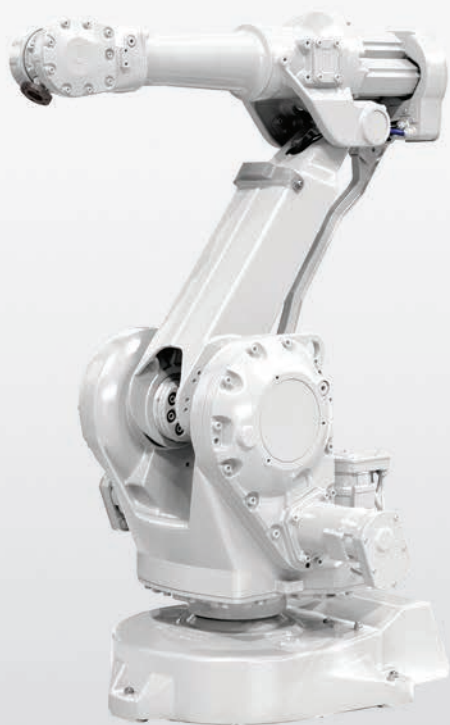

ROBOTICS

Product manual

IRB 2400



Trace back information:
Workspace 22A version a16
Checked in 2022-03-11
Skribenta version 5.4.005

Product manual

IRB 2400/L

IRB 2400/10

IRB 2400/16

M2000, M2000A, IRC5

Document ID: 3HAC022031-001

Revision: T

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Original instructions.

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Overview of this manual

About this manual

This manual contains instructions for

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

Usage

This manual should be used during

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

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

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

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

Product manual scope

The manual covers covers all variants and designs of the IRB 2400. Some variants and designs may have been removed from the business offer and are no longer available for purchase.

Organization of chapters

The manual is organized in the following chapters:

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

Continues on next page

Overview of this manual

Continued

Chapter	Contents
Calibration information	Procedures that does not require specific calibration equipment.
Decommissioning	Environmental information about the robot and its components.
Reference information	Useful information when performing installation, maintenance or repair work (lists of necessary tools, reference documents, safety standards).
Part list	Complete list of robot parts, shown in the exploded views or foldouts.
Exploded views / Foldouts	Detailed illustrations of the robot with reference numbers to the part list.
Circuit diagram	References to the circuit diagram for the robot.

References

Procedures in this product manual contain references to the following manuals:

Document name	Document ID	Note
<i>Product specification - IRB 2400</i>	3HAC042195-001	M2004
<i>Product manual, spare parts - IRB 2400</i>	3HAC049105-001	
<i>Circuit diagram - IRB 2400</i>	3HAC6670-3	
<i>Safety manual for robot - Manipulator and IRC5 or OmniCore controllerⁱ</i>	3HAC031045-001	M2004
<i>Product manual - IRC5</i> IRC5 with main computer DSQC 639.	3HAC021313-001	M2004
<i>Product manual - IRC5</i> IRC5 with main computer DSQC1000.	3HAC047136-001	M2004
<i>Product manual - S4Cplus M2000</i>	3HAC021333-001	M2000
<i>Product manual - S4Cplus M2000A</i>	3HAC022419-001	M2000A
<i>Operating manual - IRC5 with FlexPendant</i>	3HAC050941-001	M2004
<i>User's guide - S4Cplus (BaseWare OS 4.0)</i>	3HAC7793-1	M2000/M2000A
<i>Operating manual - Service Information System</i>	3HAC050944-001	M2004
<i>Operating manual - Calibration Pendulum</i>	3HAC16578-1	
<i>Operating manual - Levelmeter Calibration</i>	3HAC022907-001	M2000/M2000A
<i>Technical reference manual - Lubrication in gear-boxes</i>	3HAC042927-001	
<i>Technical reference manual - System parameters</i>	3HAC050948-001	M2004
<i>Application manual - Additional axes and stand alone controller</i>	3HAC051016-001	M2004
<i>Application manual - External axes</i>	3HAC9299-1	M2000
<i>Operating manual - RobotStudio</i>	3HAC032104-001	M2004

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

Additional document references

Document name	Document ID
<i>Application manual - CalibWare Field</i>	3HAC030421-001

Continues on next page

Revisions

Revision	Description
-	<p>First edition.</p> <p>Replaces previous manuals:</p> <ul style="list-style-type: none"> • Installation and Commissioning Manual • Maintenance Manual • Repair Manual, part 1 • Repair Manual, part 2. <p>Changes made in the material from the previous manuals:</p> <ul style="list-style-type: none"> • Model M2004 implemented.
A	<ul style="list-style-type: none"> • Chapter“ Calibration” replaced with chapter “Calibration information”. • Safety chapter rewritten. • Section Document references is completed with article numbers for calibration manuals.
B	<ul style="list-style-type: none"> • Sections are restructured into Replacement procedures, instead of removal/refitting procedures. • Procedure for refitting the motor of axis 1 is completed. • Correction made in Protection classes, robot on page 45. • Various corrections due to technical revisions etc.
C	<p>Changes made in:</p> <ul style="list-style-type: none"> • Prerequisites in section Overview • Oil change in section Maintenance
D	<p>Content updated in chapter/section:</p> <ul style="list-style-type: none"> • Section <i>What is an emergency stop?</i> added to chapter Safety. • <i>Maintenance/Maintenance schedule</i>: Interval for replacement of battery pack changed.
E	<p>Content updated in chapter/section:</p> <ul style="list-style-type: none"> • Decommissioning chapter added. • Sealing compound updated in Cut the paint or surface on the robot before replacing parts on page 112. • Circuit diagrams are not included in this document but delivered as separate files. See Circuit diagram on page 233. • List of standards updated, see Applicable standards on page 220. • Corrected spare part number for upper arm, see <i>Spare parts - upper arm, IRB 2400/10/16</i>. <p>Updates in the chapter <i>Safety</i>:</p> <ul style="list-style-type: none"> • Updated safety signal graphics for the levels <i>Danger</i> and <i>Warning</i>, see Safety signals in the manual on page 21. • New safety labels on the manipulators, see Safety symbols on manipulator labels on page 23. • Revised terminology: <i>robot</i> replaced with <i>manipulator</i>.
F	<p>Content updated in chapter/section:</p> <ul style="list-style-type: none"> • Corrected spare part number for gasket in <i>Spare parts - upper arm, IRB 2400/L</i>.

Continues on next page

Revision	Description
G	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • A new block, about general illustrations, added in section How to read the product manual on page 14. • Added Setting the system parameters for a suspended or tilted robot on page 60. • Corrections and changes in spare parts lists: <ul style="list-style-type: none"> - Item 27, 29, 34, 35, 39, 51, 57, 58 and 59 are corrected in <i>Spare parts - Upper arm</i>. The exploded view for the upper arm spare parts is updated so that item 44 (bearing for the upper and lower tie rod) is now shown, item 45 is moved and 61 is deleted, see <i>Spare part view 7</i>. - Item 16, 32, 35, 48, 56 and 134 are corrected and item 63 is removed in <i>Spare parts - Lower arm</i>. The exploded view for the lower arm spare parts is updated so that the sealings are shown for the upper and lower tie rod, see <i>Spare part view 1</i>. • Some general tightening torques have been changed/added, see updated values in Screw joints on page 223. • Added information about batteries. • Added Risk of tipping/stability on page 49. • Added Service Information System, M2000 on page 97 (information only valid for M2000 systems). • Touch-up paint added to Cut the paint or surface on the robot before replacing parts on page 112. • Added signal lamp.
H	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • All data about type of lubrication in gearboxes is moved from the manual to a separate lubrication manual, see Type and amount of oil in gearboxes on page 86. • A new SMB unit and battery is introduced, with longer battery lifetime.
J	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • Added information about risks when scrapping a decommissioned robot, see Scrapping of robot on page 217. • <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 2400</i>.
K	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • Minor corrections.
L	<p>This revision includes the following updates:</p> <ul style="list-style-type: none"> • Turning disc fixture is removed from special tools for Levelmeter calibration. • Guard plate is added to instruction "Replacement of brake release unit". See Replacement, brake release board on page 157 • Robot base hole configuration updated. • Oil change instructions for IRB2400L/5 kg added.
M	<p>Published in release R16.2. The following updates are done in this revision:</p> <ul style="list-style-type: none"> • Corrections due to updates in terminology. • Location of labels figure added.

Revision	Description
N	<p>Published in release R17.2. The following updates are made in this revision:</p> <ul style="list-style-type: none"> • Information about coupled axes in Updating revolution counters on IRC5 robots on page 205. • Caution about removing metal residues added in sections about SMB boards. • Information about minimum resonance frequency added. • Bending radius on static floor cables added. • New tightening torque for motors axis 1, axis 2 and axis 3. (Is 35 Nm, was 23 Nm) • Updated list of applicable standards. • Added information to brake release board replacement procedure. Corrected the replacement procedure and added/replaced figures in the section. • Section Start of robot in cold environments on page 77 added. • Updated information regarding disconnecting and reconnecting battery cable to serial measurement board.
P	<p>Published in release R18.1. The following updates are made in this revision:</p> <ul style="list-style-type: none"> • Added sections in General procedures on page 106. • Safety restructured. • Updated spare part number brake release board (was DSQC563, is DSQC1050). • Information about myABB Business Portal added.
Q	<p>Published in release 19B. The following updates are made in this revision:</p> <ul style="list-style-type: none"> • New touch up color Graphite White available. See Cut the paint or surface on the robot before replacing parts on page 112. • Levelmeter 2000 kit (6369901-347) no longer available. • Spare part number for o-ring in motors axis 1, 2 and 3 changed. (Is 21522012-434, was 3HAB3772-12)
R	<p>Published in release 20B. The following updates are made in this revision:</p> <ul style="list-style-type: none"> • Clarified and added information in mounting instructions for rotating sealings, see Mounting instructions for sealings on page 109. • Added information about Wrist Optimization and Calibration Pendulum in calibration chapter. • Replaced article number and name of grease, previously 3HAB3537-1.
S	<p>Published in release 21B. The following updates are made in this revision:</p> <ul style="list-style-type: none"> • Different numbers for standard cables before and after May 2018, see Power cable, power on page 75. • Illustration updated with a second connector interface view, see Supplying power to connector R1.MP on page 53.
T	<p>Published in release 22A. The following updates are done in this revision:</p> <ul style="list-style-type: none"> • Updated information about Gleitmo treated screws, see Screw joints on page 223. • Removed information about position switches as they are no longer available.

How to read the product manual

Reading the procedures

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

References to figures

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

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

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

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

References to required equipment

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

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

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

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

Safety information

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

Read more in the chapter [Safety on page 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.

Product documentation, M2000/M2000A

General

The complete product documentation kit for the M2000 robot system, including controller, robot and any hardware option, consists of the manuals listed below:

Product manuals

Manipulators, controllers, DressPack/SpotPack, and most other hardware will be 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).

Software manuals

The software documentation consists of a wide range of manuals, ranging from manuals for basic understanding of the operating system to manuals for entering parameters during operation.

A complete listing of all available software manuals is available from ABB.

Controller hardware option manual

Each hardware option for the controller is supplied with its own documentation.

Each document set contains the types of information specified below:

- Installation information
- Repair information
- Maintenance information

In addition, spare part information is supplied for the entire option.

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.



Tip

All documents can be found via myABB Business Portal, www.abb.com/myABB.

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 corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

Technical reference manuals

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

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, software).
- How to install included or required hardware.
- How to use the application.
- Examples of how to use the application.

Continues on next page

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 troubleshooters.

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1 Safety

1.1 Safety information

1.1.1 Limitation of liability

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.

The information does not cover how to design, install and operate a robot system, nor does it cover all peripheral equipment that can influence the safety of the robot system.

In particular, liability cannot be accepted if injury or damage has been caused for any of the following reasons:

- Use of the robot in other ways than intended.
- Incorrect operation or maintenance.
- Operation of the robot when the safety devices are defective, not in their intended location or in any other way not working.
- When instructions for operation and maintenance are not followed.
- Non-authorized design modifications of the robot.
- Repairs on the robot and its spare parts carried out by in-experienced or non-qualified personnel.
- Foreign objects.
- Force majeure.

Spare parts and equipment

ABB supplies original spare parts and equipment which have been tested and approved. The installation and/or use of non-original spare parts and equipment can negatively affect the safety, function, performance, and structural properties of the robot. ABB is not liable for damages caused by the use of non-original spare parts and equipment.

1 Safety

1.1.2 Requirements on personnel

1.1.2 Requirements on personnel

General

Only personnel with appropriate training are allowed to install, maintain, service, repair, and use the robot. This includes electrical, mechanical, hydraulics, pneumatics, and other hazards identified in the risk assessment.

Persons who are under the influence of alcohol, drugs or any other intoxicating substances are not allowed to install, maintain, service, repair, or use the robot.

The plant liable must make sure that the personnel is trained on the robot, and on responding to emergency or abnormal situations.

Personal protective equipment

Use personal protective equipment, as stated in the instructions.

1.2 Safety signals and symbols

1.2.1 Safety signals in the manual







Introduction to safety signals

This section specifies all safety signals used in the user manuals. Each signal consists of:

- A caption specifying the hazard level (DANGER, WARNING, or CAUTION) and the type of hazard.
- Instruction about how to reduce the hazard to an acceptable level.
- A brief description of remaining hazards, if not adequately reduced.

Hazard levels

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


Symbol	Designation	Significance
	DANGER	Signal word used to indicate an imminently hazardous situation which, if not avoided, will result in serious injury.
	WARNING	Signal word used to indicate a potentially hazardous situation which, if not avoided, could result in serious injury.
	ELECTRICAL SHOCK	Signal word used to indicate a potentially hazardous situation related to electrical hazards which, if not avoided, could result in serious injury.
	CAUTION	Signal word used to indicate a potentially hazardous situation which, if not avoided, could result in slight injury.
	ELECTROSTATIC DISCHARGE (ESD)	Signal word used to indicate a potentially hazardous situation which, if not avoided, could result in severe damage to the product.
	NOTE	Signal word used to indicate important facts and conditions.

Continues on next page

1 Safety

1.2.1 Safety signals in the manual

Continued

Symbol	Designation	Significance
	TIP	Signal word used to indicate where to find additional information or how to do an operation in an easier way.

1.2.2 Safety symbols on manipulator labels

Introduction to symbols

This section describes safety symbols used on labels (stickers) on the manipulator. 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 symbols on the labels on the product must be observed. Additional symbols added by the integrator must also be observed.




Types of symbols

Both the manipulator and the controller are marked with symbols, containing important information about the product. This is important for all personnel handling the robot, for example during installation, service, or operation.

The safety labels are language independent, they only use graphics. See [Symbols on safety labels on page 23](#).

The information labels can contain information in text.

Symbols on safety labels

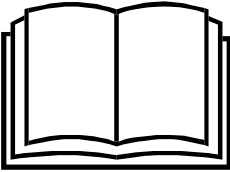
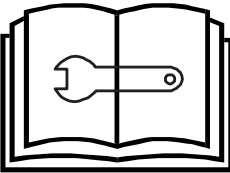
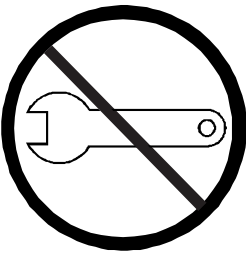
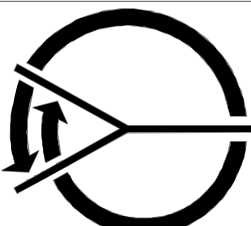

Symbol	Description
 xx0900000812	Warning! Warns that an accident <i>may</i> occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, etc.
 xx0900000811	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.
 xx0900000839	Prohibition Used in combinations with other symbols.

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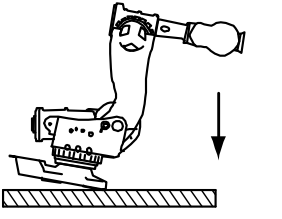

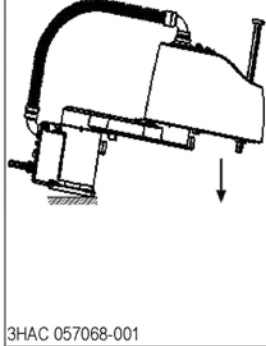
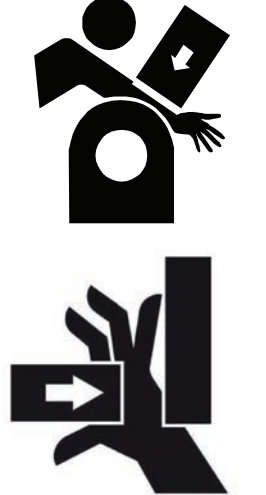
1 Safety

1.2.2 Safety symbols on manipulator labels

Continued

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



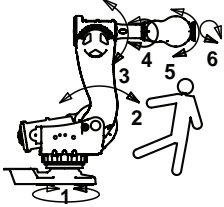
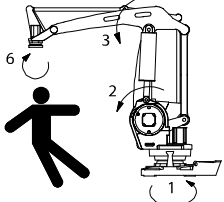
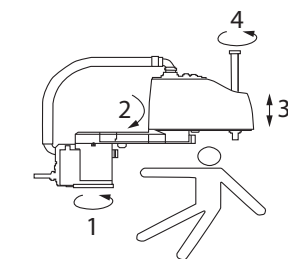
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Symbol	Description
 <p>xx0900000810</p>   <p>3HAC 057068-001</p> <p>xx1500002402</p>	<p>Tip risk when loosening bolts The robot can tip over if the bolts are not securely fastened.</p>
 <p>xx0900000817</p>	<p>Crush Risk of crush injuries.</p>

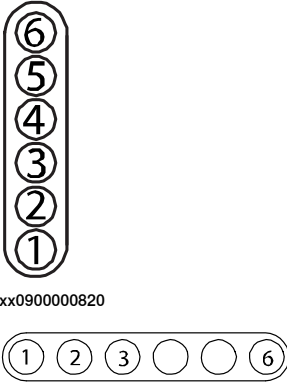

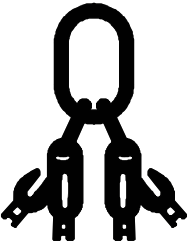



1 Safety

1.2.2 Safety symbols on manipulator labels

Continued

Symbol	Description
 xx0900000818  xx1300001087	Heat Risk of heat that can cause burns. (Both signs are used)
 xx0900000819  xx1000001141  xx1500002616	Moving robot The robot can move unexpectedly.

Continues on next page



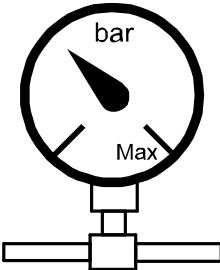
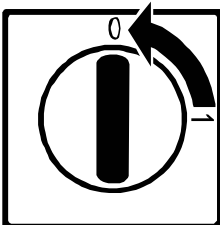

Symbol	Description
 <p>xx0900000820</p> <p>xx1000001140</p>	<p>Brake release buttons</p>
 <p>xx0900000821</p>	<p>Lifting bolt</p>
 <p>xx1000001242</p>	<p>Chain sling with shortener</p>
 <p>xx0900000822</p>	<p>Lifting of robot</p>
 <p>xx0900000823</p>	<p>Oil Can be used in combination with prohibition if oil is not allowed.</p>
 <p>xx0900000824</p>	<p>Mechanical stop</p>

Continues on next page

1 Safety

1.2.2 Safety symbols on manipulator labels

Continued

Symbol	Description
 xx1000001144	No mechanical stop
 xx0900000825	Stored energy Warns that this part contains stored energy. Used in combination with <i>Do not disassemble</i> symbol.
 xx0900000826	Pressure Warns that this part is pressurized. Usually contains additional text with the pressure level.
 xx0900000827	Shut off with handle Use the power switch on the controller.
 xx1400002648	Do not step Warns that stepping on these parts can cause damage to the parts.

1.3 Robot stopping functions

Protective stop and emergency stop

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

For more information see:

- *Product manual - IRC5*
- *Product manual - IRC5 Panel Mounted Controller*

1 Safety

1.4 Safety during installation and commissioning

1.4 Safety during installation and commissioning

National or regional regulations

The integrator of the robot system is responsible for the safety of the robot system.

The integrator is responsible that the robot system is designed and installed in accordance with the safety requirements set forth in the applicable national and regional standards and regulations.

The integrator of the robot system is required to perform a risk assessment.

Layout

The robot integrated to a robot system shall be designed to allow safe access to all spaces during installation, operation, maintenance, and repair.

If robot movement can be initiated from an external control panel then an emergency stop must also be available.

If the manipulator is delivered with mechanical stops, these can be used for reducing the working space.

A perimeter safeguarding, for example a fence, shall be dimensioned to withstand the following:

- The force of the manipulator.
- The force of the load handled by the robot if dropped or released at maximum speed.
- The maximum possible impact caused by a breaking or malfunctioning rotating tool or other device fitted to the robot.

The maximum TCP speed and the maximum velocity of the robot axes are detailed in the section *Robot motion* in the product specification for the respective manipulator.

Consider exposure to hazards, such as slipping, tripping, and falling.

Hazards due to the working position and posture for a person working with or near the robot shall be considered.

Hazards due to noise emission from the robot needs to be considered.

Consider hazards from other equipment in the robot system, for example, that guards remain active until identified hazards are reduced to an acceptable level.

Allergenic material

See [Environmental information on page 215](#) for specification of allergenic materials in the product, if any.

Securing the robot to the foundation

The robot must be properly fixed to its foundation/support, as described in the respective product manual.

When the robot is installed at a height, hanging, or other than mounted directly on the floor, there will be additional hazards.

Continues on next page

Electrical safety

Incoming mains must be installed to fulfill national regulations.

The power supply wiring to the robot must be sufficiently fused and if necessary, it must be possible to disconnect it manually from the mains power.

The power to the robot must be turned off with the main switch and the mains power disconnected when performing work inside the controller cabinet. Lock and tag shall be considered.

Harnesses between controller and manipulator shall be fixed and protected to avoid tripping and wear.

Wherever possible, power on/off or rebooting the robot controller shall be performed with all persons outside the safeguarded space.



Note

Use a CARBON DIOXIDE (CO₂) extinguisher in the event of a fire in the robot.

Safety devices

The integrator is responsible for that the safety devices necessary to protect people working with the robot system are designed and installed correctly.

When integrating the robot with external devices to a robot system:

- The integrator of the robot system must ensure that emergency stop functions are interlocked in accordance with applicable standards.
- The integrator of the robot system must ensure that safety functions are interlocked in accordance with applicable standards.

Other hazards

A robot may perform unexpected limited movement.



WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

The risk assessment should also consider other hazards arising from the application, such as, but not limited to:

- Water
- Compressed air
- Hydraulics

End-effector hazards require particular attention for applications which involve close human collaboration with the robot.

Continues on next page

1 Safety

1.4 Safety during installation and commissioning

Continued

Pneumatic or hydraulic related hazards



Note

The pressure in the complete pneumatic or hydraulic systems must be released before service and maintenance.

All components in the robot system that remain pressurized after switching off the power to the robot must be marked with clearly visible drain facilities and a warning sign that indicates the hazard of stored energy.

Loss of pressure in the robot system may cause parts or objects 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.

All pipes, hoses, and connections have to be inspected regularly for leaks and damage. Damage must be repaired immediately.

Verify the safety functions

Before the robot system is put into operation, verify that the safety functions are working as intended and that any remaining hazards identified in the risk assessment are mitigated to an acceptable level.

1.5 Safety during operation

Automatic operation

Verify the application in the operating mode manual reduced speed, before changing mode to automatic and initiating automatic operation.

Unexpected movement of robot arm



WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.



WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

1 Safety

1.6.1 Safety during maintenance and repair

1.6 Safety during maintenance and repair

1.6.1 Safety during maintenance and repair

General

Corrective maintenance must only be carried out by personnel trained on the robot. Maintenance or repair must be done with all electrical, pneumatic, and hydraulic power switched off, that is, no remaining hazards.

Hazards due to stored mechanical energy in the manipulator for the purpose of counterbalancing axes must be considered before maintenance or repair.

Never use the robot as a ladder, which means, do not climb on the controller, manipulator, including motors, or other parts. There are hazards of slipping and falling. The robot might be damaged.


Make sure that there are no loose screws, turnings, or other unexpected parts remaining after work on the robot has been performed.

When the work is completed, verify that the safety functions are working as intended.

Hot surfaces

Surfaces can be hot after running the robot, and touching these may result in burns. Allow the surfaces to cool down before maintenance or repair.

Allergic reaction

Warning	Description	Elimination/Action
 Allergic reaction	When working with lubricants there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.


Gearbox lubricants (oil or grease)

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










Note

Take special care when handling hot lubricants.

Warning	Description	Elimination/Action
 Hot oil or grease	Changing and draining gearbox oil or grease may require handling hot lubricant heated up to 90 °C.	Make sure that protective gear like goggles and gloves are always worn during this activity.

Continues on next page

Warning	Description	Elimination/Action
 Allergic reaction	When working with lubricants there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.
 Possible pressure build-up in gearbox	When opening the oil or grease plug, there may be pressure present in the gearbox, causing lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling.
 Do not overfill	Overfilling of gearbox lubricant can lead to internal over-pressure inside the gearbox which in turn may: <ul style="list-style-type: none"> • damage seals and gaskets • completely press out seals and gaskets • prevent the robot from moving freely. 	Make sure not to overfill the gearbox when filling it with oil or grease. After filling, verify that the level is correct.
 Do not mix types of oil	Mixing types of oil may cause severe damage to the gearbox.	When filling gearbox oil, do not mix different types of oil unless specified in the instructions. Always use the type of oil specified for the product.
 Heat up the oil	Warm oil drains quicker than cold oil.	Run the robot before changing the gearbox oil, if possible.
 Specified amount depends on drained volume	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.	After filling, verify that the level is correct.
 Contaminated oil in gearboxes	For lifetime reasons always drain as much oil as possible from the gearbox. The magnetic oil plugs will gather residual metal chips.	

Hazards related to batteries

Under rated conditions, the electrode materials and liquid electrolyte in the batteries are sealed and not exposed to the outside.

Continues on next page

1 Safety

1.6.1 Safety during maintenance and repair

Continued

There is a hazard in case of abuse (mechanical, thermal, electrical) which leads to the activation of safety valves and/or the rupture of the battery container. As a result under certain circumstances, electrolyte leakage, electrode materials reaction with moisture/water or battery vent/explosion/fire may follow.

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 [Operating conditions, robot on page 45](#).

See safety instructions for the batteries in *Material/product safety data sheet - Battery pack (3HAC043118-001)*.

Unexpected movement of robot arm



WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.



WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

Related information

See also the safety information related to installation and operation.

1.6.2 Emergency release of the robot axes

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 described in the section:

- [Manually releasing the brakes on page 52.](#)

The robot 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 manipulator does not result in additional hazards, for example, even more severe injuries on a trapped person.



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.

1 Safety

1.6.3 Brake testing

1.6.3 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 axis to a position where the combined weight of the manipulator 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 manipulator does not change position as the motors are switched off, then the brake function is adequate.



Note

It is recommended to run the service routine *BrakeCheck* as part of the regular maintenance, see the operating manual for the robot controller.

For robots with the option SafeMove, the *Cyclic Brake Check* routine is recommended. See the manual for SafeMove in [References on page 10](#).

1.7 Safety during troubleshooting

General

When troubleshooting requires work with power switched on, special considerations must be taken:

- Safety circuits might be muted or disconnected.
- Electrical parts must be considered as *live*.
- The manipulator can move unexpectedly at any time.



DANGER

Troubleshooting on the controller while powered on must be performed by personnel trained by ABB or by ABB field engineers.

A risk assessment must be done to address both robot and robot system specific hazards.



WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.



WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

Related information

See also the safety information related to installation, operation, maintenance, and repair.

1 Safety

1.8 Safety during decommissioning

1.8 Safety during decommissioning

General

See section [Decommissioning on page 215](#).

Unexpected movement of robot arm



WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.



WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

2 Installation and commissioning

2.1 Introduction to installation and commissioning

General

This chapter contains assembly instructions and information for installing the IRB 2400 at the working site.

See also the product manual for the robot controller.

The installation must be done by qualified installation personnel in accordance with the safety requirements set forth in the applicable national and regional standards and regulations.

Safety information

Before any installation work is commenced, all safety information must be 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

Always connect the IRB 2400 and the robot to protective earth and residual current device (RCD) before connecting to power and starting any installation work.

For more information see:

- *Product manual - IRC5*
- *Product manual - IRC5 Panel Mounted Controller*

2 Installation and commissioning

2.2.1 Pre-installation procedure

2.2 Unpacking

2.2.1 Pre-installation procedure

Introduction


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

Prerequisites for installation personnel

Installation personnel working with an ABB product must:

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

Checking the pre-requisites for installation

	Action
1	Make a visual inspection of the packaging and make sure that nothing is damaged.
2	Remove the packaging.
3	Check for any visible transport damage.  Note Stop unpacking and contact ABB if transport damages are found.
4	Clean the unit with a lint-free cloth, if necessary.
5	Make sure that the lifting accessory used (if required) is suitable to handle the weight of the robot as specified in: Weight, robot on page 42
6	If the robot is not installed directly, it must be stored as described in: Storage conditions, robot on page 45
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: Operating conditions, robot on page 45
8	Before taking the robot to its installation site, make sure that the site conforms to: <ul style="list-style-type: none">• Loads on foundation, robot on page 43• Protection classes, robot on page 45• Requirements, foundation on page 44
9	Before moving the robot, please observe the stability of the robot: Risk of tipping/stability on page 49
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: On-site installation on page 51
11	Install required equipment, if any. <ul style="list-style-type: none">• Signal lamp (option) on page 59

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 2400	380 kg

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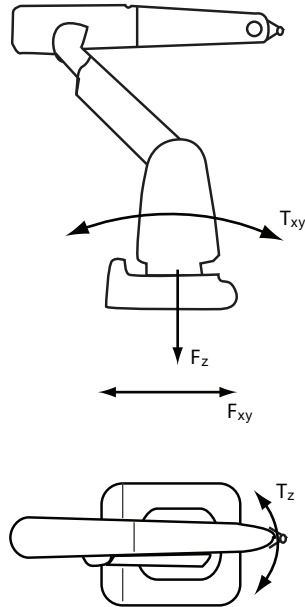
Note

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!



WARNING

The robot installation is restricted to the mounting options given in following load table(s).

Continues on next page

2 Installation and commissioning

2.2.1 Pre-installation procedure

Continued

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	IRB 2400 -10, -16: ± 2000 N IRB 2400 -L: ± 1700 N	IRB 2400 -10, -16: ± 2600 N IRB 2400 -L: ± 2100 N
Force z	IRB 2400 -10, -16: 4100 ± 1400 N IRB 2400 -L: 4100 ± 1100 N	IRB 2400 -10, -16: 4100 ± 1900 N IRB 2400 -L: 4100 ± 1400 N
Torque xy	IRB 2400 -10, -16: ± 3400 Nm IRB 2400 -L: ± 3000 Nm	IRB 2400 -10, -16: ± 4000 Nm IRB 2400 -L: ± 3400 Nm
Torque z	IRB 2400 -10, -16: ± 550 Nm IRB 2400 -L: ± 450 Nm	IRB 2400 -10, -16: ± 900 Nm IRB 2400 -L: ± 900 Nm

Suspended


Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	IRB 2400 -10, -16: ± 2000 N IRB 2400 -L: ± 1700 N	IRB 2400 -10, -16: ± 2600 N IRB 2400 -L: ± 2100 N
Force z	IRB 2400 -10, -16: $- 4100 \pm 1400$ N IRB 2400 -L: $- 4100 \pm 1100$ N	IRB 2400 -10, -16: $- 4100 \pm 1900$ N IRB 2400 -L: $- 4100 \pm 1400$ N
Torque xy	IRB 2400 -10, -16: ± 3400 Nm IRB 2400 -L: ± 3000 Nm	IRB 2400 -10, -16: ± 4000 Nm IRB 2400 -L: ± 3400 Nm
Torque z	IRB 2400 -10, -16: ± 550 Nm IRB 2400 -L: ± 450 Nm	IRB 2400 -10, -16: ± 900 Nm IRB 2400 -L: ± 900 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	5°	

Continues on next page

Requirement	Value	Note
Minimum resonance frequency	30 Hz  Note It may affect the manipulator life-time to have a lower resonance frequency than recommended.	The value is recommended for optimal performance. Due to foundation stiffness, consider robot mass including equipment. ⁱ For information about compensating for foundation flexibility, see the application manual of the controller software, section <i>Motion Process Mode</i> .

- ⁱ The minimum resonance frequency given should be interpreted as the frequency of the robot mass/inertia, robot assumed stiff, when a foundation translational/torsional elasticity is added, i.e., the stiffness of the pedestal where the robot is mounted. The minimum resonance frequency should not be interpreted as the resonance frequency of the building, floor etc. For example, if the equivalent mass of the floor is very high, it will not affect robot movement, even if the frequency is well below the stated frequency. The robot should be mounted as rigid as possible to the floor.
Disturbances from other machinery will affect the robot and the tool accuracy. The robot has resonance frequencies in the region 10 – 20 Hz and disturbances in this region will be amplified, although somewhat damped by the servo control. This might be a problem, depending on the requirements from the applications. If this is a problem, the robot needs to be isolated from the environment.

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

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

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

Parameter	Value
Minimum ambient temperature	+5° C
Maximum ambient temperature	+45° C
Maximum ambient humidity	Max. 95% at constant temperature

Protection classes, robot

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

Protection type	Protection class ^l
Manipulator, protection type Standard	IP 54
Manipulator, protection type Foundry Plus	IP 67
Manipulator, protection type Clean Room	IP 54
Manipulator, protection type Wash	IP 67

2 Installation and commissioning

2.2.2 Working range

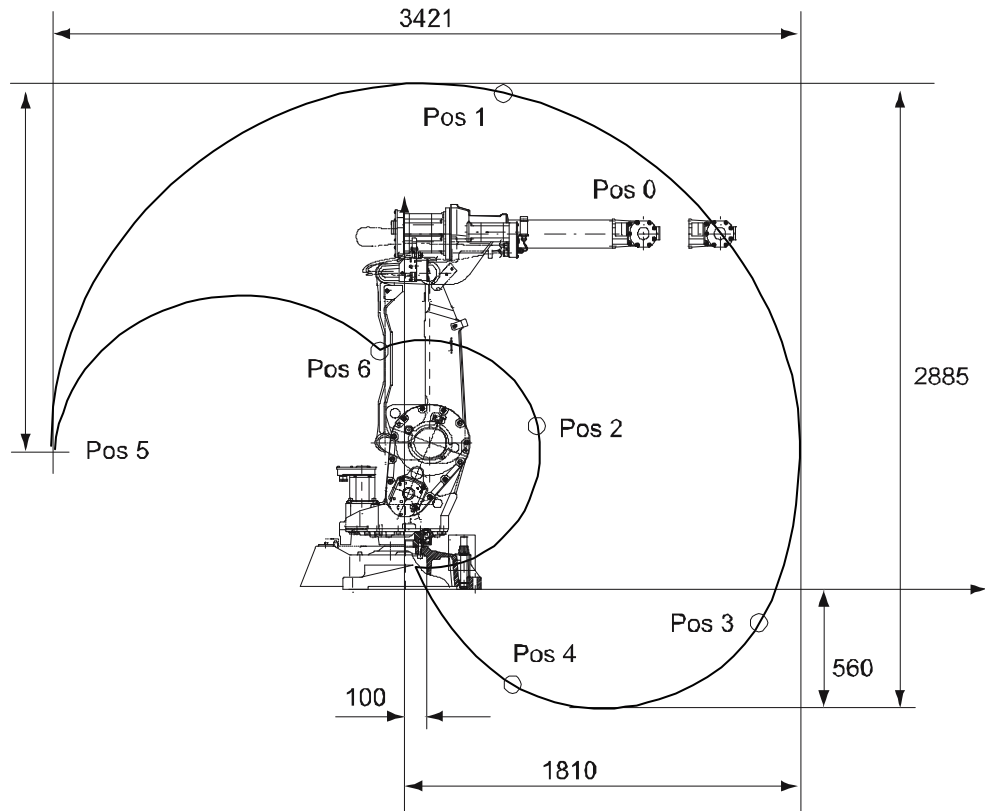
2.2.2 Working range

Working range

This section specifies the working areas of the robot models.

IRB 2400/L

The working area is the same for both floor and inverted (suspended). Positions are located at wrist center.



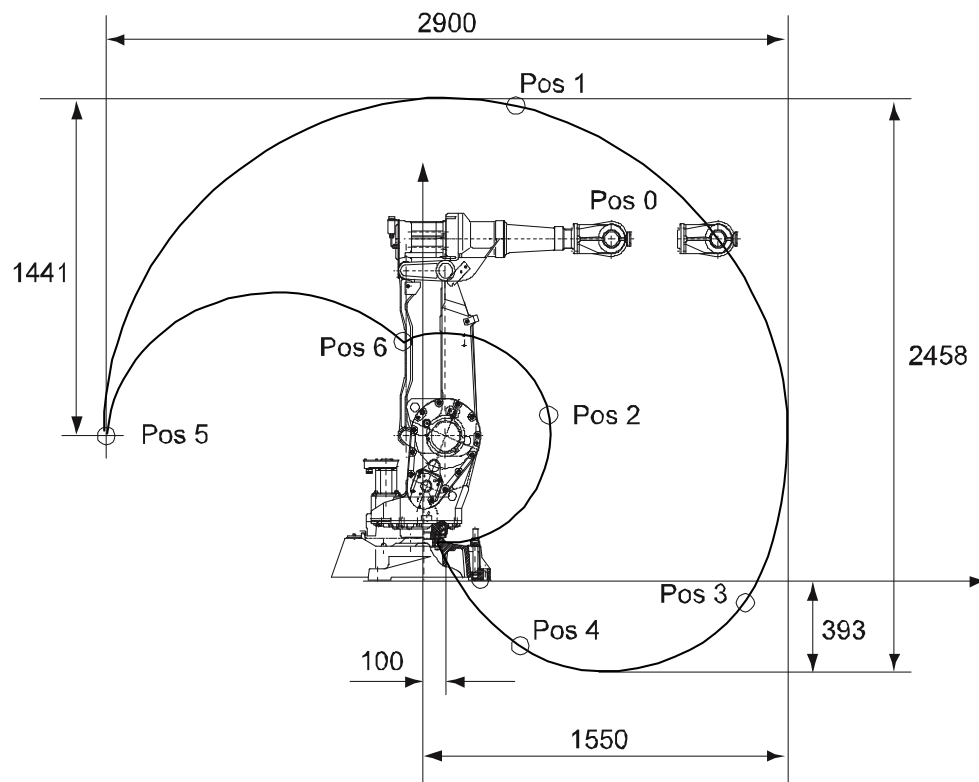
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Pos.	X	Z	Angle axis 2	Angle axis 3
0	970	1620	0	0
1	404	2298	0	-60
2	602	745	0	65
3	1577	-246	110	-60
4	400	-403	110	24.5
5	-1611	623	-100	-60
6	-115	1088	-100	65

Continues on next page

IRB 2400/10, /16

The working area is the same for both floor and inverted (suspended). Positions are located at wrist center.



xx0200000160

Pos.	X	Z	Angle axis 2	Angle axis 3
0	855	1455	0	0
1	360	2041	0	-60
2	541	693	0	65
3	1351	-118	110	-60
4	400	-302	110	18.3
5	-1350	624	-100	-60
6	-53	1036	-100	65

Positions in the working range

The table below specifies the positions inside the working range, shown in the figure above.

