Operating Manual

PacDrive™
Intelligent Servo Module and Option Modules

Article Nr.: 17130113-001
Edition: 01.2009

ELAU PACKAGING SOLUTIONS

Schneider Electric

Legal notice

Trademark

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Schneider Electric	**Manufacturer's declaration** According to the EC machine guidelines 98/37/EC	ELN 123-00/01.08 page 1/1

The product we delivered:

Drive System iSH
- Intelligent Servo Module
- PS-5 Power Supply
- DB-5 Distribution Box
is intended for installation in a machine.

Commissioning is forbidden until it is established that the machine in which this product is to be installed complies with the provisions of the EC guideline. The manufacturer guarantees that the delivered product was manufactured in accordance with the applied harmonized standards/specifications.

The following standards were applied:

- **EN 60204-1: 2006** Safety of machinery: Electrical equipment of machines - General requirements
- **EN 61800-3: 2004** EMC Product standardization for "electric drives with variable revolution speed"
- **EN 50178: 1997** Electronic equipment for use in high-current electrical systems
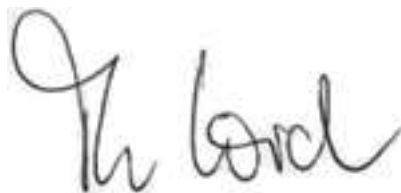
The following harmonized standards were additionally applied for the Inverter Enable function:

- **IEC 61800-5-2:2007**; "Safe Torque Off, STO" and „Safe Stop 1, SS1", SIL2-enabled
- **IEC 61508**; Part 1: 1998 + Corrigendum 1999
- **EN 61508**; Part 2: 2000; "Safe Torque Off, STO" and „Safe Stop 1, SS1", SIL 2-enabled
- **EN ISO 13849-1:2006**; PL d, EN 954-1:1996; Category 3
- **IEC 62061:2005**; SILCL 2

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2008-01-10

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1 About this manual

1.1 Introduction

Read and observe this manual before you work on the PacDrive Motor for the first time. Take particular note of the safety instructions (see 2.3 Rest dangers). As described in section 2.2, only those persons who meet the "Selection and qualification of employees" are allowed to work on the PacDrive Motor.

A copy of this manual must always be available for personnel who are entrusted to work on the PacDrive Motor.

This manual is intended to help you use the PacDrive Motor and its intended applications safely and properly.
By observing this manual, you will help to
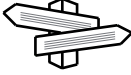
- avoid risks,
- reduce repair costs and down times of the PacDrive Motor,
- increase the life spanof the PacDrive Motor
- and increase reliability of the PacDrive Motor.

1.2 Symbols, designator and display format of safety notes

This manual divides the safety instructions into four different categories.
Hazards and their potential consequences are categorized by using a combination of symbols and signal words:

Symbol / Signal word	Meaning
⚠ DANGER	Indicates an immediate hazardous situation that can lead to death or serious injury if the safety regulations are not observed.
⚠ WARNING	Indicates a potentially hazardous situation that can lead to serious injury or death if the safety regulations are not observed.
⚠ CAUTION	Indicates a potentially hazardous situation that may result in bodily harm or property damage if the safety regulations are not observed.
CAUTION	Indicates a potentially dangerous situation that may result in damage to the device if the safety regulations are not observed.

The following symbols and designators are used in this document:

Symbol/Character	Meaning
💡	**Information Symbol:** After this symbol, you will find important instructions and useful tips on using the components.
	Marker: After this symbol, you will find references for further information.
▪	**Prerequisite symbol:** This symbol indicates a prerequisite you have to fulfill before you start to implement an instruction.
▶	**Activity symbol:** After this symbol, you will find an instruction. Follow the instructions in sequence from top to bottom.
✓	**Result symbol:** The text after this symbol contains the result of an action.
●	First level **bullet point**
–	Second level **bullet point**
📖	**Orientation aid:** Information serving as an orientation aid regarding the section's contents follows this symbol.
bold	If the descriptive text contains **keywords**, such as parameters, they are highlighted in bold.
`lBufSelect:AXIS_BUF_SELECTION;` `(* Buffer Auswahl *)`	**Program code** is written in a different font.

2 Notes for working safely with the product

The following section contains information regarding safe work with the PacDrive Motor. Anyone using or working on the PacDrive Motor must read and observe this information. The ELAU Motor is state of the art and conform to recognized technical safety regulations. Nevertheless, the use of the PacDrive Motor can present a hazard to life and limb or cause property damage.

2.1 Introduction

The ELAU Motor is intended to be installed in a machine or assembled with other components to form a machine or system..

What do you need to observe? Proper use includes that you observe the following points and the resulting rules:

- The regulative, warning and instruction signs on the connected components and in the switching cabinet
- The warning instructions on the PacDrive Motor on the connected components and in the switch cabinet
- The inspection and maintenance instructions
- The operating instructions of the other components
- All other documentation

Flawless condition Operate the PacDrive Motor only when they are in a flawless technical condition. Observe the regulations, act with safety and hazards in mind. If circumstances occur that impact safety or cause changes in the operating performance of the PacDrive Motor, switch the PacDrive Motor off immediately and contact the responsible service staff.

Use original-equipment only Use only the options and mounting parts specified in the documentation and no third-party devices or components that are not expressly approved ELAU recommends. Do not change the PacDrive Motor inappropriately.

Provide for protective measures Before installing, provide for appropriate protective devices in compliance with the local and national standards. Do not commission components without accordant protective devices. After installation, commissioning or repair, test the protective devices used.

Forbidden environments The components must not be used in the following environments:

- In dangerous (explosive) atmospheres
- In mobile, movable or floating systems
- In life support systems
- In domestic appliances

Installation and operating conditions You may only use them in accordance with the installation and operating conditions described in the documentation. The operating conditions at the installation location must be checked and maintained in accordance with the required technical data (performance data and ambient conditions). Commissioning is prohibited until it is guaranteed that the usable machine or system in which the PacDrive Motor is installed meets all requirements of EC Directive 98/37/EC (machinery directive).

In addition, the following standards, directives and regulations are to be observed:

• DIN EN 954 Part 1 Safety of machinery - Safety-related parts of control systems
• DIN EN 60204 Safety of machinery: Electrical equipment of machines
• DIN EN 292 Part 1 and Part 2 Safety of machinery: Basic Concepts, General Principles for Design
• DIN EN 50178 Electronic equipment for use in high-current electrical systems
• DIN EN 61800-3:2005 of EMC directive 2004/108/EC
• The generally applicable local and national safety and accident prevention regulations.
• The rules and regulations on accident prevention and environmental protection that apply in the country where the product is used.
• The applicable laws and ordinances

2.2   Selection and qualification of personnel

Target audi-
ence
for this manual

This manual is geared exclusively toward technically qualified personnel, who have detailed knowledge in the field of automation technology. The description is mainly for construction and application engineers from the engineering and electro-technics division as well as service and commissioning engineers.

Professional or
trained
personnel

Work on the PacDrive Motor may only be carried out by qualified professionals or by trained staff under the instruction and supervision of a qualified person in accordance with electrical regulations. Professionals are those persons who, as a result of their training, knowledge and experience and knowledge of the pertinent regulations, can

- evaluate the transferred work,
- recognize the meaning of the safety instructions and implement them consistently,
- recognize possible hazards and
- take appropriate safety measures.

Inverter Enable
function

The operators of the Inverter Enable function must be trained according to the complexity of the machine and the requirements of EN954-1 (Category 3). The training has to include the production process and the relation between the Inverter Enable function and the machine.

The specialists must be able to detect possible hazards that may arise from parameterization, changing parameter values and generally from mechanical, electrical or electronic equipment.
The specialists must be familiar with the typical standards, conditions and accident prevention regulations to be observed when working on a drive system.

Qualification directives can be found in the following publication, for example: „Safety, Competency and Commitment: Competency Guidelines for Safety-Related System Practitioners." IEE Publications, ISBN 0 85296 787 X, 1999.

2.3   Rest dangers

Health risks arising from the PacDrive Motor have been reduced by means of safety technology and design engineering. However a residual risk remains, since the Pac-Drive Motor works with electrical voltage and electrical currents.

If activities involve residual risks, a safety note is made at the appropriate points. The note details the potential hazard and its effects and describes preventative measures to avoid it. The following section contains warnings about residual risks which can be assigned no concrete action. The structure of warning instructions is identical to the safety instructions.

Assembly and handling

⚠ WARNING
CRUSHING, SHEARING, CUTTING AND HITTING DURING HANDLING • Observe the general construction and safety regulations for handling and mounting. • Use suitable mounting and transport equipment correctly and use special tools if necessary. • Prevent clamping and crushing by taking appropriate precautions. • Cover edges and angles to protect against cutting damage. • Wear suitable protective clothing (e.g. safety goggles, safety boots, protective gloves) if necessary.
Failure to follow these instructions can result in death or serious injury.

Touching hot surfaces

As warning against housing temperatures of the motor exceeding 70°C during nominal operation, the symbol shown here is affixed on the motor.

⚠ CAUTION
HOT SURFACES UP TO 100 °C • Wait until the surface temperature has cooled to allow safe contact. • Wear protective gloves. • Attach protective cover or touch guard
Failure to comply with these instructions can lead to bodily harm.

Touching electrical parts

⚠ DANGER
ELECTRICAL SHOCK, EXPLOSION OR ELECTRIC ARC
• Observe the general construction and safety regulations for working on high-current electrical systems.   • Operate electrical components only with connected protective conductor   • After installation, check the fixed connection of the protective conductor to all electrical devices to ensure that connection complies with the connection diagram.   • Make sure that the drives are at a standstill because potentially fatal voltage can occur on the motor lines in generator operation.   • Before enabling the device, safely cover the live components to prevent contact.   • Do not touch the electrical connection points of the components when the device is switched on.   • Provide protection against indirect contact (DIN EN 50178 : 1997, Section 5.3.2).   • Disconnect/plug in power connector cables only when the system is deactivated.
Failure to follow these instructions will result in death or serious injury.

Protection against magnetic and electromagnetic fields

⚠ WARNING
RISK GROUPS IN THE IMMEDIATE VICINITY OF MAGNETIC AND ELECTRO-MAGNETIC FIELDS
• Do not allow personnel with pacemakers or similar sensitive implants to work in the immediate vicinity of live conductors and motor permanent magnets.
Failure to follow these instructions can result in death or serious injury.

Dangerous Movements

There can be different causes of dangerous movements:

- Missing or faulty homing of the robot mechanics
- Wiring or cabling errors
- Errors in the application program
- Module error in the components
- Error in the measured value and signal transmitter
- Operation error
- Malfunction of protective equipment

Personal safety must be guaranteed by primary equipment monitoring or measures. Don't just rely on the internal monitoring of the drive components. Monitoring or measures should be implemented based on the specific characteristics of the equipment, in line with a risk and error analysis. This includes the valid safety regulations for the equipment.

⚠ DANGER

MISSING PROTECTIVE DEVICE OR WRONG PROTECTION

- Prevent entry to a danger zone, for example with protective fencing, mesh guards, protective coverings, or light barriers.
- Dimension the protective devices properly and do not remove them.
- Do not carry out any changes that can invalidate the protection device.
- Before accessing the drives or entering the danger zone, safely bring the drives to a stop.
- Protect existing work stations and operating terminals against unauthorized operation.
- Position EMERGENCY OFF switches so that they are easily accessible and can be quickly reached.
- Check the functionality of EMERGENCY OFF equipment before start-up and during maintenance periods.
- Prevent unintentional start-ups by disconnecting the power connection of the drive using the EMERGENCY OFF circuit or using a safe start-up lock out.
- Check the system and installation before the initial start-up for possible malfunctions in all general purposes.
- Avoid operating high-frequency, remote control, and radio devices close to the system electronics and their feed lines.
- If necessary, perform a special EMC check of the system.

Failure to follow these instructions will result in death or serious injury.

PELV circuits

The signal voltage and control voltage of the PacDrive™ devices are <33 Volts and to be designed as PELV circuits. In this range and in accordance with EN 61800-5-1, the specification as PELV system contains a protective measure to guard against direct and indirect contact with dangerous voltage through **safe separation** of the primary and secondary side in the system/machine. ELAU strongly recommends performing a safe separation on the system/machine (**PELV Protective-Extra-Low-Voltage**).

⚠ DANGER

ELECTRIC SHOCK BECAUSE OF A MISSING SAFE SEPARATION

- Only connect devices, electrical components or lines to the signal voltage connectors of these components that feature a sufficient, safe separation from the connected circuits in accordance with the standards (EN 50178 / 1997 edition - Electronic equipment for use in power installations).
- Achieve a safe separation in the entire process of the electric circuit.
- FELV circuits must always be separated from PELV circuits using a safe separation in accordance with EN 50178:1997 (Section 5.2.14.2).
- To protect from direct contact, always cover connections and contacts which guide FELV voltages.
- Avoid using FELV current circuits for safety reasons.
- Design the cover or device connection so that it can only be removed by using a tool.
- The protection measures have to be adhered on all connected devices.

Failure to follow these instructions will result in death or serious injury.

Examples for connections and contacts of a PacDrive controller to be covered:

- Sub-D connector
- serial interface
- CAN-Bus interface

3   Indicators, control elements, diagnosis

The PacDrive™ System supports the user with its comprehensive diagnostic system.
The diagnostic messages can be read out with the Automation Toolkit **EPAS-4** or in the **PD-Diagnostic**. The PacDrive™ System contains a powerful message logger in which additional diagnostic information is recorded.
Diagnostic messages are usually displayed on a control panel on the machine. If an "error" occurs, read the diagnostic message on this unit and then contact the machine manufacturer.
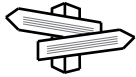
Detailed information on diagnosis is available in the Online-Help of the Automation Toolkit **EPAS-4** or in the **PD-Diagnostic**.

The PacDrive iSH is equipped with diagnostic LEDs for onsite diagnosis.
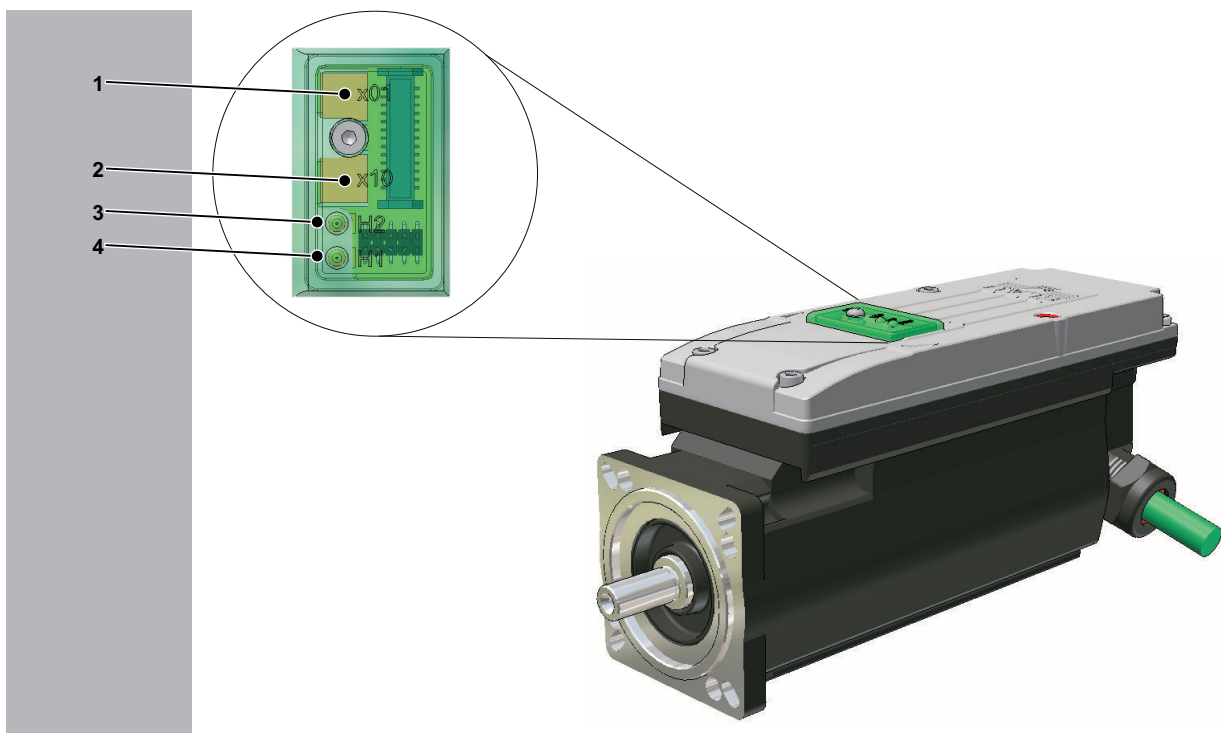
Figure 3-1: PacDrive iSH display elements and operating elements

1	Address setting SERCOS digits position S2
2	Address setting SERCOS tens position S1
3	Red LED: "err" (error display)
4	Green LED "pow" (control voltage display)

Green LED "pow" (control voltage display)

This LED indicates the device state.

OFF	Control voltage (24 V) is missing or is too low, not ready, fatal system error
Flashes slowly (0.5 Hz)	Bootloader is active, firmware is defective (Flashes in sync with err LED).

Flashes briefly (3 Hz, 30 ms ON)	Identifying the device (Parameter **IdentityDevice**) (Flashes in sync with err LED).
ON	Device ready, error diagnosis by means of PacDrive controller possible

Red LED: "err" (error display)

The error LED (err) indicates errors.

OFF	No error
Flashes slowly (0.25 Hz)	SERCOS error
Flashes slowly (0.5 Hz)	Bootloader is active, firmware is defective (Flashes in sync with pow LED).
Flashes quickly (2 Hz)	General error
Flashes for a long time (0.5 Hz, 1.8 s ON)	SERCOS ring interruption
Flashes briefly (3 Hz, 30 ms ON)	Identifying the device (Parameter **IdentityDevice**) (Flashes in sync with pow LED).
ON	Fatal system error

S1/S2 address setting with rotary switch

The two-digit SERCOS address (00 … 99) must identify every SERCOS slave in the ring unambiguously. To change the SERCOS address, remove the protective cap. See also the "Commissioning" section.

S1	Tens position of the SERCOS address
S2	Digits position of the SERCOS address

3.1 Example of a diagnostic message

2121 Bleeder Temperature Too High

Diagnostic class (standard): 2
Diagnostic code 121
Reaction: B

The bleeder is overloaded.

- ▪ The drive has incorrect dimensions.
- ▶ Check drive sizing.

- ▪ Hardware error: The braking resistor or addressing is defective.
- ▶ Contact ELAU customer service.

The meaning of the diagnostic code is explained more thoroughly in the online help section of the Automation Toolkit **EPAS-4** or the **PD-Diagnostic**.

4 Transport, storage, unpacking

4.1 Transport

- ▶ Avoid heavy shocks and/or vibrations during transport.
- ▶ Check the units for visible transport damage and inform the shipping company immediately if necessary.

4.2 Storage

- ▶ Store devices in a clean, dry room.
- ▶ Store devices at an air temperature between -25 °C and +70 °C.
- ▶ Avoid temperature variations exceeding 30 K per hour at the storage location.

For further information (see 6.2 Ambient conditions).

4.3 Unpacking

- ▶ Remove packaging.
- ▶ Check that delivery is complete.
- ▶ Check the delivered goods for transport damage.

4.4　　　Type plate
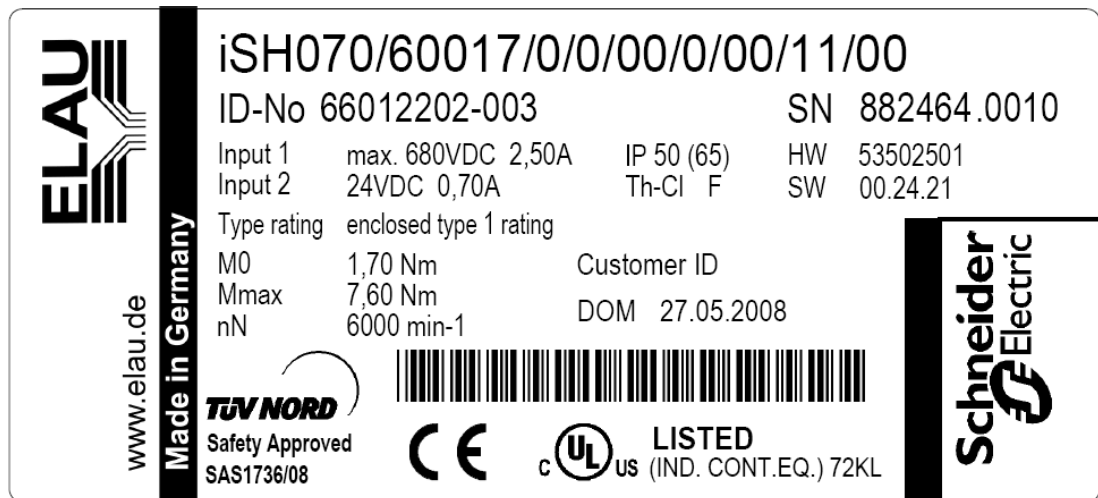
Figure 4-1: Type plate iSH

Label	Meaning
iSH 100/30044/0/0/00/0/00/01/00	Device type, see type key
ID no.	Item no.
SN	Serial number
Input 1	Rated voltage and rated current of the power supply
Input 2	Rated voltage and rated current of the electronics
Type rating	Protection class of the housing in accordance with Nema 250 and UL 50
HW	Hardware version
SW	Software version
IP	Protection class
Th-Cl	Insulation material class of the motor
M0	Standstill torque
Peak torque	Peak Torque
nN	Rated motor speed
DOM	Date of manufacture

Table 4-1: Explanation of the type plate

5 Installation and maintenance

When carrying out the following steps, make sure to exercise with the necessary accuracy and make arrangements to avoid,

- injuries and material damage,
- incorrect installation and programming of components,
- the incorrect operation of components
- and the use of non-authorized cables or modified components

zu vermeiden.

For warranty reasons, we strongly recommend that you contact ELAU personnel for initial start-up. The ELAU personnel

- will check the equipment,
- determine the optimal configuration
- and instruct the operating staff.

5.1 Initial start-up

How to check the shipment and the installation location:

Testing
- ▶ Check that delivery is complete.
- ▶ Check device for sound condition.

⚠ WARNING

DAMAGED OR MODIFIED DRIVE SYSTEMS

- Damaged drive systems must be neither mounted nor commissioned.
- Do not modify the drive systems.
- Return defective devices to ELAU GmbH.

Failure to follow these instructions can result in death or serious injury.

- ▶ Check data against type plates.
- ▶ Observe requirements for the installation location.
- ▶ Observe requirements for the protection class and the EMC rules.

Regrind the holding brake if a motor was stored for over 2 years before mounting.

How to regrind the holding brake:

⚠ DANGER

HIGH VOLTAGE

- Grind holding brake only when it is removed from the motor.

Failure to follow these instructions will result in death or serious injury.

- ▶ Move motor manually when the holding brake is closed by approx. 50 revolutions.
  - ✓ The holding brake is now ready for operation.

SERCOS address
- ▶ Remove the protective cap from the SERCOS address switch on the iSH.

▶ Using an appropriate tool, on the back of drive, set the specified SERCOS address (0-99) of the node according to the machine diagram.

💡 Be extremely careful not to assign an address more than once in a SERCOS ring. Each drive must have its own unique SERCOS address.

▶ Tighten dust cap (1Nm).
▶ Then install PacDrive Motor.

