ROBOTICS

Product manual

IRB 140

Trace back information:
Workspace 24B version a13
Checked in 2024-06-18
Skribenta version 5.5.019

Product manual

IRB 140 type C
IRB 140T type C
IRB 140-6/0.8 type C
IRB 140T-6/0.8 type C

IRC5

Document ID: 3HAC027400-001

Revision: AA

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Keep for future reference.

Additional copies of this manual may be obtained from ABB.

Original instructions.

Table of contents

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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 and calibration.

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

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

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

Product manual scope

The manual covers covers all variants and designs of the IRB 140 type C. 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.

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Chapter	Contents
Calibration information	Procedures that does not require specific calibration equipment. General information about calibration.
Decommissioning	Environmental information about the robot and its components.
Reference information	Useful information when performing installation, maintenance or repair work. Includes lists of necessary tools, additional documents, safety standards, etc.
Spare parts and exploded views	Complete spare part list and complete list of robot components, shown in exploded views.
Circuit diagram	References to the circuit diagrams for the robot.

References

Reference	Document ID
Circuit diagram - IRB 140 type C	*3HAC6816-3*
Safety manual for robot - Manipulator and IRC5 or OmniCore controller [i]	*3HAC031045-001*
Product manual - IRC5 IRC5 with main computer DSQC 639.	*3HAC021313-001*
Product manual - IRC5 IRC5 with main computer DSQC1000.	*3HAC047136-001*
Product specification - IRB 140	*3HAC041346-001*
Product manual, spare parts - IRB 140	*3HAC049099-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - Calibration Pendulum	*3HAC16578-1*
Operating manual - Service Information System	*3HAC050944-001*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC050917-001*
Application manual - CalibWare Field	*3HAC030421-001*

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

Revisions

Revision	Description
-	First edition, see also *Type C of IRB 140 on page 229*.
A	IRB 140-6/0.8 and IRB 140T-6/0.8 added.
B	*Clean Room* added. Changes made in: • *Prerequisites* in section *Overview* • *Oil change* in section *Maintenance*
C	Content updated in section: • *Making robot ready for operation, Clean room* , *Additional installation procedure*.

Continues on next page

Revision	Description
D	Content updated in section: • *Repair*, exchange of parts on *Clean room* robots • *Maintenance*, Cleaning of robot • *Maintenance schedule*: Interval for replacement of battery pack changed. • Section *What is an emergency stop?* added to chapter *Safety*.
E	Content updated in sections: • Article numbers added or replaced in sections *Replacement of complete upper arm on page 127*, *Replacement of complete lower arm on page 133*, *Replacement of gearbox, axes 1-2 and damper, axis 1 on page 204*, and *Type C of IRB 140 on page 229*.
F	Content updated in sections: • Required equipment updated in *Replacement of motor and timing belt, axis 3 on page 184*. • Spare part list updated regarding *Foundry Plus* cable guard and new wrist. • Circuit diagrams are not included in this document but delivered as separate files. See *Circuit diagram on page 245*. • List of standards updated, see *Applicable standards on page 232*. • Sealing compound updated in *Cut the paint or surface on the robot before replacing parts on page 116*. • Decommissioning chapter added. The chapter *Safety* updated with: • Updated safety signal graphics for the levels *Danger* and *Warning*, see *Safety signals in the manual on page 19*. • New safety labels on the manipulators, see *Safety symbols on manipulator labels on page 21*. • Revised terminology: *robot* replaced with *manipulator*.
G	This revision includes the following additions: • New section, *Restricting the working range on page 68*. • *Lifting and turning the manipulator on page 50*. This revision includes the following updates: • Corrected amount of oil in axes 3, 5, and 6, see Amount of oil. • Updates in chapter *Calibration*.
H	This revision includes the following updates: • Corrected article number for VK cover, see *Replacement of complete upper arm on page 127* and *Replacement of motor and timing belt, axes 5 or 6 on page 194*.
J	This revision includes the following updates: • A new block, about general illustrations, added in section *How to read the product manual on page 16*. • The option *Foundry Plus Cable Guard* is removed. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 235*. • The figure of the base is updated in concerned sections. • Added *Handling of batteries*.

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Revision	Description
K	This revision includes the following updates: • Information regarding disassembly of Clean Room robots added to concerned repair instructions. • Changed the instruction for how to fit the o-ring of the axis-4 motor when refitting the motor, see *Replacement of motor, axis 4 on page 190*. • Added figures that show an alternative layout inside the base, see *Replacing the serial measurement unit and the battery pack on page 166*. • 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 105*. • Corrected article number for battery pack. • A new SMB unit and battery is introduced, with longer battery lifetime.
L	This revision includes the following updates: • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 228*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Spare part lists Product manual, spare parts - IRB 140*.
M	This revision includes the following updates: • Minor corrections.
N	This revision includes the following updates: • Updated section *Setting the system parameters for a suspended or tilted robot on page 60*. • Turning disk fixture is removed from special tools for Levelmeter calibration.
P	This revision includes the following updates: • Removed note in Installation of signal lamp.
Q	Published in release R16.2. The following updates are done in this revision: • Added a procedure for how to lift and rotate the robot, see *Lifting and turning the manipulator on page 50*. • Section Amount of oil is removed from the manual, since the data has been moved to the separate lubrication manual, see *Type and amount of oil in gearboxes on page 105*.
R	Published in release R17.1. The following updates are done in this revision: • Added a procedure for how inspect the oil level, see *Inspection activities on page 79*.
S	Published in release R17.2. The following updates are made in this revision: • Information about coupled axes in *Updating revolution counters on IRC5 robots on page 216*. • Information about minimum resonance frequency added. • Updated list of applicable standards. • Updated inspection of oil level. • Information about grounding point added, see *Grounding and bonding point on manipulator on page 69*. • Section *Start of robot in cold environments on page 72* added.

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Revision	Description
T	Published in release R18.1. The following updates are made in this revision: • Added sections in *General procedures on page 110* • Safety section restructured. • Information about myABB Business Portal added. • Added Nickel in Environmental information.
U	Published in release R18.2. The following updates are made in this revision: • Added section for inspection of labels in maintenance chapter.
V	Published in release R18.2. The following updates are made in this revision: • Reference updated.
W	Published in release 19B. The following updates are made in this revision: • New touch up color Graphite White available. See *Cut the paint or surface on the robot before replacing parts on page 116*. • Levelmeter 2000 kit (6369901-347) no longer available.
X	Published in release 19D. The following updates are made in this revision: • Note added about the need to calibrate if the robot is other than floor mounted. See *When to calibrate on page 211*. • Added step of refitting oil plug during replacement of axis-1 and -2 gearboxes.
Y	Published in release 20A. The following updates are made in this revision: • Clarified and added information in mounting instructions for rotating sealings, see *Mounting instructions for sealings on page 112*. • Removed incorrect references to IRB 1600. The information in the concerned sections is correct, but the wrong product name was shown.
Z	Published in release 20B. The following updates are made in this revision: • Added information about Wrist Optimization and Calibration Pendulum in calibration chapter. • Replaced article number and name of grease, previously 3HAB3537-1.
AA	Published in release 24B. The following updates are done in this revision: • Text regarding fastener quality is updated, see *Fastener quality on page 58*. • Updated information about Gleitmo treated screws, see *Screw joints on page 235*. • Added information to check cables and hose after replacing the cable harness.

Product documentation

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, 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.
- Troubleshooting.
- 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.

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- Examples of how to use the application.

Operating manuals

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

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 *rear attachment screws, gearbox.*	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 *sealing, axis 2* to the gearbox.	Art. no. is specified in *Required equipment on page xx.*

Safety information

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

Read more in the chapter *Safety on page 17*.

Illustrations

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

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

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 as intended.
- 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 for their intended use. 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.

1.1.2 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.

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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 21*.

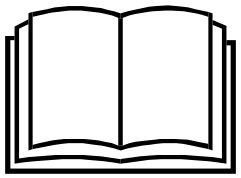
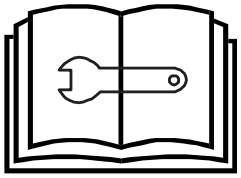
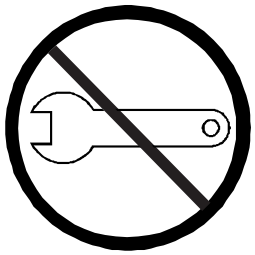
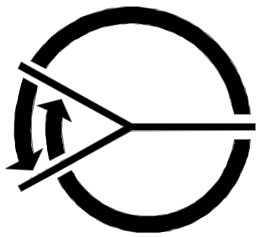
The information labels can contain information in text.

Symbols on safety labels

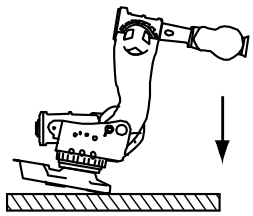
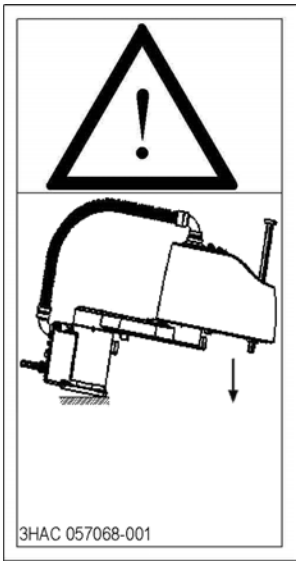
Symbol	Description
 xx0900000812	**Warning!** Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical 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.

Continues on next page

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: • No text: *Product manual*. • EPS: *Application manual - Electronic Position Switches*.
 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.

Continues on next page

Symbol	Description
 xx0900000810  xx1500002402	**Tip risk when loosening bolts** The robot can tip over if the bolts are not securely fastened.
  xx0900000817	**Crush** Risk of crush injuries.

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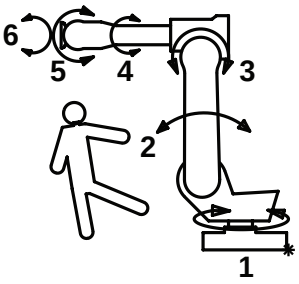
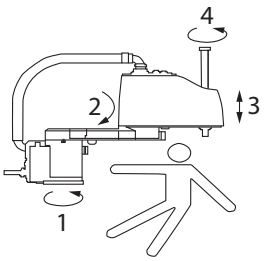
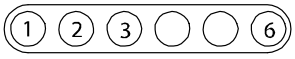
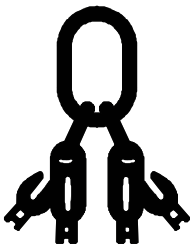
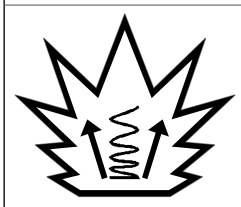
1.2.2 Safety symbols on manipulator labels
Continued

Symbol	Description
 xx0900000818  xx1300001087	**Heat** Risk of heat that can cause burns. (Both signs are used)
 xx2400000736  xx1500002616	**Moving robot** The robot can move unexpectedly.
 xx0900000820  xx1000001140	**Brake release buttons**

Continues on next page

Symbol	Description
 xx0900000821	**Lifting bolt**
 xx1000001242	**Adjustable chain sling with shortener**
 xx0900000822	**Lifting of robot**
 xx0900000823	**Oil** Can be used in combination with prohibition if oil is not allowed.
 xx0900000824	**Mechanical stop**
 xx1000001144	**No mechanical stop**
 xx0900000825	**Stored energy** Warns that this part contains stored energy. Used in combination with *Do not disassemble* symbol.

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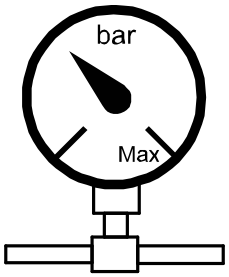
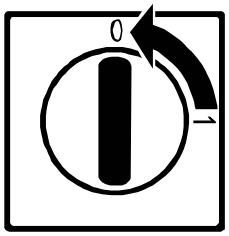
1.2.2 Safety symbols on manipulator labels

Continued

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

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

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 226* 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.

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Using lifting accessories and other external equipment

Ensure that all equipment used during installation, service and all handling of the robot are in correct condition for the intended use.

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 (CO_2) 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

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.

1.6 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 tools, loose screws, turnings, or other unexpected parts remaining after maintenance or repair work.

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 hot lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling. Put oil absorbent cloth, bags or paper at appropriate locations to catch any oil residues. Use appropriate protective gear such as heat-resistant gloves, goggles/protective visor, or a body suit if necessary.
 **Do not overfill**	Overfilling of gearbox lubricant can lead to internal over-pressure inside the gearbox which in turn may: • 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.
 **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.

Hazards related to batteries

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

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 44*.

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

Continues on next page

1.6.1 Safety during maintenance and repair
Continued

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 53*.

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.

1.6.3 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.

1.8 Safety during decommissioning

General

See section *Decommissioning on page 225*.

If the robot is decommissioned for storage, take extra precaution to reset safety devices to delivery status.

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 140 type C 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.

The technical data is detailed in section *Technical data on page 41*.

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 17* before performing any installation work.

Note

Always connect the IRB 140 type C 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 Compact*
- *Product manual - IRC5 Panel Mounted Controller*

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 41*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 44*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 44*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 42* • *Protection classes, robot on page 44* • *Requirements, foundation on page 43*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 47*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 49*
11	Install required equipment, if any. • *Installation of signal lamp (option) on page 67*

2.2.2 Technical data

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 140 type C	100 kg

Note

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

Mounting positions

The table shows valid mounting options for the manipulator.

Mounting option	Installation angle	Note
Floor mounted	0° [i]	
Wall mounted	90°	
Suspended	180°	

[i] A tilt of up to 5° does not affect the payload or reach, but it can have a negative impact on performance and lifetime. The actual value must be set in the system parameters.

Note

The actual mounting angle must always be configured in the system parameters, otherwise the performance and lifetime is affected. See *Setting the system parameters for a suspended or tilted robot on page 60*.

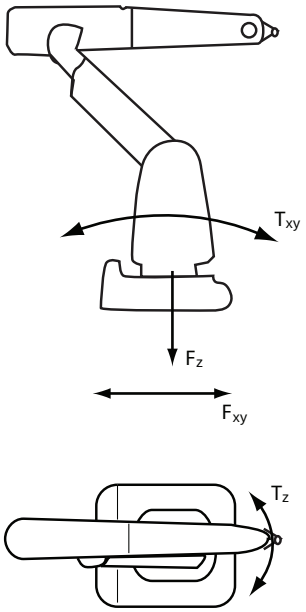
Continues on next page

2.2.2 Technical data
Continued

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.



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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).

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 1020 N	± 2000 N
Force z	- 1000 ± 620 N	- 1000 ± 1250 N
Torque xy	± 700 Nm	± 1500 Nm
Torque z	± 250 Nm	± 470 Nm

Continues on next page

Wall mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 1750 N	± 2800 N
Force z	± 850 N	± 1600 N
Torque xy	± 1020 Nm	± 1710 Nm
Torque z	± 250 Nm	± 485 Nm

Suspended

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 1020 N	± 2000 N
Force z	+ 1000 ± 620 N	+ 1000 ± 1250 N
Torque xy	± 700 Nm	± 1500 Nm
Torque z	± 250 Nm	± 470 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.
Minimum resonance frequency	22 Hz **Note** It may affect the manipulator lifetime 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 *Motion Process Mode*.

[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 possibly 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.

Continues on next page

2.2.2 Technical data
Continued

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

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

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

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

Protection classes, robot

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

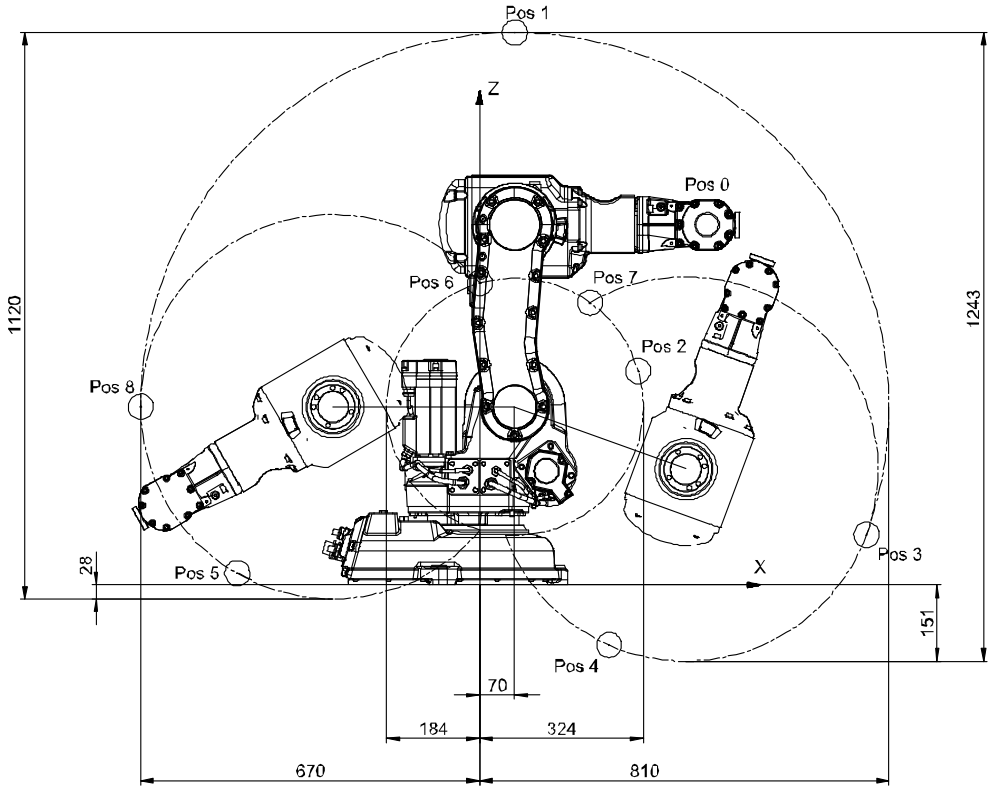
Protection type	Protection class[i]
Manipulator, protection type Standard	IP 67
Manipulator, protection type Foundry Plus	IP 67
Manipulator, protection type Clean Room	IP 67
Manipulator, protection type Wash	IP 67

i According to IEC 60529.

2.2.3 Working range, IRB 140

Working range axis 2 -3

The illustration below shows the unrestricted working range axis 2-3.



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Pos.	Position at wrist centre		Angle (degrees)	
	X	Z	Axis 2	Axis 3
0	450	712	0°	0°
1	70	1092	0°	-90°
2	314	421	0°	+50°
3	765	99	+110°	-90°
4	255	-119	+110°	+4°
5	-480	23	-90°	-150°
6	1	596	-90°	+50°
7	218	558	+110°	-230°
8	-670	352	-90°	-90°

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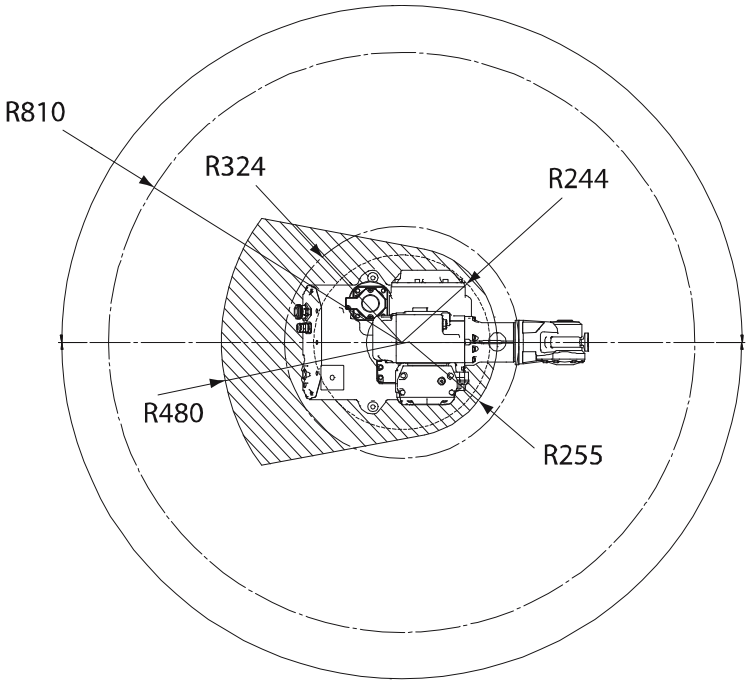
2.2.3 Working range, IRB 140
Continued

Working range axis 1

The illustrations below shows the unrestricted working range of axis 1.



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2.2.4 Risk of tipping/stability

Risk of tipping

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

The transportation position is the most stable position.

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

WARNING

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

2.2.5 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

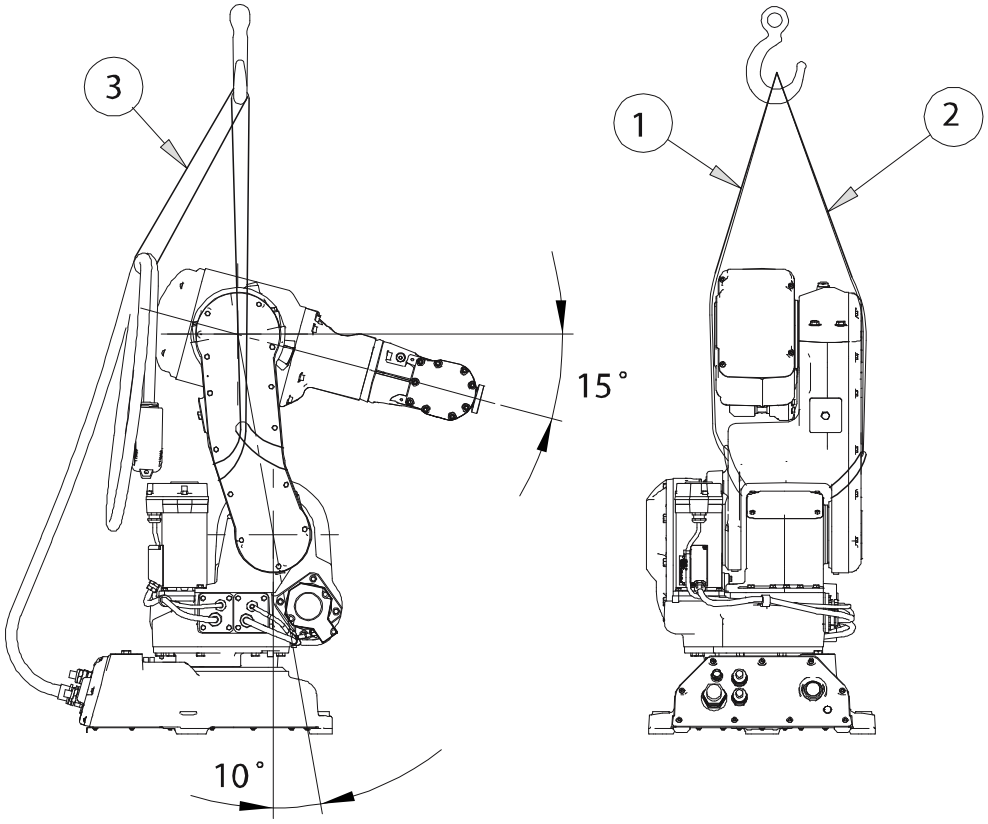
2.3.1 Lifting the manipulator with lifting slings

Introduction

This section details how to lift the manipulator using lifting slings.

Equipment	Note
Sling line for manipulator	Length: 2 m. Load: 500 kg.
Sling line for control cable	

Illustration



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1	Sling line for manipulator
2	Sling line for manipulator
3	Sling line for control cable

How to lift the manipulator

1 Adjust the manipulator to lifting position according to the illustration.
2 Put one sling line around each leg on the lower arm (positions 1 and 2).
3 Use another sling line to secure the lifting of the control cable (position 3).

2.3.2 Lifting and turning the manipulator

Required equipment

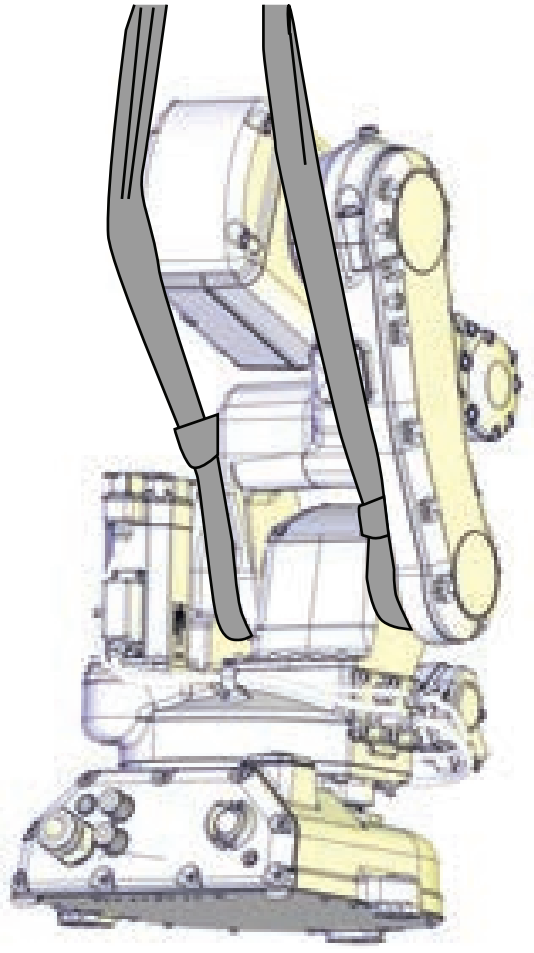
Equipment	Article number	Note
Lifting slings	-	2 pcs Length: 2 m. Lifting capacity: 1,000 kg (too narrow slings risk to damage the sealings on the axis-2 shaft).
Overhead crane or fork lift	-	

Lifting slings attached to the robot

The figure shows lifting slings attached to the robot, rigged as choker hitches, for lifting and turning the robot for installation on a wall or inverted.

WARNING

The robot will tip forward when lifting it off the ground.



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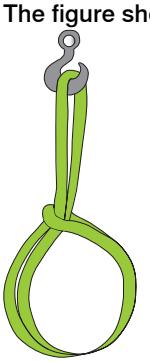
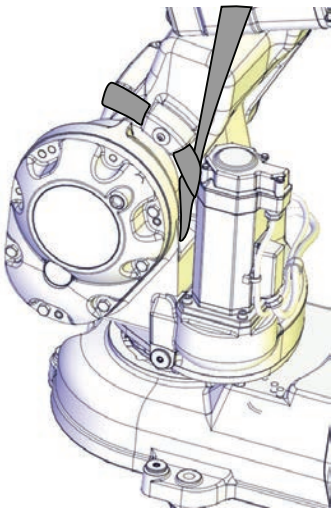
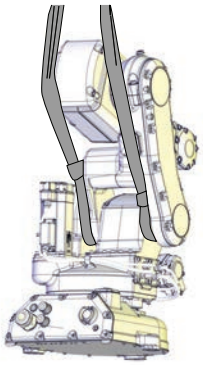
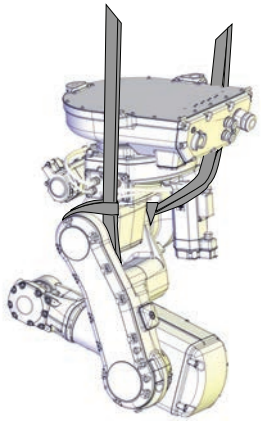
Lifting and turning the robot

The procedure details how to lift and turn the robot for installation on a wall or inverted.

	Action	Note
1	Move axis-2 to approximately -20º and axis-3 to approximately +50º. Remaining axes can be positioned as suitable, depending on equipment installed on the robot.	
2	Rig the lifting sling as a choker hitch by passing the lifting sling around the axis-2 gearbox, underneath the axis-2 damper, then through itself, then attaching it to the overhead crane or fork lift. The figure shows the principle of a choker hitch.  xx1400000730 If necessary, use an extra lifting sling to lengthen the reach between the sling and the overhead crane/fork lift. To facilitate the installation of the slings, the axis-2 damper can be removed temporarily.	 xx1600000348
3	Rig the lifting sling as a choker hitch by passing the lifting sling around the lower arm shaft, then through itself, then attaching it to the overhead crane or fork lift. If necessary, use an extra lifting sling to lengthen the reach between the sling and the overhead crane/fork lift.	 xx1600000347
4	Loosen the robot from the foundation.	
5	**CAUTION** The IRB 140 type C robot weighs 100 kg. All lifting accessories used must be sized accordingly!	

Continues on next page

2.3.2 Lifting and turning the manipulator
Continued

	Action	Note
6	Lift the robot while holding touch of the robot with your hands in order to carefully tip it forward. Keep tipping the robot forward until it hangs either horizontally or completely inverted. **WARNING** The robot will tip forward when lifting it off the ground.	The figure shows the robot rotated 180º.  xx1600000544
7	Secure the robot at its working site on the wall or inverted according to *Orienting and securing the manipulator on page 56*. Reinstall the axis-2 damper, if removed.	

2.3.3 Manually releasing the brakes

General

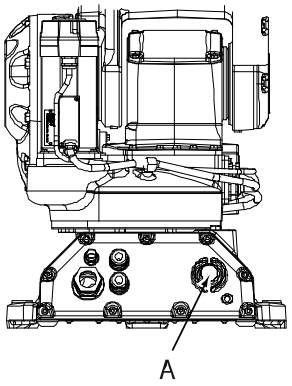
The section below details how to release the holding brakes of each axis' motor.

This may be done in one of three ways:

- using the brake release unit when the robot is connected to the controller.
- using the brake release unit when the robot is disconnected from the controller, but connected to an external power supply at the connector R1.MP.
- using an external voltage supply directly on the motor connector.

Using the brake release unit when the robot is connected to the controller

Use this procedure to release the holding brakes with the internal brake release unit.

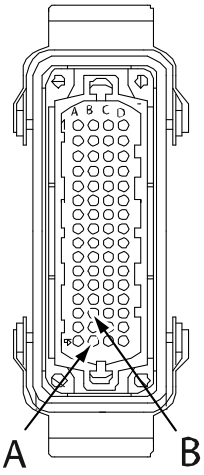
	Action	Note
1	The brake release button (A) is located at the base of the robot.	 xx0200000069
2	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways! Make sure no personnel is near or beneath the robot arm!	
3	Release the holding brakes by pushing the brake release button. The brake will function again as soon as the button is released.	

