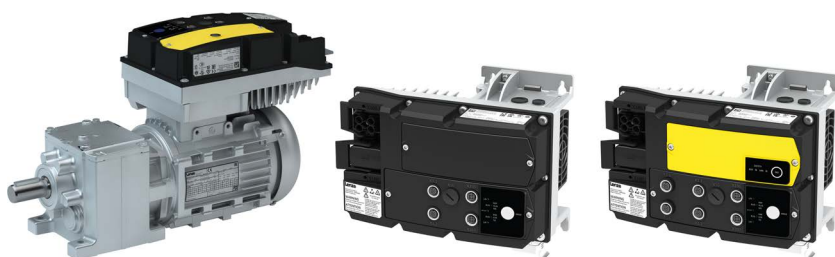


i550/i650 motec frequency inverters



0.37 ... 45 kW
0.5 ... 60 hp

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1 About this document

WARNING!

Read this documentation carefully before starting any work.

► Please observe the safety instructions!



1.1 Document description

This documentation is aimed primarily at the following target groups:

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

IEC 60364 and CENELEC HD 384 define the qualifications of these persons:

- They are familiar with installing, mounting, commissioning, and operating the product.
- They have the corresponding qualifications for their work.
- They know and can apply all regulations for the prevention of accidents, directives, and laws applicable at the place of use.

1.1.1 Change history

07/2026

- Additions: Cyber Security Information
- Additions: Option "Extended-I/O"
- Additions: Option "Extended Safety - ST" for the i650 motec
- Additions: PROFI-safe and FSoE safety buses
- Additions: Safety functions: Safe stop emergency (SSE), operation mode selector (OMS), enable switch (ES)
- Improvements and error corrections

11/2025

- Additions: High Fault Short Circuit Current Ratings (SCCR)

06/2025

- Improvements and error corrections

03/2025

- Additions: i650 motec product range
- Additions: Option "Extended Safety - S" for i650 motec

05/2024

- Improvements and error corrections

05/2023

- Additions: Reference to Standard EN 60204-1 in fusing data

04/2023

- Additions: i550 motec up to 45 kW
- Additions: Extension box

01/2023

- First released version for the i550 motec up to 5.5 kW



1.2 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.
Operating instructions	Basic information on installing and commissioning the product.
Commissioning manual	Detailed information on commissioning, configuration, and parameterization of the product.
Brochure "Accessories for VFDs and servo drives"	Product overviews, project planning information and selection tables for the following accessories: • Brake resistors • Brake switches • Mains chokes • RFI and mains filters • Sine filter • Electrical protection devices and busbars • Mounting • Operation and diagnostics • Power supply units • System cables
"Cybersecurity" manual	There is separate cybersecurity documentation for this product, which applies to this product and is an integral part of the information provided with the product.
"Logic PLC" manual	Additional documentation for the i650 motec with Logic PLC & table positioning
"Table positioning" manual	



Further documents on the product can be found on the Internet:

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

→ [i550 motec frequency inverter](#)

→ [i650 motec frequency inverter](#)

("Product support" section)

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



1.3 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



In this document, "i□□□" is used as a wildcard for the "i550" or "i650" product series.

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.



2 Product information

2.1 Product description

The i550/i650 motec frequency inverters for wall mounting and motor mounting in protection class IP66 (UL Type 4X indoor) are the ideal decentralized drive solution. The inverters can be extended for universal use with an extension box with disconnect switch with/without Type E combination motor controller and operating elements.

Fast mounting and easy commissioning thanks to user-friendly tools as well as connections for commercially available connectors are the focus of these inverters. Parameters, drive behavior and usability correspond to our proven frequency inverters. Rounded off by high energy efficiency, we thus offer a modern and sustainable drive solution.

The i650 motec frequency inverter stands out from the i550 motec due to its extended range of functions: For simple automation tasks, a logic PLC based on CODESYS in accordance with the IEC 61131-3 standard is integrated in the i650 motec. Table positioning is available for the realization of independent axes and machine modules. The "Extended Safety" option (Ethernet-based safety technology with various functions) rounds off the overall package.

The requirements of the Ecodesign Directive, standard EN IEC 61800-9-2, are met.

Application areas: Conveyor drives, traveling drives, winding drives, hoist drives, extruders, packaging machines, pumps, fans, ...

Overview			
Power range	0.37 ... 45 kW		
Mains connection	3/PE AC 230/240 V	3/PE AC 400 V	3/PE AC 480 V
Degree of protection	IP66 (UL type 4X indoor)		
Communication	CANopen, EtherCAT, EtherNet/IP, Modbus RTU, Modbus TCP, PROFINET		

Highlights

- Compact solution for decentralized drive technology, wall-mounted or motor-mounted, with a high degree of protection IP66 (UL Type 4X indoor)
- Wall-mounted expandable: Extension box with/without Type E combination motor controller and operating elements
- Fast mounting due to pluggable, standardized connections (plug & play)
- Four IO-Link ports with limited IO-Link master functionality for easy data exchange between IO-Link sensors and actuators
- Integrated regenerative module for very high energy efficiency - a brake resistor is no longer required
- Extended range of functions with the i650 motec:
 - Logic PLC
 - Table positioning
 - Ethernet-based safety technology with various functions

2.2 Features

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



Due to the high degree of protection of a shipped device, it is not possible to retrofit product options such as I/O extensions, network components, or safety components.

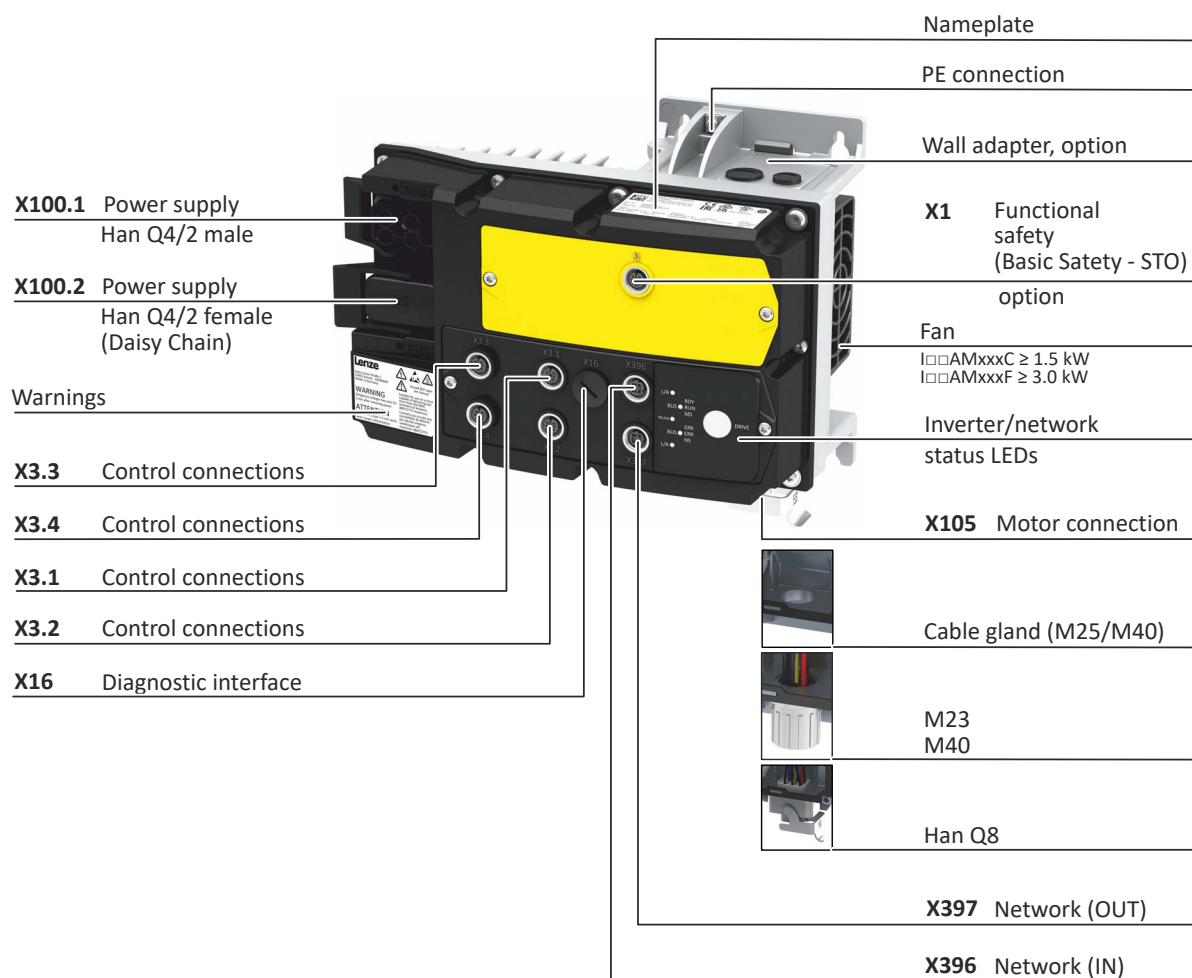


Fig. 1: Example for i550 motec with integrated safety technology "Basic Safety - STO"



Operating element 1 and potentiometer, option



Operating element 1 + 2, option

Communication cable M12

Disconnect switch

Warnings

X3.3 Control connections

X3.4 Control connections

X3.1 Control connections

X3.2 Control connections

X16 Diagnostic interface

Nameplate

PE connection

Wall adapter, option

X1 Functional safety (Basic Safety - STO) option

Fan

I□□AMxxx C ≥ 1.5 kW
I□□AMxxx F ≥ 3.0 kW

Inverter/network status LEDs

X105 Motor connection



Cable gland (M25/M40)



M23
M40



Han Q8

X397 Network (OUT)

X396 Network (IN)

Fig. 2: Example for i550 motec with integrated safety technology "Basic Safety - STO" and extension box with Type E combination motor controller and status feedback

Control element	Function
Disconnect switch, lockable	Mains voltage on/off
Operating element 1	Forward/Reverse/Stop
Operating element 2, lockable	Local control/network control
Potentiometer	Setpoint frequency

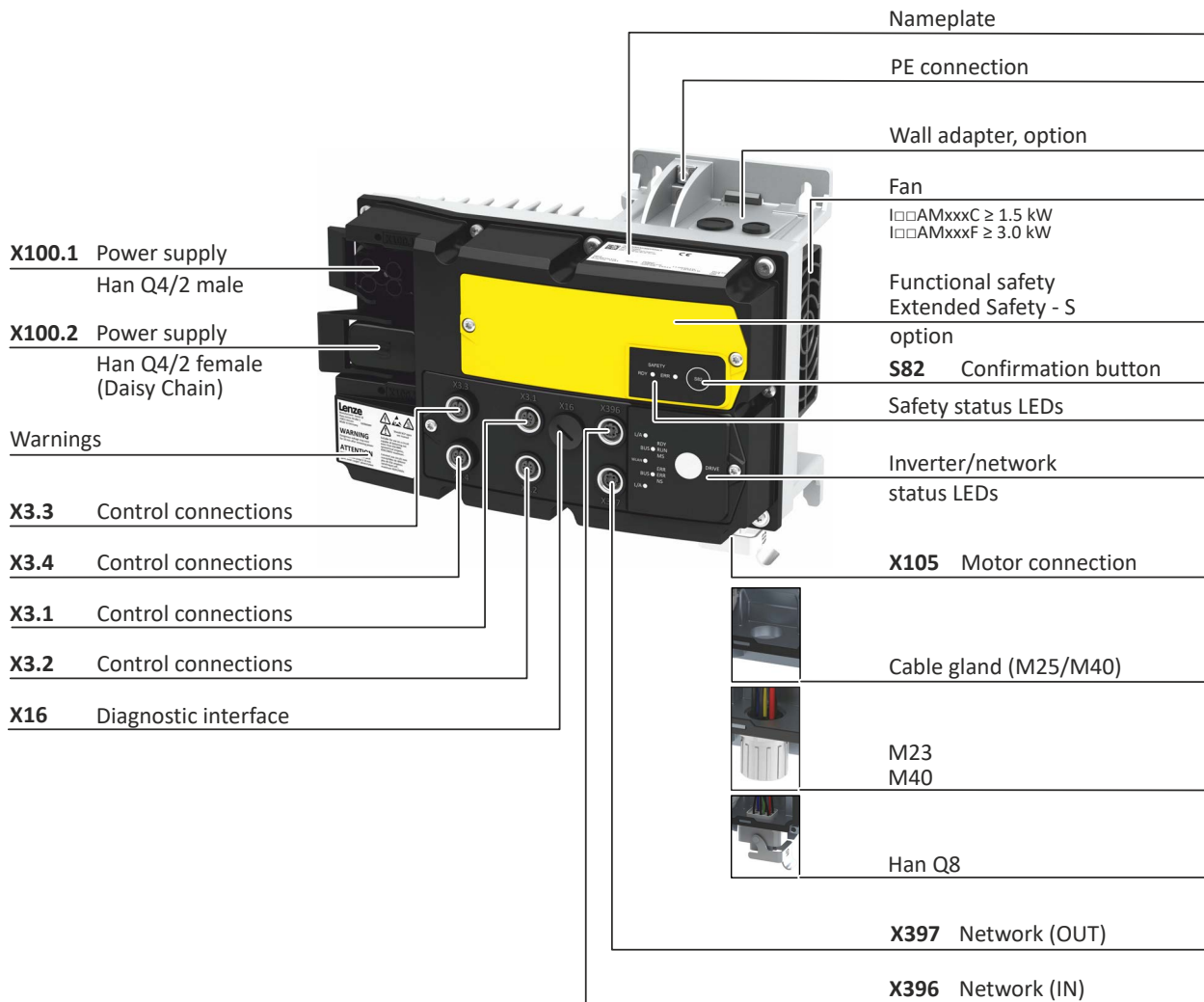


Fig. 3: Example of i650 motec with integrated functional safety "Extended Safety - S"

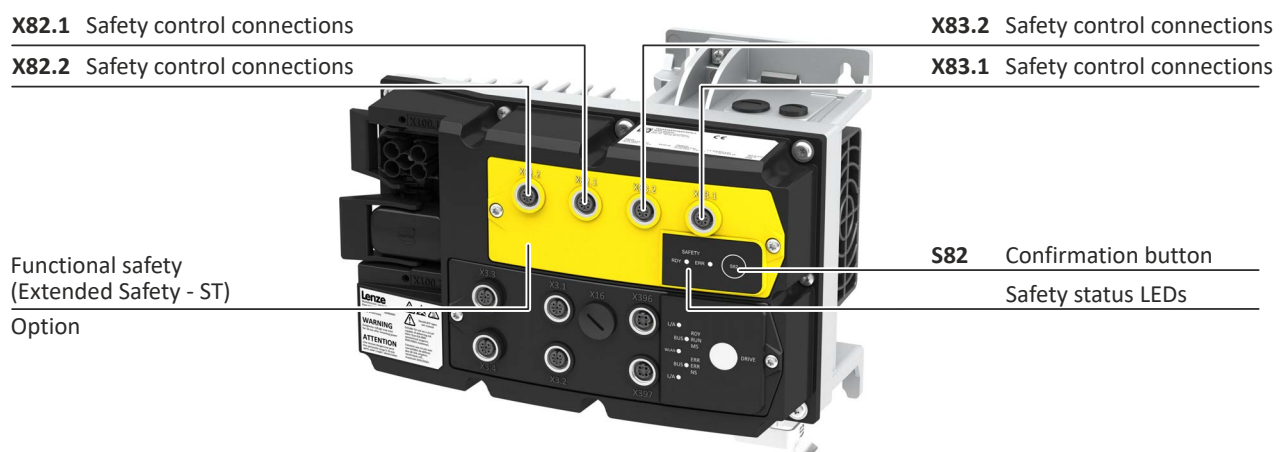


Fig. 4: Example of the i650 motec with integrated functional safety "Extended Safety - ST"



2.2.1 Connections and interfaces

The i550/i650 motec frequency inverters have these interfaces:

- DC input for mains-independent DC supply of the control electronics (incl. communication)
- Motor PTC input
- Motor holding brake
- Diagnostic interface (USB-C)

Communication and I/Os

The inverters are equipped **as standard** with one of the options listed in the following table.

- "Multi-Ethernet": With this option, you select the network required for your application (EtherCAT, EtherNet/IP, Modbus TCP, or PROFINET) when placing your order. The ordered network is then preset in the inverter. The inverter itself has the firmware for all four networks built in, and the user can switch the inverter to a different network.
- The inverter's control connections are designed as configurable M12 connectors.

Name	Network	Connection (network)	I/Os	Connection (I/Os)
Standard-I/O with Multi-Ethernet (i550 motec only)	Switchable: EtherCAT EtherNet/IP Modbus TCP PROFINET	2 x 4-pole M12 connector, D coded	2 x digital input or 1 x digital input/1 x digital output 2 x digital input	2 x 5-pole M12 connector, A coded
Application-I/O with Multi-Ethernet	Switchable: EtherCAT EtherNet/IP Modbus TCP PROFINET	2 x 4-pole M12 connector, D coded	1 x IO-Link port or 2 x digital input or 1 x digital input/1 x digital output 1 x IO-Link port or 2 x digital input or 1 x digital input/1 x digital output 1 x IO-Link port or 2 x digital input or 1 x digital input/1 x digital output 1 x IO-Link port or 2 x digital input or 1 x digital input/1 x digital output	4 x 5-pole M12 connector, A coded
Extended-I/O without network	Without	-	1 x analog input 1 x analog input or digital input 1 x analog output or temperature sensor 2 x digital input 1 x digital input or digital output 1 x digital input or digital output	4 x 5-pole M12 connector, A coded
Extended-I/O with Multi-Ethernet	Switchable: EtherCAT EtherNet/IP Modbus TCP PROFINET	2 x 4-pole M12 connector, D coded		
Extended-I/O with CANopen	CANopen	2 x 5-pole M12 connector, A coded		
Extended-I/O with Modbus RTU	Modbus RTU	2 x 5-pole M12 connector, A coded		

Functional safety

The inverters can be **optionally** equipped with integrated functional safety.

Name	Description	Connection
Basic Safety - STO	Functional safety function "Safe Torque Off (STO)" (STO corresponds to an uncontrolled standstill as defined in EN 60204-1, Category 0.)	1 x 5-pole M12 connector, A coded
Extended Safety - S (i650 motec only)	Safe stop functions: Safe torque off (STO), safe stop 1 (SS1), safe stop emergency (SSE) Auxiliary and maintenance functions: Operation mode selector (OMS), enable switch (ES), safe muting (MUT) Safety buses: PROFIsafe, FSoE and CIP Safety	-
Extended Safety - ST (i650 motec only)	Scope as "Extended Safety - S", plus I/Os: 2 x safe two-channel inputs (SIL 3/PL e) 1 x safe two-channel output (SIL 3/PL e) 2 x acknowledgment input (AIS + AIE)	4 x 5-pole M12 connector, A coded



For CIP Safety™, the "Extended Safety" version with **EtherNet/IP** is required.

CIP Safety™ is not supported if the inverter was ordered with PROFINET or EtherCAT.



2.2.2 Status LEDs

You can quickly obtain information on some operating states via the large "DRIVE" LED status display on the inverter. This status display is composed of a blue LED "RDY" and a red LED "ERR", which emit specific blinking patterns depending on the operating status:

"RDY" LED (blue)	"ERR" LED (red)	Status/meaning
off	off	No supply voltage
 on	 on	Initialisation (inverter is started)
 blinking (1 Hz)	off	Safe torque off (STO) active. The inverter has been disabled by the integrated functional safety. ▶ Safe torque off (STO)  194
	 blinking fast (4 Hz)	Safe torque off (STO) active, warning present. The inverter has been disabled by the integrated functional safety. ▶ Safe torque off (STO)  194
 blinking (2 Hz)	off	Inverter disabled
	 blinking fast (4 Hz)	Inverter disabled, warning present.
	 on	Inverter disabled, error active.
	 on briefly every 1.5 s	Inverter disabled, no DC-bus voltage.
 on	off	Inverter enabled. The motor rotates according to the specified setpoint or quick stop active.
	 blinking fast (4 Hz)	Inverter enabled, warning present. The motor rotates according to the specified setpoint or quick stop active.
	 blinking (1 Hz)	Inverter enabled, quick stop as response to fault active.
 Both LEDs are blinking in a rapidly alternating mode		Firmware update is 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  210.



2.2.3 Topologies / network

The inverters can be equipped with interfaces for various fieldbus networks. The topologies and protocols typical of each network are supported.

Multi-Ethernet

With this option, you select the network required for your application (EtherCAT, EtherNet/IP, Modbus TCP, or PROFINET) when placing your order. The ordered network is then preset in the inverter. The inverter itself has the firmware for all four networks built in, and the user can switch the inverter to a different network.

Available versions:

- Standard-I/O with Multi-Ethernet (available only for the i550 motec)
- Application-I/O with Multi-Ethernet
- Extended-I/O with Multi-Ethernet

	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
	EtherNet/IP™ (EtherNet Industrial Protocol) is an Ethernet-based fieldbus system that uses the Common Industrial Protocol™ (CIP™) for data exchange. EtherNet/IP™ and Common Industrial Protocol™ (CIP™) are trademarks and patented technologies licensed by the user organization ODVA (Open DeviceNet Vendor Association), Inc., USA. Device descriptions for the download: EDS files for Lenze devices
	The Modbus protocol is an open communication protocol based on a client/server architecture that was developed for communication with programmable logic controllers. Further development is carried out by the Modbus Organization, an international user organization based in the United States.
	PROFINET® (Process Field Network) is a real-time, Ethernet-based fieldbus system. PROFINET® is a registered trademark and patented technology licensed by the user organization PROFIBUS & PROFINET International (PI). Device descriptions for the download: GSDML files for Lenze devices

CANopen/Modbus RTU

Available versions:

- Extended-I/O with CANopen
- Extended-I/O with Modbus RTU

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



2.3 Functions

2.3.1 Overview

The functions of the frequency inverters i550/i650 motec are adapted to extensive applications.

Functions	
Motor control	Monitoring
V/f characteristic control linear/square-law (VFC plus)	Short circuit
V/f characteristic control (VFC closed loop)	Earth fault
Energy-saving function (VFC-Eco)	Device overload (ixt)
Sensorless vector control (SLVC)	Motor overload (i ² xt)
Sensorless control for synchronous motors (SL-PSM/SLSM-PSM) (up to 15 kW at 3 x 230/240 V and up to 30 kW at 3 x 400/480 V)	Mains phase failure
Servo control for asynchronous motors (SC-ASM)	Stalling protection
Motor functions	Motor current limit
Flying restart circuit	Maximum torque
Slip compensation	Ultimate motor current
DC braking	Motor speed
Oscillation damping	Load loss detection
Skip frequencies	Motor temperature
Automatic identification of the motor data	Diagnostics
Brake energy management	Error history buffer
Holding brake control	Logbook
"Voltage add" function	LED status displays
Rational Energy Ride Through (RERT)	Network
Speed feedback (HTL encoder)	EtherCAT
Frequency setpoint	EtherNet/IP
Application functions	Modbus TCP
Process controller	PROFINET
Access protection	Safety functions
Process controller sleep mode and rinse function	See chapter " Connections and interfaces ". 16
Freely assignable favorite menu	Additional functions
Parameter change-over	Logic PLC (i650 motec only)
S-shaped ramps for smooth acceleration	Table positioning (i650 motec only)
Motor potentiometer	
Flexible I/O configuration	
Automatic restart	
OEM parameter set	
Frequency output via digital output DO1	

2.3.2 Motor control types

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

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

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



2.3.3 Motor functions

2.3.3.1 Motor setting range

Rated point 120 Hz



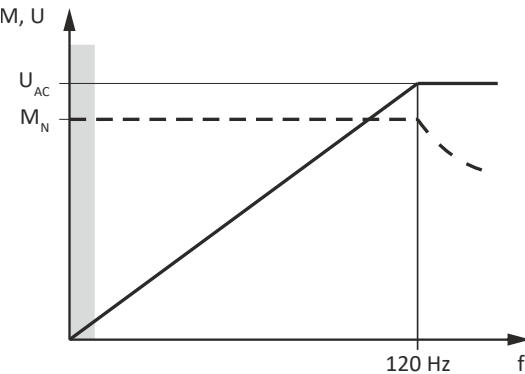
Only possible with Lenze IE5 m650-U three-phase AC motors and Lenze MF three-phase AC motors.

The rated motor torque is available up to 120 Hz.

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

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

V/f at 120 Hz



V Voltage
M Torque
f Frequency

V_{AC} Mains voltage
 M_N Rated torque



Rated point 87 Hz

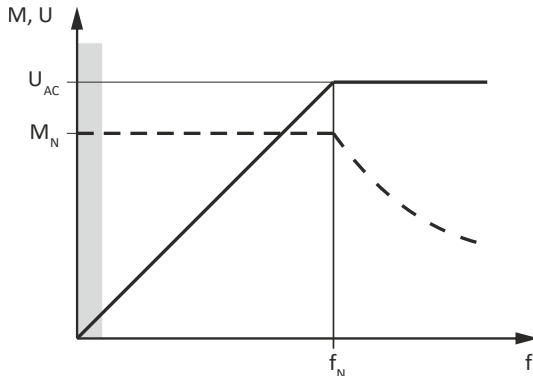
The rated motor torque is available up to 87 Hz.

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

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

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

V/f at 87 Hz

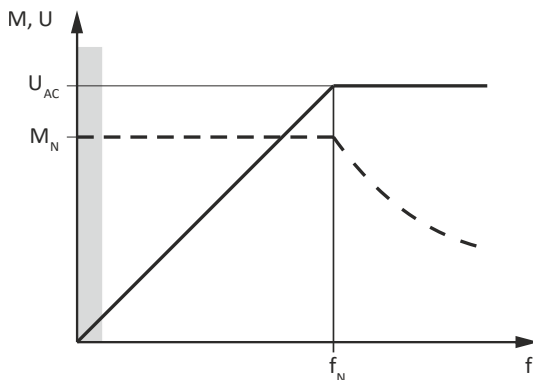


V	Voltage	U_{AC}	Mains voltage
M	Torque	M_{rated}	Rated torque
f	Frequency	f_{rated}	Rated frequency

Rated point 50 Hz

The rated motor torque is available up to 50 Hz.

V/f at 50 Hz



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



2.4 Identification of the products

Product name

The product name is used when listing the technical data for the various product variants and when assigning accessories. The assignment of product name to type code can be found in chapter "[Purchase order](#)". [220](#).

The product name contains:

- the name of the product series - "i□□□" as wildcard for "i550" or "i650"
- the version - "M" for "motec" = inverter for decentralized mounting locations/motor mounting
- the rated power in kW
- the mains voltage class - e.g. 230/240 V or 400 V
- the number of mains phases

Device series	Type	Rated power	Rated mains voltage	Product name
		kW		
i□□□	M	0.37	3 AC 230/240 V	i□□□-M0.37/230-3
		0.55		i□□□-M0.55/230-3
		0.75		i□□□-M0.75/230-3
		1.1		i□□□-M1.1/230-3
		1.5		i□□□-M1.5/230-3
		2.2		i□□□-M2.2/230-3
		3		i□□□-M3.0/230-3
		4		i□□□-M4.0/230-3
		5.5		i□□□-M5.5/230-3
		7.5		i□□□-M7.5/230-3
		11		i□□□-M11/230-3
		15		i□□□-M15/230-3
		18.5		i□□□-M18/230-3
		22		i□□□-M22/230-3

Device series	Type	Rated power	Rated mains voltage	Product name
		kW		
i□□□	M	0.37	3 AC 400/480 V	i□□□-M0.37/400-3
		0.55		i□□□-M0.55/400-3
		0.75		i□□□-M0.75/400-3
		1.1		i□□□-M1.1/400-3
		1.5		i□□□-M1.5/400-3
		2.2		i□□□-M2.2/400-3
		3		i□□□-M3.0/400-3
		4		i□□□-M4.0/400-3
		5.5		i□□□-M5.5/400-3
		7.5		i□□□-M7.5/400-3
		11		i□□□-M11/400-3
		15		i□□□-M15/400-3
		18.5		i□□□-M18/400-3
		22		i□□□-M22/400-3
		30		i□□□-M30/400-3
		37		i□□□-M37/400-3
		45		i□□□-M45/400-3



Type code structure

		I	□□	A	M	□□□	□	□	□	□	□	□	□	□	□	S
Product type	Inverters	I														
Product	i550		55													
	i650		65													
Product generation	Generation 1			A												
Mounting type	Motor and wall mounting				M											
Rated power	0.37 kW					137										
	0.55 kW					155										
	0.75 kW					175										
	1.1 kW					211										
	1.5 kW					215										
	2.2 kW					222										
	3 kW					230										
	4 kW					240										
	5.5 kW					255										
	7.5 kW					275										
	11 kW					311										
	15 kW					315										
	18.5 kW					318										
	22 kW					322										
	30 kW					330										
	37 kW					337										
	45 kW					345										
Mains voltage and connection type	3/PE AC 230/240 V										C					
	3/PE AC 400/480 V										F					
Extension box	Without extension box											0				
	Extension Box for inverters	with mains terminals										1				
		with disconnect switch										A				
		• 0.37 ... 5.5 kW (3/PE AC 230/240 V)										B				
		• 0.37 ... 11 kW (3/PE AC 400/480 V)										C				
		with disconnect switch with Type E combination motor controller										D				
		With disconnect switch with Type E combination motor controller and status feedback										E				
		with disconnect switch with status feedback and operating elements										F				
		with disconnect switch with status feedback, operating element and potentiometer														
Integrated functional safety	Without functional safety											0				
	Basic Safety - STO (BS-STO)											A				
	Extended Safety - ST (ES-IO) (available only for the i650 motec)											D				
	Extended Safety - S (ES) (available only for the i650 motec)											E				
Degree of protection	IP54, coated	UL Type 12/12K											B			
	(available only with extension box types C, D, E, and F)															
Degree of protection	IP66, coated	UL type 4X indoor											D			
Continuation ...																



Type code structure (continuation)

		I			A	M													S
Motor connection	Without adapter																		
	Wall adapter	with Han Q8																	
		with M23																	
		with M40																	
		with cable gland (M25)																	
		with cable gland (M40)																	
	Wall adapter inverters	with heatsink fan and Han Q8																	
		with heatsink fan and M23																	
		with heatsink fan and cable gland (M25)																	
	Motor adapter	for BG063 - BG071																	
		for BG080 - BG112																	
		for BG132																	
		for BG160 - BG180																	
Application area	Default parameter setting: Region EU (50 Hz networks)																		
	Default parameter setting: Region US (60 Hz networks)																		
Additional functions	Without additional functions																		
	Logic PLC & Table Positioning (available only for the i650 motec)																		
Control connections	Standard-I/O (available only for the i550 motec)																		
	Application-I/O																		
	Extended-I/O																		
Network	Without network																		
	CANopen (in preparation)																		
	Modbus RTU																		
	EtherCAT																		
	PROFINET																		
	EtherNet/IP																		
	Modbus TCP																		
Packaging	Packed individually																		S



2.5 Cyber security information

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

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



You can find the cybersecurity documentation online:

www.Lenze.com → Online Tools → Online Documentation → [Cybersecurity](#)

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



The cybersecurity documentation covers i550/i650 motec frequency inverters with firmware version ≥ V05.00.

From firmware version V05.00 onward, the i550/i650 motec frequency inverters are equipped with cybersecurity-related features and functions.

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

The client and the system operator are responsible for:

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

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



2.6 Information on EC-Dual-Use Regulation



By limiting the maximum output frequency to ± 599 Hz, the devices are not subject to the export restrictions of the EU Dual-Use Regulation 2021/821.



2.7 Ways of commissioning

The inverter can be commissioned quickly and easily via the "EASY Starter" engineering tool.

Thanks to Lenze's engineering philosophy, the high functionality is still easy to grasp.

Parameterization and commissioning are impressive thanks to clear structure and simple dialogs, leading to the desired outcome quickly and reliably.



The "PLC Designer" engineering tool is available for the i650 motec VFD with integrated Logic PLC. With "PLC Designer" (version 4.1 or later), you can program the Logic PLC according to the IEC 61131-3 standard.



All of the "EASY Starter" parameterization dialogs are also integrated into "PLC Designer," so commissioning can be performed using only "PLC Designer."

You will receive the download link for the latest version of the engineering tools free of charge by email after you have completed the download form:

<https://www.lenze.com/de-de/service/software-downloads/easy-engineering-tools>



Connect your engineering PC on which the software is installed to the diagnostic interface. This requires a USB cable with a USB-C plug.



3 Safety instructions

3.1 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!



3.2 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.

Use of explosion-protected motors

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



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



3.3 Foreseeable misuse

Inverters are not to be operated with DC motors.



3.4 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.

Protection in the event of short circuit or earth fault

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

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

Operation

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

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

All protection covers and doors must be shut during operation.

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



Safety functions

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

The user is not allowed to change inverters that come with integrated functional safety. In the event of a defect, the inverter must be replaced.

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.



3.5 Residual hazards

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

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

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

Product

Observe the warning labels on the product!



Dangerous electrical voltage:

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



Electrostatic sensitive devices:

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



High leakage current:

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



Hot surface:

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

Degree of protection - protection of persons and device protection

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

Protection of persons

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

- After the power is turned off, the power connections (X100, X105, X106, X110) will still carry dangerous electrical voltage for a certain period of time!

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

- Even when the motor is stopped, the power connections (X100, X105, X106, X110) may carry dangerous electrical voltage.

Device protection

- The maximum test voltage for insulation tests between the DC supply of the control electronics (including communication) and PE must not exceed 110 (EN 61800-5-1).

Motor protection

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

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

Protection of the machine/system

Drives can reach dangerous overspeeds.

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



Motor

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



4 Information on project planning

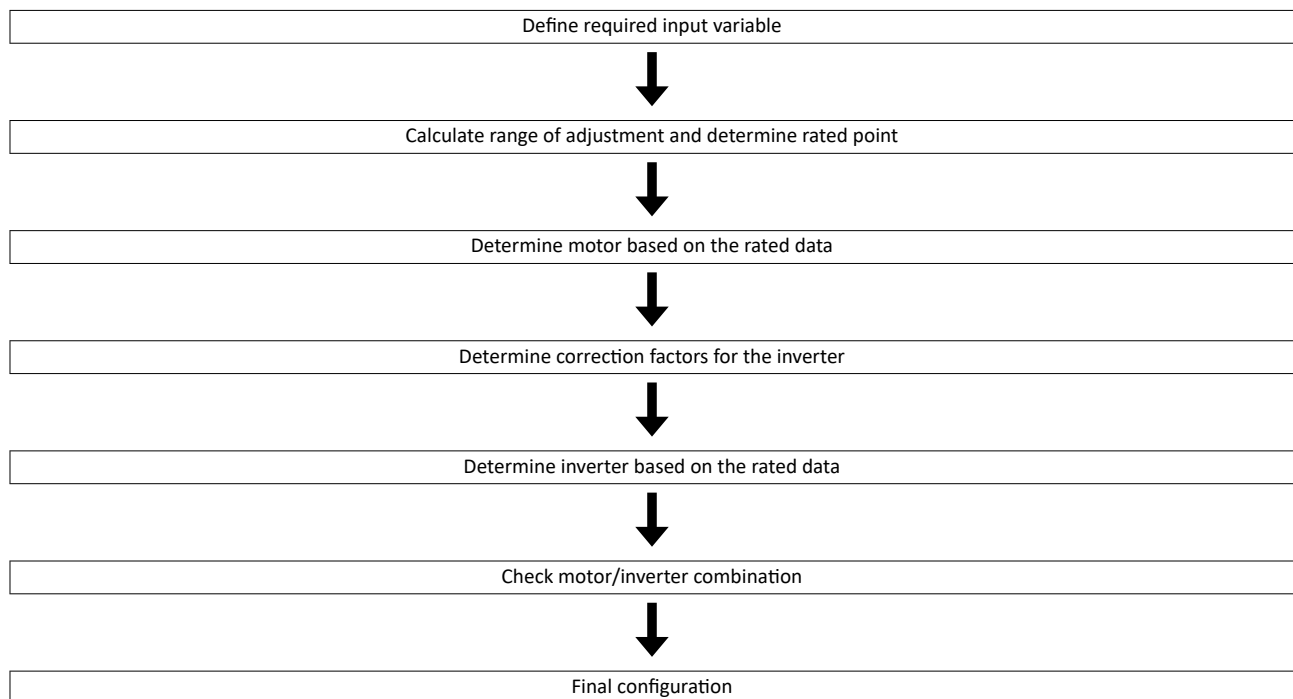
4.1 Project planning process

4.1.1 Dimensioning

Three methods for dimensioning

- **Fast:** Selection of the inverter based on the motor data of a 4-pole asynchronous motor.
- **Detailed:** In order to optimize the selection of the inverter and all drive components, it is worthwhile to execute the detailed system dimensioning based on the physical requirements of the application. For this purpose, Lenze provides the EASY System Designer (ESD) design program.
- **Manual:** The following chapter guides you step by step through the selection of a drive system.

Workflow of a configuration process



Define required input variables

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



Calculate range of adjustment and determine rated point

	Calculation	
Setting range	$V = \frac{n_{L,max}}{n_{L,min}}$	
	Setting range	Rated point
Motor with integral fan	≤ 2.50 (20 - 50 Hz)	50 Hz
	≤ 4.35 (20 - 87Hz)	87 Hz
	≤ 6 (20 - 120Hz)	120 Hz
Motor with blower	≤ 10.0 (5 - 50 Hz)	50 Hz
Motor with integral fan (reduced torque)	≤ 17.4 (5 - 87Hz)	87 Hz
	≤ 24 (5 - 120Hz)	120 Hz

Determine motor based on the rated data

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

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



Keep in mind when sizing the motor: The maximum possible output voltage of the inverter is approx. 87 % of the mains voltage.

Correction factors for the inverter

Site altitude amsl	H				
	[m]	≤ 1000	≤ 2000	≤ 3000	≤ 4000
$k_{H,INV}$		1.00	0.95	0.90	0.85
Ambient temperature	T_U				
	[°C]	≤ 40	≤ 45	≤ 50	≤ 60
Switching frequency					
8, 12 or 16 kHz	$k_{TU,INV}$	1.00	0.875	0.750	0.50

The ambient temperature correction factors do **not apply** to the inverters

- i□□□-M18/230-3,
 - i□□□-M22/230-3,
 - i□□□-M37/400-3 and
 - i□□□-M45/400-3
- to a switching frequency limit of 4 kHz at the same ambient temperature.



Determine the inverter based on the rated data

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

The information regarding overcurrent operation does **not apply** to the inverters

- i□□□-M18/230-3,
- i□□□-M22/230-3,
- i□□□-M37/400-3 and
- i□□□-M45/400-3
to reduced overcurrent operation.

Check motor/inverter combination

			Calculation
Motor torque	M	Nm	$M = \sqrt{\left(\frac{I_{out,INV}}{I_{N,MOT}}\right)^2 - (1 - \cos\varphi^2)} \times \frac{M_N}{\cos\varphi}$
			Check
Inverter overload capacity			$\frac{M_{L,max}}{M} \leq 1.5$

Final configuration

Product extensions and accessories can be found here:

- ▶ [Product extensions](#) 158
- ▶ [Accessories](#) 216



4.1.2 Operation in motor and generator mode

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

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

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

Integrated regenerative module

The inverter has a built-in regenerative module that feeds any braking energy generated by the application back into the power grid. Energy recovery is always enabled and does not require any user parameterization.

The inverter's integrated regenerative module offers significant advantages:

- Braking energy can be used despite decentralized topology.
- Dimensioning and installation of a brake resistor is not required.
- With a few exceptions (see table below), the specifications regarding the rated output current and overcurrent operation apply consistently to regenerative mode.
- Higher braking power is possible at no additional cost (compared to the design using a brake resistor).
- Additional application benefits include higher peak generator output, shorter braking times, and shorter successive braking cycles.
- Grid disturbances caused by harmonic currents are lower in motor and generator operation than in conventional drives.

The inverter can be operated on standard supply systems. See also the "Mains Connection" chapter, "Electrical supply conditions" section. [61](#)

The stricter requirements regarding grid disturbances for operation on public supply systems are met. See also the chapter "EMC Information." [86](#)

The short-circuit ratio (R_{SC}) is used to evaluate grid stability at the drive's installation site:

- Safe: > 100
- Requires individual assessment: 50 to 100
- Not recommended: < 50

The short-circuit ratio (R_{SC}) is determined, in simplified terms, as the ratio of the prospective short-circuit current between the external conductors (PSCC) at the inverter's connection point to the inverter's rated mains current:

$$\text{Short-circuit ratio } (R_{SC}) = \frac{\text{Prospective short-circuit current (PSCC)}}{\text{Rated mains current}}$$

The rated mains currents of the drives are listed in the "Technical Data" chapter:

- 3-phase mains connection, 230/240 V: [▶ Rated data 89](#)
- 3-phase mains connection, 400 V: [▶ Rated data 98](#)
- 3-phase mains connection, 480 V: [▶ Rated data 108](#)



- It is recommended to take application-specific operating points and concurrency factors into account during the operation of multiple inverters in order to determine the actual mains current.
- The short-circuit ratio (R_{SC}) is not the same as the short-circuit power ratio (R_{sce}).
- During motor operation, normal, brief interruptions or drops in the mains phases are not a problem. In generator operation, however, even brief interruptions or drops in the mains phases can cause the inverter to enter an error status. This deactivates the regenerative module and puts the motor into freewheel mode.