Wiring & Grounding

⚠ DANGER
HIGH LEAKAGE CURRENT
• Connect devices as of 3.5 mA AC (according to DIN EN 618000-5-1) via a fixed connection with the power supply network.   • In addition, connect a second protective ground conductor with the same cross-section as the main protective ground conductor or   • use a protective ground conductor with a cross section of at least 10mm² Cu or 16mm² Al.
Failure to follow these instructions will result in death or serious injury.

▶ PS-5 Connect starting with the protective ground wire.
▶ Check that terminals are secure and check necessary cable cross sectional areas for correctness.
▶ Check that the shielding works flawlessly, eliminate short circuits and interruptions.
▶ Connect ground cable to the motor flange **(1)** and tighten with a 2.8Nm torque.
  ✓ The motor is now grounded with the machine bed.
▶ Select connection cross section of ground cable appropriate to network connection wiring of the PS-5 downstream of the motor, but not less than 4 mm².
▶ Or, connect the motor to the grounded machine bed immediately above the motor flange.
▶ Remove protective cover from hybrid cables.
▶ Observing the connector coding, attach the hybrid cable and lock the retaining bracket in place.

💡 The cable length from the **PS-5** to the last **DB-5** may not exceed 20 m. The cable length from the **DB-5** to the **iSH** may not exceed 5 m.
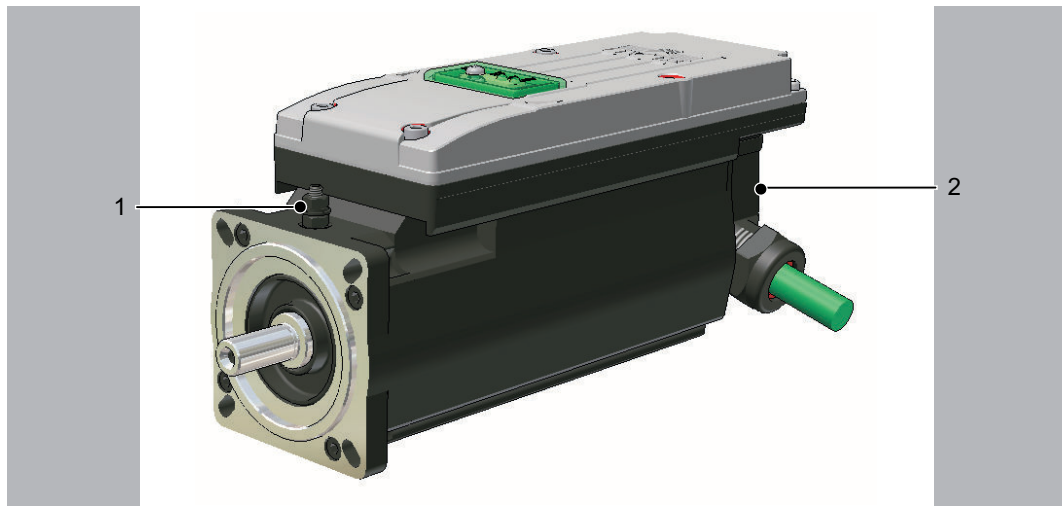
Figure 5-1: iSH connection overview

1	Ground connection
2	Connector

According to DIN EN 60204-1:2006 Section 18.2, the correct grounding of the motor has to be checked respectively proven on the completely installed machine at the installation location at all times.

CAUTION

INCORRECT USE OF COPPER AND HYBRID CABLES

- Use only original, prefabricated ELAU cables.
- For "permanently flexible" copper and hybrid cables observe the guidelines for dragchains .
- Observe the following restrictions when using ELAU copper (motor cables, feedback cables and hybrid cables) as well as fiber optic cables.
- Observe the minimum bending radius for wired cable.
- Check the wiring once again before turning on

Non-observance of these instructions can result in damage to the device.

Bending radii of cables

Restrictions	Copper cable	Hybrid cable	Fiberoptic conductor
Minimum bending radius (stationary cables)	3 x cable diameter	iSH: 5 x cable diameter (14.3 mm) SCL: 5 x cable diameter	20 x cable diameter *
Minimum bending radius (cables with an unrestricted range of motion)	-	iSH: 7.5 x cable diameter (14,3 mm)	-
Minimum bending radius (permanently flexible cables)	12 x cable diameter	iSH: 12 x cable diameter (14.3 mm) SCL: 7.5 x cable diameter	-- **
Permissible temperature range (stationary cables (according to DIN VDE))	-50 °C ... +90 °C	-50 °C ... +90 °C	0 °C ... 80 °C

Restrictions	Copper cable	Hybrid cable	Fiberoptic conductor
Permissible temperature range (stationary cables (according to DIN VDE))	-40 °C ... +90 °C	-40 °C ... +90 °C	-- **
Number of bending cycles	5 mn cycles ***	5 mn cycles ***	-- **
* When laying fiber optic conductors, a minimum bending radius of 15 x cable diameter is allowed for a short period of time. ** Fiberoptic conductors may not be laid as "permanently flexible". *** At maximum velocities of 2 m/s and maximum accelerations of 5 m/s^2			

Table 5-1: Properties of conductors used by ELAU

Use lower velocities and smaller bend radii to enhance service life of a cable.

How to finish the initial start-up:
▸ Check safety functions such as the EMERGENCY OFF switch.
▸ Resume system operation according to the operating manual (from the machine manufacturer and servo amplifier).

5.2   Configuration, homing and programming

The PacDrive™ System is adapted to your task using the EPAS-4 Automation Toolkit. The system will be configured and programmed according to IEC 61131-3 in EPAS-4.

CAUTION
FAULTY PROGRAM CHANGES
•   Program changes may only be carried out by trained personnel with detailed knowledge of the system.   •   Changes may only be carried out by your machine supplier or by ELAU employees.   •   ELAU is not liable for damages caused by unauthorized program changes.
Failure to follow these instructions can result in equipment damage.

5.3   EMC Rules

To control and regulate the motors, the mains voltage is stored by rectification in the DC bus of the servo amplifier. This stored power is supplied to the motor by precise on and off switching using six semi-conductor switches. The steep increase/decrease in voltage places considerable demands on the dielectric strength of the motor winding. An important additional aspect to observe is the electromagnetic compatibility (EMC) with other system components. The high rate of change of the clocked voltage generates harmonics of great intensity up into the high frequency range.

⚠ CAUTION

SYSTEM FAILURE DUE TO ELECTROMAGNETIC FIELDS

- During installation, select the grounding option with the lowest resistance for high frequency operation (e.g. unpainted sub plate in switching cabinet).
- Provide the largest possible contact surface area (skin effect).
- If necessary, remove existing layers (paint) to establish electrical contact.
- Lay the grounding in a star configuration from the Central Grounding Point to the corresponding connections.
- Avoid looping the grounding to prevent unnecessary influences.
- Use shielded cable only.
- Ensure large shielding transitions.
- Do not connect shields via the PIN contacts of connectors.
- Observe the circuit suggestions.
- Shorten motor cable to minimum length.
- Avoid laying cable loops in the switching cabinet.
- In conjunction with electronic controllers, do not switch inductive loads without suitable interference suppression.
- Provide suitable interference suppression. To this end, use recovery diodes for direct current operation and protector type-based, industry-standard quenching circuits during alternating current activity.
- Arrange the interference suppression immediately at the point of inductivity, as otherwise even more interference may be generated by the shock of the switching current on the interference suppression lines.
- Avoid sources of interference instead of eliminating the effects of existing interference.
- Do not arrange contacts with unsuppressed inductive loads in the same room as the PacDrive Motor. The same applies for connection lines that do not lead suppressed, switched inductances and lines that run parallel to them.
- Isolate the controller from such interference sources using a Faraday cage (separately partitioned switching cabinet).
- Mains filters and motor filters may by used depending on the combination of the servo amplifier/motor and the cable length.

Failure to follow these instructions can result in equipment damage.

5.4   Maintenance, repair, cleaning

5.4.1   Repair

Proceed as follows in case of repair:
▸ Fill in the fault report form (see 10.4 Fault report form) in the attachment (can also be sent per Fax).
▸ If possible, replace faulty components (see 5.7 Device replacement).

▶ Send faulty components back to ELAU.

5.4.2 Cleaning

The standard cooling method of the motor is by natural convection. Therefore, keep the motor surfaces free from dirt.

5.5 Spare part inventory

Keep a stock of the most important components to make sure the equipment is functioning and ready for operation at all times.

You may only exchange units with the same hardware configuration and the same software version.

▶ Indicate the following information on the spare part order:

Item name:	e.g. PacDrive iSH-070/60/011
Item no.:	e.g. 66012102-xxx
Hardware code:	e.g. HW: 22300301
Software version:	e.g. SW: 00.24.21

You will find this information on the type plate and in the controller configuration of the PacDrive System.

5.6   Type code

iSH070/60017/0/0/00/0/00/00/00

Flange Size

Rating Speed

Standstill torque

Voltage/Electronic

Shaft end

Surface

Cooling

Connection system

Sealing (Protection Class)
Shaft / Housing

Encoder

Brake

Options

Flange Size
070, 100

Rating Speed   x 100 min^{-1}
(30)

Standstill torque   /10 Nm
(e.g. 011, 017, 022, 025, 044, 058)

Voltage
0 = DC 560V / integr. servo electronic

Shaft end
0 = Smooth shaft
1 = Keyed shaft according to DIN 6885
3 = Smooth shaft, stainless steel
4 = Keyed shaft, stainless stell according to DIN 6885

Surface
0 = Standard coating

Cooling
0 = Self-cooling

Connection system
0 = Hybrid connector

Sealing (Protection class) Shaft
0x = Without shaft sealing
        (IP54 excl. IM V3: IP40)
1x = Shaft sealing (IP65)

Sealing (Protection class) Housing
x0 = Standard IP65

Encoder
0 = SinCos SKS 36
1 = SinCos SKM 36

Brake
0 = Without holding brake
1 = With holding brake

Options
00 = Without option
01 = iSH-DIS1 connected

5.7 Device replacement

▸ Observe the following warning instructions to safely replace the device.

⚠ DANGER
ELECTRICAL SHOCK, EXPLOSION OR ELECTRIC ARC
• Observe the general construction and safety regulations for working on high-current electrical systems. • Operate electrical components only with connected protective conductor • After installation, check the fixed connection of the protective conductor to all electrical devices to ensure that connection complies with the connection diagram. • Make sure that the drives are at a standstill because potentially fatal voltage can occur on the motor lines in generator operation. • Before enabling the device, safely cover the live components to prevent contact. • Do not touch the electrical connection points of the components when the device is switched on. • Provide protection against indirect contact (DIN EN 50178 : 1997, Section 5.3.2). • Disconnect/plug in power connector cables only when the system is deactivated.
Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION
HOT SURFACES UP TO 100 °C
• Wait until the surface temperature has cooled to allow safe contact. • Wear protective gloves. • Attach protective cover or touch guard
Failure to comply with these instructions can lead to bodily harm.

How to replace the PacDrive Motor:

CAUTION
ELECTROSTATIC DISCHARGE
• Do not touch any of the connections or components. • Discharge any existing static charge by touching a grounded metallic surface such as a grounded housing. • Prevent electrostatic charges; e.g., by wearing appropriate clothing.
Failure to follow these instructions can result in equipment damage.

- Put main switch in "OFF" position to free system of voltage.
- Prevent main switch from being switched back on.
- Wait at least 5 minutes after switching off before you access the components.
- Discharge DC bus.
- Before working on the equipment, check the DC bus with a measuring instrument to make sure that it is de-energized (< 50V).
- With voltages greater than 30 V AC or 42.2 V DC, disconnect PacDrive Motor from the power supply before working on the PacDrive Motor.

⚠ WARNING
UNINTENTIONAL AXIS MOVEMENTS DUE TO LOSS OF REFERENCES IN CASE OF A MOTOR REPLACEMENT
• For servo axes with indirect distance measuring systems, restore the reference to the machine coordinate system via the motor encoder every time a motor is replaced.
Failure to follow these instructions can result in death or serious injury.

CAUTION
MECHANICAL FORCE TO THE ENCODER SYSTEM
• Prevent impacts on the motor shaft when removing and attaching couplings to the motor shaft, as this could damage the encoder. • Use appropriate tools, such as an extractor. • Avoid mechanical damage to the coating of the motor housing. • Do not use cleaning fluid as it will damage the motor's aluminum housing.
Failure to follow these instructions can result in equipment damage.

- Replace the drive according to the machine manufacturer's specifications.
- Connect ground cable and tighten with a 2.8Nm torque.
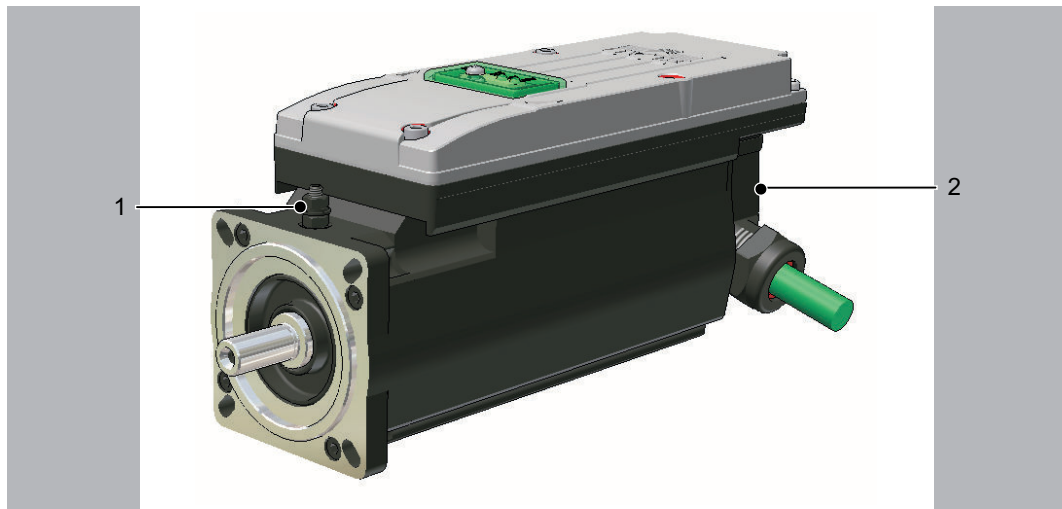
Figure 5-2: iSH connection overview

1	Ground connection
2	Connector

CAUTION
INSUFFICIENT SHIELDING/GROUNDING
• Operate the drive only with fixed cover and cable gland.
Failure to follow these instructions can result in equipment damage.

Keep a logbook for recording the maintenance history of the machine and note the replaced components (as per IEC62061, 7.2.k) 1)).

5.8   Cable replacement

In addition to the following instructions, you must observe the machine manufacturer's specifications when replacing the cables.

> # ⚠ DANGER
>
> **ELECTRICAL SHOCK, EXPLOSION OR ELECTRIC ARC**
>
> - Observe the general construction and safety regulations for working on high-current electrical systems.
> - Operate electrical components only with connected protective conductor
> - After installation, check the fixed connection of the protective conductor to all electrical devices to ensure that connection complies with the connection diagram.
> - Make sure that the drives are at a standstill because potentially fatal voltage can occur on the motor lines in generator operation.
> - Before enabling the device, safely cover the live components to prevent contact.
> - Do not touch the electrical connection points of the components when the device is switched on.
> - Provide protection against indirect contact (DIN EN 50178 : 1997, Section 5.3.2).
> - Disconnect/plug in power connector cables only when the system is deactivated.
>
> **Failure to follow these instructions will result in death or serious injury.**

▶ Put main switch in "OFF" position to free system of voltage.
▶ Prevent main switch from being switched back on.
▶ Wait at least 5 minutes after switching off before you access the components.
▶ Discharge DC bus.
▶ Before working on the equipment, check the DC bus with a measuring instrument to make sure that it is de-energized (< 50V).
▶ With voltages greater than 30 V AC or 42.2 V DC, disconnect PacDrive Motor from the power supply before working on the PacDrive Motor.

How to replace the cable:
▶ Disconnect / connect cables from the **iSH**.
▶ Disconnect / connect cables from the **DB-5**.

See chapter Device Replacement in "PacDrive **PS-5** Power Supply and **DB-5** Distribution Box".

6 Technical data

6.1 Definition of technical data

Abbre-viation	Unit	Explanation
I_0	[A_{rms}]	Standstill current Effective value of the motor current at standstill torque M_0
I_N	[A_{rms}]	Rated current Effective value of the motor current at rated torque M_N
I_{max}	[A_{rms}]	Peak current Effective value of the motor current at peak torque M_{max}
J_M	[$kgcm^2$]	Rotor moment of inertia The rotor inertia refers to a motor without brake.
k_T	[Nm/A_{rms}]	Torque constant Quotient from standstill torque M_0 and standstill current I_0 (at 120°C winding temperature)
m	[kg]	Mass Motor mass without brake and without fan
M_0	[Nm]	Standstill torque; continuous torque (100 % ED) at 5 min^{-1} At an ambient temperature of 40 °C and a winding temperature of 120 °C
M_N	[Nm]	Rated torque; continuous torque (100 % ED) at n_N Due to motor speed-dependent losses less than M_0; At an ambient temperature of 40 °C and a winding temperature of 120 °C.
M_{max}	[Nm]	Peak torque The maximum torque that the servo motor can briefly deliver to the output shaft.
n_N	[min-1]	Rated motor speed
n_{max}	[min-1]	Mechanical limit velocity
P_N	[kW]	Mechanical rated power (power delivered to the shaft) At the rated motor speed and load with the rated torque
$R_{U-V, 20}$	[Ω]	Winding resistance Resistance between two phases at a winding temperature of 20 °C.
L_{U-V}	[mH]	Winding inductance between two phases
k_E	[$V_{rms}/kmin^{-1}$]	Voltage constant; induced voltage between two phases at 1000 min^{-1}
V	[m/s^2]	Maximum vibration (all directions)
Y	[m/s^2]	Maximum shock (all directions)
T_{TK}	[°C]	Response limit temperature sensor
t_{th}	[min]	Thermal time constant
p		Pole pair number

Table 6-1: Physical sizes with units and explanations

6.2 Ambient conditions

Procedure	Parameters	Value	Basis
Operation	Class 3K3		IEC/EN 60721-3-3
	Ambient temperature	+5°C...+40°C	
	Relative humidity	5% ... 85%	
	Class 3M6		
	Shock	250 m/s^2	
	Vibration	20 m/s^2 (all directions in space)	
Transport	Class 2K3		IEC/EN 60721-3-2
	Ambient temperature	-25°C...+70°C	
	Condensation	no	
	Icing	no	
	another water	no	
	Relative humidity	5% ... 95%	
	Class 2M1		
	Shock	100 m/s^2	
	Vibration	15 m/s^2	
Long-term storage in transport packaging	Class 1K4		IEC/EN 60721-3-1
	Ambient temperature	-25°C...+55°C	
	Condensation	no	
	Icing	no	
	another water	no	
	Relative humidity	10% ... 100%	

Table 6-2: Ambient conditions Drive System iSH

6.3 Standards and regulations

Certifications	CE, cULus
Approvals	USDA - Incidental food contact, NFPA - Class A
	NSF Standard 61 - Potable water, motor coating RAL 9005

Table 6-3: Standards and regulations Drive System iSH

6.4 Mechanical and electrical data

6.4.1 iSH Controller

Pay particular attention to these limits for the control voltage if the iSH units in the system have brakes.

Category	Parameters	Value
Power supply	Supply voltage	270...680 V DC
Electronics power supply (iSH without brake)	Control voltage	DC +24 V -15% / +25%
	Current consumption	Typically 200 mA
Electronics power supply (iSH with brake)	Control voltage	DC +24 V -10% / +6%
	Current consumption iSH 070	Typically 700 mA
	Current consumption iSH 100	Typically 950 mA
	Current consumption iSH 140	Typically 1200 mA
Stray power	Electronics (iSH without brake)	4.8 W
	Electronics: Brake of iSH 070	12 W
	Electronics: Brake of iSH 100	18 W
	Electronics: Brake of iSH 140	24 W
	Power unit	Typically 10% of the rated power of the iSH
Excess voltage category	Class	3, T2 (DIN VDE 0110)
Excess voltage resistance	Class	1 (DIN VDE 0160)
Radio interference level	Class	A EN 55011 / EN 61800 - 3
Insulation material class		F
Protection class	Controller	IP65
	motor	For information about the protection class of the motor.
Isolation class	Degree of pollution	2
Motor coating		2 component high solid epoxy resin coating
Lubricant (according to FDA standard for servo motors)		Klübersynth UH1 64-62 food safe gearbox grease

Table 6-4: Technical data: iSH - controller

6.4.2 iSH-070 Servo Motor

Category	Parameters	Abbreviation [unit]	iSH-070 60 011	iSH-070 60 017	iSH-070 60 022
General data	Standstill torque	M_0 [Nm]	1.1	1.7	2.2
	Peak Torque	M_{max} [Nm]	3.5	7.6	8.7
	Rated motor speed	n_N [min^{-1}]	6000	6000	6000
	Rated torque	M_N [Nm]	0.5	1.15	1.15
	Rated power	P_N [kW]	0.31	0.72	0.72
Electrical data	Pole pair number	p	3	3	3
	Motor winding switch		Y	Y	Y
	Torque constant (120 °C)	k_T [Nm/A$_{rms}$]	0.71	0.76	0.76
	Winding resistance Ph-Ph (20 C)	$R_{U-V, 20}$ [Ω]	10.40	4.20	2.70
	Winding resistance Ph-0 (120 °C)	R_{120} [Ω]	7.23	2.92	1.88
	Winding inductance Ph-Ph	L_{U-V} [mH]	38.8	19.0	13.0
	Winding inductance Ph-0	L [mH]	19.4	9.5	6.5
	Voltage constant Ph-Ph (20 °C)	k_E [V$_{rms}$/kmin^{-1}]	46	48	49
	Standstill current	I_0 [A$_{rms}$]	1.55	2.5	3.0
	Rated current without brake (with brake)	I_N [A$_{rms}$]	0.60 (1.35)	1.5	1.5
	Peak current	I_{max} [A$_{rms}$]	5.7	11.8	12.0
Mechanical data	Moment of inertia of the rotor	J_M [kgcm²]	0.25 (0.35)	0.41 (0.51)	0.58 (0.88)
Weight		m [kg]	2.7 (3.0)	3.4 (3.7)	4.2 (4.7)
Thermal data	Thermal time constant	T_{th} [min]	35	38	51
	Response limit thermal contact	T_{TK} [°C]	130	130	130
Brake data	Brake		optional	optional	optional

