

ROBOT

KR 30-3

KR 60-3

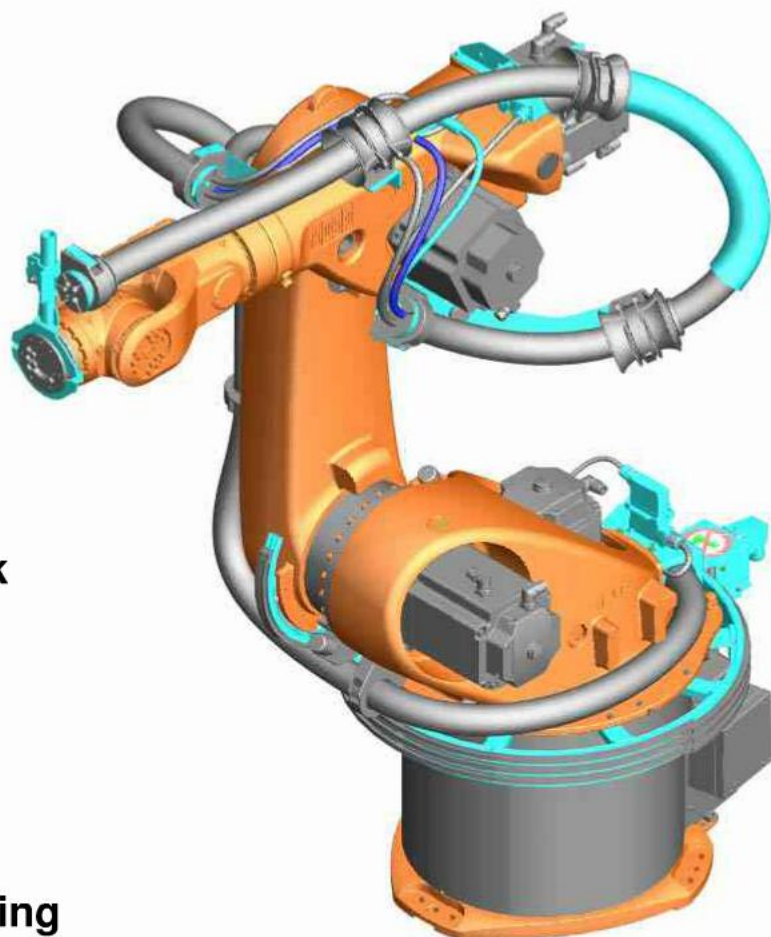
KR 30 HA

KR 60 HA

**Seminar workbook
of**

Mechanical Servicing

Issued: September 2005





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**KUKA Roboter GmbH
Zugspitzstraße 140
D-86165 Augsburg**

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Other functions not described in this documentation may be operable in the controller. The user has no claims to these functions, however, in the case of a replacement or service work.

We have checked the content of this documentation for conformity with the hardware and software described. Nevertheless, discrepancies cannot be precluded, for which reason we are not able to guarantee total conformity. The information in this documentation is checked on a regular basis, however, and necessary corrections will be incorporated in subsequent editions.

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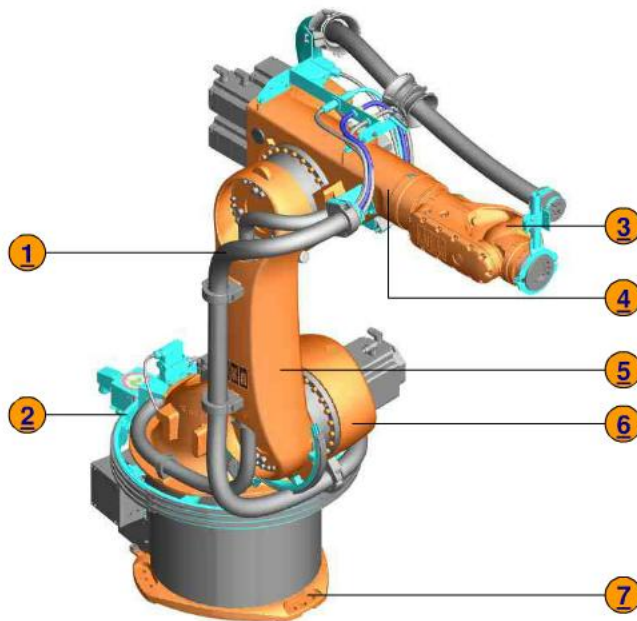


1. Overview Robot





Mechanical servicing, KR 30-3



- ① Energy supply system
- ② Axis range monitoring
- ③ Wrist
- ④ Arm
- ⑤ Link arm
- ⑥ Rotating column
- ⑦ Base frame

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2. Disassembly

2.1. Wrist

Wrist disassembly



Use the appropriate equipment to ensure that the wrist does not fall!



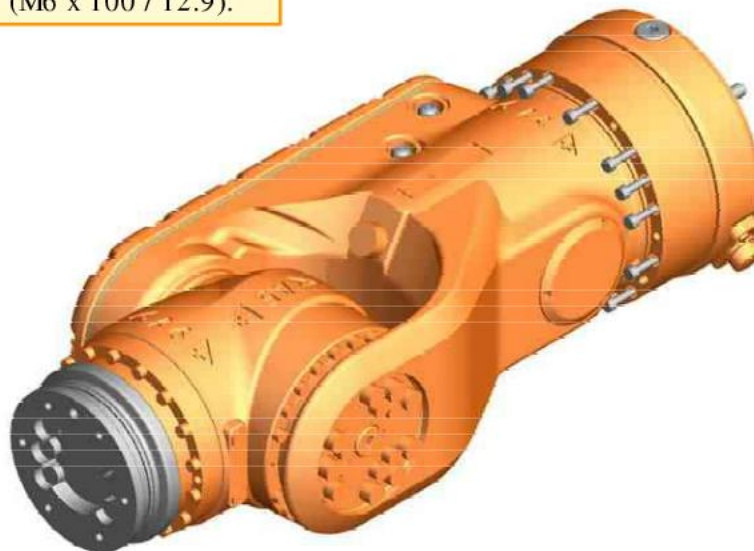
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Wrist disassembly



Loosen and remove sixteen wrist fastening screws (M6 x 100 / 12.9).



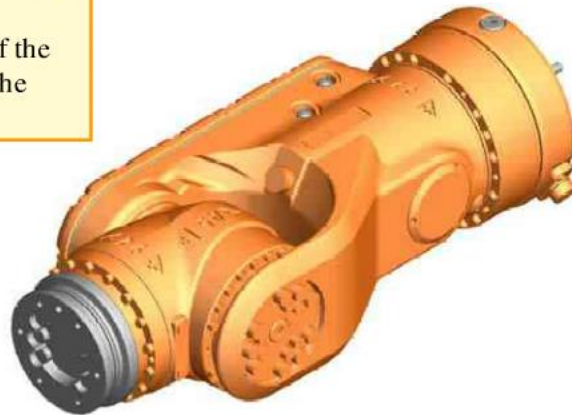
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Wrist disassembly



The wrist must not be tilted as it is being removed!
Mind the contact surface of the wrist on the arm and also the wrist drive shaft.



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Wrist disassembly

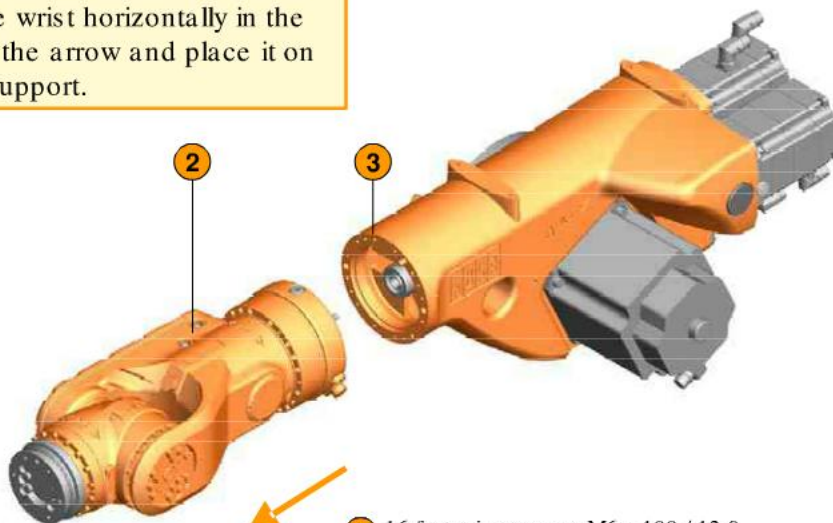


Remove the wrist horizontally in the direction of the arrow and place it on a suitable support.

1

2

3



1 16 fastening screws M6 x 100 / 12.9

2 Wrist

3 Arm

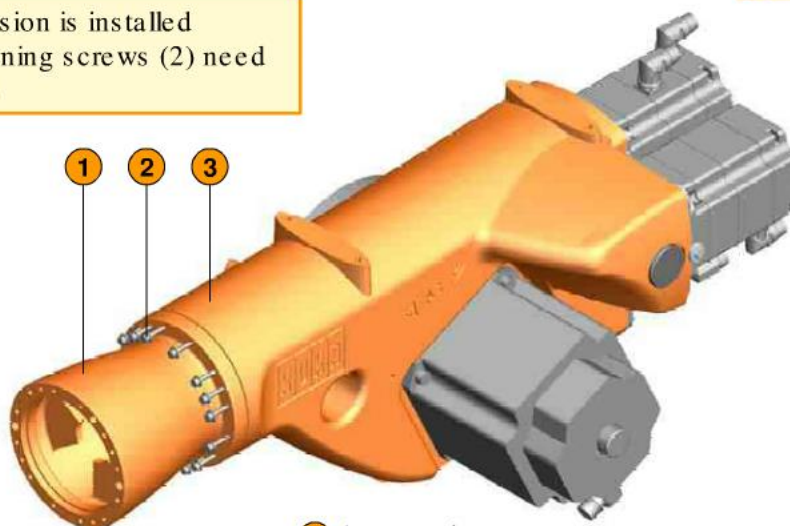
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Wrist disassembly

Arm extension

If an arm extension is installed additional fastening screws (2) need to be removed.



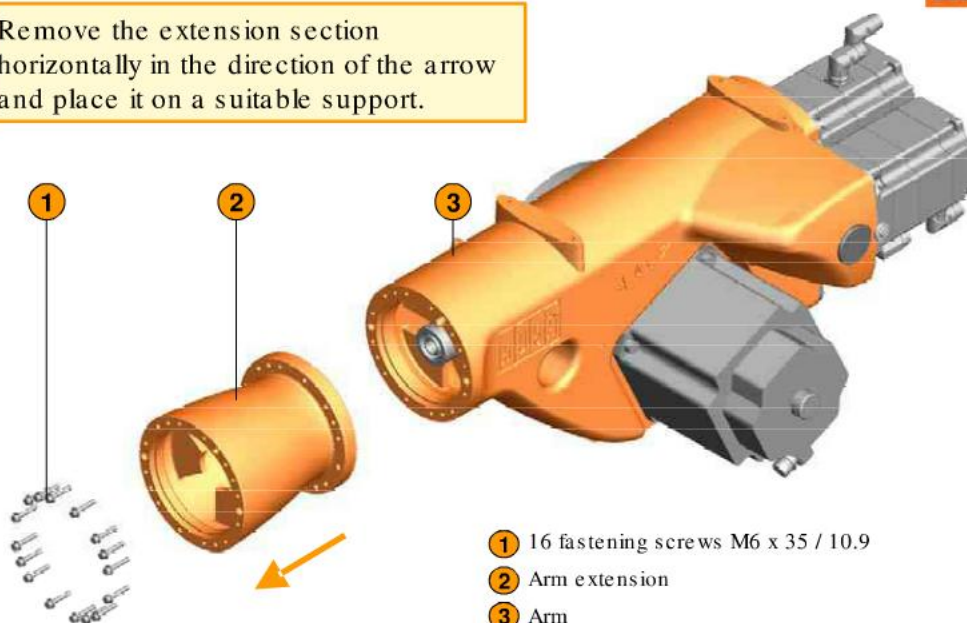
- ① Arm extension
- ② 16 fastening screws M6 x 35 / 10.9
- ③ Arm

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Wrist disassembly

Arm extension

Remove the extension section horizontally in the direction of the arrow and place it on a suitable support.



- ① 16 fastening screws M6 x 35 / 10.9
- ② Arm extension
- ③ Arm

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2.2. Arm

Arm disassembly



Unplug the motor and control connectors.



Use the appropriate equipment to ensure that the arm does not fall!



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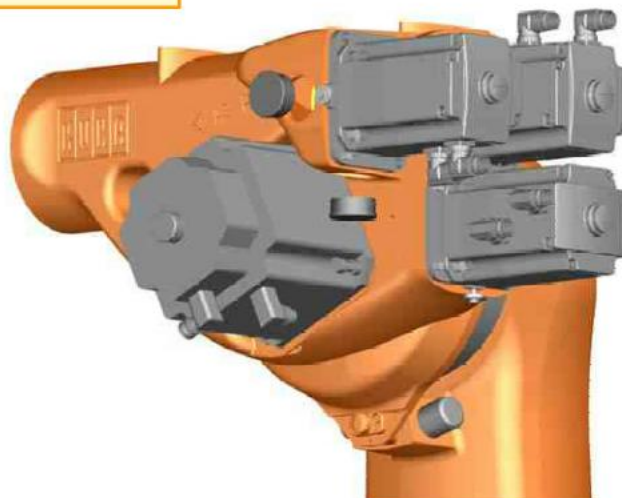
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Arm disassembly



Wrist axis motors, axis 4 to axis 6

Remove the three plugs on both sides of the arm and under the motor of axis 4.



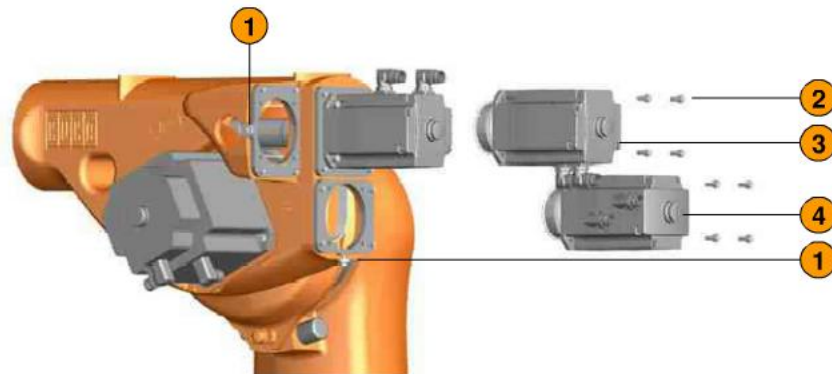
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Arm disassembly

Wrist axis motors, axis 4 to axis 6

Unscrew adjusting screws (1) by several turns, remove fastening screws (2) and remove motors.



① Adjusting screws

② 8 motor fastening screws M6 x 25 / 8.8

③ Wrist axis motor A 4

④ Wrist axis motor A 5

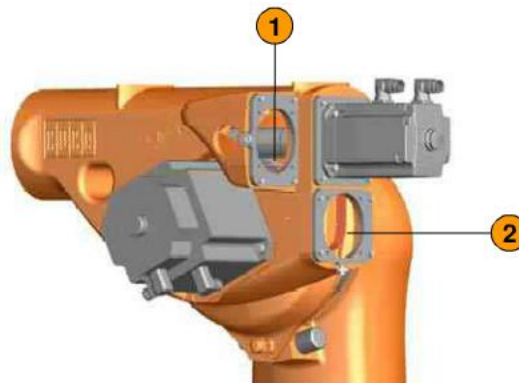
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Arm disassembly

Wrist axis motors, axis 4 to axis 6

When removing the motors their respective toothed belts in the arm must be taken off at the same time.



① Toothed belt, wrist axis motor A 4

② Toothed belt, wrist axis motor A 5

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Arm disassembly

Wrist axis motors, axis 4 to axis 6

Remove fastening screws (2) on the axis 6 motor (1) and take the motor out



Attention must be paid to any loose disc springs!



① Wrist axis motor A 6

② 4 motor fastening screws M8 x 18 / 8.8

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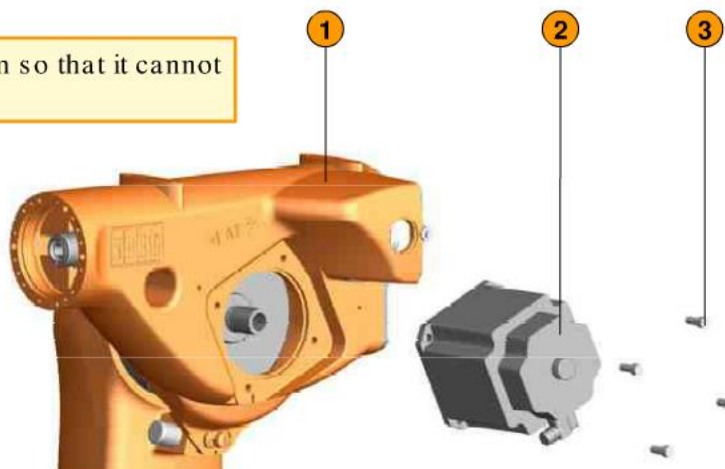
Arm disassembly

Motor A 3

Unscrew fastening screws (3) and remove motor (2).



Secure the arm so that it cannot move!



① Arm

② Motor A 3

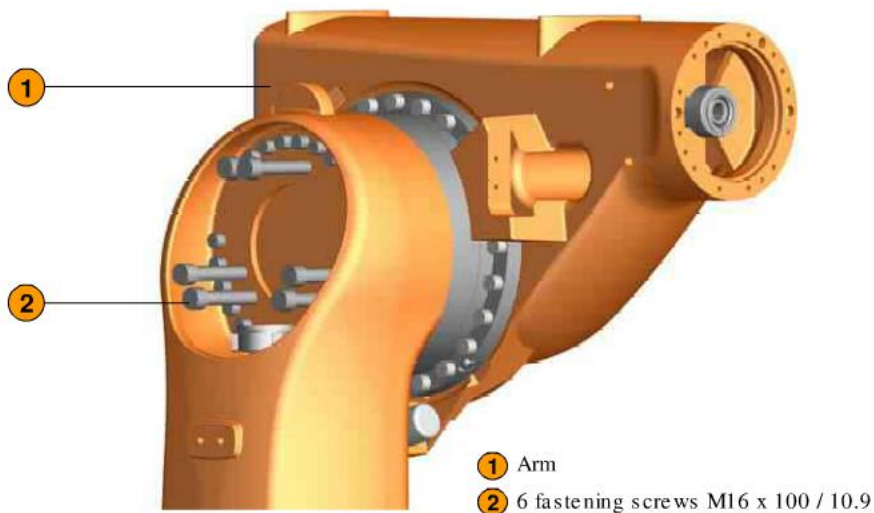
③ 4 motor fastening screws M12 x 30 / 8.8

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Arm disassembly



Loosen and remove fastening screws (2).

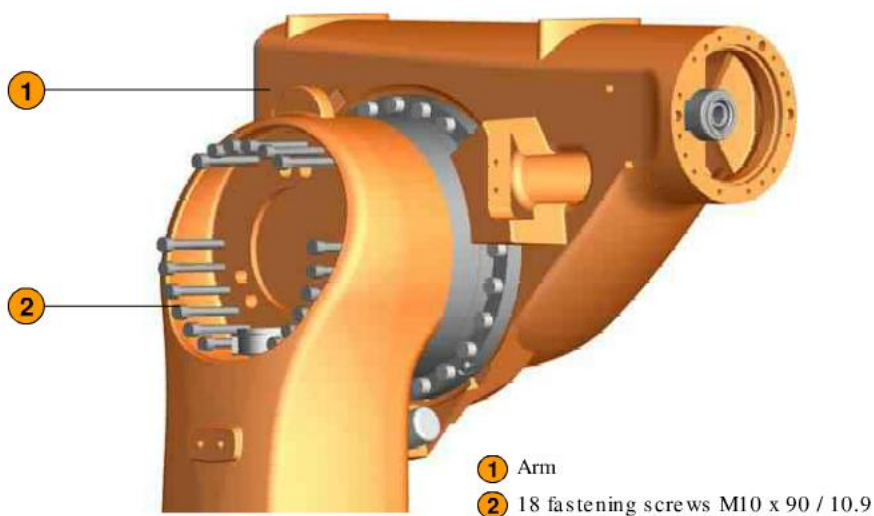


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Arm disassembly



Loosen and remove fastening screws (2).

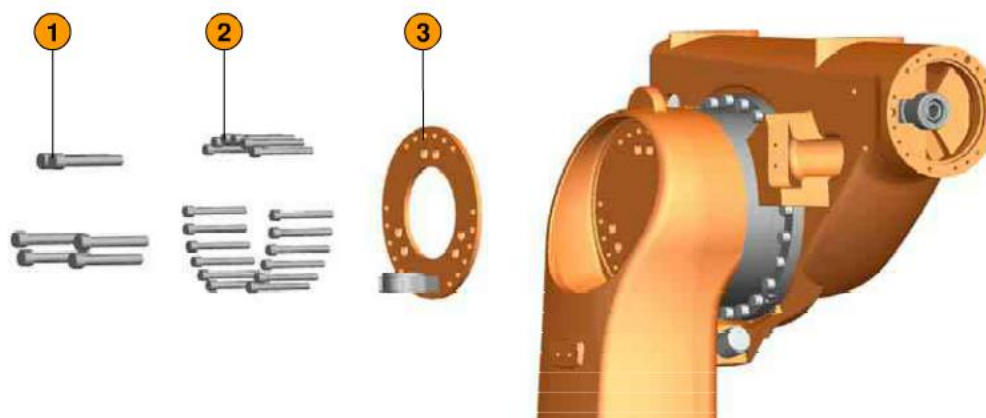


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Arm disassembly



Take off support ring (3).



- ① 6 fastening screws M16 x 100 / 10.9
- ② 18 fastening screws M10 x 90 / 10.9
- ③ Support ring

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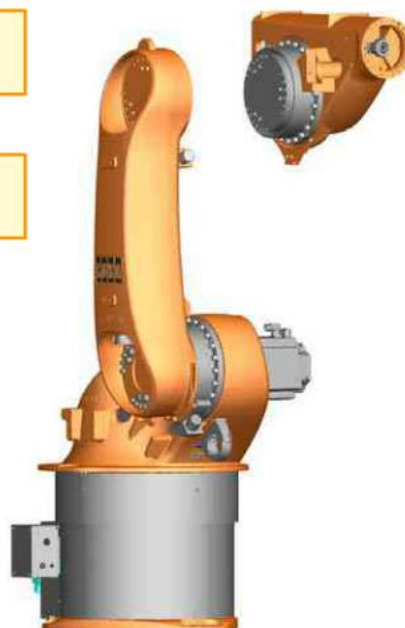
Arm disassembly



Push the arm out of its location and carefully swing it away.



The arm must not be tilted while it is being lifted off.



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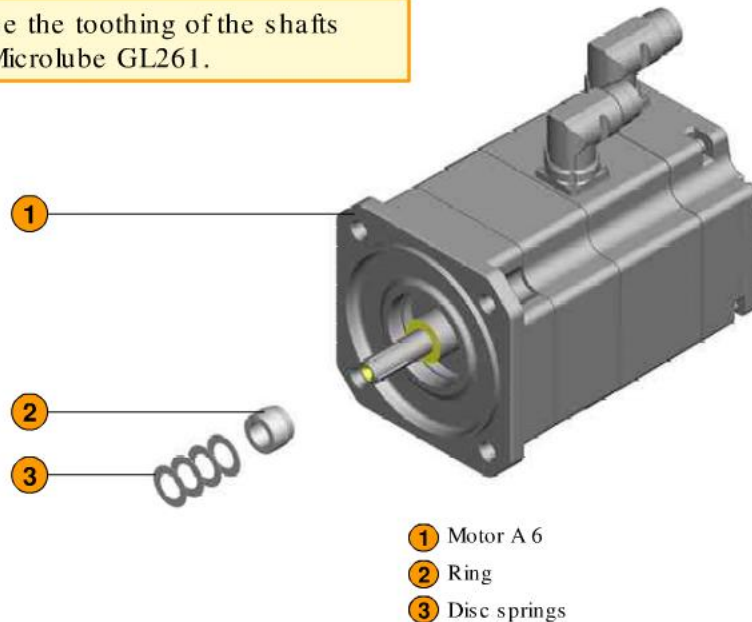


Arm disassembly



Motor A 6

Grease the toothing of the shafts with Microlube GL261.



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2.3. Link arm

Link arm disassembly

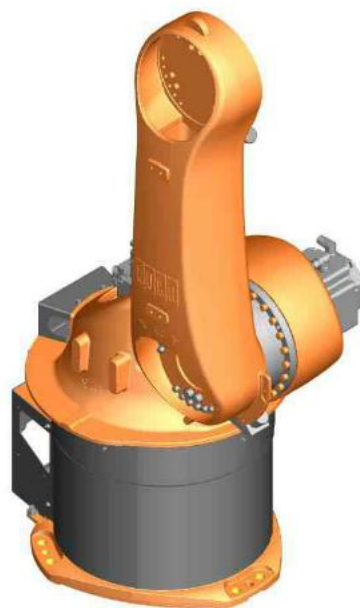


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Link arm disassembly



Use the appropriate equipment to ensure that the link arm does not fall!



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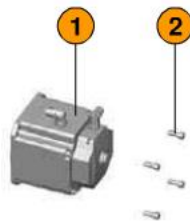
Link arm disassembly



Motor A 2



Unplug the motor and signal connectors. Remove fastening screws (2). Remove motor (1) and place it on a suitable support.



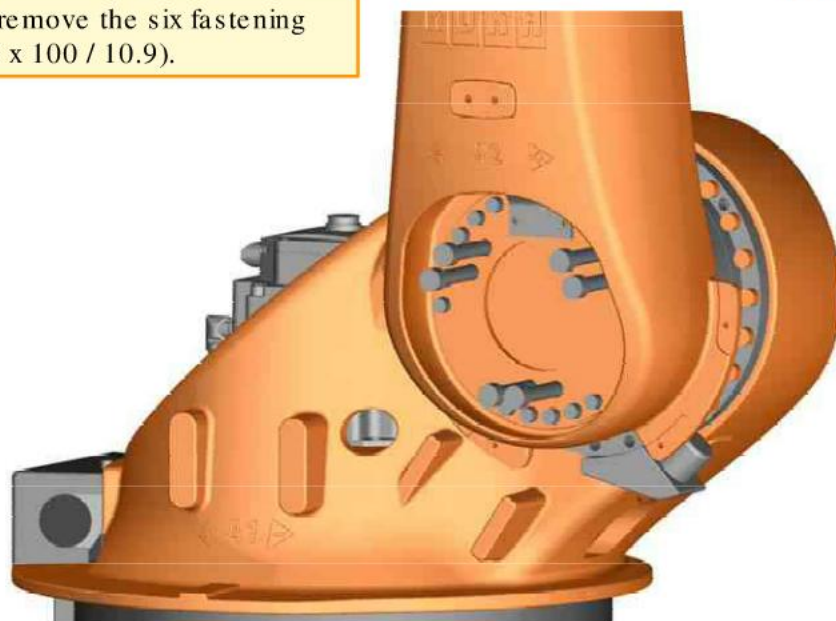
- ① Motor A 2
- ② 4 motor fastening screws M12 x 30 / 10.9

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Link arm disassembly



Loosen and remove the six fastening screws (M16 x 100 / 10.9).

