Operating Manual

Lexium ILM62

03.2012

Schneider Electric

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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1 About this manual

1.1 Introduction

Read and understand the material contained in this manual before you work on the ILM62 component for the first time. Take particular note of the safety information (see 2.3 Residual risks). As described in section 2.2, only those persons who meet the "Selection and qualification of employees" are allowed to work on the ILM62 components.

A copy of this manual must be available for personnel who work on the ILM62 components.

This manual is supposed to help you use the capabilities of the ILM62 component safely and properly.
Follow the instructions within this manual to:

- avoid risks
- reduce repair costs and downtime of the ILM62 components
- increase the service life of of the ILM62 components
- increase reliability of the ILM62 components.

1.2 Symbols, designator and display format of safety messages

Important Information

NOTE The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to warn you of potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

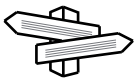
⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.

⚠ CAUTION
CAUTION indicates a potentially hazardous situation which, if not avoided, can result in minor or moderate injury.

NOTICE
NOTICE, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, can result in equipment damage.

The following symbols and designators are used in this document:

Symbol/Character	Meaning
	**Information Symbol:** After this symbol, you will find important information 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.
✕	**Problem symbol:** This symbol is followed by a description of the problem and an instruction how to solve the problem.
►	**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.
(1), (2), (3)	**Image numbers** in the text always refer to the image numbers in the **referenced** figure.
	**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.
`lBuffSelect`	**Program code** is written using a different font.

2 Safety information

This section contains information regarding working with of the ILM62 component. Qualified personnel working on the ILM62 component must read and observe this information. The ILM62 system is conform to recognized technical safety regulations.

2.1 Proper use

The ILM62 system must only be installed in a closed electrical equipment (for example, switch cabinet).

Provide for protective measures

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

Perform a risk evaluation concerning the specific use before operating the product and take appropriate security measures.

If circumstances occur that affect the safety or cause changes during the operating performance of the ILM62 components, then the ILM62 component has to be shut-down immediately and you should contact your Schneider Electric contact person.

Use original-equipment only

Use only the accessories and mounting parts specified in the documentation and no third-party devices or components that have not been expressly approved by Schneider Electric. Do not change the ILM62 component inappropriately.

The components must not be used in the following environments:

Forbidden environments

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

Installation and operating conditions

You may only use the components 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 the usable machine or system in which the ILM62 components is installed meets all requirements of EC guidelines 2006/42/EC (machine guideline).

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

- EN ISO 13849-1:2008 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
- EN 60204-1:2006 Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- EN ISO 12100-1:2003 - Safety of machines - Basic terms, general principles for design - Part 1: Basic terminology, methodology
- EN ISO 12100-2:2003 - Safety of machines - Basic terms, general principles of design - Part 2: Technical guidelines
- EN 50178: 1997 - Electronic equipment for use in power installations
- EN 61800-3:2004 Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods

- EN 61800-5-1:2007 Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy

- 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.

2.2 Qualification of personnel

Target audience for this manual

Electrical equipment must be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Qualified person

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and the installation, and has received safety training to recognize and avoid the hazards involved.

The qualified personnel must be able to detect possible hazards that may arise from parameterization, changing parameter values and generally from mechanical, electrical or electronic equipment. The qualified personnel must be familiar with the standards, provisions and regulations for the prevention of industrial accidents, which they must observe when working on the drive system.

Inverter Enable function

Qualified personnel that work with the Inverter Enable function must be trained according to the complexity of the machines and the requirements of the EN ISO 13849-1:2008. The training must include the production process and the relation between Inverter Enable function and machine.

Qualification guidelines are available in the following publication: Safety, Competency and Commitment: Competency Guidelines for Safety-Related System Practitioners. IEEE Publications, ISBN 0 85296 787 X, 1999.

2.3 Residual risks

Health risks arising from of the ILM62 component have been reduced. However a residual risk remains, since the ILM62 components work with electrical voltage and electrical currents.

If activities involve residual risks, a safety message is made at the appropriate points. This includes the potential hazard that may arise and their possible consequences, and describes preventive measures to avoid the hazard. The following are typical warnings concerning residual risks which cannot be assigned to a specific action. The structure of safety labels is identical to that of safety information.

2.3.1 Electrical parts

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- 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.
- Before enabling the device, safely cover the live components to prevent contact.
- Do not touch the electrical connection points of the components when the unit is switched on.
- Provide protection against indirect contact (EN 50178:1997, Section 5.3.2).
- Disconnect/plug in Plug-in type connectors of the cables, plug-in terminals on the device and bus bar module only when the system is disconnected from the power supply.
- Isolate the unused conductors on both ends of the motor cable because AC voltages in the motor cable can couple to unused conductors.

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK CAUSED BY HIGH TOUCH VOLTAGE

- Attach the shock protectors covers on the outside of the bus bar module combination.
- Only switch on device if the shock protectors covers have been fitted on the outside of the bus bar module combination.

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

⚠ DANGER

HAZARD OF ELECTRIC SHOCK CAUSED BY HIGH TOUCH VOLTAGE

- Before working on the device, make sure that it is de-energized.
- After unplugging it, do not touch connector CN6 at the power supply, since it still carries hazardous voltages for one second.
- When connecting an N conductor and operating IT networks, only operate the LXM62 in a switch cabinet that cannot be opened without the help of tools. As an alternative, prevent that the mains plug can be pulled, since this may expose the pins of the sleeve. If this is also not possible, use an alarm device that indicates hazardous voltages between the phase and the protective earth ground (> 60 V) and therefore, hazardous voltages at the mains plug.

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

2.3.2 Assembly and handling

⚠ WARNING

CRUSHING, SHEARING, CUTTING AND HITTING DURING HANDLING

- Observe the general construction and safety regulations for handling and assembly.
- 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.

2.3.3 Hot surfaces

⚠ CAUTION

HOT SURFACES OVER 70ºC / 158ºF

- Wait until the surface temperature has cooled to allow safe contact.
- Wear protective gloves.
- Attach protective cover or touch guard

Failure to follow these instructions can result in injury.

2.3.4 Magnetic and electromagnetic fields

⚠ WARNING

MAGNETIC AND ELECTROMAGNETIC 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.

2.3.5 Unexpected movements

There can be different causes of unexpected movements:

- Missing or incorrect homing of the drive
- Wiring or cabling errors
- Errors in the application program
- Module error in the components
- Error in the measured value and signal transmitter

Provide for personal safety by primary equipment monitoring or measures. Do not rely only on the internal monitoring of the drive components. Adapt the monitoring or other arrangements and measures to the specific conditions of the installation in accordance with a risk and error analysis carried out by the system manufacturer.

⚠ DANGER

MISSING PROTECTIVE DEVICE OR WRONG PROTECTION

- Prevent entry to a hazard area, 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 hazard area, 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-up by disconnecting the power connection of the drive using the EMERGENCY OFF circuit or using an appropriate lock-out tag-out sequence.
- 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.

2.3.6 PELV circuits

The signal voltage and the control voltage of the devices are < 30 Vdc and have to be designed as PELV circuits. In this range the specification as PELV system, according to EN 61800-5-1:2007 contains a protective measure against direct and indirect contact with dangerous voltage through a implemented **safe separation** in the system/machine of the primary and the secondary side. We recommend to design the system/machine with a safe separation (**PELV Protective-Extra-Low-Voltage**).

⚠ DANGER

HAZARD OF ELECTRIC SHOCK BY INADEQUATE PROTECTIVE SEPARATION

- Only connect devices, electrical components or lines to the signal voltage connectors of these components that feature a sufficient, protective separation from the connected circuits in accordance with the standards (EN 50178: 1999 - Electronic equipment for use in power installations - Section 5.2.14.2).

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

- ► Achieve a safe separation in the entire process of the electric circuit.
- ► To protect from direct contact, always cover connections and contacts which guide FELV (Functional Extra Low Voltage) 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 followed on all connected devices.

3 System overview

The control system consists of several single components, depending on its application.

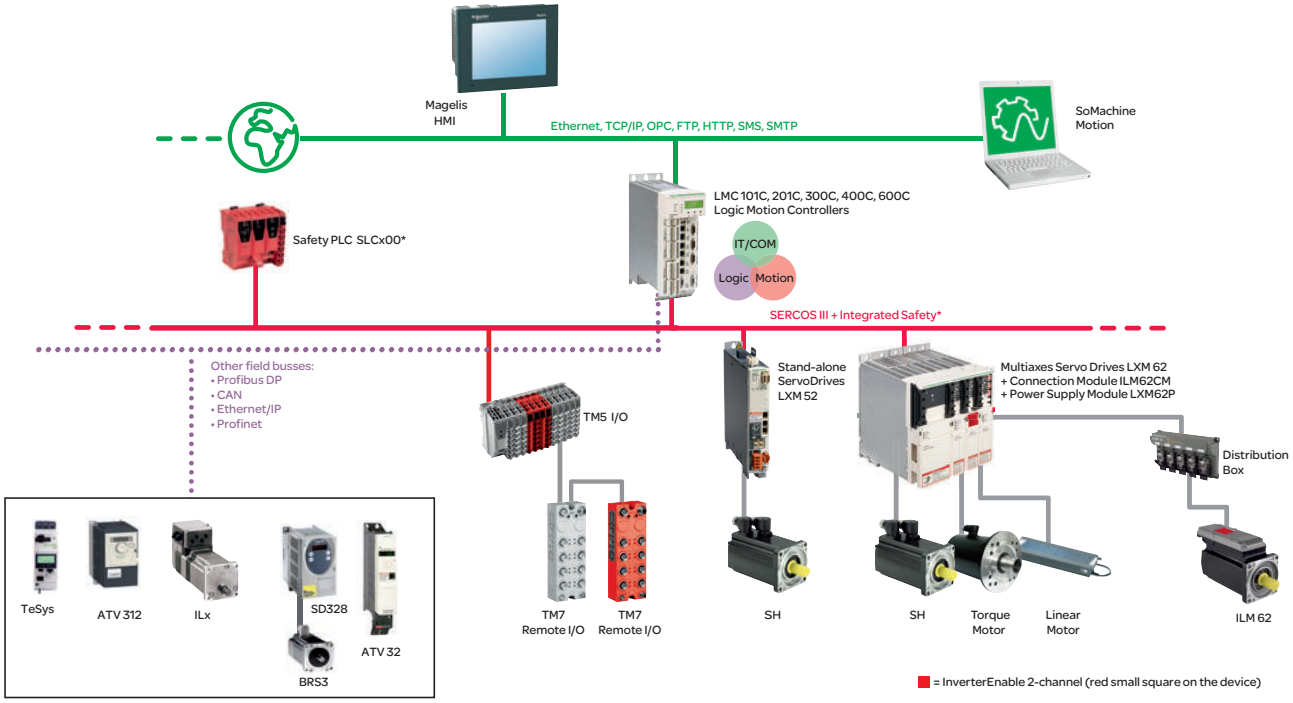


Figure 3-1: PacDrive 3 System overview

**Safety PLC* according to IEC 61508:2010 and EN ISO 13849:2008

3.1 Logic Motion Controller

The LMC (Logic Motion Controller), with a VxWorks real-time operating system, centrally implements the PLC and motion functions. A LMC synchronizes, coordinates and creates the motion functions of a machine for a maximum of:

- 4 SERCOS III servo drives (LMC 101C)
- 8 SERCOS III servo drives (LMC 201C)
- 8 SERCOS III servo drives (LMC 300C)
- 16 SERCOS III servo drives (LMC 400C)
- 99 SERCOS III servo drives (LMC 600C)

3.2 ILM62 system

The modular servo drive system ILM62 is designed for the operation of servo drives in a multi-axes system.

The power electronic components of the ILM62 are fitted inside the switch cabinet.

Using a common DC bus, the central power supply unit Power Supply Module LXM62P supplies the connected servo converters with the power required.

The Connection Module ILM62CM supplies the ILM62 motors with DC voltage from the DC bus via a hybrid cable.

The ILM62 simplifies the wiring of the devices in relation to the initial start-up and in service cases. This also applies to the cable connection of the enclosed devices to the field. All the connectors that can be connected from the outside (power input, DC bus, 24 Vdc supply, SERCOS, Ready and Inverter Enable) are designed such that a fast, simple configuration without tools can be realized on the device.

3.2.1 ILM62DB Distribution Box

The Distribution Box ILM62DB is the link between Connection Module ILM62CM and ILM62 motor. Depending on the number of drives, 1 to 4 ILM62 motors can be connected. When operating more than 4 drives, simply expand the system using one or more Distribution Box ILM62DB.

The highlights

- 1...4 connections for ILM62 motors or further Distribution Box ILM62DB
- easy wiring using pre-assembled hybrid cables
- easy to expand

3.2.2 ILM62 motor

The innovative ILM62 motor combines motor, power amplifier and digital servo controller for an axis in a space-saving housing. Due to its compact construction with integrated controller it is perfectly suitable for peripheral set-up. It is available with individual or multi-turn encoders and configures itself with the aid of the electronic nameplate in the ILM62 motor.

The ILM62 motors are available in three different flange sizes:

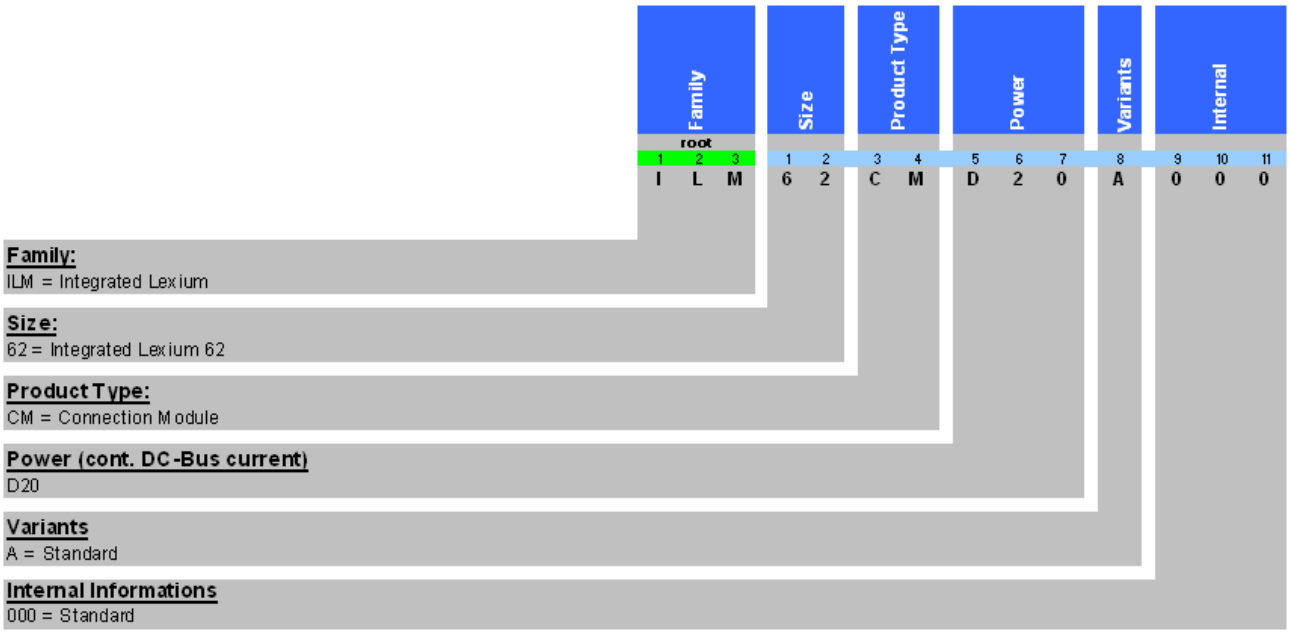
- ILM070
- ILM100
- ILM140

The highlights:

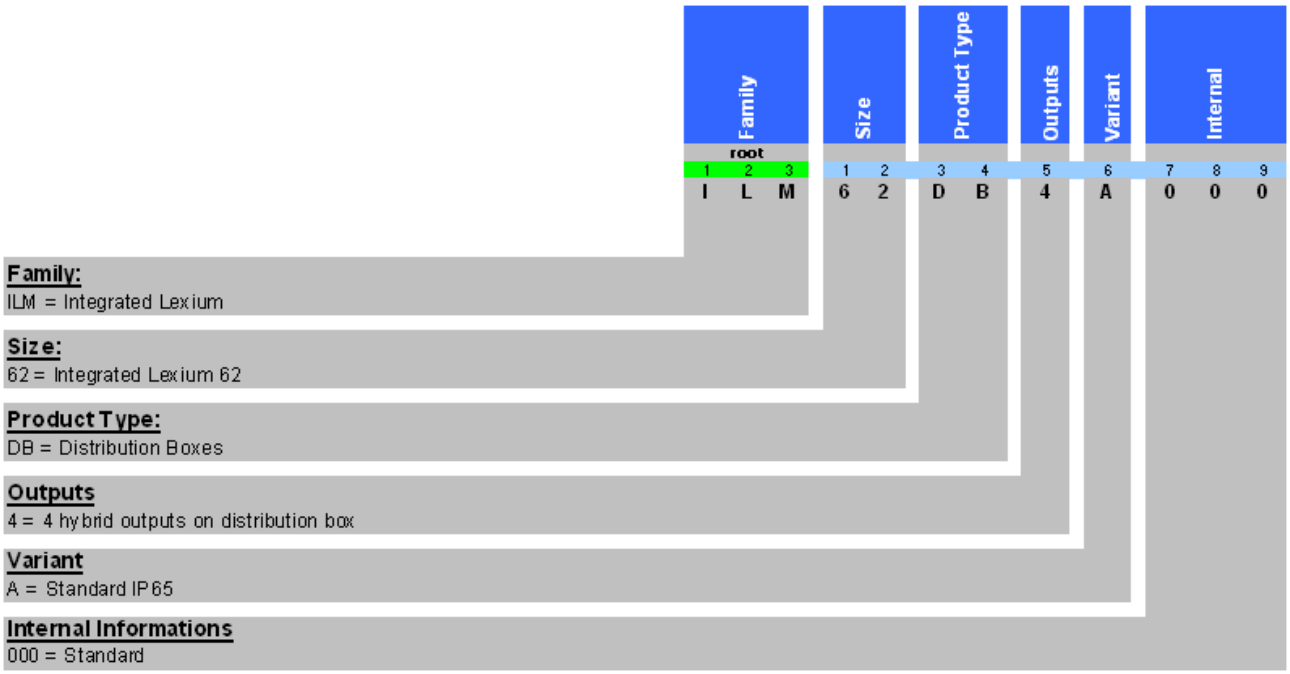
- Compact type of construction
- 3.5 times peak torque
- Integrated SERCOS interface
- High-resolution single or multi-turn encoder
- Degree of protection IP65
- Simple wiring

3.3 Type code

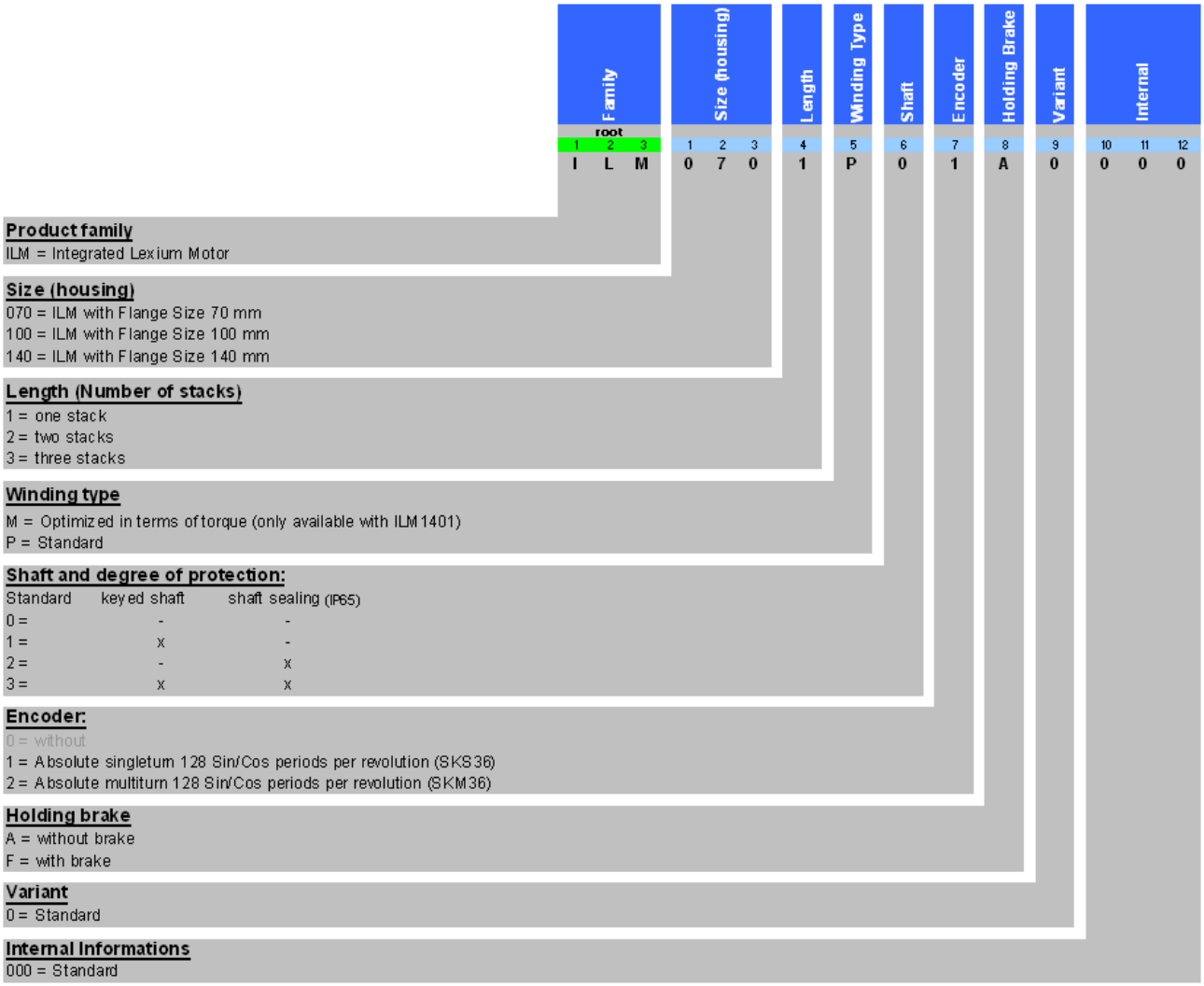
3.3.1 ILM62CM Connection Module



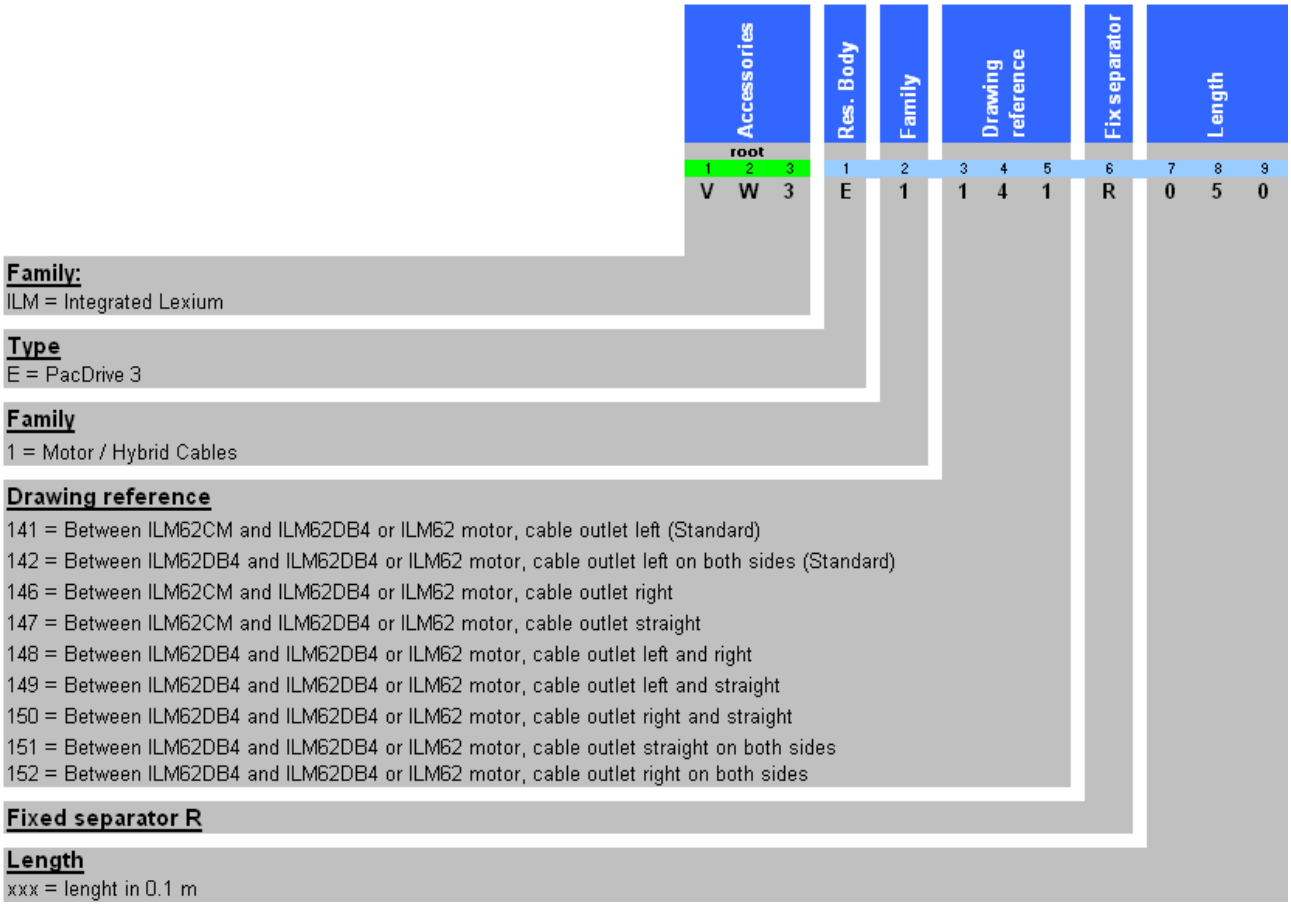
3.3.2 ILM62DB Distribution Box



3.3.3 ILM62 motor



3.3.4 ILM62 accessories



3.4 Nameplate descriptions

Technical nameplate Connection Module ILM62CM

The technical nameplate is located laterally on housing.

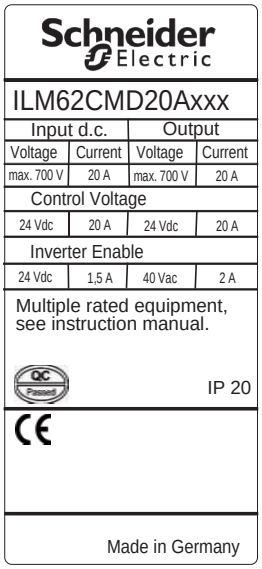


Figure 3-2: Nameplate Connection Module ILM62CM

Label	Meaning
ILM62CMxxxxxxx	Device type and Unicode
Input d.c.	Input voltage and -current (rated- and peak value per input)
Output d.c.	Output voltage and -current (rated- and peak value per output)
IP 20	Degree of protection
CE (symbol)	Area for certifications e.g. UL

Table 3-1: Explanation of the nameplate Connection Module ILM62CM

Logistic nameplate Connection Module ILM62CM

The logistic nameplate of the Connection Module ILM62CM is located on the top of the housing.

Label	Meaning
ILM62xxxxxxxxxx	Device type and Unicode
907156.0010	Serial number
RS:01	Hardware revision status
DOM	Date of manufacture

Table 3-2: Explanation of the logistic nameplate Connection Module ILM62CM

Technical nameplate Distribution Box ILM62DB

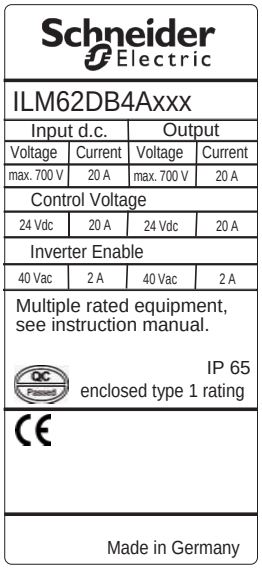


Figure 3-3: Technical nameplate Distribution Box ILM62DB

Label	Meaning
ILM62DBxxxxx	Device type, see type code
Input d.c.	Rated voltage and rated current of the power supply
Output d.c.	Rated voltage and rated current of the power supply
IP 65	Degree of protection
CE (symbol)	Area for certifications e.g. UL

Table 3-3: Explanation of the technical nameplate Distribution Box ILM62DB

Technical nameplate ILM62 motor

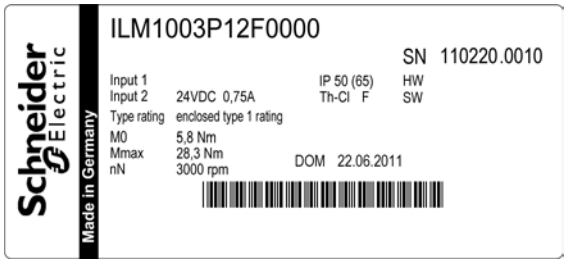


Figure 3-4: Nameplate ILM62 motor

Label	Meaning
ILM100xxxxxxxxx	Device type, see type code
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	Degree of protection of the housing in accordance with Nema 250 and UL 50
HW	Hardware version
SW	Software version
IP	Protection
Th-Cl	Insulation material class of the motor
M0	Standstill torque
Mmax	Peak torque
nN	Rated speed
DOM	Date of manufacture

Table 3-4: Explanation of the nameplate ILM62 motor

4 Indicators and control elements

4.1 Displays at the Connection Module ILM62CM

The display of the Connection Module ILM62CM consists of two LEDs that indicate the state of the DC voltage supply or the 24V voltage supply via the bus bar module.

