ROBOTICS

Product manual

IRB 120

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Workspace R17-2 version a11
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Product manual

IRB 120 - 3/0.6
IRB 120T - 3/0.6

IRC5

Document ID: 3HAC035728-001

Revision: N

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Except as may be expressly stated anywhere in this manual, nothing herein shall be construed as any kind of guarantee or warranty by ABB for losses, damages to persons or property, fitness for a specific purpose or the like.

In no event shall ABB be liable for incidental or consequential damages arising from use of this manual and products described herein.

Keep for future reference.

Additional copies of this manual may be obtained from ABB.

Original instructions.

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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.

Organization of chapters

The manual is organized in the following chapters:

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

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

References

Reference	Document ID
Product specification - IRB 120	*3HAC035960-001*
Product manual, spare parts - IRB 120	*3HAC049098-001*
Product manual - IRC5 IRC5 with main computer DSQC 639.	*3HAC021313-001*
Product manual - IRC5 IRC5 with main computer DSQC1000.	*3HAC047136-001*
Product manual - IRC5 Compact	*3HAC035738-001*
Product manual - IRC5 Panel Mounted Controller	*3HAC027707-001*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - Emergency safety information	*3HAC027098-001* Same document number regardless of language.
Operating manual - General safety information [i]	*3HAC031045-001*

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

Revisions

Revision	Description
-	First edition
A	This revision includes the following additions and/or changes: • Section "*Product documentation, M2004*" added. • Section "*How to read the product manual*" added. • **Safety chapter-** Updated safety signal graphics for levels Danger! and Warning! See section *Safety signals in the manual on page 38*. • **Safety chapter** - New safety labels on the manipulators, see *Safety symbols on product labels on page 40*. • **Safety chapter**- Revised terminology: *robot* replaced with *manipulator*. • **Safety chapter** - Information not applicable to IRB 120 in *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 53* removed. • **Installation chapter**- Illustration updated in *Risk of tipping/stability on page 62*. • **Installation chapter**- Attachment screws added in *Lifting the robot with roundslings on page 63*. • **Installation chapter**- Value in illustration updated in *Orienting and securing the robot on page 70*.

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Revision	Description
	• **Installation chapter** - Section *Setting the system parameters for a suspended or tilted robot on page 75* new. • **Installation chapter** - Section *Robot cabling and connection points on page 85* updated. • **Installation chapter** - Section *Customer connections on the robot on page 87* art. no. on connection at upper arm updated. • **Maintenance chapter** - Value for timing belt tension axis 5 updated. • **Repair chapter** - New chapter. • **Calibration chapter** - Section *Calibrating with manual calibration method on page 242* updated. • **Calibration chapter** - Section *Synchronization marks and synchronization position for axes on page 228* updated. • **Reference information chapter** - New chapter. • **Spare parts chapter** - Article numbers and illustrations updated.
B	This revision includes the following additions and/or changes: • **Installation chapter** - Lifting capacity of roundslings updated. See: *Lifting the robot with roundslings on page 63*. • **Installation chapter** - New illustration showing IRB 120 added. See: *Setting the system parameters for a suspended or tilted robot on page 75*. • **Repair chapter** - Illustrations xx0900001009 and xx0900000782 updated. See: *Removing the cable harness on page 120* and *Refitting the cable harness on page 134*. • **Repair chapter** - Illustration xx0900000924 updated. See: *Replacing the upper arm on page 155*. • **Repair chapter** - Motor axis 4 now delivered as part of the upper arm. The procedures Removal and Refitting are updated accordingly. See: *Replacing the upper arm on page 155*. • **Repair chapter** - Motor axis 4 now delivered as part of the upper arm. The section is updated accordingly. See: *Replacing motor axis 4, with gearbox on page 210*. • **Repair chapter** - Illustration xx0900001009 updated. See: *Replacing motor axis 5 on page 211*. • **Calibration chapter** updated. See sections: *Calibrating with manual calibration method on page 242* and *Synchronization marks and synchronization position for axes on page 228*. • **Reference information chapter** - "*Other standards*" added. See: *Applicable standards on page 256*. • **Reference information chapter** - Standard toolkit updated. See: *Standard toolkit on page 260*. • **Spare parts chapter** - Motor axis 4 (art. no. 3HAC037282-001) removed. Now part of the upper arm. See *Spare parts - Upper arm unit* in *Product manual, spare parts - IRB 120*. • **Circuit diagram** - Updated after circuit diagrams now are delivered as separate files. See: *Circuit diagrams on page 265*.
C	This revision includes the following additions and/or changes: • **Repair chapter** - Text added on how to position axis 5. See section *Removing the cable harness on page 120*. • **Repair chapter** - Text added on how to position axis 5. See section *Refitting the cable harness on page 134*. • **Repair chapter** - Text added on how to position axis 5. See section *Replacing the upper arm on page 155*. • **Calibration chapter** - Text added about updating the revolution counters. See section *Calibrating with manual calibration method on page 242*.

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Revision	Description
	• **Calibration chapter** - Introduction updated. See section *Synchronization marks and synchronization position for axes on page 228*. • **Spare parts chapter** - Illustration xx0900000544 updated. See *Spare parts - Upper arm unit* in *Product manual, spare parts - IRB 120*.
D	This revision includes the following additions and/or changes: • A new block, about general illustrations, added in section *How to read the product manual on page 16*. • Clean Room protection added. • Illustrations updated throughout the manual. • **Calibration chapter** - Text removed: *Updating the revolution counters*. • Added *WARNING - Safety risks during handling of batteries on page 52*.
E	This revision includes the following additions and/or changes: • Section *Expected component life* removed from the manual. • Added inspection activity for regular/daily inspection of robot to the maintenance schedule, see *Maintenance schedule on page 93*. • Added the spare part number for the gearbox grease in section Type of grease, gearboxes. • Changed the working range of axis 3, see *Working range and type of motion on page 60*. • Changed the illustration that shows the mounting surface of the tool flange, see *Fitting equipment on robot on page 72*. • Added variant IRB 120T - 3/0.6 to the manual.
F	This revision includes the following additions and/or changes: • Information regarding disassembly of *Clean Room* robots added to concerned repair instructions. • All data about type of lubrication in gearboxes is moved from the manual to a separate lubrication manual, see *Type of lubrication in gearboxes on page 107*. • Added data for extended working range of axis 6, see *Working range and type of motion on page 60*.
G	This revision includes the following additions and/or changes: • Added information about brake release for other controller variants than IRC5 Compact, see *Manually releasing the brakes on page 66*. • Procedure how to replace the axis-1 motor with gearbox has been updated. See *Replacing axis-1 motor with gearbox on page 169*. • Procedure how to replace the axis-2 motor with gearbox has been updated. See *Replacing axis-2 motor with gearbox on page 190*.
H	This revision includes the following additions and/or changes: • Changed torque value in instruction for refitting the axis-5 motor, see *Replacing motor axis 5 on page 211*. • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 253*. • Added information about how to update the revolution counters, see *Updating revolution counters on page 231*, and *Checking the synchronization position on page 249*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Spare part lists* in *Product manual, spare parts - IRB 120*
J	This revision includes the following additions and/or changes: • The list of applicable safety standards is updated. The IRB 120 does not comply with the CSA/UL standards, see id(19755)Applicable safety standards_en.xml.

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Revision	Description
K	This revision includes the following additions and/or changes: • Procedure how to change Cable harness has been updated. • Procedure how to change axis-1 motor with gearbox has been updated. *Replacing axis-1 motor with gearbox on page 169*. • Release holes in swing plate and lower arm housing added (repair instructions motor axis-1 and motor axis-2 changed) • Tightening torque for axis-3 motor changed • Updated timing belt tension for axis-3 motor and axis-5 motor
L	This revision includes the following additions and/or changes: • Removed information about signal lamp from the manual since it is not a valid option for IRB 120. • Information about manual break release added to installation chapter. • New standard calibration method is introduced (Axis Calibration). See *Calibration on page 225*. • Information about Absolute Accuracy removed from the robot. • Food grade lubrication option added.
M	Published in release R16.2. The following updates are done in this revision: • Information of some attachment screws and washers added. • Modified specification of attachment screws from M4x8 to M4x10 for fitting the bracket securing the upper arm to the base.
N	Published in release R17.2. The following updates are made in this revision: • Location and replacing procedure of lower arm have been updated. *Lower arm on page 164*. • Procedure about how to replace axis-1 motor with gearbox has been updated. *Replacing axis-1 motor with gearbox on page 169*. • Information about minimum resonance frequency added. • Bending radius for static floor cables added. • Updated list of applicable standards. • Section *Start of robot in cold environments on page 89* added.

Product documentation, IRC5

Categories for user documentation from ABB Robotics

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

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

Product manuals

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

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

Technical reference manuals

The technical reference manuals describe reference information for robotics products.

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

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Application manuals

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

An application manual generally contains information about:

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

Operating manuals

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

The group of manuals includes (among others):

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

How to read the product manual

Reading the procedures

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

References to figures

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

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

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

	Action	Note/Illustration
8.	Remove the *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 Introduction to safety information

Overview

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

- General safety aspects, important to attend to before performing any service work on the robot. These are applicable for all service work and are found in *General safety information on page 18*.
- Safety signals and symbols shown in the manual and on the robot, warning for different types of dangers, are found in *Safety signals and symbols on page 38*.
- Specific safety information, pointed out in the procedures. How to avoid and eliminate the danger is either described directly in the procedure, or in specific instructions in the section *Safety related instructions on page 46*.

1.2 General safety information

1.2.1 Introduction to general safety information

Definitions

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

Sections

The general safety information is divided into the following sections.

Section	Examples of content
Safety in the robot system on page 19	This section describes the following: • safety, service • limitation of liability • related information
Protective stop and emergency stop on page 21	This section describes protective stop and emergency stop.
Safety risks on page 22	This section lists dangers relevant when working with the product. The dangers are split into different categories. • safety risks during installation or service • risks associated with live electrical parts
Safety actions on page 31	This section describes actions which may be taken to remedy or avoid dangers. • fire extinguishing • safe use of the teach pendant or jogging device

1.2.2 Safety in the robot system

Validity and responsibility

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

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

- *Operating manual - IRC5 with FlexPendant*
- *Operating manual - General safety information* [I]
- *Product manual*

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

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

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

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

Connection of external safety devices

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

Limitation of liability

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

Related information

Type of information	Detailed in document	Section
Installation of safety devices	*Product manual for the robot*	Installation and commissioning
Changing operating modes	*Operating manual - IRC5 with FlexPendant*	Operating modes

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1.2.2 Safety in the robot system
Continued

Type of information	Detailed in document	Section
Restricting the working space	*Product manual for the robot*	Installation and commissioning
Load limits for tools and workpieces	*Product specification for the robot*	Load diagrams
Configuration of safety module (requires Functional safety options)	*Application manual - Functional safety and SafeMove*	

1.2.3 Protective stop and emergency stop

Overview

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

1.2.4 Safety risks

1.2.4.1 Safety risks during installation and service work on manipulators

Overview

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

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

The integrator of the final application is required to perform an assessment of the hazards and risks (HRA).

General risks during installation and service

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

Spare parts and special equipment

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

Personal protective equipment

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

Nation/region specific regulations

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

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Non-voltage related risks

- Make sure that no one else can turn on the power to the controller and robot while you are working with the system. A good method is to always lock the main switch on the controller cabinet with a safety lock.
- Safety zones, which must be crossed before admittance, must be set up in front of the robot's working space. Light beams or sensitive mats are suitable devices.
- Turntables or the like should be used to keep the operator out of the robot's working space.
- If the robot is installed at a height, hanging, or other than standing directly on the floor, there may be additional risks than those for a robot standing directly on the floor.
- The axes are affected by the force of gravity when the brakes are released. In addition to the risk of being hit by moving robot parts, there is a risk of being crushed by the parallel arm (if there is one).
- Energy stored in the robot for the purpose of counterbalancing certain axes may be released if the robot, or parts thereof, are dismantled.
- When dismantling/assembling mechanical units, watch out for falling objects.
- Be aware of stored heat energy in the controller.
- Never use the robot as a ladder, which means, do not climb on the motors or other parts during service work. There is a serious risk of slipping because of the high temperature of the motors and oil spills that can occur on the robot. There is also a risk of the robot being damaged.

To be observed by the supplier of the complete system

When integrating the robot with external devices and machines:

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

Complete robot

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

Continues on next page

1.2.4.1 Safety risks during installation and service work on manipulators
Continued

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

Cabling

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

Gearboxes and motors

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

1.2.4.2 CAUTION - Hot parts may cause burns!

Description

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

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

There is also a risk of fire if flammable materials are put on hot surfaces.

Elimination

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

	Action	Information
1	Always use your hand, at some distance, to feel if heat is radiating from the potentially hot component before actually touching it.	
2	Wait until the potentially hot component has cooled if it is to be removed or handled in any other way.	
3	Do not put anything on hot metal surfaces, e.g. paper or plastic.	

1.2.4.3 Safety risks related to tools/work pieces

Safe handling

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

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

Safe design

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

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

CAUTION

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

1.2.4.4 Safety risks related to pneumatic/hydraulic systems

General

Special safety regulations apply to pneumatic and hydraulic systems.

Note

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

Residual energy

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

Safe design

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

1.2.4.5 Safety risks during operational disturbances

General

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

Qualified personnel

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

Extraordinary risks

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

1.2.4.6 Risks associated with live electric parts

Voltage related risks, general

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

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

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

All work must be performed:

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

Voltage related risks, IRC5 controller

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

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

Continues on next page

1.2.4.6 Risks associated with live electric parts
Continued

Voltage related risks, robot

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

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

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

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

1.2.5 Safety actions

1.2.5.1 Safety fence dimensions

General

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

Dimensioning

The fence or enclosure must be dimensioned to withstand the force created if the load being handled by the robot is dropped or released at maximum speed. Determine the maximum speed from the maximum velocities of the robot axes and from the position at which the robot is working in the work cell (see the section *Robot motion* in the *Product specification*).

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

1.2.5.2 Fire extinguishing

Note

Use a CARBON DIOXIDE (CO_2) extinguisher in the event of a fire in the robot or controller!

1.2.5.3 Emergency release of the robot arm

Description

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

How to release the brakes is detailed in the section:

- *Manually releasing the brakes on page 66*.

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

Increased injury

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

DANGER

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

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

1.2.5.4 Brake testing

When to test

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

How to test

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

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

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

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

Note

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

1.2.5.6 Enabling device and hold-to-run functionality

Three-position enabling device

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

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

Note

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

To ensure safe use of the teach pendant, the following must be implemented:

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

Hold-to-run function

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

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

1.2.5.7 Work inside the working range of the robot

WARNING

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

- The operating mode selector on the controller must be in the manual mode position to render the three-position enabling device operational and to block operation from a computer link or remote control panel.
- The maximum speed of the robot is limited to 250 mm/s when the operating mode selector is in the position *Manual mode with reduced speed*. This should be the normal position when entering the working space.

  The position *Manual mode with full speed (100%)* may only be used by trained personnel who are aware of the risks that this entails. *Manual mode with full speed (100%)* is not available in USA or Canada.
- Pay attention to the rotating axes of the robot. Keep away from axes to not get entangled with hair or clothing. Also, be aware of any danger that may be caused by rotating tools or other devices mounted on the robot or inside the cell.
- Test the motor brake on each axis, according to the section *Brake testing on page 34*.
- To prevent anyone else from taking control of the robot, always put a safety lock on the cell door and bring the three-position enabling device with you when entering the working space.

WARNING

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

1.3 Safety signals and symbols

1.3.1 Safety signals in the manual

Introduction to safety signals

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

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

Danger levels

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

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

Continues on next page

Symbol	Designation	Significance
 xx0100000004	NOTE	Describes important facts and conditions.
 xx0100000098	TIP	Describes where to find additional information or how to do an operation in an easier way.

1.3.2 Safety symbols on product labels

Introduction to labels

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

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

Note

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

Types of labels

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

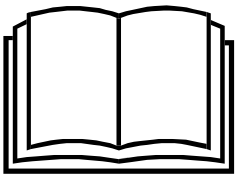
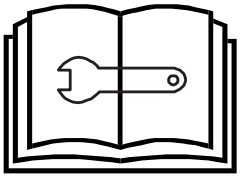
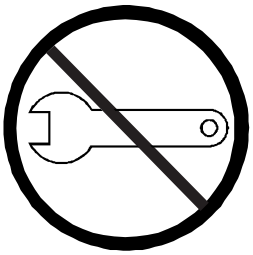
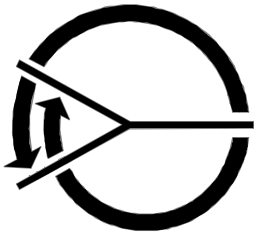
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 40*.

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

Symbols on safety labels

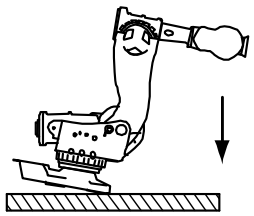
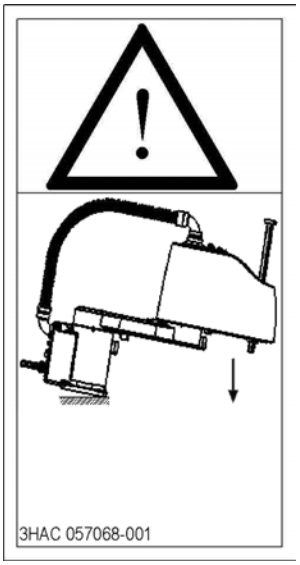
Symbol	Description
 xx0900000812	**Warning!** Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical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

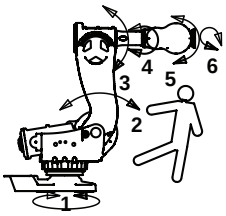
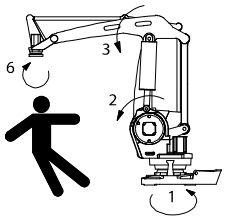
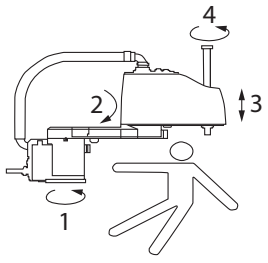
Symbol	Description
 xx0900000813	**See user documentation** Read user documentation for details. Which manual to read is defined by the symbol: • No text: *Product manual*. • EPS: *Application manual - Electronic Position Switches*.
 xx0900000816	**Before disassemble, see product manual**
 xx0900000815	**Do not disassemble** Disassembling this part can cause injury.
 xx0900000814	**Extended rotation** This axis has extended rotation (working area) compared to standard.
 xx0900000808	**Brake release** Pressing this button will release the brakes. This means that the robot arm can fall down.

Continues on next page

1.3.2 Safety symbols on product labels
Continued

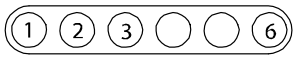
Symbol	Description
 xx0900000810  xx1500002402	**Tip risk when loosening bolts** The robot can tip over if the bolts are not securely fastened.
  xx0900000817	**Crush** Risk of crush injuries.

Continues on next page

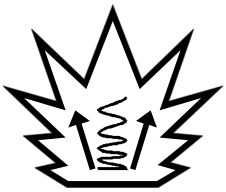
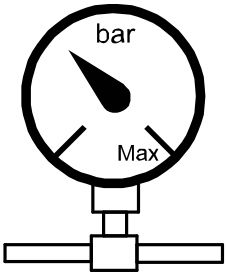
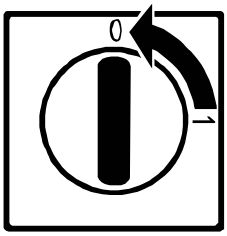
Symbol	Description
 xx0900000818  xx1300001087	**Heat** Risk of heat that can cause burns. (Both signs are used)
 xx0900000819  xx1000001141  xx1500002616	**Moving robot** The robot can move unexpectedly.

Continues on next page

1.3.2 Safety symbols on product labels
Continued

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

Continues on next page

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

1.4 Safety related instructions

1.4.1 DANGER - Moving robots are potentially lethal!

Description

Any moving robot is a potentially lethal machine.

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

Elimination

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

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

Description

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

Elimination

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

DANGER

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

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

Collision risks

CAUTION

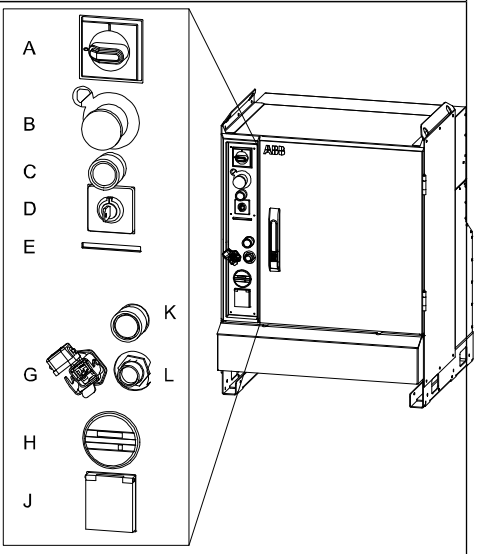
When programming the movements of the robot, always identify potential collision risks before the first test run.

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

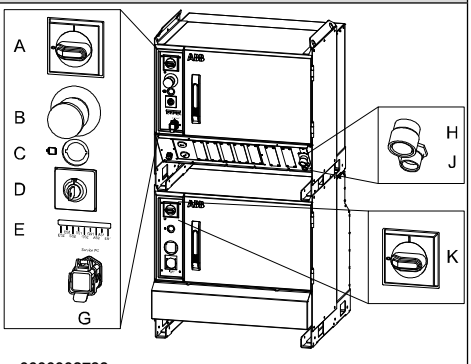
Description

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

Elimination, IRC5 Single Cabinet Controller

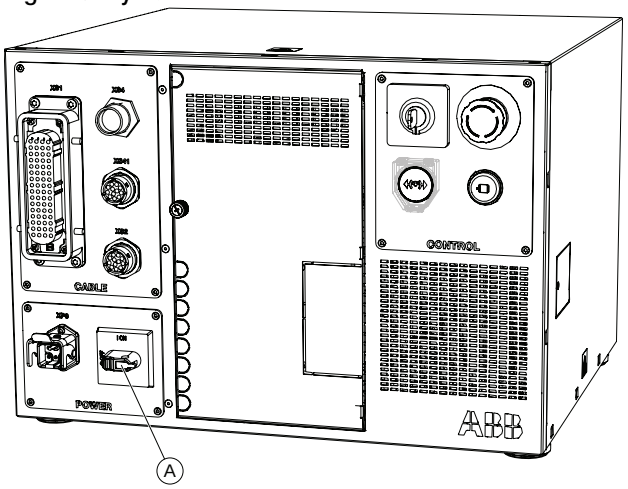
	Action	Note/illustration
1	Switch off the main switch on the controller cabinet.	 xx0600002782 A: Main switch

Elimination, IRC5 Dual Cabinet Controller

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

Continues on next page

Elimination, IRC5 Compact Controller

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

1.4.4 WARNING - The unit is sensitive to ESD!

Description

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

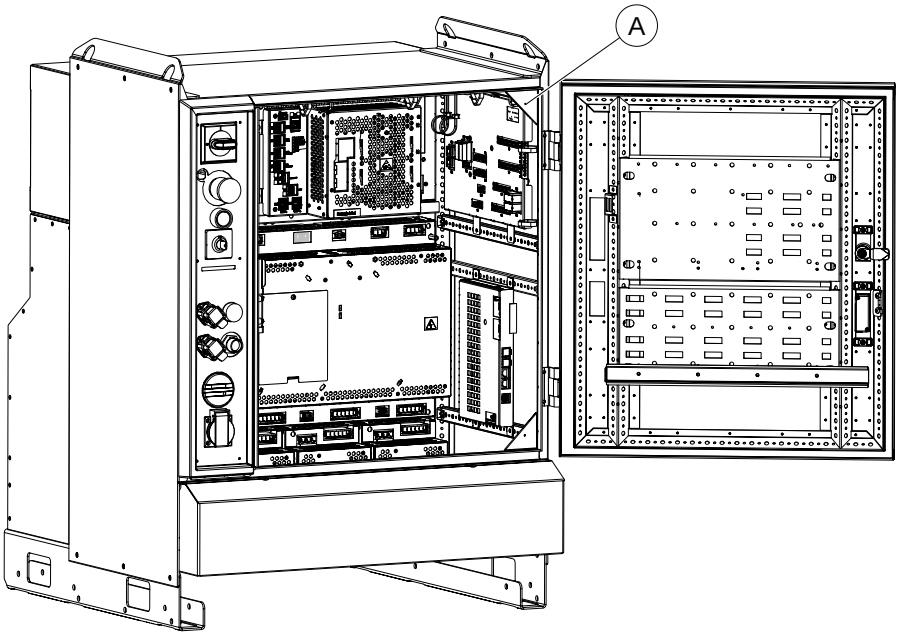
Elimination

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

Location of wrist strap button

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

IRC5

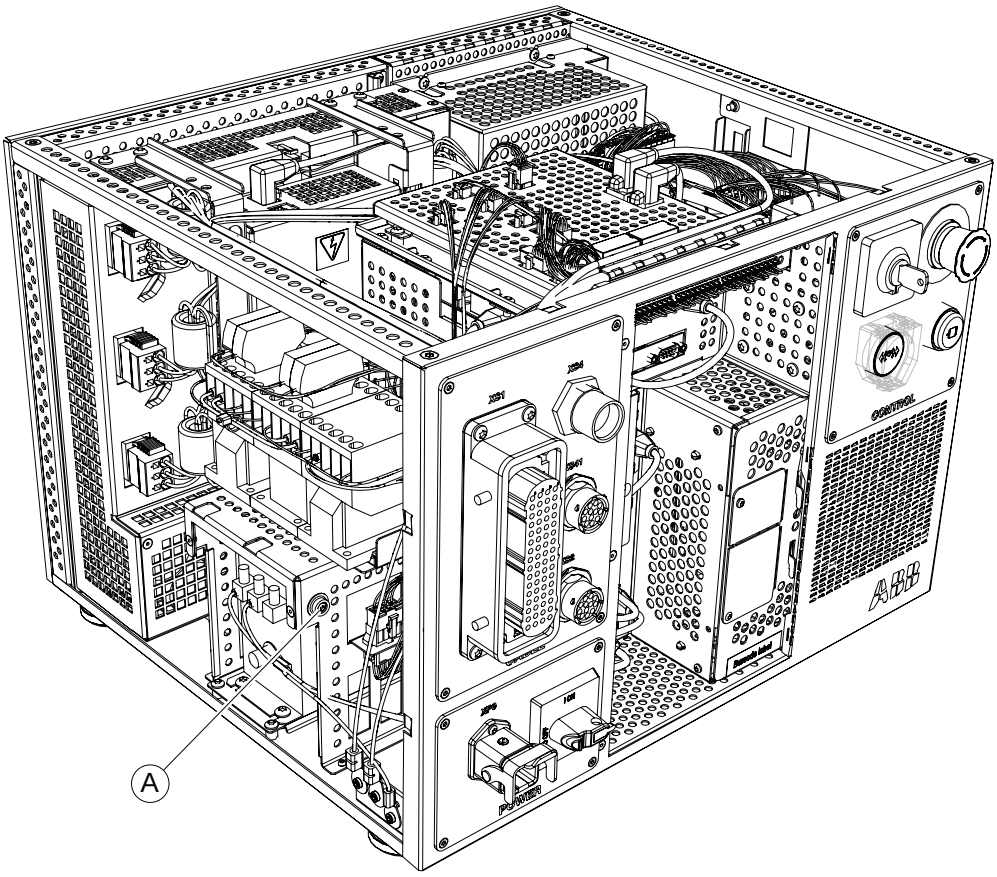


xx1300000856

A	Wrist strap button

Continues on next page

IRC5 Compact Controller



xx1400001622

A	Wrist strap button

1.4.5 WARNING - Safety risks during handling of batteries

Description

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

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

Note

Appropriate disposal regulations must be observed.

Elimination

	Action	Note
1	Do not short circuit, recharge, puncture, incinerate, crush, immerse, force discharge or expose to temperatures above the declared operating temperature range of the product. Risk of fire or explosion.	Operating temperatures are listed in *Pre-installation procedure on page 56*.
2	Use safety glasses when handling the batteries.	
3	In the event of leakage, wear rubber gloves and chemical apron.	
4	In the event of fire, use self-contained breathing apparatus.	

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

Description

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

Note

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

Note

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

Note

Appropriate disposal regulations must be observed.

Note

Take special care when handling hot lubricants.

Warnings and elimination

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

Continues on next page

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

Warning	Description	Elimination/Action
 xx0100000002 **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.
 xx0100000004 **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.
 xx0100000003 **Contaminated oil in gear boxes**	When draining the oil make sure that as much oil as possible is drained from the gearbox. The reason for this is to drain as much oil sludge and metal chips as possible from the gearbox. The magnetic oil plugs will take care of any remaining metal chips.	

2 Installation and commissioning

2.1 Introduction

General

This chapter contains assembly instructions and information for installing the IRB 120 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 120, such as:

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

Safety information

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

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

Note

If the IRB 120 is connected to power, always make sure that the robot is connected to *protective earth* before starting any installation work!

For more information see:

- *Product manual - IRC5*

2.2 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 56*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 58*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 59*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 57* • *Protection classes, robot on page 59* • *Requirements, foundation on page 58*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 62*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 63*
11	Install required equipment, if any.

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 120	25 kg

Continues on next page

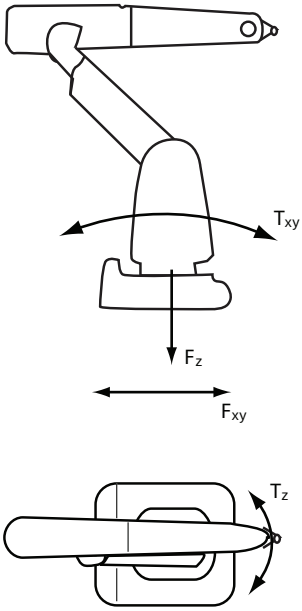
Note

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

Loads on foundation, robot

The illustration shows the directions of the robots stress forces.

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



xx1100000521

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

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

Note

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

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	±265 N	±515 N
Force z	-265 ±200 N	-265 ±365 N
Torque xy	±195 Nm	±400 Nm
Torque z	±85 Nm	±155 Nm

Continues on next page

2.2.1 Pre-installation procedure
Continued

Wall mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	±470 N	±735 N
Force z	0 ±200 N	0 ±630 N
Torque xy	±240 Nm	±450 Nm
Torque z	±90 Nm	±175 Nm

Suspended

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	±265 N	±515 N
Force z	265 ±200 N	265 ±365 N
Torque xy	±195 Nm	±400 Nm
Torque z	±85 Nm	±155 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	0.1/500 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.
Maximum tilt	5°	
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 *Application manual - Controller software IRC5*, 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 25 Hz. 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.

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

Parameter	Value
Minimum ambient temperature	-25° C

Continues on next page

Parameter	Value
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	+5ºC [i]
Maximum ambient temperature	+45ºC
Maximum ambient temperature for robots with food grade lubrication	+35ºC [ii]
Maximum ambient humidity	Max 95% at constant temperature

i At low environmental temperature < 10ºC is, as with any other machine, a warm-up phase recommended to be run with the robot. Otherwise there is a risk that the robot stops or run with lower performance due to temperature dependent oil and grease viscosity.

ii For robots with food grade lubrication, if environment temperature > 35ºC, contact ABB for further information.

Protection classes, robot

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

Protection type	Protection class
Manipulator, protection type Standard	IP 30
Manipulator, protection type Clean Room	IP 30

2.2.2 Working range and type of motion

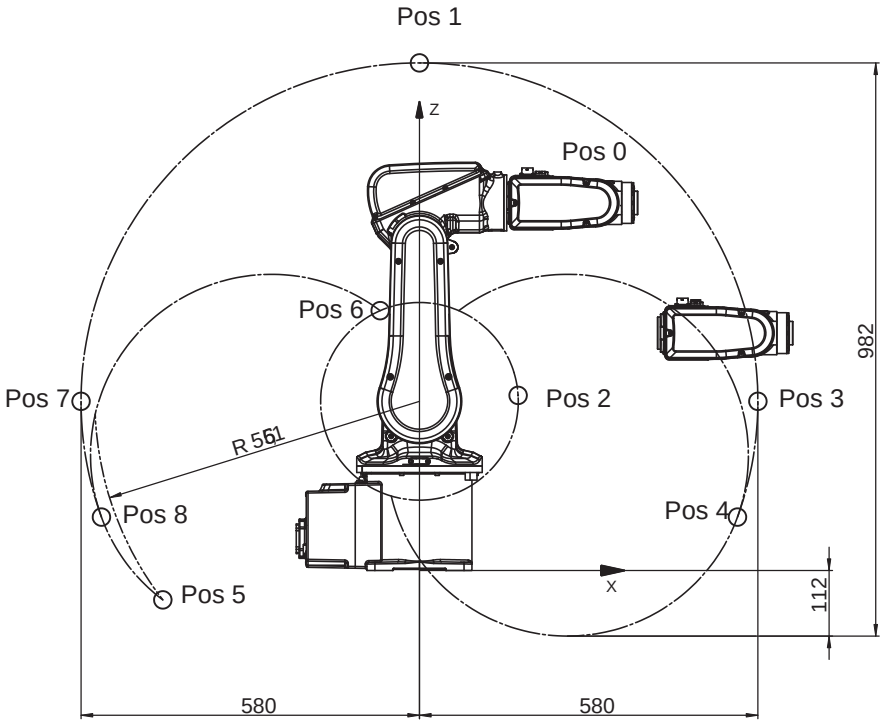
Working range

The figures show the working ranges of the robot.

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

Working range

The illustration shows the unrestricted working range of the robot.



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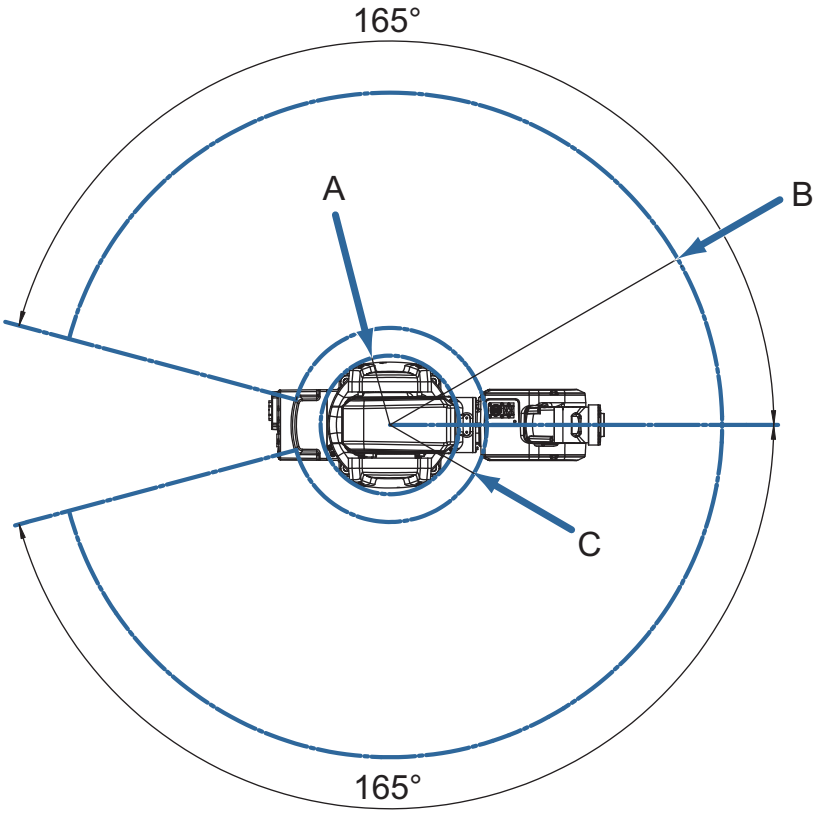
Position	Position at wrist center (mm)		Angle (degrees)	
	X	Z	Axis 2	Axis 3
A	302 mm	630 mm	0°	0°
B	0 mm	870 mm	0°	-77°
C	169 mm	300 mm	0°	+70°
D	580 mm	270 mm	+90°	-77°
E	545 mm	91 mm	+110°	-77°
F	-440 mm	-50 mm	-110°	-110°
G	-67 mm	445 mm	-110°	+70°
H	-580 mm	270 mm	-90°	-77°
J	-545 mm	91 mm	-110°	-77°

Continues on next page

Turning radius

The turning radius of robot is shown in the figure.



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Robot variant	Pos. A	Pos. B	Pos. C
IRB 120-3/0.6	R121 i	R580	R169.4

i Minimum turning radius axis 1.

Robot motion

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

Location of motion	Type of motion	Range of movement
Axis 1	Rotation motion	+165° to -165°
Axis 2	Arm motion	+110° to -110°
Axis 3	Arm motion	+70° to -110°
Axis 4	Wrist motion	+160° to -160°
Axis 5	Bend motion	+120° to -120°
Axis 6	Turn motion	+400° to -400° (default) +242 revolutions to -242 revolutions maximum i

i The default working range for axis 6 can be extended by changing parameter values in the software.
Option 610-1 Independent axis can be used for resetting the revolution counter after the axis has been rotated (no need for "rewinding" the axis).

2.2.3 Risk of tipping/stability

Risk of tipping

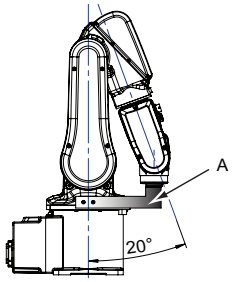
If the robot is not fastened to the foundation while moving the arm, the robot is not stable in the whole working area. Moving the arm will displace the center of gravity, which may cause the robot to tip over.

The shipping position is the most stable position.