Table 6-5: Technical data for iSH-070 without (with) brake

6.4.3   iSH-100 Servo Motor

Category	Parameters	Abbreviation [unit]	iSH-100 30 025	iSH-100 30 044	iSH-100 30 058
General data	Standstill torque	M_0 [Nm]	2.5	4.4	5.8
	Peak Torque	M_{max} [Nm]	9.6	18.3	28.3
	Rated motor speed	n_N [min^{-1}]	3000	3000	3000
	Rated torque	M_N [Nm]	1.9	2.9	3.5
	Rated power	P_N [kW]	0.6	0.91	1.10
Electrical data	Pole pair number	p	4	4	4
	Motor winding switch		Y	Y	Y
	Torque constant (120 °C)	k_T [Nm/A$_{rms}$]	1.39	1.52	1.61
	Winding resistance Ph-Ph (20 C)	$R_{U-V, 20}$ [Ω]	9.80	4.12	2.60
	Winding resistance Ph-0 (120 °C)	R_{120} [Ω]	6.82	2.86	1.81
	Winding inductance Ph-Ph	L_{U-V} [mH]	45.70	21.80	15.60
	Winding inductance Ph-0	L [mH]	22.85	10.90	7.80
	Voltage constant Ph-Ph (20 °C)	k_E [V$_{rms}$/ kmin^{-1}]	90	100	103
	Standstill current	I_0 [A$_{rms}$]	1.80	2.90	3.6
	Rated current	I_N [A$_{rms}$]	1.40	2.00	2.40
	Peak current	I_{max} [A$_{rms}$]	7.40	13.10	21.20
Mechanical data	Moment of inertia of the rotor	J_M [kgcm²]	1.40 (2.10)	2.31 (3.01)	3.22 (3.92)
Weight		m [kg]	4.9 (5.7)	6.4 (7.2)	8.1 (8.9)
Thermal data	Thermal time constant	T_{th} [min]	44	48	56
	Response limit thermal contact	T_{TK} [°C]	130	130	130
Brake data	Brake		optional	optional	optional

Table 6-6: Technical data for iSH-100 without (with) brake

6.4.4   iSH-140 Servo Motor

Category	Parameters	Abbreviation [unit]	iSH-140 30 075	iSH-140 15 085	iSH-140 20 125
General data	Standstill torque	M_0 [Nm]	7.5	8.5	12.5
	Peak Torque	M_{max} [Nm]	27.0	27.0	55.0
	Rated motor speed	n_N [min^{-1}]	3000	1500	2000
	Rated torque	M_N [Nm]	4.6	8.3	9.1
	Rated power	P_N [kW]	1.45	1.30	1.91
Electrical data	Pole pair number	p	5	5	5
	Motor winding switch		Y	Y	Y
	Torque constant (120 °C)	k_T [Nm/A$_{rms}$]	1.60	2.65	2.60
	Winding resistance Ph-Ph (20 C)	$R_{U-V,\,20}$ [Ω]	1.81	4.58	1.90
	Winding resistance Ph-0 (120 °C)	R_{120} [Ω]	1.26	3.18	1.32
	Winding inductance Ph-Ph	L_{U-V} [mH]	19.10	50.0	22.0
	Winding inductance Ph-0	L [mH]	9.55	25.0	11.0
	Voltage constant Ph-Ph (20 °C)	k_E [V$_{rms}$/ kmin^{-1}]	108	175	173
	Standstill current	I_0 [A$_{rms}$]	4.70	3.20	4.8
	Rated current	I_N [A$_{rms}$]	2.90	3.15	3.7
	Peak current	I_{max} [A$_{rms}$]	18.8	14.6	24.0
Mechanical data	Moment of inertia of the rotor	J_M [kgcm²]	7.41	7.41	12.68
Weight (with brake)		m [kg]	12.5 (13.8)	12.5 (13.8)	17.2 (18.5)
Thermal data	Thermal time constant	T_{th} [min]	64	64	74
	Response limit thermal contact	T_{TK} [°C]	130	130	130
Brake data	Brake		optional	optional	optional

Table 6-7: Technical data for iSH-140 without (with) brake

6.4.5 Encoder

SinCos® (SKS36) single turn

Parameters	Value	Unit
Number of revolutions	1	
Number of sine/cosine periods	128	Per revolution
Absolute measuring range	1	Revolution
Error limits of the digital absolute value	+/-5.3	Angular minutes
Error limits when evaluating the 128 signals (integral non-linearity)	+/-1.3	Angular minutes
Signal form	Sine	

Table 6-8: Technical data of the SinCos encoder (SKS-36)

SinCos® (SKM36) multiturn

Parameters	Value	Unit
Number of revolutions	4096	
Number of sine/cosine periods	128	Per revolution
Absolute measuring range	1	Revolution
Error limits of the digital absolute value	+/-5.3	Angular minutes
Error limits when evaluating the 128 signals (integral non-linearity)	+/-1.3	Angular minutes
Signal form	Sine	

Table 6-9: Technical data of the SinCos® encoder (SKM-36)

6.4.6 Motor shaft and bearings

Design of the shaft end

Smooth shaft end (standard) With a non-positive connection, torque transmission must be achieved only by surface pressure. That ensures safe power transmission without backlash.

Shaft end with round-ended feather key according to DIN 6885 Shaft connections with feather keys are positive. The feather key seating can deflect under continuous strain with changing torques and prolonged reverse operation, causing backlash. As a result, rotational quality is reduced due to backlash. Increasing deformation can lead to the feather key breaking and damage to the shaft. This type of shaft nub connection is only suitable for low requirements. Therefore, we recommend using smooth shaft ends.

Bearing

The back side bearing is designed as a fixed bearing and the bearing on shaft output side as a floating bearing.

Permissible shaft load

In case of technical correct use, the life of drives is limited by the bearing life. The customer may not replace the bearing, as the measuring systems integrated in the drive must then be reinitialized.
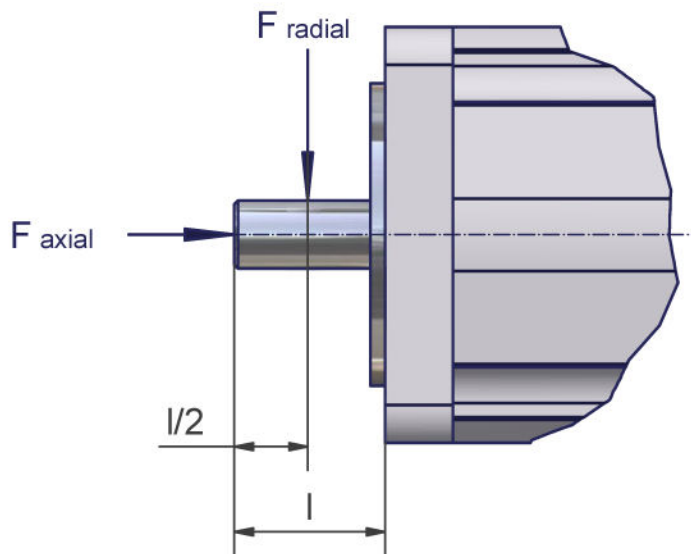

Figure 6-1: Definition of shaft load

motor	1000 min^{-1}	2000 min^{-1}	3000 min^{-1}	4000 min^{-1}	5000 min^{-1}	6000 min^{-1}
iSH-070 60 011	660	520	460	410	380	360
iSH-070 60 017	710	560	490	450	410	390
iSH-070 60 022	730	580	510	460	430	400
iSH-100 30 025	900	720	630	-	-	-
iSH-100 30 044	990	790	690	-	-	-
iSH-100 30 058	1050	830	730	-	-	-
iSH-140 15085	2210	1760	-	-	-	-
iSH-140 30075	2210	1760	1530	-	-	-
iSH-140 20125	2430	1930	-	-	-	-

Table 6-10: Permissible radial force F_{radial} [N]

Basis for calculation:
The permissible axial force F_{axial} [N] is calculated according to:

F_{axial} = 0.2 x F_{radial}

- Nominal bearing life L_{10h} = 20,000 h for a shaft without feather key nut (for operating hours at a 10% failure probability)
- Ambient temperature = 40 °C (approx. 100 °C storage temperature)
- Peak torque = 10 % ED
- Nominal torque = 100 % ED

6.4.7   Holding brake (optional)

To hold the axes without play during standstill or when the system is deactivated, you can order the servo motors with a holding brake. The permanent magnetic brake is a continuous surface unit with which the force of the permanent magnetic field is used for generating the braking effect (system opens electromagnetically).

Operating principle of the holding brake   The permanent magnetic field is compensated by an electromagnetic field for cancelling the braking effect. Reliable release without detent torque that is independent of the mounting position is ensured by a steel spring. In addition to frictionless axial armature movement, it also offers the transmission of braking torque without backlash. The motors are provided with a varistor for reducing excess voltage when the brake is engaged.

⚠ DANGER

JAMMING/SHEARING OF BODY PARTS

- The holding brake alone does not ensure protection to persons.
- To ensure personal safety, higher-level constructive measures such as mesh guards or a second brake are necessary.

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

PREMATURE WEAR DUE TO ENGAGING OF THE HOLDING BRAKE WHILE MACHINERY IS IN MOTION

- Use the holding brake only when the axes are at a standstill.
- Use the holding brake to brake an axis only in emergency stop situations. The number of emergency stops is limited by the size of the external mass used.

A non-observance of these instructions can cause bodily injury or damage the equipment.

The times mentioned in the following apply when switching in the direct current circuit, when the motor is warm, and at the rated voltage. The disconnection time is the period from the activation of the current to the dying out of the torque to 10% the rated torque of the brake. The coupling time counts as the period from when the current is switched off to the attainment of the rated torque.

The holding brake is designed differently for each series:

Technical data of the holding brake of the iSH-070

Parameters	iSH-070 60 011	iSH-070 60 017	iSH-070 60 022	Unit
Static holding torque at 120 °C	2.0	2.0	3.0	[Nm]
Coupling time	8	8	15	[ms]
Disconnection time	25	25	35	[ms]
Mass Motor mass without brake and without fan	0.22	0.22	0.32	[kg]
Moment of inertia	0.072	0.072	0.227	[kgcm2]
Rated output	11	11	12	[W]
Rated voltage	24 +6/-10%	24 +6/-10%	24 +6/-10%	[VDC]

Table 6-11: Technical data of the holding brake of the iSH-070

Technical data of the holding brake of the iSH-100

Parameters	iSH-100 30 025	iSH-100 30 044	iSH-100 30 058	Unit
Static holding torque at 120 °C	9.0	9.0	9.0	[Nm]
Coupling time	20	20	20	[ms]
Disconnection time	40	40	40	[ms]
Mass Motor mass without brake and without fan	0.45	0.45	0.45	[kg]
Moment of inertia	0.618	0.618	0.618	[kgcm2]
Rated output	18	18	18	[W]
Rated voltage	24 +6/-10%	24 +6/-10%	24 +6/-10%	[VDC]

Table 6-12: Technical data of the holding brake of the iSH-100

Technical data of the holding brake of the iSH-140

Parameters	iSH-140 30 075	iSH-140 15 085	iSH-140 20 125	Unit
Static holding torque at 120 °C	23.0	23.0	23.0 ??	[Nm]
Coupling time	40	40	40	[ms]
Disconnection time	50	50	50	[ms]
Mass Motor mass without brake and without fan	1.1	1.1	1.1	[kg]
Moment of inertia	1.8	1.8	1.8	[kgcm2]
Rated output	24	24	24	[W]
Rated voltage	24 +6/-10%	24 +6/-10%	24 +6/-10%	[VDC]

Table 6-13: Technical data of the holding brake of the iSH-140

6.5   Mounting arrangement and protection class

The drive protection class depends on the mounting arrangement. The mounting flange for all drive types is designed in such a way that the installation type is possible according to the types of construction IM B5, IM V1 und IM V3 (mounting flange with through hole). By the DIN IEC 34-7 the drives can be mounted to the machine according to the following listing types.:
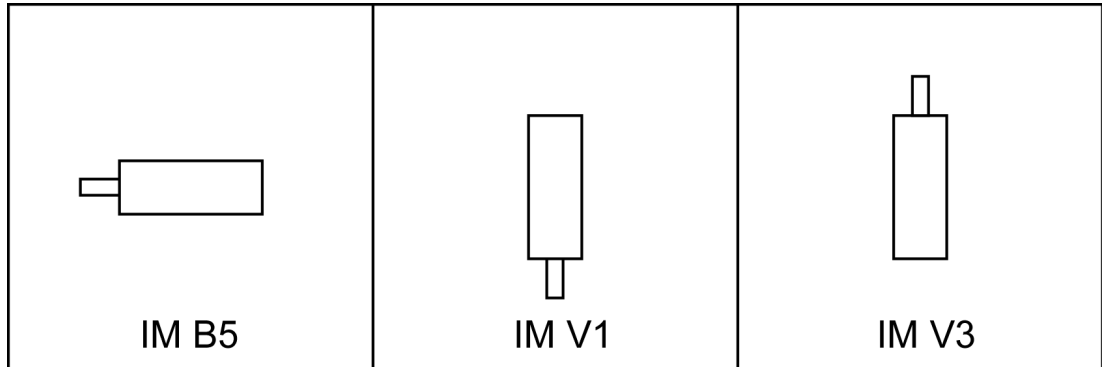

Figure 6-2: Drive installations

CAUTION
IMPERMISSIBLE MOUNTING POSITION AND PENETRATING LIQUIDS
•   Prevent liquids from remaining on the motor shaft over an extended period of time when mounting the motor in the mounting position IM V3.
Failure to follow these instructions can result in equipment damage.

It also cannot be ruled out that liquids penetrate the motor housing along the motor shaft even if a shaft sealing ring has been installed.

Motor part	Protection class (according to EN 60529)	Mounting position (conforming to DIN 42 950)
Shaft	IP 50	IM V3
	IP 54	IM B5, IM V1
	IP 65	IM V3 (Wellendichtring)
Surface/connections	IP 65	IM V3, IM V1, IM B5

Table 6-14: Protection class of iSH Motor

6.6 Torque/speed characteristic curves

The torque-speed characteristic curve represents the following characteristics:

- The permissible permanent torque (operating type S 1)
- The peak torque when the mains voltage = 230 V 3 AC
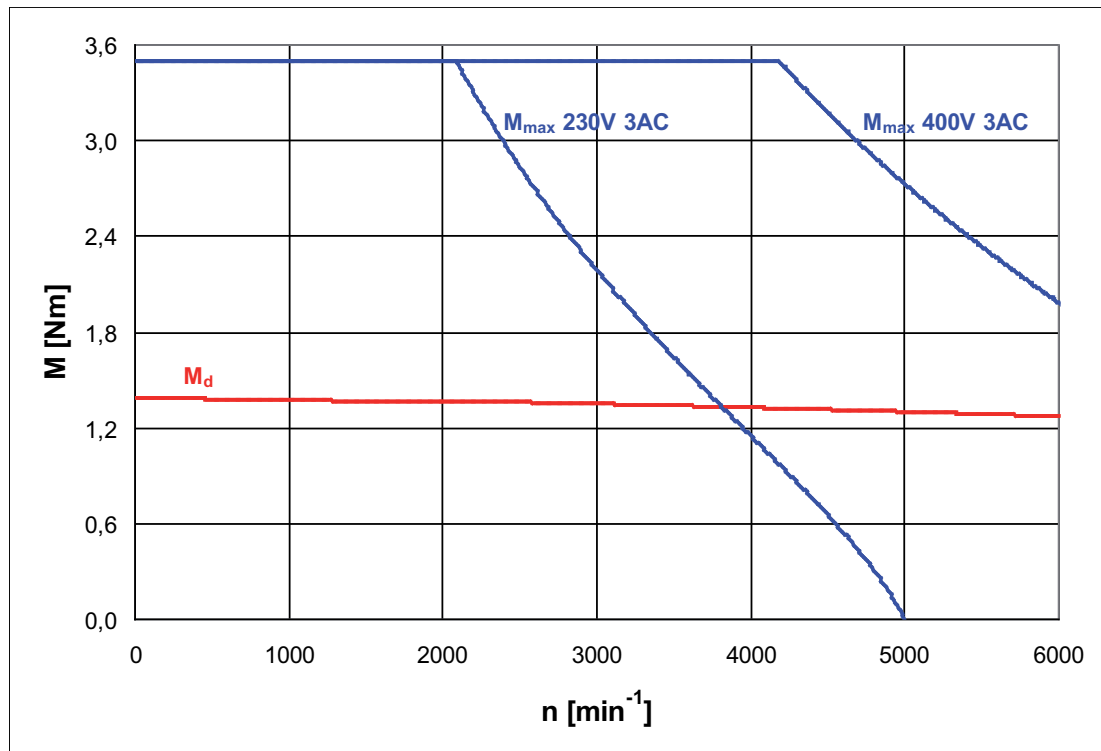
- The peak torque when the mains voltage = 400 V 3 AC

Figure 6-3: Example of a torque-speed characteristic curve

The characteristic curves refer to an ambient temperature of 40°C and a maximum winding temperature of 120°C.
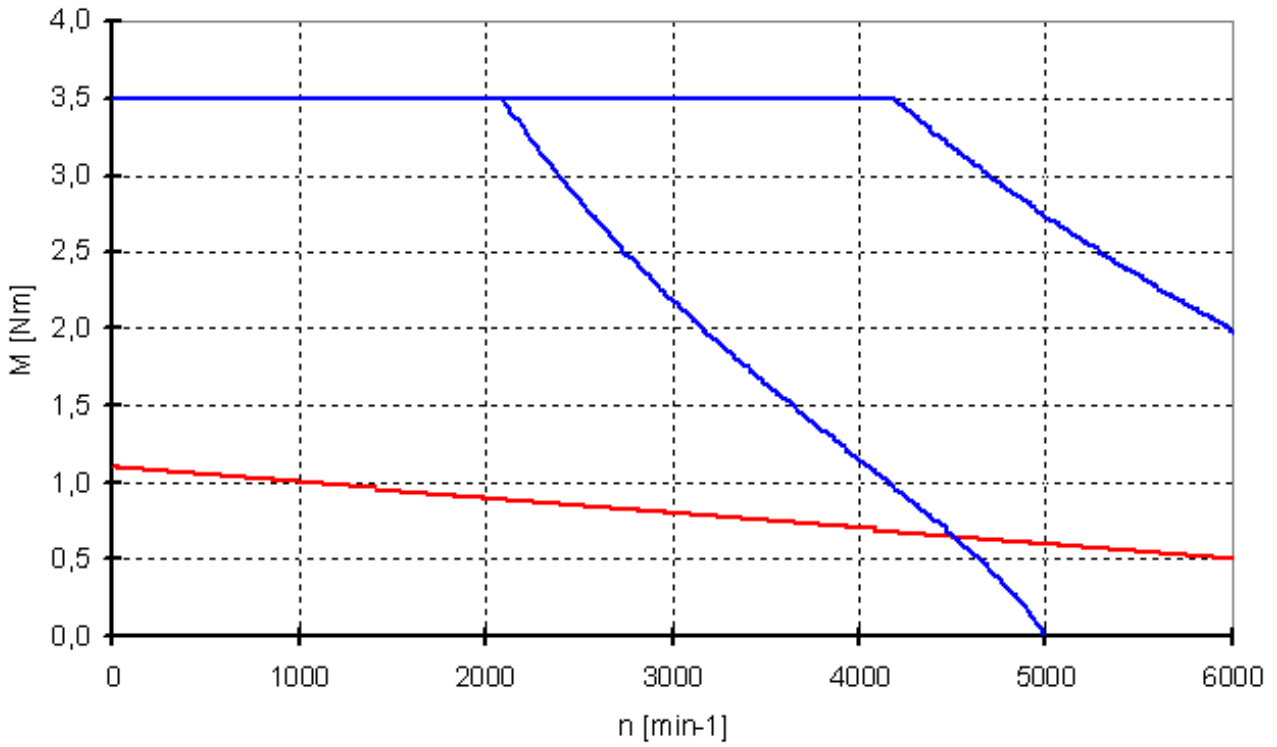
Figure 6-4: Torque-speed characteristic curve iSH 070 60 011
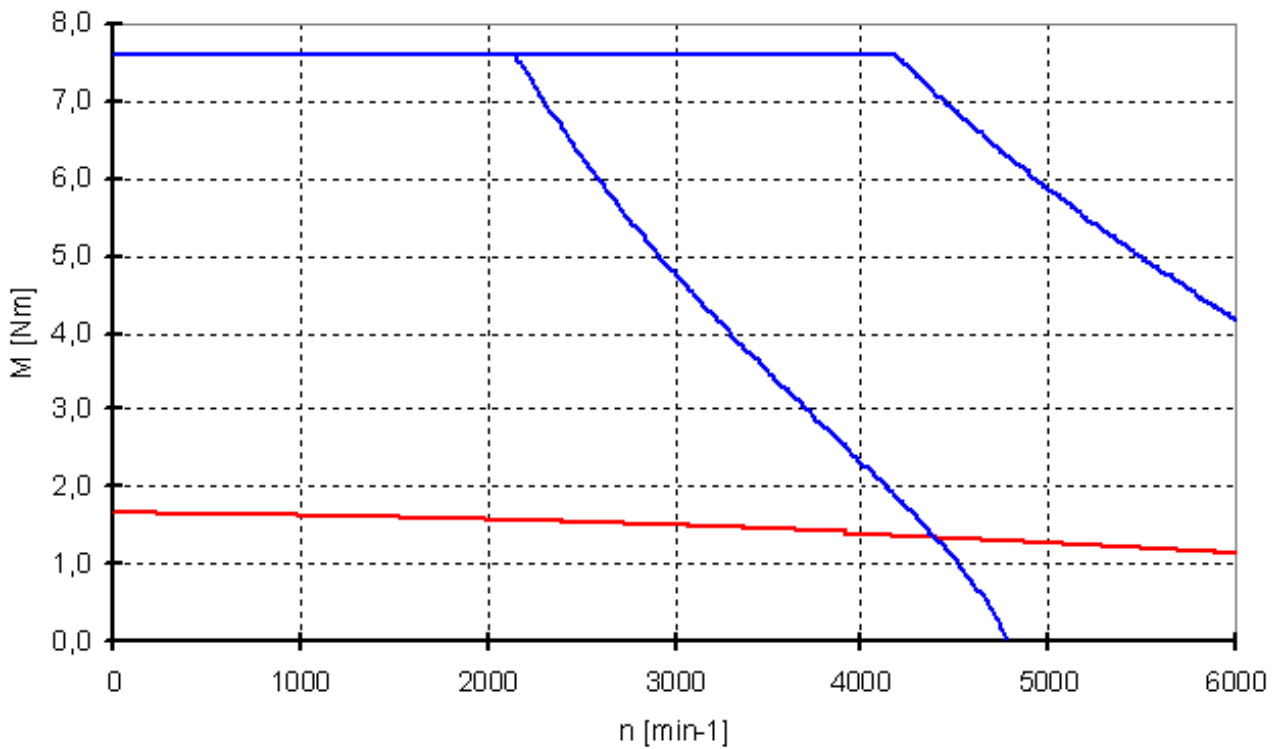

