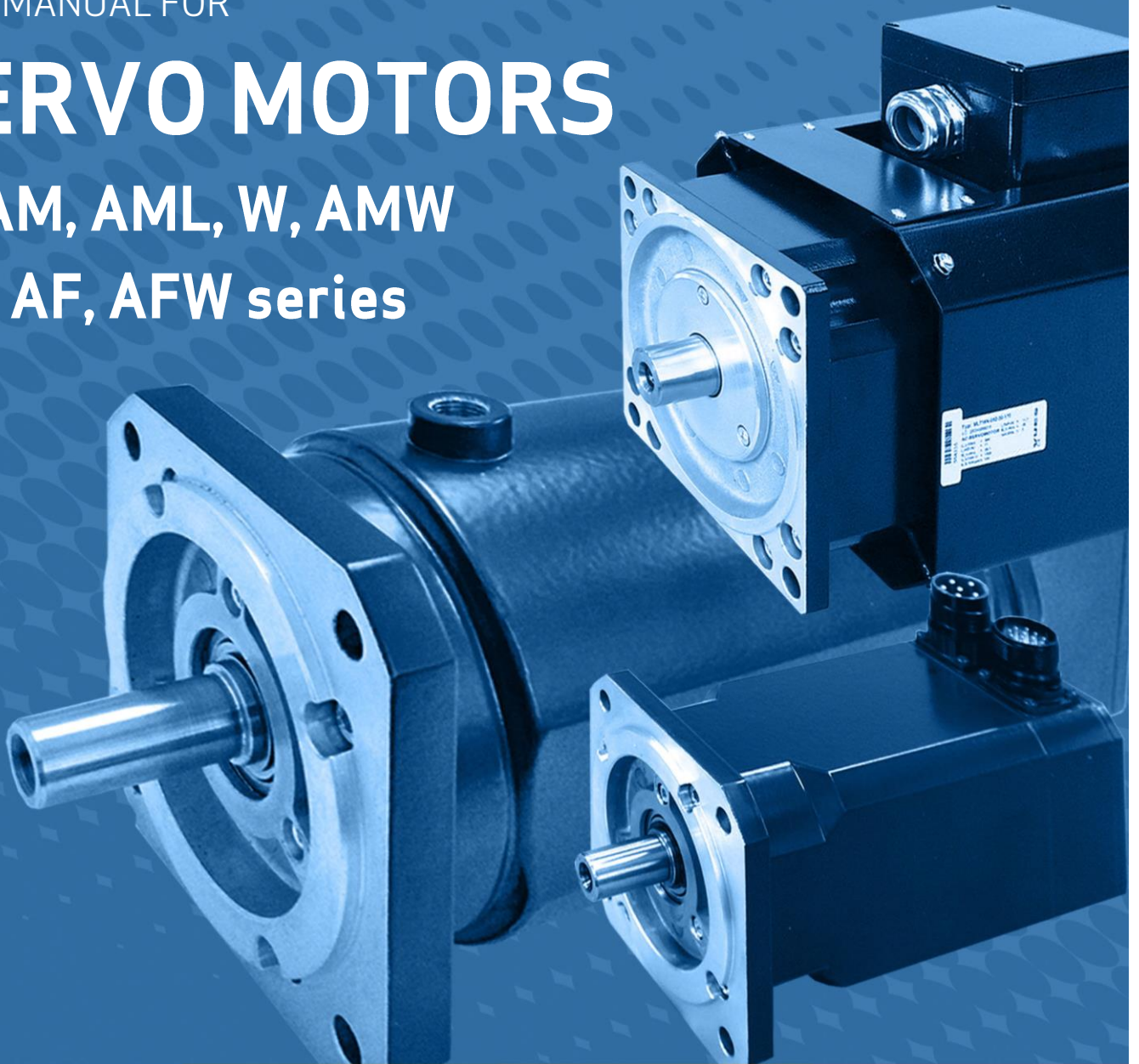


USER MANUAL FOR

# SERVO MOTORS

M, AM, AML, W, AMW  
and AF, AFW series



BRUSHLESS MODULAR SERVOMOTORS  
WITH NATURAL COOLING, LIQUID COOLING  
OR SEPARATE VENTILATION

## About Moog

Moog's Industrial Group designs and manufactures high performance motion control solutions combining electric, hydraulic, and hybrid technologies with expert consultative support in a range of applications including test, simulation, plastics, metal forming, and power generation.