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

Shipping and transportation position

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



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WARNING

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

2.3 On-site installation

2.3.1 Lifting the robot with roundslings

Introduction

This procedure details how to lift the robot using roundslings.

Required equipment

Equipment	Note
Overhead crane	-
Roundslings	(Circle) Length: 3 m Lifting capacity: 100 kg
Lifting tool, set	The set includes: • bracket • attachment screws • washers. For art. no. and details see chapter *Reference information* section: • *Special tools on page 261*

Lifting

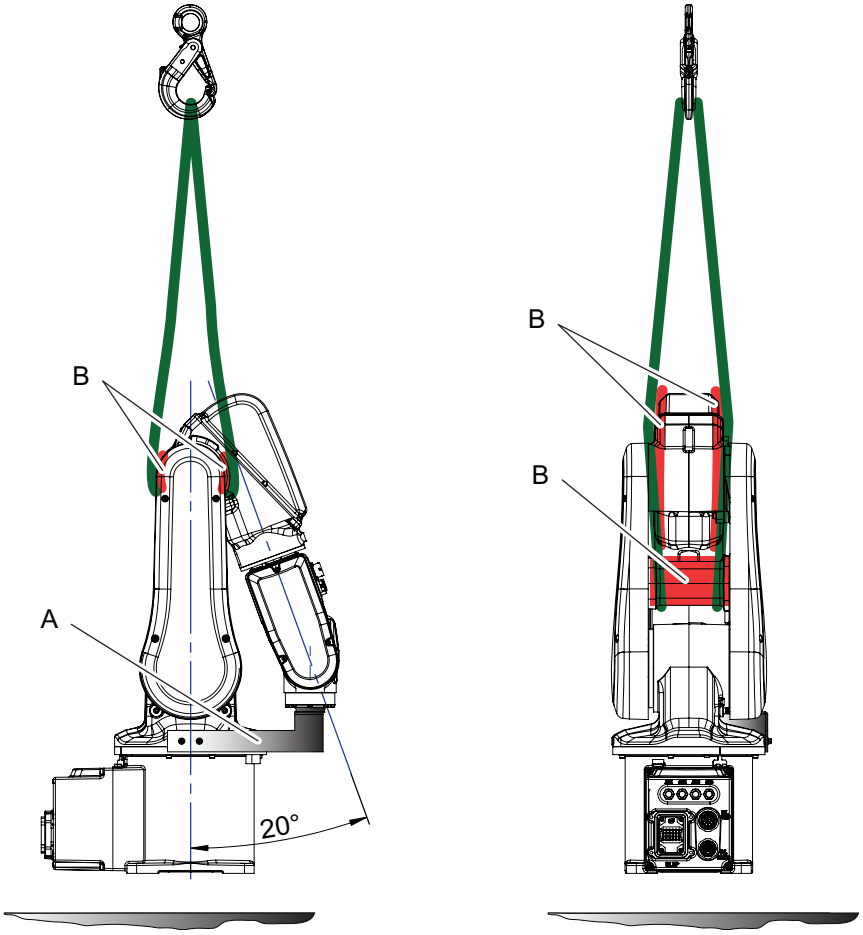
Attach the roundslings as shown in the figure.

CAUTION

Use a thick cloth between round sling and robot where robot surface directly contact with round sling.

Continues on next page

2.3.1 Lifting the robot with roundslings
Continued



xx0900000496

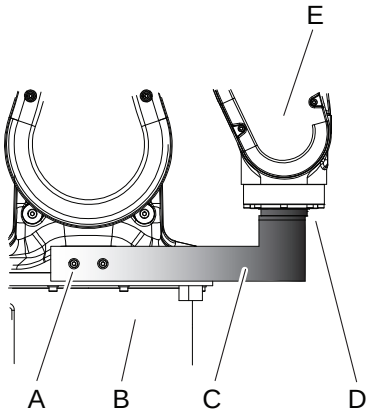
A	Bracket
B	Thick cloth

Lifting instructions

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

	Action	Note
1	**CAUTION** The IRB 120 robot weighs 25 kg. All lifting accessories used must be sized accordingly!	
2	**CAUTION** Attempting to lift the robot in any other position than that recommended may result in the robot tipping over and causing severe damage or injury!	

Continues on next page

	Action	Note
3	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	
4	Move the robot to its most stable position.	Detailed in section: • *Risk of tipping/stability on page 62*
5	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
6	Fit the *bracket* with its attachment screws and washers, in order to secure the upper arm to the base.	See *Required equipment on page 63*.  xx0900000636 Parts: • A: Attachment screws M4x10 quality steel 8.8 ELZN (2 pcs) • B: Base • C: Bracket • D: Attachment screws M5x12 quality 8.8-A2F (2 pcs) • E: Upper arm
7	Attach the *roundsling*.	See the figure in: • *Lifting on page 63*
8	Lift the robot with an overhead crane.	

2.3.2 Manually releasing the brakes

Introduction to manually releasing the brakes

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

This can be done in three ways:

- using the brake release unit (placed on the front of the IRC5 Compact controller) when the robot is connected to the controller. For other controller variants, the placing depends on the design of the cell.
- 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.

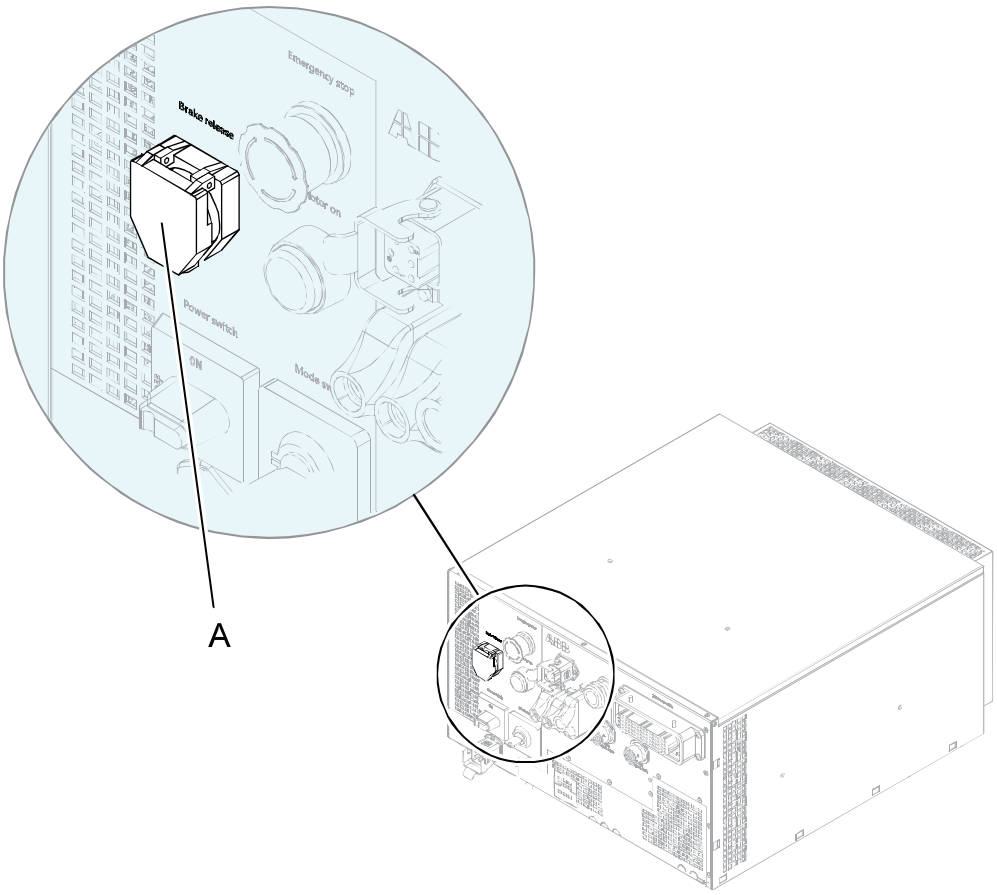
Note

On the single controller there is no brake release button. The customer or integrator is responsible to ensure that it in case of emergency is possible to release the brakes to move the manipulator axes without using motion power.

Continues on next page

Brake release button at the front of IRC5 Compact controller

The **IRB 120** robot has no brake release button, instead use the brake release button on the IRC5 Compact controller. For other controller variants, the placing depends on the design of the cell.



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A	Brake release button (beneath the cover)

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

Use this procedure to release the holding brakes using the internal brake release unit in the controller cabinet.

	Action	Note
1	The *brake release button* is located on the front of the IRC5 Compact controller. **Note** The single brake release button, is used to release the brakes on all axes.	See the figure in: • *Brake release button at the front of IRC5 Compact controller on page 67*

Continues on next page

2.3.2 Manually releasing the brakes
Continued

	Action	Note
2	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways! Make sure no personnel is near the robot when brakes are released!	
3	Release the holding brakes by pushing the brake release button. The brake will function again as soon as the button is released.	**Note** The controller must be powered on!

Using the brake release unit with an external power supply

Use this procedure to release the holding brakes, when the robot is not connected to the controller.

	Action	Note
1	**Note** Do not interchange the 24V and 0V pins. If they are mixed up, damage can be caused to the brake release unit and to the system board.	

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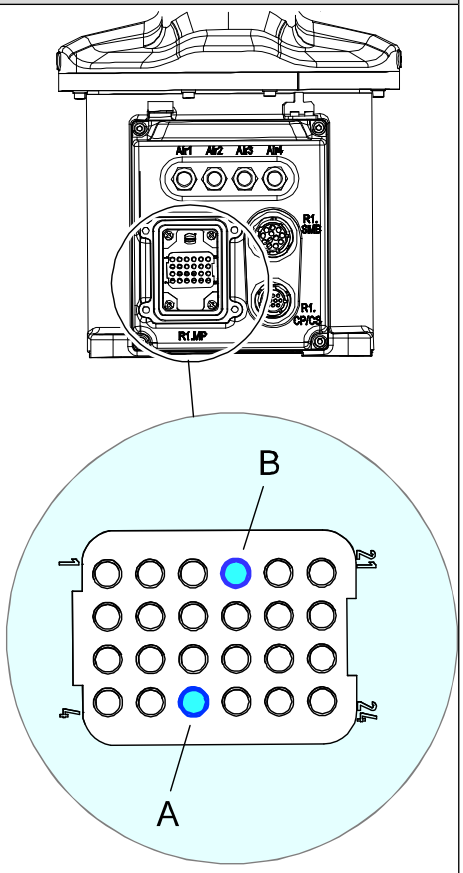
	Action	Note
2	Connect an external 24VDC power supply to connector R1.MP on the robot base.	 xx0900000638 Connect to connector R1.MP: • A: 0V to pin 12 • B: 24V to pin 13
3	**CAUTION** The holding brakes are released to all axes when power is connected to the pins.	

2.3.3 Orienting and securing the robot

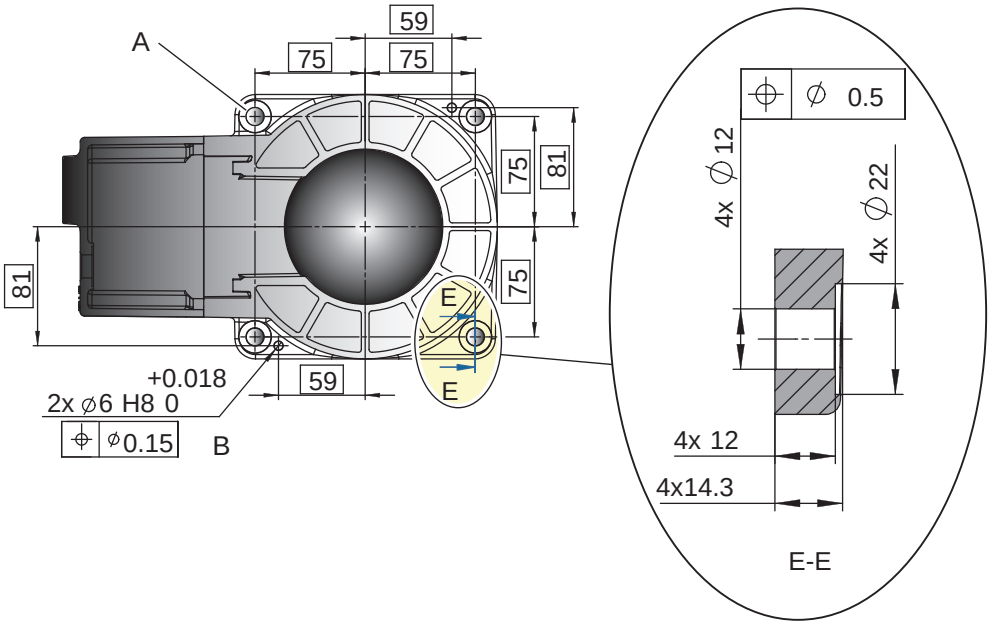
Introduction

This section details how to orient and secure the robot to the foundation or base plate in order to run the robot safely. The requirements made on the foundation are shown in sections:

- *Loads on foundation, robot on page 57*
- *Requirements, foundation on page 58*.

Hole configuration, base

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



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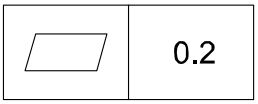
A	Holes for attachment screws (4 pcs)
B	Holes for pins (2 pcs)

Specification, attachment screws and pins

The table specifies the type of securing screws and washers to be used to secure the robot directly to the foundation. It also specifies the type of pins to be used.

Suitable screws	M10x25
Quantity	4 pcs
Quality	8.8-A3F
Suitable washer	10 mm
Guide pins	2 pcs, D6x20 ISO 2338-6 m6x30 - A1
Tightening torque	35 Nm

Continues on next page

Level surface requirements	 xx0900000643

Orienting and securing the robot

Use this procedure to orient and secure the robot.

	Action	Information
1	Make sure the installation site for the robot conforms to the specifications in section: • *Pre-installation procedure on page 56*.	
2	Prepare the installation site with attachment holes.	The hole configuration of the base is shown in the figure in: • *Hole configuration, base on page 70*
3	**CAUTION** The robot weighs 25 kg. All lifting equipment must be sized accordingly!	
4	**CAUTION** When the robot is put down after being lifted or transported, there is a risk of it tipping, if not properly secured.	
5	Lift the robot to its installation site.	How to lift the robot is described in section: • *Lifting the robot with roundslings on page 63*
6	Fit two *pins* to the holes in the base.	2 pcs, D6x20 ISO 2338-6 m6x30 - A1
7	Guide the robot gently, using the attachment screws while lowering it into its mounting position.	Make sure the robot base is correctly fitted onto the pins.
8	Fit the *securing screws* and *washers* in the attachment holes of the base.	Screws: M10x25, quality: 8.8-A3F
9	Tighten the bolts in a criss-cross pattern to ensure that the base is not distorted.	Tightening torque: 35 Nm

Securing robot on a mounting plate

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

Screw joints must be able to withstand the stress loads defined in section *Loads on foundation, robot on page 57*.

2.3.4 Fitting equipment on robot

Introduction

The robot features mounting holes for additional equipment.

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

Note

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

Note

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

Maximum loads

The table shows the maximum permitted loads for any extra equipment fitted in the holes intended for this purpose. See figure in *Fitting equipment on base and upper arm on page 73*.

Robot	Max load A (base, on each side)	Max load B (upper arm)
IRB 120	0.5 kg	0.3 kg

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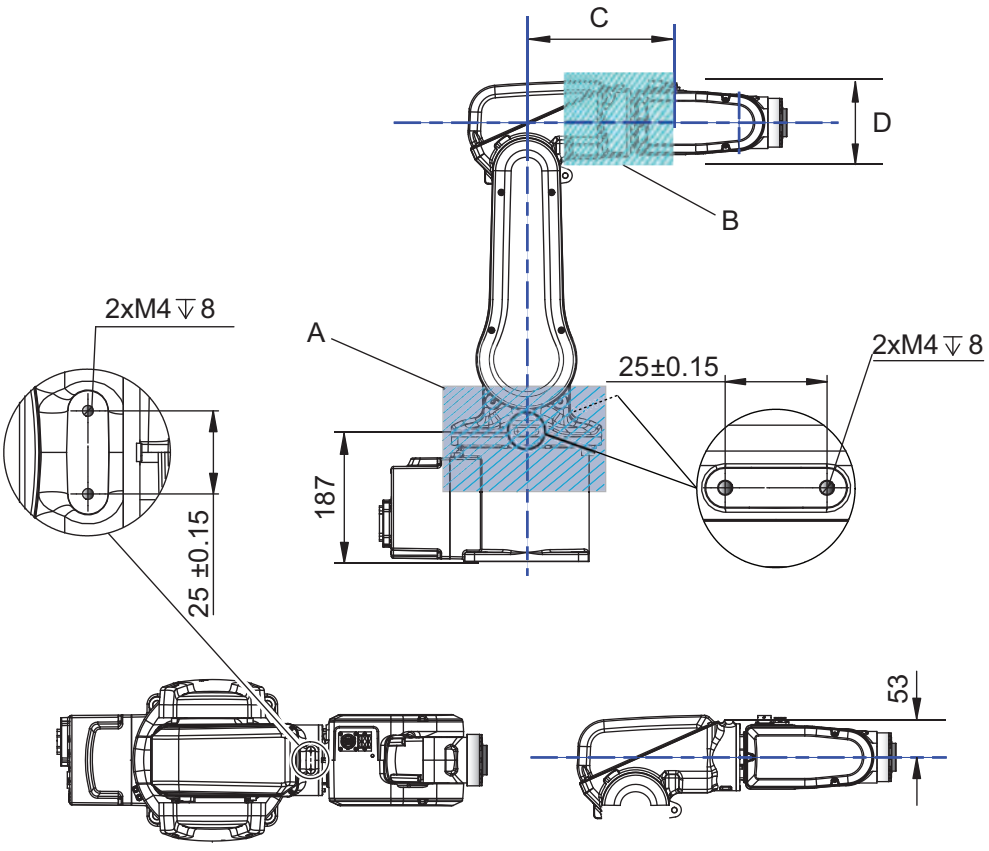
Fitting equipment on base and upper arm

The illustration shows the fitting holes available for fitting extra equipment on the base and upper arm of the robot.



xx0900000203

A	Load area base, max load 0.5 kg (on each side)
B	Load area upper arm, max load 0.3 kg
C	Max. 172 mm
D	Max. radius 75 mm

NOTE! Fitting holes at the base of the robot are placed on each side.

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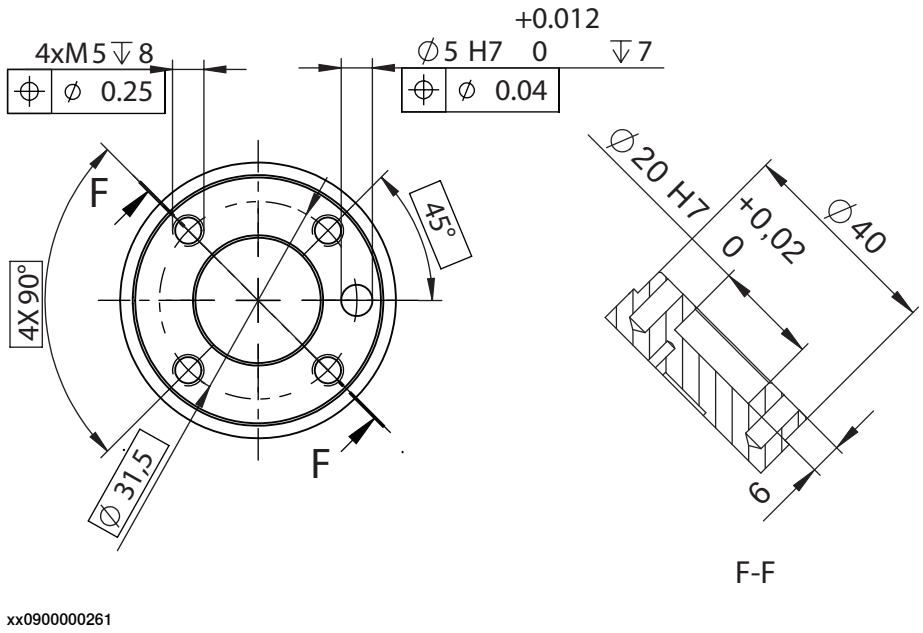
2.3.4 Fitting equipment on robot
Continued

Fitting equipment on mounting flange

The illustration shows the mechanical interface for the mounting flange.



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2.3.5 Setting the system parameters for a suspended or tilted robot

General

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

Note

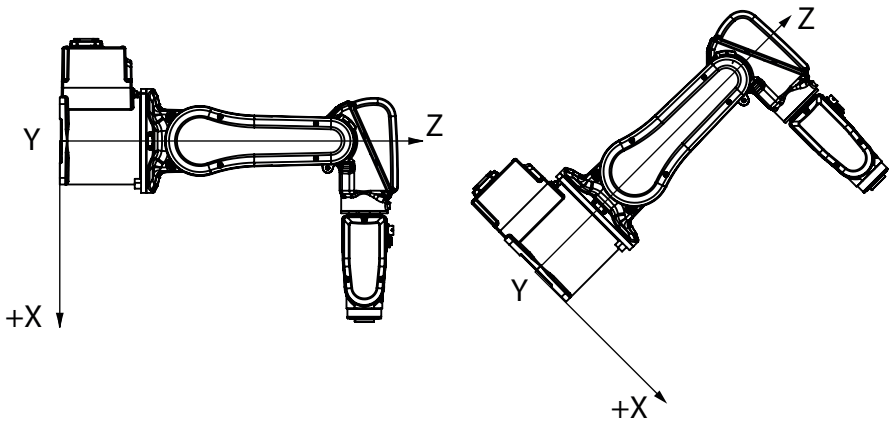
With suspended installation, make sure that the gantry or corresponding structure is rigid enough to prevent unacceptable vibrations and deflections, so that optimum performance can be achieved.

Note

The allowed mounting positions are described in the product specification for the robot. The requirements on the foundation are described in *Requirements, foundation on page 58*.

The x-direction in the base coordinate system

If the robot is wall mounted or mounted in a tilted position, it is important that the x-direction of the robot base coordinate system points downwards, as shown in the following figure.



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

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 (±3.141593/2) 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 (±3.141593/2).

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).

Continues on next page

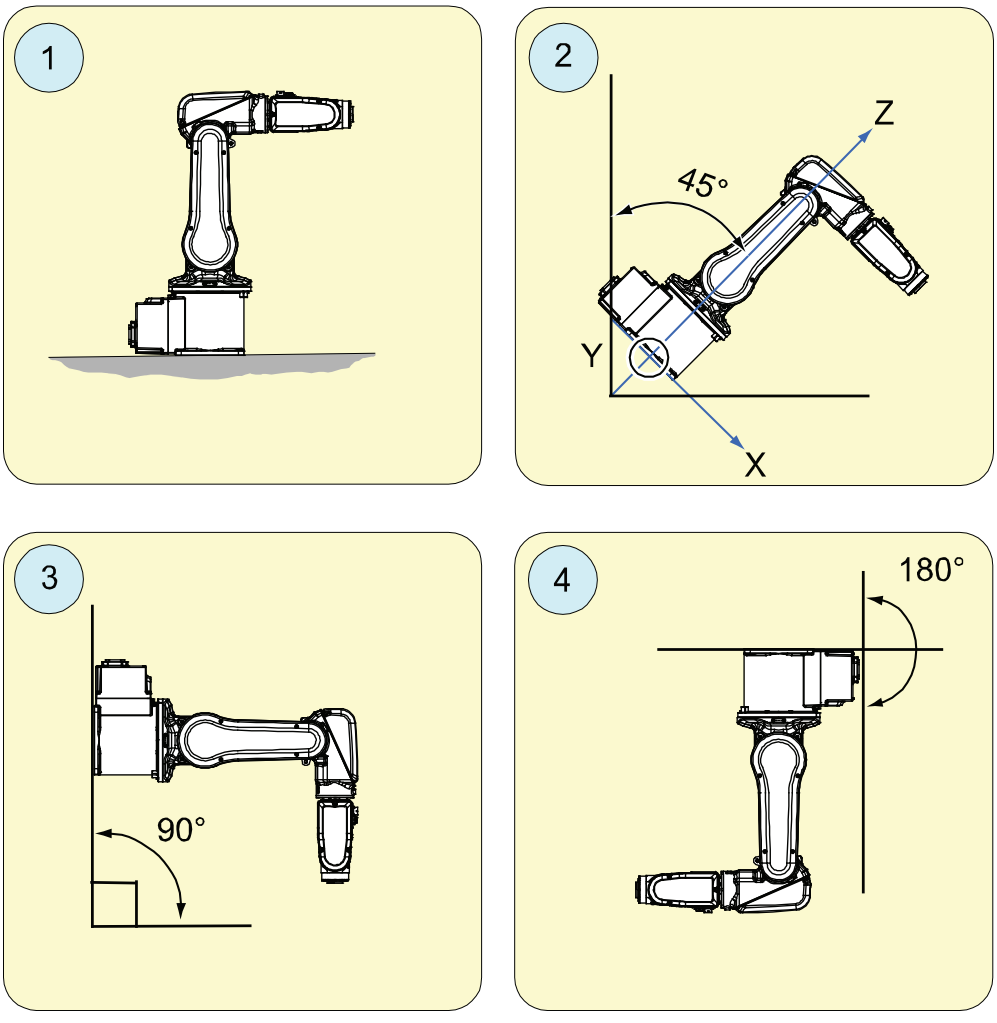
Mounting angles and values

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

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



xx1000000126

Pos 1	Floor mounted
Pos 2	Mounting angle 45° (Tilted)
Pos 3	Mounting angle 90° (Wall)
Pos 4	Mounting angle 180° (Suspended)

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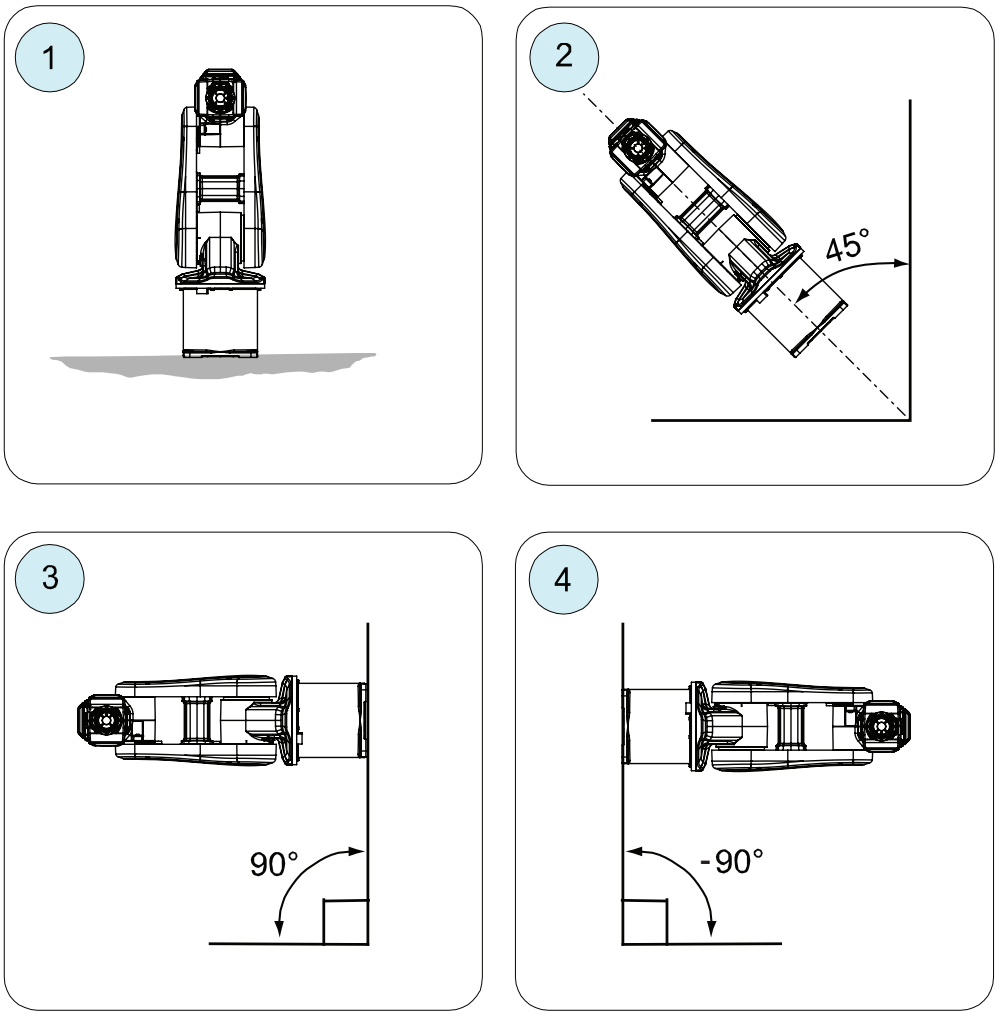
2.3.5 Setting the system parameters for a suspended or tilted robot
Continued

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



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*.

Defining the parameter in the IRC5 software

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

How to calculate a new value is detailed in *Mounting angles and values on page 77*.

Continues on next page

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

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

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

General

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

CAUTION

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

References

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

- *Operating manual - IRC5 with FlexPendant*

Stopping time and braking distances

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

2.4 Restricting the working range

2.4.1 Axes with restricted working range

General

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

The working range of the following axes may be restricted:

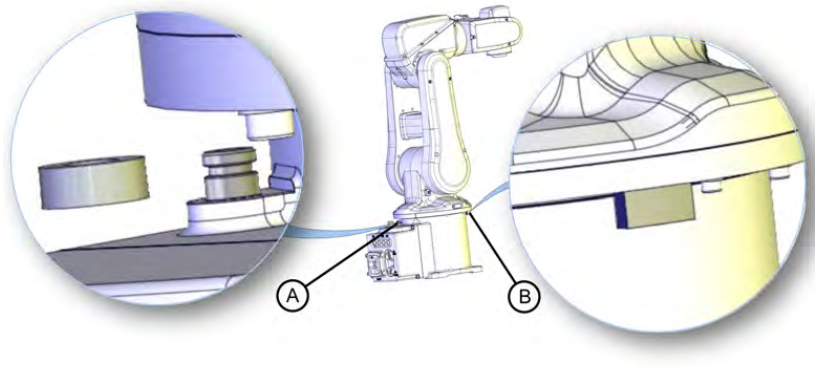
This section describes how to install hardware that restricts the working range.

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

2.4.2 Mechanically restricting the working range

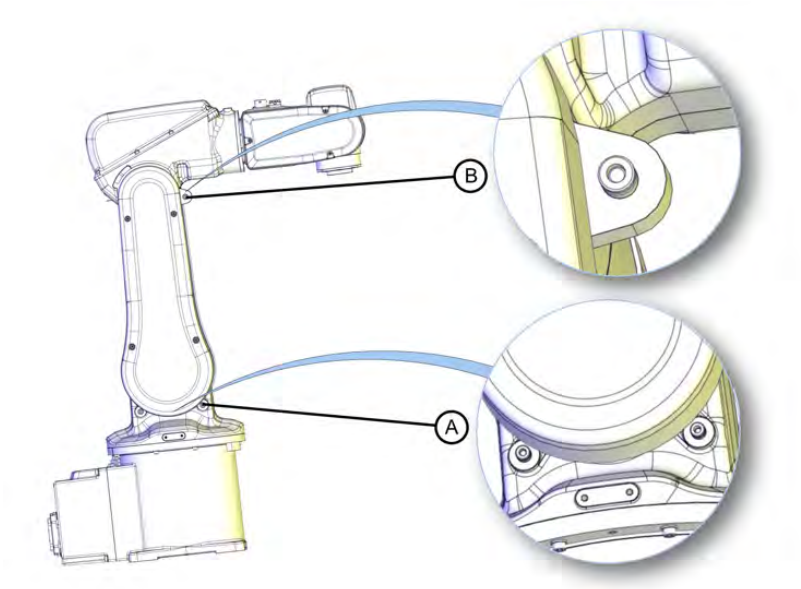
Location of mechanical stops

The figures shows where the mechanical stops are placed on the robot.



xx1000000002

A	Mechanical stop axis 1 (base)
B	Mechanical stop axis 1 (swing plate)



xx0900000583

A	Mechanical stop axis 2 (swing housing)
B	Mechanical stops axis 2 (upper arm)

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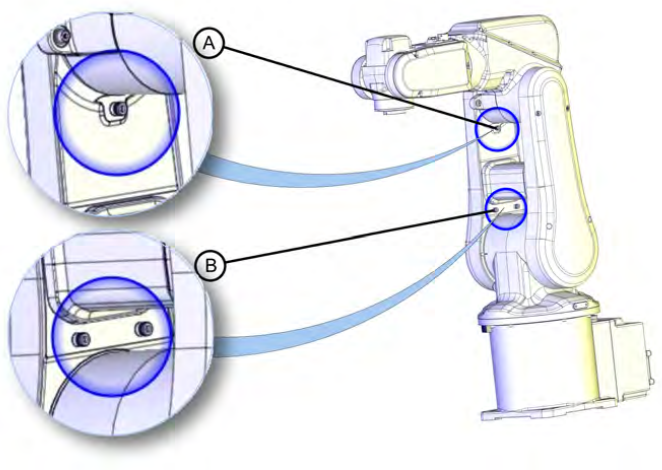


xx1000000003

A	Mechanical stop axis 3 (lower arm)
B	Mechanical stops axis 2 (lower arm)

2.5 Making robot ready for operation

2.5.1 Additional installation procedure, Clean Room

General

Robots with protection type Clean Room are specially designed to work in a clean room environment.

Clean Room robots are designed to prevent from particle emission from the robot. For example, the maintenance work possible to perform without cracking the paint. The robot is painted with four layers of polyurethane paint. The last layer being a varnish over labels to simplify cleaning. The paint has been tested regarding outgassing of Volatile Organic Compounds (VOC) and been classified in accordance with ISO 14644-8.

Any Clean Room parts that are replaced must be replaced with parts designed for use in Clean Room environments.

Clean Room class 5

According to **IPA test result**, the robot IRB 120 is suitable for use in Clean Room environment when these requirements are fulfilled:

- Air cleanliness Class 5 according to ISO 14644-1, when operated at a velocity of 50%.
- Air cleanliness Class 4 according to ISO 14644-1, when operated at a velocity of 100%.

Classification of airborne molecular contamination

Parameter				Outgassing amount		
Area (m^2)	Test duration (s)	Temp (°C)	Performed test	Total detected (ng)	Norm based on $1m^2$ and 1s(g)	Classification in accordance to ISO 14644-8
4.5E-03	3600	23	TVOC	2848	1.7E-07	-6.8
4.5E-03	60	90	TVOC	46524	1.7E-04	-3.8

Preparations before commissioning a Clean Room robot

During transport and handling of a Clean Room robot, it is likely that the robot has been contaminated with particles of different kinds. Therefore the robot must be carefully cleaned before installation.

Do not apply force on the plastic covers when lifting the robot! This may result in damage or cracks in the paint around the plastic cover.

2.6 Electrical connections

2.6.1 Robot cabling and connection points

Introduction

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

Connection point locations

For information about the connection point locations, see the chapter *Circuit diagram*.

Main cable categories

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

Cable category	Description
Robot cables	Handles power supply to, and the control of the robot's motors as well as feedback from the encoder interface board. Specified in the table in *Robot cable, power on page 85*.

The cable categories are divided into sub-categories. See *Robot cables on page 85*.

Robot cables

The robot cable is included in the standard delivery of the robot. They are completely pre-manufactured and ready to plug in.

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

Robot cable, power

Cable	Art. no.
Robot cable, power: L=3 m	3HAC032694-001
Robot cable, power: L=7 m	3HAC032695-001
Robot cable, power: L=15 m	3HAC032696-001

Robot cable, signal

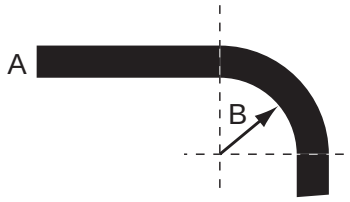
Cable	Art. no.
Robot cable, signal: L=3 m	3HAC035320-001
Robot cable, signal: L=7 m	3HAC2493-1
Robot cable, signal: L=15 m	3HAC2530-1

Continues on next page

2.6.1 Robot cabling and connection points
Continued

Bending radius for static floor cables

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



xx1600002016

A	Diameter
B	Diameter x10

2.6.2 Customer connections on the robot

Introduction

The customer cables are integrated in the robot and the connectors are placed on the upper arm housing and at the base.

Connectors

The tables describes the connectors on base and upper arm housing.

Connectors, base

Position	Description	Art. no.
Robot	UTOW71210PH06 pin connector 10p, bulkhead	3HAC022117-002
Customer connector	Connector set R1.CP/CS	3HAC037038-001

Connectors, upper arm housing

Position	Description	Art. no.
Robot	UTOW01210SH05 socket connector 10p, flange mounted	3HAC023624-002
Customer connector	Connector set R3.CP/CS	3HAC037070-001

Air, connector

Position	Description	Art. no.
Robot	4xM5	
Customer cable	SMC KJS04-M5 air connector	3HAC032049-001

Continues on next page

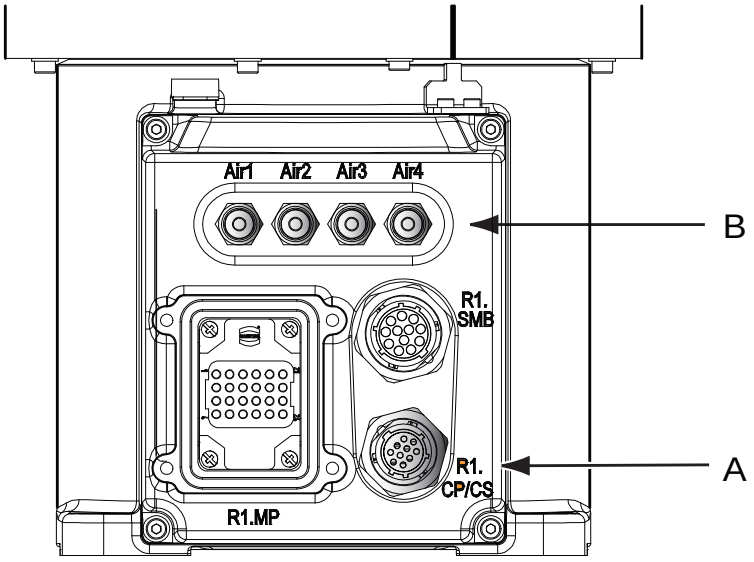
2.6.2 Customer connections on the robot
Continued

Customer connections

The location of the customer connections on the base and at the upper arm housing, are shown in the figures:

Customer connections, base

Customer connections, base.