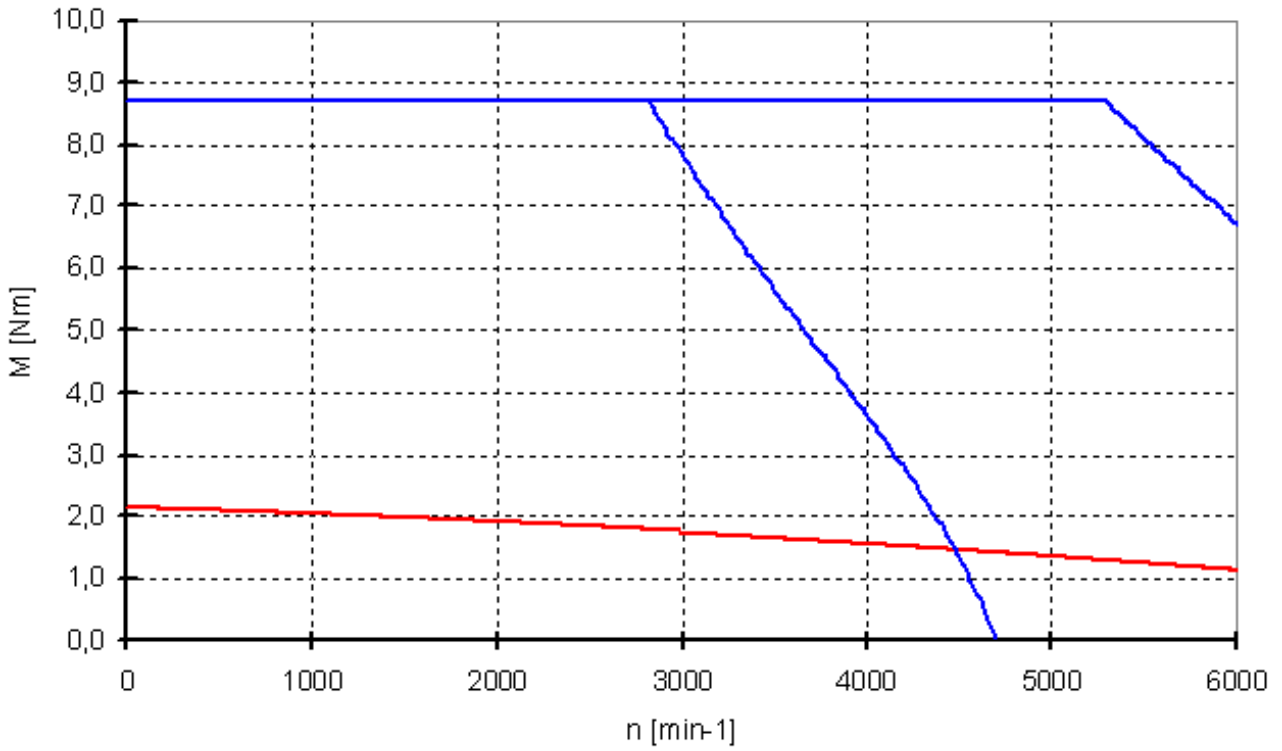Figure 6-5: Torque-speed characteristic curve iSH 070 60 017

Figure 6-6: Torque-speed characteristic curve iSH 070 60 022
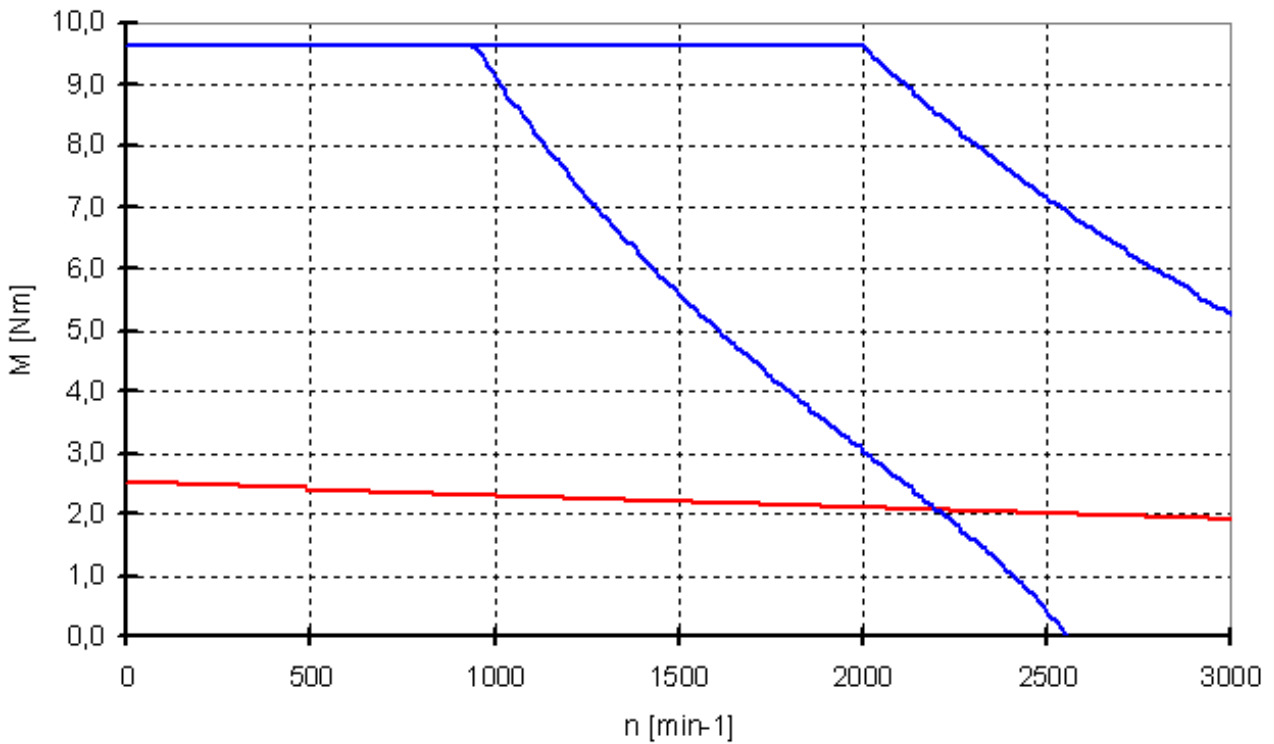

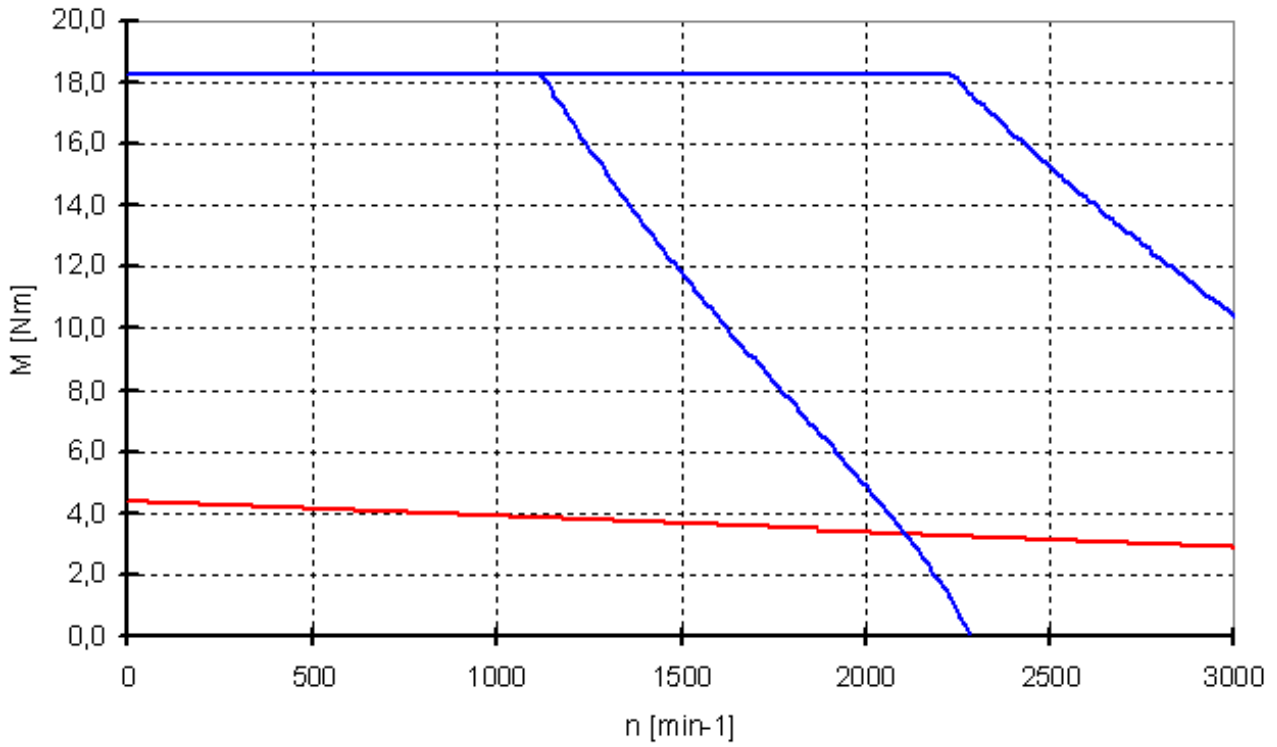Figure 6-7: Torque-speed characteristic curve iSH 100 30 025

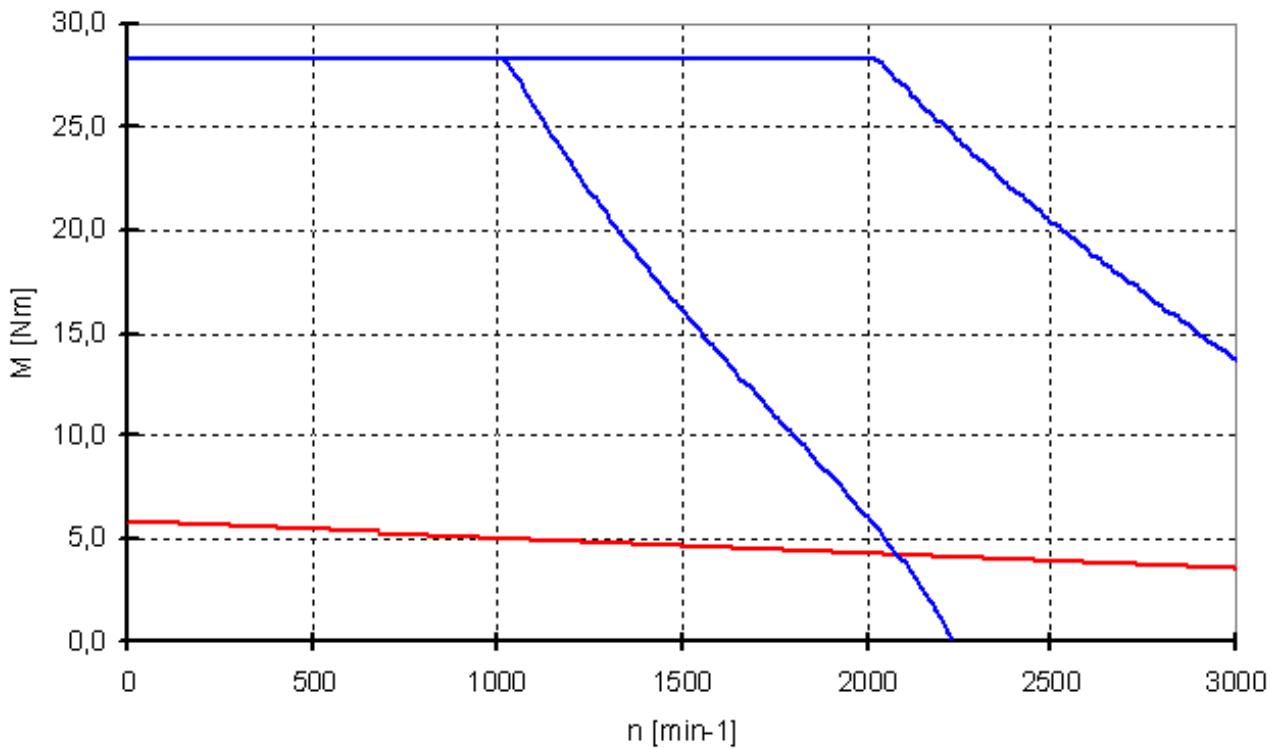*Figure 6-8: Torque-speed characteristic curve iSH 100 30 044*

Figure 6-9: Torque-speed characteristic curve iSH 100 30 058
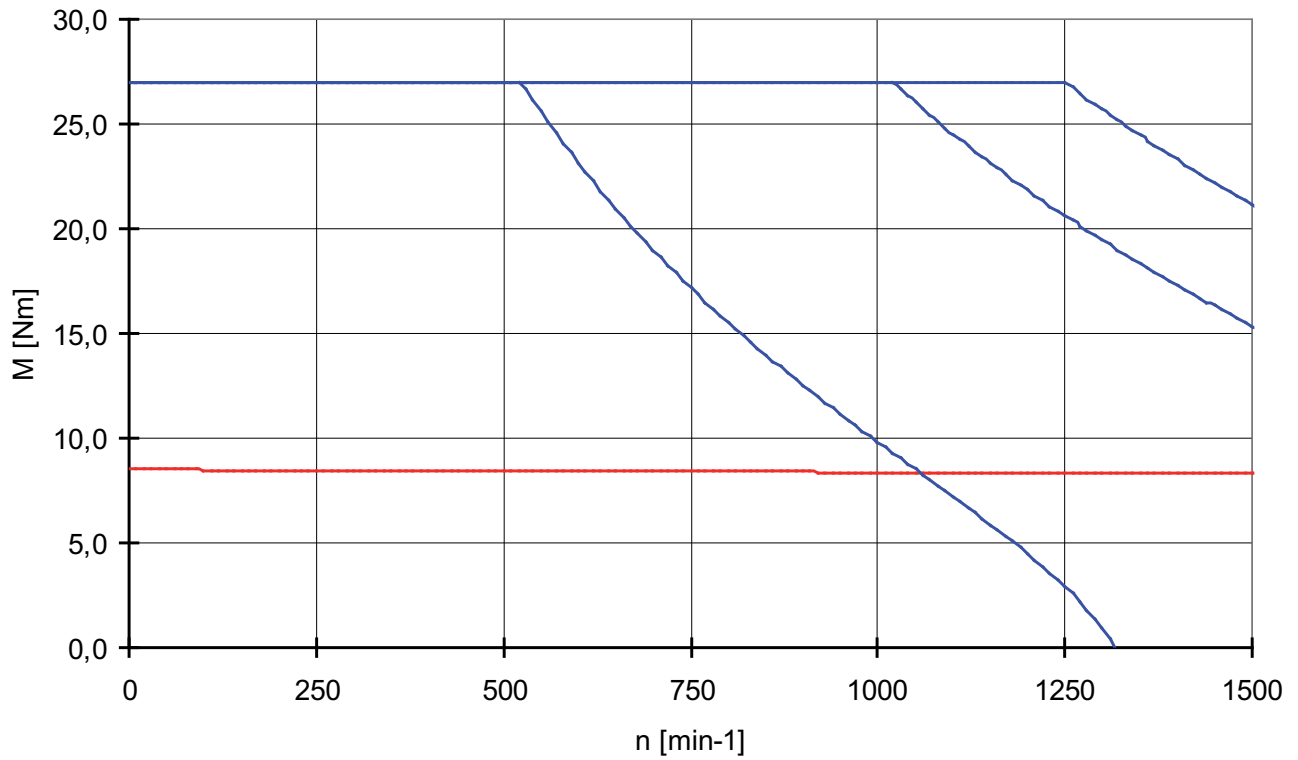
Figure 6-10: Torque-speed characteristic curve iSH 140 15 085
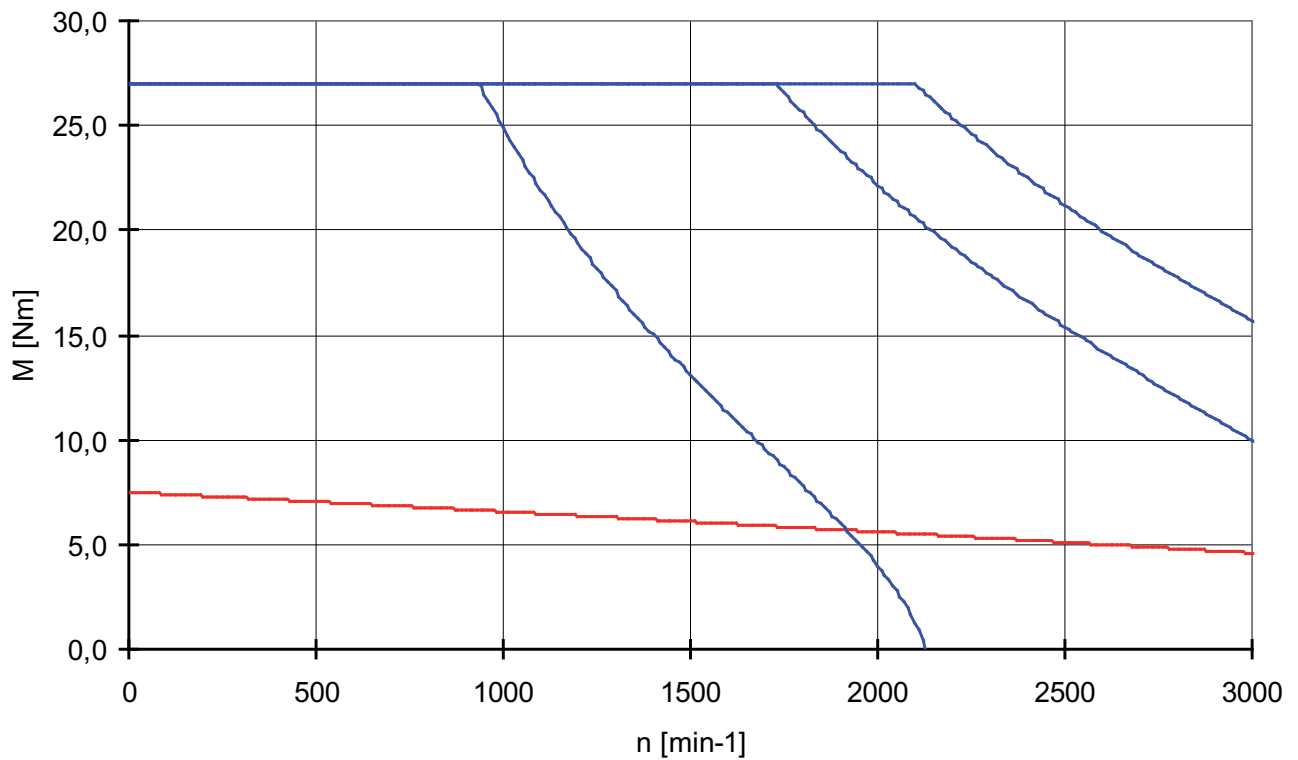
Figure 6-11: Torque-speed characteristic curve iSH 140 30 075
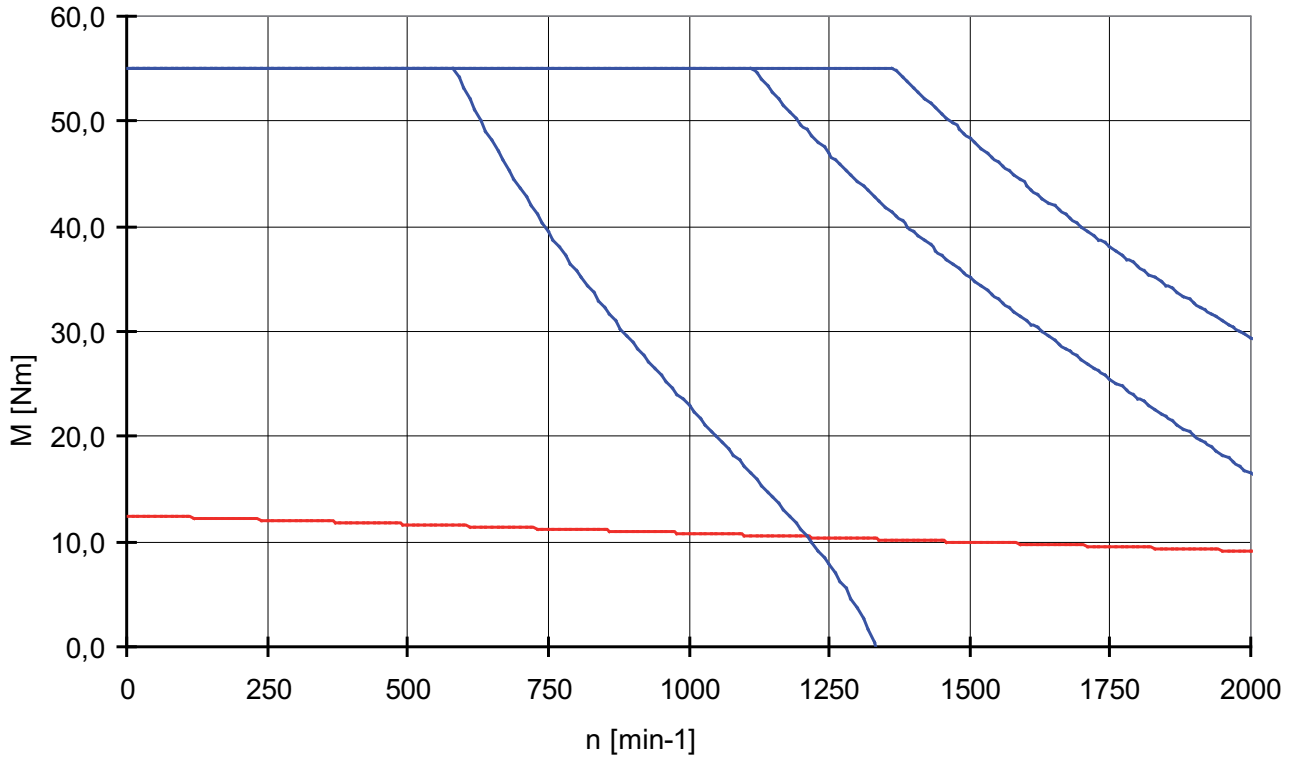
Figure 6-12: Torque-speed characteristic curve iSH 140 20 125

6.7   Electrical connections
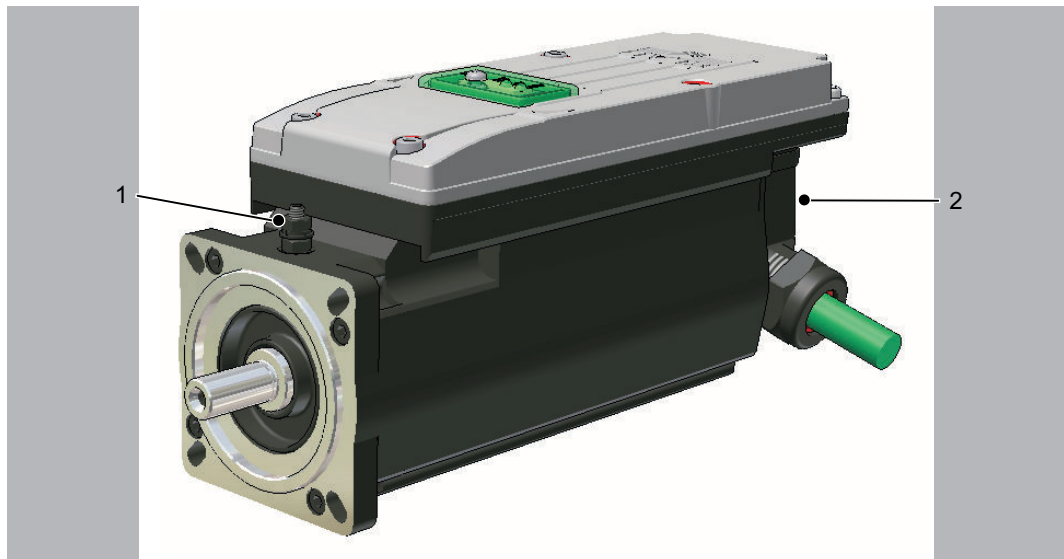
Figure 6-13: iSH connection overview

1	Additional ground connection
2	Connector
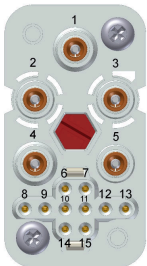
Pin	Designation	Meaning
1	PE	Ground conductor
2	DC-	DC circuit -
3	DC +	DC circuit +
4	0 V	Control voltage
5	24 V	Control voltage
6	SERC_OUT +	SERCOS output
7	SERC_OUT -	SERCOS output
8	ie1	Inverter Enable
9	ie2	Inverter Enable
10	SERC_OUT_S	SERCOS shield
11	SERC_IN_S	SERCOS shield
12	-	not connected
13	-	not connected
14	SERC_IN +	SERCOS input
15	SERC_IN -	SERCOS input

Table 6-15: Connector iSH

6.8 Dimensions

Dimensions of the iSH-070

without Option-module
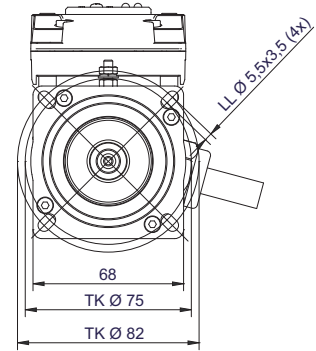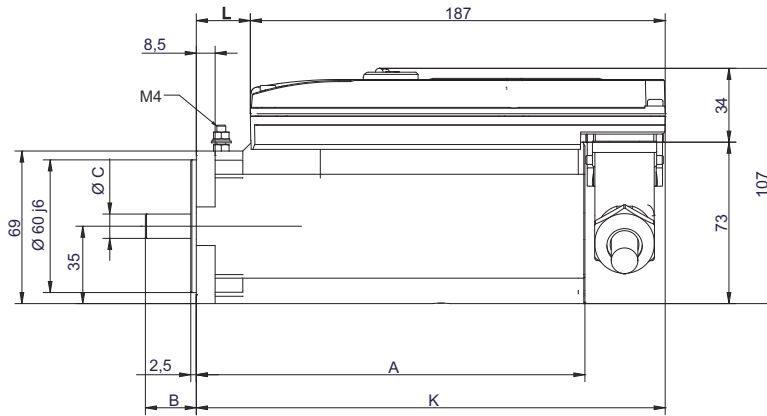
with Option-module
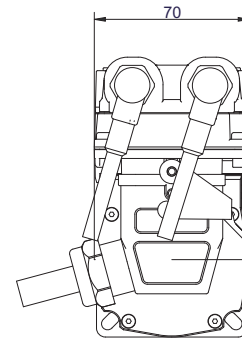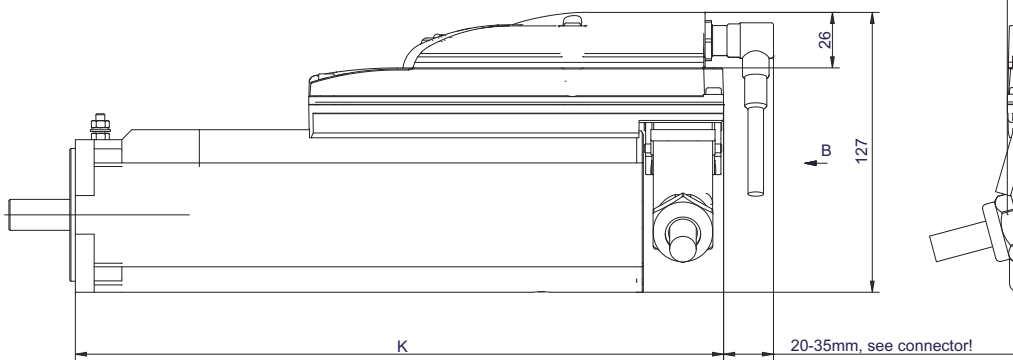
Figure 6-14: Dimension diagram for iSH-070 motor

Please note that the iSH series 070 uses different shaft diameters. The shaft diameter for the iSH070 60 022 is 14 mm.

