



# Product manual

## IRB 4600

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**Workspace R17-1 version a7**

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**Product manual**

**IRB 4600 - 60/2.05**

**IRB 4600 - 45/2.05**

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**IRB 4600 - 20/2.50**

**IRC5**

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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 robot described in this manual has the protection type *Standard* and *Foundry Plus*.

## 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 and calibration.

## 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 the robot. Contains general safety aspects as well as more specific information on 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 to plan 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.

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## 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 / part list	Complete spare part list and complete list of robot components, shown in exploded views.
Exploded views	Detailed illustrations of the robot with reference numbers to the part list.
Circuit diagram	Reference to the circuit diagram for the robot..

## References

Reference	Document ID
<i>Product manual - IRB 4600 Foundry Prime</i>	3HAC040585-001
<i>Product specification - IRB 4600</i>	3HAC032885-001
<i>Product manual, spare parts - IRB 4600</i>	3HAC049108-001
<i>Circuit diagram - IRB 4600</i>	3HAC029038-003
<i>Operating manual - General safety information</i> <sup>i</sup>	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 - Emergency safety information</i>	3HAC027098-001
<i>Operating manual - IRC5 with FlexPendant</i>	3HAC050941-001
<i>Operating manual - Trouble shooting IRC5</i>	3HAC020738-001
<i>Operating manual - Calibration Pendulum</i>	3HAC16578-1
<i>Operating manual - Service Information System</i>	3HAC050944-001
<i>Technical reference manual - Lubrication in gearboxes</i>	3HAC042927-001
<i>Technical reference manual - System parameters</i>	3HAC050948-001
<i>Application manual - Additional axes and stand alone controller</i>	3HAC051016-001
<i>Application manual - Electronic Position Switches</i>	3HAC050996-001
<i>Application manual - CalibWare Field 5.0</i>	3HAC030421-001

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

## Revisions

Revision	Description
-	First edition

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Revision	Description
A	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>• New <b>WARNING!</b> added in <i>Safety chapter</i> section <a href="#">Work inside the working range of the robot on page 40</a>.</li> <li>• New <b>WARNING!</b> added in <i>Safety chapter</i> section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a>.</li> <li>• Information about the quality and used threadlength for attachment screws on mounting flange, added in <i>Installation chapter</i> section <a href="#">Fitting equipment on wrist and mounting flange on page 90</a>.</li> <li>• The text in the introduction to chapters <i>Installation</i>, <i>Maintenance</i> and <i>Repair</i> has been updated concerning the robot being connected to earth when power connected.</li> <li>• Levelmeter calibration added in sections <a href="#">Brief description of calibration methods on page 341</a> and <a href="#">Calibration equipment, Levelmeter (alternative method) on page 384</a>.</li> <li>• Section <a href="#">Upper arm (2.05/2.50/2.55)</a> in Spare parts updated with Type A spare parts.</li> <li>• Section <a href="#">Lifting and turning a suspended mounted robot on page 74</a> added in Installation chapter.</li> <li>• Section <a href="#">Installation of Foundry Plus Cable guard (option no. 908-1) on page 106</a> added in Installation chapter.</li> <li>• New <b>DANGER!</b> added in section <a href="#">Manually releasing the brakes on page 75</a>.</li> <li>• Restricting working range with software added in section <a href="#">Mechanically restricting the working range of axis 1 on page 96</a>.</li> <li>• The sections describing <i>Replacing motors</i> axes 1 through 6 has been updated. Two new sections <a href="#">Removing motors on page 295</a> and <a href="#">Refitting motors on page 303</a> replaces the older ones.</li> </ul>
B	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>• Missing text "type A" for armhousing 3HAC034549-005 added in chapter <i>Spare parts</i> section <a href="#">Upper arm (2.05/2.50/2.55)</a>.</li> <li>• Wrist Foundry added in chapter <i>Spare parts</i>, section <a href="#">Wrist unit (20 kg and 45/60kg)</a>.</li> <li>• Motors in wrist as rebuilding parts added in section <i>Rebuilding parts</i> in <i>Spare parts IRB 4600</i>.</li> <li>• How to adjust the play on motors axes 4-6 and on wrist added in sections <a href="#">Replacing motors, axes 4, 5 and 6</a> and <a href="#">Replacing wrist unit on page 272</a>.</li> <li>• Correction of required oil level, see <a href="#">Inspecting oil level, axis 1 gearbox on page 124</a>.</li> </ul> <p>In chapter <i>Safety</i> :</p> <ul style="list-style-type: none"> <li>• Updated safety signal graphics for levels <i>Danger</i> and <i>Warning</i>, see <a href="#">Safety signals in the manual on page 42</a>.</li> <li>• New safety labels on the manipulators, see <a href="#">Safety symbols on product labels on page 44</a>.</li> <li>• Revised terminology: <i>robot</i> replaced with <i>manipulator</i>.</li> </ul>

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## Overview of this manual

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Revision	Description
C	The following updates have been made in this revision: <ul style="list-style-type: none"><li>• Added <a href="#">Installing an expansion container on page 107</a>.</li><li>• A figure showing IRB 2600 removed in section <a href="#">Orienting and securing the robot on page 78</a>.</li><li>• Section <a href="#">Installation of Foundry Plus Cable guard (option no. 908-1) on page 106</a> added.</li><li>• Updated the section <a href="#">Start of robot in cold environments on page 111</a>.</li><li>• Interval for inspection of signal lamp added in section <a href="#">Maintenance schedule on page 121</a>.</li><li>• New design of frame added in sections <a href="#">Inspecting oil level, axis 1 gearbox on page 124</a> and <a href="#">Changing the oil, axis-1 gearbox on floor mounted robots on page 160</a>.</li><li>• Figure showing required oil level added in section <a href="#">Inspecting oil level, axis 1 gearbox on page 124</a>.</li><li>• Inspection of oil level on suspended robot updated in section <a href="#">Inspecting oil level, axis 1 gearbox on page 124</a>.</li></ul>
D	The following updates have been made in this revision: <ul style="list-style-type: none"><li>• Added information about the bracket on the mechanical stop pin axis 1 has been updated in section <a href="#">Mechanically restricting the working range of axis 1 on page 96</a>, <a href="#">Inspecting the mechanical stop pin, axis 1 on page 147</a> and <a href="#">Replacing stop pin axis 1 on page 292</a></li><li>• All information about Foundry Prime is removed from the manual. This manual now only contains information for a Standard IRB 4600. The instructions for a IRB 4600 Foundry prime can be found in a separate manual. For art. No. See <a href="#">References on page 10</a>.</li></ul>

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Revision	Description
E	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>• A new block, about general illustrations, added in section <a href="#">How to read the product manual on page 18</a>.</li> <li>• Figure and describing text edited for the stress forces. Also, the actual values of the stress forces are updated. See <a href="#">Loads on foundation, robot on page 63</a>.</li> <li>• The difference in weight between the different robot variants is minor, therefor the weight specification for the robot is simplified. See <a href="#">Weight, robot on page 62</a>.</li> <li>• Removed Foundry from table with protection classes. See <a href="#">Protection classes, robot on page 65</a>.</li> <li>• Additional information about software adjustments when suspending robot, new section <a href="#">Setting the system parameters for a suspended or tilted robot on page 82</a>.</li> <li>• Note about fan cabling added in the cable list. See <a href="#">Robot cabling and connection points on page 112</a>.</li> <li>• Note about ambient temperature deleted from the maintenance schedule. See <a href="#">Maintenance schedule on page 121</a>.</li> <li>• Changed information about the robot position when removing motor. See <a href="#">Removing motors on page 295</a>.</li> <li>• Additional instructions for how to adjust the play of axes 4, 5 and 6 motors. See <a href="#">Adjusting the play of axis 4, 5 and 6 motors on page 313</a>.</li> <li>• Added step about removing/refitting axis 1 motor when replacing the axis 1 gearbox. Also added information about guide pins. See <a href="#">Replacing gearbox axis 1 on page 314</a>. Also minor additions concerning the mating of gearbox and motor, in all such instructions.</li> <li>• New section about calibration movement directions for axes is added, see <a href="#">Calibration movement directions for all axes on page 346</a>.</li> <li>• New section about how to perform a rough calibration of each robot axis is added, see <a href="#">Updating revolution counters on page 347</a>.</li> <li>• New section about how to check the calibration position is added, see <a href="#">Checking the synchronization position on page 367</a>.</li> <li>• Spare part number for tubular shaft unit is corrected, see <a href="#">Spare parts - Upper arm</a>.</li> <li>• Additional information about lifting accessories and how to attach them to the upper arm of the robot, see <a href="#">Attaching the lifting accessories to the upper arm on page 261</a>.</li> <li>• Additional information in the procedure for replacing the base with improved lifting instruction etc., see <a href="#">Replacing the base on page 246</a>.</li> <li>• Changed type of oil in axes 1, 3 and 4 gearboxes. See <a href="#">Type of lubrication in gearboxes on page 158</a>.</li> </ul>

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## Overview of this manual

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Revision	Description
F	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"><li>Corrected measurement that belong to figure xx0300000187, when fitting tools for measuring the play of axis 5, see <a href="#">Measuring the play, axis 5 on page 279</a>.</li><li>Deleted the spare part number for harnesses in <i>Spare parts - lower arm</i> and instead inserted a reference to the <i>Electrical connections</i>.</li><li>Corrected the spare part numbers for cable harnesses, see <i>Electrical connections</i>.</li><li>Added information about releasing the motor brakes in order to set the weight of different axes onto lifting accessories, see <a href="#">Replacing the complete upper arm on page 256</a>, <a href="#">Replacing gearbox axis 3 on page 330</a> and <a href="#">Replacing gearbox axis 2 on page 321</a>.</li><li>Changed the instruction for how to replace the axes 2 and 3 gearboxes without having to remove the cable harness, see <a href="#">Replacing gearbox axis 3 on page 330</a> and <a href="#">Replacing gearbox axis 2 on page 321</a>.</li><li>Added safety information about preventing roundslings from sliding when lifting the upper arm tube, see <a href="#">Replacing complete tubular shaft unit on page 266</a>.</li><li>Added information about removing painting, if any, from assembly surfaces when replacing gearboxes and motors.</li><li>Added tip to speed up the draining of axis 4 gearbox, see <a href="#">Changing the oil, axis-4 gearbox on page 183</a>.</li><li>Added information about o-ring and made other minor improvements to the instruction for replacing wrist unit, see <a href="#">Replacing wrist unit on page 272</a>.</li><li>Added information about disconnecting the battery cable when removing the cable harness, see <a href="#">Removing the complete cable harness on page 207</a>.</li><li>Added a funnel to equipment list, see <a href="#">Changing the oil, axis-3 gearbox on page 176</a>.</li><li>Added Profibus to the section about connections to extra equipment, see <a href="#">Customer connection on robot on page 114</a>.</li><li>Some general tightening torques have been changed/added, see updated values in <a href="#">Screw joints on page 379</a>.</li><li>The method of changing the axis-1 gearbox oil in suspended robots is improved, see the new section <a href="#">Changing the oil, axis-1 gearbox on suspended robots on page 166</a>.</li><li>Added spare part number for type B gearbox (axis 3), see <i>Spare parts, upper arm</i>.</li><li>Added <a href="#">WARNING - Safety risks during handling of batteries on page 57</a>.</li></ul>
G	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"><li>Cable harness for Profibus is added to the spare part list, see <i>Electrical connections</i>.</li><li>Article number for guide sleeves is added.</li><li>Information about the type and amount of oil has been removed from the manual and can now be found in the <i>Technical reference manual - Lubrication in gearboxes</i>, see <a href="#">References on page 10</a>.</li><li>Type C is added throughout the manual.</li><li>Valid for other designs than type C: Information about oil plug sealing washer on the axis-1 and axis-2 gearbox is changed. The spare part number is added.</li><li>A new SMB unit and battery is introduced, with longer battery lifetime.</li></ul>

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Revision	Description
H	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>Spare part numbers are corrected for the lower arm, see <i>Lower arm type C and Rebuilding parts</i>, and for motors, see <i>Motors type C in Product manual, spare parts - IRB 4600</i>.</li> <li>Several more spare part numbers are corrected throughout the spare part chapter.</li> <li>Section describing inspection of oil level in axis-1 gearbox for suspended robots is clarified, see <i>Inspecting oil level, axis 1 gearbox on page 124</i>.</li> </ul>
J	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>New article number for working range limit, axis 1 (Type C), is added in spare parts.</li> <li>New article number for turning tool (Type C) is added in spare parts.</li> <li>Spare parts for electrical connections, cable harness, is updated.</li> <li>Instructions on how to fill oil in suspended robot is corrected, and article number for oil change equipment is added to special tools.</li> <li>Amount of oil in axis-3 gearbox (Type C) is changed.</li> <li>Added information about risks when scrapping a decommissioned robot, see <i>Scraping of robot on page 371</i>.</li> <li><i>Spare parts and exploded views</i> are not included in this document but delivered as a separate document. See <i>Product manual, spare parts - IRB 4600</i>.</li> </ul>
K	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>Illustration changes in <i>Dimension, mounting surface and guide bushing on page 79</i>.</li> <li>Term "Guide sleeves" changed to "Guide bushings", see <i>Dimension, mounting surface and guide bushing on page 79</i>.</li> <li>A new <b>WARNING!</b> is added in the section about motor replacement, informing not to mix different motor types.</li> <li>Minor corrections.</li> </ul>
L	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>Added values for restricted working range if the robot is equipped with a gearbox Type C, see <i>Mechanically restricting the working range of axis 1 on page 96</i>.</li> <li>Information about removing the mech stop bracket added in section <i>Axes with restricted working range on page 95</i>.</li> </ul>
M	<p>The following updates have been made in this revision:</p> <ul style="list-style-type: none"> <li>Turning disk fixture is removed from special tools for Levelmeter calibration.</li> <li>Oil levels adjusted.</li> <li>Information about grounding and bonding point added, see <i>Robot cabling and connection points on page 112</i>.</li> </ul>
N	<p>Published in release R16.2. The following updates are made in this revision:</p> <ul style="list-style-type: none"> <li>Corrections due to updates in SAP terminology.</li> <li>New dimensional drawing of the turning disk added to <i>Fitting equipment on wrist and mounting flange on page 90</i>.</li> <li>New standard calibration method is introduced (Axis Calibration). See <i>Calibration on page 339</i>.</li> <li>Information about grounding point added. See <i>Robot cabling and connection points on page 112</i>.</li> </ul>
P	<p>Published in release R17.1. The following updates are made in this revision:</p> <ul style="list-style-type: none"> <li>Changed the tightening torque of the oil plug located on axis-1 gearbox.</li> </ul>

# 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</i> , gearbox.	Shown in the figure <a href="#">Location of gearbox on page xx</a> .

### 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</i> , axis 2 to the gearbox.	Art. no. is specified in <a href="#">Required equipment on page xx</a> .

---

### 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 19](#).

---

### 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.

# 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 20](#).
- 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 42](#).
- 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 50](#).

# 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
<a href="#"><i>Safety in the manipulator system on page 21</i></a>	This section describes the following: <ul style="list-style-type: none"><li>• safety, service</li><li>• limitation of liability</li><li>• related information</li></ul>
<a href="#"><i>Protective stop and emergency stop on page 23</i></a>	This section describes protective stop and emergency stop.
<a href="#"><i>Safety risks on page 24</i></a>	This section lists dangers relevant when working with the product. The dangers are split into different categories. <ul style="list-style-type: none"><li>• safety risks during installation or service</li><li>• risks associated with live electrical parts</li></ul>
<a href="#"><i>Safety actions on page 34</i></a>	This section describes actions which may be taken to remedy or avoid dangers. <ul style="list-style-type: none"><li>• fire extinguishing</li><li>• safe use of the teach pendant or jogging device</li></ul>

## 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*<sup>1</sup>
- *Product manual*

<sup>1</sup> 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!	 <b>CAUTION</b> 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
<b>Removed parts may result in collapse of the robot!</b>	 <b>WARNING</b> 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.
<b>Removed cables to the measurement system</b>	 <b>WARNING</b> 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
<b>Cable packages are sensitive to mechanical damage!</b>	 <b>CAUTION</b> 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
<b>Gears may be damaged if excessive force is used!</b>	 <b>CAUTION</b> 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**

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## **1.2.4.5 Safety risks with pressure relief valve**

---

### **Introduction**

The pressure relief valve must be kept clean and open, for it to be able to function properly.

---

### **Safety risks**

The pressure relief valve is a vital part preventing too much air pressure being built up inside the robot. If too much air pressure has been built up, there is a risk of personal injury and mechanical damage.

**1.2.4.6 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 Safety

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## 1.2.4.7 Risks associated with live electric parts

### 1.2.4.7 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*

---

### 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 Safety

---

## 1.2.5.1 Safety fence dimensions

### 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.

### 1.2.5.2 Fire extinguishing



#### Note

Use a CARBON DIOXIDE (CO<sub>2</sub>) extinguisher in the event of a fire in the robot or controller!

# 1 Safety

---

## 1.2.5.3 Emergency release of the robot arm

### 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 75.\*](#)

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.

## 1.2.5.4 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 Safety

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### 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".

## 1.2.5.6 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 Safety

### 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 37](#).
- 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.

## 1.2.5.8 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 Safety

## 1.3.1 Safety signals in the manual

## 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 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.
 xx0200000023	ELECTROSTATIC DISCHARGE (ESD)	Warns for electrostatic hazards which could result in severe damage to the product.

Continues on next page

## 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 Safety

## 1.3.2 Safety symbols on product labels

### 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 44](#).

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

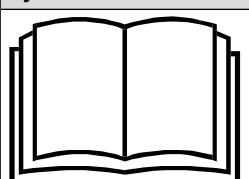
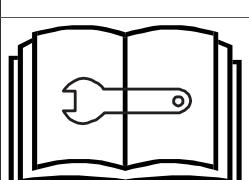
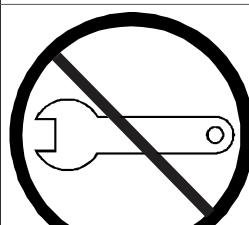
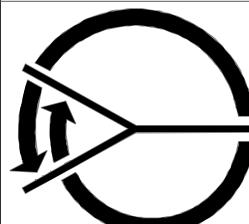
#### Symbols on safety labels

Symbol	Description
xx0900000812	<b>Warning!</b> 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.
xx0900000811	<b>Caution!</b> 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.
xx0900000839	<b>Prohibition</b> Used in combinations with other symbols.

*Continues on next page*

## 1.3.2 Safety symbols on product labels

Continued

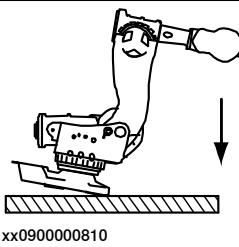
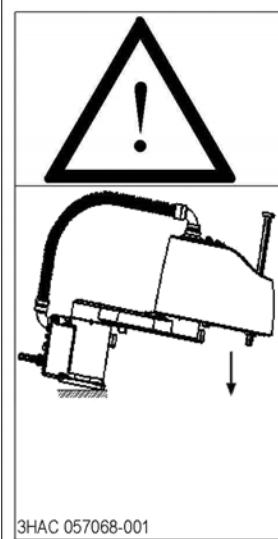
Symbol	Description
 xx0900000813	<b>See user documentation</b> Read user documentation for details. Which manual to read is defined by the symbol: <ul style="list-style-type: none"> <li>• No text: <i>Product manual</i>.</li> <li>• EPS: <i>Application manual - Electronic Position Switches</i>.</li> </ul>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

Continues on next page

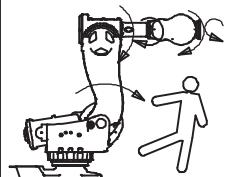
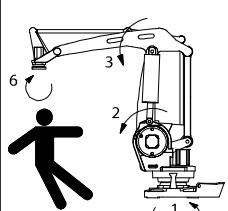
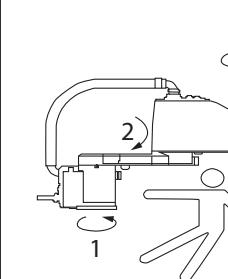
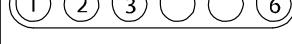
# 1 Safety

## 1.3.2 Safety symbols on product labels

*Continued*

Symbol	Description
 xx0900000810	<b>Tip risk when loosening bolts</b> The robot can tip over if the bolts are not securely fastened.
 3HAC 057068-001  xx1500002402	
 xx0900000817	<b>Crush</b> Risk of crush injuries.
 xx0900000818	<b>Heat</b> Risk of heat that can cause burns.

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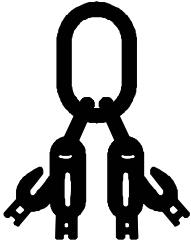
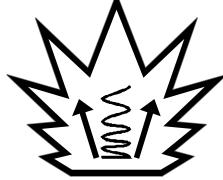
Symbol	Description
 xx0900000819	<b>Moving robot</b> The robot can move unexpectedly.
 xx1000001141	
 xx1500002616	
 xx0900000820	<b>Brake release buttons</b>
 xx1000001140	
 xx0900000821	<b>Lifting bolt</b>

*Continues on next page*

# 1 Safety

## 1.3.2 Safety symbols on product labels

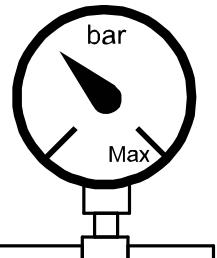
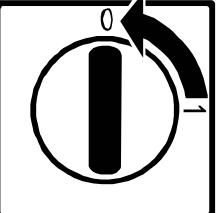
*Continued*

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

*Continues on next page*

## 1.3.2 Safety symbols on product labels

*Continued*

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

# 1 Safety

---

## 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.	

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

**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.

Mechanical stops will not always stop the movements of the robot completely.

## 1 Safety

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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!

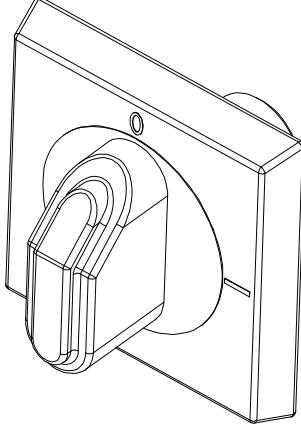
## 1.4.4 DANGER - Make sure that the main power has been switched off!

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

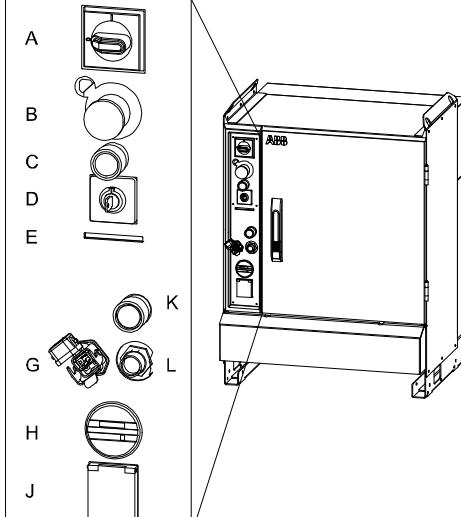
**Description**

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 <b>A: Main switch</b>

*Continues on next page*

## 1 Safety

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.	 xx0600002783 <b>K: Main switch, Drive Module</b>
2	Switch off the main switch on the Control Module.	<b>A: Main switch, Control Module</b>

## 1.4.5 WARNING - The unit is sensitive to ESD!

**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.

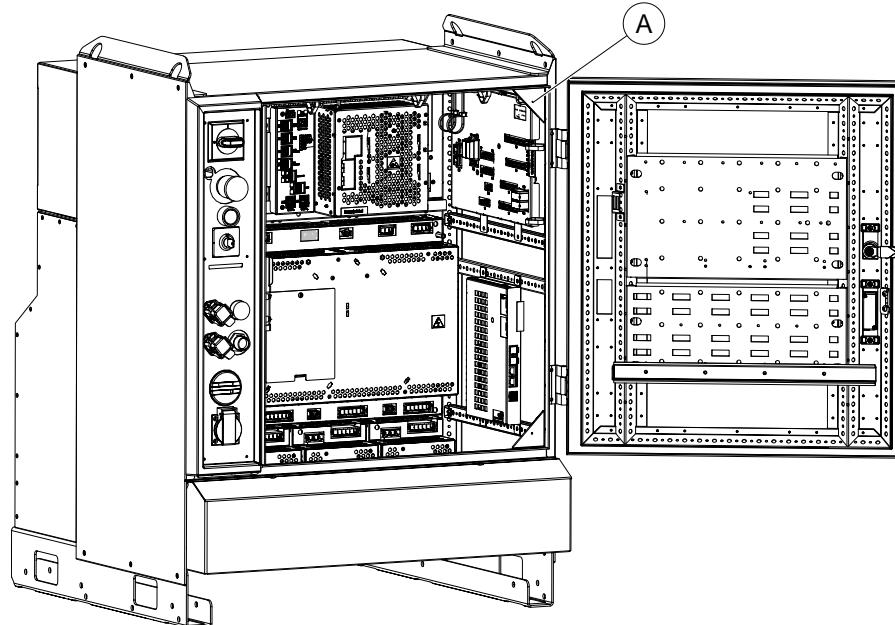
**Elimination**

	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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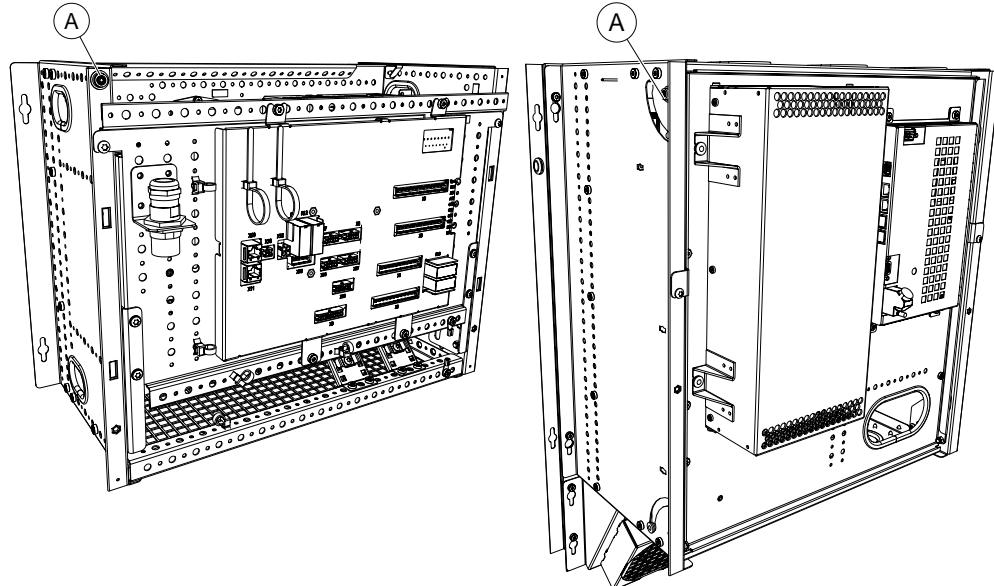
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# 1 Safety

## 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

**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 <a href="#">Pre-installation procedure on page 62</a> .
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 <b>Hot oil or grease</b>	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 <b>Allergic reaction</b>	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 <b>Possible pressure build-up in gearbox</b>	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 <b>Do not overfill</b>	<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"> <li>• damage seals and gaskets</li> <li>• completely press out seals and gaskets</li> <li>• prevent the robot from moving freely.</li> </ul>	<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 <b>Do not mix types of oil</b>	<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 <b>Heat up the oil</b>	<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 <b>Specified amount depends on drained volume</b>	<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 <b>Contaminated oil in gear boxes</b>	<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 4600 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 4600, 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 19](#) before performing any installation work.



#### Note

If the IRB 4600 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.   <b>Note</b> 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: <a href="#">Weight, robot on page 62</a>
6	If the robot is not installed directly, it must be stored as described in: <a href="#">Storage conditions, robot on page 64</a>
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: <a href="#">Operating conditions, robot on page 64</a>
8	Before taking the robot to its installation site, make sure that the site conforms to: <ul style="list-style-type: none"><li>• <a href="#">Loads on foundation, robot on page 63</a></li><li>• <a href="#">Protection classes, robot on page 65</a></li><li>• <a href="#">Requirements, foundation on page 64</a></li></ul>
9	Before moving the robot, please observe the stability of the robot: <a href="#">Risk of tipping/stability on page 70</a>
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: <a href="#">On-site installation on page 71</a>
11	Install required equipment, if any. <ul style="list-style-type: none"><li>• <a href="#">Installation of signal lamp (option) on page 94</a></li></ul>

#### Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 4600	440 kg

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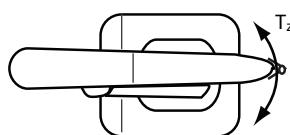
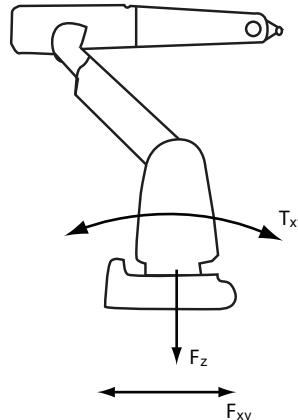
#### Note

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	$\pm 3940 \text{ N}$	$\pm 7790 \text{ N}$
Force z	$4350 \pm 2460 \text{ N}$	$4350 \pm 6360 \text{ N}$
Torque xy	$\pm 6850 \text{ Nm}$	$\pm 14090 \text{ Nm}$
Torque z	$\pm 1610 \text{ Nm}$	$\pm 2960 \text{ Nm}$

*Continues on next page*

## 2 Installation and commissioning

### 2.2.1 Pre-installation procedure

*Continued*

Suspended

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	$\pm 3940\text{N}$	$\pm 7790\text{ N}$
Force z	$-4350 \pm 2460\text{N}$	$-4350 \pm 6360\text{ N}$
Torque xy	$\pm 6850\text{ Nm}$	$\pm 14090\text{ Nm}$
Torque z	$\pm 1610\text{ Nm}$	$\pm 2960\text{ Nm}$

### 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	0.5 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	$15^\circ$	The limit for the maximum payload on the robot is reduced if the robot is tilted from $0^\circ$ . Contact ABB for further information about acceptable loads.
Minimum resonance frequency	22 Hz	

### Storage conditions, robot

The table shows the allowed storage conditions for the robot:

Parameter	Value
Minimum ambient temperature	$-25^\circ\text{ C}$
Maximum ambient temperature	$+55^\circ\text{ C}$
Maximum ambient temperature (less than 24 hrs)	$+70^\circ\text{ C}$
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	$+5^\circ\text{C}$
Maximum ambient temperature	$+45^\circ\text{C}$
Maximum ambient humidity	95% at constant temperature (gaseous only)

*Continues on next page*

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#### **Protection classes, robot**

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

<b>Protection type</b>	<b>Protection class</b>
Manipulator, protection type Standard	IP 67
Manipulator, protection type Foundry Plus	IP 67

## 2 Installation and commissioning

### 2.2.2 Working range and type of motion

#### 2.2.2 Working range and type of motion

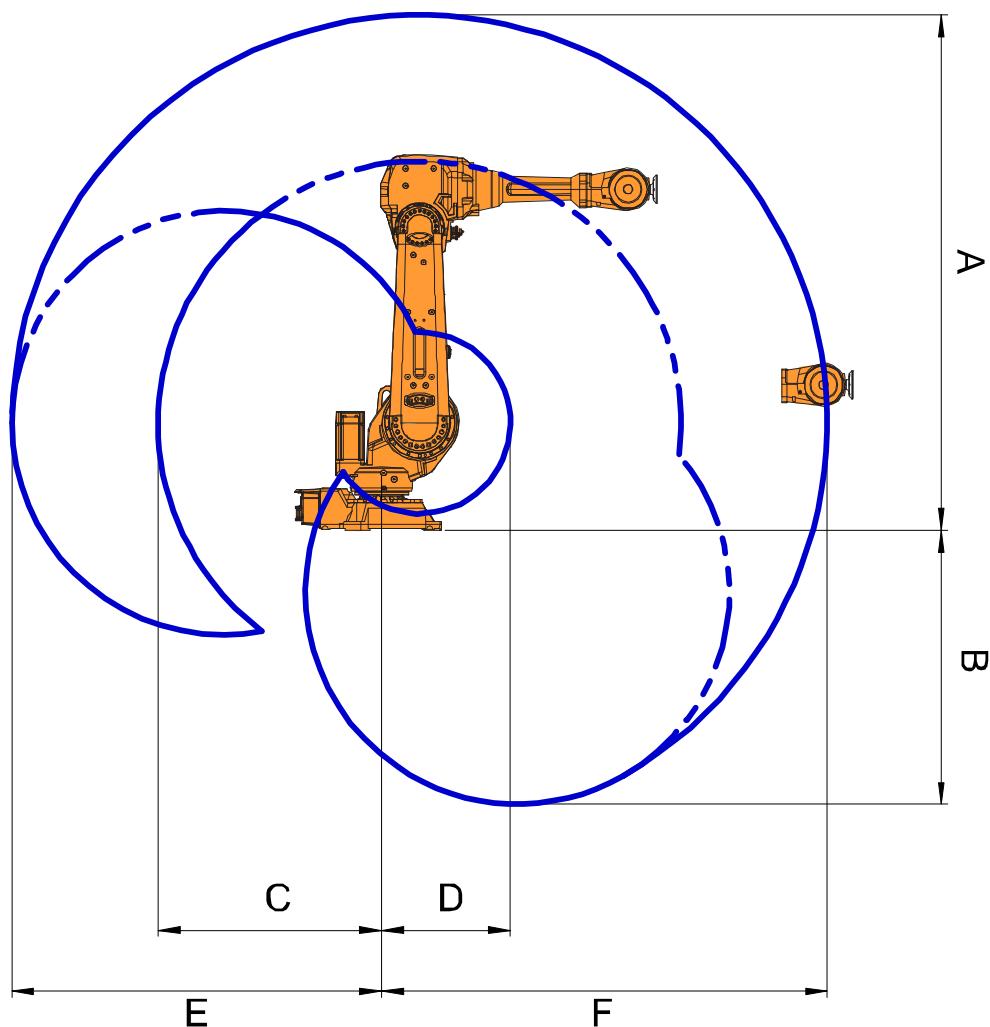
##### Working range

The figures show the working ranges of the robot variants mounted in different ways.

The extreme positions of the robot arm are specified at the wrist center (dimensions in mm).

##### Working range, floor mounted

The illustration shows the unrestricted working range when the robot is floor mounted.



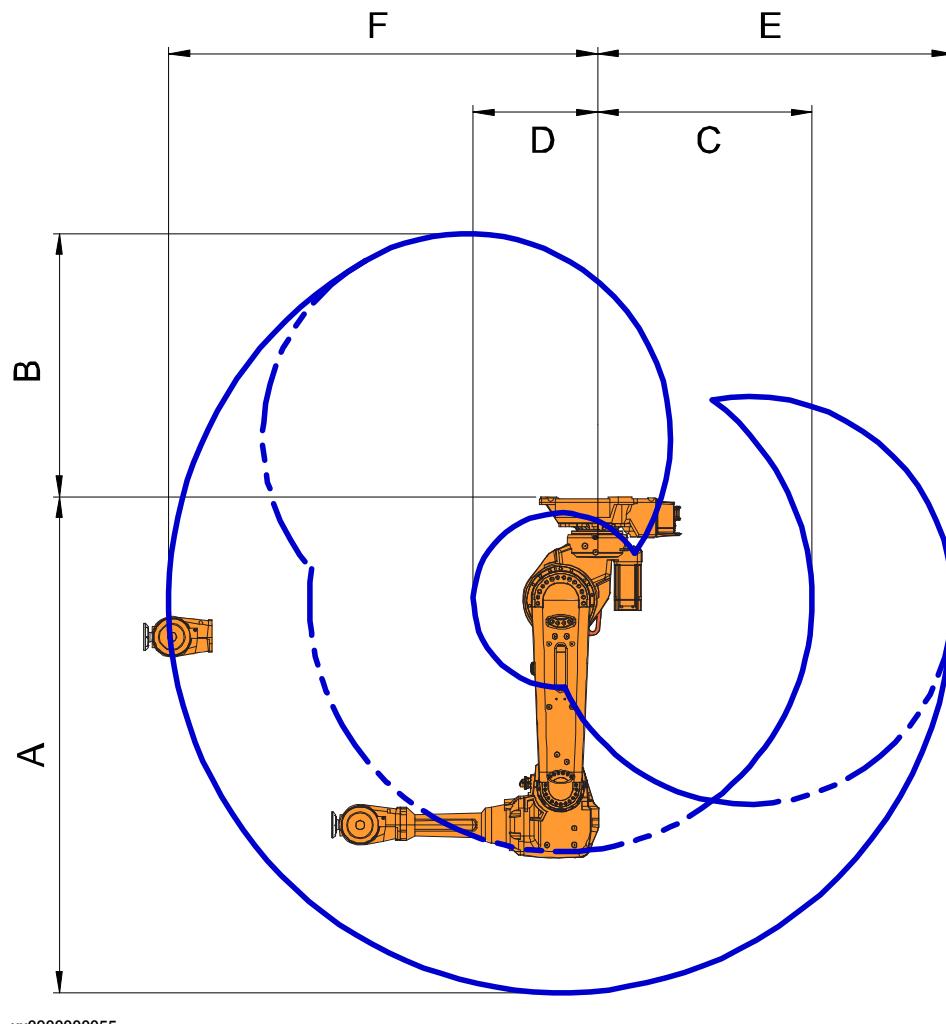
xx0800000267

Variant	Pos. A	Pos. B	Pos. C	Pos. D	Pos. E	Pos. F
IRB 4600 - 60/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 45/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 40/2.55	2872 mm	1735 mm	1393 mm	680 mm	2202 mm	2552 mm
IRB 4600 - 20/2.50	2833 mm	1696 mm	1361 mm	665 mm	2163 mm	2513 mm

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**Working range, suspended mounted**

The illustration shows the unrestricted working range when the robot is suspended mounted.



xx0900000055

Variant	Pos. A	Pos. B	Pos. C	Pos. D	Pos. E	Pos. F
IRB 4600 - 60/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 45/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 40/2.55	2872 mm	1735 mm	1393 mm	680 mm	2202 mm	2552 mm
IRB 4600 - 20/2.50	2833 mm	1696 mm	1361 mm	665 mm	2163 mm	2513 mm

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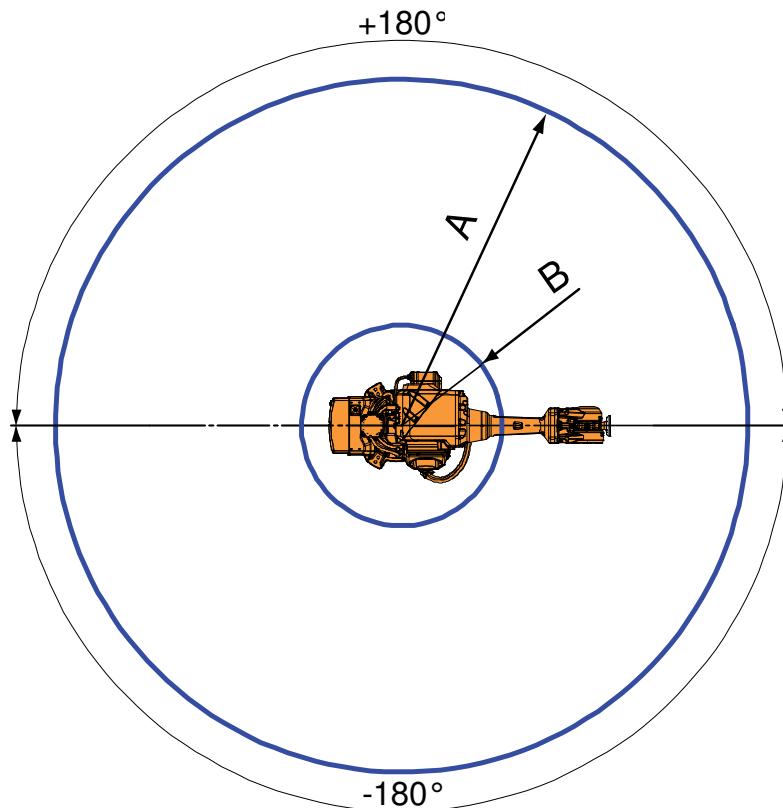
## 2 Installation and commissioning

### 2.2.2 Working range and type of motion

*Continued*

#### Turning radius

The turning radius of the robot that is floor or suspended mounted is shown in the figure.



xx0800000268

Variant	Pos. A	Pos. B
IRB 4600 - 60/2.05	R2051	R593
IRB 4600 - 45/2.05	R2051	R593
IRB 4600 - 40/2.55	R2552	R680
IRB 4600 - 20/2.50	R2513	R665

#### Robot motion, IRB 4600-60/2.05, -45/2.05, -40/2.55

The table specifies the types and ranges of motion in every axes.

Location of motion	Type of motion	Range of movement
Axis 1	Rotation motion	$\pm 180^\circ$
Axis 2	Arm motion	$+150^\circ / -90^\circ$
Axis 3	Arm motion	$+75^\circ / -180^\circ$
Axis 4	Wrist motion	$\pm 400^\circ$
Axis 5	Bend motion	$+120^\circ / -125^\circ$
Axis 6	Turn motion	$\pm 400^\circ$

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#### **Robot motion, IRB 4600-20/2.50**

The table specifies the types and ranges of motion in every axes.

<b>Location of motion</b>	<b>Type of motion</b>	<b>Range of movement</b>
Axis 1	Rotation motion	$\pm 180^\circ$
Axis 2	Arm motion	$+150^\circ / -90^\circ$
Axis 3	Arm motion	$+75^\circ / -180^\circ$
Axis 4	Wrist motion	$\pm 400^\circ$
Axis 5	Bend motion	$\pm 120^\circ$
Axis 6	Turn motion	$\pm 400^\circ$

## 2 Installation and commissioning

### 2.2.3 Risk of tipping/stability

#### 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.

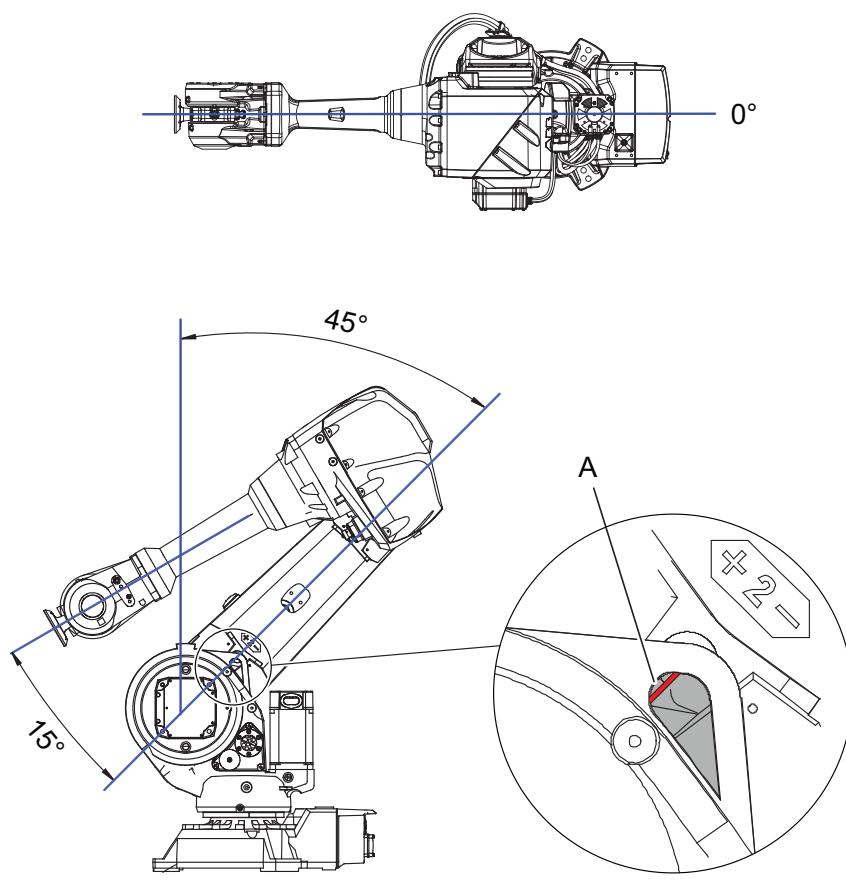
The shipping position is the most stable position.

**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.

The position of the calibration mark (A) in the figure is approximate and is used as aiming aid.



##### WARNING

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

## 2.3 On-site installation

### 2.3.1 Lifting robot with roundslings

#### Introduction

When lifting the robot use roundslings and an overhead crane.

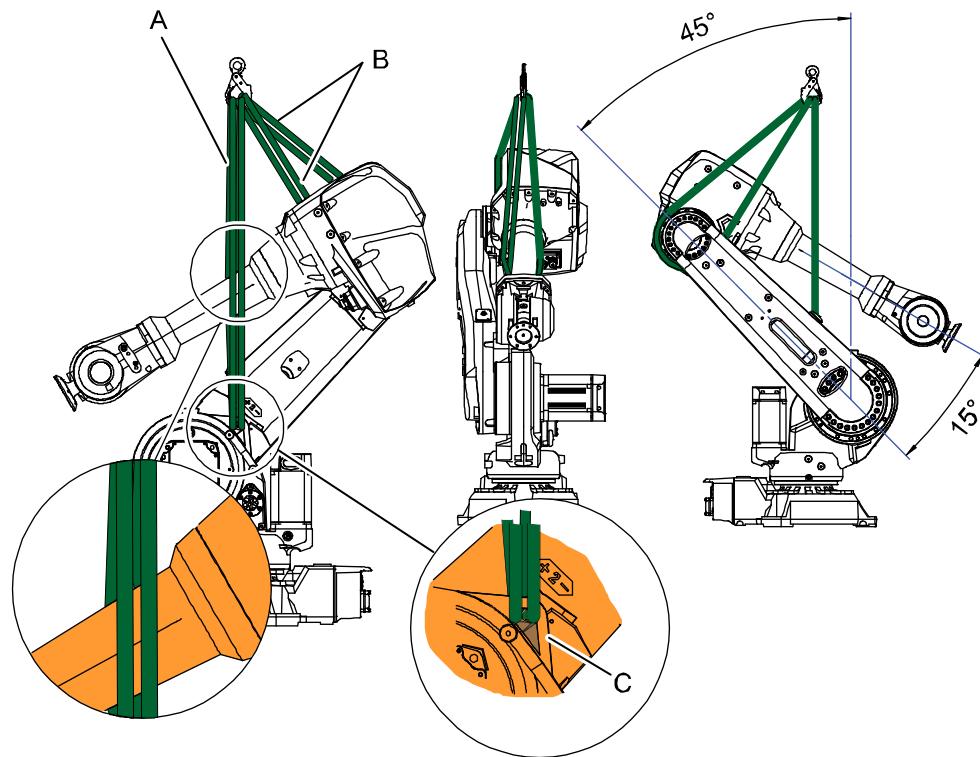
How to lift *suspended mounted robot* is described in the lifting instruction delivered with the turning tool art. no. 3HAC034766-001. See [Lifting and turning a suspended mounted robot on page 74](#).

#### Required equipment

Equipment	Note
Overhead crane	Lifting capacity 1 000 kg (Max load at 90°)
Roundslings (2 pcs)	<ul style="list-style-type: none"> <li>Lifting capacity/roundslings: 1 000 kg</li> <li>Length: 2 m</li> </ul>

#### Lifting

Attach the roundslings as shown in the figure.



xx0800000262

A	Roundsling put folded in U-shape through the lifting lug
B	Roundsling put folded in U-shape around gearbox axis 3
C	Lifting lug

*Continues on next page*

## 2 Installation and commissioning

### 2.3.1 Lifting robot with roundslings

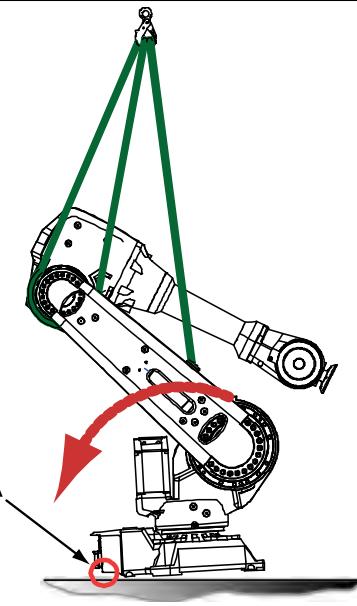
*Continued*

#### Lifting instructions

Use this procedure to lift the robot in a safe way.

	Action	Note
1	 <b>CAUTION</b> The IRB 4600 robot weighs 440 kg. All lifting accessories used must be sized accordingly!	
2	 <b>CAUTION</b> Attempting to lift the robot in any other position than that recommended may result in the robot tipping over and causing severe damage or injury!	
3	 <b>WARNING</b> Personnel must not, under any circumstances, be present under the suspended load!	
4	Move the robot to its most stable position.	Detailed in section: • <a href="#">Risk of tipping/stability on page 70</a>
5	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
6	Attach <i>roundslings A</i> to the lifting lug on the frame, and put folded in a U-shape on either side of the upper arm.	See the figure in: • <a href="#">Lifting on page 71</a>
7	Attach <i>roundslings B</i> at axis 3 gearbox by running it folded in a U-shape around the gearbox.	See the figure in: • <a href="#">Lifting on page 71</a>
8	Make sure the roundslings do not rub against any sharp edges.	

*Continues on next page*

Action	Note
<p>9 When the robot is lifted the roundslings will adjust themselves.</p> <p><b>!</b> <b>CAUTION</b></p> <p>When lifting, the robot will tilt slightly backwards! Be careful not to damage the <i>connection box</i> at the base of the robot!</p>	 <p>xx0800000291</p> <ul style="list-style-type: none"> <li>A: Area where the connection box can be damaged while lifting.</li> </ul>
10 Lift the robot with an overhead crane.	<p>Lifting capacity:</p> <ul style="list-style-type: none"> <li>See <a href="#">Required equipment on page 71</a></li> </ul>

## 2 Installation and commissioning

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### 2.3.2 Lifting and turning a suspended mounted robot

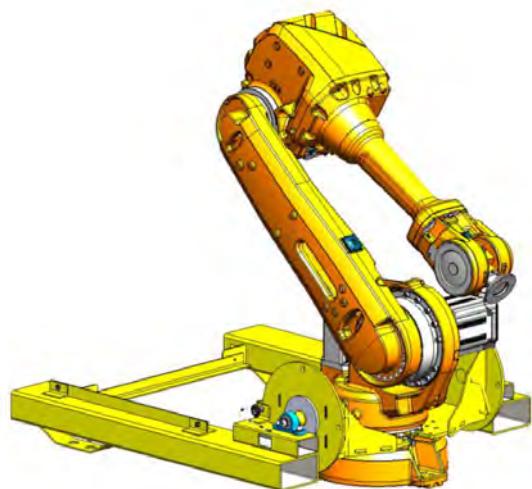
#### Introduction

How to lift and turn the robot to a suspended position using the turning accessory is described in the lifting instruction delivered with the turning accessory. Article numbers for the accessory and the instruction is specified in [Special tools on page 384](#). Any additional equipment required is specified in the instruction for the lifting accessory. Contact ABB for more information.

How to lift and turn the robot into position for **tilted** position: *Contact ABB* for more information!

---

#### Illustration



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### 2.3.3 Manually releasing the brakes

#### General

The section below describes how to release the holding brakes of each axis' motor.

This can be done in one of three ways:

- using the push-button when the robot is connected to the controller.
- using the push-button on the robot with an external power supply.
- using an external voltage supply directly on the respective brake.



#### DANGER

When releasing the holding brakes with push-buttons, the robot must be properly attached!



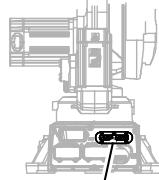
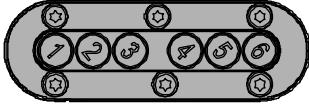
#### DANGER

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!

#### Using the push-button when the robot is connected to the controller

This procedure details how to release the holding brakes with push-buttons, when the robot is connected to the controller.

	Action	Note
1	The internal brake release unit is located at the base of the robot.	  xx0800000272
2	The brake release unit is equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes.	
3	Release the holding brake on a particular axis by pressing the corresponding button on the push-button unit and keeping it depressed.	
4	The brake will function again as soon as the button is released.	

*Continues on next page*

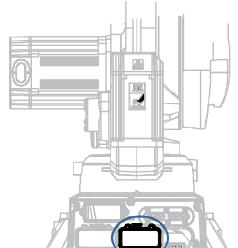
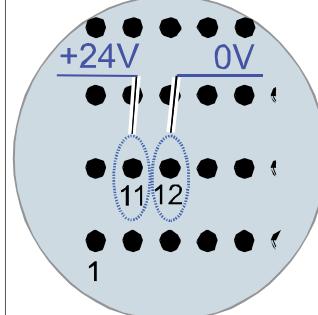
## 2 Installation and commissioning

### 2.3.3 Manually releasing the brakes

*Continued*

#### Using the push-button on the robot with an external power supply

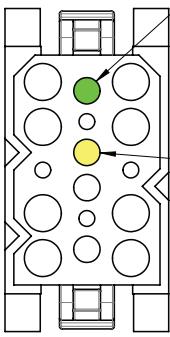
This procedure details how to release the holding brakes with the push-buttons, when the robot is **not** connected to the controller.

Action	Note
1 Connect an external 24VDC power supply to the connector R1.MP on the robot base.   <b>Note</b> Be careful not to interchange the 24V and 0V pins! If they are mixed up, damage can be caused to the brake release unit and the system board!   <b>WARNING</b> Incorrect connections can cause all brakes to be released simultaneously!	  xx0800000269 Connect to connector R1.MP: <ul style="list-style-type: none"><li>• 0V to pin 12</li><li>• +24V to pin 11</li></ul> The brake release unit is equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes. See the previous figure.
2 Release the holding brake on a particular axis by pressing the corresponding button on the push-button unit and keeping it depressed.	
3 The brake will function again as soon as the button is released.	

*Continues on next page*

#### Using an external voltage supply directly on the respective brake

This procedure details how to release the holding brake of a specific axis by supplying external voltage directly on the brake.

Action	Note
<p>1 Every axis has a holding brake built into the axis motor. This holding brake may be released by connecting 24VDC power supply directly to one of the connectors in the motor.</p> <p><b>DANGER</b></p> <p>When power is connected directly to the brake cable, the brake will be released immediately when the power is switched on. This may cause some unexpected robot movements!</p>	<p>Make the connection to the current motor according to the Circuit Diagram. See chapter <a href="#">Circuit diagram on page 391</a>.</p>
<p>2 Connect an external 24 VDC power supply to the motor, according to the figures.</p> <p><b>Note</b></p> <p>Be careful not to interchange the 24V and 0V pins! If they are mixed up, damage can be caused to the integrated quenching circuits.</p> <p><b>WARNING</b></p> <p>Incorrect connections can cause all brakes to be released simultaneously!</p>	<p>Axes 1, 2 and 3: Pos 2: +24 V Pos 5: 0 V</p>  <p>xx1400001984</p>

## 2 Installation and commissioning

### 2.3.4 Orienting and securing the robot

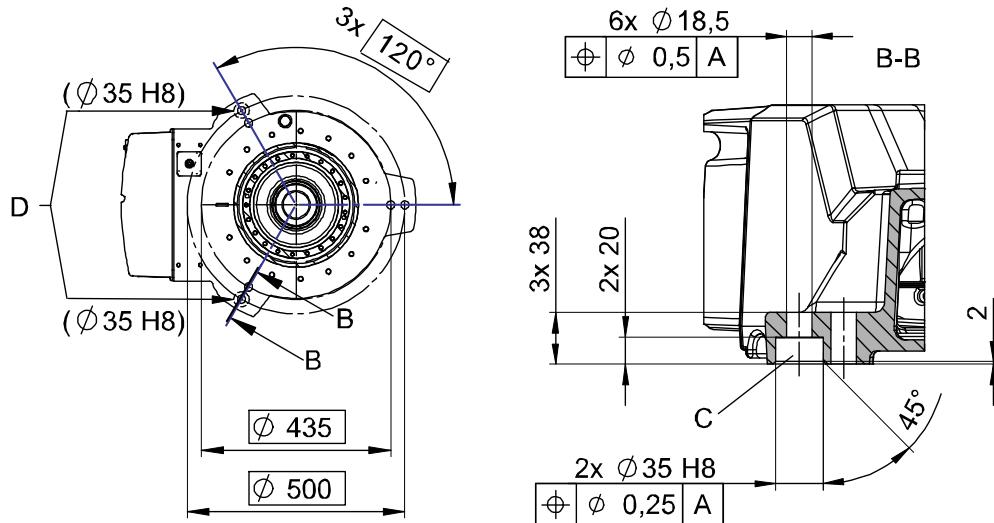
#### 2.3.4 Orienting and securing the robot

##### Introduction

This section describes how to orient and secure the robot to the foundation or base plate in order to run the robot safely. The requirements made on the foundation are shown in sections [Loads on foundation, robot on page 63](#) and [Requirements, foundation on page 64](#).

##### Hole configuration, base

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

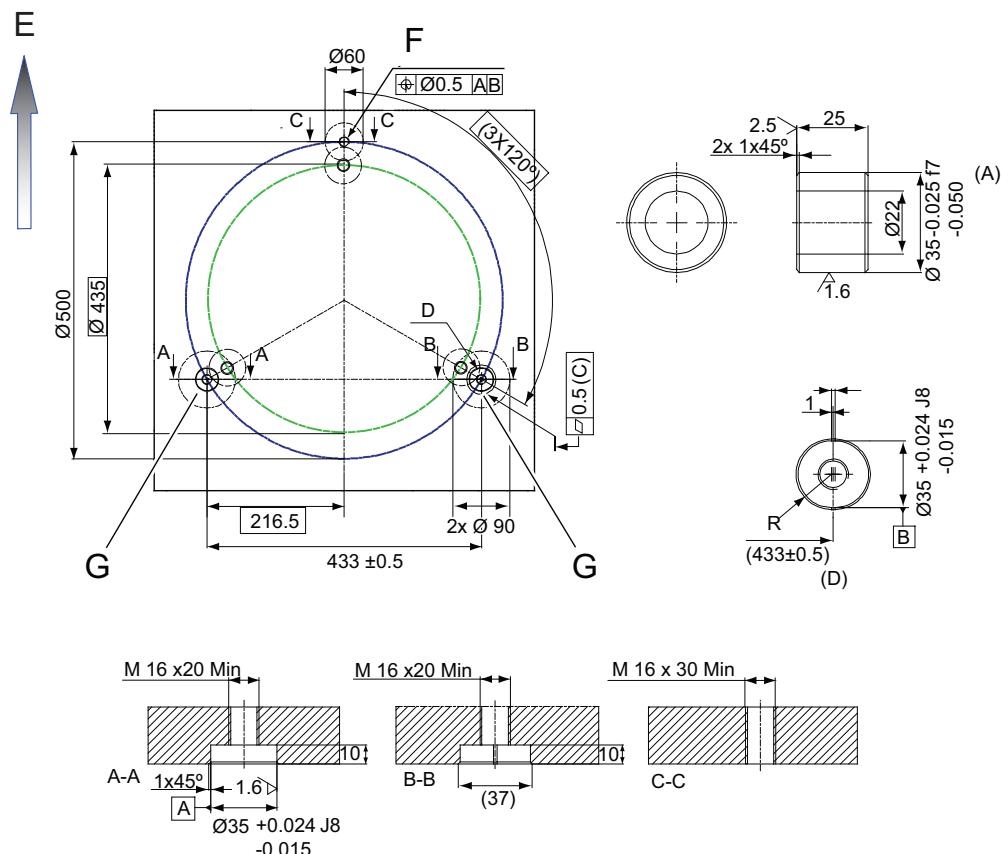


C	Hole for guide bushing
D	Rear bolt holes

*Continues on next page*

#### Dimension, mounting surface and guide bushing

The figure shows the dimension of the mounting surface and guide bushings.



xx0900000392

(C)	3x common zone
E	Position of the front of the robot
F	4xM16, depth 30 minimum
G	Guide bushings (2 pcs)

#### Specification, attachment screws

The table specifies the type of securing screws and washers to be used to secure the robot to the foundation or base plate.

Securing parts/Facts	Dimension	Note
Securing screws, oiled	M16 x 60 (installation directly on foundation) M16 x 70/80 (installation on foundation or base plate, using guide bushings) Quality 8.8	6 pcs 200 Nm
Washers	17 x 30 x 3	6 pcs

*Continues on next page*

## 2 Installation and commissioning

### 2.3.4 Orienting and securing the robot

Continued

Securing parts/Facts	Dimension	Note
Guide bushings		<p>Article number: 21510024-169, 2 pcs. Added to the rear bolt holes, to allow the same robot to be re-mounted without program adjustments.</p>  <p>xx1200000885</p>
Level surface requirements	 0.5 xx0300000251	

#### Orienting and securing the robot

Use this procedure to orient and secure the robot.

Action	Note
1 Make sure the installation site for the robot conforms to the specifications in section <a href="#">Pre-installation procedure on page 62</a> .	
2 Prepare the installation site with attachment holes.	Hole configuration of the base is shown in the figure in: <ul style="list-style-type: none"><li>• <a href="#">Hole configuration, base on page 78</a></li></ul>
3  <b>CAUTION</b>  The IRB 4600 robot weighs 440 kg. All lifting accessories used must be sized accordingly!	
4  <b>CAUTION</b>  When the robot is put down after being lifted or transported, there is a risk of it tipping, if not properly secured.	
5 Lift the robot to its installation site.	How to lift the robot is described in section: <ul style="list-style-type: none"><li>• <a href="#">Lifting robot with roundslings on page 71</a></li></ul>
6 Fit two <i>guide bushings</i> to the <i>rear bolts</i> in the base.	
7 Guide the robot gently, using the attachment screws while lowering it into its mounting position.	Make sure the robot base is correctly fitted onto the guide sleeves.

Continues on next page

	Action	Note
8	Fit the <i>securing screws and washers</i> in the attachment holes of the base.	
9	Tighten the bolts in a criss-cross pattern to ensure that the base is not distorted.	

#### Securing robot on a mounting plate

When bolting a mounting plate or frame to a concrete floor, follow the general instructions for expansion-shell bolts.

Screw joints must be able to withstand the stress loads defined in section [\*Loads on foundation, robot on page 63\*](#).

## 2 Installation and commissioning

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### 2.3.5 Setting the system parameters for a suspended or tilted robot

#### General

The robot is configured for mounting parallel to the floor, without tilting, on delivery. The method for mounting the robot in a suspended (upside down) or tilted position is basically the same as for floor mounting, but the system parameters that describe the mounting angle (how the robot is oriented relative to the gravity) must be redefined.



#### Note

With suspended installation, make sure that the gantry or corresponding structure is rigid enough to prevent unacceptable vibrations and deflections, so that optimum performance can be achieved.



#### Note

The allowed mounting positions are described in the product specification for the robot. The requirements on the foundation are described in [Requirements, foundation on page 64](#).

#### System parameters



#### Note

The mounting angle must be configured correctly in the system parameters so that the robot system can control the movements in the best possible way. An incorrect definition of the mounting angle will result in:

- Overloading the mechanical structure.
- Lower path performance and path accuracy.
- Some functions will not work properly, for example *Load Identification* and *Collision detection*.

#### Gravity Beta

If the robot is mounted upside down or tilted (rotated around the y-axis), then the robot base frame and the system parameter *Gravity Beta* must be redefined. *Gravity Beta* should then be  $\pi$  ( $\pm 3.141593$ ) if the robot is mounted upside down (suspended).

The *Gravity Beta* is a positive rotation direction around the y-axis in the base coordinate system. The value is set in radians.

*Continues on next page*

#### Gravity Alpha

The *Gravity Alpha* is a positive rotation direction around the x-axis in the base coordinate system. The value is set in radians.



##### Note

The system parameter *Gravity Alpha* is not supported for all robot types. It is not supported for IRB 140, IRB 1410, IRB 1600ID, IRB 2400, IRB 4400, IRB 6400R, IRB 6400 (except for IRB 6400 200/2.5 and IRB 6400 200/2.8), IRB 6600, IRB 6650, IRB 6650S and IRB 7600 (except for IRB 7600 325/3.1).

If the robot does not support *Gravity Alpha*, then use *Gravity Beta* along with the recalibration of axis 1 to define the rotation of the robot around the x-axis.