Continues on next page

2.3.3 Manually releasing the brakes
Continued

Using the brake release unit with an external power supply

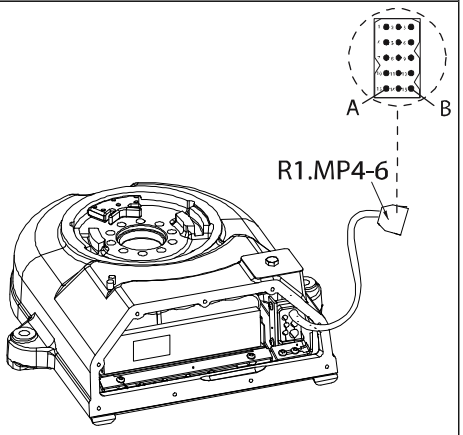
This section details how to release the holding brakes with the internal brake release unit using an external voltage supply. This is done if the robot is not connected to the controller.

	Action	Note
1	**DANGER** Incorrect connections, such as supplying power to the wrong pin, may cause all brakes to be released simultaneously!	Also, be careful not to interchange the 24V and 0V pins. If they are mixed up, damage can be caused to a resistor diode and to the system board.
2	Connect an external power supply to connector XP1.	 xx0200000071 Supply: • A: B16 24V DC • B: B14 0V
3	Push the brake release button to release the holding brakes, according to the previous procedure.	

Continues on next page

Using external power supply

This section details how to release the holding brakes using an external voltage supply. If the positions of the robot axes are to be changed without connecting the controller, an external voltage supply (24 V DC) must be connected to enable the brake release buttons on the robot.

	Action	Note/Illustration
1	Remove the screws and dismount the cover on the back of the robot base.	 xx0200000072 • A: 13 0V • B: 15 24V DC
2	Locate the R1.MP4-6 connector and disconnect.	
3	Connect an external power supply to release the holding brake on all axis.	

2.3.4 Orienting and securing the manipulator

General

This section details how to orient and secure the manipulator to the foundation in order to safely run the robot.

Bolting requirements

When bolting a mounting plate or frame 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 *Loads on foundation, robot 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:	M12
Quality	Quality 8.8
Suitable washer:	Thickness: 2.5 mm Outer diameter: 24 mm Inner diameter: 13.4 mm
Tightening torque:	85 Nm

Hole configuration and cross section

The bolt pattern requirements are shown in section *Bolt pattern on page 65*.

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	3HAC 9519-1

2.3.5 Fitting equipment on manipulator

General

The manipulator features mounting holes for additional equipment.

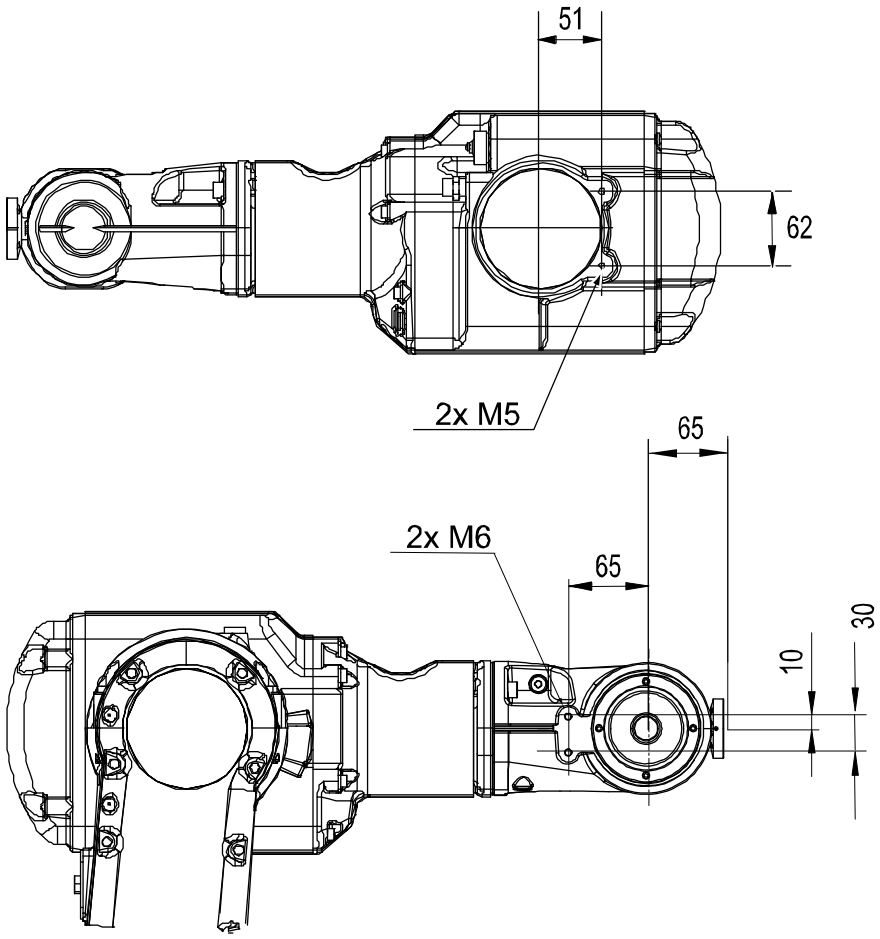
In addition to the stock mounting holes, extra mounting holes may be added on the manipulator under certain conditions. These special conditions are specified in the *Product specification - IRB 140*.

Note

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

Illustration, holes on upper arm

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



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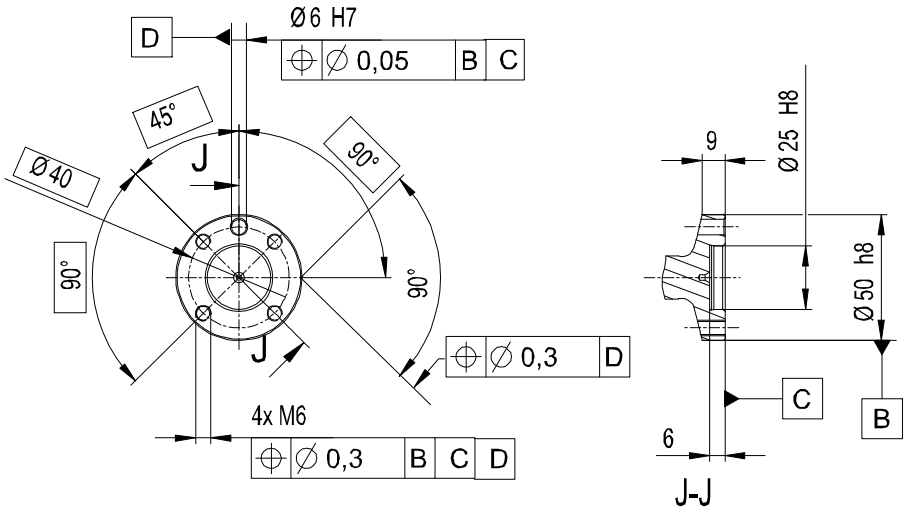
2.3.5 Fitting equipment on manipulator
Continued

Illustration, holes on mounting flange

The illustration below shows the stock holes available for fitting equipment on the mounting flange.



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Fastener quality

When fitting tools on the tool flange, only use screws with quality 12.9. For other equipment use suitable screws and tightening torque for your application.

2.3.6 Loads

Introduction

Any loads mounted on the manipulator must be defined correctly and carefully (with regard to the position of the center of gravity and inertia factor) to avoid jolting movements and overloading the motors. If this is not done correctly operation stops can occur.

References

Load diagrams, permitted extra loads (equipment) and their positions as specified in the product specification. The loads must also be defined in the software as detailed in *Operating manual - IRC5 with FlexPendant*.

Brake performance

Manipulator motor brake performance depends on any loads attached. For further information about brake performance, please contact ABB.

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. If the robot is mounted in any other angle than 0°, then the system parameters that describe the mounting angle (how the robot is oriented relative to the gravity) must be re-defined.

Note

With inverted 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 mounting positions are described in *Mounting positions on page 41*, and the requirements on the foundation are described in *Requirements, foundation on page 43*.

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 ±π/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.

Gravity Alpha

If the robot is mounted on a wall (rotated around the x-axis), then the robot base frame and the system parameter *Gravity Alpha* must be redefined. The value of *Gravity Alpha* should then be ±π/2 (±1.570796).

Continues on next page

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.

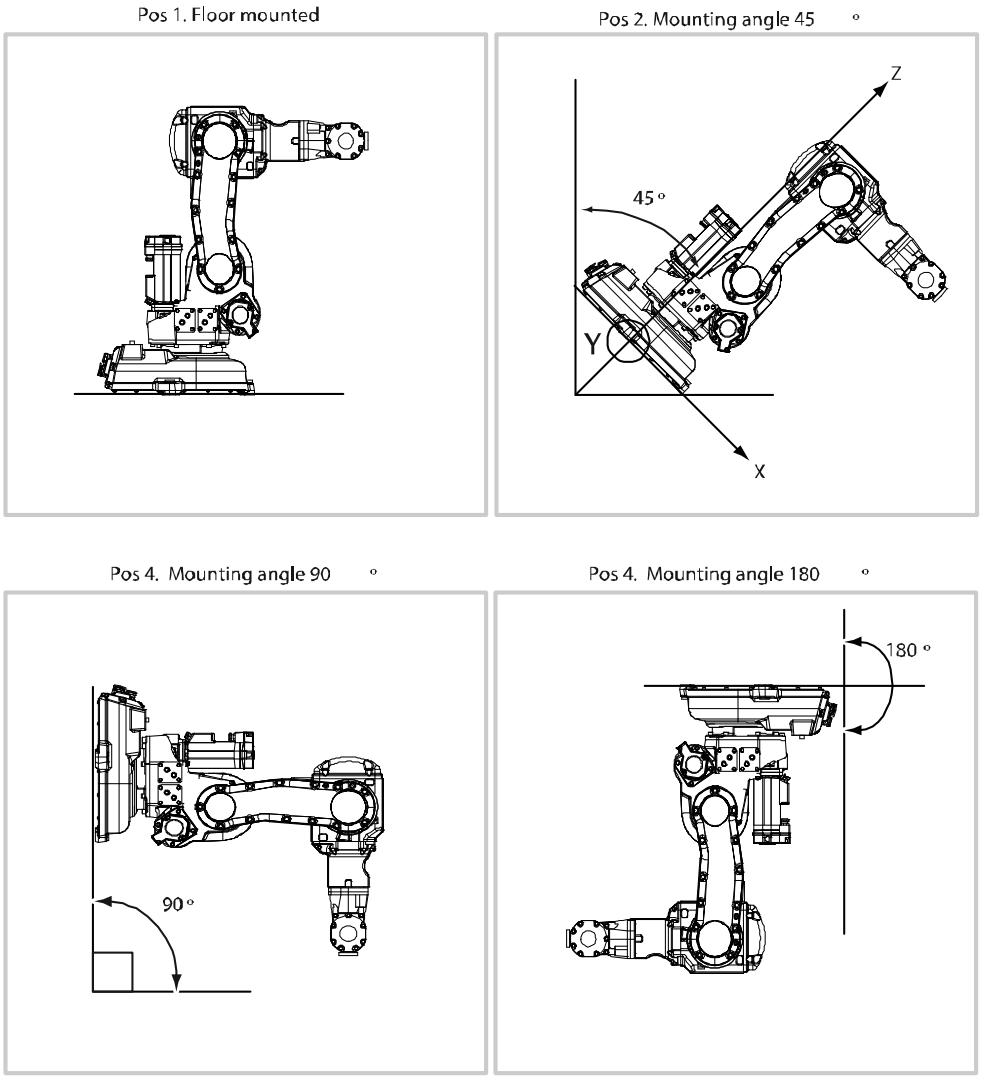
`Gravity Beta = A° x 3.141593/180 = B radians`, where `A` is the mounting angle in degrees and `B` is the mounting angle in radians.

Example of position	Mounting angle (A°)	Gravity Beta
Floor mounted	0°	0.000000 (Default)
Wall mounting	90°	1.570796
Suspended mounting	180°	3.141593

Continues on next page

2.3.7 Setting the system parameters for a suspended or tilted robot
Continued

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



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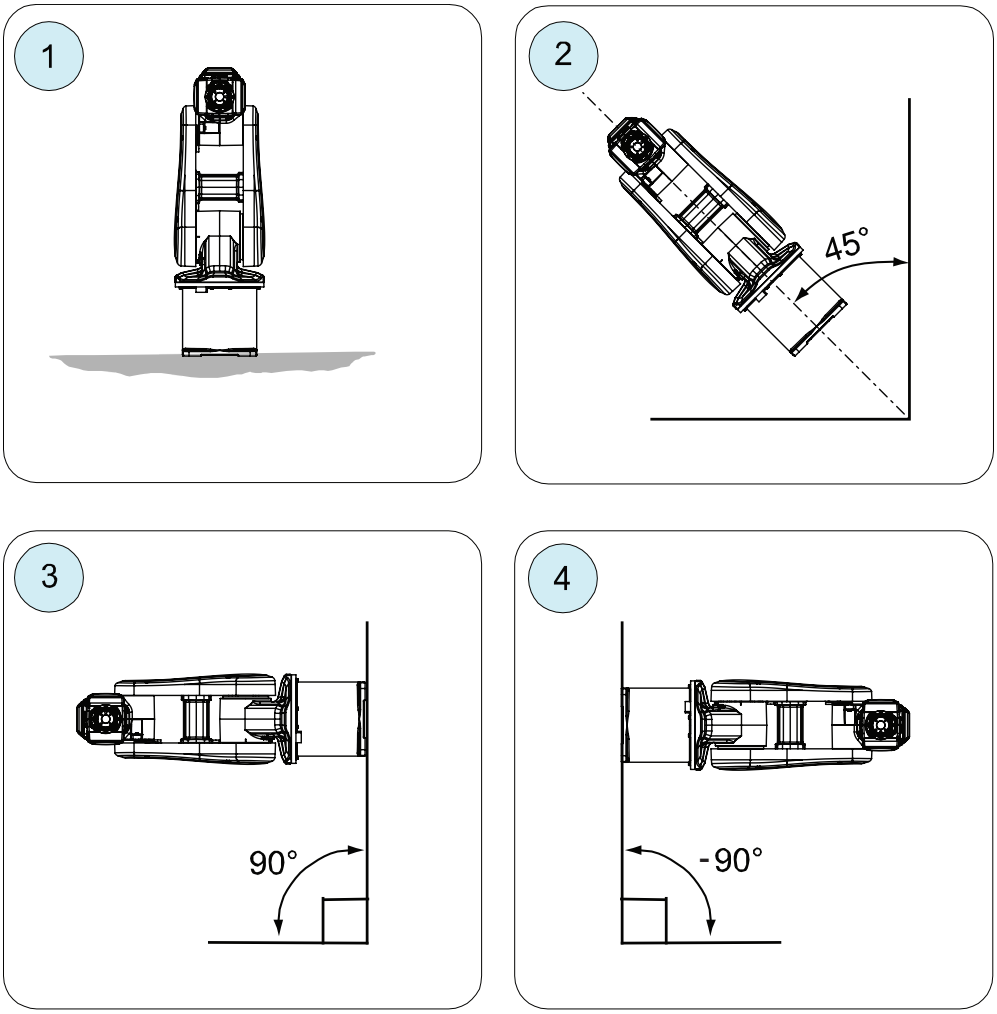
Examples of mounting angles tilted around the X axis (*Gravity Alpha*)

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

2.3.7 Setting the system parameters for a suspended or tilted robot
Continued

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*.

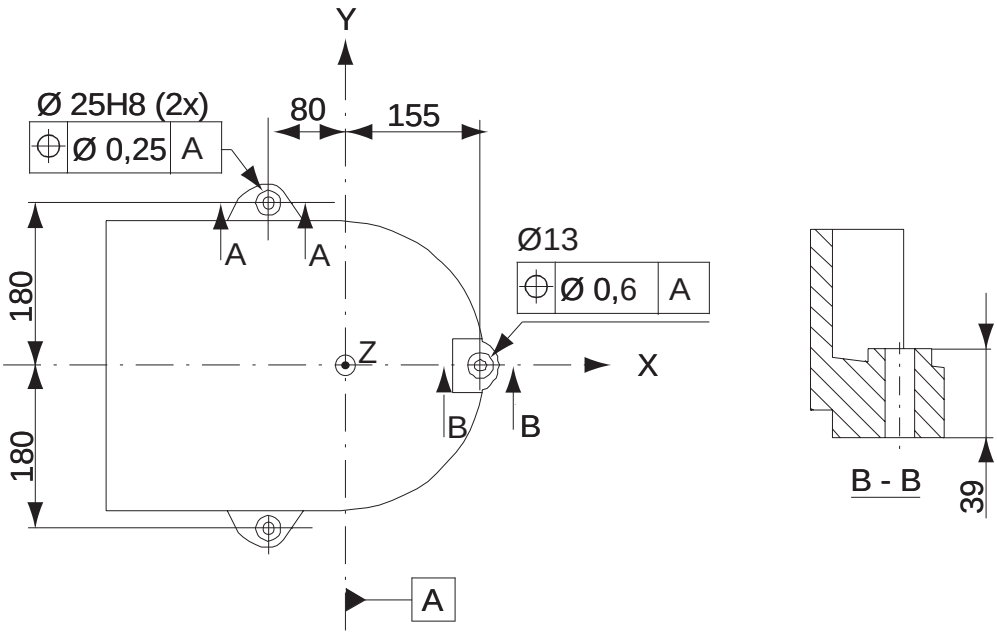
The system parameters are described in *Technical reference manual - System parameters*.

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

2.3.8 Bolt pattern

Hole configuration

The illustration below shows the hole configuration used when securing the manipulator:



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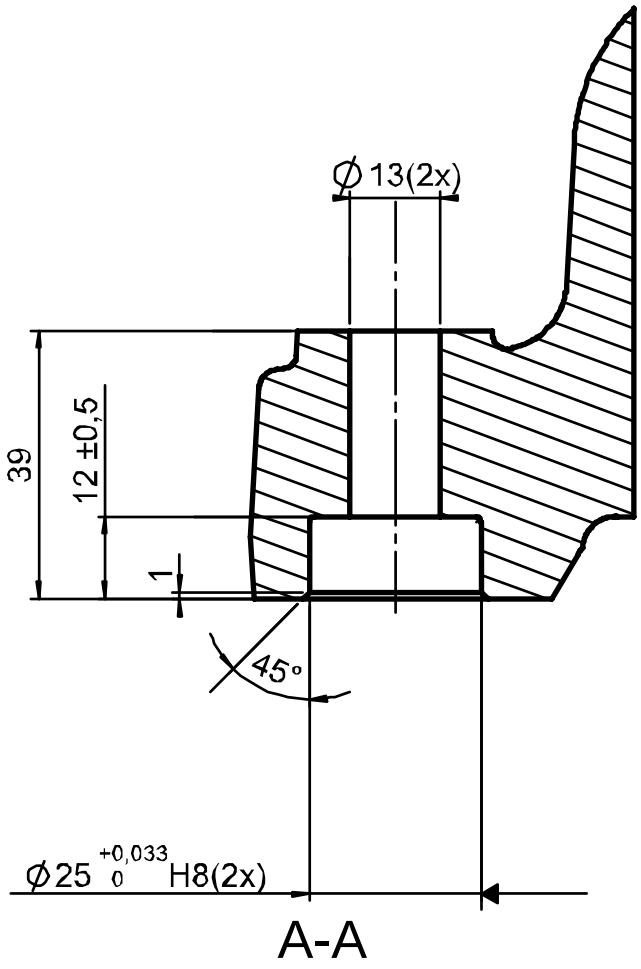
2.3.8 Bolt pattern
Continued

Cross section, guide sleeve hole

The illustration below shows the cross section of the guide sleeve holes:



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2.3.9 Installation of signal lamp (option)

Signal lamp

See the assembly instruction delivered with the signal lamp.

2.4 Restricting the working range

2.4.1 Restricting the working range

Introduction

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

> **WARNING**
>
> The working space can only be limited using software, for this reason the limited area cannot be classified as a safe zone. All work within this zone is prohibited.

System parameters

The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.

Limiting devices

Examples of limiting devices are listed below.

1 Light curtains.
2 Tread mats.
3 Other similar devices.
4 Software.

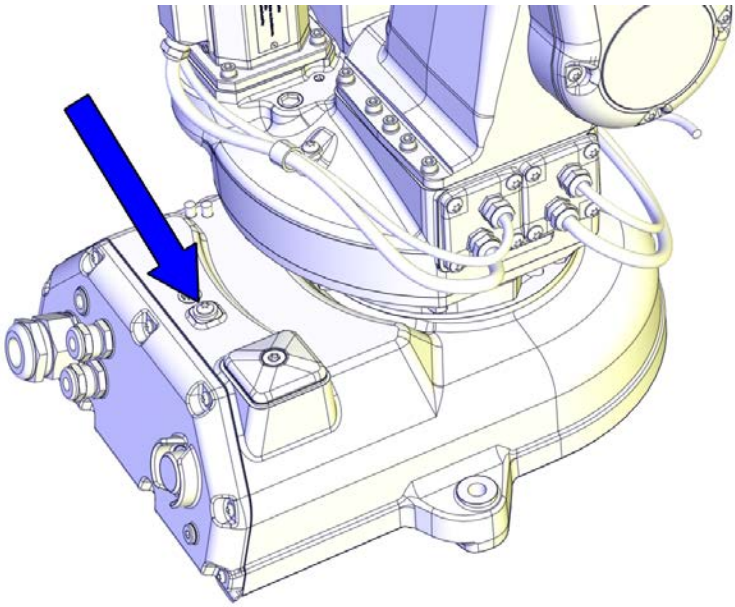
2.5 Electrical connections

2.5.1 Robot cabling and connection points

2.5.1.1 Grounding and bonding point on manipulator

Location of grounding/bonding point

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



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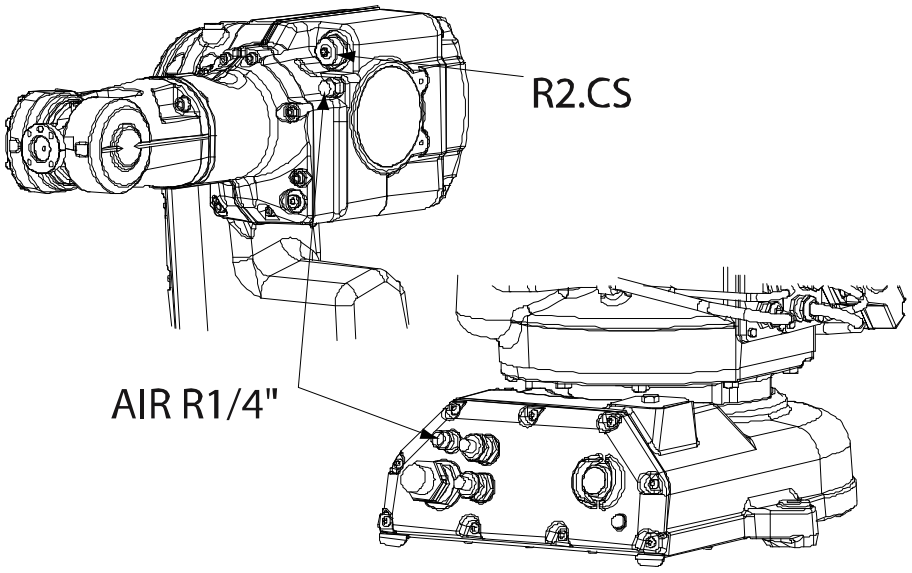
2.5.2 Customer connections on manipulator

General

For connection of extra equipment on the manipulator there are cables integrated into the manipulator's cabling. There are both air and electrical connectors on the manipulator.



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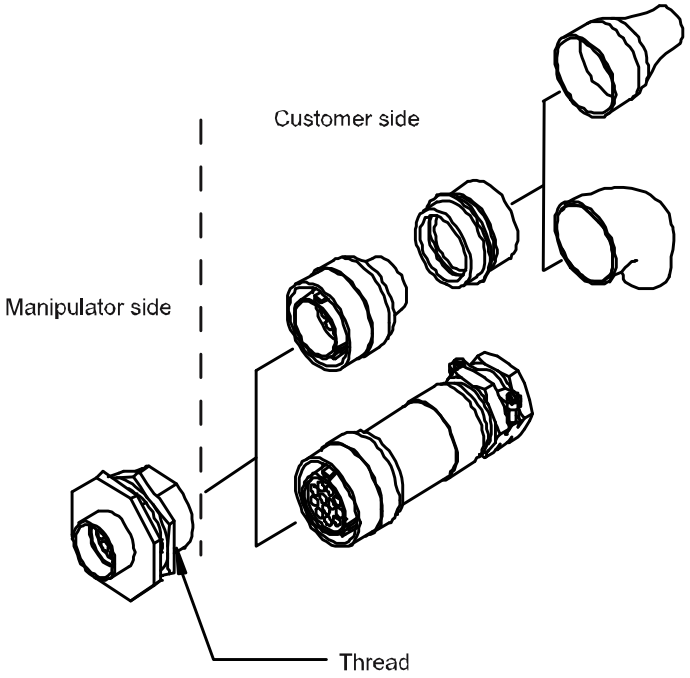
Connections

Connections	Description
For air on base / upper arm	R1/4" Max. 8 bar/hose inner diameter: 6.5 mm
Signal connector on upper arm	FCI UT 071412SH44N connector Number of signals: 12 signals, 49V, 500mA

Continues on next page

Recommended parts

To connect power and signal conductors to the upper arm connector, the following parts are recommended



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ABB's recommended contact set, for connector R2.CS (3HAC 12497-1) contains:

- Multipole connector 12 pin
- Adapter Tin plated 12 pin
- Pins for cable area 0.25-0.5 mm ^{2}
- Pins for cable area 0.5-1.5 mm ^{2}
- Shrinking hose, bootled shaped
- Shrinking hose angled

The connection set is delivered in a plastic bag also containing a Technical and assembly instruction.

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 `VelSet`.

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.

2.7 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.

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3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 140 type C.

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

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

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

Safety information

Observe all safety information before conducting any service work.

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

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 140 type C is connected to power, always make sure that the IRB 140 type C 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 Compact*
- *Product manual - IRC5 Panel Mounted Controller*
- *Robot cabling and connection points on page 69*.

3.2 Maintenance schedules

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 140 type C:

- 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, consisting of robot and controller cabinet, must be maintained regularly to ensure its function. The maintenance activities and their respective 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 sections referred to in the table can be found in the different chapters for every maintenance activity.

The table below specifies the required maintenance activities and intervals:

Maintenance activity	Equipment	Interval	Detailed in section:
Inspection	Robot	Regularly [i] For Clean Room robots: Daily	Check for abnormal wear or contamination
Inspection	Damper, axes 2-3	Regularly [i]	*Inspection, damper axes 2, 3 and 5 on page 79*
Inspection	Cable harnesses	Regularly [i]	*Inspecting the robot cabling on page 81*
Inspection	Timing belts	36 mths	*Inspection, timing belts on page 82*
Inspection	Oil	12 mths	*Inspection activities on page 79*
Inspection	Information labels	12 months	Replace any damaged, missing or unreadable labels. Replace any damaged, missing or unreadable labels. *Inspecting information labels on page 100*
Changing	Gearbox 5, oil	36 months	*Changing the oil in axes 5 and 6 gearboxes on page 106*
Changing	Gearbox 6, oil	36 months	*Changing the oil in axes 5 and 6 gearboxes on page 106*
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [ii]	*Replacing the serial measurement unit and the battery pack on page 166*

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3.2.2 Maintenance schedule

Continued

Maintenance activity	Equipment	Interval	Detailed in section:
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [iii]	*Replacing the serial measurement unit and the battery pack on page 166*
Cleaning	Complete robot	Regularly [i]	*Cleaning the IRB 140 type C on page 102*

i "Regularly" implies that the activity is to be performed regularly, but the actual interval may not be specified by the robot manufacturer. The interval depends on the operation cycle of the robot, its working environment and movement pattern. Generally, the more contaminated environment, the shorter intervals. The more demanding movement pattern (sharper bending cable harness), the shorter intervals.

ii 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.

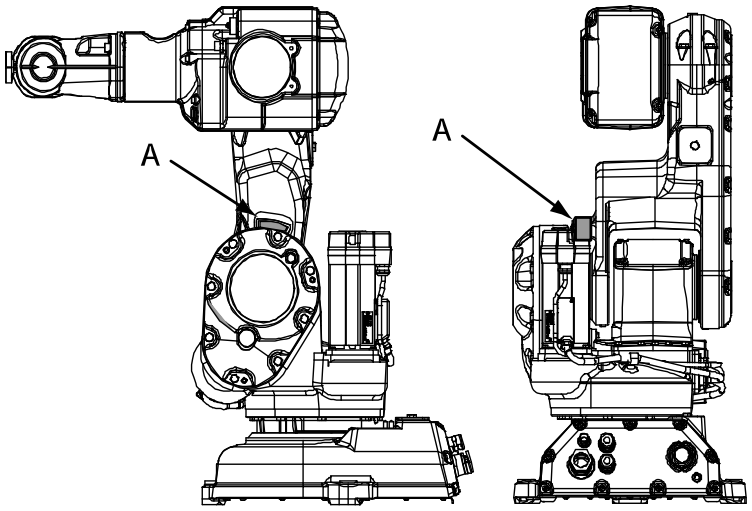
iii The battery low alert (38213 **Battery charge low**) is displayed when remaining backup capacity (robot powered off) is less than 2 months. The typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended with a battery shutdown service routine. See *Operating manual - IRC5 with FlexPendant* for instructions.

3.3 Inspection activities

3.3.1 Inspection, damper axes 2, 3 and 5

Location of dampers

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



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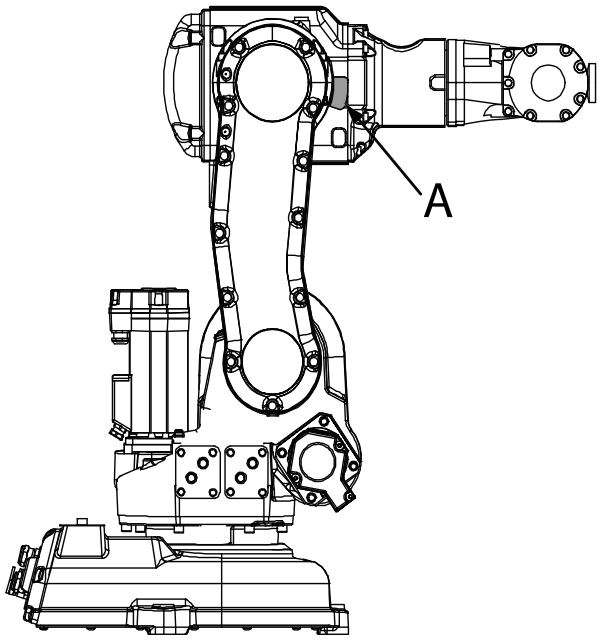
A	Damper, axis 2



xx0200000427

A	Damper, axis 3

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3.3.1 Inspection, damper axes 2, 3 and 5
Continued

Required equipment

Equipment	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 239*.

