

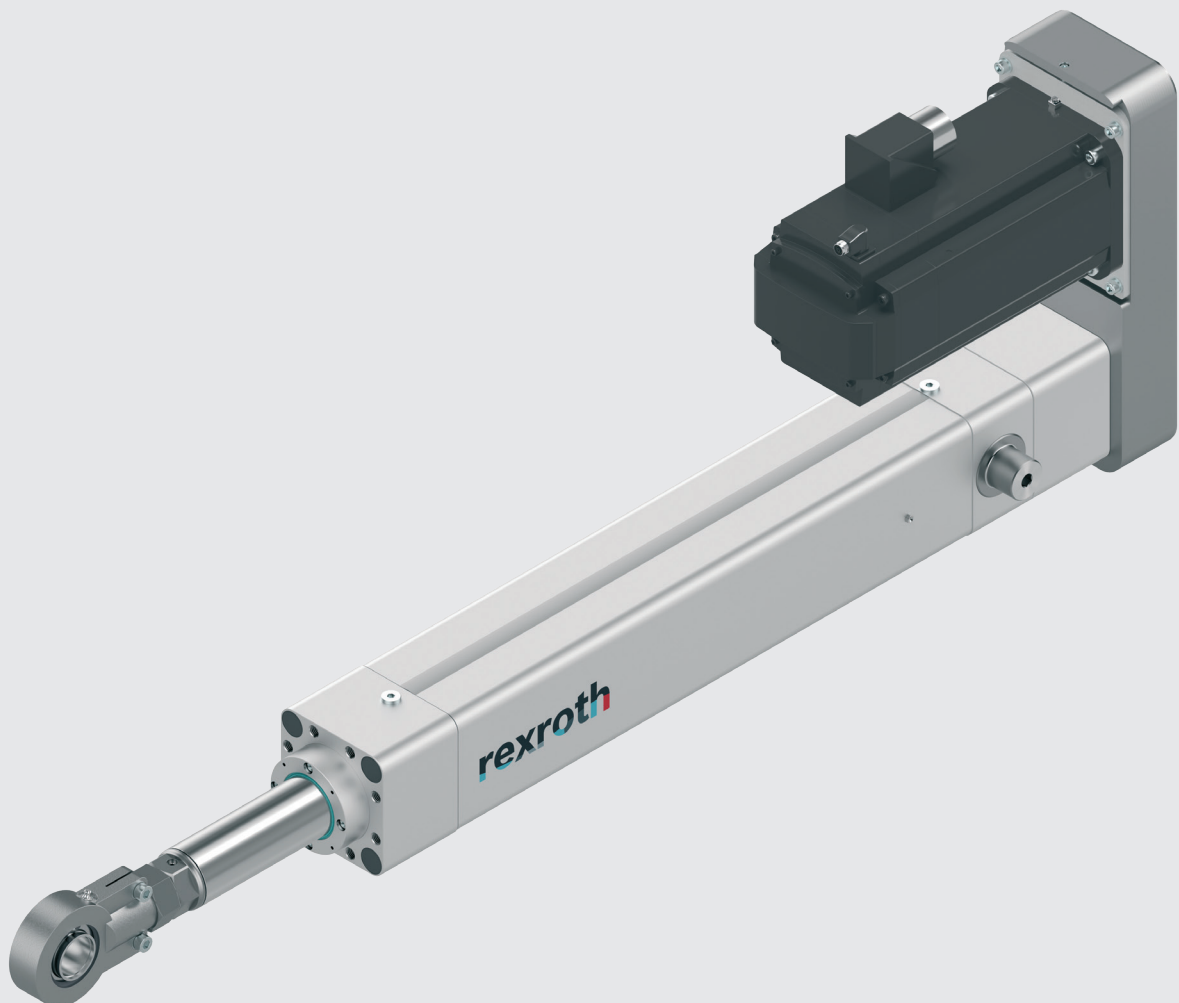
Electromechanical cylinder EMC-HP

R320103219/2026-03
EN



Instructions

ENGLISH



The information provided serves only to describe the product. No statements concerning a certain condition or suitability for a certain purpose can be derived from our information. The information given does not release the user from the obligation of own judgment and verification. Please note that our products are subject to a natural process of wear and aging.

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The title page contains an illustration of a sample configuration. The product as delivered can differ from the illustration. The original instructions are in German.

Any passing on of the product must include these instructions and the safety instructions and information for linear motion systems R320103152.

Die vorliegende Anleitung ist in folgenden Sprachen verfügbar.
These instructions are available in the following languages.

DE Deutsch (Originaldokumentation)

EN English

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1 About this documentation

1.1 Validity of the documentation

This documentation applies to the following products:

- Electromechanical cylinder EMC-HP as described in the catalog "Electromechanical cylinders EMC-HP".

This documentation is intended for assembly/installation personnel, line operators and machinery/plant users or manufacturers.

This documentation contains important information for proper and safe installation, operation, maintenance and disassembly of the electromechanical cylinder EMC-HP and for troubleshooting simple errors oneself.

► Before commencing any work with the product, be sure to read these instructions and the "Safety instructions for linear motion systems" carefully and completely.

1.2 Required and supplementary documentation

Documentation which is indicated by the book symbol  must be obtained before handling the EMC-HP and must be adhered to:

Table 1: Required documentation

	Title	Document number	Document type
	Safety instructions for linear motion systems	R320103152	Safety instructions
	Electromechanical cylinders EMC-HP	R999002086	Catalog
	Safety data sheet for Dynalub 510	R320103160	
	Safety data sheet for Dynalub 520	R320103161	
	Product data sheet for Dynalub 510	R310 2052	
	Product data sheet for Dynalub 520	R310 2053	
	System documentation from the system manufacturer		
	Instructions for the other system components		

The Rexroth documentation is available for download at www.boschrexroth.com/en/xc/myrexroth/media-directory.



1.3 Presentation of information

To enable you to work rapidly and safely with the EMC-HP while following these instructions, this documentation uses standardized safety instructions, symbols, terms and definitions, and abbreviations. These are explained in the following sections.

1.3.1 Safety instructions in this document

This document contains safety instructions before any instructions regarding actions that involve a risk of personal injury or damage to property. The safety precautions described must be adhered to.

Safety instructions are structured as follows:

 SIGNAL WORD
Type and source of hazard! Consequences if ignored. ► Hazard prevention measure.

- **Warning sign:** draws attention to the hazard
- **Signal word:** indicates the severity of the hazard
- **Type and source of hazard:** indicates the type or source of the hazard
- **Consequences:** describes the consequences that may occur if the hazard prevention measures are ignored.
- **Hazard prevention measure:** indicates how to avoid the hazard

The safety instructions cover the following hazard classes. The hazard class describes the risks involved if the safety instructions are not complied with.

Table 2: Hazard classes according to ANSI Z535.6

Warning sign, signal word	Meaning
 DANGER	Indicates a hazardous situation which will result in death or serious injury if not avoided.
 WARNING	Indicates a hazardous situation which may result in death or serious injury if not avoided.
 CAUTION	Indicates a hazardous situation which may result in minor or moderate injury if not avoided.
NOTICE	Property damage: The product or its surroundings may be damaged.

1.3.2 Symbols

The following symbols indicate information which is not related to safety but makes the documentation easier to understand.

Table 3: Meaning of the symbols

Symbol	Meaning
	If this information is not observed, the product will not be optimally used/operated.
►	Single, independent work step
1.	Numbered work steps
2.	The numbers indicate the sequence of the work steps.
⇒ 7	See section 7
⇒ ☒ Fig. 7.1	See figure 7.1
	Screw with strength class ...
⊙	Tightening torque
μ	Friction factor for screws

1.3.3 Abbreviations

The following abbreviations are used in this documentation:

Table 4: Abbreviations and definitions

Abbreviation	Meaning
EMC-HP	Electro M echanical C ylinder - H igh P ower
PLSA	P lanetary S crew A ssembly

2 Safety instructions

The general safety instructions for this product can be found in the documentation "Safety instructions for linear motion systems." You must have read and understood these before handling the product.

3 Scope of delivery

The following is included within the scope of delivery:

- Electromechanical cylinder EMC-HP according to the ordered configuration
- "Safety instructions for linear motion systems"
- Instruction manual "Electromechanical cylinder EMC-HP"
- Final inspection certificate
- ▶ Upon receipt of the delivery, immediately check for completeness against the receipt and notify the carrier or Bosch Rexroth AG if any parts are missing.

3.1 Condition as delivered

- The electromechanical cylinder EMC-HP is delivered as a completely assembled unit. The only parts not pre-assembled are pillow blocks, clevis brackets and the switches.

3.2 Accessories

The following accessories are available:

- Fastening accessories
- Load measuring pin
- Switches
- Motor attachment kit (flange and coupling, belt side drive, gear unit)

 Dimensions, material numbers, additional fastening accessories, and further information
➡ Catalog "Electromechanical cylinders EMC-HP."

4 Product description

4.1 Performance description

The electromechanical cylinder EMC-HP is a mechanical linear axis with a piston rod.

The mechanical system is based on established screw drives, which convert the rotary motion of the motor into linear motion of the piston rod.

When installing vertically, it should be remembered that the screw drive is not self-locking and must therefore be secured against falling.

4.2 Device description

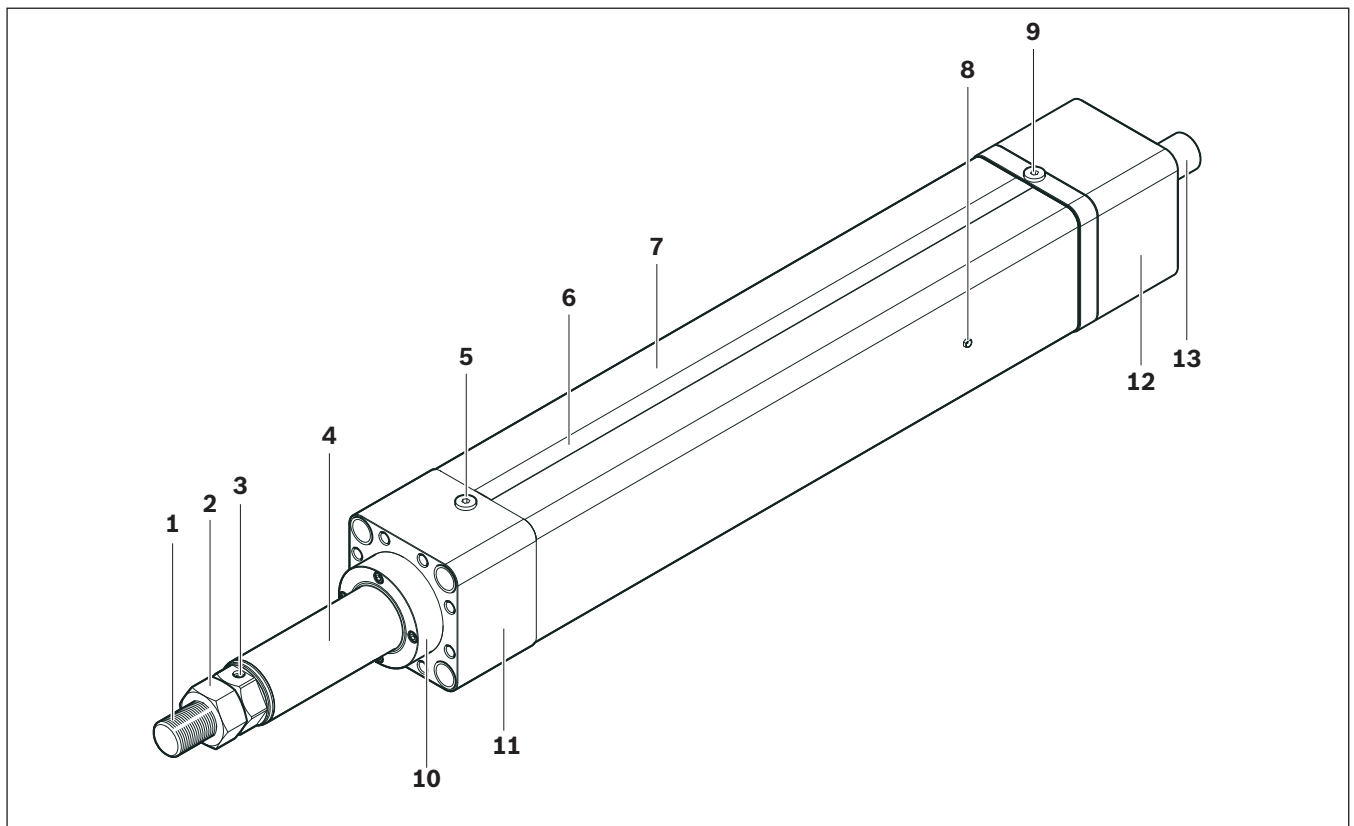


Fig. 1: Components of the electromechanical cylinder EMC-HP

An electromechanical cylinder EMC-HP comprises the following parts:

- | | |
|-----------------------------------|--|
| 1 Threaded bolt | 8 Lube nipple |
| 2 Hexagonal nut | 9 Connection for air compensation |
| 3 Wrench flats | 10 Seal holder |
| 4 Piston rod | 11 Cover |
| 5 Service opening | 12 Bottom |
| 6 Cover profile cable duct | 13 Drive journal |
| 7 Housing | |

4.3 Identification

► When ordering replacement parts, please specify all the data on the name plate.

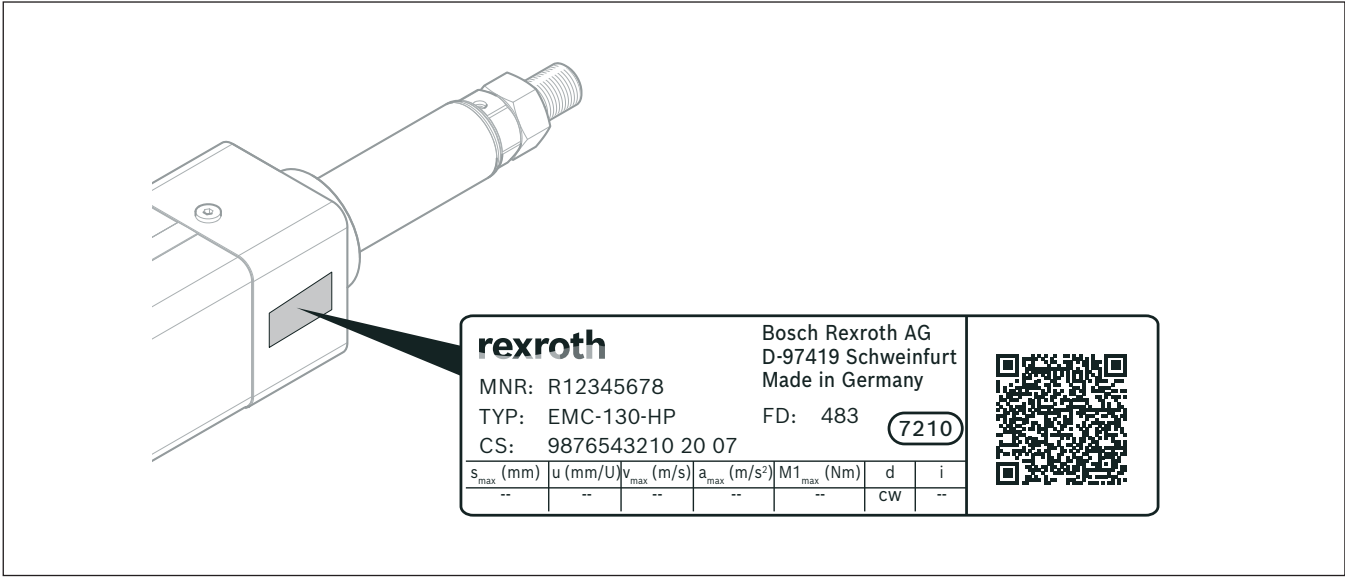


Fig. 2: Name plate (example)

The name plate of the EMC-HP carries the following information:

Table 5: Information on name plate

Name plate information	Meaning
MNR	Material number
TYP	Type designation and size
CS	Customer order number
FD	Date of manufacture
7210	Manufacturing location

The name plate contains additional technical data for commissioning ➞ 7.1 on page 34

5 Transport and storage

5.1 Transporting the EMC-HP

 **WARNING**

Risk of EMC-HP falling due to inadequate load handling equipment!
Death or severe injury.

- Use only inspected and suitable load handling equipment.
- Only attach load hoisting equipment to the housing and fasten with care.
- Do not stand under suspended loads.

NOTICE

Risk of damage to motor attachment through vibrations or shocks!

Motor can get torn off.

- ▶ When transporting the product with assembled motor, always provide support for the motor.
or
- ▶ Disassemble the motor prior to transport.

Risk of damage to the product due to improper transport/lifting ⇒ Fig. 3!

Damage to the EMC-HP.

- ▶ Pay attention to the center of gravity (C).
- ▶ Avoid damage.
- ▶ Retract the piston rod (1).
- ▶ Attach slings to the bearing housing and the front end of the housing (1).
- ▶ Prevent the EMC-HP from swinging during transport (2).
- ▶ Do not lift the EMC-HP by the piston rod (3).
The screw drive is not self-locking.
- ▶ With motor attachment (4/5) and (6/7 with holding brake), take note of the changed center of gravity and attach the rear slings to the flange or gear unit, if necessary.

