



Product manual

IRB 460

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**Product manual
IRB 460 - 110/2.4
IRC5**

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Original instructions.

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Overview of this manual

About this manual

This manual contains instructions for:

- mechanical and electrical installation of the robot
- maintenance of the robot
- mechanical and electrical repair of the robot.

The manual also contains reference information for all procedures detailed in the manual.

Usage

This manual should be used during:

- installation, from lifting the robot to its work site and securing it to the foundation, to making it ready for operation
- maintenance work
- repair work.

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

Maintenance/repair/installation personnel working with an ABB Robot must:

- be trained by ABB and have the required knowledge of mechanical and electrical installation/repair/maintenance work.

Organization of chapters

The manual is organized in the following chapters:

Chapter	Contents
Safety	Safety information that must be read through before performing any installation or service work on robot. Contains general safety aspects as well as more specific information about how to avoid personal injuries and damage to the product.
Installation and commissioning	Required information about lifting and installation of the robot.
Maintenance	Step-by-step procedures that describe how to perform maintenance of the robot. Based on a maintenance schedule that may be used in the work of planning periodical maintenance.
Repair	Step-by-step procedures that describe how to perform repair activities of the robot. Based on available spare parts.
Calibration	Calibration procedures and general information about calibration.
Decommissioning	Environmental information about the robot and its components.

Continues on next page

Overview of this manual

Continued

Chapter	Contents
Reference information	Useful information when performing installation, maintenance or repair work. Includes lists of necessary tools, additional documents, safety standards etc.
Spare part list	Reference to the spare part list for the robot.
Circuit diagram	Reference to the circuit diagram for the robot.

References

Reference	Document ID
<i>Product manual, spare parts - IRB 460</i>	3HAC040628-001
<i>Product specification - IRB 460</i>	3HAC039611-001
<i>Operating manual - General safety information</i> ⁱ	3HAC031045-001
<i>Product manual - IRC5</i> IRC5 with main computer DSQC 639.	3HAC021313-001
<i>Product manual - IRC5</i> IRC5 with main computer DSQC1000.	3HAC047136-001
<i>Operating manual - IRC5 with FlexPendant</i>	3HAC050941-001
<i>Operating manual - Service Information System</i>	3HAC050944-001
<i>Application manual - Electronic Position Switches</i>	3HAC050996-001
<i>Application manual - Additional axes and stand alone controller</i>	3HAC051016-001
<i>Technical reference manual - Lubrication in gearboxes</i>	3HAC042927-001
<i>Technical reference manual - System parameters</i>	3HAC050948-001

ⁱ This manual contains all safety instructions from the product manuals for the manipulators and the controllers.

Revisions

Revision	Description
-	First edition.
A	This revision includes the following updates: <ul style="list-style-type: none">• Added safety section, see Signal lamp (optional) on page 38.• A new block, about general illustrations, added in section How to read the product manual on page 15.• Illustrations improved throughout the Repair chapter.• Method of replacing the base updated and bits holder added in section Replacing the base, including axis 1 gearbox on page 180.• Refitting method updated in section Replacing the turning disk.• Recalibration added in section Replacing the turning disk.• Details about tools added in section Replacing the tilthouse unit on page 195.• Procedures for Removal and Refitting updated in section Replacing the upper arm on page 216.• Three legged bearing puller added in Required equipment sections Replacing linkage - upper link arm on page 232 and Replacing linkage - lower link arm on page 240.• Replacing method updated in section Replacing motors, axes 2 and 3 on page 301.

Continues on next page

Revision	Description
	<ul style="list-style-type: none"> • Text updated in section Replacing the axis 1 gearbox on page 320. • In previous section Replacing the axis 2 and 3 gearboxes, replacing gearbox axis 3 has been removed and now only describes the axis 2 gearbox. • New section included Replacing the axis 3 gearbox. • Changed the weight of the robot, see Weight, robot on page 60. • Added an illustration that shows the directions of the robot stress forces, see Loads on foundation, robot on page 61. • Added new section about how to install the signal lamp, see Installation of signal lamp, upper arm (option) on page 90. • Added information that the working range of axis 1 also can be restricted by EPS, see Introduction on page 100. • Special tools updated.
B	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • Minor corrections and editorial changes made throughout the manual. • Some general tightening torques have been changed/added, see updated values in Screw joints on page 383. • Added steps in the instruction for replacing upper end of cabling, see Replacing the cable harness, upper end (incl. axis 6) on page 165. • Added WARNING - Safety risks during handling of batteries on page 55.
C	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • The maximum allowed deviation in levelness of the base plate is changed, see Securing the base plate on page 77. • Reference to Hilti standard added to the foundation recommendation for the base plate and class designation for foundation is changed to european standard C25/C30 (previously Swedish standard K25/K30), see Securing the base plate on page 77. • All data about type of lubrication in gearboxes is moved from the manual to a separate lubrication manual, see Type and amount of oil in gearboxes on page 131. • Added a new sealing structure that contains a support ring, o-ring and radial sealing at the link, see Replacing the linkage - link on page 247 and Replacing the upper arm on page 216. • Three o-rings are added to the equipment list and procedure in section Replacing the axis 1 gearbox on page 320. • A new SMB unit and battery is introduced, with longer battery lifetime.
D	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • A new procedure is added to the manual: Option 87-1 - Installing the cooling fan for axis-1 motor on page 94. • The position of the battery holder for RMU lithium battery (3-pole battery contacts) has changed. The figures and text has been updated.
E	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • Added information about risks when scrapping a decommissioned robot, see Scrapping of robot on page 378.
F	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • New illustrations added for lower arm and lower and upper arm joints. • The maximum allowed deviation in levelness of the base plate and foundation is changed, see Securing the base plate on page 77. • Minor corrections.
G	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • Splitted instruction for fork lift accessory use in two sections. • Illustrations of SMB battery RMU improved,

Continues on next page

Overview of this manual

Continued

Revision	Description
H	This revision includes the following updates: <ul style="list-style-type: none">Article number for label updated (Combined warning label "Brake release", "Brake release buttons" and "Moving robot")
J	Published in release R16.2. The following updates are done in this revision: <ul style="list-style-type: none">Drawing of base plate is not available for purchase, faulty information removed in Securing the base plate on page 77.Corrections due to updates in SAP terminology.
K	Published in release R17.1. The following updates are done in this revision: <ul style="list-style-type: none">Added labels to the robot, one warning label (A) on the axis-6 motor, one battery label (N) and one stock robots label (P) See Inspecting the information labels on page 121.New standard calibration method is introduced (Axis Calibration). See Calibration on page 353.

Product documentation, IRC5

Categories for user documentation from ABB Robotics

The user documentation from ABB Robotics is divided into a number of categories. This listing is based on the type of information in the documents, regardless of whether the products are standard or optional.

All documents listed can be ordered from ABB on a DVD. The documents listed are valid for IRC5 robot systems.

Product manuals

Manipulators, controllers, DressPack/SpotPack, and most other hardware is delivered with a **Product manual** that generally contains:

- Safety information.
- Installation and commissioning (descriptions of mechanical installation or electrical connections).
- Maintenance (descriptions of all required preventive maintenance procedures including intervals and expected life time of parts).
- Repair (descriptions of all recommended repair procedures including spare parts).
- Calibration.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with exploded views (or references to separate spare parts lists).
- Circuit diagrams (or references to circuit diagrams).

Technical reference manuals

The technical reference manuals describe reference information for robotics products.

- *Technical reference manual - Lubrication in gearboxes*: Description of types and volumes of lubrication for the manipulator gearboxes.
- *Technical reference manual - RAPID overview*: An overview of the RAPID programming language.
- *Technical reference manual - RAPID Instructions, Functions and Data types*: Description and syntax for all RAPID instructions, functions, and data types.
- *Technical reference manual - RAPID kernel*: A formal description of the RAPID programming language.
- *Technical reference manual - System parameters*: Description of system parameters and configuration workflows.

Continues on next page

Application manuals

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, DVD with PC software).
- How to install included or required hardware.
- How to use the application.
- Examples of how to use the application.

Operating manuals

The operating manuals describe hands-on handling of the products. The manuals are aimed at those having first-hand operational contact with the product, that is production cell operators, programmers, and trouble shooters.

The group of manuals includes (among others):

- *Operating manual - Emergency safety information*
- *Operating manual - General safety information*
- *Operating manual - Getting started, IRC5 and RobotStudio*
- *Operating manual - IRC5 Integrator's guide*
- *Operating manual - IRC5 with FlexPendant*
- *Operating manual - RobotStudio*
- *Operating manual - Trouble shooting IRC5*

How to read the product manual

Reading the procedures

The procedures contain references to figures, tools, material, and so on. The references are read as described below.

References to figures

The procedures often include references to components or attachment points located on the manipulator/controller. The components or attachment points are marked with *italic text* in the procedures and completed with a reference to the figure where the current component or attachment point is shown.

The denomination in the procedure for the component or attachment point corresponds to the denomination in the referenced figure.

The table below shows an example of a reference to a figure from a step in a procedure.

	Action	Note/Illustration
8.	Remove the <i>rear attachment screws, gearbox</i> .	Shown in the figure Location of gearbox on page xx .

References to required equipment

The procedures often include references to equipment (spare parts, tools, etc.) required for the different actions in the procedure. The equipment is marked with *italic text* in the procedures and completed with a reference to the section where the equipment is listed with further information, that is article number and dimensions.

The designation in the procedure for the component or attachment point corresponds to the designation in the referenced list.

The table below shows an example of a reference to a list of required equipment from a step in a procedure.

	Action	Note/Illustration
3.	Fit a new <i>sealing, axis 2</i> to the gearbox.	Art. no. is specified in Required equipment on page xx .

Safety information

The manual includes a separate safety chapter that must be read through before proceeding with any service or installation procedures. All procedures also include specific safety information when dangerous steps are to be performed.

Read more in the chapter [Safety on page 17](#).

Illustrations

The robot is illustrated with general figures that does not take painting or protection type in consideration.

Likewise, certain work methods or general information that is valid for several robot models, can be illustrated with illustrations that show a different robot model than the one that is described in the current manual.

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1 Safety

1.1 Introduction to safety information

Overview

The safety information in this manual is divided into the following categories:

- General safety aspects, important to attend to before performing any service work on the robot. These are applicable for all service work and are found in [General safety information on page 18](#).
- Safety signals and symbols shown in the manual and on the robot, warning for different types of dangers, are found in [Safety signals and symbols on page 39](#).
- Specific safety information, pointed out in the procedures. How to avoid and eliminate the danger is either described directly in the procedure, or in specific instructions in the section [Safety related instructions on page 47](#).

1 Safety

1.2.1 Introduction to general safety information

1.2 General safety information

1.2.1 Introduction to general safety information

Definitions

This section details general safety information for personnel performing installation, repair and maintenance work.

Sections

The general safety information is divided into the following sections.

Section	Examples of content
<i>Safety in the manipulator system on page 19</i>	This section describes the following: <ul style="list-style-type: none">• safety, service• limitation of liability• related information
<i>Protective stop and emergency stop on page 21</i>	This section describes protective stop and emergency stop.
<i>Safety risks on page 22</i>	This section lists dangers relevant when working with the product. The dangers are split into different categories. <ul style="list-style-type: none">• safety risks during installation or service• risks associated with live electrical parts
<i>Safety actions on page 31</i>	This section describes actions which may be taken to remedy or avoid dangers. <ul style="list-style-type: none">• fire extinguishing• safe use of the teach pendant or jogging device

1.2.2 Safety in the manipulator system

Validity and responsibility

The information does not cover how to design, install and operate a complete system, nor does it cover all peripheral equipment that can influence the safety of the entire system. To protect personnel, the complete system must be designed and installed in accordance with the safety requirements set forth in the standards and regulations of the country where the robot is installed.

The users of ABB industrial robots are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that the safety devices necessary to protect people working with the robot system are designed and installed correctly. Personnel working with robot must be familiar with the operation and handling of the industrial robot as described in the applicable documents, for example:

- *Operating manual - IRC5 with FlexPendant*
- *Operating manual - General safety information*¹
- *Product manual*

¹ This manual contains all safety instructions from the product manuals for the robots and the controllers.

The robot system shall be designed and constructed in such a way as to allow safe access to all areas where intervention is necessary during operation, adjustment, and maintenance.

Where it is necessary to perform tasks within the safeguarded space there shall be safe and adequate access to the task locations.

Users shall not be exposed to hazards, including slipping, tripping, and falling hazards.

Connection of external safety devices

Apart from the built-in safety functions, the robot is also supplied with an interface for the connection of external safety devices. An external safety function can interact with other machines and peripheral equipment via this interface. This means that control signals can act on safety signals received from the peripheral equipment as well as from the robot.

Limitation of liability

Any information given in this manual regarding safety must not be construed as a warranty by ABB that the industrial robot will not cause injury or damage even if all safety instructions are complied with.

Related information

Type of information	Detailed in document	Section
Installation of safety devices	<i>Product manual for the robot</i>	Installation and commissioning
Changing operating modes	<i>Operating manual - IRC5 with FlexPendant</i> <i>Operator's Manual - IRC5P</i>	Operating modes

Continues on next page

1 Safety

1.2.2 Safety in the manipulator system

Continued

Type of information	Detailed in document	Section
Restricting the working space	<i>Product manual for the robot</i>	Installation and commissioning

1.2.3 Protective stop and emergency stop

Overview

The protective stops and emergency stops are described in the product manual for the controller.

1 Safety

1.2.4.1 Safety risks during installation and service work on robots

1.2.4 Safety risks

1.2.4.1 Safety risks during installation and service work on robots

Overview

This section includes information on general safety risks to be considered when performing installation and service work on the robot.

These safety instructions have to be read and followed by any person who deals with the installation and maintenance of the robot. Only persons who know the robot and are trained in the operation and handling of the robot are allowed to maintain the robot. Persons who are under the influence of alcohol, drugs or any other intoxicating substances are not allowed to maintain, repair, or use the robot.

General risks during installation and service

- The instructions in the product manual in the chapters *Installation and commissioning*, and *Repair* must always be followed.
- Emergency stop buttons must be positioned in easily accessible places so that the robot can be stopped quickly.
- Those in charge of operations must make sure that safety instructions are available for the installation in question.
- Those who install or service/maintain the robot must have the appropriate training for the equipment in question and in any safety matters associated with it.

Spare parts and special equipment

ABB does not supply spare parts and special equipment which have not been tested and approved by ABB. The installation and/or use of such products could negatively affect the structural properties of the robot and as a result of that affect the active or passive safety operation. ABB is not liable for damages caused by the use of non-original spare parts and special equipment. ABB is not liable for damages or injuries caused by unauthorized modifications to the robot system.

Personal protective equipment

Always use suitable personal protective equipment, based on the risk assessment for the robot installation.

Nation/region specific regulations

To prevent injuries and damages during the installation of the robot, the regulations applicable in the country concerned and the instructions of ABB Robotics must be complied with.

Non-voltage related risks

- Make sure that no one else can turn on the power to the controller and robot while you are working with the system. A good method is to always lock the main switch on the controller cabinet with a safety lock.

Continues on next page

1.2.4.1 Safety risks during installation and service work on robots

Continued

- Safety zones, which must be crossed before admittance, must be set up in front of the robot's working space. Light beams or sensitive mats are suitable devices.
- Turntables or the like should be used to keep the operator out of the robot's working space.
- If the robot is installed at a height, hanging, or other than standing directly on the floor, there may be additional risks than those for a robot standing directly on the floor.
- The axes are affected by the force of gravity when the brakes are released. In addition to the risk of being hit by moving robot parts, there is a risk of being crushed by the parallel arm (if there is one).
- Energy stored in the robot for the purpose of counterbalancing certain axes may be released if the robot, or parts thereof, are dismantled.
- When dismantling/assembling mechanical units, watch out for falling objects.
- Be aware of stored heat energy in the controller.
- Never use the robot as a ladder, which means, do not climb on the robot motors or other parts during service work. There is a serious risk of slipping because of the high temperature of the motors and oil spills that can occur on the robot.
- Never use the robot as a ladder, which means, do not climb on the manipulator motors or other parts during service work. There is a risk of the robot being damaged.

To be observed by the supplier of the complete system

When integrating the robot with external devices and machines:

- The supplier of the complete system must ensure that all circuits used in the safety function are interlocked in accordance with the applicable standards for that function.
- The supplier of the complete system must ensure that all circuits used in the emergency stop function are interlocked in a safe manner, in accordance with the applicable standards for the emergency stop function.

Complete robot

Safety risk	Description
Hot components!	 CAUTION Motors and gearboxes are HOT after running the robot! Touching motors and gearboxes may result in burns! With a higher environment temperature, more surfaces on the manipulator will get HOT and may also result in burns.

Continues on next page

1 Safety

1.2.4.1 Safety risks during installation and service work on robots

Continued

Safety risk	Description
Removed parts may result in collapse of the robot!	 WARNING Take any necessary measures to ensure that the robot does not collapse as parts are removed. For example, secure the lower arm according to the repair instruction if removing the axis-2 motor.
Removed cables to the measurement system	 WARNING If the internal cables for the measurement system have been disconnected during repair or maintenance, then the revolution counters must be updated.

Cabling

Safety risk	Description
Cable packages are sensitive to mechanical damage!	 CAUTION The cable packages are sensitive to mechanical damage. Handle the cable packages and the connectors with care in order to avoid damage.

Gearboxes and motors

Safety risk	Description
Gears may be damaged if excessive force is used!	 CAUTION Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

1.2.4.2 CAUTION - Hot parts may cause burns!

1.2.4.2 CAUTION - Hot parts may cause burns!**Description**

During normal operation, many robot parts become hot, especially the drive motors and gearboxes. Sometimes areas around these parts also become hot. Touching these may cause burns of various severity.

Because of a higher environment temperature, more surfaces on the robot get hot and may result in burns.

Elimination

The following instructions describe how to avoid the dangers specified above:

	Action	Information
1	Always use your hand, at some distance, to feel if heat is radiating from the potentially hot component before actually touching it.	
2	Wait until the potentially hot component has cooled if it is to be removed or handled in any other way.	

1 Safety

1.2.4.3 Safety risks related to tools/work pieces

1.2.4.3 Safety risks related to tools/work pieces

Safe handling

It must be possible to safely turn off tools, such as milling cutters, etc. Make sure that guards remain closed until the cutters stop rotating.

It should be possible to release parts by manual operation (valves).

Safe design

Grippers/end effectors must be designed so that they retain work pieces in the event of a power failure or a disturbance to the controller.

Unauthorized modifications of the originally delivered robot are prohibited. Without the consent of ABB it is forbidden to attach additional parts through welding, riveting, or drilling of new holes into the castings. The strength could be affected.



CAUTION

Ensure that a gripper is prevented from dropping a work piece, if such is used.

1.2.4.4 Safety risks related to pneumatic/hydraulic systems

General

Special safety regulations apply to pneumatic and hydraulic systems.



Note

All components that remain pressurized after separating the machine from the power supply must be provided with clearly visible drain facilities and a warning sign that indicates the need for pressure relief before adjustments or performing any maintenance on the robot system.

Residual energy

- Residual energy can be present in these systems. After shutdown, particular care must be taken.
- The pressure must be released in the complete pneumatic or hydraulic systems before starting to repair them.
- Work on hydraulic equipment may only be performed by persons with special knowledge and experience of hydraulics.
- All pipes, hoses, and connections have to be inspected regularly for leaks and damage. Damage must be repaired immediately.
- Splashed oil may cause injury or fire.

Safe design

- Gravity may cause any parts or objects held by these systems to drop.
- Dump valves should be used in case of emergency.
- Shot bolts should be used to prevent tools, etc., from falling due to gravity.

1 Safety

1.2.4.5 Safety risks during operational disturbances

General

- The industrial robot is a flexible tool that can be used in many different industrial applications.
- All work must be carried out professionally and in accordance with the applicable safety regulations.
- Care must be taken at all times.

Qualified personnel

Corrective maintenance must only be carried out by qualified personnel who are familiar with the entire installation as well as the special risks associated with its different parts.

Extraordinary risks

If the working process is interrupted, extra care must be taken due to risks other than those associated with regular operation. Such an interruption may have to be rectified manually.

1.2.4.6 Risks associated with live electric parts

Voltage related risks, general

Work on the electrical equipment of the robot must be performed by a qualified electrician in accordance with electrical regulations.

- Although troubleshooting may, on occasion, need to be carried out while the power supply is turned on, the robot must be turned off (by setting the main switch to OFF) when repairing faults, disconnecting electric leads and disconnecting or connecting units.
- The main supply to the robot must be connected in such a way that it can be turned off from outside the working space of the robot.
- Make sure that no one else can turn on the power to the controller and robot while you are working with the system. A good method is to always lock the main switch on the controller cabinet with a safety lock.

The necessary protection for the electrical equipment and robot system during construction, commissioning, and maintenance is guaranteed if the valid regulations are followed.

All work must be performed:

- by qualified personnel
- on machine/robot system in deadlock
- in an isolated state, disconnected from power supply, and protected against reconnection.

Voltage related risks, IRC5 controller

A danger of high voltage is associated with, for example, the following parts:

- Be aware of stored electrical energy (DC link, Ultracapacitor bank unit) in the controller.
- Units such as I/O modules, can be supplied with power from an external source.
- The main supply/main switch
- The transformers
- The power unit
- The control power supply (230 VAC)
- The rectifier unit (262/400-480 VAC and 400/700 VDC. Note: capacitors!)
- The drive unit (400/700 VDC)
- The drive system power supply (230 VAC)
- The service outlets (115/230 VAC)
- The customer power supply (230 VAC)
- The power supply unit for additional tools, or special power supply units for the machining process.
- The external voltage connected to the controller remains live even when the robot is disconnected from the mains.
- Additional connections.

Continues on next page

1 Safety

1.2.4.6 Risks associated with live electric parts

Continued

Voltage related risks, robot

A danger of high voltage is associated with the robot in:

- The power supply for the motors (up to 800 VDC).
 - The user connections for tools or other parts of the installation (max. 230 VAC).
-

Voltage related risks, tools, material handling devices, etc.

Tools, material handling devices, etc., may be live even if the robot system is in the OFF position. Power supply cables which are in motion during the working process may be damaged.

1.2.5 Safety actions

1.2.5.1 Safety fence dimensions

General

Install a safety cell around the robot to ensure safe robot installation and operation.

Dimensioning

The fence or enclosure must be dimensioned to withstand the force created if the load being handled by the robot is dropped or released at maximum speed.

Determine the maximum speed from the maximum velocities of the robot axes and from the position at which the robot is working in the work cell (see the section *Robot motion* in the *Product specification*).

Also consider the maximum possible impact caused by a breaking or malfunctioning rotating tool or other device fitted to the robot.

1 Safety

1.2.5.2 Fire extinguishing



Note

Use a CARBON DIOXIDE (CO₂) extinguisher in the event of a fire in the robot or controller!

1.2.5.3 Emergency release of the robot arm

Description

In an emergency situation, the brakes on a robot axis can be released manually by pushing a brake release button.

How to release the brakes is detailed in the section:

- [Manually releasing the brakes on page 74.](#)

The robot arm may be moved manually on smaller robot models, but larger models may require using an overhead crane or similar equipment.

Increased injury

Before releasing the brakes, make sure that the weight of the arms does not increase the pressure on the trapped person, further increasing any injury!



DANGER

When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways.

Make sure no personnel is near or beneath the robot arm.

1 Safety

1.2.5.4 Brake testing

1.2.5.4 Brake testing

When to test

During operation, the holding brake of each axis normally wears down. A test can be performed to determine whether the brake can still perform its function.

How to test

The function of the holding brake of each axis motor may be verified as described below:

- 1 Run each robot axis to a position where the combined weight of the robot arm and any load is maximized (maximum static load).
- 2 Switch the motor to the MOTORS OFF.
- 3 Inspect and verify that the axis maintains its position.

If the robot does not change position as the motors are switched off, then the brake function is adequate.

1.2.5.5 Risk of disabling function "Reduced speed 250 mm/s"



Note

Do not change *Transm gear ratio* or other kinematic system parameters from the FlexPendant or a PC. This will affect the safety function "Reduced speed 250 mm/s".

1 Safety

1.2.5.6 Safe use of the jogging device

1.2.5.6 Safe use of the jogging device

Three-position enabling device

The three-position enabling device is a manually operated, constant pressure push-button which, when continuously activated in one position only, allows potentially hazardous functions but does not initiate them. In any other position, hazardous functions are stopped safely.

The three-position enabling device is of a specific type where you must press the push-button only half-way to activate it. In the fully in and fully out positions, operating the robot is impossible.



Note

The three-position enabling device is a push-button located on the jogging device which, when pressed halfway in, switches the system to MOTORS ON. When the enabling device is released or pushed all the way in, the manipulator switches to the MOTORS OFF state.

To ensure safe use of the jogging device, the following must be implemented:

- The enabling device must never be rendered inoperational in any way.
- During programming and testing, the enabling device must be released as soon as there is no need for the robot to move.
- Anyone entering the working space of the robot must always bring the jogging device with him/her. This is to prevent anyone else from taking control of the robot without his/her knowledge.

Hold-to-run function

The hold-to-run function allows movement when a button connected to the function is actuated manually and immediately stops any movement when released. The hold-to-run function can only be used in manual mode.

How to operate the hold-to-run function for IRC5 is described in *Operating manual - IRC5 with FlexPendant*.

1.2.5.7 Work inside the working range of the robot



WARNING

If work must be carried out within the work area of the robot, then the following points must be observed:

- The operating mode selector on the controller must be in the manual mode position to render the three-position enabling device operational and to block operation from a computer link or remote control panel.
- The maximum speed of the robot is limited to 250 mm/s when the operating mode selector is in the position *Manual mode with reduced speed*. This should be the normal position when entering the working space.
The position *Manual mode with full speed (100%)* may only be used by trained personnel who are aware of the risks that this entails. *Manual mode with full speed (100%)* is not available in USA or Canada.
- Pay attention to the rotating axes of the robot. Keep away from axes to not get entangled with hair or clothing. Also, be aware of any danger that may be caused by rotating tools or other devices mounted on the robot or inside the cell.
- Test the motor brake on each axis, according to the section [Brake testing on page 34](#).
- To prevent anyone else from taking control of the robot, always put a safety lock on the cell door and bring the three-position enabling device with you when entering the working space.



WARNING

NEVER, under any circumstances, stay beneath any of the robot's axes! There is always a risk that the robot will move unexpectedly when robot axes are moved using the three-position enabling device or during other work inside the working range of the robot.

1 Safety

1.2.5.8 Signal lamp (optional)

1.2.5.8 Signal lamp (optional)

Description

A signal lamp with a yellow fixed light can be mounted on the robot, as a safety device.

Function

The lamp is active in MOTORS ON mode.

Further information

Further information about the MOTORS ON/MOTORS OFF mode may be found in the product manual for the controller.

1.3 Safety signals and symbols

1.3.1 Safety signals in the manual

Introduction to safety signals

This section specifies all dangers that can arise when doing the work described in the user manuals. Each danger consists of:

- A caption specifying the danger level (DANGER, WARNING, or CAUTION) and the type of danger.
- A brief description of what will happen if the operator/service personnel do not eliminate the danger.
- Instruction about how to eliminate danger to simplify doing the work.

Danger levels

The table below defines the captions specifying the danger levels used throughout this manual.

Symbol	Designation	Significance
 xx0200000022	DANGER	Warns that an accident <i>will</i> occur if the instructions are not followed, resulting in a serious or fatal injury and/or severe damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, and so on.
 xx0100000002	WARNING	Warns that an accident <i>may</i> occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, etc.
 xx0200000024	ELECTRICAL SHOCK	Warns for electrical hazards which could result in severe personal injury or death.
 xx0100000003	CAUTION	Warns that an accident <i>may</i> occur if the instructions are not followed that can result in injury and/or damage to the product. It also applies to warnings of risks that include burns, eye injury, skin injury, hearing damage, crushing or slipping, tripping, impact, fall from height, etc. Furthermore, it applies to warnings that include function requirements when fitting and removing equipment where there is a risk of damaging the product or causing a breakdown.
 xx0200000023	ELECTROSTATIC DISCHARGE (ESD)	Warns for electrostatic hazards which could result in severe damage to the product.

Continues on next page

1 Safety

1.3.1 Safety signals in the manual

Continued

Symbol	Designation	Significance
 xx010000004	NOTE	Describes important facts and conditions.
 xx010000098	TIP	Describes where to find additional information or how to do an operation in an easier way.

1.3.2 Safety symbols on product labels

Introduction to labels

This section describes safety symbols used on labels (stickers) on the product.

Symbols are used in combinations on the labels, describing each specific warning. The descriptions in this section are generic, the labels can contain additional information such as values.



Note

The safety and health symbols on the labels on the product must be observed. Additional safety information given by the system builder or integrator must also be observed.

Types of labels

Both the robot and the controller are marked with several safety and information labels, containing important information about the product. The information is useful for all personnel handling the robot system, for example during installation, service, or operation.

The safety labels are language independent, they only use graphics. See [Symbols on safety labels on page 41](#).

The information labels can contain information in text (English, German, and French).

Symbols on safety labels

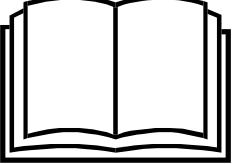
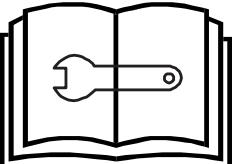
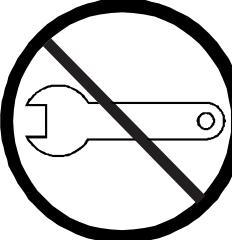
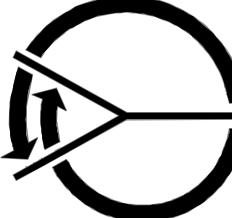
Symbol	Description
	Warning! Warns that an accident <i>may</i> occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, etc. <small>xx0900000812</small>
	Caution! Warns that an accident may occur if the instructions are not followed that can result in injury and/or damage to the product. It also applies to warnings of risks that include burns, eye injury, skin injury, hearing damage, crushing or slipping, tripping, impact, fall from height, etc. Furthermore, it applies to warnings that include function requirements when fitting and removing equipment where there is a risk of damaging the product or causing a breakdown. <small>xx0900000811</small>
	Prohibition Used in combinations with other symbols. <small>xx0900000839</small>

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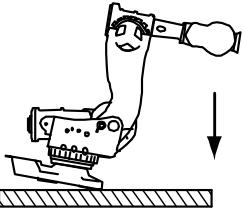
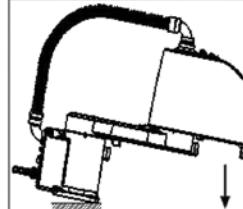
1 Safety

1.3.2 Safety symbols on product labels

Continued

Symbol	Description
 xx0900000813	See user documentation Read user documentation for details. Which manual to read is defined by the symbol: <ul style="list-style-type: none">• No text: <i>Product manual</i>.• EPS: <i>Application manual - Electronic Position Switches</i>.
 xx0900000816	Before disassemble, see product manual
 xx0900000815	Do not disassemble Disassembling this part can cause injury.
 xx0900000814	Extended rotation This axis has extended rotation (working area) compared to standard.
 xx0900000808	Brake release Pressing this button will release the brakes. This means that the robot arm can fall down.

Continues on next page

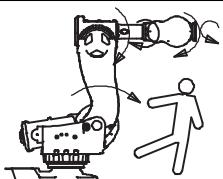
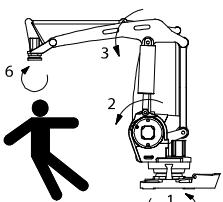
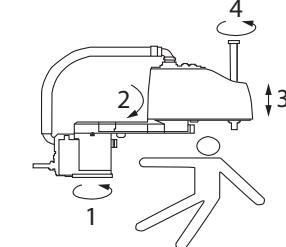
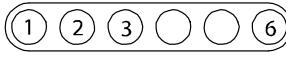
Symbol	Description
 xx0900000810	Tip risk when loosening bolts The robot can tip over if the bolts are not securely fastened.
  3HAC 057068-001	
  xx0900000817	Crush Risk of crush injuries.
 xx0900000818	Heat Risk of heat that can cause burns.

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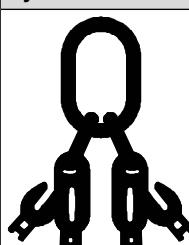
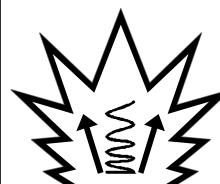
1 Safety

1.3.2 Safety symbols on product labels

Continued

Symbol	Description
 xx0900000819	Moving robot The robot can move unexpectedly.
 xx1000001141	
 xx1500002616	
 xx0900000820	Brake release buttons
 xx1000001140	
 xx0900000821	Lifting bolt

Continues on next page

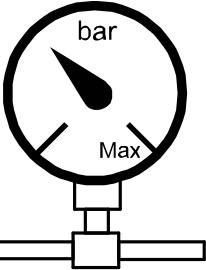
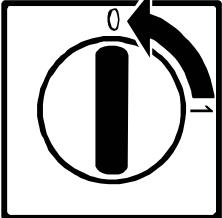
Symbol	Description
 xx1000001242	Chain sling with shortener
 xx0900000822	Lifting of robot
 xx0900000823	Oil Can be used in combination with prohibition if oil is not allowed.
 xx0900000824	Mechanical stop
 xx1000001144	No mechanical stop
 xx0900000825	Stored energy Warns that this part contains stored energy. Used in combination with <i>Do not disassemble</i> symbol.

Continues on next page

1 Safety

1.3.2 Safety symbols on product labels

Continued

Symbol	Description
 xx0900000826	Pressure Warns that this part is pressurized. Usually contains additional text with the pressure level.
 xx0900000827	Shut off with handle Use the power switch on the controller.
 xx1400002648	Do not step Warns that stepping on these parts can cause damage to the parts.

1.4.1 DANGER - Moving robots are potentially lethal!

1.4 Safety related instructions

1.4.1 DANGER - Moving robots are potentially lethal!

Description

Any moving robot is a potentially lethal machine.

When running, the robot may perform unexpected and sometimes irrational movements. Moreover, all movements are performed with great force and may seriously injure any personnel and/or damage any piece of equipment located within the working range of the robot.

Elimination

	Action	Note
1	Before attempting to run the robot, make sure all emergency stop equipment is correctly installed and connected.	Emergency stop equipment such as gates, tread mats, light curtains, etc.
2	Usually the hold-to-run function is active only in manual full speed mode. To increase safety it is also possible to activate hold-to-run for manual reduced speed with a system parameter. The hold-to-run function is used in manual mode, not in automatic mode.	How to use the hold-to-run function is described in section <i>How to use the hold-to-run function</i> in the <i>Operating manual - IRC5 with FlexPendant</i> .
3	Make sure no personnel are present within the working range of the robot before pressing the start button.	

1 Safety

1.4.2 DANGER - First test run may cause injury or damage!

Description

Since performing a service activity often requires disassembly of the robot, there are several safety risks to take into consideration before the first test run.

Elimination

Follow the procedure below when performing the first test run after a service activity, such as repair, installation, or maintenance.



DANGER

Running the robot without fulfilling the following aspects, may cause severe damage to the robot.

	Action
1	Remove all service tools and foreign objects from the robot and its working area.
2	Verify that the robot is secured to its position, see installation section in the product manual for the robot.
3	Verify that any safety equipment installed to secure the robot arm position or restrict the robot arm motion during service activity is removed.
4	Verify that the fixture and work piece are well secured, if applicable.
5	Install all safety equipment properly.
6	Make sure all personnel are standing at a safe distance from the robot, that is out of its reach behind safety fences, and so on.
7	Pay special attention to the function of the part that previously was serviced.

Collision risks



CAUTION

When programming the movements of the robot, always identify potential collision risks before the first test run.

1.4.3 WARNING - The brake release buttons may be jammed after service work

1.4.3 WARNING - The brake release buttons may be jammed after service work

Description

The brake release unit has push-buttons for the brake release of each axis motor. When service work is performed inside the SMB recess that includes removal and refitting of the brake release unit, the brake release buttons may be jammed after refitting.

**DANGER**

If the power is turned on while a brake release button is jammed in depressed position, the affected motor brake is released! This may cause serious personal injuries and damage to the robot.

Elimination

To eliminate the danger after service work has been performed inside the SMB recess, follow the procedure below.

	Action
1	Make sure the power is turned off.
2	Remove the push-button guard, if necessary.
3	Verify that the push-buttons of the brake release unit are working by pressing them down, one by one. Make sure none of the buttons are jammed in the tube.
4	If a button gets jammed in the depressed position, the alignment of the brake release unit must be adjusted so that the buttons can move freely in their tubes!

1 Safety

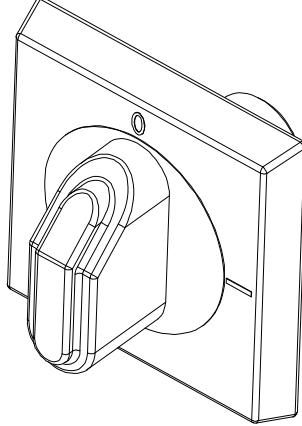
1.4.4 DANGER - Make sure that the main power has been switched off!

1.4.4 DANGER - Make sure that the main power has been switched off!

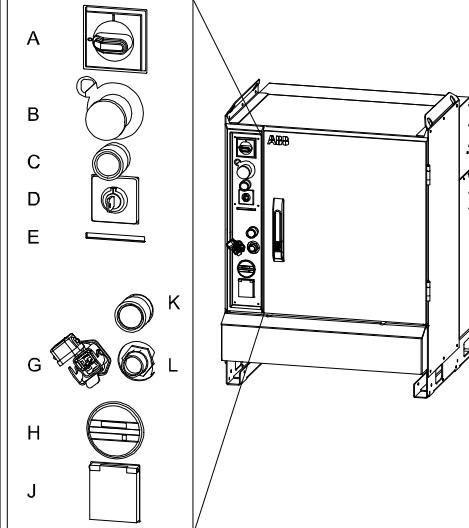
Description

Working with high voltage is potentially lethal. Persons subjected to high voltage may suffer cardiac arrest, burn injuries, or other severe injuries. To avoid these dangers, do not proceed working before eliminating the danger as detailed below.

Elimination, IRC5 Panel Mounted Controller

	Action	Note/illustration
1	Switch off the main switch for the controller.	 xx0600003255

Elimination, IRC5 Single Cabinet Controller

	Action	Note/illustration
1	Switch off the main switch on the controller cabinet.	 xx0600002782 A: Main switch

Continues on next page

1.4.4 DANGER - Make sure that the main power has been switched off!

Continued

Elimination, IRC5 Dual Cabinet Controller

	Action	Note/illustration
1	Switch off the main switch on the Drive Module.	<p>xx0600002783</p> <p>K: Main switch, Drive Module</p>
2	Switch off the main switch on the Control Module.	A: Main switch, Control Module

Elimination, IRC5 Compact Controller

	Action	Note/illustration
1	Switch off the main power switch on the controller cabinet.	<p>Note that the position of the main switch can vary depending on the year model.</p> <p>xx0900000313</p> <p>A: Main power switch</p>
2	Disconnect the input power cable from the wall socket.	

1 Safety

1.4.5 WARNING - The unit is sensitive to ESD!

Description

ESD (electrostatic discharge) is the transfer of electrical static charge between two bodies at different potentials, either through direct contact or through an induced electrical field. When handling parts or their containers, personnel not grounded may potentially transfer high static charges. This discharge may destroy sensitive electronics.

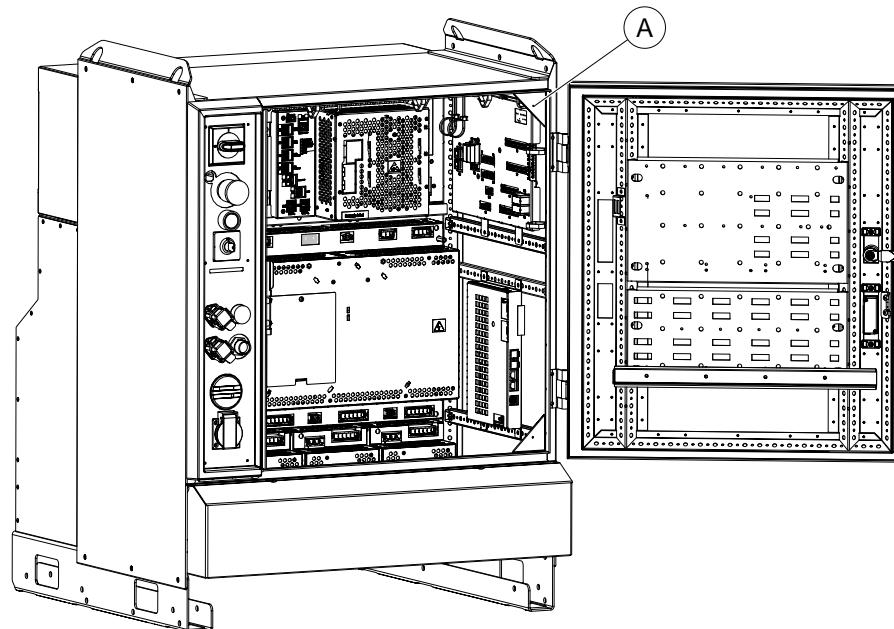
Elimination

Action	Note
1 Use a wrist strap.	Wrist straps must be tested frequently to ensure that they are not damaged and are operating correctly.
2 Use an ESD protective floor mat.	The mat must be grounded through a current-limiting resistor.
3 Use a dissipative table mat.	The mat should provide a controlled discharge of static voltages and must be grounded.

Location of wrist strap button

The location of the wrist strap button is shown in the following illustration.

IRC5



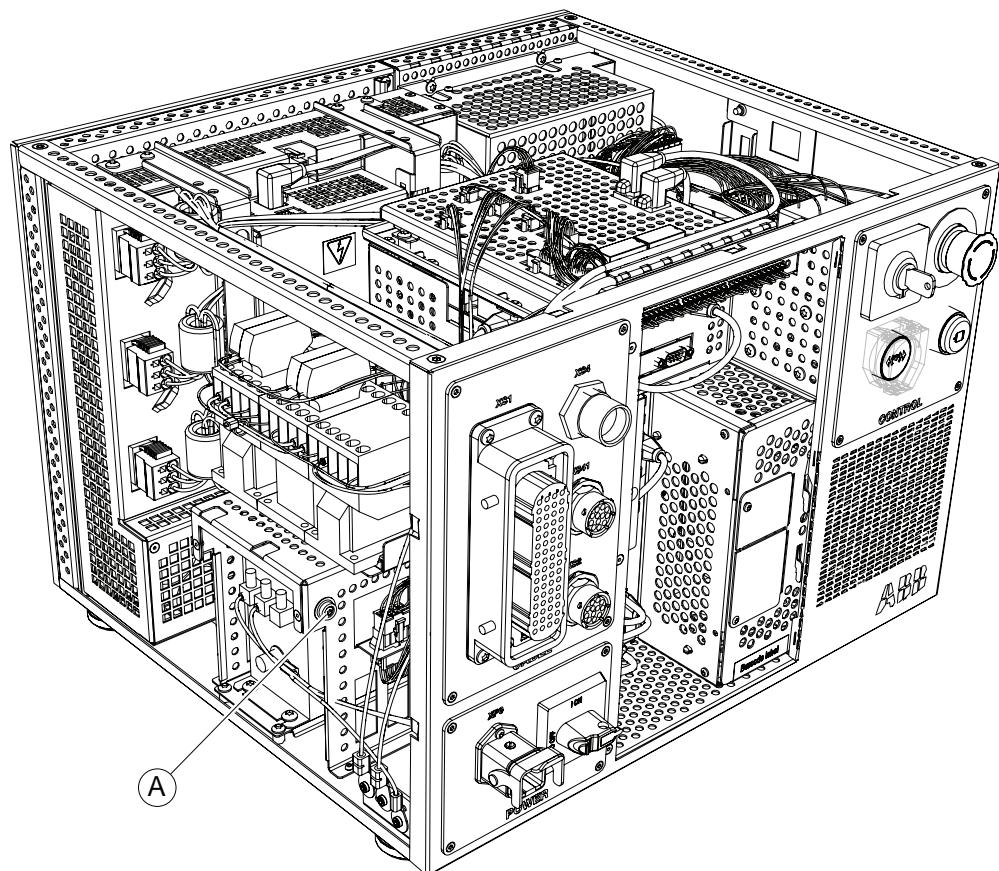
A Wrist strap button

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1.4.5 WARNING - The unit is sensitive to ESD!

Continued

IRC5 Compact Controller



xx1400001622

A	Wrist strap button
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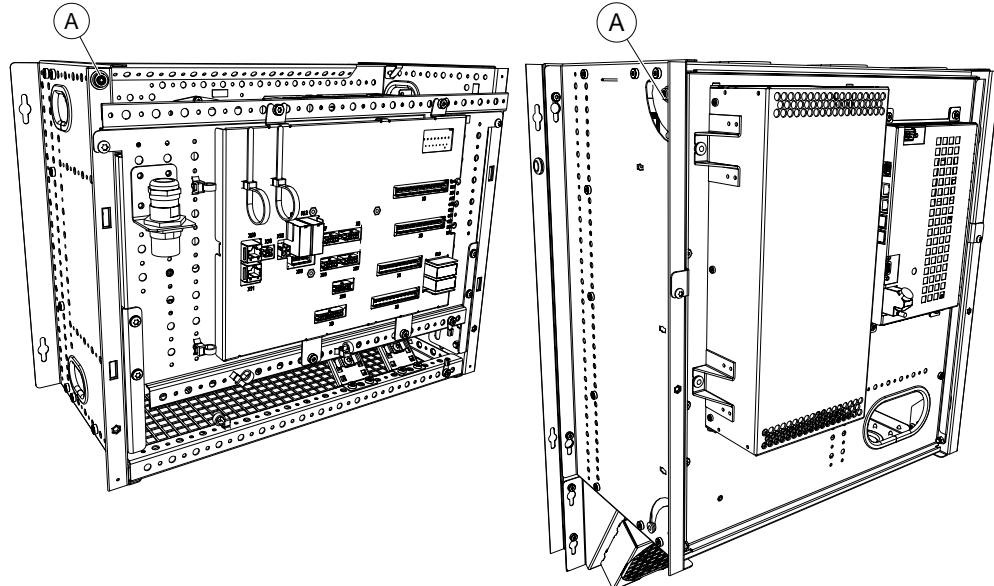
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1 Safety

1.4.5 WARNING - The unit is sensitive to ESD!

Continued

Panel Mounted Controller



xx1300001960

A	Wrist strap button
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1.4.6 WARNING - Safety risks during handling of batteries

Description

Under normal conditions of use, the electrode materials and liquid electrolyte in the batteries are not exposed to the outside, provided the battery integrity is maintained and seals remain intact.

There is a risk of exposure only in case of abuse (mechanical, thermal, electrical) which leads to the activation of safety valves and/or the rupture of the battery container. Electrolyte leakage, electrode materials reaction with moisture/water or battery vent/explosion/fire may follow, depending upon the circumstances.



Note

Appropriate disposal regulations must be observed.

Elimination

	Action	Note
1	Do not short circuit, recharge, puncture, incinerate, crush, immerse, force discharge or expose to temperatures above the declared operating temperature range of the product. Risk of fire or explosion.	Operating temperatures are listed in Pre-installation procedure on page 60 .
2	Use safety glasses when handling the batteries.	
3	In the event of leakage, wear gloves and chemical apron.	
4	In the event of fire, use self-contained breathing apparatus.	

1 Safety

1.4.7 WARNING - Safety risks during work with gearbox lubricants (oil or grease)

Description

When handling gearbox lubricants, there is a risk of both personal injury and product damage occurring. The following safety information must be regarded before performing any work with lubricants in the gearboxes.



Note

When handling oil, grease, or other chemical substances the safety information of the manufacturer must be observed.



Note

When aggressive media is handled, an appropriate skin protection must be provided. Gloves and goggles are recommended.



Note

Appropriate disposal regulations must be observed.



Note

Take special care when handling hot lubricants.

Warnings and elimination

Warning	Description	Elimination/Action
 xx0100000002 Hot oil or grease	Changing and draining gearbox oil or grease may require handling hot lubricant heated up to 90 °C.	Make sure that protective gear like goggles and gloves are always worn during this activity.
 xx0100000002 Allergic reaction	When working with gearbox lubricant there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.
 xx0100000002 Possible pressure build-up in gearbox	When opening the oil or grease plug, there may be pressure present in the gearbox, causing lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling.

Continues on next page

1.4.7 WARNING - Safety risks during work with gearbox lubricants (oil or grease)

Continued

Warning	Description	Elimination/Action
 xx0100000002 Do not overfill	<p>Overfilling of gearbox lubricant can lead to internal over-pressure inside the gearbox which in turn may:</p> <ul style="list-style-type: none"> • damage seals and gaskets • completely press out seals and gaskets • prevent the robot from moving freely. 	<p>Make sure not to overfill the gearbox when filling it with oil or grease!</p> <p>After filling, verify that the level is correct.</p>
 xx0100000002 Do not mix types of oil	<p>Mixing types of oil may cause severe damage to the gearbox.</p>	<p>When filling gearbox oil, do not mix different types of oil unless specified in the instructions. Always use the type of oil specified by the manufacturer!</p>
 xx0100000098 Heat up the oil	<p>Warm oil drains quicker than cold oil.</p>	<p>When changing gearbox oil, first run the robot for a time to heat up the oil.</p>
 xx0100000004 Specified amount depends on drained volume	<p>The specified amount of oil or grease is based on the total volume of the gearbox. When changing the lubricant, the amount refilled may differ from the specified amount, depending on how much has previously been drained from the gearbox.</p>	<p>After filling, verify that the level is correct.</p>
 xx0100000003 Contaminated oil in gear boxes	<p>When draining the oil make sure that as much oil as possible is drained from the gearbox. The reason for this is to drain as much oil sludge and metal chips as possible from the gearbox. The magnetic oil plugs will take care of any remaining metal chips.</p>	

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2 Installation and commissioning

2.1 Introduction

General

This chapter contains assembly instructions and information for installing the IRB 460 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 460, such as:

- Load diagram
- Permitted extra loads (equipment), if any
- Location of extra loads (equipment), if any.

Safety information

Before any installation work is commenced, it is extremely important that all safety information is observed!

There are general safety aspects that must be read through, as well as more specific safety information that describes the danger and safety risks when performing the procedures. Read the chapter [Safety on page 17](#) before performing any installation work.



Note

If the IRB 460 is connected to power, always make sure that the robot is connected to *protective earth* before starting any installation work!

For more information see:

- *Product manual - IRC5*

2 Installation and commissioning

2.2.1 Pre-installation procedure

2.2 Unpacking

2.2.1 Pre-installation procedure

Introduction

This section is intended for use when unpacking and installing the robot for the first time. It also contains information useful during later re-installation of the robot.

Prerequisites for installation personnel

Installation personnel working with an ABB product must:

- be trained by ABB and have the required knowledge of mechanical and electrical installation/maintenance/repair work
- conform to all national and local codes.

Checking the pre-requisites for installation

	Action
1	Make a visual inspection of the packaging and make sure that nothing is damaged.
2	Remove the packaging.
3	Check for any visible transport damage.  Note Stop unpacking and contact ABB if transport damages are found.
4	Clean the unit with a lint-free cloth, if necessary.
5	Make sure that the lifting accessory used is suitable to handle the weight of the robot as specified in: Weight, robot on page 60
6	If the robot is not installed directly, it must be stored as described in: Storage conditions, robot on page 62
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: Operating conditions, robot on page 62
8	Before taking the robot to its installation site, make sure that the site conforms to: <ul style="list-style-type: none">• Loads on foundation, robot on page 61• Protection classes, robot on page 62• Requirements, foundation on page 62
9	Before moving the robot, please observe the stability of the robot: Risk of tipping/stability on page 65
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: On-site installation on page 66
11	Install required equipment, if any. <ul style="list-style-type: none">• Installation of signal lamp, upper arm (option) on page 90

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 460	925 kg

Continues on next page



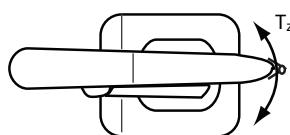
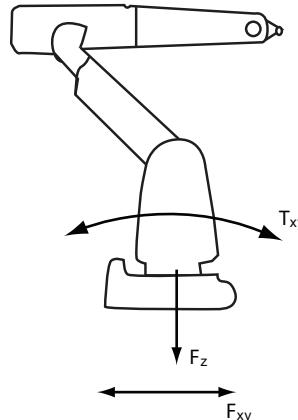
Note

The weight does not include tools and other equipment fitted on the robot!

Loads on foundation, robot

The illustration shows the directions of the robots stress forces.

The directions are valid for all floor mounted, suspended and inverted robots.



xx1100000521

F_{xy}	Force in any direction in the XY plane
F_z	Force in the Z plane
T_{xy}	Bending torque in any direction in the XY plane
T_z	Bending torque in the Z plane

The table shows the various forces and torques working on the robot during different kinds of operation.



Note

These forces and torques are extreme values that are rarely encountered during operation. The values also never reach their maximum at the same time!

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 6.2 kN	± 10.6 kN
Force z	10 ± 3.8 kN	10 ± 6.5 kN
Torque xy	± 13.7 kNm	± 23 kNm
Torque z	± 5.3 kNm	± 7.9 kNm

Continues on next page

2 Installation and commissioning

2.2.1 Pre-installation procedure

Continued

Requirements, foundation

The table shows the requirements for the foundation where the weight of the installed robot is included:

Requirement	Value	Note
Flatness of foundation surface	0.3 mm	Flat foundations give better repeatability of the resolver calibration compared to original settings on delivery from ABB. The value for levelness aims at the circumstance of the anchoring points in the robot base. In order to compensate for an uneven surface, the robot can be recalibrated during installation. If resolver/encoder calibration is changed this will influence the absolute accuracy.
Maximum tilt	5°	
Minimum resonance frequency	20 Hz	

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

Parameter	Value
Minimum ambient temperature	-25° C
Maximum ambient temperature	+55° C
Maximum ambient temperature (less than 24 hrs)	+70° C
Maximum ambient humidity	95% at constant temperature (gaseous only)

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

Parameter	Value
Minimum ambient temperature	0° C ⁱ
Maximum ambient temperature	+45° C
Maximum ambient humidity	95% at constant temperature

ⁱ During cold start (0° C - 5° C), see [Start of robot in cold environments on page 103](#).

Protection classes, robot

The table shows the available protection types of the robot, with the corresponding protection class.

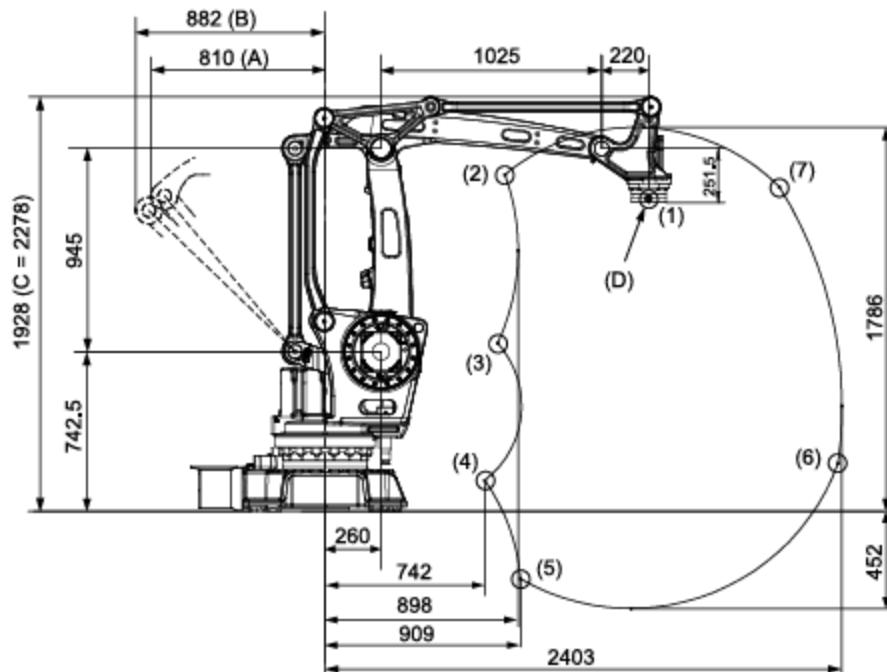
Protection type	Protection class
Manipulator, protection type Standard	IP 67

2.2.2 Working range and type of motion

Working range

The following figures show the working ranges of the robot variants. The extreme positions of the robot arm are specified at the wrist center (dimensions in mm).

IRB 460 - 110/2.4



xx1000001043

A	Maximal working range
B	Mechanical stop
C	Maximal working range
D	Tool flange center

Position in figure	Position (mm)		Angles (°)	
	X	Z	Axis 2	Axis 3
1	1505	1437	0	0
2	836	1565	-40	-20
3	802	782	-40	25
4	742	145	55	120
5	909	-314	85	120
6	2385	223	85	20
7	2111	1510	45	-20

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2 Installation and commissioning

2.2.2 Working range and type of motion

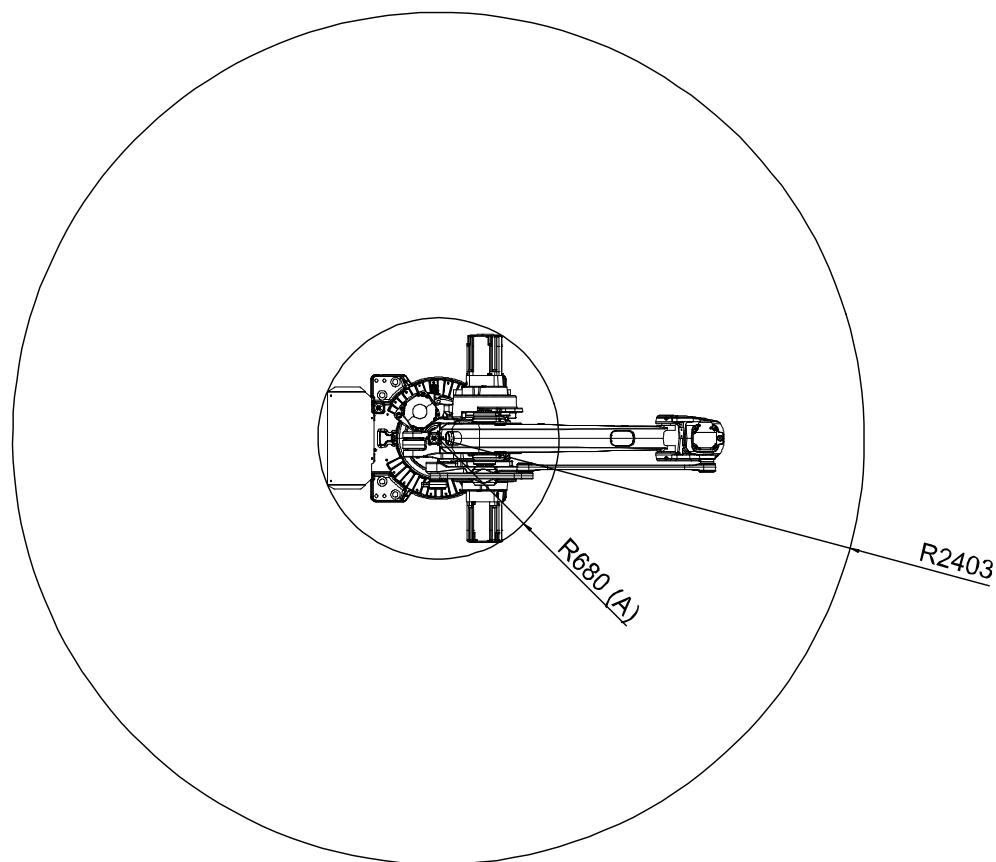
Continued

Type of motion

The table below specifies the types and ranges of the robot motion in every axis.

Axis	Type of motion	Range of motion
1	Rotation motion	-165° to +165°
2	Arm motion	-40° to +85°
3	Arm motion	-20° to +120°
2-3	Arm motion	25° to 155°
6	Turn motion	-300° to +300°

Turning radius



xx1000001202

(A)	Motor, axis 3
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2.2.3 Risk of tipping/stability

Risk of tipping

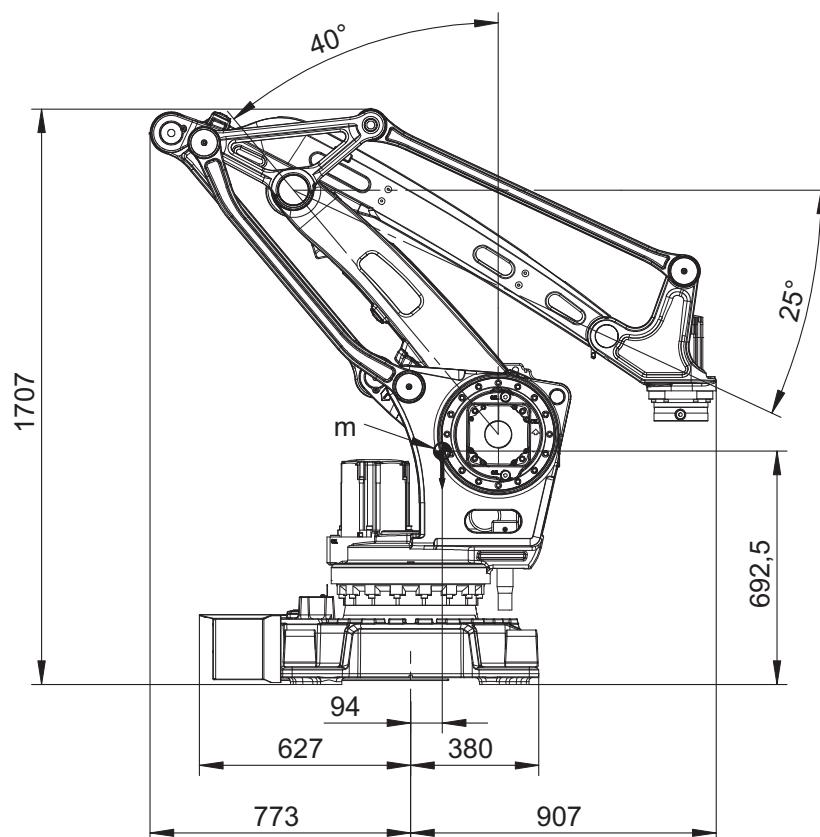
If the robot is not fastened to the foundation while moving the arm, the robot is not stable in the whole working area. Moving the arm will displace the center of gravity, which may cause the robot to tip over.

The shipping position is the most stable position.

Do not change the robot position before securing it to the foundation!

Shipping and transportation position

This figure shows the robot in its shipping position and transportation position.



xx1000001158



WARNING

The robot is likely to be mechanically unstable if not secured to the foundation.

2 Installation and commissioning

2.3.1.1 Fitting the fork lift accessory

2.3 On-site installation

2.3.1 Lifting the robot with fork lift accessory

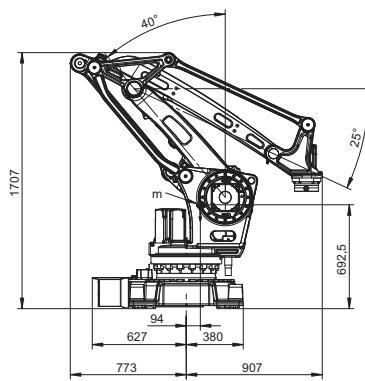
2.3.1.1 Fitting the fork lift accessory

Required equipment

The following equipment is required when lifting a robot with the fork lift accessory:

Equipment	Art. no.	Note
Fork lift pocket set	3HAC025040-003	The fork lift accessory set contains: <ul style="list-style-type: none">• fork lift pocket 3HAC025528-001, with CE-Marking fitted (4 pcs)• attachment screws M20x60 Steel 8.8-A3F (8 pcs)• Drawing Fork lift accessory set• manual <i>Directions for use - Fork lift accessory for IRB 6620, 6640, 460</i>
Fork lift truck	-	The operator must be fully trained and authorized to operate a fork lift truck.

Preparations before fitting the fork lift pockets

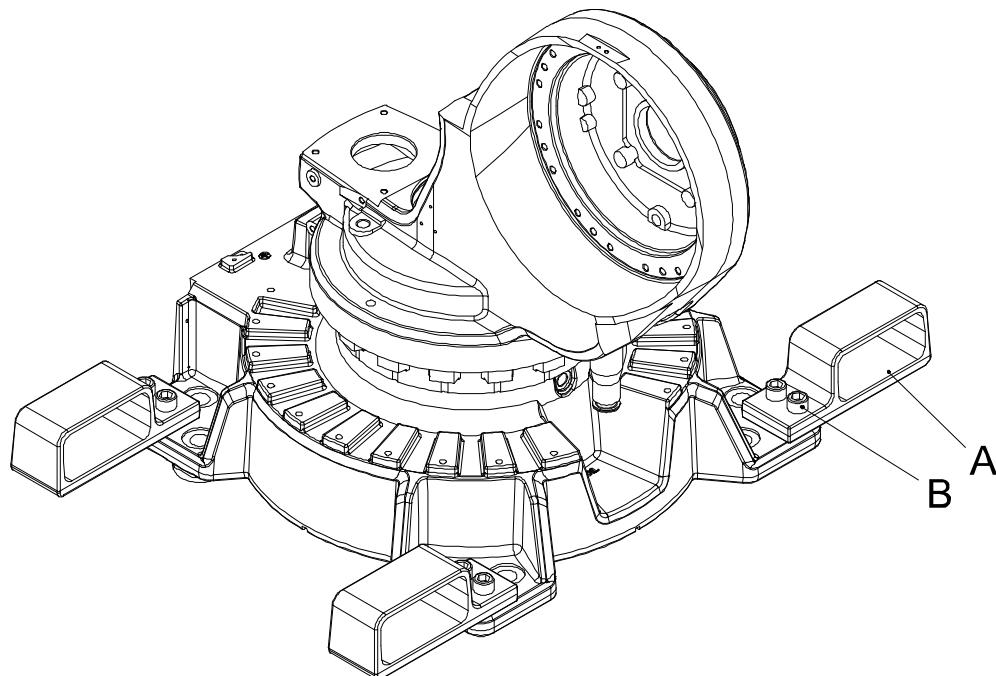
	Action	Note
1	<p>Remove any tools fitted on the axis-6 turning disk.  Note</p> <p>No tool is permitted to be fitted on the robot when lifting the robot with the fork lift accessory!</p>	DressPack, if used, can stay fitted as long as the tool fitted on the turning disk is removed.
2	<p>Jog the robot to its shipping position. See figures for the different IRB models.  Note</p> <p>The figures shows the shipping position of an <i>undressed</i> robot. If the robot is dressed, this must be taken into consideration when the robot is being lifted.</p>	 <p>xx1000001158</p>

Continues on next page

Action	Note
<p>3  DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply <p>to the robot, before entering the robot working area.</p>	

Attachment points on the robot

The fork lift accessory is fitted on the robot as shown in the figure.



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A	Fork lift pocket
B	Attachment screw M20x60 quality 8.8 (2 pcs x4)

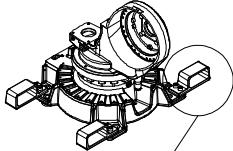
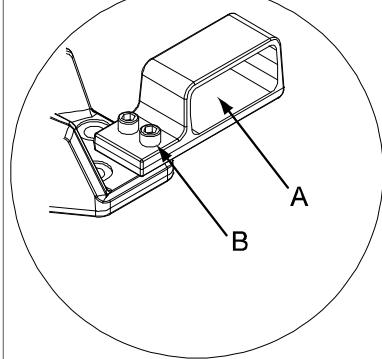
Continues on next page

2 Installation and commissioning

2.3.1.1 Fitting the fork lift accessory

Continued

Fitting the fork lift accessory set

	Action	Note
1	<p>Fit the four fork lift pockets on the base of the robot with its attachment screws.</p> <p> Note</p> <p>Before fitting any attachment screws, make sure they are not damaged in any way. Replace damaged screws.</p>	<p>Tightening torque: 300 Nm</p>   <p>xx0600002930</p> <p>A Fork lift pocket (4 pcs) B Attachment screw M20x60 quality 8.8 (2 pcs x4)</p>
2	Verify that all four fork lift pockets are properly secured before lifting.	

2.3.1.2 Lifting the robot with fork lift truck

General

The robot may be moved using a fork lift truck, provided that a complete fork lift accessory set, aimed for the robot, is used.

This section describes how to lift the robot with a fork lift truck.

Required equipment

Equipment	Art. no.	Note
Fork lift accessory	3HAC025040-003	
Fork lift truck		

Lifting the robot with fork lift truck

	Action	Note
1	Make sure that the robot is in shipping position!	 Note No load is permitted on the robot!
2	 DANGER Make sure that all supplies for electrical power, hydraulic pressure, and air pressure are turned off.	
3	Verify that all four fork lift pockets are properly secured before lifting.	

Continues on next page

2 Installation and commissioning

2.3.1.2 Lifting the robot with fork lift truck

Continued

Action	Note
<p>4 Insert fork lift forks into the pockets.</p> <p>CAUTION</p> <p>Lifting the robot with fork lift shall only be done with all four fork lift pockets fitted! If lifting with fewer than four fork lift pockets fitted, there is a risk of accidents!</p>	<p>IRB 6620</p> <p>xx0600002911</p> <p>IRB 6640</p> <p>xx0600003401</p> <p>IRB 460</p> <p>xx1000001159</p>

Continues on next page

2 Installation and commissioning

2.3.1.2 Lifting the robot with fork lift truck

Continued

	Action	Note
5	Remove the attachment bolts securing the robot to the foundation.	
6	 CAUTION The IRB 460 robot weighs 925 kg. All lifting accessories used must be sized accordingly!	
7	Carefully lift the robot.  WARNING Personnel must not, under any circumstances, be present under the suspended load!	
8	Move the robot slowly to its new position.	 Note Move the robot with low speed!
9	Secure the robot to the foundation  DANGER Do not power the robot up until it is secured properly to the foundation.	
10	Remove the fork lift accessories.	

2 Installation and commissioning

2.3.2 Lifting robot with roundslings

2.3.2 Lifting robot with roundslings

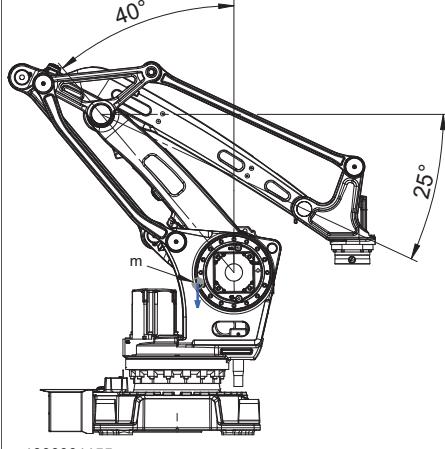
General

The robot can be lifted with roundslings according to this section.

Sling specification

Sling type	Qty	Lifting capacity	Length / Note
Roundsling, robot	5 pcs	2 000 kg	2 m

Lifting with roundslings

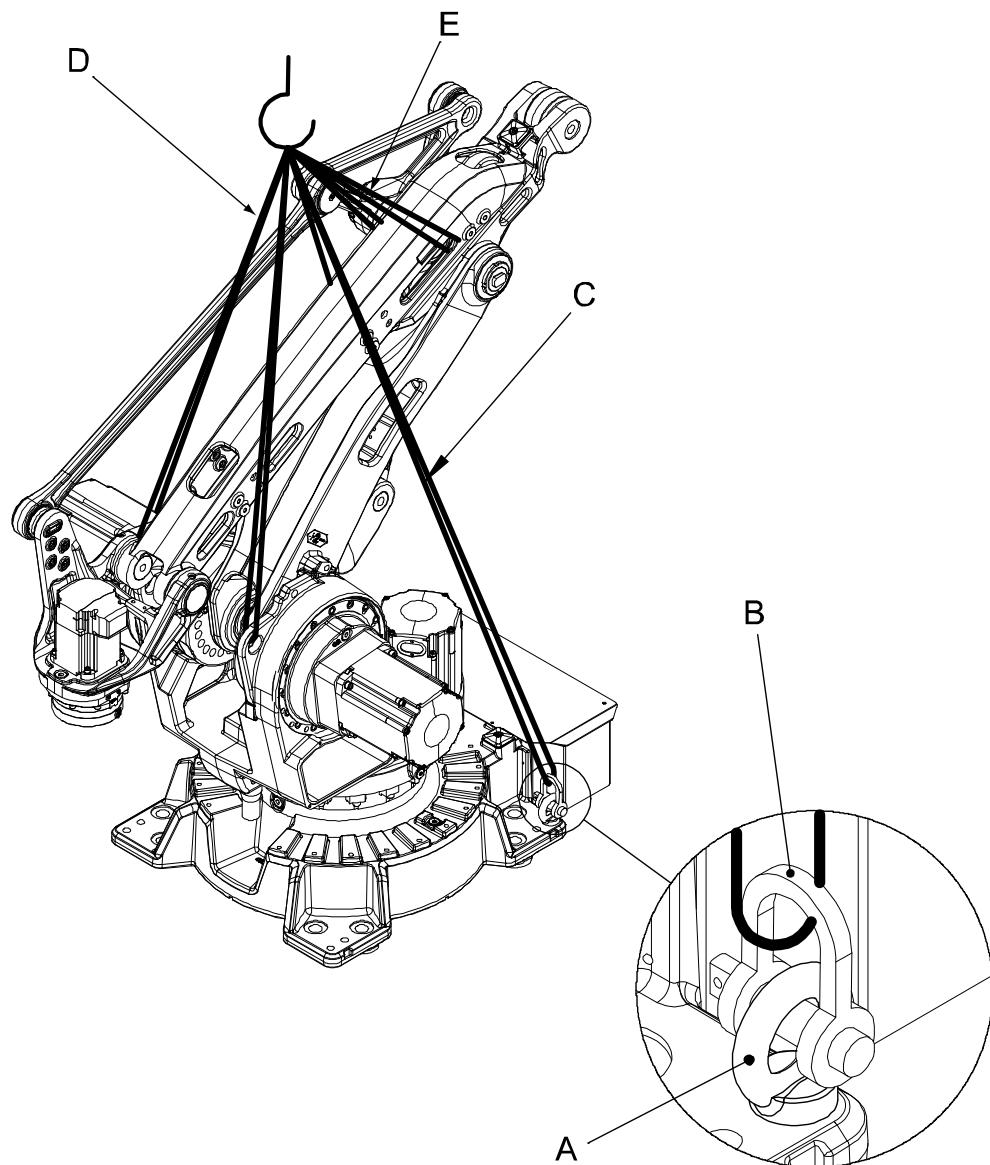
Action	Note
1 Position robot in a secure transport position.	
2 Attach <i>lifting eye bolts</i> in the rear M20 holes.	Shown in figure Attachment points on page 73 .
3 Attach roundslings to robot according to figure Attachment points on page 73 .	
4  Note Make sure that the roundslings do not lie against sensitive parts, for example harness and customer equipment!	
5  CAUTION The IRB 460 robot weighs 925 kg. All lifting accessories used must be sized accordingly!	
6  WARNING Personnel must not, under any circumstances, be present under the suspended load!	

Continues on next page

Attachment points

This figure shows how to attach the roundslings to the robot.

The illustration is similar with the label attached to the robot's lower arm.



xx1000001156

A	Lifting eye bolts M20 (2 pcs)
B	Shackle (2 pcs). Lifting capacity: 2,000 kg.
C	Roundsling, 2 m (2 pcs). Lifting capacity: 2,000 kg.
D	Roundsling, 2 m (2 pcs). Lifting capacity: 2,000 kg. Wrap once!
E	Roundsling, 2 m, secures against rotation. Lifting capacity: 2,000 kg. Wrap twice!

2 Installation and commissioning

2.3.3 Manually releasing the brakes

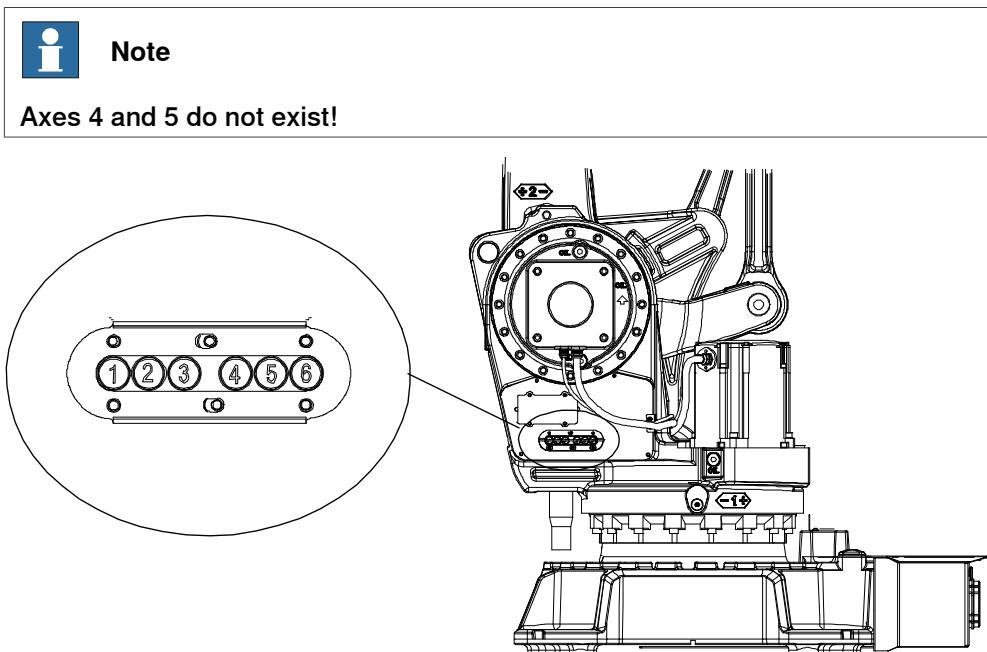
2.3.3 Manually releasing the brakes

Introduction to manually releasing the brakes

This section describes how to release the holding brakes for the motors of each axis.

Location of brake release unit

The internal brake release unit is located as shown in the figure.



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Releasing the brakes

This procedure details how to release the holding brakes when the robot is equipped with an internal brake release unit.

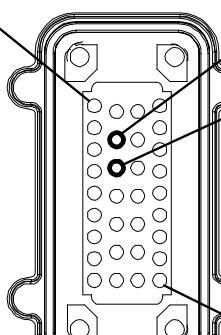
Action	Note
<p>1 The internal brake release unit is equipped with buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes.</p> <p>Note</p> <p>Axes 4 and 5 do not exist!</p> <p>If the robot is not connected to the controller, power must be supplied to the connector R1.MP according to the section Supplying power to connector R1.MP on page 75.</p>	Buttons are shown in figure Location of brake release unit on page 74 .

Continues on next page

Action	Note
2  DANGER When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways. Make sure no personnel is near or beneath the robot arm.	
3 Release the holding brake on a particular robot axis by pressing the corresponding button on the internal brake release unit. The brake will function again as soon as the button is released.	