Example of determining the short-circuit ratio (R_{SC}):

1. Measure the prospective short-circuit current between the external conductors (PSCC) at the inverter's connection point using a suitable measuring device.
2. Determination of the rated mains current, taking into account the desired operating point (e.g., applications with a reduced rated output current depending on the switching frequency or partial-load operation).
3. Calculation of the short-circuit ratio (R_{SC}) and assessment of grid stability at the inverter's installation site.

In addition, the following factors should be taken into account during the design process:

- The use of passive filters or mains chokes at the mains input to reduce grid disturbances is not permitted.
- The load on a power transformer should not exceed 30% of the transformer's rated apparent power.
- The use of a UPS system to maintain the power supply in the event of a failure is not recommended.

Different specifications regarding the rated output current during operation in regenerative mode

Inverters		Rated output current during regenerative mode
3/PE AC 230/240 V	3/PE AC 400/480 V	
i□□□-M7.5/230-3	i□□□-M15/400-3	90%
i□□□-M15/230-3	i□□□-M30/400-3	80%
i□□□-M18/230-3	i□□□-M37/400-3	80%
i□□□-M22/230-3	i□□□-M45/400-3	75%



- Monitoring of device utilization (I_{xt}) triggers an error if the utilization value exceeds the 100% threshold.
- The maximum output currents corresponding to the switching frequencies and the overload behavior of the inverters are listed in the rated data.
- At rotating-field frequencies of < 10 Hz, the time-dependent overload behavior may be reduced.



4.1.3 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.

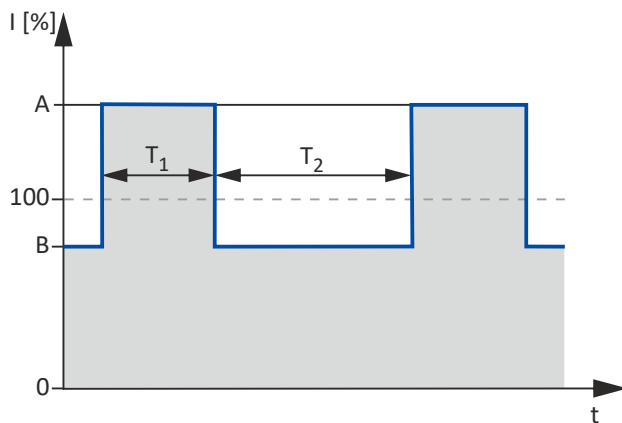
The monitoring of the device utilization (I_{xt}) triggers an error if the utilization value exceeds a threshold of 100 %.



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

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

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



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



For the inverters

- i□□□-M18/230-3,
- i□□□-M22/230-3,
- i□□□-M37/400-3 and
- i□□□-M45/400-3

the following cycles apply:

Cycle	Max. output current	Max. overload time	Max. output current during the recovery time	Min. recovery time
	A	T_1	B	T_2
s	%	s	%	s
15	166	3	62.5	12
180	125	60	62.5	120



4.2 Decentralized topologies

The frequency inverters i550/i650 motec support decentralized concepts for machines and electrical installation in particular.

Advantages

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

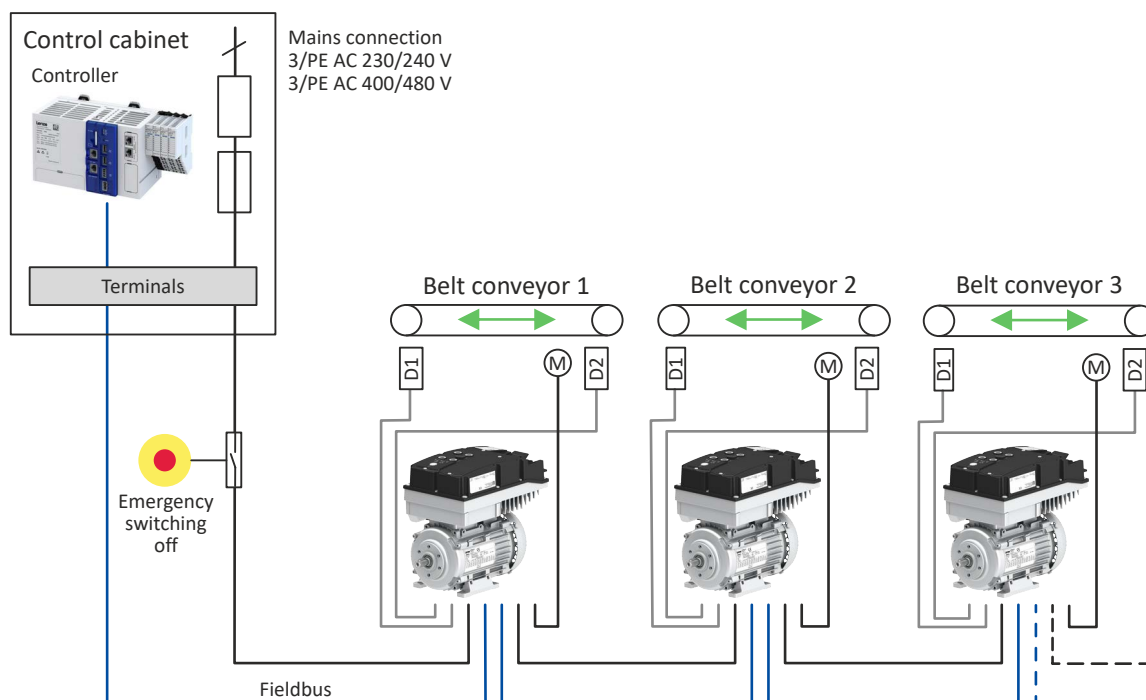


Fig. 5: Example setup



Extended by functional safety

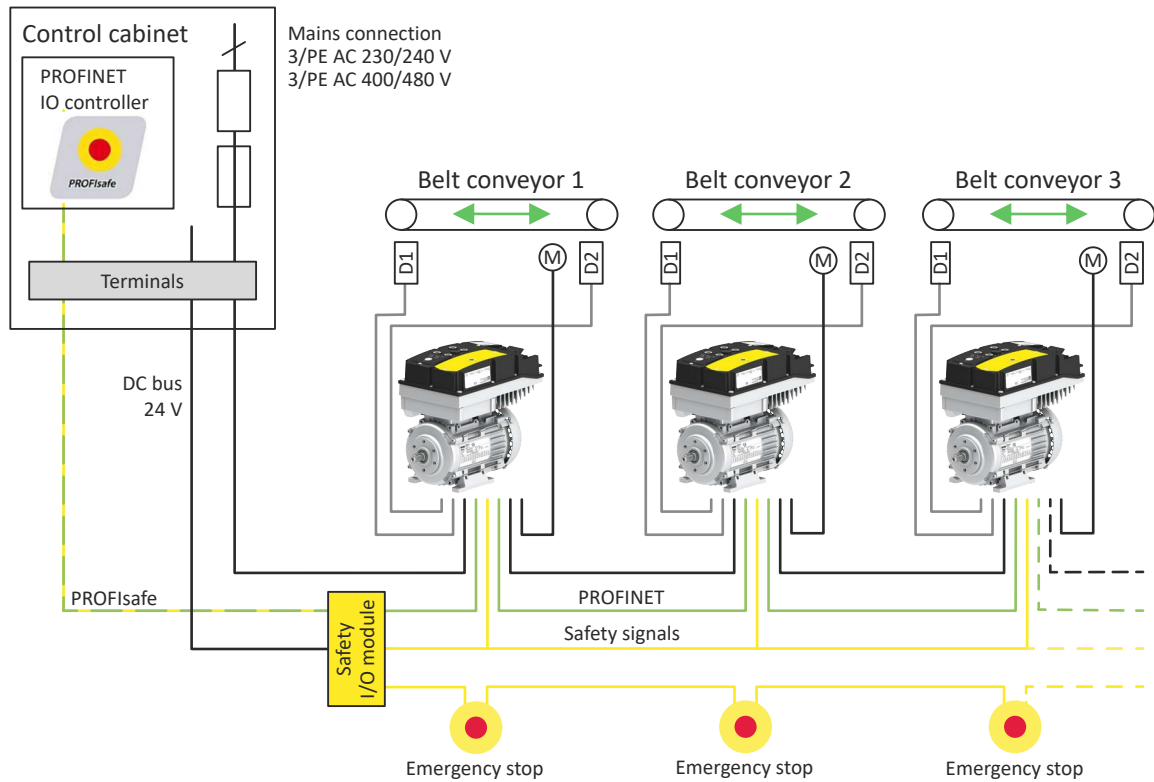


Fig. 6: Example setup for i550/i650 motec with integrated functional safety "Basic Safety - STO"





In addition to PROFIsafe, the i650 motec also supports the FSoE and CIP Safety™ safety protocols.

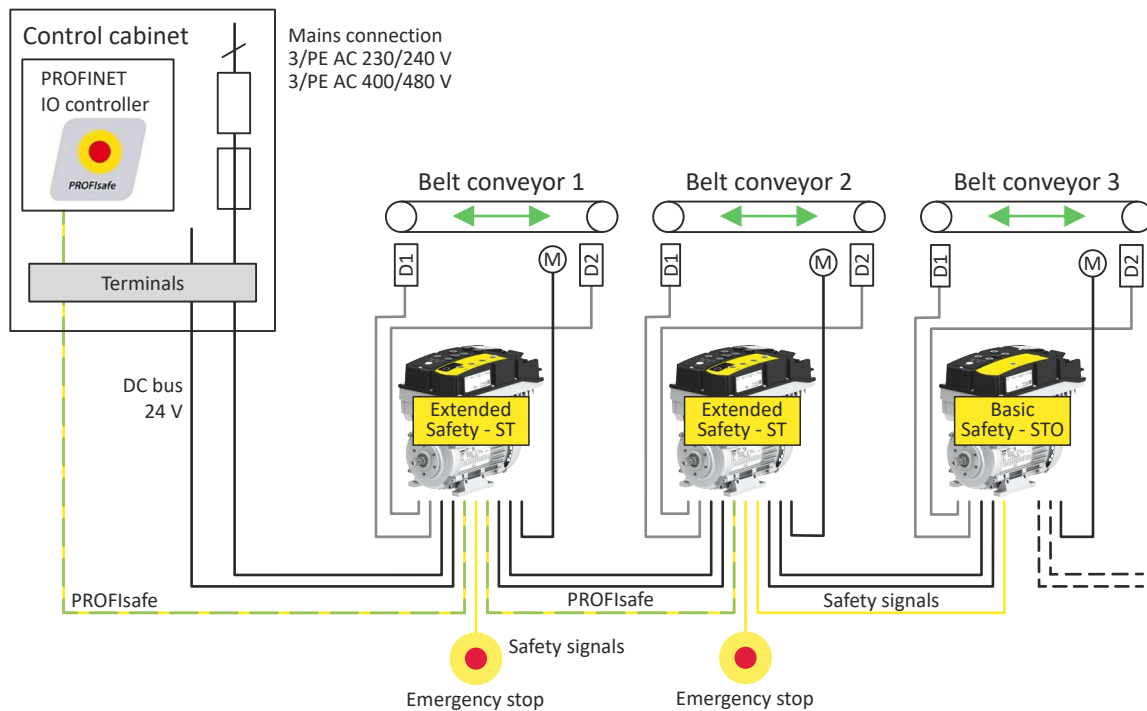


Fig. 8: Sample configuration for the combination of "Extended Safety - ST" and "Basic Safety - STO"

4.2.1 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.

See also chapter "Accessories": [▶ System cables](#) [218](#)



5 Mechanical installation

5.1 Important notes

CAUTION!

Sharp edges or residual burrs

Possible consequences: Cut injuries

- Wear suitable protective gloves against mechanical risks during mounting (PPE category II in accordance with EN 388).
-

Measures for cooling during operation

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



5.2 Preparation

Free spaces

- Maintain the specified free spaces to the other installations.

Mechanical fastening

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



5.3 Installation

Wall mounting

Inverters		Data for mounting the inverter to M25/M40 wall adapter		
Mains connection	Rated power	Tool	Screws	Tightening torque
3/PE AC 230/240 V	0.37 ... 3 kW	Torx key 25	4x M5	2.5 Nm
	4 ... 22 kW	Torx key 30	4x M6	8 Nm
3/PE AC 400/480 V	0.37 ... 5.5 kW	Torx key 25	4x M5	2.5 Nm
	7.5 ... 45 kW	Torx key 30	4x M6	8 Nm

How to mount the inverter with wall adapter on a mounting surface:

Required:

- Tool for drilling and thread cutting
 - Screwdriver
 - Fixing material
1. Prepare mounting area with corresponding threaded holes.
 2. Fit screws and washers (if applicable).
 3. Do not yet tighten the screws.
 4. Mount the inverter on the prepared mounting area via keyhole suspension.
 5. Tighten the screws.

The mechanical installation of the wall-mounted inverter is complete. You can begin the electrical installation.



Note on floor mounting an inverter without fan:

If the inverter with wall adapter is mounted upright on the floor (i.e. the control connections are at the top), the rated output values must be reduced by approx. 15%. Your Lenze contact will help you with a precise assessment.



Motor mounting

Torques for Lenze motors				
		Screws		Tightening torque
When using a Lenze motor, the following torques must be used to attach the motor adapter to the motor:		4x M4x16		3 Nm
		4x M5x16		5.9 Nm
		4x M6x20		7.5 Nm

Inverters		Data for mounting the inverter on the motor adapter		
Mains connection	Rated power	Tool	Screws	Tightening torque
3/PE AC 230/240 V	0.37 ... 3 kW	Torx key 25	4x M5	2.5 Nm
	4 ... 22 kW	Torx key 30	4x M6	8 Nm
3/PE AC 400/480 V	0.37 ... 5.5 kW	Torx key 25	4x M5	2.5 Nm
	7.5 ... 45 kW	Torx key 30	4x M6	8 Nm

How to mount the inverter with motor adapter on the motor:

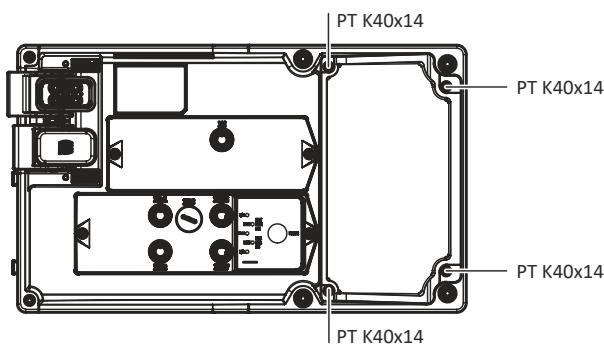
Required:

- Screwdriver
1. Remove the motor terminal box. ▶ [Video tutorials](#) 51
 2. Mount motor adapter.
 - a) Sequence for inverters 0.37 ... 5.5 kW:
Motor adapter → Wiring → Inverter (terminal block in the motor adapter)
 - b) Sequence for inverters 7.5 ... 45 kW:
Motor adapter → Inverter → Wiring (terminal connection on the drive)
 3. Wire the motor terminal block to the inverter's terminal strip or terminals using the included connection cables and, if applicable, the motor PTC and motor holding brake.
- The mechanical installation of the motor-mounted inverter is complete. You can begin the electrical installation.

Open and close the cover screw connection



For the wiring, loosen the 4 or 6 screws in the cover with a Torx key. After completion, close the cover again with the 4 or 6 screws so that the degree of protection remains guaranteed.



Inverters		Data for cover screw connection		
Mains connection	Rated power	Tool	Screws	Tightening torque
3/PE AC 230/240 V	0.37 ... 3 kW	Without cover		
	4 ... 5.5 kW	Torx key 20	4x oval head screw PT K40x14	1.4 Nm
	7.5 ... 22 kW	Torx key 20	6x oval head screw PT K40x14	1.4 Nm
3/PE AC 400/480 V	0.37 ... 5.5 kW	Without cover		
	7.5 ... 11 kW	Torx key 20	4x oval head screw PT K40x14	1.4 Nm
	15 ... 45 kW	Torx key 20	6x oval head screw PT K40x14	1.4 Nm



Tightening torques for blanking covers

Blanking cover	Tightening torque
M12 x 1 for M12 connectors	0.4 Nm
M15 x 1.5 for diagnostic interface X16	1.5 Nm



5.4 Video tutorials

Mount Lenze i550 motec frequency inverter (e.g. 0.75 kW) on Lenze three-phase geared motor

The following video shows the installation of an i550 motec frequency inverter (0.75 kW) on a Lenze three-phase geared motor (BG 063 - 071) with terminal box.

https://www.youtube.com/watch?v=KwPP_7slb9I&t=2s

NOTICE

Bridge arrangement for star or delta connection according to the requirements of the application.

Applicable for the following rated powers:

- 0.37 ... 3 kW (3/PE AC 230/240 V)
- 0.37 ... 5.5 kW (3/PE AC 400/480 V)



6 Electrical installation

6.1 Important notes

DANGER!

Dangerous electrical voltage

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

After the power is turned off, the power connections (X100, X105, X106, X110) will still carry dangerous electrical voltage for a certain period of time!

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

Even when the motor is stopped, the power connections (X100, X105, X106, X110) may carry dangerous electrical voltage.

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

Possible consequences: Death or serious injuries from electric shock

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

WARNING!

Dangerous electrical voltage

Error on device leads to overvoltage in the system.

- ▶ For auxiliary power supply with DC 20.5 ... 49.9 V only use a safely isolated power supply in accordance with the applicable 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

Mounting not according to protection class

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

► All cable glands and mounting parts must at least correspond to the protection class of the inverter.

► All openings in the housing must be closed according to the protection class.

► Device screws must be tightened to the specified tightening torque.



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".

6.1.1 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.



6.2 Preparation

Further data and information

► [Standards and operating conditions](#)  85



6.3 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.

NOTICE

Electromagnetic interference

Electromagnetic interference can interfere with the proper operation of the drive system if the specifications are not followed.

General guidelines for EMC-compliant installation:

- ▶ Use braided grounding strips that are as short as possible to implement a low-impedance equipotential bonding system for high-frequency balancing currents.
 - ▶ Use shielded, low-capacitance cables or hybrid cables with separately shielded wire pairs for the motor connection.
 - ▶ Use appropriate EMC cable glands for low-impedance shield connection of connection cables.
 - ▶ Separate power and signal cables to reduce mutual electromagnetic interference.
 - ▶ Keep unshielded power supply cables separate from shielded cables or hybrid cables used for the motor connection.
 - ▶ Avoid using unnecessarily long cables to reduce electromagnetic interference.
-



6.4 Connection according to UL

6.4.1 Important notes

WARNING!

► **UL marking**

- The integral solid state short circuit protection included in the inverter does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code / Canadian Electrical Code and any additional local codes.

► **Marquage UL**

- La protection statique intégrée contre les courts-circuits n'offre pas la même protection que le dispositif de protection du circuit de dérivation. Un tel dispositif doit être fourni, conformément au National Electrical Code / Canadian Electrical Code et aux autres dispositions applicables au niveau local.
-

WARNING!

► **UL marking**

- Use 75 °C copper wire only, except for control circuits.

► **Marquage UL**

- Utiliser exclusivement des conducteurs en cuivre 75 °C, sauf pour la partie commande.
-

WARNING!

► **UL marking**

- Suitable for motor group installation or use on a circuit capable of delivering not more than the RMS symmetrical amperes (SCCR) of the drive at its rated voltage.
- Approved fusing is specified in SCCR tables below.

► **Marquage UL**

- Convient pour l'utilisation sur une installation avec un groupe de moteurs ou sur un circuit capable de fournir au maximum une valeur de courant efficace symétrique en ampères à la tension assignée de l'appareil.
 - Les dispositifs de protection adaptés sont spécifiés dans les SCCR tableaux suivants.
-

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.

6.4.2 Fusing data

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

Standard Fault Short Circuit Current Ratings (SCCR)

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

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

Inverter	Standard Fuses (UL 248)			Circuit Breaker (UL 489)			
	SCCR	Max. rated current	Class	SCCR	Max. rated current	Min. cabinet dimensions	
	kA	A		kA	A	m ³	ft ³
i000M137C	5	30	CC, CF, J, T	5	30	-	-
i000M155C	5	30	CC, CF, J, T	5	30	-	-
i000M175C	5	30	CC, CF, J, T	5	30	-	-
i000M211C	5	30	CC, CF, J, T	5	30	-	-
i000M215C	5	30	CC, CF, J, T	5	30	-	-
i000M222C	5	30	CC, CF, J, T	5	30	-	-
i000M230C	5	30	CC, CF, J, T	5	30	-	-
i000M240C	5	30	CC, CF, J, T	5	30	-	-
i000M255C	5	30	CC, CF, J, T	5	30	-	-
i000M275C	10	125	CF, J, T	10	100	-	-
i000M311C	10	125	CF, J, T	10	100	-	-
i000M315C	10	125	CF, J, T	10	100	-	-
i000M318C	10	125	CF, J, T	10	100	-	-
i000M322C	10	125	CF, J, T	10	100	-	-
i000M137F	5	30	CC, CF, J, T	5	30	-	-
i000M155F	5	30	CC, CF, J, T	5	30	-	-
i000M175F	5	30	CC, CF, J, T	5	30	-	-
i000M211F	5	30	CC, CF, J, T	5	30	-	-
i000M215F	5	30	CC, CF, J, T	5	30	-	-
i000M222F	5	30	CC, CF, J, T	5	30	-	-
i000M230F	5	30	CC, CF, J, T	5	30	-	-
i000M240F	5	30	CC, CF, J, T	5	30	-	-
i000M255F	5	30	CC, CF, J, T	5	30	-	-
i000M275F	5	30	CC, CF, J, T	5	30	-	-
i000M311F	5	30	CC, CF, J, T	5	30	-	-
i000M315F	10	125	CF, J, T	10	100	-	-
i000M318F	10	125	CF, J, T	10	100	-	-
i000M322F	10	125	CF, J, T	10	100	-	-
i000M330F	10	125	CF, J, T	10	100	-	-
i000M337F	10	125	CF, J, T	10	100	-	-
i000M345F	10	125	CF, J, T	10	100	-	-

Electrical installation

Connection according to UL

Fusing data

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



High Fault Short Circuit Current Ratings (SCCR)

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

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

Inverter	Standard Fuses (UL 248)			Circuit Breaker (UL 489)			
	SCCR	Max. rated current	Class	SCCR	Max. rated current	Min. cabinet dimensions	
	kA	A		kA	A	m ³	ft ³
i000M137C	65	30	CC, CF, J, T	42	20	-	-
i000M155C	65	30	CC, CF, J, T	42	20	-	-
i000M175C	65	30	CC, CF, J, T	42	20	-	-
i000M211C	65	30	CC, CF, J, T	42	20	-	-
i000M215C	65	30	CC, CF, J, T	42	20	-	-
i000M222C	65	30	CC, CF, J, T	42	20	-	-
i000M230C	65	30	CC, CF, J, T	42	20	-	-
i000M240C	65	30	CC, CF, J, T	65	30	-	-
i000M255C	65	30	CC, CF, J, T	65	30	-	-
i000M275C	65	125	CF, J, T	65	100	-	-
i000M311C	65	125	CF, J, T	65	100	-	-
i000M315C	65	125	CF, J, T	65	100	-	-
i000M318C	65	125	CF, J, T	65	100	-	-
i000M322C	65	125	CF, J, T	65	100	-	-
i000M137F	65	30	CC, CF, J, T	42	20	-	-
i000M155F	65	30	CC, CF, J, T	42	20	-	-
i000M175F	65	30	CC, CF, J, T	42	20	-	-
i000M211F	65	30	CC, CF, J, T	42	20	-	-
i000M215F	65	30	CC, CF, J, T	42	20	-	-
i000M222F	65	30	CC, CF, J, T	42	20	-	-
i000M230F	65	30	CC, CF, J, T	42	20	-	-
i000M240F	65	30	CC, CF, J, T	42	20	-	-
i000M255F	65	30	CC, CF, J, T	42	20	-	-
i000M275F	65	30	CC, CF, J, T	65	30	-	-
i000M311F	65	30	CC, CF, J, T	65	30	-	-
i000M315F	65	125	CF, J, T	65	100	-	-
i000M318F	65	125	CF, J, T	65	100	-	-
i000M322F	65	125	CF, J, T	65	100	-	-
i000M330F	65	125	CF, J, T	65	100	-	-
i000M337F	65	125	CF, J, T	65	100	-	-
i000M345F	65	125	CF, J, T	65	100	-	-



6.4.2.2 Branch Circuit Protection (BCP) with Semiconductor Fuses

High Fault Short Circuit Current Ratings (SCCR)

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

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

Inverter	Semiconductor Fuses	
	SCCR	Max. rated current
	kA	A
i000M137C	65	30
i000M155C	65	30
i000M175C	65	30
i000M211C	65	30
i000M215C	65	30
i000M222C	65	30
i000M230C	65	30
i000M240C	65	30
i000M255C	65	30
i000M275C	65	125
i000M311C	65	125
i000M315C	65	125
i000M318C	65	125
i000M322C	65	125
i000M137F	65	30
i000M155F	65	30
i000M175F	65	30
i000M211F	65	30
i000M215F	65	30
i000M222F	65	30
i000M230F	65	30
i000M240F	65	30
i000M255F	65	30
i000M275F	65	30
i000M311F	65	30
i000M315F	65	125
i000M318F	65	125
i000M322F	65	125
i000M330F	65	125
i000M337F	65	125
i000M345F	65	125

Approved Manufacturers for Semiconductor Fuses

Manufacturer	Max. rated current	Designation
	A	
Eaton / Cooper Bussmann	30	FWP-30A14F
	125	FWP-125A

Electrical installation

Connection according to UL

Fusing data

Branch Circuit Protection (BCP) with Type E Combination Motor Controller



6.4.2.3 Branch Circuit Protection (BCP) with Type E Combination Motor Controller

High Fault Short Circuit Current Ratings (SCCR)

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

These devices are suitable for single motor installation when used with a Type E Combination Motor Controller.

Inverter	Type E Combination Motor Controller	
	SCCR	Max. rated current
	kA	A
i000M137C	30	16
i000M155C	30	16
i000M175C	30	16
i000M211C	30	16
i000M215C	30	16
i000M222C	30	16
i000M230C	30	16
i000M240C	30	32
i000M255C	30	32
i000M137F	30	16
i000M155F	30	16
i000M175F	30	16
i000M211F	30	16
i000M215F	30	16
i000M222F	30	16
i000M230F	30	16
i000M240F	30	16
i000M255F	30	16
i000M275F	30	32
i000M311F	30	32

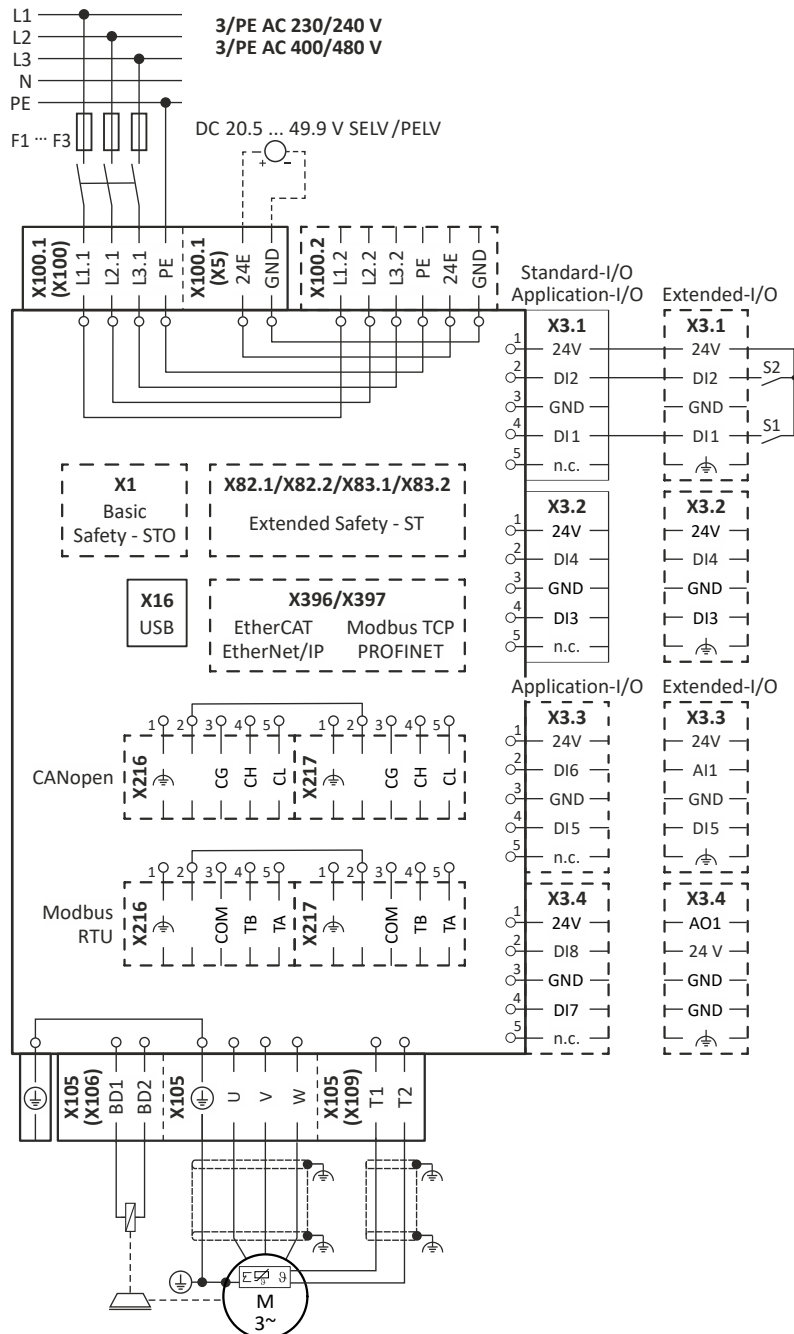
Approved Manufacturers for Type E Combination Motor Controller

Manufacturer	Max. rated current	Designation
	A	
ABB	16	MS132-16
	32	MS132-32



6.5 Mains connection

The inverters are connected directly to the 3-phase power grid. RFI filters are already integrated in all inverters. The use of external filters or mains chokes at the mains input to reduce grid disturbances is not permitted. Depending on the version, the inverter is equipped with Han Q4/2 connectors or terminal blocks for use with a cable gland for the mains connection.





Electrical supply conditions

The inverters are designed for TN and TT mains systems with a grounded neutral point. See also the "Technical data" chapter for information on "Electrical supply conditions." [88](#)

Permitted power systems

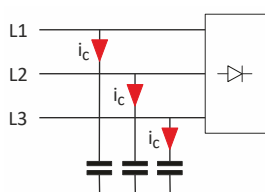
- TN mains with separate or combined neutral and protective conductors
- TT mains with and without a neutral conductor

Prohibited power systems:

- TT mains without grounded star point
- IT mains
- "Corner-grounded Delta" mains and "High-leg Delta" mains

Capacitive reactive current in standby mode

Inverters with mains-side capacitors intended for use in RFI filters generally generate capacitive reactive currents when the power supply is turned on.



The capacitive reactive currents in the 3-phase power supply system are listed below:

Inverters				Capacitive reactive current in standby mode	
				230 V / 50 Hz	240 V / 60 Hz
i000-M0.37/230-3	i000-M0.55/230-3	i000-M0.75/230-3	i000-M1.1/230-3	0.16 A	0.24 A
i000-M1.5/230-3	i000-M2.2/230-3	i000-M3.0/230-3			
i000-M4.0/230-3	i000-M5.5/230-3	i000-M7.5/230-3	i000-M11/230-3	0.43 A	0.63 A
i000-M15/230-3	i000-M18/230-3	i000-M22/230-3			

Inverters				Capacitive reactive current in standby mode	
				400 V / 50 Hz	480 V / 60 Hz
i000-M0.37/400-3	i000-M0.55/400-3	i000-M0.75/400-3	i000-M1.1/400-3	0.28 A	0.48 A
i000-M1.5/400-3	i000-M2.2/400-3	i000-M3.0/400-3	i000-M4.0/400-3		
i000-M5.5/400-3					
i000-M7.5/400-3	i000-M11/400-3	i000-M15/400-3	i000-M18/400-3	0.74 A	1.26 A
i000-M22/400-3	i000-M30/400-3	i000-M37/400-3	i000-M45/400-3		



Looping through the power distribution network results in the sum of the specified capacitive reactive currents per inverter.

Connection data

See chapter "Technical data":

- 3-phase mains connection 230/240 V ▶ [Connection data 94](#)
- 3-phase mains connection 400 V ▶ [Connection data 104](#)
- 3-phase mains connection 480 V ▶ [Connection data 114](#)

Mains cables

Mains cables with Han-Q4/2 connectors are available for the inverter as 4-pole cables (mains connection) or 6-pin cables (mains connection and 24 V supply) in the following versions:

- Connecting cable for mains/inverter connection
- Extension for the inverter/inverter connection

For more information on mains cables and other accessories, refer to the "Accessories for frequency and servo inverters" brochure.



Cable glands

Power range	Extension box	Cable glands	Use
≤ 5.5 kW (3/PE AC 230/240 V) ≤ 11 kW (3/PE AC 400/480 V)	Extension box with mains terminals	2 x M25 (unthreaded hole) 2 x M20 (unthreaded hole) 1 x M16 (unthreaded hole)	Mains cable External DC voltage supply Max. cable cross-section: 6 mm ² /AWG10
≥ 7.5 kW (3/PE AC 230/240 V) ≥ 15 kW (3/PE AC 400/480 V)	Without extension box	M40 x 1.5 (thread) M16 x 1.5 (thread)	Mains cable External DC voltage supply



Note regarding the M40 x 1.5 cable gland:

To mount the mains cable, we recommend using an M40 x 1.5 cable gland with a width across flats of 46.

6.5.1 Mains installation with several devices

Multiple inverters located in close proximity can be connected to the power supply system using the integrated Han Q4/2 connector. The mains cables are looped through from one inverter to the next via the Han-Q4/2 connector.



6.6 Motor connection

Only use motors suitable for the inverter operation.

Insulation resistance (EN 60034): max. $\hat{u} \geq 1.5 \text{ kV}$, max. $du/dt \geq 5 \text{ kV}/\mu\text{s}$

For the motor connection, the inverter is equipped with a Han Q8 connector, an M23/M40 connector, or terminals for use with a cable gland (M25/M40), depending on the version.

Connection data

See chapter "Technical data":

- 3-phase mains connection 230/240 V ▶ [Connection data](#) 94
- 3-phase mains connection 400 V ▶ [Connection data](#) 104
- 3-phase mains connection 480 V ▶ [Connection data](#) 114

Motor cables

Ready-made motor cables in various designs are available for the inverter. For more information on motor cables and other accessories, refer to the "Accessories for frequency and servo inverters" brochure.

Cable glands

Power range	Cable glands	Use
$\leq 5.5 \text{ kW}$ (3/PE AC 230/240 V) $\leq 11 \text{ kW}$ (3/PE AC 400/480 V)	M25 x 1.5 (thread)	Motor cable
	M16 x 1.5 (thread)	Additional cables
	M12 x 1.5 (thread)	
$\geq 7.5 \text{ kW}$ (3/PE AC 230/240 V) $\geq 15 \text{ kW}$ (3/PE AC 400/480 V)	M40 x 1.5 (thread)	Motor cable
	M16 x 1.5 (thread)	Additional cables
	M12 x 1.5 (thread)	

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^2t) 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



6.7 Connection of motor temperature monitoring

The inverter offers extensive protection against overload through the use of an overcurrent relay or temperature monitoring. We recommend using a PTC thermistor or thermal contact to monitor the temperature of the motor. We also recommend using the "Motor overload monitoring (i²xt)" function to monitor the motor.



In the default setting, the motor temperature monitoring is active!

The inverters rated 0.37 ... 5.5 (3/PE) and 0.37 ... 11 (3/PE) do not have a short-circuit bridge inserted between terminals T1 and T2.



If the terminals T1 and T2 are used, e.g. to connect an external PTC thermistor or a thermal contact, ensure at least one basic insulation to the potentials of motor, mains, and M12 connectors as well as to the auxiliary power supply to not restrict the safe isolation of the M12 connectors.

Connection	Connections T1 and T2
Use	Connection of PTC or thermal contact
Sensor types	PTC single sensor (DIN 44081)
	PTC triple sensor (DIN 44082)
	Thermal contact
	Note: The PT100 and PT1000 temperature sensors are not supported. The "PT1000 + 2 PTC" combination is also not supported.

Depending on the version, the connections T1 and T2 are located at connector X105 or at terminal X105/X109.

Connection data

See chapter "Technical data":

- 3-phase mains connection 230/240 V ▶ [Connection data](#) 94
- 3-phase mains connection 400 V ▶ [Connection data](#) 104
- 3-phase mains connection 480 V ▶ [Connection data](#) 114



6.8 Motor holding brake connection

The inverter supports the control of an electromagnetically ventilated spring-applied brake to provide the functionality of a motor holding brake.



The motor holding brake may only be used with motor cables up to a maximum motor cable length of 20 m.

Prefabricated motor cables in various designs are available for the inverter. For more information on motor cables and other accessories, refer to the "Accessories for VFDs and servo drives" brochure.

- Depending on the design, the connections for the BD1 and BD2 motor holding brakes are located in the X105 motor connector or, for device variants that use cable glands, on the X105 terminal block or terminal X106, respectively.
- For motor-mounted inverters, the motor holding brake is connected directly in the motor adapter via an M12 cable gland.
- The motor holding brake's connections are designed to be short-circuit-proof.
- The voltage used to control the motor holding brake is generated within the inverter, regardless of the mains voltage level, and can be configured.
- A safe release of the spring-applied brakes on Lenze motors is ensured by first applying a voltage of 133% of the rated coil voltage (release voltage) is applied for 0.5 s, and this voltage is then reduced to 66% of the rated coil voltage (holding voltage).
- The voltage level of the release sequence (release voltage/holding voltage) can be configured in steps to accommodate the use of different spring-applied brakes.



Technical data

The control of the motor holding brake has the following technical data.

- **Max. output current:** Peak value of the output current used to control the motor holding brake. Exceeding the maximum output current causes the motor holding brake to trip due to overload.
- **Output power:** Specification of the typical power rating of a motor holding brake for use with the specified inverters.

Inverters	Output voltages	Max. output current	Output power
i000-M0.37/230-3	104 V DC 180 V DC 205 V DC	0.5 A	40 W
i000-M0.55/230-3		0.65 A	60 W
i000-M0.75/230-3			
i000-M1.1/230-3		0.8 A	80 W
i000-M1.5/230-3			
i000-M2.2/230-3		1 A	100 W
i000-M3.0/230-3			
i000-M4.0/230-3			
i000-M5.5/230-3			
i000-M7.5/230-3			
i000-M11/230-3			
i000-M15/230-3			
i000-M18/230-3			
i000-M22/230-3			
i000-M0.37/400-3	180 V DC 205 V DC 215 V DC	0.5 A	40 W
i000-M0.55/400-3		0.65 A	60 W
i000-M0.75/400-3			
i000-M1.1/400-3		0.8 A	80 W
i000-M1.5/400-3			
i000-M2.2/400-3		1 A	100 W
i000-M3.0/400-3			
i000-M4.0/400-3			
i000-M5.5/400-3			
i000-M7.5/400-3			
i000-M11/400-3			
i000-M15/400-3			
i000-M18/400-3			
i000-M22/400-3			
i000-M30/400-3			
i000-M37/400-3			
i000-M45/400-3			

Connection data

See chapter "Technical data":

- 3-phase mains connection 230/240 V ▶ [Connection data](#) 94
- 3-phase mains connection 400 V ▶ [Connection data](#) 104
- 3-phase mains connection 480 V ▶ [Connection data](#) 114

Alternatively, the inverter allows a motor holding brake to be controlled via a brake switch connected to a digital output. The digital output must be parameterized accordingly.



6.9 Supply voltage connection

The connections 24E and GND are used for the mains-independent DC supply of the control electronics (incl. communication). The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version.



6.10 Control connections

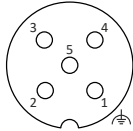
The inverter's control connections are designed as configurable M12 connectors.

- For Standard-I/O and Application-I/O, all control connections are configured as digital inputs by default.
- In Extended-I/O mode, a different function assignment is preset for control connections X3.3 and X3.4:
 - X3.3: Analog input AI1 + Digital input DI5
 - X3.4: Analog output AO1

Details on configuring the function assignment can be found in the commissioning document.

6.10.1 Standard I/O

Connection designation			X3.1					X3.2				
Pin			1	2	3	4	5	1	2	3	4	5
Pin name			24V	DI2	GND	DI1	n.c.	24V	DI4	GND	DI3	n.c.