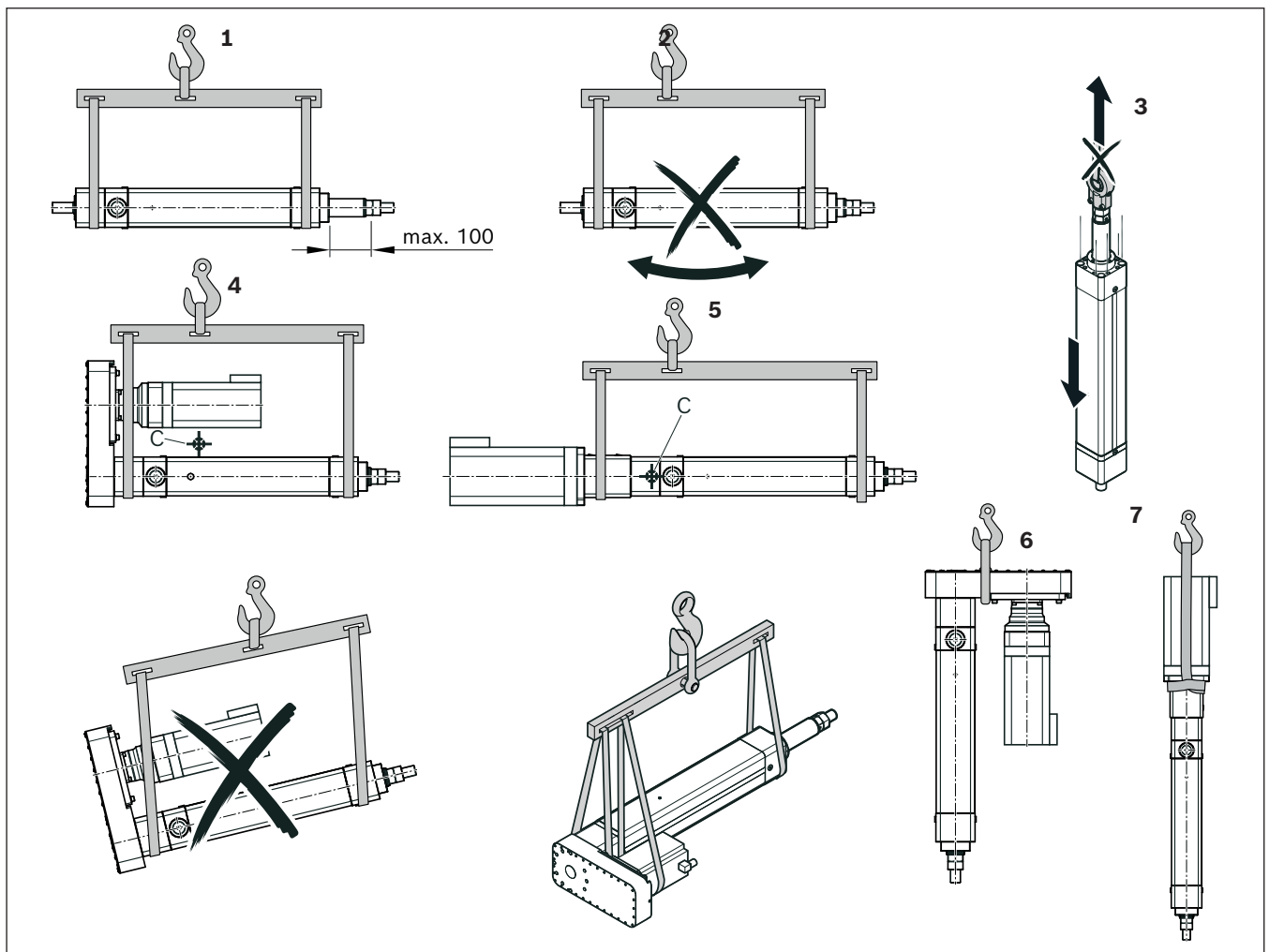


Fig. 3: Transporting the EMC-HP

5.2 Storing the EMC-HP

NOTICE

Risk of damage due to improper storage!

Potential corrosion of EMC-HP parts.

- ▶ Store the EMC-HP only in a roofed, dry area.
- ▶ Protect the EMC-HP from humidity and corrosive influences.

6 Mounting

For dimensions and material numbers of the individual components ➡ Catalog "Electromechanical cylinders EMC-HP".

WARNING

Risk of EMC-HP crashing down in vertical or hanging installations due to lack of protection against falling loads!

Death or severe injury.

- ▶ Secure the EMC-HP against falling.
 - ▶ Do not stand under the EMC-HP in the hazard area.
- ▶ Before hoisting the EMC-HP, take note of the weight ➡ Catalog "Electromechanical cylinders EMC-HP", chapter "Technical data."

6.1 Unpacking the EMC-HP

1. Before hoisting the EMC-HP, take note of the weight ➡ Catalog "Electromechanical cylinders EMC-HP", chapter "Technical data."
2. Lift the EMC-HP out of the packaging and remove the packaging material.
3. Dispose of the packaging material according to the local regulations in your country.

6.2 Required accessories

- ▶ Use suitable screws for fastening.

6.3 Installation conditions

- ▶ Observe the operating conditions ➡ Table 20 on page 46 and the catalog "Electromechanical cylinders EMC-HP".
- ▶ For special operating conditions, please contact us.

NOTICE

Risk of damage due to improper loads!

Damage to the product.

- ▶ Do not attach any projecting loads.
- ▶ Do not turn the piston rod.
- ▶ Do not use the housing for attaching other optional machine elements to absorb forces.
- ▶ Attach only standard Rexroth elements to the housing.

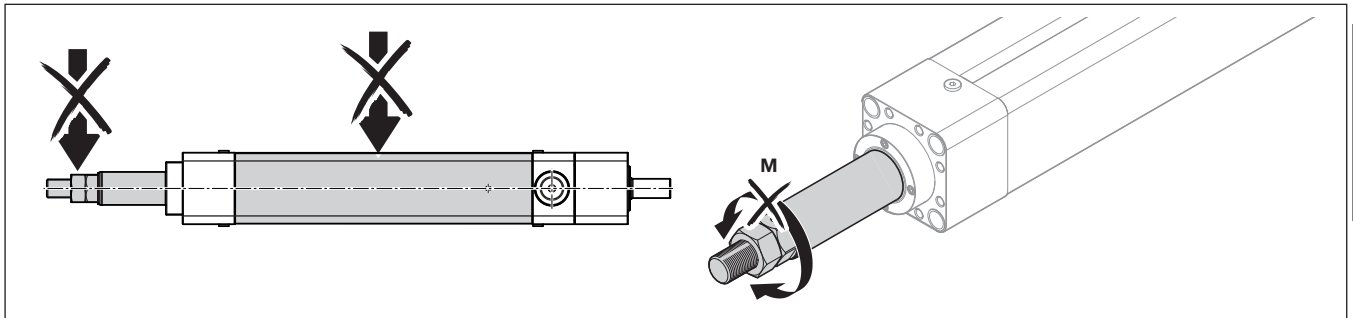


Fig. 4: Non-permissible loads

6.4 Installation position

The EMC-HP can generally be installed in any position.

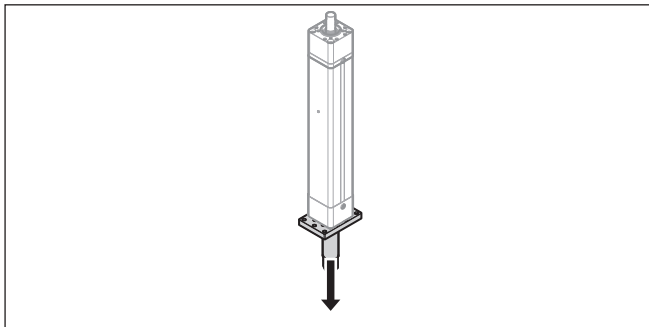


Fig. 5: EMC-HP with flange

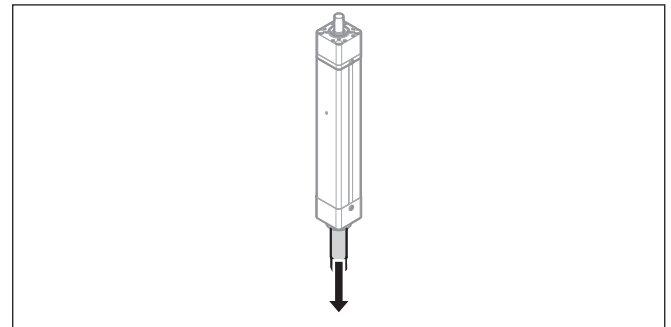


Fig. 6: Secure the piston rod against falling



The version with flange may only be installed in a vertical installation position!

! WARNING

Risk of piston rod crashing down if installed in a vertical or slanting position due to lack of arrestor devices!

Death or severe injury.

- ▶ In vertical or slanting installations, secure the piston rod of the EMC-HP against falling.
- ▶ Do not stand in the fall direction of the piston rod.

6.5 Fastening elements

The EMC-HP is supplied with the ordered fastening elements. Foot mounting, pillow blocks and clevis brackets are not ready-mounted on the EMC-HP upon delivery.

The fastening elements can also be ordered separately as accessories. Fastening elements can be mounted at the following locations on the EMC-HP:

- 1 Belt side drive **and spur gear** (only Rexroth fastening elements permitted)
- 2 Threaded bolt (customer-built accessories may be attached here)
- 3 Cover (only Rexroth fastening elements permitted)
- 4 Bottom (only Rexroth fastening elements permitted)

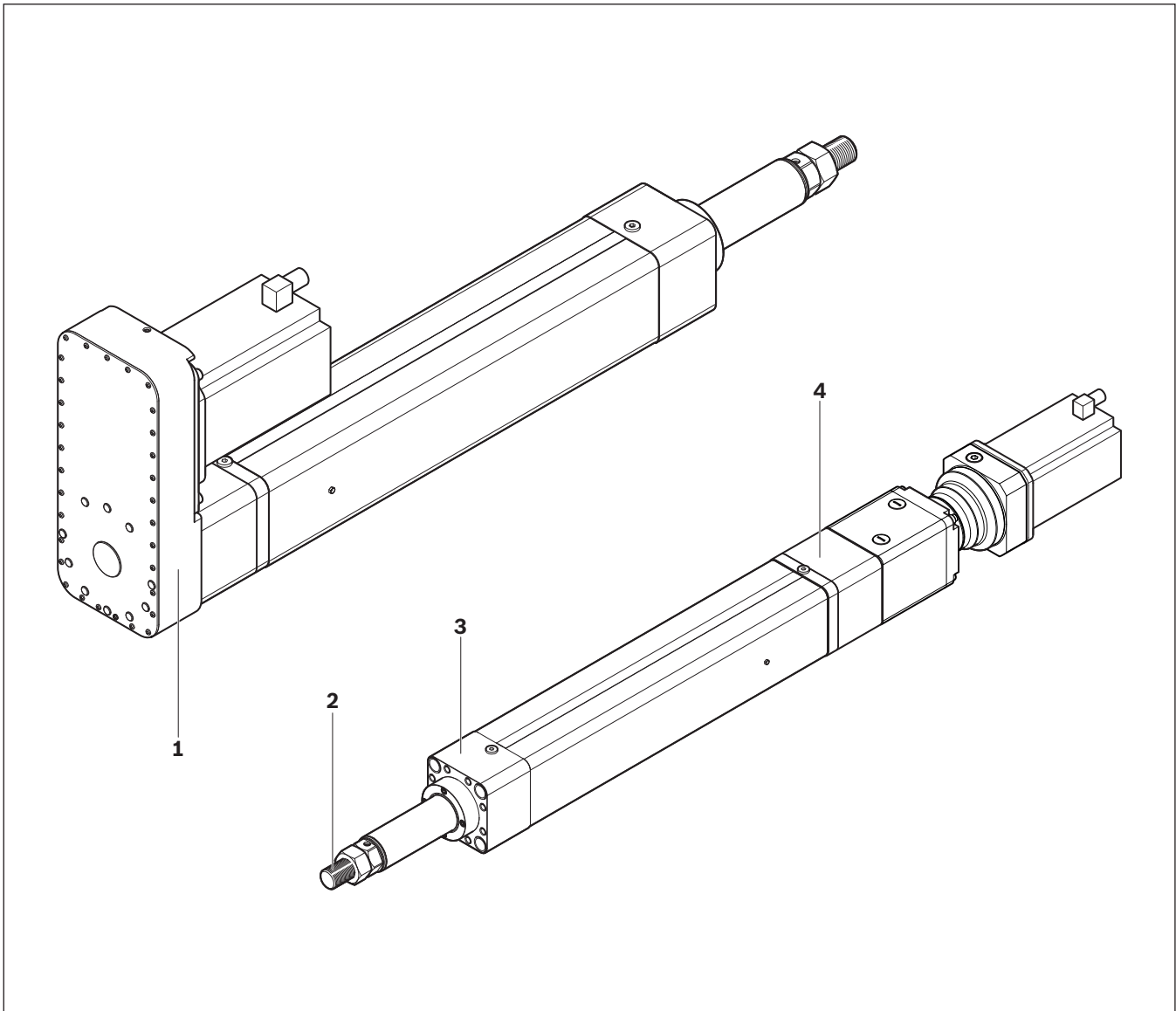
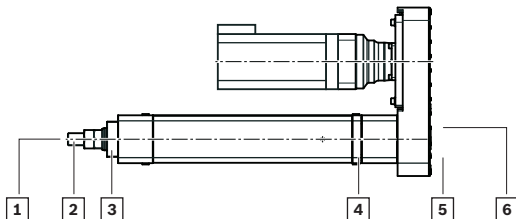
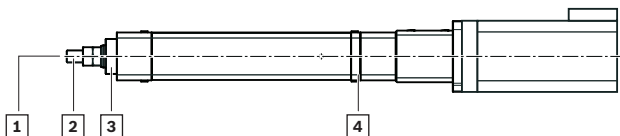
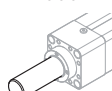
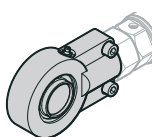
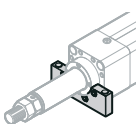
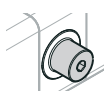
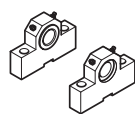
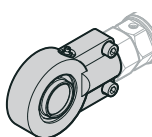
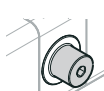
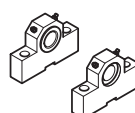
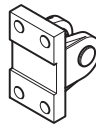
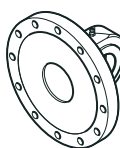
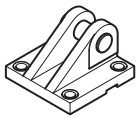
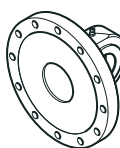
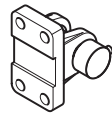
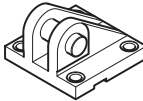
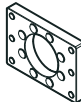
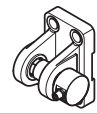


Fig. 7: Fastening options on the EMC-HP





Group 1	Group 2		Group 3		Motor attachment	Group 4	Group 5	Group 6				
000	000 		000		F000 F001 for motor flange	000 / 050 without trunnion	000	000				
	011 					002 / 003 with trunnion 	000	000 001 				
000			011 Foot mounting		S000 S090 S180 S270 with parallel mounting	002 / 003 with trunnion 	000	000 001 				
021 						000 / 050 without trunnion 	000	000				
022 							011 (not with screw cooling) 	000				
								031 ¹⁾ 		021 		
										022 		
			014 with flange 		F000 F001 for motor flange	000 / 050 without trunnion	000	000				
					S000, S09 S180, S270 with parallel mounting							
								031 ¹⁾ 				

¹⁾ With load measuring pin

6.5.1 Mounting fastening elements on the EMC-HP

⚠ CAUTION

Risk of exceeding the permissible load!

Risk of injury.

- ▶ Ensure that the actual load does not exceed the max. axial force values ➡ Chapter "Maximum axial loading of mechanical cylinder system $F_{\max \text{ EMC-HP}}$ " in the catalog "Electromechanical cylinders EMC-HP."

Mounting the spherical rod end bearing

NOTICE

Risk of twisting the piston rod due to incorrect mounting!

Damage to the EMC-HP due to application of torque!

- ▶ Take care not to subject the piston rod to torsion when tightening and loosening the lock nut.

1. Screw the lock nut **(1)** onto the threaded bolt to the stop.
2. Screw the spherical rod end bearing to the stop/to the lock nut on the threaded bolt and align.
To align, turn back the lock nut max 1.5 revolutions against the spherical rod end bearing.
3. Tighten the lock nut against the spherical rod end bearing, observing the tightening torques M_K .
4. Tighten the fastening screws **(2)** in equal steps, observing the tightening torques M_B .
5. Mount any further fastening elements as shown in the illustration. Tighten the fixing screws in equal steps, observing the tightening torques M_B .

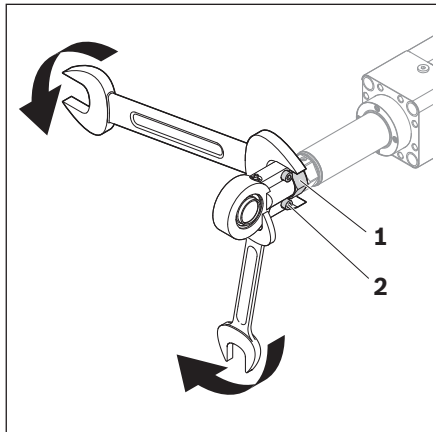


Fig. 8: Mounting the spherical rod end bearing

Table 6: Tightening torques for the spherical rod end bearing

Size	Tightening torque	
	Lock nut M_K	Fixing screws M_B
	(Nm)	(Nm)
EMC-115-HP	25	59
EMC-130-HP	30	59
EMC-160-HP	40	100
EMC-190-HP	65	86
EMC-220-HP	85	215