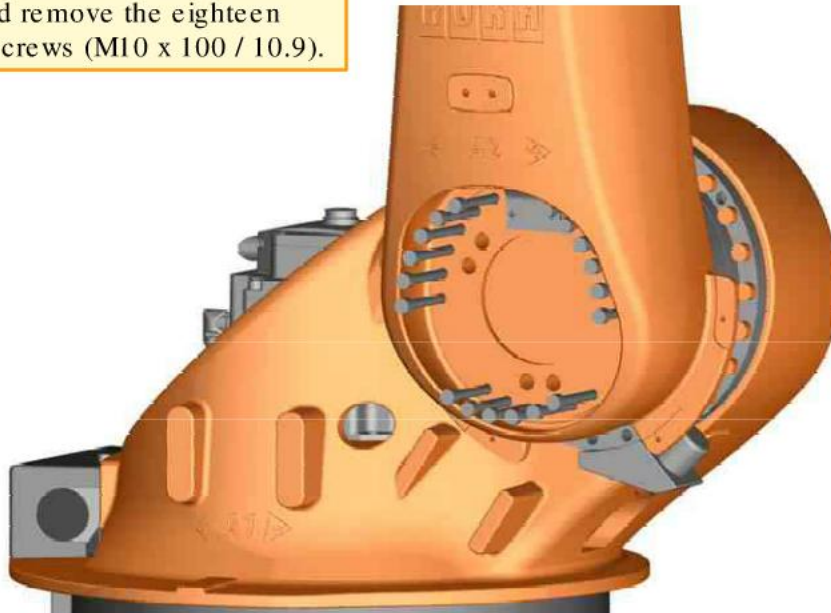


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Link arm disassembly



Loosen and remove the eighteen fastening screws (M10 x 100 / 10.9).

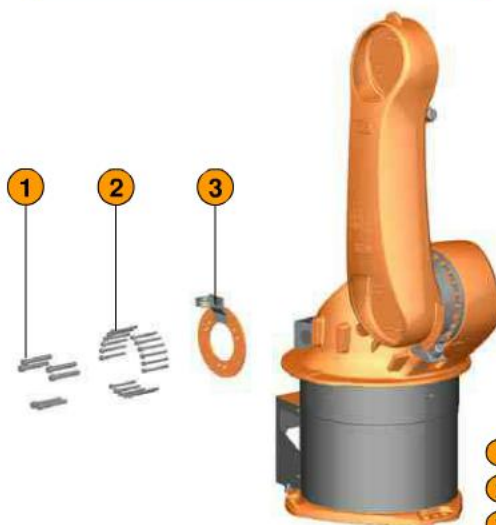


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Link arm disassembly



The link arm must not be tilted while it is being lifted off.



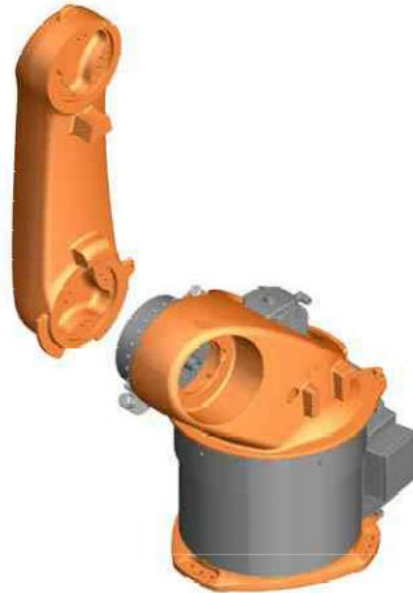
- ① 6 fastening screws M16 x 100 / 10.9
- ② 18 fastening screws M10 x 100 / 10.9
- ③ Support ring

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Link arm disassembly



Carefully lift off the link arm and place it on a suitable support.



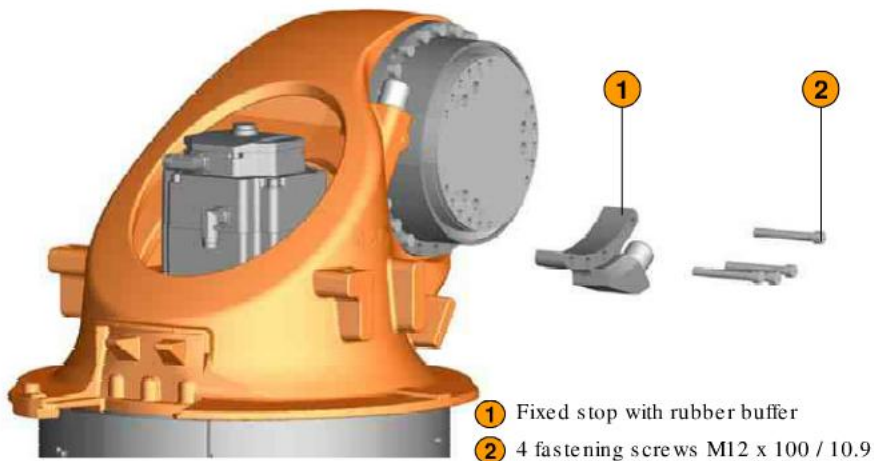
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Link arm disassembly



Gear unit A 2

To remove the motor unit, remove the screws (2) and take off the fixed stop (1).

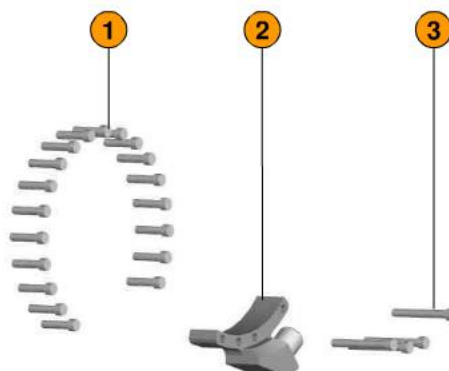
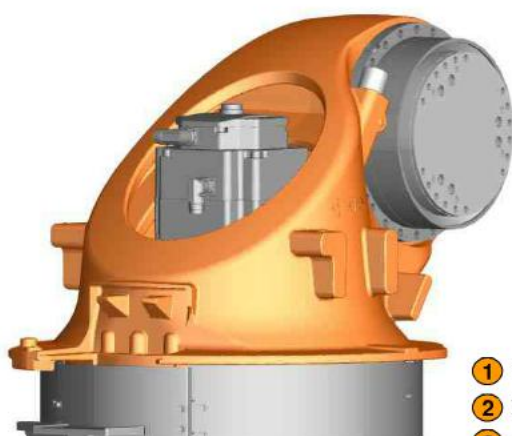


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Link arm disassembly

Gear unit A 2

Remove fixed stop (2), and loosen and remove fastening screws (3).



- ① 19 fastening screws M12 x 50 / 10.9
- ② Fixed stop with rubber buffer
- ③ 4 fastening screws M12 x 100 / 10.9

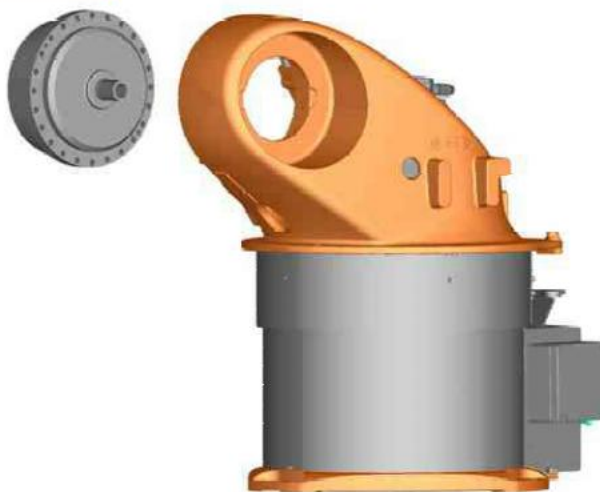
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Link arm disassembly

Gear unit A 2

Secure the gear unit with appropriate equipment, lift off and place on a suitable support.



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2.4. Rotating column

Rotating column disassembly



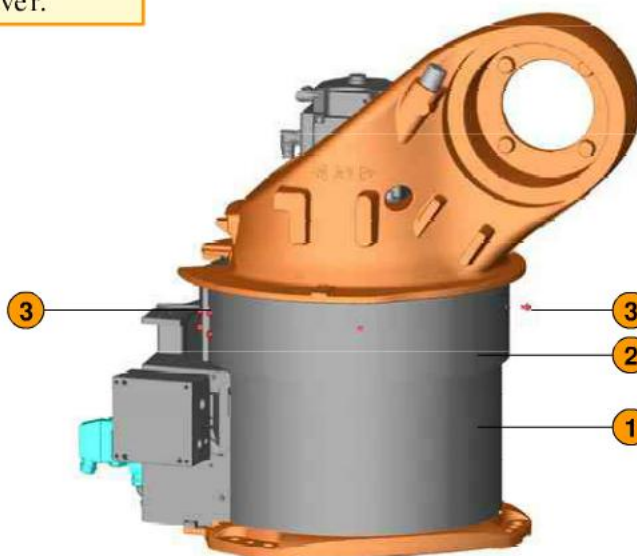
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Rotating column disassembly



Unscrew the eight screws on the upper cover and remove cover.



- ① Lower cover
- ② Upper cover
- ③ 8 screws M6 x 12 / 8.8

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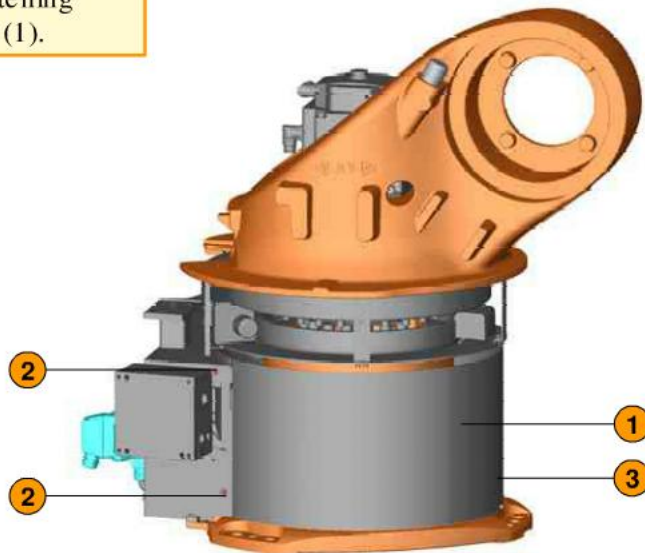
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Rotating column disassembly



Remove four hexagon nuts (2) and locking screws and one fastening screw from the lower cover (1).

- ① Lower cover
- ② 4 hexagon nuts M6 - 8
- ③ Screw M5 x 8 / 8.8



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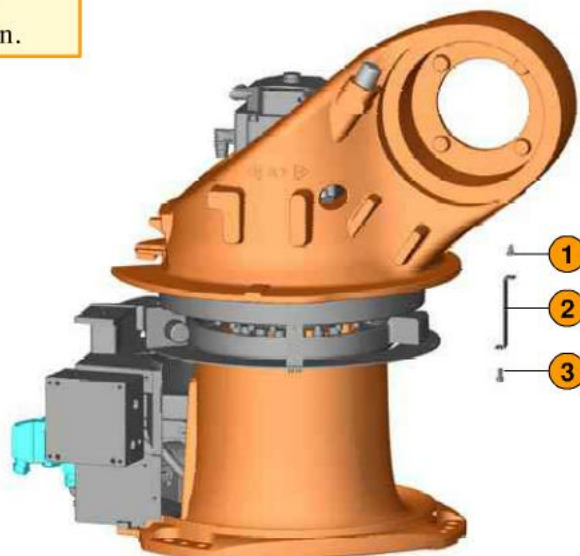
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Rotating column disassembly



Unscrew the screws from the holder, remove the holders and the ring segment from the rotating column.

- ① 6 screws M6 x 12 / 8.8
- ② 3 holders
- ③ 6 screws M6 x 12 / 8.8



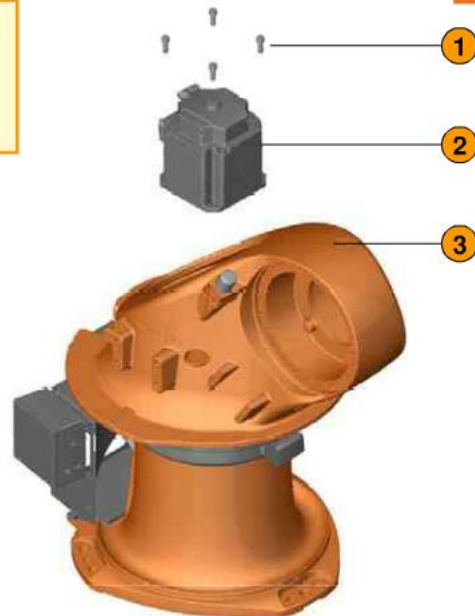
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Rotating column disassembly

Motor A 1

Loosen and remove fastening screws (1) from the motor. Carefully lift out the motor (2) and place it on a suitable support.



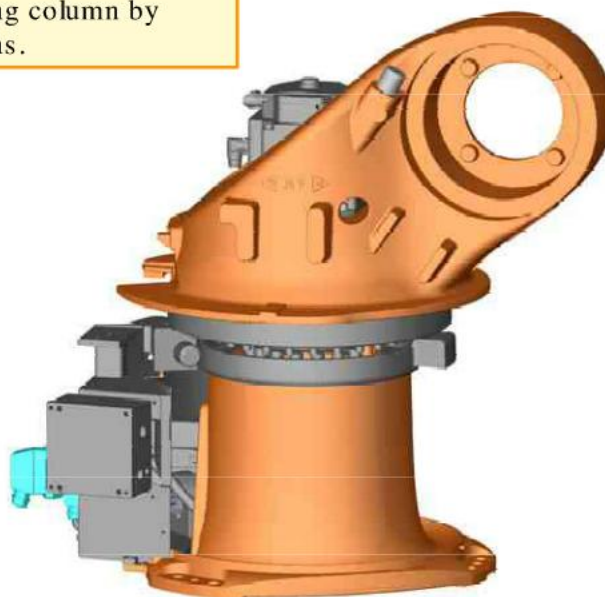
- ① 4 motor fastening screws M12 x 30 / 10.9
- ② Motor A 1
- ③ Rotating column

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Rotating column disassembly



Secure rotating column by suitable means.



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Rotating column disassembly



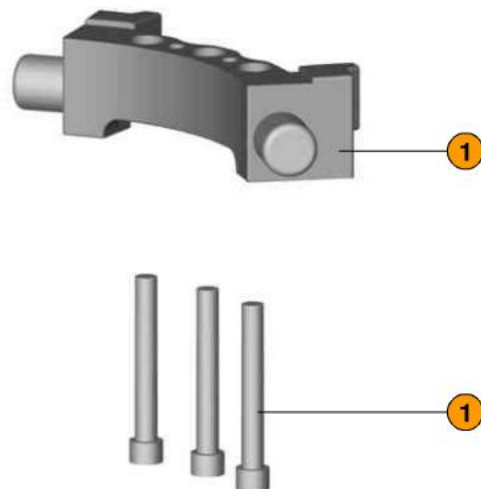
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Rotating column disassembly



Loosen and remove fastening screws (2) from the fixed stop (1). Remove fixed stop (2).



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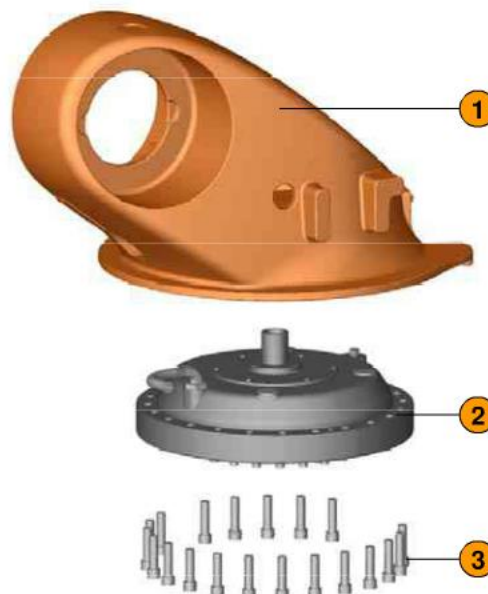
Rotating column disassembly



Remove the twenty fastening screws from the rotating column. Lift off the rotating column from the base frame with appropriate equipment, and place it on a suitable support.



The rotating column must not be tilted while it is being lifted off!



- ① Rotating column
- ② Gear unit A 1
- ③ 20 fastening screws M16 x 60 / 10.9

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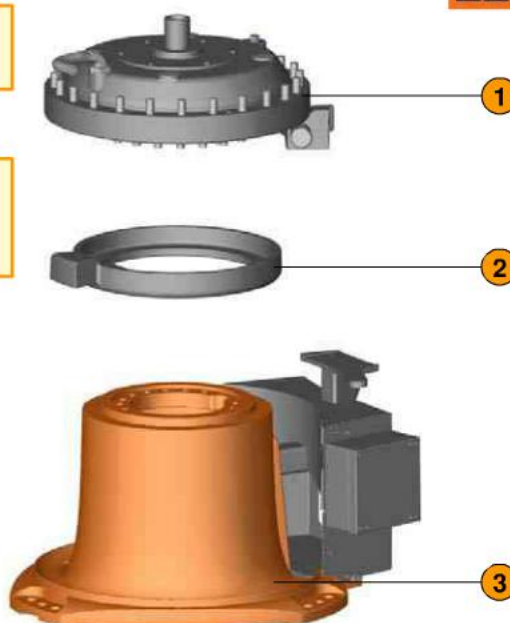
Rotating column disassembly



Take the gear unit and the trailing stop from the base frame.



When removing the gear unit pay attention to the oil drain hose.



- ① Gear unit A 1
- ② Trailing stop
- ③ Base frame

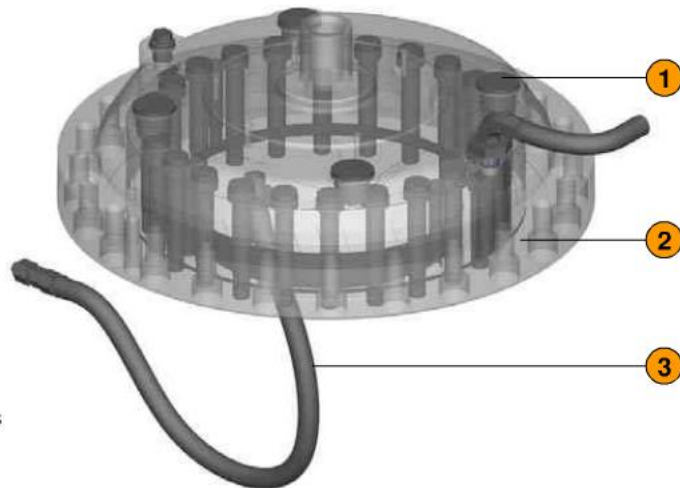
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Rotating column disassembly

Gear unit A 1

The oil must be fully drained before the gear unit can be disassembled.



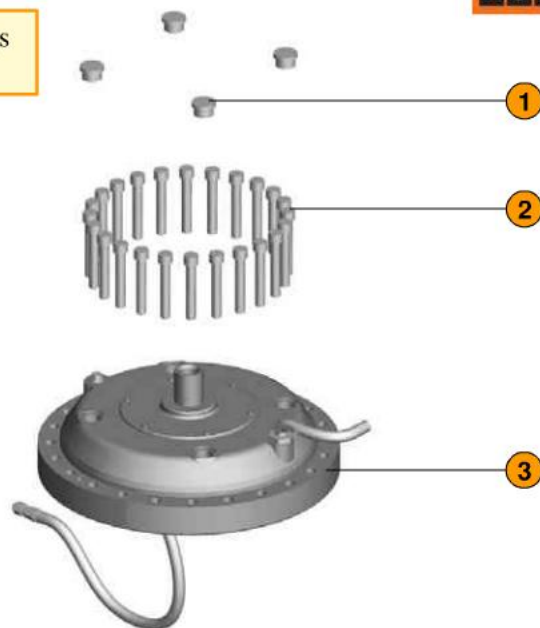
- ① Screw plug for threaded holes
- ② Gear unit A 1
- ③ Oil drain hose

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Rotating column disassembly

Gear unit A 1

Slacken and remove the screw plugs (1) and the screws (2).



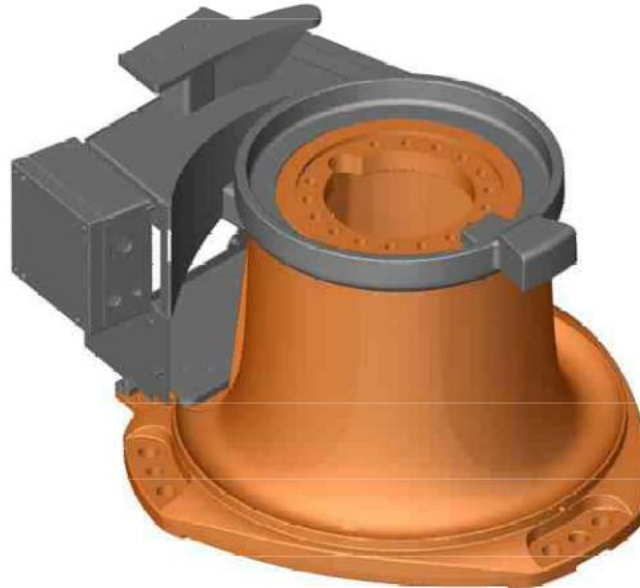
- ① Screw plug for threaded holes
- ② 24 screws M16 x 100 / 10.9
- ③ Gear unit A 1

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2.5. Base unit

Base frame



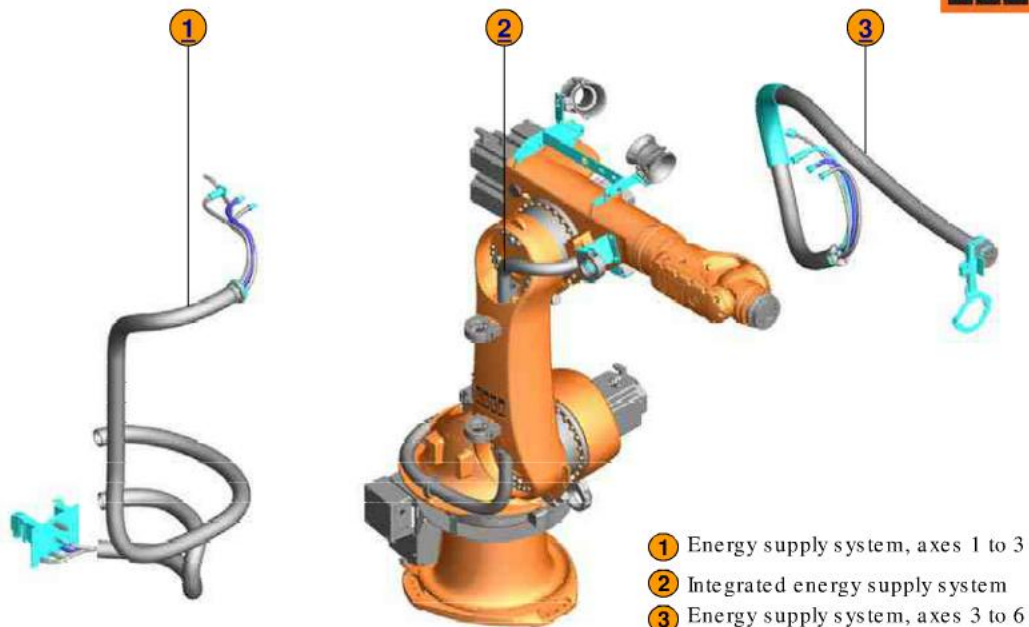
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2.6. Energy supply

Energy supply system disassembly



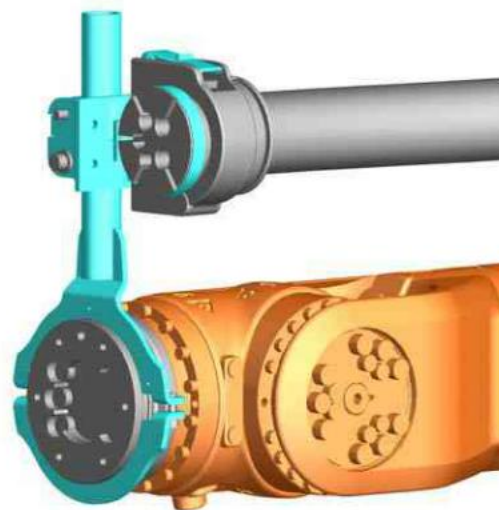
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Energy supply system disassembly



Energy supply system, axes 3 to 6

Mark position of the adjustable holder on axis 6 before disassembly.



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Energy supply system disassembly

Energy supply system, axes 3 to 6

Remove the two screws on the clamping piece of the holder and pull off energy supply system.



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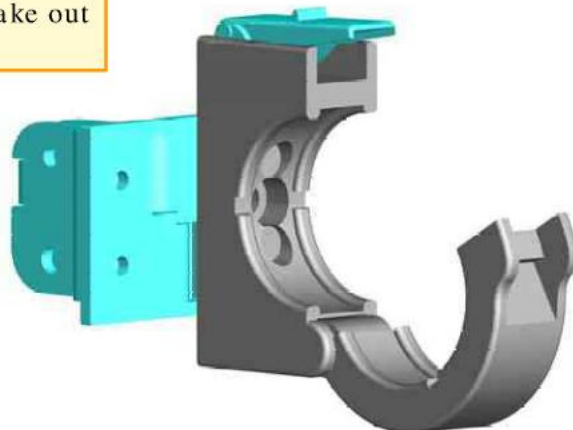
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Energy supply system disassembly

Energy supply system, axes 3 to 6

Mark position of the cable set in the hinged clamp.

Open hinged clamp on ball endpiece of energy supply system and take out energy supply system.



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Energy supply system disassembly

Energy supply system, axes 3 to 6

Undo the two screws and remove the holder on axis 6.



