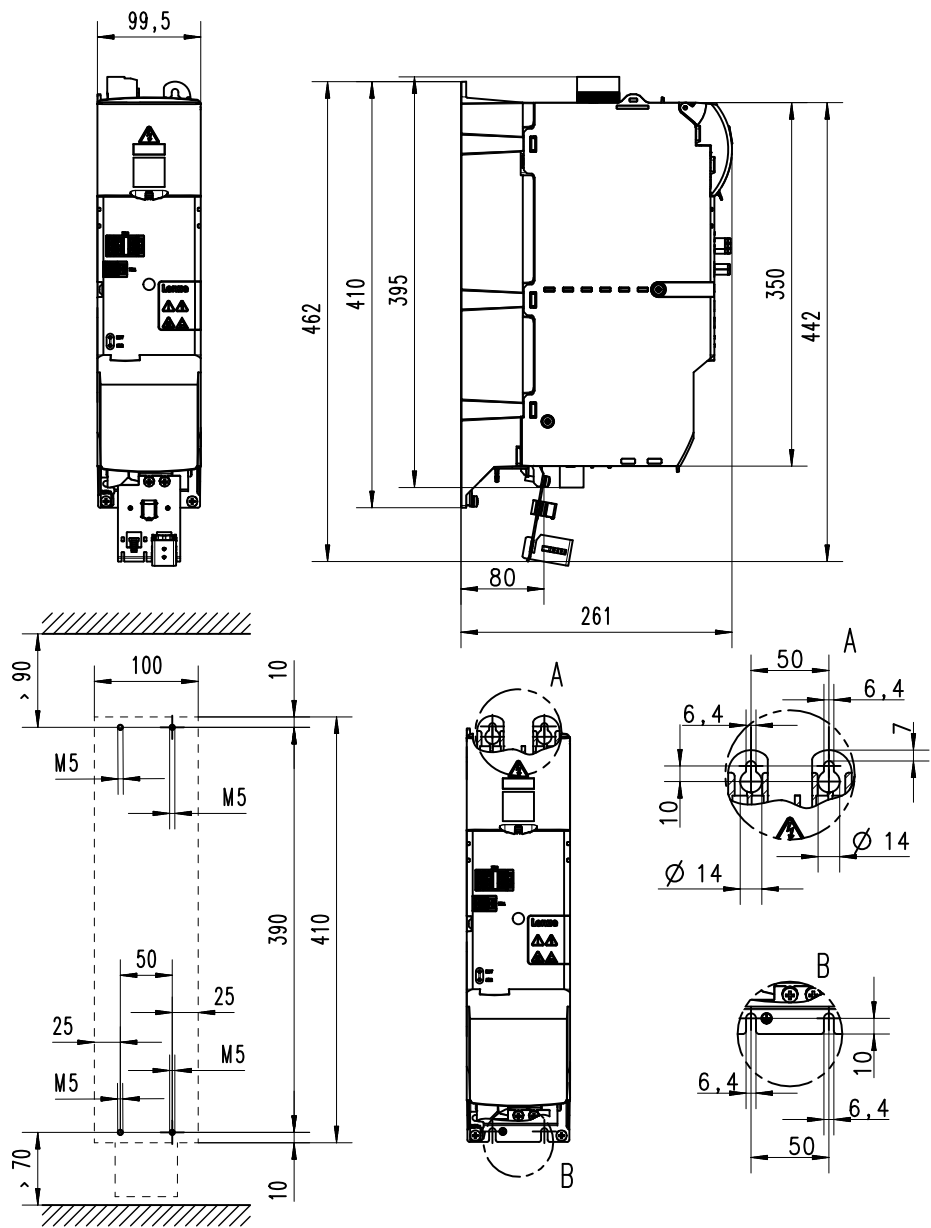
Dimensions
Power supply



60 A

The dimensions in mm apply to:

60 A	i700-CV60/400-3
Weight	5.3 kg



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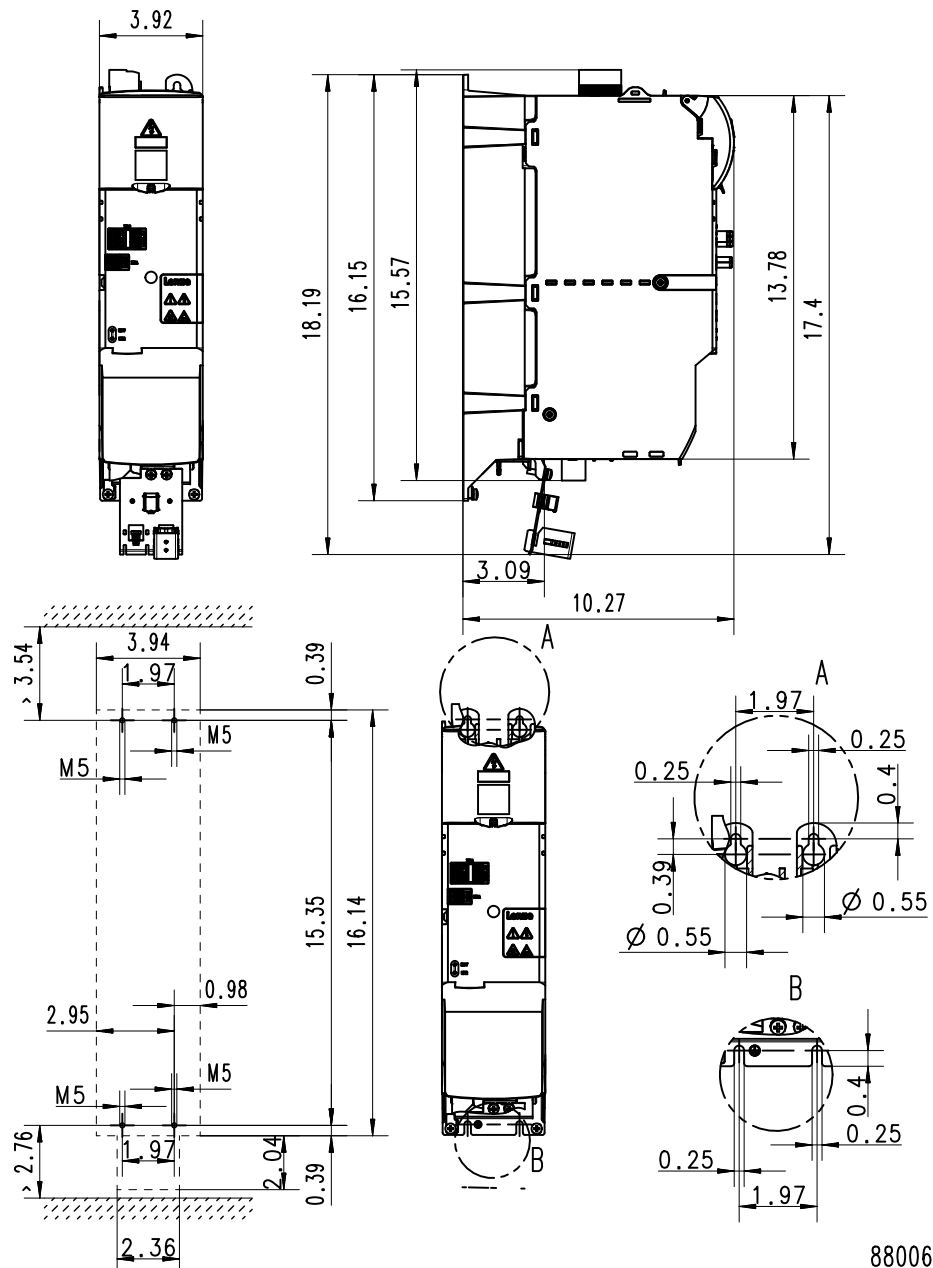
Technical data

Dimensions
Power supply

60 A

The dimensions in inch apply to:

60 A	i700-CV60/400-3
Weight	11.7 lb



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Technical data

Dimensions
Axes

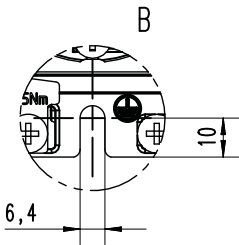
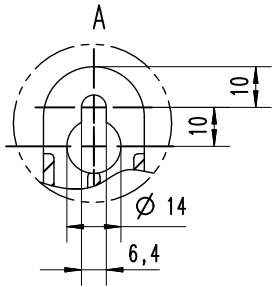
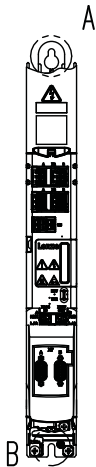
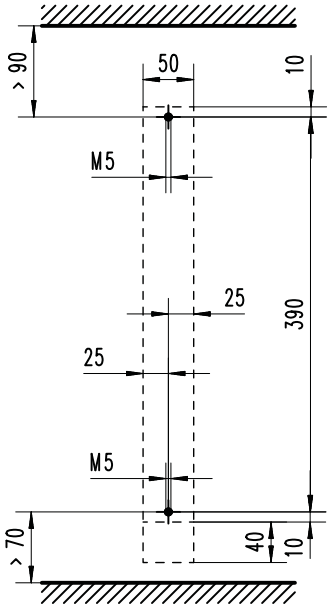
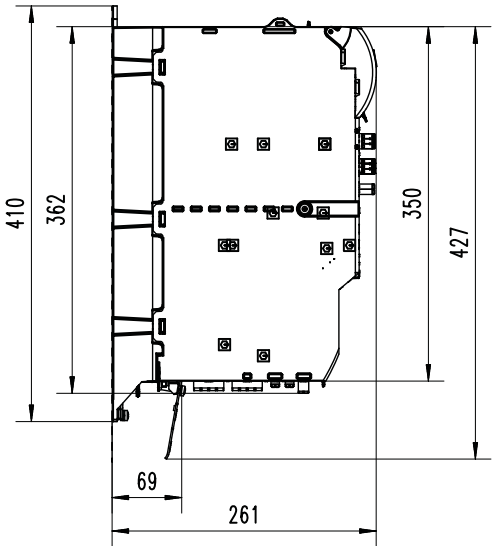
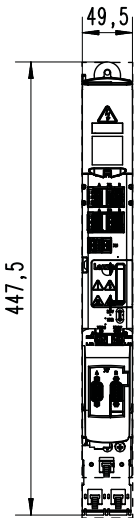


Axes

1.1 kW ... 4 kW

The dimensions in mm apply to:

1.1 kW	i750-C1.1/400-3	i750-C1.1/400-3/2
2.2 kW	i750-C2.2/400-3	i750-C2.2/400-3/2
3 kW		i750-C3/400-3/2
4 kW	i750-C4/400-3	
Weight	2.7 kg	2.9 kg



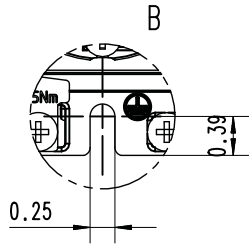
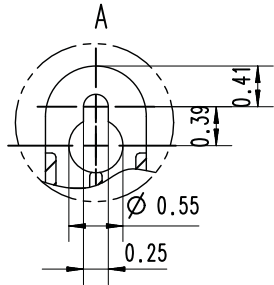
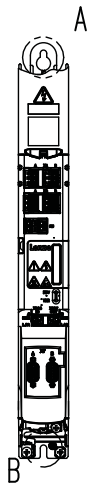
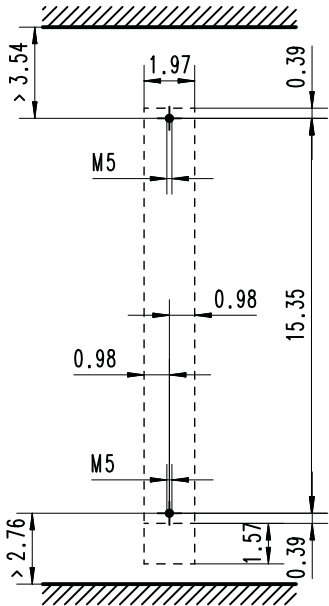
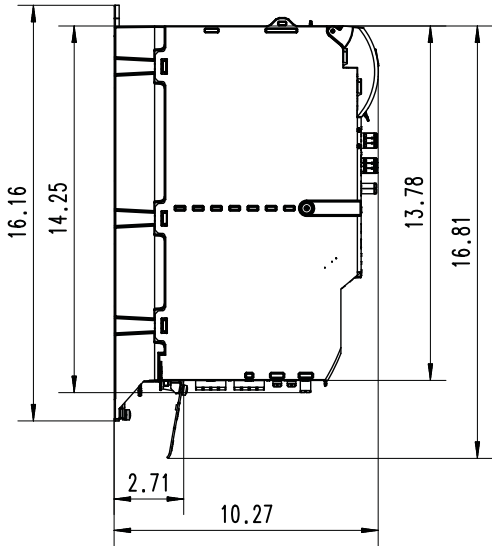
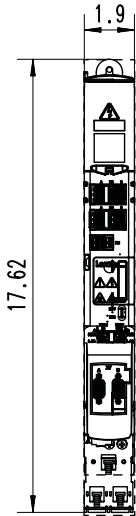
8801664-01



1.5 hp ... 5 hp

The dimensions in inch apply to:

1.5 hp	i750-C1.1/400-3	i750-C1.1/400-3/2
3 hp	i750-C2.2/400-3	i750-C2.2/400-3/2
4 hp		i750-C3/400-3/2
5 hp	i750-C4/400-3	
Weight	6 lb	6.4 lb



8801665-01

Technical data

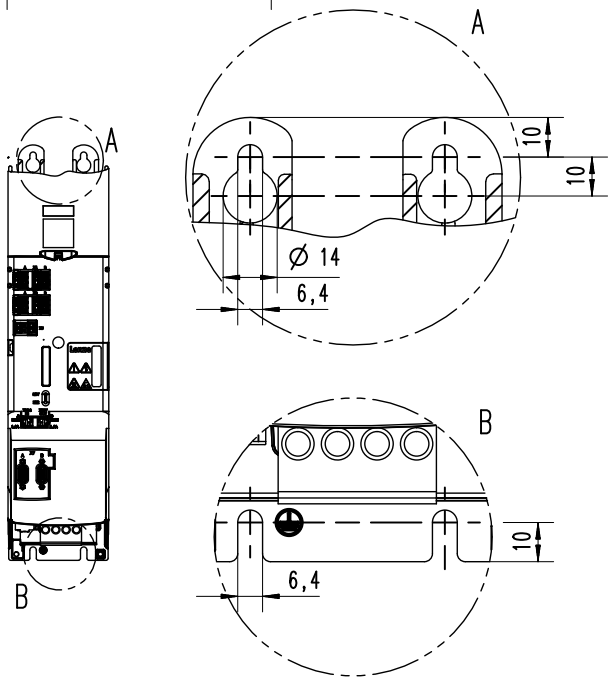
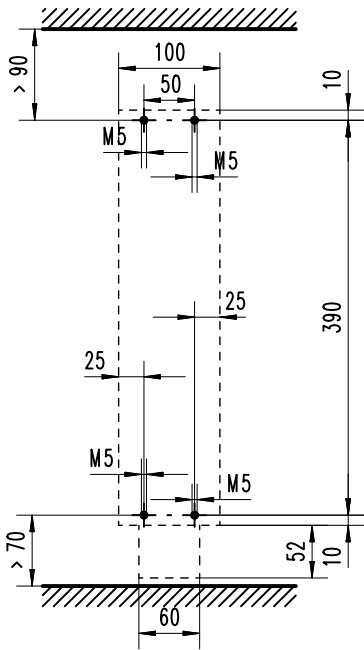
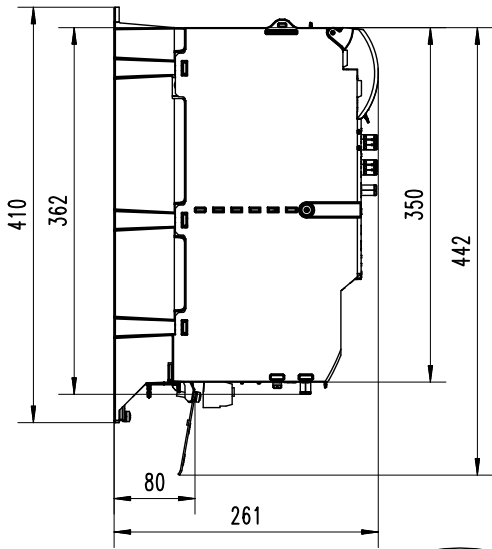
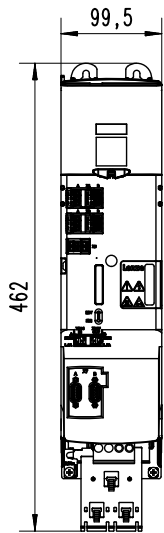
Dimensions
Axes



4 kW ... 15 kW

The dimensions in mm apply to:

4 kW	i750-C4/400-3/2
7.5 kW	i750-C7.5/400-3 i750-C7.5/400-3/2
11 kW	i750-C11/400-3
15 kW	i750-C15/400-3
Weight	5.2 kg



8801666-00

Technical data

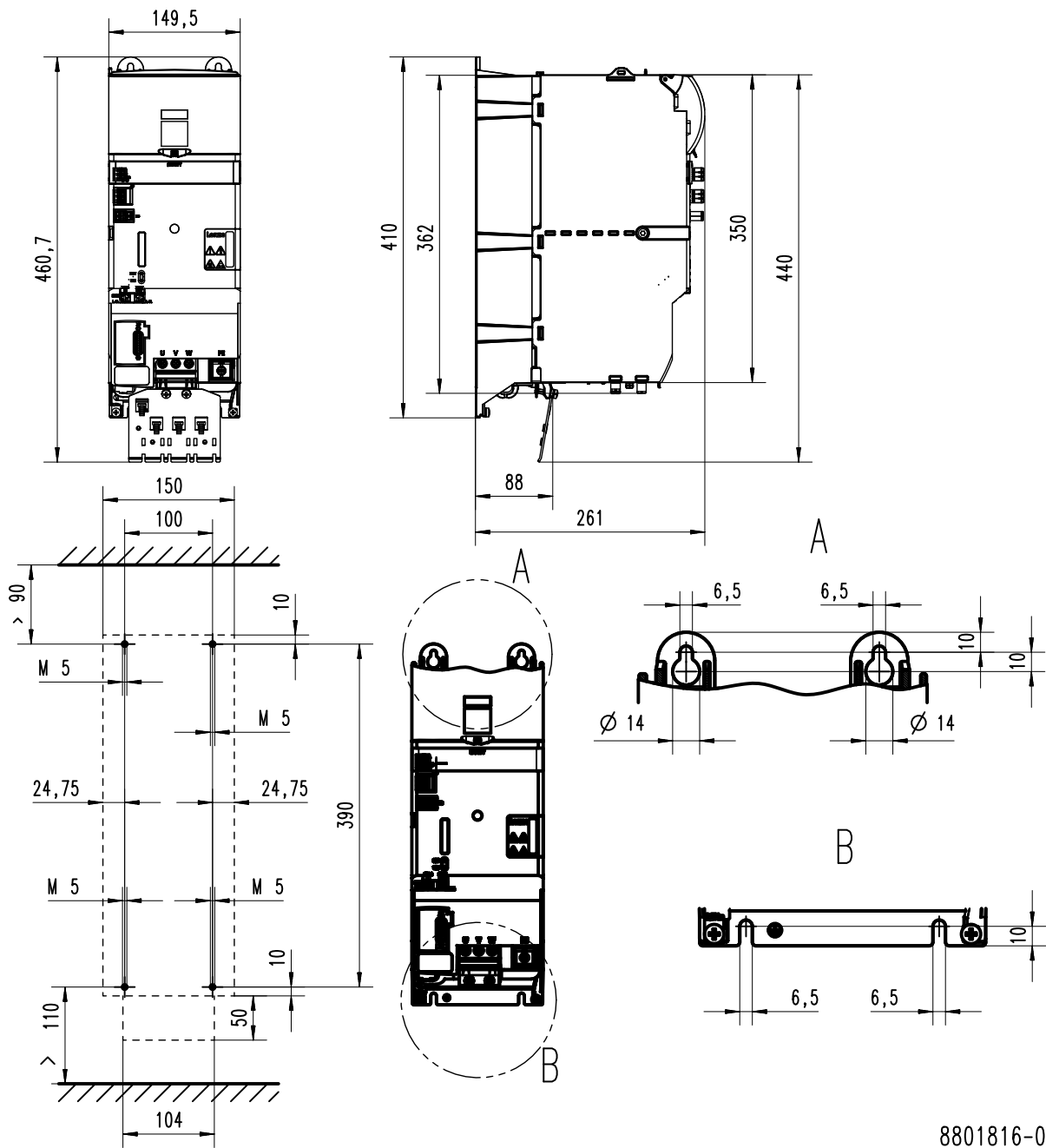
Dimensions
Axes



22 kW ... 30 kW

The dimensions in mm apply to:

22 kW	i750-C22/400-3
30 kW	i750-C30/400-3
Weight	8 kg



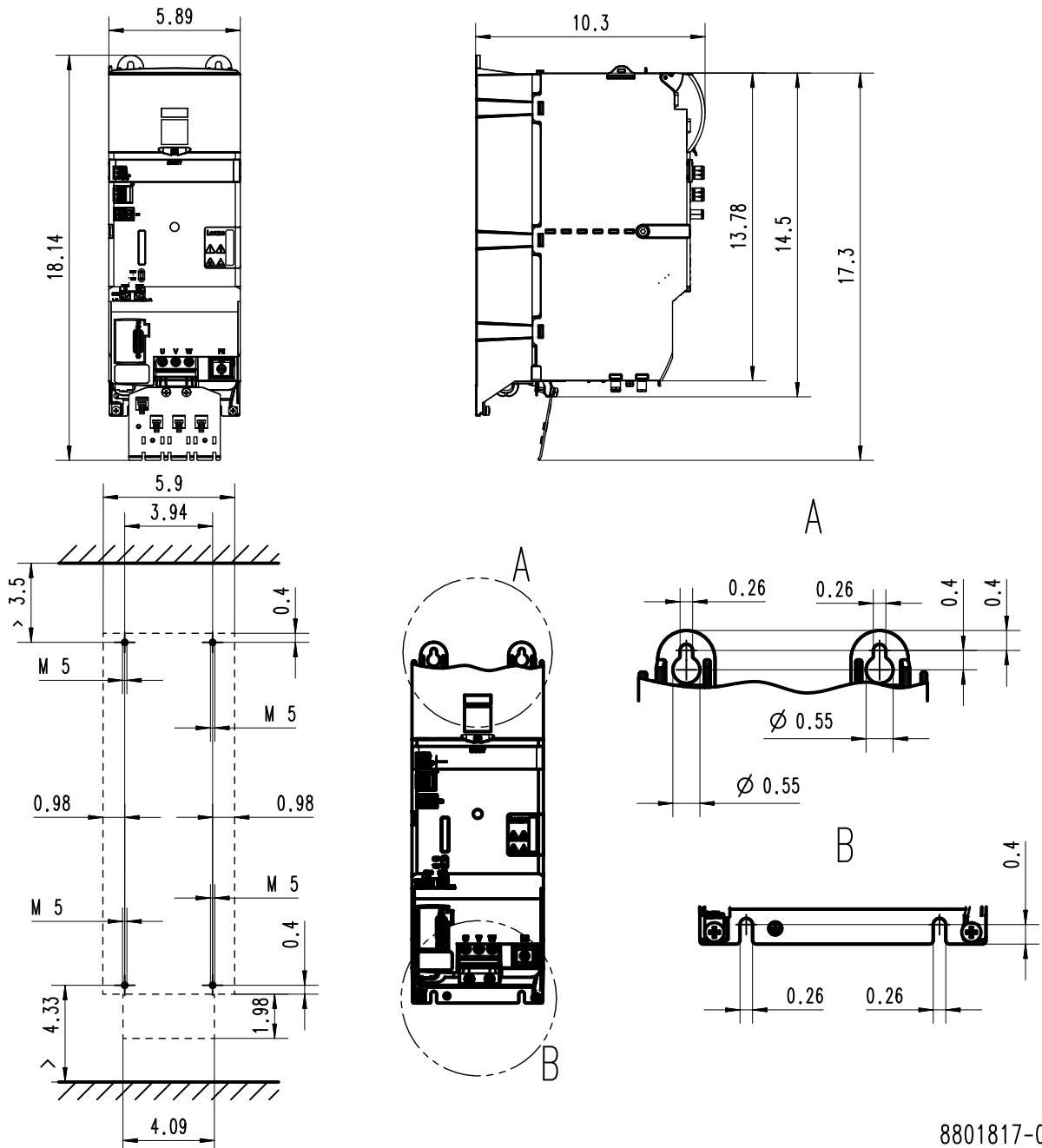
8801816-02



30 hp ... 40 hp

The dimensions in inch apply to:

30 hp	i750-C22/400-3
40 hp	i750-C30/400-3
Weight	17.6 lb



8801817-02



Performance indicators motor control

Functionality	Key figures	Data
Torque control	Repeat accuracy	< 0.1 %
	Internal resolution	30 bit $\approx 100\% M_{max}$
	Setting range (tolerance range 5 % M_n and 5 % M_{set})	1:60 (without field weakening range)
	Linearity (temperature-compensated)	<3 % (without field weakening range)
	Cycle time for the control	16 kHz (62.5 μ s)
	Rise time	62.5 μ s
	Temperature compensation of the magnets (PSM)	Available
Current control	Settling time (5 % tolerance range)	62.5 μ s
	Internal resolution	30 bit $\approx 100\% I_{max}$
	Absolute resolution	14 Bit
	Bandwidth	6 kHz
	Cycle time for the control	16 kHz (62.5 μ s)
Speed control	Repeat accuracy	<< 0.1 %
	Internal resolution	30 bit $\approx 240\,000$ rpm 1 LSB = 0.000224 rpm
	Cycle time for the control	16 kHz (62.5 μ s)
Position control	Resolver accuracy	<5 angular minutes (resolver-dependent)
	SinCos encoder accuracy	0.6 angular seconds (1024 SinCos encoder)
	Internal resolution	32 bit ≈ 1 revolution 1 LSB = $83.3 \cdot 10^{-9}$ degree
	Resolution to one revolution	CiA parameter 0x608F:001 (16 to 30 bits)
	Cycle time for the control	16 kHz (62.5 μ s)
Dynamics	Maximum acceleration 0- N_{Rated}	6000 rpm in 7 ms
	Shortest response time to a fault	62.5 μ s
Modulation	Voltage resolution of the PWM	100 MHz
	Switching frequencies	4, 8, 16 kHz (fixed, drive-optimized)
Field weakening operation	Asynchronous motor	Typical 3.0 fold (motor-dependent)
	Synchronous motor	Typical 1.5 fold (motor-dependent)
Device data	Overload capacity	2-fold
	Efficiency in the rated point	> 95 %



Product extensions

Overview

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

- ▶ [Motor encoder evaluation](#)  134
- ▶ [Functional safety](#)  139



Motor encoder evaluation

The axes are available in 3 designs for the evaluation of the motor encoder.

Example: Single axes 1.1 kW ... 4 kW



Design i750 "Hiperface DSL® (OCT)/PTC"



Design i750 "Resolver"



Design i750 "Multi-Encoder"

Example: Double axes 1.1 kW ... 4 kW



Design i750 "Hiperface DSL® (OCT)/PTC"



Design i750 "Resolver"



Design i750 "Multi-Encoder"



Resolver

Design i750 "Resolver"

- Encoder connection on 9-pin Sub-D
- Hiperface DSL® (OCT)/PTC connection X109 without function
- Motor temperature evaluation via encoder cable
- Usable Lenze motors with resolver:
 - Servo motors m850, MCS, MCA, MQA
 - Three-phase AC motors m550, m540, MF

Connection data

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-

Product extensions

Motor encoder evaluation

Incremental encoders and absolute value encoders



Incremental encoders and absolute value encoders

Design i750 "Multi-Encoder"

- Encoder connection on 15-pin Sub-D
- Hiperface DSL® (OCT)/PTC connection X109 without function
- Motor temperature evaluation via encoder cable
- Supported incremental encoders: SinCos, TTL
- Supported absolute value encoders: HIPERFACE®, SSI, SinCos+SSI, EnDat 2.1/2.2
- Usable Lenze motors with encoder:
 - Servo motors m850, MCS, MCA, MQA
 - Three-phase AC motors m550, m540, MF



Connection data

Pin assignment of incremental encoder

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

Pin assignment - absolute value encoder

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



Pin assignment - absolute value encoder EnDat

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

HIPERFACE DSL® encoder (OCT)

Design i750 "Hiperface DSL® (OCT)/PTC"

Function can be selected via parameters

One Cable Technology (OCT) via Hiperface DSL®

- Encoder connection on X109
- Digital motor temperature evaluation via sensor cable
- Usable Lenze motors with Hiperface DSL® encoder:
 - Servo motors m850, MCS

PTC

- PTC connection on X109
- Motor encoder evaluation is not possible
- Suitable Lenze motors with PTC/thermal contact:
 - Three-phase AC motors m550, m540, MF

Pin assignment for HIPERFACE DSL® (OCT) connection

Connection	Connection description	Connection type	Pin	HIPERFACE DSL® (OCT)
X109	HIPERFACE DSL	Pluggable and 2-pole	T1	+DSL
			T2	-DSL



Functional safety

General information and basics

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

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

Integrated functional safety

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

Safety component

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

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

Identification of the components

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

Standards

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

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

Risk assessment

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

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

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

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

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



Mission time

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

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



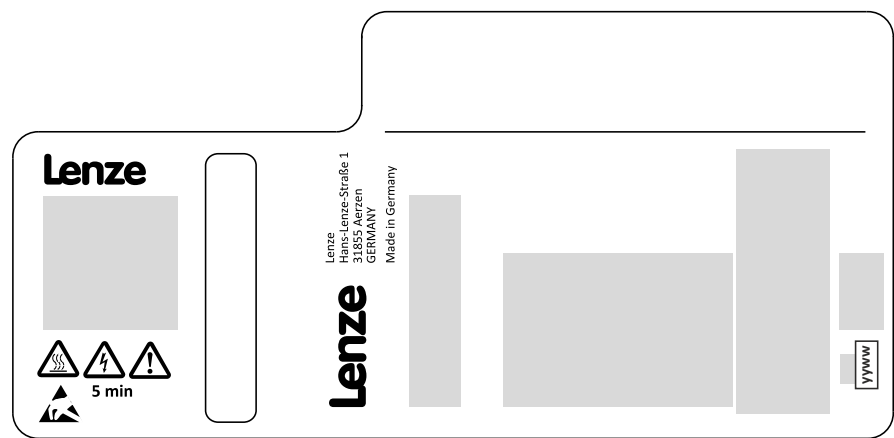
The mission time for the safety functions cannot be reset by a special proof test.

The specified mission time starts at the date of manufacture.

Mission time ▶ [Safety-related data](#)  200

Manufacturing date

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



yyww Year and week of manufacture
(2251 = CW 51 2022)

Stop functions

The stop functions differ according to how they are triggered:

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



Prioritisation

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

Hierarchy:

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

The monitoring functions have equal priorities and can be executed simultaneously with the stop function.

Acceptance

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

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

A complete test includes:

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



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

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

[Video instructions for the "Safety Validation Tool"](#)

Periodic inspections

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

Functional safety

General information and basics
Device exchange



Device exchange

Exchange a maximum of one safe device before recommissioning.

How to replace a safe device:

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



For double axes, ensure that the safe parameter sets are assigned to the correct axes.



Safe parameter setting

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

Open **+safety parameter list+**:

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



The safe parameterization is checked for plausibility.

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

Safety address

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

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



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

Document the safety address in circuit diagrams and markings.



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

Acknowledgement with confirmation button S82





Functional safety

Safe parameter setting
Acknowledgement with confirmation button S82

To acknowledge the request with the S82 confirmation button:

Precondition:

- The "RDY" LED is lit.
 - The "ERR" LED is blinking.
1. Press and hold the S82 button.
The "RDY" LED starts blinking.
 2. The "RDY" LED goes off after 3 seconds.
 3. Release the S82 button after a maximum of 2.5 seconds.
The "RDY" LED is lit.
 4. Press and hold the S82 button after a maximum of 2.5 seconds.
The "RDY" LED starts blinking.
 5. The "RDY" LED goes off after 3 seconds.
 6. Release the S82 button after a maximum of 2.5 seconds.
The acknowledgement is successfully completed.
The action is recorded in the inverter logbook.
 7. Use a function test to ensure that the acknowledgement has led to the correct result.



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



Safe interfaces

Overview: Safe interfaces in Lenze inverters

Functional safety design	Products	Safe inputs	Safe output	Safe network interfaces		
				PROFIsafe	FSoE	CIP Safety™
Basic Safety - STO	i550, i650, i750, i950	1 (STO)				
Advanced Safety - L	i750 cabinet				•	
Extended Safety - S	i650 motec					•
Extended Safety - L	i750 cabinet				•	
Extended Safety - LT	i950 cabinet	4	1	•	•	

Abbreviations used:

CIP	Common Industrial Protocol	-
FSoE	FailSafe over EtherCAT	148
PROFIsafe	Process field safety	-
STO	Safe torque off (STO)	155



Safe input signals via safety bus

Homing signals

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

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

IRS (SHom_Start)

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

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

IRL (SHom_Load)

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

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

Further information

- Safety bus: ▶ [Safe network interfaces](#) 148
- Safe homing: ▶ [Safe homing \(SHom\)](#) 190

Acknowledgement signals

Error acknowledgement (AIE)

Errors require acknowledgement with the AIE signal.