Supplying power to connector R1.MP

If the robot is not connected to the controller, power must be supplied to connector R1.MP on the robot, in order to enable the brake release buttons.

Action	Note
1  DANGER Incorrect connections, such as supplying power to the wrong pin, may cause all brakes to be released simultaneously!	
2 Supply 0V on pin 12 and 24V on pin 11.	 <p>1 +24V (11) 0V (12) 32</p>

2 Installation and commissioning

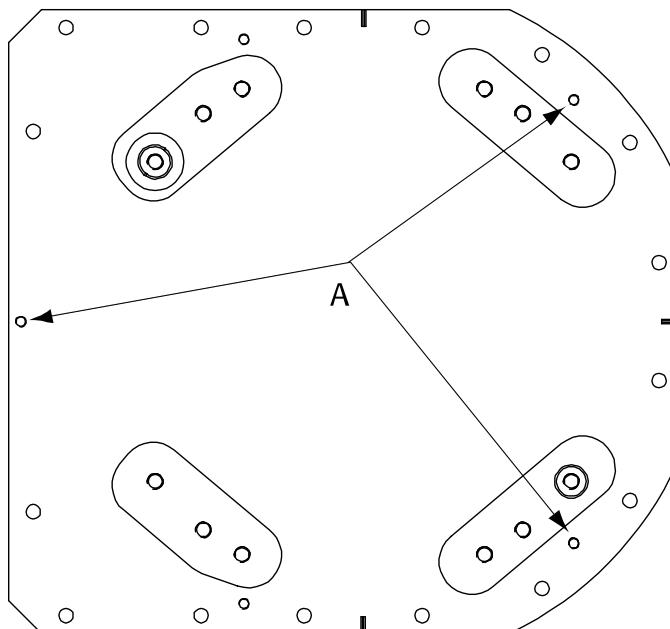
2.3.4 Lifting the base plate

2.3.4 Lifting the base plate

Required equipment

Equipment	Article number	Note
Lifting eye, M16	3HAC14457-4	3 pcs
Lifting slings		Length: approx. 2 m

Hole configuration



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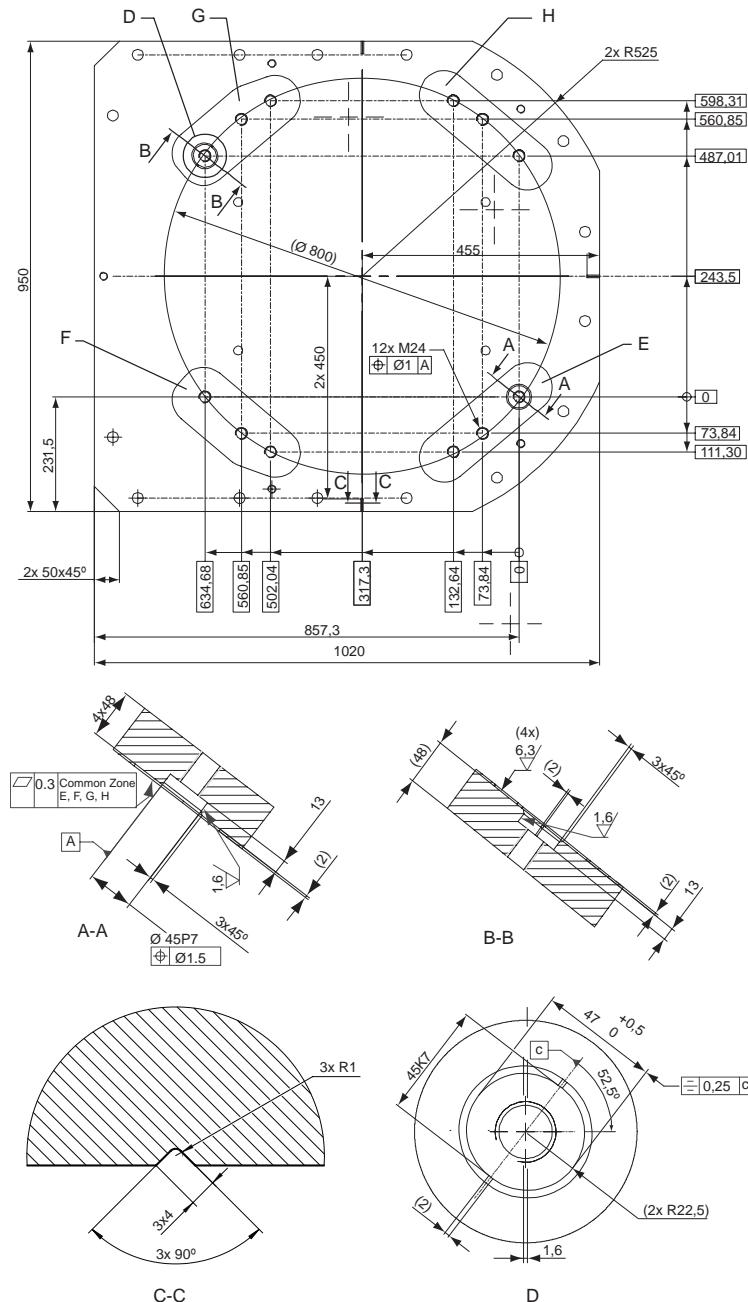
A	Attachment holes for lifting eyes (x3)
---	--

Lifting, base plate

	Action	Note
1	 CAUTION The base plate weighs 353 kg. All lifting accessories used must be sized accordingly.	
2	Fit lifting eyes in specified holes.	Shown in figure Hole configuration on page 76 .
3	 CAUTION Lift and move the base plate very slowly. If the base plate starts to swing it is a risk for injuries or damage.	

2.3.5 Securing the base plate

Base plate, dimensions



xx1000001053

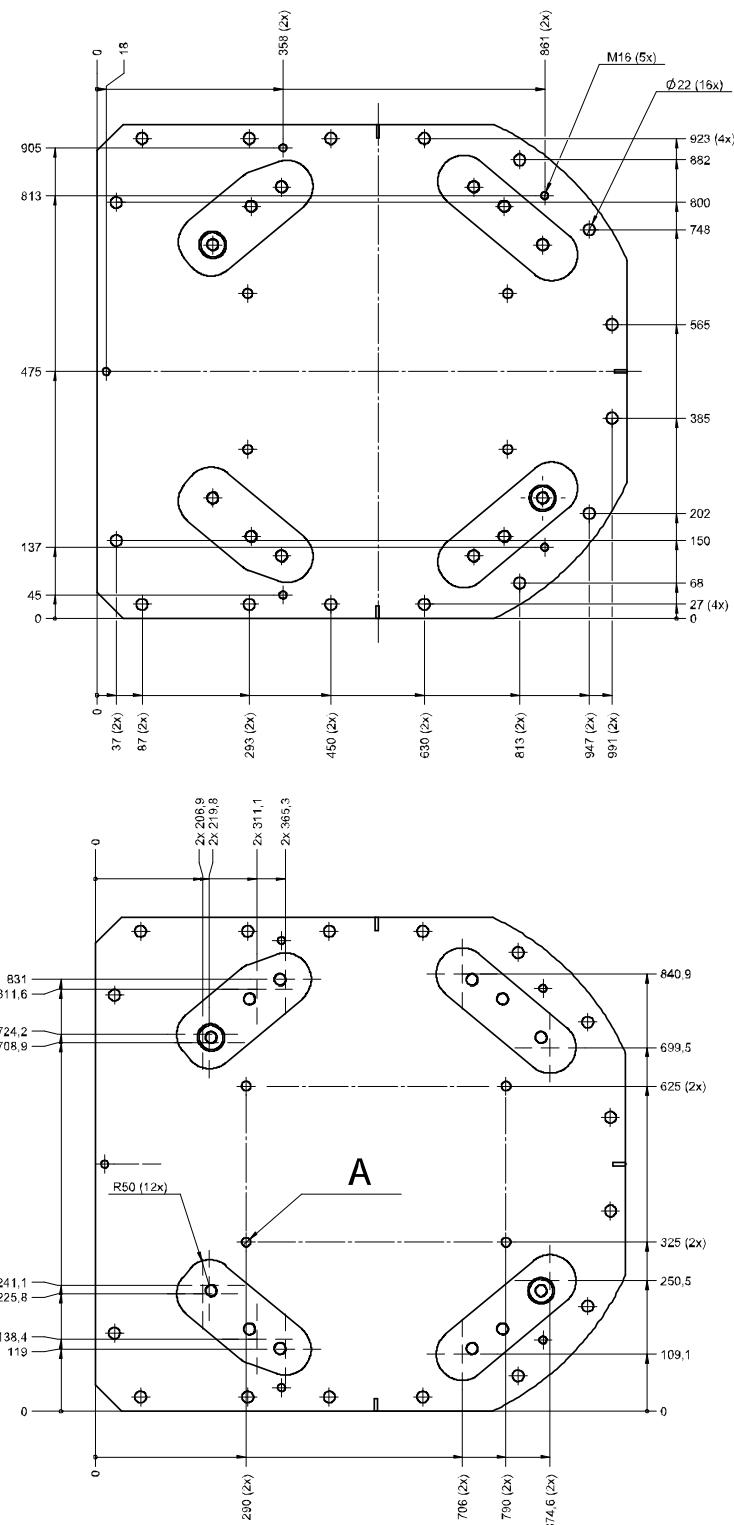
E, F, G, H	Common tolerance zone (accuracy all over the base plate from one contact surface to the other)
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2 Installation and commissioning

2.3.5 Securing the base plate

Continued



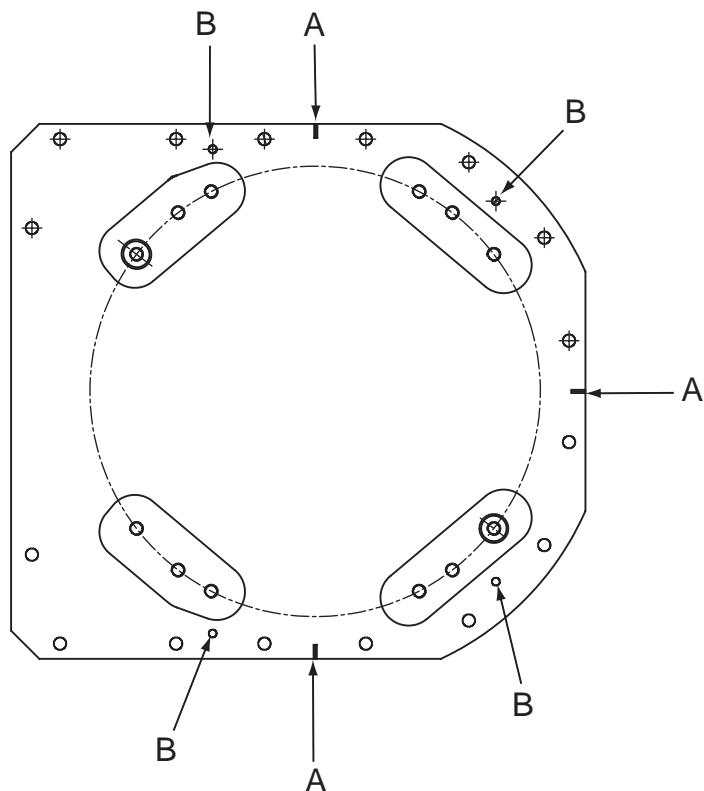
xx0400000715

A	Four holes for alternative clamping, 4x Ø18
---	---

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Base plate, orienting grooves and leveling bolts

The illustration below shows the orienting grooves and attachment holes for leveling bolts in the base plate.



xx1500000312

A	Orienting grooves (3 pcs)
B	Levelling bolts, attachment holes (4 pcs)

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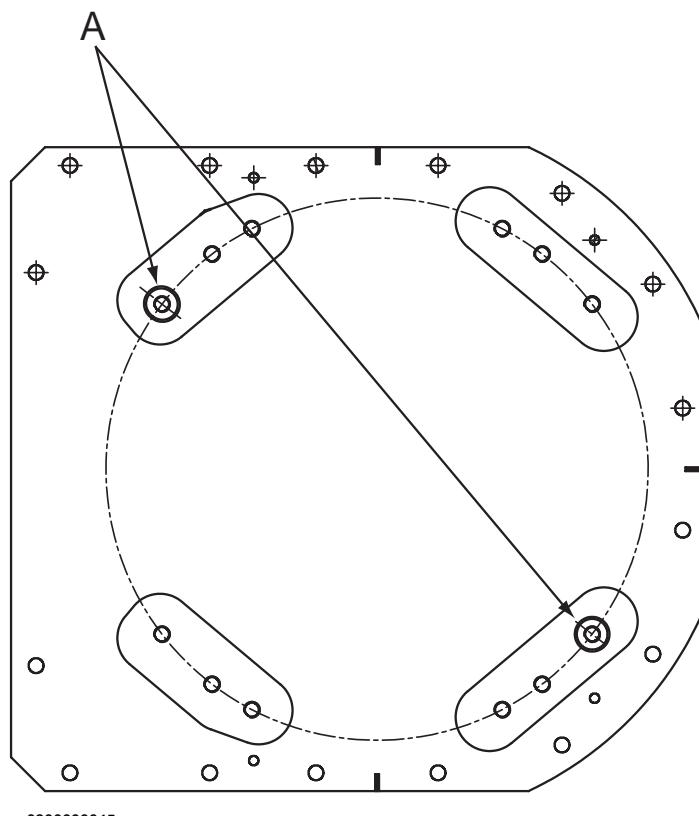
2 Installation and commissioning

2.3.5 Securing the base plate

Continued

Base plate, guide sleeve holes

The illustration below shows the orienting grooves and guide sleeve holes in the base plate.



xx0300000045

A	Guide sleeve holes (2 pcs)
---	----------------------------

Required equipment

Equipment	Article number	Note
Base plate		Includes <ul style="list-style-type: none">• guide sleeves, 3HAC12937-3• levelling screws, 9ADA120-79• attachment screws and washers for securing the robot to the base plate.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Base plate

This section details how to secure the base plate to the foundation.

	Action	Note
1	Make sure the foundation is levelled.	

Continues on next page

Action	Note
2  CAUTION The base plate weighs 353 kg! All lifting equipment used must be sized accordingly!	
3 Position base plate in relation to the robot work location using the grooves in the base plate.	Shown in figure Base plate, orienting grooves and leveling bolts on page 79 .
4 Lift the base plate to its mounting position.	Detailed in section Lifting the base plate on page 76 .
5 Use the base plate as a template and drill attachment holes as required by the selected bolt dimension.	Attachment holes: 16 pcs.
6 Fit the base plate and use the levelling bolts to level the base plate.	Shown in figure Base plate, orienting grooves and leveling bolts on page 79 .
7 If required, fit strips of sheet metal underneath the base plate to fill any gaps.	
8 Secure the base plate to the foundation with screws and sleeves.	
9 Recheck the four contact surfaces on the base plate to make sure the base plate is levelled and flat. If it is not, use pieces of sheet metal or similar to bring the base plate to a levelled position.	Maximum allowed deviation all over the base plate, from one contact surface to the other: 0.3 mm.

2 Installation and commissioning

2.3.6 Orienting and securing the robot

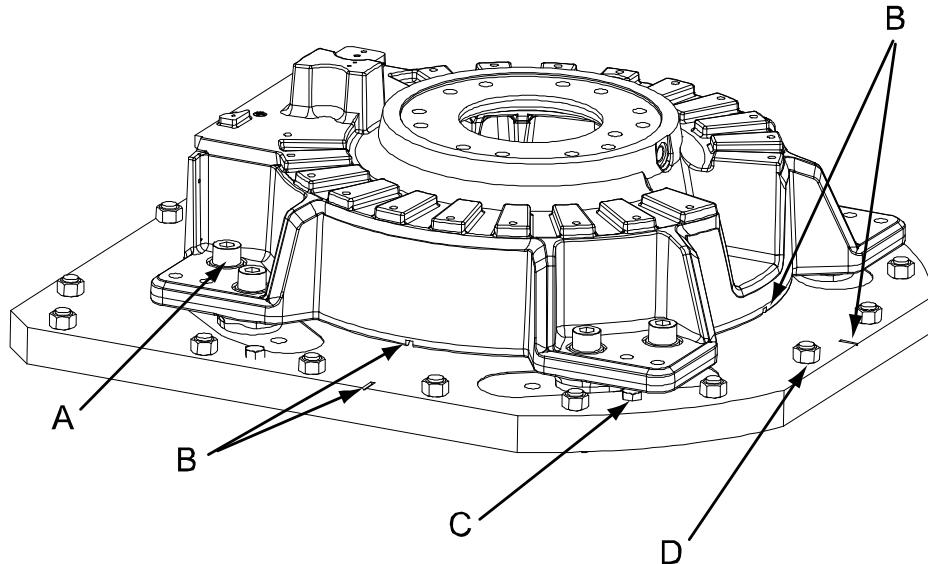
2.3.6 Orienting and securing the robot

General

This section details how to orient and secure the robot to the base plate in order to run the robot safely.

Illustration, robot fitted to base plate

This illustration shows the robot base fitted to the base plate.



xx0600002933

A	Robot attachment bolts and washers, 8 pcs (M24 x 100)
B	Orienting grooves in the robot base and in the base plate
C	Levelling screws. Note! Remove before the robot base is fitted!
D	Base plate attachment screws

Attachment screws

The table below specifies the type of securing screws and washers to be used for securing the robot to the base plate/foundation.

Suitable screws, lightly lubricated:	M24 x 100
Quality:	Quality 8.8
Suitable washer:	Thickness: 4 mm Outer diameter: 44 mm Inner diameter: 25 mm
Tightening torque:	725 Nm

Continues on next page

Securing the robot

Use this procedure to secure robot to base plate after fitting plate to the foundation.

	Action	Note
1	Lift the robot.	See section Lifting robot with round-slings on page 72 .
2	Move robot to the vicinity of its installation location.	
3	Fit two guide sleeves to the <i>guide sleeve holes</i> in the base plate.	Shown in figure Base plate, guide sleeve holes on page 80 .  Note One of the guide sleeve holes is elongated!
4	Guide the robot gently using two M24 screws while lowering it into its mounting position.	Make sure the robot base is correctly fitted onto the guide sleeves!
5	Fit the <i>bolts and washers</i> in the base attachment holes.	Specified in Attachment screws on page 82 . Shown in figure Illustration, robot fitted to base plate on page 82 .  Note Lightly lubricate screws before assembly!
6	Tighten bolts in a criss-cross pattern to ensure that the base is not distorted.	

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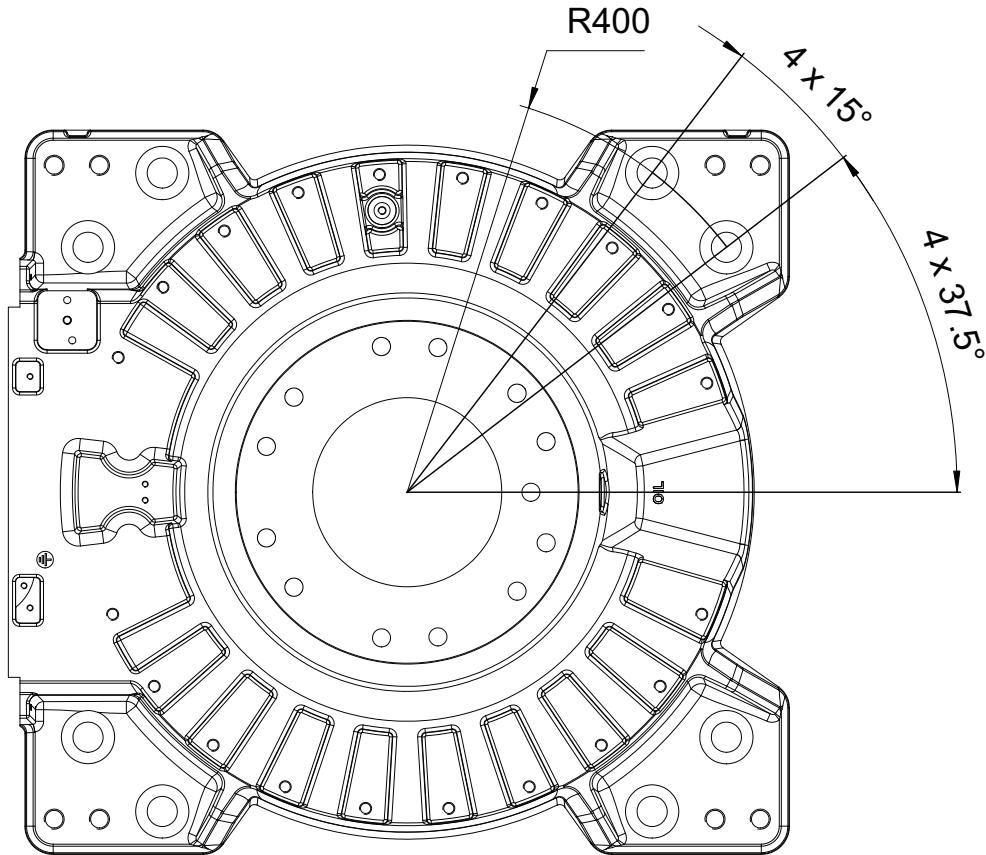
2 Installation and commissioning

2.3.6 Orienting and securing the robot

Continued

Hole configuration, base

This illustration shows the hole configuration used when securing the robot.

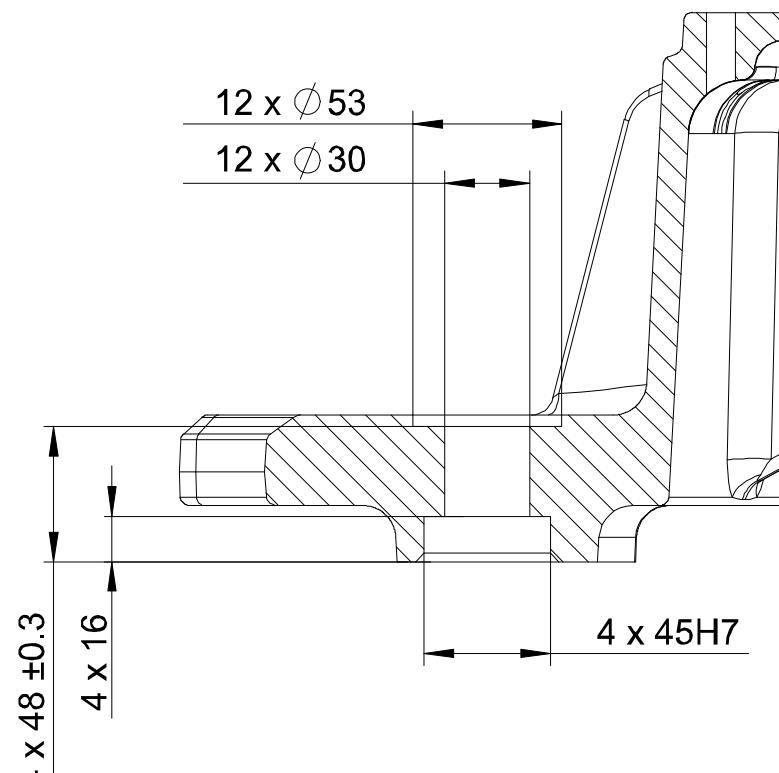


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Cross section, guide sleeve hole

This illustration shows the cross section of the guide sleeve holes.



2 Installation and commissioning

2.3.7 Fitting equipment on robot

General

The robot features mounting holes for additional equipment.



Note

All equipment and cables used on the robot, must be designed and fitted not to damage the robot and/or its parts.

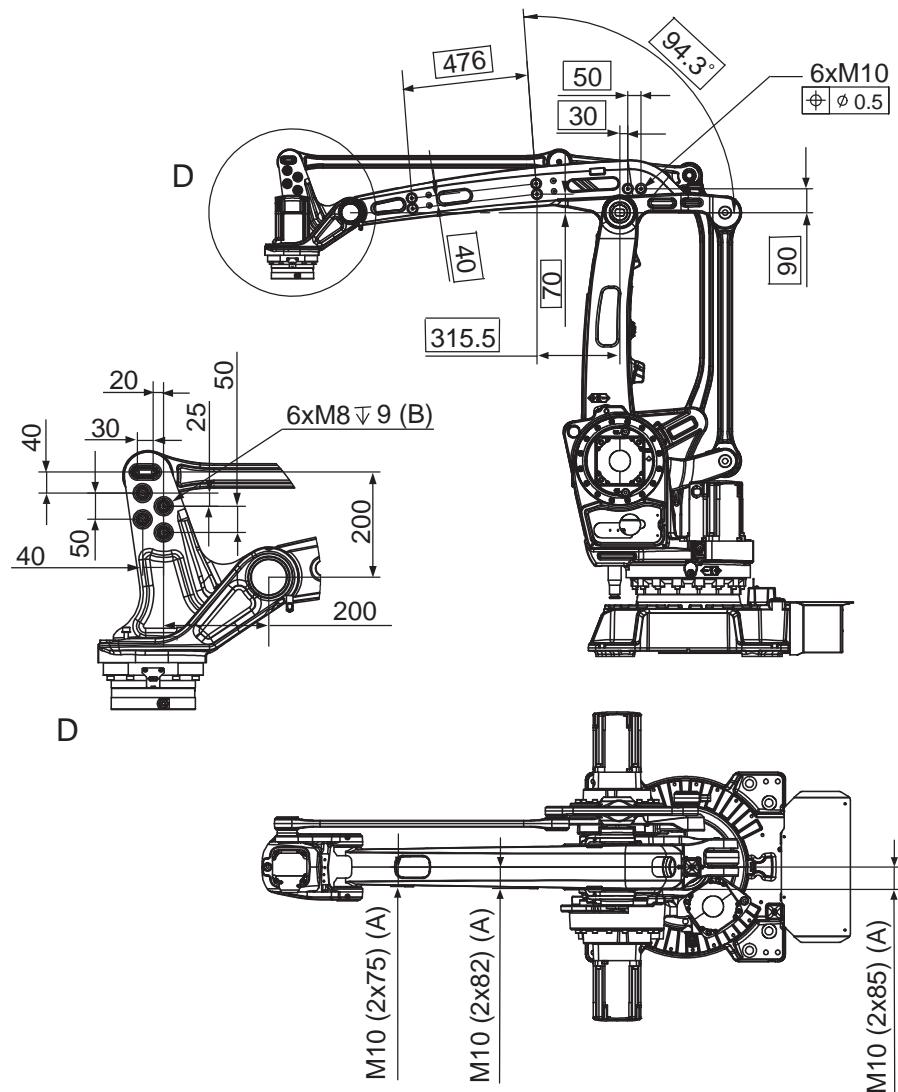
Illustration, fitting of extra equipment on upper arm

The illustration below shows the mounting holes available for fitting extra equipment on the upper arm.

For mounting of an external vacuum hose there are six holes on the upper arm.
The maximum weight for the vacuum hose and fastening device is 35 kg.

Continues on next page

Note! The weight of the extra equipment on the upper arm must be deducted from the maximal handling capacity.



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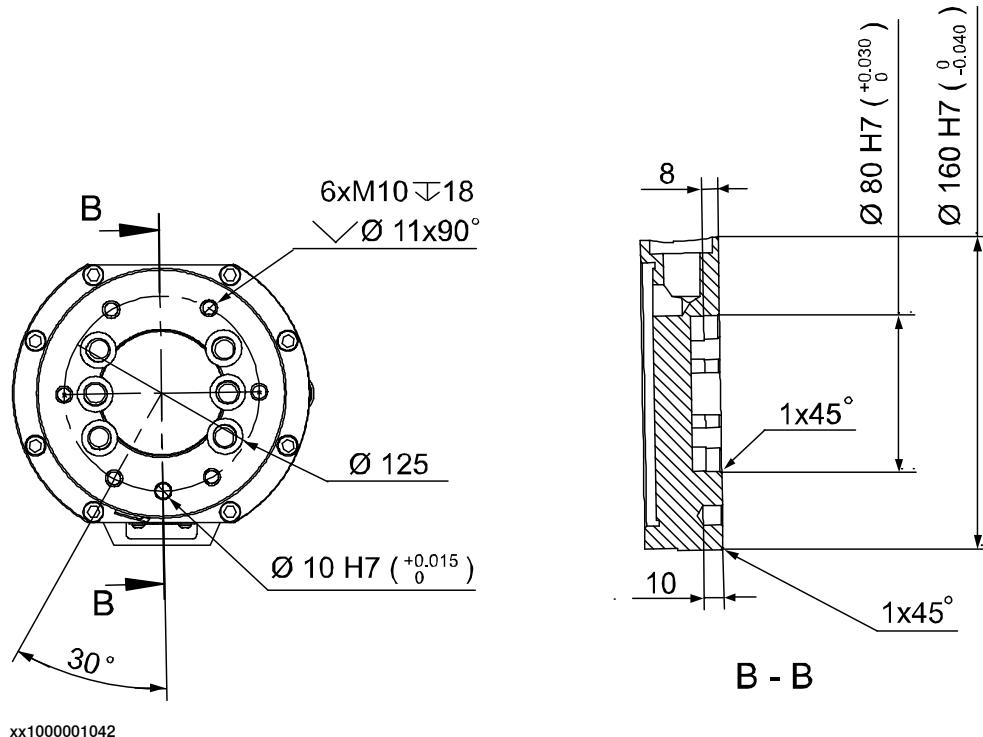
2 Installation and commissioning

2.3.7 Fitting equipment on robot

Continued

Illustration, fitting on turning disk

The illustration below shows the mounting holes available for fitting equipment on the turning disk.



xx1000001042

Fastener quality

For fastening of gripper tool flange to robot tool flange all bolt holes shall be used.
Only use screws with quality 12.9.

2.3.8 Loads fitted to the robot, stopping time and braking distances

General

Any loads mounted on the robot must be defined correctly and carefully (with regard to the position of center of gravity and mass moments of inertia) in order to avoid jolting movements and overloading motors, gears and structure.



CAUTION

Incorrectly defined loads may result in operational stops or major damage to the robot.

References

Load diagrams, permitted extra loads (equipment) and their positions are specified in the product specification. The loads must also be defined in the software as detailed in:

- *Operating manual - IRC5 with FlexPendant*

Stopping time and braking distances

The performance of the motor brake depends on if there are any loads attached to the robot. For more information, see product specification for the robot.

2 Installation and commissioning

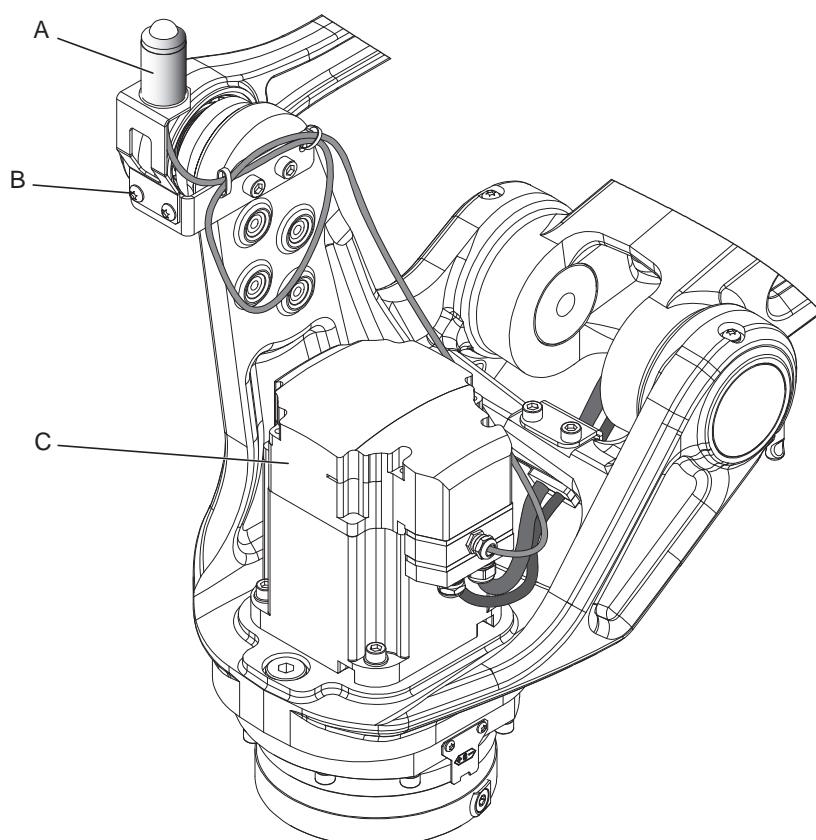
2.3.9 Installation of signal lamp, upper arm (option)

General

As an option, a signal lamp can be installed on the robot. The lamp is activated when the controller is in the MOTORS ON state.

Location of signal lamp, upper arm

The signal lamp is located on the tilthouse unit, as shown in figure.



xx1000001287

A	Signal lamp
B	Attachment screw M6x8 (2 pcs)
C	Motor cover

Required equipment

Equipment, etc.	Art. no.	Note
Signal lamp kit	Spare parts on page 393.	Complete kit with signal lamp, cables, adapter, gasket, screws etc.
Gasket	3HAC033206-001	Fitted between motor and cable gland, replace if damaged.
Standard toolkit		Content is defined in section Standard tools on page 387.

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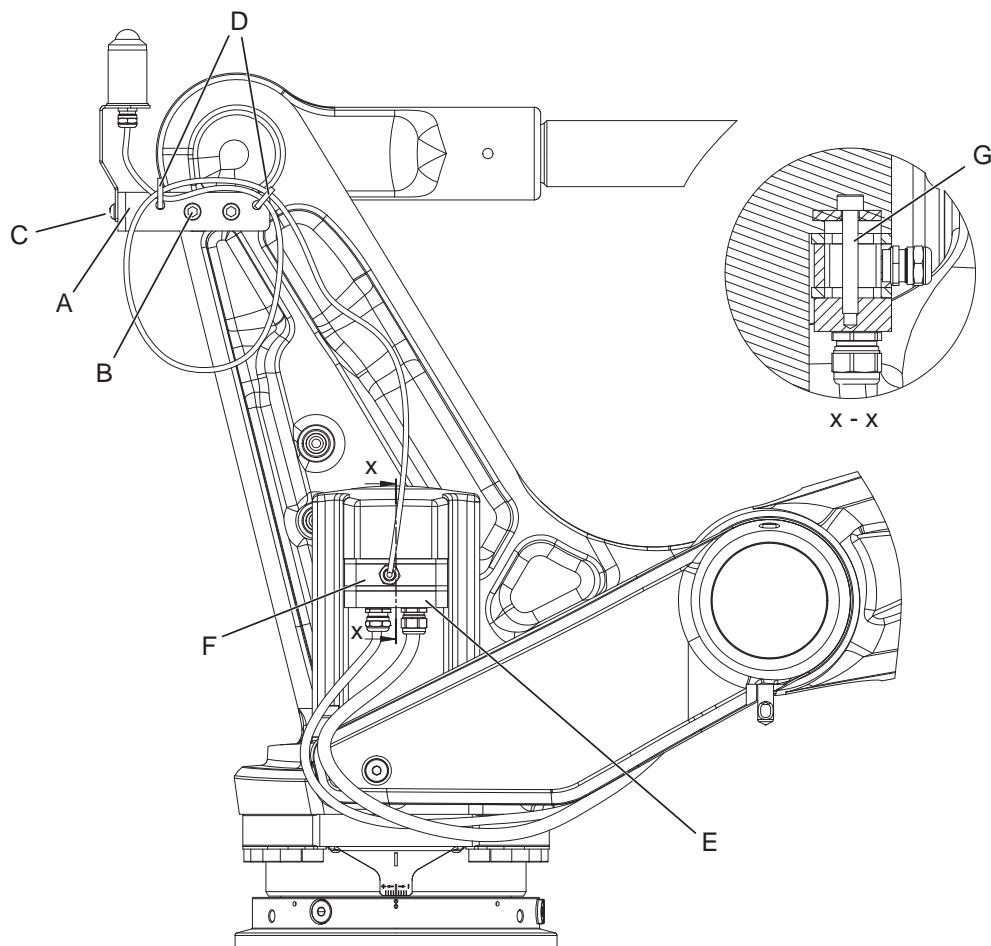
2.3.9 Installation of signal lamp, upper arm (option)

Continued

Equipment, etc.	Art. no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		

Signal lamp kit

Figure shows signal lamp kit on IRB 760.



xx1000001064

A	Signal lamp bracket
B	Attachment screws for the bracket, M8x12 (2 pcs)
C	Attachment screws for the signal lamp (2 pcs)
D	Cable straps (2 pcs)
E	Cable gland cover
F	Motor adapter including gasket
G	Attachment screw, M6x40 (1 pc)

Continues on next page

2 Installation and commissioning

2.3.9 Installation of signal lamp, upper arm (option)

Continued

Installation, signal lamp

Use this procedure to install the signal lamp to the robot.

Action	Note
1 Fit the <i>signal lamp bracket</i> to the tilthouse, with two attachment screws.	See figure Signal lamp kit on page 91 .
2 Fit the signal lamp to the bracket, with two attachment screws.	See figure Signal lamp kit on page 91 .
3 If not already connected, connect the signal lamp to the axis 6 motor.  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	See Electrical installation, signal lamp on page 92 .
4 Arrange the signal cable in a loop at the signal cable bracket with two <i>cable straps</i> .	See figure Signal lamp kit on page 91 .

Electrical installation, signal lamp

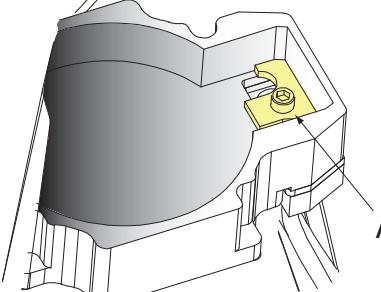
Use this procedure to connect the signal lamp to the axis 6 motor. The instruction requires that the signal lamp is already mounted to the tilthouse.

Action	Note
1  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2 Remove the <i>motor cover</i> by unscrewing the four attachment screws.	See figure Location of signal lamp, upper arm on page 90 .
3 Disconnect the motor connectors.	

Continues on next page

2.3.9 Installation of signal lamp, upper arm (option)

Continued

Action	Note
4 Remove the <i>cable gland cover</i> at the cable exit by removing the attachment screw. Replace the screw with a longer one, when refitting in following steps (enclosed in the signal lamp kit).	See figure Signal lamp kit on page 91 .  xx0600002694 A Screw that holds the cable gland
5 See how the <i>adapter</i> is going to be fitted to the motor and then fit the <i>gasket</i> to the side of the adapter that will be facing downwards. The gasket will protect the mating surfaces of the adapter and the cable gland cover.	Enclosed with signal lamp kit.
6 Place <i>gasket and motor adapter</i> above the cable gland cover and refit the complete package to the motor. Secure with <i>attachment screw M6x40</i> , enclosed with the signal lamp kit.	See figure Signal lamp kit on page 91 . In addition to the enclosed gasket that is fitted to the adapter, there is also a gasket located on the motor. Make sure it does not get damaged. Replace if damaged!
7 Push the signal cable through the hole in the adapter and connect it to the connector inside the motor.	
8 Loosen the motor cables at the glands and adjust their lengths with + 20 mm into the motor.	
9 Connect motor cables inside the motor.	
10 Secure motor cables at cable gland again.	
11 Fit the motor cover with the attachment screws. Make sure the cabling is placed correctly when refitting the cover and does not get jammed.	

2 Installation and commissioning

2.4.1 Option 87-1 - Installing the cooling fan for axis-1 motor

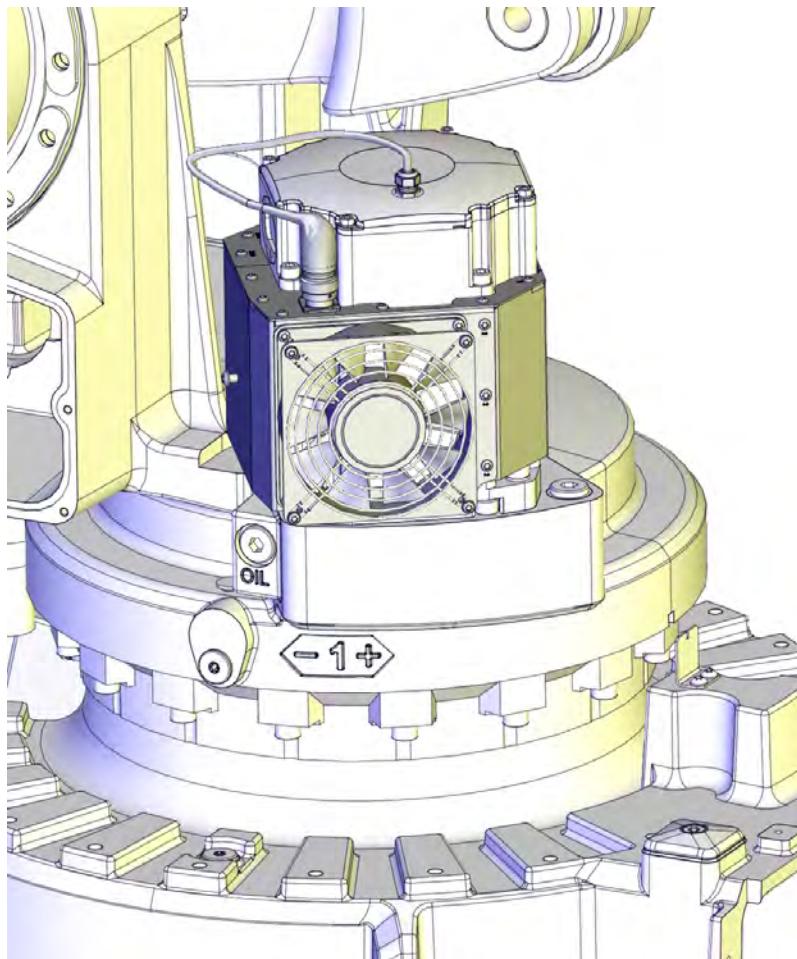
2.4 Installation of options

2.4.1 Option 87-1 - Installing the cooling fan for axis-1 motor

General

A cooling fan (option 87-1) can be installed on the axis-1 motor.

Location of cooling fan

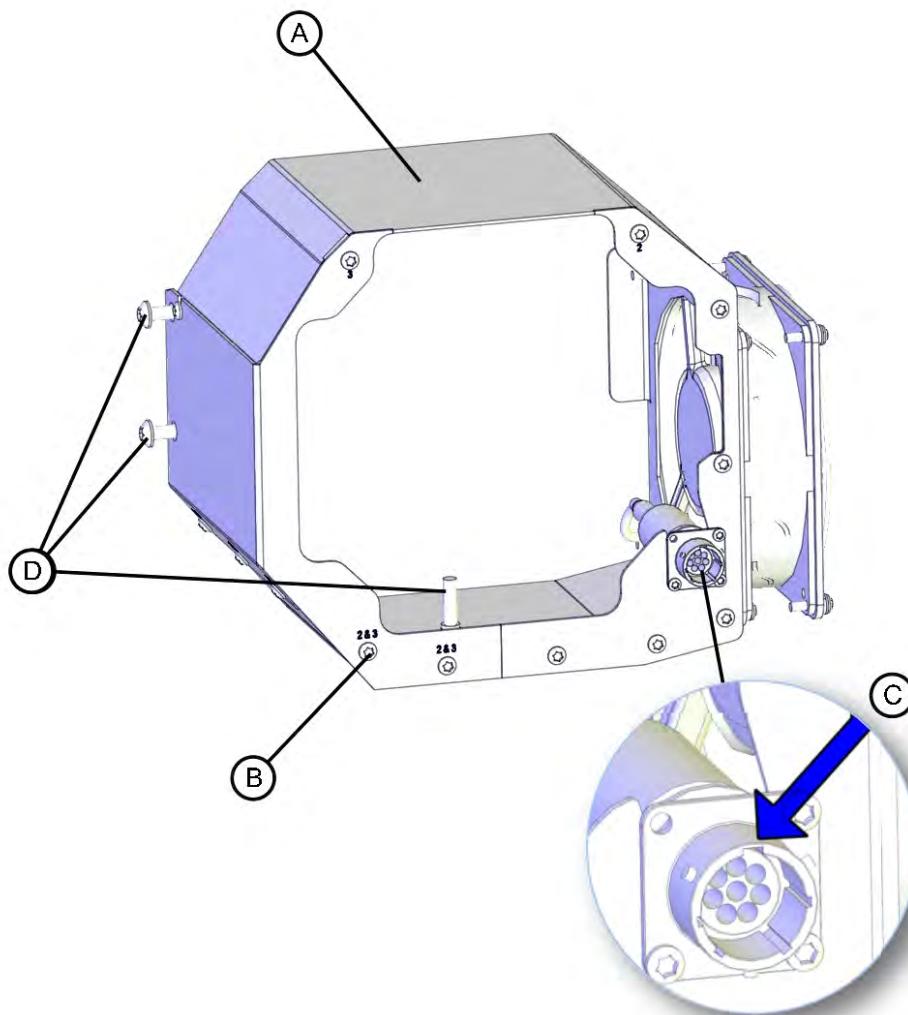


xx1300000168

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Illustration of cooling fan

The details of the cooling fan are shown in the figure below.



xx1300000763

A	Fan box
B	Attachment screws (16 pcs)
C	Groove in the connector
D	Tightening screws (3 pcs)

Required equipment

Equipment	Art. no.	Note
Cooling fan	See Product manual, spare parts - IRB 460.	
Fan axis-1 cable harness		Choose this if equipping the robot with a cooling fan on the axis-1 motor.
Motor cover		Choose this if equipping the robot with a cooling fan on the axis-1 motor.

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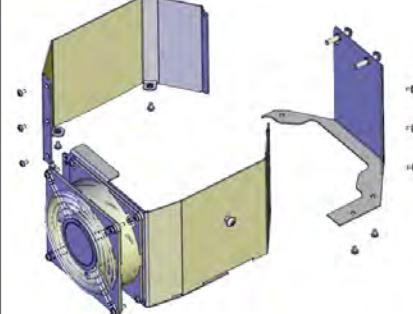
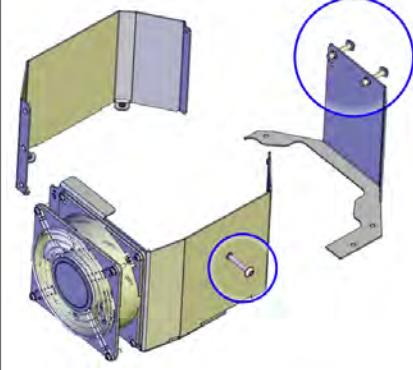
2 Installation and commissioning

2.4.1 Option 87-1 - Installing the cooling fan for axis-1 motor

Continued

Equipment	Art. no.	Note
Locking liquid	-	Loctite 243. Used for the three tightening screws.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Circuit diagram	-	See chapter Circuit diagrams on page 395 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Installing the cooling fan

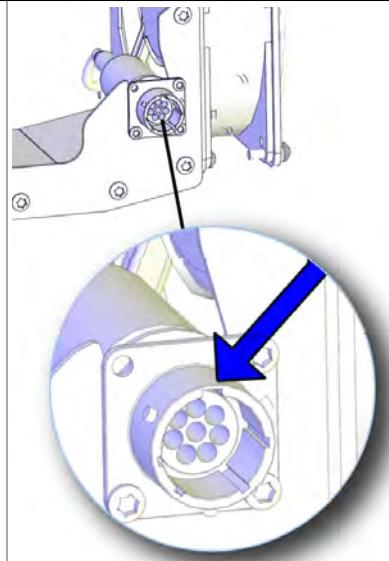
	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply to the robot• hydraulic pressure supply to the robot• air pressure supply to the robot Before entering the robot working area.	
2	Disassemble the parts of the fan box by removing the attachment screws.	 xx1300000843
3	Loosen the three tightening screws, to avoid damaging the surfaces of the motor when fitting the fan box.	 xx1300000844

Continues on next page

2 Installation and commissioning

2.4.1 Option 87-1 - Installing the cooling fan for axis-1 motor

Continued

Action	Note
4 Insert and turn the connector so that the groove points inwards, as shown in the figure.	 xx1300000764
5 Temporarily lift the motor cabling out of the way to make room for the fan box.	
6 Fit the parts of the fan box to the motor and reassemble with the attachment screws.	
7 Lift the fan box so that it does not rest directly on the robot and secure the box with the three tightening screws, using locking liquid. Tighten them properly so that the box is firmly attached to the motor.	
8 Install the cabling and make adjustments in RobotWare, as described in the following procedures.	

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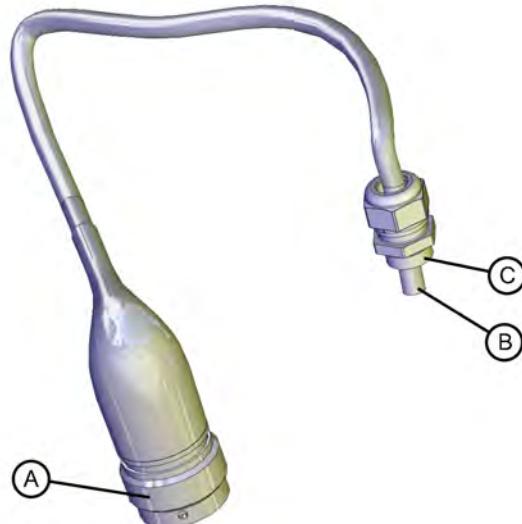
2 Installation and commissioning

2.4.1 Option 87-1 - Installing the cooling fan for axis-1 motor

Continued

Illustration of separate cable for the fan

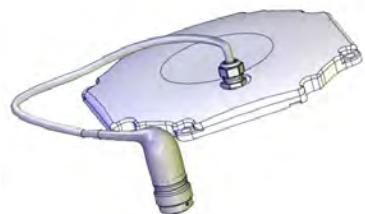
The figure below shows the cabling used for the fan on axis 1.



xx1300000765

A	Connector R3.FAN. Connected to the fan box.
B	Connector R2.FAN. Connected to the robot cable harness.
C	Screw M12x1.5. Secures the cable to the motor cover.

Installing the separate cable for the fan

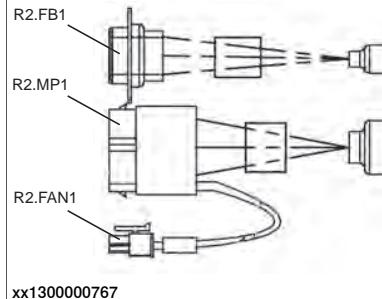
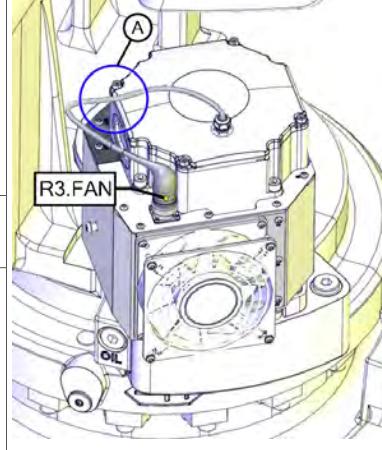
	Action	Note
1	Move the robot to its calibration position.	
2	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply to the robot• hydraulic pressure supply to the robot• air pressure supply to the robot Before entering the robot working area.	
3	Insert the fan cable through the motor cover and tighten the screw.	 xx1300000766

Continues on next page

2 Installation and commissioning

2.4.1 Option 87-1 - Installing the cooling fan for axis-1 motor

Continued

Action	Note
4 Connect the connector R2.FAN to the connector R2.FAN1 on the robot cable harness.	 <p>R2.FB1 R2.MP1 R2.FAN1 xx1300000767</p>
5 Fit the motor cover to the motor. Note Make sure to fit the motor cover at the correct direction, see the figure.	 <p>R3.FAN xx1300000768</p>
6 Connect the connector R3.FAN to the connector on the fan box.	
7 Strap the cable onto the axis-1 motor cables (at position A).	

2 Installation and commissioning

2.5.1 Introduction

2.5 Restricting the working range

2.5.1 Introduction

General

When installing the robot, make sure that it can move freely within its entire working space. If there is a risk that it may collide with other objects, its working space should be limited.

The working range of the following axis may be restricted:

- Axis 1, hardware (mechanical stop) and software (EPS) .

As standard configuration, axis 1 is allowed to move $\pm 165^\circ$.

This section describes how to install hardware that restricts the working range.

Note! Adjustments must also be made in the robot configuration software (system parameters). References to relevant manuals are included in the installation procedures.

2.5.2 Mechanically restricting the working range of axis 1

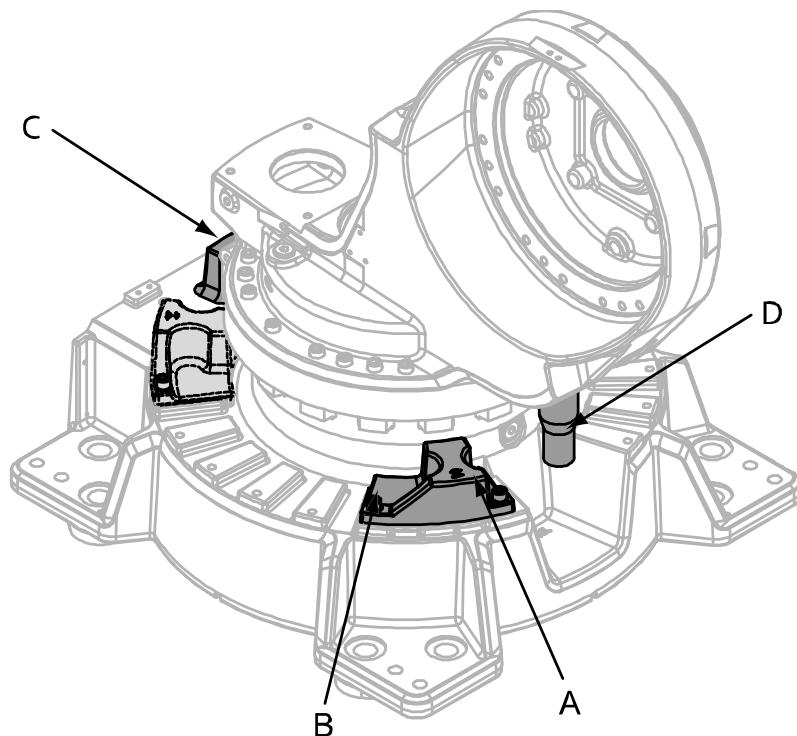
General

The working range of axis 1 is limited by fixed mechanical stops and adjustment of the system parameter configuration. The working range can be reduced by adding additional mechanical stops giving 7.5 or 15 graduation, between 22.5° and 135° in both directions.

Mechanical stops, axis 1

The illustration shows the mounting position of the stop pin and one of the additional mechanical stops available for axis 1.

The figure shows IRB 6640 but is also valid for IRB 460.



xx0600002938

A	Movable mechanical stop
B	Attachment screw plus washer, M12 x 40 quality 12.9 (2 pcs)
C	Fixed mechanical stop
D	Mechanical stop pin axis 1

Continues on next page

2 Installation and commissioning

2.5.2 Mechanically restricting the working range of axis 1

Continued

Required equipment

Equipment, etc.	Article number	Note
Movable mechanical stop set, axis 1 (+15°/-7.5°)	3HAC025204-003	Includes: <ul style="list-style-type: none">• one stop (+15°/ -7.5°), 3HAC025366-001• one stop (+7.5°/ -15°), 3HAC025367-001• attachment screws and washers• document for movable mech.stop, 3HAC025204-002
Standard toolkit	-	
<i>Technical reference manual - System parameters</i>	-	Article number is specified in section References on page 10 .

Installation, mechanical stops axis 1

Use this procedure to fit the additional mechanical stops to axis 1 of the robot. An assembly drawing is also enclosed with the product.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply to the robot• hydraulic pressure supply to the robot• air pressure supply to the robot Before entering the robot working area.	
2	Fit the additional mechanical stop to the frame according to the figure Mechanical stops, axis 1 on page 101 .	Tightening torque: 120 Nm.
3	Adjust the software working range limitations (system parameter configuration) to correspond to the mechanical limitations.	The system parameters that must be changed (<i>Upper joint bound</i> and <i>Lower joint bound</i>) are described in <i>Technical reference manual - System parameters</i> .
4	 WARNING If the mechanical stop pin is deformed after a hard collision, it must be replaced! Deformed <i>movable stops</i> and/or <i>additional stops</i> as well as deformed <i>attachment screws</i> must also be replaced after a hard collision.	

2.6 Robot in cold environments

2.6.1 Start of robot in cold environments

Introduction

This procedure describes how to start the robot in a cold environment.

Adjusting the speed

Depending on how cold the environment is and the program being used, the ramping up of speed has to be adjusted. The table shows examples of how to adjust the speed:

Work cycles	AccSet	Speed/velocity
3 Work cycles	20.20	100
5 Work cycles	40.40	400
5 Work cycles	60.60	600
5 Work cycles	100.100	1000
More than 5 Work cycles	100.100	Max.

If the program consists of large wrist movements, it is possible that the reorientation velocity, which is always high in predefined velocities, needs to be included in the ramping up.

2 Installation and commissioning

2.7.1 Robot cabling and connection points

2.7 Electrical connections

2.7.1 Robot cabling and connection points

Introduction

Connect the robot and controller to each other after securing them to the foundation. The lists below specify which cables to use for each respective application.

Main cable categories

All cables between the robot and controller are divided into the following categories:

Cable category	Description
Robot cables	Handles power supply to and control of the robot's motors as well as feedback from the serial measurement board. Specified in the table Robot cables on page 104 .
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. See the product manual for the controller, see document number in References on page 10 .

Robot cables

These cables are included in the standard delivery. They are completely pre-manufactured and ready to plug in.

Cable sub-category	Description	Connection point, cabinet	Connection point, robot
Robot cable, power	Transfers drive power from the drive units in the control cabinet to the robot motors.	XS1	R1.MP
Robot cable, signals	Transfers resolver data from and power supply to the serial measurement board.	XS2	R1.SMB

Robot cable, power

Cable	Art. no.
Robot cable, power: 7 m	3HAC026787-001
Robot cable, power: 15 m	3HAC026787-002
Robot cable, power: 22 m	3HAC026787-003
Robot cable, power: 30 m	3HAC026787-004

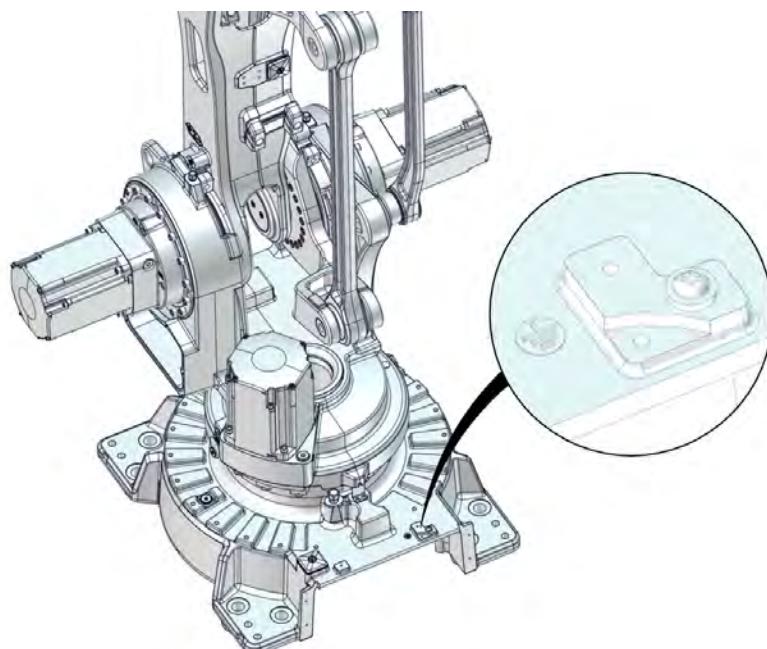
Robot cable, signals

Cable	Art. no.
Robot cable signal, shielded: 7 m	3HAC2493-1
Robot cable signal, shielded: 15 m	3HAC2530-1
Robot cable signal, shielded: 22 m	3HAC2540-1
Robot cable signal, shielded: 30 m	3HAC2566-1

Continues on next page

Grounding and bonding point on manipulator

There is a grounding/bonding point on the manipulator base. The grounding/bonding point is used for potential equalizing between control cabinet, manipulator and any peripheral devices.



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3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 460.

It is based on the maintenance schedule found at the beginning of the chapter. The schedule contains information about required maintenance activities including intervals, and refers to procedures for the activities.

Each procedure contains all the information required to perform the activity, including required tools and materials.

The procedures are gathered in different sections and divided according to the maintenance activity.

Safety information

Observe all safety information before conducting any service work!

There are general safety aspects that must be read through, as well as more specific safety information that describes the danger and safety risks when performing the procedures. Read the chapter [Safety on page 17](#) before performing any service work!



Note

If the IRB 460 is connected to power, always make sure that the IRB 460 is connected to protective earth before starting any maintenance work!

For more information see:

- *Product manual - IRC5*

3 Maintenance

3.2.1 Specification of maintenance intervals

3.2 Maintenance schedule and expected component life

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 460:

- Calendar time: specified in months regardless of whether the system is running or not.
- Operating time: specified in operating hours. More frequent running means more frequent maintenance activities.
- SIS: specified by the robot's SIS (Service Information System). A typical value is given for a typical work cycle, but the value will differ depending on how hard each part is run. The SIS used in M2004 is further described in the *Operating manual - Service Information System*.

3.2.2 Maintenance schedule

General

The robot must be maintained regularly to ensure proper function. The maintenance activities and intervals are specified in the table below.

Non-predictable situations also give rise to inspections of the robot. Any damages must be attended to immediately!

The inspection intervals *do not* specify the life of each component. Values for these are specified in the section [Expected component life on page 111](#)

Instructions for how to perform the different maintenance activities are found in sections:

- [Inspection activities on page 112](#)
- [Replacement/changing activities on page 131](#)
- [Cleaning activities on page 146](#)

Activities and intervals, standard equipment

The table below specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval
Cleaning	Robot	-
Inspection	Axis-1 gearbox, oil level	Every: • 6 months
Inspection	Axes-2 and -3 gearboxes, oil level	Every: • 6 months
Inspection	Axis-6 gearbox, oil level	Every: • 6 months
Inspection	Robot harness	Every: • 12 months ⁱ
Inspection	Information labels	Every: • 12 months
Inspection	Mechanical stop, axis 1	Every: • 12 months
Inspection	Dampers	Every: • 12 months
Changing	Axis-1 gear oil	First change when DTC ⁱⁱ reads: • 6,000 hours Second change when DTC ⁱⁱ reads: • 20,000 hours Following changes: • Every 20,000 hours
Changing	Axis 2 gear oil	First change when DTC ⁱⁱ reads: • 6,000 hours Second change when DTC ⁱⁱ reads: • 20,000 hours Following changes: • Every 20,000 hours

Continues on next page

3 Maintenance

3.2.2 Maintenance schedule

Continued

Maintenance activity	Equipment	Interval
Changing	Axis-3 gear oil	First change when DTC ⁱⁱ reads: <ul style="list-style-type: none">• 6,000 hours Second change when DTC ⁱⁱ reads: <ul style="list-style-type: none">• 20,000 hours Following changes: <ul style="list-style-type: none">• Every 20,000 hours
Changing	Axis-6 gear oil	First change when DTC ⁱⁱ reads: <ul style="list-style-type: none">• 6,000 hours Second change when DTC ⁱⁱ reads: <ul style="list-style-type: none">• 20,000 hours Following changes: <ul style="list-style-type: none">• Every 20,000 hours
Overhaul	Robot	30,000 hours
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert ⁱⁱⁱ
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert ^{iv}

- i Replace when damage or cracks are detected or life limit is approaching as specified in section [Expected component life on page 111](#).
- ii DTC = Duty Time Counter. Shows the operational time of the robot.
- iii The battery low alert (38213 **Battery charge low**) is displayed when the battery needs to be replaced. The recommendation to avoid an unsynchronized robot is to keep the power to the controller turned on until the battery is to be replaced.
See the replacement instruction for more details.
- iv The battery low alert (38213 **Battery charge low**) is displayed when remaining backup capacity (robot powered off) is less than 2 months. The typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended with a battery shutdown service routine. See *Operating manual - IRC5 with FlexPendant* for instructions.

Activities and intervals, optional equipment

The table below specifies the required maintenance activities and intervals for common optional equipment. The maintenance of other external equipment for the robot is detailed in separate documentation.

Maintenance activity	Equipment	Interval
Inspection	Signal lamp	Every: 12 months

3.2.3 Expected component life

General

The expected life of a specific component of the robot can vary greatly depending on how hard it is run.

Expected component life

Component	Expected life	Note
Cable harness	30,000 hours ⁱ	Optional upper arm harnesses not included.
Gearboxes ⁱⁱ	30,000 hours	

ⁱ Severe chemical or thermal environments, or similar environments, can result in shortened life expectancy.

ⁱⁱ Depending on application, the lifetime can vary. The Service Information System (SIS) that is integrated in the robot software can be used as guidance when planning gearbox service for the individual robot. This applies to gearboxes on axes 1, 2, 3 and 6. In some applications, such as Foundry or Washing, the robot can be exposed to chemicals, high temperature or humidity, which can have an effect on the lifetime of the gearboxes. Contact the local *ABB Robotics Service team* for more information.

The SIS for an M2004 system is described in the *Operating manual - Service Information System*.

3 Maintenance

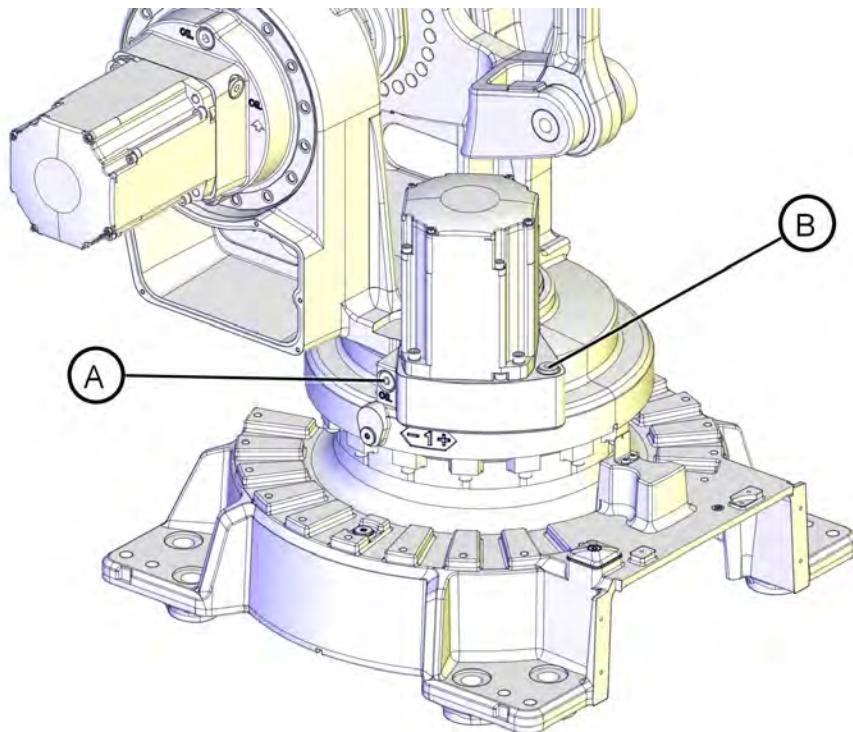
3.3.1 Inspecting the oil level in axis-1 gearbox

3.3 Inspection activities

3.3.1 Inspecting the oil level in axis-1 gearbox

Location of gearbox

The axis-1 gearbox is located between the frame and base. See oil plugs in the following figure.



xx1000001294

A	Oil plug, inspection
B	Oil plug, filing

Required equipment

Equipment	Art. no.	Note
Lubricating oil	See Type and amount of oil in gearboxes on page 131 .	 Note Do not mix with other oils!
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

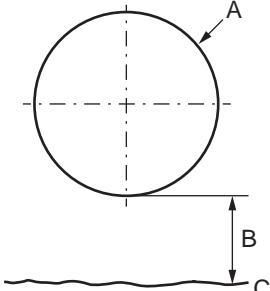
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3.3.1 Inspecting the oil level in axis-1 gearbox

Continued

Inspecting the oil level in axis-1 gearbox

Use this procedure to inspect the oil level in the axis-1 gearbox.

Action	Note
1  WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56 .	
2  DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3 Make sure that the oil temperature is $+25^{\circ}\text{C} \pm 10^{\circ}\text{C}$.	This is a precaution to reduce the temperature dependency of the measurement.
4 Open the <i>oil plug, inspection.</i>	Shown in figure Location of gearbox on page 112 .
5 Measure the oil level. Required oil level: max. 5 mm below the oil plug hole.	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
6 Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in Type of lubrication in gearboxes on page 131 . Further information about how to fill with oil is found in section Changing oil, axis-1 gearbox on page 132 .
7 Refit the oil plug.	Tightening torque: 25 Nm

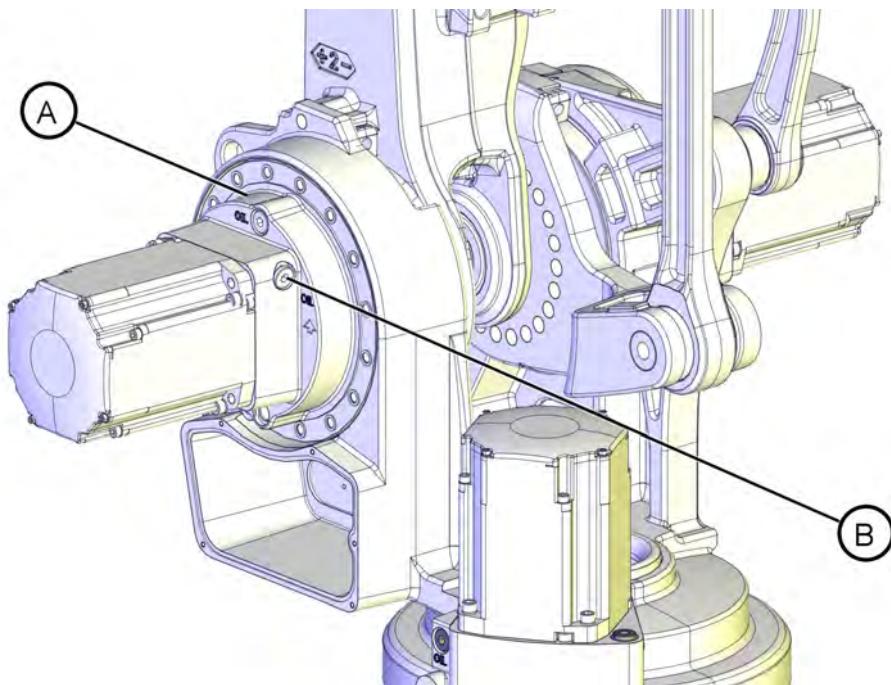
3 Maintenance

3.3.2 Inspecting, oil level gearbox axes 2 - 3

3.3.2 Inspecting, oil level gearbox axes 2 - 3

Location of gearbox, axes 2-3

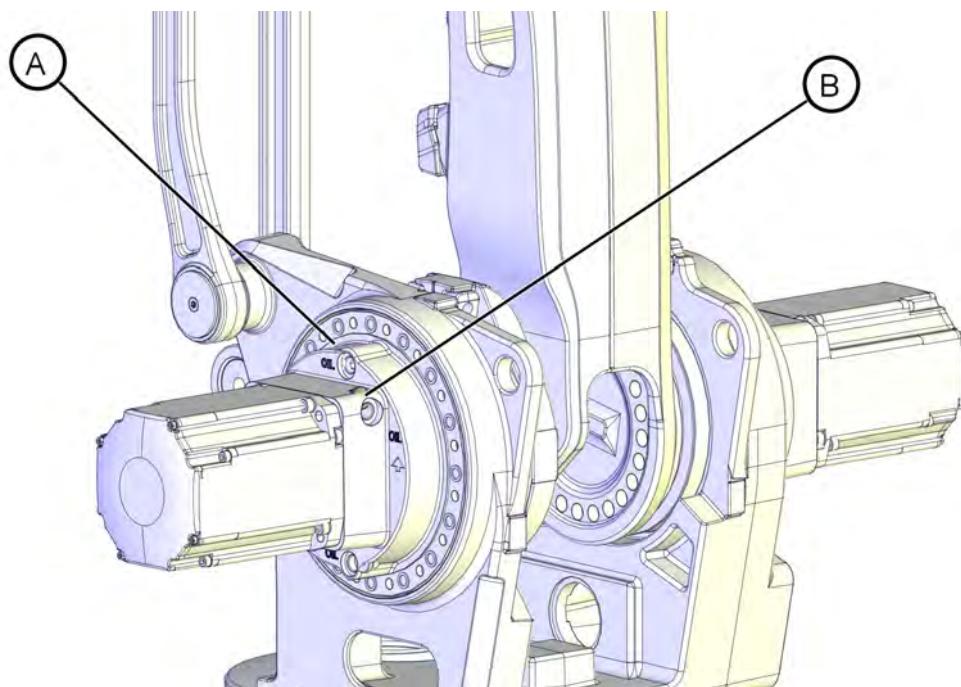
The gearboxes axes 2-3 are located in the lower arm rotational center, underneath the motor attachment.



xx1000001295

A	Gearbox, axis 2
B	Oil plug, filling

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xx1000001297

A	Gearbox, axis 3
B	Oil plug, filling

Required equipment

Equipment etc.	Art.no.	Note
Lubricating oil	See Type and amount of oil in gearboxes on page 131 .	 Note Do not mix with other oils!
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below		These procedures include references to the tools required.

Inspecting, oil level gearbox 2 - 3

Use this procedure to inspect the oil level in gearbox axes 2 - 3.

	Action	Note
1	 WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56 .	

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3 Maintenance

3.3.2 Inspecting, oil level gearbox axes 2 - 3

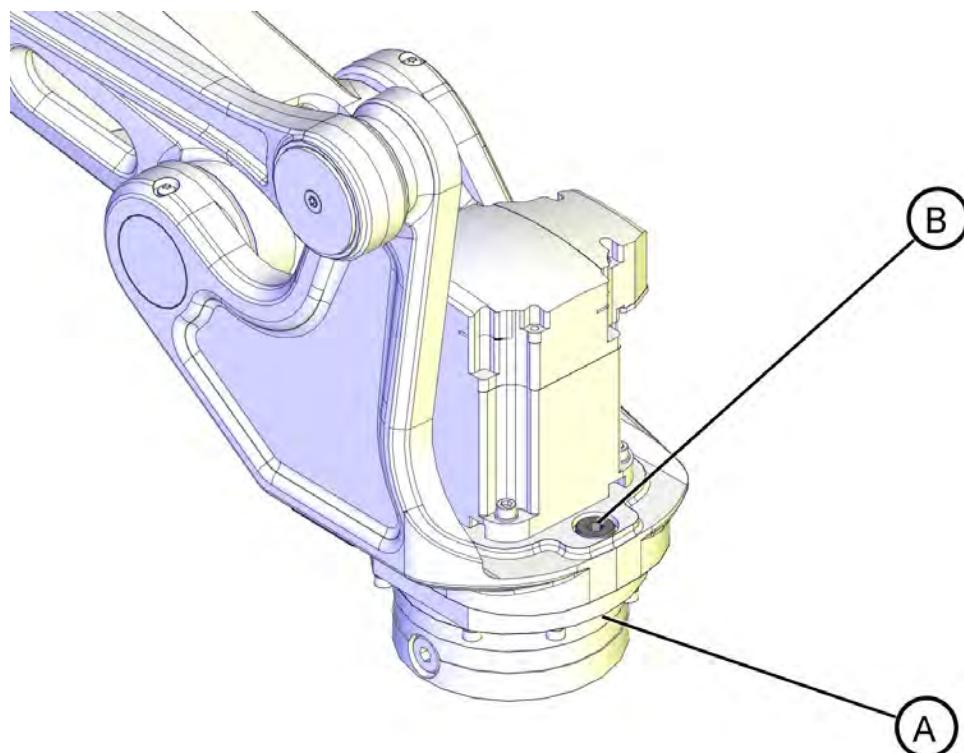
Continued

	Action	Note
2	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply to the robot• hydraulic pressure supply to the robot• air pressure supply to the robot Before entering the robot working area.	
3	Open <i>oil plug, filling</i>	See Location of gearbox, axes 2-3 on page 114 .
4	Measure oil level at the oil plug, filling. Required oil level: max. 5 mm below oil plug hole.	
5	Add <i>oil</i> if required.	Art.no. is specified in Required equipment on page 115 . Filling of oil is detailed further in section Changing oil, gearbox axes 2 and 3 on page 136 .
6	Refit oil plug, filling.	Tightening torque: 25 Nm.

3.3.3 Inspecting, oil level gearbox axis 6

Location of gearbox

The axis 6 gearbox is located in the tilthouse unit as shown in this figure.



xx1000001301

A	Gearbox, axis 6
B	Oil plug, filling

Required equipment

Equipment	Art. no.	Note
Lubricating oil	3HAC032140-001	Kyodo Yushi TMO 150
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

3 Maintenance

3.3.3 Inspecting, oil level gearbox axis 6

Continued

Inspection, oil level axis-6 gearbox

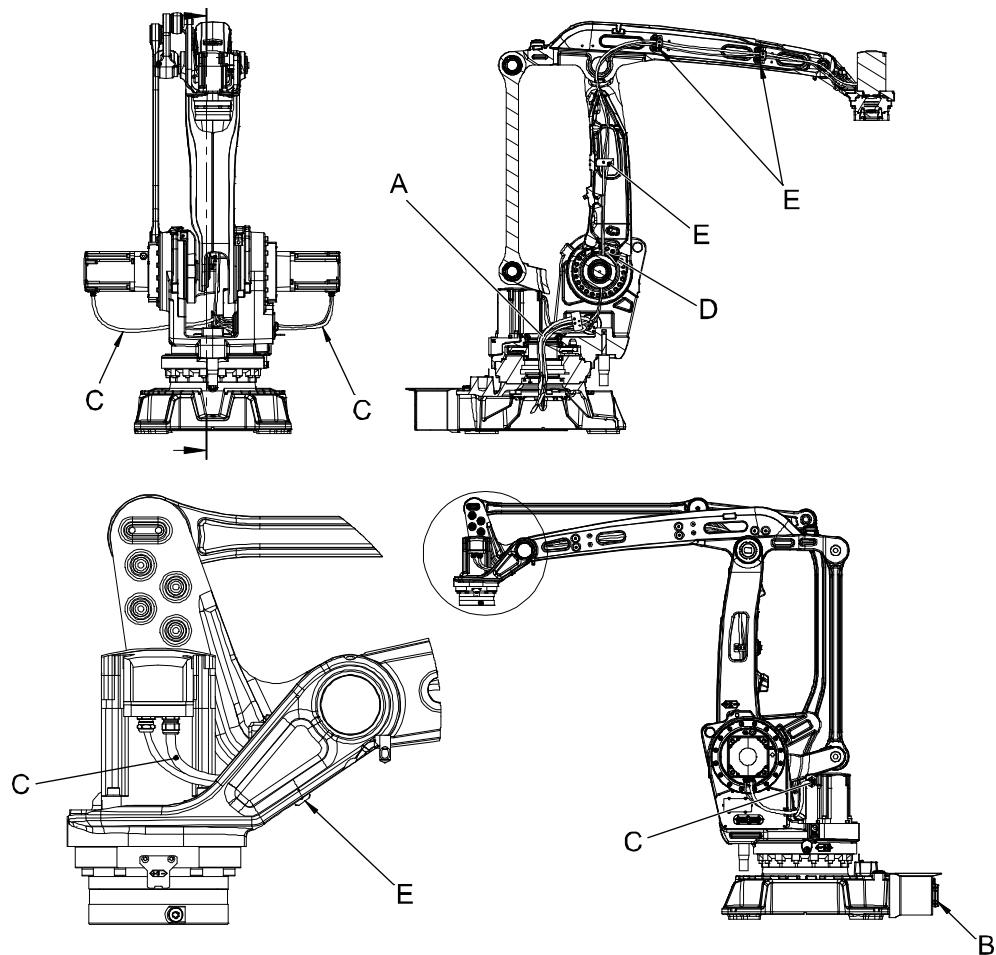
Use this procedure to inspect the oil level in the axis-6 gearbox.