Moog customers include leading automotive manufacturers, aerospace manufacturers, testing labs and global automotive racing teams.

We help performance-driven companies design and develop their next-generation machines. Moog's Industrial Group is part of Moog Inc.

For more information, please visit [www.moog.com/industrial](http://www.moog.com/industrial).



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# 1 Introduction

## 1.1 About this Document

This document gives the safe working instructions while working with the servo motors of M, AM, AML, W, AMW, AF, AFW series. It describes how to install, operate and maintain listed servo motors.

All personnel working on with the motor should have this user manual available during work and should check for the relevant information before start of the work.

## 1.2 Documents on M, AM, AML, W, AMW, AF, AFW Servo Motors

In addition to this user manual the other documents that are available on listed servo motors and servo actuators are:

- Installation drawing - provides information on motor mounting and wiring schematics for electrical installation.
- Data sheet - provides information on technical data on a specific motor size.
- Product catalogue – provides product description, bearing load diagrams, Servo Motor selection and sizing.



If the information and notes provided in this documentation do not meet your requirements, please contact Moog.

### 1.3 Typographical Conventions

#### **DANGER**

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

#### **WARNING**

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

#### **CAUTION**

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

#### **NOTICE**

NOTICE indicates possible property damage.

The following table shows the structure of a warning:



#### **SIGNAL WORD**

Type and source of hazard

Possible consequences of not avoiding the potential hazard

- How to avoid the hazardous situation

The following table shows other typographic elements:

Symbol	Explanation
	Notes about important operations and other useful information
➤	This is an action to be carried out
•	This is a bullet list
	This identifies important information

## 1.4 Structure of Warning Notices

The warning notices in this user manual have the following structure:



Figure 1: Structure of a warning notice

### Legend

- 1 Warning symbol
- 2 Signal word
- 3 Type and source of hazard
- 4 Possible consequences of a potential hazard
- 5 Hazard prevention measures

## 1.5 Abbreviations

Abbreviation	Explanation
M	Servo motors series (6 poles) with natural cooling, insulation class F
AM	Servo motors series (6 poles) with natural cooling, insulation class H
AML	Servo motors series (6 poles) with separate ventilation, insulation class H
W	Servo motors series (6 poles) with liquid cooling, insulation class F
AMW	Servo motors series (6 poles) with liquid cooling, insulation class H
AF	Servo motors series (12 poles) with natural cooling, insulation class H
AFW	Servo motors series (12 poles) with liquid cooling, insulation class H
DC	Direct Current
ESD	Electro Static Discharge

Table 1: Abbreviations

## 2 Safety Instructions

Do not attempt to install, operate, maintain or inspect the servo motor until you have read through this user manual and appended document carefully and can use the equipment correctly. Servo motors of M, AM, AML, W, AMW, AF, AFW series may only be set up and operated in conjunction with this manual.



Human safety and equipment safety must be the first considerations when performing the installation procedures for the servo motor and drive system. When it comes to electronics in your factory or workplace, you want to make sure both your facility and the employees in it are safe. What follow are the safety instructions for working on the servo motor.

### WARNING

Danger of high voltage and electrical shock hazard!

This creates the danger of death, severe injury, or extensive material damage.

- ▶ It is vital that you ensure the motor is safely earthed to the PE (Protective Earth). Electrical safety is impossible without a low-resistance earth connection.
- ▶ Do not unplug any connectors during operation.

### NOTICE

- ▶ Observe and adhere to the technical data and in particular the information given on the motor nameplate.
- ▶ The installation must comply with the local regulations and use of equipment and installation practices that promote electromagnet compatibility and safety.
- ▶ Safety equipment - To protect yourself against personal injury by falling motor, always wear suitable safety equipment, such as work shoes, when handling the motor.



Use this document if you are responsible for installing or troubleshooting motors. As with any electro-mechanical device, safety should be considered during the installation and operation. Throughout this manual you will see safety messages marked with the CAUTION and WARNING signal words. Follow the prescribed actions to avoid any potentially hazardous situation.