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 116*.

Inspection, dampers

The procedure below details how to inspect the dampers.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Check all *dampers* for damage, such as cracks or existing impressions that are larger than 1 mm.	Shown in the figure *Location of dampers on page 79*.
3	Check attachment screws for deformation.	
4	If any damage is detected, the damper must be replaced with a new one!	Replacement is detailed in sections: • *Replacing the damper, axis 2 on page 156* • *Replacing the damper, axis 3 on page 145* • *Replacement of damper, axis 5 on page 147*.

3.3.2 Inspecting the robot cabling

Introduction

CAUTION

For robots with protection type Clean Room

Always read the specific instructions before doing any repair work, see *Cut the paint or surface on the robot before replacing parts on page 116*

Location of robot cabling

The robot cabling comprises the cabling between the robot and controller cabinet as well as the externally visible cabling around motors 1 and 2.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.

Required tools and equipment

Visual inspection, no tools are required.

Other tools and procedures may be required if the spare part needs to be replaced. These are specified in the replacement procedure.

Inspection, robot cabling

Use this procedure to inspect the robot cabling.

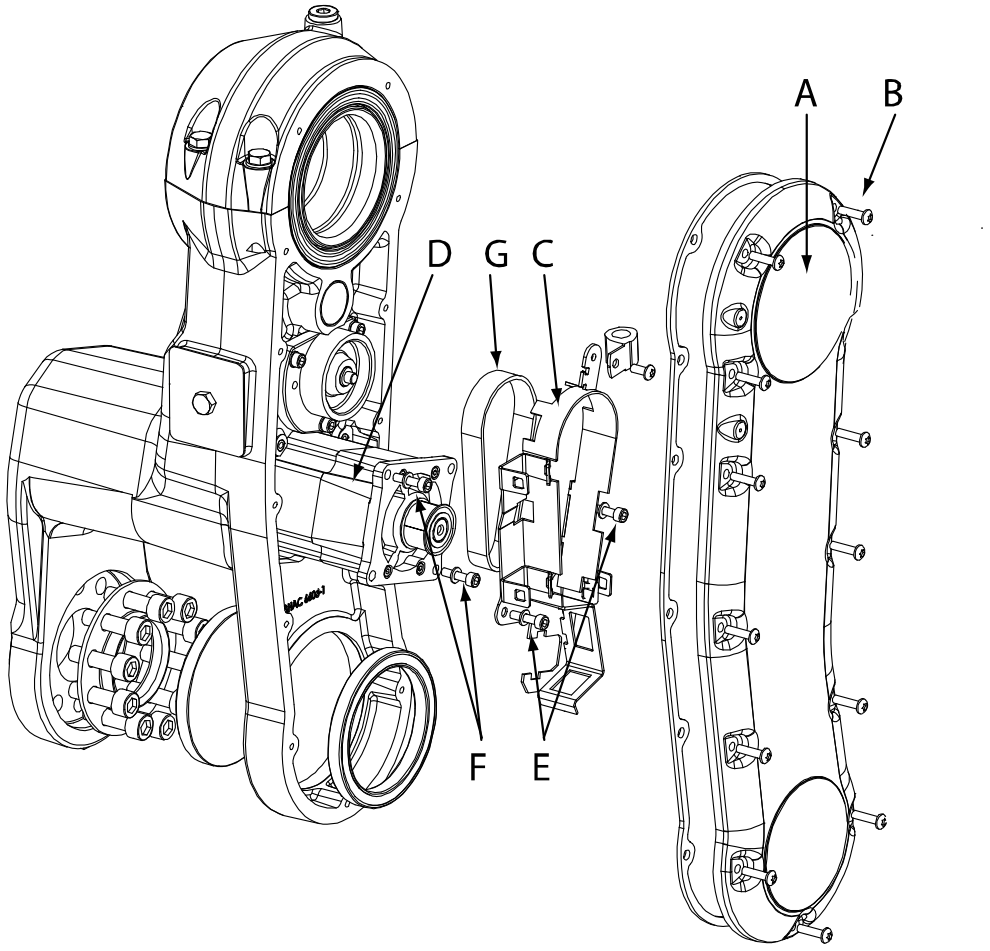
	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Visually inspect: • the control cabling between the robot and control cabinet • the cabling to motors 1 and 2. Look for abrasions, cuts or crush damage.	
3	Replace the cabling if wear or damage is detected.	This is detailed in section *Replacement of cable harness on page 118*.

3.3.3 Inspection, timing belts

Location of timing belts

Axes 3, 5 and 6 are fitted with timing belts. These are located as shown in the figures below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



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G	Timing belt, axis 3

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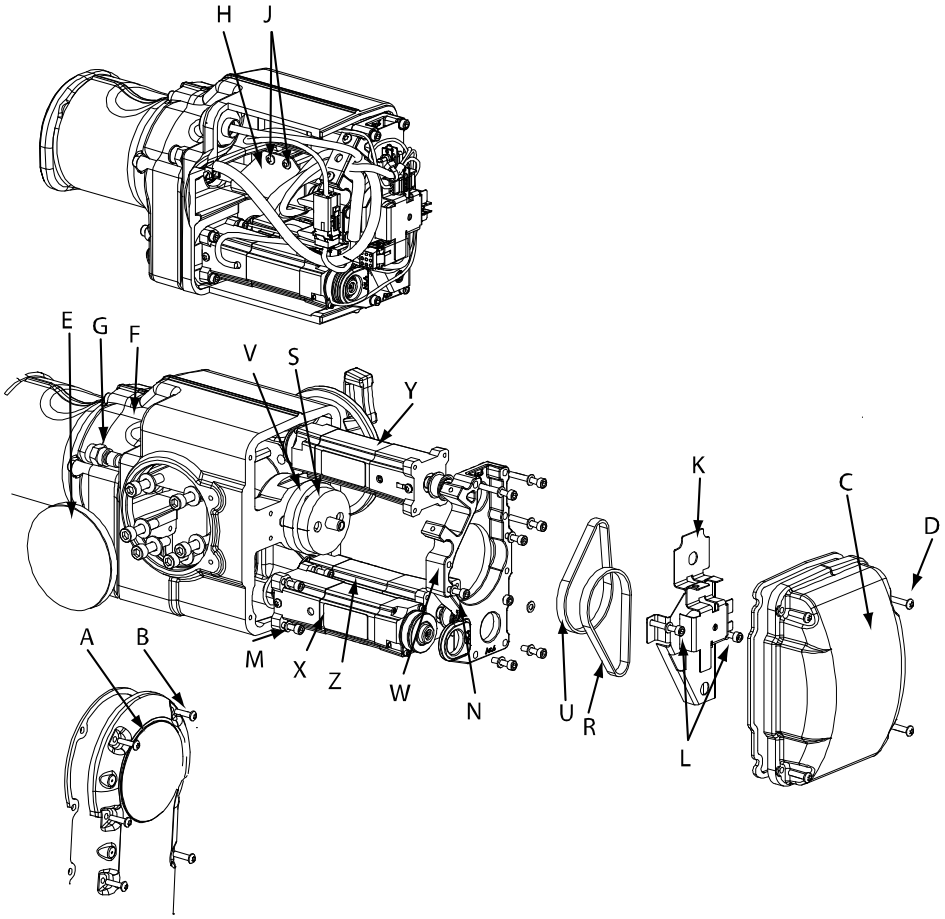

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R	Timing belt, axis 6
U	Timing belt, axis 5

Required equipment

Equipment, etc.	Art. no.	Note
Standard toolkit	3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

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3.3.3 Inspection, timing belts
Continued

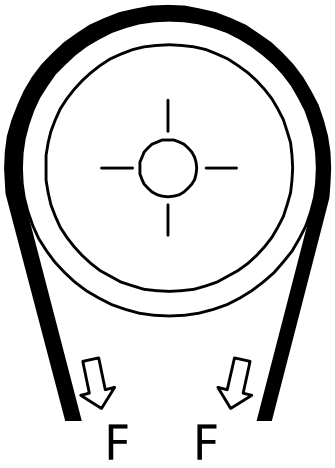
Inspection

The procedure below details how to inspect the timing belts.

WARNING

Please observe the following before commencing any repair work on the manipulator:

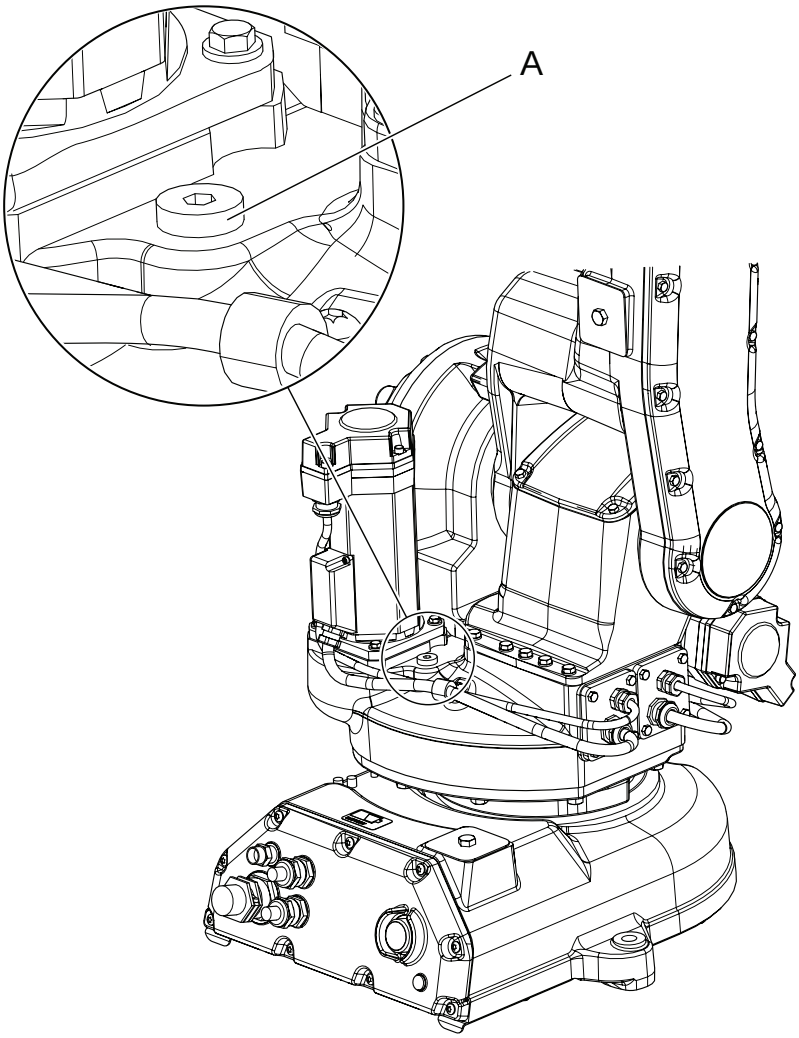
- Some parts are *HOT* after running the robot, e.g. motors and lights! Burns may result from touching them!
- Turn off all electrical power, hydraulic and pneumatic pressure supplies to the robot!
- When replacing motors/reducers, make sure that those parts of the robot which could move unexpectedly are mechanically blocked as specified in the individual procedures.

	Action	Note
1	Gain access to each belt by removing covers, etc.	These procedures are detailed in sections *Replacement of motor and timing belt, axis 3 on page 184* and *Replacement of motor and timing belt, axes 5 or 6 on page 194*.
2	Check each belt for damage.	Replace the timing belts if found defective as detailed in sections *Replacement of motor and timing belt, axis 3 on page 184* and *Replacement of motor and timing belt, axes 5 or 6 on page 194*.
3	Check each belt for tension. If the belt tension is not correct, it should be adjusted.	The belt tension should be: • Axis 3: F = 35-60 N • Axis 5: F = 35-60 N • Axis 6: F = 35-60 N .  xx0200000474 Belt tension adjustment is detailed in sections *Replacement of motor and timing belt, axis 3 on page 184* and *Replacement of motor and timing belt, axes 5 or 6 on page 194*.

3.3.4 Inspecting oil level gearbox axis 1

Location of oil plugs

The oil plug axis 1 gearbox is located as shown in the figure.



xx1700000416

A	Oil plug, filling, draining, inspection

Required equipment

Equipment	Note
Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 105*.
Standard toolkit	Content is defined in section *Standard tools on page 239*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

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3.3.4 Inspecting oil level gearbox axis 1
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 116*.

Inspecting oil level

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

Note

The suspended manipulator must be taken down and secured standing on the floor for inspection.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

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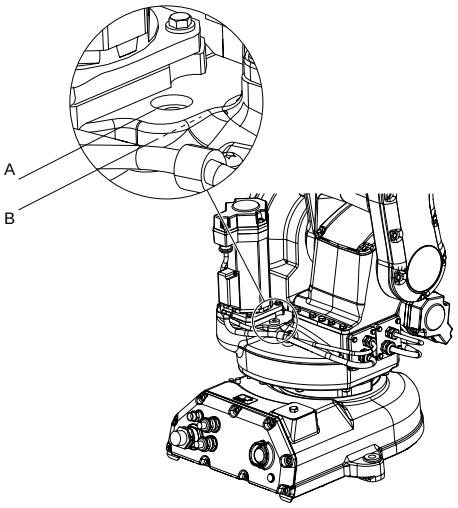
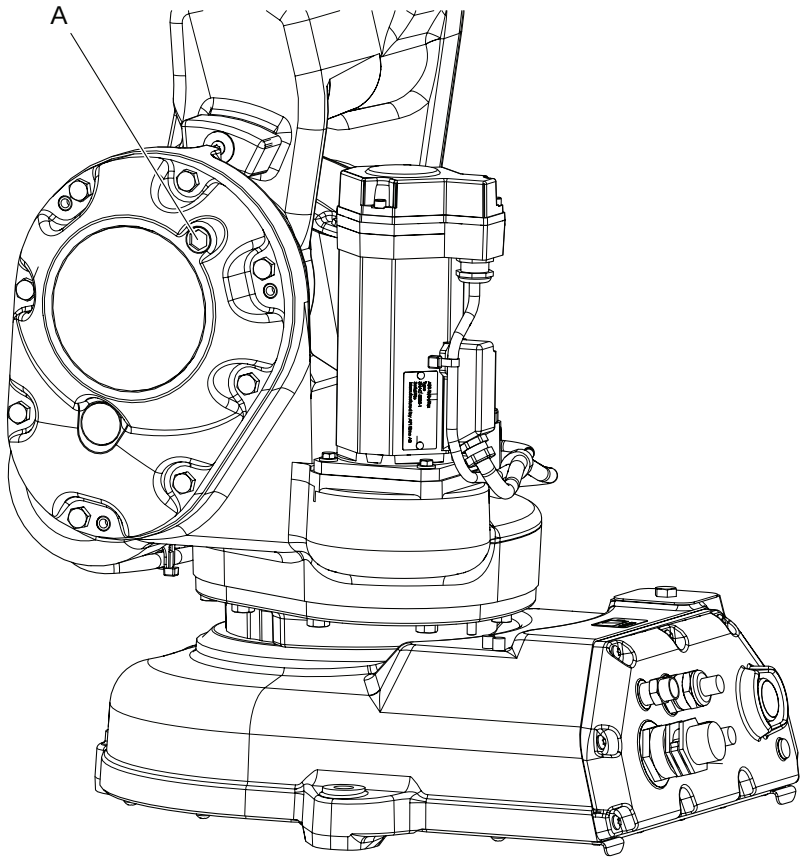
	Action	Note
4	Measure the oil level at the oil plug hole. Required oil level: • 34 ±5 mm below the upper edge of the oil plug hole. **Note** Position the axis according to illustration before measuring the oil level.	 xx1700000422 A — The upper edge of the oil plug hole B — Oil level
5	Add oil if required.	See *Technical reference manual - Lubrication in gearboxes*
6	Refit the oil plug, filling. **Note** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 10 Nm
7	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 116*. **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

3.3.5 Inspecting oil level gearbox axis 2

Location of oil plugs

The oil plug axis 2 gearbox is located as shown in the figure.



xx1700000417

A	Oil plug, filling, draining, inspection

Required equipment

Equipment	Note
Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 105*.
Standard toolkit	Content is defined in section *Standard tools on page 239*.
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 116*.

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Inspecting oil level

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

Note

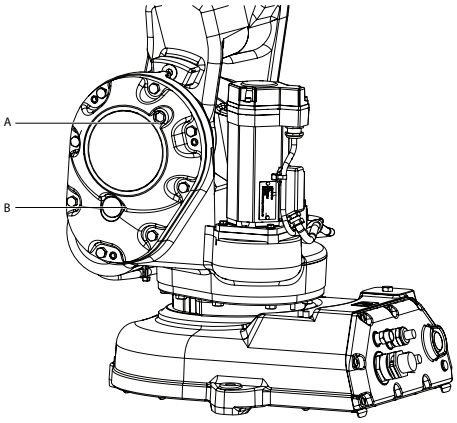
The suspended manipulator must be taken down and secured standing on the floor for inspection.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

Continues on next page

3.3.5 Inspecting oil level gearbox axis 2

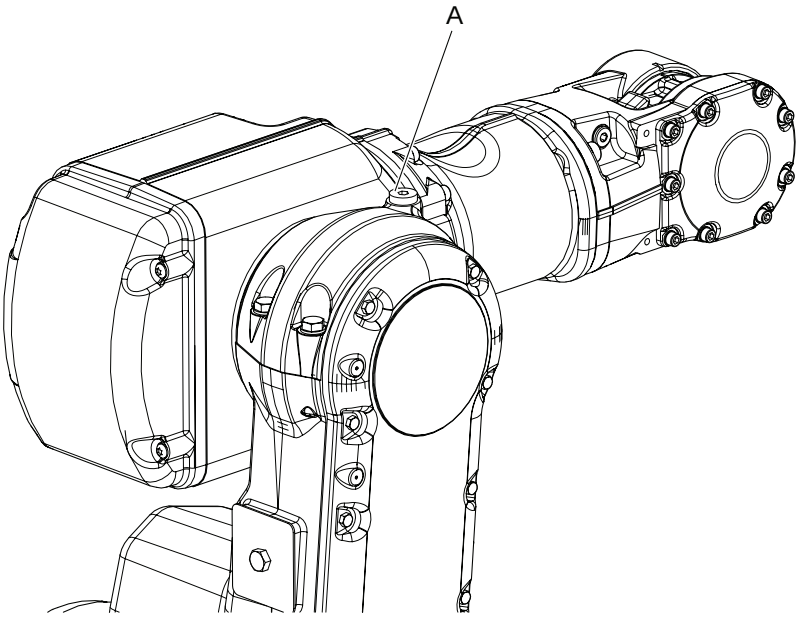
Continued

	Action	Note
4	Measure the oil level at the oil plug hole. Required oil level: • 125 -25 mm below the lower edge of the oil plug hole. **Note** If it is not possible to measure the oil level, drain all oil out and refill with initial amount according to Technical reference manual. • Remove the motor. See *Removal, motor axis 2 on page 181*. • Refill oil in the gearbox. See *Technical reference manual - Lubrication in gearboxes*. • Refit the motor. See *Refitting, motor axis 2 on page 182*. **Note** Position the axis according to illustration before measuring the oil level.	 xx1700000570 A: The lower edge of the oil plug hole B: Oil level
5	Add oil if required.	See, *Technical reference manual - Lubrication in gearboxes*.
6	Refit the oil plug, filling. **Note** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 10 Nm
7	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 116*. **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

3.3.6 Inspecting oil level gearbox axis 3

Location of oil plugs

The oil plug axis 3 gearbox is located as shown in the figure.



xx1700000418

A	Oil plug, filling, draining, inspection

Required equipment

Equipment	Note
Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 105*.
Standard toolkit	Content is defined in section *Standard tools on page 239*.
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 116*.

Continues on next page

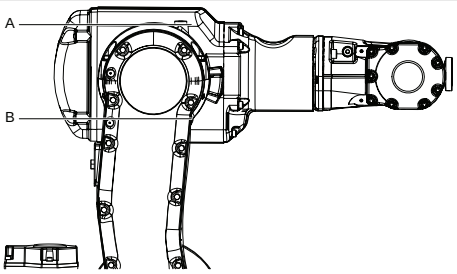
3.3.6 Inspecting oil level gearbox axis 3
Continued

Inspecting oil level

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

Note

The suspended manipulator must be taken down and secured standing on the floor for inspection.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Measure the oil level at the oil plug hole. Required oil level: • 148 ±5 mm below the upper edge of the oil plug hole. **Note** Position the axis according to illustration before measuring the oil level.	 xx1700000571 A: The upper edge of the oil plug hole B: Oil level
5	Add oil if required.	See *Technical reference manual - Lubrication in gearboxes*

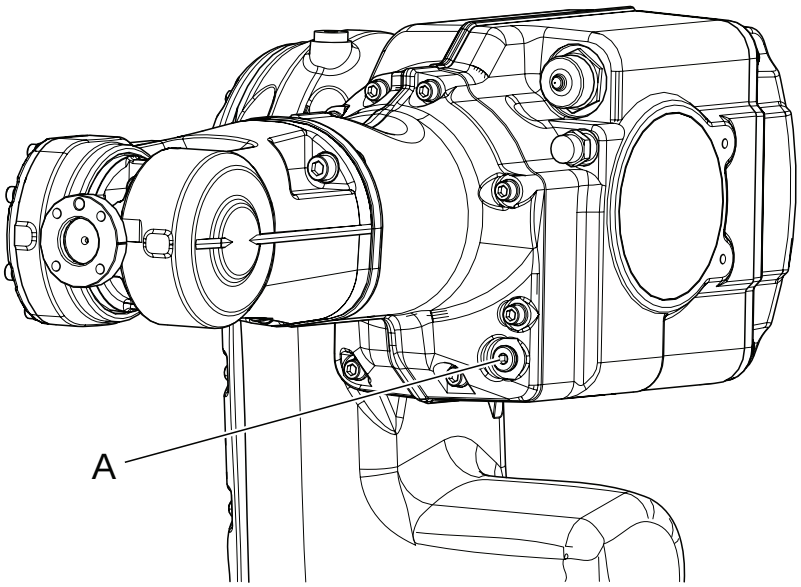
Continues on next page

	Action	Note
6	Refit the oil plug, filling. **Note** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 10 Nm
7	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 116*. **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

3.3.7 Inspecting oil level gearbox axis 4

Location of oil plugs

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



xx1700000419

A	Oil plug, filling, draining, inspection

Required equipment

Equipment	Note
Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 105*.
Standard toolkit	Content is defined in section *Standard tools on page 239*.
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 116*.

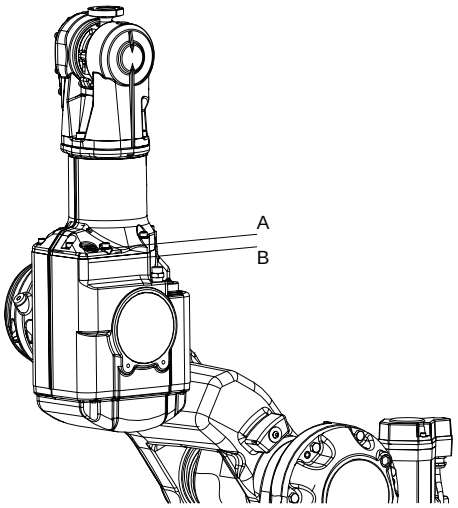
Continues on next page

Inspecting oil level

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

Note

If the surroundings prohibits an inspection of the manipulator in a suspended position, then the manipulator must be taken down and secured standing on the floor.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Measure the oil level at the oil plug hole. Required oil level: • 15 ±3 mm below the upper edge of oil plug hole. **Note** Position the axis according to illustration before measuring the oil level.	 xx1700000421 A The upper edge of the oil plug hole B Oil level

Continues on next page

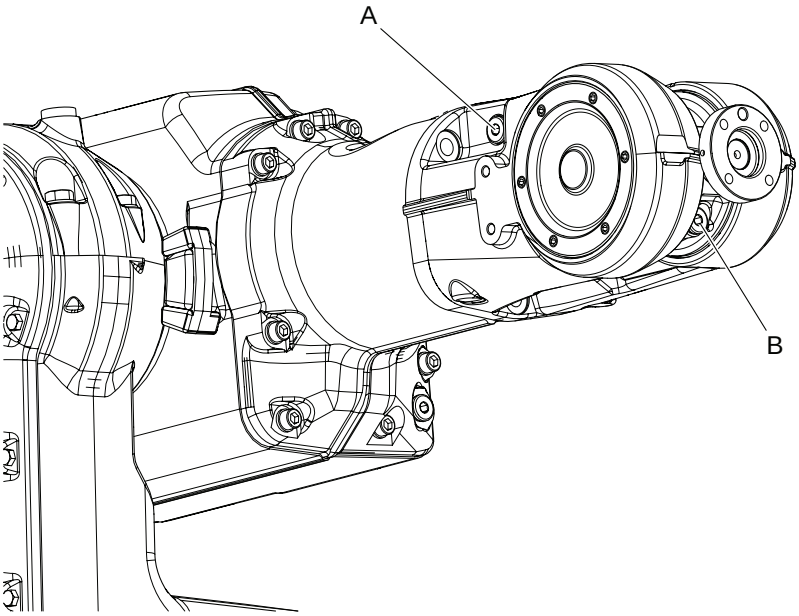
3.3.7 Inspecting oil level gearbox axis 4
Continued

	Action	Note
5	Add oil if required.	See *Technical reference manual - Lubrication in gearboxes*
6	Refit the oil plug, filling. **Note** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 10 Nm
7	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 116*. **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

3.3.8 Inspecting oil level gearbox axes 5-6

Location of oil plugs

The oil plug axis 5-6 gearbox is located as shown in the figure.



xx1700000420

A	Oil plug, filling, draining, inspection
B	Oil plug, ventilation hole

Required equipment

Equipment	Note
Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 105*.
Standard toolkit	Content is defined in section *Standard tools on page 239*.
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 116*.

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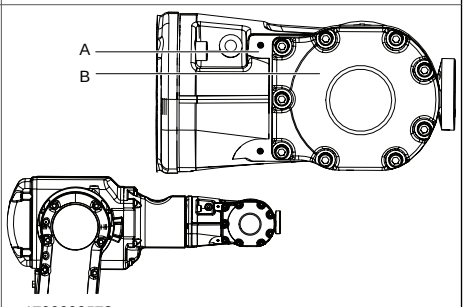
3.3.8 Inspecting oil level gearbox axes 5-6
Continued

Inspecting oil level

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

Note

If the surroundings prohibits an inspection of the manipulator in a suspended position, then the manipulator must be taken down and secured standing on the floor.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Measure the oil level at the oil plug hole. Required oil level: • 23 ±3 mm below the lower edge of the oil plug hole. **Note** Position the axis according to illustration before measuring the oil level.	 xx1700000572 A The lower edge of the oil plug hole B Oil Level
5	Add oil if required.	See *Technical reference manual - Lubrication in gearboxes*

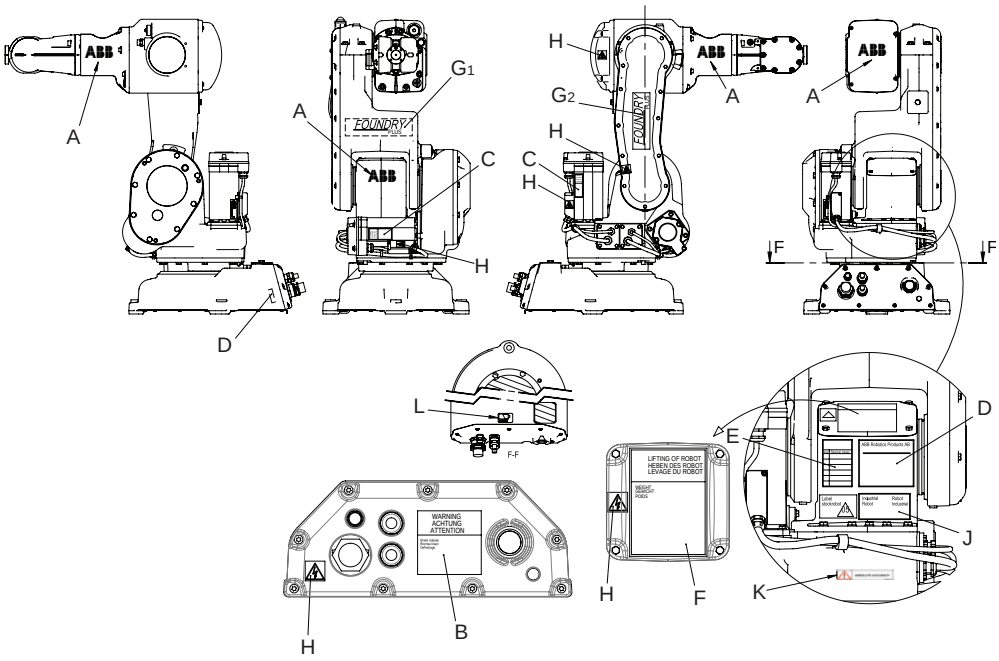
Continues on next page

	Action	Note
6	Refit the oil plug, filling. **Note** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 10 Nm
7	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 116*. **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

3.3.9 Inspecting information labels

Location of information labels

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



xx1800001184

A	ABB logotype
B	Warning label - Brake release
C	Warning label - heat (2 pcs)
D	Rating label (located inside the base)
E	Calibration label
F	Lifting instruction label
G1	Foundry or CleanRoom logotype, if applicable. Location is valid if option lamp unit is selected.
G2	Foundry or CleanRoom logotype, if applicable. Location is valid if option lamp unit is not selected.
H	Warning label - Electricity (symbol of flash) (6 pcs)
J	UL/UR label
K	Information sign - AbsAcc
L	Label - battery

Required equipment

Equipment	Spare part number	Note
Labels	See *Spare part lists on page 243*.	

Continues on next page

Inspecting labels

Use this procedure to inspect the labels on the robot.

	Action	Note
1	**DANGER** Turn off all: • 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 100*.
3	Replace any missing or damaged labels.	

3.4 Cleaning activities

3.4.1 Cleaning the IRB 140 type C

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 140 type C 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 140 type C.

Note

Always verify the protection type of the robot before cleaning.

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 104*.
ii Perform according to section *Cleaning with water and steam on page 104*.

Wiping with cloth

Additional cleaning instructions for Clean Room robots

ABB robots with protection types *Clean Room* are designed to be cleaned at a low cleaning frequency, before entering the cleanroom environment, after robot commissioning or during cleanroom maintenance.