M12 (A coded)												
  Housing is connected to functional earth												

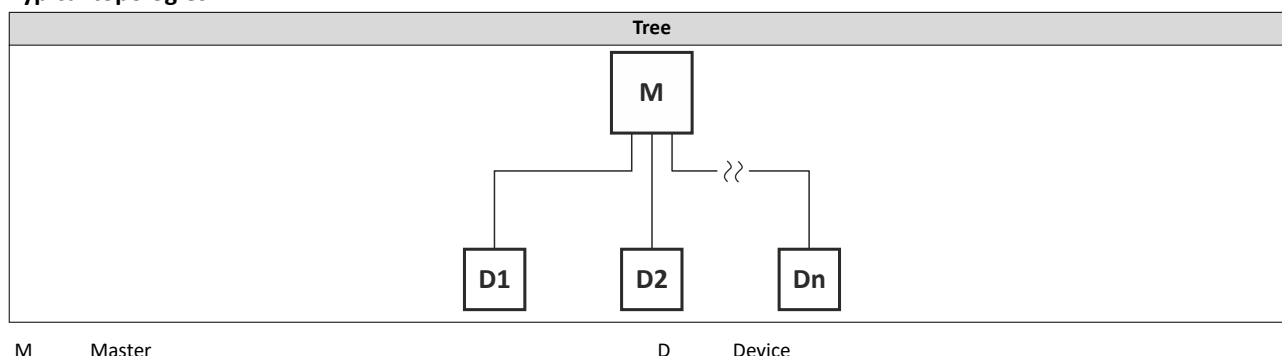


Connection designation			X3.3					X3.4				
Pin			1	2	3	4	5	1	2	3	4	5
Pin name			24V	DI6	GND	DI5	n.c.	24V	DI8	GND	DI7	n.c.

6.10.2.1 IO-Link

- The inverter (IO-Link master) supports IO-Link version 1.1
- IO-Link Devices with IO-Link version 1.0 are not supported.
- The function assignment for the X3.x connectors must be configured accordingly (see the commissioning manual for details).

Typical topologies

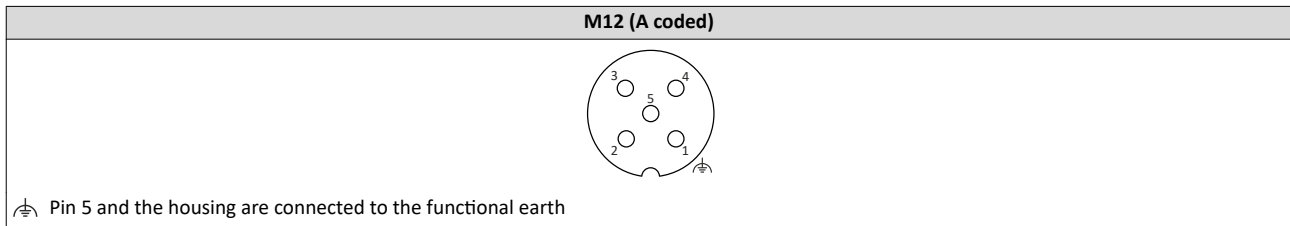




6.10.3 Extended-I/O

Connection designation			X3.1					X3.2				
Pin			1	2	3	4	5	1	2	3	4	5
Pin name			24V	DI2	GND	DI1	FE	24V	DI4	GND	DI3	FE

Connection designation			X3.3					X3.4				
Pin			1	2	3	4	5	1	2	3	4	5
Pin name			24V	AI1	GND	DI5	FE	AO1	24V	GND		FE



Shielded cables must be used for analog signals. The shield can be connected to the housing of the M12 connector and/or pin 5.

6.10.3.1 Temperature sensor

The inverter provides a connection for a temperature sensor via the Extended-I/O.

- PT100 and PT1000 temperature sensors are supported.
- The connection is made to X3.4. The function assignment of connector X3.4 must be configured accordingly (see the commissioning manual for details).
- The measured temperature values can be mapped to process data and thus transmitted over the network.
- Optionally, temperature monitoring with an adjustable response can be configured.
- The connected temperature sensor is monitored for wire breaks.
- The cable resistance to the temperature sensor can be compensated for using calibration parameters.



To directly connect a standard temperature sensor with an M12 connector, a 3-wire cable is required to prevent a short circuit between pin 1 and pin 2. Such a cable is available in the standard product line of various cable manufacturers.

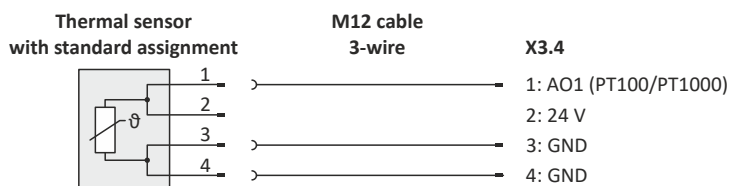


Fig. 9: Connecting a temperature sensor (PT100/PT1000) with standard assignment and an M12 connector to X3.4



6.11 Networks connection



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

- Lay communication 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 communication cable, install an independent, low-resistance equipotential bonding over the shortest possible distance parallel to the communication cable. This is especially true for long cables.
- The following applies to "Multi-Ethernet" (EtherCAT, EtherNet/IP, Modbus TCP, PROFINET):
 - The cables must be CAT5-compliant and capable of supporting $\geq$.
 - According to the specifications, CAT5 cables connect the shield via the M12 connectors (D coded). Additional shield connections are not required.
- Only certified, tested and prefabricated cables with M12 connectors from well-known manufacturers are recommended.
- Observe bending radii according to manufacturer information. Minimum bending radii of 10 x cable diameter or 20 x diameter for frequent manipulation of the cables are standard.

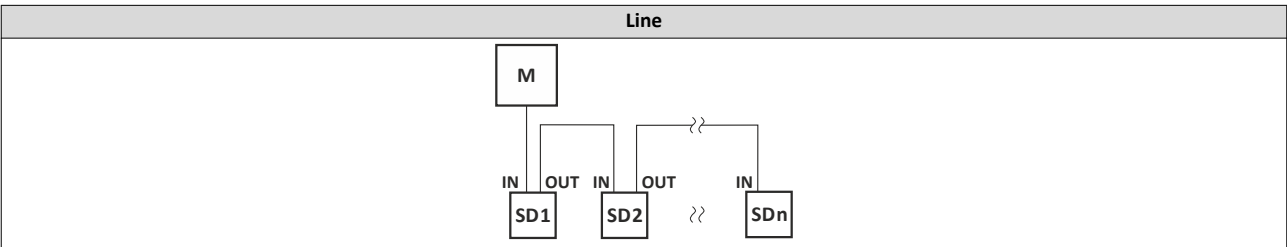
6.11.1 CANopen



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

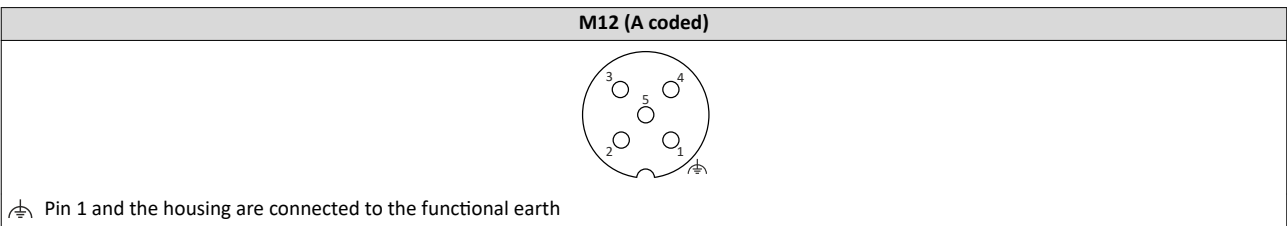
Install an M12 terminator with an integrated 120 on these two network devices (e.g., from [ESCHA](#)).

Typical topologies



M Master
SD Slave Device

Connection			CANopen									
Connection designation			X216					X217				
Connection type			M12									
Max. cable cross-section		mm²	0.34									
Max. cable cross-section		AWG	22									
Pin			1	2	3	4	5	1	2	3	4	5
Pin name			FE	to X217:2	CG	CH	CL	FE	to X216:2	CG	CH	CL



 Pin 1 and the housing are connected to the functional earth



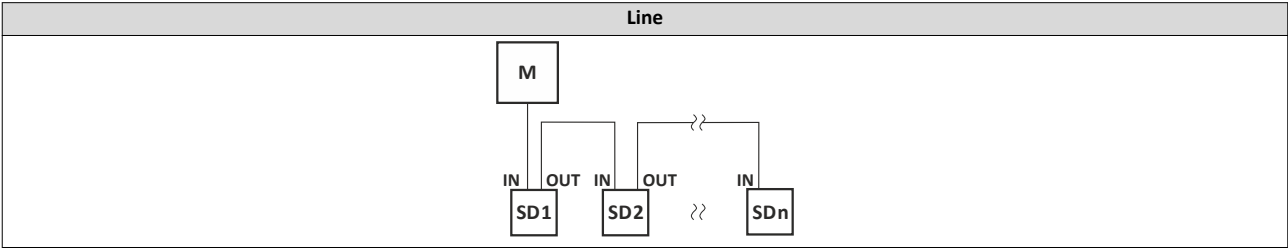
6.11.2 Modbus RTU



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

Install an M12 terminator with an integrated 120 on these two network devices (e.g., from [ESCHA](#)).

Typical topologies



M Master
SD Slave Device

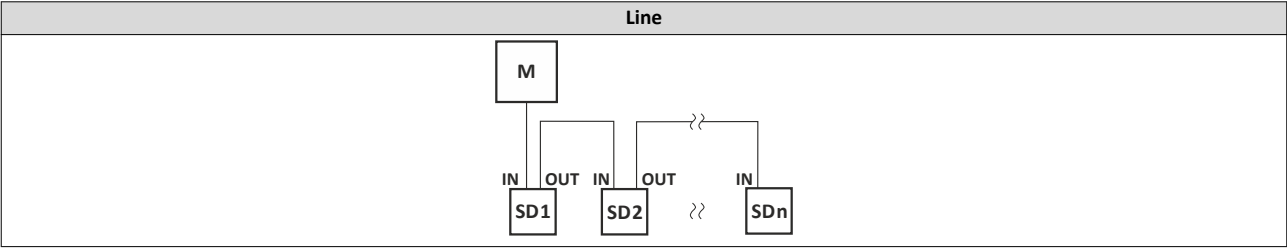
Connection			Modbus RTU									
Connection designation			X216					X217				
Connection type			M12									
Max. cable cross-section		mm²	0.34									
Max. cable cross-section		AWG	22									
Pin			1	2	3	4	5	1	2	3	4	5
Pin name			FE	to X217:2	COM	TB (D1+)	TA (D0-)	FE	to X216:2	COM	TB (D1+)	TA (D0-)

M12 (A coded)												
Pin 1 and the housing are connected to the functional earth												



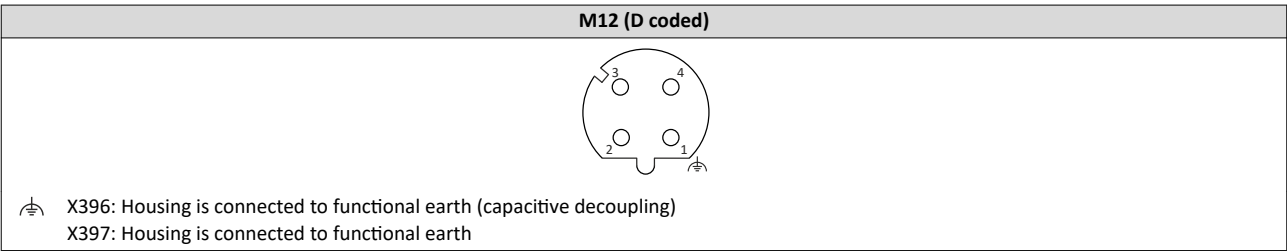
6.11.3 EtherCAT

Typical topologies



M Master
SD Slave Device

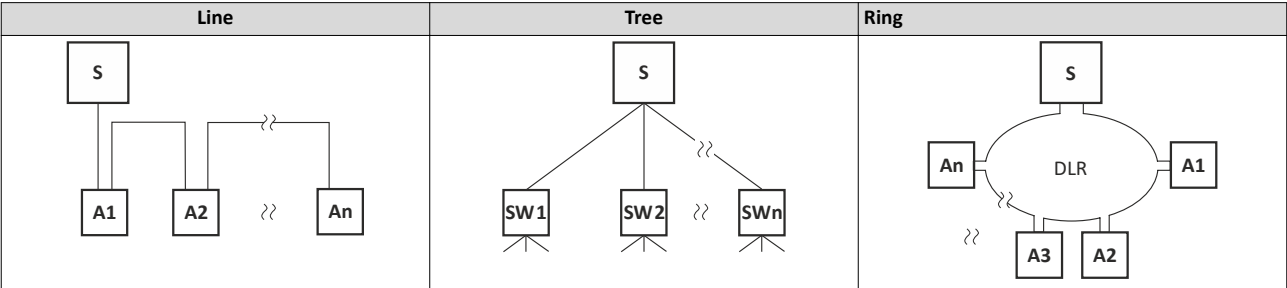
Connection			Multi-Ethernet	
Connection designation			X396	X397
Connection type			M12	
Max. cable cross-section		mm ²	0.34	0.34
Max. cable cross-section		AWG	22	22



⚡ X396: Housing is connected to functional earth (capacitive decoupling)
X397: Housing is connected to functional earth

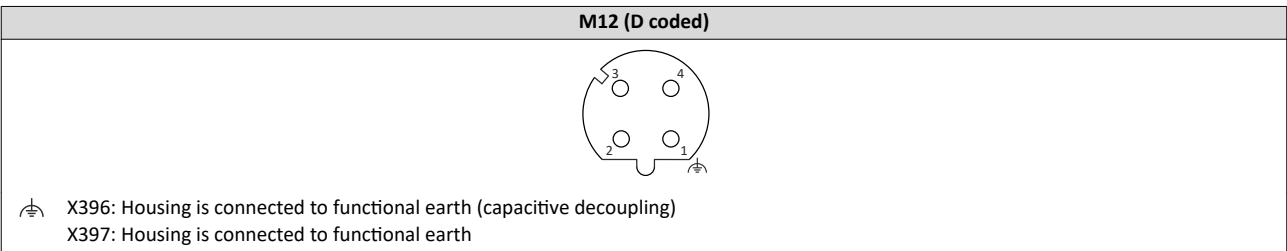
6.11.4 EtherNet/IP

Typical topologies



S Scanner
A Adapter
SW Switch

Connection			Multi-Ethernet	
Connection designation			X396	X397
Connection type			M12	
Max. cable cross-section		mm ²	0.34	0.34
Max. cable cross-section		AWG	22	22

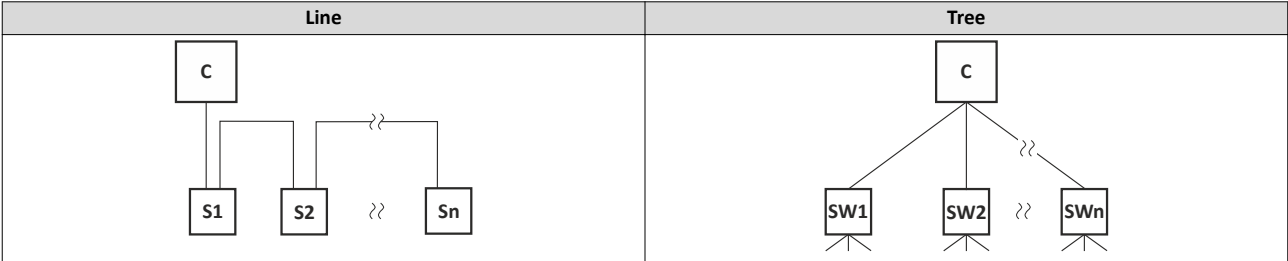


⚡ X396: Housing is connected to functional earth (capacitive decoupling)
X397: Housing is connected to functional earth



6.11.5 Modbus TCP

Typical topologies



C	Client	SW	Switch
S	Server		

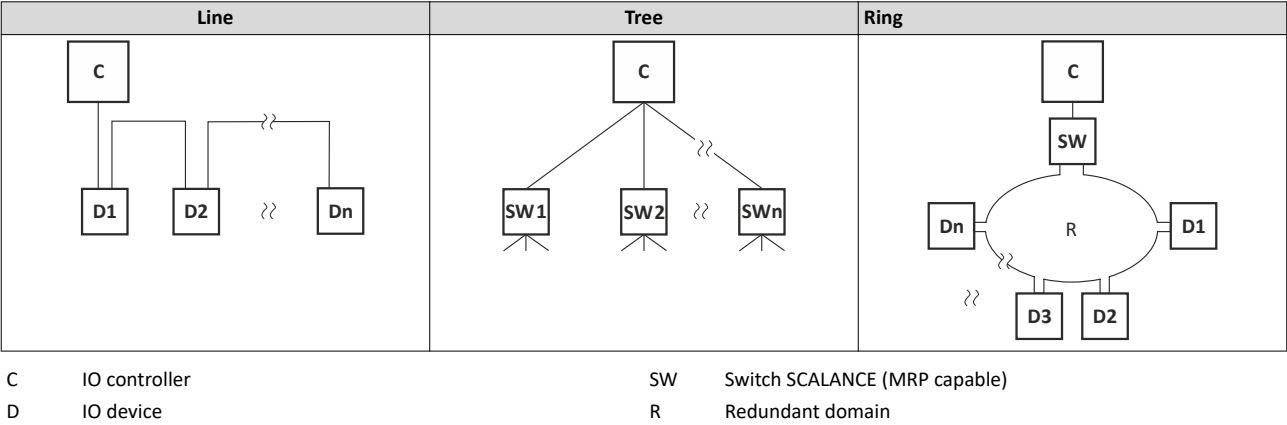
Connection			Multi-Ethernet	
Connection designation			X396	X397
Connection type			M12	
Max. cable cross-section		mm ²	0.34	0.34
Max. cable cross-section		AWG	22	22

M12 (D coded)	
	X396: Housing is connected to functional earth (capacitive decoupling)
	X397: Housing is connected to functional earth

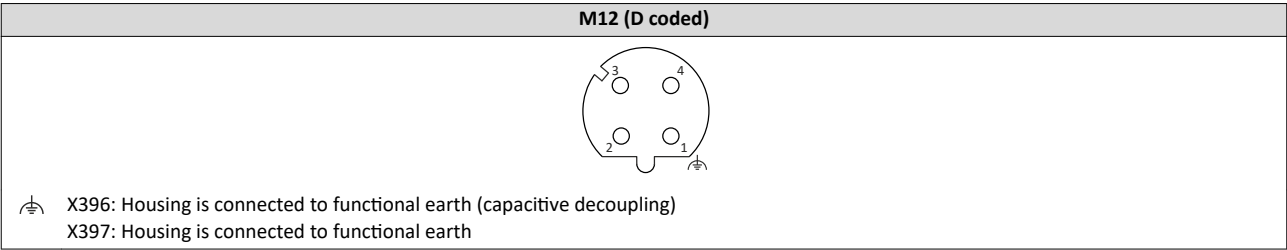


6.11.6 PROFINET

Typical topologies



Connection			Multi-Ethernet	
Connection designation			X396	X397
Connection type			M12	
Max. cable cross-section		mm²	0.34	0.34
Max. cable cross-section		AWG	22	22



6.12 Functional safety connection

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.
-



6.12.1 Basic Safety - STO

"Basic Safety - STO" is part of the product variants I55AM□□□□□A and I65AM□□□□□A.

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.

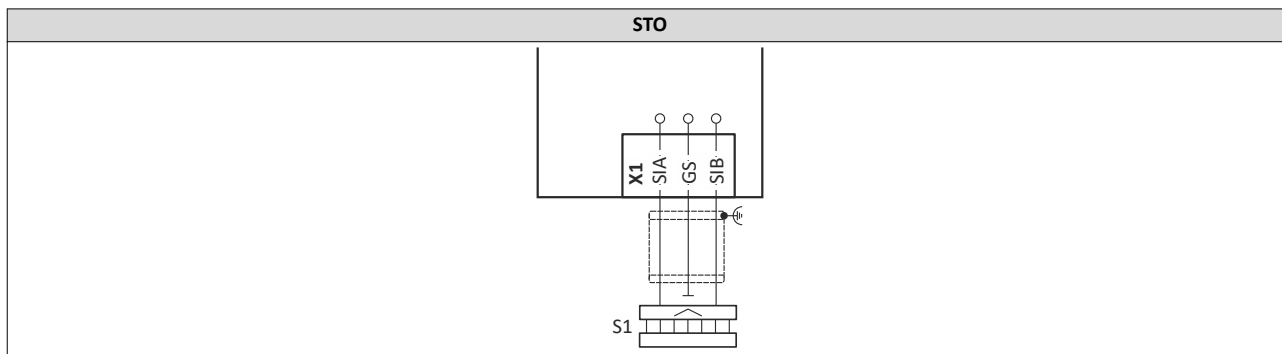


6.12.1.1 Connection diagram



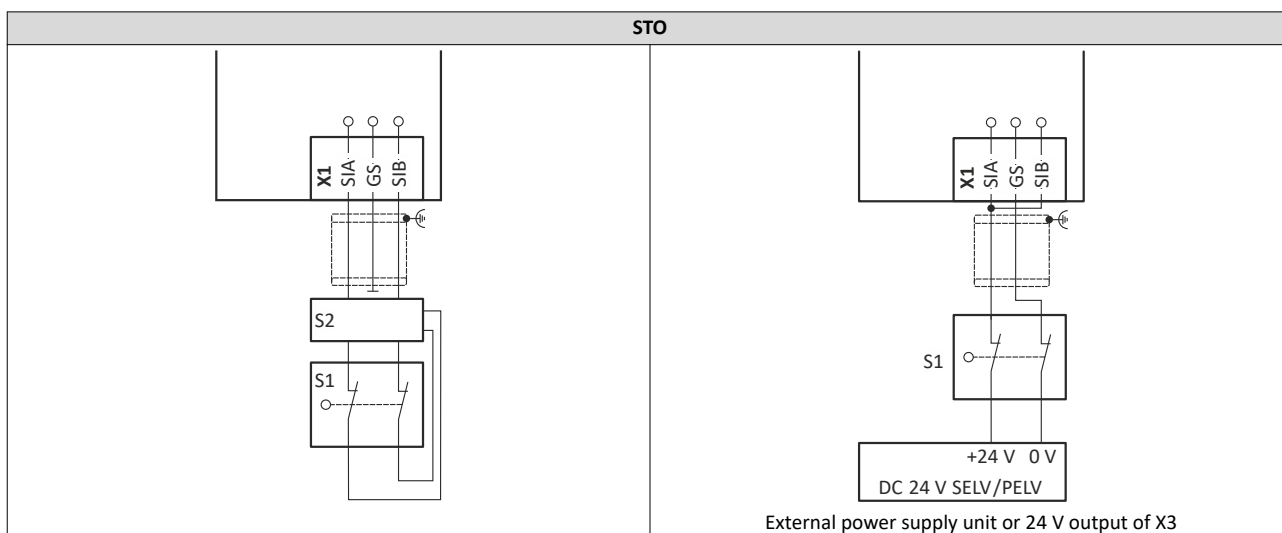
The connection diagrams shown are only example circuits. The user is responsible for the correct safety-related design and selection of the components!

Active sensors



S1 Active sensor - example of lightgrid

Passive sensors

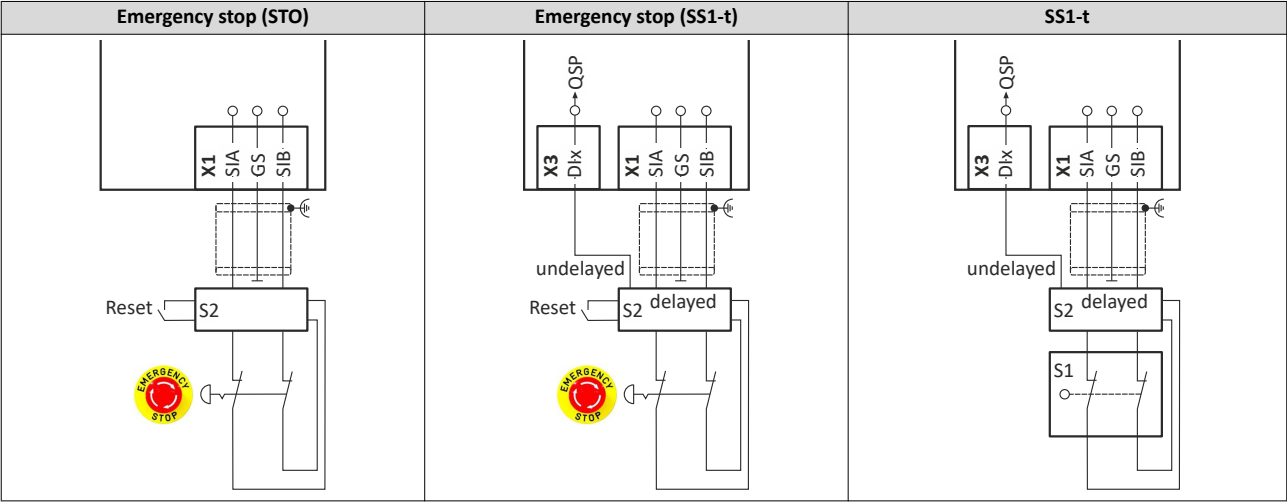


S1 Passive sensor
S2 Safety switching device

S1 Passive sensor



Passive sensors - further examples



S2 Safety switching device

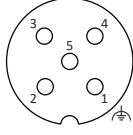
S2 Safety switching device with
 delayed contacts
QSP "Quick stop" function

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



6.12.1.2 Connection data

Connection designation			X1				
Pin			1	2	3	4	5
Pin name			n.c.	SIA	GS	SIB	n.c.

M12 (A coded)							
							
 Housing is connected to functional earth							

Connection			Basic Safety - STO				
Connection designation			X1				
Connection system			Plug connection				
Max. cable cross-section		mm ²	0.34				
Max. cable cross-section		AWG	22				
Min. cable cross-section		mm ²	0.34				
Min. cable cross-section		AWG	22				

X1	Specification	Unit	min.	typ.	max.
SIA, SIB	Input voltage LOW level	V	-3	0	5
	Input voltage HIGH level	V	15	24	30
	Switch-on time	ms		3	
	Clear time	ms		50	60
	Input current SIA	mA		10	14
	Input current SIB	mA		7	12
	Input peak current	mA		100	
	Test pulse duration	ms			1
	Test pulse interval	ms	10		
GS	Reference potential for SIA and SIB				

- Maximum cable length: 100 m
- From 30 m cable length, a shielded version is required!



6.12.2 Extended Safety

"Extended Safety - S" is part of the product variant I65AM□□□□□E.

"Extended Safety - ST" is part of the product variant I65AM□□□□□D.



The "Extended Safety - S" version has no safe inputs for controlling the safety functions. The safety functions are controlled exclusively via the safety bus.

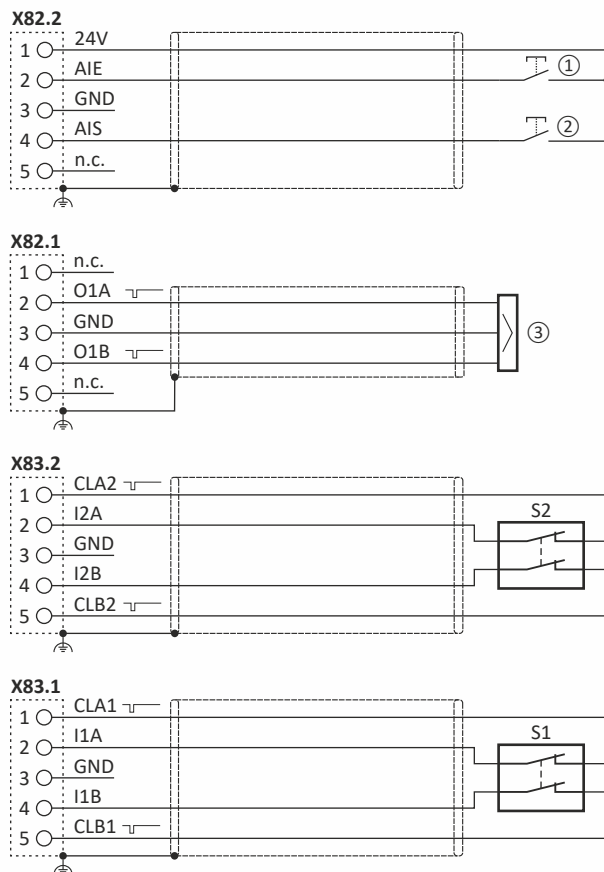
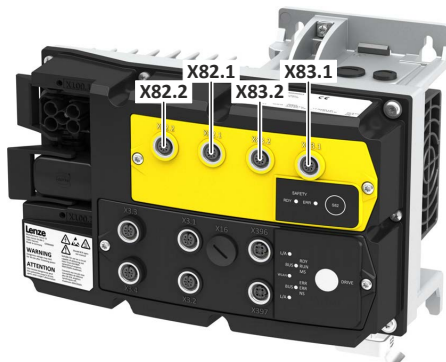
► Safety bus [183](#)

► Safety functions [193](#)

6.12.2.1 Connection diagram



The wiring diagram shown is merely an example of a circuit for the "Extended Safety - ST" version. The user is responsible for the correct safety-related design and selection of the components!



Name	Meaning
①	Error acknowledgment (AIE) button
②	Restart acknowledgment (AIS) button
③	Safe output to the higher-level safety controller
S1	Passive sensor with channels A and B
S2	Shielded cabling is required for Category 4 according to EN ISO 13849-2.



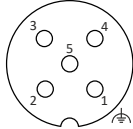
6.12.2.2 Connection data

Connection designation			X82.1				
Pin			1	2	3	4	5
Pin name			n.c.	O1A	GND	O1B	n.c.

Connection designation			X82.2				
Pin			1	2	3	4	5
Pin name			24V	AIE	GND	AIS	n.c.

Connection designation			X83.1				
Pin			1	2	3	4	5
Pin name			CLA1	I1A	GND	I1B	CLB1

Connection designation			X83.2				
Pin			1	2	3	4	5
Pin name			CLA2	I2A	GND	I2B	CLB2

M12 (A coded)							
							
 Housing is connected to functional earth							

Connection			Extended Safety - ST			
Connection designation			X82.1	X82.2	X83.1	X83.2
Connection system			Plug connection	Plug connection	Plug connection	Plug connection
Max. cable cross-section		mm ²	0.34	0.34	0.34	0.34
Max. cable cross-section		AWG	22	22	22	22
Min. cable cross-section		mm ²	0.34	0.34	0.34	0.34
Min. cable cross-section		AWG	22	22	22	22



X83.1/X83.2: To ensure flexibility in component selection, the pin assignments of the test pulse outputs CLAx and CLBx for X83.1 and X83.2 can be individually swapped via parameterization. In that case, for example, CLA1 is on pin and CLB1 is on pin .



The total current draw for O1A, O1B, 24V, CLA1, CLB1, CLA2, and CLB2 from the control electronics' mains-independent DC supply is limited to 0.9 .

X82.1/X82.2	Specification	Unit	min.	typ.	max.
O1A, O1B	PLC output, IEC-61131-2, 24 V DC				
	Output voltage LOW level	V		0	0.8
	Output voltage HIGH level	V	17	24	30
	output current	mA			300
	Cable capacity	nF			80
	Cable resistance	Ω			200
24V	24 V-supply voltage				
	Output voltage	V	18	24	30
	output current	mA			100
AIS AIE	PLC input, IEC-61131-2, 24 V, type 1				
	Input voltage LOW Level	V	-3	0	5
	Input voltage HIGH level	V	15	24	30
	Input current	mA	2		15
	Input capacitance	nF		3.3	4
	Actuation duration (pulse length) for AIE and AIS	s	0.3		10
X83.1/X83.2	Specification	Unit	min.	typ.	max.
CLA1, CLB1 CLA2, CLB2	PLC output, IEC-61131-2, 24 V DC, 50 mA				
	Output voltage LOW level	V		0	0.8
	Output voltage HIGH level	V	17	24	30
	output current	mA			300
	Cable capacity	nF			100
	Cable resistance of a passive sensor	Ω			200
I1A, I1B I2A, I2B	PLC input, IEC-61131-2, 24 V, type 1				
	Input voltage LOW Level	V	-3	0	5
	Input voltage HIGH level	V	15	24	30
	Input current	mA	2		15
	Input capacitance	nF			3.5
	Test pulse duration	ms			1
	Test pulse interval	ms	50		

- Maximum cable length: 100 m
- From 30 m cable length, a shielded version is required!



7 Technical data

7.1 Standards and operating conditions

7.1.1 Conformities and approvals

Conformities			
CE	2006/42/EC		Machinery Directive only relevant for safety components
	2009/125/EC		Ecodesign Directive
	2011/65/EU		RoHS Directive
	2014/30/EU		EMC Directive
	2014/35/EU		Low-Voltage Directive
KC (Korea)	KS C 9800-3		
RCM (Australia)	EN IEC 61800-3		
UKCA	S.I. 2008/1597		The Supply of Machinery (Safety) Regulations 2008
	S.I. 2012/3032		The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
	S.I. 2016/1091		The Electromagnetic Compatibility Regulations 2016
	S.I. 2021/745	The Ecodesign for Energy-Related Products and Energy Information Regulations 2021	
Approvals			
cULus	UL 61800-5-1		File No. E132659
			For USA and Canada



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

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

→ [i550 motec frequency inverter](#)

→ [i650 motec frequency inverter](#)

(Section "Product support")



7.1.2 Protection of persons and device protection

Degree of protection			Information applies to the mounted and ready-for-use state.
EN	EN IEC 60529	IP54	This information applies to the extension box with Type E combination motor controller.
			This information applies to the extension box with disconnect switch and operating elements
		IP66	This information applies to the extension box with disconnect switch
			Information applies to inverter without extension box
UL	UL 50E	Type 12/12K	This information applies to the extension box with Type E combination motor controller.
			This information applies to the extension box with disconnect switch and operating elements
			UL 50E Type 12/12K comparable to NEMA 12/12K
		Type 4X indoor	This information applies to the extension box with disconnect switch
			Information applies to inverter without extension box
			Flame retardancy of housing components UL94 5VA
			Housing parts UV-resistant (f1 rating)
			UL 50E Type 4X comparable to NEMA 4X
Protection against electric shock			
Isolation of control circuits	EN IEC 61800-5-1	Safe mains isolation	Double/reinforced insulation
Overvoltage category		II	2000 ... 4000 m amsl
		III	0 ... 2000 m amsl
Degree of pollution		2	
Leakage current			
AC	EN IEC 61800-5-1	> 3.5 mA	Observe regulations and safety instructions!
DC		> 10 mA	
Starting current			
		≤ 3 x rated mains current	
Protective measures			
Earth fault strength			Earth-fault protected depending on operating status
Motor stall protection			
Short-circuit strength			
Overvoltage resistance			
Motor overtemperature			PTC or thermal contact, I²xt monitoring

7.1.3 EMC data

Operation on public networks			The machine or system manufacturer is responsible for compliance with the requirements for the machine/system!
< 1 kW	EN IEC 61000-3-2	No additional measures	
> 1 kW, mains current ≤ 16 A			
Mains current > 16 A ... ≤ 75 A	EN IEC 61000-3-12	≥ 250	When designed for rated power.
Rsce			Rsce: Short circuit power ratio at the connection point between the machine/system and the public network
Noise emission			
Category C1	EN IEC 61800-3		see rated data
Category C2			
Category C3			
Interference immunity			
	EN IEC 61800-3	Requirements fulfilled	



7.1.4 Motor connection

Requirements for the shielded motor cable			
Capacitance per unit length		C-core-core/C-core-shield < 150/300 pF/m	≥ 4 mm ² / AWG 12
		C-core-core/C-core-shield < 75/150 pF/m	≤ 2.5 mm ² / AWG 14
Electric strength		U ₀ /U = 0.6/1.0 kV	U = r.m.s. value from external conductor to external conductor U ₀ = r.m.s. value external conductor to PE
	UL	U ≥ 600 V	U = r.m.s. value from external conductor to external conductor

7.1.5 Environmental conditions

Energy efficiency			
Efficiency level	EN IEC 61800-9-2	Energy efficiency class IE2	according to REGULATION (EU) 2019/1781
Climate			
Storage	EN 60721-3-1:1997	1K3 (-30 ... +60°C)	
Transport	EN 60721-3-2:1997	2K3 (-30 ... +70 °C)	
Operation	EN 60721-3-3:1995 + A2:1997	3S3	For mechanically active substances
		3K3 (-30 ... +60 °C)	Operation at a switching frequency of 4, 8, 12 or 16 kHz: Above +40°C: reduce rated output current by 2.5%/°C
		3C3	For chemically active substances
Installation altitude			
0 ... 1000 m amsl			Without current derating
1000 ... 4000 m amsl			Reduce rated output current by 5%/1000 m
Vibration resistance			
Transport	EN 60721-3-2:1998	2M2 (sine, shock)	Amplitude 3.5 mm (2 ... 9 Hz)
			Acceleration-resistant up to 1 g (9 ... 200 Hz)
			Acceleration-resistant up to 1.5 g (200 ... 500 Hz)
			In original packaging
			Type 2 (peak acceleration of 30 g)
Operation	DNV-CG-0339		Amplitude 1 mm (5 ... 13.2 Hz)
			Acceleration-resistant up to 0.7 g (13.2 ... 100 Hz)
	EN 60721-3-3:1995 + A2:1997	3M4 (sine, shock)	Amplitude 3 mm (2 ... 9 Hz)
			at 15 ... 45 kW
			Acceleration-resistant up to 1 g (9 ... 200 Hz)
		3M6 (sine, shock)	Type 1 (peak acceleration of 10 g)
			Amplitude 7 mm (2 ... 9 Hz)
			at 3 ... 11 kW
	3M7 (sine, shock)	Acceleration-resistant up to 2 g (9 ... 200 Hz)	
		Type 2 (peak acceleration of 25 g)	
		Amplitude 10 mm (2 ... 9 Hz)	
		Acceleration-resistant up to 3 g (9 ... 200 Hz)	
		up to 2.2 kW	
		Type 2 (peak acceleration of 25 g)	
	EN 60721-3-3:2019	3M12 (noise, Shock)	Spectral acceleration density up to 0.1 g²/Hz (5 ... 200 Hz)
		Type 1 (peak acceleration of 2 g)	
EN IEC 61800-5-1		Amplitude 0.075 mm (10 ... 57 Hz)	
		Acceleration-resistant up to 1 g (57 ... 150 Hz)	



7.1.6 Electrical supply conditions

Permitted power systems			
TN			Voltage to earthed neutral point: max. 300 V
TT			

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

The following is supported:

- [3-phase mains connection 230/240 V](#) 89
- [3-phase mains connection 400 V](#) 98
- [3-phase mains connection 480 V](#) 108

7.1.7 Certification of the integrated functional safety

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

EN ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems – Part 1
EN 61508, Part 1-7:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
EN 61800-5-1:2023,4.4	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 → Frequency inverters

→ [i550 motec frequency inverter](#)

→ [i650 motec frequency inverter](#)

(Section "Product support")



7.2 3-phase mains connection 230/240 V

7.2.1 Rated data

- The output currents apply to an ambient temperature of max. 40 °C (104 °F).
- The maximally possible output voltage is approx. 87 % of the mains voltage.