Dimensions table

Dimensions	iSH070 60 011	iSH070 60 017	iSH070 60 022
A (with brake)	175 (182)	189 (215)	222 (256)
B	23	23	30
C	11 k6	11 k6	14 k6
K (with brake)	212 (219)	226 (252)	259 (293)
L (with brake)	25 (31)	38 (64)	71 (105)

Table 6-16: Dimensions of the iSH 070 (dimension specifications in mm)

Dimensions of the iSH-100

without Option-module

with Option-module

20-35mm, see connector!
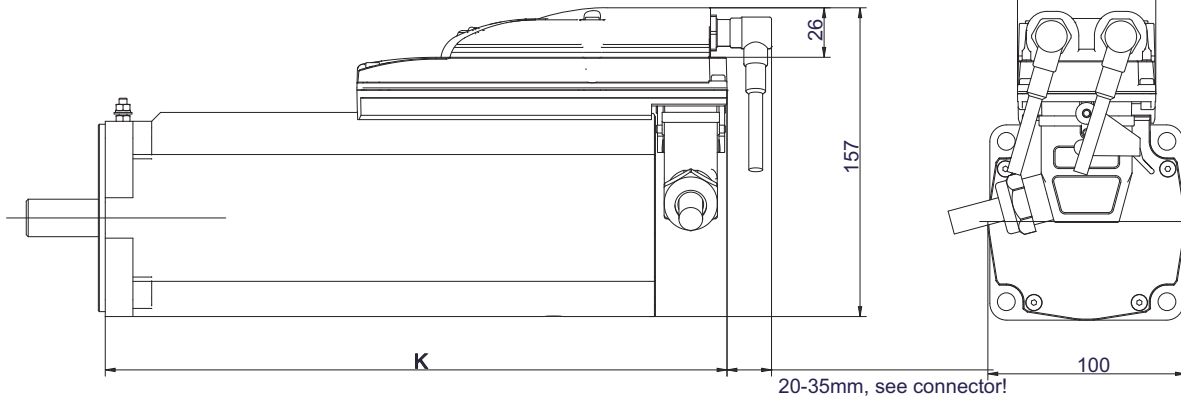
Figure 6-15: Dimension diagram for iSH-100 motor

Dimensions table

Dimensions	iSH100 30 025	iSH100 30 044	iSH100 30 058
A (with brake)	178 (207)	212 (243)	248 (279)
B	40	40	40
C	19 k6	19 k6	19 k6
K (with brake)	215 (243)	249 (280)	285 (315)
L (with brake)	27 (55)	61 (92)	97 (127)

Table 6-17: Dimensions of the iSH 100 (dimension specifications in mm)

Dimensions of the iSH-140
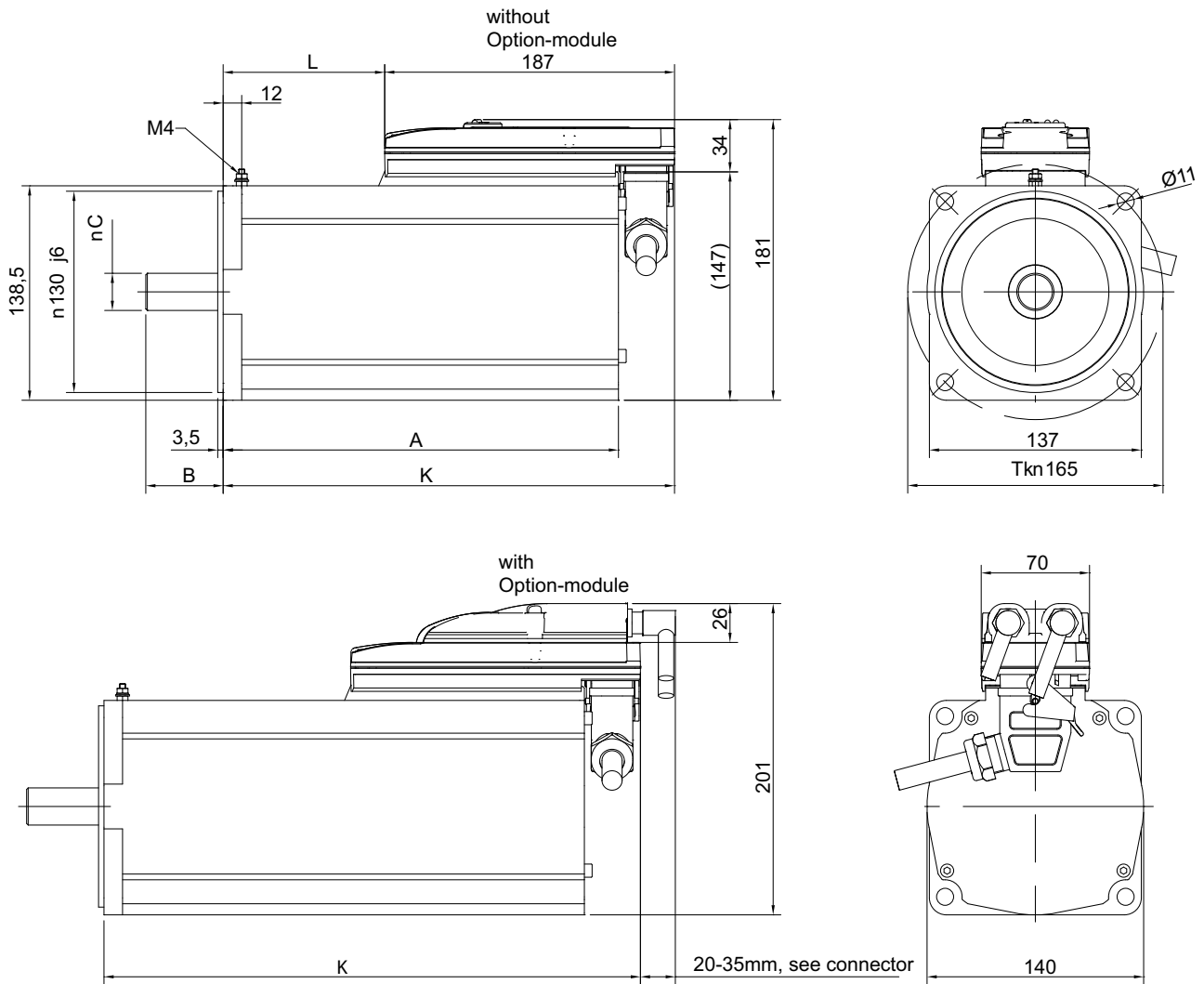
Figure 6-16: Dimension diagram for iSH-140 motor

Dimensions table

Dimensions	iSH140 XX 075	iSH140 XX 085	iSH140 XX 125
A (with brake)	218 (256)	218 (256)	273 (311)
B	50	50	50
C	24 k6	24 k6	24 k6
K (with brake)	254 (292)	254 (292)	309 (347)
L (with brake)	67 (105)	67 (105)	122 (160)

Table 6-18: Dimensions of the iSH 140 (dimension specifications in mm)

Dimensions of the iSH-feather key
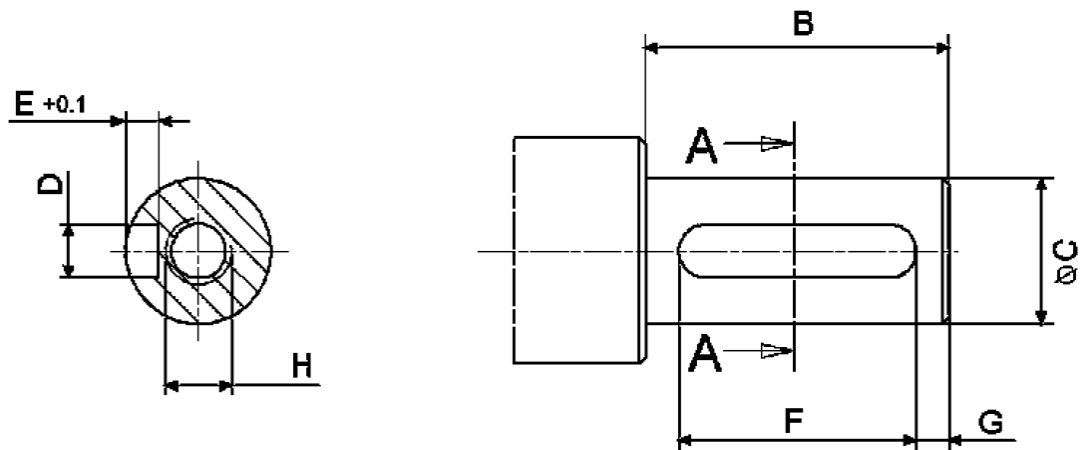
Figure 6-17: Dimension diagram iSH feather key

Dimension tables

Dimensions	iSH070 60 011	iSH070 60 017	iSH070 60 022
B	23	23	30
C	11 k6	11 k6	14 k6
D	4 N9	4 N9	5 N9
E	2.5	2.5	3
F	18	18	20
G	2.5	2.5	5
H	DIN 332-D M4	DIN 332-D M4	DIN 332-D M5
Feather key (N9)	DIN 6885-A4x4x18	DIN 6885-A4x4x18	DIN 6885-A5x5x20

Table 6-19: Dimensions of the iSH-070 feather key (in mm)

Dimensions	iSH100 30 025	iSH100 30 044	iSH100 30 058
B	40	40	40
C	19 k6	19 k6	19 k6
D	6 N9	6 N9	6 N9
E	3.5	3.5	3.5
F	30	30	30
G	5	5	5
H	DIN 332-D M6	DIN 332-D M6	DIN 332-D M6
Feather key (N9)	DIN 6885-A6x6x30	DIN 6885-A6x6x30	DIN 6885-A6x6x30

Table 6-20: Dimensions of the iSH-100 feather key (in mm)

7 Type code

iSH070/60017/0/0/00/0/00/00/00

Flange Size

Rating Speed

Standstill torque

Voltage/Electronic

Shaft end

Surface

Cooling

Connection system

Sealing (Protection Class) Shaft / Housing

Encoder

Brake

Options

Flange Size
070, 100

Rating Speed   x 100 min^{-1}
(30)

Standstill torque   /10 Nm
(e.g. 011, 017, 022, 025, 044, 058)

Voltage
0 = DC 560V / integr. servo electronic

Shaft end
0 = Smooth shaft
1 = Keyed shaft according to DIN 6885
3 = Smooth shaft, stainless steel
4 = Keyed shaft, stainless stell according to DIN 6885

Surface
0 = Standard coating

Cooling
0 = Self-cooling

Connection system
0 = Hybrid connector

Sealing (Protection class) Shaft
0x = Without shaft sealing
       (IP54 excl. IM V3: IP40)
1x = Shaft sealing (IP65)

Sealing (Protection class) Housing
x0 = Standard IP65

Encoder
0 = SinCos SKS 36
1 = SinCos SKM 36

Brake
0 = Without holding brake
1 = With holding brake

Options
00 = Without option
01 = iSH-DIS1 connected

8   Optional module iSH-DIO8

Features:

- 8 bidirectional floating inputs/outputs (configurable in the PLC configuration)
- Connection via two M12 connectors (8-pin), each with 4 inputs/outputs
- Floating internal power supply of outputs up to 0.1 A total current for 8 inputs/outputs
- Maximum 2 A total output current via 8 outputs when using external supply voltage
- 0.5 A output current max. per output when using external supply
- Short-circuit detection and open-circuit detection on outputs
- Two inputs with special functions (touch probe, counter)

8.1   Technical data

Parameters	Value
Item name	iSH-DIO8 I/O module
Order number	13 13 02 67
iSH-DIO8 supply - Control voltage / control current	DC 24 V (-15% / +20%) when using internal I/O supply: max. 300 mA when using external I/O supply: max. 80 mA
digital inputs - Number - Voltage in U_{IN} 0 range - Voltage in U_{IN} 1 range - Input current - Electrical isolation - Protected against reverse polarity - Input filter	8 (IEC61131-2 Type I) DC -3 ... 5 V DC 15 ... 30 V I_{IN} = 2 mA at U_{IN} = 15 V 500 V floating opposite PE Yes 1 or 5 ms, configurable
digital outputs - Number- Output voltage- Rated current per output- Total module current across all 8 inputs/outputs- Activation current- Leakage current 0 signal- Transmission time- Short-circuit proof- Supply output- Electrical isolation	8 (IEC61131-2) $(+U_L\text{-}3\text{ V}) < U_{OUT} < +U_L$ I_e = 500 mA When using internal I/O supply: 0.1 A When using external I/O supply: 2.0 A I_{emax} > 2 A for 1 s < 0.4 mA 100 µs Yes DC 24 V (-15% / +20%) / 2 A 500 V floating opposite PE
Weight	0,22 kg
Ambient conditions - Protection class - Ambient temp. during operation - During storage and transport - Excess voltage category - Degree of radio interference	IP 65 +5...+40 °C -25...+70 °C, Temperature fluctuation t_{max} = 30 K/h Class A EN55011 / EN61800-3
Approval	CE, cULus

Table 8-1: Technical data for iSH-DIO8

8.2   Installation
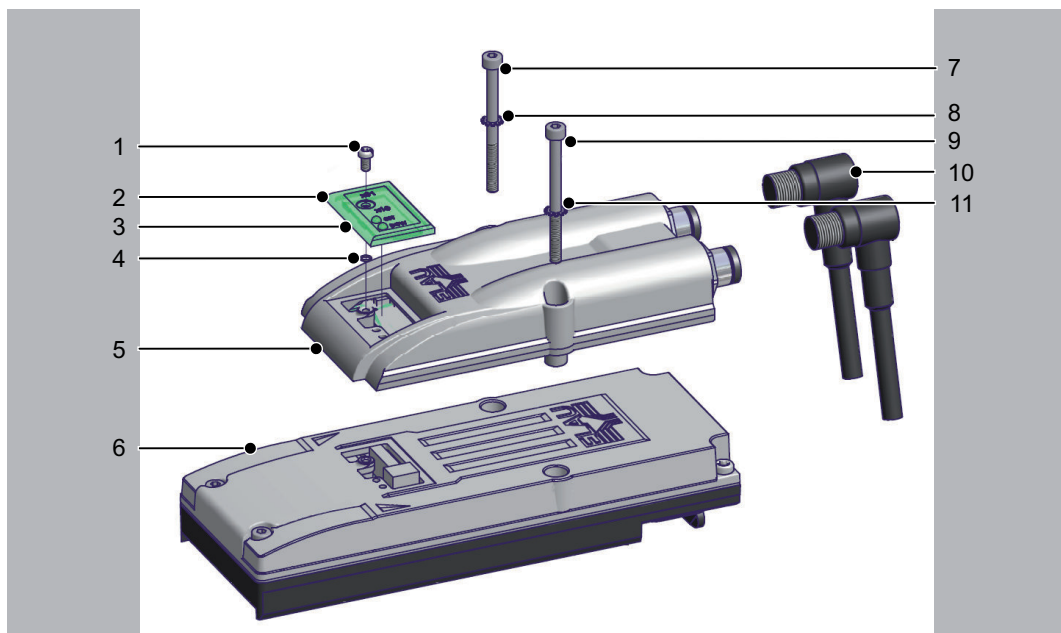
Figure 8-1: Mounting the iSH-DIO8 optional module on the iSH

1	Torx M3x6 screw
2	Protective cap
3	Protective cap gasket
4	O-Ring (2.5 x 0.6)
5	Optional module **iSH-DIO8**
6	Intelligent Servo Module **iSH**
7	M4x50 hexagon socket screw
8	M4 serrated lock washer
9	M4x50 hexagon socket screw
10	M12 connector
11	M4 serrated lock washer

How to install the iSH-DIO8 optional module.

required tool
- Hexagon socket screwdriver 3.0
- Torx TX10 screwdriver

▶   Check delivery for completeness:
  - Optional module **iSH-DIO8** with seal
  - 2 Torx screws M4x50
  - 2 serrated lock washers M4

<table>
<tr><td colspan="2" align="center">⚠ CAUTION</td></tr>
<tr><td colspan="2">

ELECTROSTATIC DISCHARGE!

- Touch circuit boards only on edges. Do not touch any of the circuit points or components.
- Before touching the circuit boards you should remove any static loads. When doing so, first touch a grounded metallic surface such as the housing.
- Do not put the circuit boards on a metal surface.
- Avoid the production of electrostatic charge by having suitable clothing, carpets and furniture and by moving the boards as little as possible.

Damage to component possible!
</td></tr>
</table>

Prepare instal-lation

▸ Open main switch.
▸ Prevent main switch from being switched back on.
▸ Loosen screw 6 with screwdriver (Torx).
▸ Remove screw 6 with insulating washer 5 and protective cap 4 and protective cap gasket 3 from **iSH**.
▸ Loosen screws 7 (M4x30) with screwdriver (hexagon socket).

<table>
<tr><td align="center">⚠ CAUTION</td></tr>
<tr><td>

INSUFFICIENT SHIELDING/GROUNDING/TIGHTNESS!

- Serrated lock washers 8 must be removed when removing screws 7.

Potential damage to components.
</td></tr>
</table>

▸ Remove screws 7 with serrated lock washers 8.

<table>
<tr><td align="center">⚠ CAUTION</td></tr>
<tr><td>

INCORRECT INSTALLATION.

- **iSH-DIO8** with the three fixing pins.
- The seal of **iSH-DIO8** must be completely inserted into the groove of the iSH-DIO8.

Potential damage to components.
</td></tr>
</table>

Assemble

▸ Place **iSH-DIO8** on **iSH**.

▸ Plug screws 7 (M4x50!) with serrated lock washers 8 through **iSH-DIO8** into **iSH**.
▸ Gently turn screw 7 inward with a screwdriver (hexagon socket).
▸ Tighten screws 7 with 2 Nm.
▸ Tighten screws 7 with 4 Nm.
▸ Fit protective cap 4 together with protective cover seal 3 onto **iSH-DIO8**.
▸ Screw the protective cap on tightly (to 1 Nm) with screw 6 and insulating washer 5 using a Torx screwdriver.

