

Mxxx / Axxx

Rotating / linear electrical machine

Operating Manual



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This operating manual may be obtained from **WITTENSTEIN cyber motor GmbH** by specifying article number **50015493**. Alternatively, it is available to download at: <http://wittenstein-cyber-motor.de>

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1 About this manual

This manual contains necessary information for the safe use of the electro-mechanical actuator Mxxx or Axxx. The electromagnetic actuator (including motors, motor-gearbox combinations and linear actuators) will be referred to simply as the motor in the following.

Every motor is identified uniquely with its material number (MN, actual term) respectively article code (AC, former term) and serial number (SN) (also see chapter 3.2 "Identification plate").

In case of conflict between this general operating manual and the product-specific documentation, the product-specific documentation applies. This operating manual is valid for the product (motor) unless another, product-specific documentation exists.

If the product was delivered as a functional model, development sample or A sample, this status is clearly indicated in the order confirmation and the delivery note. In this case, adapted regulations regarding the intended use (see chapter 2.4 "Intended use") as well as the guarantee and liability (see chapter 2.5 "Guarantee and liability"), described in the appendix of this document apply.

The operator must ensure that these instructions are read through by all persons assigned to install, operate, or maintain the motor, and that they fully comprehend them.

Store these instructions within reach of the motor.

These **safety instructions** should be shared with colleagues working in the vicinity of the device to ensure individual safety.

The original instructions were prepared in German; all other language versions are translations of these instructions.

1.1 Signal words

The following signal words are used to indicate possible hazards, prohibitions, and important information:

	⚠ DANGER
	This signal word indicates an imminent danger that will cause serious injuries or even death.
	⚠ WARNING
	This signal word indicates a potential hazard that could cause serious injuries and even death.
	⚠ CAUTION
	This signal word indicates a potential hazard that could cause minor or serious injuries.
	NOTICE
	This signal word indicates a potential hazard that could lead to material damage.
	A note without signal word draws your attention to application tips or especially important information when handling the motor.

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1.2 Safety symbols

The following safety symbols are used to indicate possible hazards, prohibitions, and important information:



General danger



Hot surface



Suspended loads



Danger of being pulled in



Magnetic field



Information



Electric voltage



Electrostatic discharge sensitive component



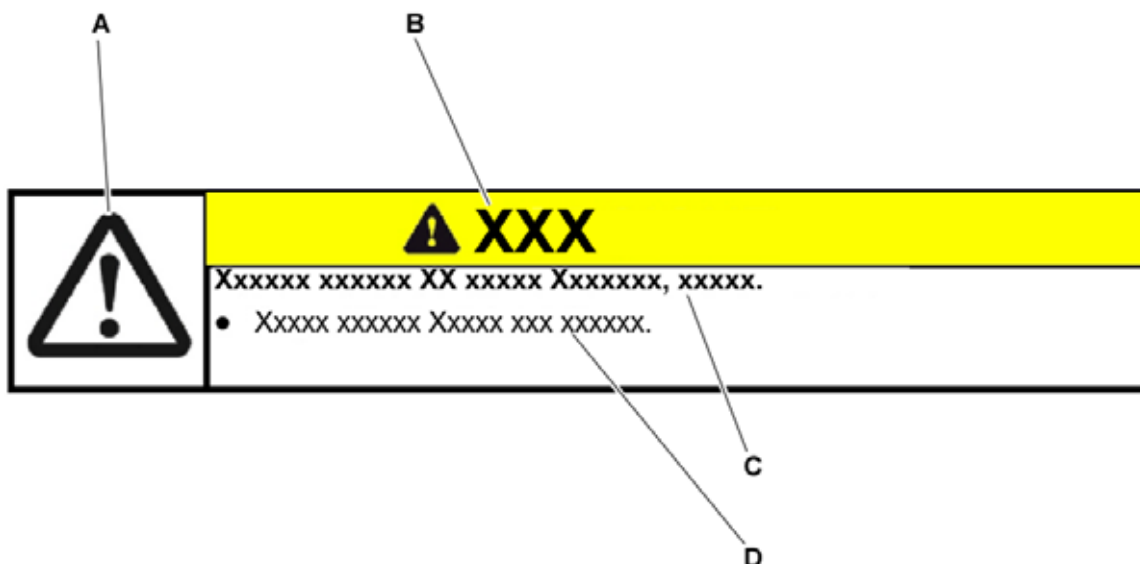
Crushing hazard



Pacemaker ban

1.3 Design of the safety instructions

The safety instructions of these instructions are designed according to the following pattern:



- A** = Safety symbol (see Chapter 1.2 "Safety symbols")
- B** = Signal word (see Chapter 1.1 "Signal words")
- C** = Type and consequence of the danger
- D** = Prevention of the danger

1.4 Information symbols

The following information symbols are used:

- Indicates an action to be performed
- ➔ Indicates the results of an action
- ① Provides additional information on handling

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2 Safety

This instruction, in particular the safety notes, and the rules and regulations applicable at the usage site are to be observed by all individuals working with the motor.

In addition to the safety instructions in this manual, also observe any (legal and otherwise) applicable environmental and accident prevention rules and regulations (e.g. personal safety equipment).

2.1 EC/EU Directive

The motor has been constructed in accordance with the relevant EC/EU directives for the relevant model and design. The motor complies with all applicable EC/EU regulations. The motor bears the CE marking to the extent required by applicable EC/EU regulations.

Observe applicable regulations for electrical installation (e.g. wire cross-sections, fuses).

It is the responsibility of the plant builder to ensure that all requirements that apply to the entire system are fulfilled.

The EC/EU Declaration of Conformity or Declaration of Incorporation of Incomplete Machinery can be found in the download area of our website <http://wittenstein-cyber-motor.de>. Please contact our sales department if you have any questions. Always provide the serial number when doing so.

The motor and all its individual components are RoHS compliant according to the Directive 2011/65 / EU, unless customer specific requirements make this directive void.

2.2 Dangers

The motor has been built in accordance with the current state of the art and the generally accepted safety engineering practice.

The motor may be used for its intended purpose (ref. chapter 2.4 "Intended use") and in a flawless condition with regard to safety only in order to avoid danger to the user or damage to the machine.

- Read the general safety instructions before beginning work (see Chapter 2.7 "General safety instructions").

2.3 Personnel

Only persons who have read and understood these instructions may carry out work on the motor.

2.4 Intended use

The motor is designed for use in industrial systems.

The motor can be optionally equipped with a holding brake.

- A holding brake is no safety brake, as defined by DIN EN 13849-1 or by the German BGHM regarding hanging axes (only available in German), and is therefore not intended to be used as a brake for the protection of persons or as a dynamic brake.