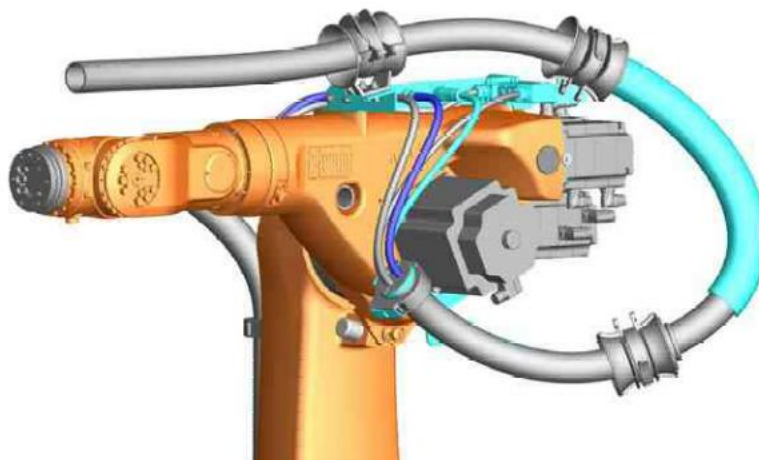
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Energy supply system disassembly

Energy supply system, axes 3 to 6

Mark position of the cable set in the clamps.



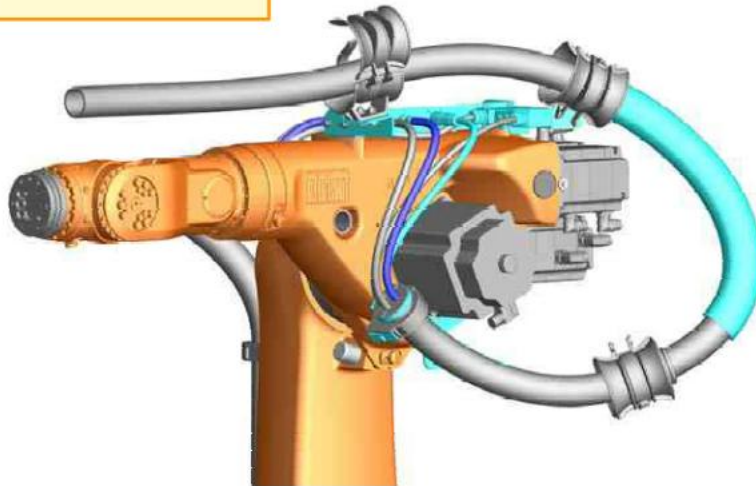
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Energy supply system disassembly

Energy supply system, axes 3 to 6

Open clamps on the arm and unscrew cable and hoses at the connection plate.



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Energy supply system disassembly

Energy supply system, axes 3 to 6

Lay energy supply system down on a suitable support surface.



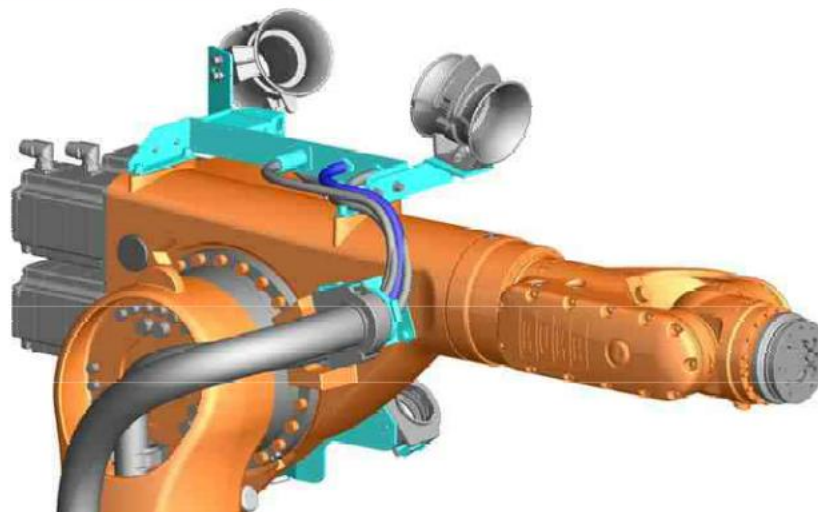
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Energy supply system disassembly

Energy supply system, axes 1 to 3

Unscrew cable and hoses at the connection plate.

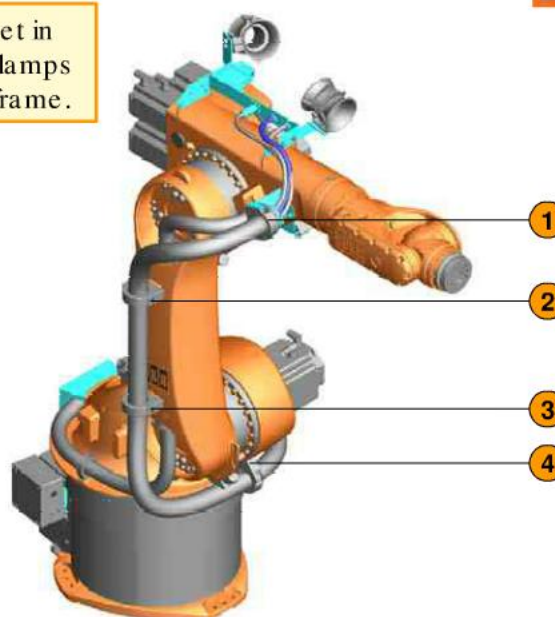


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Energy supply system disassembly

Energy supply system, axes 1 to 3

Mark the position of the cable set in the clamps and open the four clamps on the arm, link arm and base frame.

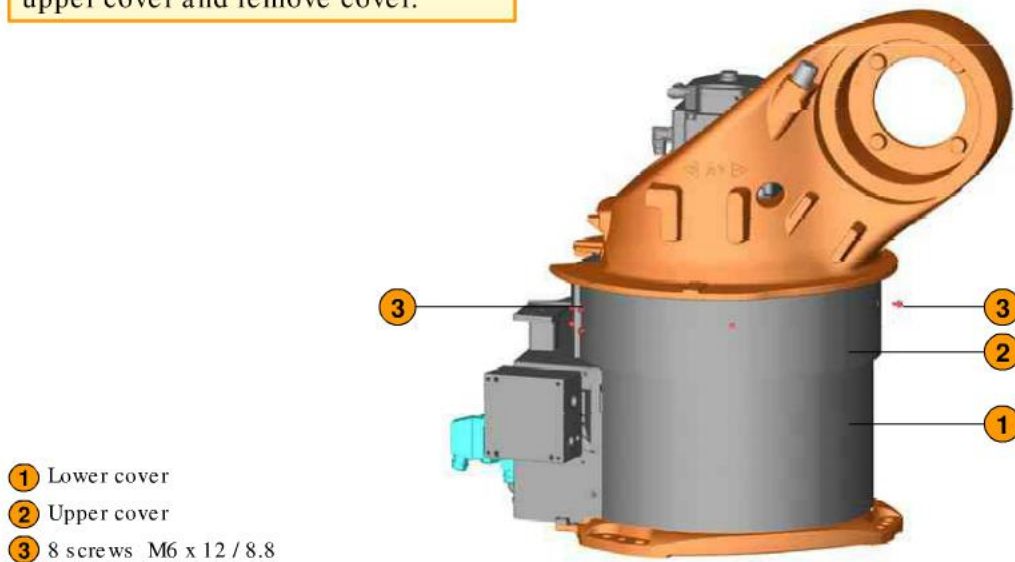


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Energy supply system disassembly

Energy supply system, axes 1 to 3

Unscrew the eight screws on the upper cover and remove cover.



- ① Lower cover
- ② Upper cover
- ③ 8 screws M6 x 12 / 8.8

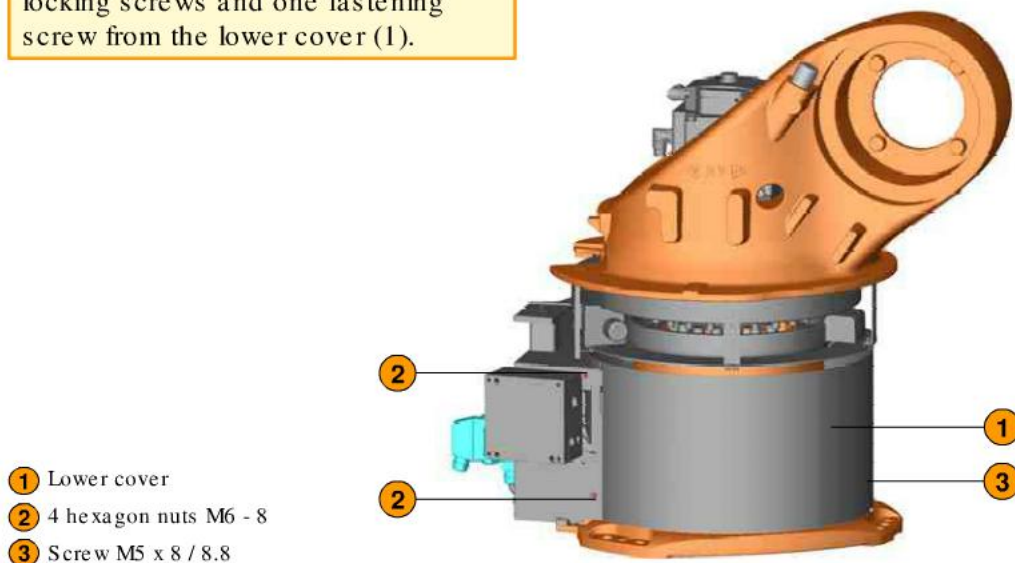
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Energy supply system disassembly

Energy supply system, axes 1 to 3

Unscrew four hexagon nuts (2) and locking screws and one fastening screw from the lower cover (1).



- ① Lower cover
- ② 4 hexagon nuts M6 - 8
- ③ Screw M5 x 8 / 8.8

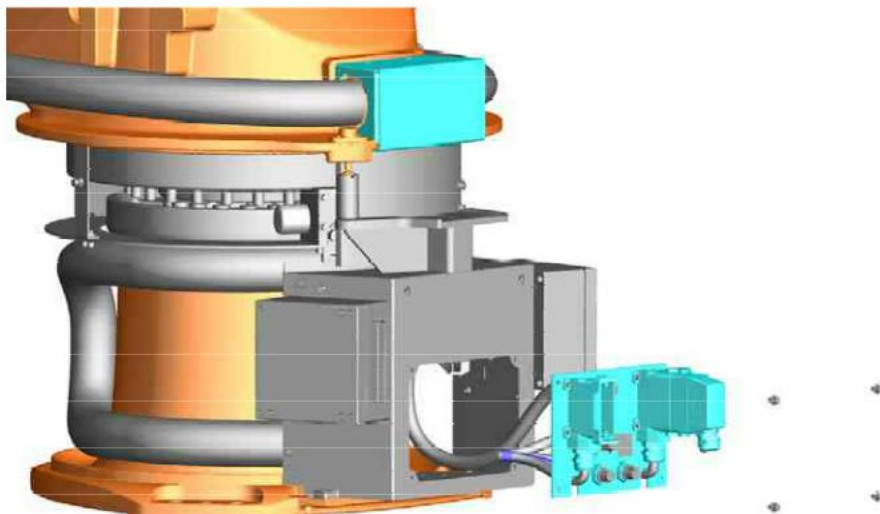
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Energy supply system disassembly

Energy supply system, axes 1 to 3

Remove base frame cover plate.



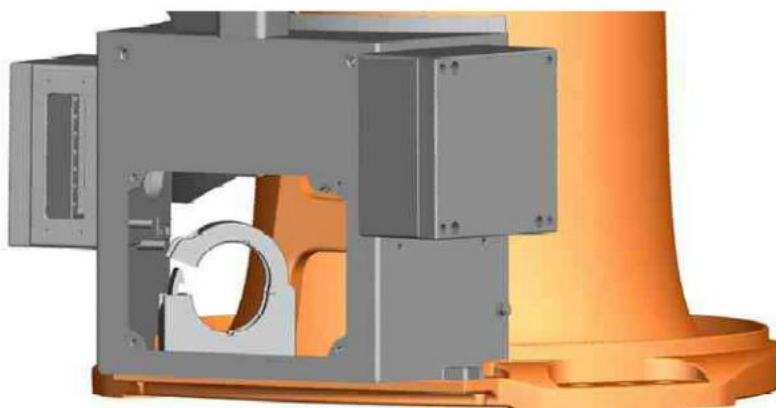
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Energy supply system disassembly

Energy supply system, axes 1 to 3

Mark the position of the cable set in the hinged clamp, open tube clamp in the base frame and take out energy supply system.



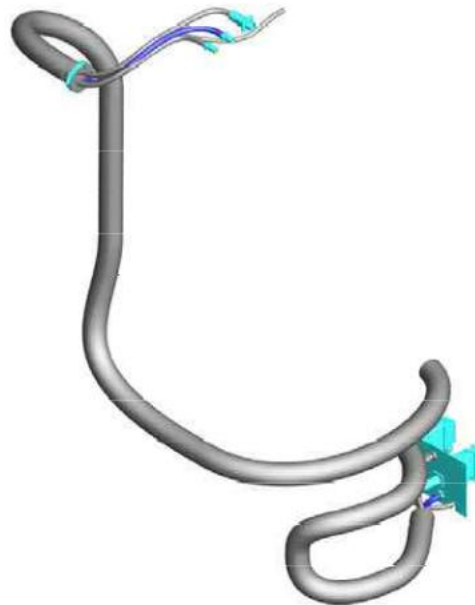
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Energy supply system disassembly

Energy supply system, axes 1 to 3

Carefully pull out energy supply system from top to bottom through rotating column and base frame.



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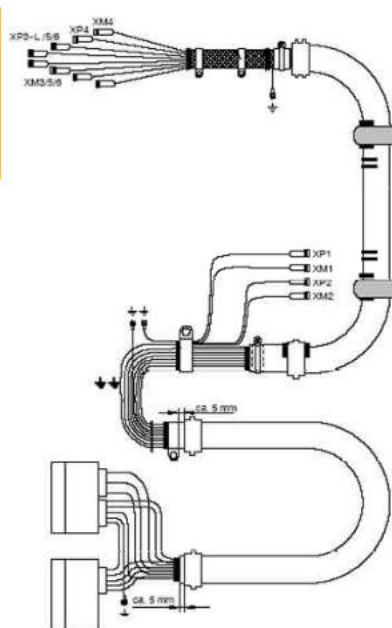
Energy supply system disassembly

Integrated energy supply system



Protective gloves must be worn!

All accident prevention regulations must be observed when handling cable grease.



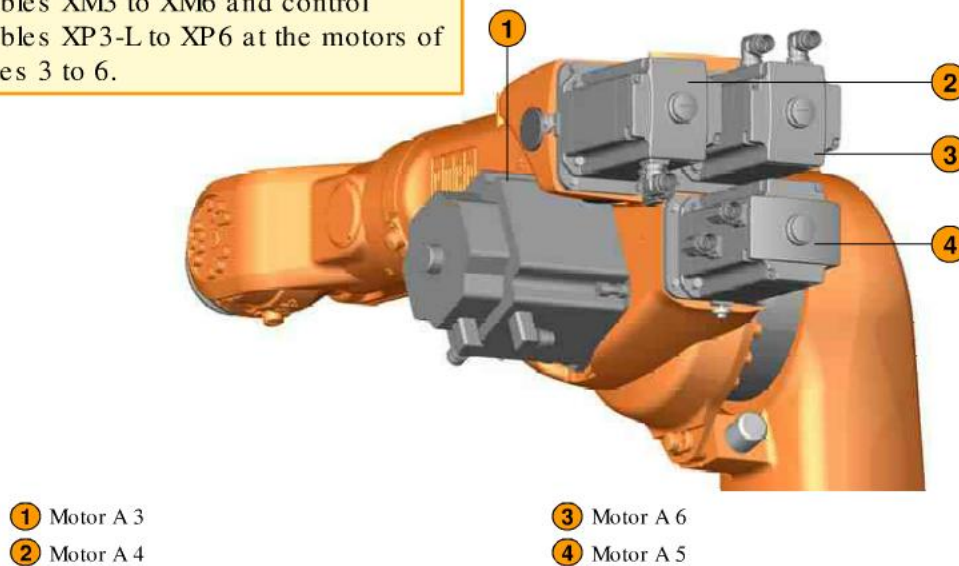
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Energy supply system disassembly

Integrated energy supply system

Unplug connectors for the motor cables XM3 to XM6 and control cables XP3-L to XP6 at the motors of axes 3 to 6.

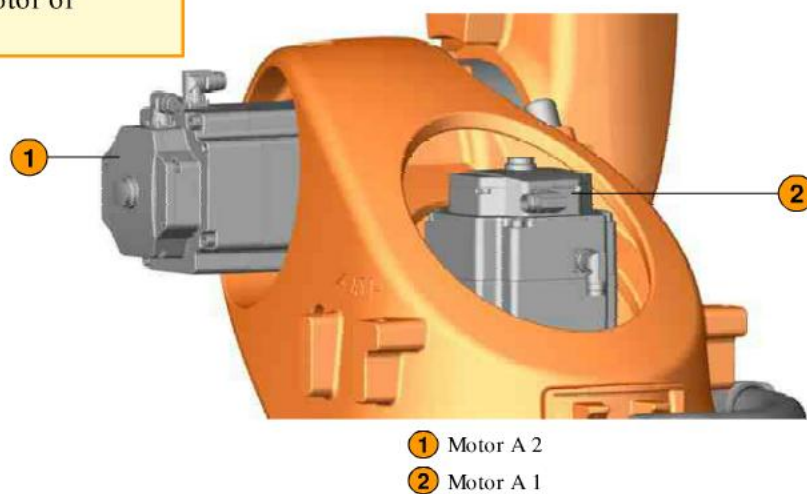


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Energy supply system disassembly

Integrated energy supply system

Unplug cables XM1 and XP1 at the motor of axis 1 and the cables XM2 and XP2 at the motor of axis 2.

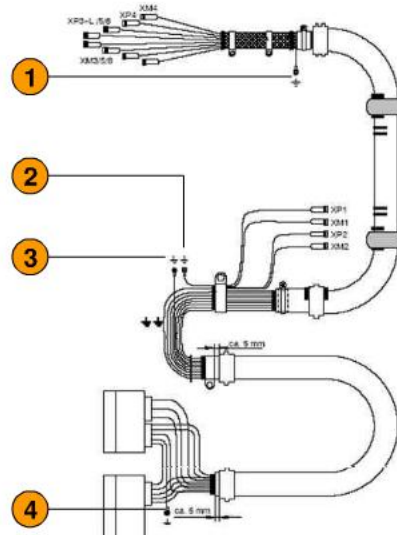


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Energy supply system disassembly

Integrated energy supply system

Disconnect four ground conductor connections.



- ① Ground conductor, rotating column – arm
- ② Ground conductor, arm - rotating column
- ③ Ground conductor, base frame - rotating column
- ④ Ground conductor, rotating column - base frame

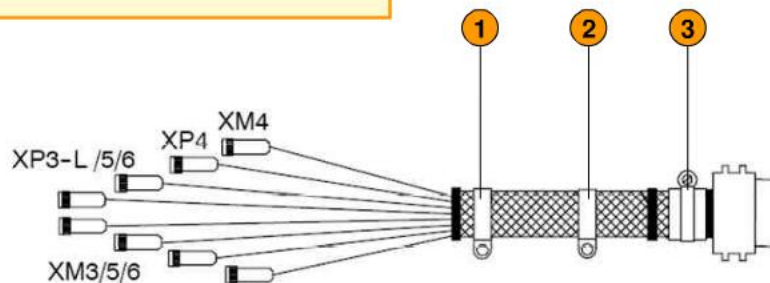
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Energy supply system disassembly

Integrated energy supply system

Mark the position of the dress package in the clips prior to disassembly and remove clips (1), (2) and (3).



- ① Cable clip 1
- ② Cable clip 2
- ③ Cable clip 3

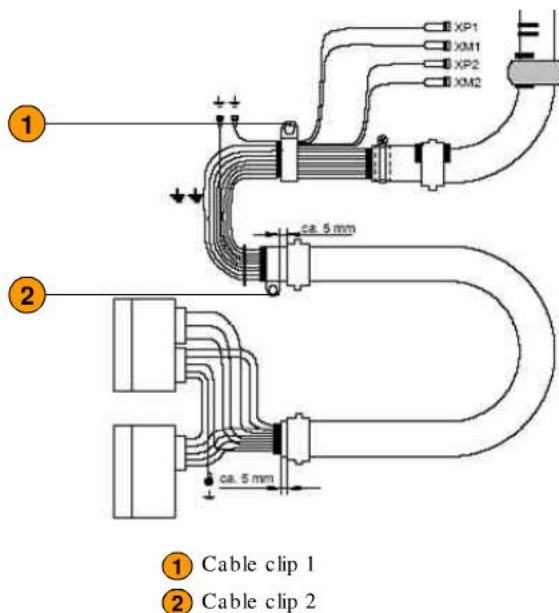
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Energy supply system disassembly

Integrated energy supply system

Mark the position of the dress package in the clips prior to disassembly and remove cable clips (1) and (2).

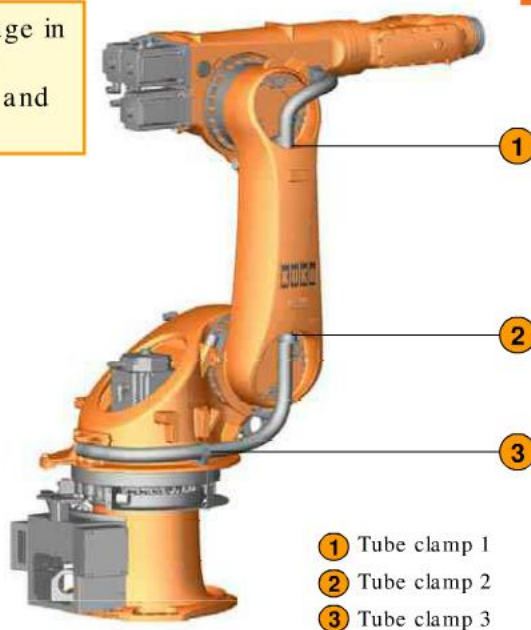


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Energy supply system disassembly

Integrated energy supply system

Mark position of the dress package in the clamps prior to disassembly. Open the clamps in the link arm and on the rotating column.



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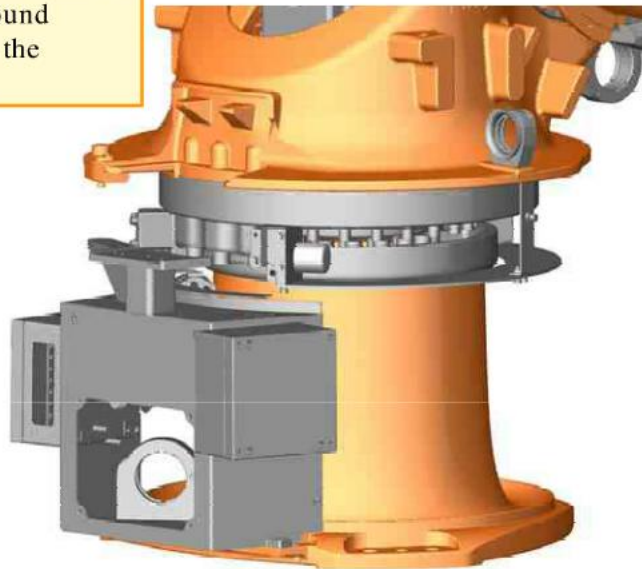


Energy supply system disassembly



Integrated energy supply system

Pull cable set with connectors XM3 to XM6, XP3-L to XP6 and ground conductor carefully through the opening in the base frame.



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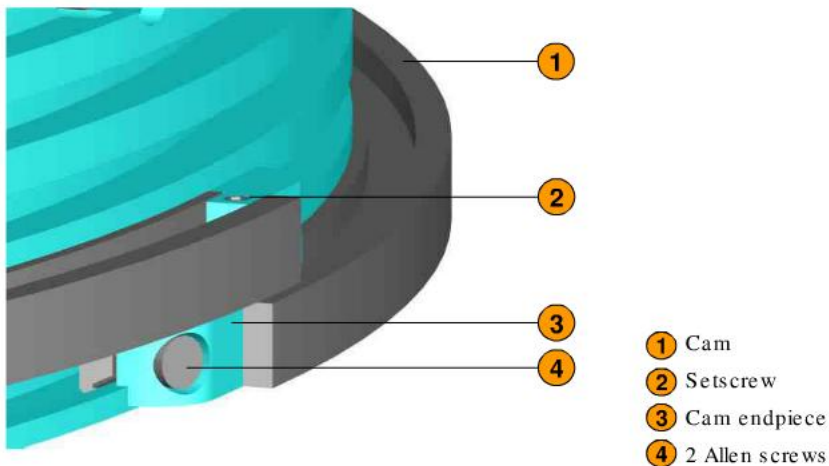


2.7. Axis monitoring

Axis range monitoring disassembly



Remove the Allen screws and the cam connections. Remove cams and carefully store all the individual parts.

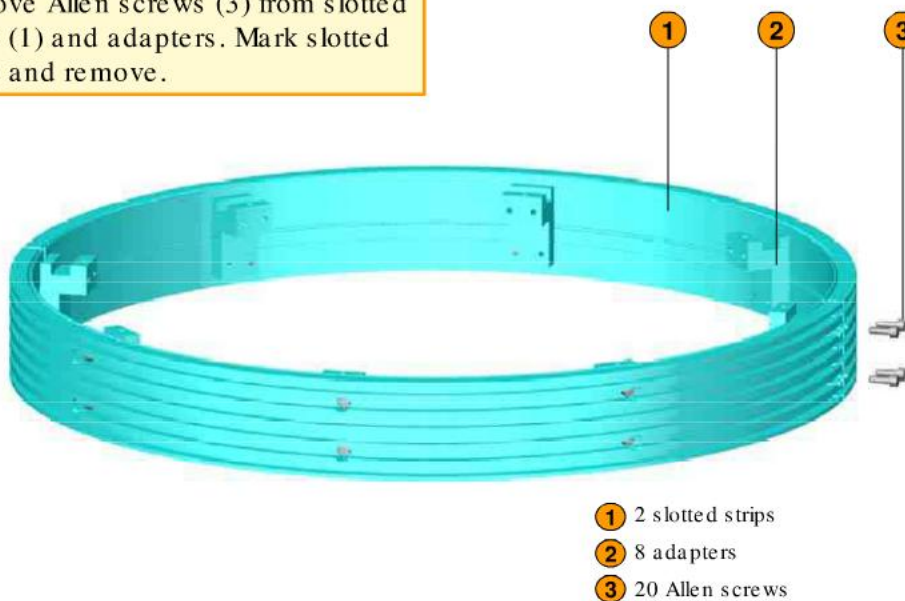


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Axis range monitoring disassembly



Remove Allen screws (3) from slotted strips (1) and adapters. Mark slotted strips and remove.