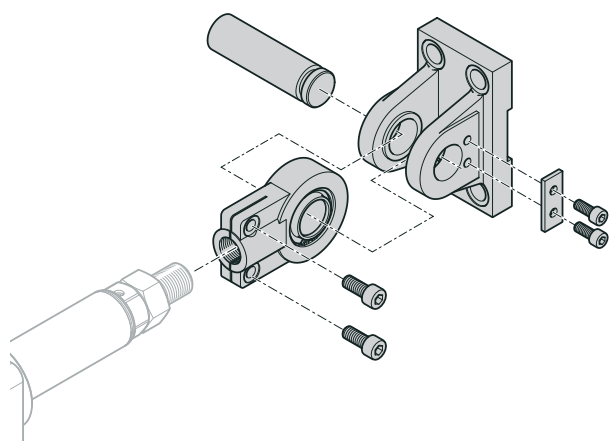


Fig.9.1

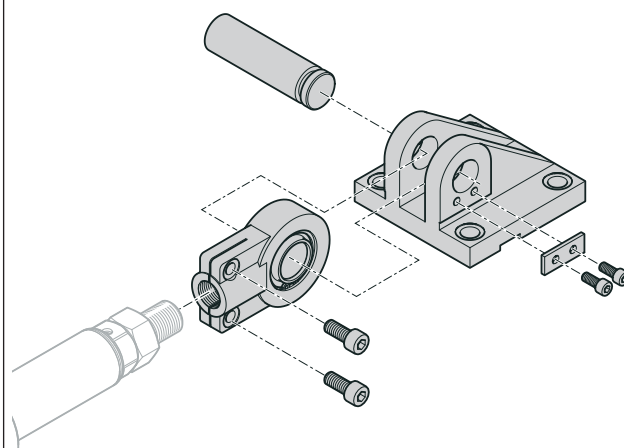


Fig.9.2

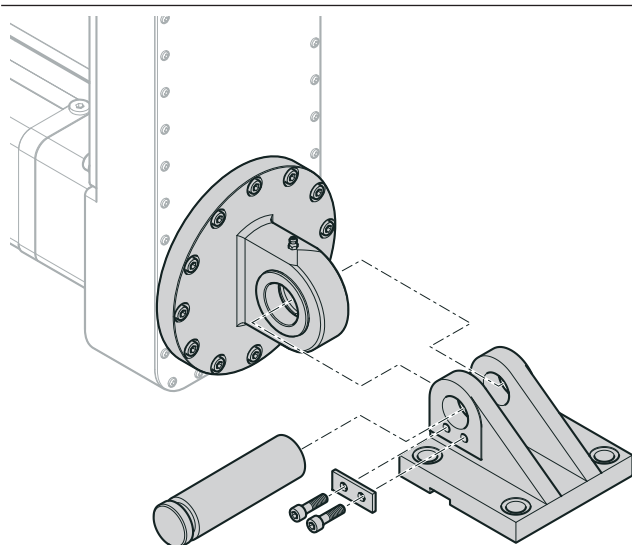


Fig.9.3

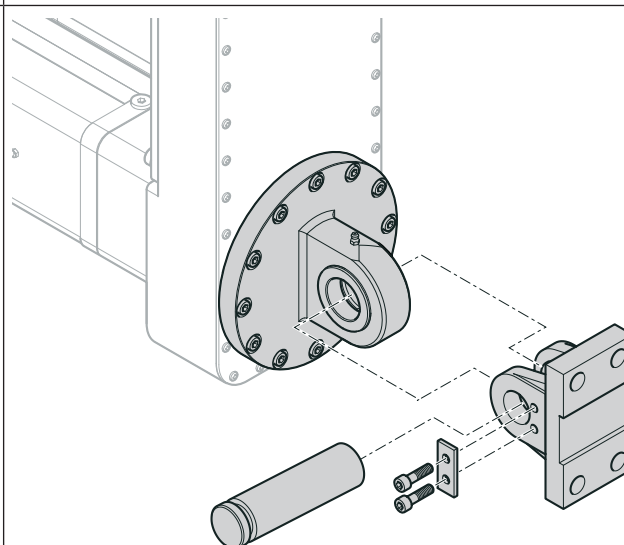


Fig.9.4

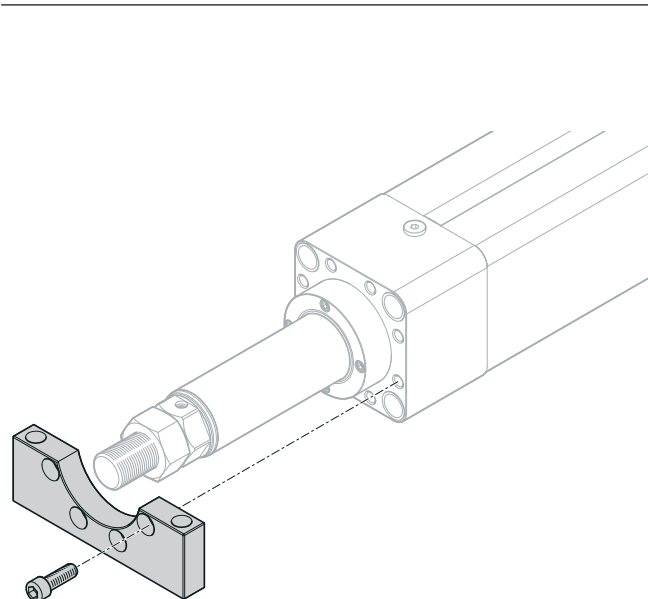


Fig.9.5

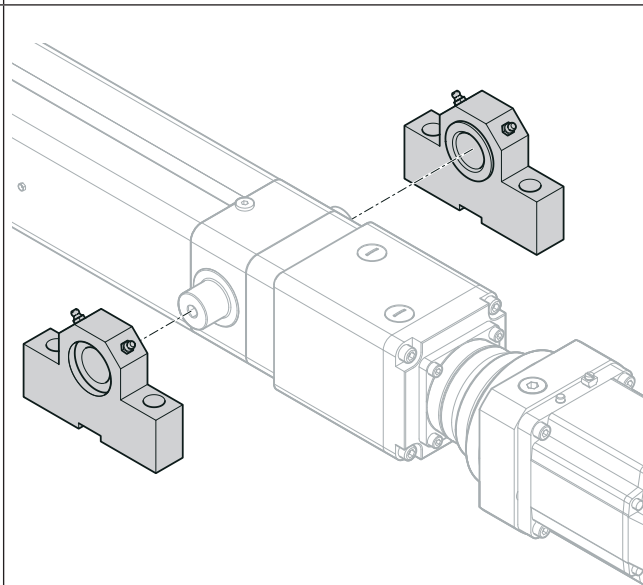


Fig.9.6

Fig. 9: Mounting the fastening elements

Mounting the load measuring pin

The load measuring pin replaces the standard pin. Like the standard pin, it is installed between the spherical rod end bearing and the clevis bracket or following the belt side drive between pivot head and clevis bracket.

i The load measuring pin may only be used on the EMC-HP version with anti-twist feature. It is not suitable for absorbing torques!

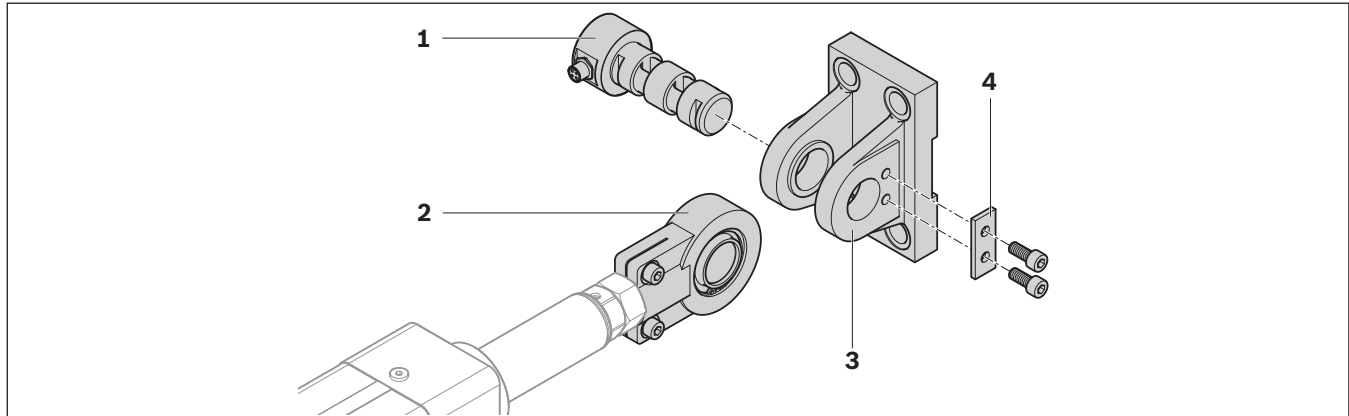


Fig. 10: Load measuring pin

1. Remove the pin lock (4) on the standard pin.
2. Take out the standard pin.

NOTICE

Potential malfunction due to incorrect mounting!

Damage to the load measuring pin or even failure.

- ▶ Push the load measuring pin into the bore by hand.
- ▶ Do **not** use a hammer or press to fit the load measuring pin.

3. Push the load measuring pin (1) by hand between the spherical rod end bearing (2) and the clevis bracket (3).
4. Use the included pin lock (4) to secure the load measuring pin (1) axially and against twisting on one side of the clevis bracket (3).
5. Align the electrical connection on the load measuring pin according to the application. Polarity of the connection ➔ Fig. 11.

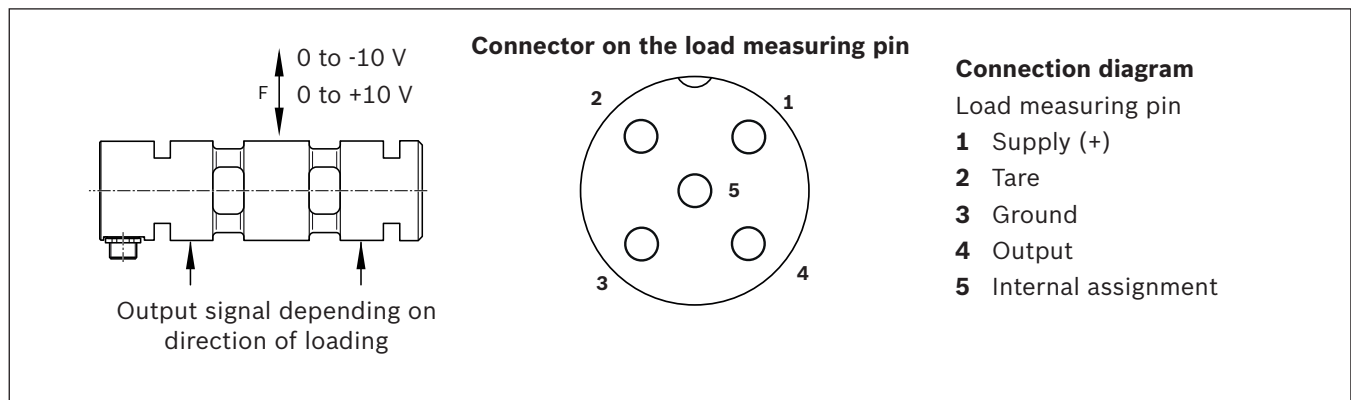


Fig. 11: Connecting the electrical power supply to the load measuring pin

Table 7: Metrological specifications for load measuring pin

Measurement range	EMC-115-HP: 44 kN
	EMC-130-HP: 70 kN
	EMC-160-HP: 100 kN
	EMC-190-HP: 150 kN
	EMC-220-HP: 250 kN
Material	Stainless steel
Protection class	IP65
Hardness (load range)	38 HRC
Mechanical system	
Operating load	150% of MB ¹⁾
Breaking load	300% of MB
Accuracy	
Non-linearity	±0.5% of MB
Repeatability	±0.25% of MB
Hysteresis	±0.2% of MB
Temperature drift at zero point	±0.05% of MB/K. ²⁾
Temperature drift over measurement range	±0.05% of MB/K.
Compensated temperature	+10 ... +40 °C
Operating temperature	-20 ... +60 °C

Table 8: Electrical specifications for load measuring pin

	EMC-115-HP, EMC-160-HP	EMC-130-HP, EMC-190-HP, EMC-220-HP
Output signal 0 kN	0 ±0.03 V	0 ±0.03 V
Output signal MB	-10 ... 10 V ±0.2 V	-10 ... 10 V ±0.2 V
Power supply voltage	19 ... 28 V	24 V ±2 V
Tare (zero setting function)	7.2 ... 24 V	7.2 ... 24 V
Current consumption	50 mA (24 V)	25 mA (24 V)
Bandwidth	2.5 ±0.2 KHz	2.5 ±0.2 KHz
Connection	Connector M12x1	Connector M12x1

¹⁾ MB = Measurement range

²⁾ MB/K. = Measurement range per Kelvin

Connection cable

Table 9: Technical data, connection cable

Length	5 m
Rated voltage	250 V
Rated current	4 A
Connector outlet	Angled
Connection type 1	Female connector M12, 4-pin
Connection type 2	Flying leads
Type of cable	PUR black, shielded
Suitable for drag chains	Yes
Cable cross-section	4x0.34 mm ²
Cable diameter D	5.9 ±0.2 mm
Static bending radius	>10 x D
Dynamic bending radius	>5 x D
Bending cycles	> 2 million
Ambient temperature, stationary	-25 ... +80 °C
Ambient temperature, in motion	-40 ... +80 °C
Protection class	IP65

Table 10: Colors, connection cable

Color	Function
brn	Supply (+)
wht	Tare
blu	GND 0 V
blk	Output
–	Internal assignment

6.6 Fastening the EMC-HP to the adjoining structure

⚠ WARNING

Risk of piston rod crashing down if installed in a vertical or slanting position due to lack of arrestor devices!

Death or severe injury.

- ▶ In vertical or slanting installations, secure the piston rod of the EMC-HP against falling.
- ▶ Do not stand in the fall direction of the piston rod.

NOTICE

Risk of distortive stress on the EMC-HP due to incorrect fastening!

Malfunction of the EMC-HP.

- ▶ Avoid any distortive stress on the piston rod and housing.

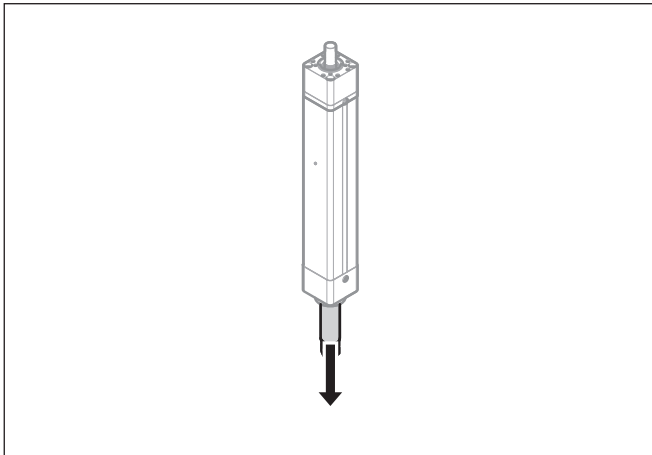


Fig. 12: Secure the piston rod in vertical installations

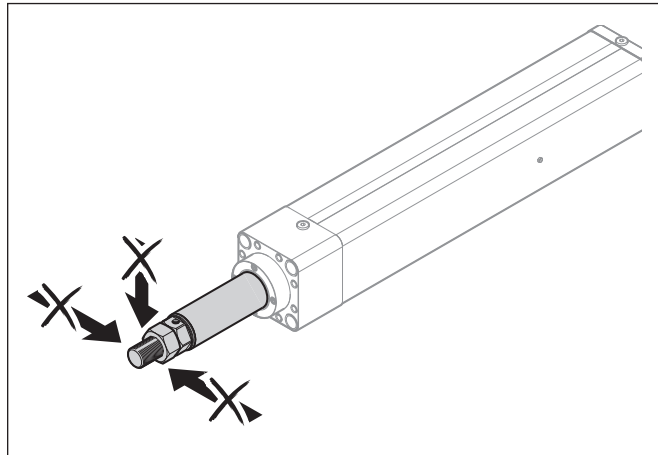


Fig. 13: Avoid distortive stress

1. Bring the EMC-HP into position (piston rod extended/retracted).
2. To extend the piston rod, turn the drive journal of the EMC-HP counterclockwise. It is best to turn the drive journal by hand.
If a motor brake is installed, disengage it and remove the sealing plug (1). Insert the Allen key into the end of the screw and turn to set the piston rod position. Screw in the screw plug.
If the piston rod is extended using the motor, use only a low motor speed.

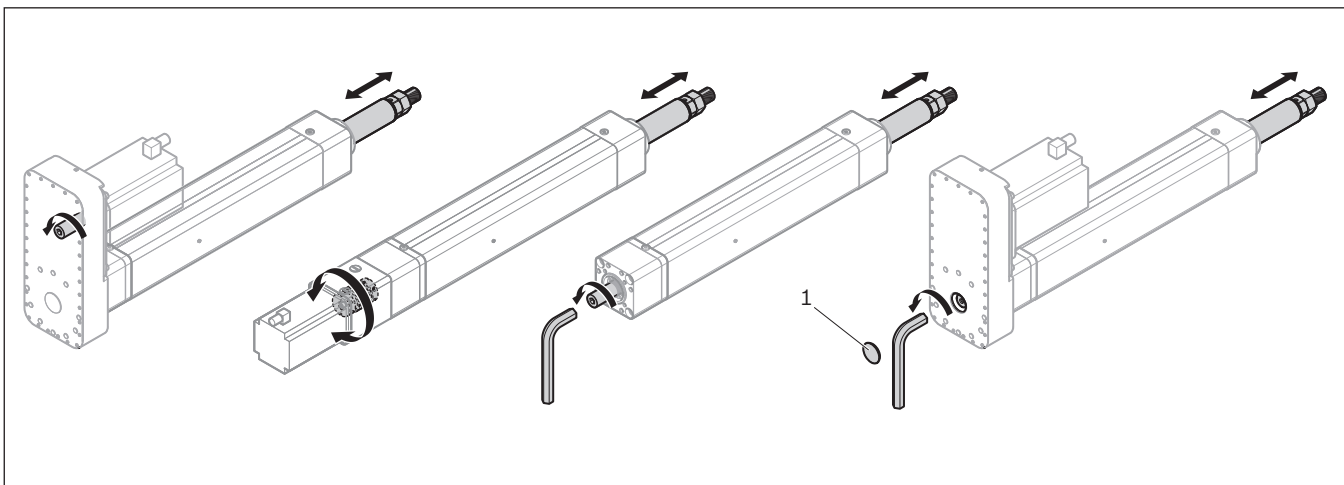


Fig. 14: Extending the piston rod

6.7 Mounting the electric drive

NOTICE

Risk of excessive torque and rotary speed if limits are not observed!

Damage to the EMC-HP.

► Observe the specified limits.

Technical data and limits ➔ Catalog "Electromechanical cylinders EMC-HP."

The EMC-HP has the following drive types:

- Flange (2) and coupling with motor (1) (optionally with gear unit (3))
- Belt side drive (4) with motor (1) (optionally with gear unit)
- Spur gear (5) with motor (1) (optionally with gear unit).

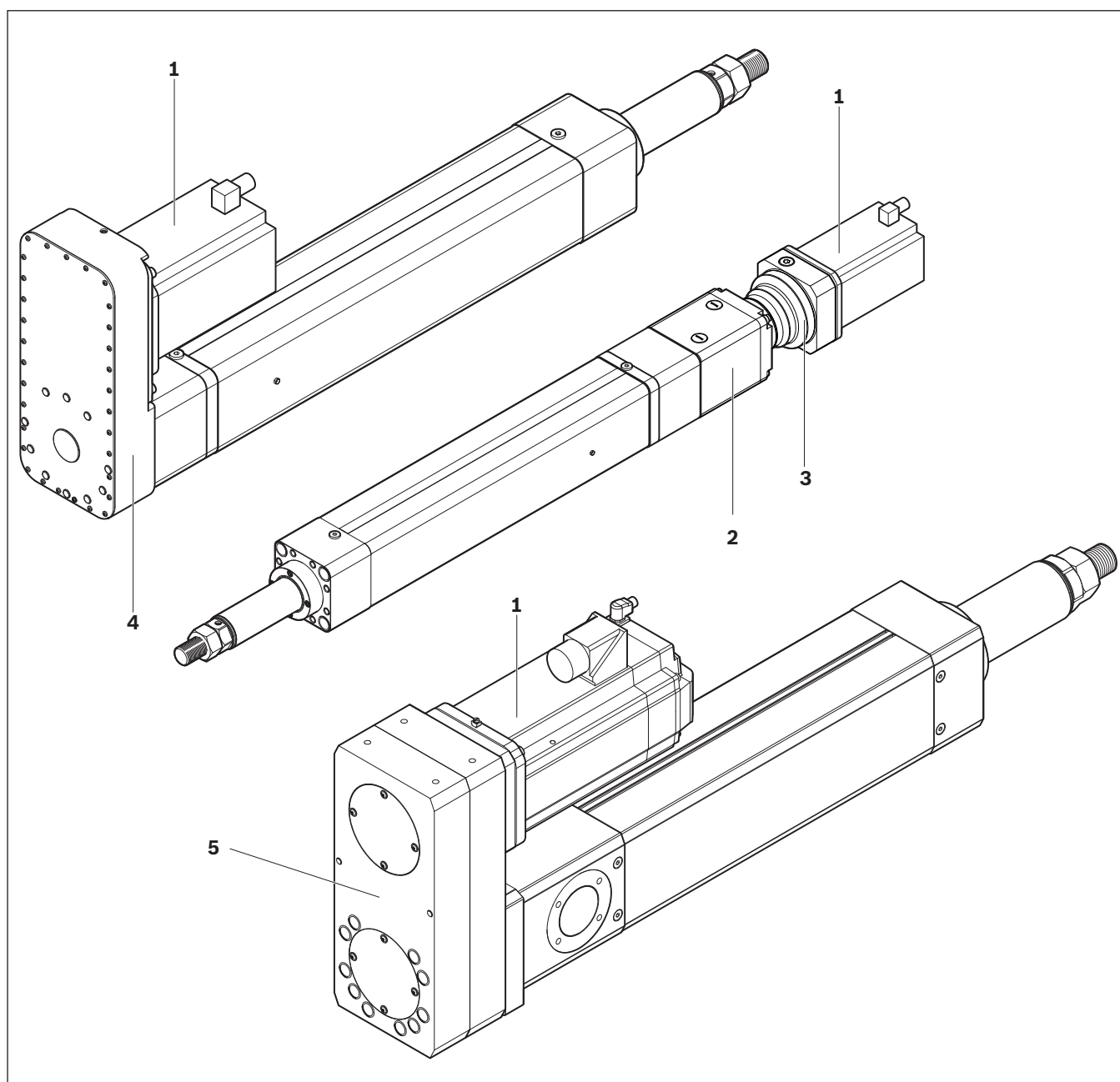


Fig. 15: Drive types

6.7.1 Mounting the motor with flange and coupling

 The screw journal of the EMC-HP and the motor journal must be completely free of grease and oil before mounting. Observe the tightening torques ➡ Table 21 on page 46.