Wipe-down cleaning method is recommended. Robot surfaces shall be wiped with clean and low particle emission cleanroom cloth which is soaked in 70% ethanol .

Use the following procedure to clean Clean Room robots:

1 Before cleaning, use the lint free cloth to remove dirt, debris or any other contaminant from the to-be cleaned surfaces.
   - Make sure no visible residues left.
   - Never apply hard forces on or rub against the robot surfaces to remove dirt or debris; otherwise, protective paint layers may be damaged.

Continues on next page

3.4.1 Cleaning the IRB 140 type C
Continued

2 Wet a clean cloth with the cleaning detergent and then wipe the robot painting surfaces.
   - Make sure no cleaning agents are sprayed onto robot surfaces or into the robot structure.
   - Wipe from the surface center to edge and always in the same direction.

3 Wait a few minutes for detergent volatilization.
   - Make sure no residue of cleaning agents left on the robot surfaces after wipe down cleaning.

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), provided that the robot is not equipped with the option of motor cooling fans.[1]

The following list defines the prerequisites:

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

I 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]

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 2500 kN/m^2 (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.

1 See *Cleaning methods on page 103* for exceptions.

2 See *Cleaning methods on page 103* for exceptions.

3.5 Changing/ replacing activities

3.5.1 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

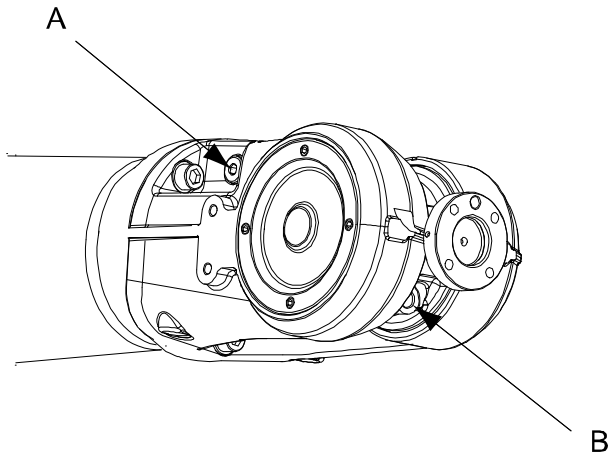
Equipment	Note
Oil dispenser	Includes pump with outlet pipe. Use the suggested dispenser or a similar one: • Orion OriCan article number 22590 (pneumatic)
Nipple for quick connect fitting, with o-ring	

3.5.2 Changing the oil in axes 5 and 6 gearboxes

Location of oil plugs

The gearboxes for axes 5 and 6 are located in the wrist unit as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0600002846

A	Oil plug, draining and filling
B	Oil plug, vent hole

Required equipment

Equipment, etc.	Note
Lubricating oil	Information about the oil is found in *Technical reference manual - Lubrication in gearboxes*. See *Type and amount of oil in gearboxes on page 105*.
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Standard toolkit	Content is defined in section *Standard tools on page 239*.
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.

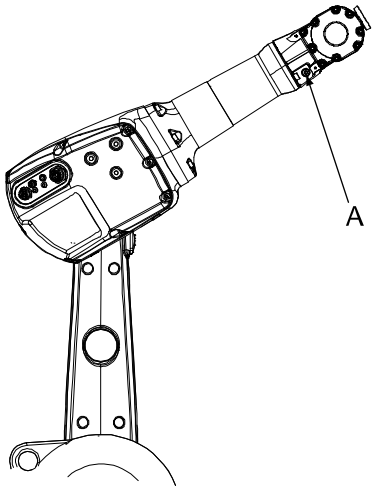
CAUTION

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 116*.

Continues on next page

Draining, wrist unit

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

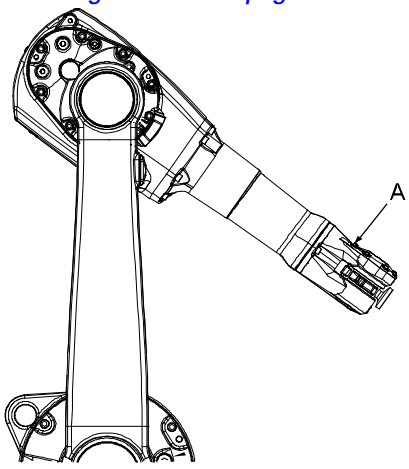
	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
3	Position the robot as shown in the figure to the right: • upper arm: upwards for a standing robot • axis 4: 180º, to a position where the oil plug (A), faces downwards. **Note!** The total amount of oil will not be drained. There will remain approximately 50 ml in the wrist unit.	The capacity of the vessel must be sufficient to take the complete amount of oil.  xx0500001434 A Oil plug, draining and filling The position for an *inverted robot* is the opposite!
4	Remove the both *oil plugs*. Both oil plugs must be removed in order to drain the wrist unit properly.	Shown in the figure *Location of oil plugs on page 106*.
5	Refit the oil plug, vent hole.	

Continues on next page

3.5.2 Changing the oil in axes 5 and 6 gearboxes
Continued

Filling oil, wrist unit

The procedure below details how to fill oil in the gearboxes in the wrist unit.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 32*.	
3	Remove the *oil plug, draining and filling.*	Shown in the figure *Location of oil plugs on page 106*!
4	Position the robot as shown in the figure to the right: • upper arm: downwards for a standing robot • axis 4: 90º, to a position where the oil plug (A), faces upwards. Fill oil in the wrist unit through the oil plug.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 105*.  xx0500001435 • A: Oil plug, draining and filling The position for an *inverted robot* is the opposite.
5	Refit the oil plug.	

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes repair activities for the IRB 140 type C. Each procedure contains the information required to perform the activity, for example spare parts numbers, required special tools, and materials.

WARNING

Repair activities not described in this chapter must only be carried out by ABB.

Report replaced units

Note

When replacing a part on the IRB 140 type C, report to your local ABB the serial number, the article number, and the revision of both the replaced unit and the replacement unit.

This is particularly important for safety equipment to maintain the safety integrity of the installation.

Safety information

Make sure to read through the chapter *Safety on page 17* before commencing any service work.

Note

If the IRB 140 type C is connected to power, always make sure that the IRB 140 type C is connected to protective earth and a residual current device (RCD) before starting any repair work.

For more information see:

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

4.2 General procedures

4.2.1 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

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.

4.2.2 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 following procedures describe how to fit rotating sealings.

CAUTION

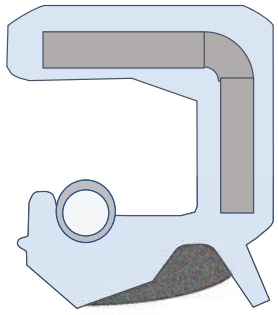
Please observe the following before commencing any assembly of sealings:

- Protect the sealing during transport and mounting, especially the main lip on radial sealings.
- 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.
- Do not lubricate a static side of a sealing with grease, since this may result in movement of the sealing during operation.

  The only exception for lubrication of static sides of a sealing, is to use P-80 rubber lubrication gel against certain aluminium surfaces. If usage of P-80 is relevant, it is stated in the repair procedures.

Radial sealings

A radial sealing consists of a flexible rubber lip bonded to a rigid metal case. Only one side of the sealing is static with a metal insert.



xx2300000433

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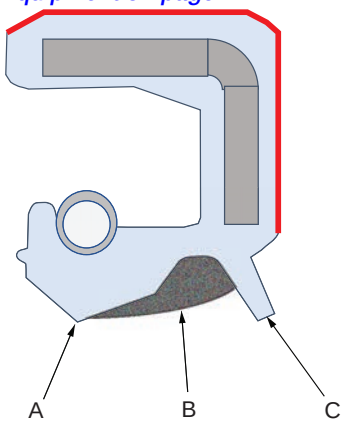
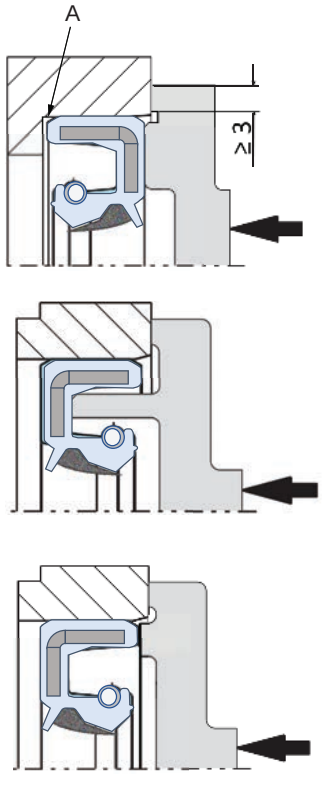
	Action	Note
1	Check the sealing to ensure that: • The sealing is of the correct type. • There is no damage on the main lip.	
2	Inspect the shaft surface before mounting. If scratches or damage are found, the shaft must be replaced since it may result in future leakage. Do not try to grind or polish the 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.	Article number is specified in *Equipment on page 112*.  xx2000000071 A Main lip B Grease C Dust lip **Note** Ensure that no grease is applied to the red marked surface.

Continues on next page

4.2.2 Mounting instructions for sealings

Continued

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

Flange sealings and static sealings

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

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

O-rings

The following procedure describes how to fit o-rings.

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

Continues on next page

	Action	Note
3	Check the o-ring grooves and mating surfaces. They should be free of pores, contamination and obvious scratches/damage.	
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.	

4.2.3 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.

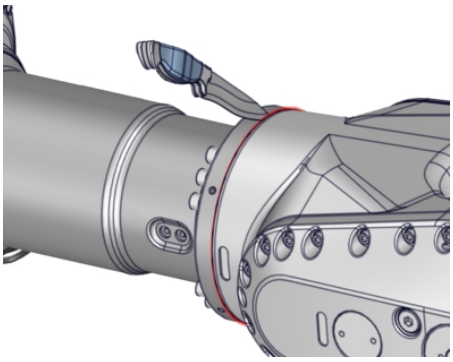
For robots with protection type Clean Room

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

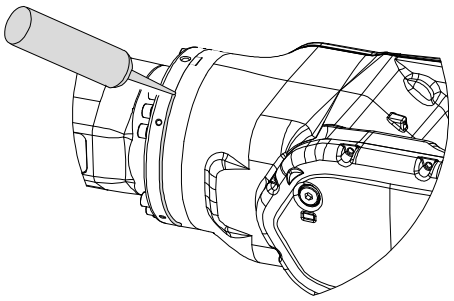
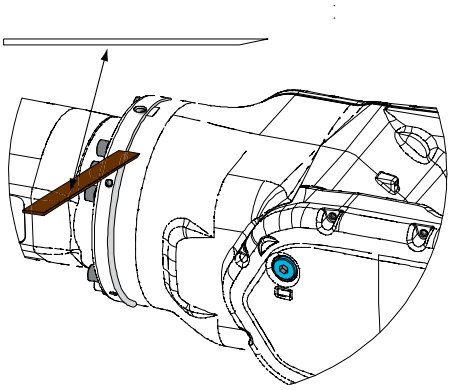
Removing

	Action	Description
1	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.	 xx2300000950
2	Carefully grind the paint edge that is left on the structure to a smooth surface.	

Refitting

	Action	Description
1	Before the parts are refitted, clean the joint so that it is free from oil and grease.	Use ethanol on a lint free cloth.

Continues on next page

	Action	Description
2	Place the tooling pin in hot water.	
3	Seal all refitted joints with sealing compound.	 xx0900000122
4	Use the tooling pin to even out the surface of the sealing compound.	 xx0900000125
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.

4.3 Complete robot

4.3.1 Replacement of cable harness

Location of cable harness

The cable harness runs from the base to the motors of axes 3-6.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable harness	3HAC 7370-1		Standard and Foundry versions Clean room version Includes cabling: • Cable harness, power axis 1-3 • Cable harness, power axis 4-6 • Cable harness, signals axis 1-3 • Cable harness, signals axis 4-6 • Cable harness, customer connections
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
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		3HAC 6816-3	See chapter *Circuit diagram on page 245*.

Continues on next page

Removal, cable harness

The procedure below details how to remove the cable harness.

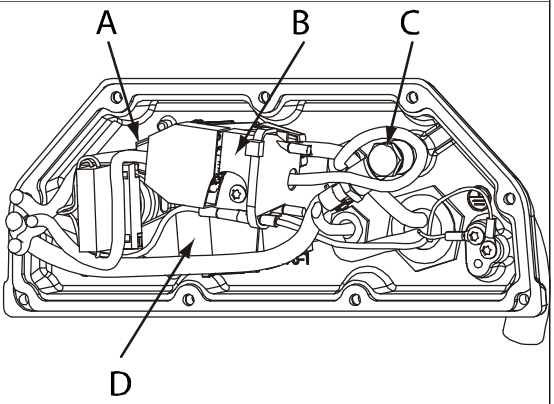
WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

CAUTION

The cable packs are sensitive to mechanical damage! They must be handled with care, especially the connectors, in order to avoid damaging them!

	Action	Note/Illustration
1	**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 116*.	
2	Remove the serial measurement board.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
3	Disconnect connectors in the manipulator base.	 xx0300000090 Connectors: • A: R1.MP1-3 • B: R1.CS • C: Air hose • D: R1.MP4-6

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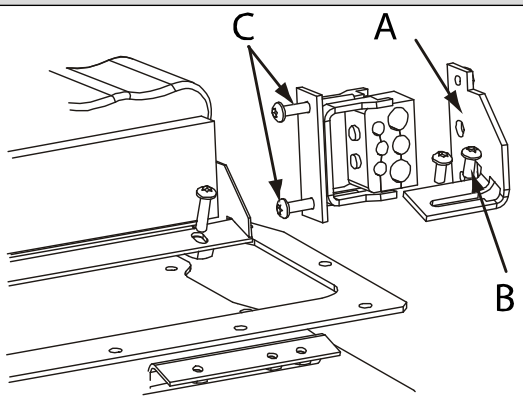
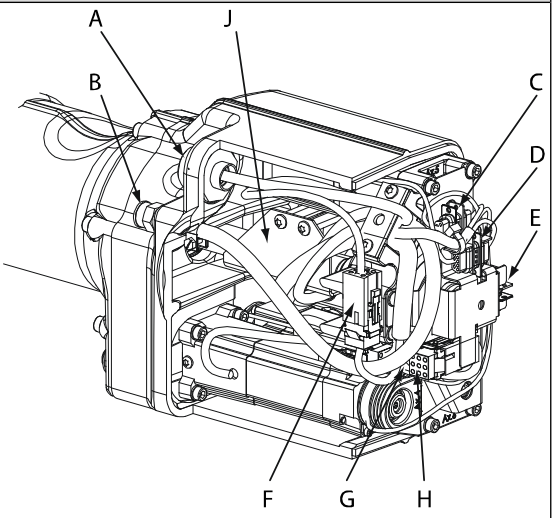
4.3.1 Replacement of cable harness

Continued

	Action	Note/Illustration
4	Remove the cable holder by unscrewing its attachment screws.	 xx0300000091 • A: Cable holder • B: Attachment screws • C: Cable securing screws
5	Remove the cables from the cable holder by unscrewing the cable securing screws.	See figure above!
6	Remove the *cover, arm housing*.	Detailed in section *Replacement of cover, arm housing on page 149*.
7	Remove the *lower arm cover*.	Detailed in section *Replacement of lower arm cover and gasket on page 152*.
8	Gently knock out the *VK cover*.	Detailed in section *Removing the VK cover on page 130*.

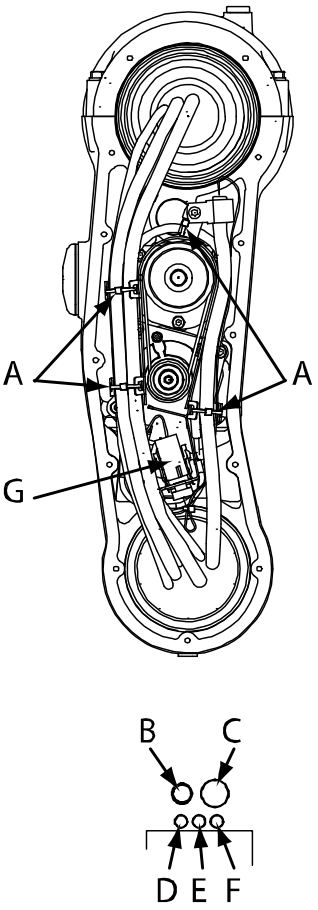
Continues on next page

	Action	Note/Illustration
9	Disconnect connectors in the rear of the upper arm.	 xx0300000092 Connectors: • A: R2.CS • B: Pressurized air connection • C: R3.FB4 • D: R3.FB5 • E: R3.FB6 • F: R3.MP5 • G: R3.MP4 • H: R3.MP6 Parts: • J: Shield
10	Remove the *shield* by unscrewing its attachment screws.	See figure above!
11	Cut any cable ties securing the cabling inside the lower arm.	

Continues on next page

4.3.1 Replacement of cable harness

Continued

	Action	Note/Illustration
12	Disconnect the connectors inside the lower arm.	 xx0200000449 • G: Connectors R3.MP3 and R3.FB3
13	Pull the cables out of the upper arm.	
14	Remove the *cover, console*.	Detailed in section *Replacement of cover, console on page 158*.
15	Disconnect the connectors inside the console and undo the cable holders.	Connectors: • R3.MP1 • R3.MP2 • R3.FB1 • R3.FB2
16	Gently pull the cabling from the base up through the console.	
17	Gently pull the cabling out of the lower arm.	

Continues on next page

Refitting, cable harness

The procedure below details how to refit the cable harness.

WARNING

Please observe the following before commencing any repair work on the manipulator:

- - Motors and gears are *HOT* after running the robot! Burns may result from touching the motors or gears!
- - Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!
- - Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, e.g. to secure the lower arm with fixtures if removing motor, axis 2.

CAUTION

The cable packs are sensitive to mechanical damage! They must be handled with care, especially the connectors, in order to avoid damaging them!

	Action	Note/Illustration
1	Refit in reverse order to what is detailed above. Detailed below are some recommendations on how to route the cables.	
2	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
3	Make sure that the harness (cables and hose) routed through the console and base (through axis 1) are individually routed straight and not twisted with other cables. This to prevent strained cables and folded air hose during movement of the manipulator.	

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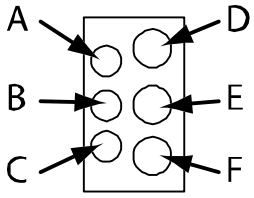
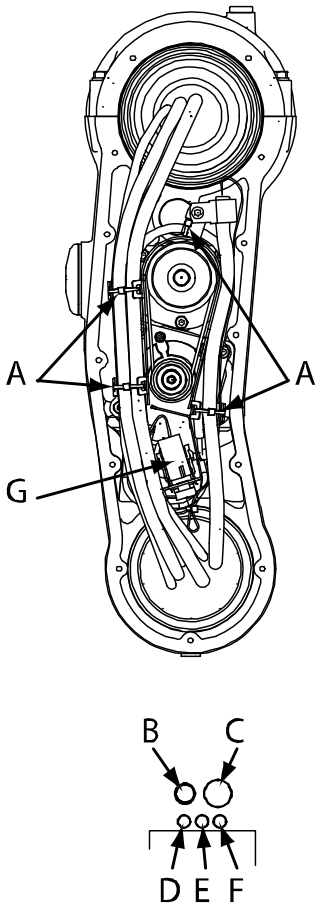
4.3.1 Replacement of cable harness

Continued

	Action	Note/Illustration
4	Cable distribution in the cable holder in the manipulator base.	 xx0300000093 Cables: • A: Signal • B: Signal • C: Customer signal • D: Power cable, axes 4-6 • E: Pressurized air supply • F: Power cable, axes 1-3
5	Make sure that the air hose is not folded when installing the rear cable cover and cut the hose to a suitable length, if needed.	

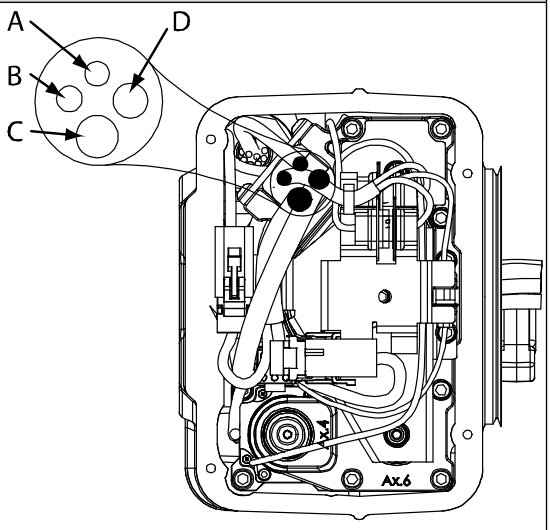
Continues on next page

	Action	Note/Illustration
6	Cable layout in the lower arm.	 xx0200000449 • A: Cable ties • B: Pressurized air hose • C: Power cables, axes 4, 5 and 6 • D: Customer cables, signal • E: Signal cables, axes 4, 5 and 6 • F: Signal cable, axis 3 • G: Connectors R3.MP3 and R3.FB3

Continues on next page

4.3.1 Replacement of cable harness

Continued

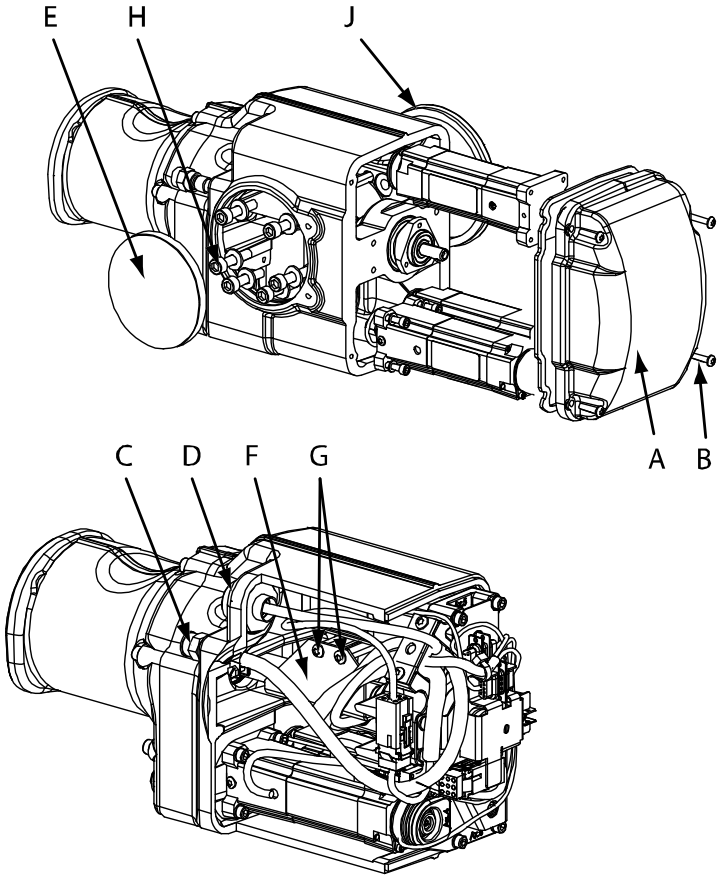
	Action	Note/Illustration
7	Cable holder in the upper arm.	 xx0300000094 Cables: • A: Customer signal • B: Signal • C: Pressurized air supply • D: Power cables
8	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the Clean Room robot free from particles with spirit on a lint free cloth.	

4.3.2 Replacement of complete upper arm

Location of upper arm

The upper arm is located on top of the manipulator as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000446

A	Cover, armhousing
B	Attachment screws, cover armhousing, (4 pcs)
C	CS-connector
D	Pressurized air connector
E	VK cover
F	Cable guide
G	Attachment screws, cable guide
H	Attachment screws, upper arm (6 pcs)
J	Sealing ring

Continues on next page

4.3.2 Replacement of complete upper arm
Continued

Required equipment

Equipment	Spare part no.	Art. no.	Note
Upper arm	See *Spare part lists on page 243*.		Includes all required sealings and gaskets.
Sealing ring		3HAB3732-13	To be replaced if damaged only. Included in the upper arm assembly.
VK cover		3HAA2166-13	
Gasket upper arm cover		3HAC7867-1	
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Special socket		-	For fitting the CS-connector.
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.

WARNING

Please observe the following before doing any repair work on the manipulator:

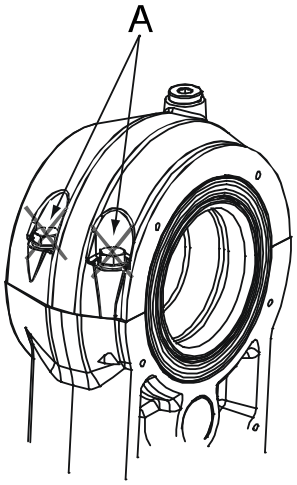
- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Removal, upper arm

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

	Action	Note
1	**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 116*.	
2	Run the manipulator arm to a horizontal position.	
3	Remove all brackets securing any exterior cabling to the upper arm by unscrewing their attachment screws respectively.	

Continues on next page

	Action	Note
4	Remove the rear *cover armhousing* by unscrewing its four *attachment screws*.	Shown in the figure *Location of upper arm on page 127*!
5	**DO NOT** under any circumstance unscrew the six screws on top of the lower arm! Doing so will cause the manipulator to require a complete rebuild!	 xx0300000101 • A: **DO NOT** touch these screws! (NOTE! Only two screws shown!)
6	Disconnect all cables to/from motors 4-6.	Connectors • R3.MP4 • R3.MP5 • R3.MP6 • R3.FB4 • R3.FB5 • R3.FB6
7	Disconnect any connector from the CS-connector.	Shown in the figure *Location of upper arm on page 127*!
8	Use a *special socket* to remove the *CS-connector* from the housing and pull it into the upper arm assembly.	Shown in the figure *Location of upper arm on page 127*! Art. no. specified in section *Required equipment on page 128*!
9	Remove the *pressurized air connector* from the housing and pull it into the upper arm assembly.	Shown in the figure *Location of upper arm on page 127*! Art. no. specified in section *Required equipment on page 128*!
10	Remove the *VK-cover* from the upper arm/lower arm joint.	Shown in the figure *Location of upper arm on page 127*! Detailed in section *Removing the VK cover on page 130*.
11	Remove the *cable guide* by unscrewing its two *attachment screws*.	Shown in the figure *Location of upper arm on page 127*!
12	Gently pull all cables and hoses out.	
13	Remove the upper arm by unscrewing its six *attachment screws*.	Shown in the figure *Location of upper arm on page 127*!
14	Lift the upper arm and place it on a secure surface.	

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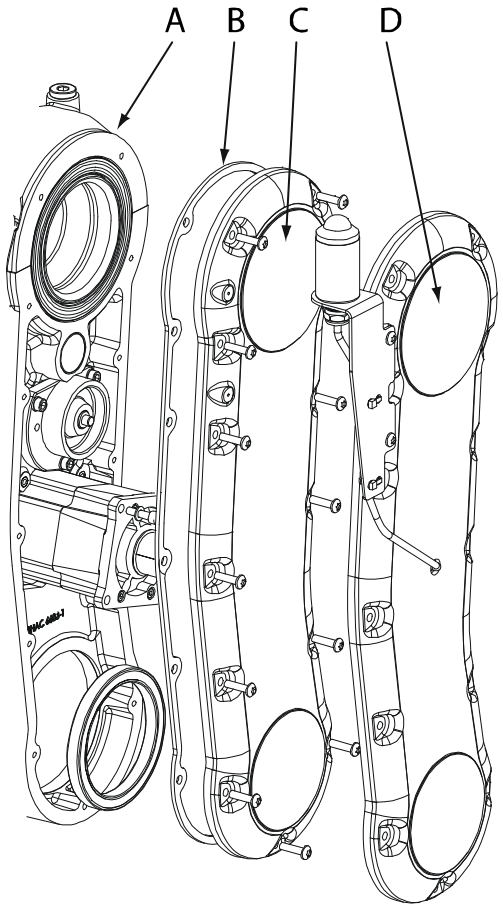
4.3.2 Replacement of complete upper arm
Continued

Removing the VK cover

The procedure below details how to remove the VK cover from the upper arm.



xx0200000433

A	Lower arm
B	Lower arm cover gasket
C	Cover l. arm, spare (without lamp unit)
D	Cover l. arm, spare (with lamp unit)

	Action	Note
1	Remove the lower arm cover by unscrewing its attachment screws.	
2	Tap the *VK cover* with a long blunt edged bar through the hole in the lower arm to press it out.	Make sure to press the circumference of the VK cover evenly to avoid damaging it. Shown in the figure in section *Location of upper arm on page 127*!
3	If the VK cover is damaged, it must be replaced on refitting.	Specified in section *Replacement of complete upper arm on page 127*.

Continues on next page

Refitting

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Check the *sealing ring* to see whether it is damaged. Replace if it is damaged!	Shown in the figure *Location of upper arm on page 127*! Art. no. specified in section *Required equipment on page 128*!
3	Lift the upper arm into position.	
4	Secure the upper arm with its six *attachment screws*.	Shown in the figure *Location of upper arm on page 127*! Tightening torque: 35 Nm ± 3 Nm
5	Gently pull all cables and hoses through the hole in the upper arm.	
6	Reconnect all connectors to motors 4-6.	Connectors • R3.MP4 • R3.MP5 • R3.MP6 • R3.FB4 • R3.FB5 • R3.FB6
7	Refit the *cable guide* with its two *attachment screws*.	Shown in the figure *Location of upper arm on page 127*!
8	Pull the *pressurized air connector* through the housing and secure it into fitting in the upper arm assembly.	Shown in the figure *Location of upper arm on page 127*!
9	Pull the *CS-connector* through the housing and secure it into the fitting in the upper arm assembly. Use a *special socket*to secure it.	Shown in the figure *Location of upper arm on page 127*! Art. no. specified in section *Required equipment on page 128*!
10	Reconnect any connector previously connected externally to the CS connector.	
11	Fit a new*VK-cover* to the upper arm/lower arm joint. Gently knock it into position.	Shown in the figure *Location of upper arm on page 127*! Art. no. specified in section *Required equipment on page 128*! Use a plastic mallet or similar.
12	Refit the rear cover armhousing with its four *attachment screws*.	Shown in the figure *Location of upper arm on page 127*!
13	Refit any brackets securing any exterior cabling to the upper arm with their attachment screws respectively.	

Continues on next page

4.3.2 Replacement of complete upper arm
Continued

	Action	Note
14	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
15	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.