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

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

Restart acknowledgement (AIS)

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

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

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

Further information

- Safety bus: ▶ [Safe network interfaces](#) 148

Functional safety

Safe interfaces
Safe network interfaces
FSoE connection



Safe network interfaces

FSoE connection



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

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

Preconditions

ESI file

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

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



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

Addressing

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



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



Advanced Safety

FSoE output data

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

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

Byte-Offset	Bit-Offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Command (CMD)							
Byte 1	AIE (0↗1)	-	-	-	-	-	SS1	STO
Byte 2	-	-	-	-	-	-	-	AIS (0↗1)
Byte 3	CRC_0 (low-byte)							
Byte 4	CRC_0 (high-byte)							
Byte 5	-	-	-	-	-	-	-	-
Byte 6	-	-	-	-	-	SBC	-	-
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 inverter transmits FSoE input data (status information) to the safety controller:

- Data length: 19 bytes
- Status information is HIGH-active, the bit status "1" indicates the active status information.

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Command (CMD)							
Byte 1	Error active	-	-	-	-	-	-	STO active
Byte 2	-	-	-	-	-	-	-	SS1 active
Byte 3	CRC_0 (low-byte)							
Byte 4	CRC_0 (high-byte)							
Byte 5	-	-	-	-	-	-	-	-
Byte 6	-	-	-	-	-	-	-	-
Byte 7	CRC_1 (low-byte)							
Byte 8	CRC_1 (high-byte)							
Byte 9	-	-	-	-	-	-	-	-
Byte 10	-	-	-	-	MUT active	-	-	-
Byte 11	CRC_2 (low-byte)							
Byte 12	CRC_2 (high-byte)							
Byte 13	-	-	-	-	-	-	-	-
Byte 14	-	-	-	-	-	SBC activated	SBC active	-
Byte 15	CRC_3 (low-byte)							
Byte 16	CRC_3 (high-byte)							
Byte 17	Connection-ID (low-byte)							
Byte 18	Connection-ID (high-byte)							

Functional safety

Safe interfaces
Safe network interfaces
FSoE connection



Extended Safety

FSoE output data

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

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

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Command (CMD)							
Byte 1	AIE (0↗1)	SDIneg	SDIpos	-	SOS	SS2	SS1	STO
Byte 2	SSE	SLI	ES (HIGH-active)	RMS (HIGH-active)	-	SHom load (0↗1)	SHom start (0↗1)	AIS (0↗1)
Byte 3	CRC_0 (low-byte)							
Byte 4	CRC_0 (high-byte)							
Byte 5	SLP4	SLP3	SLP2	SLP1	SLS4	SLS3	SLS2	SLS1
Byte 6	-	-	-	-	-	SBC	-	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 inverter transmits FSoE input data (status information) to the safety controller:

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

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Command (CMD)							
Byte 1	Error active	SDIneg active	SDIpos active	-	SOS active	-	-	STO active
Byte 2	SSE active	SLI active	ES active	RMS active	-	SOS observed	SS2 active	SS1 active
Byte 3	CRC_0 (low-byte)							
Byte 4	CRC_0 (high-byte)							
Byte 5	SLS4 observed	SLS3 observed	SLS2 observed	SLS1 observed	SLS4 active	SLS3 active	SLS2 active	SLS1 active
Byte 6	SCA4 within limits	SCA3 within limits	SCA2 within limits	SCA1 within limits	SLP4 observed	SLP3 observed	SLP2 observed	SLP1 observed
Byte 7	CRC_1 (low-byte)							
Byte 8	CRC_1 (high-byte)							
Byte 9	SSM within limits	SMS observed	PDSSneg observed	PDSSpos observed	SDIneg observed	SDIpos observed	SHom available	SHom active
Byte 10	-	-	-	-	MUT active	Positive direction	n=0	Safe speed OK
Byte 11	CRC_2 (low-byte)							
Byte 12	CRC_2 (high-byte)							
Byte 13	-	-	-	-	-	-	-	-
Byte 14	-	-	-	-	-	SBC activated	SBC active	-
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)							



Safe speed and position analysis

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

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

Important notes

 **DANGER!**

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

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

- Reliably exclude functional errors via design measures.
- Utilize motors and encoder systems with guaranteed features.



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

Operation with 1-encoder system with resolver

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

Limit values

Synchronous servo motors	Encoder type	Encoder product code	Maximum permissible angular acceleration	Minimum time per 1,000 1/min speed stroke
MCS 06	Resolver	RV03	56,000 rad/s ²	1.9 ms
MCS 09 ... 19			19000 rad/s ²	5.5 ms
MDXKS 56 / 71			17000 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				



Motor-encoder combinations

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

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

▶ [Safety-related characteristics Extended Safety](#) 201
- Also observe the supplied documentation of the encoder manufacturer.

Permissible motor-encoder combinations for safe speed and position monitoring

Synchronous servo motors

Synchronous servo motor	Safety-rated encoder			
Type	Encoder type	Encoder product code	Max. speed [rpm]	Risk reduction
MCS 06 ... 19 MDXKS 56 / 71	SinCos absolute value, single-turn	AS1024-8V-K2	±16000	PL d / SIL 2
	SinCos absolute value, multi-turn	AM1024-8V-K2		
M85AS040 ... 080	HIPERFACE DSL® (OCT)	AM17-8V-D2	±12000	
MCS 06 ... 19 M85AS120 ... m850S190	SinCos absolute value, multi-turn	AM128-8V-K2	±16000	
	HIPERFACE DSL® (OCT)	AM20-8V-D2	±15000	
MCS 06 ... 19 MDXKS 56 / 71 M85AS120 ... m850S190	Resolver	RV03	±10000/number of pole pairs	PL e / SIL 3

Asynchronous servo motors

Asynchronous servo motor	Safety-rated encoder			
Type	Encoder type	Encoder product ID	Max. speed [rpm]	Risk reduction
MCA 10 ... 26 MQA 20 ... 26	Resolver	RV03	±10000/number of pole pairs	PL e / SIL 3

Three-phase AC motors

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



Safety functions

Overview: Safety functions in Lenze inverters

Functional safety design	Products	Stop functions								Monitoring functions								Operation and diagnostics		
		Without feedback						With feedback		With feedback								MUT	Safety bus	I/Os
		STO	SS1	SSE	SBC	CAS	SS2	SOS	SMS	SLS	SSM	SDI	SLI	PDSS	SLP	SCA				
Basic Safety - STO	i550, i650, i750, i950	●																	●	
Advanced Safety - L	i750 cabinet	●	●		●												●	●		
Extended Safety - S	i650 motec	●	●														●	●		
Extended Safety - L	i750 cabinet	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●		
Extended Safety - LT	i950 cabinet	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

Abbreviations used:

STO	Safe torque off (STO)	155
SS1	Safe stop 1 (SS1)	160
SSE	Safe stop emergency (SSE)	167
SBC	Safe brake control (SBC)	177
CAS	STO cascading (CAS)	-
SS2	Safe stop 2 (SS2)	169
SOS	Safe operating stop (SOS)	175
SMS	Safe maximum speed (SMS)	179
SLS	Safely-limited speed (SLS)	180
SSM	Safe speed monitor (SSM)	184
SDI	Safe direction (SDI)	187
SLI	Safely-limited increment (SLI)	186
PDSS	Position-dependent safe speed (PDSS)	182
SLP	Safely-limited position (SLP)	185
SCA	Safe cam (SCA)	189
MUT	Safe Muting (MUT)	197
I/Os	Safe inputs	-
	Safe output	-



Safe torque off (STO)

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

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

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

Functional safety

Safety functions
Safe torque off (STO)
Basic Safety - STO



Basic Safety - STO

Function included in variant:	Basic Safety - STO		
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Preconditions

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

Important notes

 DANGER!

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

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

Possible consequences: Death or severe injuries

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

 DANGER!

The power supply is not safely disconnected.

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

► Turn off the power supply.

 DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

► Set the motor to standstill mechanically.

 DANGER!

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

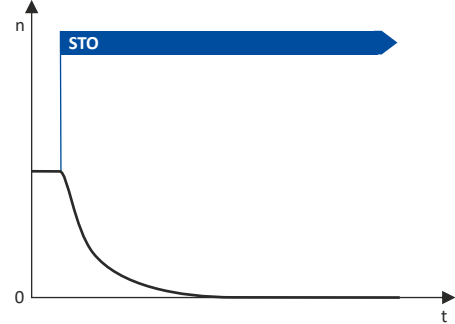
Possible consequences: Death or severe injuries

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



Functional description

STO



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

Activation

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

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

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

Functional safety

Safety functions
Safe torque off (STO)
Advanced Safety/Extended Safety



Advanced Safety/Extended Safety

Function included in variant:		Advanced Safety	Extended Safety
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Preconditions

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

Important notes

 DANGER!

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

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

Possible consequences: Death or severe injuries

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

 DANGER!

The power supply is not safely disconnected.

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

► Turn off the power supply.

 DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

► Set the motor to standstill mechanically.

 DANGER!

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

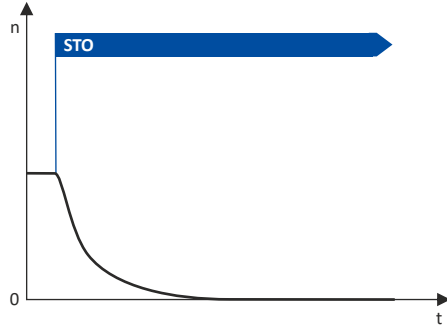
Possible consequences: Death or severe injuries

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



Functional description

STO



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

Activation

Directly:

- Via a safety bus

Automatically by activating the safety functions:

- Safe stop emergency (SSE)

Automatically after the safety functions have expired:

- Safe stop 1 (SS1)

As a result of errors in the stop functions:

- Safe Operating Stop (SOS)

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

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

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

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

Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Whether the restart needs to be acknowledged or if it launches automatically can be parameterized in a manner dependent on the preceding stop function.

Functional safety

Safety functions
Safe stop 1 (SS1)



Safe stop 1 (SS1)

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

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



Safe stop 1 time controlled (SS1-t)

Function included in variant:		Advanced Safety	Extended Safety
-------------------------------	--	-----------------	-----------------

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

Preconditions

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

Important notes

 **DANGER!**

The power supply is not safely disconnected.
Possible consequences: Death or severe injuries due to electrical voltage.
► Turn off the power supply.

 **DANGER!**

Uncontrolled rotation of the motor possible.
Possible consequences: Death or severe injuries
► Set the motor to standstill mechanically.

 **DANGER!**

Automatic restart can occur if the request of the safety function is deactivated.
Possible consequences: Death or severe injuries
► You must provide external measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

Functional safety

Safety functions

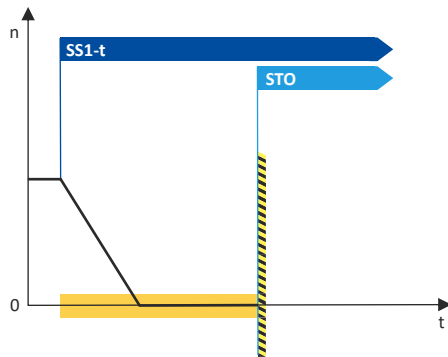
Safe stop 1 (SS1)

Safe stop 1 time controlled (SS1-t)



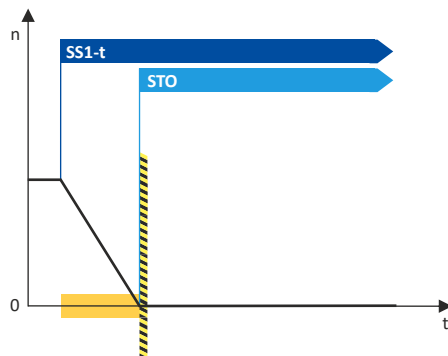
Functional description

SS1-t (STO after stop time)



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

SS1-t (STO at standstill)



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

Activation

Directly:

- Via a safety bus

Automatically by activating the safety functions:

- Safe stop emergency (SSE)

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

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

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

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



Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Restarting is only possible after the stop time has elapsed completely.
- Whether the restart needs to be acknowledged or if it launches automatically can be parameterized in a manner dependent on the preceding stop function.

Error behavior

States that trigger an event and an error stop:

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

Functional safety

Safety functions
Safe stop 1 (SS1)
Safe stop 1 ramp monitored (SS1-r)



Safe stop 1 ramp monitored (SS1-r)

Function included in variant:			Extended Safety
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SS1-r triggers the normal stop STO after the stop time has elapsed or after reaching standstill.
SS1-r also monitors the deceleration ramp of the application.

Preconditions

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

Important notes

 DANGER!

Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.
Possible consequences: Death or severe injuries
► Use a safety-rated encoder system to use this function.

 DANGER!

The power supply is not safely disconnected.
Possible consequences: Death or severe injuries due to electrical voltage.
► Turn off the power supply.

 DANGER!

Uncontrolled rotation of the motor possible.
Possible consequences: Death or severe injuries
► Set the motor to standstill mechanically.

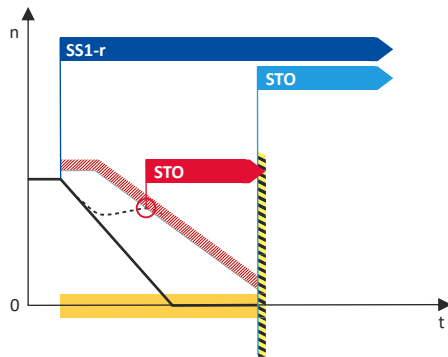
 DANGER!

Automatic restart can occur if the request of the safety function is deactivated.
Possible consequences: Death or severe injuries
► You must provide external measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.



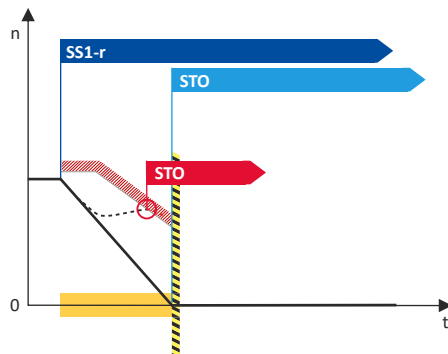
Functional description

SS1-r (STO after stop time)



- If the SS1-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- SS1-r activates the normal stop STO when the parameterized stop time has elapsed and the monitoring ramp has not been exceeded.
- If standstill has not yet been reached, the motor coasts down.

SS1-r (STO at standstill)



- If the SS1-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- SS1-r activates the normal stop STO when standstill is detected and the monitoring ramp has not been exceeded.
- Detection of standstill:
 - For applications without encoder: $n \leq 5 \text{ rpm}$
 - For applications with encoder: n is within the parameterized tolerance window

Functional safety

Safety functions

Safe stop 1 (SS1)

Safe stop 1 ramp monitored (SS1-r)



Activation

Directly:

- Via a safety bus

Automatically by activating the safety functions:

- Safe stop emergency (SSE)

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

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

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

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

Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Restarting is only possible after the stop time has elapsed completely.
- Whether the restart needs to be acknowledged or if it launches automatically can be parameterized in a manner dependent on the preceding stop function.

Error behavior

States that trigger an event and an error stop:

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



Safe stop emergency (SSE)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

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

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

SSE immediately triggers the assigned stop function.

Preconditions

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

Important notes



Connect the emergency stop button, which must not be overridden by the safe repair mode (RMS), to the SSE function via the safety controller and the safety bus.