1. Push the flange (4) into the locating feature on the EMC-HP and screw it down using four screws (5).
Observe the specified tightening torques ➡ Table 21 on page 46.

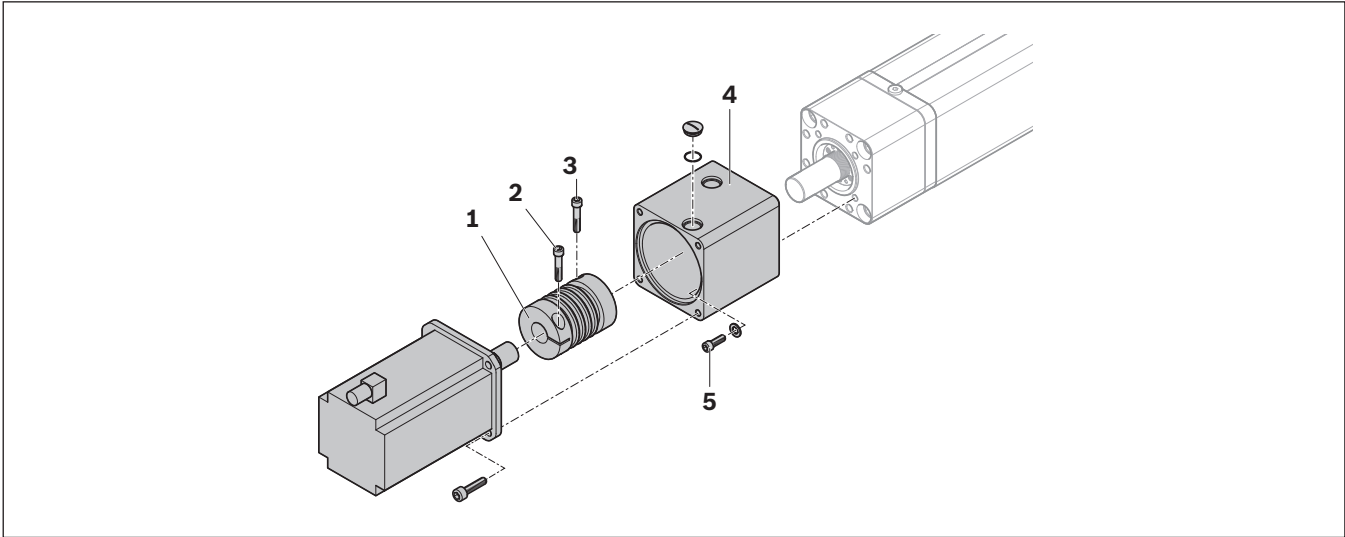


Fig. 16: Mounting the flange with coupling

2. Insert the coupling (1) into the flange (4) on the screw journal of the EMC-HP until a fastening screw (3) on the coupling becomes accessible through the bore in the flange.
3. Adjust dimension A.

Table 11: Adjusting dimension A

Motor	A (mm)				
	EMC-115-HP	EMC-130-HP	EMC-160-HP	EMC-190-HP	EMC-220-HP
MS2N07	10	10	—	—	—
MS2N10	10	10	7	5	14
	—	—	7	5	14

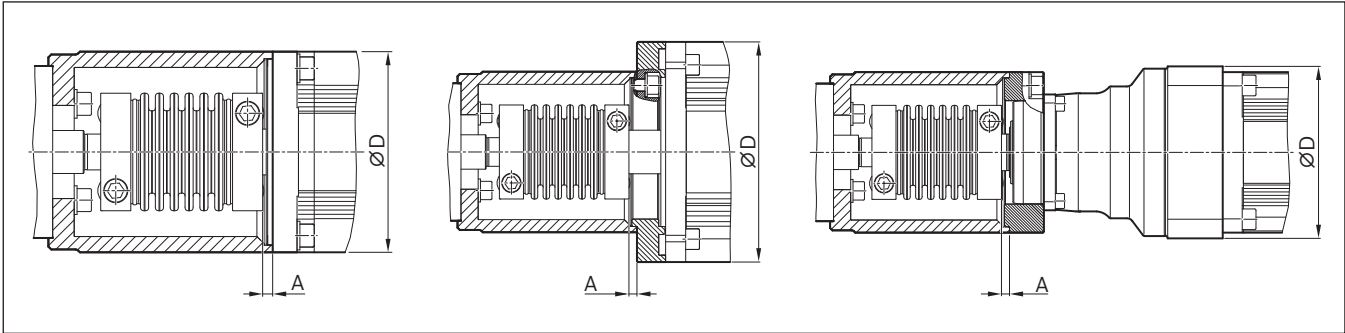


Fig. 17: Adjusting dimension A

4. If necessary for tightening the screw (1), move the piston rod (2) so that the screw journal turns.

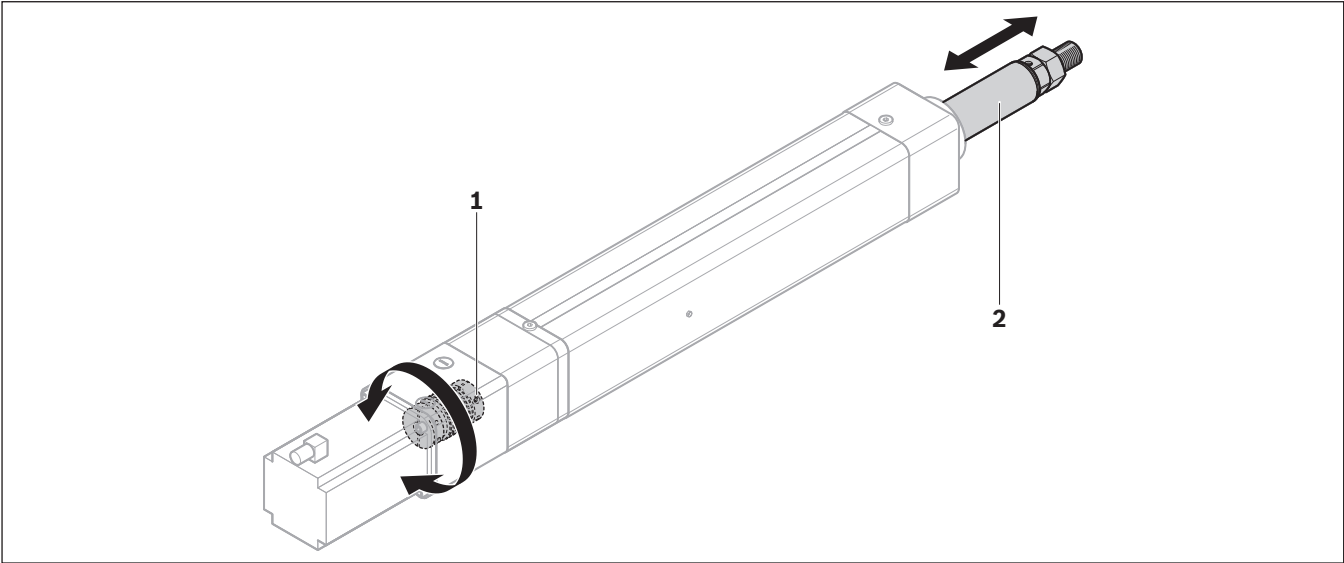


Fig. 18: Moving the piston rod

5. Tighten the fastening screw (3) of the coupling with the tightening torque M_A ➔ Table 14.

Table 12: Tightening torques for the coupling

 12.9	M10	M12	M14
⌀ M_A (Nm)	50	85	138

6. Push the motor into the locating feature of the flange and coupling ➔ Fig. 16 on page 20 and fasten with four screws with tightening torque ➔ Table 21 on page 46.
7. Tighten the fastening screw (2) of the coupling on the motor side with the tightening torque M_A ➔ Table 12.
8. If necessary for tightening the second screw (3), release the motor brake and move the piston rod so that the screw journal turns.
9. Seal all threads in the flange using screw plugs.

6.7.2 Mounting the motor with belt side drive

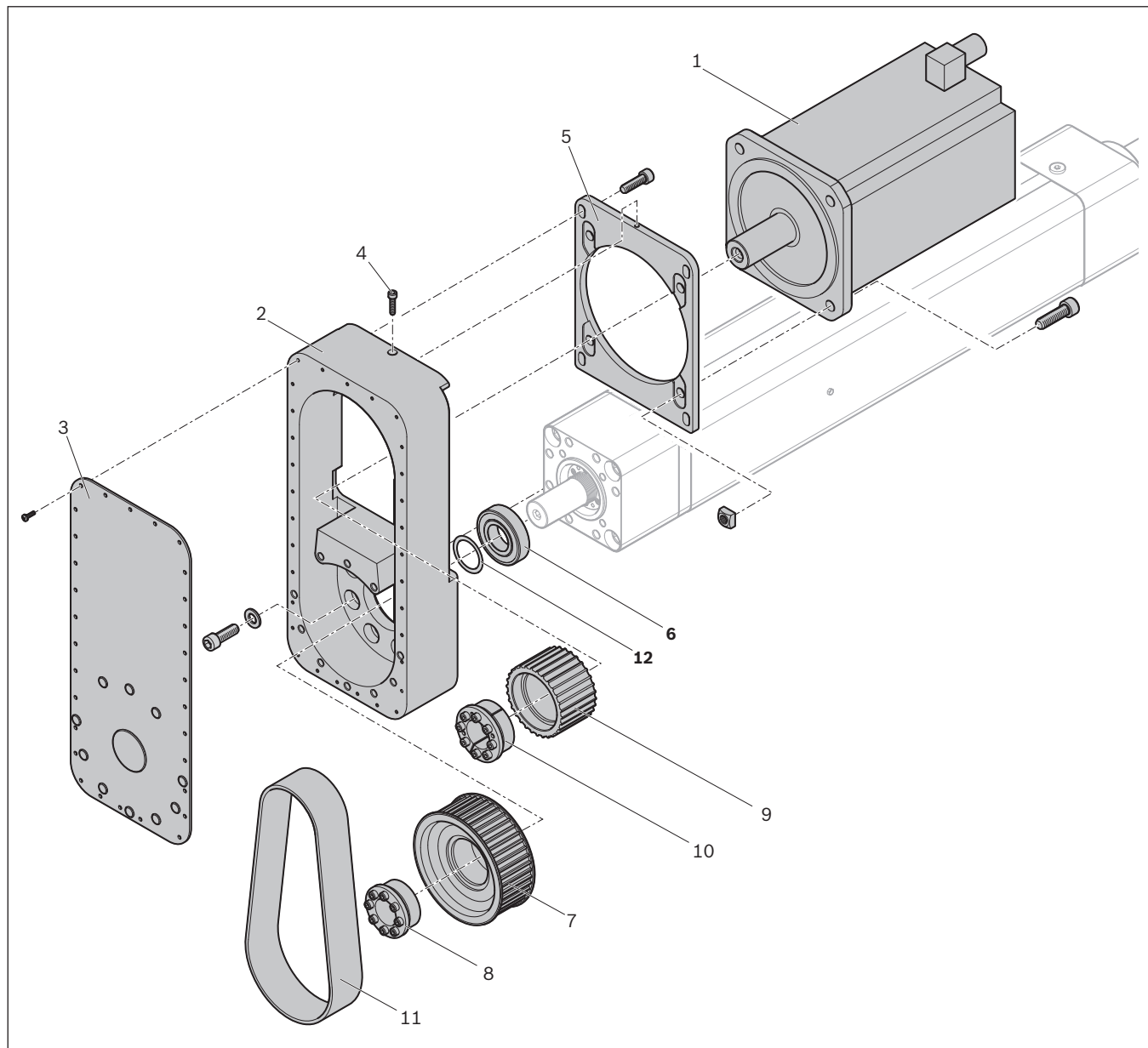


Fig. 19: Mounting the belt side drive and motor on the EMC-HP

- | | | |
|--------------------------|--|--|
| 1 Motor | 5 Adapter plate | 9 Belt pulley (motor-side) |
| 2 Housing | 6 Bearing (in the housing) | 10 Tensioning unit (motor side) |
| 3 Housing cover | 7 Belt pulley (system-side) | 11 Toothed belt |
| 4 Adjusting screw | 8 Tensioning unit (system side) | 12 Washer |

i When mounting, all screws that are not coated with threadlocking adhesive on delivery should be secured with medium-strength threadlocking adhesive.

Mounting the housing and system-side belt pulley

- 1. Push the bearing (6) onto the screw end.
- 2. Align the housing (2) to the bearing and screw it to the EMC-HP ➡ Fig. 20.
Observe the mounting orientation and the specified tightening torques ➡ Table 21 on page 46.
- 3. Push the washer (12) onto the screw end. Push the system-side belt pulley (7) with fitted toothed belt (11) and tensioning unit (8) onto the journal of the EMC-HP until it reaches the stop ➡ Fig. 19 on page 22.
- 4. Evenly tighten the screws (13) ➡ Fig. 21 cross-wise in several stages to the tightening torques of the tensioning units ➡ table 13.

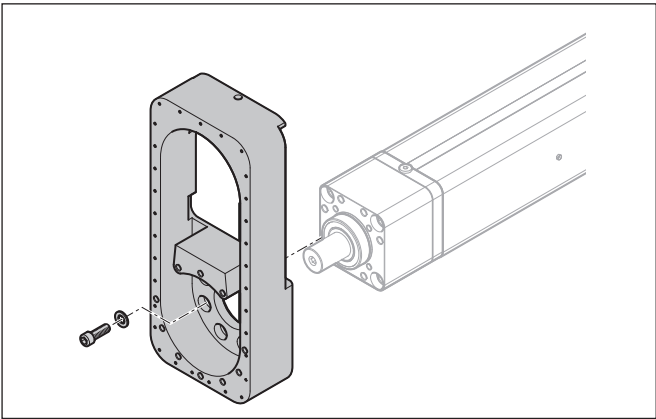


Fig. 20: Mounting the housing

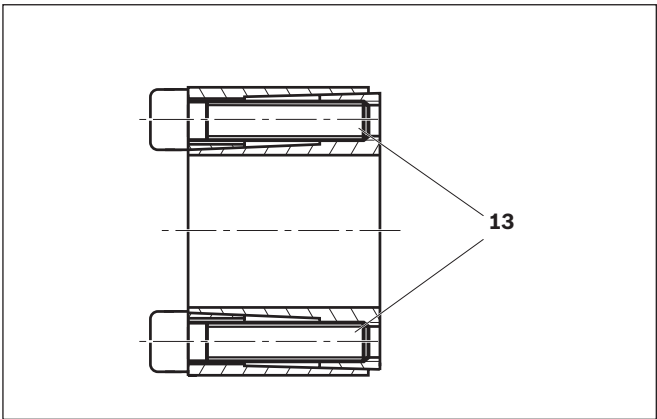


Fig. 21: Tensioning unit

Table 13: Tightening torque for the tensioning units

$\mu = 0.125$	M6	M8	M10
$\odot M_A$ (Nm)	17	41	83

Mounting the motor-side belt pulley and motor/gear unit.

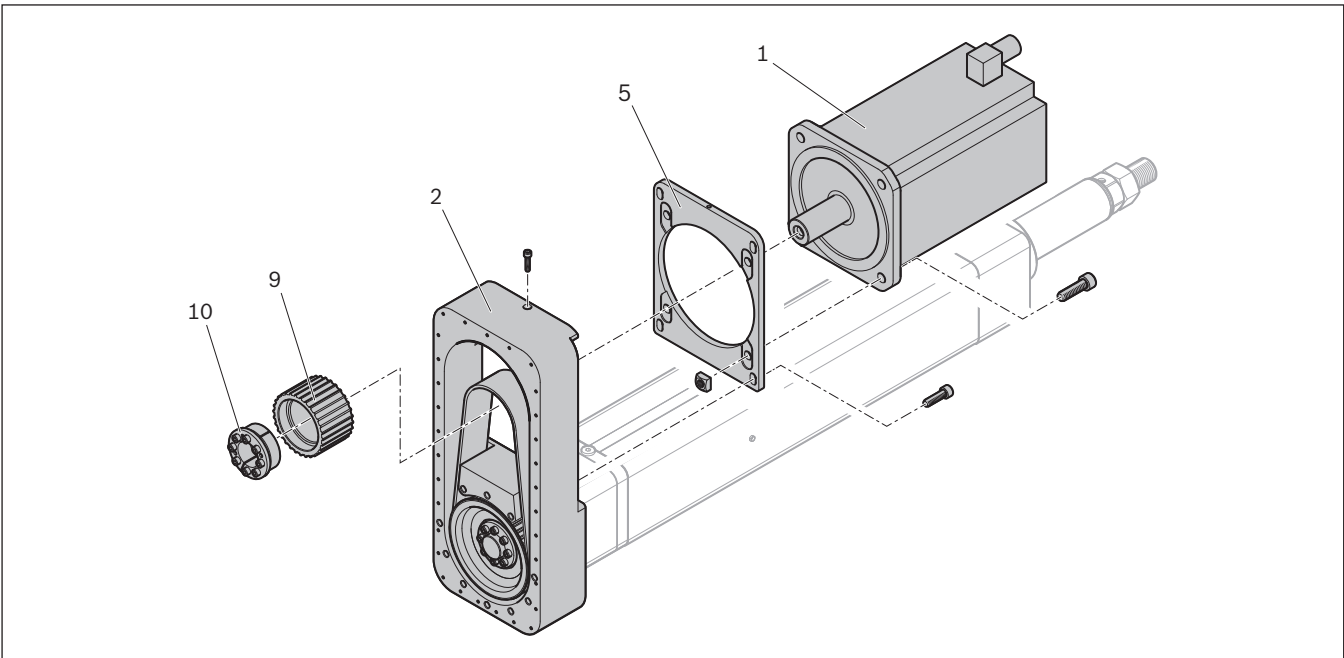


Fig. 22: Mounting the adapter plate

1. Mount the adapter plate (5) on the motor (1) or gear unit.
2. Pre-mount the motor or gear unit with adapter plate (5) on the housing (2) so that the adapter plate can still be moved.
3. Attach the belt pulley (9) and tensioning unit (10) to the motor journal and guide them into the toothed belt (11).
4. Push the tensioning unit into the belt pulley right up to the stop.
5. Set a clearance of 2.5 (± 0.2) mm between belt pulley and cover plate.
6. Evenly tighten the screws (13) cross-wise in several stages to the tightening torque of the tensioning units ➡ Table 21 on page 46.
7. Centrally align the toothed belt on the belt pulley.
8. Screw down the adjusting screw (4) through the housing into the adapter plate.
9. Adjust the belt frequency using a frequency meter and adjusting screw (4) (for the table refer to the cover inside of the belt side drive).
10. Tighten the screws in the adapter plate ➡ Table 21 on page 46.
11. Check the belt frequency and adjust again if necessary.
12. Mount the cover (3) on the housing.
13. Mount the motor (1) at the gear unit (if available).
14. Perform a functional check.