	Action	Note
1	 WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56 .	
2	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
3	Open <i>oil plug, filling</i> .	Shown in figure Location of gearbox on page 117 .
4	Required oil level: 23 mm ± 2 mm below the motor mounting surface.	
5	Add <i>oil</i> if required.	Art. no. is specified in Required equipment on page 117 . Further information about how to fill the oil may be found in the section Changing oil, gearbox axis 6 on page 140 .
6	Refit <i>oil plug, filling</i> .	Tightening torque: 25 Nm.

3.3.4 Inspecting, cable harness

Location of cable harness, axes 1-6

The axes-1-6 cable harness is shown below.



xx1000001373

A	Cable harness robot, axes 1-6
B	Connectors at base
C	Motor cables
D	Cable guide, axis 2
E	Metal clamps

Required equipment

Visual inspection, no tools are needed.

Continues on next page

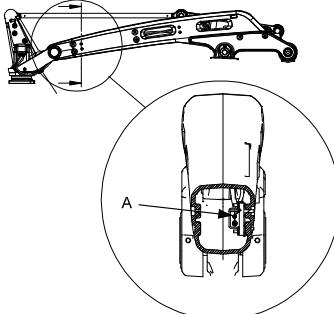
3 Maintenance

3.3.4 Inspecting, cable harness

Continued

Inspecting cable harness, axes 1-6

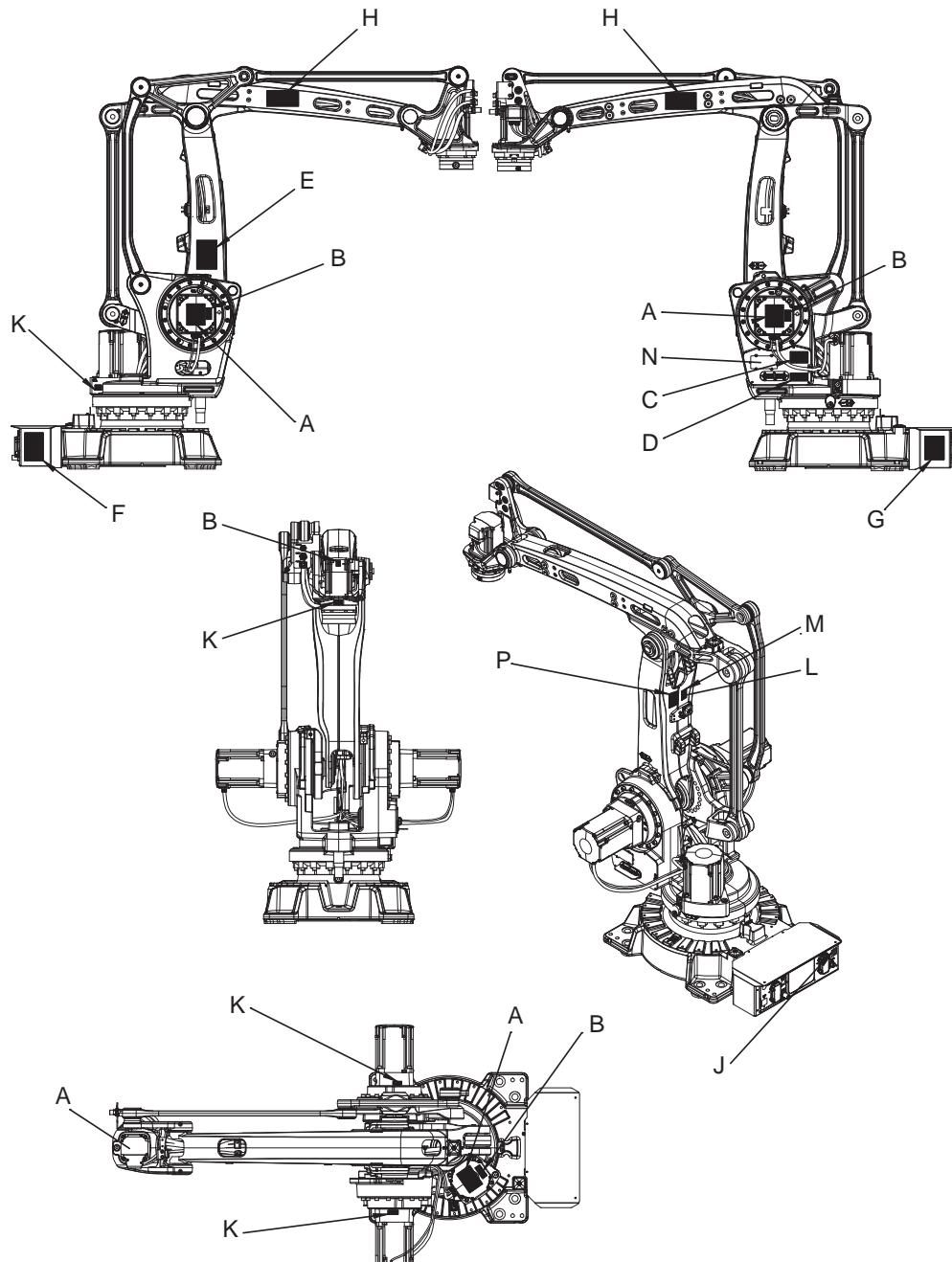
Use this procedure to inspect cable harness of axes 1-6.

Action	Note
1  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2 Make an overall inspection of the cable harness in order to detect wear and damage.	
3 Check the <i>connectors at the base</i> .	Shown in figure Location of cable harness, axes 1-6 on page 119
4 Check the <i>motor cables</i> .	Shown in figure Location of cable harness, axes 1-6 on page 119 .
5 Check the <i>cable guide axis 2</i> . Replace if damaged.	Shown in figure Location of cable harness, axes 1-6 on page 119 .
6 Check the <i>metal clamps</i> on the lower arm.	Shown in figure Location of cable harness, axes 1-6 on page 119
7 Check the metal clamps holding the cable harness inside the upper arm, as shown in figure to the right.	 xx0500002498 A: Metal clamp inside upper arm
8 Check the metal clamp holding the motor cable on axis 6.	Shown in figure Location of cable harness, axes 1-6 on page 119 .
9 Replace the cable harness if wear or damage is detected!	Detailed in section: Replacing cable harness, lower end (axes 1-3) on page 155 . Replacing the cable harness, upper end (incl. axis 6) on page 165 .

3.3.5 Inspecting the information labels

Location of labels

These figures show the location of the information labels to be inspected. The symbols are described in section [Safety symbols on product labels on page 41](#).



xx1000001292

A	Warning label "Heat" (located on motor cover), 3HAC4431-1 (4 pcs)
B	Warning label, symbol of flash (located on motor cover), 3HAC1589-1 (4 pcs)
C	Combined warning label "Moving robot", "Shut off with handle" and "Before dismantling see product manual", 3HAC17804-1

Continues on next page

3 Maintenance

3.3.5 Inspecting the information labels

Continued

D	Combined warning label "Brake release", "Brake release buttons" and "Moving robot", 3HAC054583-001
E	Instruction label for lifting of robot, 3HAC039135-001
F	Warning label "Tip risk when loosening bolts", 3HAC9191-1
G	Information label at base, specifying which oil is filled in gearboxes, 3HAC032906-001
H	ABB Logotype, 3HAC17765-2 (2 pcs)
J	UL label, 3HAC2763-1
K	Information label near each gearbox, specifying which oil is used in gearboxes, 3HAC032726-001 (4 pcs)
L	Label serial number
M	Label calibration
N	Label, battery
P	Label, stock robots

Required tools and equipment

Visual inspection, no tools are required.

Inspecting, labels

Action	Note
1  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2 Inspect the labels, located as shown in the figures.	
3 Replace any missing or damaged labels.	Article numbers for the labels and plate set is specified in Spare parts on page 393 .

3.3.6 Inspecting the axis-1 mechanical stop pin



WARNING

Mechanical stop pin can not be fitted onto robot if option 810-1 *Electronic Position Switch* is used.

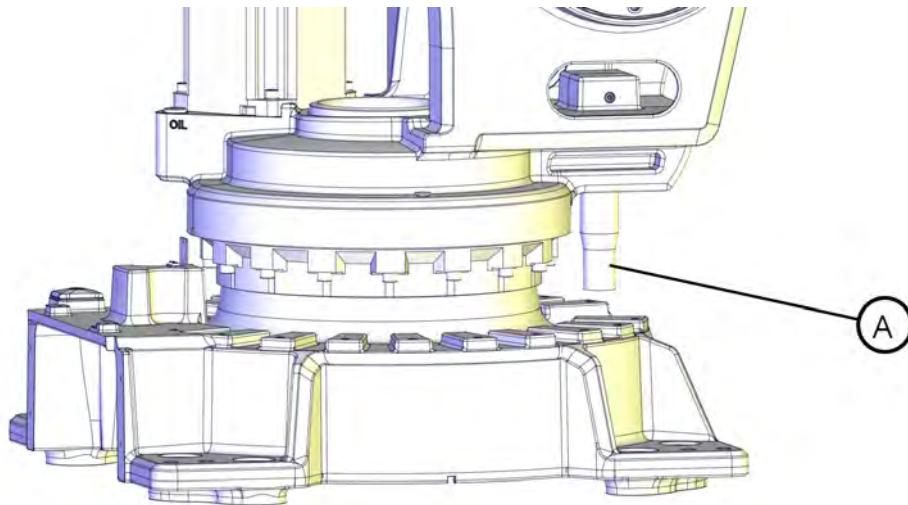


WARNING

Mechanical stop pin can not be fitted onto robot if option 561-1 *Extended work range axis 1* is used.

Location of mechanical stop pin

The axis-1 mechanical stop is located as shown in the figure.



xx1000001302

A

Mechanical stop pin, axis 1

Required equipment

Visual inspection, no tools are required.

Inspecting, mechanical stop pin

Use this procedure to inspect the axis-1 mechanical stop pin.

	Action	Note
1	<p></p> <p>DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply <p>to the robot, before entering the robot working area.</p>	

Continues on next page

3 Maintenance

3.3.6 Inspecting the axis-1 mechanical stop pin

Continued

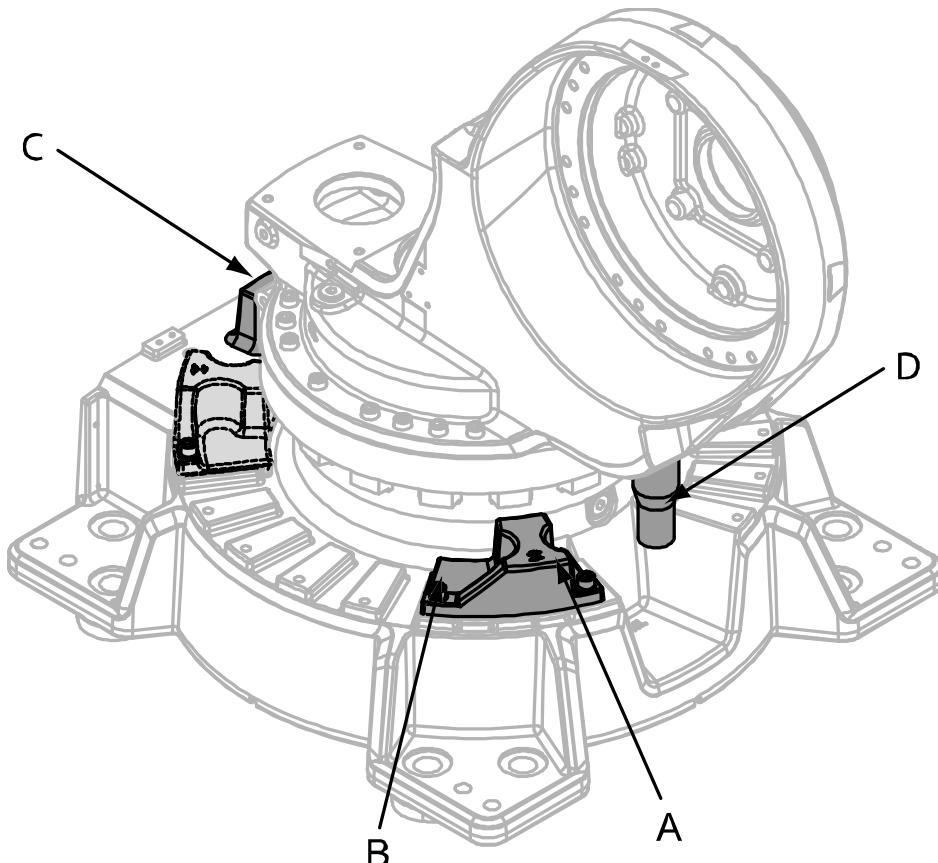
Action	Note
<p>2 Inspect the axis-1 mechanical stop pin. If the mechanical stop pin is bent or damaged, it must be replaced.</p> <p> Note</p> <p>The expected life of gearboxes can be reduced after collision with the mechanical stop.</p>	

3.3.7 Inspecting the additional mechanical stops

3.3.7 Inspecting the additional mechanical stops

Location of mechanical stops

This figure shows the location of the additional mechanical stop on axis 1.



xx0600002938

A	Additional stop, axis 1
B	Attachment screws and washers (2 pcs)
C	Fixed stop
D	Mechanical stop pin, axis 1

Required equipment

Equipment etc.	Article number	Note
Mechanical stop	See Spare parts on page 393 .	
Standard toolkit	-	Content is defined in section Standard tools on page 387 .

Continues on next page

3 Maintenance

3.3.7 Inspecting the additional mechanical stops

Continued

Inspecting, mechanical stops

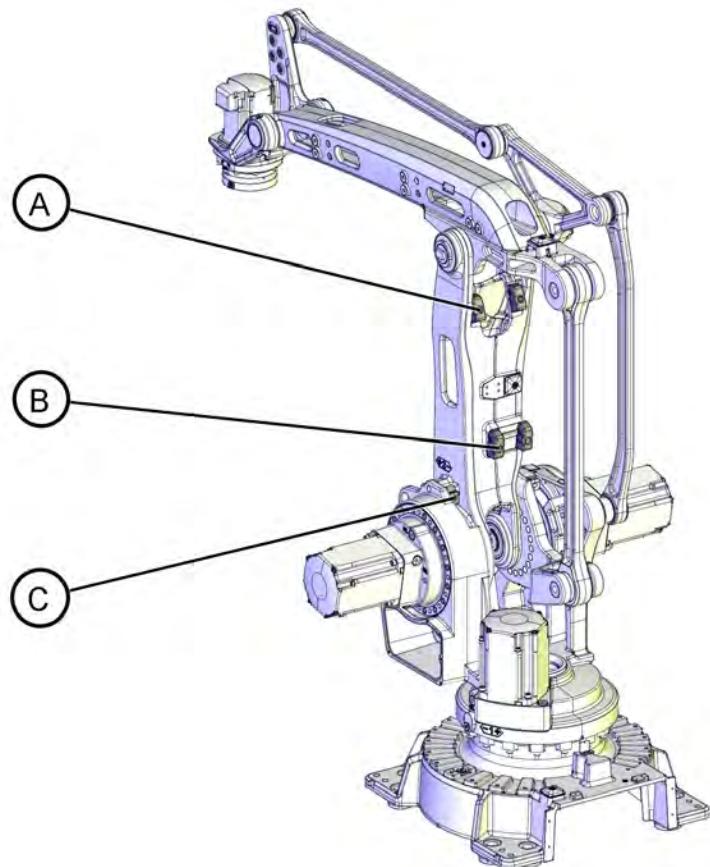
Use this procedure to inspect the additional mechanical stops.

Action	Note
1  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2 Make sure no additional stops are damaged.	Shown in figure Location of mechanical stops on page 125 .
3 Make sure the stops are properly attached. Correct tightening torque, additional mechanical stops: <ul style="list-style-type: none">• Axis 1 = 115 Nm	
4 If any damage is detected, the mechanical stops must be replaced! Correct attachment screws: <ul style="list-style-type: none">• Axis 1: M12 x 40, quality 12.9.	Article number is specified in Required equipment on page 125 .

3.3.8 Inspection, dampers

Location of dampers

This figure shows the location of dampers.



xx1000001345

A	Damper, lower arm, upper (2 pcs)
B	Damper, lower arm, lower (2 pcs)
C	Damper, axis 2 (2 pcs)
-	Damper, axis 3 (2 pcs). Not visible in this view.

Required equipment

Equipment	Art.no.	Note
Damper lower arm, upper	See Spare parts on page 393 .	To be replaced if damaged.
Damper lower arm, lower	See Spare parts on page 393 .	To be replaced if damaged.
Damper axis 2, 3	See Spare parts on page 393 .	To be replaced if damaged.

Continues on next page

3 Maintenance

3.3.8 Inspection, dampers

Continued

Inspecting, dampers

Use this procedure to inspect the dampers.

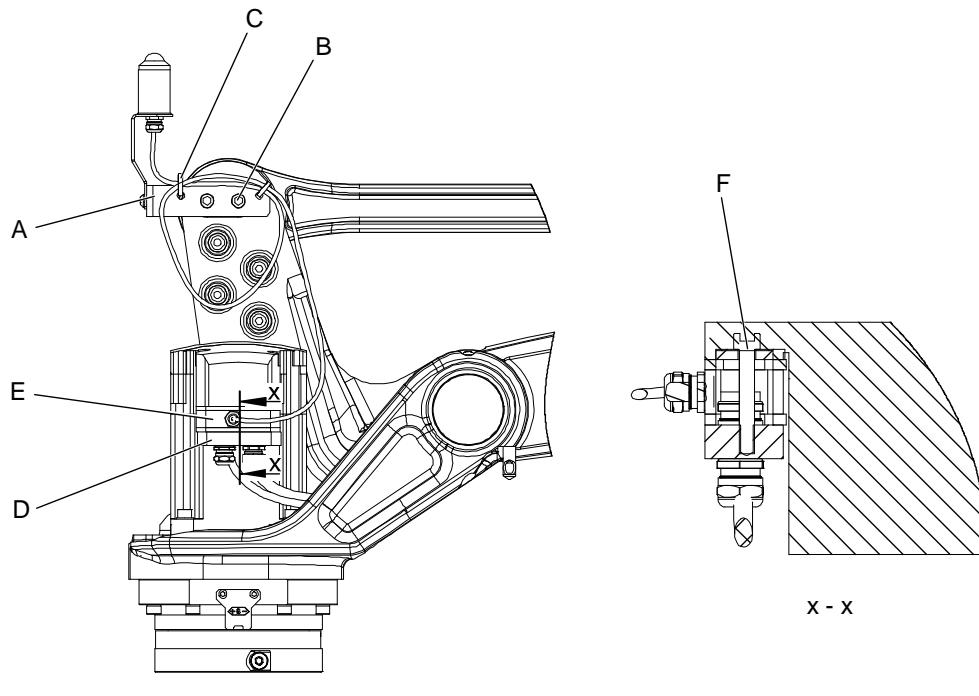
Action	Note
1  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply to the robot• hydraulic pressure supply to the robot• air pressure supply to the robot Before entering the robot working area.	
2 Check all <i>dampers</i> for damage, cracks or existing impressions larger than 1 mm.	Shown in figure Location of dampers on page 127 .
3 Check attachment screws for deformation.	
4 If any damage is detected, the <i>damper</i> must be replaced with a new one.	Art.no. is specified in Required equipment on page 127 .

3.3.9 Inspecting the signal lamp (option)

3.3.9 Inspecting the signal lamp (option)

Location of signal lamp

The signal lamp is located as shown in this figure.



xx1000001288

A	Signal lamp bracket
B	Attachment screws, M8x12 and bracket (2 pcs)
C	Cable straps (2 pcs)
D	Cable gland cover
E	Motor adapter including gasket
F	Attachment screw, M6x40 (1 pc)

Required tools and equipment

Equipment	Article number	Note
Signal lamp kit	See Spare parts on page 393 .	To be replaced if damage is detected.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .

Inspecting, signal lamp

Use this procedure to inspect the function of the signal lamp.

Action	Note
1 Inspect that signal lamp is lit when motors are put in operation ("MOTORS ON").	

Continues on next page

3 Maintenance

3.3.9 Inspecting the signal lamp (option)

Continued

Action	Note
<p>2</p> <p> DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply <p>to the robot, before entering the robot working area.</p>	
<p>3</p> <p>If the lamp is not lit, trace the fault by:</p> <ul style="list-style-type: none">• inspecting whether the signal lamp is broken. If so, replace it.• inspecting cable connections.• measuring the voltage in the connectors of motor axis 6 (=24V).• inspecting the cabling. Replace the cabling if a fault is detected.	Article number is specified in Required tools and equipment on page 129 .

3.4.1 Type of lubrication in gearboxes

3.4 Replacement/changing activities

3.4.1 Type of lubrication in gearboxes

Introduction

This section describes where to find information about the *type of lubrication*, *article number* and the *amount of lubrication* in the specific gearbox. It also describes the equipment needed when working with lubrication.

Type and amount of oil in gearboxes

Information about the *type of lubrication*, *article number* as well as the *amount* in the specific gearbox can be found in *Technical reference manual - Lubrication in gearboxes* on the Documentation DVD (released twice a year). The revision of the manual published on the Documentation DVD, will contain the latest updates when the Documentation DVD is released.

Before starting any inspection, maintenance, or changing activities of lubrication, always contact the local ABB Service organization for more information.

For ABB personnel: Always check ABB Library for the latest revision of the manual *Technical reference manual - Lubrication in gearboxes*, in order to always get the latest information of updates about lubrication in gearboxes. A new revision will be published on ABB Library immediately after any updates. Therefore the manual published on the documentation DVD may not contain the latest updates about lubrication.

Location of gearboxes

The figure shows the location of the gearboxes.

Equipment

Equipment	Note
Oil dispenser	Includes pump with outlet pipe. Use the suggested dispenser or a similar one: <ul style="list-style-type: none">Orion OriCan article number 22590 (pneumatic)
Nipple for quick connect fitting, with o-ring	

3 Maintenance

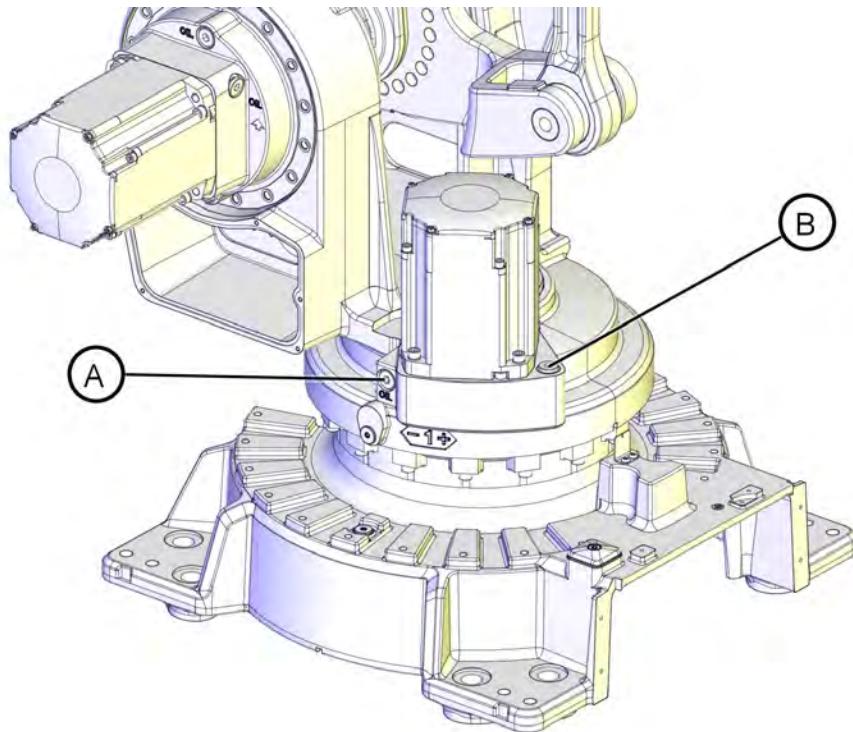
3.4.2 Changing oil, axis-1 gearbox

3.4.2 Changing oil, axis-1 gearbox

Location of oil plugs

The axis-1 gearbox is located between the frame and base. See oil plugs in the following figure.

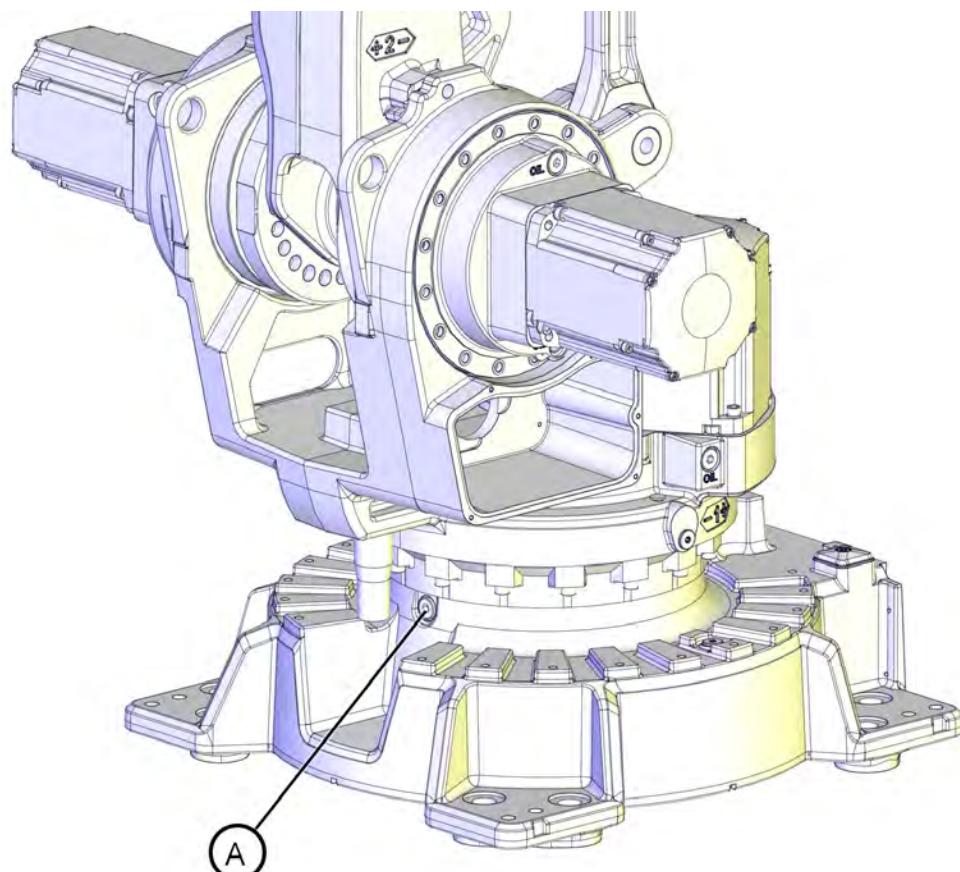
falseThe oil is drained through a hose, which is located at the rear of the robot base.



xx1000001294

A	Oil plug, inspection
B	Oil plug, filling

Continues on next page



xx1000001346

A	Oil plug, draining
---	--------------------

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See Type and amount of oil in gearboxes on page 131 .	See Type and amount of oil in gearboxes on page 131 .	 Note Do not mix with other oils!
Oil collecting vessel	-		Capacity: 8,000 ml.
Oil exchange equipment	3HAC021745-001		Content is defined in section Special tools on page 388 .
Standard toolkit	-		Content is defined in section Standard tools on page 387 .

Continues on next page

3 Maintenance

3.4.2 Changing oil, axis-1 gearbox

Continued

Draining oil, axis-1 gearbox

Use this procedure to drain oil in gearbox axis 1.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2	 WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <i>WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56.</i>	
3	Remove <i>oil plug, filling</i> , in order to drain oil quicker!	Shown in Location of oil plugs on page 132 .
4	Remove <i>oil plug, draining</i> , and drain gearbox using a hose with a nipple and an oil collecting vessel.	Shown in Location of oil plugs on page 132 . Vessel capacity is specified in Required equipment on page 133 .  Note Draining is time-consuming. Elapsed time depends on the temperature of the oil.
5	Refit oil plugs.	Tightening torque: 25 Nm.

Filling oil, axis-1 gearbox

Use this procedure to fill gearbox axis 1 with oil.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	

Continues on next page

Action	Note
2  WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <i>WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56.</i>	
3 Open the <i>oil plug, filling.</i>	Shown in figure <i>Location of oil plugs on page 132.</i>
4 Refill the gearbox with clean <i>lubricating oil.</i> The correct oil level is detailed in section <i>Inspecting the oil level in axis-1 gearbox on page 112.</i>	Where to find type of oil and total amount is detailed in <i>Type and amount of oil in gearboxes on page 131.</i>
5 Refit the oil plug, filling.	Tightening torque: 25 Nm.

3 Maintenance

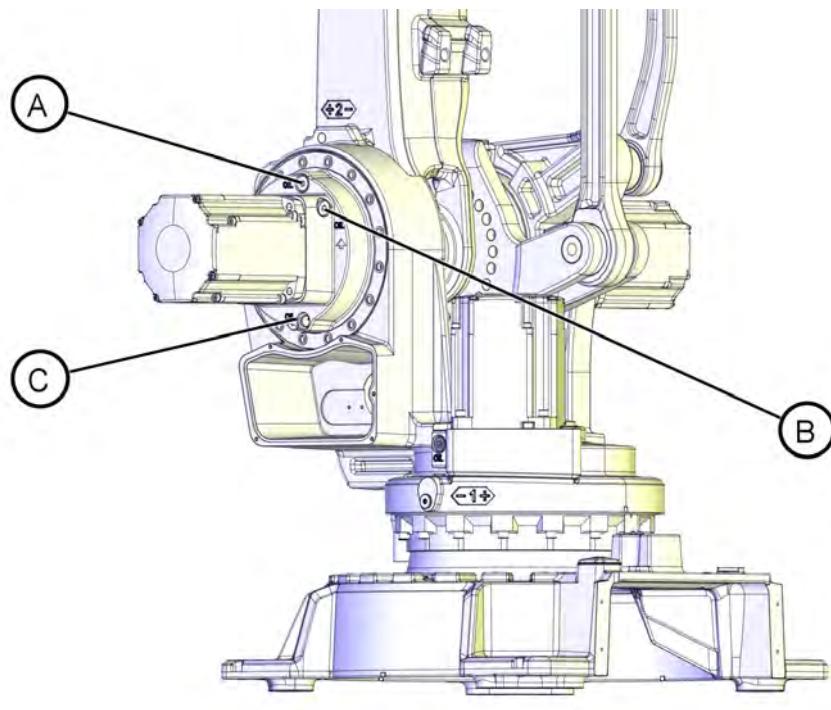
3.4.3 Changing oil, gearbox axes 2 and 3

3.4.3 Changing oil, gearbox axes 2 and 3

Location of oil plugs

Gearboxes, axes 2 and 3, are located in lower arm rotational center, underneath motor attachment.

The figure shows the position of gearbox, axis 2.

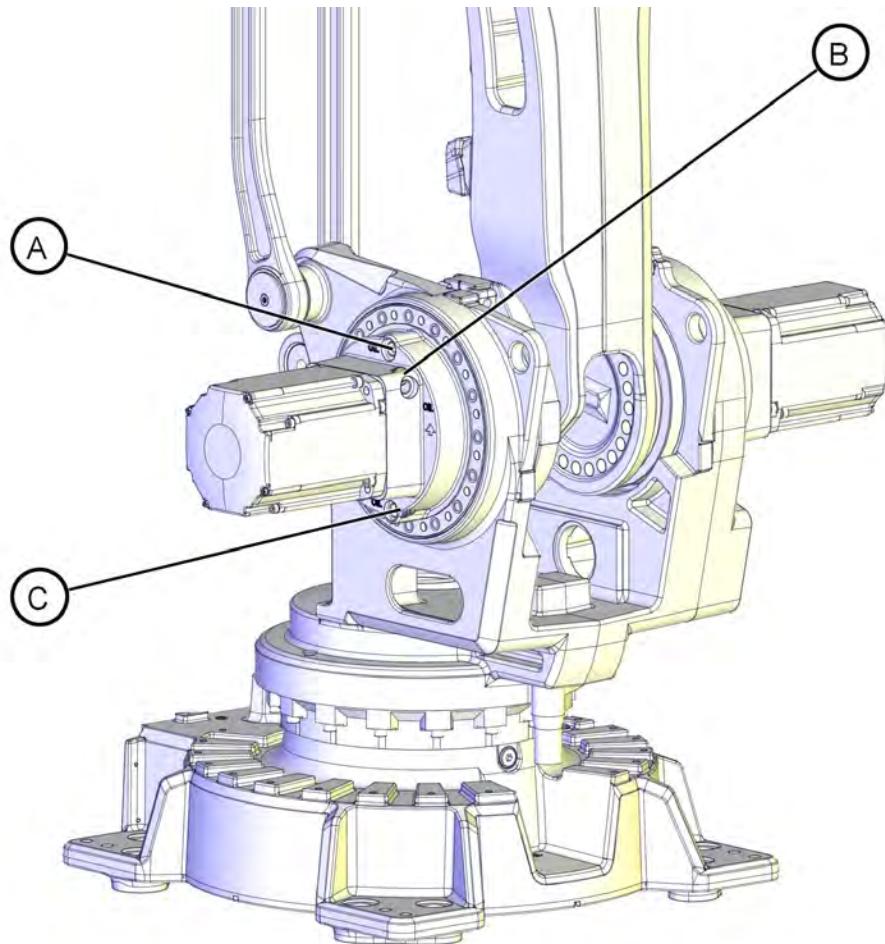


xx1000001348

A	Ventilation hole plug, gearbox axis 2
B	Oil plug, filling
C	Oil plug, draining

Continues on next page

The figure shows position of gearbox, axis 3.



xx1000001351

A	Ventilation hole plug, gearbox axis 3
B	Oil plug, filling
C	Oil plug, draining

Required equipment

Equipment etc.	Art. no.	Amount	Note
Lubricating oil	See Type and amount of oil in gearboxes on page 131 .	3,200 ml in each gearbox	 Note Do not mix with other oils!
Oil collecting vessel			Capacity: 4,000 ml
Oil exchange equipment	3HAC021745-001		Content is defined in section Special tools on page 388 .
Standard toolkit	-		Content is defined in section Standard tools on page 387 .

Continues on next page

3 Maintenance

3.4.3 Changing oil, gearbox axes 2 and 3

Continued

Draining, axes 2 and 3

Use this procedure to drain oil in gearbox axes 2 and 3.

When using oil change equipment, follow the instructions enclosed with kit.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2	 WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56 .	
3	Remove the <i>ventilation hole plug</i> .	Shown in Location of oil plugs on page 136 .
4	Remove the <i>oil plug, draining</i> , and drain gearbox using a hose with a nipple and an oil collecting vessel.	Shown in Location of oil plugs on page 136 . Vessel capacity is specified in Required equipment on page 137 . Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
5	Refit the oil plug, draining.	Tightening torque: 25 Nm.

Filling, axes 2 and 3

Use this procedure to fill gearboxes of axes 2 and 3 with oil.

When using oil change equipment, follow the instructions enclosed with kit.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	

Continues on next page

	Action	Note
2	 WARNING Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56 .	
3	Remove the <i>oil plug, filling</i> . (<i>Ventilation hole plug</i> should also be removed.)	Shown in Location of oil plugs on page 136 . Tightening torque: 24 Nm.
4	Refill gearbox with <i>lubricating oil</i> . The <i>amount of oil</i> to be filled depends on the amount that was previously drained.	Art.no. and total amount are specified in Required equipment on page 137 .
5	Refit <i>oil plug, filling</i> and <i>ventilation hole plug</i> .	Shown in Location of oil plugs on page 136 . Tightening torque: 25 Nm.

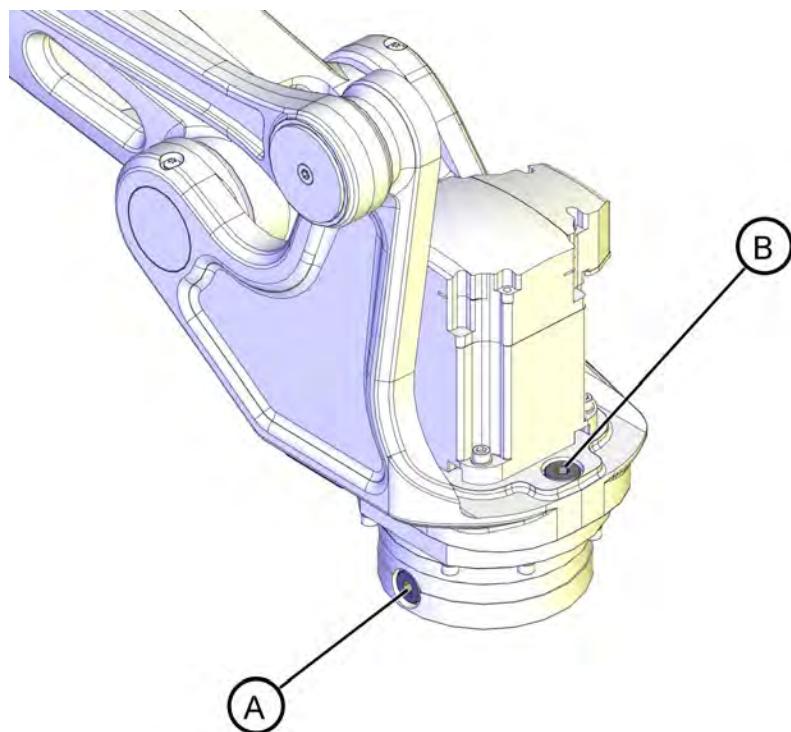
3 Maintenance

3.4.4 Changing oil, gearbox axis 6

3.4.4 Changing oil, gearbox axis 6

Location of oil plugs

Gearbox axis 6 is located in the center of the tilt house unit.



xx1000001353

A	Oil plug, draining
B	Oil plug, filling

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubrication oil	3HAC032140-001	300 ml	Kyodo Yushi TMO 150 Do not mix with other oil types!
Oil exchange equipment	3HAC021745-001		
Oil collecting vessel			Vessel capacity: 400 ml.
Standard toolkit		-	Content is defined in section Standard tools on page 387 .

Draining, oil

Use this procedure to drain oil from gearbox axis 6.

When using oil change equipment, follow the instructions enclosed with kit.

	Action	Note
1	Put tilt house in a suitable position.	

Continues on next page

Action	Note
<p>2</p> <p> DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply <p>to the robot, before entering the robot working area.</p>	
<p>3</p> <p>Drain oil from gearbox into a vessel by removing <i>oil plug, draining</i>. Also remove <i>oil plug, filling</i>.</p>	<p>Shown in figure Location of oil plugs on page 140.</p> <p>Vessel capacity is specified in Required equipment on page 140.</p>
4	Refit oil plugs, draining and filling.

Filling, oil

Use this procedure to fill gearbox axis 6 with oil.

When using oil change equipment, follow the instructions enclosed with kit.

Action	Note
<p>1</p> <p> DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply <p>to the robot, before entering the robot working area.</p>	
2	Remove the <i>oil plug, filling</i> .
3	Refill the gearbox with <i>lubricating oil</i> . Amount of oil to be refilled depends on the amount that was previously drained. Correct oil level is detailed in section Inspection, oil level axis-6 gearbox on page 118 .
4	Refit the oil plug.

3 Maintenance

3.4.5 Replacing the SMB battery



Note

The battery low alert (38213 **Battery charge low**) is displayed when the battery needs to be replaced. The recommendation to avoid an unsynchronized robot is to keep the power to the controller turned on until the battery is to be replaced.

For a SMB board with 3-pole battery contact (RMU101 3HAC044168-001 or RMU102 3HAC043904-001), the lifetime of a new battery is typically 36 months.

For a SMB board with 2-pole battery contact (DSQC), the typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended for longer production breaks with a battery shutdown service routine. See *Operating manual - IRC5 with FlexPendant* for instructions.



WARNING

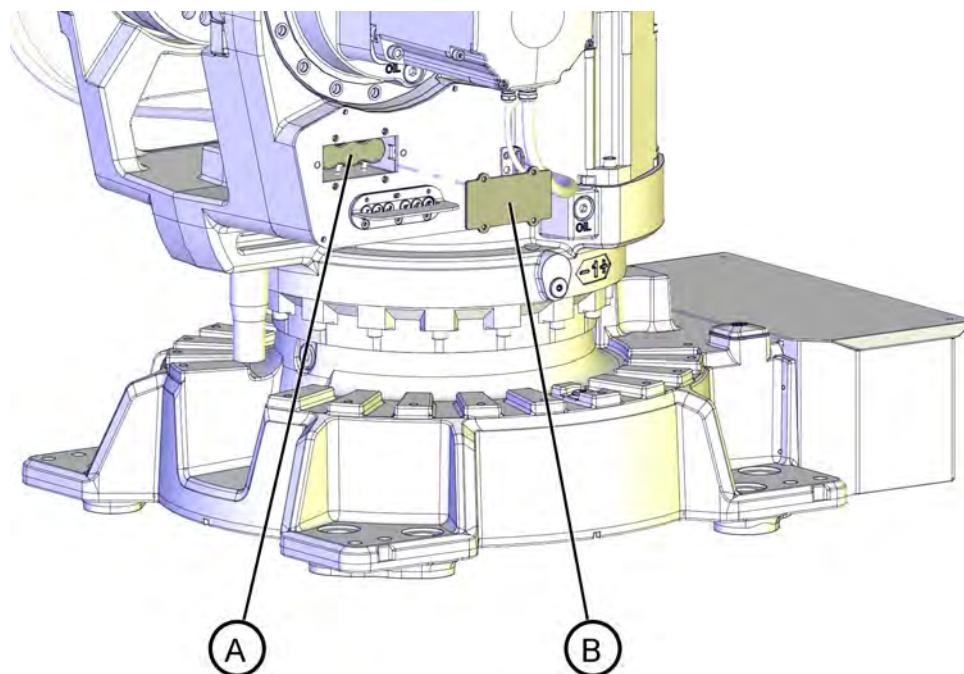
See instructions for batteries, [WARNING - Safety risks during handling of batteries on page 55](#).

Continues on next page

Location of SMB battery

The SMB battery (SMB = serial measurement board) is located on the left hand side of the frame as shown in the figure.

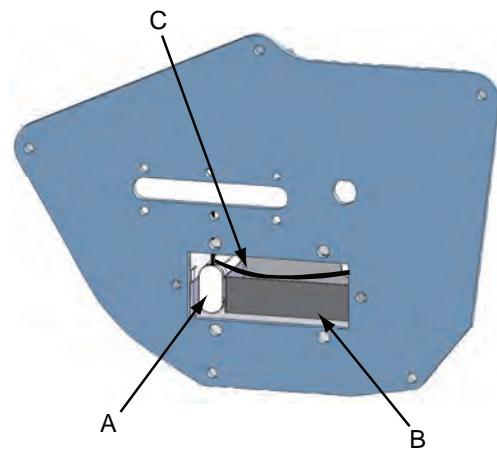
Battery pack with a 2-pole battery contact (DSQC)



xx1000001360

A	SMB battery pack
B	SMB battery cover

Battery pack with a 3-pole battery contact (RMU)



xx1300001116

- A Battery pack RMU
- B Battery holder
- C Battery cable

Continues on next page

3 Maintenance

3.4.5 Replacing the SMB battery

Continued

Required equipment



Note

There are two variants of SMB units and batteries. One with 2-pole battery contact (DSQC) and one with 3-pole battery contact (RMU). The variant with the 3-pole battery contact has longer lifetime for the battery.

It is important that the SMB unit uses the correct battery. Make sure to order the correct spare parts. Do not exchange battery contacts!

Equipment, etc.	Spare part no.	Note
Battery unit	For spare part no. see: • Spare parts on page 393	Battery includes protection circuits. Only replace with a specified spare part or an ABB-approved equivalent.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Circuit diagram	-	See chapter Circuit diagrams on page 395 .

Removing, battery

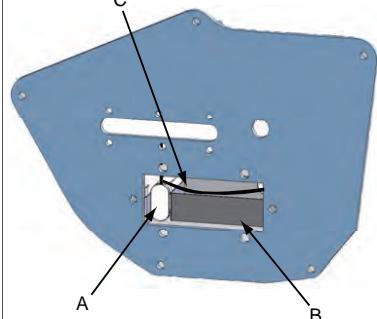
Use this procedure to remove the SMB battery.

	Action	Note
1	Move the robot to its calibration position.	This is done in order to facilitate updating of the revolution counter.
2	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
3	 ELECTROSTATIC DISCHARGE (ESD) The unit is sensitive to ESD. Before handling the unit please read the safety information in the section WARNING - The unit is sensitive to ESD! on page 52	
4	Remove the <i>SMB battery cover</i> by unscrewing the attachment screws.	Shown in figure Location of SMB battery on page 143 .
5	Pull out the battery and disconnect the <i>battery cable</i> .	Shown in figure Location of SMB battery on page 143 .
6	Remove the <i>SMB battery</i> . Battery includes protection circuits. Only replace with a specified spare part or with an ABB-approved equivalent.	Shown in figure Location of SMB battery on page 143 .

Continues on next page

Refitting, battery

Use this procedure to refit the SMB battery.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	 ELECTROSTATIC DISCHARGE (ESD) The unit is sensitive to ESD. Before handling the unit please read the safety information in the section WARNING - The unit is sensitive to ESD! on page 52	
3	Reconnect the <i>battery cable</i> and install the battery pack into the SMB/battery recess.  Note RMU batteries are installed together with a battery holder to be properly secured inside the recess. See figure.	Art. no. is specified in Required equipment on page 144 . Shown in figure Location of SMB battery on page 143 .  xx1300001116 A Battery pack RMU B Battery holder C Battery cable
4	Secure the <i>SMB battery cover</i> with its attachment screws.	Shown in figure Location of SMB battery on page 143 .
5	Update the revolution counters.	Detailed in chapter Calibration - section Updating revolution counters on page 360 .
6	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

3 Maintenance

3.5.1 Cleaning the IRB 460

3.5 Cleaning activities

3.5.1 Cleaning the IRB 460



WARNING

Turn off all electrical power supplies to the manipulator before entering its work space.

General

To secure high uptime it is important that the IRB 460 is cleaned regularly. The frequency of cleaning depends on the environment in which the manipulator works. Different cleaning methods are allowed depending on the type of protection of the IRB 460.



Note

Always verify the protection type of the robot before cleaning.

Oil spills

Oil spills from gearboxes

Use the following procedure if any oil spills are detected that can be suspected to originate from a gearbox.

- 1 Inspect that the oil level in the suspected gearbox is according to the recommendations, see [Inspection activities on page 112](#).
- 2 Write down the oil level.
- 3 Inspect the oil level again after, for example, 6 months.
- 4 If the oil level is decreased then replace the gearbox.

Oil spills discolors painted surfaces

Oil spills on painted surfaces of the robot can result in discoloration.



Note

After all repair and maintenance work involving oil, always wipe the robot clean from all surplus oil.

Dos and don'ts!

This section specifies some special considerations when cleaning the robot.

Always!

- Always use cleaning equipment as specified! Any other cleaning equipment may shorten the life of the robot.
- Always check that all protective covers are fitted to the robot before cleaning!

Continues on next page

Never!

- Never point the water jet at connectors, joints, sealings, or gaskets!
- Never use compressed air to clean the robot!
- Never use solvents that are not approved by ABB to clean the robot!
- Never spray from a distance closer than 0.4 meters!
- Never remove any covers or other protective devices before cleaning the robot!

Cleaning methods

These following table defines what cleaning methods are allowed for ABB manipulators depending on the protection type.

Protection type	Cleaning method			
	Vacuum cleaner	Wipe with cloth	Rinse with water	High pressure water or steam
Standard	Yes	Yes. With light cleaning detergent.	Yes. It is highly recommended that the water contains a rust-prevention solution and that the manipulator is dried afterwards.	No

Cleaning with water and steam

Instructions for rinsing with water

ABB robots with protection types *Standard*, *Foundry Plus*, *Wash*, or *Foundry Prime* can be cleaned by rinsing with water (water cleaner).¹

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 700 kN/m² (7 bar)¹
- Fan jet nozzle should be used, min. 45° spread
- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum flow: 20 liters/min¹

¹ Typical tap water pressure and flow

Cables

Movable cables need to be able to move freely:

- Remove waste material, such as sand, dust and chips, if it prevents cable movement.
- Clean the cables if they have a crusty surface, for example from dry release agents.

¹ See [Cleaning methods on page 147](#) for exceptions.

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4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes all repair activities recommended for the IRB 460 and any external unit.

It is made up of separate procedures, each describing a specific repair activity. Each procedure contains all the information required to perform the activity, for example spare parts numbers, required special tools, and materials.



WARNING

Repair activities not described in this chapter must only be carried out by ABB. Otherwise damage to the mechanics and electronics may occur.

Required equipment

The details of the equipment required to perform a specific repair activity are listed in the respective procedures.

The details of equipment are also available in different lists in the chapter [Reference information on page 379](#).

Safety information

There are general safety information and specific safety information. The specific safety information describes the danger and safety risks while performing specific steps in a procedure. Make sure to read through the chapter [Safety on page 17](#) before commencing any service work.



Note

If the IRB 460 is connected to power, always make sure that the IRB 460 is connected to earth before starting any repair work.

For more information see:

- *Product manual - IRC5*

4 Repair

4.2.1 Performing a leak-down test

4.2 General procedures

4.2.1 Performing a leak-down test

When to perform a leak-down test

After refitting any motor and gearbox, the integrity of all seals enclosing the gearbox oil must be tested. This is done in a leak-down test.

Required equipment

Equipment, etc.	Article number	Note
Leak-down tester	-	
Leak detection spray	-	

Performing a leak-down test

Action	Note
1 Finish the refitting procedure of the motor or gear in question.	
2 Remove the topmost oil plug on the gear and replace it with the <i>leak-down tester</i> . Regulators, which are included in the leak-down test, may be required.	
3 Use caution, apply compressed air and raise the pressure with the knob until the correct value is shown on the manometer.  CAUTION The pressure must under no circumstance be higher than 0.25 bar (20-25 kPa). Also during the time when the pressure is raised.	Correct value: 0.2-0.25 bar (20-25 kPa)
4 Disconnect the compressed air supply.	
5 Wait for approximately 8-10 minutes and make sure that no pressure loss occurs.	If the compressed air is significantly colder or warmer than the gearbox to be tested, a slight pressure increase or decrease may occur. This is quite normal.
6 If any pressure drop occurred, then localize the leak as described in step 7. If no pressure drop occurred, then remove the leak-down tester and refit the oil plug. The test is complete.	
7 Spray any suspected leak areas with the leak detection spray. Bubbles indicate a leak.	
8 When the leak has been localized, take the necessary measures to correct the leak.	

4.2.2 Mounting instructions for bearings

General

This section describes how to mount and grease different types of bearings on the robot.

Equipment

Equipment, etc.	Article number	Note
Grease	3HAB3537-1	Used to grease the bearings, if not specified otherwise.

Assembly of all bearings

Follow the following instructions while mounting a bearing on the robot.

Action	Note
1 To avoid contamination, let a new bearing remain in its wrapping until it is time for fitting.	
2 Ensure that the parts included in the bearing fitting are free from burrs, grinding waste, and other contamination. Cast components must be free of foundry sand.	
3 Bearing rings, inner rings, and roller elements must not be subjected to direct impact. The roller elements must not be exposed to any stresses during the assembly work.	

Assembly of tapered bearings

Follow the preceding instructions for the assembly of the bearings when mounting a tapered bearing on the robot.

In addition to those instructions, the following procedure must be carried out to enable the roller elements to adjust to the correct position against the race flange.

Action	Note
1 Tension the bearing gradually until the recommended pre-tension is achieved.  Note The roller elements must be rotated a specified number of turns before pre-tensioning is carried out and also rotated during the pre-tensioning sequence.	
2 Make sure the bearing is properly aligned as this will directly affect the durability of the bearing.	

Greasing of bearings

The bearings must be greased after assembly according to the following instructions:

- The bearings must not be completely filled with grease. However, if space is available beside the bearing fitting, the bearing may be totally filled with grease when mounted, as excessive grease will be pressed out from the bearing when the robot is started.

Continues on next page

4 Repair

4.2.2 Mounting instructions for bearings

Continued

- During operation, the bearing should be filled to 70-80% of the available volume.
- Ensure that grease is handled and stored properly to avoid contamination.

Grease the different types of bearings as following description:

- *Grooved ball bearings* must be filled with grease from both sides.
- *Tapered roller bearings* and axial needle bearings must be greased in the split condition.

4.2.3 Mounting instructions for seals

General

This section describes how to mount different types of seals onto the robot.

Equipment

Equipment, etc.	Article number	Note
Grease	3HAB3537-1	Used to lubricate the seals.

Rotating seals

The procedure below describes how to fit rotating seals.



CAUTION

Please observe the following before commencing any assembly of seals:

- Protect the sealing surfaces during transport and mounting.
- Keep the seal in its original wrappings or protect it well before actual mounting.
- The fitting of seals and gears must be carried out on clean workbenches.
- Use a protective sleeve for the sealing lip during mounting, when sliding over threads, keyways, etc.

	Action	Note
1	Check the seal to ensure that: <ul style="list-style-type: none"> • The seal is of the correct type (provided with cutting edge). • There is no damage to the sealing edge (feel with a fingernail). 	
2	Inspect the sealing surface before mounting. If scratches or damage are found, the seal must be replaced since it may result in future leakage.	
3	Lubricate the seal with grease just before fitting. (Not too early - there is a risk of dirt and foreign particles adhering to the seal.) Fill 2/3 of the space between the dust tongue and sealing lip with grease. The rubber coated external diameter must also be greased, unless otherwise specified.	Article number is specified in Equipment on page 153 .
4	Mount the seal correctly with a mounting tool. Never hammer directly on the seal as this may result in leakage.	

Continues on next page

4 Repair

4.2.3 Mounting instructions for seals

Continued

Flange seals and static seals

The following procedure describes how to fit flange seals and static seals.

Action	
1	Check the flange surfaces. They must be even and free from pores. It is easy to check flatness using a gauge on the fastened joint (without sealing compound). If the flange surfaces are defective, the parts may not be used because leakage could occur.
2	Clean the surfaces properly in accordance with the recommendations of ABB.
3	Distribute the sealing compound evenly over the surface, preferably with a brush.
4	Tighten the screws evenly when fastening the flange joint.

O-rings

The following procedure describes how to fit o-rings.

Action	Note
1 Ensure that the correct o-ring size is used.	
2 Check the o-ring for surface defects, burrs, shape accuracy, and so on.	Defective o-rings may not be used.
3 Check the o-ring grooves. The grooves must be geometrically correct and should be free of pores and contamination.	Defective o-rings may not be used.
4 Lubricate the o-ring with grease.	
5 Tighten the screws evenly while assembling.	

4.3 Complete robot

4.3.1 Replacing cable harness, lower end (axes 1-3)

Overview

The cable harness 1-6 is undivided.

How to replace the cable harness is described in two steps - lower end (axes 1-3) and upper end (axis 6). This procedure describes how to replace the lower end of the cable harness. How to replace the upper end can be found in section *Replacing the cable harness, upper end (incl. axis 6) on page 165*.

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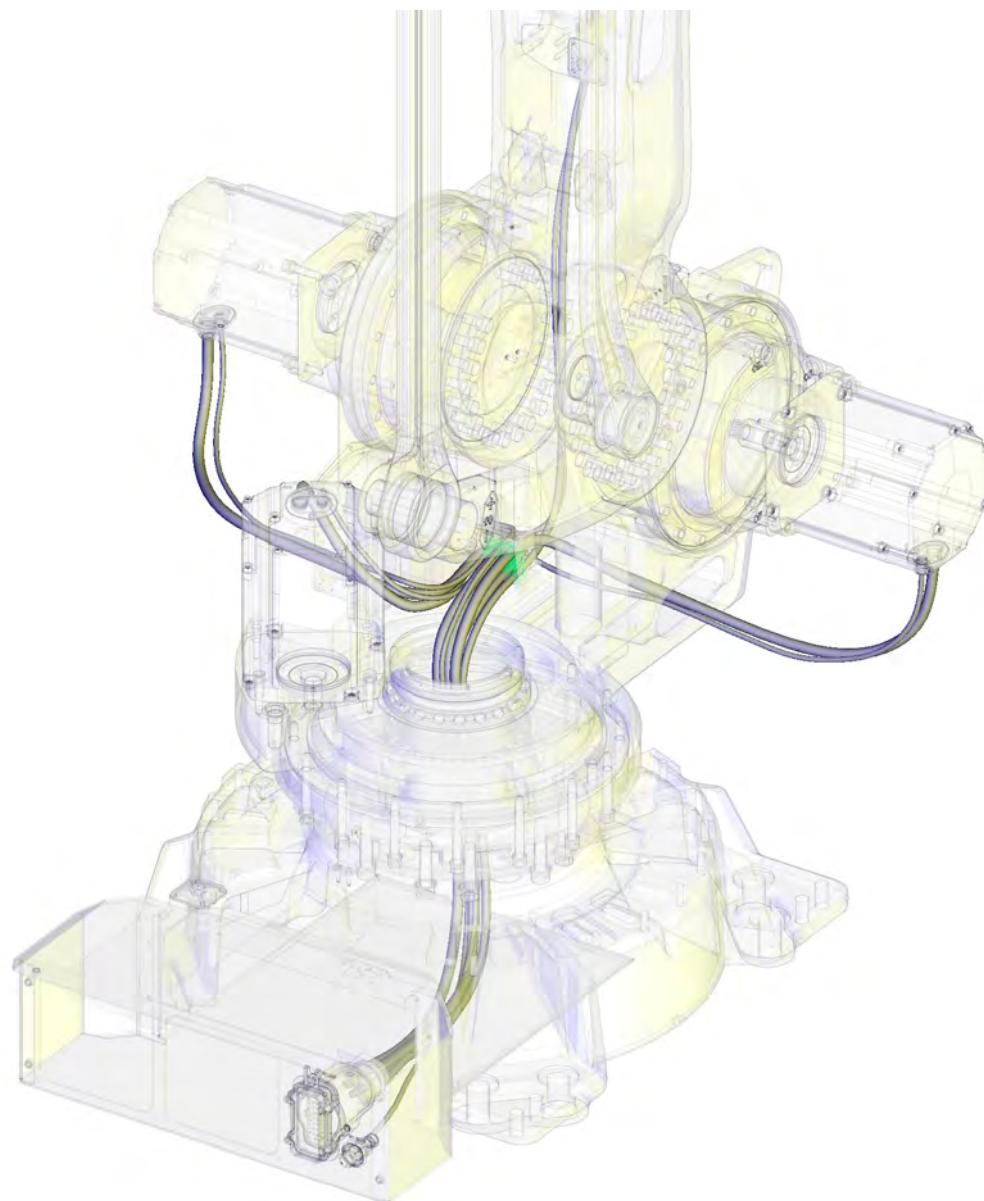
4 Repair

4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

Location of cable harness - lower end (axes 1-3)

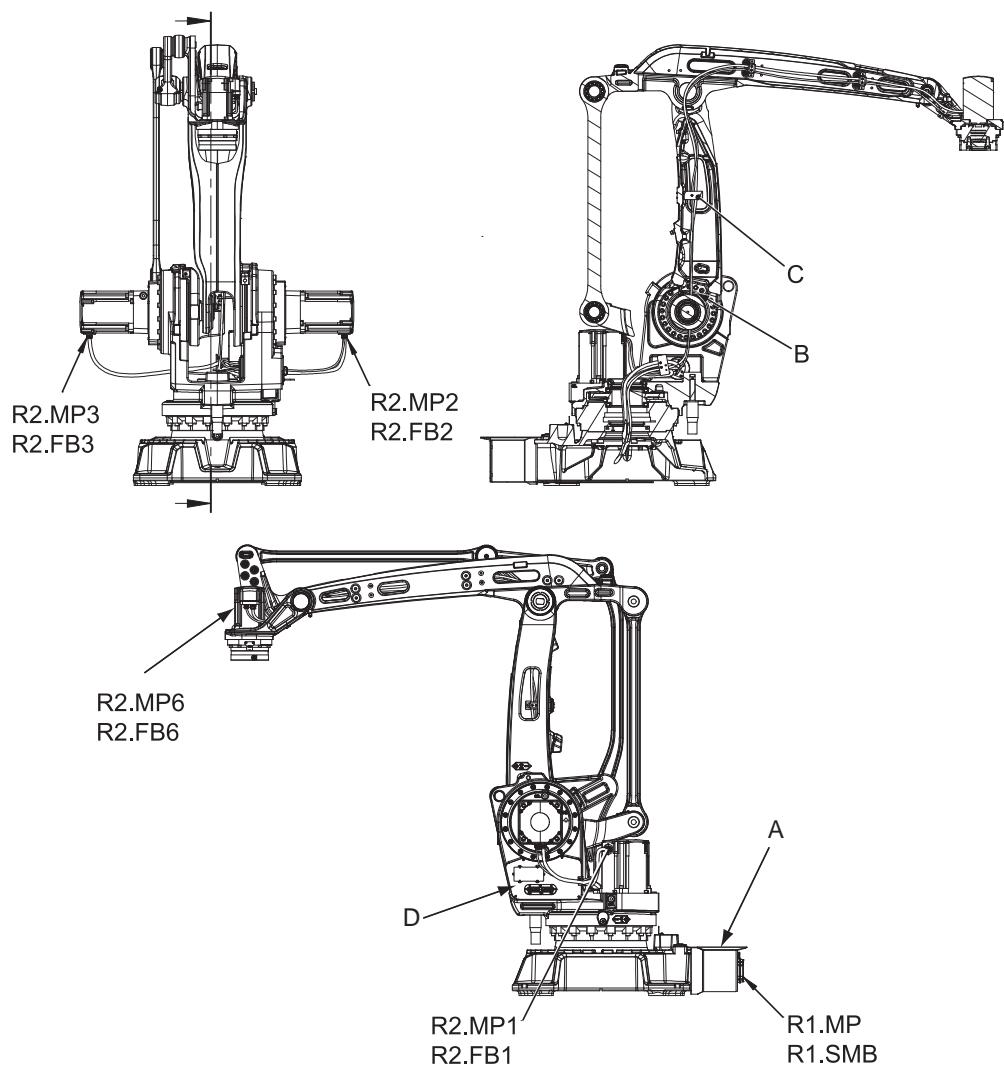
The cable harness, lower end (axes 1-3) is located throughout the base, frame and lower arm as shown in the figure.



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4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

xx1100000154

A	Rear cover plate
B	Cable guide, axis 2
C	Metal clamp
D	SMB cover
R2.MP6, R2.FB6	Connectors to the axis 6 motor

Required equipment

Equipment, etc.	Art.no.	Note
Cable harness 1-6	For spare part no. see: • <i>Spare parts on page 393</i>	
Gasket	3HAC3438-1	Motor, axes 1-3 Replace if damaged.
Standard toolkit	-	The content is defined in the section <i>Standard tools on page 387</i> .

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4 Repair

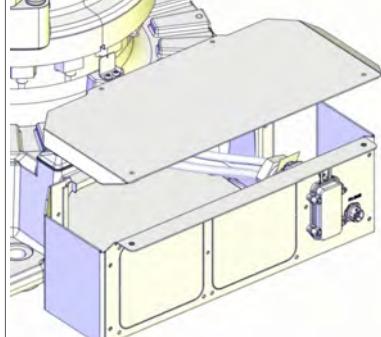
4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

Equipment, etc.	Art.no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	-	These procedures include references to the tools required.
Circuit diagram	-	See Circuit diagrams on page 395 .

Removing the cable harness - lower end (axes 1-3)

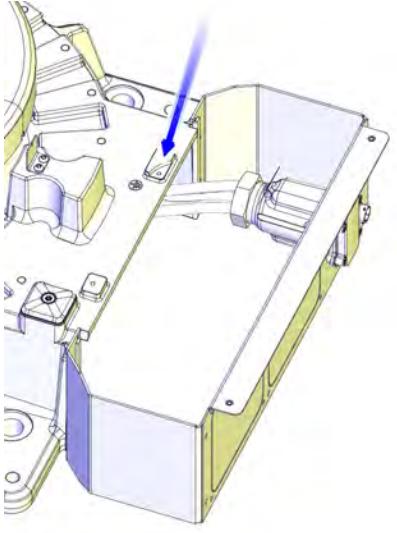
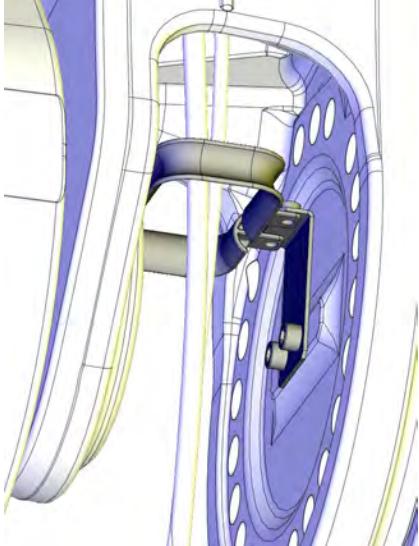
Use this procedure to remove the cable harness, lower end (axes 1-3).

	Action	Note
1	Move the robot to the calibration position.	This is done in order to facilitate updating of the revolution counter.
2	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
3	Remove the <i>rear cover plate</i> from the robot by removing its attachment screws.	 xx1100000155

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4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

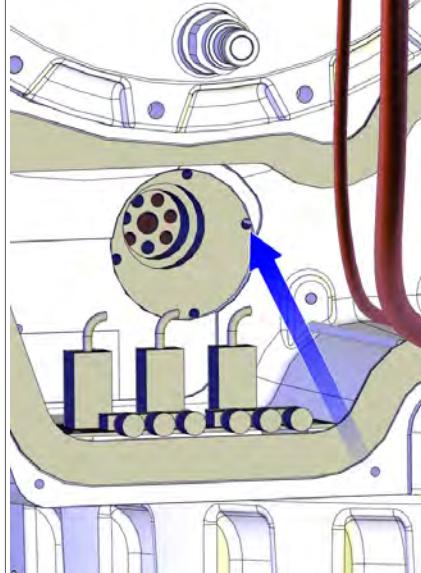
Action	Note
4 Disconnect the <i>earth cable</i> .	 xx1100000156
5 Disconnect the connectors <i>R1.MP</i> and <i>R1.SMB</i> .	See the figure Location of cable harness - lower end (axes 1-3) on page 156 .
6 Unscrew the screws of the <i>cable guide axis 2</i> inside the lower arm and loosen the cable guide.	 xx1100000157
7 Unscrew the nuts (outside the lower arm) that secure the <i>metal clamp</i> that hold the cable harness inside the lower arm.	
8 Unscrew the screws of the motor covers for axes 1, 2 and 3 and lift away the covers. This is done in order to reach the motor connectors.	
9 Disconnect all connectors at motors for axes 1, 2 and 3.	See sections: <ul style="list-style-type: none">• Replacing motor, axis 1 on page 292• Replacing motors, axes 2 and 3 on page 301

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4 Repair

4.3.1 Replacing cable harness, lower end (axes 1-3)

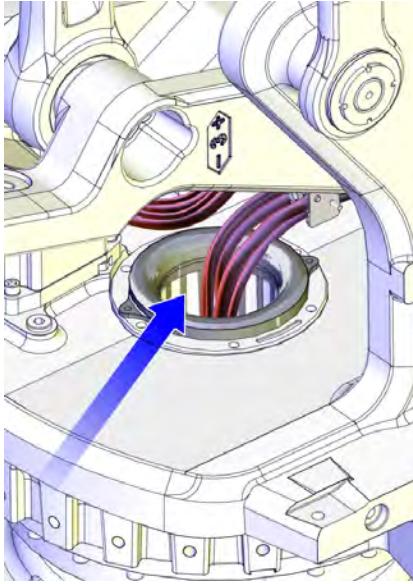
Continued

	Action	Note
10	Open the SMB cover carefully.	See the figure Location of cable harness - lower end (axes 1-3) on page 156 .
11	Disconnect connector R1.G on the <i>battery cable</i> between the battery and the SMB unit.  Note This causes a necessary updating of the revolution counter after refitting!	
12	Disconnect connectors R2.SMB, R1.SMB1-3, R1.SMB6 from the SMB unit.	
13	Disconnect X8, X9 and X10 from the brake release unit.	
14	Remove the SMB cover and put somewhere safe.	
15	Unscrew the screws for the <i>cable gland SMB</i> from inside the SMB recess and lift the cable gland out. Perform this removal with care, in order not to damage any of the components inside the SMB recess.	 xx1000001330

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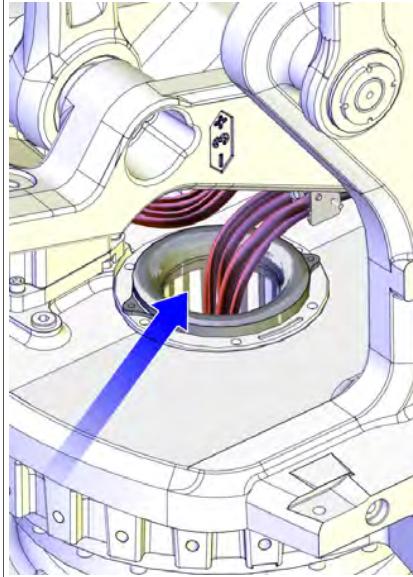
4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

Action	Note
16 Gently pull the cable harness out from the base through the <i>cable guide</i> , axis 1 and frame.	 xx1000001331
17 Continue removing the cable harness in the upper arm.	See section <i>Replacing the cable harness, upper end (incl. axis 6) on page 165.</i>

Refitting, cable harness - lower end (axes 1-3)

Use this procedure to refit the cable harness, lower end (axes 1-3).

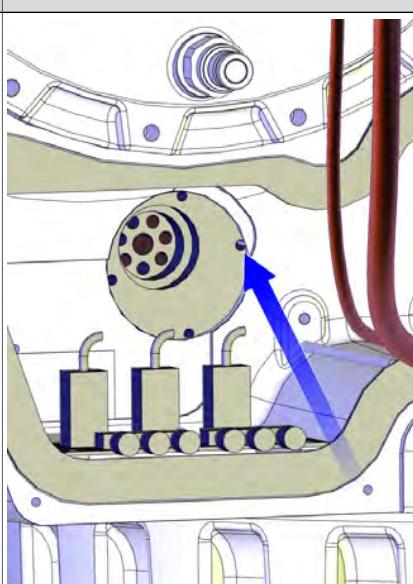
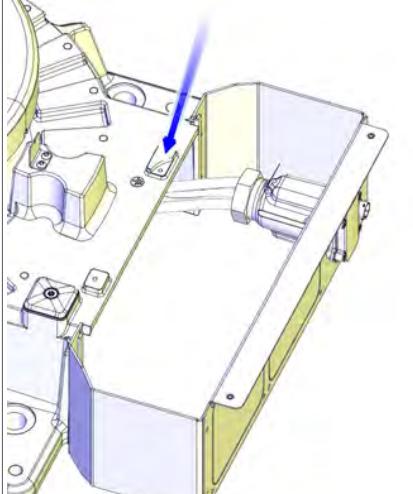
Action	Note
1 Push the cable harness and connectors down through the cable guide axis 1 in the center of the frame. CAUTION Make sure the cables are not twisted with each other or with customer harness (if any)!	 xx1000001331

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4 Repair

4.3.1 Replacing cable harness, lower end (axes 1-3)

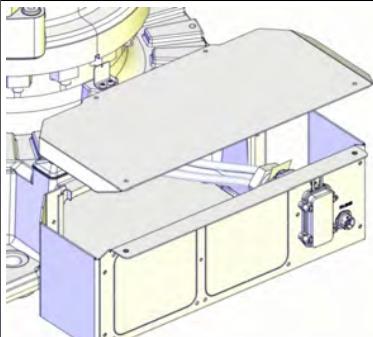
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Action	Note
2 Pull out the cables and connectors of the SMB unit through the frame and refit the <i>cable gland</i> with its <i>attachment screws</i> from inside the SMB recess. Perform this refitting with care, in order not to damage any of the components inside the SMB recess.	 xx1000001330
3 Reconnect connectors <i>R1.MP</i> and <i>R1.SMB</i> at the robot base.	Tightening torque for R1.SMB: 10 Nm. Attachment points are shown in the figure Location of cable harness - lower end (axes 1-3) on page 156 .
4 Reconnect the <i>earth cable</i> .	 xx1100000156

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4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

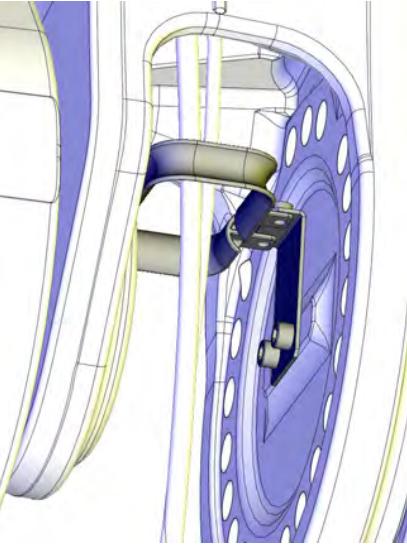
Action	Note
5 Refit the <i>rear cover plate</i> to the robot base with its attachment screws.	 xx1100000155
6 Reconnect all connectors at <i>motors axes 1, 2 and 3</i> and refit the motor covers.	See sections: <ul style="list-style-type: none">• Replacing motor, axis 1 on page 292• Replacing motors, axes 2 and 3 on page 301
7 Reconnect connectors R2.SMB, R1.SMB1-3, R1.SMB6 of the SMB unit. Reconnect X8, X9 and X10 to the brake release unit. Reconnect R1.G.	
8 Secure the <i>SMB cover</i> with its attachment screws. If cabling is used for 7th axis (option), refit the connector R2.FB7 to the SMB cover and tighten with 6 Nm.	
9  WARNING Before continuing any service work, please observe the safety information in section WARNING - The brake release buttons may be jammed after service work on page 49!	
10 Push the cable harness up through the lower arm.	
11 Fasten the metal clamp that hold the cable harness in the lower arm with the nuts.	

Continues on next page

4 Repair

4.3.1 Replacing cable harness, lower end (axes 1-3)

Continued

	Action	Note
12	Refit the <i>cable guide, axis 2.</i>	 xx1100000157
13	Continue refitting the cable harness in the upper arm.	See section <i>Replacing the cable harness, upper end (incl. axis 6) on page 165.</i>
14	Update the revolution counter!	See section <i>Updating revolution counters on page 360.</i>
15	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage! on page 48.</i>	

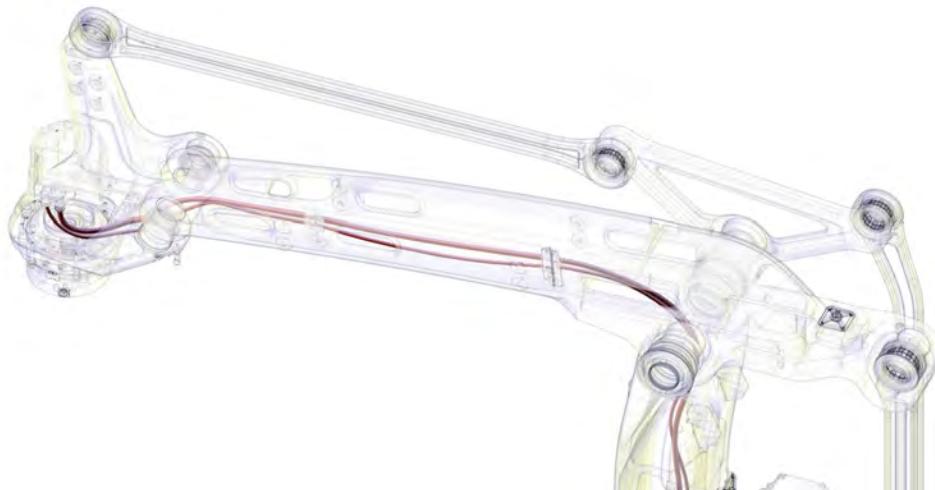
4.3.2 Replacing the cable harness, upper end (incl. axis 6)

4.3.2 Replacing the cable harness, upper end (incl. axis 6)**Overview**

Replacement of the cable harness is detailed in two steps - lower end (axes 1-3) and upper end. The procedure below details replacement of the cable harness in the upper end (incl. axis 6). The procedure for replacing the lower end (axis 1-3) is detailed in section [Replacing cable harness, lower end \(axes 1-3\) on page 155](#).