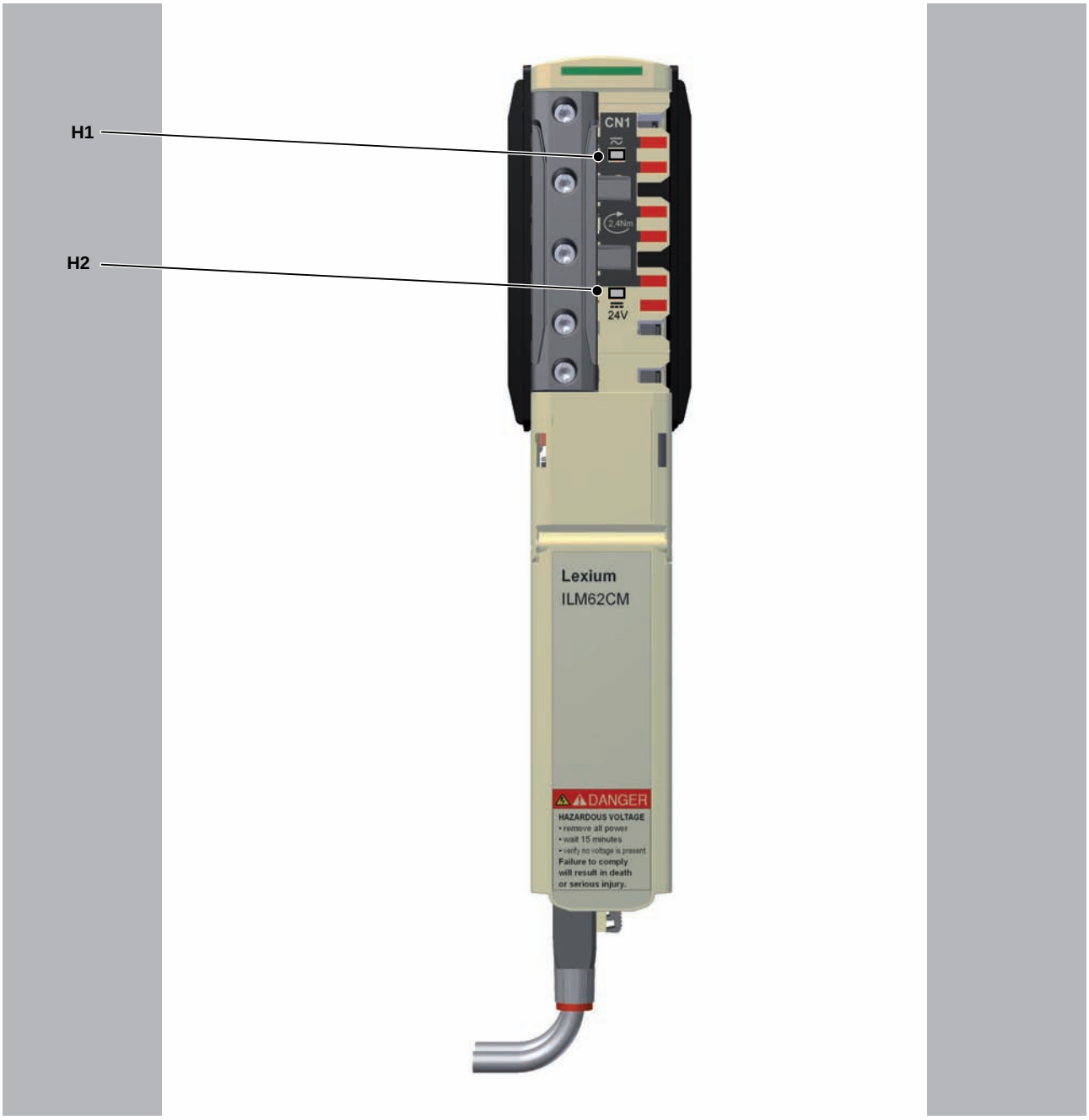


Figure 4-1: Diagnosis LEDs of the Connection Module ILM62CM

H1	DC bus power supply
H2	24V power supply

4.1.1 24Vdc LED

Color	State	Meaning	Notes
	OFF	24 Vdc logic supply inactive	24 Vdc voltage < 3 V
	ON (green)	24 Vdc logic supply active	24 Vdc voltage ≥ 3 V

Table 4-1: 24Vdc LED

4.1.2 DC bus LED

Color	State	Meaning	Notes
	OFF	DC bus supply inactive	DC bus voltage < 42 Vdc
	ON (red)	DC bus supply active	DC bus voltage ≥ 42 Vdc

Table 4-2: DC bus LED

The DC bus LED is no clear display for a non-existing DC bus voltage.

4.2 Displays at the Distribution Box ILM62DB

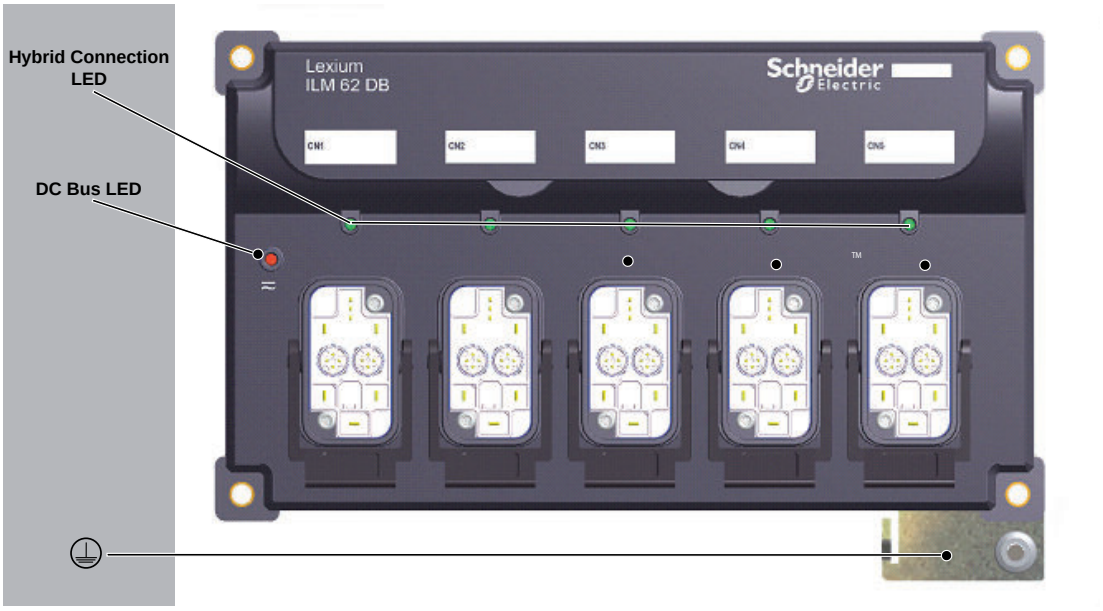


Figure 4-2: Display and operating elements of the Distribution Box ILM62DB

4.2.1 DC bus LED

The LED indicates the status of the DC bus voltage.

Color	State	Meaning	Notes
	OFF	DC bus supply inactive	DC bus voltage < 42 Vdc
	ON (red)	DC bus supply active	DC bus voltage ≥ 42 Vdc

Table 4-3: DC bus LED

The DC bus LED is no clear sign for a non-existing DC bus voltage.

4.2.2 Hybrid connection LED

Color	State	Meaning	Notes
	OFF	Hybrid connection open	
	ON	Hybrid plug connected	

Table 4-4: Hybrid connection LED

4.3 Displays at the ILM62 motor

The display at the ILM62 motor consists of four color LEDs that are used to display the status information.

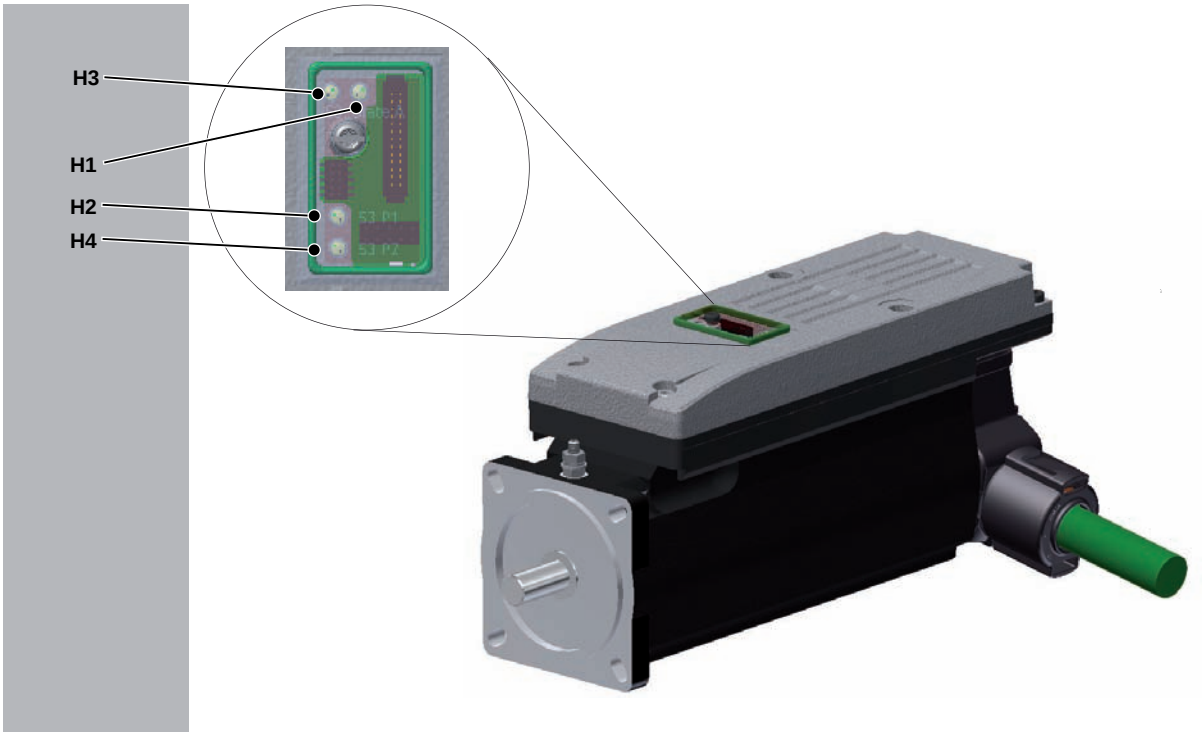


Figure 4-3: Diagnosis LEDs of the ILM62 motor

H1	State LED
H2	Port 1 LED
H3	S3 LED
H4	Port 2 LED

4.3.1 State LED

Color	State	Meaning	Instructions/information for the user	Prio (5 ... 0)
	OFF	Device is not working.	► If the 24V LED is off, replace the device.	0
	Flashing slowly (2 Hz, 250 ms) (green)	Initialization of the device (firmware boot process, compatibility check of the hardware, updating the firmware)	► Waiting until initialization is complete.	4
	Flashing slowly (2 Hz, 40 ms) (green)	Identification of the device	► If necessary, identify the device via the PLC configuration.	1
	ON (green)	Device has been initialized and waits for the PLC configuration.	► Configure device as active. ► Configure device as inactive. ► Configure device for the execution of motions.	5
	ON (red)	A non repairable error has been detected: • Watchdog • Firmware • Checksum • Internal error	► Power OFF/ON (Power Reset) ► If this condition persists, exchange the device.	2
	Flashing slowly (2 Hz, 250 ms) (red)	A general error has been detected.	► The PLC configuration shows which error has been detected. ► Error in the EPAS menu **[Online]** – **[Reset diagnosis messages of controller]**. ► Otherwise restart device.	3

Table 4-5: State LED

4.3.2 Port LED

Color	State	Meaning
	OFF	No cable connected
	ON (orange)	Connection, no SERCOS III communication
	ON (green)	Connection, active SERCOS III communication

Table 4-6: Port LED

4.3.3 S3 LED

Color	State	Meaning	Instructions/information for the user	Prio (0 - 3)
	Off	The device is switched off or there is no communication due to an interrupted or separated connection.	SERCOS boot-up or hot plug	0
	On (green)	Active SERCOS III connection without an error in the CP4.	-	0.1
	Flashing (2 Hz, 250 ms) (green)	The device is in Loopback mode. Loopback describes the situation in which the SERCOS III telegrams have to be sent back on the same port on which they were received. **Possible causes:** • Line topology or • SERCOS III ring break	**Workaround:** ► Close ring. **Reset condition:** ► Acknowledge error in the EPAS menu **[Online]** – **[Reset diagnosis message of controller]**. ► Switch from CP0 to CP1 alternatively. **Note:** If during phase CP1 a line topology or ring break was detected (device in loopback mode), the LED condition does not change.	2
	On (red)	SERCOS III diagnosis class 1 (DK1) error has been detected on port 1 and/or 2. There is no SERCOS III communication possible anymore on the ports.	**Reset condition:** ► Acknowledge error in the EPAS menu **[Online]** – **[Reset diagnosis message of controller]**. ► Switch from CP0 to CP1 alternatively.	1
	Flashing (2 Hz, 250 ms) (red)	Communication error at port 1 and/or port 2 has been detected. **possible causes:** • Telegram failure • CRC error	**Reset condition:** ► The PLC configuration shows which error has been detected. ► Acknowledge error in the EPAS menu **[Online]** – **[Reset diagnosis message of controller]**. ► Switch from CP2 to CP3 alternatively.	0.3
	On (orange)	The device is in a communications phase CP0 up to and including CP3 or HP0 up to and including HP2. SERCOS III telegrams are received.	-	0.2
	Flashing (4 Hz, 125 ms) (orange)	Device identification	-	3

Table 4-7: S3 LED

5 Planning

5.1 Electromagnetic Compatibility, EMC

⚠ WARNING
RISK OF ELECTROMAGNETIC DISTURBANCES OF SIGNALS AND DEVICES • Use proper EMC shielding techniques to help prevent unexpected device operation. **Failure to follow these instructions can result in death or serious injury.**

This product meets the EMC requirements in accordance with the standard IEC 61800-3:2004, provided that the EMC measures described in this manual are complied with during installation. The values are based on a reference application:

- 1 x Power Supply Module LXM62PD84 with line choke
- 1 x Connection Module ILM62CM
- 3 x Distribution Box ILM62DB
- 3 x ILM070, 4 x ILM100, 3 x ILM140
- Hybrid cable 1 x 8 m between Connection Module ILM62CM and first Distribution Box ILM62DB
- Hybrid cable 2 x 1 m between Distribution Box ILM62DB and Distribution Box ILM62DB
- Hybrid cables 3 x 1 m, 4 x 1.5 m, 3 x 2 m between Distribution Box ILM62DB and ILM62 motor

For further information on this (see 7.5 Mechanical and electrical data).

Enclosure layout

The prerequisite for compliance with the specified limit values is an EMC compatible layout. Comply with the following specifications:

EMC Measures	Target
Use galvanized or chromium-plated sub plates, bond metallic parts across large surface areas, remove paint layer from contact surfaces.	Good conductivity by surface area contact
Ground enclosure, door and sub plates by using grounding strips or grounding cables with a cross-section of 10 mm^2 (AWG 6).	Reduce emission.
Supplement switch devices such as contactors, relays or magnetic valves with interference suppression combinations or spark supressor elements (e.g. diodes, varistors, RC elements).	Reduce mutual interference coupling.
Fit power and control components separately.	Reduce mutual interference coupling.

Shielded cables

EMC Measures	Target
Place cable shields on the surface, use cable clamps and grounding strips.	Reduce emission.
At the switch cabinet outfeed, connect the shield of all shielded cables via cable clamps to the sub plate across large surface areas.	Reduce emission.
Ground shields of digital signal cables on both sides across large surface areas or through conducting connector housings.	Reduce interference action on signal cables, reduce emissions.
Ground shield of analog signal cables directly on the device (signal input), insulate the shield at the other cable end or ground the same through a capacitor, such as 10nF.	Reduce grounding loops by low frequency interferences.
Use only shielded motor supply cables with a copper braid and at least 85% cover, ground shield on both sides across a large surface area.	Specifically discharge interference currents, reduce emissions.

Cable routing

EMC Measures	Target
Do not route fieldbus cables and signal cables together with cabling for direct and alternating voltages above 60 V in the same cable duct (fieldbus cables can be routed together with signal cables and analog cables in the same duct). Recommendation: Routing in separated cable cuts with a distance of at least 20 cm (7.84 in.).	Reduce mutual interference coupling.
Keep the cables as short as possible. Do not install any unnecessary cable loops, short cable routing from a central grounding point in the switch cabinet to the external grounding connection.	Reduce capacitive and inductive interference couplings.
Insert a potential equalization for: • large surface installation • different voltage infeeds • networking across buildings	Reduce current on cable shield, reduce emissions.
Use fine wire potential equalization conductor.	Discharging of high frequency interference currents.
If motor and machine are not connected in a conducting fashion, e.g. due to an insulated flange or a connection not across a full surface, the motor must be grounded via a grounding cable > 10 mm^2 (AWG 6) or a grounding strip.	Reduce emissions, increase interference resistance.
Use twisted pair for 24Vdc signals.	Reduce interference action on signal cables, reduce emissions.

Voltage supply

EMC Measures	Target
Operate product on mains with a grounded neutral.	Enable the effect of the integrated mains filter.
Protection circuit if there is a risk of overvoltage.	Reduce risk of damage due to overvoltages.

Motor and encoder cables

From an EMC point of view, motor supply cables and encoder cables are particularly critical. Only use pre-configured cables, or cables with the prescribed properties, and comply with the following EMC measures.

EMC Measures	Target
Do not fit any switching elements in motor supply cables or encoder cables.	Reduce interference coupling.
Route motor cable with a distance of at least 20cm (7.84 in.) to the signal cables or insert shield plates between the motor supply cable and the signal cable.	Reduce mutual interference coupling.
For long cabling, use potential equalization cables.	Reduce current on cable shield.
Route motor supply cables and encoder cables without any separation point. [1)]	Reduce interference radiation.
[1)] If a cable must be cut through for installation purposes, the cables must be connected at the point of separation by means of screen connections and metal housing.	

Additional measures for improving the EMC

Depending on the respective application, the following measures may lead to a EMC compatible layout:

EMC Measures	Target
Upstream connection of line chokes	Reduction of the harmonic network oscillations, extension of the service life of the product.
Upstream connection of external integrated mains filters	Improvement of the EMC limit values.
Special EMC-suitable layout, e.g. within an enclosed switch cabinet complete with 15 dB attenuation of the interferences emitted	Improvement of the EMC limit values.

5.2 Switch Cabinet Planning

5.2.1 Protection

- ► Install components such that a degree of protection corresponding to the actual operational environment is set up.

For more information on the degree of protection of the component (see 7.2 Ambient conditions).

The following ambient conditions may damage the components:

- Oil
- Moisture
- Electromagnetic interference
- Ambient temperature
- Metal dust deposits

5.2.2 Mechanical and climatic environmental conditions in the switch cabinet

- ► Observe climatic and mechanical ambient conditions.

For more information on the general climatic and mechanical environmental conditions according to EN 60721 Classification of environmental conditions Part 3: Classification of groups of environmental parameters and their severities - main sections 1-3 (see 7.2 Ambient conditions).

- ► Check the technical data of the device as to whether the permitted deviations (e.g. higher shock load or higher temperature) are specified.

5.2.3 Using Cooling Units

How to proceed when installing a cooling unit:

NOTICE

WATER DAMAGE RESULTING FROM CONDENSATE/CONDENSATION

- Ensure proper installation of cooling unit.

Failure to follow these instructions can result in equipment damage.

- ► Position the cooling units so that no condensate drips out of the cooling unit onto electronic components or is sprayed by the cooling air flow.
- ► Provide specially designed switch cabinets for cooling units on the top of the switch cabinet.
- ► Design the switch cabinet so that the cooling unit fan cannot spray any accumulated condensate onto the electronic components when it restarts after a pause.
- ► When using cooling units, use only well-sealed switch cabinets so that warm, humid outside air, which causes condensation, does not enter the cabinet.
- ► When operating switch cabinets with open doors during commissioning or maintenance, ensure that the electronic components are at no time cooler than the air in the switch cabinet after the doors are shut, in order to prevent any condensation.
- ► Continue to operate the cooling unit even when the system is switched off, so that the temperature of the air in the switch cabinet and the air in the electronic components remains the same.
- ► Set cooling unit to a fixed temperature of 40 °C / 104 °F.
- ► For cooling units with temperature monitoring, set the temperature limit to 40 °C / 104 °F so that the internal temperature of the switch cabinet does not fall below the external air temperature.

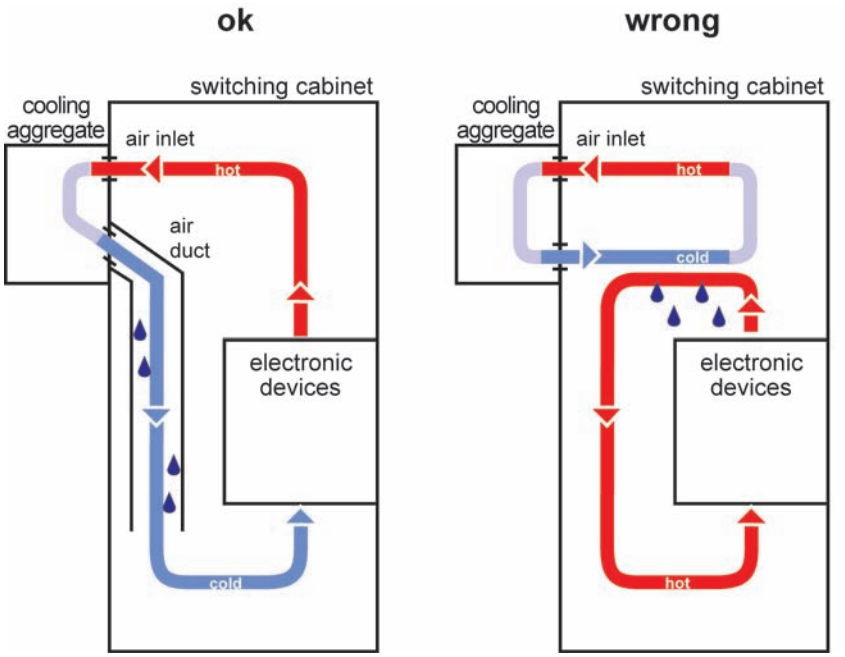


Figure 5-1: Installing a cooling unit

5.3 Wiring notes

- Only use Schneider Electric devices or certified devices for your application.
- For connecting of the ILM62 components, only use the cables included within the scope of delivery.
- If possible, only use pre-configured cables.

For further information (see 5.3.1 Cable characteristics).

- If required, order a suitable torque indicator from Schneider.

For information on the tightening torques and cable cross-sections (see 7.8 Electrical connections).

Observe the following critical points when wiring:

1. Observe the minimum cross-sections of the cables.
2. Comply with branch conditions.
3. Check shields.
4. Ensure ground.
5. Ensure connection of the motors to the machine ground.
6. Prevent any ground loops.
7. Do not pull plug-in terminals when under load.
8. Use a large shielding area.
9. Do not interchange the connections of the hybrid cable at the Connection Module ILM62CM.
10. Do not interchange the EMERGENCY OFF circuits. This has to be observed especially when two different safety circuits are used for axis A and axis B of the DoubleDrive.

Example:

If, for example, two parallel conductors are shown as coming from one point, you may not run just one conductor and then branch it off at a later point. If it is wired this way, induction loops (interference senders and antennas) as well as interfering potential shifts may occur.

5.3.1 Cable characteristics

Property	Value
Permissible voltage hybrid cable	1000 V
Temperature range	-40 ... +80 °C / -40 ... +176 °F
Cable diameter	14.8 mm ± 0.3 mm
Minimum bending radius	5 x diameter (fixed routing) 10 x diameter (mobile, 5 million bending cycles)
Sheath	PUR, oil resistant, halogen-free

Table 5-1: Hybrid cable characteristics

Hybrid cables are suitable for use with drag chains.

5.3.2 ESD Protection Measures

- Observe the following instructions for ESD protection in order to avoid any damage due to electrostatic discharge:

NOTICE

ELECTROSTATIC DISCHARGE

- Do not touch any of the electrical connections.
- Prevent electrostatic charges; e.g., by wearing appropriate clothing.
- Remove existing static charge by touching a grounded, metallic surface, like for example, a grounded housing.

Failure to follow these instructions can result in equipment damage.

5.3.3 Conditions for UL compliant use

If you use the ILM62 system in accordance with UL508C, you must additionally meet the following conditions:

- Connect device only in an environment with pollution degree 2 or a similar environment.
- Use devices only in connection with a Power Supply Module LXM62P.
- Check if the screws of the wiring bus have been tightened with 2.5 Nm (22.13 lbf in).
- Only use Hybrid connection cable approved by Schneider and comply with the requirements of NFPA 79.

For further information on conform use, see the Lexium LXM62 operator manual.

5.3.4 Fusing the mains connection

For further information on the safeguard of the mains connection, see the Lexium LXM 62 operator manual.

5.3.5 Leakage current

Application	per Connection Module	per Distribution Box
typical (400 V, 50 Hz)	< 9 mA	< 18 mA
maximum (480 V + 10 %, 60 Hz)	< 15 mA	< 30 mA

Table 5-2: Leakage currents per device

Use an isolating transformer, if the leakage current is too high for the respective application.

For specifications on the leakage current of the power supply LXM62 P, see the Lexium LXM62 operator manual.

5.3.6 Mains filter

This product meets the EMC requirements in accordance with the standard IEC 61800-3:2004, provided that the EMC measures described in this manual are complied with during installation. The values are based on the reference application (see 5.1 Electromagnetic Compatibility, EMC) specified in the manual.

The connected cable length and the number of connected motors has no significant influence on the grid-bound ermitted interference. Thus, usually no external integrated mains filter is required also for larger applications.

In the case of combined systems (ILM62 and LXM62), the selection of the external integrated mains filter depends on the devices installed in the switch cabinet and the motor supply cables (also see Lexium LXM62 operator manual). The hybrid cable of the ILM62 is not to be considered as motor supply cable.

You can connect in additional external integrated mains filters if the internal attenuation of interferences is not sufficient. Use our application for this purpose.

5.3.7 Line chokes

For further information on the use of line chokes, see the Lexium LXM62 operator manual.

5.3.8 Mains contactor

For further information on the use of a mains contactor, see the Lexium LXM62 operator manual.

5.3.9 Residual current operated protective device

For further information on fault current protection equipment, see the Lexium LXM62 operator manual.

5.4 Functional safety

Standard IEC 61508

Standard IEC 61508 "Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems" deals with safety-related functions. Here, not only one individual component, but always an entire function chain (e.g. from the sensor via the logic processing units to the actual actor) is regarded as a unit. Overall, this function chain must meet the requirements of the respective safety integrity level.

SIL, Safety integrity Level

Standard IEC 61508 specifies 4 safety integrity levels (SIL) for safety functions. SIL1 is the lowest stage and SIL4 is the highest stage. The basis for determining the safety integrity level is an evaluation of the hazard potential on the basis of the hazard and risk analysis. Thus, it is determined which stage of the safety function can be allocated to the function chain concerned and which hazard potential must be covered by it.

PFH, probability of a dangerous failure per hour

In order to maintain the safety function, standard IEC 61508 requests graded fault controlling and fault elimination measures depending on the requested SIL. All components of a safety function are subject to a probability test to evaluate the effectiveness of the taken error-controlling measures. Here, the PFH (probability of a dangerous failure per hour) is determined for the safety systems. This is the probability per hour that a safety system fails, thus posing a hazard, and that the safety function can no longer be executed properly. The PFH must not exceed certain values, depending on the SIL for the entire safety system. The individual PFHs of a function chain are added up. The result must not exceed the maximum value specified in the standard.

SIL	PFH at high requirement rate or continuous requirement
4	$\geq 10^{-9}$ ... $<10^{-8}$
3	$\geq 10^{-8}$ ... $<10^{-7}$
2	$\geq 10^{-7}$ ... $<10^{-6}$
1	$\geq 10^{-6}$ ... $<10^{-5}$

Table 5-3: Interrelation of SIL and PFH

HFT and SFF

Depending on the SIL for the safety system, standard IEC 61508 requests a certain HFT (hardware fault tolerance) in connection with a certain SFF (safe failure fraction). The hardware fault tolerance is the property of a system to be able to execute the requested safety function despite one or several pending hardware faults. The SFF of a system is defined as the ratio of the safe failure fraction to the total failure rate of the system. According to IEC 61508, the maximum reachable SIL of a system is also determined by the hardware fault tolerance HFT and the Safe Failure Fraction SFF of the system. IEC 61508 distinguishes two types of subsystems (type A subsystem, type B subsystem). These types are determined on the basis of criteria that are defined in the standard for the safety-relevant components.

SFF	HFT type A subsystem			HFT type B subsystem		
	0	1	2	0	1	2
< 60%	SIL1	SIL2	SIL3	----	SIL1	SIL2
60% ... <90%	SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% ... < 99%	SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
≥99%	SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

Table 5-4: Interrelation between SFF and HFT

Error-preventing measures

Systematic errors in the specification, in the hardware and the software, improper usage and maintenance errors of the safety system must be avoided where possible. For this purpose, IEC 61508 stipulates a series of error-preventing measures, which must be performed depending on the aimed SIL. These error-preventing measures

must accompany the entire life cycle of the safety system, i.e. from the design to the decommissioning of the system.

5.4.1 Process minimizing risks associated with the machine

The goal of designing machines safely is to protect people. The risk associated with machines with electrically controlled drives comes chiefly from moving machine parts.

Hazard and risk analysis

On the basis of the system configuration and utilization, a hazard and risk analysis can be carried out for the system (for example, according to EN ISO 14121 or EN ISO 13849-1:2008). 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.

The EN ISO 13849-1:2008 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design describes an iterative process for the selection and design of safety-related parts of controllers to reduce the risk to the machine to a reasonable degree:

This is how you perform risk assessment and risk minimization according to EN ISO 14121:

1. Setting machine limits.
2. Identifying risks associated with the machine
3. Assessing risks.
4. Evaluating risks.
5. Minimizing risks by:
   - intrinsically safe design
   - protective devices
   - user information (see EN ISO 12100-1:2003, Figure 4)
6. Designing safety-related controller parts (SRP/CS) in an interactive process.

This is how you design the safety-related controller parts in an interactive process:

- Identifying required safety functions executed via SCRP/CS.
- Determining required properties for each safety function.
- Determining the required performance level PL_r.
- Identifying safety-related parts executing the safety function.
- Determining the performance level PL of the afore-mentioned safety-related parts.
- Verifying performance level PL for the safety function ($PL \geq PL_r$).
- Checking, if all requirements have been met (validation).