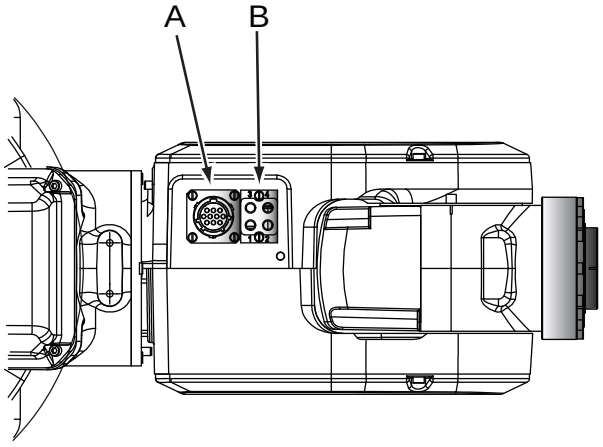


xx0900000639

Pos	Connection	Description	Number	Value
A	R1.CP/CS	Customer power/signal	10	49 V, 500 mA
B	Air	Max 5 bar	4	Inner house diameter 4 mm

Customer connections, upper arm housing

Customer connections, upper arm housing.



xx0900000640

Pos	Connection	Description	Number	Value
A	R3.CP/CS	Customer power/signal	10	49 V, 500 mA
B	Air	Max 5 bar	4	Inner house diameter 4 mm

2.7 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.

	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.

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3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 120.

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

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

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

Safety information

Observe all safety information before conducting any service work!

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

Note

If the IRB 120 is connected to power, always make sure that the IRB 120 is connected to protective earth before starting any maintenance work!

For more information see:

- *Product manual - IRC5*

3.2 Maintenance schedule

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 120:

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

3.2.2 Maintenance schedule

General

The robot, 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 damages 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 1, 2 and 3	Regularly [i]	*Inspecting dampers on page 99*
Inspection	Cable harnesses	Regularly [i]	*Inspecting the robot cabling on page 95*
Inspection	Timing belts	36 mths [ii]	*Inspecting timing belts on page 101*
Inspection	Plastic covers	Regularly [i]	*Inspecting plastic covers on page 105*
Inspection	Mechanical stop pins	Regularly [i]	*Inspecting mechanical stops on page 96*
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [iii]	*Replacing the battery pack on page 109*
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [iv]	*Replacing the battery pack on page 109*
Cleaning	Complete robot	Regularly [i]	*Cleaning the IRB 120 on page 112*

[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] Service inspection including dismounting of robot parts shall always be done outside the clean room area.

Continues on next page

3.2.2 Maintenance schedule

Continued

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

See the replacement instruction for more details.

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

3.3 Inspection activities

3.3.1 Inspecting the robot cabling

Introduction

CAUTION

Always read the specific instructions if the robot has protection type Clean Room, before doing any repair work, see *Replacing parts on the robot on page 118*

Location of robot cabling

The robot cabling comprises the cabling between the robot and controller cabinet.

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.

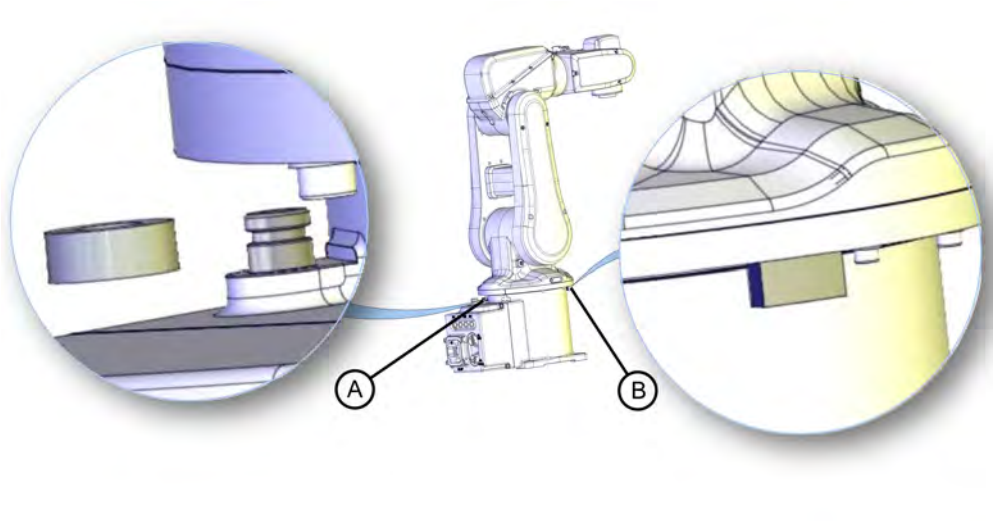
	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Visually inspect: • the control cabling between the robot and control cabinet Look for abrasions, cuts or crush damages.	
3	Replace the cabling if wear or damage is detected.	

3.3.2 Inspecting mechanical stops

Location of mechanical stops

The mechanical stops on axes 1, 2 and 3 are located as shown in the figures.

Axis 1



xx1000000002

A	Mechanical stop axis 1 (base)
B	Mechanical stop axis 1 (swing plate)

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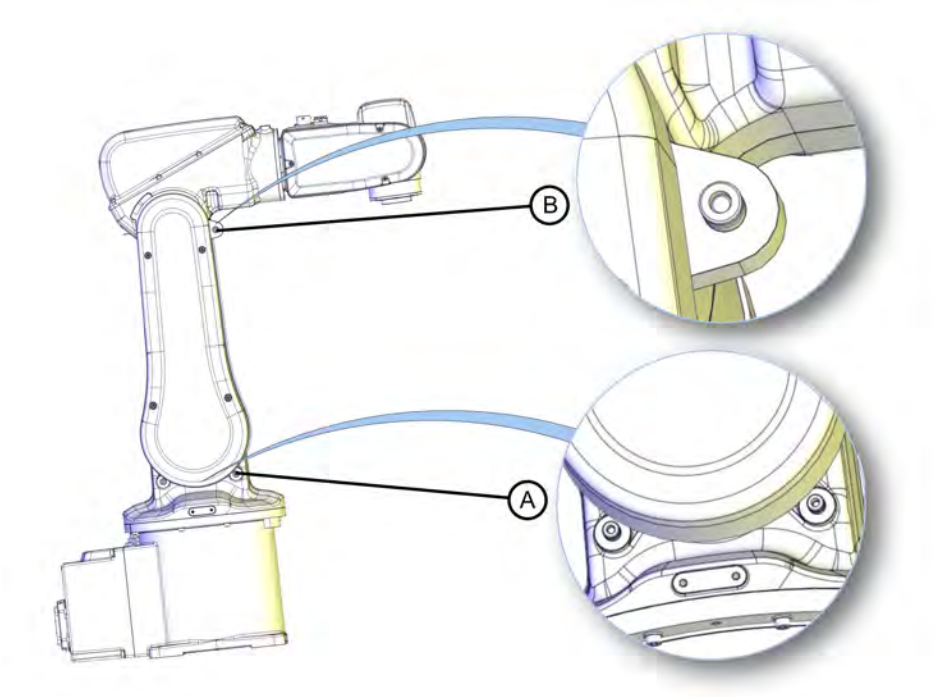
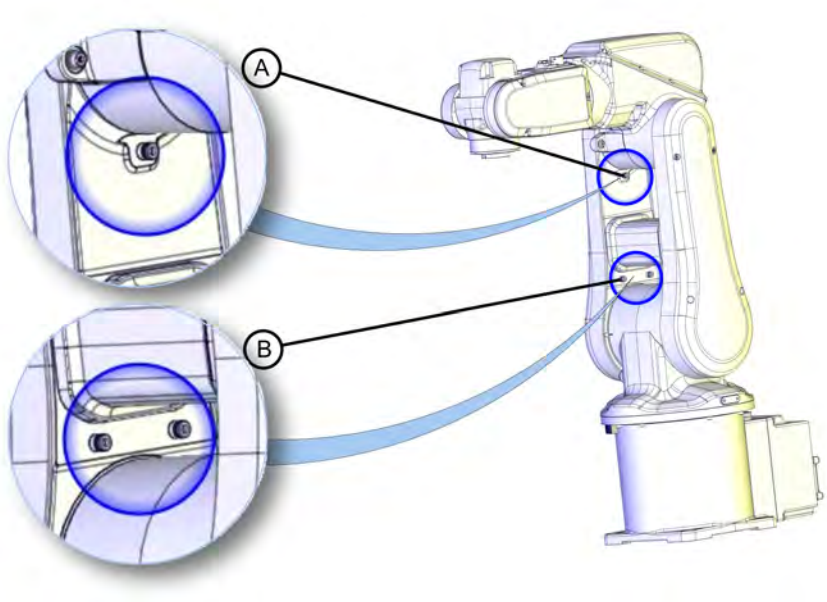
Axis 2



xx0900000583

A	Mechanical stops axis 2 (swing housing)
B	Mechanical stop axis 3 (upper arm)

Axis 3



xx1000000003

A	Mechanical stop axis 3 (lower arm)
B	Mechanical stops axis 2 (lower arm)

Continues on next page

3.3.2 Inspecting mechanical stops
Continued

Required spare parts

Note

The spare part numbers that are listed in the table can be out of date. See the latest revision of *Product manual, spare parts - IRB 1200* on ABB Library.

Spare part	Article number	Note
Mechanical stop set	See *Spare parts on page 263*.	
Mechanical stop set	See *Spare parts on page 263*.	
Mechanical stop set	See *Spare parts on page 263*.	

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.

Inspecting mechanical stops

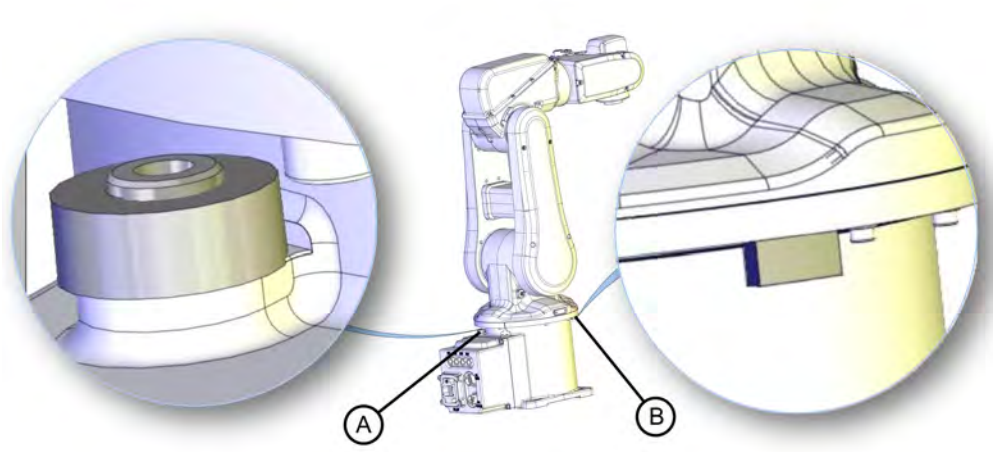
Use this procedure to inspect mechanical stops on axes 1, 2 and 3.

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Inspect the *mechanical stops*.	See the figures in: • *Location of mechanical stops on page 96*
3	Replace if the mechanical stop is: • bent • loose • damaged. **Note** The expected life of gearboxes can be reduced as a result of collisions with the mechanical stop.	

3.3.3 Inspecting dampers

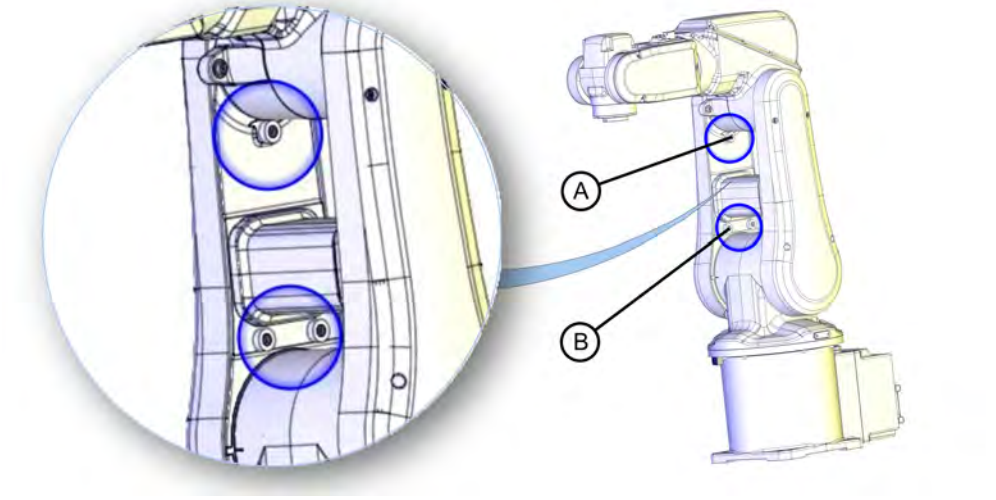
Location of dampers

The location of dampers are shown in the figures.



xx0900000579

A	Damper, axis 1
B	Mechanical stop axis 1 (swing plate)



xx0900000582

A	Damper, axis 3
B	Dampers, axis 2

Required equipment

Equipment	Art. no.	Note
Standard toolkit	-	The content is defined in the section *Standard toolkit on page 260*.

Continues on next page

3.3.3 Inspecting dampers
Continued

Inspecting dampers

Use this procedure to inspect the dampers.

	Action	Information
1	 **DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check all *dampers* for damage such as: • cracks • existing impressions larger than 1 mm.	See the figure in: • *Location of dampers on page 99*
3	Check all *attachment screws* for deformation.	
4	If any damage is detected, the damper must be replaced with a new one!	

3.3.4 Inspecting timing belts

Introduction

CAUTION

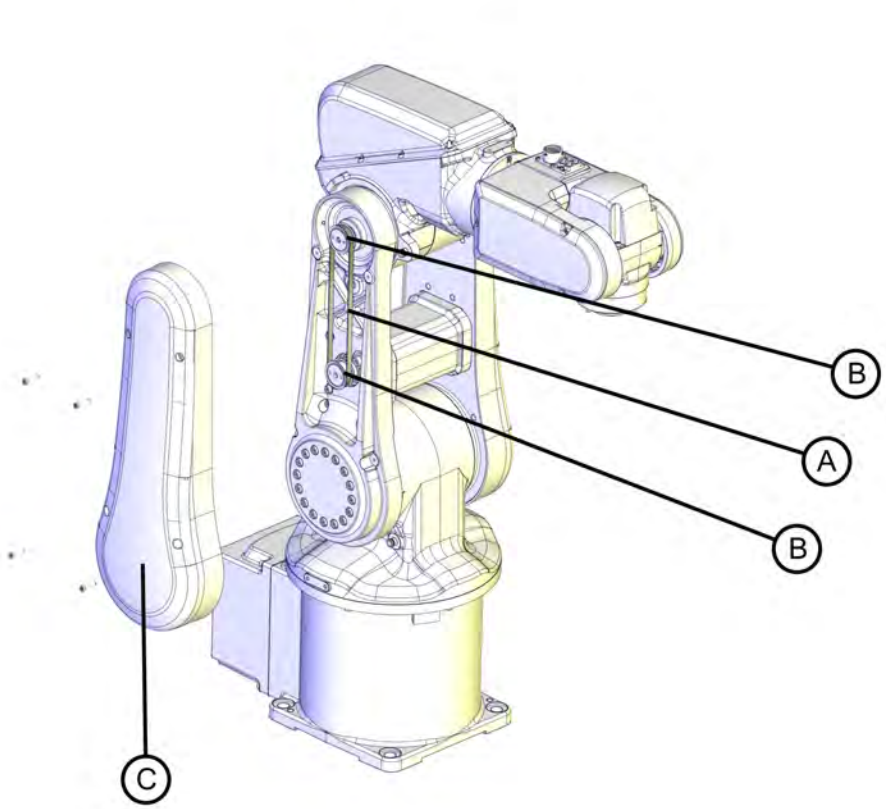
Always read the section "General procedures" befor doing any repair work.

Replacing parts on the robot on page 118

Location of timing belts

The timing belts are located as shown in the figures.

Axis 3



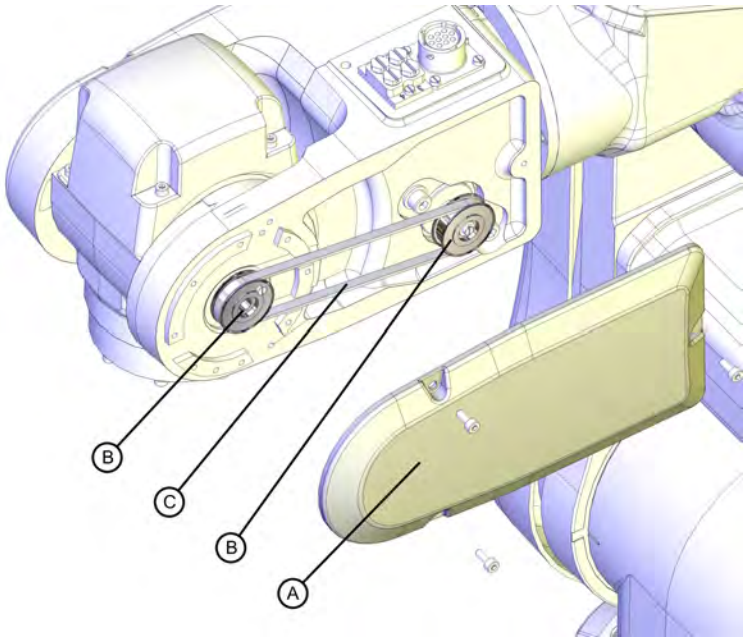
xx0900000610

A	Timing belt, axis 3
B	Timing belt pulley (2 pcs)
C	Lower arm cover

Continues on next page

3.3.4 Inspecting timing belts
Continued

Axis 5



xx0900000611

A	Wrist side cover
B	Timing belt pulley (2 pcs)
C	Timing belt, axis 5

Required tools and equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required if the spare part needs to be replaced. These are specified in the replacement procedure.	

Timing belt tension

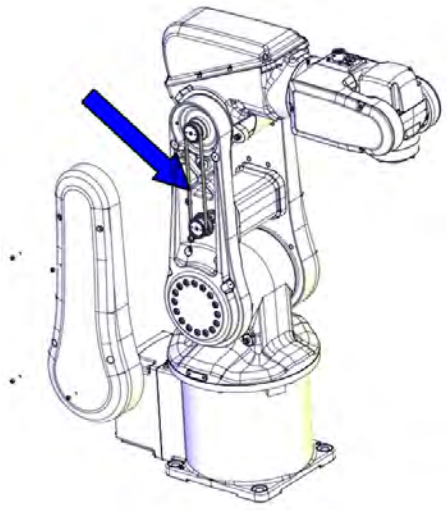
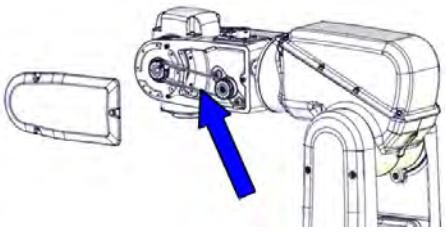
The table describes the timing belt tension.

Axis	Timing belt tension
Axis 3	New belt: F = 18-19.7N Used belt: F = 12.5-14.3N
Axis 5	New belt: F = 7.6-8.4N Used belt: F = 5.3-6.1N

Continues on next page

Inspecting timing belts

Use this procedure to inspect timing belts.

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Gain access to each *timing belt* by removing the cover.	 xx1300002286  xx1300002287
3	Check the timing belts for damage or wear.	

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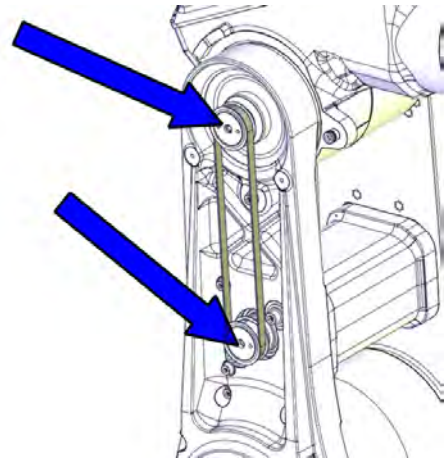
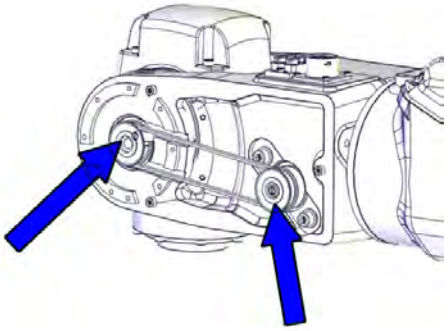
3.3.4 Inspecting timing belts
Continued

	Action	Information
4	Check the *timing belt pulleys* for damage.	 xx1300002288  xx1300002289
5	If any damage or wear is detected, the part must be replaced!	
6	Check each belt for tension. If the belt tension is not correct, adjust it!	Axis 3: . New belt: F = 18-19.7N Used belt: F = 12.5-14.3N Axis 5: . New belt: F = 7.6-8.4N Used belt: F = 5.3-6.1N

3.3.5 Inspecting plastic covers

Introduction

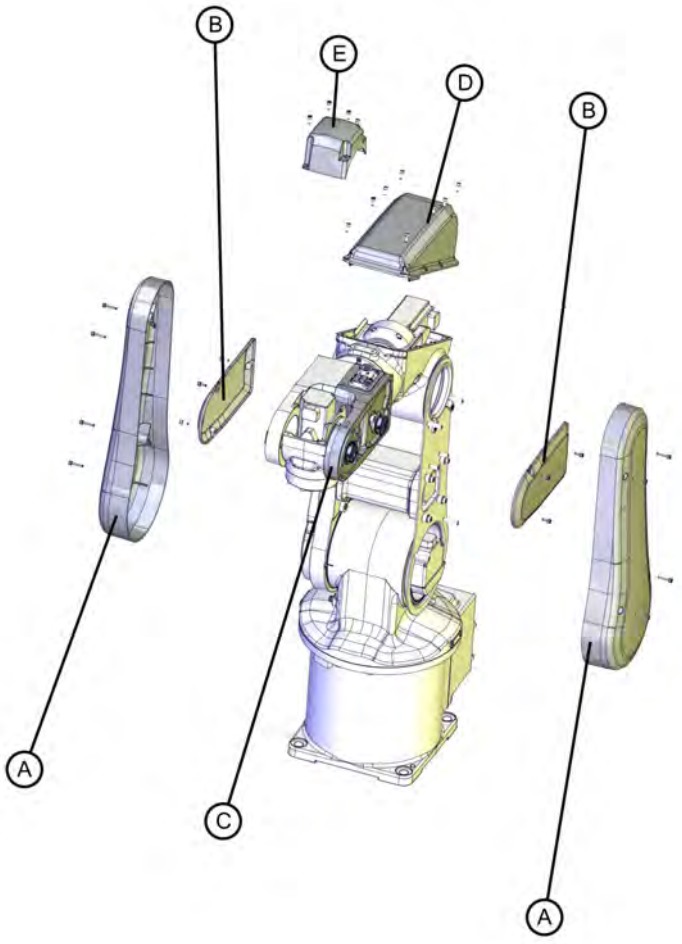
CAUTION

Always read the section "General procedures" befor doing any repair work.

Replacing parts on the robot on page 118

Location of plastic covers

Plastic covers are located as shown in the figure.



xx0900000607

A	Lower arm cover (2 pcs)
B	Wrist side cover (2 pcs)
C	Wrist support
D	Housing cover
E	Tilt cover

Continues on next page

3.3.5 Inspecting plastic covers
Continued

Inspecting plastic covers

Use this procedure to inspect the plastic covers on the robot.

	Action	Information
1	 **DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check the plastic covers for: • cracks • other kind of damage.	
3	Replace the plastic cover if cracks or damage is detected.	

3.4 Replacement/changing activities

3.4.1 Type of lubrication in gearboxes

Introduction

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

> **CAUTION**
>
> Always read the specific instructions for Clean Room robots before doing any repair work, see *Replacing parts on the robot on page 118*.

Type and amount of oil in gearboxes

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

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

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

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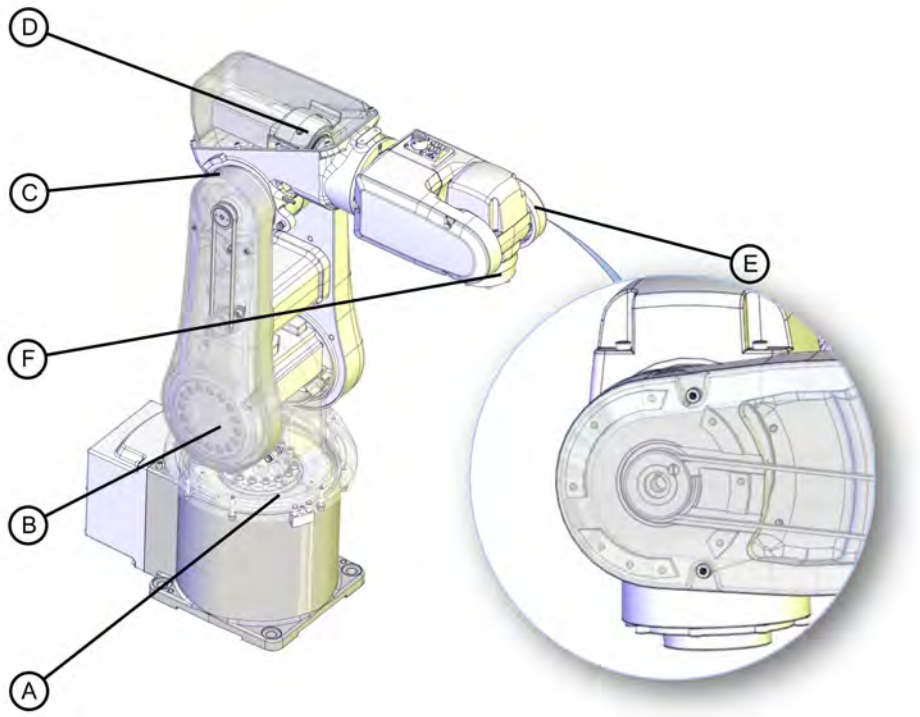
3.4.1 Type of lubrication in gearboxes

Continued

Location of gearboxes

The figure shows the location of the gearboxes.



xx0900000612

A	Gearbox. axis 1 (inside the base)
B	Gearbox, axis 2
C	Gearbox, axis 3
D	Gearbox, axis 4
E	Gearbox, axis 5
F	Gearbox, axis 6

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	

3.4.2 Replacing the battery pack

Introduction

The section describes how to replace the battery pack on the robot.

CAUTION

Always read the section "General procedures" befor doing any repair work.

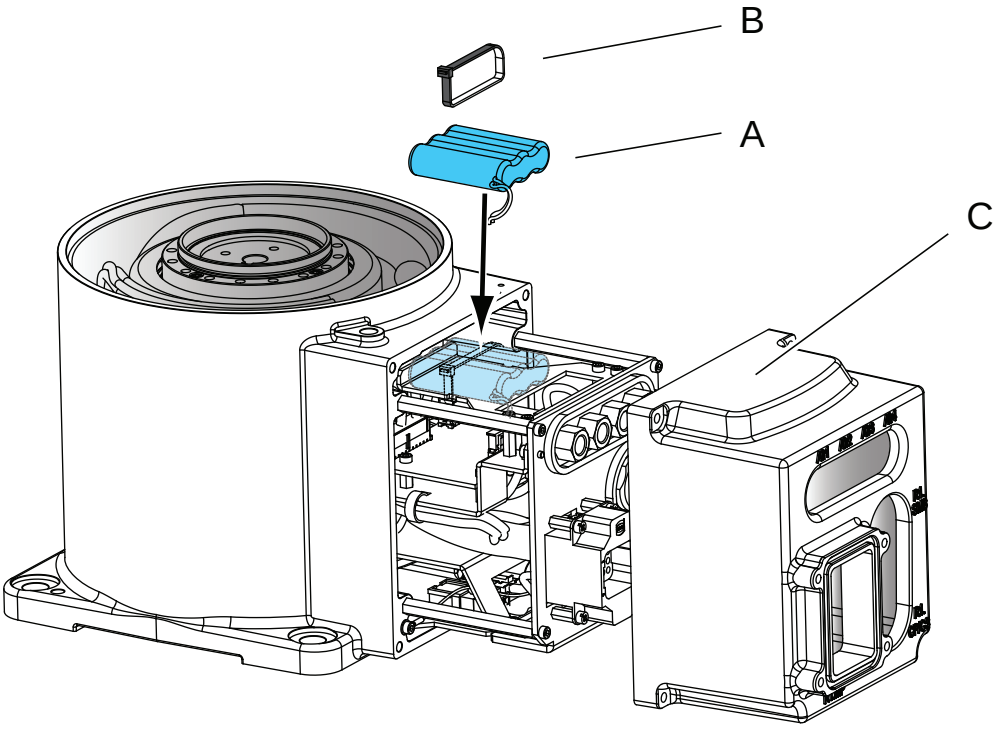
Replacing parts on the robot on page 118

WARNING

See instructions for batteries, *WARNING - Safety risks during handling of batteries on page 52*.

Location of the battery pack

The location of the battery pack is inside the base cover as shown in the figure.



xx0900000588

A	Cable strap
B	Battery pack
C	Base cover

Continues on next page

3.4.2 Replacing the battery pack

Continued

Required equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Removing the battery pack

Use this procedure to remove the battery pack.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
3	Remove the *base cover* from the robot by removing its attachment screws.	The *battery pack* is located inside the base cover as shown in the figure in: • *Location of the battery pack on page 109*
4	Disconnect the battery cable from the Encoder Interface Board.	
5	Cut the cable strap.	
6	Remove the battery pack.	

Refitting the battery pack

Use this procedure to refit the battery pack.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Fit the new battery pack with a *cable strap*.	See the figure in: • *Location of the battery pack on page 109*
3	Connect the battery cable to the Encoder Interface Board.	
4	Refit the *base cover* to the robot with its attachment screws.	See the figure in: • *Location of the battery pack on page 109*

Continues on next page

	Action	Information
5	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
6	Update the revolution counters.	

3.5 Cleaning activities

3.5.1 Cleaning the IRB 120

WARNING

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

General

To secure high uptime it is important that the IRB 120 is cleaned regularly. The frequency of cleaning depends on the environment in which the manipulator works.

Different cleaning methods are allowed depending on the type of protection of the IRB 120.

Note

Always verify the protection type of the robot before cleaning.

Dos and don'ts!

This section specifies some special considerations when cleaning the robot.

Always!

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

Never!

- Never use compressed air to clean the robot!
- Never use solvents that are not approved by ABB to clean the robot!
- Never remove any covers or other protective devices before cleaning the robot!

Cleaning methods

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

Protection type	Cleaning method			
	Vacuum cleaner	Wipe with cloth	Rinse with water	High pressure water or steam
Standard	Yes	Yes. With light cleaning detergent.	No	No
Clean room	Yes	Yes. With light cleaning detergent, spirit or isopropyl alcohol.	No	No

Continues on next page

Wiping with cloth

Additional cleaning instructions for robots with food grade lubrication

Make sure that no liquid flows into the robot or stagnates in any gap or surface after cleaning.

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.

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4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes all repair activities recommended for the IRB 120 and any external unit.

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

WARNING

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

Required equipment

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

The details of equipment are also available in different lists in the chapter *Reference information on page 255*.

Safety information

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

Note

If the IRB 120 is connected to power, always make sure that the IRB 120 is connected to earth before starting any repair work.

For more information see:

- *Product manual - IRC5*

4.2 General procedures

4.2.1 Mounting instructions for seals

General

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

Equipment

Equipment, etc.	Article number	Note
Grease	3HAB3537-1	Used to lubricate the seals.
Grease	3HAC043771-001	Used to lubricate the seals of robots with food grade lubrication.

Rotating seals

The procedure below describes how to fit rotating seals.

CAUTION

Please observe the following before commencing any assembly of seals:

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

	Action	Note
1	Check the seal to ensure that: • The seal is of the correct type (provided with cutting edge). • There is no damage to the sealing edge (feel with a fingernail).	
2	Inspect the sealing surface before mounting. If scratches or damage are found, the seal must be replaced since it may result in future leakage.	
3	Lubricate the seal with grease just before fitting. (Not too early - there is a risk of dirt and foreign particles adhering to the seal.) Fill 2/3 of the space between the dust tongue and sealing lip with grease. The rubber coated external diameter must also be greased, unless otherwise specified.	Article number is specified in *Equipment on page 116*.
4	Mount the seal correctly with a mounting tool. Never hammer directly on the seal as this may result in leakage.	
5	Make sure no grease left on the robot surface.	

Continues on next page

Flange seals and static seals

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

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

O-rings

The following procedure describes how to fit o-rings.

	Action	Note
1	Ensure that the correct o-ring size is used.	
2	Check the o-ring for surface defects, burrs, shape accuracy, or deformation.	Defective o-rings, including damaged or deformed o-rings, may not be used.
3	Check the o-ring grooves. The grooves must be geometrically correct and should be free of pores and contamination.	Defective o-rings may not be used.
4	Lubricate the o-ring with grease.	
5	Tighten the screws evenly while assembling.	
6	Make sure that no grease is left on the robot surface.	

4.2.2 Replacing parts on the robot

General

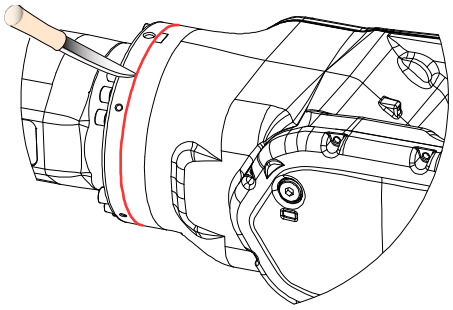
Follow the procedures in this section whenever breaking the surface paint of the robot during replacement of parts.

When replacing parts on a robot with protection type Clean Room, 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		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, White	3HAC036639-001	
Touch up paint Standard/Foundry Plus, ABB Orange	3HAC037052-001	

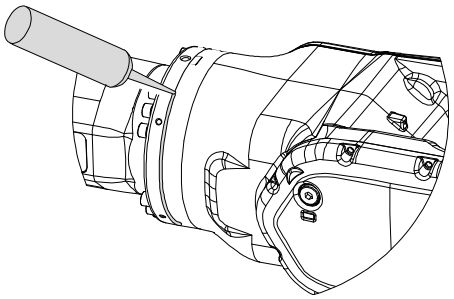
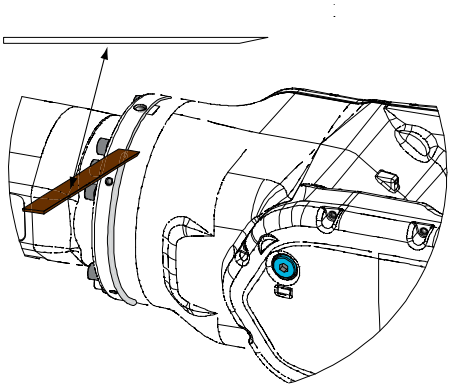
Removing

	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. **CAUTION** Be careful not to damage the plastic covers when cutting! **CAUTION** Seal glue is filled in the gap between lower arm cover and lower arm (axis 3 timing belt side). The glue should be removed and the surface cleaned.	 xx0900000121
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.
2	Place the tooling pin in hot water.	

Continues on next page

	Action	Description
3	Seal all refitted joints with Sikaflex 521FC.	 xx0900000122
4	Use the tooling pin to even out the surface of the Sikaflex seal.	 xx0900000125
5	Wait 15 minutes.	Sikaflex 521FC skin dry time (15 minutes).
6	**Note** Always read the instruction in the product data sheet in the paint repair kit for Foundry Prime.	3HAC035355-001
7	Use Touch up paint Clean Room, white to paint the joint. **Note** Always read the instruction in the product data sheet in the paint repair kit for Clean Room.	3HAC036639-001

Note

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

4.3 Cable harness

4.3.1 Removing the cable harness

Introduction

These procedures describes how to remove the complete cable harness in:

1. the wrist - *Removing the cable harness in the wrist on page 121*
2. the upper arm housing - *Removing the cable harness in the upper arm housing on page 126*
3. the lower arm and swing plate - *Removing the cable harness in the lower arm on page 128*
4. the base - *Removing the cable harness in the base on page 130*.

Note

It is necessary to perform the removal in the order as listed above!