Position in figure	Position (mm)		Angles (°)	
	X	Z	Axis 2	Axis 3
1	870	1139	0	0
2	510	1246	-28	-17
3	446	722	-28	31
4	515	218	60	119

Continues on next page

2 Installation and commissioning

2.2.2 Working range

Continued

Position in figure	Position (mm)		Angles (°)	
	X	Z	Axis 2	Axis 3
5	607	-73	85	119
6	1506	210	85	26
7	1313	1148	42	-17

2.2.3 Risk of tipping/stability

Risk of tipping

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

The shipping position is the most stable position.



WARNING

The robot will be mechanically unstable if not properly secured to the foundation.

2 Installation and commissioning

2.2.4 The unit is sensitive to ESD

2.2.4 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.

Safe handling

Use one of the following alternatives:

- Use a wrist strap.

Wrist straps must be tested frequently to ensure that they are not damaged and are operating correctly.

- Use an ESD protective floor mat.

The mat must be grounded through a current-limiting resistor.

- Use a dissipative table mat.

The mat should provide a controlled discharge of static voltages and must be grounded.

2.3 On-site installation

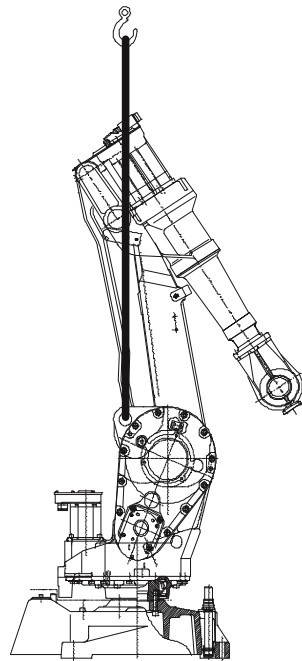
2.3.1 Lifting robot with lifting slings

Required equipment

Equipment	Note
Sling line Type: KDBK 7-8.	Length: 2 m. Load at 90° : 380 kg.

Illustration, attachment of lifting slings

The figure below shows how to attach the lifting slings to the robot.



xx020000164

Lifting of robot

	Action	Note
1	Move the robot to the lifting position shown in the figure above.	If necessary, release the brakes as detailed in section Manually releasing the brakes on page 52 .
2	Attach the straps to the special eye bolts on the gearboxes for axes 2 and 3.	
3	Lift the robot carefully.	

2 Installation and commissioning

2.3.2 Manually releasing the brakes


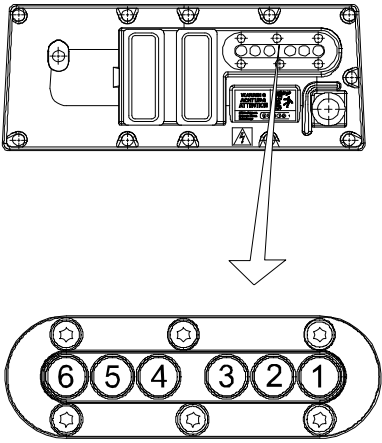
2.3.2 Manually releasing the brakes

General

The holding brakes of each axis' motor are of an electromechanical type and are released when voltage is applied. This section details how to release the brakes, using the internal brake release unit, in order to enable the axes to move manually. The brake of each motor can also be released by connecting an external voltage supply directly on the motor connector, see the circuit diagram or the repair procedures for each motor (section [Motors on page 164](#)).

Releasing the brakes using the brake release unit

The procedure below details how to release the holding brakes using the internal brake release unit.

	Action	Note/Illustration
1	 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!	
2	If the robot is not connected to the controller, power must be supplied to the connector R1.MP.	Detailed in section Supplying power to connector R1.MP on page 53 .
3	The internal brake release unit is located at the base of the robot and equipped with buttons for controlling the holding brakes for each axis separately. The buttons are numbered according to the numbers of the axes. To release the brake on a particular robot axis, push the corresponding button on the internal brake release panel and keep it depressed. The brake will function again as soon as the button is released.	 xx0600002697

Continues on next page

2 Installation and commissioning

2.3.3 Orienting and securing the robot

2.3.3 Orienting and securing the robot

General

This section details how to orient and secure the robot to the foundation in order to safely run the robot. The requirements for the foundations are shown in [Requirements, foundation on page 44](#).

For suspended mounting, see [Setting the system parameters for a suspended or tilted robot on page 60](#).

Bolting requirements

When bolting a base plate or the base to a concrete floor, follow the general instructions for expansion-shell bolts. The screw joint must be able to withstand the stress loads defined in section [Pre-installation procedure on page 42](#).



Note

When the robot is to be mounted in a tilted or a suspended position, the guide sleeves must be used to secure the bolted joint.

Attachment screws

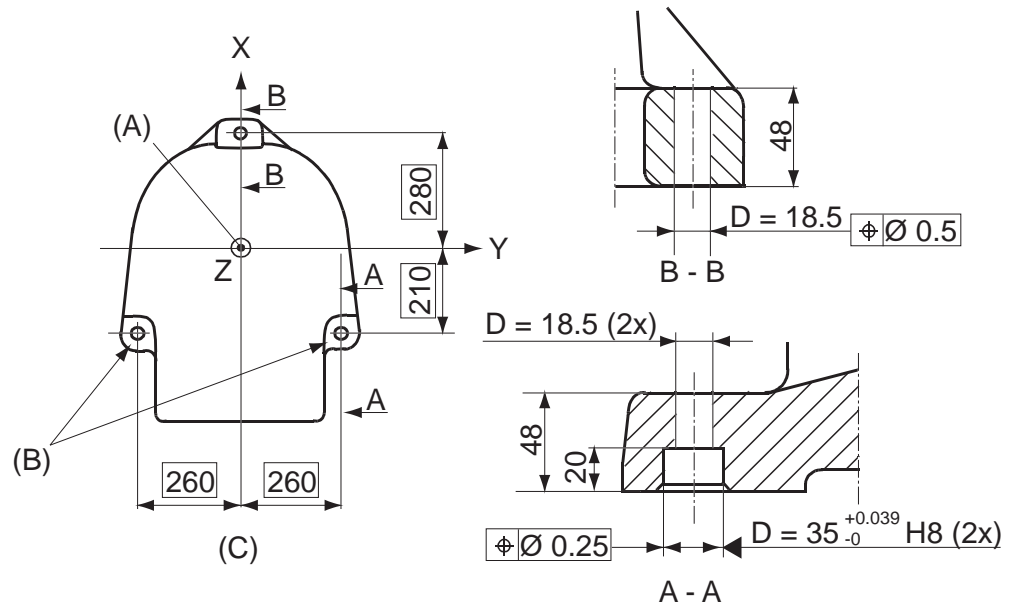
The table below specifies the type of securing screws and washers to be used for securing the robot to the base plate/foundation.

Suitable screws, lightly lubricated:	M16 x 50
Quality	Quality 8.8
Suitable washer:	Thickness: 3 mm Outer diameter: 30 mm Inner diameter: 17 mm
Tightening torque:	190 Nm

Continues on next page

Hole configuration

The figure below shows the hole configuration of the robot base, and cross section of the guide sleeve holes used when securing the robot.



xx1400002065

Guide sleeves

Two guide sleeves can be fitted to the two rear bolt holes to allow the same robot to be remounted without re-adjusting the program.

Equipment	Art. no.
Guide sleeves	2151 0024-169

2 Installation and commissioning

2.3.4 Mounting the robot in suspended position

2.3.4 Mounting the robot in suspended position

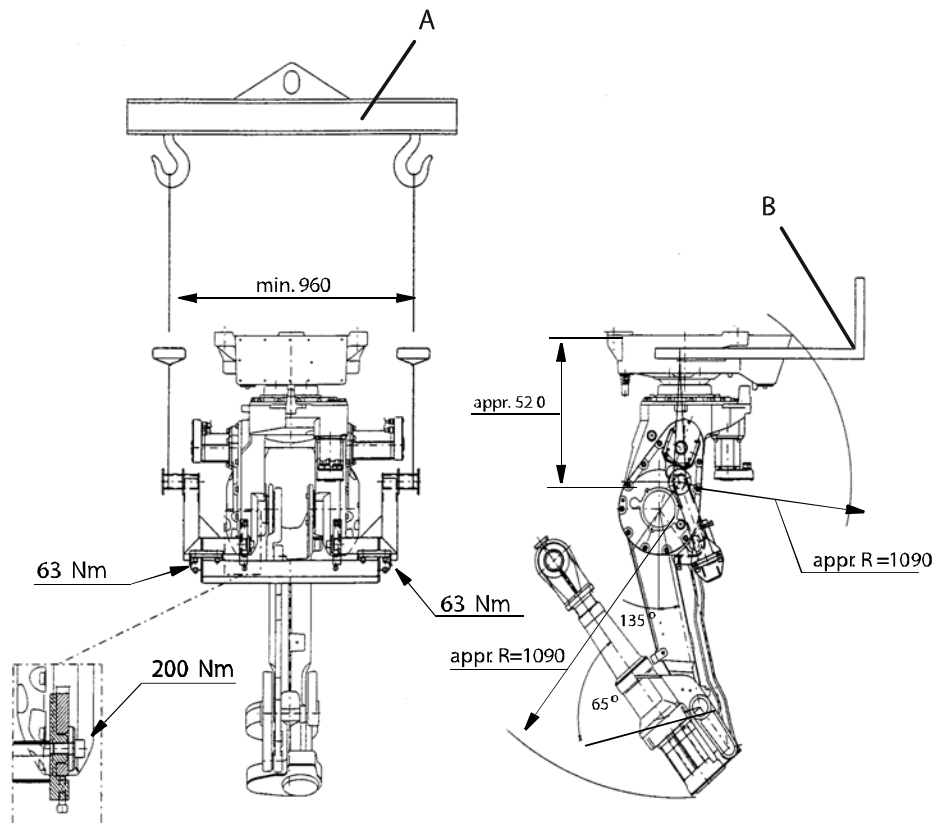
General

The robot can be mounted in a suspended position. This section details how to turn the robot.

How to change the system parameters is detailed in [Setting the system parameters for a suspended or tilted robot on page 60](#).

Turning the robot

- 1 Use the special tool for inverted mounting, see following figure.



xx0200000212

A	Lifting beam
B	Fork lift
-	Inverted mounting tool 3HAB8961-1

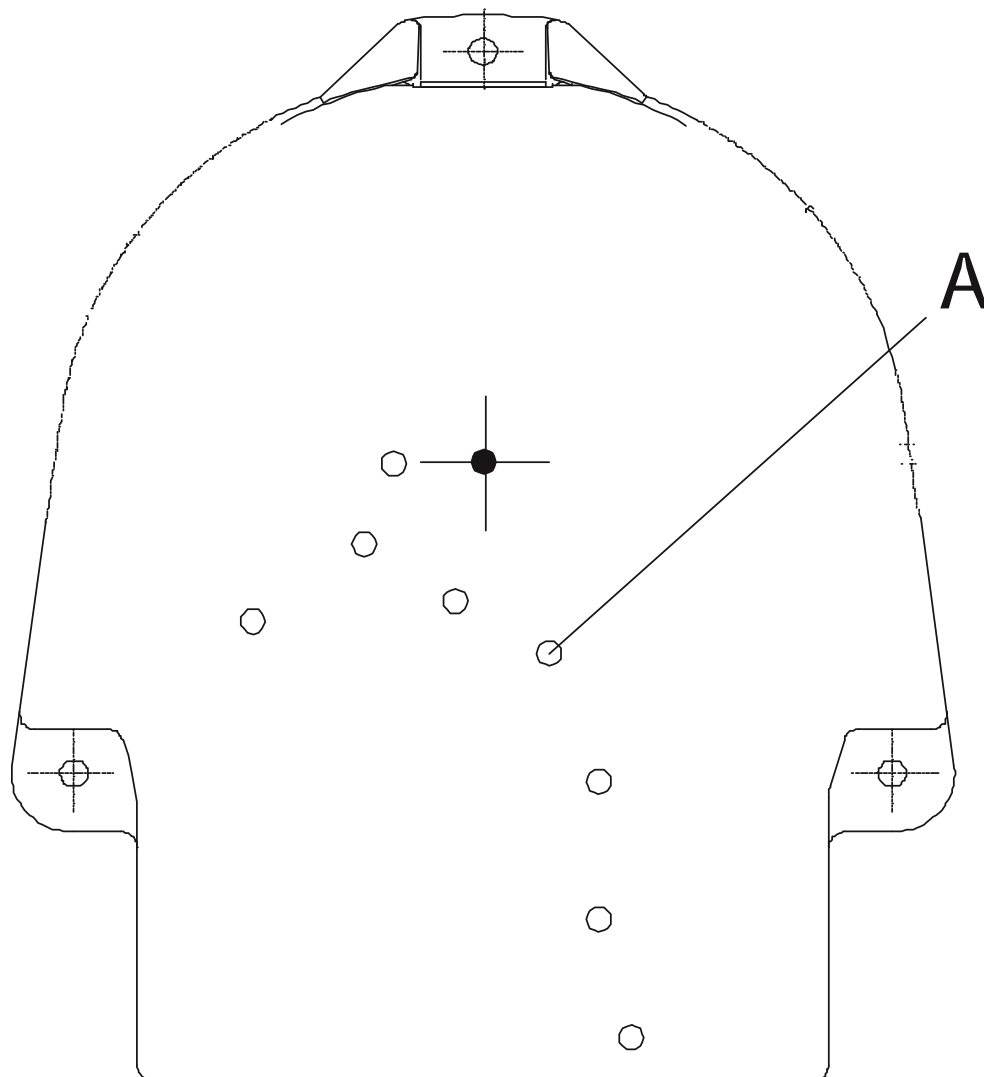
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2 Installation and commissioning

2.3.4 Mounting the robot in suspended position

Continued

- 2 Seal the eight holes in the bottom plate with plastic plugs, see following figure.



xx0200000215

A	Plastic plugs (x8)
---	--------------------

2 Installation and commissioning

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

2.3.5 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 be defined in the software.

- *User's guide - S4Cplus (BaseWare OS 4.0)*
- *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.

2.3.6 Signal lamp (option)

Description

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

Installation

See the assembly instruction delivered with the signal lamp.

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.

2 Installation and commissioning

2.3.7 Setting the system parameters for a suspended or tilted robot

2.3.7 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 re-defined.



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 44](#).

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 on a wall (rotated around the y-axis), then the robot base frame and the system parameter *Gravity Beta* must be redefined. *Gravity Beta* should then be π (+3.141593) if the robot is mounted upside down (suspended), or $\pm\pi/2$ (± 1.570796) if mounted on a wall.

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°)	Gravity Beta
Floor mounted	0°	0.000000 (Default)
Suspended mounting	180°	3.141593

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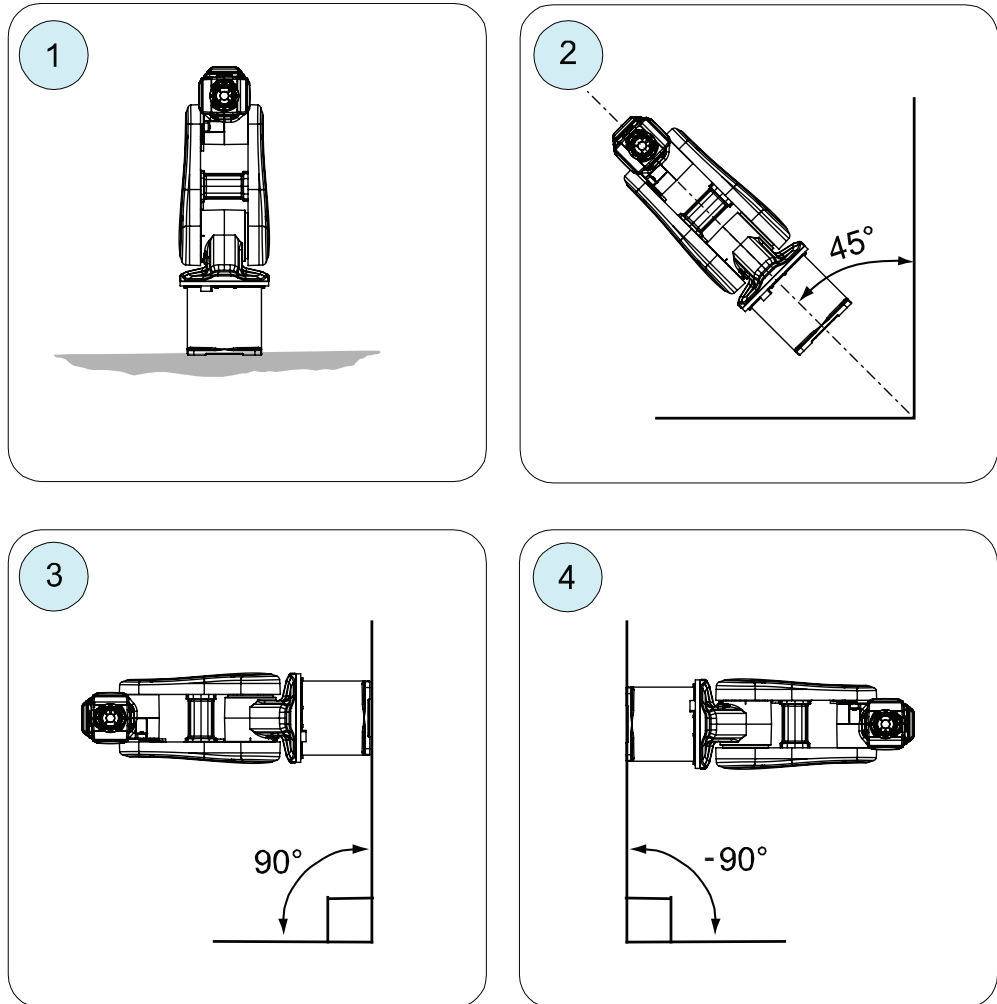
2 Installation and commissioning

2.3.7 Setting the system parameters for a suspended or tilted robot

Continued

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

The following illustration shows the IRB 120, but the same principle applies for all robots.



xx1500000532

Pos	Mounting angle	Gravity Alpha
1	0° (Floor mounted)	0
2	45° (Tilted)	0.785398
3	90° (Wall)	1.570796
4	-90° (Wall)	-1.570796



Note

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

Continues on next page

Defining the parameter in the software, M2000/M2000A

Following steps describes how to enter the correct gravity beta values.

	Action
1	Choose <i>Topics: Manipulator</i> .
2	Choose <i>Types: Robot</i> .
3	Select <i>Master</i> and press Enter.
4	Select the desired parameter <i>Gravity Beta</i> and change its value.
5	Press OK to confirm.

Defining the parameter in RobotWare

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 61](#).

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

The system parameters are configured in RobotStudio or on the FlexPendant.

2 Installation and commissioning

2.4.1 Axes with restricted working range

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)
- Axis 2, hardware (mechanical stop).

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



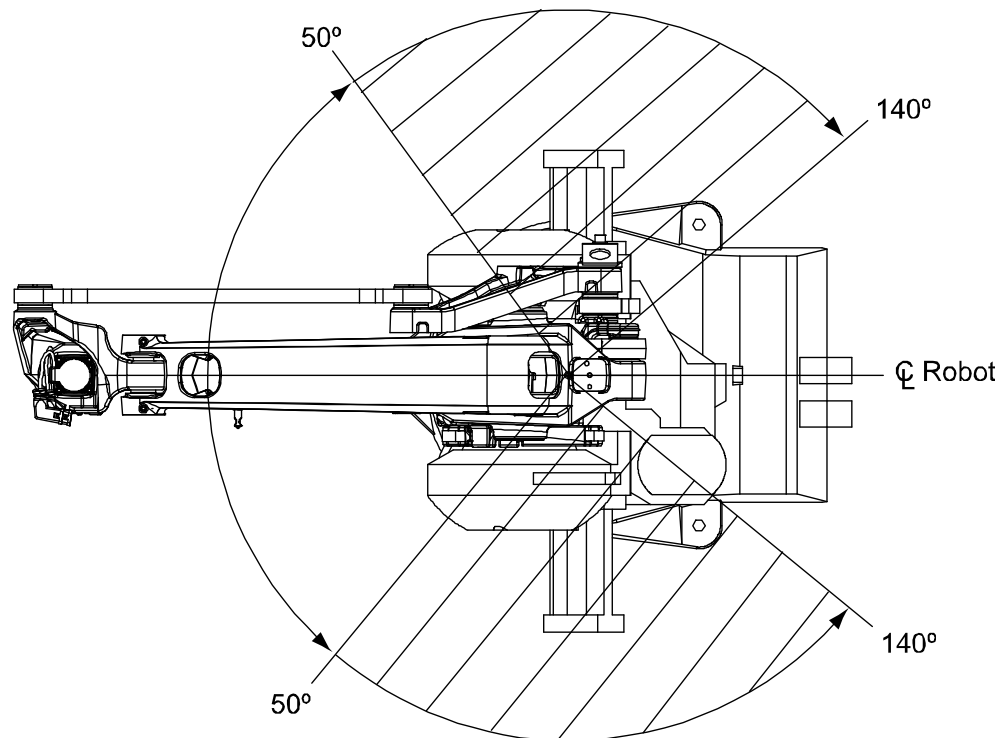
Note

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

2.4.2 Mechanically restricting the working range of axis 1

Restrictions in the working range

The working range of axis 1 can be restricted within the area from 50° to 140° as shown in the figure below. The restrictions are made by fitting two extra stops to the robot base and adjusting the system parameter configuration.



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Continues on next page

2 Installation and commissioning

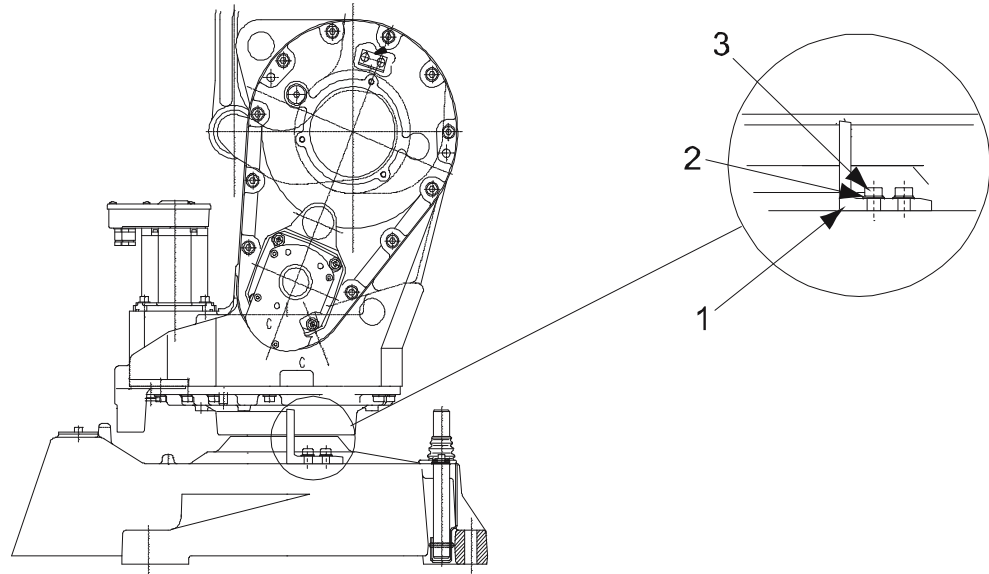
2.4.2 Mechanically restricting the working range of axis 1

Continued

Location of the mechanical stop, axis 1

The extra mechanical stop is fitted to the robot base as shown in the figure below.

Note! The stop must only be mounted in the direction shown below!



xx020000205

1	Mechanical stop, axis 1, removable
2	Plain washer
3	Hex socket head cap screw

Required equipment

Equipment	Art. no.	Note
Mechanical stop unit, axis 1	3HAB7298-1	Includes: <ul style="list-style-type: none"> removable stop (2 pcs) plain washers (4 pcs) hex socket head cap screw (4 pcs, M12x30) drill template (1 pc)
<i>User's guide - S4Cplus (BaseWare OS 4.0) (RobotWare 4.0)</i> <i>Technical reference manual - System parameters</i>	-	Art. no. is specified in References on page 10 .

Fitting, mechanical stop axis 1

The procedure below details how to fit a mechanical stop to the robot base.


	Action	Note
1	Decide where to fit the extra mechanical stops, according to the figure Location of where to drill holes for extra stops on page 68 .	
2	Make a copy of the drill template, enclosed with the mechanical stop.	The template is also shown in the figure Drill template on page 70 in scale 1:1.

Continues on next page

2 Installation and commissioning

2.4.2 Mechanically restricting the working range of axis 1

Continued

	Action	Note
3	Use the template to mark the center of the two holes on each stop.	Place the template edge edge with the robot base, as shown in the figure Location of where to drill holes for extra stops on page 68 .
4	Drill the holes through, Ø 10.2. Cut threads, M12.	
5	Fit the stops to the robot base, but without tightening the screws.	Note! The stops must be mounted in correct direction, as shown in the figure Location of where to drill holes for extra stops on page 68 .
6	Turn axis 1 manually and check the working range between the stops.	If necessary; correct the angle of impact.
7	Tighten the screws.	
8	Adjust the software working range limitations (system parameter configuration) to correspond to the mechanical limitations.	How to define the range of movement in RobotWare 4.0 is detailed in <i>User's guide - S4Cplus (BaseWare OS 4.0), chapter System Parameters - topic Manipulator</i> . The system parameters that must be changed (<i>Upper joint bound</i> and <i>Lower joint bound</i>) are described in <i>Technical reference manual - System parameters</i> .
9	 WARNING If the <i>mechanical stop pin</i> is deformed after a hard collision, it must be replaced! Deformed <i>movable stops</i> and/or <i>additional stops</i> as well as deformed <i>attachment screws</i> must also be replaced after a hard collision.	

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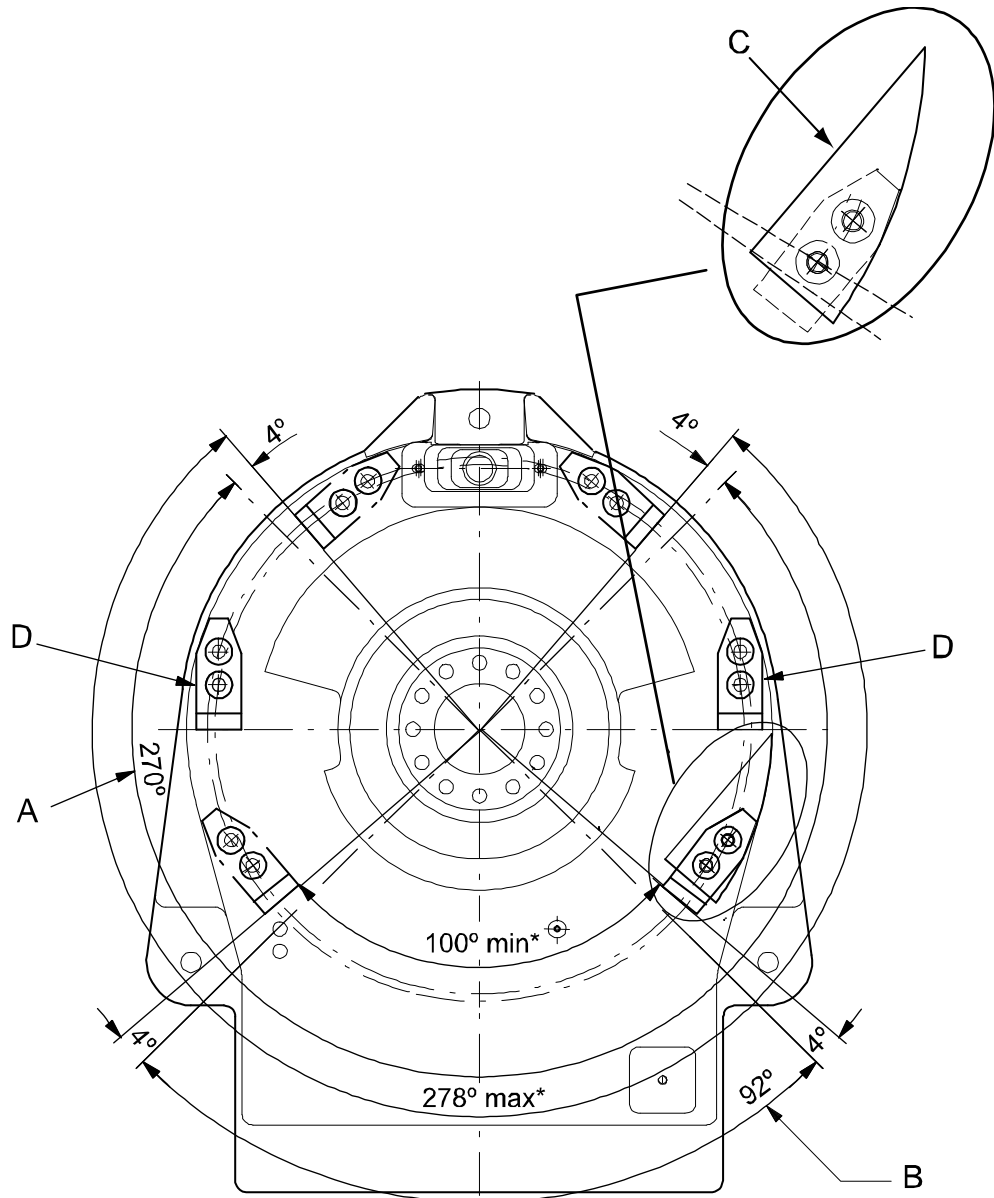
2 Installation and commissioning

2.4.2 Mechanically restricting the working range of axis 1

Continued

Location of where to drill holes for extra stops

The figure below shows the drill pattern used when drilling for mechanical stops on axis 1.



xx020000206

A	Maximum working range, axis 1
B	Minimum working range, axis 1
C	Drilling pattern enclosed with the mechanical stop.
D	This mounting direction only
*	The minimum and maximum measurement between the mechanical stops. The difference between the measurement and the minimum and maximum working range is $2 \times 4^\circ$, which corresponds to the width of the stop pin (at the frame).

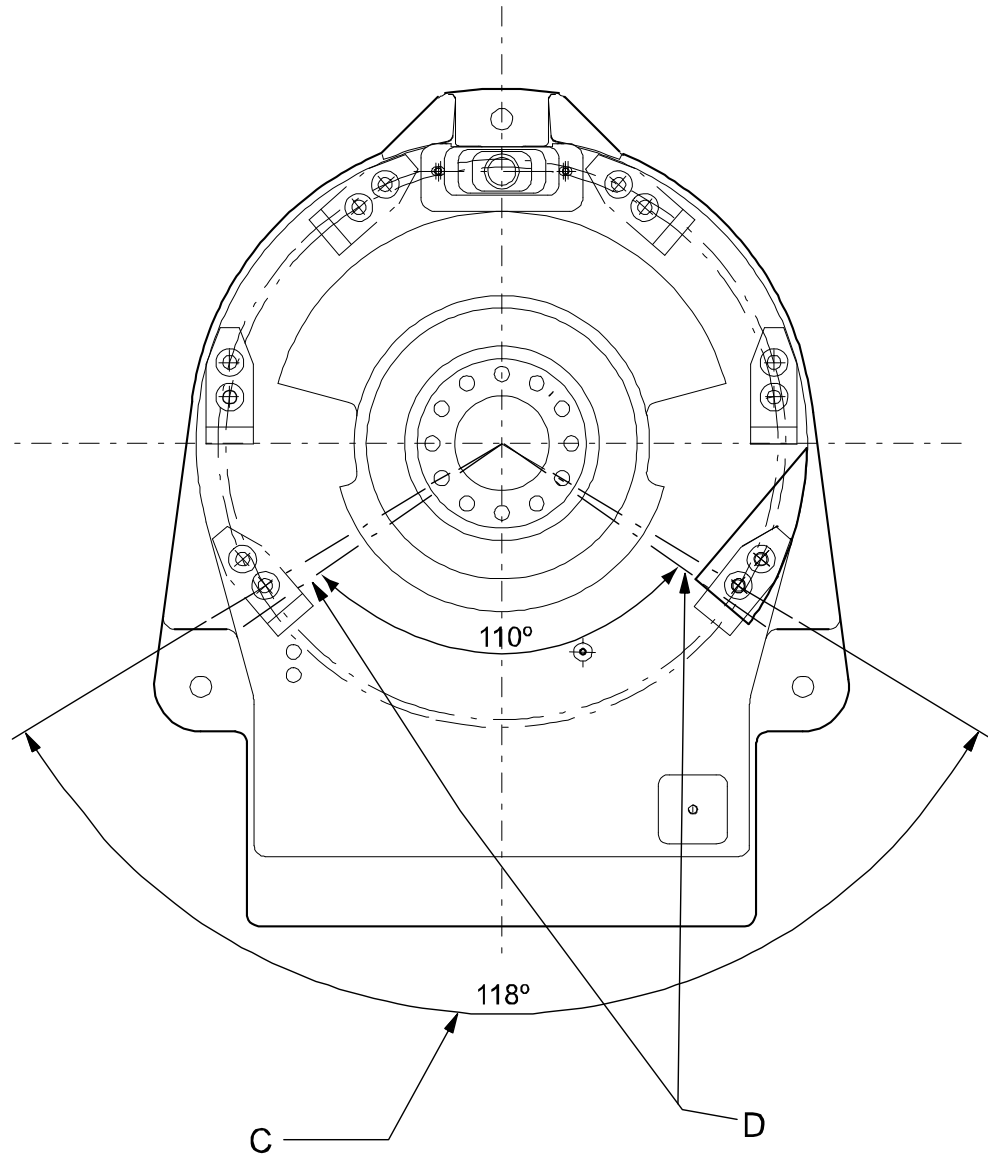
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2 Installation and commissioning

2.4.2 Mechanically restricting the working range of axis 1

Continued

Hidden stiffening ribs and forbidden drilling sector



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C	Drilling not allowed inside this sector!
D	Center lines for the hidden stiffening ribs

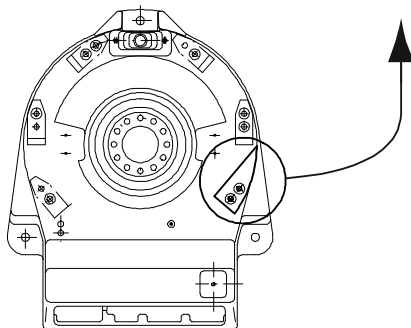
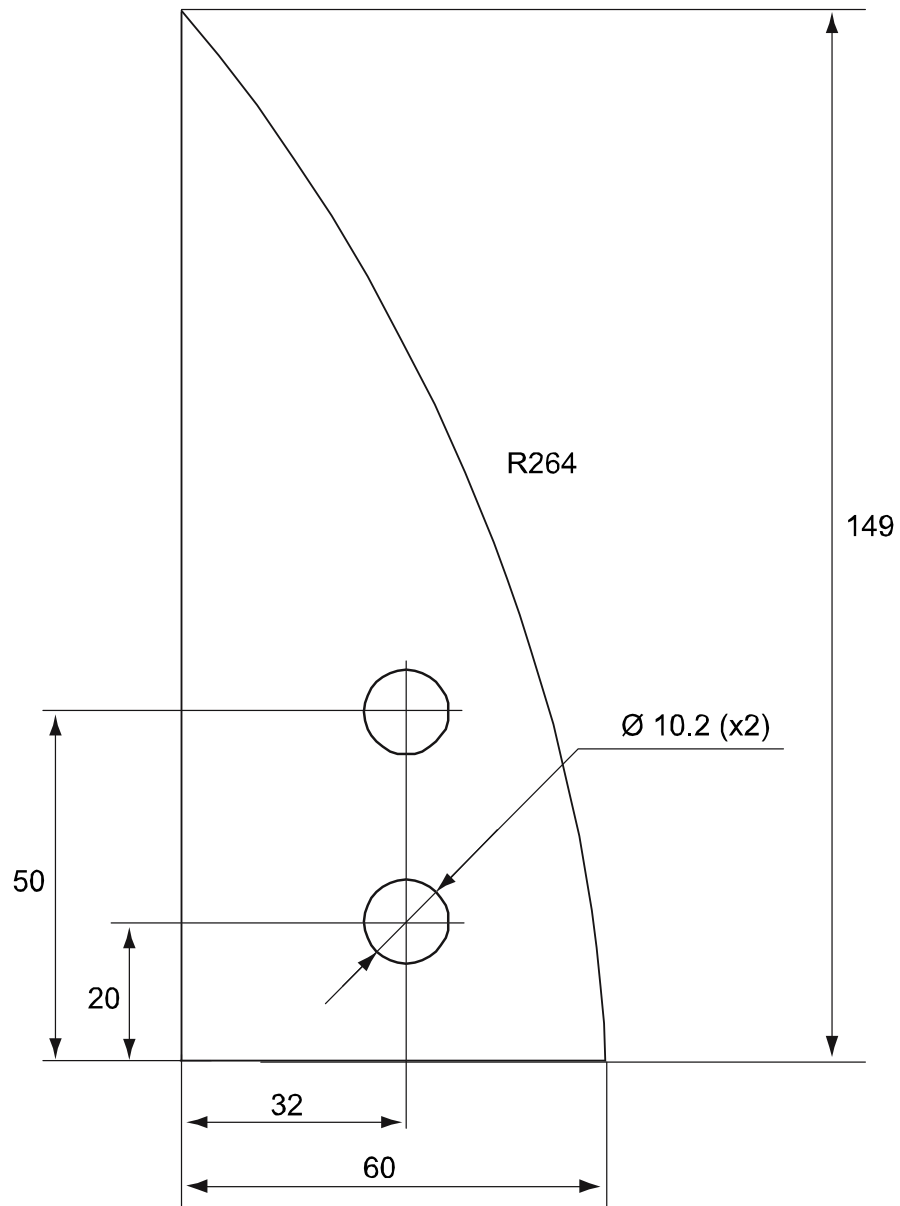
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2 Installation and commissioning

2.4.2 Mechanically restricting the working range of axis 1

Continued

Drill template



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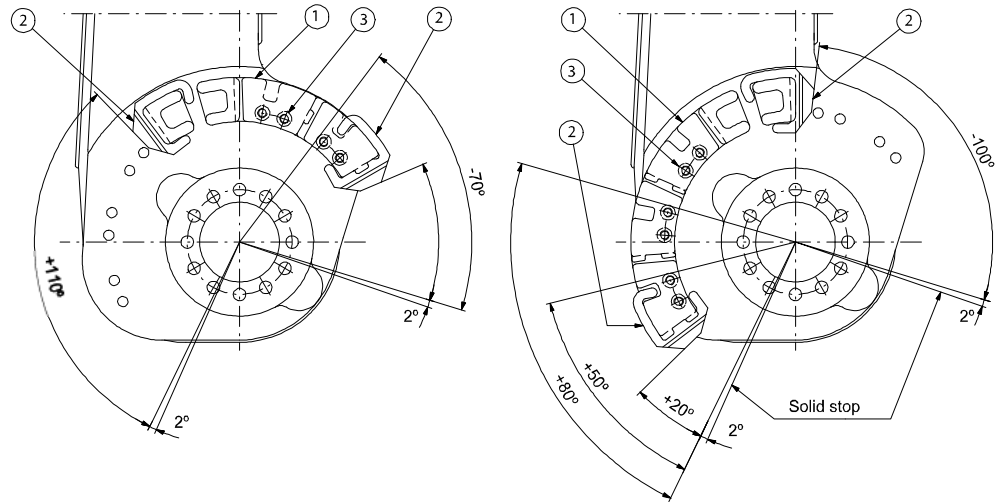
2.4.3 Mechanically restricting the working range of axis 2

General

The range of rotation for axis 2 can be limited mechanically by fitting extra stops on the lower arm.