Additional information ist available on www.schneider-electric.com.

5.4.2 Inverter Enable function

Functional Description

With the Inverter Enable function (IE) you can bring drives to a safe stop. This Inverter Enable function relates to the components

- Connection Module ILM62CM, Distribution Box ILM62DB and ILM62 motor

The Inverter Enable 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.

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 are only restricted to the upper limit required by the relevant safety standards. (see 5.4.2.6 Safety standards) This is expressed by the following characteristic values:

- PFH and SFF according to EN 61508:2010
- MTTF_d and DC_avg according to EN ISO 13849-1:2008

Scope of operation (designated safety function)

The Inverter Enable function relates to Connection Module ILM62CM, Distribution Box ILM62DB and ILM62 motor, hereinafter referred to as "ILM62 system".

The function is selected via a signal(pair) at the input of the Connection Module ILM62CM (2), which is forwarded to all drives (7) of the Connection Module ILM62CM network. The supply voltage (AC) needs not be interrupted (see figure below).

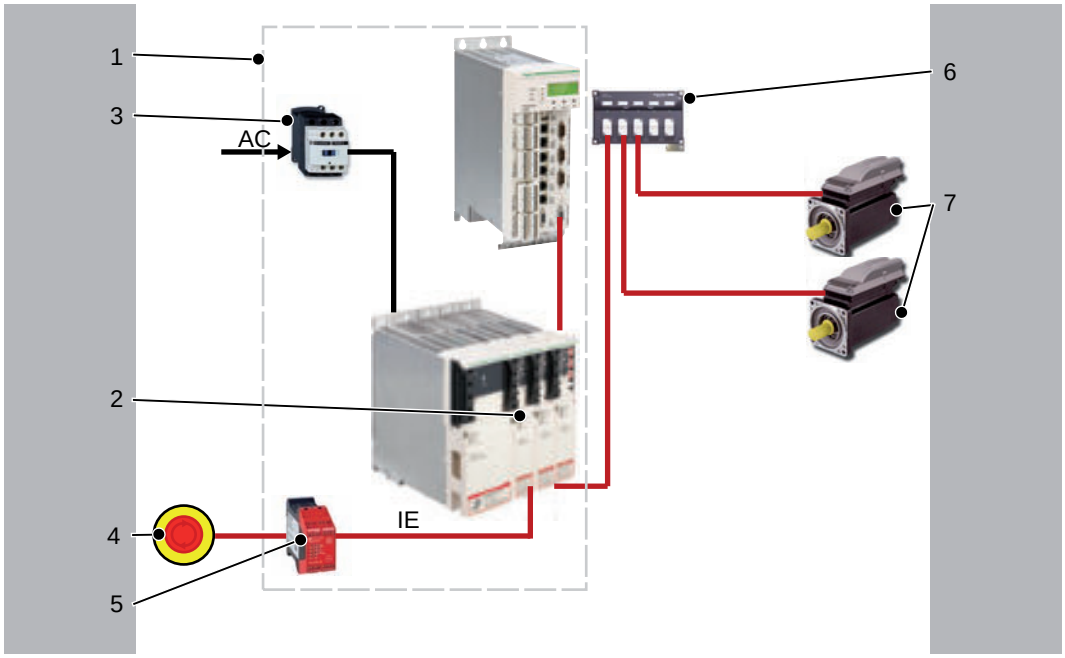


Figure 5-2: ILM62 system with emergency stop

1	switch cabinet
2	Connection Module ILM62CM
3	Contactor
4	Emergency stop switch
5	Safety switching device (e.g. Preventa XPS AV)
6	Distribution Box ILM62DB
7	ILM62 motor

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.

The architecture of the safety function is designed with a hardware error tolerance of 1, this means, single errors do not lead to an unsafe condition. The safety switching is realized with simple function blocks (Type A).

Safe state

This torque-free state is automatically engaged 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 at the Connection Module ILM62CM, the power stage control of all Connection Module ILM62CM connected to this ILM62 motors 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 established in the connected ILM62 motors.
This Inverter Enable input has a redundant design (DC voltage from which the Connection Module ILM62CM generates AC voltage which is fed to the hybrid cable). The failure of one of the two channels already results in the logical zero. When the power supply is cut off, the power stage becomes de-energized, and an diagnosis 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.

Stop category 0

In stop category 0 (Safe Torque Off, STO) the drive stops in an uncontrolled manner. If this means a hazard to your machine, you must take suitable measures (see hazard and risk analysis).

Stop category 1

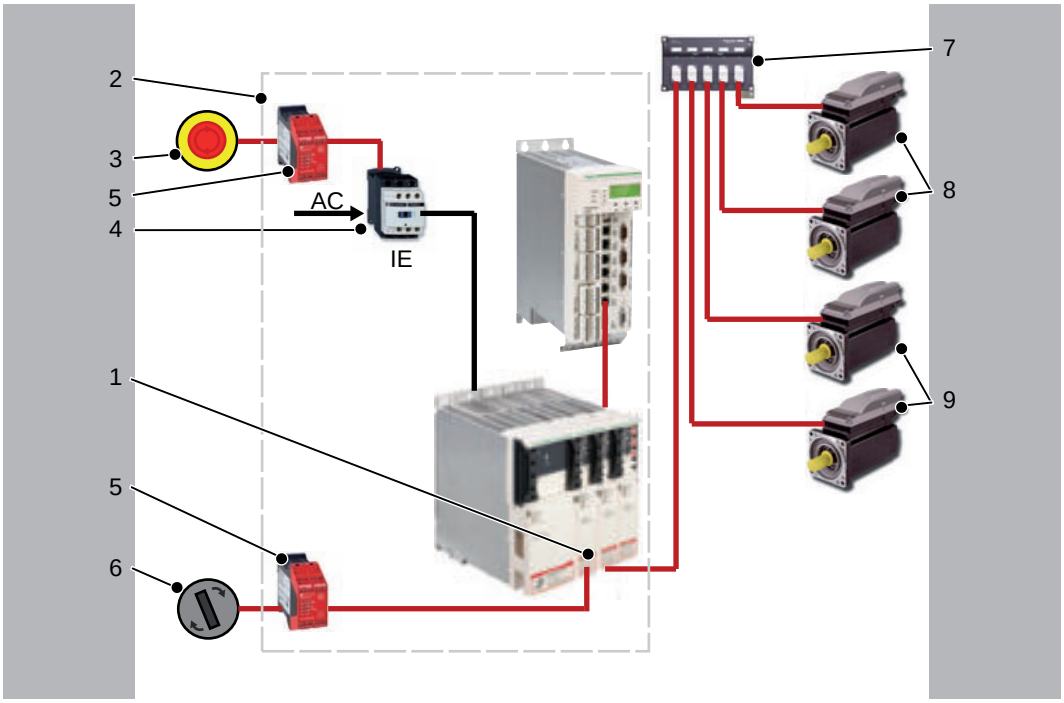
For stops of category 1 (Safe Stop 1, SS1) you can request a controlled stop via the PacController. The controlled stop by the PacController is not safe, not monitored and not guaranteed to work in case of power outage or an error. The final switch off in the safe state is ensured by switching off the "Inverter Enable" input on the Connection Module ILM62CM. This has to be implemented by means of an external safety switching device with safe delay (see Application proposal (see 5.4.2.2.1 Application proposals)).

Execute muting

- ▶ You can deactivate the Inverter Enable function by using the optional module 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 that is to be used with the parameter `InverterEnableConfig` of the ILM62 motor in the PLC configuration.

If the set mode does not match the real configuration of the ILM62 motor, then the diagnosis message 8978 "InverterEnableConfig invalid" with "Ext. diagnosis = x(HW)! =y(Cfg)" is triggered. The drive does not switch to control mode as long as the configuration is wrong. The error can only be acknowledged if the set `InverterEnableConfig` corresponds to the real configuration. This can be used to divide the drives on a Connection Module ILM62CM in two groups if it is technically not possible to use two Connection Module ILM62CM for the two groups in the existing machine.

If only some of the drives attached to a Connection Module ILM62CM (1) are to be put in the safe state, this can be achieved by the configuration of the drives. This can be of interest e.g. for cleaning modes (6). If an optional module DIS1 (9) is set, then the IE signal will be ignored. To implement the emergency stop, the supply voltage on the Connection Module ILM62CM must be interrupted; see illustration below.



1	Connection Module ILM62CM
2	switch cabinet
3	Emergency stop switch
4	Contactor
5	Safety switching device (e.g. Preventa XPS AV)
6	Switch: Operating mode (normal/cleaning)
7	Distribution Box ILM62DB
8	ILM62 motor (without DIS1)
9	ILM62 motor (with DIS1)

Table 5-5: Implementation of "Emergency off" and "Cleaning mode iwith Inverter Enable" in two protective circuits

ILM	Cleaning	Emergency stop	Parameter InverterEnableConfig
ILM62 motor without DIS1 (8)	Torque-free motor	Torque-free motor	Standard/1
ILM62 motor with DIS1 (9)	-	Torque-free motor	Off/0

⚠ WARNING

UNCONTROLLED AXIS MOVEMENT

- Make sure that nobody has access to the hazard area as long as the DC bus by ILM62 with DIS1 still has residual charge.

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

Validity of the safety proof

The safety verification for the Inverter Enable function of the ILM62 system applies to the following hardware codes:

Unicode	Hardware code:
ILM 070/xx	xxxxxxxxx1xx
ILM 100/xx	xxxxxxxxx1xx
ILM140/xx	xxxxxxxxx1xx
DIS1	1
ILM62CM	xxxxxx1xx
ILM62DB	xxxxxx1xx
Safety proof for higher hardware codes is also planned.	

Interface

The operation of the Inverter Enable function takes place via the switching thresholds of the Inverter Enable input (IE_p1/IE_p2 at Pin1/Pin2, IE_n1/IE_n2 at Pin3/Pin4) on the Connection Module ILM62CM.
Technical data of the input:

- max. downtime: 500 µs at U_{IE} > 20 V with dynamic control
- max. test pulse ratio: 1 Hz
- STO active: -3 V ≤ U_{IE} ≤ 5 V
- Power stage active: 18 V ≤ U_{IE} ≤ 30 V

Technical data and information on the electrical connections of the ILM62 system or the Connection Module ILM62CM can be found under of this operating instruction.

Lifetime and response time

Lifetime

The Inverter Enable function is designed for a maximum of 15 years of operation. Afterwards, the safety function in the ILM62 system no longer complies with the specified values SFF, PFH, DC_avg and MTTFd. This is the normative note on the lifetime or test interval according to EN 62061:2005, Section 7.2.k) 5) or EN 13849-1:2008, Chapters 10 and 11. The expiration date of the device can be determined by the date listed on the rating plate +15 years. Please include this date in the maintenance schedule of the plant.

Response time with Inverter Enable function

The maximum response time until switch off with the Inverter Enable function is max. 5 ms. This is the time from the corresponding change of the Inverter Enable input at the Connection Module ILM62CM (Safe Torque Off, STO).

⚠ WARNING

UNCONTROLLED MOVEMENT OF THE SYSTEM

- Should a response time be required because of the risk assessment of the machine, the total response time of the machine has to be considered.
- All components related to the safety functions from the sensor to the drive shaft or the driven mechanics have to be considered.

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

Response time with DIS1

The response time to switch off when the DIS1 (without the Inverter Enable function) is used depends on the load on the Connection Module ILM62CM (i.e. on the machine)

and has to be determined from the application. Axes with DIS1 become torque-free via the mains contactor and come to a stop.

Setup, installation, and maintenance

⚠ DANGER

LOSS OF ELECTRICAL SAFETY

- Only operate the Connection Module ILM62CM with power supply units that are certified according to the EN 60950 or EN 50178 (so-called "safe voltage outputs"). These power supplies supply no overvoltage above DC 120 V for more than 120 ms and no permanent overvoltage above DC 60 V.

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

► 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).
Per Connection Module ILM62CM a maximum of 45 ILM62 motors can be connected.

For further information on the dimensions of the maximum system extension (see 6.1.5 Wiring)

Application proposals

There is one application recommendation to implement the safe stop of category 1 (SS1):

- EL-1122-05-xx: Inverter Enable circuit Connection Module ILM62CM/ILM62 motor using the PacDrive Controller LMCx00C with safety switch device for an emergency stop circuit

Notes on application suggestions

General

- All application suggestions provide for a protected Inverter Enable-wiring (switch cabinet IP54) from the safety switch device to the Connection Module ILM62CM, as faults need to be ruled out.
- Protection against automatic restart is ensured by the external safety switch device.

Notes on EL-1122

The mains contactor in this circuit suggestion is not necessary for functional safety purposes. It is, however, used in the application suggestion for the device protection of the Power Supply Module LXM62P or the components connected to it.

⚠ WARNING

DANGEROUS MOTIONS

- Ensure that the residual energy stored in the drives equipped with DIS1 cannot cause any dangerous motions in case of an error.

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

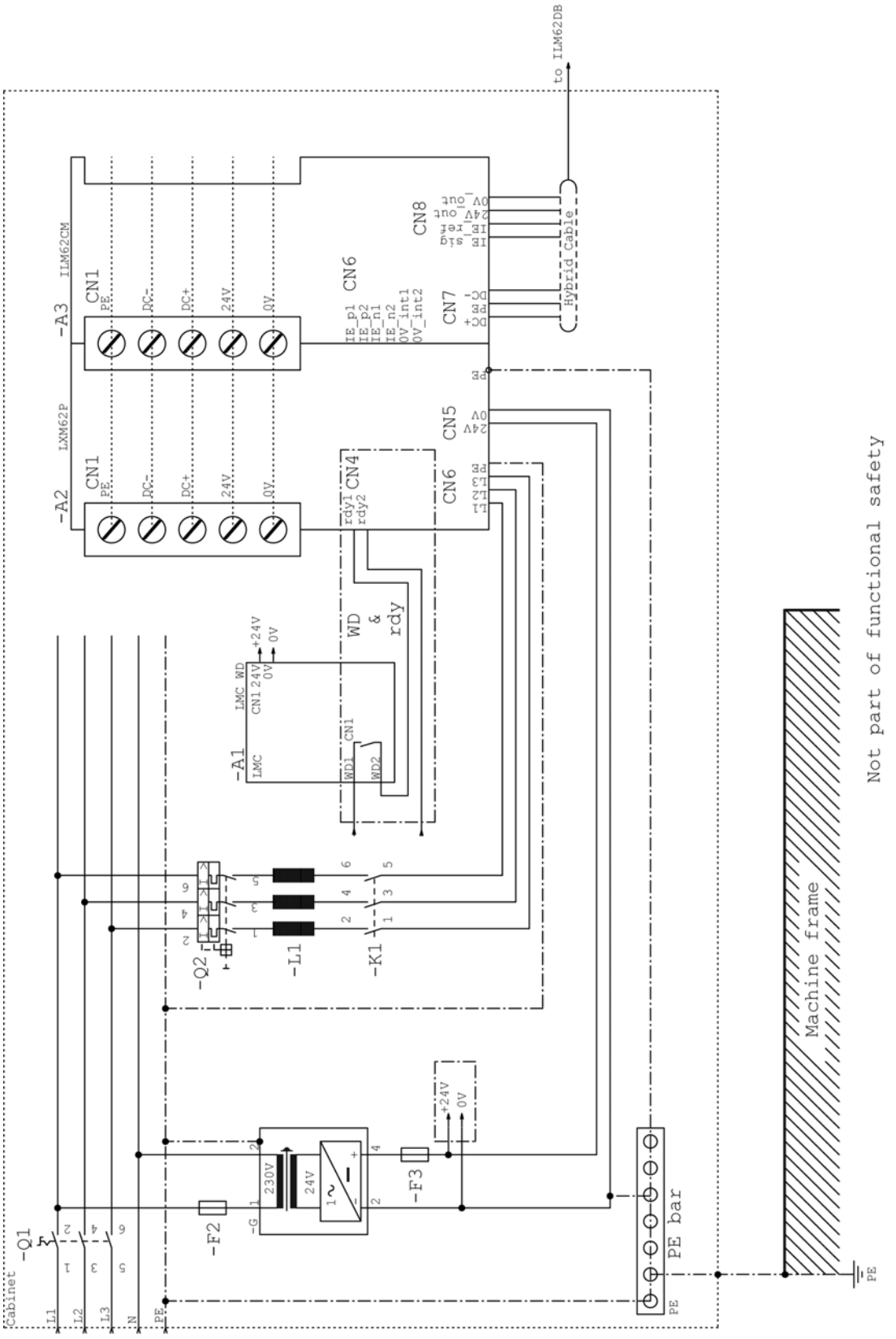


Figure 5-3: EL-1122-05-xx Sheet 1

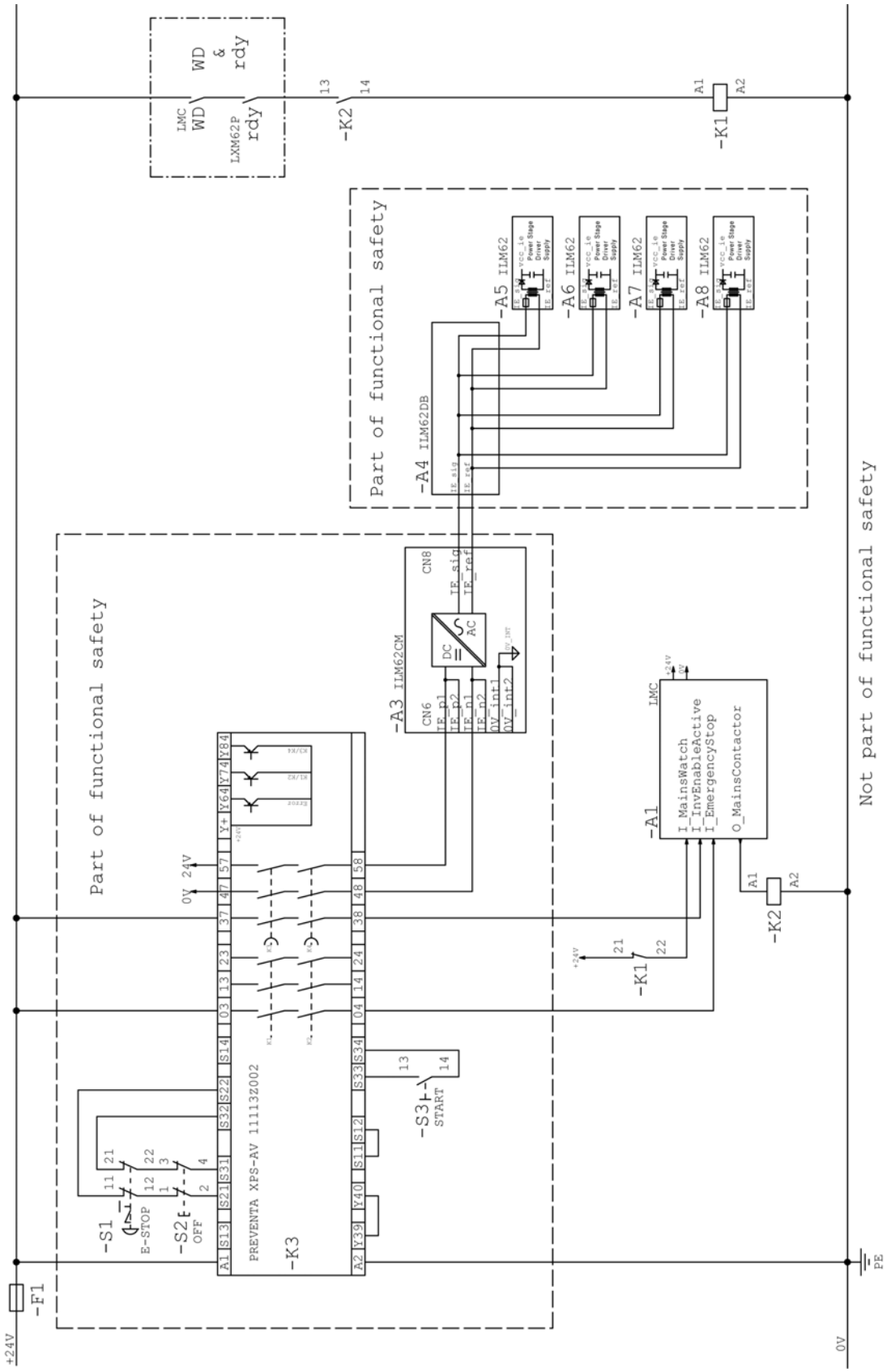


Figure 5-4: EL-1122-05-xx Sheet 2

Mode selection

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

⚠ WARNING

IMPROPERLY CONFIGURED SAFETY-RELATED SYSTEM

- 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.

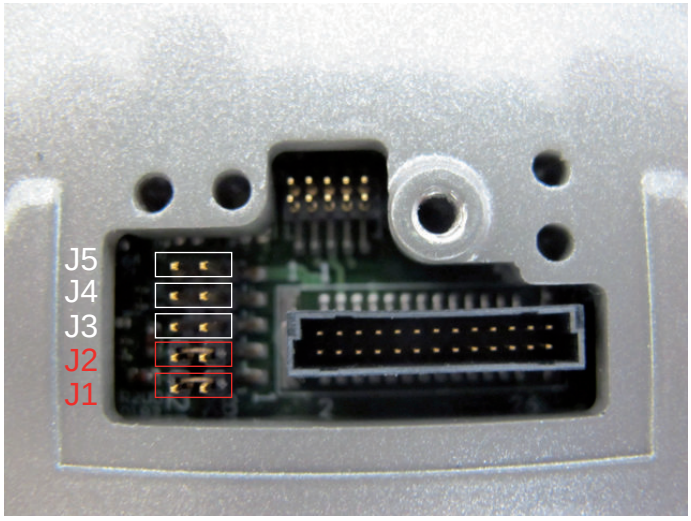
The mode selection between STO and SS1 is made by an external safety switch device. If SS1 is selected, this external device will select STO after a certain safe time.

The user will be warned (diagnosis message 8978 "InverterEnableConfig invalid"), if the mode set in the parameter `InverterEnableConfig` does not correspond to the real devices. This means, if `InverterEnableConfig` = "Off / 0", then the DIS1 must be plugged into the ILM62.

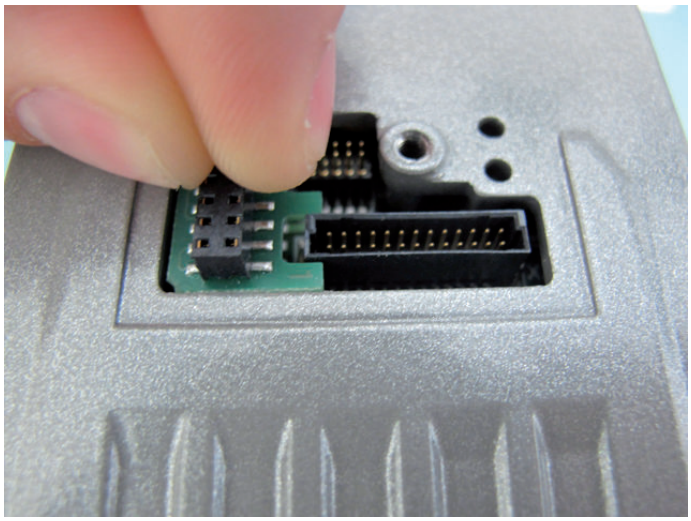
Optional module DIS1

How to install the optional module DIS1:

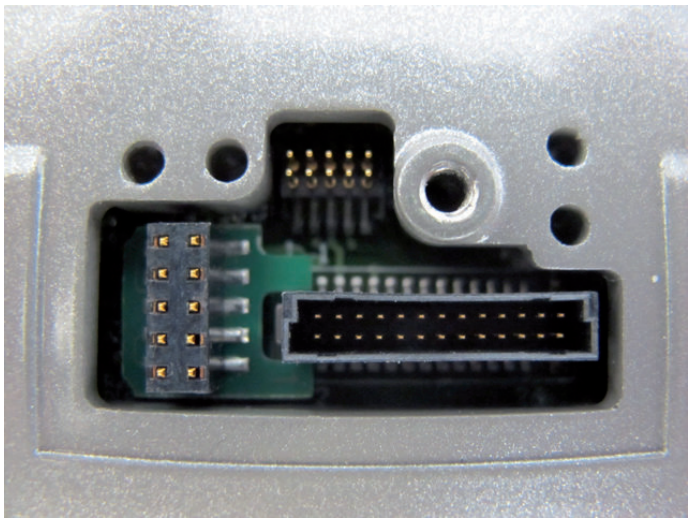
- ► Open main switch.
- ► Prevent main switch from being switched back on.
- ► Remove the Transparent cover plate on the motor.
- ► Remove plugged in jumpers J1 and J2 (see figure).



- ► Plug optional module DIS1 onto contact pins, as shown in the following figure.



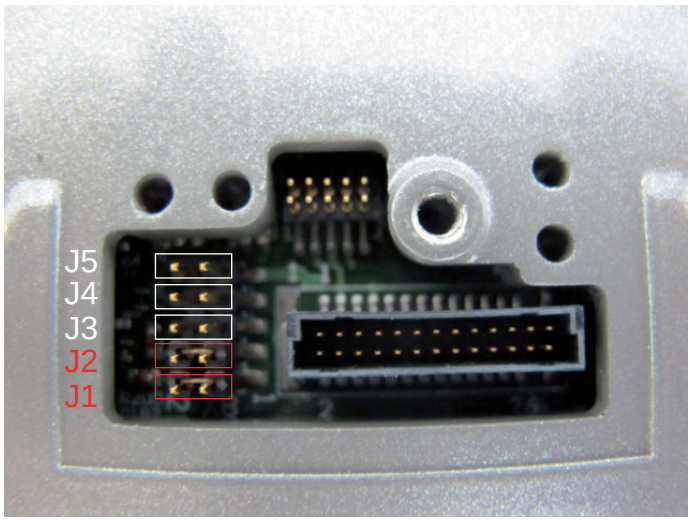
✓ The module is plugged in.



- ▸ Plug the Transparent cover plate on the motor and tighten it.

How to disassemble the optional module DIS1:

- ▸ Open main switch.
- ▸ Prevent main switch from being switched back on.
- ▸ Remove the Transparent cover plate on the motor.
- ▸ Remove the optional module DIS1.
- ▸ Plug in jumpers J1 and J2 (see figure).



- Plug the Transparent cover plate on the motor and tighten it.

Commissioning

- Carry out a functional test of the STO function for all drives that need the safety function.
- In so doing, ensure that the 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.

Prevention of reasonably foreseeable misuse

Checkplug connections

- Check all terminals, connectors and other connections on all system components for correct and firm fit.
- Use only sturdy connectors and safe fixtures.
- Check the protective earth ground 24Vdc PELV supply.
- Check the wiring of the safety function to the axes to avoid an interchange of the IE_sig and IE_ref inputs as well as the 24V supply.
- Use coded connectors (see 5.3 Wiring notes) and perform a commissioning test (see 6.1 Commissioning).
- Use only suitable transport packaging to forward or return individual devices.

Acting of external forces

The safe state of the motor is the torque-free output shaft. If external forces act upon the output shaft, it will not necessarily maintain its position. Take additional precautions 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

UNCONTROLLED MOVEMENT OF THE AXES

- Do not use the internal holding brake as a safety function.
- Only use specified external brakes as safety function.

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

The ILM62 motor has no safe output to connect such a brake.

Hybrid connection

- ► Do not exceed the maximum number of bending cycles of the cable.
- ► Observe the installing instructions and the maintenance cycles of this manual.
- ► Do not exceed the maximum permitted lifetime of the cables.

⚠ WARNING

STAYING IN THE HAZARD AREA

- 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 working 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.

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 not possible to make any statement about the Inverter Enable function after those 15 years have passed. If you wish to ensure the functionality in the sense of safety standards and product liability after this period, you need to exchange the device that includes the safety function.

Check the DIS1 module explicitly and subject the drive to an appropriate functional test after you have replaced of a ILM servo module.

Keep a logbook for tracing the maintenance history of the machine and note the replaced components (as per EN 62061:2005).

See the "Installation and Maintenance" of this operating instruction chapter for information about initial start-up and maintenance.

Physical environment

The ILM62 Inverter Enable system is not protected against physical or chemical sources of danger by any design features. 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. Switch cabinet devices, like for example a connection module ILM62CM do not possess this high degree of protection and are therefore only intended for use in environments according to IP54 or higher (e.g. switch cabinets).

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”, SIL3 compatible
- IEC 61508; Part 1:2010
- EN 61508; part 2:2010; "Safe Torque Off, STO" and "Safe Stop 1, SS1", SIL 3 compatible
- EN ISO 13849-1:2008; PL eCategory 3
- IEC 62061:2005; SILCL 3

Certification was handled by TÜV NORD SysTec GmbH & Co. KG (Augsburg, Germany) (certificate no. SAS-0217/08-2).

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

- CE
- UL

The Inverter Enable function achieves the following safety integrity:

- Safety Integrity Level (SIL) 3, according to EN 61508:2010
- Performance level (PL) e according to EN ISO 13849-1:2008

The probability of dangerous failures per hour (PFH) and the safe failure fraction (SFF) according to EN 61508: 2010 and the diagnostic coverage (DC) according to EN ISO 13849-1: 2008 for the devices are as follows:

- Connection Module ILM62CM: PFH: $1.3*10^{-9}$/h, SFF: 99.9%, DC: 99.0%, **MTTFd: 881 years**
- Distribution Box ILM62DB: included in Connection Module ILM62CM and ILM62 motor calculations
- ILM62 motor: PFH: $0.08*10^{-9}$/h, SFF: 99.9%, DC: 99.0%, **MTTFd: 14487 years**

A system with maximum configuration (consisting of 3x Connection Module ILM62CM, 100x ILM62 motors)results in the following values:

- PFH: $11.9*10^{-9}$/h, SFF: 99.9 %, DC: 99.0 %, **MTTFd: 97 years**

Figures for other configurations within the machine can be requested from Schneider Electric.

5.5 Special Conditions

5.5.1 Increased ambient temperature

If the ambient temperature exceeds 40 °C / 104 °F, the performance of the entire system is reduced.

Multiply the values with the permanent current at 40 °C / 104 °F, in order to receive the final permanent current value.