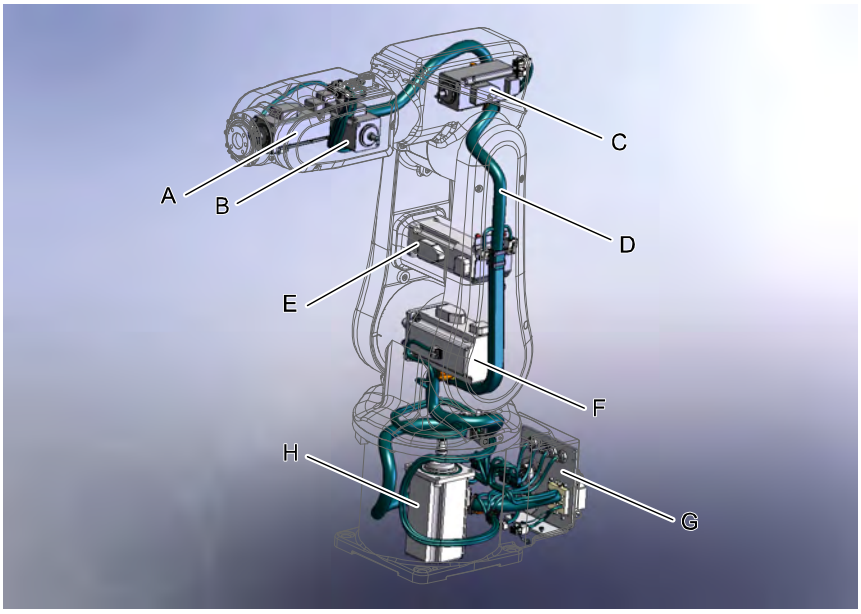
CAUTION

Always read the section "General procedures" before doing any repair work.

Replacing parts on the robot on page 118

Location of the cable harness.

The cable harness is located as shown in the figure.



xx0900000905

A	Motor axis 6
B	Motor axis 5

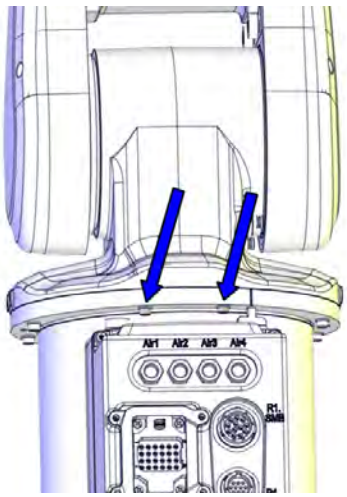
Continues on next page

C	Motor axis 4
D	Cable harness
E	Motor axis 3
F	Motor axis 2
G	Plate (part of the cable harness)
H	Motor axis 1

Required equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
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.
Flange sealant	for example Loctite 574
Cable grease	Shell Alvania Grease WR2
Cable grease, for food grade lubrication	Mobil FM222. Used for lubrication of cable contact areas for robots with food grade lubrication.

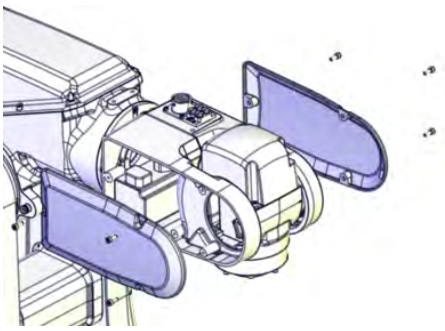
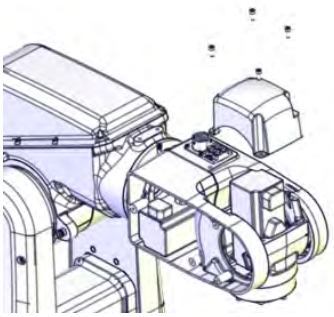
Removing the cable harness in the *wrist*

	Action	Information
1	Jog axis 1 to 90° position.	
2	Unscrew *two attachment screws* securing the swing housing to the base, not possible to reach with axis 1 in 0° position.	 xx1300001598
3	Jog • axis 1 to 0° position • axis 2 to -50° position • axis 3 to +50° position • axis 4 to 0° position • axis 5 to +90° position • axis 6 - no significance	

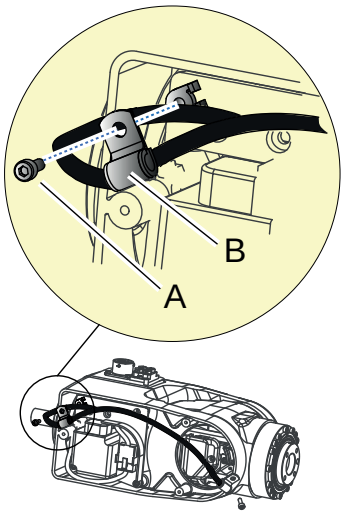
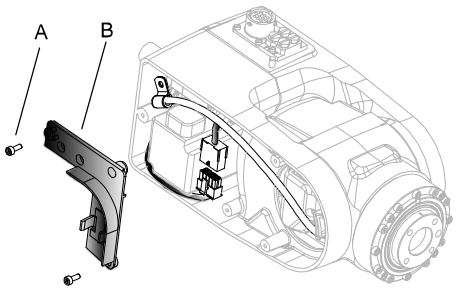
Continues on next page

4.3.1 Removing the cable harness

Continued

	Action	Information
4	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
5	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
6	Remove the *wrist side covers* on both sides.	 xx1400002899 Parts: • Wrist side covers (2 pcs) • Attachment screws (6 pcs)
7	Remove the *tilt cover*.	 xx1400002900 Parts: • Attachment screws(4 pcs) • Tilt cover

Continues on next page

	Action	Information
8	Unscrew the *attachment screw* securing the *clamp* at motor axis 5.	 xx0900000912 Parts: • A: Attachment screw • B: Clamp
9	Disconnect customer contact R2.CP/CS	
10	Remove the *connector support* at axis 5.	 xx0900000888 Parts: • A: Attachment screws (2 pcs) • B: Connector support

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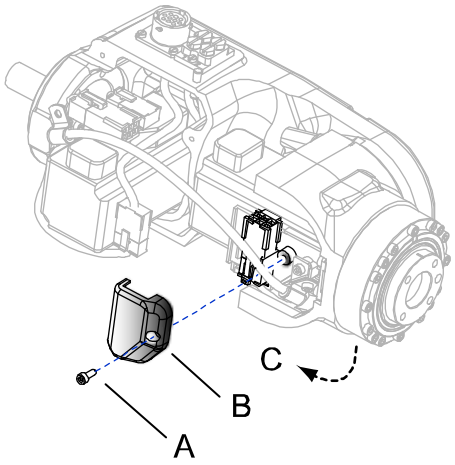
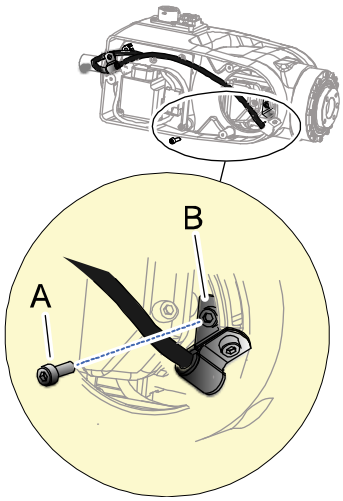
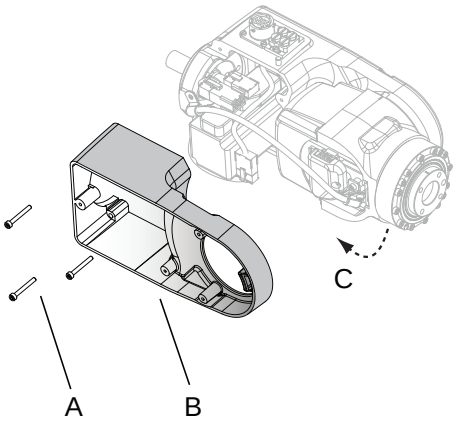
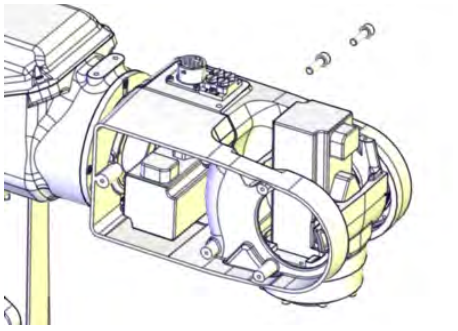
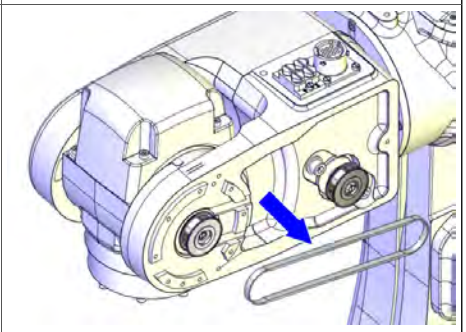
4.3.1 Removing the cable harness

Continued

	Action	Information
11	Remove the *connector cover*.	 xx0900000902 Parts: • A: Attachment screw • B: Connector cover • C: Axis 5 shall be in 90° position
12	Unscrew the *attachment screw* securing the *clamp* at motor axis 6.	 xx0900001000 Parts: • A: Attachment screw • B: Clamp
13	Disconnect connectors: • R2.MP5 and R2. ME5, motor axis 5 • R2.MP6 and R2. ME6, motor axis 6.	
14	Gently pull the cables from motor axis 5 and motor axis 6 out of the wrist housing.	

Continues on next page

	Action	Information
15	Remove the *wrist housing (plastic)*. **CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	 xx0900000900 Parts: • A: Attachment screws (3 pcs) • B: Wrist housing (plastic) • (C: Axis 5 shall be in 90° position)
16	Unscrew the *attachment screws* securing *motor axis 5*.	 xx1400002901 Parts: • Attachment screws and washers (2 pcs)
17	Tilt the *motor axis 5* to be able to remove the *timing belt*.	 xx0900001019

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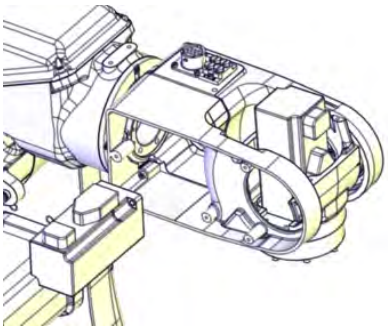
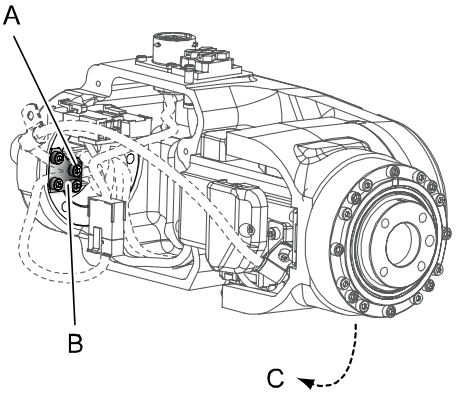
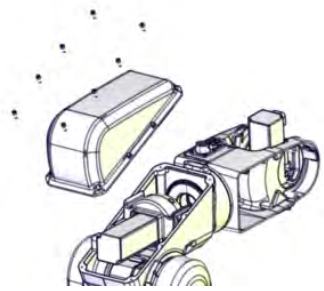
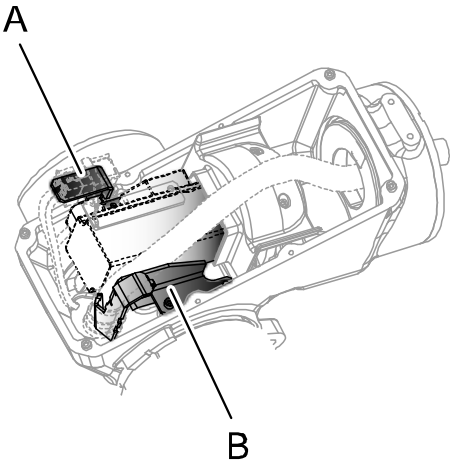
4.3.1 Removing the cable harness
Continued

	Action	Information
18	Carefully remove *motor axis 5*.	 xx1400002906
19	Disconnect air hoses.	

Removing the cable harness in the *upper arm housing*

	Action	Information
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
2	Unscrew the *two attachment screws* securing the *cable harness* in the bracket. Leave the bracket fastened in the housing.	 xx0900001018 Parts: • A: Attachment screws (4 pcs) • B: Cable bracket • (C: Axis 5 shall be in 90° position)

Continues on next page

	Action	Information
3	Remove the*housing cover*.	 xx1400002909 Parts: • Housing cover • Attachment screws (8 pcs)
4	Carefully pull the cable harness out of the wrist housing to axis 4.	
5	Cut cable ties at cable bracket A.	 xx0900001023 Parts: • A: Cable bracket • B: Cable bracket
6	Disconnect connectors: • R2.MP4 • R2.ME4.	

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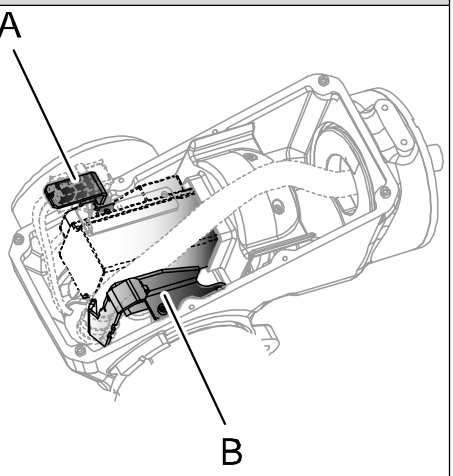
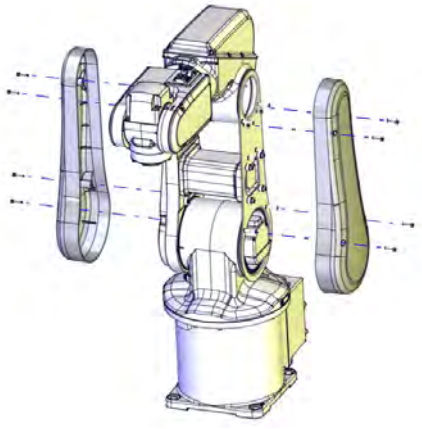
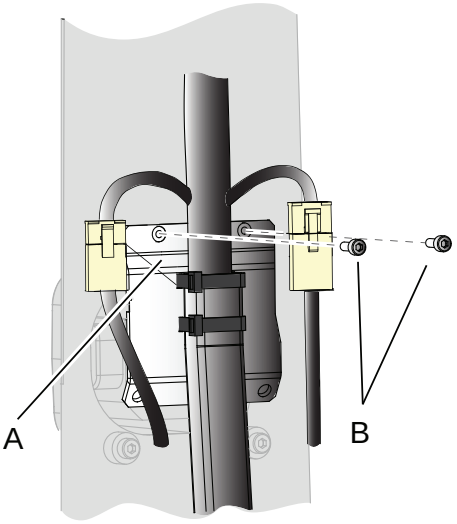
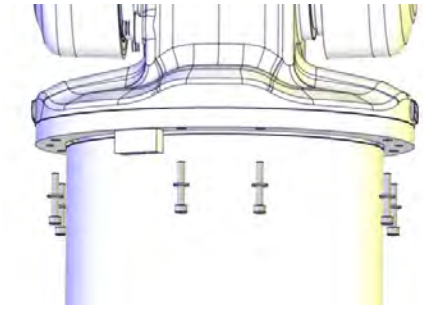
4.3.1 Removing the cable harness
Continued

	Action	Information
7	Cut cable ties at cable bracket B.	 xx0900001023 Parts: • A: Cable bracket • B: Cable bracket
8	Carefully pull the cable harness out of the upper arm housing.	

Removing the cable harness in the *lower arm*

	Action	Information
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
2	Remove the *lower arm cover*.	 xx0900000848
3	Cut *cable ties* for motor axis 3 cables.	
4	Pull the *cable harness* out through the upper arm housing to axis 3.	

Continues on next page

	Action	Information
5	Disconnect connectors: • R2.MP3 • R2.ME3.	
6	Detach the *cable bracket* from the lower arm plate.	 xx0900000879 Parts: • A: Cable bracket • B: Attachment screws (2 pcs)
7	Remove six remaining *attachment screws* between swing housing and base.	 xx1300001604
8	Carefully lift the robot and put it down close to the base of the robot. **CAUTION** Do not stretch the cable harness.	
9	Cut *cable ties* at motor axis 2.	
10	Disconnect connectors: • R2.MP2 • R2.ME2	

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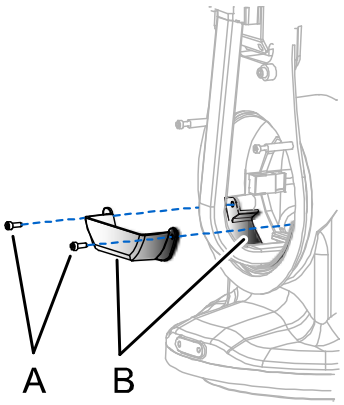
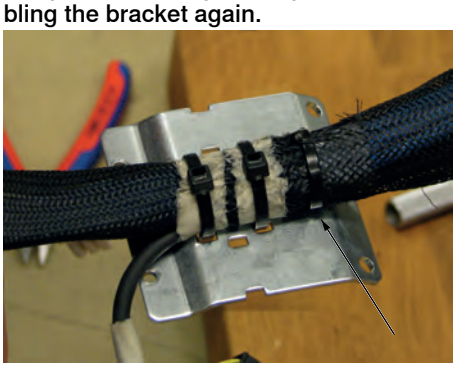
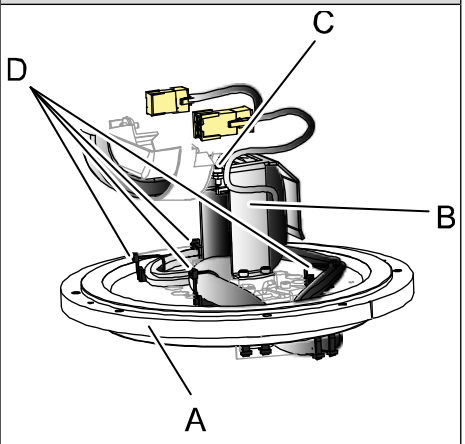
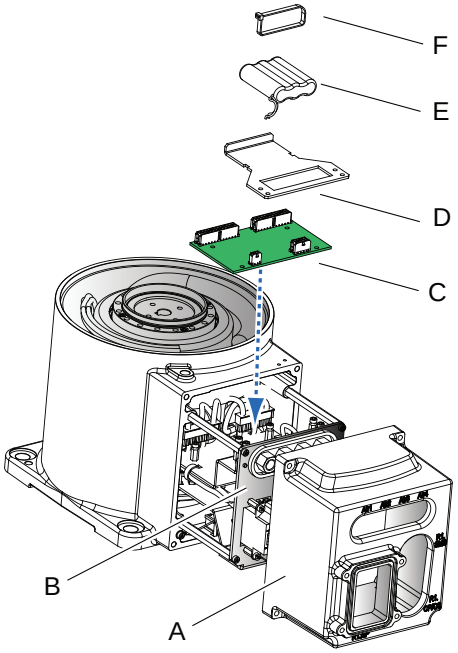
4.3.1 Removing the cable harness
Continued

	Action	Information
11	Remove *cable guide*.	 xx0900000857 Parts: • A: Attachment screws (2 pcs) • B: Cable guide

Removing the cable harness in the *base*

	Action	Information
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
2	If the cable harness is being reused: • Take a picture of the bracket (from the wrist) mounted on the harness • Place a cable tie close to the bracket • Cut old cable ties	The picture will be good help when assembling the bracket again.  xx1500000001
3	Remove the bracket (from the wrist) on the cable harness.	
4	Tighten the screw after removal of bracket.	
5	Guide the cable harness and pull it carefully in below motor in axis 2.	
6	**Tip** Take a picture of cable harness placement in the swing housing before removal.	

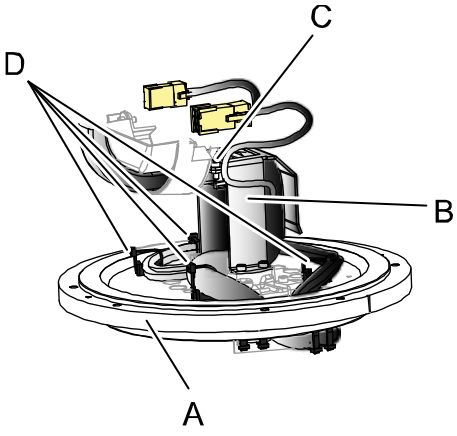
Continues on next page

	Action	Information
7	Cut the *cable ties* securing the cable harness and the air hoses on the *swing plate* at motor axis 1.	 xx0900000884 Parts: • A: Swing plate • B: Cable holder • C: Attachment screws (2 pcs) • D: Cable ties (4 pcs)
8	Remove the *base cover* from the robot by removing its attachment screws.	 xx0900000842 A: Base cover B: Plate C: Encoder Interface Board (EIB board) D: Bracket E: Battery pack F: Cable tie

Continues on next page

4.3.1 Removing the cable harness

Continued

	Action	Information
9	Disconnect connector cables from the power source, motor cables and SMB. • R1.A1 • R1.A2 • R1.A3 • R1.A4	
10	Disconnect the battery cables.	
11	Remove attachment screws securing *bracket with the battery pack*.	D in figure above. Do not remove the battery pack from the bracket.
12	Remove attachment screws securing the *plate*.	
13	Disconnect connectors from EIB board: • R1.ME4-6 (J4) • R1.ME1-3 (J3) • R2.EIB	
14	Remove the *EIB board*.  **ELECTROSTATIC DISCHARGE (ESD)** Put the board in an ESD protective bag.	
15	Cut *cable tie*.	
16	Disconnect connectors: • R2.MP1 • R2.ME1.	
17	Disconnect *earth connection*.	
18	Unscrew the *attachment screws* securing the cable harness to the *cable holder*.	 xx0900000884 Parts: • A: Swing plate • B: Cable holder • C: Attachment screws (2 pcs) • D: Cable ties (4 pcs)

Continues on next page

	Action	Information
19	**CAUTION** Cable harness and hoses are sensitive equipment. Use caution when handling cable harness.	
20	Carefully push and pull the *complete cable harness* past motor axis 1.	

4.3.2 Refitting the cable harness

Introduction

These procedures describes how to refit the complete cable harness in:

1. the base - *Refitting the cable harness in the base on page 135*
2. the lower arm - *Refitting the cable harness in the lower arm on page 138*
3. the upper arm housing and swing plate - *Refitting the cable harness in the upper arm housing on page 141*
4. the wrist - *Refitting the cable harness in the wrist on page 142*.

Note

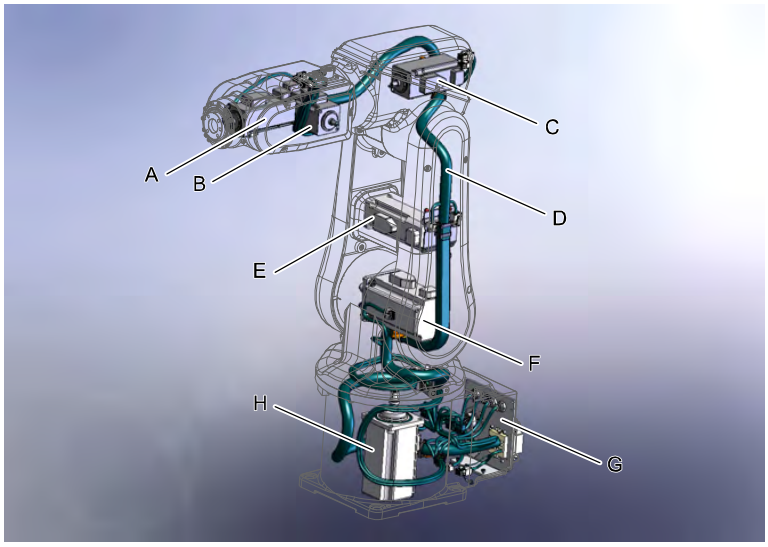
It is necessary to perform the refitting in the order as listed above!

CAUTION

Always read the section "General procedures" befor doing any repair work.
Replacing parts on the robot on page 118

Location of the cable harness

The cable harness is located as shown in the figure.



xx0900000905

A	Motor axis 6
B	Motor axis 5
C	Motor axis 4
D	Cable harness
E	Motor axis 3
F	Motor axis 2

Continues on next page

G	Plate (part of the cable harness)
H	Motor axis 1

Required equipment

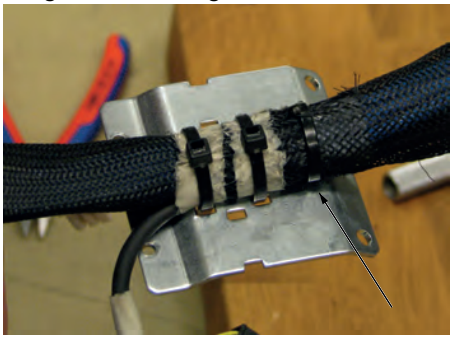
Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Flange sealant	For example Loctite 574
Cable grease	Shell Alvania Grease WR2
Cable grease, for food grade lubrication	Mobil FM222. Used for lubrication of cable contact areas for robots with food grade lubrication.

Note

Apply some cable grease on the cable harness where wear exists and also on the plastic parts of the robot.

Refitting the cable harness in the *base*

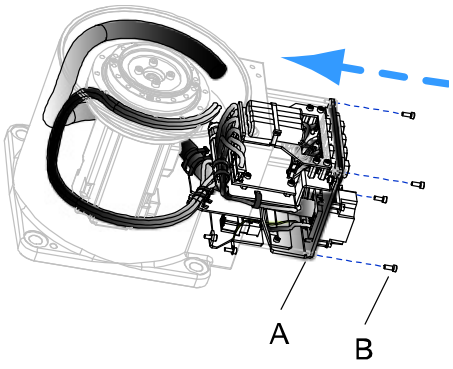
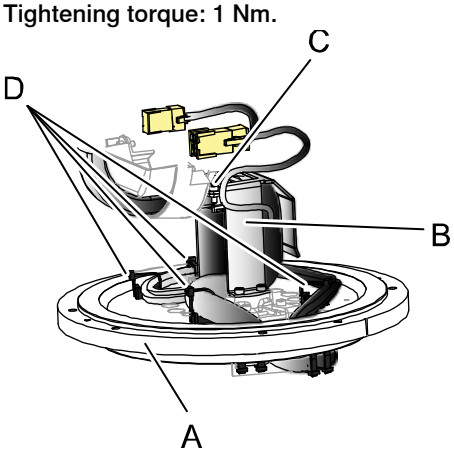
Use this procedure to refit the cable harness in the *base*.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Check that: • the cable harness and its parts are clean and without damages.	
3	Remove the bracket from the cable harness and mark the position. • Take a picture of the bracket mounted on the harness • Place a cable tie close to the bracket • Cut old cable ties	The picture will be good help when assembling the bracket again.  xx1500000001
4	Refit the *plate* with EIB board.	

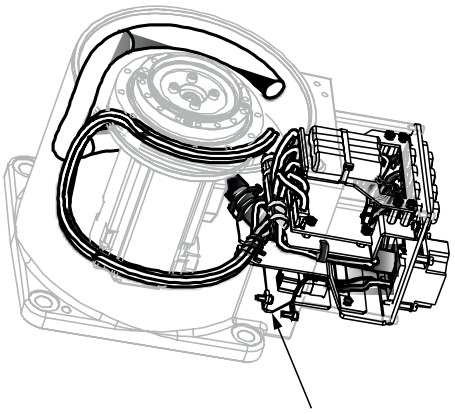
Continues on next page

4.3.2 Refitting the cable harness

Continued

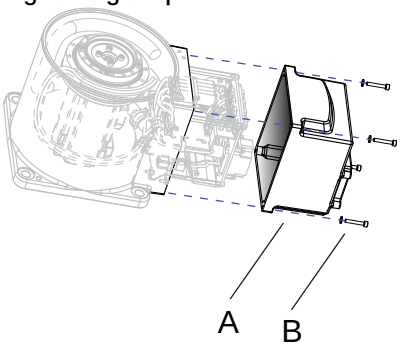
	Action	Information
5	Carefully pull the cable harness through the swing plate. **CAUTION** Cable harness and hoses are sensitive equipment. Use caution when handling cable harness.	
6	Place the *cables* from cable harness on the right side in frame, and the *air hoses* on the left side in the frame.	 xx0900000836
7	Secure the cable harness to the *cable holder* with the *attachment screws*.	Tightening torque: 1 Nm.  xx0900000884 Parts: • A: Swing plate • B: Cable holder • C: Attachment screws (2 pcs) • D: Cable ties (4 pcs)
8	Carefully push and pull the cable harness out from the frame. **CAUTION** Cable harness and hoses are sensitive equipment. Use caution when handling cable harness.	
9	Put some cable grease on the cable harness (including air hoses).	

Continues on next page

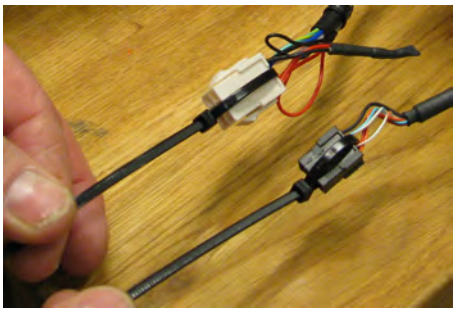
	Action	Information
10	Place the cable harness inside the cable holder.	
11	Loosen the *cable bracket* next to motor axis 1.	 xx1500000002
12	Reconnect connectors: • R2.MP1 • R2.ME1.	
13	Secure the *motor cables* to the cable bracket with cable ties.	
14	Fasten *cable bracket*.	M3x8 (2 pcs)
15	Refit the *PE cable*.	Är detta earth connection? Om inte, vad är det för kabel?
16	Refit the *EIB board*. **Note** Use ESD protective equipment.	Attachment screw (4 pcs) M3x8
17	Connect *board*. • R1.ME4-6 (J4) • R1.ME1-3 (J3) • R2.EIB.	
18	Connect *battery cables*.	
19	Refit the *battery plate*.	Attachment screw (4 pcs) M3x8
20	Refit the *EIB plate*. **CAUTION** Cables are sensitive equipment. Use caution when handling cables.	Attachment screw (4 pcs) M3x8

Continues on next page

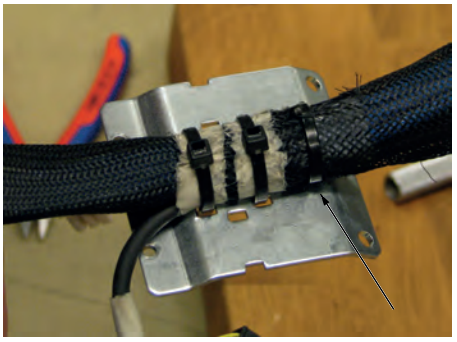
4.3.2 Refitting the cable harness
Continued

	Action	Information
21	Refit the *base cover*.	Tightening torque: 4 Nm  xx0900000829
22	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

Refitting the cable harness in the *lower arm*

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Place the *cable harness* in the *holder* on the swing plate. • Put cable R2.MP2 towards back • Put cable R2.ME2 towards front	
3	Tighten screws in bracket.	Attachment screw M3x8 (2 pcs)
4	Secure *air hoses* on the *swing plate* with *cable ties*.	
5	Secure the *cable harness* on the *swing plate* with *cable ties*.	
6	Put cable ties on the motor connections to ease the mounting in axis-2 motor.	 xx1500000003

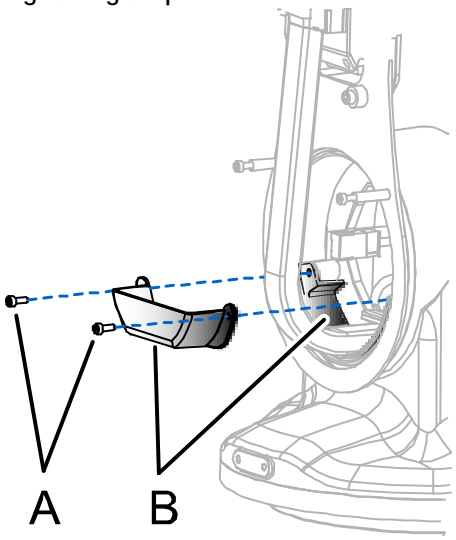
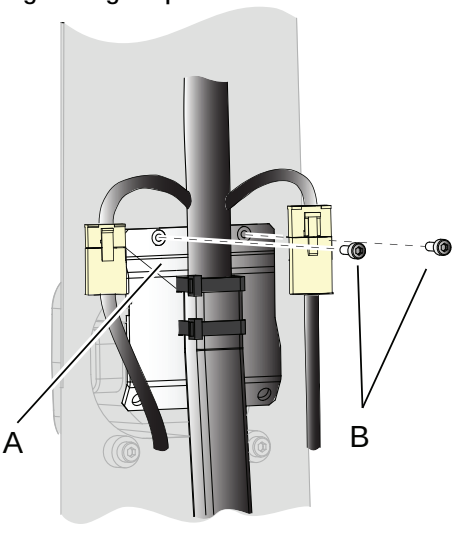
Continues on next page

	Action	Information
7	Carefully push and pull cable harness past the axis-2 motor. **CAUTION** Cables are sensitive equipment. Use caution when handling cables.	
8	Fit lower arm on the swing plate while pulling the cable harness out. **CAUTION** Be careful not to squeeze the cables.	
9	Tighten attachment screws on the swing plate.	M4x25 (6 pcs)
10	Refit the *cable bracket* on the cable harness. Use the picture to localize the correct position.	 xx1500000001
11	Fasten the bracket at axis-3 motor.	M3x8 (2 pcs)
12	Remove the cable ties on the motor connectors at axis-2 motor.	
13	Reconnect connectors: • R2.MP3 • R2.ME3.	
14	Place the connector cables by the motor and fasten the connectors with cable ties around the motor.	

Continues on next page

4.3.2 Refitting the cable harness

Continued

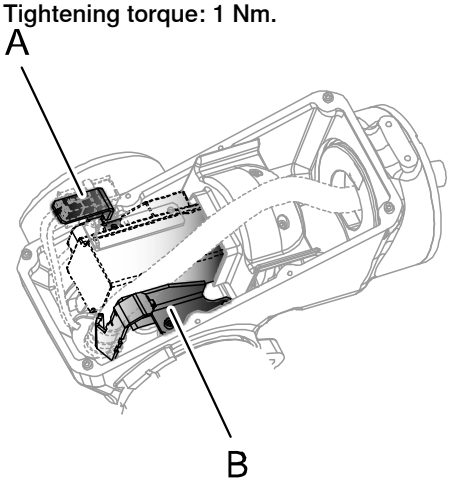
	Action	Information
15	Fit the *cable guide*. **CAUTION** The plastic will crack if screws are tightened too hard.	Tightening torque: 1 Nm.  xx0900000857 Parts: • A: Attachment screws (2 pcs) • B: Cable guide
16	*Reconnect* the motor connections, axis-3 motor • R2.ME3 • R2.MP3.	
17	Fasten *motor cables* with cable ties on the cable bracket.	
18	Fit the *cable bracket* to the lower arm plate.	Tightening torque: 1 Nm.  xx0900000879 Parts: • A: Cable bracket • B: Attachment screws (2 pcs)
19	Pull the *cable harness* through the upper arm housing.	
20	Verify that the cable harness is not twisted.	

Continues on next page

	Action	Information
21		
22	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

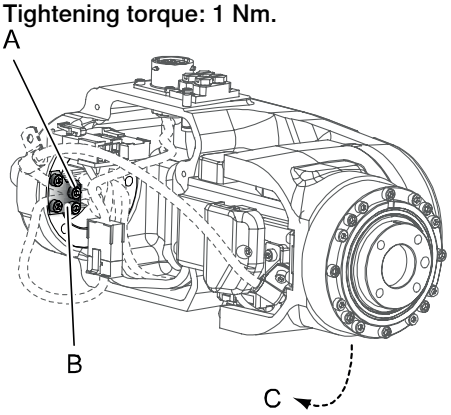
Refitting the cable harness in the *upper arm housing*

Use this procedure to refit the cable harness in the *upper arm housing*.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Reconnect connectors: • R2.MP4 • R2.ME4.	
3	Fasten motor cables with a cable tie.	
4	Fasten the cable harness with cable ties on the cable bracket. Adjust the lenght on the cable harness so the motor cables reaches its connectors.	Tightening torque: 1 Nm.  xx0900001023 Parts: • A: Cable bracket • B: Cable bracket
5	Push the *cable harness* in through the *wrist housing*.	