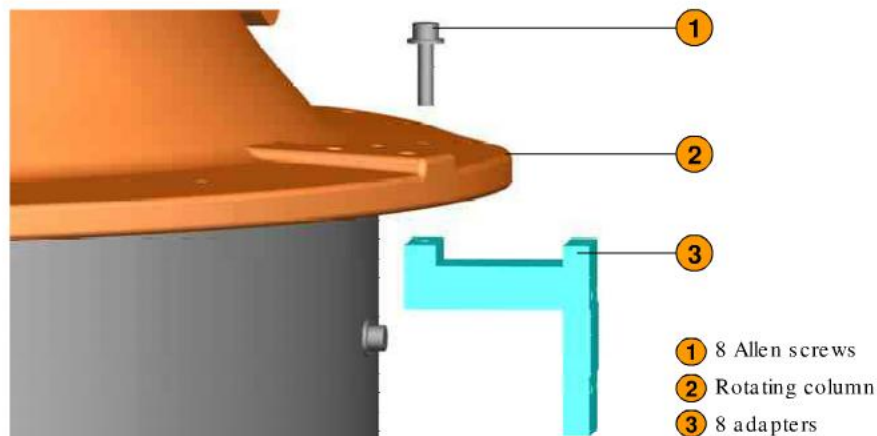


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Axis range monitoring disassembly



Remove Allen screws together with lock washers from the adapters.
Remove adapters from rotating column.



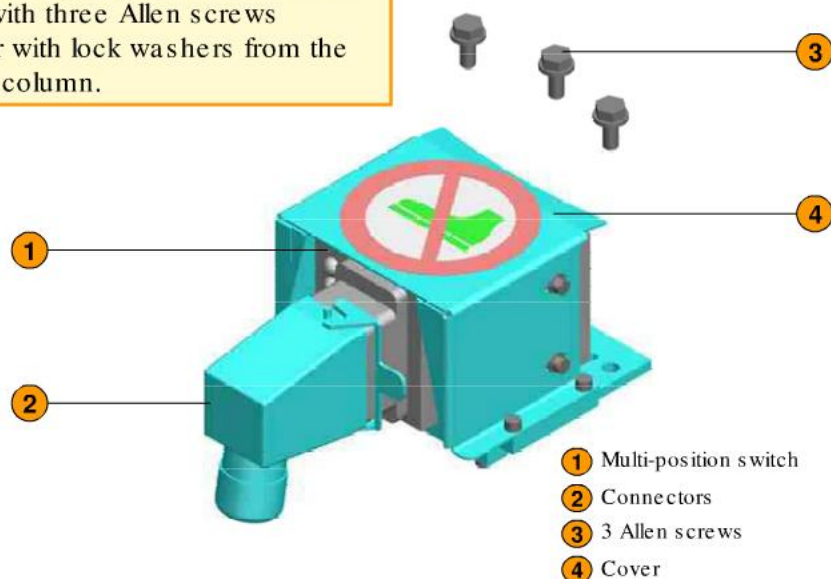
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Axis range monitoring disassembly



Remove the group of sensors and the holder with three Allen screws together with lock washers from the rotating column.

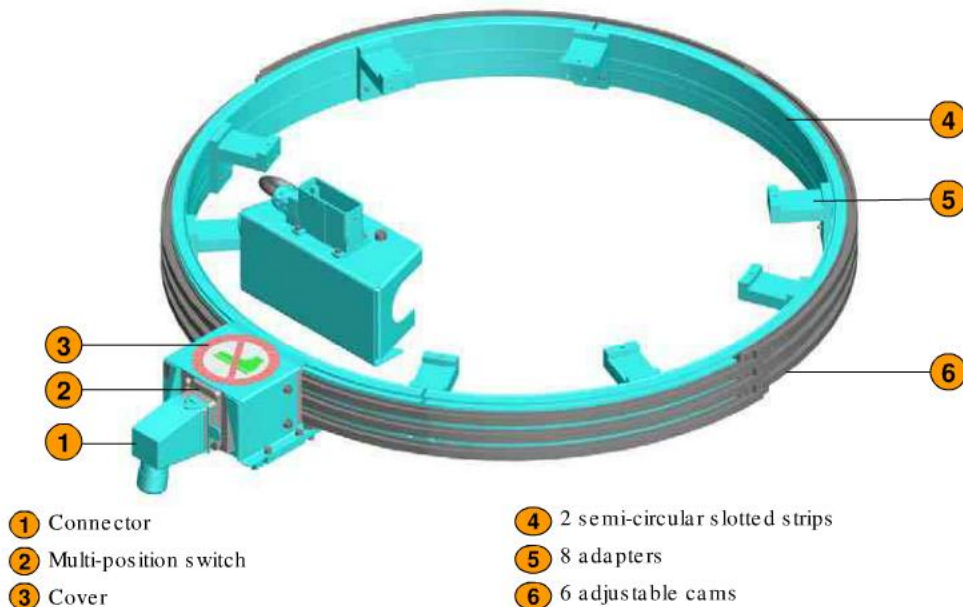


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Axis range monitoring disassembly

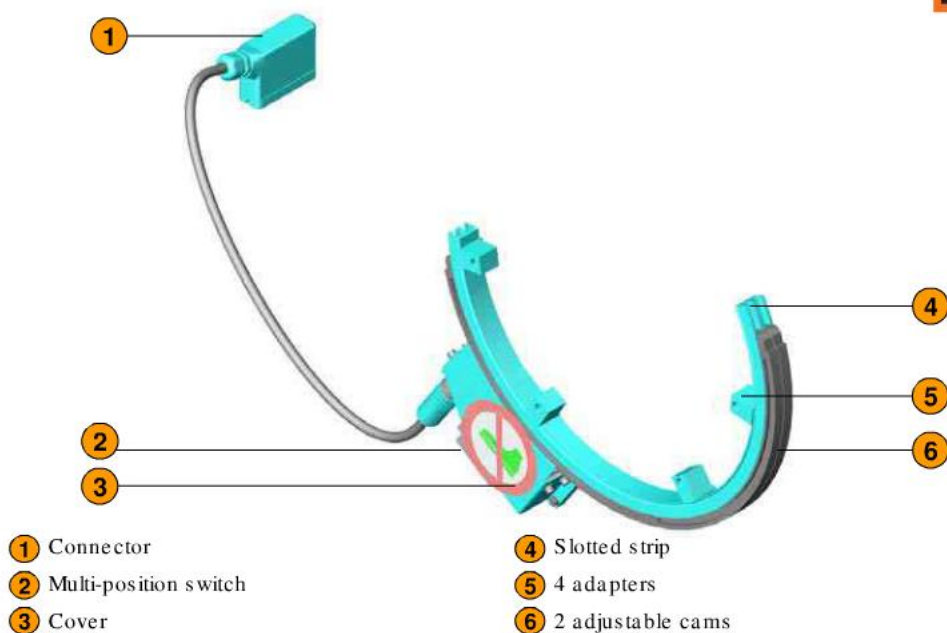
Axis 1



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Axis range monitoring disassembly

Axis 2



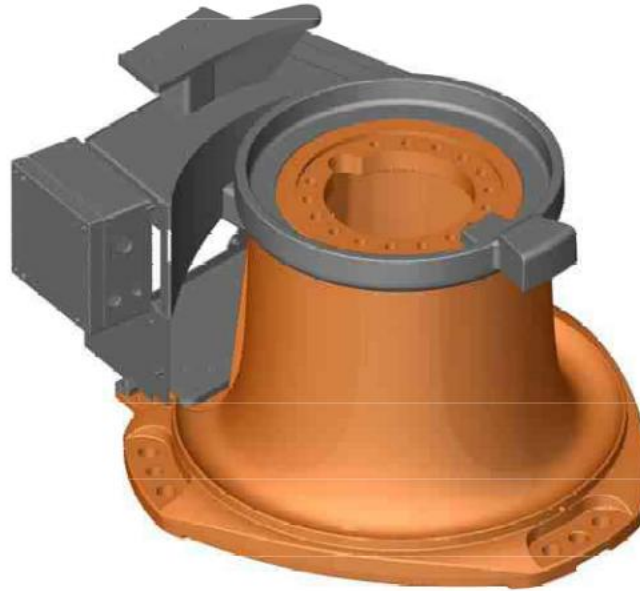
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3. Assembly

3.1. Base unit

Base frame



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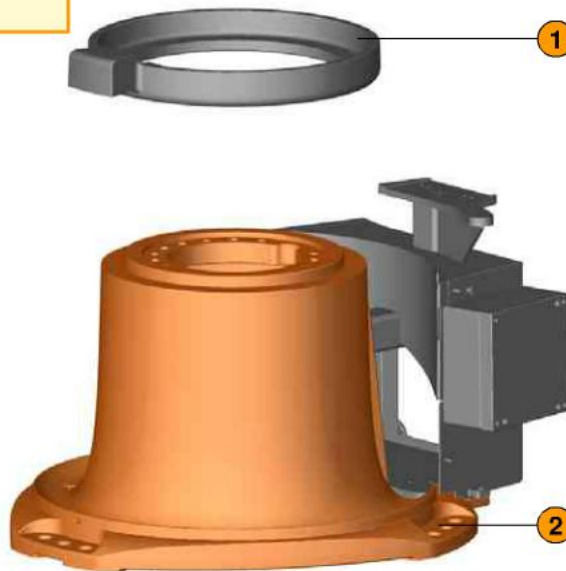
3.2. Rotating column

Rotating column assembly



Grease trailing stop (1) and place it on the base frame (2).

- ① Trailing stop
- ② Base frame



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Rotating column assembly

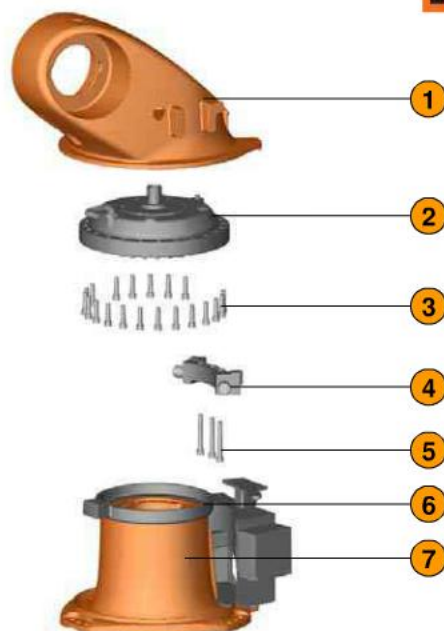


Fasten the gear unit (2) to the base frame.



When mounting the gear unit pay attention to the oil drain hose.

- ① Rotating column
- ② Gear unit A 1
- ③ Fastening screws M16 x 60 / 10.9
- ④ Fixed stop, axis 1
- ⑤ Fastening screws M16 x 120 / 10.9
- ⑥ Trailing stop
- ⑦ Base frame



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Rotating column assembly

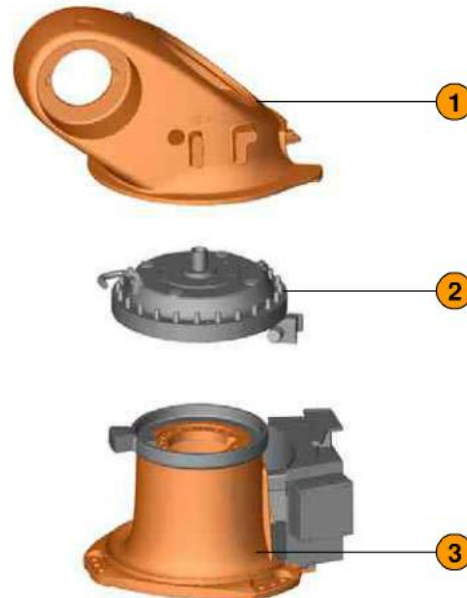


With suitable equipment, carefully mount the rotating column down on the base frame.



Secure rotating column by suitable means.

- ① Rotating column
- ② Gear unit A 1
- ③ Base frame



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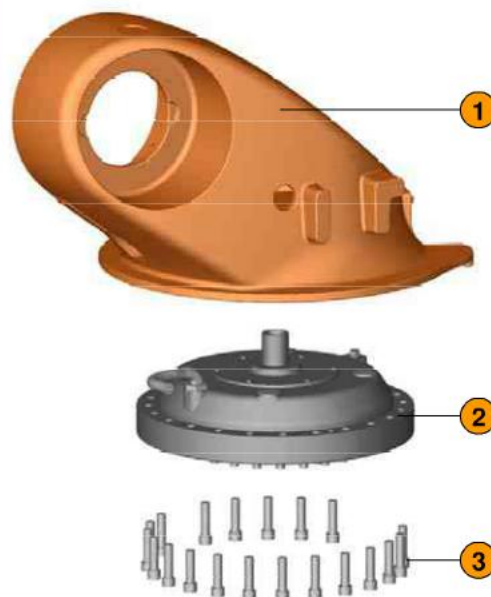
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Rotating column assembly



Screw in the gear unit fastening screws (3) on the rotating column and tighten with a torque of 250 Nm.

- ① Rotating column
- ② Gear unit A 1
- ③ Fastening screws M16 x 60 / 10.9



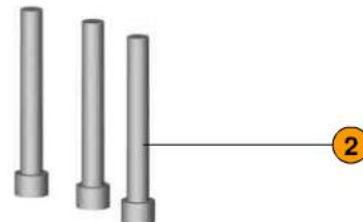
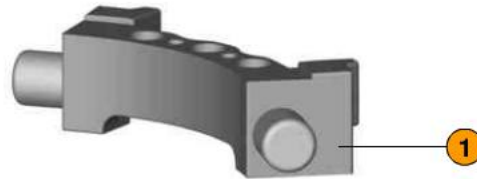
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Rotating column assembly



Mount the fixed stop (1) in the intended position, insert the fastening screws (2) and tighten with 250 Nm.



- ① Fixed stop, axis 1
- ② Fastening screws M16 x 120 / 10.9

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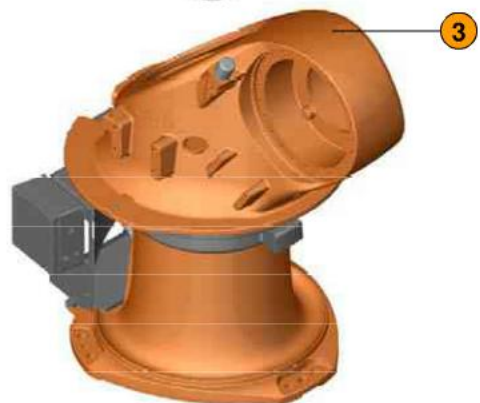
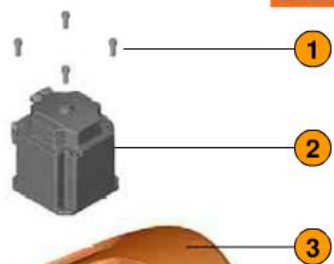
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Rotating column assembly



Motor A 1

Carefully insert motor (2) and fastening screws (1), applying a torque of 104 Nm.



- ① 4 motor fastening screws M12 x 30 / 10.9
- ② Motor A 1
- ③ Rotating column

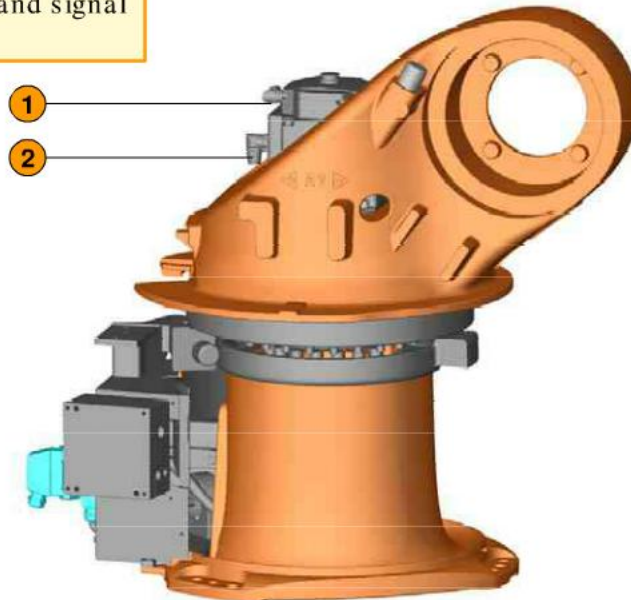
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Rotating column assembly

Motor A 1

Carefully plug in the motor and signal connectors and tighten.



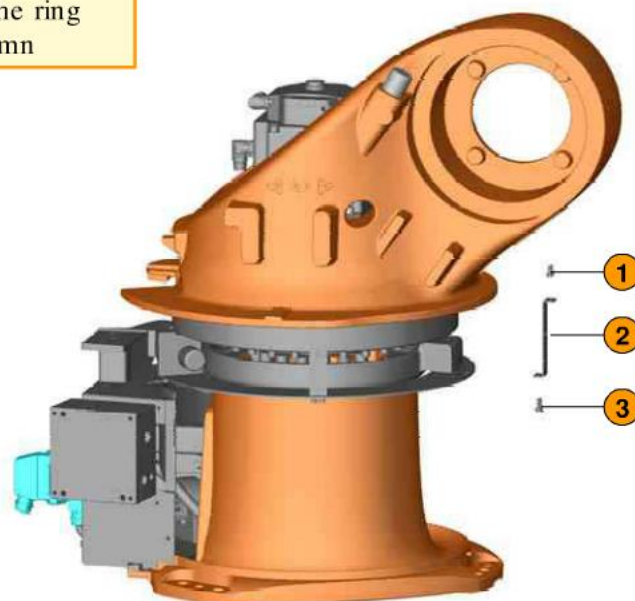
- ① Signal connector XP 1
- ② Motor connector XM 1

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Rotating column assembly

Fasten the holders (2) and the ring segment to the rotating column



- ① 6 screws M6 x 12 / 8.8
- ② 3 holders
- ③ 6 screws M6 x 12 / 8.8

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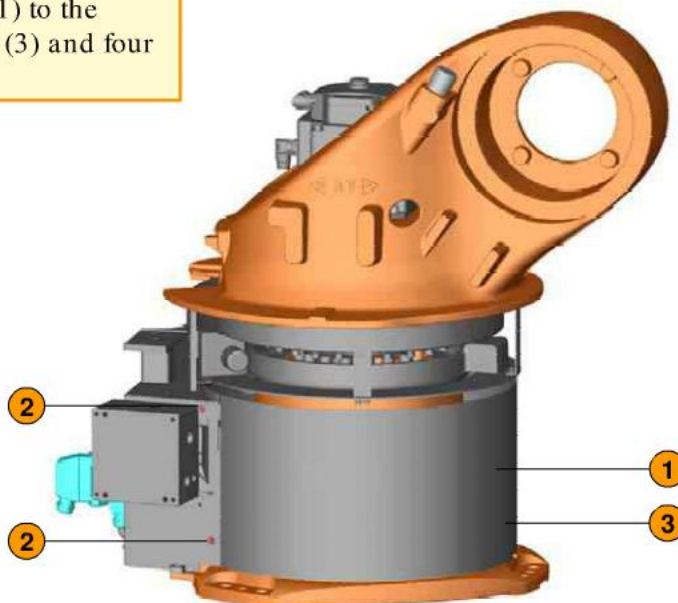
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Rotating column assembly



Fasten the lower cover (1) to the base frame with a screw (3) and four nuts (2).

- ① Lower cover
- ② 4 hexagon nuts M6 - 8
- ③ Screw M5 x 8 / 8.8



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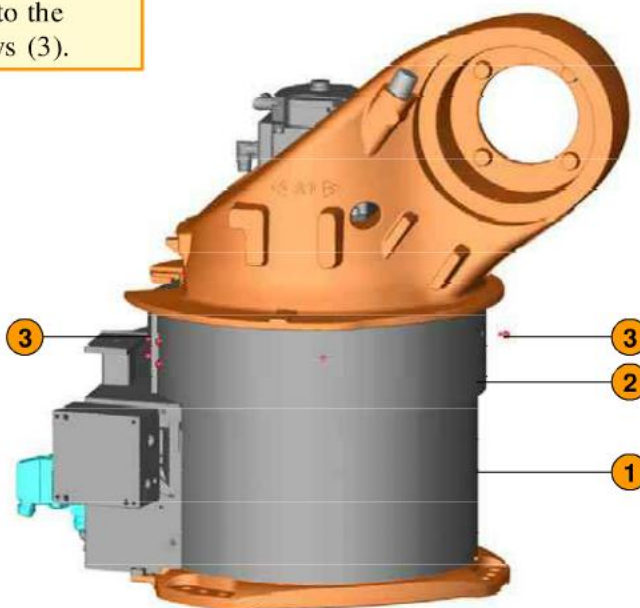
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Rotating column assembly



Fasten the upper cover (2) to the base frame with eight screws (3).

- ① Lower cover
- ② Upper cover
- ③ 8 screws M6 x 12 / 8.8



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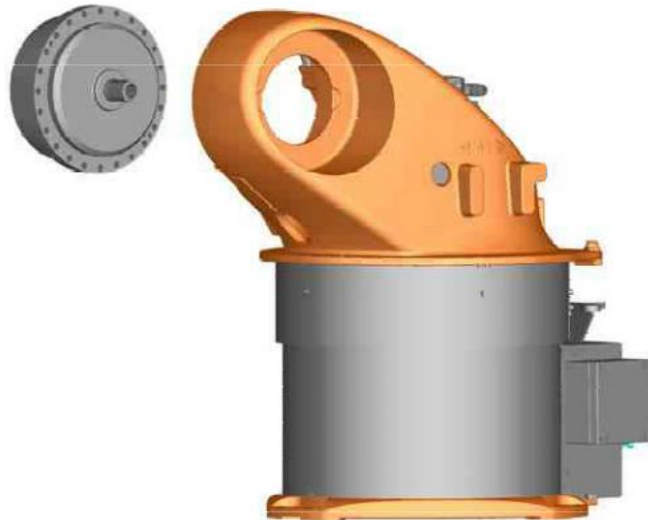


3.3. Link arm

Link arm assembly

Gear unit A 2

Place the gear unit onto the link arm using the centering aids.

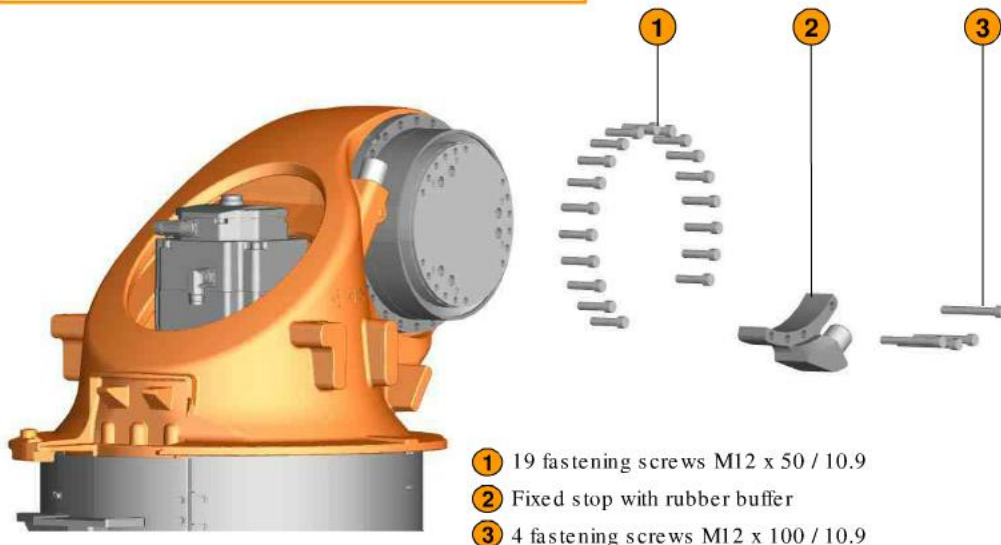


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Link arm assembly

Gear unit A 2

Mount the gear unit in the intended position and tighten the screws with 104 Nm.

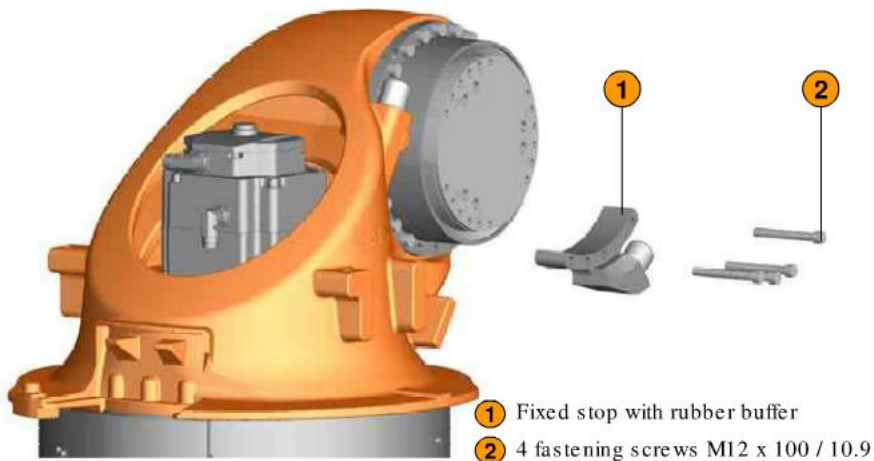


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Link arm assembly

Gear unit A 2

Mount the fixed stop in the intended position and tighten the screws with 104 Nm.

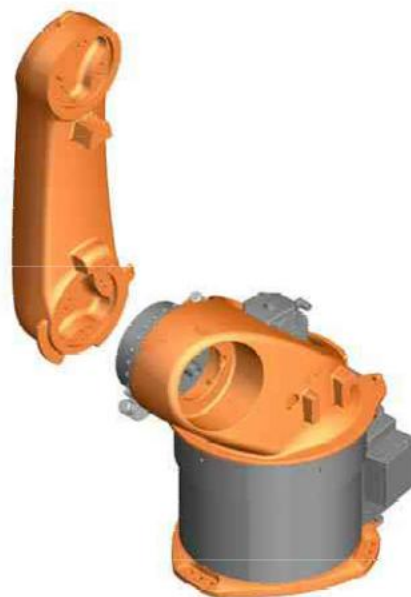


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Link arm assembly

Lift the link arm with the appropriate equipment and carefully insert it into the rotating column using the centering aids.



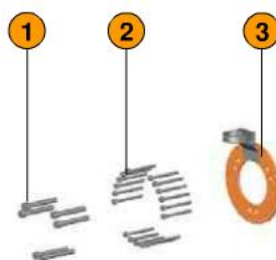
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Link arm assembly



CAUTION! When installing the support ring observe the correct order of the screws: first insert the small screws and then the large screws.