Information on the intended use of specific motor versions can be found in the sections below.

2.4.1 Cooling type H and version H

Motors of cooling type H and version H, recognizable by the 30-digit type code (position 13 and position 25) xxxxxxxx-xxxH-xxxx-xxxxHx-xxx, may only be operated when completely filled with oil. Please contact our sales department for information on the permissible oil types. Always provide the serial number when doing so.

2.4.2 Version R

Motors design R, recognizable by the 30-digit type code (position 25) xxxxxxxx-xxxx-xxxx-xxxxRx-xxx, may not be used in applications that are critical for safety. Only gearboxes that have been applied with grease may be installed in motors of design R. Installing gearboxes that have been applied with oil is not permitted. Please contact our sales department for information on the permissible grease types. Always provide the serial number when doing so.

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2.4.3 Version V

With motors of version V, recognizable by the 30-digit type code (position 25) xxxxxxxx-xxxx-xxxx-xxxxVx-xxx, any contamination of the motor (e.g. through improper handling) must be avoided. This applies in particular to assembly and operation. If the attachment of a gearbox is permissible, then only suitable grease-lubricated gearboxes may be attached. Attaching oil-lubricated gearboxes is not permissible. Please contact our sales department for information on the permissible grease types. Always provide the serial number when doing so.

2.4.4 Version L

With motors of version L, recognizable by the 30-digit type code (position 25) xxxxxxxx-xxxx-xxxx-xxxxLx-xxx, any contamination of the motor (e.g. through improper handling) must be avoided. This applies in particular to assembly and operation. In case of soiling, clean using a suitable method. If the attachment of a gearbox is permissible, then only suitable grease-lubricated gearboxes may be attached. Attaching oil-lubricated gearboxes is not permissible. Please contact our sales department for information on the permissible grease types. Always provide the serial number when doing so.

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2.5 Guarantee and liability

Guarantee and liability claims are excluded for personal injury and material damage in case of

- Ignoring the information on transport and storage
- Improper use (misuse)
- Improper or neglected maintenance and repair
- Improper assembly / disassembly or improper operation
- Operation of the motor with defective protection devices and mechanisms
- Operation of a severely soiled motor
- Changes or modifications that have been realized without the written approval of **WITTENSTEIN cyber motor GmbH**

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2.6 Other applicable documents

You have already received the following documents for your specific motor:

- Customer drawing (5007–...)
- Signal list (5085–...)
- Motor speed and torque characteristics (5012–...)








For additional information, please contact our sales department. Always provide the serial number in this case.

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2.7 General safety instructions

	<p>⚠ DANGER</p>
	<p>Faulty electrical connections or unapproved, current-carrying components can cause serious injuries and even death.</p> <ul style="list-style-type: none"> ● Have all electrical connection work performed by trained technicians only. The valid standards and directives must be observed for this. ● Immediately replace damaged cables or plugs.
	<p>⚠ WARNING</p>
	<p>When the motor shaft is still turning or when the motor is externally driven (generator operation), voltage is induced. This can lead to lethal current surges.</p> <ul style="list-style-type: none"> ● Ensure that no plugs and connections are exposed.

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	<p style="text-align: center;">⚠ WARNING</p> <p>Components equipped with permanent magnets and components that feature magnetic fields can influence/impede the function of active medical implants (e.g. pacemakers, defibrillators). This can lead to severe injuries or even death.</p> <ul style="list-style-type: none"> • Keep a sufficient distance to these components (stator, rotor) during assembly. • If there are concerns, contact the manufacturer of the active medical implants or consult WITTENSTEIN cyber motor GmbH.
	<p style="text-align: center;">⚠ WARNING</p> <p>Objects flung out by moving components can cause serious injuries and death.</p> <ul style="list-style-type: none"> • Remove objects and tools from the motor prior to starting it up.
 	<p style="text-align: center;">⚠ WARNING</p> <p>Moving components on the motor can pull in or crush parts of the body and cause serious injuries and even death.</p> <ul style="list-style-type: none"> • Keep a sufficient distance to moving machine components when the motor is running. • Secure the machine against restarting and unintentional movements during assembly and maintenance work.
	<p style="text-align: center;">⚠ WARNING</p> <p>A wrong direction of rotation or direction of movement may result in serious injury or death.</p> <p>The direction of rotation or movement may differ from the standard IEC 60034-8.</p> <ul style="list-style-type: none"> • Before and during startup, ensure that the motor has the correct direction of rotation or movement. • Be sure to avoid collision (caused e.g. by crashing against an end stop). • With the danger area secured, check the direction of rotation or movement in a slow motion, ideally by limiting the current and torque.
	<p style="text-align: center;">⚠ WARNING</p> <p>A damaged motor can cause accidents with the risk of injury.</p> <ul style="list-style-type: none"> • Never operate a motor that has been overloaded due to misuse or a machine crash. • Replace the affected motors, even if no external damage is visible.
	<p style="text-align: center;">⚠ CAUTION</p> <p>A hot motor housing may cause severe burns.</p> <ul style="list-style-type: none"> • Touch the motor housing with protective gloves or after a longer standstill of the motor only.

3 Description of the motor

3.1 General information

All motors are brushless electrical machines and conform to the applicable standards and regulations, in particular:

- **IEC 60034** Rotating electrical machines
- **2006/95/EC** Low-Voltage Directive, if the directive applies to the motor according to article 1 (valid until 19 Apr 2016 [time of production])
- **2014/35/EU** Low-Voltage Directive, if the directive applies to the motor according to article 1 (valid from 20 Apr 2016 [time of production]: Supersedes the old directive 2006/95/EC)

The motor can be optionally equipped with a holding brake. The holding brake is **not** a safety brake.

The variants of the **motors without housing** enable individual installation on the part of the customer. Generally, this results in especially compact and low-mass drive solutions. The deviating assembly procedure is described in Chapter 5.6 "Installing a kit motor".

In general, the **ALxx series motors (linear actuators)** consist of a synchronous servo motor with integrated threaded spindle and bearings:

- The rotation of the motor is transformed into a linear movement of the tappet via the threaded spindle. Depending on the required accuracy, power density and efficiency, trapezoidal, ball screw or planetary roller spindles are used as threaded spindles.
- If it is not possible to realize a rotation lock with the customer's equipment, a linear actuator with the optional integrated rotation lock must be used.

3.2 Identification plate

The identification plate contains important information about the motor characteristics.

Customer-specific variations of the design of the identification plate are permissible.

- Use the motor designation (B) to select the corresponding EC Declaration of Conformity in our download area (see Chapter 2.1 "EC/EU Directive").
- Further details can be found in the supplied motor speed and torque characteristics (5012-...).