Restrictions in working range

The figure below shows the mechanical stops available. The number of items that are needed for different working ranges are specified in the following table.



xx0200000208

Working range	Qty. item 1	Qty. item 2	Qty. item 3
+110° / -100°	-	-	-
+110° / -70°	1	2	2
+110° / -40°	2	2	4
+80° / -100°	1	2	2
+80° / -70°	2	2	4
+80° / -40°	3	2	6
+50° / -100°	2	2	4
+50° / -70°	3	2	6
+50° / -40°	4	2	8
+20° / -100°	3	2	6
+20° / -70°	4	2	8
+20° / -40°	5	2	10

Required equipment

Equipment	Art. no.	Note
Stop, axis 2	3HAC 2624-1	

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2 Installation and commissioning

2.4.3 Mechanically restricting the working range of axis 2

Continued

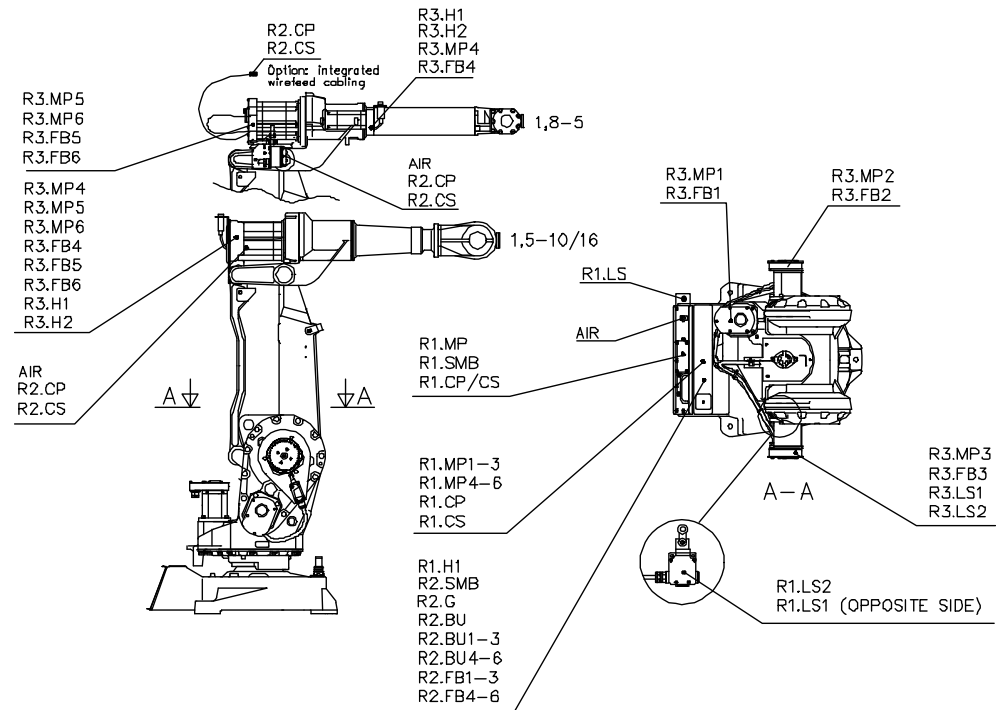
Equipment	Art. no.	Note
<i>User's guide - S4Cplus (BaseWare OS 4.0) (RobotWare 4.0)</i> <i>Technical reference manual - System parameters</i>	-	Art. no. is specified in section References on page 10 .
Standard toolkit	-	The content is defined in the section Standard tools on page 227 .

2.5 Electrical connections

2.5.1 Connectors on robot

Connectors on the robot

The figure below shows all connections of the robot cabling, including the customer connections.



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2 Installation and commissioning

2.5.2 Robot cabling and connection points

2.5.2 Robot cabling and connection points

Introduction

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

Main cable categories

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

Cable category	Description
Robot cables	Handles power supply to and control of the robot's motors as well as feedback from the serial measurement board. Specified in the table Robot cables on page 74 .
Position switch cables (option)	Handles supply to and feedback from any position switches on the robot. Specified in the table Position switch cables, robot base to controller (option) on page 76 .
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. See the product manual for the controller ¹⁾ .
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> or <i>Application manual - External axes (M2000)</i> ¹⁾ .

¹⁾ Art. no. is specified in section [References on page 10](#).

The cable categories are divided into sub-categories, specified below:

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

Continues on next page

Power cable, power



Note

Depending on whether the manipulator is built before or after 2018-05, the connection interface differs, and the choice of manipulator cable must be made accordingly. Check the interface and select cable according to the following tables.

Before May 2018

Art. no.	Description	Note
3HAC2492-1	Control cable power 7 m	Standard
3HAC2529-1	Control cable power 15 m	Standard
3HAC2839-1	Control cable power 22 m	Standard
3HAC2564-1	Control cable power 30 m	Standard
3HAC9038-1	Control cable power 7 m	Foundry Wash
3HAC9038-2	Control cable power 15 m	Foundry Wash
3HAC9038-3	Control cable power 22 m	Foundry Wash
3HAC9038-4	Control cable power 30 m	Foundry Wash

From May 2018

Art. no.	Description	Note
3HAC9038-1	Control cable power 7 m	Standard Foundry Wash
3HAC9038-2	Control cable power 15 m	Standard Foundry Wash
3HAC9038-3	Control cable power 22 m	Standard Foundry Wash
3HAC9038-4	Control cable power 30 m	Standard Foundry Wash

Robot cable, signals

Cable	Art. no.
Robot cable signal, shielded: 7 m	3HAC7998-1
Robot cable signal, shielded: 15 m	3HAC7998-2
Robot cable signal, shielded: 22 m	3HAC7998-3
Robot cable signal, shielded: 30 m	3HAC7998-4

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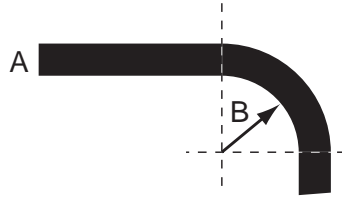
2 Installation and commissioning

2.5.2 Robot cabling and connection points

Continued

Bending radius for static floor cables

The minimum bending radius is 10 times the cable diameter for static floor cables.



xx1600002016

A	Diameter
B	Diameter x10

Position switch cables, robot base to controller (option)

These cables are *not* included in the standard delivery, but are included in the delivery if the position switch option is ordered. The position switches can also be ordered without cables. The cables are completely pre-manufactured and ready to plug in.

Cabling between robot base and controller

Cable	Art. no.	Connection point, robot	Connection point, cabinet
Position switch cable, axis 1, 7 m	3HAC7997-1	R1.SW	XS8
Position switch cable, axis 1, 15 m	3HAC7997-2	R1.SW	XS8
Position switch cable, axis 1, 22 m	3HAC7997-3	R1.SW	XS8
Position switch cable, axis 1, 30 m	3HAC7997-4	R1.SW	XS8

2.6 Start of robot in cold environments

Introduction

This section describes how to start the robot in a cold environment if it is not starting the normal way.

Problems with starting the robot

Event message from Motion Supervision

Use this procedure if an event message indicates a problem with Motion supervision at start-up. More information about Motion Supervision is found in *Technical reference manual - System parameters*.

	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.	

Robot stopping with other event message

Use this procedure if the robot is not starting.

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

Adjusting the speed and acceleration during warm-up

Depending on how cold the environment is and what program is being used, the speed might need to be ramped up until reached maximum. The table shows examples of how to adjust the speed:

Work cycles	AccSet	Speed/velocity
3 Work cycles	20, 20	v100 (100 mm/s)
5 Work cycles	40, 40	v400 (400 mm/s)
5 Work cycles	60, 60	v600 (600 mm/s)
5 Work cycles	100, 100	v1000 (1000 mm/s)
More than 5 Work cycles	100, 100	Max.

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

2 Installation and commissioning

2.7 Test run after installation, maintenance, or repair

2.7 Test run after installation, maintenance, or repair

Safe handling

Use the following procedure after installation, maintenance, or repair, before initiating motion.



DANGER

Initiating motion without fulfilling the following aspects, may increase the risk for injury or cause damage to the robot.

	Action
1	Remove all tools and foreign objects from the robot and its working area.
2	Verify that the robot is properly secured to its position by all screws, before it is powered up.
3	Verify that any safety equipment installed to secure the position or restrict the robot motion during service activity is removed.
4	Verify that the fixture and work piece are well secured, if applicable.
5	Verify that all safety equipment is installed, as designed for the application.
6	Verify that no personnel are inside the safeguarded space.
7	If maintenance or repair has been done, verify the function of the part that was maintained.
8	Verify the application in the operating mode manual reduced speed.

Collision risks



CAUTION

When programming the movements of the robot, always identify potential collision risks before initiating motion.

3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 2400.

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.

The maintenance must be done by qualified personnel in accordance with the safety requirements set forth in the applicable national and regional standards and regulations.



Note

If the IRB 2400 is connected to power, always make sure that the IRB 2400 is connected to protective earth and a residual current device (RCD) before starting any maintenance work.

For more information see:

- *Product manual - IRC5*
- *Product manual - IRC5 Panel Mounted Controller*
- [Robot cabling and connection points on page 74.](#)

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 2400:

- 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*.

Robots with the functionality *Service Information System* activated can show active counters in the device browser in RobotStudio, or on the FlexPendant.

3.2.2 Maintenance schedule

General

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

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

The inspection intervals *do not* specify the life of each component.

Activities and intervals, standard equipment

The table below specifies the required maintenance activities and intervals and also refers to the section where performing the activity is detailed.

Maintenance activity	Interval	Note	Detailed in section:
Oil change in gearboxes, axes 1,2, 3 and 4.	40000 h	Lubricated for life. Maintenance free units.	
Oil change in wrist unit	After first 4000 h, then every 60 month ⁱ 12000 h ⁱⁱ		Oil change, gearbox axes 5-6 (wrist unit) on page 87.
Replacement of battery pack, SMB unit	Battery low alert ⁱⁱⁱ	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Replacement of SMB battery on page 91.
Replacement of battery pack, SMB unit	36 months or battery low alert ^{iv}	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	Replacement of SMB battery on page 91.
Inspection of all signal cabling in lower and upper arm	36 months	Replace if damaged.	
Inspection of information labels	12 months	Replace any damaged, missing or unreadable labels.	Inspecting information labels on page 82
Replacement of mechanical stop axis 1	60 months	Replace if bent.	Fitting, mechanical stop axis 1 on page 66.

ⁱ Change the oil for the first time after 4000 hours, then after every 60 months.

ⁱⁱ Changing interval if the robot is working in an environment temperature over 40°C.

ⁱⁱⁱ 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.

^{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.

3 Maintenance

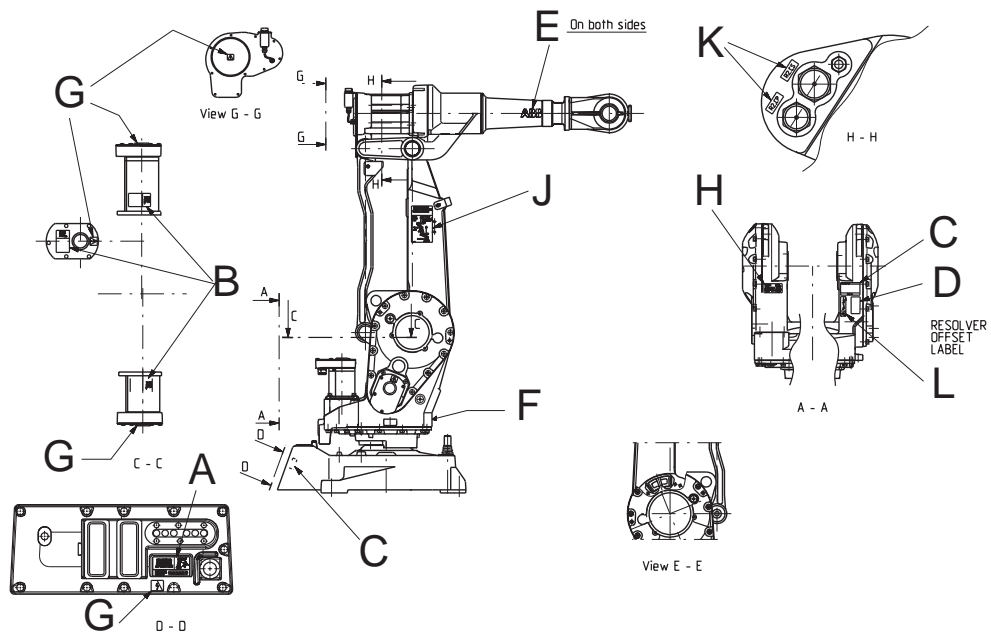
3.3.1 Inspecting information labels

3.3 Inspection activities

3.3.1 Inspecting information labels

Location of information labels

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



xx1600001279

A	Instruction - Brake release unit
B	Warning sign - Heat (3 pcs)
C	Rating label
D	Calibration label (4 pcs)
E	ABB logotype (2 pcs)
F	Protection class logotype
G	Warning sign - Symbol of flash (5 pcs)
H	UL/UR label
J	Instruction plate - Lifting of robot
K	Designation sign
L	Information sign - AbsAcc


Continues on next page

Required equipment

Equipment	Spare part number	Note
Labels	See Spare part lists on page 231 .	

Inspecting labels

Use this procedure to inspect the labels on the robot.

	Action	Note
1	 DANGER Turn off all: <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Check all labels.	See the figure in Location of information labels on page 82 .
3	Replace any missing or damaged labels.	

3 Maintenance

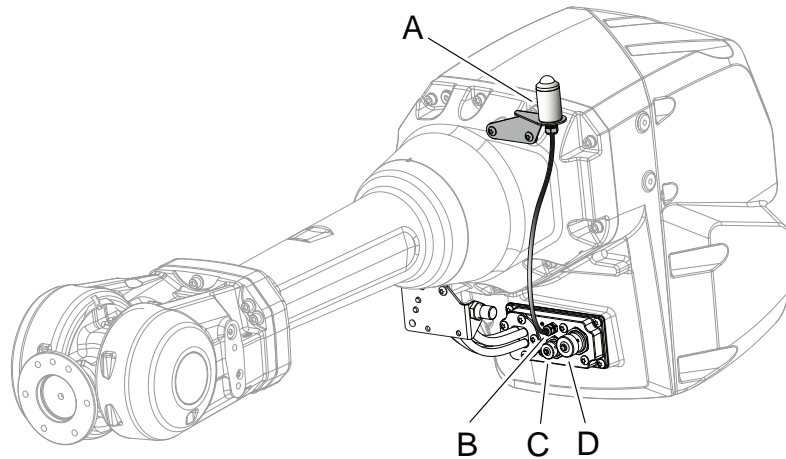
3.3.2 Inspecting Signal lamp (option)

3.3.2 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 Standard tools on page 227.
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.



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112.](#)

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!

Continues on next page

	Action	Note
1	Check that the signal lamp is lit when motors are put in operation ("MOTORS ON").	
2	If the signal lamp is not lit, continue tracing the fault with the steps below.	
3	 <p>DANGER</p> <p>Turn off all:</p> <ul style="list-style-type: none"> • electric power supply • hydraulic pressure supply • air pressure supply <p>to the robot, before entering the robot working area.</p>	
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.	
8	<p>Seal and paint the joints that have been opened. Also repair possible damages of the special Foundry Prime paint coat of the robot. See Cut the paint or surface on the robot before replacing parts on page 112.</p> <p> Note</p> <p>After all repair work, wipe the robot free from particles with spirit on a lint free cloth.</p>	

3 Maintenance

3.4.1 Type of lubrication in gearboxes

3.4 Changing activities

3.4.1 Type of lubrication in gearboxes

Introduction

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

Type and amount of oil in gearboxes

Information about the type of lubrication, article number as well as the amount in the specific gearbox can be found in *Technical reference manual - Lubrication in gearboxes* available for registered users on myABB Business Portal, www.abb.com/myABB.

Location of gearboxes

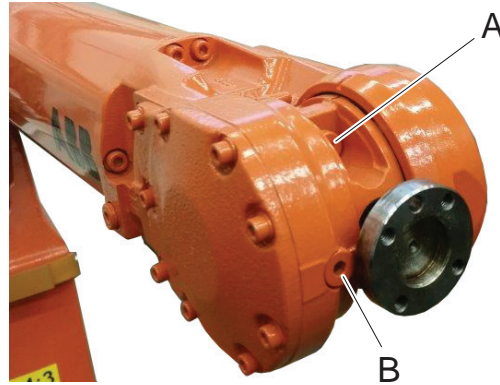
The figure shows the location of the gearboxes.

Equipment

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

3.4.2 Oil change, gearbox axes 5-6 (wrist unit)

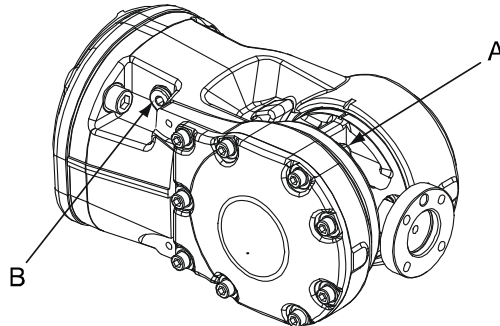
Location of oil plugs, axes 5-6 (IRB 2400L/5)



xx160000097

A	Oil plug (drain/fill plug)
B	Oil plug (went plug)

Location of oil plugs, axes 5-6 (IRB 2400/10/16)



xx030000118

A	Oil plug (drain/fill plug)
B	Oil plug (went plug)

Required equipment

Equipment	Note
Lubricating oil	Information about the oil is found in <i>Technical reference manual - Lubrication in gearboxes</i> . See Type and amount of oil in gearboxes on page 86 .
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Standard toolkit	The content is defined in the section Standard tools on page 227 .

Continues on next page

3 Maintenance

3.4.2 Oil change, gearbox axes 5-6 (wrist unit)

Continued



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).



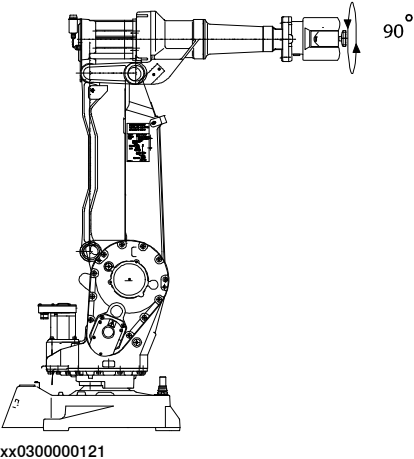
Draining the gearbox, axes 5-6 (IRB 2400L/5)

	Action	Note/Illustration
1	DANGER The robot must have power during the oil change. Place a sign that clearly indicates that service work is ongoing.	
2	WARNING Handling gearbox oil involves several safety risks, see Gearbox lubricants (oil or grease) on page 34 .	
3	Run the upper arm to a horizontal position and turn axis 4 to the calibration position.	 xx1600000098
4	Turn axis 4 through 180° so that the oil plug (A) on the tilt housing is pointing downwards.	
5	Remove oil plugs A and B	Shown in the figure Location of oil plugs, axes 5-6 (IRB 2400L/5) on page 87 .
6	Turn axis 5 -30° if necessary to drain all oil.	

Continues on next page


Draining the gearbox, axes 5-6 (IRB 2400/10/16)

The procedure below details how to drain the oil from the wrist unit.

	Action	Note/Illustration
1	 DANGER The robot must have power during the oil change. Place a sign that clearly indicates that service work is ongoing.	
2	 WARNING Handling gearbox oil involves several safety risks, see Gearbox lubricants (oil or grease) on page 34 .	
3	Run the upper arm to a horizontal position and turn axis 4 to the calibration position.	
4	Remove the <i>oil plugs</i> in the wrist.	Shown in the figure Location of oil plugs, axes 5-6 (IRB 2400/10/16) on page 87 .
5	Turn axis 4 through 90° so that the oil plug on the side of the wrist is pointing downwards.	 <p>xx0300000121</p>
6	Then turn axis 4 another 90°.	
7	Let the remaining oil run out through the hole on the tilt housing.	

Refilling, gearbox axes 5-6

The procedure below details how to refill oil to the wrist unit.



	Action	Note
1	Run the upper arm to a horizontal position and turn axis 4 to the calibration position.	
2	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

Continues on next page

3 Maintenance

3.4.2 Oil change, gearbox axes 5-6 (wrist unit)

Continued

	Action	Note
3	 WARNING Handling gearbox oil involves several safety risks, see Gearbox lubricants (oil or grease) on page 34 .	
4	Valid for IRB 2400L/5 kg Fill oil in the plug hole (A) located on the tilt housing (axis 5) until the oil reaches up to oil plug (B) in the front of the wrist.	
5	Valid for IRB 2400/10/16 kg Fill oil in the plug hole (A) located on the tilt housing (axis 5) until the oil reaches up to the hole located on the side of the wrist.	
6	 Note If the robot is mounted in suspension, the wrist should be turned 180°.	
7	Refit the oil plugs to the wrist.	

3.4.3 Replacement of 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 [Hazards related to batteries on page 35](#).

Location of SMB battery unit

The SMB battery unit is located inside the robot base, as shown in the figure below.

A	SMB connection
B	SMB battery RMU
C	SMB battery connector

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 battery with the 3-pole contact has a longer lifetime.

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	Spare part no.	Note
Battery unit (2-pole battery contact)	3HAC16831-1	Lithium battery. This battery requires that the serial measurement unit 3HAC17396-1 is installed.
Battery unit (3-pole battery contact)	3HAC044075-001	RMU Lithium battery. Can only be used with SMB unit 3HAC046277-001 containing SMB board 3HAC044168-001.
Gasket, cover	3HAC3200-1	Always replace with a new one!

Continues on next page

3 Maintenance

3.4.3 Replacement of SMB battery

Continued

Equipment	Spare part no.	Note
Standard toolkit		The content is defined in the section Standard tools on page 227 .
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.



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Replacement, SMB battery

The procedure below details how to replace the SMB battery.

	Action	Note
1	<p>DANGER</p> <p>Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	
2	<p>xx0200000023</p> <p>WARNING</p> <p>The unit is sensitive to ESD. Before handling the unit please read the safety information in the section The unit is sensitive to ESD on page 50</p>	
3	<p>Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).</p> <p>CAUTION</p> <p>Clean cover from metal residues before opening.</p> <p>Metal residues can cause shortage on the boards which can result in hazardous failures.</p>	
4	<p>Remove the battery terminals from the serial measuring board and cut the clasp that keeps the battery unit in place.</p>	
5	<p>Fit the new battery and connect the terminals to the serial measuring board.</p>	<p>Shown in the figure Location of SMB battery unit on page 91.</p>
6	<p>Refit the cover to the robot base, together with a new gasket.</p>	<p>Always replace a removed gasket with a new!</p> <p>Spare part no. is specified in Required equipment on page 91.</p>

Continues on next page

	Action	Note
7	Update the revolution counters!	Detailed in the section Updating revolution counters on IRC5 robots on page 205 .

3 Maintenance

3.5.1 Cleaning the IRB 2400

3.5 Cleaning activities

3.5.1 Cleaning the IRB 2400



DANGER

Turn off all:

- electric power supply
- hydraulic pressure supply
- air pressure supply

to the robot, before entering the safeguarded space.

General

To secure high uptime it is important that the IRB 2400 is cleaned regularly. The frequency of cleaning depends on the environment in which the product works. Different cleaning methods are allowed depending on the type of protection of the IRB 2400.



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 82](#).
- 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.

Special cleaning considerations

This section specifies some special considerations when cleaning the robot.

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

Continues on next page

Cleaning methods

The following table defines what cleaning methods are allowed depending on the protection type.

Protection type	Cleaning method			
	Vacuum cleaner	Wipe with cloth	Rinse with water	High pressure water or steam
Standard	Yes	Yes. With light cleaning detergent.	Yes. It is highly recommended that the water contains a rust-prevention solution and that the manipulator is dried afterwards.	No
Foundry Plus	Yes	Yes. With light cleaning detergent or spirit.	Yes. It is highly recommended that the water contains a rust-prevention solution.	Yes ⁱ . It is highly recommended that the water and steam contains rust preventive, without cleaning detergents.
Wash	Yes	Yes. With light cleaning detergent or spirit.	Yes. It is highly recommended that the water contains a rust-prevention solution.	Yes ⁱⁱ . It is highly recommended that the water and steam contains rust preventive, without cleaning detergents.
Clean room	Yes	Yes. With light cleaning detergent, spirit or isopropyl alcohol.	No	No

ⁱ Perform according to section [Cleaning with water and steam on page 95](#).

ⁱⁱ Perform according to section [Cleaning with water and steam on page 95](#).

Cleaning with water and steam

Instructions for rinsing with water

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

The following list defines the prerequisites:

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

¹ Typical tap water pressure and flow

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.²

¹ See [Cleaning methods on page 95](#) for exceptions.

² See [Cleaning methods on page 95](#) for exceptions.

Continues on next page

3 Maintenance

3.5.1 Cleaning the IRB 2400

Continued

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 2500 kN/m² (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

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.

3.6 Service Information System, M2000

3.6.1 Using the SIS system

General

This is a brief description of how to use the Service Information System, SIS for M2000 robot systems. Details may be found in:

- Service Information System, SIS
- Defining the SIS input parameters
- Setting the SIS parameters
- Importing/exporting SIS data
- Reading the SIS output logs

The section is only valid for M2000 systems. For information regarding M2004 robot systems, see additional documentation, *Operating manual - Service Information System*. Article number is specified in section [References on page 10](#).

Basic procedure

	Action	Reference
1	Determine which of the system functions you require.	These are described in Description of Service Information System (SIS) on page 98 .
2	Define what values are adequate and suitable for your application in your production environment.	Recommendations on how to define these are given in SIS system parameters on page 101 .
3	Enter these parameters in the system.	How to do this is detailed in Setting the SIS parameters on page 102 .
4	Run the robot in normal operation.	
5	Reset the counter if a repair is made, or if a counter for any other reason is restarted.	The TPU displays for resetting any SIS value are shown in Description of Service Information System (SIS) on page 98 .
6	When a time limit, set in the parameters, is exceeded, a message may be read on the Tech Pendant Unit (TPU).	How to access this is detailed in Reading the SIS output logs on page 103 .
7	If the log containing the message is to be available from an external PC, or if the SIS parameters are to be entered from an external PC, a set of software tools are available to build such an application.	These are described in Exporting the SIS data on page 104 .

3 Maintenance

3.6.2 Description of Service Information System (SIS)

3.6.2 Description of Service Information System (SIS)

General

Service Information System (SIS) is a software function within the robot controller, which simplifies maintenance of the robot system. It supervises the operating time and mode of the robot, and alerts the operator when a maintenance activity is scheduled.

Maintenance is scheduled by setting the system parameters of the type SIS Parameters, see section [Setting the SIS parameters on page 102](#). All system parameters are described in *User's Guide - System Parameters*.

Supervised functions

The following counters are available:

- Calendar time counter, a general alarm based on calendar time
- Operation time counter, a general alarm based on operational time
- Gearbox 1 operation time counter, based on percentage of the axis 1 gearbox service interval
- Gearbox 2 operation time counter, based on percentage of the axis 2 gearbox service interval
- Gearbox 3 operation time counter, based on percentage of the axis 3 gearbox service interval
- Gearbox 6 operation time counter, based on percentage of the axis 6 gearbox service interval

Counters are reset when maintenance has been performed.

The counter status is displayed after running the service routine for maintenance. Status "OK" indicates that no service interval limit has been exceeded by that counter.

Calendar time

This is a clock within the control system that keeps track of the service interval, based on calendar time.

When the calendar time limit for maintenance is reached, a message is displayed on the TPU. How to access this is detailed in section [Reading the SIS output logs on page 103](#).

The following information is available about the calendar time in the service routine.

Prev service	Date when the counter was reset last time, i.e. after the last service.
Elapsed time	Elapsed time since the counter was reset the last time.
Next service	Date when next scheduled service is planned. This date is calculated using system parameters, as detailed in section Setting the SIS parameters on page 102 .
Remaining time	Remaining time to next scheduled service date.

Continues on next page

Operation time

This is a function within the control system that keeps track of the amount of time the "MOTORS ON" signal is active, i.e. the amount of time the robot is in the operating mode.

When the operation time limit for maintenance is reached, a message is displayed on the TPU. How to access this is detailed in section [Reading the SIS output logs on page 103](#).

The following information is available about the operation time in the service routine.

Service interval	The specified service interval until another service will be required. This parameter was entered manually as detailed in section Setting the SIS parameters on page 102 .
Elapsed time	Operation time since the service interval was set the last time.
Remaining time	Remaining operation time until the time set in service interval has expired.

Gearbox

Based on measurements, torque and RPM, for example, the system calculates an expected service interval for each gearbox. When service is due, a message will be shown on the TPU. How to access this is detailed in section [Reading the SIS output logs on page 103](#).

The following information is available about the joint service status in the service routine.

Joint x OK	Service status for axis x, i.e. the automatically calculated time parameter has not been exceeded.
Joint x NOK	The service interval for the axis in question has been reached.
Joint x N/A	No service time parameter calculation available. Applies to axes 4 and 5 (IRB 6600 and IRB 7600).

The following information is available for the axis service status in the service routine.

Consumed time	The consumed time as a percentage of the total amount of time.
Elapsed time	Operation time for axis x since calculation began.
Remaining time	Remaining operation time for axis x until the service time parameter value has been reached.

Reset values

Counters may be reset at any time by running the service routine.

When resetting, the counter variables are reset. The variables are described in section [Exporting the SIS data on page 104!](#)

Service interval exceeded

When the service time has been exceeded for the selection made, an error message (Service interval exceeded!) is displayed.

Continues on next page

3 Maintenance

3.6.2 Description of Service Information System (SIS)

Continued

No data available

When no data is available for the selection made, a message (No data available!) is displayed when trying to display the data.

3.6.3 SIS system parameters

General

This section details the system parameters that may be set with estimated values. The values can be defined by the operating organization as knowledge of the robot's working conditions are accumulated.

Since the counters are to be used for purposes defined by the user, ABB cannot give any recommendations regarding their definitions.

Operation time limit (service level)

The number of operation hours selected as service interval.

E.g. by setting the value "20,000", the SIS will save this as the nominal time for activating the alarm, not counting the percentage described below.

Operation time warning

A percentage of the "Operation time limit" specified above.

E.g. by setting the value "90", the SIS will alert the operator 18,000 hours after an operation time "Reset" was made the last time.

Calendar time limit (service level)

The number of calendar years selected as service interval.

E.g. by setting the value "2", the SIS will save this as the nominal time for activating the alarm, not counting the percentage described below.

Calendar time warning

A percentage of the "Calendar time limit" specified above.

E.g. by setting the value "90", the SIS will alert the operator after 90% of two years, i.e. 657 days after a calendar time "Reset" was made the last time.

Gearbox warning

A percentage of the gearbox service interval as calculated by the system. E.g. by setting the value "90", the SIS will alert the operator after 90% of the expected service interval of *each* gearbox.

The robot system automatically detects and stores all required variables to calculate the expected service interval (estimated remaining lifetime) of each gearbox. This is done by extrapolating data from earlier operation into a function of time, using a formula including:

- input and output torque
- gearbox spindle speed
- other variables

3 Maintenance

3.6.4 Setting the SIS parameters

3.6.4 Setting the SIS parameters

General

If the SIS system is to function properly, a number of parameters must be set. This is detailed below.

Procedure M2000

This is an instruction of how to enter SIS parameters to the M2000 robot system.

	Action	Note
1	Open "System parameters" using the TPU.	Detailed in the User's Guide.
2	Go to "System parameters/Manipulator/types 2".	
3	Select "0 SIS parameters" and press "Enter".	
4	Select the required system The parameter list is displayed.	
5	Select the required parameters by stepping up and down through the parameter list.	Available parameters are described in section SIS system parameters on page 101 .

3.6.5 Reading the SIS output logs

General

Whenever a set condition has expired (e.g. max allowed operation time before service), a message to this effect will be shown in the Operational log.

Access to logs

How to open a log and show its contents is detailed in the User's Guide, chapter *Service*.

Available messages

The following messages may be shown:

Available in:	SIS message in the log:	Meaning:
Calendar time	Service Message Service is due! X calendar days since last service.	The manually set calendar time limit has expired. How to set the limit is detailed in section Setting the SIS parameters on page 102 . Proceed with the required service as detailed in chapter Repair on page 105 or chapter Maintenance on page 79 depending on which type of service.
Calendar time	Service Message X calendar days to next service.	X number of calendar days remain until the manually set calendar time limit expires. How to set the value determining when the message is to be shown, is detailed in section Setting the SIS parameters on page 102 .
Operation time	Service Message Service is due! X production hours since last service.	The manually set operation time limit has expired. How to set the limit is detailed in section Setting the SIS parameters on page 102 . Proceed with the required service as detailed in chapter Repair on page 105 or chapter Maintenance on page 79 depending on which type of service.
Operation time	Service Message X production hours to next service.	X number of operation hours remain until the manually set operation time limit expires. How to set the value determining when the message is to be shown, is detailed in section Setting the SIS parameters on page 102 .
Gearbox time	Service Message Gearbox x requires service!	The automatically calculated gearbox time limit has expired. Proceed with the required service as detailed in chapter Repair on page 105 or chapter Maintenance on page 79 depending on which type of service.
Gearbox time	Service Message X% of the service interval has expired for gearbox x!	X percent of gearbox hours remain until the automatically calculated gearbox time limit expires. How to set the value determining when the message is to be shown, is detailed in section Setting the SIS parameters on page 102 .

3 Maintenance

3.6.6 Exporting the SIS data

3.6.6 Exporting the SIS data

General

This section describes the available variables for entering SIS parameters as well as showing any values of exceeded time limits as detected by the SIS counters.

In a M2000 robot system, the values can be read on a PC using "Webware SDK". How to access these variables and how to perform the actual programming sequences are detailed in the robot system User's Guide.

Definitions

The table below defines the names and functions of all software variables available for communication between the SIS and an external computer.

Signal	Unit	Counter type	Function
sisRestartDate	seconds	Calendar time	The date on which the supervision was started/reset last time.
sisCalendarT	seconds	Calendar time	The number of hours since start/last reset.
sisTotRunT	seconds	Operation time	Total number of operation hours since the system was started. Corresponds to the operating time counter on the control cabinet.
sisRunT	seconds	Operation time	The number of operation hours since start/last reset of the operation time counter. Corresponds to the operating time counter on the control cabinet.
sisL10h_1	hours	Gearbox time	Estimated life of gearbox axis 1
sisL10h_Time_1	seconds	Gearbox time	Operation time of gearbox axis 1
sisL10h_2	hours	Gearbox time	Estimated life of gearbox axis 2
sisL10h_Time_2	seconds	Gearbox time	Operation time of gearbox axis 2
sisL10h_3	hours	Gearbox time	Estimated life of gearbox axis 3
sisL10h_Time_3	seconds	Gearbox time	Operation time of gearbox axis 3
sisL10h_6	hours	Gearbox time	Estimated life of gearbox axis 6
sisL10h_Time_6	hours	Gearbox time	Operation time of gearbox axis 6

4 Repair

4.1 Introduction

Structure of this chapter

This chapter details all repair activities recommended for the robot and any external units of the robot.

It is made up of separate procedures, each detailing 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.

The procedures are gathered in sections, divided according to the component location on the robot.

Required equipment

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

The details of equipments are also available in different lists in the chapter [References on page 10](#).

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 2400 is connected to power, always make sure that the IRB 2400 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 upper oil plug on the gear and replace it with the leak-down tester. Regulators, which are included in the leak-down test, may be required.	
3	Use caution, apply compressed air and raise the pressure with the knob until the correct value is shown on the manometer.  CAUTION The pressure must under no circumstance be higher than 0.25 bar (20-25 kPa). Also during the time when the pressure is raised.	Correct value: 0.2-0.25 bar (20-25 kPa)
4	Disconnect the compressed air supply.	
5	Wait for approximately 8-10 minutes and make sure that no pressure loss occurs.	If the compressed air is significantly colder or warmer than the gearbox to be tested, a slight pressure increase or decrease may occur. This is quite normal.
6	If any pressure drop occurred, then localize the leak as described in step 7. If no pressure drop occurred, then remove the leak-down tester and refit the oil plug. The test is complete.	
7	Spray any suspected leak areas with the leak detection spray. Bubbles indicate a leak.	
8	When the leak has been localized, take the necessary measures to correct the leak.	

4.2.2 Mounting instructions for bearings

General

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

Equipment

Equipment, etc.	Article number	Note
Grease	3HAC042536-001	Shell Gadus S2 Used to grease the bearings, if not specified otherwise.

Assembly of all bearings


Attend to 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



Note

This instruction is not valid for solid oil bearings.

Continues on next page

4 Repair

4.2.2 Mounting instructions for bearings

Continued

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.
- 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 sealings

General

This section describes how to mount different types of sealings.

Equipment

Consumable	Article number	Note
Grease	3HAC042536-001	Shell Gadus S2

Rotating sealings

The procedure below describes how to fit rotating sealings.



CAUTION

Please observe the following before commencing any assembly of sealings:

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

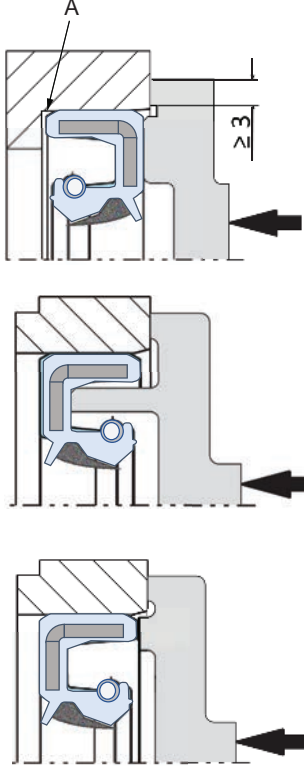
Action	Note
1 Check the sealing to ensure that: <ul style="list-style-type: none"> • The sealing is of the correct type. • There is no damage on the main lip. 	
2 Inspect the shaft surface before mounting. If scratches or damage are found, the shaft must be replaced since it may result in future leakage. Do not try to grind or polish the shaft surface to get rid of the defect.	
3 Lubricate the sealing with grease just before fitting. (Not too early - there is a risk of dirt and foreign particles adhering to the sealing.) Fill 2/3 of the space between the dust lip and the main lip with grease. If the sealing is without dust lip, just lubricate the main lip with a thin layer of grease.	<p>Article number is specified in Equipment on page 109.</p> <p>xx2000000071</p> <p>A Main lip B Grease C Dust lip</p>

Continues on next page

4 Repair

4.2.3 Mounting instructions for sealings

Continued

	Action	Note
4	<p>Mount the sealing correctly with a mounting tool. Never hammer directly on the sealing as this may result in leakage.</p>	 <p>xx2000000072</p> <p>A Gap</p>
5	<p>Make sure that no grease is left on the robot surface.</p>	

Flange sealings and static sealings

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

	Action
1	<p>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.</p>
2	<p>Clean the surfaces properly in accordance with the recommendations of ABB.</p>
3	<p>Distribute the sealing compound evenly over the surface, preferably with a brush.</p>
4	<p>Tighten the screws evenly when fastening the flange joint.</p>

O-rings

The following procedure describes how to fit o-rings.