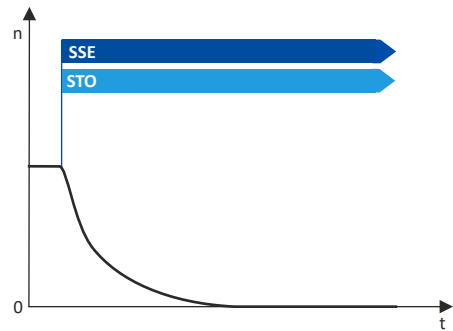
Functional safety

Safety functions
Safe stop emergency (SSE)

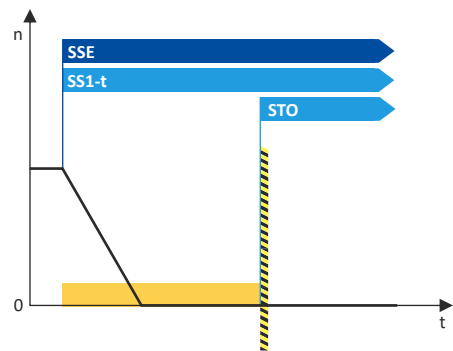


Functional description

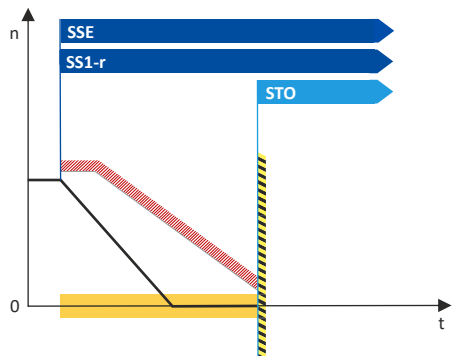
SSE (STO)



SSE (SS1-t)



SSE (SS1-r)



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

Activation

Directly:

- Via a safety bus



Functional safety

Safety functions
Safe stop 2 (SS2)

Safe stop 2 (SS2)

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

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

Functional safety

Safety functions
Safe stop 2 (SS2)
Safe stop 2 time controlled (SS2-t)



Safe stop 2 time controlled (SS2-t)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

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

Preconditions

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

Important notes

 **DANGER!**

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

Possible consequences: Death or severe injuries

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

 **DANGER!**

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

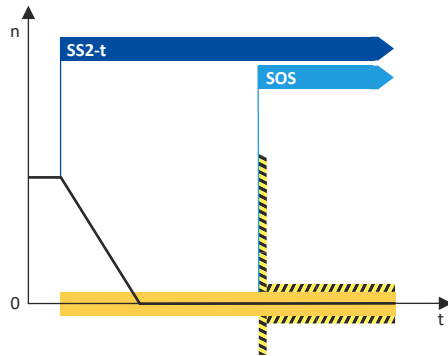
Possible consequences: Death or severe injuries

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



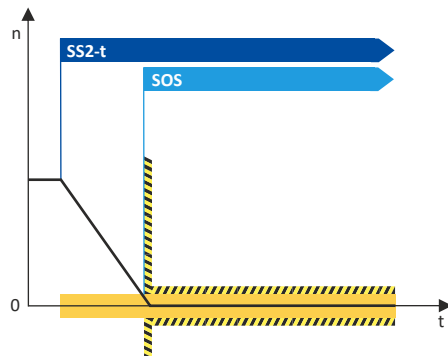
Functional description

SS2-t (SOS after stop time)



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

SS2-t (SOS at $n = 0$)



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

Activation

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

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

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

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

Error behavior

States that trigger an event and an error stop:

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

Functional safety

Safety functions
Safe stop 2 (SS2)
Safe stop 2 ramp monitored (SS2-r)



Safe stop 2 ramp monitored (SS2-r)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

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

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

Preconditions

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

Important notes

 **DANGER!**

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

Possible consequences: Death or severe injuries

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

 **DANGER!**

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

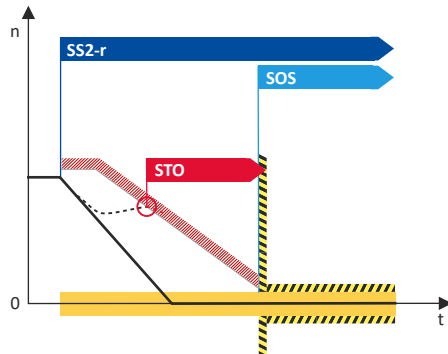
Possible consequences: Death or severe injuries

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



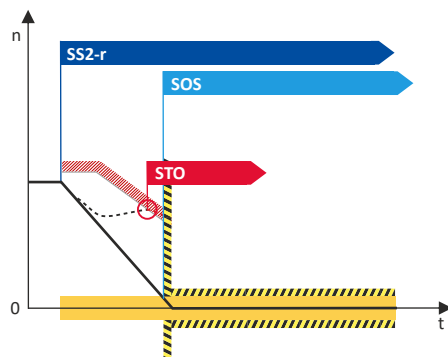
Functional description

SS2-r (SOS after stop time)



- If the SS2-r-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- SS2-r activates the normal stop SOS when the parameterized stop time has elapsed and the monitoring ramp has not been exceeded.

SS2-r (SOS at $n = 0$)



- If the SS2-r-r stop function is activated, a monitoring ramp is calculated and placed over the deceleration ramp in the application.
- SS2-r activates the normal stop SOS if the speed $n = 0$ is detected and the monitoring ramp has not been exceeded.

Activation

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

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

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

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

Functional safety

Safety functions

Safe stop 2 (SS2)

Safe stop 2 ramp monitored (SS2-r)



Error behavior

States that trigger an event and an error stop:

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



Safe operating stop (SOS)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

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

Preconditions

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

Important notes

 **DANGER!**

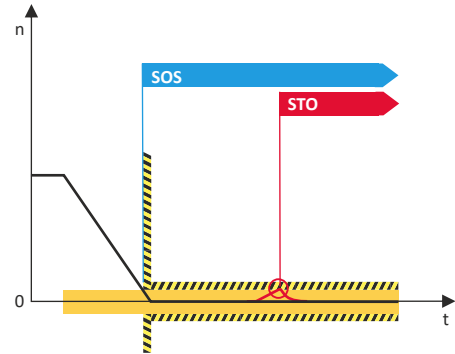
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.
Possible consequences: Death or severe injuries
► Use a safety-rated encoder system to use this function.

 **DANGER!**

Automatic restart can occur if the request of the safety function is deactivated.
Possible consequences: Death or severe injuries
► Parameterize the acknowledged restart.
► Take external measures according to EN ISO 13849-1 to ensure that the drive only restarts after confirmation.

Functional description

SOS



- SOS is activated when the speed $n = 0$ is detected. The reached position is actively held and monitored.
- Relative position changes are added and saved. The value is continuously compared with the tolerance window for the position deviation.
- When the SOS state is requested again, the sum of the last position changes is reset.

Activation

Directly:

- Via a safety bus

Automatically after the safety functions have expired:

- Safe stop 2 (SS2)

Functional safety

Safety functions

Safe operating stop (SOS)



Error behavior

States that trigger an event and an error stop:

- The position change has exceeded the tolerance window $p = 0$.
 - Event: SOS - Tolerance limit exceeded (0x2A00FF91)
 - Error stop STO



Safe brake control (SBC)

Function included in variant:		Advanced Safety	Extended Safety
-------------------------------	--	-----------------	-----------------

The "Safe Brake Control (SBC)" safety function enables the safe control of a brake of the drive that is active at standstill, i.e. the brake closes when the brake voltage is switched off. To prevent the motor from working against the closed brake, STO can be activated simultaneously or with a time delay.

Preconditions

- Only use safety-rated brakes.
- The brake is connected to X106.
- Brake function and brake control monitoring are controlled via X106.

Important notes

 **DANGER!**

Use of non-safety-rated brakes

Possible consequences: Death or severe injuries

- Only use safety-rated brakes with suitable safety-related parameters according to EN ISO 13849-1 and/or EN 62061 or EN IEC 61508.

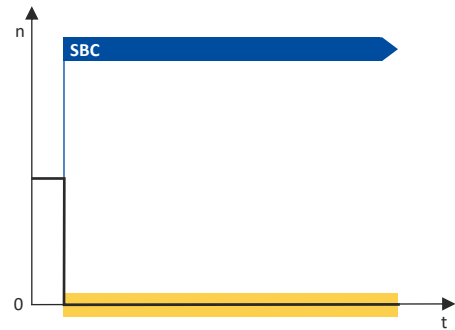


The internal test rate of the brake output (X106) restricts the request rate to max. 1 brake request/10 seconds.

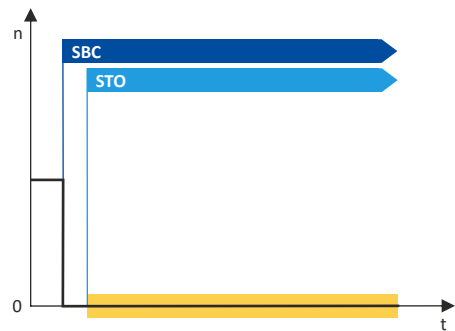
Depending on the application test rate of the connected brake to be released you must reduce the request rate accordingly.

Functional description

SBC



SBC (STO)



Functional safety

Safety functions
Safe brake control (SBC)



Activation

Directly:

- Via a safety bus

Error behavior

The brake is applied when any error is detected.

States that trigger an event:

- Incompatible configuration of the brake control
 - Event: SBC - Device configuration incompatible (0x2A006187)
- Faulty test of the brake control
 - Event: SBC - Test pulse error (0x2A00508E)
- The brake control supply is switched off.
 - Event: SBC - Remains stuck at LOW (0x2A00508F)



Safe maximum speed (SMS)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safe maximum speed (SMS)" safety function monitors the maximum speed of the drive.

Preconditions

- A safety-rated encoder system records the speed.

Important notes

 **DANGER!**

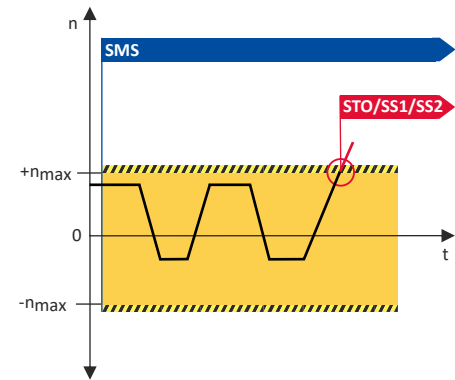
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

SMS



This function monitors the amount of the set maximum speed of the drive.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: SMS monitored
 - In status word bit 4

Activation

Via parameterization:

- Maximum speed > 0 activates the function.

Error behavior

States that trigger an event and an error stop:

- The actual speed has exceeded the maximum speed.
 - Event: SMS - Nmax exceeded (0x2A00FF90)
 - Error stop Parameterizable

Functional safety

Safety functions
Safely-limited speed (SLS)



Safely-limited speed (SLS)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safely limited speed (SLS)" safety function monitors up to 4 arbitrary operating speeds of the drive.

Preconditions

- A deceleration ramp in the application decelerates the drive.
- A safety-rated encoder system records the speed.

Important notes

 **DANGER!**

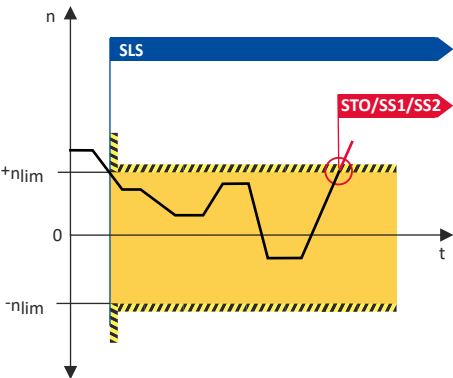
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

SLS



The function monitors up to 4 speed limits of the drive.

- Monitoring is activated when the set start delay has elapsed or the actual speed is within the set monitoring limits.
- In addition, the permissible direction of movement can be monitored within the monitoring limits.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: SLS1 monitored ... SLS4 monitored
 - In status word bit 0 ... Bit 3

Activation

Directly:

- Via a safety bus
- Via an internal status signal
- Automatically when referencing safely



Error behavior

States that trigger an event and an error stop:

- The actual speed has exceeded a speed limit.
 - Event: SLS1 - Nlim1 exceeded (0x2A00FF89)
 - Event: SLS2 - Nlim2 exceeded (0x2A00FF8A)
 - Event: SLS3 - Nlim3 exceeded (0x2A00FF8B)
 - Event: SLS4 - Nlim4 exceeded (0x2A00FF8C)
 - Error stop Parameterizable
- The drive is moving in the wrong direction.
 - Event: SDIpos - Wrong direction (0x2A00FF8E)
 - Event: SDIneg - Wrong direction (0x2A00FF8F)
 - Error stop Parameterizable

Functional safety

Safety functions
Position-dependent safe speed (PDSS)



Position-dependent safe speed (PDSS)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The safety function "Safe position-dependent speed (PDSS) monitors the speed of a drive depending on the absolute position along a limited movement range in order to ensure timely standstill at the position limits.

As a result, mechanical buffers can be dimensioned smaller or mechanical buffers and limit switches can be dispensed with altogether. A suitable safety-rated mechanical braking system may be required.

Application examples:

- Monitoring a storage and retrieval unit between the end positions

Preconditions

- The reference run must be executed.
- A safety-rated encoder system records speed and position.

Important notes

 **DANGER!**

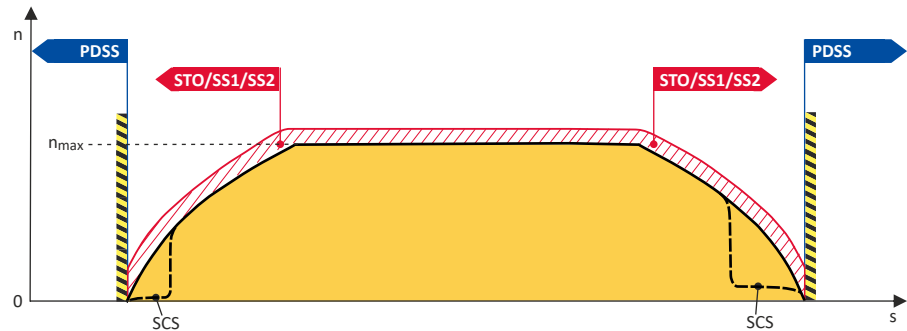
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

PDSS



- PDSS uses the parameterized values for the maximum speed, for the decelerations and for the absolute end positions to calculate the maximum speed at each position in order to ensure timely standstill at the position limits.
- In addition, two creep speeds (SCS) can be parameterized to approach the position limits more slowly.
- From the end positions, the drive can travel with maximum speed.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: PDSSpos monitored
 - In status word bit 16
- Output of the status message: PDSSneg monitored
 - In status word bit 17



Activation

Directly:

- Via a safety bus

Via parameterization:

- Function permanently active

Error behavior

States that trigger an event and an error stop:

- The actual speed has exceeded the speed limit.
 - Event: PDSS - Velocity exceeded (0x2A00FF9D)
 - Error stop Parameterizable
- The actual creep speed has exceeded the speed limit.
 - Event: PDSS - Creep velocity SCS exceeded (0x2A00FF9E)
 - Error stop Parameterizable

Functional safety

Safety functions
Safe speed monitor (SSM)



Safe speed monitor (SSM)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safe speed monitoring (SSM)" safety function monitors the amount of any operating speed of the drive.

A status message indicates compliance with the monitoring limits.

Application examples:

- Safe standstill monitoring
- Despite excessive speed, no immediate machine standstill may occur. The operating personnel is only informed safely.

Preconditions

- A safety-rated encoder system records the speed.

Important notes

 **DANGER!**

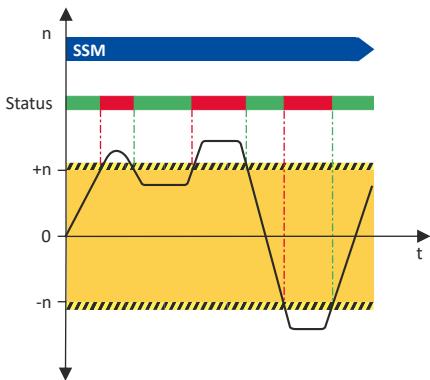
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

SSM



The function compares the actual speed with the parameterized speed limits.

If the actual speed of the drive is within the monitoring limits:

- Output of the status message: SSM within limits
 - In status word bit 5

Activation

Via parameterization:

- Monitored speed > 0 activates the function.

Error behavior

If the monitoring limits are exceeded, no error message is output and no error stop is triggered.

Only the "SSM within limits" status is reset.



Safely-limited position (SLP)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safely limited position (SLP)" safety function monitors up to 4 absolute position limits of a permissible movement range.

Preconditions

- The reference run must be executed.
- A safety-rated encoder system records speed and position.

Important notes

 **DANGER!**

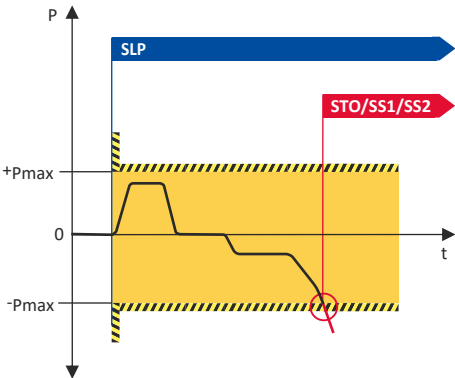
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

SLP



The function monitors up to 4 upper and lower position limits of the drive.

- After requesting the function, the monitoring is active immediately.

If the actual position of the drive is within the monitoring limits:

- Output of the status message: SLP1 monitored ... SLP4 monitored
 - In status word Bit 8 ... Bit 11

Activation

Directly:

- Via a safety bus

Error behavior

States that trigger an event and an error stop:

- The actual position has exceeded a position limit.
 - Event: SLP1 - Position limits exceeded (0x2A00FF97)
 - Event: SLP2 - Position limits exceeded (0x2A00FF98)
 - Event: SLP3 - Position limits exceeded (0x2A00FF99)
 - Event: SLP4 - Position limits exceeded (0x2A00FF9A)
 - Error stop Parameterizable



Safely-limited increment (SLI)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safely limited increment (SLI)" safety function monitors the amount of a maximum permissible position change.