DANGER

When performing the first test run after a service activity (repair, installation or maintenance), it is vital that:

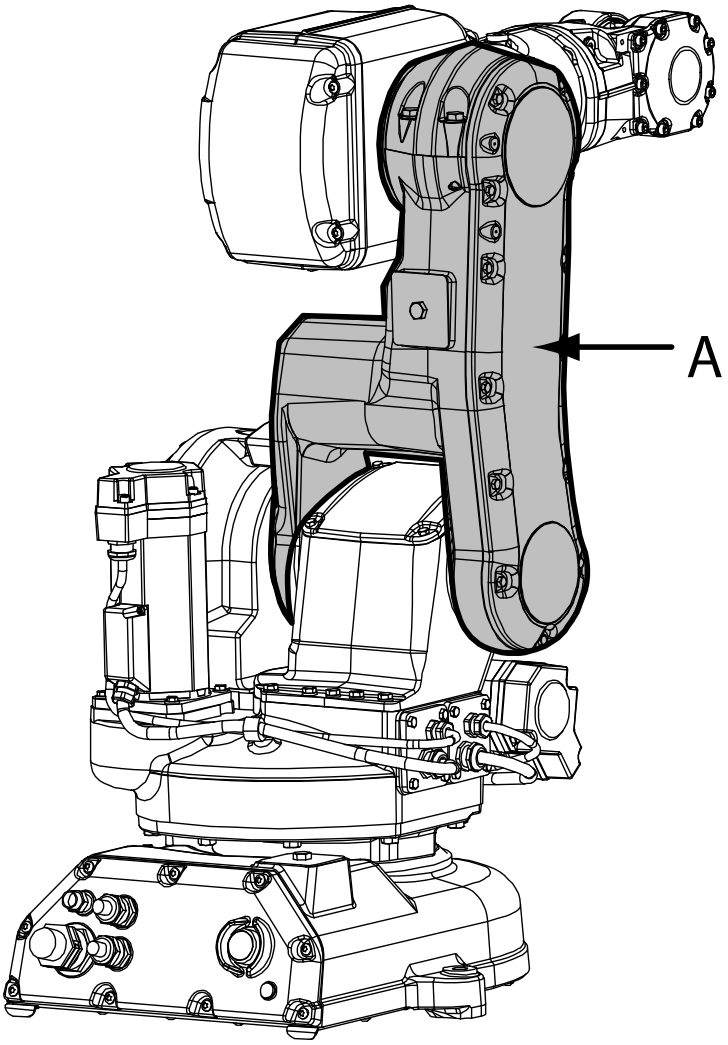
- all the service tools and other foreign objects are removed from the manipulator!
- all normal safety equipment is installed properly, e.g. FlexPendant enabling device.
- all personnel are standing at a safe distance from the manipulator, i.e. out of its reach behind safety fences, etc.
- special attention is paid to the function of the part that has been serviced.

4.3.3 Replacement of complete lower arm

Location of lower arm

The lower arm is located between upper arm and frame as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000469

A	Lower arm

Required equipment

Equipment	Spare part no.	Art. no.	Note
Lower arm, spare	3HAC034935-001		Standard and Foundry versions Includes all required bearings, oil and VK cover.

Continues on next page

4.3.3 Replacement of complete lower arm
Continued

Equipment	Spare part no.	Art. no.	Note
Lower arm, spare	3HAC034937-001		Clean room versions Includes all required bearings, oil and VK cover.
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Lifting device for lower arm			Lifting capacity >16 kg
Special socket		-	For fitting the CS-connector
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.

Removal, lower arm

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

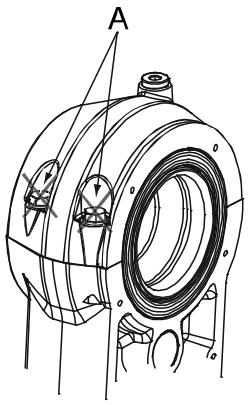
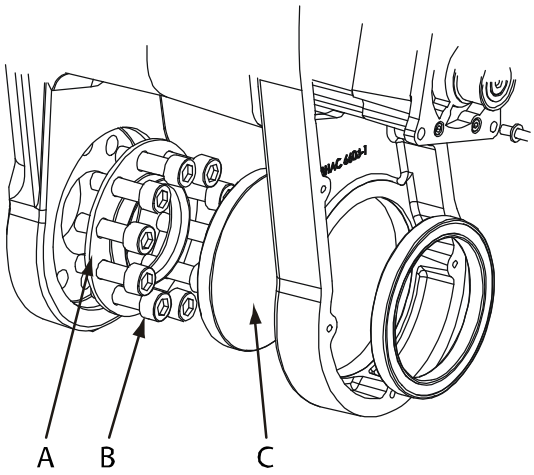
WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Information
1	**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 116*.	
2	Remove the console.	Detailed in section *Replacement of console on page 161*.

Continues on next page

	Action	Information
3	**DO NOT** under any circumstance unscrew the six screws on top of the lower arm! Doing so will cause the manipulator to require a complete rebuild!	 xx0300000101 Parts: • A: **DO NOT** touch these screws! (Note! Only 2 screws are shown.)
4	Remove the VK cover by pressing a screwdriver, or similar, through it and pulling.	 xx0300000097 Parts: • A: Washer • B: Lower arm attachment screws (10 pcs) • C: VK cover
5	Unscrew the*lower arm attachment screws*. Also remove the washer.	Shown in the figure above!
6	Raise the lifting device to remove the lower arm.	

Refitting, lower arm

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Fit the lifting device and lift the lower arm into position.	

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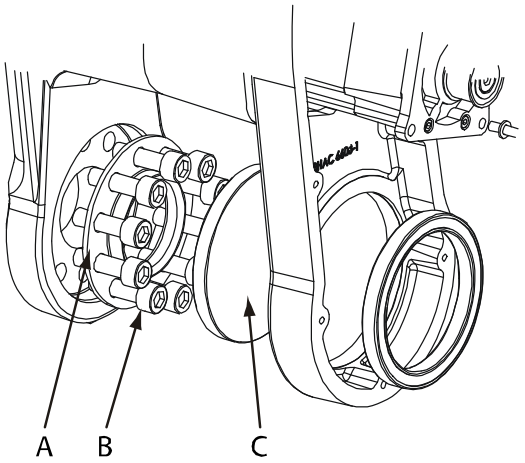
4.3.3 Replacement of complete lower arm

Continued

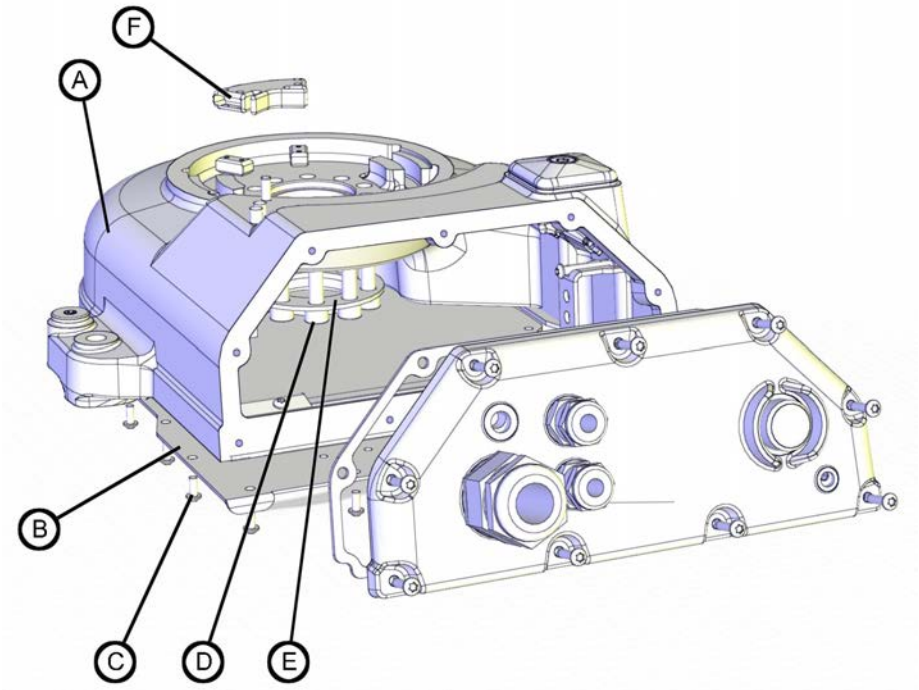
	Action	Note
3	Fit the lower arm to gearbox, axis 2, and secure it with its attachment screws and washers.	 xx0300000097 Parts: • A: Washer • B: Lower arm attachment screws (10 pcs) • C: VK cover Tightening torque: 35 Nm ± 3 Nm
4	Fit a new *VK cover* by gently tapping it into position.	Shown in the figure above!
5	Refit the console.	Detailed in section *Replacement of console on page 161*.
6	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
7	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General Calibration information is included in section, *Calibration information on page 211*

4.3.4 Replacement of base

Location of base

The base is located at the bottom of the robot as shown in the figure below.

A more detailed view of the components and its position may be found in *Spare part lists and exploded views*.



xx0200000423

A	Base
B	Bottom plate
C	Attachment screws, bottom plate (26 pcs)
D	Attachment screws and washers, gearbox/base (10 pcs each)
E	Damper, axis 1
F	Washer

Required equipment

Equipment	Spare part no.	Art. no.	Note
Base, spare	For spare part number, see: • *Spare part lists on page 243*.		Standard and Foundry versions. Includes parallel pin 3HAC 3785-2.
Base, spare	For spare part number, see: • *Spare part lists on page 243*.		Clean room versions. Includes parallel pin 3HAC 3785-2.

Continues on next page

4.3.4 Replacement of base
Continued

Equipment	Spare part no.	Art. no.	Note
Lifting slings		-	
Locking liquid			Loctite 574 For sealing the base to the gearbox 1-2.
Grease		3HAC042536-001	For lubricating the V-ring.
Isopropanol			For cleaning the mating surfaces.
Standard toolkit		-	Content is defined in section *Standard tools on page 239*.
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 116*.

Removal, base

The procedure below details how to remove the base from the robot.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**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 116*.	
3	Remove the axis 1 and 2 motors.	Detailed in sections: • *Replacement of motor, axis 1 on page 176* • *Replacement of motor, axis 2 on page 180*
4	Remove the cable harness.	Detailed in section *Replacement of cable harness on page 118*.

Continues on next page

	Action	Note
5	Remove the serial measurement unit.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
6	Remove the complete upper arm.	Detailed in section *Replacement of complete upper arm on page 127*.
7	Remove the complete lower arm.	Detailed in section *Replacement of complete lower arm on page 133*.
8	Unfasten the base from the installation site by removing the attachment bolts from the foundation.	
9	Fit the *lifting slings* to the robot, lift it and place it with the side of the lower arm downwards on a work bench.	
10	Remove the *bottom plate*.	Shown in the figure *Location of base on page 137*.
11	Secure the weight of the base and remove the *gearbox/base attachment screws and washer*.	Shown in the figure *Location of base on page 137*.
12	Separate the base from the gearbox unit.	

Refitting, base

The procedure below details how to refit the base to the robot.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
3	Place the robot with the side of the lower arm downwards on a workbench.	
4	Clean the mating surfaces between the base and the gearbox unit with isopropanol.	
5	Lubricate the mating surface on the base with Loctite 574.	
6	Lift the base to mounting position.	
7	Secure the base to the gearbox unit with the *gearbox/base attachment screws and washer*.	Shown in the figure *Location of base on page 137*. Tightening torque: 35 Nm ± 3Nm
8	Refit the *bottom plate* and secure it with its *attachment screws*.	Shown in the figure *Location of base on page 137*.
9	Turn the robot to stand upright.	

Continues on next page

4.3.4 Replacement of base
Continued

	Action	Note
10	Secure the base to the foundation.	Attachment bolt and tightening torque are specified in section *Attachment screws on page 56*
11	Refit the complete lower arm.	Detailed in section *Replacement of complete lower arm on page 133*.
12	Refit the complete upper arm.	Detailed in section *Replacement of complete upper arm on page 127*.
13	Refit motors 1 and 2.	Detailed in sections *Replacement of motor, axis 1 on page 176* and *Replacement of motor, axis 2 on page 180* respectively.
14	Refit the serial measurement unit.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
15	Refit the cable harness.	Detailed in section *Replacement of cable harness on page 118*.
16	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*  **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
17	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.
18	 **DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

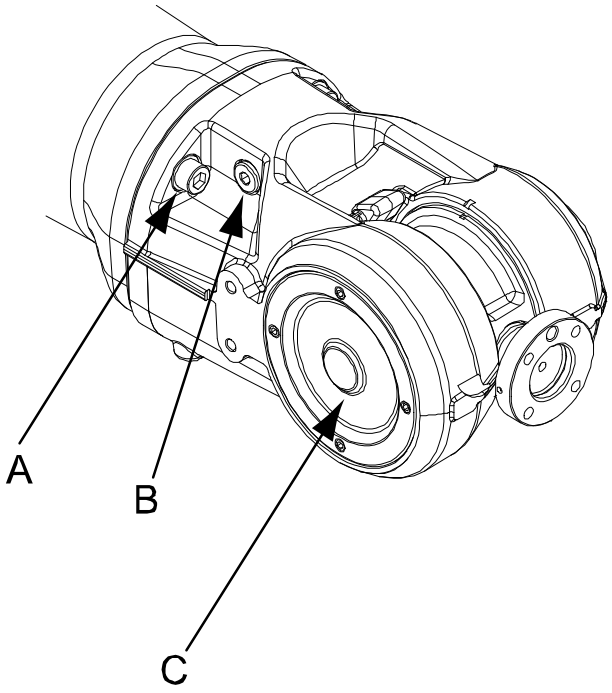
4.4 Upper arm

4.4.1 Replacing the wrist unit

Location of wrist unit

The wrist unit is located in the frontmost part of the upper arm.

A more detailed view of the components and its position may be found in *Spare parts - Spare part lists and exploded views*.



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A	Attachment screws, wrist unit (3 pcs)
B	Oil plug (only one shown)
C	Wrist unit

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Wrist Standard/Foundry			Standard and Foundry versions. O-ring sealing plate not included! **Note**! The wrist, standard/Foundry is **not** interchangeable with art. no. 3HAC 10475-1!
Wrist unit (CR)	3HAC 026569-003		Clean room versions O-ring sealing plate not included!

Continues on next page

4.4.1 Replacing the wrist unit

Continued

Equipment, etc.	Spare part no.	Art. no.	Note
O-ring sealing plate			Must be replaced. **Note!** The o-ring sealing plate is **not** interchangeable with art.no. 3HAC 7191-1!
Grease		3HAC 3537-1	For lubricating the o-ring sealing plate.
Standard toolkit		-	Content is defined in section *Standard tools on page 239*.
Arm		3HAC 9037-1	For adjusting the gear play, motor/pinion.
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 116*.

Removal, wrist unit

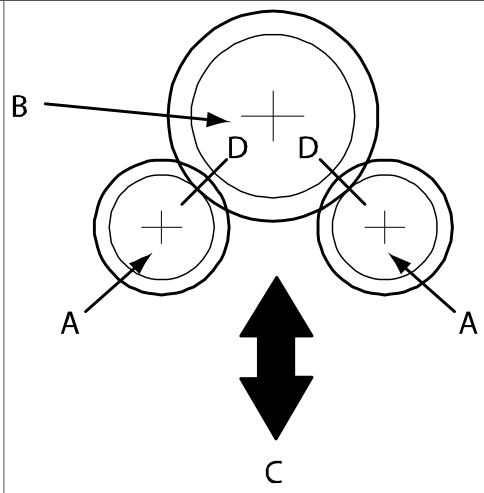
The procedure below details how to remove the complete wrist unit.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**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 116*.	
3	Drain the oil from the wrist unit.	Detailed in section *Changing the oil in axes 5 and 6 gearboxes on page 106*.
4	Remove the wrist unit by unscrewing its three attachment screws.	Shown in the figure in section *Location of wrist unit on page 141*.

Continues on next page

Refitting, wrist unit

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Move the robot to a position where the upper arm is vertical.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Lightly lubricate the o-ring sealingplate with *grease*.	Art. no. is specified in section *Required equipment on page 141*.
5	In order to release the brake, connect the 24 VDC power supply to motors:	Connect to connector R3.MP5 or 6: • +: pin 7 • -: pin 8
6	Fit the *o-ring sealingplate* and the *wrist unit* to the upper arm with the attachment screws, but do not tighten them.	*Do not* tighten its attachment screws! Use a new o-ring! Spare part no. is specified in *Required equipment on page 141*.
7	Fit the *arm* to the rear of the motor.	Art. no. is specified in section *Required equipment on page 141*.
8	Manually push the wrist to adjust the wrist in relation to the gear in the gearbox. The gear play must be checked according to subsections *Measuring the gear play, axis 5 on page 200* and *Measuring the gear play, axis 6 on page 202*	 xx0200000445 A Wrist unit, axes 5 and 6 gears B Drive shafts from motors, axes 5 and 6 gears C Adjustment direction D Gear play
9	Tighten the wrist unit attachment screws.	Tightening torque: 28 Nm.

Continues on next page

4.4.1 Replacing the wrist unit

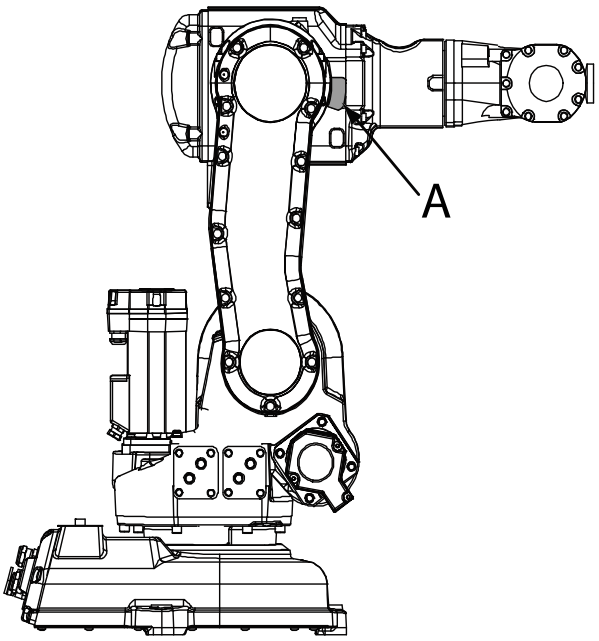
Continued

	Action	Note
10	Check the gear play by moving axes 5 and 6 by hand.	The gear play should be as decribed in subsection *Measuring the gear play, axis 5 on page 200* and *Measuring the gear play, axis 6 on page 202* to pass the test.
11	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 241*.
12	Refill the wrist unit with oil.	Detailed in section *Changing the oil in axes 5 and 6 gearboxes on page 106*.
13	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*  **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
14	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.
15	 **DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.4.2 Replacing the damper, axis 3

Location of damper, axis 3

A more detailed view of the components and its position may be found in *Spare part lists and exploded views*.



xx0200000427

A	Damper, axis 3

Required equipment

Equipment, etc.	Art. no.	Note
Damper, axis 3	3HAC 7881-1	
Standard toolkit		Content is defined in section *Standard tools on page 239*.

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 116*.

Removing the damper axis 3

Use this procedure to remove the damper.

	Action	Note
1	Run the robot to a position where it is best to enable access to the access 3 damper.	Shown in the figure *Location of damper, axis 3 on page 145*.

Continues on next page

4.4.2 Replacing the damper, axis 3
Continued

	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the damper by gently prying it from the cast tab.	

Refitting the damper axis 3

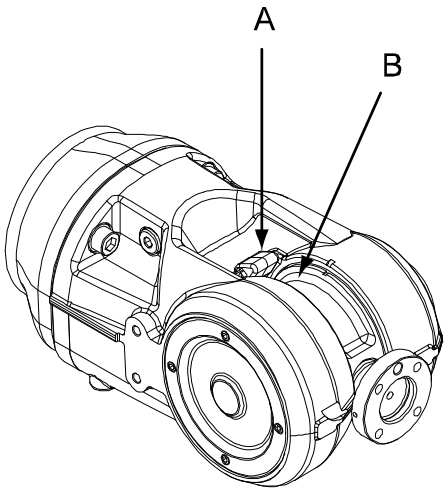
Use this procedure to refit the damper.

	Action	Note
1	Run the robot to a position where it is best to enable access to the location where the axis 3 damper is fitted.	Shown in the figure *Location of damper, axis 3 on page 145*.
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Refit the damper by gently pressing it onto the cast tab on the upper arm.	
4	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.4.3 Replacement of damper, axis 5

Location of damper, axis 5

The damper, axis 5, is located as shown in the figure below!



xx0600002806

A	Damper, axis 5
B	Recess

Required equipment

Equipment, etc.	Spare part no.	Note
Damper, axis 5	3HAB 8964-1	
Standard toolkit		Content is defined in section *Standard tools on page 239*.

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 116*.

Removal, damper axis 5

The procedure below details how to remove the damper, axis 5.

	Action	Note
1	Run the robot to a position that enables the end of the *damper* to be pushed into the *recess* in the wrist unit.	Shown in the figure *Location of damper, axis 5 on page 147*.

Continues on next page

4.4.3 Replacement of damper, axis 5
Continued

	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Unhook the end of the damper, and push it into the recess.	
4	Manually move the wrist (robot axis 5) away from the damper to pull it out.	

Refitting, damper axis 5

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

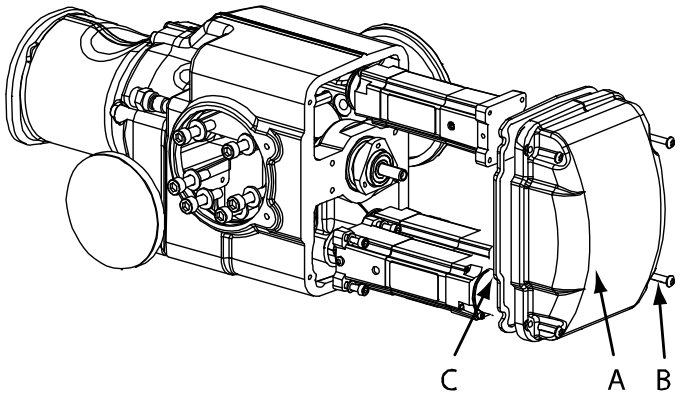
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Push the end of the damper into the gap between the wrist unit and upper arm.	Make sure the damper is turned the correct way!
3	Manually move the wrist (robot axis 5) in order to pull the damper into position.	
4	Fold out the damper hooks to secure it in position.	
5	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.4.4 Replacement of cover, arm housing

Location of cover, armhousing

The cover, armhousing is located on the rear of the upper arm as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



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A	Cover, arm housing
B	Attachment screws, cover, armhousing
C	Gasket, upper arm cover

Required equipment

Equipment, etc.	Spare part. no.	Art. no.	Note
Cover, arm housing	3HAC 10473-1		Standard and Foundry version Includes gasket 3HAC 7867-1
Cover, arm housing	3HAC 10473-3		Clean Room versions Includes gasket 3HAC 7867-1
Gasket, upper arm cover		3HAC 7867-1	
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
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 116*.

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4.4.4 Replacement of cover, arm housing

Continued

Removal

The procedure below details how to remove the cover, armhousing.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note
1	**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 116*.	
2	Manually, run the robot to a position that enables access to the rear of the upper arm.	
3	Remove the *cover, armhousing* by unscrewing its *attachment screws*.	Shown in the figure *Location of cover, armhousing on page 149*. NOTE! Do not damage the gasket inside the cover!

Refitting

The procedure below details how to refit cover, armhousing.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	

Continues on next page

	Action	Note
2	Manually, run the robot to a position that enables access to the rear of the upper arm.	Shown in the figure *Location of cover, armhousing on page 149*.
3	Make sure the *gasket* inside the *cover, arm housing* has not been damaged.	Replace if damaged. Shown in the figure *Location of cover, armhousing on page 149*.
4	Secure the cover, arm housing to the upper arm with its attachment screws.	
5	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

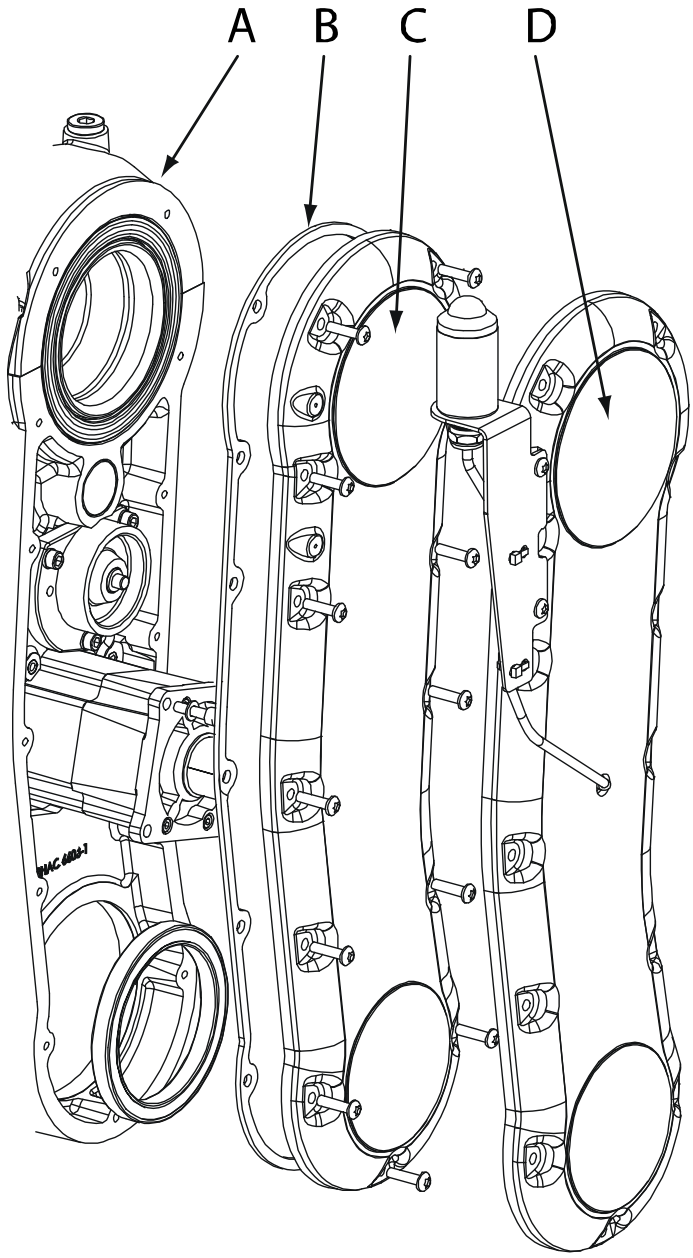
4.5 Lower arm

4.5.1 Replacement of lower arm cover and gasket

Location of lower arm cover and gasket

The lower arm cover and gasket are located as shown in the figure below.

A more detailed view of the components and its position may be found in section *Spare part lists on page 243*.



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A	Lower arm
B	Gasket lower-arm cover

Continues on next page

C	Cover l. arm, spare (without lamp unit)
D	Cover l. arm, spare (with lamp unit)

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Lower arm	For spare part number, see: • *Spare part lists on page 243*.		
Cover, lover arm, spare, Std/F	3HAC 10471-1		Standard and Foundry versions No lamp unit included Includes gasket 3HAC 7869-1
Cover, lower arm, spare, CR	3HAC 10471-3		Clean room versions No lamp unit included Includes gasket 3HAC 7869-1
Gasket lower-arm cover	3HAC 7869-1		
Isopropanol		1177 1012-208	For cleaning sealing surfaces
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
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 116*.

Removal, lower arm cover and gasket

The procedure below details how to remove the lower arm cover and gasket.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Continues on next page

4.5.1 Replacement of lower arm cover and gasket
Continued

	Action	Note
1	**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 116*.	
2	Remove the *lower arm cover* by unscrewing its attachment screws.	Shown in the figure *Location of lower arm cover and gasket on page 152*.
3	If the gasket is to be replaced, proceed below! Use a knife to gently remove the old gasket from the cover.	
4	Clean the sealing surface with *isopropanol*, making sure it is completely clean and free from scratches and burrs.	Art. no. specified in section *Required equipment on page 153*.

Refitting, lower arm cover and gasket

The procedure below details how to refit the lower arm cover and gasket.

WARNING

Please observe the following before commencing any repair work on the manipulator:

- - Motors and gears are *HOT* after running the robot! Burns may result from touching the motors or gears!
- - Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!
- - Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, e.g. to secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	If the *Gasket lower-arm cover* is to be replaced, proceed below. If not, see further down!	Shown in the figure *Location of lower arm cover and gasket on page 152*.
3	Remove the protective backing from the self-adhesive gasket and fit it onto the cover sealing surface.	Make absolutely sure it is correctly located!
4	Refit the *lower arm cover* with its attachment screws.	Shown in the figure *Location of lower arm cover and gasket on page 152*.

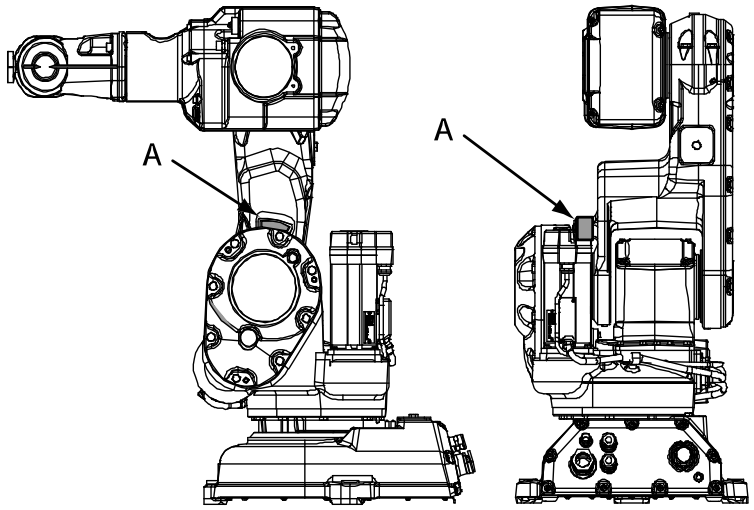
Continues on next page

	Action	Note
5	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

4.5.2 Replacing the damper, axis 2

Location of damper, axis 2

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000426

A	Damper, axis 2

Required equipment

Equipment, etc.	Art. no.	Note
Damper, axis 2	3HAC 7880-1	
Standard toolkit	-	Content is defined in section *Standard tools on page 239*.
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 116*.

Continues on next page

Removing the damper

Use this procedure to remove the damper.

	Action	Note
1	**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 116*.	
2	Run the robot to a position where it is best to enable access to the attachment screw of the damper.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove the damper by unscrewing the attachment screw and washer.	

Refitting the damper

Use this procedure to refit the damper.