### 2.1 Safety Oriented Systems

The use of control technology in safety-oriented systems calls for special measures. When planning to use control technology in a safety-oriented system, the user should seek detailed advice in addition to referring to all the potentially available standards or guidelines on safety-engineering installations.



## 2.2 Qualified Personnel

Only properly qualified personnel are permitted to perform such tasks as transport, assembly, setup and maintenance of the motors.

Qualified personnel are those who are specialized with required knowledge and experience, who have been trained to perform such work and authorized to commission systems and circuits, in accordance with established safety practices and standards. The qualified personnel must know and observe all relevant national and international standards and regulations.

## 2.3 Electrical Hazards

Certain electrical systems have to be maintained and cleaned by staff. Before they can be accessed, the systems have to be disconnected from the mains supply to eliminate electrical hazards to operating staff.

- The motor must be demonstrably disconnected from the mains
- Secure against reconnection
- Verify that the system is dead
- Carry out earthing and short circuiting
- Provide protection from adjacent live parts
- Safety regulations for work on the equipment in which the motor is applied must be observed.

## 2.4 Thermal Hazards

### CAUTION



**Burn hazard!**

The surface temperature of the motor may reach up to 100 °C (212 °F) and may become very hot in operation, according to their protection category.

- ▶ Do not touch hot surfaces, measure the temperature, and wait until the motor has cooled down below 40 °C (104 °F) before touching it.

### 3 Product Information

- Moog servo motors of M, AM, AML, W, AMW, AF, AFW series benefit from a brushless construction which means that they are maintenance free. The longevity of the motors is limited only by the life of the bearings, which have lifetime lubrication (a L10h life of 20,000 operation hours with the recommended maximum axial and radial loads).
- The servo motors comply with 2014/30/EC (Low voltage directive) and 2014/35/EC (EMC Directive) directives, 2011/65/EU (RoHS) and related harmonized standards.
- Moog servo motors of M, AM, AML, W, AMW, AF, AFW series are designed and manufactured in accordance with strict CE standards, using rugged components with proven reliability in harsh thermal and shock load environments.
- CE certified

#### 3.1 Intended use

The motors in our product range are intended exclusively for commercial systems. They comply with the applicable standards and regulations. Serious personal injury and property damage can result from:

- Improper use
- Incorrect installation or operation
- Unauthorized removal of the required protective covers from the housing.

The technical data and information on the nameplates or in the product-specific data sheets for the motors form the basis for the proper commissioning of the motors. All instructions must be followed at all times.

**Warranty and claims for defects:** For related information, please check Conditions of Purchase of Moog Brno.

#### 3.2 Manufacturer Name and Address

The following table shows all the information regarding the manufacturer:

Info	Description
Moog Company	Moog Brno s.r.o.
Address	Mostecká 992/26, 614 00 Brno, Czech Republic
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Web Site	<a href="http://www.moogbrno.cz">http://www.moogbrno.cz</a>

Table 2: Manufacturer name and address

#### 3.3 Authorized representative for the EU

The following table shows all the information regarding the authorized representative in the EU and Switzerland:

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Table 3: Authorized Representative for the EU and Switzerland

## 4 Shipment and Storage

Please check the contents of each delivery are as ordered and that no damage, especially the areas of the shaft and connectors, has occurred during transit. Any problems should be immediately addressed to a Moog representative with a description of the fault or damage.


### CAUTION

#### **Danger of personal injury and damage to property!**

Failure to observe these safety procedures could result in personnel injury or equipment damage.

- ▶ Do not forget to observe the safety signs on the motor.
- ▶ Do not open or attempt to open the motor.

## 4.1 Transport and Storage

<b>⚠ WARNING</b>	
	<p><b>Heavy weight!</b>  <b>Danger during lifting and transporting procedures!</b></p> <ul style="list-style-type: none"> <li>▶ Improper handling, unsuitable or defective devices, tools etc. can cause injuries and/ or property damage. Lifting devices, ground conveyors and lifting tackle must respond to all relevant regulations.</li> <li>▶ Motors with weight over 50 kg are fitted with lifting eyes, unless otherwise specified. The lifting eye provided should not be used for lifting entire machine. Only the component attached to this support may be safely lifted by it.</li> </ul>