##### Note

The parameter is supported for all robots on track when the system parameter *7 axes high performance motion* is set, see *Technical reference manual - System parameters*.

#### Gamma Rotation

*Gamma Rotation* defines the orientation of the robot foot on the travel carriage (track motion).

#### Mounting angles and values

The parameter *Gravity Beta* (or *Gravity Alpha*) specifies the mounting angle of the robot in radians. It is calculated in the following way.

$\text{Gravity Beta} = A^\circ \times 3.141593/180 = B \text{ radians}$ , where  $A$  is the mounting angle in degrees and  $B$  is the mounting angle in radians.

Example of position	Mounting angle ( $A^\circ$ )	Gravity Beta
Floor mounted	$0^\circ$	0.000000 (Default)
Tilted mounting	$15^\circ$	0.261799
Suspended mounting	$180^\circ$	3.141593

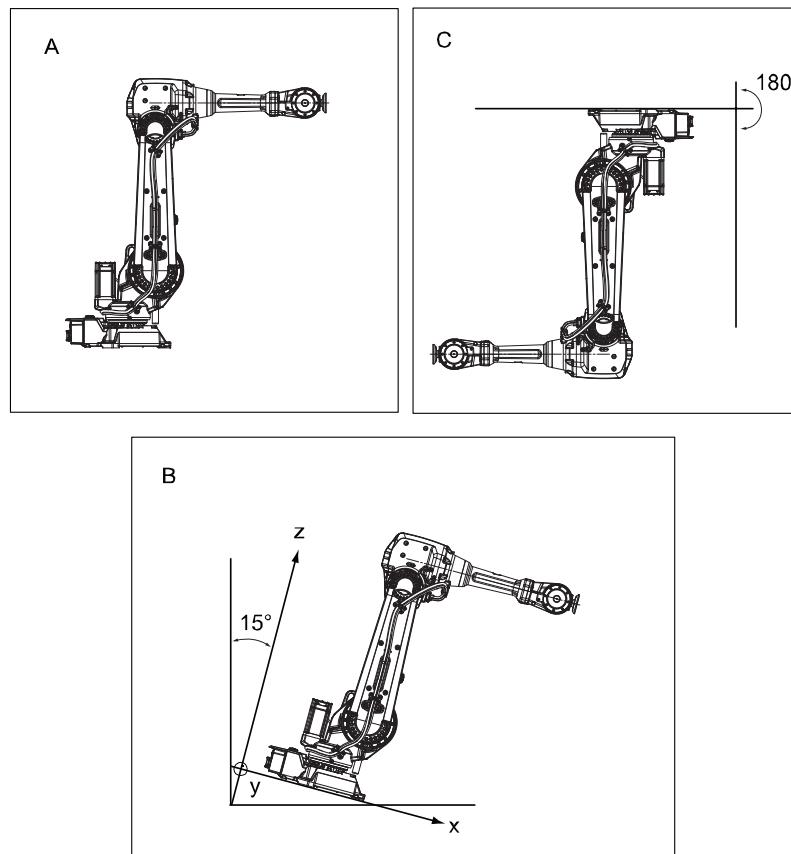
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## 2 Installation and commissioning

### 2.3.5 Setting the system parameters for a suspended or tilted robot

*Continued*

Examples of mounting angles tilted around the Y axis (*Gravity Beta*)

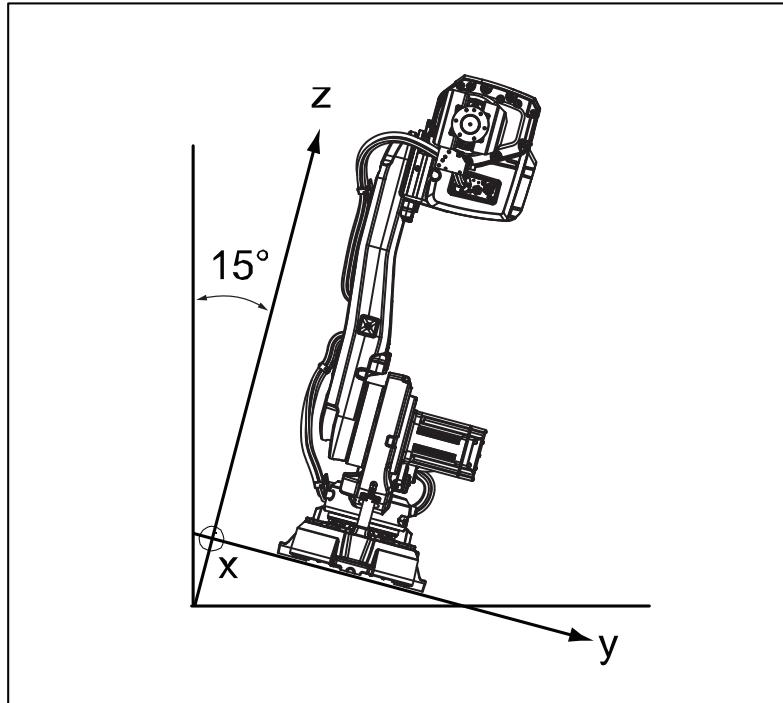


xx1700000267

A	Floor mounted
B	Tilted mounting, mounting angle 15°.
C	Suspended mounting, mounting angle 180°.

*Continues on next page*

Examples of mounting angles tilted around the X axis (*Gravity Alpha*)



xx1700000268

-	Tilted mounting, mounting angle 15°.
---	--------------------------------------



#### Note

For suspended robots (180°), it is recommended to use *Gravity Beta* instead of *Gravity Alpha*.

#### Defining the parameter in the IRC5 software

The value of the system parameters that define the mounting angle must be redefined when changing the mounting angle of the robot. The parameters belong to the type *Robot*, in the topic *Motion*.

How to calculate a new value is detailed in [Mounting angles and values on page 83](#).

The system parameters are described in *Technical reference manual - System parameters*.

The system parameters are redefined in the **Configuration Editor**, in RobotStudio or on the FlexPendant.

## 2 Installation and commissioning

### 2.3.6 Fitting equipment on robot

#### 2.3.6 Fitting equipment on robot

##### Introduction

The robot features mounting holes for additional equipment.

Access to any of the following mounting holes may be obstructed by any additional cabling, equipment, etc., fitted by the robot user. Make sure the required mounting holes are accessible when planning the robot cell.



##### Note

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

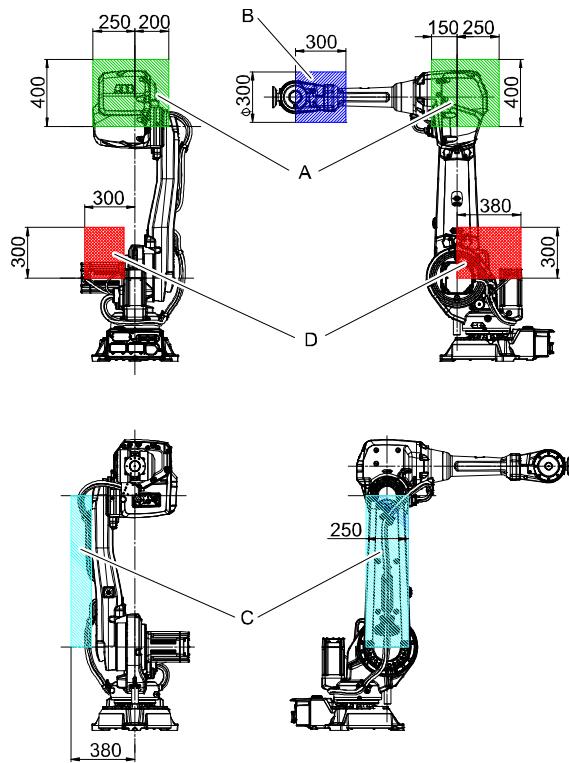


##### Note

Never drill a hole in the robot without first consulting ABB!

##### Fitting equipment on robot - Load areas

The shaded area indicates the permitted positions (center of gravity) for any extra equipment fitted in the holes intended for this purpose.



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Variant	Max load A	Max load B	Max load C	Max load A+C	Max load D
IRB 4600-60/2.05	15 kg	5 kg <sup>i</sup>	15 kg	15 kg	35 kg
IRB 4600-45/2.05	15 kg	5 kg <sup>ii</sup>	15 kg	15 kg	35 kg

Continues on next page

Variant	Max load A	Max load B	Max load C	Max load A+C	Max load D
IRB 4600-40/2.55	15 kg	5 kg <sup>iii</sup>	15 kg	15 kg	35 kg
IRB 4600-20/2.50	10 kg	1 kg	10 kg	10 kg	35 kg

i Payload + B = Max 60 kg

ii Payload + B = Max 45 kg

iii Payload + B = Max 40 kg

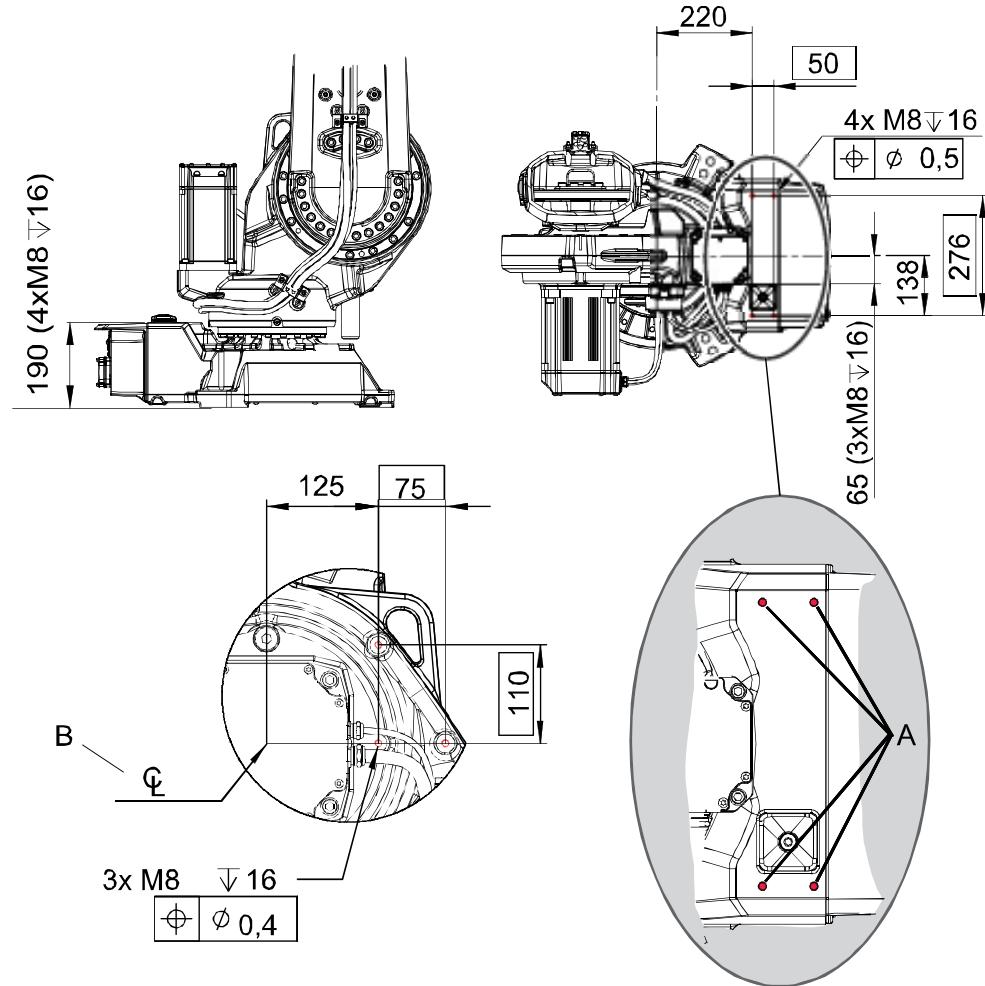


#### Note

Maximum loads must never be exceeded!

### Fitting equipment on base and frame

The illustrations show the fitting holes available for fitting extra equipment on the base and frame of the robot.



xx0800000276

A	Attachment holes on base
B	Center axis 2

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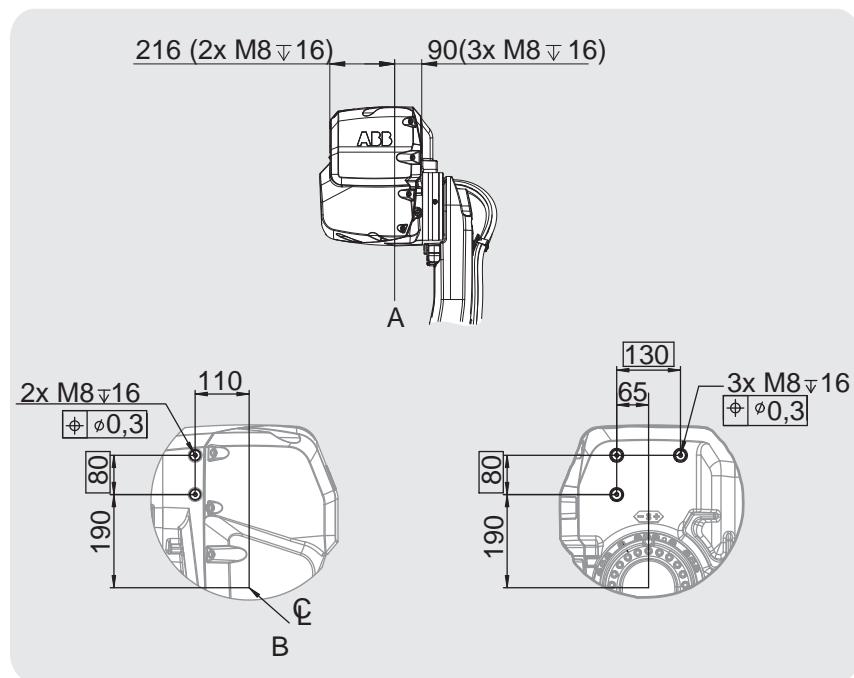
## 2 Installation and commissioning

### 2.3.6 Fitting equipment on robot

*Continued*

#### Fitting equipment on lower and upper arm

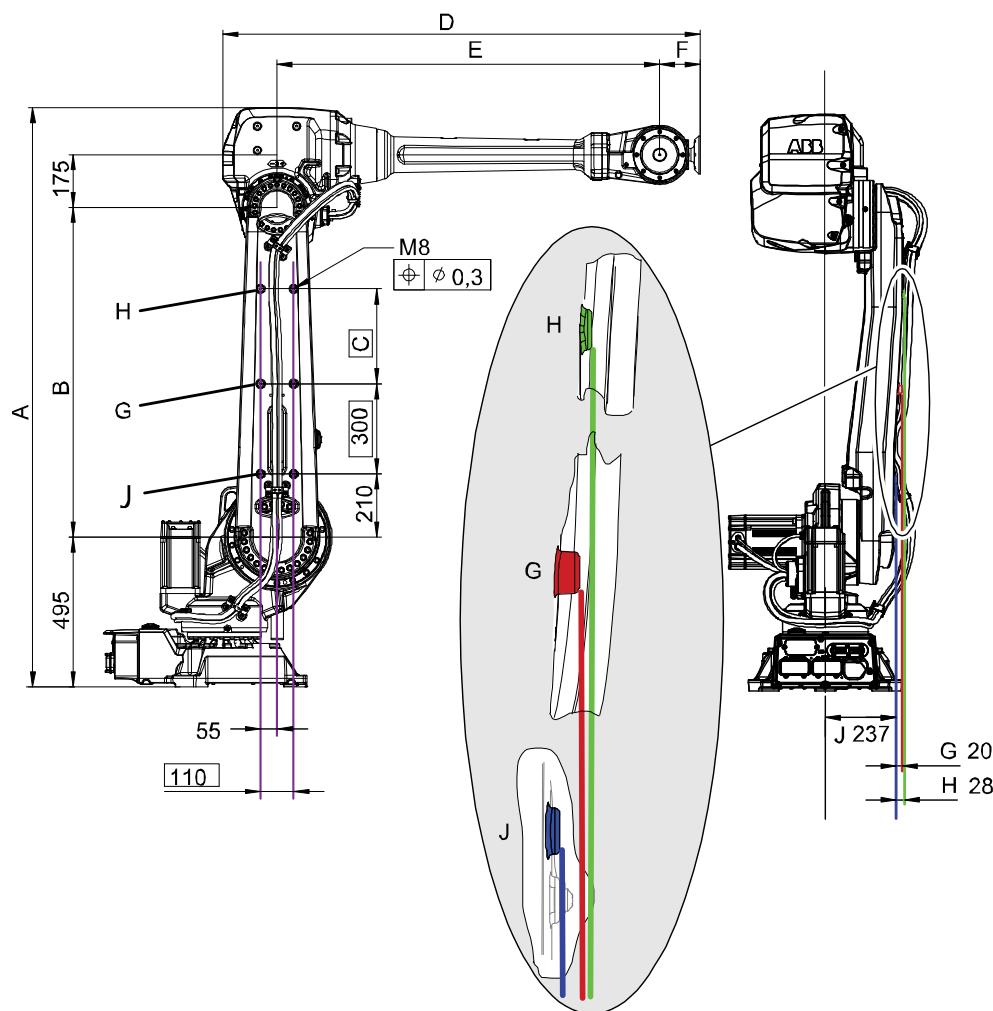
The illustrations show the fitting holes available for fitting extra equipment on the lower and upper arm of the robot.



xx0800000280

A	Center axis 4
B	Center axis 3

*Continues on next page*



xx0800000279

Variant	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	J (mm)
60/2.05	1727	900	See note i	1276	960	135	20	See note i	237
45/2.05	1727	900	See note i	1276	960	135	20	See note i	237
40/2.55	1922	1095	315	1586	1270	135	20	28	237
20/2.50	1922	1095	315	1496.5	1230.5	85	20	28	237

i Position H and measurement C is only applicable to IRB 4600 - 40/2.55 and IRB 4600 - 20/2.50.  
Position H and measurement C is only applicable to IRB 4600 - 40/2.55 and IRB 4600 - 20/2.50.

Variant	Attachment screws
60/2.05	4x M8, through
45/2.05	4x M8, through
40/2.55	6x M8, through
20/2.50	6x M8, through

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## 2 Installation and commissioning

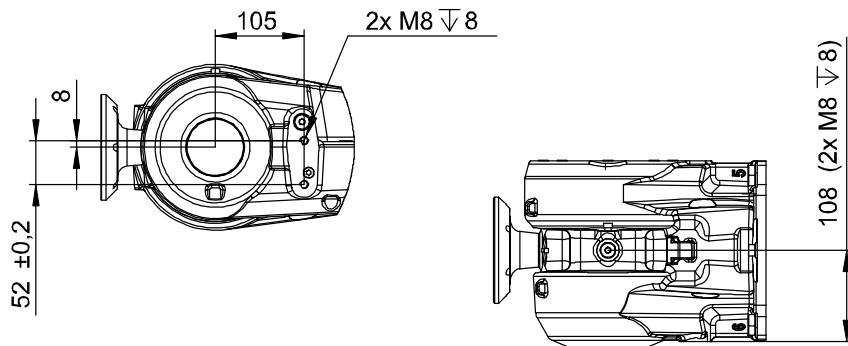
### 2.3.6 Fitting equipment on robot

*Continued*

#### Fitting equipment on wrist and mounting flange

Extra equipment on wrist, robot versions IRB 4600 -60/2.05, -45/2.05 and -40/2.55

The illustration shows the fitting holes available for fitting extra equipment on the wrist of the robot.

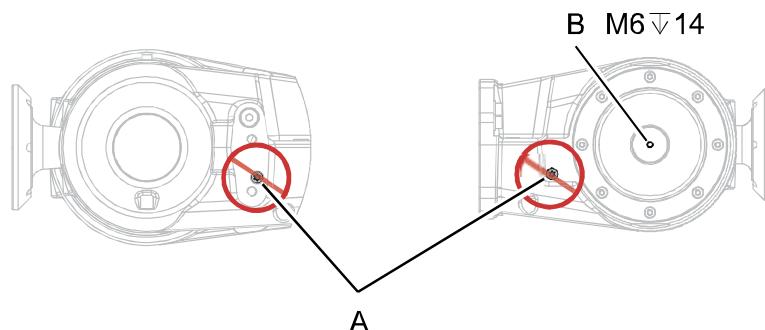


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#### Note

Do not remove screws indicated in the illustration below!



xx0800000281

A	Screws not to be removed! Do not use these holes for fitting equipment on the wrist!
B	Screw hole intended for swivel fitting.

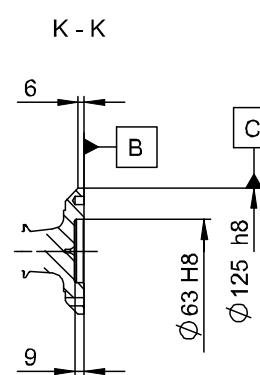
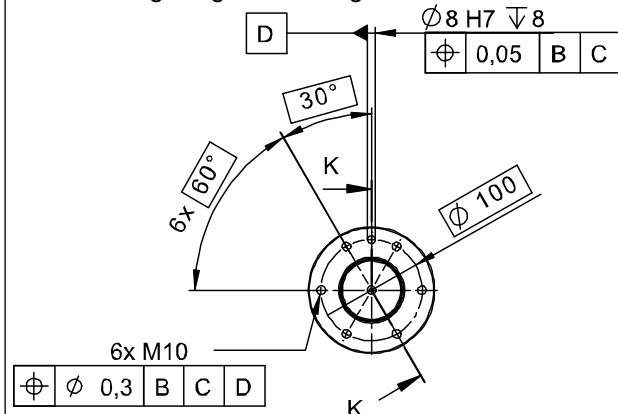
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Extra equipment on mounting flange, robot versions IRB 4600 -60/2.05, -45/2.05 and -40/2.55

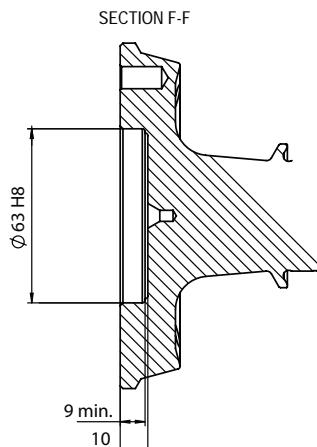
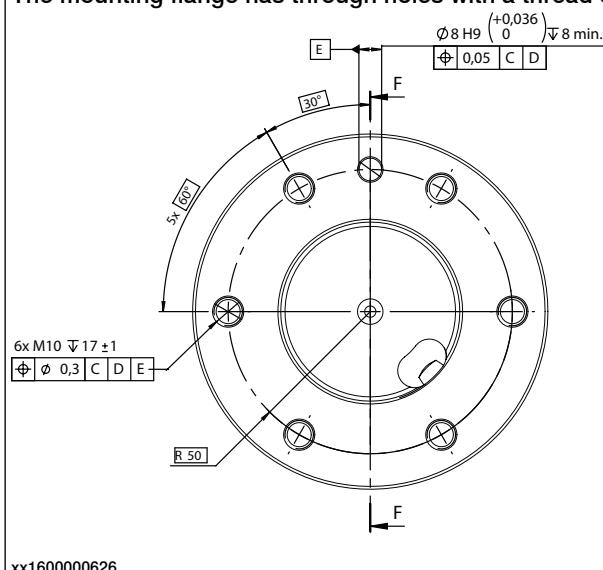
The illustration shows the mechanical interface for the mounting flange.

There are two versions of the mounting flange, differences are shown in the figures.

The mounting flange has through holes with a thread all the way through.



The mounting flange has through holes with a thread only part way through the hole.



#### Note

Use attachment screws M10, quality 12.9 and 15 mm *used* thread length.

*Continues on next page*

## 2 Installation and commissioning

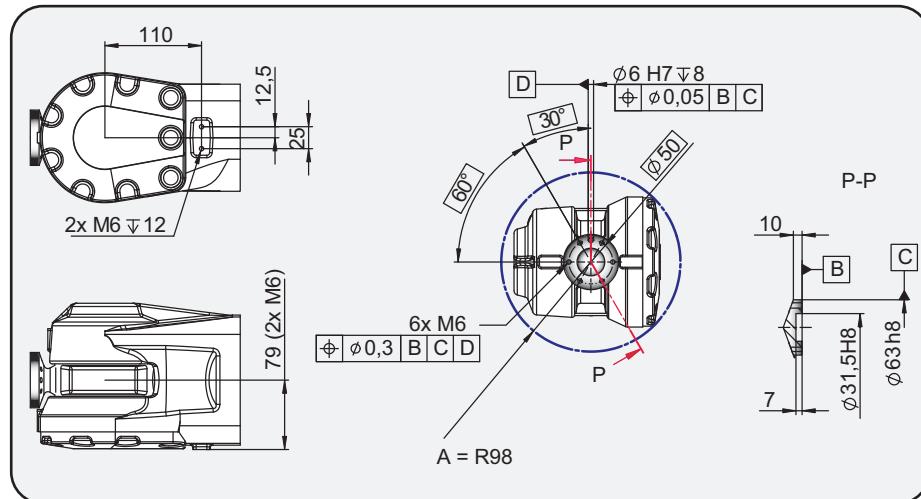
### 2.3.6 Fitting equipment on robot

Continued

#### Extra equipment on wrist and mounting flange, robot version IRB 4600 -20/2.50

The illustration shows the fitting holes available for fitting extra equipment on the wrist of the robot version IRB 4600 -20/2.50.

The illustration also shows the mechanical interface for the mounting flange of the robot version IRB 4600 -20/2.50.



xx0800000278

A	Smallest circumscribed radius axis 4
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#### Note

Use attachment screws M6, quality 12.9 and 10 mm used thread length.

#### 2.3.7 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**

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### **2.3.8 Installation of signal lamp (option)**

---

#### **Signal lamp**

See the assembly instruction delivered with the signal lamp.

## 2.4 Restricting the working range

### 2.4.1 Axes with restricted working range

#### 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 axes may be restricted:

- Axis 1, hardware (mechanical stop) and software
- Axis 2, software
- Axis 3, software.

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



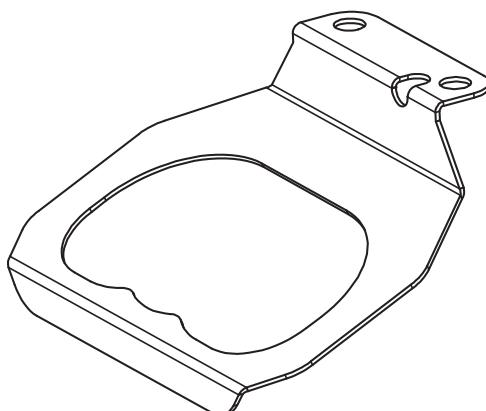
#### Note

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



#### WARNING

Remove the mechanical stop bracket if the robots full working range is from a mechanical stop to another mechanical stop. Otherwise the mechanical stop pin will be worn out.



xx1500000253

## 2 Installation and commissioning

### 2.4.2 Mechanically restricting the working range of axis 1

#### 2.4.2 Mechanically restricting the working range of axis 1

##### Mechanically restricting the working range

The information in this section is valid both for the floor and the suspended mounted robot.

The working range of axis 1 is limited by fixed mechanical stops. The working range can be reduced further by adding movable mechanical stops.

The mechanical turning range can be limited in steps of 22.5° from the synchronization position, between values defined in the table. The values differ depending on which design of the gearbox (and base) the robot is equipped with.

Design of gearbox <sup>i</sup>	Limitation in mechanical turning range, calculated from synchronization position
Type C	±126° to ±13.5° in steps of 22.5°
Other design than Type C	±129° to ±16.5° in steps of 22.5°

<sup>i</sup> Description of the different designs of gearboxes is found in [Type C of IRB 4600 on page 373](#).



##### Note

The software working range limitations must be adjusted to correspond to the changes in the mechanical limitations of the working range. The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.

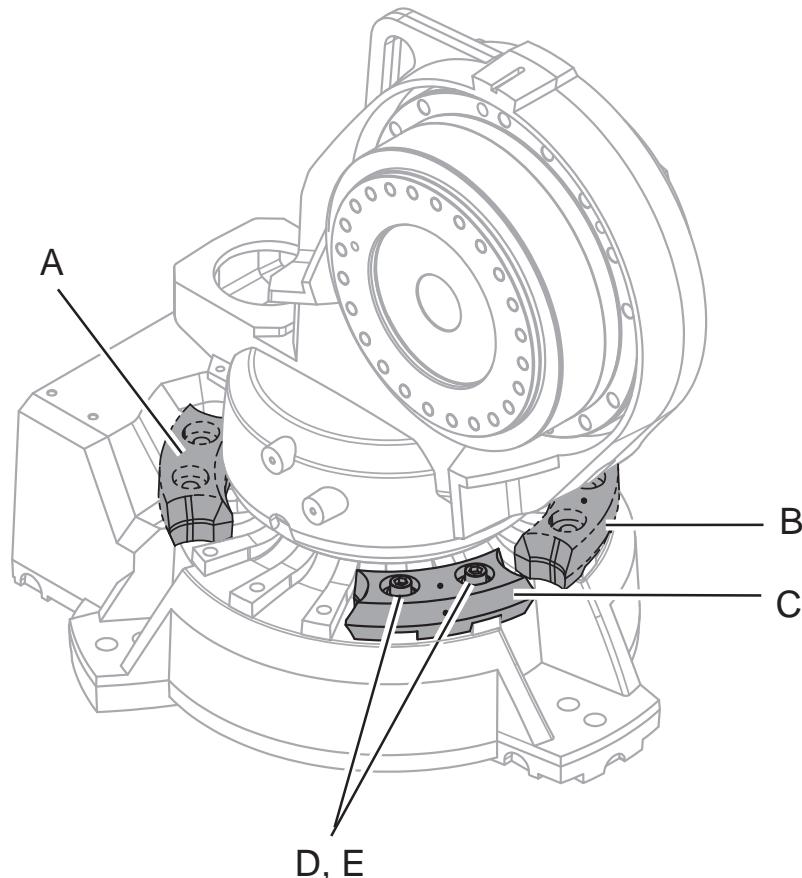
##### Required equipment

Equipment, etc.	Art. no.	Note
Mechanical stop, axis 1	See <a href="#">Spare part lists on page 389</a> .	Includes two additional stop lugs, attachment screws, washers and instruction
Attachment screw	See <a href="#">Spare part lists on page 389</a> .	2 pcs/stop lug Hex socket head cap screw M12x40, quality 8.8-A3F
Washer	See <a href="#">Spare part lists on page 389</a> .	2 pcs/lug 13x24x2.5
Standard toolkit		Content is defined in section <a href="#">Standard tools on page 383</a> .
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

#### Additional stops

The additional stops are fitted as shown in the figure.



xx0800000273

A	Movable mechanical stop. Limited to -126° (Type C) or -129° (other design than Type C).
B	Movable mechanical stop. Limited to +13.5° (Type C) or +16.5° (other design than Type C).
C	Movable mechanical stop. Limited to -13.5° (Type C) or -16.5° (other design than Type C).
D	Attachment screws
E	Washers

#### Fitting, mechanical stop axis 1

How to fit the additional mechanical stop to the base is described in the procedure.

Mounting instructions are also supplied with the kit.

	Action	Note
1	Determine the position of the stop lugs.	See the figure <a href="#">Additional stops on page 97</a> for guidance.
2	Fit the stop lugs firmly with attachment screws and washers according to the figure <a href="#">Additional stops on page 97</a> .	Specified in <a href="#">Required equipment on page 96</a> . Tightening torque: 82 Nm

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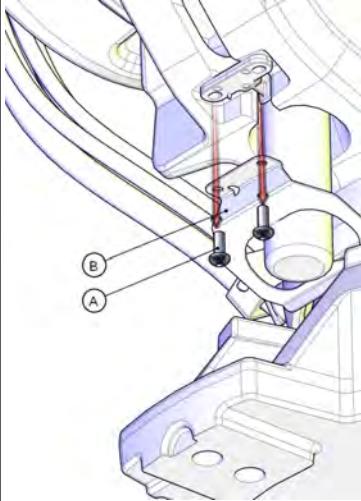
## 2 Installation and commissioning

### 2.4.2 Mechanically restricting the working range of axis 1

*Continued*

#### Preparing the robot for working range $\pm 180^\circ$

This procedure describes how to prepare the robot for working range  $\pm 180^\circ$ .

Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2 Remove the two screws holding the mechanical stop and the bracket.	 xx1100000091 A Attachment screw B Bracket, stop axis 1
3 Remove the bracket.	
4 Refit the attachment screws.	

## 2.5 Installing options

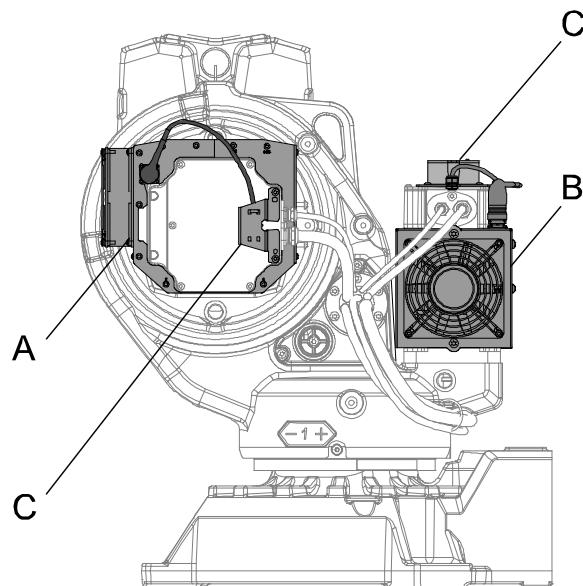
### 2.5.1 Installation of cooling fan for motors (option)

#### General

A cooling fan can be installed on motor axis 1 and/or axis 2!

#### Location of cooling fans

The fans are installed on the motors, axes 1 or 2, as shown in the figure below.



xx0900000135

A	Fan, motor axis 2
B	Fan, motor axis 1
C	Protection cover

*Continues on next page*

## 2 Installation and commissioning

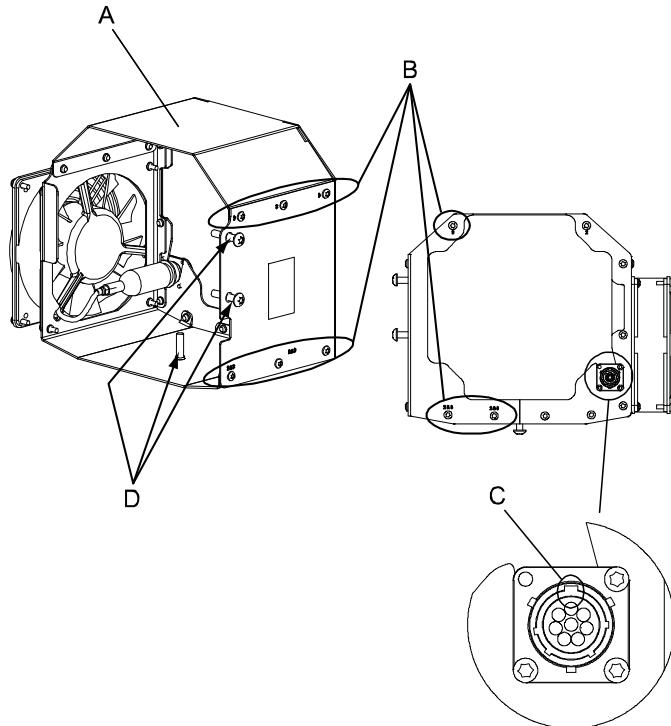
### 2.5.1 Installation of cooling fan for motors (option)

*Continued*

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#### Cooling fan

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



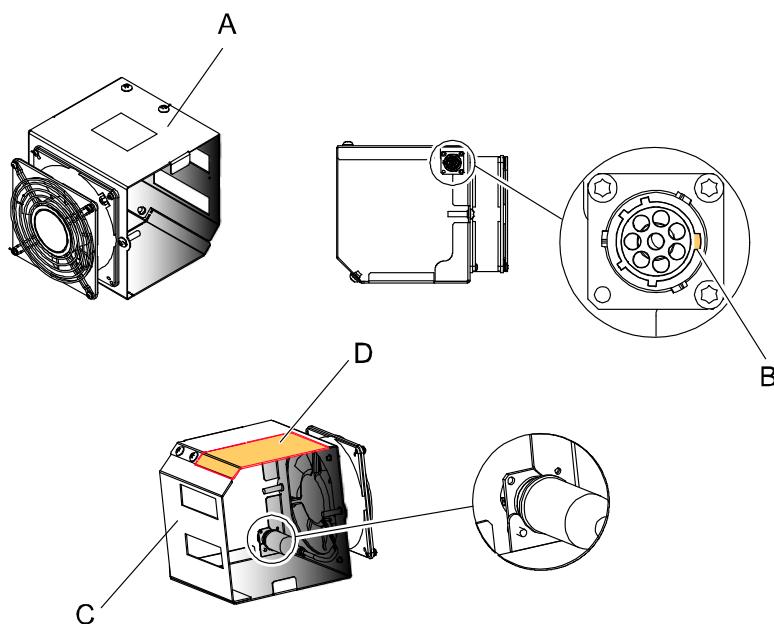
xx0500002158

A	Fanbox (motor axis 2)
B	Attachment screws, fanbox plates (9 pcs)
C	Groove in the connector
D	Tightening screws, fanbox (3 pcs)

*Continues on next page*

### 2.5.1 Installation of cooling fan for motors (option)

*Continued*



xx0900000137

A	Fanbox (motor axis 1)
B	Groove in the connector
C	Back plate
D	Part of the fanbox that can be removed, if needed.

#### Required equipment

Equipment	Art. no.	Note
Cooling fan axis 1, set	-	For Spare part no. see chapter <i>Spare parts</i> , section: • <a href="#">Spare part lists on page 389</a>
Cooling fan axis 2, set	-	For Spare part no. see chapter <i>Spare parts</i> , section: • <a href="#">Spare part lists on page 389</a>
Locking liquid	-	Loctite 243. Used for the three tightening screws.
Standard toolkit	-	Content is defined in section <a href="#">Standard tools on page 383</a> .
Circuit diagram	-	See chapter <a href="#">Circuit diagram on page 391</a> .
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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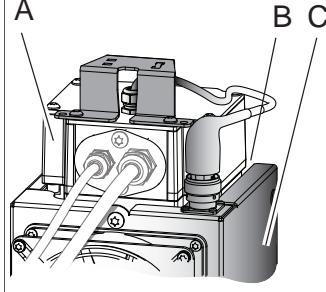
## 2 Installation and commissioning

### 2.5.1 Installation of cooling fan for motors (option)

*Continued*

#### Installation, fan on motor axis 1

Use this procedure to install the cooling fan on motor axis 1.

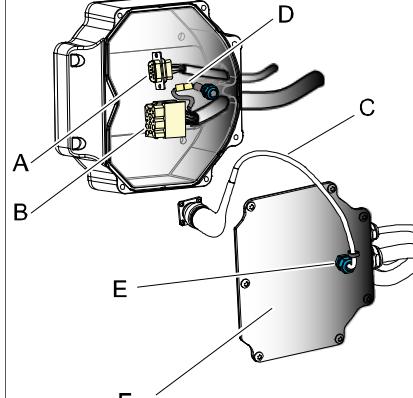
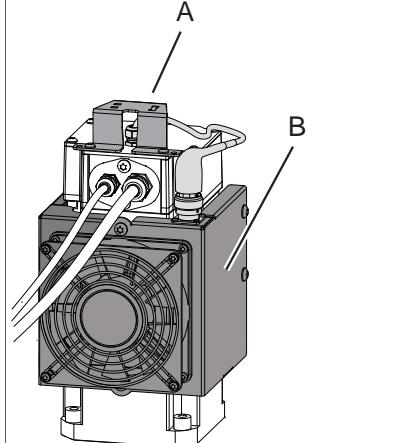
	Action	Note
1	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply to the robot</li><li>• hydraulic pressure supply to the robot</li><li>• air pressure supply to the robot</li></ul> Before entering the robot working area.	
2	Remove the back plate of the fanbox.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Cooling fan on page 100</a></li></ul>
3	Place the fanbox around motor axis 1.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Cooling fan on page 100</a></li></ul>
4	Refit the back plate of the fanbox.	
5	 <b>Tip</b>  If there is a lack of space between motor and robot, it is possible to remove part of the fanbox.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Cooling fan on page 100</a></li></ul>
6	Push the fanbox in line with the connection box.	Align the upper part of the fan with the lower part of the connection box.  xx1000000124 <b>Parts:</b> <ul style="list-style-type: none"><li>• A: Connection box</li><li>• B: Position where the fan shall be aligned with connection box</li><li>• C: Fan</li></ul>
7	Fit the fanbox with two attachment screws M6x25.	

*Continues on next page*

## 2 Installation and commissioning

### 2.5.1 Installation of cooling fan for motors (option)

*Continued*

Action	Note
8 Connect the fan connector to motor and fan.	 <p>xx0900000405</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Connector, signal</li> <li>• B: Connector, power</li> <li>• C: Fan cable</li> <li>• D: Connector, fan</li> <li>• E: Cable gland</li> <li>• F: Motor cover, with fan cable</li> </ul>
9 After fitting the motor cover, fit the protection cover using two attachment screws for the motor cover.	 <p>xx0900000406</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Protection cover</li> <li>• B: Fan</li> </ul>
10 Secure the fan cable to the protection cover with a cable strap.	

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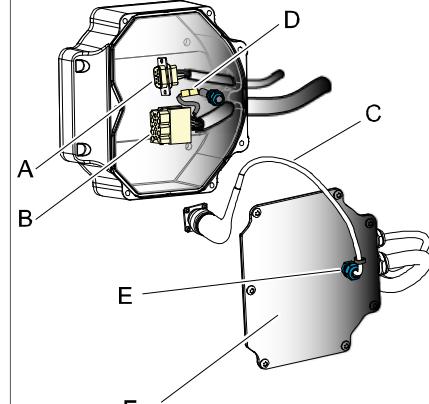
## 2 Installation and commissioning

### 2.5.1 Installation of cooling fan for motors (option)

*Continued*

#### Installation, fan on motor axis 2

Use this procedure to install the cooling fan on motor axis 2.

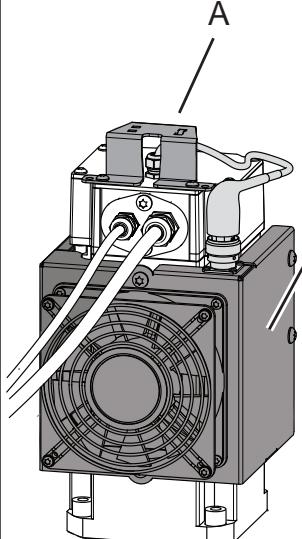
Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply to the robot</li><li>• hydraulic pressure supply to the robot</li><li>• air pressure supply to the robot</li></ul> Before entering the robot working area.	
2 Remove the back plate of the fanbox.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Cooling fan on page 100</a></li></ul>
3 Place the fanbox around motor axis 1.	
4 Refit the back plate of the fanbox.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Cooling fan on page 100</a></li></ul>
5 Fit the fanbox with two attachment screws M6x30.	
6 Connect the fan connector to motor and fan.	 <p>xx0900000405</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"><li>• A: Connector, signal</li><li>• B: Connector, power</li><li>• C: Fan cable</li><li>• D: Connector, fan</li><li>• E: Cable gland</li><li>• F: Motor cover, with fan cable</li></ul>

*Continues on next page*

## 2 Installation and commissioning

### 2.5.1 Installation of cooling fan for motors (option)

*Continued*

Action	Note
7 After fitting the motor cover, fit the <i>protection cover</i> using two attachment screws for the motor cover.	 <p>xx0900000406</p> <p>Parts:</p> <ul style="list-style-type: none"><li>• A: Protection cover</li><li>• B: Fan</li></ul>

## **2 Installation and commissioning**

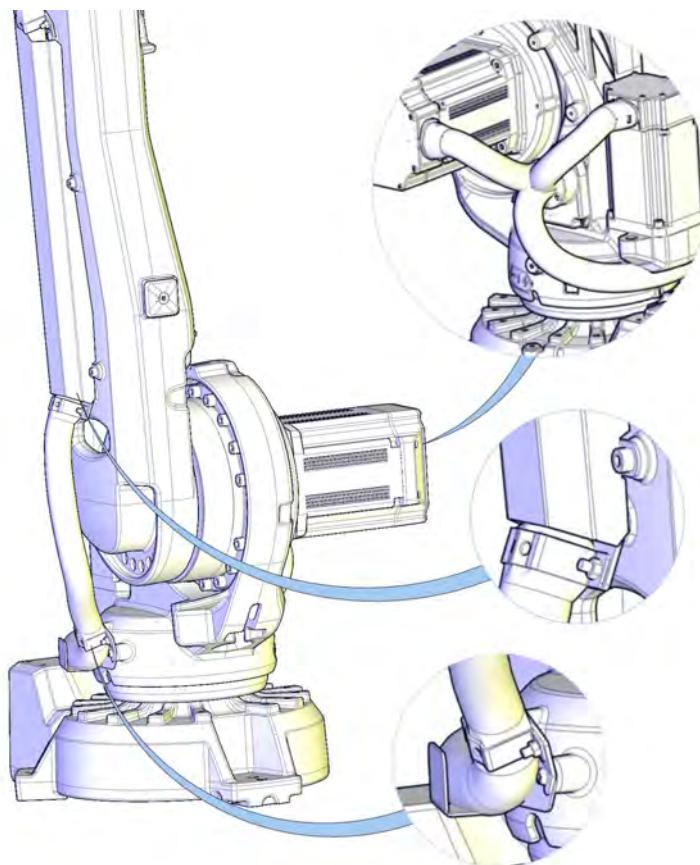
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### **2.5.2 Installation of Foundry Plus Cable guard (option no. 908-1)**

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#### **Introduction**

Separate instructions for IRB 2600, 4600, 6620, 6640, 6650S, 6660 and 7600 are available in English, German, French, Spanish and Italian and can be found on the DVD delivered with the Cable guard, article number 3HAC035933-001.



xx1100000097

### 2.5.3 Installing an expansion container



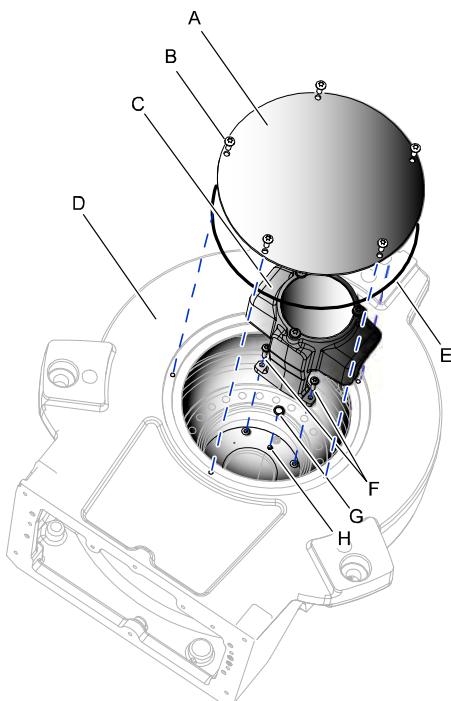
#### Note

This section is not applicable to type C. Expansion container is not needed on this type.

#### Introduction to the expansion container

The expansion container is needed on suspended robots to make sure that the amount of oil in gearbox axis 1 covers all important parts. Robots ordered as suspended robots have the expansion container installed on delivery.

#### Expansion container



xx1000000318

A	Cover
B	Attachment screw M6x16, quality 8.8-A2F (5 pcs)
C	Oil expansion container with cover
D	Base
E	O-ring D220x5
F	Attachment screw M5x20, quality 8.8-A2F and washer (2+2 pcs)
G	O-ring D1=9.5 D2=1.6
H	Oil plug (to be removed)

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## 2 Installation and commissioning

### 2.5.3 Installing an expansion container

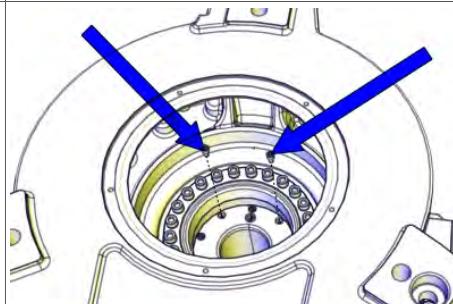
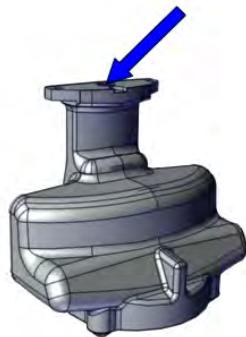
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#### Required equipment

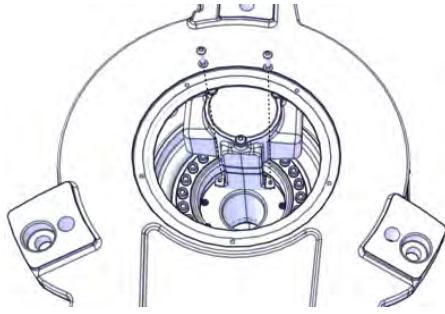
Equipment	Note
Expansion container	Kit including oil.
Lifting accessory	3HAC034766-001
Lifting instruction	Included with the lifting accessory.
Grease	-
O-ring for base cover	Replace if damaged.

#### Installing an expansion container

Use this procedure to install the expansion container.

Action	Information
1 Lift the robot using the lifting accessory and place it in suspended position with the base free for installation work.	See <i>Lifting and turning a suspended mounted robot on page 74</i> .
2 Remove the cover and the o-ring from the base.	
3 Remove the two existing attachment screws.	 xx1500001958 The screws must be replaced with longer screws.
4 Remove the oil plug from the base.	
5 Apply some grease on the small o-ring and place it in the recess on the expansion container.	
6 Fit a plastic plug in the oil drain hole.	 xx1500001956

Continues on next page

Action	Information
7 Fill oil in expansion container, and press down the <i>VK-cover</i> . Secure with three screws and washers.	 xx1500001957
8 Place the <i>expansion container</i> in the base and place it so the drain holes match.	
9 Secure the expansion container with the <i>attachment screws and washers</i> .	 xx1500001959 Tightening torque 6 Nm.
10 Check the <i>o-ring</i> used on the cover. Replace it if damaged.	
11 Refit the <i>cover</i> on the base with its <i>attachment screws</i> .	
12 Turn the robot so it is not suspended.	
13 Turn the robot to suspended position.	
14 Inspect the oil level.	See procedure for suspended robot, <a href="#"><i>Inspecting oil level, axis 1 gearbox on page 124</i></a> .

## 2 Installation and commissioning

### 2.6.1 Start of robot in hot environments

## 2.6 Robot in hot environments

### 2.6.1 Start of robot in hot environments

#### Introduction

This procedure describes how to start the robot in a hot environment. This procedure must be performed the first time the robot is started in a hot environment or if it has not been used for some time in a hot environment.

There is a possibility that some overpressure has been built up in the system. This overpressure must be released before starting up the robot.

#### Releasing overpressure in gearboxes

Use this procedure before the start of the robot in a hot environment to release potential overpressure being built up in gearboxes.

	Action	Note
1	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	 <b>CAUTION</b>  Before approaching the potentially hot robot component, observe the safety information in section <i>CAUTION - Hot parts may cause burns! on page 27.</i>	
3	 <b>Note</b>  Before opening the oil plug, make certain that the oil plug is above the oil level. Place the robot accordingly.	
4	 <b>Note</b>  Open the oil plug just enough for the overpressure to be released.	 <b>Tip</b>  Hold a cloth or some paper over the oil plug while opening it to prevent surplus oil causing burns or other injuries.
5	Let the overpressure leave the gearbox.	
6	Refit the oil plug.	
7	Continue releasing the overpressure on all gearboxes.	

## 2.7 Robot in cold environments

### 2.7.1 Start of robot in cold environments

#### Introduction

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

#### Starting in cold environment

Use this procedure to start the robot in a cold environment if it is not starting the normal way:

	Action	Note
1	Turn off motion supervision.	
2	Start the robot.	
3	When the robot has reached normal working temperature, the motion supervision can be turned on again.	

#### If still not starting...

If the robot is still not starting after turning off motion supervision, use this procedure:

	Action	Note
1	Start the robot with its normal program but with reduced speed.	The speed can be regulated with the RAPID instruction <code>AccSet</code> .

#### 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

### 2.8.1 Robot cabling and connection points

## 2.8 Electrical connections

### 2.8.1 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 <a href="#">Robot cables on page 112</a> .
Fan cables (option)	Handles supply to and feedback from any cooling fan on the robot. Specified in the table <a href="#">Fan cables (option) on page 113</a> .
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. The customer cables also handle databus communication. See the product manual for the controller, see document number in <a href="#">References on page 10</a> .
External axes cables (option)	Handles power supply to and control of the external axes' motors as well as feedback from the servo system. See the <i>Application manual - Additional axes and stand alone controller (M2004)</i> , see document number in <a href="#">References on page 10</a> .

#### 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

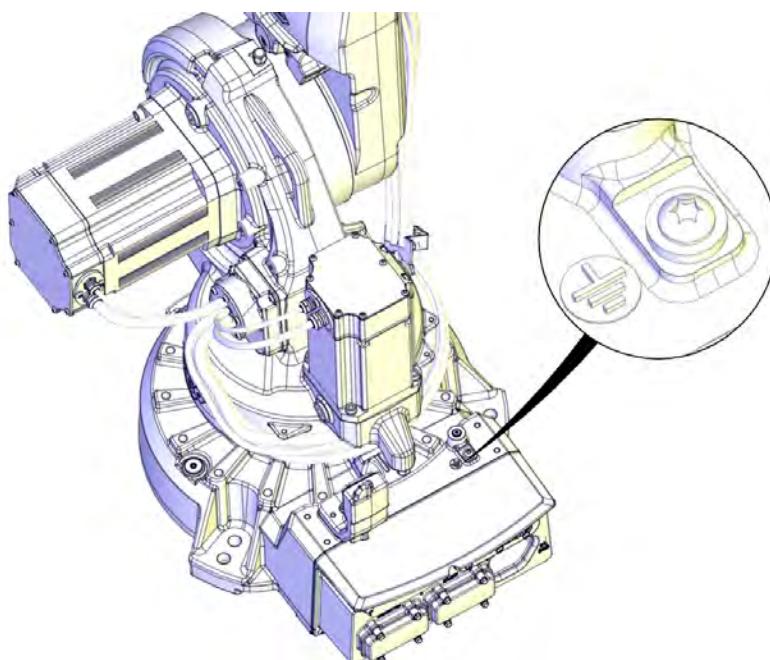
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#### Robot cable, signals

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

#### 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.



xx1600001004

#### Fan cables (option)

These cables are *not* included in the standard delivery, but are included in the delivery if the fan option is ordered. The cables are completely pre-manufactured and ready to plug in.

Cabling to be installed on the robot is specified in section *Installation of cooling fan for motors (option) on page 99*.

## 2 Installation and commissioning

### 2.8.2 Customer connection on robot

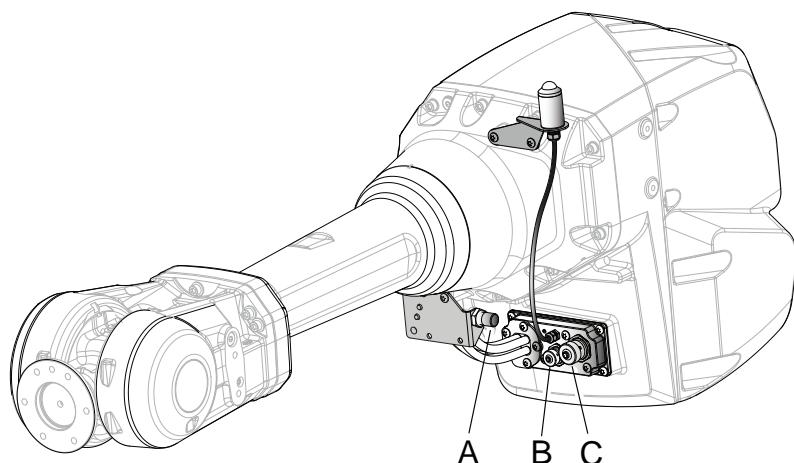
#### 2.8.2 Customer connection on robot

##### Location of customer connection

For the connection of extra equipment to the robot, cables and air hose are integrated into the robot's cabling, and there is one UTOW71210SH06 and one UTOW71626SH06 connector on the front part of the upper arm.

The customer connections are located on the robot as shown in the figure.

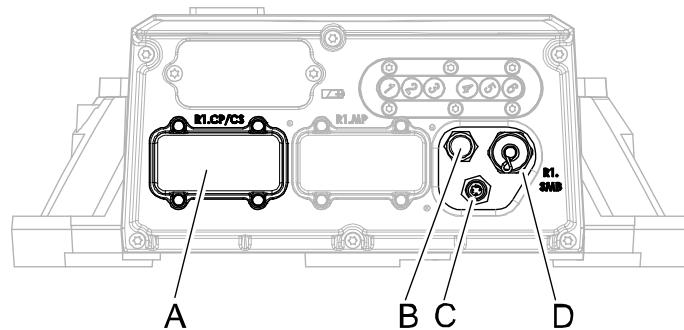
Customer connection upper arm.



xx0800000289

A	Air M16x1.5 (24° cone sealing)
B	R2.CP
C	R2.CS

##### Customer connections base



xx0800000288

A	R1.CP/CS
B	Air M16x1.5
C	R1.CBUS
D	R1.SMB

*Continues on next page*

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#### Extra equipment connections

Connections to the:

- air hose ( 3/8") is located on the front part of the upper arm and at the base.  
Max. 8 bar. Inner hose diameter: 9.5 mm.
- signal cabling (option) is located on the front of the upper arm.

Number of signals, customer connections R1.CP/CS:

- 23 (50V, 0.5A)
- 9 (300V, 2A). 8 are double crimped in R1.CP/CS and one is only accessible in the robot base.
- 2 DeviceNet or Profibus R1.CP/CS
- One protective ground

Number of signals, customer connections R1.CBUS:

- 4 EtherNet R1.CBUS

---

#### Connection sets

To connect power and signal conductors to the robot base/upper arm connectors, the following parts are recommended.

Connection set	Connector	Art. no.	Content
PROC1 on base	R1.CP/CS	3HAC16667-1	<ul style="list-style-type: none"><li>• Sockets for cable area of 0.14-2.5 mm<sup>2</sup></li><li>• Hood foundry</li><li>• Hinged frame, hood</li><li>• Multicontact-module, female</li></ul>
Connector set on base	R1.CP/CS	3HAC033181-001	<ul style="list-style-type: none"><li>• Hose coupling</li><li>• M12 connector, male</li></ul>
R2.CP/R2.CS	R2.CP/R2.CS	3HAC025396-001	<ul style="list-style-type: none"><li>• Pins for cable area 0.21 - 0.93 mm<sup>2</sup></li><li>• Bottle shaped shrinking hose</li><li>• Angle shaped shrinking hose</li></ul>

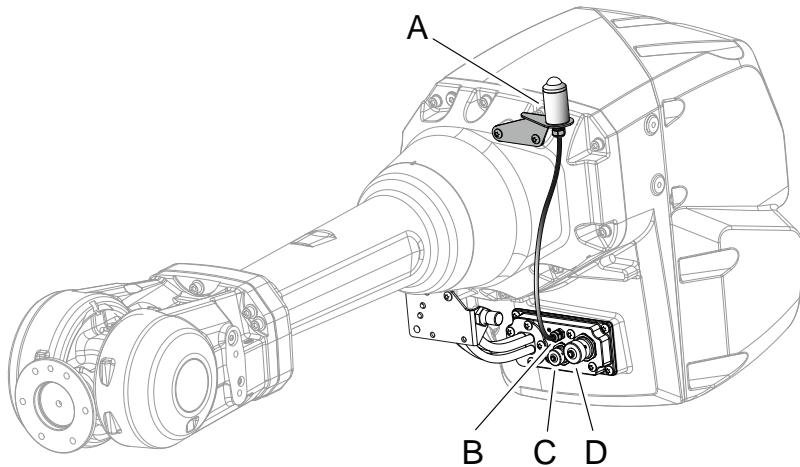
## 2 Installation and commissioning

### 2.8.3 Customer connections on upper arm

#### 2.8.3 Customer connections on upper arm

##### Customer connections on upper arm

The figure shows the customer connections on the upper arm, including the optional signal lamp that can be fitted to the armhouse.



xx0800000290

A	Signal lamp
B	R3.H1 +, R3.H2 -
C	R2.CP
D	R2.CS

##### Power supply connections on upper arm

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CPA	XP6.1	R2.CP.A	R1.CP/CS.d1
CPB	XP6.2	R2.CP.B	R1.CP/CS.d6
CPC	XP6.3	R2.CP.C	R1.CP/CS.d3
CPD	XP6.4	R2.CP.D	R1.CP/CS.d4
CPE	XP6.1	R2.CP.E	R1.CP/CS.d1
CPF	XP6.2	R2.CP.F	R1.CP/CS.d6
CPG		R2.CP.G (Earth)	
CPH	-	R2.CP.H	R1.CP/CS.d7
CPJ	XP6.3	R2.CP.J	R1.CP/CS.d3
CPK	XP6.4	R2.CP.K	R1.CP/CS.d4

*Continues on next page*

#### Signal connection on upper arm

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CSA	XP5.1.1	R2.CS.A	R1.CP/CS.b1
CSB	XP5.1.2	R2.CS.B	R1.CP/CS.b2
CSC	XP5.2.1	R2.CS.C	R1.CP/CS.b3
CSD	XP5.2.2	R2.CS.D	R1.CP/CS.b4
CSE	XP5.2.3	R2.CS.E	R1.CP/CS.b5
CSF	XP5.2.4	R2.CS.F	R1.CP/CS.b6
CSG	XP5.1.9	R2.CS.G	R1.CP/CS.b7
CSH	XP5.1.10	R2.CS.H	R1.CP/CS.b8
CSJ	XP5.1.11	R2.CS.J	R1.CP/CS.b9
CSK	XP5.1.12	R2.CS.K	R1.CP/CS.b10
CSL	XP5.1.3	R2.CS.L	R1.CP/CS.b11
CSM	XP5.1.4	R2.CS.M	R1.CP/CS.b12
CSN	XP5.1.5	R2.CS.N	R1.CP/CS.b13
CSP	XP5.1.6	R2.CS.P	R1.CP/CS.b14
CSR	XP5.3.1	R2.CS.R	R1.CP/CS.b15
CSS	XP5.3.2	R2.CS.S	R1.CP/CS.b16
CST	XP5.3.3	R2.CS.T	R1.CP/CS.b18
CSU	XP5.3.4	R2.CS.U	R1.CP/CS.b19
CSV	XP5.3.5	R2.CS.V	R1.CP/CS.b20
CSW	XP5.3.6	R2.CS.W	R1.CP/CS.b21
CSX	XP5.2.9	R2.CS.X	R1.CP/CS.b22
CSY	XP5.2.10	R2.CS.Y	R1.CP/CS.b23
CSZ	XP5.2.11	R2.CS.Z	R1.CP/CS.b24

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# 3 Maintenance

## 3.1 Introduction

### Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 4600.

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 19](#) before performing any service work!



#### Note

If the IRB 4600 is connected to power, always make sure that the IRB 4600 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**

#### **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 4600:

- 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 following table.

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 123](#)

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

- [Inspection activities on page 124](#)
- [Replacement activities on page 158](#)
- [Cleaning activities on page 198](#)

### Activities and intervals, standard equipment

The following table specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval
Cleaning	Robot	<a href="#">Cleaning the IRB 4600 on page 198</a>
Inspection	Oil level in axis-1 gearbox	Every 12 months.
Inspection	Oil level in axis-2 gearbox	Every 12 months.
Inspection	Oil level in axis-3 gearbox	Every 12 months.
Inspection	Oil level in axis-4 gearbox	Every 12 months.
Inspection	Oil level in axis-5-6 gearbox	Every 12 months.
Inspection	Robot harness	Every 12 months <sup>i</sup> .
Inspection	Information labels	Every 12 months.
Inspection	Dampers	Every 12 months.
Inspection	Pressure relief valve	Every 12 months <sup>ii</sup> .
Inspection	Mechanical stop	Every 12 months.
Change	Oil in axis-1 gearbox	First change when DTC <sup>iii</sup> reads: • 6,000 hours  Second change when DTC <sup>iii</sup> reads: • 24,000 hours  Following changes: • Every 24,000 hours.
Change	Oil in axis-2 gearbox	First change when DTC <sup>iii</sup> reads: • 6,000 hours  Second change when DTC <sup>iii</sup> reads: • 24,000 hours  Following changes: • Every 24,000 hours.