	Action	Note
1	Run the robot to a position where it is best to enable access to the attachment screw of the damper.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Secure the damper with the attachment screw and washer.	1 pc: M6 x 16.
4	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

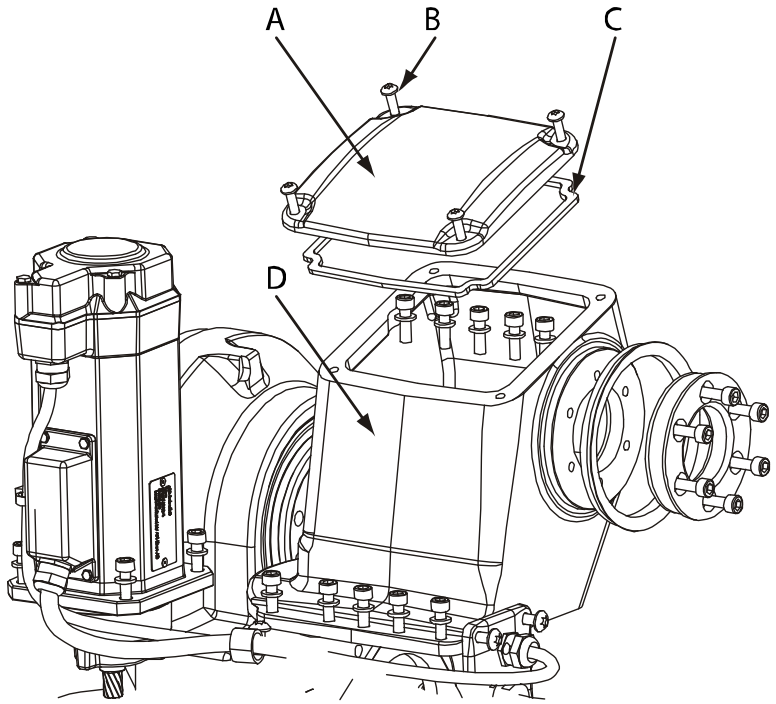
4.6 Frame and base

4.6.1 Replacement of cover, console

Location of cover, console

The cover, console is located on top of the console as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000462

A	Cover, console
B	Attachment screws, cover, console (4 pcs)
C	Gasket
D	Console

Required equipment

Equipment, etc.	Spare part. no.	Art. no.	Note
Cover, console, spare	3HAC 10472-1		Standard and Foundry version Includes gasket 3HAC 7868-1
Cover, console, spare	3HAC 10472-3		Clean Room versions Includes gasket 3HAC 7868-1
Gasket, cover console		3HAC 7868-1	

Continues on next page

Equipment, etc.	Spare part. no.	Art. no.	Note
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
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.

Removal

The procedure below details how to remove the cover, console.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note
1	**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 116*.	
2	Manually, run the robot to a position that enables access to the top of the *console*.	Shown in the figure *Location of cover, console on page 158*.
3	Remove the *cover, console* by unscrewing its *attachment screws*.	NOTE! Do not damage the gasket inside the cover!

Continues on next page

4.6.1 Replacement of cover, console
Continued

Refitting

The procedure below details how to refit cover, console.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

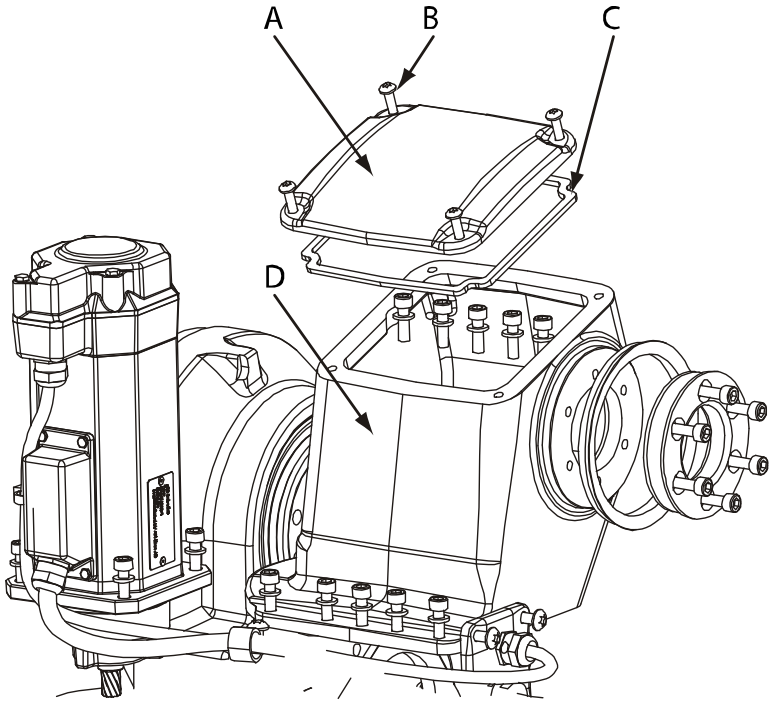
	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Manually, run the robot to a position that enables access to the top of the *console*.	Shown in the figure *Location of cover, console on page 158*.
3	Make sure the *gasket* inside the *cover, console* has not been damaged.	Replace if damaged. Shown in the figure *Location of cover, console on page 158*.
4	Secure the cover, console to the console with its attachment screws.	
5	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

4.6.2 Replacement of console

Location of console

The console is located on top of gearbox, axes 1-2 as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000462

A	Cover, console
B	Attachment screws, cover, console (4 pcs)
C	Gasket
D	Console

Required equipment

Equipment, etc.	Spare part. no.	Art. no.	Note
Console, spare	3HAC 10478-1		Standard and Foundry version
Console, spare	3HAC 10478-3		Clean Room versions
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
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

4.6.2 Replacement of console
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 116*.

Removal

The procedure below details how to remove the cover, console.

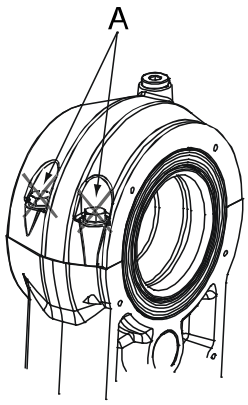
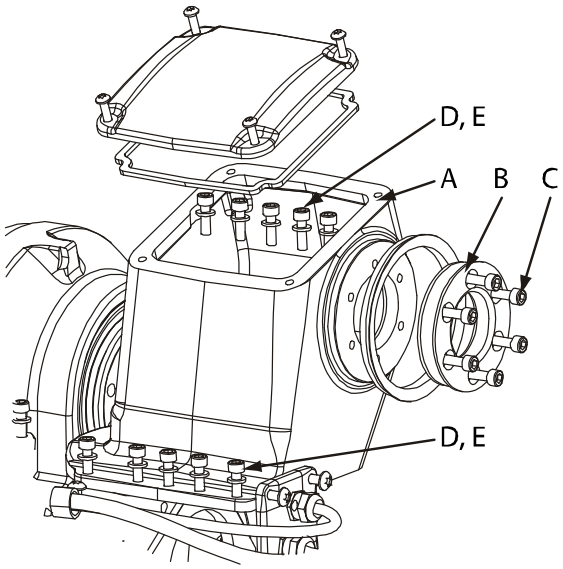
WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note/Illustration
1	**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 116*.	
2	Remove the cable harness.	Detailed in section *Replacement of cable harness on page 118*.
3	Remove the serial measurement board.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
4	Remove the complete upper arm.	Detailed in section *Replacement of complete upper arm on page 127*.

Continues on next page

	Action	Note/Illustration
5	**DO NOT** under any circumstance unscrew the six screws on top of the lower arm! Doing so will cause the manipulator to require a complete rebuild!	 xx0300000101 Parts: • A: **DO NOT** touch these screws! (Note! Only two screws shown!)
6	Remove the motor of axis 3.	Detailed in section *Replacement of motor and timing belt, axis 3 on page 184*.
7	Attach the lifting device to the lower arm.	
8	Remove the bearing hub by unscrewing its attachment screws.	 xx0300000096 Parts: • A: Console • B: Bearing hub • C: Bearing hub attachment screws (6 pcs) • D: Console attachment screws (10 pcs) • E: Washers (10 pcs)
9	Remove the *console* by unscrewing its *attachment screws*.	Shown in the figure above!

Continues on next page

4.6.2 Replacement of console
Continued

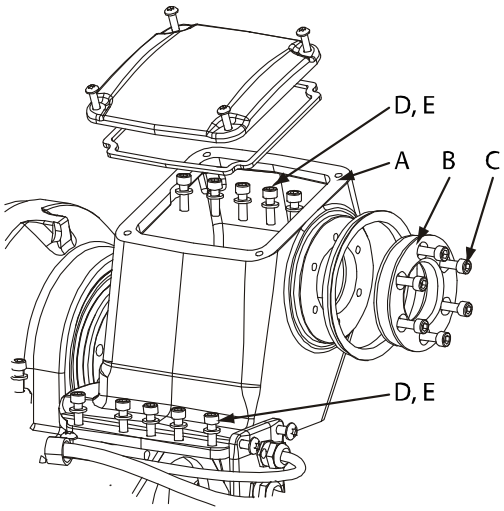
Refitting

The procedure below details how to refit cover, console.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note/Illustration
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Refit the console and secure it with its attachment screws and washers.	 xx0300000096 Parts: • A: Console • B: Bearing hub • C: Bearing hub attachment screws (6 pcs) • D: Console attachment screws (10 pcs) • E: Washers (10 pcs) Tightening torque: 11 Nm ± 1 Nm
3	Refit the *bearing hub* and secure it with its *attachment screws*.	Shown in the figure above! Tightening torque: 15 Nm ± 1 Nm
4	Refit the complete upper arm.	Detailed in section *Replacement of complete upper arm on page 127*.
5	Refit motor 3 and timing belt.	Detailed in section *Replacement of motor and timing belt, axis 3 on page 184*.

Continues on next page

	Action	Note/Illustration
6	Refit the serial measurement board.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
7	Refit the cable harness.	Detailed in section *Replacement of cable harness on page 118*.
8	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
9	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.

4.6.3 Replacing the serial measurement unit and the battery pack

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.

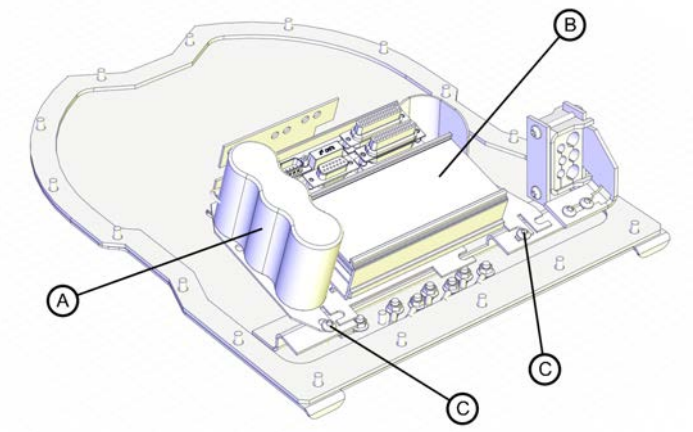
WARNING

See *Hazards related to batteries on page 33*.

Location of serial measurement unit and battery pack

The serial measurement unit and battery pack are located inside the manipulator base as shown in the figure below (different layouts are shown).

DSQC 633A

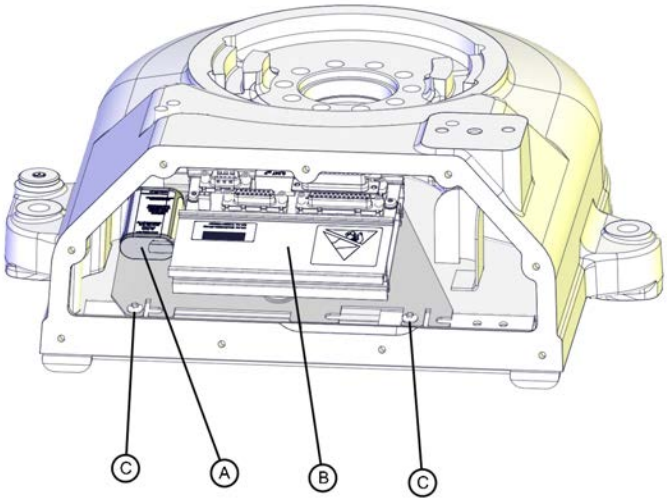


xx1200000831

A	Battery pack with 2-pole battery contact
B	Serial measurement board (SMB), DSQC 633A
C	SMB attachment screws (2 pcs)

Continues on next page

RMU101



xx1300000279

A	Battery pack RMU with 3-pole battery contact
B	Serial measurement board (SMB), RMU 101
C	Attachment screws (2 pcs)

Required equipment

All spare parts are listed in *Spare parts* in *Product manual, spare parts - IRB 140*.

Note

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

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

Equipment, etc.	Note
Serial measurement unit	See *Spare parts* in *Product manual, spare parts - IRB 140*.
Battery pack	See *Spare parts* in *Product manual, spare parts - IRB 140*.
Cable tie	Indoors
Gasket base-cover	Replace only if required!
Standard toolkit, IRB 140	Content is defined in section *Standard tools on page 239*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Circuit diagram	See chapter *Circuit diagram on page 245*.

Continues on next page

4.6.3 Replacing the serial measurement unit and the battery pack
Continued

Removal

The procedure below details how to remove the serial measurement unit and battery pack.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

DANGER

Follow these instruction to prevent the unit to be damaged from ESD:

- The unit is sensitive to electrostatic discharge. It will be destroyed if subjected to electrostatic voltages.
- Before handling, make sure you are grounded through a special ESD wrist bracelet or similar.

CAUTION

This component is classified as hazardous waste and must be disposed of accordingly!

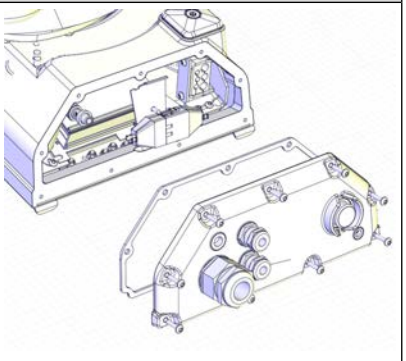
If in doubt of the correct disposal procedure, please contact your local environmental authority!

CAUTION

The cable packs are sensitive to mechanical damage! They must be handled with care, especially the connectors, in order to avoid damaging them!

	Action	Note
1	**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 116*.	
2	Set the robot system to MOTORS OFF state.	This will simplify calibration of the robot after replacement since no coarse calibration will be required.

Continues on next page

	Action	Note
3	Remove the *rear cable cover* from the base of the robot by unscrewing its attachment screws.	 xx1200000830
4	Remove the *serial measurement unit* by unscrewing its *attachment screws*. The removal is simplified by pushing the unit to the side and then pulling it backwards.	Shown in the figure *Location of serial measurement unit and battery pack on page 166*!
5	If only the battery is to be replaced, disconnect the cables to the battery only! Disconnect all connectors from the serial measurement unit.	Connectors • R2.SMB • R2.FB1-3 • R2.FB4-6 • R2.G
6	Lift the board out.	
7	If the battery pack is to be replaced, proceed below! Cut the cable tie and disconnect the battery connector to remove the *battery pack*. Battery includes protection circuits. Replace it only with the specified spare part in the refitting instruction or with an ABB approved eqvivalent.	Shown in the figure *Location of serial measurement unit and battery pack on page 166*!

Refitting

The procedure below details how to refit the serial measurement unit and battery pack.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Continues on next page

4.6.3 Replacing the serial measurement unit and the battery pack
Continued

DANGER

Follow these instruction to prevent the unit to be damaged from ESD:

- The unit is sensitive to electrostatic discharge. It will be destroyed if subjected to electrostatic voltages.
- Before handling, make sure you are grounded through a special ESD wrist bracelet or similar.

CAUTION

This component is classified as Hazardous waste and must be disposed of accordingly!

If in doubt of the correct disposal procedure, please contact your local environmental authority!

CAUTION

The cable packs are sensitive to mechanical damage! They must be handled with care, especially the connectors, in order to avoid damaging them!

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Connect the new battery pack to the serial measurement unit and secure it with a cable tie.	
3	Reconnect all connectors to the unit.	Connectors • R2.SMB • R2.FB1-3 • R2.FB4-6 • R2.G
4	Place the serial measurement unit *in position inside the manipulator base* and secure it with its four *attachment screws*.	Shown in the figure *Location of serial measurement unit and battery pack on page 166*!
5	Make sure the gasket sealing the *rear cable cover* has not been damaged. Replace the gasket if required.	Shown in the figure *Location of serial measurement unit and battery pack on page 166*! Art. no. specified in section *Required equipment on page 167*!
6	Making sure all cables are correctly located behind the *rear cable cover*, refit it into position. Make sure no cables or other equipment fitted behind the cover get pinched by the cover.	Shown in the figure *Location of serial measurement unit and battery pack on page 166*!
7	Secure the rear cable cover to the base of the robot with its *attachment screws*.	Shown in the figure *Location of serial measurement unit and battery pack on page 166*!

Continues on next page

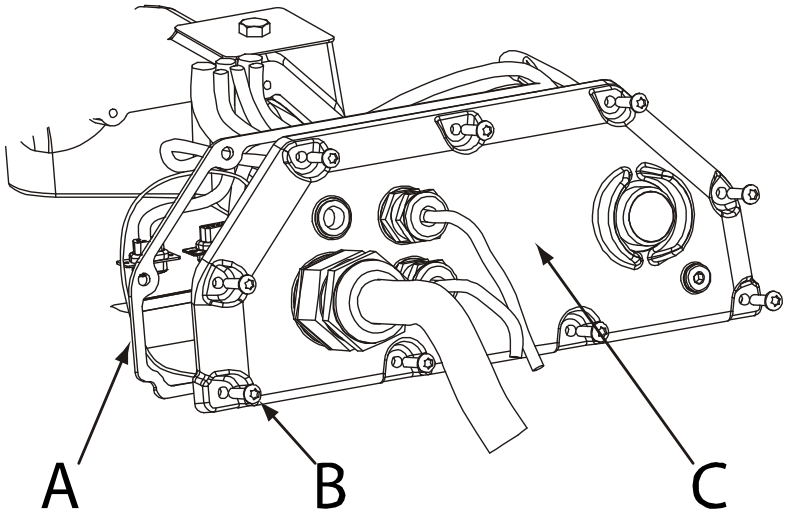
	Action	Note
8	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
9	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.

4.6.4 Replacement of control cable

Location of control cable

The control cable is located on the rear of the manipulator base as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000467

A	Gasket, base-cover
B	Attachment screws and washers (9 pcs each), control cable
C	Control cable, spare

Required equipment

Equipment, etc.	Spare part. no.	Art. no.	Note
Control cable, spare	3HAC 10476-1		3 m Standard and Foundry versions Cover gasket included
Control cable, spare	3HAC 10477-1		7 m Standard and Foundry versions Cover gasket included
Control cable, spare	3HAC 11331-1		15 m Standard and Foundry versions Cover gasket included
Control cable, spare	3HAC 13090-1		22 m Standard and Foundry versions Cover gasket included

Continues on next page

Equipment, etc.	Spare part. no.	Art. no.	Note
Control cable, spare	3HAC 13089-1		30 m Standard and Foundry versions Cover gasket included
Control cable, spare	3HAC 10476-4		3 m Clean Room versions Cover gasket included
Control cable, spare	3HAC 10477-2		7 m Clean Room versions Cover gasket included
Control cable, spare	3HAC 11331-2		15 m Clean Room versions Cover gasket included
Control cable, spare	3HAC 13090-2		22 m Clean Room versions Cover gasket included
Control cable, spare	3HAC 13089-2		30 m Clean Room versions Cover gasket included
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
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.

Removal

The procedure below details how to remove the control cable.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

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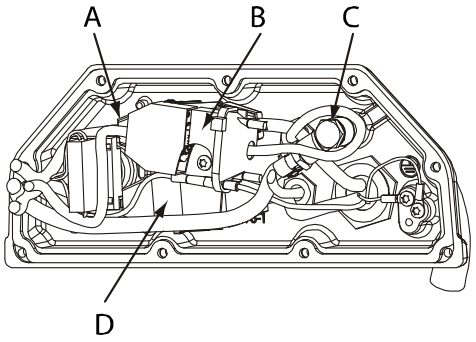
4.6.4 Replacement of control cable

Continued

	Action	Note
1	**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 116*.	
2	Make sure the robot system has been switched off, and that no power is supplied to the manipulator.	
3	Remove the *Control cable, spare* by unscrewing its attachment screws.	Shown in the figure *Location of control cable on page 172*. Make sure the gasket does not get damaged!
4	Disconnect connectors inside the manipulator base.	 xx0300000090 Connectors: • A: R1.MP1-3 • B: R1.CS • C: Air hose • D: R1.MP4-6
5	Pull the cable out of the manipulator base.	
6	Disconnect the connectors from the control cabinet.	

Refitting

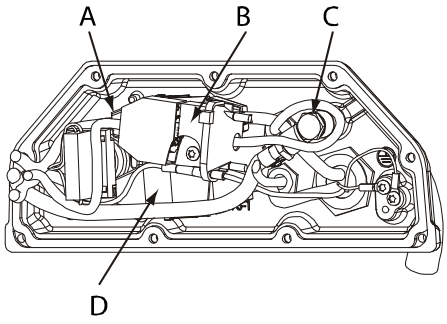
The procedure below details how to refit control cable.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Continues on next page

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Place the *control cable* on the floor with the manipulator base cover close to the manipulator.	Shown in the figure *Location of control cable on page 172*.
3	Connect the connectors inside the manipulators base.	 xx0300000090 Connectors: • A: R1.MP1-3 • B: R1.CS • C: Air hose • D: R1.MP4-6
4	Fit a *new gasket* when refitting the cover.	Included in the spare part
5	Fit the cover onto the manipulator base and secure it with its *attachment screws*.	Shown in the figure *Location of control cable on page 172*.
6	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

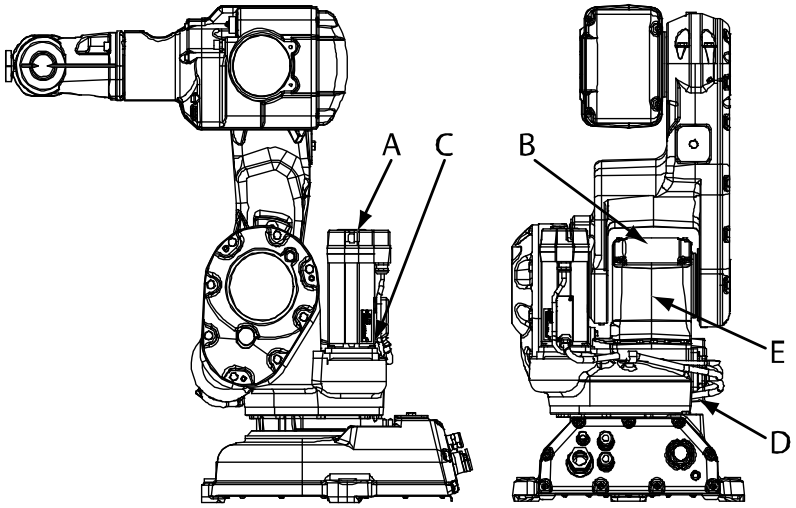
4.7 Motors

4.7.1 Replacement of motor, axis 1

Location of motor axis 1

The motor axis 1 is located on the rear of the manipulator as shown in the figure below:

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000407

A	Motor, axis 1
B	Cover for connector access
C	Motor attachment screws (4 pcs)
D	Cable gland attachment screws (4 pcs)
E	Console

Required equipment

Equipment, etc.	Art no.	Note
Rot. ac motor with pinion	For spare part number, see: • *Spare part lists on page 243*.	
O-ring	21522012-426	Must be replaced when replacing motor! Included in the spare parts motor kits
Grease	3HAC042536-001	Used to lubricate the o-ring
Standard toolkit	3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Arm	3HAC9037-1	For adjusting the gear play, motor/pinion

Continues on next page

Equipment, etc.	Art no.	Note
Power supply		24 VDC, max. 1,5 A For releasing the brakes
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *Circuit diagram on page 245*.

Removal

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

CAUTION

If the manipulator normally works in an inverted position, it must be removed from this position and placed on the floor before the work detailed in this instruction may be carried out!

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Note

Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

	Action	Note
1	**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 116*.	
2	Remove the *cover for connector access* on top of the motor by unscrewing its four attachment screws.	Shown in the figure *Location of motor axis 1 on page 176*. Detailed in section *Replacement of cover, console on page 158*.

Continues on next page

4.7.1 Replacement of motor, axis 1

Continued

	Action	Note
3	Disconnect the motor 1 connectors inside the console.	Connectors: • R3.MP1 • R3.FB1
4	Cut any cable ties and remove any brackets securing the cables.	
5	Remove the cable gland by removing its *attachment screws*, and pull the cables out from the console.	Shown in the figure *Location of motor axis 1 on page 176*.
6	In order to release the brakes, connect the 24 VDC power supply:	Connect to connector R3.MP1 • +: pin 7 • -: pin 8
7	Remove the motor by unscrewing its four *attachment screws* and plain washers.	Shown in the figure *Location of motor axis 1 on page 176*.
8	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	
9	Remove the motor by gently lifting it straight up.	

Refitting

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

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Note

Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Make sure the mating surfaces on the motor and the gearbox are clean and free from burrs.	
3	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the *o-ring* with *grease*.	Art. no. is specified in section *Required equipment on page 176*.
4	In order to release the brake, connect the 24 VDC power supply:	Connect to connector R2.MP1 • +: pin 7 • -: pin 8

Continues on next page

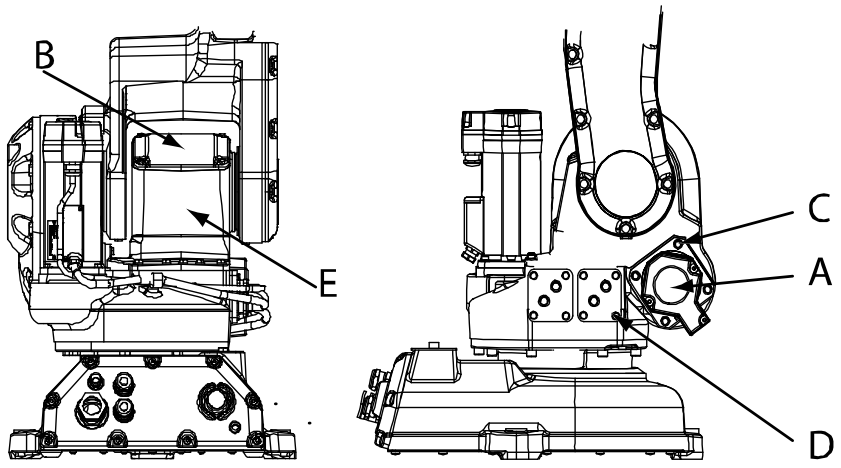
	Action	Note
5	Fit the motor, making sure the motor pinion is properly mated to gearbox 1.	Make sure the motor is turned the right way, i.e. connections rearwards. Make sure the motor pinion does not get damaged!
6	Fit the motor with four attachment screws and plain washers.	Tightening torque: approx 2 Nm
7	Fit the *Arm* to the end of the motor shaft.	Art. no. is specified in section *Required equipment on page 176*.
8	Adjust the motor in relation to the gear in the gearbox. Use the Arm tool to wiggle the motor shaft back and forth to feel the play.	There should be a barely noticable gear play.
9	Tighten the motor attachment screws.	Tightening torque: approx 11 Nm ± 1 Nm
10	Disconnect the brake release voltage.	
11	Make sure the *cable gland gasket* has not been damaged. Replace, if it has.	Art. no. is specified in section *Required equipment on page 176*.
12	Push the cables into the console, and refit the cable gland with its attachment screws.	
13	Perform a *leak-down test*.	Detailed in section *Performing a leak-down test on page 241*.
14	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
15	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.
16	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.7.2 Replacement of motor, axis 2

Location of motor axis 2

The motor axis 2 is located on the front of the robot as shown in the figure.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000408

A	Motor, axis 2
B	Cover for connector access
C	Motor attachment screws (4 pcs)
D	Cable gland attachment screws (4 pcs)
E	Console

Required equipment

Equipment, etc.	Art. no.	Note
Rot. ac motor with pinion	For spare part number, see: • *Spare part lists on page 243*	
O-ring	21522012-426	Must be replaced when replacing motor.
Locking liquid		Loctite 574
Isopropanol	-	For cleaning mating surfaces.
Standard toolkit	-	Content is defined in section *Standard tools on page 239*.
Rotation tool, motor	3HAC9037-1	For adjusting the gear play, motor/pinion
Power supply	-	24 VDC, 1.5 A. For releasing the brakes.

Continues on next page

Equipment, etc.	Art. no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See chapter *Circuit diagram on page 245*.

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 116*.

Removal, motor axis 2

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**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 116*.	
4	Remove the *cover for connector access* on top of the motor by unscrewing its four attachment screws.	Shown in the figure *Location of motor axis 2 on page 180*.
5	Disconnect the motor connectors inside the console.	Connectors: • R3.MP2 • R3.FB2
6	Cut any cable ties and remove any brackets or clamps securing the cables.	
7	Remove the cable gland by removing its *attachment screws*, and pull the cables out from the console.	Shown in the figure *Location of motor axis 2 on page 180*.
8	**DANGER** Secure the weight of the lower arm properly before releasing the brakes of motor, axis 2! When releasing the holding brakes of the motor, the lower arm will be movable and may fall down!	

Continues on next page

4.7.2 Replacement of motor, axis 2
Continued

	Action	Note
9	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP2 • +: pin 7 • -: pin 8
10	**WARNING** 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.	
11	Remove the motor by unscrewing its four *attachment screws* and plain washers.	Shown in the figure *Location of motor axis 2 on page 180*.
12	Remove the motor by gently pulling it out, making sure the motor pinion does not get damaged while moving it away from the gear.	
13	Disconnect the brake release voltage.	
14	Remove any remaining oil from the gearbox by siphoning it off.	

Refitting, motor axis 2

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Make sure the mating surfaces on the motor and the gearbox are clean and free from burrs. If necessary, clean the surfaces with isopropanol.	
3	Replace the *o-ring* if damaged. 1 Apply enough Loctite 574 to the motor groove. 2 Refit the *o-ring*. Make sure the *o-ring* on the circumference of the motor is seated properly.	Art. no. is specified in section *Required equipment on page 180*.
4	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP2: • +: pin 7 • -: pin 8
5	Remove the *motor cover* from top of the motor.	Shown in the figure *Location of motor axis 2 on page 180*.
6	Fit the *rotation tool* to the end of the motor shaft.	Art. no. is specified in section *Required equipment on page 180*.
7	Fit the motor, making sure the motor pinion is properly mated to gearbox 2. Use the rotation tool to rotate the motor pinion, when mating it to the gear.	Make sure the motor is turned the right way, i.e. connections rearwards. Make sure the motor pinion does not get damaged!
8	Secure the motor with four attachment screws and plain washers, but do not tighten yet.	Tightening torque: approx 2 Nm.