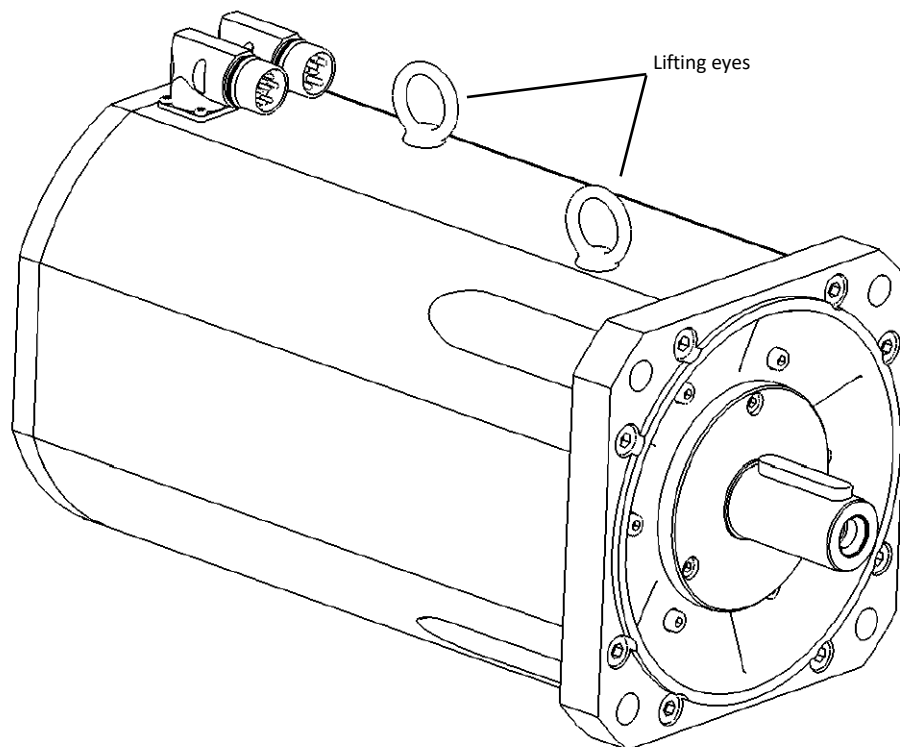


Figure 2: Hoisting points

Use suitable suspension and load devices for transportation and assembly. Use lifting eyes provided by the manufacturer. Improper handling may lead to serious injury.

In case of intermediate storage, observe the following storage conditions:

- Recommended ambient temperature: +15 to +25°C (+60 to +78°F),
- Permissible temperature: -20 to +70°C (-4 to +158°F), temperature fluctuation: < 10°C (18°F) per day.
- Relative humidity: < 65 % non-condensing is recommended, 90 % is permissible.
- Ensure there are minimal vibration and shock where servo motors are stored.

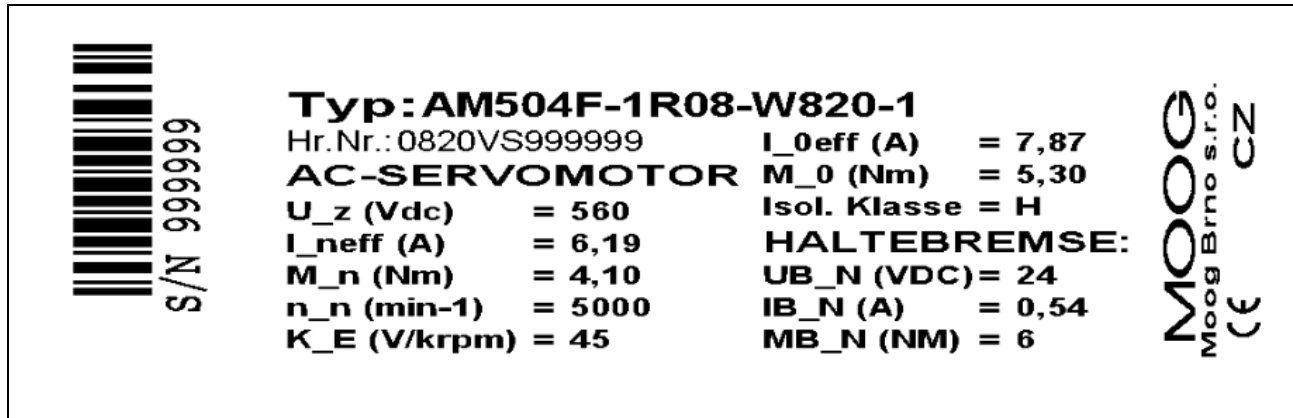
### NOTICE

#### **Damage due to dirt, moisture**

Storage outside or under the wrong climatic conditions can cause corrosion and other damage to the servo motor. Condensation due to temperature fluctuations can result in electronic malfunctions.