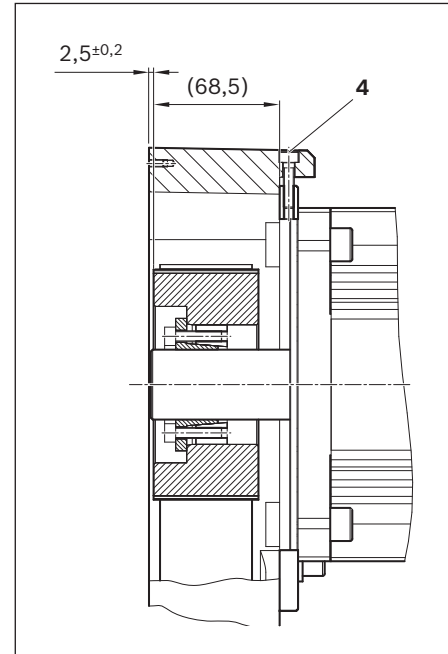


Fig. 23: Belt pulley clearance

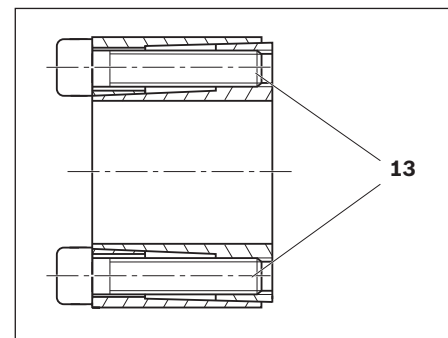


Fig. 24: Tensioning unit

6.7.3 Mounting the motor with spur gear

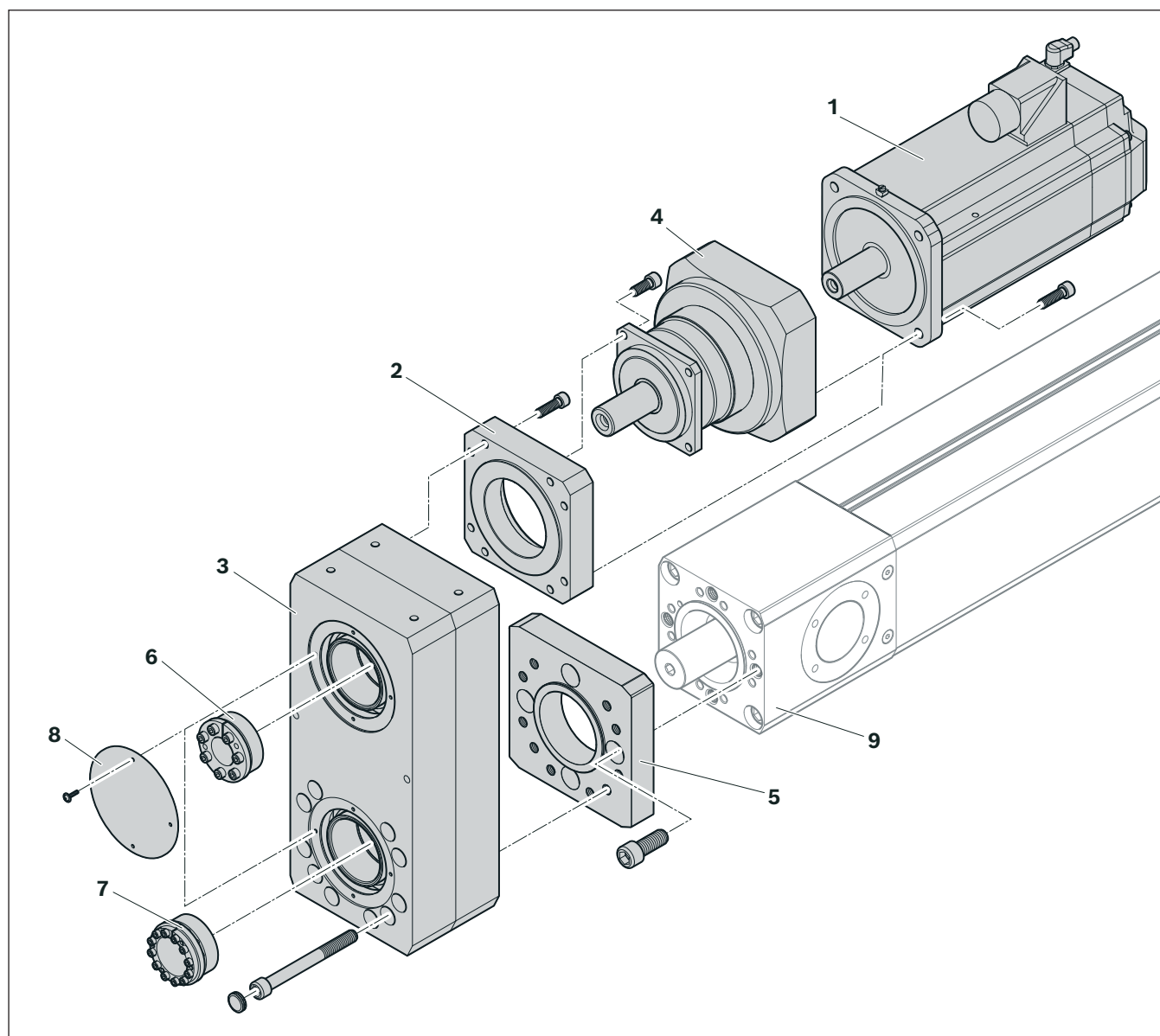


Fig. 25: Mounting spur gear and motor on the EMC-HP

- | | | |
|--|--------------------------------|---------------------------------|
| 1 Motor | 4 Planetary gear | 7 Tensioning unit (system side) |
| 2 Planetary gear motor plate/adapter plate | 5 Planetary gear adapter plate | 8 Cover |
| 3 Spur gear | 6 Tensioning unit (motor side) | 9 Bottom EMC |



When mounting, all screws that are not coated with threadlocking adhesive on delivery should be secured with medium-strength threadlocking adhesive.

Mounting the spur gear

1. Push the adapter plate (5) (only for EMC-HP size 190) on the locating feature of the EMC-HP bottom (9), taking into account the mounting orientation of the spur gear (3) on the EMC-HP. Tighten four hex socket head cap screws (5.1) with tightening torque ➔ Table 21 on page 46.
2. Loosen the pan head screws (8.1) and remove the cover (8) from the spur gear (3).
3. Position the spur gear (3) on the adapter plate (5) or directly on the bottom (9) of the EMC-HP over the locating feature, observing the spur gear mounting orientation on the EMC-HP. Preassemble the spur gear with 10 hex socket head cap screws (3.1) so that the spur gear (3) can still be aligned.
4. Push the tensioning unit (7) into the spur gear (3) to the stop. Tighten the hex socket head cap screws (7.1) cross-wise applying the tightening torque ➔ Table 14.
5. Tighten the hex socket head cap screws (3.1) applying the tightening torque ➔ Table 21 on page 46.
6. Fasten caps (3.2) and cover (8) with pan-head screws (8.1).

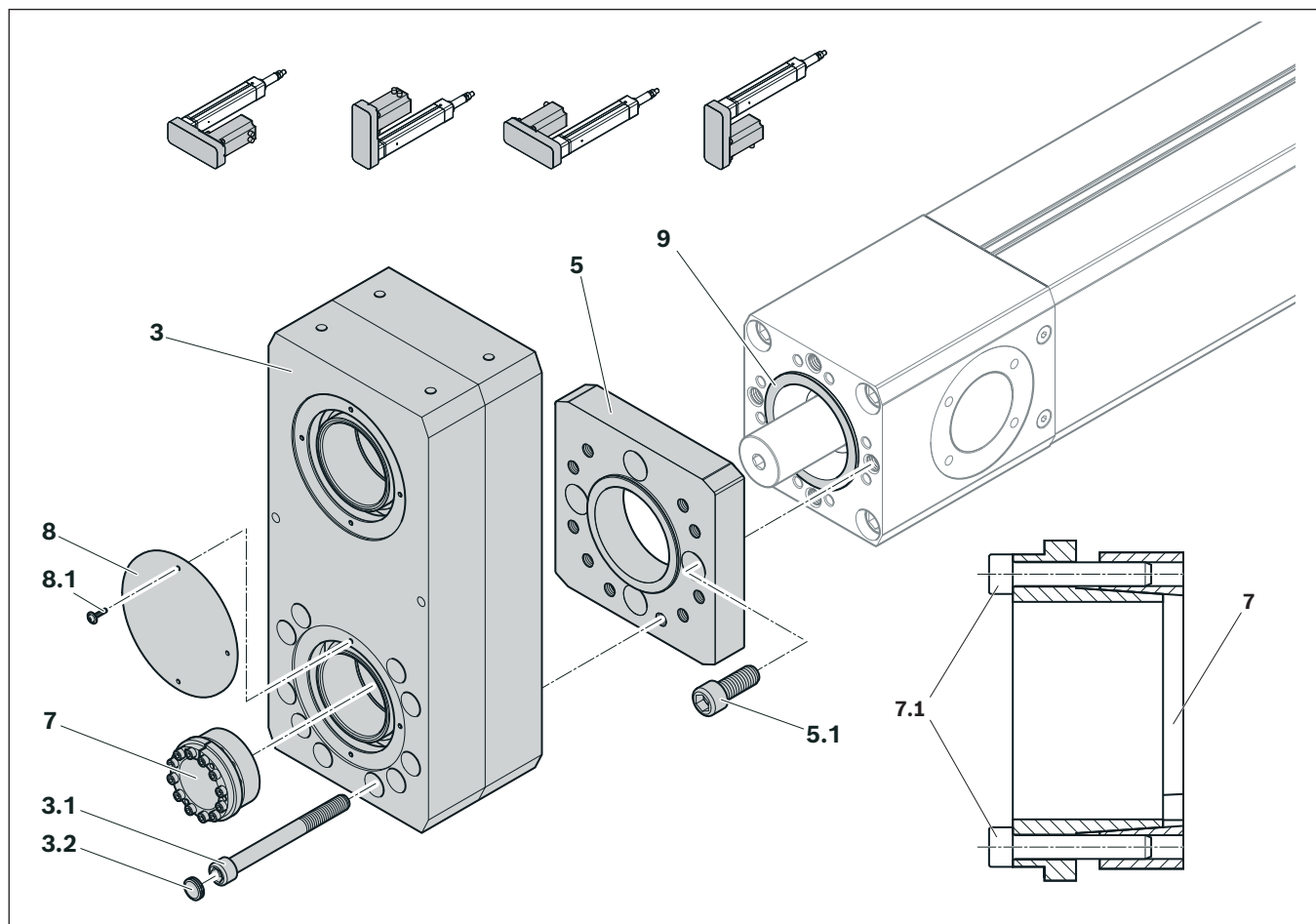


Fig. 26: Mounting the spur gear

Table 14: Tightening torques of the tensioning units

 (6.1/7.1) $\mu = 0.125$	M6	M8	M10
$\varnothing M_A$ (Nm)	17	41	83

Mounting the motor directly

1. Fasten the motor plate (2) at the spur gear (3) using the hex socket head cap screws (2.1) and applying the tightening torque ➔ Table 21 on page 46 .
2. Preassemble the motor (1) at the motor plate (2) using the hex socket head cap screws (1.1).
3. Push the tensioning unit (6) into the spur gear (3) to the stop. Tighten the hex socket head cap screws (6.1) cross-wise applying the tightening torque ➔ Table 14 on page 26 .
4. Tighten the hex socket head cap screws (1.1) cross-wise applying the tightening torque ➔ Table 21 on page 46.
5. Fasten the cover (8) with pan-head screws (8.1).

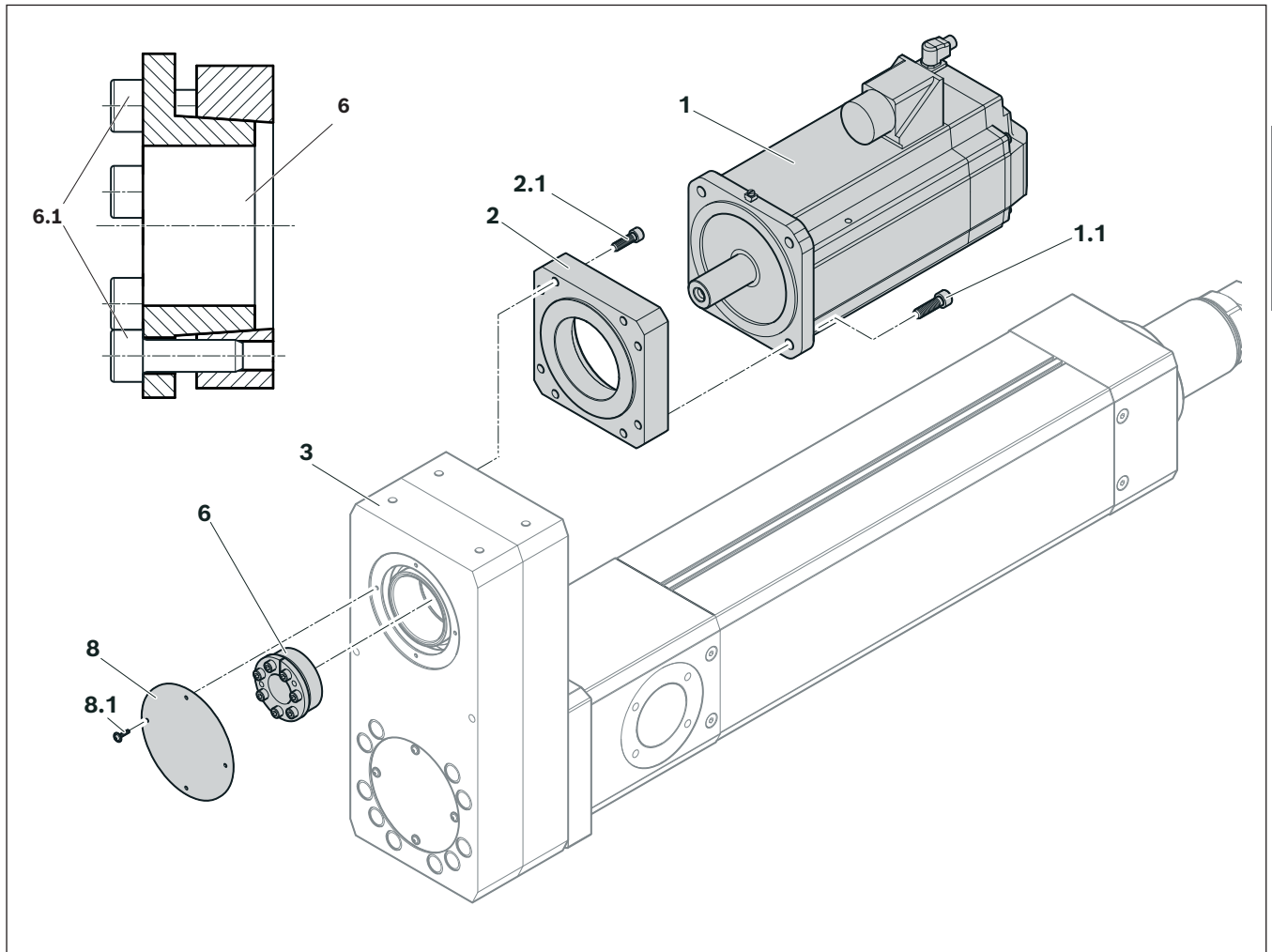


Fig. 27: Mounting the motor directly (figure shows size -190)

Mounting the motor with planetary gear

1. Fasten the adapter plate (2) for the planetary gear (4) at the spur gear (3) using hex socket head cap screws (2.1) and applying the tightening torque ➔ Table 21 on page 46 .
2. Preassemble the planetary gear (4) at the adapter plate (2) using hex socket head cap screws (4.1).
3. Push the tensioning unit (6) into the spur gear (3) to the stop. Tighten the hex socket head cap screws (6.1) cross-wise applying the tightening torque ➔ Table 14 on page 26 .
4. Tighten the hex socket head cap screws (4.1) cross-wise applying the corresponding tightening torque ➔ Table 21 on page 46 .
5. Mount the motor (1) according to the instructions of the planetary gear (4).
6. Fasten the cover (8) with the pan-head screws (8.1).