*Continues on next page*

### 3 Maintenance

#### 3.2.2 Maintenance schedule

*Continued*

Maintenance activity	Equipment	Interval
Change	Oil in axis-3 gearbox	First change when DTC <sup>iii</sup> reads: • 6,000 hours  Second change when DTC <sup>iii</sup> reads: • 24,000 hours  Following changes: • Every 24,000 hours.
Change	Oil in axis-4 gearbox	No change needed.
Change	Oil in axis-5-6 gearbox	First change when DTC <sup>iii</sup> reads: • 6,000 hours  Second change when DTC <sup>iii</sup> reads: • 24,000 hours  Following changes: • Every 24,000 hours.
Overhaul	Robot	Every: • 40,000 hours .
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert <sup>iv</sup>
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert <sup>v</sup>

- i Replace when damage or cracks is detected or life limit is approaching that specified in section [Expected component life on page 123](#).
- ii Check more often if the environment is very contaminated.
- iii DTC = Duty Time Counter. Shows the operational time of the robot.
- iv 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.
- v 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 following table specifies the required maintenance activities and intervals for common optional equipment. The maintenance of other external equipment for the robot is detailed in separate documents.

Maintenance activity	Equipment	Interval	Note
Inspection	Signal lamp	Every: 12 months	
Inspection	Additional mechanical stop, axis 1	Every: 12 months	
Inspection	Motor fan	Every 12 months	Inspect the fan for contamination that could hinder the air supply. Clean if necessary.

### 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 - protection type Standard

Component	Expected life	Note
Cable harness Normal usage <sup>i</sup>	40,000 hours <sup>ii</sup>	Not including: • Possible SpotPack harnesses • Optional upper arm harnesses
Cable harness Extreme usage <sup>iii</sup>	20,000 hours <sup>ii</sup>	Not including: • Possible SpotPack harnesses • Optional upper arm harnesses
Gearboxes <sup>iv</sup>	40,000 hours	

<sup>i</sup> Examples of "normal usage" in regard to movement: most material handling applications.

<sup>ii</sup> Severe chemical or thermal environments, or similar environments, can result in shortened life expectancy.

<sup>iii</sup> Examples of "extreme usage" in regard to movement: press tending, very severe palletizing applications, major use of axis 1 movement.

<sup>iv</sup> Depending on application, the lifetime can vary. The Service Information System (SIS), integrated in the robot software, can be used as a guidance for planning service of gearbox for the individual robot. This applies to gearboxes on axes 1, 2 and 3. The lifetime of gearbox axes 4, 5 and 6 is not calculated by SIS (See the *Operating manual - Service Information System*) In 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 gearboxes. Contact the local *ABB Robotics Service team* for more information.

The SIS for an IRC5 system is described in the *Operating manual - Service Information System*.

## 3 Maintenance

### 3.3.1 Inspecting oil level, axis 1 gearbox

## 3.3 Inspection activities

### 3.3.1 Inspecting oil level, axis 1 gearbox

#### Mounting position of the robot

If the robot is floor mounted, follow the procedures in [Inspecting the gearbox oil level in a floor mounted robot on page 125](#).

If the robot is suspended, follow the procedures in [Inspecting the gearbox oil level in a suspended robot \(Other design than Type C\) on page 128](#).



#### Note

If the suspended robot is design **Type C**, the oil level can not be inspected while the robot is hanging upside down. To make sure that the correct amount of oil is refilled after some repair work, make a note of how much oil was drained and make sure to refill with the same amount. If in doubt, the suspended robot must be dismantled from its suspended position, secured in a floor mounted position, and then the oil level can be inspected according to [Inspecting the gearbox oil level in a floor mounted robot on page 125](#).

The method described in this section of inspecting the oil level in a suspended robot is only valid for **Other design than Type C**.

Read more about design **Type C** in section [Type C of IRB 4600 on page 373](#).

#### Required equipment

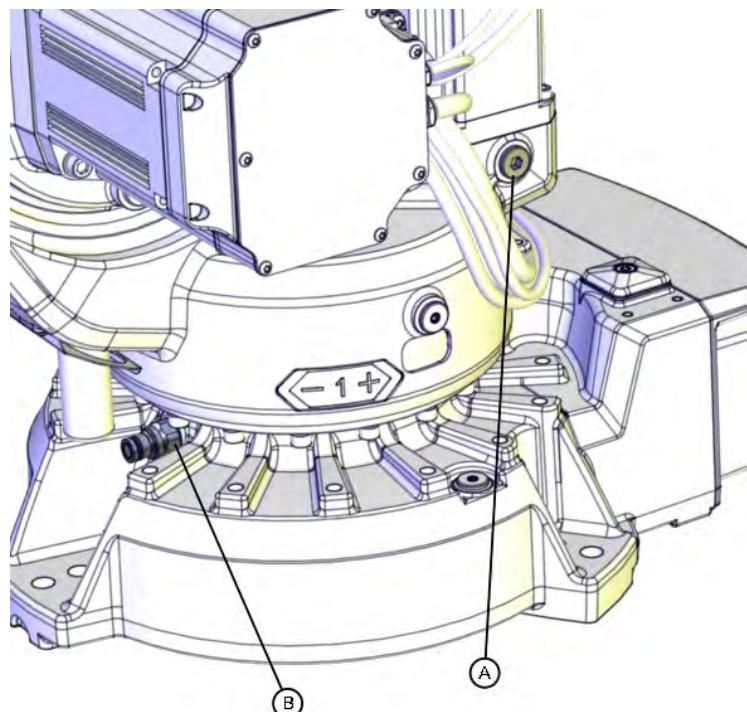
Equipment	Note
Only valid for Other design than Type C: Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
Other tools and 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*

**Inspecting the gearbox oil level in a floor mounted robot****Location of oil plugs (floor mounted)**

The axis 1 gearbox is located between the frame and base of the robot. The oil plug for inspection is shown in the figure.

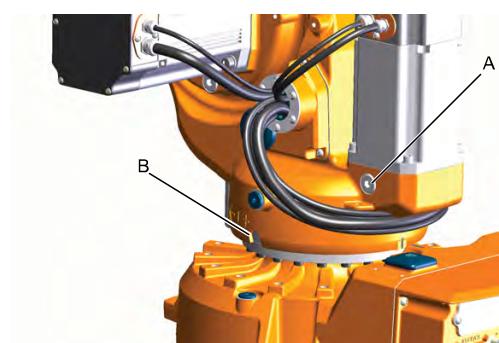
Type C



xx1200000632

A	Oil plug, filling and inspection
B	Oil plug, draining

Other design (1) than Type C



xx0800000304

A	Oil plug, inspection
B	Oil plug, gearbox

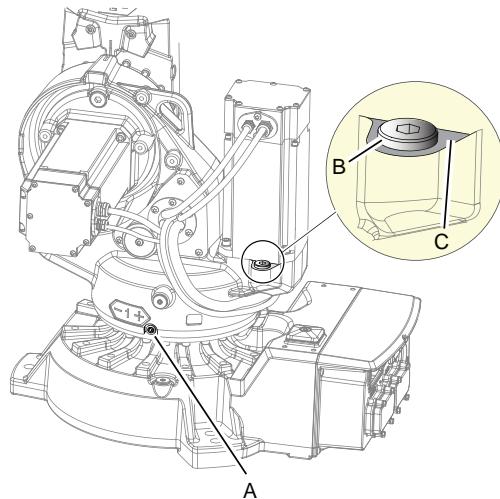
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### 3 Maintenance

#### 3.3.1 Inspecting oil level, axis 1 gearbox

*Continued*

Other design (2) than Type C



xx1000000669

A	Oil plug draining, on gearbox
B	Oil plug filling, on surface for motor flange
C	Surface for motor flange

#### Inspecting oil level, axis-1 gearbox (floor mounted)

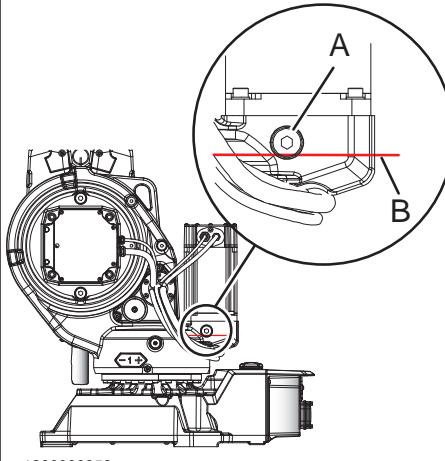
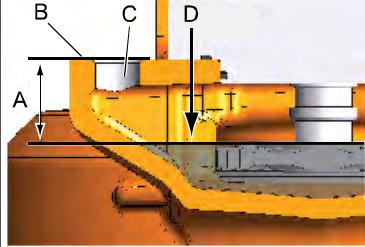
Use this procedure to inspect the oil level in the axis-1 gearbox, when the robot is floor mounted.

	Action	Note
1	 <b>WARNING</b>  Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
2	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3	 <b>CAUTION</b>  The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

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### 3.3.1 Inspecting oil level, axis 1 gearbox

*Continued*

	Action	Note
4	Open the <i>oil plug, inspection.</i>	See <a href="#">Location of oil plugs (floor mounted) on page 125</a> .
5	<p> Note</p> <p>Valid for Type C and Other design (1) than Type C</p> <p>Measure the oil level by looking into the hole of the oil plug inspection.</p> <p>Required oil level:</p> <ul style="list-style-type: none"> <li>• 0 -5 mm, up to the lower edge of the oil plug hole of the oil plug inspection.</li> </ul>	 <p>xx1200000859</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A Oil plug inspection</li> <li>B Approximate oil level</li> </ul>
6	<p> Note</p> <p>Valid for Other design (2) than Type C:</p> <p>Measure the oil level at the oil plug hole.</p> <p>Required oil level:</p> <ul style="list-style-type: none"> <li>• <math>35 \pm 3</math> mm below the surface for the motor flange.</li> </ul> <p>The oil level shall only just start to be observed when looking through the oil filling hole. See figure!</p>	 <p>xx1000000824</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: <math>35 \pm 3</math> mm</li> <li>• B: Surface for motor flange</li> <li>• C: Filling hole</li> <li>• D: Oil level</li> </ul>
7	Add oil if required.	How to fill oil is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Changing the oil, axis-1 gearbox on floor mounted robots on page 160</a></li> </ul>
8	Refit the oil plug, inspection.	Tightening torque: <ul style="list-style-type: none"> <li>• 24 Nm</li> </ul>

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### 3 Maintenance

#### 3.3.1 Inspecting oil level, axis 1 gearbox

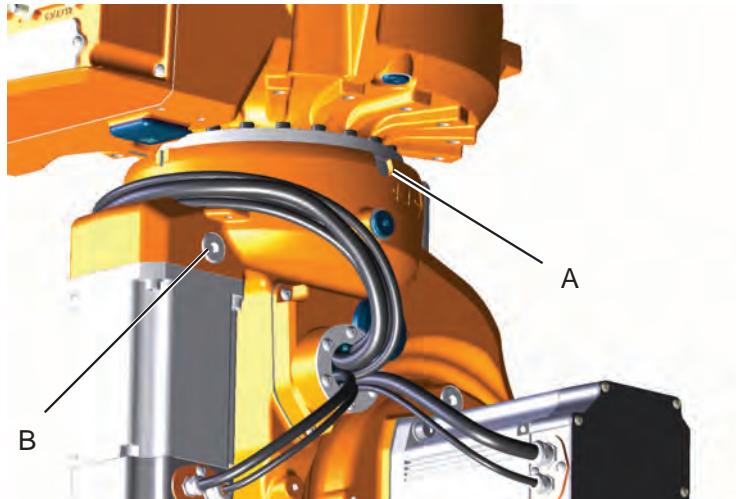
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#### Inspecting the gearbox oil level in a suspended robot (Other design than Type C)

Location of oil plugs (suspended)

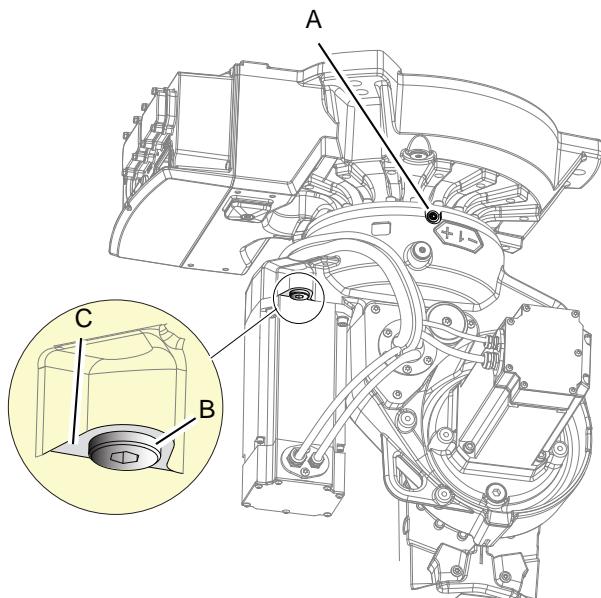
Other design (1) than Type C



xx1200000883

A	Oil plug, filling
B	Oil plug, draining

Other design (2) than Type C



xx1000001436

A	Filling oil plug, on gearbox
B	Draining oil plug, on surface for motor flange
C	Surface for motor flange

*Continues on next page*

## Inspecting oil level, axis-1 gearbox (suspended robot)

Use this procedure to inspect the oil level in the axis-1 gearbox, when the robot is suspended.

This procedure is only valid for **Other design than Type C**.

**Note**

If the suspended robot is design **Type C**, the oil level can not be inspected while the robot is hanging upside down. To make sure that the correct amount of oil is refilled after some repair work, make a note of how much oil was drained and make sure to refill with the same amount. If in doubt, the suspended robot must be dismantled from its suspended position, secured in a floor mounted position, and then the oil level can be inspected according to [Inspecting the gearbox oil level in a floor mounted robot on page 125](#).

**Note**

If the suspended robot is **Other design than Type C**, and the axis-1 gearbox is filled with an amount of oil suited for an inverted position, the oil level can only be inspected in the inverted position! If the robot was taken down to stand on the floor, the oil level would be above the oil plug hole, which would result in oil leakage if the plug would be opened while robot stands on the floor!

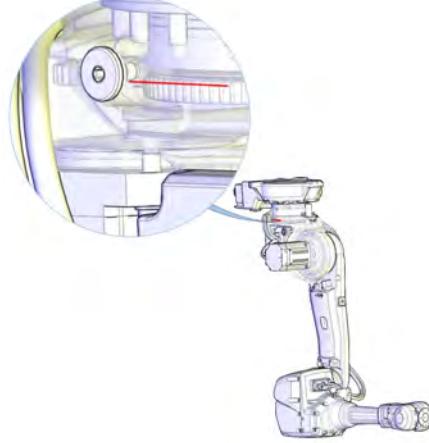
	Action	Note
1	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
2	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
3	 <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

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### 3 Maintenance

#### 3.3.1 Inspecting oil level, axis 1 gearbox

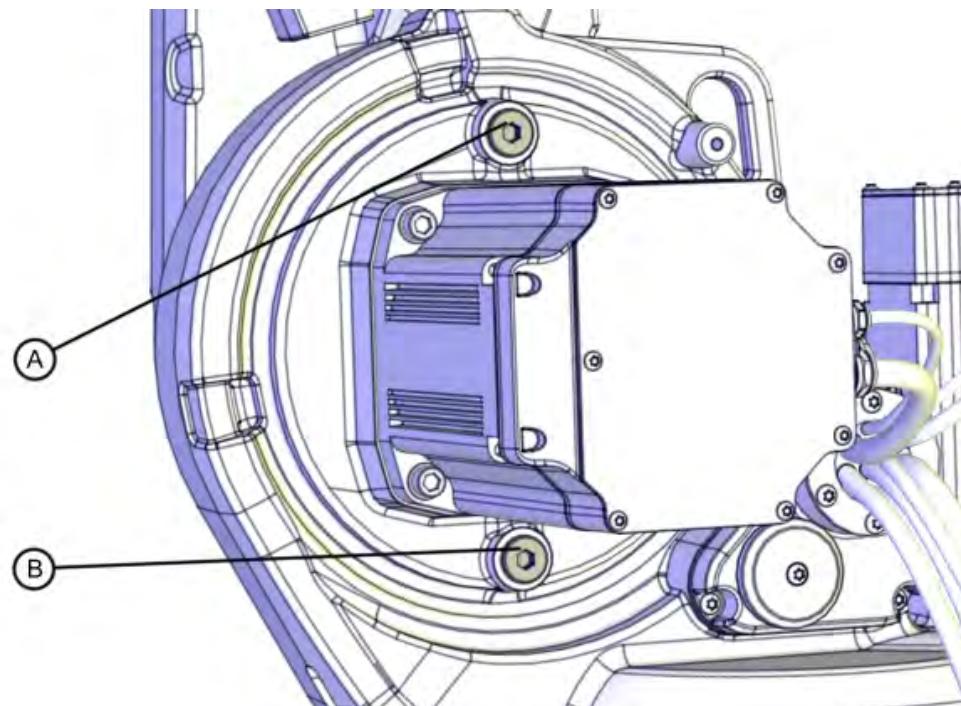
Continued

Action	Note
4 Open the <i>oil plug inspection</i> on the axis 1 gearbox.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs (floor mounted) on page 125</a></li></ul>
5 Required oil level: <ul style="list-style-type: none"><li>• up to the lower edge of the oil plug hole.</li></ul> <p><b>Note</b> The oil plugs on gearbox axis 1 are now on top.</p>	 xx1100000008
6 Add oil if required.	How to fill oil is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing the oil, axis-1 gearbox on floor mounted robots on page 160</a></li></ul>
7 Refit the oil plug. <p><b>Note</b> <b>Only valid for Other design than Type C:</b> Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.</p>	Tightening torque: <ul style="list-style-type: none"><li>• 3-8 Nm</li></ul>

### 3.3.2 Inspecting the oil level, axis 2 gearbox

#### Location of axis 2 gearbox

The axis 2 gearbox is located in the lower arm rotational center, underneath the motor attachment. The oil plugs are shown in the figure.



xx0800000305

A	Oil plug, filling
B	Oil plug, draining (Quick connect fitting)

#### Required equipment

Equipment	Note
Only valid for Other design than Type C: Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a> .
Oil plug (Quick connect fitting)	For article number see <a href="#">Spare part lists on page 389</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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

#### 3.3.2 Inspecting the oil level, axis 2 gearbox

Continued

##### Inspecting oil level, axis 2 gearbox

Use this procedure to inspect the oil level in the axis 2 gearbox.

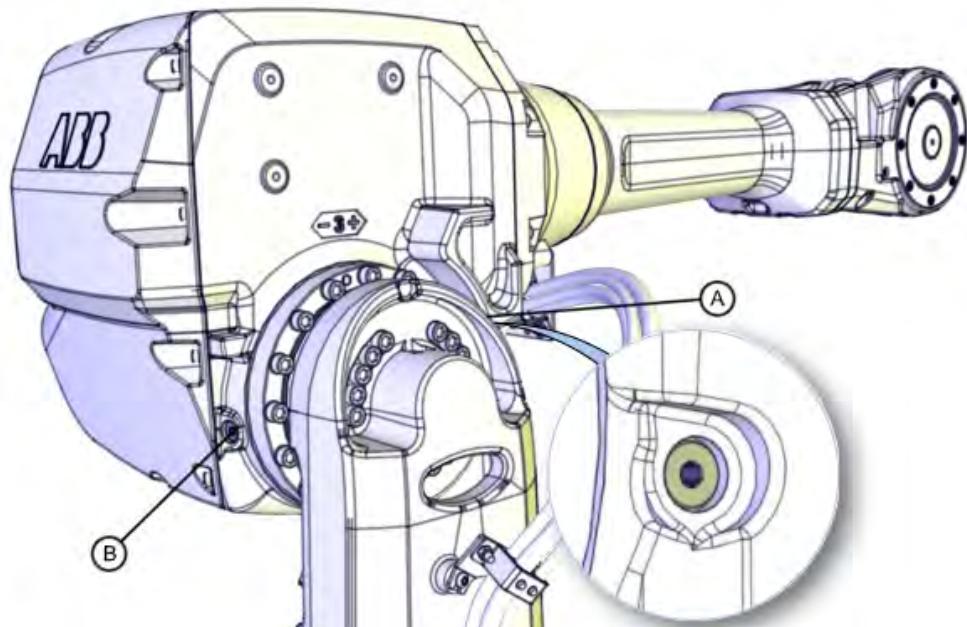
	Action	Note
1	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
2	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3	 <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Open the correct <i>oil plug</i> depending on how the robot is fitted: <ul style="list-style-type: none"><li>• Floor mounted: <i>oil plug, filling</i></li><li>• Suspended: <i>oil plug, draining (Quick connect fitting)</i></li></ul>	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of axis 2 gearbox on page 131</a></li></ul>
	 <b>Note</b> Always open the oil plug on top, depending how the robot is fitted!	
5	Measure the oil level at the oil plug hole. Required oil level: <ul style="list-style-type: none"><li>• 42 mm ± 5 mm below the lower edge of the oil plug hole.</li></ul>	
6	Add oil if required.	How to fill oil is described in section <ul style="list-style-type: none"><li>• <a href="#">Changing the oil, axis-2 gearbox on page 172</a></li></ul>
7	Refit the oil plug, filling.   <b>Note</b> <b>Only valid for Other design than Type C:</b> Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: <ul style="list-style-type: none"><li>• 24 Nm</li></ul>

### 3.3.3 Inspecting the oil level, axis 3 gearbox

#### Location of axis 3 gearbox

The axis 3 gearbox is located in the upper arm rotational center, underneath the motor attachment. The oil plug for inspection is shown in the figure.

Type C



xx1200000633

A	Oil plug, armhouse (Not visible in this figure. See enlarged figure!)
B	Oil plug, armhouse

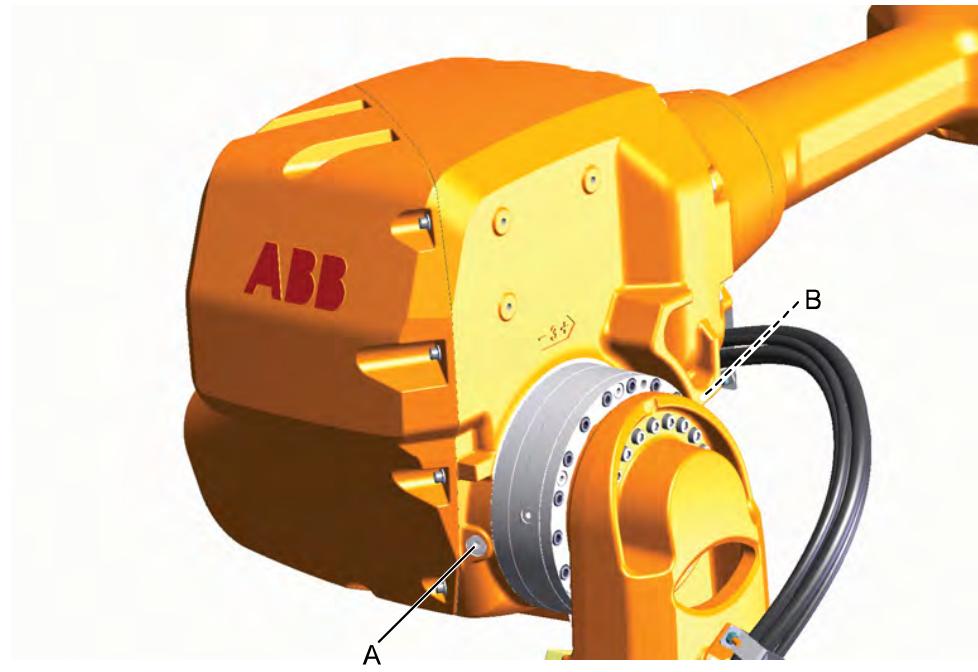
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### 3 Maintenance

#### 3.3.3 Inspecting the oil level, axis 3 gearbox

*Continued*

Other design than Type C



xx0800000306

A	Oil plug, armhouse
B	Oil plug, gearbox (not visible in this figure)

#### Required equipment

Equipment	Note
Lubrication oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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 the oil level, axis 3 gearbox

Use this procedure to inspect the oil level in the axis 3 gearbox.

Action	Note
1  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
2 Move the robot to where the upper arm is placed in a +30° position.	

*Continues on next page*

Action	Note
3  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
4  <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5 <b>Type C:</b> Open the <i>oil plug, armhouse</i> (pos. B). <b>Other design than Type C:</b> Open the <i>oil plug, armhouse</i> .	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of axis 3 gearbox on page 133</a></li></ul>
6 Measure the oil level at the oil plug hole. Required oil level: <ul style="list-style-type: none"><li>• oil in the gearbox shall be just below the edge of the oil plug hole.</li></ul>	
7 Add oil if required.	How to fill oil is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing the oil, axis-3 gearbox on page 176</a></li></ul>
8 Refit the oil plug.	Tightening torque: <ul style="list-style-type: none"><li>• Other design than Type C, in armhouse: 10 Nm</li><li>• Other design than Type C, in gearbox: 3 Nm</li><li>• Type C, both plugs: 10 Nm</li></ul>

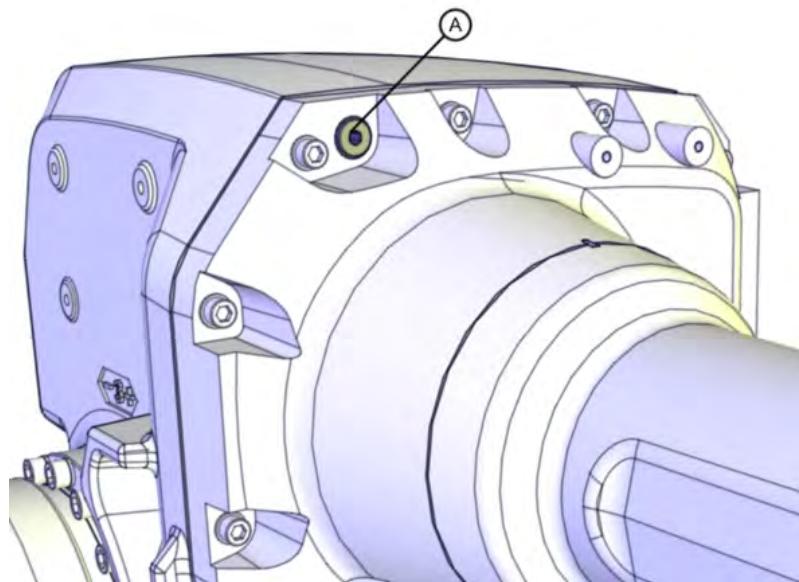
### 3 Maintenance

#### 3.3.4 Inspecting the oil level, axis 4 gearbox

#### 3.3.4 Inspecting the oil level, axis 4 gearbox

##### Location of axis 4 gearbox

The axis 4 gearbox is located in the upper armhouse. The oil plug is shown in the figure.



xx0800000307

A	Oil plug, for filling and draining
---	------------------------------------

##### Required equipment

Equipment	Note
Lubrication oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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 the oil level, axis 4 gearbox

Use this procedure to inspect the oil level in the axis 4 gearbox.

	Action	Note
1	<p> <b>WARNING</b></p> <p>Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a>.</p>	

Continues on next page

	Action	Note
2	Move the robot to where the upper arm points straight up and the oil plug hole is on top of the axis 4 gearbox.	
3	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
4	 <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5	Open the <i>oil plug</i> .	See the figure in: • <a href="#">Location of axis 4 gearbox on page 136</a>
6	Measure the oil level at the oil plug hole. Required oil level: <ul style="list-style-type: none"> <li>• <math>35 \pm 5</math> mm below the oil plug flange.</li> </ul>	
7	Add oil if required.	How to fill oil is described in section: • <a href="#">Changing the oil, axis-4 gearbox on page 183</a>
8	Refit the oil plug, filling.	Tightening torque: <ul style="list-style-type: none"> <li>• 10 Nm</li> </ul>

### 3 Maintenance

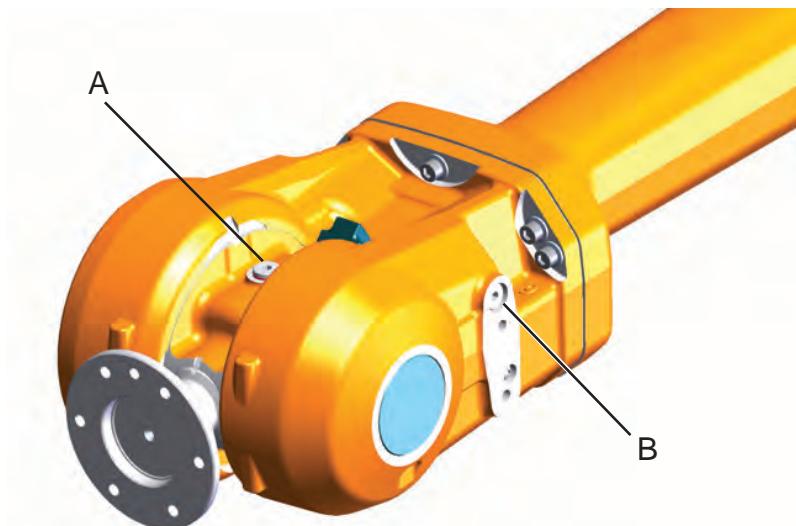
#### 3.3.5 Inspecting oil level, gearbox axes 5 - 6

##### 3.3.5 Inspecting oil level, gearbox axes 5 - 6

###### Location of gearbox, axes 5-6

The gearbox axes 5-6 is located in the wrist unit. The oil plug is shown in the figure.

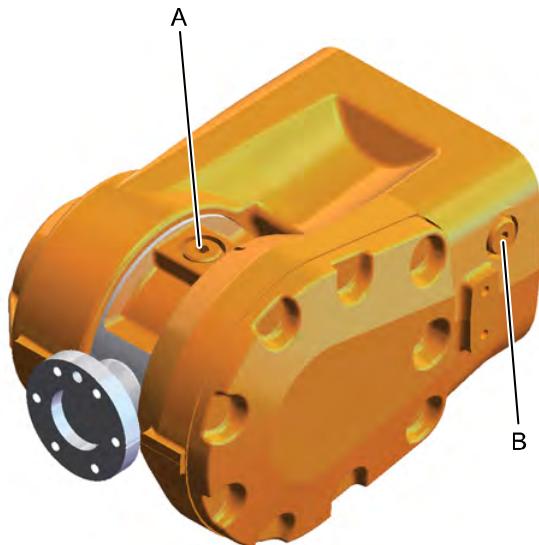
The figure shows IRB 4600 -60/2.05, -45/2.05, -40/2.55 with wrist 60 kg



xx0800000308

A	Oil plug, tilthouse
B	Oil plug, wrist (also used as air inlet when draining from oil plug A)

The figure shows IRB 4600 -20/2.50 with wrist 12/20 kg



xx0900000139

A	Oil plug, tilthouse
B	Oil plug, wrist (also used as air inlet when draining from oil plug A)

*Continues on next page*

**Required equipment**

Equipment	Note
Lubrication oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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 axes 5-6 - wrist 60 kg**

Use this procedure to inspect the oil level in gearbox axes 5-6.

	Action	Note
1	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
2	Move the robot to where the upper arm is placed in its calibration position.	
3	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
4	 <b>CAUTION</b> The gearbox can contain an excess of pressure that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5	Open the <i>oil plug, wrist</i> .	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox, axes 5-6 on page 138</a></li> </ul>
6	Required oil level: <ul style="list-style-type: none"> <li>• 3 ±3 mm below the edge of the oil plug hole.</li> </ul>	 <b>Note</b> Open the <i>oil plug, tilthouse</i> when inspecting. This will level up oil in axes 5 and 6. See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Inspecting oil level, gearbox axes 5 - 6 on page 138</a></li> </ul>

*Continues on next page*

### 3 Maintenance

#### 3.3.5 Inspecting oil level, gearbox axes 5 - 6

Continued

Action	Note
7 Add <i>oil</i> if required.	How to fill oil is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing oil, axes-5 and -6 gearbox on page 187</a></li></ul>
8 Refit the oil plugs.	Tightening torque: <ul style="list-style-type: none"><li>• 10 Nm</li></ul>

#### Inspecting oil level, gearbox axes 5-6 alternative method - wrist 60 kg

Use this procedure to inspect the oil level in gearbox axes 5-6 as an alternative method.

Action	Note
1  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
2 Move the robot to where the upper arm is placed in its calibration position.	
3 Move the upper arm (axis 3) to a horizontal position, then rotate (axis 4) +90°.	This will put the <i>oil plug, wrist</i> on top. See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of gearbox, axes 5-6 on page 138</a></li></ul>  <b>Note</b> In this position it is not possible to open the <i>oil plug, tilthouse</i> , in order to level up oil in axes 5 and 6!
4  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
5  <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
6 Open the <i>oil plug, wrist</i> .	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of gearbox, axes 5-6 on page 138</a></li></ul>

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## 3.3.5 Inspecting oil level, gearbox axes 5 - 6

Continued

	Action	Note
7	Required oil level: • 63 ±3 mm below the edge of the oil plug hole.	
8	Add oil if required.	How to fill oil is described in section: • <a href="#">Changing oil, axes-5 and -6 gear-boxes on page 187</a>
9	Refit oil plug, wrist.	Tightening torque: • 10 Nm

**Inspecting oil level, gearbox axes 5-6 - wrist 12/20 kg**

Use this procedure to fill oil in the gearbox.

	Action	Note
1	Move the robot to a position where the upper arm is close to horizontal and axis 4 in the calibration position.	
2	 <b>DANGER</b> Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	 <b>CAUTION</b> The gearbox can contain an excess of pressure that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Remove the <i>oil plug, wrist</i> .	See the figure in: • <a href="#">Location of gearbox, axes 5-6 on page 138</a>
5	Required oil level: • 3 ± 3 mm from the lower edge of the oil plug in the wrist house. Open the oil plug in the tilthouse to allow the oil level between axis 5 and 6 to level.	
6	If necessary, refill oil.	How to fill oil is described in section: • <a href="#">Changing oil, axes-5 and -6 gear-boxes on page 187</a>
7	Refit the oil plug.	Tightening torque: • 10 Nm

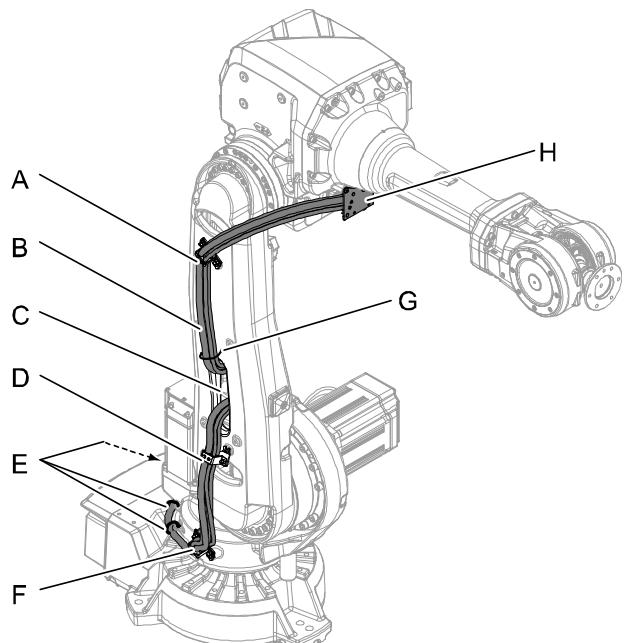
### 3 Maintenance

#### 3.3.6 Inspecting the cable harness

##### 3.3.6 Inspecting the cable harness

###### Location of cable harness

The figure shows the location of the cable harness.



xx0900000012

A	Bracket, lower arm
B	Cable harness
C	Hole in lower arm
D	Bracket, lower arm
E	Cable straps steel (One not visible here)
F	Bracket, frame
G	Cable strap plastic, lower arm
H	Bracket, armhouse

###### Required equipment

Equipment	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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	<a href="#">See chapter Circuit diagram on page 391</a> .

*Continues on next page*

**Inspecting the cable harness**

Use this procedure to inspect the cable harness. The inspection points are shown in the figure [Location of cable harness on page 142](#)

	Action	Note
1	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	Make an overall visual inspection of the cable harness in order to detect wear or damage.	
3	Check the <i>connectors at the base</i> .	
4	Check the <i>connectors at the armhouse</i> .	
5	Check all <i>brackets and straps</i> are properly attached to the robot.	
6	Replace the cable harness if wear, cracks or damage is detected.	How to replace the cable harness is described in <a href="#">Repair on page 201</a> .

### 3 Maintenance

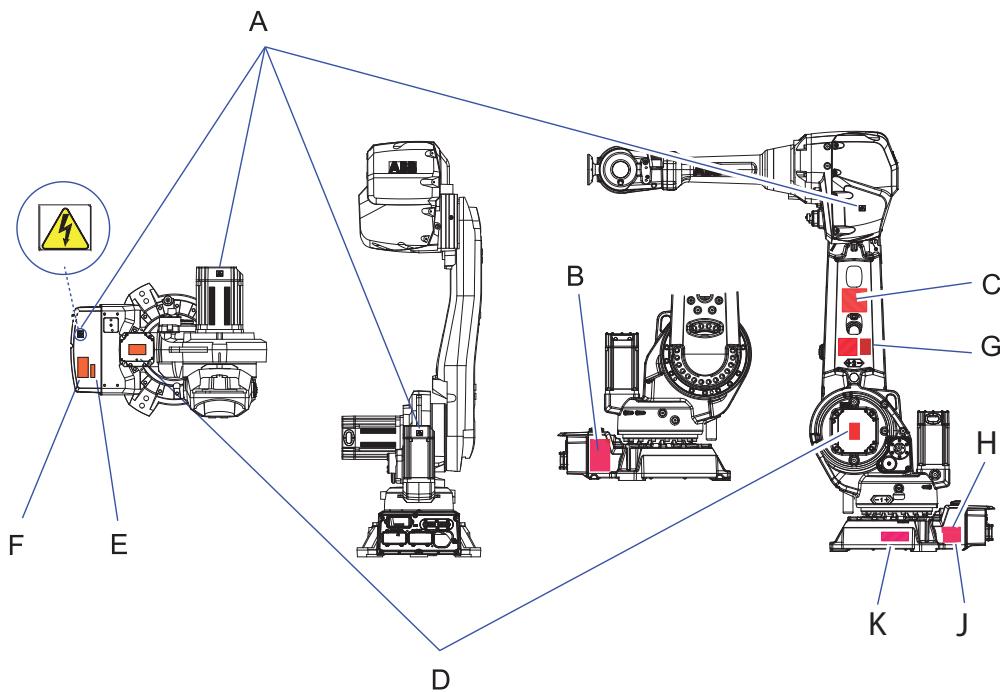
#### 3.3.7 Inspecting information labels

##### 3.3.7 Inspecting information labels

###### Location of information labels

The figure shows the location of the information labels to be inspected.

Type C

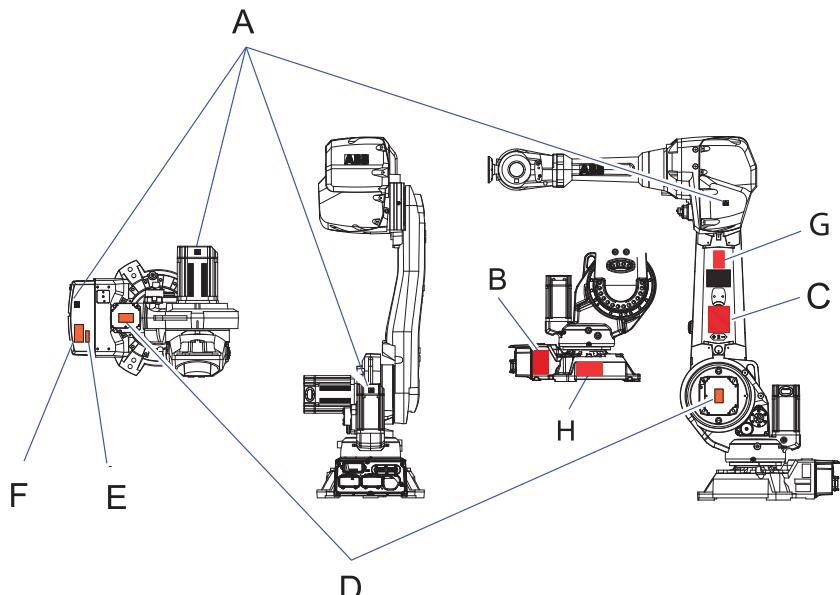


xx1200000519

A	Warning - Symbol of flash
B	Warning - Risk of tipping
C	Label - Lifting instruction
D	Warning - High temperature
E	Label - Max. air pressure
F	Warning - Brake release unit
G	Label - Calibration
H	AbsAcc Information Sign
J	UL-Label
K	Oil quality

Continues on next page

## Other design than Type C



xx1000000197

A	Warning - Symbol of flash (4 pcs)
B	Warning - Risk of tipping
C	Label - Lifting instruction
D	Warning - "High temperature" (2 pcs)
E	Label - Max. air pressure
F	Warning - Brake release unit
G	Label - Calibration
H	Label - Suspended robot

## Required equipment

Equipment	Spare part number	Note
Labels	For spare part number of a specific label see <a href="#">Spare part lists on page 389</a> .	Labels are sold separately.

## Inspecting labels

Use this procedure to inspect the labels on the robot.

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

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### 3 Maintenance

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#### 3.3.7 Inspecting information labels

*Continued*

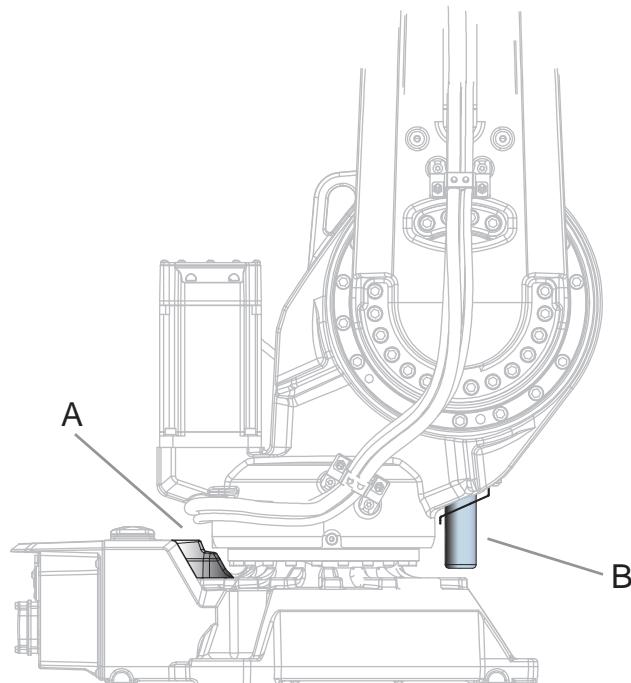
	Action	Note
2	Check all labels.	See the figure in <a href="#"><i>Location of information labels on page 144.</i></a>
3	Replace any missing or damaged labels.	

## 3.3.8 Inspecting the mechanical stop pin, axis 1

## 3.3.8 Inspecting the mechanical stop pin, axis 1

## Location of mechanical stop pin, axis 1

The mechanical stop pin is located on the frame as shown in the figure.



xx0800000298

A	Fixed stop
B	Mechanical stop pin, axis 1

## Required equipment

Equipment	Art. no.	Note
Mechanical stop pin axis 1	See <a href="#">Spare part lists on page 389</a> .	
Standard toolkit		Content is defined in section <a href="#">Standard tools on page 383</a> .
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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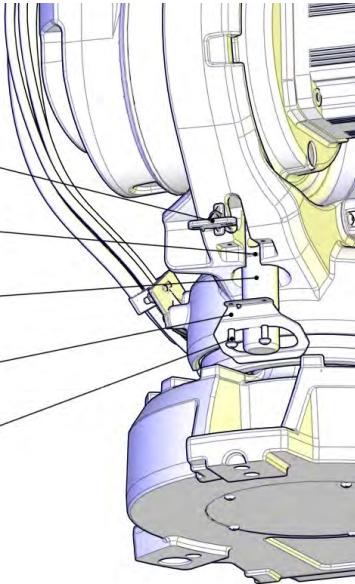
### 3 Maintenance

#### 3.3.8 Inspecting the mechanical stop pin, axis 1

Continued

##### Inspection of mechanical stop pin, axis 1

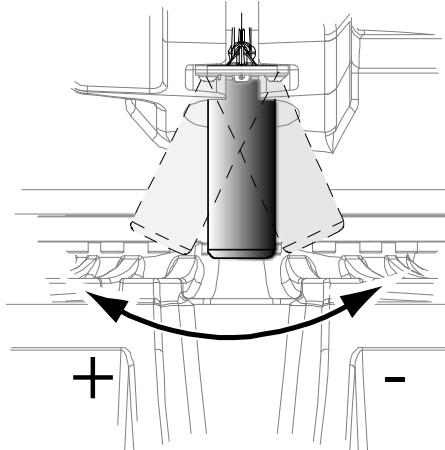
Use this procedure to inspect the mechanical stop pin, axis 1.

Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2 Regularly check that the <i>mechanical stop pin</i> is not bent or damaged in any other way.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of mechanical stop pin, axis 1 on page 147</a></li></ul>
3  <b>Note</b> If the mechanical stop pin has been deformed or damaged, it must be replaced.	How to replace the stop pin is described in section <a href="#">Replacing stop pin axis 1 on page 292</a> .
4 Check that the mechanical stop pin is properly attached.	 <p>xx0800000045</p> <p>Parts:</p> <ul style="list-style-type: none"><li>A Attachment screws</li><li>B Bracket</li><li>C O-ring (2 pcs)</li><li>D Bracket</li><li>E Stop pin</li></ul>

Continues on next page

#### 3.3.8 Inspecting the mechanical stop pin, axis 1

*Continued*

Action	Note
5 Check that the <i>mechanical stop pin</i> can move freely in both directions and the <i>bracket</i> works as it is supposed to.	

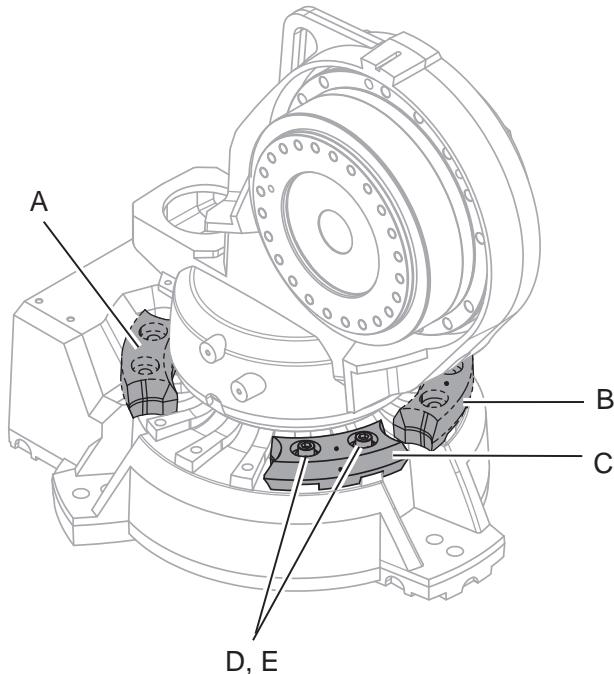
### 3 Maintenance

#### 3.3.9 Inspecting additional mechanical stops

#### 3.3.9 Inspecting additional mechanical stops

##### Location of additional mechanical stops

The figure shows the location of the additional stops.



xx0800000273

A	Movable mechanical stop. Limited to -129°
B	Movable mechanical stop. Limited to +16.5°
C	Movable mechanical stop. Limited to -16.5°
D	Attachment screws
E	Washers

##### Required equipment

Equipment etc.	Note
Mechanical stop set, axis 1	<b>Includes:</b> <ul style="list-style-type: none"><li>Stop</li><li>Attachment screws plus washers</li><li>Document for movable mechanical stop</li></ul> <b>For spare part no. see chapter Spare Parts.</b>
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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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**Inspecting additional mechanical stops**

Use this procedure to inspect the additional mechanical stops on axis 1.

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	Check the <i>additional mechanical stops</i> on axis 1 for damage.	See the figure in: • <a href="#">Location of additional mechanical stops on page 150</a>
3	Make sure the stops are properly attached.	Tightening torque: • 82 Nm
4	If any damage on stops or attachment screws etc. is detected, the <i>mechanical stops</i> must be replaced!	Attachment screws: • M12x40, quality 8.8-A3F • 2 pcs/stop lug

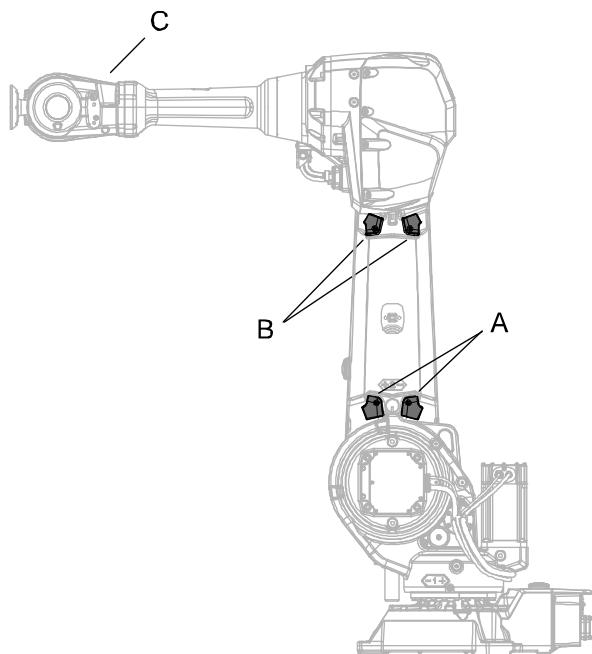
### 3 Maintenance

#### 3.3.10 Inspecting dampers

#### 3.3.10 Inspecting dampers

##### Location of dampers

The figure shows the location of all dampers to be inspected.



xx0800000297

A	Dampers axis 2
B	Dampers axis 3
C	Damper axis 5

##### Required equipment

Equipment	Spare part no.	Note
Damper	See <a href="#">Spare part lists on page 389</a> .	
Standard toolkit	-	Content is defined in section <a href="#">Standard tools on page 383</a> .

##### Inspecting dampers

Use this procedure to inspect the dampers.

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

Continues on next page

#### 3.3.10 Inspecting dampers

*Continued*

Action	Note
2 Check all <i>dampers</i> for damage or cracks.	See the figure in: • <a href="#">Location of dampers on page 152</a>
3 Check all dampers for existing impressions larger than 2-3 mm.	
4 Check attachment screws for deformation.	
5 If any damage is detected the damper must be replaced.	

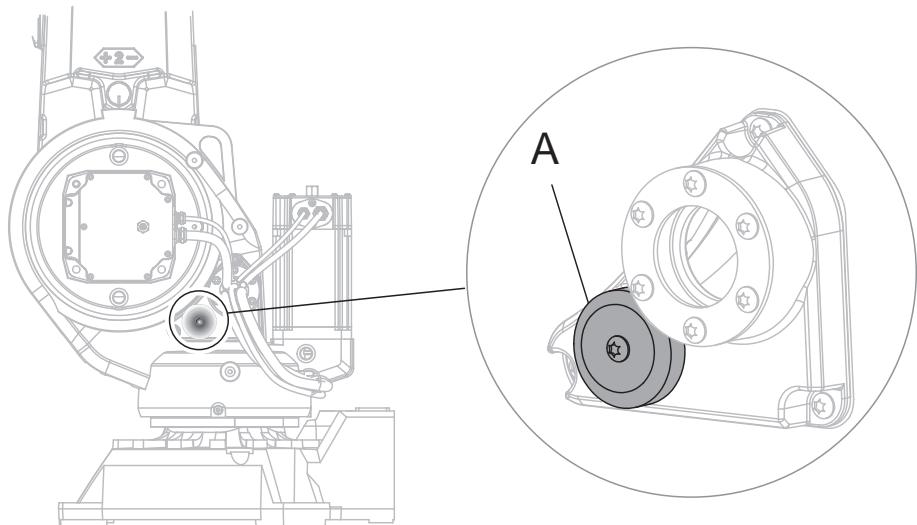
### 3 Maintenance

#### 3.3.11 Inspecting the pressure relief valve

##### 3.3.11 Inspecting the pressure relief valve

###### Location of the pressure relief valve

The figure shows the location of the pressure relief valve.



xx0900000131

A Pressure relief valve

###### Required equipment

Equipment	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

###### Inspecting pressure relief valve

Use this procedure to inspect the pressure relief valve.

Action	Note
<p>1</p> <p> <b>DANGER</b></p> <p>Turn off all:</p> <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> <p>to the robot, before entering the robot working area.</p>	
<p>2</p> <p> <b>DANGER</b></p> <p>It is important to keep the pressure relief valve open and clean. If the air pressure is stopped up, too much pressure can be built up which can be hazardous.</p>	

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#### 3.3.11 Inspecting the pressure relief valve

*Continued*

Action	Note
3 Check if the <i>pressure relief valve</i> is not contaminated or covered with litter.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#"><i>Location of the pressure relief valve on page 154</i></a></li></ul>
4 Clean if necessary.	 Note Use a cloth or a brush!

### 3 Maintenance

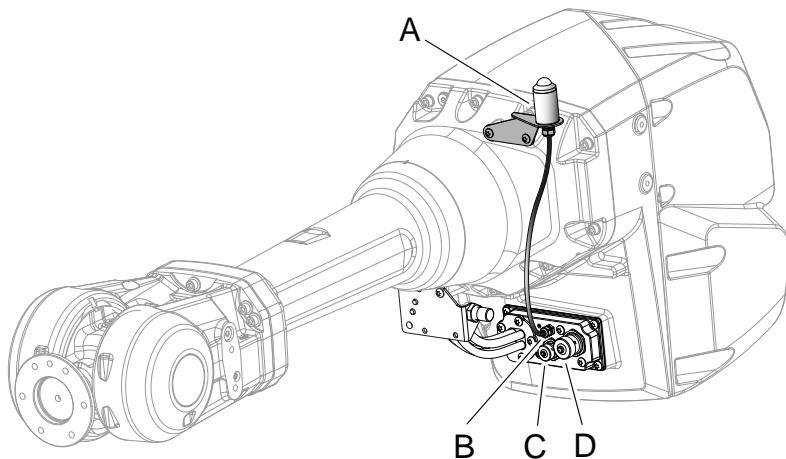
#### 3.3.12 Inspecting Signal lamp (option)

#### 3.3.12 Inspecting Signal lamp (option)

##### Location of signal lamp

Signal lamp is an option.

Located as shown in the figure.



xx0800000290

A	Signal lamp
B	R3.H1 +, R3.H2 -
C	R2.CP
D	R2.CS

##### Required equipment

Equipment	Note
Signal lamp	For spare parts no. see Spare parts - <i>Spare parts options in Product manual, spare parts - IRB 2600</i> .
Standard toolkit	Content is defined in section <i>Standard tools on page 383</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.

##### Inspecting signal lamp

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



##### Note

If the signal lamp is damaged, it shall be replaced!

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

Continues on next page

Action	Note
2 If the signal lamp is not lit, continue tracing the fault with the steps below.	
3  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
4 Check whether the signal lamp is broken. If so, replace.	
5 Check the cable connections.	
6 Measure the voltage in connectors, motor axis 3.	24V
7 Check the cabling. If a fault is detected, replace.	

### **3 Maintenance**

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#### **3.4.1 Type of lubrication in gearboxes**

### **3.4 Replacement 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.

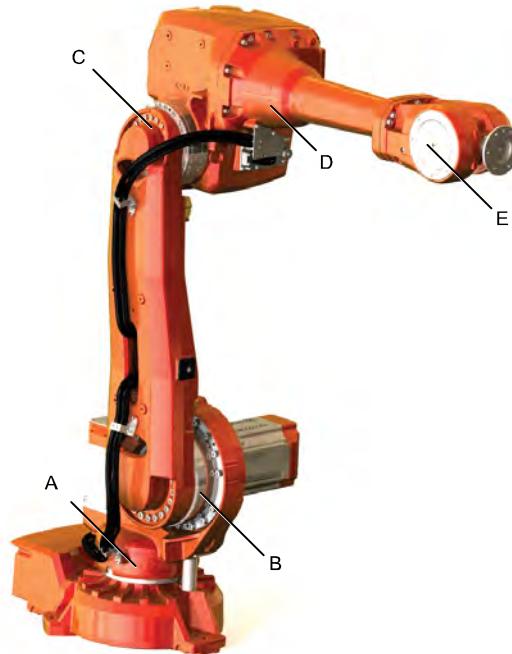
For ABB personnel: Always check ABB Library for the latest revision of the manual *Technical reference manual - Lubrication in gearboxes*, in order to always get the latest information of updates about lubrication in gearboxes. A new revision will be published on ABB Library immediately after any updates.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

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**Location of gearboxes**

The figure shows the location of the gearboxes.



xx0800000311

A	Axis-1 gearbox
B	Axis-2 gearbox
C	Axis-3 gearbox
D	Axis-4 gearbox
E	Axis-5 and -6 gearbox

---

**Equipment**

Equipment	Note
Oil dispenser	Includes pump with outlet pipe. Use the suggested dispenser or a similar one: • Orion OriCan article number 22590 (pneumatic)
Nipple for quick connect fitting, with o-ring	Type C: Used on the axes-1 and -2 gearboxes. Other design than Type C: Used on the axis-2 gearbox.
Not valid for type C: Expansion container, gearbox axis 1	Used when the robot is fitted in a suspended position.

### 3 Maintenance

---

#### 3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

#### 3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

##### Floor mounted or suspended robot

Depending on whether the robot is floor mounted or suspended, the method of changing the oil is different.

This section describes how to change the axis-1 gearbox oil in a floor mounted robot.



##### Note

The method of changing oil on the axis-1 gearbox is different on **Type C** compared to **Other design than Type C**.

Both methods are described in this section.

##### Changing oil in a suspended robot

How to change the oil in a suspended robot see [\*Changing the oil, axis-1 gearbox on suspended robots on page 166\*](#).

##### Location of oil plugs

The axis 1 gearbox is located between the frame and base of the robot.

The oil plugs of the different types, are shown in the figures.

##### Type C



##### Note

**Only valid for type C.**

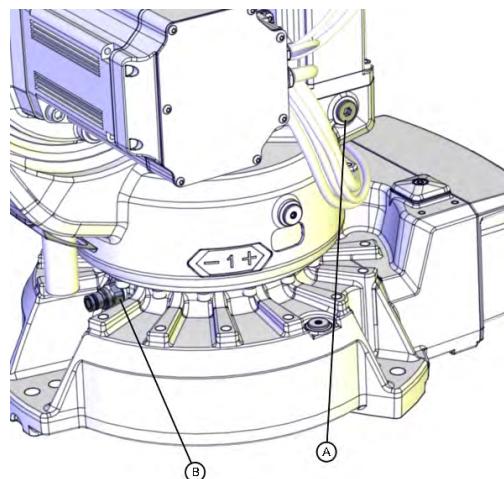
Oil plugs for filling and draining are not depending on in which position the robot is mounted:

- Draining = Oil plug on base.
- Filling = Oil plug on surface for motor flange.

*Continues on next page*

#### 3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

*Continued*



xx1200000632

A	Oil plug, filling and inspection
B	Oil plug, draining (Also used for filling if an oil dispenser is used.)

Other design than Type C



#### Note

Use correct oil plugs for filling and draining depending on which position the robot is mounted:

Floor mounted:

- Draining = Oil plug on gearbox.
- Filling = Oil plug on surface for motor flange.

Mounted in suspended position:

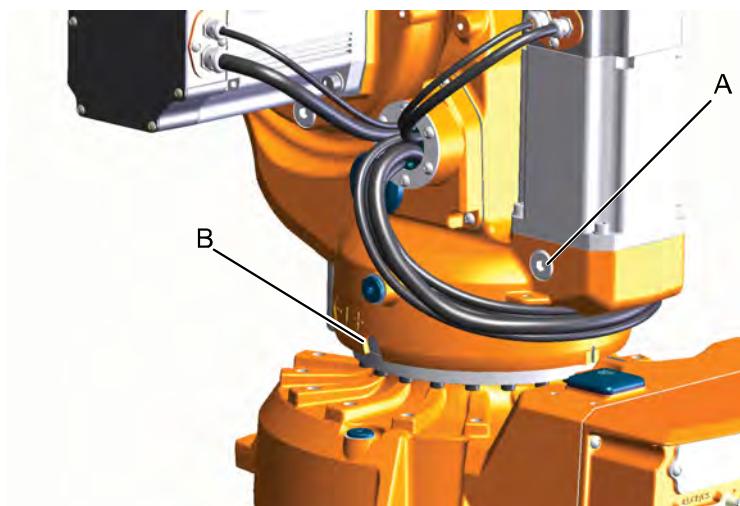
- Draining and filling = Oil plug on surface for motor flange.

*Continues on next page*

### 3 Maintenance

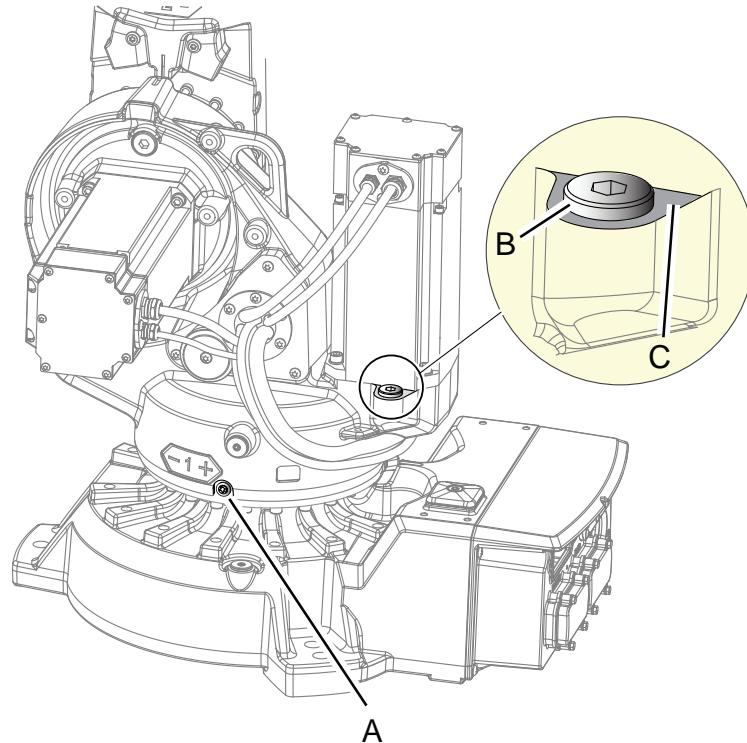
#### 3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

*Continued*



xx0800000304

A	Oil plug, filling
B	Oil plug, draining



xx1000000669

A	Oil plug, draining
B	Oil plug, filling
C	Surface for motor flange

*Continues on next page*

**Required equipment**

Equipment	Note
Only valid for Other design than Type C: Oil plug sealing washer, gearbox	3HAC029646-001
Lubricating oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a>
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Oil dispenser	One example of oil dispenser can be found in section: • <a href="#">Type of lubrication in gearboxes on page 158</a>
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

**Draining, axis-1 gearbox**

Use this procedure to drain the gearbox of oil.

**Tip**

In order to save time, a pneumatic oil dispenser can be used to suck out the oil from the gearbox. Follow the instructions below!

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
3	 <b>CAUTION</b> The gearbox can contain an excess of pressure that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

*Continues on next page*

### 3 Maintenance

#### 3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

*Continued*

Action	Note
4 Put an <i>oil collecting vessel</i> as close as possible to the draining hole placed in: <ul style="list-style-type: none"> <li>• Type C: the base.</li> <li>• Other design than Type C: the gearbox.</li> </ul>	For the capacity of vessel, see section: <ul style="list-style-type: none"> <li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li> </ul>
5 Only valid for Other design than Type C: Replace <i>oil plug draining</i> quickly with a nipple (M10x1.5) where a draining hose is fitted.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 160</a></li> </ul>  Note Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
6 Connect the <i>oil dispenser</i> .	One example can be found in section: <ul style="list-style-type: none"> <li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li> </ul>
7 Open the <i>oil plug filling</i> .   <b>WARNING</b> If the oil plug filling is not open when the oil dispenser is working, there is a risk of damaging vital parts in the gearbox!	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 160</a></li> </ul>
8 Using a low air pressure, start sucking the oil out from the gearbox with the oil ejector equipment.	
9 Only valid if an <i>oil dispenser</i> is not used: If an oil dispenser is not used, open the oil plug draining and drain oil into an oil collecting vessel.	 Note Time consuming activity!
10   <b>WARNING</b> Used oil is hazardous material and must be disposed of in a safe way. See section <a href="#">Decommissioning on page 369</a> for more information.	
11   Note There will be some oil left in the gearbox after draining.	
12 Refit the <i>oil plug draining</i> .   Note Only valid for Other design than Type C: Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 160</a></li> </ul> Tightening torque: <ul style="list-style-type: none"> <li>• Other design than Type C: 3-8 Nm</li> <li>• Type C: 24 Nm</li> </ul>

*Continues on next page*

## 3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

Continued

**Filling oil, axis-1 gearbox**

Use this procedure to fill the gearbox with oil.