## 5 Motor Nameplate

The motor nameplate data are used for the setting of the servo drive. If you contact Moog concerning an issue, identification data of the motor must be supplied. **Please note that the specific design of the nameplate may vary.**



		Description
Identification data	Typ	Motor type and Motor model number (ordering number)
	S/N	Serial number
	Hr.Nr.	Week and year of production + serial number
Motor technical data	U <sub>z</sub> (Vdc)	Rated voltage
	I <sub>neff</sub> (A)	Rated current
	M <sub>n</sub> (Nm)	Rated torque
	n <sub>n</sub> (min-1)	Rated speed
	K <sub>E</sub> (V/krpm)	Voltage Constant
	I <sub>0eff</sub> (A)	Standstill current
	M <sub>0</sub> (Nm)	Standstill torque
Brake technical data (optional)	UB <sub>N</sub> (VDC)	Rated voltage of standstill brake
	IB <sub>N</sub> (A)	Rated current of standstill brake
	MB <sub>N</sub> (NM)	Rated (holding) torque of standstill brake
Standards	Isol. Klasse	Insulation class
	CE	Conformity certificate will be supplied upon request

Note: listed technical data are valid for ambient temperature range from 0 to 40 °C

Table 4: Motor nameplate

## 6 Installation

### WARNING

#### Danger of personal injury!

Working with and on the motor without the required basic electrical knowledge may cause injuries or parts may be damaged.

- ▶ The motor is intended for installation and use by qualified personnel, familiar with electrical machines and safety requirements.
- ▶ The safety equipment necessary to prevent accidents and electrical shocks must be provided by the installer.
- ▶ Ensure that the installation drawing and data sheet are available.

Following care must be taken while installing the motor:

- Read the name plate, warning and caution plates on the motor carefully.
- Permissible radial and axial loads should be known to the personnel.
- Screwed-in lifting eye bolts can be removed after installation.
- Refer to the installation drawing before installing.

### CAUTION



#### Electrical hazard!

Moog motors may contain ESD sensitive parts. For motors with such parts, additional care is required.

- ▶ Do not touch the connector pins with bare hands.
- ▶ If the user carries out a HI pot test, then pins must be short circuited before the test is carried out. The polarity must be carefully observed. Avoid currents >4 mA in the KTY circuit

### NOTICE

#### Risk of damage

- ▶ Release the brake before starting the motor or by supplying proper voltage as defined by the manufacturer.
- ▶ Do not use the holding brake to stop the motor. It is not meant to be safely used as a working brake.



When installing and mounting the motor, ensure that the shaft extension is protected against impact and pressure.



Respect the technical data on the labeling plates on the motor enclosure.

## 6.1 Recommended Drives

The Moog motors are designed to be used together with a sinusoidal servo drive. There are no special requirements regarding the type or model of drive to use, however, Moog recommends a fully digital controller with extremely high bandwidth capability, such as Moog's own DM2020 (Multi axes), DS2020 (Single axis) or DR2020 (Decentralized) Servo Drives