3.2.1 MRxx series identification plate

The identification plate is attached to the motor housing, or, for motors without motor housing on the stator, to the winding overhang for example.

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		Designation
		A
		Serial number
		B
		Motor designation (ordering code)
		C
		Material number or article code (order number)
		D
		UL marking
		E
		Protection class
		F
		Time of manufacture
		G
		Place of manufacture
		H
		Country of manufacture
		I
		CE marking
		J
		Bus DC voltage U_{DC}
		K
		Continuous stall current I_0
		L
		No-load speed n_0
		M
		Continuous stalling torque M_0
		N
		Insulation class
		O
		Customer-specific motor designation
		P
		Braking torque / brake voltage
		Q
		Company headquarters

Tbl-1: MRxx identification plate

3.2.2 Identification plate for ARxx series (motor-gearbox combination)

The identification plate is attached to the motor housing.

		Designation
		A
		Serial number
		B
		Motor designation (ordering code)
		C
		Material number or article code (order number)
		D
		UL marking
		E
		Protection class
		F
		Time of manufacture
		G
		Place of manufacture
		H
		Country of manufacture
		I
		CE marking
		J
		Bus DC voltage U_{DC}
		K
		Continuous stall current I_0
		L
		Allowed continuous output speed n_0
		M
		Allowed continuous output torque M_0
		N
		Insulation class
		O
		Ratio
		P
		Customer-specific motor designation
		Q
		Braking torque / brake voltage
		R
		Company headquarters

Tbl-2: ARxx identification plate

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3.2.3 ALxx series identification plate (linear actuator)

The identification plate is attached to the linear actuator housing.

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		Designation
A	Serial number	Serial number
B	Motor designation (ordering code)	Motor designation (ordering code)
C	Material number or article code (order number)	Material number or article code (order number)
D	UL marking	UL marking
E	Protection class	Protection class
F	Time of manufacture	Time of manufacture
G	Place of manufacture	Place of manufacture
H	Country of manufacture	Country of manufacture
I	CE marking	CE marking
J	Bus DC voltage U_{DC}	Bus DC voltage U_{DC}
K	Continuous stall current I_0	Continuous stall current I_0
L	Maximum speed v_{max}	Maximum speed v_{max}
M	Continuous force F_0	Continuous force F_0
N	Insulation class	Insulation class
O	Pitch p	Pitch p
P	Customer-specific motor designation	Customer-specific motor designation
Q	Braking torque / brake voltage	Braking torque / brake voltage
R	Company headquarters	Company headquarters

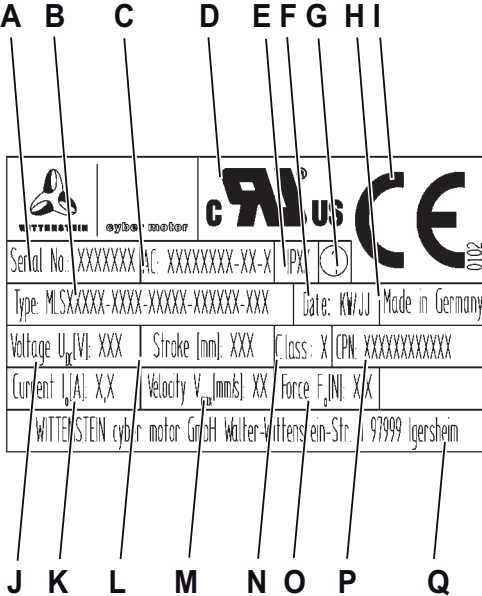
The diagram shows a rectangular identification plate with the following fields and labels:

- A**: Serial No. (XXXXXX)
- B**: Type (ALSHXXX-XXXX-XXXX-XXXX-XXX)
- C**: Material number or article code (XXXXXXXX-XX-X)
- D**: UL marking (UL)
- E**: Protection class (IPXX)
- F**: Date (KW/JJ)
- G**: Place of manufacture (Made in Germany)
- H**: Country of manufacture (Germany)
- I**: CE marking (CE)
- J**: Voltage U_g (V) (XXX)
- K**: Current I_A (A) (X.X)
- L**: Maximum speed v_{max} (mm/s) (XX)
- M**: Continuous force F_0 (kN) (X.X)
- N**: Insulation class (Class: X)
- O**: Pitch p (mm) (X)
- P**: Customer-specific motor designation (CPN: XXXXXXXXXXXXX)
- Q**: Braking torque / brake voltage (Brake: X.X(kN) 24V_{DC})
- R**: Company headquarters (WITTENSTEIN cyber motor GmbH, Walter-Wittensin-Str. 1 97999 Wersheim)

Tbl-3: ALxx identification plate

3.2.4 MLxx / PLxx / SLxx series identification plate (linear motor)

The identification plate is attached to the motor housing. If primary or secondary parts are fitted, it is attached, for example, on the side of the respective component.

		Designation
		A
		Serial number
		B
		Motor designation (ordering code)
		C
		Material number or article code (order number)
		D
		UL marking
		E
		Protection class
		F
		Time of manufacture
		G
		Place of manufacture
		H
		Country of manufacture
		I
		CE marking
		J
		Bus DC voltage U_{DC}
		K
		Continuous stall current I_0
		L
		Stroke
		M
		Maximum speed V_{max}
		N
		Insulation class
		O
		Continuous force F_0
		P
		Customer-specific motor designation
		Q
		Company headquarters

Tbl-4: MLxx / PLxx / SLxx identification plate


3.3 Performance data

The maximum permissible technical specifications are available in the motor characteristic (5012-...).

Please contact our sales department for further information. Always indicate the serial number in that context.

3.4 Temperature monitoring

On motors with integrated temperature sensor, a tripping device or detection circuit that prevents the permissible temperature limit from being exceeded needs to be connected to the motor drive.

	NOTICE
	<p>If the temperature limit is exceeded, the motor will be damaged.</p> <ul style="list-style-type: none"> Select a sufficiently dimensioned motor so that the permissible operating temperature will not be exceeded even under the most demanding conditions.

3.5 Weight

The weight of your motor can be found in the supplied motor speed and torque characteristics (5012-...).

4 Transport and storage



4.1 Scope of delivery

- Check the completeness of the delivery against the delivery note.
 - ① Missing parts or damage must be notified immediately in writing to the carrier, the insurance company, or **WITTENSTEIN cyber motor GmbH**.

4.2 Packaging

- Dispose of the packaging materials at the recycling sites intended for this purpose. Observe the applicable national regulations concerning disposal.