Power Supply Module LXM62P

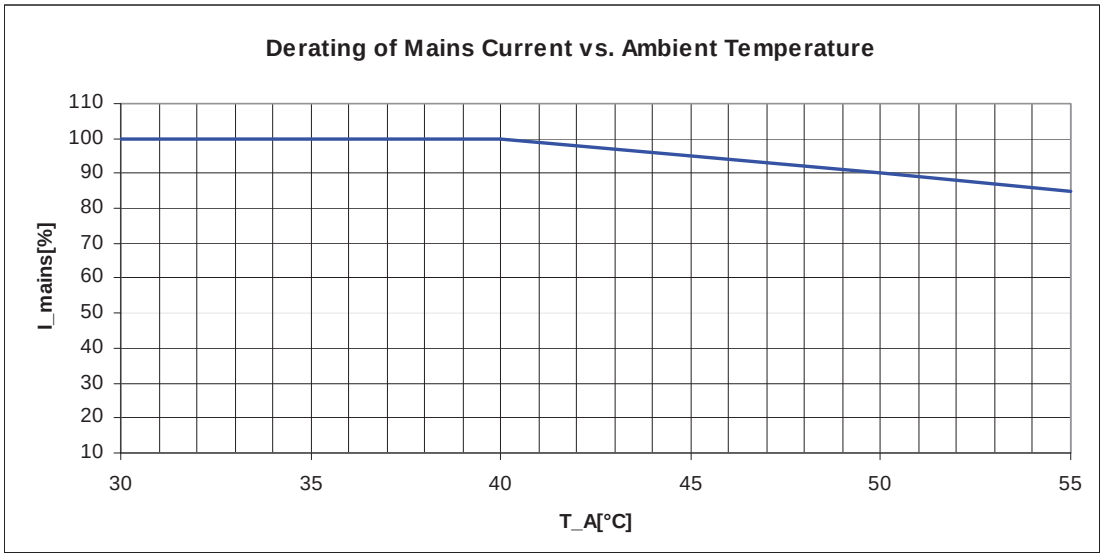


Figure 5-5: Power reduction at a change of the ambient temperature (Power Supply Module LXM62P)

Connection Module ILM62CM

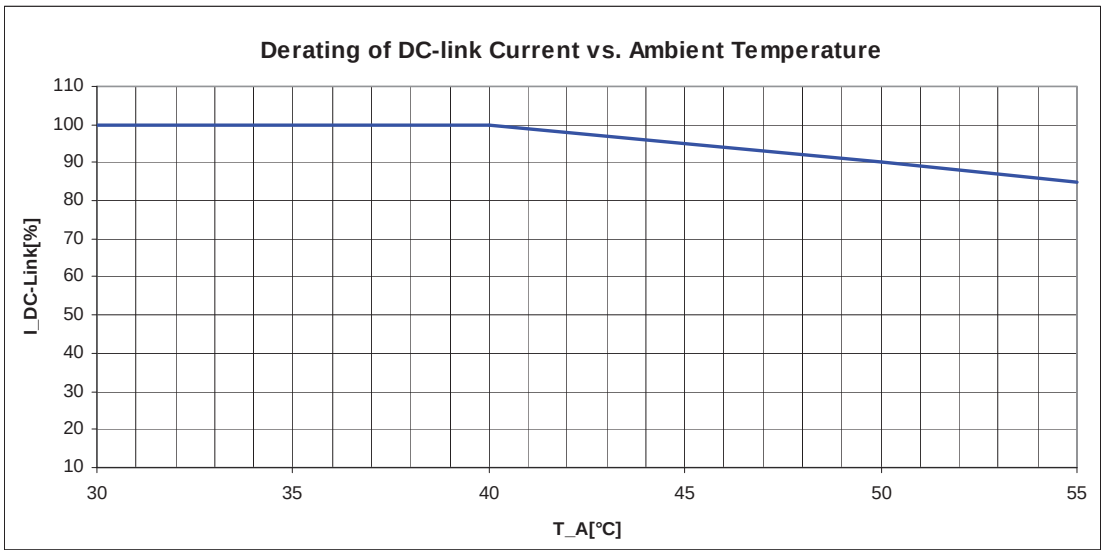


Figure 5-6: Power reduction at a change of the ambient temperature (Connection Module ILM62CM)

A detailed list of the rated and peak currents at variable ambient temperatures can be found in the Chapter "Mechanical and electrical data" (see 7.5 Mechanical and electrical data).

ILM62 motor

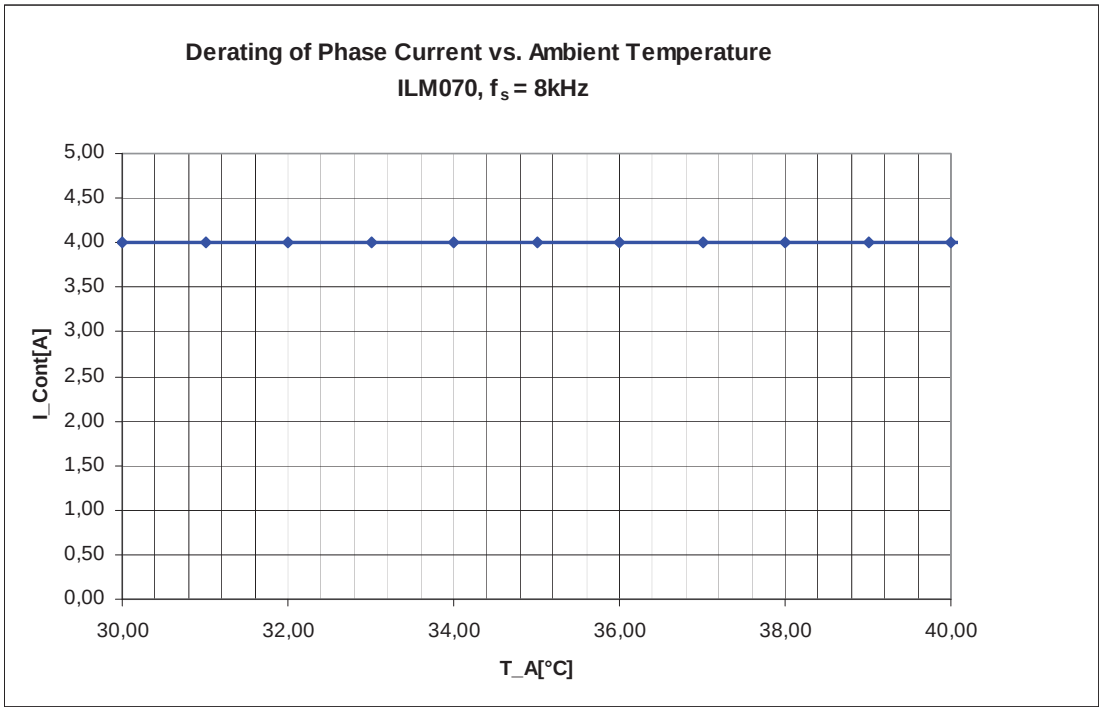


Figure 5-7: Power reduction at a change of the ambient temperature at 8 kHz (ILM070 Servo Motor)

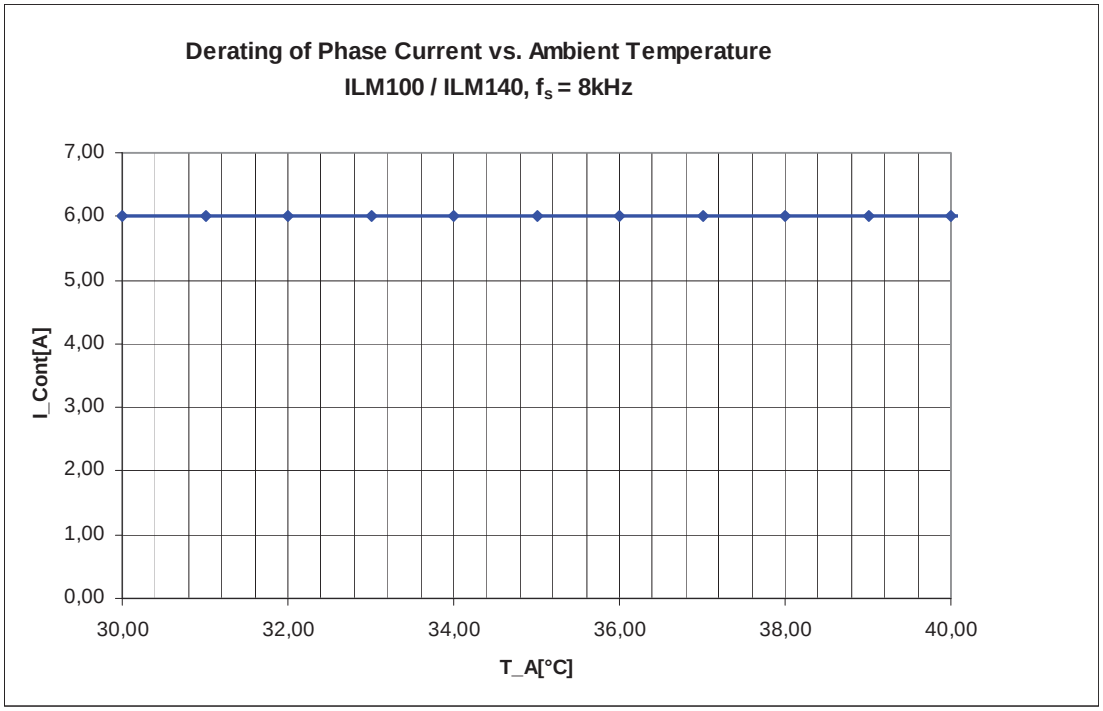


Figure 5-8: Power reduction at a change of the ambient temperature at 8 kHz (ILM100 and ILM140 Servo Motor)

A detailed list of the rated and peak currents at variable ambient temperatures can be found in the Chapter "Mechanical and electrical data" (see 7.5 Mechanical and electrical data).

5.5.2 Low air pressure

If the installation altitude exceeds the specified rated installation altitude, the performance of the entire system is reduced.

Power Supply Module LXM62P

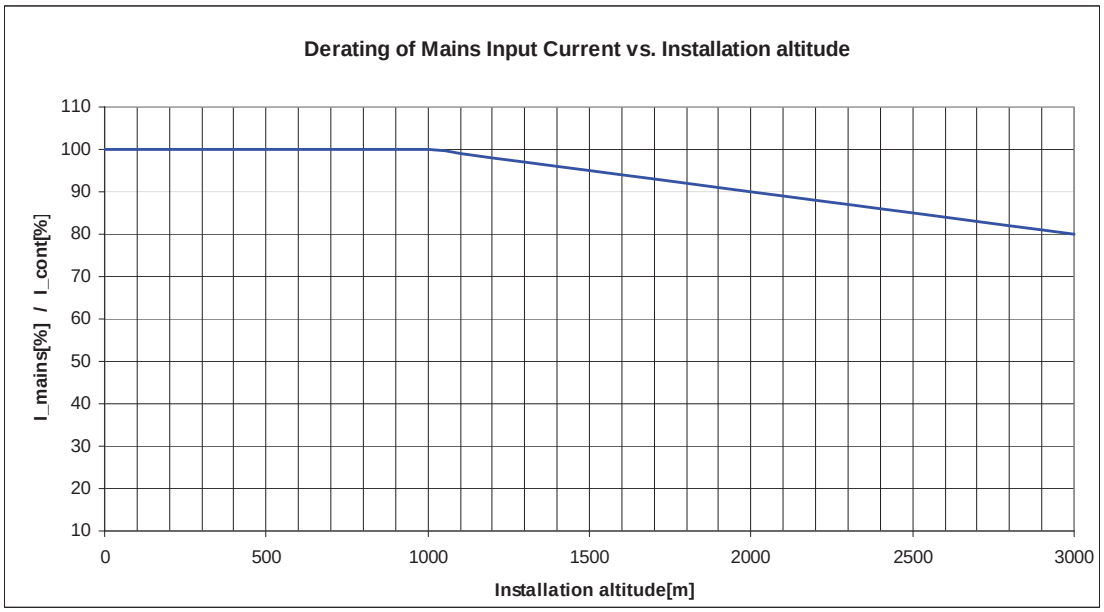


Figure 5-9: Power reduction at increased installation altitude (Power Supply Module LXM62P)

Connection Module ILM62CM

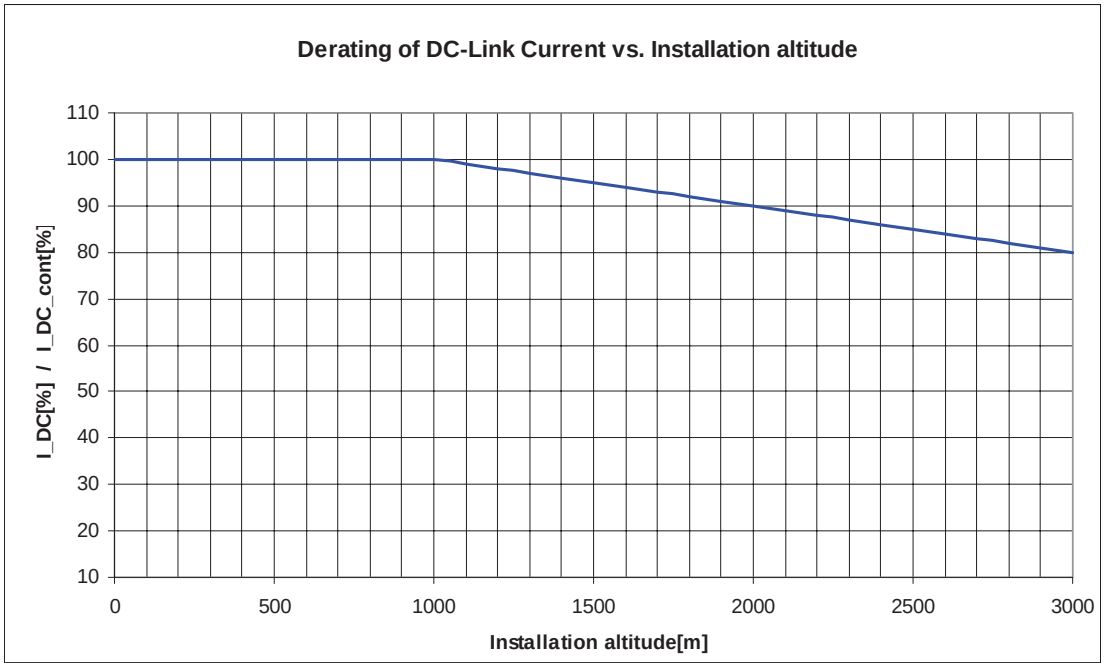


Figure 5-10: Power reduction at increased installation altitude (Connection Module ILM62CM)

ILM62 motor

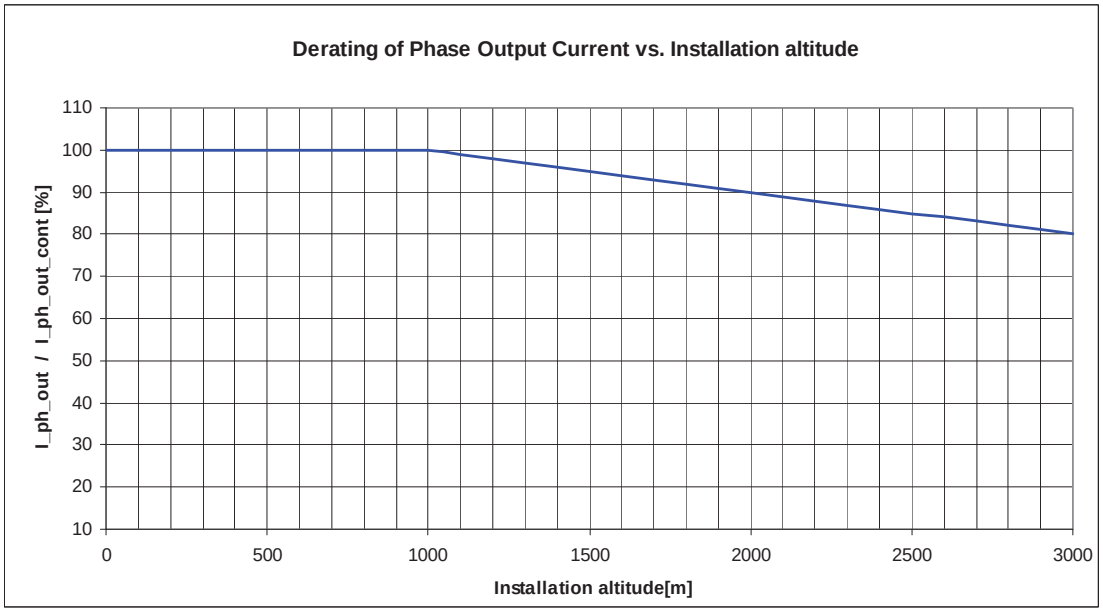


Figure 5-11: Power reduction at increased installation altitude for 8 kHz (ILM62 motor)

Multiply the values with the permanent current at 40 °C / 104 °F, in order to receive the final permanent current value.

6 Installation and maintenance

For warranty reasons, we recommend that you employ Schneider personnel for initial start-up. The personnel

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

► Proceed with care during the following steps and take all precautions described in order to help to avoid the following points:

- Injuries and material damage
- Incorrect installation and programming of components
- the incorrect operation of components
- The use of non-authorized cables or modified components

6.1 Commissioning

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- 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.
- Before enabling the device, safely cover the live components to prevent contact.
- Do not touch the electrical connection points of the components when the unit is switched on.
- Provide protection against indirect contact (EN 50178:1997, Section 5.3.2).
- Disconnect/plug in Plug-in type connectors of the cables, plug-in terminals on the device and bus bar module only when the system is disconnected from the power supply.
- Isolate the unused conductors on both ends of the motor cable because AC voltages in the motor cable can couple to unused conductors.

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

► Pay attention to the ESD protection measures, to avoid damages caused by electrostatic discharge.

NOTICE

ELECTROSTATIC DISCHARGE

- Do not touch any of the electrical connections or components.
- Prevent electrostatic charges; e.g., by wearing appropriate clothing.
- If necessary at all, touch circuit boards only on the edges.
- Move the circuit boards as little as possible, to avoid the formation of electrostatic charge caused by clothing, carpet, or furnishings.
- Remove existing static charge by touching a grounded, metallic surface, like for example, a grounded housing.

Failure to follow these instructions can result in equipment damage.

6.1.1 Preparing commissioning

ESD protection

- Observe the following instructions for ESD protection in order to avoid any damage due to electrostatic discharge:

NOTICE

ELECTROSTATIC DISCHARGE

- Do not touch any of the electrical connections.
- Prevent electrostatic charges; e.g., by wearing appropriate clothing.
- Remove existing static charge by touching a grounded, metallic surface, like for example, a grounded housing.

Failure to follow these instructions can result in equipment damage.

Unpacking

How to unpack the device:

- Remove packaging.
- Dispose of the packaging material in accordance with the relevant local regulations.

Verifying

How to check the device:

- Check that delivery is complete.
- Check if the device is in working condition.

⚠ WARNING

DAMAGED OR MODIFIED DRIVE SYSTEMS

- Damaged drive systems must be neither mounted nor commissioned.
- Do not modify the drive systems.
- Send back inoperative devices.

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 degree of protection and the EMC rules.
- In addition to the following instructions, also note the information in the chapter "Planning".
- Then install ILM62 component.

6.1.2 Grinding the holding brake

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

How to regrind the holding brake:

- The motor is disassembled. The holding brake is closed.

⚠ 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.

- ▶ Check the holding torque of the holding brake using a torque wrench.
- ▶ Compare the value to the specified holding torque of the holding brake upon delivery (see 7.5.9 Holding brake (optional)).
- ▶ If the holding torque of the holding brake clearly deviates from the specified values, manually turn the motor shaft by 25 rotations in both directions.
- ▶ Please repeat the process.
  If the holding torque is not restored after 3 repetitions, please contact your sales partner.

6.1.3 Preparing the switching cabinet

⚠ WARNING

FLAMMABLE MATERIALS

- Do not install flammable materials in the immediate vicinity.

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

- ▶ Avoid "Hot Spot" in the switch cabinet.

⚠ DANGER

ELECTRIC SHOCK DUE TO MISSING GROUNDING

- At the installation points, remove paint across a large surface, before installing the devices (metallically blank).

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

- ▶ If necessary, install additional fan.
- ▶ Do not block the fan air inlet.
- ▶ Perform mounting bores in the switch cabinet in the 45 mm-pattern (1.77 in.) (± 0.2 mm / ± 0.01 in.).
- ▶ Observe tolerances as well as distances to the cable ducts and adjacent switch cabinet series.

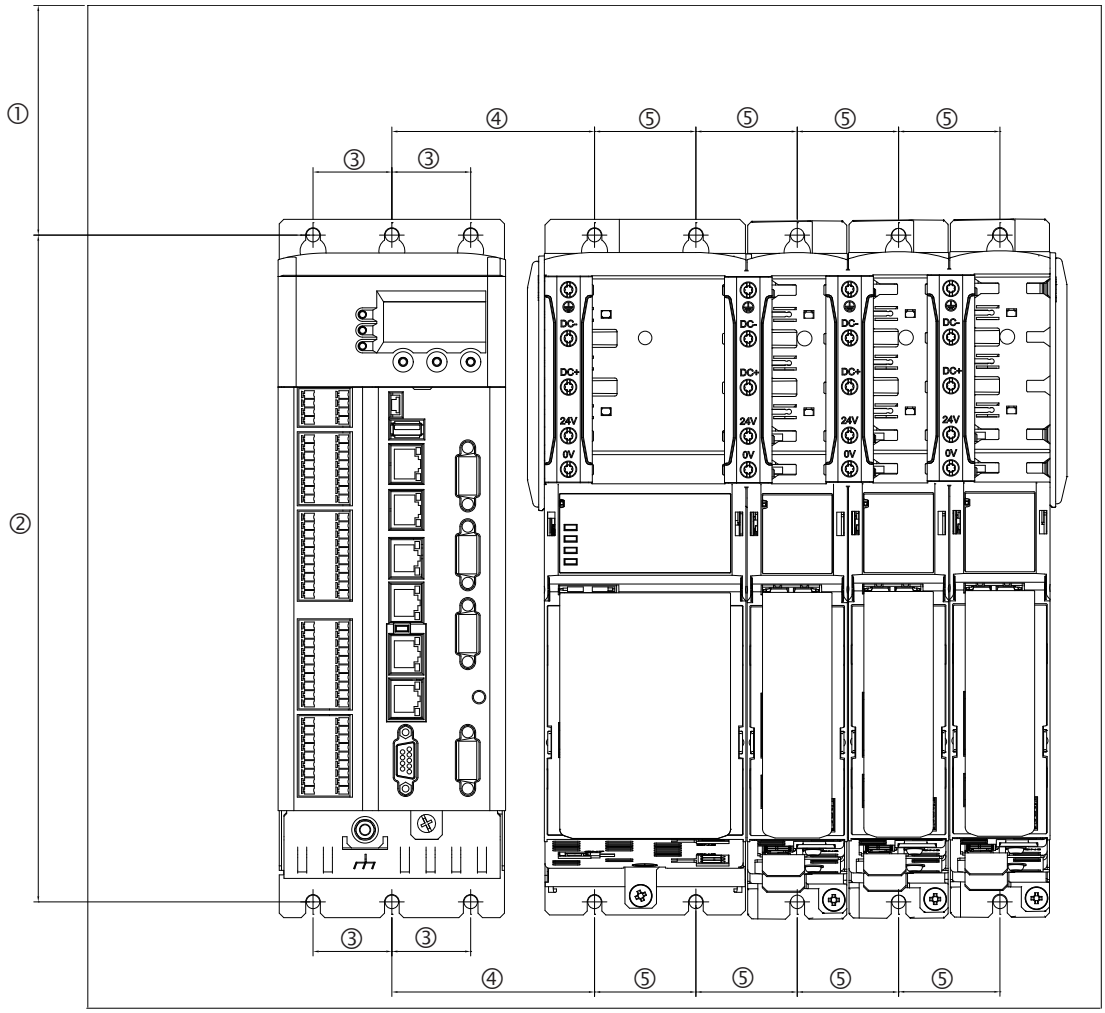


Figure 6-1: Required distances in the switch cabinet for the controller, power supply, Connection Module

-	mm	in.	thread
(1)	X (± 0.2)	X (± 0.01)	M6
(2)	296 (+ 0.5 ; -0)	11.65 (± 0.01)	M6
(3)	35 (± 0.2)	1.38 (± 0.01)	M6
(4)	90 (±0.2)	3.54 (± 0.01)	M6
(5)	45 (±0.2)	1.77 (± 0.01)	M6

- Keep a distance of at least 100 mm (3.94 in.) above and below the devices.

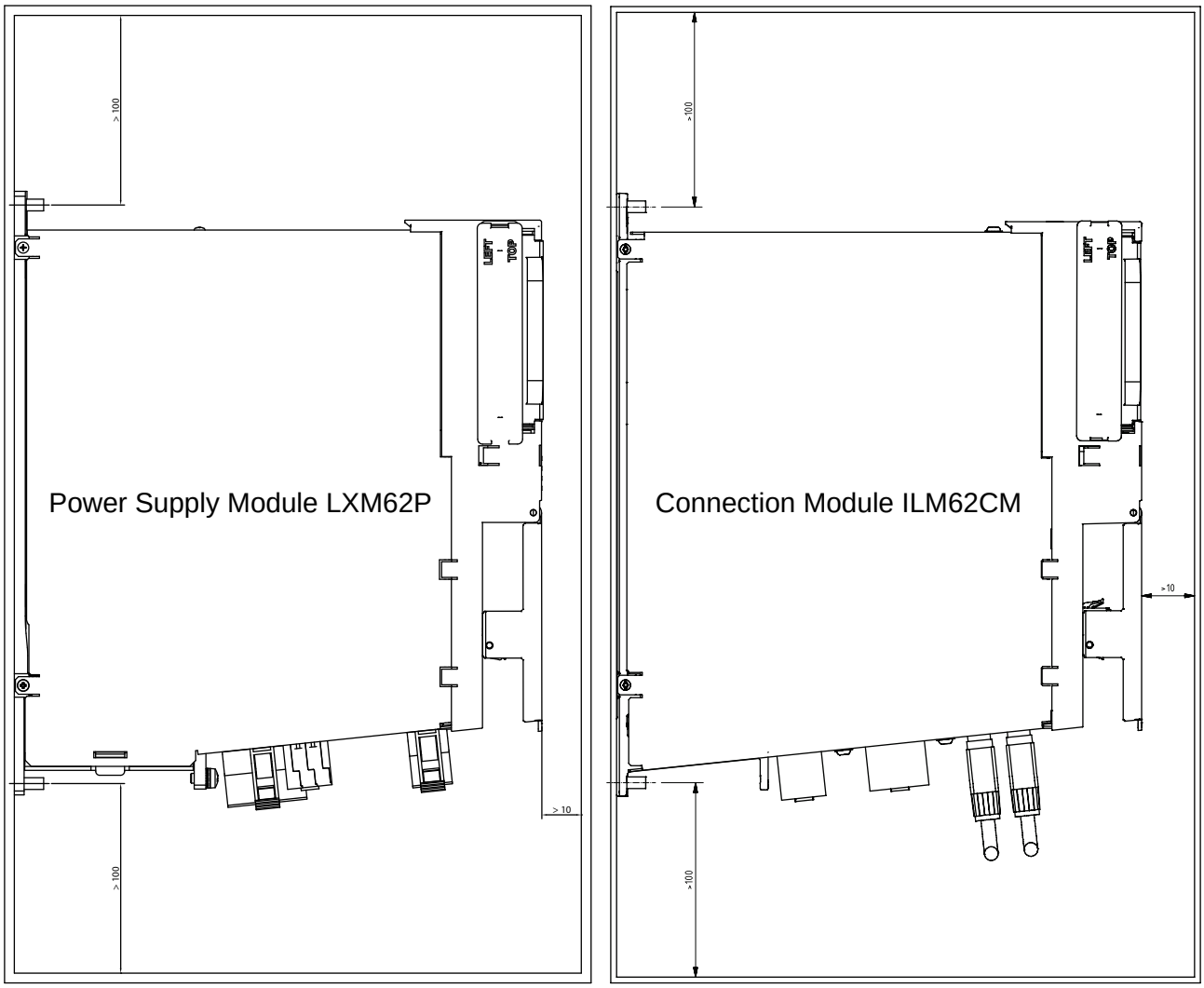


Figure 6-2: Required distances in the switch cabinet

- Do not lay any cables or cable ducts over the servo amplifiers or braking resistor modules.

6.1.4 Mechanical mounting

- Remove the shock protector covers on the module sides (power supply and Connection Module ILM62CM) on which the modules are connected with each other.
- For this purpose, press the screwdriver in the opening **(1)** (blade width 5.5 - 8 mm / 0.22 - 0.31 in.) on the top side of the module to loosen the shock protective cover.
- Subsequently, remove the shock protectors covers toward the outside.

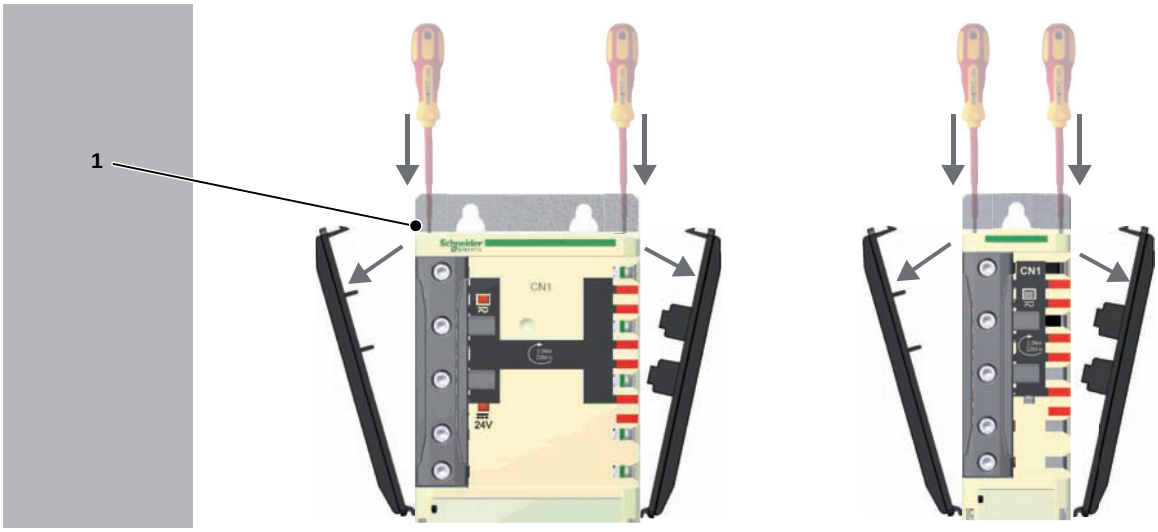


Figure 6-3: Remove the shock protectors covers.