Product name			i000-M0.37/230-3	i000-M0.55/230-3	i000-M0.75/230-3	i000-M1.1/230-3
Rated power	P _{rated}	kW	0.37	0.55	0.75	1.1
Rated power	P _{rated}	hp	0.5	0.75	1	1.5
Mains voltage range			3 AC 207 V ... 264 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-230/240 V			
Rated mains current						
without mains choke		A	2.2	2.9	3.8	5.4
with mains choke		A	-			
Apparent output power		kVA	0.9	1.2	1.5	2.2
Rated output current						
2 kHz		A	2.4	3.2	4.2	6
8 kHz		A	2.4	3.2	4.2	6
12 kHz		A	1.9	2.6	3.4	4.8
16 kHz		A	1.7	2.1	2.8	4
Power loss						
2 kHz		W	19	23	29	39
8 kHz		W	24	30	38	52
12 kHz		W	23	29	36	49
16 kHz		W	23	29	36	49
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	3.6	4.8	6.3	9
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	1.8	2.4	3.2	4.5
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	4.8	6.4	8.4	12
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	1.8	2.4	3.2	4.5
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 230/240 V

Rated data



Product name			i□□□-M1.5/230-3	i□□□-M2.2/230-3	i□□□-M3.0/230-3	i□□□-M4.0/230-3
Rated power	P _{rated}	kW	1.5	2.2	3	4
Rated power	P _{rated}	hp	2	3	4	5
Mains voltage range			3 AC 207 V ... 264 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-230/240 V			
Rated mains current						
without mains choke		A	6.3	8.6	10.8	14
with mains choke		A	-			
Apparent output power		kVA	2.5	3.5	4.3	6
Rated output current						
2 kHz		A	7	9.6	12	16.5
8 kHz		A	7	9.6	12	16.5
12 kHz		A	6	8.2	10.2	14.0
16 kHz		A	5	6.9	8.6	12.4
Power loss						
2 kHz		W	44	58	71	96
8 kHz		W	59	79	97	131
12 kHz		W	60	80	98	125
16 kHz		W	60	81	99	135
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	10.5	14.4	18	24.8
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	5.3	7.2	9	12.4
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	14	19.2	24	33
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	5.3	7.2	9	12.4
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data

3-phase mains connection 230/240 V
Rated data

Product name			i□□□-M5.5/230-3	i□□□-M7.5/230-3	i□□□-M11/230-3	i□□□-M15/230-3
Rated power	P _{rated}	kW	5.5	7.5	11	15
Rated power	P _{rated}	hp	7.5	10	15	20
Mains voltage range			3 AC 207 V ... 264 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-230/240 V			
Rated mains current						
without mains choke		A	19.6	24.7	35.7	45.9
with mains choke		A	-			
Apparent output power		kVA	8.3	10.5	15.2	19.5
Rated output current						
2 kHz		A	23	29	42	54
8 kHz		A	23	29	42	54
12 kHz		A	19.6	24.7	35.7	-
16 kHz		A	17.3	21.8	31.5	-
Power loss						
2 kHz		W	131	163	234	299
8 kHz		W	181	226	325	416
12 kHz		W	172	229	329	-
16 kHz		W	186	233	334	-
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	34.5	43.5	63	81
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	17.3	21.8	31.5	40.5
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	46	58	84	108
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	17.3	21.8	31.5	40.5
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 230/240 V
Rated data



Product name			i□□□-M18/230-3	i□□□-M22/230-3
Rated power	P _{rated}	kW	18.5	22
Rated power	P _{rated}	hp	25	30
Mains voltage range			3 AC 207 V ... 264 V, 45 Hz ... 65 Hz	
Output voltage			3 AC 0-230/240 V	
Rated mains current				
without mains choke		A	57.8	68
with mains choke		A	-	
Apparent output power		kVA	24.6	28.9
Rated output current				
2 kHz		A	68	80
4 kHz		A	68	80
Power loss				
2 kHz		W	375	440
4 kHz		W	399	469
when the inverter is disabled		W	6	
Overcurrent cycle 180 s				
Max. output current (≤ 4 kHz)		A	85	100
Overload time	T ₁	s	60	60
Recovery time	T ₂	s	120	120
Max. output current during the recovery time		A	51	60
Overcurrent cycle 15 s				
Max. output current (≤ 4 kHz)		A	113	133
Overload time	T ₁	s	3	3
Recovery time	T ₂	s	12	12
Max. output current during the recovery time		A	51	60
Max. motor cable length shielded				
without EMC category		m	-	
Category C1 (4 kHz)		m	-	
Category C2 (4 kHz)		m	10	
Category C3 (4 kHz)		m	50	
Max. motor cable length unshielded				
without EMC category		m	100	



7.2.2 Fusing data (EN 60204-1)



- 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](#) 57

Standard short-circuit strength

Inverter	Fuse (IEC 60269-1)			Circuit breaker (IEC 60947-2)			RCD (IEC 62423)		
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type	Number of devices per RCD
	kA		A	kA		A	mA		
i000M137C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M155C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M175C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M211C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M215C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M222C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M230C	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M240C	5	gG	32	5	B	32	≥ 30	Typ B	1
i000M255C	5	gG	32	5	B	32	≥ 30	Typ B	1
i000M275C	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M311C	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M315C	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M318C	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M322C	10	gR	125	10	B	100	≥ 30	Typ B	1

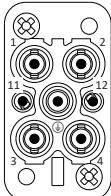
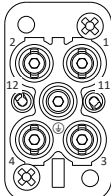
Increased short-circuit strength

Inverter	Fuse (IEC 60269-1)			Circuit breaker (IEC 60947-2)			RCD (IEC 62423)		
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type	Number of devices per RCD
	kA		A	kA		A	mA		
i000M137C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M155C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M175C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M211C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M215C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M222C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M230C	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M240C	65	gG	30	65	B	30	≥ 30	Typ B	1
i000M255C	65	gG	30	65	B	30	≥ 30	Typ B	1
i000M275C	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M311C	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M315C	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M318C	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M322C	65	gR	125	65	B	100	≥ 30	Typ B	1



7.2.3 Connection data

Rated power	P _{rated}	kW	0.37 ... 5.5													
Connection			Mains connection													
Connection type			Han Q4/2													
Connector name			Q4/2 male							Q4/2 female (Daisy Chain)						
Connection designation			X100.1							X100.2						
Pin			⊕	1	2	3	4	11	12	⊕	1	2	3	4	11	12
Pin name			PE	L1.1	L2.1	L3.1	n.c.	24E	GND	PE	L1.2	L2.2	L3.2	n.c.	24E	GND
Max. cable cross-section		mm ²	6	6	6	6	-	2.5	2.5	6	6	6	6	-	2.5	2.5
Max. cable cross-section		AWG	10	10	10	10	-	14	14	10	10	10	10	-	14	14
Min. cable cross-section		mm ²	1.5	1.5	1.5	1.5	-	0.14	0.14	1.5	1.5	1.5	1.5	-	0.14	0.14
Min. cable cross-section		AWG	16	16	16	16	-	26	26	16	16	16	16	-	26	26

Han Q4/2 male	Han Q4/2 female
	

Rated power	P _{rated}	kW	7.5 ... 22													
Connection			Mains connection													
Connection designation			X100													
Connection system			Screw terminal													
Connection type			Non-pluggable													
Max. cable cross-section		mm ²	35													
Max. cable cross-section		AWG	2													
Min. cable cross-section		mm ²	0.5													
Min. cable cross-section		AWG	20													
Stripping length		mm	18													
Stripping length		in	0.7													
Tightening torque		Nm	3.8													
Tightening torque		lb-in	34													
Required tools			Torx key 20													



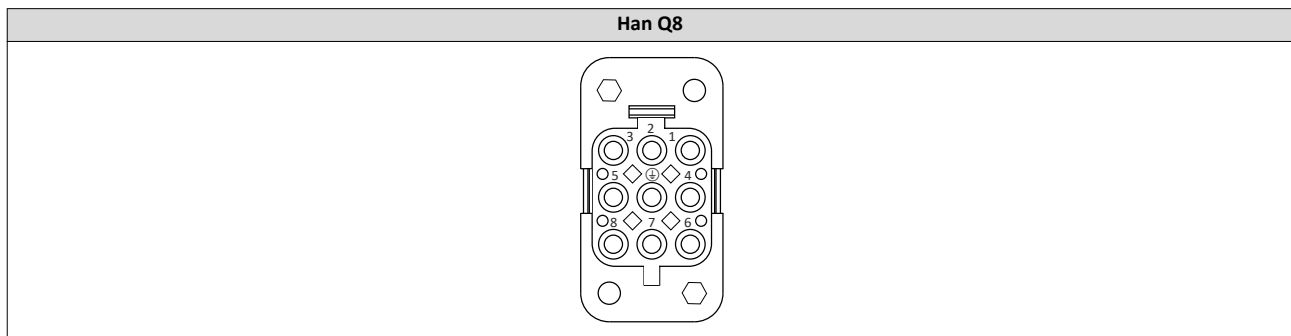
Technical data

3-phase mains connection 230/240 V

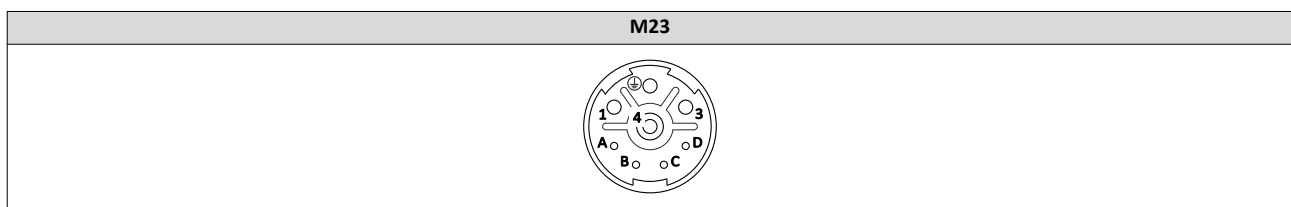
Connection data

Rated power	P _{rated}	kW	0.37 ... 3	4 ... 5.5	7.5 ... 22
Connection			Protective earth (PE)		
Connection designation			Symbol for protective earth (PE)		
Connection system			Screw		
Max. cable cross-section		mm ²	6	16	25
Max. cable cross-section		AWG	10	6	3
Min. cable cross-section		mm ²	1.5	2.5	4
Min. cable cross-section		AWG	16	14	12
Stripping length		mm	10	12	18
Stripping length		in	0.4	0.47	0.7
Tightening torque		Nm	2	3.4	4
Tightening torque		lb-in	18	30	35
Required tool			Torx key 20	Torx key 25	Torx key 30

Rated power	P _{rated}	kW	0.37 ... 5.5								
Connection			Motor connection								
Connection designation			X105								
Connection type			Han Q8								
Pin			1	2	3	4	5	6	7	8	⊕
Pin name			U	n.c.	W	BD1	T1	BD2	V	T2	PE



Rated power	P _{rated}	kW	0.37 ... 5.5							
Connection			Motor connection							
Connection designation			X105							
Connection type			M23							
Pin			1	3	4	A	B	C	D	⊕
Pin name			U	V	W	T1	T2	BD1	BD2	PE



Technical data

3-phase mains connection 230/240 V
Connection data



Rated power	P _{rated}	kW	7.5 ... 22							
Connection			Motor connection							
Connection designation			X105							
Connection type			M40							
Pin			-	+	1	2	⊕	V	V	W
Pin name			BD2	BD1	T1	T2	PE	U	V	W

M40										

Rated power	P _{rated}	kW	0.37 ... 3	4 ... 5.5	7.5 ... 22
Connection			Motor connection		
Connection designation			X105		
Connection system			Spring terminal		Screw terminal
Connection type			Non-pluggable		
Max. cable cross-section		mm ²	2.5	16	35
Max. cable cross-section		AWG	14	4	2
Min. cable cross-section		mm ²	0.14	0.75	0.5
Min. cable cross-section		AWG	26	18	20
Stripping length		mm	8	18	18
Stripping length		in	0.32	0.7	0.7
Tightening torque		Nm	-	-	3.8
Tightening torque		lb-in	-	-	34
Required tools			Slotted screwdriver 0.6 x 3.5	Slotted screwdriver 0.8 x 4.0	Torx key 20

Rated power	P _{rated}	kW	7.5 ... 22	
Connection			24 V supply for control electronics	
Connection designation			X5	
Connection system			Spring terminal	
Pin name			24E	GND
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	9	
Stripping length		in	0.35	
Required tools			Slotted screwdriver 0.5 x 3.0	



Technical data

3-phase mains connection 230/240 V
Connection data

Rated power	P _{rated}	kW	4 ... 22	
Connection			Motor brake	
Connection designation			X106	
Connection system			Spring terminal	
Pin name			BD1	BD2
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	9	
Stripping length		in	0.35	
Required tools			Slotted screwdriver 0.5 x 3.0	

Rated power	P _{rated}	kW	4 ... 5.5		7.5 ... 22	
Connection			Motor temperature monitoring			
Connection designation			X109			
Connection system			Spring terminal		Screw terminal	
Pin name			T2	T1	T2	T1
Max. cable cross-section		mm ²	1.5	1.5	1.5	1.5
Max. cable cross-section		AWG	16	16	16	16
Min. cable cross-section		mm ²	0.25	0.25	0.25	0.25
Min. cable cross-section		AWG	22	22	22	22
Stripping length		mm	9		6	
Stripping length		in	0.35		0.24	
Required tools			Slotted screwdriver 0.4 x 2.5			



7.3 3-phase mains connection 400 V

7.3.1 Rated data

- The output currents apply to an ambient temperature of max. 40 °C (104 °F).
- The maximally possible output voltage is approx. 87 % of the mains voltage.

Product name			i000-M0.37/400-3	i000-M0.55/400-3	i000-M0.75/400-3	i000-M1.1/400-3
Rated power	P_{rated}	kW	0.37	0.55	0.75	1.1
Rated power	P_{rated}	hp	0.5	0.75	1	1.5
Mains voltage range			3 AC 360 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-400/480 V			
Rated mains current						
without mains choke		A	1.2	1.6	2.2	2.9
with mains choke		A	-			
Apparent output power		kVA	0.8	1.1	1.4	1.9
Rated output current						
2 kHz		A	1.3	1.8	2.4	3.2
8 kHz		A	1.3	1.8	2.4	3.2
12 kHz		A	1	1.4	1.9	2.6
16 kHz		A	0.9	1.2	1.6	2.1
Power loss						
2 kHz		W	18	22	28	35
8 kHz		W	22	29	36	47
12 kHz		W	22	28	35	45
16 kHz		W	22	28	35	45
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	2	2.7	3.6	4.8
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	1.4	1.8	2.4
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	2.6	3.6	4.8	6.4
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	1	1.4	1.8	2.4
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data

3-phase mains connection 400 V
Rated data

Product name			i□□□-M1.5/400-3	i□□□-M2.2/400-3	i□□□-M3.0/400-3	i□□□-M4.0/400-3
Rated power	P _{rated}	kW	1.5	2.2	3	4
Rated power	P _{rated}	hp	2	3	4	5
Mains voltage range			3 AC 360 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-400/480 V			
Rated mains current						
without mains choke		A	3.5	5.0	6.6	8.6
with mains choke		A	-			
Apparent output power		kVA	2.4	3.4	4.4	5.7
Rated output current						
2 kHz		A	3.9	5.6	7.3	9.5
8 kHz		A	3.9	5.6	7.3	9.5
12 kHz		A	3.1	4.5	6.2	8.1
16 kHz		A	2.6	3.7	5.2	6.8
Power loss						
2 kHz		W	41	57	72	92
8 kHz		W	55	77	98	126
12 kHz		W	53	74	100	128
16 kHz		W	53	74	101	129
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	5.9	8.4	11	14.3
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	2.9	4.2	5.5	7.1
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	7.8	11.2	14.6	19
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	2.9	4.2	5.5	7.1
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 400 V
Rated data



Product name			i□□□-M5.5/400-3	i□□□-M7.5/400-3	i□□□-M11/400-3	i□□□-M15/400-3
Rated power	P _{rated}	kW	5.5	7.5	11	15
Rated power	P _{rated}	hp	7.5	10	15	20
Mains voltage range			3 AC 360 V ... 440 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-400/480 V			
Rated mains current						
without mains choke		A	11.7	14	20	27.2
with mains choke		A	-			
Apparent output power		kVA	7.8	9.9	14.2	19.3
Rated output current						
2 kHz		A	13	16.5	23.5	32
8 kHz		A	13	16.5	23.5	32
12 kHz		A	11.1	14	20	28.8
16 kHz		A	9.3	11.9	17	22.4
Power loss						
2 kHz		W	124	155	218	295
8 kHz		W	171	215	303	411
12 kHz		W	173	217	307	416
16 kHz		W	174	222	313	424
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	19.5	24.8	35.3	48
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	9.8	12.4	17.6	24
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	26	33	47	64
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	9.8	12.4	17.6	24
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data

3-phase mains connection 400 V
Rated data

Product name			i□□□-M18/400-3	i□□□-M22/400-3	i□□□-M30/400-3
Rated power	P _{rated}	kW	18.5	22	30
Rated power	P _{rated}	hp	25	30	40
Mains voltage range			3 AC 360 V ... 440 V, 45 Hz ... 65 Hz		
Output voltage			3 AC 0-400/480 V		
Rated mains current					
without mains choke		A	34	40	51.9
with mains choke		A	-		
Apparent output power		kVA	24.1	28.3	36.8
Rated output current					
2 kHz		A	40	47	61
8 kHz		A	40	47	61
12 kHz		A	36	40.0	-
16 kHz		A	29.2	32.0	-
Power loss					
2 kHz		W	368	431	558
8 kHz		W	512	601	778
12 kHz		W	548	643	-
16 kHz		W	585	601	-
when the inverter is disabled		W	6		
Overcurrent cycle 180 s					
Max. output current (≤ 8 kHz)		A	60	70.5	91.5
Overload time	T ₁	s	60	60	60
Recovery time	T ₂	s	120	120	120
Max. output current during the recovery time		A	30	35.3	45.8
Overcurrent cycle 15 s					
Max. output current (≤ 8 kHz)		A	80	94	122
Overload time	T ₁	s	3	3	3
Recovery time	T ₂	s	12	12	12
Max. output current during the recovery time		A	30	35.3	45.8
Max. motor cable length shielded					
without EMC category		m	-		
Category C1 (8 kHz)		m	-		
Category C2 (8 kHz)		m	10		
Category C3 (8 kHz)		m	50		
Max. motor cable length unshielded					
without EMC category		m	100		

Technical data

3-phase mains connection 400 V
Rated data



Product name			i□□□-M37/400-3	i□□□-M45/400-3
Rated power	P _{rated}	kW	37	45
Rated power	P _{rated}	hp	50	60
Mains voltage range			3 AC 360 V ... 440 V, 45 Hz ... 65 Hz	
Output voltage			3 AC 0-400/480 V	
Rated mains current				
without mains choke		A	64.6	71.4
with mains choke		A	-	
Apparent output power		kVA	45.8	50.6
Rated output current				
2 kHz		A	76	84
4 kHz		A	76	84
Power loss				
2 kHz		W	693	765
4 kHz		W	739	816
when the inverter is disabled		W	6	
Overcurrent cycle 180 s				
Max. output current (≤ 4 kHz)		A	95	105
Overload time	T ₁	s	60	60
Recovery time	T ₂	s	120	120
Max. output current during the recovery time		A	47.5	52.5
Overcurrent cycle 15 s				
Max. output current (≤ 4 kHz)		A	127	140
Overload time	T ₁	s	3	3
Recovery time	T ₂	s	12	12
Max. output current during the recovery time		A	47.5	52.5
Max. motor cable length shielded				
without EMC category		m	-	
Category C1 (4 kHz)		m	-	
Category C2 (4 kHz)		m	10	
Category C3 (4 kHz)		m	50	
Max. motor cable length unshielded				
without EMC category		m	100	



7.3.2 Fusing data (EN 60204-1)



- 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](#) 57

Standard short-circuit strength

Inverter	Fuse (IEC 60269-1)			Circuit breaker (IEC 60947-2)			RCD (IEC 62423)		
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type	Number of devices per RCD
	kA		A	kA		A	mA		
i000M137F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M155F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M175F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M211F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M215F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M222F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M230F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M240F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M255F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M275F	5	gG	32	5	B	32	≥ 30	Typ B	1
i000M311F	5	gG	32	5	B	32	≥ 30	Typ B	1
i000M315F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M318F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M322F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M330F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M337F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M345F	10	gR	125	10	B	100	≥ 30	Typ B	1

Increased short-circuit strength

Inverter	Fuse (IEC 60269-1)			Circuit breaker (IEC 60947-2)			RCD (IEC 62423)		
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type	Number of devices per RCD
	kA		A	kA		A	mA		
i000M137F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M155F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M175F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M211F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M215F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M222F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M230F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M240F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M255F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M275F	65	gG	30	65	B	30	≥ 30	Typ B	1
i000M311F	65	gG	30	65	B	30	≥ 30	Typ B	1
i000M315F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M318F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M322F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M330F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M337F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M345F	65	gR	125	65	B	100	≥ 30	Typ B	1



7.3.3 Connection data

Rated power	P _{rated}	kW	0.37 ... 11													
Connection			Mains connection													
Connection type			Han Q4/2													
Connector name			Q4/2 male							Q4/2 female (Daisy Chain)						
Connection designation			X100.1							X100.2						
Pin			⊕	1	2	3	4	11	12	⊕	1	2	3	4	11	12
Pin name			PE	L1.1	L2.1	L3.1	n.c.	24E	GND	PE	L1.2	L2.2	L3.2	n.c.	24E	GND
Max. cable cross-section		mm ²	6	6	6	6	-	2.5	2.5	6	6	6	6	-	2.5	2.5
Max. cable cross-section		AWG	10	10	10	10	-	14	14	10	10	10	10	-	14	14
Min. cable cross-section		mm ²	1.5	1.5	1.5	1.5	-	0.14	0.14	1.5	1.5	1.5	1.5	-	0.14	0.14
Min. cable cross-section		AWG	16	16	16	16	-	26	26	16	16	16	16	-	26	26

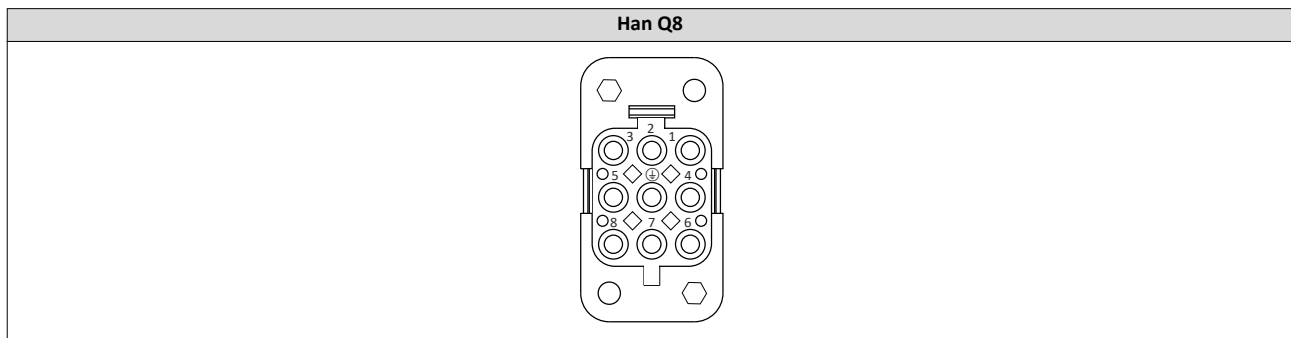
Han Q4/2 male	Han Q4/2 female

Rated power	P _{rated}	kW	15 ... 45													
Connection			Mains connection													
Connection designation			X100													
Connection system			Screw terminal													
Connection type			Non-pluggable													
Max. cable cross-section		mm ²	35													
Max. cable cross-section		AWG	2													
Min. cable cross-section		mm ²	0.5													
Min. cable cross-section		AWG	20													
Stripping length		mm	18													
Stripping length		in	0.7													
Tightening torque		Nm	3.8													
Tightening torque		lb-in	34													
Required tools			Torx key 20													

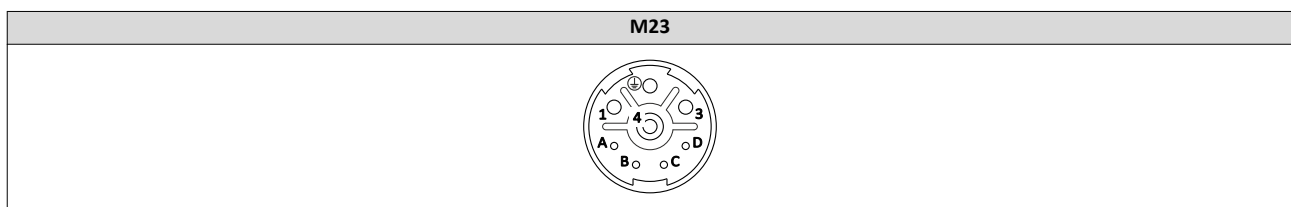


Rated power	P _{rated}	kW	0.37 ... 5.5	7.5 ... 11	15 ... 45
Connection			Protective earth (PE)		
Connection designation			Symbol for protective earth (PE)		
Connection system			Screw		
Max. cable cross-section		mm ²	6	16	25
Max. cable cross-section		AWG	10	6	3
Min. cable cross-section		mm ²	1.5	2.5	4
Min. cable cross-section		AWG	16	14	12
Stripping length		mm	10	12	18
Stripping length		in	0.4	0.47	0.7
Tightening torque		Nm	2	3.4	4
Tightening torque		lb-in	18	30	35
Required tool			Torx key 20	Torx key 25	Torx key 30

Rated power	P _{rated}	kW	0.37 ... 11								
Connection			Motor connection								
Connection designation			X105								
Connection type			Han Q8								
Pin			1	2	3	4	5	6	7	8	⊕
Pin name			U	n.c.	W	BD1	T1	BD2	V	T2	PE



Rated power	P _{rated}	kW	0.37 ... 11							
Connection			Motor connection							
Connection designation			X105							
Connection type			M23							
Pin			1	3	4	A	B	C	D	⊕
Pin name			U	V	W	T1	T2	BD1	BD2	PE



Technical data

3-phase mains connection 400 V
Connection data



Rated power	P _{rated}	kW	15 ... 45							
Connection			Motor connection							
Connection designation			X105							
Connection type			M40							
Pin			-	+	1	2	⊕	V	V	W
Pin name			BD2	BD1	T1	T2	PE	U	V	W

M40										

Rated power	P _{rated}	kW	0.37 ... 5.5	7.5 ... 11	15 ... 45
Connection			Motor connection		
Connection designation			X105		
Connection system			Spring terminal		Screw terminal
Connection type			Non-pluggable		
Max. cable cross-section		mm ²	2.5	16	35
Max. cable cross-section		AWG	14	4	2
Min. cable cross-section		mm ²	0.14	0.75	0.5
Min. cable cross-section		AWG	26	18	20
Stripping length		mm	8	18	18
Stripping length		in	0.32	0.7	0.7
Tightening torque		Nm	-	-	3.8
Tightening torque		lb-in	-	-	34
Required tools			Slotted screwdriver 0.6 x 3.5	Slotted screwdriver 0.8 x 4.0	Torx key 20

Rated power	P _{rated}	kW	15 ... 45	
Connection			24 V supply for control electronics	
Connection designation			X5	
Connection system			Spring terminal	
Pin name			24E	GND
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	9	
Stripping length		in	0.35	
Required tools			Slotted screwdriver 0.5 x 3.0	



Rated power	P _{rated}	kW	7.5 ... 45	
Connection			Motor brake	
Connection designation			X106	
Connection system			Spring terminal	
Pin name			BD1	BD2
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	9	
Stripping length		in	0.35	
Required tools			Slotted screwdriver 0.5 x 3.0	

Rated power	P _{rated}	kW	7.5 ... 11		15 ... 45	
Connection			Motor temperature monitoring			
Connection designation			X109			
Connection system			Spring terminal		Screw terminal	
Pin name			T2	T1	T2	T1
Max. cable cross-section		mm ²	1.5	1.5	1.5	1.5
Max. cable cross-section		AWG	16	16	16	16
Min. cable cross-section		mm ²	0.25	0.25	0.25	0.25
Min. cable cross-section		AWG	22	22	22	22
Stripping length		mm	9		6	
Stripping length		in	0.35		0.24	
Required tools			Slotted screwdriver 0.4 x 2.5			



7.4 3-phase mains connection 480 V

7.4.1 Rated data

- The output currents apply to an ambient temperature of max. 40 °C (104 °F).
- The maximally possible output voltage is approx. 87 % of the mains voltage.

Product name			i000-M0.37/400-3	i000-M0.55/400-3	i000-M0.75/400-3	i000-M1.1/400-3
Rated power	P_{rated}	kW	0.37	0.55	0.75	1.1
Rated power	P_{rated}	hp	0.5	0.75	1	1.5
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-400/480 V			
Rated mains current						
without mains choke		A	1.0	1.4	1.9	2.7
with mains choke		A	-			
Apparent output power		kVA	0.8	1.2	1.5	2.2
Rated output current						
2 kHz		A	1.1	1.6	2.1	3
8 kHz		A	1.1	1.6	2.1	3
12 kHz		A	0.9	1.3	1.7	2.4
16 kHz		A	0.7	1.1	1.4	2
Power loss						
2 kHz		W	18	23	29	39
8 kHz		W	23	30	38	52
12 kHz		W	22	29	36	49
16 kHz		W	22	29	36	49
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	1.7	2.4	3.2	4.5
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	0.8	1.2	1.6	2.3
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	2.2	3.2	4.2	6
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	0.8	1.2	1.6	2.3
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data

3-phase mains connection 480 V
Rated data

Product name			i□□□-M1.5/400-3	i□□□-M2.2/400-3	i□□□-M3.0/400-3	i□□□-M4.0/400-3
Rated power	P _{rated}	kW	1.5	2.2	3	4
Rated power	P _{rated}	hp	2	3	4	5
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-400/480 V			
Rated mains current						
without mains choke		A	3.2	4.3	5.7	7.4
with mains choke		A	-			
Apparent output power		kVA	2.5	3.5	4.6	5.9
Rated output current						
2 kHz		A	3.5	4.8	6.3	8.2
8 kHz		A	3.5	4.8	6.3	8.2
12 kHz		A	2.8	3.8	5.4	7.0
16 kHz		A	2.3	3.2	4.5	5.9
Power loss						
2 kHz		W	44	58	74	95
8 kHz		W	59	79	102	131
12 kHz		W	57	75	103	132
16 kHz		W	57	75	104	134
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	5.3	7.2	9.5	12.3
Overload time	T ₁	s	60	60	60	60
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	2.6	3.6	4.7	6.2
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	7	9.6	12.6	16.4
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	2.6	3.6	4.7	6.2
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			

Technical data

3-phase mains connection 480 V

Rated data



Product name			i□□□-M5.5/400-3	i□□□-M7.5/400-3	i□□□-M11/400-3	i□□□-M15/400-3
Rated power	P _{rated}	kW	5.5	7.5	11	15
Rated power	P _{rated}	hp	7.5	10	15	20
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz			
Output voltage			3 AC 0-400/480 V			
Rated mains current						
without mains choke		A	9.9	11.9	17.9	23
with mains choke		A	-			
Apparent output power		kVA	8.0	10.1	15.2	19.5
Rated output current						
2 kHz		A	11	14	21	27
8 kHz		A	11	14	21	27
12 kHz		A	9.4	11.9	17.9	24.3
16 kHz		A	7.9	10.1	15.2	18.9
Power loss						
2 kHz		W	125	158	234	299
8 kHz		W	173	219	325	416
12 kHz		W	175	221	329	421
16 kHz		W	177	226	335	430
when the inverter is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	16.5	21	31.5	40.5
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	8.3	10.5	15.8	20.3
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	22	28	42	54
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	8.3	10.5	15.8	20.3
Max. motor cable length shielded						
without EMC category		m	-			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	50			
Max. motor cable length unshielded						
without EMC category		m	100			



Technical data

3-phase mains connection 480 V
Rated data

Product name			i□□□-M18/400-3	i□□□-M22/400-3	i□□□-M30/400-3
Rated power	P _{rated}	kW	18.5	22	30
Rated power	P _{rated}	hp	25	30	40
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz		
Output voltage			3 AC 0-400/480 V		
Rated mains current					
without mains choke		A	28.9	34.3	44.2
with mains choke		A	-		
Apparent output power		kVA	24.6	29.2	37.6
Rated output current					
2 kHz		A	34	40.4	52
8 kHz		A	34	40.4	52
12 kHz		A	30.6	34.3	-
16 kHz		A	24.8	27.5	-
Power loss					
2 kHz		W	375	444	570
8 kHz		W	522	620	796
12 kHz		W	559	663	-
16 kHz		W	596	620	-
when the inverter is disabled		W	6		
Overcurrent cycle 180 s					
Max. output current (≤ 8 kHz)		A	51	60.6	78
Overload time	T ₁	s	60	60	60
Recovery time	T ₂	s	120	120	120
Max. output current during the recovery time		A	25.5	30.3	39
Overcurrent cycle 15 s					
Max. output current (≤ 8 kHz)		A	68	80.8	104
Overload time	T ₁	s	3	3	3
Recovery time	T ₂	s	12	12	12
Max. output current during the recovery time		A	25.5	30.3	39
Max. motor cable length shielded					
without EMC category		m	-		
Category C1 (8 kHz)		m	-		
Category C2 (8 kHz)		m	10		
Category C3 (8 kHz)		m	50		
Max. motor cable length unshielded					
without EMC category		m	100		

Technical data

3-phase mains connection 480 V
Rated data



Product name			i□□□-M37/400-3	i□□□-M45/400-3
Rated power	P _{rated}	kW	37	45
Rated power	P _{rated}	hp	50	60
Mains voltage range			3 AC 432 V ... 528 V, 45 Hz ... 65 Hz	
Output voltage			3 AC 0-400/480 V	
Rated mains current				
without mains choke		A	55.3	65.5
with mains choke		A	-	
Apparent output power		kVA	47	55.7
Rated output current				
2 kHz		A	65	77
4 kHz		A	65	77
Power loss				
2 kHz		W	711	841
4 kHz		W	758	897
when the inverter is disabled		W	6	
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	81.3	96.3
Overload time	T ₁	s	60	60
Recovery time	T ₂	s	120	120
Max. output current during the recovery time		A	48.8	57.8
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	108	128
Overload time	T ₁	s	3	3
Recovery time	T ₂	s	12	12
Max. output current during the recovery time		A	48.8	57.8
Max. motor cable length shielded				
without EMC category		m	-	
Category C1 (4 kHz)		m	-	
Category C2 (4 kHz)		m	10	
Category C3 (4 kHz)		m	50	
Max. motor cable length unshielded				
without EMC category		m	100	



7.4.2 Fusing data (EN 60204-1)



- 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](#) 57

Standard short-circuit strength

Inverter	Fuse (IEC 60269-1)			Circuit breaker (IEC 60947-2)			RCD (IEC 62423)		
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type	Number of devices per RCD
	kA		A	kA		A	mA		
i000M137F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M155F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M175F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M211F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M215F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M222F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M230F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M240F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M255F	5	gG	32	5	B	32	≥ 30	Typ B	3
i000M275F	5	gG	32	5	B	32	≥ 30	Typ B	1
i000M311F	5	gG	32	5	B	32	≥ 30	Typ B	1
i000M315F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M318F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M322F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M330F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M337F	10	gR	125	10	B	100	≥ 30	Typ B	1
i000M345F	10	gR	125	10	B	100	≥ 30	Typ B	1

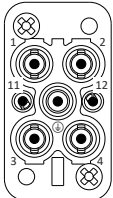
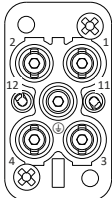
Increased short-circuit strength

Inverter	Fuse (IEC 60269-1)			Circuit breaker (IEC 60947-2)			RCD (IEC 62423)		
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type	Number of devices per RCD
	kA		A	kA		A	mA		
i000M137F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M155F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M175F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M211F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M215F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M222F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M230F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M240F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M255F	65	gG	30	42	B	20	≥ 30	Typ B	3
i000M275F	65	gG	30	65	B	30	≥ 30	Typ B	1
i000M311F	65	gG	30	65	B	30	≥ 30	Typ B	1
i000M315F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M318F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M322F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M330F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M337F	65	gR	125	65	B	100	≥ 30	Typ B	1
i000M345F	65	gR	125	65	B	100	≥ 30	Typ B	1



7.4.3 Connection data

Rated power	P _{rated}	kW	0.37 ... 11													
Connection			Mains connection													
Connection type			Han Q4/2													
Connector name			Q4/2 male							Q4/2 female (Daisy Chain)						
Connection designation			X100.1							X100.2						
Pin			⊕	1	2	3	4	11	12	⊕	1	2	3	4	11	12
Pin name			PE	L1.1	L2.1	L3.1	n.c.	24E	GND	PE	L1.2	L2.2	L3.2	n.c.	24E	GND
Max. cable cross-section		mm ²	6	6	6	6	-	2.5	2.5	6	6	6	6	-	2.5	2.5
Max. cable cross-section		AWG	10	10	10	10	-	14	14	10	10	10	10	-	14	14
Min. cable cross-section		mm ²	1.5	1.5	1.5	1.5	-	0.14	0.14	1.5	1.5	1.5	1.5	-	0.14	0.14
Min. cable cross-section		AWG	16	16	16	16	-	26	26	16	16	16	16	-	26	26

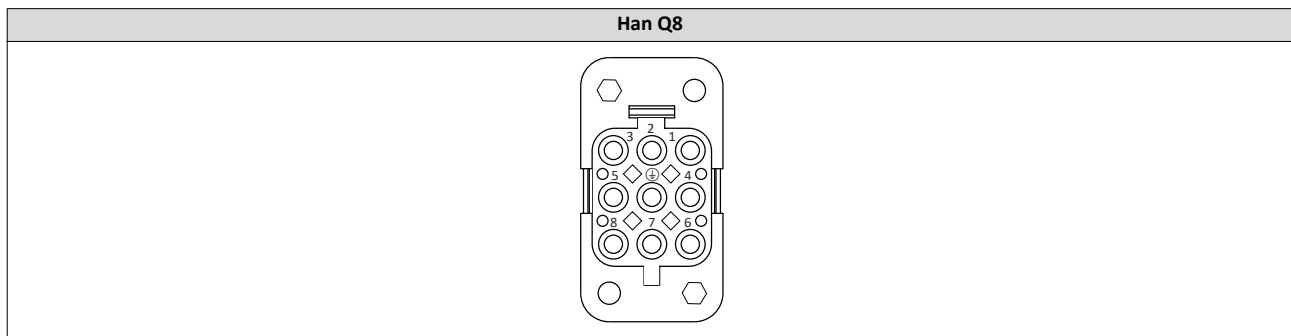
Han Q4/2 male	Han Q4/2 female
	

Rated power	P _{rated}	kW	15 ... 45													
Connection			Mains connection													
Connection designation			X100													
Connection system			Screw terminal													
Connection type			Non-pluggable													
Max. cable cross-section		mm ²	35													
Max. cable cross-section		AWG	2													
Min. cable cross-section		mm ²	0.5													
Min. cable cross-section		AWG	20													
Stripping length		mm	18													
Stripping length		in	0.7													
Tightening torque		Nm	3.8													
Tightening torque		lb-in	34													
Required tools			Torx key 20													

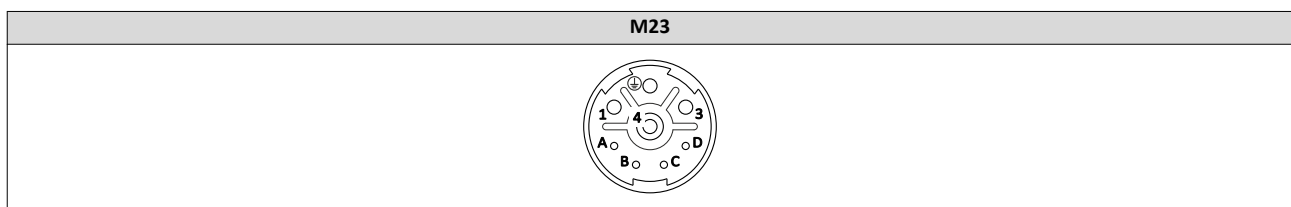


Rated power	P _{rated}	kW	0.37 ... 5.5	7.5 ... 11	15 ... 45
Connection			Protective earth (PE)		
Connection designation			Symbol for protective earth (PE)		
Connection system			Screw		
Max. cable cross-section		mm ²	6	16	25
Max. cable cross-section		AWG	10	6	3
Min. cable cross-section		mm ²	1.5	2.5	4
Min. cable cross-section		AWG	16	14	12
Stripping length		mm	10	12	18
Stripping length		in	0.4	0.47	0.7
Tightening torque		Nm	2	3.4	4
Tightening torque		lb-in	18	30	35
Required tool			Torx key 20	Torx key 25	Torx key 30

Rated power	P _{rated}	kW	0.37 ... 11								
Connection			Motor connection								
Connection designation			X105								
Connection type			Han Q8								
Pin			1	2	3	4	5	6	7	8	⊕
Pin name			U	n.c.	W	BD1	T1	BD2	V	T2	PE



Rated power	P _{rated}	kW	0.37 ... 11							
Connection			Motor							
Connection designation			X105							
Connection type			M23							
Pin			1	3	4	A	B	C	D	⊕
Pin name			U	V	W	T1	T2	BD1	BD2	PE

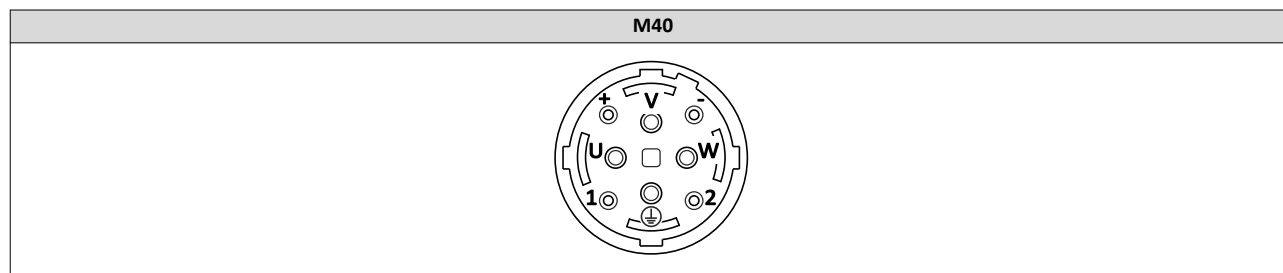


Technical data

3-phase mains connection 480 V
Connection data



Rated power	P _{rated}	kW	15 ... 45							
Connection			Motor							
Connection designation			X105							
Connection type			M40							
Pin			-	+	1	2	⊕	V	V	W
Pin name			BD2	BD1	T1	T2	PE	U	V	W



Rated power	P _{rated}	kW	0.37 ... 5.5	7.5 ... 11	15 ... 45
Connection			Motor connection		
Connection designation			X105		
Connection system			Spring terminal		Screw terminal
Connection type			Non-pluggable		
Max. cable cross-section		mm ²	2.5	16	35
Max. cable cross-section		AWG	14	4	2
Min. cable cross-section		mm ²	0.14	0.75	0.5
Min. cable cross-section		AWG	26	18	20
Stripping length		mm	8	18	18
Stripping length		in	0.32	0.7	0.7
Tightening torque		Nm	-	-	3.8
Tightening torque		lb-in	-	-	34
Required tools			Slotted screwdriver 0.6 x 3.5	Slotted screwdriver 0.8 x 4.0	Torx key 20

Rated power	P _{rated}	kW	15 ... 45	
Connection			24 V supply for control electronics	
Connection designation			X5	
Connection system			Spring terminal	
Pin name			24E	GND
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	9	
Stripping length		in	0.35	
Required tools			Slotted screwdriver 0.5 x 3.0	



Technical data

3-phase mains connection 480 V
Connection data

Rated power	P _{rated}	kW	7.5 ... 45	
Connection			Motor brake	
Connection designation			X106	
Connection system			Spring terminal	
Pin name			BD1	BD2
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	22	22
Stripping length		mm	9	
Stripping length		in	0.35	
Required tools			Slotted screwdriver 0.5 x 3.0	

Rated power	P _{rated}	kW	7.5 ... 11		15 ... 45	
Connection			Motor temperature monitoring			
Connection designation			X109			
Connection system			Spring terminal		Screw terminal	
Pin name			T2	T1	T2	T1
Max. cable cross-section		mm ²	1.5	1.5	1.5	1.5
Max. cable cross-section		AWG	16	16	16	16
Min. cable cross-section		mm ²	0.25	0.25	0.25	0.25
Min. cable cross-section		AWG	22	22	22	22
Stripping length		mm	9		6	
Stripping length		in	0.35		0.24	
Required tools			Slotted screwdriver 0.4 x 2.5			



7.5 Ecodesign Directive

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

Legend

□□	Wildcard for product series (55 for i550, 65 for i650)
Operating point (f; I)	f = relative motor stator frequency; I = relative torque-producing current
Power losses	The power losses at the operating points (f; I) and in the standby state refer to the rated apparent output power. The power losses for options (e.g. for diagnostics) and for accessories can be found in the additional product documentation on the Internet.