4.3 Transport

	<p style="text-align: center;">⚠ WARNING</p> <p>Suspended loads can fall and can cause serious injuries and even death.</p> <ul style="list-style-type: none"> • Do not stand under suspended loads. • Secure the motor before transport with suitable fasteners (e.g. belts).
	<p style="text-align: center;">NOTICE</p> <p>Hard shocks caused by harsh handling during transportation (e.g. falling, hard dropping) can damage the motor.</p> <ul style="list-style-type: none"> • Only use hoisting equipment and lifting accessories with sufficient capacity. • Never exceed the maximum permissible load for hoisting equipment. • Slowly put down the motor.

Note the weight of the payload and use an appropriate transport device.

Specifications on the weights, refer to Chapter 3.5 "Weight".

Ambient temperatures between -20° C and +50° C are permissible for transport only.

4.4 Storage

Store the motor in a horizontal position at a temperature of 0 °C to + 40 °C in the original packaging. The ambient conditions must be dry, dust-free, and low in vibrations (see Chapter 6.1 "Safety instructions and operating conditions"). Store the motor for a maximum of 2 years.



For storage logistics, we recommend the "first in - first out" method.

5 Assembly

- Read the general safety instructions before beginning work (see Chapter 2.7 "General safety instructions").
- Unless explicitly agreed otherwise for customer-specific motors, perform the assembly according to the following sections.


5.1 Preparations

Section 5.6 "Installing a kit motor" lists the different assembly sequence for **kit motors**.


	<p style="text-align: center;">NOTICE</p> <p>Pressurized air may damage the seals of the motor.</p> <ul style="list-style-type: none"> ● Do not use pressurized air for cleaning the motor.
	<p style="text-align: center;">NOTICE</p> <p>If present, the temperature sensors and rotor position encoders, particularly Hall Effect sensors and encoders, can be damaged by electrostatic discharge.</p> <ul style="list-style-type: none"> ● Observe the directives concerning ESD protection.

- Clean / degrease the output shaft of the motor with a clean and lint-free cloth as well as a grease-dissolving, non-aggressive cleaning agent.
- Dry all fitting surfaces to neighboring components in order to achieve the proper friction values of the screw connections.
- Check the fitting surfaces additionally for damage and impurities.
- Use:
 - Property class 10.9 bolts for Mxxx series motors.
 - Property class 12.9 bolts for Axxx series motors.
- Use:
 - Washers (hardness class 300 HV) for motors with an aluminum flange. The contact pressure must not exceed 230 N/mm².
 - **No washers** for motors with a stainless steel flange.

5.1.1 Preparations for ALxx series (linear actuators)

	<p style="text-align: center;">NOTICE</p> <p>Improper assembly can damage the linear actuator.</p> <ul style="list-style-type: none"> ● Only install the linear actuator on level, no-vibration, rigid structures. ● Ensure freedom of motion of the customer application. ● Arrange the linear actuator and the application optimally with respect to one other to avoid lateral forces and thus premature wear of the threaded spindle. ● Avoid lateral forces and bending torques on the screw. ● Avoid banging and knocking the screw.
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	NOTICE
	<p>Moving outside the permissible stroke path, at both the minimum and maximum position, will damage the threaded spindle.</p> <ul style="list-style-type: none"> ● Limit the stroke of the linear actuator using appropriate measures (e.g. stops, buffers) for the extended and retracted end position. ① These end stops must be dimensioned appropriately and be capable of absorbing the kinetic energy of the moving parts, which may be moving at high speeds.

5.2 Attaching Motor to a machine


	<ul style="list-style-type: none"> ● Observe the safety and processing instructions for the threadlocker to be used.
--	---

- Coat the fastening screws with a threadlocker (e.g. Loctite® 243).
- Fasten the motor to the machine:
 - either via the through-holes of the machine
 - or via the through-holes of the motor.
- ① If screws are screwed into the motor, observe the maximum permissible lengths of the screws.
- ① Mount the motor in such a way that the identification plate remains legible.
- ① Only use washers for motors that have an aluminum flange.
- ① For specified tightening torques for screws of property class 10.9 and 12.9, see section 9.2 "Tightening torques for common thread sizes in general mechanical engineering", table "Tbl-14".

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5.3 Components mounted to the output side

	NOTICE
	<p>Tensions during the assembly may damage the motor.</p> <ul style="list-style-type: none"> ● Do not use force when mounting components or attachments (e.g. gears or tools) on the motor. ● Never attempt to assemble by force or hammering! ● Screw in the screws only up to their maximum depth. ● Only use suitable tools and devices for assembly.

For additional information, please contact our sales department. Always provide the serial number when doing so.

5.4 Connecting the cooling circuit

This section only applies for motors with water cooling.

The following conditions must be fulfilled:

- Minimum flow:
 - 5 l/min at max. 35 °C supply temperature
 - 10 l/min at 40 °C supply temperature
- ① Supply temperatures and flow rates may vary from the above guidelines for customer specific motors.

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Designation	Unit	Value
pH value	pH	6.5 –8.5
Total hardness	dH	< 15
Conductance	mS/m	< 50
Grain size	µm	max. 100
Supply temperature	°C	min. 15 (due to condensation)
Flow	l/min	min. 5
Pressure	bar	max. 6


Tbl-5: Guideline for recommended water quality

Antifreeze must be added to the cooling circuit. Commercially available products can be used. The cooling effect depends on the chemical compound and concentration of the antifreeze product. These products are known for their use as an additive in the cooling circuits of motor vehicles. Concentrates are often sold that must be diluted with water according to a specified mixing ratio (if the quantity of antifreeze is greater, the solution will remain liquid at lower temperatures). Radiator antifreeze products of high quality intended for the engines of vehicles are composed of glycols and small quantities of various additives. These substances also help prevent rust and overheating. They also have lubricating properties which protect the entire cooling system. A well-known brand name among coolants is Glystantin[®], a trademark of BASF. This product has been approved by **WITTENSTEIN cyber motor GmbH**.

5.5 Installing electrical connections

	<ul style="list-style-type: none"> ● Make sure that the maximum cable length of the power supply cable between the motor and the power electronics does not exceed 75m.
	<div style="background-color: red; color: white; text-align: center; padding: 5px;">⚠ DANGER</div> <p>Electrically live parts cause electric shocks if touched, leading to serious injuries and even death.</p> <ul style="list-style-type: none"> ● Observe the five safety rules of electrical engineering before starting electrical installation work: <ul style="list-style-type: none"> - Disconnect. - Secure against being switched on again. - Check that there is no voltage. - Ground and short-circuit. - Cover neighboring and electrified parts. ● Before switching the voltage back on, check that all electrified parts are equipped with suitable and undamaged contact protection. ● Check that protective caps are on the plugs. If protective caps are missing, check the plugs for damage and soiling.
	<div style="background-color: red; color: white; text-align: center; padding: 5px;">⚠ DANGER</div> <p>Electric operation during moisture may result in electric shocks and can cause serious injuries and even death.</p> <ul style="list-style-type: none"> ● Execute the electric assembly only in dry areas.