	Action	Note
1	<p>Ensure that the correct o-ring size is used.</p>	
2	<p>Check the o-ring for surface defects, burrs, shape accuracy, or deformation.</p>	<p>Defective o-rings, including damaged or deformed o-rings, may not be used.</p>

Continues on next page

	Action	Note
3	Check the o-ring grooves. The grooves must be geometrically correct and should be free of pores and contamination.	
4	Lubricate the o-ring with grease.	
5	Tighten the screws evenly while assembling.	
6	Check that the o-ring is not squashed outside the o-ring groove.	
7	Make sure that no grease is left on the robot surface.	

4 Repair

4.2.4 Cut the paint or surface on the robot before replacing parts

4.2.4 Cut the paint or surface on the robot before replacing parts

General

Follow the procedures in this section whenever breaking the paint of the robot during replacement of parts.

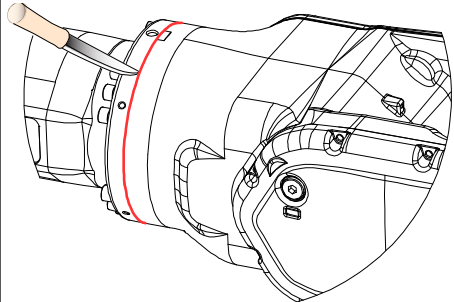
For robots with protection type Clean Room

When replacing parts on the robot, it is important to make sure that after the replacement, no particles will be emitted from the joint between the structure and the new part, and that the easy cleaned surface is retained.

Required equipment

Equipment	Spare parts	Note
Sealing compound	3HAC026759-001	Sikaflex 521 FC. Color white.
Tooling pin		Width 6-9 mm, made of wood.
Cleaning agent		Ethanol
Knife		
Lint free cloth		
Touch up paint Clean Room/Hygienic	3HAC036639-001	White
Touch up paint Standard/Foundry Plus	3HAC067974-001	Graphite White
Touch up paint Standard/Foundry Plus	3HAC037052-001	ABB Orange

Removing

Action	Description
1	<p>Cut the paint with a knife in the joint between the part that will be removed and the structure, to avoid that the paint cracks.</p>  <p>xx0900000121</p>
2	<p>Carefully grind the paint edge that is left on the structure to a smooth surface.</p>

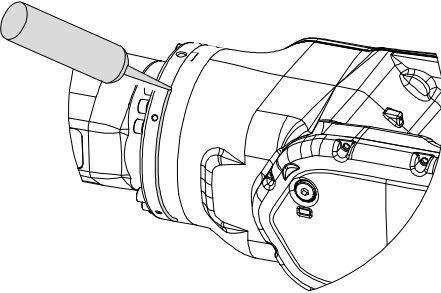
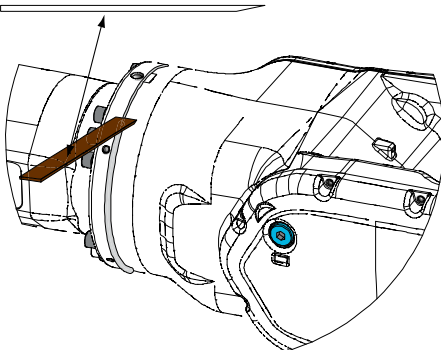

Refitting


Action	Description
1	<p>Before the parts are refitted, clean the joint so that it is free from oil and grease.</p> <p>Use ethanol on a lint free cloth.</p>
2	<p>Place the tooling pin in hot water.</p>

Continues on next page

4.2.4 Cut the paint or surface on the robot before replacing parts

Continued

	Action	Description
3	Seal all refitted joints with sealing compound.	 <p>xx0900000122</p>
4	Use the tooling pin to even out the surface of the sealing compound.	 <p>xx0900000125</p>
5	For robots with protection type Clean Room Wait 10 minutes.	For robots with protection type Clean Room Sikaflex 521FC skin dry time (10 minutes).
6	Use Touch up paint Clean Room/Hygienic, white to paint any damaged surfaces.  Note Always read the instruction in the product data sheet in the paint repair kit for Clean Room/Hygienic.	3HAC036639-001

 **Note**
 After all repair work, wipe the robot free from particles with spirit on a lint free cloth.

4 Repair

4.2.5 The brake release buttons may be jammed after service work

4.2.5 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.

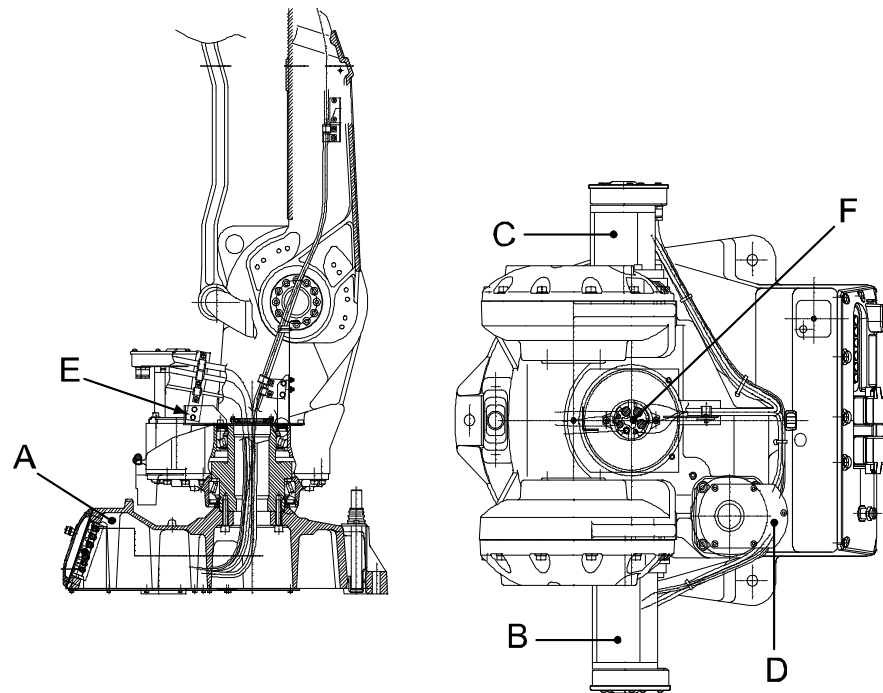
4.3 Complete robot

4.3.1 Replacement of cable unit, axes 1-3

Location of cabling

The cable unit of axes 1-3 is run from the base of the robot to the motors, axes 1, 2 and 3, as shown in the figure below.

A more detailed view of the component and its position may be found in chapter *Spare parts and exploded views*.



xx0500002541

A	Connectors behind the cover plate at the robot base; R1.MP1-3 and R2.BU1-3. At the serial measurement board; R2.G (battery), R2.FB1-3.
B	Connectors at motor 2; R3.MP2 and R3.FB2
C	Connectors at motor 3; R3.MP3, R3.FB3, R3.LS1 and R3.LS2
D	Connectors at motor 1; R3.MP1, R3.FB1
E	Upper bracket
F	Cable guide in the middle of the frame

Continues on next page

4 Repair

4.3.1 Replacement of cable unit, axes 1-3

Continued

Required equipment

Equipment, etc.	Spare part number	Article number	Note
Cable unit axes 1-3, Standard	3HAC4791-1		Includes: <ul style="list-style-type: none"> • cabling • covers, motor 1-3 • attachment screws • gaskets, motor axes 1-3
Sealing	3HAC4113-1		Sealing in the base for the cables. Always use a new sealing.
Gasket, cover	3HAC3200-1		
Cable straps, outdoor		2166 2055-3	
Flange sealing		12340011-116	Loctite 574
Circuit diagram			See the chapter Circuit diagram on page 233 .
Standard toolkit			The content is defined in the section Standard tools on page 227 .
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.




CAUTION

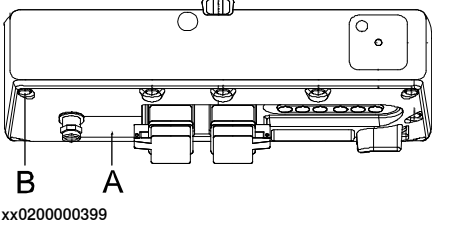
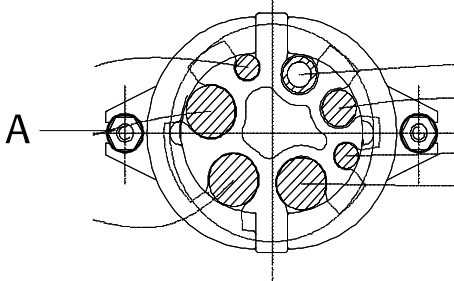
Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, cable unit, axes 1-3

The procedure below details how to remove the cabling of axes 1-3.

	Action	Note/Illustration
1	In order to facilitate refitting of the cable harness, move the robot to the specified position: <ul style="list-style-type: none"> • Axis 1: 0° • Axis 2: 0° • Axis 3: 0° • Axis 4: 0° • Axis 5: +90° • Axis 6: no significance 	Axes 2 and 3 may be tilted slightly to improve access.
2	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

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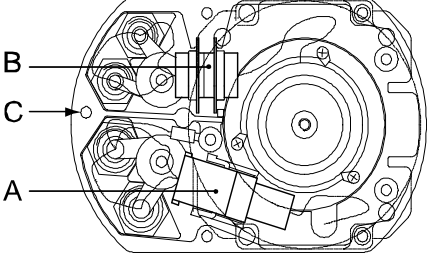
	Action	Note/Illustration
3	Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).	 <p>xx0200000399</p>
4	Disconnect the connectors R1.MP1-3 and R2.BU1-3 inside the base.	
5	Disconnect all the earth cables on the R1.M1-3 cable from the back of the cover.	
6	<p>Loosen the nuts and remove the SMB unit carefully from the bracket.</p> <p>The cable between the battery and the SMB unit may stay connected, in order to avoid recalibration of the robot. Be careful not to let the weight of the SMB unit strain the cable!</p> <p>In order to remove the SMB unit completely, the connector R2.G must be disconnected! This causes a necessary recalibration of the robot!</p>	
7	Disconnect the connector R2.FB 1-3 from the connection R2.SMB1-4 on the SMB unit.	
8	Unscrew the four screws securing the cable gland.	This releases the cable harness from the frame.
9	<p>Remove the cable guide in the middle of the frame by removing the attachment screws of the holder (A).</p> <p>Remove the cables from the guide.</p>	 <p>xx0200000404</p> <p>Note! Different robot versions are fitted with different versions of the holder. Make sure the correct one is used to avoid cable failure.</p>
10	Remove the upper bracket securing the cables to the arm house by unscrewing its two attachment screws.	Note! Do not remove or loosen any of the cable brackets from the new harness, the angle of the brackets is factory optimized.
11	Remove the cover of the motors 1-3.	

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4 Repair


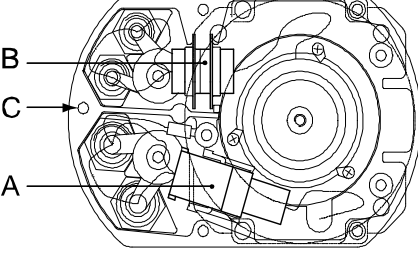
4.3.1 Replacement of cable unit, axes 1-3

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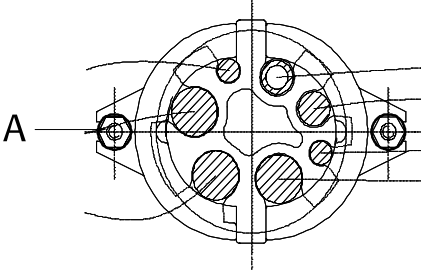
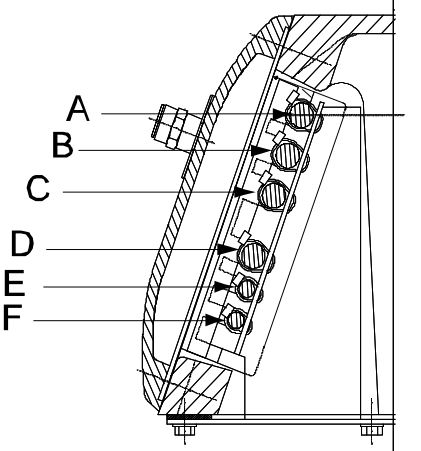
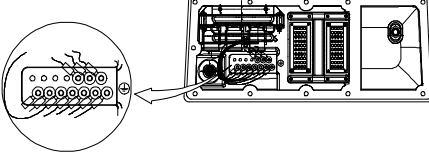
	Action	Note/Illustration
12	Disconnect all the connectors at the motors of axes 1, 2 and 3.	 <p data-bbox="948 577 1054 595">xx0200000401</p> <p data-bbox="1018 613 1198 707">R3.MP1-3 R3.FB1-3 Connection box</p>
13	Remove the three screws of the connection box for the motors of axes 1, 2 and 3.	
14	Gently pull the cable harness out.	

Refitting, cable unit, axes 1-3

The procedure below details how to refit the cabling of axes 1-3 to the robot.

	Action	Note/Illustration
1	 <p data-bbox="564 1039 676 1072">DANGER</p> <p data-bbox="475 1099 943 1155">Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	
2	Gently pull down the cable harness through the center hole of axis 1.	
3	Fit a new <i>gasket</i> and fit the connection box on motor 1, 2 and 3, using the three attachment screws.	The gasket is included in the spare part of the cable unit, spare part no. is specified in Required equipment on page 116 .
4	Reconnect all the connectors at motors 1, 2 and 3.	 <p data-bbox="975 1653 1082 1671">xx0200000401</p> <p data-bbox="1043 1688 1224 1783">R3.MP1-3 R3.FB1-3 Connection box</p>
5	Refit the cover of the motors, axes 1, 2 and 3, with the five attachment screws.	
6	Refit the upper bracket securing the cables to the arm house, using the two attachment screws.	

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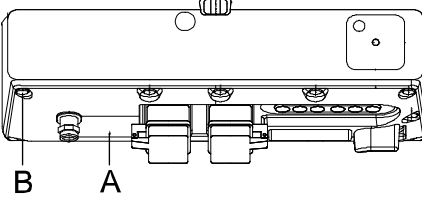

	Action	Note/Illustration
7	<p>Fit the cable guide to the harness and secure the holder to the frame with its two attachment screws (A).</p>	 <p>xx0200000404</p> <p>Note! Different robot versions are fitted with different versions of the holder. Make sure the correct one is used to avoid cable failure.</p>
8	<p>Secure the cabling inside the base. Insert the cables in the sealing: Power cable Power cable Power cable Customer cable Signal cable Signal cable</p> <p>Note! Make sure that each cable is fitted in the same position as the old one, otherwise the conduit entry will not be watertight. Use six <i>cable straps</i>.</p> <p>Note! Always use a new <i>sealing</i>, combined with a <i>flange sealing</i> (Loctite 574).</p>	 <p>xx0200000402</p> <p>Art. numbers are specified in <i>Required equipment on page 116</i>.</p>
9	<p>Connect the connectors R2.FB 1-3 to the connection R2.SMB1-4 on the SMB unit.</p>	
10	<p>Refit the SMB unit to the bracket with the nuts. Be careful not to let the weight of the SMB-unit strain the cable!.</p>	<p>Note! The cable between the battery and the SMB-unit may stay connected, in order to avoid recalibration of the robot.</p>
11	<p>Connect all the earth cables on the R1.M1-3 cable to the back of the cover.</p>	 <p>xx0200000403</p>
12	<p>Connect the connectors R1.MP1-3 and R2.BU1-3 inside the base.</p>	

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4 Repair

4.3.1 Replacement of cable unit, axes 1-3

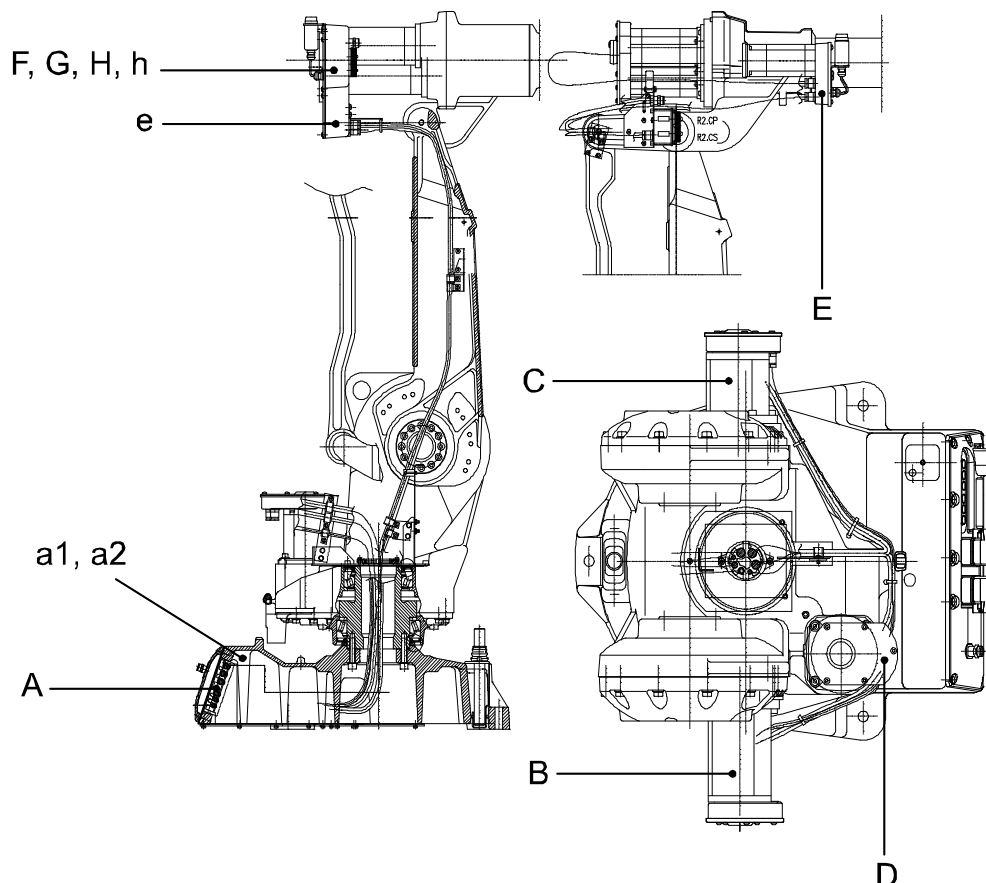
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	Action	Note/Illustration
13	Refit the rear cover plate (A) on the robot with its attachment screws (B), together with a new <i>gasket</i> .	 <p>The illustration shows a top-down view of the rear cover plate assembly. Label 'A' points to the rear cover plate, and label 'B' points to the attachment screws. Below the illustration is the part number xx020000399.</p> <p>Spare part no. is specified in Required equipment on page 116.</p>
14	If the battery has been disconnected from the SMB unit, the revolution counters must be updated!	Detailed in the section Updating revolution counters on IRC5 robots on page 205 .
15	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.3.2 Replacement of cable harness, axes 4-6

Location of cable harness

The cable harness runs throughout the robot as shown in the figure below.



xx0200000396

A	Connector at robot base, R1.MP, R1.SMB and R1.C/CS
a1	Electrical connectors rear of the cover plate at the robot base , R1.MP1-3, R1.MP4-6, R1.CS, R1.CP, R1.H1, R2.BU, R2.BU1-3, R2.BU4-6,
a2	Connectors at the serial measurement board (SMB-unit), R2.SMB1-2 (empty), R2.G (bat), R2.FB1-3 and R2.FB4-6
B	Connectors at motor 2, R3.MP2 and R3.FB2
C	Connectors at motor 3, R3.MP3, R3.FB3, R3.LS1 and R3.LS2
D	Connectors at motor 1, R3.MP1, R3.FB1
E	Connectors at motor 4 (5 kg option), R3.MP4 and R3.FB4
e	Connectors at motor 4 (15 kg option), R3.MP4 and R3.FB4
F	Connectors at motor 5, R3.MP5 and R3.FB5
G	Connectors at motor 6, R3.MP6 and R3.FB6
H	Connectors R3.H1 and R3.H2 (5 kg option)
h	Connectors R3.H1 and R3.H2 (15 kg option)

Continues on next page

4 Repair

4.3.2 Replacement of cable harness, axes 4-6

Continued

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable unit axes 4-6 Standard	3HAC 9330-1		IRB 2400/L
Cable unit axes 4-6 Standard	3HAC9328-1		IRB 2400 /10, /16
Cable unit, axes 4-6 Opt 043	3HAC 8520-1		IRB 2400/L Option 043
Gasket, motor axes 4-6	3HAC4429-1		
Sealing	3HAB 5922-1		
Flange sealing		12340011-116	Loctite 574
Cable straps, outdoor		21662055-1	L=208mm
Circuit diagram			See the chapter Circuit diagram on page 233 .
Standard toolkit			The content is defined in the section Standard tools on page 227 .
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.



CAUTION

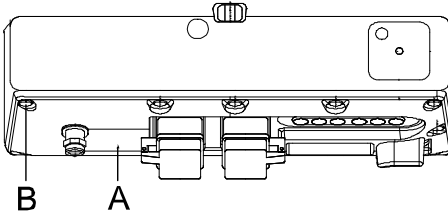
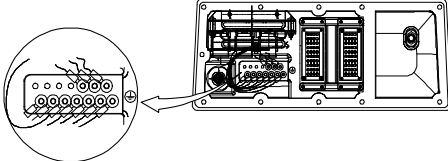
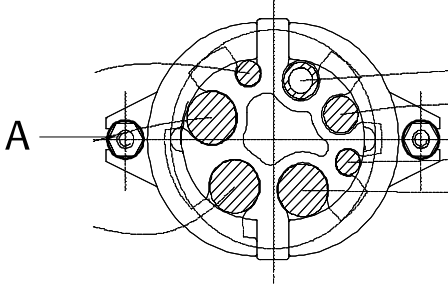
Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, cable harness, axes 4-6

The procedure below details how to remove the cable harness, axes 4-6.

	Action	Note/Illustration
1	<p>DANGER</p> <p>Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	
2	<p>In order to facilitate refitting of the cable harness, run the robot to the specified position:</p> <ul style="list-style-type: none"> • Axis 1: 0 ° • Axis 2: 0 ° • Axis 3: 0 ° • Axis 4: 0 ° • Axis 5: +90 ° • Axis 6: no significance 	<p>Axes 2 and 3 may be tilted slightly to improve access.</p>

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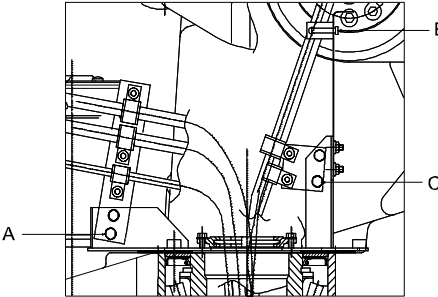
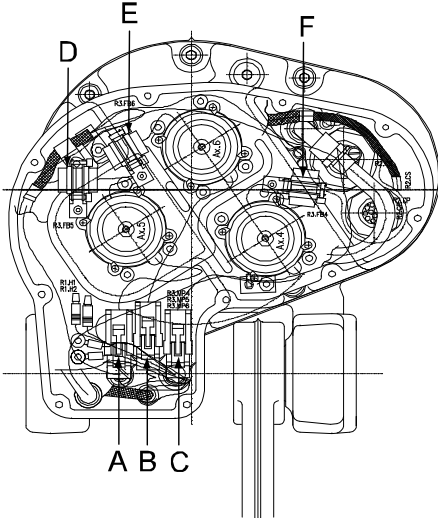
	Action	Note/Illustration
3	Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).	 <p>xx0200000399</p>
4	Disconnect connectors R1.MP4-6 and R2.BU4-6.	
5	Disconnect all the earth cables on the R1.M4-6 cable from the back of the cover.	 <p>xx0200000403</p>
6	<p>Loosen the nuts holding the SMB-unit slightly, then remove it carefully from the bracket.</p> <p>The cable between the battery and the SMB-unit may stay connected, in order to avoid recalibration of the robot. Be careful not to let the weight of the SMB-unit strain the cable!</p> <p>In order to remove the SMB-unit completely, the connector R2.G must be disconnected! This causes a necessary recalibration of the robot!</p>	
7	Disconnect connector R2.FB 4-6 from the connection R2.SMB4-6 on the SMB-unit.	
8	Unscrew the four screws securing the cable gland.	This releases the cable harness from the frame.
9	Remove the adapter plate from the harness by removing its two attachment screws (A).	 <p>xx0200000404</p> <p>Note! Different robot versions are fitted with different plate versions. Make sure the correct one is used to avoid cable failure.</p>

Continues on next page

4 Repair


4.3.2 Replacement of cable harness, axes 4-6

Continued

	Action	Note/Illustration
10	Remove the upper bracket securing the cables to the arm house by unscrewing its two attachment screws (C). Cut the strip clamp (B).	 <p>xx0200000405</p>
11	Remove the back cover of the motors 4-6, fitted with torx screw.	
12	Disconnect all connectors at motor 4, 5 and motor 6, R3.MP4-6 and R3.FB4-6: A - R3.MP5 B - R3.MP6 C - R3.MP4 D - R3.FB5 E - R3.FB6 F - R3.FB4	 <p>xx0200000406</p>
13	Remove all screws holding the motor case on motor 4-6.	
14	Gently pull the cable harness out.	

Refitting, cable harness, axes 4-6

The procedure below details how to refit the cable harness, axes 4-6.

	Action	Note/Illustration
1	 <p>DANGER</p> <p>Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	

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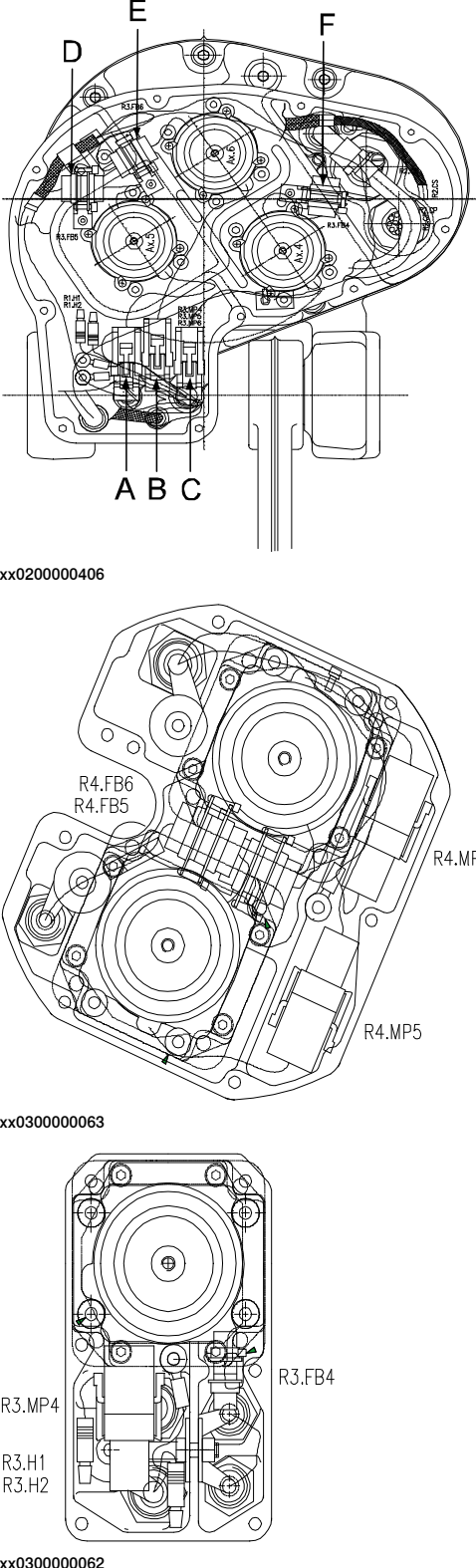
	Action	Note/Illustration
2	In order to facilitate refitting of the cable harness, run the robot to the specified position: <ul style="list-style-type: none">• Axis 1: 0 °• Axis 2: 0 °• Axis 3: 0 °• Axis 4: 0 °• Axis 5: +90 °• Axis 6: no significance	Axes 2 and 3 may be tilted slightly to improve access.
3	Gently pull down the cable harness through the center of the lower arm and through the hole of axis 1.	
4	Fit a new gasket and fit the motor case on motor 4-6 using the nine torx screws	Note! Always use a new gasket! Art. no. is specified in Required equipment on page 122 .

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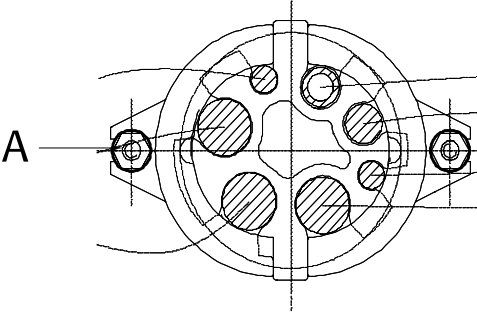
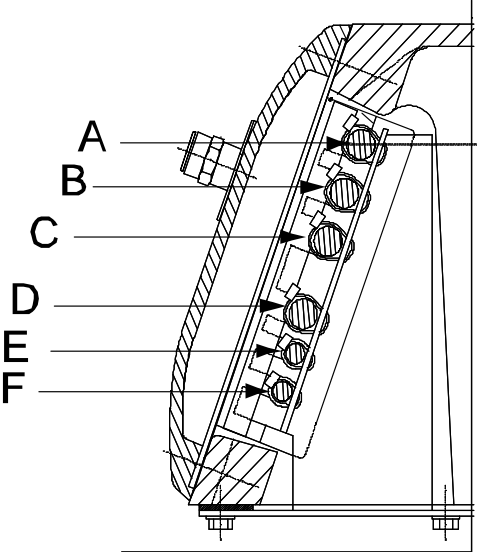
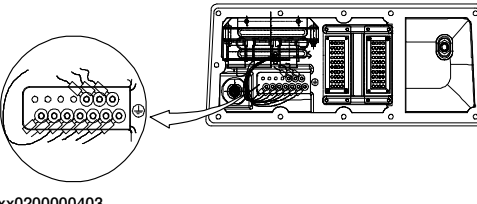
4 Repair

4.3.2 Replacement of cable harness, axes 4-6

Continued

	Action	Note/Illustration
5	<p>Reconnect all connectors at motor 4, 5 and 6. R3.MP 4-6 (A) and R3.FB 1-3 (B)</p> <p>A - R3.MP5 B - R3.MP6 C - R3.MP4 D - R3.FB5 E - R3.FB6 F - R3.FB4</p>	 <p>xx0200000406</p> <p>xx0300000063</p> <p>xx0300000062</p>
6	Fit the back cover of the motors 4-6.	

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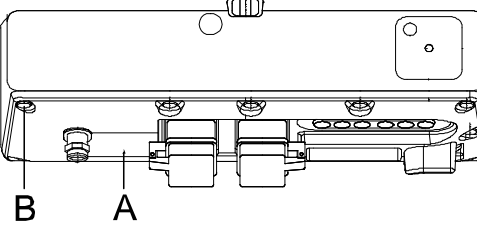

	Action	Note/Illustration
7	Fit the upper bracket securing the cables to the arm house, using the two attachment screws.	
8	Fit the adapter plate to the harness by using its two attachment screws (A).	 <p data-bbox="954 739 1061 761">xx0200000404</p> <p data-bbox="954 772 1436 851">Note! Different robot versions are fitted with different plate versions. Make sure the correct one is used to avoid cable failure.</p>
9	<p>Fit all the screws securing the cable gland.</p> <p>This attaches the cable harness to the frame.</p> <p>Cables</p> <ul style="list-style-type: none"> • A - Power • B - Power • C - Power • D - Customer • E - Signal • F - Signal <p>Note! Make sure that each cable is fitted at the same position as the old ones, otherwise the conduit entry will not be watertight.</p> <p>Note! Always use a new <i>sealing</i> and combine it with a <i>flange sealing</i> (Loctite 574).</p>	 <p data-bbox="954 1433 1061 1456">xx0200000402</p> <p data-bbox="954 1467 1436 1523">Art. no:s. are specified in <i>Required equipment on page 122</i>.</p>
10	Connect connectors R2.FB 4-6 to the connection R2.SMB4-6 on the SMB-unit.	
11	Fit the SMB-unit to the bracket with the nuts, be careful not to let the weight of the SMB-unit strain the battery cable!.	<p>Note! The cable between the battery and the SMB-unit may stay connected, in order to avoid recalibration of the robot.</p>
12	Run all the earth cables on the R1.M4-6 cable to the back of the cover.	 <p data-bbox="954 1904 1061 1926">xx0200000403</p>
13	Connect connectors R1.MP4-6 and R2.BU4-6.	

Continues on next page

4 Repair

4.3.2 Replacement of cable harness, axes 4-6

Continued

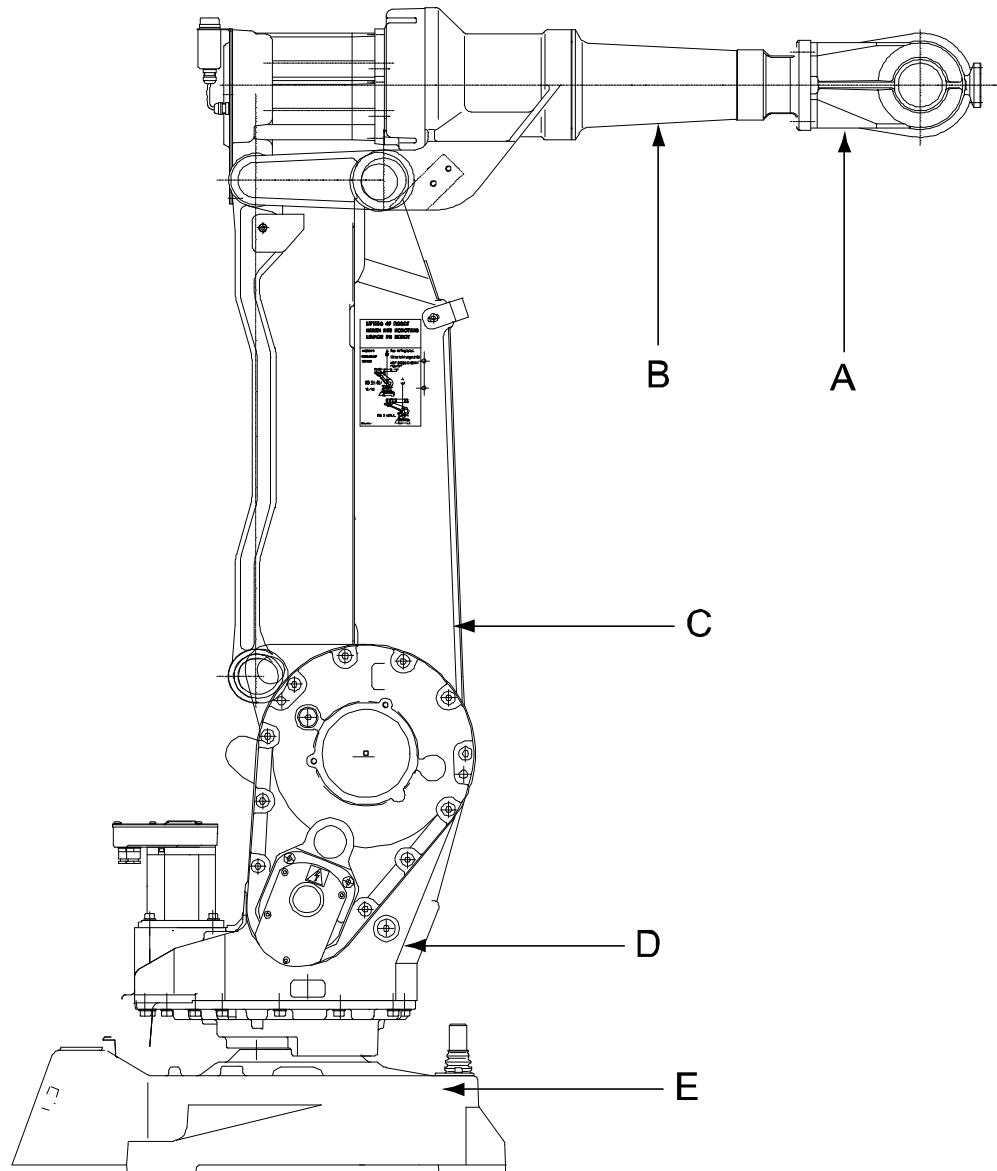
	Action	Note/Illustration
14	Refit the rear cover plate (A) on the robot with its attachment screws (B).	 <p>xx0200000399</p>
15	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.4 Upper arm

4.4.1 Replacement of wrist IRB 2400/10/16

Location of wrist

The wrist is defined as the axis 5 and 6 of the robot. This is shown in pos (A) in the figure below.



xx0300000103

A	Wrist
B	Upper arm
C	Lower arm
D	Frame
E	Base

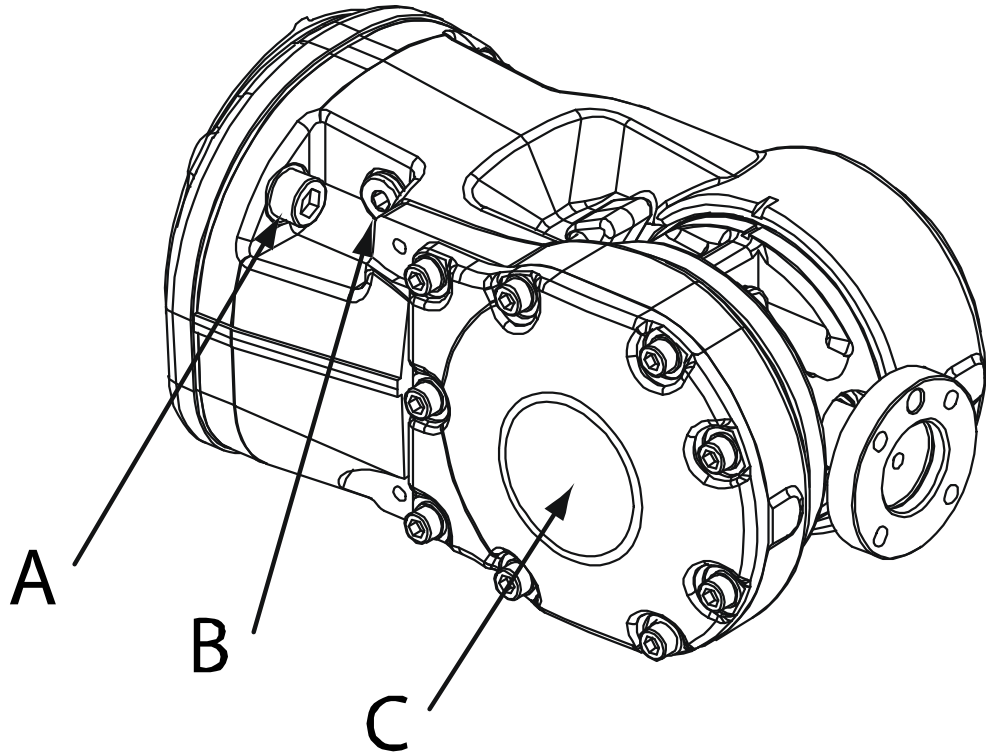
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4 Repair

4.4.1 Replacement of wrist IRB 2400/10/16

Continued

Wrist unit



xx0300000104

A	Attachment screws and washers
B	Oil plug
C	Wrist

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Wrist, Standard	3HAB9398-1		ABB Orange
	3HAC050646-001		Graphite White
O-ring		3HAB3772-12	Replace if damaged.
Grease		3HAC042536-001	Shell Gadus S2
Guide pins		-	M8, length = 70 mm
Measuring tool		3HAB7887-1	
Power supply		-	24 VDC, 1.5 A. For releasing the brakes.
Standard toolkit		-	The content is defined in the section Standard tools on page 227 .