Action	Note
<p>1  <b>DANGER</b> Turn off all:<ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul>to the robot, before entering the robot working area.</p>	
<p>2  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a>.</p>	
<p>3  <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.</p>	
4 Open the <i>oil plug, filling</i> .	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 160</a></li> </ul>
<p>5 Refill the gearbox with <i>lubrication oil</i>.  <b>Note</b> The exact amount of oil to be filled depends on the amount previously being drained.</p>	The type and amount of oil in the gearbox is detailed in section: <ul style="list-style-type: none"> <li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li> </ul>
6 Inspect the oil level.	How to inspect the oil level is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Inspecting oil level, axis 1 gearbox on page 124</a></li> </ul>
<p>7 Refit the <i>oil plug</i>.  <b>Note</b> <b>Only valid for Other design than Type C:</b> Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.</p>	Tightening torque: <ul style="list-style-type: none"> <li>• 24 Nm</li> </ul>

### 3 Maintenance

#### 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

##### 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

###### Floor mounted or suspended robot

Depending on whether the robot is floor mounted or suspended, the method of changing the oil is different.

How to change oil if the robot is floor mounted, see [Changing the oil, axis-1 gearbox on floor mounted robots on page 160](#).



###### Note

The method of changing oil on the axis-1 gearbox is different on **Type C** compared to **Other design than Type C**.



###### Note

**Only valid for Type C!**

If the robot has design **Type C** the basic method to change oil in a suspended robot of this type, when still mounted in a suspended position, is to fill the same amount of oil that was drained. Measure the amount of oil that was drained and make a note of the result. The same amount shall later be refilled.

###### Location of oil plugs

The axis-1 gearbox is located between the frame and base of the robot. The oil plugs are shown in the figures.

###### Other design than Type C



###### Note

Use correct oil plugs for filling and draining depending on which position the robot is mounted:

**Floor mounted:**

- Draining = Oil plug on gearbox.
- Filling = Oil plug on surface for motor flange.

**Mounted in suspended position:**

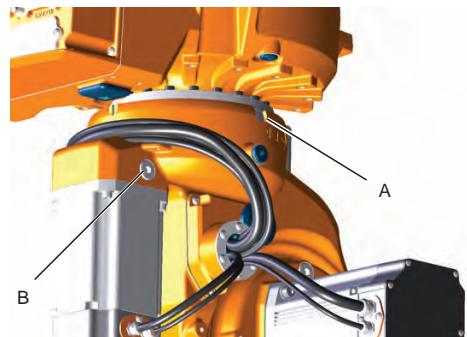
- Filling = Oil plug on surface for motor flange.
- Draining = Oil plug on surface for motor flange.

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### 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

*Continued*

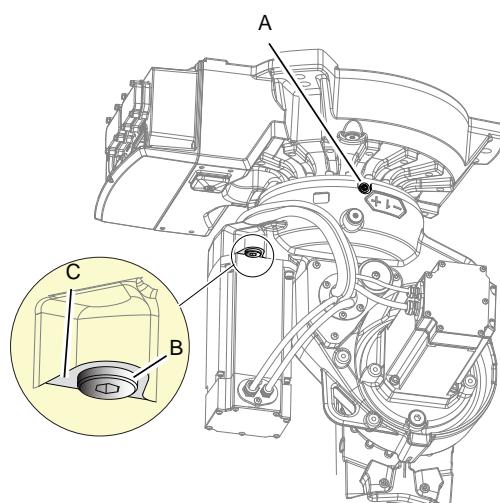
Other design than Type C:



xx1200000883

- A Oil plug, venting
- B Oil plug, draining and filling

Type C:



xx1000001436

A	Oil plug for filling and venting
B	Oil plug for draining
C	Motor flange

#### Required equipment

Equipment	Note
Only valid for Other design than Type C: Oil plug sealing washer, gearbox	3HAC029646-001
Lubricating oil	See section <a href="#">Type of lubrication in gearboxes on page 158</a>
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Oil dispenser	One example of oil dispenser can be found in section: <ul style="list-style-type: none"> <li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li> </ul>

*Continues on next page*

### 3 Maintenance

#### 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

Continued

Equipment	Note
Oil change equipment	See section <a href="#">Special tools on page 384</a>
Hose	Used with the oil dispenser
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

#### Draining, axis-1 gearbox

Use this procedure to drain the gearbox of oil.



##### Tip

In order to save time, a pneumatic oil dispenser can be used to suck out the oil from the gearbox. Follow the instructions below!

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
3	 <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Connect the <i>oil dispenser</i> to the <i>oil plug for draining</i> .	See <a href="#">Required equipment on page 167</a> . See <a href="#">Location of oil plugs on page 166</a> .
5	Put the end of the hose in an <i>oil collecting vessel</i> .	The capacity of the vessel must be sufficient to take the complete amount of oil.
6	Open the end plug of the hose.	
7	Open the <i>oil plug, venting</i> .	See <a href="#">Location of oil plugs on page 166</a> .
8	Using a low air pressure, start sucking the oil out from the gearbox with the oil change equipment.	

Continues on next page

## 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

Continued

Action	Note
9  <b>WARNING</b> Used oil is hazardous material and must be disposed of in a safe way. See section <a href="#">De-commissioning on page 369</a> for more information.	
10 Let the oil drain until the gearbox is empty.   <b>Note</b> There will be some oil left in the gearbox after draining. Measure the volume of the drained oil in the vessel.	 <b>Tip</b> Make a note how much oil was drained. The same amount shall later be refilled.
11 Remove the hose and clean it.	

**Filling oil, axis-1 gearbox**

Use this procedure to fill the gearbox with oil.

 <b>Note</b>
<b>Only valid for Type C!</b> The basic method to change oil in a suspended robot of this type, when still mounted in a suspended position, is to fill the same amount of oil that was drained.  The only way to inspect the oil level after some repair work, is to make a note how much oil was drained and to refill with the same amount. If in doubt, the suspended robot must be dismantled from its inverted position and the oil being inspected with the robot in a floor mounted position.

Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	

Continues on next page

### 3 Maintenance

#### 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

Continued

	Action	Note
3	 <b>CAUTION</b>  The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Verify that the hose of the oil change equipment is clean and then fit the quick connection to the <i>oil plug for filling</i> .	See <a href="#">Location of oil plugs on page 166</a> .
5	Open the <i>oil plug for venting</i> .	See <a href="#">Location of oil plugs on page 166</a> .
6	Prepare oil change equipment with the same amount of <i>lubrication oil</i> that was drained.   <b>Note</b>  The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in <a href="#">Type and amount of oil in gearboxes on page 158</a> .
7	Inspect the oil level.	How to inspect the oil level is described in section: <ul style="list-style-type: none"><li>• <a href="#">Inspecting oil level, axis 1 gearbox on page 124</a></li></ul>
8	Disconnect the oil change equipment and put on the protective hood on the oil plug.	
9	Refit the <i>oil plug for venting</i> .   <b>Note</b>  Only valid for Other design than Type C: Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: <ul style="list-style-type: none"><li>• Other design than Type C: 3-8 Nm</li><li>Type C: 24 Nm</li></ul>

#### Expansion container axis-1 gearbox, suspended mounted robots

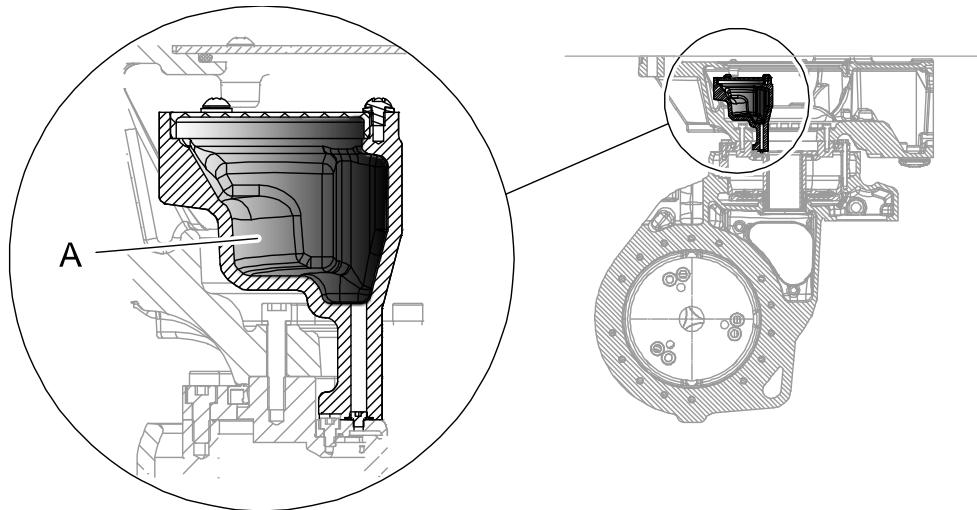
 <b>Note</b>
<b>Not valid for Type C!</b>
<b>Expansion container is not needed on Type C.</b>

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## 3.4.3 Changing the oil, axis-1 gearbox on suspended robots

*Continued*

When the robot is fitted in a suspended mounted position, an expansion container for oil must be fitted on gearbox axis 1.



xx0900000129

A	Expansion container
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**Note**

The expansion container is installed on delivery on the robot if ordered as option suspended/inverted mounted. If a floor mounted robot shall be fitted in a suspended mounted position, an expansion container must be installed. See [Installing an expansion container on page 107](#).

### 3 Maintenance

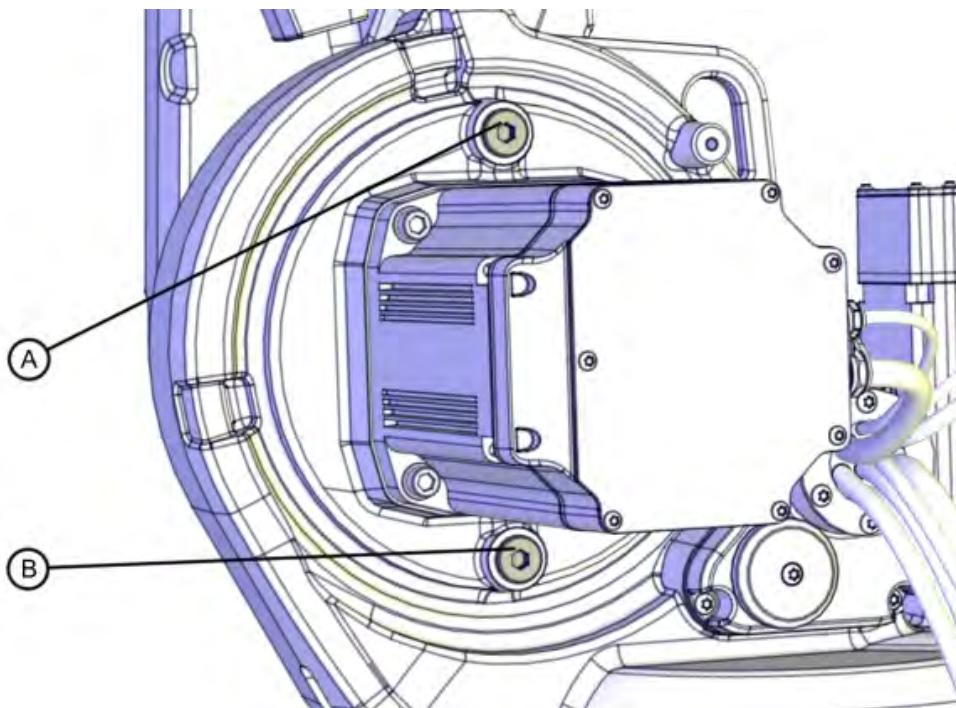
#### 3.4.4 Changing the oil, axis-2 gearbox

#### 3.4.4 Changing the oil, axis-2 gearbox

##### Location of oil plugs

The axis-2 gearbox is located in the lower arm rotational center, underneath the motor attachment.

Oil plugs are shown in the figure.



xx0800000305

A	Oil plug, filling (draining when suspended mounted)
B	Oil plug, draining (filling when suspended mounted) (Quick connect fitting)

##### Required equipment

Equipment	Note
Only valid for Other design than Type C: Oil plug sealing washer, gearbox	3HAC029646-001
Lubricating oil	Information about the oil is found in <i>Technical reference manual - Lubrication in gearboxes</i> . See <a href="#">Type and amount of oil in gearboxes on page 158</a> .
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Nipple (TEMA IF 3820 S06)	To be fitted on a hose, and then used for draining connected to the <i>quick connect fitting</i> . See <a href="#">Location of oil plugs on page 172</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

Continues on next page

**Draining, axis-2 gearbox**

Use this procedure to drain the gearbox of oil.

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <b><i>WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58.</i></b>	
3	 <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Either <ul style="list-style-type: none"> <li>• connect a nipple to the <i>quick connect fitting</i> in the hole for draining</li> </ul> or <ul style="list-style-type: none"> <li>• remove the <i>quick connect fitting</i>.</li> </ul>	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 172</a></li> </ul>
5	Open the <i>oil plug, filling</i> .	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 172</a></li> </ul>  <b>Note</b> Drainage will be quicker if the oil plug, filling is removed.
6	Drain the gearbox oil using an <i>oil collecting vessel</i> .	 <b>Note</b> Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
7	 <b>WARNING</b> Used oil is hazardous material and must be disposed of in a safe way. See section <a href="#"><b>De-commissioning on page 369</b></a> for more information.	

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### 3 Maintenance

#### 3.4.4 Changing the oil, axis-2 gearbox

Continued

	Action	Note
8	 <b>Note</b>  There will be some oil left in the gearbox after draining.	
9	 <b>Note</b>  <b>Only valid for Other design than Type C:</b> Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 24 Nm

#### Filling oil, axis-2 gearbox

Use this procedure to fill the gearbox with oil.

	Action	Note
1	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	 <b>WARNING</b>  Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
3	 <b>CAUTION</b>  The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Open <i>oil plug, filling</i> .	See the figure in: • <a href="#">Location of oil plugs on page 172</a>
5	 <b>Note</b>  The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in <a href="#">Type and amount of oil in gearboxes on page 158</a> .

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#### 3.4.4 Changing the oil, axis-2 gearbox

*Continued*

Action	Note
6 Inspect the oil level.	How to inspect the oil level is described in section: <ul style="list-style-type: none"><li>• <a href="#"><i>Inspecting the oil level, axis 2 gearbox on page 131</i></a></li></ul>
7 Refit oil plug.   <b>Note</b>  <b>Only valid for Other design than Type C:</b> Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: <ul style="list-style-type: none"><li>• 24 Nm</li></ul>

### 3 Maintenance

#### 3.4.5 Changing the oil, axis-3 gearbox

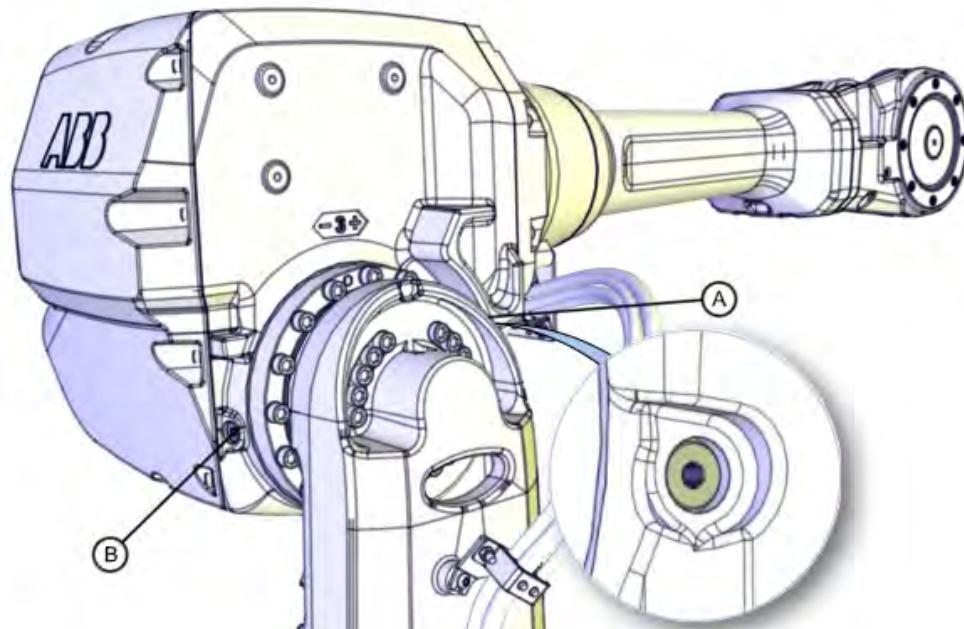
#### 3.4.5 Changing the oil, axis-3 gearbox

##### Location of oil plugs

The axis-3 gearbox is located in the upper arm rotational center.

Oil plugs are shown in the figure.

Type C

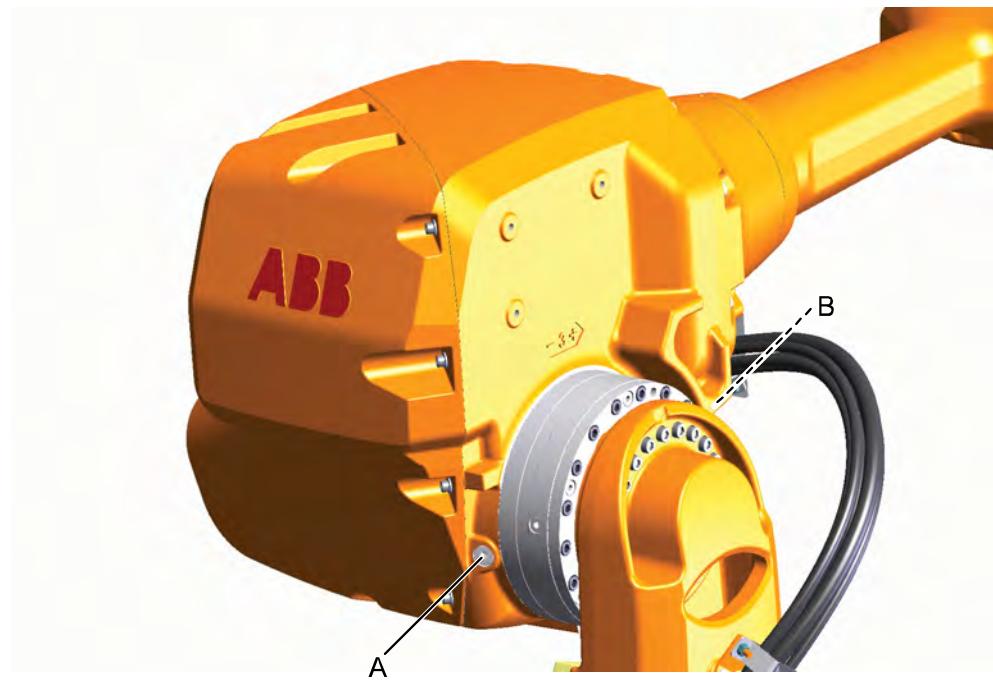


xx1200000633

A	Oil plug, armhouse (not visible in this figure)
B	Oil plug, armhouse

*Continues on next page*

Other design than Type C



xx0800000306

A	Oil plug, armhouse
B	Oil plug, gearbox (not visible in this figure)

#### Required equipment

Equipment	Note
Lubricating oil	Information about the oil is found in <i>Technical reference manual - Lubrication in gearboxes</i> . See <a href="#">Type and amount of oil in gearboxes on page 158</a> .
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Oil dispenser	One example of oil dispenser can be found in section: • <a href="#">Type of lubrication in gearboxes on page 158</a>
Funnel	 xx1200000862
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

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### 3 Maintenance

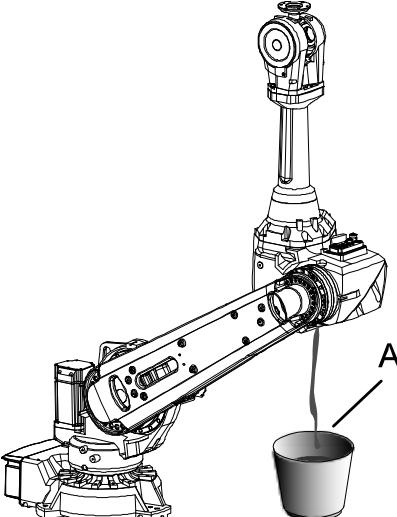
#### 3.4.5 Changing the oil, axis-3 gearbox

Continued

##### Draining, axis-3 gearbox

Use this procedure to drain the gearbox of oil.

There is an alternative method to drain the gearbox. See [Draining - alternative method on page 179](#).

Action	Note
1 Move the robot to an upright position as shown in the figure.	 xx0800000327 • A: Oil collecting vessel
2  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
4  <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5 Open the <i>oil plug, armhouse</i>	See the figure in: • <a href="#">Location of oil plugs on page 176</a>

Continues on next page

Action	Note
6 Type C: Open the other oil plug in the <i>armhouse</i> and use it as a ventilation hole.  Other design than Type C: Open the <i>oil plug, gearbox</i> and use it as a ventilation hole.	See the figure in: <ul style="list-style-type: none"> <li><a href="#">Location of oil plugs on page 176</a></li> </ul>
7 Drain the gearbox oil using an <i>oil collecting vessel</i> .	 Note  Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
8  <b>WARNING</b>  Used oil is hazardous material and must be disposed of in a proper way. See section <i>Decommissioning</i> for more information.	
9 Refit oil plugs.	Tightening torque:  Other design than Type C, in armhouse: 10 Nm  Other design than Type C, in gearbox: 3 Nm  Type C, both plugs: 10 Nm

**Draining - alternative method**

Use this procedure to drain the oil from the gearbox, as an alternative method.

If this method is used, oil must be sucked out of the gearbox using an oil dispenser.

Action	Note
1 Move the upper arm of the robot to a position where the <i>oil plug, gearbox</i> is pointing at the floor.	See the figure in: <ul style="list-style-type: none"> <li><a href="#">Location of oil plugs on page 176</a></li> </ul>
2  <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
3  <b>CAUTION</b>  The gearbox can contain an excess of pressure that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

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### 3 Maintenance

#### 3.4.5 Changing the oil, axis-3 gearbox

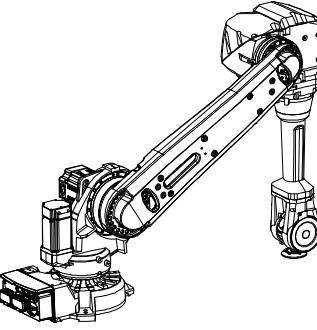
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	Action	Note
4	Use an <i>oil dispenser</i> fitted to the <i>oil plug, gearbox</i> to drain the oil.	An example of oil dispenser is detailed in section: <ul style="list-style-type: none"><li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li></ul> See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 176</a></li></ul>
5	Replace the <i>oil plug, gearbox</i> with a nipple where a draining hose is fitted.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 176</a></li></ul>
6	Connect the <i>oil dispenser</i> .	One example can be found in section: <ul style="list-style-type: none"><li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li></ul>
7	Open the <i>oil plug, armhouse</i> now pointing upwards and use it as a ventilation hole.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 176</a></li></ul>  <b>WARNING</b> <p>The oil plug, gearbox must be open when the oil dispenser equipment is used! Otherwise sealings and other parts will be damaged.</p>
8	Start sucking the oil out from the gearbox with the oil ejector equipment.	For capacity of the vessel see section: <ul style="list-style-type: none"><li>• <a href="#">Type of lubrication in gearboxes on page 158</a></li></ul>
9	 <b>WARNING</b> <p>Used oil is hazardous material and must be disposed of in a proper way. See section <i>Decommissioning</i> for more information.</p>	
10	 <b>Note</b> <p>There will be some oil left in the gearbox after draining!</p>	
11	Refit the <i>oilplugs</i> .	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 176</a></li></ul> Tightening torque: <b>Other design than Type C</b> , in armhouse: 10 Nm <b>Other design than Type C</b> , in gearbox: 3 Nm <b>Type C</b> , both plugs: 10 Nm

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**Filling oil, axis-3 gearbox**

Use this procedure to fill the gearbox with oil.

Action	Note
1 Move the upper arm to a position where the wrist is pointing towards the floor as shown in the figure.	
2  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <b>WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58.</b>	
4  <b>CAUTION</b> The gearbox can contain an excess of pressure that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5 Open the <i>oil plug, armhouse.</i>	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 176</a></li></ul>
6 Refill the gearbox with <i>lubricating oil.</i>  <b>Tip</b> Use a funnel.  <b>Note</b> The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in <a href="#">Type and amount of oil in gearboxes on page 158.</a>

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### 3 Maintenance

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#### 3.4.5 Changing the oil, axis-3 gearbox

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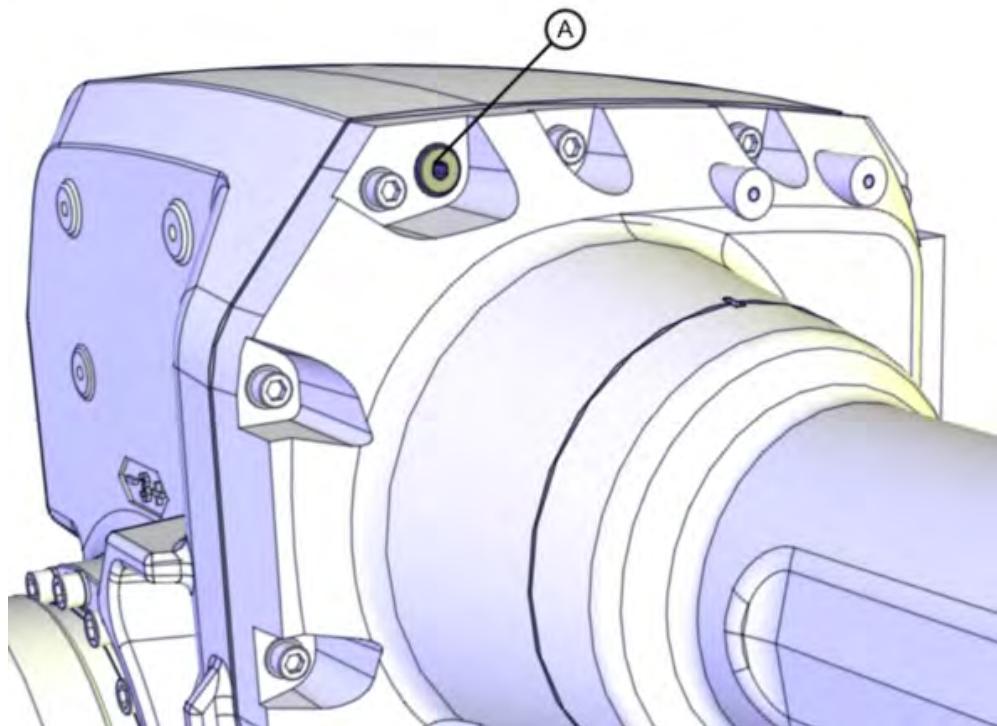
	Action	Note
7	Inspect the <i>oil level</i> .	How to inspect oil is described in section: <ul style="list-style-type: none"><li>• <a href="#"><i>Inspecting the oil level, axis 3 gearbox on page 133</i></a></li></ul>
8	Refit the <i>oil plug</i> .	Tightening torque: <b>Other design than Type C</b> , in arm-house: 10 Nm <b>Other design than Type C</b> , in gearbox: 3 Nm <b>Type C</b> , both plugs: 10 Nm

### 3.4.6 Changing the oil, axis-4 gearbox

#### Location of oil plugs

The axis-4 gearbox is located in the front of the upper armhouse.

The oil plug is shown in the figure.



xx0800000307

A	Oil plug, for filling and draining
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#### Required equipment

Equipment	Note
Lubricating oil	Where to find information of the <i>type of oil, article number</i> and the <i>amount</i> in the gearbox, see section <a href="#">Type of lubrication in gearboxes on page 158</a>
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Plastic hose	Used for venting the gearbox during draining. A suitable hose would be a hose normally used for compressed air. Length: minimum 300 mm. Diameter: 5 mm.
Funnel	 xx1200000862

*Continues on next page*

### 3 Maintenance

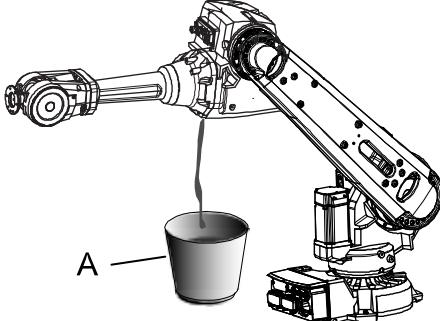
#### 3.4.6 Changing the oil, axis-4 gearbox

Continued

Equipment	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

#### Draining oil

Use this procedure to drain oil from the gearbox.

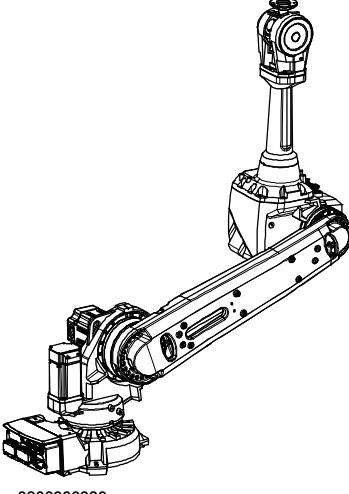
Action	Note
1 Move the robot to the position shown in the figure.	 xx0800000328 • A: Oil collecting vessel
2  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
4  <b>CAUTION</b> The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5 Open oil plug, draining.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 183</a></li></ul>

Continues on next page

Action	Note
6 Drain the gearbox oil using an <i>oil collecting vessel</i> .	 Note <b>Tip</b> Insert a compressed air hose approximately 100 mm into the gearbox, to vent the gearbox. This speeds up the draining significantly.
7	 <b>WARNING</b> Used oil is hazardous material and must be disposed of in a safe way. See section <a href="#">De-commissioning on page 369</a> for more information.
8 Refit the oil plug.	Tightening torque: 10 Nm.

**Filling oil**

Use this procedure to fill oil in the gearbox.

Action	Note
1 Move the upper arm to the position shown in the figure.	 xx0800000330
2	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.

*Continues on next page*

### 3 Maintenance

#### 3.4.6 Changing the oil, axis-4 gearbox

Continued

Action	Note
3	 <b>WARNING</b>
	Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <b>WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58.</b>
4	 <b>CAUTION</b>
	The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.
5	Open the <i>oil plug, filling.</i>
	See the figure in: • <a href="#">Location of oil plugs on page 183</a>
6	Refill the gearbox with <i>lubricating oil.</i>
	 <b>Tip</b>
	Use a funnel.
	 <b>Note</b>
	The amount of oil to be filled depends on the amount previously being drained.
7	Refit the <i>oil plug.</i>
	Tightening torque: 10 Nm.

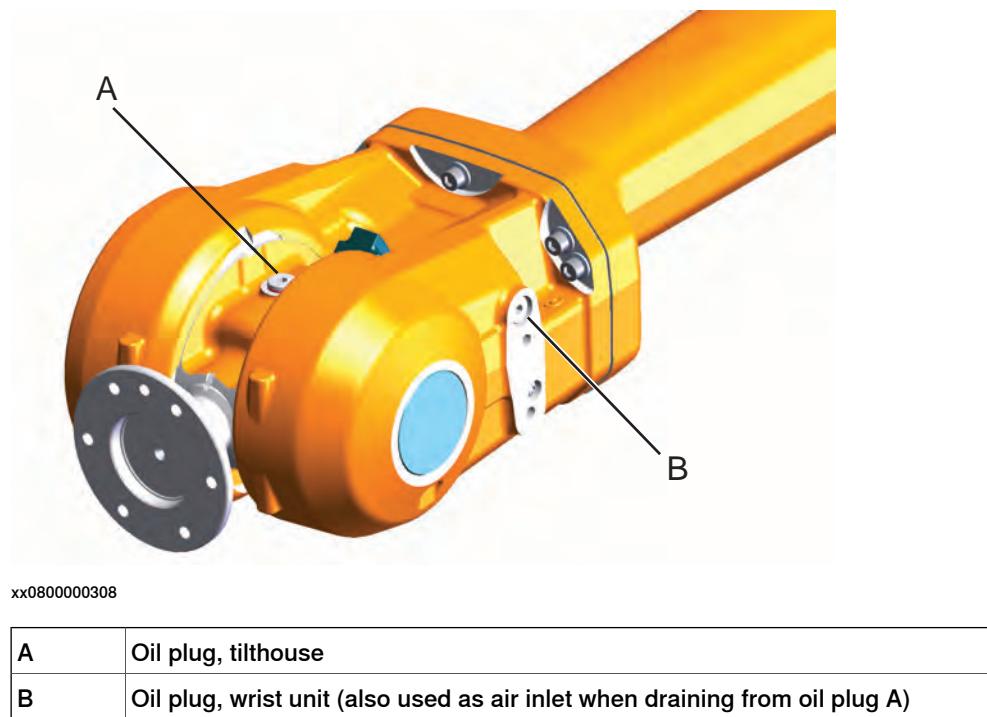
### 3.4.7 Changing oil, axes-5 and -6 gearboxes

#### Location of oil plugs

The axes-5 and -6 gearboxes are located in the wrist unit.

The oil plug is shown in the figure.

The figure shows wrist variant 60 kg



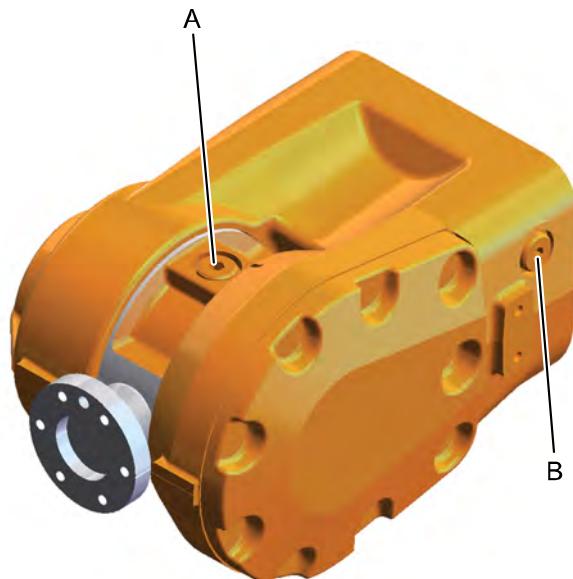
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### 3 Maintenance

#### 3.4.7 Changing oil, axes-5 and -6 gearboxes

Continued

The figure shows wrist variant 12/20 kg



xx0900000139

A	Oil plug, tilthouse
B	Oil plug, wrist (also used as air inlet when draining from oil plug A)



#### Note

The gearboxes for axes-5 and -6 are the same.

#### Required equipment

Equipment	Note
Lubrication oil	Where to find information of the <i>type of oil, article number</i> and the <i>amount</i> in the gearbox, see section: <a href="#">Type of lubrication in gearboxes on page 158</a>
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

#### Draining axes-5 and -6 gearbox - wrist 60 kg

Use this procedure to drain oil from the gearbox.



#### CAUTION

The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.

	Action	Note
1	Move the <i>upper arm</i> to a position where it points downwards.	

Continues on next page

	Action	Note
2	Move axis 5 to a position where the <i>oil plug, tilthouse</i> points downwards.	The turning disk shall be in a horizontal position.
3	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
4	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
5	Put an <i>oil collecting vessel</i> under the wrist in order to collect drained oil.	The capacity of the vessel must be sufficient to take the complete amount of oil.
6	Open the <i>oil plug, tilthouse</i> .	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 187</a></li> </ul>
7	Open the oil plug, wrist (air inlet). This is done for the ventilation of the gearbox and to facilitate draining.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of oil plugs on page 187</a></li> </ul>
8	Drain the gearbox.	 <b>Note</b> Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
9	 <b>WARNING</b> Used oil is hazardous material and must be disposed of in a safe way. See section <a href="#">Decommissioning on page 369</a> for more information.	

**Draining axes-5 and -6 gearbox - wrist 12/20 kg**

Use this procedure to drain oil from the gearbox.

**CAUTION**

The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.

*Continues on next page*

### 3 Maintenance

#### 3.4.7 Changing oil, axes-5 and -6 gearboxes

Continued

	Action	Note
1	Move the upper arm to a horizontal position.	
2	Turn axis-4 to the calibration position.	
3	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
4	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <b>WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58.</b>	
5	Remove the <i>oil plugs</i> in the wrist.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 187</a></li></ul>
6	Turn axis-4 through 90° so that the oil plug on the side of the wrist points downwards.	
7	Then turn axis-4 another 90°.	
8	Let the remaining oil run out through the oil plug hole, tilthouse.	

#### Filling oil axes-5 and -6 gearbox - wrist 60 kg

Use this procedure to fill oil in the gearbox.

 <b>CAUTION</b>
The gearbox can contain an <i>excess of pressure</i> that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.

	Action	Note
1	Move the upper arm to a position where the <i>oil plug, wrist</i> points upwards.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 187</a></li></ul>
2	Move axis-5 to a position where the <i>oil plug, tilthouse</i> points upwards.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 187</a></li></ul>
3	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	

Continues on next page

Action	Note
4  <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
5 Open <i>oil plug, wrist.</i>	See the figure in: • <a href="#">Location of oil plugs on page 187</a>
6 Open <i>oil plug, tilthouse.</i>	See the figure in: • <a href="#">Location of oil plugs on page 187</a>
7 Refill oil using <i>oil plug, wrist.</i>   <b>Note</b> There will be some oil left in the gearbox after draining.	There will be oil left in the gearbox after draining. Therefore the amount of oil filled will be less than the total amount. When filling oil in a wrist (60 kg) begin by only filling 1.500 ml. Check oil level. If needed add more oil.
8 Refill the gearbox with <i>lubrication oil.</i>   <b>Note</b> The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in <a href="#">Type and amount of oil in gearboxes on page 158</a> .
9 Inspect the <i>oil level.</i>	How to inspect the oil level is described in section: • <a href="#">Inspecting oil level, gearbox axes 5 - 6 on page 138</a>
10 Refit both oil plugs.	Tightening torque: • 10 Nm

**Filling oil axes-5 and -6 gearbox - wrist 12/20 kg**

Use this procedure to fill oil in the gearbox.

**CAUTION**

The gearbox can contain an excess of pressure that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.

Action	Note
1 Run the upper arm to a horizontal position.	
2 Turn axis-4 to the calibration position.	

*Continues on next page*

### 3 Maintenance

#### 3.4.7 Changing oil, axes-5 and -6 gearboxes

Continued

	Action	Note
3	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
4	 <b>WARNING</b> Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section <a href="#">WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 58</a> .	
5	Open the <i>oil plug, tilthouse</i> .	See in figure: <ul style="list-style-type: none"><li>• <a href="#">Location of oil plugs on page 187</a></li></ul>
6	Refill the gearbox with <i>lubrication oil</i> .  <b>Note</b> The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in <a href="#">Type and amount of oil in gearboxes on page 158</a> .
7	Inspect the oil level.	How to inspect the oil level is described in section: <ul style="list-style-type: none"><li>• <a href="#">Inspecting oil level, gearbox axes 5 - 6 on page 138</a></li></ul>
8	 <b>Note</b> If the robot is fitted in a suspended position, the wrist should be turned 180°.	
9	Refit the oil plugs.	Tightening torque: <ul style="list-style-type: none"><li>• 10 Nm</li></ul>

### 3.4.8 Replacing 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 an 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 an SMB board with 2-pole battery contact, 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 57](#).

*Continues on next page*

### 3 Maintenance

#### 3.4.8 Replacing SMB battery

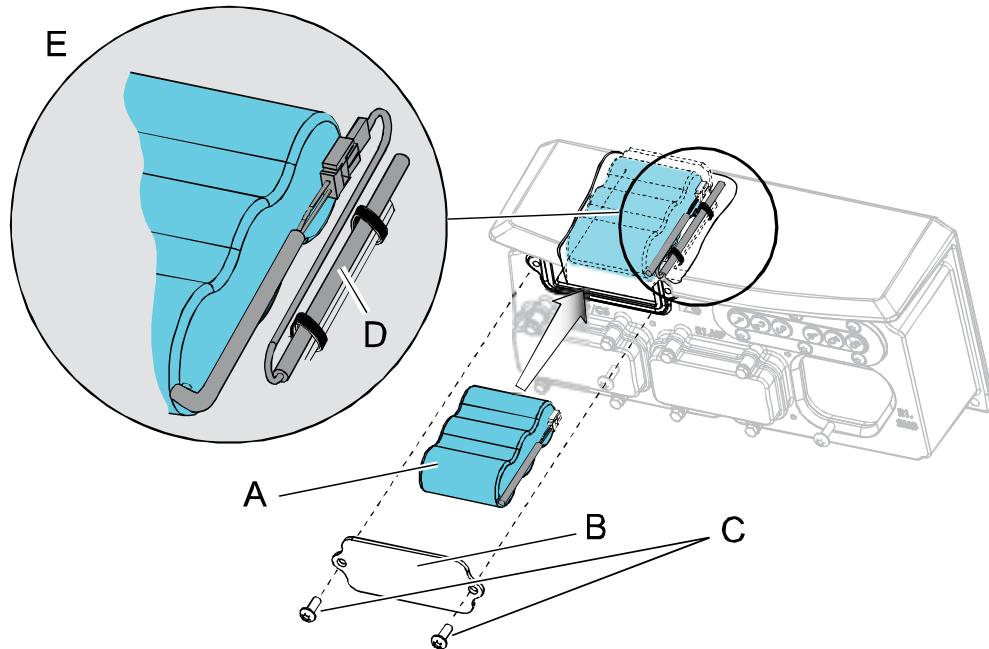
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##### Location of SMB battery

The SMB battery is located at the base of the robot, as shown in the figure.

DSQC 633A

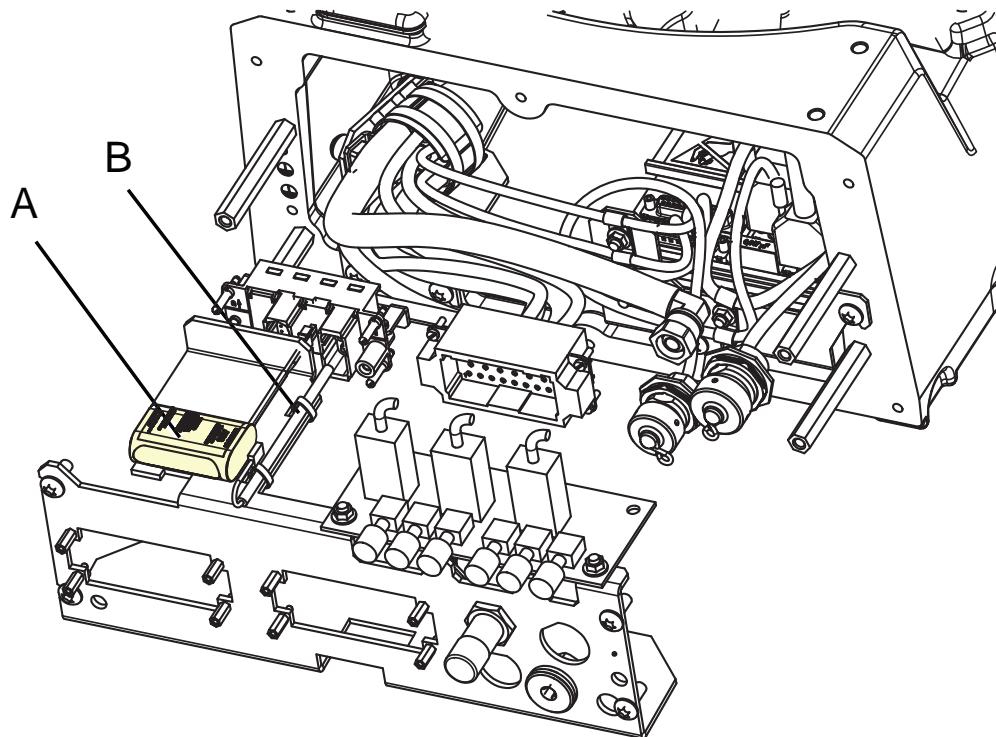


xx0800000322

A	SMB battery (2-pole battery contact)
B	Battery cover
C	Attachment screws
D	SMB battery cable
E	How to arrange the battery cable

*Continues on next page*

RMU 101



xx1300000339

A	SMB battery (3-pole battery contact)
B	Battery cover

#### Required equipment



##### Note

There are two variants of SMB units and batteries. One with 2-pole battery contact and one with 3-pole battery contact. 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	Note
SMB battery pack	Battery includes protection circuits. Replace it only with given spare part no. or an ABB approved equivalent. See <a href="#">Spare part lists on page 389</a> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
Circuit diagram	See chapter <a href="#">Circuit diagram on page 391</a> .

Continues on next page

### 3 Maintenance

#### 3.4.8 Replacing SMB battery

*Continued*

##### Removing SMB 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 the updating of the revolution counter.
2	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3	 <b>ELECTROSTATIC DISCHARGE (ESD)</b> The unit is sensitive to ESD. Before handling the unit please read the safety information in the section <b>WARNING - The unit is sensitive to ESD! on page 55</b>	
4	Remove the <i>SMB battery cover</i> .	See the figure in <a href="#">Location of SMB battery on page 194</a> .
5	Pull out the <i>SMB battery</i> .	See the figure in <a href="#">Location of SMB battery on page 194</a> .
6	Disconnect the <i>battery cable</i> and remove the battery.	See the figure in <a href="#">Location of SMB battery on page 194</a> .
7	How to dispose of the used SMB battery, see chapter <a href="#">Decommissioning on page 369</a> .	

##### Refitting SMB battery

Use this procedure to refit the SMB battery.

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	 <b>ELECTROSTATIC DISCHARGE (ESD)</b> The unit is sensitive to ESD. Before handling the unit please read the safety information in the section <b>WARNING - The unit is sensitive to ESD! on page 55</b>	
3	Reconnect the <i>battery cable</i> to the <i>SMB battery</i> .	See the figure in <a href="#">Location of SMB battery on page 194</a> .

*Continues on next page*

Action	Note
4 Put the battery unit into its recess while arranging the SMB cables as shown in the figure.	See the figure in <a href="#">Location of SMB battery on page 194</a> .
5 Secure the <i>SMB cover</i> with its <i>attachment screws</i> .	See the figure in <a href="#">Location of SMB battery on page 194</a> .
6 Update the revolution counter.	Detailed in <a href="#">Updating revolution counters on page 347</a> .
7  <b>DANGER</b> Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 3 Maintenance

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### 3.5.1 Cleaning the IRB 4600



#### 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 4600 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 4600.



#### 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 124](#).
- 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
<b>Standard</b>	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
<b>Foundry Plus</b>	Yes	Yes. With light cleaning detergent or spirit.	Yes. It is highly recommended that the water contains a rust-prevention solution.	Yes <sup>i</sup> . It is highly recommended that the water and steam contains rust preventive, without cleaning detergents.

<sup>i</sup> Perform according to section [Cleaning with water and steam on page 199](#).

**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).<sup>1</sup>

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 700 kN/m<sup>2</sup> (7 bar)<sup>1</sup>
- Fan jet nozzle should be used, min. 45° spread
- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum flow: 20 liters/min<sup>1</sup>

<sup>1</sup> Typical tap water pressure and flow

**Instructions for steam or high pressure water cleaning**

ABB robots with protection types *Foundry Plus*, *Wash*, or *Foundry Prime* can be cleaned using a steam cleaner or high pressure water cleaner.<sup>2</sup>

<sup>1</sup> See [Cleaning methods on page 199](#) for exceptions.

<sup>2</sup> See [Cleaning methods on page 199](#) for exceptions.

*Continues on next page*

### **3 Maintenance**

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#### **3.5.1 Cleaning the IRB 4600**

*Continued*

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 2500 kN/m<sup>2</sup> (25 bar)
- Fan jet nozzle should be used, min. 45° spread
- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum water temperature: 80° C

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#### **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.

# 4 Repair

## 4.1 Introduction

### Structure of this chapter

This chapter describes all repair activities recommended for the IRB 4600 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 375](#).

### 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 19](#) before commencing any service work.



### Note

If the IRB 4600 is connected to power, always make sure that the IRB 4600 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.   <b>CAUTION</b>  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**

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### **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"> <li>• The seal is of the correct type (provided with cutting edge).</li> <li>• There is no damage to the sealing edge (feel with a fingernail).</li> </ul>	
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 <a href="#">Equipment on page 205</a> .
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 Removing the complete cable harness

---

#### Introduction

This procedure describes how to remove the complete cable harness.

How to refit the cable harness is described in section [Refitting the complete cable harness on page 220](#).

The removal procedure is presented in the order the work is recommended to be performed. Therefore the order is different in the two procedures removal and refitting of the cable harness. Cross references will make it easy to find what is needed to know as the work continues.

The section *Removing the complete cable harness* consists of the following parts presented in the order the work is recommended to be performed:

- Removal in the *base* [Removing cable harness in base on page 210](#)
- Removal in the *frame* [Removing cable harness in frame on page 216](#)
- Removal in *lower arm* and *armhouse* [Removing cable harness in lower arm and armhouse on page 217](#).

How to replace the SMB unit, brake release unit and motors can be found in:

- SMB unit [Removing the SMB unit on page 237](#)
- Brake release unit [Removing the brake release board on page 243](#)
- Motors [Removing motors on page 295](#)

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## 4 Repair

### 4.3.1 Removing the complete cable harness

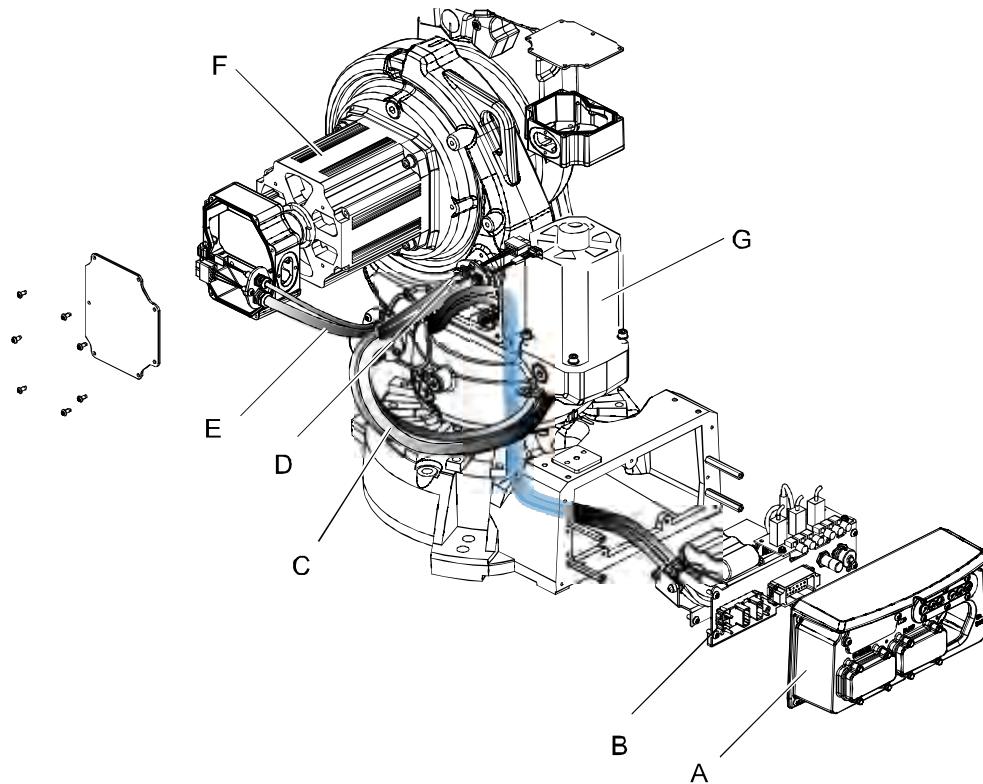
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#### Location of the cable harness

The location of the cable harness in the base, frame and lower arm is shown in the figures.

Cable harness, base and frame.



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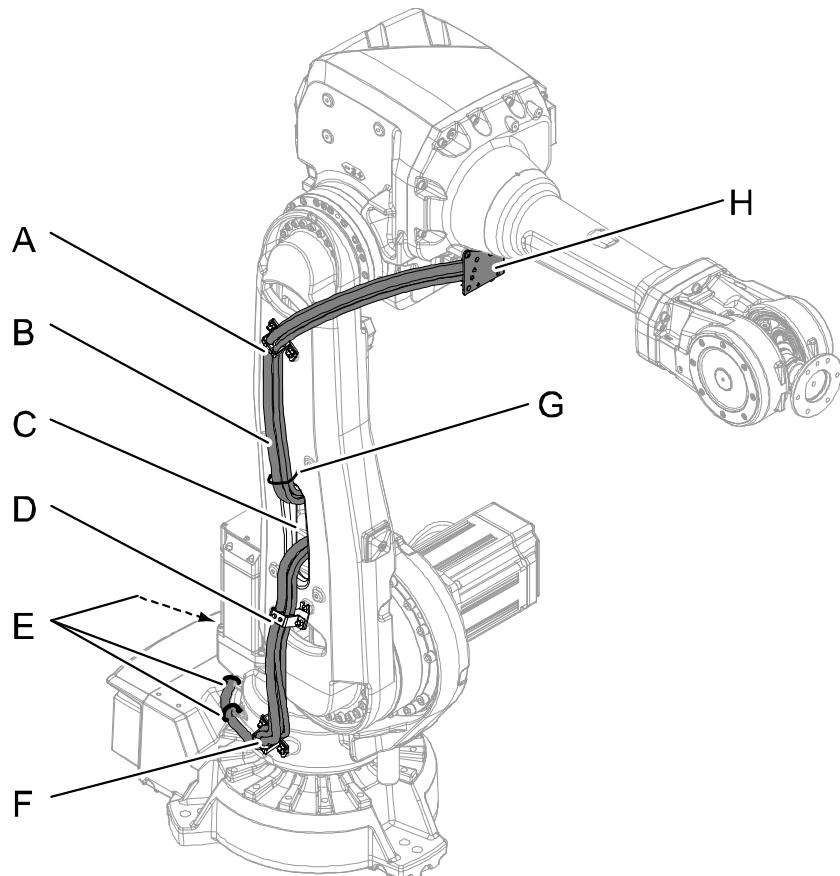
A	Cover base
B	Bracket
C	Cable harness
D	Axis-1 motor cable
E	Axis-2 motor cable
F	Axis-2 motor
G	Axis-1 motor

*Continues on next page*

## 4.3.1 Removing the complete cable harness

*Continued*

Cable harness, lower arm.



xx0900000012

A	Bracket, lower arm
B	Cable harness
C	Hole in lower arm
D	Bracket, lower arm
E	Cable straps, one not visible here (steel)
F	Bracket, frame
G	Cable strap, lower arm (plastic)
H	Bracket, armhouse

## Required equipment

Equipment	Note
Deep well hexagon socket	Width 30 mm
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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

### 4.3.1 Removing the complete cable harness

*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"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

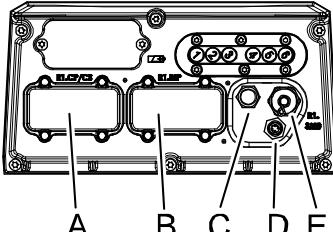
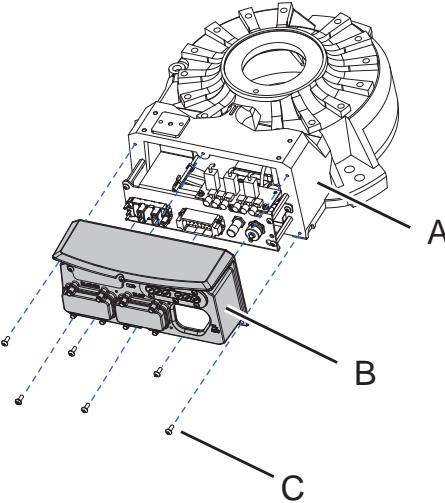
#### Removing cable harness in base

Use this procedure to remove the cable harness in the base.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	

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### 4.3.1 Removing the complete cable harness Continued

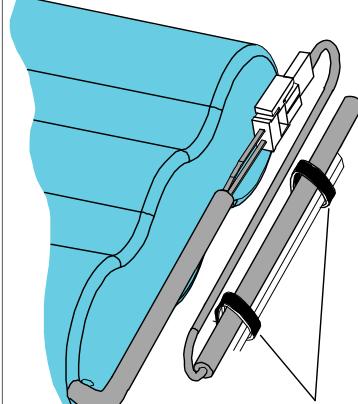
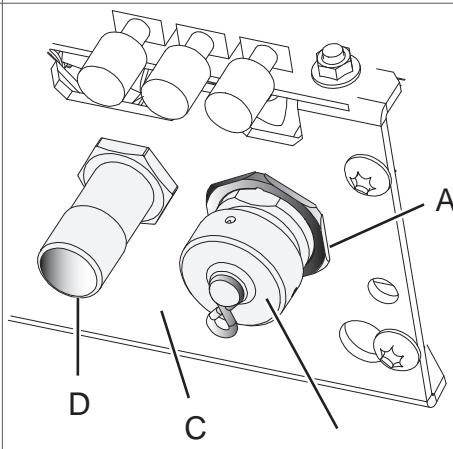
Action	Note
<p>3 Disconnect the following connectors on the <i>base cover</i>:</p> <ul style="list-style-type: none"> <li>• R1.CP/CS</li> <li>• R1.MP</li> <li>• R1.CBUS (if used)</li> </ul> <p><b>Tip</b></p> <p>Do not remove the <i>R1.SMB-connector</i> and <i>air hose connector</i> at this stage. It will be easier to remove these two when the cover base has been removed.</p>	 <p>xx0900000014</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: R1.CP/CS</li> <li>• B: R1.MP</li> <li>• C: Air hose connector</li> <li>• D: Position of R1.CBUS (if used)</li> <li>• E: R1.SMB</li> </ul>
4 Remove the <i>cover base</i> .	 <p>xx0800000456</p> <p>A Base B Cover base C Attachment screws</p>
5 Disconnect connectors on the brake release unit:	

*Continues on next page*

## 4 Repair

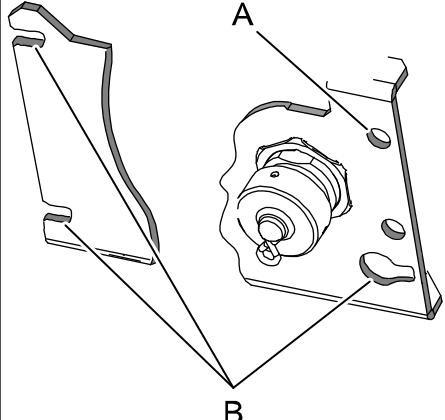
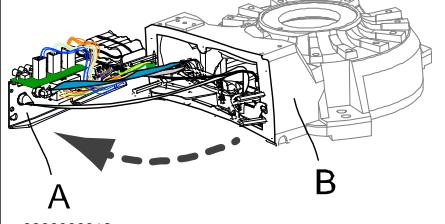
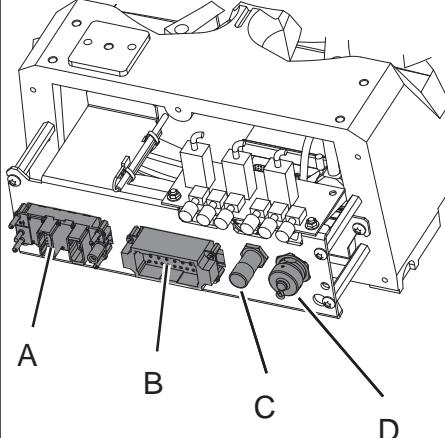
### 4.3.1 Removing the complete cable harness

*Continued*

Action	Note
6 Cut the <i>cable straps</i> securing the battery cable.	 xx0900000099 <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Cable straps (2 pcs)</li> </ul>
7 Disconnect the battery cable.	
8 Unscrew the thin nut securing the R1.SMB connector on the outside of the bracket.	 xx1200000889 <p> <b>A</b> Thin nut, width 30 mm  <b>B</b> R1.SMB  <b>C</b> Bracket  <b>D</b> Air connector </p>
9 Unscrew the nut for the air connection on the inside of the bracket.	

*Continues on next page*

### 4.3.1 Removing the complete cable harness Continued

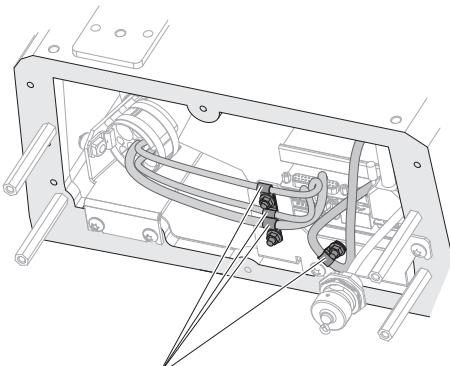
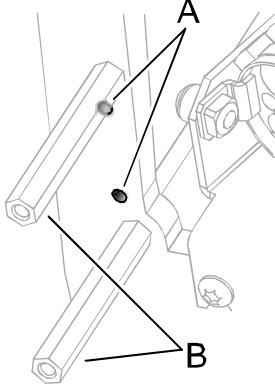
Action	Note
10 Remove the screw that secures the bracket and unscrew the three other screws a little just enough to be able to slide the bracket sideways.	 <p>xx0900000100</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Screw to be removed</li> <li>B: Screws to be unscrewed (3 pcs)</li> </ul>
11 Remove the <i>bracket</i> by sliding it off the remaining three attachment screws and put it at a 90° angle from the base.  Putting the bracket at a 90° angle facilitates the disconnecting of cables from the bracket.	 <p>xx090000013</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Bracket at a 90° angle</li> <li>B: Base</li> </ul>
12 Remove connectors and air hose connector completely from the <i>bracket</i> : <ul style="list-style-type: none"> <li>R1.CP/CS</li> <li>R1.MP</li> <li>R1.SMB</li> <li>Air hose connector</li> <li>R1.CBUS (if used)</li> </ul>	 <p>xx1200000890</p> <p> <b>A</b> R1.CP/CS  <b>B</b> R1.MP  <b>C</b> Air hose connector  <b>D</b> R1.SMB         </p>
13 Remove the <i>SMB unit</i> from its attachment screws.  Leave the screws in the base.	<p>How to remove the <i>SMB unit</i> is described in section:</p> <ul style="list-style-type: none"> <li><a href="#">Removing the SMB unit on page 237</a></li> </ul>

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## 4 Repair

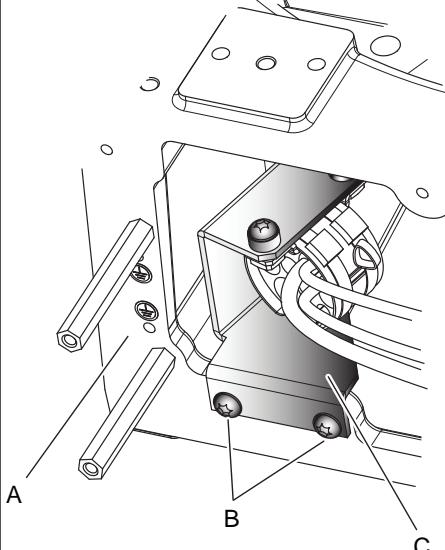
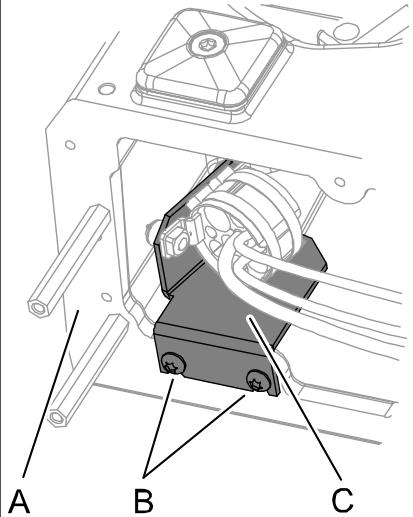
### 4.3.1 Removing the complete cable harness

*Continued*

Action	Note
14 Disconnect connectors on the SMB unit: <ul style="list-style-type: none"> <li>• R1.SMB1-2</li> <li>• R1.SMB2-6</li> <li>• R2.SMB</li> </ul>	
15 Disconnect the <i>screen connections</i> of: <ul style="list-style-type: none"> <li>• R1.SMB1-2</li> <li>• R1.SMB2-6</li> </ul>	 <p>A xx0900000035</p> <p>Parts:  • A: Screen connection (4 pcs)</p>
16 Disconnect the <i>earth cables</i> .	 <p>A B xx0900000015</p> <p>Parts:  • A: Earth  • B: Distance screws</p>

*Continues on next page*

### 4.3.1 Removing the complete cable harness Continued

Action	Note
<p><b>17 Valid for Type C.</b> Remove the <i>bracket</i> securing the cable package inside the base on the left side, by following these steps:</p> <ul style="list-style-type: none"> <li>• Unscrew the attachment screws just enough to be able to remove the bracket.</li> <li>• Lift the bracket off the screws.</li> </ul>	 <p>xx1200000860</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Base</li> <li>• B: Attachment screws</li> <li>• C: Bracket</li> </ul>
<p><b>18 Valid for Other design than Type C.</b> Remove the <i>bracket</i> securing the cable package inside the base on the left side, by following these steps:</p> <ul style="list-style-type: none"> <li>• Unscrew the attachment screws just enough to be able to remove the bracket.</li> <li>• Lift the bracket off the screws.</li> </ul>	 <p>xx0900000018</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Base</li> <li>• B: Attachment screws</li> <li>• C: Bracket</li> </ul>
<p><b>19 Continue removal of the cable package from the frame.</b></p>	<p>How to remove the cable package from the frame is described in section</p> <ul style="list-style-type: none"> <li>• <i>Removing cable harness in frame on page 216</i></li> </ul>

Continues on next page

## 4 Repair

### 4.3.1 Removing the complete cable harness

Continued

#### Removing cable harness in frame

Use this procedure to remove the cable harness in the frame.