Preconditions

- A safety-rated encoder system records speed and position.

Important notes

 **DANGER!**

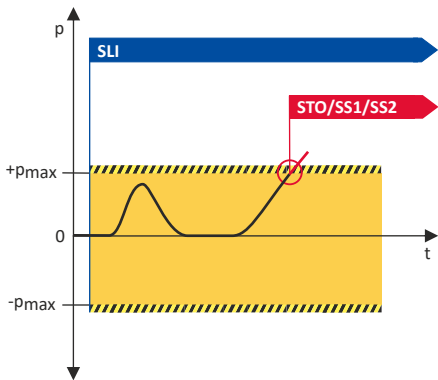
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

SLI



The function monitors the parameterized maximum position change.

- After requesting the function, the monitoring is active immediately.

Activation

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

Directly:

- Via a safety bus

Error behavior

States that trigger an event and an error stop:

- The position change has exceeded the monitoring limit.
 - Event: SLI - Safely limited increment exceeded (0x2A00FF96)
 - Error stop Parameterizable



Safe direction (SDI)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safe direction (SDI)" safety function monitors the direction of rotation of the drive.

A tolerance window can be used to define the number of increments that the drive may move in the blocked direction.

Preconditions

- The application guides the drive in the permitted direction of movement.
- A safety-rated encoder system records speed and position.

Important notes

 **DANGER!**

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

Possible consequences: Death or severe injuries

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

NOTICE

The start delay is activated.

Machine and system parts can be destroyed if this setting is not taken into account when calculating the safety distance.

► Only use this function if the safety distance has been calculated beforehand, taking the set delay into account.

► Evaluate the feedback: "SDIpos - Wrong direction" or "SDIpos - Wrong direction".

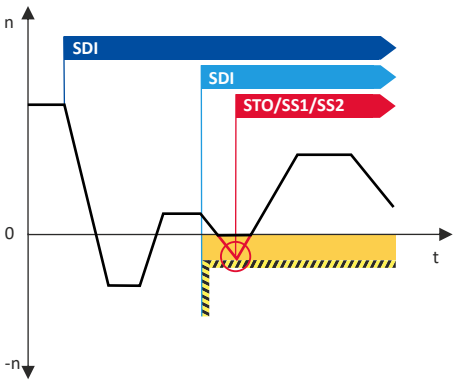
Functional safety

Safety functions
Safe direction (SDI)

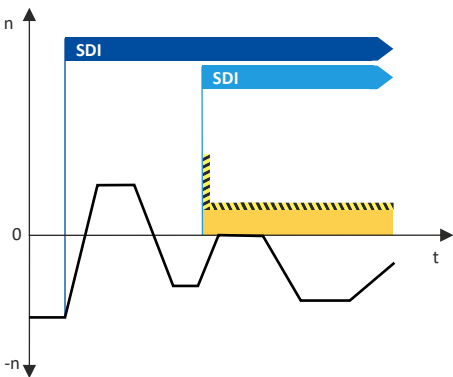


Functional description

SDI (SDIpos)



SDI (SDIneg)



The function monitors the permissible direction of movement of the drive.

- Monitoring becomes active when the set start delay has expired.
- In addition, the number of increments that the drive may move in the blocked direction without triggering an error stop can be defined within the monitoring limits.

If the direction of movement of the drive is within the monitoring limits:

- Output of the status message: SDIpos monitored
 - In status word bit 6
- Output of the status message: SDIneg monitored
 - In status word bit 7

Activation

Directly:

- Via a safety bus

Error behavior

States that trigger an event and an error stop:

- The drive is moving in the wrong direction.
 - Event: SDIpos - Wrong direction (0x2A00FF8E)
 - Event: SDIneg - Wrong direction (0x2A00FF8F)
 - Error stop Parameterizable



Safe cam (SCA)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

The "Safe cam (SCA)" safety function monitors up to 4 arbitrary absolute lower and upper position limits.

A status message indicates compliance with the monitoring limits.

Application examples:

- Monitoring the parking position of a storage and retrieval machine.
- Collision avoidance for an X-Y-Z gantry when there is a fixed obstacle in the travel range.

Preconditions

- The reference run must be executed.
- A safety-rated encoder system records speed and position.

Important notes

 **DANGER!**

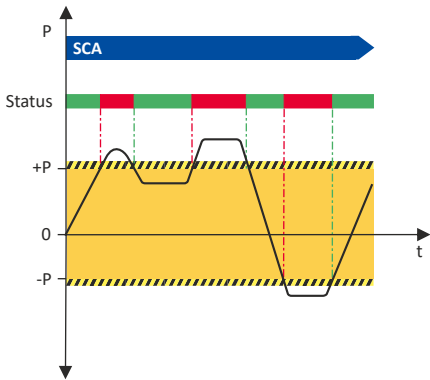
Uncontrolled rotation of the motor possible if no safety-rated encoder system is used.

Possible consequences: Death or severe injuries

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

Functional description

SCA



The function compares the absolute actual position with the parameterized position limits.

If the actual position of the drive is within the monitoring limits:

- Output of the status message: SCA1 within limits ... SCA4 within limits
 - In status word bit 12 ... bit 15

Activation

Via parameterization:

- Lower and upper position limits $\neq 0$ activate the function.

Error behavior

If the monitoring limits are exceeded, no error message is output and no error stop is triggered.

Only the "SCA1 within limits" ... "SCA4 within limits" status is reset.

Functional safety

Safety functions
Safe homing (SHom)



Safe homing (SHom)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

Safety functions based on absolute positions require an absolute reference point to calculate and monitor the position.

- This reference point is defined with the complete reference run.
- The mini reference run can replace the complete reference run in certain operating states.



Functional safety

Safety functions
Safe homing (SHom)
Complete homing

Complete homing

The reference position determined with the reference run is the absolute reference point for the safety functions:

- Safely-limited position (SLP)
- Position-dependent safe speed (PDSS)
- Safe cam (SCA)

Important notes

DANGER!

When switched off, the motor position must not be changed by external forces.

Possible consequences: Death or severe injuries

- Make sure that the motor position does not change.

NOTICE

Undetected local change of the home position.

An unrecognized local change of the home position leads to incorrect values of the absolute position.

- Mount the components for detecting the reference position mechanically so that the home position cannot change due to external influences.

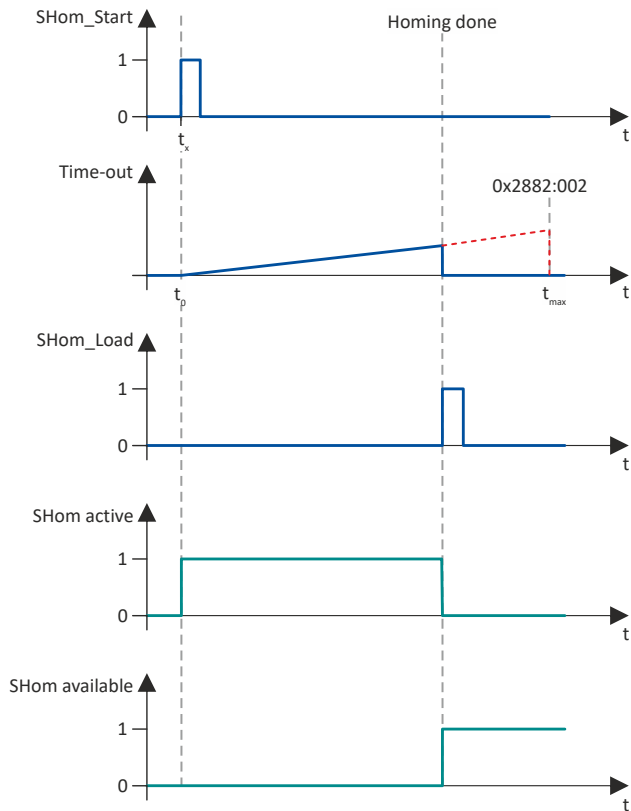
Functional safety

Safety functions
Safe homing (SHom)
Complete homing



Functional description

SHom



Sequence of the reference run

1. The reference run process is started via the defined input source.
2. The superimposed application must start the reference run. The drive independently takes over the motion control.
3. The reference run is performed with the set safely limited speed (SLS).
4. The reference signal "SHom_Load" is expected within the defined "Timeout" period, which adopts the parameterized position value as the "Home Position" when the reference position is passed.
5. Once the reference point is set, the reference run is ended.
6. The drive changes to normal operation.

By parameterization it can be set whether the current position is stored non-volatilely when the voltage supply is switched off. If the restart conditions are fulfilled after the voltage supply is switched on again and after a mini reference run, no new reference run is performed.

If the reference run is active:

- Output of the status message: SHom active
 - In status word bit 20

If the reference point is successfully accepted:

- Output of the status message: SHom available
 - In status word bit 21

Activation

Directly:

- Via a safety bus



Error behavior

States that trigger an event and an error stop:

- The reference run is faulty.
 - Event: SHom - Time-out (0x2A00FFA6)
 - Event: SHom - Home position deleted (0x2A00FFA7)
 - Event: SHom - Tolerance of start position exceeded (0x2A00FFA9)
 - Event: SHom - Tolerance of position comparison exceeded (0x2A00FFAA)
 - Error stop STO

Mini-homing

The mini reference run can replace the complete reference run in certain operating states.

The mini reference run is a minimum movement to check the plausibility of absolute position values.

After the reference run has been completed successfully, the drive switches to normal operation.

Preconditions

- A complete reference run was carried out before the first call.
- "Load saved reference" is set as a restart condition.

Functional description

- The drive moves at the parameterized safely limited speed SLS.
- The minimum distance for the mini reference run is calculated automatically:
 - Minimum distance $\geq 4 \times$ tolerance window for the position comparison
- Sequence of the plausibility check during the mini reference run:
 1. Are the saved position and the current position within the parameterized tolerance window for the starting position?
 2. Are the position value currently received from the inverter and the internal position value within the parameterized tolerance window for the position comparison?
 3. If the plausibility check is successful, the status bit "SHom present" is set.
 4. The drive changes to normal operation.



If complete homing is to be performed via the home position switch despite the "SHom present" status bit being set, the status bit must be reset with the "Clear home position" command.

Only the status bit is reset via this path. The superimposed application must start the complete reference run.

Activation

Automatically in the operating states:

- After mains switching
- After returning from the repair mode select (RMS)

Error behavior

States that trigger an event and an error stop:

- The mini reference run is faulty.
 - Event: SHom - Tolerance of start position exceeded (0x2A00FFA9)
 - Event: SHom - Tolerance of position comparison exceeded (0x2A00FFAA)
 - Error stop STO

A complete reference run is required.



Repair mode selector (RMS)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

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

Application examples

- If an encoder fails, the drive must be moved to a position in which it can be repaired.



The connected encoders are not evaluated safety-related.
Only the stop function configurable for RMS and the enable switch ES are active. All other safety functions are deactivated.

Preconditions

- A source for the ES enable switch must be configured.
- A stop function for RMS must be configured.

Important notes

**DANGER!**

Unexpected motions with unexpected speed.
Violation of the permissible movement limits.
Possible consequences: Death or severe injuries

- ▶ Use RMS exclusively to free an axis from a "deadlock".
- ▶ If necessary, take additional safety measures to ensure that no persons can be endangered, since all monitoring functions are deactivated except for the ES enable switch.
- ▶ Use other functions to move the drive when it is not in a "deadlock"!

**DANGER!**

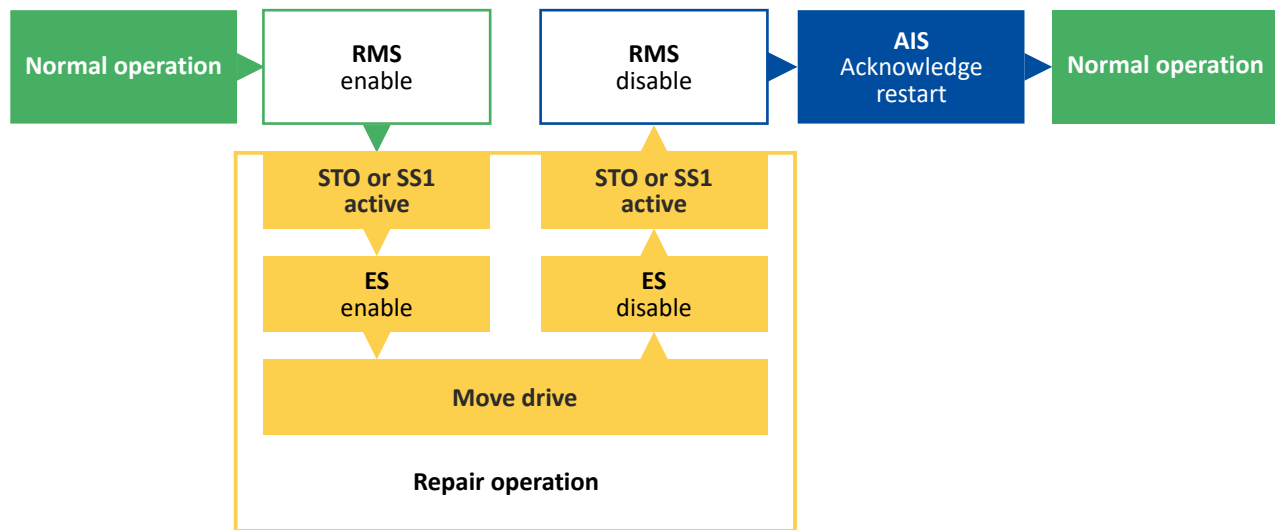
When returning to normal operation, the automatic restart is not permissible.
Possible consequences: Death or severe injuries

- ▶ Parameterize the acknowledged restart.



Functional description

RMS



Repair operation procedure

1. Activate RMS via the configured trigger source.
The stop function configured for RMS is activated.
Speed functions and absolute position functions are deactivated.
The SHom status is reset.
2. Activate the enable switch ES via the configured trigger source.
The stop function is now overruled.
3. The drive can now be released from the "deadlock".
4. When the action is complete, deactivate the ES enable switch.
The drive can no longer be moved.
The stop function configured for RMS is activated.
5. Deactivate the trigger source for RMS.
The encoder evaluation is switched active again.
The repair mode is finished.
6. The minireference run starts automatically.
7. After a successful minireference run, the drive waits for the restart to be acknowledged.
8. Acknowledge the restart with the signal AIS.
The drive changes to normal operation.

Activation

Directly:

- Via a safety bus

Error behavior

States that trigger an event and an error stop:

- The mini reference run is faulty.
 - Event: SHom - Tolerance of start position exceeded (0x2A00FFA9)
 - Event: SHom - Tolerance of position comparison exceeded (0x2A00FFAA)
 - Error stop STO

A complete reference run is required.

After completion of the complete reference run, the drive switches to normal operation.

Functional safety

Safety functions
Enable switch (ES)



Enable switch (ES)

Function included in variant:			Extended Safety
-------------------------------	--	--	-----------------

This function allows the normal stop functions to be overridden during repair mode.

Preconditions

The repair mode must be configured and activated.

Functional description

- The enable button overrides the stop function active in repair mode. The stop function is deactivated without delay.
- The drive can then be moved freely as long as the enable switch is active.
- If the enable switch is deactivated, the stop function for repair mode is reactivated without delay.

Activation

Directly:

- Via a safety bus



Safe Muting (MUT)

Function included in variant:		Advanced Safety	Extended Safety
-------------------------------	--	-----------------	-----------------

This function deactivates all functions of the safety bus.

"Safe Muting" is used to move the drive even if the inverter is in a safety state.

- The function may only be used during commissioning or for maintenance work.
- The function is active for a maximum of 30 minutes.
- It can be ended at any time.

Preconditions

To activate the Safe Muting function, you need:

- A PC with »EASY Starter« (1.16 or higher) or »PLC Designer«.
- A permanent communication link between engineering tool and inverter.
- In a network, the Safe Muting function can only be activated for one inverter at a time.
- The muting password was assigned via the password dialog in the **+Safety parameter list+**.
- The active safe parameter set in the inverter must contain the settings for safe muting:
 - The sources to be hidden.
 - The muting password.

Important notes

DANGER!

Activating the Safe Muting function deactivates safety functions!

Possible consequences: Death or severe injuries

- Only authorized personnel may activate the Safe Muting function.
- An emergency stop switch-off must be present that cannot be deactivated by Safe Muting.