Continues on next page

Equipment, etc.	Spare part no.	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.

**CAUTION**

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, wrist unit

The procedure below details how to remove the wrist from the robot upper arm.

The wrist, which includes axes 5 and 6, is a complete unit comprising drive units and gearboxes. It is a replacement unit of complex design and should not normally be serviced on-site. Instead it should be sent to ABB for service etc.

ABB recommends its customers to carry out only the following servicing and repair work on the wrist.

	Action	Note
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the <i>oil plug</i> on the wrist and drain it from all the oil.	Shown in the figure Wrist unit on page 130 .
3	Undo the <i>attachment screws</i> and remove the wrist.	Shown in the figure Wrist unit on page 130 .

Refitting, wrist unit

The wrist, which includes axes 5 and 6, is a complete unit comprising drive units and gearboxes. It is a replacement unit of complex design and should not normally be serviced on-site. Instead it should be sent to ABB for service.

The procedure below details how to refit the wrist to the robot upper arm.

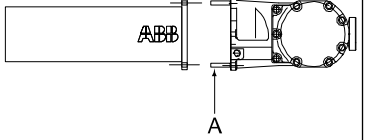
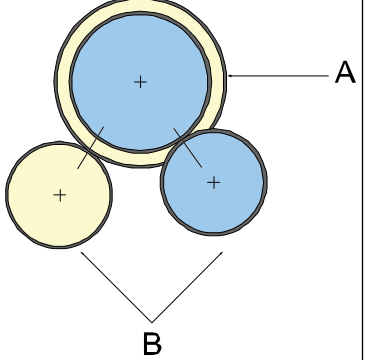
	Action	Note/Illustration
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Clean the surface of the tubular shaft.	
3	Lubricate the <i>o-ring</i> with <i>grease</i> to be sure that it does not get displaced, and fit it in its position on the upper arm tubular.	Art. no. is specified in Required equipment on page 130 .

Continues on next page


4 Repair

4.4.1 Replacement of wrist IRB 2400/10/16

Continued

	Action	Note/Illustration
4	Fit the two <i>guide pins</i> (A) diagonally on the wrist. Carefully push the wrist against the tubular. When the gears are meeting each other, they may need to be rotated to mesh properly.	Specified in Required equipment on page 130 .  xx0200000424
5	Fix the wrist with two screws and two washers. Remove the M8 guide pins and fit the other two screws and washers.	
6	In order to release the brakes, connect the 24 VDC power supply to the motor. Note! Release the brakes of the two motors, but one at a time!	Connect to motor axis 5, connector R3.MP5: <ul style="list-style-type: none"> • + :pin 7 • -: pin 8 Connect to motor axis 6, connector R3.MP6: <ul style="list-style-type: none"> • + : pin 7 • -: pin 8
7	Fit the <i>measuring tool</i> at the rear of the motor.	Art. no. is specified in Required equipment on page 130 .
8	Push the wrist, as shown in the figure to the right, to locate the smallest play in the same way as for adjustment of play when changing motors for axes 5 and 6, detailed in section Replacement of motors, axes 4-6, IRB 2400/10/16 on page 186 .	 xx0200000425 A Gears on drive shaft unit, axis 5-6 B Gears on the wrist
9	Tighten the attachment screws and washers.	Tightening torque: 17 Nm.
10	Check the play by moving axes 5 and 6 by hand.	
11	Refill the wrist unit with oil.	This is detailed in section Oil change, gearbox axes 5-6 (wrist unit) on page 87 .
12	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .

Continues on next page

	Action	Note/Illustration
13	 DANGER Make sure all safety requirements are met when performing the first test run.	

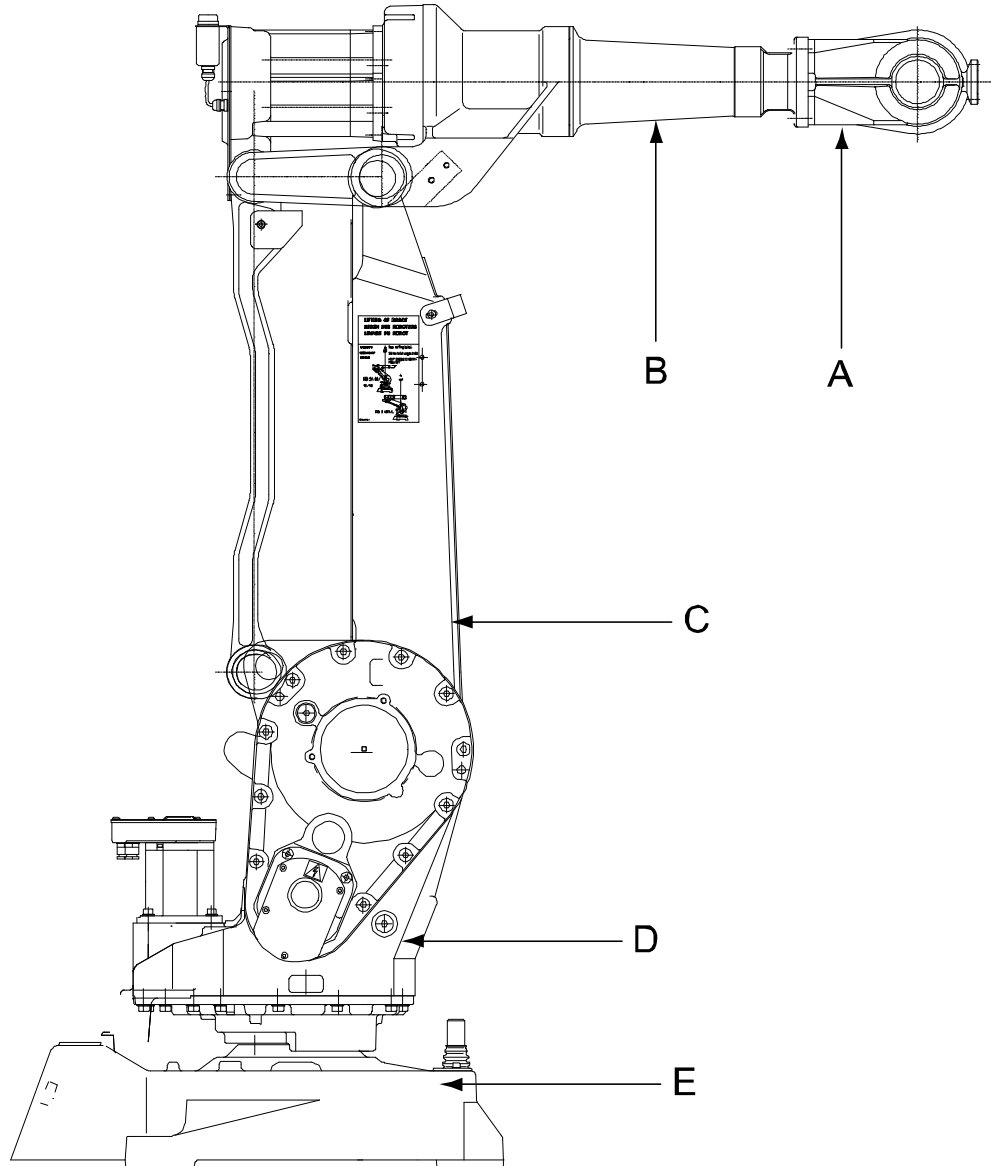
4 Repair

4.4.2 Replacement of wrist IRB 2400L

4.4.2 Replacement of wrist IRB 2400L

Location of wrist

The wrist is defined as the axis 5 and 6 of the robot and shown in pos (A) in the figure below.



xx020000409

A	Wrist
B	Upper arm
C	Lower arm
D	Frame
E	Base

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Note
Wrist, 5 kg	3HAC10814-1	Standard and Foundry.
Locking liquid	-	Loctite 574
Standard toolkit	-	The content is defined in the section Standard tools on page 227 .
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.



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, wrist unit

The procedure below details how to remove the wrist from the robot upper arm. The wrist, which includes axes 5 and 6, is a complete unit comprising drive units and gearboxes. It is a replacement unit of complex design and should not normally be serviced on-site. Instead it should be sent to ABB for service etc. ABB recommends its customers to carry out only the following servicing and repair work on the wrist.

	Action	Note/Illustration
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the oil plug from the wrist and drain it from all the oil.	<p style="text-align: center;">xx0300000104</p> <p>A Screw B Oil plug (air inlet) C Wrist unit</p>
3	Undo the screws and remove the wrist.	

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4 Repair

4.4.2 Replacement of wrist IRB 2400L

Continued

Refitting, wrist unit

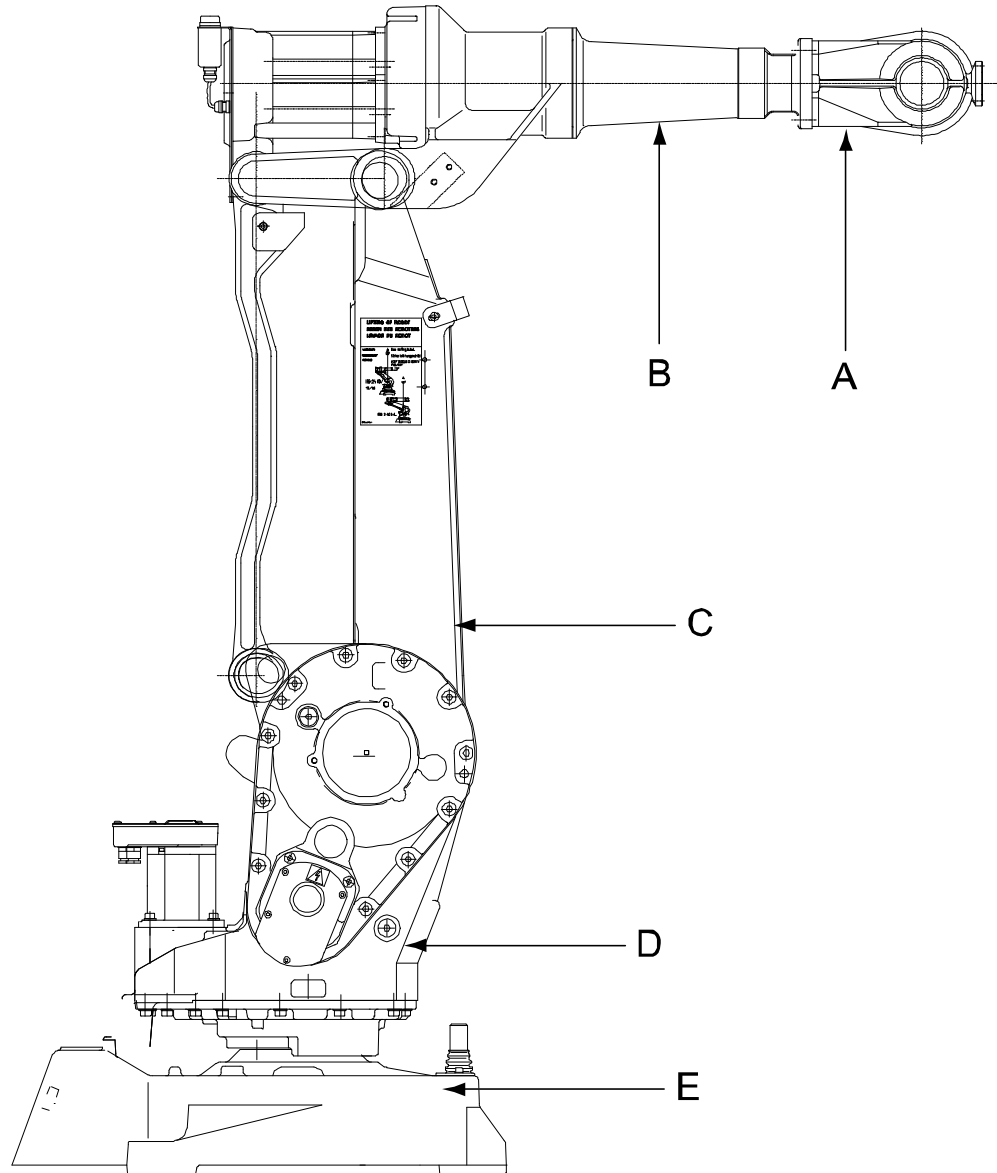
The procedure below details how to refit the wrist unit to the robot.

	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Clean the surface of the tubular shaft.	
3	Apply Loctite 574 all around.	
4	Fit the wrist, tighten the attachment screws.	Tightening torque: 8.3 Nm +10%.
5	Screw the clamping sleeves together using screws to a torque of 5.7 Nm.	
6	Refit the plugs.	
7	Refit the cover at the motor side of axis 5-6.	
8	Calibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
9	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.4.3 Replacement of complete upper arm

Location of upper arm

The upper arm is located on top of the robot as shown in (A) and (B) the figure below. The complete upper arm includes the wrist unit.



xx020000409

A	Wrist axis 5-6
B	Upper arm axis 3-4
C	Lower arm axis 2
D	Frame axis 1
E	Base

Continues on next page

4 Repair

4.4.3 Replacement of complete upper arm

Continued

Required equipment

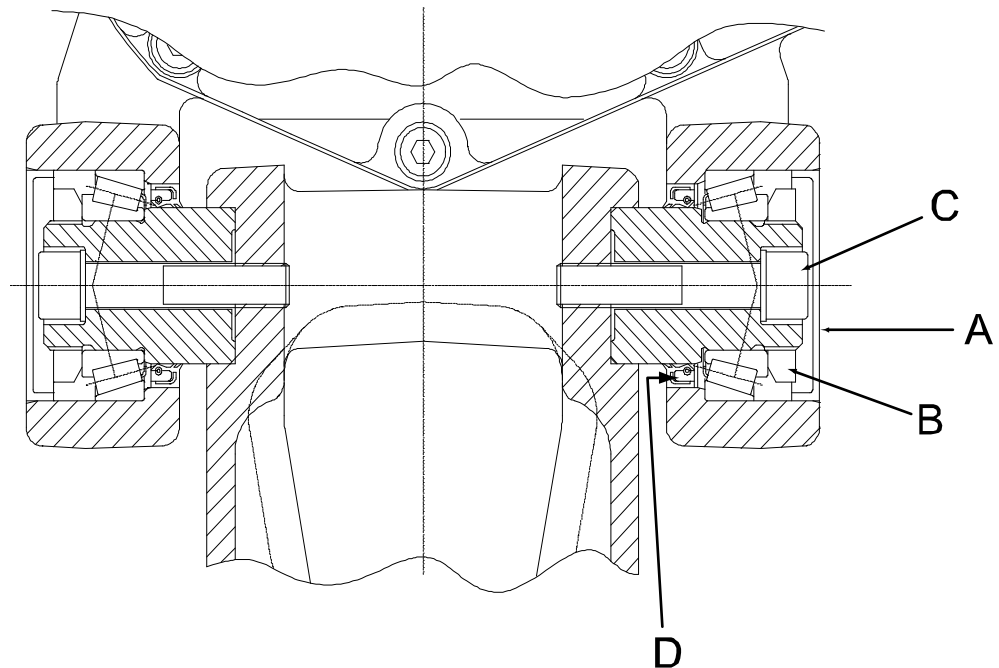
Equipment	Art. no.	Note
Lifting device, upper arm	-	
Dismounting tool, shaft ends	3HAB9009-1	Used for removing the shafts from the upper arm.
Mounting tool, bearing	3HAB6464-1	
Lifting tool (chain)	-	To be used together with lifting eye, M12 and lifting device, upper arm.
Standard toolkit	-	The content is defined in the section Standard tools on page 227 .
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.



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Upper arm attachment




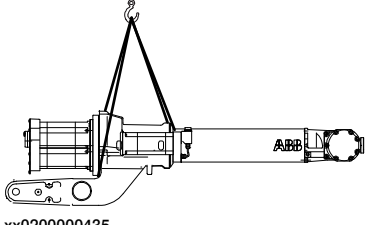
xx0200000436

A	Cover
B	KM nuts
C	Attachment screw
D	Sealing (insert a strap under the sealing to let the air go out when fitting the cover)

Continues on next page


Removal, upper arm

The procedure below details how to remove the complete upper arm.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the tie rod.	Detailed in section Replacement of tie rod on page 145 .
3	Loosen the connectors of the motors of axes 4, 5 and 6.	Detailed in section Replacement of motors, axes 4-6, IRB 2400L on page 179 .
4	Disconnect the connection box from the motors.	
5	Remove the covers (Left + Right).	Shown in the figure Upper arm attachment on page 138 .
6	Undo the KM nuts (Left + Right).	Shown in the figure Upper arm attachment on page 138 .
7	Remove the attachment screws (Left + Right).	Shown in the figure Upper arm attachment on page 138 .
8	Fit the lifting device to the upper arm, and lift enough for the strap to stretch <i>without lifting the robot</i> .	 xx0200000435 Lifting without lifting tool!
9	Pull out the shaft, using the <i>dismounting tool for shaft ends</i> . Mark the shafts (left, right).	Art. no. is specified in Required equipment on page 138 .

Refitting, upper arm

The procedure below details how to refit the complete upper arm.


	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Fit sealings in the upper arm.	
3	Fit the inner ring of the bearings on shafts, using the <i>mounting tool for bearings</i> .	Art. no. is specified in Required equipment on page 138 .
4	Raise the upper arm into the mounting position.	
5	Fit shaft spindles (both sides).	

Continues on next page

4 Repair

4.4.3 Replacement of complete upper arm

Continued

	Action	Note
6	Insert the <i>screws</i> and tighten.	Tightening torque: 90 Nm. Shown in the figure Upper arm attachment on page 138 .
7	<p><i>The following procedure must be performed within 10 minutes, before the Loctite starts to harden.</i></p> <ul style="list-style-type: none">• Apply Loctite 243 on the KM-nuts.• Fit and tighten the <i>KM-nut</i> on the left side first (robot seen from behind) so that the bearing comes against the collar.• Unscrew the KM-nut and then retighten with a torque of 35 Nm.• Tighten the KM-nut on the right side, move the upper arm up and down at the same time, until there is no play.• Unscrew the nut again.• Tighten the KM-nut with a torque of 35 Nm.• Push in a strap under the <i>sealing</i> to let the air go out and then fit the <i>covers</i>.	Shown in the figure Upper arm attachment on page 138 .
8	Fit the calibration plate for axis 3.	
9	Reconnect the connection boxes and the cabling.	
10	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
11	 DANGER Make sure all safety requirements are met when performing the first test run.	

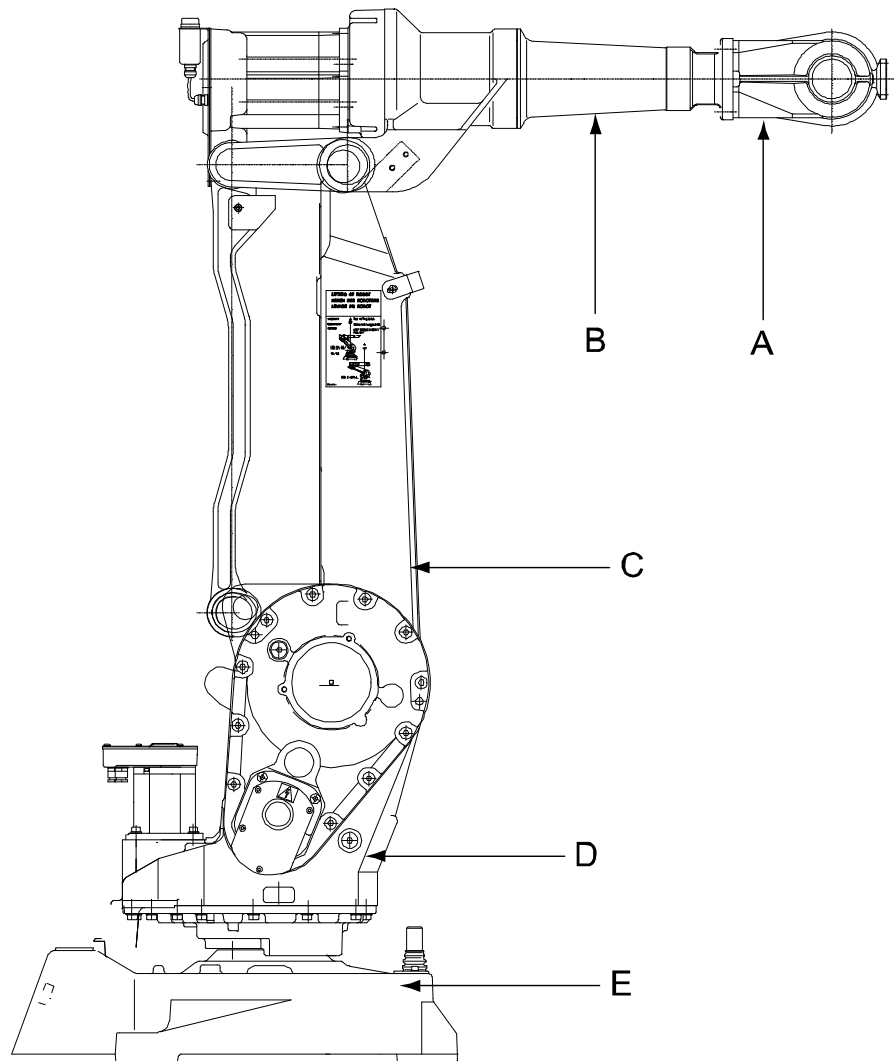
4.5 Lower arm

4.5.1 Replacement of complete lower arm

Location of lower arm

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

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx020000409

A	Wrist
B	Upper arm
C	Lower arm
D	Frame
E	Base

Continues on next page

4 Repair

4.5.1 Replacement of complete lower arm

Continued

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Lower arm	3HAC4796-1		2400/10, /16
Lower arm	3HAC4797-1		2400L
Sealing ring (V-ring)	3HAB3732-13		Replace if damaged.
Bearing grease		3HAC042536-001	Used to lubricate the sealing ring.
Hoisting equipment		-	
Standard toolkit			The content is defined in the section Standard tools on page 227 .
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
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.





CAUTION

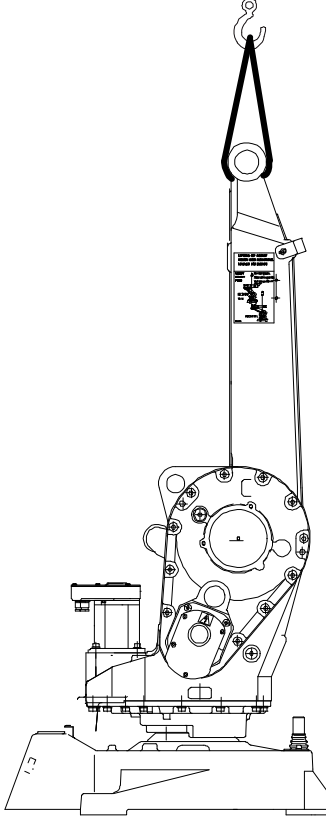
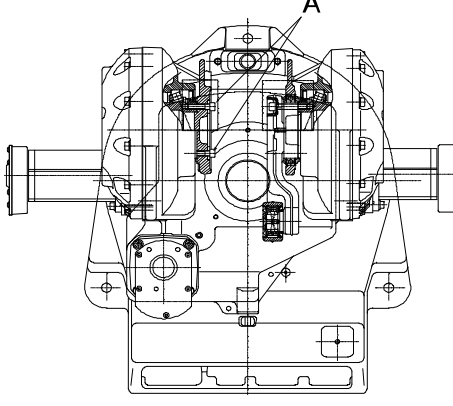
Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, lower arm

The procedure below details how to remove the complete lower arm.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the upper arm.	Detailed in section Removal, upper arm on page 139 .
3	 CAUTION The robot lower arm weighs 27 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	

Continues on next page

	Action	Note/Illustration
4	Fit the lifting equipment to the lower arm to secure its weight.	 <p>xx0200000439</p>
5	Remove the tie rod.	Detailed in section Removal, tie rod on page 147 .
6	Remove the parallel arm.	Detailed in section Removal, parallel arm on page 161 .
7	Pull down the cabling from inside the lower arm and remove any cable attachments.	
8	Remove the <i>attachment screws</i> and the <i>spring tension plate</i> .	 <p>xx0200000440</p> <p>Attachment screws</p>
9	Remove the lower arm.	

Continues on next page




4 Repair

4.5.1 Replacement of complete lower arm

Continued

Refitting, lower arm

The procedure below details how to refit the complete lower arm.

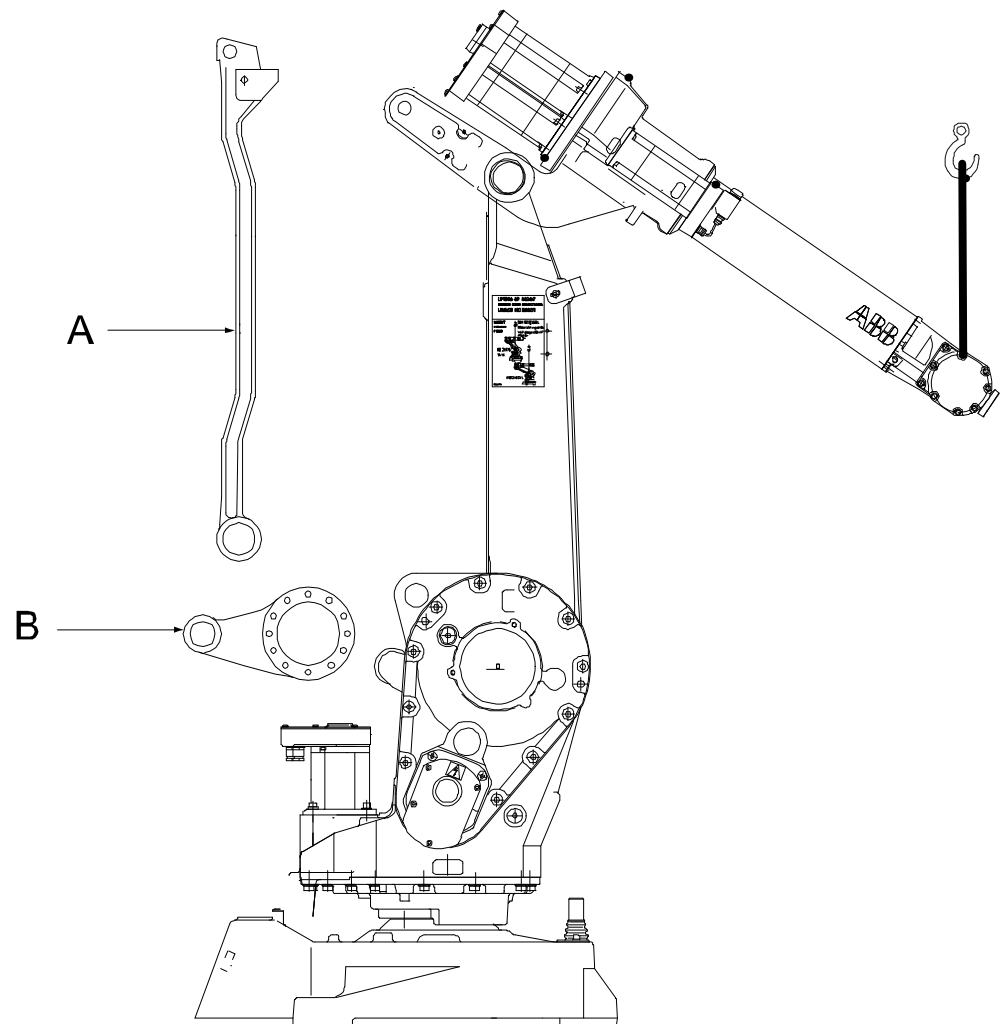
	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Move the damper and calibration marking to the new lower arm.	
3	Make sure that the <i>sealing ring</i> is fitted properly to the gearbox, undamaged and properly lubricated with <i>grease</i> . If damaged, replace with a new one.	Spare part no. is specified in Required equipment on page 142 . Shown in the figure Location of lower arm on page 141 .
4	 CAUTION The robot lower arm weighs 27 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	
5	Lift the lower arm into position.	
6	Fit the <i>spring tension plate</i> to the lower arm and secure the arm to the gearbox with the 12 <i>attachment screws</i> .	12 pcs; M10 x 40. Tightening torque: 72 Nm.
7	Refit the parallel arm.	Detailed in section Refitting, parallel arm on page 162 .
8	Refit the tie rod.	Detailed in section Refitting, tie rod on page 147 .
9	Refit the upper arm.	Detailed in section Refitting, upper arm on page 139 .
10	Refit the cabling.	Detailed in section Refitting, cable harness, axes 4-6 on page 124 .
11	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
12	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.5.2 Replacement of tie rod

Location of tie rod

The tie rod is located as shown in the figure below.

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx020000444

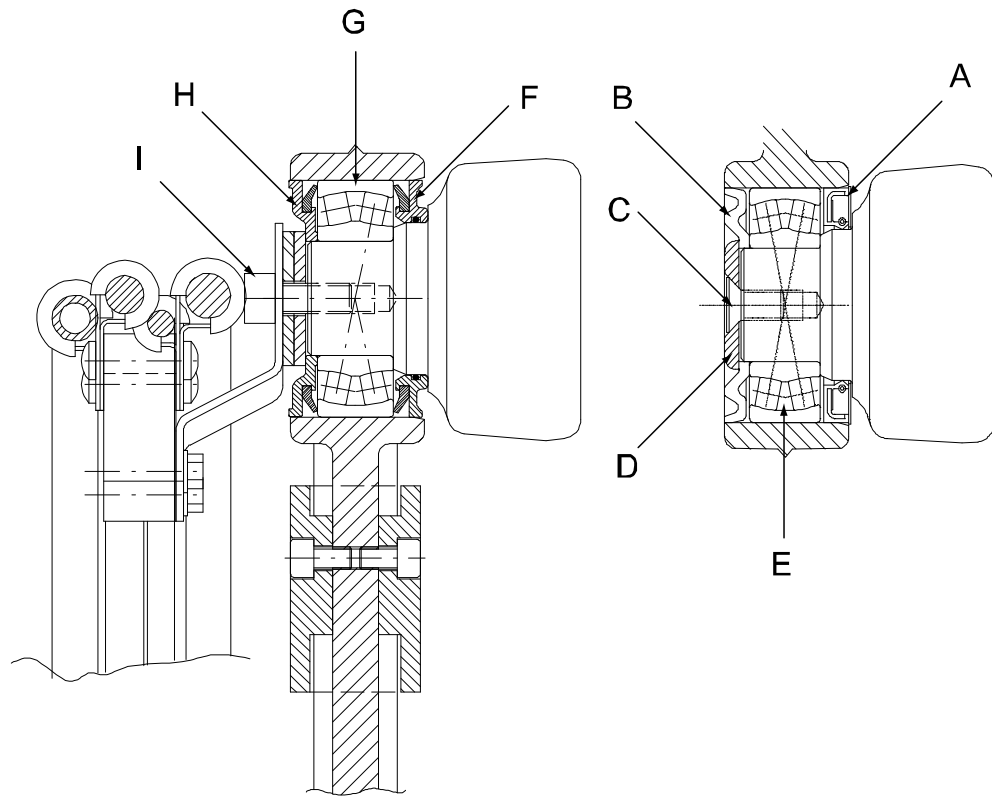
A	Tie rod
B	Parallel arm

Continues on next page

4 Repair

4.5.2 Replacement of tie rod

Continued



xx020000443

A	Bearing sealing
B	Back up ring
C	Attachment screw
D	Locking washer
E	Spherical roller bearing
	<i>Upper connection IRB 2400 5 kg</i>
F	Bearing sealing
G	Spherical roller bearing
H	Bearing sealing
I	Screw

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Locking liquid		3HAB7116-1	Loctite 243
Grease		3HAC042536-001	
Press tool, parallel bar bearing		3HAB6324-1	
Mounting tool, parallel bar		3HAB6331-1	Used to fit the tie rod.
Standard toolkit		-	The content is defined in the section Standard tools on page 227 .

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
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.



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, tie rod

The procedure below details how to remove the tie rod from the robot.

	Action	Note
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	CAUTION The robot upper arm weighs 23 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	
3	Use a crane to secure the weight of the upper arm.	Shown in the figure Location of tie rod on page 145 .
4	Remove the <i>attachment screw</i> from the upper and lower end.	Shown in the figure Location of tie rod on page 145 .
5	Remove the <i>locking washer</i> from both ends.	Shown in the figure Location of tie rod on page 145 .
6	Insert a screw in the center of each end, to be used as support.	M8
7	Use a puller to pull out the tie rod.	
8	Remove the bearings and seals.	Shown in the figure Location of tie rod on page 145 .

Refitting, tie rod

The procedure below details how to refit the tie rod to the robot.



	Action	Note
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

Continues on next page

4 Repair

4.5.2 Replacement of tie rod

Continued

	Action	Note
2	Make sure the weight of the upper arm is properly secured.	Use a crane!
3	Fit the new <i>spherical roller bearings</i> to the tie rod using the <i>press tool, parallel bar bearing</i> . Lubricate the bearings with bearing grease.	Shown in the figure Location of tie rod on page 145 . Art. no. is specified in Required equipment on page 146 .
4	Fit new <i>bearing sealings</i> to the shaft ends and lubricate the shaft ends with grease.	Shown in the figure Location of tie rod on page 145 . Spare part no. is specified in Required equipment on page 146 .
5	Refit the tie rod, using the <i>mounting tool, parallel bar</i> .  Note Press by hand!	Art. no. is specified in Required equipment on page 146 .
6	Fit new bearing sealings to the bearings.	
7	Refit the back up ring.	Shown in the figure Location of tie rod on page 145 .
8	Refit the locking washer.	Shown in the figure Location of tie rod on page 145 .
9	Refit the <i>attachment screw</i> at both ends of the bar, using <i>locking liquid</i> .	M8 x 16. Loctite 243 Shown in the figure Location of tie rod on page 145 .
10	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
11	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.6 Frame and base

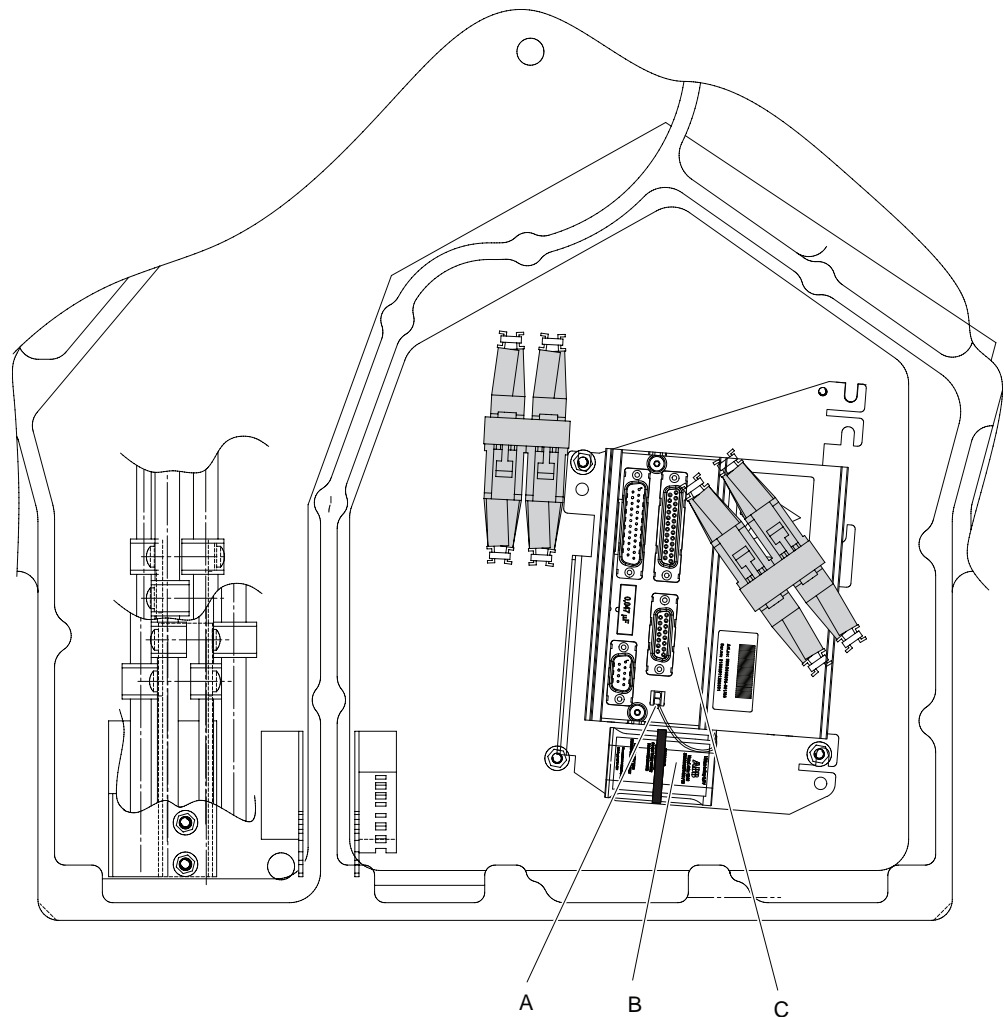
4.6.1 Replacement of SMB unit

Location of SMB unit

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

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).

Note that the robot is shown with the SMB cover already removed!



xx130000289

A	SMB battery cable
B	SMB battery RMU (3-pole battery contact)
C	SMB unit RMU 101

Continues on next page

4 Repair

4.6.1 Replacement of SMB unit

Continued

Required equipment



Note

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

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

Equipment	Spare part no.	Art. no.	Note
Gasket, base cover		3HAB 5537-1	Must always be replaced!
Serial measurement unit	3HAC17396-1		Contains serial measurement board 3HAC031851-001 and battery pack 3HAC16831-1.
Serial measurement unit	3HAC046277-001		Contains serial measurement board 3HAC044168-001 and battery pack 3HAC44075-001.
Standard toolkit			The content is defined in the section Standard tools on page 227 .
Circuit diagram		-	See the chapter Circuit diagram on page 233 .
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.