- ① 6 fastening screws M16 x 100 / 10.9
- ② 18 fastening screws M10 x 100 / 10.9
- ③ Support ring

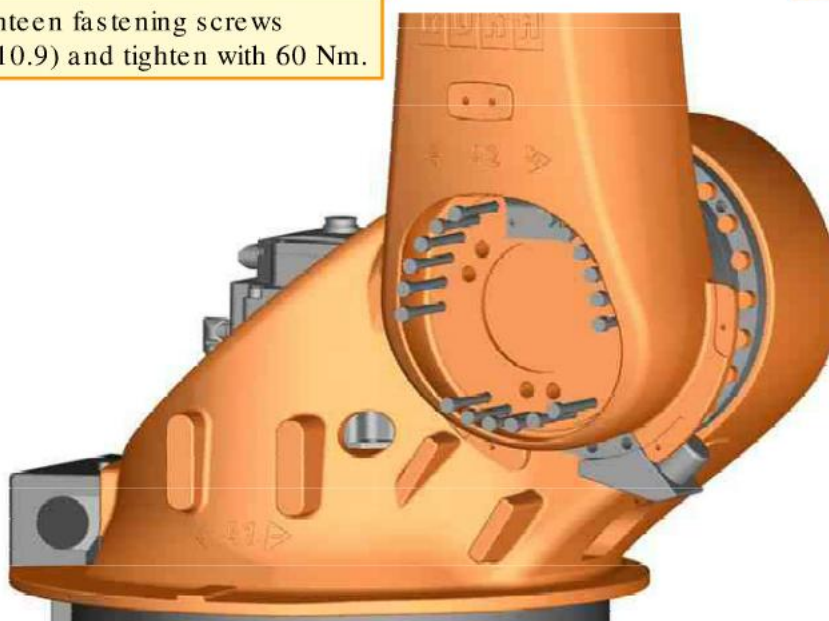


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Link arm assembly



Insert the eighteen fastening screws (M10 x 100 / 10.9) and tighten with 60 Nm.

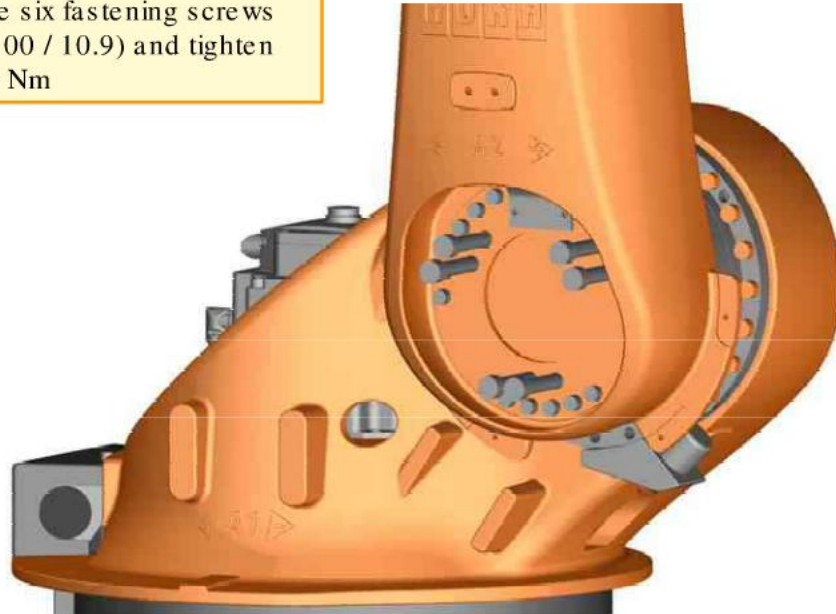


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Link arm assembly



Insert the six fastening screws (M16 x 100 / 10.9) and tighten with 250 Nm



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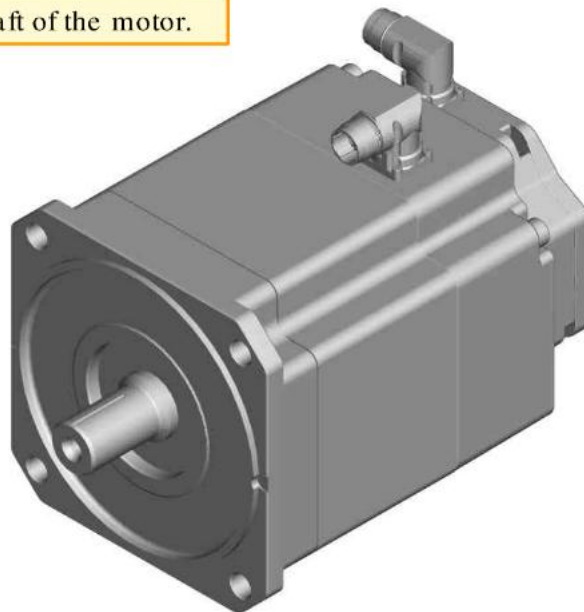
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Link arm assembly



Motor A 2

Grease the toothed shaft of the motor.



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Link arm assembly



Motor A 2

Carefully insert the motor (1) and tighten screws with a torque of 104 Nm.



① Motor A 2

② 4 motor fastening screws M12 x 30 / 10.9

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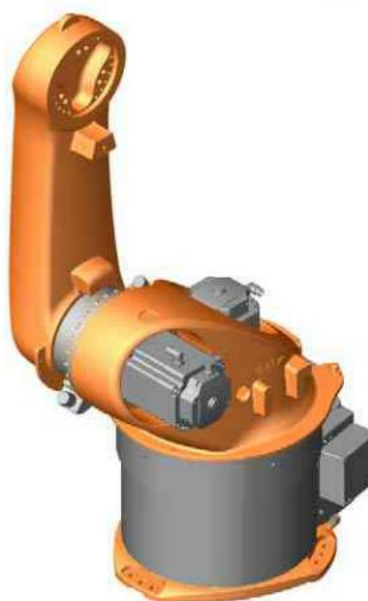
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Link arm assembly



Motor A 2

Carefully plug in the motor and signal connectors and tighten.



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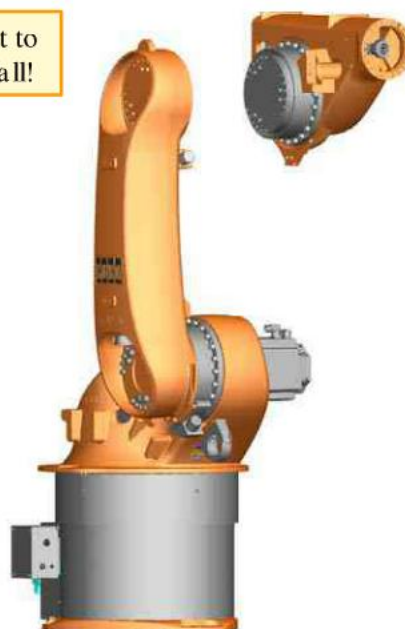


3.4. Arm

Arm assembly



Use the appropriate equipment to ensure that the arm does not fall!



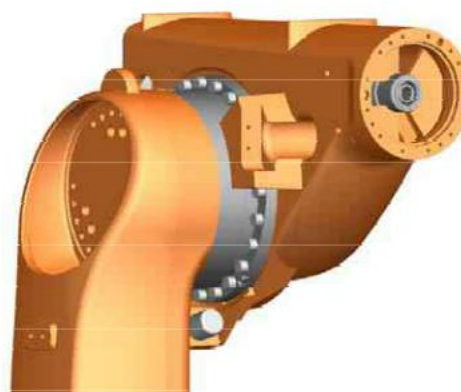
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Arm assembly



CAUTION! When installing the support ring observe the correct order of the screws: first insert the outer screws and then the inner screws.



- ① 6 fastening screws M16 x 100 / 10.9
- ② 18 fastening screws M10 x 90 / 10.9
- ③ Support ring

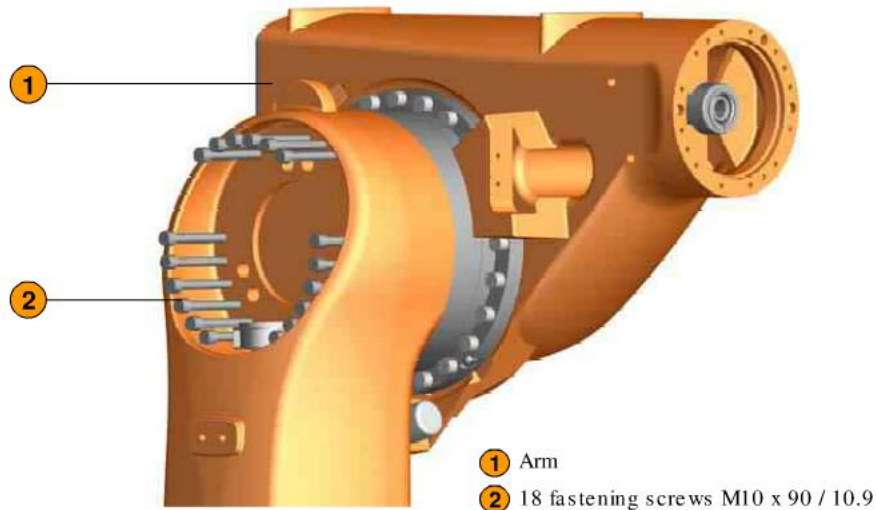
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Arm assembly



Tighten fastening screws (2) with a torque of 60 Nm.

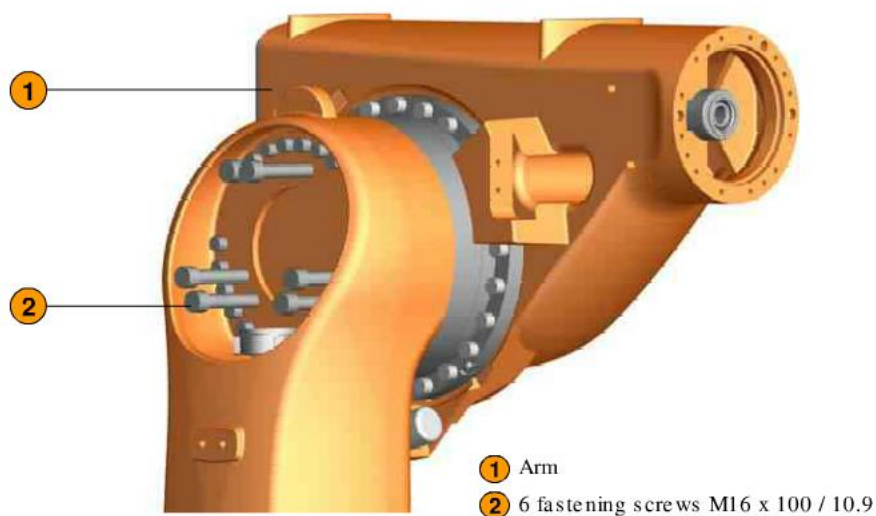


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Arm assembly



Tighten fastening screws (2) with a torque of 250 Nm.

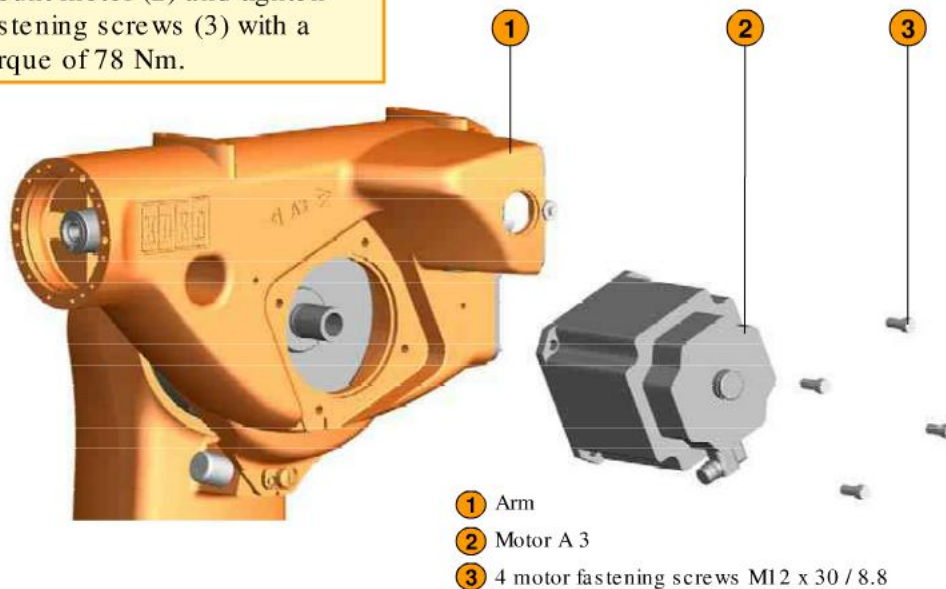


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Arm assembly

Motor A 3

Mount motor (2) and tighten fastening screws (3) with a torque of 78 Nm.

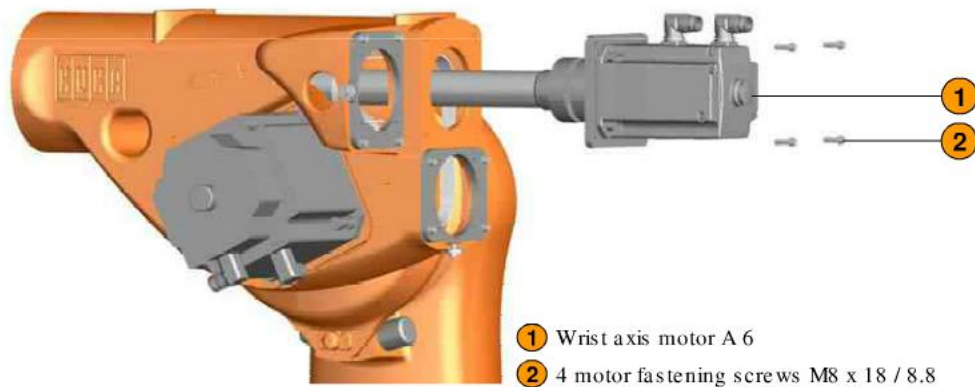


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Arm assembly

Wrist axis motors, axis 4 to axis 6

Insert the A 6 motor with disc springs and the drive shaft, screw in the fastening screws (2) on the motor and tighten with 23 Nm.



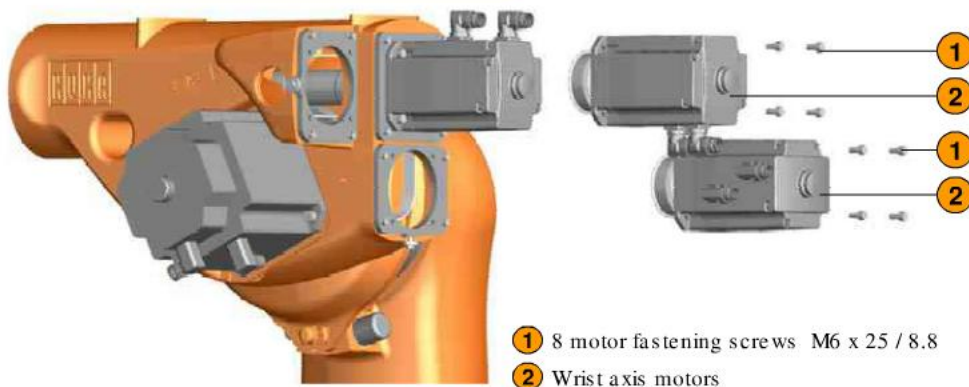
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Arm assembly

Wrist axis motors, axis 4 to axis 6



When inserting the A 4 and A 5 motors, the respective toothed belts must at the same time be fitted onto the toothed belt pulley of the corresponding motor.

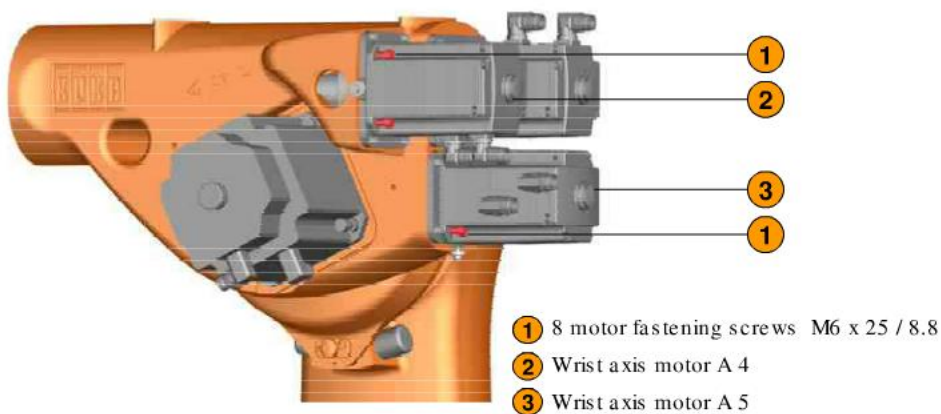


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Arm assembly

Wrist axis motors, axis 4 to axis 6

Insert fastening screws (1) on the A 4 and A 5 motors but do not yet tighten because the toothed belts still have to be tensioned.

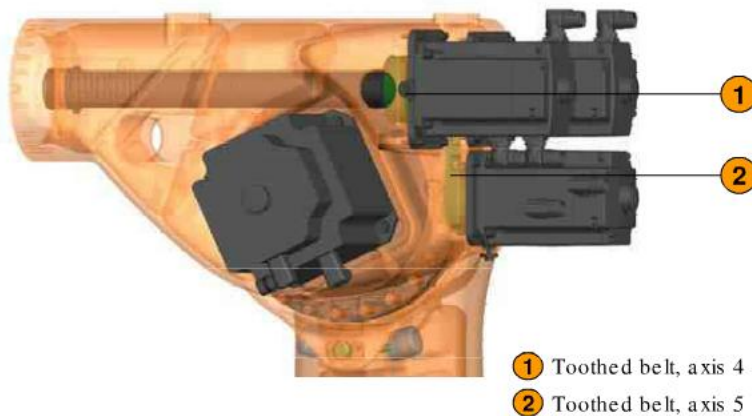


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Arm assembly

Wrist axis motors, axis 4 to axis 6

Adjust the toothed belt tension of axis 4 and axis 5 to 130 ± 5 Hz using the strand tension meter.



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Arm assembly

Wrist axis motors, axis 3 to axis 6

Carefully plug in the motor and signal connectors and tighten.



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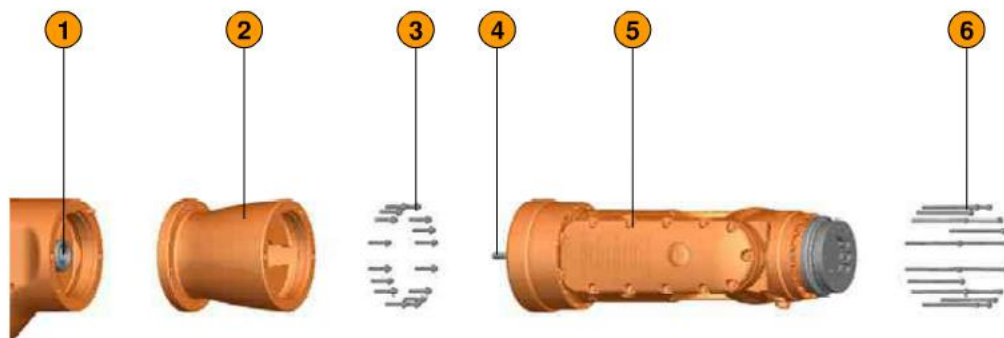
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3.5. Wrist

Wrist assembly

Arm extension



① Drive shaft

② Arm extension

③ 16 wrist fastening screws M6 x 100 / 12.9

④ Drive shaft

⑤ Wrist

⑥ 16 wrist fastening screws M6 x 35 / 10.9

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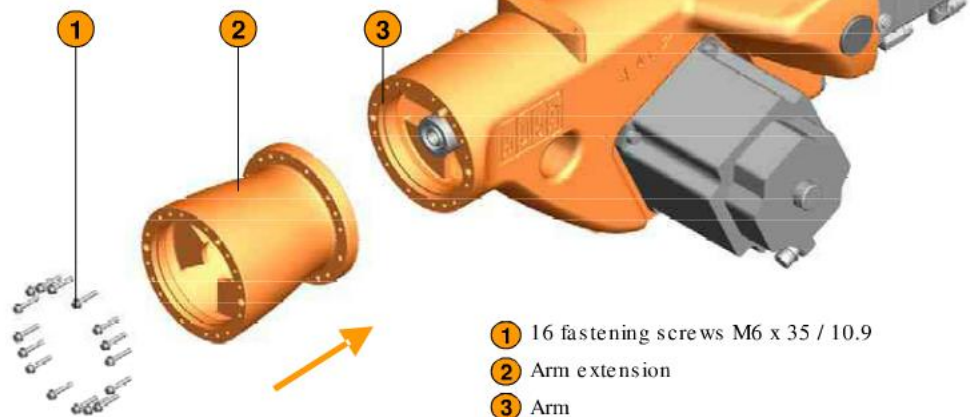
Wrist assembly

Arm extension

Insert the arm extension (2) into the location.



Attention must be paid to drive shafts!



① 16 fastening screws M6 x 35 / 10.9

② Arm extension

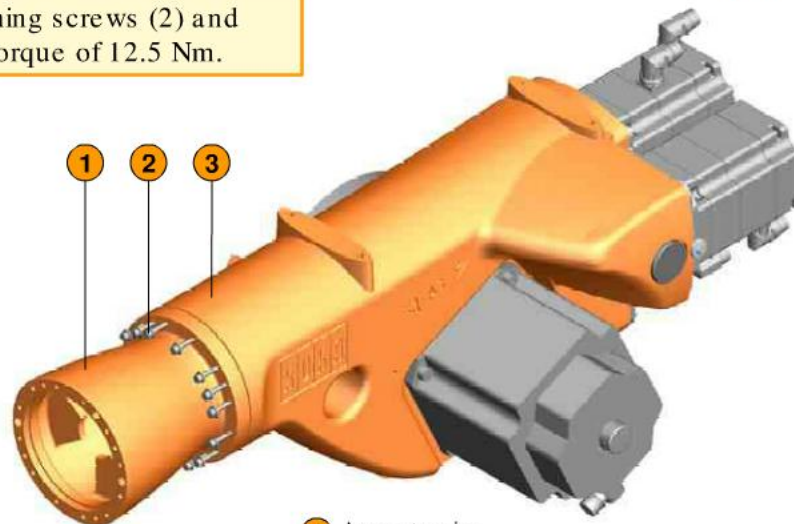
③ Arm

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Wrist assembly

Arm extension

Screw in fastening screws (2) and tighten with a torque of 12.5 Nm.



- ① Arm extension
- ② 16 fastening screws M6 x 35 / 10.9
- ③ Arm

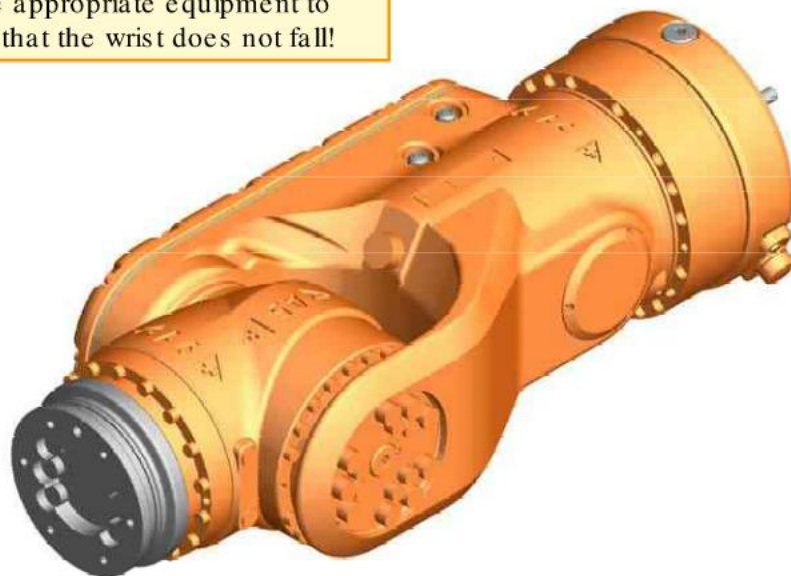
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Wrist assembly



Use the appropriate equipment to ensure that the wrist does not fall!



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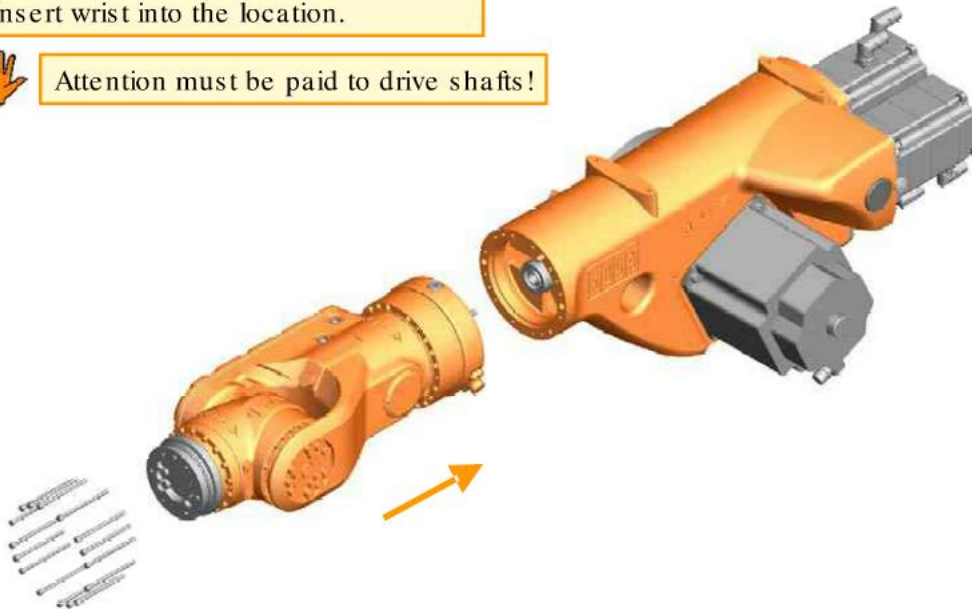
Wrist assembly



Insert wrist into the location.



Attention must be paid to drive shafts!



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Wrist assembly



Insert sixteen wrist fastening screws (M6 x 100 / 12.9).