8.3   Electrical connections

Optional module iSH-DIO8
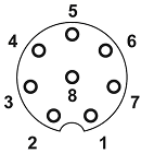
Pin	Designation	Meaning
1	IO.0	Input/output 0
2	IO.1	Input/output 1
3	IO.2	Input/output 2
4	IO.3	Input/output 3
5	24 V	Control voltage
6	24 V	Control voltage
7	0 V	Control voltage
8	0 V	Control voltage
Shield	PE	Shield

Table 8-2: Electrical connections for iSH-DIO8 outlet X4 - inputs/outputs
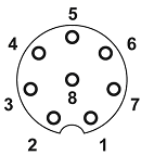
Pin	Designation	Meaning
1	IO.4	Input/output 4
2	IO.5	Input/output 5
3	IO.6	Input/output 6
4	IO.7	Input/output 7
5	24 V	Control voltage
6	24 V	Control voltage
7	0 V	Control voltage
8	0 V	Control voltage
Shield	PE	Shield

Table 8-3: Electrical connections for iSH-DIO8 outlet X5 - inputs/outputs

Block diagram iSH-DIO8
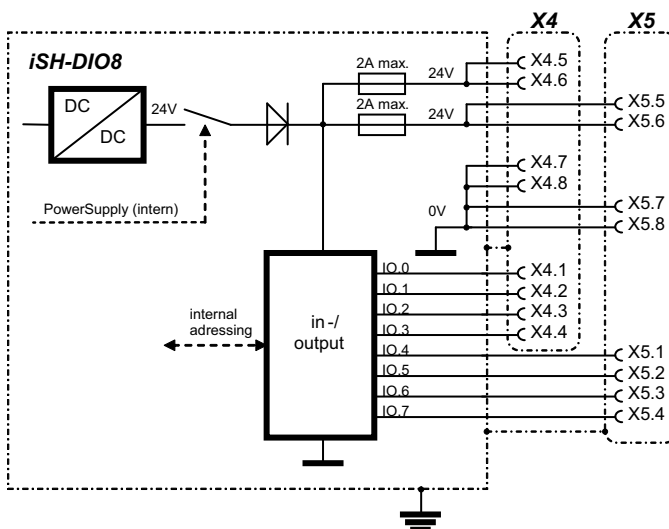
Figure 8-2: Block diagram iSH-DIO8

DIO-4 M12 distributor

outlet *) **3**   **4** outlet *)

outlet *) **1**   **2** outlet *)

*) locking torque 0,6 ... 0,7 Nm
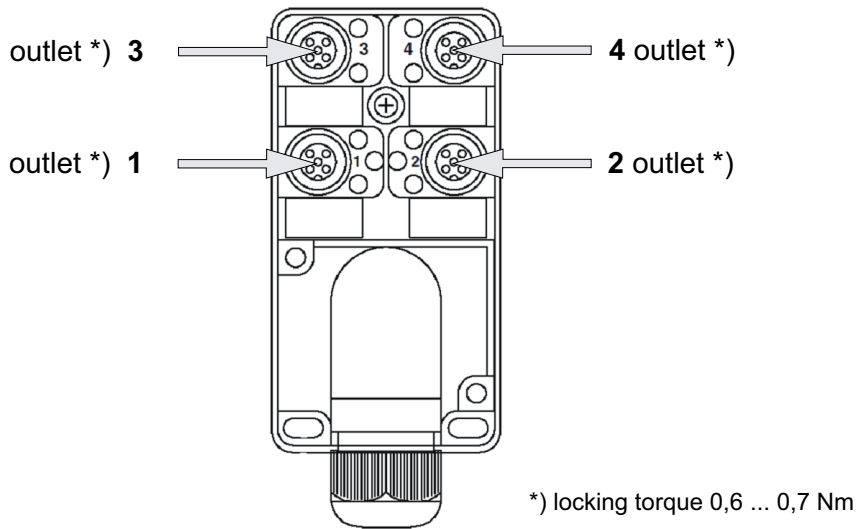
Figure 8-3: Connection scheme M12 distributor DIO-4
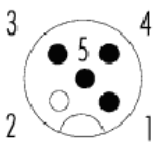
Pin	Designation	Meaning
1	24 V	Control voltage
2	free	Reserved
3	0 V	Control voltage
4	IO.x	Input/output x (X4: 0 ... 3 or X5: 4 ... 7)
5	PE	Shield

Table 8-4: Electrical connections for DIO-4 outlet 1 ... 4 - Inputs/Outputs

CAUTION
THERE IS NO POTENTIAL ISOLATION AMONG ANY OF THE 8 INPUTS/OUTPUTS. • When using an external power supply, you must protect it with 2 A (time-lag). • The control voltage when using external I/O supply can be supplied either via the X4, X5 outlets or via the DIO-4 M12 distributor.
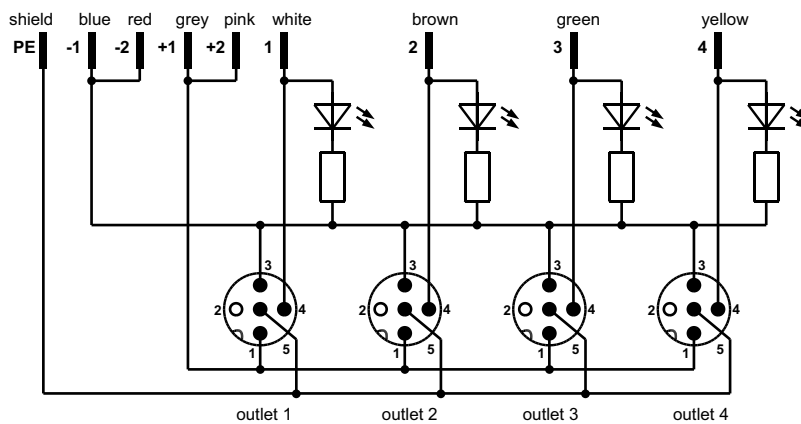
Figure 8-4: Block diagram DIO-4

8.4 Dimensions
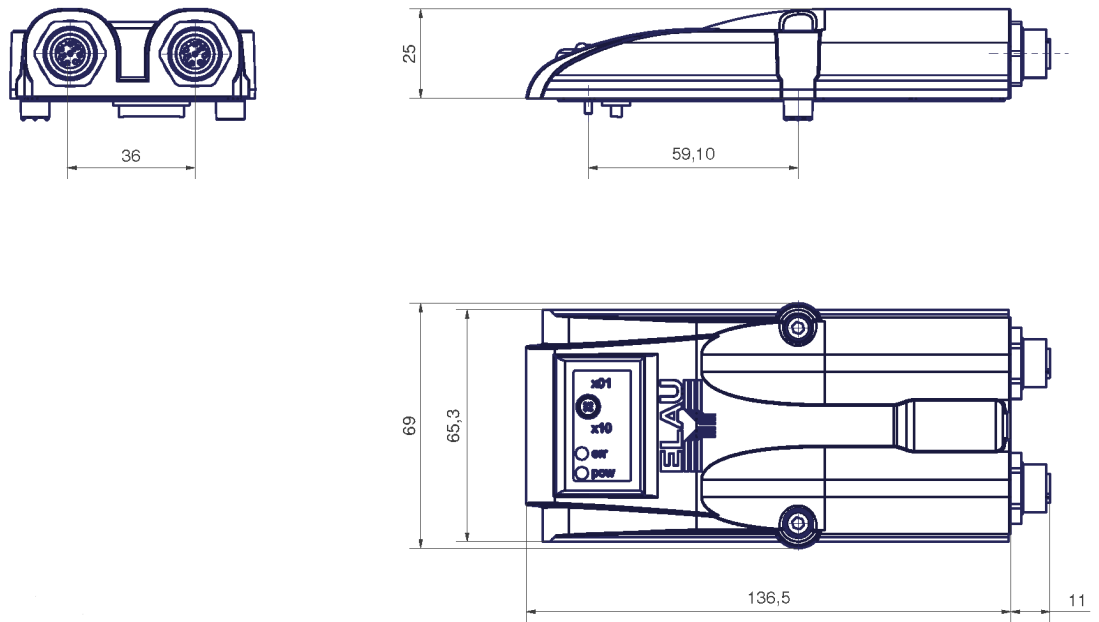
Figure 8-5: iSH-DIO8 dimension diagram
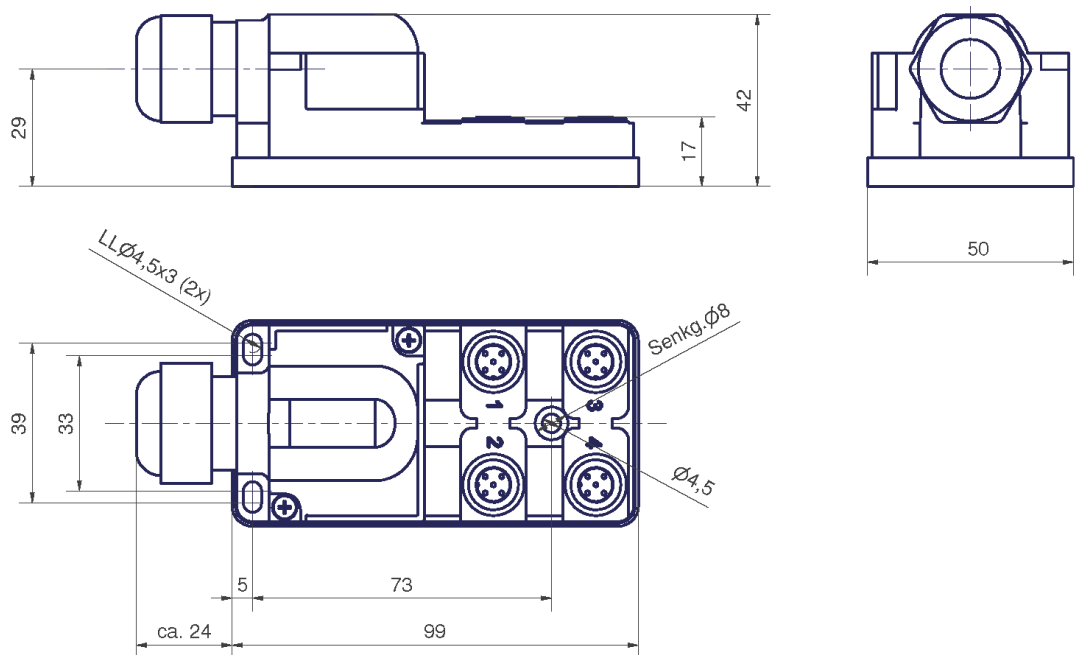
Figure 8-6: DIO-4 M12 DISTRIBUTOR dimension diagram

8.5   Wiring

-1	blue	
+1	gray	
1	white	
3	green	
PE	Shield	
4	yellow	
2	brown	
+2	pink	
-2	red	
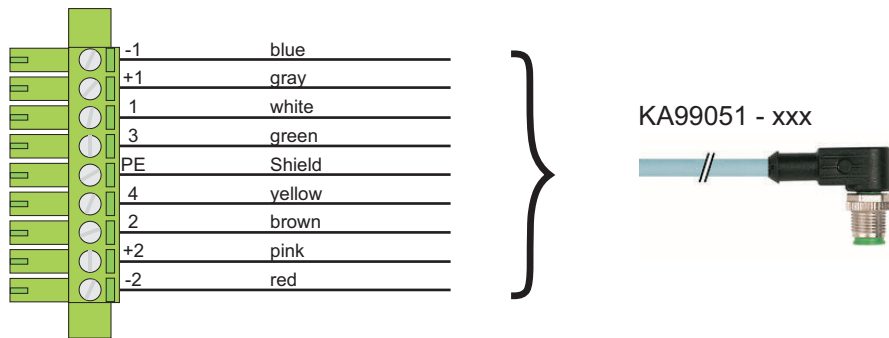
KA99051 - xxx

Figure 8-7: Cable configuration KA99051-xxx for connection of DIO-4 M12 distributor

M12-8 pin

M12-5 pin

24 V DC
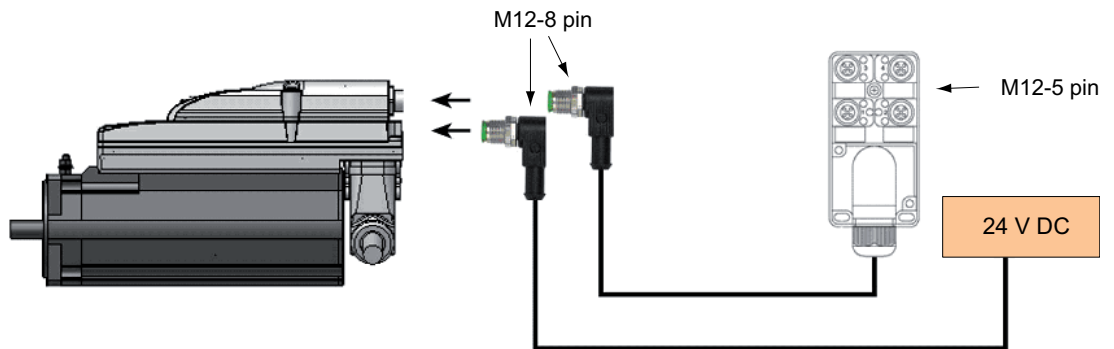
Figure 8-8: 2-4 inputs/ outputs with external supply

24 V DC

M12-8 pin   M12-5 pin
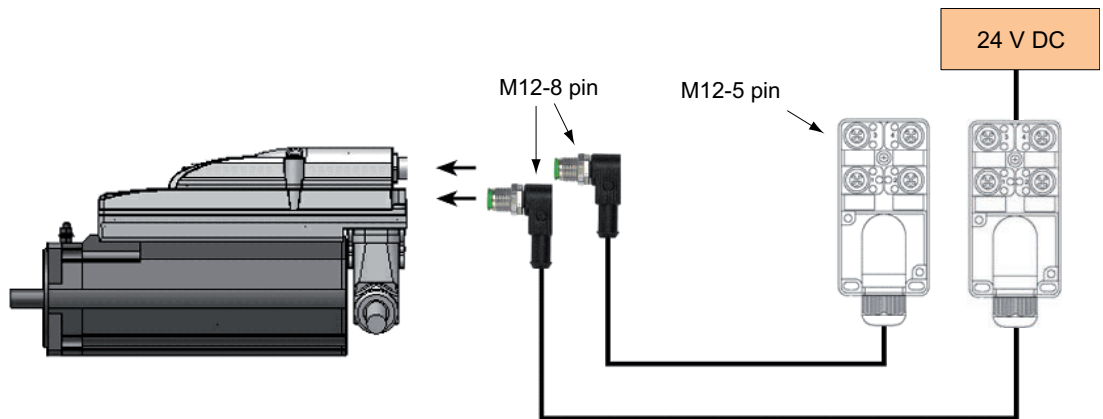
Figure 8-9: 5-7 inputs/ outputs with external supply

9 Inverter Enable function

9.1 Introduction

With the Inverter Enable function (IE) you can bring drives to a safe stop. This function includes the components **PS-5**, **DB-5** and **iSH**. The InverterEnabe function requires further components, e.g. emergency stop, safety switching unit (optional) and connections. The following chapter describes the correct use of the Inverter Enable function.

⚠ WARNING

LOSS OF INVERTER ENABLE FUNCTION

- Observe all requirements in the following sections for the correct functioning of the Inverter Enable functions.

Failure to follow these instructions can result in death or serious injury.

The Inverter Enable function must be used correctly to enable proper operation. Nevertheless, the accidental loss of the Inverter Enable function cannot be ruled out. Such losses of the Inverter Enable function are only restricted to the upper limit required by the relevant safety standards. (see 9.8 Safety standards) This is expressed by the characteristics PFH and SFF.

In the sense of those standards, the requirements of stop category 0 (Safe Torque Off, STO) and stop category 1 (Safe Stop 1, SS1) can be met. Both categories lead to a torque-free motor while SS1 takes this state after a predefined time. As a result of the hazard and risk analysis, it may be necessary to choose an additional brake as a safety option (e.g. for pending loads).

The function is selected via a signal (pair) at the input of the **PS-5 (2)**, which is forwarded to all drives **(7)** of the **PS-5** group. The supply voltage **(AC)** needs not be interrupted (see figure below).

If only some of the drives attached to a **PS-5 (1)** should be put in the safe state, this can be achieved by the configuration of the drives. This is interesting e.g. for cleaning modes **(6)**. If an optional module **iSH-DIS1 (9)** has been set, the IE signal will be ignored. To implement the emergency stop, the power supply on the **PS-5** must be interrupted; see illustration below.

iSH	Cleaning	Emergency stop	Parameter InverterEnableMode
iSH without iSH-DIS1 **(8)**	Torque-free motor	Torque-free motor	Standard/1
iSH with iSH-DIS1 **(9)**	-	Torque-free motor	Off/0

⚠ WARNING

UNCONTROLLED AXIS MOVEMENT

- Take care that nobody has access to the danger zone while there is any charge remaining in the DC circuit between iSH and iSH-DIS1.

Failure to follow these instructions can result in death or serious injury.

9.2   Preparatory measures taken by the machine manufacturer

Hazard and risk analysis

Based on the plant configuration and utilization, a hazard and risk analysis can be carried our for the plant (e.g. according to EN1050 or ISO13849:2006). The results of this analysis must be considered when using the "Inverter Enable" safety function. The circuit resulting from this analysis may deviate from the application examples. For example, additional safety components may be required. In principle, the results from the hazard and risk analysis have priority.

Using additional safety equipment

In its final state, the Inverter Enable function provides a torque-free drive. Therefore, unexpected or non-braked motions cannot be ruled out due to external loads.

⚠ WARNING

MISSING SAFETY FUNCTION

- Use an external safety brake.
- Do not use the optional brake available for **iSH** as a safety function.

Failure to follow these instructions can result in death or serious injury.

Observe the following when the machine is in operation as well as during maintenance and start-up for a drive or the machine:

▶ Provide additional appropriate safety measures (e.g. excluding any stay in the danger zone or additional safety equipment such as a brake) in the machine if the hazard and risk analysis indicates material damage or physical injury which cannot be eliminated by design.

▶ The machine concept must guarantee personal safety.

Always observe the valid rules for safety and accident prevention (e.g. for the US, see NEMA ICS1.1 and NEMA ICS7.1) and observe the specified ambient conditions, given technical data etc.

9.3 Functional Description

9.3.1 Scope of operation (designated safety function)

The Inverter Enable function relates to **PS-5**, **DB-5** and **iSH**, hereinafter referred to as "iSH system".

Operating principle
The Inverter Enable function safely switches off the motor torque. It is sufficient to set a logical zero at the function input. There is no need to interrupt the power supply. There is no monitoring at standstill.
Inverter Enable is equivalent to "safe torque off (STO)" according to IEC 61800-5-2.

Safe state
This torque-free state is automatically assumed when errors are detected in the system. Therefore it is the safe state of the drive.

Mode of operation:
By setting a logical one for the "Inverter Enable" input on the **PS-5**, the output stage control of all **iSH**-drives connected to this **PS-5** become possible (necessary condition). If, on the other hand, this input is set to a logical zero, the power supply at the Inverter Enable input is interrupted and no torque can be built up in the connected **iSH** drives.
This "Inverter Enable" input has a redundant design (a.c. voltage from which the **PS-5** generates d.c. voltage which is fed to the hybrid cables.). The failure of one of the two channels already results in the logical zero. When the power supply is cut off, the final stage becomes de-energized, and an error message is generated. The motor can no longer generate torque and stops unbraked.

You can use the Inverter Enable function to implement the control function "Stopping in case of emergency" (EN 60204-1) for stop categories 0 and 1. Use a suitable external safety circuit to prevent the unexpected restart of the drive after a stop, as required in the machine directive (see application suggestion (see 9.4.1 Application proposals)).

Stop category 0
In stop category 0 (Safe Torque Off, STO) the drive stops in an uncontrolled way. If this means a hazard in your machine. You must take suitable measures (see hazard and risk analysis (see 9.2 Preparatory measures taken by the machine manufacturer)).

Stop category 1
For stops of category 1 (Safe Stop 1, SS1) you can request a controlled stop via the PacController. The controlled stop by the PacController is not safe, not monitored and not guaranteed to work in case of power outage or an error. Final switch off in the safe state is ensured by switching off the "Inverter Enable" input on the **PS-5**. This has to be implemented by means of an external safety switching device with safe delay (see application suggestion (see 9.4 Setup, installation, and maintenance)).

Execute muting
▸ You can mute the Inverter Enable function by using the optional module **iSH-DIS1**.
  ✓ The safe state can only be achieved if the power supply is switched off.
▸ To avoid misconfigurations, you now have to define the configuration to be used with the parameter "**InverterEnableMode**" of the **iSH** in the PLC configuration.

If the set mode does not match the real configuration of the **iSH**, error message 123 "Inverter Enable error" with the extended diagnostic message "Wrong Mode: xx" is triggered. "xx" is the mode which the **iSH** currently has. The drive doesn't switch to control mode as long as the configuration is wrong. The error can only be acknowledged if the **InverterEnableMode** setting corresponds to the real configuration. This can be used to divide the drives on one **PS-5** into two groups, if it is technically not possible to use two **PS-5** for the two groups in the existing machines.

9.3.2 Validity of the safety proof

The Inverter Enable function relates to **PS-5**, **DB-5**, **iSH-HCN1**, **iSH-DIS1** and **iSH**, hereinafter referred to as "**iSH** system", and is valid for the following hardware codes:

Device	Item no.	Hardware code:
iSH 070/xx	6601 2xxx-xxx	xx401xxx or
iSH 100/xx	6601 3xxx-xxx	xx402xxx or xx502xxx or
iSH 140/xx	6601 4xxx-xxx	xx503xxx or xx513xxx
iSH DIS1	5113 0325	1
PS-5	1313 0265	xx4xxx or xx5xxx
DB-5	1313 0266-1	2xxx or 3xxx or 4xxx or 5xxx
Hybrid cable	1515 4513-xxx,1515 4514-xxx, 1515 4515-xxx,1515 4516-xxx, 1515 4517-xxx	not existing
iSH HCN1	1515 4417	1
Safety proof for higher hardware codes is also planned.		

Firmware version 00.24.20 or higher is required in the controllers and the **iSH** system.

9.3.3   Interface

The Inverter Enable function is operated via the switching thresholds of the "Inverter Enable" input (IE1 on Pin1, IE2 on Pin2) of the **PS-5**.
Technical data of the input:

- Max. test pulse width: none
- Max. switching frequency of input signal: 10 Hz

For technical data and information on electrical connections of the **PS-5**, please see the operating manual "Power Supply PS-5 and Distribution Box DB-5".

For technical data and information about the electrical connections of the iSH system, see the operating manual "PacDrive Intelligent Servo Module iSH and Optional Module".

There must be a description of or reference to the connector assignment with input and output clamps of the Inverter Enable-clamps on the **PS-5**.

9.3.4   Lifetime and response time

The Inverter Enable function is designed for a maximum of 15 years of operation. After this time, flawless functionality can no longer be guaranteed. The expiry date of the device is the date given on the type plate plus +15 years. Please include this date in the maintenance schedule of the plant.

Response time with Inverter Enable function

The response time until switch off with Inverter Enable function (without using the **iSH-DIS1**) is not more than 20 ms. This is the time from the corresponding change of the "Inverter Enable" input on the **PS-5** to the torque-free **iSH** motor (safe torque off, STO).

Response time with iSH-DIS1

The response time to switch off when the **iSH-DIS1** (without the Inverter Enable function) is used depends on the load on the **PS-5** (i.e. on the machine) and has to be determined from the application. Axes with **iSH-DIS1** become torque free via the mains contactor and come to a stop.

9.4 Setup, installation, and maintenance

⚠ DANGER
LOSS OF ELECTRICAL SAFETY
• Only operate the **PS-5** with power supply units certified according to EN 60950 or EN 50178 (so-called "safe voltage outputs"). These power supplies supply no excess voltage above DC 120 V for more than 120 ms and no permanent excess voltage above DC 60 V.
Failure to follow these instructions can result in death or serious injury.

▸ Make sure the the drive system is only operated with specific cables, accessories and spare parts approved by ELAU.

▸ To use the Inverter Enable function, observe the specified maximum configurations (number of devices, network structure and cable length). Otherwise the system will always be in safe state (power drop of the Inverter Enable signal over the cable length). The system must not include more than 4 **PS-5**, 40 **DB-5** and 95 **iSH**-motors.

▸ Do not use pulsed semiconductor outputs with external safety switch devices.

9.4.1   Application proposals

There are three application suggestions to implement the safe stop of category 1 (SS1):

- EL-1054-05-xx: Inverter Enable circuit **iSH/PS-5** using the PacDrive Controller **Cx00** with safety switch device for two protective circuits
- EL-1055-05-xx: Inverter Enable circuit **iSH/PS-5** and **MC-4** using the PacDrive Controller **Cx00** with safety switch device for two protective circuits
- EL-1056-05-xx: Inverter Enable circuit **iSH/PS-5** and **iSH-DIS1** using the PacDrive Controller **Cx00** with safety switch device

Notes on application suggestions

General • All application suggestions provide for a protected IE+/IE- wiring (switch cabinet IP54) from the safety switch device to the **PS-5**, as faults need to be ruled out.
- All application suggestions are designed with two protective circuits (emergency stop and safety gate). As required, one of those can be removed.
- Protection against automatic restart is ensured by the external safety switch device.

Notes on EL-1054 The mains contactor K1 in this circuit proposal is not necessary for functional safety purposes. It is, however, used in the application suggestion for the device protection of **PS-5/iSHs**.