##### Tip

Before starting this procedure, first remove the cable harness in the base. See [Removing the complete cable harness on page 207](#).

Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2 Disconnect the <i>motor cables</i> on the axis-1 and axis-2 motors.	How to remove the motor cables is described in section: <ul style="list-style-type: none"><li>• <a href="#">Removing motors on page 295</a></li></ul>
3 Remove the <i>bracket</i> securing the cable package to the frame.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of the cable harness on page 208</a></li></ul>
4 Cut the <i>cable straps</i> securing the cable harness to the frame and lower arm.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of the cable harness on page 208</a></li></ul>
5 Prepare the end of the cable package in the base with tape as shown in the figure.  <b>Tip</b> In order to protect the connectors from getting residual grease on the cable harness, put some plastic over them prior to pushing it through the hole in the frame.	<p>xx1200000886</p> <p>A Tape B Connectors to SMB unit and Brake release unit C R1.CP/CS D Air hose E R1.MP F R1.SMB (Connector bent and taped upwards)</p>

Continues on next page

## 4.3.1 Removing the complete cable harness

*Continued*

Action	Note
6 Pull out the cable package through the hole in the frame.   <b>Note</b>  Use caution when performing this procedure in order not to damage cables or other components!	
7 Continue the removal of the cable package from the lower arm and armhouse.	How to remove the cable package from the lower arm and armhouse is described in section: • <a href="#">Removing cable harness in lower arm and armhouse on page 217</a>

**Removing cable harness in lower arm and armhouse**

Use this procedure to remove the cable harness in the lower arm and armhouse.

**Tip**

Before starting this procedure, first remove the cable harness in the base [Removing the complete cable harness on page 207](#) and frame [Removing the complete cable harness on page 207](#).

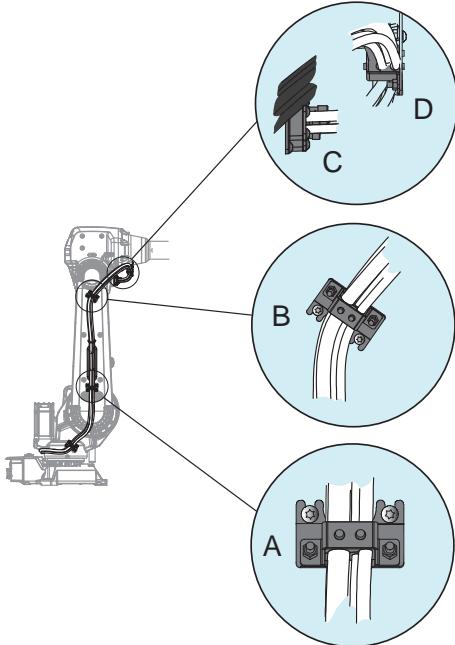
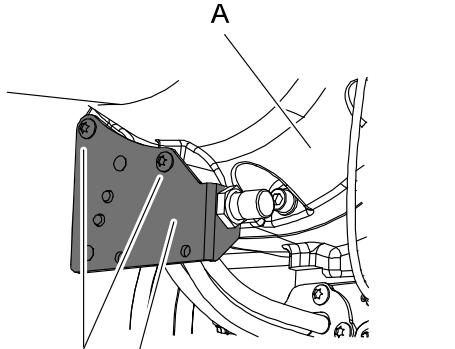
Action	Note
1  <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2 Cut the <i>cable strap</i> on the lower arm.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of the cable harness on page 208</a> (Cable harness, lower arm)</li></ul>

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## 4 Repair

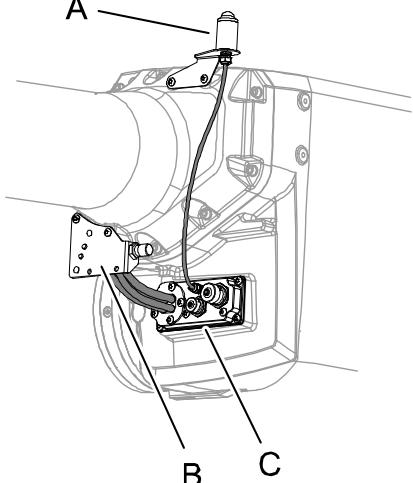
### 4.3.1 Removing the complete cable harness

*Continued*

Action	Note
3 Remove the <i>brackets</i> on the lower arm.	 <p>xx0900000020</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Bracket, lower arm</li> <li>• B: Bracket, lower arm</li> <li>• C: Bracket, armhouse</li> <li>• D: Cable bracket</li> </ul>
4 Remove the <i>bracket</i> on the armhouse.	 <p>xx0800000335</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Tubular shaft unit</li> <li>• B: Attachment screws</li> <li>• C: Bracket, armhouse</li> </ul>

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4.3.1 Removing the complete cable harness  
*Continued*

Action	Note
5 Remove the <i>cable cover</i> on the armhouse.	 <p>xx0800000338</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Signal lamp</li> <li>• B: Bracket</li> <li>• C: Cable cover, armhouse</li> </ul>
6 Remove signal lamp if used.	
7 Continue the removal of the cable package by disconnecting the motor cables of the axis-3, axis-4, axis-5 and axis-6 motors.	<p>How to remove the <i>motor cables</i> from the <i>axis-3, axis-4, axis-5 and axis-6 motors</i> see section:</p> <ul style="list-style-type: none"> <li>• <a href="#">Removing motors on page 295</a></li> </ul>

### 4.3.2 Refitting the complete cable harness

#### 4.3.2 Refitting the complete cable harness

---

##### Introduction

This procedure describes how to refit the complete cable harness.

How to remove the cable harness is described in [Removing the complete cable harness on page 207](#).

The refitting procedure is presented in the order the work is recommended to be performed.

Therefore the order is different in the two procedures removal and refitting of the cable harness. Cross references will make it easy to find what is needed to know as the work continues.

The section *Refitting the complete cable harness* consists of the following parts presented in the order the work is recommended to be performed:

- Refitting in the frame [Refitting the cable harness in the frame on page 223](#)
- Refitting in the base [Refitting the cable harness in the base on page 226](#)
- Refitting in the lower arm and armhouse [Refitting the cable harness in the lower arm and armhouse on page 232](#).

How to refit the SMB unit, brake release unit and motors can be found in:

- SMB unit [Refitting the SMB unit on page 239](#)
- Brake release unit [Refitting the brake release board on page 244](#)
- Motors [Refitting motors on page 303](#)

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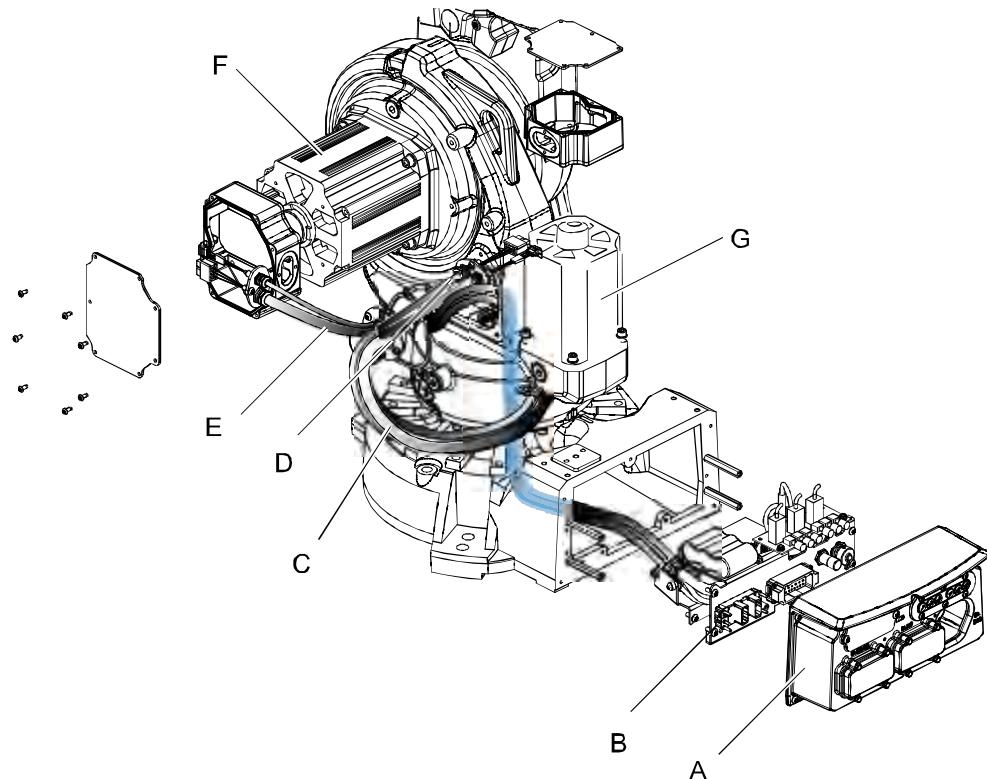
### 4.3.2 Refitting the complete cable harness

*Continued*

#### Location of the cable harness

The location of the cable harness in the base, frame and lower arm is shown in the figures.

Cable harness, base and frame.



xx0900000009

A	Cover base
B	Bracket
C	Cable harness
D	Axis-1 motor cable
E	Axis-2 motor cable
F	Axis-2 motor
G	Axis-1 motor

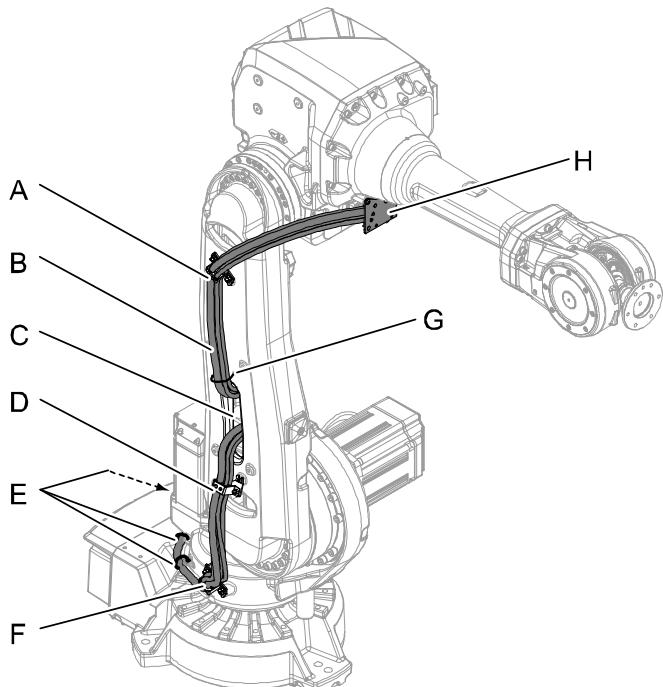
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## 4 Repair

### 4.3.2 Refitting the complete cable harness

*Continued*

Cable harness, lower arm.



xx0900000012

A	Bracket, lower arm
B	Cable harness
C	Hole in lower arm
D	Bracket, lower arm
E	Cable straps, one not visible here (steel)
F	Bracket, frame
G	Cable strap, lower arm (plastic)
H	Bracket, armhouse

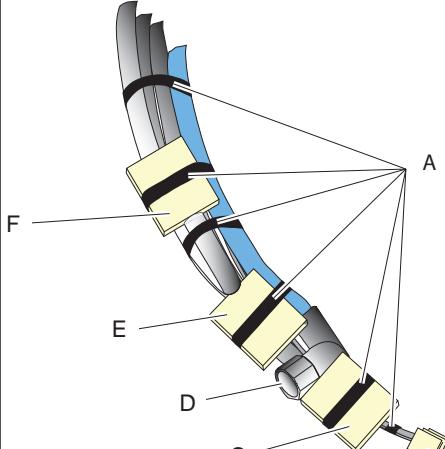
### Required equipment

Equipment	Note
Deep well hexagon socket	Width 30 mm
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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.
Cable grease	Shell Alvania WR2

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**Refitting the cable harness in the frame**

Use this procedure to refit the cable harness in the frame.

Action	Note												
<b>1</b>  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.													
<b>2</b> Apply <b>cable grease</b> on these surfaces: <ul style="list-style-type: none"> <li>• cable guide inside the hole</li> <li>• the part of the cable harness that runs through the cable guide.</li> </ul>	Cable grease is specified in: <ul style="list-style-type: none"> <li>• <a href="#">Required equipment on page 222</a></li> </ul>												
<b>3</b>  <b>Note</b> Two alternative methods to insert the cable package in frame and base are presented below. Choose one of the methods.													
<b>4</b> <i>Use this procedure when replacing the old cable harness:</i> <b>Method 1, step 1:</b> Prepare the end of the cable package in the base with tape as shown in the figure.  <b>Tip</b> In order to protect the connectors from getting residual grease on the cable harness, put some plastic over them prior to pushing it through the hole in the frame.	 xx1200000886 <table> <tr> <td><b>A</b></td> <td>Tape</td> </tr> <tr> <td><b>B</b></td> <td>Connectors to SMB unit and Brake release unit</td> </tr> <tr> <td><b>C</b></td> <td>R1.CP/CS</td> </tr> <tr> <td><b>D</b></td> <td>Air hose</td> </tr> <tr> <td><b>E</b></td> <td>R1.MP</td> </tr> <tr> <td><b>F</b></td> <td>R1.SMB (Connector bent and taped upwards)</td> </tr> </table>	<b>A</b>	Tape	<b>B</b>	Connectors to SMB unit and Brake release unit	<b>C</b>	R1.CP/CS	<b>D</b>	Air hose	<b>E</b>	R1.MP	<b>F</b>	R1.SMB (Connector bent and taped upwards)
<b>A</b>	Tape												
<b>B</b>	Connectors to SMB unit and Brake release unit												
<b>C</b>	R1.CP/CS												
<b>D</b>	Air hose												
<b>E</b>	R1.MP												
<b>F</b>	R1.SMB (Connector bent and taped upwards)												

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## 4 Repair

### 4.3.2 Refitting the complete cable harness

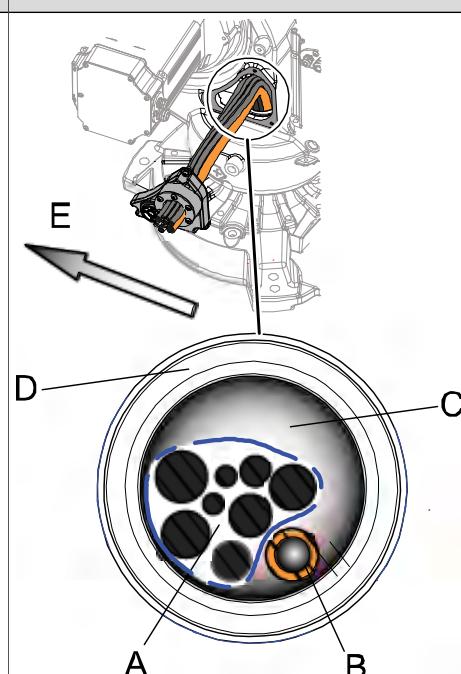
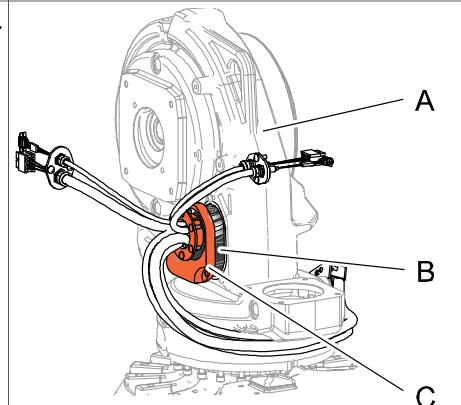
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Action	Note
<p>5 <i>Use this procedure when replacing the old cable harness:</i></p> <p><b>Method 1, step 2:</b></p> <p>Push the cable package carefully in through the base and up through the hole in the frame.</p> <p> <b>Note</b></p> <p>Use caution when performing this procedure in order not to damage cables or other components!</p>	
<p>6 <i>Use this procedure when replacing the old cable harness:</i></p> <p><b>Method 2:</b></p> <p>Push the cable harness carefully into the <b>hole in the frame</b> and out of the hole in the base.</p> <p>Perform the procedure in the following order:</p> <ul style="list-style-type: none"><li>• R1.MP</li><li>• R1.CP/CS</li><li>• R1.SMB1-2 and R1.SMB3-6</li><li>• Air hose.</li></ul> <p> <b>Note</b></p> <p>Use caution when performing this procedure in order not to damage cables or other components!</p> <p> <b>Tip</b></p> <p>In order to protect the connectors from getting residual grease on the cable harness, put some plastic over them prior to pushing it through the hole in the frame.</p>	
<p>7 <i>Use this procedure when fitting a new cable harness:</i></p> <p>Without removing the plastic around cables and hose, push the cable harness through the hole in the frame.</p> <p> <b>Note</b></p> <p>Use caution when performing this procedure in order not to damage cables or other components!</p>	<p> <b>Note</b></p> <p>Check that cables and air hose are placed as shown in the figure above.</p>

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### 4.3.2 Refitting the complete cable harness

*Continued*

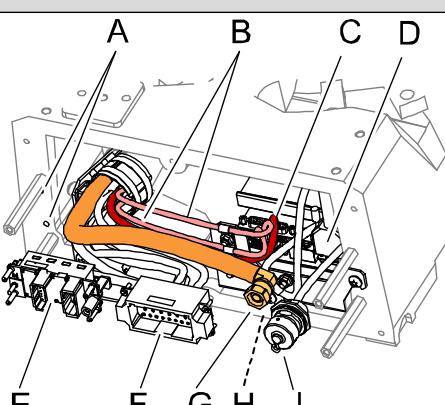
Action	Note
8	<p><b>Note</b></p> <p>It is vital that the position of the air hose is correct, as shown in the figure!</p>  <p>xx0900000096</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>A: Cables</li> <li>B: Air hose</li> <li>C: Hole in frame</li> <li>D: Cable guide</li> <li>E: Position of the front of the robot</li> </ul>
9	<p>Secure the cover to the frame with its attachment screws.</p>  <p>xx0900000016</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>A: Frame</li> <li>B: Hole in frame</li> <li>C: Cover</li> </ul>
10	<p>Connect the axis-1 and axis-2 motor cables.</p> <p>How to refit the motor cables is described in section:</p> <ul style="list-style-type: none"> <li><a href="#">Refitting motors on page 303</a></li> </ul>

*Continues on next page*

## 4 Repair

### 4.3.2 Refitting the complete cable harness

*Continued*

Action	Note
11 Sort out the different cables the way they later will be fit on the bracket in the base.	 xx0900000017 <b>Connections:</b> <ul style="list-style-type: none"> <li>• A: Earth cables</li> <li>• B: R1.SMB1-2</li> <li>• C: R1.SMB3-6</li> <li>• D: R2.SMB</li> <li>• E: R1.CP/CS</li> <li>• F: R1.MP</li> <li>• G: Air hose</li> <li>• H: Position of R1.CBUS (if used)</li> <li>• J: R1.SMB</li> </ul>
12 Continue the refitting of the cable harness in the base.	How to refit the cable harness in the base is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Refitting the cable harness in the base on page 226</a></li> </ul>

#### Refitting the cable harness in the base

Use this procedure to refit the cable harness in the base.



#### Tip

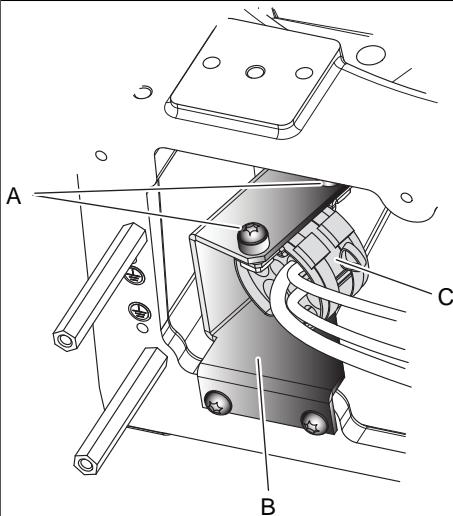
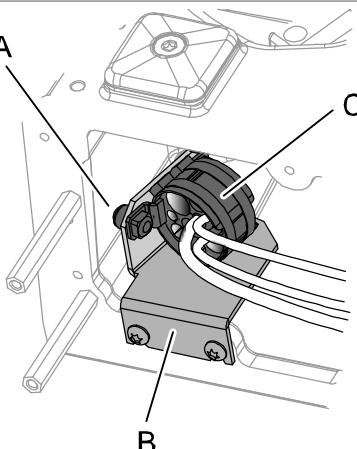
Before starting this procedure, first refit the cable harness in the *frame*. See:

- [Refitting the complete cable harness on page 220](#)

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

*Continues on next page*

### 4.3.2 Refitting the complete cable harness Continued

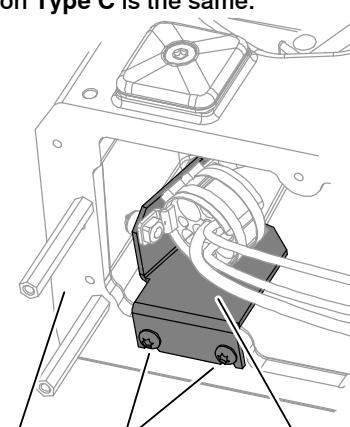
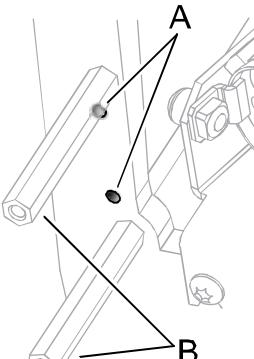
Action	Note
<p><b>2 Valid for Type C.</b> Attach the <i>cable harness</i> to the bracket.</p>	 <p>xx1200000861</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Attachment screw and nut</li> <li>• B: Bracket</li> <li>• C: Cable harness</li> </ul>
<p><b>3 Valid for other design than Type C.</b> Attach the <i>cable harness</i> to the bracket.</p>	 <p>xx0900000098</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Attachment screw and nut</li> <li>• B: Bracket</li> <li>• C: Cable harness</li> </ul>

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## 4 Repair

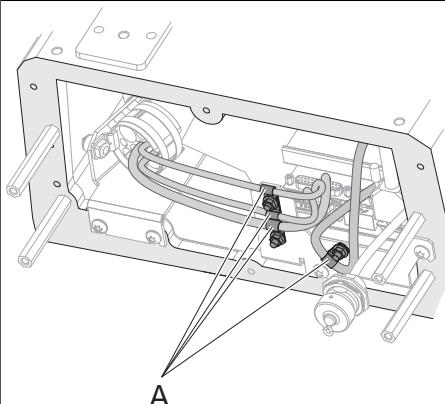
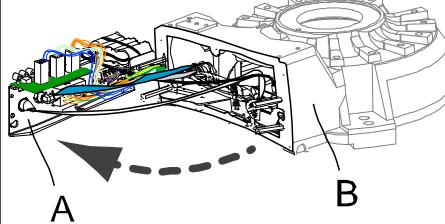
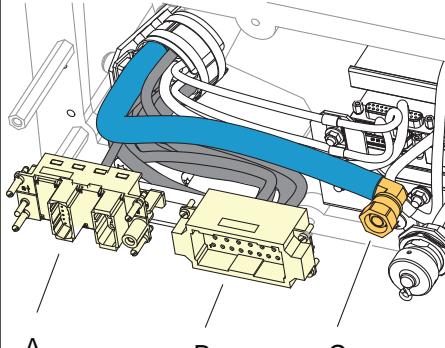
### 4.3.2 Refitting the complete cable harness

*Continued*

Action	Note
4 Secure the <i>bracket</i> on its <i>attachment screws</i> in the base.	<p>The figure shows Other design than Type C. The principle of securing the bracket on Type C is the same.</p>  <p>xx0900000018</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Base</li> <li>B: Attachment screws (2 pcs)</li> <li>C: Bracket</li> </ul>
5 Refit the <i>earth cables</i> .	 <p>xx0900000015</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Earth</li> <li>B: Distance screws</li> </ul>
6 Connect the contacts on the SMB unit: <ul style="list-style-type: none"> <li>R1.SMB1-2</li> <li>R1.SMB3-6</li> <li>R2.SMB</li> </ul>	
7 Refit the SMB unit.	<p>How to refit the SMB unit is described in section:</p> <ul style="list-style-type: none"> <li><a href="#">Refitting the SMB unit on page 239</a></li> </ul>

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### 4.3.2 Refitting the complete cable harness Continued

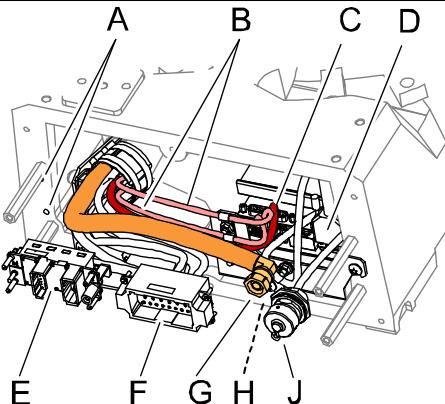
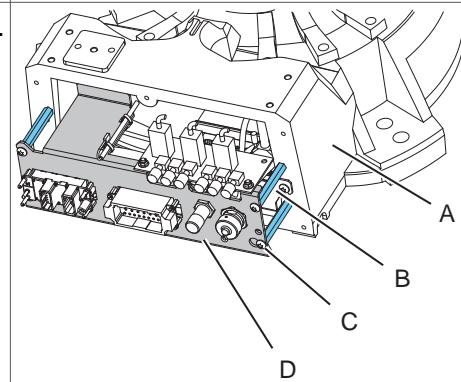
Action	Note
8 Refit the cables with the <i>screen connections</i> .	 <p>xx0900000035</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Screen connections (4 pcs)</li> </ul>
9  <b>Tip</b> When refitting connectors on the <i>bracket</i> , put it at a 90° angle.	 <p>xx0900000013</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Bracket</li> <li>B: Base</li> </ul>
10 Before refitting the connectors on the bracket, arrange cables and connectors as shown in the figure.	 <p>xx1200000857</p> <p> <b>A</b> R1.CP/CS  <b>B</b> R1.MP  <b>C</b> Air hose     </p>

Continues on next page

## 4 Repair

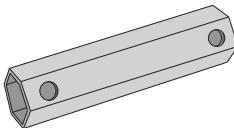
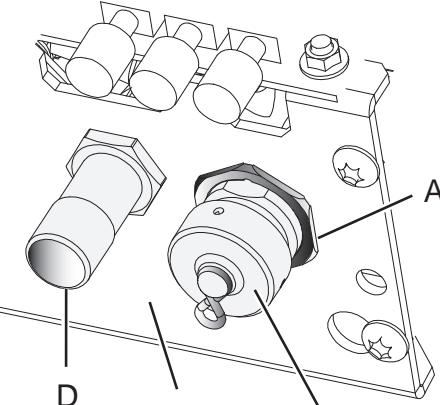
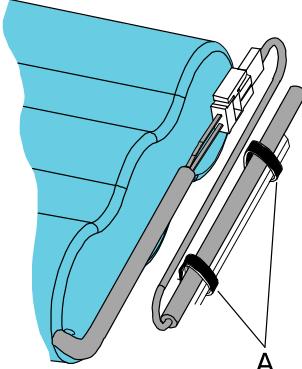
### 4.3.2 Refitting the complete cable harness

*Continued*

Action	Note
<p>11 Refit the <i>connectors</i> and <i>air hose</i> on the bracket:</p> <ul style="list-style-type: none"> <li>• R1.CP/CS</li> <li>• R1.CBUS (if used)</li> <li>• R1.MP</li> </ul> <p> <b>Tip</b></p> <p>Do not refit the <i>R1.SMB-connector</i> and <i>air hose</i> at this stage. It will be easier to refit these two when the bracket has been fitted to the distance screws.</p>	 <p>xx0900000017</p> <p>Connectors:</p> <ul style="list-style-type: none"> <li>• A: Earth cables</li> <li>• B: R1.SMB1-2</li> <li>• C: R1.SMB3-6</li> <li>• D: R2.SMB</li> <li>• E: R1.CP/CS</li> <li>• F: R1.MP</li> <li>• G: Air hose</li> <li>• H: Position of R1.CBUS (if used)</li> <li>• J: R1.SMB</li> </ul>
<p>12 Secure the bracket on the distance screws.</p>	 <p>xx1200000887</p> <p>A Base B Distance screw C Attachment screw D Bracket</p>
<p>13 Reconnect connectors on the brake release unit:</p> <ul style="list-style-type: none"> <li>• X8</li> <li>• X9</li> <li>• X10</li> </ul>	

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### 4.3.2 Refitting the complete cable harness Continued

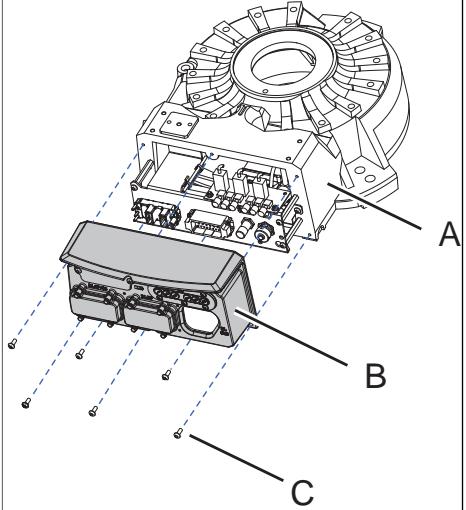
Action	Note
14 Refit the <i>R1.SMB</i> -connector on the bracket.	<p> <b>Tip</b></p> <p>Use a deep well hexagon socket, width 30 mm (like the ones used for spark plugs, or similar).</p>  <p>xx1200000888</p>  <p>xx1200000889</p> <p>A Thin nut, width 30 mm B R1.SMB C Bracket D Air connector</p>
15 Refit the <i>air hose connector</i> on the bracket.	<p> <b>Note</b></p> <p>Check that there is no leakage from the air hose.</p>
16 Reconnect the battery cable.	
17 Secure the battery cable with <i>cable straps</i> .	 <p>xx0900000099</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Cable straps (2 pcs)</li> </ul>

Continues on next page

## 4 Repair

### 4.3.2 Refitting the complete cable harness

*Continued*

Action	Note
18 Use caution when pushing the <i>base cover</i> into position while at the same time checking that no cables are damaged.	 <p>xx0800000456</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Base</li> <li>• B: Base cover</li> <li>• C: Attachment screws (6 pcs)</li> </ul>
19 Secure the <i>base cover</i> with its attachment screws.	
20 Refit the <i>bracket</i> on the frame.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of the cable harness on page 221</a></li> </ul>
21 Refit the <i>cable straps</i> securing the cable harness to the frame.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of the cable harness on page 221</a></li> </ul>
22 Continue the refitting of the cable package on lower arm and armhouse.	How to refit the cable harness on the <i>lower arm and armhouse</i> is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Refitting the cable harness in the lower arm and armhouse on page 232</a></li> </ul>

#### Refitting the cable harness in the lower arm and armhouse

Use this procedure to refit the cable harness in the *lower arm and armhouse*.



#### Tip

Before starting this procedure, first refit the cable harness in the *frame and base*.

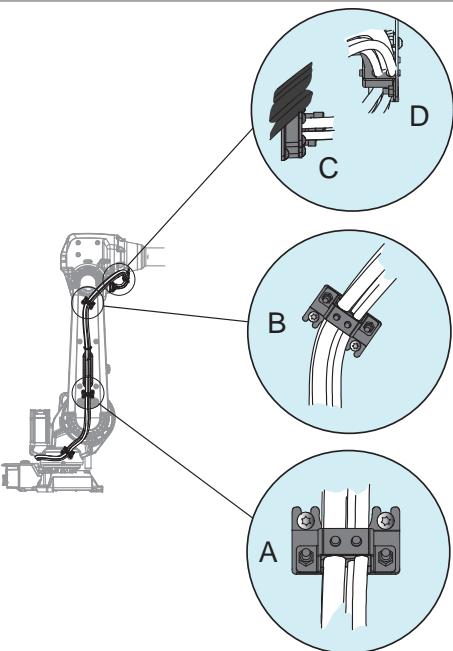
See:

- [Refitting the complete cable harness on page 220](#)
- [Refitting the complete cable harness on page 220](#)

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### 4.3.2 Refitting the complete cable harness

*Continued*

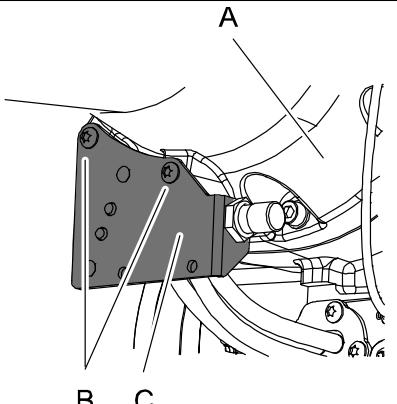
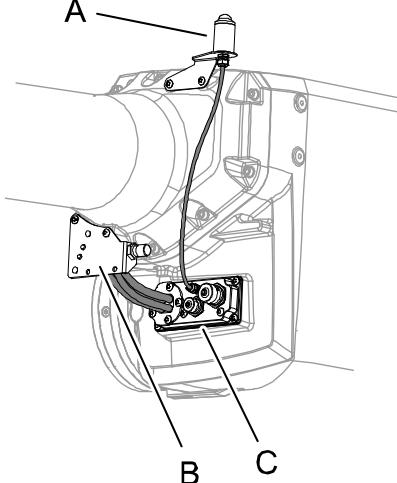
Action	Note
<b>1</b>  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
<b>2</b> Secure the <i>brackets</i> on the lower arm.	 xx0900000020 <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Bracket, lower arm</li> <li>• B: Bracket, lower arm</li> <li>• C: Bracket, armhouse</li> <li>• D: Cable bracket</li> </ul>
<b>3</b> Refit the <i>cable straps</i> securing the cable harness to the lower arm.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of the cable harness on page 221</a> (Cable harness, lower arm)</li> </ul>
<b>4</b> Push the cable harness carefully into the armhouse.	

*Continues on next page*

## 4 Repair

### 4.3.2 Refitting the complete cable harness

*Continued*

Action	Note
5 Secure the <i>bracket, armhouse</i> with its attachment screws.	 <p>xx0800000335</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Tubular shaft unit</li> <li>• B: Attachment screws</li> <li>• C: Bracket, armhouse</li> </ul>
6 Secure the <i>bracket</i> to the armhouse with its attachment screws.	 <p>xx0800000338</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Signal lamp</li> <li>• B: Bracket, armhouse</li> <li>• C: Cable bracket</li> </ul>
7 Reconnect the axis-3, axis-4, axis-5 and axis-6 motor cables.	How to connect the axis-3, axis-4, axis-5 and axis-6 motor cables, see: <ul style="list-style-type: none"> <li>• <a href="#">Refitting motors on page 303</a></li> </ul>
8 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in <a href="#">Calibrating with Axis Calibration method on page 351</a> . General calibration information is included in section <a href="#">Calibration on page 339</a> .

*Continues on next page*

## 4.3.2 Refitting the complete cable harness

*Continued*

	Action	Note
9	 <b>WARNING</b> The cover on the armhouse must be fitted when the robot is running. It is a vital part for the stability of the robot.	
10	 <b>DANGER</b> Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <b>DANGER - First test run may cause injury or damage! on page 51.</b>	

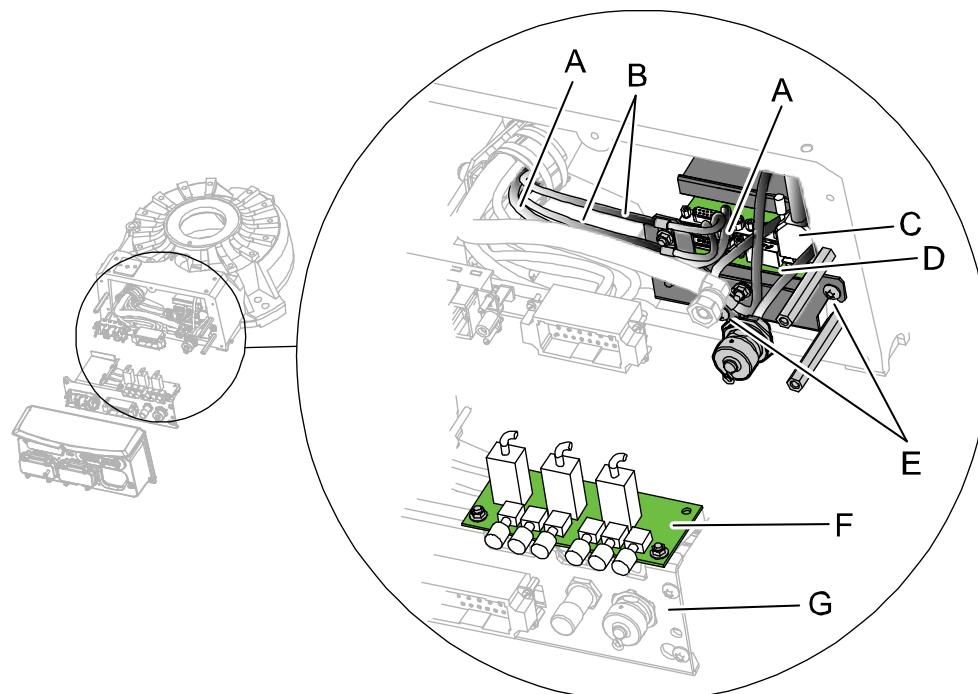
## 4 Repair

### 4.3.3 Replacing SMB unit

#### 4.3.3 Replacing SMB unit

##### Location of SMB unit

The SMB unit (SMB = Serial measurement board) is located in the base below the brake release unit, as shown in the figure.



xx0800000466

A	R1.SMB3-6
B	R1.SMB1-2
C	R2.SMB
D	SMB unit
E	Attachment screws M6x16 quality 8.8-A2F (2 pcs)
F	Brake release unit
G	Bracket

##### Required equipment



##### Note

There are different variants of SMB units and batteries. The variant with the 3-pole battery contact (RMU) 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	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

Continues on next page

Equipment	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.
SMB unit	For spare part no. see chapter Spare parts, section: • <a href="#">Spare part lists on page 389</a>

**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"> <li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li> <li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li> </ul>	
	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 <a href="#">Reference calibration routine on page 352</a> .  Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
	If the robot is to be calibrated with fine calibration:  Remove all external cable packages (DressPack) and tools from the robot.	

**Removing the SMB unit**

Use this procedure to remove the SMB unit.

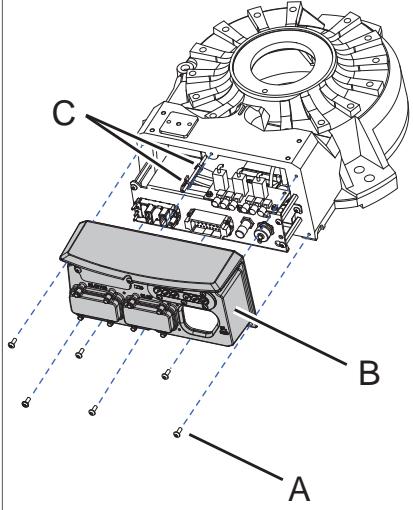
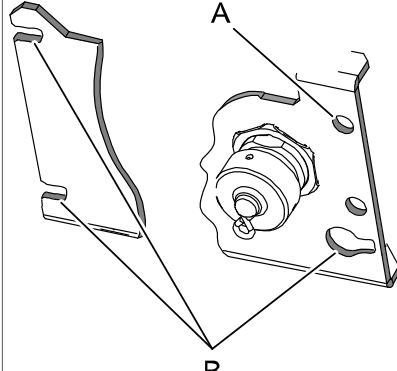
	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	

*Continues on next page*

## 4 Repair

### 4.3.3 Replacing SMB unit

*Continued*

Action	Note
3 Remove the <i>base cover</i> .	 <p>xx0900000103</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Attachment screws (6 pcs)</li> <li>• B: Base cover</li> <li>• C: Cable straps, securing the battery cable (2 pcs)</li> </ul>
4 Cut the <i>cable straps</i> securing the battery cable.	
5 Remove the screw that secures the bracket and unscrew the three other screws a little just enough to be able to slide the bracket sideways.	<p> <b>Note</b></p> <p>It is not needed to remove these three screws.</p>  <p>xx0900000100</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Screw to be removed</li> <li>• B: Screws to be unscrewed a little (3 pcs)</li> </ul>

*Continues on next page*

Action	Note
6 Remove the <i>bracket</i> by sliding it off the remaining three attachment screws and put it at a 90° angle from the base.  Putting the bracket at a 90° angle facilitates the disconnecting of cables from the bracket.	Cable harness can stay connected to all connectors except to the SMB unit.   xx0900000013  Parts: <ul style="list-style-type: none"><li>• A: Bracket at a 90° angle</li><li>• B: Base</li></ul>
7 Disconnect cable clamps.	 xx0900000035  Parts: <ul style="list-style-type: none"><li>• A: Cable clamps</li></ul>
8 Unscrew the <i>attachment screws</i> securing the SMB unit just enough to be able to remove the SMB unit.	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of SMB unit on page 236</a></li></ul>
9 Remove the SMB unit.	
10 Disconnect contacts on the SMB unit: <ul style="list-style-type: none"><li>• R1.SMB1-2</li><li>• R1.SMB3-6</li><li>• R2.SMB</li><li>• Battery cable</li></ul>	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of SMB unit on page 236</a></li></ul>

**Refitting the SMB unit**

Use this procedure to refit the SMB unit.

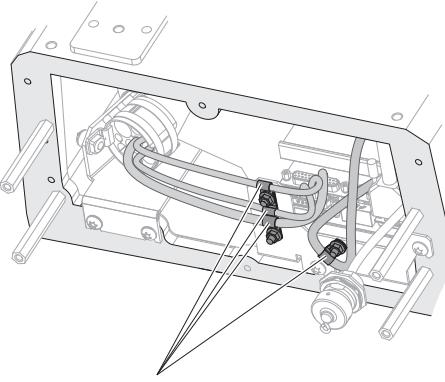
Action	Note
1  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	

*Continues on next page*

## 4 Repair

### 4.3.3 Replacing SMB unit

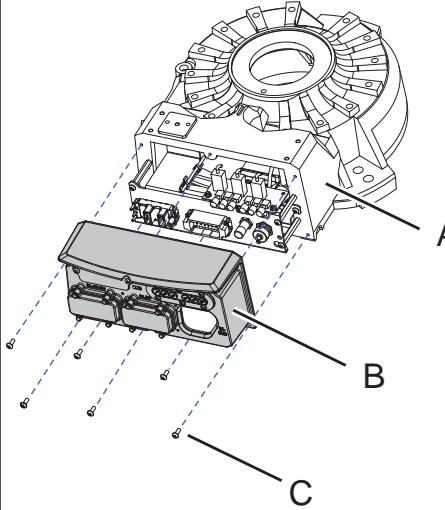
*Continued*

Action	Note
2 Reconnect contacts on the SMB unit: <ul style="list-style-type: none"><li>• R1.SMB1-2</li><li>• R1.SMB3-6</li><li>• R2.SMB</li><li>• Battery cable</li></ul>	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of SMB unit on page 236</a></li></ul>
3 Place the SMB unit on its <i>attachment screws</i> .	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of SMB unit on page 236</a></li></ul>
4 Secure the SMB unit with its attachment screws.	
5 Refit the <i>cable clamps</i> .	 <p>A</p> <p>xx0900000035</p> <p>Parts:<ul style="list-style-type: none"><li>• A: Cable clamps</li></ul></p>
6 Put back the cable harness in the base and refit the bracket on the distance screws.   <b>Note</b>  Use caution when performing this procedure order not to damage cables or other components!	See the figure in: <ul style="list-style-type: none"><li>• <a href="#">Location of SMB unit on page 236</a></li></ul>
7 Secure the battery cable with cable straps.	

*Continues on next page*

### 4.3.3 Replacing SMB unit

*Continued*

Action	Note
8 Use caution when pushing the <i>base cover</i> into position while at the same time checking that no cables are damaged.	 <p>xx0800000456</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Attachment screws (6 pcs)</li> <li>• B: Base cover</li> <li>• C: Base</li> </ul>
9 Refit the <i>base cover</i> .	
10 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 <a href="#">Calibrating with Axis Calibration method on page 351</a>.</p> <p>General calibration information is included in section <a href="#">Calibration on page 339</a>.</p>
11  <b>DANGER</b> Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

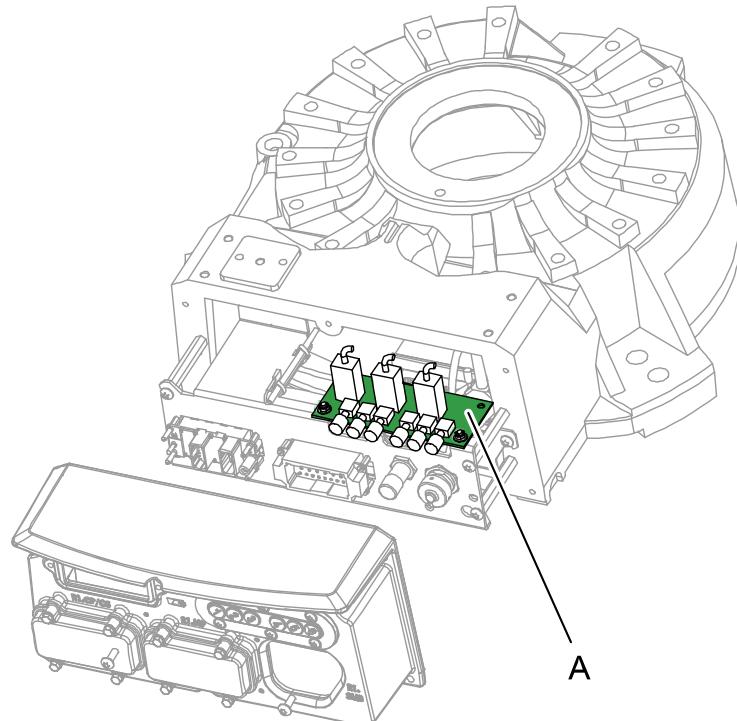
## 4 Repair

### 4.3.4 Replacing the brake release board

#### 4.3.4 Replacing the brake release board

##### Location of brake release board

The brake release board is located as shown in the figure.

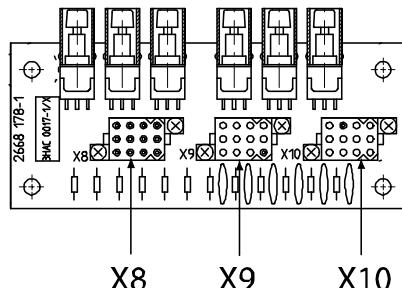


xx0900000101

A      Brake release board

##### Connectors on push-button board

The connectors X8, X9 and X10 are placed on the push-button board as shown in the figure below.



xx0300000201

##### Required equipment

Equipment	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

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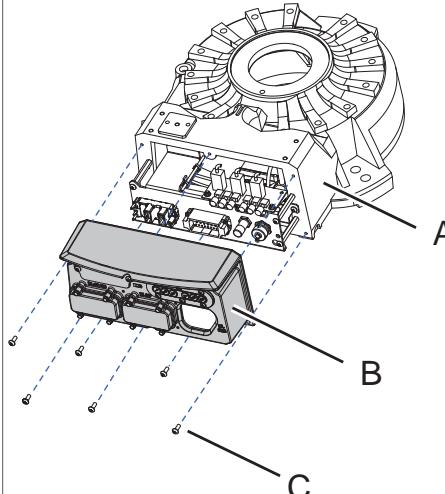
## 4.3.4 Replacing the brake release board

Continued

Equipment	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.

**Removing the brake release board**

Use this procedure to remove the brake release board.

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	Remove the <i>base cover</i> .	 xx0800000456 <b>Parts:</b> A Base B Base cover C Attachment screws M6x16 quality 8.8-A2F (6 pcs)
3	Disconnect connectors X8, X9 and X10 from the brake release board.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Connectors on push-button board on page 242</a></li> </ul>
4	Remove the <i>nuts</i> securing the brake release board.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of brake release board on page 242</a></li> </ul>
5	Remove the brake release board.	

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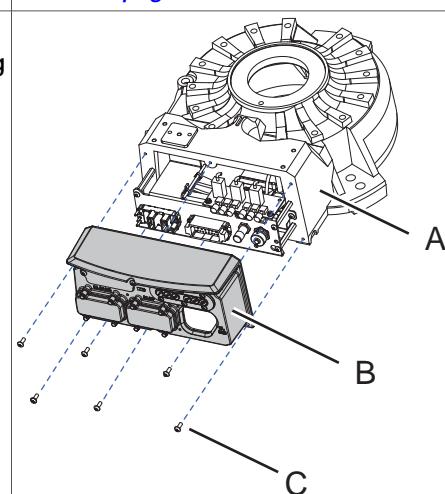
## 4 Repair

### 4.3.4 Replacing the brake release board

*Continued*

#### Refitting the brake release board

Use this procedure to refit the brake release board.

Action	Note
<p>1</p> <p> <b>DANGER</b></p> <p>Turn off all:</p> <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> <p>to the robot, before entering the robot working area.</p>	
<p>2</p> <p>Secure the brake release board to the <i>bracket</i> with its <i>nuts with flange</i>.</p>	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of brake release board on page 242</a></li> </ul>
<p>3</p> <p>Reconnect connectors X8, X9 and X10 to the brake release board.</p>	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Connectors on push-button board on page 242</a></li> </ul>
<p>4</p> <p>Use caution when pushing the <i>base cover</i> into position while at the same time checking that no cables are damaged.</p>	 <p>xx0800000456</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A Base</li> <li>B Base cover</li> <li>C Attachment screws M6x16 quality 8.8-A2F (6 pcs)</li> </ul>
<p>5</p> <p>Secure the <i>base cover</i> with its <i>attachment screws</i>.</p>	
<p>6</p> <p>Check that the <i>brake release buttons</i> not are jammed.</p>	How to check and fix the brake release buttons if jammed, is described in section: <ul style="list-style-type: none"> <li>• <a href="#">WARNING - The brake release buttons may be jammed after service work on page 52</a></li> </ul>

*Continues on next page*

## 4.3.4 Replacing the brake release board

Continued

	Action	Note
7	 <b>WARNING</b>  Before continuing any service work, please observe the safety information in section <b>WARNING - The brake release buttons may be jammed after service work on page 52!</b>	
8	 <b>DANGER</b>  Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <b>DANGER - First test run may cause injury or damage! on page 51.</b>	

## 4 Repair

### 4.3.5 Replacing the base

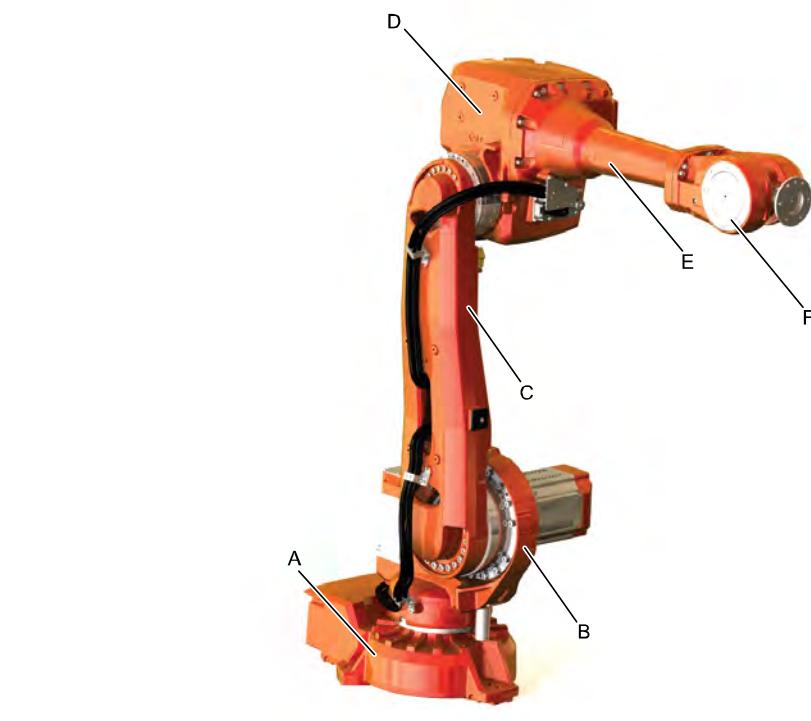
#### 4.3.5 Replacing the base

##### Location of base and complete arm system

The complete arm system is defined as:

- complete upper arm (includes: wrist unit, tubular shaft unit and armhouse)
- lower arm
- frame.

The location of the base and the complete arm system is shown in the figure.



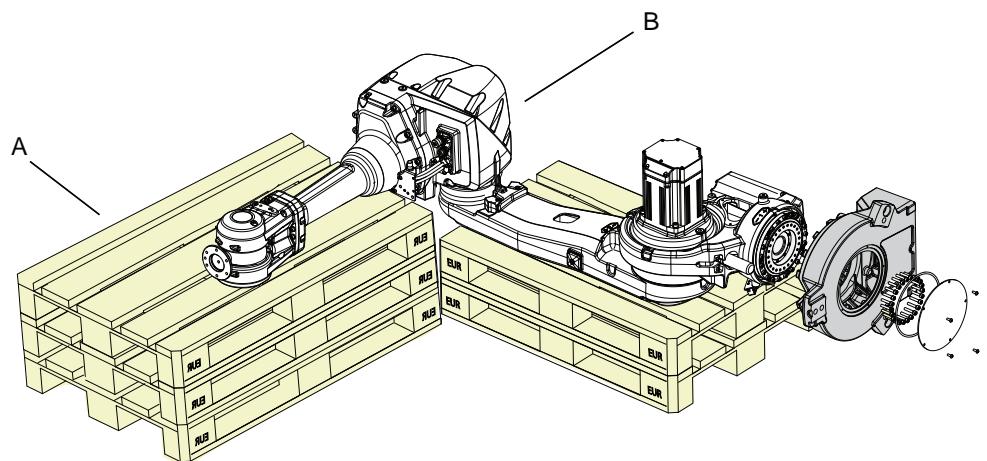
xx0800000345

A	Base
B	Frame
C	Lower arm
D	Armhouse (part of Upper arm complete)
E	Tubular shaft unit (part of Upper arm complete)
F	Wrist unit (part of Upper arm complete)

Continues on next page

**Position of robot when replacing base from complete arm system**

During the removal and refitting of the base from the complete arm system, the following method is recommended. How to perform the method is detailed in the procedures below. The position of the robot on loading pallets is shown in the figure.



xx0800000352

A	Loading pallets
B	Robot

**Required equipment**

Equipment	Note
Roundslings	3 pcs. Lengths: 2 m (2 pcs), 1.5 m (1 pc). Lifting capacity: 1 000 kg.
Crowbar	Small
Guide pins	
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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.
Loctite 7063	For cleaning.
Loctite 574	For sealing.

*Continues on next page*

## 4 Repair

### 4.3.5 Replacing the base

*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.

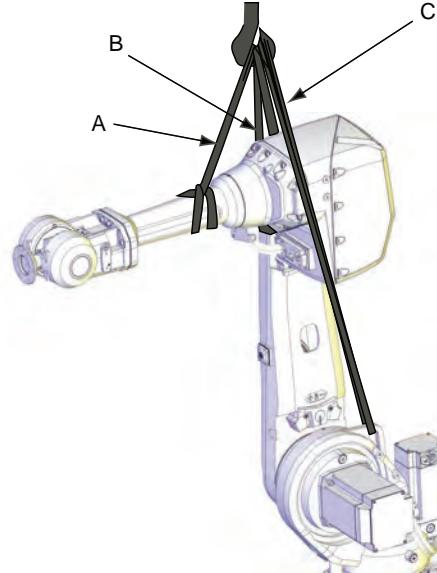
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
	<b>If the robot is to be calibrated with reference calibration:</b> 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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
	<b>If the robot is to be calibrated with fine calibration:</b> Remove all external cable packages (DressPack) and tools from the robot.	

#### Removing the base

Use this procedure to remove the base from the 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 position shown in the figure.	 xx0800000336

*Continues on next page*

Action	Note
<p>3</p>  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
<p>4</p>  <b>Note</b> Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.	How to drain oil is detailed in section <ul style="list-style-type: none"> <li>• <a href="#">Changing the oil, axis-1 gearbox on floor mounted robots on page 160</a></li> </ul>
<p>5</p>  <b>Tip</b> Wrap up the cabling against the frame to keep it undamaged during the remaining work.	How to remove the cable harness in base and frame is detailed in sections: <ul style="list-style-type: none"> <li>• <a href="#">Removing cable harness in base on page 210</a></li> <li>• <a href="#">Removing cable harness in frame on page 216</a></li> <li>• <a href="#">Removing cable harness in lower arm and armhouse on page 217</a></li> </ul>
<p>6</p> Secure the robot with <i>roundslings</i> in an overhead crane.	Dimensions are specified in <a href="#">Required equipment on page 247</a> .  xx1100000582 A Roundsling 1.5 m B Roundsling 2 m C Roundsling 2 m

Continues on next page

## 4 Repair

### 4.3.5 Replacing the base

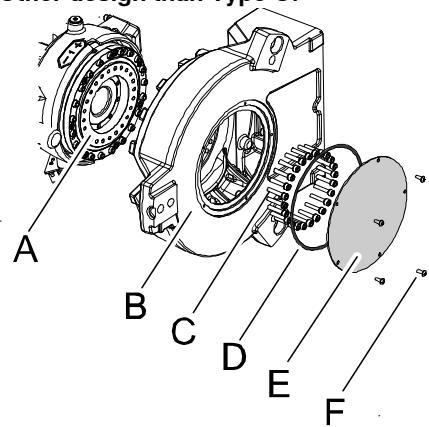
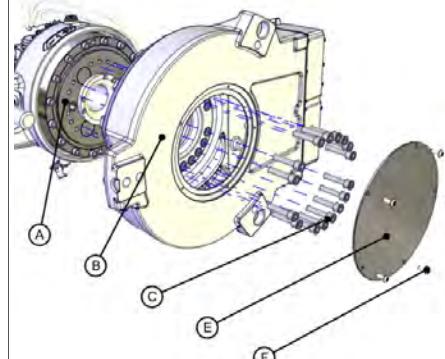
Continued

	Action	Note
7	 <b>CAUTION</b> The IRB 4600 robot weighs 440 kg. All lifting accessories used must be sized accordingly!	
8	 <b>Tip</b> Put the robot on its side on a couple of loading pallets put on top of each other in order to create a more comfortable working situation.	See the figure in: • <i>Position of robot when replacing base from complete arm system on page 247</i>
9	 <b>DANGER</b> Do not remove either <i>motor axis 2 or 3</i> at this stage! This will make the upper and lower arms move in a dangerous way and can cause serious personal injury or mechanical damage to the robot.	
10	Remove the bolts securing the robot to the foundation and carefully put it on the <i>loading pallets</i> as shown in the figure.	See the figure in: • <i>Position of robot when replacing base from complete arm system on page 247</i>   <b>WARNING</b> It is important to secure the robot properly on the loading pallet. Small movements can make the robot alter its position, which can cause personal injury or mechanical damage.

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### 4.3.5 Replacing the base

*Continued*

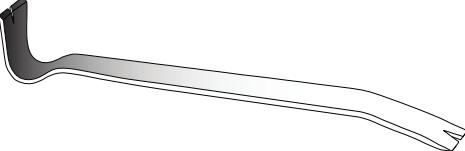
Action	Note
11 Remove the <i>cover plate</i> at the bottom of the base.	<p><b>Other design than Type C:</b></p>  <p>xx0800000357</p> <p><b>Type C:</b></p>  <p>xx1200000634</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>A: Gearbox axis 1</li> <li>B: Base</li> <li>C: Other design than Type C: Attachment screws M8x40 quality Steel 12.9 Gleitmo and washers (24+24 pcs)</li> <li>C: Type C: Attachment screws M12x50 quality Steel 12.9 Gleitmo and washers (24+24 pcs)</li> <li>D: O-ring (Not visible behind cover plate in figure of Type C)</li> <li>E: Cover plate</li> <li>F: Attachment screws M6x16 quality 8.8-A2F (5 pcs)</li> </ul>
12  <b>CAUTION</b> The robot base weighs 60 kg. All lifting accessories used must be sized accordingly!	
13 Secure the <i>base</i> of the robot with round-slings in an overhead crane or similar.	

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## 4 Repair

### 4.3.5 Replacing the base

*Continued*

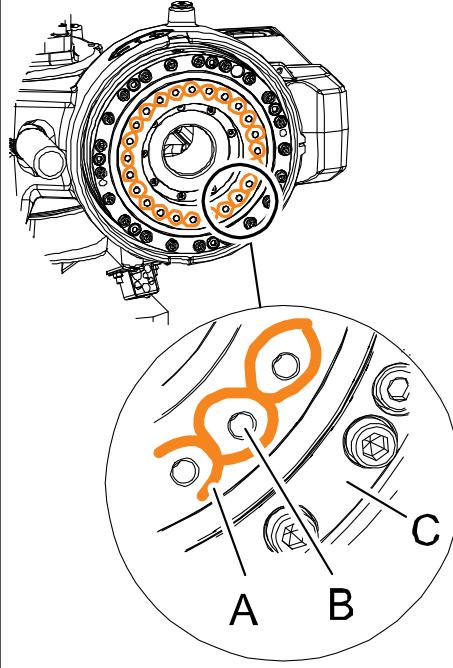
Action	Note
14 Remove the <i>attachment screws</i> that secure the base to the axis 1 gearbox.   <b>Note</b>  The attachment screws on <b>Type C</b> are different from the ones on <b>Other design than type C!</b>	Shown in previous figure.
15 Remove the base carefully.   <b>Tip</b>  A small crowbar will probably be needed to carefully remove the base.   xx1200000891	

#### Refitting the base

Use this procedure to refit the base to the complete arm system.

Action	Note
1  <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2 Remove residues of old Loctite and other contaminations from surfaces before applying new Loctite 574.	 <b>Tip</b>  Use Loctite 7063 (or similar) for cleaning.