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	⚠ DANGER
	<p>Excessively high contact voltages may cause electrical shock, which may lead to serious injuries and even death.</p> <ul style="list-style-type: none"> • Avoid excessively high contact voltages (e.g. in the event of damage to the insulation) by providing all exposed and electrically live parts with a protective earth. • Connect the terminal provided at the motor (e.g. direct PE conductor, grounding terminal, ground pin in the motor connector) with the relevant counterpart in the system ground. • For protective earth, use a conductor cross-section that is at least equal to the motor's power supply cable, unless otherwise provided in applicable regulation.

A protective earth is not required when:

- the rated voltage is limited to 50 VAC (rms) or 120 VDC **and** there is no applicable regulation to the contrary, or
- the motor is equipped with additional insulation, or
- the motor is designed for incorporation into devices that are equipped with additional insulation.

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	<p>The cables of all motors must be arranged in such a manner that a minimum bending radius of 10 times the outer diameter is observed. The cables may be twisted no more than $\pm 30^\circ$ on a length of 1 m.</p>
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5.6 Installing a kit motor


The following information is valid only for kit motors.

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	⚠ CAUTION
	<p>Components equipped with permanent magnets attract ferromagnetic objects. This can cause serious crushing injuries, but also damage or contamination due to small metal parts.</p> <ul style="list-style-type: none"> • Secure the primary part or the secondary part against unintentional movements. • Keep small metal parts (e.g. swarf or chips) away from the primary or secondary part.

	<ul style="list-style-type: none"> • Observe the safety and processing instructions for the cleaning agents and adhesives to be used.
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	⚠ WARNING
	<p>Components equipped with permanent magnets and components that feature magnetic fields can influence/impede the function of active medical implants (e.g. pacemakers, defibrillators). This can lead to severe injuries or even death.</p> <ul style="list-style-type: none"> • Keep a sufficient distance to these components (stator, rotor) during assembly. • If there are concerns, contact the manufacturer of the active medical implants or consult WITTENSTEIN cyber motor GmbH.

Kit motors consist of a permanent magnet rotor and a stator with free electrical connections. The motor shaft and housing are provided by the customer.

Dimensions and tolerances for the various caseless motor are specified in there relevant dimensional drawings. Should there be differences between this manual and the dimension sheet, the information in the dimension sheet applies.

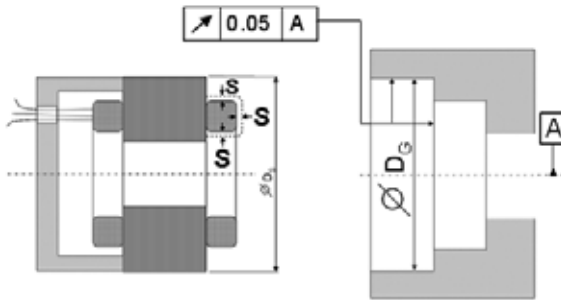
NOTICE

If the minimum gap between the Hall effect sensors and the rotor is not maintained, the Hall effect sensors may be damaged.

- Make sure the minimum gap is maintained.

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5.6.1 Installing the stator



The figure shows the requirements for positional tolerances inside the housing.

Table "Tbl-6" shows the required housing dimensions for a successful gluing process.

① For sizes not listed in the table, please contact our sales department.

Between the winding heads and the surrounding parts (in particular housing, terminal shielding, bearings) the following minimum air gap S must be observed:

- Bus DC voltage $U_{DC} \leq 48 \text{ V DC}$: $S = 1 \text{ mm}$
- Bus DC voltage $U_{DC} > 48 \text{ V DC}$: $S = 3 \text{ mm}$

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Motor type	Diameter D_G [mm]	Steel or aluminum housing tolerance [mm]
MRSF019	19.3	+ 0.02 / 0.00
MRSF028	27.5	+ 0.05 / + 0.03
MRSF038	38.1	+ 0.09 / + 0.07
MRSF049	49.0	+ 0.07 / + 0.05
MRSF064	64.0	+ 0.08 / + 0.06

Tbl-6: Housing inner diameter for the glued joint

- Prepare the stator and the housing.
 - Prepare cleaning agents and adhesive.
- ① It is recommended to use an adhesive with a shear strength of $15 - 30 \text{ N/mm}^2$ (2200 - 4400 PSI).

Suitable adhesives for steel housings include Loctite® 638, which has a continuous temperature resistance of 120 °C.

Suitable adhesives for aluminum housings include Loctite® 648, which has a continuous temperature resistance of 150 °C.

Observe the safety data sheet when using Loctite® 638 or 648.

- Clean the relevant surfaces with a suitable cleaning agent before gluing.
 - Apply adhesive to the relevant surfaces and slide the stator into the housing until flush.
 - Keep the housing vertical until the adhesive has cured.
- ① This achieves an even joint and low eccentricity.

The stator of a kit motor is delivered with free terminals for application-specific final assembly at the customer. See the dimensional drawing for details.

- Observe the safety instructions in chapter 5.5 "Installing electrical connections".

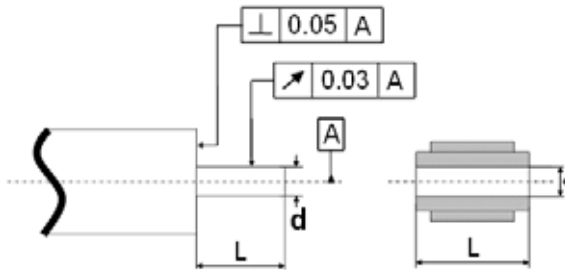
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5.6.2 Installing the rotor

The rotors are delivered so that the magnets on one side are axially flush with the rotor carrier. For motors with integrated Hall sensor boards, the rotor side (with flush magnets) must be on the side with the Hall sensor board. This rotor side must also be flush with the stator packet. This is a prerequisite for flawless commutation.



The figure on the side shows the requirements for shape and positional tolerance (in the figure, the shaft diameter is indicated as d).

Table "Tbl-7" shows the dimensional tolerances for successfully gluing the shaft.

ⓘ For sizes not listed in the table, please contact our sales department.

Motor type	Shaft diameter d * [mm]	Shaft diameter tolerance (mm)
MRSF019	3.0	- 0.006 / - 0.020 (f8)
MRSF028	4.5	- 0.010 / - 0.028 (f8)
MRSF038	6.2	- 0.013 / - 0.035 (f8)
MRSF049	10.0	- 0.013 / - 0.028 (f7)
MRSF064	12.0	- 0.016 / - 0.034 (f7)
* Please contact our sales department for other shaft diameters.		