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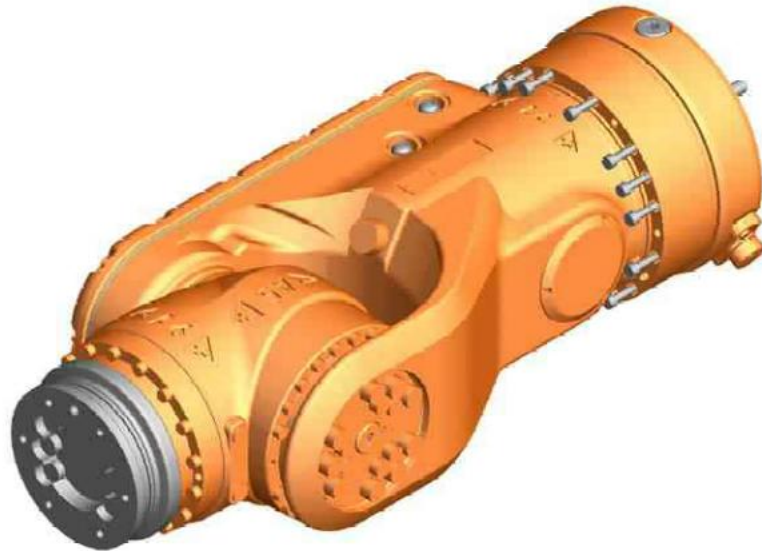
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Wrist assembly



...and tighten with a torque of 12.5 Nm.



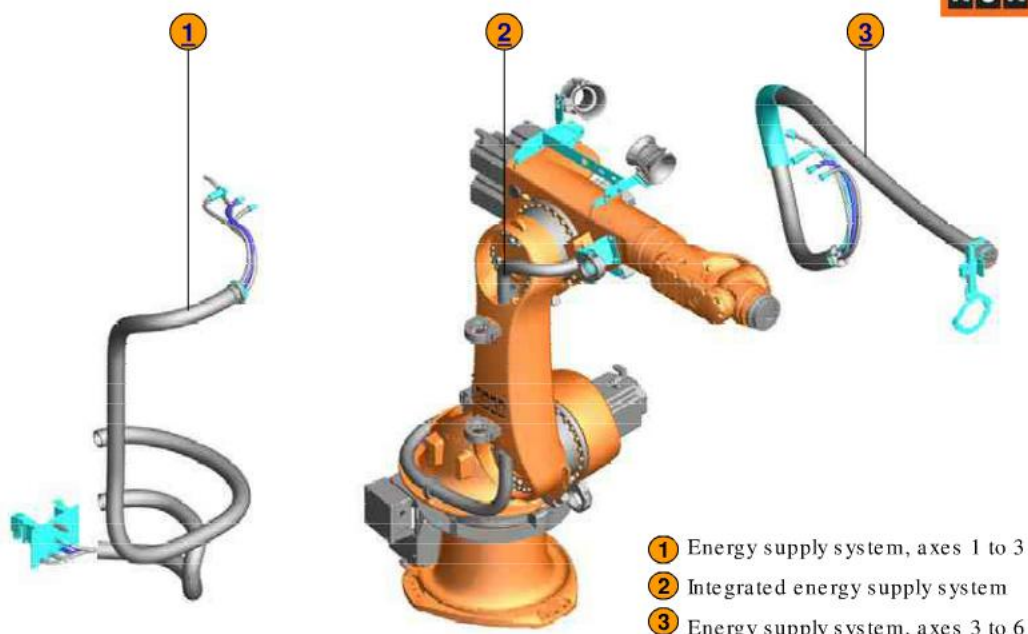
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3.6. Energy supply

Energy supply system assembly



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Energy supply system assembly

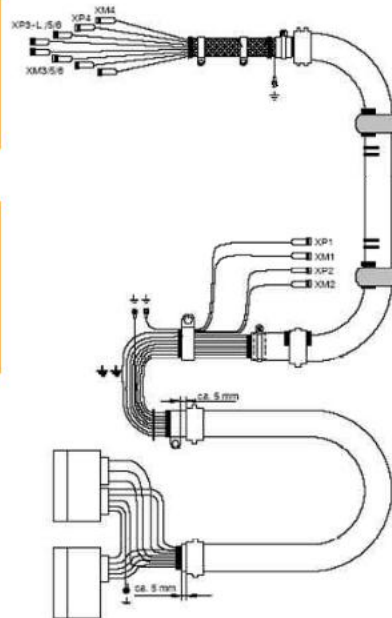
Integrated energy supply system



Before the new cable set assembly is installed, the greased surfaces of the robot must be cleaned of old grease.



Protective gloves must be worn!
All accident prevention regulations must be observed when handling cable grease.



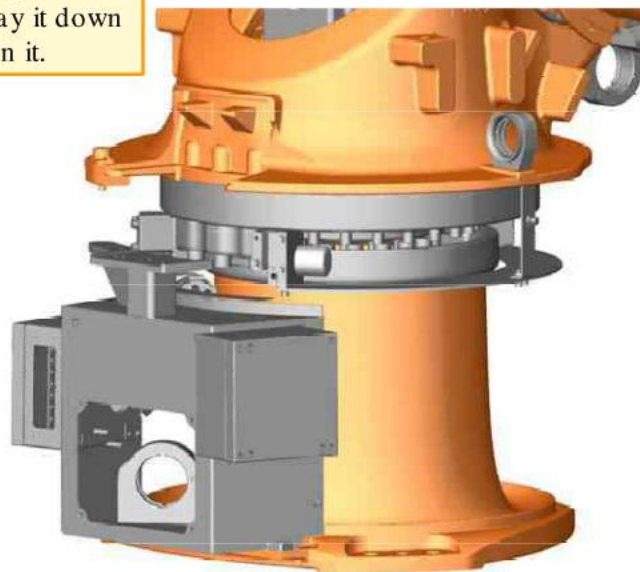
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Energy supply system assembly

Integrated energy supply system

Pull cable set carefully through the base frame aperture, then lay it down fully extended and straighten it.



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Energy supply system assembly

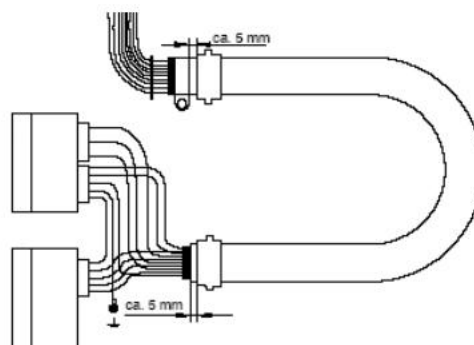


Integrated energy supply system

Attach flexible tube with the tube clamp to the base frame. Arrange the cable bundle in a gentle curve between the junction boxes and the tube clamp.



The cables must not be subjected to any tensile forces. Cable straps are not permitted in this area.



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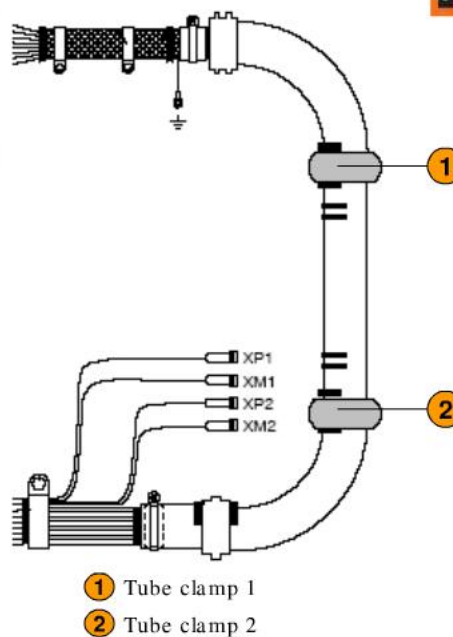
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Energy supply system assembly



Integrated energy supply system

The cables must be greased between (1) and (2). If necessary, regrease cables approx. 100 to 200 mm into flexible tube.



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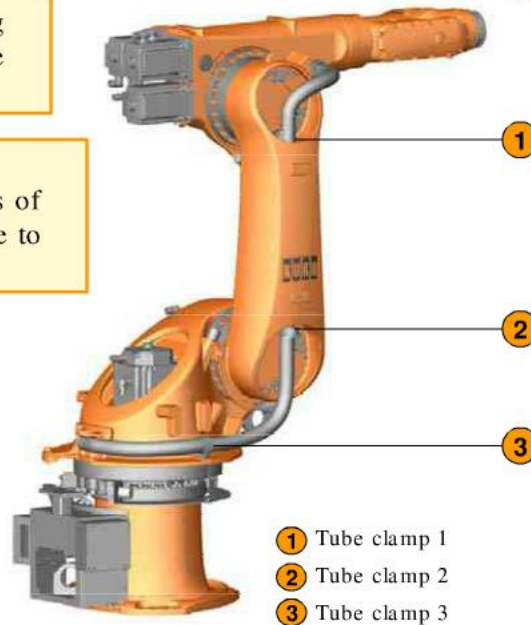
Energy supply system assembly

Integrated energy supply system

Close tube clamps. The marking must be flush with the end of the tube.



The flexible tube must lie correctly in the indentations of the clamp and must be able to turn easily.



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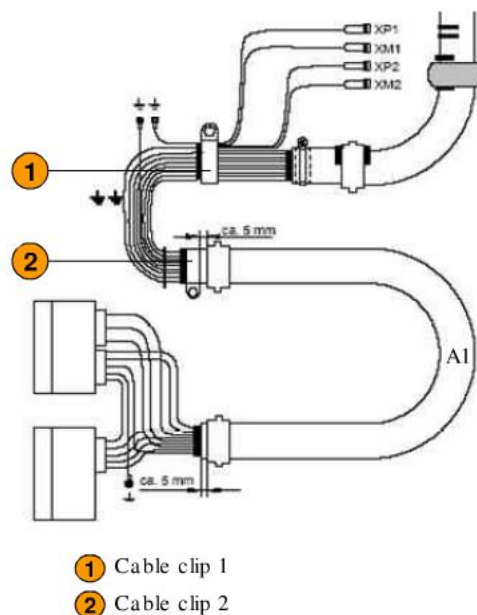
Energy supply system assembly

Integrated energy supply system

Take hold of cable bundle and turn it in a tight curve down to the cable clip (1). Place cable clip (2) around the cable bundle emerging from flexible tube A1 and fasten.



Observe white mark!



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Energy supply system assembly

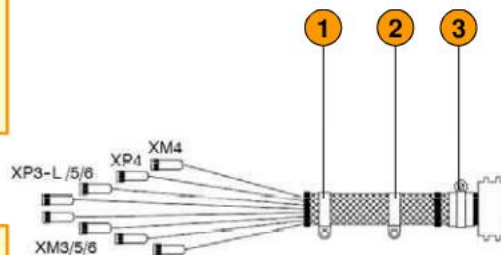


Integrated energy supply system

Push worm thread clip (3) as far as possible into the buffer and fasten. Run cables XP3-L to XP6 and XM3 to XM6 in a tight curve to cable clip (2). Fasten cables and secure them with cable straps. Run cables in parallel to cable clip (1) and fasten them.



The cables must not be trapped or pinched.



- ① Cable clip 1
- ② Cable clip 2
- ③ Cable clip 3

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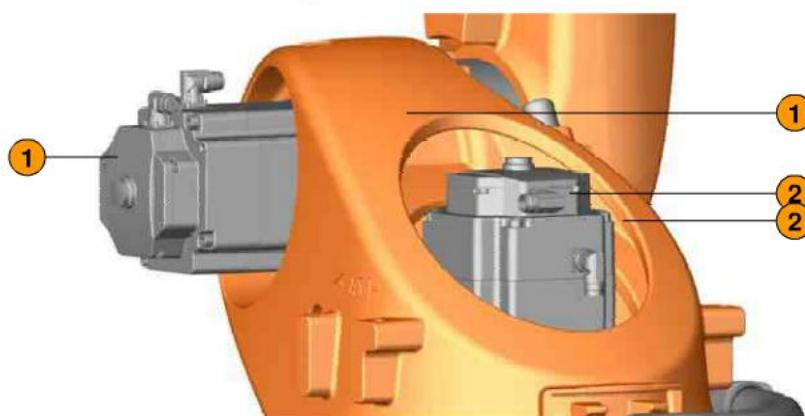
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Energy supply system assembly



Integrated energy supply system

Plug in cables XM1 and XP1 at the motor of axis 1 and the cables XM2 and XP2 at the motor of axis 2.



- ① Motor A 2
- ② Motor A 1

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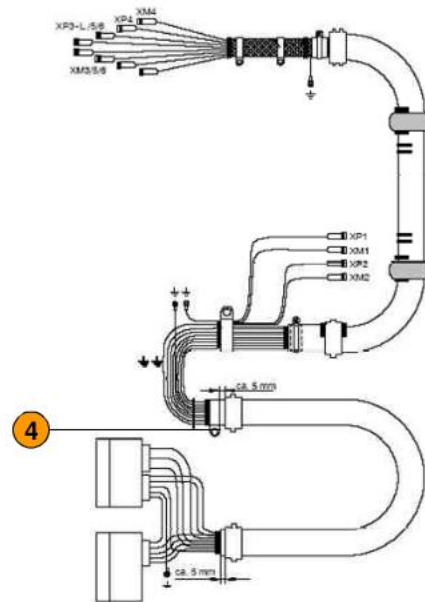
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Energy supply system assembly

Integrated energy supply system

Bundle cables XM2 and XP2 leading from axis 2 motor with cable strap and push remaining lengths back into rotating column housing. Bundle cables XM1, XM2 and XP1, XP2 on the rotating column housing with cable straps. Bundle all thirteen cables between the cable clip (4) and the aperture using cable straps so that individual cables do not slip back and rub against the base frame.



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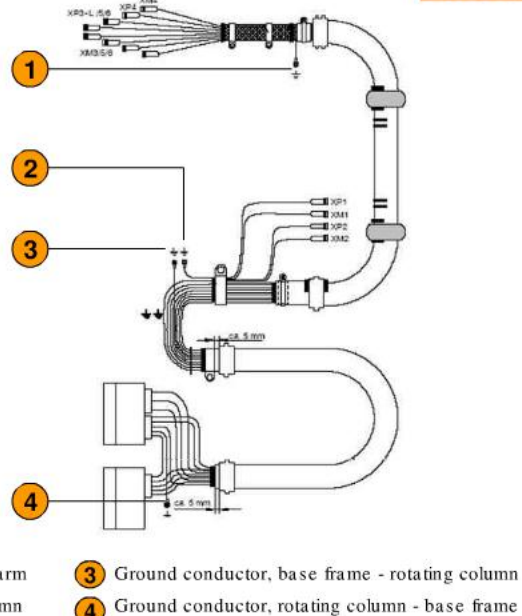
Energy supply system assembly

Integrated energy supply system

Make four ground conductor connections.



All ground conductor connecting elements, including the PE bolts and the corresponding tapped holes in the robot, must be free from grease and paint.



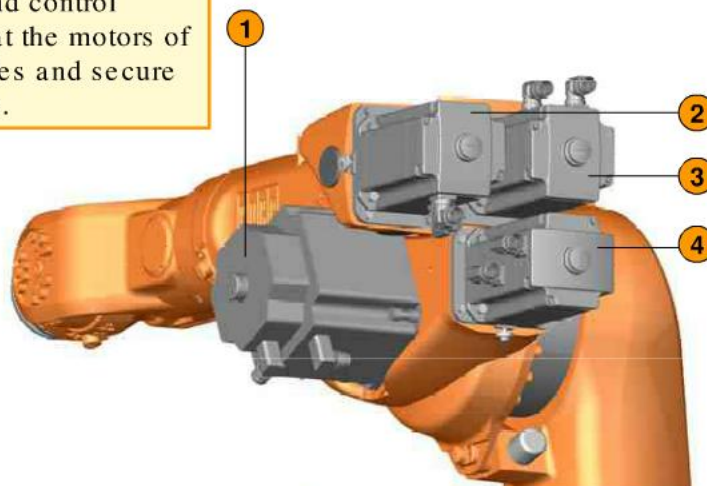
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Energy supply system assembly

Integrated energy supply system

Plug in connectors for the motor cables XM3 to XM6 and control cables XP3-L to XP6 at the motors of axes 3 to 6. Align cables and secure them with cable straps.



1 Motor A 3

2 Motor A 4

3 Motor A 6

4 Motor A 5

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Energy supply system assembly

Integrated energy supply system



When the robot electrical installations (cable set) are completely installed in the robot, the following tests must be carried out:

- Continuity test of the protective circuit according to DIN EN 60204-1/20.2
- Insulation test according to DIN EN 60204-1/20.3
- Voltage test according to DIN EN 60204-1/20.4

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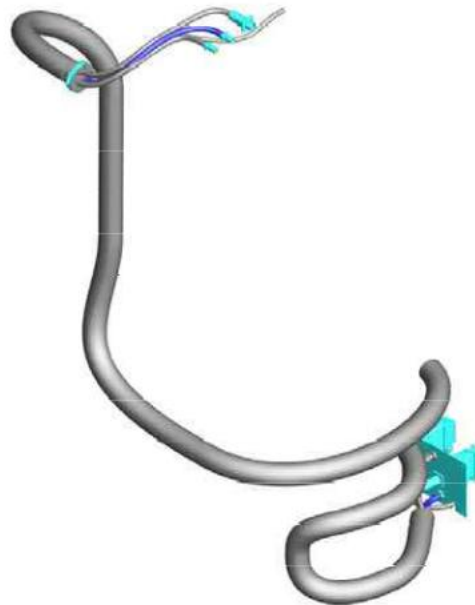


Energy supply system assembly



Energy supply system, axes 1 to 3

Carefully pull in energy supply system for axes 1 to 3 through opening of connection plate on base frame, and insert it in base frame and rotating column.



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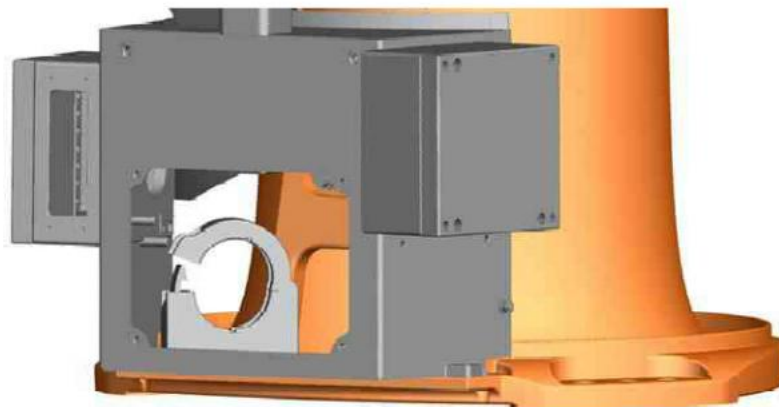
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Energy supply system assembly



Energy supply system, axes 1 to 3

Place energy supply system into hinged clamp in base frame, and close hinged clamp.



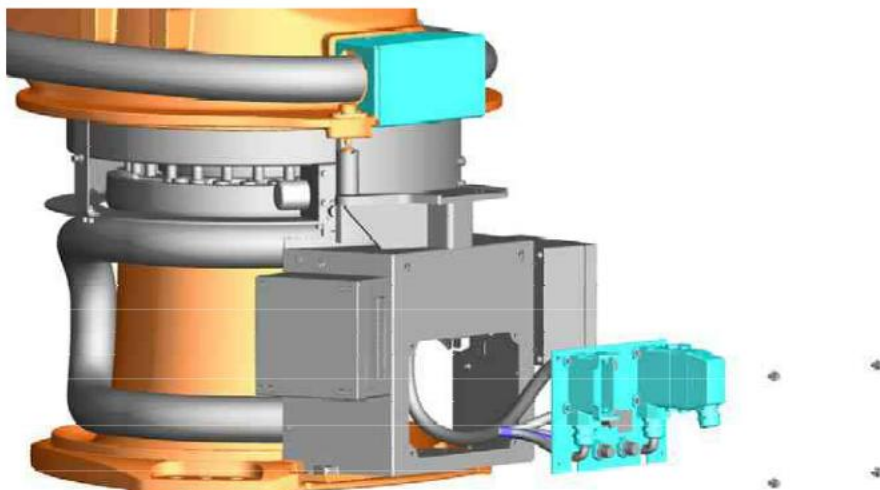
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Energy supply system assembly

Energy supply system, axes 1 to 3

Mount connection plate for energy supply system on the base frame and fasten with screws.

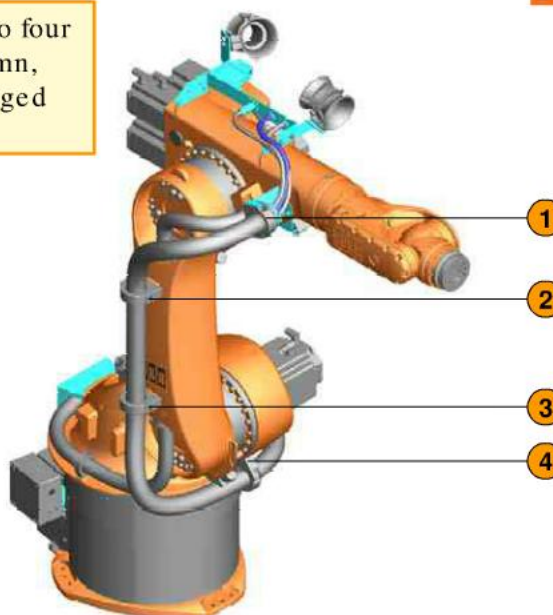


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Energy supply system assembly

Energy supply system, axes 1 to 3

Place energy supply system into four hinged clamps on rotating column, link arm and arm, and close hinged clamps.



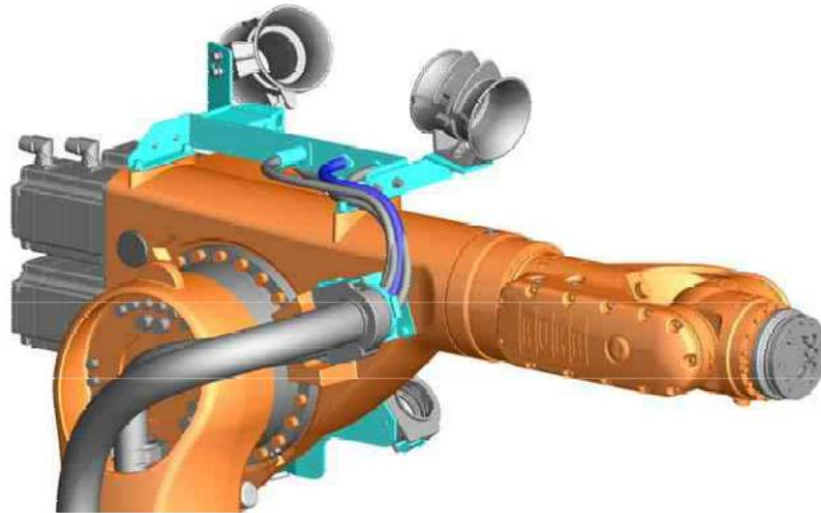
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Energy supply system assembly

Energy supply system, axes 1 to 3

Fasten cables and hoses at the connection plate.



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Energy supply system assembly

Energy supply system, axes 3 to 6

Use the markings to place the energy supply system into the clamps.

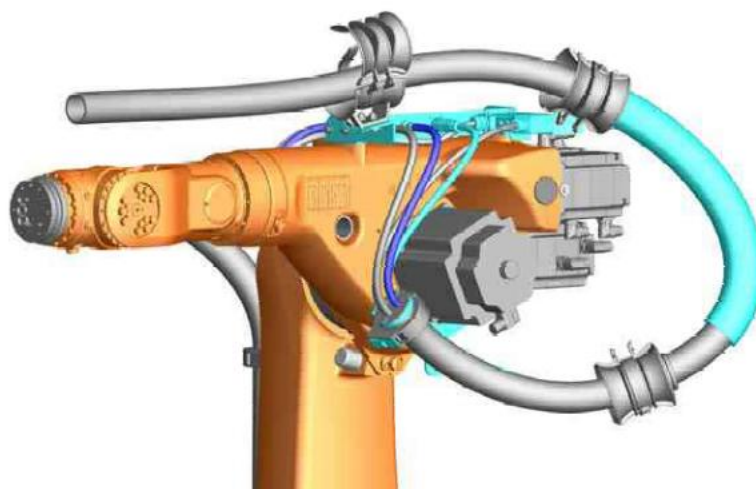


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Energy supply system assembly

Energy supply system, axes 3 to 6

Close clamps on the arm.

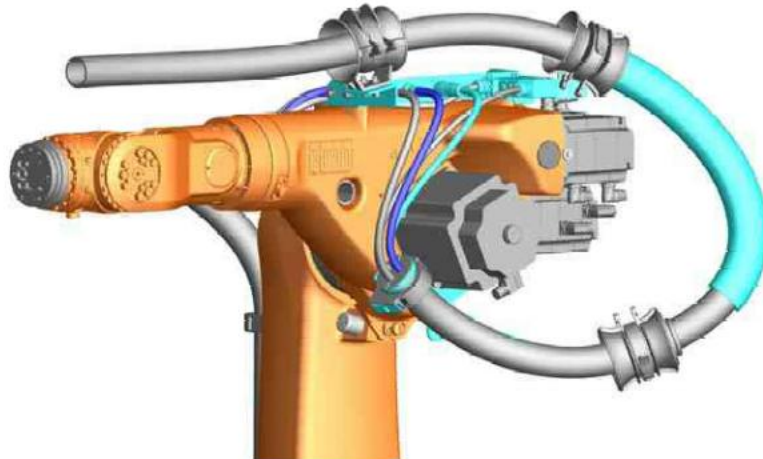


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Energy supply system assembly

Energy supply system, axes 3 to 6

Fasten cables and hoses to the connection plate.



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Energy supply system assembly

Energy supply system, axes 3 to 6

Place adjustable holder of axis 6 into the position marked previously and fasten with screws.



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Energy supply system assembly

Energy supply system, axes 3 to 6

Push the energy supply system endpiece onto the holder on axis 6 and screw on tightly.