Location of cable harness, upper end

The upper end of the cable harness is located as shown in the figure.



xx1100000158

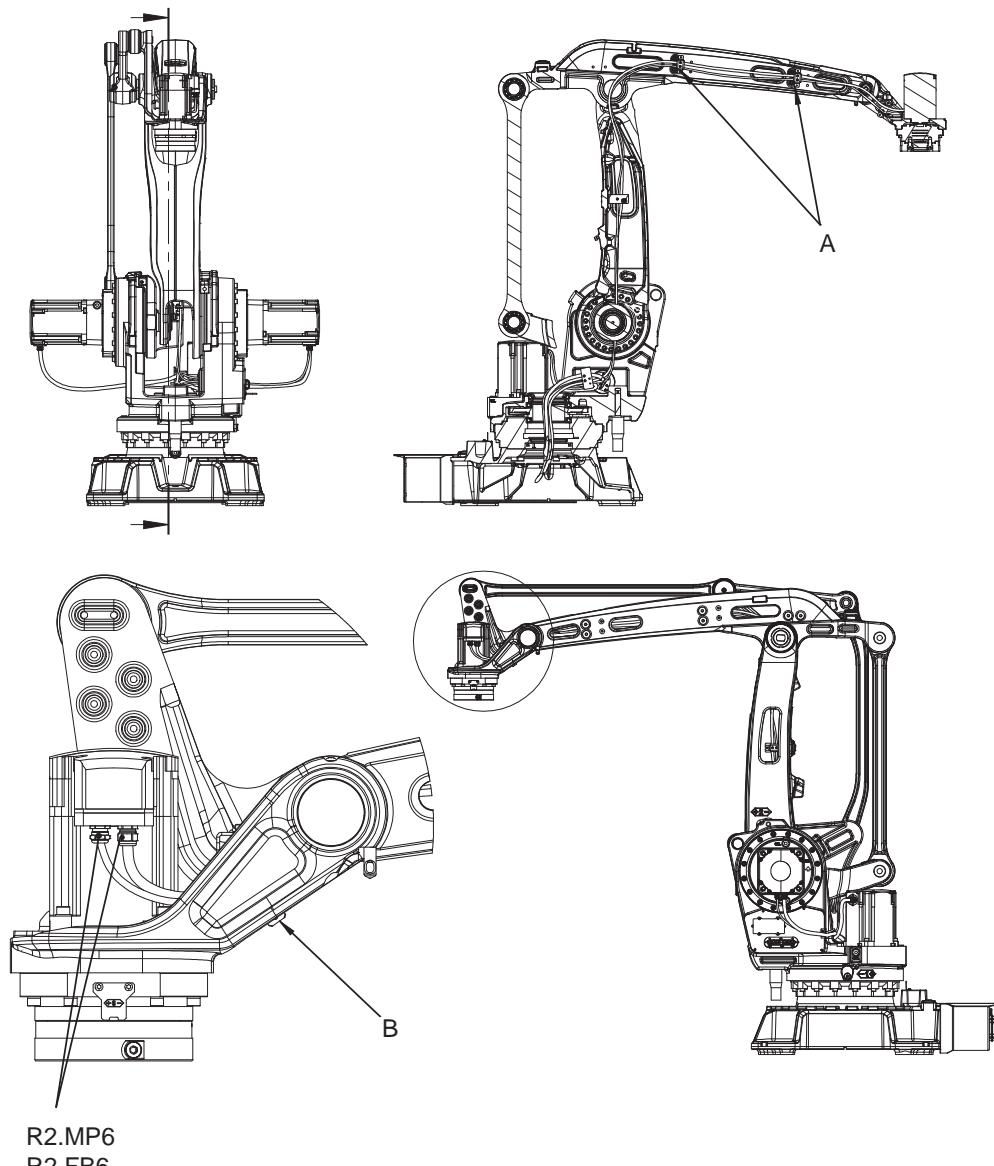
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4 Repair

4.3.2 Replacing the cable harness, upper end (incl. axis 6)

Continued

The motor axis 6 is located as shown in the figure below.



R2.MP6

R2.FB6

xx1100000159

- A: Metal clamps with nuts (upper arm)
- B: Metal clamp (tilthouse)
- R2.MP6, R2.FB6 = Connectors to the axis 6 motor

Required equipment

Equipment, etc	Art.no.	Note
Cable harness, 1-6	For spare part no. see: • Spare parts on page 393	
Gasket	-	Motor, axis 6
Standard toolkit	-	Content is defined in section Standard tools on page 387 .

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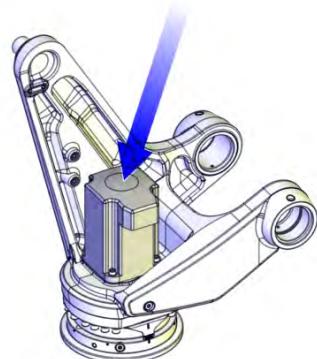
4.3.2 Replacing the cable harness, upper end (incl. axis 6)

Continued

Equipment, etc	Art.no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	See chapter Circuit diagrams on page 395 .	

Removing cable harness, upper end (incl. axis 6)

Use this procedure to remove the cable harness, upper arm (incl. axis 6).

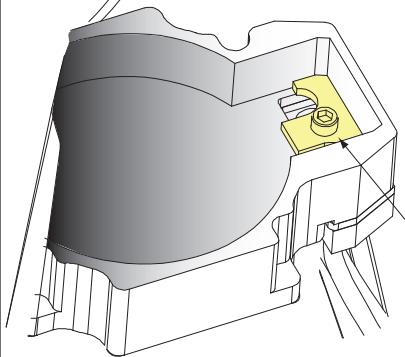
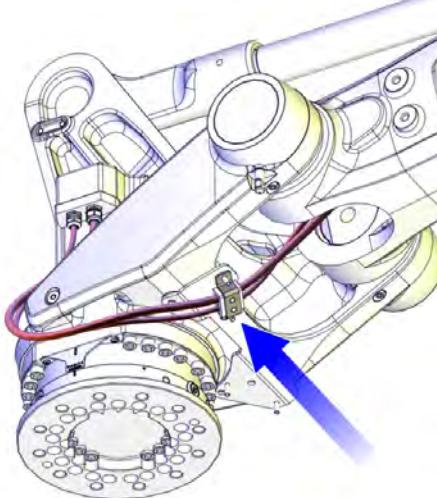
	Action	Note
1	Move the robot to the calibration position.	This is done in order to facilitate updating of the revolution counter.
2	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	If the complete cable harness is being replaced, start removal by removing the cable harness, lower end .	Detailed in section Replacing cable harness, lower end (axes 1-3) on page 155 .
4	Remove the axis 6 motor cover by removing its attachment screws, in order to reach the connectors.	 xx1000001106

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4 Repair

4.3.2 Replacing the cable harness, upper end (incl. axis 6)

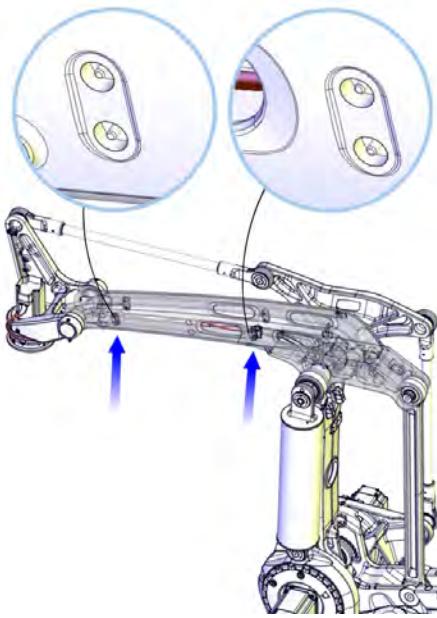
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	Action	Note
	<p>Remove the <i>cable gland cover</i> at the cable exit by unscrewing its <i>attachment screw</i> on the inside.</p> <p> Note</p> <p>Make sure the gasket is not damaged!</p>	 <p>xx0600002694</p> <ul style="list-style-type: none"> A: Screw securing the cable gland
5	Disconnect connectors at axis 6 motor.	
6	Remove the metal clamp that holds the cable at the tilt house, by removing its nuts.	 <p>xx1000001336</p>
7	Carefully pull the cable harness out of motor axis 6.	

Continues on next page

4.3.2 Replacing the cable harness, upper end (incl. axis 6)

Continued

Action	Note
8 Remove the nuts (on the outside of the upper arm) that secure the cable harness metal clamps inside the upper arm (2 + 2 pcs).	 xx1000001338
9 Carefully pull out the cable harness from the upper and lower arm.	

Refitting cable harness, upper end

Use this procedure to refit the cable harness, upper end.

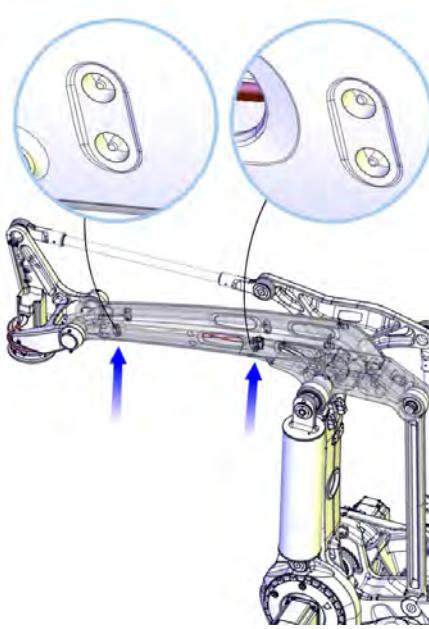
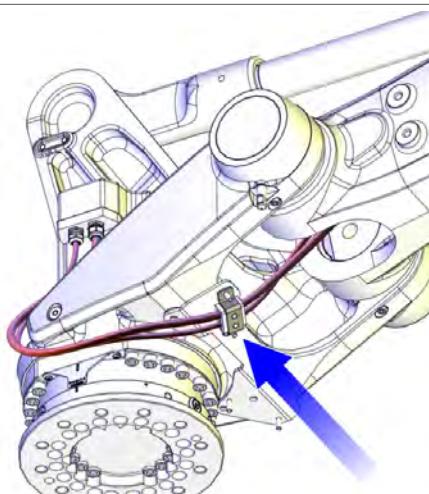
Action	Note
1 Start by fitting the cable harness, lower end if it has been removed.	Detailed in section Replacing cable harness, lower end (axes 1-3) on page 155
2 Push the cable harness through the upper arm tube.	

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4 Repair

4.3.2 Replacing the cable harness, upper end (incl. axis 6)

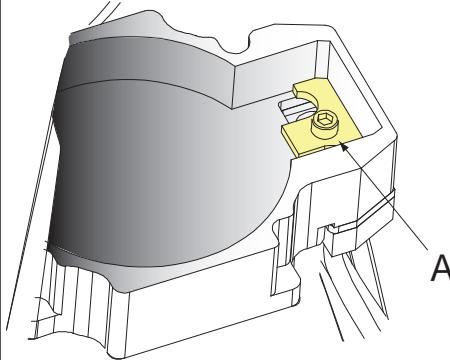
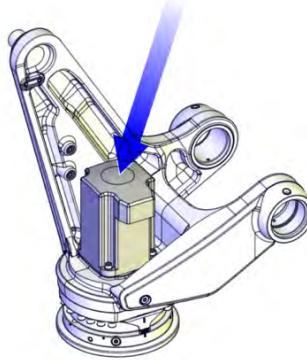
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Action	Note
3 Refit the cable harness inside the upper arm by refitting the cable clamps with the nuts (2 + 2 pcs) from the outside of the upper arm.	 xx1000001338
4 Refit the <i>metal clamp</i> at the tilthouse with its nuts.	 xx1000001336
5 Push the axis 6 motor cables carefully through the cable gland. i Note Do not twist the cables!	
6 Reconnect all connectors in motor axis 6.	
7 Check the <i>gasket</i> . If damaged, replace it.	

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4.3.2 Replacing the cable harness, upper end (incl. axis 6)

Continued

Action	Note
8 Refit the cable gland with its <i>attachment screw</i> .	 <p>xx0600002694</p> <ul style="list-style-type: none"> A: Screw holding the cable gland <p>Make sure the gasket is not damaged! Replace if damaged.</p>
9 Refit the <i>cover</i> , motor axis 6 with its <i>attachment screws and washers</i> . Make sure the cabling is placed correctly when refitting the cover and does not get jammed.	 <p>xx1000001106</p>
10 Update the revolution counter!	Detailed in section Updating revolution counters on page 360 .
11  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

4 Repair

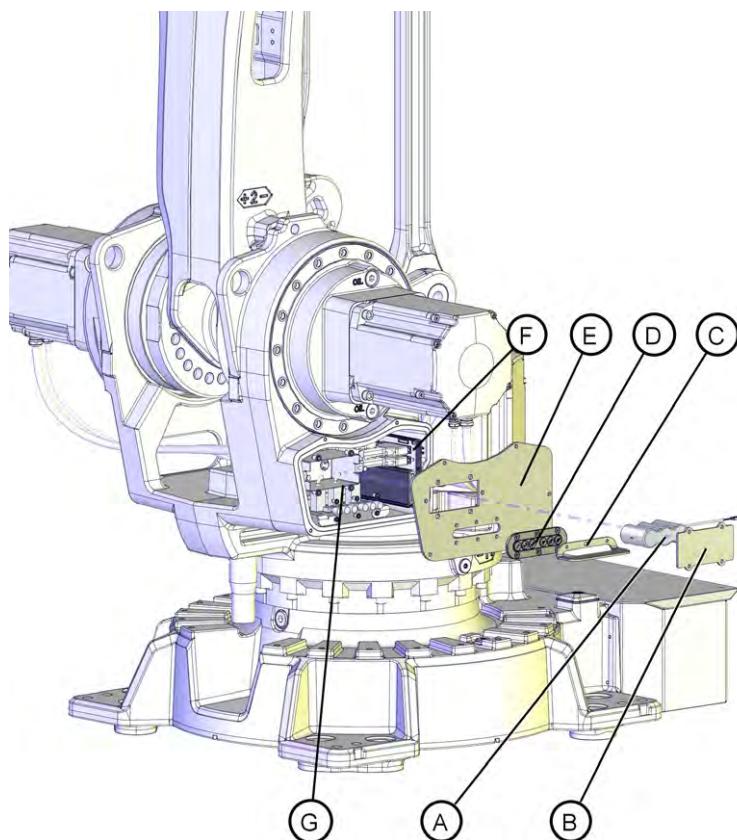
4.3.3 Replacing the SMB unit

4.3.3 Replacing the SMB unit

Location of SMB unit

The SMB unit (SMB = serial measurement board) is located on the left hand side of the frame as shown in the figure.

SMB board DSQC 633A (with 2-pole contact)

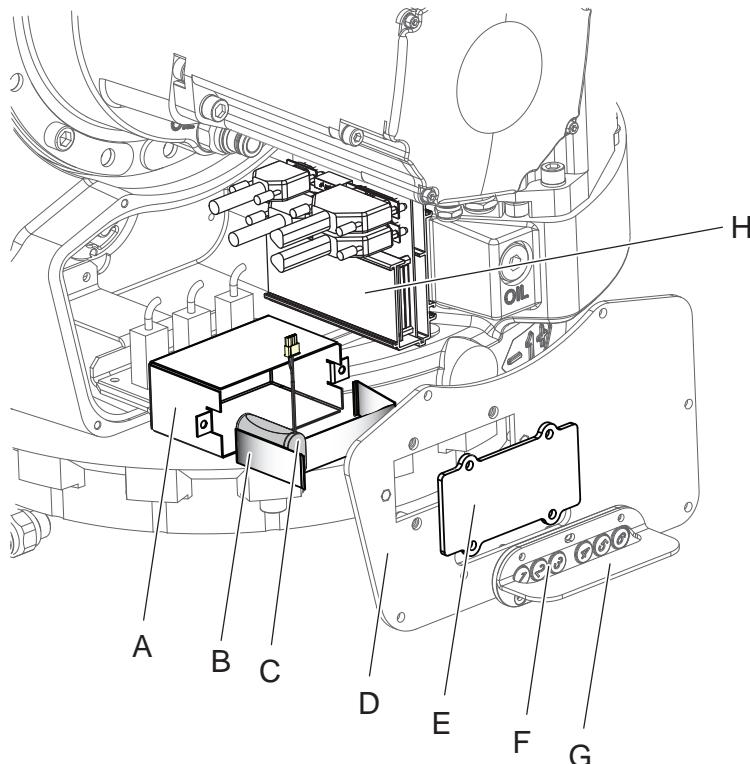


xx1100000105

A	Battery pack (2-pole battery contact)
B	Cover
C	BU button guard plate
D	Push button guard
E	Cover SMB
F	SMB unit
G	Brake release unit

Continues on next page

SMB board RMU 101 (with 3-pole contact)



xx1300001115

A	Battery box
B	Battery holder
C	Battery pack, RMU lithium (3-pole battery contact)
D	SMB cover
E	Battery cover
F	BU button guard plate
G	Push button guard
H	Serial measurement board, RMU 101

Required equipment



Note

There are different variants of SMB units and batteries. The variant with the 3-pole battery contact has longer lifetime for the battery.

It is important that the SMB unit uses the correct battery. Make sure to order the correct spare parts. Do not replace the battery contact!

Equipment, etc.	Art. no.	Note
SMB unit	For spare part number, see: Spare parts on page 393 .	

Continues on next page

4 Repair

4.3.3 Replacing the SMB unit

Continued

Equipment, etc.	Art. no.	Note
Battery pack	For spare part number, see: Spare parts on page 393 .	
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Circuit diagram	-	See chapter Circuit diagrams on page 395 .

Removing, SMB unit

Use this procedure to remove the SMB unit.

	Action	Note
1	Move the robot to the calibration position.	
2	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
3	 xx0200000023 WARNING! The unit is sensitive to ESD. Before handling the unit please read the safety information in the section WARNING - The unit is sensitive to ESD! on page 52	
4	Remove the <i>SMB cover</i> by unscrewing its attachment screws.	Shown in the figure Location of SMB unit on page 172 .
5	Use caution and remove the connectors X8, X9 and X10 from the brake release board, if need of more space.	
6	Remove the nuts and washers from the <i>guide pins</i> that secure the board.	Shown in the figure Location of SMB unit on page 172 .
7	Use caution and disconnect the connectors from the SMB unit when pulling the board out.	Connectors R1.SMB1-3, R1.SMB4-6 and R2.SMB
8	Disconnect the <i>battery cable</i> from the SMB unit.	Shown in the figure Location of SMB unit on page 172 .

Continues on next page

Refitting, SMB unit

Use this procedure to refit the SMB unit.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	 xx0200000023 WARNING! The unit is sensitive to ESD. Before handling the unit please read the safety information in the section WARNING - The unit is sensitive to ESD! on page 52	
3	Connect the <i>battery cable</i> to the SMB unit.	Shown in the figure Location of SMB unit on page 172 .
4	Connect all connectors to the SMB board: R1.SMB1-3, R1.SMB6 and R2.SMB	Art. no. is specified in Required equipment on page 173 . Shown in the figure Location of SMB unit on page 172 .
5	Fit the <i>SMB unit</i> onto the <i>guide pins</i> .	
6	Secure the SMB unit to the pins with the nuts and washers.	
7	If disconnected, reconnect the connectors X8, X9 and X10 to the brake release board.	
8	Secure the <i>SMB cover</i> with its attachment screws. If cabling is used for 7th axis (option), refit the 7th axis connector to the SMB cover and tighten with 6 Nm.	Shown in the figure Location of SMB unit on page 172 .
9	Update the revolution counter!	See Updating revolution counters on page 360 .
10	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

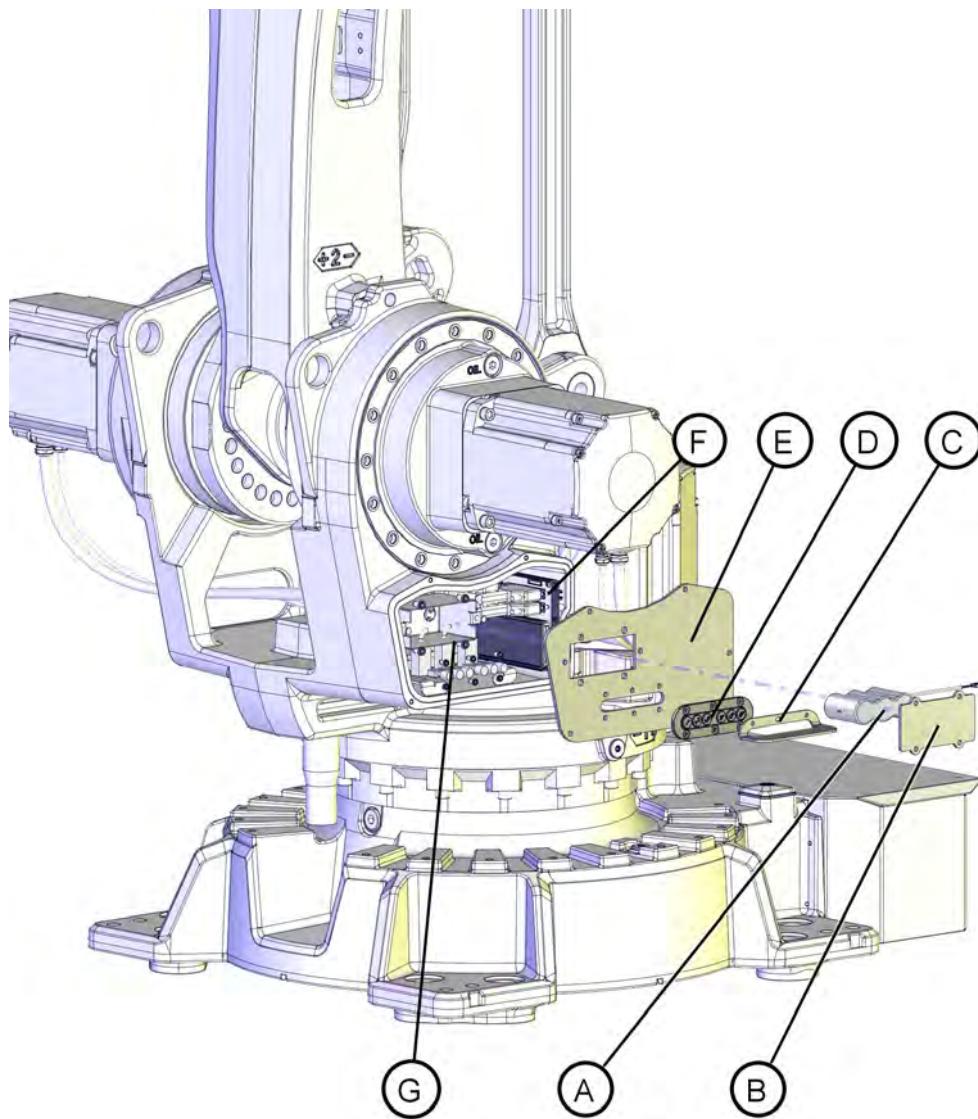
4 Repair

4.3.4 Replacing the brake release board

4.3.4 Replacing the brake release board

Location of brake release board

The brake release unit is located together with the SMB unit on the left hand side of the frame, right next to the gearbox, axis 2, as shown in figure below.



xx1100000105

A	Battery pack (2-pole battery contact)
B	Cover
C	BU button guard plate
D	Push button guard
E	Cover SMB
F	SMB unit
G	Brake release unit

Continues on next page

Required equipment

Equipment, etc.	Art. no.	Note
Brake release board with buttons	For spare part no. see: • Spare parts on page 393	
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Removing, brake release board

Use this procedure to remove the brake release board.

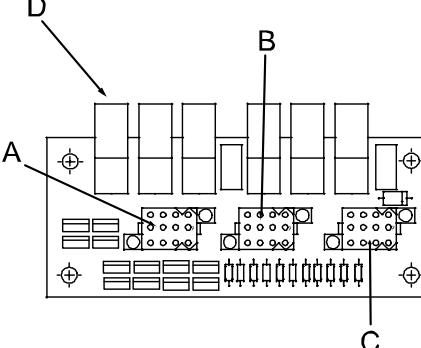
	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	 ELECTROSTATIC DISCHARGE (ESD) The unit is sensitive to ESD. Before handling the unit read the safety information in section WARNING - The unit is sensitive to ESD! on page 52	
3	Remove the <i>push button guard</i> from the SMB cover.	Shown in the figure Location of brake release board on page 176 . The guard must be removed to ensure a correct refitting of the brake release board.
4	Open the <i>SMB cover</i> by unscrewing the attachment screws. Let the battery stay connected, to avoid the need of synchronization of the robot!	Shown in the figure Location of brake release board on page 176 .
5	Remove the complete brake release board (including brake release board and bracket) from the SMB recess, by removing its two attachment screws.	

Continues on next page

4 Repair

4.3.4 Replacing the brake release board

Continued

Action	Note
6 Disconnect the connectors X8, X9 and X10 from the <i>brake release board</i> .	 <p>xx0200000129</p> <ul style="list-style-type: none"> • A: Connector X8 • B: Connector X9 • C: Connector X10 • D: Push buttons <p>Location of the brake release unit is shown in the figure Location of brake release board on page 176.</p>
7 Remove the brake release board from the bracket by removing the four attachment screws.	

Refitting, brake release board

Use this procedure to refit the brake release board.

Action	Note
1  ELECTROSTATIC DISCHARGE (ESD)	
The unit is sensitive to ESD. Before handling the unit read the safety information in section WARNING - The unit is sensitive to ESD! on page 52	
2 Fasten the <i>brake release board</i> on the bracket with the attachment screws. Make sure the board is positioned as straight as possible on the bracket! The push buttons can otherwise get jammed when the SMB cover is refitted.	Shown in the figure Location of brake release board on page 176 . Art. no. is specified in Required equipment on page 177 .

Continues on next page

4.3.4 Replacing the brake release board

Continued

Action	Note
3 Connect the connectors X8, X9 and X10 to the brake release board.	<p>xx0200000129</p> <ul style="list-style-type: none"> A: Connector X8 B: Connector X9 C: Connector X10 D: Push buttons
4 Refit the complete brake release board (including brake release board and bracket) to the SMB recess with the two attachment screws.	
5 Refit the <i>SMB cover</i> with its attachment screws. The push button guard must not be mounted on the cover before the check described in following warning is made!	Shown in the figure Location of brake release board on page 176 .
6 WARNING Before continuing any service work, please observe the safety information in section WARNING - The brake release buttons may be jammed after service work on page 49 !	
7 Refit the <i>push button guard</i> to the SMB cover.	Shown in the figure Location of brake release board on page 176 .
8 If the battery has been disconnected the revolution counter must be updated.	Detailed in the Calibration chapter - section Updating revolution counters on page 360 .
9 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

4 Repair

4.3.5 Replacing the base, including axis 1 gearbox

4.3.5 Replacing the base, including axis 1 gearbox

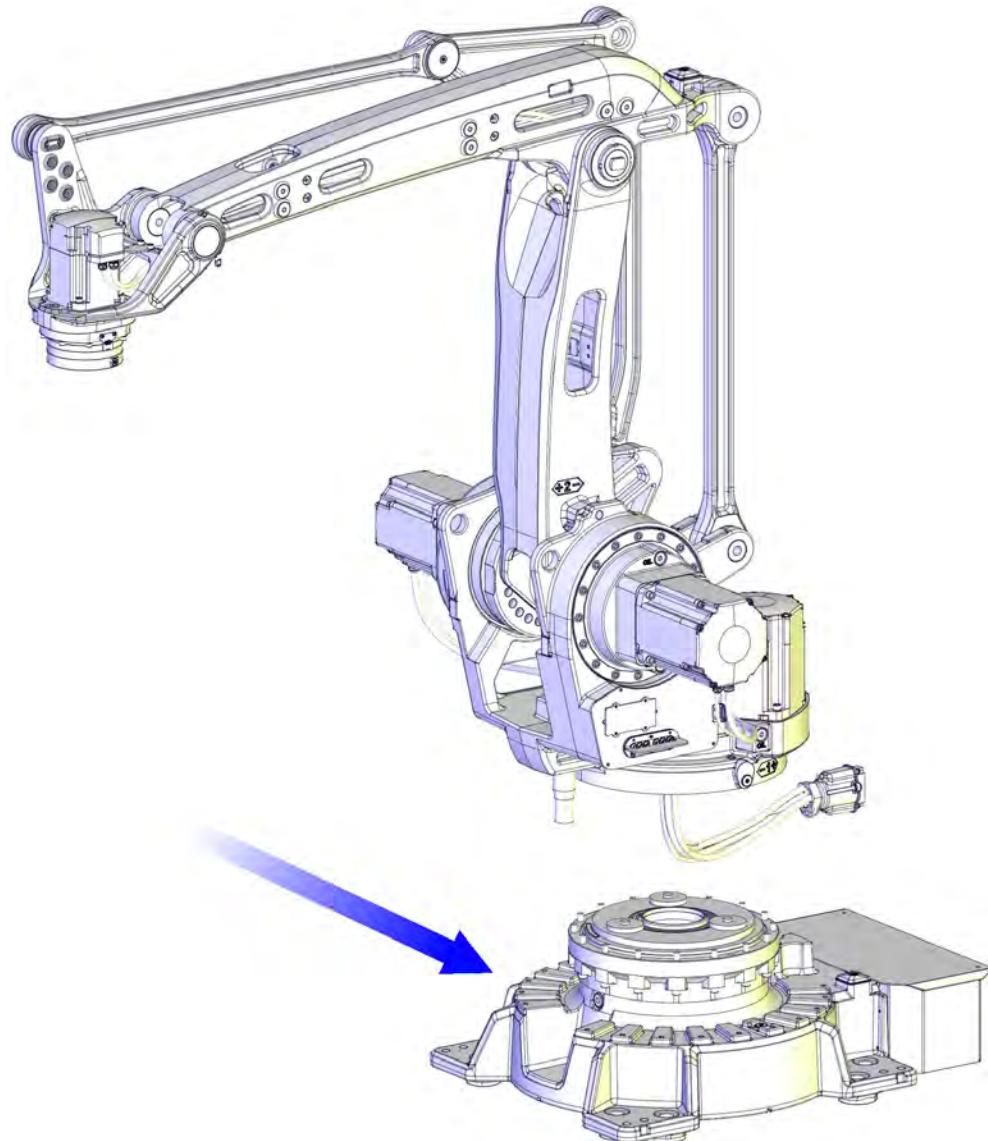
Introduction

The term *complete arm system* used in this procedure is defined as the complete robot excluding:

- base
- gearbox axis 1

Location of the base

The location of the base, including gearbox axis 1, is shown in the figure. It also shows the complete arm system as defined above.



xx1100000246

Continues on next page

Required equipment

Equipment, etc.	Art. no.	Note
Guide pins M12 x 130	3HAC022637-001	Used to guide the complete arm system when refitting. Always use the guide pins in pairs! Guide pins that are longer than 140 mm will not be possible to remove because the lack of space.
Roundsling		4 pcs. Lifting capacity 1,000 kg
Adapter	3HAC040381-001	
Lifting eye, M12	3HAC025333-005	
Shackle	-	Lifting capacity: 1,000 kg.
Bits holder	-	Stahlwille 736/40 D10 (or similar) Used on the M12x140 screws.
Power supply	-	24 VDC, max. 1.5 A For releasing the brakes.
Crank	-	Used to turn the gear when mating it to the frame.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See chapter Circuit diagrams on page 395 .

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none"> • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot. 	

Continues on next page

4 Repair

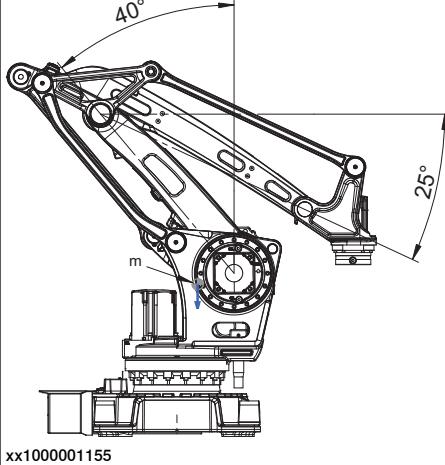
4.3.5 Replacing the base, including axis 1 gearbox

Continued

Action	Note
<p>If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.</p>	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
<p>If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.</p>	

Removing the complete arm system

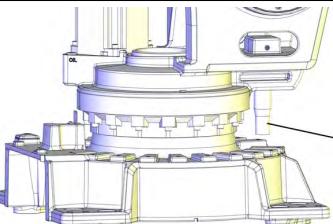
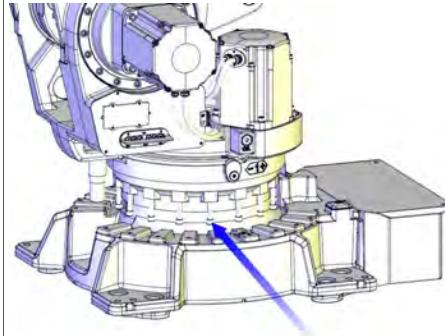
Use this procedure to remove the complete arm system.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Move the robot to the transport position.	 xx1000001155
3  DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4 Run an overhead crane to a position above the robot.	

Continues on next page

4.3.5 Replacing the base, including axis 1 gearbox

Continued

	Action	Note
5	Remove the mechanical stop pin from the frame.	 xx1000001302 <ul style="list-style-type: none"> • A: Mechanical stop pin
6	Drain the axis 1 gearbox.	See Changing oil, axis-1 gearbox on page 132 .
7	Loosen the cable connectors from the base and pull up the cabling from the base, through the hole in the center of the frame.	See Replacing cable harness, lower end (axes 1-3) on page 155 .
8	Remove the axis 1 motor.	See Replacing motor, axis 1 on page 292 .
9	 CAUTION The robot arm system weighs 750 kg. All lifting accessories used must be sized accordingly!	
10	Fit the roundslings as described in Fitting the lifting accessories to the complete arm system on page 185 .	
11	Stretch the roundslings so that they secure the weight of the arm system.	Adjust the length of each roundsling so that the lift is done completely level.
12	Unfasten the arm system from the base by unscrewing the attachment screws.	 xx1100000247 <p> Note Use a bits holder with a thin head to remove the screws. For example Stahlwille 736/40 D10 or similar. The space is cramped.</p>
13	Fit two <i>guide pins</i> in the holes. This will facilitate the removal of the complete arm system and prevent damage on the gearbox.	Article number is specified in Required equipment on page 181 .

Continues on next page

4 Repair

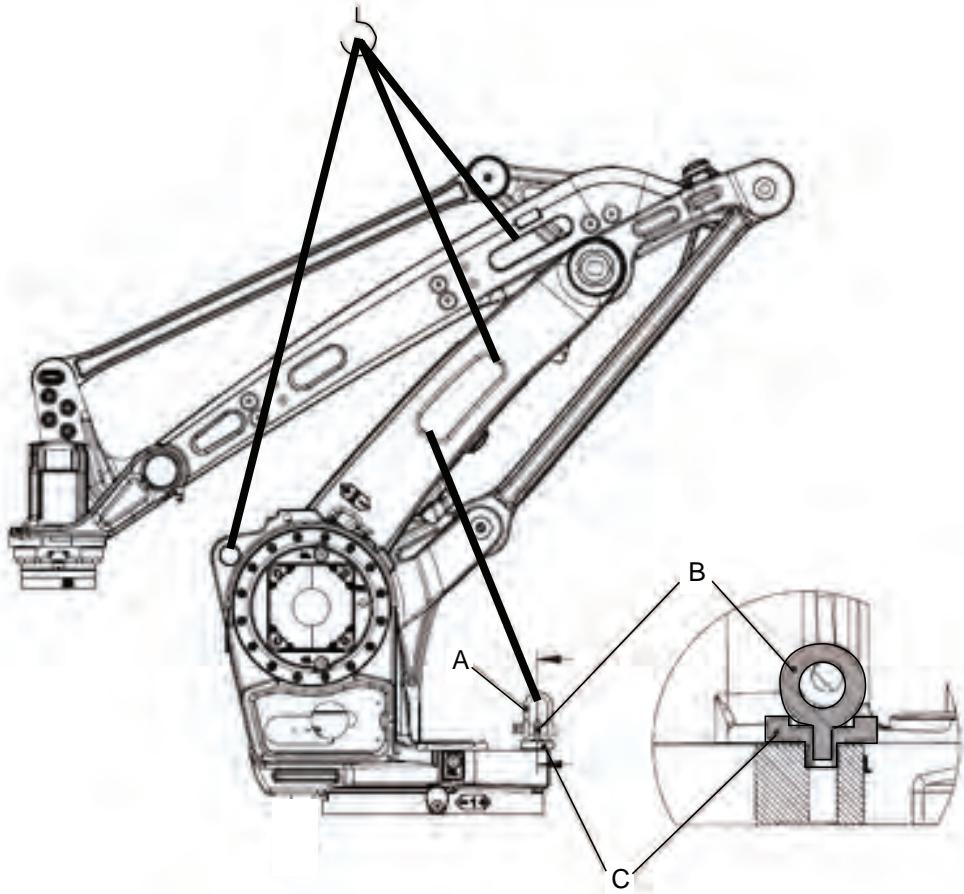
4.3.5 Replacing the base, including axis 1 gearbox

Continued

Action	Note
<p>14 Lift the <i>complete arm system</i> carefully and secure it in a safe area.</p> <p> CAUTION</p> <p>The lift must be done completely level! Make sure the roundslings are adjusted prior to lifting the arm system.</p> <p> Note</p> <p>Continue lifting even if the arm system turns out to be unbalanced despite earlier adjustments! The risk of damaging the interface is bigger if the load is lowered unbalanced!</p> <p> CAUTION</p> <p>Always move the robot at very low speed, making sure it does not tip!</p>	<p> Note</p> <p>Make sure all hooks and attachments stay in the correct position while lifting the arm system and that the lifting accessory does not wear against sharp edges.</p>
<p>15 If needed, continue to remove the axis 1 gearbox from the base.</p>	<p>See <i>Replacing the axis 1 gearbox on page 320</i>.</p>

Continues on next page

Fitting the lifting accessories to the complete arm system



xx1100000249

- A Shackle
 B Lifting eye, M12
 C Adapter

	Action	Note
1	Fit a roundsling from the frame to the overhead crane.	
2	Fit a roundsling from the lower arm to the overhead crane.	
3	Fit a roundsling from the upper arm to the overhead crane.	
4	Fit the <i>adapter</i> to the oil plug hole for filling oil into axis 1 gearbox.	Art. no. is specified in <i>Required equipment on page 181</i> .
5	Fit a <i>lifting eye</i> and a <i>shackle</i> to the adapter.	Art. no. is specified in <i>Required equipment on page 181</i> .
6	Fit a roundsling between the lower arm and the shackle.	The roundsling will take the load of the frame during the lift of the arm system, provided that the brake of axis 2 is released.

Continues on next page

4 Repair

4.3.5 Replacing the base, including axis 1 gearbox

Continued

Refitting the complete arm system

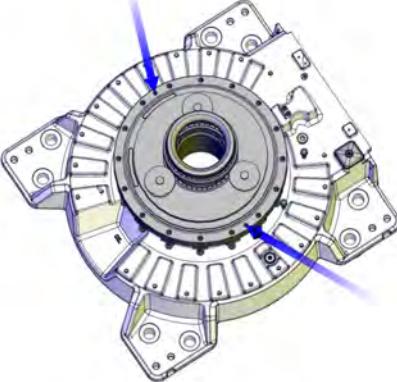
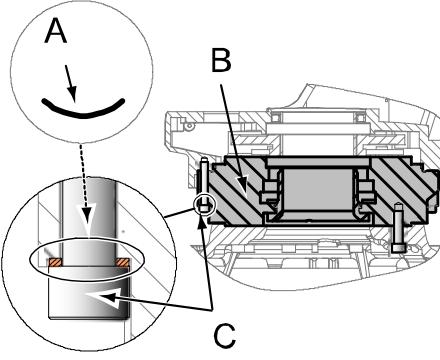
Use this procedure to refit the complete arm system.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
2	Refit the axis 1 gearbox, if it has been removed.	See <i>Replacing the axis 1 gearbox on page 320</i> .
3	 CAUTION The robot arm system weighs 750 kg. All lifting accessories used must be sized accordingly!	
4	Fit the roundslings as described in <i>Fitting the lifting accessories to the complete arm system on page 185</i> .	
5	Stretch the roundslings so that they secure the weight of the arm system.	Adjust the length of each roundsling so that the lift is done completely level.
6	Lift the complete arm system and move it at very low speed to the mounting site, making sure it does not tip!  Note The refitting must be made completely level! Make sure the roundslings are adjusted prior to refitting the arm system.	 Note Make sure all hooks and attachments stay in the correct position while lifting the arm system and that the lifting accessory does not wear against sharp edges.

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4.3.5 Replacing the base, including axis 1 gearbox

Continued

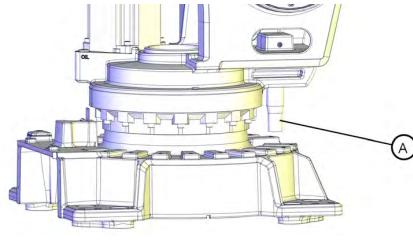
	Action	Note
7	Fit two <i>guide pins</i> in the holes in the axis 1 gearbox, shown in the figure.	 Tip In order to make refitting easier it is recommended to use two guide pins of different lengths. Notice that longer guide pins than 140 mm will not be possible to remove after refitting because of lack of space.  xx1100000257 Dimension is specified in Required equipment on page 181 .
8	Look through the empty mounting hole of the axis 1 motor to assist in aligning the assembly during refitting of the complete arm system.	
9	Lower the complete arm system with guidance from the guide pins previously fitted to the axis 1 gearbox.	 Note The refitting must be made completely level! Make sure the roundslings are adjusted prior to refitting the arm system.
10	Place the <i>serrated lock washers</i> on the attachment screws.	 Note Check that the <i>serrated lock washers</i> are turned the correct way. See figure!
		Reused screws can be used providing they are lubricated as described in Screw joints on page 383 .  xx0600003070 Parts: A Serrated lock washer (24 pcs) B Axis 1 gearbox C Attachment screws M12x110 quality 12.9 gleitmo (24 pcs)

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4 Repair

4.3.5 Replacing the base, including axis 1 gearbox

Continued

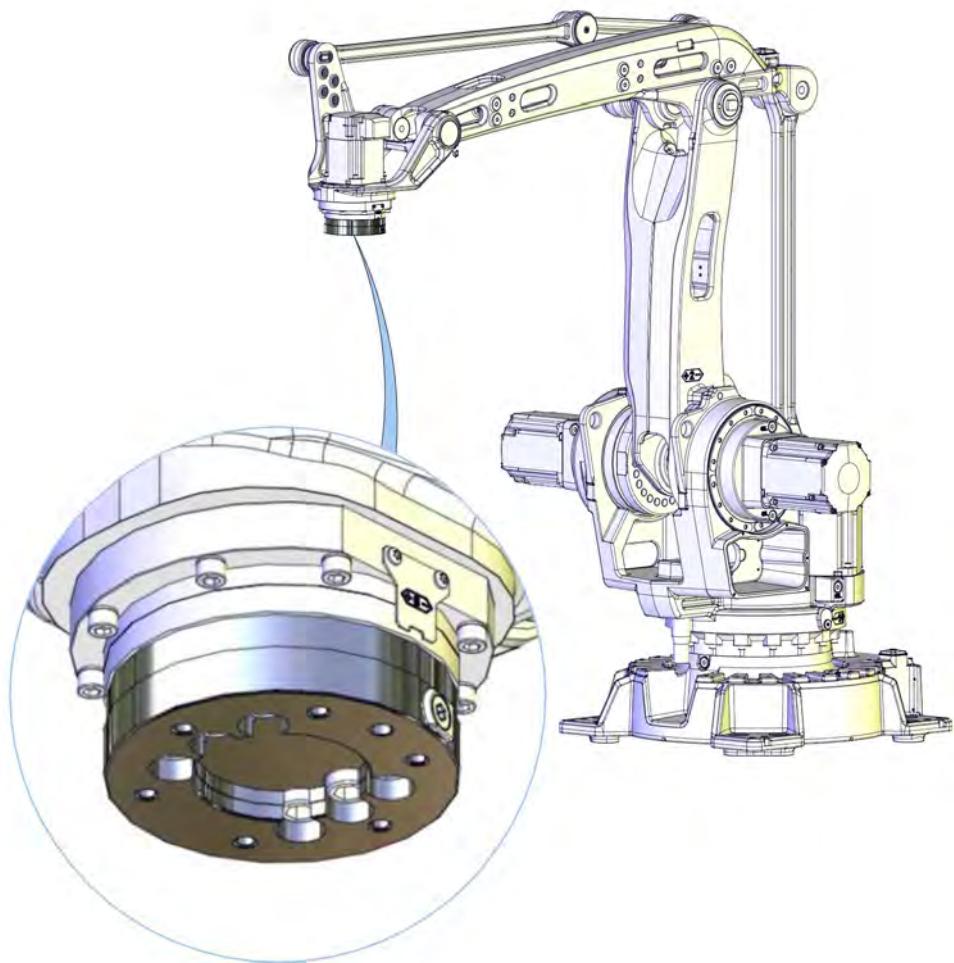
Action	Note
11 Fit 14 of the 16 attachment screws before the arm system is completely lowered. This is done in order to be able to attach all screws into the threads correctly.	
12 Replace the guide pins with the remaining attachment screws and secure the complete arm system to the base with its attachment screws and washers.	
13 Lower the arm system completely.	
14 Secure the complete arm system with its <i>attachment screws</i> .	Tightening torque: • 120 Nm.
15 Refit the cable harness in the base and the frame.	See <i>Replacing cable harness, lower end (axes 1-3) on page 155</i> .
16 Refit the axis 1 motor.	See <i>Replacing motor, axis 1 on page 292</i> .
17 Refit the mechanical stop pin to the frame.	 xx1000001302 A: Mechanical stop pin
18 Perform a leak-down test of the axis 1 gearbox.	See <i>Performing a leak-down test on page 150</i> .
19 Refill the axis 1 gearbox with lubricating oil.	See <i>Changing oil, axis-1 gearbox on page 132</i> .
20 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in <i>Calibrating with Axis Calibration method on page 364</i> . General calibration information is included in section <i>Calibration on page 353</i> .
21  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage! on page 48</i> .	

4.4 Upper and lower arm

4.4.1 Replacing the turning disk

Location of turning disk

The turning disk is located in the front of the wrist housing as shown in the figure below.



xx1100000132

Required equipment

Equipment, etc.	Art. no.	Note
Turning disk	For spare part no. see: Spare parts on page 393 .	O-rings are not included!

Continues on next page

4 Repair

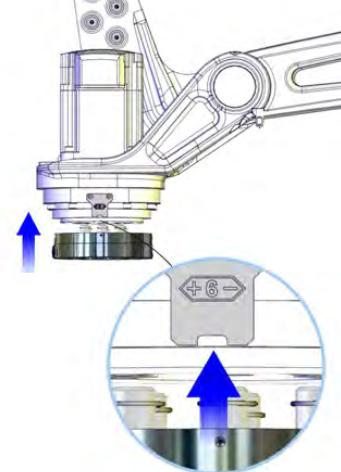
4.4.1 Replacing the turning disk

Continued

Equipment, etc.	Art. no.	Note
O-ring	3HAB3772-65 (1pc) 21520431-20 (6 pcs)	Must be replaced when replacing the turning disk!
Grease	3HAB3537-1	Used to lubricate the o-rings.
Flange sealant	3HAC034903-001	Loctite 574
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

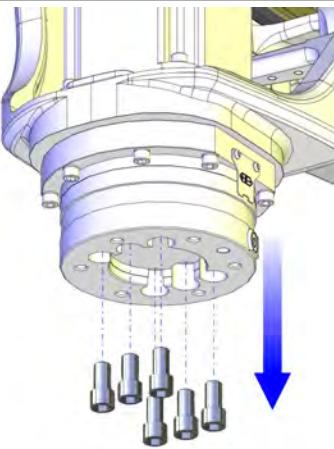
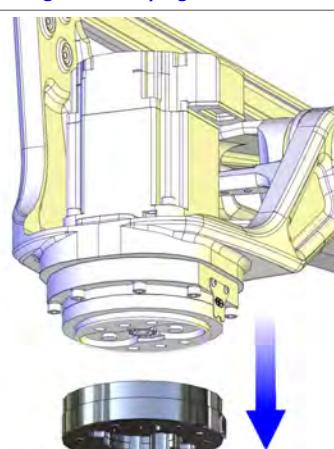
Removing, turning disk

Use this procedure to remove the turning disk.

Action	Note
1 Run the robot to a position where the tilthouse is best positioned for the turning disk to be replaced.	
2 Rotate axis 6 to its calibration position.	 Note This is done in order to facilitate fitting of the turning disk in the correct position.  xx1100000139
3  DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4 Remove any equipment fitted to the turning disk.	

Continues on next page

4.4.1 Replacing the turning disk
Continued

Action	Note
5 Drain the axis 6 gearbox.	See section <ul style="list-style-type: none">• Changing oil, gearbox axis 6 on page 140
6 Remove the <i>attachment screws</i> that secure the turning disk.	 xx1100000075 Shown in the figure Location of turning disk on page 189 .
7 Remove the <i>turning disk</i> .	 xx1100000076
8 <i>Foundry Plus:</i> Remove old flange sealant residues and other contamination from the contact surfaces.	

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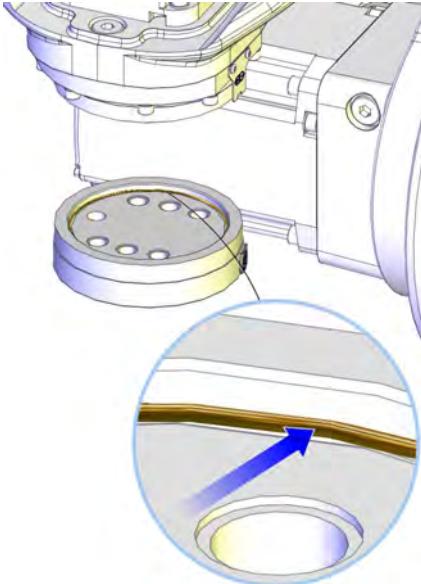
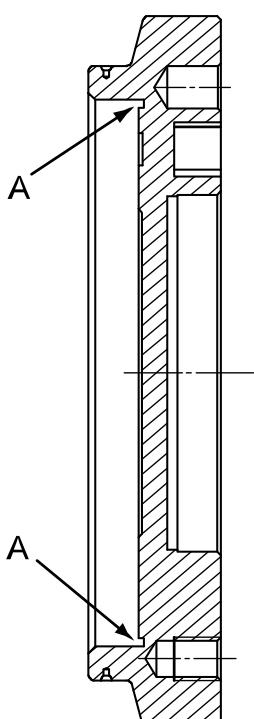
4 Repair

4.4.1 Replacing the turning disk

Continued

Refitting, turning disk

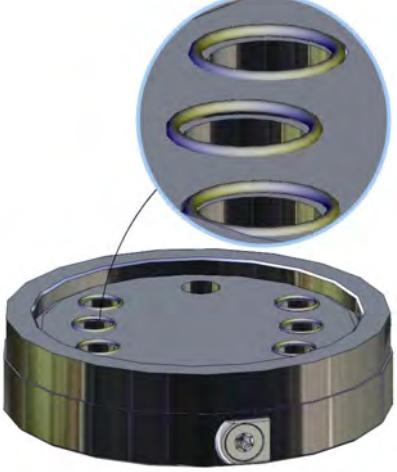
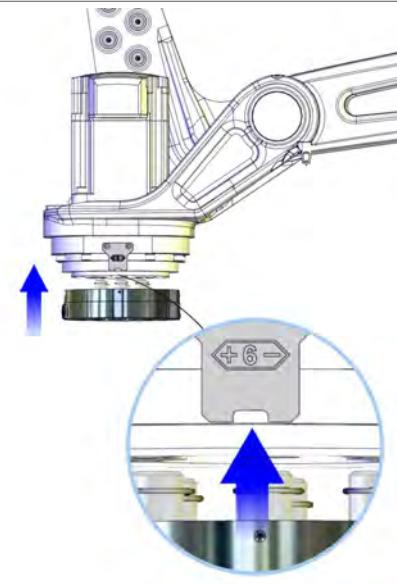
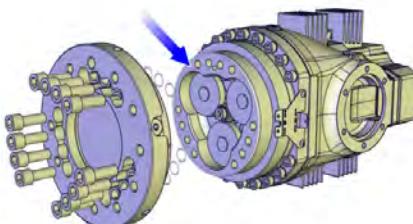
Use this procedure to refit the turning disk.

Action	Note
1 Lubricate the <i>o-ring</i> of the turning disk with grease and fit it to the turning disk.	<p>Art. no. is specified in Required equipment on page 189.</p>  <p>xx1100000140</p>  <p>xx0200000218</p> <ul style="list-style-type: none">• A: Sealing surface, o-ring

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4.4.1 Replacing the turning disk

Continued

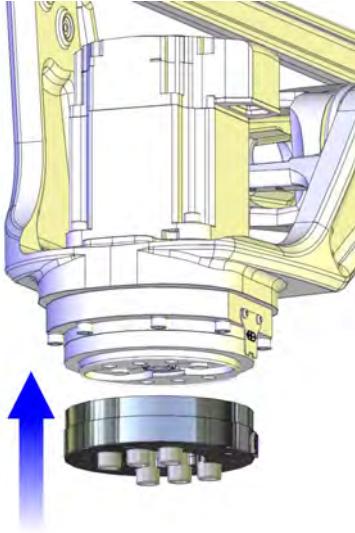
Action	Note
2 Put some grease on the <i>o-rings</i> (6 pcs) and fit them in turning disk as shown in the figure.	 xx1100000080
3 Locate the calibration mark on the turning disk and place the turning disk at the tilthouse so that the calibration mark matches the calibration scale at the tilthouse. The hole pattern of the turning disk allows the turning disk to be fitted in three different rotated positions. Matching the calibration marks guarantees that the turning disk is fitted at the correct turn, provided that the axis 6 was set in calibration position before the turning disk was removed!	 xx1100000139
4 <i>Foundry Plus:</i> Apply Loctite 574 flange sealant on the contact surface.	 xx1400000995

Continues on next page

4 Repair

4.4.1 Replacing the turning disk

Continued

Action	Note
5 Secure the turning disk with its <i>attachment screws</i> .	 xx1100000078 <p>Attachment screws M10x25 quality 12.9 (6 pcs)</p> <p>Tightening torque:</p> <ul style="list-style-type: none"> • 175 Nm <p>Reused screws may be used, providing they are lubricated as detailed in section Screw joints on page 383 before fitting.</p>
6 Perform a <i>leak-down test</i> of the gearbox axis 6.	Detailed in the section Performing a leak-down test on page 150 .
7 Refill the axis 6 gearbox with oil.	See section <ul style="list-style-type: none"> • Changing oil, gearbox axis 6 on page 140
8 Refit any equipment removed during disassembly to the turning disk.	
9  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

4.4.2 Replacing the tilthouse unit

Introduction

This section describes how to replace the tilthouse unit. The section consists of these parts:

- [*Location of tilthouse unit on page 196*](#)
- [*Location of axes 2 and 3 sides of the robot on page 197*](#)
- [*X-ray view of the assembly of the tilthouse unit on page 199*](#)
- [*Press tool pre-mounting outer race bearings on page 200*](#)
- [*Press tool for removal of shaft on page 201*](#)
- [*Removing the tilthouse unit on page 203*](#)
- [*Premounting outer race of bearing and radial sealing, axis 2 side on page 209*](#)
- [*Premounting outer race of bearing and radial sealing, axis 3 side on page 210*](#)
- [*Refitting shafts on page 211*](#)
- [*Refitting lock nuts and the remaining parts on page 213*](#)

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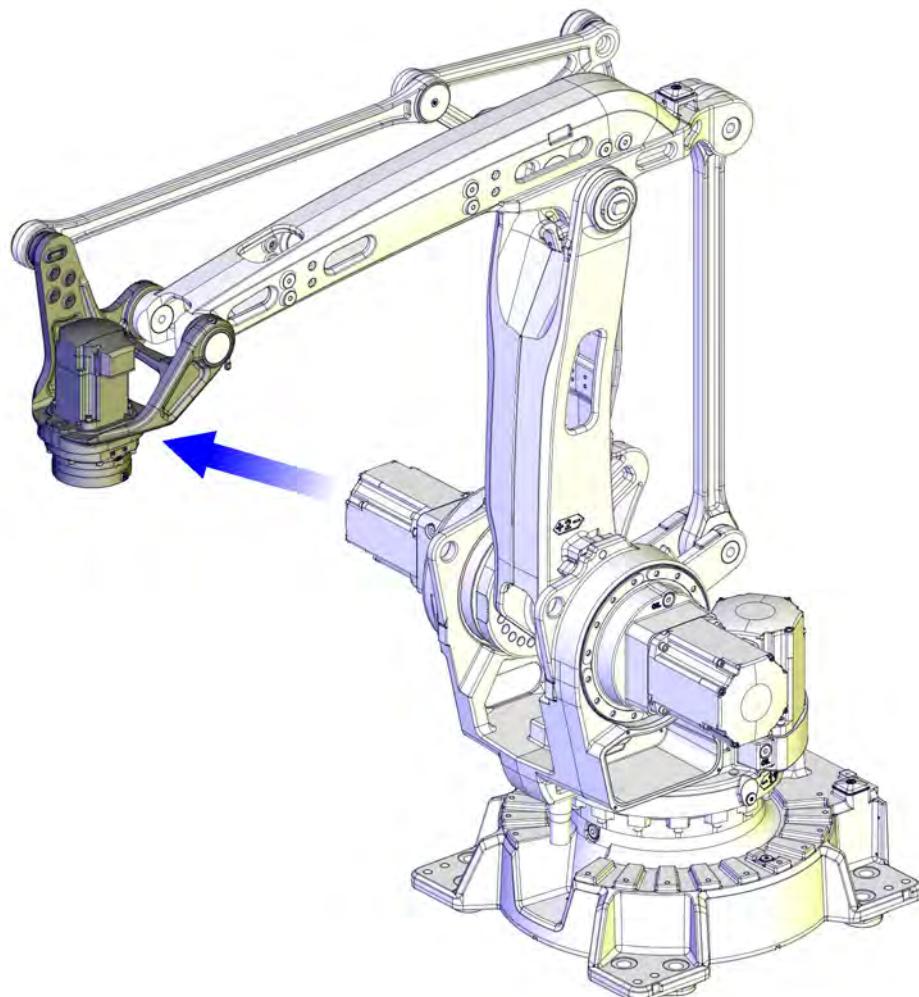
4 Repair

4.4.2 Replacing the tilthouse unit

Continued

Location of tilthouse unit

The tilthouse unit is located as shown in the figure.

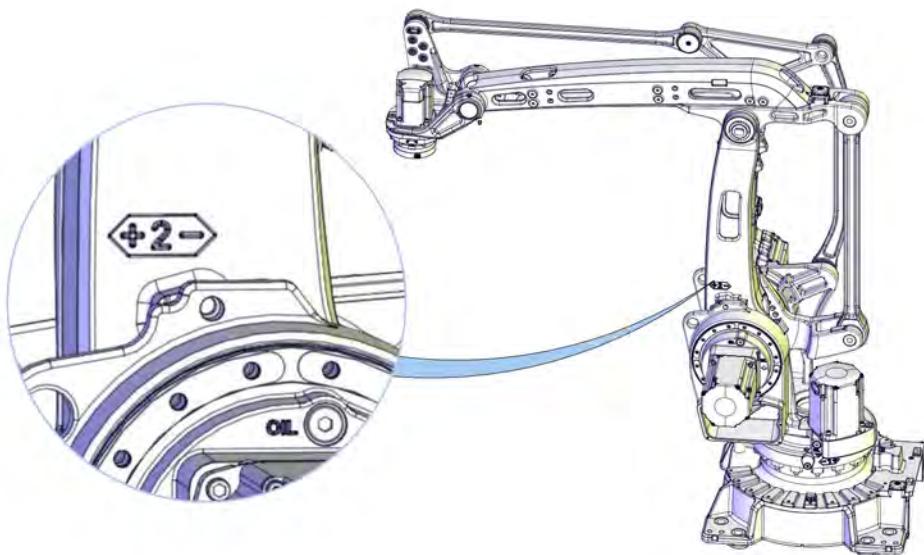


xx1100000213

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Location of axes 2 and 3 sides of the robot

The figures shows the location of the axes 2 and 3 sides of the robot. See markings on the lower arm (*axis 2*) and the parallel arm (*axis 3*). These two sides of the robot will be referred to in the replacing procedures.



xx1100000214

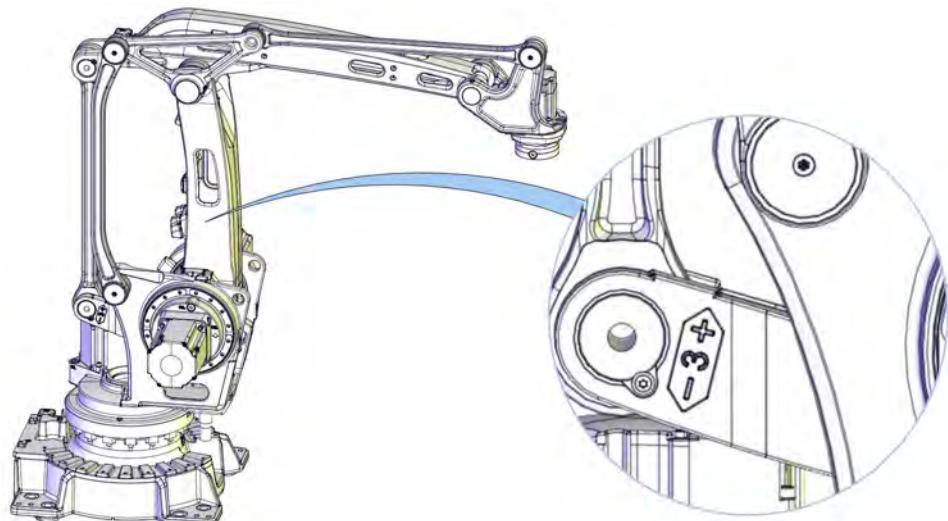
Axis 2 side (See marking on lower arm)

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4 Repair

4.4.2 Replacing the tilthouse unit

Continued



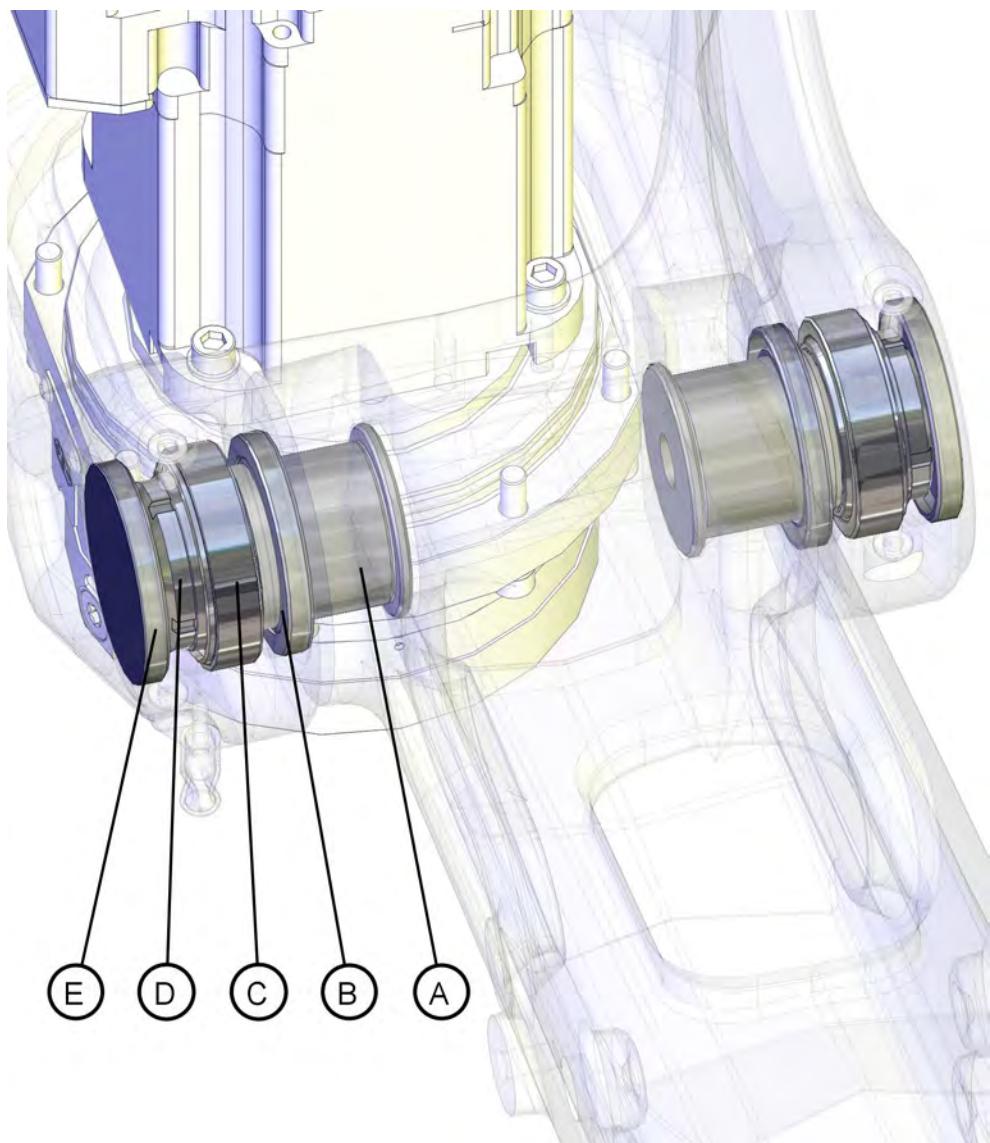
xx1100000215

Axis 3 side (See marking on parallel arm)

Continues on next page

X-ray view of the assembly of the tilthouse unit

The figure shows a X-ray view of how the tilthouse unit is fitted to the upper arm.
Both sides looks the same.



xx1100000216

- | | |
|---|----------------|
| A | Shaft |
| B | Radial sealing |
| C | Bearing |
| D | Lock nut |
| E | VK cover 65x8 |

VK cover 19x6 (Inside VK cover 65x8), not shown in this figure

Required equipment

Equipment, etc.	Art.no.	Note
VK cover	Spare parts on page 393	VK 19x6 (2 pcs)

Continues on next page

4 Repair

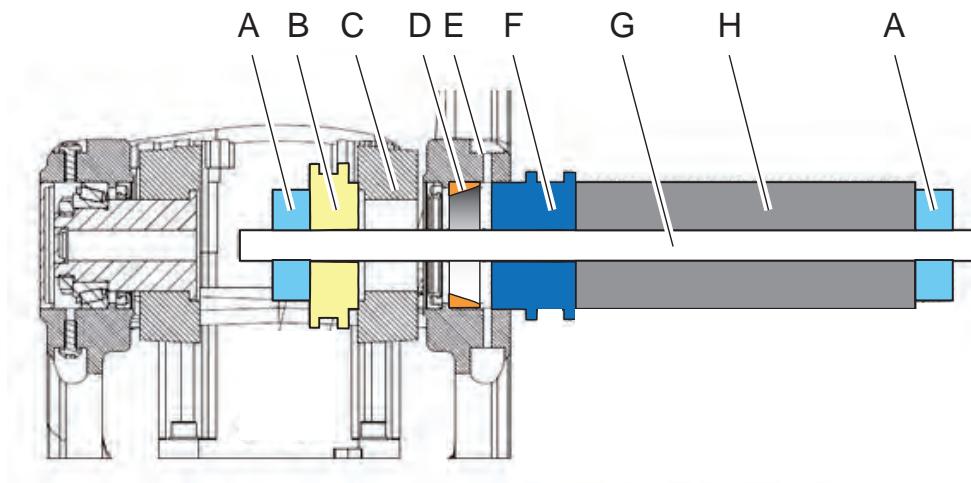
4.4.2 Replacing the tilthouse unit

Continued

Equipment, etc.	Art.no.	Note
VK cover	Spare parts on page 393	VK 65x8 (2 pcs)
Sealing ring	3HAB3701-19	D=70/85 T=8 (2 pcs)
Taper roller bearing	3HAA2103-13	
Press tool, premounting outer race bearing	3HAC040028-001	Used for mounting outer bearing races.
Press tool, replacing shaft	3HAC040029-001	Used for assembly and disassembly.
Auxiliary shaft	3HAC040035-001	Used for disassembly of shaft.
KM7 socket	3HAC040025-001	
Grease	3HAB3537-1	
Rust preventive		Dinitrol 490
Locking liquid	3HAB7116-1	Loctite 243
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Press tool pre-mounting outer race bearings

The press tool used for pre-mounting the outer bearing races in the tilthouse, consists of the parts shown in the figure. For art. no. see [Required equipment on page 199](#).



xx1100000250

- A** Thread washer (2 pcs)
- B** Support washer (3HAC040029-001)
- C** Upper arm
- D** Outer race bearing

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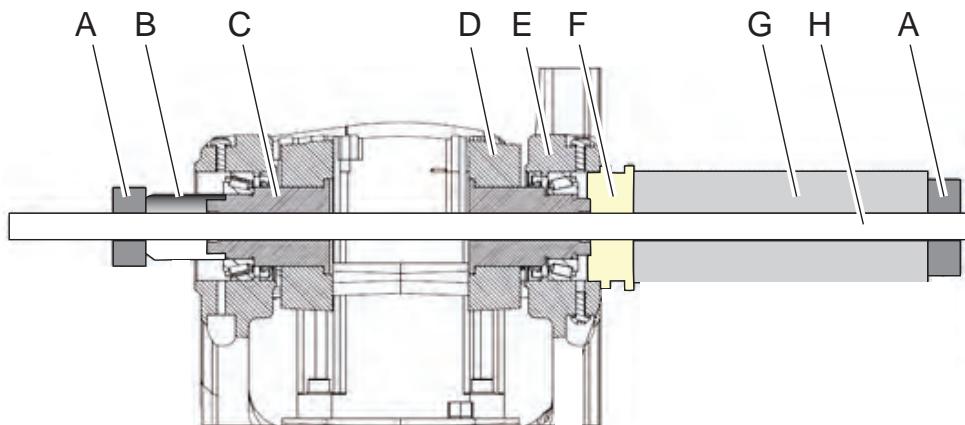
E	Tilthouse
F	Press washer (3HAC040028-002)
G	Threaded bar M16
H	Hydraulic cylinder

Press tool for removal of shaft

The *press tool replacing shaft* is used both for removal and refitting. See figure how to use the tool depending on purpose. For art. no. see [Required equipment on page 199](#).

The *press tool replacing shaft* and *auxiliary bushing* applied as shown in the figure is used to disassemble the shaft.

The press tool consists of the parts shown in the figure.



xx1100000252

A	Thread washer (2 pcs)
B	Auxiliary shaft (3HAC040035-001) Only used on removal.
C	Shaft axis 2
D	Upper arm
E	Tilthouse
F	Support bushing (3HAC040029-002)
G	Hydraulic cylinder
H	Threaded bar M16

Press tool for fitting of shaft

The *press tool replacing shaft* is used both for removal and refitting. See figure how to use the tool depending on purpose. For art. no. see [Required equipment on page 199](#).

The *press tool replacing shaft* applied as shown in the figure is used to fit the shaft. The press tool consists of the parts shown in the figure. **NOTE!** The thread washer

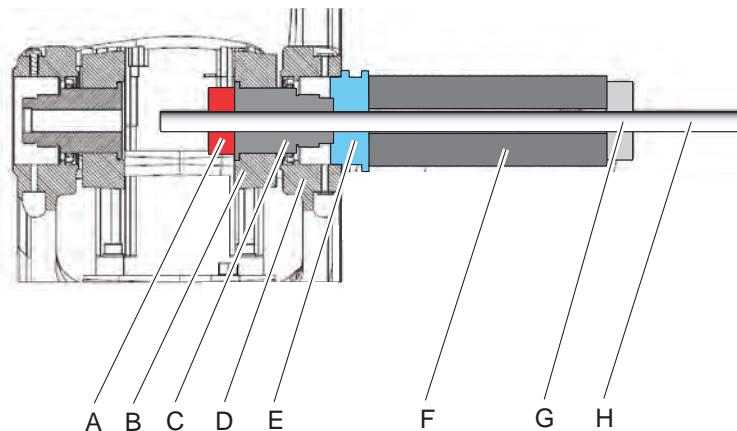
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4 Repair

4.4.2 Replacing the tilthouse unit

Continued

(shown as A) in the figure must be used when fitting the shaft. If not the shaft will not be pressed in completely.



xx1100000256

A	Thread washer, 3HAC040029-001
B	Upper arm
C	Shaft axis 3
D	Tilthouse
E	Support bushing
F	Hydraulic cylinder
G	Thread washer
H	Threaded bar M16

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	

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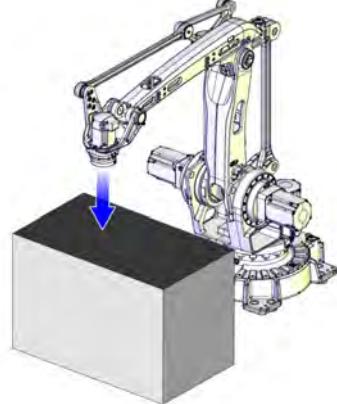
4.4.2 Replacing the tilthouse unit

Continued

Action	Note
<p>If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.</p>	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
<p>If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.</p>	

Removing the tilthouse unit

Use this procedure to remove the tilthouse unit.

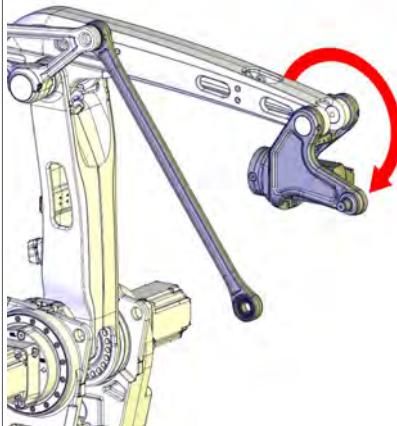
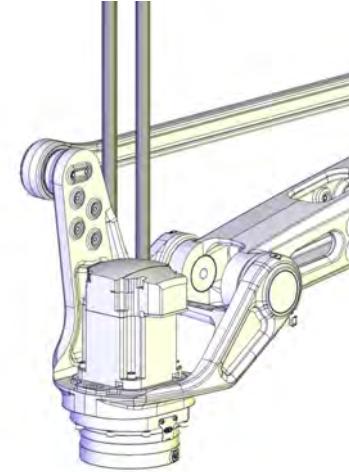
Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Move the robot to a position where the tilthouse rests on a workbench, pallets or similar.	 xx1100000225

Continues on next page

4 Repair

4.4.2 Replacing the tilthouse unit

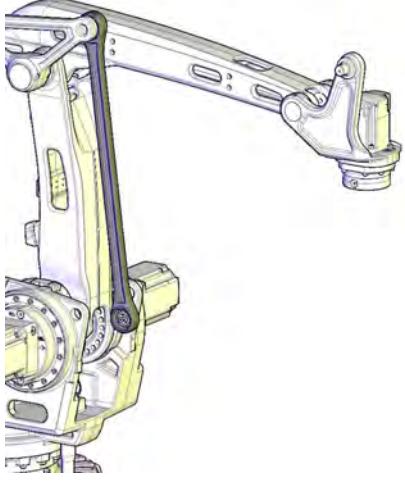
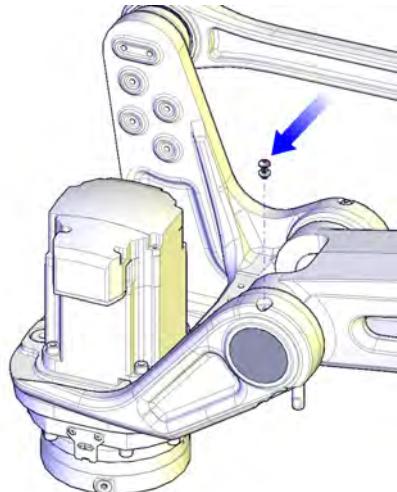
Continued

Action	Note
<p>3 This is done in order to prevent the tilthouse from falling down when the upper link is removed.</p> <p>DANGER</p> <p>If not secured the tilthouse will fall down when the upper link is removed. See figure!</p>	 xx1100000226
<p>4</p> <p>DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply <p>to the robot, before entering the robot working area.</p>	
<p>5 Secure the tilthouse with a <i>roundsling</i> in an overhead crane or similar.</p>	 xx1100000227
<p>6 Disconnect <i>motor cables</i> from motor axis 6. Place the motor cables in a way that it will not be damaged.</p>	See Replacing motor, axis 6 on page 312

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4.4.2 Replacing the tilthouse unit

Continued

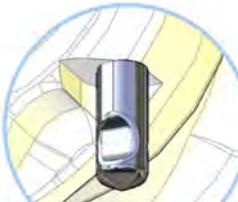
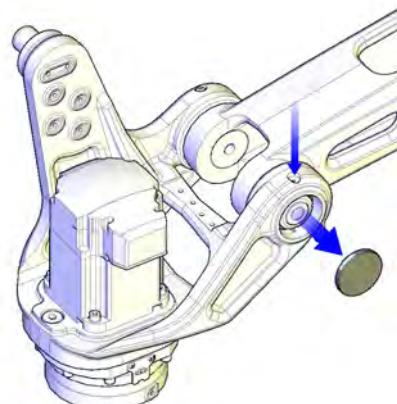
Action	Note
7 Disassemble the <i>upper link arm</i> from the tilt-house unit.  Note It is not needed to remove the upper link from the link.	See Replacing linkage - upper link arm on page 232  xx1100000228
8 Remove one of the <i>M6 screws and washer</i> for filling grease.	 xx1100000230

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4 Repair

4.4.2 Replacing the tilthouse unit

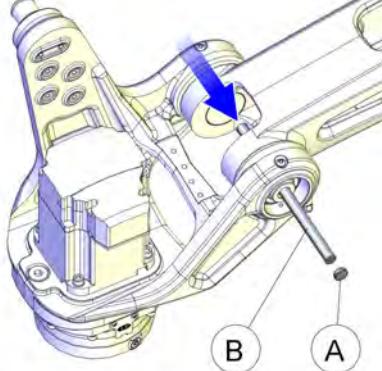
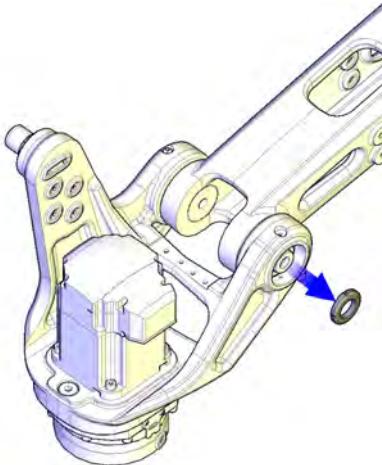
Continued

Action	Note
9 Be careful not to damage the <i>ball plug!</i>  Note Do not remove the ball plug!	 xx1100000231
10 Remove one shaft at a time by following the steps below, starting on axis 2 side.	
11 Use compressed air in the M6 <i>hole for filling grease</i> , in order to remove the <i>VK cover</i> . Put a hand with some paper over the VK cover in order to catch it.  CAUTION Only a very low air pressure is needed!	 xx1100000232

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4.4.2 Replacing the tilthouse unit

Continued

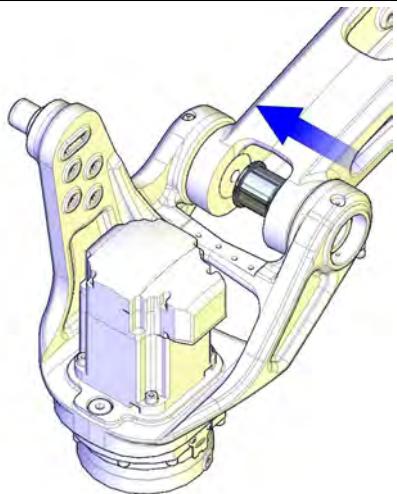
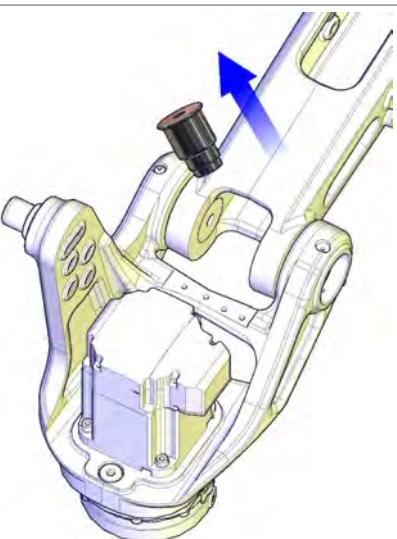
Action	Note
12 Remove the <i>small VK cover</i> from the inside with the help of a short punch or similar.	 <p>xx1100000233</p> <p>Parts:</p> <ul style="list-style-type: none"> A: VK cover B: Punch
13 Remove the <i>lock nut</i> .	 <p>xx1100000234</p>
14 Apply the <i>press tool shaft</i> and <i>auxiliary bushing</i> used for removing the shaft, as shown in the figure in: <ul style="list-style-type: none"> • Press tool for removal of shaft on page 201 	<p>For art.no:s. see Required equipment on page 199.</p> <p>The longer threaded bar: M16 length 450 mm</p> <p> Note</p> <p>A longer threaded bar M16 is needed when removing the shaft than the one specified when fitting.</p>

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4 Repair

4.4.2 Replacing the tilthouse unit

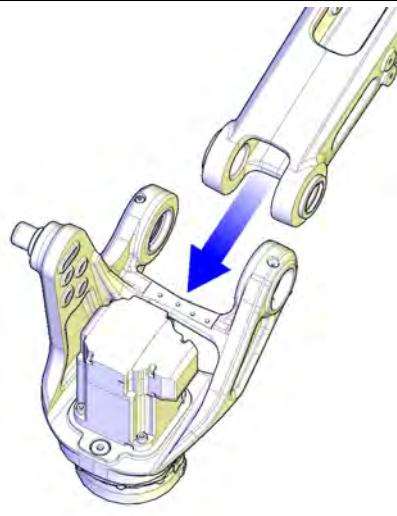
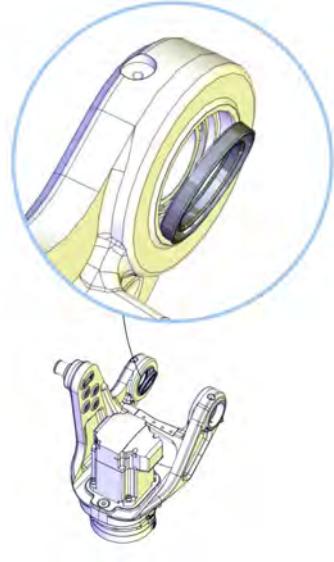
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Action	Note
15 Press out the <i>shaft</i> with the press tool.	 xx1100000235
16 Remove the <i>press tool shaft</i> and the <i>shaft</i> .	 xx1100000236
17 Check that the tilthouse is secured in an overhead crane or similar before proceeding with the next shaft.	
18 Remove the shaft on the axis 3 side in the same way by following the steps above.	
19  CAUTION The robot tilt house weighs 50 kg. All lifting accessories used must be sized accordingly!	