- Afterwards, screw the pan-head screws M6 (socket head cap screws) into the prepared installation bores.
- Keep a distance of 10 mm (0.39 in.) between the screw head and the mounting plate.
- Hook in device and check the vertical mounting arrangement.
- Arrange power supply and Connection Module ILM62CM in the following order from inside to outside due to the current carrying capacity:
  1st power supply
  2nd Connection Module ILM62CM

By doing this, the load on the DC bus- and 24V-supply at the wiring bus is reduced.

- Tighten the mounting screws (torque: 4.6 Nm/41 lbf in).

6.1.5 Wiring

This is how you wire the modules:

- ► Check if the slide on the Bus Bar Module can be easily moved.
- ► Connect devices via the slide of the Bus Bar Module.
- ► Tighten the screws of the Bus Bar Module (torque: 2.5 Nm / 22 lbf in).

⚠ DANGER

HAZARD OF ELECTRIC SHOCK CAUSED BY HIGH TOUCH VOLTAGE

- Attach the shock protectors covers on the outside of the bus bar module combination.
- Only switch on device if the shock protectors covers have been fitted on the outside of the bus bar module combination.

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

- ► Mount the shock protector covers LEFT TOP (1) and RIGHT TOP (2) on the outside of the bus bar module combination.

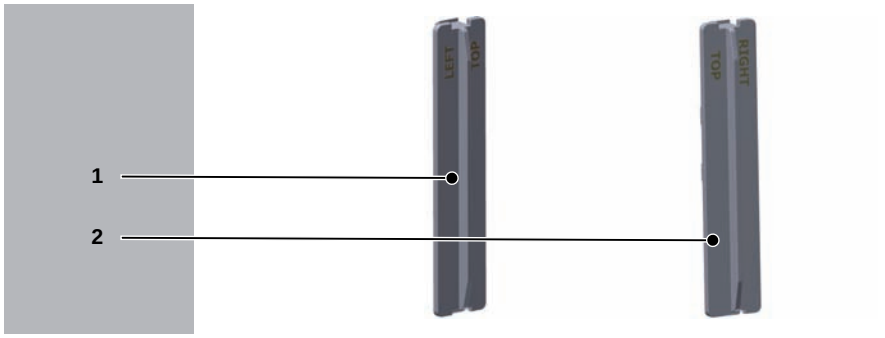


Figure 6-4: Shock protector covers

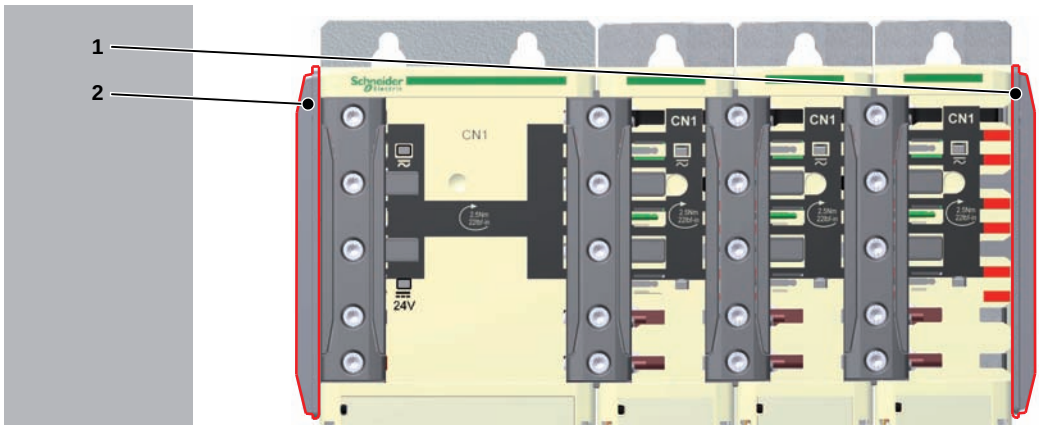


Figure 6-5: Shock protectors on the outside of the bus bar module combination.

- ► Connect the additional protective conductor with the ring cable shoe and the M5 screw to the heat sink of the power supply (tightening torque: 3.5 Nm / 31 lbf in).
- ► Starting from the heat sink, observe the following sequence: toothed gear, ring cable shoe, toothed gear, washer and screw.

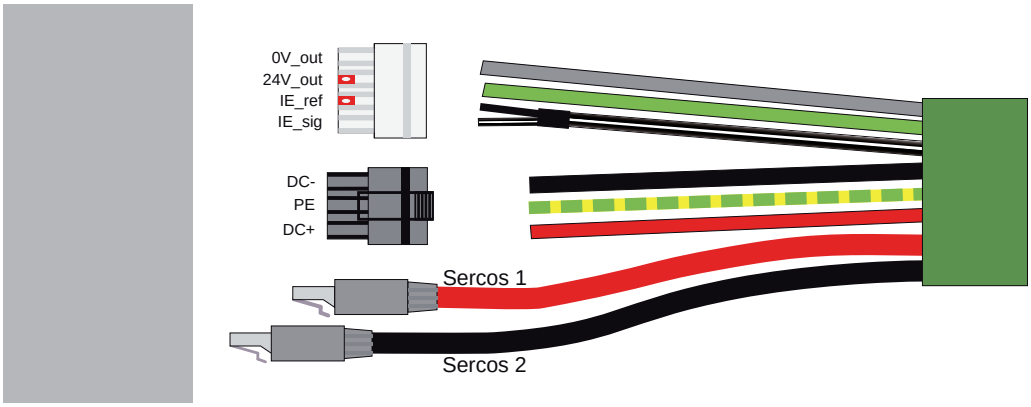
⚠ DANGER

HAZARD OF ELECTRIC SHOCK CAUSED BY HIGH TOUCH VOLTAGE

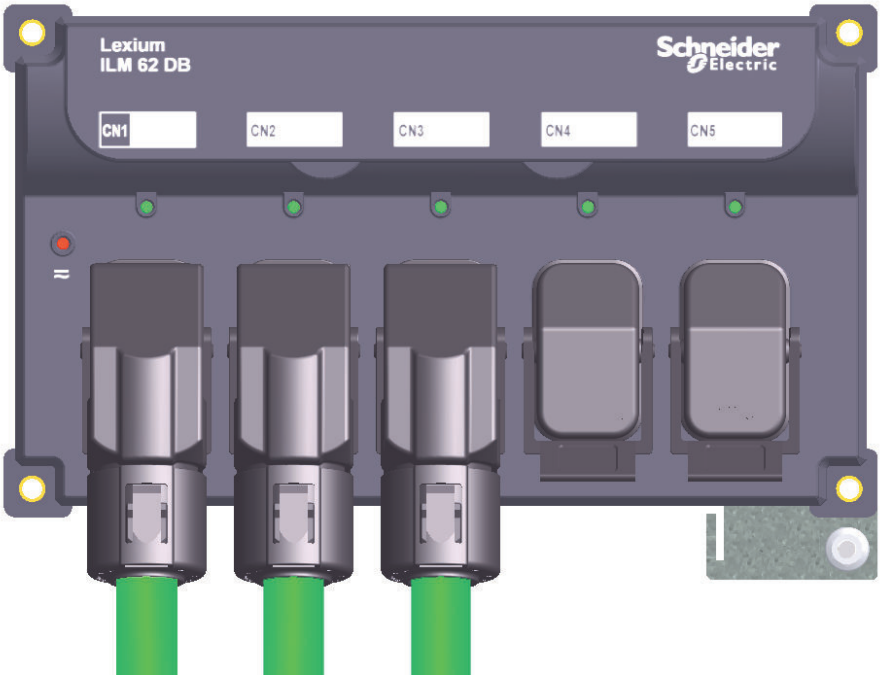
- Connect devices with a leakage current of 3.5 mAac or more through a fixed connection to the power supply network.
- In addition, implement one of the measures according to EN 50178:1997, Section 5.3.2.1.

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

- ► 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 it with a 2.8 Nm (24,76 lbf in) torque.
  - ✓ The motor is now grounded with the machine bed.
- ► Do not choose a connection cross-section of the earthing cable that is smaller than the cross-section of the main connection.
- ► Or, connect the motor to the grounded machine bed immediately above the motor flange.
- ► Connect connections **CN4, CN5, CN7 and CN8** (SERCOS, DC bus voltage, Inverter Enable) at the Connection Module with the Distribution Box ILM62DB by means of the pre-assembled hybrid cable.



- ► Connect up to four ILM62 motors at the Distribution Box ILM62DB using hybrid cables. Engage the respective mounting bracket at both connection sides. Close unused hybrid inputs with strapping plugs (order number VW3E6023).



The SERCOS ring can only be closed with a strapping plug.

► Prior to this, remove protective cover from the hybrid cables.

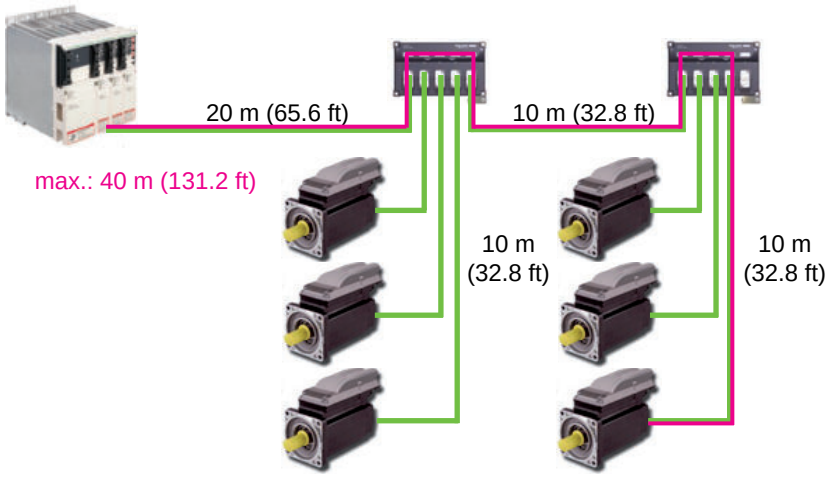
The following boundary conditions must be observed for the system layout:

- maximum cable length of 20 m (65.2 ft) from Connection Module ILM62CM to Distribution Box ILM62DB
- maximum cable length of 10 m (32,8 ft) from Distribution Box ILM62DB to Distribution Box ILM62DB
- maximum cable length of 10 m (32,8 ft) from Distribution Box ILM62DB to ILM62 motor
- sum of all cable lengths max. 200 m (656 ft)
- maximum distance of 50 m (164 ft) between 2 active SERCOS slaves e.g. way back in the SERCOS ring from the ILM62 motor to the Power Supply Module LXM62P
- Connection Module ILM62CM and Distribution Box ILM62DB are no active SERCOS slaves.

Use the configuration tool to obtain an exact system layout for the respective available network topology.

In the following, two examples for the longer distance between 2 active SERCOS slaves for which a maximum length of 50 m (164 ft) is permissible. This critical distance is respectively marked in red.

In this example of a net topology in line structure the longest distance is between the Power Supply Module LXM62P and the last ILM62 motor.



In this example of a net topology in tree-structure the longest distance is between two ILM62 motors and not between the Power Supply Module LXM62P and the last ILM62 motor.

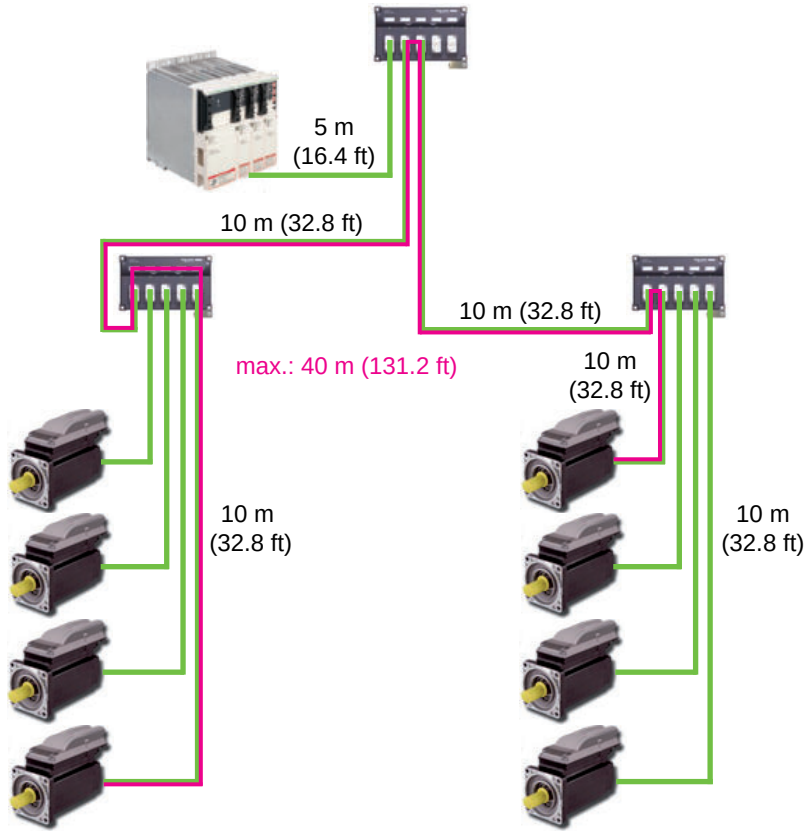


Figure 6-6: Connection overview ILM62 motor

1	Ground connection
2	Hybrid 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.

6.2 Maintenance, repair, cleaning

- Observe the following instructions before carrying out maintenance on Device:

How to de-energize the system:

- Set main switch to "OFF Position".
- Prevent main switch from being switched back on.
- After switching off, wait 15 minutes so that the DC bus can discharge.
- Check whether the DC-BUS LED has turned off on all components located in the axis group.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Before working on the device, check the DC bus with a measuring instrument to make sure that it is de-energized (< 42.4Vdc).

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

- Check DC+ to PE and DC- to PE with a suitable measuring instrument to make sure it is de-energized before working on the device.

Help in case of a problem:

✕ DC bus does not discharge completely.
- Do not repair or operate component.
- Contact the Schneider Electric contact partner.

6.2.1 Fuse replacement Connection Module ILM62CM

How to replace the fuses:

- There was a failure of the Connection Module ILM62CM:
  DC bus LED at the Power Supply Module LXM62P flashes
  DC bus LED at the Connection Module ILM62CM is off

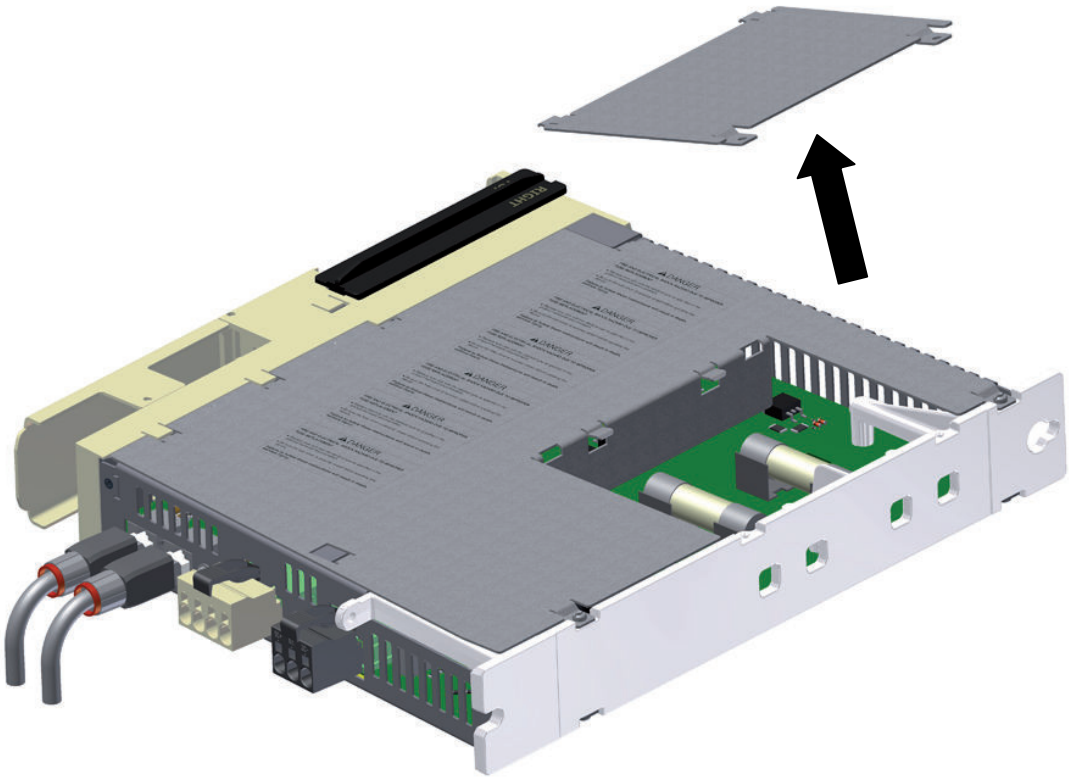
⚠ DANGER

FIRE AND ELECTRICAL SHOCK HAZARD DUE TO IMPROPER FUSE REPLACEMENT

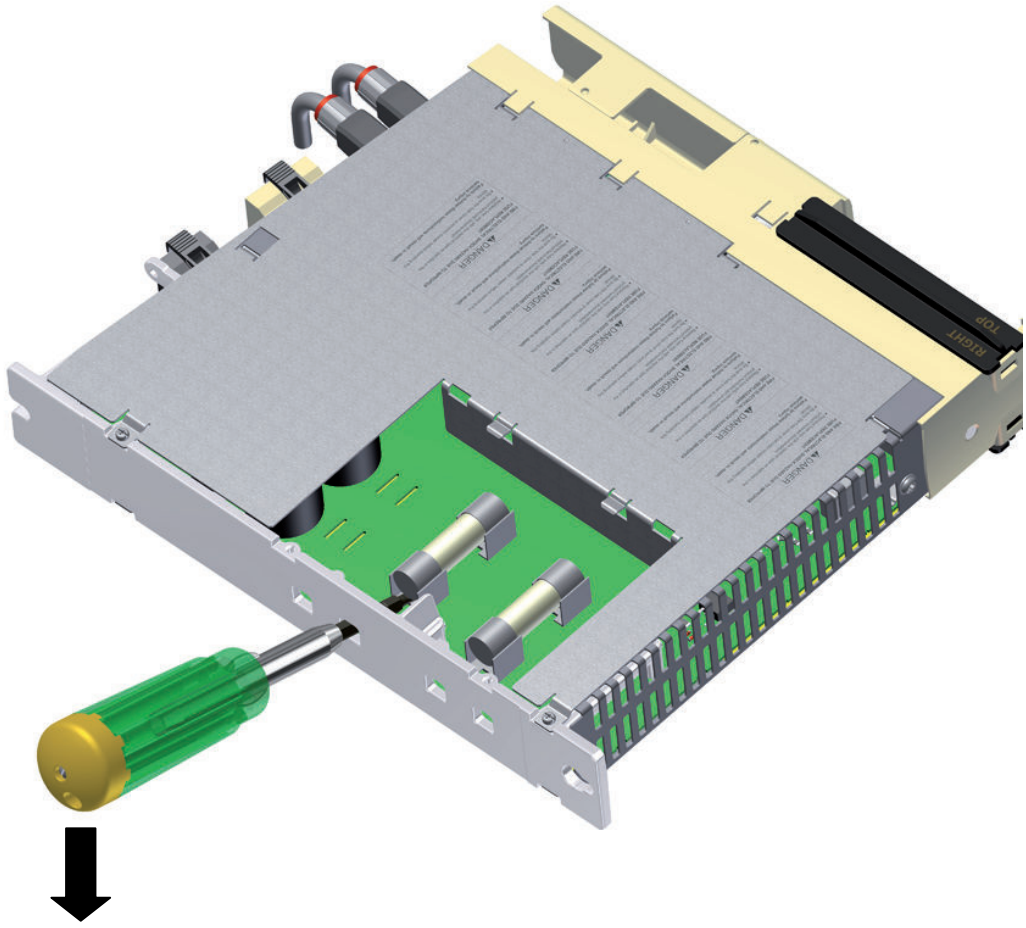
- Replace fuse only by a fuse of identical type as specified in the product documentation.
- Be sure the fuse cover is securely closed before operating the device.

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

- ► Dismount (see 6.4 Device-, parts- or cable exchange) Connection Module ILM62CM.
- ► Open maintenance flap.



- On the back side of the housing remove both fuses from the holding device using a screwdriver and replace them by new fuses (order number VW3E6024) of the same type.



- Close maintenance flap and mount (see 6.1.4 Mechanical mounting) the Connection Module ILM62CM.
- ILM62 Restart (see 6.1.5 Wiring) the system.

If after the fuse replacement the Connection Module ILM62CM still is not ready for operation or fails again after recommissioning, contact your Schneider Electric responsible.

6.2.2 Repair

In case of repair proceed as follows :

- ► Contact the Schneider Electric contact partner.
- ► Observe the following instructions for ESD protection in order to avoid any damage due to electrostatic discharge:

NOTICE
ELECTROSTATIC DISCHARGE • Do not touch any of the electrical connections. • Prevent electrostatic charges; e.g., by wearing appropriate clothing. • Remove existing static charge by touching a grounded, metallic surface, like for example, a grounded housing. **Failure to follow these instructions can result in equipment damage.**

6.2.3 Cleaning

This is how you clean the ILM62 component:

- ► De-energize ILM62 components.
- ► Remove ILM62 components.
- ► Use cleaning processes appropriate to the degree of protection of the ILM62 components.

It is not possible to test in advance, all materials of the Schneider Electric product range that are used presently and in the future on the compatibility with the cleaning agents available on the market.

NOTICE
DAMAGE CAUSED BY CLEANING AGENTS • Before using a cleaning agent, carry out a compatibility test in relation to the cleaning agent and the component affected. • Do not use alkaline detergent, as polycarbonates can lose their stability if you come into contact with them. • Do not use any chloride-containing cleaning agents as these corrode the stainless steel and in particular the welds, and thus reduce the strength of the mechanics. **Failure to follow these instructions can result in equipment damage.**

For more information on the material properties of your component (see 7.5 Mechanical and electrical data).

- ► Then blow out ILM62 components with dry pressurized air (max. 1 bar / 14.5 PSI).

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

6.3 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 devices with the same hardware configuration and the same software version.
- Indicate the following information on the spare part order:

Item name:	for example, ILM0701P01A0000
Hardware code:	for example, RS02
Software version:	e.g. SW: 00.24.21

This information can be found on the nameplate.

6.4 Device-, parts- or cable exchange

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- 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.
- Before enabling the device, safely cover the live components to prevent contact.
- Do not touch the electrical connection points of the components when the unit is switched on.
- Provide protection against indirect contact (EN 50178:1997, Section 5.3.2).
- Disconnect/plug in Plug-in type connectors of the cables, plug-in terminals on the device and bus bar module only when the system is disconnected from the power supply.
- Isolate the unused conductors on both ends of the motor cable because AC voltages in the motor cable can couple to unused conductors.

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

NOTICE

IMPROPER REPLACEMENT OR OPENING OF THE ILM62 COMPONENTS

- Do not open the ILM62 component for commissioning or replacement.
- In addition to the following instructions, you must observe the machine manufacturer's specifications when replacing the of the ILM62 components.
- Replace defective devices as a whole.

Failure to follow these instructions can result in equipment damage.

- ► Pay attention to the ESD protection measures, to avoid damages caused by electrostatic discharge.

NOTICE

ELECTROSTATIC DISCHARGE

- Do not touch any of the electrical connections or components.
- Prevent electrostatic charges; e.g., by wearing appropriate clothing.
- If necessary at all, touch circuit boards only on the edges.
- Move the circuit boards as little as possible, to avoid the formation of electrostatic charge caused by clothing, carpet, or furnishings.
- Remove existing static charge by touching a grounded, metallic surface, like for example, a grounded housing.

Failure to follow these instructions can result in equipment damage.

How to de-energize the system:

- ► Set main switch to "OFF Position".
- ► Prevent main switch from being switched back on.
- ► After switching off, wait 15 minutes so that the DC bus can discharge.
- ► Check whether the DC-BUS LED has turned off on all components located in the axis group.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Before working on the device, check the DC bus with a measuring instrument to make sure that it is de-energized (< 42.4Vdc).

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

- ► Check DC+ to PE and DC- to PE with a suitable measuring instrument to make sure it is de-energized before working on the device.

Help in case of a problem:

- ✕ DC bus does not discharge completely.
- ► Do not repair or operate component.
- ► Contact the Schneider Electric contact partner.

For more information on the DC bus LED (see 4.1.2 DC bus LED).

NOTICE

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 tracing the maintenance history of the machine and note the replaced components (as per EN 62061:2005).

6.4.1 Replacement of devices and cables of Connection Module ILM62CM

How to replace the ILM62 component:

- ▶ Disconnect all connection cables on the device to be replaced.
- ▶ Undo the screwed connections on the wiring bus (CN1) of the component to be replaced.
- ▶ If available, undo the screwed connections of the device adjacent to the right-hand side.
- ▶ Push both slides (CN1) to the center of the device.

⚠ CAUTION

DROPPING HEAVY LOAD

- Do not fully remove the mounting hardware of the device before removing the device.

Failure to follow these instructions can result in injury or equipment damage.

- ▶ Undo screwed connections to the device mounting on the device rear wall each at the top end and bottom end.
- ▶ Remove ILM62 component and exchange the complete unit.
- ▶ Fit new ILM62 component and tighten the screwed connections of the device mounting each at the top end and bottom end.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK CAUSED BY HIGH TOUCH VOLTAGE

- Attach the shock protectors covers on the outside of the bus bar module combination.
- Only switch on device if the shock protectors covers have been fitted on the outside of the bus bar module combination.

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

- ▶ Check whether a shock protectors cover is fitted to the wiring bus (CN1) at the end of an axis group.
- ▶ Connect ILM62 component according to the machine's circuit diagram.

⚠ DANGER

WRONG CONFIGURATION OF NEW CABLES

- If you are not using prefabricated cables, make sure that the configuration of the new cables complies with the connection diagram of the machine manufacturer.

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

- ▶ Following replacement of a ILM62 component, proceed as for the initial start-up.

For further information on this (see 6.1 Commissioning).

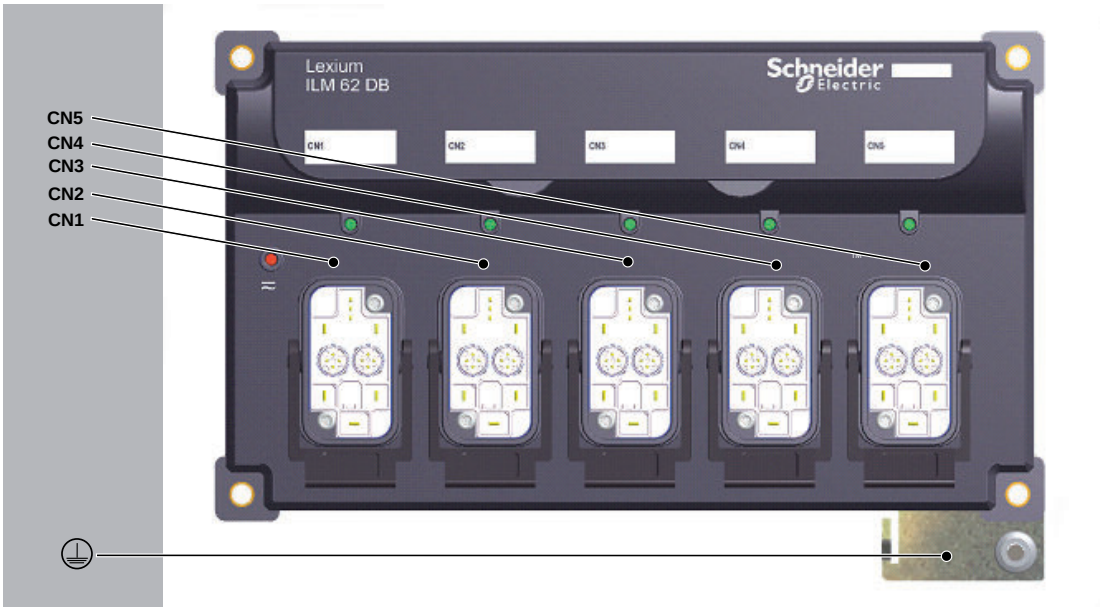
Keep a logbook for tracing the maintenance history of the machine and note the replaced components (as per EN 62061:2005).

6.4.2 Replacement of devices and cables of Distribution Box ILM62DB

How to replace the Distribution Box ILM62DB:

- ▶ Pay attention to the ESD protection measures, to avoid damages caused by electrostatic discharge.

NOTICE
ELECTROSTATIC DISCHARGE • Do not touch any of the electrical connections or components. • Prevent electrostatic charges; e.g., by wearing appropriate clothing. • If necessary at all, touch circuit boards only on the edges. • Move the circuit boards as little as possible, to avoid the formation of electrostatic charge caused by clothing, carpet, or furnishings. • Remove existing static charge by touching a grounded, metallic surface, like for example, a grounded housing. **Failure to follow these instructions can result in equipment damage.**



- ▶ Unplug plug connector of the hybrid connector (cable connection to the Connection Module) at CN1. Before this, loosen the mounting brackets.
- ▶ Loosen plug connectors of the hybrid connectors of all connected motors (CN2 to CN5).
- ▶ Dismount earthing cable of shielding of the Distribution Box ILM62DB.
- ▶ Replace Distribution Box ILM62DB as a whole.
- ▶ Attach connectors of the hybrid connectors of all motors to be connected (CN2 to CN5). Safeguard using mounting brackets.
- ▶ Attach plug connector of the hybrid connector (cable connection of Connection Module) at CN1 and lock mounting brackets.
- ▶ Mount earthing cable at shielding of the Distribution Box ILM62DB.