Activation

How to activate and deactivate Safe Muting:

1. Open **+Safety parameter list+**:
 - a) »EASY Starter«: Open the **+Safety parameter list+** tab.
 - b) »PLC Designer«: Open the **Safe parameter set** object under the axis in the device tree.
2. Click muting dialog.
The password dialog opens.
3. Enter muting password.
The muting dialog opens.
4. Use the displayed data to ensure that the correct inverter has been selected.
Optical device identification is activated automatically. The two LEDs "RDY" and "ERR" on the front of the selected inverter flash quickly.
5. **Start** activates the function.
The function is now active for a maximum of 30 minutes. The remaining time is displayed.
6. End function
 - a) The function is automatically ended after 30 minutes.
 - b) **Stop** ends the function manually.
 - c) If the connection between engineering tool and inverter is disconnected, the function is aborted immediately with an error message.
Monitored operation is reactivated immediately.
All previously deactivated safety functions are active again.



Diagnostics

Status LEDs

The LEDs "RDY" and "ERR" show the current safety status:

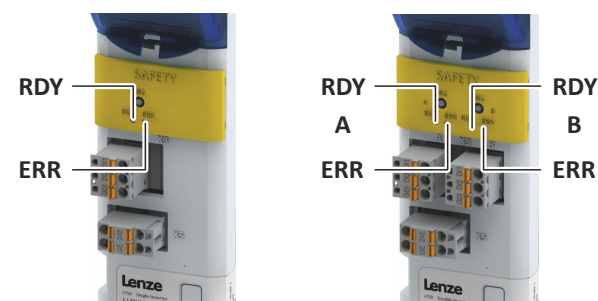
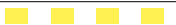


Fig. 9: Position of the RDY and ERR LEDs

 **DANGER!**

- Unreliable status information possible due to LEDs.
- LEDs are not reliable status indicators. There is no guarantee that the LEDs provide accurate information.
- Possible consequences: Death or severe injuries
- Only use LEDs for general diagnostics during commissioning or troubleshooting.
 - Do not use LEDs as status displays.

LED "RDY" (yellow)	Status	Meaning
off	-	No status message active.
 blinking yellow 2 Hz	SOS active	
 blinking yellow 1 Hz	Service status	Transfer of parameter set requested.

Display for requested acknowledgement

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
 on	off	Restart	The device is working correctly.
	 blinking red 1 Hz	acknowledgement requested	During startup, a modified parameter set was detected in the "Init" state.
	 blinking red 2 Hz		During startup, a changed safety address was detected in the "Init" state.
	 blinking red		During startup, a changed assignment between OCT encoder and inverter was detected in the "Init" state.

Display in the event of errors

	LED "ERR" (red)	Status	Meaning
	off	-	The device is working correctly.
	 blinking red 2 Hz	Safety bus error	Communication via the safety bus is not established: • There is no valid configuration. • The start-up has not been completed yet.
	 blinking red 1 Hz	Safety technology error	One of the following errors has been detected: • A monitoring device has been activated. • An acknowledgeable error is active.



Display for critical device errors

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
blinking yellow	blinking red	Critical system error	"Lock-out" (CPU stopped) STO is active. If the system error occurs again after switching the 24 V supply, the device is defective. It must be replaced.



Safety-related data

Safety-related characteristics Basic Safety - STO

Basics of the safety-related characteristics			
	Source of failure rates	SN 29500	When no values from the component manufacturers were available.
	Average max. ambient temperature	60 °C	
Basic Safety - STO			
EN IEC 61508, part 1-7 EN 62061	SFF	99 %	
	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
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Category	4	
	Performance Level	e	
	MTTF _d	High	> 100 years
	Mean diagnostic coverage DCavg		99 %

Safety-related characteristics Advanced Safety

Basics of the safety-related characteristics			
	Source of failure rates	SN 29500	When no values from the component manufacturers were available.
	Average max. ambient temperature	60 °C	
Safety-related characteristic values for all safety functions except Safe Brake Control (SBC)			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 3	
	PFH [1/h]	< 1 E-09	< 1 % of SIL 3
	PFD _{avg} (T)	< 1 E-04	< 10 % of SIL 3 after T = 20 years
	SFF	99 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	e	
	Category	4	
	MTTF _d	High	> 250 years
	Mean diagnostic coverage DCavg		95 %
Safety-related characteristic values for the Safe Brake Control (SBC) safety function			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 2	
	PFH [1/h]	< 1 E-08	< 1 % of SIL 2
	PFD _{avg} (T)	< 1 E-03	< 10 % of SIL 2 after T = 20 years
	SFF	99 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	d	
	Category	2	
	MTTF _d	High	> 230 years
	Mean diagnostic coverage DCavg		95 %



Safety-related characteristics Extended Safety



The achievable risk reductions (PL/SIL) also depend on the motor/encoder combination used.

Match the values given here with the values for the motor/encoder combinations:

► [Motor-encoder combinations](#) 153

Basics of the safety-related characteristics			
	Source of failure rates	SN 29500	When no values from the component manufacturers were available.
	Average max. ambient temperature	60 °C	
All safety functions except Safe Brake Control (SBC) for drive systems with motors with resolvers and SinCos encoders			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 3	
	PFH [1/h]	< 1 E-09	< 1 % of SIL 3
	PFD _{avg} (T)	< 1 E-04	< 10 % of SIL 3 after T = 20 years
	SFF	99 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	e	
	Category	4	
	MTTF _d	High	> 250 years
	Mean diagnostic coverage DCavg		95 %
All safety functions except Safe Brake Control (SBC) for drive systems with motors with HIPERFACE DSL® encoders (OCT)			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 2	
	PFH [1/h]	< 5 E-09	< 0.5 % of SIL 2
	PFD _{avg} (T)	< 5 E-04	< 5 % of SIL 2 after T = 20 years
	SFF	> 90 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	d	
	Category	3	
	MTTF _d	High	> 300 years
	Mean diagnostic coverage DCavg	Medium	> 90 %
Safe Brake Control (SBC) safety function independent of the parameterized motor encoder system			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 2	
	PFH [1/h]	< 1 E-08	< 1 % of SIL 2
	PFD _{avg} (T)	< 1 E-03	< 10 % of SIL 2 after T = 20 years
	SFF	99 %	
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Performance Level	d	
	Category	2	
	MTTF _d	High	> 230 years
	Mean diagnostic coverage DCavg		95 %



Response times of the safety unit

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

Response time of encoder monitoring

Time required to detect faults caused by continuous signal errors at the encoder interface.			[ms]
		Default setting	50
		Parameterizable via: 0x2878:004	12/50/100

It must be evaluated for each application what minimum response time is possible.

The longer the reaction time, the more the safe speed is filtered.

During dynamic processes (acceleration, deceleration), the safely evaluated speed lags behind the actual speed of the drive. This time offset must be taken into account when reaching limit values.

Response 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

FSoE communication response times

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.

Response time to a status word from the safety module (input data)		[ms]
T _{_Input} T _{_I}	Internal transfer time of the FSoE data from the safety module to the safe control system	8

Tab. 1: Response time to status word

Response time to a control word (output data)		[ms]
T _{_Output} T _{_O}	Internal transfer time of the FSoE data from the safe control to the safety module	16

Tab. 2: Response time to a control word

If safety bus communication is disturbed, the system switches to the fail-safe state after the safety bus monitoring time (T_{_WD}) has elapsed. Communication via the safety bus is deactivated.



Calculation of the maximum response times

To determine the response time to a safety function request, the entire system must be taken into account:

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

The ETG FSoE protocol specification contains formulas for calculating the maximum response time in fault-free operation and in the event of a fault.

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



This chapter refers to calculations using a safety bus and safety PLC.



In the "Application Knowledge Base", Lenze provides an Excel table as a calculation aid. This can be used to easily calculate the reaction times.

[Link to "Application Knowledge Base"](#)

Please note the following:

The variables for the individual response times are named differently in the documentation for the c250-S safety controller than in the FSoE protocol specification of the ETG.

In the following graphics, the differences are marked with "Lenze" and "ETG".

Definition of the single response times

Name Lenze	Name ETG	Description	Comment
T_Sensor	T_S	Processing time of the sensor until the signal is available at the interface.	See technical data of the sensor
T_InputFilter		Parameterized filter time of the safe input.	
T_Input	T_I	Processing time of the safe input.	E.g. safety I/O module, FSoE sensor or inverter. See technical data
T_WDInput	T_WD_In	Monitoring time parameterized in the safety PLC (c250-S) for the safe input module.	E.g. safety I/O module, FSoE sensor or inverter.
T_EtherCAT	T_Com	EtherCAT cycle time	
T_FSoE		Processing time of the communication, depending on the EtherCAT cycle time	The documentation of the c250-S specifies max. $3 \times T_EtherCAT$. The ETG FSoE protocol specification specifies max. $2 \times T_Com$. It depends on the application which factor can be used. Factor 3 means improved availability of secure communications.
T_SafetyPLC	T_L	Processing time of the safety PLC (c250-S).	Corresponds to the set cycle time of the safety application.
T_Output	T_O	Processing time of the safe output.	E.g. safety I/O module or inverter. See technical data
T_WDOutput	T_WD_Out	Monitoring time parameterized in the safety PLC (c250-S) for the safe output module.	E.g. safety I/O module or inverter.
T_Aktor	T_A	Processing time of the actuator.	See technical data of the actuator

Functional safety

Safety-related data
Calculation of the maximum response times



Maximum response time with error-free communication

i Note the different factors for calculating the processing time of the communication:
The documentation of the c250-S specifies max. $3 \times T_{\text{EtherCAT}}$.
The ETG FSoE protocol specification specifies max. $2 \times T_{\text{Com}}$.
It depends on the application which factor can be used. Factor 3 means improved availability of secure communications.

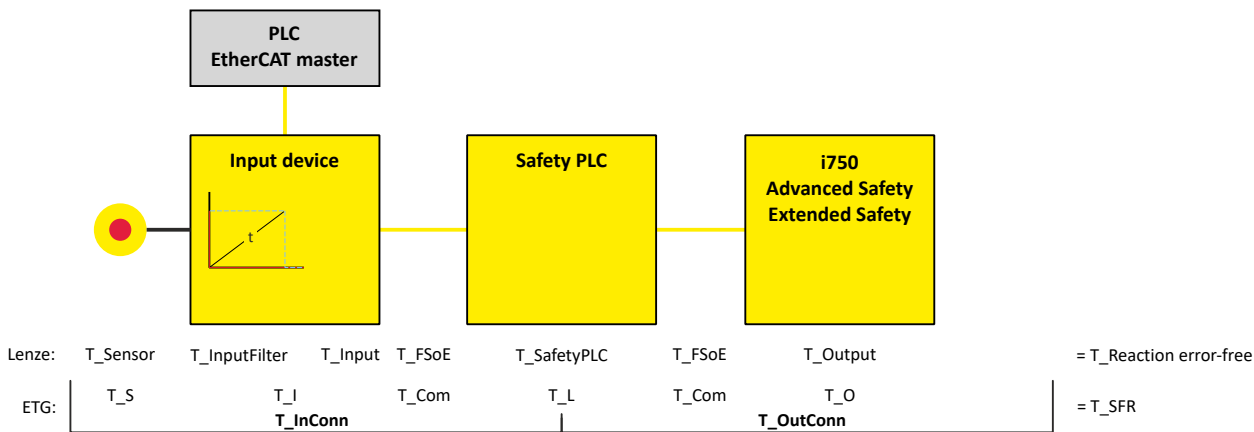


Fig. 10: Maximum response time with error-free communication **without** Safe Brake Control (SBC)

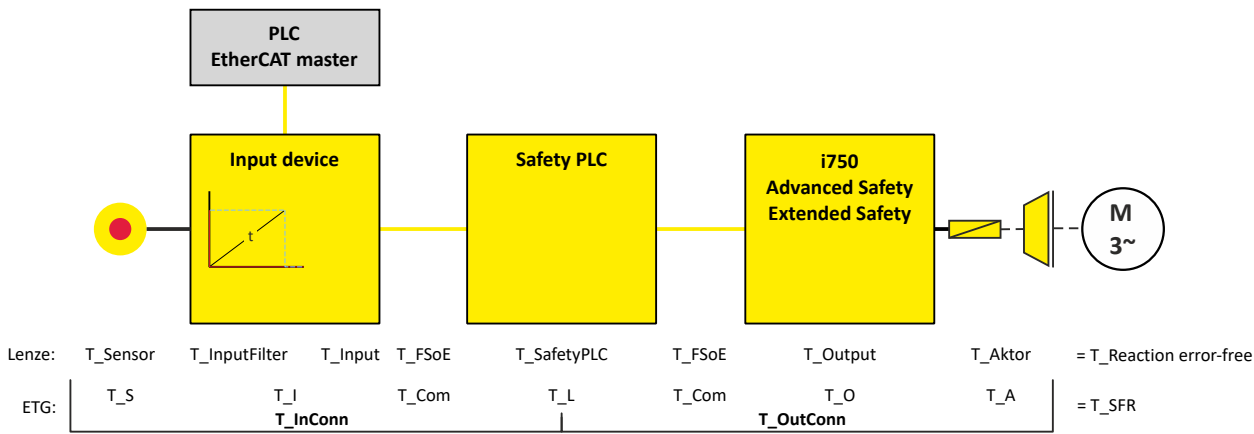


Fig. 11: Maximum response time with error-free communication **with** Safe Brake Control (SBC)

Calculation of the maximum response time with error-free communication

	Max. response time without SBC		Max. response time with SBC
T_InConn	$2 \times T_S$ $+ 2 \times T_I$ $+ 2 \times T_{\text{Com}} (3 \times T_{\text{Com}})$ $+ 2 \times T_L$		$2 \times T_S$ $+ 2 \times T_I$ $+ 2 \times T_{\text{Com}} (3 \times T_{\text{Com}})$ $+ 2 \times T_L$
T_OutConn	$+ 2 \times T_L$ $+ 2 \times T_{\text{Com}} (3 \times T_{\text{Com}})$ $+ 2 \times T_O$		$+ 2 \times T_L$ $+ 2 \times T_{\text{Com}} (3 \times T_{\text{Com}})$ $+ 2 \times T_O$ $+ 2 \times T_A$
	= T_SFR		= T_SFR



Response time in case of communication interruption

The FSoE watchdog time T_WD is included in the calculation of the maximum response time in case of communication interruption.

The FSoE watchdog time T_WD can be calculated according to the formula in the ETG FSoE protocol specification.

The processing times in the individual subsystems and the processing time of the communication are included in this calculation. In addition, a reserve of 20% is added.

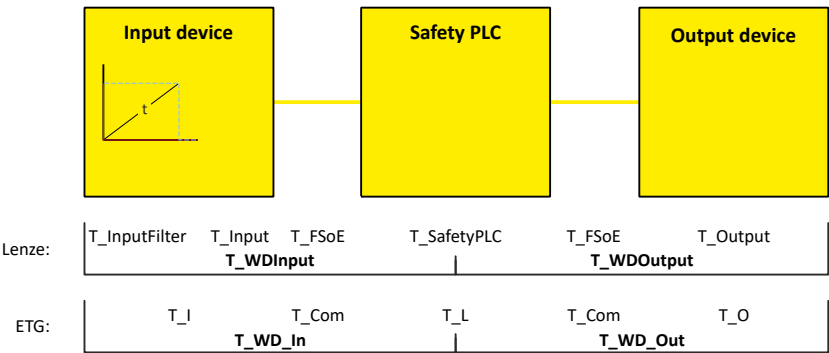


Fig. 12: FSoE watchdog time

i

Depending on the input module and the output module used, the calculation may result in different values.

The higher value must always be used for further calculation to improve the availability of secure communication.