Continues on next page

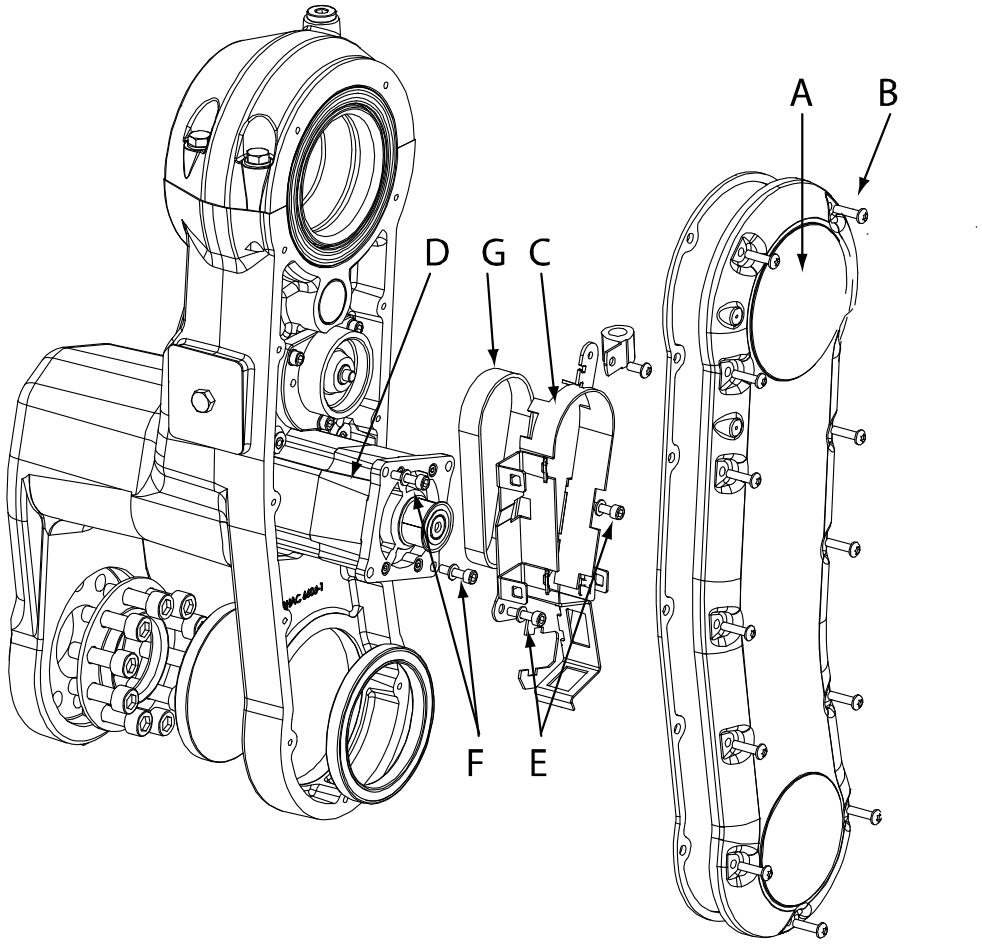
	Action	Note
9	Adjust the motor in relation to the gear in the gearbox. Use the rotation tool to wiggle the motor shaft back and forth to feel the play. Tap with a plastic mallet.	There should be a barely noticable gear play.
10	Refit the motor cover to the top of the motor. Be careful not to damage the cables!	
11	Tighten the motor attachment screws.	Tightening torque: approx 11 Nm ± 1 Nm
12	Disconnect the brake release voltage.	
13	Make sure the *cable gland cover gasket* has not been damaged. Replace if it has.	Art. no. is specified in section *Required equipment on page 180*.
14	Push the cables into the console, and refit the cable gland with its attachment screws.	
15	Refit all cable ties and brackets.	
16	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 241*.
17	Refill the gearbox with oil.	See, *Technical reference manual - Lubrication in gearboxes*.
18	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
19	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.
20	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.7.3 Replacement of motor and timing belt, axis 3

Location of motor axis 3

The motor axis 3 is located behind the lower arm cover on the right hand side of the manipulator as shown in the figure below.

For a more detailed view of the components and its position, see *Spare part lists on page 243*.



xx0200000448

A	Lower arm cover
B	Attachment screws, lower arm cover (13 pcs)
C	Belt shield
D	Motor 3
E	Attachment screws, belt shield (3 pcs)
F	Attachment screws, motor 3 (4 pcs)
G	Belt

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Rotating AC motor with pinion	3HAC7866-1 3HAC021756-001		
Timing belt		3HAC6793-1	
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 245*.

Removing the motor, axis 3

Use this procedure to remove the motor, axis 3.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Note

Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

	Action	Note
1	**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 116*.	
2	Remove any equipment hindering access to the *lower arm cover*.	Shown in the figure in section *Location of motor axis 3 on page 184*.
3	Remove the lower arm cover by unscrewing its *attachment screws*.	Shown in the figure in section *Location of motor axis 3 on page 184*.

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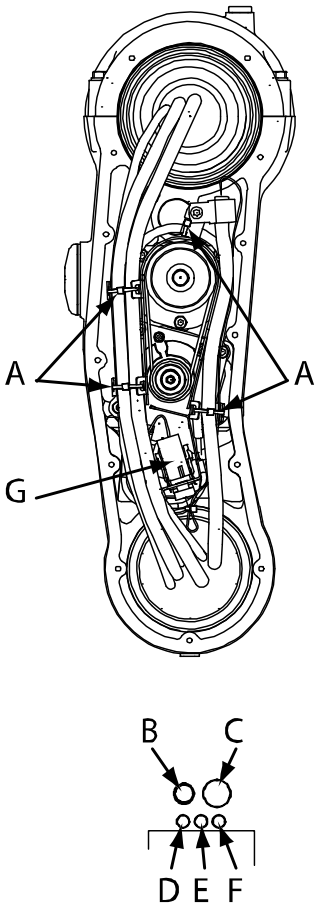
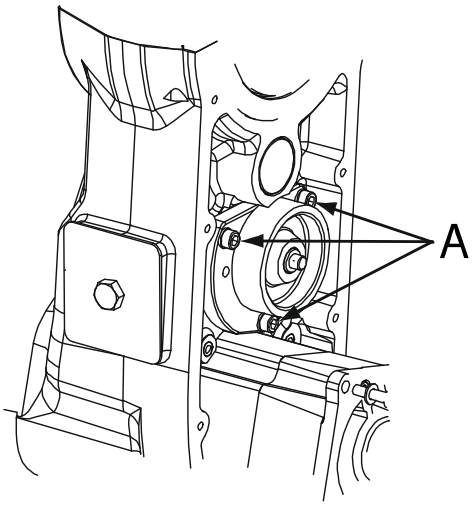
4.7.3 Replacement of motor and timing belt, axis 3

Continued

	Action	Note
4	Cut the cable ties to simplify accessing the motor.	 xx0200000449 • A: Cable ties • B: Pressurized air hose • C: Power cables, axes 4, 5 and 6 • D: Customer cables, signal • E: Signal cables, axes 4, 5 and 6 • F: Signal cable, axis 3 • G: Connectors R3.MP3 and R3.FB3
5	Disconnect motor connectors.	Connectors: • R3.MP3 • R3.FB3 • R3.H1 (if Safety lamp is fitted) • R3.H2 (if Safety lamp is fitted)

Continues on next page

	Action	Note
6	**DO NOT** under any circumstance unscrew the three screws securing the belt wheel! Doing so will cause the manipulator to require a complete rebuild!	 xx0300000102 Parts: • **DO NOT** touch these screws! (3 pcs)
7	Remove the *belt shield* by unscrewing its two *attachment screws*.	Shown in the figure in section *Location of motor axis 3 on page 184*.
8	Remove the remaining motor *attachment screws*.	Shown in the figure in section *Location of motor axis 3 on page 184*.
9	Remove the belt.	Shown in the figure in section *Location of motor axis 3 on page 184*.
10	Remove the *motor*.	Shown in the figure in section *Location of motor axis 3 on page 184*.

Refitting the motor, axis 3

Use this procedure to refit the motor, axis 3.

WARNING

Please observe the following before doing any repair work on the manipulator:

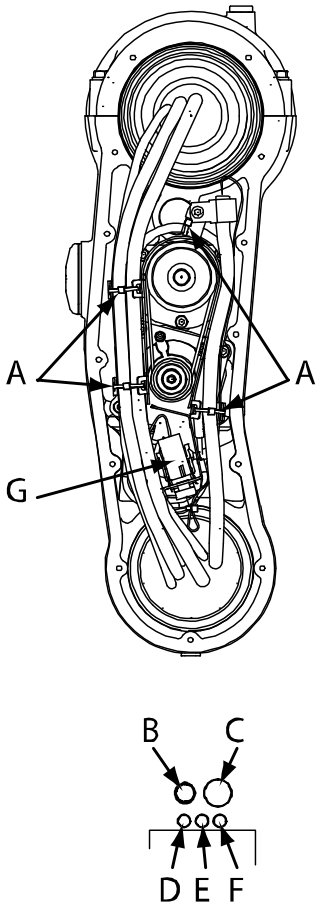
- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Make sure the mating surfaces on the motor and the lower arm are clean and free from burrs.	

Continues on next page

4.7.3 Replacement of motor and timing belt, axis 3

Continued

	Action	Note
3	Fit the motor in the lower arm.	
4	Fit the *belt*.	Shown in the figure in section *Location of motor axis 3 on page 184*.
5	Tighten the two motor attachment screws slightly, but *not* completely.	
6	Adjust the position of the motor in such a way that the correct belt tension is achieved.	Correct belt tension F=35 - 60 N
7	**DO NOT** adjust the belt tension using the intermediate wheel securing screws.	
8	Fit the belt shield and secure it with the two remaining screws.	Tightening torque: 4 Nm ± 0.5 Nm
9	Tighten the last motor attachment screws.	Tightening torque: 4 Nm ± 0.5 Nm
10	Refit the cabling as shown.	 xx0200000449 • A: Cable ties • B: Pressurized air hose • C: Power cables, axes 4, 5 and 6 • D: Customer cables, signal • E: Signal cables, axes 4, 5 and 6 • F: Signal cable, axis 3 • G: Connectors R3.MP3 and R3.FB3

Continues on next page

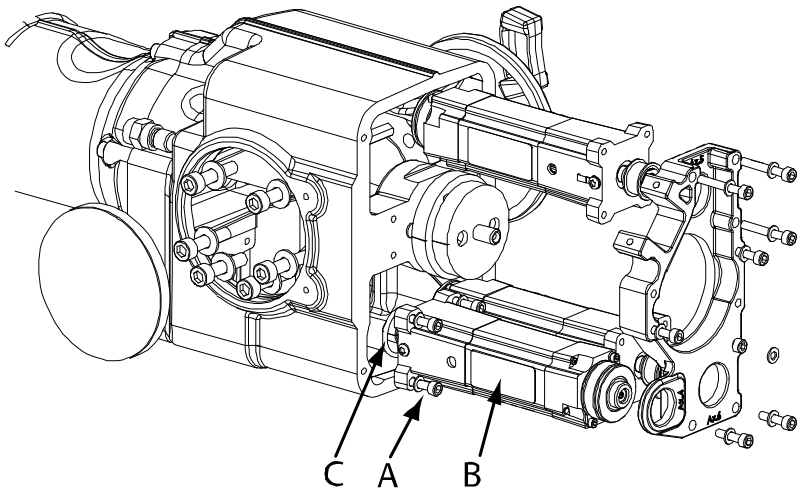
	Action	Note
11	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
12	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.7.4 Replacement of motor, axis 4

Location of motor

The motor axis 4 is located on the left hand side of the upper arm as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0600003262

A	Attachment screws, motor 4 (3 pcs)
B	Motor, axis 4
C	O-ring

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Rot. ac motor with pinion	For spare part number, see: • *Spare part lists on page 243*		Does *not include* the o-ring!
O-ring		3HAC3772-24	Must be replaced when replacing motor!
Grease		3HAC042536-001	Used for lubricating the o-ring.
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Power supply		-	24 VDC, max. 1,5 A. For releasing the brakes.
Rotation tool, motor		3HAC9037-1	For adjusting the gear play.

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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.
Circuit diagram			See chapter *Circuit diagram on page 245*.

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 116*.

Removal, motor axis 4

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**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 116*.	
4	Manually move the robot to a position where the upper arm points straight down.	This will enable the motor 4 to be removed without draining the oil in the gearbox.
5	Remove the motors for axes 5 and 6.	Detailed in section *Replacement of motor and timing belt, axes 5 or 6 on page 194*.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4 • +: pin 7 • -: pin 8
7	Remove the *motor, axis 4* by unscrewing the motor *attachment screws*.	Shown in the figure *Location of motor on page 190*.
8	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	

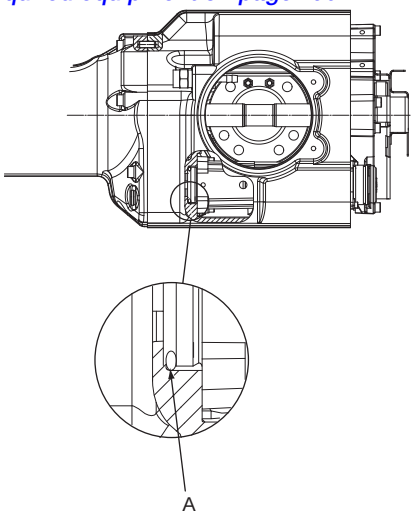
Continues on next page

4.7.4 Replacement of motor, axis 4
Continued

	Action	Note
9	Remove the motor by gently lifting it out.	Make sure the motor pinion is not damaged!
10	Remove the o-ring from the arm housing.	

Refitting, motor axis 4

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Clean the mating surfaces on the *motor* and the gearbox.	Shown in the figure *Location of motor on page 190*.
3	Lightly lubricate a new *o-ring* (A) and put it in the bottom of the machined hole of the arm housing.	Art. no. is specified in section *Required equipment on page 190*.  xx1200000823
4	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4 • +: pin 7 • -: pin 8
5	Fit the motor with the attachment screws, compressing the o-ring in axial direction. Until the motor shaft is adjusted to the gear, as described in following steps, only tighten the screws lightly.	Shown in the figure *Location of motor on page 190*. Tightening torque: approx. 2 Nm.
6	Fit the *rotational tool* to the end of the motor shaft.	Art. no. is specified in section *Required equipment on page 190*.
7	Adjust the motor in relation to the gear in the gearbox. Use the arm tool to wiggle the motor shaft back and forth to feel the play.	There should be a barely noticable gear play.
8	Tighten the motor *attachment screws*.	Shown in the figure *Location of motor on page 190*. Tightening torque: 6 Nm ± 0.6 Nm.

Continues on next page

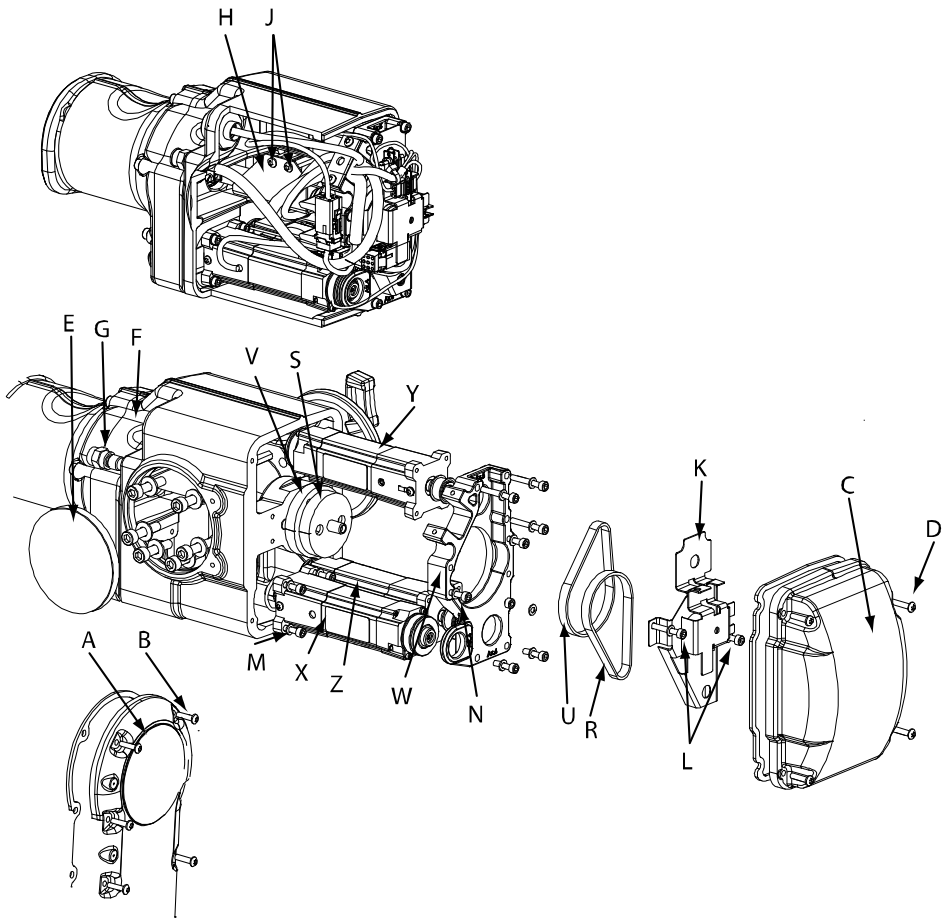
	Action	Note
9	Refit motors 5 and 6.	Detailed in section *Replacement of motor and timing belt, axes 5 or 6 on page 194*.
10	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 241*.
11	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*  **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
12	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.
13	 **DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.7.5 Replacement of motor and timing belt, axes 5 or 6

Location of motor and timing belt, axes 5 or 6

The motor and timing belt axes 5 or 6 are located in the rear of the upper arm as shown in the figure below.

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0600003261

A	Lower arm cover
B	Attachment screws, lower arm cover
C	Cover, armhousing
D	Attachment screws, cover armhousing (4 pcs)
E	VK cover
F	Pressurized air hose (on front of upper arm)
G	CS connector
H	Cable guide
J	Attachment screws, cable guide

Continues on next page

K	Belt shield
L	Attachment screws, belt shield
M	Motor attachment screws, 4 pcs per motor
N	Attachment screws, motor console
R	Timing belt, axis 6
S	Pulley, axis 6
U	Timing belt, axis 5
V	Pulley, axis 5
W	Motor console, ax. 5-6
X	Motor, axis 4
Y	Motor, axis 5
Z	Motor, axis 6

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Rot. ac motor with pinion	3HAC021757-001		Axis 4 Standard, Clean room and Foundry versions
Rot. ac motor with pinion	3HAC021758-001		Axes 5 and 6 Standard, Clean room and Foundry versions
Timing belt	3HAC6779-1		Axes 5 and 6
VK cover		3HAA2166-13	
Standard toolkit		3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Special socket 30 mm			For fitting the CS-connector
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		3HAC6816-3	See chapter *Circuit diagram on page 245*.
Sonic Tension Meter			Model 505C

Continues on next page

4.7.5 Replacement of motor and timing belt, axes 5 or 6
Continued

Removal

The procedure below details how to remove motor, axis 5 or 6.

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Note

Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

	Action	Note
1	**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 116*.	
2	Run the robot to a position where the upper arm is close to horizontal	
3	Remove the *lower arm cover* by unscrewing its *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
4	Remove the rear *cover armhousing* by unscrewing its four *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
5	Disconnect all cables to/from motors 4-6.	Connectors: • R3.MP4 • R3.MP5 • R3.MP6 • R3.FB4 • R3.FB5 • R3.FB6
6	Disconnect any connector from the CS-connector.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
7	Use a *special socket* to remove the CS-connector from the housing and pull it into the upper arm assembly.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Art. no. specified in section *Required equipment on page 195*

Continues on next page

	Action	Note
8	Remove the *pressurized air connector* from the housing and pull it into the upper arm assembly.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Art. no. specified in section *Required equipment on page 195*!
9	Remove the *VK-cover* from the upper arm/lower arm joint.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Detailed in section *Removing the VK cover on page 130*.
10	Remove the *cable guide* by unscrewing its two *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
11	Gently pull the cables out of the upper arm.	
12	Remove the *belt shield* by unscrewing its *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
13	Loosen the *motor attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
14	Remove the *pulley* and *belt* from motor, axis 6.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
15	Remove the *pulley* and *belt* from motor, axis 5.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
16	Remove the *motor console, ax. 5-6* by unscrewing its *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!

Refitting

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

WARNING

Please observe the following before doing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Note

Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!

Continues on next page

4.7.5 Replacement of motor and timing belt, axes 5 or 6

Continued

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	
2	Make sure the mating surfaces on the motor and the console are clean and free from burrs.	
3	Fit the motors in the *motor console* without tightening the attachment screws.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
4	Fit the motor console in the upper arm housing. Secure with its *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Tightening torque: 4 Nm ± 0.5 Nm
5	Fit *timingbelt*, axis 5.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
6	Tighten the motor attachment screws to enable the motor to be shifted slightly.	This will facilitate adjustment of the belt tension.
7	Adjust the belt tension axis 5.	Correct belt tension F=25 - 50 N
8	Secure the motor with its attachment screws including the ones in the motor console.	Tightening torque: 4 Nm ± 0.5 Nm
9	Fit *timing belt*, axis 6.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
10	Repeat the belt adjustment procedure detailed above for the remaining motor axis 6.	Correct belt tension F=20 - 40 N
11	Secure the motor with its attachment screws.	Tightening torque: 4 Nm ± 0.5 Nm
12	Fit the *belt shield* with its attachment screws.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Tightening torque: 4 Nm ± 0.5 Nm
13	Pull the *pressurized air connector* through the housing and secure it into fitting in the upper arm assembly.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Art. no. specified in section *Required equipment on page 195*
14	Pull the *CS-connector* through the housing and secure it into the fitting in the upper arm assembly. Use a *special socket*to secure it.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Art. no. specified in section *Required equipment on page 195*
15	Reconnect any connector to the CS-connector.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!

Continues on next page

	Action	Note
16	Reconnect all cables to/from motors 4-6.	Connectors • R3.MP4 • R3.MP5 • R3.MP6 • R3.FB4 • R3.FB5 • R3.FB6
17	Refit the *cable guide* with its two *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
18	Fit a new *VK-cover* to the upper arm/lower arm joint. Gently knock it into position.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*! Art. no. specified in section *Required equipment on page 195* Use a plastic mallet or similar.
19	Refit the rear cover armhousing with its four *attachment screws*.	Shown in the figure in section *Location of motor and timing belt, axes 5 or 6 on page 194*!
20	Refit any brackets securing any exterior cabling to the upper arm with their attachment screws respectively.	
21	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
22	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.

4.7.6 Adjustments and measurements

4.7.6.1 Measuring the gear play, axis 5

General

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

Certain measurement tools must be fashioned to enable measuring. The dimensions of these are specified.

Required equipment

Equipment, etc.	Art no.	Note
Standard toolkit	3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Arm	3HAC 9037-1	For adjusting the gear play, motor/pinion
Measurement dial with magnetic base		Measuring accuracy 0.01mm
Power supply		24 VDC, max. 1.5 A For releasing the brakes
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.

WARNING

Please observe the following before doing any repair work on the manipulator:

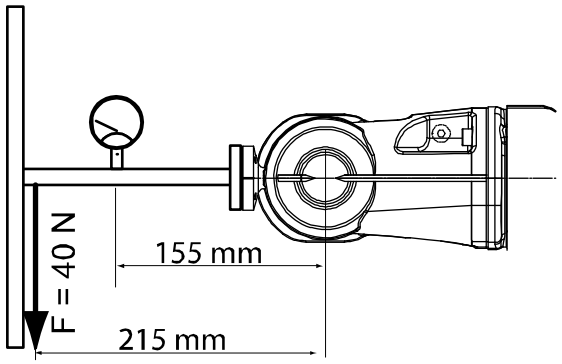
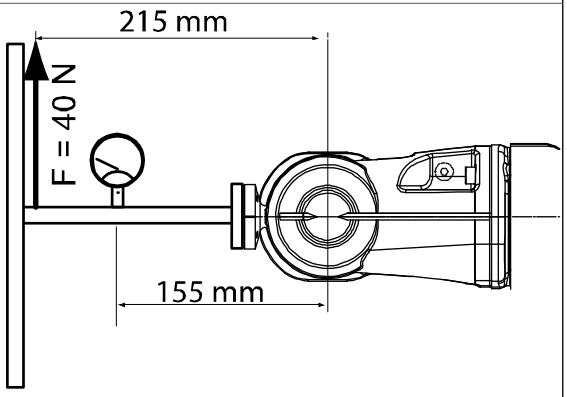
- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Measurement

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

	Action	Note
1	Manually, turn axis 4 90°.	

Continues on next page

	Action	Note
2	Fit the dial fitting arm and dial to the manipulator turning disk as shown in the figure. Apply the 40 N load as shown.	 xx0200000457
3	Remove the load and read **Value 1**.	
4	Apply 40 N load as shown.	 xx0200000458
5	Remove the load and read **Value 2**.	
6	Calculate the gear play value.	Gear play value = value 1 - value 2
7	Determine whether or not the value is OK.	OK < 0.18 mm (4.1 arc minutes)

4.7.6.2 Measuring the gear play, axis 6

General

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

Certain measurement tools must be fashioned to enable measuring. The dimensions of these are specified.

Required equipment

Equipment, etc.	Art no.	Note
Standard toolkit	3HAC020812-001	Content is defined in section *Standard tools on page 239*.
Arm	3HAC 9037-1	For adjusting the gear play, motor/pinion
Measurement dial with magnetic base		Measuring accuracy 0.01 mm
Power supply		24 VDC, max. 1.5 A For releasing the brakes
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.

WARNING

Please observe the following before doing any repair work on the manipulator:

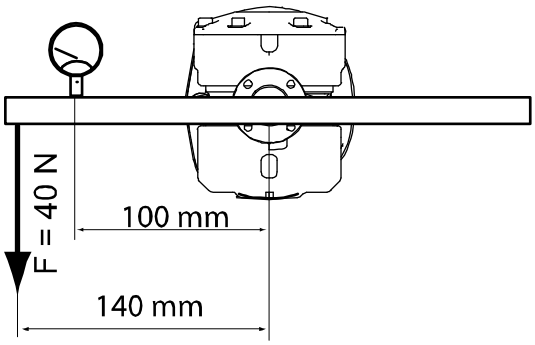
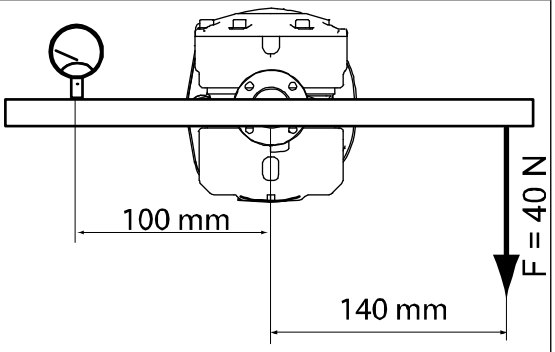
- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic, and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, for example secure the lower arm with fixtures if removing motor, axis 2.

Measurement

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

	Action	Note
1	Manually, turn axis 4 90°.	

Continues on next page

	Action	Note
2	Fit the dial fitting arm and dial to the manipulator turning disk as shown in the figure. Apply the 40 N load as shown.	 xx0200000460
3	Remove the load and read **Value 1**.	
4	Apply 40 N load as shown.	 xx0200000461
5	Remove the load and read **Value 2**.	
6	Calculate the gear play value.	Gear play value = value 1 - value 2
7	Determine whether or not the value is OK.	OK < 0.30 mm (10.3 arc minutes)

4.8 Gearboxes

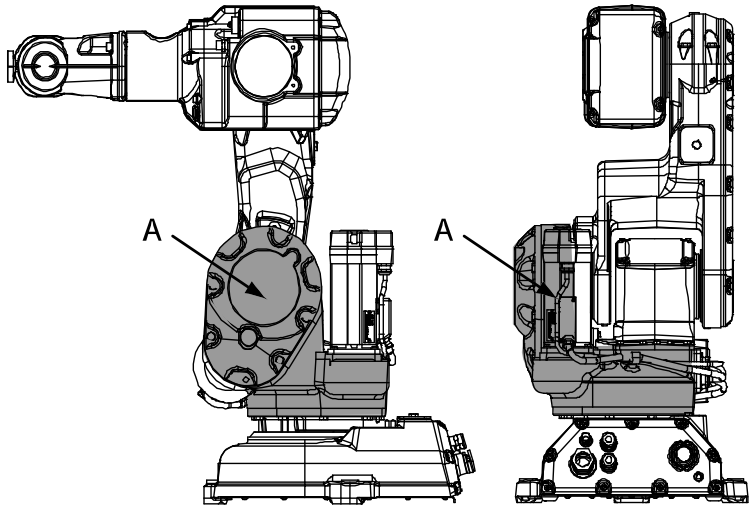
4.8.1 Replacement of gearbox, axes 1-2 and damper, axis 1

Location of gearbox unit, axes 1-2

The gearboxes of axes 1 and 2 are located as shown in the figure below. Note that both gearboxes, 1 and 2, are a single unit!

The damper, axis 1, is shown in the figure in the procedure!