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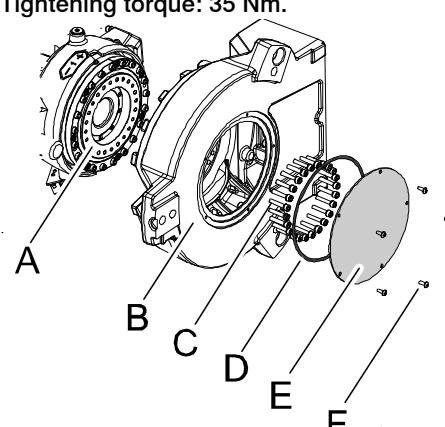
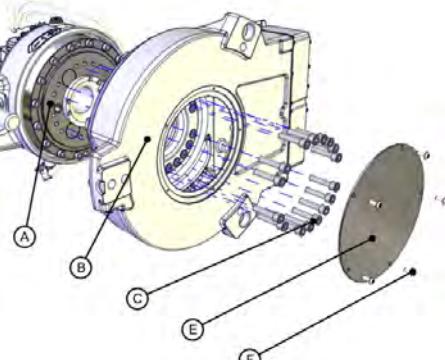
Action	Note
3 Apply Loctite 574 around the <i>screwholes</i> on gearbox axis 1 as shown in the figure.	 <p>xx0800000353</p> <p>Parts</p> <ul style="list-style-type: none"> <li>• A: Loctite 574</li> <li>• B: Screwhole in gearbox axis 1</li> <li>• C: Gearbox axis 1</li> </ul>
4  <b>CAUTION</b> The robot base weighs 60 kg. All lifting accessories used must be sized accordingly!	
5 Secure the <i>base</i> with a roundsling in an overhead crane or similar and lift it to the mounting site.	
6 Apply guide pins in opposite holes in the axis-1 gearbox.	

Continues on next page

## 4 Repair

### 4.3.5 Replacing the base

*Continued*

Action	Note
7 Refit the base with its <i>attachment screws</i> and <i>washers</i> .	<p><b>Other design than Type C:</b> Tightening torque: 35 Nm.</p> <p><b>Note</b></p> <p>The attachment screws on Type C are different from the ones on Other design than Type C!</p>  <p>xx0800000357</p> <p><b>Type C:</b> Tightening torque: 110 Nm.</p>  <p>xx1200000634</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Gearbox axis 1</li> <li>• B: Base</li> <li>• C: Other design than Type C: Attachment screws M8x40 quality Steel 12.9 Gleitmo and washers (24+24 pcs)</li> <li>• C: Type C: Attachment screws M12x50 quality Steel 12.9 Gleitmo and washers (24+24 pcs)</li> <li>• D: O-ring (Not visible behind cover plate in figure of Type C)</li> <li>• E: Cover plate</li> <li>• F: Attachment screws M6x16 quality 8.8-A2F (5 pcs)</li> </ul>
8 Apply some grease to the <i>o-ring</i> and refit the <i>o-ring</i> between the <i>cover</i> and <i>base</i> .	
9 Refit the <i>cover plate</i> at the bottom of the <i>base</i> with its <i>attachment screws</i> .	

*Continues on next page*

Action	Note
10  <b>CAUTION</b>  The IRB 4600 robot weighs 440 kg. All lifting accessories used must be sized accordingly!	
11 Lift the robot from the loading pallets, using caution and refit it to the foundation.	
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 <a href="#">Calibrating with Axis Calibration method on page 351</a> . General calibration information is included in section <a href="#">Calibration on page 339</a> .
13  <b>DANGER</b>  Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 4 Repair

### 4.4.1 Replacing the complete upper arm

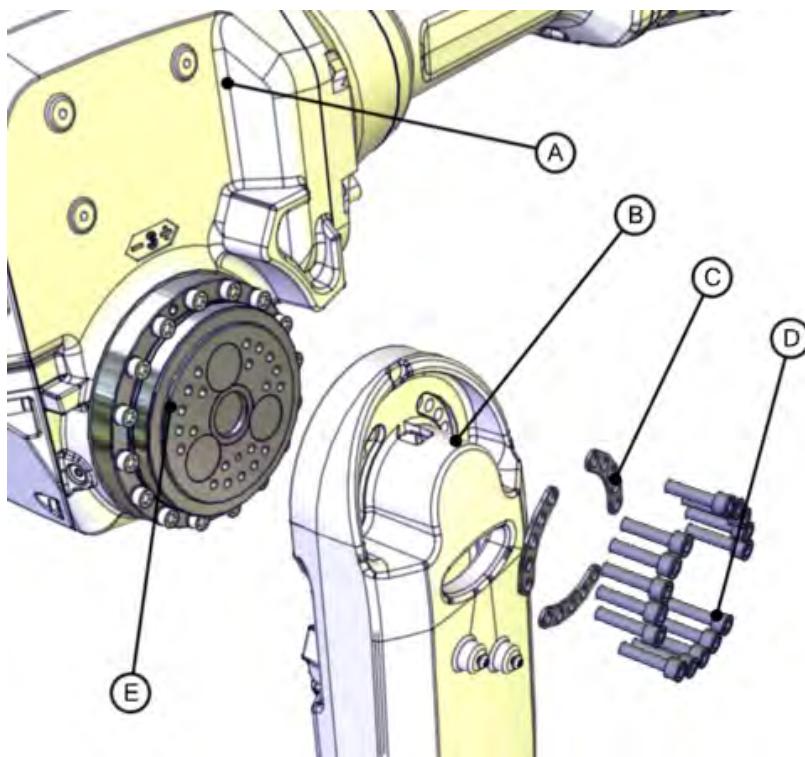
## 4.4 Upper arm

### 4.4.1 Replacing the complete upper arm

#### Location of the complete upper arm

Type C

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



xx1200000635

A	Upper arm
B	Lower arm
C	Washer (3 pcs)  xx1200000520
D	Attachment screws M10x40 quality steel 12.9 Gleitmo (15 pcs)
E	Axis-3 gearbox

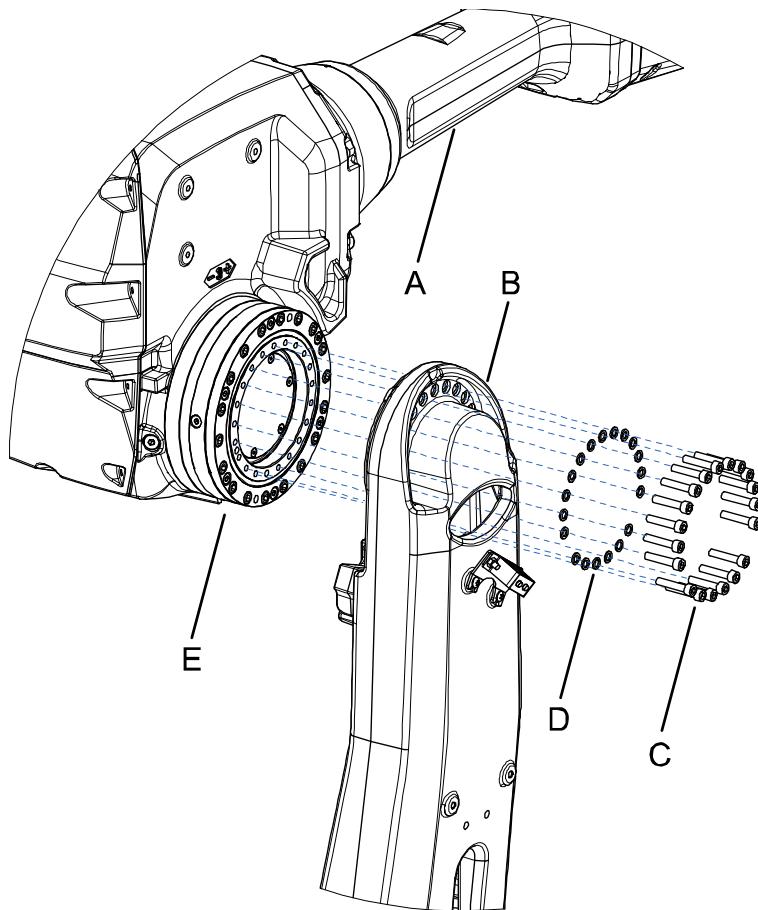
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## 4.4.1 Replacing the complete upper arm

*Continued*

## Other design than Type C

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



xx0800000337

A	Upper arm
B	Lower arm
C	Attachment screws M8x40 quality steel 12.9 Gleitmo (19 pcs)
D	Washers quality steel 8.4x13x1.5 (19 pcs)
E	Axis-2 gearbox

## Required equipment

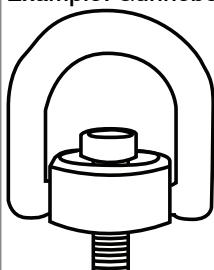
Equipment	Note
Armhouse	For spare parts no. see Spare parts - <i>Upper arm (2.05/2.50/2.55)</i> in <i>Product manual, spare parts - IRB 2600</i> .
Tubular shaft unit	For spare parts no. see Spare parts - <i>Upper arm (2.05/2.50/2.55)</i> in <i>Product manual, spare parts - IRB 2600</i> .

*Continues on next page*

## 4 Repair

### 4.4.1 Replacing the complete upper arm

*Continued*

Equipment	Note
Rotating lifting point	2 pcs. Dimension: M8. Example: Gunnebo RLP GrabiQ M8-10.  xx1100000564
Washer	Required if the screw in the rotating lifting point bottoms. Inner diameter: 12 mm. Outer diameter: min. 23 mm. Thickness: enough to prevent the screw in the rotating lifting point to bottom.
Roundslings	3 pcs. Length: 1.5 m. Lifting capacity: 500 kg.
Screws	2 pcs. Used to prevent the roundsling at the wrist from sliding. Dimension: <ul style="list-style-type: none"><li>• M6. Length: 70 mm. Quality: 8.8. (IRB 4600 - 20/2.5)</li><li>• M8. Length: 70 mm. Quality: 8.8. (IRB 4600 - 60/2.05, - 45/2.05, - 40/2.55)</li></ul>
Guide pins	Type C: M10 (2 pcs) Other design than Type C: M8 (2 pcs)
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	

*Continues on next page*

## 4.4.1 Replacing the complete upper arm

Continued

Action	Note
<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 <a href="#">Reference calibration routine on page 352</a>.</p> <p>Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a>.</p>
<p>If the robot is to be calibrated with fine calibration:</p> <p>Remove all external cable packages (DressPack) and tools from the robot.</p>	

**Removing the complete upper arm**

Use this procedure to remove the complete upper arm. This procedure can be done without draining the axis 3 gearbox.

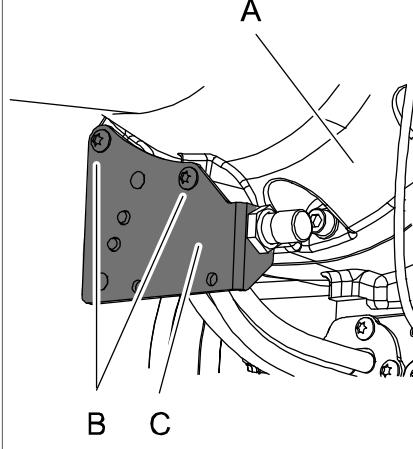
Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Run the robot to the position shown in the figure. The robot must be floor mounted and the upper arm must be horizontally positioned.	 xx0800000336
3  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
4  <b>CAUTION</b> The robot upper arm weighs 140 kg. All lifting accessories used must be sized accordingly!	
5 Attach the lifting accessories to the upper arm.	See <a href="#">Attaching the lifting accessories to the upper arm on page 261</a> .

*Continues on next page*

## 4 Repair

### 4.4.1 Replacing the complete upper arm

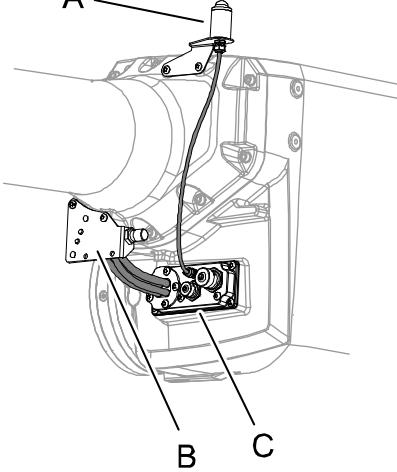
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Action	Note
6 <b>Unload the weight of the upper arm by stretching the roundslings.</b>   <b>Tip</b>  Turn on the power temporarily and release the brakes of axis 3 to rest the weight onto the roundslings.	
7  <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
8 Disconnect all <i>motor cables</i> from motors axes 3, 4, 5 and 6.	How to disconnect cables from motors is detailed in sections: <ul style="list-style-type: none"> <li>• <a href="#">Removing motors on page 295</a></li> </ul>
9 Remove the <i>bracket</i> fitted on the tubular shaft unit.	 xx0800000335 <b>Parts:</b> <ul style="list-style-type: none"> <li>• A: Tubular shaft unit</li> <li>• B: Attachment screws M6x16 quality 8.8-A2F (2 pcs)</li> <li>• C: Bracket</li> </ul>
10 Remove the <i>signal lamp</i> , if used.	

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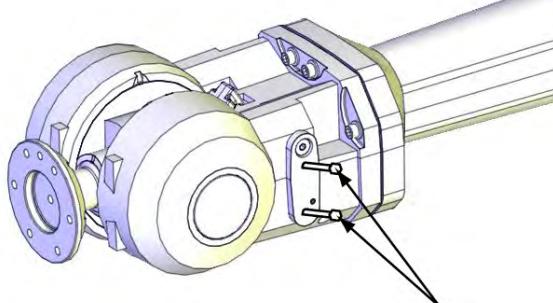
## 4.4.1 Replacing the complete upper arm

Continued

Action	Note
11 Remove the <i>cable bracket</i> on the armhouse.	 <p>xx0800000338</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Signal lamp</li> <li>B: Bracket</li> <li>C: Cable bracket</li> </ul>
12 Using caution, pull the cable package out of the hole where the cable bracket was fitted.	
13 Remove the <i>attachment screws</i> securing the upper arm to the lower arm.	<p>See the figure in:</p> <ul style="list-style-type: none"> <li><a href="#">Location of the complete upper arm on page 256</a></li> </ul> <p> Note</p> <p>Do not remove the attachment screws securing the gearbox axis 3 to the arm-house!</p>
14 Remove the complete upper arm.	

## Attaching the lifting accessories to the upper arm

## Attaching the lifting accessories

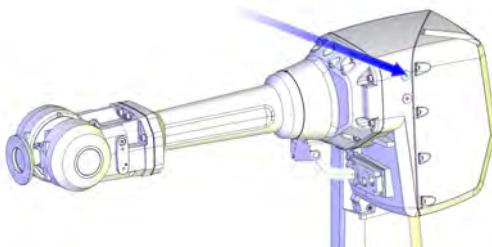
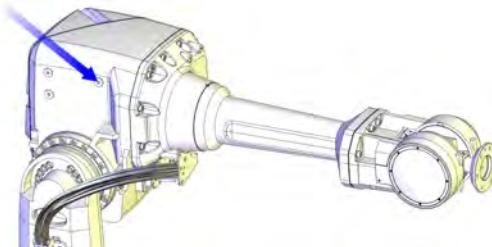
Action	Note
1 Fit two <i>screws</i> in the wrist unit. The purpose of these screws is to prevent the roundsling from sliding.	<p>Dimension is specified in <a href="#">Required equipment on page 257</a>.</p>  <p>xx1100000568</p>

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## 4 Repair

### 4.4.1 Replacing the complete upper arm

*Continued*

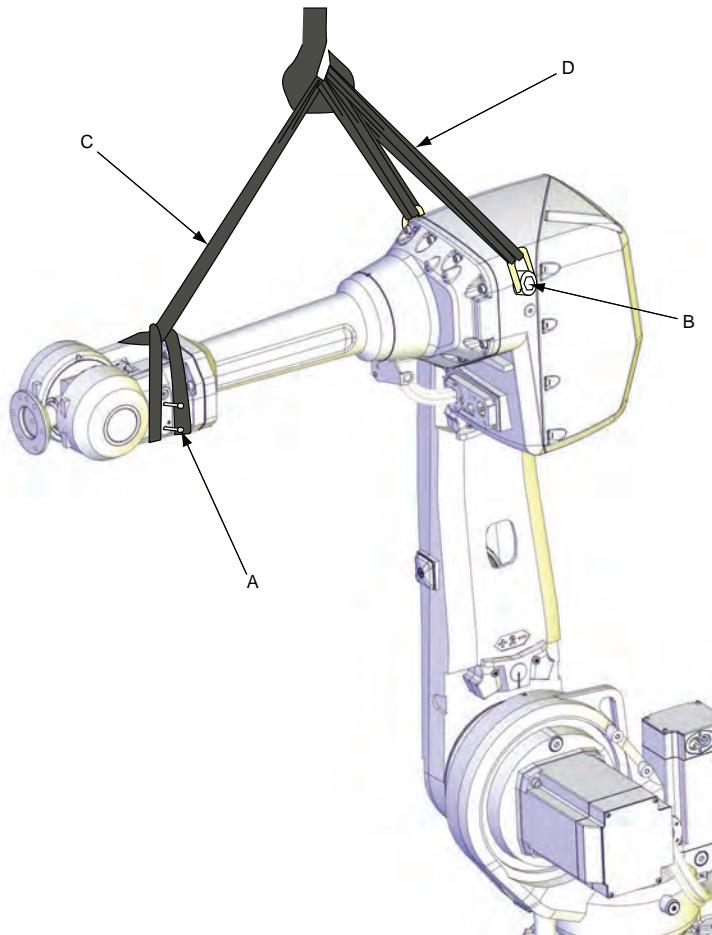
Action	Note
2 Fit two <i>rotating lifting points</i> to the attachment holes in the arm house, see the figure. Secure the lifting point tightly against the arm house, but at the same time making sure that the screw does not bottom. Use an extra washer if the screw does bottom. Tightening torque: 30 Nm.	Dimension is specified in <a href="#">Required equipment on page 257</a> .  xx1100000565  xx1100000566
3 Run a <i>roundsling</i> through each rotating lifting point and fasten both ends at the lifting hook.	Dimension is specified in <a href="#">Required equipment on page 257</a> . See figure <a href="#">Attaching the roundslings to the upper arm on page 263</a> .
4 Make a loop of the third <i>roundsling</i> , running it around the wrist unit. Run the roundsling on both sides of the screws and fasten the free end of the roundsling to the lifting hook.	Dimension is specified in <a href="#">Required equipment on page 257</a> . See figure <a href="#">Attaching the roundslings to the upper arm on page 263</a> .

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## 4.4.1 Replacing the complete upper arm

*Continued*

## Attaching the roundslings to the upper arm



xx1100000567

A	Screws to prevent the roundsling from sliding, 2 pcs
B	Rotating lifting point, 2 pcs
C	Roundsling around wrist unit Length: 1.5 m.
D	Roundsling attached to arm house, 2 pcs Length: 1.5 m.

## Refitting the complete upper arm

Use this procedure to refit the complete upper arm.

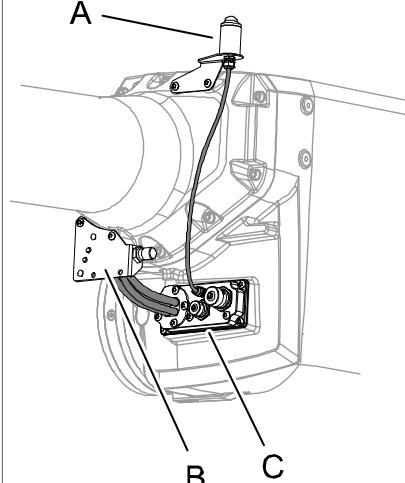
Action	Note
<p>1</p> <p> <b>DANGER</b></p> <p>Turn off all:</p> <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> <p>to the robot, before entering the robot working area.</p>	

*Continues on next page*

## 4 Repair

### 4.4.1 Replacing the complete upper arm

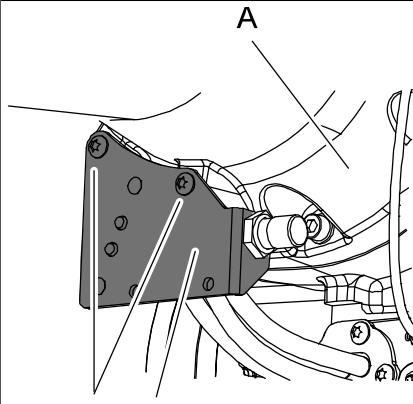
*Continued*

Action	Note
2  <b>CAUTION</b> The robot upper arm weighs 140 kg. All lifting accessories used must be sized accordingly!	
3 Clean all assembly surfaces.	
4 Attach the lifting accessories to the upper arm.	See <a href="#">Attaching the lifting accessories to the upper arm on page 261</a> .
5 Fit <i>guide pins</i> to the upper arm.	Specified in <a href="#">Required equipment on page 257</a> .
6 Lift the upper arm to the robot using an overhead crane.	
7 Release the brakes of the axis 3 motor.	
8 Refit the upper arm to the lower arm with its <i>attachment screws</i> .   <b>Note</b> Use new attachment screws! It may be necessary to turn the gear by rotating the motor pinion with a <i>rotation tool, motor</i> beneath the motor cover.	See the figure in: <ul style="list-style-type: none"><li><a href="#">Location of the complete upper arm on page 256</a></li></ul> Tightening torque Other design than Type C: <ul style="list-style-type: none"><li>35 Nm</li></ul> Tightening torque and angle Type C: <ul style="list-style-type: none"><li>50 Nm and 90° angle</li></ul>
9 Using caution, push the cable package through the hole where the cable bracket will be fitted.	 xx0800000338 Parts: <ul style="list-style-type: none"><li>A: Signal lamp</li><li>B: Bracket</li><li>C: Cable bracket</li></ul>
10 Refit the <i>cable bracket</i> with its attachment screws.	
11 Reconnect all <i>motor cables</i> .	How to connect motor cables is detailed in sections: <ul style="list-style-type: none"><li><a href="#">Refitting motors on page 303</a></li></ul>

*Continues on next page*

## 4.4.1 Replacing the complete upper arm

*Continued*

Action	Note
12 Refit the <i>bracket</i> on the <i>tubular shaft unit</i> .	 <p>A B C</p> <p>xx080000335</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Tubular shaft unit</li> <li>• B: Attachment screws M6x16 quality 8.8-A2F (2 pcs)</li> <li>• C: Bracket</li> </ul>
13 Refit the <i>signal lamp</i> , if used.	
14 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 <a href="#">Calibrating with Axis Calibration method on page 351</a>.</p> <p>General calibration information is included in section <a href="#">Calibration on page 339</a>.</p>
15  <b>DANGER</b>	<p>Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a>.</p>

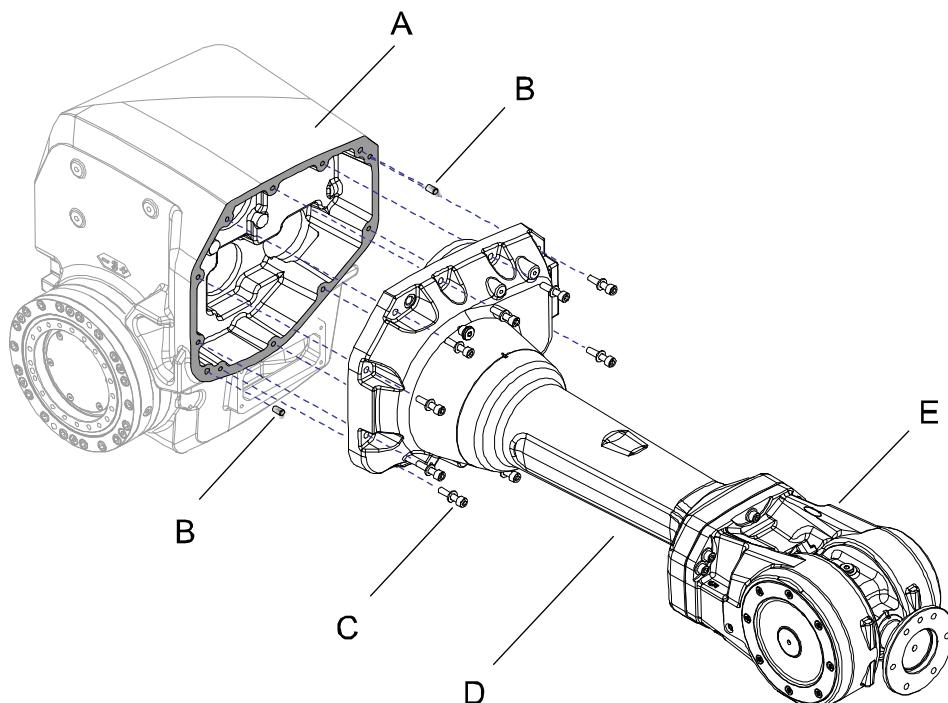
## 4 Repair

### 4.4.2 Replacing complete tubular shaft unit

#### 4.4.2 Replacing complete tubular shaft unit

##### Location of tubular shaft unit

The tubular shaft unit is located as shown in the figure.



xx0800000334

A	Armhouse
B	Parallel pin, hardened 8x16 m6 (2 pcs)
C	Attachment screws M8x35 quality 8.8-A2F and washers (10 + 10 pcs)
D	Tubular shaft unit
E	Wrist unit

##### Required equipment

Equipment	Note
Tubular shaft unit	For spare parts no. see Spare parts - <i>Upper arm (2.05/2.50/2.55)</i> in <i>Product manual, spare parts - IRB 2600</i> .
Guide pins	2 pcs. Dimension: M8.
Cleaning agent	Isopropanol
Sealing liquid	Loctite 574
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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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### 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"> <li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li> <li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li> </ul>	
	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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

### Removing complete tubular shaft unit

Use this procedure to remove the complete tubular shaft unit.

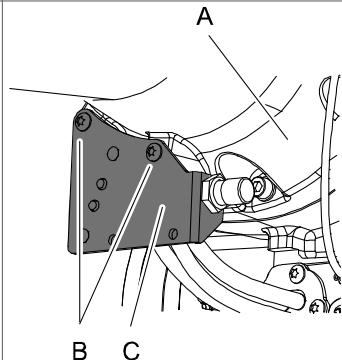
	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Drain oil from gearbox axis 4.	How to drain the oil from the gearbox is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Changing the oil, axis-4 gearbox on page 183</a></li> </ul>
3	Move the robot to the position shown in the figure.	 xx0800000336

Continues on next page

## 4 Repair

### 4.4.2 Replacing complete tubular shaft unit

*Continued*

Action	Note
4  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
5 Remove the <i>bracket</i> securing the cable package to the tubular shaft unit by removing its attachment screws.	 xx0800000335 <b>Parts:</b> <ul style="list-style-type: none"> <li>• A: Tubular shaft unit</li> <li>• B: Attachment screws M6x16 quality 8.8-A2F (2 pcs)</li> <li>• C: Bracket</li> </ul>
6 Place the cable package in a way that it will not be damaged in the continued removal procedure.	
7 Remove motors axes 4, 5 and 6.	How to remove motors is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Removing motors on page 295</a></li> </ul>
8  <b>Tip</b> If only the tubular shaft unit shall be replaced, it is a good idea to remove the <i>wrist unit</i> at this stage.	How to remove the wrist unit is detailed in section: <ul style="list-style-type: none"> <li>• <a href="#">Removal of wrist unit on page 274</a></li> </ul>
9  <b>CAUTION</b> The robot arm tube weighs 65 kg. All lifting accessories used must be sized accordingly!	

*Continues on next page*

Action	Note
<p>10 Secure the <i>tubular shaft unit</i> with round-slings in an overhead crane.</p> <p> <b>CAUTION</b></p> <p>Prevent the slings from sliding!</p> <p>For example a small plate can be fitted to the lower attachment hole for the cable bracket (removed in a previous step). The plate should be fitted so it points downwards and functions as a mechanical stop for the roundsling.</p> <p>At the other end of the tubular shaft unit, a shackle can be fitted if the wrist unit is removed.</p>	
<p>11 Remove the <i>attachment screws</i> that secure the tubular shaft unit.</p>	<p>See the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of tubular shaft unit on page 266</a></li> </ul>
<p>12 Remove the <i>tubular shaft unit</i> using caution. The tubular shaft unit is fitted with Loctite.</p> <p> <b>CAUTION</b></p> <p>Do not damage the gears when removing the tubular shaft unit.</p> <p> <b>CAUTION</b></p> <p>Remaining oil will drain out from the gearbox cavity when the tubular shaft is lifted out.</p>	<p> <b>Note</b></p> <p>There are two parallel pins guiding the tubular shaft unit into its place. See figure in <a href="#">Replacing complete tubular shaft unit on page 266</a>.</p>

### Refitting complete tubular shaft unit

Use this procedure to refit the tubular shaft unit.

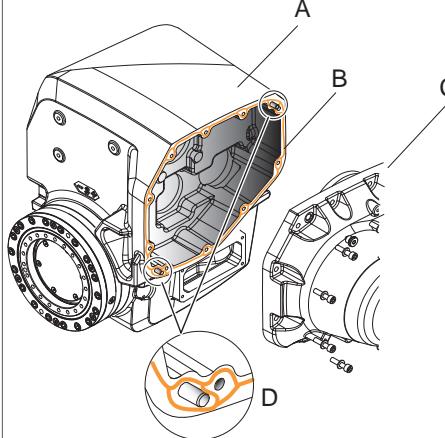
Action	Note
<p>1  <b>DANGER</b></p> <p>Turn off all:</p> <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> <p>to the robot, before entering the robot working area.</p>	
<p>2 Remove residues of old Loctite and other contaminations from the assembly surfaces.</p> <p>Remove any painting from the assembly surfaces, with a knife.</p>	

*Continues on next page*

## 4 Repair

### 4.4.2 Replacing complete tubular shaft unit

*Continued*

Action	Note
3 Apply sealing liquid (Loctite 574) on the surface between the tubular shaft unit and the armhouse.  Make sure to apply the sealing liquid in circles around each of the attachment holes.	 <p>xx0800000457</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A Armhouse</li> <li>B Surface where Loctite 574 shall be applied</li> <li>C Tubular shaft unit</li> <li>D Cylindrical pin (2 pcs)</li> </ul>
4  <b>CAUTION</b>  The robot arm tube weighs 65 kg. All lifting accessories used must be sized accordingly!	
5 Secure the tubular shaft unit with a round-sling in an overhead crane.   <b>CAUTION</b>  Prevent the slings from sliding! For example a small plate can be fitted to the lower attachment hole for the cable bracket (removed in a previous step). The plate should be fitted so it points downwards and functions as a mechanical stop for the roundsling.  At the other end of the tubular shaft unit, a shackle can be fitted if the wrist unit is removed.	
6 Fit <i>guide pins</i> in the upper arm house.	Specified in <a href="#">Required equipment on page 266</a> .
7 Refit the tubular shaft unit, using caution.   <b>CAUTION</b>  Do not damage the gears when refitting the tubular shaft unit.	 <b>Note</b>  There are two parallel pins guiding the tubular shaft unit into its place.

*Continues on next page*

## 4.4.2 Replacing complete tubular shaft unit

Continued

	Action	Note
8	Secure the tubular shaft unit with its <i>attachment screws</i> .	See the figure in: • <a href="#">Location of tubular shaft unit on page 266</a> Tightening torque: 22 Nm
9	Refit motors axes 4, 5 and 6.	How to refit motors is described in section: • <a href="#">Refitting motors on page 303</a>
10	Perform a leak-down test.	See <a href="#">Performing a leak-down test on page 202</a> .
11	Refit the <i>bracket</i> securing the cable package to the tubular shaft unit, with its <i>attachment screws</i> .	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws M6x16 quality 8.8-A2F (2 pcs) • C: Bracket
12	If the <i>wrist unit</i> has been removed from the tubular shaft unit, refit it now.	How to refit the wrist unit is detailed in section: • <a href="#">Refitting of wrist unit on page 275</a>
13	Refill gearbox axis 4 with oil.	How to refill oil in gearbox is described in section: • <a href="#">Changing the oil, axis-4 gearbox on page 183</a>
14	Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in <a href="#">Calibrating with Axis Calibration method on page 351</a> . General calibration information is included in section <a href="#">Calibration on page 339</a> .
15	 <b>DANGER</b> Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 4 Repair

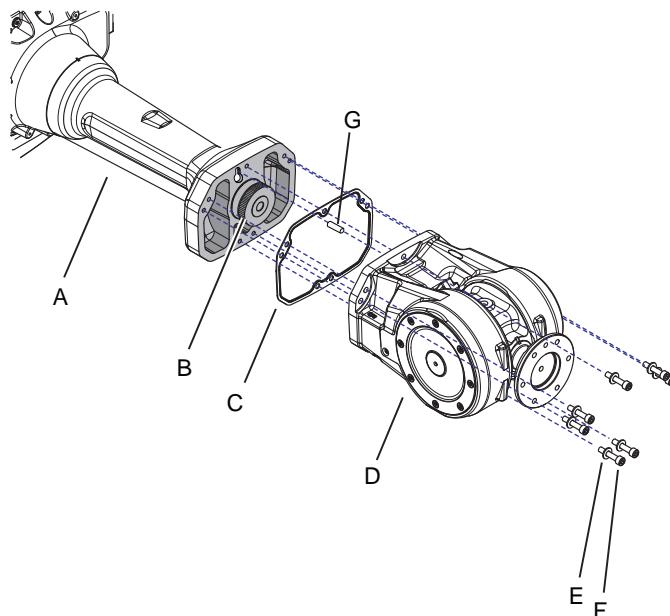
### 4.4.3 Replacing wrist unit

#### 4.4.3 Replacing wrist unit

##### Location of wrist unit

The wrist unit is located in the upper arm as shown in the figures.

IRB 4600 -60/2.05, -45/2.05, -40/2.55

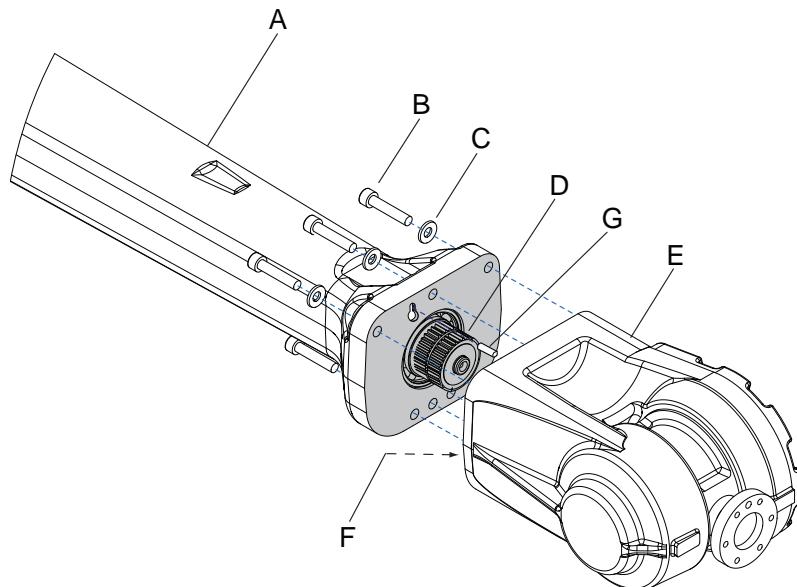


xx0800000333

A	Upper arm
B	Gear
C	O-ring sealing plate
D	Wrist unit
E	Spring washer, conical 8.4x18x2, quality steel-mZn12c (7 pcs)
F	Attachment screw M8x40, quality steel 12.9 Gleitmo (7 pcs)
G	Guide pin (only available for robots that are calibrated with Axis Calibration)

*Continues on next page*

## IRB 4600 -20/2.50



xx0800000341

A	Upper arm
B	Attachment screw M8x40, quality steel 12.9 Gleitmo (5 pcs)
C	Spring washer, conical 8.4x18x2, quality steel-mZn12c (5 pcs)
D	Gears
E	Wrist unit
F	O-ring (Placed on the wrist. Not visible here)
G	Guide pin (only available for robots that are calibrated with Axis Calibration)

## Required equipment

Equipment	Note
Wrist unit	For spare parts no. see Spare parts - <i>Upper arm (2.05/2.50/2.55)</i> in <i>Product manual, spare parts - IRB 2600</i> .
O-ring	For spare parts no. see Spare parts - <i>Upper arm (2.05/2.50/2.55)</i> in <i>Product manual, spare parts - IRB 2600</i> .
Measuring tool	For adjusting the play.
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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

### 4.4.3 Replacing wrist unit

*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"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

#### Removal of wrist unit

Use this procedure to remove the wrist unit.

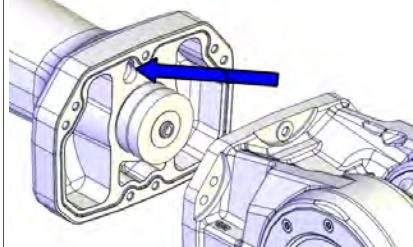
Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
3 Drain oil from gearbox axes 5-6.	How to drain the oil from gearbox axes 5-6 is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing oil, axes-5 and -6 gearboxes on page 187</a></li></ul>

*Continues on next page*

Action	Note
<p>4</p> <p> <b>CAUTION</b></p> <p>The robot wrist unit weighs 25 kg (IRB 4600 - 60/2.05, - 45/2.05, -40/2.55) and 15 kg (IRB 4600 - 20/2.50). All lifting accessories used must be sized accordingly!</p>	
<p>5</p> <p>Secure the wrist unit with a roundsling in an overhead crane or similar.</p>	
<p>6</p> <p>Remove the <i>attachment screws</i> and carefully remove the wrist unit.</p> <p> <b>CAUTION</b></p> <p>Do not damage gears!</p>	<p>See the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of wrist unit on page 272</a></li> </ul>

**Refitting of wrist unit**

Use this procedure to refit the wrist unit.

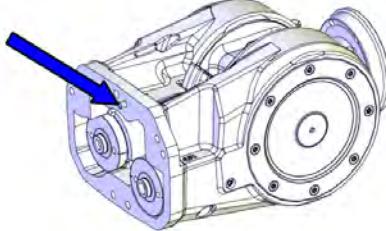
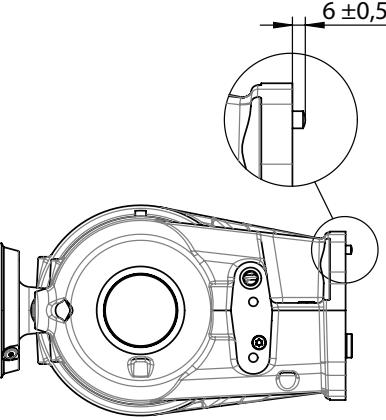
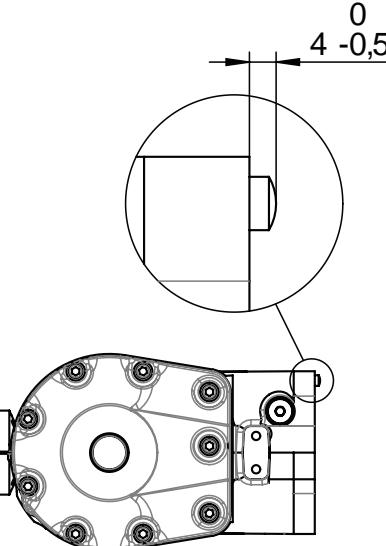
Action	Note
<p>1</p> <p> <b>DANGER</b></p> <p>Turn off all:</p> <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> <p>to the robot, before entering the robot working area.</p>	
<p>2</p> <p>Check if there is a parallel pin hole in the upper arm tube.</p> <p>The hole is available on robots that are calibrated with the Axis Calibration method.</p>	 <p>xx1600000690</p>

*Continues on next page*

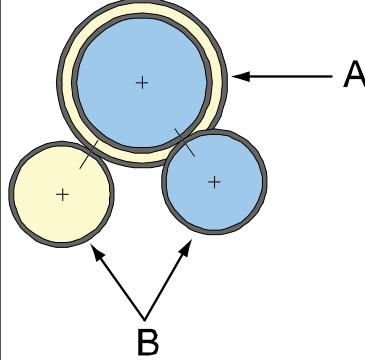
## 4 Repair

### 4.4.3 Replacing wrist unit

*Continued*

Action	Note
<p>3 If there is a hole, fit the parallel pin into the corresponding hole in the wrist (enclosed with the new wrist spare part).</p> <p><b>Note</b></p> <p>If the parallel pin is not installed on a robot calibrated with Axis Calibration, the calibration result will be affected negatively.</p>	 <p>xx1600000689</p> <p>Verify that the parallel pin sticks out from the wrist according to the measurement given below. IRB 4600 -60/2.05, -45/2.05, -40/2.55</p>  <p>xx1600000702</p> <p>IRB 4600 -20/2.50</p>  <p>xx1600000703</p>
<p>4 Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.</p>	

*Continues on next page*

Action	Note
5 Not applicable to variant IRB 4600-20/2.50. Fit the o-ring sealing plate.	See the figure in: • <a href="#">Location of wrist unit on page 272</a>
6 Check the o-ring. Replace if damaged.	See the figure in:
7 Prepare the refitting of the wrist by inserting the attachment screws and washers in the upper arm tube.	• <a href="#">Location of wrist unit on page 272</a>
8  <b>CAUTION</b>  The robot wrist unit weighs 25 kg (IRB 4600 - 60/2.05, - 45/2.05, -40/2.55) and 15 kg (IRB 4600 - 20/2.50). All lifting accessories used must be sized accordingly!	
9 Carefully put the <i>wrist unit</i> in its place on the <i>upper arm</i> .   <b>CAUTION</b> Do not damage gears!   <b>CAUTION</b> Make sure that the o-ring stays in place on the wrist unit!	
10 Adjust the play of the wrist by following these steps: • Fit the <i>measuring tool</i> at the rear of the motor. • Push the wrist as shown in the figure to locate the smallest play in the same way as for adjustment of motors for axes 4, 5 and 6. See <a href="#">Refitting motors on page 303</a> .	 xx1000000223 Parts: • A: Gears on drive shaft unit, axes 5-6 • B: Gears on the wrist
11 Secure the wrist unit with its <i>attachment screws</i> and <i>washers</i> .	See the figure in • <a href="#">Location of wrist unit on page 272</a> Tightening torque: 35 Nm.
12 Measure the play by moving axes 5 and 6 with the measuring tool.	How to measure the play is described in sections: • <a href="#">Measuring the play, axis 5 on page 279</a> • <a href="#">Measuring the play, axis 6 on page 282</a>

Continues on next page

## 4 Repair

### 4.4.3 Replacing wrist unit

*Continued*

	Action	Note
13	Perform a leak-down test.	See <a href="#">Performing a leak-down test on page 202</a> .
14	Refill oil in gearbox axes 5-6.	How to fill oil in gearbox axes 5-6 is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing oil, axes-5 and -6 gearboxes on page 187</a></li></ul>
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 <a href="#">Calibrating with Axis Calibration method on page 351</a> . General calibration information is included in section <a href="#">Calibration on page 339</a> .
16	 <b>DANGER</b>  Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 4.4.4 Measuring the play, axis 5

### General

After reassembly due to repair work or any other reason, the play in axis 5 and 6 must be checked to ensure the repetition accuracy of the robot positioning. The procedure for axis 5 is detailed below.

### Required equipment

Equipment, etc.	Art. no.	Note
Standard toolkit	-	Content is defined in section <a href="#">Standard tools on page 383</a> .
Measuring tool, play (IRB 4600 -60/2.05, -45/2.05, -40/2.55)	3HAB1611-6	
Measuring tool, play (IRB 4600 -20/2.50)	3HAB6337-1	
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.

### Measurement, axis 5

The procedure below details how to measure the play of axis 5.



#### Note

The measuring tool and measuring values differ depending on robot version!

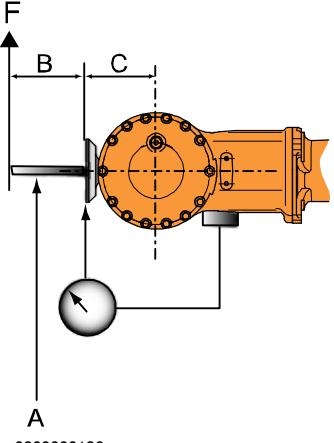
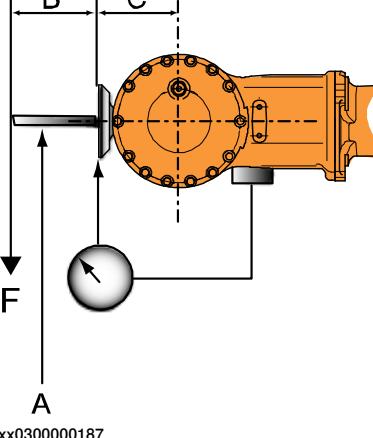
	Action	Information
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	Move the robot to calibration position and turn the axis 4 90°.	
3	Fit the <i>measuring tool, play</i> to the turning disk.	Art. no. is specified in <a href="#">Required equipment on page 279</a> .

*Continues on next page*

## 4 Repair

### 4.4.4 Measuring the play, axis 5

*Continued*

Action	Information
4 Apply load F in one direction, as shown in the figure to the right.   <b>Note</b>  Different load and distances for the different robot versions, as specified to the right!	 xx0300000186 <b>Values for IRB 4600 -60/2.05, -45/2.05, -40/2.55:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 100 mm</li> <li>• C: 135 mm</li> <li>• F: 90N</li> </ul> <b>Values for IRB 4600 -20/2.50:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 140 mm</li> <li>• C: 85 mm</li> <li>• F: 40N</li> </ul>
5 Remove the load and set the dial indicator to zero.	
6 Apply load F in the opposite direction, as shown in the figure to the right.	 xx0300000187 <b>Values for IRB 4600 -60/2.05, -45/2.05, -40/2.55:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 135 mm</li> <li>• C: 100 mm</li> <li>• F: 90N</li> </ul> <b>Values for IRB 4600 -20/2.50:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 140 mm</li> <li>• C: 85 mm</li> <li>• F: 40N</li> </ul>

*Continues on next page*

**4.4.4 Measuring the play, axis 5***Continued*

	Action	Information
7	Remove the load and measure the play by reading the dial indicator.	The maximum play allowed at the given distance from the center of axis 5 is, for robot version: <ul style="list-style-type: none"><li>• IRB 4600 -60/2.05, -45/2.05, -40/2.55: <b>0.15 mm</b></li><li>• IRB 4600 -20/2.50: <b>0.12 mm</b></li></ul>

## 4 Repair

### 4.4.5 Measuring the play, axis 6

#### 4.4.5 Measuring the play, axis 6

##### General

After reassembly due to repair work or any other reason, the play in axis 5 and 6 must be checked to ensure the repetition accuracy of the robot positioning. The procedure for axis 6 is detailed below.

##### Required equipment

Equipment	Art. no.	Note
Standard toolkit	-	Content is defined in section <a href="#">Standard tools on page 383</a> .
Measuring tool, play (IRB 4600 -60/2.05, -45/2.05, -40/2.55)	3HAB1611-6	
Measuring tool, play (IRB 4600 -20/2.50)	3HAB6337-1	
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.

##### Measurement, axis 6

The procedure below details how to measure the play in axis 6.



##### Note

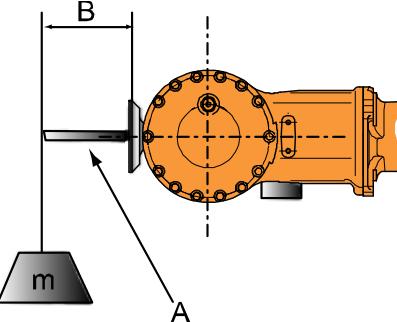
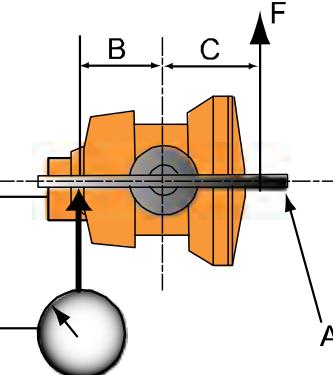
The measuring tool and measuring values differ depending on robot version!

	Action	Information
1	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	Fit the <i>measuring tool, play</i> to the turning disk.	Art. no. is specified in <a href="#">Required equipment on page 282</a> .

*Continues on next page*

## 4.4.5 Measuring the play, axis 6

Continued

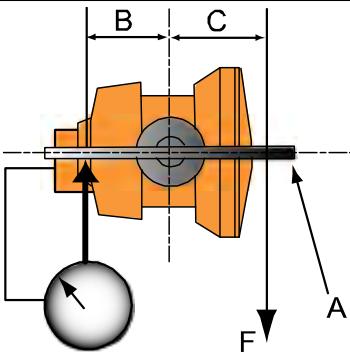
Action	Information
3 Attach a weight (m) at a distance (B) from the wrist flange, in order to avoid the effects of play on axis 5.   <b>Note</b>  Different weight and distance for the different robot versions, as specified to the right!	 xx0300000188 <b>Values for robot versions IRB 4600 - 60/2.05, -45/2.05, -40/2.55:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 100 mm</li> <li>• m: 20 kg</li> </ul> <b>Values for robot version IRB 4600 -20/2.50:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 140 mm</li> <li>• m: 10 kg</li> </ul>
4 Apply load F in one direction.   <b>Note</b>  Different load and distances for the different robot versions, as specified to the right!	 xx0300000189 <b>Values for robot versions IRB 4600 - 60/2.05, -45/2.05, -40/2.55:</b> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 100 mm</li> <li>• C: 100 mm</li> <li>• F: 50N</li> </ul> <b>Values for robot version IRB 4600 -20/2.50:</b> <ul style="list-style-type: none"> <li>• A: Mearuring tool, play</li> <li>• B: 100 mm</li> <li>• C: 150 mm</li> <li>• F: 40N</li> </ul>
5 Remove the load and set the dial indicator to zero.	

Continues on next page

## 4 Repair

### 4.4.5 Measuring the play, axis 6

*Continued*

Action	Information
6 Apply load F in the opposite direction, as shown in the figure to the right.	 <p>xx0300000190</p> <p><b>Values for robot versions IRB 4600 - 60/2.05, -45/2.05, -40/2.55:</b></p> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 100 mm</li> <li>• C: 150 mm</li> <li>• F: 50N</li> </ul> <p><b>Values for robot version IRB 4600 -20/2.50:</b></p> <ul style="list-style-type: none"> <li>• A: Measuring tool, play</li> <li>• B: 100 mm</li> <li>• C: 150 mm</li> <li>• F: 40N</li> </ul>
7 Remove the load and measure the play by reading the dial indicator.	<p>The maximum play allowed at the given distance (B) from the center of axis 6 is, for robot version:</p> <ul style="list-style-type: none"> <li>• IRB 4600 -60/2.05, -45/2.05, -40/2.55: <b>0.16 mm</b></li> <li>• Values for IRB 4600 -20/2.55: <b>0.22 mm</b></li> </ul>

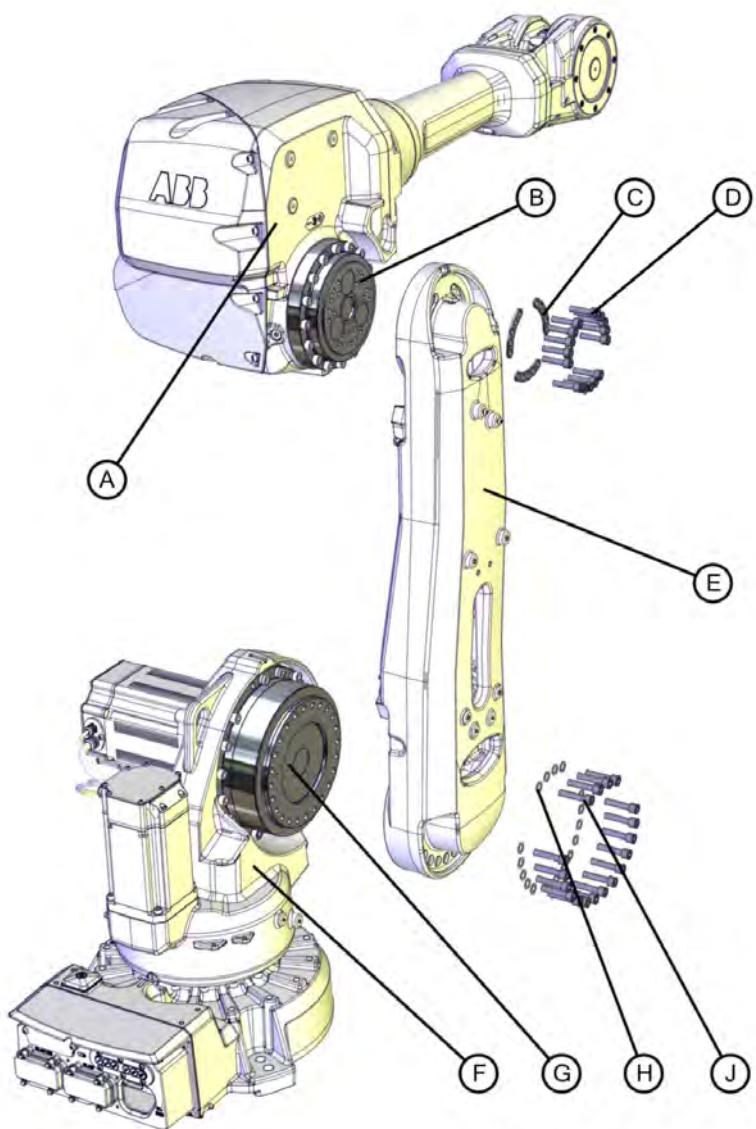
## 4.5 Lower arm

### 4.5.1 Replacing the lower arm

#### Location of lower arm

Type C

The lower arm is located as shown in the figure.



xx1200000636

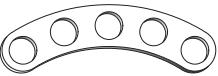
A	Upper arm
B	Axis-3 gearbox

*Continues on next page*

## 4 Repair

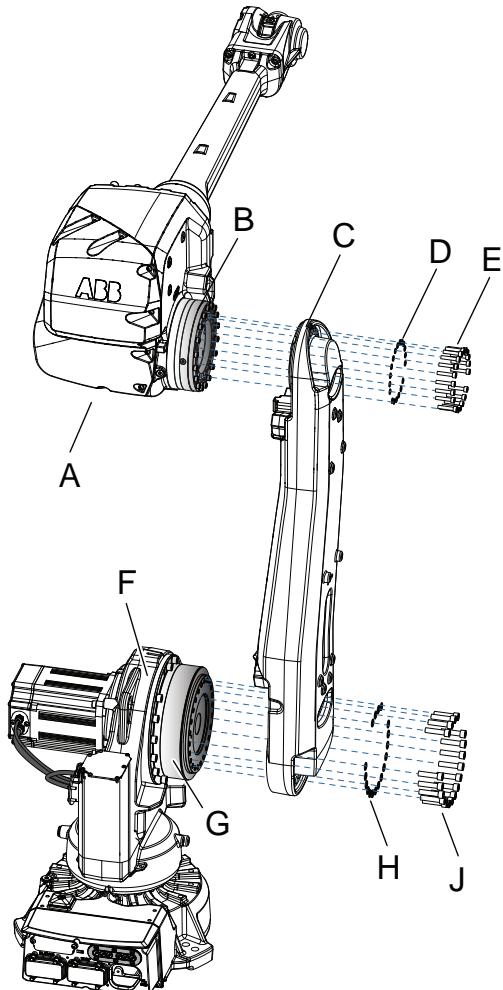
### 4.5.1 Replacing the lower arm

*Continued*

C	Washer with five holes (3 pcs)  xx1200000520
D	Attachment screws M10x40 quality Steel 12.9 Gleitmo (15 pcs)
E	Lower arm
F	Frame
G	Axis-2 gearbox
H	Washer (18 pcs)
J	Attachment screws M12x50 quality Steel 12.9 Gleitmo (18 pcs)

Other design than Type C

The lower arm is located as shown in the figure.



xx0800000360

A	Upper arm
B	Axis-3 gearbox
C	Lower arm

*Continues on next page*

D	Washer (19 pcs)
E	Attachment screws M8x40 quality Steel 12.9 Gleitmo (19 pcs)
F	Frame
G	Axis-2 gearbox
H	Washer (18 pcs)
J	Attachment screws M12x50 quality Steel 12.9 Gleitmo (18 pcs)

### Required equipment

Equipment	Note
Lower arm	For spare parts no. see Spare parts - Lower arm and motors in <i>Product manual, spare parts - IRB 2600</i> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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	<p>Decide which calibration routine to use for calibrating the robot.</p> <ul style="list-style-type: none"> <li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li> <li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li> </ul>	
	<p><b>If the robot is to be calibrated with reference calibration:</b>            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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <i>Operating manual - Calibration Pendulum</i> .
	<p><b>If the robot is to be calibrated with fine calibration:</b>            Remove all external cable packages (DressPack) and tools from the robot.</p>	

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## 4 Repair

### 4.5.1 Replacing the lower arm

*Continued*

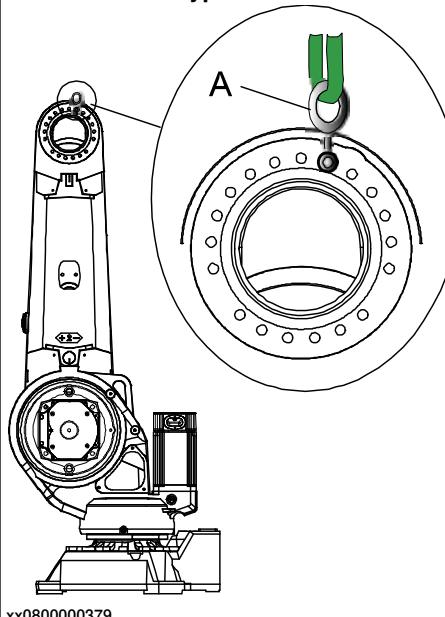
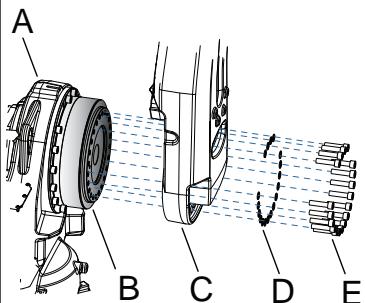
#### Removing the lower arm

Use this procedure to remove the lower arm.

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 position shown in the figure.	 xx0800000336
3  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
4 Remove the <i>cable package</i> from all axes except in the base.	How to remove the cable package in frame, lower arm and armhouse is described in sections: <ul style="list-style-type: none"><li>• <a href="#">Removing cable harness in frame on page 216</a></li><li>• <a href="#">Removing cable harness in lower arm and armhouse on page 217</a></li></ul>
5 Secure the upper arm with a roundsling in an overhead crane.	
6 Remove the <i>complete upper arm</i> and put it on a loading pallet.	How to remove the complete upper arm is described in section: <ul style="list-style-type: none"><li>• <a href="#">Removing the complete upper arm on page 259</a></li></ul>
7  <b>CAUTION</b> The robot lower arm weighs 65 kg. All lifting accessories used must be sized accordingly!	

*Continues on next page*

4.5.1 Replacing the lower arm  
Continued

Action	Note
8 Fit a <i>lifting lug</i> in one of the upper holes in the lower arm, for the attachment screws.	<p>The figure shows other design than Type C, but the principle of fitting the lifting lug is the same on Type C.</p>  <p>xx0800000379</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Lifting lug</li> </ul>
9 Remove the <i>attachment screws</i> securing the lower arm to gearbox axis 2.	 <p>xx0800000377</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Frame</li> <li>B: Gearbox axis 2</li> <li>C: Lower arm</li> <li>D: Washer (17 pcs)</li> <li>E: Attachment screws M12x50 quality steel Gleitmo 12.9 (17 pcs)</li> </ul>
10 Remove the lower arm.	

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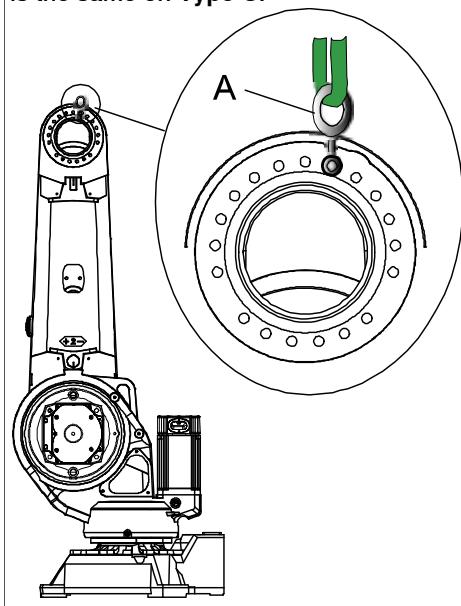
## 4 Repair

### 4.5.1 Replacing the lower arm

*Continued*

#### Refitting the lower arm

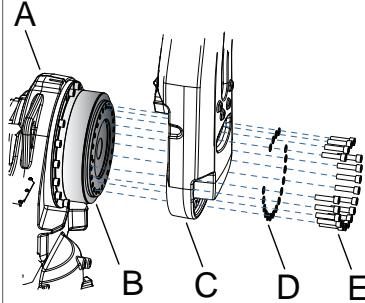
Use this procedure to refit the lower arm.

Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2  <b>CAUTION</b> The robot lower arm weighs 65 kg. All lifting accessories used must be sized accordingly!	
3 Fit a <i>lifting lug</i> in one of the upper holes in the lower arm, for the attachment screws.	The figure shows other design than Type C, but the principle of fitting the lifting lug is the same on Type C.  xx0800000379 Parts: <ul style="list-style-type: none"><li>• A: Lifting lug</li></ul>
4 Secure the lower arm with a roundsling in an overhead crane and lift it to the robot.	

*Continues on next page*

## 4.5.1 Replacing the lower arm

Continued

Action	Note
5 Refit the <i>attachment screws</i> securing the lower arm to gearbox axis 2.	 <p>xx0800000377</p> <p>Tightening torque:</p> <ul style="list-style-type: none"> <li>• 110 Nm</li> </ul> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Frame</li> <li>• B: Gearbox axis 2</li> <li>• C: Lower arm</li> <li>• D: Washer (17 pcs)</li> <li>• E: Attachment screws M12x50 quality steel Gleitmo 12.9 (17 pcs)</li> </ul>
6 Secure the complete upper arm with round-slings in an overhead crane and lift it to the robot.	
7 Refit the <i>complete upper arm</i> .	How to refit the complete upper arm is described in section: <ul style="list-style-type: none"> <li>• <a href="#">Refitting the complete upper arm on page 263</a></li> </ul>
8 Refit the <i>cable package</i> .	How to refit the cable package in frame, lower arm and armhouse is described in sections: <ul style="list-style-type: none"> <li>• <a href="#">Refitting the cable harness in the frame on page 223</a></li> <li>• <a href="#">Refitting the cable harness in the lower arm and armhouse on page 232</a></li> </ul>
9 Recalibrate the robot.	Pendulum Calibration is described in <i>Operating manual - Calibration Pendulum</i> , enclosed with the calibration tools. Axis Calibration is described in <a href="#">Calibrating with Axis Calibration method on page 351</a> . General calibration information is included in section <a href="#">Calibration on page 339</a> .
10  <b>DANGER</b> Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 4 Repair

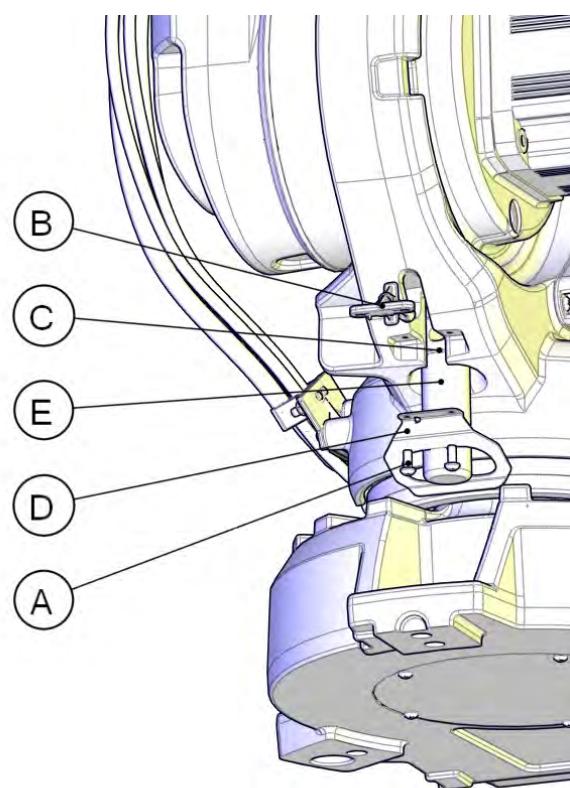
### 4.6.1 Replacing stop pin axis 1

## 4.6 Frame and base

### 4.6.1 Replacing stop pin axis 1

#### Location of stop pin axis 1

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



xx0800000045

A	Attachment screws M6x16 quality 8.8-A2F (2 pcs)
B	Bracket
C	O-ring (2 pcs)
D	Bracket
E	Stop pin

#### Required equipment

Equipment	Note
Stop pin	For spare parts no. see Spare parts - Frame and base in <i>Product manual, spare parts - IRB 2600</i> .
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .

*Continues on next page*

## 4.6.1 Replacing stop pin axis 1

Continued

Equipment	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.

**Removing the stop pin, axis 1**

Use this procedure to remove the stop pin axis 1.

	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	Remove the <i>attachment screws</i> securing the <i>bracket</i> and <i>stop pin</i> .	See the figure in • <a href="#">Location of stop pin axis 1 on page 292</a>
3	Remove the <i>bracket</i> and <i>stop pin</i> .	See the figure in • <a href="#">Location of stop pin axis 1 on page 292</a>

**Refitting the stop pin, axis 1**

Use this procedure to refit the stop pin axis 1.

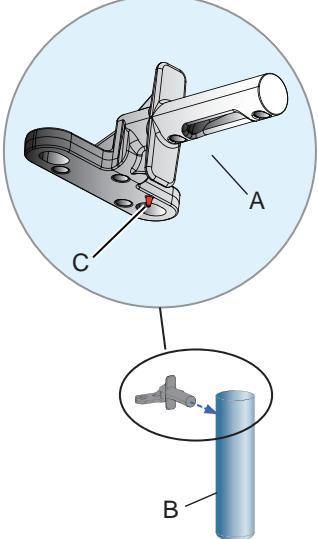
	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	Fit the two <i>o-rings</i> on the stop pin.	See the figure in • <a href="#">Location of stop pin axis 1 on page 292</a>

Continues on next page

## 4 Repair

### 4.6.1 Replacing stop pin axis 1

*Continued*

Action	Note
3 Fit the <i>stop pin</i> on the <i>bracket</i> .	 <b>Note</b> The small spike on the bracket shall be pointing downwards for correct fitting of the stop pin!  xx0800000453 <b>Parts:</b> <ul style="list-style-type: none"> <li>• A: Bracket</li> <li>• B: Stop pin</li> <li>• C: Small spike</li> </ul>
4 Secure the stop pin on the frame with its <i>attachment screws</i> .	See the figure in <ul style="list-style-type: none"> <li>• <a href="#">Location of stop pin axis 1 on page 292</a></li> </ul>
5  <b>DANGER</b>	Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#"><b>DANGER - First test run may cause injury or damage! on page 51.</b></a>

## 4.7 Motors

### 4.7.1 Removing motors

#### Introduction

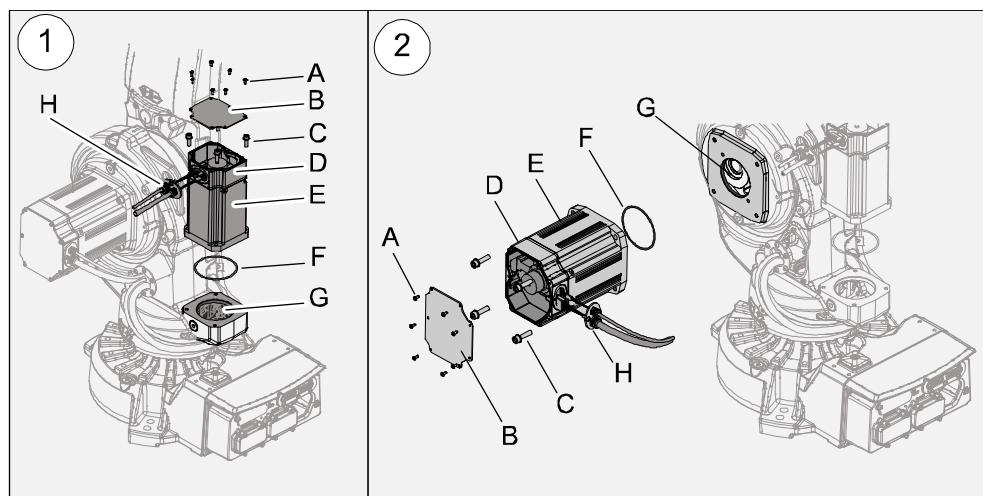
This procedure describes how to remove motors on all axes of the robot.

#### Location of axis-1 and axis-2 motors

The axis-1 and axis-2 motors are located as shown in the figure.

Motors:

- (1) = Axis-1 motor
- (2) = Axis-2 motor



xx0900000302

A	Attachment screws M5x16, quality Steel 8-A2F (7 pcs)
B	Motor cover
C	Attachment screws, axis-1 motor (4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
C	Attachment screws, axis-2 motor (4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
D	Connection box
E	Axis-1 motor
F	Axis-2 motor
G	O-ring
H	Hole
H	Cable gland cover

*Continues on next page*

## 4 Repair

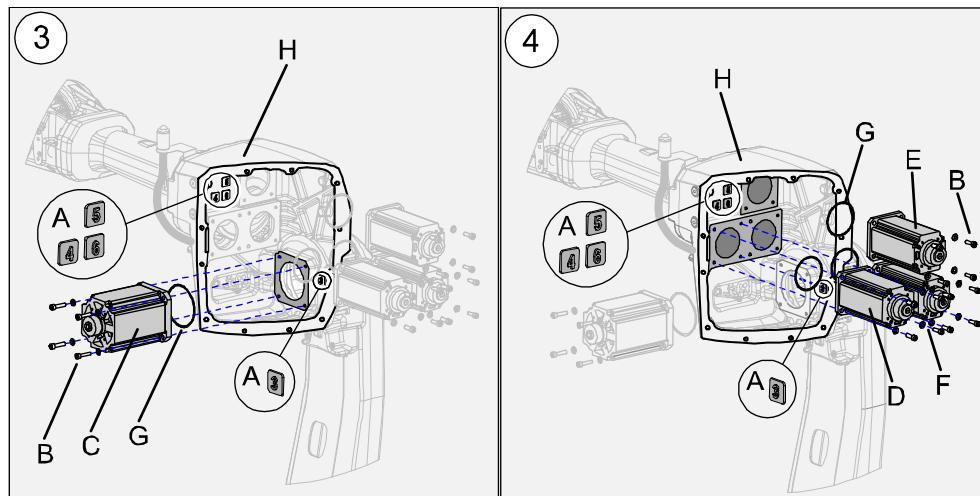
### 4.7.1 Removing motors

*Continued*

#### Location of axis-3, axis-4, axis-5 and axis-6 motors

The axis-3, axis-4, axis-5 and axis-6 motors are located as shown in the figures.

Motors: (3) = Axis-3 motor. (4) = Axis-4, axis-5 and axis-6 motors.



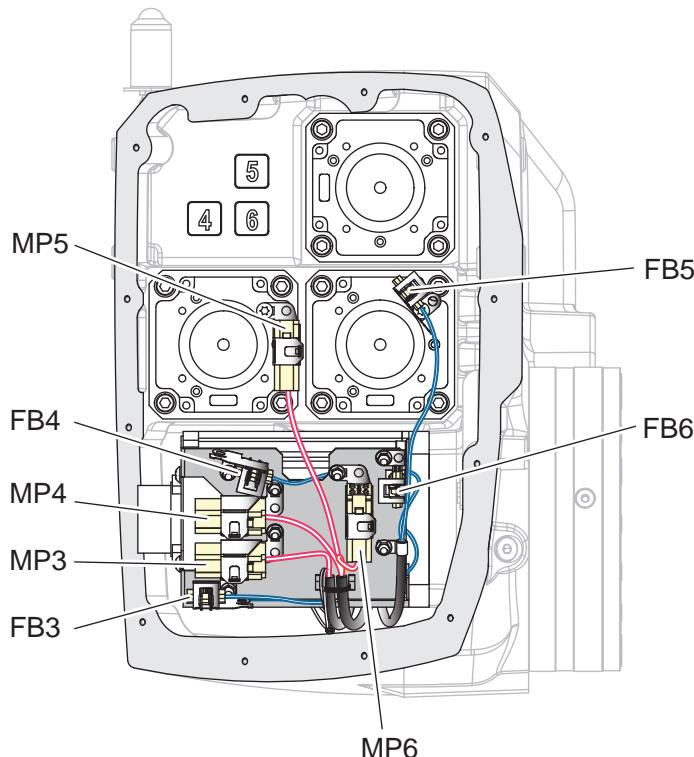
xx0900000303

A	Markings inside armhouse, identifying the position of each motor
B	Attachment screws, axis-3 motor (4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
B	Attachment screws, axis-4, axis-5 and axis-6 motors (3x4 pcs) + washers. <a href="#">Tightening torques and attachment screws on page 307</a>
C	Axis-3 motor
D	Axis-4 motor
E	Axis-5 motor
F	Axis-6 motor
G	O-ring (axis-4, axis-5 and axis-6)
H	Armhouse

*Continues on next page*

**Connectors, axis-3 and axis-4 motors**

The figure shows the connectors of motors axes 3-6.



xx0900000410

**Required equipment**

Equipment	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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.

**Weights**

The motors for the different axes weighs according to the table:

Motor	Weight in kg
Axis-1 motor	13 kg
Axis-2 motor	25 kg
Axis-3 motor	13 kg
Axis-4 motor	8 kg
Axis-5 motor	8 kg
Axis-6 motor	8 kg

*Continues on next page*

## 4 Repair

### 4.7.1 Removing motors

*Continued*



#### CAUTION

All lifting equipment must be sized accordingly!

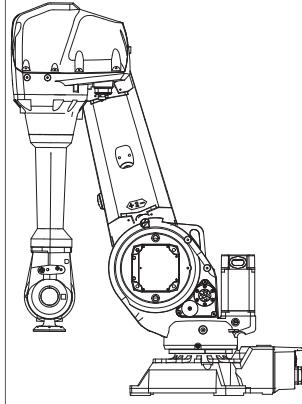
#### Deciding calibration routine

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.

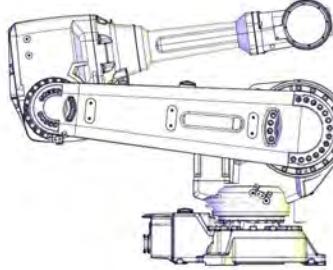
Action	Note
1 Decide which calibration routine to use for calibrating the robot. <ul style="list-style-type: none"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

#### Position of robot

Use this procedure to place the robot in the position recommended in order to facilitate replacement of motors.

Action	Information
Axis-1, axis-4, axis-5 and axis-6 motor <ul style="list-style-type: none"><li>• Move the robot to a position where the wrist is pointing to the floor, as shown in the figure. This will make it possible to remove the motors without draining the oil from the gearbox.</li></ul>	 xx0800000388

*Continues on next page*

Action	Information
<b>Axis-2 motor</b> <ul style="list-style-type: none"> <li>Move the robot to a position where the lower arm rests firmly on the damper of axes 2 and 3. Release the brake of axis 2 to be sure that the lower arm rests in the end position.</li> </ul>	 xx1100000548
<b>Axis-3 motor</b> <ul style="list-style-type: none"> <li>Move axis-2 to 0° and axis-3 to maximal +. Release the brake of axis-3 to be sure that the upper arm is completely vertical and rests against the damper of axis-2 and axis-3.</li> </ul>	

## Draining gearbox

Use this procedure to drain gearboxes, if needed.



### Note

Draining of gearbox is only needed when removing the axes 2 and 3 motors.

	Action	Note
1	Axis-1 motor: <ul style="list-style-type: none"><li>Draining of gearbox is not needed.</li></ul>	-
2	Axis-2 motor: <ul style="list-style-type: none"><li>The gearbox has to be drained before removing the motor.</li></ul>	How to drain the gearbox is described in section: <ul style="list-style-type: none"><li><a href="#">Changing the oil, axis-2 gearbox on page 172</a></li></ul>
3	Axis-3 motor: <ul style="list-style-type: none"><li>The gearbox has to be drained before removing the motor.</li></ul>	How to drain the gearbox is described in section: <ul style="list-style-type: none"><li><a href="#">Changing the oil, axis-3 gearbox on page 176</a></li></ul>
4	Axis-4, axis-5 and axis-6 motors: <ul style="list-style-type: none"><li>Draining of gearbox oil is not needed if robot is positioned as recommended.</li></ul>	-

## Removing motors

Use this procedure to remove the axis-1, axis-2, axis-3, axis-4, axis-5 and axis-6 motors.



### Note

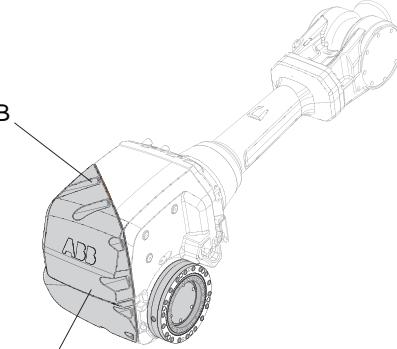
The procedure contains information how to remove motors on all axes of the robot. Some steps are only applicable to a certain motor. Follow the steps carefully in order not to miss vital information!

*Continues on next page*

## 4 Repair

### 4.7.1 Removing motors

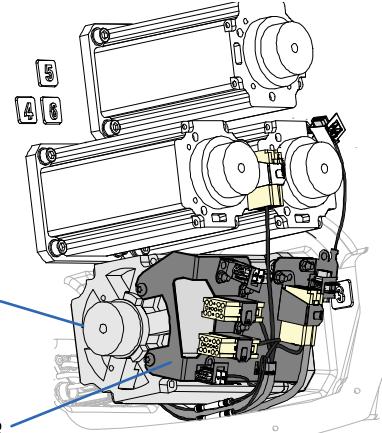
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Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Move the robot to the recommended position for the motor that shall be removed.	See <a href="#">Removing motors on page 295</a> . • <a href="#">Position of robot on page 298</a>
3 <p style="text-align: center;"> <b>DANGER</b></p> <p>Turn off all:</p> <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> <p>to the robot, before entering the robot working area.</p>	
4 Check if the gearbox needs to be drained.	See <a href="#">Removing motors on page 295</a> . • <a href="#">Draining gearbox on page 299</a>
5 <b>Only applicable to axis-3, axis-4, axis-5 and axis-6 motors!</b>  Remove the cover in the back of the arm house.   <b>WARNING</b>  The robot must never be run without the cover in the armhouse fitted! It is a vital supporting part of the robot.	 xx0800000389 <b>Parts:</b> <ul style="list-style-type: none"> <li>• A: Cover</li> <li>• B: Attachment screws (10 pcs) + washers.</li> </ul>
6 <b>Only applicable to motors on axes 1 and 2 with fan fitted!</b>  Remove the fan before starting the removal!	How to remove the fan is detailed in section: • <a href="#">Installation of cooling fan for motors (option) on page 99</a>
7 <b>Only applicable to axis-1 and axis-2 motors!</b>  Remove the motor cover.	See the figure in: • <a href="#">Location of axis-1 and axis-2 motors on page 295</a>
8 <b>Only applicable to axis-1 and axis-2 motors!</b>  Remove the cable gland cover.	See the figure in: • <a href="#">Location of axis-1 and axis-2 motors on page 295</a>
9 <b>Only applicable to axis-1 and axis-2 motors!</b>  Remove the connection box.	See the figure in: • <a href="#">Location of axis-1 and axis-2 motors on page 295</a>
 <b>Note</b>  Only needed if the motor shall be replaced with a new one.	

*Continues on next page*

## 4.7.1 Removing motors

Continued

	Action	Note
10	Disconnect the <i>motor cables</i> .	<p> Note</p> <p>When removing the axis-3 motor, the cables of the axis-4, axis-5 and axis-6 motors must be disconnected too. This must be done in order to be able to remove the bracket on top of the axis-3 motor.</p>
11	<b>Only applicable to axis-3 motor!</b> Remove the <i>bracket</i> from the axis-3 motor.	 xx0800000390
12	In order to release the brakes of the motor to be removed, connect the 24 VDC power supply to the motor. <b>Only applicable to motors axes 2 and 3!</b> Release the brake of axis 2 until the lower arm firmly rests on the damper.	<p>Connectors:</p> <ul style="list-style-type: none"> <li>• Axis-1 motor: R2.MP1</li> <li>• Axis-2 motor: R2.MP2</li> <li>• Axis-3 motor: R2.MP3</li> <li>• Axis-4 motor: R2.MP4</li> <li>• Axis-5 motor: R2.MP5</li> <li>• Axis-6 motor: R2.MP6</li> </ul> <p>Connect to pins:</p> <ul style="list-style-type: none"> <li>• + : pin 2</li> <li>• - : pin 5</li> </ul> <p> CAUTION</p> <p>The connections for the motor brakes (24 VDC connection) are phase dependent. If the connection on the pins is switched, it can cause severe damage to vital parts.</p>
13	<p> Note</p> <p>Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!</p>	

Continues on next page

## 4 Repair

### 4.7.1 Removing motors

Continued

	Action	Note
14	Remove the attachment screws securing the motor. If needed use a 300 mm extension for bits 1/2" (Motor axis 1).	See the figure in: <ul style="list-style-type: none"><li><a href="#">Location of axis-1 and axis-2 motors on page 295</a></li></ul>
15	If required, press the motor out of position by fitting two screws in the threaded holes in the motor flange.	 Note Always use removal tools in pairs diagonal to each other.
16	Remove the motor!	 CAUTION Lift the motor gently in order not to damage pinion or gears.
17	<b>Only applicable to motor axis 1!</b> Cover the hole if replacement of motor axis 1 is not immediate, in order to avoid contamination.	See the figure in: <ul style="list-style-type: none"><li><a href="#">Location of axis-1 and axis-2 motors on page 295</a></li></ul>
18	<b>Only applicable to motors axes 4, 5 and 6!</b> Check that the o-ring also is removed. It might stay in the armhouse when the motor is removed.	See the figure in: <ul style="list-style-type: none"><li><a href="#">Location of axis-1 and axis-2 motors on page 295</a></li></ul>

## 4.7.2 Refitting motors

### Introduction

This procedure describes how to refit motors on all axes of the robot.



#### WARNING

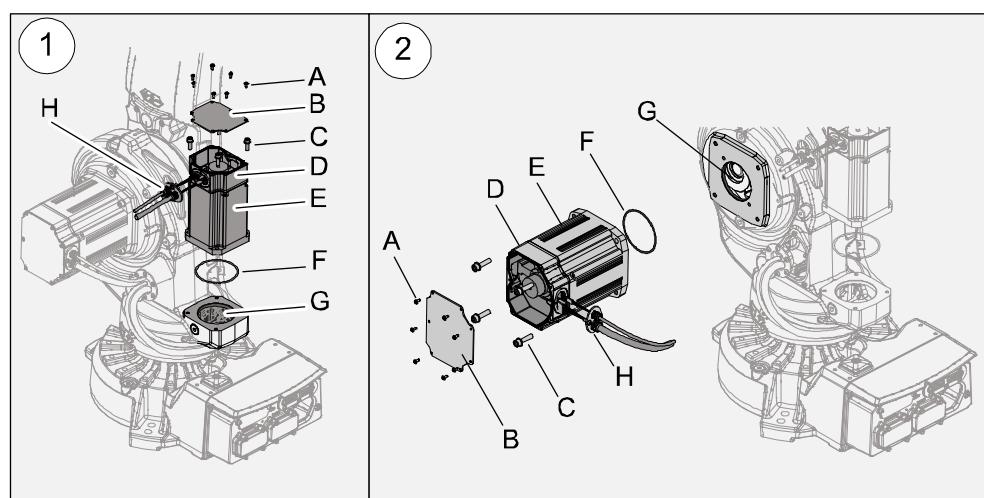
When a motor is replaced, make sure to use the correct type of new motor. Motors of different types may not be compatible. See the *Spare parts manual* delivered as a separate document on the documentation DVD.

### Location of axis-1 and axis-2 motors

The axis-1 and axis-2 motors are located as shown in the figure.

#### Motors:

- (1) = Axis-1 motor
- (2) = Axis-2 motor



xx0900000302

A	Attachment screws M5x16, quality Steel 8-A2F (7 pcs)
B	Motor cover
C	Axis-1 motor: Attachment screws(4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
C	Axis-2 motor: Attachment screw (4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
D	Connection box
E	Axis-1 motor
E	Axis-2 motor
F	O-ring
G	Hole
H	Cable gland cover

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## 4 Repair

### 4.7.2 Refitting motors

Continued

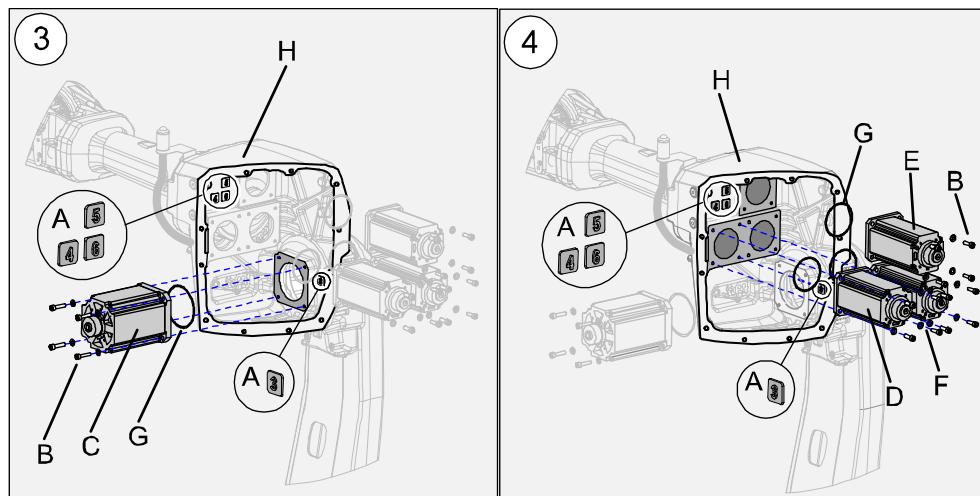
#### Location of axis-3, axis-4, axis-5 and axis-6 motors

The axis-3, axis-4, axis-5 and axis-6 motors are located as shown in the figures.

Motors:

(3) = Axis-3 motor

(4) = Axis-4, axis-5 and axis-6 motors



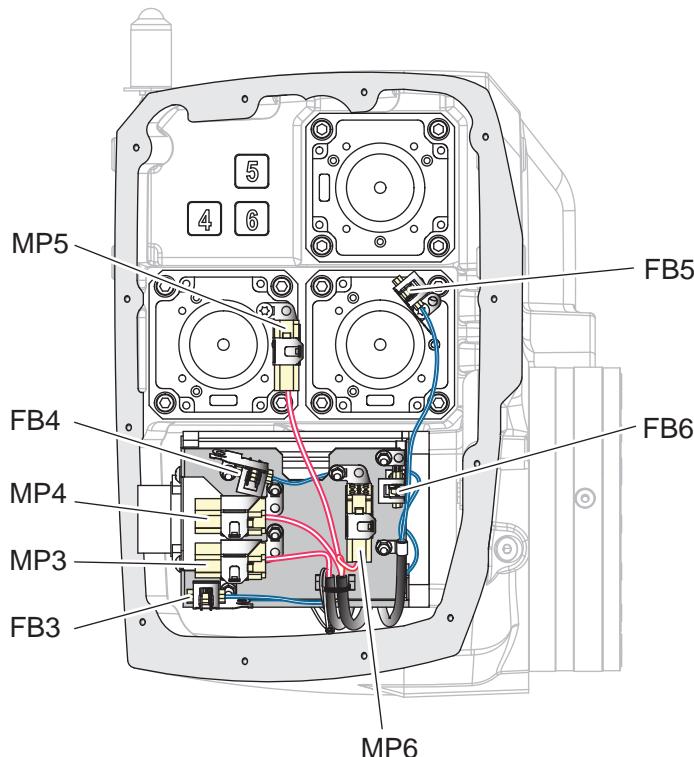
xx0900000303

A	Markings inside armhouse, identifying the position of each motor
B	Attachment screws, axis-3 motor, (4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
B	Attachment screws, axis-4, axis-5 and axis-6 motors, (3x4 pcs) + washers. See <a href="#">Tightening torques and attachment screws on page 307</a>
C	Axis-3 motor
D	Axis-4 motor
E	Axis-5 motor
F	Axis-6 motor
G	O-ring (axis-4, axis-5 and axis-6)
H	Armhouse

Continues on next page

**Connectors, axis-3 and axis-4 motors**

The figure shows the connectors of the axis-3 and axis-4 motors.



xx0900000410

**Required equipment**

Equipment	Note
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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.
Lifting tool, axis-2	For art. no. see <a href="#">Reference information</a> .
Lifting tool, axis-3	For art. no. see <a href="#">Reference information</a> .
Motors	For spare part no. see <a href="#">Spare part lists on page 389</a> .

**Weights**

The motors for the different axes weighs according to the table:

Motor	Weight in kg
Axis-1 motor	13 kg
Axis-2 motor	25 kg
Axis-3 motor	13 kg
Axis-4 motor	8 kg
Axis-5 motor	8 kg

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## 4 Repair

### 4.7.2 Refitting motors

*Continued*

Motor	Weight in kg
Axis-6 motor	8 kg

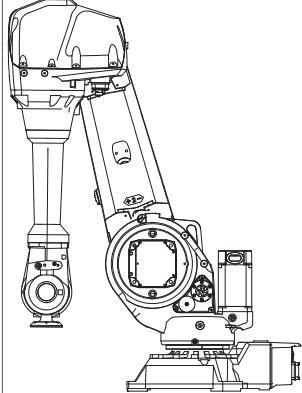
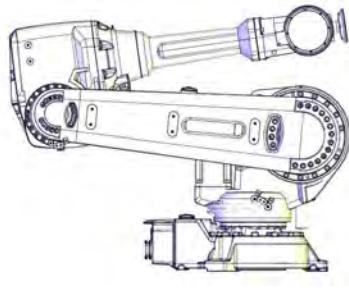


#### CAUTION

All lifting equipment must be sized accordingly!

### Position of robot

Use this procedure to place the robot in the position recommended in order to facilitate replacement of motors.

Action	Information
Axis-1, axis-4, axis-5 and axis-6 motors <ul style="list-style-type: none"><li>Move the robot to a position where the wrist is pointing to the floor, as shown in the figure. This will make it possible to remove the motors without draining the oil from the gearbox.</li></ul>	 xx0800000388
Axis-2 motor <ul style="list-style-type: none"><li>Move the robot to a position where the lower arm rests firmly on the axis-3 damper. Release the axis-2 brake to be sure that the lower arm rests in the end position.</li></ul>	 xx1100000548
Axis-3 motor <ul style="list-style-type: none"><li>Move axis-2 to 0° and axis-3 to maximal +. Release the axis-3 brake to be sure that the upper arm is completely vertical and rests against the damper.</li></ul>	

### Filling oil in gearbox

Use this procedure to fill oil in gearbox, if needed.



#### Note

Filling oil in the gearbox is only needed when refitting motors axes 2 and 3.

*Continues on next page*

	Action	Note
1	Axis-1 motor: • Filling gearbox oil not needed.	-
2	Axis-2 motor: • Refill oil in gearbox after refitting.	How to fill oil in gearbox is described in section: • <a href="#">Changing the oil, axis-2 gearbox on page 172</a>
3	Axis-3 motor: • Refill oil in gearbox after refitting.	How to fill oil in gearbox is described in section: • <a href="#">Changing the oil, axis-3 gearbox on page 176</a>
4	Axis-4, axis-5 and axis-6 motors: • Filling gearbox oil not needed.	-

**Tightening torques and attachment screws**

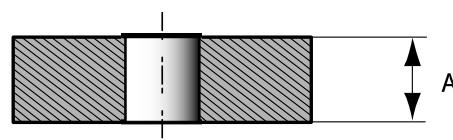
The table shows the tightening torques for all motors.

Motor	Attachment screw	Quality	Tightening torque
Motor, axis 1	M8x25	8.8-A2F	22 Nm
Motor, axis 2	<a href="#">Screwlengths depending on flange thickness on page 307</a>	8.8-A2F	35 Nm
Motor, axis 3	<a href="#">Screwlengths depending on flange thickness on page 307</a>	8.8-A2F	22 Nm
Motor, axis 4	M8x25	8.8-A2F	22 Nm
Motor, axis 5	M8x25	8.8-A2F	22 Nm
Motor, axis 6	M8x25	8.8-A2F	22 Nm

**Screwlengths depending on flange thickness**

Screwlengths can vary depending on when the robot is delivered. The different screwlengths depends on the different flange thickness of motors. Make sure to use the correct screwlength! See table:

Motor axis 2		Motor axis 3	
Flange thickness	Attachment screws	Flange thickness	Attachment screws
18.5 mm	M10x40	15 mm	M8x35
16 mm	M10x35	13 mm	M8x30



xx0900000443

A	Flange thickness
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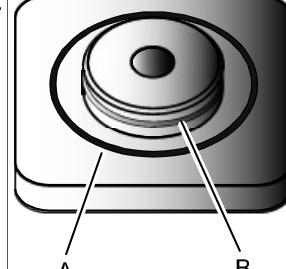
## 4 Repair

### 4.7.2 Refitting motors

Continued

#### Preparations before the refitting of motors

Use this procedure to make necessary preparations before refitting motors.

Action	Note
1  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2 Grind the paint on the surface carefully to get a smooth surface.	
3 Clean the surface from contamination such as oil and dirt. Remove any painting from the assembly surfaces, with a knife.	
4 Make sure that the motor and the pinion are not damaged or scratched.	
5 Lightly lubricate the o-ring with grease.	
6 Make sure the <i>o-ring</i> on the flange of the motor is seated properly.	 xx0900000082 Parts: <ul style="list-style-type: none"><li>• A: Correct position of o-ring</li><li>• B: Incorrect position of o-ring !</li></ul> Replace with a new o-ring if damaged!

Continues on next page

Action	Note
7 In order to release the brakes, connect the 24 VDC power supply.	<p>Connectors:</p> <ul style="list-style-type: none"> <li>• Motor axis 1: R2.MP1</li> <li>• Motor axis 2: R2.MP2</li> <li>• Motor axis 3: R2.MP3</li> <li>• Motor axis 4: R2.MP4</li> <li>• Motor axis 5: R2.MP5</li> <li>• Motor axis 6: R2.MP6</li> </ul> <p>Connect to pins:</p> <ul style="list-style-type: none"> <li>• + : pin 2</li> <li>• - : pin 5</li> </ul> <p> <b>CAUTION</b></p> <p>The connections for the motor brakes (24 VDC connection) are phase dependent. If the connection on the pins is switched, it can cause severe damage to vital parts.</p>



#### Note

A fan is recommended to be used to avoid overheating of motor and gear in applications with intensive motion (high average torque and/or short wait time) of axes 1 and 2. IP54 is valid for cooling fan.

A fan is also recommended to be used if the environmental temperature is high. How to install a fan is described in section [Installation of cooling fan for motors \(option\) on page 99](#).

## Refitting motors

Use this procedure to refit motors axes 1, 2, 3, 4, 5 and 6.



#### Note

The procedure contains information how to refit motors on all axes of the robot. Some steps are only applicable to a certain motor. Follow the steps carefully in order not to miss vital information!

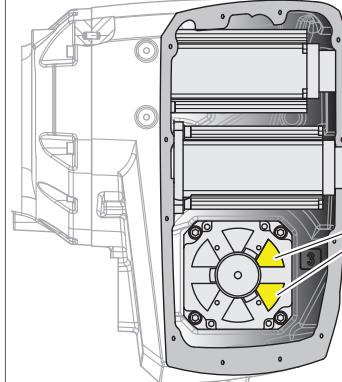
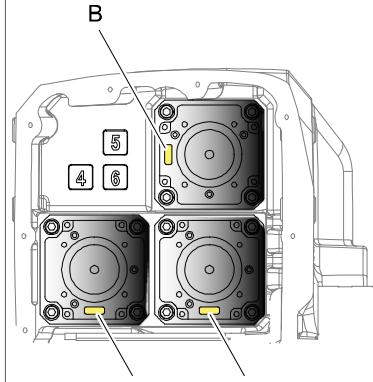
Action	Information
1 <b>Note</b> Before starting the refitting of the motor, first make the necessary preparations!	See <a href="#">Refitting motors on page 303</a> . • <a href="#">Preparations before the refitting of motors on page 308</a>
2 <b>Note</b> Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3 Place the motor carefully in the gearbox.	

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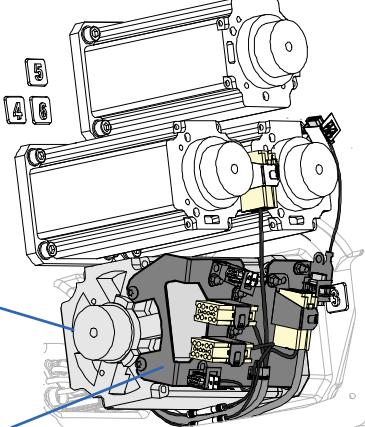
## 4 Repair

### 4.7.2 Refitting motors

*Continued*

Action	Information
4 Fit the motor, making sure the motor pinion is properly mated to the gear in the gearbox.	Make sure that: <ul style="list-style-type: none"> <li>• the motor is turned the correct way</li> <li>• the pinion or gear of the motor does not get damaged!</li> </ul>
5 <b>Applicable to motor axis 3!</b> Make sure that the wire exit holes of motor axis 3 are in the correct position. See illustration!	 xx0900000300 <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Wire exit holes, motor axis 3</li> </ul>
6 <b>Applicable to motors axes 4, 5 and 6!</b> Make sure that the wire exit hole of the motor is in the correct position.	 xx0900000062 <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Wire exit hole, motor axis 4</li> <li>• B: Wire exit hole, motor axis 5</li> <li>• C: Wire exit hole, motor axis 6</li> </ul>
7 <b>Only applicable to motors axes 4, 5 and 6!</b> Fit the attachment screws for the motor and fasten them slightly. The motor must be able to move parallel to the gear during the adjustment of the play.	
8 <b>Only applicable to motors axes 4, 5 and 6!</b> Adjust the play of the motor.	See <a href="#">Adjusting the play of axis 4, 5 and 6 motors on page 313</a> .
9 Secure the motor with its attachment screws and washers.   <b>Note</b>  Apply the correct tightening torque!	Tightening torque and attachment screws are specified in the table: <ul style="list-style-type: none"> <li>• <a href="#">Tightening torques and attachment screws on page 307</a></li> </ul>
10 Disconnect the brake release voltage.	

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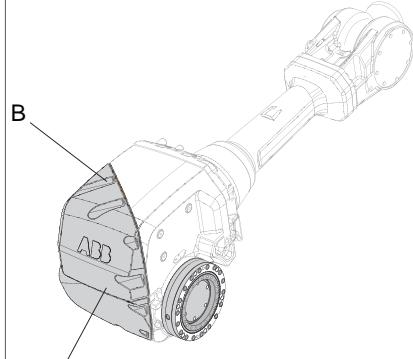
Action	Information
<p><b>11 Only applicable to motors axes 1 and 2!</b> Refit the connection box (if it has been removed).</p> <p> <b>Note</b> Make sure that the o-ring is in place!</p>	<p>See the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of axis-1 and axis-2 motors on page 303</a></li> </ul>
<p><b>12 Applicable to motor axis 3!</b> Refit the bracket on motor axis 3.</p>	 <p>A B xx0800000390</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Motor axis 3</li> <li>• B: Bracket</li> </ul>
<b>13 Reconnect the motor cables.</b>	
<p><b>14 Applicable to motor axes 1 and 2!</b> Refit the <b>cable gland</b> and <b>motor covers</b>. Make sure that the <b>o-ring</b> is in place!</p>	<p>See the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of axis-1 and axis-2 motors on page 303</a></li> </ul> <p> <b>Note</b> Make sure that the cover is tightly sealed!</p>
<p><b>15 Applicable to motors axis 2!</b> Refill gearbox oil.</p>	<p>How to fill oil in the gearbox is described in sections:</p> <ul style="list-style-type: none"> <li>• <a href="#">Changing the oil, axis-2 gearbox on page 172</a></li> <li>• <a href="#">Changing the oil, axis-3 gearbox on page 176</a></li> </ul>
<p><b>16 Applicable to motors axes 3, 4, 5 and 6!</b> Make sure that the gasket on the cover on the armhouse is intact.</p>	If the gasket is damaged, it need to be replaced.

Continues on next page

## 4 Repair

### 4.7.2 Refitting motors

*Continued*

	Action	Information
17	<p><b>Applicable to motors axes 3, 4, 5 and 6!</b> Refit the cover in the back of the armhouse with its attachment screws and washers.</p> <p> <b>WARNING</b></p> <p>The cover on the armhouse must be fitted when the robot is running. It is a vital part for the stability of the robot.</p>	<p>Make sure that the cover is tightly sealed.</p>  <p>xx0800000389</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Cover</li> <li>• B: Attachment screws M6x25, quality 8.8-A2F (10 pcs)</li> </ul> <p><b>Tightening torque:</b></p> <ul style="list-style-type: none"> <li>• 14 Nm</li> </ul>
18	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 <i>Calibrating with Axis Calibration method on page 351</i>.</p> <p>General calibration information is included in section <i>Calibration on page 339</i>.</p>
19	<p> <b>DANGER</b></p> <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 51</i>.</p>	

## 4.7.3 Adjusting the play of axis 4, 5 and 6 motors

## 4.7.3 Adjusting the play of axis 4, 5 and 6 motors

## Required equipment

Equipment	Note
Measuring tool	For adjusting the play.
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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.

## Adjusting the play of axis 4, 5 and 6 motors

	Action	Note
1	Fit the measuring tool at the rear of the motor.	
2	<p>Adjust the play on the motor by starting with a big play and then gradually finding the smallest play. Use swift movements in order to avoid noticing the magnetic field which causes the gears to stick together. Follow the instructions for current motor:</p> <p><b>Motor axis 4:</b></p> <ol style="list-style-type: none"> <li>Turn the motor shaft six turns and find the smallest play within this range.</li> </ol> <p><b>Axis 5 motor:</b></p> <ol style="list-style-type: none"> <li>Turn the outgoing shaft for axis 4 in intervals of 90° for one full turn and find the smallest play for the axis 5 motor within this range.</li> <li>Turn the axis 5 motor one full turn at a time for a total of five turns and find the smallest play within this range.</li> </ol> <p><b>Axis 6 motor:</b></p> <ol style="list-style-type: none"> <li>Turn the outgoing shaft for axis 4 in intervals of 90° for one full turn and find the smallest play for the axis 6 motor within this area.</li> <li>Turn the axis 5 motor one full turn at a time for a total of five turns and find the smallest play for axis 6 within this range.</li> <li>Turn the axis 6 motor one full turn at a time for a total of three turns and find the smallest play for axis 6 within this range.</li> </ol>	
3	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing".	

## 4 Repair

### 4.8.1 Replacing gearbox axis 1

## 4.8 Gearboxes

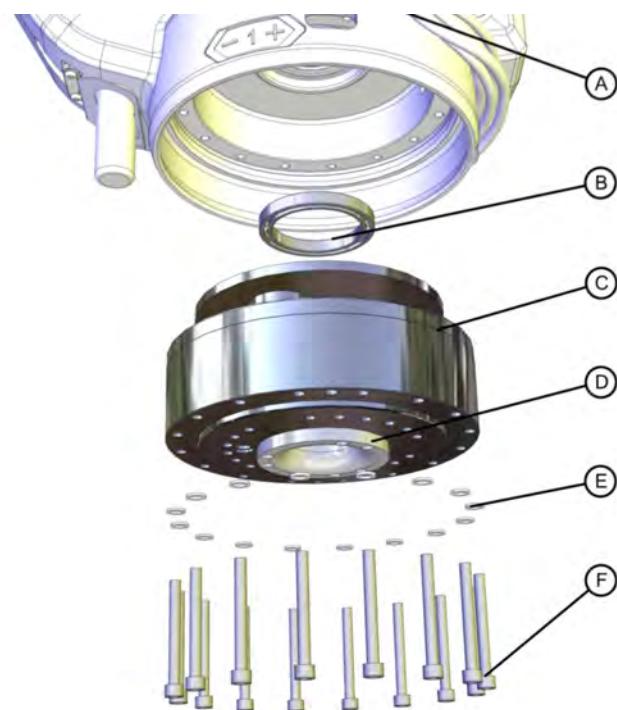
### 4.8.1 Replacing gearbox axis 1

#### Location of gearbox

The gearbox is located as shown in the figure.

This exploded view only shows the principle of the assembly. The actual replacing is recommended to be done with the robot resting on its side. See illustration in section *Replacing the base: Position of robot when replacing base from complete arm system on page 247*.

Type C



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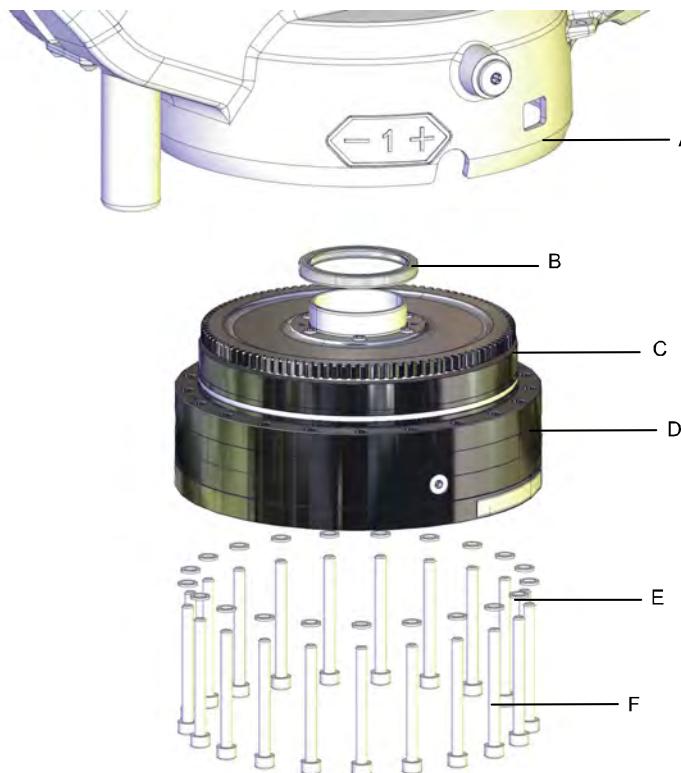
A	Frame
B	Radial sealing
C	Axis-1 gearbox with O-ring
D	Harness pipe
E	Washer (16 pcs)
F	Attachment screws M10x100 quality Steel 12.9 Gleitmo (16 pcs)

Continues on next page

## 4.8.1 Replacing gearbox axis 1

*Continued*

Other design than Type C



xx0800000400

A	Frame
B	Radial sealing
C	O-ring
D	Axis-1 gearbox
E	Washer (21 pcs)
F	Attachment screws M8x80 quality Steel 12.9 Gleitmo (21 pcs)

## Required equipment

Equipment	Note
Gearbox	See <a href="#">Spare part lists on page 389</a> .
Guide pins	<b>Type C:</b> M10 (2 pcs) <b>Other design than Type C:</b> M8 (2 pcs) Used to guide the gearbox during removal/re-fitting.
Standard toolkit	Content is defined in section <a href="#">Standard tools on page 383</a> .
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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## 4 Repair

### 4.8.1 Replacing gearbox axis 1

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"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

#### Removing gearbox axis 1

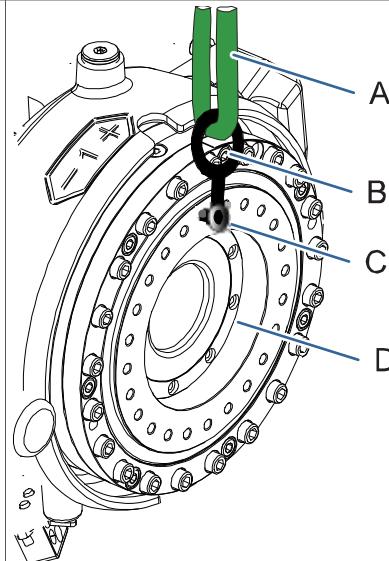
Use this procedure to remove the gearbox.

Action	Note
1 Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2 Drain the oil from the gearbox.	How to drain the oil from the gearbox is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing the oil, axis-1 gearbox on floor mounted robots on page 160</a></li></ul>
3 Move the robot to the calibration position.	
4  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
5 Remove the axis 1 motor.	<a href="#">See Removing motors on page 295</a> .

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## 4.8.1 Replacing gearbox axis 1

Continued

Action	Note
6 In order to reach gearbox axis 1, it is necessary first to remove the base from the complete arm system.	How to remove the base from the complete arm system is described in section: • <a href="#">Removing the base on page 248</a>
7 Fit a <i>lifting lug</i> in the <i>uppermost hole</i> for the attachment screws securing the base, as shown in the figure.	 <p>xx0800000440</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>A: Roundsling</li> <li>B: Lifting lug</li> <li>C: Uppermost attachment hole for securing the base</li> <li>D: Gearbox axis 1</li> </ul>
8  <b>CAUTION</b>  The gearbox weighs 27 kg. All lifting accessories used must be sized accordingly!	
9 Secure the gearbox in an overhead crane or similar.	
10 Remove the <i>attachment screws</i> securing the gearbox.	See the figure in: • <a href="#">Location of gearbox on page 314</a>
11 Insert guide pins in two, diagonally located, attachment holes in the gearbox.	Always use guide pins in pairs!
12  <b>Note</b>  Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
13  <b>Note</b>  There will be some excess oil running out of the gearbox when it is removed. Put some absorbent material to catch the oil.	

Continues on next page

## 4 Repair

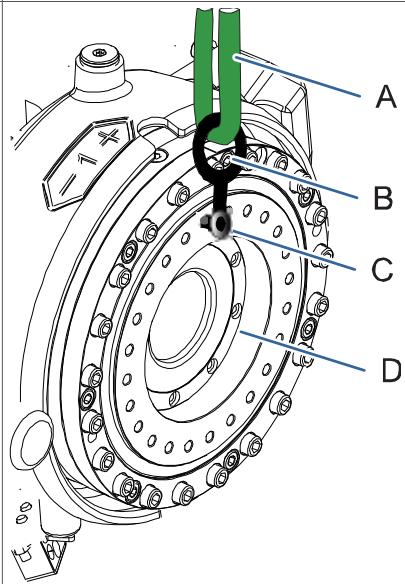
### 4.8.1 Replacing gearbox axis 1

Continued

	Action	Note
14	Using caution slide the gearbox out onto the guide pins and lift it away. If necessary use removal tools to remove the gearbox.	 Note  Always use removal tools in pairs diagonal to each other.

### Refitting gearbox axis 1

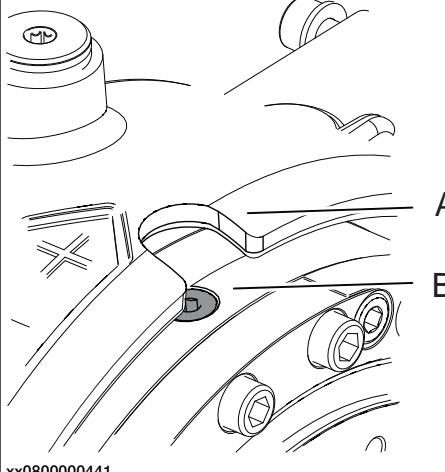
Use this procedure to refit the gearbox.

	Action	Note
1	 <b>DANGER</b>  Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	
2	Fit a lifting lug in the <i>uppermost hole</i> for the attachment screws securing the base, as shown in the figure.	 xx0800000440  Parts: <ul style="list-style-type: none"><li>• A: Roundsling</li><li>• B: Lifting lug</li><li>• C: Uppermost attachment hole for securing the base</li><li>• D: Gearbox axis 1</li></ul>

Continues on next page

## 4.8.1 Replacing gearbox axis 1

Continued

	Action	Note
3	<p><b>Only valid for Other design than Type C:</b></p> <p><b>Note</b></p> <p>Check, when fitting the lifting lug, that <b>both oil plugs</b> will be placed in the correct position after the gearbox is fitted as shown in the figure. The oil plugs shall be placed in the <i>openings</i> in the frame.</p>	 <p>A: Opening for oil plug in frame B: Oil plug</p> <p>xx0800000441</p> <p>Parts:</p> <ul style="list-style-type: none"> <li>• A: Opening for oil plug in frame</li> <li>• B: Oil plug</li> </ul>
4	Apply grease on the <i>o-ring</i> .	<p>See the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox on page 314</a></li> </ul> <p>Replace o-ring if damaged.</p>
5	Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	
6	Fit guide pins into two of the holes for the attachment screws.	Always use guide pins in pairs!
7	<p><b>Note</b></p> <p>Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!</p>	
8	<p><b>CAUTION</b></p> <p>The gearbox weighs 27 kg. All lifting accessories used must be sized accordingly!</p>	
9	Lift the gearbox onto the guide pins and slide it into position, using caution.	<p><b>Only valid for Other design than Type C:</b></p> <p>Double check that the oil plugs are in the correct position.</p>
10	Secure the gearbox with its attachment screws.	<p>See the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox on page 314</a></li> </ul> <p>Tightening torque:</p> <ul style="list-style-type: none"> <li>• Other design than Type C: 35 Nm</li> <li>• Type C: 68 Nm</li> </ul>
11	Refit the <i>base</i> on the <i>complete arm system</i> .	<p>How to refit the base on the complete arm system is described in section:</p> <ul style="list-style-type: none"> <li>• <a href="#">Refitting the base on page 252</a></li> </ul>

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## 4 Repair

### 4.8.1 Replacing gearbox axis 1

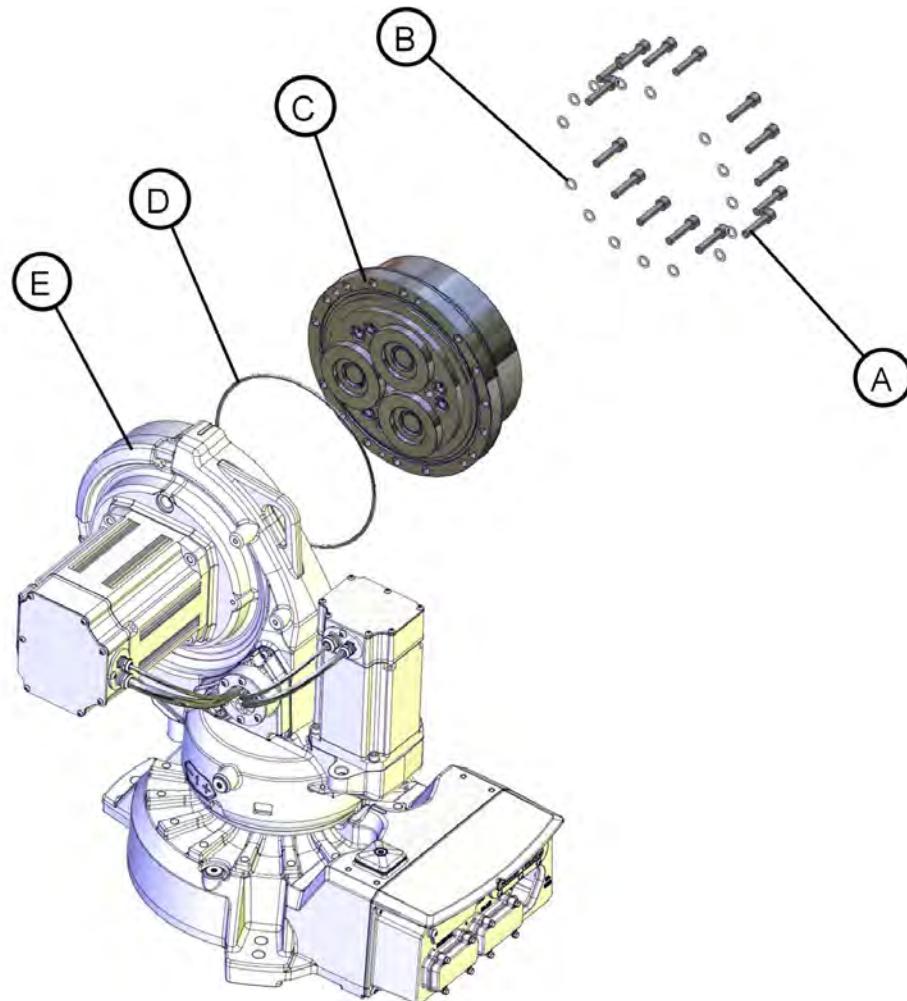
Continued

	Action	Note
12	Refit the cable harness in the base, the frame and the lower arm.	See <a href="#">Replacing gearbox axis 1 on page 314</a> . <ul style="list-style-type: none"><li>• <a href="#">Refitting the cable harness in the base on page 226</a></li><li>• <a href="#">Refitting the cable harness in the frame on page 223</a></li><li>• <a href="#">Refitting the cable harness in the lower arm and armhouse on page 232</a></li></ul> .
13	Refill oil in the gearbox.	How to fill oil in gearbox is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing the oil, axis-1 gearbox on floor mounted robots on page 160</a></li></ul>
14	Recalibrate the robot.	Pendulum Calibration is described in <a href="#">Operating manual - Calibration Pendulum</a> , enclosed with the calibration tools. Axis Calibration is described in <a href="#">Calibrating with Axis Calibration method on page 351</a> . General calibration information is included in section <a href="#">Calibration on page 339</a> .
15	 <b>DANGER</b>  Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 4.8.2 Replacing gearbox axis 2

### Location of gearbox axis 2

The gearbox is located as shown in the figure.



xx0800000438

A	Attachment screws M12x50 quality Steel 12.9 Gleitmo (15 pcs)
B	Washers (15 pcs)
C	Gearbox axis 2
D	O-ring
E	Frame

### Required equipment

Equipment	Article number	Note
Rotation tool	3HAB7887-1	
Lifting accessories	-	Roundslings.

*Continues on next page*

## 4 Repair

### 4.8.2 Replacing gearbox axis 2

Continued

Equipment	Article number	Note
Standard toolkit		Content is defined in section <a href="#">Standard tools on page 383</a> .
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"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
	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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

#### Removing gearbox axis 2

Use this procedure to remove the gearbox.



#### WARNING

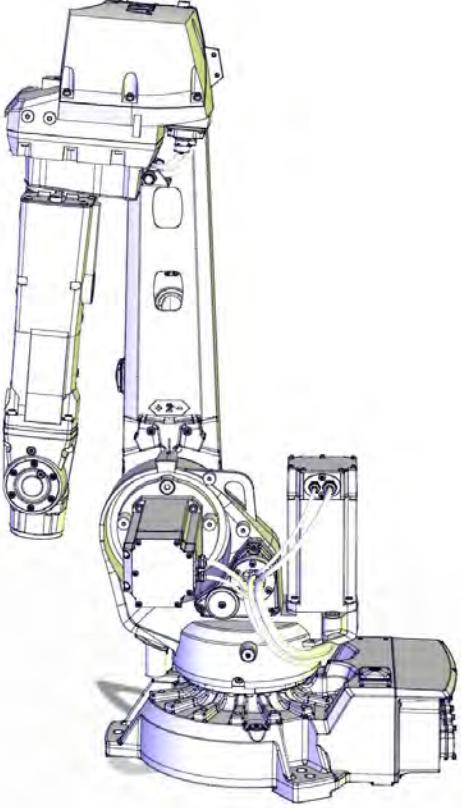
The procedure details how to replace the gearbox without removing the cable harness, only by loosening it. This means that the upper and lower arm will be separated from the frame but still be connected to the frame through the cabling. Be careful not to damage the cables!

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

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## 4.8.2 Replacing gearbox axis 2

*Continued*

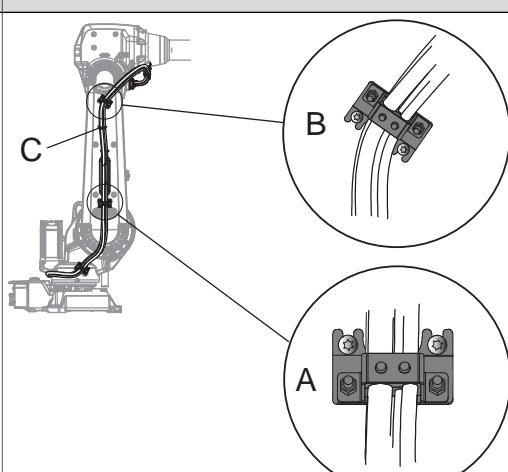
Action	Note
2 Move the robot to the position shown in the figure. Upper arm should rest on the axis-3 damper.	The figure shows IRB 2600 but the position of the robot is correct.  xx1200000068
3  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
4 Drain the gearbox.	How to drain the gearbox is described in section: <ul style="list-style-type: none"> <li>• <i>Changing the oil, axis-2 gearbox on page 172</i></li> </ul>

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## 4 Repair

### 4.8.2 Replacing gearbox axis 2

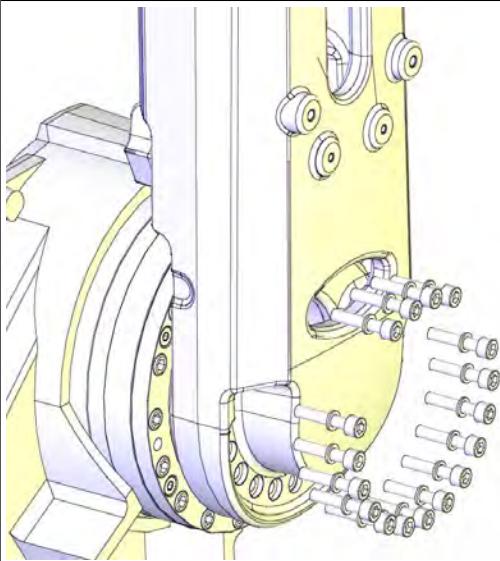
*Continued*

Action	Note
5 Loosen the cabling from the lower arm by removing two cable brackets and a cable strap.	 <p>xx1100000946</p> <p>A Cable bracket B Cable bracket C Cable strap</p>
6 Attach a roundsling around the upper arm house.	
7 Unload the weight of the lower and upper arm package by stretching the roundslings with the overhead crane. Turn on the power temporarily and release the brakes of axis 2 to rest the weight onto the roundslings.	
8  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"><li>• electric power supply</li><li>• hydraulic pressure supply</li><li>• air pressure supply</li></ul> to the robot, before entering the robot working area.	

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## 4.8.2 Replacing gearbox axis 2

Continued

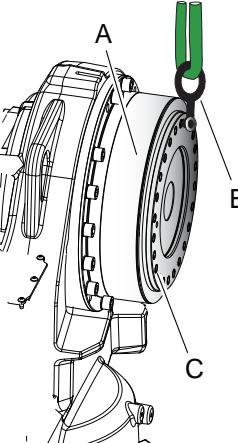
Action	Note
9 Remove the <i>attachment screws and washers</i> that secure the lower arm to the axis 2 gearbox.	 xx1200000085
10 Remove the lower and upper arm package from the frame.  <b>WARNING</b> The cable harness is still installed on the robot! Make sure not to damage the cables or the cable brackets on the robot.	
11  <b>CAUTION</b> The gearbox weighs 51 kg. All lifting accessories used must be sized accordingly!	

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## 4 Repair

### 4.8.2 Replacing gearbox axis 2

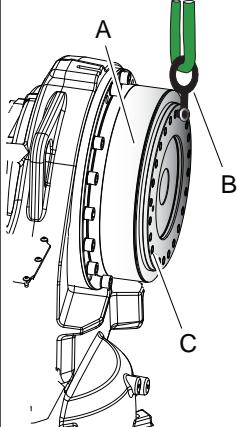
*Continued*

Action	Note
12 Fit a <i>lifting lug</i> in the uppermost hole for the attachment screws that secure the lower arm to the gearbox.	 xx0800000445 <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Gearbox axis 2</li> <li>• B: Lifting lug</li> <li>• C: Holes for attachment screws securing the lower arm to gearbox axis 2</li> </ul>
13 Secure the gearbox with a roundsling in an overhead crane or similar.	
14 Remove the <i>attachment screws and washers</i> that secure the gearbox to the frame.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox axis 2 on page 321</a></li> </ul>
15 Fit guide pins to help guiding the gearbox out from the frame.	
16 If necessary, use removal tools to remove the gearbox.	<p> <b>Note</b></p> <p>Always use removal tools in pairs diagonal to each other.</p>
17 Remove the gearbox.	<p> <b>CAUTION</b></p> <p>Use caution in order not to damage gearbox or pinion!</p>

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**Refitting gearbox axis 2**

Use this procedure to refit the gearbox.

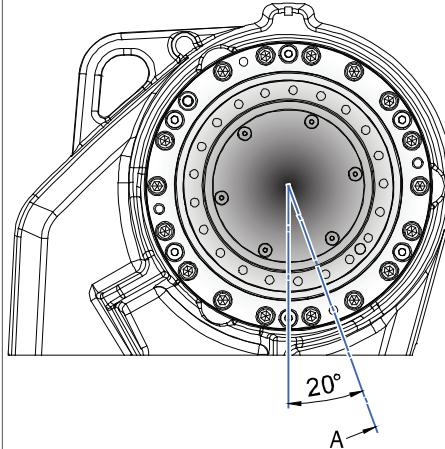
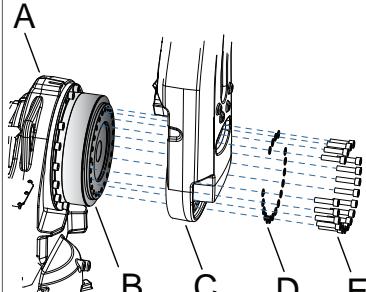
Action	Note
<b>1</b>  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
<b>2</b>  <b>CAUTION</b> The gearbox weighs 51 kg. All lifting accessories used must be sized accordingly!	
<b>3</b> Fit a lifting lug in the uppermost hole for the attachment screws securing the lower arm to the gearbox.	 xx0800000445 <b>Parts:</b> <ul style="list-style-type: none"> <li>• A: Gearbox axis 2</li> <li>• B: Lifting lug</li> <li>• C: Holes for attachment screws securing the lower arm to gearbox axis 2.</li> </ul>
<b>4</b> Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	
<b>5</b> Apply some grease on the o-ring before fitting.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox axis 2 on page 321</a></li> </ul>
<b>6</b> Fit two guide pins in opposite holes in the frame.	
<b>7</b> Secure the gearbox with a roundsling in an overhead crane or similar.	
<b>8</b> Release the brakes of the axis 2 motor.	