Calculation of the FSoE watchdog time

	Input module		Output module
	$2 \times T_I$ $+ 4 \times T_{Com} \text{ (} 6 \times T_{Com} \text{)}$ $+ 2 \times T_L$ $+ \Delta T \text{ (} 20 \% \text{)}$		$+ 4 \times T_{Com} \text{ (} 6 \times T_{Com} \text{)}$ $+ 2 \times T_L$ $+ 2 \times T_O$ $+ \Delta T \text{ (} 20 \% \text{)}$
	$= T_{WD_In}$		$= T_{WD_Out}$

Functional safety

Safety-related data

Calculation of the maximum response times



Calculation of the maximum response time in case of communication interruption in the input module

	Max. response time without SBC		Max. response time with SBC
T_InConn_wc	$2 \times T_S$ $+ T_{WD_In}$		$2 \times T_S$ $+ T_{WD_In}$
T_OutConn	$+ 2 \times T_L$ $+ 2 \times T_{Com} (3 \times T_{Com})$ $+ 2 \times T_O$		$+ 2 \times T_L$ $+ 2 \times T_{Com} (3 \times T_{Com})$ $+ 2 \times T_O$ $+ 2 \times T_A$
	$= T_{SFR_wc} (In)$		$= T_{SFR_wc} (In)$

Calculation of the maximum response time in case of communication interruption in the output module

	Max. response time without SBC		Max. response time with SBC
T_InConn	$2 \times T_S$ $+ 2 \times T_I$ $+ 2 \times T_{Com} (3 \times T_{Com})$ $+ 2 \times T_L$		$2 \times T_S$ $+ 2 \times T_I$ $+ 2 \times T_{Com} (3 \times T_{Com})$ $+ 2 \times T_L$
T_OutConn_wc	$2 \times T_L$ $+ T_{WD_Out}$		$2 \times T_L$ $+ T_{WD_Out}$ $+ 2 \times T_A$
	$= T_{SFR_wc} (Out)$		$= T_{SFR_wc} (Out)$

Calculation of the maximum response time in case of communication interruption for the entire system

	Max. response time without SBC		Max. response time with SBC
T_SFR_wc	$= \max \{T_{SFR_wc} (In); T_{SFR_wc} (Out)\}$		$= \max \{T_{SFR_wc} (In); T_{SFR_wc} (Out)\}$

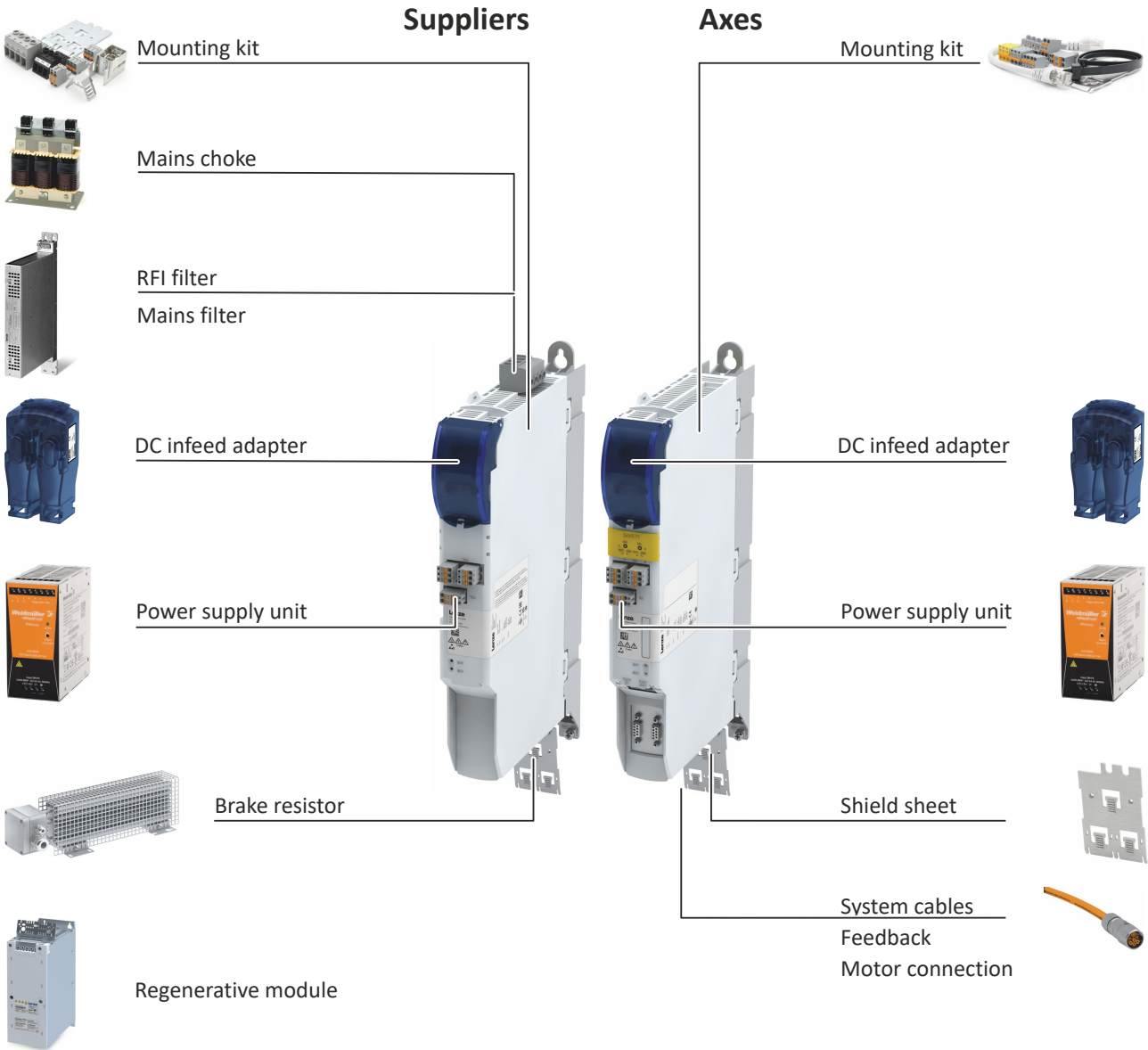


Accessories

Overview

For the i750 servo inverter, the following accessories are available:

- ▶ Components for operation in the DC-bus group [208](#)
- ▶ Brake resistors [209](#)
- ▶ Mains chokes [210](#)
- ▶ RFI filters / Mains filters [211](#)
- ▶ Regenerative modules [212](#)
- ▶ Power supply units [213](#)
- ▶ Mounting [214](#)(mounting kits, shield fixings, multipoint connectors)
- ▶ System cables [218](#)



Accessories

Components for operation in the DC-bus group
DC infeed adapters



Components for operation in the DC-bus group

DC infeed adapters

DC infeed adapter i700 E70AZEVE001

The "DC infeed adapter i700" enables the touch-safe connection of one or two single cores with ring cable lugs to the DC busbar system.

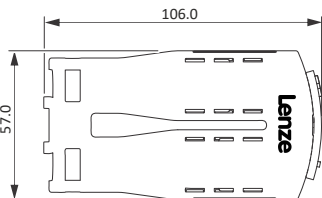
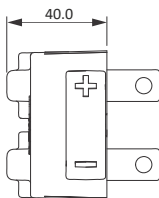
Mounting is possible on the left or right side of the suppliers and axes.



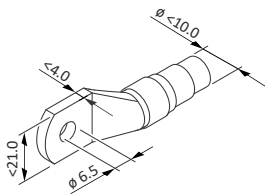
Application areas

- Distributing the installation over several rows, groups or control cabinets
- Connecting the regenerative power supply module of the "Servo Drives 9400" device series
- Connection of other wired components to the busbar system

Dimensions



E70AZEVE001



Ring cable lugs, single cores

All dimensions in mm

DC power supply adapter i700			
Order code			E70AZEVE001
Connection description			Touch-proof connection of single cores to the DC busbar system
Max. ampacity		A	120
Connection type			Screw M6
Max. cable cross-section			
Single core		mm ²	35
Single core		AWG	2
2 single cores		mm ²	25
2 single cores		AWG	4
Tightening torque		Nm	5
Tightening torque		lb-in	44.3
Required tool			Crosstip screwdriver PH3



Brake resistors

- To decelerate greater moments of inertia or with a longer operation in generator mode an external brake resistor is required.
- The brake resistor absorbs the produced brake energy and converts it into heat.



Assignment of these accessories to the devices depends on the mains connection:

► [Technical data](#) 91

Here you can also find the order codes.

Accessories

Mains chokes



Mains chokes

- Mains chokes reduce the feedback effects of the inverter on the supplying mains by their high inductive resistance reducing high-frequency interference.
- The effective mains current is reduced which saves energy.
- Mains chokes can be used without restrictions in conjunction with RFI filters.
- Please note that the use of a mains choke reduces the mains voltage at the input of the inverter by 4 % (typical voltage drop across the mains choke in the rated point).



Assignment of these accessories to the devices depends on the mains connection:

► [Technical data](#)  91

Here you can also find the order codes.



RFI filters / Mains filters

RFI and mains filters are used to ensure compliance with the EMC requirements of EN IEC 61800-3. This standard defines the EMC requirements for electrical drive system in various categories.

- RFI filters are capacitive accessory components. RFI filters reduce conducted noise emissions. RFI filters are also called EMC filters.
- Mains filters are a combination of mains choke and RFI filter. Mains filters reduce the conducted noise emission.

Definition of the environments

(EN IEC 61800-3)

First environment

The first environment comprises residential buildings or locations that are directly connected to a low-voltage system for supplying residential areas.

Second environment

The second environment comprises facilities or locations that are not directly connected to a low-voltage system for supplying residential areas.

Category C1

Category C1 defines the requirements for drive systems that are intended for the use in the first environment at a rated voltage lower than 1000 V.

The limit values of the EN IEC 61800-3 comply with EN 55011 class B.

Category C2

Category C2 defines the requirements for permanently installed fixed drive systems that are intended for the use in the first environment at a rated voltage lower than 1000 V. Installation and commissioning may only be carried out by specialist personnel with EMC knowledge.

The limit values of the EN IEC 61800-3 comply with EN 55011 class A group 1.

Category C3

Category C3 defines the requirements for drive systems that are exclusively intended for the use in the second environment at a rated voltage lower than 1000 V.

The limit values of the EN IEC 61800-3 comply with EN 55011 class A group 2.



Assignment of these accessories to the devices depends on the mains connection:

► [Technical data](#) 91

Here you can also find the order codes.



Regenerative modules

For feeding energy from the DC bus of a drive system back into a 3-phase AC system



r750 regenerative module

Device features:

- Self-synchronizing with the AC system
- Automatic operation
 - Self-optimizing
 - Self-parameterizing
 - No parameterization of operating conditions required
- Scaling of the regenerative power by parallel operation of further regenerative modules of this series
- Controlling power peaks by parallel operation of a brake chopper is possible
- High peak regenerative power
- High efficiency
- Operation without external filters possible
- Polarity reversal protection of the device is integrated in the DC-bus connection.
- Operation without external supply voltage
 - Direct supply from the DC bus or from the AC system
- Measured value via the regenerated energy



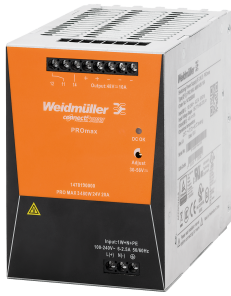
Further information can be found in the mounting and switch-on instructions for the r750 regenerative module.



Power supply units

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

The parameterization and diagnostics can be executed when the mains input at the inverter is deenergized.



Type designation			EZVA024				
			005BB000000	010BB000000	005FB000000	010FB000000	020FB000000
Mains connection		V	1 AC 230/240		2 oder 3 AC 400/480		
Netzspannungsbereich		V	85 ... 277		360 ... 575		
Rated current		A	1	1.5	0.3	0.4	0.85
Rated output voltage		V	24				
Ausgangsspannungsbereich		V	22.5 ... 29.5				
Rated output current		A	5	10	5	10	20
Degree of protection			IP20				
Abmessungen (H x B x T)		mm	130 x 40 x 125	130 x 60 x 125	130 x 40 x 125	130 x 60 x 125	130 x 70 x 150
Weight		kg	0.86	1.05	0.78	1.32	1.6



Mounting

Mounting kits

Please note the following:

- Suppliers are delivered without mounting kit. The mounting kit must always be ordered separately.
- Axes can be ordered with or without mounting kit. [► Order details](#)  221

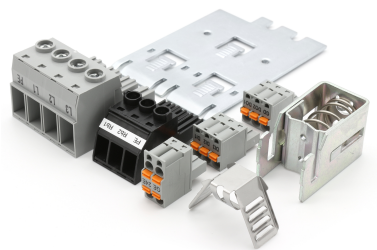


The individual parts of the mounting kits are also available as multiple packages.
E.g. for service purposes or for the separate production of cable harnesses.

[► Multipoint connectors](#)  217

[► Shield mounting kit](#)  216

Supplier



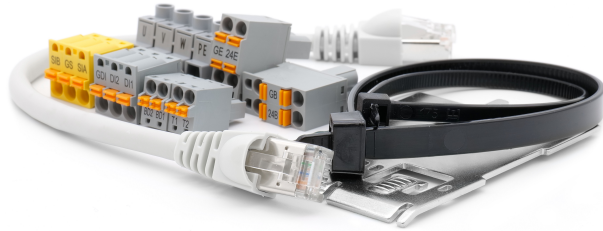
Supplier		Mounting kit			
	Output current				
	A DC	Contents	Piece	Order code	
i700-CV30/400-3	30	Terminal set	1	E70AZEVK005	
		Shield sheet 50 mm wide for the brake resistor cable	1		
		Fixing clip for cable diameter 6 ... 9 mm for shield connection	1		
		Wire clamp for cable diameter 4 ... 15 mm for shield connection	1		
i700-CV60/400-3	60	Terminal set	1	E70AZEVK006	
		Shield sheet 100 mm wide for the brake resistor cable	1		
		Fixing clip for cable diameter 6 ... 9 mm for shield connection	1		
		Wire clamp for cable diameter 10 ... 20 mm for shield connection	1		
Additional kit for parallel connection of suppliers					
		Swivel hooks for DC bus and PE connection	3	E70AZEVK007	



Accessories

- Mounting
- Mounting kits

Axes



Axes		Mounting kit			
	Output power		Contents	Piece	Order code
	kW	HP			
Single axes					
i750-C1.1/400-3 i750-C2.2/400-3 i750-C4/400-3	1.1 2.2 4	1.5 3 5	Terminal set	1	E75AZEVK001
			EtherCAT cable 100 mm for connection to the next axis	1	
			Shield sheet 50 mm wide for the motor cable	1	
			Cable tie 4.8 x 200 mm for shield connection	1	
			Cable tie 7.6 x 200 mm for shield connection	1	
i750-C7.5/400-3 i750-C11/400-3 i750-C15/400-3	7.5 11 15	10 15 20	Terminal set	1	E75AZEVK003
			EtherCAT cable 100 mm for connection to the next axis	1	
			Shield sheet 100 mm wide for the motor cable	1	
			Cable tie 4.8 x 200 mm for shield connection	1	
			Cable tie 7.6 x 200 mm for shield connection	1	
i750-C22/400-3 i750-C30/400-3	22 30	30 40	Terminal set	1	E75AZEVK005
			EtherCAT cable 250 mm for connection to the next axis	1	
			Shield sheet 104 mm wide for the motor cable	1	
			Cable tie 4.8 x 200 mm for shield connection	1	
			Cable tie 7.6 x 200 mm for shield connection	1	
Double axes					
i750-C1.1/400-3/2 i750-C2.2/400-3/2	2 x 1.1 2 x 2.2	2 x 1.5 2 x 3	Terminal set	1	E75AZEVK002
			EtherCAT cable 100 mm for connection to the next axis	1	
			Shield sheet 50 mm wide for the motor cable	1	
			Cable tie 4.8 x 200 mm for shield connection	2	
			Cable tie 7.6 x 200 mm for shield connection	2	
i750-C4/400-3/2 i750-C7.5/400-3/2	2 x 4 2 x 7.5	2 x 5 2 x 10	Terminal set	1	E75AZEVK004
			EtherCAT cable 100 mm for connection to the next axis	1	
			Shield sheet 100 mm wide for the motor cable	1	
			Cable tie 4.8 x 200 mm for shield connection	2	
			Cable tie 7.6 x 200 mm for shield connection	2	



Shield mounting kit

Shield sheets, fixing clips, and wire clamps in multiple packaging are available for shield attachment.

Supplier

Supplier		Shield mounting			
	Output current	Multiple packaging			
	A DC	Contents	Piece	Order code	
i700-CV30/400-3	30	Shield sheet 50 mm wide for the brake resistor cable	25	EZAMBHXM008/M	
		Fixing clip for cable diameter 6 ... 9 mm for shield connection	20	EZAMBHXM007/M	
		Wire clamp for cable diameter 4 ... 15 mm for shield connection	10	EZAMBHXM006/M	
i700-CV60/400-3	60	Shield sheet 100 mm wide for the brake resistor cable	25	EZAMBHXM009/M	
		Fixing clip for cable diameter 6 ... 9 mm for shield connection	20	EZAMBHXM007/M	
		Wire clamp for cable diameter 10 ... 20 mm for shield connection	10	EZAMBHXM003/M	

Axes

Axes			Shield mounting				
	Output power		Multiple packaging			Piece	Order code
	kW	HP	Contents				
Single axes							
i750-C1.1/400-3	1.1	1.5	Shield plate 48 mm wide for the motor cable		25	EZAMBHXM008/M	
i750-C2.2/400-3	2.2	3	Fixing clip for cable diameter 6 ... 9 mm for shield connection		20	EZAMBHXM007/M	
i750-C4/400-3	4	5	Wire clamp for cable diameter 4 ... 15 mm for shield connection		10	EZAMBHXM006/M	
i750-C7.5/400-3	7.5	10	Shield plate 60 mm wide for the motor cable		25	EZAMBHXM009/M	
i750-C11/400-3	11	15	Fixing clip for cable diameter 6 ... 9 mm for shield connection		20	EZAMBHXM007/M	
i750-C15/400-3	15	20	Wire clamp for cable diameter 10 ... 20 mm for shield connection		10	EZAMBHXM003/M	
Double axes							
i750-C1.1/400-3/2 i750-C2.2/400-3/2	2 x 1.1	2 x 1.5	Shield plate 48 mm wide for the motor cable		25	EZAMBHXM008/M	
	2 x 2.2	2 x 3	Fixing clip for cable diameter 6 ... 9 mm for shield connection		20	EZAMBHXM007/M	
			Wire clamp for cable diameter 4 ... 15 mm for shield connection		10	EZAMBHXM006/M	
i750-C4/400-3/2 i750-C7.5/400-3/2	2 x 4	2 x 5	Shield plate 60 mm wide for the motor cable		25	EZAMBHXM009/M	
	2 x 7.5	2 x 10	Fixing clip for cable diameter 6 ... 9 mm for shield connection		20	EZAMBHXM007/M	
			Wire clamp for cable diameter 10 ... 20 mm for shield connection		10	EZAMBHXM003/M	



Multipoint connectors

Some connections are equipped with pluggable multipoint connectors. Pluggable multipoint connectors are available individually, e.g. for service purposes or for the separate production of cable harnesses.