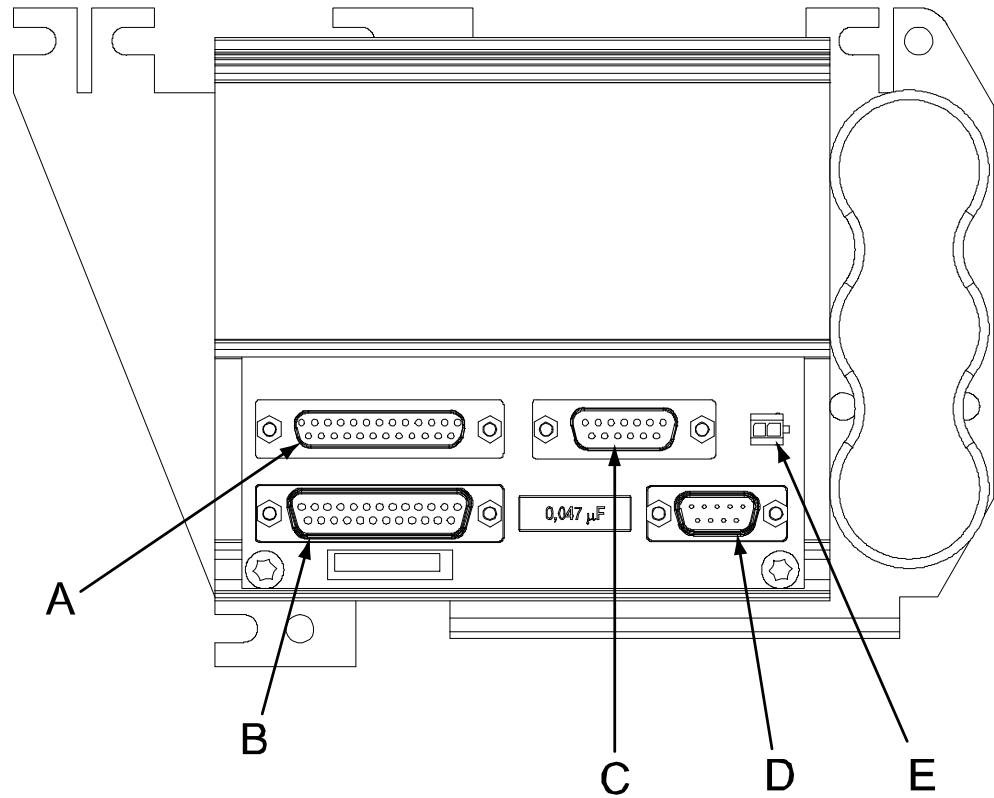


CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

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SMB unit, layout



xx0600002645

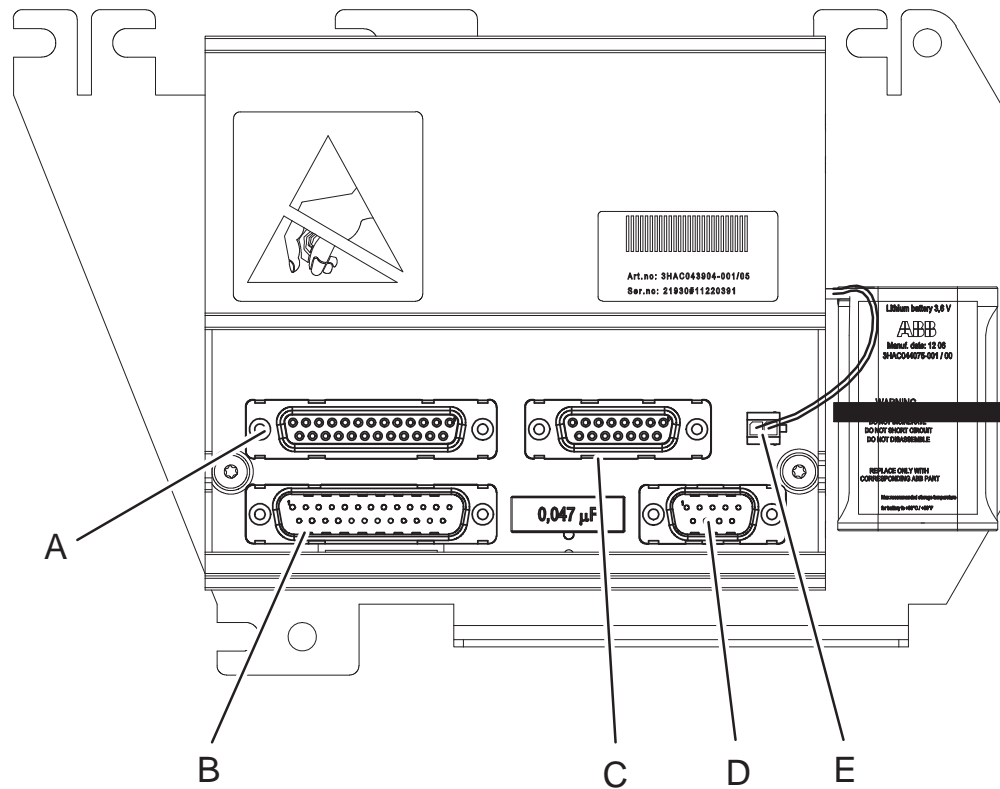
A	Connector R2.SMB4-6
B	Connector R2.SMB1-3
C	Connector R2.SMB1-2 (external axis)
D	Connector R2.SMB
E	Connector R2.G (battery unit)

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4 Repair

4.6.1 Replacement of SMB unit

Continued





xx1300000310


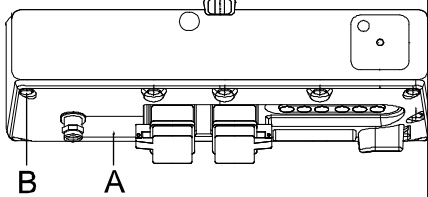
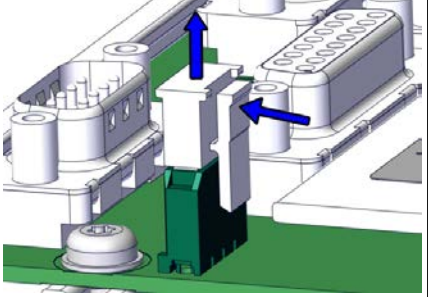
A	Connector R2.SMB4-6
B	Connector R2.SMB1-3
C	Connector R2.SMB1-2 (external axis)
D	Connector R2.SMB
E	Connector R2.G (battery unit)

Replacement, SMB unit

The procedure below details how to replace the SMB unit.

	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	 ELECTROSTATIC DISCHARGE (ESD) The unit is sensitive to ESD. Before handling the unit read the safety information in section The unit is sensitive to ESD on page 50 .	

Continues on next page

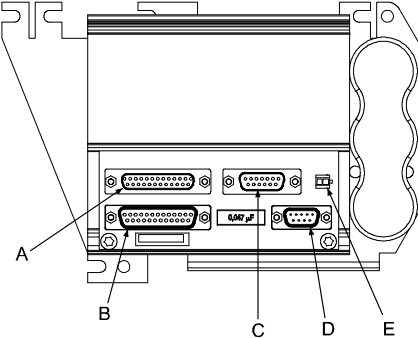
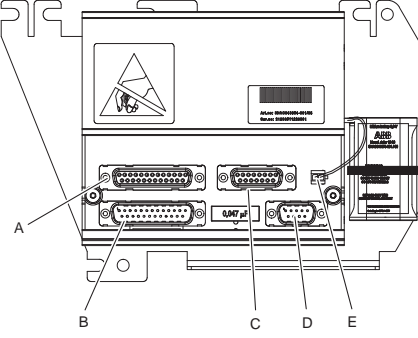
	Action	Note
3	<p>Remove the rear cover plate (A) from the base by unscrewing the attachment screws (B).</p> <p> CAUTION</p> <p>Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.</p>	 <p>xx0200000399</p>
4	Remove the SMB battery.	Detailed in section Replacement, SMB battery on page 92 .
5	<p>Remove the SMB cover by unscrewing its attachment screws.</p> <p>Pull the battery cable through the hole in the SMB cover.</p>	
6	Remove the two locknuts and washers from the <i>pins</i> securing the board.	
7	Disconnect the battery cable by pressing down the upper lip of the R2.G connector to release the lock while pulling the connector upwards.	 <p>xx1700000993</p>

Continues on next page

4 Repair

4.6.1 Replacement of SMB unit

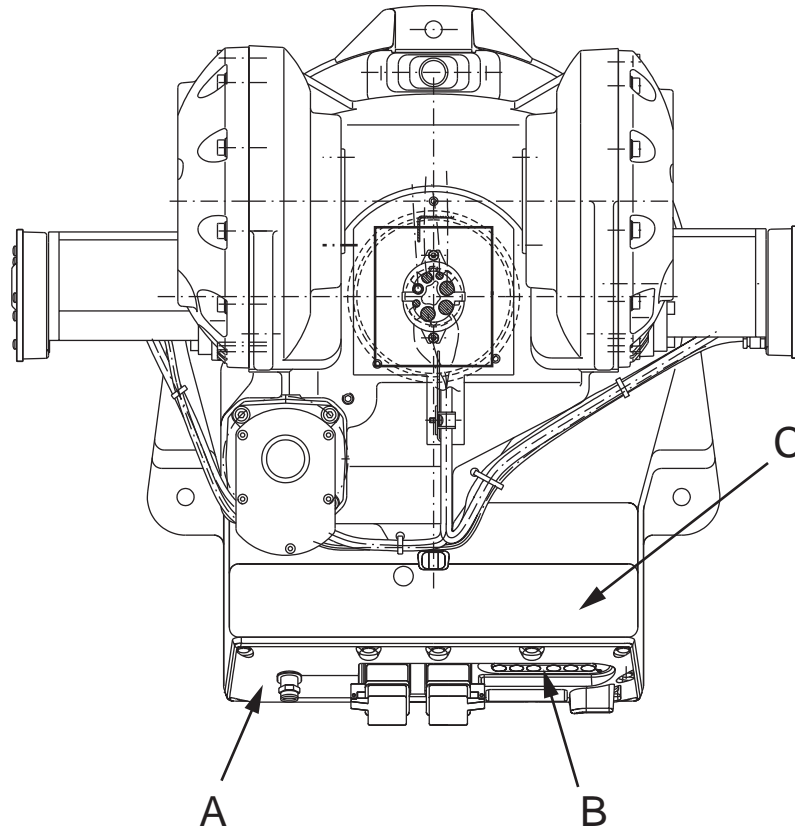
Continued

	Action	Note	
8	Gently disconnect the remaining connectors from the SMB unit when pulling the board out.	 <p>xx0600002645</p>  <p>xx1300000310</p> <p>A Connector R2.SMB4-6 B Connector R2.SMB1-3S C Connector R2.SMB1-2 (external axis) D Connector R2.SMB E Connector R2.G (battery unit)</p>	
9	Gently connect the connectors to the new SMB unit and push the board in. Make sure the lock on the battery cable connector R2.G snaps into place during refitting.		
10	Refit the SMB cover using the attachment lock nuts. Pull the battery cable through the hole in the SMB cover.		
11	Reassemble the two locknuts and washers to the pins securing the board.		
12	Refit the SMB battery.		
13	Fit a new <i>gasket</i> to the cover and refit the cover with the attachment screws.	Always replace a removed gasket with a new! Art. no. is specified in Required equipment on page 150 .	
14	Update the revolution counters!	Detailed in the section Updating revolution counters on IRC5 robots on page 205 .	

4.6.2 Replacement of brake release unit

Location of brake release unit

The brake release unit is located behind the base cover at the robot base, as shown below.



xx170001192

A	Base cover
B	Push-button guard
C	Brake release unit (located inside the base)

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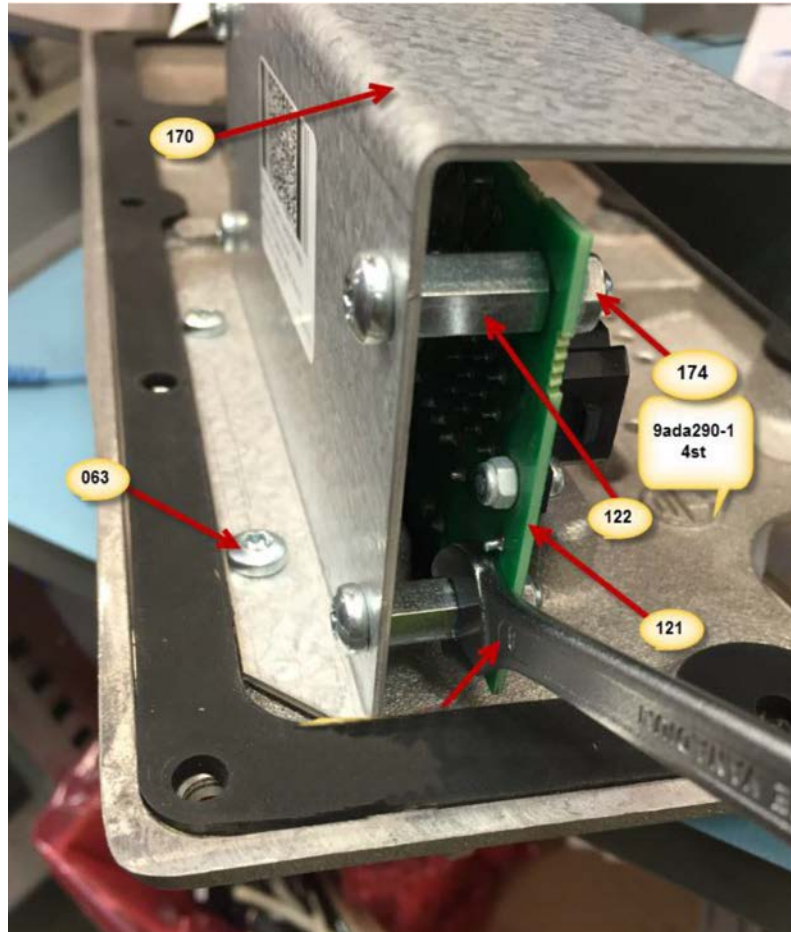
4 Repair

4.6.2 Replacement of brake release unit

Continued

Brake release unit on removed base cover

The figure shows the base cover, removed from the robot base. The brake release board is fastened to a plate with distance bolts and nuts, and the plate is fastened to the base cover.



xx1700001191

063	Attachment screws (2 pcs), brake release board plate
121	Brake release board
122	Distance bolt M5x15 (4 pcs)
170	Brake release board plate
174	Hexagon nut with flange M5 (4 pcs)

Required equipment

Equipment, etc.	Spare part number	Note
Brake release unit with harness and bracket	3HAC065018-001	DSQC1050
Standard toolkit	-	The content is defined in the section Standard tools on page 227 .

Continues on next page

Equipment, etc.	Spare part number	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.



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Replacement, brake release board

The procedure below details how to replace the brake release board.

Removing the brake release board

	Action	Note
1	<p>DANGER</p> <p>If the robot normally works in an inverted position, it must be removed from this position and placed on the floor before the work detailed in this procedure may be carried out!</p>	
2	<p>DANGER</p> <p>Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	
3	<p>ELECTROSTATIC DISCHARGE (ESD)</p> <p>The unit is sensitive to ESD. Before handling the unit read the safety information in section The unit is sensitive to ESD on page 50.</p>	
4	Remove the push-button guard from the base cover.	The guard must be removed to ensure a correct refitting of the brake release board.
5	<p>Remove the base cover carefully in order not to strain any cabling. The brake release board is fastened to the cover.</p> <p>CAUTION</p> <p>Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.</p>	
6	Take a picture or make notes of how the robot cabling is positioned in regard to the brake release board.	

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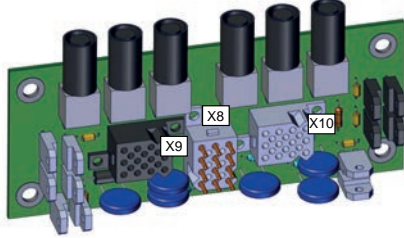


4 Repair

4.6.2 Replacement of brake release unit


Continued

	Action	Note
7	Remove the <i>brake release board plate</i> from the base cover by unscrewing the two <i>attachment screws</i> .	See Brake release unit on removed base cover on page 156 .
8	Remove the board from the plate by unscrewing the nuts from the distance bolts. Use a wrench to hold the distance bolt while unscrewing the nut.	
9	Disconnect the cables from the brake release board.	

Refitting the brake release board

	Action	Note
1	<p>Connect the connectors X8, X9 and X10 to the brake release board.</p> <p>Be careful not to damage the sockets or pins. Make sure the connector and its locking arms are snapped down properly.</p>  <p>xx170000978</p>	
2	<p>Fit the board to the brake release board plate and secure with the four distance bolts and nuts. Use a wrench to hold the distance bolt while fastening the nut.</p> <p>Maximum tightening torque: 5 Nm.</p> <p>Verify that the robot cabling is positioned correctly, according to previously taken picture/notes.</p> <p> WARNING</p> <p>Screened cables must not get in contact with the brake release board after installation. Eliminate all risks of contact between screened cables and the brake release board.</p>	
3	Refit the <i>brake release board plate</i> to the base cover with the two <i>attachment screws</i> .	See Brake release unit on removed base cover on page 156 .
4	<p> WARNING</p> <p>Before continuing any service work, follow the safety procedure in section The brake release buttons may be jammed after service work on page 114!</p>	
5	Refit the cover to the rear of the base.	
6	Refit the push button guard to the base cover.	

Continues on next page

	Action	Note
7	Press the push buttons 1 to 6, one at a time, to make sure that the buttons are moving freely and do not stay in a locked position.	
8	If the battery has been disconnected the revolution counter must be updated.	Detailed in the Calibration chapter - section Updating revolution counters on IRC5 robots on page 205 .
9	 DANGER Make sure all safety requirements are met when performing the first test run.	

4 Repair

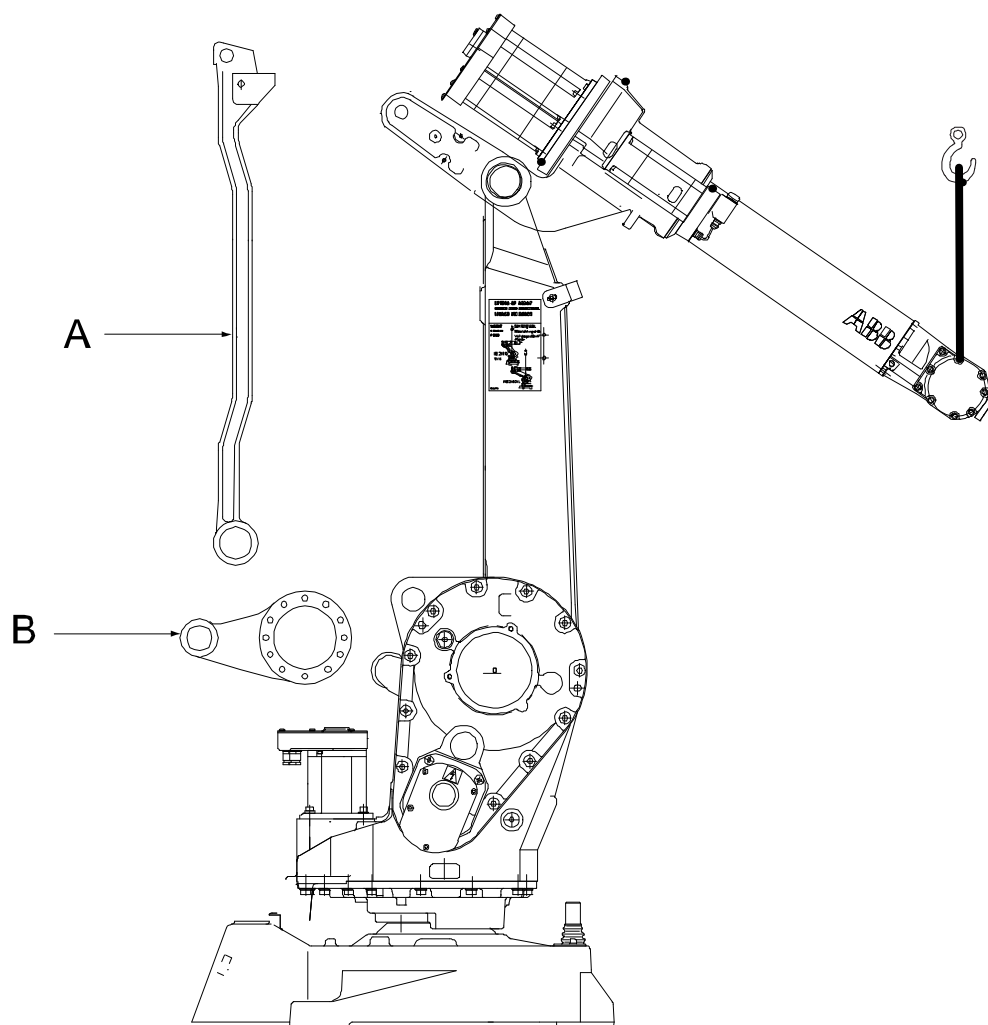
4.6.3 Replacement of parallel arm

4.6.3 Replacement of parallel arm

Location of parallel arm

The parallel arm is located at the frame, as shown in the figure below.

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx020000444

A	Tie rod
B	Parallel arm

Required equipment

Equipment	Spare part no.	Art. no.	Note
Groove ball bearing	3HAB3643-12		
Sealing ring	3HAB5515-1		
Bearing grease		3HAC042536-001	

Continues on next page

Equipment	Spare part no.	Art. no.	Note
Standard toolkit			The content is defined in the section Standard tools on page 227 .
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
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.

**CAUTION**

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, parallel arm

The procedure below details how to remove the parallel arm.

	Action	Note
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the tie rod.	Detailed in section Removal, tie rod on page 147 .
3	Remove the parallel arm by removing its eight attachment screws and washers.	

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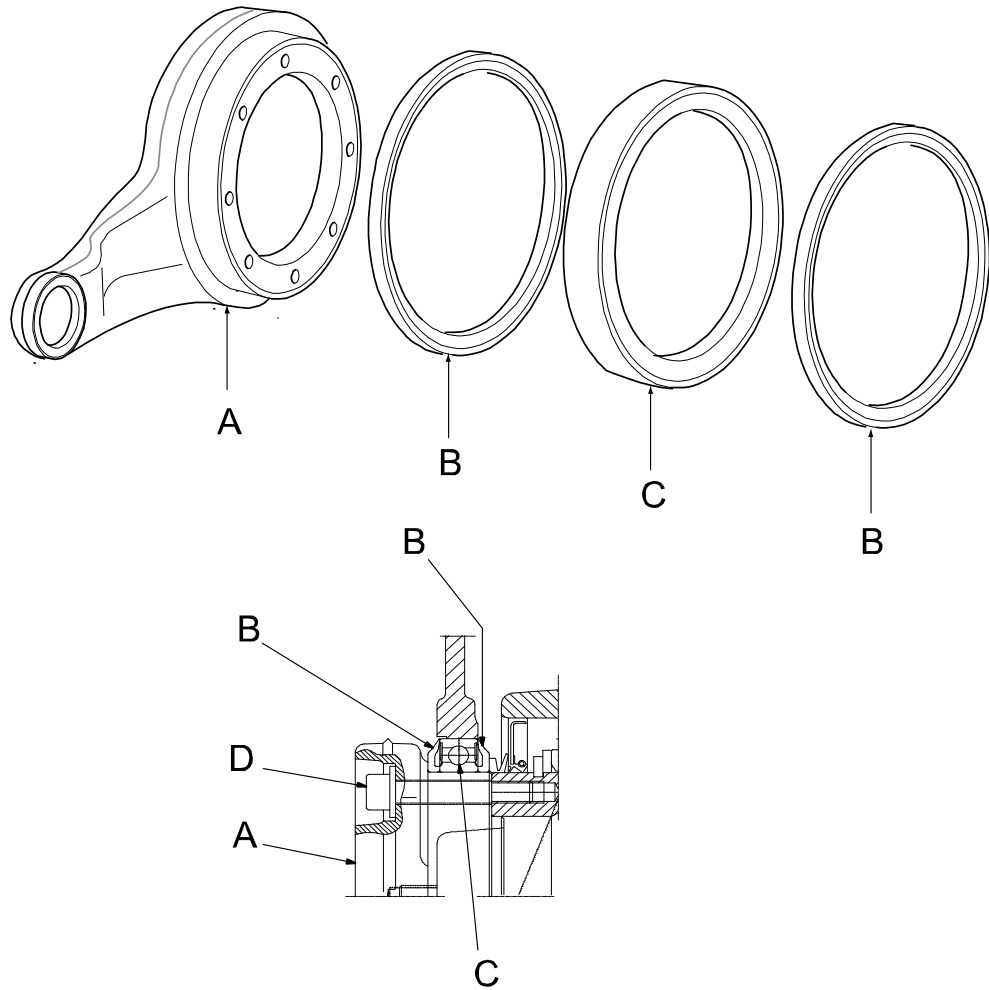
4 Repair

4.6.3 Replacement of parallel arm

Continued

Assembly, parallel arm

The figure below shows the assembly of the parallel arm.




xx020000450


A	Parallel arm
B	Sealing V- ring (2 pcs)
C	Groove ball bearing
D	Attachment screws and washers (8 pcs)

Refitting, parallel arm

The procedure below details how to refit the complete parallel arm to the robot.

	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Fit one of the two <i>V-rings</i> to the parallel arm.	Shown in the figure Assembly, parallel arm on page 162 .

Continues on next page

	Action	Note
3	Heat up the new bearing to 170° and fit it to the parallel arm.	
4	Fit the second V-ring to the parallel arm.	
5	Fit the complete parallel arm to the robot with the eight attachment screws and washers.	8 pcs; M10x60. Tightening torque: 72 Nm.
6	Refit the tie rod.	Detailed in section Refitting, tie rod on page 147 .
7	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
8	 DANGER Make sure all safety requirements are met when performing the first test run.	

4 Repair

4.7.1 Replacement of motor, axis 1

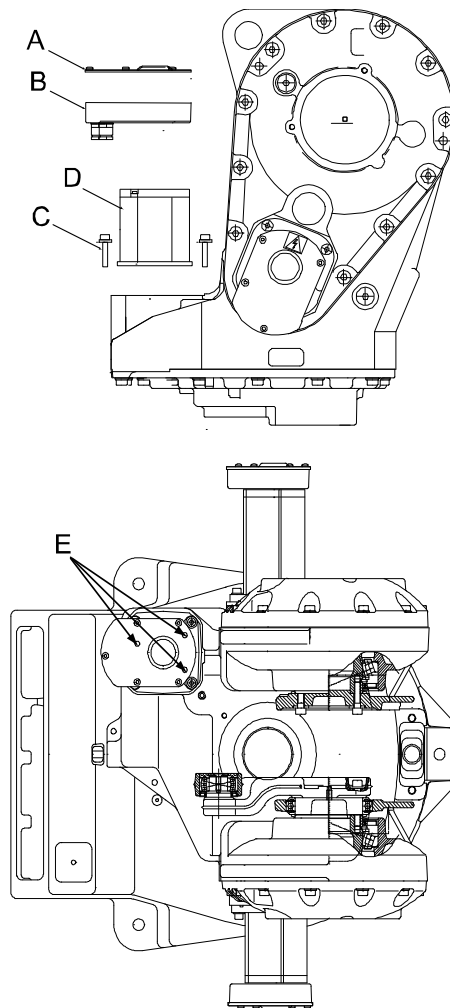
4.7 Motors

4.7.1 Replacement of motor, axis 1

Location of motor, axis 1

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

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx020000465

A	Cover
B	Connection box
C	Attachment screws and washers, motor (4 pcs)
D	Motor axis 1
E	Correct orientation of holes

Continues on next page

Required equipment

**Note**

The different motors are not compatible. Make sure to replace with correct model!


Equipment	Spare part no.	Art. no.	Note
Motor axis 1	3HAC4789-1		IRB 2400 /L, /10, /16 (Elmo)
	3HAC14271-1		IRB 2400 /Wall mounted (Elmo)
	3HAC021346-001		Color: ABB Orange IRB 2400 /L, /10, /16 (Yaskawa)
	3HAC021346-003		Color: Graphite White IRB 2400 /L, /10, /16 (Yaskawa)
	3HAC021961-001		IRB 2400 /Wall mounted (Yaskawa)
O-ring		21522012-434	Always fit a new one!
Gasket		3HAB 3676-1	
Measuring tool, motor		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section Special tools on page 228 .
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See the chapter Circuit diagram on page 233 .

**CAUTION**

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, motor axis 1

The procedure below details how to remove the motor, axis 1.

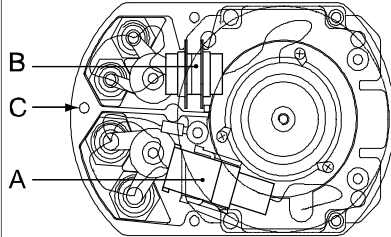
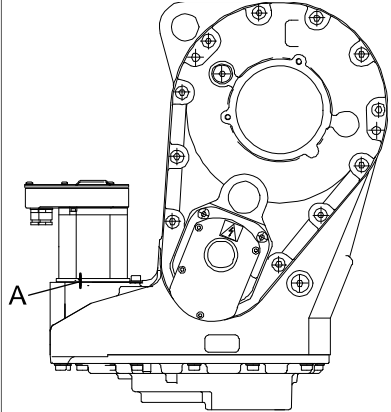
	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

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4 Repair


4.7.1 Replacement of motor, axis 1

Continued

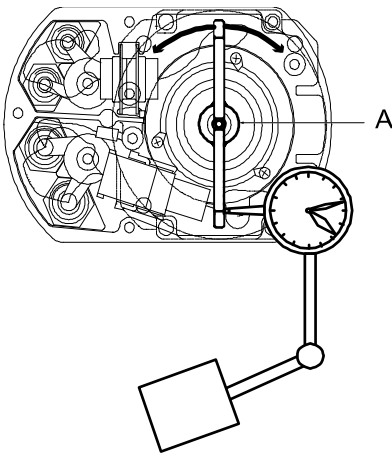
	Action	Note/Illustration
2	Remove the <i>cover</i> of the connection box.	Shown in the figure Location of motor, axis 1 on page 164
3	Disconnect the connectors R3.MP1 and R3.FB1.	 <p>xx020000401</p> <ul style="list-style-type: none"> • A: R3.MP1 • B: R3.FB1 • C: Connection box
4	Remove the <i>connection box</i> by unscrewing its three attachment screws and plain washers.	Shown in the figure Location of motor, axis 1 on page 164 .
5	Use a marker pen to mark the position of the motor (A), if the same motor is to be refitted.	 <p>xx0600002646</p>
6	Unscrew the four <i>attachment screws and washers</i> of the motor.	Shown in the figure Location of motor, axis 1 on page 164 .
7	Gently lift the motor straight up, making sure not to damage the motor pinion.	

Refitting, motor axis 1

The procedure below details how to refit the motor, axis 1.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor is un-scratched.	
3	Fit the new <i>o-ring</i> .	Always fit a new one, see article number in Required equipment on page 165 .

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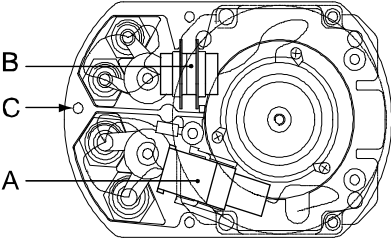

	Action	Note/Illustration
4	Fit the motor by gently lowering it straight down.	Note the position of the motor! Use the mark , made on the motor base before removal. See also orientation of the holes on top of the motor, shown in the figure Location of motor, axis 1 on page 164 .
5	Tighten the four <i>attachment screws and washers</i> .	Tightening torque: 2 Nm.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect power supply to connector R3.MP1: <ul style="list-style-type: none"> • + : pin 7 • - : pin 8
7	Fit the <i>measuring tool</i> to the rear of the motor.	Article number is specified in Required equipment on page 165 . Shown in the figure below.
8	Rotate the motor shaft several turns, using the measuring tool. There must always be some backlash, meaning that the shaft should go easy to rotate!	
9	Place the tip of a dial indicator against the scribed mark on the measuring tool.	The tip of the dial indicator must measure on a 50 mm radius from the center of the motor shaft.  <p style="text-align: center;">xx0200000473 Measuring tool</p>
10	Set the gear play to 0.02 mm, which corresponds to a reading on the dial indicator of 0.13 mm.	
11	Pull gently in one direction. Note the reading. (The gear must not turn.)	
12	Then gently knock on the tool in the other direction and note the reading. The difference in reading = gear play. The gear play should be 0.02 mm which corresponds to a reading on the dial indicator of 0.13 mm.	
13	Tighten the motor attachment screws.	4 pcs. Tightening torque: 35 Nm
14	Refit the <i>connection box</i> with the three attachment screws and plain washers. Make sure the gasket is fitted properly!	Shown in the figure Location of motor, axis 1 on page 164 .

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4 Repair

4.7.1 Replacement of motor, axis 1

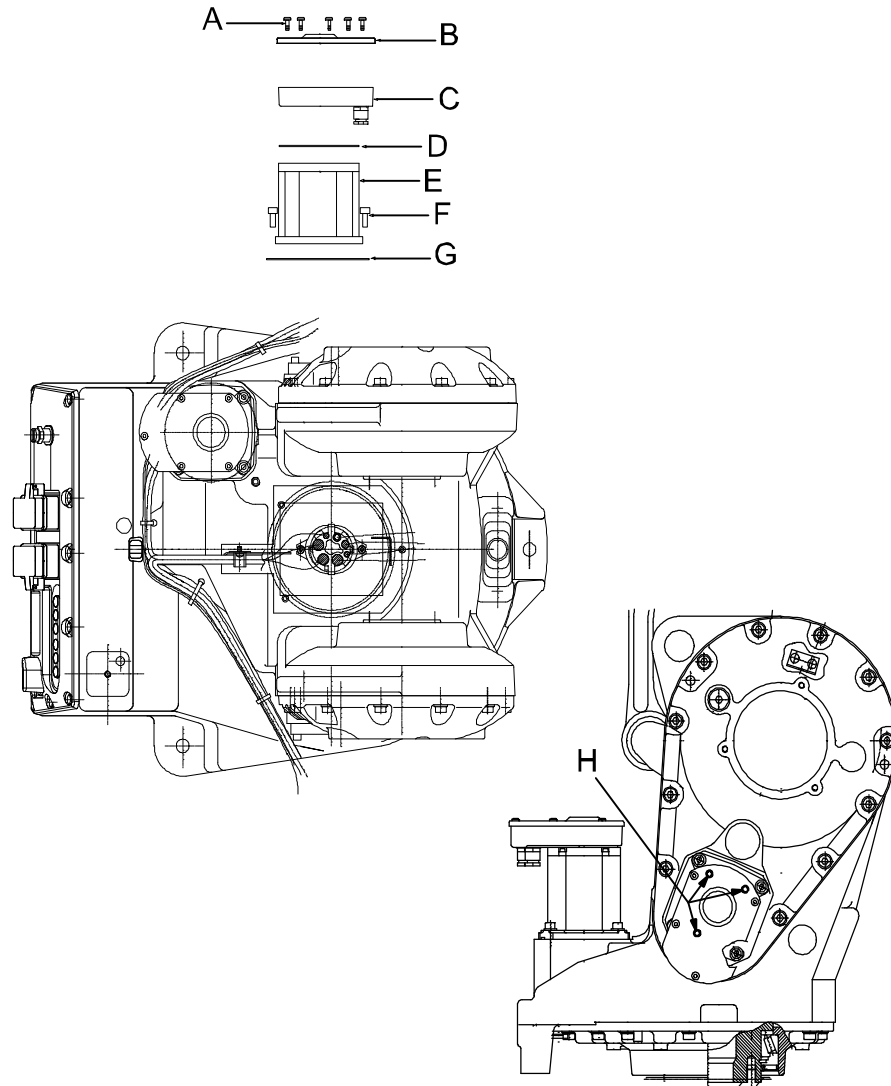
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	Action	Note/Illustration
15	Reconnect the connectors R3.MP1 and R3.FB1.	 <p>xx0200000401</p> <ul style="list-style-type: none">• A: R3.MP1• B: R3.FB1• C: Connection box
16	Refit the <i>cover</i> of the connection box.	Shown in the figure Location of motor, axis 1 on page 164 .
17	Re-calibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
18	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.7.2 Replacement of motor, axis 2

Location of motor, axis 2

The motor, axis 2, is located on the left hand side of the robot as shown in the figure below:



xx020000470

A	Attachment screws, cover (5 pcs)
B	Cover
C	Connection box
D	Gasket
E	Motor, axis 2
F	Attachment screws, motor (4 pcs)
G	O-ring
H	Correct orientation of holes on top of motor

Continues on next page

4 Repair

4.7.2 Replacement of motor, axis 2

Continued

Required equipment



Note

The different motors are not compatible. Make sure to replace with correct model!

Equipment, etc.	Spare part no.	Art. no.	Note
Motor, axis 2	3HAC4790-1		(Elmo)
Motor, axis 2	3HAC021350-001		Color: ABB Orange (Yaskawa)
	3HAC021350-003		Color: Graphite White (Yaskawa)
O-ring		21522012-434	Always fit a new one!
Gasket		3HAB3676-1	
Measuring tool, motor		3HAB7887-1	
Power supply			24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section Standard tools on page 227 .
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See the chapter Circuit diagram on page 233 .



CAUTION

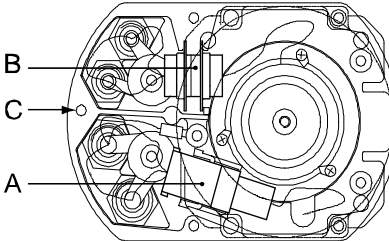

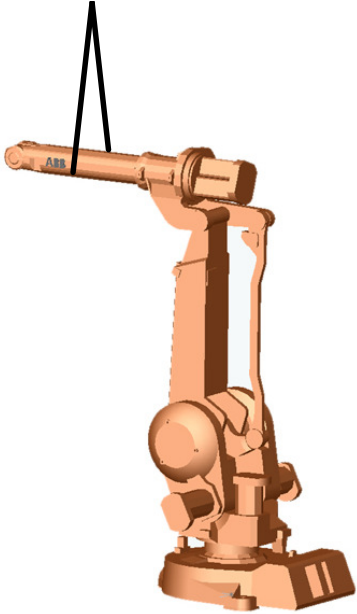

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, motor axis 2

The procedure below details how to remove the motor, axis 2.

	Action	Note/Illustration
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the <i>cover</i> of the connection box.	Shown in the figure Location of motor, axis 2 on page 169 .

Continues on next page

	Action	Note/Illustration
3	Disconnect the motor connectors R3.MP2 and R3.FB2.	 <p>xx020000401</p> <ul style="list-style-type: none"> • A: R3.MP2 • B: R3.FB2 • C: Connection box
4	Remove the connection box by unscrewing its three attachment screws and plain washers.	
5	Use a marker pen to mark out the position of the motor, if the same motor is to be refitted.	
6	<p> DANGER</p> <p>Secure the weight of the lower arm properly before releasing the brakes of motor, axis 2!</p> <p>When releasing the holding brakes of the motor, the lower arm will be movable and may fall down!</p>	<p>Secure the robot arms before unscrewing any of the attachment screws of the axis 2 motor.</p>  <p>xx0700000660</p>
7	<p> WARNING</p> <p>Oil will be running out of the motor attachment hole when removing the motor! It may also be hot! Take any necessary measures to collect the oil.</p>	
8	Unscrew the four <i>attachment screws and washers</i> of the motor.	Shown in the figure Location of motor, axis 2 on page 169 .
9	Remove the motor by gently lifting it straight out.	