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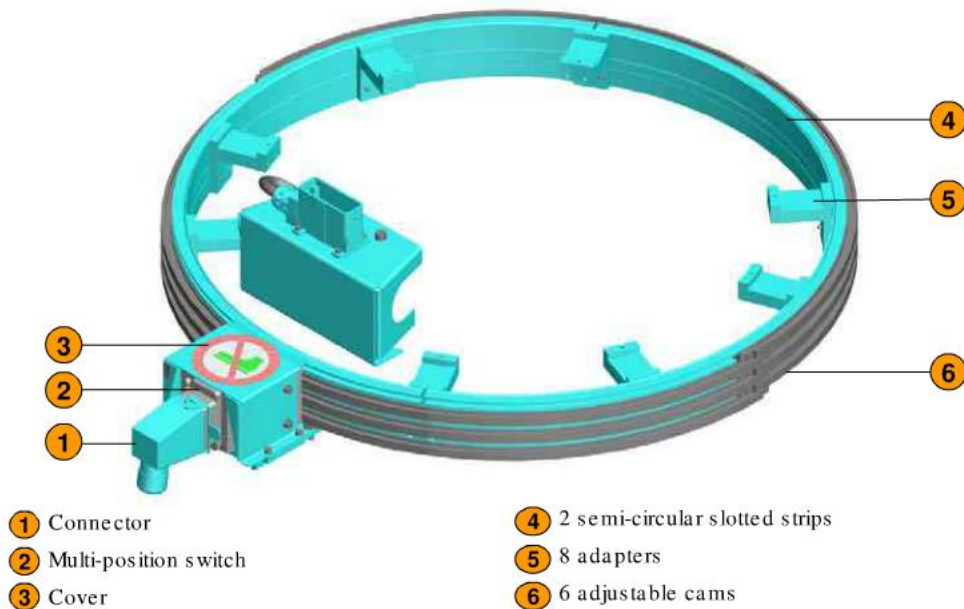
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3.7. Axis monitoring

Axis range monitoring assembly

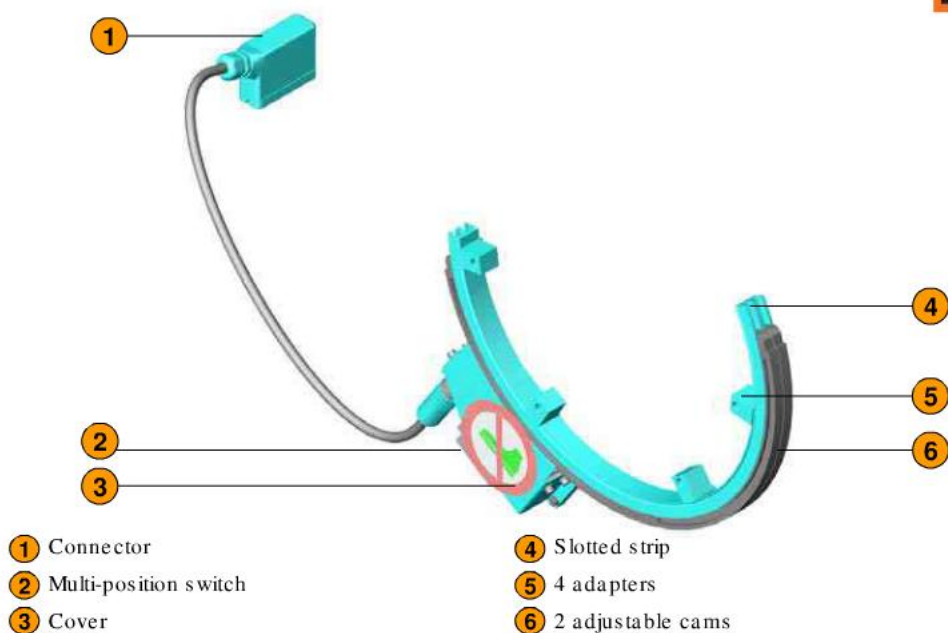
Axis 1



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Axis range monitoring assembly

Axis 2

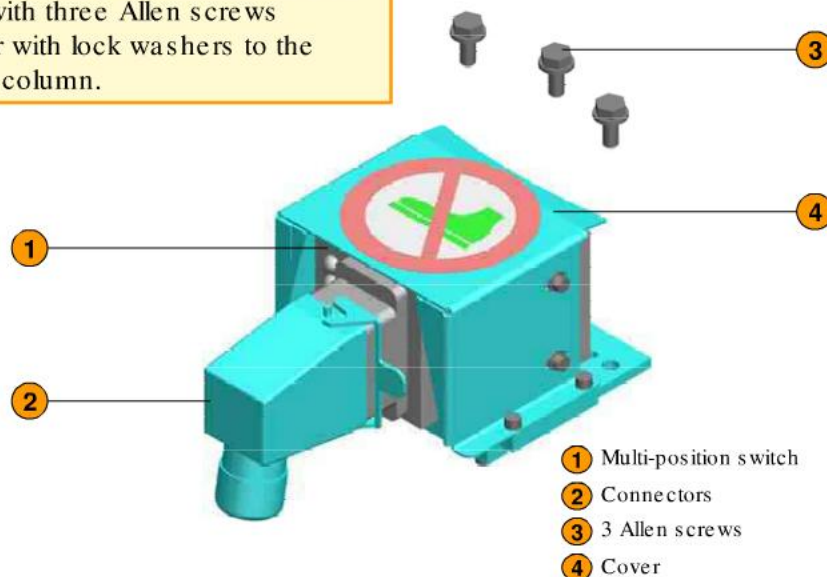


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Axis range monitoring assembly



Fasten the group of sensors and the holder with three Allen screws together with lock washers to the rotating column.

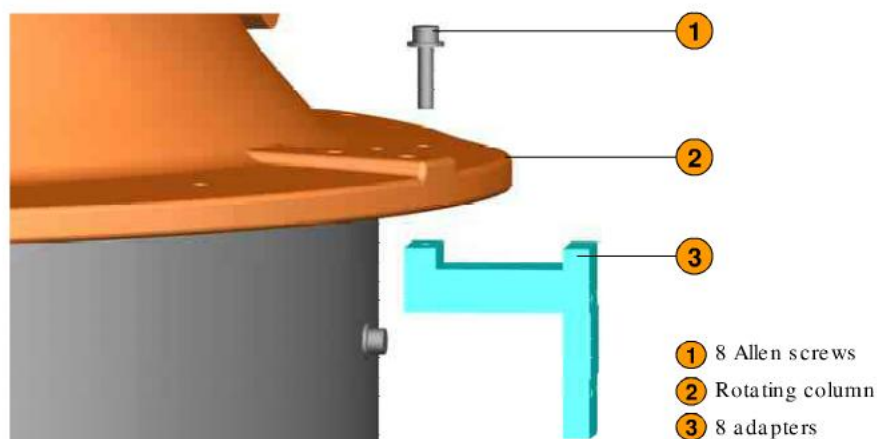


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Axis range monitoring assembly



Place adapters in the groove provided on the rotating column, and fasten with Allen screws and lock washers.

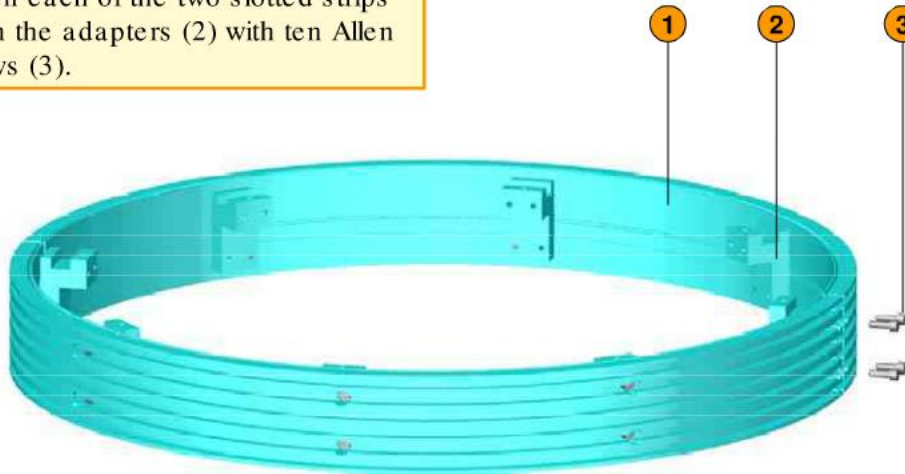


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Axis range monitoring assembly



Fasten each of the two slotted strips (1) on the adapters (2) with ten Allen screws (3).



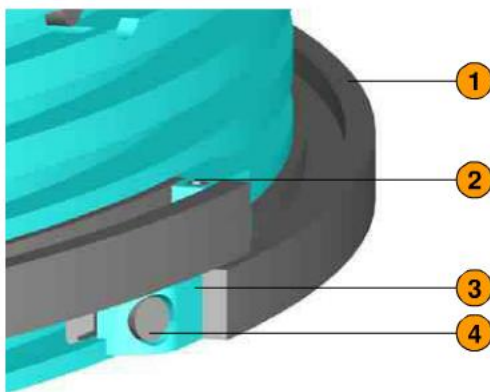
- ① 2 slotted strips
- ② 8 adapters
- ③ 20 Allen screws

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Axis range monitoring assembly



Insert cam endpieces (3) into the slotted strips and fasten cams (1) to a cam endpiece (3) at each end using a setscrew (2). Tighten screws (4).



- ① Cam
- ② Setscrew
- ③ Cam endpiece
- ④ 2 Allen screws

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4. Maintenance

4.1. Wrist axes

Wrist axes maintenance

Wrist axes oil change

Unscrew the oil drain plugs and collect the used oil in a suitable container.



① Drain plug, axis 4

② Drain plug, axis 5, axis 6

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Wrist axes maintenance

Wrist axes oil change

Move the wrist into the filling position and pour in the oil.



Observe correct quantity!



① Filler plug, axis 4

② Filler plug axis 5, axis 6

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Wrist axes maintenance

Belt removal, wrist

Loosen and remove thirteen fastening screws M5 x 20 / 10.9.



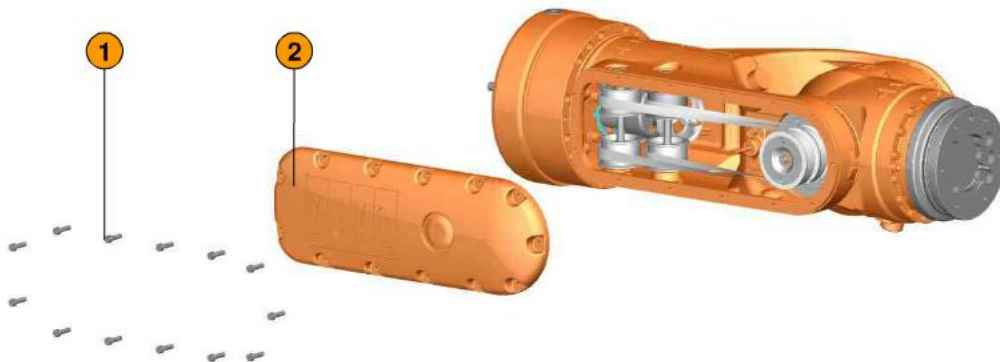
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Wrist axes maintenance

Belt removal, wrist

Remove cover.



- ① 13 fastening screws M5 x 20 / 10.9
- ② Cover

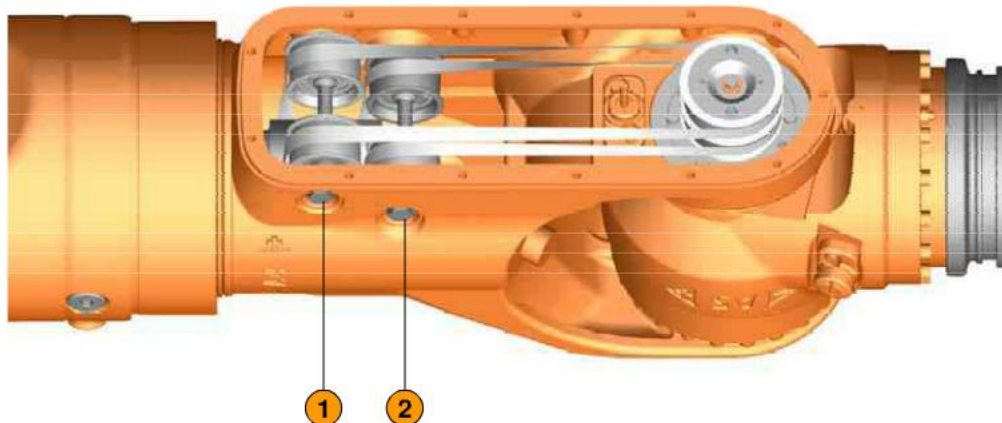
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Wrist axes maintenance

Belt removal, wrist

Slacken self-locking nut of axis 5 (1).



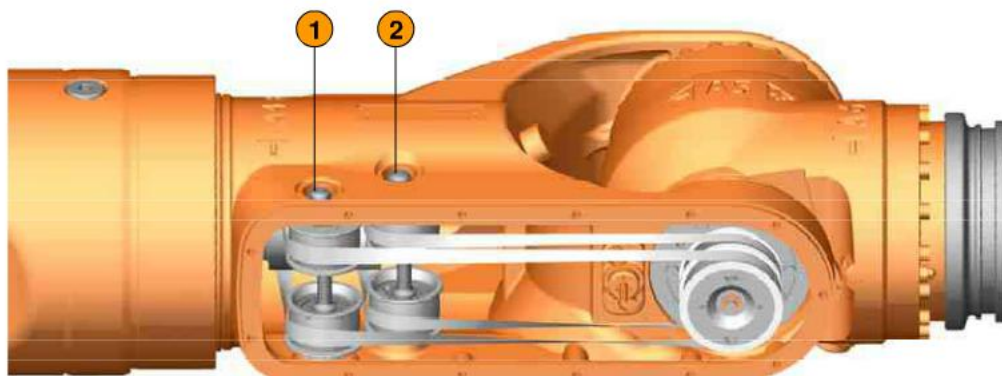
- ① Self-locking nut, axis 5
- ② Self-locking nut, axis 6

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Wrist axes maintenance

Belt removal, wrist

Slacken the toothed belt of axis 5 with the eccentric shaft (1).



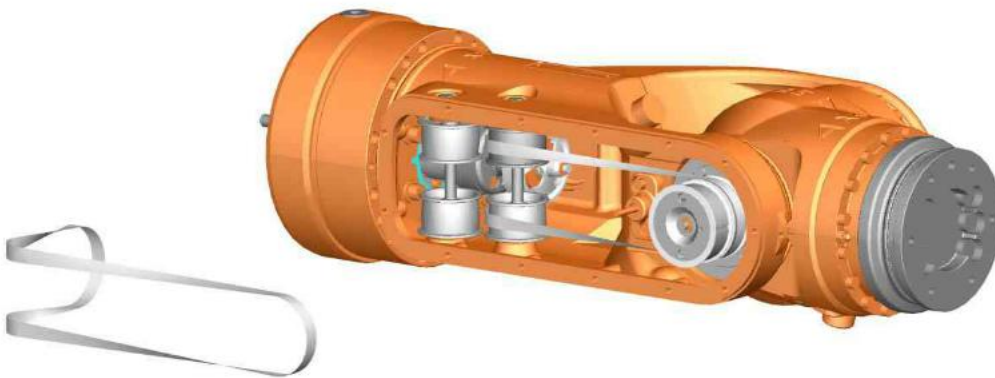
- ① M8 - 8 hexagon nut, axis 5
- ② M8 - 8 hexagon nut, axis 6

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Wrist axes maintenance

Belt removal, wrist

Remove the toothed belt of axis 5 from the drive unit.

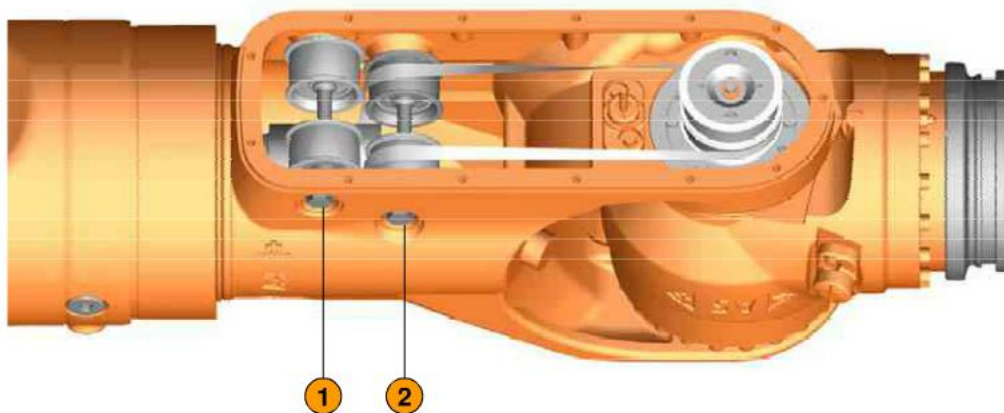


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Wrist axes maintenance

Belt removal, wrist

Loosen self-locking nut of axis 6 (2).



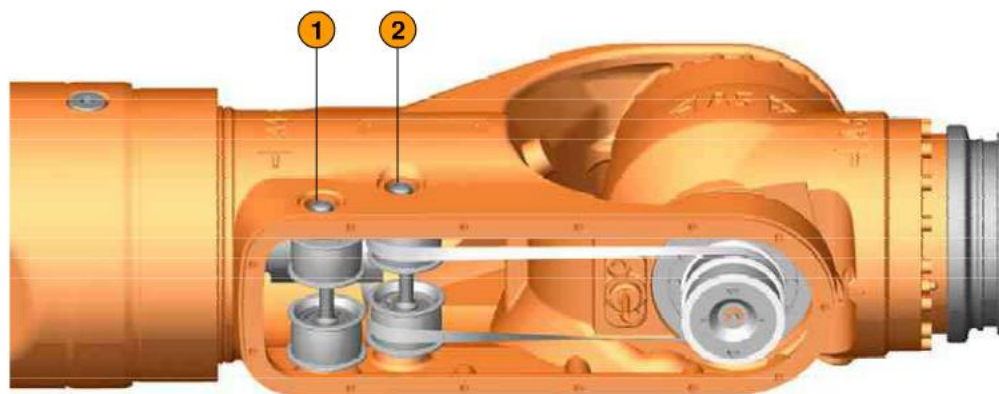
- ① Self-locking nut, axis 5
- ② Self-locking nut, axis 6

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Wrist axes maintenance

Belt removal, wrist

Slacken the toothed belt of axis 6 with the eccentric shaft (2).



① M8 - 8 hexagon nut, axis 5

② M8 - 8 hexagon nut, axis 6

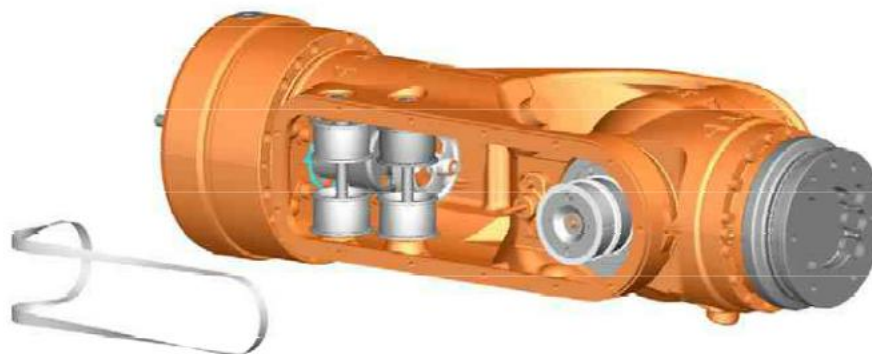
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Wrist axes maintenance

Belt removal, wrist

Remove the toothed belt of axis 6 from the drive unit.

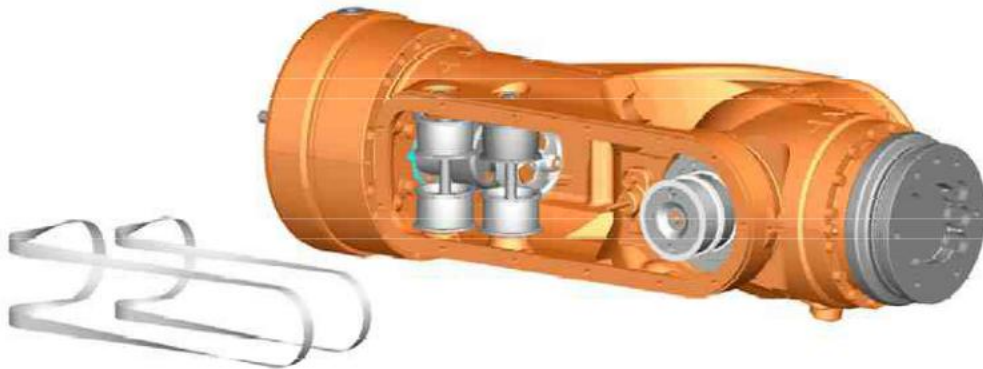


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Wrist axes maintenance

Wrist belts



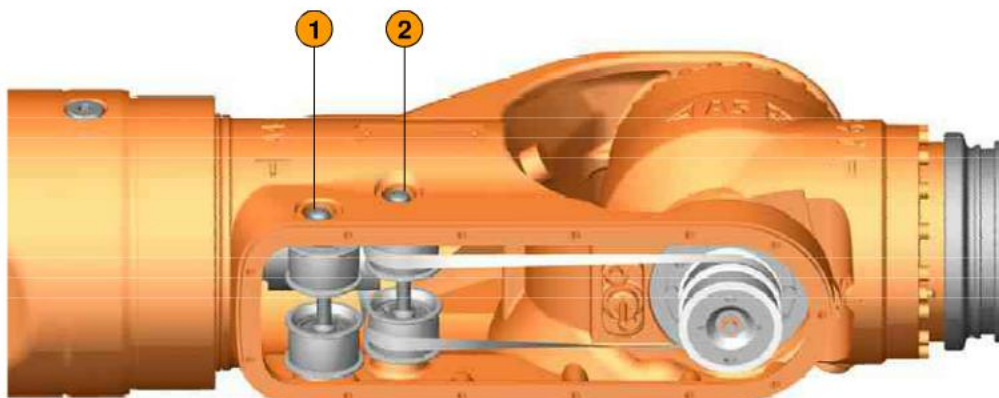
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Wrist axes maintenance

Belt installation, wrist



Insert the toothed belts in the correct order.



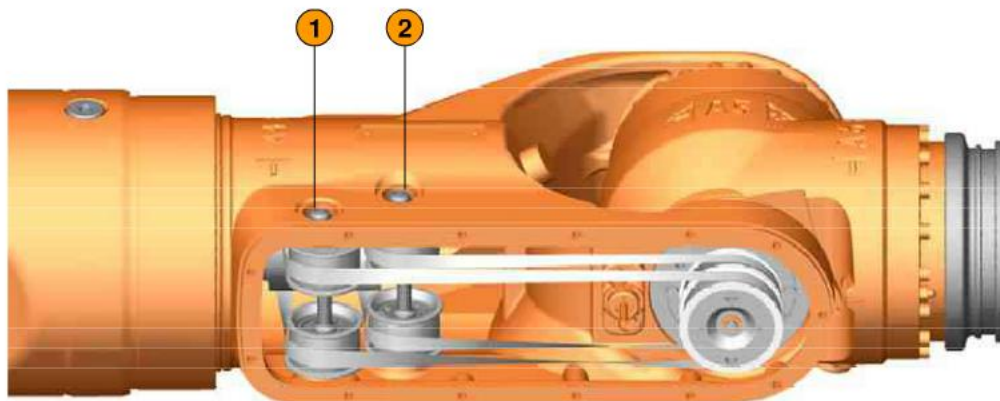
- ① M8 - 8 hexagon nut, axis 5
- ② M8 - 8 hexagon nut, axis 6

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Wrist axes maintenance

Belt installation, wrist

Slightly pretension the toothed belts with the eccentric shaft.



① M8 - 8 hexagon nut, axis 5

② M8 - 8 hexagon nut, axis 6

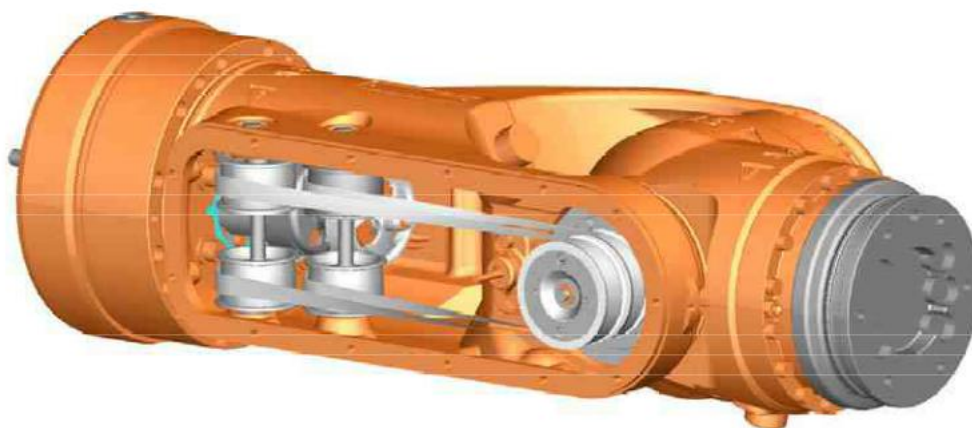
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Wrist axes maintenance

Belt installation, wrist

Adjust the toothed belt tension of axis 6 (185 ± 5 Hz) and axis 5 (130 ± 5 Hz) using the strand tension meter.



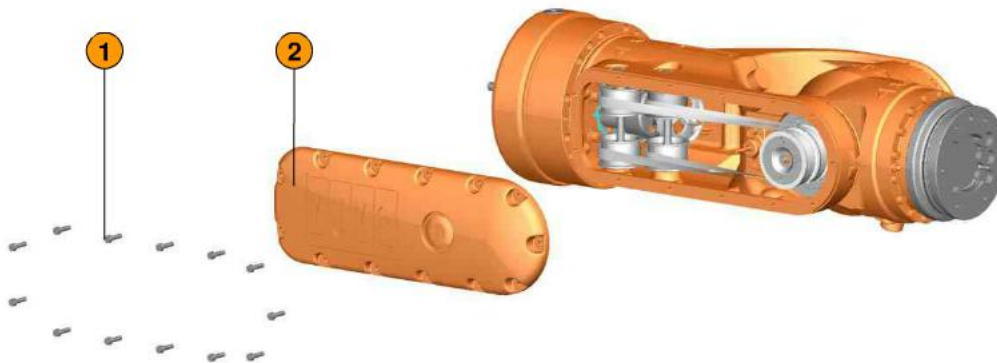
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Wrist axes maintenance

Belt installation, wrist

Fasten cover with thirteen screws
M5 x 20 / 10.9.



- ① 13 fastening screws M5 x 20 / 10.9
- ② Cover

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Wrist axes maintenance

Belt installation, wrist

Tighten screws with a torque of 7.5 Nm.



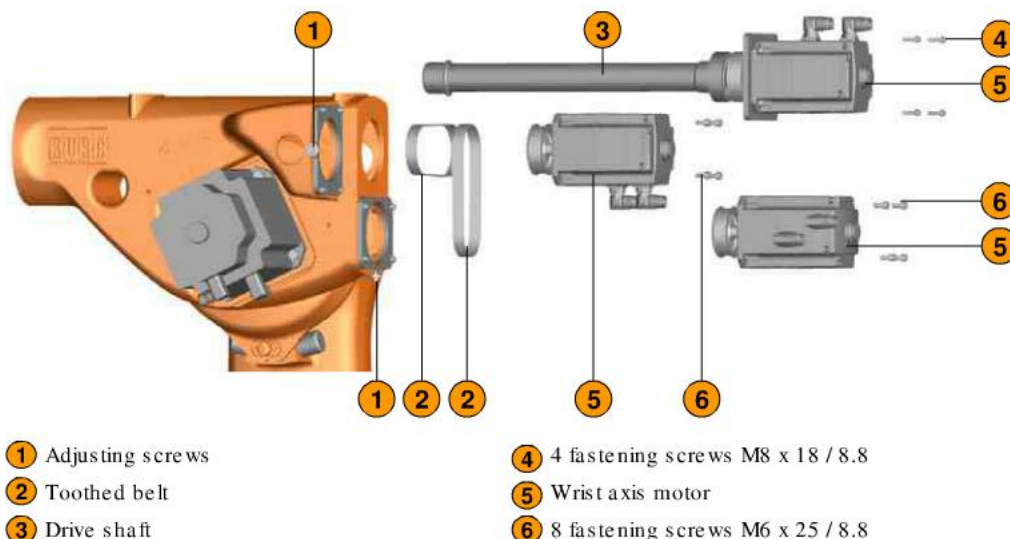
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Wrist axes maintenance

Belt removal, wrist axis motors

Remove motors and check belts.