Continues on next page

4.4.2 Replacing the tilthouse unit

Continued

Action	Note
20 Remove the tilthouse and lift it to a safe place. Check that bearings are kept clean. Replace if damaged.	 xx1100000237
21 Force away the <i>sealing ring</i> with a screwdriver or similar. The sealing ring must be replaced with new ones when refitting.	 xx1100000243
22 If needed replace bearings.	

Premounting outer race of bearing and radial sealing, axis 2 side

Use this procedure to fit the outer race of the bearing and radial sealing in the tilthouse on the axis 2 side, before fitting the tilthouse to the upper arm.

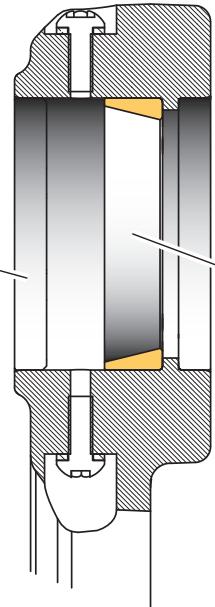
Action	Note
1 This work is best done on a workbench or similar.	
2 Fit the <i>radial sealing</i> in the hole.	
3 Apply some <i>grease</i> in the hole for the <i>bearings</i> .	Art.no. is specified in Required equipment on page 199 .

Continues on next page

4 Repair

4.4.2 Replacing the tilthouse unit

Continued

Action	Note
<p>4 Fit the outer race of the bearing. Normally this can be done by hand. If needed apply the <i>press tool pre-mounting bearing</i> and fit the <i>outer race</i> of the bearing. See <i>Press tool pre-mounting outer race bearings</i> on page 200.</p> <p> Note</p> <p>Check that the races are turned the correct way! See figure!</p>	<p>For art.no. see <i>Required equipment on page 199</i>.</p>  <p>xx1100000244</p> <p>Parts:</p> <ul style="list-style-type: none"> A: Surface for VK cover B: Outer race bearing axis 2 side
5 Apply grease on the inner diameter of the <i>radial sealing</i> .	See <i>X-ray view of the assembly of the tilthouse unit</i> on page 199.

Premounting outer race of bearing and radial sealing, axis 3 side

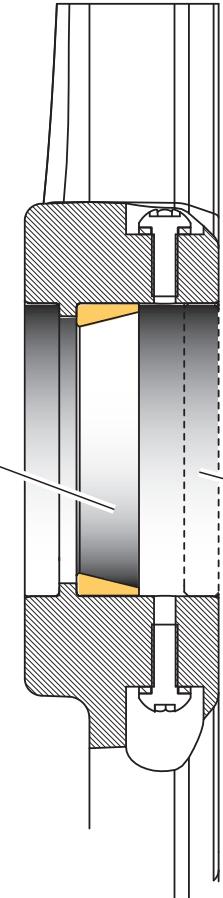
Use this procedure to fit the outer race of the bearing and radial sealing in the tilthouse on the axis 3 side, before fitting the tilthouse to the upper arm.

Action	Note
1 This work is best done on a workbench or similar.	
2 Fit the <i>radial sealing</i> in the hole.	See <i>X-ray view of the assembly of the tilthouse unit</i> on page 199.
3 Apply some <i>grease</i> in the hole for the <i>bearings</i> .	Art.no. is specified in <i>Required equipment on page 199</i> .

Continues on next page

4.4.2 Replacing the tilthouse unit

Continued

Action	Note
<p>4 Fit the outer race of the bearing. Normally this can be done by hand. If needed apply the <i>press tool pre-mounting bearing</i> and fit the <i>outer race</i> of the bearing. See <i>Press tool pre-mounting outer race bearings</i> on page 200.</p> <p> Note</p> <p>Check that the races are turned the correct way! See figure!</p>	<p>Art.no. specified in <i>Required equipment on page 199</i>.</p>  <p>xx1100000245</p> <p>Parts:</p> <ul style="list-style-type: none"> A: Outer race bearing axis 3 side B: Surface for VK cover
5 Apply grease on the inner diameter of the <i>radial sealing</i> .	See <i>X-ray view of the assembly of the tilthouse unit</i> on page 199.

Refitting shafts

Before starting this procedure, prepare the tilthouse as described in:

- *Premounting outer race of bearing and radial sealing, axis 2 side* on page 209
- *Premounting outer race of bearing and radial sealing, axis 3 side* on page 210

Use this procedure to refit the shafts of the tilthouse unit.

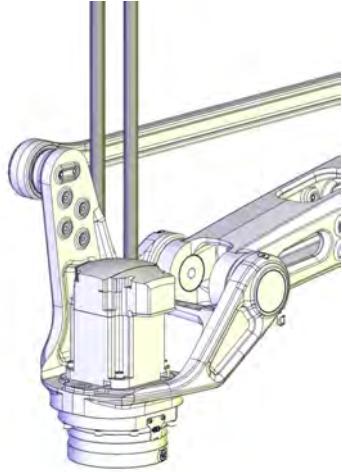
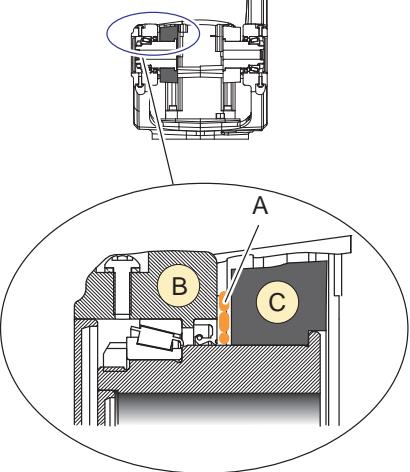
Action	Note
<p>1  CAUTION</p> <p>The robot tilt house weighs 50 kg. All lifting accessories used must be sized accordingly!</p>	

Continues on next page

4 Repair

4.4.2 Replacing the tilthouse unit

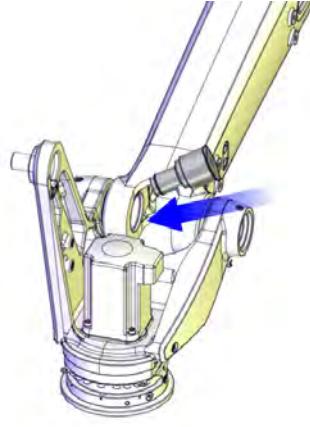
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Action	Note
2 Secure the tilthouse with a <i>roundsling</i> in an overhead crane or similar and lift it to its mounting position on the upper arm and let it rest on a workbench, some pallets or similar (as when removing it).	 xx1100000227
3 Apply <i>rust preventive (Dinitrol 490)</i> on the surface where the tilthouse faces the upper arm.	 xx1100000248 <p>Parts:</p> <ul style="list-style-type: none"> A: Dinitrol 490 B: Tilthouse C: Upper arm
4 Apply some <i>grease</i> in the hole for the <i>shaft</i> in the upper arm.	Art. no. is specified in Required equipment on page 199 .
5  Note Refit the axis 2 side first!	See Location of axes 2 and 3 sides of the robot on page 197 .

Continues on next page

4.4.2 Replacing the tilthouse unit

Continued

Action	Note
6 Push the <i>shaft</i> into its hole, from the inside.	The figure shows IRB 760 but the principle is the same.  xx1000001438
7 Align the holes in the upper arm and tilthouse as close as possible.	
8 Apply the <i>press tool shaft</i> prepared for refitting the shaft, as shown in the figure in: NOTE! Use the correct thread washer pressing against the shaft. See figure! If the correct thread washer isn't used, the shaft will not be pressed in completely. • Press tool for fitting of shaft on page 201 .	
9 Press the parts together.	
10 Fit the axis 3 side in the same way, by following the steps above.	

Refitting lock nuts and the remaining parts

Before starting this procedure, perform the procedure:

- [Refitting shafts on page 211](#)

Use this procedure to refit the lock nuts and the other remaining parts of the tilthouse unit.

Action	Note
1  Note Start the assembly on the axis 2 side!	

Continues on next page

4 Repair

4.4.2 Replacing the tilthouse unit

Continued

Action	Note
2 Place the <i>inner race of the bearing</i> on the shaft on the axis 2 side and push it in position.  Note Normally it shall be possible to fit the bearing into position very easy.	
3 Apply <i>locking liquid (Loctite 243)</i> on the threads of the lock nut KM7.	
4 Secure the axis 2 shaft with the <i>lock nut</i> .  Note Flat side of the lock nut facing inwards!	Tightening torque: • 90 Nm
5 Place the <i>inner race of the bearing</i> on the shaft on the axis 3 side and push it in position.  Note Normally it shall be possible to fit the bearing into position very easy.	
6 Apply <i>locking liquid (Loctite 243)</i> on the threads of the lock nut KM7.	
7 Secure the axis 3 shaft with the lock nut.  Note Flat side of the lock nut facing inwards!	Tightening torque: 90 Nm.  Note Rotate the tilthouse while securing the lock nut on the axis 3 side.
8 Wipe clean the surfaces for the VK-covers with Isopropanol.	
9 Fit the small <i>VK covers</i> on axes 2 and 3 using a plastic mallet.	
10 Fit the big <i>VK covers</i> on axes 2 and 3 using a plastic mallet.	
11 Fill bearings with <i>grease</i> by removing both M6 screws on either side. One hole is used for filling and the other for letting out air. Fill until grease spills out of the air hole.	
12 Fit the <i>M6 screws</i> and <i>washers</i> covering the grease filling holes.	
13 Refit the <i>upper link arm</i> .	See Replacing linkage - upper link arm on page 232
14 Refit the <i>motor cable, axis 6</i> .	See Replacing motor, axis 6 on page 312

Continues on next page

4.4.2 Replacing the tilthouse unit

Continued

Action	Note
15 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .
16  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

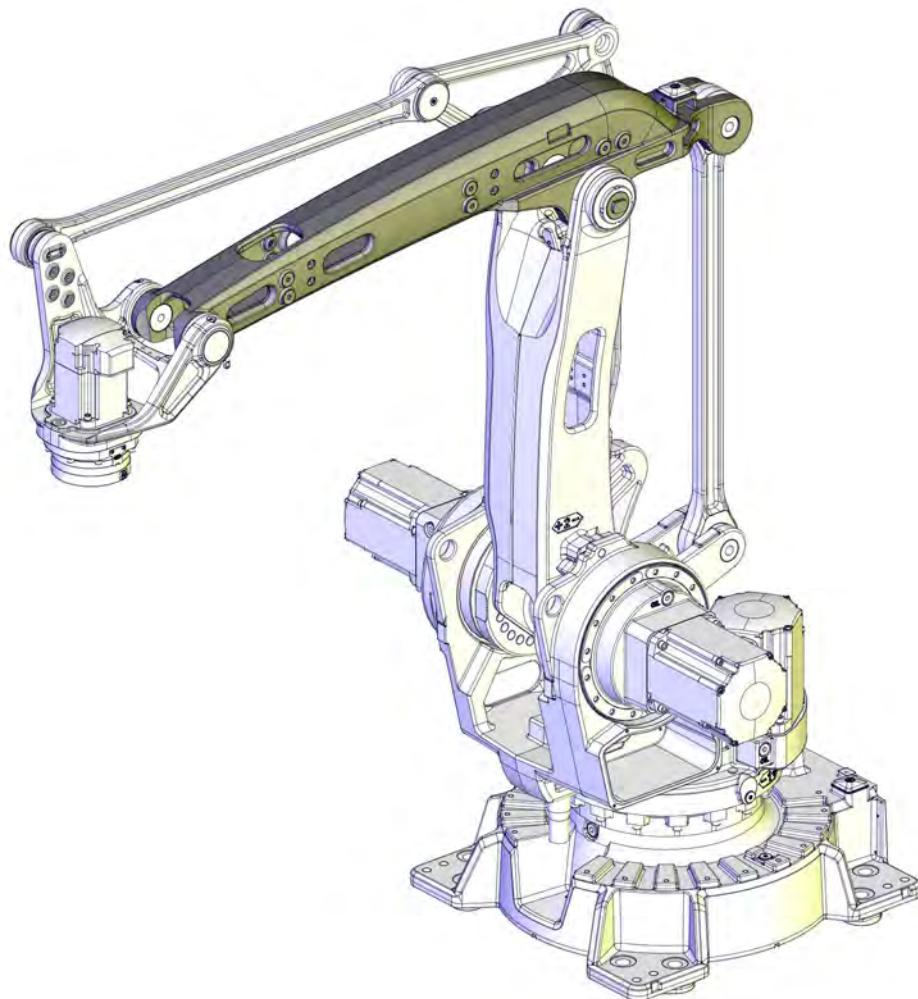
4 Repair

4.4.3 Replacing the upper arm

4.4.3 Replacing the upper arm

Location of the upper arm

The upper arm is located as shown in the figure.



xx1100000262

Different versions of the sealing structure

Robots that are delivered from October 2012 and forward has a new sealing structure at the link that consists of a support ring, o-ring and radial sealing.

Robots delivered before October 2012 has a sealing structure that consists of a POM sealing, if not updated with the new sealing structure according to above.

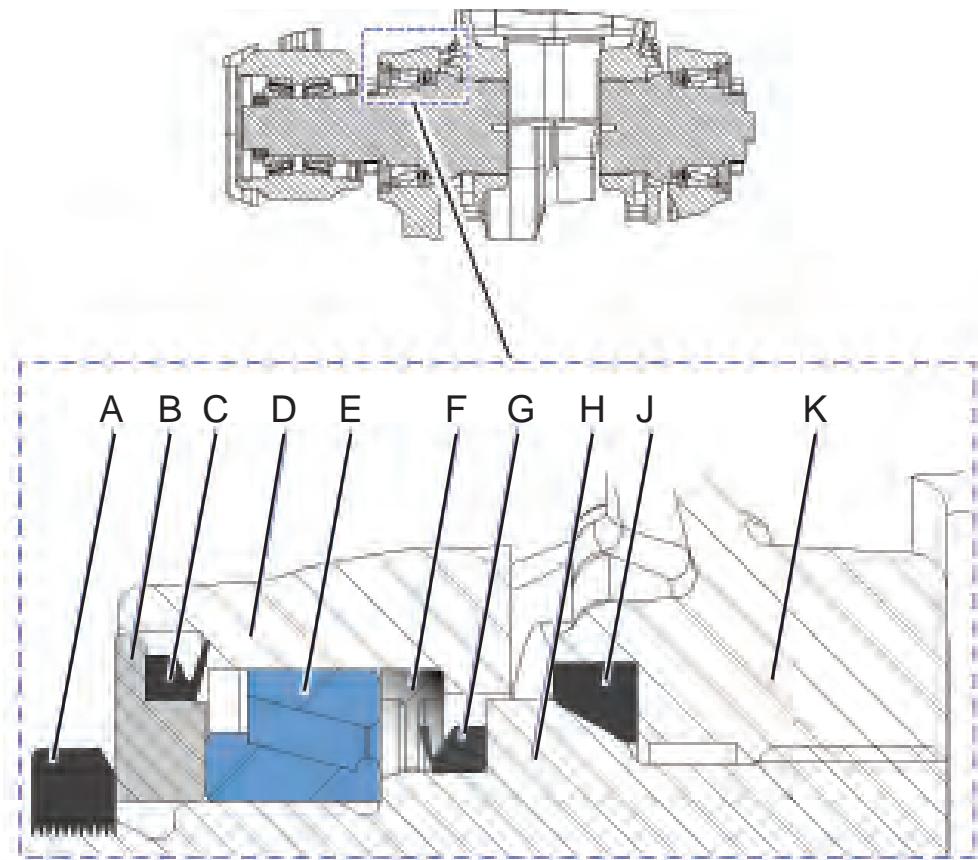
The removal and refitting procedures describe both versions of sealing structures. The steps that differ are marked with information about which sealing structure the step is valid for.

Continues on next page

Cut away view of the assembly of the upper arm components

The figure shows a cut away view how the upper arm is fitted to the lower arm.

Design with POM sealing



xx1100000273

- | | |
|---|-----------------------|
| A | Lock nut |
| B | Support ring |
| C | Sealing ring (V-ring) |
| D | Lower arm |
| E | Bearing |
| F | T-ring |
| G | Sealing ring (V-ring) |
| H | Shaft |
| J | Bushing |
| K | Upper arm |

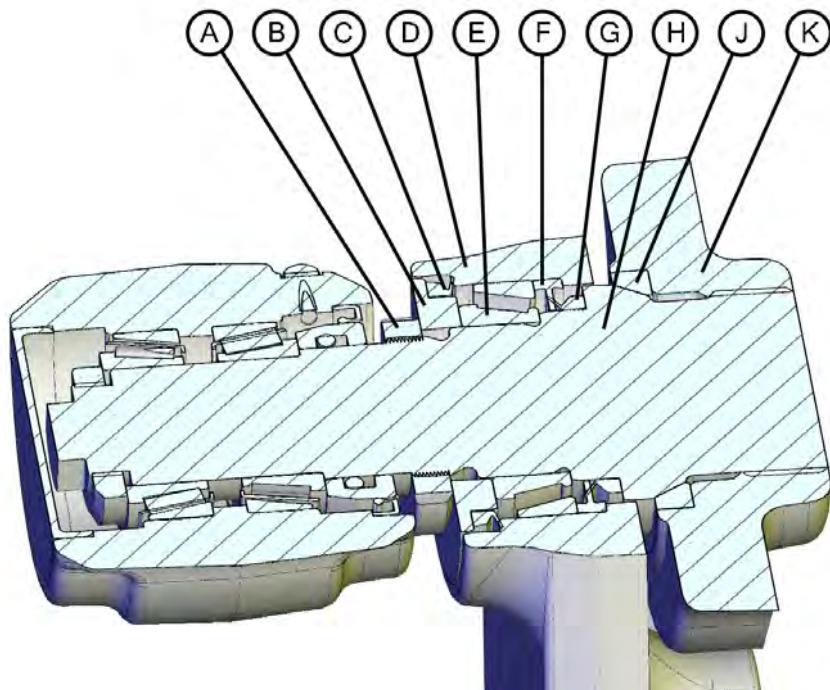
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4 Repair

4.4.3 Replacing the upper arm

Continued

Design with support ring



xx1300000013

A	Lock nut
B	Support ring
C	Sealing ring (V-ring)
D	Lower arm
E	Bearing
F	T-ring
G	Sealing ring (V-ring)
H	Shaft
J	Bushing
K	Upper arm

Press tool, upper arm

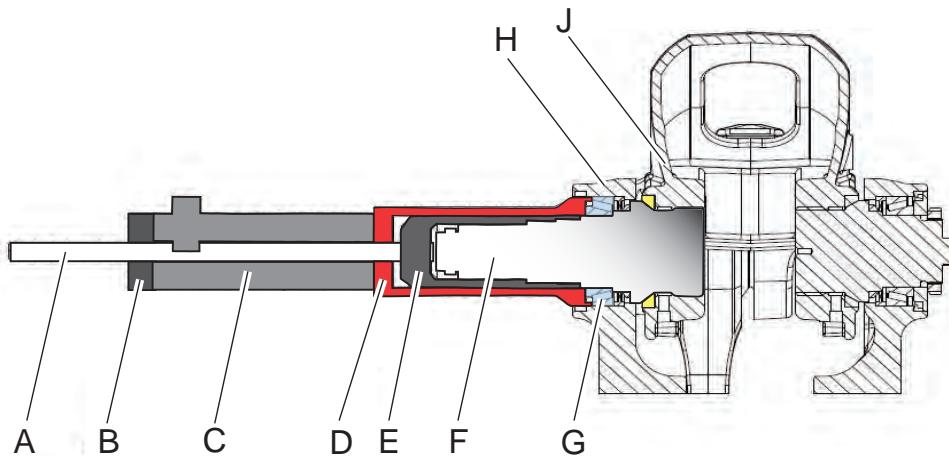
The *press tool upper arm* is used to assemble T-ring and bearing in the upper arm.
For art. no. see [Required equipment on page 220](#).

Continues on next page

4.4.3 Replacing the upper arm

Continued

The same tool is used for removal and refitting but some parts are different. See figure!



xx1100000269

- A Threaded bar M16
- B Thread washer (3HAC040021-004)
- C Hydraulic cylinder (3HAC040021-005)
- D Press bushing (3HAC040026-003). Only used at assembly.
- E Auxiliary shaft (3HAC040026-002)
- F Shaft
- G Bearing
- H Lower arm
- J Upper arm

Continues on next page

4 Repair

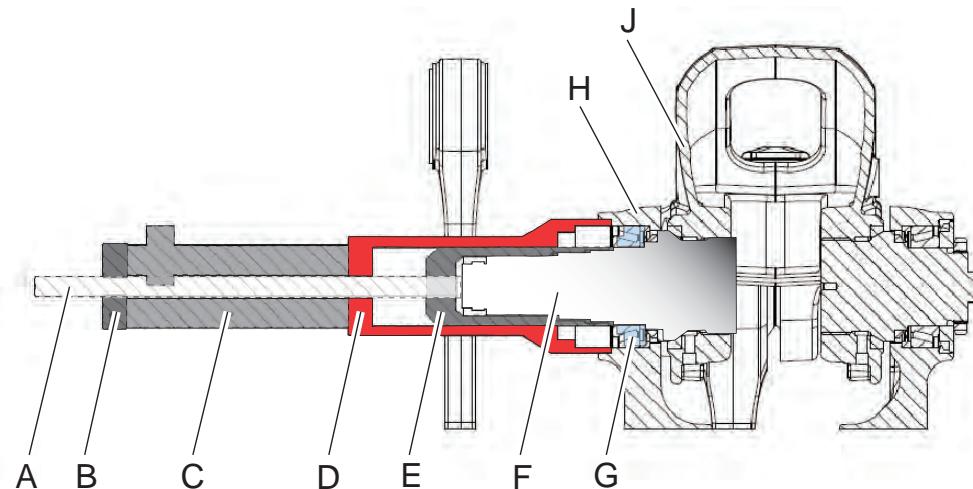
4.4.3 Replacing the upper arm

Continued

Pull tool, shaft

The *pull tool shaft* is used to remove the shaft, bearing and T-ring in the upper arm. For art. no. see [Required equipment on page 220](#).

The *pull tool shaft* is using the same parts as the press tool upper arm but the press bushing is replaced by the *support bushing*. See part marked red in the figure.



xx1100000270

- | | |
|---|---|
| A | Threaded bar M16 |
| B | Thread washer |
| C | Hydraulic cylinder |
| D | Support bushing (3HAC040026-004). Only used at removal. |
| E | Auxiliary shaft (3HAC040026-002) |
| F | Shaft |
| G | Bearing |
| H | Lower arm |
| J | Upper arm |

Required equipment

Equipment, etc.	Art.no.	Note
Upper arm, axis 4	For spare part no. see: • Spare parts on page 393	Includes: • 3HAC037314-001 bushing (2 pcs)
V-ring	2216264-16	
T-ring	3HAC022581-001	
Adapter	3HAC040027-001	The adapter consists of two parts: the adapter and a protective cover. Always use the protective cover together with the adapter!

Continues on next page

4.4.3 Replacing the upper arm

Continued

Equipment, etc.	Art.no.	Note
Press tool, upper arm	3HAC040026-001	Including: <ul style="list-style-type: none">• 3HAC040021-004 Thread washer• 3HAC040021-005 Hydraulic cylinder• 3HAC040026-003 Press bushing• 3HAC040026-002 Auxiliary shaft
Support, bushing	3HAC040026-004	When used with the parts from Press tool upper arm this tool is called <i>Pull tool, shaft</i> . The only difference is that the <i>press bushing</i> is replaced by the <i>support bushing</i> .
Socket, KM 12	3HAC040023-001	
Locking liquid	3HAB7116-1	Loctite 243
Bearing grease	3HAB3537-1	
Lubricant paste		Molycote 1000
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .

Continues on next page

4 Repair

4.4.3 Replacing the upper arm

Continued

Action	Note
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Preparations before removing the shafts of the upper arm

Use this procedure to do the necessary preparations before removing the upper arm.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Remove all equipment fitted to upper arm and tilthouse unit.	
3 Jog axes 2 and 3 to the following positions: Axis 2: +40 degrees. Axis 3: -40 degrees.	
4  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
5 Remove the <i>cable harness</i> in the upper arm.	See section <ul style="list-style-type: none">• Replacing the cable harness, upper end (incl. axis 6) on page 165
6  CAUTION The robot upper arm weighs 120 kg. All lifting accessories used must be sized accordingly!	
7 Secure the upper arm with a roundsling in an overhead crane or similar.	
8 Raise the lifting equipment to take the weight of the upper arm.	
9 Remove the <i>linkage system</i> .	See section <ul style="list-style-type: none">• Replacing linkage - upper link arm on page 232• Replacing linkage - lower link arm on page 240• Replacing the linkage - link on page 247
10 Remove the <i>tilthouse unit</i> .	See section <ul style="list-style-type: none">• Replacing the tilthouse unit on page 195

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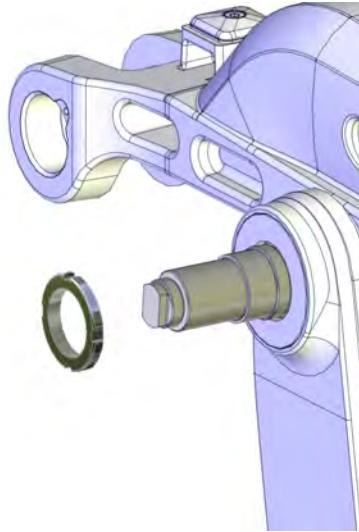
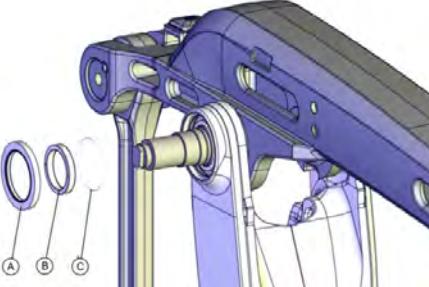
4.4.3 Replacing the upper arm

Continued

Action	Note
11 Remove the <i>parallel rod</i> .	For more information, see Replacing parallel rod on page 264 .

Removing the upper arm- part 1

Use this procedure to remove the upper arm - part 1.

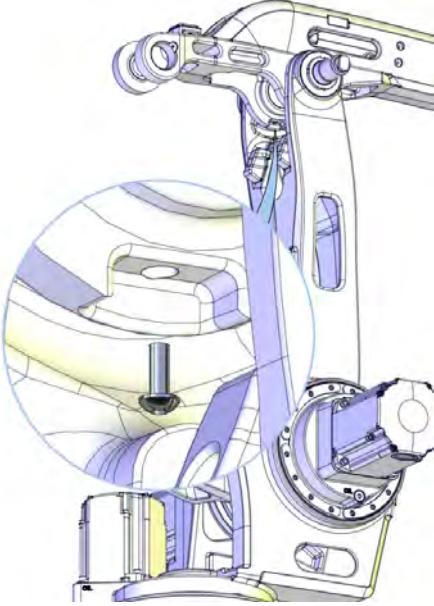
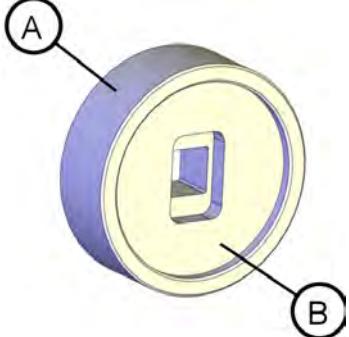
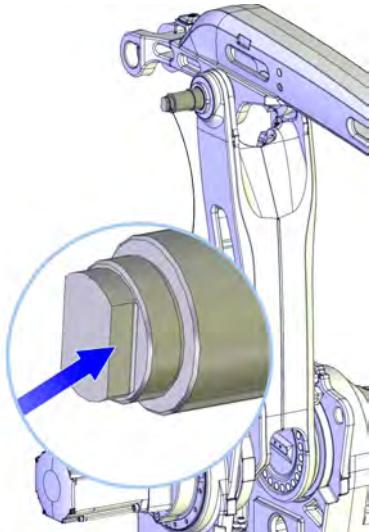
Action	Note
1 Remove the <i>lock nuts (KM12)</i> securing the shafts on axis 2 and axis 3 sides.  Note Remove lock nuts on axis 2 and 3 sides!	 xx1100000266
2 Remove the <i>Radial seal, sleeve and O-ring</i> from the shaft.  Note Remove <i>Radial seal, sleeve and O-ring</i> on both axis 2 and 3 sides!	 xx1100000267 Parts: <ul style="list-style-type: none">• A: Radial seal with dust lip• B: Sleeve• C: O-ring

Continues on next page

4 Repair

4.4.3 Replacing the upper arm

Continued

Action	Note
3 Remove the <i>set screws</i> securing the axis 2 and 3 shafts. One on each shaft.	 xx1100000263
4 Place the <i>adapter</i> (<i>including the protection cover</i>) on the shaft. The adapter consists of two parts: the adapter and a protective cover. Always fit the protective cover to the adapter when using the adapter!  xx1100000264 <ul style="list-style-type: none"> • A: Protective cover • B: Adapter 	 xx1100000265

Removing the upper arm - part 2

Use this procedure to remove the upper arm - part 2.

Action	Note
1 Start the continued removal of shafts on the axis 3 side.	
2 NOTE! The axis 3 shaft must be removed in more than one step. The reason is the fitting of the outer race of the bearing is very tight.	

Continues on next page

4.4.3 Replacing the upper arm

Continued

	Action	Note
3	Begin by carefully applying torque to release the shaft of axis 3. NOTE! Perform this move with care. Threads can otherwise be damaged.	
4	Continue releasing the shaft until the gap between the upper and lower arms on the axis 2 side has disappeared. NOTE! The shaft at this point still connects to the upper arm through the threads.	
5	Apply the <i>pull tool shaft</i> and pull the shaft with bearing and T-ring out, until the gap between upper and lower arms on the axis 3 side disappears.	TIP! Use a bar or similar to push the upper arm against the axis 3 side during the pulling out of the shaft. Insert the bar into the gap on the axis 2 side.
6	Remove the pull tool shaft and apply the adaptor on the shaft.	
7	Continue releasing the shaft from the upper arm using the adaptor. Release until the gap between lower and upper arms on the axis 2 side disappears again.	The upper arm will start to move against the axis 2 side again.
8	Check that the threads on the shaft and the upper arm are completely separated.	If the answer is "No", repeat the steps above to make sure the threads of the shaft and the upper arm are completely separated, before continuing.
9	If the answer is "Yes" pull the shaft out completely together with bearing and T-ring using the <i>pull tool shaft</i> .	
10	Put the shaft in a clean and safe place.	
11	 DANGER Before continuing check that the upper arm is secured in an overhead crane or similar. With axis 3 removed there will be no support for the upper arm.	
12	Remove the axis 2 shaft by following the steps above.	
13	Remove the <i>upper arm</i> .	
14	Check the V-ring! Replace if damaged!	

Preparations of the shafts before refitting the upper arm

Use this procedure to do the necessary preparations of shafts and bearings before refitting the upper arm.

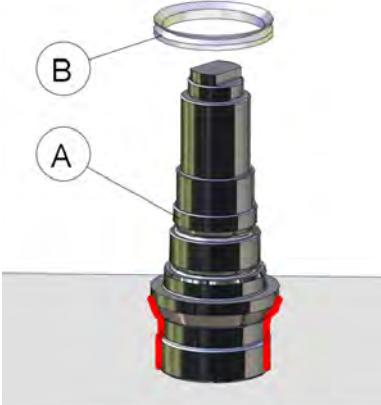
	Action	Note
1	This procedure is best performed on a work-bench or similar.	
2	Place the shafts on the workbench.	

Continues on next page

4 Repair

4.4.3 Replacing the upper arm

Continued

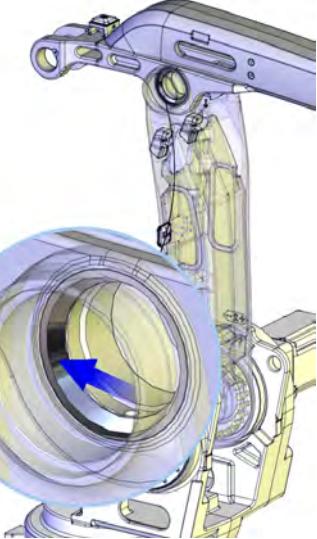
Action	Note
3 Fit the <i>sealing ring (V-ring)</i> on the shaft.	 xx1100000268 Parts: <ul style="list-style-type: none"> A: Shaft B: Sealing ring (V-ring)
4 Apply some <i>grease</i> on shafts and sealing rings.	 Note Do not apply grease on threads and cones of the shafts. See area marked red in the figure above!
5 Fill bearings with bearing grease.	 Note Rotate the bearing during filling grease to make sure the lubrication for both outer and inner races are good.
6 Apply <i>lubricant paste (Molykote 1000)</i> on threads and cones of the shafts.	

Preparations before refitting the shafts of the upper arm

Use this procedure to do the necessary preparations before refitting the shafts.

Action	Note
1  CAUTION The robot upper arm weighs 120 kg. All lifting accessories used must be sized accordingly!	
2 Secure the <i>upper arm</i> with a roundsling in an overhead crane or similar.	

Continues on next page

Action	Note
<p>3 Check that the <i>bushings</i> in the upper arm are without damages and still in the correct position.</p> <p> Note</p> <p>If damaged, replace the bushing!</p>	 xx1100000271
<p>4 Move the <i>upper arm</i> to its mounting position. Make sure that the <i>upper arm</i> is placed in a horizontal position.</p>	<p> Note</p> <p>Make sure that the upper arm is placed correctly in a way that the shafts can be inserted without being damaged!</p>

Refitting the upper arm shafts

Use this procedure to refit the upper arm shafts.

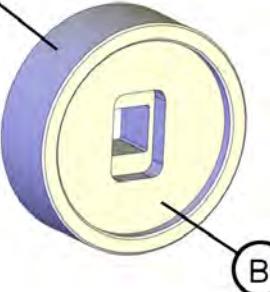
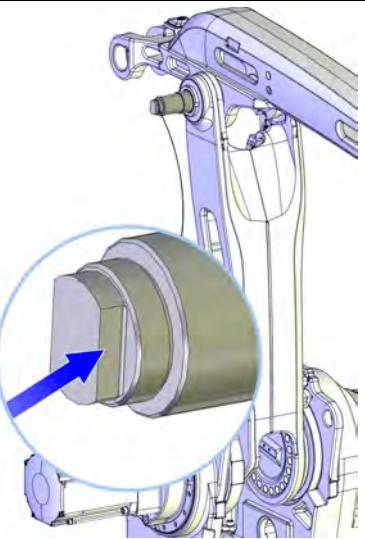
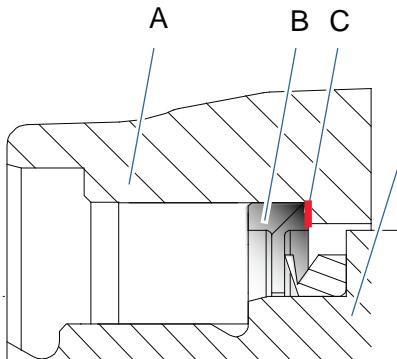
Action	Note
<p>1 NOTE! Refit the shaft on the axis 3 side first!</p>	
<p>2 Carefully fit the <i>shaft</i> into the threads of the upper arm, by hand only.</p> <p> Note</p> <p>Do not use force since threads otherwise can be damaged!</p>	

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4 Repair

4.4.3 Replacing the upper arm

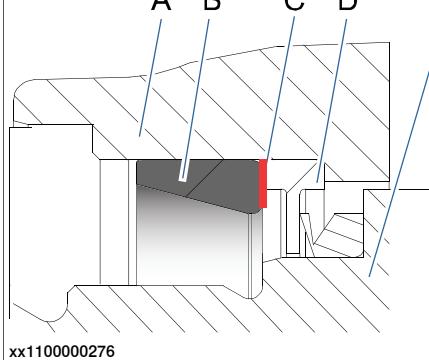
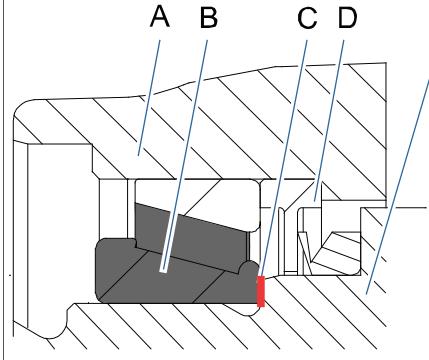
Continued

Action	Note
<p>3 Place the <i>adapter (including the protection cover)</i> on the shaft.</p> <p>The adapter consists of two parts: the adapter and a protective cover. Always fit the protective cover to the adapter when using the adapter!</p>  <p>xx1100000264</p> <ul style="list-style-type: none"> • A: Protective cover • B: Adapter 	 <p>xx1100000265</p>
<p>4 Place the <i>T-ring</i> on the shaft by hand as close to its final position as possible.</p>	 <p>xx1100000274</p> <p>Parts:</p> <ul style="list-style-type: none"> • A: Lower arm • B: T-ring • C: Surface on lower arm on which the T-ring rests against • D: Shaft

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4.4.3 Replacing the upper arm

Continued

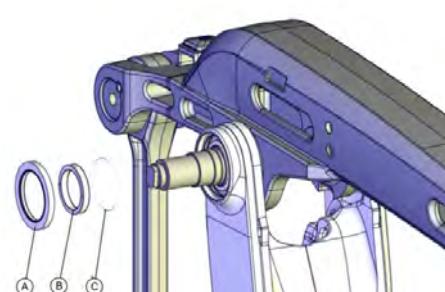
Action	Note
5 Place the <i>outer race of the bearing</i> on the shaft as close to its final position as possible.	 <p>xx1100000276</p> <p>Parts:</p> <ul style="list-style-type: none"> • A: Lower arm • B: Outer bearing • C: Surface on T-ring on which outer race rests against • D: T-ring • E: Shaft
6 Apply the press tool upper arm and press both parts into their final position.	<p> Note</p> <p>Make sure that the T-ring is pressed in all the way and rests against the lower arm correctly. See figure!</p> <p> Note</p> <p>Make sure the bearing is pressed in all the way and rests in the correct position on the shaft. See figure!</p>
7 Fill the inner race of the bearing with grease.	
8 Fit the <i>inner race of the bearing</i> on the shaft and press it in using the <i>press tool upper arm</i> .	<p> Note</p> <p>Make sure the bearing is pressed in all the way and rests in the correct position on the shaft. See figure!</p>  <p>xx1100000275</p> <p>Parts:</p> <ul style="list-style-type: none"> • A: Lower arm • B: Bearing inner race • C: Surface on shaft on which the inner race of bearing rests against • D: T-ring • E: Shaft

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4 Repair

4.4.3 Replacing the upper arm

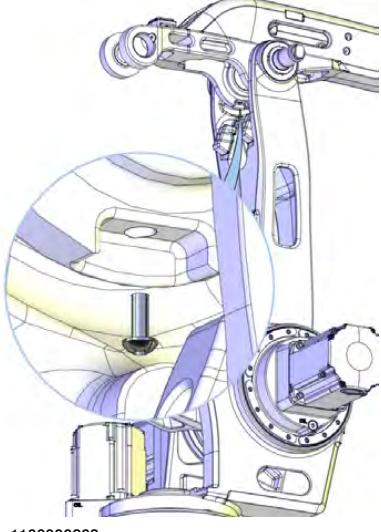
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Action	Note
9 Fit the <i>O-ring, Sleeve and Radial seal.</i>	 <p>xx1100000267</p> <p>Parts:</p> <ul style="list-style-type: none"> • A: Radial seal with dust lip • B: Sleeve • C: O-ring
10 Only applicable to the axis 3 side! Secure the shaft with the lock nut on the axis 3 side by following this order: 1 Apply locking liquid (Loctite 243) on the threads of the lock nut. 2 Tighten the lock nut with a tightening torque of 90 Nm. NOTE! Notice the different procedures for axis 3 and axis 2 sides!	
11 Only applicable to the axis 2 side! Secure the shaft with the lock nut on the axis 2 side by following this order: 1 Tighten the lock nut with a tightening torque of 200 Nm. Move the upper arm while applying the torque. 2 Unscrew the lock nut 3 Apply locking liquid (Loctite 243) on the threads of the lock nut. 4 Tighten the lock nut with a tightening torque of 90 Nm. Move the upper arm while applying the torque. NOTE! Notice the different procedures for axis 3 and axis 2 sides!	NOTE! Moving the upper arm while tightening the lock nut is important for a correct fit!
12 Refit the shaft on the axis 2 side, by following the steps in this procedure.	

Continues on next page

Refitting the upper arm - concluding procedures

Use this procedure for the concluding refitting of the upper arm.

Action	Note
1 Apply locking liquid (Loctite 243) in the two holes for the <i>set screws</i> and fit the screws.	 xx1100000263 Tightening torque: 34 Nm.
2 Wipe residual grease and contamination off the shafts.	
3 Refit the <i>tilthouse unit</i> .	See Replacing the tilthouse unit on page 195 .
4 Refit the <i>parallel rod</i> .	See Replacing parallel rod on page 264 .
5 Refit the <i>cable harness</i> in the upper arm.	See section <ul style="list-style-type: none"> Replacing the cable harness, upper end (incl. axis 6) on page 165
6 Refit the <i>linkage system</i> starting with the link.	See Replacing the upper arm on page 216 . <ul style="list-style-type: none"> Replacing linkage - upper link arm on page 232 Replacing linkage - lower link arm on page 240 Replacing the linkage - link on page 247
7 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .
8  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

4 Repair

4.4.4 Replacing linkage - upper link arm

4.4.4 Replacing linkage - upper link arm

Overview

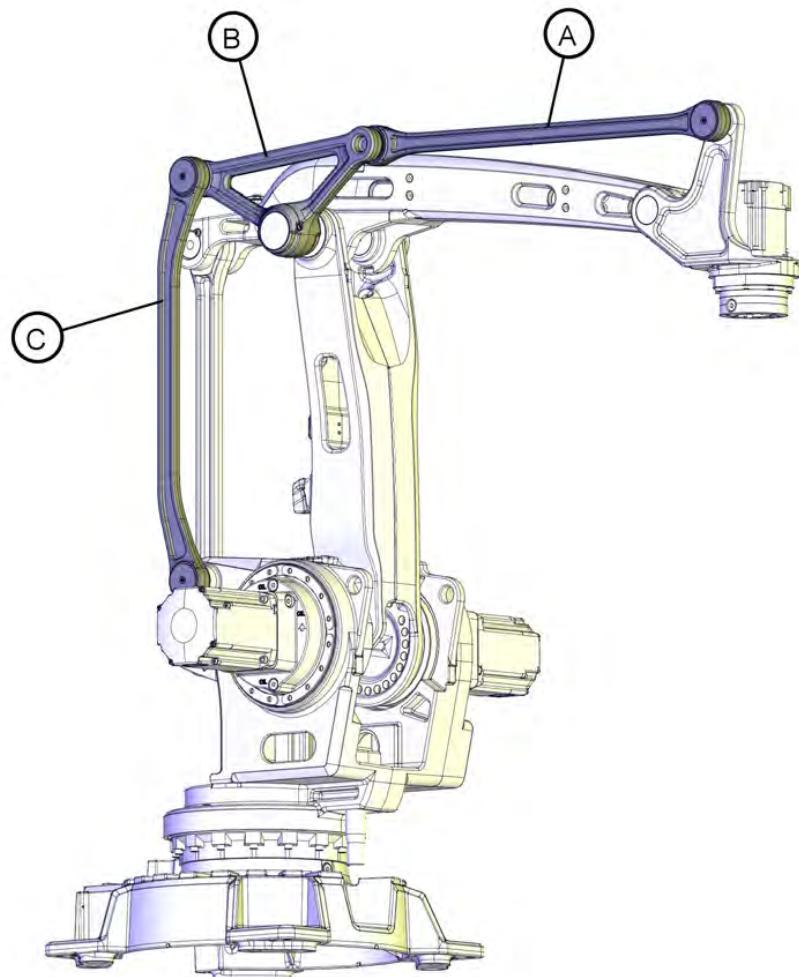
The linkage consists of three basic parts - *upper link arm*, *lower link arm* and *link*. This procedure describes how to remove and refit the upper link arm.

How to replace lower link arm and link see:

- [Replacing linkage - lower link arm on page 240](#)
- [Replacing the linkage - link on page 247](#)

Location of upper link arm

The upper link arm is located as shown in the figure.



xx1100000167

- | | |
|---|----------------|
| A | Upper link arm |
| B | Link |
| C | Lower link arm |

Continues on next page

4.4.4 Replacing linkage - upper link arm

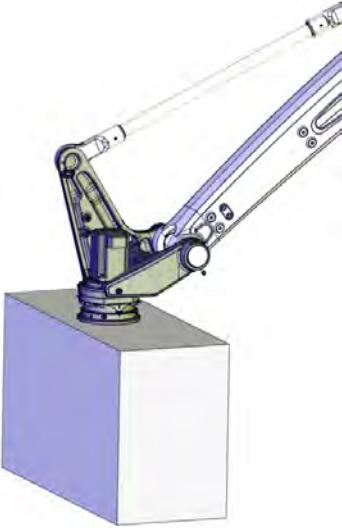
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Required equipment

Equipment	Art no.	Note
Upper link arm	For spare part no. see: • Spare parts on page 393	
Spherical roller bearing	For spare part no. see: • Spare parts on page 393	Replace if damaged. (2 pcs)
Bearing grease	3HAB3537-1	
Bearing puller		Bearing puller with three legs.
Locking liquid	3HAB7116-1	Loctite 243
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See refer- ences to these procedures in the step-by-step instructions below.		These procedures include references to the tools re- quired.

Removing the upper link arm

Use this procedure to remove the upper link arm.

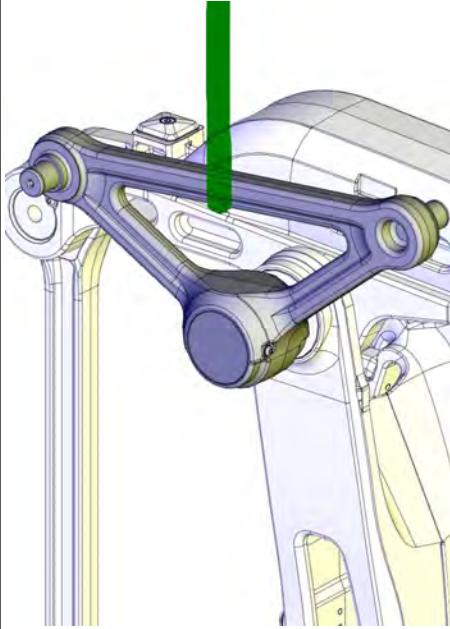
	Action	Note
1	Put the robot in a position where it is possible to reach all parts that shall be removed.	Check especially that it is possible to remove the locking washer at the link.
2	<p>Let the <i>tilthouse</i> rest on a workbench, on some pallets or similar.</p> <p>This is done in order to prevent the <i>tilthouse</i> from falling downwards when the upper link arm is removed.</p> <p> CAUTION</p> <p>In order to avoid accidents, also secure the upper arm in an overhead crane.</p>	 <p>xx1000001132</p>

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4 Repair

4.4.4 Replacing linkage - upper link arm

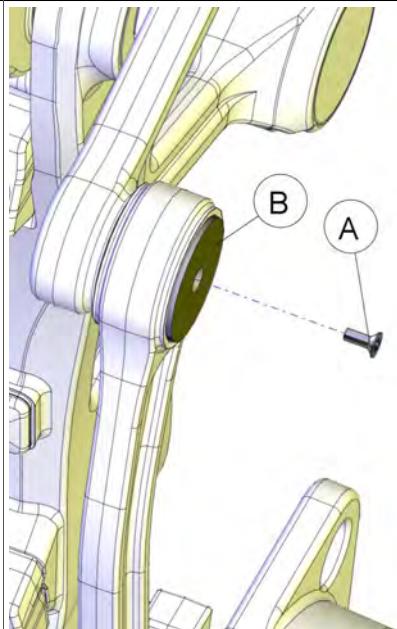
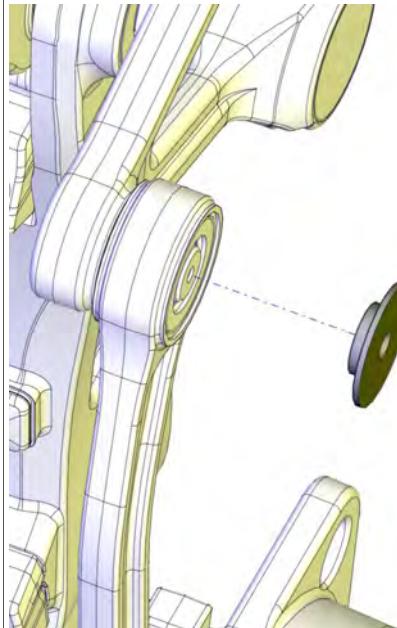
Continued

Action	Note
3  CAUTION If the lower link arm is removed, secure the <i>link</i> with a roundsling in an overhead crane. Use the hole in the middle of the link. This is done in order to prevent the link from moving if both the upper and lower link arms are removed.	 xx1100000173
4  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	

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4.4.4 Replacing linkage - upper link arm

Continued

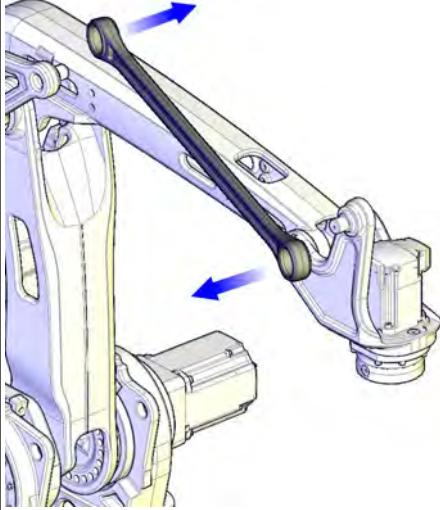
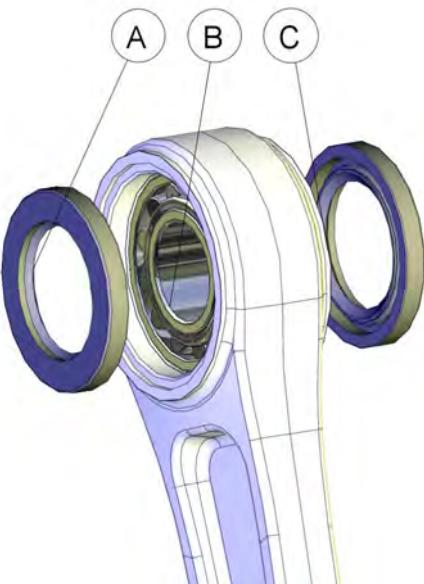
Action	Note
5 Remove the <i>lock screw</i> securing the <i>locking washer</i> .	 <p>xx1100000170</p> <p>Parts:</p> <ul style="list-style-type: none"> A Lock screw B Locking washer
6 Remove the <i>locking washer</i> .	 <p>xx1100000171</p>

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4 Repair

4.4.4 Replacing linkage - upper link arm

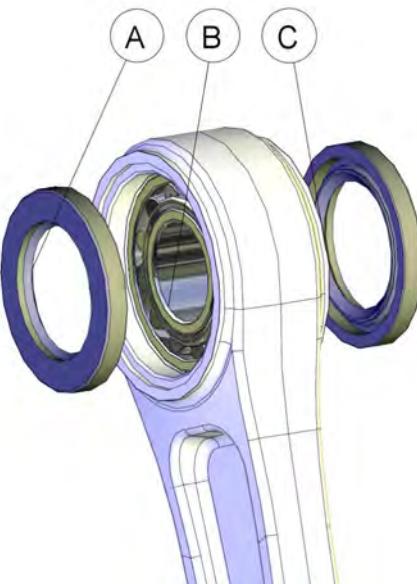
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Action	Note
7 Remove the <i>upper link arm</i> as shown in the figure. A three legged bearing puller will be needed to remove the link arm from the link. To remove it from the tilthouse a plastic mallet can be used.	 xx1100000169
8 Remove the <i>radial sealing rings</i> .	 xx1100000172 Parts: A Radial sealing ring B Bearing C Radial sealing ring
9 Remove residual grease.	

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Refitting the upper link arm

Use this procedure to refit the upper link arm.

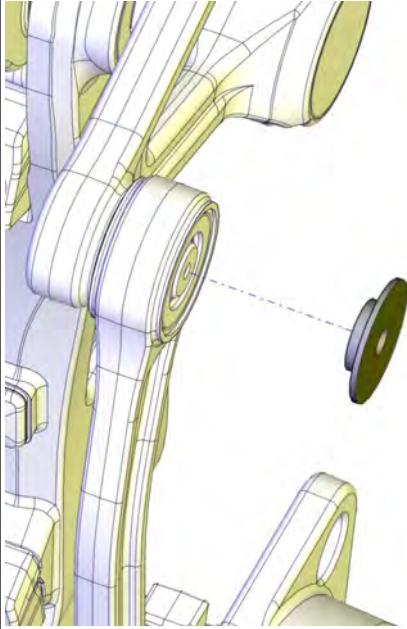
Action	Note
1 If needed, replace the <i>bearings</i> in the upper link arm.  Note The bearings are sensitive for pushes. Make sure they are not damaged!	
2 Lubricate the bearings properly with <i>bearing grease</i> .	
3 Fit <i>radial sealing rings</i> in the upper link arm as shown in the figure.	 xx1100000172 Parts: A Radial sealing ring B Bearing C Radial sealing ring

Continues on next page

4 Repair

4.4.4 Replacing linkage - upper link arm

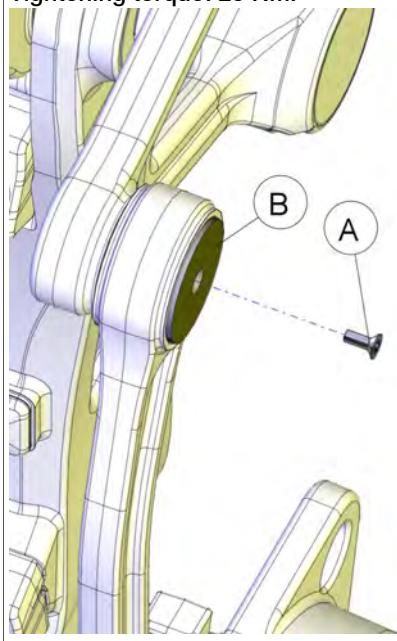
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Action	Note
4 Place the <i>locking washer</i> in the upper link arm.	 xx1100000171
5 Apply a bearing puller with three legs and press the upper link arm on to the shaft.  Note The press force shall be applied on the locking washer.	Check that the upper link arm is pushed completely in position.
6 Apply <i>locking liquid</i> on the lock screw.	Loctite 243.

Continues on next page

4.4.4 Replacing linkage - upper link arm

Continued

Action	Note
7 Secure the <i>locking washer</i> with the <i>lock screw</i> .	<p>Tightening torque: 25 Nm.</p>  <p>xx1100000170</p> <p>Parts:</p> <ul style="list-style-type: none"> A Lock screw B Locking washer
8  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage!</i> on page 48.	

4 Repair

4.4.5 Replacing linkage - lower link arm

4.4.5 Replacing linkage - lower link arm

Overview

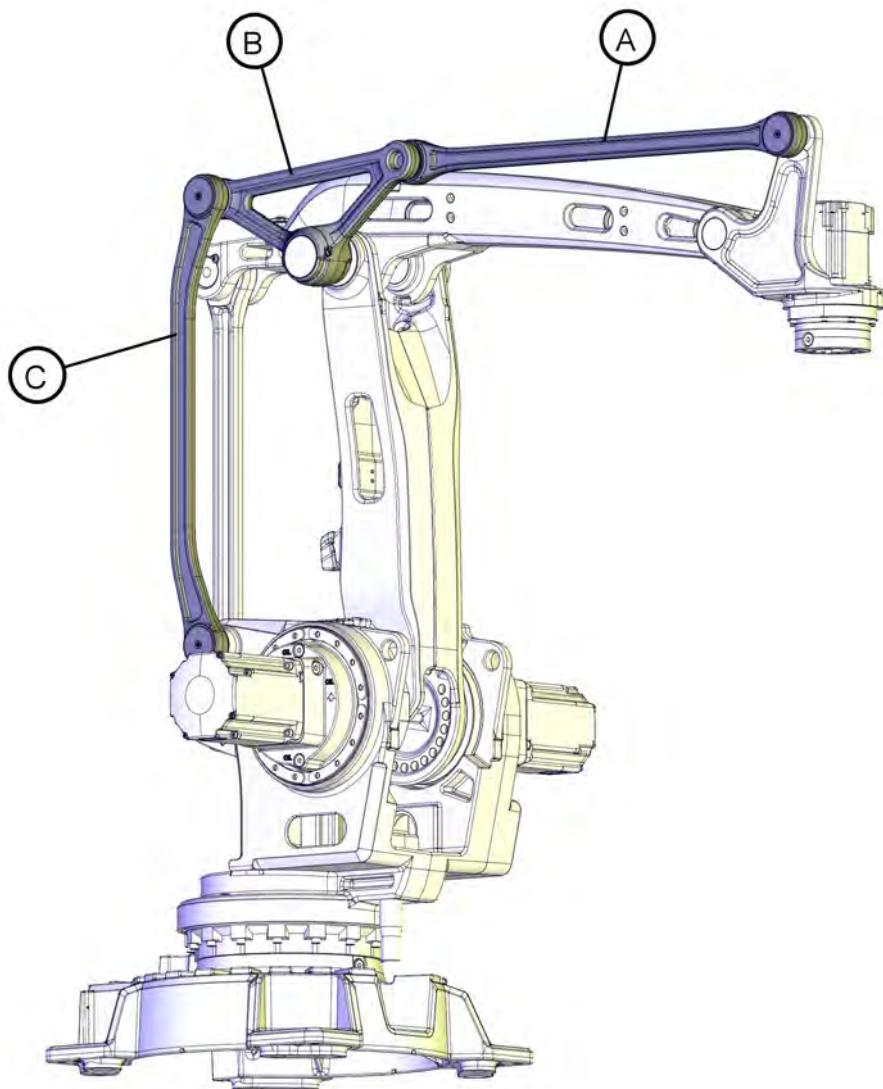
The linkage consists of three basic parts - *upper link arm*, *lower link arm* and *link*. This procedure describes how to remove and refit the lower link arm.

How to replace the upper link arm arm and link see:

- [Replacing linkage - upper link arm on page 232](#)
- [Replacing the linkage - link on page 247](#)

Location of lower link arm

The lower link arm is located as shown in the figure.



xx1100000167

- | | |
|---|----------------|
| A | Upper link arm |
| B | Link |

Continues on next page

C Lower link arm

Required equipment

Equipment	Art no.	Note
Lower link arm	For spare part no. see: • Spare parts on page 393	
Spherical roller bearing	For spare part no. see: • Spare parts on page 393	Replace if damaged. 2 pcs
Bearing grease	3HAB3537-1	Tribol GR 100-2 PD
Bearing puller		Bearing puller with three legs.
Locking liquid	3HAB7116-1	Loctite 243
Standard toolkit		Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See refer- ences to these procedures in the step-by-step instructions below.		These procedures include references to the tools re- quired.

Removing the lower link arm

Use this procedure to remove the lower link arm.

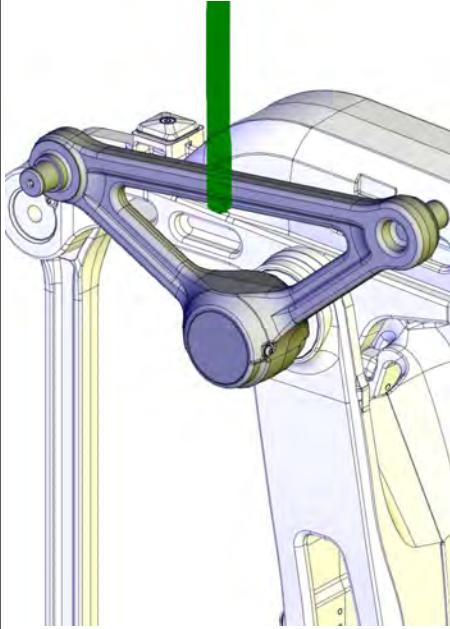
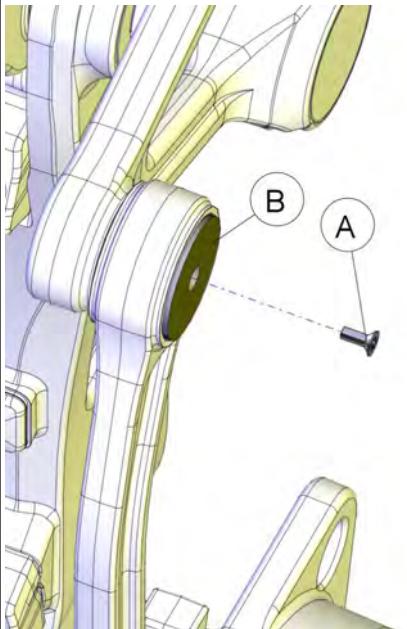
	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

Continues on next page

4 Repair

4.4.5 Replacing linkage - lower link arm

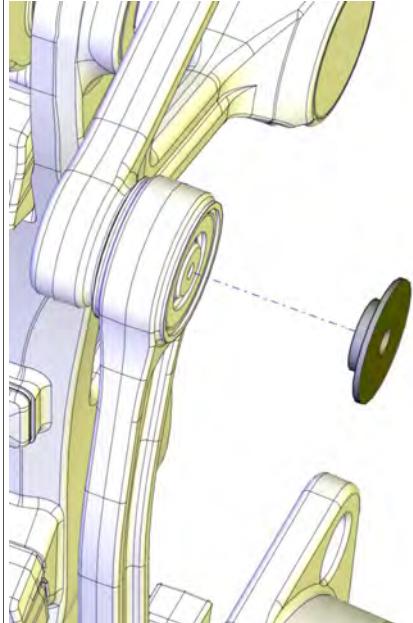
Continued

Action	Note
2  CAUTION If the upper link arm is removed, secure the <i>link</i> with a roundsling in an overhead crane. Use the hole in the middle of the link. This is done in order to prevent the link from moving if both the upper and lower link arms are removed.	 xx1100000173
3 Remove the <i>lock screw</i> securing the locking washer.	 xx1100000170 Parts: A Lock screw B Locking washer

Continues on next page

4.4.5 Replacing linkage - lower link arm

Continued

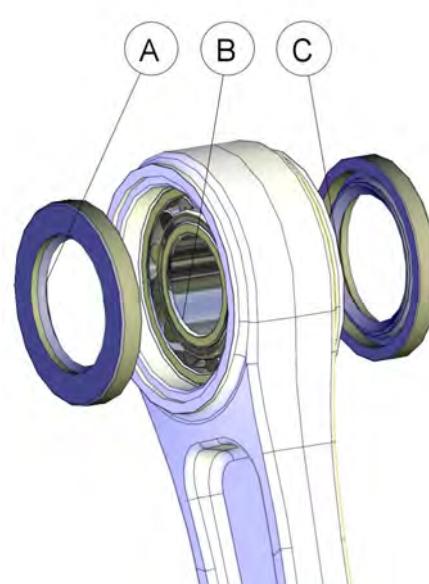
Action	Note
4 Remove the <i>locking washer</i> .	 xx1100000171
5 Remove the <i>lower link arm</i> by lifting it straight out. A three legged bearing puller will be needed to remove the link arm from the link. To remove it from the frame a plastic mallet can be used.	 xx1100000174

Continues on next page

4 Repair

4.4.5 Replacing linkage - lower link arm

Continued

Action	Note
6 Remove the <i>radial sealing rings</i> .	 xx1100000172 Parts: A Radial sealing ring B Bearing C Radial sealing ring
7 Remove residual <i>grease and sealing compound</i> .	

Refitting the lower link arm

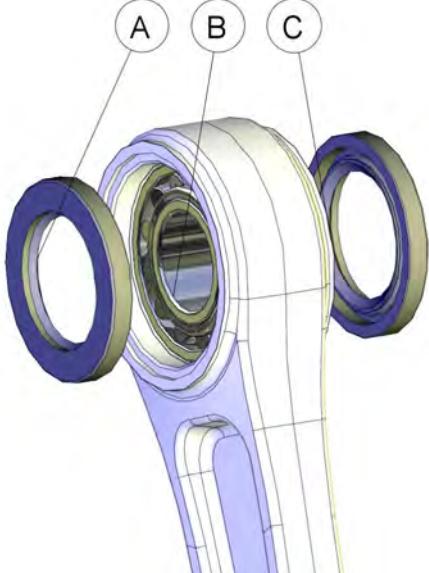
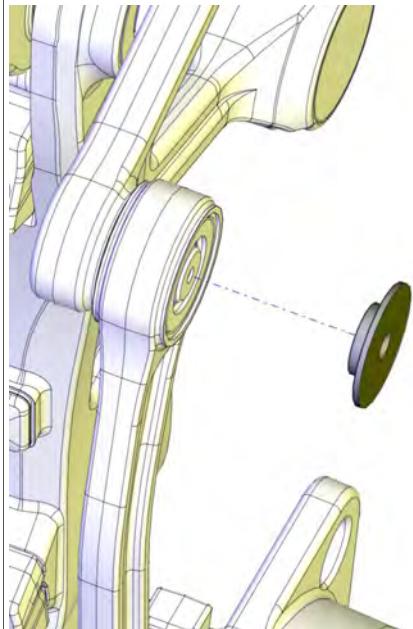
Use this procedure to refit the lower link arm.

Action	Note
1 If needed, replace the <i>bearings</i> .  Note The bearings are sensitive for pushes. Make sure they are not damaged!	Spare part no. is specified in Required equipment on page 241 .
2 Lubricate the bearings properly with <i>bearing grease</i> .	For art. no. see Required equipment on page 241 .

Continues on next page

4.4.5 Replacing linkage - lower link arm

Continued

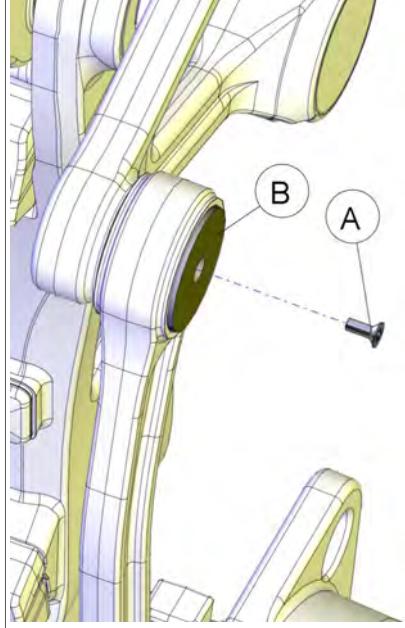
Action	Note
3 Fit the <i>radial sealing rings</i> in the lower link arm as shown in the figure.	 <p>xx1100000172</p> <p>Parts:</p> <ul style="list-style-type: none"> A Radial sealing ring B Bearing C Radial sealing ring
4 Place the <i>locking washer</i> in the lower link arm.	 <p>xx1100000171</p>
5 Apply a bearing puller with three legs and press the lower link arm on to the shaft.	<p>Check that the lower link arm is pushed completely in position.</p> <p> Note</p> <p>The press force shall be applied on the locking washer.</p>

Continues on next page

4 Repair

4.4.5 Replacing linkage - lower link arm

Continued

Action	Note
6 Apply locking liquid on the lock screw.	Loctite 243
7 Secure the <i>locking washer</i> with the lock screw.	<p>Tightening torque: 25 Nm.</p>  <p>xx1100000170</p> <p>Parts:</p> <ul style="list-style-type: none"> A Lock screw B Locking washer
8  DANGER	<p>Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage! on page 48</i>.</p>

4.4.6 Replacing the linkage - link

Overview

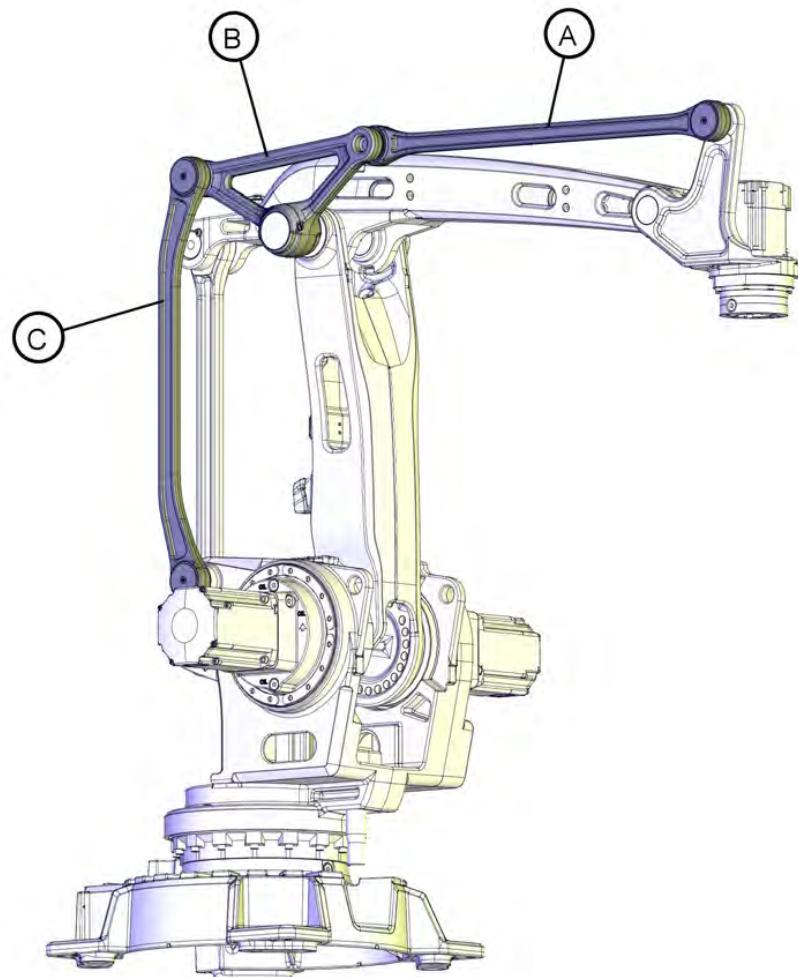
The linkage consist of three basic parts - *upper link arm*, *lower link arm* and *link*. This procedure describes how to remove and refit the link.

How to replace the upper and lower link arms see:

- [Replacing linkage - upper link arm on page 232](#)
- [Replacing linkage - lower link arm on page 240](#)

Location of link

The link is located as shown in the figure.



xx1100000167

- | | |
|---|----------------|
| A | Upper link arm |
| B | Link |
| C | Lower link arm |

Continues on next page

4 Repair

4.4.6 Replacing the linkage - link

Continued

Different versions of the sealing structure

Robots that are delivered from October 2012 and forward has a new sealing structure at the link that consists of a support ring, o-ring and radial sealing.

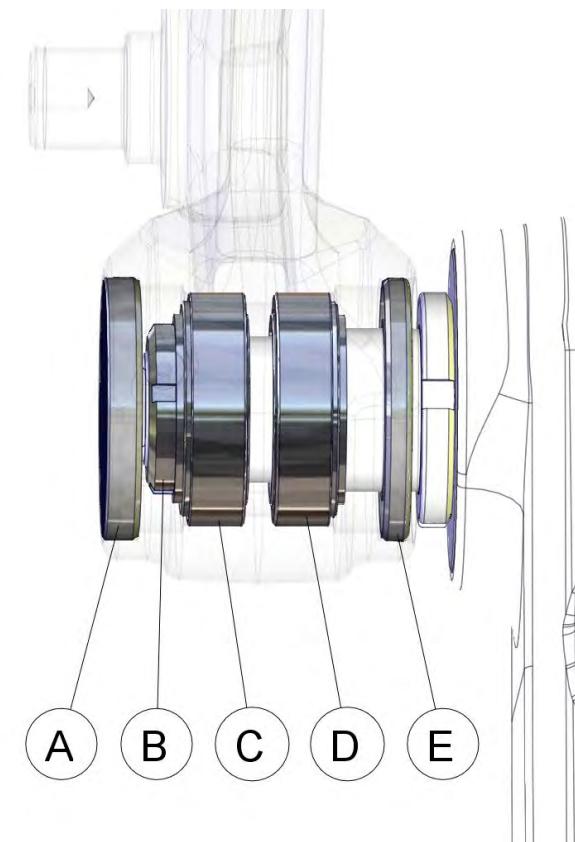
Robots delivered before October 2012 has a sealing structure that consists of a POM sealing, if not updated with the new sealing structure according to above.

The removal and refitting procedures describe both versions of sealing structures. The steps that differ are marked with information about which sealing structure the step is valid for.

X-ray view of the assembly of the link

The figure shows an X-ray view of the assembly of the link.

Design with POM sealing

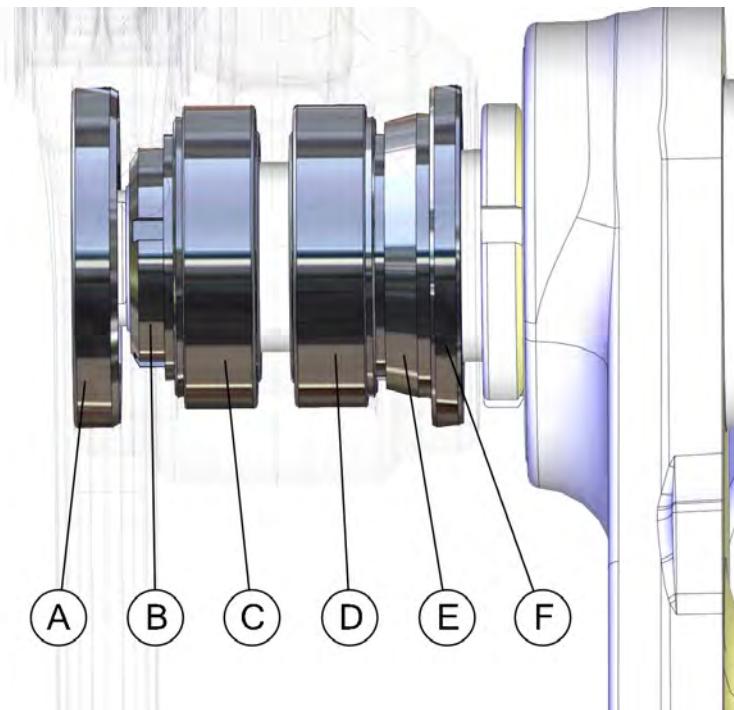


xx1100000212

A	VK cover
B	Lock nut
C	Bearing
D	Bearing
E	POM Sealing

Continues on next page

Design with support ring



xx1300000007

- | | |
|----------|--------------------------------|
| A | VK cover |
| B | Lock nut |
| C | Bearing |
| D | Bearing |
| E | Support ring, including o-ring |
| F | Radial sealing |

Required equipment

Equipment, etc.	Art. no.	Note
Link		For spare part number, see: • Spare parts on page 393
Bearing		Replace if damaged.
Radial sealing i		Replace if damaged.
Support ring i		Replace if damaged.
O-ring i		Replace if damaged.
Auxiliary shaft	3HAC040022-002	Used for bearings.
Press tool link (bearing outer races)	3HAC040030-001	Used to press the outer races of bearings in link.
Press tool support	3HAC040031-001	
Press tool, link	3HAC040022-001	Used to fit the link.
Socket KM 8	3HAC040024-001	
Bearing puller	-	Used to remove the link.