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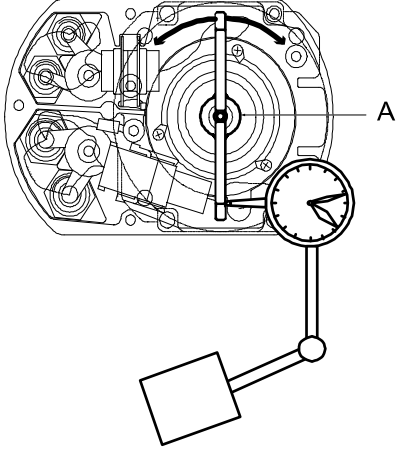
4 Repair

4.7.2 Replacement of motor, axis 2

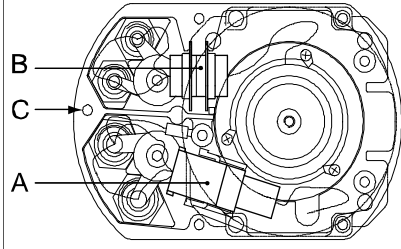

Continued

Refitting, motor axis 2

The procedure below details how to refit the motor, axis 2.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor is unscratched.	
3	Fit the <i>o-ring</i> .	Always fit a new one, see art. no. in Required equipment on page 170 .
4	Fit the motor by gently lifting it straight on.	Note the position of the motor! Use the mark on the motor base, made before removing the motor. Also see the orientation holes on the motor cover, shown in the figure Location of motor, axis 2 on page 169 .
5	Fit the four attachment screws and tighten them slightly. Make the adjustments described below before tightening the screws properly.	4 pcs. Tightening torque: 2 Nm.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP2: <ul style="list-style-type: none"> • +: pin 7 • -: pin 8
7	Fit the <i>measuring tool</i> to the rear of the motor.	See the figure below. Art. no. is specified in Required equipment on page 170 .
8	Rotate the motor shaft several turns, using the measuring tool. There must always be some backlash, meaning that the shaft should go easy to rotate!	
9	Place the tip of a dial indicator against the scribed mark on the measuring tool.	The tip of the dial indicator must measure on a 50 mm radius from the center of the motor shaft.  <p style="text-align: right;">A</p> <p style="text-align: right;">xx0200000473</p> <p style="text-align: center;">A Measuring tool</p>
10	Set the gear play to 0.02 mm, which corresponds to a reading on the dial indicator of 0.13 mm.	

Continues on next page

	Action	Note/Illustration
11	Pull gently in one direction. Note the reading. (The gear must not turn.)	See the figure above.
12	Then gently knock on the tool in the other direction and note the reading. The difference in reading = gear play. The gear play should be 0.02 mm which corresponds to a reading on the dial indicator of 0.13 mm.	See the figure above.
13	Tighten the four attachment screws.	4 pcs. Tightening torque: 35 Nm.
14	Perform a leak-down test.	Detailed in section Performing a leak-down test on page 106 .
15	Fill the gearbox with oil.	Where to find type of oil and total amount is detailed in Type and amount of oil in gearboxes on page 86 .
16	Refit the <i>connection box</i> and secure with the three attachment screws and plain washers. Make sure that the gasket is fitted properly!	Shown in the figure Location of motor, axis 2 on page 169 .
17	Reconnect connectors R3.MP2 and R3.FB2.	 <p>xx0200000401</p> <ul style="list-style-type: none"> • A: R3.MP2 • B: R3.FB2 • C: Connection box
18	Refit the <i>cover</i> of the connection box.	Shown in the figure Location of motor, axis 2 on page 169 .
19	Re-calibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
20	 <p>DANGER</p> <p>Make sure all safety requirements are met when performing the first test run.</p>	

4 Repair

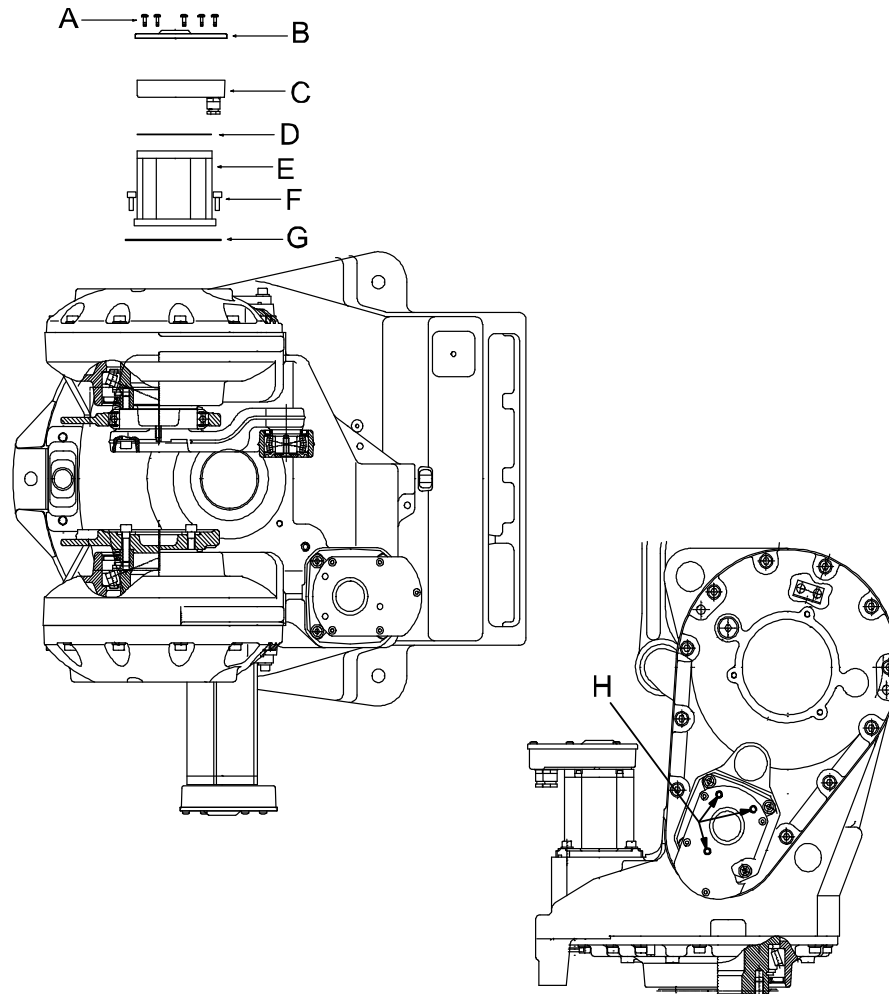
4.7.3 Replacement of motor, axis 3

4.7.3 Replacement of motor, axis 3

Location of motor, axis 3

The motor, axis 3, is located on the right hand side of the robot, as shown in the figure below:

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx020000471

A	Attachment screws, cover
B	Cover
C	Connection box
D	Gasket
E	Motor, axis 2
F	Attachment screws, motor (4 pcs)
G	O-ring
H	Correct orientation of holes on top of motor

Continues on next page

Required equipment

Note! The different motors are not compatible. Make sure to replace with correct model!

Equipment	Spare part no.	Art. no.	Note
Motor axis 3	3HAC4789-1		(Elmo)
	3HAC021346-001		Color: ABB Orange (Yaskawa)
	3HAC021346-003		Color: Graphite White (Yaskawa)
Gasket		3HAB3676-1	
O-ring		21522012-434	Always fit a new one.
Measuring tool, motor		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit		-	The content is defined in the section Standard tools on page 227 .
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram		-	See the chapter Circuit diagram on page 233 .



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, motor axis 3

The procedure below details how to remove the motor, axis 3.

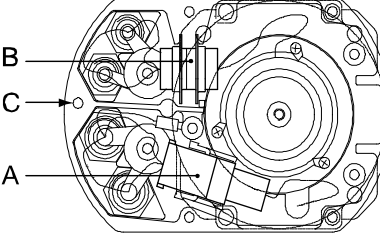

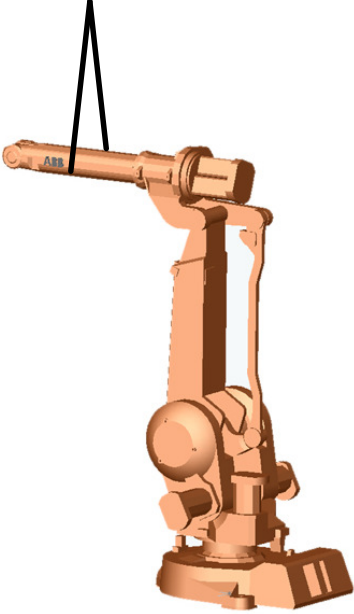

	Action	Note/Illustration
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the <i>cover</i> of the connection box.	Shown in the figure Location of motor, axis 3 on page 174 .

Continues on next page

4 Repair

4.7.3 Replacement of motor, axis 3


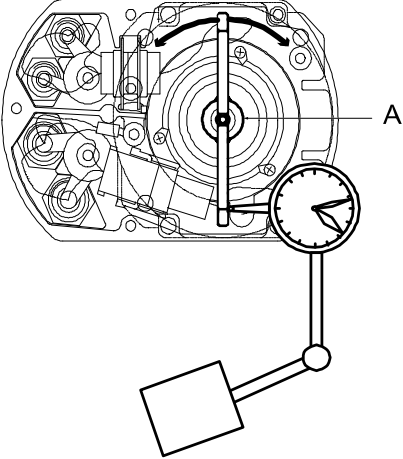
Continued

	Action	Note/Illustration
3	Disconnect the motor connectors R3.MP3 and R3.FB3.	 <p>xx0200000401</p> <ul style="list-style-type: none"> • A: R3.MP3 • B: R3.FB3 • C: Connection box
4	Remove the <i>connection box</i> by unscrewing its three attachment screws and plain washers.	Shown in the figure Location of motor, axis 3 on page 174 .
5	Use a marker pen to mark out the position of the motor, if the same motor is to be refitted.	
6	<p> DANGER</p> <p>Secure the weight of the upper arm properly before releasing the brakes of motor, axis 3.</p> <p>When releasing the holding brakes of the motor, the upper arm will be movable and may fall down!</p>	<p>Secure the upper arm before loosening any of the screws on the motor!</p>  <p>xx0700000660</p>
7	<p> WARNING</p> <p>Oil will be running out of the motor attachment hole when removing the motor! It may also be hot! Take any necessary measures to collect the oil.</p>	
8	Unscrew the four <i>attachment screws</i> and plain washers of the motor.	Shown in the figure Location of motor, axis 3 on page 174 .
9	Remove the motor by gently lifting it straight out.	

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Refitting, motor axis 3

The procedure below details how to refit the motor, axis 3.

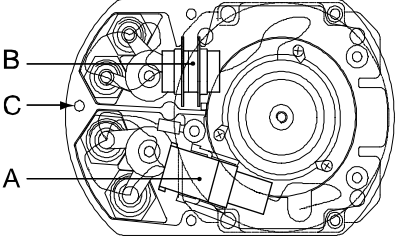

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor is unscratched.	
3	Fit a new <i>o-ring</i> to the motor.	Always mount a new one, see art. no. in section Required equipment on page 175 .
4	Fit the motor, by gently lifting it straight on.	Note the position of the motor! Use the mark on the motor base, made before removal. Also see the orientation holes on the motor cover, shown in the figure Location of motor, axis 3 on page 174 .
5	Tighten the four screws lightly.	Tightening torque: 2 Nm.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP3: <ul style="list-style-type: none"> • +: pin 7 • -: pin 8
7	Fit the <i>measuring tool</i> to the rear of the motor.	See the figure below. Art. no. is specified in Required equipment on page 175 .
8	Rotate the motor shaft several turns, using the measuring tool. There must always be some backlash, meaning that the shaft should go easy to rotate!	See the figure below.
9	Place the tip of a dial indicator against the scribed mark on the measuring tool.	<p>The tip of the dial indicator must measure on a 50 mm radius from the center of the motor shaft.</p>  <p>xx0200000473</p> <p>A Measuring tool</p>
10	Set the gear play to 0.02 mm, which corresponds to a reading on the dial indicator of 0.13 mm.	

Continues on next page

4 Repair

4.7.3 Replacement of motor, axis 3

Continued

	Action	Note/Illustration
11	Pull gently in one direction. Note the reading. <i>(The gear must not turn.)</i>	See the figure above.
12	Then gently knock on the tool in the other direction and note the reading. The difference in reading = gear play. The gear play should be 0.02 mm which corresponds to a reading on the dial indicator of 0.13 mm.	See the figure above.
13	Tighten the four motor attachment screws.	4 pcs. Tightening torque: 35 Nm.
14	Perform a leak-down test.	Detailed in section Performing a leak-down test on page 106 .
15	Refill the gearbox with oil.	Where to find type of oil and total amount is detailed in Type and amount of oil in gearboxes on page 86 .
16	Refit the <i>connection box</i> with the three attachment screws and plain washers. Make sure that the gasket is fitted properly!	Shown in the figure Location of motor, axis 3 on page 174 .
17	Reconnect the motor connectors R3.MP3 and R3.FB3.	 <p>xx0200000401</p> <ul style="list-style-type: none"> • A: R3.MP3 • B: R3.FB3 • C: Connection box
18	Refit the <i>cover</i> of the connection box.	Shown in the figure Location of motor, axis 3 on page 174 .
19	Re-calibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
20	 <p>DANGER</p> <p>Make sure all safety requirements are met when performing the first test run.</p>	

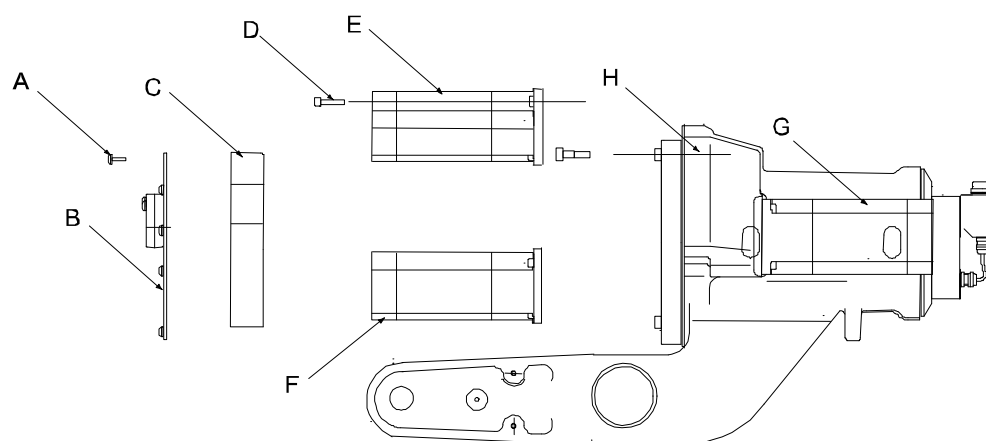
4.7.4 Replacement of motors, axes 4-6, IRB 2400L

Location of motors axes 4-6

The motor of axis 4 is located on the right hand side of the robot as shown in the figure below:

The motors of axes 5 and 6 are located on the back side of the robot as shown in the figure below:

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx020000476

A	Torx screw
B	Cover
C	Connection box
D	Screw
E	Motor 6
F	Motor 5
G	Motor 4
H	Gearbox

Required equipment

Note! The different motors are not compatible. Make sure to replace with correct model!

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit axis 4	3HAC11864-1		(Elmo)
Motor unit axis 4	3HAC021740-001		(Yaskawa)
Motor unit axes 5-6	3HAC11865-1		(Elmo)
Motor unit axes 5-6	3HAC021741-001		(Yaskawa)
O-ring	21522011-414		
Locking liquid		3HAB7116-1	Loctite 243

Continues on next page

4 Repair

4.7.4 Replacement of motors, axes 4-6, IRB 2400L

Continued

Equipment, etc.	Spare part no.	Art. no.	Note
Bearing grease		3HAC042536-001	
Lubricating oil		11712016-604	30 ml For the gearbox of axis 4.
Measuring tool		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section Standard tools on page 227 .
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See the chapter Circuit diagram on page 233 .


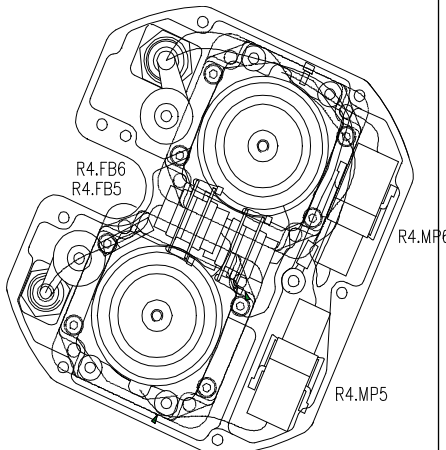


CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, motor axes 5-6

The procedure below details how to remove the motor, axes 5 and 6.


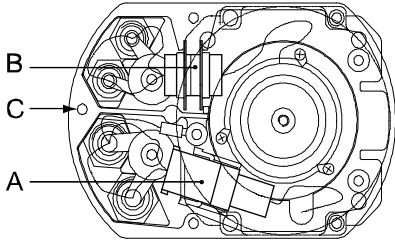
Action	Note/Illustration
<p>1</p>  <p>DANGER</p> <p>Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	
<p>2</p> <p>Remove the cover of the connection box.</p>	Shown in the figure Location of motors axes 4-6 on page 179 .
<p>3</p> <p>Loosen connectors R3.MP5-6 and R3.FB5-6.</p>	 <p>xx0300000063</p>

Continues on next page

	Action	Note/Illustration
4	Remove the connection box by unscrewing its three attachment screws and plain washers.	
5	Use a marker pen to mark out the position of the motors, if same motors are to be refitted.	Shown in the figure <i>Location of motors axes 4-6 on page 179</i> .
6	Unscrew the attachment screws and plain washers of the motors.	
7	Remove the motors by gently lifting them straight out (horizontal movement).	Shown in the figure <i>Location of motors axes 4-6 on page 179</i> .

Removal, motor axis 4

The procedure below details how to remove the motor, axis 4.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Drain the oil from the axis 4 gearbox.	
3	Remove the cover of the connection box.	 <p>xx020000401</p> <ul style="list-style-type: none"> • A: R3.MP4 • B: R3.FB4 • C: Connection box
4	Disconnect the connectors R3.MP4 and R3.FB4.	
5	Remove the connection box by unscrewing its three attachment screws and plain washers.	
6	Use a marker pen to mark out the position of the motor.	
7	Remove the motor by unscrewing its attachment screws and plain washers.	
8	Remove the motor by gently lifting it straight out (horizontal movement).	

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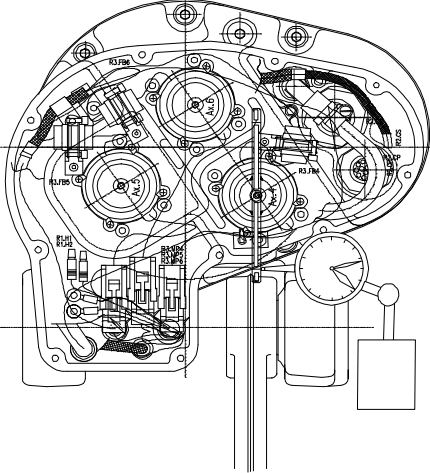
4 Repair

4.7.4 Replacement of motors, axes 4-6, IRB 2400L


Continued

Refitting, motor axis 4

The procedure below details how to refit the motor, axis 4.


	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched	
3	Fit a new <i>o-ring</i> on the motor.	Spare part no. is specified in <i>Required equipment on page 179</i> .
4	Lubricate the gear with <i>bearing grease</i> .	Art. no. is specified in <i>Required equipment on page 179</i> .
5	Fit the <i>measuring tool</i> at the rear of the motor.	 <p>xx0300000005</p>
6	The motor's fixing screws shall be fastened, but do not tighten them, to ensure that the motor will be able to move parallel to the gear when the adjustment is done	
7	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4: <ul style="list-style-type: none"> • + : pin 7 • -: pin 8
8	Start with a play in all positions and then locate the smallest play by turning the motor shaft six turns and thereby finding the area with the smallest play within this range. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
9	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". Do not use force!	
10	Tighten the motor attachment screws and secure them with locking fluid.	4.1 Nm Loctite 243

Continues on next page

	Action	Note/Illustration
11	Perform a leak-down test.	Detailed in section Performing a leak-down test on page 106 .
12	Refill the axis 4 gearbox with <i>lubricating oil</i> .	Art. no. and amount is specified in Required equipment on page 179 .
13	Reconnect the cabling.	Detailed in section Refitting, cable harness, axes 4-6 on page 124 .
14	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
15	 DANGER Make sure all safety requirements are met when performing the first test run.	

Refitting, motor axis 5

The procedure below details how to refit the motor, axis 5.


	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched.	
3	Fit a new <i>o-ring</i> on the motor.	Spare part no. is specified in Required equipment on page 179 .
4	Fit the <i>measuring tool</i> at the rear of the motor.	Look at the figure in the procedure Refitting, motor axis 4 on page 182 . Art. no. is specified in Required equipment on page 179 .
5	The motor's fixing screws shall be fastened, but do not tighten them, to ensure that the motor will be able to move parallel to the gear when the adjustment is done.	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connector to connector R3.MP5: <ul style="list-style-type: none"> • + : pin 7 • - : pin 8
7	Locate the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, one full turn, and thereby finding the area where the play for motor 5 becomes smallest. Turn the motor for axis 5 one full turn at a time for a total of five turns. Find where the smallest play is within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	

Continues on next page

4 Repair


4.7.4 Replacement of motors, axes 4-6, IRB 2400L

Continued


	Action	Note
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". Do not use force!	
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Described in Refitting, cable harness, axes 4-6 on page 124 .
11	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
12	 DANGER Make sure all safety requirements are met when performing the first test run.	

Refitting, motor axis 6

The procedure below details how to refit the motor, axis 6.

	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched	
3	Fit an new <i>o-ring</i> on the motor.	Spare part no. is specified in Required equipment on page 179 .
4	Fit the <i>measuring tool</i> at the rear of the motor.	Look at the figure in the procedure Refitting, motor axis 4 on page 182 . Art. no. is specified in Required equipment on page 179 .
5	The motor's fixing screws shall be fastened, but do not tighten them, to ensure that the motor will be able to move parallel to the gear when the adjustment is done	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP6: <ul style="list-style-type: none"> • + : pin 7 • -: pin 8

Continues on next page

	Action	Note
7	<p>Find the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, totally one whole turn, and thereby finding the area where the play for motor 6 becomes smallest.</p> <p>Turn the motor for axis 5 one full turn at the time, totally five turns. Find the smallest play for axis 6 within this area.</p> <p>Turn the motor for axis 6 one full turn at a time for a time for a total of three turns. Find the smallest play for axis 6 within this area.</p> <p>Use swift movements to avoid noticing the magnetic field, which makes the gears stick together</p>	
8	<p>Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". Do not use force!</p>	
9	<p>Tighten the motor attachment screws and secure them with locking fluid.</p>	<p>Tightening torque: 4.1 Nm. Loctite 243</p>
10	<p>Reconnect the cabling.</p>	<p>Described in Refitting, cable harness, axes 4-6 on page 124.</p>
11	<p>Recalibrate the robot.</p>	<p>Calibration is detailed in a separate calibration manual enclosed with the calibration tools.</p> <p>General calibration information is included in the section Calibration information on page 199.</p>
12	<p> DANGER</p> <p>Make sure all safety requirements are met when performing the first test run.</p>	

4 Repair

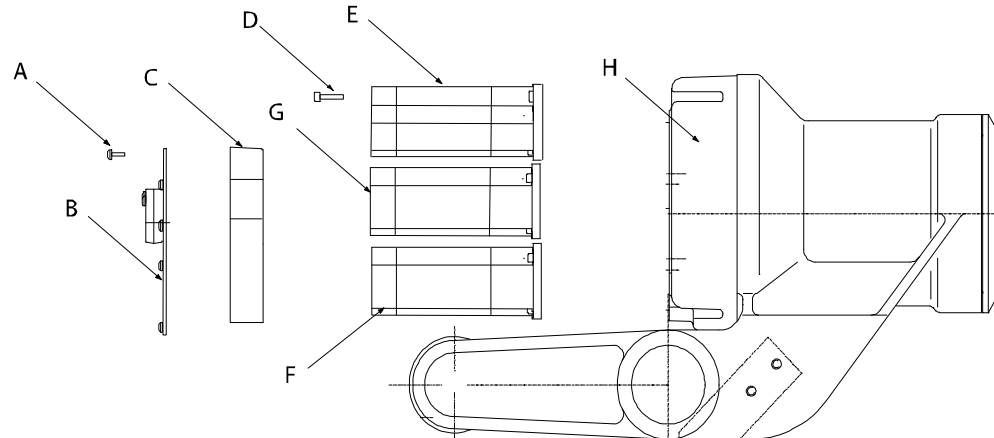
4.7.5 Replacement of motors, axes 4-6, IRB 2400/10/16

4.7.5 Replacement of motors, axes 4-6, IRB 2400/10/16

Location of motors axis 4-6

The motors axis 4-6 are located on the back of the upper arm as shown in the figure below:

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).



xx0300000108

A	Torx screw
B	Cover
C	Connection box
D	Screw
E	Motor axis 6
F	Motor axis 5
G	Motor axis 4
H	Gearbox

Required equipment

Note! The different motors are not compatible. Make sure to replace with correct model!

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit axis 4	3HAC10602-1		(Elmo)
Motor unit axis 4	3HAC021353-001		(Yaskawa)
Motor unit axis 5	3HAC10600-1		IRB 2400/10 (Elmo)
Motor unit axis 5	3HAC10601-1		IRB 2400/16 (Elmo)
Motor unit axis 5	3HAC021722-001		Color: ABB Orange IRB 2400/10/16 (Yaskawa)
	3HAC021722-003		Color: Graphite White IRB 2400/10/16 (Yaskawa)

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit axis 6	3HAC10602-2		(Elmo)
	3HAC021731-001		Color: ABB Orange (Yaskawa)
	3HAC021731-003		Color: Graphite White (Yaskawa)
O-ring	3HAB3772-12		One piece for each motor.
Locking liquid		3HAB 7116-1	Loctite 243
Bearing grease		3HAB 3537-1	
Lubricating oil		3HAC 0860-1	1,500 ml Optimol BM 100 For the gearbox of axis 4.
Measuring tool		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section Standard tools on page 227 .
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.

**CAUTION**

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, motors axes 4-6 (10/16 kg)

The procedure below details how to remove the motors of axes 4-6.

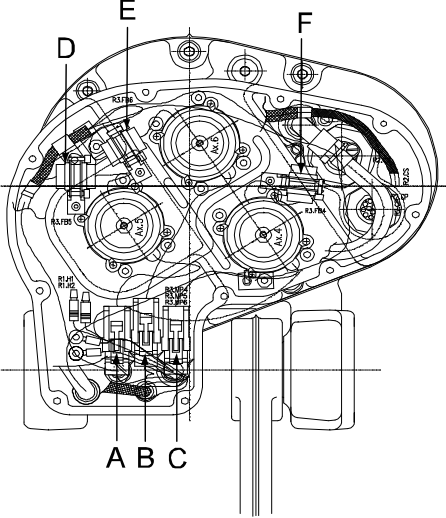
	Action	Note/Illustration
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Drain the oil from the axis 4 gearbox.	
3	Remove the cover of the connection box.	Shown in the figure Location of motors axis 4-6 on page 186 .

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4 Repair


4.7.5 Replacement of motors, axes 4-6, IRB 2400/10/16

Continued

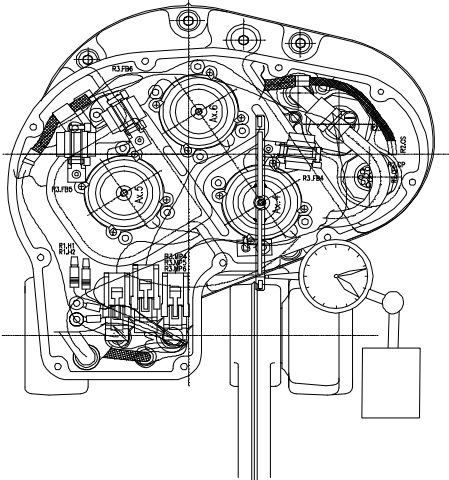
	Action	Note/Illustration
4	Disconnect the connectors R3.MP4-6 and R3.FB4-6.	 <p>xx0200000406</p> <p>A R3.MP5 B R3.MP6 C R3.MP4 D R3.FB5 E R3.FB6 F R3.FB4</p>
5	Remove the connection box by unscrewing its three attachment screws and plain washers.	
6	Use a marker pen to mark out the position of the motors, if same motors are to be refitted.	
7	Remove the attachment screws and plain washers from the motors.	
8	Remove the motors by gently lifting them straight out (horizontal movement).	

Refitting, motor axis 4

The procedure below details how to refit the motor, axis 4.

	Action	Note/Illustration
1	 <p>DANGER</p> <p>Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!</p>	
2	Check that the assembly surfaces are clean and the motor unscratched.	
3	Fit a new <i>o-ring</i> on the motor.	Spare part no. is specified in Required equipment on page 186 .
4	Lubricate the gear with bearing grease.	Art. no. is specified in Required equipment on page 186 .

Continues on next page


	Action	Note/Illustration
5	Fit the <i>measuring tool</i> at the rear of the motor.	 <p data-bbox="983 801 1086 824">xx0300000005</p> <p data-bbox="983 840 1442 898">Art. no. is specified in Required equipment on page 186.</p>
6	The motor's fixing screws shall be fastened, but do not tighten them, to be sure that the motor will be able to move parallel to the gear when the adjustment is done	
7	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4: <ul style="list-style-type: none"> • + : pin 7 • -: pin 8
8	Start with a play in all positions and then find the smallest play by turning the motor shaft six turns and thereby finding the area with the smallest play within this range. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
9	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". Do not use force!	
10	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
11	Refill the gearbox with oil.	Art. no. and amount is specified in Required equipment on page 186 .
12	Reconnect the cabling.	Described in Refitting, cable harness, axes 4-6 on page 124 .
13	Recalibrate the robot. (When all service work is done, i.e. the other motors are also refitted.)	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .

Continues on next page

4 Repair


4.7.5 Replacement of motors, axes 4-6, IRB 2400/10/16

Continued


	Action	Note/Illustration
14	 DANGER Make sure all safety requirements are met when performing the first test run.	

Refitting, motor axis 5

The procedure below details how to refit the motor, axis 5.


	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched.	
3	Fit a new <i>o-ring</i> on the motor.	Spare part no. is specified in Required equipment on page 186 .
4	Fit the <i>measuring tool</i> at the rear of the motor.	See how to fit the tool in the figure in the procedure Refitting, motor axis 4 on page 188 . Art. no. is specified in Required equipment on page 186 .
5	The motor's fixing screws shall be fastened, but do not tighten them, to be sure that the motor will be able to move parallel to the gear when the adjustment is done	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP5: <ul style="list-style-type: none">• + : pin 7• -: pin 8
7	Find the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, one full turn, and thereby finding the area where the play for motor 5 becomes smallest. Turn the motor for axis 5 one full turn at a time for a total of five turns. Find where the smallest play is within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". Do not use force!	
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Detailed in section Refitting, cable harness, axes 4-6 on page 124 .

Continues on next page

	Action	Note
11	Recalibrate the robot. (When all service work is done, i.e. the other motors are also refitted.)	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
12	 DANGER Make sure all safety requirements are met when performing the first test run.	

Refitting, motor axis 6

The procedure below details how to refit the motor, axis 6.


	Action	Note
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unstructured.	
3	Fit a new <i>o-ring</i> on the motor.	Spare part no. is specified in Required equipment on page 186 .
4	Fit the <i>measuring tool</i> at the rear of the motor.	See how to fit the tool in the figure in the procedure Refitting, motor axis 4 on page 188 . Art. no. is specified in Required equipment on page 186 .
5	The motor's fixing screws shall be fastened, but do not tighten them, to be sure that the motor will be able to move parallel to the gear when the adjustment is done	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP6: <ul style="list-style-type: none"> • + : pin 7 • -: pin 8
7	Find the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, one full turn, and thereby finding the area where the play for motor 6 becomes smallest. Turn the motor for axis 5 one full turn at the time, totally five turns. Find the smallest play for axis 6 within this area. Turn the motor for axis 6 one full turn at a for a total of three turns. Find the smallest play for axis 6 within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together	
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". Do not use force!	

Continues on next page

4 Repair

4.7.5 Replacement of motors, axes 4-6, IRB 2400/10/16

Continued

	Action	Note
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Detailed in section Refitting, cable harness, axes 4-6 on page 124 .
11	Recalibrate the robot. (When all service work is done, i.e. the other motors are also refitted.)	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
12	 DANGER Make sure all safety requirements are met when performing the first test run.	

4.8 Gearboxes

4.8.1 Replacement of gearbox, axis 1-3

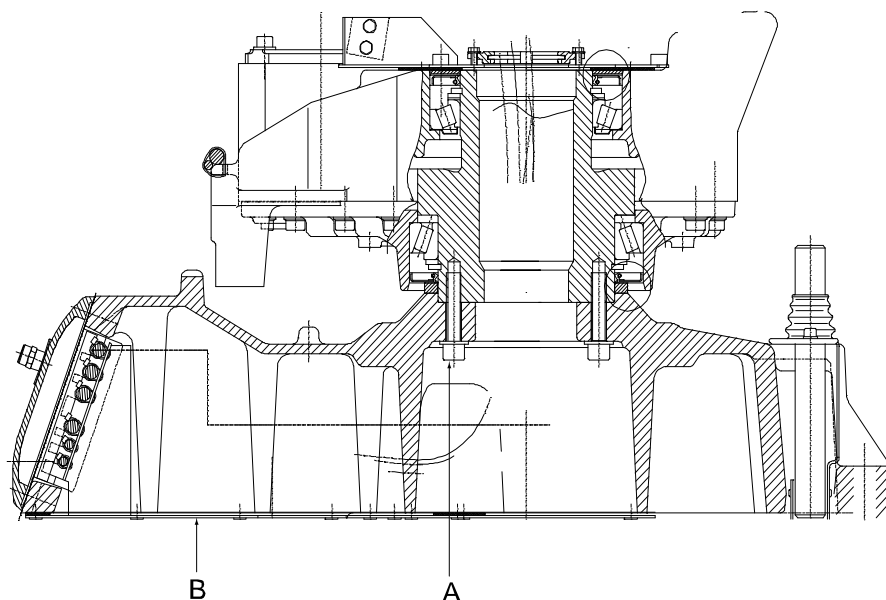
Location of gearbox, axis 1-3

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

Axis 1 gearbox is of the conventional type, manufactured with high precision. Together with the gearboxes for axes 2 and 3, it forms a complete unit.

A more detailed view of the component and its position may be found in chapter [Spare part lists on page 231](#).

Note! The gearbox is not normally serviced or adjusted.



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A	Attachment screws, gearbox unit
B	Bottom plate

Required equipment

Equipment	Spare part no.	Art. no.	Note
Gearbox, axes 1-3	3HAC025711-001		
Standard toolkit	-		The content is defined in the section Standard tools on page 227 .
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
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

4.8.1 Replacement of gearbox, axis 1-3

Continued



CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

Removal, gearbox axis 1-3

The procedure below details how to remove the gearbox, axis 1-3.



	Action	Note
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the cable unit, axes 1-3.	Detailed in section Removal, cable unit, axes 1-3 on page 116 .
3	Remove the complete lower arm.	Detailed in section Removal, lower arm on page 142 .
4	Remove the motor, axis 1.	Detailed in section Removal, motor axis 1 on page 165 .
5	Remove the motor, axis 2.	Detailed in section Removal, motor axis 2 on page 170 .
6	Remove the motor, axis 3.	Detailed in section Removal, motor axis 3 on page 175 .
7	CAUTION The complete gearbox unit weighs 200 kg without the base. All lifting accessories used must be sized accordingly!	
8	Place the remaining parts of the robot upside-down on a table or similar surface and remove the bottom plate.	
9	Undo the 12 attachment screws.	
10	Lift away the base from the gearbox unit.	

Refitting, gearbox axis 1-3

The procedure below details how to refit the gearbox, axis 1-3.

	Action	Note
1	DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	

Continues on next page

	Action	Note
2	 CAUTION The complete gearbox unit weighs 200 kg without the base. All lifting accessories used must be sized accordingly!	
3	Place the gearbox unit upside-down on a table or similar surface.	
4	Fit the base to the gearbox unit and secure with the 12 screws and washers.	12 pcs; M12x50. Tightening torque: 54 Nm.
5	Refit the bottom plate to the base.	
6	Turn the base and gearbox unit around and secure to the installation site.	This is detailed in section Orienting and securing the robot on page 54 .
7	Refit the motor, axis 1.	Described in section Refitting, motor axis 1 on page 166 .
8	Refit the motor, axis 2.	Described in section Refitting, motor axis 2 on page 172 .
9	Refit the motor, axis 3.	Described in section Refitting, motor axis 3 on page 177 .
10	Refit the complete lower arm.	Described in section Refitting, lower arm on page 144 .
11	Refit the cable unit, axes 1-3.	Described in section Refitting, gearbox axis 1-3 on page 194 .
12	Calibrate the robot.	Calibration is described in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
13	 DANGER Make sure all safety requirements are met when performing the first test run.	

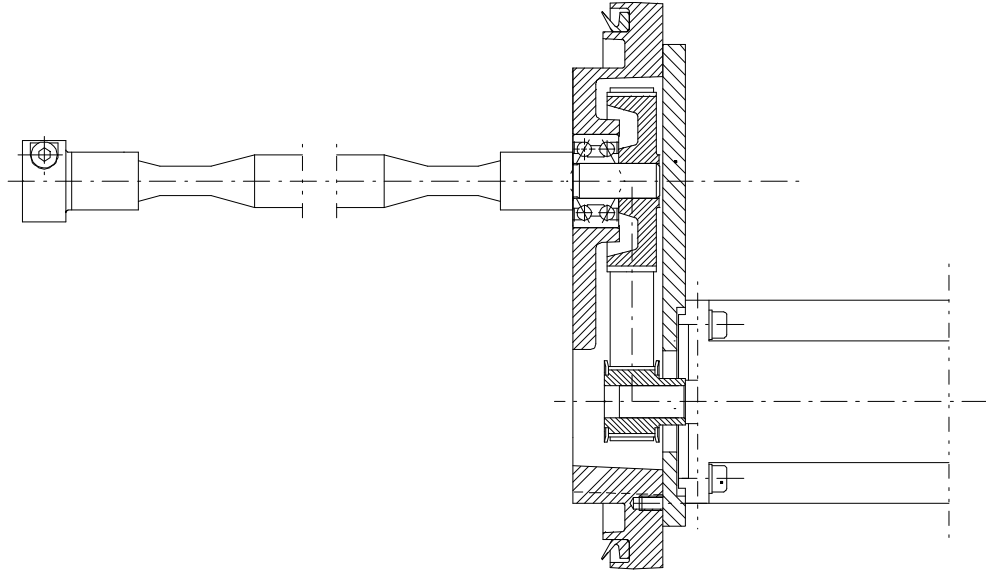
4 Repair

4.8.2 Replacement of drive shaft unit, IRB 2400L

4.8.2 Replacement of drive shaft unit, IRB 2400L

Location, drive shaft unit

The drive shaft unit is defined as the gears and drive belts to axes 5 and 6. This is shown in the figure below.