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Wrist axes maintenance

Belt installation, wrist axis motors

Install motors and adjust the toothed belt tension of axis 4 and axis 5 to 130 ± 5 Hz using the strand tension meter.



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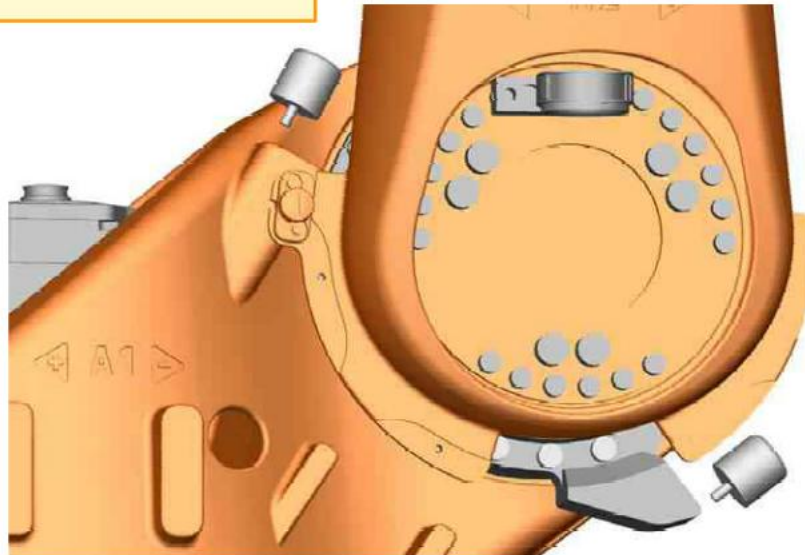


4.2. Basic axes

Main axes maintenance



Replace defective rubber buffers with new ones.



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Main axes maintenance



Axis 3

Change gear unit oil.



Observe correct quantity!



① Filler plug, axis 3

② Drain plug, axis 3

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Main axes maintenance



Axis 2

Change gear unit oil.



Observe correct quantity!



① Filler plug, axis 2

② Drain plug, axis 2

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Main axes maintenance

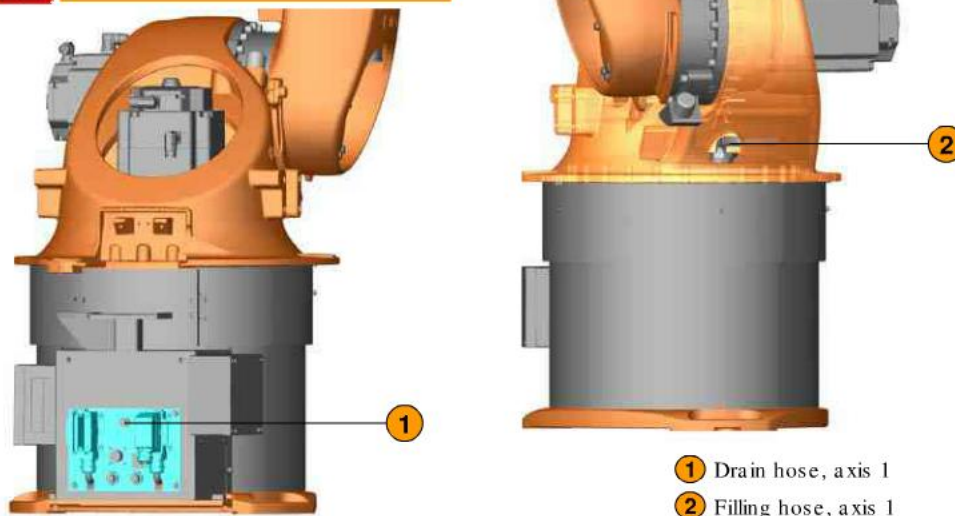


Axis 1

Change gear unit oil.



Observe correct quantity!



① Drain hose, axis 1

② Filling hose, axis 1

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5. Exercises



Overview: Mechanics course exercises



Exercises: [Notes](#)

- Exercise 1: [Robot installation and commissioning](#)
- Exercise 2: [Disassembly of the wrist and wrist axis motors](#)
- Exercise 3: [Disassembly of the energy supply system and motor cables](#)
- Exercise 4: [Disassembly of the arm/link arm](#)
- Exercise 5: [Rotating column disassembly](#)
- Exercise 6: [Assembly of rotating column](#)
- Exercise 7: [Link arm/arm assembly](#)
- Exercise 8: [Assembly of the energy supply system and motor cables](#)
- Exercise 9: [Assembly of the wrist and wrist axis motors](#)
- Exercise 10: [Adjustment of belt tension](#)
- Exercise 11: [Range monitoring adjustment](#)
- Exercise 12: [Energy supply system adjustment](#)
- Exercise 13: [Troubleshooting](#)
- Exercise 14: [Robot arm extension installation](#)
- Exercise 15: [Oil change on wrist/gear unit](#)
- Exercise 16: [Load data determination](#)



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Assembly instructions



- Before beginning assembly, clean all mounting surfaces and rectify any uneven areas.
- Make sure the installation position is correct!
- Use centering pins.
- Clean and lightly grease motor toothing with Microlube GL 261



Do not tilt components during installation!



Tighten all screws with a torque wrench and, if possible, in a diagonally opposite sequence. Increase the tightening torque to the specified value in several stages.

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Disassembly instructions



- Mark the position of the components prior to disassembly.
- Secure the robot to guard against the risk of unintended motion. This can be done by supporting it from below or by securing it with a rope from above.



Do not tilt components while dismantling!



During disassembly of the motors, the controller must always be switched off and secured against being switched back on!

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EXERCISE: Robot installation and commissioning



- Move the robot into the test cell.



Pay attention to the locating pins in the floor.

- Fasten the robot to the mounting plate with the appropriate hexagon screws
- Move the appropriate control cabinet to the test cell and connect it to the robot.
- Connect all the necessary connectors to the connection panel of the cabinet.



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EXERCISE: Robot installation and commissioning



- Close the safety gate and switch the control cabinet on.
- Check the machine data and the function of the robot



No persons or objects are allowed in the danger zone during start-up!



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EXERCISE: Wrist and wrist axis motors disassembly



- Transport the robot to the assembly area



The robot must only be transported in its prescribed transport position!

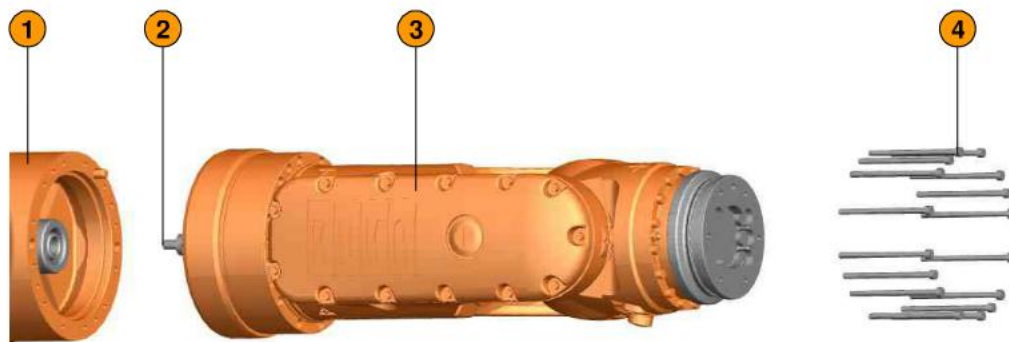
- Secure robot onto the mounting plate
- Move the robot into a suitable disassembly position



Support wrist so that it cannot fall down!

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EXERCISE: Wrist and wrist axis motors disassembly



1 Arm

2 Drive shaft

3 Wrist

4 16 wrist fastening screws M6 x 100 / 12.9

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EXERCISE: Wrist and wrist axis motors disassembly



- Slacken and remove wrist fastening screws (4).
- Pull the wrist out horizontally.

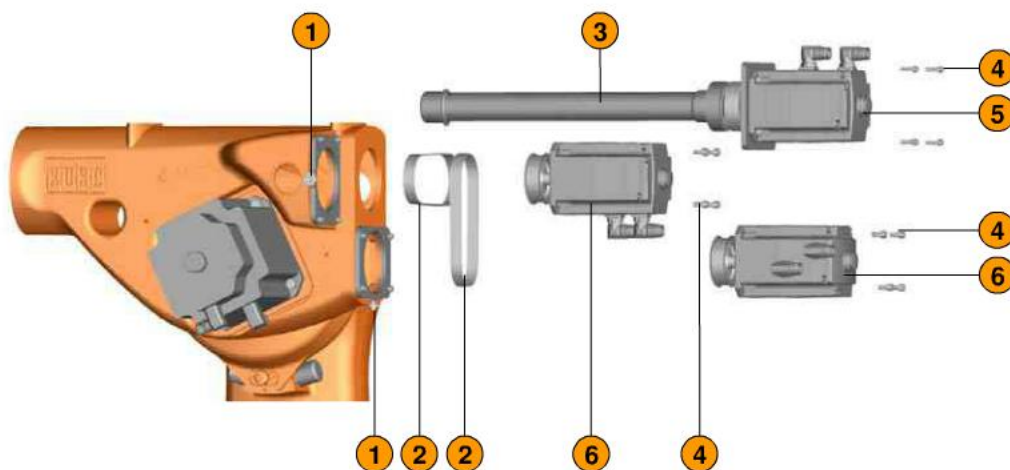


The wrist must not be tilted as it is being removed!
Pay attention to the contact surface of the wrist on the arm!
And also to the drive shaft (2) of the wrist!



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EXERCISE: Wrist and wrist axis motors disassembly



① Adjusting screws

② Toothed belt

③ Drive shaft

④ 4 fastening screws M8 x 18 / 8.8

⑤ Wrist axis motor

⑥ 8 fastening screws M6 x 25 / 8.8

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EXERCISE: Wrist and wrist axis motors disassembly



Any tooling mounted must be either secured to prevent it from turning, or removed!

- Twist off connectors on the motors of the wrist axis.
- Remove plugs.
- Remove adjusting screws (1).
- Remove fastening screws (4) on the motors A 4 and A 5.
- Remove motors A 4 and A 5.



When removing the A 4 and A 5 motors, their respective toothed belts in the arm must be taken off at the same time.

- Remove fastening screws (4) on the motor A 6.
- Remove motor A 6.



Attention must be paid to any loose disc springs when taking the motor A 6 out!

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EXERCISE: Energy supply system disassembly



-  Disassemble energy supply system and motor cables in accordance with Section 2.6.
- Mark positions of the energy supply system in the clamps.



Make markings with white Edding marker!



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EXERCISE: Arm/link arm disassembly



-  Disassemble arm in accordance with Section 2.2.
-  Disassemble link arm in accordance with Section 2.3.



The components must not be tilted while the link arm is being lifted off.



Support components so that they cannot fall down!





EXERCISE: Rotating column disassembly



-  Disassemble rotating column in accordance with Section 2.4.



The rotating column must not be tilted while it is being lifted off!



Support rotating column so that it cannot fall down!

EXERCISE: Rotating column assembly



-  Assemble rotating column in accordance with Section 3.2.
- Use installation aids.



Support rotating column so that it cannot fall down!

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EXERCISE: Link arm/arm assembly



-  Assemble link arm in accordance with Section 3.3.
-  Assemble arm in accordance with Section 3.4.



Support components so that they cannot fall down!



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EXERCISE: Energy supply system assembly



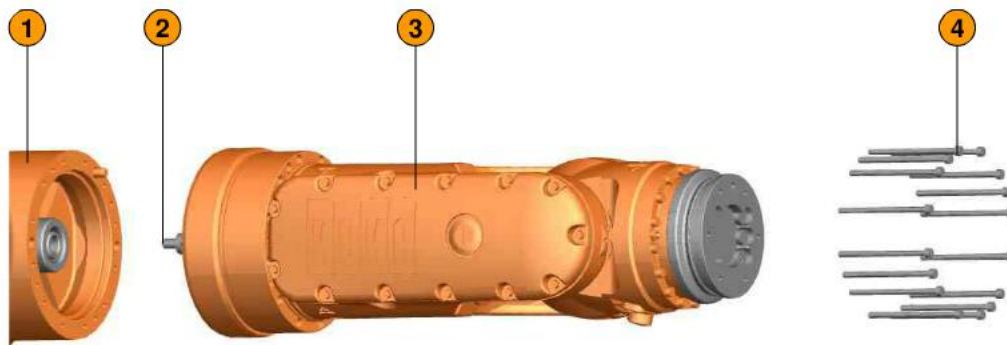
-  Assemble energy supply system and motor cables in accordance with Section 3.6.



Pay attention to the white markings!



EXERCISE: Wrist axis motors/wrist assembly



① Arm

② Drive shaft

③ Wrist

④ 16 wrist fastening screws M6 x 100 / 12.9

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EXERCISE: Wrist axis motors/wrist assembly



- Mount wrist horizontally and carefully insert it into the guideway



Support wrist so that it cannot fall down!

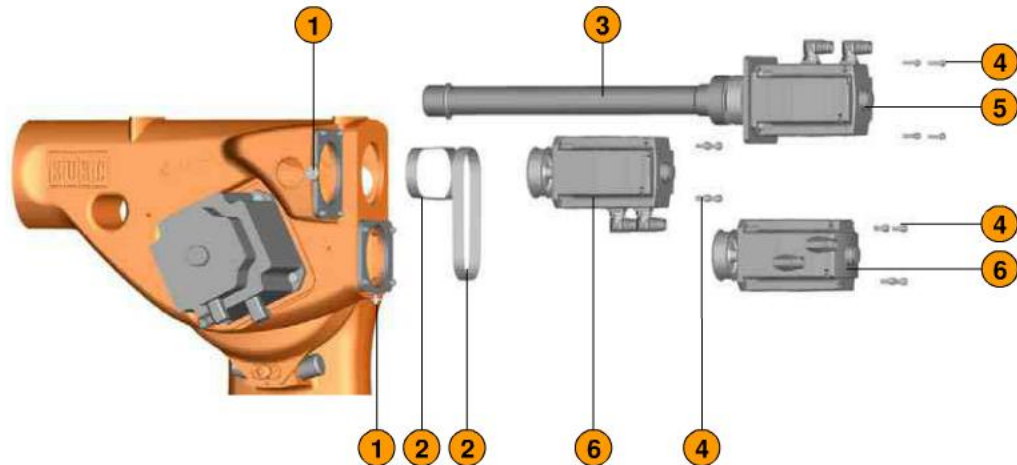
- Screw in wrist fastening screws and tighten with a torque of 12.5 Nm.



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EXERCISE: Wrist axis motors/wrist assembly



① Adjusting screws

② Toothed belt

③ Drive shaft

④ 4 fastening screws M8 x 18 / 8.8

⑤ Wrist axis motor

⑥ 8 fastening screws M6 x 25 / 8.8

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EXERCISE: Wrist axis motors/wrist assembly



- Insert motors A 4 and A 5.



When inserting the A 4 and A 5 motors, the respective toothed belts must at the same time be fitted onto the toothed belt pulley of the corresponding motor.

- Insert fastening screws (4) on the A 4 and A 5 motors but do not yet tighten because the toothed belts still have to be tensioned.
- Insert motor A 6 with disc springs and drive shaft (3).
- Screw in fastening screws (4) on motor A 6 and tighten with a torque of 5.6 Nm.

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EXERCISE: Adjustment of belt tension



- After installing the wrist axis motors, adjust the toothed belt tension of axis 4 and axis 5 to 130 ± 5 Hz using the strand tension meter.

The belt tension in the wrist must also be adjusted.

- Remove cover on the wrist.
- Slacken self-locking nuts of axes 5 and 6 and take the toothed belt from the drive unit.
- Insert the toothed belts in the correct order.
- Adjust the toothed belt tension to 130 ± 5 Hz (axis 5) and to 185 ± 5 Hz (axis 6) using the strand tension meter.
- Mount cover.

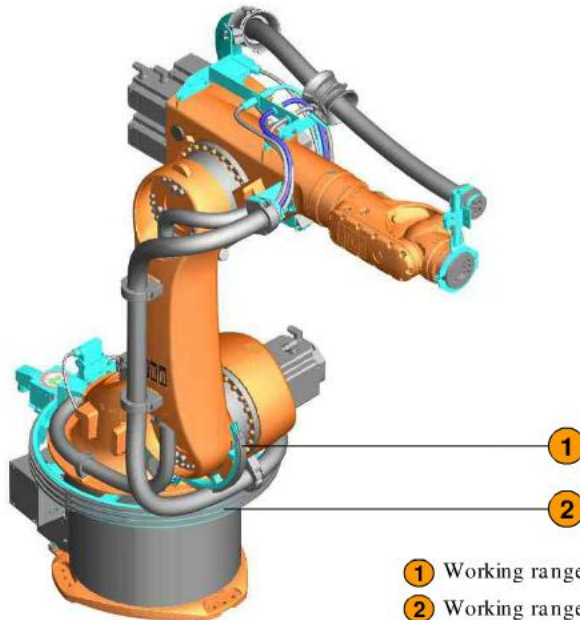


Correctly adjust belt tensions!



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EXERCISE: Range monitoring adjustment

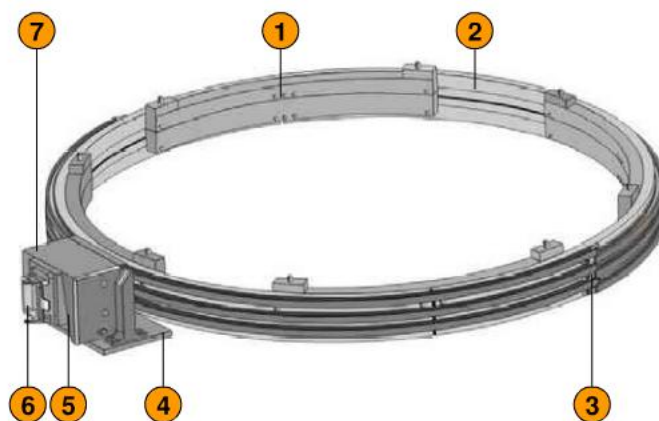


- ① Working range monitoring A 2
- ② Working range monitoring A 1

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EXERCISE: Range monitoring adjustment



The working range monitoring for axis 1 consists of four semi-circular ring segments (1), two semi-circular slotted strips (2), six adjustable cams (3) located in the slotted strips, and a plate (4) for mounting the multi-position limit switch (5). The plate (4) is screwed to the robot base frame. The proximity switches are grouped together in a housing to form a multi-position limit switch

and are connected to the electrical system via a connector (6). The multi-position limit switches are protected against mechanical stress by a cover plate (7).

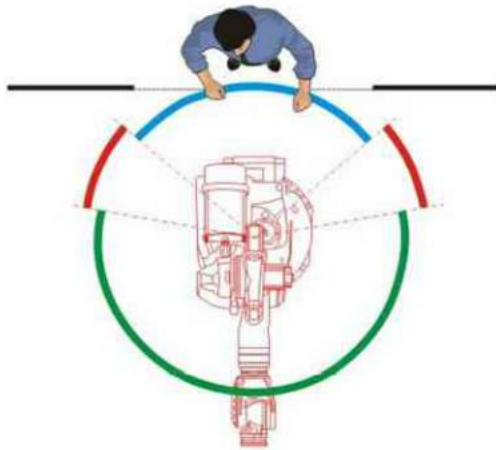
The number of cams depends on the number of ranges to be monitored. Two proximity switches and two cams are required for each monitoring range.

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EXERCISE: Range monitoring adjustment



- Safeguarded zone
- Danger zone
- Enabled zone

The length of an actuating cam, and thus the angle of its arc, depends on the size of the **safeguarded zone**. The **danger zone** consists of the angle of the safeguarded zone plus approx. 30° on either side for the braking distance. The robot's braking distance at maximum velocity is approx. 30° , but is also dependent on the mass inertia of the robot. The danger zone is safeguarded by means of a break-contact proximity switch. The **enabled zone** consists of the angle between the danger zone and 360° . The length of the cams must therefore be calculated so that the overall length is always 360° .

The cams for the danger and safety zones are located on one cam track, and for the enabled zone they are located on a second cam track.

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EXERCISE: Range monitoring adjustment



- Adjust the axis range monitoring of A 1.

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EXERCISE: Energy supply system adjustment



Snap clips

With plastic or metal fasteners. They are opened and closed without the need for tools.



Flexible tubes

Abrasion-resistant and flexible. They offer increased protection against wear and an increased service life around the wrist.

- DN 52 for handling applications
- DN 70 for welding applications



Clamping pieces

Greater protection for supply lines and better clamping by surrounding them completely.



Protectors

For tube protection. Fully ribbed and can also be used for joining two tubes.

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EXERCISE: Energy supply system adjustment



Combined endpiece

Combines roles in a single unit to offer strain relief for flexible tube and serve as a clamping piece.



Ball joint

Supply tube fed into ball joint on axis 6, for greatest possible freedom of movement of the in-line wrist.



Holder on tool flange (axis 6)

Freely configurable, optional 25 mm and 45° steps. Heights and angular position adjustable. Mark position to ensure clear reproducibility.

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EXERCISE: Energy supply system adjustment



- Adjust the energy supply system to ensure that the test program used can be optimally executed.



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EXERCISE: Troubleshooting



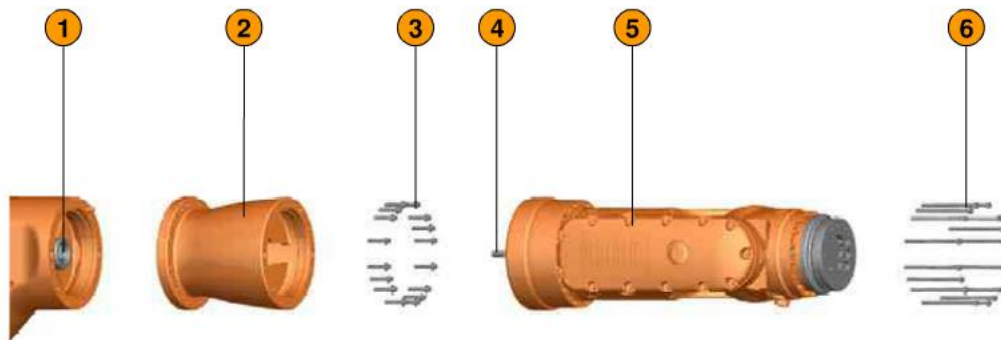
- The robot cannot be put into operation. By testing and exchanging modules, find the errors to make the robot ready for operation once more.



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EXERCISE: Arm extension installation



- | | |
|--|--|
| ① Drive shaft | ④ Drive shaft |
| ② Arm extension | ⑤ Wrist |
| ③ 16 wrist fastening screws M6 x 35 / 10.9 | ⑥ 16 wrist fastening screws M6 x 90 / 10.9 |

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EXERCISE: Arm extension installation



- Wrist disassembly
- Mount arm extension horizontally and carefully insert it into the guideway
- Screw in fastening screws (3) and tighten with a torque of 12.5 Nm.
- Wrist assembly



The modules must not be tilted as they are being removed!
Pay attention to the drive shaft!



Support modules so that they cannot fall down!

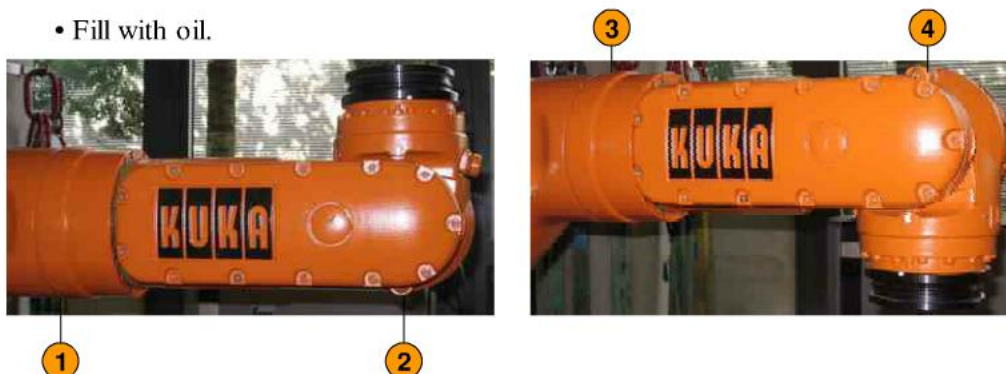
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EXERCISE: Oil change on wrist/gear unit



- Drain oil and collect in a suitable container.
- Fill with oil.



Observe correct filling quantity!

① Drain plug, axis 4

② Drain plug, axis 5, axis 6

③ Filler plug, axis 4

④ Filler plug axis 5, axis 6

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EXERCISE: Load data determination



- Open the program "Load data determination" via the menu function "Setup" - "Service"



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EXERCISE: Load data determination



- Define the type of tool (Compact, Regular, Large).
- Set the possible angles of axes A 3 to A 6
-  Robot selection
-  Test run, warm-up, measurement run



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6. Tightening torques table

Tightening torques table

Work instruction AA 10/05/07

Screw connections (general)



Tightening torques for shank-type screws in Nm applied with a torque wrench, unless otherwise specified in the drawing, for screwed connections made from metallic materials

- 1) Attention must be paid to cleanness
- 2) Visually inspect threaded holes and screws. Remove any dirt
- 3) Condition of the screw:
 - no bonding: lightly oil
 - with bonding: grease-free (see gluing instruction AA10/05/04)
- 4) Tightening procedure: tighten in diagonally opposite sequence with an inspected torque wrench. See table for tightening torques
- 5) All screws must be tightened using the torque specified here
- 6) All screws must be tightened evenly

ONLY USE SILICON-FREE AUXILIARY MATERIALS

Strength class

	8.8	10.9	12.9
M3	1.2	1.6	2.0
M4	2.8	3.7	4.4
M5	5.6	7.5	9.0
M6	9.5	12.5	15.0
M8	23.0	31.0	36.0
M10	45.0	60.0	70.0
M12	78.0	104.0	125.0
M14	113.0	165.0	195.0
M16	195.0	250.0	305.0
M20	370.0	500.0	600.0
M24	640.0	860.0	1030.0

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