Continues on next page

4 Repair

4.4.6 Replacing the linkage - link

Continued

Equipment, etc.	Art. no.	Note
Locking liquid	3HAB7116-1	Loctite 243
Locking liquid ⁱ	12340011-116	Loctite 574
Grease	3HAB3537-1	
Standard toolkit		Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

ⁱ Valid for design with support ring.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

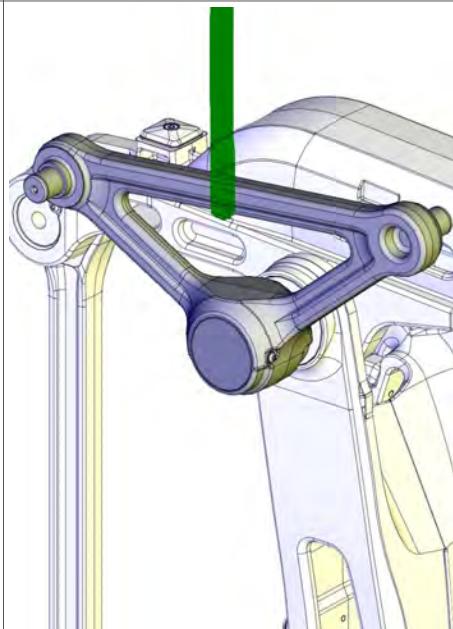
Removing the link

Use this procedure to remove the link.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

Continues on next page

4.4.6 Replacing the linkage - link Continued

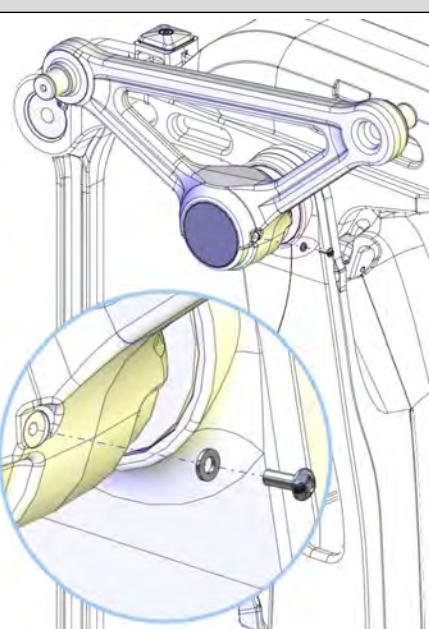
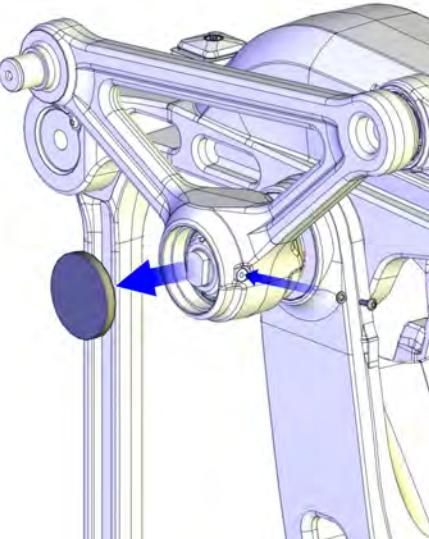
Action	Note
<p>2  DANGER Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.</p>	
<p>3 Secure the link with a <i>roundsling</i> in an overhead crane. Use the hole in the middle of the link.  CAUTION This is done to prevent the link from moving when the upper and lower link arms are removed which can cause an accident.</p>	 xx1100000173
<p>4 Remove <i>upper</i> and <i>lower</i> link arms.</p>	How to remove <i>upper</i> link arm see: • Replacing linkage - upper link arm on page 232 How to remove <i>lower</i> link arm see: • Replacing linkage - lower link arm on page 240

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4 Repair

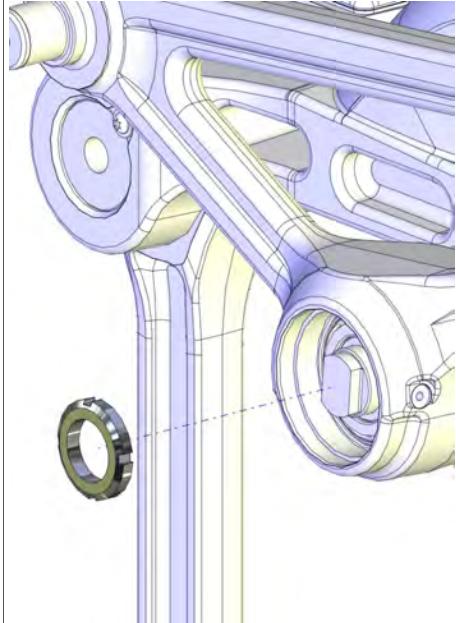
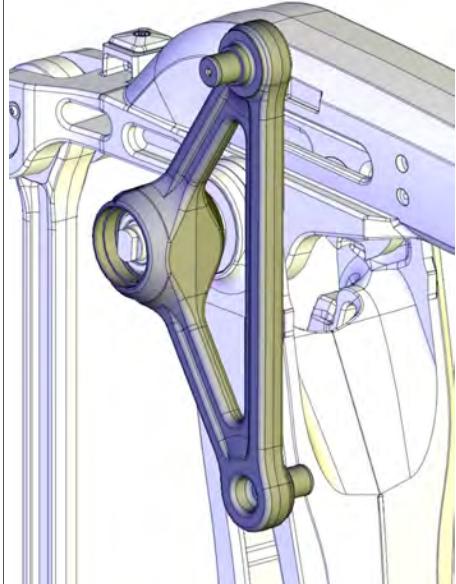
4.4.6 Replacing the linkage - link

Continued

Action	Note
5 Remove screw and washer in the hole for filling grease.	 xx1100000196
6 Use compressed air to remove the VK cover. Blow with a very low air pressure into the hole for filling grease. Put one hand with some paper on top of the VK cover in order to catch it when it is released.  CAUTION Only a very low air pressure is needed!	 xx1100000195

Continues on next page

4.4.6 Replacing the linkage - link Continued

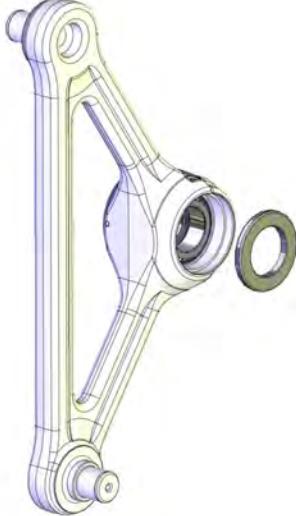
	Action	Note
7	Remove the <i>lock nut</i> (KM8).	 xx1100000197
8	Fit the <i>auxiliary shaft</i> on the shaft of the link.	
9	Put the end of the link which is facing the upper rod, downwards in order to find room to knock on it with a plastic mallet from the inside. Knock on the link as close as possible to its center. <p>Note</p> <p>Loosen the lifting force a little before start knocking. If not the link can be locked by the lifting power.</p>	Normally a not too hard knock is needed to loosen the link. If needed use a bearing puller to remove the link.  xx1100000198
10	Use a pair of levers or apply a <i>bearing puller</i> and bend the link loose.	
11	Remove the link.	

Continues on next page

4 Repair

4.4.6 Replacing the linkage - link

Continued

Action	Note
12 Remove the <i>POM sealing</i> or the <i>support ring</i> (depending on version of sealing structure).	 xx1100000199
13 Wipe off residual grease.	
14 Valid for design with support ring. Remove the radial sealing from the link, if the link is to be replaced with a new spare part. Replace the radial sealing, if damaged.	
15 If needed, replace bearings.	

Preparations - fitting outer races of the bearings in link

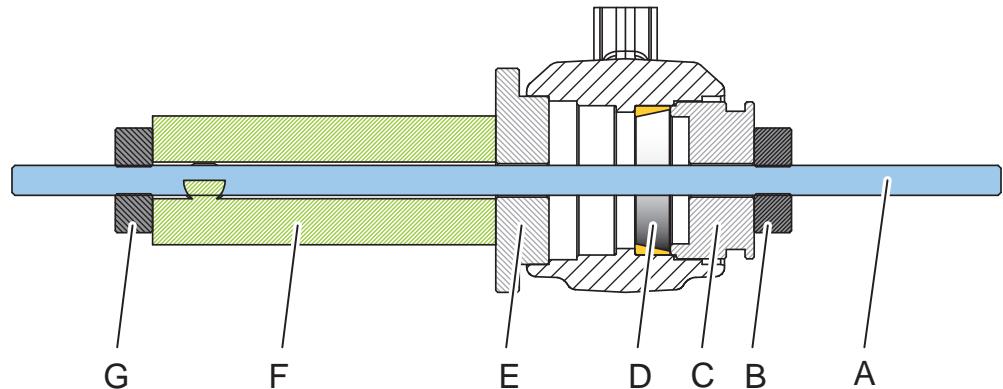
Use this procedure to fit the *outer races* of the bearings in the link. Fit the outer races one at a time using the *press tool* as shown in the figures. For art. no. see [Required equipment on page 249](#).

Continues on next page

4.4.6 Replacing the linkage - link Continued

The figure shows the *press tool* and its parts, placed in the link ready to start the pressing of the outer races of the bearings.

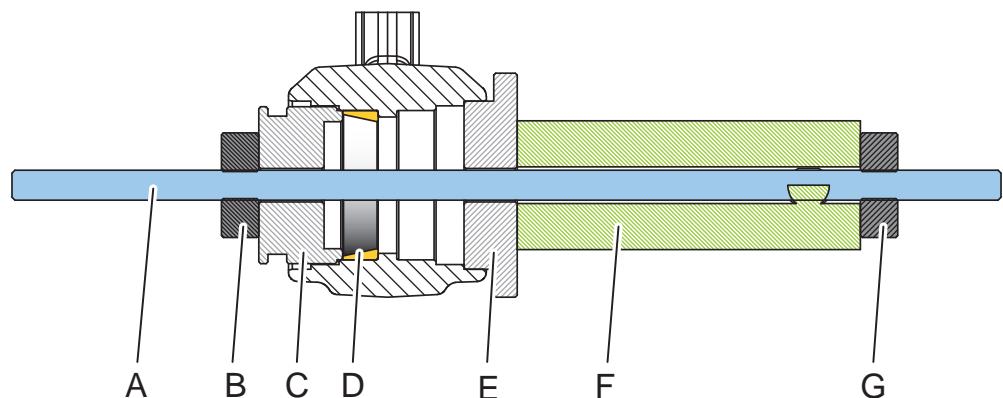
Pressing the outer race of the *inner bearing*



xx1100000210

- A** Threaded bar M16
- B** Stop nut
- C** Press tool link (bearing outer races)
- D** Outer race of the inner bearing in link
- E** Press tool support
- F** Hydralic cylinder
- G** Stop nut

Pressing the outer race of the *outer bearing*



xx1100000209

- A** Threaded bar M16
- B** Thread washer
- C** Press tool link (bearing outer races)
- D** Outer race of the outer bearing in link
- E** Press tool support
- F** Hydralic cylinder
- G** Thread washer

Continues on next page

4 Repair

4.4.6 Replacing the linkage - link

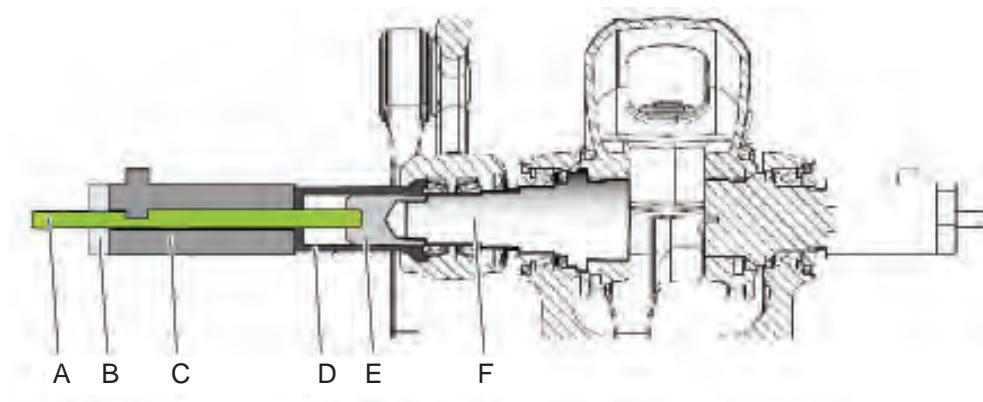
Continued

Action	Note
1 Put the <i>link</i> on a workbench.	
2 Apply one of the <i>outer race</i> of the bearings on the <i>pressing tool link</i> and press it in position. See figure above!	Art. no. is specified in Required equipment on page 249 Check that the parts and the tool are applied correctly, as shown in the figures above.
3 Apply the other <i>outer race</i> of the bearings on the <i>pressing tool link</i> and press it in position. See figure above!	Art. no. is specified in Required equipment on page 249 Check that the parts and the tool are applied correctly, as shown in the figures above.

Press tool link

The figure shows the *press tool link* fitted to a link with the POM sealing. The press tool is fitted in the same way to a link that has a support ring instead of a POM sealing.

For art. no. see [Required equipment on page 249](#).



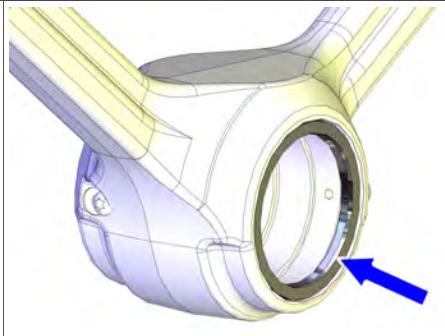
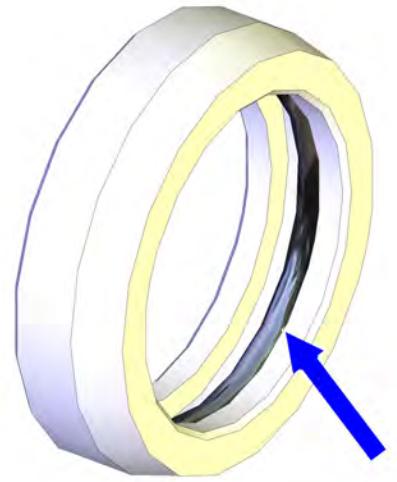
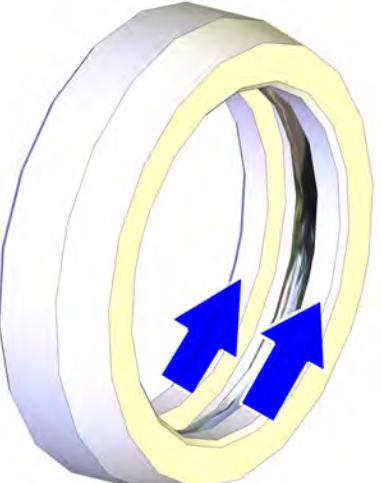
xx1100000211

- A Threaded bar M16
- B Thread washer
- C Hydraulic cylinder
- D Press bush
- E Auxiliary shaft
- F Shaft

Continues on next page

Refitting the link

Use this procedure to refit the link of the linkage.

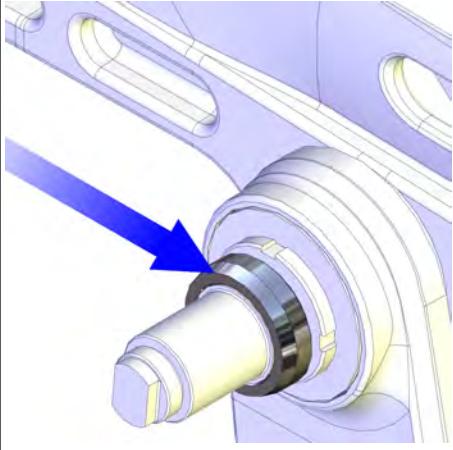
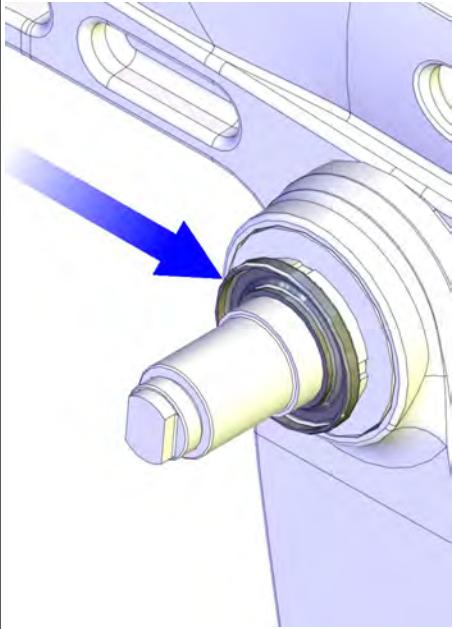
Action	Note
1 Valid for design with support ring. Place the radial sealing in the link.	 xx1300000006
2 Valid for design with support ring. Place the o-ring inside the groove of the support ring.	 xx1300000005
3 Valid for design with support ring. Apply locking liquid on the inner surface of the support ring.	Loctite 574  xx1300000008

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4 Repair

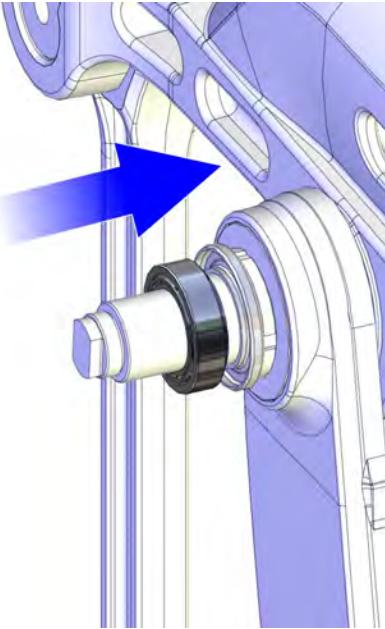
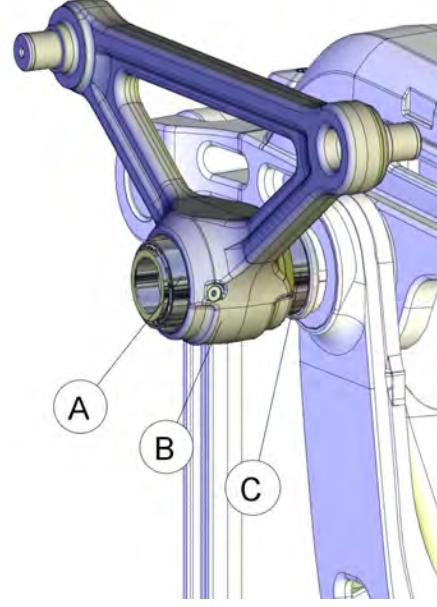
4.4.6 Replacing the linkage - link

Continued

	Action	Note
4	Valid for design with support ring. Fit the support ring with the included o-ring on the shaft. Use a plastic mallet, if necessary.  Note Align the chamfer side of the support ring with the shaft shoulder as shown in figure.	 xx1300000004
5	Valid for design with POM sealing. Place the <i>POM sealing</i> on the shaft.	 xx1100000200
6	Secure the link with a <i>roundsling</i> in an overhead crane and lift it to the mounting position.	
7	Fit the <i>auxiliary shaft</i> on the shaft.	Art.no. is specified in Required equipment on page 249

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4.4.6 Replacing the linkage - link Continued

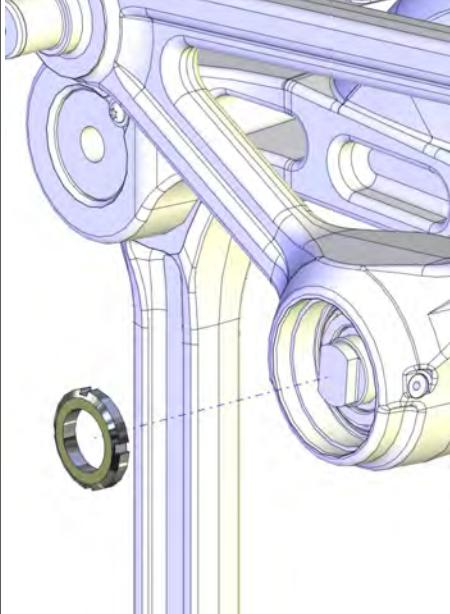
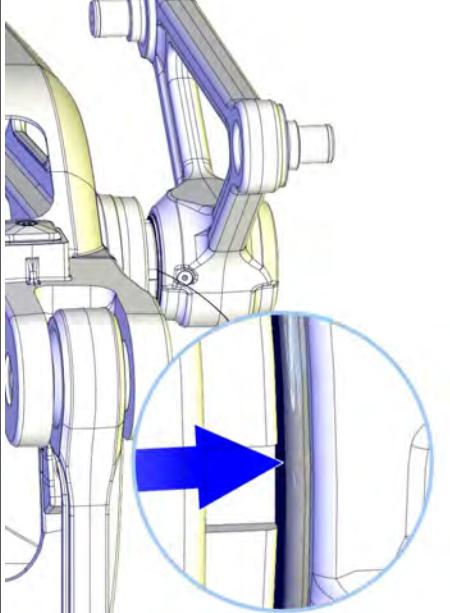
Action	Note
8 Place the <i>inner race</i> of the <i>inner bearing</i> on the shaft and press it in position using the <i>press tool link</i> .	<p>Art. no. is specified in Required equipment on page 249.</p>  <p>xx1100000201</p> <p>Auxiliary shaft not shown in this figure.</p>
9 Place the <i>inner race</i> of the <i>outer bearing</i> and <i>link</i> , in the following order on the shaft: <ul style="list-style-type: none"> • link • bearing 	 <p>xx1100000202</p> <p>Parts:</p> <ul style="list-style-type: none"> A: Inner race of outer bearing B: Link C: Inner bearing complete
10 Press the parts together with the <i>press tool link</i> .	Art.no. is specified in Required equipment on page 249 .

Continues on next page

4 Repair

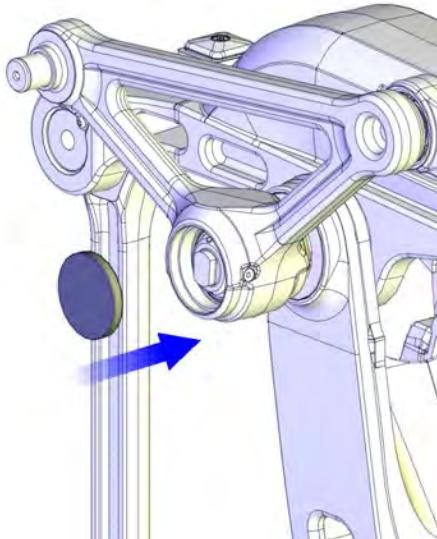
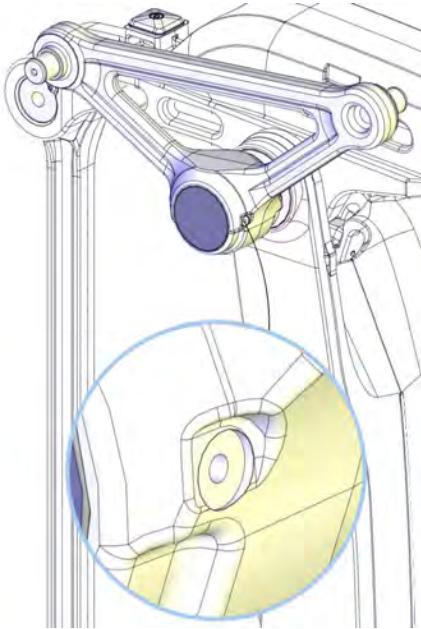
4.4.6 Replacing the linkage - link

Continued

Action	Note
11 Apply <i>locking liquid</i> on the <i>lock nut</i> .	 <p>Loctite 243 xx1100000197</p>
12 Secure the lock nut in these three steps: 1 Tighten with a torque of 300 Nm, while rotating the link at the same time. 2 Unscrew the lock nut 3 Tighten the lock nut finally with a tightening torque of 90 Nm.	<p> Note</p> <p>The recommended order of tightening the lock nut is important to follow to avoid future problems with the shaft.</p>
13 Valid for design with POM sealing. Use a screwdriver carefully to fit the POM sealing into its final position.	 <p>xx1100000204</p>

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4.4.6 Replacing the linkage - link Continued

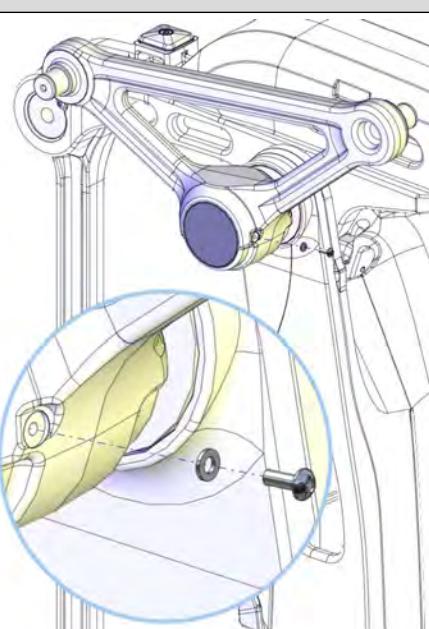
Action	Note
14 Refit the VK cover.	 xx1100000205
15 Fill the link with grease.	<p>Art.no. is specified in Required equipment on page 249</p>  xx1100000206

Continues on next page

4 Repair

4.4.6 Replacing the linkage - link

Continued

Action	Note
16 Refit the <i>screw and washer</i> in the hole for filling grease.	 xx1100000196
17 Refit the <i>upper link arm</i> .	See section Replacing linkage - upper link arm on page 232
18 Refit the <i>lower link arm</i> .	See section Replacing linkage - lower link arm on page 240
19 Recalibrate the robot!	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .
20  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

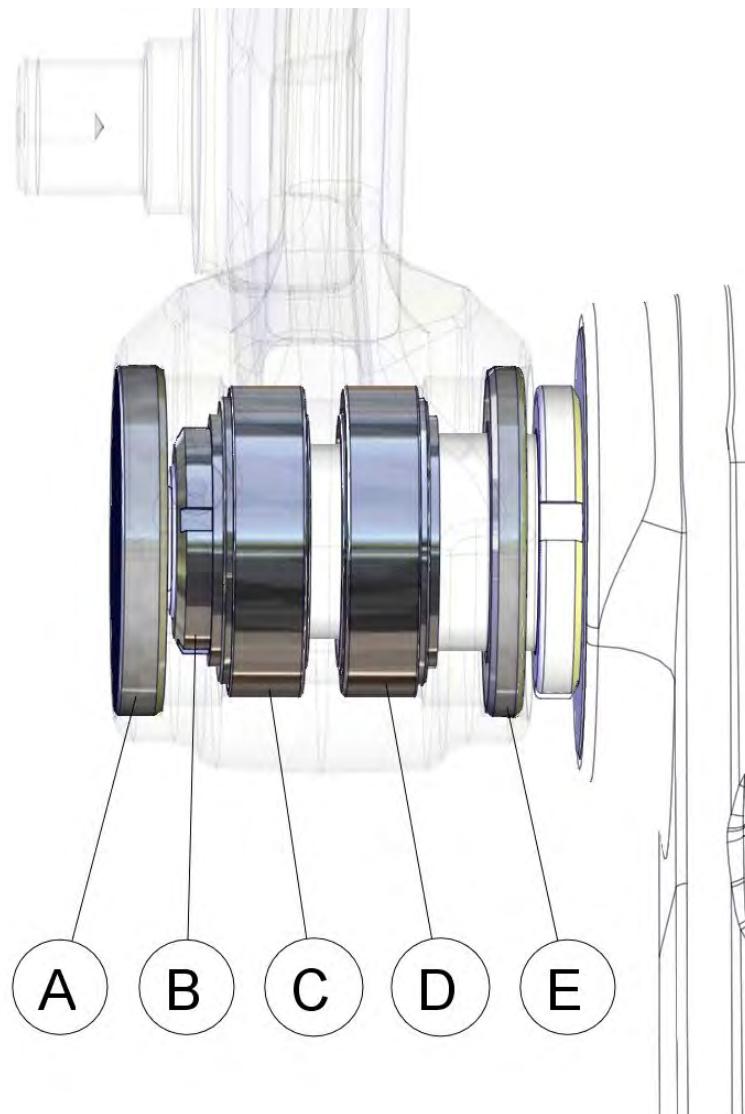
4.4.7 Replacing the POM sealing for the link system

Overview

The linkage consist of three basic parts - *upper link arm*, *lower link arm* and *link*. How to replace the POM sealing is described in the same section as how to replace the link, see [Replacing the linkage - link on page 247](#).

X-ray view of the assembly of the link

The figure shows a X-ray view of the assembly of the link.



xx1100000212

A	VK cover
B	Lock nut
C	Bearing
D	Bearing
E	POM Sealing

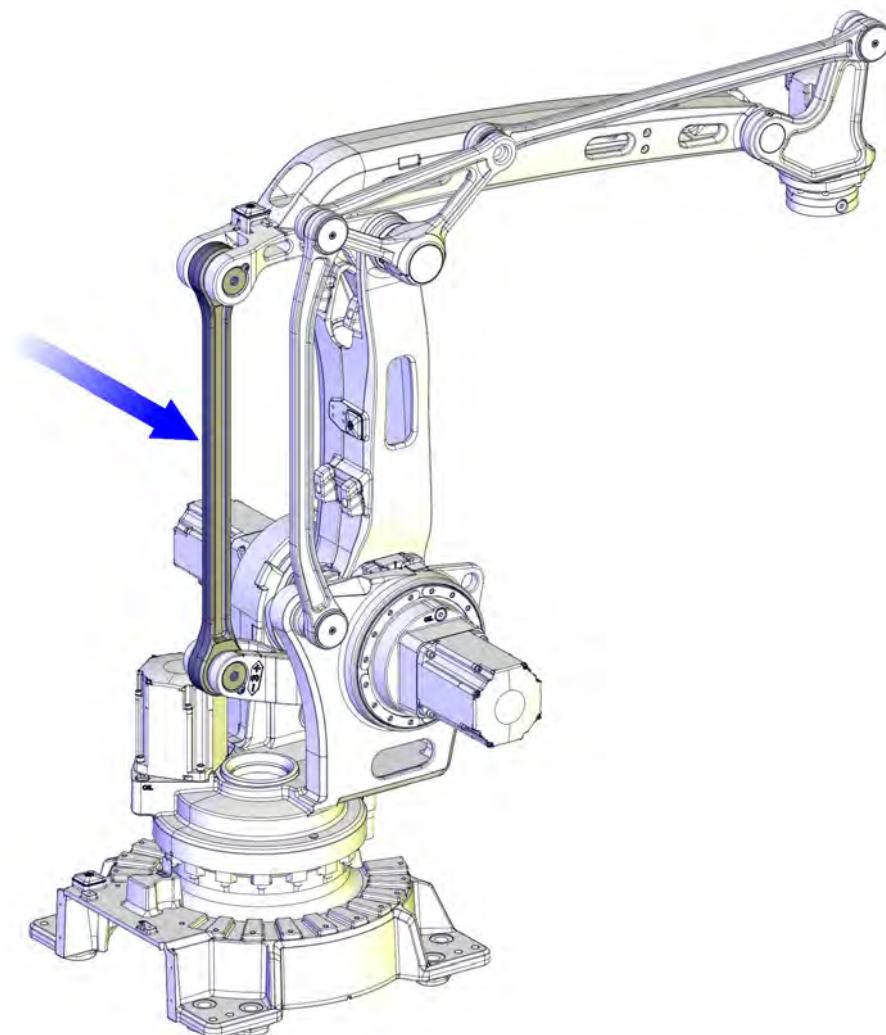
4 Repair

4.4.8 Replacing parallel rod

4.4.8 Replacing parallel rod

Location of the parallel rod

The parallel rod is located as shown in the figure.



xx1100000164

Required equipment

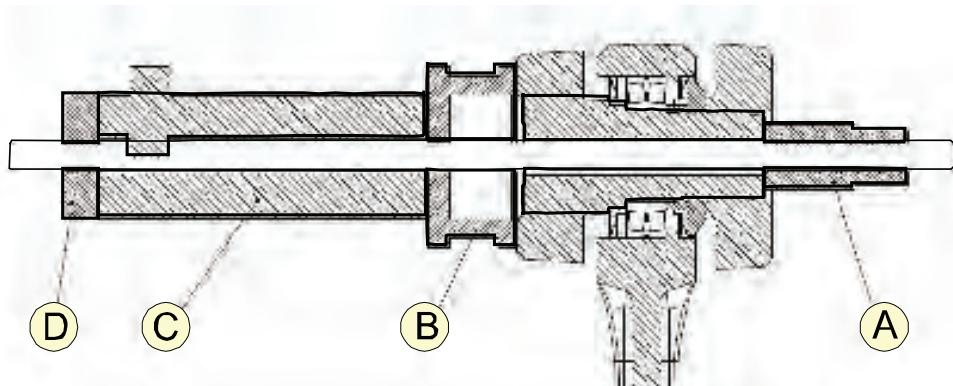
Equipment, etc.	Art.no.	Note
Parallel rod	For spare part no. see: • Spare parts on page 393	
Mounting/Demounting tool	3HAC040021-001	
Locking liquid	3HAB7116-1	Loctite 243
Standard toolkit	-	Content is defined in section Standard tools on page 387 .

Continues on next page

Equipment, etc.	Art.no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

How to apply the mounting/demounting tool for removal

This figure shows how to apply the mounting/demounting tool when removing the parallel rod. For art. no. see Required equipment.



xx1100000166

- A** Thread bush
- B** Support bush
- C** Hydraulic cylinder
- D** Thread washer

Removing the parallel rod

Use this procedure to remove the parallel rod. The procedure is the same in both ends.

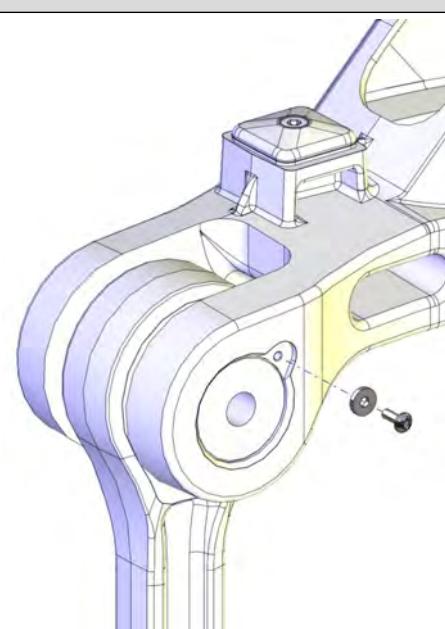
	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	 CAUTION In order to avoid accidents secure the upper arm with a <i>roundsling</i> in an overhead crane or similar.	

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4 Repair

4.4.8 Replacing parallel rod

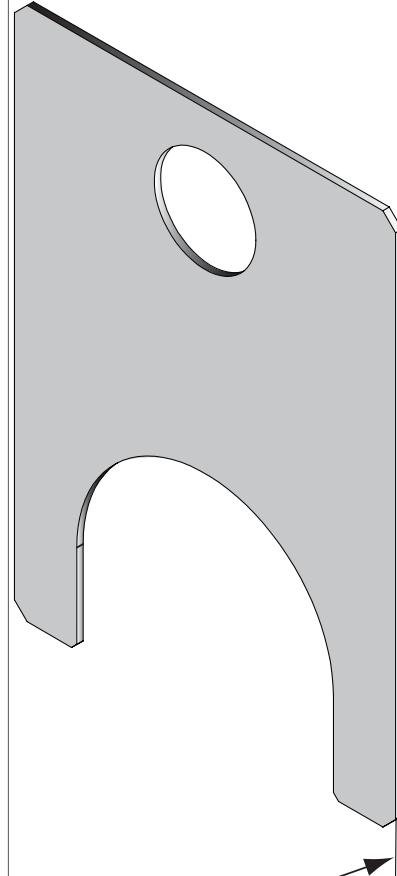
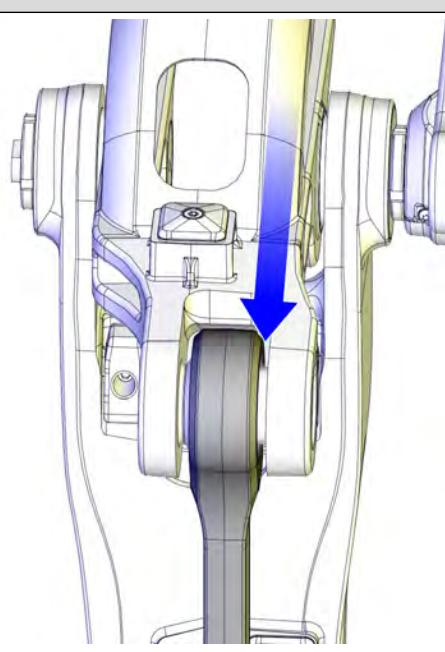
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Action	Note
3 Remove the <i>lock screw and washer</i> , securing the shaft of the parallel rod in position.	 xx1100000141

Continues on next page

4.4.8 Replacing parallel rod

Continued

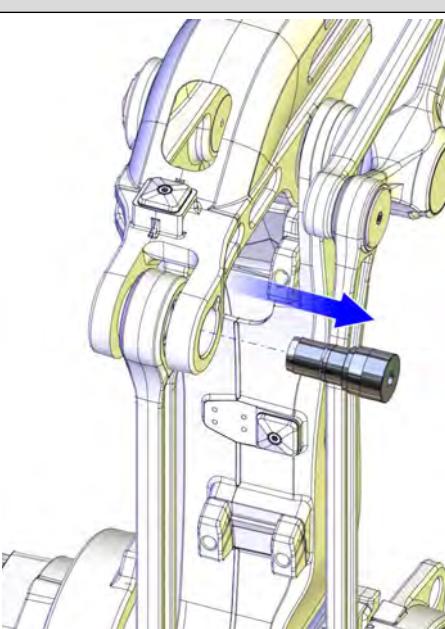
Action	Note
<p>4 Apply a <i>shims</i> ($T= 8 \text{ mm}$) on axis 3 side, as shown in the figure to the right.</p>  <p>xx1100000030</p> <p>A: Thickness = 8 mm.</p>	 <p>xx1100000142</p>
<p>5 Apply the <i>mounting/demounting</i> tool to the shaft.</p>	For art. no. see: <ul style="list-style-type: none"> • Required equipment on page 264

Continues on next page

4 Repair

4.4.8 Replacing parallel rod

Continued

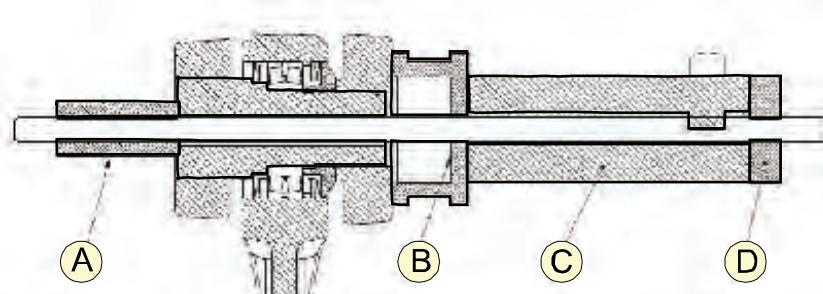
Action	Note
6 Remove the upper shaft.	 xx1100000144
7 Move the <i>parallel rod</i> backwards from its upper connection point and let it rest against the base.	 xx1100000146

Continues on next page

Action	Note
8 Remove the <i>thrust washer</i> with a <i>POM sealing</i> fitted on the axis 2 side.	 xx1100000145 <p>Parts:</p> <ul style="list-style-type: none"> A: Thrust washer B: Bearing C: POM sealing fitted on thrust washer (axis 2 side) D: POM sealing (axis 3 side)
9 Remove the <i>POM sealing</i> on the axis 3 side. See figure above!	
10 Remove the <i>lower end</i> of the parallel rod in the same way as the upper end	
11 Remove the parallel rod from the robot.	
12 Replace the <i>bearings</i> , if necessary.	

How to apply the mounting/demounting tool for refitting

This figure shows how to apply the mounting/demounting tool when refitting the parallel rod. For art. no. see Required equipment.



xx1100000165

- | | |
|---|--------------------|
| A | Thread bush |
| B | Support bush |
| C | Hydraulic cylinder |

Continues on next page

4 Repair

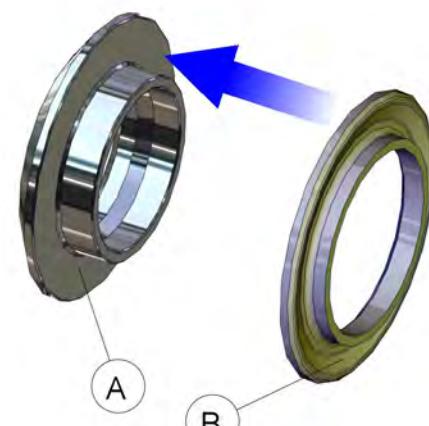
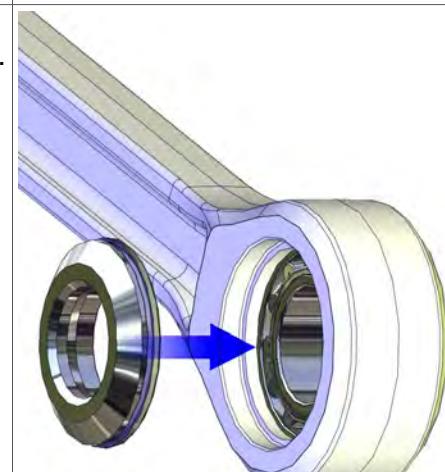
4.4.8 Replacing parallel rod

Continued

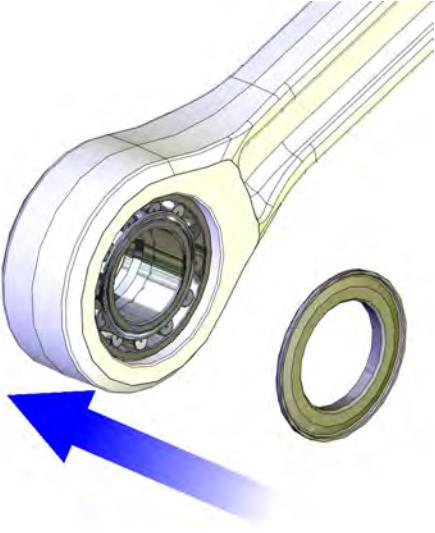
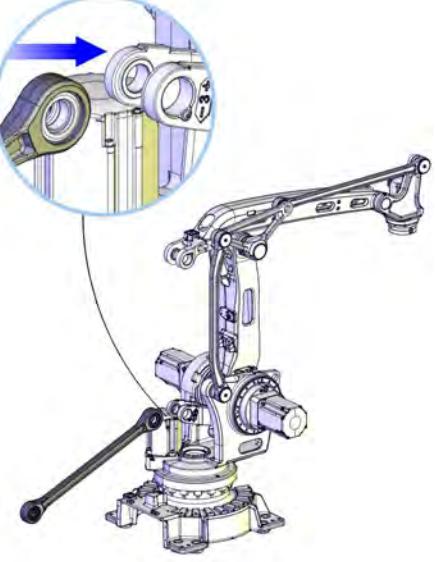
D Tread washer

Refitting the parallel rod

Use this procedure to refit the parallel rod. The procedure is the same in both ends.

Action	Note
1 Start refitting the lower end of the parallel rod.	
2 Make sure the bearings are in the correct position in the parallel rod.	
3 Fit a <i>POM sealing</i> on the <i>thrust washer</i> .	 <p>xx1100000148</p> <ul style="list-style-type: none">A: Thrust washerB: POM sealing
4 Put the <i>thrust washer</i> (with a POM sealing fitted) on the axis 2 side of the parallel rod.	 <p>xx1100000149</p>

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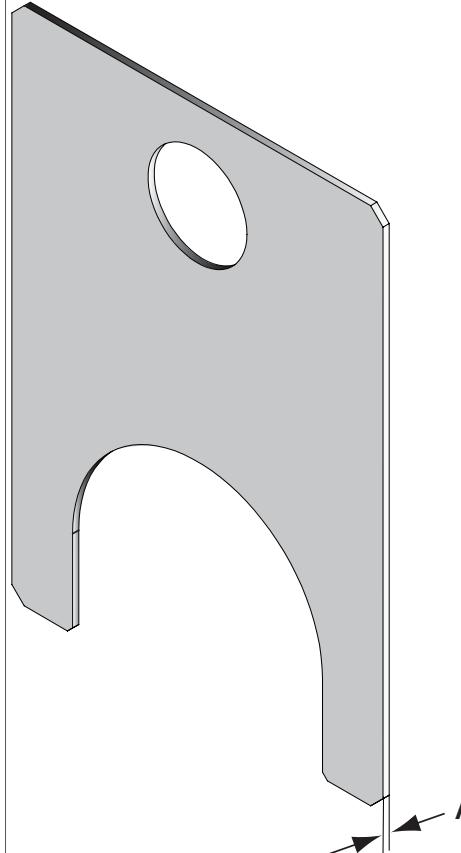
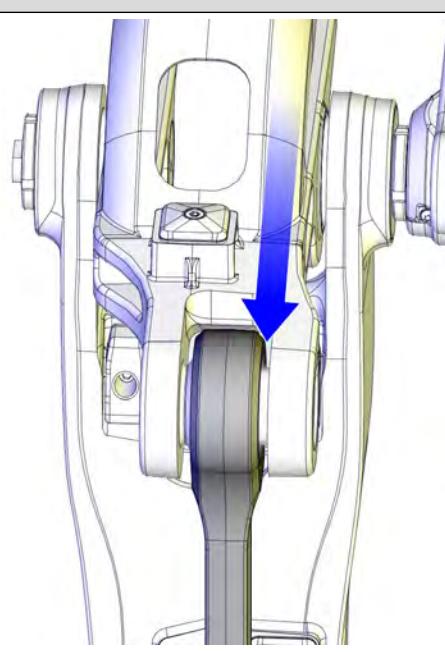
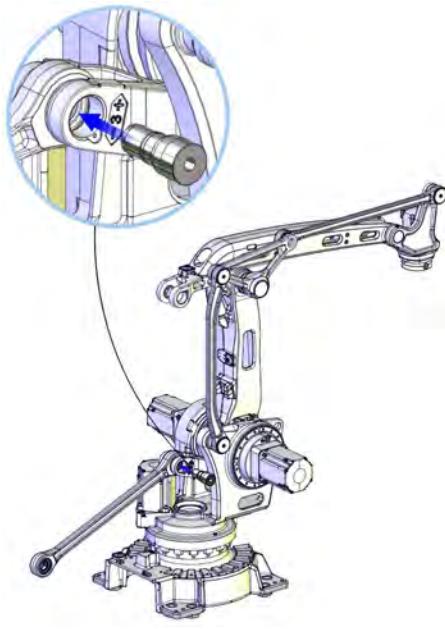
Action	Note
5 Place the other <i>POM sealing</i> on the axis 3 side.	 xx1100000151
6 Place the parallel rod in its mounting position in the lower end.	 xx1100000161

Continues on next page

4 Repair

4.4.8 Replacing parallel rod

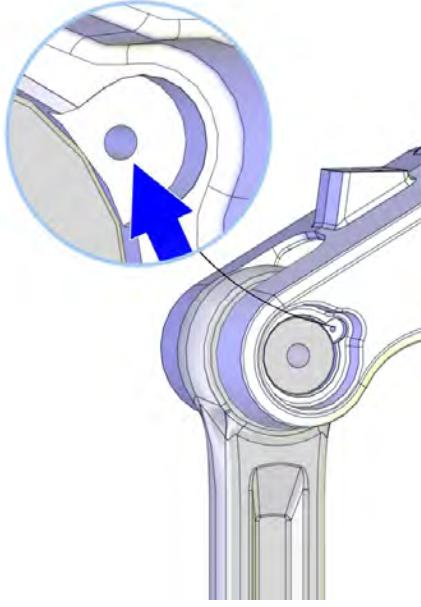
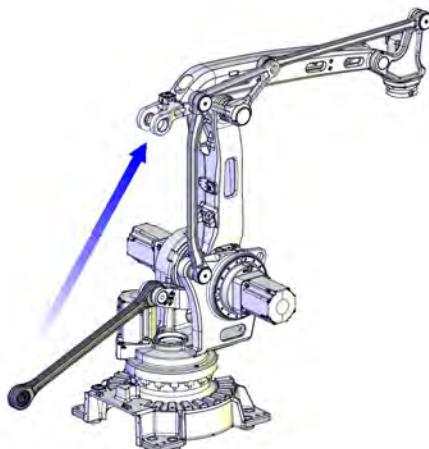
Continued

Action	Note
<p>7 Apply a shims ($T=8$ mm) on the axis 3 side, as shown in the figure to the right. Do not press the shims down too far.</p>  <p>xx1100000030 A = Thickness 8 mm</p>	 <p>xx1100000142</p>
<p>8 Refit the shaft using the <i>mounting/demounting tool</i>.</p>	 <p>xx1100000162</p>

Continues on next page

4.4.8 Replacing parallel rod

Continued

Action	Note
9 Apply <i>locking liquid</i> in the hole of the lock screw.	Loctite 243  xx1000001349
10 Refit the <i>lock screw</i> and plain washer.	Lock screw: M6x 16 Plain washer: 6.4x12x1.6
11 Lift the parallel rod up into position for fitting of the upper end.	 xx1100000163
12 Refit the <i>upper end</i> of the parallel rod in the same way.	

Continues on next page

4 Repair

4.4.8 Replacing parallel rod

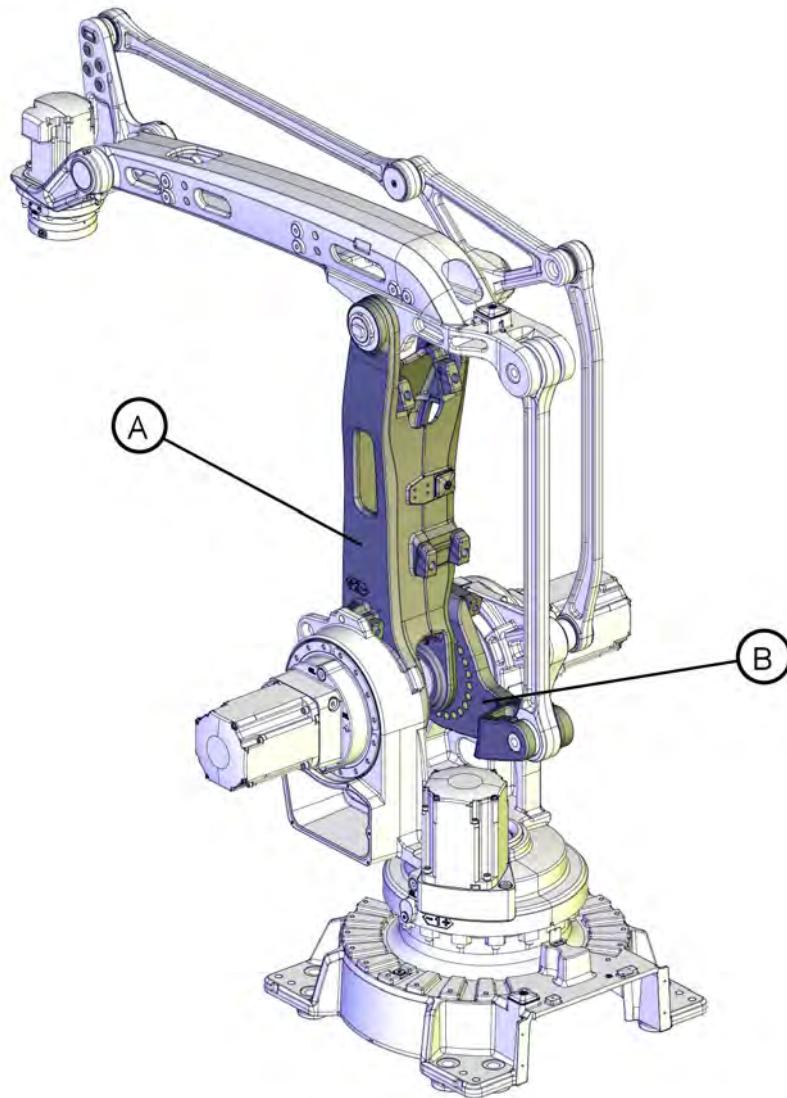
Continued

	Action	Note
13	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48.	

4.4.9 Replacing the complete lower arm system

4.4.9 Replacing the complete lower arm system**Location of lower arm system**

The complete lower arm system consist of *lower arm* and *parallel arm*. The lower arm system is located as shown in the figure.



xx1100000175

- | | |
|---|--------------|
| A | Lower arm |
| B | Parallel arm |

Required equipment

Equipment, etc.	Art.no.	Note
Lower arm	For art. no. see: • <i>Spare parts on page 393</i>	
Lock screw	-	M16x90

Continues on next page

4 Repair

4.4.9 Replacing the complete lower arm system

Continued

Equipment, etc.	Art.no.	Note
Rotation tool		
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See Circuit diagrams on page 395 .

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing the lower arm system

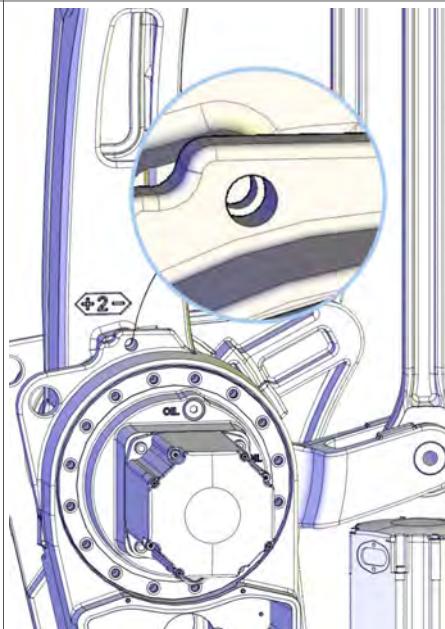
Use this procedure to remove the lower arm system.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

Continues on next page

4.4.9 Replacing the complete lower arm system

Continued

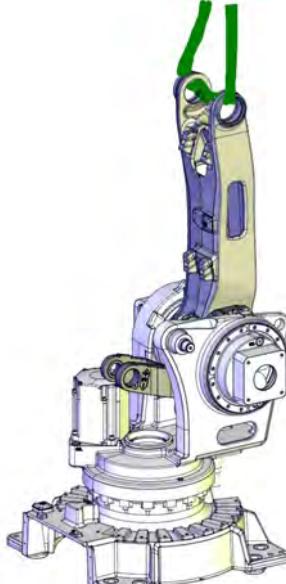
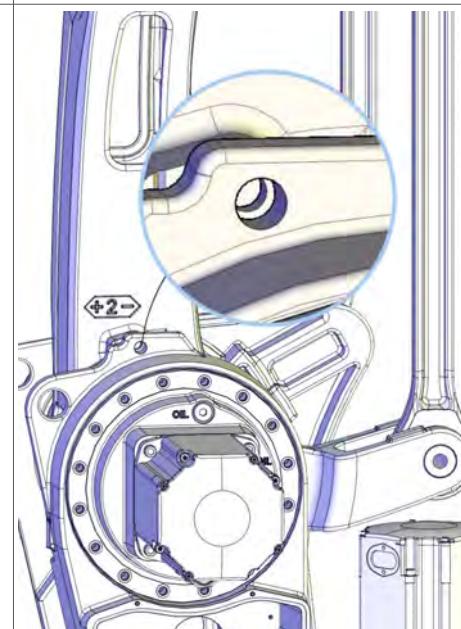
Action	Note
2  DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3 Secure the lower arm with a <i>lock screw M16x90</i> in the hole as shown in the figure.	 xx1000001179
4 Remove the <i>linkage</i> starting with upper link arm.	See sections: <ul style="list-style-type: none"> • Replacing linkage - upper link arm on page 232 • Replacing linkage - lower link arm on page 240 • Replacing the linkage - link on page 247
5 Remove the <i>parallel rod</i> .	See section Replacing parallel rod on page 264 .
6 Remove the <i>cable harness</i> in upper and lower arms. Secure the cable harness in a way that it is protected from getting damaged and from oil spill.	See sections: <ul style="list-style-type: none"> • Replacing cable harness, lower end (axes 1-3) on page 155 • Replacing the cable harness, upper end (incl. axis 6) on page 165
7 Remove the <i>complete upper arm</i> .	See section Replacing the upper arm on page 216 .
8 Remove the cover on <i>motors axes 2-3</i> and disconnect the motor cables. Motors are removed in order to be able to rotate lower and parallel arms.	See section Replacing motors, axes 2 and 3 on page 301 .

Continues on next page

4 Repair

4.4.9 Replacing the complete lower arm system

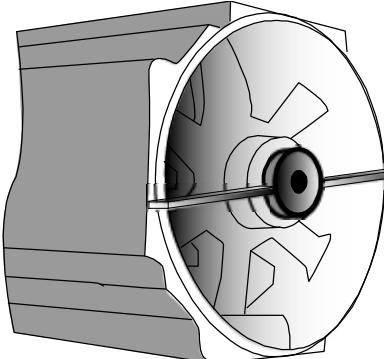
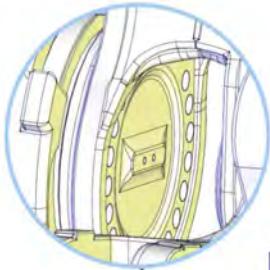
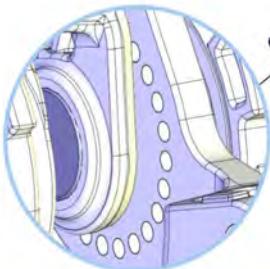
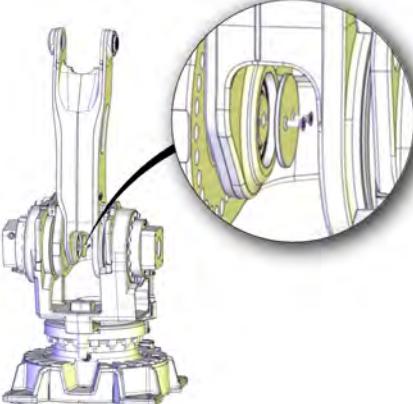
Continued

Action	Note
9 !	CAUTION The robot lower arm weighs 110 kg. All lifting accessories used must be sized accordingly!
10	Secure the <i>complete lower arm system</i> with a <i>roundsling</i> in an overhead crane or similar.
	 xx1100000179
11	Remove the <i>lock screw</i> securing the lower arm system.
	 xx1000001179
12	In order to release the brake, connect the <i>24VDC power supply</i> .
	Connect to connector R2.MP2 or R2.MP3 depending on which side: <ul style="list-style-type: none"> • + : pin 2 • - : pin 5

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4.4.9 Replacing the complete lower arm system

Continued

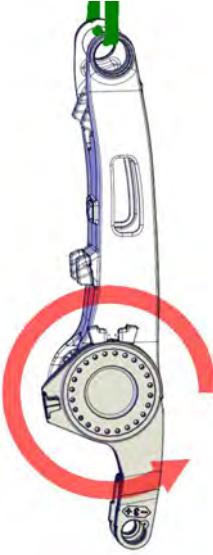
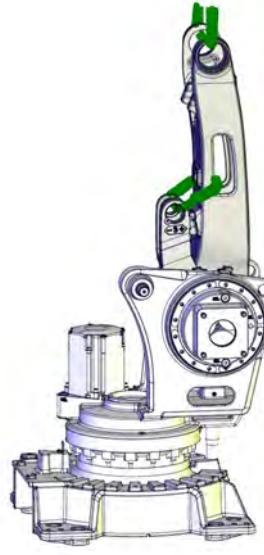
Action	Note
<p>13 Remove all <i>attachment screws (M12)</i> securing the lower arm system, on both sides.</p>  <p>xx0200000165</p> <p>A: Rotation tool</p> <p>Note</p> <p>The lower and parallel arms need to be rotated in order to reach all attachment screws. Release the brake and use a <i>rotation tool</i> fitted to the motor axis.</p>	  <p>xx1100000180</p>
<p>14 Remove the two screws, and remove the <i>sealing cover</i>.</p>	 <p>xx1100000181</p>
<p>15 The space between gearboxes is cramp. Therefore push the lower and parallel arms together with the help of an iron bar or similar before removing them.</p>	<p>Note</p> <p>If the parts are not pushed together, it will be difficult to remove the complete lower arm.</p>

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4 Repair

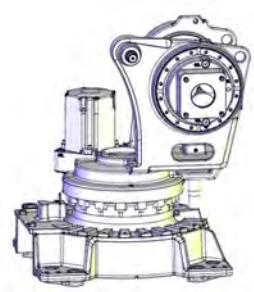
4.4.9 Replacing the complete lower arm system

Continued

	Action	Note
16	 DANGER Before removing the lower arm system the parallel arm must be secured to the lower arm. If not secured the parallel arm can fall down and cause a serious accident!	 xx1100000182
17	Move the parallel arm and secure it to the lower arm as shown in the figure, to prevent it from falling down.	 xx1100000178

Continues on next page

4.4.9 Replacing the complete lower arm system
Continued

Action	Note
18 Remove the <i>complete lower arm system</i> .	  xx1100000183
19 How to remove the <i>parallel arm</i> is described in section Replacing the parallel arm on page 285 .	

Refitting the lower arm system

Use this procedure to refit the lower arm system.

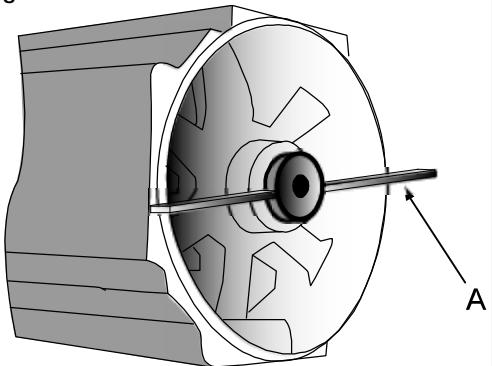
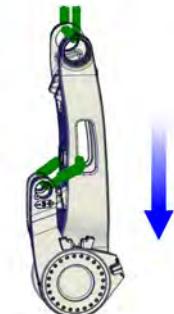
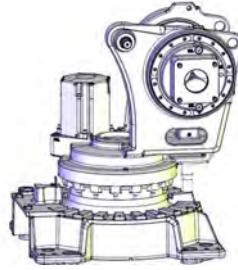
Action	Note
1 Fit the <i>parallel arm</i> to the lower arm.	See section <ul style="list-style-type: none"> • Replacing the parallel arm on page 285
2  CAUTION The robot lower arm weighs 110 kg. All lifting accessories used must be sized accordingly!	

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4 Repair

4.4.9 Replacing the complete lower arm system

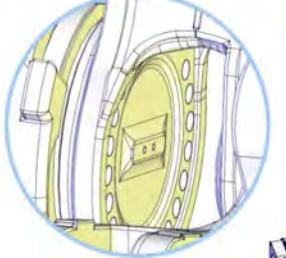
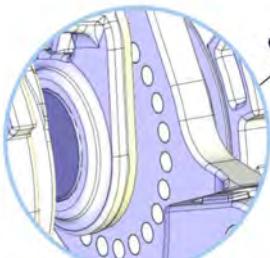
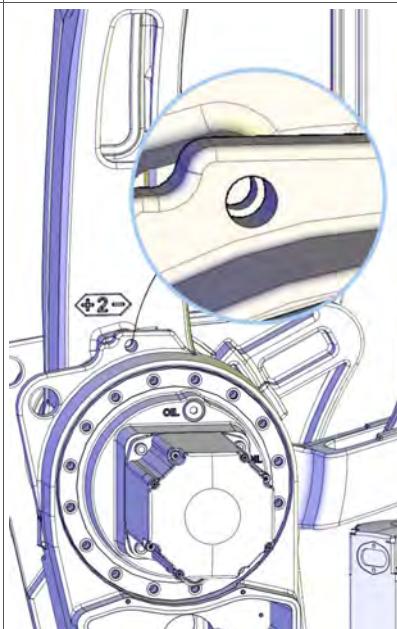
Continued

Action	Note
3 Fit a roundsling, to the lower arm system and lift it up.  DANGER Secure the parallel arm to the lower arm before lifting the lower arm system. If not secured, the parallel arm can fall down and cause a serious accident!	 xx1100000184
4 In order to release the brake, connect the 24VDC power supply.	Connect to connector R2.MP2 or R2.MP3 depending on which side: <ul style="list-style-type: none"> • + : pin 2 • - : pin 5
5 Place the lower arm system in its mounting position. If the hole pattern need to be adjusted, release the brake and use a <i>rotation tool</i> to find the correct hole pattern by moving the gears.  xx0200000165 A: Rotation tool	For art. no. see: <ul style="list-style-type: none"> • Required equipment on page 275   xx1100000185
6  Note Refit the axis 2 side first!	

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4.4.9 Replacing the complete lower arm system

Continued

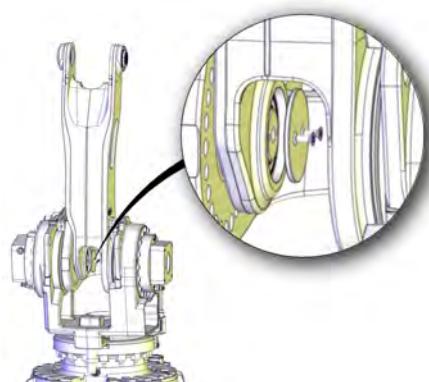
Action	Note
7 Refit all <i>M12 attachment screws</i> with washers on the <i>axis 2 side</i> that are possible to fit at this stage.	Tightening torque M12: 120 Nm   xx1100000180
8 Push the parallel arm against the axis 3 side with the help of an iron bar or similar.	
9 Refit all <i>M12 attachment screws</i> with washers on the <i>axis 3 side</i> that are possible to fit. See figure above!	Tightening torque M12: 120 Nm
10 Change the position of the lower arm in order to reach the remaining attachment holes, and fit the remaining screws.	
11 Secure the lower arm by fitting a <i>lock screw M16x90</i> .	 xx1000001179

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4 Repair

4.4.9 Replacing the complete lower arm system

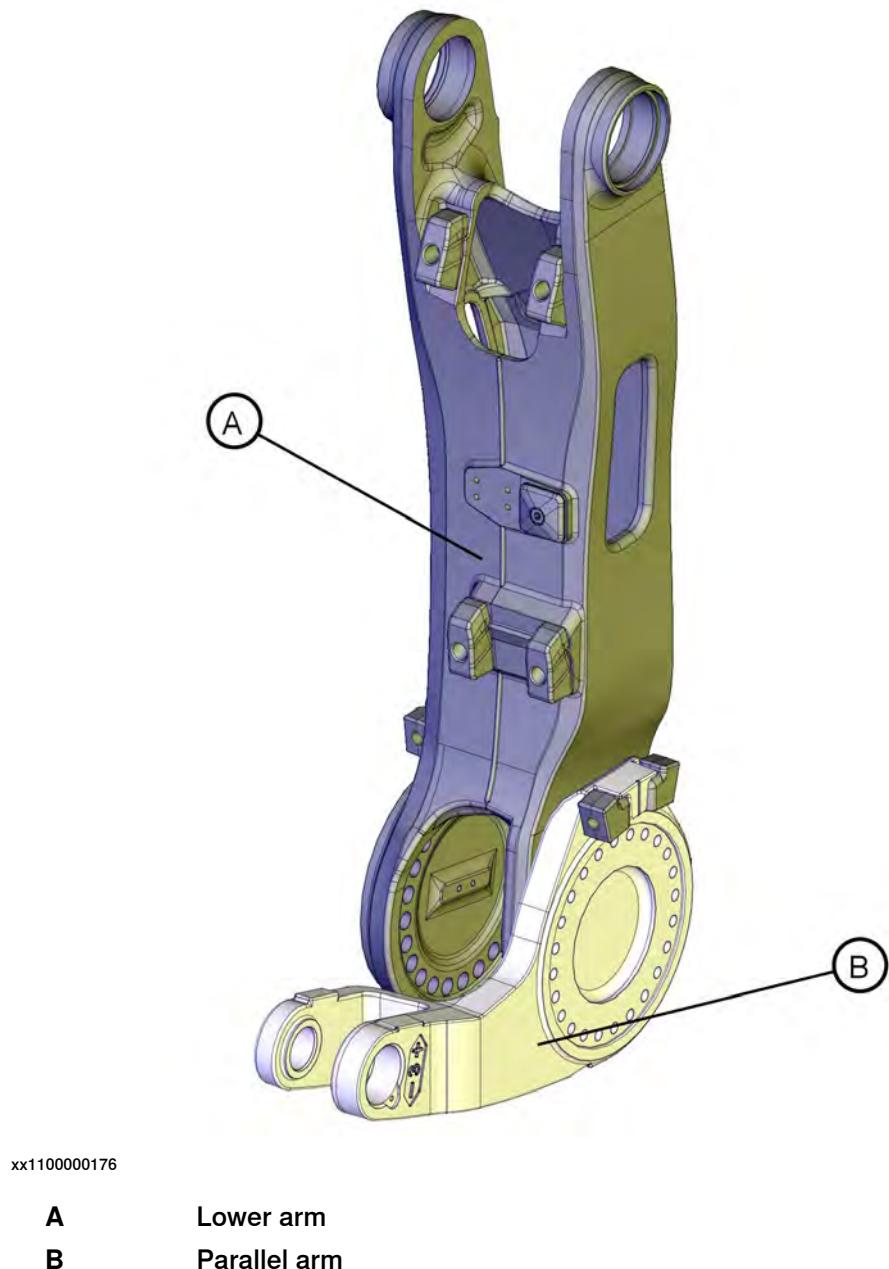
Continued

Action	Note
12 Refit the <i>sealing cover</i> , and secure with the two screws.	 xx1100000181
13 Reconnect the <i>motor cables</i> axes 2-3 and refit the cover.	See section Replacing motors, axes 2 and 3 on page 301 .
14 Refit the <i>complete upper arm</i> .	See section Replacing the upper arm on page 216 .
15 Refit the <i>cable harness</i> in the upper arm and lower arms.	See Replacing the cable harness, upper end (incl. axis 6) on page 165 and Replacing cable harness, lower end (axes 1-3) on page 155 .
16 Refit the <i>parallel rod</i> .	See section Replacing parallel rod on page 264
17 Refit the <i>linkage</i> starting with the link.	See sections: <ul style="list-style-type: none">• Replacing the linkage - link on page 247• Replacing linkage - lower link arm on page 240• Replacing linkage - upper link arm on page 232
18 Remove the <i>lock screw</i> .	
19 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .
20  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

4.4.10 Replacing the parallel arm

Location of parallel arm

The parallel arm is located as shown in the figure.



Required equipment

Equipment, etc.	Art.no.	Note
Parallel arm	For spare part no. see: • Spare parts on page 393	
Bearing grease	3HAB3537-1	

Continues on next page

4 Repair

4.4.10 Replacing the parallel arm

Continued

Equipment, etc.	Art.no.	Note
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

Action	Note
1 Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing the parallel arm

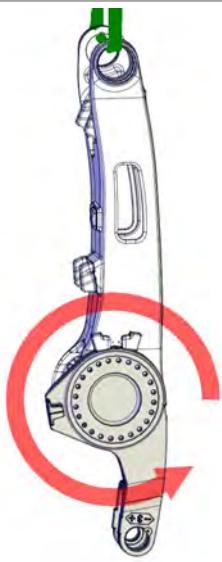
Use this procedure to remove the parallel arm.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Remove the <i>complete lower arm system</i> from the robot.	See section Replacing the complete lower arm system on page 275 .

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4.4.10 Replacing the parallel arm

Continued

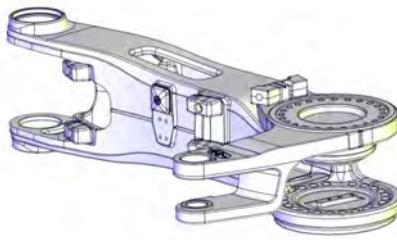
Action	Note
<p>3  DANGER Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.</p>	
<p>4  DANGER Secure the parallel arm to the lower arm before lifting the lower arm system. If not secured, the parallel arm can fall down and cause a serious accident!</p>	 xx1100000182
<p>5  CAUTION The robot lower arm weighs 110 kg. All lifting accessories used must be sized accordingly!</p>	

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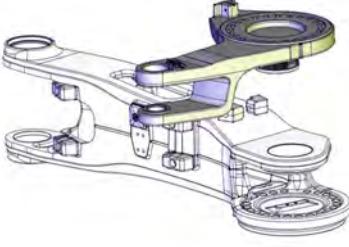
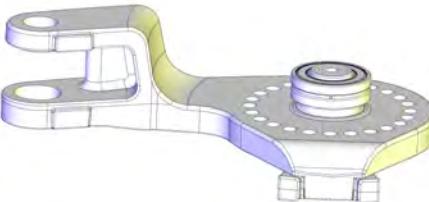
4 Repair

4.4.10 Replacing the parallel arm

Continued

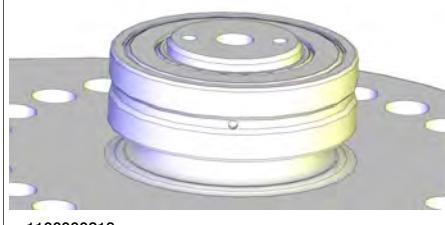
Action	Note
6 Secure the <i>lower arm system</i> as shown in the figure.	 xx1100000184
7 Put the lower arm system on a workbench as shown in the figure.  Tip Removal of the parallel arm is best performed on a workbench.	 xx1100000186
8  CAUTION The parallel arm system weighs 40 kg. All lifting accessories used must be sized accordingly!	
9 Secure the <i>parallel arm</i> with a roundsling in an overhead crane.	

Continues on next page

Action	Note
10 Remove the parallel arm from the lower arm by lifting it straight up.  Tip If needed use a plastic mallet and hit the parallel arm from inside.	 xx1100000187
11 Turn the <i>parallel arm</i> over and put it on a workbench or similar, as shown in the figure.	 xx1100000189
12 If needed, replace bearings.	

Refitting the parallel arm

Use this procedure to refit the parallel arm.

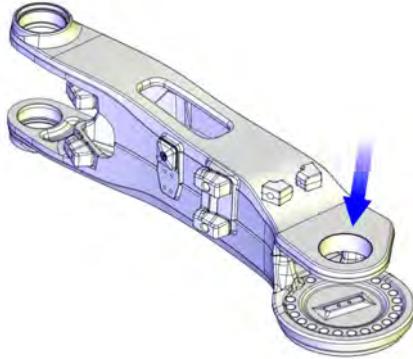
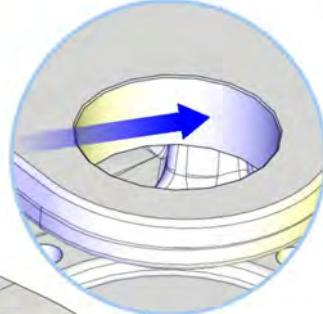
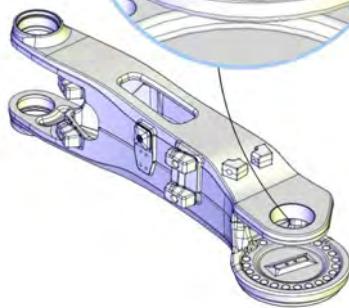
Action	Note
1 Refitting the parallel arm is best performed on a workbench.	
2 Check that the assembly and the condition of the <i>bearing</i> is good. If not, replace damaged parts.	 xx1100000218

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4 Repair

4.4.10 Replacing the parallel arm

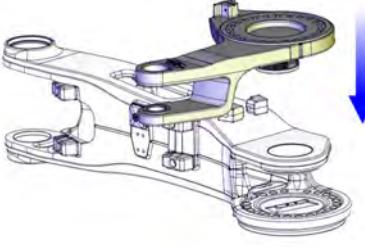
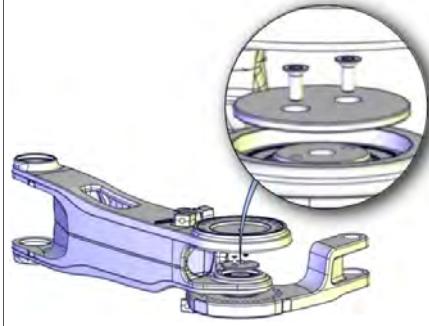
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Action	Note
3 Check that the lower arm is placed on the workbench as shown in the figure with the hole for the bearing pointing up.	 xx1100000193
4 Apply some grease in the hole for the bearing.	Art. no. is specified in Required equipment on page 285   xx1100000192
5  CAUTION The parallel arm system weighs 40 kg. All lifting accessories used must be sized accordingly!	
6 Lift the <i>parallel arm</i> to where the lower arm is placed.	

Continues on next page

4.4.10 Replacing the parallel arm

Continued

Action	Note
<p>7 Push the <i>parallel arm</i> with bearing fitted, onto the lower arm.</p> <p> Tip</p> <p>Use a plastic mallet if needed. Knock on the casting surface of the parallel arm.</p>	 xx1100000194
<p>8 Refit the <i>sealing cover</i>, and secure with two screws.</p>	 xx1400000070
<p>9 Refit the <i>complete lower arm system</i>.</p>	<p>See section Replacing the complete lower arm system on page 275.</p>
<p>10 Recalibrate the robot.</p>	<p>Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i>, enclosed with the calibration tools.</p> <p>Axis Calibration is described in Calibrating with Axis Calibration method on page 364.</p> <p>General calibration information is included in section Calibration on page 353.</p>
<p>11  DANGER</p> <p>Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48.</p>	

4 Repair

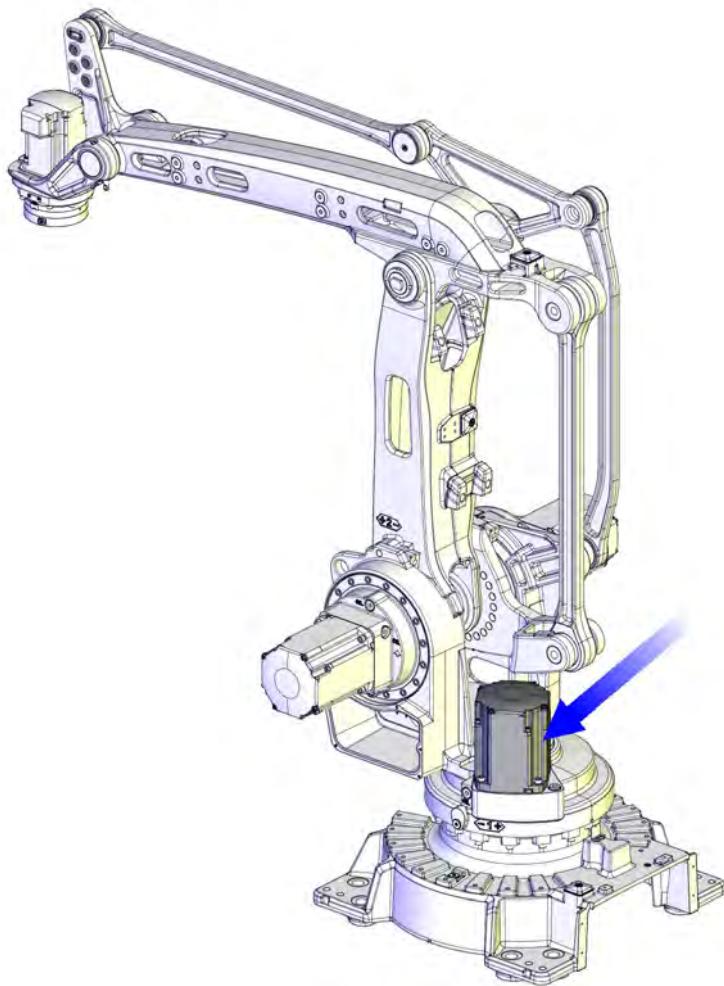
4.5.1 Replacing motor, axis 1

4.5 Motors

4.5.1 Replacing motor, axis 1

Location of motor axis 1

The motor axis 1 is located on the left hand side of the robot as shown in the figure.



xx1000001171

Continues on next page

Required equipment

Equipment, etc	Art.no.	Note
Motor axis 1	For spare part number, see: • Spare parts on page 393	Includes: <ul style="list-style-type: none">• motor• pinion• o-ring (The old o-ring must be replaced when replacing the motor)
Screw	-	M12x100 fully, threaded
Grease	3HAB3537-1	Used to lubricate the o-ring
Bits extension	3HAC023760-001	Used to reach the attachment screws for the motor.
Power supply	-	24 VDC, max. 1,5 A For releasing the brakes.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter Circuit diagrams on page 395 .