**Please contact the manufacturer for any special requirements (e.g. additional data for inverter settings).**

## 6.2 Mounting

- The motor shaft should be degreased carefully before mounting a coupling. When using a degreaser (grease dissolving substance), prevent it from flowing into the bearing as this will destroy the lifetime lubrication. A clamp coupling or a shrink connection is recommended to provide a reliable torque transmission. For direct drive, use flexible couplings. Alignment has to be coaxial, poor alignment will lead to mechanical vibration during operation. The resulting damage to the bearings can reduce the motor's life and submit the motor shaft to a cycle bending that may cause mechanical ruptures.
- We recommend to use tapered couplings to improve transmission stiffness and avoid elasticity problems due, for instance, to key and key housings. If, for any reason, a key must be selected, please assure a proper interference fitting on shoulders of motor shaft and pulley or pinion. If available, use the front thread to assemble the pulley or pinion to the motor shaft.
- Please check our catalogue (or relevant documentation in case of non-catalogue variants) for maximum permissible shaft load. Please note that this load may vary depending on mounting orientation. Please contact the manufacturer for related questions.
- Excessive axial force on the rotor shaft can result in bearing failure and impair the functionality of the brake, when present. This may lead either to reduced braking force or brake failure. Therefore excessive pressure and shocks on the front end of the shaft and the back housing must be avoided under all circumstances.
- Moog recommends the use of socket screws according to ISO 4762 (old DIN 912) 8.8. The mounting of Moog motors can be eased considerably by the use of hexagonal ball ended Allen keys.
- In order to simplify motor assembly, the mechanical coupling and to improve reliability, it is strongly recommended to use a lubricating anti-fritting corrosion paste. We recommend KLUBERPASTE 46 MR 401 or equivalent.



**NOTE: The stroke of a hammer blow always exceeds the maximum permissible axial and radial forces.**

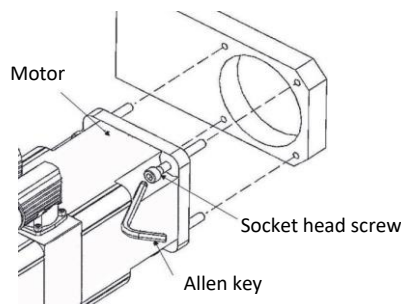


Figure 3: Mounting Detail



## 6.3 Standstill brakes

Motors can be equipped with a standstill brake upon request. Depending on the motor type and size, spring brakes or permanent magnet brakes are used.



### **WARNING**

**The standstill brakes cannot be used to slow down the motion of the motor.** The improper use of standstill brakes can result in serious injuries and severe material damages.

Before starting up the machine, check that the nominal braking torque level has been reached.

Make sure to open the brake before activating the motor. The brake can be closed only after the motor has come to a complete stop.

Avoid applying lubricants to the motor shaft end. The brake is installed mostly on the shaft end side of the motor.

## 6.4 Liquid Cooled Motors (AMW, AFW)

Liquid cooled motors must have a proper closed loop cooling circuit. The cooling medium has to be composed from desalted and demineralized water chemically neutral and with the addition of anti-corrosion agent. Such products must be compatible with the materials of the housings (aluminum and its alloys), with the materials of the gaskets (Viton) and with all the components of the circuit.

### NOTICE

**Do not connect the cooling system to a regular water line!**

Using regular, untreated water can cause severe damage to the cooling system and it is to be avoided in any circumstance.

For additional conditions, refer to the following notes:

- Maximal water inlet pressure (< 1 min)  $P_{max} = 1 \text{ MPa}$  (10 Bar)
- Rated water inlet pressure  $P_n = 0,5 \text{ MPa}$  (5 Bar) max.
- Minimal water flow and minimal pressure drop: listed in the catalogue or relevant datasheet (varies according to motor, size)
- PH-value: 6,5 to 7,5
- The recommended water hardness is 0,7 mmol/l. If cooling water does not meet this parameter, plasticizers should be used

The use of inhibitors to prevent corrosion in aluminum is strongly recommended. The ratio of anticorrosive agent (25%) to water (75%) should not be exceeded, otherwise a reduction in performance may occur.

Alternatively, other coolant can be used, such as water-glycol antifreeze, various coolant oils, etc. In this case, however, reduced performance is to be expected. The specific derating is determined by calculation after consultation with the manufacturer.

A constant monitoring of cooler flow is recommended.

Inlet cooling media temperature must be between 25° and 40°C to avoid condensation inside of the motor; in any case the inlet coolant temperature must be higher than the motor frame temperature of at least 2°C

Inox pipe fittings are recommended for connecting the cooling circuit to the motor. Before activating the motor, make sure the cooling circuit is completely filled and leak free.

## 7 Electrical Interfaces

For the correct connection, it is best to use the mating connectors and cable characteristics indicated by Moog. When using non-Moog components, the cable specifications must be fulfilled in every way.

### WARNING

#### **Hazardous voltage!**

The rotating motor can generate high voltages.