Performance losses										
0; 25	f; I	%	2.8	2.7	1.8	1.6	1.5	1.6	2.0	1.7
0; 50	f; I	%	2.9	2.7	1.9	1.8	1.7	1.8	2.3	2.0
0; 100	f; I	%	3.1	3.0	2.4	2.4	2.2	2.3	3.0	2.7
50; 25	f; I	%	2.9	2.7	1.8	1.6	1.6	1.6	2.1	1.8
50; 50	f; I	%	2.9	2.8	2.0	1.9	1.8	1.9	2.4	2.1
50; 100	f; I	%	3.3	3.2	2.5	2.5	2.3	2.4	3.2	2.9
90; 50	f; I	%	3.0	2.8	2.1	2.0	1.8	1.9	2.5	2.2
90; 100	f; I	%	3.0	3.0	2.4	2.4	2.2	2.3	3.0	2.8
In standby mode		%	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY							
Commercial register number			Hannover HRB 204803							
Model identifier of the product			□□AM137 C	□□AM155 C	□□AM175 C	□□AM211 C	□□AM215 C	□□AM222 C	□□AM230 C	□□AM240 C
Apparent output power		kVA	0.8	1.1	1.5	2.1	2.4	3.3	4.2	5.7
Indicative rated output power of the motor		kW	0.37	0.55	0.75	1.1	1.5	2.2	3	4
Rated output current		A	2.4	3.2	4.2	6	7	9.6	12	16.5
Maximum operating temperature		°C	40							
Rated input frequency		Hz	50							
Rated input voltage		V	230							
Switching frequency		kHz	8							
Rated apparent output power		kVA	0.977	1.19	1.71	2.29	3.3	4.44	4.44	5.85



Performance losses										
0; 25	f; l	%	1.0	0.8	0.9	1.1	0.7	0.7	3.6	3.2
0; 50	f; l	%	1.2	1.0	1.1	1.5	0.9	0.9	3.6	3.2
0; 100	f; l	%	1.9	1.7	1.9	2.5	1.7	1.8	3.8	3.4
50; 25	f; l	%	1.0	0.9	0.9	1.2	0.7	0.7	3.6	3.2
50; 50	f; l	%	1.3	1.1	1.2	1.6	1.1	1.1	3.6	3.2
50; 100	f; l	%	2.1	1.8	2.1	2.7	2.0	2.1	3.9	3.5
90; 50	f; l	%	1.4	1.2	1.3	1.7	1.2	1.2	3.7	3.3
90; 100	f; l	%	2.1	1.9	2.0	2.8	2.2	2.3	3.4	3.1
In standby mode		%	0.1	0.1	0.1	0.1	0.1	0.1	0.6	0.5
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY							
Commercial register number			Hannover HRB 204803							
Model identifier of the product			l□□AM255 C	l□□AM275 C	l□□AM311 C	l□□AM315 C	l□□AM318 C	l□□AM322 C	l□□AM137 F	l□□AM155 F
Apparent output power		kVA	8.0	10.0	14.6	18.7	23.6	27.7	0.8	1.1
Indicative rated output power of the motor		kW	5.5	7.5	11.0	15.0	18.5	22.0	0.37	0.55
Rated output current		A	23	29	42	54	68	80	1.3	1.8
Maximum operating temperature		°C	40							
Rated input frequency		Hz	50							
Rated input voltage		V	230						400	
Switching frequency		kHz	8				4		8	
Rated apparent output power		kVA	9.95	14.4	19.5	19.5	23.9	28.3	0.977	1.19



Performance losses										
0; 25	f; l	%	2.1	1.8	1.4	1.3	1.9	1.9	1.2	1.3
0; 50	f; l	%	2.3	1.9	1.5	1.5	2.1	2.1	1.4	1.5
0; 100	f; l	%	2.6	2.3	1.8	1.8	2.6	2.6	1.9	2.2
50; 25	f; l	%	2.2	1.8	1.4	1.3	1.9	1.9	1.2	1.3
50; 50	f; l	%	2.3	2.0	1.5	1.5	2.2	2.1	1.4	1.6
50; 100	f; l	%	2.7	2.3	1.9	1.9	2.7	2.7	2.0	2.3
90; 50	f; l	%	2.3	2.0	1.6	1.5	2.2	2.2	1.4	1.7
90; 100	f; l	%	2.4	2.1	1.7	1.8	2.4	2.4	1.8	2.2
In standby mode		%	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY							
Commercial register number			Hannover HRB 204803							
Model identifier of the product			l□□AM175 F	l□□AM211 F	l□□AM215 F	l□□AM222 F	l□□AM230 F	l□□AM240 F	l□□AM255 F	l□□AM275 F
Apparent output power		kVA	1.5	1.9	2.4	3.4	4.4	5.7	7.8	10.0
Indicative rated output power of the motor		kW	0.75	1.1	1.5	2.2	3	4	5.5	7.5
Rated output current		A	2.4	3.2	3.9	5.6	7.3	9.5	13	16.5
Maximum operating temperature		°C	40							
Rated input frequency		Hz	50							
Rated input voltage		V	400							
Switching frequency		kHz	8							
Rated apparent output power		kVA	1.71	2.29	3.3	4.44	4.44	5.85	9.95	9.95



Performance losses									
0; 25	f; l	%	1.1	0.9	0.9	0.7	0.9	0.5	0.5
0; 50	f; l	%	1.3	1.2	1.1	0.9	1.2	0.7	0.7
0; 100	f; l	%	2.0	1.9	1.7	1.5	2.0	1.3	1.3
50; 25	f; l	%	1.1	1.0	0.9	0.8	1.0	0.5	0.5
50; 50	f; l	%	1.4	1.2	1.2	1.0	1.3	0.8	0.7
50; 100	f; l	%	2.2	2.0	1.9	1.6	2.1	1.4	1.4
90; 50	f; l	%	1.5	1.3	1.2	1.0	1.3	0.8	0.8
90; 100	f; l	%	2.1	1.9	1.7	1.5	2.0	1.5	1.5
In standby mode		%	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Efficiency level			IE2	IE2	IE2	IE2	IE2	IE2	IE2
Manufacturer			Lenze SE · Hans-Lenze-Str. 1 · 31855 Aerzen · GERMANY						
Commercial register number			Hannover HRB 204803						
Model identifier of the product			□□AM311F	□□AM315F	□□AM318F	□□AM322F	□□AM330F	□□AM337F	□□AM345F
Apparent output power		kVA	14.2	19.3	24.1	28.3	36.8	45.8	50.6
Indicative rated output power of the motor		kW	11.0	15.0	18.5	22.0	30.0	37.0	45.0
Rated output current		A	23.5	32	40	47	61	76	84
Maximum operating temperature		°C	40						
Rated input frequency		Hz	50						
Rated input voltage		V	400						
Switching frequency		kHz	8					4	
Rated apparent output power		kVA	14.4	19.5	28.3	38.2	38.2	47.0	56.2



7.6 Control connections

7.6.1 Standard-I/O

Digital inputs

Connection		X3.1 / DI1 + DI2 X3.2 / DI3 + DI4	
Switching type		PNP, NPN	Parameterizable
PNP switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
NPN switching level			
LOW	V	> +15	
HIGH	V	< +5	
Input resistance	kΩ	4.6	
Cycle time	ms	1	
External-voltage protection	V	±30	The following restriction applies to DI1 due to the switchability to DO1: External-voltage protection = +30 V. In the event of a negative voltage, the integrated freewheeling diode conducts.

Digital outputs

Connection		X3.1 / DO1	
Switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
max. output current	mA	100	
Cycle time	ms	1	
Short-circuit strength		Unlimited period	
External-voltage protection	V	+30	In the event of a negative voltage, the integrated freewheeling diode conducts.
Polarity reversal protection		Integrated freewheeling diode for switching the inductive load	
Overload behavior		Voltage reduction or switching off and on periodically	
Reset or switch-on behavior		Output is switched off	LOW

Digital inputs | Encoder inputs

Encoder input 1			
Type		Incremental HTL encoder	
Two-track connection		X3.2 / DI3 X3.2 / DI4	Track A Track B
Frequency range	kHz	0 ... 200	



24 V outputs

Application		Primarily for the supply of digital inputs.	
Connection		X3.1 / 24 V X3.2 / 24 V	
DC output voltage			
Typical	V	24	SELV/PELV
Range	V	16 ... 28	
max. output current	mA	400	Total current for all I/Os (M12 plug connector) • The maximum output current is limited to 400 mA even with an external DC supply. • Above +40 °C the max. output current is reduced by 2.5 %/°C
Short-circuit strength		Unlimited period	
External-voltage protection	V	+30	
Overcurrent fusing		Automatically resettable	



7.6.2 Application-I/O

Digital inputs

Connection		X3.1 / DI1 + DI2 X3.2 / DI3 + DI4 X3.3 / DI5 + DI6 X3.4 / DI7 + DI8	
Switching type		PNP, NPN	Parameterizable
PNP switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
NPN switching level			
LOW	V	> +15	
HIGH	V	< +5	
Input resistance	kΩ	4.6	
Cycle time	ms	1	
External-voltage protection	V	±30	

Digital outputs

Connection		X3.1 / DO1 X3.2 / DO2 X3.3 / DO3 X3.4 / DO4	
Switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
max. output current	mA	100	
Cycle time	ms	1	
Short-circuit strength		Unlimited period	
External-voltage protection	V	±30	
Polarity reversal protection		Integrated freewheeling diode for switching the inductive load	
Overload behavior		Voltage reduction or switching off and on periodically	
Reset or switch-on behavior		Output is switched off	LOW

Digital inputs | Encoder inputs

Encoder input 1			
Type		Incremental HTL encoder	
Two-track connection		X3.2 / DI3 X3.2 / DI4	Track A Track B
Frequency range	kHz	0 ... 200	
Encoder input 2			
Type		Incremental HTL encoder	
Two-track connection		X3.3 / DI5 X3.3 / DI6	Track A Track B
Frequency range	kHz	0 ... 200	



IO-Link ports

Use		For communicating with sensors and actuators (IO-Link Devices) with port class A.	The inverter (IO-Link master) supports IO-Link version 1.1 IO-Link Devices with IO-Link version 1.0 are not supported.
Connection		X3.1 / IO-Link Port 1 X3.2 / IO-Link Port 2 X3.3 / IO-Link Port 3 X3.4 / IO-Link Port 4	
max. output current	mA	200	Per IO-Link port - Above +40 °C the max. output current is reduced by 2.5%/°C - An external DC supply is recommended for using the IO-Link ports. ▶ DC input 129

24 V outputs

Use		Primarily for the supply of digital inputs.	
Connection		X3.1 / 24V X3.2 / 24V X3.3 / 24V X3.4 / 24V	
DC output voltage			
Typical	V	24	SELV/PELV
Range	V	16 ... 28	
max. output current	mA	400/1000	Total current for all I/Os (M12 connector) - The maximum output current of 1000 mA is only possible with an external DC supply. Otherwise, the maximum output current is limited to 400 mA. - Above +40 °C the max. output current is reduced by 2.5%/°C
Short-circuit strength		Unlimited period	
External voltage withstand capability	V	+30	
Overcurrent fusing		Automatically resettable	



7.6.3 Extended-I/O

Digital inputs

Connection		X3.1 / DI1 + DI2 X3.2 / DI3 + DI4 X3.3 / DI5	
Switching type		PNP, NPN	Parameterizable
PNP switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
NPN switching level			
LOW	V	> +15	
HIGH	V	< +5	
Input resistance	kΩ	4.6	
Cycle time	ms	1	
External voltage withstand capability	V	±30	The following restriction applies to DI1/DI5 due to their ability to be switched to DO1/DO3: External voltage withstand capability = +30 V. In the event of a negative voltage, the integrated free-wheeling diode conducts.

Digital outputs

Connection		X3.1 / DO1 X3.3 / DO3	
Switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
max. output current	mA	100	
Cycle time	ms	1	
Short-circuit strength		Unlimited period	
External voltage withstand capability	V	+30	If the voltage is negative, the built-in free-wheeling diode conducts.
Polarity reversal protection		Integrated freewheeling diode for switching the inductive load	
Overload behavior		Voltage reduction or switching off and on periodically	
Reset or switch-on behavior		Output is switched off	LOW

Digital inputs | Encoder inputs

Encoder input 1			
Type		Incremental HTL encoder	
Two-track connection		X3.2 / DI3 X3.2 / DI4	Track A Track B
Frequency range	kHz	0 ... 200	



Analog inputs

Connection		X3.1 / AI2 X3.3 / AI1	
Cycle time	ms	1	
Operation as voltage input			
DC input voltage	V	0 ... 10	
		0 ... 5	
		2 ... 10	short-circuit protected
		-10 ... 10	
Input resistance	kΩ	70	
Accuracy	mV	± 50	Typical
Input voltage in the event of a wire break	V	- 0.2 ... 0.2	Display "0"
External voltage withstand capability	V	± 30	
Operation as current input			
Input current	mA	0 ... 20	
		4 ... 20	wire break detection
Accuracy	mA	± 0.1	Typical
Input current in the event of a wire break	mA	< 0.1	Display "0"
Input resistance	Ω	< 250	
External voltage withstand capability	V	± 30	

Analog output

Connection		X3.4 / AO1	
Short-circuit strength		Unlimited period	
External voltage withstand capability	V	+ 30	
Operation as a voltage output			
D/A converter resolution	Bit	12	
DC output voltage	V	0 ... 10	
		0 ... 5	
		2 ... 10	
Max. output current	mA	5	
Min. load resistance	kΩ	≥ 2.2	
Max. capacitive load	μF	1	
Accuracy	mV	± 100	Typical
Operation as a current output			
output current	mA	0 ... 20	
		4 ... 20	wire break detection
Accuracy	mA	± 0.3	Typical



24 V outputs

Use		Primarily for the supply of digital inputs.	
Connection		X3.1 / 24V X3.2 / 24V X3.3 / 24V X3.4 / 24V	
DC output voltage			
Typical	V	24	SELV/PELV
Range	V	16 ... 28	
max. output current	mA	400/1000	Total current for all I/Os (M12 connector) - The maximum output current of 1000 mA is only possible with an external DC supply. Otherwise, the maximum output current is limited to 400 mA. - Above +40 °C the max. output current is reduced by 2.5%/°C
Short-circuit strength		Unlimited period	
External voltage withstand capability	V	+30	
Overcurrent fusing		Automatically resettable	

10 V output

Connection		X3.3 / 10V	
Use		Primarily for supplying a potentiometer (1 ... 10 kΩ)	
DC output voltage			
Typical	V	10	
Accuracy	mV	± 100	
Max. output current	mA	10	
Max. capacitive load	μF	1	
Short-circuit strength		Unlimited period	
External voltage withstand capability	V	+ 30	



7.6.4 DC input

Use		Input for mains-independent DC supply of the control electronics (incl. communication)	
Connection		X100.1 / 24E + GND X100.2 / 24E + GND	Applies to inverters: • 0.37 ... 5.5 kW and mains voltage 230/240 V • 0.37 ... 11 kW and mains voltage 400/480 V
		X5 / 24E + GND	Applies to inverters: • 7.5 ... 22 kW and mains voltage 230/240 V • 15 ... 45 kW and mains voltage 400/480 V
Capacity to be charged	μF	440	
Polarity reversal protection		In case of polarity reversal: No function and no destruction	
Suppression of voltage pulses		Suppressor diode 48 V, bidirectional	
Power supply unit		SELV/PELV	Externally to create a mains-independent DC supply
Rated current	A	10	Looping is only possible with X100.1 and X100.2

Rated data DC input for version with standard I/O

DC input voltage			
Typical	V	24 or 48	IEC 61131-2
Range	V	20.5 ... 49.9	
Input power			Depending on the use and state of inputs and outputs.
Typical	W	3.6	
Max.	W	13.2	
Input current			
Typical	A	0.15	
Max.	A	0.55	
Short-term inrush current			
Typical	A	2.5	
Max.	A	8.5	

Rated data DC input for version with Application-I/O or Extended-I/O

DC input voltage			
Typical	V	24 or 48	IEC 61131-2
Range	V	20.5 ... 49.9	
Input power			Depending on the use and state of inputs and outputs.
Typical	W	3.6	
Max.	W	27.6	
Input current			
Typical	A	0.15	
Max.	A	1.15	
Short-term inrush current			
Typical	A	3	
Max.	A	9.5	

7.6.5 Extension box

Current consumption	mA	60	Current consumption of the Extension Box in operation Applies to Extension Box • with disconnect switch with status feedback and operating elements • with disconnect switch with status feedback, operating element and potentiometer
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7.7 Dimensions

7.7.1 Inverters without extension box, Design/installation: wall



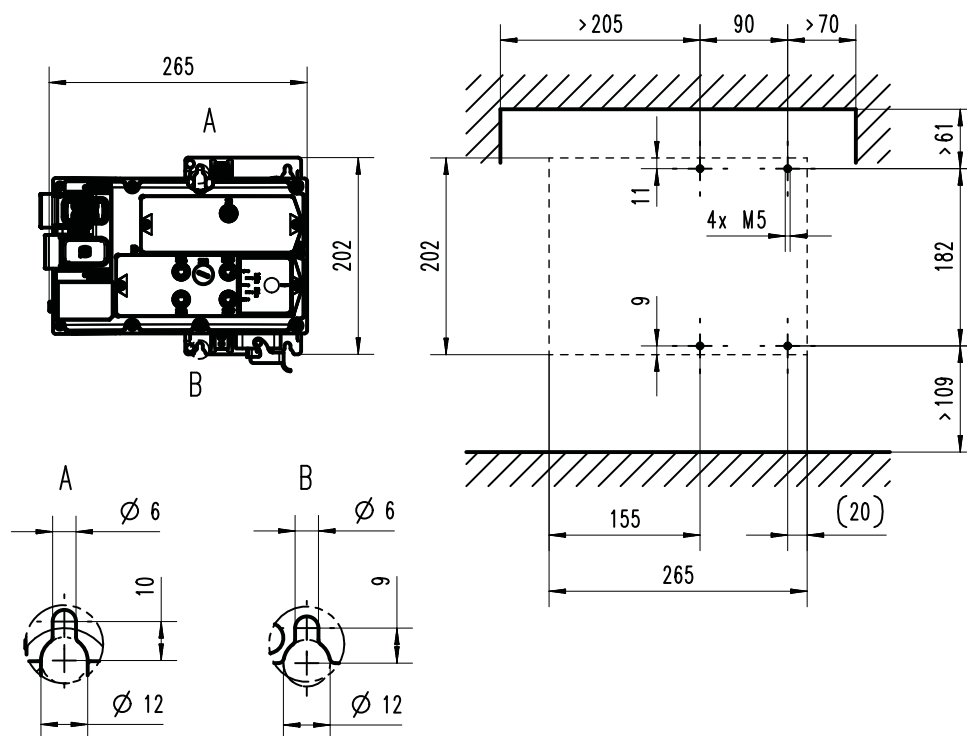
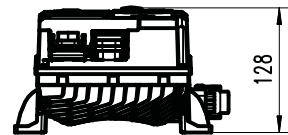
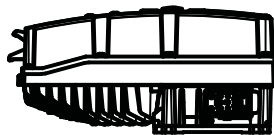
The specified installation clearances are minimum dimensions to ensure a sufficient air circulation for cooling purposes. They do not consider the bend radiuses of the connecting cables.



0.37 kW ... 2.2 kW

The dimensions in mm apply to:

0.37 kW	i□□□-M0.37/230-3	i□□□-M0.37/400-3
0.55 kW	i□□□-M0.55/230-3	i□□□-M0.55/400-3
0.75 kW	i□□□-M0.75/230-3	i□□□-M0.75/400-3
1.1 kW	i□□□-M1.1/230-3	i□□□-M1.1/400-3
1.5 kW		i□□□-M1.5/400-3
2.2 kW		i□□□-M2.2/400-3
Weight	3.2 kg	3.2 kg



Technical data

Dimensions

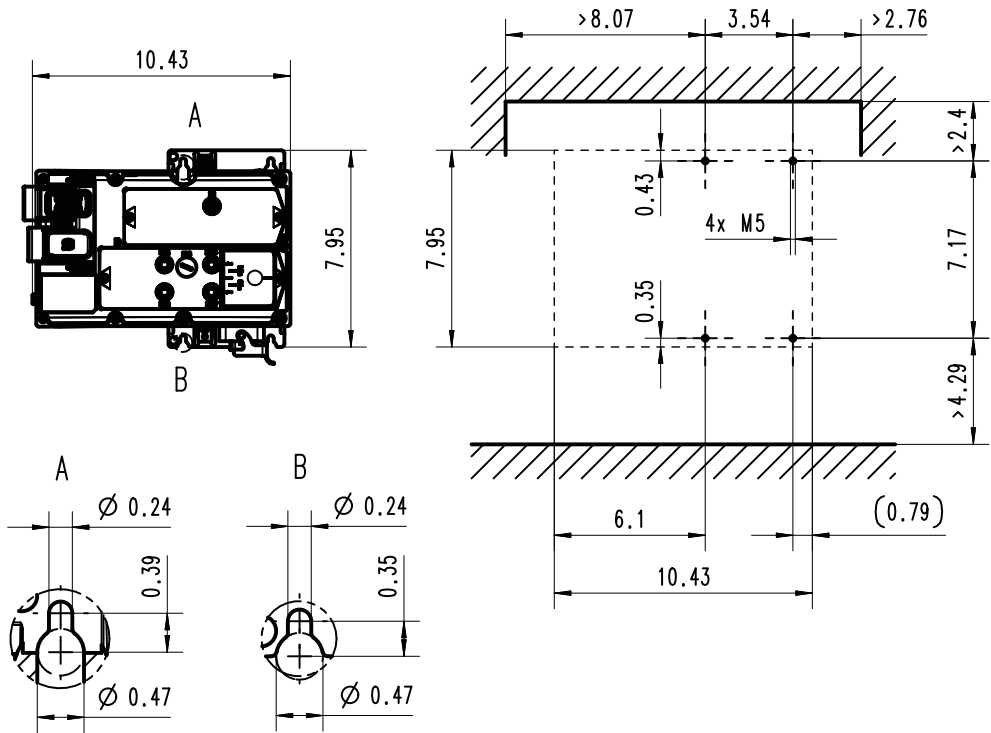
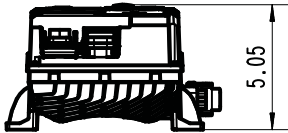
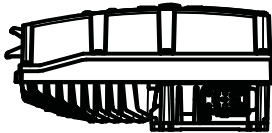
Inverters without extension box, Design/installation: wall



0.5 hp ... 3 hp

The dimensions in inch apply to:

0.5 hp	i□□□-M0.37/230-3	i□□□-M0.37/400-3
0.75 hp	i□□□-M0.55/230-3	i□□□-M0.55/400-3
1 hp	i□□□-M0.75/230-3	i□□□-M0.75/400-3
1.5 hp	i□□□-M1.1/230-3	i□□□-M1.1/400-3
2 hp		i□□□-M1.5/400-3
3 hp		i□□□-M2.2/400-3
Weight	7 lb	7 lb



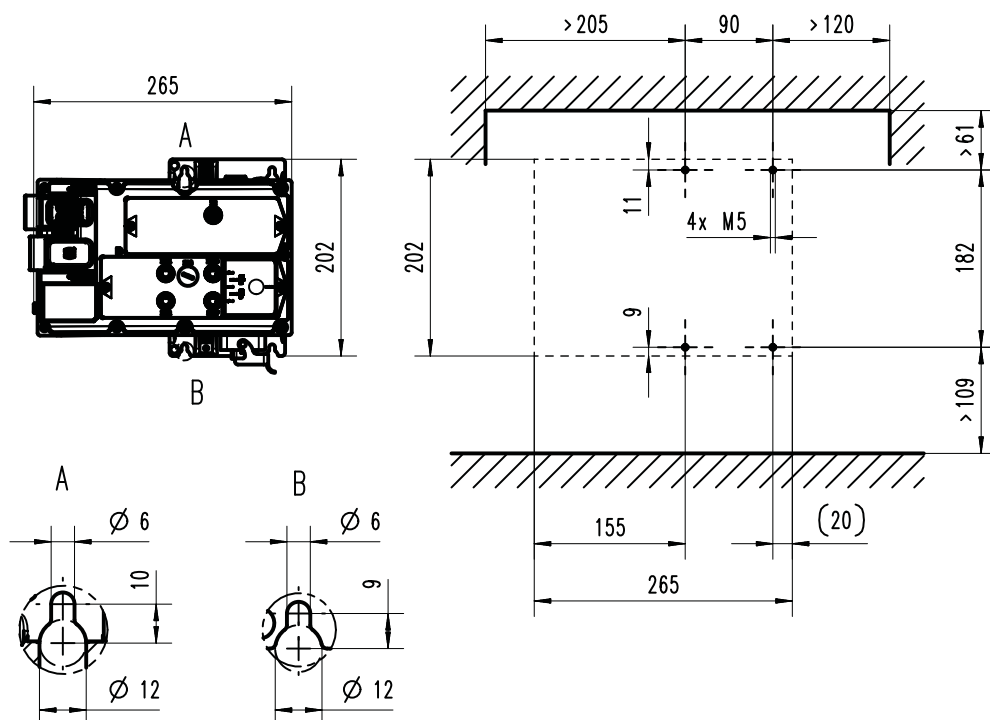
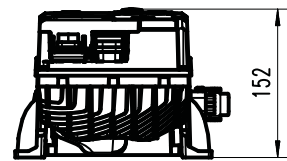
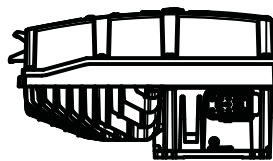
8801642



1.5 kW ... 5.5 kW

The dimensions in mm apply to:

1.5 kW	i□□□-M1.5/230-3	
2.2 kW	i□□□-M2.2/230-3	
3 kW	i□□□-M3.0/230-3	i□□□-M3.0/400-3
4 kW		i□□□-M4.0/400-3
5.5 kW		i□□□-M5.5/400-3
Weight	3.8 kg	3.8 kg



8801643

Technical data

Dimensions

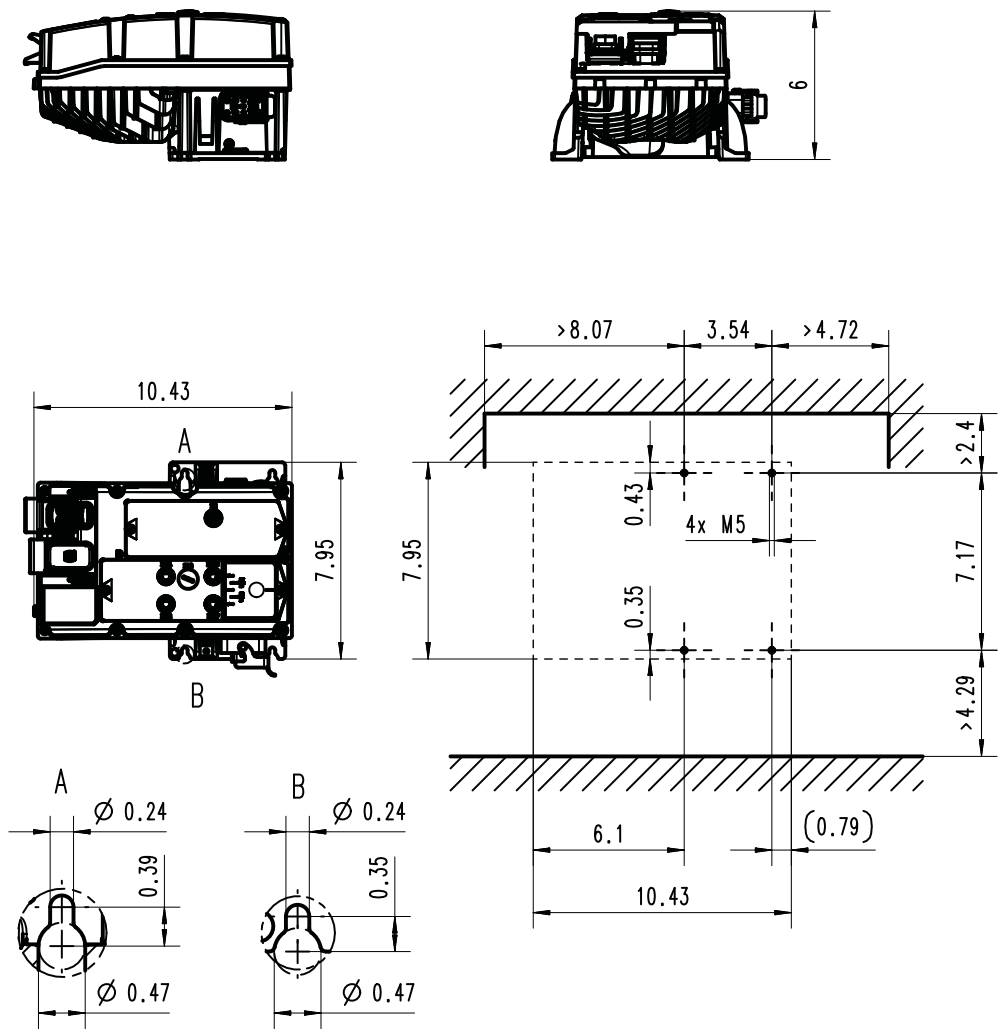
Inverters without extension box, Design/installation: wall



2 hp ... 7.5 hp

The dimensions in inch apply to:

2 hp	i□□□-M1.5/230-3	
3 hp	i□□□-M2.2/230-3	
4 hp	i□□□-M3.0/230-3	i□□□-M3.0/400-3
5 hp		i□□□-M4.0/400-3
7.5 hp		i□□□-M5.5/400-3
Weight	8.4 lb	8.4 lb



8801644



Technical data

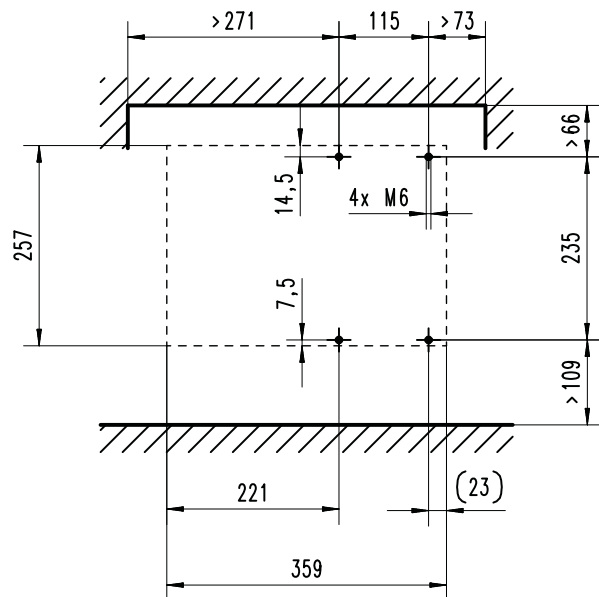
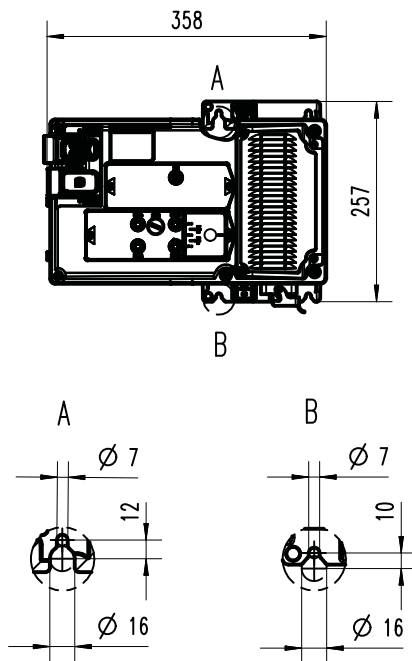
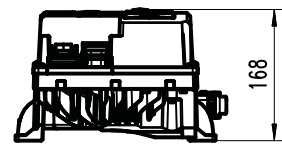
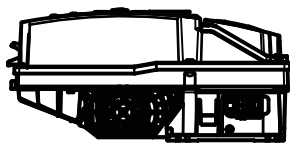
Dimensions

Inverters without extension box, Design/installation: wall

4 kW ... 11 kW

The dimensions in mm apply to:

4 kW	i□□□-M4.0/230-3	
5.5 kW	i□□□-M5.5/230-3	
7.5 kW		i□□□-M7.5/400-3
11 kW		i□□□-M11/400-3
Weight	6 kg	6 kg



8801724

Technical data

Dimensions

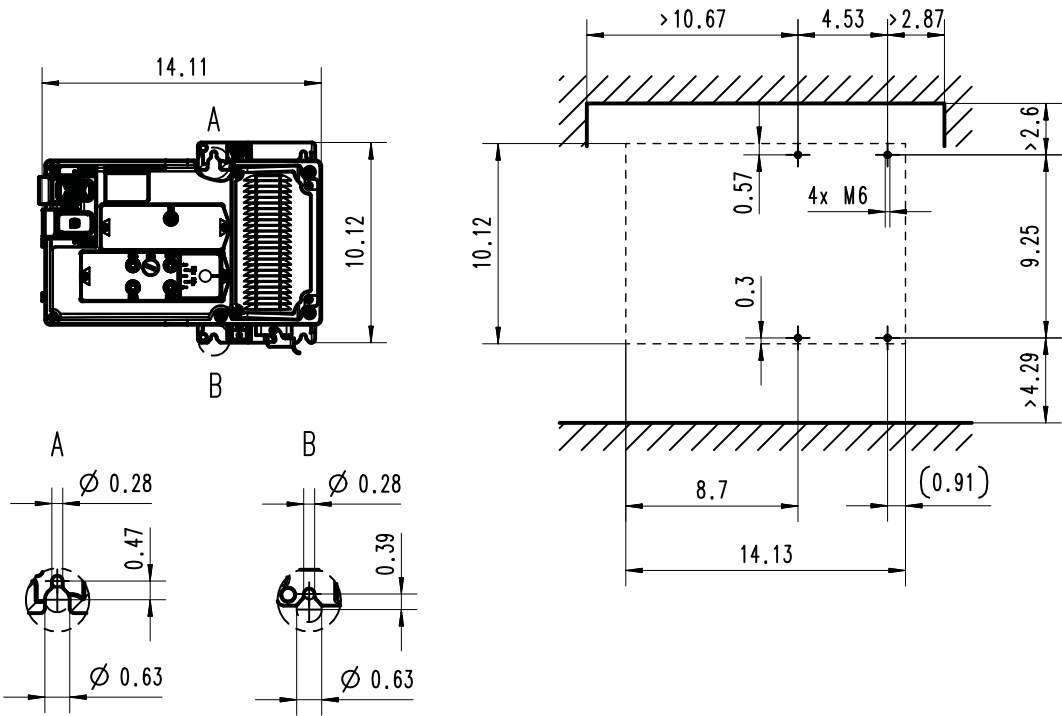
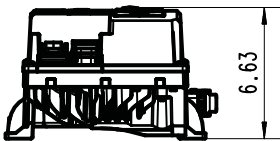
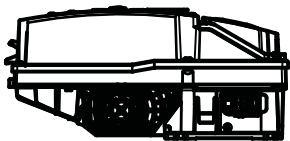
Inverters without extension box, Design/installation: wall



5 hp ... 15 hp

The dimensions in inch apply to:

5 hp	i□□□-M4.0/230-3	
7.5 hp	i□□□-M5.5/230-3	
10 hp		i□□□-M7.5/400-3
15 hp		i□□□-M11/400-3
Weight	13.2 lb	13.2 lb

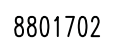
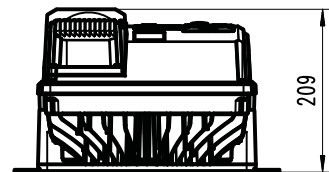


8801725



The dimensions in mm apply to:

Motor connection design: Wall adapter for cable gland (M40)



Technical data

Dimensions

Inverters without extension box, Design/installation: wall

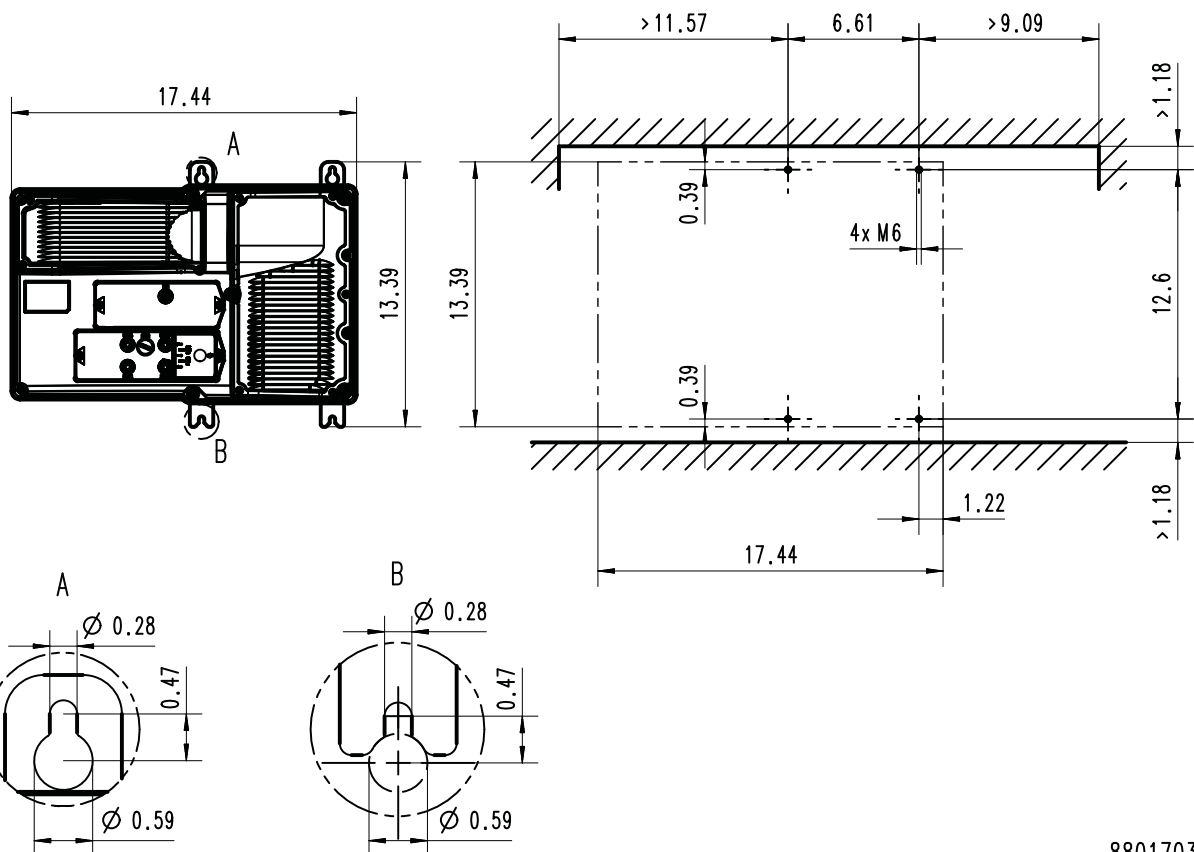
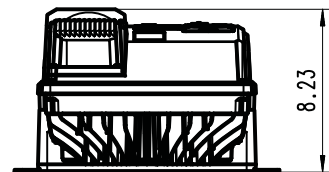
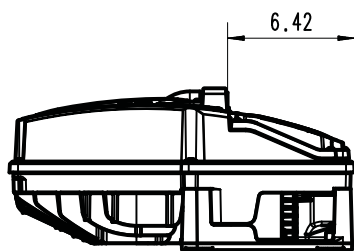