Continues on next page

4.3.2 Refitting the cable harness
Continued

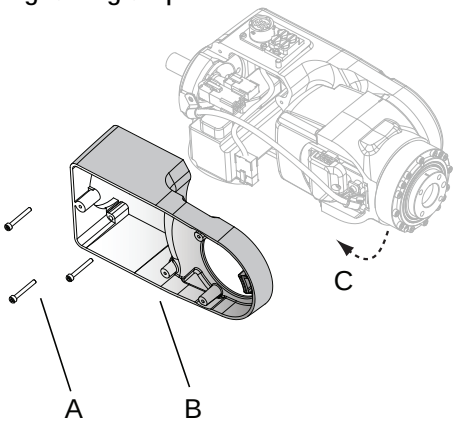
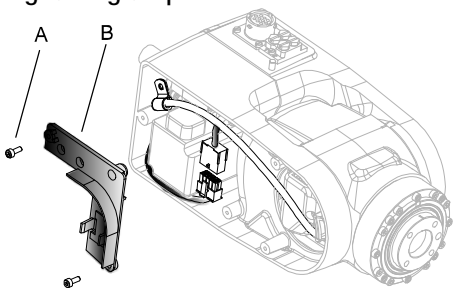
	Action	Information
6	Refit the *cable bracket* in the housing with its *attachment screws*.	Tightening torque: 1 Nm.  xx0900001018 Parts: • A: Attachment screws (2 pcs) • B: Cable bracket
7	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

Refitting the cable harness in the *wrist*

Use this procedure to refit the cable harness in the *wrist*.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Reconnect *air hoses*. Put them flat to make room for the motor.	
3	Reconnect customer contact R2.CS	
4	Place the *motor* in axis 5.	
5	Refit the *timing belt*.	
6	Fasten the motor just enough to still be able to move the motor.	M5x16 (2 pcs) and washers
7	Tension the timing belt to 7.6 - 8.4 Nm.	**Tip** Use a tension scale to have the correct torque.
8	Tighten motor *attachment screws*.	Tightening torque: 5.5 Nm

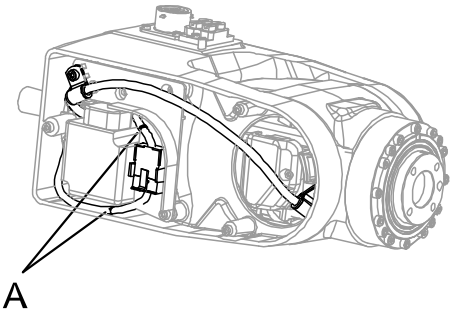
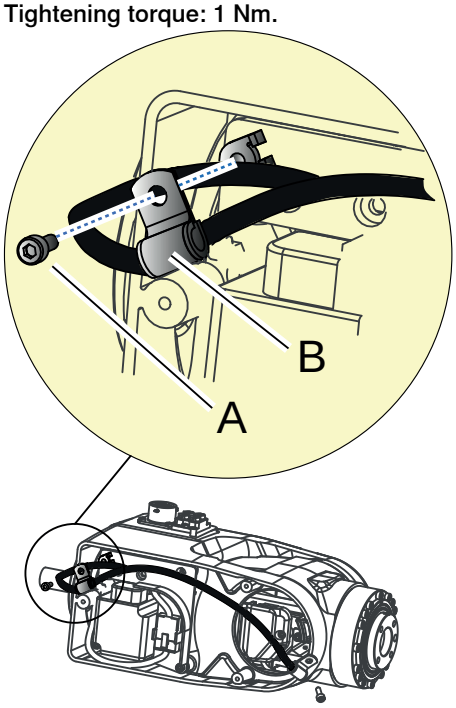
Continues on next page

	Action	Information
9	Refit the *wrist housing (plastic)*.	Tightening torque: 2 Nm  xx0900000900 • A: Attachment screws, M3x25 (3 pcs) • B: Wrist housing (plastic) • C: (Axis 5 shall be in 90° position)
10	Reconnect connectors: • R2.MP5 • R2.ME5.	
11	Put the cables around the motor.	
12	Refit *connector support (plastic)*.	Tightening torque: 1 Nm.  xx0900000888 Parts: • A: Attachment screws, M3x8 (2 pcs) • B: Connector support (plastic)
13	Fasten *cables* to axis 6 in the connector support.	

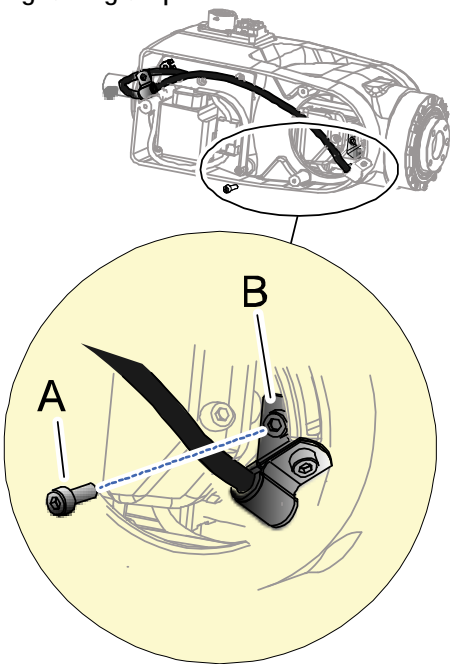
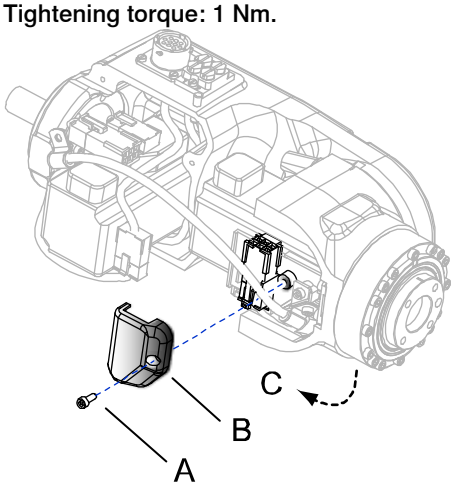
Continues on next page

4.3.2 Refitting the cable harness

Continued

	Action	Information
14	Secure the cable harness with *cable ties*.	 xx0900001009 Parts: • A: Cable ties
15	Refit the *attachment screw* securing the *clamp* at motor axis 5. **CAUTION** Make sure that the cables run loose from the circular edge into motor axis 6.	Tightening torque: 1 Nm.  xx0900000912 Parts: • A: Attachment screw • B: Clamp
16	Reconnect connectors: • R2.MP6 • R2.ME6.	

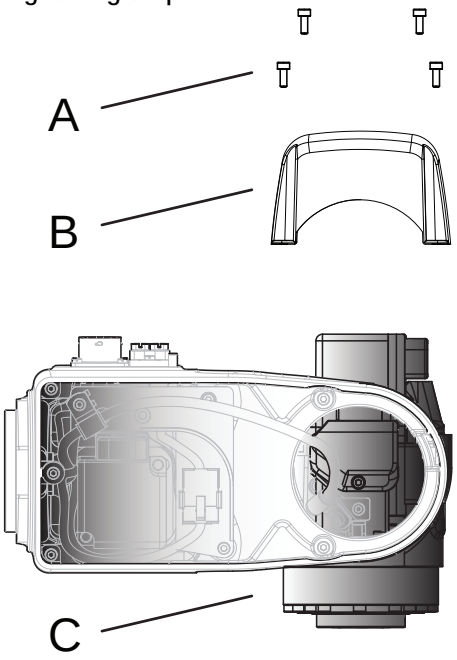
Continues on next page

	Action	Information
17	Refit the *attachment screw* securing the *clamp* at motor axis 6.	Tightening torque: 1 Nm.  xx0900001000 Parts: • A: Attachment screw • B: Clamp
18	Refit the *connector cover*.	Tightening torque: 1 Nm.  xx0900000902 Parts: • A: Attachment screw M3x8 (1 pcs) • B: Connector cover • C: (Axis 5 shall be in 90° position)
19	Put *cable grease* on the cable harness in the wrist.	
20	Clean all the *covers* if they are dirty.	
21	Put *cable grease* inside the covers.	

Continues on next page

4.3.2 Refitting the cable harness

Continued

	Action	Information
22	Refit the *wrist side covers*.	Tightening torque: 1 Nm. Attachment screw M3x8 (3 pcs)
23	Refit the *tilt cover*.	Tightening torque: 1 Nm.  xx0900000901 Parts: • A: Attachment screw M3x8 (4 pcs) • B: Tilt cover • C: Motor axis 6
24	Put cable grease on the sleeve in axis 4.	
25	Refit the *housing cover* at axis 4. • *housing cover* and • *lower arm cover*.	Tightening torque: 1 Nm Attachment screw M3x8 (8 pcs)
26	Put cable grease on the cable harness and sleeve in lower arm.	
27	Refit the *lower arm cover* at axis 4.	Tightening torque: 1 Nm Attachment screw M3x8 (4 pcs)
28	Connect the robot to the *power* source. **DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	
29	Jog the robot to 90° in axis 1.	
30	Fasten the two remaining screws at swing plate/base.	

Continues on next page

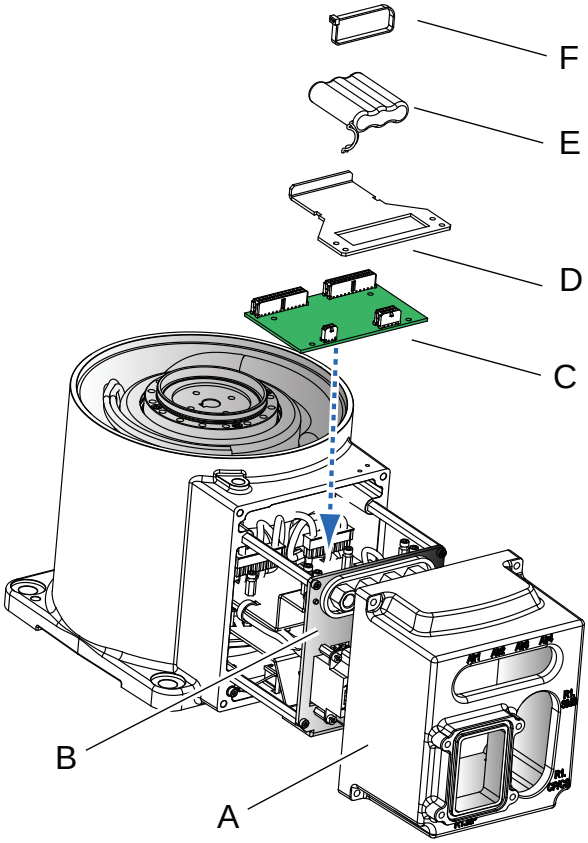
	Action	Information
31	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
32	Recalibrate the robot.	See chapter: • *Calibration*
33	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.3.3 Replacing the Encoder Interface board

Introduction

This procedure describes how to replace the Encoder Interface board.

Location of the Encoder Interface board



xx0900000842

A	Base cover
B	Plate
C	Encoder Interface Board (EIB board)
D	Bracket
E	Battery pack
F	Cable strap

Required equipment

Equipment	Note
Standard tools	The content is defined in the section *Standard toolkit on page 260*.
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

Removing the EIB board

Use this procedure to remove the EIB board.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
3	Remove the *base cover*.	See the figure in : • *Location of the Encoder Interface board on page 148*
4	Remove the attachment screws securing the *plate*.	See the figure in: • *Location of the Encoder Interface board on page 148*
5	Pull carefully out the cable harnesss main a little in order to reach the EIB board.	
6	Disconnect the battery cable.	
7	Remove the *bracket* where the battery is fitted.	See the figure in: • *Location of the Encoder Interface board on page 148*
8	Disconnect connectors: • R1.ME1-3 • R1.ME4-6 • R2.EIB.	
9	Remove the *EIB board*.	See the figure in: • *Location of the Encoder Interface board on page 148*

Refitting the EIB board

Use this procedure to refit the EIB board.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Fit the EIB board.	Tightening torque: 2 Nm. See the figure in: • *Location of the Encoder Interface board on page 148*
3	Reconnect connectors: • R1.ME1-3 • R1.ME4-6 • R2.EIB.	

Continues on next page

4.3.3 Replacing the Encoder Interface board

Continued

	Action	Information
4	Fit the *plate* where the battery is fitted.	See the figure in: • *Location of the Encoder Interface board on page 148*
5	Reconnect the battery cable.	
6	Push the cable harness main carefully into the *base*.	**CAUTION** Arrange the cable harness inside correctly in a way that: • it is not damaged in the continued refitting process • extra wear will not occur after production is restarted, which will shorten the life of the harness. See section • *Refitting the cable harness on page 134*.
7	Secure the *plate* with its attachment screws.	Tightening torque: 2 Nm. See the figure in: • *Location of the Encoder Interface board on page 148*
8	Refit the *base cover*.	Tightening torque: 4 Nm. See the figure in: • *Location of the Encoder Interface board on page 148*
9	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
10	Recalibrate the robot.	See chapter: • *Calibration on page 225*
11	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.4 Plastic covers

4.4.1 Replacing plastic covers

Introduction

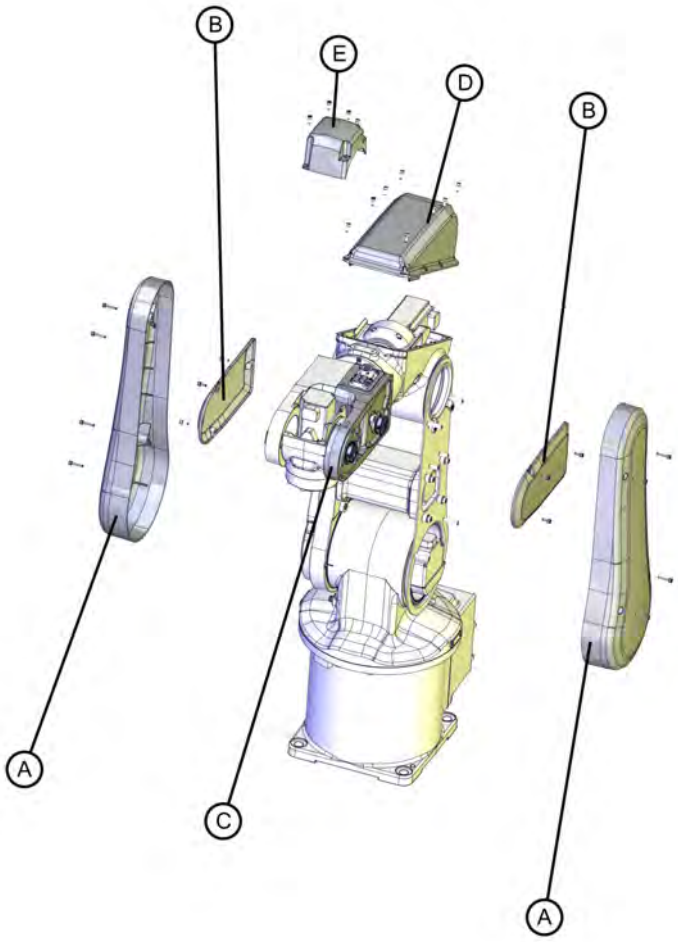
The section describes how to replace the plastic covers on the robot.

> **CAUTION**
>
> Always read the section "General procedures" before doing any repair work.
> *Replacing parts on the robot on page 118*

Continues on next page

4.4.1 Replacing plastic covers
Continued

Location of the plastic covers



xx0900000607

A	Lower arm cover (2 pcs.)
B	Wrist side cover (2 pcs.)
C	Wrist housing (plastic)
D	Housing cover
E	Tilt cover

Required equipment

Equipment	Note
Standard tools	The content is defined in the section *Standard toolkit on page 260*.
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

Attachment screws and tightening torques

The table shows what attachment screws and tightening torques to be used.

Cover	Attachment screw	Screw quality	Qty.	Tightening torque
Lower arm cover	M3x16	Steel 12.9 Black oxide	4+4	1 Nm
Wrist side cover	M3x8	Steel 12.9 Black oxide	3+3	1 Nm
Wrist housing (plastic)	M3x25	Steel 12.9 Black oxide	3	1 Nm
Housing cover	M3x8	Steel 12.9 Black oxide	8	1 Nm
Tilt cover	M3x8	Steel 12.9 Black oxide	4	1 Nm

Removing plastic covers

Use this procedure to remove the plastic covers.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
3	Remove the attachment screws securing the plastic cover.	
4	Remove the plastic cover.	
5	If the cover shall be reused, keep it clean and put in a safe place.	

Refitting plastic covers

Use this procedure to refit the plastic covers.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Before fitting the plastic cover, check it for cracks or any other damage.	If the plastic cover is cracked or has any other damage it must be replaced with a new one.
3	Fit the plastic cover and secure it with its *attachment screws*. Which attachment screws to use is described in the table: • *Attachment screws and tightening torques on page 153*	

Continues on next page

4.4.1 Replacing plastic covers

Continued

	Action	Information
4	For *tightening torques*, see the table: • *Attachment screws and tightening torques on page 153*	
5	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

4.5 Upper arm

4.5.1 Replacing the upper arm

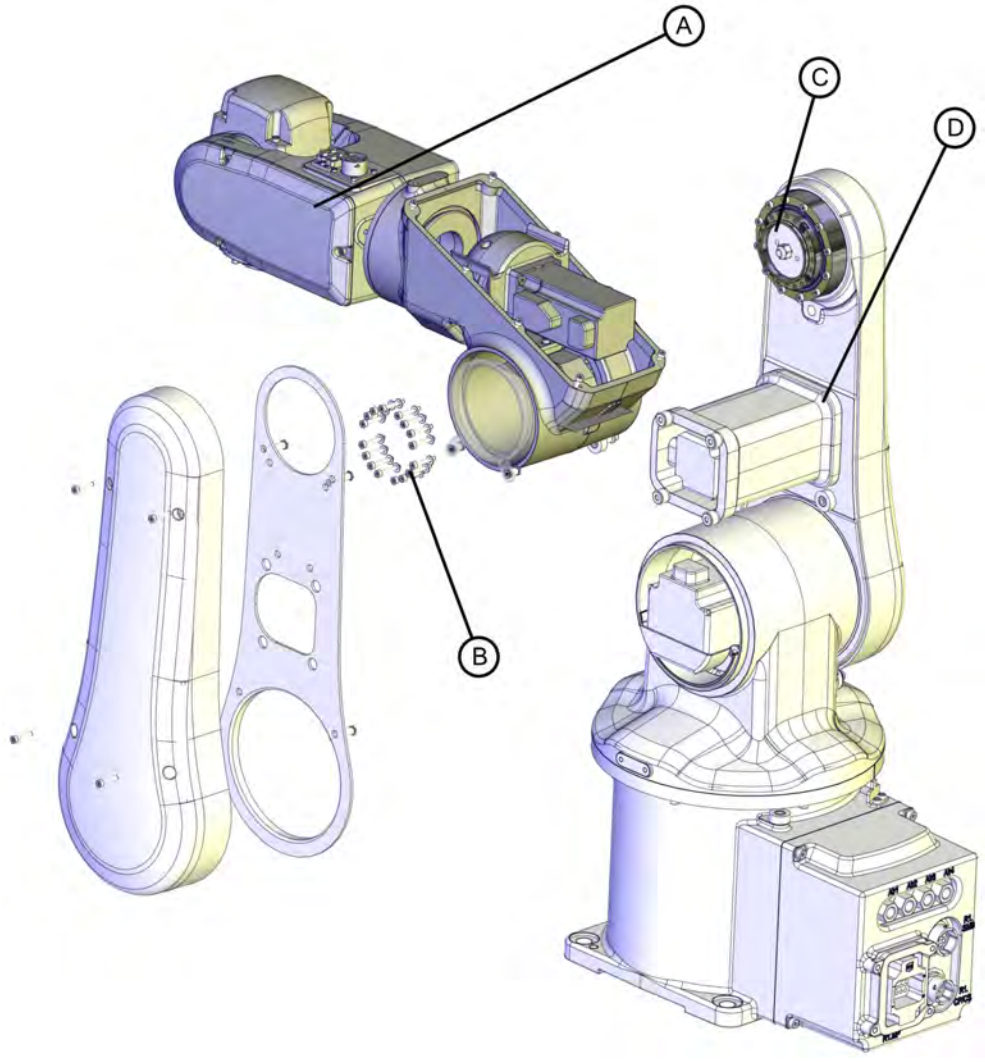
Introduction

This procedure describes how to replace the upper arm.

> **CAUTION**
>
> Always read the section "General procedures" befor doing any repair work.
>
> *Replacing parts on the robot on page 118*

Location of upper arm

The upper and lower arms are located as shown in the figure.



xx0900000924

A	Upper arm, complete with wrist

Continues on next page

4.5.1 Replacing the upper arm

Continued

B	Attachment screws (16 pcs)
C	Gearbox, axis 3
D	Lower arm

Required equipment

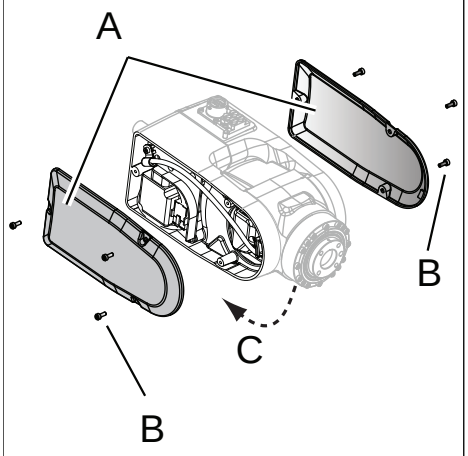
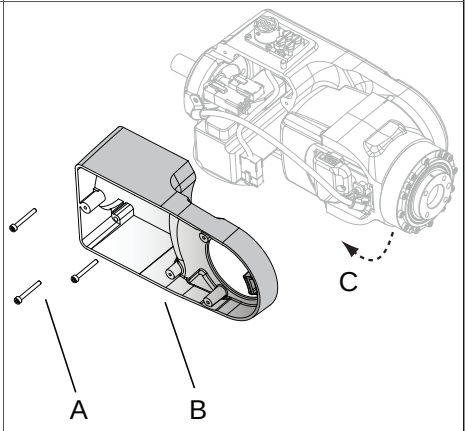
Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Loctite 7063	For removing residues of Loctite.
Loctite 574	

Removing the upper arm

Use this procedure to remove the upper arm.

	Action	Information
1	Move axis 5 to a 90° position.	
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	

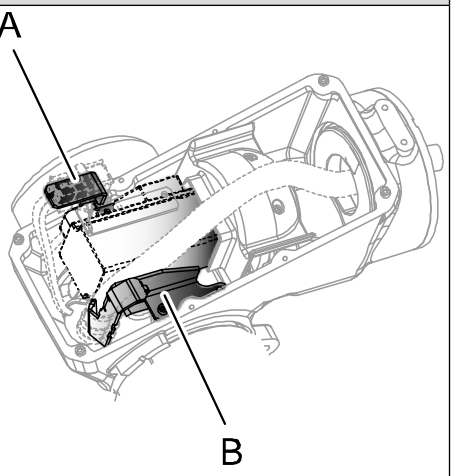
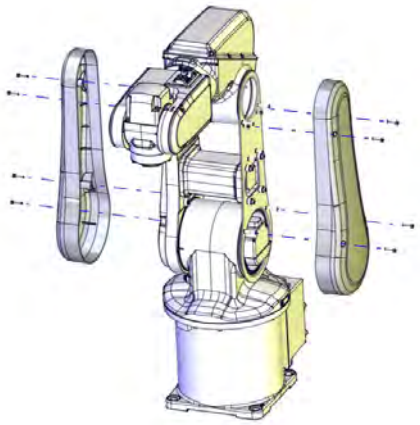
Continues on next page

	Action	Information
4	Remove the *wrist covers*.	 xx0900000999 Parts: • A: Wrist covers (2 pcs) • B: Attachment screws (3+3 pcs) • C: Axis 5 shall be in 90° position
5	Remove *motor axis 5*.	See section • *Replacing motor axis 5 on page 211*
6	Remove the *cable harness* in the *wrist*.	See section • *Removing the cable harness on page 120*.
7	Pull the *cable harness* out of the *wrist housing*.	
8	Remove the *wrist housing (plastic)*.	 xx0900000900 Parts: • A: Attachment screws (3 pcs) • B: Wrist housing (plastic) • C: Axis 5 shall be in 90° position
9	Remove the *cable harness* in the *upper arm housing*.	See section • *Removing the cable harness on page 120*.

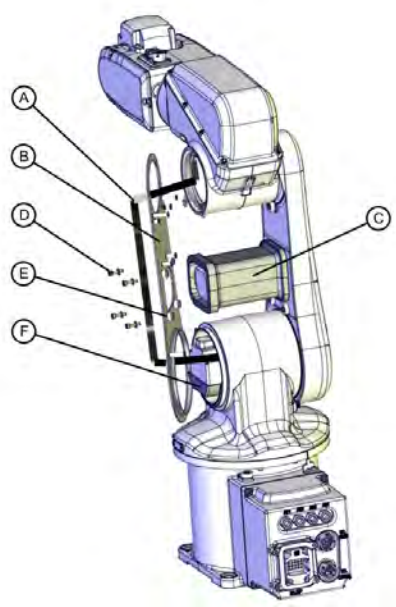
Continues on next page

4.5.1 Replacing the upper arm

Continued

	Action	Information
10	Unscrew the attachment screws securing the *cable brackets* on both sides of motor axis 4.	 xx0900001023 Parts: • A: Cable bracket • B: Cable bracket
11	Remove the *lower arm covers* on both sides of the robot.	 xx0900000848
12	Remove the *cable harness* in the *lower arm*.	See section • *Removing the cable harness on page 120*.

Continues on next page

	Action	Information
13	Unscrew the *attachment screws* securing the *lower arm plate* to the *motor cover*.	 xx0900000851 Parts: • A: Cable harness • B: Lower arm plate • C: Motor cover • D: Attachment screws (4 pcs) • E: Holes for attachment screws (4 pcs) • F: Cable guide
14	Pull out the cable harness through the upper arm housing.	
15	Secure the upper arm by holding it firmly.	
16	Unscrew the *attachment screws* securing the *upper arm with wrist* to *gearbox axis 3*.	See the figure in: • *Location of upper arm on page 155*
17	Remove the upper arm.	

Refitting the upper arm

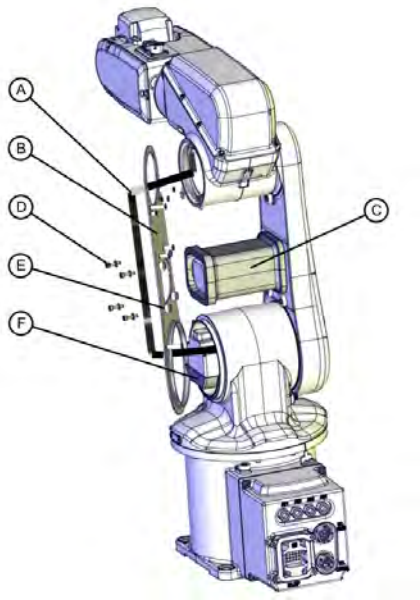
Use this procedure to refit the upper arm.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Check that: • All assembly surfaces are clean and without damages.	
3	Remove old residues of Loctite from the assembly surfaces on gearbox axis 3 and upper arm, using *Loctite 7063*.	See *Replacing the upper arm on page 155*. • *Required equipment on page 156*
4	Apply *Loctite 574* on the assembly surfaces on *gearbox axis 3* and the *upper arm*.	

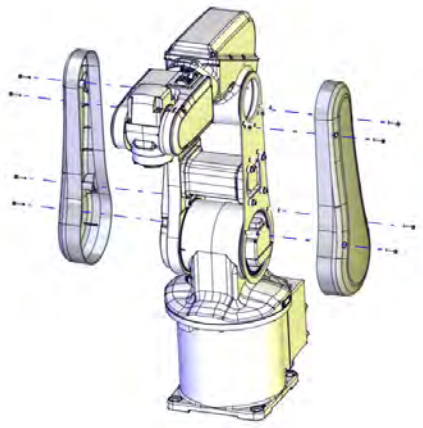
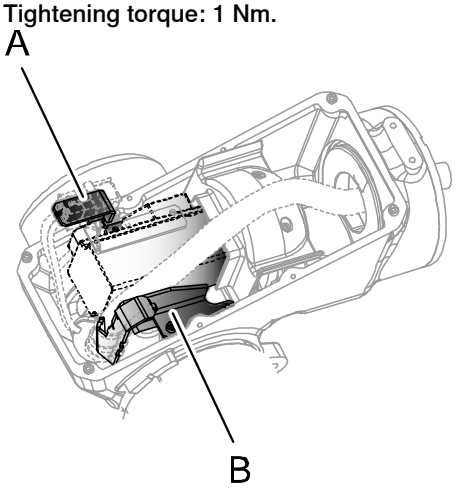
Continues on next page

4.5.1 Replacing the upper arm

Continued

	Action	Information
5	Secure the *upper arm including wrist* to *gearbox axis 3* with its *attachment screws*.	Tightening torque: 2 Nm. Attachment screws M3x20 q12.9 and washers (16 + 16 pcs) See the figure in: • *Location of upper arm on page 155*
6	Push the *cable harness* into the *upper arm housing*.	See section • *Refitting the cable harness on page 134*
7	Refit the *lower arm plate*.	Tightening torque: 4 Nm.  xx0900000851 Parts: • A: Cable harness • B: Lower arm plate • C: Motor cover • D: Attachment screws M4x16 q12.9 and washers (4 + 4 pcs) • E: Holes for attachment screws (4 pcs) • F: Cable guide
8	Secure the *cable harness* to the *lower arm plate*.	See section • *Refitting the cable harness on page 134*

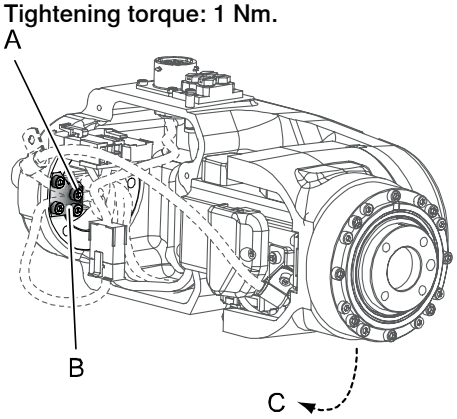
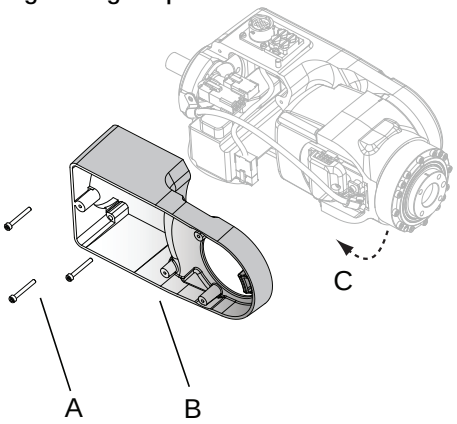
Continues on next page

	Action	Information
9	Refit the *lower arm covers*.	Tightening torque: 1 Nm.  xx0900000848
10	Secure the *cable harness* in the *upper arm housing*.	See section • *Refitting the cable harness on page 134*
11	Refit the two *cable brackets* on either side of motor axis 4.	Tightening torque: 1 Nm.  xx0900001023 Parts: • A: Cable bracket • B: Cable bracket
12	Push the cable harness into the wrist.	

Continues on next page

4.5.1 Replacing the upper arm

Continued

	Action	Information
13	Refit the *cable bracket*.	Tightening torque: 1 Nm.  xx0900001018 Parts: • A: Attachment screws (4 pcs) • B: Cable bracket • C: Axis 5 shall be in 90° position
14	Refit the *cable harness* in the *wrist*.	See section • *Refitting the cable harness on page 134*
15	Refit the *wrist housing (plastic)*.	Tightening torque: 1 Nm.  xx0900000900 Parts: • Attachment screws (3 pcs) • B: Wrist housing (plastic) • C: Axis 5 shall be in 90° position
16	Refit *motor axis 5*.	See section • *Replacing motor axis 5 on page 211*
17	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

Continues on next page

	Action	Information
18	Recalibrate the robot.	See chapter: • *Calibration on page 225*.
19	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.6 Lower arm

4.6.1 Replacing the lower arm

Introduction

This procedure describes how to replace the lower arm.

Gearbox axis 3 is included in the lower arm.

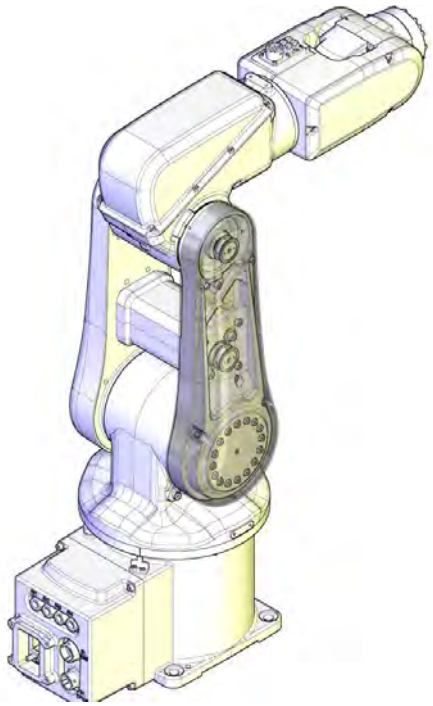
CAUTION

Always read the section "General procedures" befor doing any repair work.

Replacing parts on the robot on page 118

Location of the lower arm

The lower arm is located as shown in the figure.



xx1100000961

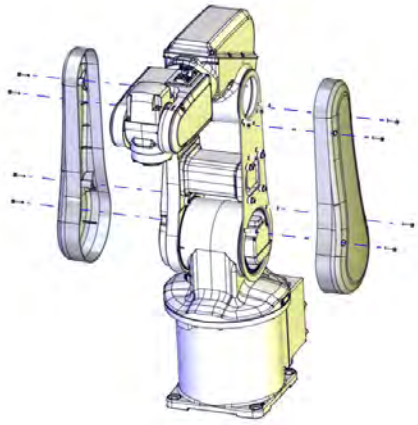
Required equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
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.
Flange sealant	for example Loctite 574

Continues on next page

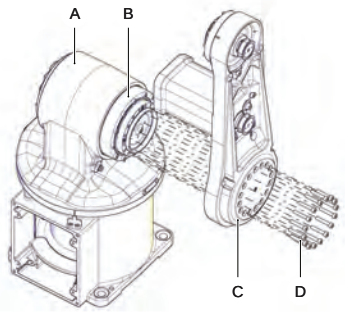
Removing the lower arm

Use this procedure to remove the lower arm.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
3	Remove the *lower arm covers* on both sides of the robot.	 xx0900000848
4	Remove the *cable harness* in the *lower arm*.	See section • *Removing the cable harness in the wrist on page 121*
5	Unscrew the attachment screws securing the lower and upper arms and separate the two.	
6	Unscrew the attachment screws securing the motor cover to the lower arm plate.	

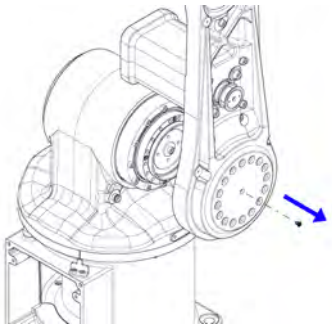
Continues on next page

4.6.1 Replacing the lower arm
Continued

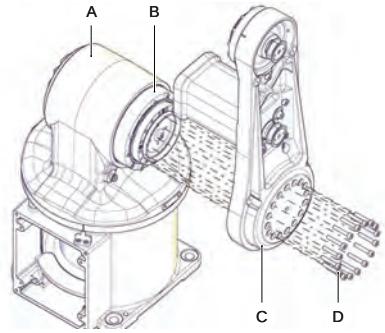
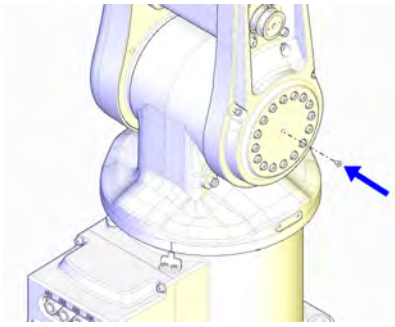
	Action	Information
7	Unscrew the *attachment screws* securing the *lower arm* to *axis-2 gearbox*.	 xx0900000859 Parts: • A: Swing housing • B: Gearbox axis 2 • C: Lower arm • D: Attachment screws (16 pcs)
8	Remove the *lower arm*.	
9	Remove *axis-3 motor* and *timing belt*.	See section • *Replacing axis-3 motor with gearbox on page 202*

Refitting the lower arm

Use this procedure to refit the lower arm.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Check that: • all assembly surfaces are clean and without damages.	
3	Remove old residues of Loctite from the assembly surfaces on gearbox axis 2 and lower arm, using *Loctite 7063*.	See *Replacing the lower arm on page 164*. • *Required equipment on page 164*
4	Apply *flange sealant* on the assembly surfaces on axis-2 gearbox and lower arm.	
5	Remove the screw from the air release hole of lower arm housing.	 xx1700000766

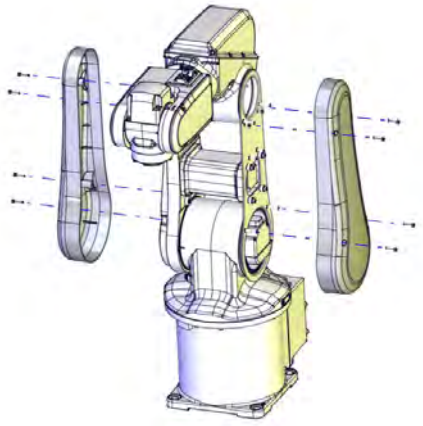
Continues on next page

	Action	Information
6	Refit the *lower arm* to *axis-2 gearbox* with its *attachment screws*.	Tightening torque: 4 Nm.  xx1700000767 Parts: • A: Swing housing • B: Gearbox axis 2 • C: Lower arm • D: Attachment screws M4x25 q12.9 and washers (16 + 16 pcs)
7	Refit the screw in the air release hole on the lower arm housing, and apply Loctite 243 on this screw.	 xx1700000768
8	Refit the *motor cover*.	Tightening torque: 4 Nm.
9	Refit *axis-3 motor*.	See section • *Replacing axis-3 motor with gear-box on page 202*
10	Secure the *upper* and *lower arms* with the attachment screws (16 pcs).	Tightening torque: 2 Nm.
11	Refit the *cable harness* in the *lower arm*.	See section • *Refitting the cable harness on page 134*

Continues on next page

4.6.1 Replacing the lower arm

Continued

	Action	Information
12	Refit the *lower arm covers*.	Tightening torque: 1 Nm.  xx0900000848
13	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
14	Recalibrate the robot.	See chapter: • *Calibration on page 225*.
15	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.7 Motors and motors with gearboxes

4.7.1 Replacing axis-1 motor with gearbox

Introduction

This procedure describes how to replace:

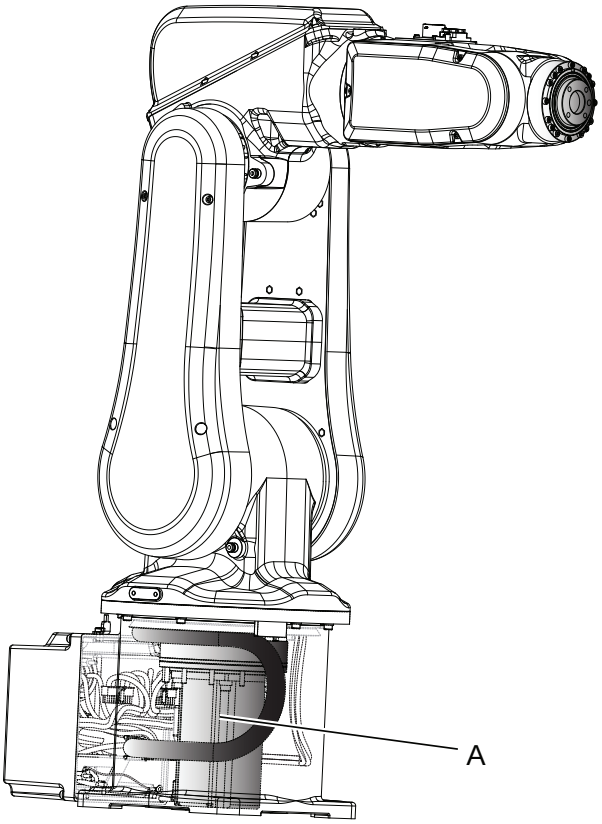
- axis-1 motor with gearbox.