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Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Drive shaft unit, axes 5-6	3HAC11804-1		
Gear belt	3HAA2393-1		2 pcs
Adjustment tool		3HAA7601-50	
Lifting device, robot		-	
Standard toolkit			The content is defined in the section Standard tools on page 227 .
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.



CAUTION


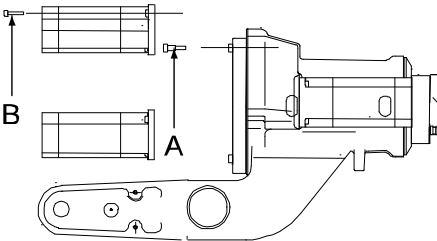
Always cut the paint with a knife and grind the paint edge when disassembling parts. See [Cut the paint or surface on the robot before replacing parts on page 112](#).

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Removal, drive shaft unit

The procedure below details how to remove the drive shaft unit from the robot upper arm.

NOTE! ABB recommends its customers to carry out only the following servicing and repair work on the drive shaft unit.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the wrist.	Detailed in section Removal, wrist unit on page 135 .
3	Loosen the connection box and disconnect the connectors on the motors of axes 5 and 6. Mark the motor number on the motors, to simplify the reconnecting.	Detailed in section Replacement of motors, axes 4-6, IRB 2400L on page 179 .
4	Undo the screws.	 <p>xx0300000021</p> <ul style="list-style-type: none"> • A: Screws • B: Motor screws
5	Squeeze the drive shafts together at the tip of the tubular shaft, so they can pass through the tube.	
6	Pull out the complete drive mechanism of axes 5 and 6.	
7	Undo the screws and nuts, holding the motors and remove both motors.	Detailed in section Replacement of motors, axes 4-6, IRB 2400L on page 179 .
8	Undo the screws and remove the motor plate.	
9	Remove the gear belts.	

Continues on next page

4 Repair


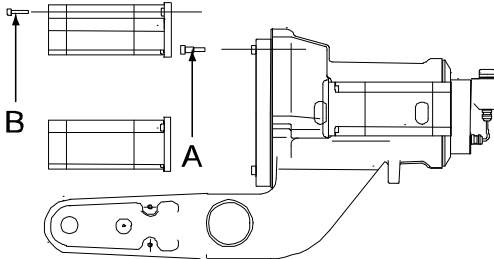

4.8.2 Replacement of drive shaft unit, IRB 2400L

Continued

Refitting, drive shaft unit

The procedure below details how to remove the drive shaft unit from the robot upper arm.

NOTE! ABB recommends its customers to carry out only the following servicing and repair work on the drive shaft unit.

	Action	Note/Illustration
1	 DANGER Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Install the belts.	
3	Fit the plate using screws and washers.	Note! Do not forget the nuts on the motors!
4	Fit the motors.	
5	Push the motors sideways to tighten the belts, using the tool. Place the round post of the <i>adjustment tool</i> into the motor pulley and let the cam press to the outer diameter of the large pulley.	Art. no. is specified in Required equipment on page 196 . Tighten screws B (shown in the illustration below) to 4.1 Nm.
6	Rotate the drive shafts. Check the tension on the belt.	
7	Install the drive mechanism in the tubular shaft.	Do not forget the rubber damper.
8	Tighten screws.	 <p>xx0300000021</p> <ul style="list-style-type: none"> • A: 8.3 Nm
9	Install the cabling and fit the cover to the motors axes 5 and 6.	Detailed in Replacement of motors, axes 4-6, IRB 2400L on page 179 .
10	Refit the wrist.	Detailed in section Refitting, wrist unit on page 136 .
11	Calibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section Calibration information on page 199 .
12	 DANGER Make sure all safety requirements are met when performing the first test run.	

5 Calibration information

5.1 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 re-calibrated 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 IRC5 robots on page 205](#). 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 re-calibrated for new resolver values.

If the robot has *absolute accuracy* calibration, it needs to be calibrated for new absolute accuracy.

Robot is not floor mounted

The original calibration data delivered with the robot is generated when the robot is floor mounted. If the robot is not floor mounted, then the robot accuracy could be affected. The robot needs to be calibrated after it is mounted.

5 Calibration information


5.2 Calibration methods

5.2 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>	Calibration Pendulum Levelmeter calibration (alternative method)
Absolute accuracy calibration (optional)	<p>Based on standard calibration, and besides positioning the robot at synchronization position, the Absolute accuracy calibration also compensates for:</p> <ul style="list-style-type: none"> • Mechanical tolerances in the robot structure • Deflection due to load <p>Absolute accuracy calibration focuses on positioning accuracy in the Cartesian coordinate system for the robot.</p> <p>Absolute accuracy calibration data is found on the SMB (serial measurement board) in the robot.</p> <p>For robots with RobotWare 5.05 or older, the absolute accuracy calibration data is delivered in a file, absacc.cfg, supplied with the robot at delivery. The file replaces the calib.cfg file and identifies motor positions as well as absolute accuracy compensation parameters.</p> <p>A robot calibrated with Absolute accuracy has a sticker next to the identification plate of the robot.</p> <p>To regain 100% Absolute accuracy performance, the robot must be recalibrated for absolute accuracy after repair or maintenance that affects the mechanical structure.</p> <div style="text-align: center;">  </div> <p>xx0400001197</p>	CalibWare
Optimization	<p>Optimization of TCP reorientation performance. The purpose is to improve reorientation accuracy for continuous processes like welding and gluing.</p> <p>Wrist optimization will update standard calibration data for axes 4 and 5.</p>	Wrist Optimization

Continues on next page

Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of many of 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.

Wrist Optimization method

Wrist Optimization is a method for improving reorientation accuracy for continuous processes like welding and gluing and is a complement to the standard calibration method.

The following routines are available for the Wrist Optimization method:

- Wrist Optimization

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.

Levelmeter calibration - alternative method

Levelmeter calibration is referred to as the alternative method for calibration of ABB robots because of the less accurate values obtained during calibration. The method uses the same principles as Calibration Pendulum, but does not have as good of mechanical tolerances to the toolkit parts as the standard method with Calibration Pendulum.

This method may, after calibration, require modifications in the robot program and is therefore not recommended.

The calibration equipment (Levelmeter 2000) for levelmeter calibration is ordered as separate parts for each robot, and includes the *Operating manual - Levelmeter Calibration*, which describes the method and the different routines further.

CalibWare - Absolute Accuracy calibration

The CalibWare tool guides through the calibration process and calculates new compensation parameters. This is further detailed in the *Application manual - CalibWare Field*.

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 replacements that do not include taking apart the robot structure, standard calibration is sufficient.

References

Article numbers for the calibration tools are listed in the section [Special tools on page 228](#).

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5 Calibration information

5.2 Calibration methods

Continued

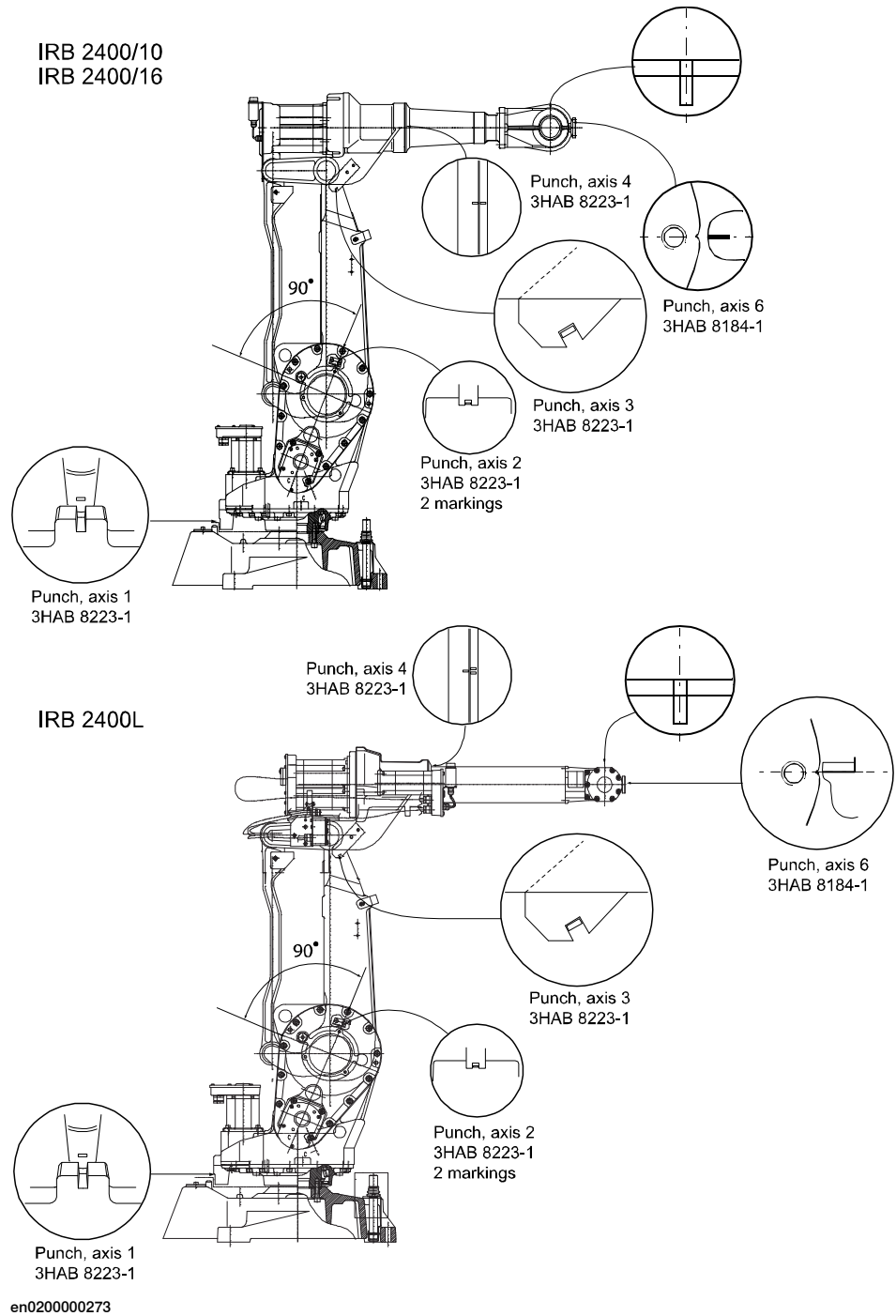
The calibration equipment for Calibration Pendulum is delivered as a complete toolkit, including the *Operating manual - Calibration Pendulum*, which describes the method and the different routines further.

5.3 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 2400



5 Calibration information

5.4 Calibration movement directions for all axes

5.4 Calibration movement directions for all axes

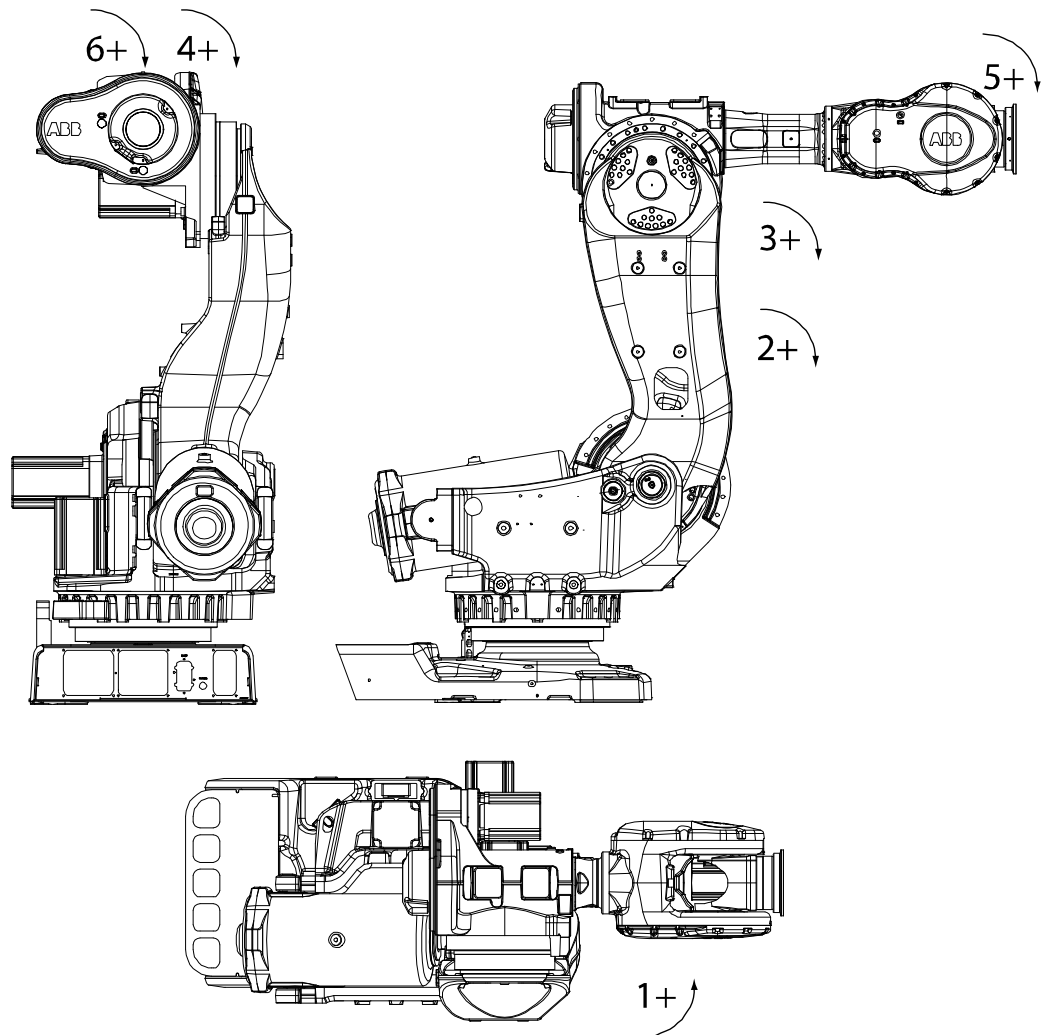
Overview

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!



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5.5 Updating revolution counters on IRC5 robots

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.

Coupled axes

When updating the revolution counters for a coupled axis, also the axis it is coupled to needs to be at its synchronization position for the update to be correct; i.e. axis 4 needs to be in synchronization position when updating axis 5 and 6.

With reversed coupled joints, the relationship is the opposite, i.e. axis 4 needs to be in synchronization position to update axis 3.

Coupled axes	IRB 140	IRB 1410	IRB 1520	IRB 1600	IRB 1600ID	IRB 1660ID	IRB 910 SC	IRB 2400	IRB 2600	IRB 2600ID	IRB 4400	IRB 4450S	IRB 4600
Axis 4, 5, 6	x			x				x	x		x	x	x
Axis 5, 6		x	x		x	x				x			
Axis 4, 3							x						

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. IRB 140, 1400, 2400, 4400, 6600ID/6650ID, 6640ID: Axes 5 and 6 must be positioned together!	See Synchronization marks and synchronization position for axes on page 203 .
3	When all axes are positioned, update the revolution counter.	Step 2 - Updating the revolution counter with the TPU on page 206 (BaseWare 4.0). Step 2 - Updating the revolution counter with the FlexPendant on page 208 .

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

Continues on next page

5 Calibration information

5.5 Updating revolution counters on IRC5 robots

Continued

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.


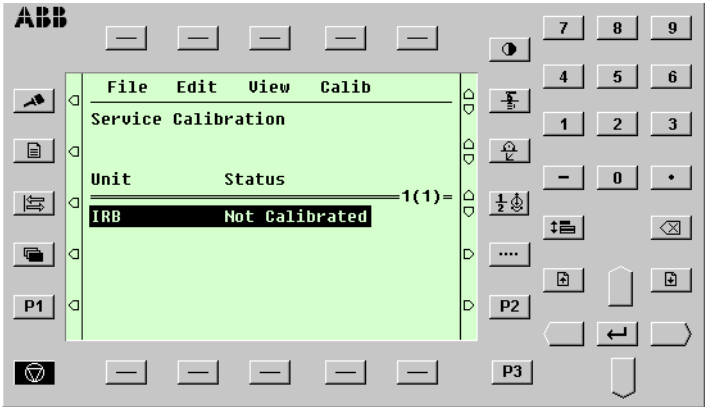
If one of the following mentioned axes are rotated one or more turns from its calibration position before updating the revolution counter, the correct calibration position will be lost due to non-integer gear ratio. This affects the following manipulators:

Manipulator variant	Axis 4	Axis 6
IRB 2400	No	No

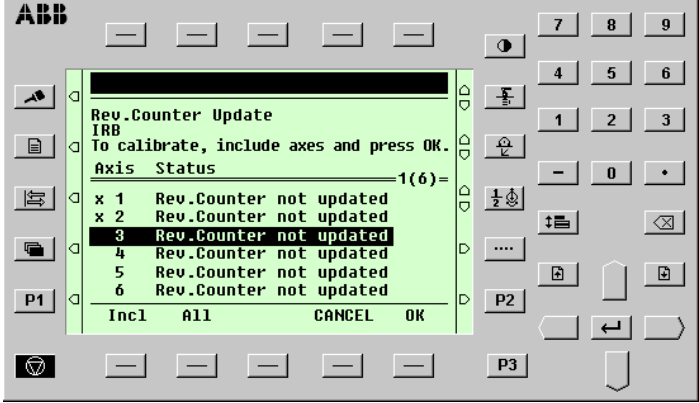

If the synchronization marks seem to be wrong (even if the motor calibration data is correct), try to rotate the axis one turn, update the revolution counter and check the synchronization marks again (try both directions, if needed).

Step 2 - Updating the revolution counter with the TPU

Use this procedure to update the revolution counter with the TPU (BaseWare 4.0).

Action	Note
<p>1 Press the button Miscellaneous then ENTER to select the service window.</p>  <p>xx0100000194</p>	
<p>2 Select Calibration from the View menu. The Calibration window appears. If there is more than one unit connected to the manipulator, they will be listed in the window.</p>  <p>xx0100000201</p>	

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Action		Note
3	<p>Select the desired unit and choose Rev Counter Update from the Calib menu. The Revolution Counter Update window appears.</p>  <p>xx0100000202</p>	
4	<p>Select the desired axis and press Incl to include it (it will be marked with an x) or press All to select all axes.</p>	
5	<p>Press OK when all axes that are to be updated are marked with an x. CANCEL returns to the Calibration window.</p>	
6	<p>Press OK again to confirm and start the update. CANCEL returns to the Revolution Counter Update window.</p>	
7	<p>At this point, it is <i>recommended</i> that the revolution counter values are saved to a diskette.</p>	Not required.
8	<p> CAUTION</p> <p>If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update.</p> <p>How to perform the check is detailed in section Checking the synchronization position on page 213.</p>	

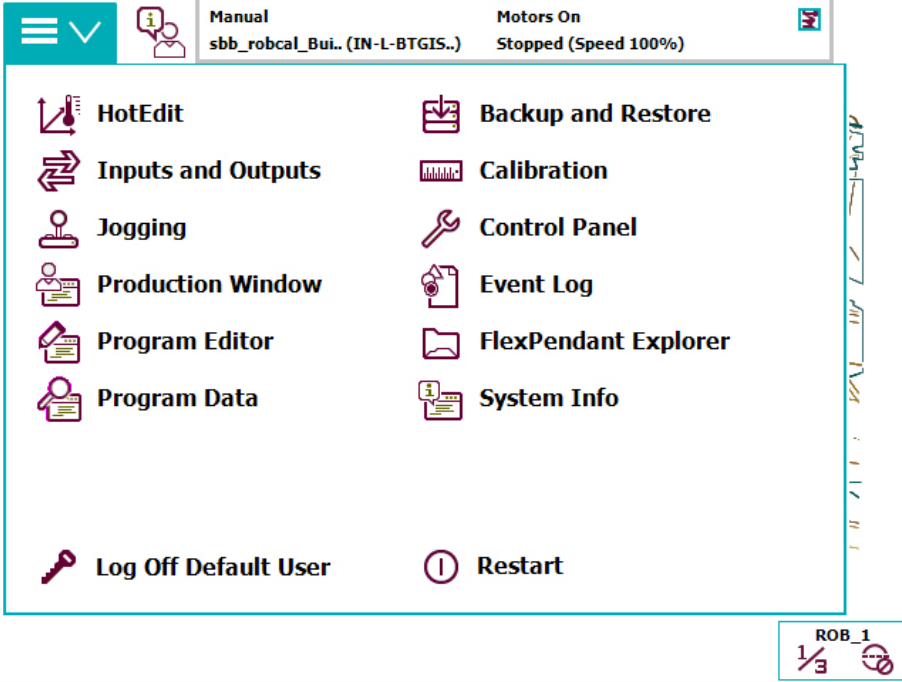
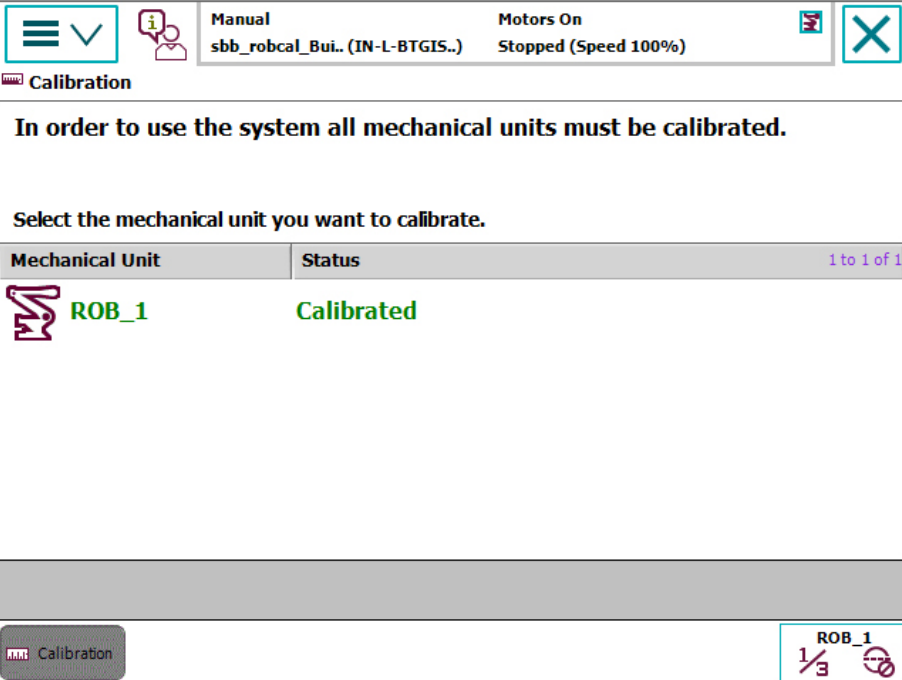
5 Calibration information

5.5 Updating revolution counters on IRC5 robots

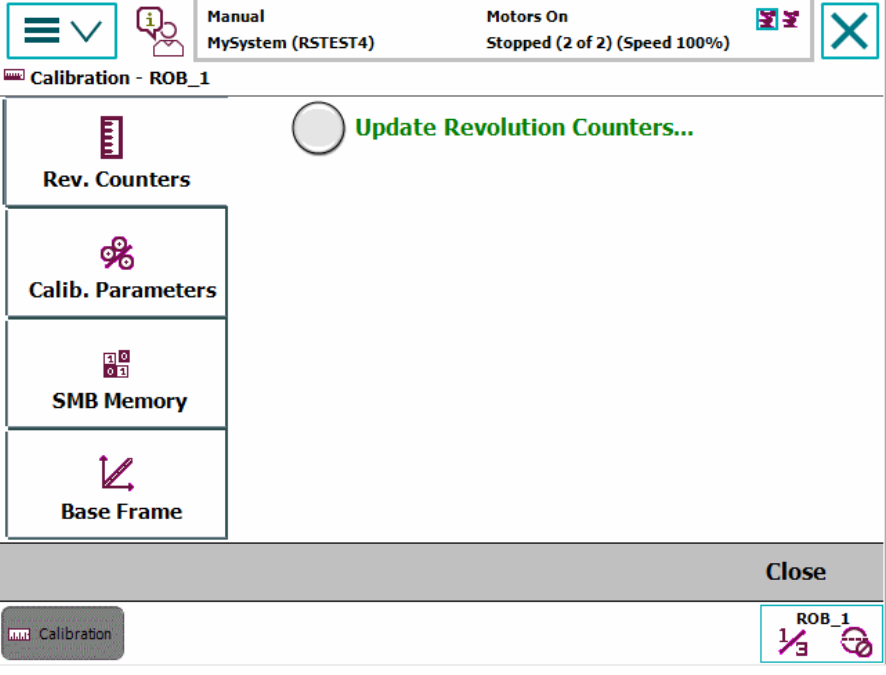

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Step 2 - Updating the revolution counter with the FlexPendant

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

	Action
1	<p>On the ABB menu, tap Calibration.</p>  <p>xx1500000942</p>
2	<p>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>A screen is displayed, tap Rev. Counters.</p> 
4	<p>Tap Update Revolution Counters.... A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions:</p> <ul style="list-style-type: none"> • Tap Yes to update the revolution counters. • Tap No to cancel updating the revolution counters. <p>Tapping Yes displays the axis selection window.</p>
5	<p>Select the axis to have its revolution counter updated by:</p> <ul style="list-style-type: none"> • Ticking in the box to the left • Tapping Select all to update all axes. <p>Then tap Update.</p>
6	<p>A dialog box is displayed, warning that the updating operation cannot be undone:</p> <ul style="list-style-type: none"> • Tap Update to proceed with updating the revolution counters. • Tap Cancel to cancel updating the revolution counters. <p>Tapping Update updates the selected revolution counters and removes the tick from the list of axes.</p>
7	<p> CAUTION</p> <p>If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See Checking the synchronization position on page 213.</p>

5 Calibration information

5.6 Calibrating with Calibration Pendulum method

5.6 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.

5.7 Calibrating with Wrist Optimization method

When to run Wrist Optimization

Wrist Optimization routine is run to improve TCP reorientation performance.

Calibrating the robot with standard calibration method overwrites the optimized positions of axes 4, 5. Re-run the **Wrist Optimization** routine after standard calibration to re-achieve the optimized positions of the wrist axes.

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.

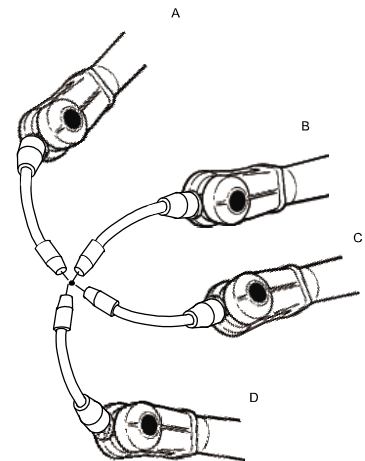
- 1 Choose calibration routine Wrist Optimization.
- 2 Modify targets for 4-point tool frame definition, in Wrist Optimization routine.



Tip

Select positions with large reorientations around the TCP. For best results, make sure that axis 4 and 5 have large movements.

- a Jog the robot to an appropriate position, A, for the first approach point.
Use small increments to accurately position the tool tip as close to the reference point as possible.
- b Tap **Modify Position** to define the point.
- c Repeat for each approach point to be defined, positions B, C, and D.
Jog away from the fixed world point to achieve the best result. Just changing the tool orientation will not give as good a result.



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- 3 Improved calibration data to the wrist axes is identified and presented.
- 4 Optimized positions for the wrist axes are presented.

Continues on next page

5 Calibration information

5.7 Calibrating with Wrist Optimization method

Continued

- 5 The robot moves to the optimized positions for the wrist axes and automatically overwrites previous calibration data.



WARNING

Robot moves automatically when pressing **Calibrate**.

- 6 Wrist optimization is finished.
- 7 Redefine / verify TCP for all tools.

5.8 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 on the TPU, S4Cplus

Use this procedure to create a program that runs all the robot axes to their synchronization position.

	Action	Note
1	Create the following program: <pre>MoveAbsJ [[0,0,0,0,0,0], [9E9, 9E9,9E9,9E9,9E9,9E9]] \NoEOffs, v1000, z50, Tool0</pre>	
2	Run the program in manual mode.	
3	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See Synchronization marks and synchronization position for axes on page 203 and Updating revolution counters on IRC5 robots on page 205 .

Using a `MoveAbsJ` instruction

Use this procedure to create a program that runs all the robot axes to their synchronization position.

	Action	Note
1	On ABB menu tap Program editor .	
2	Create a new program.	
3	Use MoveAbsJ in the Motion&Proc menu.	
4	Create the following program: <pre>MoveAbsJ [[0,0,0,0,0,0], [9E9,9E9,9E9,9E9,9E9,9E9]] \NoEOffs, v1000, fine, tool0</pre>	
5	Run the program in manual mode.	
6	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See Synchronization marks and synchronization position for axes on page 203 and Updating revolution counters on IRC5 robots on page 205 .

Continues on next page


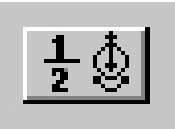
5 Calibration information

5.8 Checking the synchronization position

Continued

Using the jogging window on the TPU, S4Cplus

Use this procedure to jog the robot to synchronization position of all axes.

	Action	Illustration/Note
1	Open the Jogging window.	 xx0100000195
2	Select running axes-by-axes.	 xx0100000196
3	Manually run the robot axes to a position where the axis position value read on the TPU, is equal to zero.	
4	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See Synchronization marks and synchronization position for axes on page 203 and Updating revolution counters on IRC5 robots on page 205 .

Using the jogging window

Use this procedure to jog the robot to the synchronization position of all axes.

	Action	Note
1	On the ABB menu, tap Jogging .	
2	Tap Motion mode to select group of axes to jog.	
3	Tap to select the axis to jog, axis 1, 2, or 3.	
4	Manually run the robots axes to a position where the axis position value read on the FlexPendant, is equal to zero.	
5	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See Synchronization marks and synchronization position for axes on page 203 and Updating revolution counters on IRC5 robots on page 205 .

6 Decommissioning

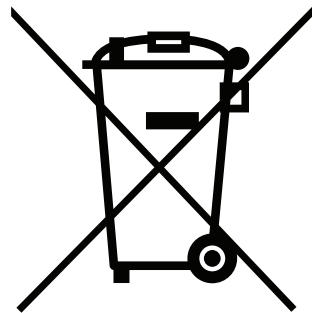
6.1 Environmental information

Introduction

ABB robots contain components in different materials. During decommissioning, all materials should be dismantled, recycled, or reused responsibly, according to the relevant laws and industrial standards. Robots or parts that can be reused or upcycled helps to reduce the usage of natural resources.

Symbol

The following symbol indicates that the product must not be disposed of as common garbage. Handle each product according to local regulations for the respective content (see table below).



xx1800000058

Materials used in the product

The table specifies some of the materials in the product and their respective use throughout the product.

Dispose components properly according to local regulations to prevent health or environmental hazards.

Material	Example application
Aluminium	Covers, synchronization brackets
Batteries, Lithium	Serial measurement board
Cast iron/nodular iron	Base, lower arm, upper arm
Copper	Cables, motors
Neodymium	Brakes, motors
Nickel	Turning disc (foundry)
Oil, grease	Gearboxes
Plastic/rubber	Cables, connectors, drive belts, and so on.
Steel	Gears, screws, base-frame, and so on.

Continues on next page

6 Decommissioning

6.1 Environmental information

Continued

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.

6.2 Scrapping of robot

Important when scrapping the robot



DANGER

When a robot is disassembled while being scrapped, it is very important to remember the following before disassembling starts, in order to prevent injuries:

- Always remove all batteries. 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 Reference information

7.1 Introduction

General

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

7 Reference information

7.2 Applicable standards

7.2 Applicable standards



Note

The listed standards are valid at the time of the release of this document. Phased out or replaced standards are removed from the list when needed.

General

The product is designed in accordance with ISO 10218-1:2011, Robots for industrial environments - Safety requirements -Part 1 Robots, and applicable parts in the normative references, as referred to from ISO 10218-1:2011. In case of deviations from ISO 10218-1:2011, these are listed in the declaration of incorporation which is part of the product delivery.

Normative standards as referred to from ISO 10218-1

Standard	Description
ISO 9283:1998	Manipulating industrial robots - Performance criteria and related test methods
ISO 10218-2	Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration
ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
ISO 13849-1:2006	Safety of machinery - Safety related parts of control systems - Part 1: General principles for design
ISO 13850	Safety of machinery - Emergency stop - Principles for design
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

Region specific standards and regulations

Standard	Description
ANSI/RIA R15.06	Safety requirements for industrial robots and robot systems
ANSI/UL 1740	Safety standard for robots and robotic equipment
CAN/CSA Z 434-03	Industrial robots and robot Systems - General safety requirements

Other standards used in design

Standard	Description
ISO 9787:2013	Robots and robotic devices -- Coordinate systems and motion nomenclatures
IEC 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments
IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
ISO 13732-1:2006	Ergonomics of the thermal environment - Part 1
IEC 60974-1:2012 ⁱ	Arc welding equipment - Part 1: Welding power sources

Continues on next page

Standard	Description
IEC 60974-10:2014 ⁱ	Arc welding equipment - Part 10: EMC requirements
ISO 14644-1:2015 ⁱⁱ	Classification of air cleanliness
IEC 60529:1989 + A2:2013	Degrees of protection provided by enclosures (IP code)

ⁱ Only valid for arc welding robots. Replaces IEC 61000-6-4 for arc welding robots.

ⁱⁱ Only robots with protection Clean Room.

7 Reference information

7.3 Unit conversion

7.3 Unit conversion

Converter table

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

Quantity	Units		
Length	1 m	3.28 ft.	39.37 in
Weight	1 kg	2.21 lb.	
Weight	1 g	0.035 ounces	
Pressure	1 bar	100 kPa	14.5 psi
Force	1 N	0.225 lbf	
Moment	1 Nm	0.738 lbf-ft	
Volume	1 L	0.264 US gal	

7.4 Screw joints

General

This section describes how to tighten the various types of screw joints on ABB robots.

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. It is recommended by ABB for M6-M20 screw joints. 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.

Generally, screws are lubricated with *Gleitmo 603* mixed with *Geomet 500* or *Geomet 702* in proportion 1:3. *Geomet* thickness varies according to screw dimensions, refer to the following.

Dimension	Lubricant	Geomet thickness
M6-M20 (any length except M20x60)	<i>Gleitmo 603 + Geomet 500</i>	3-5 µm
M6-M20 (any length except M20x60)	<i>Gleitmo 603 + Geomet 720</i>	3-5 µm
M20x60	<i>Gleitmo 603 + Geomet 500</i>	8-12 µm
M20x60	<i>Gleitmo 603 + Geomet 720</i>	6-10 µm

Screws lubricated in other ways

Screws lubricated with Molykote 1000 or Molykote P1900 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.

Continues on next page

7 Reference information

7.4 Screw joints

Continued

Lubricant	Article number
Molykote 1000 (molybdenum disulphide grease)	3HAC042472-001
Molykote P1900 (molybdenum disulphide grease)	3HAC070875-001

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.
- *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*.



Note

A 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*.



Note

A special torque specified in the repair, maintenance or installation procedure overrides the standard torque.

Dimension	Tightening torque (Nm)	Tightening torque (Nm)	Tightening torque (Nm)
	Class 8.8, oil-lubricated	Class 10.9, oil-lubricated	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

Continues on next page

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
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.*



Note

A special torque specified in the repair, maintenance or installation procedure overrides the standard torque.

Dimension	Tightening torque (Nm) Class 10.9, lubricated ⁱ	Tightening torque (Nm) Class 12.9, lubricated ⁱ
M8	28	35
M10	55	70
M12	96	120
M16	235	300
M20	460	550
M24	790	950

ⁱ Lubricated with Molykote 1000, Gleitmo 603 or equivalent

7 Reference information

7.5 Weight specifications

7.5 Weight specifications


Definition

In installation, repair, and maintenance procedures, weights of the components handled are sometimes specified. All components exceeding 22 kg (50 lbs) are highlighted in this way.

To avoid injury, ABB recommends the use of a lifting accessory when handling components with a weight exceeding 22 kg. A wide range of lifting accessories and devices are available for each manipulator model.

Example

Following is an example of a weight specification in a procedure:

	Action	Note
	 CAUTION The arm weighs 25 kg. All lifting accessories used must be sized accordingly.	

7.6 Standard tools

General

All service (repairs, maintenance, and installation) procedures contains lists of tools required to perform the specified activity.

All special tools required are listed directly in the procedures while all the tools that are considered standard are gathered in the standard toolkit and defined in the following table.

This way, the tools required are the sum of the standard toolkit and any tools listed in the instruction.

Contents, standard toolkit

Qty	Tool
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	KM socket (KM10) (6369901-480)
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

7 Reference information

7.7 Special tools

7.7 Special tools

General

All service instructions contain lists of tools required to perform the specified activity. The required tools are a sum of standard tools, defined in the section [Standard tools on page 227](#), and of special tools, listed directly in the instructions and also gathered in this section.

Special tools

The table below specifies the special tools required during the service procedures. The tools are also specified directly in the concerned procedures for repair.

Description	Art. no.	Note
Guide pins	-	M8, length = 70 mm Used for guiding the wrist into place.
Measuring tool	3HAB7887-1	Used for measuring the gear play when refitting the motors.
Dismounting tool, shaft ends	3HAB9009-1	Used for removing the shafts from the upper arm.
Mounting tool, bearing	3HAB6464-1	
Adjustment tool	3HAA7601-50	

Calibration equipment, Levelmeter (alternative method)

The table below 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	
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	
Turn disk fixture	3HAC68080011-GU	

Calibration equipment, Calibration Pendulum

The table below specifies the calibration equipment needed when calibrating the robot with the Calibration Pendulum method.

Description	Art. no.	Note
Calibration Pendulum toolkit	3HAC15716-1	Complete kit that also includes operating manual.

7.8 Lifting equipment and lifting instructions

General

Many repair and maintenance activities require different pieces of lifting equipment, which are specified in each procedure.

The use of each piece of lifting equipment is *not* detailed in the activity procedure, but in the instruction delivered with each piece of lifting equipment.

This implies that the instructions delivered with the lifting equipment should be stored for later reference.

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8 Spare part lists

8.1 Spare part lists and illustrations

Location

Spare parts and exploded views are not included in the manual but delivered as a separate document for registered users on myABB Business Portal, www.abb.com/myABB.



Tip

All documents can be found via myABB Business Portal, www.abb.com/myABB.

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9 Circuit diagram

9.1 Circuit diagrams

Overview

The circuit diagrams are not included in this manual, but are available for registered users on myABB Business Portal, www.abb.com/myABB.

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 Panel Mounted Controller</i>	<i>3HAC026871-020</i>
<i>Circuit diagram - Euromap 67, design 14</i>	<i>3HAC024120-005</i>
<i>Circuit diagram - Spot welding cabinet</i>	<i>3HAC057185-001</i>

Manipulators

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 6620</i>	<i>3HAC025090-001</i>
<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>

Continues on next page

9 Circuit diagram

9.1 Circuit diagrams

Continued

Product	Article numbers for circuit diagrams
<i>Circuit diagram - IRB 6660</i>	<i>3HAC025744-001 3HAC029940-001</i>
<i>Circuit diagram - IRB 6700 / IRB 6790</i>	<i>3HAC043446-005</i>
<i>Circuit diagram - IRB 7600</i>	<i>3HAC13347-1 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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