A more detailed view of the components and its position may be found in chapter *Spare part lists on page 243*.



xx0200000422

A	Gearbox unit, axes 1-2

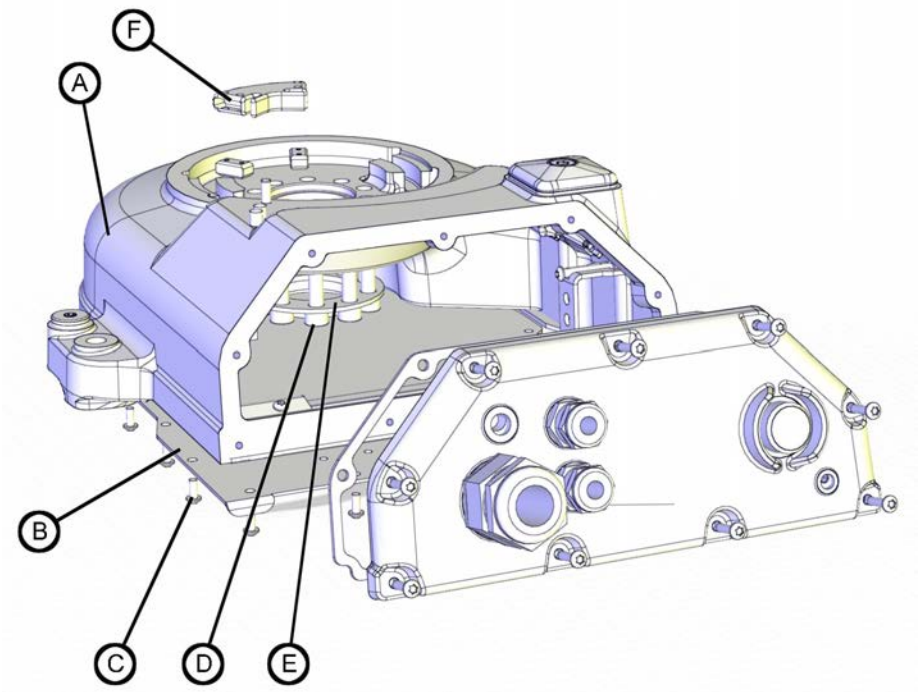
Required equipment

Equipment	Art. no.	Note
Gearbox, axis 1 and 2	For spare part number, see: • *Spare part lists on page 243*.	Includes: • gearbox • all required lubricant • all o-rings and sealing rings.
Damper, axis 1	3HAC7527-1	
Isopropanol	-	For cleaning the mating surfaces before fitting.
Flange sealing	12340011-116	2 ml
Locking liquid	-	Loctite 574
Sealing ring	3HAC6965-1	Replace only when damaged!
Lifting slings	-	
Standard toolkit		Content is defined in section *Standard tools on page 239*.

Continues on next page

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

Illustration, base



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A	Base
B	Bottom plate
C	Attachment screws, bottom plate (26 pcs)
D	Attachment screws and washers, gearbox/base (10 pcs each)
E	Damper, axis 1
F	Washer

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 116*.

Continues on next page

4.8.1 Replacement of gearbox, axes 1-2 and damper, axis 1
Continued

Removal, gearbox unit axes 1-2

The procedure below details how to remove the complete gearbox unit, axes 1-2.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**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 116*.	
3	Remove the oil plug and drain all oil from gearbox axis 1 using a drain pump.	
4	Remove the oil plug and drain all oil from gearbox axis 2 using a drain pump.	
5	Remove the motor, axis 2.	Detailed in section *Replacement of motor, axis 2 on page 180*.
6	Remove the motor, axis 1.	Detailed in section *Replacement of motor, axis 1 on page 176*.
7	Remove the cable harness.	Detailed in section *Replacement of cable harness on page 118*.
8	Remove the serial measurement board.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
9	Remove the upper arm.	Detailed in section *Replacement of complete upper arm on page 127*.
10	Remove the lower arm.	Detailed in section *Replacement of complete lower arm on page 133*.
11	Unfasten the base from the installation site by removing the attachment bolts from the foundation.	
12	**CAUTION** The gearbox unit weighs 30 kg. All lifting accessories used must be sized accordingly!	
13	Fit the lifting slings to the base/gearbox unit and place it with the lower arm side downwards, on top of a suitable workbench.	

Continues on next page

	Action	Note
14	Remove the *bottom plate* by unscrewing its 26 attachment screws.	Shown in the figure *Illustration, base on page 205*.
15	Secure the weight of the base with lifting slings.	
16	Remove the *gearbox/base attachment screws and washer*.	Shown in the figure *Illustration, base on page 205*.
17	Separate the base from the gearbox unit.	

Removal of damper, axis 1

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

	Action	Note
1	Open the base of the robot.	Detailed in section *Removal, gearbox unit axes 1-2 on page 206*.
2	Remove the damper, axis 1.	

Refitting of damper, axis 1

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

	Action	Note
1	Fit the *damper, axis 1*.	Shown in the figure *Refitting, gearbox unit axes 1-2 on page 207*.
2	Proceed with assembling the robot.	Detailed in section *Refitting, gearbox unit axes 1-2 on page 207*.

Refitting, gearbox unit axes 1-2

The procedure below details how to refit the complete gearbox unit, axes 1-2.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**CAUTION** The gearbox unit weighs 30 kg. All lifting accessories used must be sized accordingly!	
3	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116*	

Continues on next page

4.8.1 Replacement of gearbox, axes 1-2 and damper, axis 1

Continued

	Action	Note
4	Place the gearbox unit with the lower arm side downwards on a suitable workbench.	
5	Clean the mating surfaces of the base and of the gearbox unit with isopropanol.	
6	Fit a small amount of Loctite 574 on the mating surface in the gearbox unit.	Shown in the figure *Illustration, base on page 205*.
7	Fit the base to the gearbox unit and secure it with the *attachment screws* and the washer.	Shown in the figure *Illustration, base on page 205*. 20 pcs, tightening torque: 35 Nm ± 3 Nm.
8	Refit the *bottom plate* and secure it with its *attachment screws*.	Shown in the figure *Location of gearbox unit, axes 1-2 on page 204*.
9	Fit the *lifting slings* to the base/gearbox unit, turn it right side up and move it to the installation site.	
10	Secure the base to the foundation	Attachment bolts and the tightening torque are specified in section *Attachment screws on page 56*
11	Refit the lower arm.	Detailed in section *Replacement of complete lower arm on page 133*.
12	Refit the upper arm.	Detailed in section *Replacement of complete upper arm on page 127*.
13	Refit the serial measurement board.	Detailed in section *Replacing the serial measurement unit and the battery pack on page 166*.
14	Refit the cable harness.	Detailed in section *Replacement of cable harness on page 118*.
15	Refit the motors, axes 1 and 2.	Detailed in sections: • *Replacement of motor, axis 1 on page 176* • *Refitting, motor axis 2 on page 182*.
16	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 241*.
17	Fill the two gearboxes with oil.	See, *Technical reference manual - Lubrication in gearboxes*.
18	Refit the oil plugs, axes 1 and 2.	Tightening torque: 10 Nm
19	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 116* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
20	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. General calibration information is included in section *Calibration information on page 211*.

Continues on next page

	Action	Note
21	 **DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 73*.	

4.8.2 Service work on gearbox, axis 4

General

The gearbox, axis 4, is intended to run without requiring any repairs or maintenance work. This implies that it must under *no circumstances* be opened or serviced.

If it requires replacement, the complete upper arm is to be replaced. This procedure is detailed in section *Replacement of complete upper arm on page 127*.

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 216*. 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 reachability 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.

5.2 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	The calibrated robot is positioned at calibration position. Standard calibration data is found on the SMB (serial measurement board) or EIB in the robot.	Calibration Pendulum Levelmeter calibration (alternative method)
Absolute accuracy calibration (optional)	Based on standard calibration, and besides positioning the robot at synchronization position, the Absolute accuracy calibration also compensates for: • Mechanical tolerances in the robot structure • Deflection due to load Absolute accuracy calibration focuses on positioning accuracy in the Cartesian coordinate system for the robot. Absolute accuracy calibration data is found on the serial measurement board (SMB) or other robot memory. For IRC5 robots, 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. A robot calibrated with Absolute accuracy has a sticker next to the identification plate of the robot (IRC5). To regain 100% Absolute accuracy performance, the robot must be recalibrated for absolute accuracy after repair or maintenance that affects the mechanical structure.  xx0400001197	CalibWare
Optimization	Optimization of TCP reorientation performance. The purpose is to improve reorientation accuracy for continuous processes like welding and gluing. Wrist optimization will update standard calibration data for axes 4, 5 and 6.	Wrist Optimization

Continues on next page

Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of some ABB robots.

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 actual instructions of how to perform the wrist optimization procedure is given on the FlexPendant.

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 240*.

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.

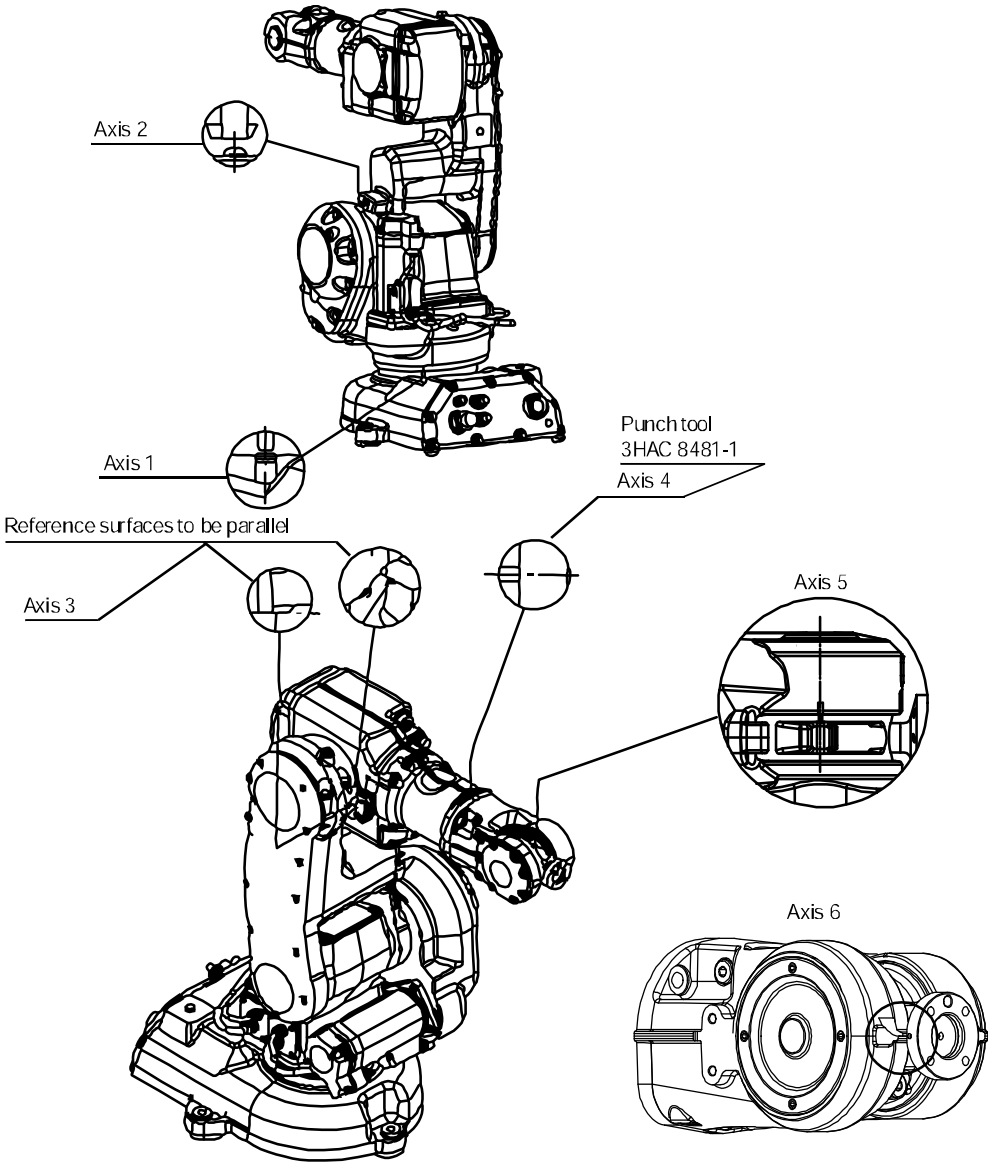
5.3 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 140

The illustration below shows the calibration scale positions on the robot.



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5.4 Calibration movement directions for all axes

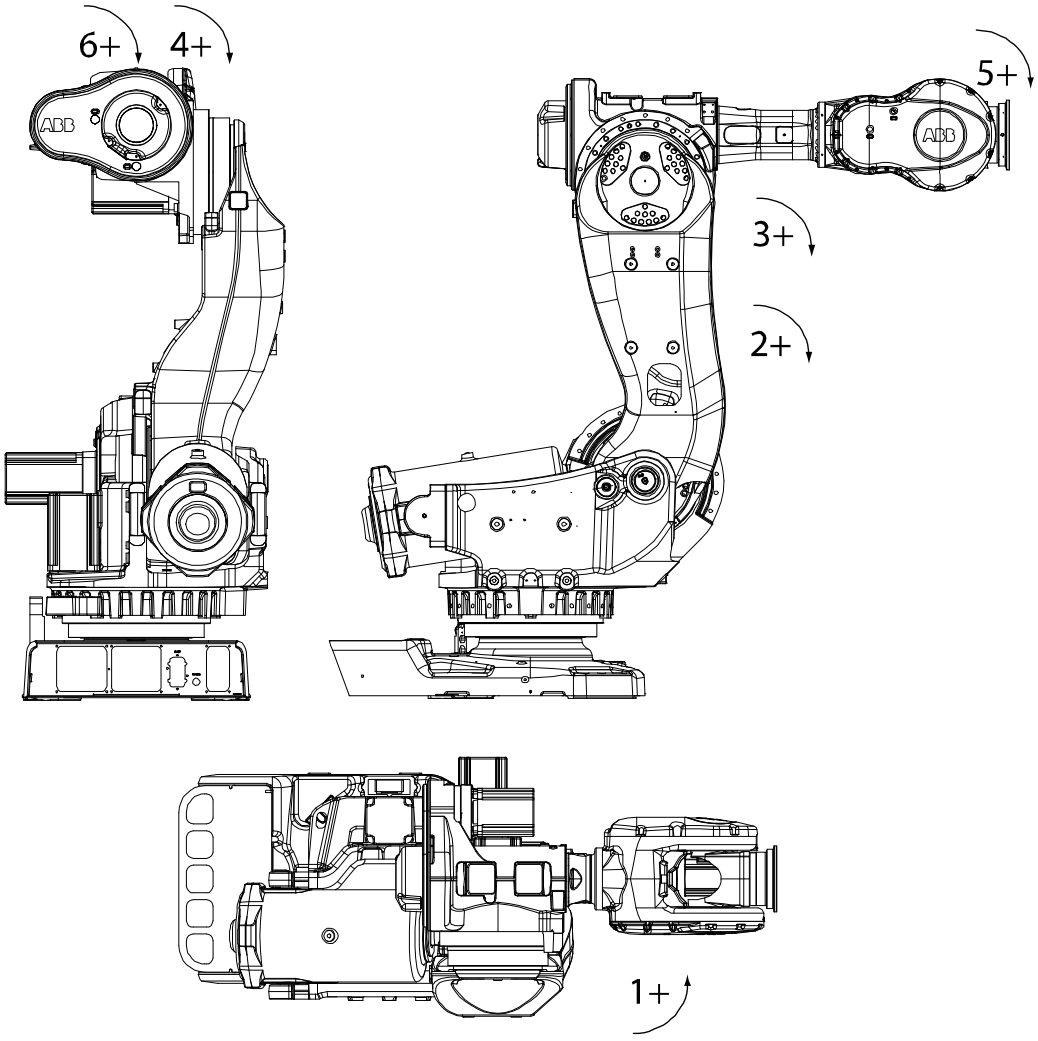
Overview

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 1410	IRB 1510	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
Axis 5, 6	x	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 214*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 217*.

Correct calibration position of axis 4 and 6

When jogging the manipulator to synchronization position, it is extremely important to make sure that axes 4 and 6 of the following mentioned manipulators are positioned correctly. The axes can be calibrated at the wrong turn, resulting in an incorrect manipulator calibration.

Make sure the axes are positioned according to the correct calibration values, not only according to the synchronization marks. The correct values are found on a label, located either on the lower arm, underneath the flange plate on the base or on the frame.

Continues on next page

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.

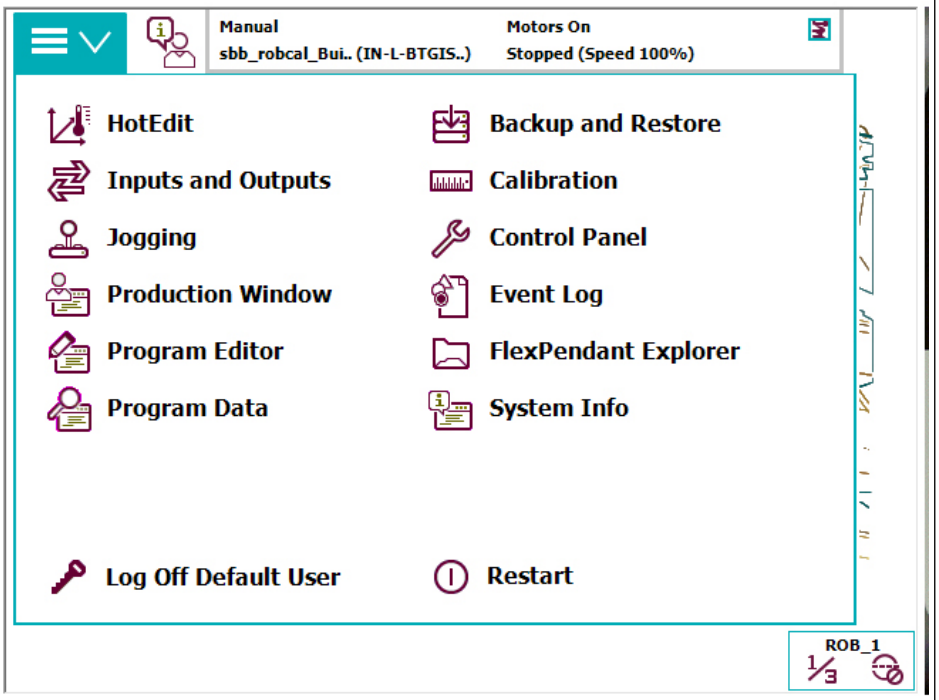
If one of the following mentioned axes are rotated one or more turns from its calibration position before updating the revolution counter, the correct calibration position will be lost due to non-integer gear ratio. This affects the following manipulators:

Manipulator variant	Axis 4	Axis 6
IRB 140	Yes	Yes

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 FlexPendant

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

	Action
1	On the **ABB** menu, tap **Calibration**.  xx1500000942

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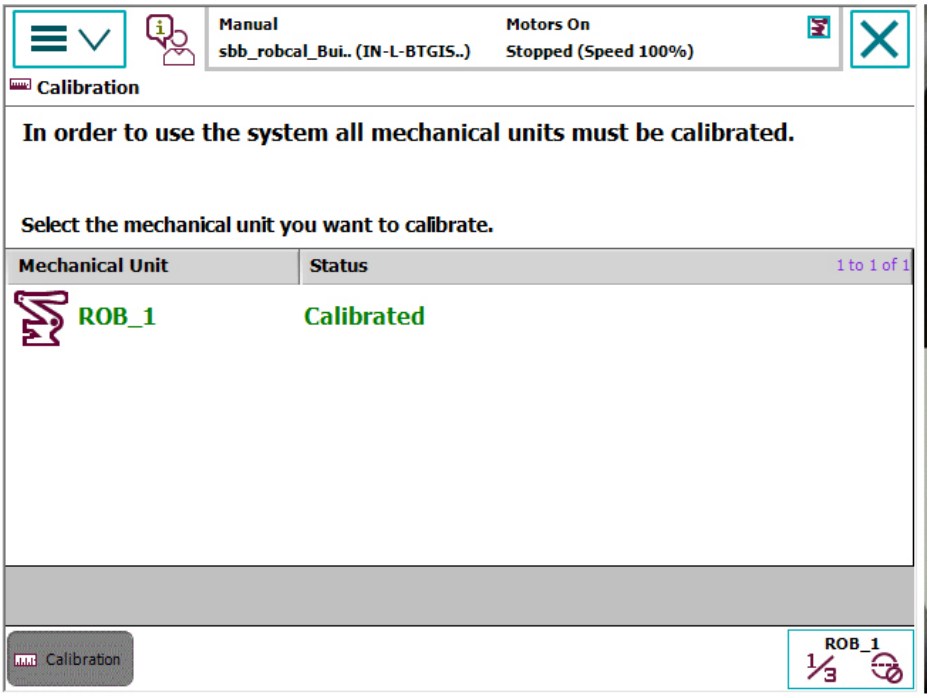
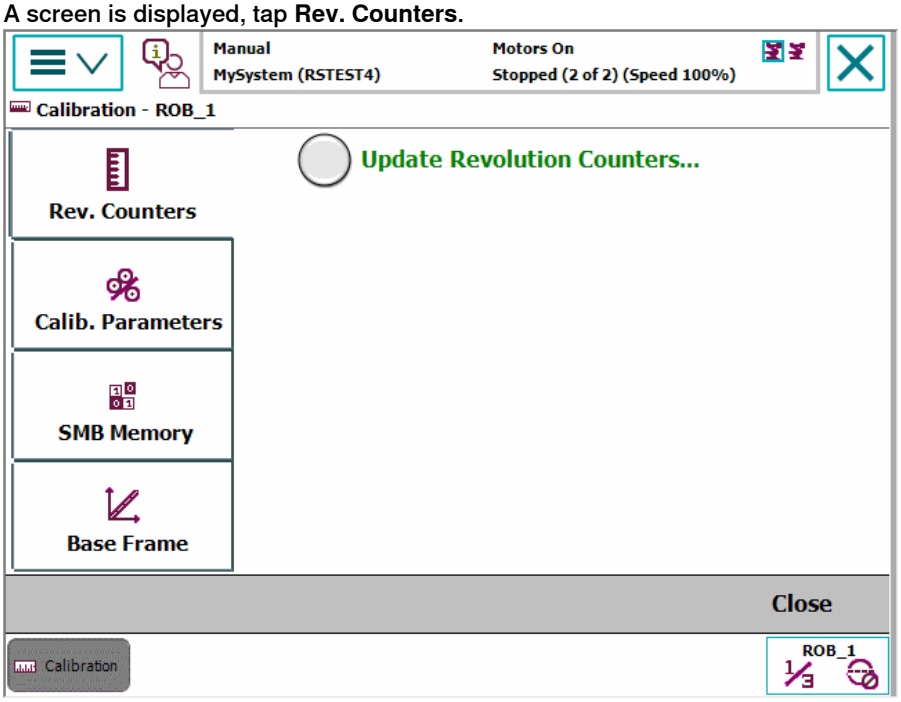
	Action
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943
3	A screen is displayed, tap **Rev. Counters**.  en0400000771

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	Action
4	Tap **Update Revolution Counters...**. A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: • Tap **Yes** to update the revolution counters. • Tap **No** to cancel updating the revolution counters. Tapping **Yes** displays the axis selection window.
5	Select the axis to have its revolution counter updated by: • Ticking in the box to the left • Tapping **Select all** to update all axes. Then tap **Update**.
6	A dialog box is displayed, warning that the updating operation cannot be undone: • Tap **Update** to proceed with updating the revolution counters. • Tap **Cancel** to cancel updating the revolution counters. Tapping **Update** updates the selected revolution counters and removes the tick from the list of axes.
7	**CAUTION** If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See *Checking the synchronization position on page 223*.

5.6 Calibrating with Calibration Pendulum method

Where to find information for Calibration Pendulum

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.

5.7 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, 6. 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.

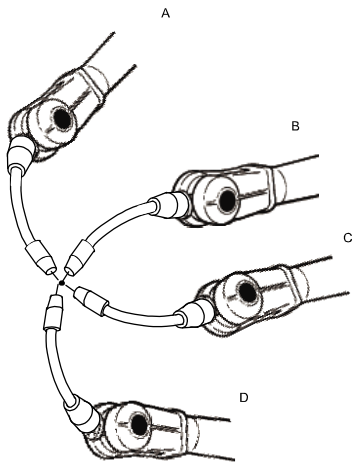
a Jog the robot to an appropriate position, A, for the first approach point.

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 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.

Continues on next page

5.8.1 Checking the synchronization position on IRC5 robots

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:
	`MoveAbsJ [[0,0,0,0,0,0],`
	`[9E9,9E9,9E9,9E9,9E9,9E9]]`
	`\NoEOffs, v1000, fine, tool0`	

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 214* and *Updating revolution counters on IRC5 robots on page 216*.

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 214* and *Updating revolution counters on IRC5 robots on page 216*.

6 Decommissioning

6.1 Introduction to decommissioning

Introduction

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

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

> **Note**
>
> The decommissioning process shall be preceded by a risk assessment.

Disposal of materials used in the robot

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

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

See also *Environmental information on page 226*.

Transportation

Prepare the robot or parts before transport, this to avoid hazards.

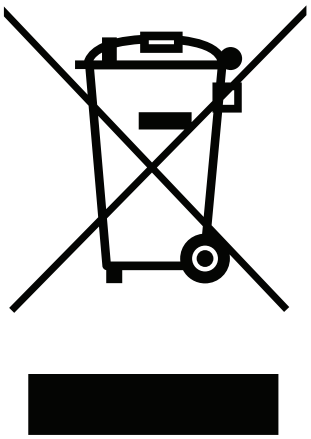
6.2 Environmental information

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

Oil and grease

Where possible, arrange for oil and grease to be recycled. Dispose of via an authorized person/contractor in accordance with local regulations. Do not dispose of oil and grease near lakes, ponds, ditches, down drains, or onto soil. Incineration must be carried out under controlled conditions in accordance with local regulations.

Also note that:

- Spills can form a film on water surfaces causing damage to organisms. Oxygen transfer could also be impaired.
- Spillage can penetrate the soil causing ground water contamination.

6.3 Scrapping of robot

Note

The decommissioning process shall be preceded by a risk assessment.

Important when scrapping the robot

DANGER

The risk assessment should consider hazards arising in the decommissioning, such as, but not limited to:

- 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.
- A used robot does not have the same performance as on delivery. Springs, brakes, bearings, and other parts might be worn or broken.

7 Robot description

7.1 Type C of IRB 140

Type C new upper arm and wrist

Type C of IRB 140 has a new upper arm, complete and a new wrist unit. As a result of this, the following parts differ from earlier versions:

- Upper arm, complete
- Wrist unit
- O-ring sealing plate

How to know which type the robot is?

The robots using RobotWare version 5.07.01 or newer have the new upper arm.

Use this procedure to check which RobotWare version is installed:

1. On the FlexPendant **ABB** menu, tap **System Info**.
2. Tap **System properties**. The RobotWare version is displayed on the right side.

Contact ABB if you are unsure of the type.

Which parts are interchangeable and which are not?

The following parts are not interchangeable:

- The wrist unit with spare part no. 3HAC026569-001 is not interchangeable with spare part no. 3HAC10475-1.
- The o-ring sealing plate with spare part no. 3HAC025420-001 is not interchangeable with spare part no. 3HAC 7191-1.

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8 Reference information

8.1 Introduction

General

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

8.2 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

Deviations from ISO 10218-1:2011 for IRC5 with MultiMove

A deviation exists towards ISO 10218-1:2011, paragraph *5.9 Control of simultaneous motion*, for the option MultiMove. See the application manual for MultiMove.

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

Continues on next page

Standard	Description
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
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.

8.3 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	

8.4 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)	*Gleitmo 603 + Geomet 500*	3-5 µm
M6-M20 (any length except M20x60)	*Gleitmo 603 + Geomet 720*	3-5 µm
M20x60	*Gleitmo 603 + Geomet 500*	8-12 µm
M20x60	*Gleitmo 603 + Geomet 720*	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

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%**!

Tightening torque for 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.

Tightening torque for 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) Class 8.8, oil-lubricated	Tightening torque (Nm) Class 10.9, oil-lubricated	Tightening torque (Nm) Class 12.9, oil-lubricated
M5	6	-	-
M6	10	-	-
M8	24	34	40
M10	47	67	80
M12	82	115	140
M16	200	290	340
M20	400	560	670

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

Tightening torque for lubricated screws (Molykote, Gleitmo or equivalent) with allen head screws

The following table specifies the recommended standard tightening torque for *screws lubricated with Molycote 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]
M5		8
M6		14
M8	28	35
M10	55	70
M12	96	120
M16	235	300
M20	460	550
M24	790	950

i Lubricated with Molycote 1000, Gleitmo 603 or equivalent

8.5 Weight specifications

Definition

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

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

Example

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

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

8.6 Standard tools

General

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

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

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

Contents, standard toolkit

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

8.7 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 239*, and of special tools, listed directly in the instructions and also gathered in this section.

Calibration equipment, Levelmeter (alternative method)

The following table specifies the calibration equipment required when calibrating the robot with the alternative method, Levelmeter Calibration.

Description	Art. no.	Note
Angle bracket	68080011-LP	
Calibration bracket	3HAC13908-9	
Calibration tool ax1	3HAC13908-4	
Measuring pin	3HAC13908-5	
Sensor fixture	68080011-GM	
Sensor plate	3HAC0392-1	
Sync. adapter	3HAC13908-1	

Calibration equipment, Calibration Pendulum

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

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

8.8 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.

The gearbox must be drained of oil before performing the 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, but **do not** refill the gearbox with oil before performing the leak-down test.	
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.	

8.9 Lifting accessories and lifting instructions

General

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

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

The instructions delivered with the lifting accessories should be stored for later reference.

9 Spare part lists

9.1 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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10 Circuit diagram

10.1 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
Circuit diagram - IRC5	*3HAC024480-011*
Circuit diagram - IRC5 Compact	*3HAC049406-003*
Circuit diagram - IRC5 Panel Mounted Controller	*3HAC026871-020*

Manipulators

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 120	*3HAC031408-003*
Circuit diagram - IRB 140 type C	*3HAC6816-3*
Circuit diagram - IRB 260	*3HAC025611-001*
Circuit diagram - IRB 360	*3HAC028647-009*
Circuit diagram - IRB 390	*3HAC060545-009*
Circuit diagram - IRB 460	*3HAC036446-005*
Circuit diagram - IRB 660	*3HAC025691-001*
Circuit diagram - IRB 760	*3HAC025691-001*
Circuit diagram - IRB 1200	*3HAC046307-003*
Circuit diagram - IRB 1410	*3HAC2800-3*
Circuit diagram - IRB 1600/1660	*3HAC021351-003*
Circuit diagram - IRB 1510	*3HAC087368-003*
Circuit diagram - IRB 1520	*3HAC039498-007*
Circuit diagram - IRB 2400	*3HAC6670-3*
Circuit diagram - IRB 2600	*3HAC029570-007*
Circuit diagram - IRB 4400/4450S	*3HAC9821-1*
Circuit diagram - IRB 4600	*3HAC029038-003*
Circuit diagram - IRB 6620	*3HAC025090-001*
Circuit diagram - IRB 6620 / IRB 6620LX	*3HAC025090-001*
Circuit diagram - IRB 6640	*3HAC025744-001*
Circuit diagram - IRB 6650S	*3HAC13347-1* *3HAC025744-001*

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10.1 Circuit diagrams
Continued

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 6660	*3HAC025744-001* *3HAC029940-001*
Circuit diagram - IRB 6700 / IRB 6790	*3HAC043446-005*
Circuit diagram - IRB 7600	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 14000	*3HAC050778-003*
Circuit diagram - IRB 910SC	*3HAC056159-002*

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