Axis-1 gearbox is part of axis-1 motor when ordered as a spare part. The procedure below describes the replacement of axis-1 motor and gearbox as one unit. For further information, please **contact ABB**.

> **CAUTION**
>
> Always read the section "General procedures" before doing any repair work.
>
> *Replacing parts on the robot on page 118*

Location of axis-1 motor with gearbox

The axis-1 motor with gearbox is located as shown in the figure.



xx0900000871

A	Axis-1 motor with gearbox

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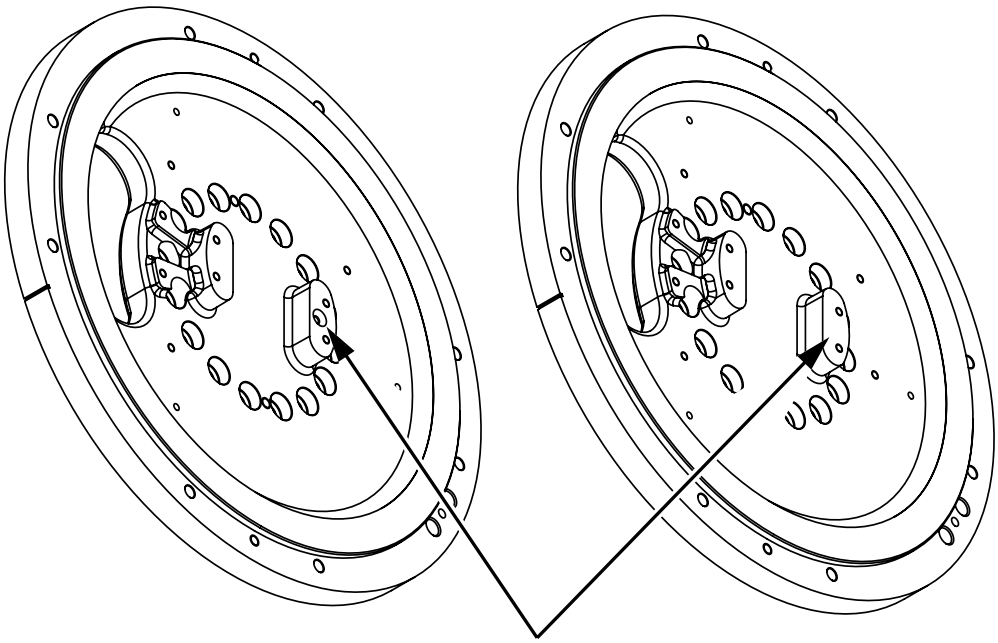
4.7.1 Replacing axis-1 motor with gearbox
Continued

There are two different designs of the swing plate, inside the base. One of the designs has an air release hole and the other does not.



xx1500000112

Required equipment

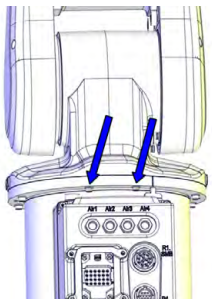
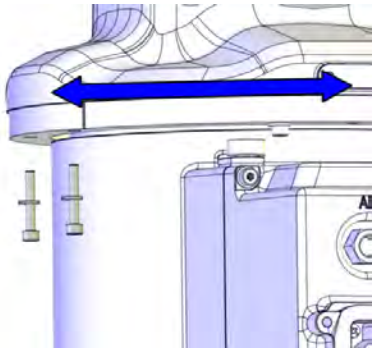
Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Flange sealant, for example Loctite 574	Amount 2 ml
Cable grease	Shell Alvania Grease WR2
Cable grease, for food grade lubrication	Mobil FM222. Used for lubrication of cable contact areas for robots with food grade lubrication.
Loctite 243	

Continues on next page

Removing the axis-1 motor with gearbox

Use these procedures to remove the axis-1 motor, with gearbox.

Removal, step 1 - Preparations

	Action	Information
1	**Note** If the robot is fitted in any other position than floor mounted, it must first be removed from this position. The replacing procedure of the axis-1 motor with gearbox is best performed with the robot in an upright position.	
2	**CAUTION** Use caution performing these procedures. The cable harness will still be fitted or partly fitted during the procedures.	
3	The two most back screws that secure the swing house, are difficult to reach with axis-1 in calibration position. Therefore jog axis-1 to be able to reach those screws.	
4	Jog axis 1 to 90° position.	
5	Remove the two attachment screws securing the swing housing to the base. (Not possible to reach with axis 1 in 0° position.)	 xx1300001598  xx1300001599

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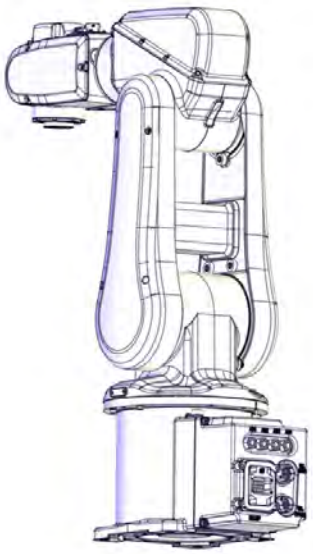
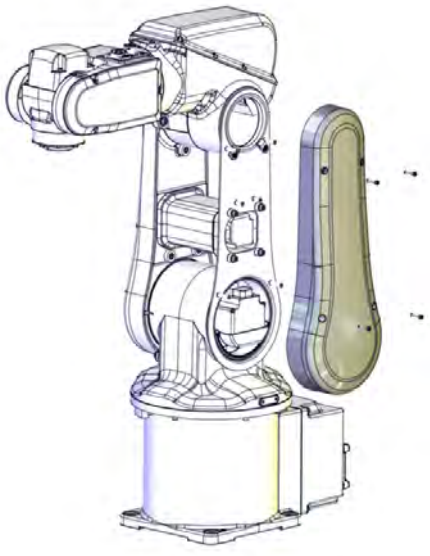
4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
6	Jog • axis 1 to 0° position • axis 2 to -50° position • axis 3 to +50° position • axis 4 to 0° position • axis 5 to +90° position • axis 6 - no significance	 xx1300001600
7	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
8	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
9	Remove the lower arm cover on the side of the lower arm plate.	 xx1300001124

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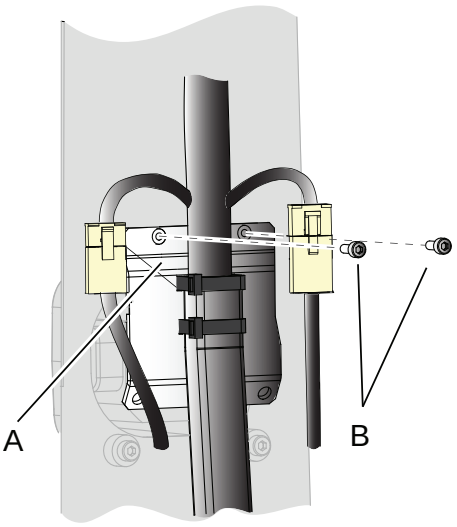
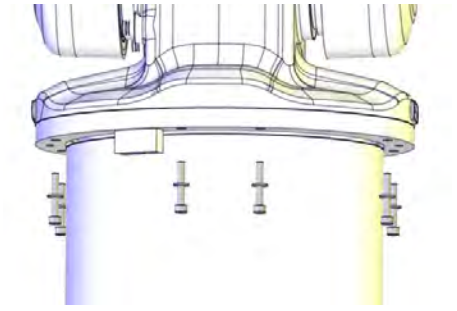
Removal, step 2 - Swing housing

	Action	Information
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
2	Remove the *cable bracket* from the lower arm.	 xx0900000879 A – Bracket B – Attachment screws (2 pcs)
3	Cut *cable ties* at motor axis 2.	
4	Disconnect *connectors*: • R2.MP2 • R2.ME2	
5	Remove the remaining *attachment screws* securing the swing housing.	 xx1300001604
6	If needed, use two screws to press the swing housing out.	

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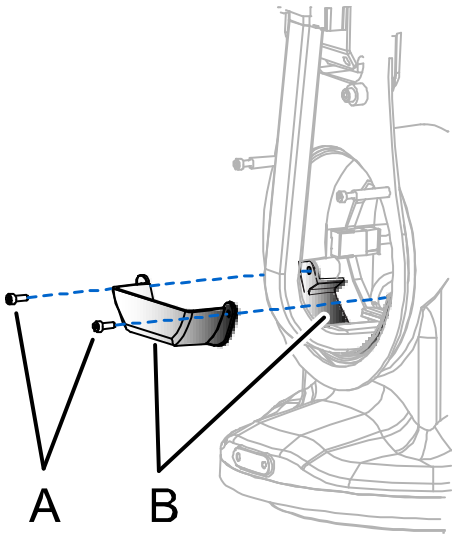
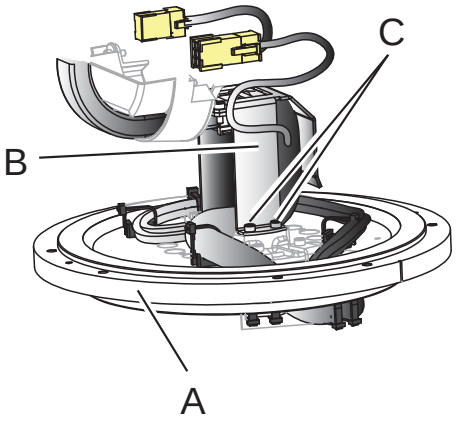
4.7.1 Replacing axis-1 motor with gearbox

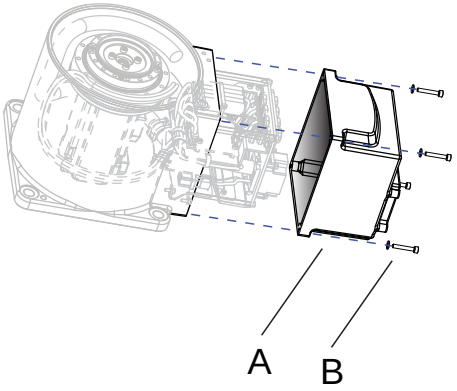
Continued

	Action	Information
7	Remove both *cable guides*.	 xx0900000857 A – Attachment screws (2 pcs) B – Cable guides (2 pcs)
8	Carefully pull the axis 2 motor cables out as long as possible.	
9	Guide the cable harness and carefully push/pull it in below motor in axis2, as long as possible, without damaging any cables. **Note** Do not use excessive force!	
10	Carefully *lift the upper arm, lower arm, and swing housing* and put it down close to the base of the robot as far as the (still connected) cable harness permit. **CAUTION** Do not stretch the cable harness.	**Tip** Use a solid box in a suitable size made of a material that will not damage the robot in any way. Some plastic in the bottom of the box makes a good "bed" for the robot to rest on.

Continues on next page

	Action	Information
11	Remove the attachment screws securing the cable bracket on the swing plate. **Note** Leave cable ties and clamps fitted!	 xx1300001596 A – Swing plate B – Cable bracket C – Attachment screws (2+2 pcs)
12	**CAUTION** Make sure the cable harness is not damaged in the process!	

Removal, step 3 - Base

	Action	Information
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
2	Remove the *base cover*.	 xx0900000829 A – Base cover B – Attachment screws (4 pcs)

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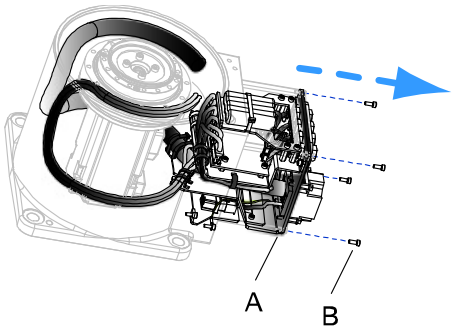
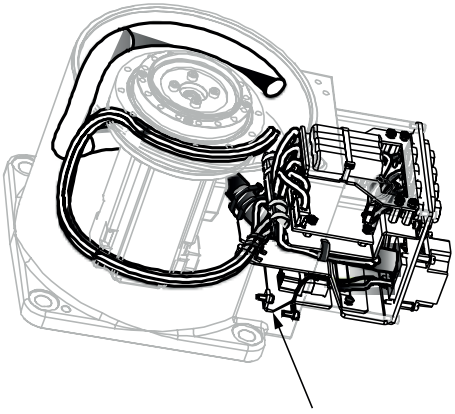
4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
3	Remove the plate with the EIB board and battery fitted, and pull it out in order to reach the connector of the battery cable.	 xx0900000831 A – Plate B – Attachment screws (4 pcs)
4	**CAUTION** Disconnect the battery cable connector very carefully! If too much force is used there is a risk of damaging the connector!	
5	Loosen *attachment screws* holding cable bracket with connectors.	 xx1500000002
6	Cut the cable ties connecting the axis-1 motor cables to the base.	
7	Disconnect the axis-1 motor cables.	

Removal, step 4 - Axis-1 motor with gearbox

	Action	Information
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	

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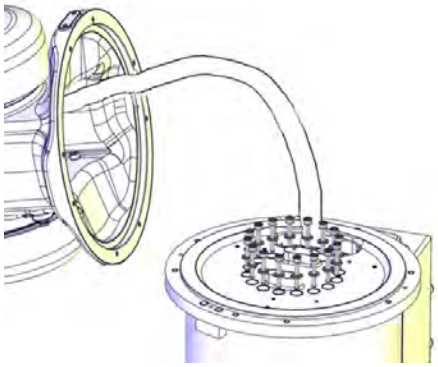
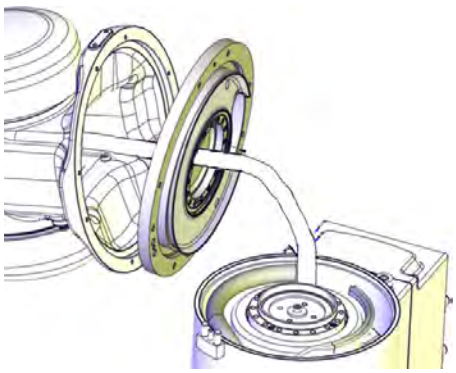
	Action	Information
2	Remove the attachment screws securing the swing plate.	 xx1300001605 A — Attachment screws and washers (16 + 16 pcs) B — Swing plate C — Base
3	**Tip** Make a note of the position of the swing plate before removing it.	 xx1400002558
4	Use caution and lift the swing plate up and put it close to the rest of the removed arm system of the robot. Use the protrude holes to force the swing plate loose. **CAUTION** Do not damage the cable harness!	 xx1300001606
5	**CAUTION** Protect the gearbox from dust and/or foreign particles.	
6	Remove screw from swing plate centre.	

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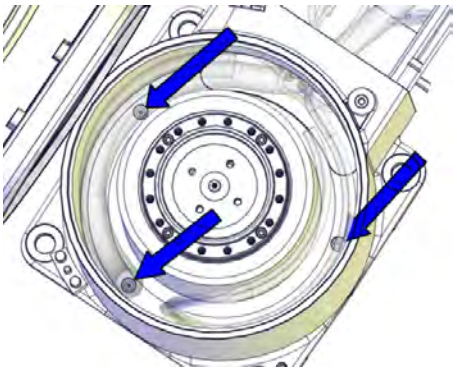
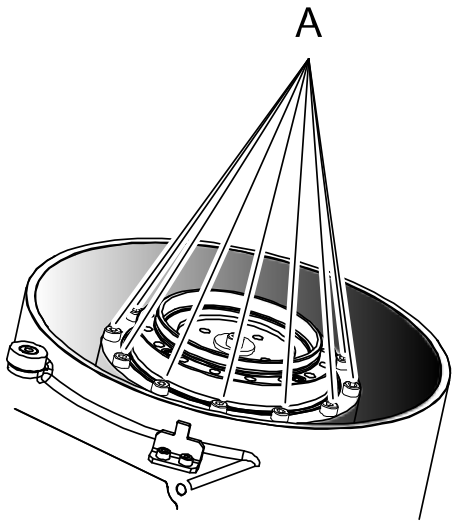
4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
7	Remove the attachment screws securing the cable guide.	 xx1300001607
8	Use caution and lift the cable guide up, moving it over the cable harness and placing it close to the rest of the removed parts of the robot. **CAUTION** Do not damage the cable harness in the process!	 xx1300001608
9	Remove the attachment screws securing the axis-1 motor with gearbox.	 xx0900001054 A — Attachment screws (12 pcs)

Continues on next page

	Action	Information
10	Use caution and push the axis-1 motor cables through the recess, while at the same time lifting the the axis-1 motor with gearbox up. **CAUTION** Lift with a firm grip on both motor and gearbox, in order not to damage any parts.	**CAUTION** Connectors can get stuck in the cramp space through the recess!

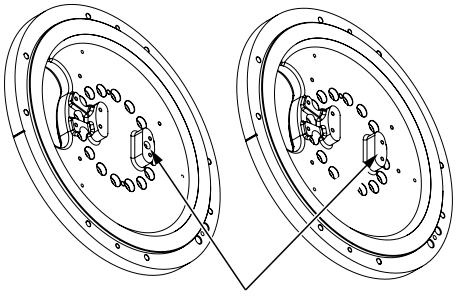
Refitting the motor and gearbox axis 1

Use these procedures to refit both motor and gearbox axis 1.

CAUTION

Use extreme caution performing these procedures. The cable harness will still be fitted or be partly fitted during the procedures.

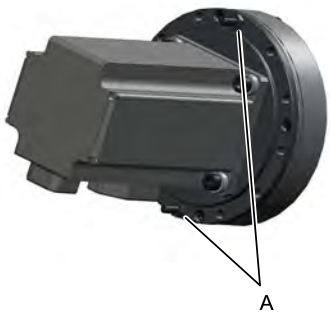
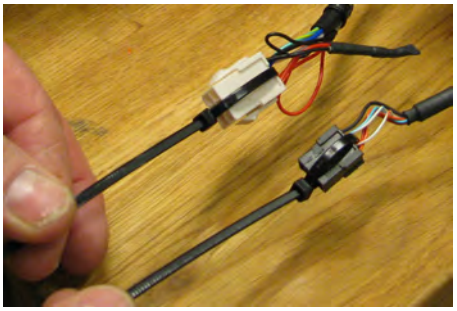
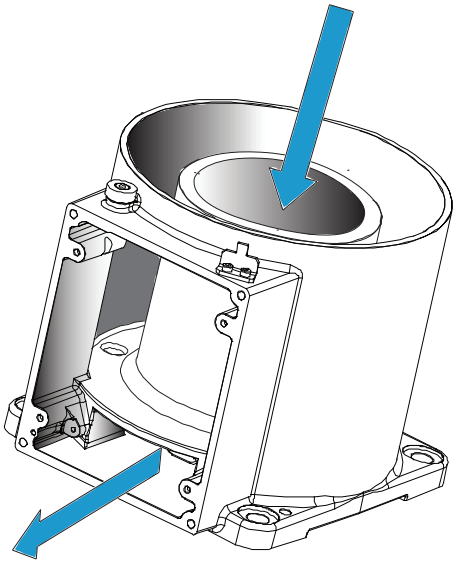
Refitting, step 1 - Axis-1 motor with gearbox

	Action	Information
1	Wipe the contact surfaces between motor flange and base clean from old residues of Loctite and other contamination. Make sure that: • all assembly surfaces are clean from old residues of Loctite and other contamination, and are without damages • motor and gearbox are clean and without damages.	
2	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
3	If robot has an air release hole: Remove the screw in the air release hole on the swing plate to release pressure inside the base.	 xx1500000112

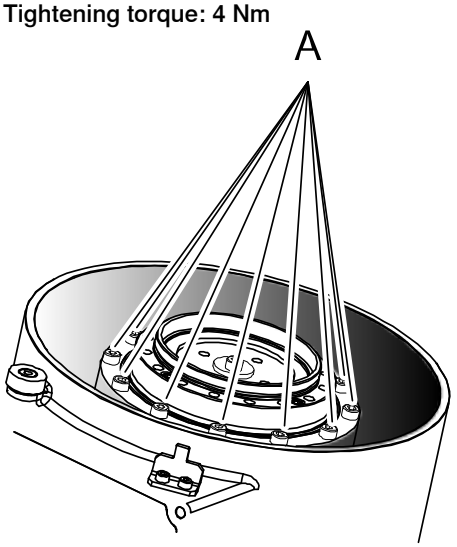
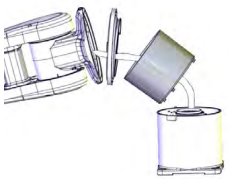
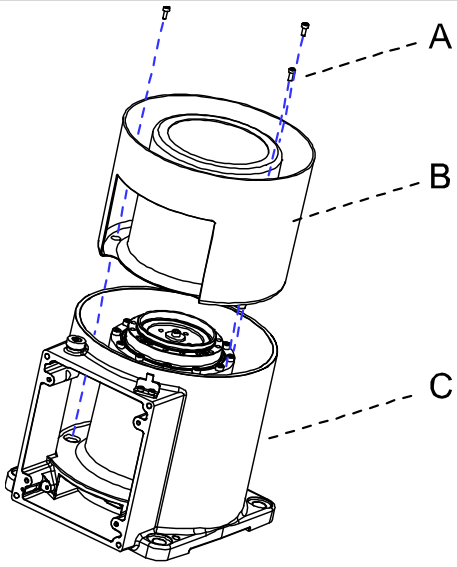
Continues on next page

4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
4	Remove the two screws with nuts securing the axis-1 motor and gearbox during transport.	 xx0900001050 A: Securing screws and nuts (2 pcs), used during transport
5	**Tip** Extend the motor connection cables with cable ties to ease pulling the cables through the base.	 xx1500000003
6	Hold the axis-1 motor, and carefully push the motor cables through the recess in the bottom of the base.	 xx1300001117
7	Before fitting the axis-1 motor with gearbox, find the position for the attachment screws, where the motor cables reaches out as long as possible into the base. With motor and gearbox fitted and motorcables out of the hole, remove the cable ties.	

Continues on next page

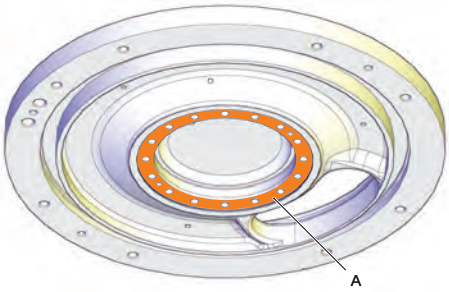
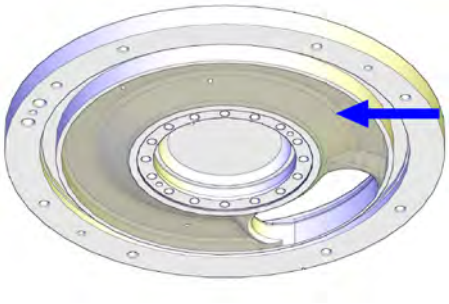
	Action	Information
8	Secure the axis-1 motor with gearbox.	Tightening torque: 4 Nm  xx0900001054 A: Attachment screw, M4x40 q12.9 (12 pcs)
9	Use caution and move the cable guide over the cable harness and fit it in the base. **CAUTION** Make sure not to damage the cable package.  xx1300001608	 xx0900000800 A: Attachment screws M3x8 q12.9 (3 pcs) B: Cable guide C: Base
10	Secure the cable guide with its attachment screws.	Tightening torque: 2 Nm.
11	Apply cable grease on the inside surfaces of the cable guide.	

Continues on next page

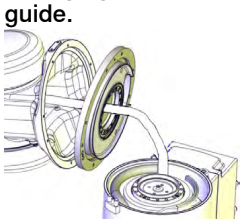
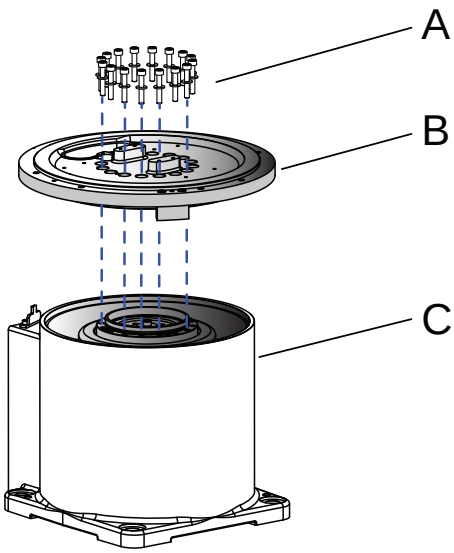
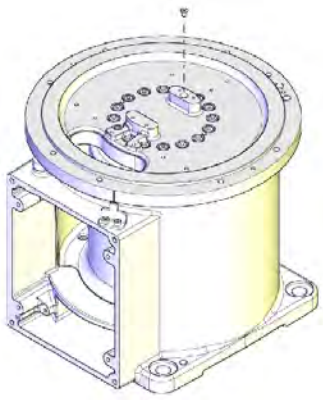
4.7.1 Replacing axis-1 motor with gearbox

Continued

Refitting, step 2 - Base

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Wipe clean the contact surfaces between base and swing plate from old residues of Loctite and other contamination.	
3	Wipe clean countersink hole in swing plate and screw.	
4	Apply flange sealant (Loctite 574) on the assembly surfaces on swing plate and gear.	 xx0900000835 A: Area where to apply Loctite 574
5	Apply a thin layer of cable grease on the plastic surface of the part of the cable guide fitted on the swing plate.	 xx1300001125
6	Apply cable grease on cables and hoses before running the package in through the cable guide.	

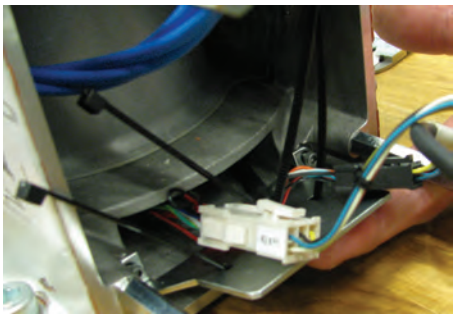
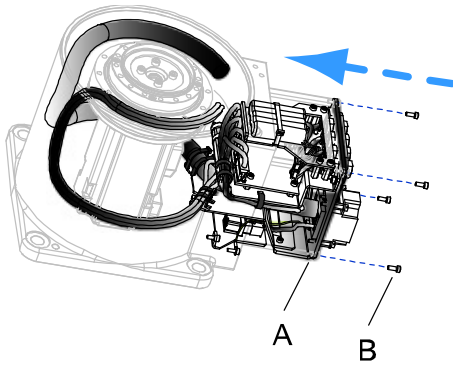
Continues on next page

	Action	Information
7	Fit the swing plate while at the same time arranging the cable harness in the cable guide.  xx1300001606 **CAUTION** Be careful not to damage the cable harness.	Tightening torque: 4 Nm.  xx0900000799 A: Attachment screws and washers M4x25 q 12.8 (16+16 pcs) B: Swing plate C: Base
8	Refit the screw in the air release hole on the swing plate, and apply Loctite 243 on this screw.	 xx1700000769
9	Connect connectors: • R2.MP1 • R2.ME1	
10	**Tip** To facilitate assembly of cable ties, loosen the screws holding the plate a little bit.	

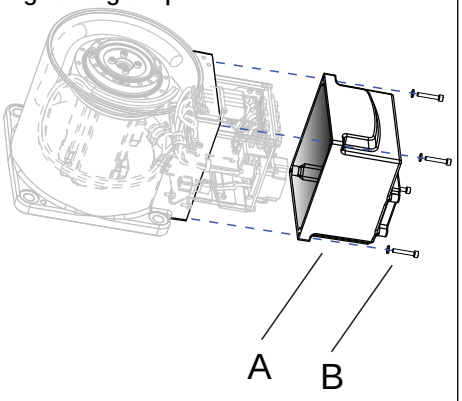
Continues on next page

4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
11	Secure the connectors to the plate with cable ties.	 xx1400002559
12	Refit the attachment screws that secure the cable plate, if removed.	
13	Use caution and reconnect the battery cable connector. **CAUTION** If too much force is used when the battery cable is connected, there is a risk of damaging the connector. **Tip** Leaving the attachment screws securing the bracket with battery unscrewed, will make it easier to connect the battery cable.	
14	Secure the bracket with battery (if it has been removed).	
15	Make sure the earth cable is connected and undamaged.	
16	Use caution and push in the plate with the EIB board and battery into the base. **Note** Make sure that the cables are placed correctly and that no cables are damaged!	 xx0900000836 Parts: • A: Plate • B: Attachment screws M3x8 q12.8 (4 pcs)
17	Secure the plate with its attachment screws.	Tightening torque: 2 Nm.

Continues on next page

	Action	Information
18	Use caution and refit the base cover. **CAUTION** Make sure not to damage the cables in the process.	Tightening torque: 4 Nm.  xx0900000829 Parts: • A: Base cover • B: Attachment screws M4x25 q12.8 (4 pcs)

Refitting, step 3 - Swing house

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Lift swing house and armsystem (upper and lower arms) and hold the parts in an angle in order to be able to fit the cable holder on the swing plate. **Tip** The easiest and most safe way to do this, is with two persons working together: • Person 1 holding the armsystem in an angle • Person 2 fitting the cable holder.	

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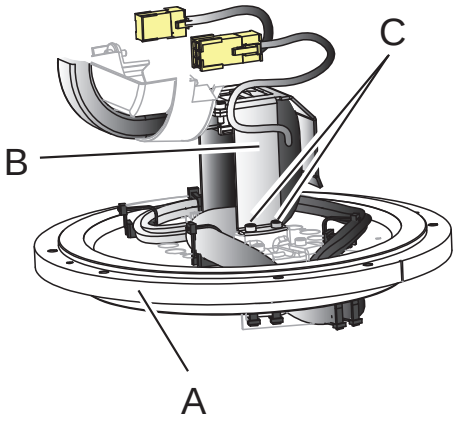
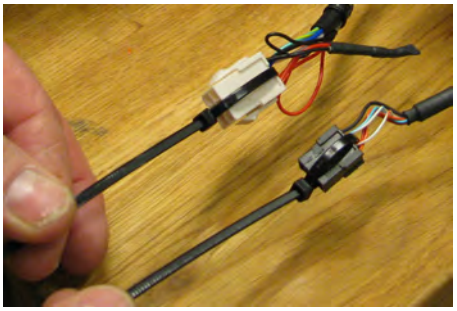
4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
3	Secure the cable holder.	 xx1300001596 A – Swing plate B – Cable bracket C – Attachment screws M4x25 q12.8 (2+2 pcs)
4	While still holding the armsystem lifted in an angle, use caution and push the axis-2 motor cables into the swing house, one on each side of the motor.	
5	**Tip** Extend the motor connection cables with cable ties to ease pulling the cables through the base.	 xx1500000003 *Figure 4.1:*
6	Use caution and push the rest of the cables into the swing house.	
7	Wipe clean the contact surfaces between swing plate and swing house from old residues of Loctite and other contamination.	
8	Use caution and move the swing house over the cable harness and put it into fitting position.	

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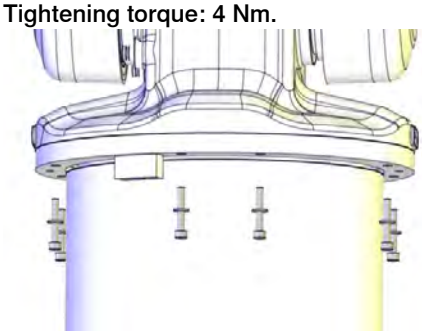
	Action	Information
9	Secure the swing house with the six attachment screws possible to reach at this point.	Tightening torque: 4 Nm.  xx1300001604 M4x25 (6 pcs) Attachment screws M4x25 q12.9 (6 pcs)

Refitting, step 4 - Concluding procedure

	Action	Information
1	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
2	Connect connectors: • R2.MP2 • R2.ME2	
3	Arrange the axis-2 motor cables so that they will not be damaged.	
4	Secure the motor cables around the axis-2 motor with a cable tie.	

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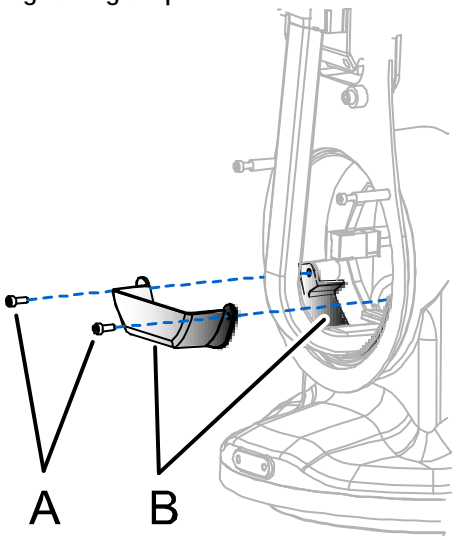
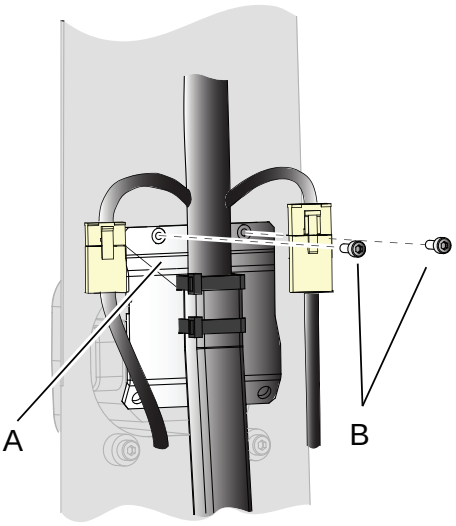
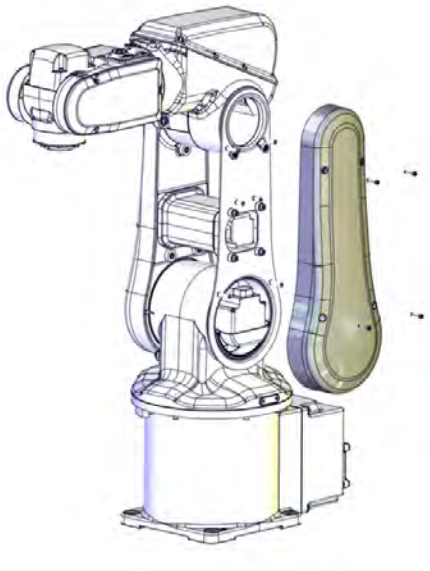
4.7.1 Replacing axis-1 motor with gearbox

Continued

	Action	Information
5	Fit the two cable guides.	Tightening torque: 1 Nm.  xx0900000857 A – Attachment screws M3x8 (2 pcs) B – Cable guides (2 pcs)
6	Fit the cable bracket on the lower arm plate.	 xx0900000879 A – Cable bracket B – Attachment screws M3x8 (2 pcs)
7	Lubricant the inside of the lower arm cover with cable grease.	

Continues on next page

	Action	Information
8	Fit the lower arm cover.	Tightening torque: 2 Nm  xx1300001124
9	Power up the robot.	
10	Turn on the controller and jog the robot to calibration position.	
11	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
12	Jog axis-1 to 90° position in order to be able to reach the remaining two attachment screws securing the swing house.	
13	Recalibrate the robot.	See chapter: • *Calibration on page 225*.
14	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.7.2 Replacing axis-2 motor with gearbox

Introduction

This procedure describes how to replace:

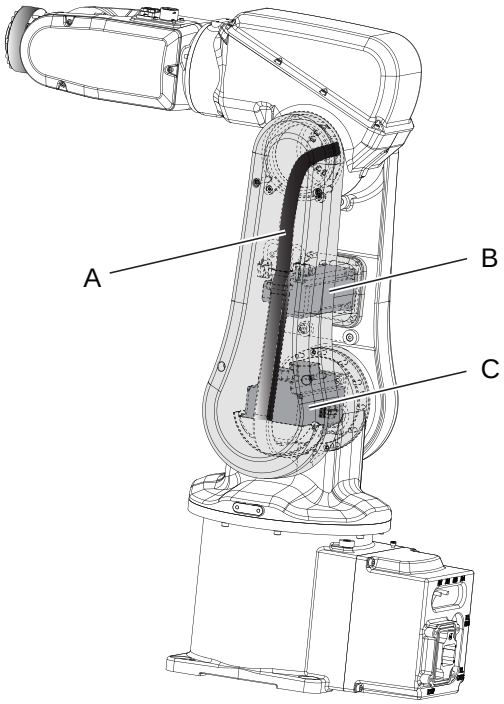
- motor axis 2 with gearbox.

Gearbox axis 2 is a part of motor axis 2 when ordered as a spare part. The procedure below describes the replacement of motor and gearbox axis 2 as one unit. For information how to replace gearbox axis 2, please **contact ABB**.