Notes on EL-1055 To monitor the mains contactor, the positively driven contacts of the mains contactor K1 must be monitored by the PacDrive Controller when switching it on. This can be accomplished by using the "ContactorControl" software component either separately or integrated into the template.

Notes on EL-1056 To monitor the mains contactors, the positively driven contacts of the mains contactors K1 and K2 must be monitored by the PacDrive Controller when switching them on. This can be accomplished by using the "ContactorControl" software component either separately or integrated into the template.

⚠ WARNING

DANGEROUS MOVEMENTS

- Make sure that the residual energy stored in the drives equipped with **iSH-DIS1** cannot cause any dangerous movement in case of an error.

Failure to follow these instructions can result in death or serious injury.
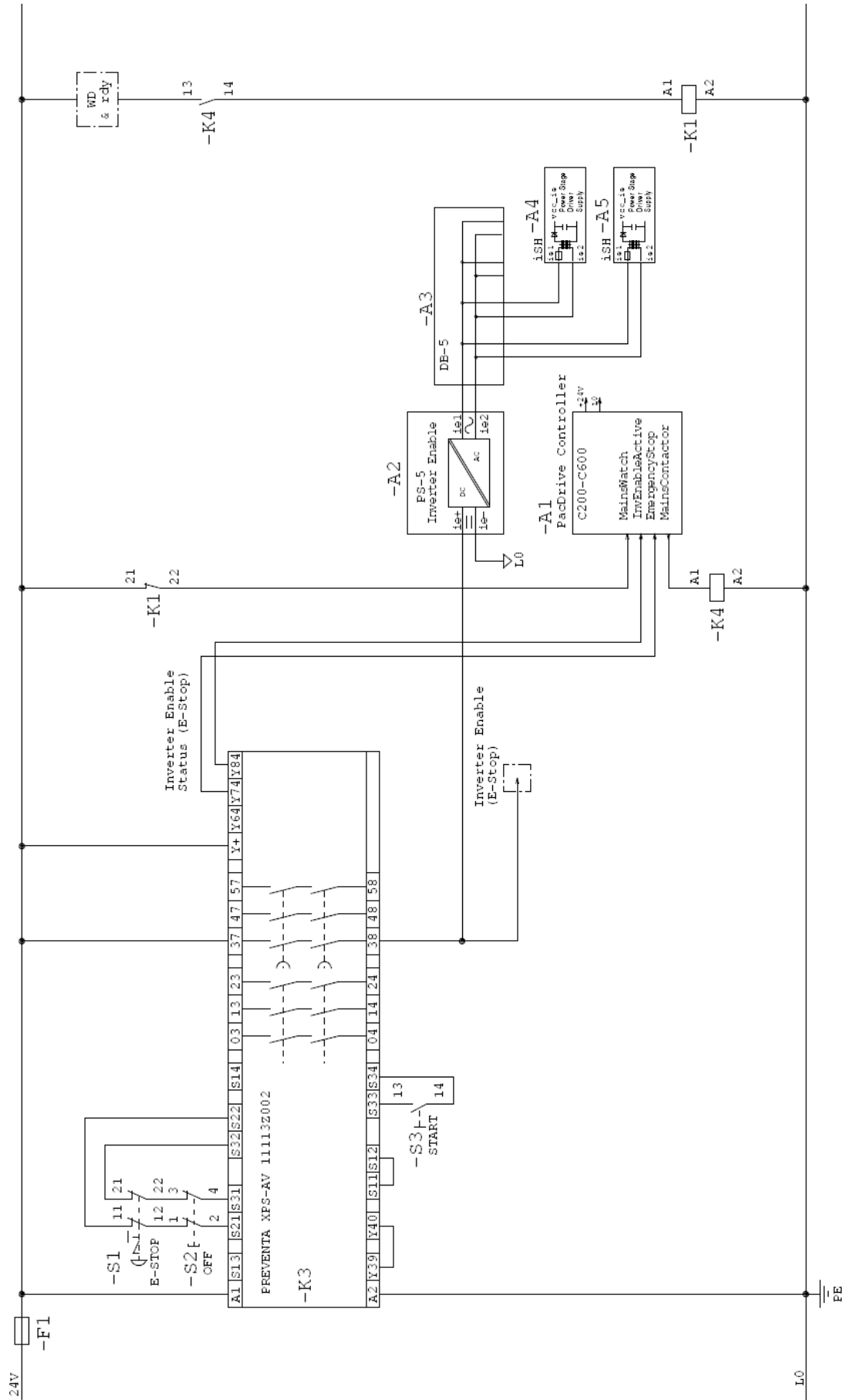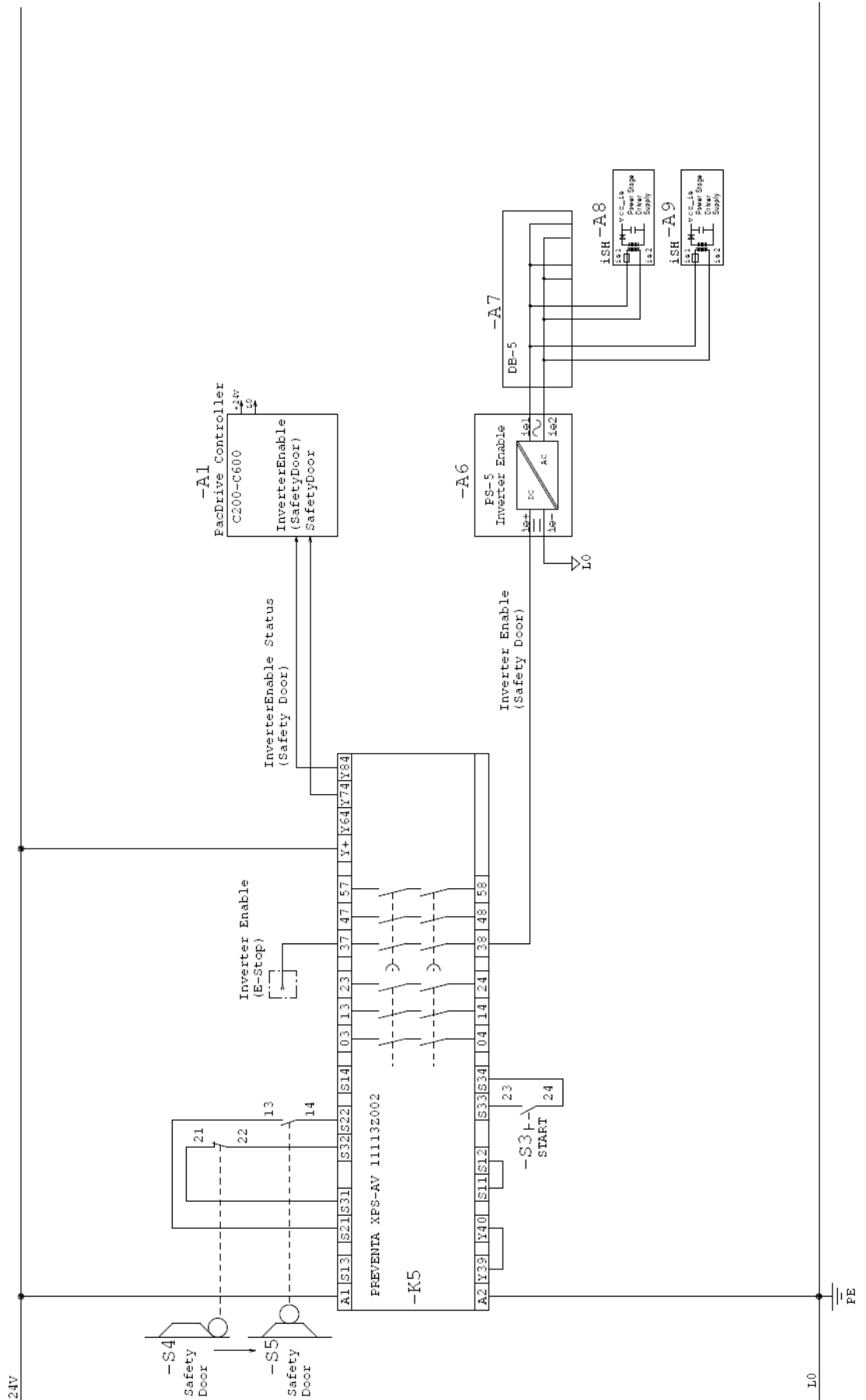

Figure 9-1: EL-1054-05-xx Sheet 1

Figure 9-2: EL-1054-05-xx Sheet 2
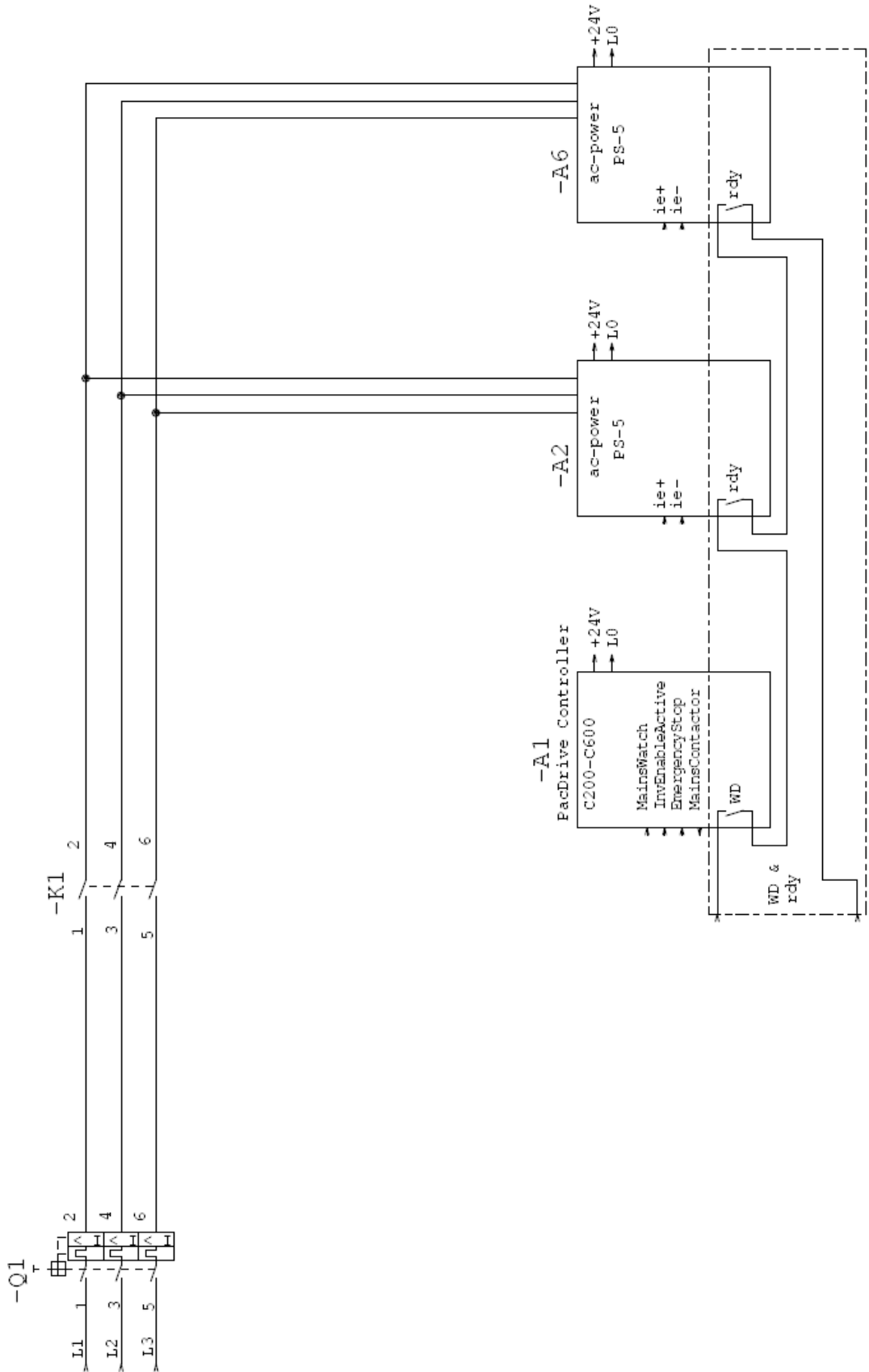
Figure 9-3: EL-1054-05-xx Sheet 3

Figure 9-4: EL-1055-05-xx Sheet 1
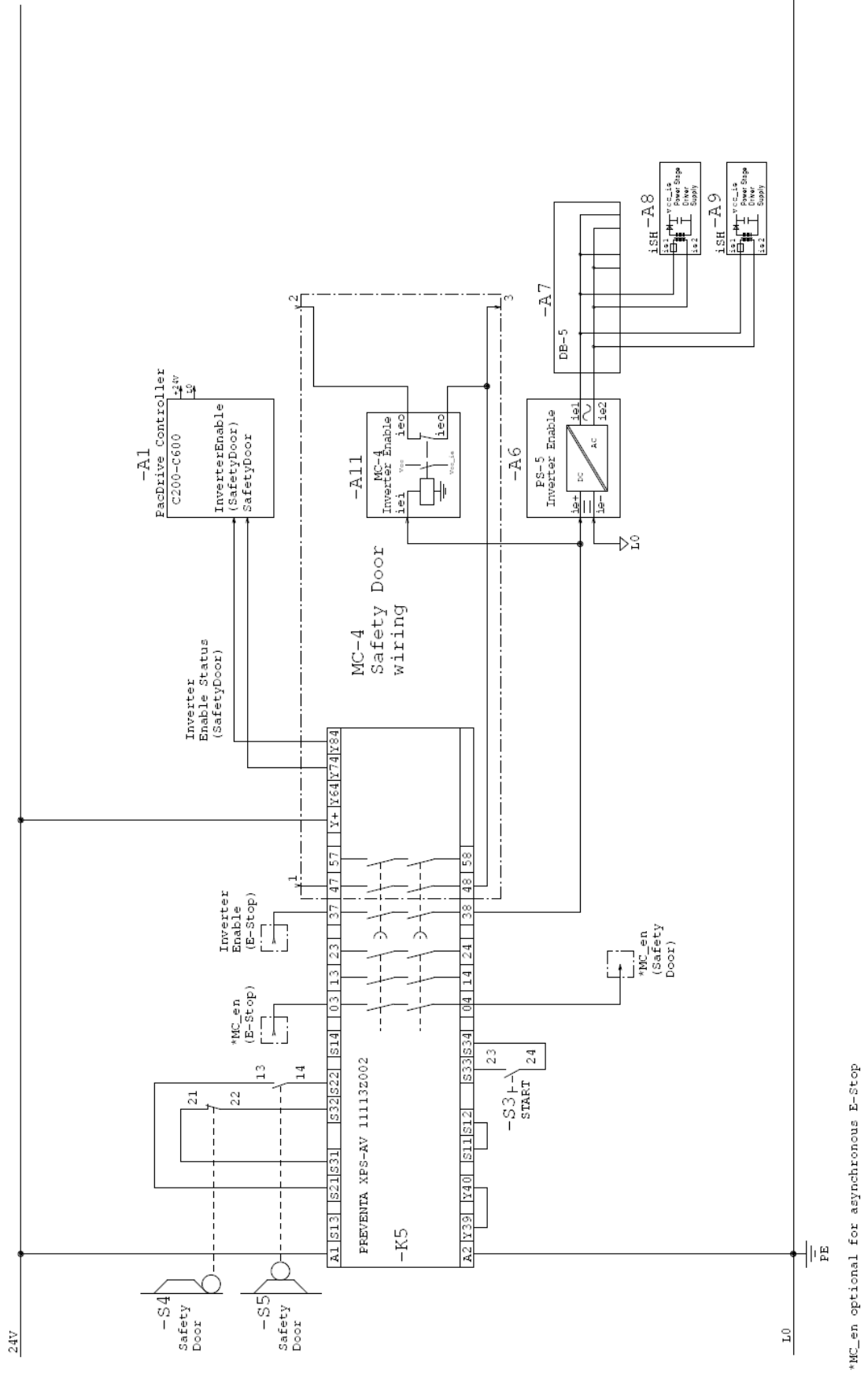
Figure 9-5: EL-1055-05-xx Sheet 2
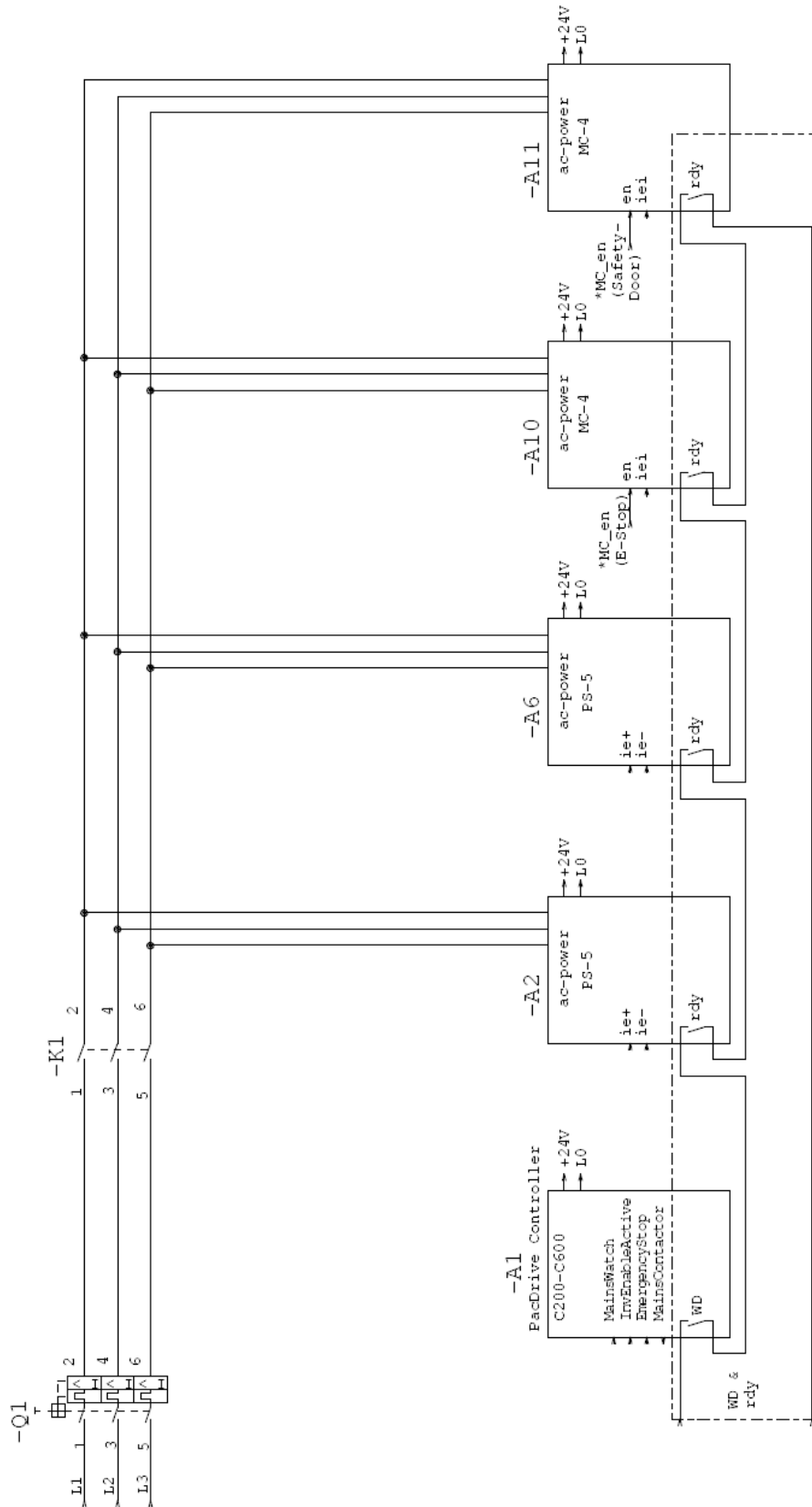
Figure 9-6: EL-1055-05-xx Sheet 3
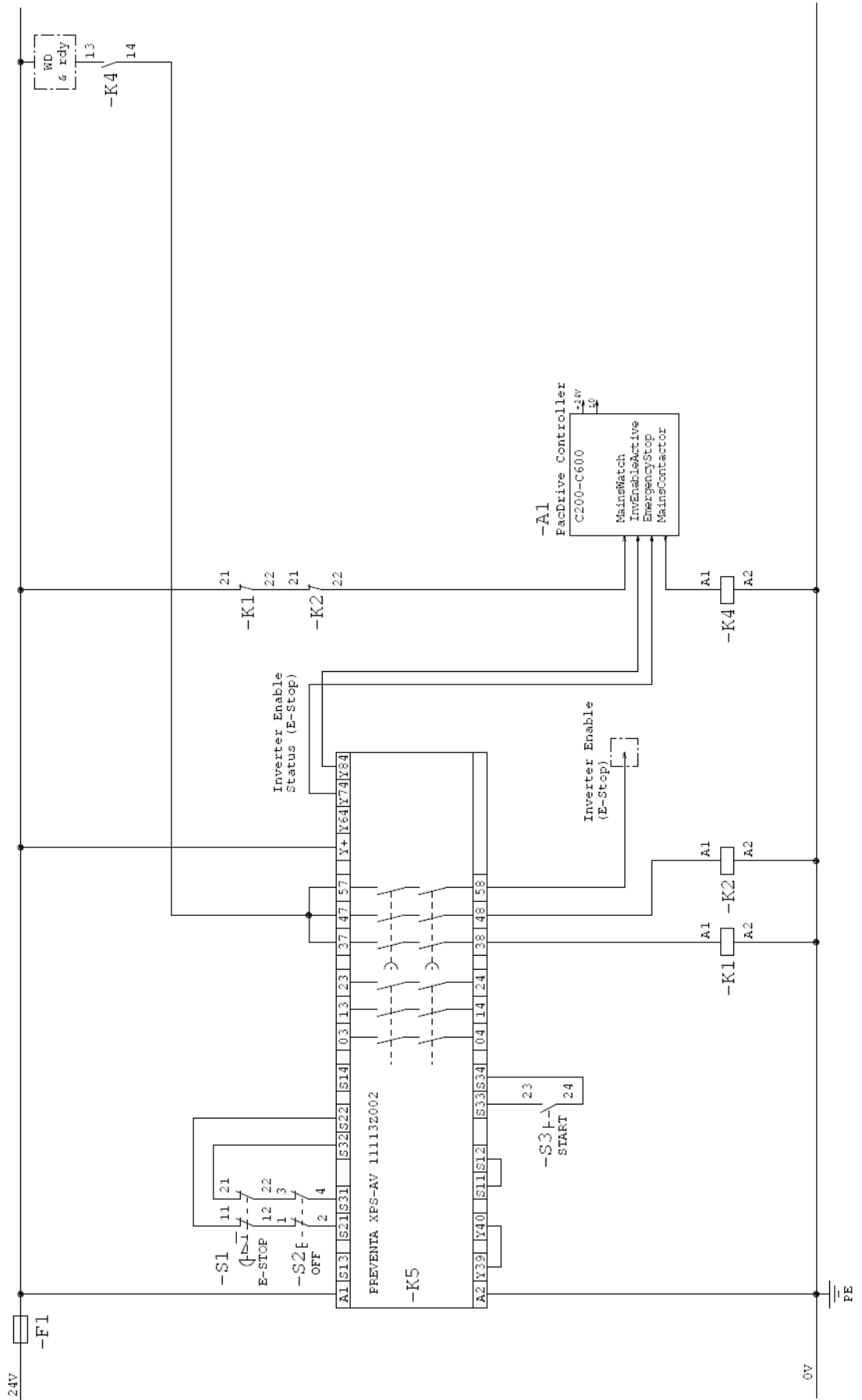
Figure 9-7: EL-1056-05-xx Sheet 1
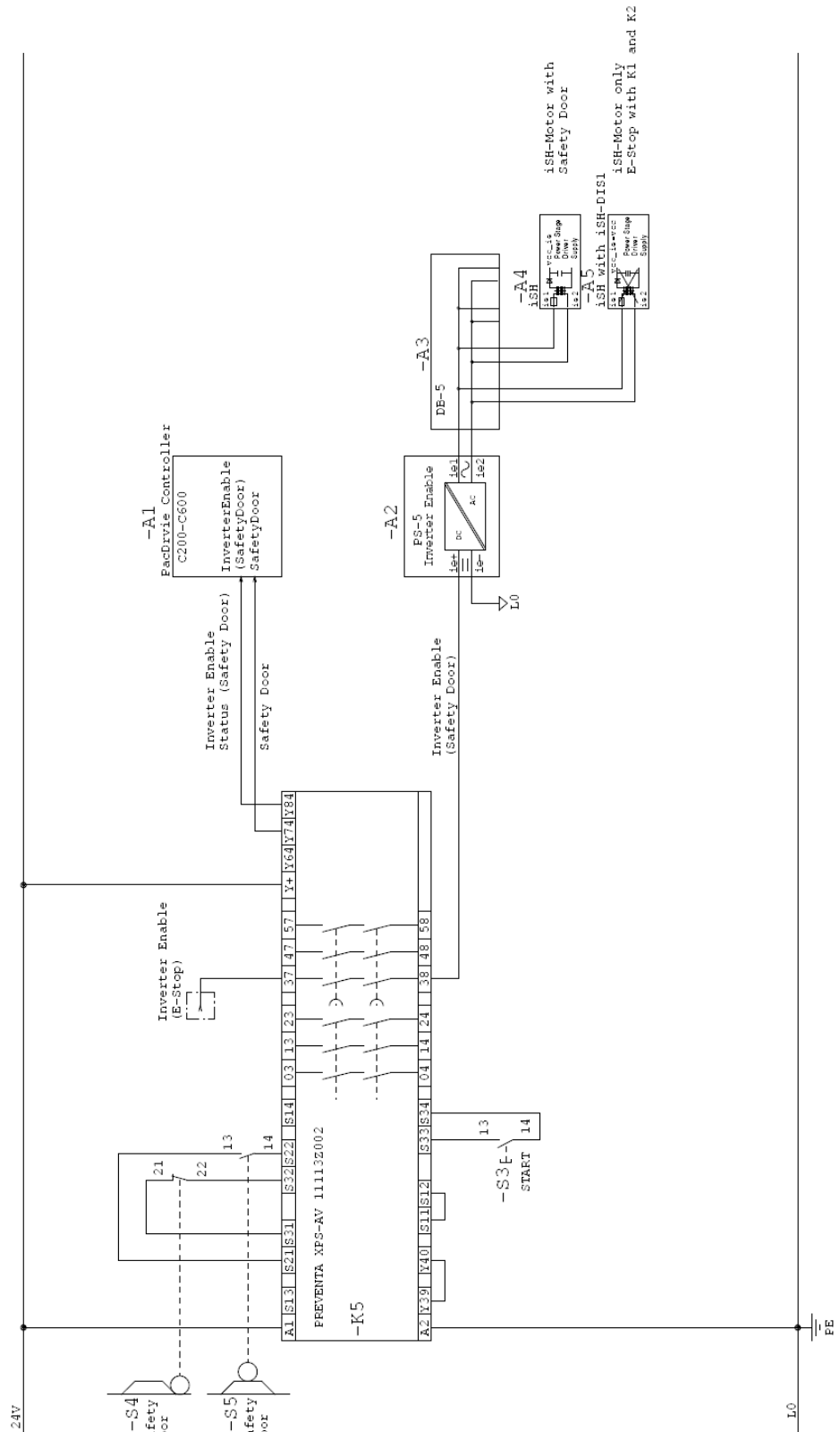
Figure 9-8: EL-1056-05-xx Sheet 2
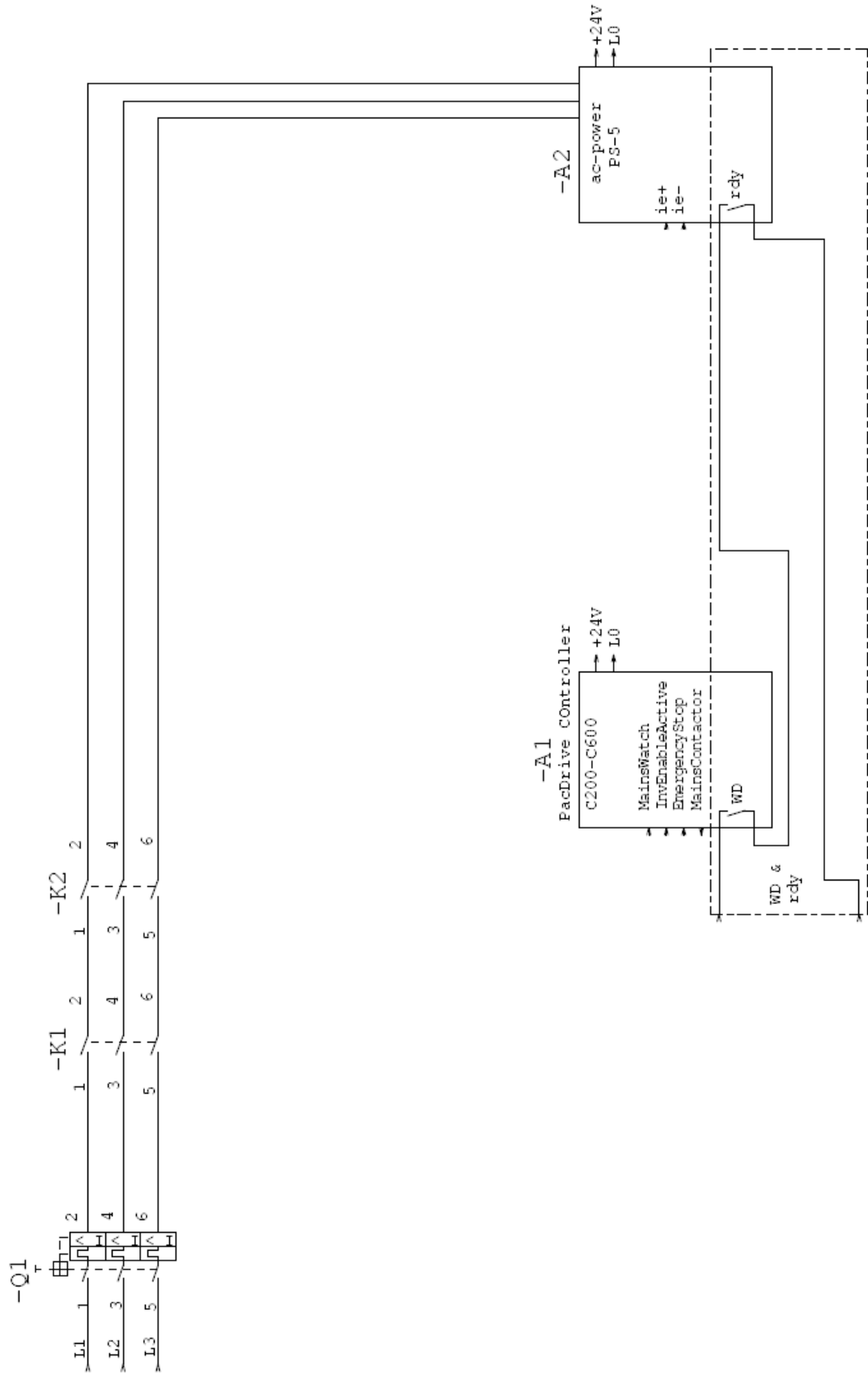
Figure 9-9: EL-1056-05-xx Sheet 3