- ▶ Always make sure that there are no exposed cables.
- ▶ Only use appropriate power cables and plugs.
- ▶ Pay attention to the pin assignment according to the motor drawings and documentation.
- ▶ It is recommended to secure the plug connection to avoid accidental disconnections
- ▶ Do not disconnect any plug during operation. There is a risk of death or serious health or material damage.

Connection and disconnection of the motors must be made with the controller switched off. Simply disabling the controller is not sufficient. During installation, special attention should be paid to the diameter of the protective earth (PE) conductor, which must be sized according to legal safety rules.

We recommend shielding power and signal cables. The shielding should be connected to earth at both ends.

In case of use of the standstill brake:

- Used brakes require a smoothed (non-pulsating) DC voltage.
- To ensure the function in the event of large temperature fluctuations, it is advisable to supply the brake coil with constant current.

### 7.1 Cables, connectors and wiring

The electrical connection can be performed in one of the following ways:

- Using connectors
- Using terminal blocks
- Using free cable ends

For specific wiring schematic, please check the relevant documentation or contact the manufacturer.

#### **EMC**

For compliance with Directive 2014/30/EC (EMC), and for correct system operation, the signal and power cables must be shielded (minimum cover 85%). Cable shielding must be connected to ground on both ends using a radio frequency connection (i.e. 360°). The cables and cable shields must be connected in accordance with the EMC requirements of the used drive.

### **NOTICE**

Small wire diameters lead to an unacceptable heating in the cable. This results in a power loss to the motor, particularly marked the longer the cables used are.

## 7.2 Connector types

Moog motors have Threaded, Speedtec and Speedtec-ready connectors mounted on them. The Threaded and Speedtec-ready connectors will have O-ring in them.

The mating connectors are of two types Threaded and Speedtec plug type.

If a Speedtec-ready connector is used with a Threaded plug mating connector, the O-ring does not need to be removed from the motor connector, i.e., the connector can be used as is.

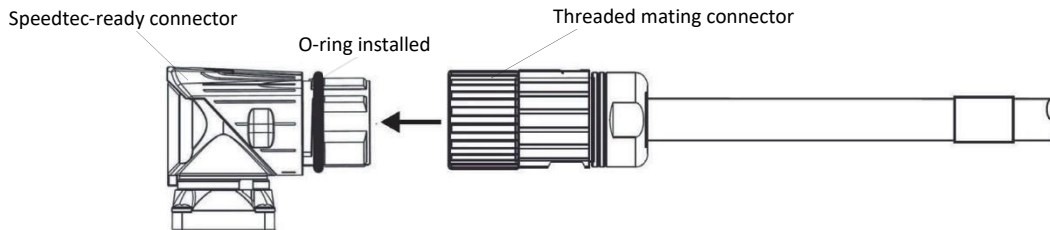


Figure 6: Speedtec-ready motor connector with O-ring

If a Speedtec-ready connector is used with a Speedtec plug mating connector, the O-ring should be removed from the motor connector.

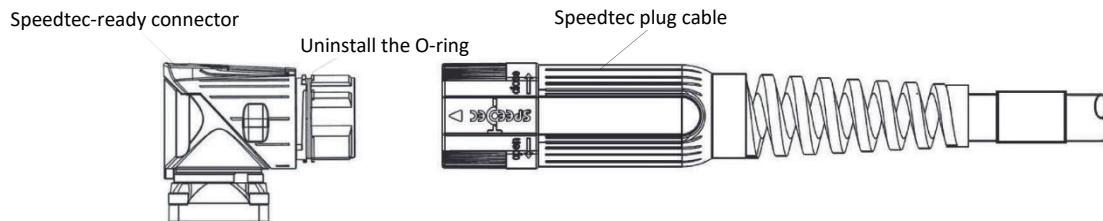


Figure 7: Speedtec-ready motor connector with O-ring uninstalled

## 8 Maintenance

### WARNING

#### **Risk of injury!**

In case of motor disassembly, make sure that all electrically powered parts of the motor, windings and any accessory device which otherwise may lead to fatal injury is safely disassembled.

### NOTICE

Because of product liability issues any motor damage should be repaired by Moog. Non-Moog staff may be unable to comply with safety rules (e.g. VDE guide lines) and Moog quality standards. Any unexpected mechanical rotation of parts can cause severe damage during maintenance.