How to replace the cables:

Cable installation

- Wire earthing cable between Connection Module ILM62CM and Distribution Box ILM62DB.
- If available, pull off the strapping plug from contacts CN1 - CN5. Before this, loosen the mounting brackets.
- Remove protective cover at the hybrid connector.
- Wire pre-assembled hybrid connector for the connection between Connection Module ILM62CM and Distribution Box ILM62DB. Attach plug connector at X1 connection of the Distribution Box ILM62DB. Perform connections CN4-5, CN6, CN7 and CN8 at the Connection Module ILM62CM according to the connection overview in Chapter (see 7.8.1 Connection Module ILM62CM).
- Attach hybrid connector at ILM62 motor and connect to one of connections CN2-CN5. Lock both connections using mounting brackets.

Cable removal

- Dismount earthing cable between Connection Module ILM62CM and Distribution Box ILM62DB.
- Loosen the mounting bracket (ILM62 motor and Distribution Box ILM62DB), pull off the hybrid connector at the ILM62 motor and loosen the plug connector of connections CN2-CN5.
- Close free connections of the Distribution Box ILM62DB with strapping plugs.
- Equip the loosened hybrid cable with protective covers.

Keep a logbook for tracing the maintenance history of the machine and note the replaced components (as per EN 62061:2005).

6.4.3 Replacement of devices and cables of ILM62 motor

How to replace the ILM62 motor:

⚠ CAUTION

ELECTROSTATIC DISCHARGE!

- Use the original or similar packaging to send back components.
- Components must be packaged in ESD packaging/film.

Failure to follow these instructions can result in damage to components and loss of warranty claim.

NOTICE

IMPROPER REPLACEMENT OR OPENING OF THE ILM62 COMPONENTS

- Do not open the ILM62 component to put it into operation or replace it.
- In addition to the following instructions, you must observe the machine manufacturer's specifications when replacing of the ILM62 components.

Failure to follow these instructions can result in equipment damage.

- ► Take preliminary measures.
- ► Put main switch in "OFF" position to free system of voltage.
- ► Prevent main switch from being switched back on.

⚠ 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.

NOTICE

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.

Failure to follow these instructions can result in equipment damage.

- ► Replace the drive according to the machine manufacturer's specifications.
- ► Connect earthing cable and tighten with a 2.8 Nm torque.

Figure 6-7: Connection overview ILM62 motor

1	Ground connection
2	Hybrid connector

How to replace the cables:

- ▶ Disconnect / attach the earthing cable and hybrid connector from/at the ILM62 motor.
- ▶ Disconnect / attach the earthing cable and hybrid connector from/at the Distribution Box ILM62DB.

NOTICE
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 tracing the maintenance history of the machine and note the replaced components (as per EN 62061:2005).

7 Technical data

7.1 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 the standstill torque M_0 and standstill current I_0 .
m	[kg]	Mass Motor mass without brake and without fan
M_0	[Nm]	Standstill torque; Continuous torque (100% ED) at 5 min^{-1} by an ambient temperature of 40 °C ..
M_N	[Nm]	Rated torque; Continuous torque (100% ED) by n_N due to the speed-dependent losses less than M_0, by an ambient temperature of 40 °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 7-1: Physical sizes with units and explanations

7.2 Ambient conditions

Connection Module ILM62CM

Ambient conditions

Procedure	Parameter	Value	Basis
Operation	**Class 3K3**		IEC/EN 60721-3-3
	Degree of protection housing	IP 20 with plugged-in connectors	
	Degree of protection installation site	IP54, if safety circuit with Inverter Enable is used	
	Pollution degree	2	
	Ambient temperature	+5 °C...+55 °C / +41 °F...+131 °F	
	Condensation	No	
	Icing	No	
	other liquid	No	
	Relative humidity	5% ... 85%	
	Class 3M4		
	Vibration	10 m/s^2	
	Shock	100 m/s^2	
Transport	**Class 2K3**		IEC/EN 60721-3-2
	Ambient temperature	-25 °C...+70 °C / -13 °F...+158 °F	
	Condensation	No	
	Icing	No	
	other liquid	No	
	Relative humidity	5% ... 95%	
	Class 2M2		
	Vibration	15 m/s^2	
	Shock	300 m/s^2	
Long-term storage in transport packaging	**Class 1K4**		IEC/EN 60721-3-1
	Ambient temperature	-25 °C...+55 °C / -13 °F...+131 °F	
	Condensation	No	
	Icing	No	
	other liquid	No	
	Relative humidity	5% ... 95%	

Table 7-2: Ambient conditions Connection Module ILM62CM

Installation altitude

The installation altitude is defined as height above sea level.

Installation altitude without power reduction	<1000 m (<3281 ft.)
Installation altitude while complying with all of the following conditions: • 55 °C (131 °F) max. ambient temperature • Reduction of the continuous power by 1 % per 100 m (328 ft.) above 1000 m (3281 ft.)	1000 ... 2000 m (3281 ... 6562 ft.)
Installation altitude above sea level when complying with all of the following conditions: • 40 °C max. ambient temperature • Reduction of the continuous power by 1 % per 100 m (328 ft.) above 1000 m (3281 ft.) • Overvoltages of the supplying grid limited to an overvoltage category III according to IEC 60664-1/IEC61800-5-1	2000 ... 3000 m (6562 ... 9843 ft.)

Installation location and connection

For operation, the Power Supply Module LXM62P and the Connection Module ILM62CM must be mounted in a closed switch cabinet. The devices must only be operated with fixed connections.

Pollution degree and degree of protection

Pollution degree	according to IEC61800-5-1	2
Protection	according to IEC61800-5-1	IP 20 (switch cabinet), IP65 (field devices)

Degree of protection when using the safety function

Ensure that no conductive pollution can deposit in the product (pollution degree 2). Conductive pollutions can cause the safety function to be ineffective.

Distribution Box ILM62DB

Procedure	Parameter	Value	Basis
Operation	**Class 3K3**		**IEC/EN 60721-3-3**
	Degree of protection housing	IP 65 with plugged-in connectors	
	Pollution degree	2	
	Ambient temperature	+5 °C...+55 °C / +41 °F...+131 °F	
	Condensation	No	
	Icing	No	
	other liquid	No	
	Relative humidity	5% ... 85%	
	Class 3M7		
	Vibration	30 m/s^2	
	Shock	250 m/s^2	
Transport	**Class 2K3**		**IEC/EN 60721-3-2**
	Ambient temperature	-25 °C...+70 °C / -13 °F...+158 °F	
	Condensation	No	
	Icing	No	
	other liquid	No	
	Relative humidity	5% ... 95%	
	Class 2M2		
	Vibration	10 m/s^2	
	Shock	300 m/s^2	
Long-term storage in transport packaging	**Class 1K4**		**IEC/EN 60721-3-1**
	Ambient temperature	-25 °C...+55 °C / -13 °F...+131 °F	
	Condensation	No	
	Icing	No	
	other liquid	No	
	Relative humidity	5% ... 85%	

Table 7-3: Ambient conditions Distribution Box ILM62DB

ILM62 motor

Procedure	Parameter	Value	Basis
Operation	**Class 3K3**		**IEC/EN 60721-3-3**
	Degree of protection housing	IP 65 with plugged-in connectors	
	Ambient temperature	+5°C...+40°C	
	Relative humidity	5% ... 85%	
	Class 3M7		
	Shock	250 m/s^2	
	Vibration	30 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	
	other liquid	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	
	other liquid	No	
	Relative humidity	10% ... 100%	

Table 7-4: Ambient conditions for ILM62 motor

7.3 Standards and regulations

CE	EC Low Voltage Directive 2006/95/EC • EN 61800-5-1:2007
	EC EMC Directive 2004/108/EC • EN 61800-3:2004
UL	UL 508C: Power Conversion Equipment

Table 7-5: Standards and regulations

Functional safety	EN ISO 13849-1:2008, PL e, EN 61508:2010, SIL 3

Table 7-6: Standards and regulations - Functional safety

7.4 Motor options

Designation	Description
Motor shaft	Standard shaft with round-ended feather key according to DIN 6885 T1
Brake	Electromagnetic/permanently magnetic holding brake
Cooling	Air cooling (fan cover)

Table 7-7: Technical data of the motor options

7.5 Mechanical and electrical data

7.5.1 Connection Module ILM62CM

Category	Parameter	Value
Product configuration	Item name	ILM62CMD20
Electronics power supply (CN1)	Control voltage	DC +24 V -20% / +25%
	Input current	20 A
Power supply (CN1)	DC_Bus Voltage	DC 250 ... 700 V
	Input current	20 A rated current
	DC link capacity	220 µF
	Discharge time	5 min (max.)
	Overvoltage	860 Vdc
Output DC bus (CN7)	DC_Bus Voltage	DC 250 ... 700 V
	Output current	20 A rated current
Inverter Enable power supply (CN6)	Control voltage	DC +24 V -20% / +25%
Inverter Enable output signal (CN8)	IE voltage	AC 40 V (eff.)
	IE current	2 A
	IE signal frequency	100 kHz
Interfaces	SERCOSIII	integrated
Cooling		Natural convection
Protection		IP20
Isolation class	Pollution degree	2 (IEC 61800-5-1:2007)
Overvoltage resist-ance	Class	1 (DIN VDE 0160)
Overvoltage category	Class	III (EN 61800-5-1:2007)
Radio interference level	Class	A EN 55011 / EN 61800 - 3
Dimensions	Housing D x W x H	270 mm x 44.5 mm x 310 mm (10.63 in. x 1.75 in. x 12.20 in.)
Weight	Weight (with packaging)	3 kg (4 kg) / 6.6 lbs (8.8 lbs)

Table 7-8: Technical data Connection Module ILM62CM

7.5.2 Distribution Box ILM62DB

Category	Parameter	Value
Product configuration	Item name	Distribution Box ILM62DB
DC power supply (CN1 - CN5)	DC_Bus Voltage	DC 250 V ... 700 V
	Rated current	20 A
	DC capacity	100 µF
Electronics power supply (CN1 - CN5)	Control voltage / -current	DC 24 V (-20%..+25%) / max 20 A
	Control voltage capacity	1000 µF
Inverter Enable (CN1 - CN5)	IE voltage	AC 42 V (eff.)
	IE current	2 A (eff.)
	IE signal frequency	100 kHz
Ethernet SERCOS (CN1 - CN5)	Data rate	100 Mbit/s
Cooling		Natural convection
Protection		IP 65
Isolation class	Pollution degree	2 (IEC 61800-5-1:2007)
Overvoltage category	Class	III (IEC 61800-5-1:2007), T2 (DIN VDE 0110)
Overvoltage resist-ance	Class	1 (DIN VDE 0160)
Radio interference level	Class	A EN 55011 / EN 61800 - 3
Material		Polycarbonate [Lexan 940A]
Dimensions	Housing D x W x H	151.4 mm x 230 mm x 94 mm (5.96 in. x 9.05 in. x 3.70 in.)
Weight		0.85 kg (1.8 lbs)

Table 7-9: Technical data Distribution Box ILM62DB

7.5.3 ILM motor controller

Category	Parameter	Value
Power Supply	Supply voltage	250 ... 700 V DC
	Connection capacity	700 nF
Electronics power supply (without brake)	Control voltage	DC +24 V -20% / +25%
	Current consumption	250 mA (max.)
	Voltage monitoring	Undervoltage limit: 18.5 V Overvoltage limit: 31 V
Electronics power supply (with brake)	Control voltage	DC +24 V -20% / +25%
	Current consumption ILM 070	Typically 550 mA
	Current consumption ILM 100	Typically 750 mA
	Current consumption ILM 140	typical 1.0 A
	Voltage monitoring	Undervoltage limit: 18.5 V Overvoltage limit: 31 V
Cooling		Natural convection
Overvoltage category	Class	III (EN 61800-5-1:2007), T2 (DIN VDE 0110)
Overvoltage resist-ance	Class	1 (DIN VDE 0160)
Radio interference level	Class	A EN 55011 / EN 61800 - 3
Insulation material class		F
Protection	Controller	IP65
	Motor	For information on the degree of protection of the motor, see Technical data ILM62 motors.
Isolation class	Pollution degree	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 7-10: Technical data ILM motor controller

7.5.4 ILM070 Servo Motor

Category	Parameter	Abbreviation [unit]	ILM070 1 P	ILM070 2 P	ILM070 3 P
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	I_N [A_{rms}]	0.60	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 [$kgcm^2$]	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 7-11: Technical data ILM070 without (with) brake

7.5.5 ILM100 Servo Motor

Category	Parameter	Abbreviation [unit]	ILM100 1 P	ILM100 2 P	ILM100 3 P
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	3.60
	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 [$kgcm^2$]	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 7-12: Technical data ILM100 without (with) brake

7.5.6 ILM140 Servo Motor

Category	Parameter	Abbreviation [unit]	ILM140 1 P	ILM140 1 M	ILM140 2 P
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 [$kgcm^2$]	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 7-13: Technical data ILM140 without (with) brake

7.5.7 Encoder

SinCos® (SKS36) Singleturn

Parameter	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 7-14: Technical data of the SinCos encoder (SKS-36)

SinCos® (SKM36) Multiturn

Parameter	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 7-15: Technical data of the SinCos® encoder (SKM-36)

7.5.8 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 hub 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.

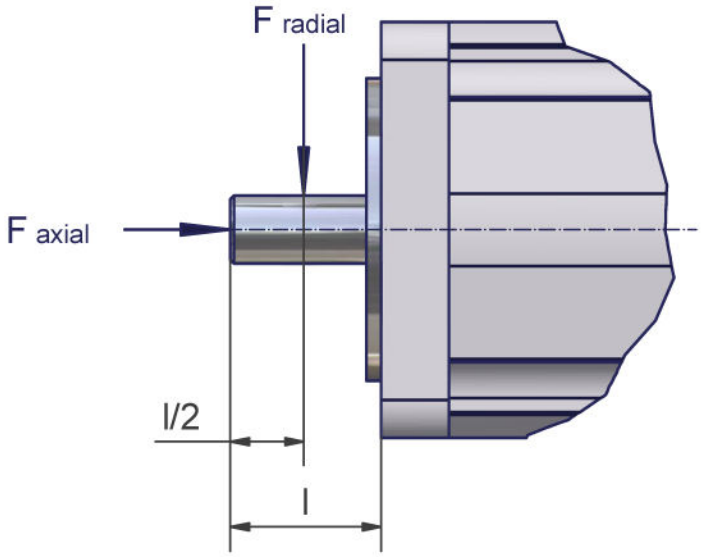


Figure 7-1: Definition of shaft load

Motor	1000 min^{-1}	2000 min^{-1}	3000 min^{-1}	4000 min^{-1}	5000 min^{-1}	6000 min^{-1}
ILM070 1 P	660	520	460	410	380	360
ILM070 2 P	710	560	490	450	410	390
ILM070 3 P	730	580	510	460	430	400
ILM100 1 P	900	720	630	-	-	-
ILM100 2 P	990	790	690	-	-	-
ILM100 3 P	1050	830	730	-	-	-
ILM140 1 M	2210	1760	-	-	-	-
ILM140 1 P	2210	1760	1530	-	-	-
ILM140 2 P	2430	1930	-	-	-	-

Table 7-16: Permissible radial force F_{radial} [N]

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

$F_{axial} = 0.2 \times F_{radial}$

- 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

7.5.9 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 overvoltage 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.

Failure to follow these instructions can result in injury or equipment damage.

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 switching on the current to the dying out of the torque to 10% of 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 ILM070

Parameter	ILM070 1 P	ILM070 2 P	ILM070 3 P	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	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 7-17: Technical data of the holding brake of the ILM070

Technical data of the holding brake of the ILM100

Parameter	ILM100 1 P	ILM100 2 P	ILM100 3 P	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	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 7-18: Technical data of the holding brake of the ILM100

Technical data of the holding brake of the ILM140

Parameter	ILM140 1 P	ILM140 1 M	ILM140 2 P	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	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 7-19: Technical data of the holding brake of the ILM140

7.6 Mounting arrangement and degree of protection

The drive degree of protection 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 and 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.:

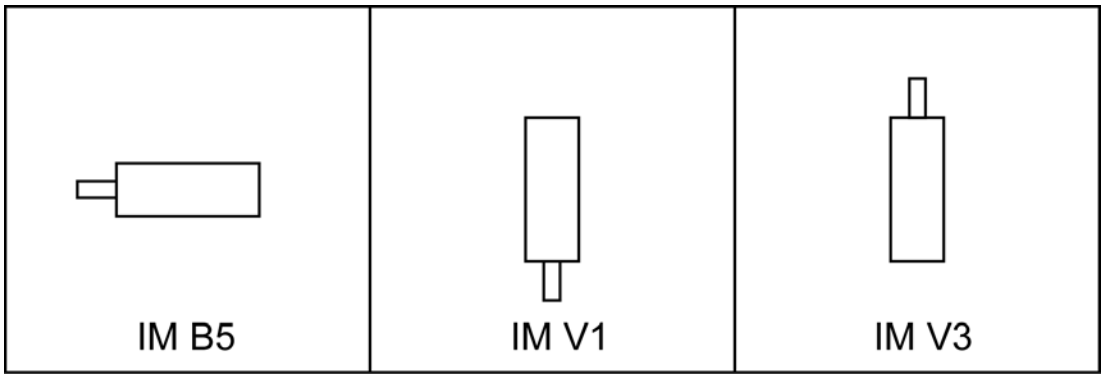


Figure 7-2: Drive installations

NOTICE

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	Degree of protection (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 (shaft sealing ring)
Surface/connections	IP 65	IM B5, IM V1, IM V3

Table 7-20: Degree of protection of the ILM servo motor

7.7 Torque/speed characteristic curves

The torque-speed characteristic curve represents the following characteristics:

- The permissible permanent torque (operating type S 1)
- The peak torque with mains voltage = 3 x 230 Vac

- The peak torque with mains voltage = 3 x 400 Vac

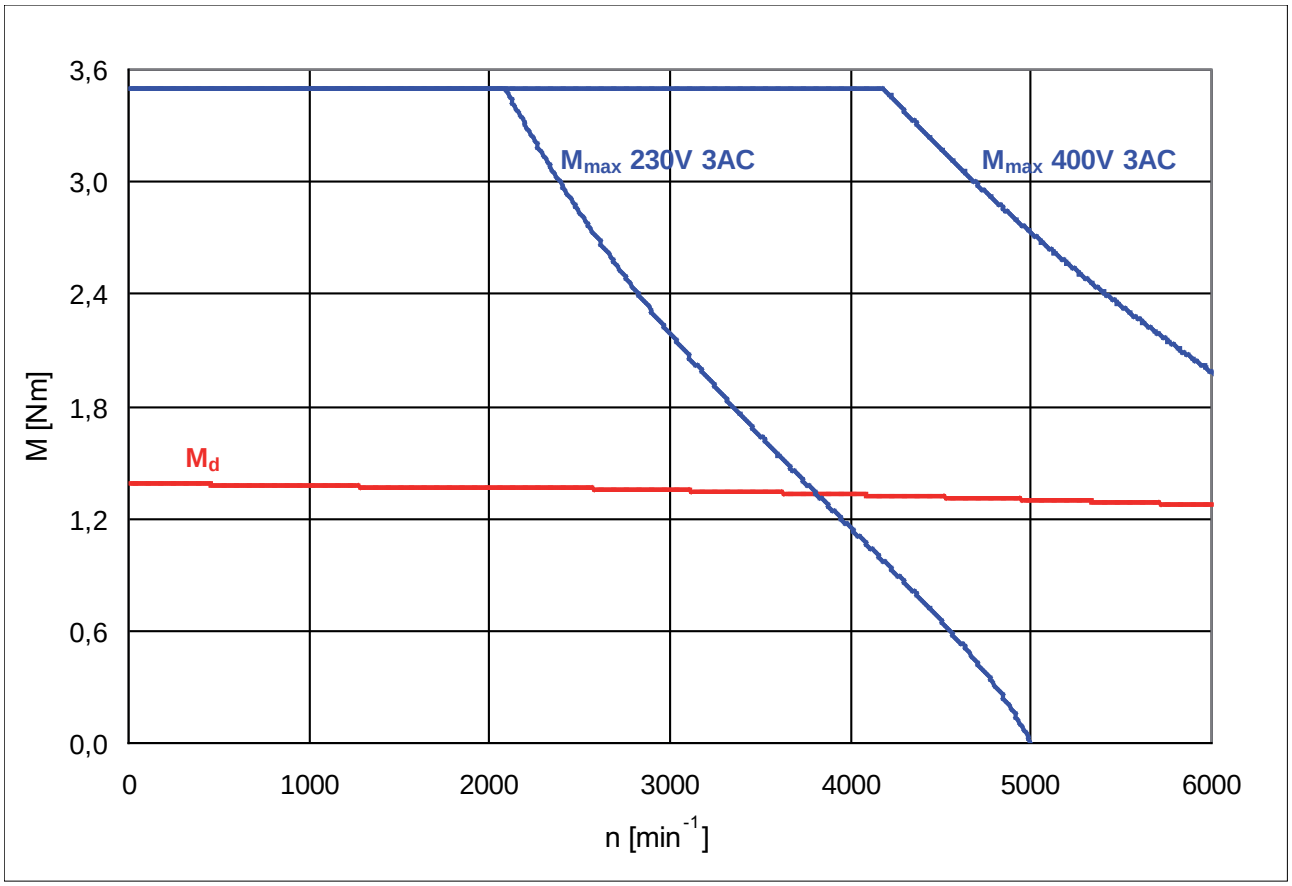


Figure 7-3: Example of a torque-speed characteristic curve

The characteristic curves refer to an ambient temperature of 40°C and a maximum winding temperature of 120°C.