Tbl-7: Shaft diameter for glued joint

- Prepare the rotor and the motor shaft.
- Prepare cleaning agents and adhesive.
 - ⓘ It is recommended to use an adhesive with a shear strength of 15 – 30 N/mm² (2200 – 4400 PSI). Suitable adhesives include Loctite® 638, which has a continuous temperature resistance of 120 °C.
 - Observe the safety data sheet when using Loctite® 638.
- Clean the relevant surfaces with a suitable cleaning agent before gluing.
- Apply adhesive to the relevant surfaces and slide the rotor onto the motor shaft until flush.
- Keep the motor shaft vertical until the adhesive has cured.
 - ⓘ This achieves an even joint and low eccentricity.

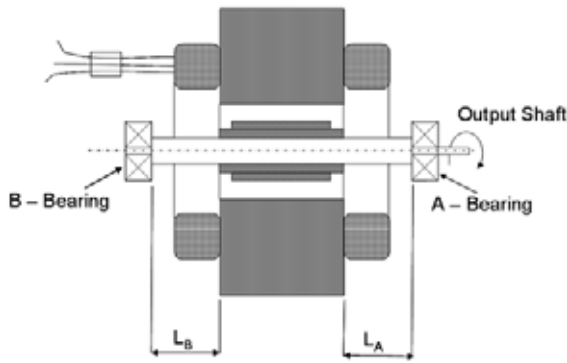
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The purpose of the bearing is to ensure the precise centering of the stator package. It is recommended to place the fixed bearing on the A side (torque output side) and the floating bearing on the B side. The floating bearing must permit an axial shift, in particular to compensate for heat expansion.

The bearings must be installed according to manufacturer specifications. Improper installation may result in excessive operating noise and a reduced lifespan of the bearings.

Table "Tbl-8" shows the recommended groove ball bearings for the A and B side (other bearing types may be applicable depending on the user). The table shows the minimum gaps L_A and L_B between the bearing and the rotor carrier. Observing these minimum gaps is important to exclude bearing damage from magnetic fields.

ⓘ For sizes not listed in the table, please contact our sales department.

Motor	L_A [mm]	Recommended bearings A	L_B [mm]	Recommended bearings B
MRSF019	5.6	604 - 2Z	7.0	604 - 2Z
MRSF028	8.0	606 - 2Z	6.5	634 - 2Z
MRSF038	9.2	626 - 2Z	7.3	635 - 2Z
MRSF049	13.5	6001 - 2Z	15.0	608 - 2Z
MRSF064	17.0	6001 - 2Z	15.0	6000 - 2Z

Tbl-8: Recommended bearings and associate minimum gaps

5.7 Installing the primary part / secondary part

The following specifications are only applicable for primary parts or secondary parts.

	<h2>⚠ CAUTION</h2>
	<p>Components equipped with permanent magnets attract ferromagnetic objects. This can cause serious crushing injuries, but also damage or contamination due to small metal parts.</p> <ul style="list-style-type: none"> Secure the primary part or the secondary part against unintentional movements. Keep small metal parts (e.g. swarf or chips) away from the primary or secondary part.
	<ul style="list-style-type: none"> Observe the safety and processing instructions for the cleaning agents and adhesives to be used.

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⚠ WARNING

Components equipped with permanent magnets and components that feature magnetic fields can influence/impede the function of active medical implants (e.g. pacemakers, defibrillators). This can lead to severe injuries or even death.

- Keep a sufficient distance to these components (stator, rotor) during assembly.
- If there are concerns, contact the manufacturer of the active medical implants or consult **WITTENSTEIN cyber motor GmbH**.

On linear motors, secondary parts are generally equipped with permanent magnets and primary parts are equipped with electrical connections. On special types of linear motors, such as homopolar motors, the primary parts and the secondary parts can both be equipped with permanent magnets and/or with electrical connections.

Linear guides and installation areas / installation housings are provided by the customer.

Dimensions and tolerances for the various primary parts or secondary parts are specified in the corresponding dimension sheets. Should there be differences between this manual and the dimension sheet, the information in the dimension sheet applies.

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NOTICE

If the permissible distance between the Hall effect sensors and the secondary part is not maintained, the Hall effect sensors can become damaged.

- Make sure the permissible distance is maintained.

To ensure a constant force along the entire movement range, a defined air gap height must be maintained. For this purpose, the individual parts of the motor (primary and secondary part) have respective tolerances. The distance to the mounting surface, the parallelism, as well as the symmetry of the primary and secondary parts of the linear motor in the machine have to lie within a certain tolerance along the entire travel path. Possible deformations resulting from weight, attraction and process forces must be taken into account.

If the specified nominal air gap is not complied with, the specified performance statistics will be reduced or changed, and/or the primary part may come into contact with the secondary part and thus damage or destroy motor components.

For installation of the motors in the machine construction, a defined installation height with tolerances is specified by **WITTENSTEIN cyber motor GmbH**. This automatically maintains the air gap according to the specified dimensions and tolerances –even if individual motor components are exchanged.

Parts of the machine must be aligned to one another before the primary and/or secondary part can be mounted. The machine sled in particular must be brought into a defined position in relation to the machine base. During alignment, comply with the tolerances concerning parallelism and symmetry in addition to those concerning the installation dimensions. Prerequisite for compliance with the tolerances is that the fastening bores and/or the threaded bores for the primary and/or secondary part are drilled in the machine strictly according to the dimensions specified in the respective dimensional drawing. Once this has been done, the center lines of the fastening bores or threaded bores can be used to align the parts.

Ensure that the specified tolerances concerning the parallelism and symmetry are complied with during the movement of the primary or secondary part along the entire travel path.

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6 Startup and operation

- Unless explicitly agreed otherwise for customer-specific motors, perform the assembly and operate the unit according to the following sections.

6.1 Safety instructions and operating conditions

- Read the general safety instructions before beginning work (see Chapter 2.7 "General safety instructions").
- Measure the insulation resistance of the motor prior to startup.
 - ⓘ The insulation resistance has to be at least 50 MΩ when new and at least 20 MΩ after being used!
- For motors with grease-lubricated bearings (standard version): If the motor has not been operated for more than 1 year, a grease distribution run of the motor bearings is recommended. To do this, operate the motor at 50% of its rated speed for 60 s in both directions of rotation.
- If the motor is equipped with a holding brake, ensure that the instructions in chapter 6.1.4 "Holding brake" are observed.

Improper use can cause damage to the motor.

- Ensure that the limit values in the following sub-chapters are observed.
- If this requirement cannot be fulfilled, please contact our sales department. Always provide the serial number when doing so.
- Only operate the motor when it is firmly mounted.