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## 4 Repair

### 4.8.2 Replacing gearbox axis 2

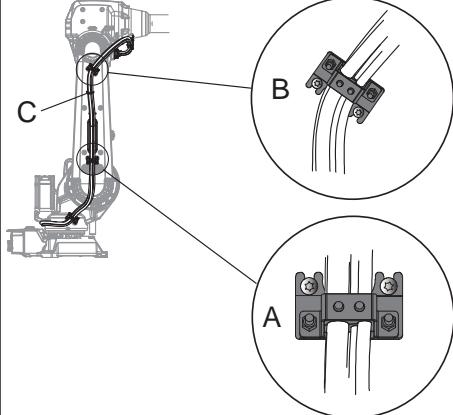
*Continued*

Action	Note
<p>9 Lift the gearbox onto the guide pins and slide it into position while rotating the motor pinion to find the mating position. Use a <i>rotation tool</i>.</p> <p> <b>Note</b></p> <p>The position of the oil plug shall be according to the illustration.</p>	<p>Article number is specified in <a href="#">Required equipment on page 321</a>.</p>  <p>xx1000000307</p> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Position of oil plug on gearbox</li> </ul>
10 Secure the gearbox with its <i>attachment screws and washers</i> .	<p>See screw dimension in the figure in:</p> <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox axis 2 on page 321</a></li> </ul> <p>Tightening torque: 110 Nm</p>
11 Perform a leak-down test.	<p>See <a href="#">Performing a leak-down test on page 202</a>.</p>
12 Fit the guide pins to the gearbox.	
13 Lift the upper and lower arms into mounting position and guide them in place with the guide pins.  It might be necessary to rotate the motor pinion with the rotating tool to find the mating position.	
14 Refit the <i>attachment screws</i> that secure the lower arm to the axis 2 gearbox.	 <p>xx0800000377</p> <p><b>Tightening torque:</b></p> <ul style="list-style-type: none"> <li>• 110 Nm</li> </ul> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Frame</li> <li>• B: Gearbox axis 2</li> <li>• C: Lower arm</li> <li>• D: Washer (18 pcs)</li> <li>• E: Attachment screws M12x50 quality 12.9 steel Gleitmo (18 pcs)</li> </ul>

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## 4.8.2 Replacing gearbox axis 2

Continued

Action	Note
15 Refit the cable brackets and cable strap to the lower arm.	 <p>xx1100000946</p> <p>A Cable bracket B Cable bracket C Cable strap</p>
16 Refill the gearbox with <i>lubrication oil</i> .	<p>How to fill the gearbox with oil is described in section:</p> <ul style="list-style-type: none"> <li>• <a href="#">Changing the oil, axis-2 gearbox on page 172</a></li> </ul>
17 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 <a href="#">Calibrating with Axis Calibration method on page 351</a>.</p> <p>General calibration information is included in section <a href="#">Calibration on page 339</a>.</p>
18  <b>DANGER</b>  Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

## 4 Repair

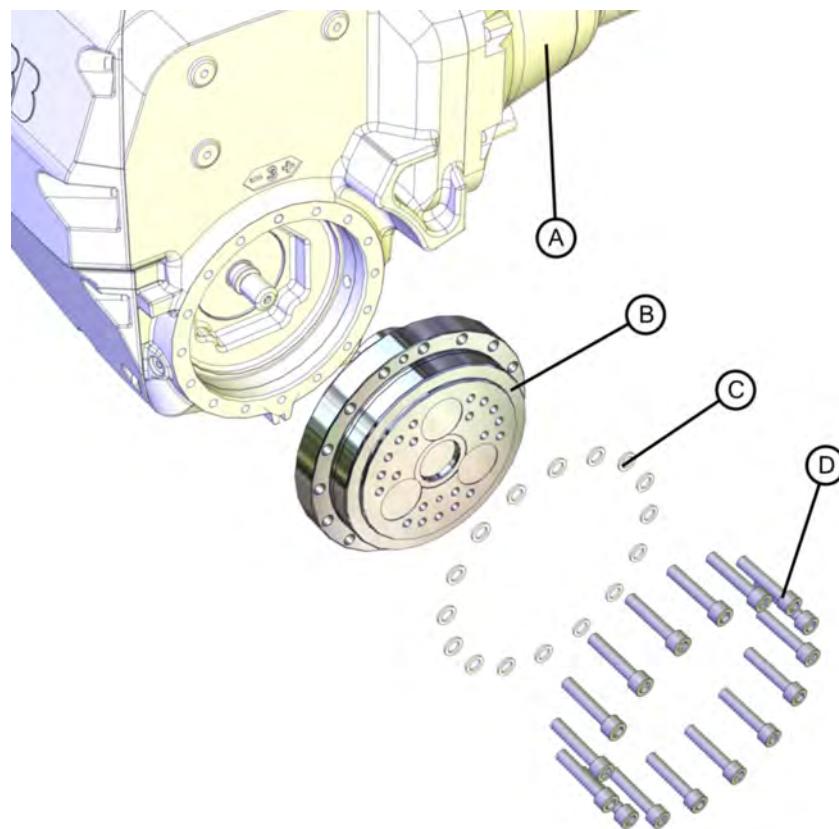
### 4.8.3 Replacing gearbox axis 3

#### 4.8.3 Replacing gearbox axis 3

##### Location of gearbox axis 3

The gearbox is located as shown in the figure.

Type C

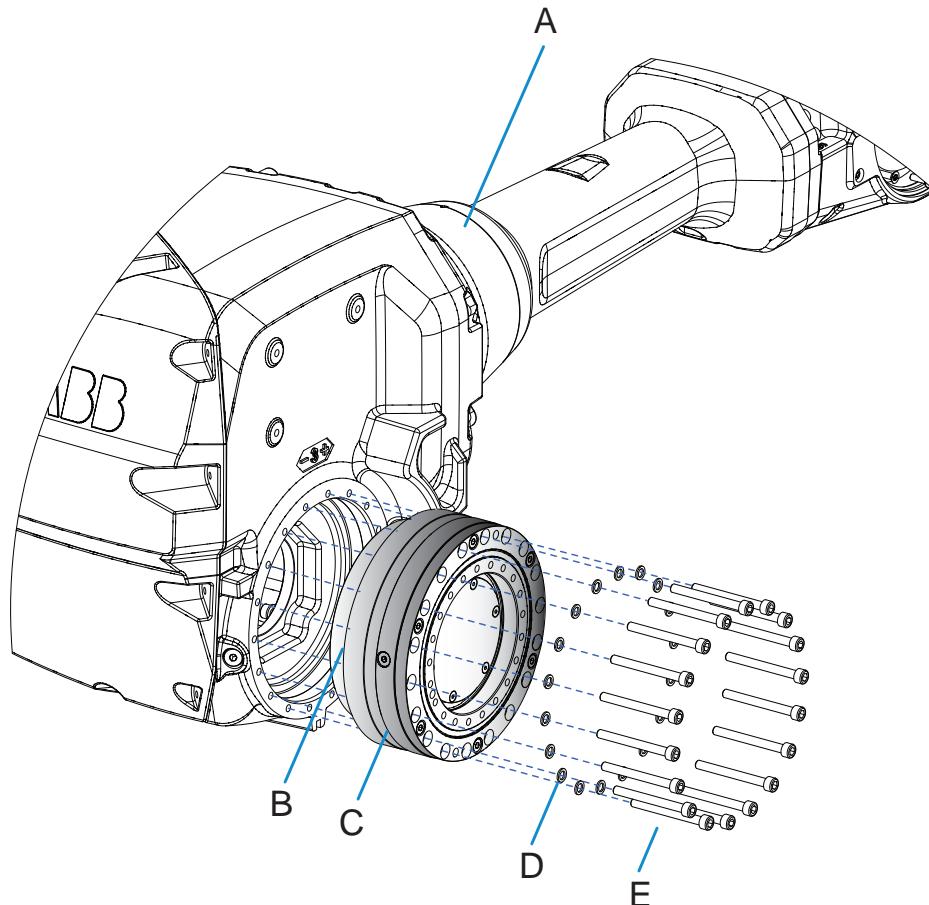


xx1200000638

A	Upper arm
B	Axis-3 gearbox
C	Washers (16 pcs)
D	Attachment screws M10x50 quality Steel 12.9 Gleitmo (16 pcs)

*Continues on next page*

Other design than Type C



xx0800000398

A	Upper arm
B	O-ring
C	Axis-3 gearbox
D	Washers (18 pcs)
E	Attachment screws M8x80 quality Steel 12.9 Gleitmo (18 pcs)

#### Required equipment

Equipment	Art. no.	Note
Gearbox		See <a href="#">Spare part lists on page 389</a> .
Guide pins		Type C: M10 (2 pcs) Other design than Type C: M8 (2 pcs) Used to guide the gearbox and the upper arm during removal/refitting.
Rotation tool	3HAB7887-1	
Standard toolkit		Content is defined in section <a href="#">Standard tools on page 383</a> .

*Continues on next page*

## 4 Repair

### 4.8.3 Replacing gearbox axis 3

Continued

Equipment	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.

#### 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"><li>• Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot.</li><li>• Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.</li></ul>	
	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 <a href="#">Reference calibration routine on page 352</a> . Read more about reference calibration for Pendulum Calibration in <a href="#">Operating manual - Calibration Pendulum</a> .
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

#### Removing gearbox axis 3

Use this procedure to remove the gearbox.



#### WARNING

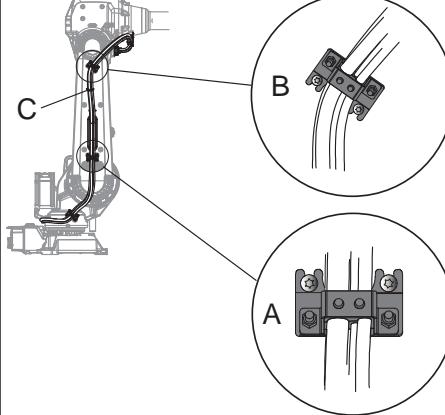
The procedure details how to replace the gearbox without removing the cable harness. This means that the upper and lower arm will be separated but still be connected to each other through the cabling. Be careful not to damage the cables!

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Drain the gearbox.	How to drain the gearbox is described in section: <ul style="list-style-type: none"><li>• <a href="#">Changing the oil, axis-3 gearbox on page 176</a></li></ul>

Continues on next page

## 4.8.3 Replacing gearbox axis 3

Continued

Action	Note
3 Move the robot to the position shown in the figure.	 xx0800000336
4  <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
5 Unscrew the attachment screws securing the cable harness to the lower arm by the two cable brackets and a cable strap.	 xx1100000946 A Cable bracket B Cable bracket C Cable strap
6 Loosen the cabling from the lower arm by unhooking the two cable brackets.   <b>CAUTION</b> The cable harness is still mounted in other parts of the robot. Make sure not to damage the cable harness or any cable brackets in the continued removal.	
7 Attach the lifting accessories to the upper arm.	See <a href="#">Attaching the lifting accessories to the upper arm on page 261</a>
8 Connect the 24 VDC power supply to the axis-3 motor and release the brakes.	

Continues on next page

## 4 Repair

### 4.8.3 Replacing gearbox axis 3

*Continued*

Action	Note
9 Releasing the brakes of the axis-3 motor unloads the weight of the upper arm by stretching the roundslings.	
10 Remove the <i>attachment screws</i> that secure the upper arm to the lower arm.   <b>Note</b>  Do not remove the attachment screws securing the gearbox axis 3 to the armhouse!	See the figure in: • <a href="#">Location of the complete upper arm on page 256</a>
11  <b>CAUTION</b>  The robot upper arm weighs 140 kg. All lifting accessories used must be sized accordingly!	
12 Remove the upper arm from the lower arm and leave it hanging in the air.   <b>CAUTION</b>  When the upper arm no longer is attached to the robot, the armhouse has a tendency to drop down a little. In order to prevent this is to rise the front end of the upper arm a little before removing the attachment screws securing the upper arm.	 <b>WARNING</b>  The cable harness is still installed on the robot! Make sure not to damage the cable harness or the cable brackets on the robot.
13  <b>CAUTION</b>  The gearbox weighs 23 kg. All lifting accessories used must be sized accordingly!	
14 Remove two attachment screws diagonally located and insert guide pins.	Always use guide pins in pairs!
15 Remove the remaining <i>attachment screws</i> that secures the gearbox.	See the figure in: • <a href="#">Location of gearbox axis 3 on page 330</a>
16  <b>Note</b>  There will be some surplus oil in the gearbox. Place some absorbant cloth or similar under the gearbox.	
17 Slide the gearbox carefully out onto the guide pins and lift it away. If necessary, use a pair of screws to push out the gearbox.   <b>CAUTION</b>  Remaining oil will drain out from the gearbox cavity when the gearbox is lifted out.	 <b>Note</b>  Always use removal tools in pairs diagonal to each other.

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**Refitting the gearbox axis 3**

Use this procedure to refit the gearbox.

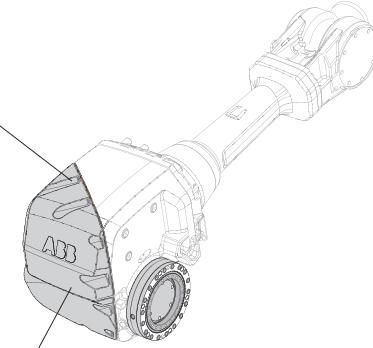
	Action	Note
1	 <b>DANGER</b> Turn off all: <ul style="list-style-type: none"> <li>• electric power supply</li> <li>• hydraulic pressure supply</li> <li>• air pressure supply</li> </ul> to the robot, before entering the robot working area.	
2	 <b>CAUTION</b> The gearbox weighs 23 kg. All lifting accessories used must be sized accordingly!	
3	Clean all assembly surfaces. Remove any painting or other contamination from the assembly surfaces, with a knife.	
4	Apply some grease on the o-ring before fitting it to the gearbox.	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox axis 3 on page 330</a></li> </ul>
5	Fit two guide pins in two opposite screw holes in the upper arm.	Always use guide pins in pairs!
6	Remove the arm house cover.	
7	Attach the rotation tool on the axis-3 motor.	
8	Release the brakes of the axis 3 motor.	
9	Lift the gearbox onto the guide pins.	
10	 <b>Note</b> Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
11	Slide the gearbox into position while rotating the motor pinion to find the mating position. Use a <i>rotation tool</i> .   <b>Tip</b> Two persons are required for this step since the upper arm is hanging freely in the air. One person needs to hold the upper arm still while the other fits the gearbox into the upper arm.	Article number for the rotation tool is specified in <a href="#">Required equipment on page 331</a> .
12	Rotate the motor pinion and slide the gearbox into position.	

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## 4 Repair

### 4.8.3 Replacing gearbox axis 3

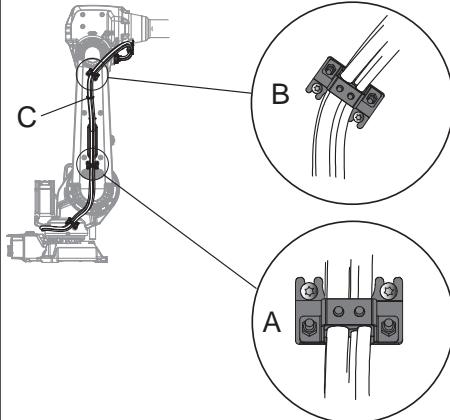
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Action	Note
13 Secure the gearbox with its <i>attachment screws and washers</i> .	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of gearbox axis 3 on page 330</a></li> </ul> Tightening torque: 35 Nm.
14 Remove the guide pins and replace them with the remaining attachment screws.	
15 Perform a leak-down test.	See <a href="#">Performing a leak-down test on page 202</a> .
16 Fit <i>guide pins</i> in the upper arm.	Specified in <a href="#">Required equipment on page 331</a> .
17 Move the upper arm to its mounting position.  (With the brakes of the axis 3 motor still released.)	
18 Refit the upper arm to the lower arm with its <i>attachment screws</i> .	See the figure in: <ul style="list-style-type: none"> <li>• <a href="#">Location of the complete upper arm on page 256</a></li> </ul> Tightening torque: <ul style="list-style-type: none"> <li>• Type C: 50 Nm and 90° angle</li> <li>• Other design than Type C: 35 Nm</li> </ul>
19 Remove the guide pins and replace with the remaining attachment screws.	
20 Remove the 24 VDC power supply.	
21 Refit the upper armhouse cover with its attachment screws and washers.	Tightening torque: 14 Nm. Make sure that the cover is tightly sealed.   <b>WARNING</b> The cover on the armhouse must be fitted when the robot is running. It is a vital part for the stability of the robot. <div style="text-align: right;">    xx0800000389 </div> <p><b>Parts:</b></p> <ul style="list-style-type: none"> <li>• A: Cover</li> <li>• B: Attachment screws M6x25, quality 8.8-A2F (10 pcs)</li> </ul>

*Continues on next page*

## 4.8.3 Replacing gearbox axis 3

Continued

Action	Note
22 Refit the two cable brackets and a cable strap to the lower arm.	 <p>xx1100000946</p> <p>A Cable bracket B Cable bracket C Cable strap</p>
23 Refill the gearbox with <i>lubrication oil</i> .	<p>How to fill the gearbox with oil is described in section:</p> <ul style="list-style-type: none"> <li>• <a href="#">Changing the oil, axis-3 gearbox on page 176</a></li> </ul>
24 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 <a href="#">Calibrating with Axis Calibration method on page 351</a>.</p> <p>General calibration information is included in section <a href="#">Calibration on page 339</a>.</p>
25  <b>DANGER</b>  Make sure all safety requirements are met when performing the first test run. These are further detailed in the section <a href="#">DANGER - First test run may cause injury or damage! on page 51</a> .	

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# 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 351](#).

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 <sup>i</sup>
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"><li>Mechanical tolerances in the robot structure</li><li>Deflection due to load</li></ul> <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><b>ABSOLUTE ACCURACY</b></p> <p>xx0400001197</p>	CalibWare

- <sup>i</sup> 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*

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#### 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 4600 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 351](#).

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 384](#).

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 347](#). 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

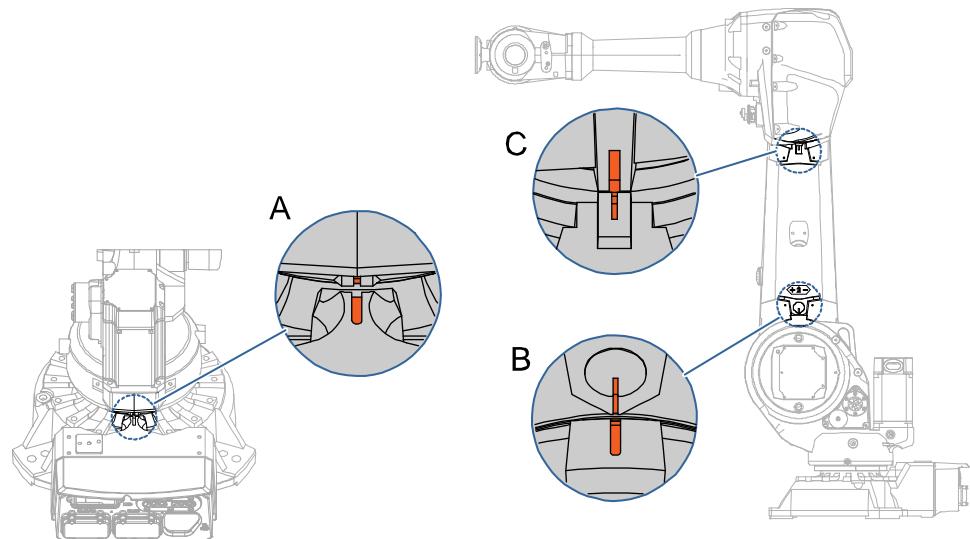
**Introduction**

This section shows the position of the synchronization marks and the synchronization position for each axis.

**Synchronization marks, IRB 4600**

The figures show the positions of the synchronization marks for all robot variants.

IRB 4600 - 60/2.05, -45/2.05, 40/2.55, -20/2.50



xx0800000312

<b>A</b>	Synchronization mark, axis 1
<b>B</b>	Synchronization mark, axis 2
<b>C</b>	Synchronization mark, axis 3

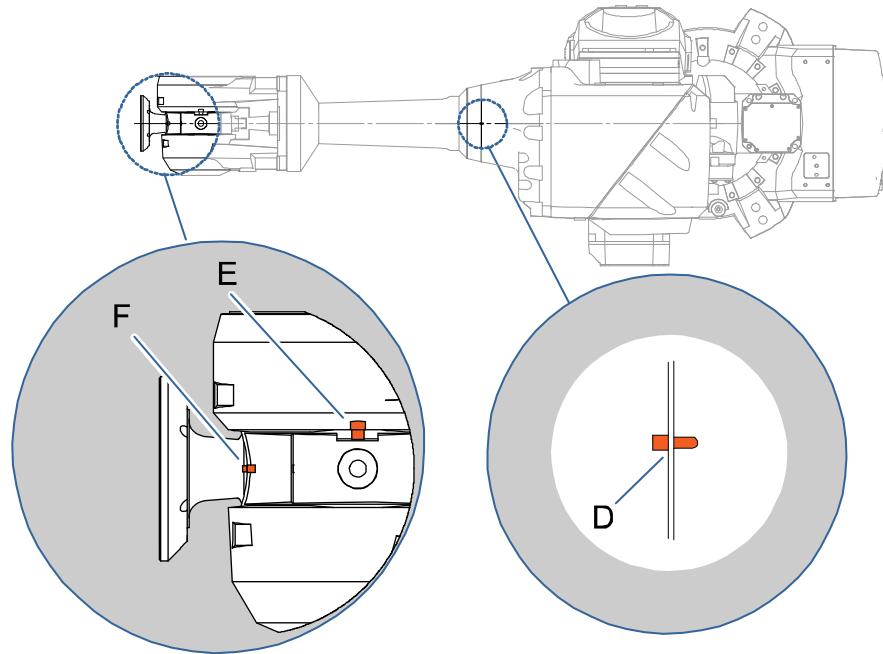
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## 5 Calibration

### 5.2.1 Synchronization marks and synchronization position for axes

*Continued*

IRB 4600 - 60/2.05, -45/2.05, 40/2.55



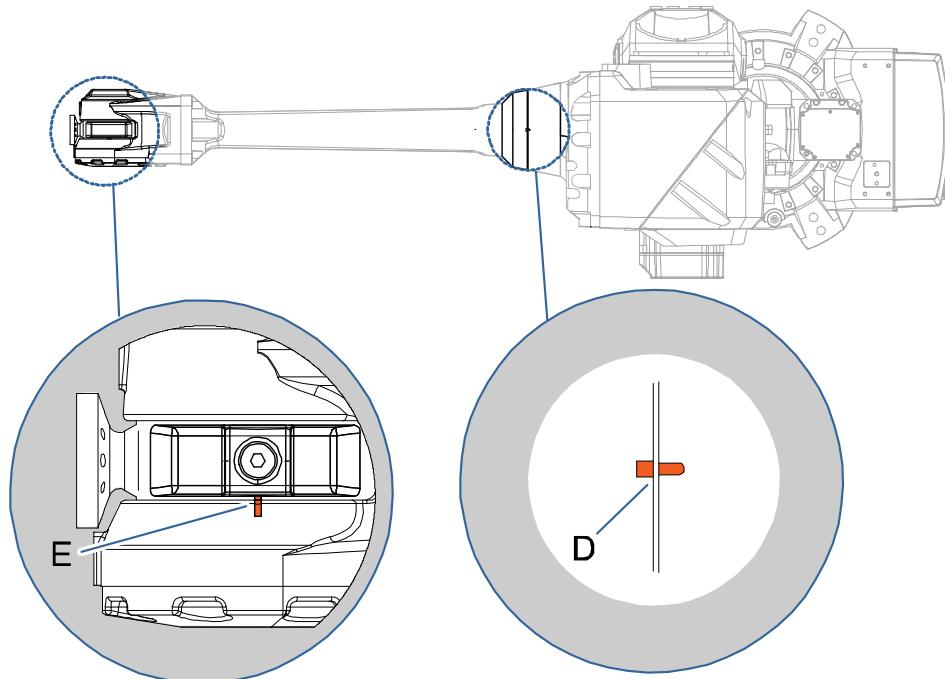
xx0800000313

D	Synchronization mark, axis 4
E	Synchronization mark, axis 5
F	Synchronization mark, axis 6

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5.2.1 Synchronization marks and synchronization position for axes  
*Continued*

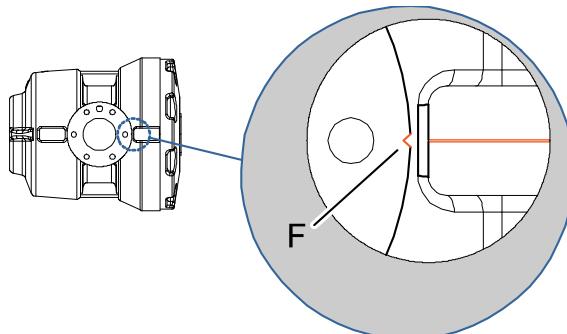
IRB 4600 -20/2.50



xx0800000320

D	Synchronization mark, axis 4
E	Synchronization mark, axis 5

IRB 4600 -20/2.50



xx0800000321

F	Synchronization mark, axis 6
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## 5 Calibration

### 5.2.2 Calibration movement directions for all axes

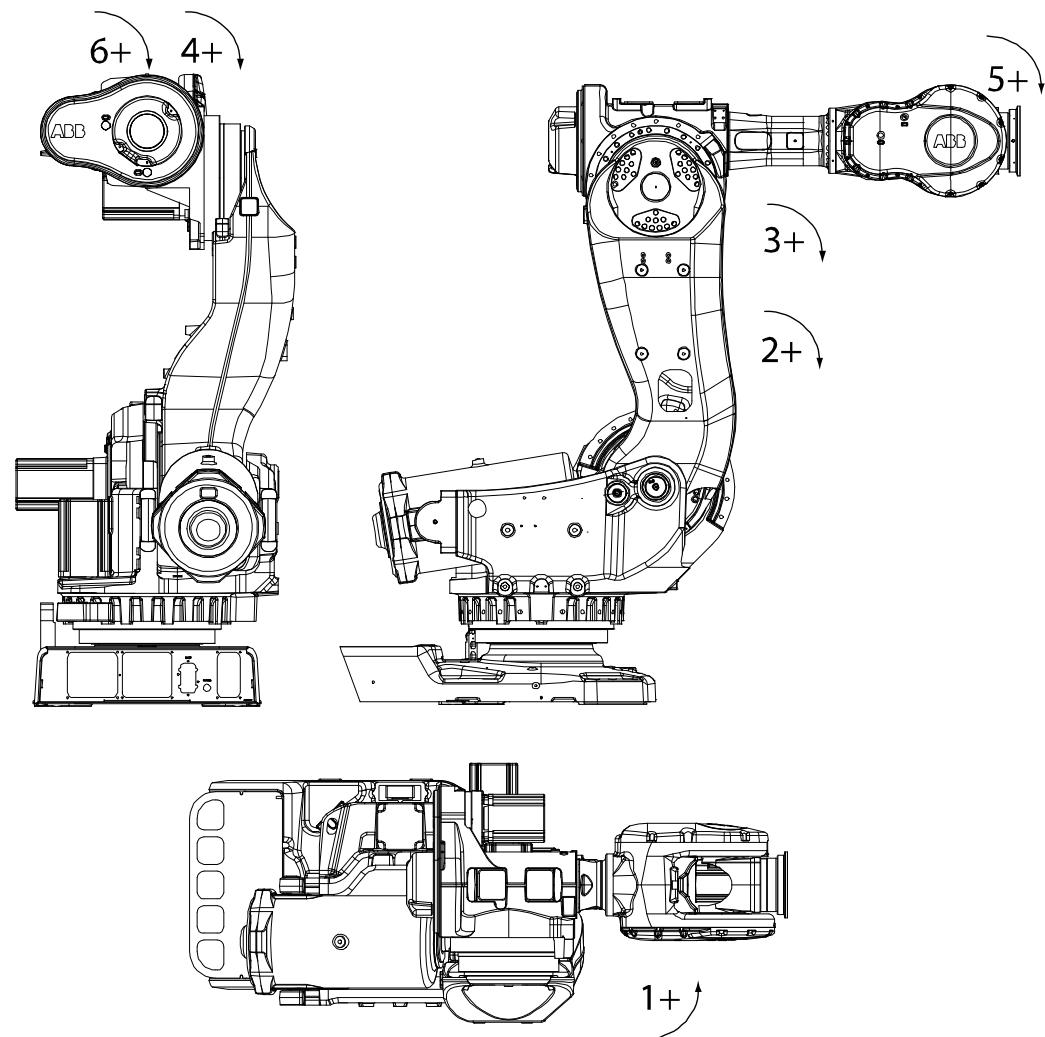
#### Overview

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, 6 axes

Note! The graphic shows an IRB 7600. The positive direction is the same for all 6-axis robots, except the positive direction of axis 3 for IRB 6400R, which is in the opposite direction!



xx0200000089

## 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 <a href="#">Synchronization marks and synchronization position for axes on page 343</a> .
3	When all axes are positioned, update the revolution counter.	<a href="#">Step 2 - Updating the revolution counter with the FlexPendant on page 348</a> .

### 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 4600	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).

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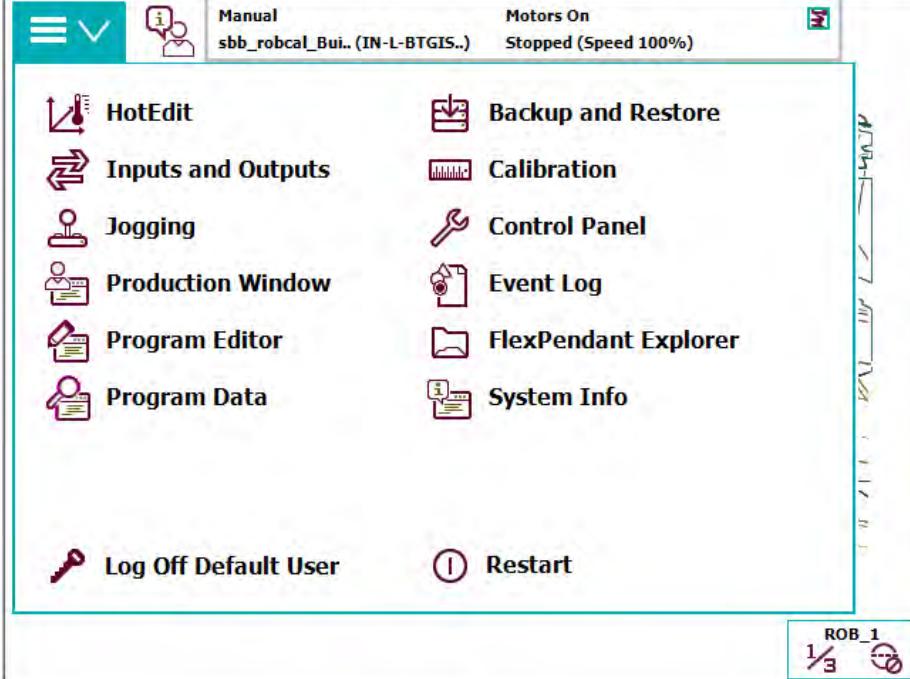
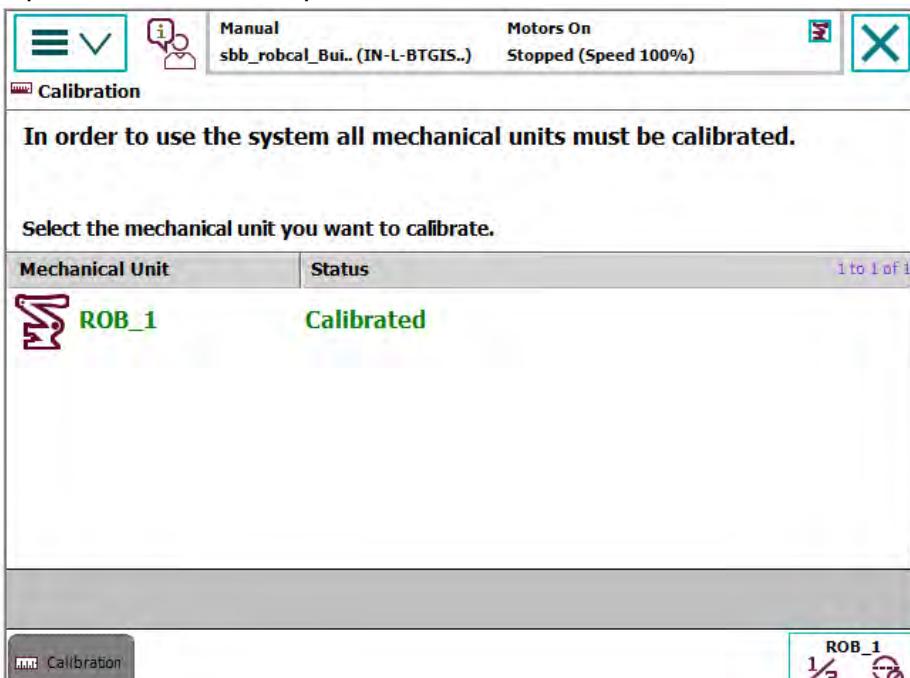
## 5 Calibration

### 5.3 Updating revolution counters

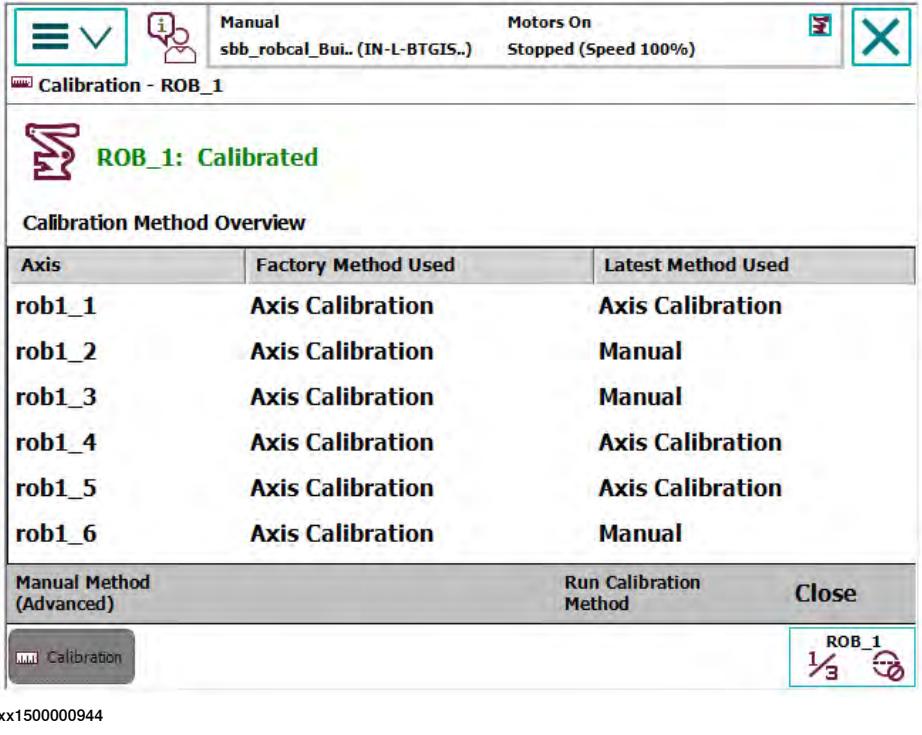
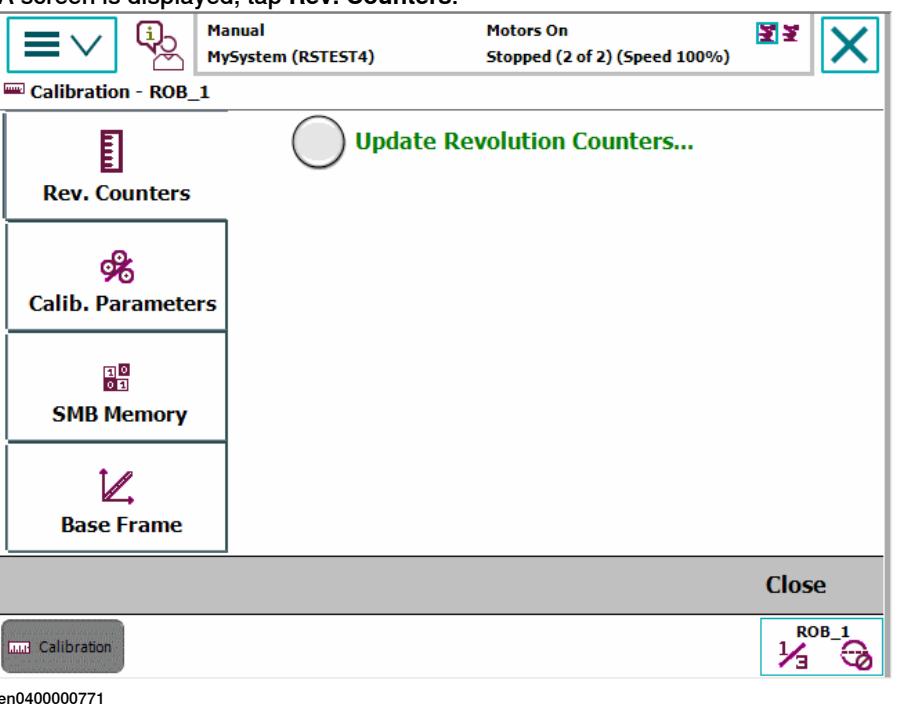
*Continued*

#### Step 2 - Updating the revolution counter with the FlexPendant

Use this procedure to update the revolution counter with the FlexPendant (IRC5).

Action
1 On the ABB menu, tap Calibration.
 <p>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>xx1500000943</p>

*Continues on next page*

	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 <b>Manual Method (Advanced)</b>.</p>  <table border="1"> <thead> <tr> <th>Axis</th> <th>Factory Method Used</th> <th>Latest Method Used</th> </tr> </thead> <tbody> <tr> <td>rob1_1</td> <td>Axis Calibration</td> <td>Axis Calibration</td> </tr> <tr> <td>rob1_2</td> <td>Axis Calibration</td> <td>Manual</td> </tr> <tr> <td>rob1_3</td> <td>Axis Calibration</td> <td>Manual</td> </tr> <tr> <td>rob1_4</td> <td>Axis Calibration</td> <td>Axis Calibration</td> </tr> <tr> <td>rob1_5</td> <td>Axis Calibration</td> <td>Axis Calibration</td> </tr> <tr> <td>rob1_6</td> <td>Axis Calibration</td> <td>Manual</td> </tr> </tbody> </table> <p>Manual Method (Advanced) Run Calibration Method Close</p> <p>Calibration</p> <p>xx1500000944</p>	Axis	Factory Method Used	Latest Method Used	rob1_1	Axis Calibration	Axis Calibration	rob1_2	Axis Calibration	Manual	rob1_3	Axis Calibration	Manual	rob1_4	Axis Calibration	Axis Calibration	rob1_5	Axis Calibration	Axis Calibration	rob1_6	Axis Calibration	Manual
Axis	Factory Method Used	Latest Method Used																				
rob1_1	Axis Calibration	Axis Calibration																				
rob1_2	Axis Calibration	Manual																				
rob1_3	Axis Calibration	Manual																				
rob1_4	Axis Calibration	Axis Calibration																				
rob1_5	Axis Calibration	Axis Calibration																				
rob1_6	Axis Calibration	Manual																				
4	<p>A screen is displayed, tap <b>Rev. Counters</b>.</p>  <p>Rev. Counters</p> <p>Update Revolution Counters...</p> <p>Calib. Parameters</p> <p>SMB Memory</p> <p>Base Frame</p> <p>Close</p> <p>Calibration</p> <p>en0400000771</p>																					

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## 5 Calibration

### 5.3 Updating revolution counters

*Continued*

	Action
5	<p><b>Tap Update Revolution Counters....</b></p> <p>A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions:</p> <ul style="list-style-type: none"><li>• Tap Yes to update the revolution counters.</li><li>• Tap No to cancel updating the revolution counters.</li></ul> <p>Tapping Yes displays the axis selection window.</p>
6	<p>Select the axis to have its revolution counter updated by:</p> <ul style="list-style-type: none"><li>• Ticking in the box to the left</li><li>• Tapping Select all to update all axes.</li></ul> <p>Then tap Update.</p>
7	<p>A dialog box is displayed, warning that the updating operation cannot be undone:</p> <ul style="list-style-type: none"><li>• Tap Update to proceed with updating the revolution counters.</li><li>• Tap Cancel to cancel updating the revolution counters.</li></ul> <p>Tapping Update updates the selected revolution counters and removes the tick from the list of axes.</p>
8	<p> <b>CAUTION</b></p> <p>If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury!</p> <p>Check the synchronization position very carefully after each update. See <a href="#">Checking the synchronization position on page 367</a>.</p>

## 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.

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## 5 Calibration

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### 5.4.1 Description of Axis Calibration

*Continued*

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#### 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.

Also choose this routine if the robot is suspended.

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.

---

#### How to calibrate a suspended robot

The IRB 4600 is calibrated floor standing in factory, prior to shipping.

To calibrate a suspended robot, reference calibration must be used. Reference values for a suspended robot must be created with the robot mounted at its working position, not standing on a floor.

To calibrate a suspended robot with the fine calibration routine, the robot must first be taken down and then be mounted standing on the floor.

## 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. Contains a removal tool for removing special protection plugs on the turning disk.

### Examining the calibration tool

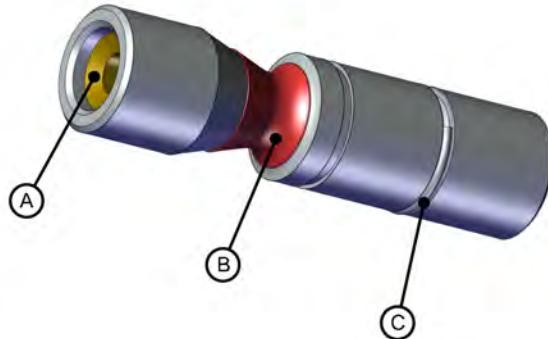
#### Check prior to usage

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

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## 5 Calibration

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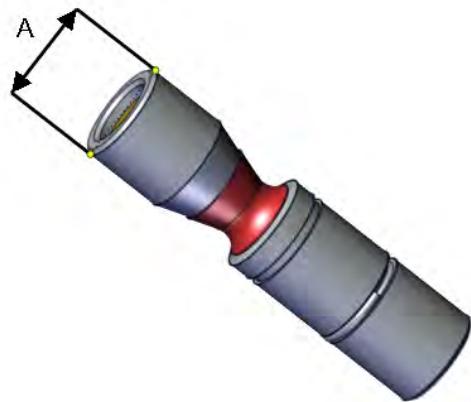
### 5.4.2 Calibration tools for Axis Calibration

*Continued*

#### 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).
- Straightness within 0.005 mm.



xx1500000951

A	Outer diameter
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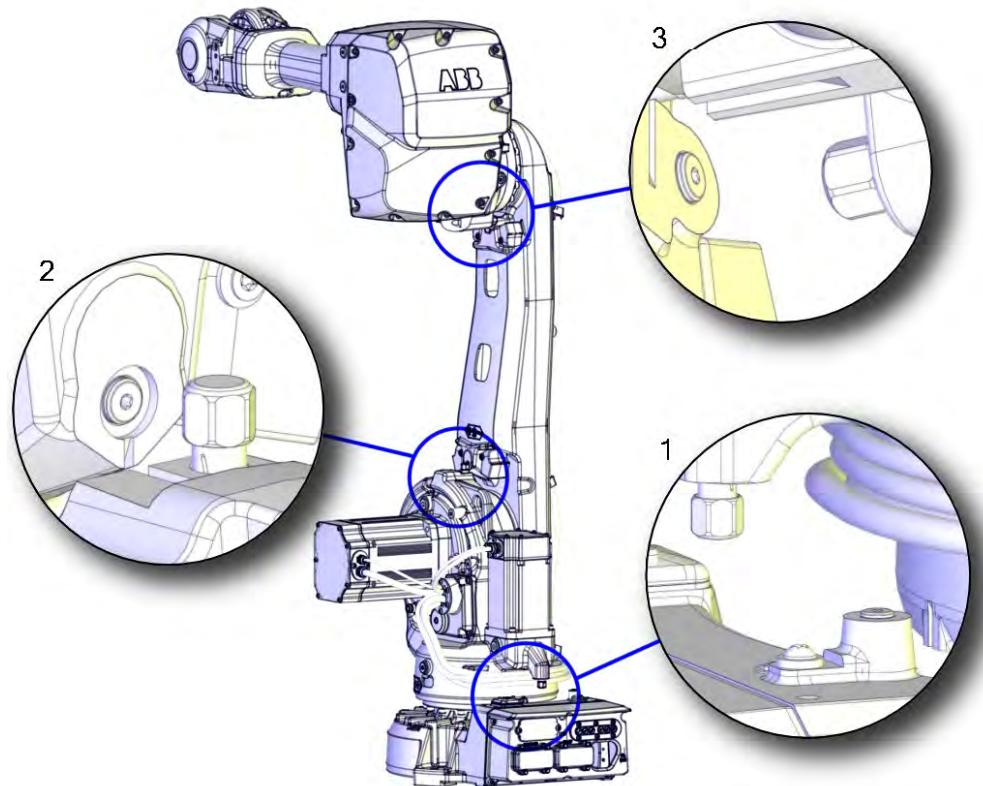
### 5.4.3 Installation locations for the calibration tools

#### 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.



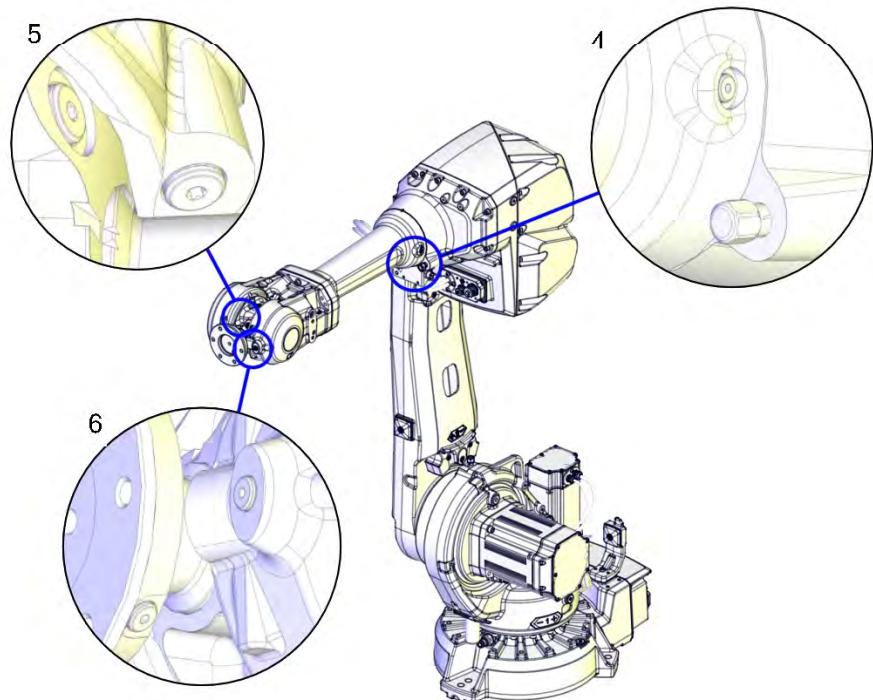
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## 5 Calibration

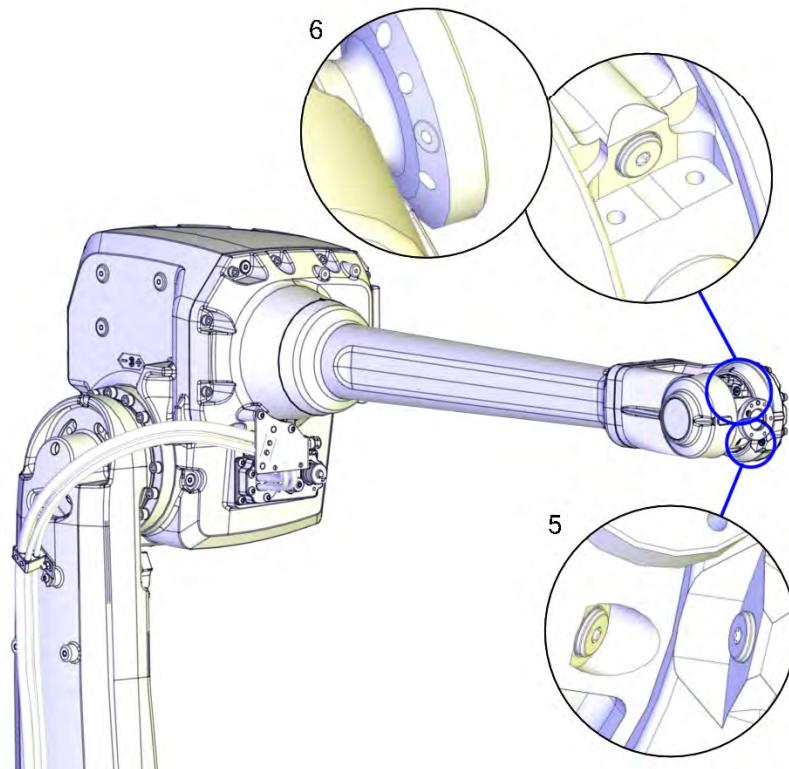
### 5.4.3 Installation locations for the calibration tools

*Continued*



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IRB 4600 - 20/2.50



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### 5.4.3 Installation locations for the calibration tools

*Continued*

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#### 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 (protection type Standard)	Contains replacement calibration pin covers and protective plugs for the bushing.
Protective plug on turning disc	3HAC057511-001	Only on IRB 4600 - 20/2.50. Replace if damaged or missing.

## 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. Contains a removal tool for removing special protection plugs on the turning disk.

##### Required consumables

Consumable	Article number	Note
Clean cloth	-	

##### Spare parts

Spare part	Article number	Note
Protection cover and plug set	3HAC059487-001 (protection type Standard)	Contains replacement calibration pin covers and protective plugs for the bushing.
Protective plug on turning disc	3HAC057511-001	Only on IRB 4600 - 20/2.50. Replace if damaged or missing.

##### 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 352](#).
- 2 Choose which axis/axes to calibrate.
- 3 The robot moves to synchronization position.
- 4 Validate the synchronization marks.

*Continues on next page*

- 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.  
Use the removal tool included in the calibration tool box to remove the special protection plug(s) on the turning disc.
- 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.  
Refit the protection plug(s) to the turning disc, push until the steel spring ring snaps into place.
- 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	 <b>DANGER</b> 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	 <b>Note</b> Wipe the calibration tool clean.  The calibration method is exact. Dust, dirt or color flakes will affect the calibration value.	Use a clean cloth.

*Continues on next page*

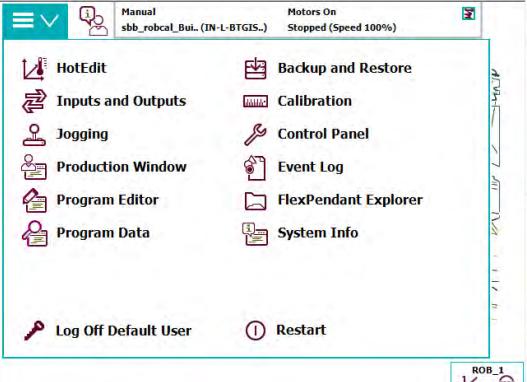
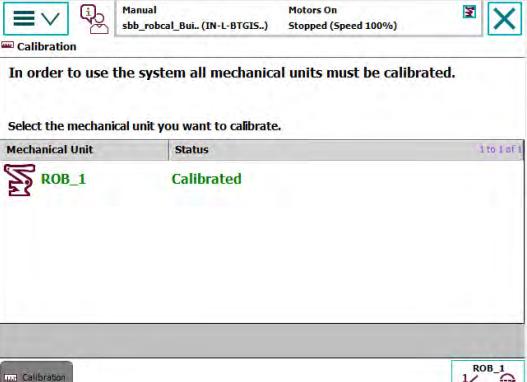
## 5 Calibration

### 5.4.4 Axis Calibration - Running the calibration procedure

*Continued*

#### Starting the calibration procedure

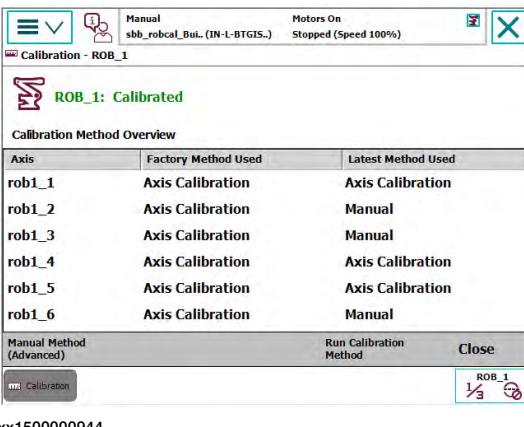
Use this procedure to call for the Axis Calibration method on the FlexPendant.

Action	Note
<p>1 On the ABB menu, tap Calibration.</p>  <p>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>xx1500000943</p>	

*Continues on next page*

#### 5.4.4 Axis Calibration - Running the calibration procedure

*Continued*

Action	Note
<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.</p> <p><b>Tap Run Calibration Method.</b> 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.
4 Follow the instructions given on the FlexPendant.	A brief overview of the sequence that will be run on the FlexPendant is given in <a href="#">Overview of the calibration procedure on the FlexPendant on page 358</a> .

#### 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.
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 <a href="#">Starting the calibration procedure on page 360</a>.</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 <a href="#">Calibration movement directions for all axes on page 346</a></p>

#### Axis Calibration with SafeMove option

To be able to run Axis Calibration SafeMove needs to be unsynchronized. The Axis Calibration routine recognizes if the robot is equipped with SafeMove and will force SafeMove to unsynchronize automatically.

*Continues on next page*

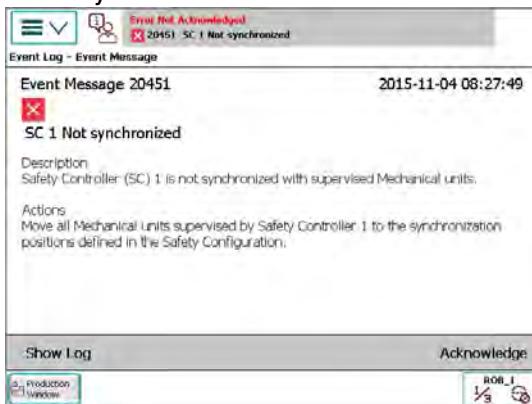
## 5 Calibration

### 5.4.4 Axis Calibration - Running the calibration procedure

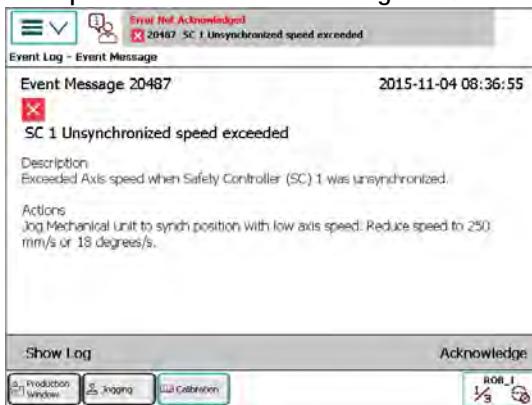
*Continued*

However, SafeMove may generate other warning messages anytime during the Axis Calibration routine.

Safety controller not synchronized - SafeMove message

Action	Note
<p>1 SafeMove generates the message "Safety controller not synchronized".</p>  <p>The screenshot shows the 'Event Log - Event Message' window. It displays an event message for 'SC 1 Not synchronized'. The message details: Event Message 20451, Date 2015-11-04 08:27:49, and a description: 'Safety Controller (SC) 1 is not synchronized with supervised Mechanical units.' Actions: 'Move all Mechanical Units supervised by Safety Controller 1 to the synchronization positions defined in the Safety Configuration.' Below the message, there are 'Show Log' and 'Acknowledge' buttons. The 'Acknowledge' button is highlighted with a green border. The status bar at the bottom shows 'xx1500002480'.</p>	
<p>2 Confirm unsynchronized state by pressing Acknowledge to continue Axis Calibration procedure.</p>	
<p>3 Restart Axis Calibration procedure by pressing Play.</p>	

Unsynchronized speed exceeded - SafeMove message while saving robot data

Action	Note
<p>1 SafeMove generates the message "Unsynchronized speed exceeded" while saving robot data.</p>  <p>The screenshot shows the 'Event Log - Event Message' window. It displays an event message for 'SC 1 Unsynchronized speed exceeded'. The message details: Event Message 20487, Date 2015-11-04 08:36:55, and a description: 'Exceeded Axis speed when Safety Controller (SC) 1 was unsynchronized.' Actions: 'Jog Mechanical Unit to synch position with low axis speed. Reduce speed to 250 mm/s or 18 degrees/s.' Below the message, there are 'Show Log' and 'Acknowledge' buttons. The 'Acknowledge' button is highlighted with a green border. The status bar at the bottom shows 'xx1500002481'.</p>	
<p>2 Press Acknowledge to continue Axis Calibration procedure.</p>	
<p>3 Restart Axis Calibration procedure by pressing Play.</p>	

*Continues on next page*

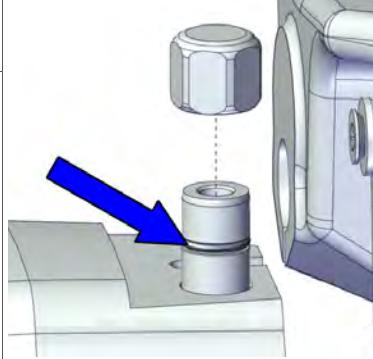
## 5.4.4 Axis Calibration - Running the calibration procedure

*Continued*

Unsynchronized time limit expired - SafeMove message anytime during Axis Calibration routine

Action	Note
1 SafeMove generates the message "Unsynchronized time limit expired" (anytime). 	
2 Press OK to continue Axis Calibration procedure.	
3 Restart Axis Calibration procedure by pressing Play.	

## After calibration

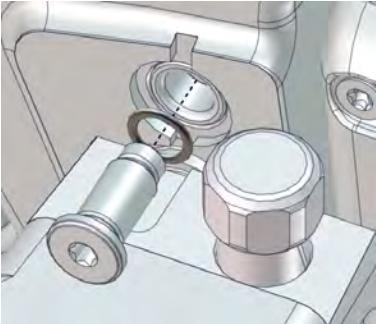
Action	Note
1 Check the o-ring on the fixed calibration pin. Replace if damaged or missing.	
2 Reinstall the protective cover on the fixed calibration pin on each axis, directly after the axis has been calibrated. Replace the cover with new spare part, if missing or damaged.	 xx1600002102 Protection cover and plug set: . 3HAC059487-001 (protection type Standard)

*Continues on next page*

## 5 Calibration

### 5.4.4 Axis Calibration - Running the calibration procedure

*Continued*

	Action	Note
3	<p>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.</p> <p>Replace the plug and the sealing with new spare part, if missing or damaged.</p>	 <p>xx1500000952</p> <p>Protection cover and plug set: . 3HAC059487-001 (protection type Standard)</p>

#### 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 Calibration

---

### 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 <a href="#">Checking the synchronization position on page 367</a> .
2 Adjust the <i>synchronization marks</i> when the calibration is done, if necessary.	This is detailed in section <a href="#">Synchronization marks and synchronization position for axes on page 343</a> .
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.	

## 5.7 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 <b>Program editor</b> .	
2	Create a new program.	
3	Use <b>MoveAbsJ</b> in the <b>Motion&amp;Proc</b> menu.	
4	Create the following program: <pre>MoveAbsJ [[0,0,0,0,0,0], [9E9,9E9,9E9,9E9,9E9,9E9]] \NoEOoffs, 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 <a href="#">Synchronization marks and synchronization position for axes on page 343</a> and <a href="#">Updating revolution counters on page 347</a> .

### 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 <b>Jogging</b> .	
2	Tap <b>Motion mode</b> 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 <a href="#">Synchronization marks and synchronization position for axes on page 343</a> and <a href="#">Updating revolution counters on page 347</a> .

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# 6 Decommissioning

## 6.1 Introduction

---

### Introduction

This section contains information to consider when taking a product, robot or controller, out of operation.

It deals with how to handle potentially dangerous components and potentially hazardous materials.

---

### General

All used grease/oils and dead batteries **must** be disposed of in accordance with the current legislation of the country in which the robot and the control unit are installed.

If the robot or the control unit is partially or completely disposed of, the various parts **must** be grouped together according to their nature (which is all iron together and all plastic together), and disposed of accordingly. These parts **must** also be disposed of in accordance with the current legislation of the country in which the robot and control unit are installed.

## **6 Decommissioning**

---

### **6.2 Environmental information**

#### **6.2 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.

#### 6.3 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.

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# 7 Robot description

## 7.1 Type C of IRB 4600

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### Type C - alternative gearboxes

Type C of IRB 4600 have an alternative supplier of the axis-1 and axis-3 gearboxes.

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### How to know which of the types is described, in the manual

Throughout the manual the alternative gearboxes are described as "Type C". Other types of gearboxes are called "Other design than Type C". The manual describes all the types of gearboxes.

---

### Interchangeable parts

Type C gearboxes are not interchangeable with other designs of the axis-1 and axis-3 gearboxes.

---

### Notable changes connected to the Type C gearboxes

- Dimension and number of attachments screws are different.
- Washers between the lower arm and axis-3 gearbox, are different.
- Tightening torques are different.
- Tightening torque with angle 90 degrees added when the lower arm is secured to the axis-3 gearbox.
- The frame and base are redesigned to fit the axis-1 gearbox and are not compatible with other designs of the gearbox. This affects the installation of additional mechanical stops on axis 1 and the values of possible restricted working range.

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# 8 Reference information

## 8.1 Introduction

---

### General

This chapter includes general information, complementing the more specific information in the different procedures in the manual.

## 8 Reference information

### 8.2 Applicable standards

#### 8.2 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 <sup>i</sup>	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 <sup>ii</sup>	Arc welding equipment - Part 1: Welding power sources
EN IEC 60974-10 <sup>ii</sup>	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)

<sup>i</sup> Only robots with protection Clean Room.

<sup>ii</sup> 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*

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#### **Other standards**

<b>Standard</b>	<b>Description</b>
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

## **8 Reference information**

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### **8.3 Unit conversion**

#### **8.3 Unit conversion**

---

##### **Converter table**

Use the following table to convert units used in this manual.

<b>Quantity</b>	<b>Units</b>		
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	

## 8.4 Screw joints

### General

This section describes how to tighten the various types of screw joints on the IRB 4600.

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*

## 8 Reference information

### 8.4 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 <sup>i</sup>	Tightening torque (Nm) Class 12.9, lubricated <sup>i</sup>
M8	28	35
M10	55	70
M12	96	120
M16	235	280
M20	460	550
M24	790	950

<sup>i</sup> 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

## **8 Reference information**

---

### **8.5 Weight specifications**

#### **8.5 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:

	<b>Action</b>	<b>Note</b>
	 <b>CAUTION</b> The robot weighs 440 kg. All lifting accessories used must be sized accordingly!	

## 8.6 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
1	Ring-open-end spanner 8-19 mm
1	Socket head cap 2.5-17 mm
1	Torx socket no: 20-60
1	Torque wrench 10-100 Nm
1	Small screwdriver
1	Plastic mallet
1	Ratchet head for torque wrench 1/2"
1	Socket head cap no: 5, socket 1/2" bit L 20 mm
1	Socket head cap no: 6, socket 1/2" bit L 20 mm
1	Socket head cap no: 8, socket 1/2" bit L 20 mm
1	Small cutting plier
1	T-handle with ball head

## 8 Reference information

### 8.7 Special tools

#### 8.7 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 383](#), and of special tools, listed directly in the instructions and also gathered in this section.

##### Measuring tools, play

The tools listed for measuring the play are used after service work on axes 5 and 6.

Description	Robot variant	Art. no.
Measuring tool, play	IRB 4600 - 60/2.05, -45/2.05, -40/2.55	3HAB1611-6
Measuring tool, play	IRB 4600 - 20/2.50	3HAB6337-1

##### Special tools

The following table specifies the special tools required during several of the service procedures. The tools may be ordered separately and are also specified directly in concerned instructions in the product manual.

Description	Qty	Art. no.
Guide pins, removal/refitting of axis 1 gearbox	2 pcs	-
Guide pins, removal/refitting of axis 3 gearbox	2 pcs	-

##### Oil change equipment

The following table specifies the oil change equipment. The tool is specified directly in concerned instructions in the product manual.

Description	Included parts	Art. no.
Oil change equipment	<ul style="list-style-type: none"><li>• vacuum pump with regulator, hose and coupling</li><li>• couplings and adapters</li><li>• pump (manual) with hose and coupling</li><li>• graduated measuring glass</li><li>• oil gun</li><li>• user instructions.</li></ul>	3HAC021745-001

##### Calibration equipment, Levelmeter (alternative method)

The following table specifies the calibration equipment required when calibrating the robot with the alternative method, Levelmeter Calibration.

Description	Art. no.	Note
Angle bracket	68080011-LP	
Calibration bracket	3HAC13908-9	

*Continues on next page*

Description	Art. no.	Note
Calibration tool ax1	3HAC13908-4	
Levelmeter 2000 kit	6369901-347	Includes one sensor.
Measuring pin	3HAC13908-5	
Sensor fixture	68080011-GM	
Sensor plate	3HAC0392-1	
Sync. adapter	3HAC13908-1	

### 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. Contains a removal tool for removing special protection plugs on the turning disk.

### Turning tool for suspended mounting

The following table specifies the lifting tool required when fitting the robot in a suspended position.

Description	Art. no.	Note
Turning tool (includes lifting instruction)	3HAC034766-001	Valid for other designs than type C.

*Continues on next page*

## 8 Reference information

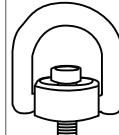
### 8.7 Special tools

*Continued*

Description	Art. no.	Note
Turning tool (includes lifting instruction 3HAC051688-001)	3HAC048502-001	Valid for all types

### Lifting accessories

This table specifies the lifting accessories required during several of the service procedures. The lifting accessories can be ordered separately and are also specified directly in concerned instructions.

Description	Qty	Article no.	Note
Lifting accessory, axis 2			
Lifting accessory, axis 3			
Rotating lifting point	2 pcs	-	<p>For lifting of upper arm. Dimension: M8. Example: Gunnebo RLP GrabiQ M8-10.</p>  <p>xx1100000564</p>

## 8.8 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.

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# **9 Spare part lists**

## **9.1 Spare part lists and illustrations**

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### **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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# 10 Circuit diagram

## 10.1 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*

## 10 Circuit diagram

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### 10.1 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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