10 hp ... 60 hp

The dimensions in inch apply to:

10 hp	i□□□-M7.5/230-3	
15 hp	i□□□-M11/230-3	
20 hp	i□□□-M15/230-3	i□□□-M15/400-3
25 hp	i□□□-M18/230-3	i□□□-M18/400-3
30 hp	i□□□-M22/230-3	i□□□-M22/400-3
40 hp		i□□□-M30/400-3
50 hp		i□□□-M37/400-3
60 hp		i□□□-M45/400-3
Weight	29.3 lb	29.3 lb

Motor connection design: Wall adapter for cable gland (M40)



8801703

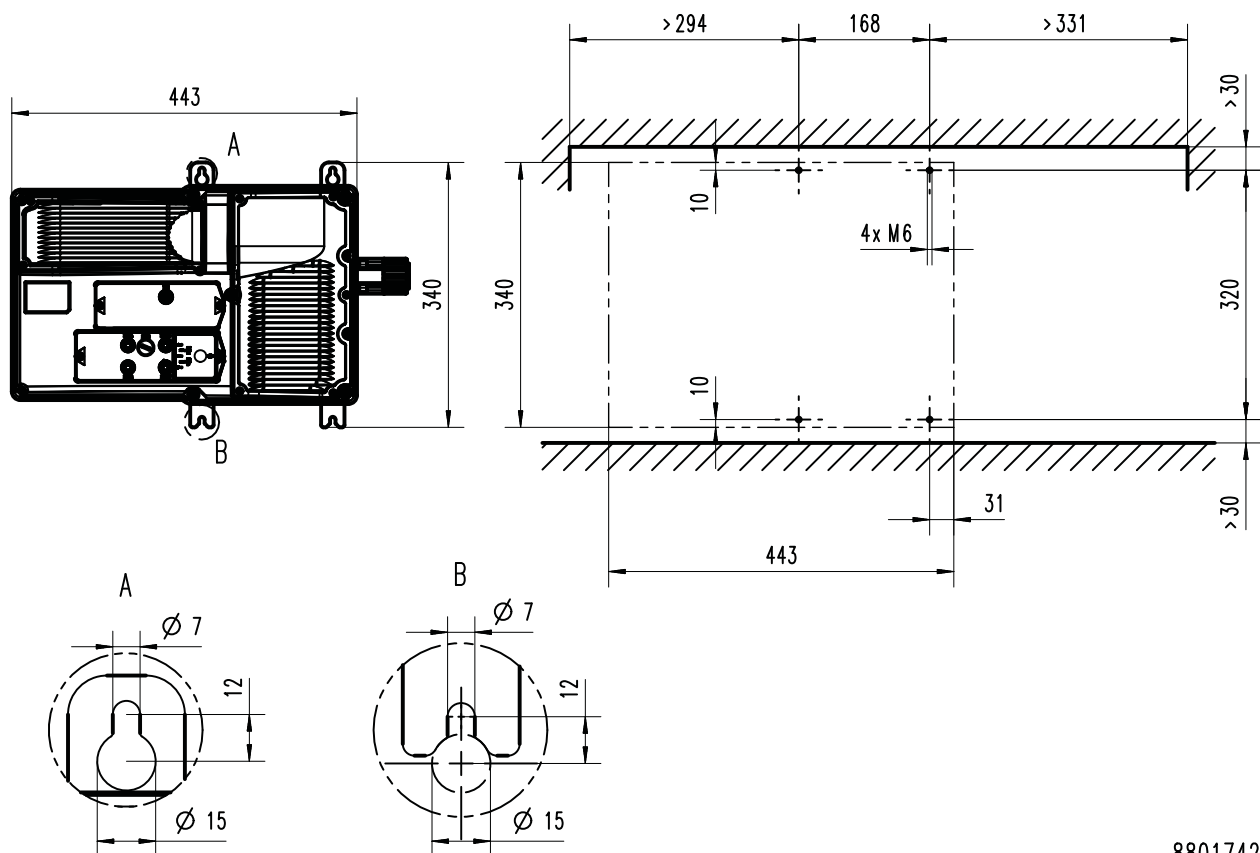
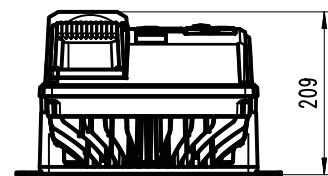
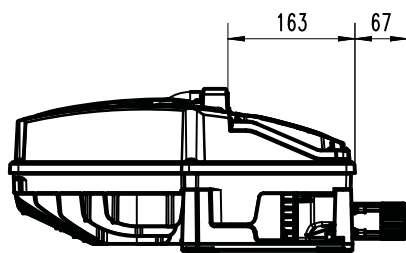


7.5 kW ... 22 kW

The dimensions in mm apply to:

7.5 kW	i□□□-M7.5/230-3	
11 kW	i□□□-M11/230-3	
15 kW		i□□□-M15/400-3
18.5 kW		i□□□-M18/400-3
22 kW		i□□□-M22/400-3
Weight	13.3 kg	13.3 kg

Motor connection design: Wall adapter with M40



8801742

Technical data

Dimensions

Inverters without extension box, Design/installation: wall

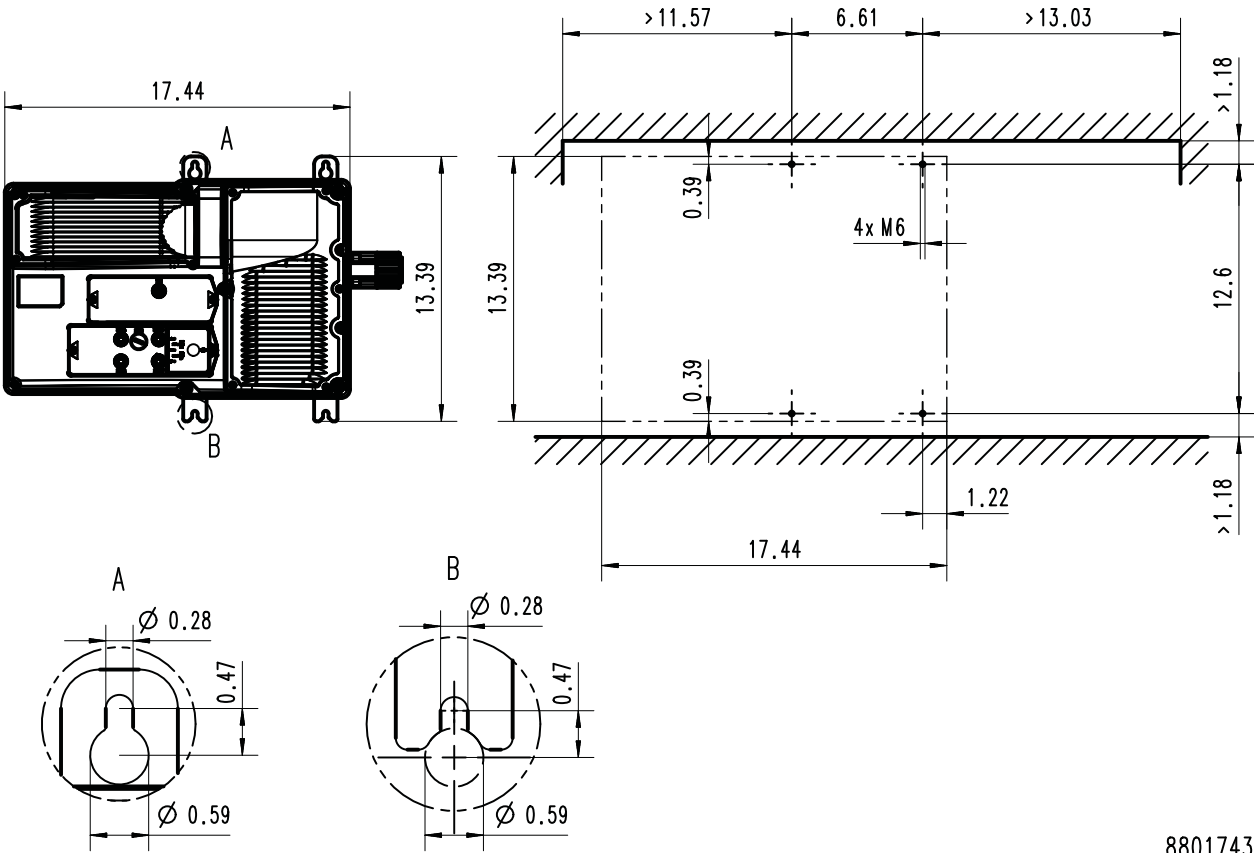
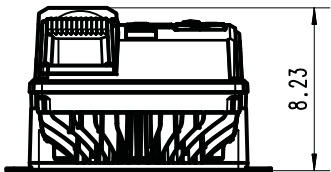
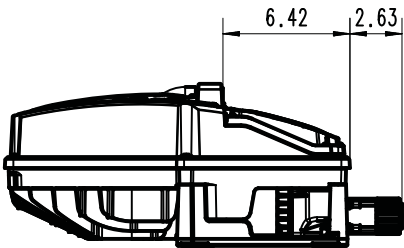


10 hp ... 30 hp

The dimensions in inch apply to:

10 hp	i□□□-M7.5/230-3	
15 hp	i□□□-M11/230-3	
20 hp		i□□□-M15/400-3
25 hp		i□□□-M18/400-3
30 hp		i□□□-M22/400-3
Weight	29.3 lb	29.3 lb

Motor connection design: Wall adapter with M40



8801743



7.7.2 Inverters with extension box, Design/installation: wall



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.

Technical data

Dimensions

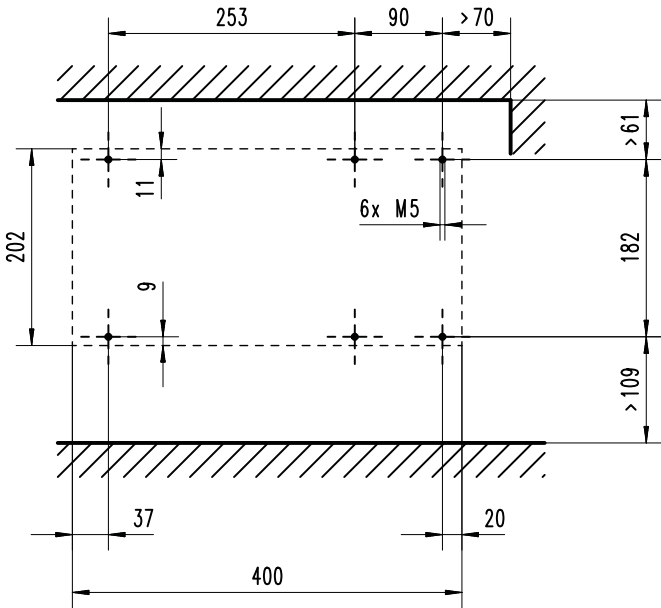
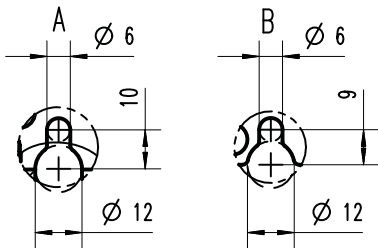
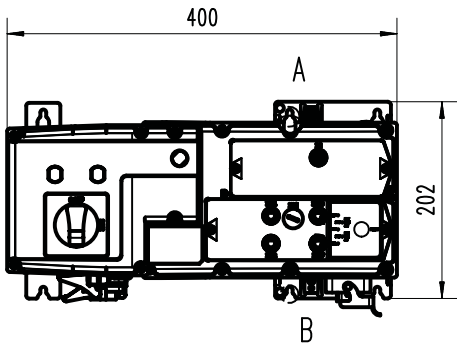
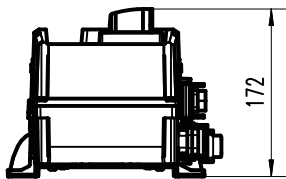
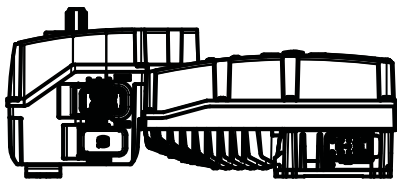
Inverters with extension box, Design/installation: wall



0.37 kW ... 2.2 kW

The dimensions in mm apply to:

0.37 kW	i□□□-M0.37/230-3	i□□□-M0.37/400-3
0.55 kW	i□□□-M0.55/230-3	i□□□-M0.55/400-3
0.75 kW	i□□□-M0.75/230-3	i□□□-M0.75/400-3
1.1 kW	i□□□-M1.1/230-3	i□□□-M1.1/400-3
1.5 kW	i□□□-M1.5/230-3	i□□□-M1.5/400-3
2.2 kW	i□□□-M2.2/230-3	i□□□-M2.2/400-3
Weight	4.3 kg	4.3 kg



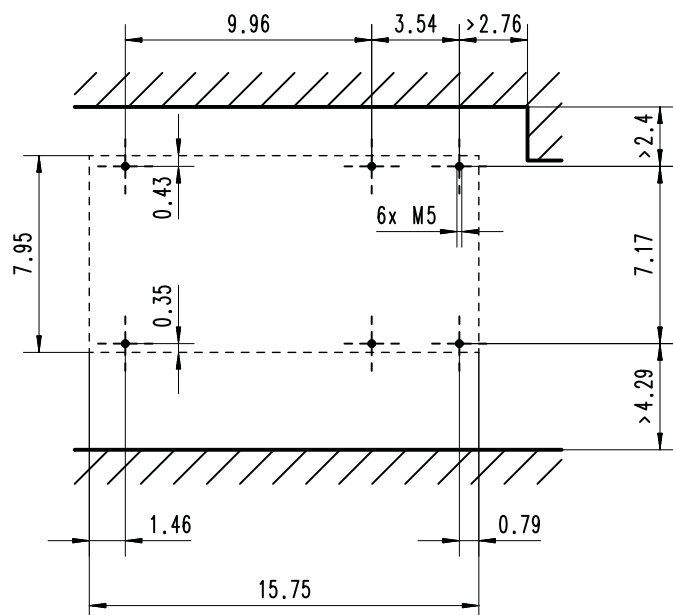
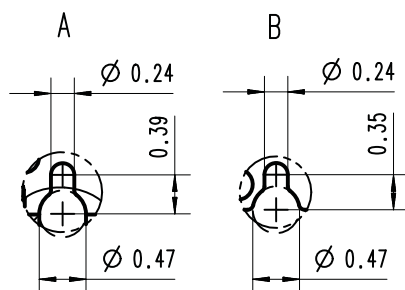
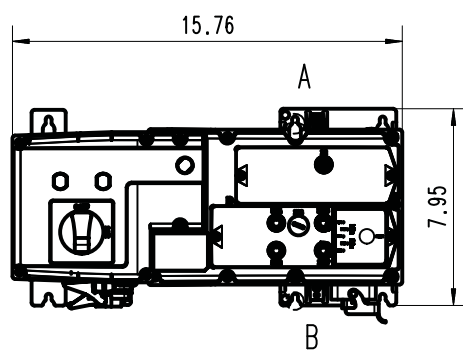
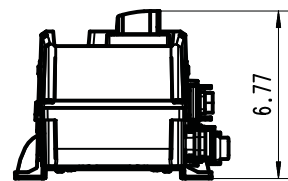
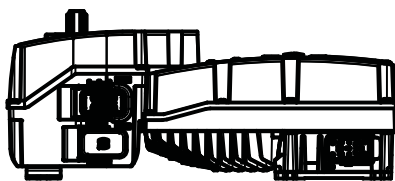
8801653



0.5 hp ... 3 hp

The dimensions in inch apply to:

0.5 hp	i□□□-M0.37/230-3	i□□□-M0.37/400-3
0.75 hp	i□□□-M0.55/230-3	i□□□-M0.55/400-3
1 hp	i□□□-M0.75/230-3	i□□□-M0.75/400-3
1.5 hp	i□□□-M1.1/230-3	i□□□-M1.1/400-3
2 hp	i□□□-M1.5/230-3	i□□□-M1.5/400-3
3 hp	i□□□-M2.2/230-3	i□□□-M2.2/400-3
Weight	9.5 lb	9.5 lb



8801654

Technical data

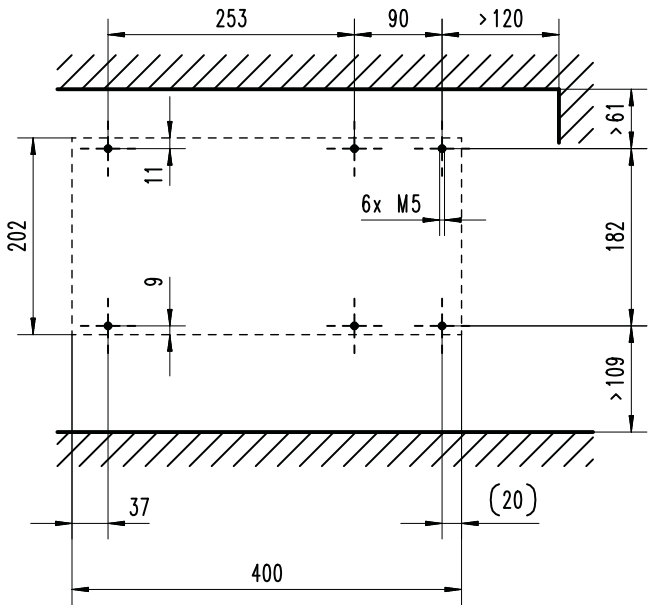
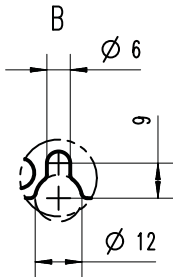
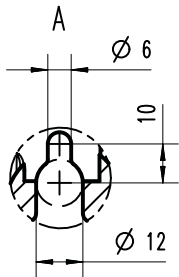
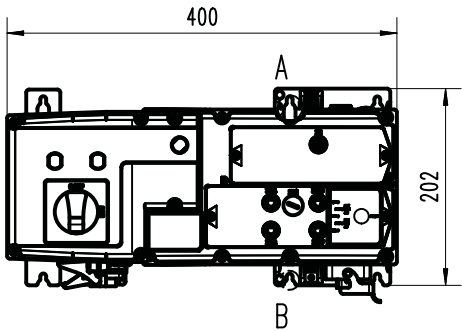
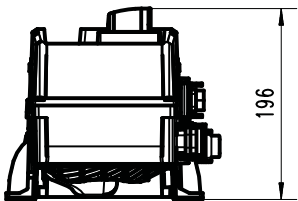
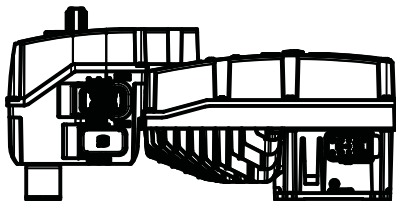
Dimensions
Inverters with extension box, Design/installation: wall



3 kW ... 5.5 kW

The dimensions in mm apply to:

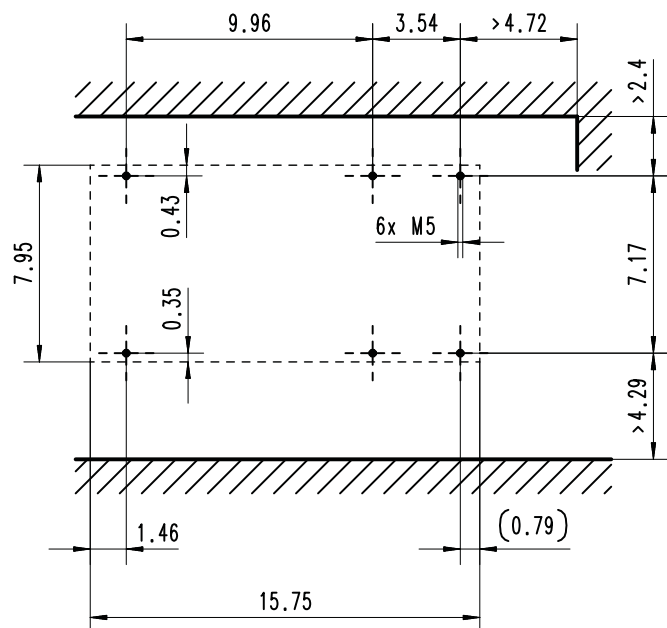
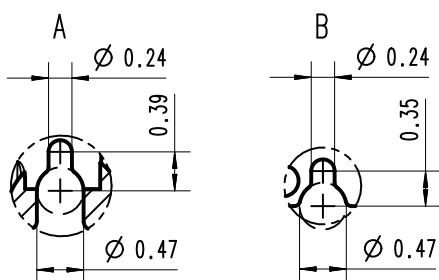
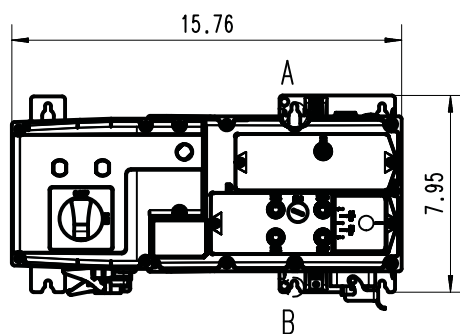
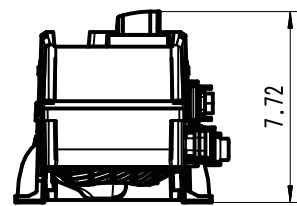
3 kW	i□□□-M3.0/230-3	i□□□-M3.0/400-3
4 kW		i□□□-M4.0/400-3
5.5 kW		i□□□-M5.5/400-3
Weight	5 kg	5 kg



8801655



The dimensions in inch apply to:



145

Technical data

Dimensions

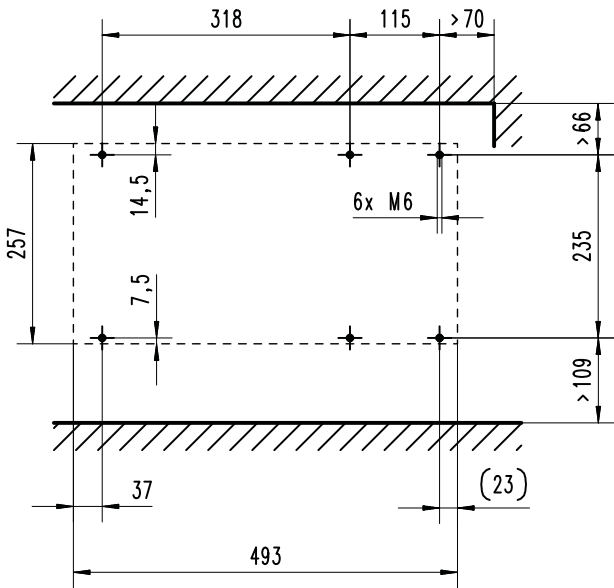
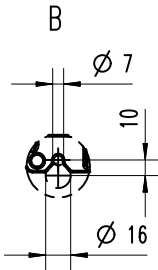
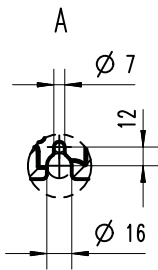
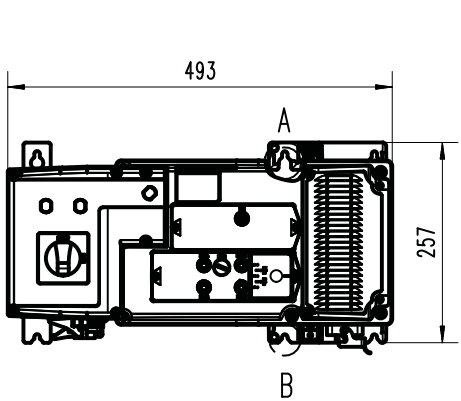
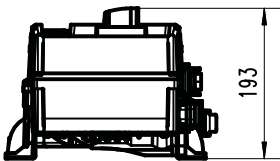
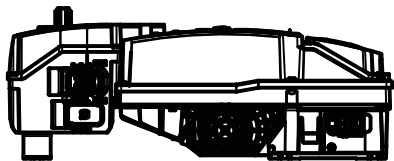
Inverters with extension box, Design/installation: wall



4 kW ... 11 kW

The dimensions in mm apply to:

4 kW	i□□□-M4.0/230-3	
5.5 kW	i□□□-M5.5/230-3	
7.5 kW		i□□□-M7.5/400-3
11 kW		i□□□-M11/400-3
Weight	7.4 kg	7.4 kg



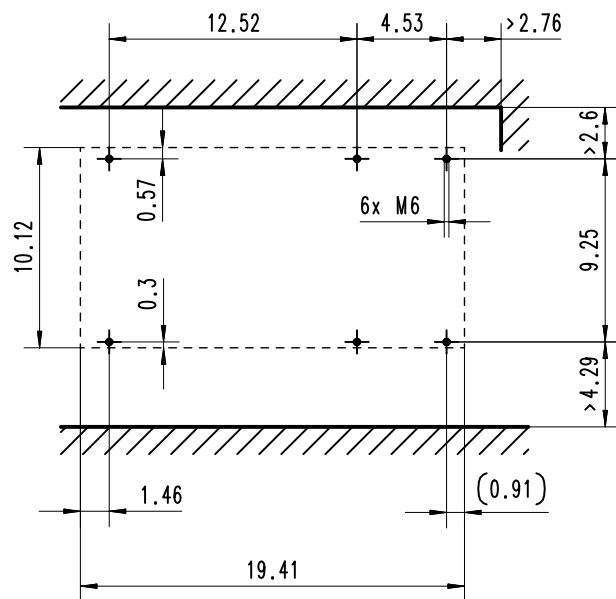
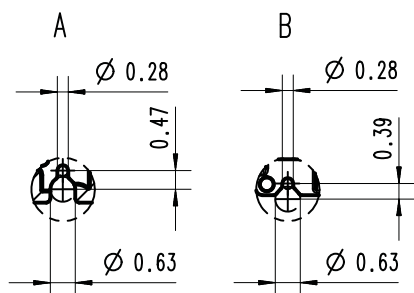
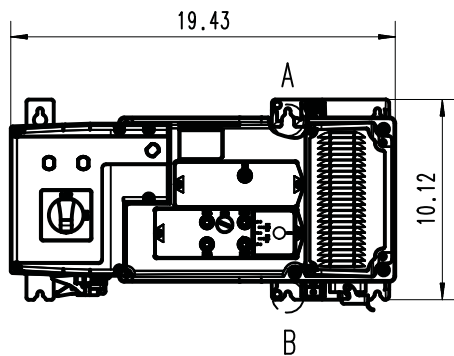
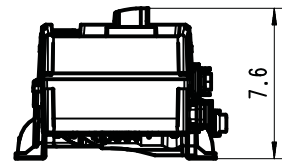
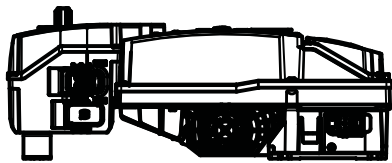
8801726



5 hp ... 15 hp

The dimensions in inch apply to:

5 hp	i□□□-M4.0/230-3	
7.5 hp	i□□□-M5.5/230-3	
10 hp		i□□□-M7.5/400-3
15 hp		i□□□-M11/400-3
Weight	16.3 lb	16.3 lb



8801727



7.7.3 Inverters without extension box, Design/installation: motor



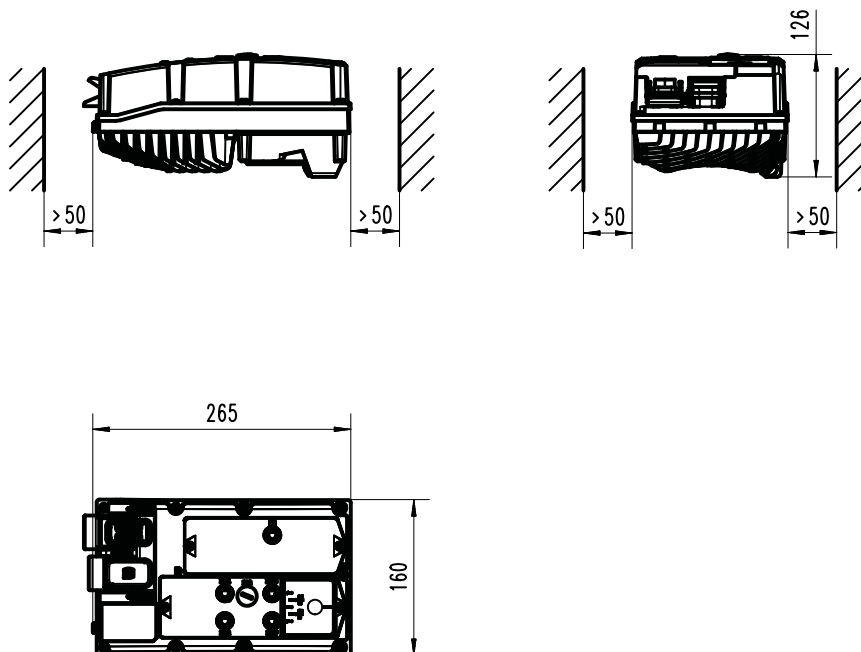
The specified installation clearances are minimum dimensions to ensure a sufficient air circulation for cooling purposes. They do not consider the bend radiuses of the connecting cables.



0.37 kW ... 2.2 kW

The dimensions in mm apply to:

0.37 kW	i□□□-M0.37/230-3	i□□□-M0.37/400-3
0.55 kW	i□□□-M0.55/230-3	i□□□-M0.55/400-3
0.75 kW	i□□□-M0.75/230-3	i□□□-M0.75/400-3
1.1 kW	i□□□-M1.1/230-3	i□□□-M1.1/400-3
1.5 kW		i□□□-M1.5/400-3
2.2 kW		i□□□-M2.2/400-3
Weight	2.9 kg	2.9 kg



Technical data

Dimensions

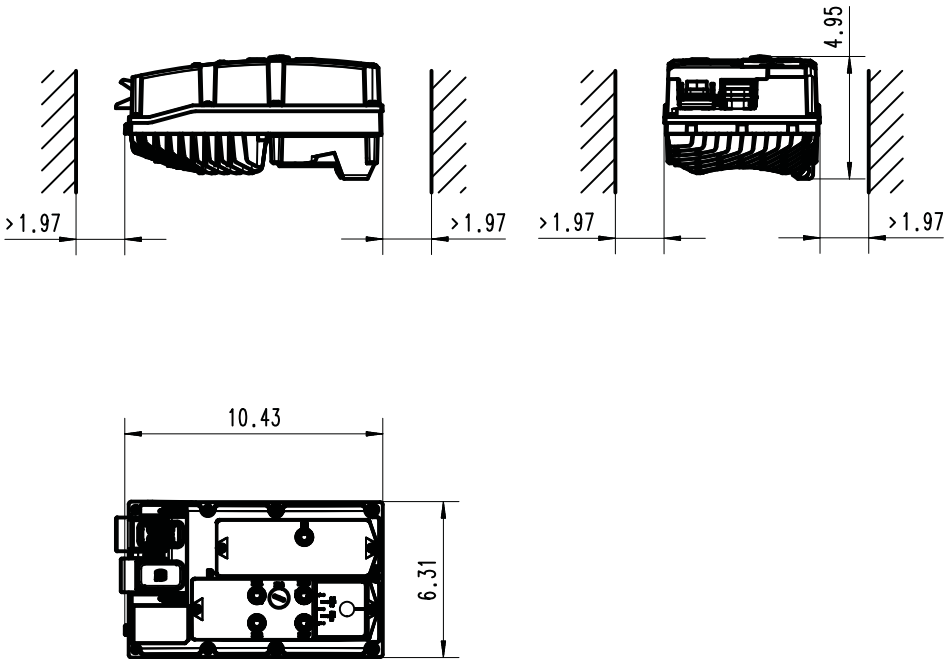
Inverters without extension box, Design/installation: motor



0.5 hp ... 3 hp

The dimensions in inch apply to:

0.5 hp	i□□□-M0.37/230-3	i□□□-M0.37/400-3
0.75 hp	i□□□-M0.55/230-3	i□□□-M0.55/400-3
1 hp	i□□□-M0.75/230-3	i□□□-M0.75/400-3
1.5 hp	i□□□-M1.1/230-3	i□□□-M1.1/400-3
2 hp		i□□□-M1.5/400-3
3 hp		i□□□-M2.2/400-3
Weight	6.4 lb	6.4 lb



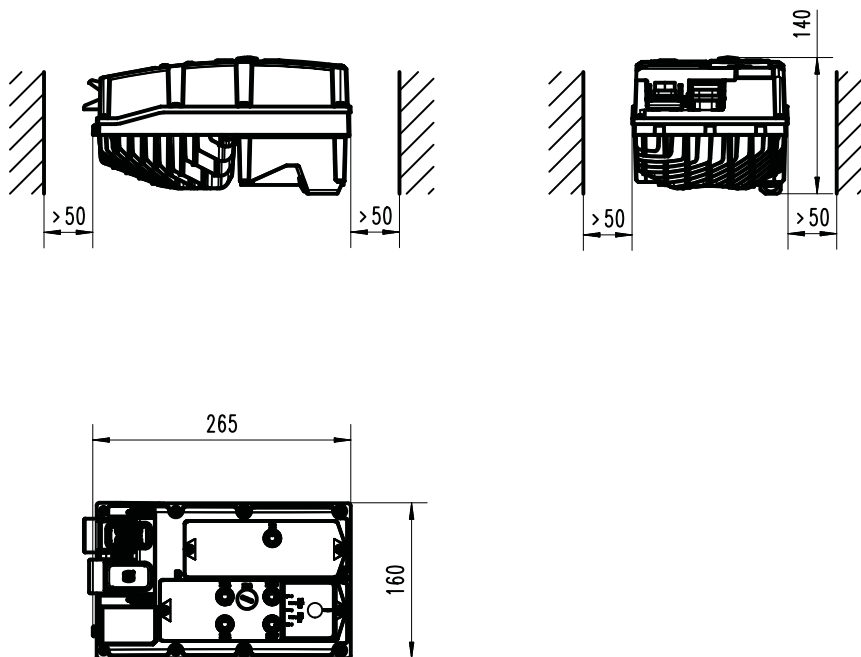
8801681



1.5 kW ... 5.5 kW

The dimensions in mm apply to:

1.5 kW	i□□□-M1.5/230-3	
2.2 kW	i□□□-M2.2/230-3	
3 kW	i□□□-M3.0/230-3	i□□□-M3.0/400-3
4 kW		i□□□-M4.0/400-3
5.5 kW		i□□□-M5.5/400-3
Weight	3.4 kg	3.4 kg



Technical data

Dimensions

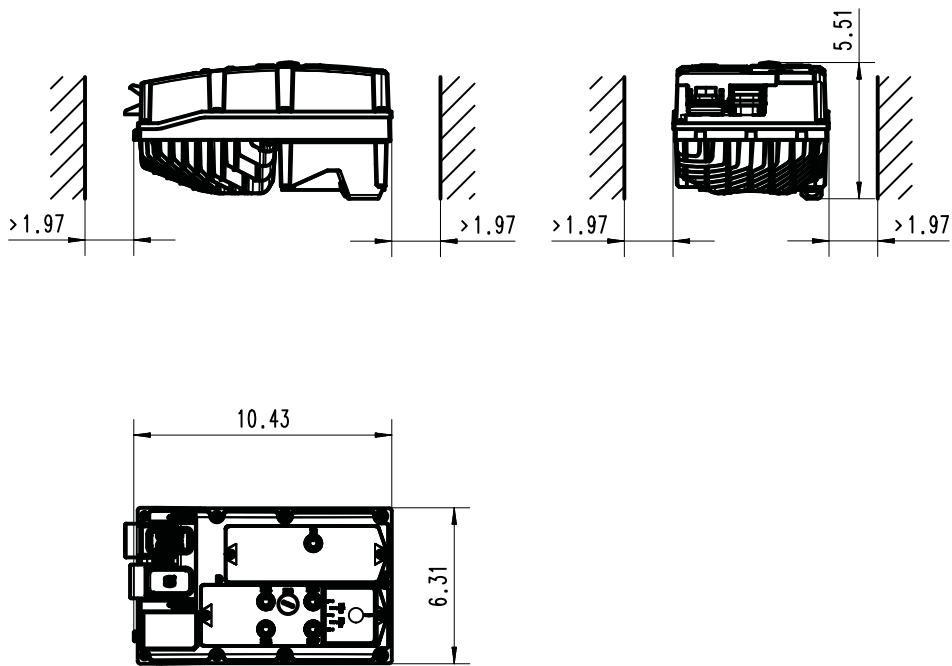
Inverters without extension box, Design/installation: motor



2 hp ... 7.5 hp

The dimensions in inch apply to:

2 hp	i□□□-M1.5/230-3	
3 hp	i□□□-M2.2/230-3	
4 hp	i□□□-M3.0/230-3	i□□□-M3.0/400-3
5 hp		i□□□-M4.0/400-3
7.5 hp		i□□□-M5.5/400-3
Weight	7.5 lb	7.5 lb



8801683



Technical data

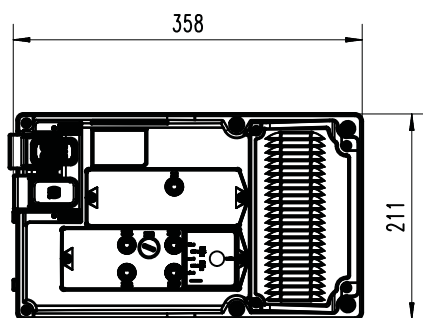
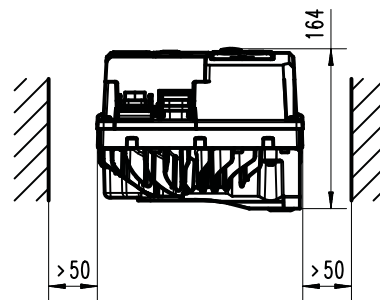
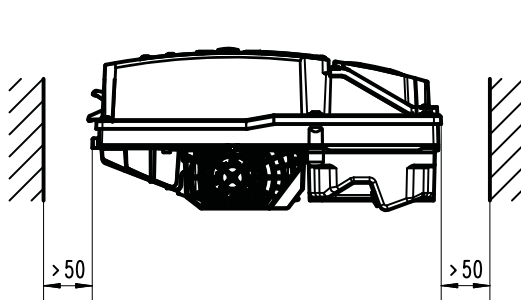
Dimensions

Inverters without extension box, Design/installation: motor

4 kW ... 11 kW

The dimensions in mm apply to:

4 kW	i□□□-M4.0/230-3	
5.5 kW	i□□□-M5.5/230-3	
7.5 kW		i□□□-M7.5/400-3
11 kW		i□□□-M11/400-3
Weight	5.4 kg	5.4 kg