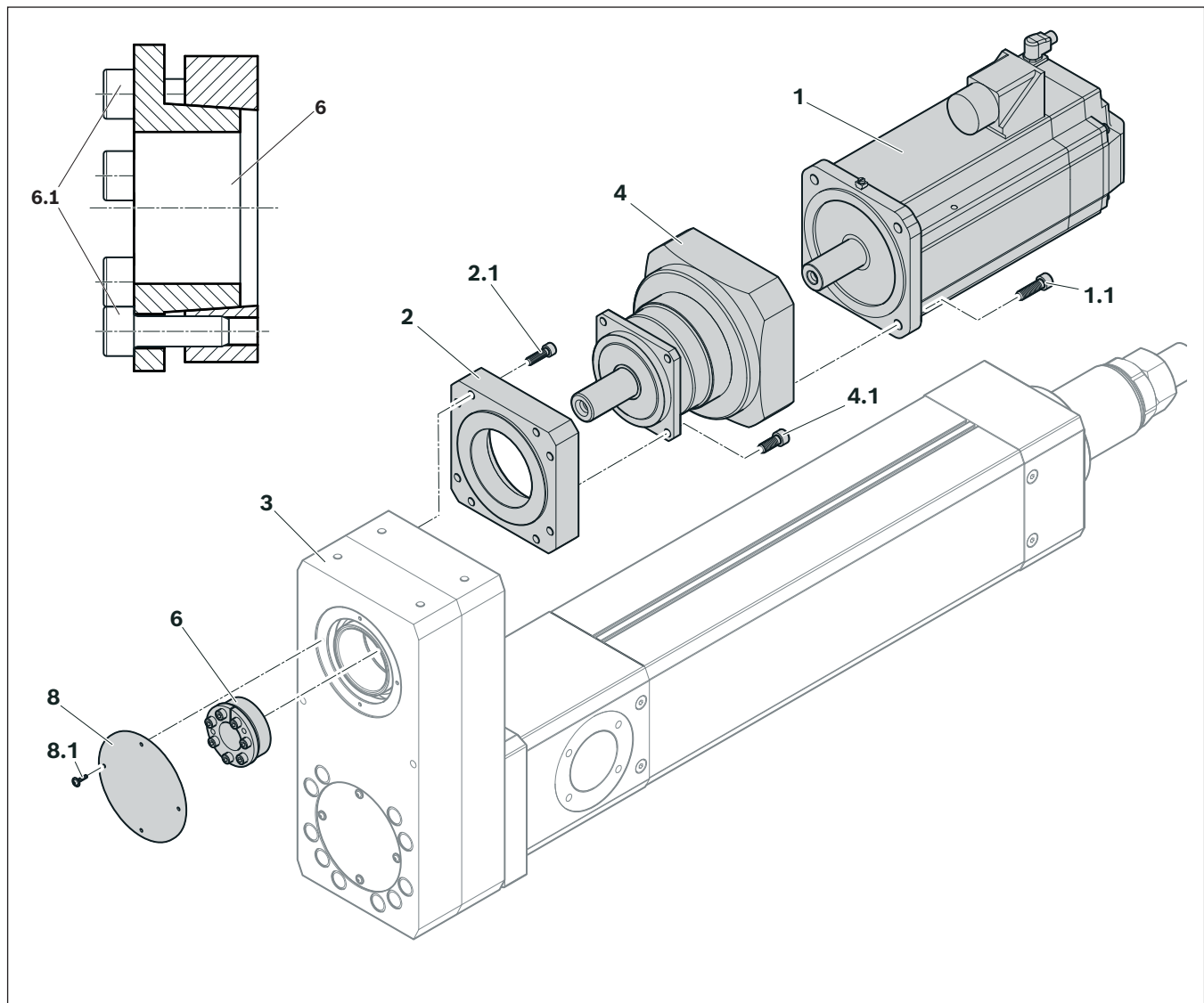


Fig. 28: Mounting the motor with planetary gear

6.8 Mounting the switching system

NOTICE

Risk of collision due to incorrect mounting of the switching system!

Damage to the EMC-HP, adjoining structure and workpieces.

6.8.1 Mounting the switches



The switches can be inserted into either or both of the two T-slots.

1. Insert the switches (magnetic field sensors) **(1)** into the T-slot of the housing **(2)** in such a way that the clamping screw **(3)** points outwards ➡ Fig. 29.
2. Move the switches into the desired switch activation point.
Take care to ensure that the active zone of the switch is between $L_{0\ 1Mag}$ and $L_{smax\ 1Mag}$. ➡ Fig. 30 on page 30 and Table 15 on page 30.

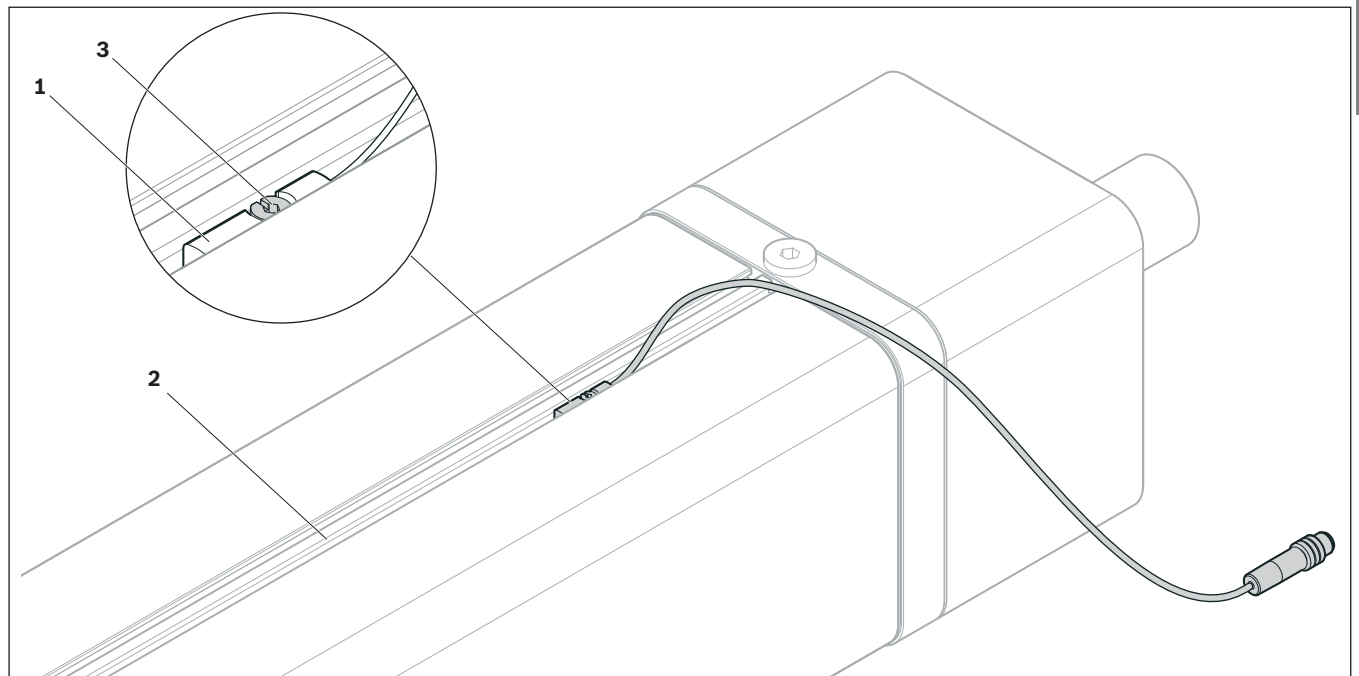


Fig. 29: Mounting the switches

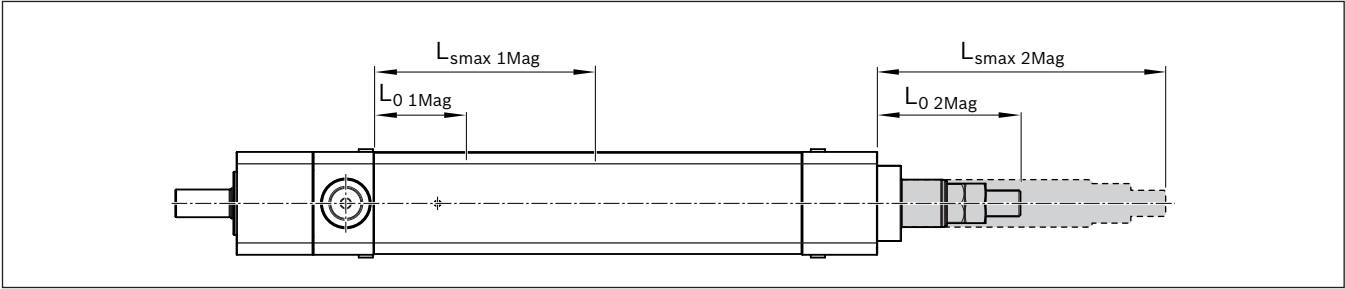


Fig. 30: Setting the switching points

Table 15: Setting the switching points

Size	Dimensions (mm)		At travel range s_{max} mm	
	At travel range 0 mm			
	$L_0\ 1Mag$	$L_0\ 2Mag$	$L_{smax}\ 1Mag$	$L_{smax}\ 2Mag$
EMC-115-HP	106.1	139.00	$106.1 + s_{max}$	$139 + s_{max}$
EMC-130-HP	118.1	155.00	$118.1 + s_{max}$	$155 + s_{max}$
EMC-160-HP	145.1	176.00	$145.1 + s_{max}$	$176 + s_{max}$
EMC-190-HP	142.5	184.20	$142.5 + s_{max}$	$184.2 + s_{max}$
EMC-220-HP	180.6	390.25	$180.6 + s_{max}$	$390.25 + s_{max}$

 The dimensions in the table indicate the position of the magnet as a function of the maximum travel range s_{max} .

1. Fix in place by turning the clamping screw **(1)** ➡ Fig. 29 on page 29. Tighten the screw by hand and check the switch is secure.

Mounting the cover for the T-slot for switches.

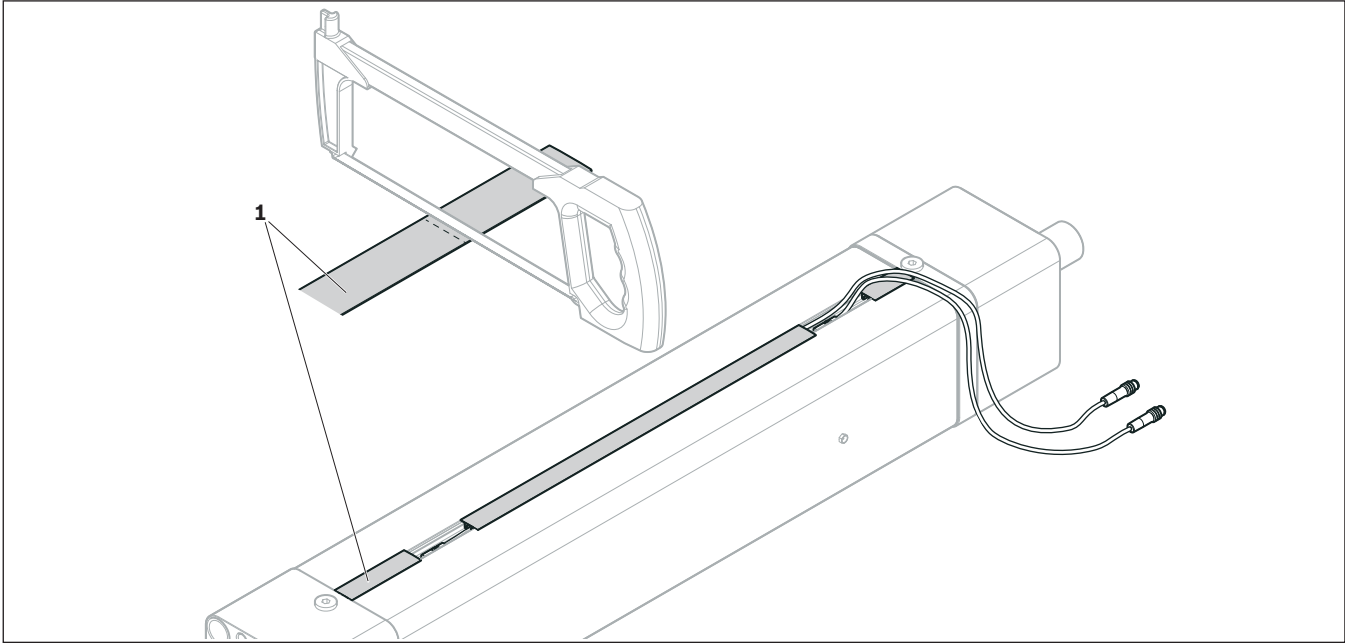


Fig. 31: Mounting the cover for the T-slot for switches

2. Cut the cover for T-slot for switches **(1)** to size and debur it
3. Press the cover for T-slot for switches into the profile. Leave out the switches.

6.8.2 Connecting the switches

1. Connect the switches as illustrated in the drawing.
2. After connection, allow the cylinder to travel slowly while you check the switching points. Adjust if necessary.

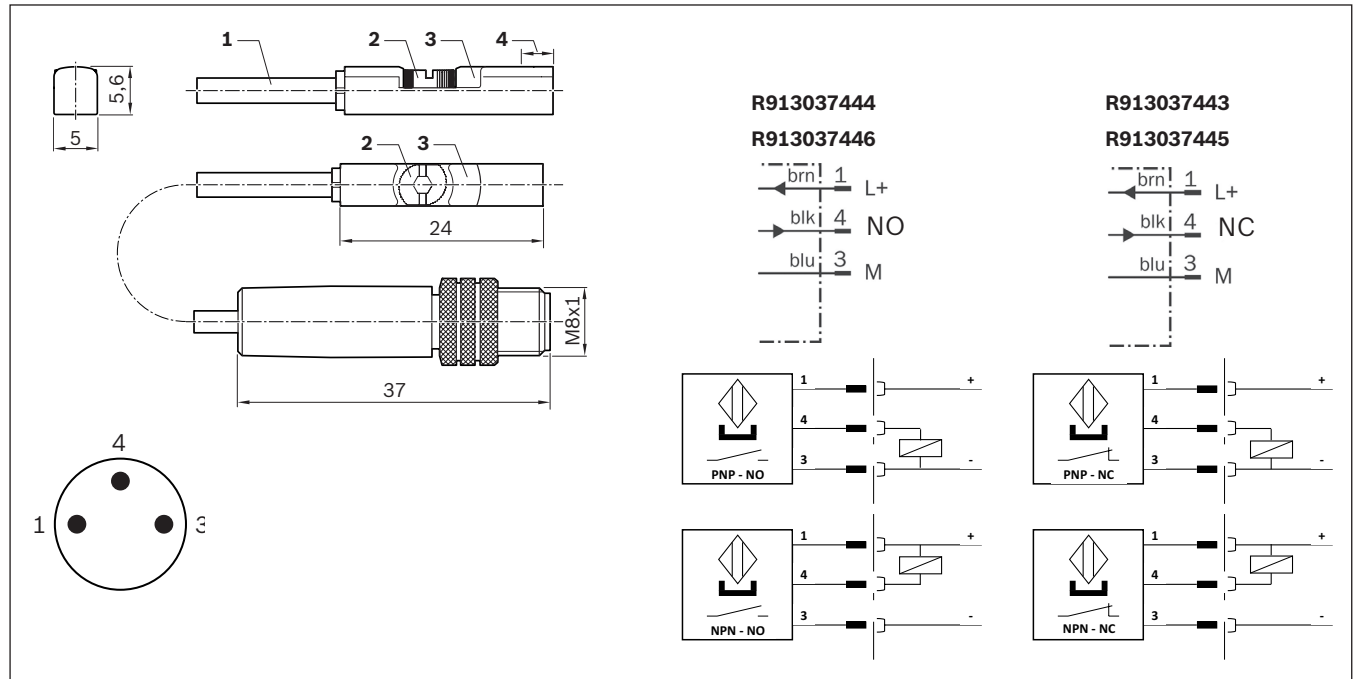


Fig. 32: Connecting the switches

- 1 Connection
- 2 Clamping screw
- 3 LED display
- 4 Position of sensor element: 2.0 mm

NOTICE

Collision of PLSA nut with cover or base!

Damage to the product, adjoining structure and workpieces.

- Take care not to overshoot the positions shown in Table 15 on page 30.



For further technical data relating to the switches ➡ Product catalog.

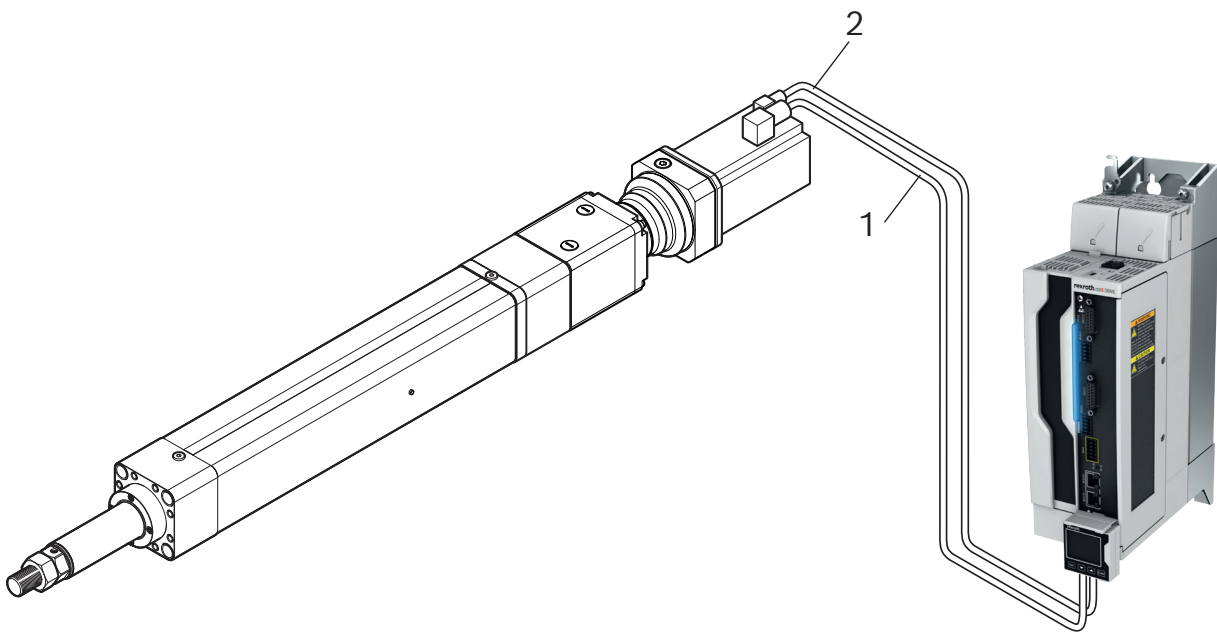
6.9 Connecting the electrical power supply to the EMC-HP

⚠ WARNING

Risk of electric shock due to contact with live parts!

Death or severe injury.

- ▶ Before working on the electrical equipment, switch off the power supply and secure it against being switched on again.
- ▶ Follow the safety instructions given in the documentation for the controller used.
- ▶ Observe the safety regulations for working with high-voltage equipment!
- ▶ Consult the documentation for the motor/controller used.
- ▶ Route the motor cable (1) and encoder cable (2) separately from each other.



Cable drag chain (example: two-cable solution)

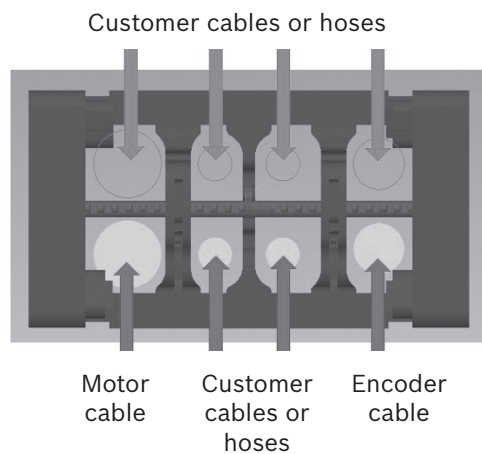


Fig. 33: Connecting the electrical power supply to the EMC-HP

7 Commissioning

- ▶ The EMC-HP must not be put into service until it has been verified that the final product (for example, a machine or system) into which the Rexroth product has been installed complies with the country-specific requirements, safety regulations and standards for the application.