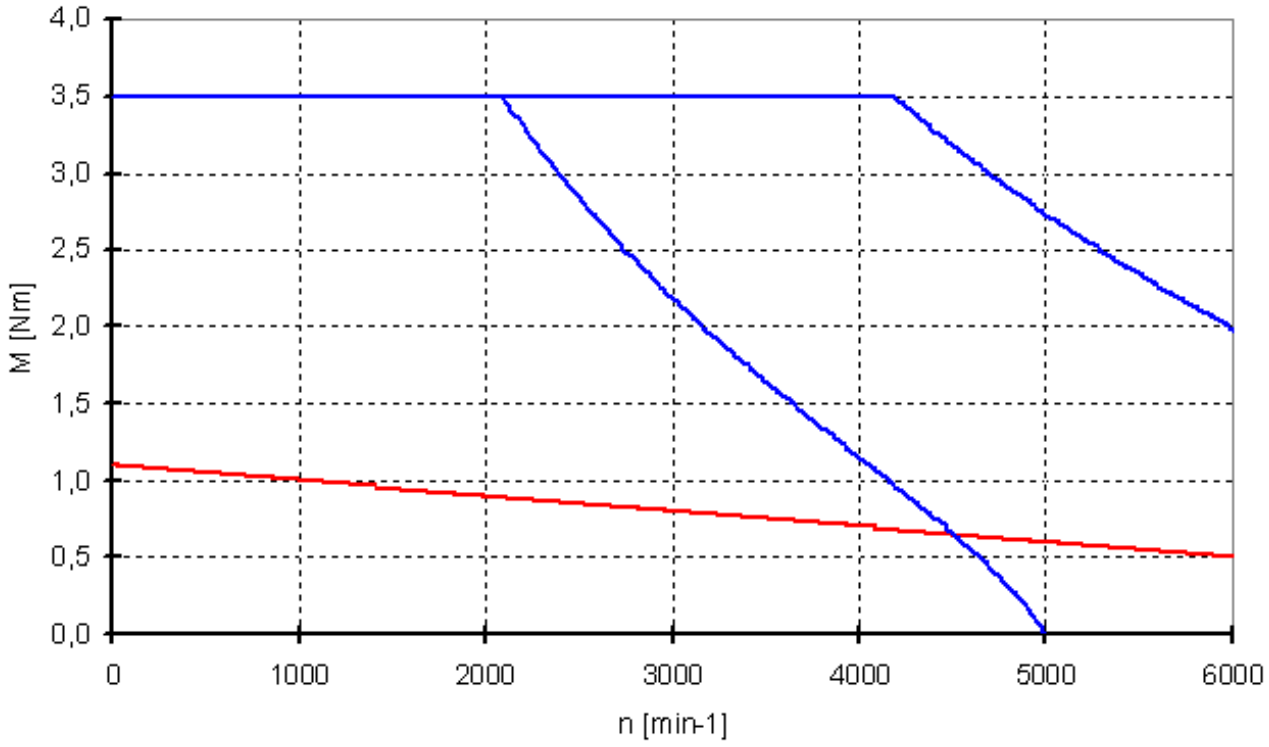


Figure 7-4: Torque-speed characteristic curve ILM 070 1 P

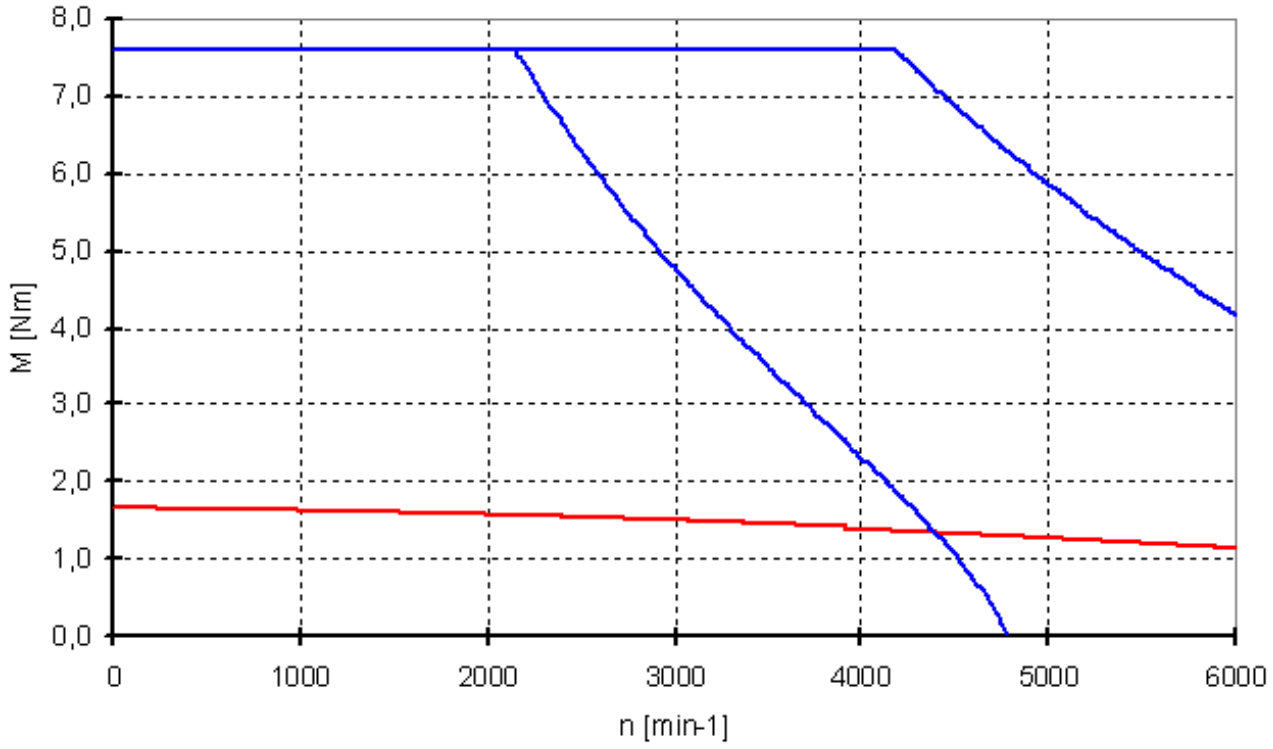


Figure 7-5: Torque-speed characteristic curve ILM 070 2 P

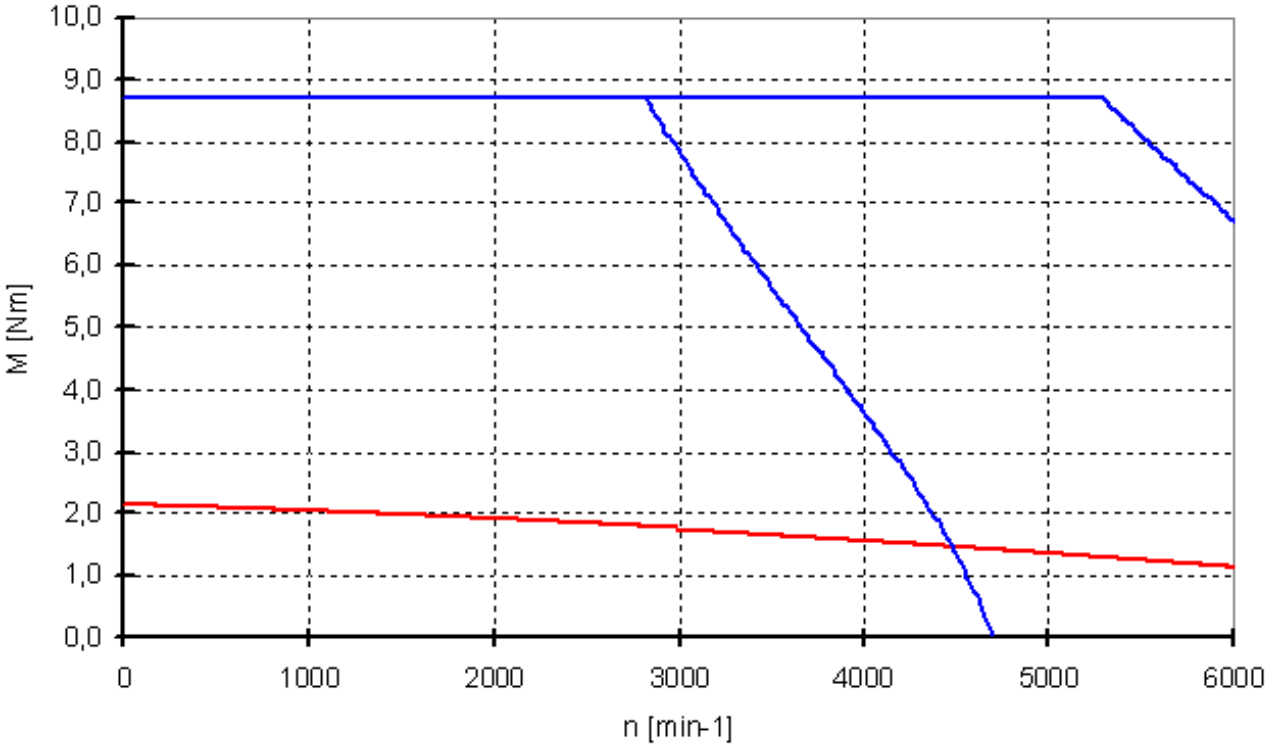


Figure 7-6: Torque-speed characteristic curve ILM 070 3 P

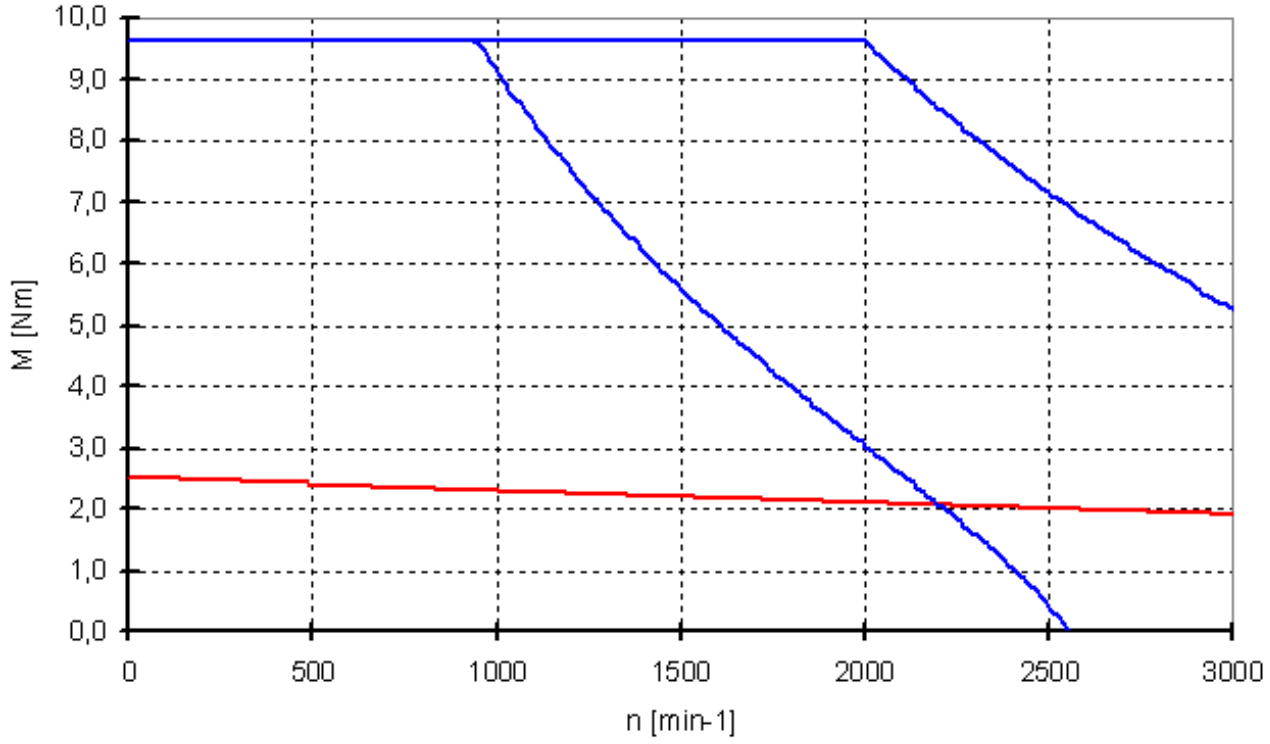


Figure 7-7: Torque-speed characteristic curve ILM 100 1 P

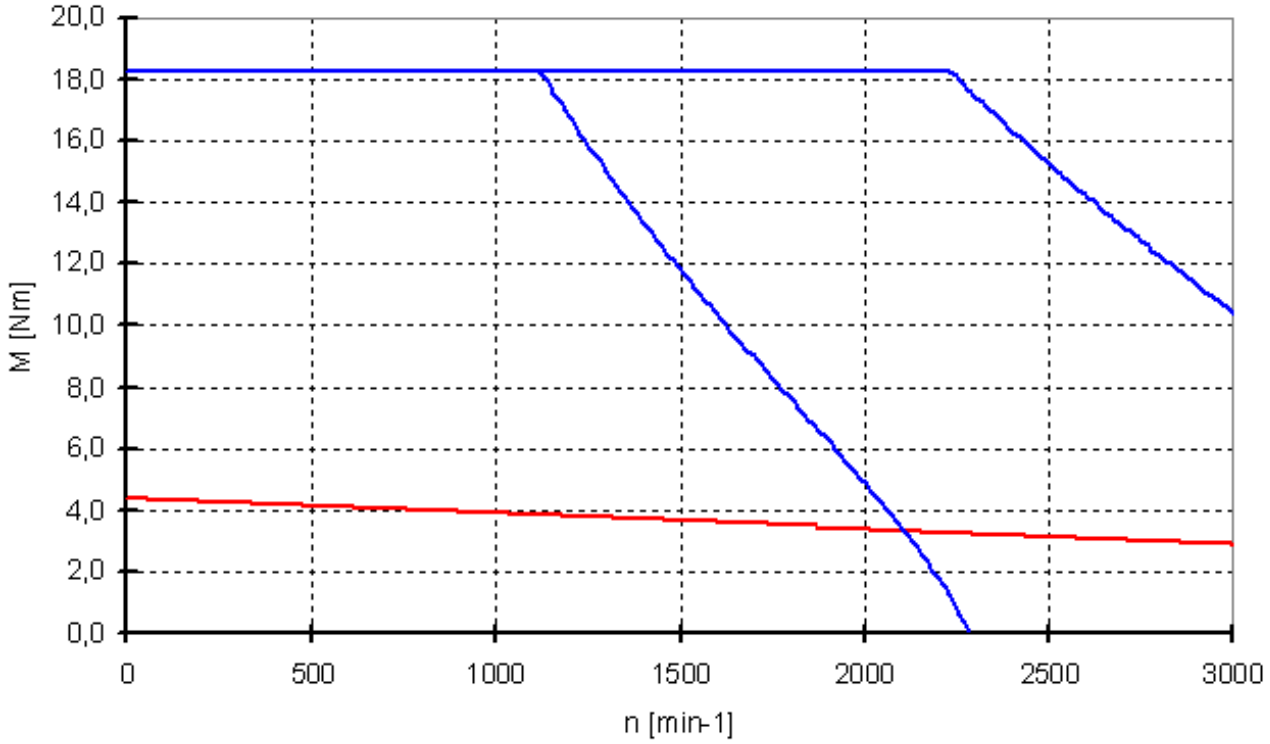


Figure 7-8: Torque-speed characteristic curve ILM 100 2 P

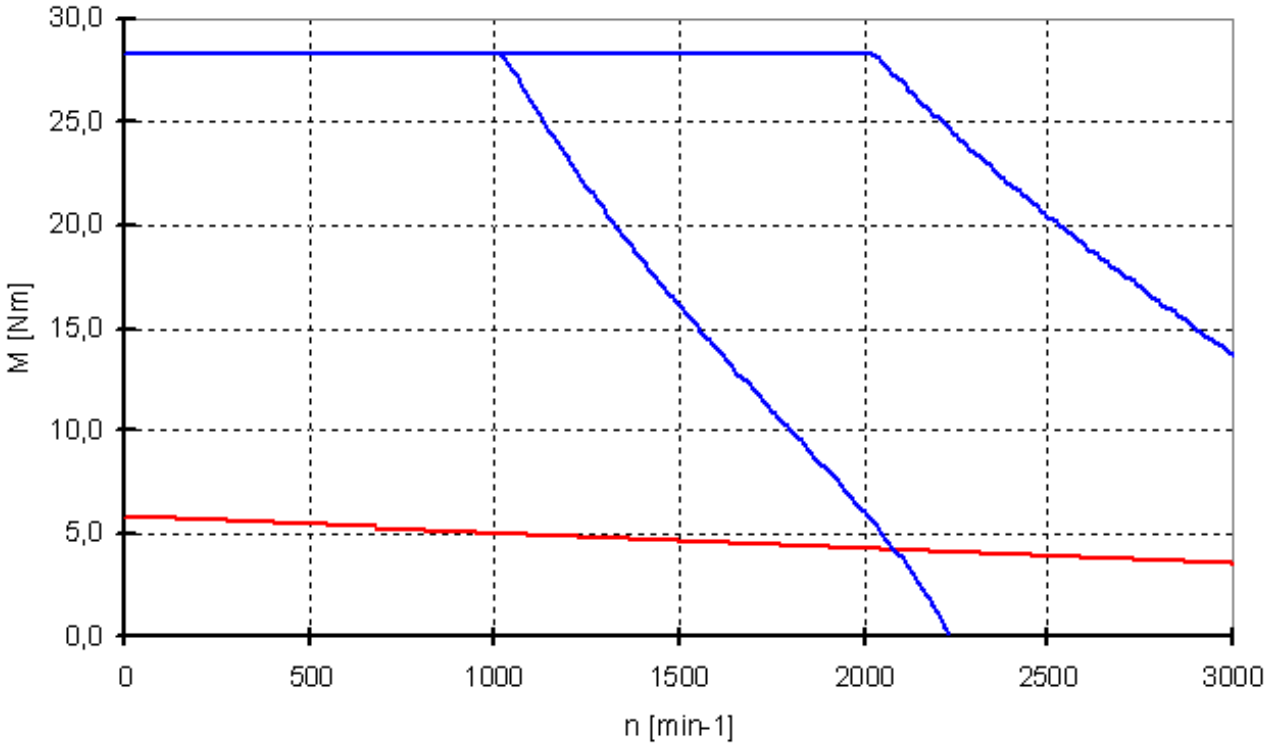


Figure 7-9: Torque-speed characteristic curve ILM 100 3 P

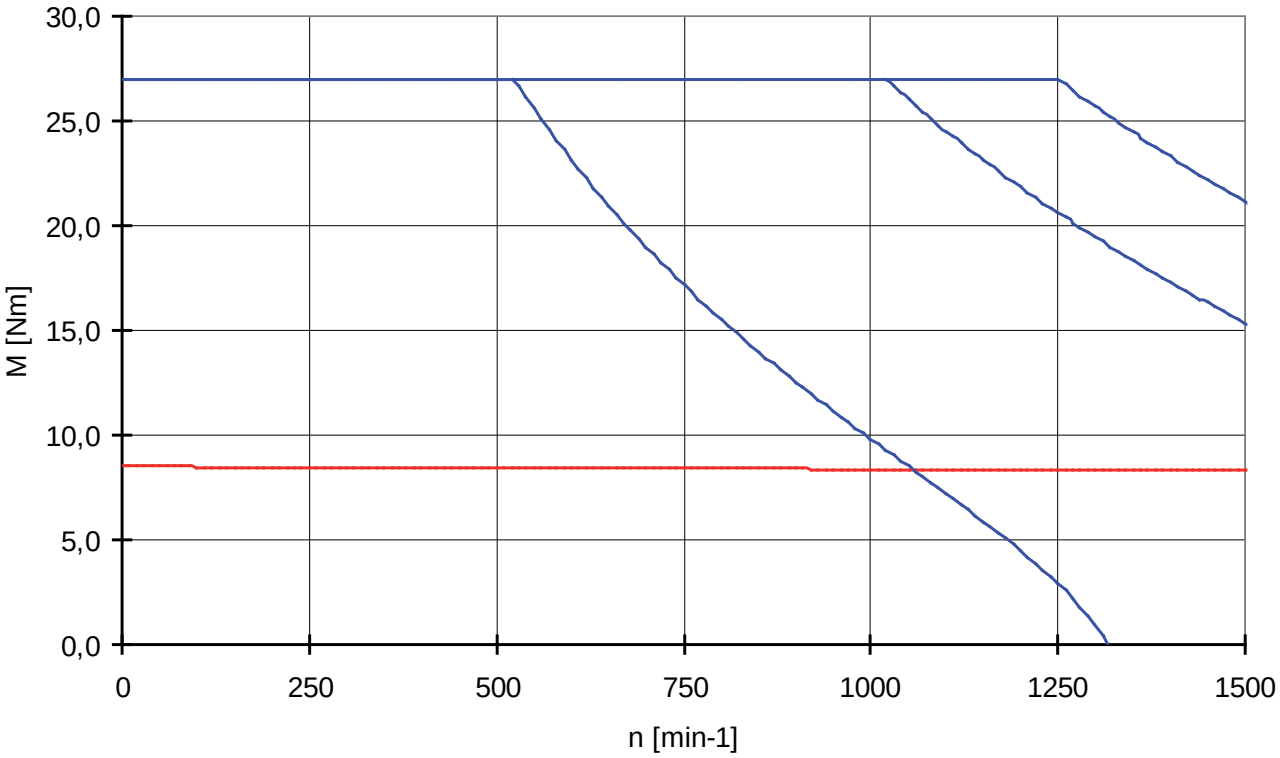


Figure 7-10: Torque-speed characteristic curve ILM 140 1 M

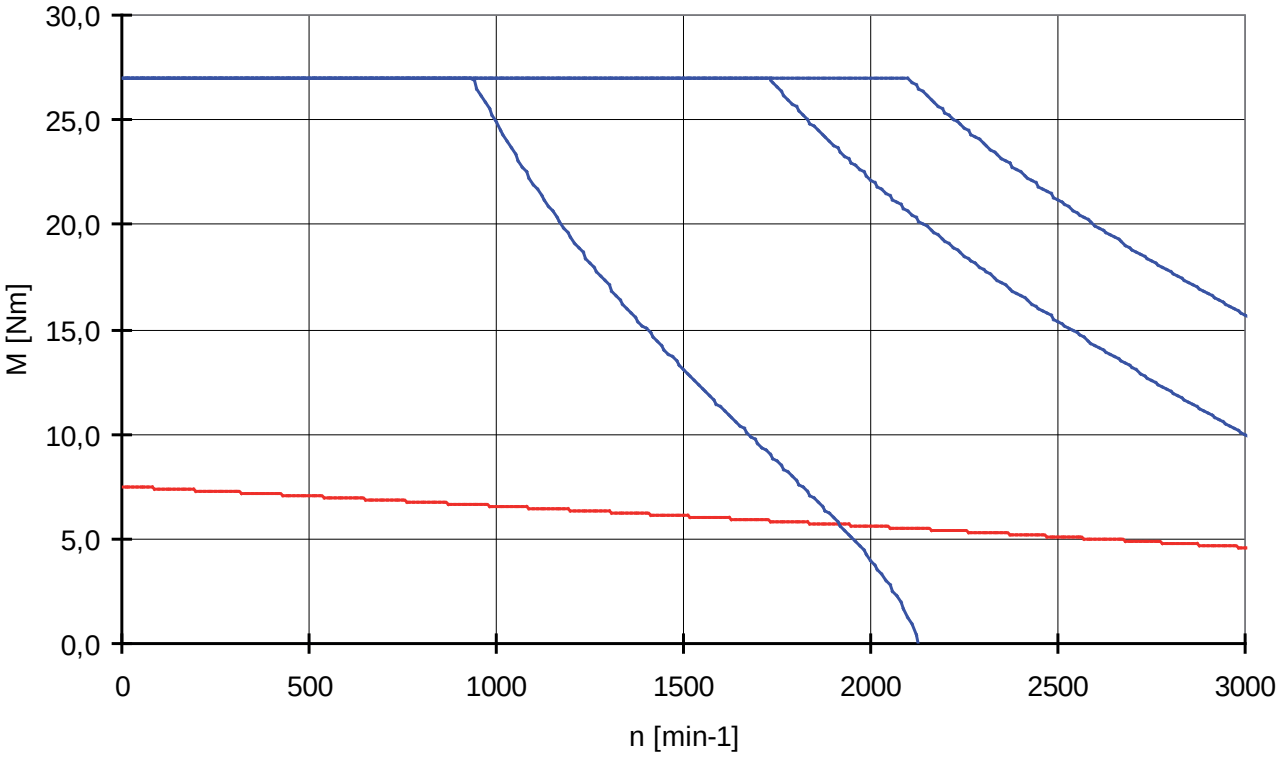


Figure 7-11: Torque-speed characteristic curve ILM 140 1 P

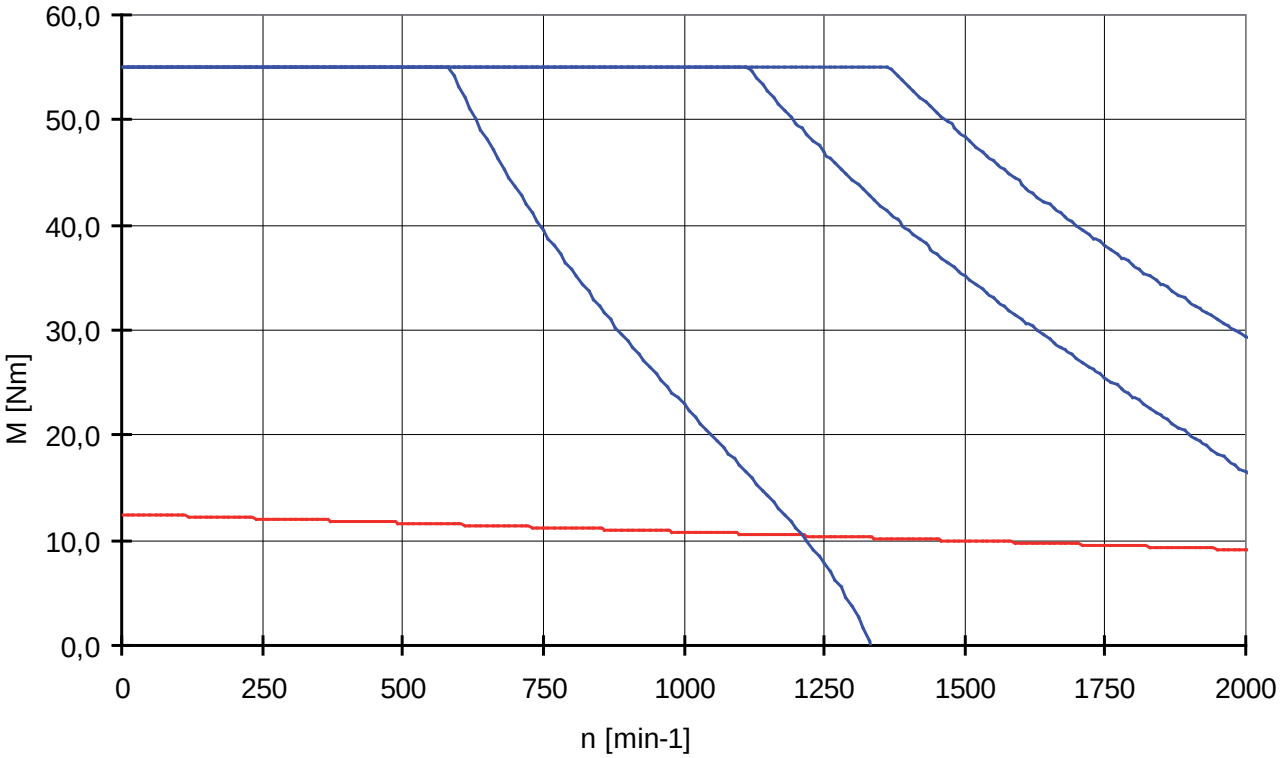


Figure 7-12: Torque-speed characteristic curve ILM 140 2 P

7.8 Electrical connections

7.8.1 Connection Module ILM62CM

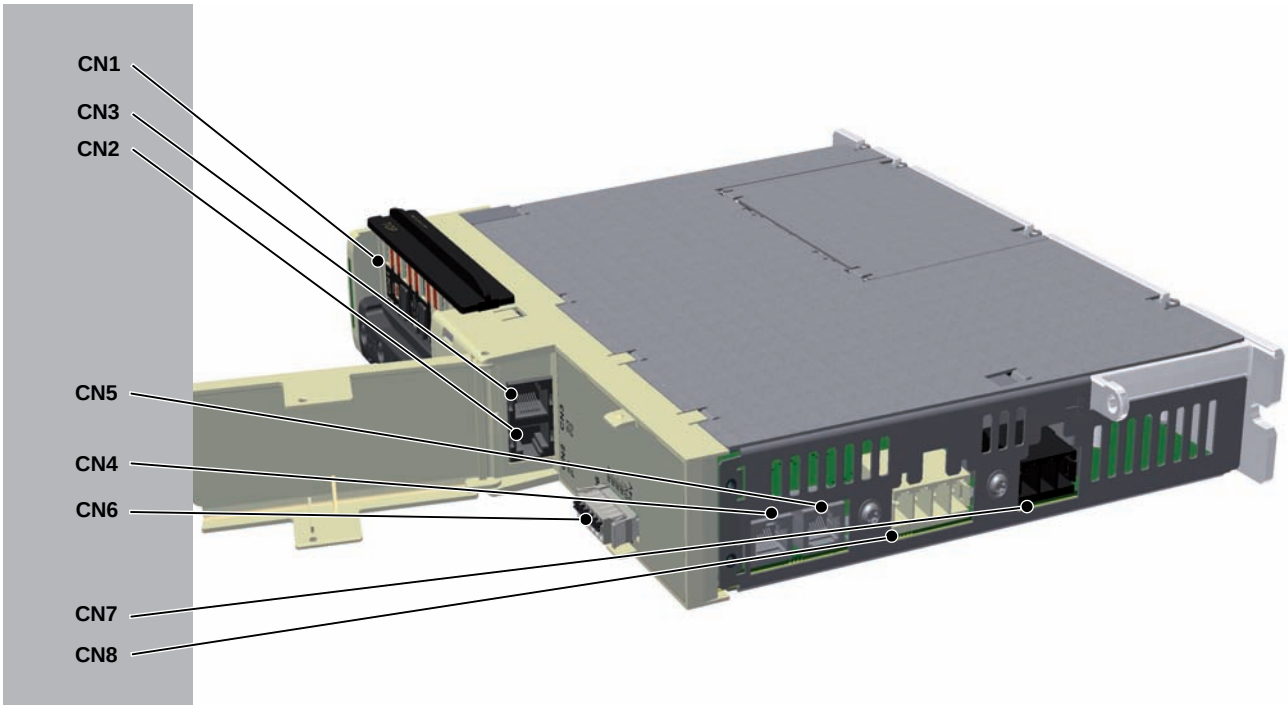
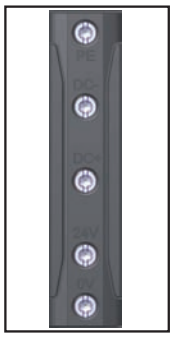


Figure 7-13: Connection overview Connection Module ILM62CM

Connection	Meaning	Connection cross-section [mm²]/ [AWG]	Tightening torque [Nm] / [lbf in]
CN1	Bus Bar Module	- / -	2.5 / 22.14
CN2/CN3	SERCOS /// communi-cation	- / -	- / -
CN4	SERCOS /// communi-cation	- / -	- / -
CN5	SERCOS /// communi-cation	- / -	- / -
CN6	Inverter Enable 24 V	0.5 … 16 / 20 ... 6	- / -
CN7	DC bus output	0.2 ... 6 / 24 ... 10	- / -
CN8	Inverter Enable signal output / 24 V output	0.2 ... 6 / 24 ... 10	- / -
⏚	Ground conductor	10 (cable shoe) / 6	3.5 / 30.98

CN1 - Bus Bar Module

The DC bus voltage and the 24Vdc control voltage will be distributed and the protective conductor connected via the Bus Bar Module. A separate cabling is not required.

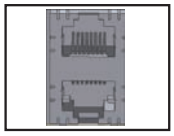


Pin	Designation	Meaning
1	⏚	Ground conductor
2	DC-	- DC bus voltage
3	DC +	Dc bus voltage +
4	24V	Supply voltage +
5	0V	Supply voltage -

Table 7-21: Electrical connection - Bus Bar Module

CN2/CN3 - SERCOS *III*

The Sercos /// connection is used for communication between the LMC controller, the power supply and the Connection Module or modules.

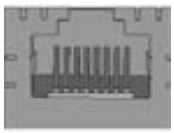


Pin	Designation	Meaning
1.1	Eth0_Tx+	Positive transmission signal
1.2	Eth0_Tx-	Negative transmission signal
1.3	Eth0_Rx+	Positive received signal
1.4	n.c.	-
1.5	n.c.	-
1.6	Eth0_Rx-	Negative received signal
1.7	n.c.	-
1.8	n.c.	-
2.1	Eth1_Tx+	Positive transmission signal
2.2	Eth1_Tx-	Negative transmission signal
2.3	Eth1_Rx+	Positive received signal
2.4	n.c.	-
2.5	n.c.	-
2.6	Eth1_Rx-	Negative received signal
2.7	n.c.	-
2.8	n.c.	-

Table 7-22: Electrical connection - SERCOS III

CN4 - SERCOS ///

The Sercos /// connection is used for communication between Connection Module ILM62CM and ILM62 motor.

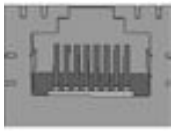


Pin	Designation	Meaning
1	Eth0_Tx+	Positive transmission signal
2	Eth0_Tx-	Negative transmission signal
3	Eth0_Rx+	Positive received signal
4	n.c.	-
5	n.c.	-
6	Eth0_Rx-	Negative received signal
7	n.c.	-
8	n.c.	-

Table 7-23: Electrical connection - SERCOS III

CN5 - SERCOS ///

The Sercos /// connection is used for communication between the connection module and the ILM motor.

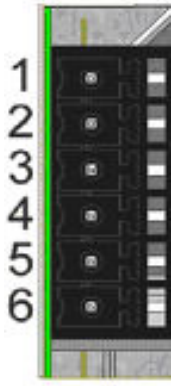


Pin	Designation	Meaning
1	Eth0_Tx+	Positive transmission signal
2	Eth0_Tx-	Negative transmission signal
3	Eth0_Rx+	Positive received signal
4	n.c.	-
5	n.c.	-
6	Eth0_Rx-	Negative received signal
7	n.c.	-
8	n.c.	-

Table 7-24: Electrical connection - SERCOS III

CN6 - Inverter Enable power supply 24V

The Inverter Enable voltage connection supplies the Inverter Enable output.

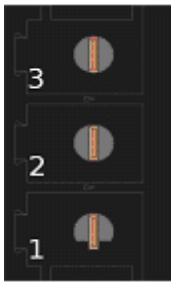


Pin	Designation	Meaning
1	IE_p1	Supply voltage 24V for IE
2	IE_p2	Supply voltage 24V for IE
3	IE_n1	Supply voltage 0V for IE
4	IE_n2	Supply voltage 0V for IE
5	0V_int1	Control voltage 0V
6	0V_int2	Control voltage 0V

Table 7-25: Inverter Enable supply voltage 24V

CN7 - DC bus output

Via the hybrid cable the DC bus output is connected to the Distribution Box ILM62DB or directly connected to an ILM62 motor and supplies the ILM62 motor with the required power.



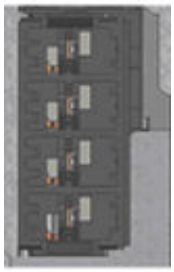
Pin	Designation	Meaning	Color of cable core
1	DC +	Dc bus voltage +	red
2	PE	Ground conductor	green/yellow
3	DC-	- DC bus voltage	black

Table 7-26: Electrical connection - DC bus output

The insulation-stripped length of the wires of the DC bus connector is 15 mm (0.59 in.).

CN8 - Inverter Enable output

The Inverter Enable signal safely switches off the motor torque.

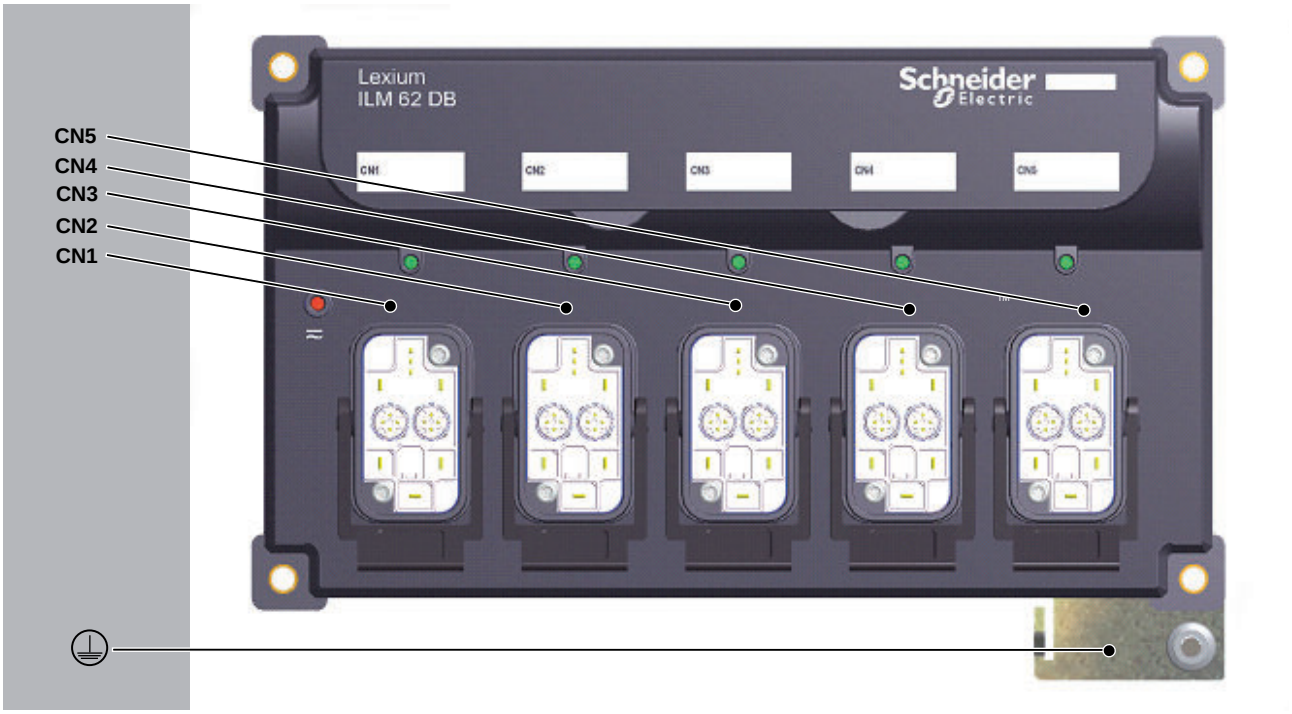


Pin	Designation	Meaning	Color of cable core
1	IE_sig	IE signal 1	white (core)
2	IE_ref	IE signal 2	white (shield)
3	24V_out	Control voltage 24V	green
4	0V_out	Control voltage 0V	gray

Table 7-27: Inverter Enable output

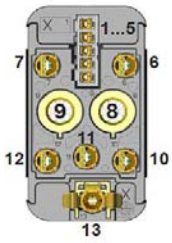
The insulation-stripped length of the wires of the 24V input connector is 15 mm (0.59 in.).