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	<p>Decide which calibration routine to use for calibrating the robot.</p> <ul style="list-style-type: none"> • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot. 	
	<p>If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.</p>	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .

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4 Repair

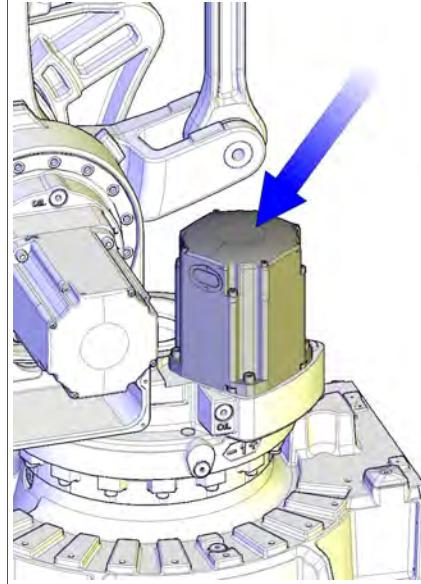
4.5.1 Replacing motor, axis 1

Continued

Action	Note
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing motor axis 1

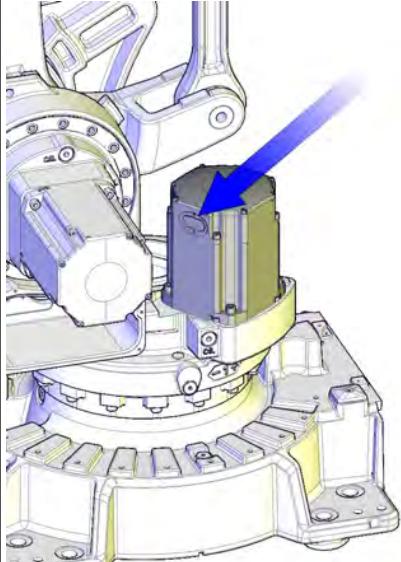
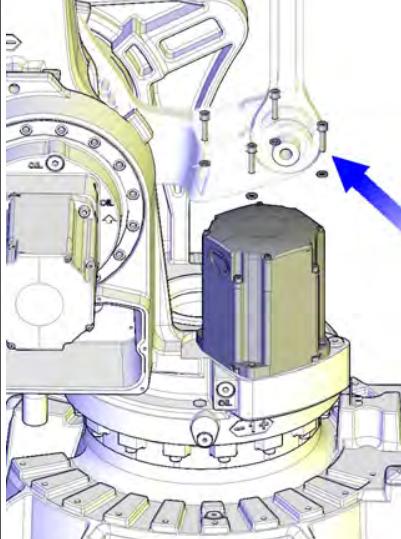
Use this procedure to remove motor axis 1.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
3 Remove the <i>motor cover</i> to get access to the connectors on top of the motor.	

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4.5.1 Replacing motor, axis 1

Continued

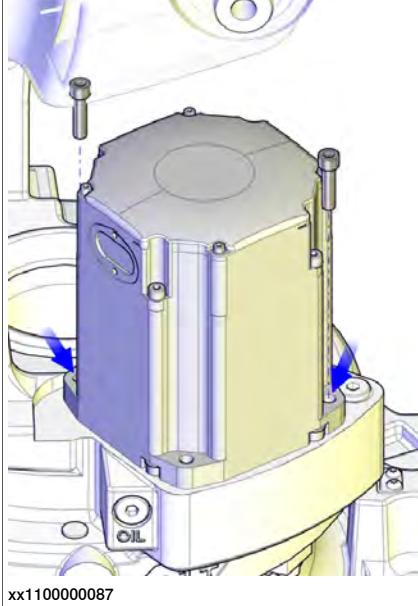
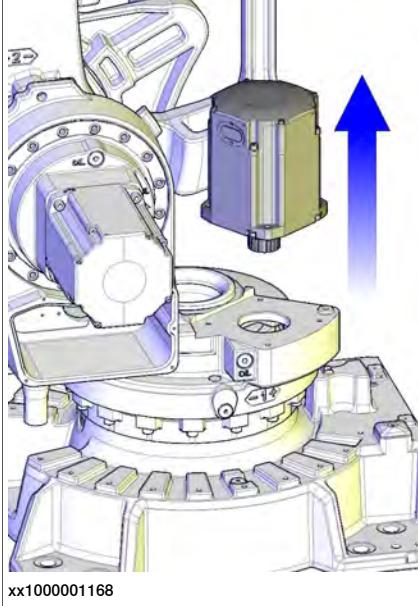
Action	Note
4 Remove the <i>cable gland cover</i> at the cable exit of the motor.	 Note Make sure the gasket is undamaged! Replace if damaged.  xx1000001166
5 Disconnect all connectors beneath the motor cover.	
6 In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP1 <ul style="list-style-type: none"> • + : pin 2 • - : pin 5
7 Remove the <i>attachment screws</i> of the motor. Use the bits extension.	 xx1000001167

Continues on next page

4 Repair

4.5.1 Replacing motor, axis 1

Continued

Action	Note
8 If required, press the motor out of position by fitting two screws in the holes on the motor for pressing out the motor.	Always use removal screws and tools in pairs! M12x100, fully threaded 
9  CAUTION The motor weighs 29 kg. All lifting accessories used must be sized accordingly!	
10 Remove the motor by carefully lifting it straight up to get the pinion away from gear.  CAUTION Be careful not to damage the pinion in the process!	
11 Disconnect the brake release voltage.	
12 Check the pinion. If there is any damage, the pinion must be replaced.	

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Refitting motor axis 1

Use this procedure to refit motor axis 1.

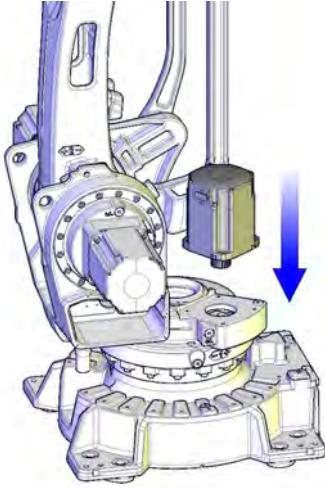
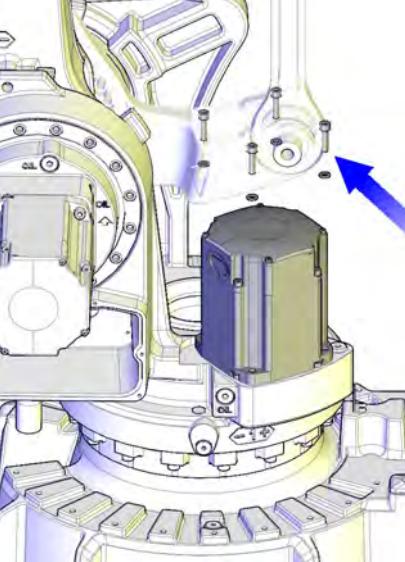
Action	Note
<p>1 Make sure the <i>o-ring</i> on the <i>circumference</i> of the motor is seated properly. Lightly lubricate the <i>o-ring</i> with <i>grease</i>.</p>	<p>xx1000001096</p> <p>Parts:</p> <ul style="list-style-type: none"> A Circumference of motor B O-ring <p> Note</p> <p>The o-ring must be replaced when replacing the motor.</p>
<p>2 CAUTION</p> <p>The motor weighs 29 kg. All lifting accessories used must be sized accordingly!</p>	
<p>3 In order to release the brake, connect the 24 VDC power supply.</p>	<p>Connect to connector R2.MP1</p> <ul style="list-style-type: none"> • + : pin 2 • - : pin 5

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4 Repair

4.5.1 Replacing motor, axis 1

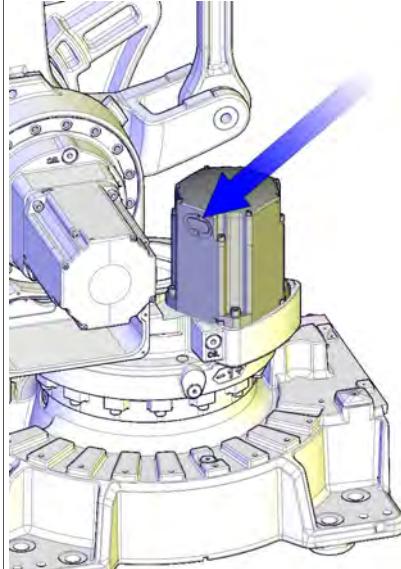
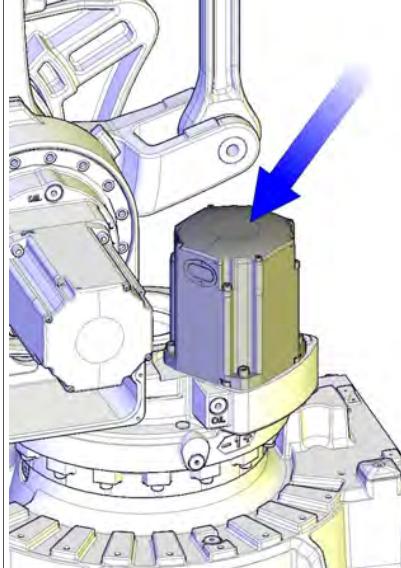
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Action	Note
<p>4 Gently lower the <i>motor</i> into the gear, making sure the <i>pinion</i> is properly mated to the gearbox of axis 1.</p> <p> Note Make sure the motor is turned the right way. See figure.</p> <p> Note Make sure the motor pinion does not get damaged!</p>	 xx1000001169
<p>5 Secure the motor with its four <i>attachment screws</i> and <i>plain washers</i>. Use the bits extension.</p>	 xx1000001167 Attachment screws: <ul style="list-style-type: none"> M10x40 quality 12.9 Gleitmo Tightening torque: <ul style="list-style-type: none"> 50 Nm
6 Disconnect the brake release voltage.	
7 Reconnect all connectors beneath the motor cover.	

Continues on next page

4.5.1 Replacing motor, axis 1

Continued

Action	Note
8 Refit the <i>cable gland cover</i> at the cable exit with its attachment screws.	 Note Make sure the cover is tightly sealed! Replace gasket if damaged.  xx1000001166
9 Refit the <i>motor cover</i> with its attachment screws.	 Note Make sure the cover is tightly sealed!  xx1000001165
10 Recalibrate the robot!	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .

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4 Repair

4.5.1 Replacing motor, axis 1

Continued

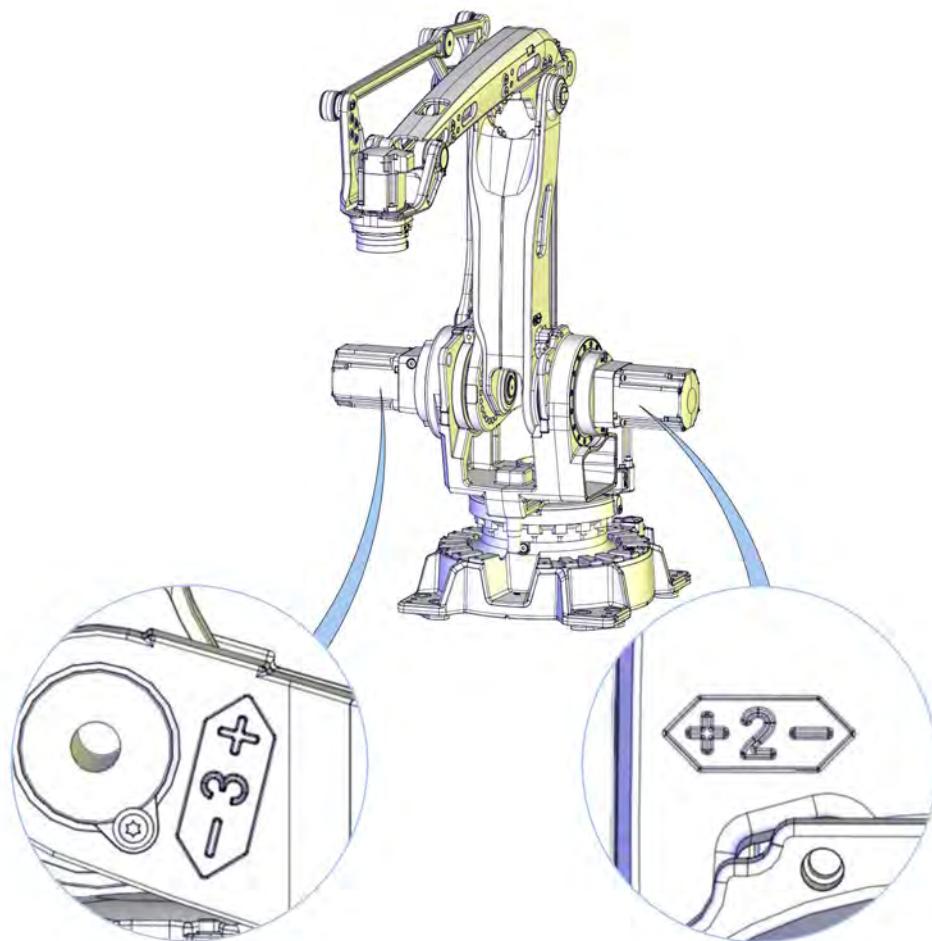
	Action	Note
11	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage!</i> on page 48.	

4.5.2 Replacing motors, axes 2 and 3

Location of motors, axes 2 and 3

The motors axes 2 and 3 are located on either side of the robot as shown in the figure.

The procedure is the same for both motors.



xx1000001174

Required equipment

Equipment, etc.	Art. no.	Note
Motor axes 2-3	For spare part no. see: • Spare parts on page 393 chapter	Includes <ul style="list-style-type: none"> motor pinion o-ring (the o-ring must be replaced when the motor is replaced)

Continues on next page

4 Repair

4.5.2 Replacing motors, axes 2 and 3

Continued

Equipment, etc.	Art. no.	Note
Grease	3HAB3537-1	For lubricating the o-ring.
Guide pins	3HAC13120-2	M10x150 For guiding the motor. Guide pins are to be used in pairs!
Lifting accessory, motor axes 2-3	3HAC14586-1	
Lock screw	-	M16x90 For securing the lower arm.
Bits extension	3HAC023760-001	Used to reach the attachment screws for the motor.
Power supply	-	24 VDC, 1.5 A For releasing the brakes.
Rotation tool		Used to rotate the motor pinion when mating it to the gear, when brakes are released with 24 VDC power supply.
Standard toolkit		Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter Circuit diagrams on page 395 .

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	<p>Decide which calibration routine to use for calibrating the robot.</p> <ul style="list-style-type: none"> • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot. 	
	<p>If the robot is to be calibrated with reference calibration:</p> <p>Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot.</p> <p>If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.</p>	<p>Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values.</p> <p>Creating new values requires possibility to move the robot.</p> <p>Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365.</p> <p>Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum.</p>

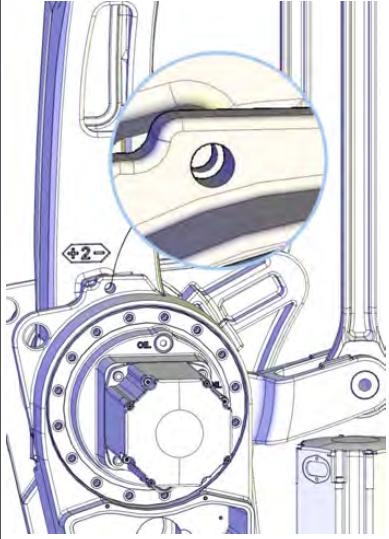
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Action	Note
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing motors axes 2 and 3

Use this procedure to remove motors axes 2 and 3.

The procedure is the same for both motors.

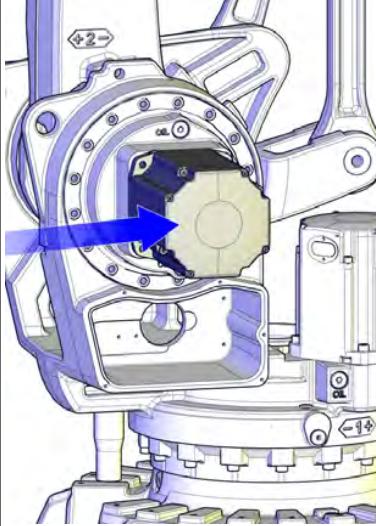
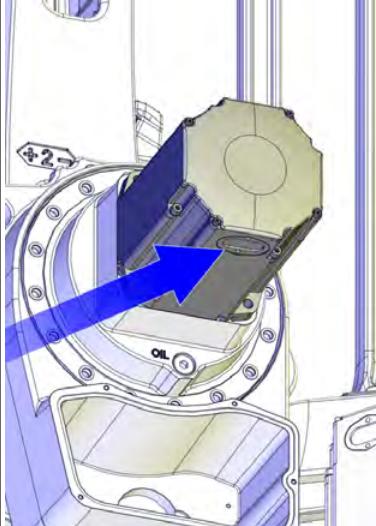
Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Run the robot to a position close enough to its calibration position, to allow the lock screw to be inserted into the <i>hole for lock screw</i> .	
3 Lock the <i>lower arm</i> by inserting the <i>lock screw</i> into the hole of the frame. This is done in order to secure axis 2 from collapsing when the axis 2 motor is being removed. ! CAUTION Tighten by hand!	See figure above.
4 Run axis 3 to the end position so that it rests against the mechanical stop. Release the brake of axis 3 in order to set the weight of axis 3 against the mechanical stop. This is done in order to secure axis 3 from collapsing when the axis 3 motor is being removed.	

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4 Repair

4.5.2 Replacing motors, axes 2 and 3

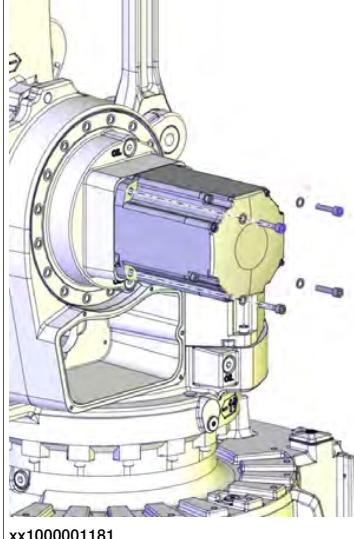
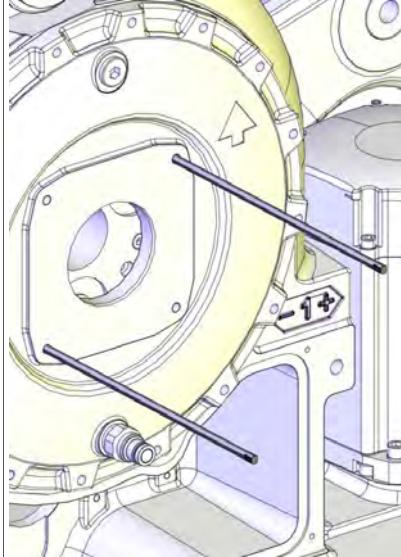
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Action	Note
<p>5</p>  DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
<p>6</p> Drain the oil from <i>gearbox</i> .	See section <ul style="list-style-type: none"> • <i>Changing oil, gearbox axes 2 and 3 on page 136.</i>
<p>7</p> Remove the <i>motor cover</i> .	 xx1000001182
<p>8</p> Remove the <i>cable gland cover</i> at the cable exit.  Note Make sure the gasket is not damaged! Replace if damaged.	 xx1000001183
<p>9</p> Disconnect all connectors beneath the motor cover.	

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4.5.2 Replacing motors, axes 2 and 3

Continued

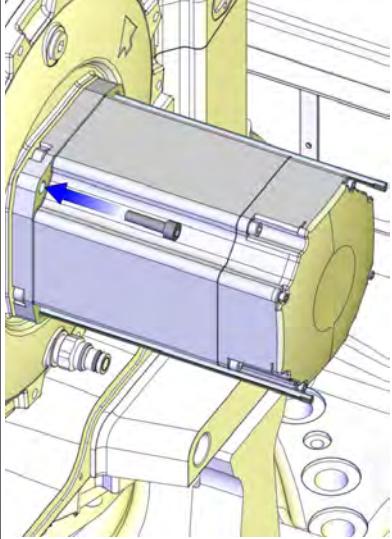
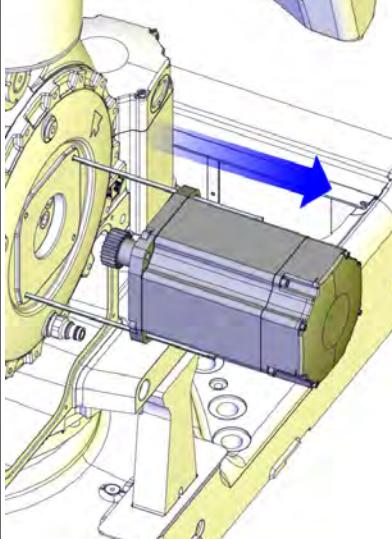
Action	Note
10 In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP2 <ul style="list-style-type: none"> • + : pin 2 • - : pin 5
11 Unscrew <i>attachment screws and washers</i> of the motor. Use the <i>bits extension</i> .	
12 Fit two <i>guide pins</i> in two of the motors attachment holes.	<p>Art. no. is specified in Required equipment on page 301. The figure shows IRB 760 but the principle is the same.</p> 

Continues on next page

4 Repair

4.5.2 Replacing motors, axes 2 and 3

Continued

	Action	Note
13	If required, press the motor out of position by fitting two <i>screws</i> in the remaining attachment holes of the motor, diagonal to each other.	<p>M12x70, fully threaded. Always use the removal screws and tools in pairs!</p> 
14	Remove the two screws and fit the <i>lifting tool, motor axes 2-3</i> to the motor.	Art. no. is specified in <i>Required equipment on page 301</i> .
15	<p> CAUTION The motor weighs 29 kg. All lifting accessories used must be sized accordingly!</p>	
16	Pull out the <i>motor</i> on the guide pins to get the pinion away from the gear. Make sure the pinion does not get damaged!	<p>The figure shows IRB 760 but the principle is the same.</p> 
17	Remove the motor by gently lifting it straight out and place it on a secure surface.	

Continues on next page

Action	Note
18 Disconnect the brake release voltage!	
19 Check the pinion. If there is any damage, the motor pinion must be replaced.	

Refitting, motors axes 2 and 3

Use this procedure to refit motors axes 2 and 3.

The procedure is the same for both motors.

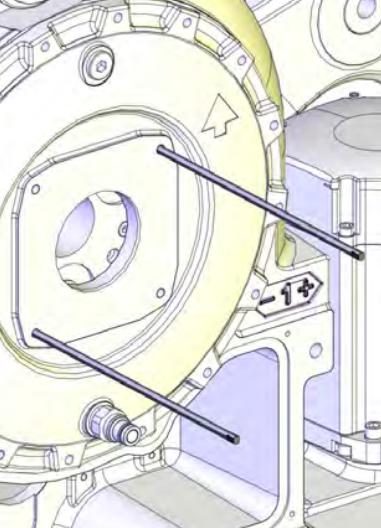
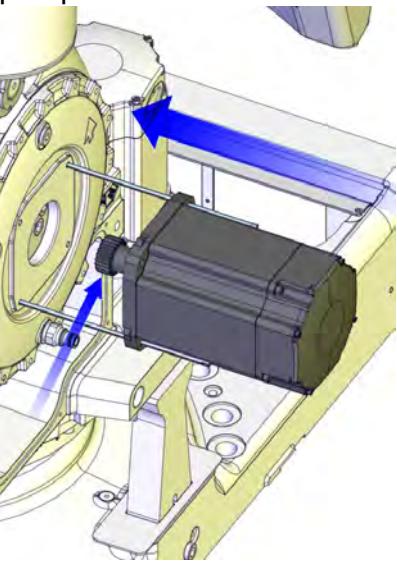
Action	Note
1 Make sure the <i>o-ring</i> on the <i>circumference</i> of the motor is seated properly. Lightly lubricate the <i>o-ring</i> with grease.	 xx1000001186 Parts: <ul style="list-style-type: none"> B: O-ring C: Circumference
2 In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP1 <ul style="list-style-type: none"> + : pin 2 - : pin 5
3 Fit the <i>lifting tool, motor axes 2-3</i> to the motor.	Art. no. is specified in Required equipment on page 301 .

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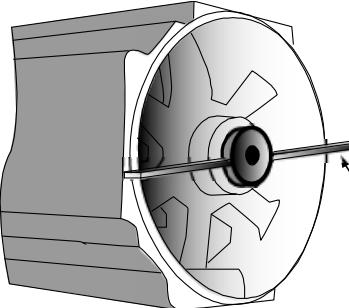
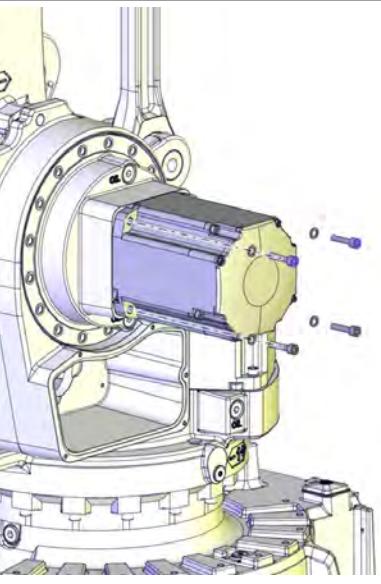
4 Repair

4.5.2 Replacing motors, axes 2 and 3

Continued

Action	Note
4 Fit the two <i>guide pins</i> in the two lower motor attachment holes.	Art. no. is specified in Required equipment on page 301 . The figure shows IRB 760 but the principle is the same. 
5  CAUTION The motor weighs 29 kg. All lifting accessories used must be sized accordingly!	
6 Lift the <i>motor</i> and guide it on to the <i>guide pins</i> , as close to the correct position as possible without pushing the motor <i>pinion</i> into the gear.	The figure shows IRB 760 but the principle is the same. 
7 Remove the lifting tool and allow the motor to rest on the guide pins.	

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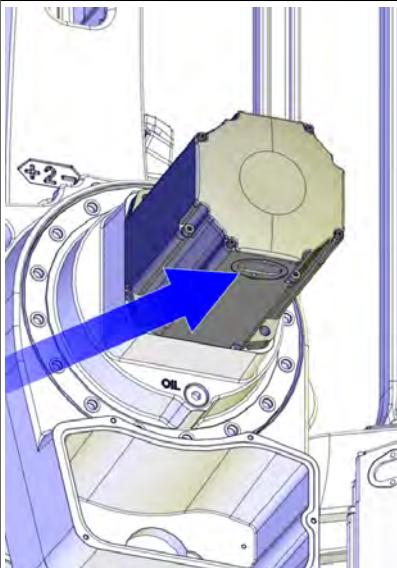
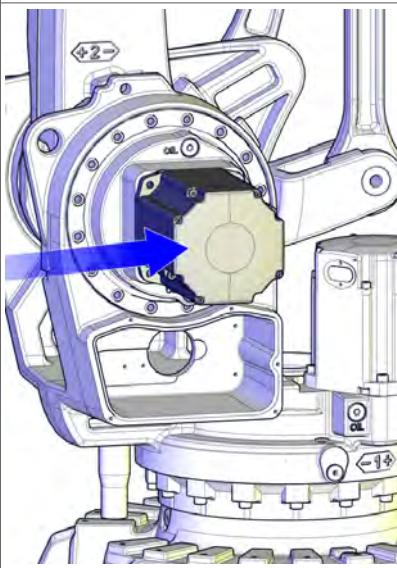
Action	Note
8 Use the <i>rotation tool</i> in order to rotate the motor pinion when mating it to the gear (see figure). Fit the motor, making sure the motor pinion is properly mated to the gear of gearbox axis 2-3 and that it doesn't get damaged.	 Note The rotation tool is used beneath the motor cover, directly on the motor shaft as shown in figure above. xx0200000165 Part: Rotation tool
9 Remove the guide pins.	
10 Secure the motor with its four <i>attachment screws</i> and <i>plain washers</i> . Use the <i>bits extension</i> . Reused screws can be used, providing they are lubricated as detailed in section <i>Screw joints on page 383</i> before fitting.	 xx1000001181 Attachment screws: <ul style="list-style-type: none"> M10 x 40 quality 12.9 Gleitmo Tightening torque: <ul style="list-style-type: none"> 50 Nm
11 Disconnect the brake release voltage.	
12 Reconnect all connectors beneath the motor cover.	Connect in accordance with markings on connectors.

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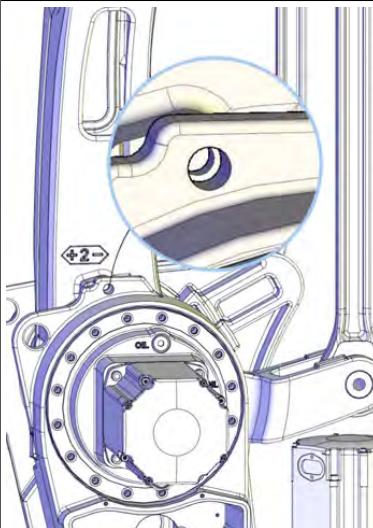
4 Repair

4.5.2 Replacing motors, axes 2 and 3

Continued

	Action	Note
13	<p>Refit the <i>cable gland cover</i> at the cable exit with its two attachment screws.</p> <p>Note</p> <p>Use a new gasket!</p>	
14	<p>Refit the <i>motor cover</i> with its attachment screws and washers.</p> <p>Note</p> <p>Make sure the cover is tightly sealed!</p>	

Continues on next page

Action	Note
15 Remove the <i>lock screw</i> from the <i>hole for lock screw</i> .	 xx1000001179
16 Perform a leak-down test of the axis 2 or 3 gearbox.	See section Performing a leak-down test on page 150 .
17 Refill the gearbox with oil.	See section Changing oil, gearbox axes 2 and 3 on page 136 .
18 Recalibrate the robot!	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .
19  DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .	

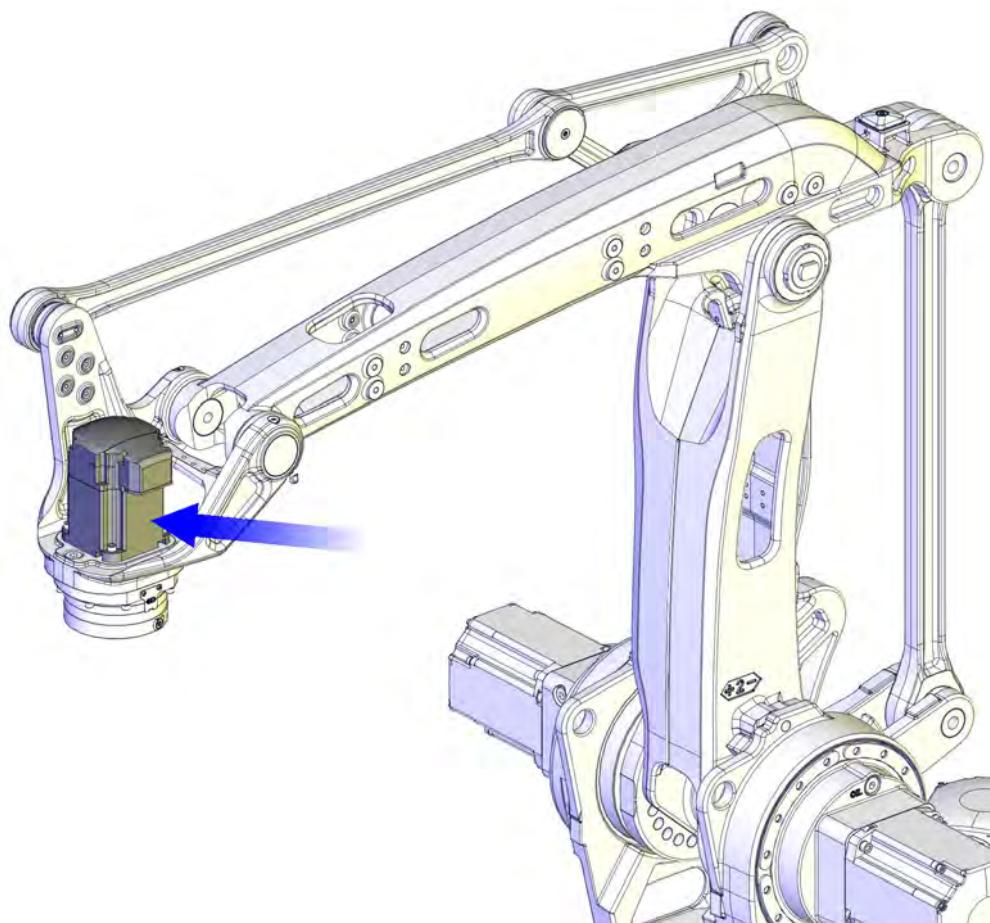
4 Repair

4.5.3 Replacing motor, axis 6

4.5.3 Replacing motor, axis 6

Location of motor axis 6

Motor axis 6 is located in the center of the tilthouse as shown in the figure.



xx1100000090

Required equipment

Equipment, etc.	Art.no.	Note
Motor axis 6	For spare part no. see: • Spare parts on page 393	Includes <ul style="list-style-type: none">• motor• pinion• o-ring (the o-ring must be replaced when the motor is replaced)
Bits extension	3HAC023760-001	Used to reach attachment screws for motor.

Continues on next page

Equipment, etc.	Art.no.	Note
Locking liquid	3HAB7116-1	Loctite 243
Power supply	-	24 VDC, 1.5 A For releasing the brakes.
Grease	3HAB3537-1	For lubricating the o-ring.
Standard toolkit	-	Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter Circuit diagrams on page 395 .

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none"> • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot. 	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing, motor axis 6

Use this procedure to remove motor, axis 6.

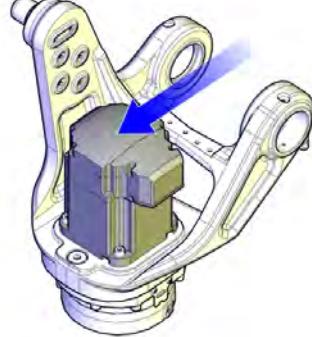
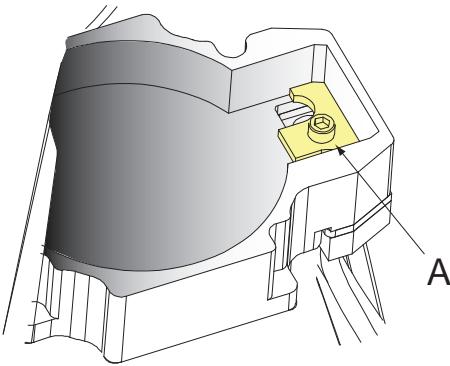
	Action	Information
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

Continues on next page

4 Repair

4.5.3 Replacing motor, axis 6

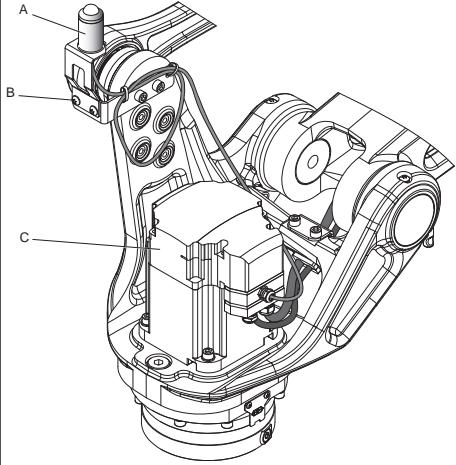
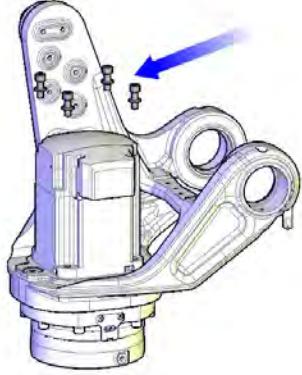
Continued

Action	Information
<p>2 Run the robot to a position where it is easiest to remove the motor axis 6 when standing in front of the robot.</p> <p>Note The motor axis 6 can be replaced without draining the gear oil.</p>	
<p>3 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area. </p>	
4 Remove <i>motor cover</i> .	 xx1000001223
<p>5 Remove the <i>cable gland cover</i> at the cable exit by unscrewing its <i>attachment screw (A)</i> on the inside.</p> <p>Note Make sure the gasket is not damaged!</p>	 xx0600002694

Continues on next page

4.5.3 Replacing motor, axis 6

Continued

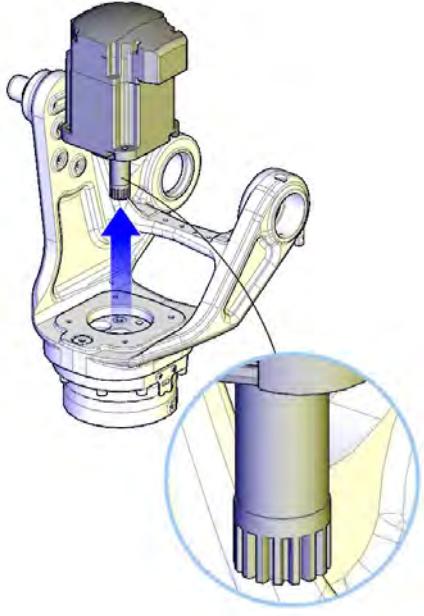
Action	Information
6 Disconnect all connectors beneath the cover.  Note The connection to the <i>UL lamp</i> , must also be disconnected, if the robot is equipped with one.	 xx1000001287 A Signal lamp B Attachment screw M6x8 (2 pcs) C Motor cover
7 In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP6 • + : pin 2 • - : pin 5
8 Remove <i>attachment screws and washers</i> . Use the bits extension.	 xx1000001225
9 If required, press the motor out of position by fitting two screws in the motor attachment holes diagonal to each other	Always use the screws for removal in pairs!

Continues on next page

4 Repair

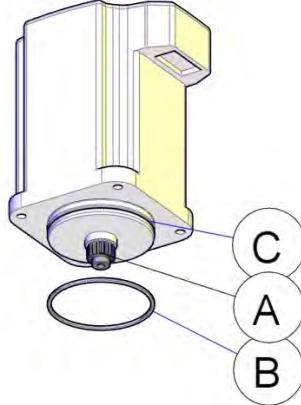
4.5.3 Replacing motor, axis 6

Continued

Action	Information
<p>10 Lift the motor carefully to get the <i>pinion</i> away from the gear.</p> <p>Note Make sure the <i>pinion</i> does not get damaged!</p>	 xx1000001226
11 Disconnect the brake release voltage.	
12 Remove the motor by gently lifting it straight up and place it on a secure surface.	

Refitting, motor axis 6

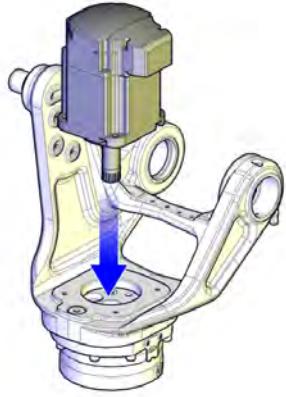
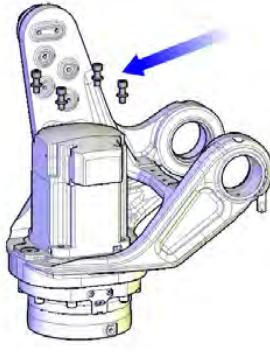
Use this procedure to refit motor axis 6.

Action	Information
<p>1 Make sure the <i>o-ring</i> on the <i>circumference</i> of the motor is seated properly. Lightly lubricate the <i>o-ring</i> with grease.</p> <p>Note The <i>o-ring</i> must be replaced when the motor is replaced.</p>	 xx1000001109 <p>Parts:</p> <ul style="list-style-type: none"> • A: Pinion • B: O-ring • C: Circumference

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4.5.3 Replacing motor, axis 6

Continued

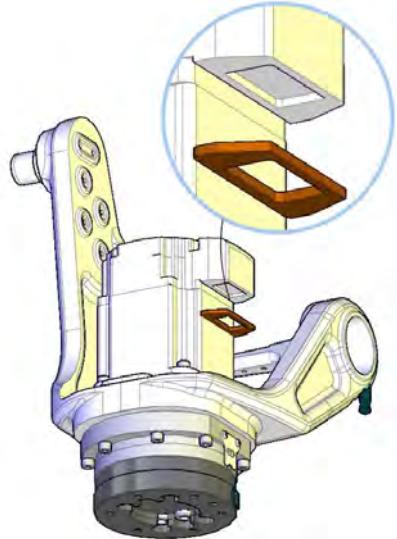
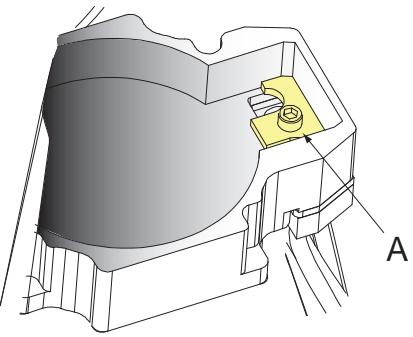
Action	Information
2 In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP6 <ul style="list-style-type: none"> + : pin 2 - : pin 5
3 Fit the two <i>guide pins</i> in two of the motor attachment holes.	Art. no. is specified in Required equipment on page 312 .
4 Lift the motor carefully in place. Make sure the motor <i>pinion</i> is properly mated to the gearbox, axis 6.  Note Make sure the motor is turned the correct way. See figure!	 xx1000001228
5 Remove the guide pins.	
6 Apply <i>locking liquid (Loctite 243)</i> on the attachment screws.	
7 Secure the motor with its four <i>attachment screws and washers</i> . Reused screws may be used, providing they are lubricated as detailed in section Screw joints on page 383 before fitting.	 xx1000001225 Washers: <ul style="list-style-type: none"> 8.4x16x1.6 quality Steel-A2F Attachment screws: <ul style="list-style-type: none"> M10 x 40 quality 8.8-A2F Tightening torque: <ul style="list-style-type: none"> 50 Nm

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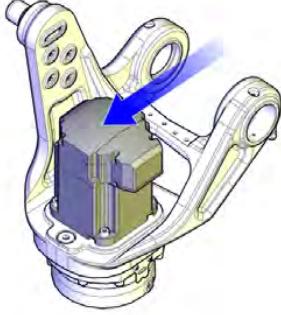
4 Repair

4.5.3 Replacing motor, axis 6

Continued

Action	Information
8 Disconnect the brake release voltage.	
9 Perform a leak-down test of the axis 6 gearbox.	See section Performing a leak-down test on page 150 .
10 Reconnect all connectors in motor axis 6.	Connect in accordance with markings on connectors.
11 Refit the connections to the UL lamp, if the robot is equipped with one.	
12 Check the gasket. If damaged, replace it.	 xx1000001224
13 Refit the cable gland with its attachment screw.	 xx0600002694 <ul style="list-style-type: none"> • A: Screw holding the cable gland <p>Make sure the gasket is not damaged! Replace if damaged.</p>

Continues on next page

	Action	Information
14	<p>Refit the cover, motor axis 6 with its <i>attachment screws and washers</i>.</p> <p> Note</p> <p>Make sure the cover is tightly sealed!</p>	 <p>xx1000001223</p>
15	Recalibrate the robot!	<p>Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i>, enclosed with the calibration tools.</p> <p>Axis Calibration is described in Calibrating with Axis Calibration method on page 364.</p> <p>General calibration information is included in section Calibration on page 353.</p>
16	 DANGER <p>Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48.</p>	

4 Repair

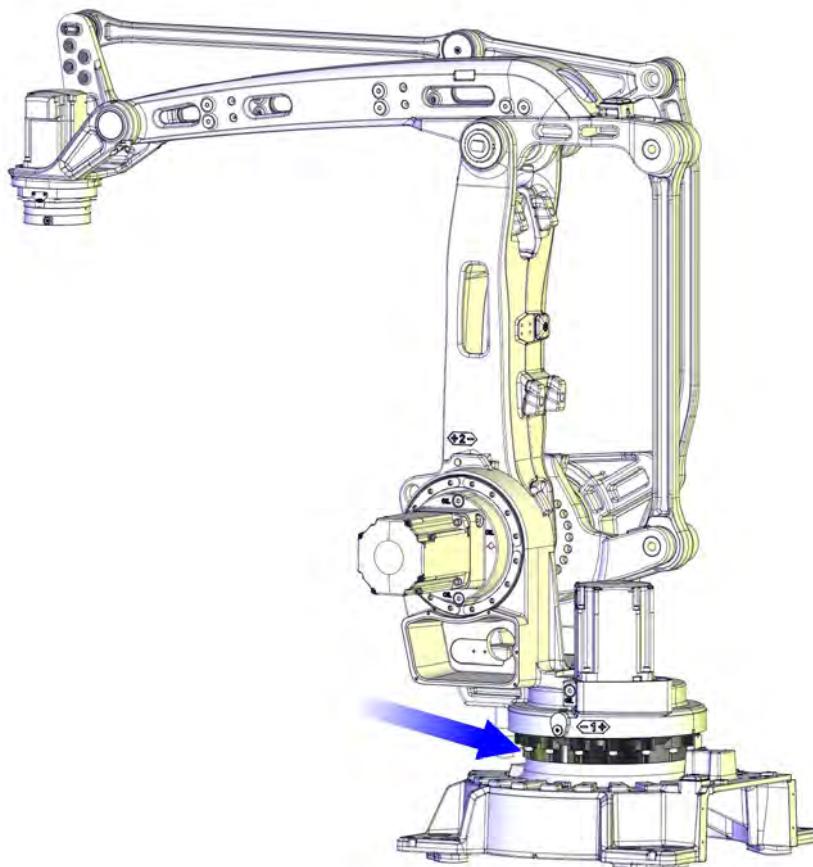
4.6.1 Replacing the axis 1 gearbox

4.6 Gearboxes

4.6.1 Replacing the axis 1 gearbox

Location of gearbox

The axis 1 gearbox is located between the frame and base as shown in the figure.



xx1100000122

Required equipment

Equipment, etc.	Art. no.	Note
Gearbox	For spare part no. see: • Spare parts on page 393.	Includes: • gearbox • all o-rings and sealing rings
O-ring	3HAB3772-93	Replace if damaged!

Continues on next page

4.6.1 Replacing the axis 1 gearbox
Continued

Equipment, etc.		Art. no.	Note
O-ring		3HAB3772-97	3 pcs Replace if damaged!
Oil seal		For spare part no. see: • <i>Spare parts on page 393</i>	Replace if damaged!
Grease		3HAB3537-1	For lubricating the o-rings.
Support, base and gear 1		3HAC15535-1	
Adapter		3HAC040381-001	
Lifting eye, M12		3HAC025333-005	2 pcs
Shackle			Lifting capacity: 1,000 kg.
Lifting accessory (chain)		3HAC15556-1	
Guide pins		3HAC022637-001	2 pcs, M12x130. Used for guiding the gearbox into place in the base. Always use guide pins in pairs!
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC058080-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
Standard toolkit		-	Content is defined in section <i>Standard tools on page 387</i> .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Continues on next page

4 Repair

4.6.1 Replacing the axis 1 gearbox

Continued

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

Action	Note
1 Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, gearbox axis 1

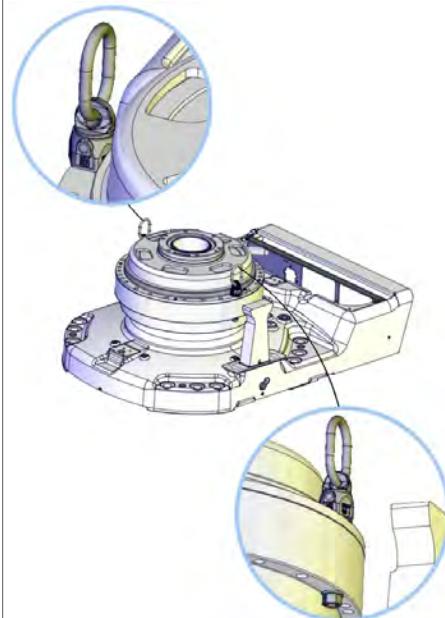
Use this procedure to remove gearbox, axis 1.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Move the robot to its most stable position, shown in the figure to the right. Jog the robot to this position: Axis 2 = -40 degrees Axis 3 = +65 degrees	
3  DANGER Turn off all: <ul style="list-style-type: none">• electric power supply• hydraulic pressure supply• air pressure supply to the robot, before entering the robot working area.	
4 Drain the axis 1 gearbox.	See Changing oil, axis-1 gearbox on page 132 .

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4.6.1 Replacing the axis 1 gearbox

Continued

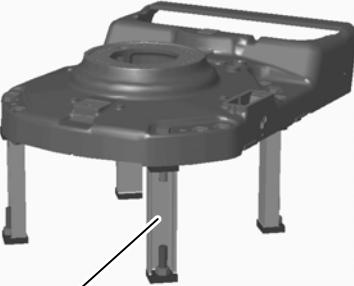
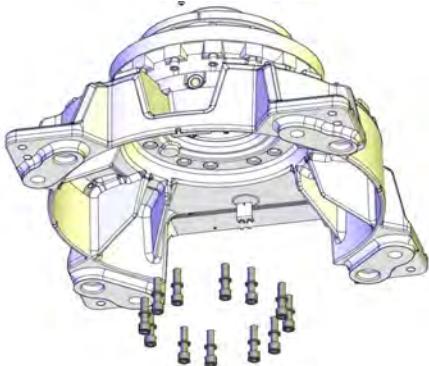
	Action	Note
5	Remove the complete arm system.	See Replacing the base, including axis 1 gearbox on page 180 .
6	Unfasten the robot base from the foundation by removing the base attachment screws.	
7	Fit two <i>lifting eyes</i> on each side of the gearbox. Attach the <i>lifting accessory, base and gear 1</i> and a <i>roundsling</i> , to the gearbox and base.	The figure shows IRB 760 but is also valid for IRB 460.  xx1000001395 Specified in Required equipment on page 320 .
8	 CAUTION The base and axis 1 gearbox weighs 130 kg + 108 kg. All lifting accessories used must be sized accordingly!	
9	Lift the robot base including the axis 1 gearbox to allow the <i>base and gear 1 support</i> be fitted on each sides of the base.	Art. no. is specified in Required equipment on page 320 .

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4 Repair

4.6.1 Replacing the axis 1 gearbox

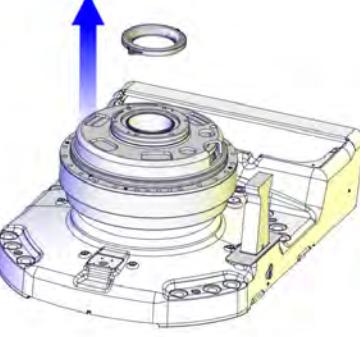
Continued

	Action	Note
10	Secure the support to the base and to the foundation. Make sure the base remains in a stable position before performing any work underneath the base!	<p>The figure shows IRB 760 but is also valid for IRB 460.</p>  <p>A xx1000000364</p> <p>A Support base (4 pcs)</p>
11	Remove the bottom plate from underneath the base in order to get access to the attachment screws.	
12	Unscrew the attachment screws and remove the washers.	 <p>xx1100000207</p> <p>Attachment screws: 12 pcs. Washers: 12 pcs.</p>

Continues on next page

4.6.1 Replacing the axis 1 gearbox

Continued

Action	Note
13 Remove the cable guide in the center of gearbox 1 by unscrewing its attachment screws.	 xx1000001387
14 ! CAUTION The gearbox weighs 108 kg. All lifting accessories used must be sized accordingly!	
15 Lift the gearbox away with the already mounted lifting tools.	
16 Turn the gearbox, and remove the protection pipe by unscrewing two attachment screws. Note Move the protective pipe over to the new gearbox.	 xx1400000786

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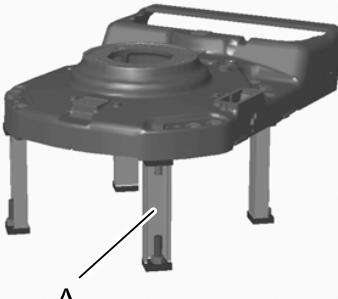
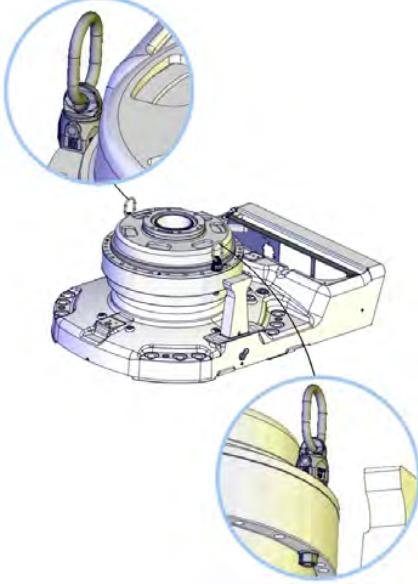
4 Repair

4.6.1 Replacing the axis 1 gearbox

Continued

Refitting, gearbox axis 1

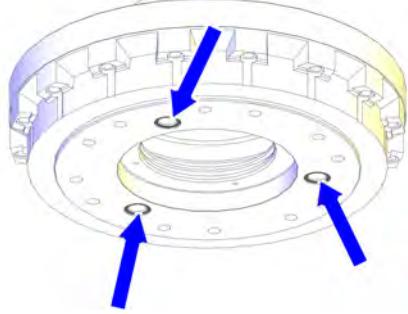
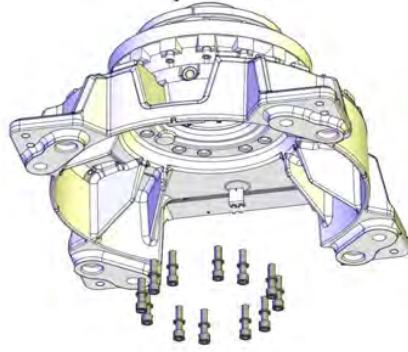
Use this procedure to refit gearbox, axis 1.

	Action	Note
1	Fit the <i>support, base and gear 1</i> to the base. Mounting of the support, base and gear 1 is detailed in section Removal, gearbox axis 1 on page 322 . The figure shows IRB 760 but is also valid for IRB 460.	 xx100000364 A Support base (4 pcs)
2	Make sure the <i>o-ring</i> is seated properly in its groove on the gearbox. Lightly lubricate the o-ring with <i>grease</i> .	Art no. is specified in Required equipment on page 320 .
3	Fit two <i>lifting eyes</i> on each side of the gearbox. Attach the <i>lifting accessory, base and gear 1</i> and a <i>roundsling</i> , to the gearbox.	Specified in Required equipment on page 320 .  xx1000001395
4	Fit two <i>guide pins</i> in two of the attachment holes in the gearbox, parallel to each other.	Specified in Required equipment on page 320 .

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4.6.1 Replacing the axis 1 gearbox

Continued

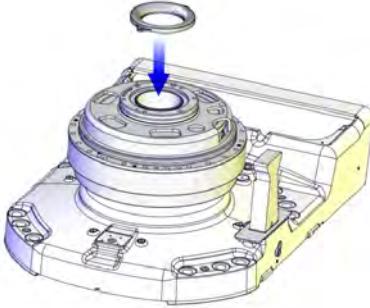
Action	Note
5 !	CAUTION The gearbox weighs 108 kg. All lifting accessories used must be sized accordingly!
6	Check the three o-rings. Replace if damaged!  xx1300000015
7	Lift gearbox axis 1 onto the guide pins and lower it carefully to its mounting position.
8	Secure the gearbox with its <i>attachment screws</i> and washers. 12 pcs, M16x60 quality 12.9 Gleitmo Tightening torque: 300 Nm Reused screws may be used, providing they are lubricated as detailed in section Screw joints on page 383 before fitting.  xx1100000207

Continues on next page

4 Repair

4.6.1 Replacing the axis 1 gearbox

Continued

Action	Note
9 Refit the cable guide in the center of gearbox 1 with its attachment screws.	<p>The figure shows IRB 760 but is also valid for IRB 460.</p>  <p>xx1000001393</p>
10  CAUTION The base and axis 1 gearbox weighs 130 kg + 108 kg. All lifting accessories used must be sized accordingly!	
11 Lift the robot base and gearbox 1 and remove the base and gear support.	
12 Secure the base to the mounting site.	See Orienting and securing the robot on page 82 .
13 Refit the complete arm system.  CAUTION This is a complex task to be performed with utmost care in order to avoid injury or damage!	See Replacing the base, including axis 1 gearbox on page 180 .
14 Perform a leak-down test.	See section Performing a leak-down test on page 150 .
15 Refill the gearbox with oil.	See Changing oil, axis-1 gearbox on page 132 .
16 Recalibrate the robot.	<p>Pendulum Calibration is described in Operating manual - Calibration Pendulum, enclosed with the calibration tools.</p> <p>Axis Calibration is described in Calibrating with Axis Calibration method on page 364.</p> <p>General calibration information is included in section Calibration on page 353.</p>

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	Action	Note
17	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage! on page 48.</i>	

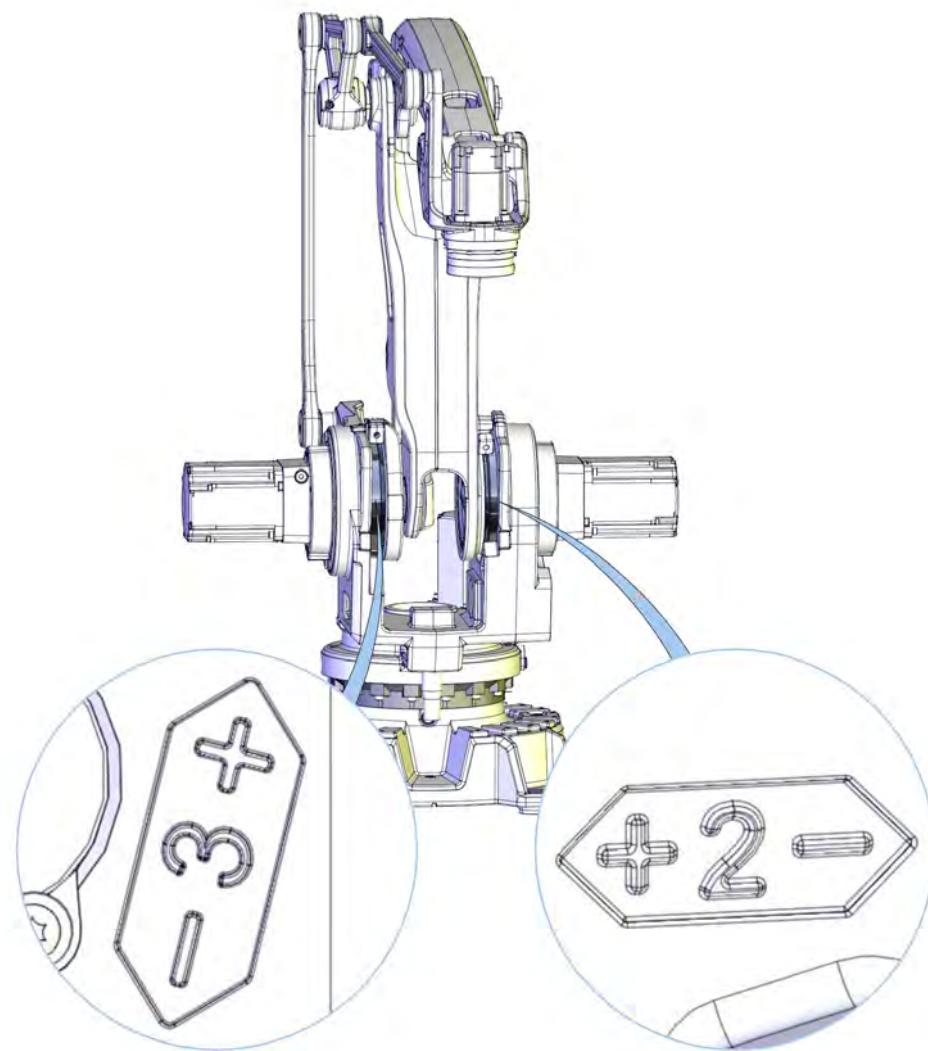
4 Repair

4.6.2 Replacing the axis 2 gearbox

4.6.2 Replacing the axis 2 gearbox

Location of the axis 2 gearbox

The axis 2 and 3 gearboxes are located on either side of the frame as shown in the figure.



xx1100000123

Required equipment

Equipment, etc.	Art.no	Note
Gearbox, axis 2 or axis 3	For spare part no. see: • Spare parts on page 393	
Lock screw M16x90	-	
Screw	M12x60	Fully threaded
Bits extension	-	

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4.6.2 Replacing the axis 2 gearbox

Continued

Equipment, etc.	Art.no	Note
Guide pins	-	M12 Always use guide pins in pairs.
Guide pins	-	M12 Length: 150 mm (the longer one) One shorter than the other. Always use guide pins in pairs.
Pinion crank	-	Used to move the gearbox.
Lifting tool	3HAC025214-001	For lifting gearbox. Includes lifting instruction art. no. 3HAC025523-001.
Standard toolkit		Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none"> • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot. 	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

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4 Repair

4.6.2 Replacing the axis 2 gearbox

Continued

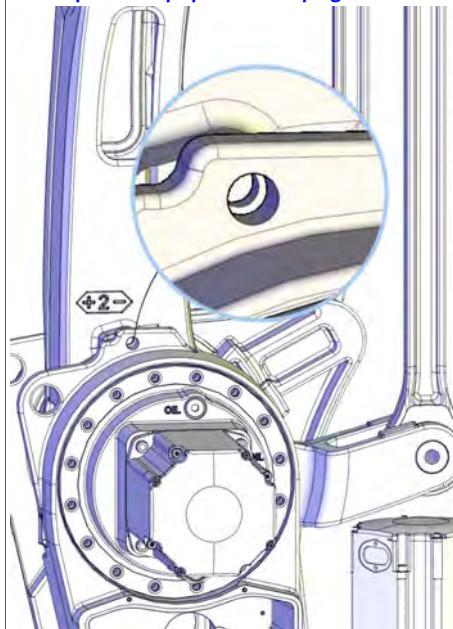
Preparations before removing the axis 2 gearbox

Use this procedure to do the necessary preparations before removing the axis 2 gearbox.



Note

Do not replace both gearboxes at the same time, unless the complete arm system is already removed!

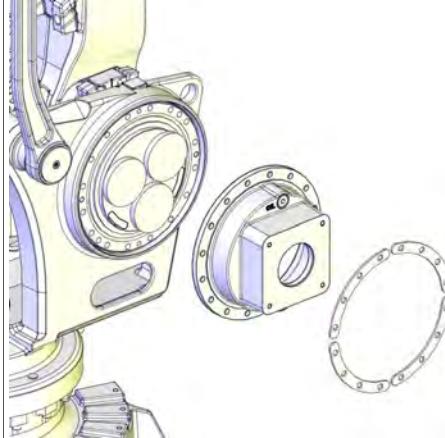
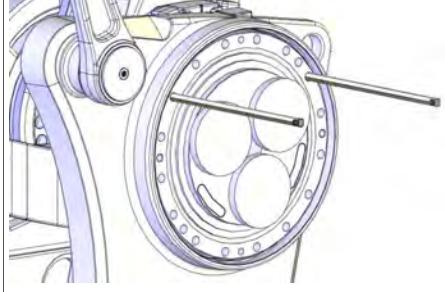
Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Drain the gearbox from oil. Note Time-consuming activity!	See .
3 Jog axis 2 to 0 degrees and axis 3 to max + degrees.	
4 Insert the <i>lock screw</i> in the lower arm in order to secure axis 2. NOTE! Perform this by hand only!	Dimension of the lock screw is specified in Required equipment on page 330 .  xx1000001179
5 Release the brakes on axes 2 and 3 in order to let the parallel arm rest on the damper.	
6 Apply a roundsling (or similar) securing the parallel rod to the lower arm. This is done in order to lock the parallel arm in position.	

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Action	Note
7  DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

Removing the axis 2 gearbox

Use this procedure to remove the axis 2 gearbox.

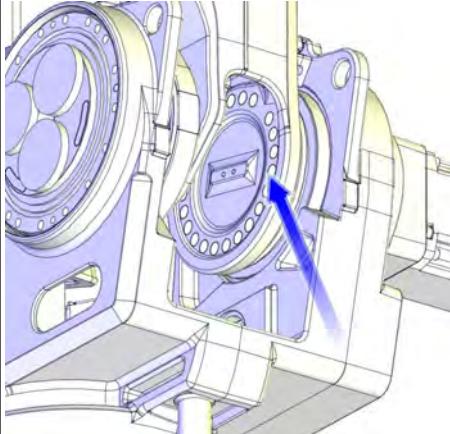
Action	Note
1 Remove the axis 2 motor. Protect the cables from getting damaged and from getting contaminated with oil spill.	See Replacing motors, axes 2 and 3 on page 301 .
2 Unscrew the attachment screws of the motor flange and lift away the washers and the motor flange.	
3 Apply two <i>guide pins</i> into two opposite holes in the gearbox.	  Note Always use guide pins in pairs.
4  CAUTION The gearbox weighs 51 kg. All lifting accessories used must be sized accordingly!	
5 Fit the <i>lifting tool</i> to the gearbox.	Art. no. is specified in Required equipment on page 330 .

Continues on next page

4 Repair

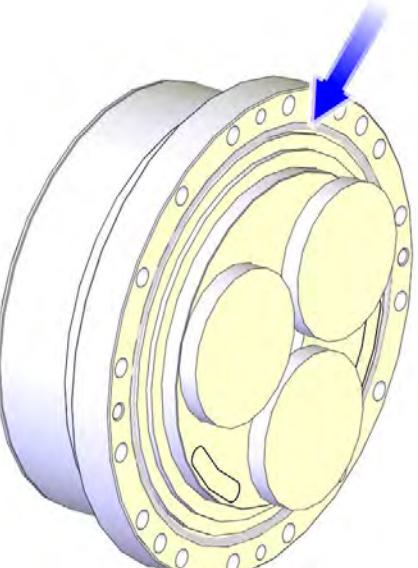
4.6.2 Replacing the axis 2 gearbox

Continued

Action	Note
6 Unscrew the <i>M12 attachment screws</i> securing the gearbox to the lower arm system.	 xx1100000221
7 If required, apply two <i>fully threaded M12x60</i> screws to the holes in the gearbox, in order to press it free.	
8 Lift out the axis 2 gearbox using an overhead crane or similar, with guidance from the fitted guide pins.	

Preparations before refitting the axis 2 gearbox

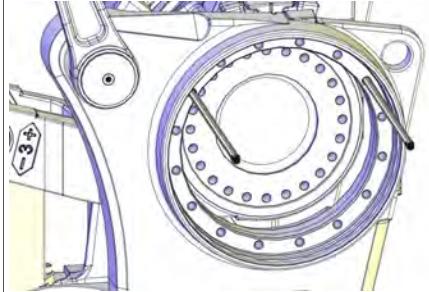
Use this procedure to do the necessary preparations before removing the axis 2 gearbox.

Action	Note
1 Clean all contact surfaces from residuals of paint and contamination.	
2 Make sure that the <i>o-ring</i> is fitted to the gearbox.	 xx1100000223
3 Lightly lubricate the <i>o-ring</i> with grease.	
4 Apply some grease on all contact surfaces.	

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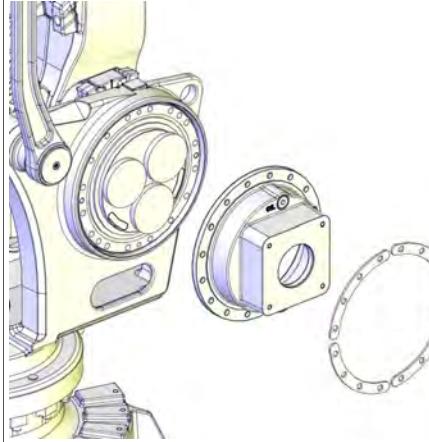
4.6.2 Replacing the axis 2 gearbox

Continued

Action	Note
5 Fit two guide pins in opposite holes for the gearbox, in the frame.	 xx1100000224
6 Fit two guide pins in opposite holes of the gearbox. One of the guide pins shorter than the other in order to facilitate fitting into the lower arm.	NOTE! The position of the guide pins must be in a way that they are possible to be removed later.

Refitting, the axis 2 gearbox

Use this procedure to refit the axis 2 gearbox.

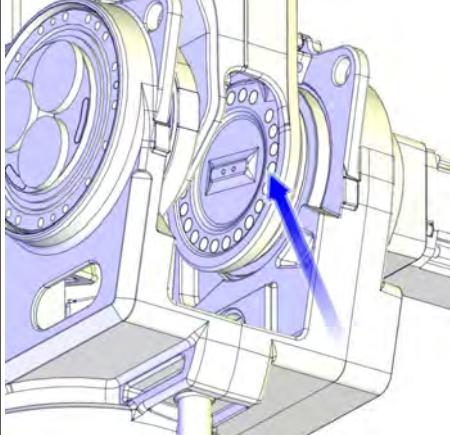
Action	Note
1  CAUTION The gearbox weighs 51 kg. All lifting accessories used must be sized accordingly!	
2 Fit the <i>lifting tool</i> to the gearbox.	Art. no. is specified in <i>Required equipment on page 330</i> .
3 Use an overhead crane or similar and lift the gearbox on to the guide pins.	
4 Slide the gearbox carefully on the guide pins to its mounting position.	
5 Use a crank to move the gearbox in order to find the holes for the attachment screws.	
6 Secure the gearbox and the motor flange to the frame with the <i>attachment screws and washers</i> .	 xx1100000219 Attachment screws: M12x60 quality 12.9 gleitmo (16 pcs) Tightening torque: 120 Nm

Continues on next page

4 Repair

4.6.2 Replacing the axis 2 gearbox

Continued

Action	Note
7 Remove the <i>guide pins</i> and replace them with the remaining attachment screws.	
8 Secure the gearbox to the lower arm system with the <i>attachment screws and washers</i> .	 xx1100000221 Attachment screws: M12x40 quality 12.9 gleitmo (21 pcs) Tightening torque: 120 Nm
9 Remove guide pins in the lower arm.	
10 Secure the rest of the attachment screws.	Tightening torque: 120 Nm

Concluding refitting procedure of the axis 2 gearbox

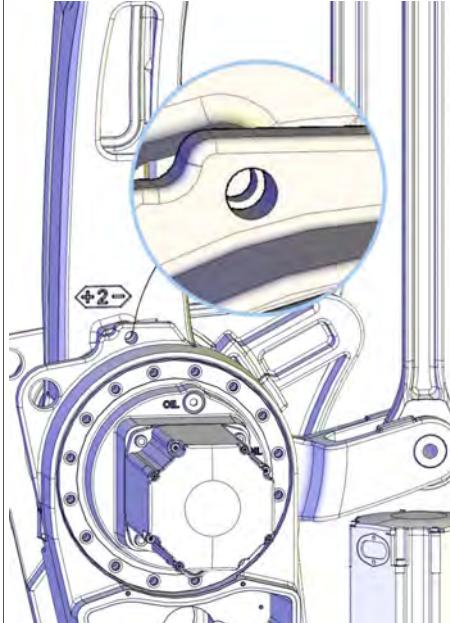
Use this procedure for the concluding refitting of the axis 2 gearbox.

Action	Note
1 Wipe the gearbox clean from residual grease.	
2 Refit the <i>motor</i> .	See Replacing motors, axes 2 and 3 on page 301 .
3 Perform a leakdown test.	See Performing a leak-down test on page 150 .
4 Refill the gearbox with oil.	Draining, axes 2 and 3 on page 138

Continues on next page

4.6.2 Replacing the axis 2 gearbox

Continued

Action	Note
5 Remove the <i>lock screw</i> , lower arm.	 xx1000001179
6 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .
7	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! on page 48 .

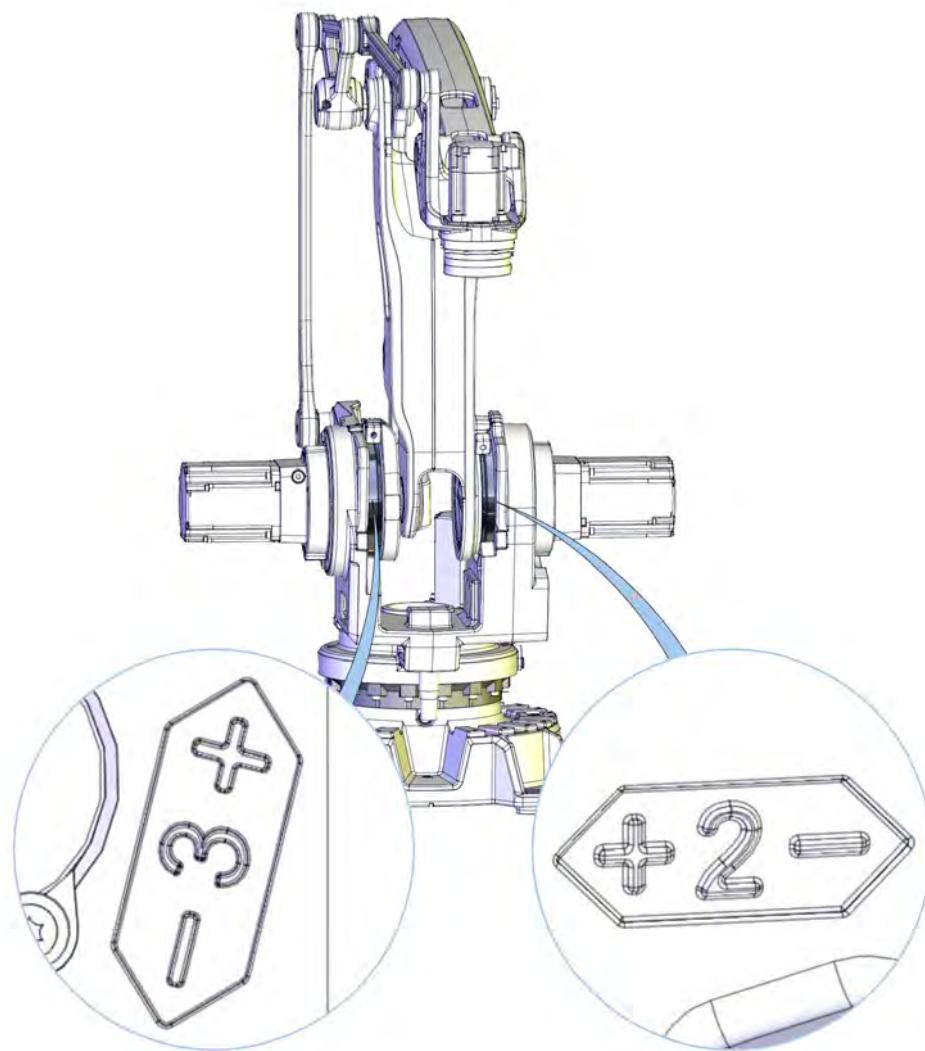
4 Repair

4.6.3 Replacing the axis 3 gearbox

4.6.3 Replacing the axis 3 gearbox

Location of the axis 3 gearbox

The axis 2 and 3 gearboxes are located on either side of the frame as shown in the figure.



Required equipment

Equipment, etc.	Art.no	Note
Gearbox, axis 2 or axis 3	For spare part no. see: • Spare parts on page 393	
Lock screw M16x90	-	
Screw	M12x60	Fully threaded.
Bits extension	-	

Continues on next page

4.6.3 Replacing the axis 3 gearbox

Continued

Equipment, etc.	Art.no	Note
Guide pins	-	M12 Always use guide pins in pairs.
Guide pins	-	M12 Length: 150 mm (the longer one) One shorter than the other. Always use guide pins in pairs.
Pinion crank	-	Used to move the gearbox.
Lifting tool	3HAC025214-001	For lifting gearbox. Includes lifting instruction art. no. 3HAC025523-001.
Standard toolkit		Content is defined in section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none"> • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot. 	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Continues on next page

4 Repair

4.6.3 Replacing the axis 3 gearbox

Continued

Preparations before removing the axis 3 gearbox

Use this procedure to do the necessary preparations before removing the axis 3 gearbox.



Note

Do not replace both gearboxes at the same time, unless the complete arm system is already removed!

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Drain the gearbox from oil. Note Time-consuming activity!	<i>Draining, axes 2 and 3 on page 138</i>
3 Jog axis 2 to 0 degrees and axis 3 to max + degrees.	
4 Release the brakes on axis 3 in order to let the parallel arm rest on the damper.	
5 Disassemble the lower end of the parallel rod (alternately remove the complete parallel rod). This is done in order to be able to move the parallel arm in the continued removal process.	See <i>Replacing parallel rod on page 264</i> .
6 Jog axis 3 (the parallel arm) to max - degrees.	
7 Release the brakes on axis 3 in order to let the parallel arm rest on the damper.	
8 Jog axis 2 carefully to about +50 degrees. NOTE! Check that the upper arm is moved forwards during jogging.	
9 Let the tilthouse rest against something rigid that can take the weight of the upper arm.	

Removing the axis 3 gearbox

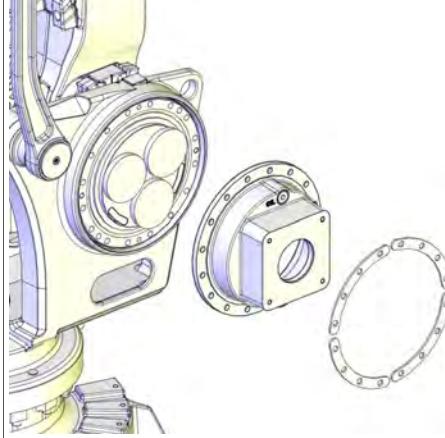
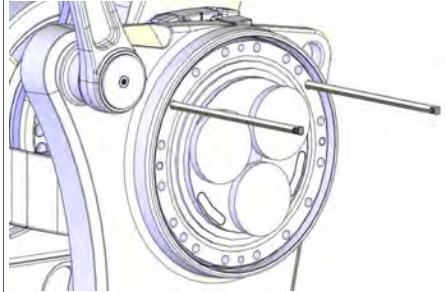
Use this procedure to remove the axis 3 gearbox.