> **CAUTION**
>
> Always read the section "General procedures" before doing any repair work.
>
> *Replacing parts on the robot on page 118*

Location of motor axis-2 with gearbox

Axis-2 motor with gearbox is located as shown in the figure.



xx0900000847

A	Cable harness
B	Motor axis-3
C	Motor axis-2 with gearbox

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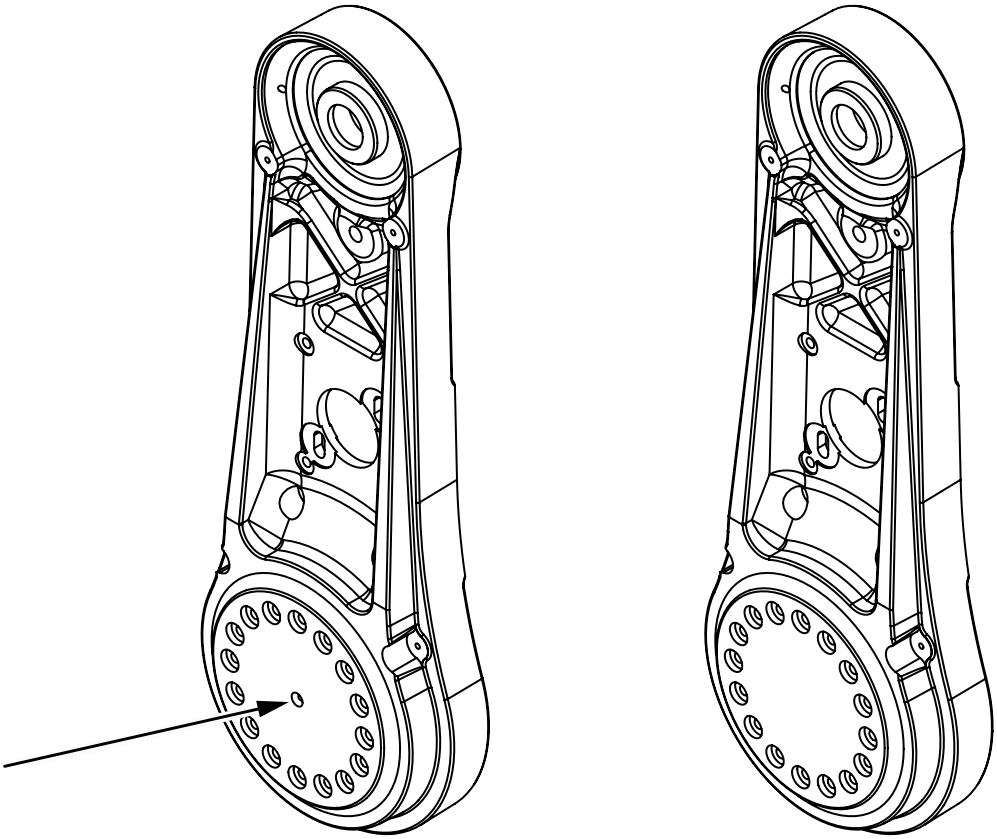
There are two different designs of the lower arm housing. One of the designs has an air release hole and the other does not.



xx1500000113

Required equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Loctite 7063	For removing residues of Loctite.
Loctite 574	Amount: 2 ml.

Removing axis-2 motor with gearbox

Use this procedure to remove axis-2 motor with gearbox.

CAUTION

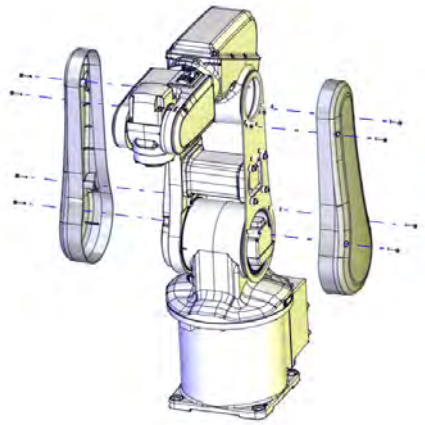
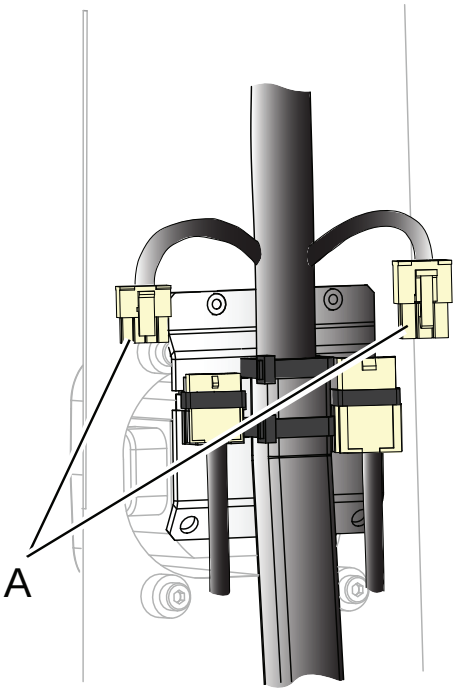
Use extreme caution performing these procedures. The cable harness will still be fitted or be partly fitted during the procedures.

	Action	Information
1	Jog the robot to calibration position.	

Continues on next page

4.7.2 Replacing axis-2 motor with gearbox

Continued

	Action	Information
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
4	Remove the lower arm covers on both sides of the lower arm.	 xx0900000848
5	Disconnect connectors: • R2.MP3 • R2.ME3	 xx0900000850 Parts: • A: Connectors

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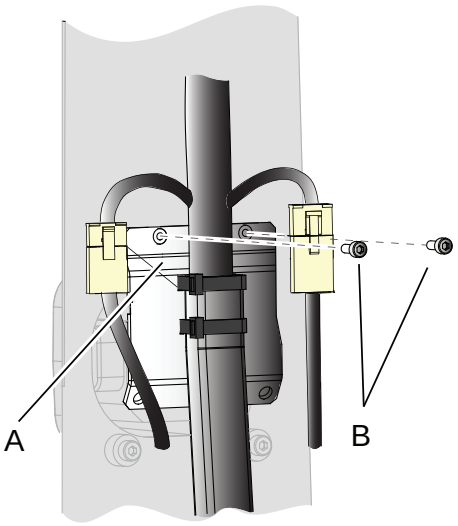
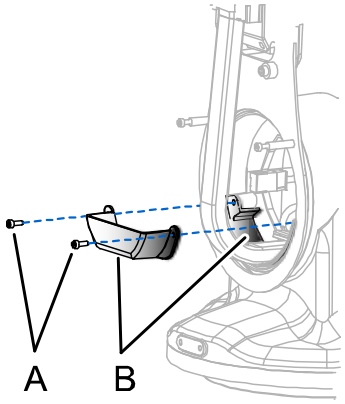
	Action	Information
6	Unscrew the attachment screws securing the cable bracket in order to disconnect the cable harness from the lower arm.	 xx0900000879 Parts: • A: Cable bracket • B: Attachment screws (2 pcs)
7	Remove both cable guides.	 xx0900000857 Parts: • A: Attachment screws (2+2 pcs) • B: Cable guides (2 pcs)

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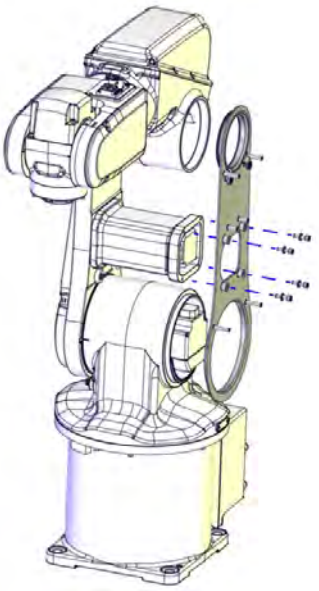
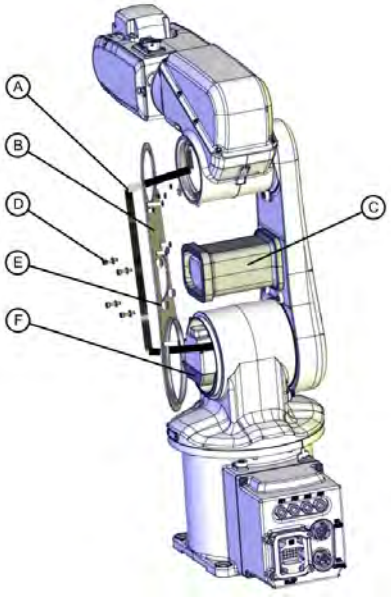
4.7.2 Replacing axis-2 motor with gearbox

Continued

	Action	Information
8	Unscrew the attachment screws securing the lower arm plate to the motor cover.	 xx1300001123
9	Use caution, pull out the cable harness as far as possible without causing damage and put the lower arm plate in an angle.	 xx0900000851 Parts: • A: Cable harness • B: Lower arm plate • C: Motor cover • D: Attachment screws (4 pcs) • E: Holes for attachment screws (4 pcs) • F: Cable guide

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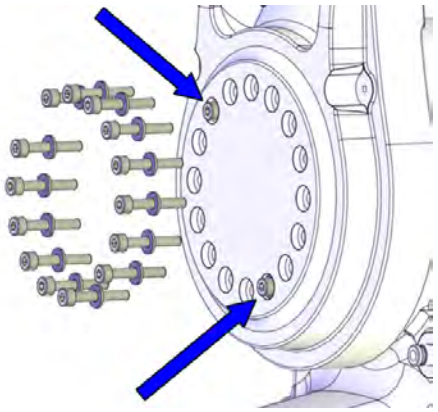
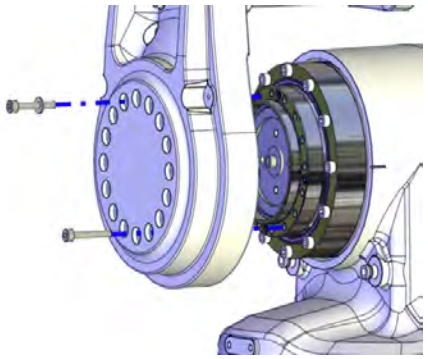
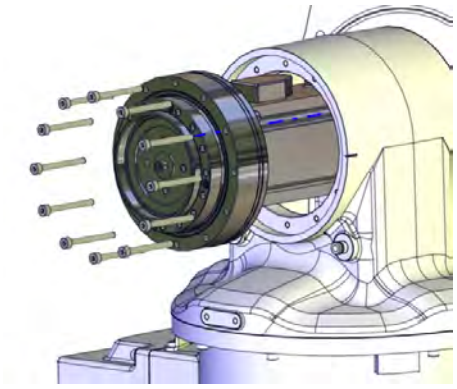
	Action	Information
10	Leave two attachment screws fitted and unscrew the remaining screws, that secure the lower arm to the axis-2 gearbox.	 xx1300001121
11	Take a hold of the upper and lower arm in a firm grip.	
12	Use caution and unscrew the two remaining attachment screws that secure the lower arm to the axis-2 gearbox.	 xx1300001119
13	**Air hole design:** Remove screw from swing plate.	
14	Use caution and put the lower and upper arms beside the swing housing and base, making sure not to damage the cable harness. **Tip** Place the armsystem on some plastic or in a box with soft edges. The armsystem must be placed in a way that it will not be able to move or be moved.	
15	Disconnect connectors: • R2.MP2 • R2.ME2	

Continues on next page

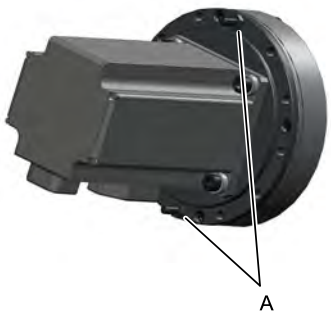
	Action	Information
16	Unscrew the attachment screws and plain washers that secure the axis-2 motor with gearbox to the swing housing, use caution and remove the axis-2 motor. **CAUTION** In order not to damage any parts, hold the two parts in a firm grip when removing the motor with gearbox.	 xx1300001120

Refitting motor axis 2 with gearbox

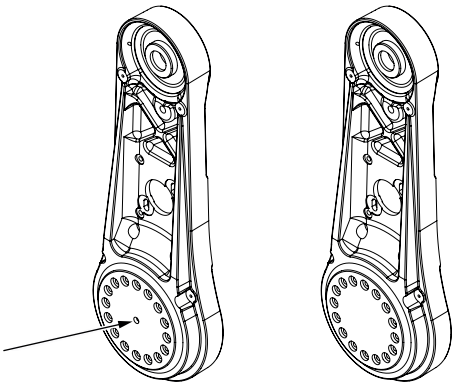
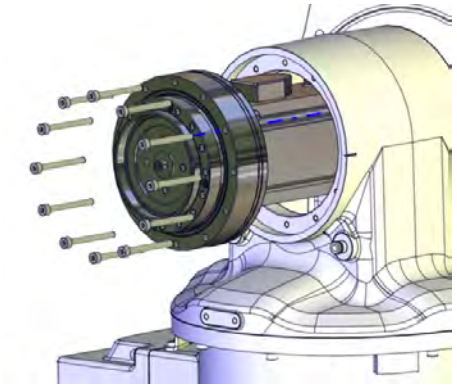
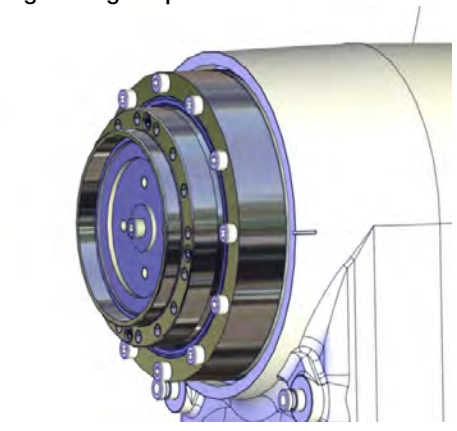
Use this procedure to refit motor axis 2 with gearbox.

CAUTION

Use extreme caution performing these procedures. The cable harness will still be fitted or be partly fitted during the procedures.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Before refitting, make sure that: • all assembly surfaces are clean and without damages • motor and gearbox are clean and without damages.	**Tip** Use Loctite 7063 (Superclean).
3	Remove the two screws with nuts securing motor axis 2 with gearbox while being transported.	 xx0900001050 Parts: • A: Screws with nuts, used during transport (2 pcs)
4	Remove old residues of Loctite and other contamination, from the assembly surfaces of the lower arm.	
5	Wipe clean screw and countersink hole on swing plate.	

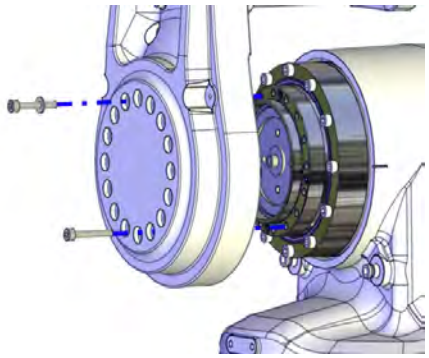
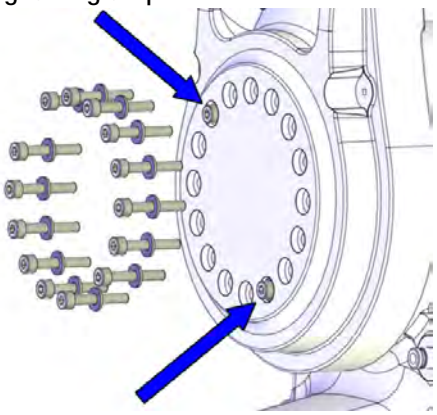
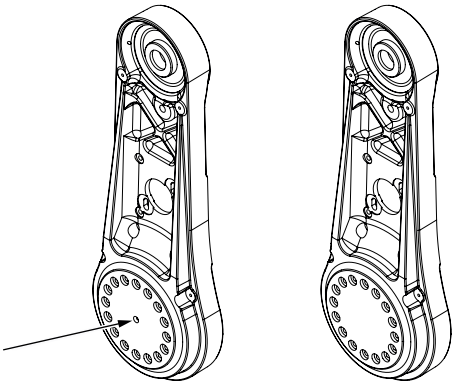
Continues on next page

	Action	Information
6	Refill the same amount of grease in the gearbox, that has been wiped off.	
7	If the robot has an air release hole: Remove the screw in the air release hole on the lower arm housing to release pressure inside the lower arm.	 xx1500000113
8	Apply flange sealant (Loctite 574) on the assembly surfaces of the lower arm and gearbox.	
9	Place the axis-2 motor with gearbox in the swing housing. **CAUTION** In order not to damage any parts, hold the two parts in a firm grip when refitting the motor with gearbox.	 xx1300001120
10	Secure the axis-2 motor with gearbox to the swing housing with its attachment screws.	Tightening torque: 4 Nm.  xx1300001122 Attachment screws M4x20 q12.9 (12 pcs)

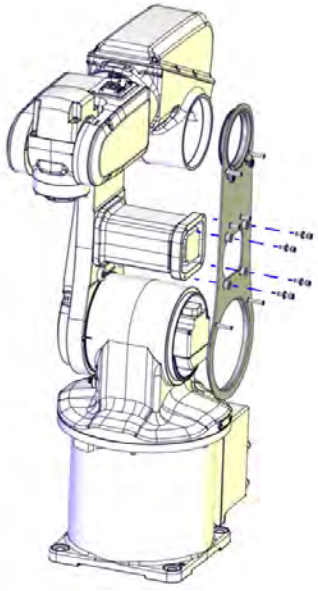
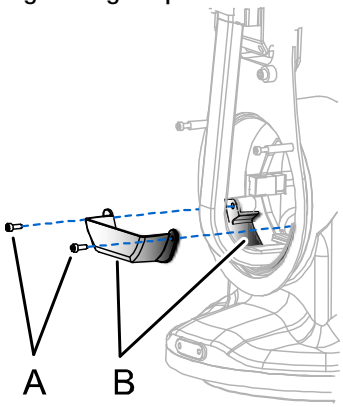
Continues on next page

4.7.2 Replacing axis-2 motor with gearbox

Continued

	Action	Information
11	While holding the upper and lower arms, secure the lower arm to the axis-2 motor with gearbox with two of the attachment screws.	 xx1300001119
12	Secure the axis-2 motor with gearbox to the lower arm with the remaining attachment screws. Tighten all screws.	Tightening torque: 4 Nm.  xx1300001121 Attachment screws M4x25 q12.9 and washers (16 + 16 pcs)
13	If the robot has an air release hole: Add Loctite 243 and refit the screw in the air release hole on the lower arm housing.	 xx1500000113

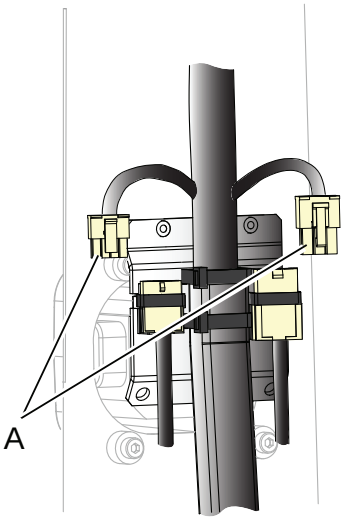
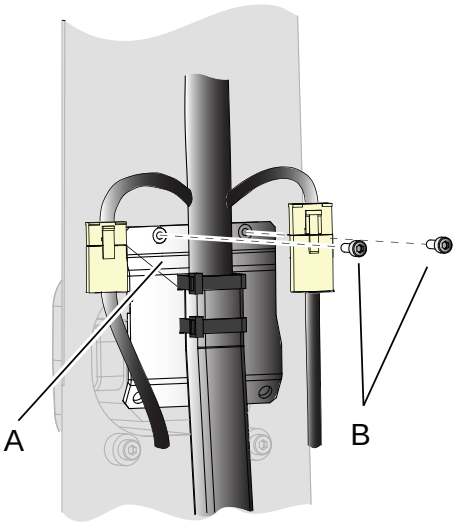
Continues on next page

	Action	Information
14	Refit the lower arm plate. **Note** Make sure that the lower arm plate is centered!	Tightening torque: 4 Nm.  xx1300001123 Attachment screws M4x16 q12.9 and washers (4 + 4 pcs)
15	Reconnect the axis-2 motor cables: • R2.MP2 • R2.ME2	
16	Secure the motor cables around the axis-2 motor with cable ties. **Note** Put the tie on the side in order to make the lower arm cover fit well.	
17	Refit the two cable guides.	Tightening torque : 1 Nm.  xx0900000857 Parts: • A: Attachment screws M3x8 (2 pcs) • B: Cable guides (2 pcs)

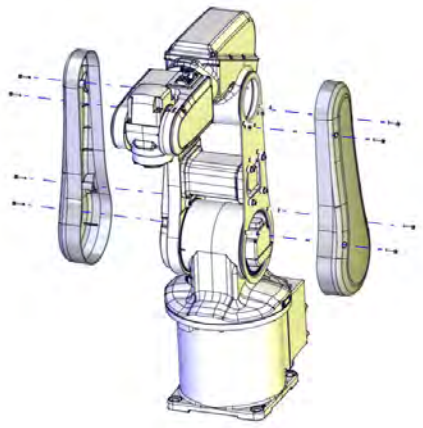
Continues on next page

4.7.2 Replacing axis-2 motor with gearbox

Continued

	Action	Information
18	Reconnect connectors: • R2.MP3 • R2.ME3.	 xx0900000850 Connectors: • A: R2.ME3 • B: R2.MP3
19	Refit the cable bracket on the lower arm.	 xx0900000879 Parts: • A: Cable bracket • B: Attachment screws M3x8 (2 pcs)
20	**DANGER** Check that the cable harness is intact and connected correctly on all axes!	

Continues on next page

	Action	Information
21	Refit the *lower arm covers*.	Tightening torque: 2 Nm.  xx0900000848
22	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
23	Recalibrate the robot.	See chapter: • *Calibration on page 225*.
24	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.7.3 Replacing axis-3 motor with gearbox

Introduction

This procedure describes how to replace axis-3 motor.

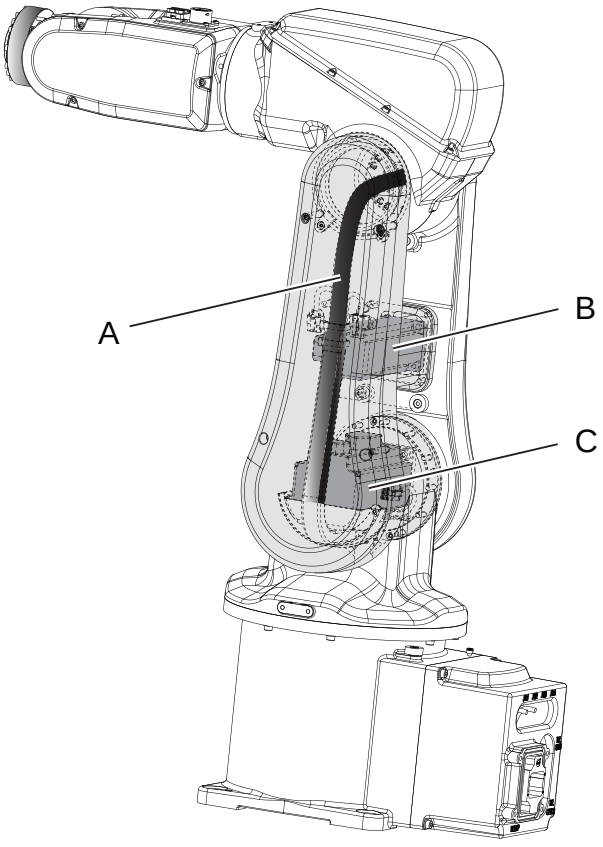
How to replace axis-3 gearbox, see section:

- *Replacing gearbox axis 3 on page 220*

> **CAUTION**
>
> Always read the section "General procedures" before doing any repair work.
> *Replacing parts on the robot on page 118*

Location of axis-3 motor

The axis-3 motor is located as shown in the figure.



xx0900000847

A	Cable harness
B	Motor axis 3
C	Motor axis 2

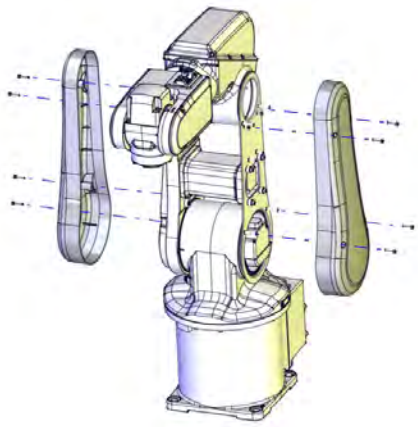
Continues on next page

Required equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
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.
Flange sealant (Loctite 574)	Amount: 2 ml.

Removing axis-3 motor

Use this procedure to replace axis-3 motor.

	Action	Information
1	Secure the arm system before removing motor axis 3.	
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
4	Remove the *lower arm covers* on both sides of the of the lower arm.	 xx0900000848

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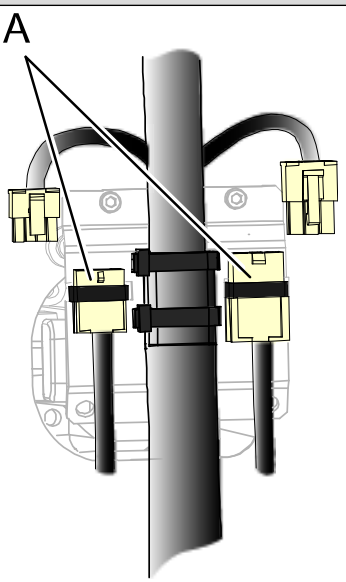
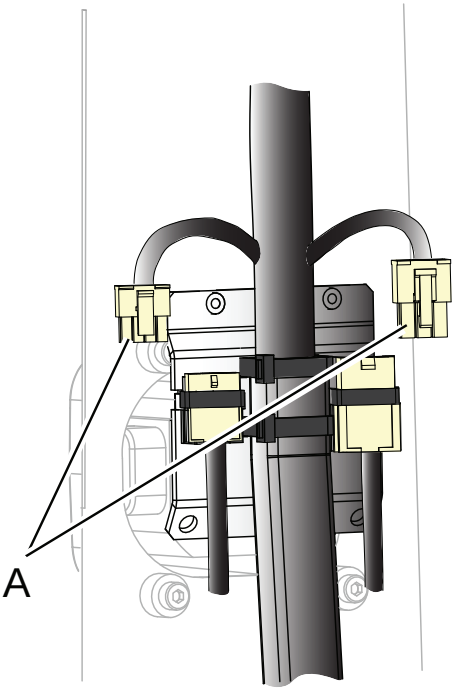
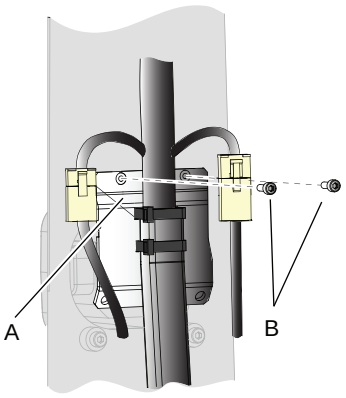
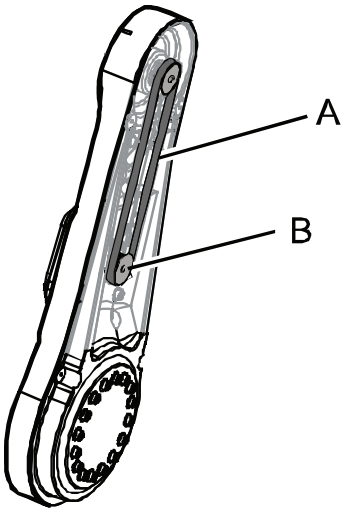
4.7.3 Replacing axis-3 motor with gearbox

Continued

	Action	Information
5	Cut the *cable straps* securing the connectors.	 xx0900000849 Parts: • A: Cable straps (2 pcs)
6	Disconnect connectors: • R2.MP3 • R2.ME3.	 xx0900000850 Parts: • A: Connectors R2.MP3 and R2.ME3

Continues on next page

	Action	Information
7	Unscrew the *attachment screws* securing the *cable bracket*.	 xx0900000879 Parts: • A: Cable bracket • B: Attachment screws (2 pcs)
8	Move the *cable harness* a little to the side.	
9	Unscrew the *attachment screws* securing the *motor axis 3*.	
10	Remove the *timing belt* from the *pulleys* on the motor axis.	 xx0900000876 Parts: • A: Timing belt • B: Pulleys (2 pcs)
11	Remove the motor.	

Refitting axis-3 motor

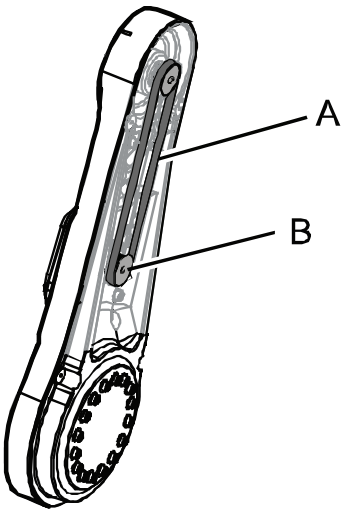
Use this procedure to refit axis-3 motor.

	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	

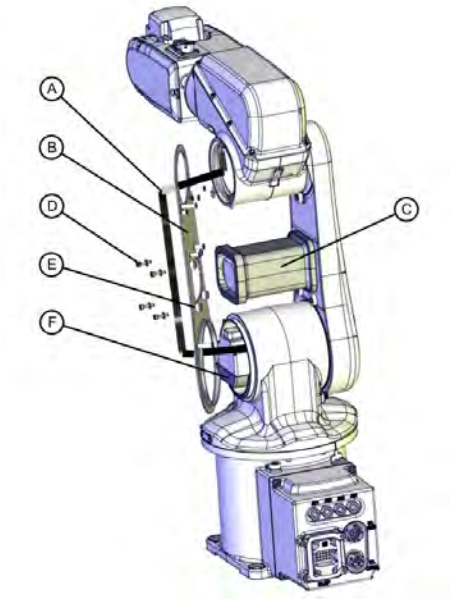
Continues on next page

4.7.3 Replacing axis-3 motor with gearbox

Continued

	Action	Information
2	Make sure that: • all assembly surfaces are clean and without damages • motor and gearbox are clean and undamaged.	
3	Place the *axis-3 motor* in the *motor cover*.	
4	Refit the *timing belt* on the *pulleys*.	 xx0900000876 Parts: • A: Timing belt • B: Pulleys (2 pcs)
5	Tighten the *attachment screws* and *washers* securing the motor, just enough to still be able to move the motor.	
6	Move the motor to a position where a good *timing belt tension* is reached. **Tip** Use a handheld spring balance to measure the timing belt tension.  xx1400002560	New belt: F = 18-19.7N Used belt: F = 12.5-14.3N **Note** Do not strech the timing belt too much!
7	Secure the *axis-3 motor* with its *attachment screws* and *washers*.	Tightening torque: 4 Nm.

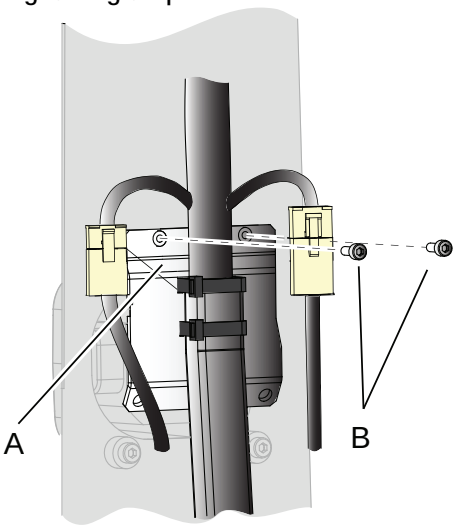
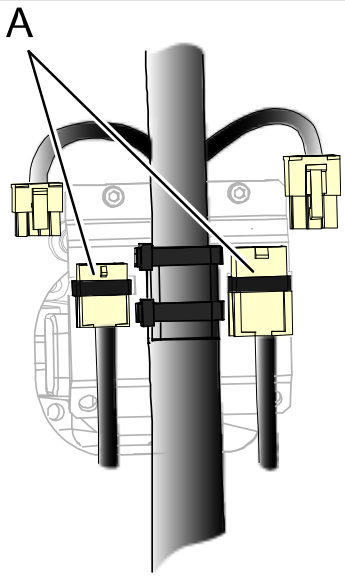
Continues on next page

	Action	Information
8	Refit the *lower arm plate*.	Tightening torque: 4 Nm.  xx0900000851 Parts: • A: Cable harness • B: Lower arm plate • C: Motor cover • D: Attachment screws (4 pcs) • E: Holes for attachment screws (4 pcs) • F: Cable guide
9	Reconnect connectors: • R2.MP3 • R2.ME3.	

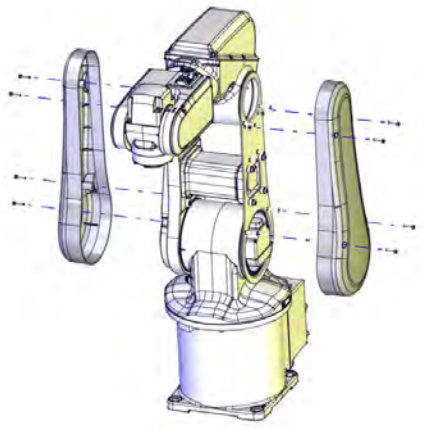
Continues on next page

4.7.3 Replacing axis-3 motor with gearbox

Continued

	Action	Information
10	Secure the cable harness by refitting the *cable bracket* to the lower arm plate.	Tightening torque: 1 Nm.  xx0900000879 Parts: • A: Cable bracket • B: Attachment screws (2 pcs)
11	Secure the connectors with *cable ties*. **Note** Put the strap tie on the side in order to make the lower arm cover fit well.	 xx0900000849 Parts: • A: Cable ties (2 pcs)

Continues on next page

	Action	Information
12	Refit the *lower arm covers*.	Tightening torque: 1 Nm.  xx0900000848
13	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
14	Recalibrate the robot.	See chapter: • *Calibration on page 225*.
15	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.7.4 Replacing motor axis 4, with gearbox

Introduction

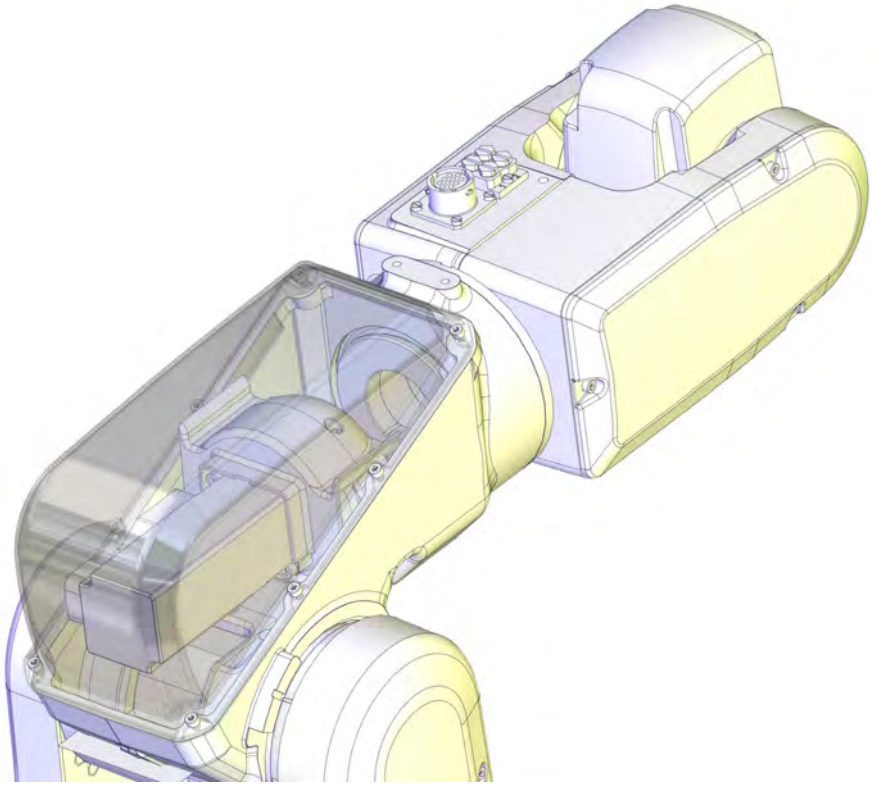
Motor axis 4 is delivered as part of the upper arm when ordered as a spare part.