8801722

Technical data

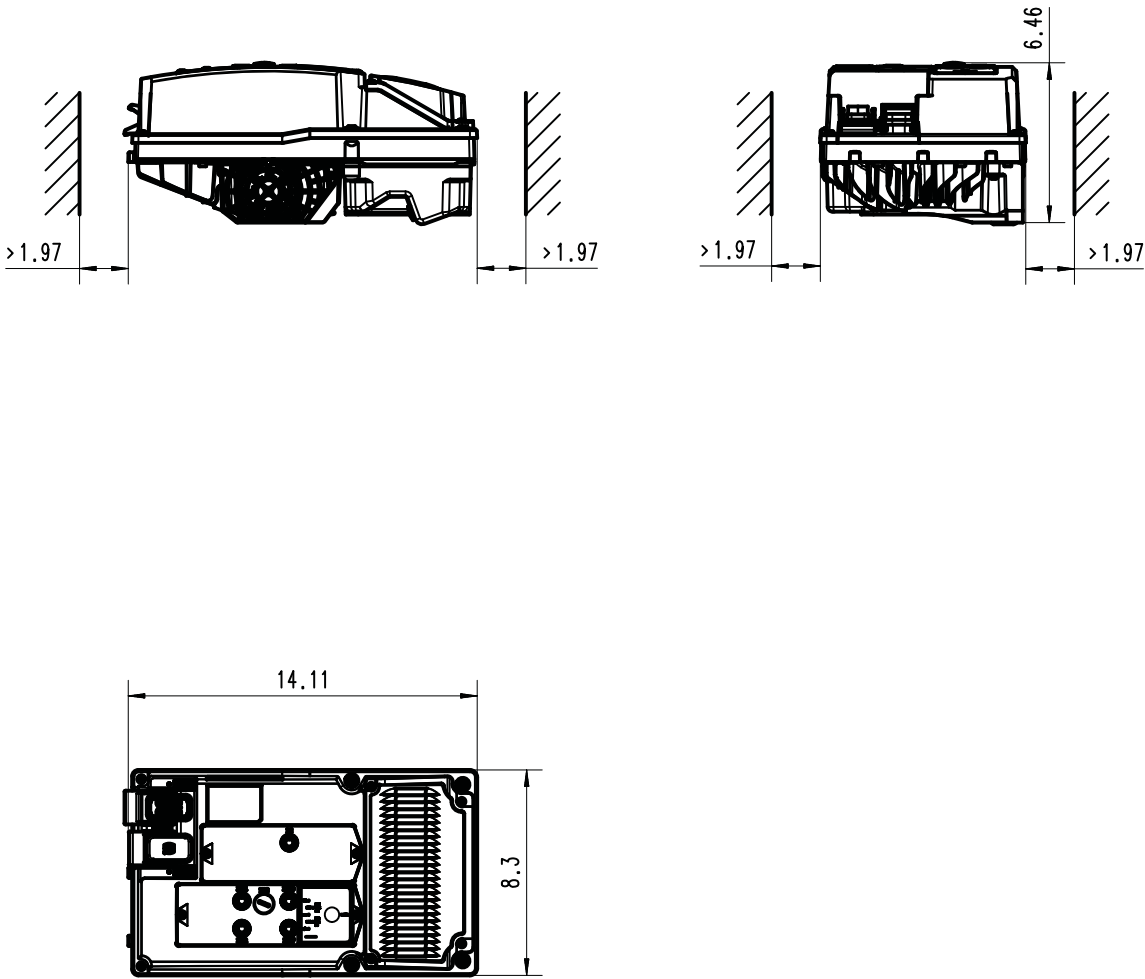
Dimensions
Inverters without extension box, Design/installation: motor



5 hp ... 15 hp

The dimensions in inch apply to:

5 hp	i□□□-M4.0/230-3	
7.5 hp	i□□□-M5.5/230-3	
10 hp		i□□□-M7.5/400-3
15 hp		i□□□-M11/400-3
Weight	11.9 lb	11.9 lb



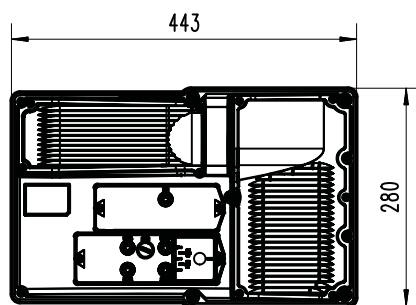
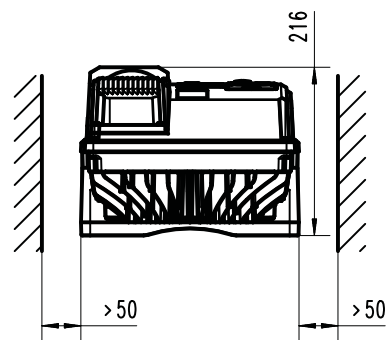
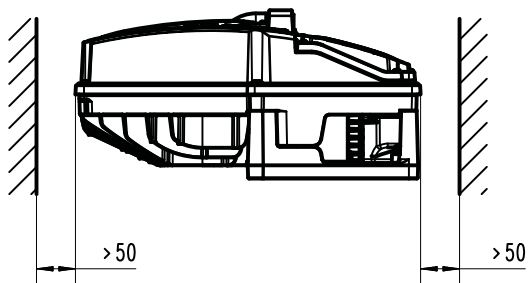
8801723



7.5 kW ... 45 kW

The dimensions in mm apply to:

7.5 kW	i□□□-M7.5/230-3	
11 kW	i□□□-M11/230-3	
15 kW	i□□□-M15/230-3	i□□□-M15/400-3
18.5 kW	i□□□-M18/230-3	i□□□-M18/400-3
22 kW	i□□□-M22/230-3	i□□□-M22/400-3
30 kW		i□□□-M30/400-3
37 kW		i□□□-M37/400-3
45 kW		i□□□-M45/400-3
Weight	12.5 kg	12.5 kg



Technical data

Dimensions

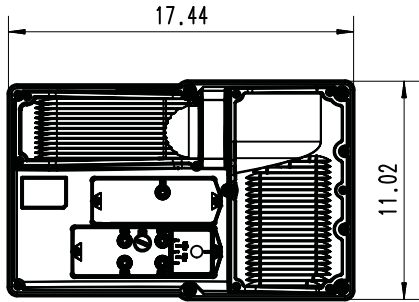
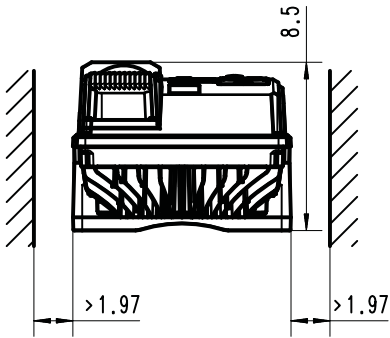
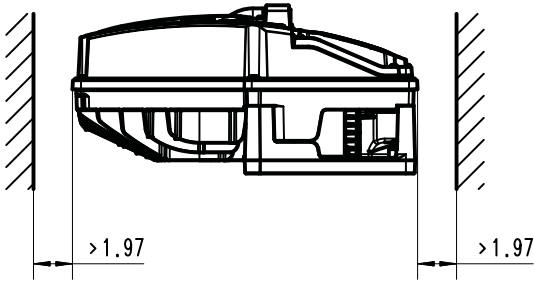
Inverters without extension box, Design/installation: motor



10 hp ... 60 hp

The dimensions in inch apply to:

10 hp	i□□□-M7.5/230-3	
15 hp	i□□□-M11/230-3	
20 hp	i□□□-M15/230-3	i□□□-M15/400-3
25 hp	i□□□-M18/230-3	i□□□-M18/400-3
30 hp	i□□□-M22/230-3	i□□□-M22/400-3
40 hp		i□□□-M30/400-3
50 hp		i□□□-M37/400-3
60 hp		i□□□-M45/400-3
Weight	27.6 lb	27.6 lb

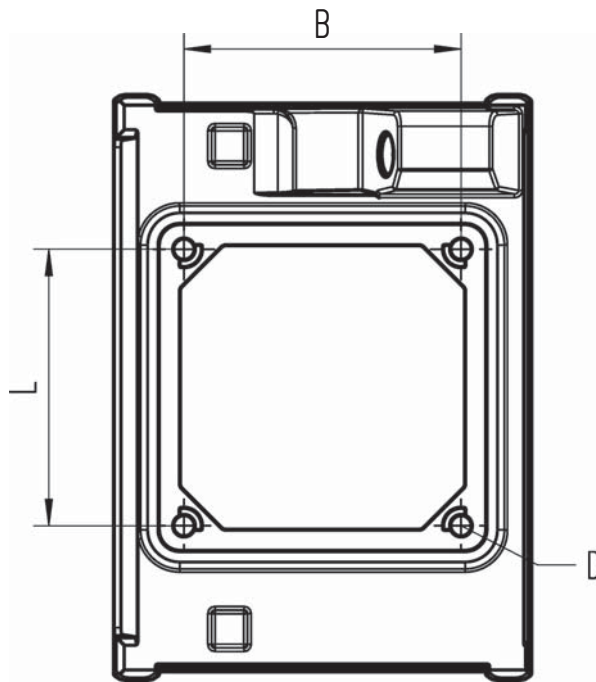


8801733



7.7.4 Motor adapter

Distance of the fixing screws



Motor design	L	B	D
	[mm]	[mm]	[mm]
BG063 - BG071	60	60	4.4
BG080 - BG112	73	73	5.4
BG132	82	82	6.4
BG160 - BG180	95	95	6.4



8 Product extensions

8.1 I/O extensions

Depending on the version, various functions are available that can be assigned to the X3.x M12 connectors.

Category	Function assignment	Version		
		Standard-I/O	Application-I/O	Extended-I/O
Digital inputs	DI1	•	•	•
	DI2	•	•	•
	DI3	•	•	•
	DI4	•	•	•
	DI5		•	•
	DI6		•	
	DI7		•	
	DI8		•	
Digital outputs	DO1	•	•	•
	DO2		•	
	DO3		•	•
	DO4		•	
IO-Link	IO-Link Port 1		•	
	IO-Link Port 2		•	
	IO-Link Port 3		•	
	IO-Link Port 4		•	
HTL output	Pulse train	•	•	•
Encoder interface X3.2	Encoder	•	•	•
	Low-resolution HTL-encoder	•	•	•
	Pulse-In/Pulse-Direction	•	•	•
Encoder interface X3.3	Encoder		•	
	Low-resolution HTL-encoder		•	
	Pulse-In/Pulse-Direction		•	
Table positioning	Touch probe		•	
Analog inputs	AI1 -			•
	AI2			•
Analog output	AO1			•
	Temperature sensor			•

"DIx" function assignment:

- Standard digital inputs for control tasks.
- Logic level "HIGH-active" or "LOW-active", debounce time, and inversion can be parameterized.

"DOx" function assignment:

- Standard digital outputs.
- Switch-on delay and switch-off delay can be parameterized.

"IO-Link" function assignment:

- For communicating with sensors and actuators (IO-Link devices) with port class A.
- The inverter (IO-Link master) supports IO-Link version 1.1
- IO-Link Devices with IO-Link version 1.0 are not supported.
- Further details: [IO-Link](#) [161](#)

"Encoder" function assignment:

- For connecting a single-track or two-track HTL encoder (max. 200 kHz).
- A single-track HTL encoder (track A) cannot be used for motor speed feedback.
- A two-track HTL encoder (track A and B) must have a phase offset of exactly 90° between track A and B (error $\leq \pm 10^\circ$). Inverted tracks are not required.
- Encoder increments: ≤ 16384 increments per revolution



"Pulse-In" function assignment:

- To evaluate the signal of a low-cost HTL encoder or a reference frequency ("Pulse-Train") and to accept it as a setpoint signal.
- The detection of a direction signal ("Pulse-Direction") is also supported.

"Pulse-Train" function assignment:

- For output of a reference frequency ("Pulse Train"). Other inverters can interpret this signal as a setpoint signal, for example.

"Touch Probe" function assignment:

- For evaluating a reference switch for positioning using a touch probe (remaining-distance positioning). For more information about this function, see the "Table Positioning" manual.

"Alx" function assignment:

- For acquiring an analog signal (for example, for the process controller).
- Can be configured as a voltage input or current input.

Function assignment "AO1":

- To output an analog signal.
- Can be configured as a voltage source or a current source.

"Temperature Sensor" function assignment:

- For measuring temperature via a connected temperature sensor
e.g., PT100 or PT1000).

Further details on configuring the function assignment can be found in the commissioning document.

8.1.1 Standard I/O



Fig. 10: Example of an i550 motec with Standard-I/O

X3.1	Function assignment			
Pin	Default setting	Further possible settings		
1	24 V	24 V	24 V	
2	DI2	DI2	DI2	
3	GND	GND	GND	
4	DI1	DO1	Pulse train	
5	not assigned			
	Housing is connected to functional earth			

X3.2	Function assignment				
Pin	Default setting	Further possible settings			
1	24 V	24 V	24 V	24 V	
2	DI4	Encoder (B)	Pulse-In	Pulse-In	
3	GND	GND	GND	GND	
4	DI3	Encoder (A)	DI3	Pulse-Direction	
5	not assigned				
	Housing is connected to functional earth				



8.1.2 Application I/O



Fig. 11: Example of an i650 motec with Application-I/O

X3.1 Function assignment								
Pin	Default setting	Further possible settings						
1	24 V	24 V	24 V / L+	24 V	24 V	24 V	24 V / L+	24 V
2	DI2	DI2	DI2	DI2	Touch probe			
3	GND	GND	GND / L-	GND	GND	GND	GND / L-	GND
4	DI1	DO1	IO-Link Port 1	Pulse train	DI1	DO1	IO-Link Port 1	Pulse train
5	not assigned							
	Housing is connected to functional earth							

X3.2 Function assignment								
Pin	Default setting	Further possible settings						
1	24 V	24 V	24 V / L+	24 V	24 V	24 V	24 V / L+	24 V
2	DI4	DI4	DI4	Encoder (B)	Pulse-In			
3	GND	GND	GND / L-	GND	GND	GND	GND / L-	GND
4	DI3	DO2	IO-Link Port 2	Encoder (A)	DI3	DO2	IO-Link Port 2	Pulse-Direction
5	not assigned							
	Housing is connected to functional earth							

X3.3 Function assignment								
Pin	Default setting	Further possible settings						
1	24 V	24 V	24 V / L+	24 V	24 V	24 V	24 V / L+	24 V
2	DI6	DI6	DI6	Encoder (B)	Pulse-In			
3	GND	GND	GND / L-	GND	GND	GND	GND / L-	GND
4	DI5	DO3	IO-Link Port 3	Encoder (A)	DI5	DO3	IO-Link Port 3	Pulse-Direction
5	not assigned							
	Housing is connected to functional earth							

X3.4 Function assignment			
Pin	Default setting	Further possible settings	
1	24 V	24 V	24 V / L+
2	DI8	DI8	DI8
3	GND	GND	GND / L-
4	DI7	DO4	IO-Link Port 4
5	not assigned		
	Housing is connected to functional earth		



8.1.2.1 IO-Link

The inverter provides four IO-Link ports via the Application-I/O.



IO-Link is a registered trademark. It may only be used by members of the IO-Link community and non-members that have purchased the corresponding license. Detailed information on use can be found in the IO-Link Community Rules:

<https://io-link.com>

IO-Link is the standardized IO technology (IEC 61131-9) for communication with sensors and actuators. Point-to-point communication is based on the three-wire sensor and actuator connection without additional requirements concerning the cable material.

IO-Link is no fieldbus but the further development of the existing connection technology for sensors and actuators.

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input 129

Bus-related information			
Name		IO-Link version 1.1	Note: IO-Link Devices with IO-Link version 1.0 are not supported.
Communication medium		Unshielded 3-wire standard cable	
Use		Connecting IO-Link Devices (Port Class A) to the inverter (IO-Link Master)	
Connection system		M12 connector (A coded)	
Connection designation		X3.x: L+, C/Q, L-	

Technical data			
Topology			
Master - device		Tree (point to point)	
Station			
Type		Master	
Master - device		1:1	
Baud rate	kbps	230.4	COM3
Max. Length	m	20	
Max. cable length between IO-Link master and IO-Link device	m	20	
Process data IO-Link master			
Input		32 Byte	
Output		32 Byte	

Processing time of process data			
Cycle time	ms	2	



8.1.3 Extended I/O



Fig. 12: Example of an i550 motec with Extended-I/O

X3.1 Function assignment						
Pin	Default setting	Further possible settings				
1	24 V	24 V	24 V	24 V	24 V	24 V
2	DI2	DI2	DI2	AI2	AI2	AI2
3	GND	GND	GND	GND	GND	GND
4	DI1	DO1	Pulse train	DI1	DO1	Pulse train
5	Pin 5 and the housing are connected to the functional earth					

X3.2 Function assignment				
Pin	Default setting	Further possible settings		
1	24 V	24 V	24 V	24 V
2	DI4	Encoder (B)	Pulse-In	Pulse-In
3	GND	GND	GND	GND
4	DI3	Encoder (A)	DI3	Pulse-Direction
5	Pin 5 and the housing are connected to the functional earth			

X3.3 Function assignment				
Pin	Default setting	Further possible settings		
1	24 V	24 V	10 V	10 V
2	AI1 -	AI1 -	AI1 -	AI1 -
3	GND	GND	GND	GND
4	DI5	DO3	DI5	DO3
5	Pin 5 and the housing are connected to the functional earth			

X3.4 Function assignment		
Pin	Default setting	Further possible settings
1	AO1	Temperature sensor
2	24 V	24 V
3	GND	GND
4	GND	GND
5	Pin 5 and the housing are connected to the functional earth	



Shielded cables must be used for analog signals. The shield can be connected to the housing of the M12 connector and/or pin 5.



8.2 Networks

8.2.1 CANopen

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

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input □ 129

Bus-related information			
Name		CANopen CiA 301 V4.2.0	
Communication medium		CAN cable in accordance with ISO 11898-2	
Use		Connection of the inverter to a CANopen network	
Status display		2 LEDs (RUN, ERR)	
Connection designation		X216 X217	

Technical data			
Bus terminating resistor	Ω	120	Terminated on both sides
Integrated bus terminating resistor		No	Connection via M12 connector
Network topology			
Without repeater		Line	
With repeater		Line or tree	
Device			
Type		Responder	
Max. number without repeater		127	Per bus segment, incl. host system
Address		1 ... 127	Parameterizable
Transmission rate	kbps	20, 50, 125, 250, 500, 800 or 1000	Parameterizable
Max. theoretical bus length	m	2500, 1000, 500, 250, 100, 50 or 25	Total cable length, depending on the transmission rate and the type of cable used.
Max. cable length between two devices		Not limited	The maximum bus length is the determining factor
Process data			
Transmit PDOs	Bytes	max. 32	PDOs can be configured for 1-, 2- and 4-byte parameters of the device
Receive PDOs	Bytes	max. 32	
Cycle time	ms	Integer multiple of 1 ms	
Transmission mode for TPDOs			
With change of data		Yes	
Time-controlled, multiple of	ms	10	
Upon receipt		1 ... 240 sync telegrams	
Parameter data			
SDO channels		Max. 2 servers	

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

Product extensions

Networks
CANopen



Processing time of process data			
Update cycle	ms	1	In the inverter
Processing time	ms	0 ... 1	
Application task runtime of the technology application used (tolerance)	ms	1 ... x	
Other data			
Note: There are no interdependencies between parameter data and process data.			



8.2.2 Modbus RTU

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

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input □ 129

Bus-related information			
Name		Modbus RTU	
Communication medium		RS485 (EIA)	
Use		Connection as a Modbus server	
Status display		2 LEDs (RUN, ERR)	
Connection designation		X216 X217	

Technical data			
Communication profile		Modbus RTU	
Bus terminating resistor	Ω	120	Terminated on both sides
Integrated bus terminating resistor		No	Connection via M12 connector
Network topology			
Without repeater		Line	
Device			
Type		Server	
Max. number without repeater		32	Per bus segment, incl. host system
Max. number with repeater		90	
Address		1 ... 247	Parameterizable
Transmission rate	kbps	2.4, 4.8, 9.6, 19.2, 38.4, 57.6 or 115.2	Parameterizable
Max. theoretical cable length	m	600, 300, 150, 75, 37, 24 or 12	Total cable length, depending on the transmission rate and the type of cable used.
Max. cable length between two devices		Not limited	The maximum bus length is the determining factor
Data channel			
SDO channels		Max. 2 servers, with 1 ... 8 bytes	Supported functions: • Read Holding Registers • Preset Single Register • Preset Multiple Registers • Read/Write 4 x registers

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

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



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

8.2.3 EtherCAT

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

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input □ 129

Bus-related information			
Name		EtherCAT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection as EtherCAT slave	
Status display		2 LEDs (RUN, ERR)	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		EtherCAT	
		CANopen over EtherCAT	
		File over Ethernet (FoE)	
		Ethernet over EtherCAT (EoE)	
Safety over EtherCAT (FSoE)		Optionally	
Vendor ID [hex]		0x3B	
Network topology		Line, tree, ring	
Device			
Type		EtherCAT slave	
Max. number		65535	In the entire network
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data			PDOs can be configured for 1-, 2- and 4-byte parameters of the device
Transmit PDOs	Bytes	max. 32	
Receive PDOs	Bytes	max. 32	
Cycle time	ms	Integer multiple of 1 ms	

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

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

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



8.2.4 EtherNet/IP

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

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input □ 129

Bus-related information			
Name		EtherNet/IP	
Communication medium		Ethernet 10 Mbps, 100 Mbps, half duplex, full duplex	
Use		Connection as EtherNet/IP adapter	
Status display		2 LEDs (MS, NS)	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		EtherNet/IP	
		AC Drive	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line, tree, ring	
With repeater		-	
Device			
Type		Adapter (Device)	
Max. number		254	Per subnetwork
Address		Station name	
Max. cable length	m	Not limited	The length between the devices is decisive
Max. cable length between two devices	m	100	
Process data			PDOs can be configured for 1-, 2- and 4-byte parameters of the device
Transmit PDOs	Bytes	max. 32	
Receive PDOs	Bytes	max. 32	
Cycle time	ms	> 4	
Switching method		Store and forward Cut-through	
Switch latency	µs	~ 125	With maximum telegram length
Other data		Additional TCP/IP channel	

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

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

Product extensions

Networks
EtherNet/IP



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



8.2.5 Modbus TCP

Modbus is an internationally approved Ethernet-based communication protocol, designed for commercial and industrial automation applications.

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input □ 129

Bus-related information			
Name		Modbus TCP	
Communication medium		Ethernet 10 Mbps, 100 Mbps, half duplex, full duplex	
Use		Connection as a Modbus TCP server (secondary) to a client (primary)	
Status display		2 LEDs	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		Modbus/TCP	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line, tree, ring	
With repeater		-	
Device			
Type		Server	
Max. Number		254	Per subnetwork
Address		Station name	
Max. Cable length	m	Not limited	The length between the devices is decisive
Max. cable length between two devices	m	100	
Process data			
Transmit PDOs	Bytes	256	
Receive PDOs	Bytes	256	
Cycle time	ms	> 4	
Switching method		-	
Switch latency	µs	~ 125	At maximum telegram length
Other data		Additional TCP/IP channel	

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

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



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

8.2.6 PROFNET

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

General information			
Version		Optionally	
DC supply for the control electronics (including communication)		Internal 24 V power supply unit	Mains-dependent DC supply
		External supply to 24E and GND	Mains-independent DC supply with 24 ... 48 V (20.5 ... 49.9 V) The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version. ▶ DC input □ 129

Bus-related information			
Name		PROFINET RT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Integration as PROFINET IO device	
Status display		2 LEDs (RDY, ERR)	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		PROFINET	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		Yes	
Network topology			
Without repeater		Line, tree, ring	
With repeater		-	
Device			
Type		IO device with real-time communication properties (RT) Conformance class B	
Max. number		255	Per subnetwork
Address		Station name	
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data			PDOs can be configured for 1-, 2- and 4-byte parameters of the device
Transmit PDOs	Bytes	max. 32	
Receive PDOs	Bytes	max. 32	
Cycle time	ms	1, 2, 4, 8, 16	
Switching method		Cut-through	
Other data		Additional TCP/IP channel	

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

9 Functional safety

The i550/i650 motec frequency inverter is available in the following functional safety versions:

- Basic Safety - STO
- Extended Safety - S (available only for the i650 motec)
- Extended Safety - ST (available only for the i650 motec)

Functional overview

		Functional safety version		
		Basic Safety - STO (BS-STO)	Extended Safety - S (ES)	Extended Safety - ST (ES-IO)
Safe inputs and outputs				
	Sensor inputs	1 (STO)	-	2
	Acknowledgement inputs	-	-	AIS + AIE
	Safe output	-	-	1
Safety bus				
	PROFIsafe connection	-	•	•
	FSoE connection	-	•	•
	CIP Safety connection	-	•	•
Safe stop functions				
	Safe torque off (STO)	•	•	•
	Safe stop 1 (SS1)	-	•	•
	Safe stop emergency (SSE)	-	•	•
Auxiliary and maintenance functions for functional safety				
	Operation mode selector (OMS)	-	•	•
	Enable switch (ES)	-	•	•
	Safe Muting (MUT)	-	•	•



For CIP Safety™, the "Extended Safety" version with **EtherNet/IP** is required. CIP Safety™ is not supported if the inverter was ordered with PROFINET or EtherCAT.

PROFIsafe and FSoE, on the other hand, are also supported by a drive ordered with EtherNet/IP. In this case, however, the user must reconfigure the drive for PROFINET or EtherCAT.



9.1 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.

Safety components are marked in yellow.

NOTICE

Excessive humidity or condensation

Malfunction or irreparable damage to safety component

► Only commission the safety component when it has acclimatized.

Standards

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

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

Risk assessment

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

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

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

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

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



Mission time

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

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



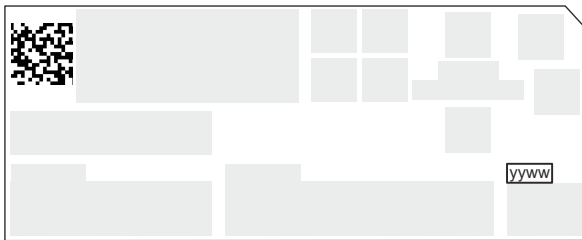
The mission time for the safety functions cannot be reset by a special proof test.

The specified mission time starts at the date of manufacture.

Mission time ► [Safety-related data](#) 212

Manufacturing date

The manufacturing date can be found on the nameplate:



yyww Year of manufacture and week of
manufacture (2144 = CW 44 2021)

9.1.1 Stop functions

The stop functions differ according to how they are triggered:

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



9.1.2 Prioritisation

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

Hierarchy:

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

Notes:

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

9.1.3 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

9.1.4 Periodic inspections

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

The user must document these tests.

The correct sequence of the safety-oriented functions must be checked in periodic inspections. The risk analysis or applicable regulations determine the time distances between the tests.

The inspection interval should not exceed one year.



9.1.5 Device exchange

Exchange a maximum of one safe device before recommissioning.



The following procedure assumes that the safe parameter set for the application is available as a file. Otherwise, a complete commissioning of the functional safety must be carried out.

How to replace a safe device with Extended Safety:

Preconditions:

- The safe parameter set for the application is available as a file.
 - There is an online connection between the engineering tool and the replacement device.
1. Check the compatibility of the replacement device.
 2. Open the parameterization dialog for safety parameters:
 - a) »EASY Starter«: Open the **Safety parameter list** tab.
 - b) »PLC Designer«: In the device tree, under the axis, open the object **Safety parameter set** in the device tree under the axis.
 3. Reset the safe parameter set to the default settings if the replacement device was previously used for test purposes or for another application:
 - a) Execute the "Reset safe parameter set in the device" command.
 - b) Enter password (default setting: "Lenze Safety").
 - c) Confirm the query as to whether the safe parameter set in the device should be reset with "Yes".
 4. Load the safe parameter set for the application from the file into the replacement device:
 - a) Execute the "Load safety parameter set from file" command.
 - b) Enter password (default setting: "Lenze Safety").
 - c) Confirm the query as to whether the existing safe parameter set should be overwritten with the parameter set from the file with "Yes".
 5. Transfer the safe parameter set to the replacement device.
 6. Carry out a functional test.



9.2 Safe parameter setting

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

Open parameterization dialog for safety parameters:

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



Safe parameter setting is only possible if the control electronics have an existing mains-dependent or mains-independent DC supply.

Safe parameter setting is not possible if the device is powered exclusively via the USB interface.



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.

9.2.1 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.

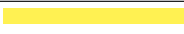
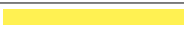


9.2.2 Acknowledgement with confirmation button S82

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

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

Display for requested acknowledgment

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
 on	off	Restart acknowledgment requested	The device is working correctly.
	 flashes (2 Hz)		During startup, a modified parameter set was detected in the "Init" state.
	 flashes (4 Hz)		During startup, a changed safety address was detected in the "Init" state.
The detection of a firmware update is indicated by the subsequent flashing of the safety LEDs.			
 on	 1 second, increasing	Software confirmation requested	During startup, a modified safety-related software component (-or- was detected.



All requests are acknowledged with the same steps.

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

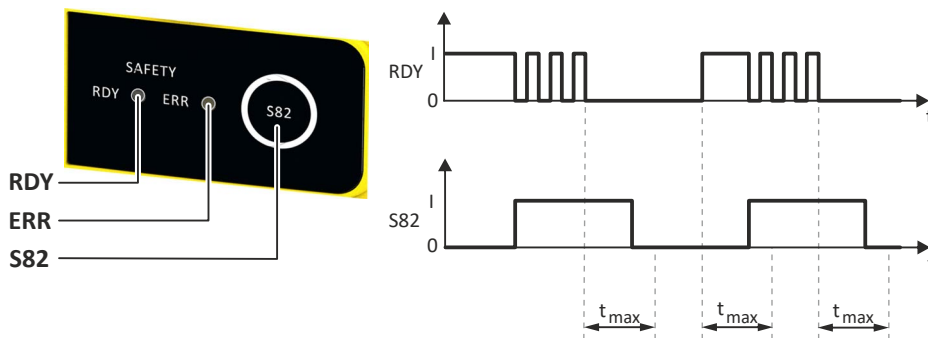


Fig. 13: Sequence of the acknowledgement procedure

RDY LED "RDY"

S82 Confirmation button S82

t Time axis

t_{max} Maximum permissible response time

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.



9.3 Safe interfaces

9.3.1 Safe inputs

Function included in variant:	Basic Safety - STO		Extended Safety - ST
-------------------------------	--------------------	--	----------------------

The components used must comply with the risk reduction required for the application.

Passive sensors

Passive sensors are two-channel, contact-based switching elements.

Please note the following:

- The switches must be wired according to the closed-circuit principle.
- Passive sensors are connected to the inverter via a safety switching device.
With Extended Safety - ST, the safety component takes over the role of the safety relay.
- An external safety component must monitor the connection cables and the function of the sensors if complete exclusion of faults cannot be guaranteed.

The contacts must switch at the same time (equivalent). Safety functions are triggered when only one channel is activated. If only one channel is active, this indicates a faulty sensor or an incorrect wiring configuration.

Examples of passive sensors:

- Door contact switch
- Emergency stop control units

Active sensors

Active sensors are devices with two-channel semiconductor outputs (OSSD outputs).

Test pulses for monitoring the outputs and cables are permissible.

P/M-switching sensors switch the positive and negative cable or the signal and ground cable of a sensor signal. P/M-switching sensors are supported only in Basic Safety - STO.

Please note the following:

- The maximum permissible connection capacity of the outputs.
- Active sensors are connected directly to the inverter.
- Monitoring for short circuits must be carried out by the active sensor.

The outputs must switch at the same time (equivalent). Safety functions are triggered when only one channel is activated. If only one channel is active, this indicates a sensor malfunction or improper wiring.

Examples of active sensors:

- Lightgrid
- Laser scanner
- Controllers

Further information on connecting passive and active sensors

Electrical installation ► [Functional safety connection](#) 77



9.3.1.1 Sensor inputs

Function included in variant:			Extended Safety - ST
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Contact function test



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

Safe input in the ON state

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

Safe input in the OFF state

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

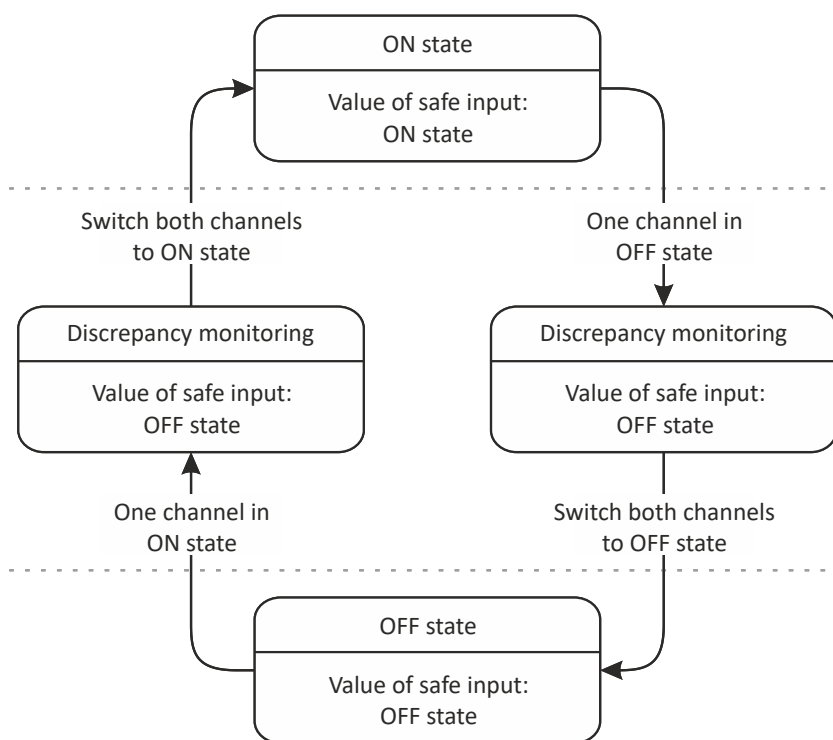


Fig. 14: Contact function test – state behavior

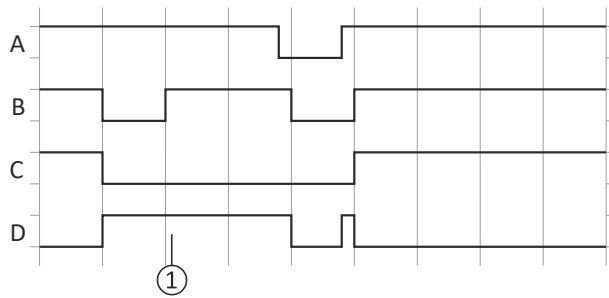


Fig. 15: Contact function test – error-free input signals

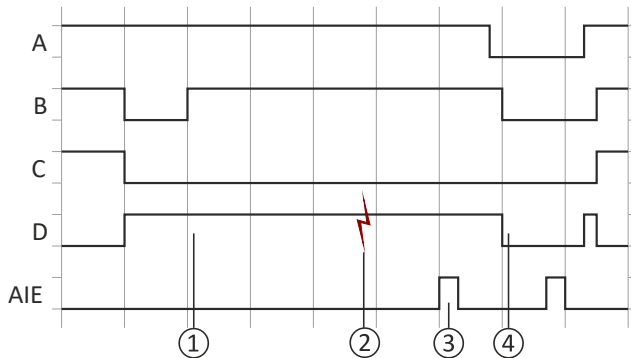


Fig. 16: Contact function test – faulty input signals

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

9.3.1.2 Acknowledgement inputs

Function included in variant:			Extended Safety - ST
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Error acknowledgement (AIE)

Errors require acknowledgement with the AIE signal.

Error acknowledgement via the safe input AIE:

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

Restart acknowledgement (AIS)

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

Restart acknowledgement via the safe input AIS:

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

Further information

- Connection diagram: [▶ Extended Safety 82](#)
- Acknowledgement via the safety bus: [▶ Acknowledgement signals 192](#)



9.3.2 Safe output

Function included in variant:			Extended Safety - ST
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Via the safe output O1A/O1B information can be output to a higher-level unit (e .g. safety PLC) or external switching elements (actuators) can be controlled.



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

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

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

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

These errors are not detected:

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

Further information on the connection

Electrical installation ► [Functional safety connection](#) 77



9.3.3 Safety bus

Function included in variant:			Extended Safety
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PROFIsafe ist das zertifizierte Safety-Protokoll zur Übertragung von sicherheitsgerichteten Daten über PROFINET®.

► [PROFIsafe connection](#)  184



Fail-safe-over-EtherCAT (FSoE) ermöglicht die Übertragung von sicheren Informationen über das FSoE-Protokoll nach Spezifikation ETG.5100 S, Version 1.2.0 der EtherCAT Nutzerorganisation (ETG).

Safety over EtherCAT® ist eine eingetragene Marke und patentierte Technologie, lizenziert durch die Beckhoff Automation GmbH, Deutschland.

► [FSoE connection](#)  187



CIP Safety™ ist das zertifizierte Safety-Protokoll zur Übertragung von sicherheitsgerichteten Daten über EtherNet/IP® nach der Spezifikation „The CIP Networks Library Volume 5 CIP Safety“ der Open DeviceNet Vendor Association (ODVA).

► [CIP Safety connection](#)  189



9.3.3.1 PROFIsafe connection



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

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

Preconditions



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

Addressing

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

Definition of the PROFIsafe address

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

PROFIsafe address type 1

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

PROFIsafe address type 2

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



PROFIsafe Frame



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

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

PROFIsafe data

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

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

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

Structure of the PROFIsafe output data

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

- Data length: 16 bytes
- Control commands are LOW-active; a bit value of "0" activates the function.
- Exceptions: See the information 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	AIE (0/1)	-	-	-	-	-	SS1	STO
Byte 1	SSE	-	ES (HIGH active)	-	OMS (HIGH active)	-	-	AIS (0/1)
Byte 2	-	-	-	-	-	-	-	-
Byte 3	-	-	-	-	-	-	SD-Out1 (HIGH active)	-
Byte 4	-	-	-	-	-	-	-	-
Byte 5	-	-	-	-	-	-	-	-
Byte 6	-	-	-	-	-	-	-	-
Byte 7	-	-	-	-	-	-	-	-
Byte 8	-	-	-	-	-	-	-	-
Byte 9	-	-	-	-	-	-	-	-
Byte 10	-	-	-	-	-	-	-	-
Byte 11	-	-	-	-	-	-	-	-
Byte 12	Status byte							
Byte 13	CRC2 (sequential number)							
Byte 14								
Byte 15								



Structure of PROFIsafe input data

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

- Data length: 16 bytes
- Status information is HIGH-active; a bit value of "1" indicates that the status information is active.

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Error active	-	-	-	-	-	-	STO active
Byte 1	SSE active	-	ES active	-	OMS active	-	-	SS1 active
Byte 2	-	-	-	-	-	-	-	-
Byte 3	-	-	-	-	-	-	-	-
Byte 4	-	-	-	-	-	-	-	-
Byte 5	-	-	-	-	MUT active	-	-	-
Byte 6	SD-In2-B	SD-In2-A	SD-In1-B	SD-In1-A	-	-	SD-In2	SD-In1
Byte 7	SD-In-AIS	SD-In-AIE	-	-	-	-	-	SD-Out1 active
Byte 8	-							
Byte 9	-							
Byte 10	-							
Byte 11	-							
Byte 12	Status byte							
Byte 13	CRC2 (sequential number)							
Byte 14								
Byte 15								



9.3.3.2 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.

Structure of the FSoE output data

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

- Data length: 11 bytes
- Control commands are LOW-active; a bit value of "0" activates the function.
- Exceptions: See the information 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	SSE	-	ES (HIGH active)	-	OMS (HIGH active)	-	-	AIS (0/1)
Byte 3	CRC_0 (Low-Byte)							
Byte 4	CRC_0 (High-Byte)							
Byte 5	-	-	-	-	-	-	-	-
Byte 6	-	-	-	-	-	-	SD-Out1 (HIGH active)	-
Byte 7	CRC_1 (Low-Byte)							
Byte 8	CRC_1 (High-Byte)							
Byte 9	Connection-ID (Low-Byte)							
Byte 10	Connection-ID (High-Byte)							



Structure of the FSoE input data

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

- Data length: 31 bytes
- Status information is HIGH-active; a bit value of "1" indicates that the status information is active.

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	SSE active	-	ES active	-	OMS active	-	-	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	SD-In2-B	SD-In2-A	SD-In1-B	SD-In1-A	-	-	SD-In2	SD-In1
Byte 14	SD-In-AIS	SD-In-AIE	-	-	-	-	-	SD-Out1
Byte 15	CRC_3 (Low-Byte)							
Byte 16	CRC_3 (High-Byte)							
Byte 17	-							
Byte 18	-							
Byte 19	CRC_4 (Low-Byte)							
Byte 20	CRC_4 (High-Byte)							
Byte 21	-							
Byte 22	-							
Byte 23	CRC_5 (Low-Byte)							
Byte 24	CRC_5 (High-Byte)							
Byte 25	-							
Byte 26	-							
Byte 27	CRC_6 (Low-Byte)							
Byte 28	CRC_6 (High-Byte)							
Byte 29	Connection-ID (Low-Byte)							
Byte 30	Connection-ID (High-Byte)							



9.3.3.3 CIP Safety connection



CIP Safety™ is the certified safety protocol for the transmission of safety-related data via EtherNet/IP® in accordance with the specification "The CIP Networks Library Volume 5 CIP Safety" of the Open DeviceNet Vendor Association (ODVA).



Preconditions

- The CIP Safety™ safety protocol is supported (bit 2 in 0x212C:003 is set).
- The network selection is set to "EtherNet/IP".
- Current EDS file
 - The EDS file can be used to integrate Lenze EtherNet/IP devices into the EtherNet/IP configuration software of PLC manufacturers.
 - [Download of the EDS file](#)

Configure safety configuration

- Before integrating the inverter into a safety network, the safe parameter set must be reset for each device.
- The "Safety Network Number" (SNN) must be unique for each safety network or safety subnet in the entire system.
- The user must carefully check the effects of device combinations with different SIL levels in the safety network.

Verify safety configuration

- The signature of the security configuration (SCID) is automatically verified via the checksums.
- The user must visually check whether all safe configuration data has been correctly downloaded to the inverter.
- When a safety device is configured directly from a workstation, the user must compare the transferred SCID data and configuration data with the SCID data and configuration data originally viewed in the workstation.
- If the user configures safety connections with a SCID = 0, the user is responsible for ensuring that the originator (safety master) and target (inverter) are configured correctly.



Please note the following:

- This configuration setting bypasses the standard, automated safety configuration check!
- This poses a higher risk to the safety integrity of the system.