Action	Note
1 Unscrew as many attachment screws that is possible to remove in the parallel arm at this point.	
2 Jog axis 3 (the parallel arm) to max + degrees.	
3 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

Continues on next page

4.6.3 Replacing the axis 3 gearbox

Continued

Action	Note
4 Unscrew the remaining attachment screws in the parallel arm.	
5 Remove the axis 3 motor.	See <i>Replacing motors, axes 2 and 3 on page 301</i> .
6 Unscrew the attachment screws of the motor flange and lift away the washers and the motor flange.	 xx1100000219
7 Apply two <i>guide pins</i> in opposite holes of the gearbox.	 xx1100000220 <p>Note</p> <p>Always use guide pins in pairs.</p>
8 CAUTION The gearbox weighs 51 kg. All lifting accessories used must be sized accordingly!	
9 Fit the <i>lifting tool</i> to the gearbox.	
10 If required, apply two <i>fully threaded M12x60</i> screws to the holes in the gearbox, in order to press it free.	
11 Lift out the <i>gearbox</i> from the frame using an overhead crane or similar, with guidance from the fitted guide pins.	

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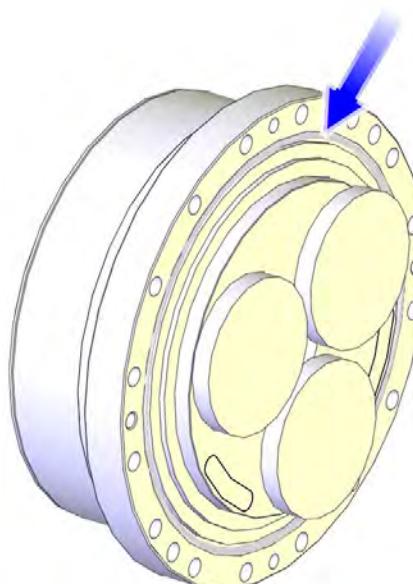
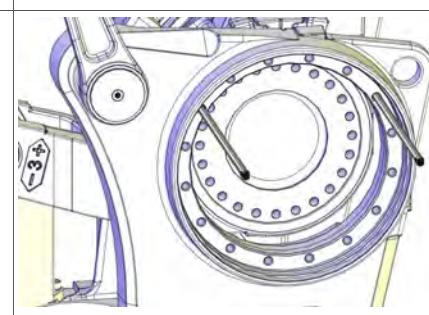
4 Repair

4.6.3 Replacing the axis 3 gearbox

Continued

Preparations before refitting the axis 3 gearbox

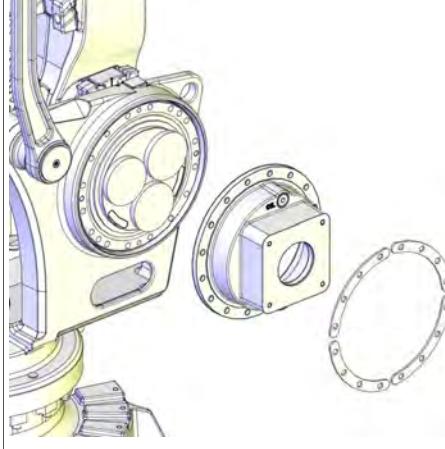
Use this procedure to do the necessary preparations before removing the axis 3 gearbox.

Action	Note
1 Clean all contact surfaces from residuals of paint and contamination.	
2 Make sure that the <i>o-ring</i> is fitted to the gearbox.	 xx1100000223
3 Lightly lubricate the <i>o-ring</i> with grease.	
4 Apply some grease on all contact surfaces.	
5 Apply two <i>guide pins</i> in opposite holes for the gearbox, in the frame.	 xx1100000224
6 Apply two <i>guide pins</i> in opposite holes of the gearbox. One of the guide pins shorter than the other in order to facilitate fitting into the lower arm.	NOTE! The position of the guide pins must be in a way that they are possible to be removed later.
7  CAUTION The gearbox weighs 51 kg. All lifting accessories used must be sized accordingly!	
8 Fit the <i>lifting tool</i> to the gearbox.	Art. no. is specified in Required equipment on page 330 .

Continues on next page

Refitting the axis 3 gearbox

Use this procedure to refit the axis 3 gearbox.

Action	Note
1 Slide the gearbox carefully on the guide pins to its mounting position, using an overhead crane (or similar)..	
2 Use a crank to move the gearbox in order to find the holes for the attachment screws.	
3 Secure the gearbox and the motor flange to the frame with the <i>attachment screws and washers</i> .	 xx1100000219 <p>Attachment screws: M12x60 quality 12.9 gleitmo (16 pcs) Tightening torque: 120 Nm</p>
4 Remove the <i>guide pins</i> and replace them with the remaining attachment screws.	
5 Secure as many attachment screws that is possible to fit in this position, in the parallel arm and secure the axis 3 gearbox.	Attachment screws: M12x40 quality 12.9 gleitmo (21 pcs) Tightening torque: 120 Nm
6 Refit the axis 3 motor.	See Replacing motors, axes 2 and 3 on page 301 .
7 Jog axes 2 and 3 to a position where the remaining attachment screws can be fitted and secured.	Tightening torque: 120 Nm
8 Jog axis 3 (the parallel arm) very carefully to the position where the parallel rod can be refitted to the parallel arm.	
9 Refit the parallel rod.	See Replacing parallel rod on page 264 .
10 Perform a leakdown test.	See Performing a leak-down test on page 150 .
11 Refill the gearbox with oil.	Draining, axes 2 and 3 on page 138
12 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .

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4 Repair

4.6.3 Replacing the axis 3 gearbox

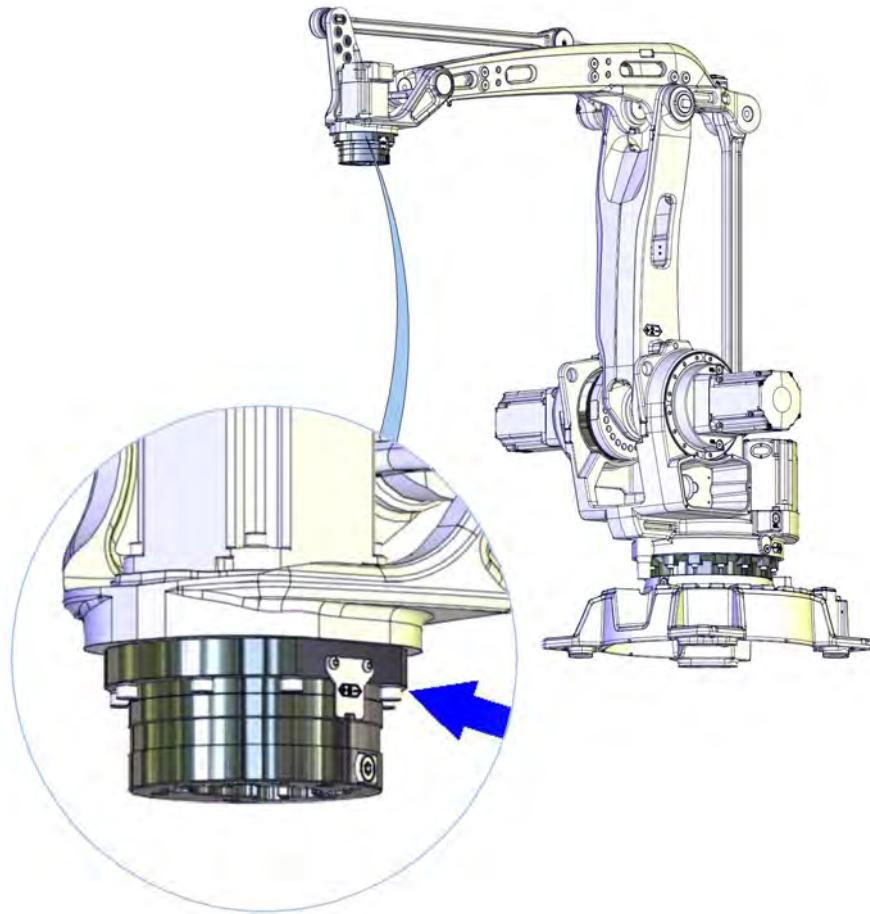
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	Action	Note
13	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <i>DANGER - First test run may cause injury or damage! on page 48.</i>	

4.6.4 Replacing gearbox axis 6

Location of gearbox axis 6

The axis 6 gearbox is located in the center of the wrist as shown in the figure.



xx1100000124

Required equipment

Equipment	Art. no.	Note
Gearbox axis 6	For spare part no. see: • Spare parts on page 393.	Includes o-ring
Turning disk	For spare part no. see: • Spare parts on page 393.	

Continues on next page

4 Repair

4.6.4 Replacing gearbox axis 6

Continued

Equipment	Art. no.	Note
Washers	3HAA1001-172	Not included in gearbox. Replace only if damaged!
O-ring	3HAB3772-58	
164.7x3.53	3HAB3772-57	Must be replaced when reassembling gearbox.
150.0x2.0	3HAB3772-64	Must be replaced when reassembling gearbox.
13.1x1.6	3HAB3772-61	Must be replaced when reassembling gearbox.
Grease	3HAB3537-1	For lubricating o-ring
Guide pins	-	Always use guide pins in pairs!
Standard toolkit		The content is defined in the section Standard tools on page 387 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

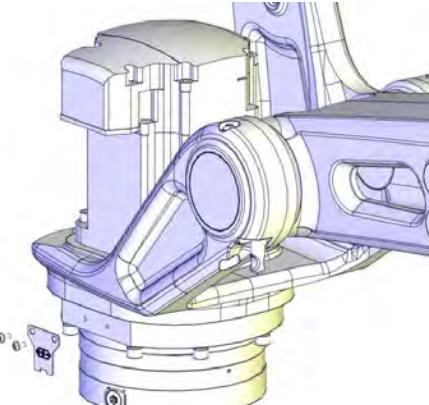
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

Action	Note
1 Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none">• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in Reference calibration routine on page 365 . Read more about reference calibration for Pendulum Calibration in Operating manual - Calibration Pendulum .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

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Removing gearbox axis 6

Use this procedure to remove gearbox axis 6.

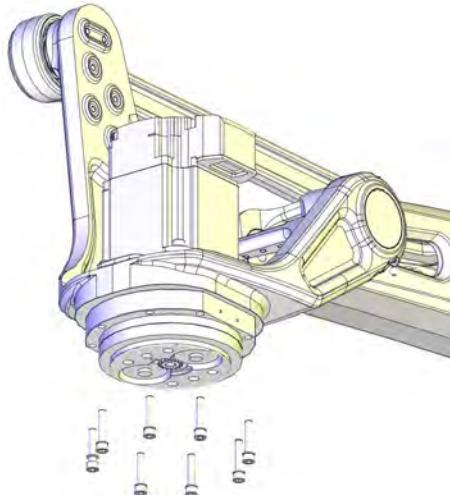
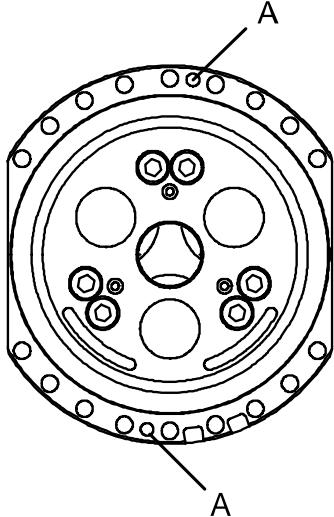
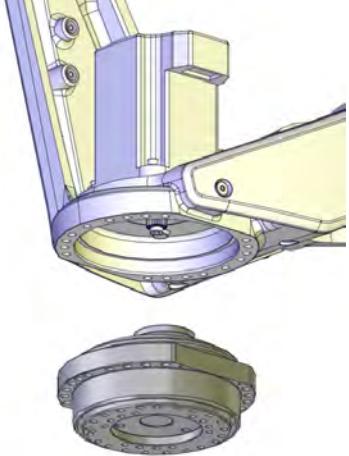
	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Jog the robot to a position where the tilt-house unit is placed in an appropriate service position.	
3	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Drain the <i>oil</i> from the gearbox.	See section <ul style="list-style-type: none"> • Changing oil, gearbox axis 6 on page 140
5	Remove the <i>turning disk</i> .	See section <ul style="list-style-type: none"> • Replacing the turning disk on page 189
6	Remove the <i>calibration plate axis 6</i> .	 xx1100000239

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4 Repair

4.6.4 Replacing gearbox axis 6

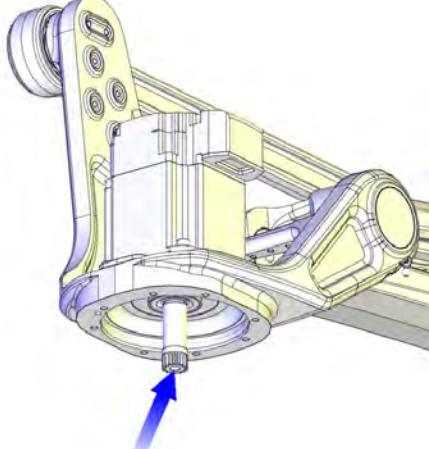
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Action	Note
7 Remove the gearbox by unscrewing the <i>attachment screws and washers</i> that secure it.	 xx1100000229
8 If required apply two M8 screws in the holes shown in the figure, and press out the gearbox.	 xx0200000220
9 Remove <i>gearbox axis 6</i> carefully without damaging pinion or gear.	 xx1000001412

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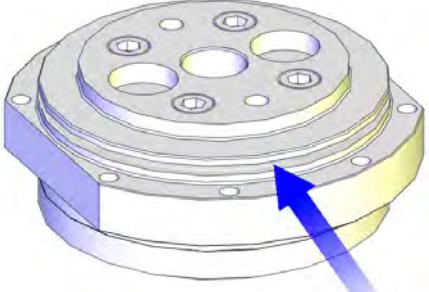
4.6.4 Replacing gearbox axis 6

Continued

Action	Note
10 Check the pinion. A damaged pinion must be replaced!	 xx1100000240

Refitting gearbox axis 6

Use this procedure to refit gearbox axis 6.

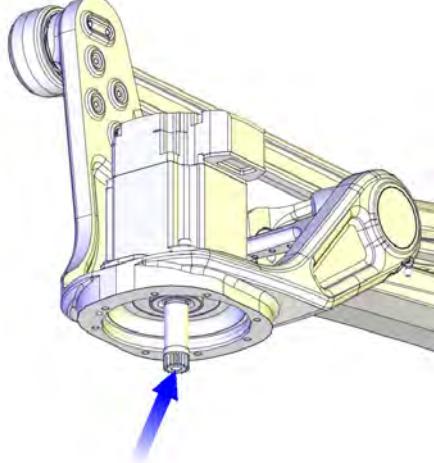
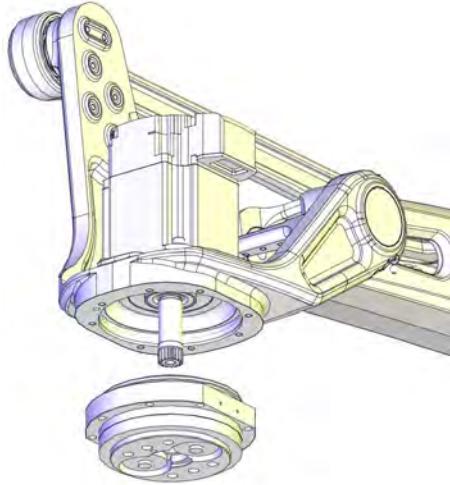
Action	Note
 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2 Make sure the o-ring is undamaged and fitted to the gearbox. If the o-ring is damaged, replace! Lubricate the o-ring with grease.	For art. no. see: Required equipment on page 345 .  xx1100000241
3 Release the brakes of the axis 6 motor manually.	See section <ul style="list-style-type: none"> • Manually releasing the brakes on page 74

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4 Repair

4.6.4 Replacing gearbox axis 6

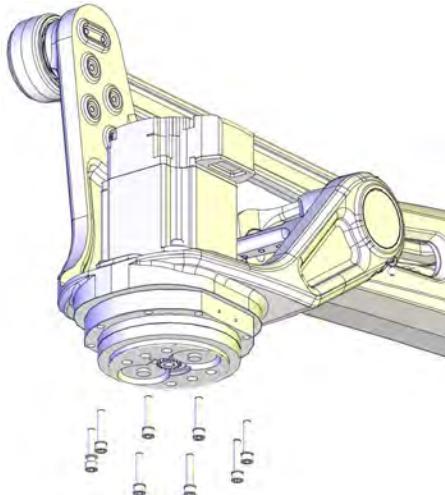
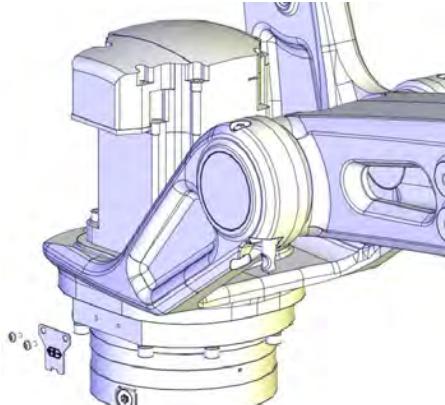
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Action	Note
4 Check that the <i>pinion</i> is undamaged on the axis 6 motor.	 xx1100000240
5 Carefully insert the <i>axis 6 gearbox</i> into the tilthouse, using guide pins. Make sure the gears of the gearbox mate with the pinion of the axis 6 motor.  CAUTION Do not damage pinion or gears in the process!	 xx1100000242

Continues on next page

4.6.4 Replacing gearbox axis 6

Continued

Action	Note
6 Secure the gearbox with its <i>attachment screws and washers</i> . Reused screws may be used, providing they are lubricated as detailed in section Screw joints on page 383 before fitting.	 xx1100000229 M8x40 quality 12.9 Gleitmo (8 pcs) Tightening torque: 30 Nm
7 Refit the <i>turning disk</i> .	See section <ul style="list-style-type: none">Replacing the turning disk on page 189
8 Perform a <i>leak-down test</i> .	See section <ul style="list-style-type: none">See section Performing a leak-down test on page 150.
9 Refill the gearbox with <i>oil</i> .	See section <ul style="list-style-type: none">Changing oil, gearbox axis 6 on page 140
10 Refit the <i>calibration plate</i> .	 xx1100000239
11 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in Calibrating with Axis Calibration method on page 364 . General calibration information is included in section Calibration on page 353 .

Continues on next page

4 Repair

4.6.4 Replacing gearbox axis 6

Continued

	Action	Note
12	 DANGER Make sure all safety requirements are met when performing the first test run. These are further detailed in the section DANGER - First test run may cause injury or damage! <i>on page 48.</i>	

5 Calibration

5.1 Introduction to calibration

5.1.1 Introduction and calibration terminology

Calibration information

This chapter includes general information about the recommended calibration methods and also the detailed procedures for updating the revolution counters, checking the calibration position etc.

Detailed instructions of how to perform Axis Calibration are given on the FlexPendant during the calibration procedure. To prepare calibration with Axis Calibration method, see [Calibrating with Axis Calibration method on page 364](#).

Detailed instructions of how to perform Pendulum Calibration are given in the documentation enclosed with the calibration tools.

Calibration terminology

Term	Definition
Calibration method	A collective term for several methods that might be available for calibrating the ABB robot. Each method contains calibration routines.
Synchronization position	Known position of the complete robot where the angle of each axis can be checked against visual synchronization marks.
Calibration position	Known position of the complete robot that is used for calibration of the robot.
Standard calibration	A generic term for all calibration methods that aim to move the robot to calibration position.
Fine calibration	A calibration routine that generates a new zero position of the robot.
Reference calibration	A calibration routine that generates a new zero position of the robot. This routine is more flexible compared to fine calibration and is used when tools and process equipment are installed. Requires that a reference is created before being used for recalibrating the robot.
Update revolution counter	A calibration routine to make a rough calibration of each manipulator axis.
Synchronization mark	Visual marks on the robot axes. When marks are aligned, the robot is in synchronization position.

5 Calibration

5.1.2 Calibration methods

5.1.2 Calibration methods

Overview

This section specifies the different types of calibration and the calibration methods that are supplied by ABB.

Types of calibration

Type of calibration	Description	Calibration method
Standard calibration	<p>The calibrated robot is positioned at calibration position.</p> <p>Standard calibration data is found on the SMB (serial measurement board) or EIB in the robot.</p> <p>For robots with RobotWare 5.04 or older, the calibration data is delivered in a file, calib.cfg, supplied with the robot at delivery. The file identifies the correct resolver/motor position corresponding to the robot home position.</p>	Axis Calibration or Calibration Pendulum ⁱ
Absolute accuracy calibration (optional)	<p>Based on standard calibration, and besides positioning the robot at synchronization position, the Absolute accuracy calibration also compensates for:</p> <ul style="list-style-type: none">Mechanical tolerances in the robot structureDeflection due to load <p>Absolute accuracy calibration focuses on positioning accuracy in the Cartesian coordinate system for the robot.</p> <p>Absolute accuracy calibration data is found on the SMB (serial measurement board) in the robot.</p> <p>For robots with RobotWare 5.05 or older, the absolute accuracy calibration data is delivered in a file, absacc.cfg, supplied with the robot at delivery. The file replaces the calib.cfg file and identifies motor positions as well as absolute accuracy compensation parameters.</p> <p>A robot calibrated with absolute accuracy has a sticker next to the identification plate of the robot.</p> <p>To regain 100% absolute accuracy performance, the robot must be recalibrated for absolute accuracy!</p>  <p>ABSOLUTE ACCURACY</p> <p>xx0400001197</p>	CalibWare

- ⁱ The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.
Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.
If no data is found related to standard calibration, Calibration Pendulum is used as default.

Continues on next page

Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of all ABB robots (except IRB 6400R, IRB 640, IRB 1400H, and IRB 4400S).

Two different routines are available for the Calibration Pendulum method:

- Calibration Pendulum II
- Reference calibration

The calibration equipment for Calibration Pendulum is delivered as a complete toolkit, including the *Operating manual - Calibration Pendulum*, which describes the method and the different routines further.

Axis Calibration method

Axis Calibration is a standard calibration method for calibration of IRB 460 and is the most accurate method for the standard calibration. It is the recommended method in order to achieve proper performance.

The following routines are available for the Axis Calibration method:

- Fine calibration
- Update revolution counters
- Reference calibration

The calibration equipment for Axis Calibration is delivered as a toolkit.

An introduction to the calibration method is given in this manual, see [Calibrating with Axis Calibration method on page 364](#).

The actual instructions of how to perform the calibration procedure and what to do at each step is given on the FlexPendant. You will be guided through the calibration procedure, step by step.

CalibWare - Absolute Accuracy calibration

To achieve a good positioning in the Cartesian coordinate system, Absolute Accuracy calibration is used as a TCP calibration. The CalibWare tool guides through the calibration process and calculates new compensation parameters. This is further detailed in the *Application manual - CalibWare Field 5.0*.

If a service operation is done to a robot with the option Absolute Accuracy, a new absolute accuracy calibration is required in order to establish full performance. For most cases after motor and transmission replacements that do not include taking apart the robot structure, standard calibration is sufficient. Standard calibration also supports wrist exchange.

References

Article numbers for the calibration tools are listed in the section [Special tools on page 388](#).

The calibration equipment for Calibration Pendulum is delivered as a complete toolkit, including the *Operating manual - Calibration Pendulum*, which describes the method and the different routines further.

5 Calibration

5.1.3 When to calibrate

5.1.3 When to calibrate

When to calibrate

The system must be calibrated if any of the following situations occur.

The resolver values are changed

If resolver values are changed, the robot must be recalibrated using the calibration methods supplied by ABB. Calibrate the robot carefully with standard calibration, according to information in this manual.

If the robot has *absolute accuracy* calibration, it is also recommended, but not always necessary to calibrate for new absolute accuracy.

The resolver values will change when parts affecting the calibration position are replaced on the robot, for example motors or parts of the transmission.

The revolution counter memory is lost

If the revolution counter memory is lost, the counters must be updated. See [Updating revolution counters on page 360](#). This will occur when:

- The battery is discharged
- A resolver error occurs
- The signal between a resolver and measurement board is interrupted
- A robot axis is moved with the control system disconnected

The revolution counters must also be updated after the robot and controller are connected at the first installation.

The robot is rebuilt

If the robot is rebuilt, for example, after a crash or when the reach ability of a robot is changed, it needs to be recalibrated for new resolver values.

If the robot has *absolute accuracy* calibration, it needs to be calibrated for new absolute accuracy.

5.2 Synchronization marks and axis movement directions

5.2 Synchronization marks and axis movement directions

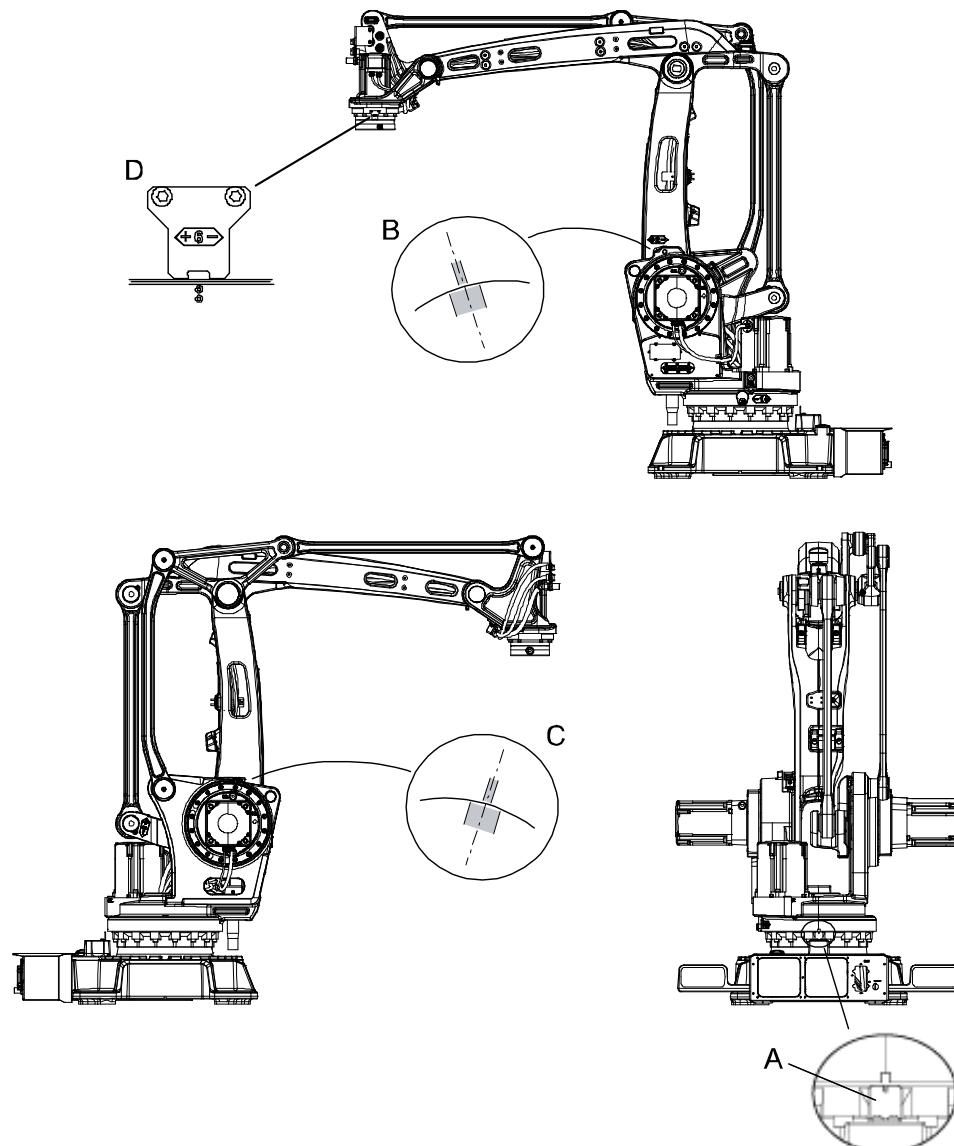
5.2.1 Synchronization marks and synchronization position for axes

Introduction

This section shows the position of the synchronization marks and the synchronization position for each axis.

Synchronization marks, IRB 460

This illustration shows the positions of the calibration scales and marks on the robot.



xx1000001433

A	Calibration plate, axis 1
B	Calibration mark, axis 2

Continues on next page

5 Calibration

5.2.1 Synchronization marks and synchronization position for axes

Continued

C	Calibration mark, axis 3
D	Calibration plate and marking, axis 6

5.2.2 Calibration movement directions for all axes

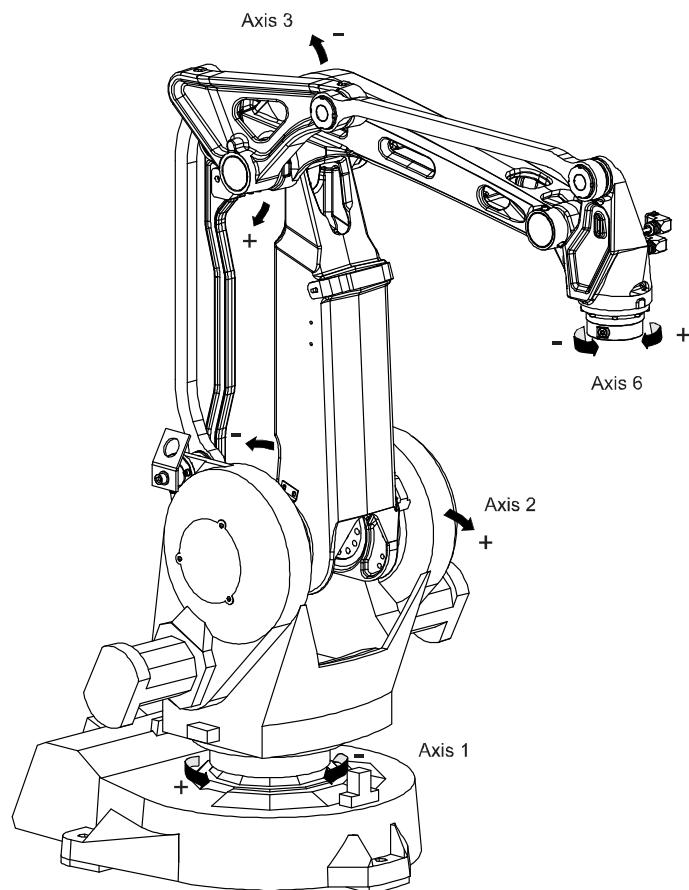
Overview

When calibrating, the axis must consistently be run towards the calibration position in the same direction in order to avoid position errors caused by backlash in gears and so on. Positive directions are shown in the graphic below.

Calibration service routines will handle the calibration movements automatically and these might be different from the positive directions shown below.

Manual movement directions, 4 axes

Note! The graphic shows an IRB 260. The positive direction is the same for all 4-axis robots



xx0500001927

5 Calibration

5.3 Updating revolution counters

5.3 Updating revolution counters

Introduction

This section describes how to do a rough calibration of each manipulator axis by updating the revolution counter for each axis, using the FlexPendant.

Step 1 - Manually running the manipulator to the synchronization position

Use this procedure to manually run the manipulator to the synchronization position.

Action	Note
1 Select axis-by-axis motion mode.	
2 Jog the manipulator to align the synchronization marks.	See Synchronization marks and synchronization position for axes on page 357 .
3 When all axes are positioned, update the revolution counter.	Step 2 - Updating the revolution counter with the FlexPendant on page 361 .

Correct calibration position of axis 4 and 6

When jogging the manipulator to synchronization position, it is extremely important to make sure that axes 4 and 6 of the following mentioned manipulators are positioned correctly. The axes can be calibrated at the wrong turn, resulting in an incorrect manipulator calibration.

Make sure the axes are positioned according to the correct calibration values, not only according to the synchronization marks. The correct values are found on a label, located either on the lower arm, underneath the flange plate on the base or on the frame.

At delivery the manipulator is in the correct position, do NOT rotate axis 4 or 6 at power up before the revolution counters are updated.

If one of the following mentioned axes are rotated one or more turns from its calibration position before updating the revolution counter, the correct calibration position will be lost due to non-integer gear ratio. This affects the following manipulators:

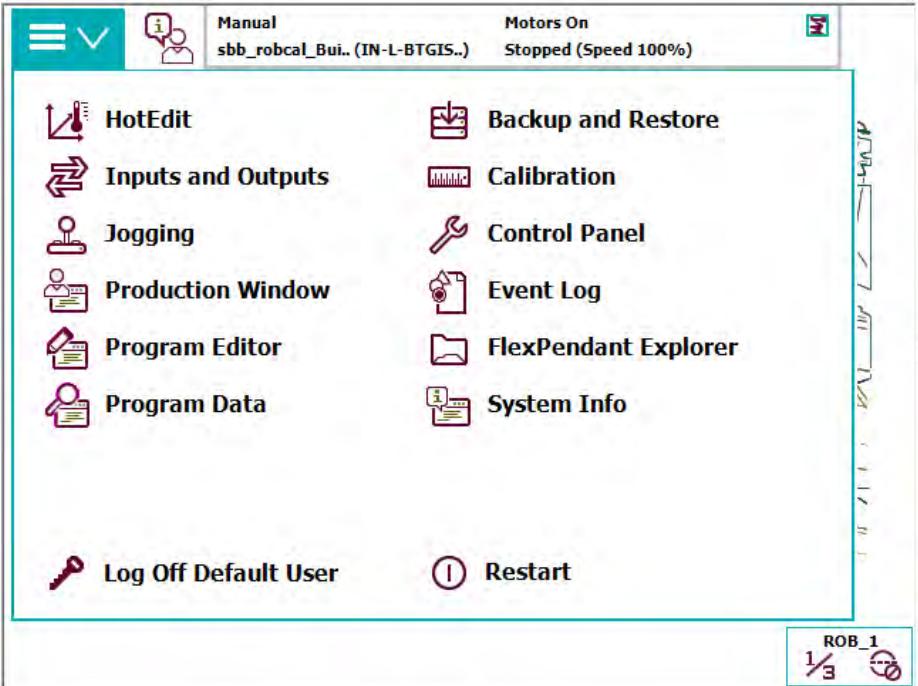
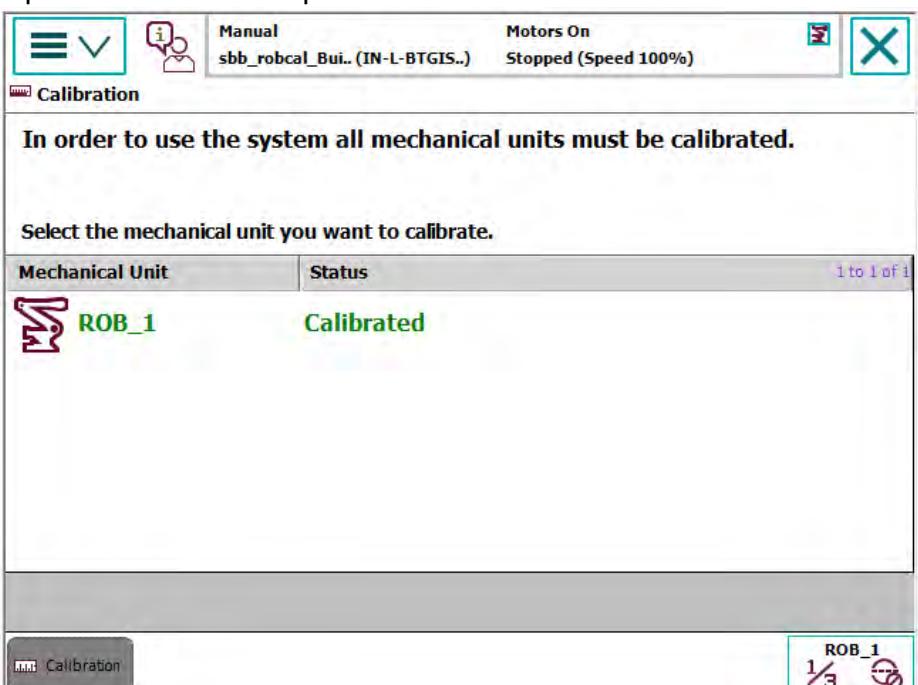
Manipulator variant	Axis 4	Axis 6
IRB 460	No	No

If the synchronization marks seem to be wrong (even if the motor calibration data is correct), try to rotate the axis one turn, update the revolution counter and check the synchronization marks again (try both directions, if needed).

Continues on next page

Step 2 - Updating the revolution counter with the FlexPendant

Use this procedure to update the revolution counter with the FlexPendant (IRC5).

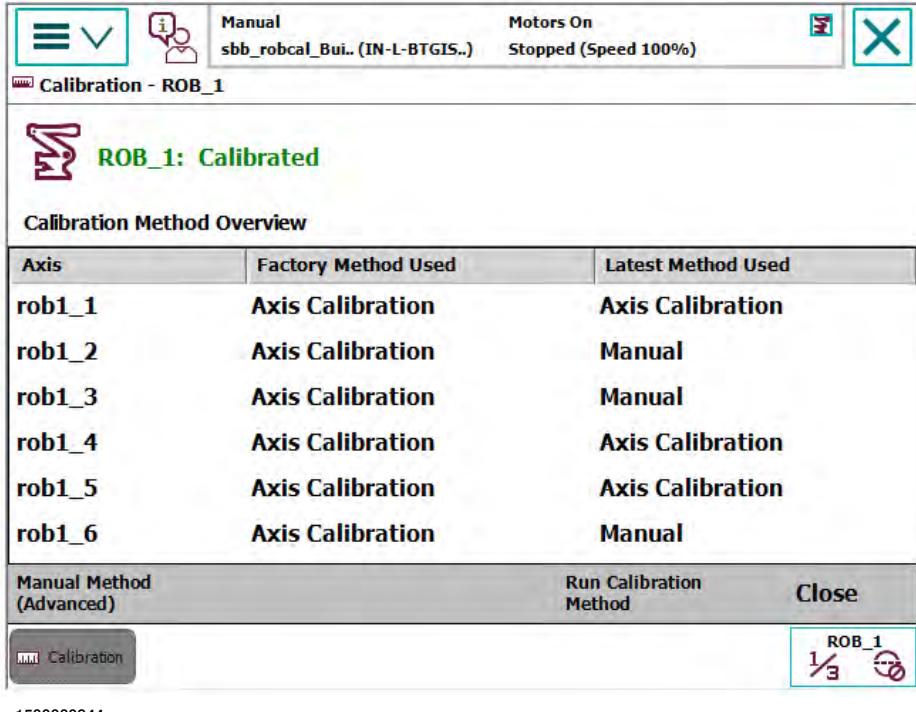
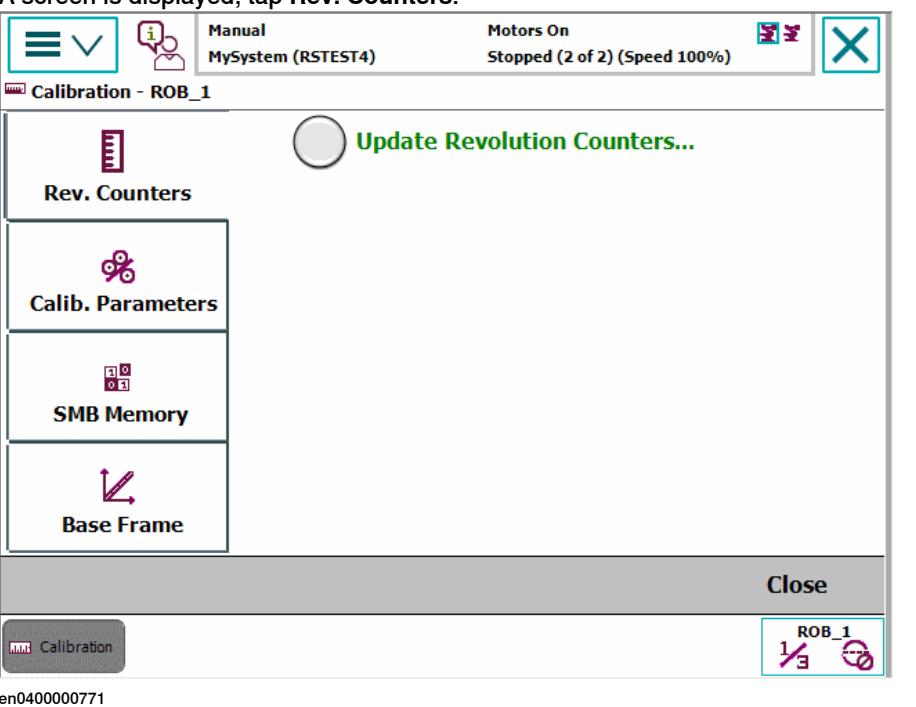
Action
<p>1 On the ABB menu, tap Calibration.</p>  <p>The screenshot shows the ABB menu interface. At the top, there are icons for 'Manual' (blue), 'sbb_robcal_Bui.. (IN-L-BTGIS..)' (grey), 'Motors On' (green), and 'Stopped (Speed 100%)' (green). Below the menu bar is a list of options: HotEdit, Backup and Restore; Inputs and Outputs, Calibration; Jogging, Control Panel; Production Window, Event Log; Program Editor, FlexPendant Explorer; Program Data, System Info. At the bottom left is a 'Log Off Default User' button, and at the bottom right is a 'Restart' button. The status bar at the bottom shows 'xx1500000942'.</p>
<p>2 All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.</p>  <p>The screenshot shows the 'Calibration' screen. At the top, there are icons for 'Manual' (blue), 'sbb_robcal_Bui.. (IN-L-BTGIS..)' (grey), 'Motors On' (green), and 'Stopped (Speed 100%)' (green). Below the title 'Calibration' is a message: 'In order to use the system all mechanical units must be calibrated.' A table titled 'Select the mechanical unit you want to calibrate.' shows one entry: 'Mechanical Unit' (ROB_1) and 'Status' (Calibrated). At the bottom left is a 'Calibration' button, and at the bottom right is a status bar showing 'ROB_1 1/3'.</p>

Continues on next page

5 Calibration

5.3 Updating revolution counters

Continued

Action	
3	<p>This step is valid for RobotWare 6.02 and later.</p> <p>Calibration method used at factory for each axis is shown, as well as calibration method used during last field calibration.</p> <p>Tap Manual Method (Advanced).</p> 
4	<p>A screen is displayed, tap Rev. Counters.</p> 

Continues on next page

Action
5 Tap Update Revolution Counters.... A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: <ul style="list-style-type: none">• Tap Yes to update the revolution counters.• Tap No to cancel updating the revolution counters. Tapping Yes displays the axis selection window.
6 Select the axis to have its revolution counter updated by: <ul style="list-style-type: none">• Ticking in the box to the left• Tapping Select all to update all axes. Then tap Update .
7 A dialog box is displayed, warning that the updating operation cannot be undone: <ul style="list-style-type: none">• Tap Update to proceed with updating the revolution counters.• Tap Cancel to cancel updating the revolution counters. Tapping Update updates the selected revolution counters and removes the tick from the list of axes.
8  CAUTION If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See Checking the synchronization position on page 376 .

5 Calibration

5.4.1 Description of Axis Calibration

5.4 Calibrating with Axis Calibration method

5.4.1 Description of Axis Calibration

Instructions for Axis Calibration procedure given on the FlexPendant

The actual instructions of how to perform the calibration procedure and what to do at each step is given on the FlexPendant. You will be guided through the calibration procedure, step by step.

This manual contains a brief description of the method, additional information to the information given on the FlexPendant, article number for the tools and images of where to fit the calibration tools on the robot.

Overview of the Axis Calibration procedure

The Axis Calibration procedure applies to all axes, and is performed on one axis at the time. The robot axes are both manually and automatically moved into position, as instructed on the FlexPendant.

A fixed calibration pin/bushing is installed on each robot axis at delivery.

The Axis Calibration procedure described roughly:

- A removable calibration tool is inserted by the operator into a calibration bushing on the axis chosen for calibration, according to instructions on the FlexPendant.



WARNING

Calibrating the robot with Axis Calibration requires special calibration tools from ABB. Using other pins in the calibration bushings may cause severe damage to the robot and/or personnel.



WARNING

The calibration tool must be fully inserted into the calibration bushing, until the steel spring ring snaps into place.

- During the calibration procedure, RobotWare moves the robot axis chosen for calibration so that the calibration tools get into contact. RobotWare records values of the axis position and repeats the coming-in-contact procedure several times to get an exact value of the axis position.



WARNING

Risk of pinching! The contact force for large robots can be up to 150 kg. Keep a safe distance to the robot.

- The axis position is stored in RobotWare with an active choice from the operator.

Continues on next page

Routines in the calibration procedure

The following routines are available in the Axis Calibration procedure, given at the beginning of the procedure on the FlexPendant.

Fine calibration routine

Choose this routine to calibrate the robot when there are no tools, process cabling or equipment fitted to the robot.

Reference calibration routine

Choose this routine to create reference values and to calibrate the robot when the robot is dressed with tools, process cabling or other equipment.

If calibrating the robot with reference calibration there must be reference values created before repair is made to the robot, if values are not already available.

Creating new values requires possibility to move the robot. The reference values contain positions of all axes, torque of axes and technical data about the tool installed. The reference value is unique for the current setup of the robot and will be named according to tool name, date etc.

Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values.

When reference calibration is performed, the robot is restored to the status given by the reference values.

Update revolution counters

Choose this routine to make a rough calibration of each manipulator axis by updating the revolution counter for each axis, using the FlexPendant.

Validation

In the mentioned routines, it is also possible to validate the calibration data.

Position of robot axes

The axis chosen for calibration is automatically run by the calibration program to its calibration position during the calibration procedure.

In order for the axis to be able to be moved to calibration position, or in order for getting proper access to the calibration bushing, other axes might need to be jogged to positions different from 0 degrees. Information about which axes are allowed to be jogged will be given on the FlexPendant. These axes are marked with **Unrestricted** in the FlexPendant window.

5 Calibration

5.4.2 Calibration tools for Axis Calibration

5.4.2 Calibration tools for Axis Calibration

Calibration tool set

The calibration tools used for Axis Calibration are designed to meet requirements for calibration performance, durability and safety in case of accidental damage.



WARNING

Calibrating the robot with Axis Calibration requires special calibration tools from ABB. Using other pins in the calibration bushings may cause severe damage to the robot and/or personnel.

Equipment, etc.	Article number	Note
Calibration tool box, Axis Calibration	3HAC058080-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

Examining the calibration tool

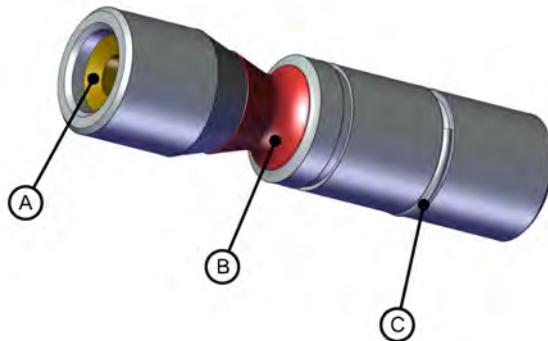
Check prior to usage

Before using the calibration tool, make sure that the tube insert, the plastic protection and the steel spring ring are present.



WARNING

If any part is missing or damaged, the tool must be replaced immediately.



xx1500001914

A	Tube insert
B	Plastic protection
C	Steel spring ring

Periodic check of the calibration tool

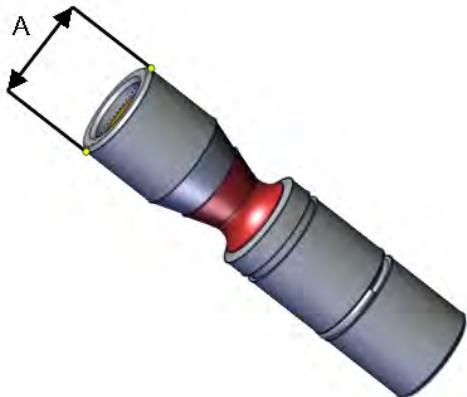
If including the calibration tool in a local periodic check system, the following measures should be checked.

- Outer diameter within Ø12g4 mm, Ø8g4 mm or Ø6g5 mm (depending on calibration tool size).

Continues on next page

5.4.2 Calibration tools for Axis Calibration *Continued*

- Straightness within 0.005 mm.



xx1500000951

A	Outer diameter
---	----------------

5 Calibration

5.4.3 Installation locations for the calibration tools

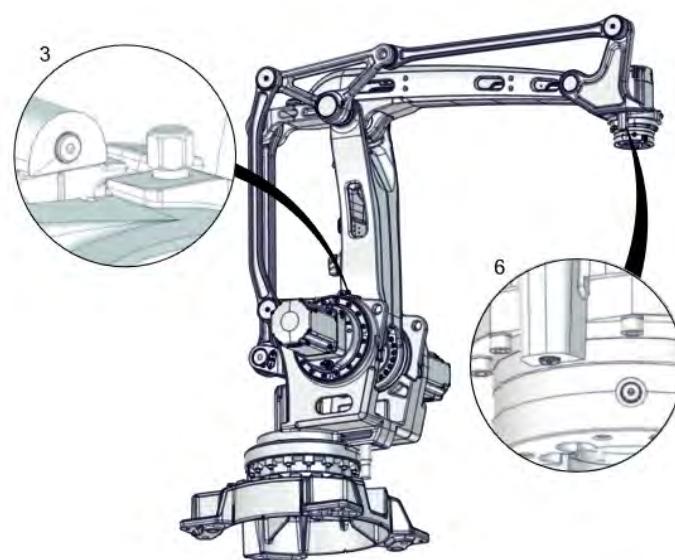
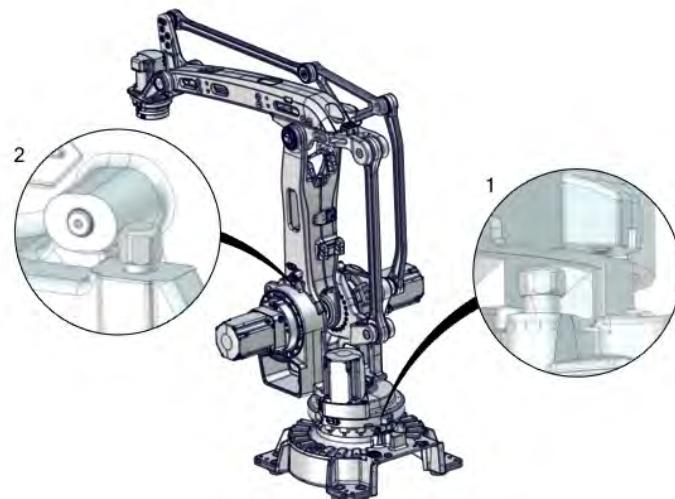
5.4.3 Installation locations for the calibration tools

Location of fixed calibration items

The figure shows how the robot is equipped with items for installation of calibration tools for Axis Calibration (fixed calibration pins and/or bushings). The figure does not show installed calibration tools.

A fixed calibration pin and a bushing for the movable calibration tool are located on each axis as follows.

If there is not enough space on an axis to install a fixed calibration pin, the axis is equipped with two bushings instead, for installation of two calibration tools when calibration is carried out. This is shown in the figure.



Continues on next page

5.4.3 Installation locations for the calibration tools

Continued

Spare parts

When calibration is not being performed, a protective cover and an o-ring should always be installed on the fixed calibration pin as well as a protective plug, included a sealing, in the bushing. Replace damaged parts with new, if needed.

Spare part	Article number	Note
Protection cover and plug set	3HAC059487-001	Contains replacement calibration pin covers and protective plugs for the bushing.

5 Calibration

5.4.4 Axis Calibration - Running the calibration procedure

5.4.4 Axis Calibration - Running the calibration procedure

Required tools

The calibration tools used for Axis Calibration are designed to meet requirements for calibration performance, durability and safety in case of accidental damage.



WARNING

Calibrating the robot with Axis Calibration requires special calibration tools from ABB. Using other pins in the calibration holes may cause severe damage to the robot and/or personnel.

Equipment, etc.	Article number	Note
Calibration tool box, Axis Calibration	3HAC058080-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

Required consumables

Consumable	Article number	Note
Clean cloth	-	

Spare parts

Spare part	Article number	Note
Protection cover and plug set	3HAC059487-001	Contains replacement calibration pin covers and protective plugs for the bushing.

Overview of the calibration procedure on the FlexPendant

The actual instructions of how to perform the calibration procedure and what to do at each step is given on the FlexPendant. You will be guided through the calibration procedure, step by step.

Use the following list to learn about the calibration procedure before running the RobotWare program on the FlexPendant. It gives you a brief overview of the calibration procedure sequence.

After the calibration method has been called for on the FlexPendant, the following sequence will be run.

- 1 Choose calibration routine. The routines are described in [Routines in the calibration procedure on page 365](#).
- 2 Choose which axis/axes to calibrate.
- 3 The robot moves to synchronization position.
- 4 Validate the synchronization marks.
- 5 The robot moves to preparation position.
- 6 Remove the protective cover from the fixed pin and the protection plug from the bushing, if any, and install the calibration tool.

Continues on next page

5.4.4 Axis Calibration - Running the calibration procedure

Continued

- 7 The robot performs a measurement sequence by rotating the axis back and forth.
- 8 Remove the calibration tool and reinstall the protective cover on the fixed pin and the protection plug in the bushing, if any.
- 9 The robot moves to verify that the calibration tool is removed.
- 10 Choose whether to save the calibration data or not.

Calibration of the robot is not finished until the calibration data is saved, as last step of the calibration procedure.

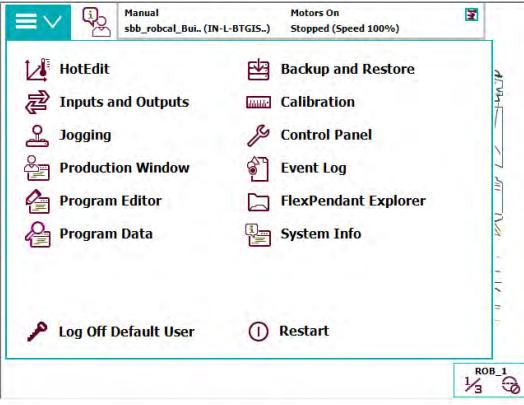
Preparation prior to calibration

The calibration procedure is described in the FlexPendant while conducting it.

Action	Note
1  DANGER While conducting the calibration, the robot needs to be connected to power. Make sure that the robots working area is empty, as the robot can make unpredictable movements.	
2  Note The calibration method is exact. Dust, dirt or color flakes will affect the calibration value.	Use a clean cloth.

Starting the calibration procedure

Use this procedure to call for the Axis Calibration method on the FlexPendant.

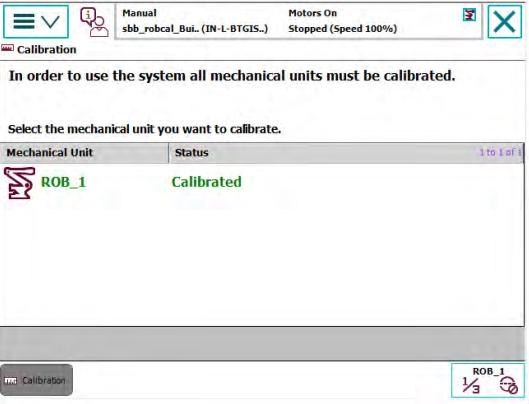
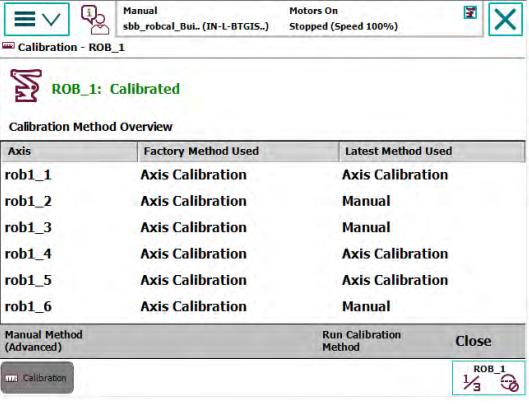
Action	Note
1 On the ABB menu, tap Calibration. 	

Continues on next page

5 Calibration

5.4.4 Axis Calibration - Running the calibration procedure

Continued

Action	Note
<p>2 All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.</p> 	
<p>3 Calibration method used at factory for each axis is shown, as well as calibration method used for the robot during last field calibration. Tap Run Calibration Method. The software will automatically call for the procedure for the valid calibration method.</p> 	The FlexPendant will give all information needed to proceed with Axis Calibration.
<p>4 Follow the instructions given on the FlexPendant.</p>	A brief overview of the sequence that will be run on the FlexPendant is given in Overview of the calibration procedure on the FlexPendant on page 370 .

Restarting an interrupted calibration procedure

If the Axis Calibration procedure is interrupted before the calibration is finished, the RobotWare program needs to be started again. Use this procedure to take required action.

Situation	Action
The three-position enabling device on the FlexPendant has been released during robot movement.	Press and hold the three-position enabling device and press Play.

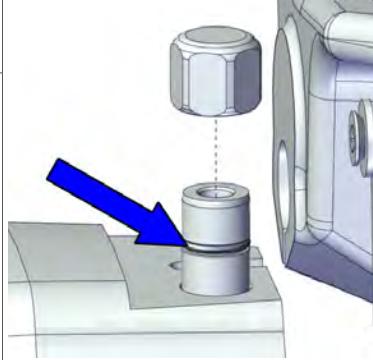
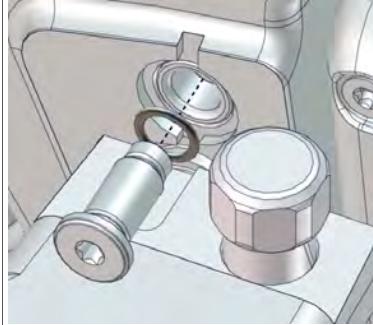
Continues on next page

5.4.4 Axis Calibration - Running the calibration procedure

Continued

Situation	Action
The RobotWare program is terminated with PP to Main.	<p>Remove the calibration tool, if it is installed, and restart the calibration procedure from the beginning. See Starting the calibration procedure on page 371.</p> <p>If the calibration tool is in contact the robot axis needs to be jogged in order to release the calibration tool. Jogging the axis in wrong direction will cause the calibration tool to break. Directions of axis movement is shown in Calibration movement directions for all axes on page 359</p>

After calibration

	Action	Note
1	Check the o-ring on the fixed calibration pin. Replace if damaged or missing.	
2	Reinstall the protective cover on the fixed calibration pin on each axis, directly after the axis has been calibrated. Replace the cover with new spare part, if missing or damaged.	 xx1600002102 Protection cover and plug set: 3HAC059487-001.
3	Reinstall the protective plug and sealing in the bushing on each axis, directly after the axis has been calibrated. Ensure that the sealing is not damaged. Replace the plug and the sealing with new spare part, if missing or damaged.	 xx1500000952 Protection cover and plug set: 3HAC059487-001.

5 Calibration

5.5 Calibrating with Calibration Pendulum method

5.5 Calibrating with Calibration Pendulum method

Where to find information for Calibration Pendulum

Detailed instructions of how to perform Pendulum Calibration are given in the documentation enclosed with the calibration tools.

5.6 Verifying the calibration

Introduction

Always verify the results after calibrating *any* robot axis to verify that all calibration positions are correct.

Verifying the calibration

Use this procedure to verify the calibration result.

	Action	Note
1	Run the calibration home position program twice. Do not change the position of the robot axes after running the program!	See Checking the synchronization position on page 376 .
2	Adjust the <i>synchronization marks</i> when the calibration is done, if necessary.	This is detailed in section Synchronization marks and synchronization position for axes on page 357 .
3	Write down the values on a new label and stick it on top of the calibration label. The label is located on the lower arm.	
4	Remove any calibration equipment from the robot.	

5 Calibration

5.7 Checking the synchronization position

5.7 Checking the synchronization position

Introduction

Check the synchronization position of the robot before beginning any programming of the robot system. This may be done:

- Using a **MoveAbsJ** instruction with argument zero on all axes.
- Using the **Jogging** window on the FlexPendant.

Using a **MoveAbsJ** instruction

Use this procedure to create a program that runs all the robot axes to their synchronization position.

	Action	Note
1	On ABB menu tap Program editor .	
2	Create a new program.	
3	Use MoveAbsJ in the Motion&Proc menu.	
4	Create the following program: <pre>MoveAbsJ [[0,0,0,0,0,0], [9E9,9E9,9E9,9E9,9E9,9E9]] \NoEOffs, v1000, fine, tool0</pre>	
5	Run the program in manual mode.	
6	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See Synchronization marks and synchronization position for axes on page 357 and Updating revolution counters on page 360 .

Using the jogging window

Use this procedure to jog the robot to the synchronization position of all axes.

	Action	Note
1	On the ABB menu, tap Jogging .	
2	Tap Motion mode to select group of axes to jog.	
3	Tap to select the axis to jog, axis 1, 2, or 3.	
4	Manually run the robots axes to a position where the axis position value read on the FlexPendant, is equal to zero.	
5	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See Synchronization marks and synchronization position for axes on page 357 and Updating revolution counters on page 360 .

6 Decommissioning

6.1 Environmental information

Hazardous material

The table specifies some of the materials in the product and their respective use throughout the product.

Dispose components properly to prevent health or environmental hazards.

Material	Example application
Batteries, NiCad or Lithium	Serial measurement board
Copper	Cables, motors
Cast iron/nodular iron	Base, lower arm, upper arm
Steel	Gears, screws, base frame, and so on.
Neodymium	Brakes, motors
Plastic/rubber	Cables, connectors, drive belts, and so on.
Oil, grease	Gearboxes
Aluminium	Covers, synchronization brackets

Oil and grease

Where possible, arrange for oil and grease to be recycled. Dispose of via an authorized person/contractor in accordance with local regulations. Do not dispose of oil and grease near lakes, ponds, ditches, down drains, or onto soil. Incineration must be carried out under controlled conditions in accordance with local regulations.

Also note that:

- Spills can form a film on water surfaces causing damage to organisms. Oxygen transfer could also be impaired.
- Spillage can penetrate the soil causing ground water contamination.

6 Decommissioning

6.2 Scrapping of robot

6.2 Scrapping of robot

Important when scrapping the robot



DANGER

When a robot is disassembled while being scrapped, it is very important to remember the following before disassembling starts, in order to prevent injuries:

- Always remove all batteries from the robot. If a battery is exposed to heat, for example from a blow torch, it will explode.
- Always remove all oil/grease in gearboxes. If exposed to heat, for example from a blow torch, the oil/grease will catch fire.
- When motors are removed from the robot, the robot will collapse if it is not properly supported before the motor is removed.

7 Reference information

7.1 Introduction

General

This chapter includes general information, complementing the more specific information in the different procedures in the manual.

7 Reference information

7.2 Applicable standards

7.2 Applicable standards



Note

The listed standards are valid at the time of the release of this document. Phased out or replaced standards are removed from the list when needed.

Standards, EN ISO

The product is designed in accordance with the requirements of:

Standard	Description
EN ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 13849-1	Safety of machinery, safety related parts of control systems - Part 1: General principles for design
EN ISO 13850	Safety of machinery - Emergency stop - Principles for design
EN ISO 10218-1	Robots for industrial environments - Safety requirements -Part 1 Robot
EN ISO 9787	Robots and robotic devices -- Coordinate systems and motion nomenclatures
EN ISO 9283	Manipulating industrial robots, performance criteria, and related test methods
EN ISO 14644-1 ⁱ	Classification of air cleanliness
EN ISO 13732-1	Ergonomics of the thermal environment - Part 1
EN IEC 61000-6-4 (option 129-1)	EMC, Generic emission
EN IEC 61000-6-2	EMC, Generic immunity
EN IEC 60974-1 ⁱⁱ	Arc welding equipment - Part 1: Welding power sources
EN IEC 60974-10 ⁱⁱ	Arc welding equipment - Part 10: EMC requirements
EN IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1 General requirements
IEC 60529	Degrees of protection provided by enclosures (IP code)

ⁱ Only robots with protection Clean Room.

ⁱⁱ Only valid for arc welding robots. Replaces EN IEC 61000-6-4 for arc welding robots.

European standards

Standard	Description
EN 614-1	Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles
EN 574	Safety of machinery - Two-hand control devices - Functional aspects - Principles for design

Continues on next page

Other standards

Standard	Description
ANSI/RIA R15.06	Safety requirements for industrial robots and robot systems
ANSI/UL 1740	Safety standard for robots and robotic equipment
CAN/CSA Z 434-14	Industrial robots and robot Systems - General safety requirements

7 Reference information

7.3 Unit conversion

7.3 Unit conversion

Converter table

Use the following table to convert units used in this manual.

Quantity	Units		
Length	1 m	3.28 ft.	39.37 in
Weight	1 kg	2.21 lb.	
Weight	1 g	0.035 ounces	
Pressure	1 bar	100 kPa	14.5 psi
Force	1 N	0.225 lbf	
Moment	1 Nm	0.738 lbf-ft	
Volume	1 L	0.264 US gal	

7.4 Screw joints

General

This section describes how to tighten the various types of screw joints on the IRB 460.

The instructions and torque values are valid for screw joints comprised of metallic materials and do *not* apply to soft or brittle materials.

UNBRAKO screws

UNBRAKO is a special type of screw recommended by ABB for certain screw joints. It features special surface treatment (Gleitmo as described below) and is extremely resistant to fatigue.

Whenever used, this is specified in the instructions, and in such cases, *no other type of replacement screw* is allowed. Using other types of screws will void any warranty and may potentially cause serious damage or injury.

Gleitmo treated screws

Gleitmo is a special surface treatment to reduce the friction when tightening the screw joint. Screws treated with Gleitmo may be reused 3-4 times before the coating disappears. After this the screw must be discarded and replaced with a new one.

When handling screws treated with Gleitmo, protective gloves of **nitrile rubber** type should be used.

Screws lubricated in other ways

Screws lubricated with Molycote 1000 should *only* be used when specified in the repair, maintenance or installation procedure descriptions.

In such cases, proceed as follows:

- 1 Apply lubricant to the screw thread.
- 2 Apply lubricant between the plain washer and screw head.
- 3 Screw dimensions of M8 or larger must be tightened with a torque wrench. Screw dimensions of M6 or smaller may be tightened without a torque wrench if this is done by trained and qualified personnel.

Lubricant	Article number
Molycote 1000 (molybdenum disulphide grease)	11712016-618

Tightening torque

Before tightening any screw, note the following:

- Determine whether a **standard** tightening torque or **special** torque is to be applied. The **standard** torques are specified in the following tables. Any **special** torques are specified in the repair, maintenance or installation procedure descriptions. **Any special torque specified overrides the standard torque!**
- Use the *correct* tightening torque for each type of screw joint.
- Only use *correctly calibrated* torque keys.

Continues on next page

7 Reference information

7.4 Screw joints

Continued

- Always *tighten the joint by hand*, and never use pneumatic tools.
- Use the *correct tightening technique*, that is *do not jerk*. Tighten the screw in a slow, flowing motion.
- Maximum allowed total deviation from the specified value is 10%!

Oil-lubricated screws with slotted or cross-recess head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws with slotted or cross-recess head screws*. Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Oil-lubricated screws with allen head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws with allen head screws*. Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Dimension	Tightening torque (Nm) Class 8.8, oil-lubricated	Tightening torque (Nm) Class 10.9, oil-lubricated	Tightening torque (Nm) Class 12.9, oil-lubricated
M5	6	-	-
M6	10	-	-
M8	24	34	40
M10	47	67	80
M12	82	115	140
M16	200	290	340
M20	400	560	670
M24	680	960	1150

Lubricated screws (Molykote, Gleitmo or equivalent) with allen head screws

The following table specifies the recommended standard tightening torque for *screws lubricated with Molykote 1000, Gleitmo 603 or equivalent with allen head screws*. Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Dimension	Tightening torque (Nm) Class 10.9, lubricated ⁱ	Tightening torque (Nm) Class 12.9, lubricated ⁱ
M8	28	35
M10	55	70
M12	96	120
M16	235	280
M20	460	550
M24	790	950

ⁱ Lubricated with Molykote 1000, Gleitmo 603 or equivalent

Continues on next page

Water and air connectors

The following table specifies the recommended standard tightening torque for *water and air connectors* when *one or both* connectors are made of *brass*. Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Dimension	Tightening torque Nm - Nominal	Tightening torque Nm - Min.	Tightening torque Nm - Max.
1/8	12	8	15
1/4	15	10	20
3/8	20	15	25
1/2	40	30	50
3/4	70	55	90

7 Reference information

7.5 Weight specifications

7.5 Weight specifications

Definition

In installation, repair, and maintenance procedures, weights of the components handled are sometimes specified. All components exceeding 22 kg (50 lbs) are highlighted in this way.

To avoid injury, ABB recommends the use of a lifting accessory when handling components with a weight exceeding 22 kg. A wide range of lifting accessories and devices are available for each manipulator model.

Example

Following is an example of a weight specification in a procedure:

	Action	Note
	 CAUTION The robot weighs 925 kg. All lifting accessories used must be sized accordingly!	

7.6 Standard tools

General

All service (repairs, maintenance, and installation) procedures contains lists of tools required to perform the specified activity.

All special tools required are listed directly in the procedures while all the tools that are considered standard are gathered in the standard toolkit and defined in the following table.

This way, the tools required are the sum of the standard toolkit and any tools listed in the instruction.

Contents, standard toolkit

Qty	Tool	Rem.
1	Ring-open-end spanner 8-19 mm	
1	Socket head cap 5-17 mm	
1	Torx socket no: 20-60	
1	Box spanner set	
1	Torque wrench 10-100 Nm	
1	Torque wrench 75-400 Nm	
1	Ratchet head for torque wrench 1/2	
2	Hexagon-headed screw M10x100	
1	Hexagon-headed screw M16x90	
1	Hex bit socket head cap no. 14 socket 40 mm L=100 mm	
1	Hex bit socket head cap no. 14 socket 40 mm L=20 mm	To be shortened to 12 mm
1	Hex bit socket head cap no. 6 socket 40 mm L=145 mm	
1	Hex bit socket head cap no. 6 socket 40mm bit L=220 mm	
1	Multigrip plier	
1	Plastic mallet	

7 Reference information

7.7 Special tools

7.7 Special tools

General

All service instructions contain lists of tools required to perform the specified activity. The required tools are a sum of standard tools, defined in the section [Standard tools on page 387](#), and of special tools, listed directly in the instructions and also gathered in this section.

Calibration equipment, Calibration Pendulum

The following table specifies the calibration equipment needed when calibrating the robot with the Calibration Pendulum method.

The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.

Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.

If no data is found related to standard calibration, Calibration Pendulum is used as default.

Description	Art. no.	Note
Calibration Pendulum toolkit	3HAC15716-1	Complete kit that also includes operating manual.

Calibration equipment, Axis Calibration

The following table specifies the calibration equipment needed when calibrating the robot with the Axis Calibration method.

The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.

Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.

If no data is found related to standard calibration, Calibration Pendulum is used as default.

Description	Art. no.	Note
Calibration tool box, Axis Calibration	3HAC058080-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

Special tools

This table specifies the special tools required during several of the service procedures. The tools are specied directly in concerned instructions.

Description	Qty	Article no.
Guide pins M12x130	2	3HAC022637-001
Guide pins M10x150	2	3HAC13120-2

Continues on next page

Description	Qty	Article no.
Guide pins M10x140 (Used with one of the M10x150 guide pins when replacing the axis 2 and 3 gear-boxes)	1	-
Lifting eye M12	2	3HAC025333-005
Adapter (used with lifting eye M12)	2	3HAC040381-001
Shackle, lifting capacity 1,000 kg (Used with lifting eye M12)	2	-
Lifting eye bolt, M20	2	-
Shackle, lifting capacity 2,000 kg (Used with lifting eye bolt M20)	2	-
Crank	1	-
Press tool, premounting outer race bearing The tool consists of: <ul style="list-style-type: none">• 3HAC040028-002 Pressing tool for bearing• 3HAC040028-003 Pressing tool for bearing• 3HAC040021-004 Pressing tool• 3HAC040021-005 Hollow cylinder RCH 123• 3HAC040022-004 Threaded bar M16	1	3HAC040028-001
Press tool, replacing shaft tilthouse The tool consists of: <ul style="list-style-type: none">• 3HAC040029-002 Pressing tool bearing• 3HAC040029-003 Pressing tool bearing• 3HAC040021-004 Pressing tool• 3HAC040021-005 Hollow cylinder RCH 123• 3HAC040022-004 Threaded bar M16 length 450 mm (removal). For refitting length 350 mm.	1	3HAC040029-001
Auxiliary shaft Used together with press tool 3HAC040029-001 (only when removing).	1	3HAC040035-001
KM7 socket	1	3HAC040025-001
Adapter	1	3HAC040027-001

Continues on next page

7 Reference information

7.7 Special tools

Continued

Description	Qty	Article no.
Press tool, upper arm The tool is also used as Pull tool. <i>Difference:</i> Press bushing is used instead of support bushing. The tool consists of: <ul style="list-style-type: none">• 3HAC040026-003 Press bushing• 3HAC040026-002 Pressing tool upper arm• 3HAC040021-004 Thread washer• 3HAC040021-005 Hollow cylinder RCH 123• 3HAC040022-004 Threaded bar M16 length 350 mm.	1	3HAC040026-001
Pull tool, upper arm The tool is also used as Press tool. <i>Difference:</i> Support bushing is used instead of Press bushing. The tool consists of: <ul style="list-style-type: none">• 3HAC040026-004 Support bushing• 3HAC040026-002 Pressing tool upper arm• 3HAC040021-004 Thread washer• 3HAC040021-005 Hollow cylinder RCH 123• 3HAC040022-004 Threaded bar M16 length 350 mm.	1	3HAC040026-001
KM12 socket	1	3HAC040023-001
Auxiliary shaft	1	3HAC040022-002
Press tool link, bearing outer races	1	3HAC040030-001
Lower part of pressing tool	1	3HAC040031-001
Press tool, link The tool consists of: <ul style="list-style-type: none">• 3HAC040022-002 Pressing tool• 3HAC040022-003 Pressing tool• 3HAC040021-004 Pressing tool• 3HAC040021-005 Hollow cylinder RCH 123• 3HAC040022-004 Threaded bar M16 length 350 mm.	1	3HAC040022-001
KM8 socket	1	3HAC040024-001
Mounting/Demounting tool (Parallel rod) The tool consists of: <ul style="list-style-type: none">• 3HAC040021-004 Pressing tool• 3HAC040021-002 Pressing tool• 3HAC040021-003 Pressing tool• 3HAC040021-005 Hollow cylinder RCH 123• 3HAC040021-006 Threaded bar M16 length 530 mm.	1	3HAC040021-001
Shims thickness 8 mm	1	-

Continues on next page

Description	Qty	Article no.
Rotation tool	1	-
Screw M12x100 Fully threaded	2	-
Screw M12x60 Fully threaded	2	-
Bits extension	1	3HAC023760-001
Bits holder Stahlwille 736/40 D10 (or similar)	1	-
Lifting accessory, motor axes 2-3	1	3HAC14586-1
Support, base and gear ax 1	1	3HAC15535-1
Lifting accessory, base and gear ax 1	1	3HAC15556-1
Lifting accessory	1	3HAC025214-001
Oil collecting vessel capacity 8,000 ml	1	-
Oil exchange equipment	1	3HAC021745-001

7 Reference information

7.8 Lifting accessories and lifting instructions

General

Many repair and maintenance activities require different pieces of lifting accessories, which are specified in each procedure.

The use of each piece of lifting accessories is *not* detailed in the activity procedure, but in the instruction delivered with each piece of lifting accessories.

This implies that the instructions delivered with the lifting accessories should be stored for later reference.

8 Spare parts

8.1 Spare part lists and illustrations

Location

Spare parts and exploded views are not included in the manual but delivered as a separate document on the documentation DVD.

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9 Circuit diagrams

9.1 Circuit diagrams

Overview

The circuit diagrams are not included in this manual, but delivered as separate documents on the documentation DVD. See the article numbers in the tables below.

Controllers

Product	Article numbers for circuit diagrams
<i>Circuit diagram - IRC5</i>	<i>3HAC024480-011</i>
<i>Circuit diagram - IRC5 Compact</i>	<i>3HAC049406-003</i>
<i>Circuit diagram - IRC5 Panel Mounted Controller</i>	<i>3HAC026871-020</i>
<i>Circuit diagram - Euromap</i>	<i>3HAC024120-004</i>
<i>Circuit diagram - Spot welding cabinet</i>	<i>3HAC057185-001</i>

Robots

Product	Article numbers for circuit diagrams
<i>Circuit diagram - IRB 120</i>	<i>3HAC031408-003</i>
<i>Circuit diagram - IRB 140 type C</i>	<i>3HAC6816-3</i>
<i>Circuit diagram - IRB 260</i>	<i>3HAC025611-001</i>
<i>Circuit diagram - IRB 360</i>	<i>3HAC028647-009</i>
<i>Circuit diagram - IRB 460</i>	<i>3HAC036446-005</i>
<i>Circuit diagram - IRB 660</i>	<i>3HAC025691-001</i>
<i>Circuit diagram - IRB 760</i>	<i>3HAC025691-001</i>
<i>Circuit diagram - IRB 1200</i>	<i>3HAC046307-003</i>
<i>Circuit diagram - IRB 1410</i>	<i>3HAC2800-3</i>
<i>Circuit diagram - IRB 1600/1660</i>	<i>3HAC021351-003</i>
<i>Circuit diagram - IRB 1520</i>	<i>3HAC039498-007</i>
<i>Circuit diagram - IRB 2400</i>	<i>3HAC6670-3</i>
<i>Circuit diagram - IRB 2600</i>	<i>3HAC029570-007</i>
<i>Circuit diagram - IRB 4400/4450S</i>	<i>3HAC9821-1</i>
<i>Circuit diagram - IRB 4600</i>	<i>3HAC029038-003</i>
<i>Circuit diagram - IRB 6400RF</i>	<i>3HAC8935-1</i>
<i>Circuit diagram - IRB 6600 type A</i>	<i>3HAC13347-1 3HAC025744-001</i>
<i>Circuit diagram - IRB 6600 type B</i>	<i>3HAC13347-1 3HAC025744-001</i>
<i>Circuit diagram - IRB 6620</i>	<i>3HAC025090-001</i>

Continues on next page

9 Circuit diagrams

9.1 Circuit diagrams

Continued

Product	Article numbers for circuit diagrams
<i>Circuit diagram - IRB 6620 / IRB 6620LX</i>	<i>3HAC025090-001</i>
<i>Circuit diagram - IRB 6640</i>	<i>3HAC025744-001</i>
<i>Circuit diagram - IRB 6650S</i>	<i>3HAC13347-1</i> <i>3HAC025744-001</i>
<i>Circuit diagram - IRB 6660</i>	<i>3HAC025744-001</i> <i>3HAC029940-001</i>
<i>Circuit diagram - IRB 6700</i>	<i>3HAC043446-005</i>
<i>Circuit diagram - IRB 7600</i>	<i>3HAC13347-1</i> <i>3HAC025744-001</i>
<i>Circuit diagram - IRB 14000</i>	<i>3HAC050778-003</i>
<i>Circuit diagram - IRB 910SC</i>	<i>3HAC056159-002</i>

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