! WARNING

Risk of injury due to moving parts (e.g. piston rod)!

Crushing.

- ▶ Do not reach into moving parts while the system is in operation.
- ▶ Do not stand in the hazard area in front of the piston rod.
- ▶ Make sure that no one is in front of the piston rod before commissioning.

NOTICE

Risk of liquid or humidity penetration due to insufficient impermeability!

Motor damage, short circuit.

- ▶ Before commissioning, make sure all plug-and-socket connections have been correctly plugged in.
- ▶ Before commissioning, make sure all seals and plug-and-socket connections are tight.

Risk of collisions due to overshooting end positions!

Damage to the product.

- ▶ Do not allow the product to collide with a stop.
- ▶ If required by the application, the piston rod may be moved to the stop in the end position for referencing without load. In doing so, do not exceed the maximum starting speed of 1 mm/s or the maximum starting force of 10% ($F_{\max}$ EMC-HP).
- ▶ Observe the max. travel range $s_{\max}$ of the EMC-HP.
- ▶ In all installation positions, make sure there is a sufficient safety margin (excess travel s_e) on two sides of the stroke.

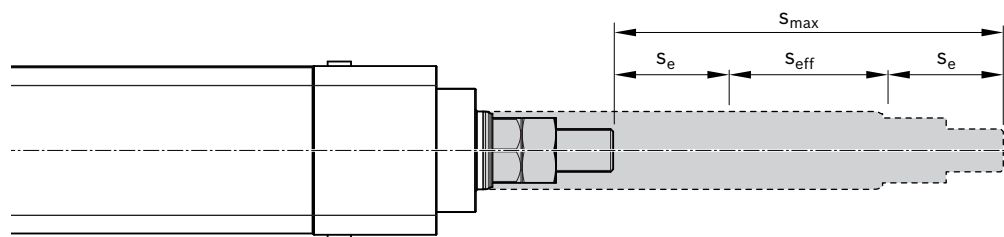


Fig. 34: Excess travel s_e EMC-HP



For safe operation, the excess travel path must be greater than the braking distance. The acceleration travel can be assumed as a guideline value for the braking distance.

The following is sufficient in most cases: Excess travel $s_e = 2 \cdot \text{screw lead (P)}$

7.1 Name plate with parameters for easy commissioning

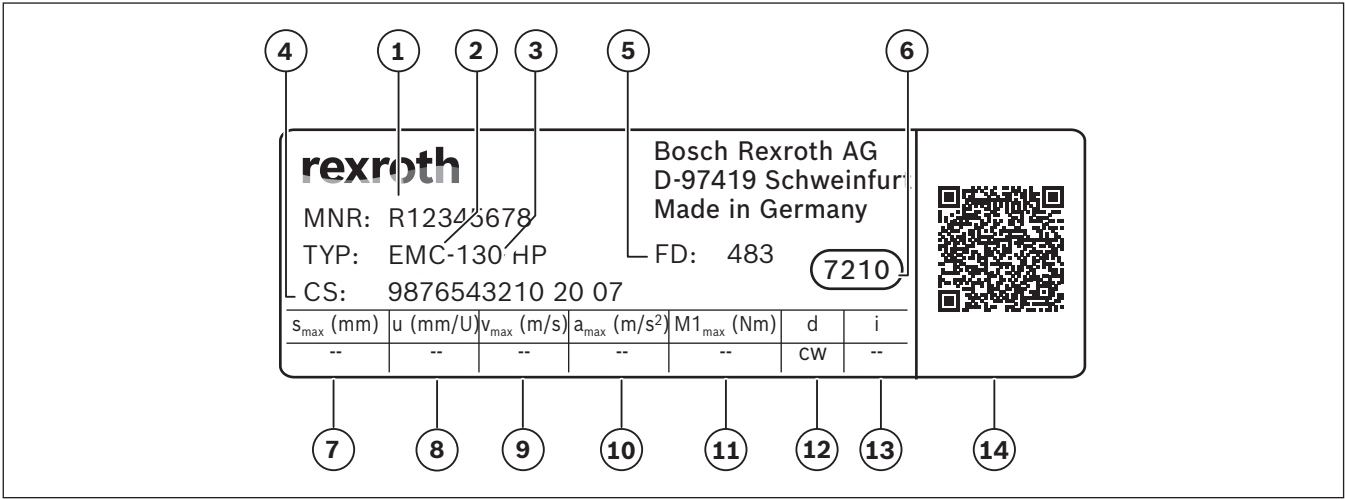


Fig. 35: Name plate (example)

- 1

Material number
- 2

Short product name
- 3

Size
- 4

Customer information
- 5

Date of manufacture
- 6

Manufacturing location
- 7

s_{max} – max. travel range (mm)
- 8

u – lead constant without motor attachment (mm/rev)
- 9

v_{max} – max. speed (m/s)
- 10

a_{max} – max. acceleration (m/s²)
- 11

$M1_{max}$ – max. drive torque at motor journal (Nm)
- 12

d – direction of rotation of the motor for travel in positive direction
- 13

i – gear ratio
- 14

QR code

 The values given describe the mechanical limit values of the axle.

7.2 Checking the operating conditions

- ▶ Observe the ambient temperature, load, rotary speed of the screw drive (PLSA), travel speed, and maximum travel range ➡ 14 on page 46 and the catalog "Electromechanical cylinders EMC-HP."
- ▶ For special operating conditions, please contact us.

7.3 Initial commissioning

NOTICE

Risk of collisions due to overshooting end positions!

Damage to the product.

- ▶ Do not exceed the max. travel range of the EMC-HP.
- ▶ For all installation positions, comply with the safety distance (excess travel) on two sides.
- ▶ Before start-up, check the direction of rotation for retracting/extending the piston rod.
- ▶ Only allow the piston rod to travel very slowly.
- ▶ Make sure that the travel area is unobstructed.

- ▶ For further information on the commissioning, refer to the enclosed instructions R320103223

7.4 Recommissioning after removal

- ▶ When recommissioning the unit, proceed as described in the chapter "Initial commissioning" ➔ 7.3 on page 34.

7.5 Test run, running in

⚠ CAUTION

Motor becomes very hot during operation!

Risk of burns.

- ▶ Do not touch the motor during running in or operation or only touch it while wearing suitable protective equipment (e.g. heat-resistant gloves).
- ▶ The EMC-HP may only be put into service after running successful trials under near-real production conditions.
- ▶ Move at low speed over the entire travel range. While doing so, be sure to check the settings and the function of the limit switches.
- ▶ If necessary, optimize the interaction of the mechanical equipment and the electronics.

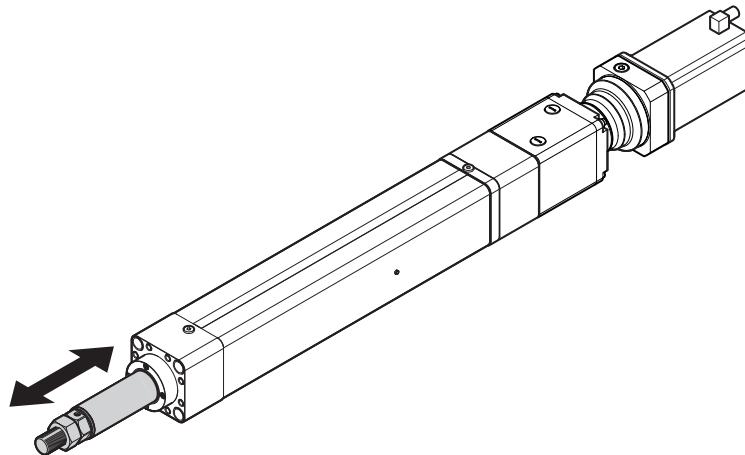


Fig. 36: Moving the EMC-HP

8 Operation

⚠ WARNING

Risk of electric shock due to contact with live parts!

Death or severe injury.

- ▶ Before working on the electrical equipment, switch off the power supply and secure it against being switched on again.

Risk of injury due to moving parts (e.g. piston rod)!

Crushing.

- ▶ Do not reach into moving parts while the system is in operation.
- ▶ Do not stand in the hazard area in front of the piston rod.
- ▶ Make sure that no one is in front of the piston rod before commissioning.

⚠ CAUTION

Motor becomes very hot during operation!

Risk of burns.

- ▶ Do not touch the motor during operation or only touch it while wearing suitable protective equipment (e.g. heat-resistant gloves).

NOTICE

Risk of collisions due to overshooting end positions!

Damage to the product.

- ▶ Do not allow the product to collide with a stop.
- ▶ Observe the max. travel range $s_{\max}$ of the EMC-HP.
- ▶ In all installation positions, make sure there is a sufficient safety margin (excess travel s_e) on two sides of the stroke.

Lubricant may escape!

Environmental pollution.

- ▶ Due to the stroke movement of the piston rod, a certain amount of lubricant is discharged.

Risk of motor overheating when overloaded!

Risk of fire.

- ▶ During operation, be sure to comply with technical data such as load capacities, torques, maximum rotary speeds, motor data, etc. ➞ Product catalog.

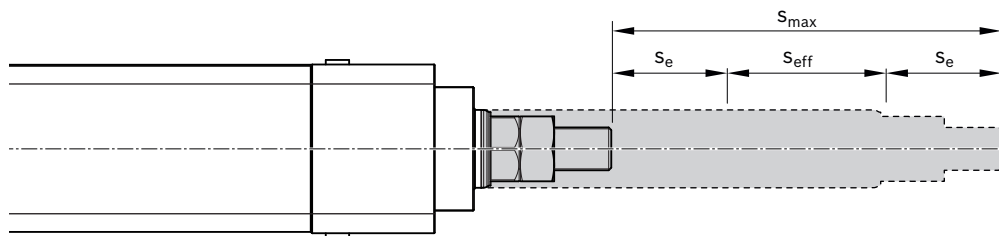


Fig. 37: Excess travel s_e EMC-HP

9 Cleaning and care

NOTICE

Risk of damage due to improper cleaning, e.g. use of solvents and high-pressure jets!

Degradation of seals and functional failure of the product.

- ▶ Do not use high-pressure cleaning equipment.
- ▶ For cleaning, use only water and, if necessary, a mild detergent.

- ▶ Before cleaning, seal all openings with suitable protective caps/devices.

10 Maintenance and repair

The only maintenance required is lubrication of the screw drive using a commercially available manual grease gun. Basic lubrication is carried out by the manufacturer.

The end bearings of the screw drive are greased for life and will not require relubrication under normal operating conditions.

10.1 Lubrication

- ▶ Before using lubricants, read and observe the appropriate safety data sheets!

NOTICE

Risk of property damage due to insufficient lubrication!

Loss of performance and corrosion.

- ▶ Lubricate when the travel range has been covered.

Risk of insufficient lubrication due to use of improper lubricants!

Damage to the EMC-HP, shorter relubrication intervals, loss of performance in short stroke applications and under load; possible chemical interactions between plastic materials and lubricants.

- ▶ Do not use lubricants containing solid particles (e.g. graphite or MoS₂)!
- ▶ Use only the recommended lubricants ➞ Table 16 on page 38

Shorter lubrication intervals in special environmental conditions (contamination, vibrations, impact loads, etc.)!

Inadequate lubrication.

- ▶ Reduce the recommended relubrication intervals to suit the prevailing environmental conditions.
- ▶ Even under normal operating conditions, the system must be relubricated **at least every 2 years** due to aging of the grease.

Performance altered by special operating conditions!

Damage to the EMC-HP.

- ▶ Before commissioning the EMC-HP under special operating conditions (➞ 14 on page 46), please consult Bosch Rexroth AG. This applies especially to environments with glass fiber or wood dust, solvents, short stroke and extreme temperatures.

10.2 Grease lubrication

10.2.1 Lubrication intervals

Always when the specified travel range has been covered.

- For special operating conditions (e.g. special type of end fixity, dust, solvents, etc.), the lubricants must be adapted to the application.
- Under normal operating conditions, the system must be relubricated **at least every 2 years** (aging of grease), or when the specified travel range has been covered.

Conditions:

- Load (PLSA) $\leq 0.3 C$ (C = dynamic load capacity (N) $\Rightarrow$ catalog)
- $n_{\min}$ 100 rpm
- Any installation position
- Temperature $\leq 60^\circ\text{C}$
- Mode of operation: No short stroke (short stroke = stroke $< s_{\min}$)



Short stroke is defined as when the travel range in the application is less than $s_{\min}$ $\Rightarrow$ 14 on page 46. In the case of continuous short-stroke operation, adequate lubricant distribution in the screw drive nut is not ensured and premature wear may occur.

It is recommended to reduce the lubrication interval and to regularly perform lubricating strokes $\geq s_{\min}$.

PLSA

- With short stroke (travel range $< s_{\min}$): divide the relubrication interval and relubrication quantity by three (only valid for distances $> 3 \times P$). For distances $< 3 \times P$ please contact Bosch Rexroth.
P = screw lead

For short stroke (stroke $< s_{\min}$) a reduction must be taken into consideration for the life expectancy calculation.

Lubricant

Do not use greases containing solid particles (e.g., graphite or MoS_2)!

Recommended lithium soap greases:

Table 16: Recommended lubricant

Grease		Low-temperature grease
Consistency class NLGI 2 in accordance with DIN 51818 We recommend Dynalub 510 (Bosch Rexroth) Cartridge (400 g) R341603700 Bucket (5 kg) R341603500	Consistency class NLGI 00 in accordance with DIN 51818 We recommend Dynalub 520 (Bosch Rexroth) Cartridge (400 g) R341604300 Bucket (5 kg) R341604200	Klüber BEM 34-132
Can also be used	Can also be used	
Elkalub GLS 135 / N2 (Chemie-Technik) Tribol GR 100-2PD (Castrol)	Elkalub GLS 135 / N00 (Chemie-Technik) Tribol GR 100-00PD (Castrol)	

- For normal operating conditions, lubricate according to the table.
- For special operating conditions, please contact us.

Low-temperature grease

Table 17: Low-temperature grease

Grease	Temperature range	Material number
Klüber BEM 34-132	-30 to +50 °C	R341603600 Cartridge (400 g)



When using the low-temperature grease Klüber BEM 34-132, the friction torque at -30 °C will increase by a factor of 3. The lubrication interval is halved with the same lubricant quantity!

10.2.2 Relubricating the EMC-HP

The lube nipples (**1** und **2**) are located on the housing.

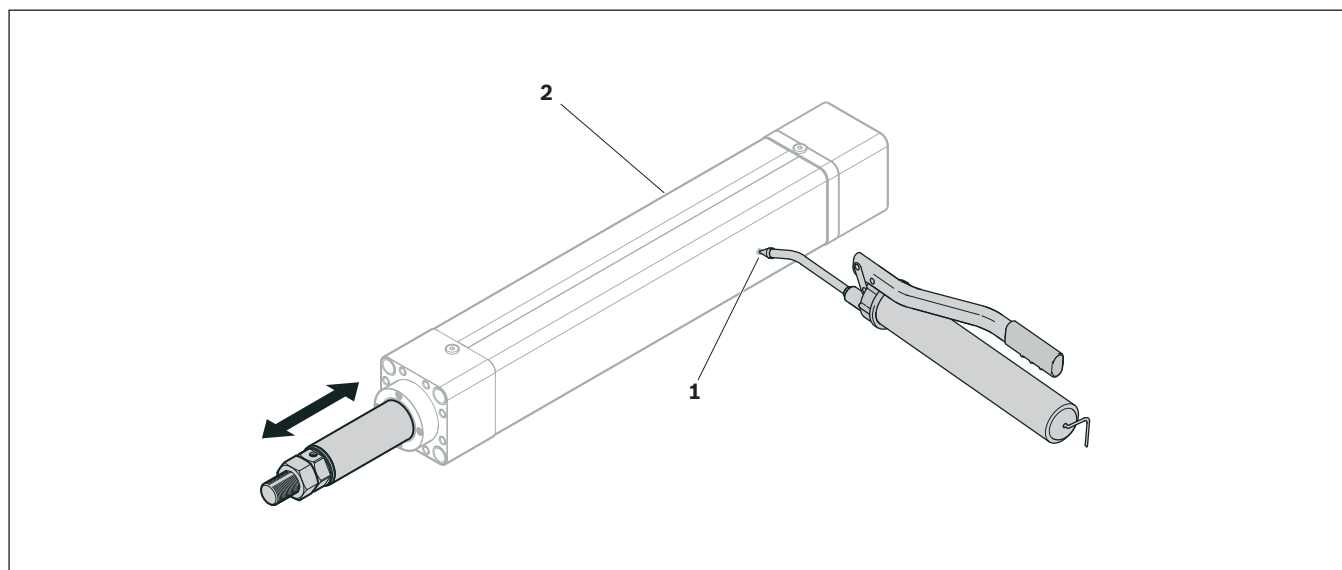


Fig. 38: Lubricating the EMC-HP



Funnel-type lube nipple DIN 3405-A M6 (hydraulic-type lube nipple DIN 71412 M6 can also be used), screw-in depth max. 6 mm

- 1. Check that the operating conditions are normal ➡ "14 Operating conditions" on page 46.
- 2. There are 2 options for reaching the lubrication position:
(Deviation of the lubrication position by ± 1 mm permissible)
 - a) Move the piston rod to stroke position **S₂** (reference position) see figure
 - b) Without limit switch, extend from the rear end position by **S₁**.

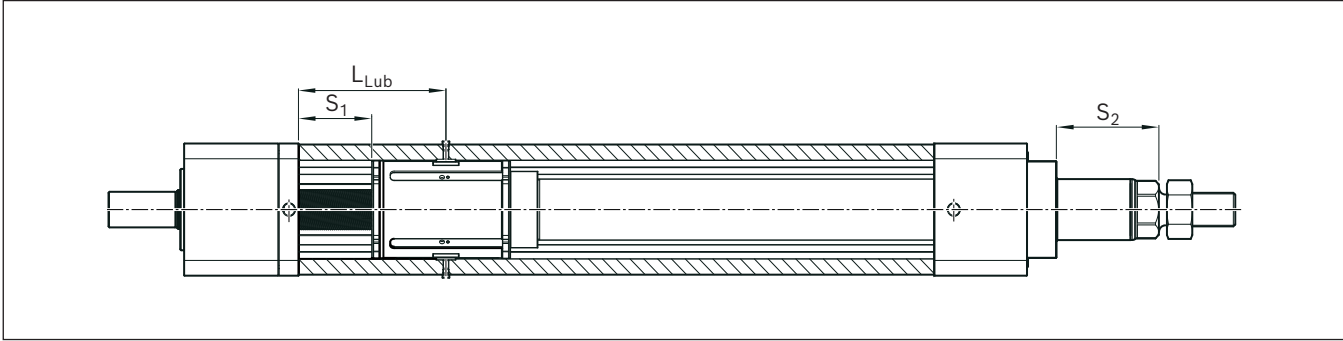


Fig. 39: Lubrication positions

Table 18: Lubrication positions

Size	Dimensions (mm)		
	L _{Lub}	S ₁	S ₂
EMC-115-HP	143.5	75	115.0
EMC-130-HP	151.0	75	116.0
EMC-160-HP	164.5	75	118.0
EMC-190-HP	160.0	75	127.5
EMC-220-HP	180.0	75	135.5

- 3. Apply grease to the screw drive via the lube nipple **(1)** or **(2)** ➡ Fig. 38 on page 39. Apply the grease in several partial amounts. Travel over the entire stroke between lubricating procedures.