Test and validate safety configuration

- After installation, after each change to the safety configuration and after a device replacement, the user must test the safety configuration loaded into the inverter with user tests:
 - To test and verify the configuration of an originator with connection data, it must first be downloaded to the inverter. This is the only way to confirm the SCID of the inverter.
 - Check the signature of the safety configuration (SCID). Only then can the safety configuration be considered verified.
 - Check and prove the operability of the safety configuration used.
 - Test the configurations of the safety connections after they have been applied in the originator (safety master). Only then is it ensured that the target connection functions as intended.
- Further information:
 - [Acceptance](#) 174
 - [Periodic inspections](#) 174
 - [Device exchange](#) 175



Structure of the CIP Safety output data (instance ID: 161)

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

- Data length: 24 bytes
- Control commands are LOW-active, the bit state "0" activates the function.
- Exceptions: See details in the table.

The detail "0↗1" means a change of state from "0" to "1".

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	AIE (0↗1)	-	-	-	-	-	SS1	STO
Byte 1	SSE	-	ES (HIGH-active)	-	OMS (HIGH-active)	-	-	AIS (0↗1)
Byte 2	-	-	-	-	-	-	-	-
Byte 3	-	-	-	-	-	-	SD-Out1 (HIGH-active)	-
Byte 4	-							
Byte 5	-							
Byte 6	-							
Byte 7	-							
Byte 8	Mode Byte							
Byte 9	CRC-S3 (low-byte)							
Byte 10	CRC-S3 (high-byte)							
Byte 11	Complement Data							
Byte 12								
Byte 13								
Byte 14								
Byte 15								
Byte 16								
Byte 17								
Byte 18								
Byte 19	CRC-S5_0							
Byte 20	CRC-S5_1							
Byte 21	Timestamp16 (low-byte)							
Byte 22	Timestamp16 (high-byte)							
Byte 23	CRC-S5_2							

Functional safety

Safe interfaces
Safety bus
Acknowledgement signals



Structure of the CIP Safety input data (instance ID: 171)

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

- Data length: 32 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	Error active	-	-	-	-	-	-	STO active
Byte 1	SSE active	-	ES active	-	OMS active	-	-	SS1 active
Byte 2	-	-	-	-	-	-	-	-
Byte 3	-	-	-	-	-	-	-	-
Byte 4	-	-	-	-	-	-	-	-
Byte 5	-	-	-	-	MUT active	-	-	-
Byte 6	SD-In2-B	SD-In2-A	SD-In1-B	SD-In1-A	-	-	SD-In2	SD-In1
Byte 7	SD-In-AIS	SD-In-AIE	-	-	-	-	-	SD-Out1 active
Byte 8	-							
Byte 9	-							
Byte 10	-							
Byte 11	-							
Byte 12	Mode Byte							
Byte 13	CRC-S3 (low-byte)							
Byte 14	CRC-S3 (high-byte)							
Byte 15	Complement Data							
Byte 16								
Byte 17								
Byte 18								
Byte 19								
Byte 20								
Byte 21								
Byte 22								
Byte 23								
Byte 24								
Byte 25								
Byte 26								
Byte 27	CRC-S5_0							
Byte 28	CRC-S5_1							
Byte 29	Timestamp16 (low-byte)							
Byte 30	Timestamp16 (high-byte)							
Byte 31	CRC-S5_2							

9.3.3.4 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.



9.4 Safety functions

Note on the function diagrams shown in this chapter

In the function diagrams shown for each safety function, the y-axis is indicated by "n" (for speed).

In contrast to a servo inverter, the output frequency is decisive for a frequency inverter. Therefore, all trigger thresholds and limits for the frequency inverter must also be set in the form of frequency values in [Hz].



9.4.1 Safe torque off (STO)

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

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

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

► [Basic Safety - STO](#) 195

► [Extended Safety](#) 197



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

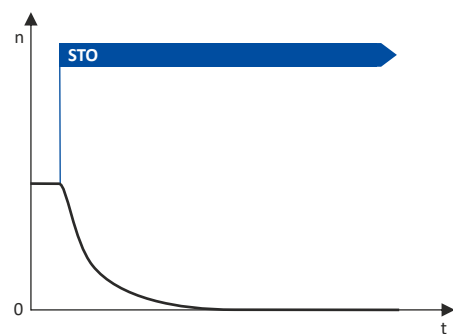
Functional safety

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



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.



9.4.1.2 Extended Safety

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

Preconditions

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

Important notes

DANGER!

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

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

Possible consequences: Death or severe injuries

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

DANGER!

The power supply is not safely disconnected.

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

- Turn off the power supply.

DANGER!

Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

- Set the motor to standstill mechanically.

DANGER!

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

Possible consequences: Death or severe injuries

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

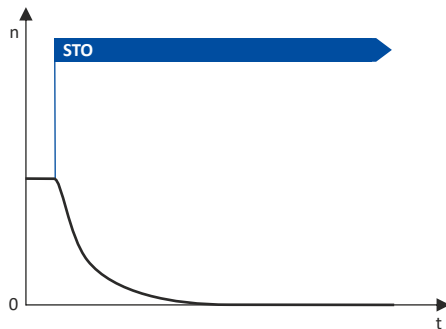
Functional safety

Safety functions
Safe torque off (STO)
Extended Safety



Functional description

STO



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

Activation

Directly:

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

Indirectly:

- As a possible error response

Automatically after the safety functions have expired:

- Safe stop 1 (SS1)

Automatically when transferring the safe parameter set

Restart

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



9.4.2 Safe stop 1 (SS1)

Function included in variant:			Extended Safety
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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.

Functional safety

Safety functions

Safe stop 1 (SS1)

Safe stop 1 time controlled (SS1-t)



9.4.2.1 Safe stop 1 time controlled (SS1-t)

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

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

Preconditions

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

Important notes



The power supply is not safely disconnected.

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

- Turn off the power supply.



Uncontrolled rotation of the motor possible.

Possible consequences: Death or severe injuries

- Set the motor to standstill mechanically.



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

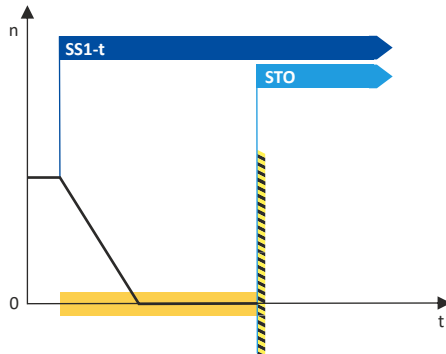
Possible consequences: Death or severe injuries

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



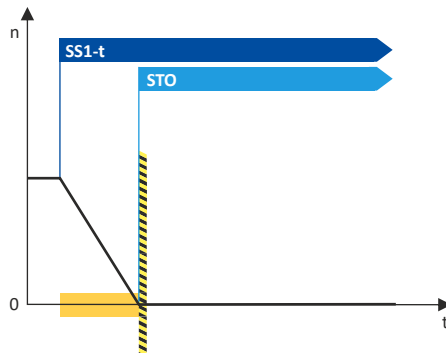
Functional description

SS1-t (STO after stop time)



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

SS1-t (STO at standstill)



- SS1-t activates the normal stop STO when standstill is detected.
- A waiting time can also be parameterized.
 - The waiting time starts when the standstill is detected.
 - SS1-t activates the normal stop STO when the waiting time has elapsed.
- Detection of standstill:
 - Output frequency of the inverter ≤ 0.5 Hz for 100 ms

Activation

Directly:

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

Indirectly:

- As a possible error response

Restart

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

Functional safety



Safety functions

Safe stop 1 (SS1)

Safe stop 1 time controlled (SS1-t)

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



9.4.3 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

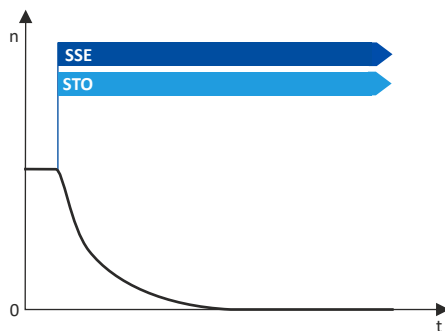


Connect emergency stop buttons that cannot be overridden by a special operating mode to the SSE function. To do this, parameterize the safe input as the trigger source for the SSE function.

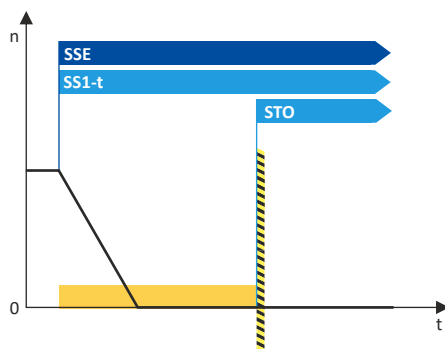
The SSE function can also be requested via the safety bus using the "SSE" bit.

Functional description

SSE (STO)



SSE (SS1-t)



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

Activation

Directly:

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



Restart

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



9.4.4 Operation mode selector (OMS)

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

This function can be used to switch between normal operation and special operation of the drive.

The special operation makes it possible to override a normal stop (e.g. STO or SS1) by enabling it via the enable switch (ES). The "emergency stop" function also has the highest priority in special operation.

Preconditions

- A source for activating the function must be configured. 0x28A8
 - Only one safe input or the safety bus can be configured as a source.
 - If a safe input is configured as a source, the function at LOW level must be selected carefully, since according to the closed-circuit principle, no additional danger may emanate from normal operation or special operation. 0x28A9:003
- A source for the ES enable switch must be configured. 0x28AE
- A stop function for special operation must be configured. 0x28A9:001
- A motion function for special operation must be configured. 0x28A9:002



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

Important notes



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

Possible consequences: Death or severe injuries

- If "automatic restart" is parameterized, this must be prevented by special measures, e.g. by programming in the higher-level control system.



Functional description

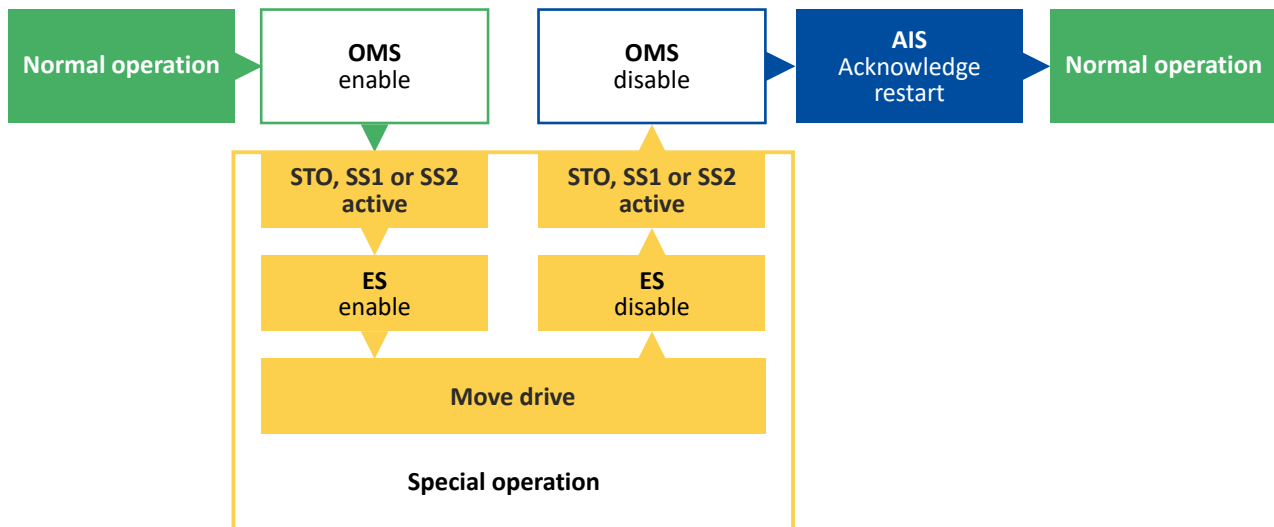


Fig. 17: OMS function

Sequence of the special operation

1. Activate OMS via the configured trigger source.
The stop function configured for OMS is activated.
2. Activate the enable switch ES via the configured trigger source.
The stop function is now overruled.
3. The drive can be moved with the configured motion function.
If monitoring functions are activated, the movement is monitored.
4. When the action is complete, deactivate the ES enable switch.
The drive can no longer be moved.
The stop function configured for OMS is activated.
5. Deactivate the trigger source for OMS.
The special operation is finished.
6. The drive waits for the restart to be acknowledged.
7. Acknowledge the restart via terminal AIS or the safety bus.
The drive changes to normal operation.



Behavior of the function in the event of an error

Activation of OMS via a safe input

- In case of a wire breakage at the safe input when OMS is activated via HIGH level:
 - OMS is deactivated.
 - The drive changes to normal operation. No stop function is triggered.
- In the event of an error at the safe input (e.g. discrepancy error):
 - OMS is deactivated.
 - The "ERR" LED is blinking.
 - The drive changes to normal operation. No stop function is triggered.
 - Once the error has been corrected and acknowledged, the special operation can be reactivated.

Activation of OMS via the safety bus

- In case of failure of safe communication:
 - OMS is deactivated.
 - The drive changes to normal operation. No stop function is triggered.

Error when executing the movement function

- When a parameterized monitoring responds:
 - The parameterized stop function for special operation is triggered.
 - The drive does not change to normal operation.

9.4.5 Enable switch (ES)

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

This function allows you to override the normal stop functions in special mode.

Preconditions

Special operation must be configured and activated.

Functional description

- The enable switch overrides the stop function active in special 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 special operation is activated again without delay.

Activation

Directly:

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



9.4.6 Safe Muting (MUT)

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

This function disables selected safe inputs and outputs and all functions of the safety bus.

A typical use case for "safe muting" is during initial commissioning, when not all safety interfaces have been wired yet.

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

Preconditions

To activate the Safe Muting function, you need:

- A PC with »EASY Starter« or »PLC Designer«.
- A permanent communication link between the engineering tool and the inverter.
- In a network, the Safe Muting function can only be activated for one inverter at a time.
- A muting password was set using the password dialog in the parameterization dialog for safety parameters.
- The active safe parameter set in the inverter must include the settings for Safe Muting:
 - The sources to be hidden.
 - The muting password.

Important notes



Activating the Safe Muting function deactivates safety functions!

Possible consequences: Death or severe injuries

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



Activation

To set the Safe Muting password (or change an existing password):

1. Open the parameterization dialog for safety parameters:
 - a) »EASY Starter«: Open the **Safety parameter list** tab.
 - b) »PLC Designer«: In the device tree, under the axis, open the object **Safety parameter set** in the device tree under the axis.
2. Click the "  " button and execute the "Muting Password" command.
The "Change Muting Password" dialog box opens.
3. Set the muting password.
4. Transfer the safety parameters to the device so that the change to the muting password takes effect.

To activate and deactivate safe muting:

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



9.5 Diagnostics

9.5.1 Status LEDs

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

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

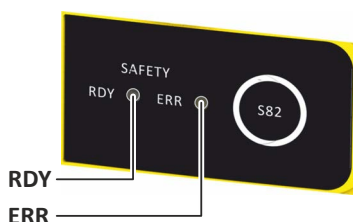


Fig. 18: Position of the RDY and ERR LEDs

⚠ 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 (2 Hz)	Service status	Transfer of parameter set requested.

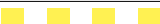
Display for requested acknowledgment

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
 on	off	Restart	The device is working correctly.
	 flashes (2 Hz)	acknowledgment requested	During startup, a modified parameter set was detected in the "Init" state.
	 flashes (4 Hz)		During startup, a changed safety address was detected in the "Init" state.

The detection of a firmware update is indicated by the subsequent flashing of the safety LEDs.

 on	 1 second, increasing	Software confirmation requested	During startup, a modified safety-related software component (-or- was detected.
---	---	---------------------------------	--

Display in the event of errors

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
	off	-	The device is working correctly.
	 blinking (2 Hz)	Error	One of the following errors has been detected: - A monitoring device has been activated. - An acknowledgeable error is active. - Discrepancy of the inputs
 blinking (2 Hz)	 blinking (2 Hz)		One of the following errors has been detected: - Discrepancy of the configuration parameters - CRC checksum error
	 blinking (4 Hz)	Safety bus error	Communication via the safety bus is not established: - There is no valid configuration. - The start-up has not been completed yet.



Display for critical device errors

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



For more information on diagnostics and fault elimination, refer to the inverter commissioning document.



9.6 Safety-related data

9.6.1 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	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	> 3200 years
	Mean diagnostic coverage DC _{avg}		99 %

Further data and information

Electrical installation ► [Functional safety connection](#) 77

9.6.2 Safety-related characteristics Extended 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	
Extended Safety - S and Extended Safety - ST			
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
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Category	4	
	Performance Level	e	
	MTTF _d	High	> 130 years
	Mean diagnostic coverage DC _{avg}	High	95 %
Extended Safety - ST (safe single-channel inputs)			
The safety-related parameters of the safe single-channel inputs differ due to their SIL 2 classification.			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 2	
	PFH [1/h]	< 2 E-08	< 1 % of SIL 2
	PFD _{avg} (T)	< 1.5 E-03	< 10 % of SIL 2 after T = 20 years
	Proof test interval T	20 years	Mission time
EN ISO 13849-1	Category	2	
	Performance Level	c	
	MTTF _d	High	> 40 years
	Mean diagnostic coverage DC _{avg}	High	95 %

Further data and information

Electrical installation ► [Functional safety connection](#) 77



9.6.3 Response times of the safety unit

For the calculation of the response time to the request of a safety function, the overall system must be taken into account:

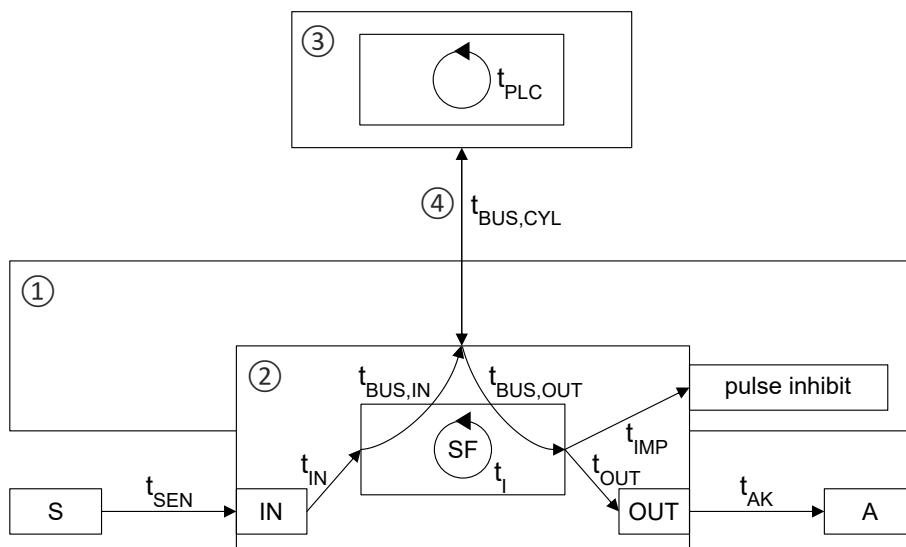
- Response time of the connected safety sensors.
- Internal processing time.
- Deceleration times, braking times, and stop times from the parameterized safety functions.
- Safety bus:
 - Monitoring time for cyclic services.
 - Monitoring time in the safety PLC.
 - Processing time in the safety PLC
- Deceleration times due to further components.



-
- 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.
 - Include the times of the safety functions in the calculation, e.g. for SS1 the stop time until STO is active.
-



Response times for the "Extended Safety" version



- | | | | |
|---|-------------------|----|---------------------------|
| 1 | Basic device | 4 | Safety bus |
| 2 | Integrated safety | SF | Triggered safety function |
| 3 | Safety PLC | | |

Response times of safety modules		
t_i	Processing time of the integrated safety (taking into account the feedback from the status flags for the input)	4 ms
t_{SEN}	Response time of the safety sensors	See manufacturer information
t_{IN}	Input delay of the safe inputs	
	Parameterizable via 0x211A:001, 0x211A:002, 0x211A:016 ... 0x211A:019	0 ... 100 ms
	Input filter	2 ms
$t_{BUS,IN}$	Sending a safety telegram to the safety PLC	
	PROFIsafe	40 ms
	FSoE	8 ms
	CIP Safety	20 ms
$t_{BUS,OUT}$	Receiving a safety telegram from the safety PLC	
	PROFIsafe	108 ms
	FSoE	16 ms
	CIP Safety	32 ms
t_{OUT}	Delay in safe output	4 ms
t_{AK}	Time until the safety actuators have shut down.	See manufacturer information
$t_{BUS,CYL}$	Safety bus cycle time	
	PROFIsafe	See "Project Planning" in the Safety PLC
	FSoE	
	CIP Safety	
t_{PLC}	Cycle time of the safety PLC	See the manufacturer's specifications for the safety PLC
t_{IMP}	Time delay of the safe pulse inhibit	6 ms



Response times of a function	
Triggering STO via the safety bus	$t_{PLC} + t_{BUS,CYL} + t_{BUS,OUT} + t_{IMP}$
	$t_{PLC} + t_{BUS,CYL} + (108, 16 \text{ or } 32 \text{ ms}) + 6 \text{ ms}$
STO status flag feedback via safety bus	$t_{PLC} + t_{BUS,CYL} + t_{BUS,OUT} + t_I + t_{BUS,IN} + t_{PLC}$
	$t_{PLC} + t_{BUS,CYL} + (108, 16 \text{ or } 32 \text{ ms}) + 4 \text{ ms} + (40, 8 \text{ or } 20 \text{ ms}) + t_{PLC}$
Triggering STO via a safe input	$t_{SEN} + t_{IN} + t_I + t_{IMP}$
	$t_{SEN} + (0 \dots 100 \text{ ms}) + 2 \text{ ms} + 4 \text{ ms} + 6 \text{ ms}$
Triggering the safe output via the safety bus	$t_{PLC} + t_{BUS,CYL} + t_{BUS,OUT} + t_{OUT} + t_{AK}$
	$t_{PLC} + t_{BUS,CYL} + (108, 16 \text{ or } 32 \text{ ms}) + 4 \text{ ms} + t_{AK}$
Transmission of the safe input to the safety PLC	$t_{SEN} + t_{IN} + t_{BUS,IN} + t_{BUS,CYL} + t_{PLC}$
	$t_{SEN} + (0 \dots 100 \text{ ms}) + (40, 8 \text{ or } 20 \text{ ms}) + t_{BUS,CYL} + t_{PLC}$
Triggering STO via a safe input and feeding back the STO status flag to the safety PLC	STO trigger: $t_{SEN} + t_{IN} + t_I + t_{IMP}$
	STO trigger: $t_{SEN} + (0 \dots 100 \text{ ms}) + 4 \text{ ms} + 6 \text{ ms}$
	STO status flag: $t_{SEN} + t_{IN} + t_I + t_{BUS,IN} + t_{BUS,CYL} + t_{PLC}$
	STO status flag: $t_{SEN} + (0 \dots 100 \text{ ms}) + 4 \text{ ms} + (40, 8 \text{ or } 20 \text{ ms}) + t_{BUS,CYL} + t_{PLC}$



10 Accessories

10.1 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		EZVA048	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	2.3	0.3	0.4	0.85
Rated output voltage		V	24		48	24		
Ausgangsspannungsbereich		V	22.5 ... 29.5		30 ... 56	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 90 x 150	130 x 40 x 125	130 x 60 x 125	130 x 70 x 150
Weight	m	kg	0.86	1.05	2	0.78	1.32	1.6



10.2 Screw connection membrane set

A pressure compensation element with membrane technology prevents condensed water from forming in the device and ensures trouble-free operation. This ensures maintenance of the protection class.

Possible applications include scenarios with large differences in temperature and humidity between indoor and outdoor areas. The resulting negative pressure inside the device causes air flow from the outside to the inside and can lead to condensed water forming inside the unit.

Screw connection, membrane set		
Type designation	Design	
EZAMBHXX026		5 x M12 screw connection with integrated membrane



10.3 System cables

Pre-assembled system cables are the ideal solution for easily connecting or interconnecting Lenze products. Wiring errors are thus reliably prevented.

Mains, motor, feedback and blower cables are available. Depending on the application, the cables are equipped with standard connectors, making integration into the machine's peripherals very easy.



Note for devices with a wall adapter and an M23 connector for the motor connection:

The M23 connector for the motor connection does not have a fixed orientation in the wall adapter; instead, its orientation can vary within a certain range. For this reason, we do not recommend using a motor cable with an angled M23 connector!

Further information on system cables and other accessories can be found in the brochure "[Accessories for frequency inverters and servo inverters](#)".



10.4 Wall and motor adapters

Wall adapter

Example with Han Q8



Example with M23



Example with cable gland (M25)



Power range of inverters	Type designation	Motor connection version
0.37 ... 1.1 kW (3/PE AC 230/240 V) 0.37 ... 2.2 kW (3/PE AC 400/480 V)	I6ZAC0M3AS	With Han Q8
	I6ZAC0M3CS	With M23
	I6ZAC0M3BS	With cable gland (M25)
1.5 ... 3 kW (3/PE AC 230/240 V) 3 ... 5.5 kW (3/PE AC 400/480 V)	I6ZAC0M4DS	With heatsink fan and Han Q8
	I6ZAC0M4FS	With heatsink fan and M23
	I6ZAC0M4ES	With heatsink fan and cable gland (M25)
4 ... 5.5 kW (3/PE AC 230/240 V) 7.5 ... 11 kW (3/PE AC 400/480 V)	I6ZAC0M5AS	With Han Q8
	I6ZAC0M5CS	With M23
	I6ZAC0M5BS	With cable gland (M25)
7.5 ... 22 kW (3/PE AC 230/240 V) 15 ... 45 kW (3/PE AC 400/480 V)	I6ZAC0M6GS	With cable gland (M40)

Motor adapter

Example of motor designs BG063 and BG071



Power range of inverters	Type designation	Version
0.37 ... 1.1 kW (3/PE AC 230/240 V) 0.37 ... 2.2 kW (3/PE AC 400/480 V)	I6ZAC0M3IS	For motor designs BG063 and BG071
	I6ZAC0M3JS	For motor designs BG080, BG090, BG100 and BG112
1.5 ... 3 kW (3/PE AC 230/240 V) 3 ... 5.5 kW (3/PE AC 400/480 V)	I6ZAC0M4JS	For motor designs BG080, BG090, BG100 and BG112
	I6ZAC0M4KS	For motor design BG132
4 ... 5.5 kW (3/PE AC 230/240 V) 7.5 ... 11 kW (3/PE AC 400/480 V)	I6ZAC0M5JS	For motor designs BG080, BG090, BG100 and BG112
	I6ZAC0M5KS	For motor design BG132
	I6ZAC0M5LS	For motor designs BG160 and BG180
7.5 ... 22 kW (3/PE AC 230/240 V) 15 ... 45 kW (3/PE AC 400/480 V)	I6ZAC0M6KS	For motor design BG132
	I6ZAC0M6LS	For motor designs BG160 and BG180



11 Purchase order

11.1 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](#)



Aftersales Service

You can use our online support to directly request support and repairs for specific Lenze products or order spare parts and call up technical data and documentation.

www.Lenze.com → [Support](#)

Simply enter the material number or scan the nameplate with our integrated scan function. All support information is immediately available to you at a glance.



11.2 Order details

The following is a list of the information required to order an i550 motec frequency inverter.

Order example

Description of the component		Type code
i550 motec frequency inverter	I55AM	I55AM 222 F 0 A D B 0 0 0 K S
Rated power 2.2 kW / 3 hp	222	
3-phase mains connection 400 V	F	
Extension box: Without extension box	0	
Integrated functional safety: Basic Safety - STO	A	
Protection class: IP66, coated / UL Type 4X indoor	D	
Motor connection: Wall adapter with cable gland (M25)	B	
Default parameter setting: Region EU (50-Hz networks)	0	
Additional functions: Without	0	
Control connections: Standard I/O	0	
Network: EtherCAT	K	
Packaging: Packed individually	S	



Assignment of product name and type code

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

The product name contains:

- the name of the product series - "i□□□" as wildcard for "i550" or "i650"
- the version - "M" for "motec" = inverter for decentralized mounting locations/motor mounting
- the rated power in kW
- the mains voltage class - e.g. 230/240 V or 400/480 V
- the number of mains phases

This information results in the first 9 characters of the type code:

Complete inverter				
Rated power		Product name	Type code	
kW	hp		i550 motec	i650 motec
3-phase mains connection 230/240 V				
0.37	0.5	i□□□-M0.37/230-3	I55AM137C	I65AM137C
0.55	0.75	i□□□-M0.55/230-3	I55AM155C	I65AM155C
0.75	1	i□□□-M0.75/230-3	I55AM175C	I65AM175C
1.1	1.5	i□□□-M1.1/230-3	I55AM211C	I65AM211C
1.5	2	i□□□-M1.5/230-3	I55AM215C	I65AM215C
2.2	3	i□□□-M2.2/230-3	I55AM222C	I65AM222C
3	4	i□□□-M3.0/230-3	I55AM230C	I65AM230C
4	5.5	i□□□-M4.0/230-3	I55AM240C	I65AM240C
5.5	7.5	i□□□-M5.5/230-3	I55AM255C	I65AM255C
7.5	10	i□□□-M7.5/230-3	I55AM275C	I65AM275C
11	15	i□□□-M11/230-3	I55AM311C	I65AM311C
15	20	i□□□-M15/230-3	I55AM315C	I65AM315C
18.5	25	i□□□-M18/230-3	I55AM318C	I65AM318C
22	30	i□□□-M22/230-3	I55AM322C	I65AM322C
Three-phase mains connection 400/480 V				
0.37	0.5	i□□□-M0.37/400-3	I55AM137F	I65AM137F
0.55	0.75	i□□□-M0.55/400-3	I55AM155F	I65AM155F
0.75	1	i□□□-M0.75/400-3	I55AM175F	I65AM175F
1.1	1.5	i□□□-M1.1/400-3	I55AM211F	I65AM211F
1.5	2	i□□□-M1.5/400-3	I55AM215F	I65AM215F
2.2	3	i□□□-M2.2/400-3	I55AM222F	I65AM222F
3	4	i□□□-M3.0/400-3	I55AM230F	I65AM230F
4	5	i□□□-M4.0/400-3	I55AM240F	I65AM240F
5.5	7.5	i□□□-M5.5/400-3	I55AM255F	I65AM255F
7.5	10	i□□□-M7.5/400-3	I55AM275F	I65AM275F
11	15	i□□□-M11/400-3	I55AM311F	I65AM311F
15	20	i□□□-M15/400-3	I55AM315F	I65AM315F
18.5	25	i□□□-M18/400-3	I55AM318F	I65AM318F
22	30	i□□□-M22/400-3	I55AM322F	I65AM322F
30	40	i□□□-M30/400-3	I55AM330F	I65AM330F
37	50	i□□□-M37/400-3	I55AM337F	I65AM337F
45	60	i□□□-M45/400-3	I55AM345F	I65AM345F



Type code structure

		I	□□	A	M	□□□	□	□	□	□	□	□	□	□	□	S
Product type	Inverters	I														
Product	i550		55													
	i650		65													
Product generation	Generation 1			A												
Mounting type	Motor and wall mounting				M											
Rated power	0.37 kW					137										
	0.55 kW					155										
	0.75 kW					175										
	1.1 kW					211										
	1.5 kW					215										
	2.2 kW					222										
	3 kW					230										
	4 kW					240										
	5.5 kW					255										
	7.5 kW					275										
	11 kW					311										
	15 kW					315										
	18.5 kW					318										
	22 kW					322										
	30 kW					330										
	37 kW					337										
	45 kW					345										
Mains voltage and connection type	3/PE AC 230/240 V										C					
	3/PE AC 400/480 V										F					
Extension box	Without extension box											0				
	Extension Box for inverters	with mains terminals										1				
		with disconnect switch										A				
		• 0.37 ... 5.5 kW (3/PE AC 230/240 V)										B				
		• 0.37 ... 11 kW (3/PE AC 400/480 V)										C				
		with disconnect switch with Type E combination motor controller										D				
		With disconnect switch with Type E combination motor controller and status feedback										E				
		with disconnect switch with status feedback and operating elements										F				
		with disconnect switch with status feedback, operating element and potentiometer														
Integrated functional safety	Without functional safety											0				
	Basic Safety - STO (BS-STO)											A				
	Extended Safety - ST (ES-IO) (available only for the i650 motec)											D				
	Extended Safety - S (ES) (available only for the i650 motec)											E				
Degree of protection	IP54, coated UL Type 12/12K (available only with extension box types C, D, E, and F)												B			
	IP66, coated UL type 4X indoor												D			
Continuation ...																



Type code structure (continuation)

			I	□□	A	M	□□□	□	□	□	□	□	□	□	□	□	□	□	S					
Motor connection	Without adapter													0										
	Wall adapter	with Han Q8												A										
		with M23												C										
		with M40												H										
		with cable gland (M25)												B										
		with cable gland (M40)												G										
		Wall adapter inverters												with heatsink fan and Han Q8	D									
	with heatsink fan and M23													F										
	with heatsink fan and cable gland (M25)													E										
	Motor adapter	for BG063 - BG071												I										
		for BG080 - BG112												J										
		for BG132												K										
		for BG160 - BG180												L										
Application area	Default parameter setting: Region EU (50 Hz networks)													0										
	Default parameter setting: Region US (60 Hz networks)													1										
Additional functions	Without additional functions													0										
	Logic PLC & Table Positioning (available only for the i650 motec)													P										
Control connections	Standard-I/O (available only for the i550 motec)													0										
	Application-I/O													1										
	Extended-I/O													2										
Network	Without network																		0					
	CANopen (in preparation)																						2	
	Modbus RTU																						3	
	EtherCAT																						K	
	PROFINET																						L	
	EtherNet/IP																						M	
	Modbus TCP																						W	
Packaging	Packed individually																			S				



12 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>



13 Appendix

13.1 Good to know

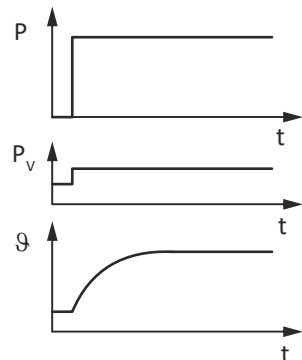
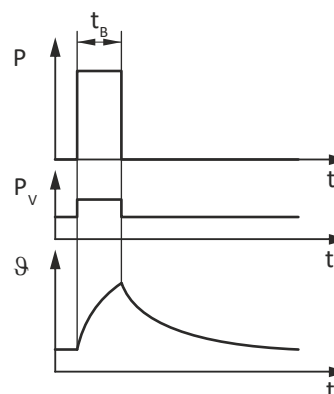
13.1.1 Operating modes of the motor

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



13.1.2 Motor control types

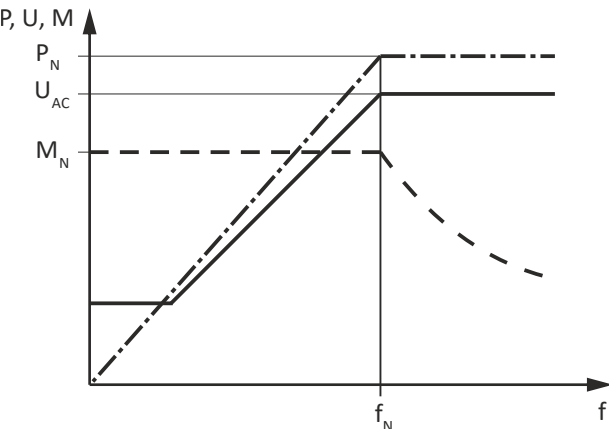
The inverter provides various motor control types.

Linear V/f characteristic control

The output voltage is increased proportionately to the output frequency.

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

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



P Power
V Voltage
M Torque
f Frequency

P_N Rated power
 U_{AC} Mains voltage
 M_N Rated torque
 f_N Rated frequency



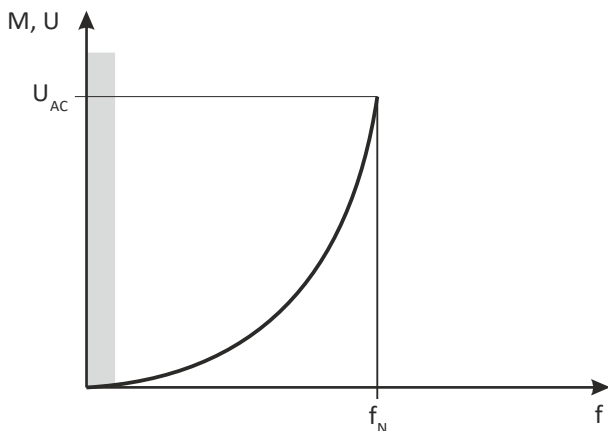
Square-law V/f characteristic control

The output voltage is increased squaredly to the output frequency.

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

Application areas are for instance:

- Pumps
- Fans
- Ventilators

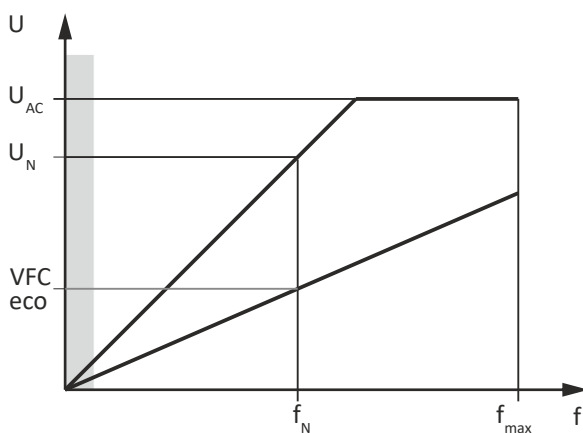


V Voltage
f Frequency
M Torque

U_{AC} Mains voltage
 f_N Rated frequency

VFCeco

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



V Voltage
 U_{AC} Mains voltage
 U_N Rated voltage

f Frequency
 f_N Rated frequency
 f_{max} Max. frequency

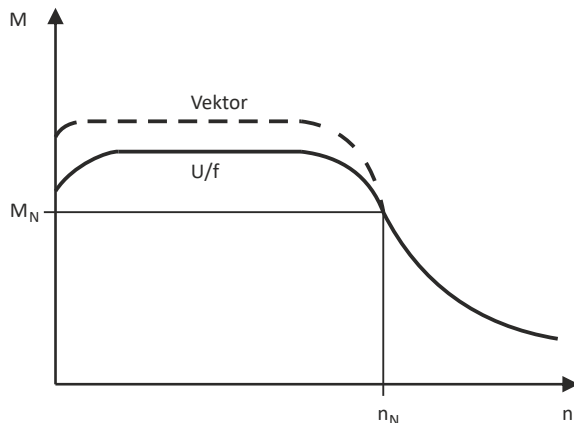


Sensorless vector control (SLVC)

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

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

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



M Torque
n Speed

M_N Rated torque
 n_N Rated speed

Application areas are for instance:

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

13.1.3 Switching frequencies

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

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

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

Options for the switching frequency:

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



13.1.4 Enclosures

The protection class indicates the suitability of a product for specific ambient conditions with regard to humidity as well as the protection against contact and the ingress of foreign particles. The protection classes are classified in the EN IEC 60034-5/EN IEC 60529.

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

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



13.2 Glossary

Definitions in functional safety

Abbreviation	Meaning
AIE	Acknowledge In Error, error acknowledgement
AIS	Acknowledge In Stop, restart acknowledgement
OFF state	Triggered signal status of the safety sensors
CCF	Common Cause Error (also β -value)
CIP	Common Industrial Protocol
EC_FS	Error Class Fail Safe
EC_SS1	Error Class Safe Stop 1
EC_SS2	Error Class Safe Stop 2
EC_STO	Error Class Safe Torque Off Stop 0
ON state	Signal status of the safety sensors in normal operation
FIT	Failure In Time, 1 FIT = 10^{-9} Error/h
FMEA	Failure Mode and Effect Analysis
FSoE	FailSafe over EtherCAT
GSDML	Device description file with PROFINET-specific data to integrate the configuring software of a PROFINET controller.
HFT	Hardware Failure Tolerance
nBD	Speed value Base-Drive, internally determined actual speed from standard application
nSD	Safe-Drive speed value, internally determined actual speed from the safety application
n_safe	Actual speed determined from validation of nBD and nSD. Enters the further processing of the speed-dependent safety functions.
OSSD	Output Signal Switching Device, tested signal output
pBD	Base-Drive position value, internally determined actual position from standard application
pSD	Safe-Drive position value, internally determined actual position from the safety application
p_safe	Actual position determined from validation of pBD and pSD. Enters the further processing of the position-dependent safety functions.
PELV	Protective Extra Low Voltage
PL	Performance Level according to EN ISO 13849-1
PM	Plus-Minus-switched signal paths
PP	Plus-Plus-switched signal paths
PS	PROFIsafe
PWM	Pulse Width Modulation
SCS	Safe Creeping Speed
SD-In	Safe Digital Input
SD-Out	Safe Digital Output
SELV	Safety Extra Low Voltage
SFF	Safe Failure Fraction
SIL	Safety Integrity Level according to EN IEC 61508

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