9.4.2 Operating states

> # ⚠ DANGER
>
> **UNINTENTIONAL RESTART OF THE MOTOR**
>
> - Make sure that the restart of the motor (e.g. when the power supply returns after an outage or after a safety requirement has been removed) to reach the stop category is only possible after receipt of an enable signal.
> - Make sure that the enable signal meets the specified safety criteria.
>
> **Failure to follow these instructions can result in death or serious injury.**

9.4.3 Mode selection

You can choose between the functions STO and SS1 and deactivate/mute the chosen function by using the **iSH-DIS1**. This mode selection is already covered by the application suggestions above.

> # ⚠ WARNING
>
> **HIGH PROBABILITY OF DANGEROUS FAILURES**
>
> - Implement a safety-related time for the SS1 function using an external safety switch device in order to execute the safety function, thus ensuring sufficient error detection according to the standards.
>
> **Failure to follow these instructions can result in death or serious injury.**

The mode selection between STO and SS1 is made by an external safety switch device. If SS1 is selected, this external device will select STO after a certain safe time.

The user will be warned (diagnostic message 123 "Inverter Enable error") if the mode set in the parameter InverterEnableMode does not match the real devices. That means if **InverterEnableMode** = "Off / 0", then the **iSH-DIS1** must be plugged in on the **iSH**.

9.4.4   Optional module iSH-DIS1

⚠ DANGER
ELECTRICAL SHOCK, EXPLOSION OR ELECTRIC ARC •   Observe the general construction and safety regulations for working on high-current electrical systems. •   Operate electrical components only with connected protective conductor •   After installation, check the fixed connection of the protective conductor to all electrical devices to ensure that connection complies with the connection diagram. •   Make sure that the drives are at a standstill because potentially fatal voltage can occur on the motor lines in generator operation. •   Before enabling the device, safely cover the live components to prevent contact. •   Do not touch the electrical connection points of the components when the device is switched on. •   Provide protection against indirect contact (DIN EN 50178 : 1997, Section 5.3.2). •   Disconnect/plug in power connector cables only when the system is deactivated. **Failure to follow these instructions will result in death or serious injury.**

CAUTION
ELECTROSTATIC DISCHARGE •   Touch circuit boards only on edges. •   Do not touch any of the connections or components. •   Discharge any existing static charge by touching a grounded metallic surface such as a grounded housing. •   Prevent electrostatic charges; e.g., by wearing appropriate clothing. **Failure to follow these instructions can result in equipment damage.**

How to install the iSH-DIS1 optional module.
▶   Open main switch.
▶   Prevent main switch from being switched back on.
▶   Remove green, transparent cover plate on the motor.
▶   Remove plugged in jumpers J1 and J2 (see figure).
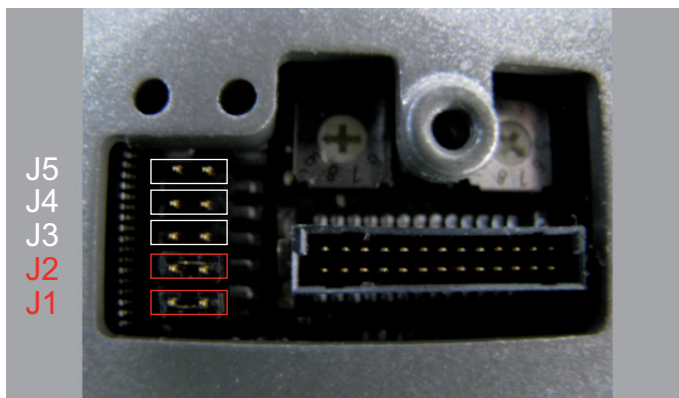
▶   Plug optional module iSH-DIS1 onto contact pins, as shown in the following diagram.
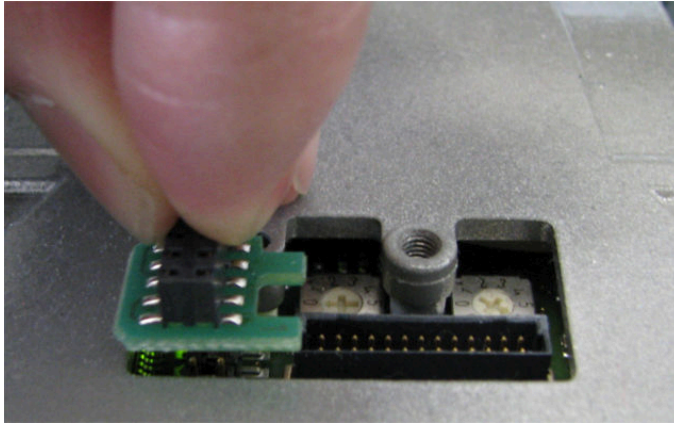
✓   The module is plugged in.
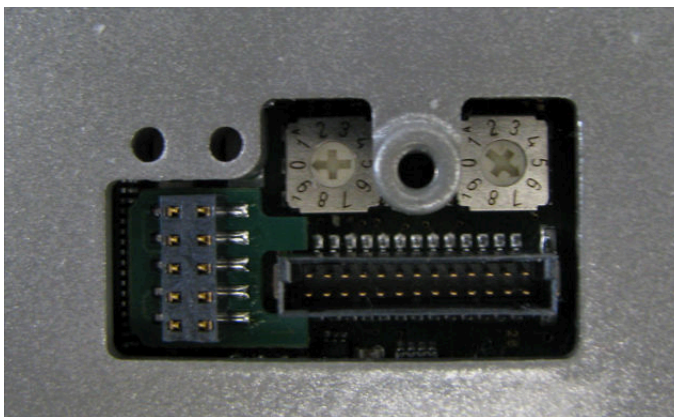
▶   Place green, transparent cover plate onto the motor and tighten the screws.

How to disassemble the optional module iSH-DIS1:
▶   Open main switch.
▶   Prevent main switch from being switched back on.
▶   Remove green, transparent cover plate on the motor.
▶   Remove optional module iSH-DIS1.
▶   Plug in jumpers J1 and J2 (see figure).
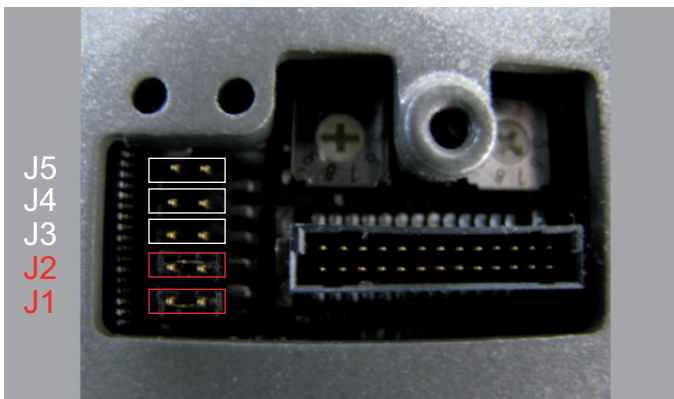
▶   Place green, transparent cover plate onto the motor and tighten the screws.

9.4.5   Commissioning

▶   Carry out a functional test of the STO function for all drives that need the safety function.
▶   In so doing, check that the **iSH-DIS1** jumper in particular is placed correctly.

► Complete installation in accordance with the EMC regulations and further specifications in the device operating manuals.
► Then commission the drive systems.

9.5   Prevention of reasonably foreseeable misuse

Checkplug connections
▸ Check explicitly for **iSH** and **DB-5** if all connectors are placed correctly.
▸ Use only sturdy connectors and safe fixtures.
▸ Check clamping points and make sure that connections are firmly seated on the **PS-5** (see PS-5 operating manual, section on commissioning + electrical connections).

Transport packaging
▸ Use only suitable transport packaging to forward individual devices or return them to ELAU.

Acting of external forces
The safe state of the **iSH**-motor is the torque-free output shaft. If external forces act upon the output shaft, it will not necessarily maintain its position. Take additional safety measures if this is one of the protection goals of the hazard and risk analysis.

Pending & pulling loads
▸ If it is a protection goal for the machine to safely block pending or pulling loads, you need to ensure this by means of an additional, suitable brake which is designed as a safety function.

⚠ WARNING
MISSING SAFETY FUNCTION
• Use an external safety brake. • Do not use the optional brake available for **iSH** as a safety function.
Failure to follow these instructions can result in death or serious injury.

The **iSH**-motor has no safe output to connect such a brake.

Hybrid connection
▸ The maximum number of bending cycles of the cable must not be exceeded.
▸ Observe wiring instructions and maintenance cycles (see "Project planning notes for the PacDrive System") .
▸ Do not exceed the maximum permissible lifetime of the hybrid cable.

⚠ WARNING
STAYING IN THE DANGER ZONE
▪ At plant start-up, the connected drives are normally outside the range of vision of the plant personnel and cannot be monitored directly. • Only start the plant if there are no persons within the action area of moving plant components and when the plant can be operated safely.
Failure to follow these instructions can result in death or serious injury.

9.6   Maintenance

As the Inverter Enable function has been designed for a lifetime of 15 years, no routine checks are necessary to maintain or verify functional safety. Due to the aging of components and the related failure rate, it is impossible to make any statement about the Inverter Enable function after those 15 years. If you wish to ensure the functionality in the sense of safety standards and product liability after this period, you need to exchange the iSH.

Check the **iSH-DIS1** module explicitly and subject the drive to an appropriate functional test after you have replaced the **iSH** servo module.

Keep a logbook for recording the maintenance history of the machine and note the replaced components (as per IEC62061, 7.2.k) 1)).

See the "Installation and Maintenance" section of the "PacDrive Intelligent Servo Module iSH and Optional Module" operating manual for information about commissioning and maintenance.

9.7   Physical environment

The **iSH** Inverter Enable system is not protected by design against physical or chemical sources of danger. Possible sources of danger include:

- toxic,
- explosive,
- corrosive,
- highly reactive, or
- inflammable types.

⚠ WARNING
LOSS OF THE INVERTER ENABLE FUNCTION
• Observe the ambient, storage and transport temperatures of the individual components indicated in the operating manuals of the components. • Please prevent the formation of moisture during the operation, storage and transport of individual components. • Please adhere to the vibration and shock requirements specified in the operating manuals for the components when operating, storing and transporting system components.
Failure to follow these instructions can result in death or serious injury.

In principle, all plugs and plug-in connectors which include Inverter Enable must be designed according to IP54 or higher. For **iSH** and **DB-5**, this is ensured by the design according to IP65. All other components (**PS-5**, plug-in connections in the hybrid cable) do not have this high protection class and therefore are only intended for use in an environment according to IP54 or higher (e.g. switch cabinet).

9.8 Safety standards

The Inverter Enable function was developed and tested according to the following standards for functional safety:

- IEC 61800-5-2:2007; "Safe Torque Off, STO" and "Safe Stop 1, SS1", SIL2-enabled
- IEC 61508; Part 1:1998 + Corrigendum 1999
- EN 61508; Part 2:2000; "Safe Torque Off, STO" and "Safe Stop 1, SS1", SIL 2-enabled
- EN ISO 13849-1:2006; PL d, EN 954-1:1996; Category 3
- IEC 62061:2005; SILCL 2

Certification was handled by TÜV NORD SysTec GmbH & Co. KG (Augsburg, Germany) (certificate no. SAS1736/08).

Those components that include the IE function are generally tested according to

- CE
- cULus

The Inverter Enable function achieves the following safety integrity:

- Safety Integrity Level (SIL) 2, according to IEC61508:1998.
- Performance level (PL) d, category 3 according to ISO13849:2007

The probability of dangerous failures per hour (PFH) and the safe failure fraction (SFF) according to IEC61508-2:2000 and the diagnostic coverage (DC) according to ISO13849:2006 for the devices are as follows:

- **PS-5**: PFH: 3.66×10^{-9}/h, SFF: 99.9%, DC: 98.7%, **MTTFd: 408 years**
- **DB-5**: included in PS-5 and iSH calculations
- **iSH**: PFH: 0, SFF: 100%, DC: 100%

A system with maximum configuration (consisting of 4x**PS-5**, 40x**DB-5**, 95x**iSH**) results in the following values:

- PFH: 1.46×10^{-8}/h, SFF: 100%, DC: 98.7%, **MTTFd: 102 years**

Figures for other configurations within the machine can be requested from ELAU GmbH.

10 Appendix

10.1 Contact addresses

ELAU GmbH Deutschland

Dillberg 12 - 16
D-97828 Marktheidenfeld, Germany
Tel.: +49 (0) 9391 / 606 - 0
Fax: 09391/606-300
e-mail: info@elau.de
Internet: www.elau.de

ELAU GmbH Customer Service

P.O. Box 1255
D-97821 Marktheidenfeld, Germany
Phone: +49 (0) 9391 / 606 - 142
Fax: +49 (0) 9391 / 606 - 340
e-mail: info@elau.de
Internet: www.elau.de
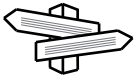
See the ELAU Homepage (www.elau.de) for additional contact addresses.

10.2 Product training courses

We also offer a number of training courses about our products.

Our seminar leaders with several years of experience will help you take advantage of the extensive possibilities offered by the PacDrive™ System.

See the ELAU Homepage (www.elau.de) for further information and our current seminar schedule.

10.3 Changes
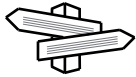
The latest product documentation, application notes and the change service are always available on the ELAU Homepage.

11/2007

- New edition of the operating manual

03/2008

- Update name plate, type code
- Added optional module iSH-DIS1
- Added circuit diagrams for optional module iSH-DIO8
- Added chapter "Inverter Enable"
- Updated chapter "Overview"
- Update on order numbers

08/2008

- Update of the type plate
- Revised chapter "Inverter Enable function"
- Improvement of layout

01/2009

- Acceptance of the iSH-140
- Amendments & corrections to technical data
- Amendments to section Initial Start-Up
- Amendments to section Device Replacement
- Amendments to section Cable Replacement
- Update of section Inverter Enable Function
- Update of the type plate
- Amendment to the warning instructions

10.4   Fault report form

This fault report is required without fail to enable efficient processing.

Send the fault report to your ELAU GmbH-representative or to:

ELAU GmbH
Customer Service Department
Dillberg 12
97828 Marktheidenfeld, Germany
Fax: +49 (0) 93 91 / 606 - 340

Return address:

Company:	City:	Date:
Department:	Name:	Phone:

Specifications regarding product in question

Item name: ....

Item no.: ....

Serial number: ....

Software version: ....

Hardware code: ....

Parameter included: Yes [ ] No [ ]

IEC - Program included: Yes [ ] No [ ]

Information about machine on which the error occurred:

Machine manufacturer: ....

Type: ....

Operating hours: ....

Machine no.: ....

Date of commissioning: ....

Manufacturer / Type of machine control:

....

How did the error present:

....

....

....

Additional information:

Condition of error:	Causes:	Accompanying side effects:
[ ] is always available	[ ] unknown	[ ] problems in the mechanism
[ ] during commissioning	[ ] wiring error	[ ] power failure (24V)
[ ] occurs sporadically	[ ] mechan. damage	[ ] controller failure

[ ] occurs after approx. hours   [ ] moisture in device   [ ] motor failure

[ ] occurs by concussion   [ ] defect encoder   [ ] broken cable

[ ] depends on the temperature   [ ] insufficient ventilation

[ ] foreign objects in the device

Is there an air conditioner in the switch cabinet? Y / N [ ]

Have there been similar errors in the same axis previously?
How often: ....

Did the errors always occur on certain days or at certain times of day?

....

Further information:

....
....
....
....
....
....
....
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....
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PacDrive Intelligent Servo Module iSH and Option Modules