Table 19: Lubricant quantity for screw drives in the EMC-HP

Size	Grease relubrication quantity
	(cm ³)
EMC-115-HP	11 + s _{max} /75
EMC-130-HP	20 + s _{max} /60
EMC-160-HP	29 + s _{max} /50
EMC-190-HP	75 + s _{max} /40
EMC-220-HP	125 + s _{max} /30

s_{max} = maximum travel range (mm) of the EMC-HP

PLSA grease lubrication
(e.g. Dynalub 510)

Load-dependent relubrication
intervals

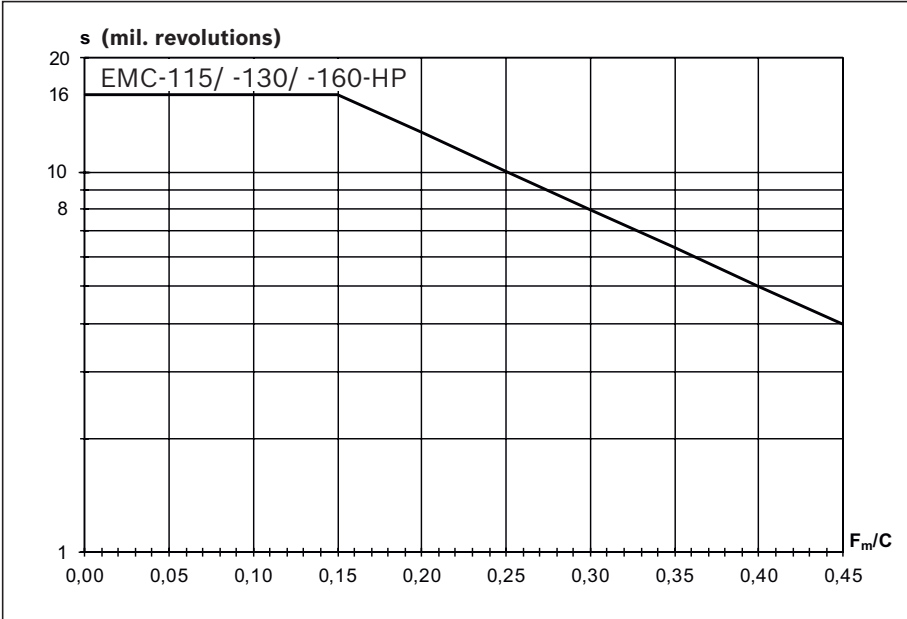
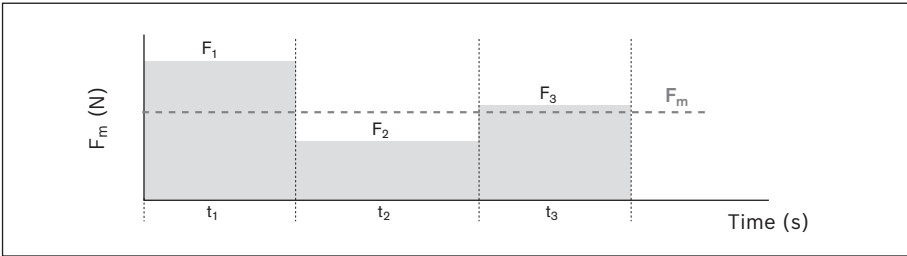


Fig. 40: Relubrication intervals

The load ratio **F_m/C** is the quotient of the average load **F_m** and the dynamic load capacity **C**

When both the load and the rotary speed vary, the average load **F_m** is calculated as follows:



$$F_m = \sqrt[3]{|F_1|^3 \cdot \frac{|v_1|}{v_m} \cdot \frac{t_1}{t_{tot}} + |F_2|^3 \cdot \frac{|v_2|}{v_m} \cdot \frac{t_2}{t_{tot}} + \dots + |F_n|^3 \cdot \frac{|v_n|}{v_m} \cdot \frac{t_n}{t_{tot}}}$$

Conversion of lubrication
interval **s** from millions of
revolutions to kilometers:

$$s \text{ in kilometers} = \frac{s \text{ in Mio. (Revs)} \cdot \text{lead } P \text{ (mm)}}{10^6}$$

Example:

$$s \text{ in kilometers} = \frac{50 \cdot 10^6 \text{ (revs)} \cdot 16 \text{ (mm)}}{10^6} = 800$$

- $t_1, t_2, \dots, t_n$ = Discrete time steps in phases 1 ... n (s)
- t_{tot} = Total of time steps $t_1, t_2, \dots, t_n$ (s)
- $v_1, v_2, \dots, v_n$ = Speed in phase 1 ... n (m/s)
- v_m = Average speed (m/s)
- F_m = Average load (N)
- s = Relubrication interval in mil. revolutions (10^6 revs)

PLSA liquid grease lubrication (e.g. Dynalub 520)

 When using liquid grease, the recommended lubrication interval is 75% of the specified value of grease lubrication (with the same lubricant quantity)!

10.3 Oil lubrication

If the "oil bath lubrication" option is selected, the EMC-HP is maintenance-free at the following operating conditions:

Operating conditions	Value/condition
Ambient temperature	0 °C ... 50 °C
Ambient temperature of cylinder with Rexroth servo motor	0 °C ... 40 °C. Loss of performance above 40 °C
Travel range s_{min}	see EMC-HP catalog
Load	$F_m/C \leq 0.2$
Average rotary speed	$n_m > 30$ rpm
Oil service life	14000 h
Oil mileage	15000 km
Oil check interval	Recommendation every 4 years. An oil with 220 mm ² /s (40 °C) viscosity is used by default (e.g. Shell Tonna S3 M 220) annual check if operating conditions differ

Installation position	
Horizontal	±5° inclination; intended for normal operation. (normal operating conditions)
Vertical	The following applies to travel range s: - Piston rod extends upwards (⇒ Fig. 41): the cylinder must not be exclusively operated in the limited travel range. - Piston rod extends downwards (⇒ Fig. 42): the cylinder must not be exclusively operated in the limited travel range.

EMC-HP -115/-130/-160

NOTICE

Travel range for sizes -115/-130/-160

Damage to the product.

► Observe travel range according to diagrams (observe installation position)

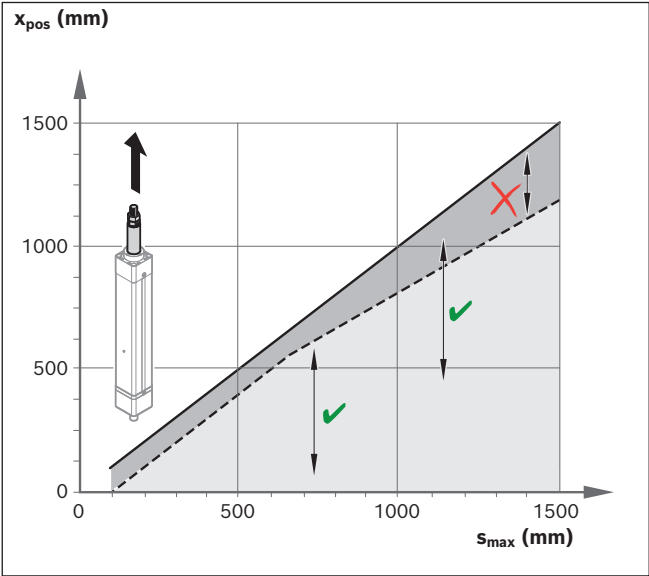


Fig. 41: for sizes -115/-130/-160

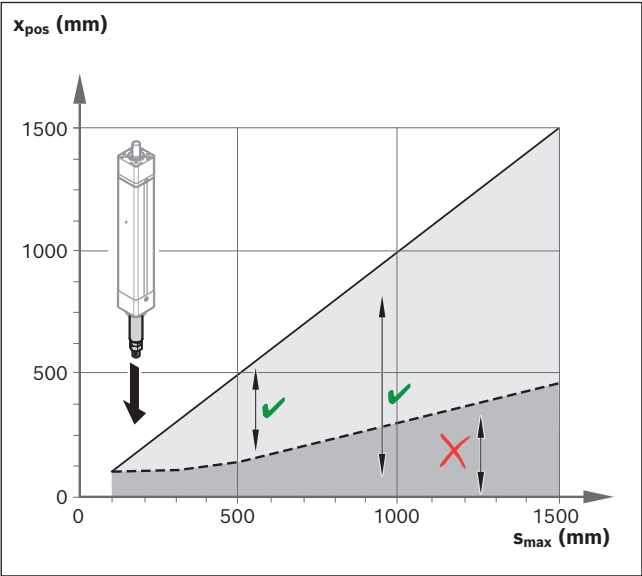


Fig. 42: for sizes -115/-130/-160

x_{pos} = Current stroke position (mm)
 s_{max} = Maximum travel range (mm)

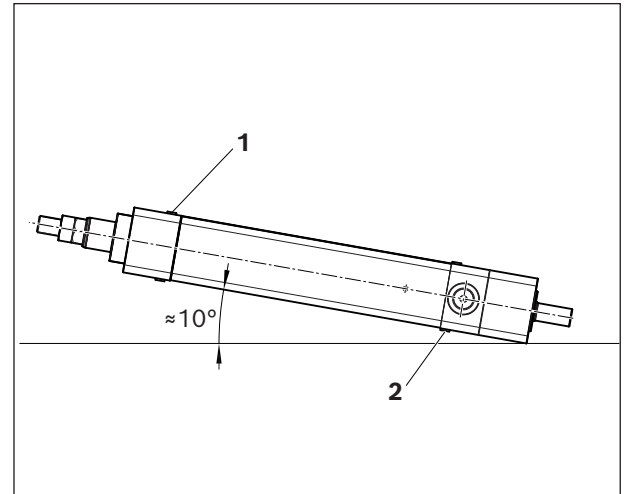
- Limitless travel range
- Limited travel range

Replacement of used oil:

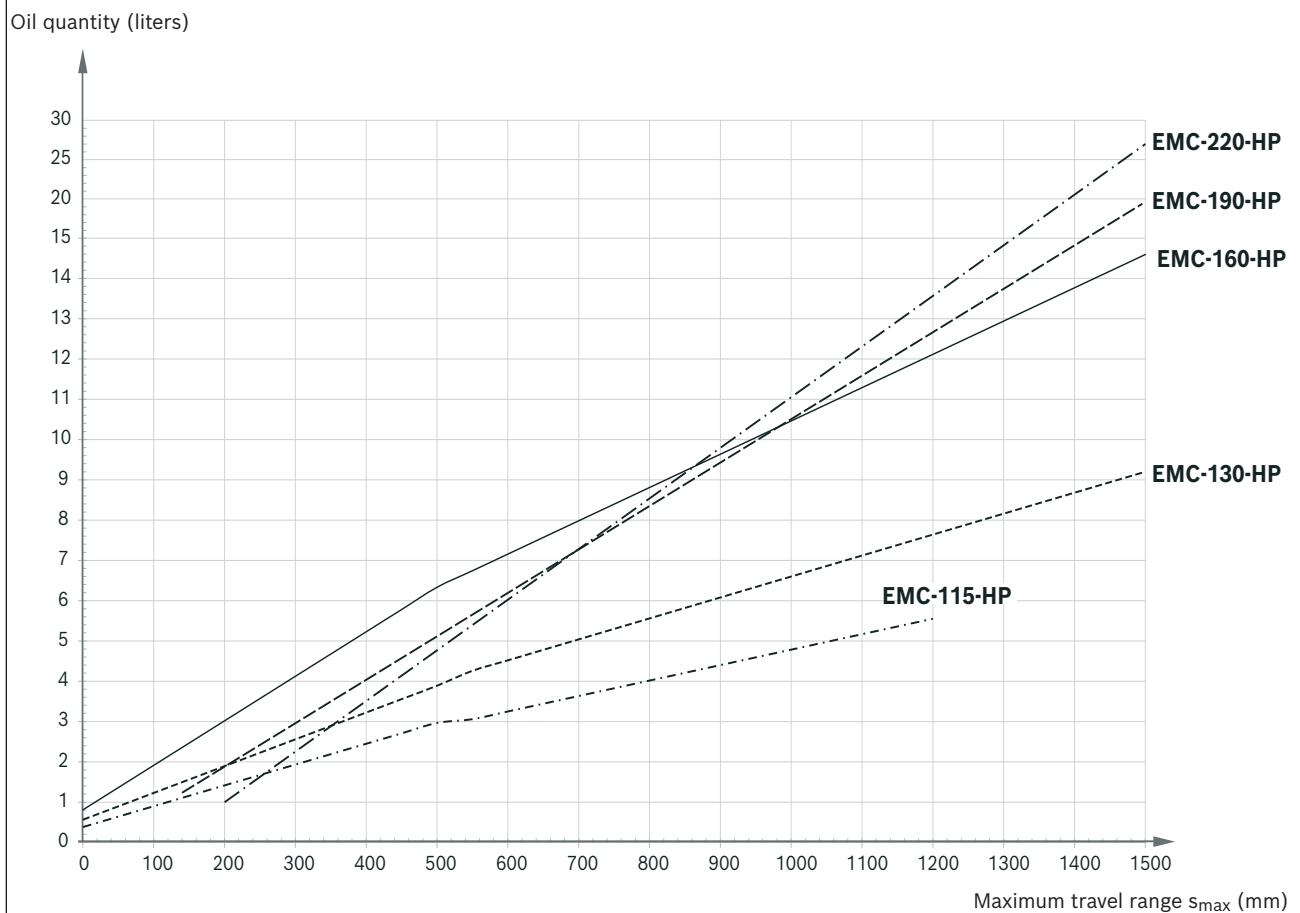
1. Retract the cylinder at operating temperature and bring it into an inclined position of approx. 10° (the cylinder may have to be removed for this purpose) (⇒ Fig. 43).
2. Place a suitable collection tray under the cylinder.
3. Loosen the upper service fitting (1) to ensure pressure compensation.

⚠ Lubricant may leak out!

4. Screw out the lower service fitting (2) and the upper service fitting (1).
5. Drain the oil.
6. Close the lower service opening (2) again.
7. Fill in fresh oil according to diagram (⇒ Fig. 44) at the upper service opening (1).
8. Fully extend the piston rod and close the service fitting (1).

**Fig. 43:****NOTICE****Non-compliance with the oil quantity!****Damage to the product.**

- ▶ Drain the used oil completely. The oil quantity must match the refill quantity.
- ▶ Fill in oil in a quantity according to diagram. Do not exceed the oil quantity.

**Fig. 44:**

10.4 Repair

Repairs to the EMC-HP may only be carried out by Bosch Rexroth.

11 Removal and replacement

To assure correct operation of the EMC-HP after the replacement of assemblies (e.g. planetary screw assembly, piston rod, etc.), assemblies may only be removed and replaced by Rexroth.

The only exceptions to this rule are the work steps described in this chapter.

⚠ WARNING

Risk of the piston rod crashing down if installed in a vertical or slanting position as the unit is not self-locking!

Death or severe injury.

- ▶ If the EMC-HP is installed vertically or on a slant, secure the piston rod against falling before loosening the fastening screws.
- ▶ Do not stand in the fall direction of the piston rod.

Risk of electric shock due to contact with live parts!

Death or severe injury.

- ▶ Before working on the electrical equipment, switch off the power supply and secure it against being switched on again.



Fig. 45: Secure the piston rod in vertical installations

11.1 Removing the drive

1. Removal is carried out in reverse mounting order "Mounting" on page 10.

CAUTION

Potential uncontrolled motion of the preloaded toothed belt in the belt side drive when loosening the screws!

Risk of injury.

- ▶ Take care when unscrewing the fastening screws on the motor.

12 Disposal

The EMC-HP contains a number of different materials: Aluminum, steel, plastics, grease and oils, possibly electronic components.

NOTICE

Environmentally hazardous materials can pollute the environment if not disposed of properly.

Environmental pollution.

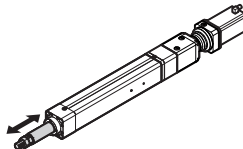
- ▶ Collect any leaking lubricants and oils and dispose of them correctly.
- ▶ The EMC-HP and its components must be disposed of correctly and in compliance with all applicable national and international guidelines and regulations.

13 Technical data

Technical data ➞ Catalog "Electromechanical cylinders EMC-HP."

14 Operating conditions

Table 20: Operating conditions

Operating conditions			Value	Symbol
Ambient temperature of cylinder with Rexroth servo motor			0 °C ... 40 °C, loss of performance above 40 °C	
Ambient temperature of cylinder mechanics			-10 °C ... +50 °C (up to +60 °C with low duty cycle and power)	
Ambient temperature of cylinder mechanics with PLSA and low-temperature grease			-30 °C ... +50 °C (up to +60 °C with low duty cycle and power)	
Travel range s_{min}	EMC-115-HP	30 x 5	85 mm	
		30 x 10	85 mm	
	EMC-130-HP	39 x 5	110 mm	
		39 x 10	110 mm	
	EMC-160-HP	48 x 5	130 mm	
		48 x 10	130 mm	
	EMC-190-HP	60 x 10	150 mm	
		60 x 20	150 mm	
	EMC-220-HP	75 x 10	190 mm	
75 x 20		190 mm		
Load			PLSA ≤ 0.3 C	

14.1 Tightening torques

Table 21: Tightening torques

 8.8	M6	M8	M10	M12	M14	M16	M20	M24	M30	M36
⌀ M _A (Nm)	9.5	23	46	80	127	194	392	675	1350	2350
μ = 0.125										

 10.9	M6	M8	M10	M12	M14	M16	M20	M24	M30	M36
⌀ M _A (Nm)	14	34	68	116	186	285	558	960	1920	3340
μ = 0.125										

14.2 Service and support

- ▶ When ordering replacement parts, please specify all the data on the name plate.
- ▶ To order replacement parts, please contact your local Bosch Rexroth AG regional center. To find it, visit www.boschrexroth.com/contact

In urgent cases, our Bosch Rexroth Customer Service help desk and hotline staff will be happy to assist you in any way they can.

Phone: +49 (0) 9352 40 50 60

E-mail: Service@boschrexroth.de

Return address:

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SERVICE
Röntgenstraße 5
97424 Schweinfurt

14.2.1 Assembly videos

[Assembly videos are available on YouTube](#)



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