6.1.1 Humidity / Temperature

For continuous operation of motors, the limit values are valid according to the classification 3K4 acc. to DIN EN 60721-3-3:1995, Table 1 (see Table "Tbl-9").

Temperature range	Relative humidity	Absolute humidity	Temperature change speed
0 ... 40°C ^a	5 ... 95%	1 ... 29 g/m ³	0.5 °C/min
^a extended in comparison to standard value			

Tbl-9: Limit values for temperature and humidity

6.1.2 Vibration

Based on vibrations at a stationary place of use, limit values apply according to DIN EN 60721-3-3:1995 and DIN EN 60068-2-6:2007.

Maximum permissible vibration load (55-2000 Hz)
10 m/s ²

Tbl-10: Limit value for vibration load

Note: With regard to vibration load, please note that this operating manual applies to a wide variety of motors. Increased vibration load may be permissible in specific cases. For additional information, please contact our sales department. Always provide the motor designation and serial number when doing so.

6.1.3 Shock

Unless specified otherwise, the limit values for the maximum permissible shock load (brief acceleration) are according to DIN EN 60721-3-3:1995 and DIN EN 60068-2-27:2009.



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Direction	Maximum permissible shock load (11 ms)
axial	10 m/s ²
radial	150 m/s ²

Tbl-11: Limit values for shock load

Note: With regard to shock load, please note that this operating manual applies to a wide variety of motors. Increased shock loads may be permissible in specific cases. For additional information, please contact our sales department. Always provide the motor designation and serial number when doing so.

6.1.4 Holding brake

The following instructions apply exclusively to **electrical** holding brakes.

- If the motor is equipped with a holding brake, ensure that this brake is vented during startup, and that the motor is never operated with the brake applied.
 - ⓘ The brake is applied in a currentless state. Control of the brake is performed by the customer using the regulating device. Technical data on the brake can be found on the identification plate, in the technical documentation (5098-...) as well as the signal list (5085-...).
 - ⓘ A holding brake is no safety brake, as defined by DIN EN 13849-1 or by the German BGHM regarding hanging axes (only available in German), and is therefore not intended to be used as a brake for the protection of persons or as a dynamic brake.

Emergency stop

The effective braking torques of a holding brake differ due to physical factors, and it is necessary to consider use during a malfunction as well as normal operation:

- In normal use, the operating principle when using the holding brake to clamp / secure an axle in standstill is a static friction with the friction coefficient μ_H . This means the "static holding torque" M_4 as specified in the specification sheets is reached.
- In the case of a malfunction, the operating principle when using the holding brake to shut down a moving axle (emergency stop) is a dynamic friction with the friction coefficient μ_G . This means the "dynamic braking torque" is reached. The dynamic braking torque is lower than the static holding torque M_4 .
- Observe the design of the axle to ascertain if the holding brake may be used for an emergency stop:
 - The maximum occurring load torque,
 - The maximum distance available,
 - The moment of inertia of the entire axle, and
 - The maximum energy in the entire axle.
- ⓘ Otherwise the delay effect of the brake may not be enough to stop the axle.

The holding brake may become worn if used for emergency stop. For this reason, it is recommended that the required holding torque for the axle is at most 60% of the static holding torque M_4 of the holding brake used.

Running in the holding brake

The holding brake may no longer reach the specified holding torque M_4 due to the effects of storage, conditions or type of use, overvoltage or high temperature, combined with ambient conditions (soiling, humidity, etc.).

- To restore the holding power, perform the run-in procedure described by the brake manufacturer.
 - Apply the brake briefly for a defined time (at the specified speed of the motor and for a

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defined number of runs) and then release it again.

- Or, drive the motor against the applied brake for a defined number of revolutions at a specified speed.
- ① For additional information and for correct data on the grinding-in process, contact our sales department. Always provide the ordering code and serial number.

Commissioning the holding brake

To make sure the holding brake is functioning, it has to be tested during startup.

- If the regulating device has a function for integrated testing of the holding torque during secure limited movement and secure limited speed, then use this function and observe the instructions from the regulating device's manufacturer.

If no such function is present, we recommend that the user proceeds as follows:

- Limit the permitted range of movement and the maximum speed using the parameters in the regulating device so that no danger to persons or property can arise from movement of the axle.
- Calculate the power of the motor I_{M4} required to achieve the holding torque M_4 with the torque constant, and limit the maximum current of the regulating device to this value.
- Apply current to the motor with the holding brake applied, gradually increasing the current to I_{M4} . During this, the motor must not move. Observe the permitted time for applying current of I_{M4} to the motor.
- If movement does occur, the user should ideally switch off the current supply automatically to avoid uncontrolled movement of the axle.
- If the holding torque M_4 is not reached, perform the grinding-in process described by the brake manufacturer.
- After the grinding-in process check again the holding torque M_4 .

If the holding torque M_4 specified in the brake's technical data is reached, then the holding brake is ready for operation.

If the holding torque M_4 specified in the brake's technical data is **not** reached then:

- Repeat the grinding-in procedure.
 - ① The grinding-in process may only be repeated twice during a testing procedure for the holding torque M_4 .

If the holding torque M_4 is not reached after the third grinding-in process then the holding brake **is not functioning properly**:

- Do **not** start up the drive. Contact our sales department.
 - ① Always provide the ordering code and serial number.

Testing the holding brake regularly

To ensure the permanent functioning of the holding brake, it has to be regularly applied and checked.

- It is recommended that the holding brake is released and applied at least twice daily by deactivating the controller.
- It is recommended that the holding torque M_4 of the brake is checked at least once a day.

Provisional run-in data

Use of the following data is recommended if no data is available for the motor regarding the run-in process:

- Within 24 h **of the first startup**, grind in the brake as follows:
 - The brake is applied
 - At a speed of 100 min^{-1}



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- Once for 5 revolutions
- Ambient temperature between 0 °C and +40 °C
- Grind in the brake **after startup** as follows:
 - Apply and release every 500 ms
 - At a speed of 100 min⁻¹
 - For a duration of 30 s
 - Ambient temperature between 0 °C and +40 °C

6.2 Operation

	NOTICE
<p>Due to oxygen in the air, UV rays, and cable movements, the bearing grease and the insulation materials age.</p> <ul style="list-style-type: none"> ● Send the motor for revision to WITTENSTEIN cyber motor GmbH after 6 years at the latest. 	

- Use the motor only up to its maximum limit values, see Chapter 3.3 "Performance data".

6.2.1 Voltage gradient

Unless otherwise agreed, the voltage gradient of the pulsed voltage at the power terminals of the motor is limited to a maximum of 8kV / μs.

- In case of doubt, please consult the supplier of your power electronics.
- ① An inadmissible high voltage gradient may lead to premature failure of the insulation system of the motor winding.