Supplier

Supplier		Multipoint connectors		
	Output current	Multiple packaging		
	A DC	Contents	Piece	Order code
i700-CV30/400-3 i700-CV60/400-3	30 60	X21 (24E, GE) - external 24 V supply connection	50	EZAEVE003/M
		X100 (L1, L2, L3, PE) - mains connection	50	EZAEVE008/M
		X20.1 (DI1, DI2, DI3) - digital inputs	50	EZAEVE009/M
		X20.2 (DO1, DO2, GD) - digital outputs	50	EZAEVE010/M
		X103 - (Rb1, Rb2, PE) - brake resistor connection	50	EZAEVE011/M

Axes

Axes			Terminal strips		
	Output power		Multiple packaging		
	kW	HP	Contents	Piece	Order code
Single axes					
i750-C1.1/400-3 i750-C2.2/400-3 i750-C4/400-3	1.1 2.2 4	1.5 3 5	X1 (SIA, SIB, GS) - Basic Safety - STO connection	50	EZAEVE048/M
			X3 (DI1, DI2, GD) - digital inputs	50	EZAEVE049/M
			X5 (24E, GE) - external 24 V supply connection	50	EZAEVE003/M
			X106 (BD1, BD2) - motor holding brake connection	50	EZAEVE051/M
			X107 (24B, GB) - 24 V supply connection for motor holding brake	50	EZAEVE050/M
			X109 (T1, T2) - HIPERFACE DSL® (OCT)/PTC connection	50	EZAEVE052/M
			X105 (U, V, W, PE) - motor connection (max. 2.5 mm²)	50	EZAEVE005/M
i750-C7.5/400-3 i750-C11/400-3 i750-C15/400-3	7.5 11 15	10 15 20	X1 (SIA, SIB, GS) - Basic Safety - STO connection	50	EZAEVE048/M
			X3 (DI1, DI2, GD) - digital inputs	50	EZAEVE049/M
			X5 (24E, GE) - external 24 V supply connection	50	EZAEVE003/M
			X106 (BD1, BD2) - motor holding brake connection	50	EZAEVE051/M
			X107 (24B, GB) - 24 V supply connection for motor holding brake	50	EZAEVE050/M
			X109 (T1, T2) - HIPERFACE DSL® (OCT)/PTC connection	50	EZAEVE052/M
			X105 (U, V, W, PE) - motor connection (max. 6 mm²)	25	EZAEVE006/M
i750-C22/400-3 i750-C30/400-3	22 30	30 40	X1 (SIA, SIB, GS) - Basic Safety - STO connection	50	EZAEVE048/M
			X3 (DI1, DI2, GD) - digital inputs	50	EZAEVE049/M
			X5 (24E, GE) - external 24 V supply connection	50	EZAEVE003/M
			X107 (24B, GB) - 24 V supply connection for motor holding brake	50	EZAEVE050/M
			X109 (T1, T2) - HIPERFACE DSL® (OCT)/PTC connection	50	EZAEVE052/M
Double axes					
i750-C1.1/400-3/2 i750-C2.2/400-3/2 i750-C4/400-3/2 i750-C7.5/400-3/2	2 x 1.1 2 x 2.2 2 x 4 2 x 7.5	2 x 1.5 2 x 3 2 x 5 2 x 10	X1 (SIA, SIB, GS) - Basic Safety - STO connection	50	EZAEVE048/M
			X3 (DI1, DI2, GD) - digital inputs	50	EZAEVE049/M
			X5 (24E, GE) - external 24 V supply connection	50	EZAEVE003/M
			X106 (BD1, BD2) - motor holding brake connection	50	EZAEVE051/M
			X107 (24B, GB) - 24 V supply connection for motor holding brake	50	EZAEVE050/M
			X109 (T1, T2) - HIPERFACE DSL® (OCT)/PTC connection	50	EZAEVE052/M
			X105 (U, V, W, PE) - motor connection (max. 2.5 mm²)	50	EZAEVE005/M



System cables

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

The One Cable Technology (OCT) is possible with MCS and m850 servo motors. You need a special hybrid cable for this:

Order code	Length	Description			
EYP0080A0020M13A00	2 m	Motor end M23 connector 3 power wires, 1 PE Cable cross-section 1.5 mm ²	1 pair of control wires for controlling the motor holding brake Cable cross-section 0.75 mm ²	1 pair of control wires for transferring the Hiperface DSL® protocol Cable cross-section 0.32 mm ²	
EYP0080A0035M13A00	3.5 m				
EYP0080A0050M13A00	5 m				
EYP0080A0075M13A00	7.5 m				
EYP0080A0100M13A00	10 m				
EYP0080A0150M13A00	15 m				
EYP0080A0200M13A00	20 m				
EYP0080A0500M13A00	50 m				
EYP0080A1000M13A00	100 m				
EYP0081A0020M13A00	2 m	Motor end M23 connector 3 power wires, 1 PE Cable cross-section 2.5 mm ²	1 pair of control wires for controlling the motor holding brake Cable cross-section 1 mm ²		
EYP0081A0035M13A00	3.5 m				
EYP0081A0050M13A00	5 m				
EYP0081A0075M13A00	7.5 m				
EYP0081A0100M13A00	10 m				
EYP0081A0150M13A00	15 m				
EYP0081A0200M13A00	20 m				
EYP0081A0500M13A00	50 m				
EYP0081A1000M13A00	100 m				
EYP0085A0020M12A00	2 m	Motor end M40 connector 3 power wires, 1 PE Cable cross-section 4 mm ²			
EYP0085A0035M12A00	3.5 m				
EYP0085A0050M12A00	5 m				
EYP0085A0075M12A00	7.5 m				
EYP0085A0100M12A00	10 m				
EYP0085A0150M12A00	15 m				
EYP0085A0200M12A00	20 m				
EYP0085A0500M12A00	50 m				
EYP0085A1000M12A00	100 m				
EYP0086A0020M12A00	2 m	Motor end M40 connector 3 power wires, 1 PE Cable cross-section 6 mm ²			
EYP0086A0035M12A00	3.5 m				
EYP0086A0050M12A00	5 m				
EYP0086A0075M12A00	7.5 m				
EYP0086A0100M12A00	10 m				
EYP0086A0150M12A00	15 m				
EYP0086A0200M12A00	20 m				
EYP0086A0500M12A00	50 m				
EYP0086A1000M12A00	100 m				



Information on further motor cables is provided in the "System cables and system connectors" manual (→ [Download](#)).

More information about the One Cable Technology (OCT):

▶ [HIPERFACE DSL® encoder \(OCT\)](#)  83



EtherCAT cable for connection to the next axis

Axes			EtherCAT cable		
	Output power		Multiple packaging		
	kW	HP	Contents	Piece	Order code
Single axes					
i750-C1.1/400-3	1.1	1.5	EtherCAT cable 100 mm for connection to the next axis	10	EYC0000A0000X001/M
i750-C2.2/400-3	2.2	3			
i750-C4/400-3	4	5			
i750-C7.5/400-3	7.5	10			
i750-C11/400-3	11	15			
i750-C15/400-3	15	20			
Double axes					
i750-C1.1/400-3/2	2 x 1.1	2 x 1.5	EtherCAT cable 100 mm for connection to the next axis	10	EYC0000A0000X001/M
i750-C2.2/400-3/2	2 x 2.2	2 x 3			
i750-C4/400-3/2	2 x 4	2 x 5			
i750-C7.5/400-3/2	2 x 7.5	2 x 10			



Purchase order

Notes on ordering

»EASY Product Finder«

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

The link and the QR code lead directly to the "EASY Product Finder": [EASY Product Finder](#)





Order details

The following is a list of the information required to place the order.

Supplier - assignment of product name and order code

When listing the technical data of the various variants, the easily legible product name is used.
The product name contains the rated output current in A, the mains voltage class and the number of phases. This information results in the first 12 characters of the order code:
The other positions of the order code indicate options and design variants. The following table shows the structure of the complete order code.

Mains connection	DC rated output current	Product name	Type designation
V	A		
3 AC 230/400/480	30	i700-CV30/400-3	E70ACPSE0304
	60	i700-CV60/400-3	E70ACPSE0604

Supplier - complete order code

		E	7	0	A	C	P	S	E	□□□	4	□
Product type	Electronics	E										
Product family	i700		7									
Product	i700			0								
Product generation	Generation A				A							
Mounting type	Control cabinet mounting					C						
Design	Supplier						P					
Control code								S				
									E			
Rated output current	30 A DC									030		
	60 A DC									060		
Mains voltage	3/PE AC 230 V 3/PE AC 400 V 3/PE AC 480 V										4	
Degree of protection	IP20											S
	IP20, coated											V

Supplier - order example

Description of the component	Order code
Supplier	E70ACPSE 030 4 V
Rated output current 30 A DC (i700-CV30/400-3)	
3-phase mains connection 400 V	
Protection class IP20, coated	
Mounting kit for supplier 30 A	E70AZEVK005



The mounting kit must always be ordered separately.

▶ [Mounting kits](#) 214

Axes - assignment of product name and order code

When listing the technical data of the various variants, the easily legible product name is used.
The product name contains the power in kW, mains voltage class and the number of phases.
This information results in the first 10 characters of the order code:
The other positions of the order code indicate options and design variants. The following table shows the structure of the complete order code.



Output voltage	Leistung		Product name	Type designation
	kW	hp		
3x400V 3x480V 3x230/240V	1.1	1.5	i750-C1.1/400-3	I75AE211F1
	2.2	3	i750-C2.2/400-3	I75AE222F1
3x480V 3x400V 3x230/240V	4	5	i750-C4/400-3	I75AE240F1
3x230/240V 3x400V 3x480V	7.5	10	i750-C7.5/400-3	I75AE275F1
3x480V 3x230/240V 3x400V	11	15	i750-C11/400-3	I75AE311F1
3x400V 3x480V 3x230/240V	15	20	i750-C15/400-3	I75AE315F1
3x480V 3x230/240V 3x400V	22	30	i750-C22/400-3	I75AE322F1
3x400V 3x230/240V 3x480V	30	40	i750-C30/400-3	I75AE330F1

Output voltage	Leistung		Product name	Type designation
	kW	hp		
3x480V 3x230/240V 3x400V	1.1	1.5	i750-C1.1/400-3/2	I75AE211F2
3x230/240V 3x400V 3x480V	2.2	3	i750-C2.2/400-3/2	I75AE222F2
3x480V 3x230/240V 3x400V	3	4	i750-C3/400-3/2	I75AE230F2
3x480V 3x400V 3x230/240V	4	5	i750-C4/400-3/2	I75AE240F2
	7.5	10	i750-C7.5/400-3/2	I75AE275F2



Axes - complete order code

		I	7	5	A	E				F			V	0	0			S
Product type	Inverter	I																
Product family	i700		7															
Product	i750			5														
Product generation	Generation A				A													
Mounting type	Control cabinet mounting					E												
Rated power (Examples)	1.1 kW								211									
	2.2 kW								222									
	7.5 kW								275									
Mains voltage	3/PE AC 230 V									F								
	3/PE AC 400 V																	
	3/PE AC 480 V																	
Motor connections	Single axis										1							
	Double axis										2							
Integrated functional safety	Basic Safety - STO											A						
	Advanced Safety											F						
	Extended Safety											B						
Degree of protection	IP20, coated												V					
Interference suppression	Without													0				
Design types	Dual Use														0			
	Scope of supply															0		
																K		
	Motor encoder Axis 1 and axis 2	Single axis															20	
																	30	
																	Q0	
		Double axis															22	
																	33	
																	QQ	
	Packaging																	S

Axes - order example

Description of the component	Order code
Double axis	i75A E 240 F 2 B V00K QQS
3-phase mains connection 400 V	
Power 2 x 4 kW (i750-C4/400-3/2)	
Design: Double axis	
Safety technology: Extended Safety	
Scope of supply: With mounting kit	
Feedback: HIPERFACE DSL® (OCT)	



The axes can also be ordered without mounting kit.

Mounting kits for separate order: [▶ Mounting kits](#)  214



Environmental notes and recycling

Lenze products are intended for use by companies in industrial environments. This means that they are also subject to requirements regarding recycling and disposal. Both mechanical and electrical components such as electric motors, gearboxes, and inverters contain valuable raw materials that can be recycled and reused. Proper recycling is important and sensible from both an economic and ecological perspective.

For information on the proper disposal and legal requirements of our products, please refer to the information on the respective product page on the Internet:

<https://www.lenze.com/en-de/products>

If you require support, please contact your local branch:

<https://www.lenze.com/en-de/company/global-presence>

Note: By disposing of devices and packaging properly, you are helping us to protect the environment and conserve resources.



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

<https://www.lenze.com/en-de/company/sustainability>



Appendix

Good to know

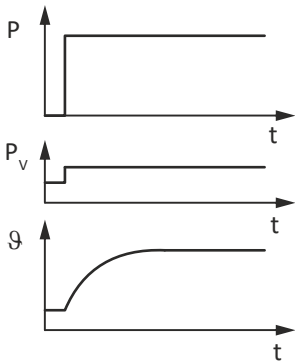
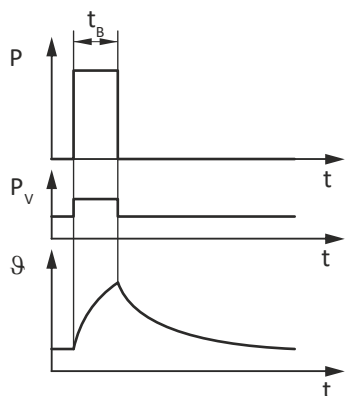
Operating modes of the motor

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

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

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

The most important operating modes

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 t Time t_L Idle time Θ Temperature	P_v Power loss t_B Load period t_S Cycle duration

Enclosures

The protection class indicates the suitability of a product for specific ambient conditions with regard to humidity as well as the protection against contact and the ingress of foreign particles. The protection classes are classified in the EN 60034-5/ EN IEC 60529.

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

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



Glossary

Definitions in functional safety

Abbreviation	Meaning
AIE	Acknowledge In Error, error acknowledgement
AIS	Acknowledge In Stop, restart acknowledgement
OFF state	Triggered signal status of the safety sensors
CCF	Common Cause Error (also β -value)
EC_FS	Error Class Fail Safe
EC_SS1	Error Class Safe Stop 1
EC_SS2	Error Class Safe Stop 2
EC_STO	Error Class Safe Torque Off Stop 0
ON state	Signal status of the safety sensors in normal operation
FIT	Failure In Time, 1 FIT = 10 ⁻⁹ Error/h
FMEA	Failure Mode and Effect Analysis
FSoE	FailSafe over EtherCAT
GSDML	Device description file with PROFINET-specific data to integrate the configuring software of a PROFINET controller.
HFT	Hardware Failure Tolerance
Cat.	Category according to EN ISO 13849-1
nBD	Speed value Base-Drive, internally determined actual speed from standard application
nSD	Safe-Drive speed value, internally determined actual speed from the safety application
n_safe	Actual speed determined from validation of nBD and nSD. Enters the further processing of the speed-dependent safety functions.
OSSD	Output Signal Switching Device, tested signal output
pBD	Base-Drive position value, internally determined actual position from standard application
pSD	Safe-Drive position value, internally determined actual position from the safety application
p_safe	Actual position determined from validation of pBD and pSD. Enters the further processing of the position-dependent safety functions.
PELV	Protective Extra Low Voltage
PL	Performance Level according to EN ISO 13849-1
PM	Plus-Minus – switched signal paths
PP	Plus-Plus – switched signal paths
PS	PROFIsafe
PWM	Pulse Width Modulation
SCS	Safe Creeping Speed
SD-In	Safe Digital Input
SD-Out	Safe Digital Output
SELV	Safety Extra Low Voltage
SFF	Safe Failure Fraction
SIL	Safety Integrity Level according to EN IEC 61508

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