### NOTICE

Each time the motor is disassembled, make sure that the phasing of the encoder system is done properly and by Moog personnel.

Observe the following prescriptions:

- Before performing any maintenance procedure make sure that the shaft rotation is locked. Make sure that the equipment connected to the shaft cannot cause any rotation. If necessary, disconnect the load before performing maintenance.
- Check for bearing noise and vibrations during normal operation at regular intervals.
- Bearing service life is approx. 20,000 hours, unless otherwise stated.
- Brakes should be checked on fixed regular intervals to ensure safe and trouble-free running of the motor.
- Check that full engagement and disengagement works for each brake.
- Some types of magnetic brakes, such as the COMBIPERM type from KEB, are subject to a running-in program before delivery. For normal industrial applications, a maintenance interval of 4 weeks is recommended. For safety applications, it is recommended to check the brake function at regular intervals to be determined by the user.
- Keep the motor clean in order to ensure free ventilation flow for cooling.
- Check that the motor is not noisy during operation and vibration does not exceed standard levels.
- To detect and correct any irregularities at early stages it is recommended to carry out an inspection after the first 50/75 operation hours.
- For liquid cooled motors (AMW, AFW) it is recommended to periodically clean and check the cooling circuit. The use of cleaning products and/or deposit removers has to be subjected to preventive verification of compatibility with the materials of the housings (aluminum and its alloys), with the materials of the gaskets (Viton) and with all the components of the circuit.

## 9 Troubleshooting

Problem	Cause	Action
Motor does not start	Wrong connections	Check the connections of the motor power and signal cables.
	Mechanical brake	Check that the brake is supplied with the voltage (VDC) as defined by the manufacturer.
	Mechanical failure	Check that the mechanics coupled to the servo motor allow free rotation.
	Parameters	Check the parameter settings of the drive system.
	Overload	Reduce the load or contact application engineer for more details.
Motor does not reach the rated speed	Parameters	Check the parameter settings of the drive system.
	Overload	Reduce the load or contact application engineer for more details.
Motor runs in wrong direction	Connections	Check both the power and signal connections on the motor and drive side.
Motor overheats	Overload	Reduce the load or contact application engineer for more details.
	Wrong connections	Check that no phase is incidentally open or grounded.
	Harmonic distortion	High harmonic distortion in the frequency converter output is not allowed.
Vibrations or loud noise	Bearing failure	Contact Moog for repairs.
	Misalignment	Check the correct alignment of the motor and load. Ignoring misalignment can cause serious damage of bearings, shaft and mechanics.

## 10 Motor Disposal

In accordance with directive 2012/19/EC electronic devices are "special waste" (WEEE) and must be subjected to treatment and professional elimination.

Moog motors may contain environmentally regulated materials, such as lead solder and circuit boards. It is the user's sole responsibility to dispose of the motors in accordance with specific local and national regulations. Be sure to send the material to authorized disposal facilities under controlled conditions. If it is possible to recycle the component materials, always do so with the support of authorized professionals.

### 10.1 What to do if repairs are required?

The servo motor can be repaired only by Moog; opening of the motor will void the warranty.

For warranty as well as post-warranty repairs please follow the procedure described below:

- Perform all required procedures for safely placing out of service your motor and re-send it to the address of the manufacturer (with the original packing material if available).
- All parts such as gears, toothed wheels, pinions etc. not fitted by Moog should be removed because Moog cannot guarantee a correct disassembly. Grease and dirt on the front flange should be removed.
- Moog would appreciate a detailed failure or breakdown report attached to the delivery paperwork. "**For Repair**" should be clearly stated on the delivery note.
- After the motor has been received a complete analysis will be performed by our technicians. During this process, Moog may request details about the operating conditions (duty cycle, loading forces, etc.) from the customer.
- Based on the performed analysis, a repair proposal is issued, together with a price calculation for labor and material, (if the motor is not repairable, a commercial proposal for its replacement can be issued).
- If the repair proposal is approved, the motor is repaired and sent back to the customer.

# MORE PRODUCTS. MORE SUPPORT.

Moog designs a range of motion control products to complement those featured in this document. Moog also provides service and support for all of our products. For more information, contact the Moog facility closest to you.

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