6.2.2 Operation of Mxxx / ARxx

This section does **not** apply to series MLxx / PLxx / SLxx (linear motors) and ALxx (linear actuators). Circumferential radial forces on the shaft are not permitted.

- ① If this requirement cannot be fulfilled, please contact our sales department. Always provide the serial number when doing so.

The motor is balanced so that the limit values in Table "Tbl-12" are not exceeded for rigid clamping.

Clamping	Displacement [μm]	Speed [mm/s]	Acceleration [m/s ²]
Rigid	21	1.3	2

Tbl-12: Limits vibration level A (RMS)

- If the limits are exceeded, look for the cause by checking the following possibilities, among others:
 - Unsuitable foundation
 - Natural frequency of the driven load machine
 - Nonconforming setting of the current and speed regulator
- Take appropriate corrective measures to ensure the life of the motor.

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7 Maintenance and disposal

- Read the general safety instructions before beginning work (see Chapter 2.7 "General safety instructions").
- Unless explicitly agreed otherwise for customer-specific motors, perform the maintenance and disposal according to the following sections.

7.1 Maintenance work

7.1.1 Cleaning

The motor may not come into contact with the solvents hexane and toluene, because they impair the adhesion of the identification plates.

7.1.2 Checking the holding brake

The motor can be optionally equipped with a holding brake.

To ensure the permanent functioning of the holding brake, it has to be regularly applied and checked.

- It is recommended that the holding brake is released and applied at least twice daily by deactivating the controller.
- It is recommended that the holding torque M_4 of the brake is checked at least once a day.

① Details can be found in chapter 6.1.4 "Holding brake".

7.1.3 Visual inspection

Perform a **monthly** visual inspection:

- Check the motor and moving cables for damage.
- Check whether the cables are completely labeled.

The motor can be optionally equipped with a felt ring.

- Check the felt ring for damage every 4000 hours.

① Replacing the felt ring is recommended every 8000 hours.

7.1.4 Relubrication

Relubrication of series Mxxx (motor) or ARxx (motor-gearbox combination)

A change of lubricant in motors of this design is not necessary. All motor bearings and gearboxes are permanently lubricated at the factory.

Relubricating the ALxx series (linear actuators)

Depending on the load cycle, but no later than 1 million cycles, relubrication is to be performed at regular intervals. For demanding load cycles in particular, significantly more frequent relubrication may be necessary.

To achieve the optimal life of the linear actuator, the type of lubrication, quantity of lubricant and lubrication interval is to be specified in consultation with the manufacturer according to the specific application.

Information on the lubrication points on the linear actuator and the types of lubrication and lubrication quantities can be found in the individual scaled drawing (5007-...).

Relubrication of series MLxx / PLxx / SLxx (linear motors)



A change of lubricant in motors of this design is not necessary. All guides are permanently lubricated at the factory if guides from **WITTENSTEIN cyber motor GmbH** are included in the delivery as complete motors.

7.2 Start-up after maintenance work

- If relubrication of the guides is agreed upon individually, take the lubrication intervals into account in order to ensure the proper operation and only use the specified lubricants.
- When using primary and/or secondary parts, contact the manufacturer of the linear guides concerning the lubrication intervals and the lubricants to be used.

7.1.5 Motor feedback system

- Check the functionality every 40000 hours.

7.2 Start-up after maintenance work

- Attach all safety devices.

7.3 Disposal

- Dispose of the motor at the recycling sites intended for this purpose.
- ① Observe the applicable national regulations concerning disposal.

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8 Malfunctions

	NOTICE
	<p>Changed operational behavior can be an indication of existing damage to the motor or cause damage to the motor.</p> <ul style="list-style-type: none"> Do not put the motor back into operation until the cause of the malfunction has been rectified.

Fault	Possible cause	Solution
Motor does not start	Incorrectly connected	Check the connections using the signal list
	Parameter set does not correspond to motor	Check the motor data record in the power electronics
Increased operating temperature	Motor is heavily soiled	Clean the outside of the motor
	Ambient temperature too high/low air pressure due to altitude	Ensure adequate cooling.
	Motor becomes very hot / encoder set incorrectly	Check the power electronics of the motor and the power supply or consult our Customer Service department.
	With felt ring option: Felt ring worn	Change the felt ring.
	ALxx: Threaded spindle heavily worn	Consult our Customer Service department.
Increased operating noises	Damaged bearings	Consult our Customer Service department.
	ALxx: Threaded spindle damage	
	ARxx: Gearbox damage	
	MLxx / PLxx / SLxx: Guide damage	
Sporadic failure	Damaged cable	Consult our Customer Service department.

Tbl-13: Malfunctions

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9 Appendix

9.1 Adapted regulations for functional model, development sample or A sample

9.1.1 Intended use

The functional model, development sample or A sample (“sample”) is only used for verifying the functional principle. The sample is intended for laboratory operation only and may not be put on the market. It also exhibits limited suitability for durability testing only.

The sample is explicitly **NOT** intended for use in industrial systems.

9.1.2 Guarantee and liability

Guarantee and liability claims are excluded for personal injury and material damage in case of

- Putting the sample on the market
- Ignoring the information on transport and storage
- Improper use (misuse)
- Improper or neglected maintenance and repair
- Improper assembly / disassembly or improper operation
- Operation of the sample with defective protection devices and mechanisms
- Operation of a severely soiled sample
- Changes or modifications that have been realized without the written approval of **WITTENSTEIN cyber motor GmbH**.

9.2 Tightening torques for common thread sizes in general mechanical engineering

The specified tightening torques for set screws and nuts are calculated values and are based on the following conditions:

- Calculation in accordance with VDI 2230 (February 2003 version)
- Friction value for thread and contact surfaces $\mu=0.10$
- Utilization of the yield stress 90%
- Torque tools type II classes A and D in accordance with ISO 6789

The settings are values rounded to usual commercial scale gradations or setting possibilities.

- Use the **exact** values in this table to set your tools.

	Tightening torque [Nm] with thread												
Property class Screw / Nut	M2	M3	M4	M5	M6	M8	M10	M12	M14	M16	M18	M20	M22
8.8 / 8	0.323	1.15	2.64	5.2	9.0	21.5	42.5	73.5	118	180	258	362	495
10.9 / 10	0.474	1.68	3.88	7.6	13.2	32.0	62.5	108	173	264	368	520	700
12.9 / 12	0.555	1.97	4.55	9.0	15.4	37.5	73.5	126	202	310	430	605	820

Tbl-14: Tightening torques for headless screws and nuts

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Revision history

Revision	Date	Comment	Chapter
01	18.02.16	New version	All
02	14.12.16	Security	2, 5
03	11.05.17	Security Removed chapter 6.3	2, 5 6
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