7.8.2 Distribution Box ILM62DB



Connection	Meaning
CN1	Input (Connection Module ILM62CM or Distribution Box ILM62DB)
CN2	Output (Distribution Box ILM62DB or ILM62 motor)
CN3	Output (Distribution Box ILM62DB or ILM62 motor)
CN4	Output (Distribution Box ILM62DB or ILM62 motor)
CN5	Output (Distribution Box ILM62DB or ILM62 motor)
⏚	Ground conductor

Table 7-28: Connection overview Distribution Box ILM62DB



Pin	Designation	Meaning
1	IE_sig	Inverter Enable (differential signal)
2	IE_ref	
3	Hybrid cable detection	Hybrid cable detection
4	Hybrid cable detection	Hybrid cable detection
5	n.c.	-
6	24V	Control voltage 24V
7	0V	Control voltage 0V
8.1	Rx+	SERCOSIII port 1 – input
8.2	Tx-	SERCOSIII port 1 – output
8.3	Rx-	SERCOSIII port 1 – input
8.4	Tx+	SERCOSIII port 1 – output
9.1	Rx+	SERCOSIII port 2 – input
9.2	Tx-	SERCOSIII port 2 – output
9.3	Rx+	SERCOSIII port 2 – input
9.4	Tx-	SERCOSIII port 2 – output
10	DC-	- DC bus voltage
11	Shield	Shielded connector
12	DC +	Dc bus voltage +
13	PE	Ground conductor

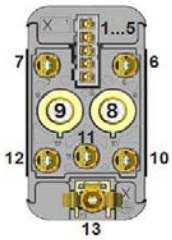
Table 7-29: Connector Distribution Box ILM62DB

Always use the supplied covers for unused connections as protection against dangerous voltages and to guarantee degree of protection IP 65.

7.8.3 ILM62 motor

Figure 7-14: Connection overview ILM62 motor

1	Ground connection
2	Hybrid connector



Pin	Designation	Meaning
1	IE_sig	Inverter Enable (differential signal)
2	IE_ref	
3	Brake	Braking signal
4	n.c.	-
5	n.c.	-
6	24V	Control voltage 24V
7	0V	Control voltage 0V
8.1	Rx+	SERCOSIII port 1 – input
8.2	Tx-	SERCOSIII port 1 – output
8.3	Rx-	SERCOSIII port 1 – input
8.4	Tx+	SERCOSIII port 1 – output
9.1	Rx+	SERCOSIII port 2 – input
9.2	Tx-	SERCOSIII port 2 – output
9.3	Rx+	SERCOSIII port 2 – input
9.4	Tx-	SERCOSIII port 2 – output
10	DC-	- DC bus voltage
11	Shield	Shielded connector
12	DC +	Dc bus voltage +
13	PE	Ground conductor

Table 7-30: Connector ILM62 motor

7.9 Dimensions

7.9.1 Connection Module ILM62CM

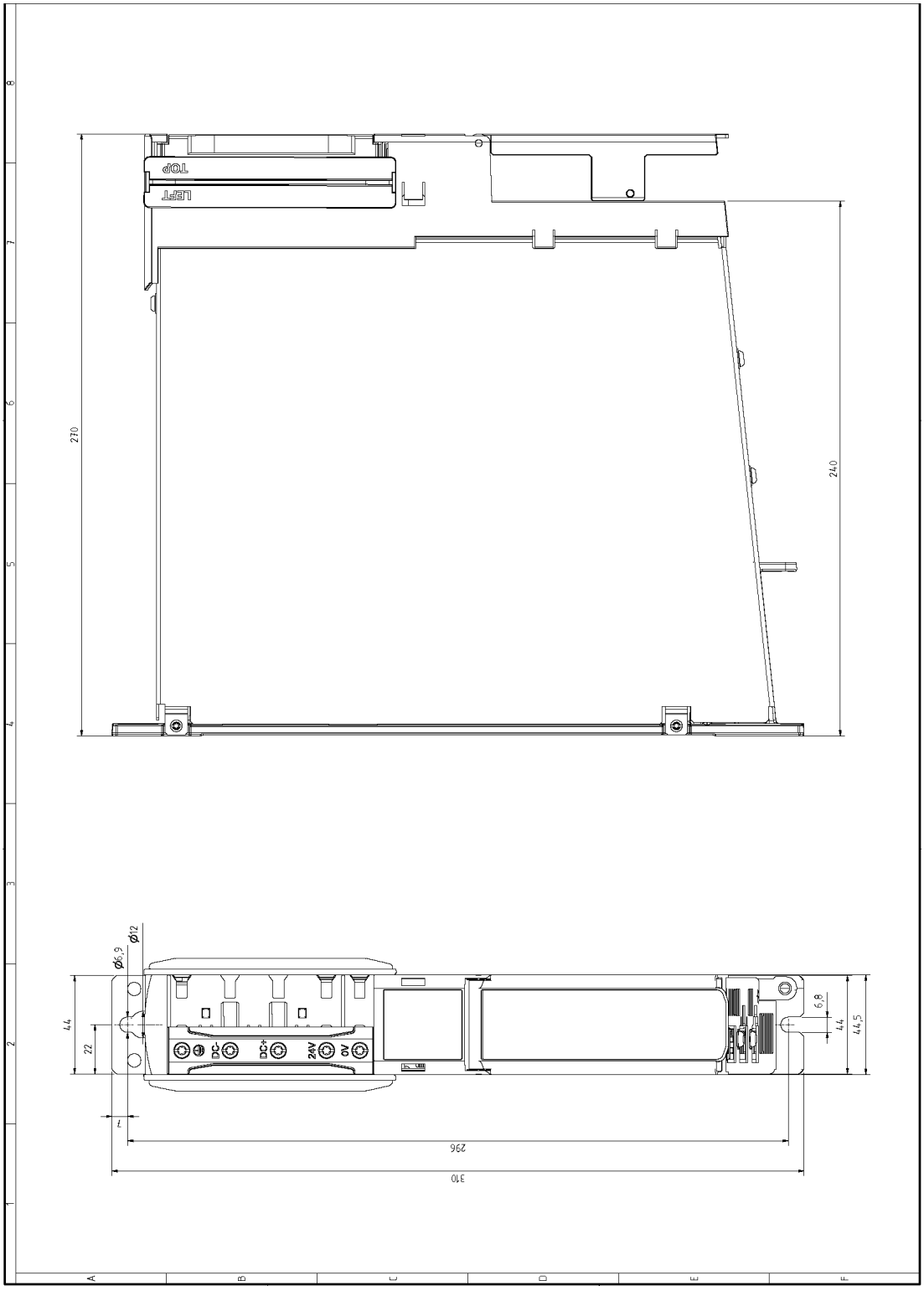


Figure 7-15: Dimensions Connection Module ILM62CM in mm (calculation table in the appendix)

7.9.2 Distribution Box ILM62DB

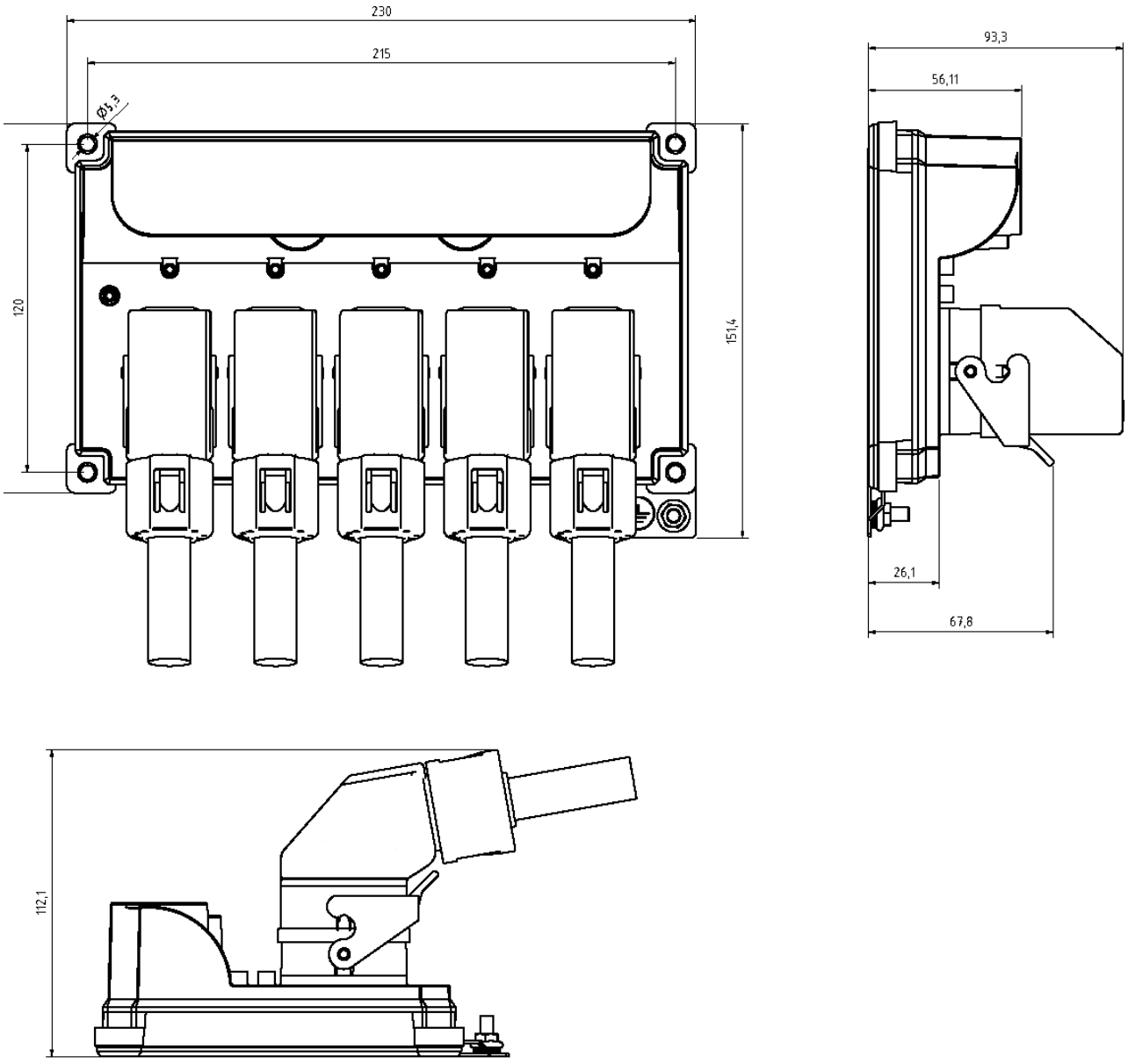
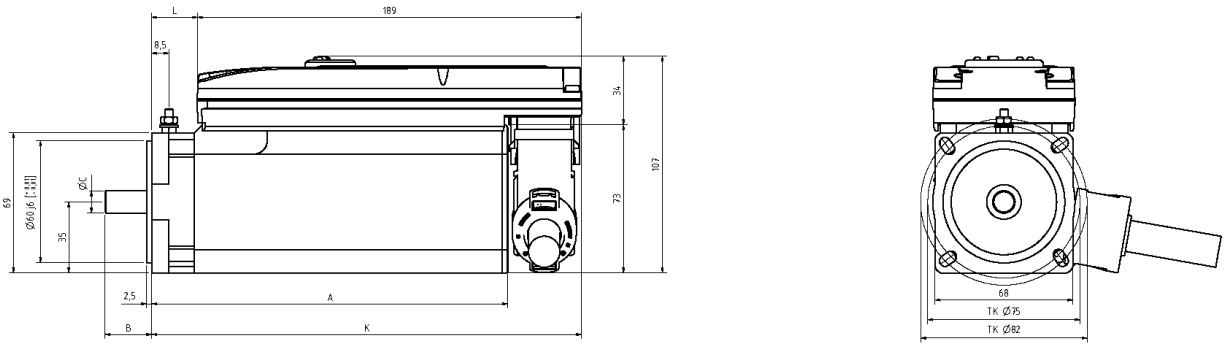


Figure 7-16: Dimensions Distribution Box ILM62DB in mm (calculation table in the appendix)

7.9.3 ILM62 motors

Dimensions ILM070

without Option-module



with Option-module

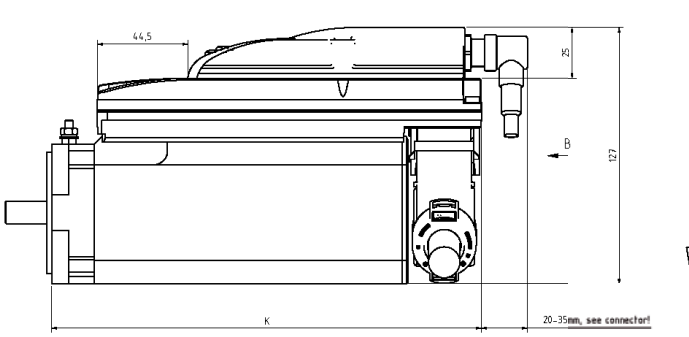


Figure 7-17: Dimensions ILM070 motor in mm (calculation table in the appendix)

Please note that the ILM series 070 uses different shaft diameters. The shaft diameter for the ILM070 3 P is 14 mm.

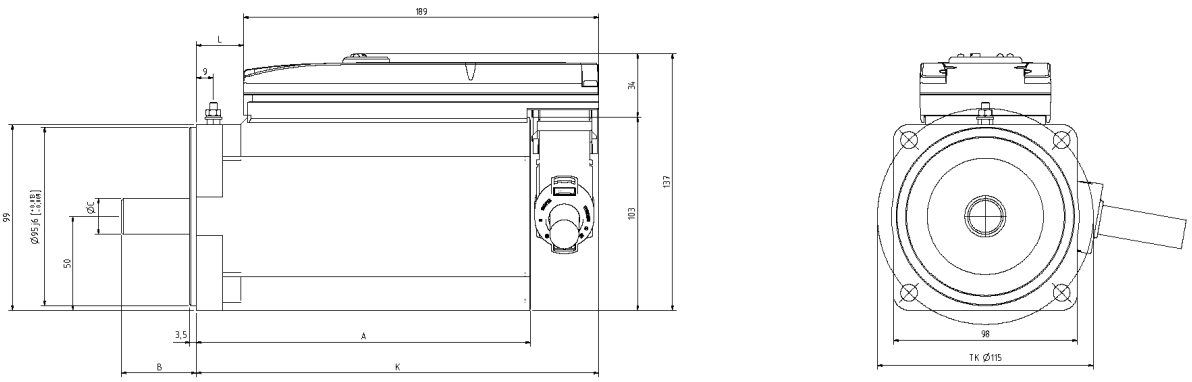
Dimensions table

Dimensions	ILM070 1 P	ILM070 2 P	ILM070 3 P
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)

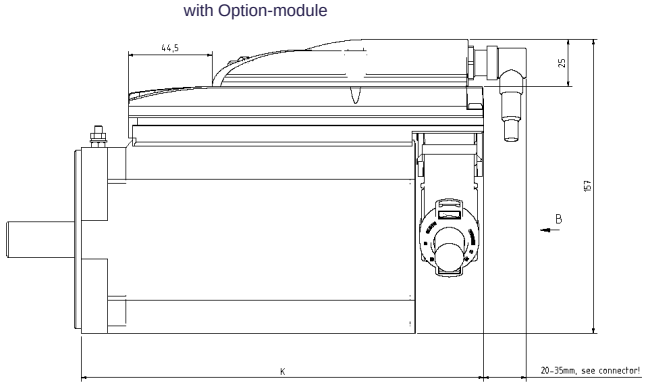
Table 7-31: Dimensions of the ILM070 (dimension specifications in mm)

Dimensions ILM100

without Option-module



with Option-module



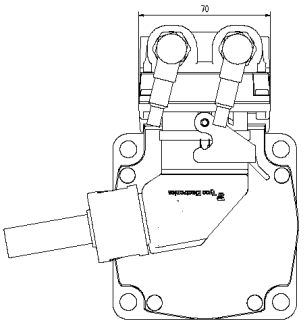


Figure 7-18: Dimensions ILM100 motor in mm (calculation table in the appendix)

Dimensions table

Dimensions	ILM100 1 P	ILM100 2 P	ILM100 3 P
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 7-32: Dimensions of the ILM100 (dimension specifications in mm)

Dimensions ILM140

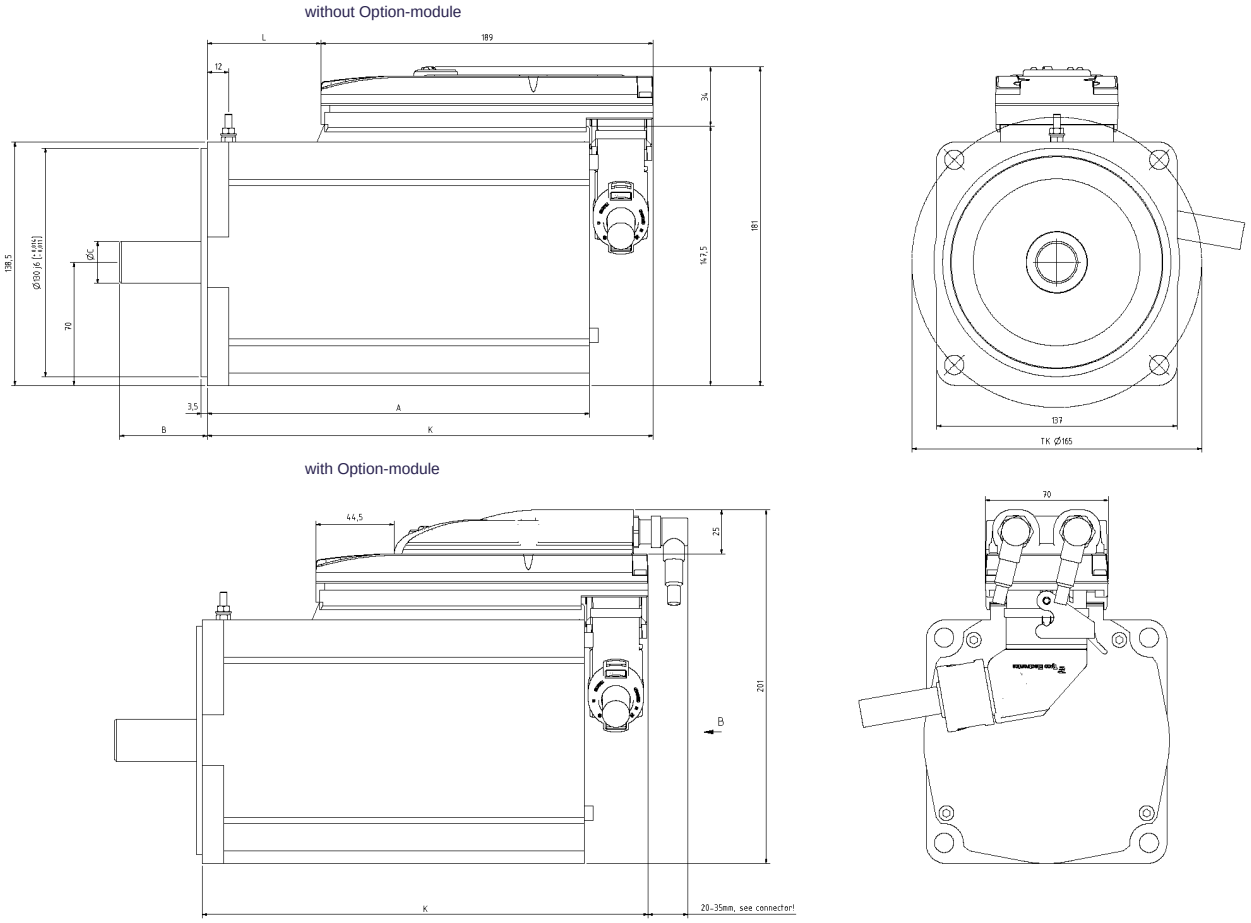


Figure 7-19: Dimensions ILM140 motor in mm (calculation table in the appendix)

Dimensions table

Dimensions	ILM140 1 P	ILM140 1 M	ILM140 2 P
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 7-33: Dimensions of the ILM140 (dimension specifications in mm)

Dimensions of the feather key

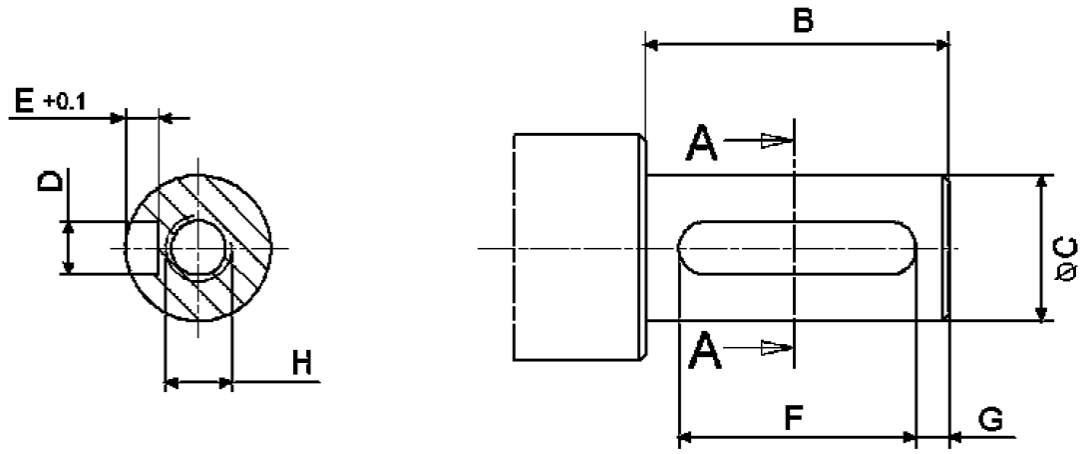


Figure 7-20: Dimension diagram of the feather key

Dimension tables

Dimensions	ILM070 1 P	ILM070 2 P	ILM070 3 P
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 7-34: Dimensions of the ILM070 feather key (dimension specifications in mm)

Dimensions	ILM100 1 P	ILM100 2 P	ILM100 3 P
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 7-35: Dimensions of the ILM100 feather key (dimension specifications in mm)

8 Appendix

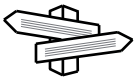
8.1 Contact addresses

Schneider Electric Automation GmbH

Dillberg 12 - 16
D-97828 Marktheidenfeld, Germany
Tel.: +49 (0) 9391 / 606 - 0
Fax: 09391/606-300
Email: info-marktheidenfeld@schneider-electric.com
Internet: www.schneider-electric.com

Machine Solution Service

97828 Marktheidenfeld, Germany
Phone: +49 (0) 9391 / 606 - 265
Fax: +49 (0) 9391 / 606 - 340
Email: support@schneider-electric.com
Internet: www.schneider-electric.com

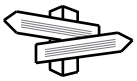


See the homepage (www.schneider-electric.com) for additional contact addresses.

8.2 Product training courses

Schneider Electric offers a number of product training courses.

Our training instructors will help you take advantage of the extensive possibilities offered by the system.



See the homepage (www.schneider-electric.com) for further information and our current seminar schedule.

8.3 Disposal

The components consist of different materials, which can be re-used and must be disposed of separately. The packaging cannot be returned to the manufacturer.

- ▶ Dispose of the packaging in accordance with the relevant national regulations.
- ▶ Dispose of the packaging at the disposal sites provided for this purpose.
- ▶ Dispose of ILM62 components in accordance with the applicable national regulations.

8.4 EC declaration of conformity

EC DECLARATION OF CONFORMITY Month.Year: 09.2011	Schneider Electric

We:	**Schneider Electric industries SA** **35, rue Joseph Monier** **92506 Rueil Malmaison, France**

Hereby declare that the products

Trademark	**Schneider Electric**
Product	**Adjustable speed electrical power drive systems**

Reference	Description
ILM62CMD20A#	Connection Module to LXM62 system
ILM62DBA#	Distribution Box with four outputs
ILM0701P#	Integrated Servo Motor 6000 rpm, 1.1 Nm
ILM0702P#	Integrated Servo Motor 6000 rpm, 1.7 Nm
ILM0703P#	Integrated Servo Motor 6000 rpm, 2.2 Nm
ILM1001P#	Integrated Servo Motor 3000 rpm, 2.5 Nm
ILM1002P#	Integrated Servo Motor 3000 rpm, 4.4 Nm
ILM1003P#	Integrated Servo Motor 3000 rpm, 5.8 Nm
ILM1401P#	Integrated Servo Motor 3000 rpm, 7.5 Nm
ILM1401M#	Integrated Servo Motor 1500 rpm, 8.5 Nm
ILM1402P#	Integrated Servo Motor 2000 rpm, 12.5 Nm
# followed by additional numbers or letters for options or internal use	

all the essential protection requirements that are described in the following directives are defined, corresponding. Furthermore, the conformity with the following harmonized European standards explained:

Directive	Harmonized Standard
DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (EMC) of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC	EN 61800-3:2004
DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits	EN 61800-5-1:2007

It is important that the component is subject to correct installation, maintenance and use conforming to its intended purpose, to the applicable regulations and standards, to the supplier's instructions, user manual and to the accepted rules of the art.

First year of affixing CE Marking: 2011
France -Rueil Malmaison, September 2011

Wolfgang Reinelt, Ph.D.
Machine Solutions Quality Vice-President

8.5 Units and conversion tables

8.5.1 Length

	in	ft	yd	m	cm	mm
in	-	/ 12	/ 36	* 0.0254	* 2.54	* 25.4
ft	* 12	-	/3	* 0.30479	* 30.479	* 304.79
yd	* 36	* 3	-	* 0.9144	* 91.44	* 914.4
m	/ 0.0254	/ 0.30479	/ 0.9144	-	*100	* 1000
cm	/ 2.54	/ 30.479	/ 91.44	/ 100	-	* 10
mm	/ 25.4	/ 304.79	/ 914.4	/ 1000	/ 10	-

8.5.2 Mass

	lb	oz	slug	0.22 kg	g
lb	-	* 16	* 0.03108095	* 0.4535924	* 453.5924
oz	/ 16	-	* $1.942559*10^{-3}$	* 0.02834952	* 28.34952
slug	/ 0.03108095	/ $1.942559*10^{-3}$	-	* 14.5939	* 14593.9
0.22 kg	/ 0.45359237	/ 0.02834952	/ 14.5939	-	* 1000
g	/ 453.59237	/ 28.34952	/ 14593.9	/ 1000	-

8.5.3 Force

	lb	oz	p	dyne	N
lb	-	* 16	* 453.55358	* 444822.2	* 4.448222
oz	/ 16	-	* 28.349524	* 27801	* 0.27801
p	/ 453.55358	/ 28.349524	-	* 980.7	* $9.807*10^{-3}$
dyne	/ 444822.2	/ 27801	/ 980.7	-	/ $100*10^{3}$
N	/ 4.448222	/ 0.27801	/ $9.807*10^{-3}$	* $100*10^{3}$	-

8.5.4 Output

	HP	W
HP	-	* 746
W	/ 746	-

8.5.5 Rotation

	min^{-1}(rpm)	rad/s	deg./s
min^{-1}(rpm)	-	* π / 30	* 6
rad/s	* 30 / π	-	* 57.295
deg./s	/ 6	/ 57.295	-

8.5.6 Torque

	lb•in	lb•ft	oz•in	Nm	kp•m	kp•cm	dyne•cm
lb•in	-	/ 12	* 16	* 0.112985	* 0.011521	* 1.1521	* 1,129*10^{6}
lb•ft	* 12	-	* 192	* 1.355822	* 0.138255	* 13.8255	* 13,558*10^{6}
oz•in	/ 16	/ 192	-	* 7.0616*10^{-3}	* 720.07*10^{-6}	* 72.007*10^{-3}	* 70615.5
Nm	/ 0.112985	/ 1.355822	/ 7.0616*10^{-3}	-	* 0.101972	* 10.1972	* 10*10^{6}
kp•m	/ 0.011521	/ 0.138255	/ 720.07*10^{-6}	/ 0.101972	-	* 100	* 98,066*10^{6}
kp•cm	/ 1.1521	/ 13.8255	/ 72.007*10^{-3}	/ 10.1972	/ 100	-	* 0,9806*10^{6}
dyne•cm	/ 1,129*10^{6}	/ 13,558*10^{6}	/ 70615.5	/ 10*10^{6}	/ 98,066*10^{6}	/ 0,9806*10^{6}	-

8.5.7 Moment of inertia

	lb•in^2	lb•ft^2	kg•m^2	kg•cm^2	kg•cm^2•s^2	oz•in^2
lb•in^2	-	/ 144	/ 3417.16	/ 0.341716	/ 335.109	* 16
lb•ft^2	* 144	-	/3	*0.30479	*30.479	*304.79
kg•m^2	* 3417.16	/ 0.04214	-	*0.9144	*91.44	*914.4
kg•cm^2	* 0.341716	/ 421.4	/0.9144	-	*100	*1000
kg•cm^2•s^2	* 335.109	/ 0.429711	/91.44	/100	-	*10
oz•in^2	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	-

8.5.8 Temperature

	°F	max	K
°F	-	(°F - 32) * 5/9	(°F - 32) * 5/9 + 273.15
max	°C * 9/5 + 32	-	°C + 273.15
K	(K - 273.15) * 9/5 + 32	K - 273.15	-

8.5.9 Conductor cross-section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm^2	42.4	33.6	26.7	21.2	16.8	13.3	10.5	8.4	6.6	5.3	4.2	3.3	2.6

AWG	14	15	16	17	18	19	20	21	22	23	24	25	26
mm^2	2.1	1.7	1.3	1.0	0.82	0.65	0.52	0.41	0.33	0.26	0.20	0.16	0.13

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