How to replace the complete upper arm is described in section:

- *Replacing the upper arm on page 155*

Location of motor axis 4, with gearbox

Motor axis 4, with gearbox is located as shown in the figure:



xx0900000785

4.7.5 Replacing motor axis 5

Introduction

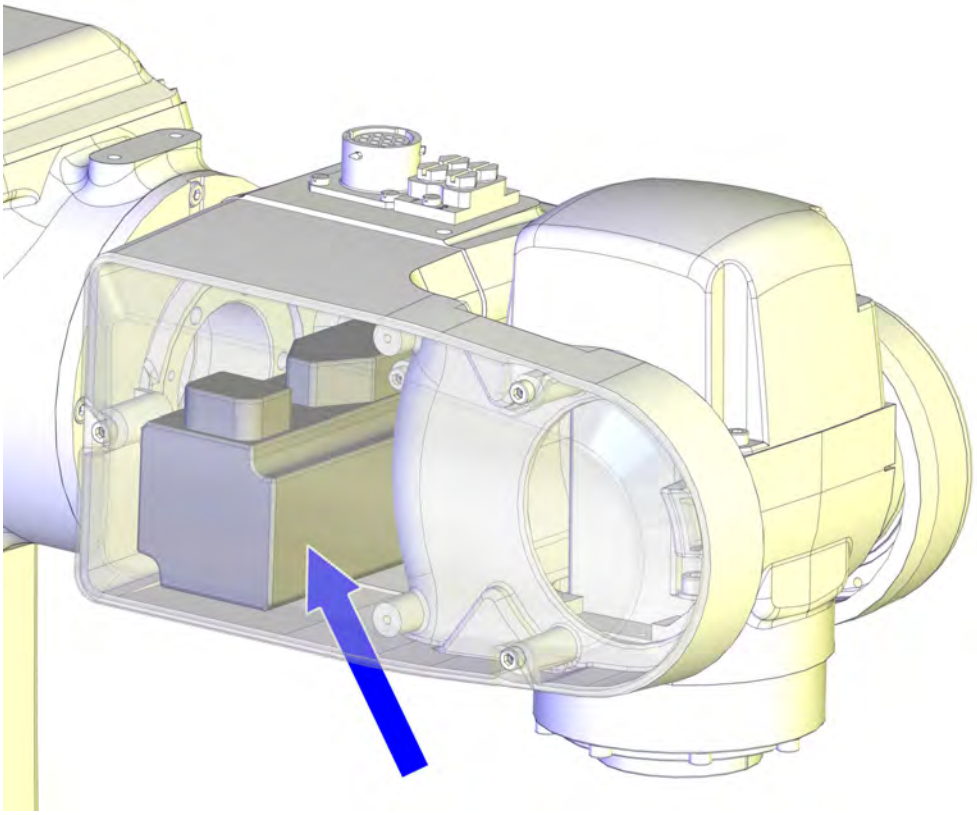
This procedure describes how to replace:

- motor axis 5 with pulley.

> **CAUTION**
>
> Always read the section "General procedures" befor doing any repair work.
>
> *Replacing parts on the robot on page 118*

Location of motor axis 5

The motor axis 5 is located as shown in the figure.



xx0900000890

Required equipment

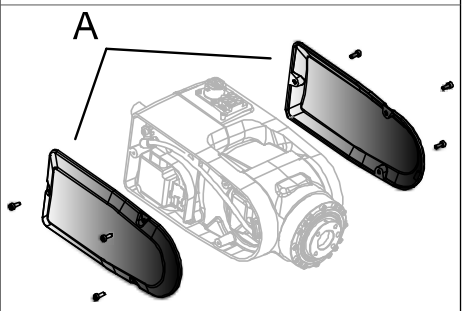
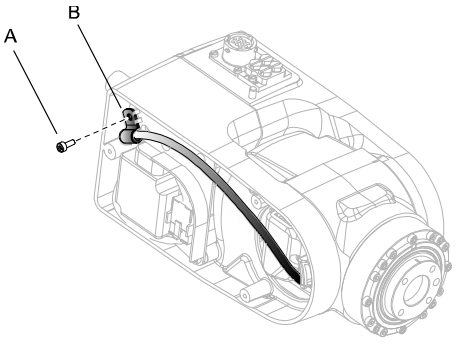
Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Continues on next page

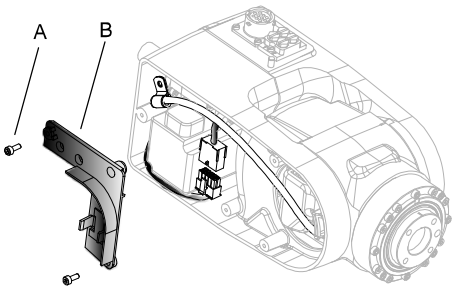
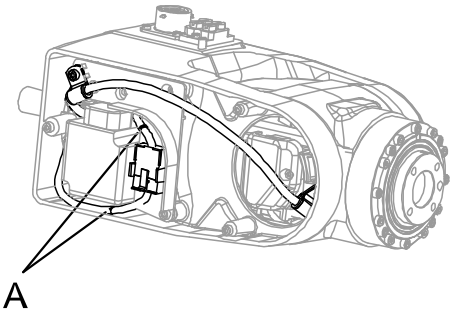
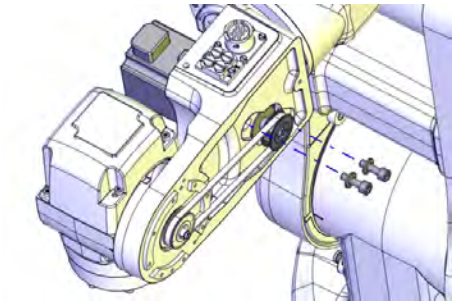
4.7.5 Replacing motor axis 5
Continued

Removing motor axis 5 with pulley

Use this procedure to remove motor axis 5 with pulley.

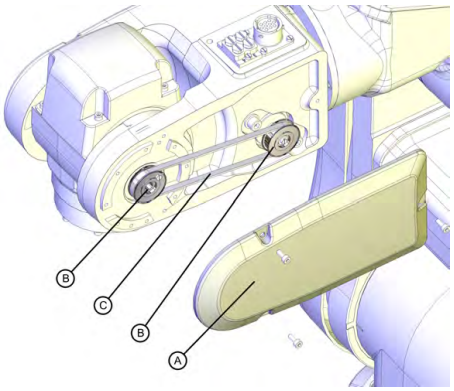
	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts of a Clean Room robot! See *Replacing parts on the robot on page 118*	
3	Remove the *wrist side covers* on both sides of the wrist.	 xx0900000886 Parts: • A: Wrist side covers (2 pcs)
4	Loosen the *attachment screw* securing the *clamp*.	 xx0900000887 Parts: • A: Attachment screw • B: Clamp

Continues on next page

	Action	Information
5	Remove the *connector support*.	 xx0900000888 Parts: • A: Attachment screws (2 pcs) • B: Connector support
6	Cut the *cable straps*.	 xx0900001009 Parts: • A: Cable straps (2 pcs)
7	Disconnect connectors for motor axis 5: • R2.MP5 • R2.ME5	
8	Unscrew the *attachment screws* securing *motor axis 5*.	 xx1100000960

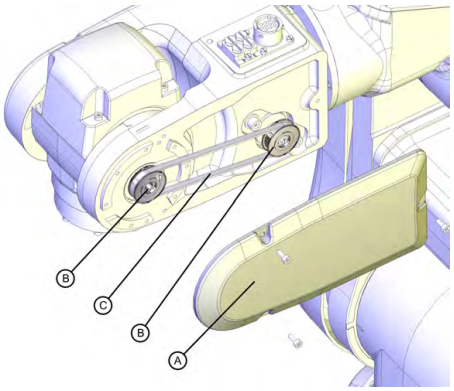
Continues on next page

4.7.5 Replacing motor axis 5
Continued

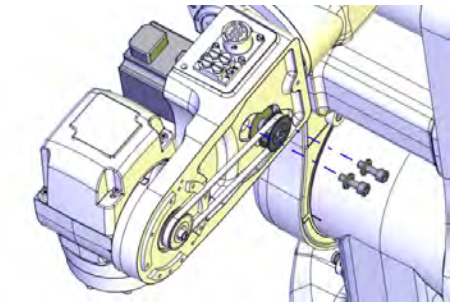
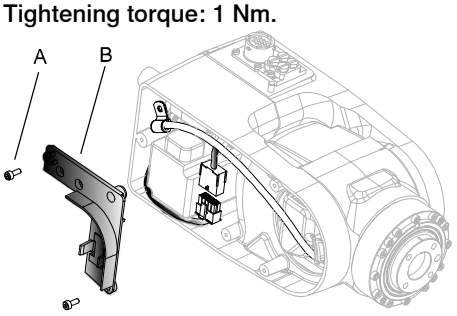
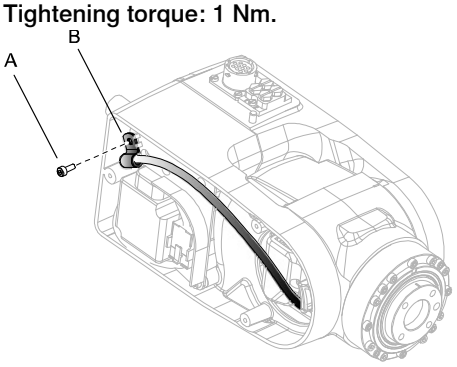
	Action	Information
9	Remove the *timing belt* from the *pulleys*.	 xx0900000611 Parts: • A: Wrist side cover • B: Pulley (2 pcs) • C: Timing belt
10	Remove the motor with pulley.	

Refitting motor axis 5

Use this procedure to refit motor axis 5.

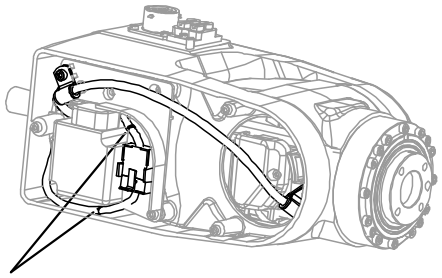
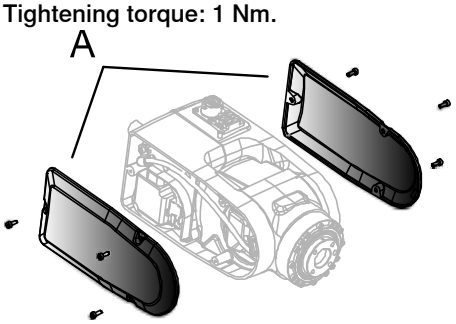
	Action	Information
1	Clean Room robots: clean the joints that have been opened. See *Replacing parts on the robot on page 118*	
2	Check that: • all assembly surfaces are clean and without damages • the motor is clean and undamaged.	
3	Place the motor in the wrist housing.	
4	Reconnect connectors: • R2.MP5 • R2.ME5	
5	Refit the *timing belt* on the *pulleys*.	 xx0900000611 Parts: • A: Wrist side cover • B: Pulley (2 pcs) • C: Timing belt

Continues on next page

	Action	Information
6	Tighten the *attachment screws* and *washers* securing the *motor*, just enough (2 Nm) to still be able to move the motor.	 xx1100000960 Attachment screws M5x16 q12.9 and washers (2 + 2 pcs)
7	Move the motor to a position where a good timing belt tension is reached.	New belt: F = 7.6-8.4N Used belt: F = 5.3-6.1N
8	Secure *motor axis 5* with its *attachment screws* and *washers*.	Tightening torque: 4 Nm.
9	Refit the *connector support*.	Tightening torque: 1 Nm.  xx0900000888 Parts: • A: Attachment screws (2 pcs) • B: Connector support
10	Refit the *clamp* with its *attachment screw*.	Tightening torque: 1 Nm.  xx0900000887 Parts: • A: Attachment screw • B: Clamp

Continues on next page

4.7.5 Replacing motor axis 5
Continued

	Action	Information
11	Secure the cables with *cable straps*.	 xx0900001009 Parts: • A: Cable straps (2 pcs)
12	Refit the *wrist side covers*.	Tightening torque: 1 Nm.  xx0900000886 Parts: • A: Wrist side covers (2 pcs)
13	Clean Room robots: seal and paint the joints that have been opened. See *Replacing parts on the robot on page 118* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
14	Recalibrate the robot.	See chapter: • *Calibration on page 225*.
15	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 47*.	

4.7.6 Replacing motor axis 6

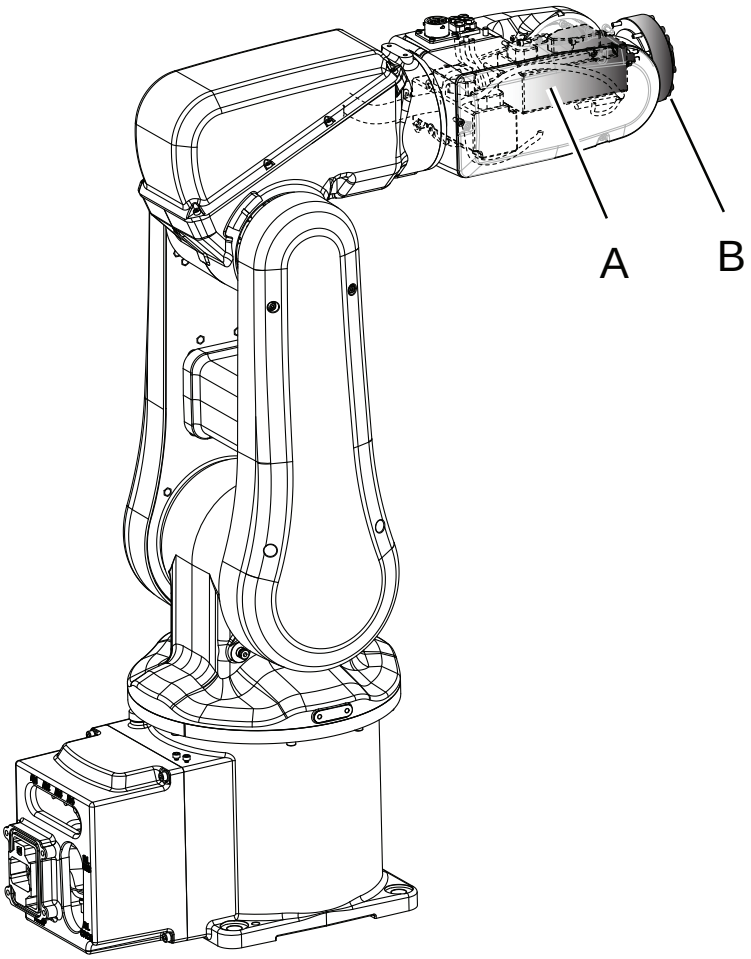
Introduction

The motor axis 6 is delivered as part of the upper arm. How to replace the upper arm see section *Replacing the upper arm on page 155*.

Motor axis 6 is a part of the upper arm when ordered as a spare part. For more information how to replace motor axis 6, please **contact ABB**.

Location of motor axis 6

Motor axis 6 is located as shown in the figure.



xx0900000910

A	Motor axis 6
B	Gearbox axis 6

4.8 Gearboxes

4.8.1 Replacing gearbox axis 1

Introduction

The gearbox axis 1 is delivered as a part of motor axis 1. For information how to replace motor with gearbox axis 1, see section *Replacing axis-1 motor with gearbox on page 169*.

4.8.2 Replacing gearbox axis 2

Introduction

The gearbox axis 2 is delivered as a part of motor axis 2. For information how to replace motor with gearbox axis 2, see section *Replacing axis-2 motor with gearbox on page 190*.

4.8.3 Replacing gearbox axis 3

Overview

Gearbox axis 3 is delivered as a part of the lower arm. For more information how to replace gearbox axis 3, please **contact ABB**.

Location of gearbox axis 3

Gearbox axis 3 is located as shown in the figure.

xx0900001040

A	Gearbox axis 3
B	Lower arm

4.8.4 Replacing gearbox axis 4

Introduction

Gearbox axis 4 is delivered as a part of the upper arm.

How to replace the upper arm see:

- *Replacing the upper arm on page 155*

For more information how to replace gearbox axis 4, please **contact ABB**.

4.8.5 Replacing gearbox axis 5

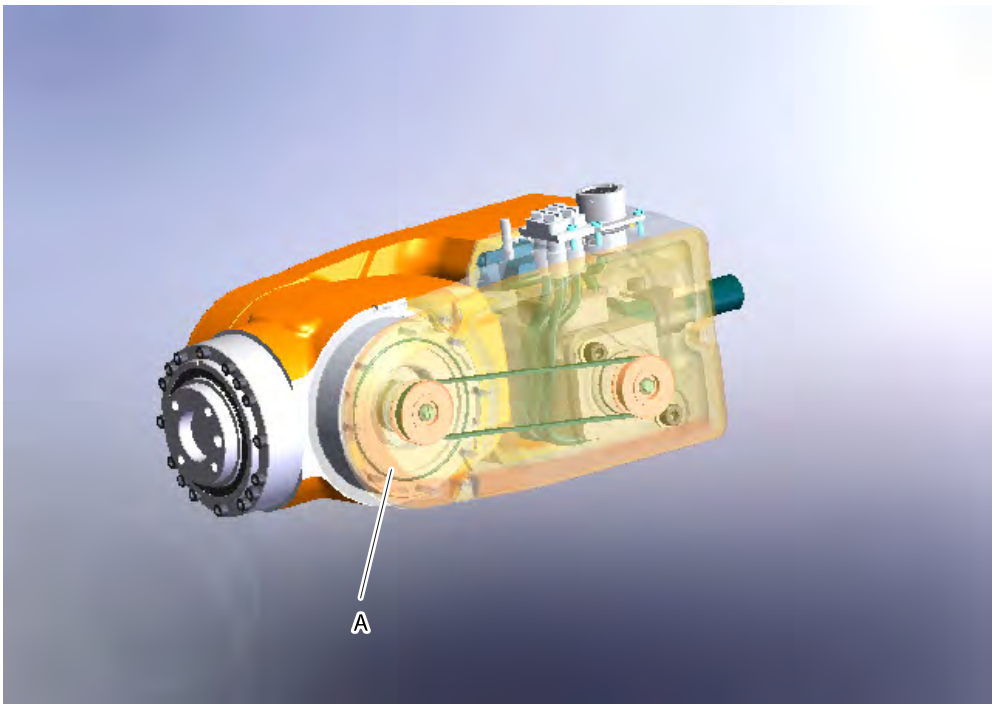
Overview

Gearbox axis 5 is delivered as a part of the upper arm. How to replace the upper arm is decribed in section *Replacing the upper arm on page 155*.

For more information how to replace gearbox axis 5, please **contact ABB**.

Location of gearbox axis 5

Gearbox axis 5 is located as shown in the figure.



xx0900001041

A	Gearbox axis 5

4.8.6 Replacing gearbox axis 6

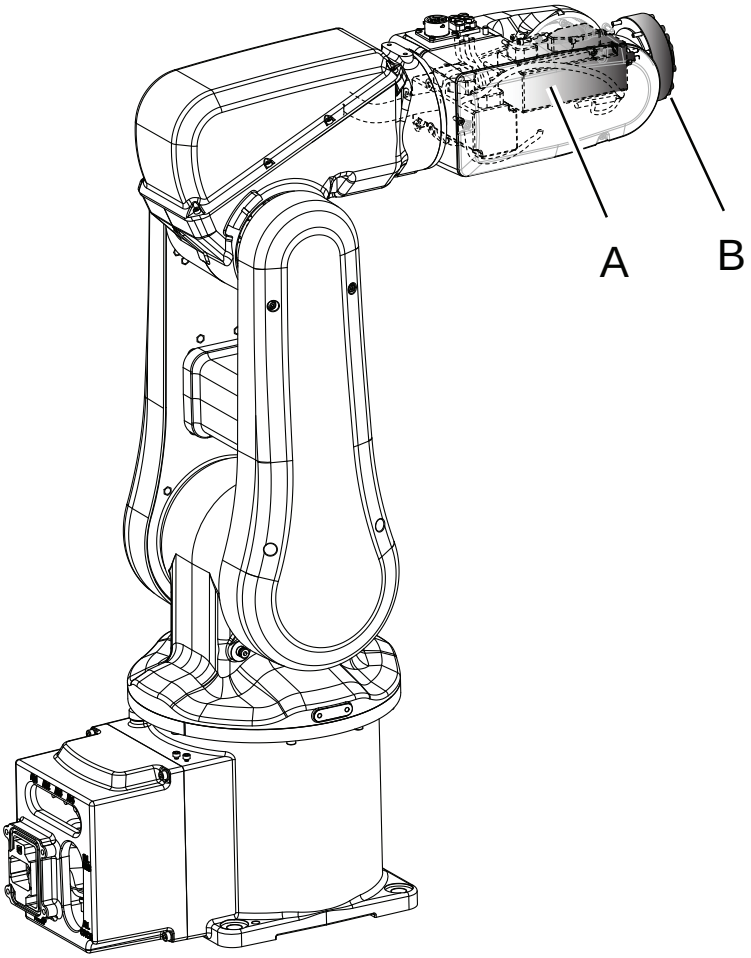
Introduction

The gearbox axis 6 is delivered as part of the upper arm. How to replace the upper arm is described in section *Replacing the upper arm on page 155*.

For more information how to replace gearbox axis 6, please **contact ABB**.

Location of gearbox axis 6

Gearbox axis 6 is located as shown in the figure:



xx0900000910

A	Motor axis 6
B	Gearbox axis 6

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5 Calibration

5.1 Introduction to calibration

5.1.1 Introduction and calibration terminology

Calibration information

This chapter includes general information about the recommended calibration methods and also the detailed procedures for updating the revolution counters, checking the calibration position etc.

Detailed instructions of how to perform Axis Calibration are given on the FlexPendant during the calibration procedure. To prepare calibration with Axis Calibration method, see *Calibrating with Axis Calibration method on page 235*.

Calibration terminology

Term	Definition
Calibration method	A collective term for several methods that might be available for calibrating the ABB robot. Each method contains calibration routines.
Synchronization position	Known position of the complete robot where the angle of each axis can be checked against visual synchronization marks.
Calibration position	Known position of the complete robot that is used for calibration of the robot.
Standard calibration	A generic term for all calibration methods that aim to move the robot to calibration position.
Fine calibration	A calibration routine that generates a new zero position of the robot.
Reference calibration	A calibration routine that in the first step generates a reference to current zero position of the robot. The same calibration routine can later on be used to recalibrate the robot back to the same position as when the reference was stored. This routine is more flexible compared to fine calibration and is used when tools and process equipment are installed. Requires that a reference is created before being used for recalibrating the robot.
Update revolution counter	A calibration routine to make a rough calibration of each manipulator axis.
Synchronization mark	Visual marks on the robot axes. When marks are aligned, the robot is in synchronization position.

5.1.2 Calibration methods

Overview

This section specifies the different types of calibration and the calibration methods that are supplied by ABB.

Types of calibration

Type of calibration	Description	Calibration method
Standard calibration	The calibrated robot is positioned at calibration position. Standard calibration data is found on the SMB (serial measurement board) or EIB in the robot. For robots with RobotWare 5.04 or older, the calibration data is delivered in a file, calib.cfg, supplied with the robot at delivery. The file identifies the correct resolver/motor position corresponding to the robot home position.	Axis Calibration or manual calibration [i]

i The robot is calibrated by either manual calibration or Axis Calibration at factory. Always use the same calibration method as used at the factory.
Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.
If no data is found related to standard calibration, manual calibration is used as default.

Brief description of calibration methods

Axis Calibration method

Axis Calibration is a standard calibration method for calibration of IRB 120 and is the most accurate method for the standard calibration. It is the recommended method in order to achieve proper performance.

The following routines are available for the Axis Calibration method:

- Fine calibration
- Update revolution counters

The calibration equipment for Axis Calibration is delivered as a toolkit.

An introduction to the calibration method is given in this manual, see *Calibrating with Axis Calibration method on page 235*.

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.

Manual calibration method

Manual calibration method is a method based on releasing the motor brakes of the robot and manually moving the robot into a calibration position. The manual calibration is using the manual methods for fine calibration and updating revolution counters. See *Calibrating with manual calibration method on page 242*.

References

Article numbers for the calibration tools are listed in the section *Special tools on page 261*.

5.1.3 When to calibrate

When to calibrate

The system must be calibrated if any of the following situations occur.

The resolver values are changed

If resolver values are changed, the robot must be recalibrated using the calibration methods supplied by ABB. Calibrate the robot carefully with standard calibration, according to information in this manual.

The resolver values will change when parts affecting the calibration position are replaced on the robot, for example motors or parts of the transmission.

The revolution counter memory is lost

If the revolution counter memory is lost, the counters must be updated. See *Updating revolution counters on page 231*. This will occur when:

- The battery is discharged
- A resolver error occurs
- The signal between a resolver and measurement board is interrupted
- A robot axis is moved with the control system disconnected

The revolution counters must also be updated after the robot and controller are connected at the first installation.

The robot is rebuilt

If the robot is rebuilt, for example, after a crash or when the reach ability of a robot is changed, it needs to be recalibrated for new resolver values.

5.2 Synchronization marks and axis movement directions

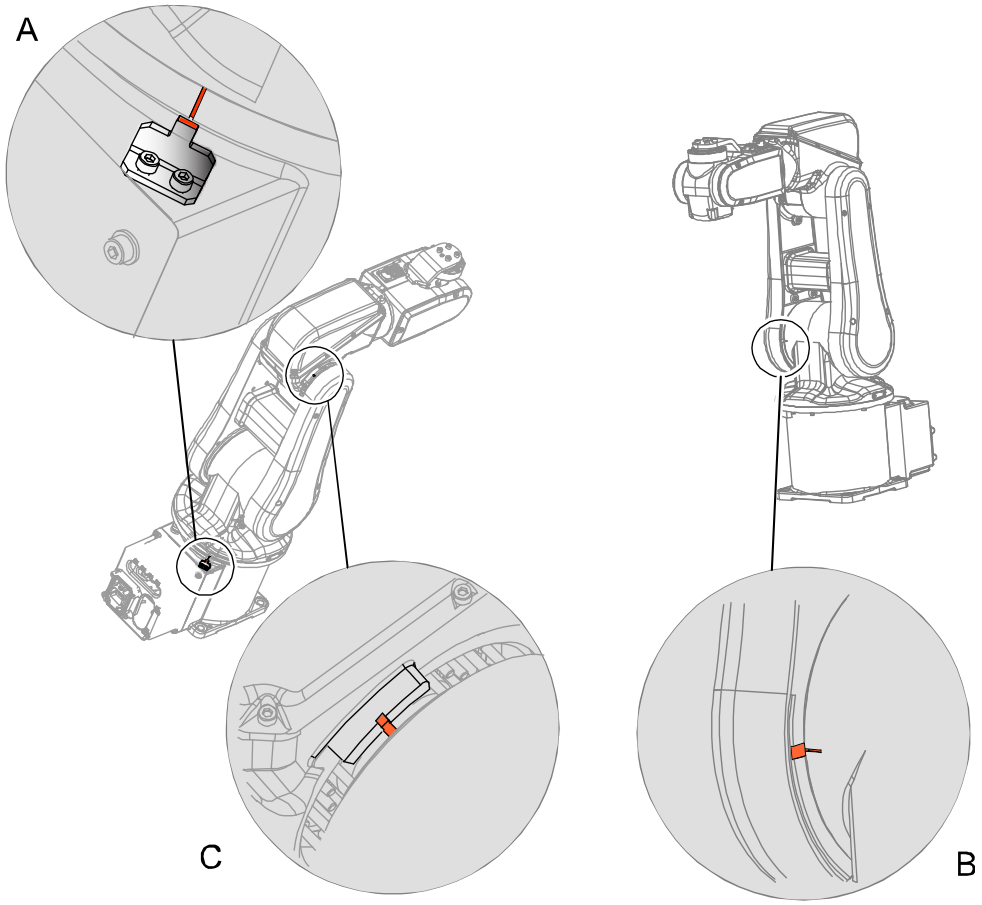
5.2.1 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 120

The illustrations show the synchronization marks on IRB 120.



xx0900000574

A	Calibration mark axis 1
B	Calibration mark axis 2
C	Calibration mark axis 3

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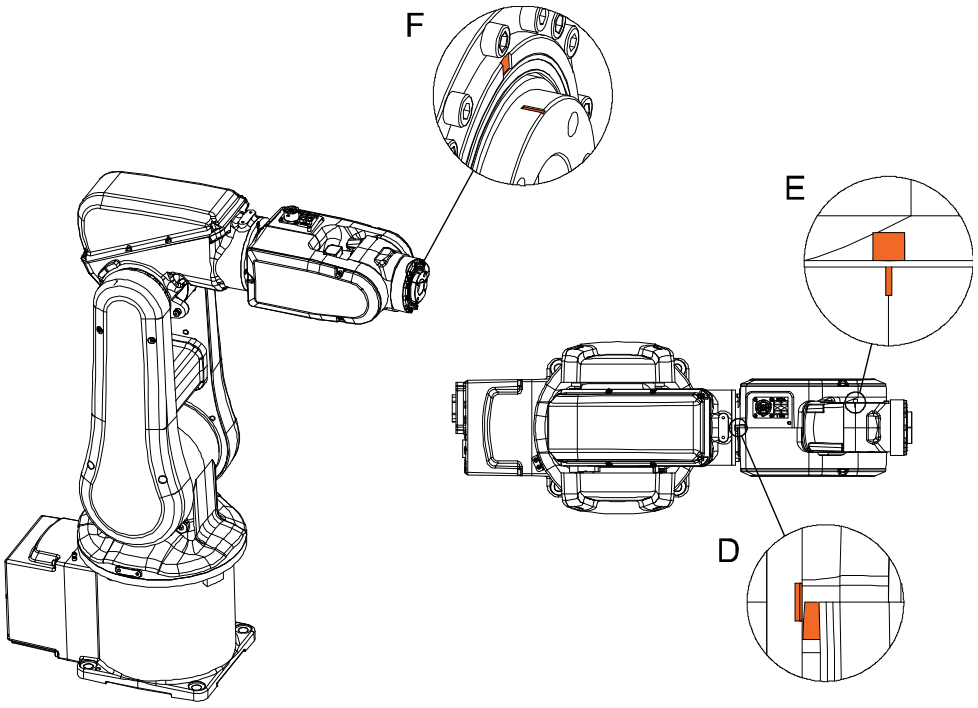


xx0900000575

D	Calibration marks axis 4
E	Calibration marks axis 5
F	Calibration marks axis 6

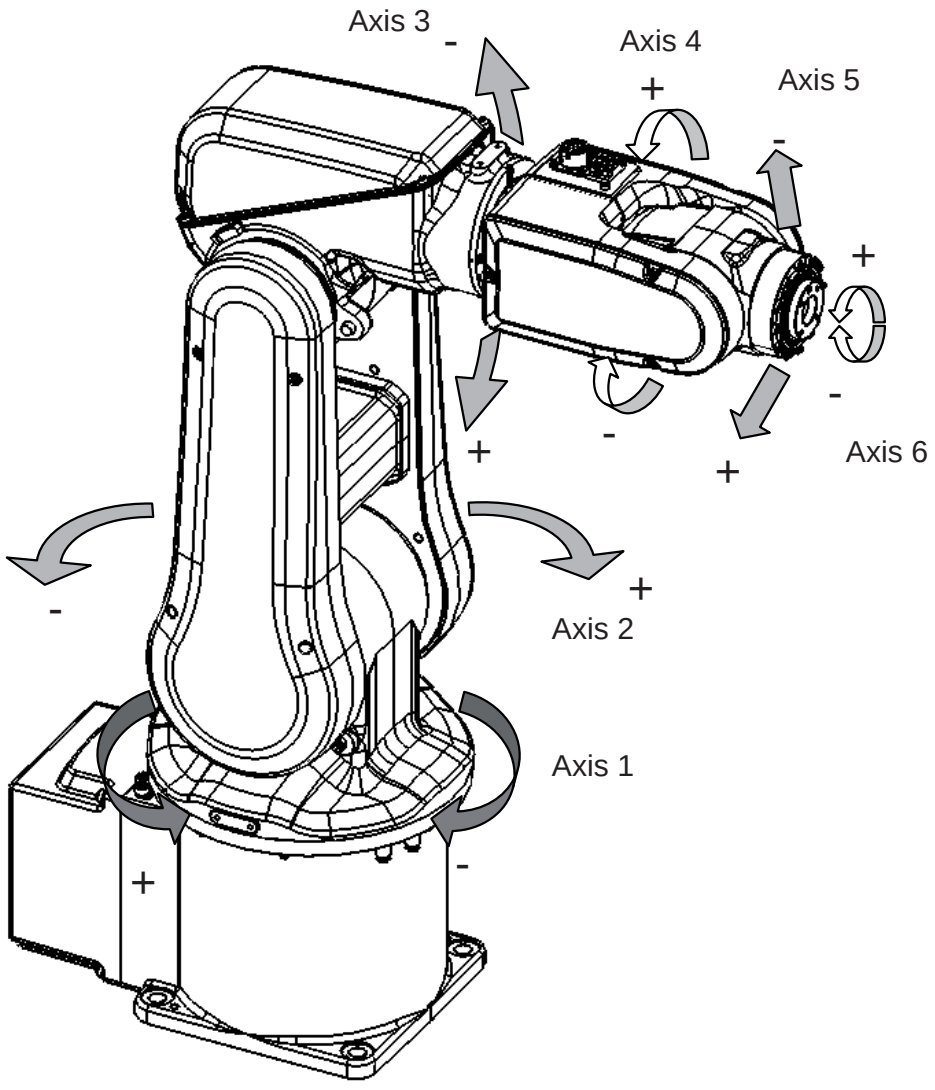
5.2.2 Calibration movement directions for all axes

Overview

When calibrating, the axis must consistently be run towards the calibration position in the same direction in order to avoid position errors caused by backlash in gears and so on. Positive directions are shown in the graphic below.

Calibration service routines will handle the calibration movements automatically and these might be different from the positive directions shown below.

Manual movement directions



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5.3 Updating revolution counters

Introduction

This section describes how to do a rough calibration of each manipulator axis by updating the revolution counter for each axis, using the FlexPendant.

Step 1 - Manually running the manipulator to the synchronization position

Use this procedure to manually run the manipulator to the synchronization position.

	Action	Note
1	Select axis-by-axis motion mode.	
2	Jog the manipulator to align the synchronization marks.	See *Synchronization marks and synchronization position for axes on page 228*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 232*.

Correct calibration position of axis 4 and 6

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

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

At delivery the manipulator is in the correct position, do NOT rotate axis 4 or 6 at power up before the revolution counters are updated.

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

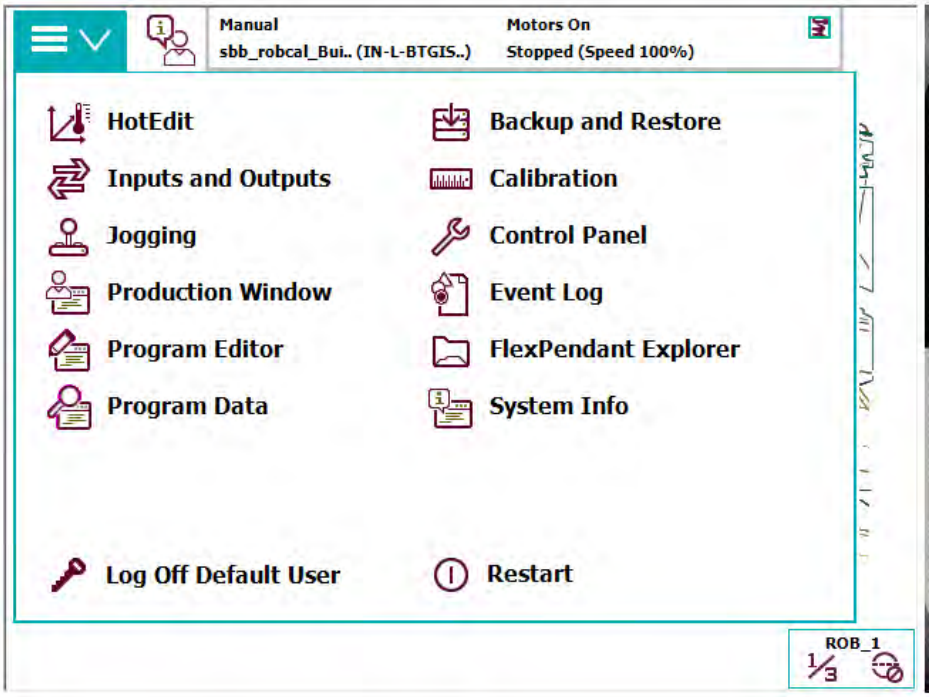
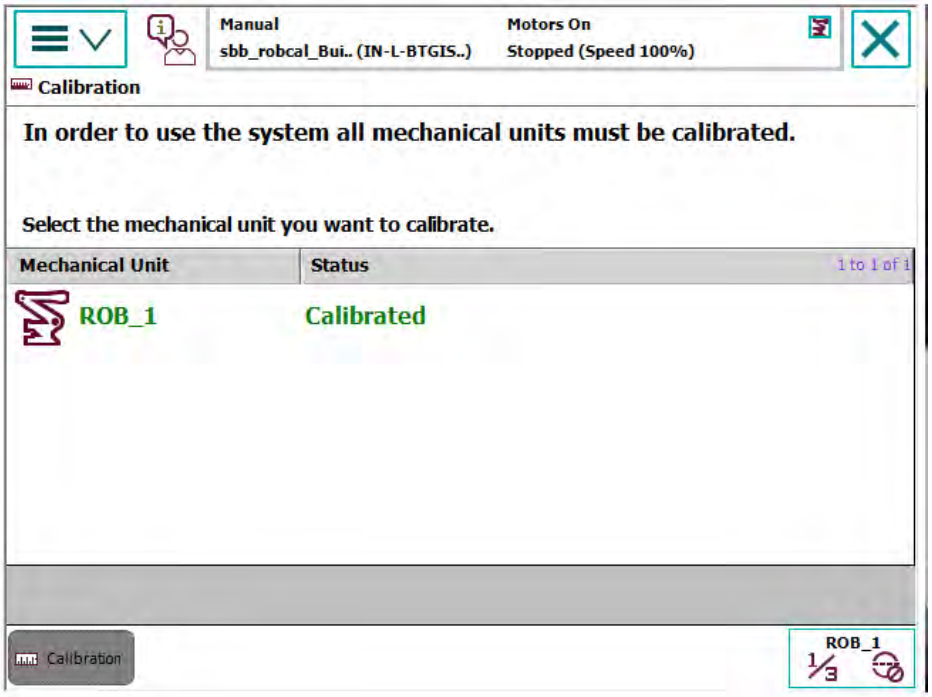
Manipulator variant	Axis 4	Axis 6
IRB 120	No	Yes

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).

Continues on next page

Step 2 - Updating the revolution counter with the FlexPendant

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

	Action
1	On the **ABB** menu, tap **Calibration**.  xx1500000942
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943

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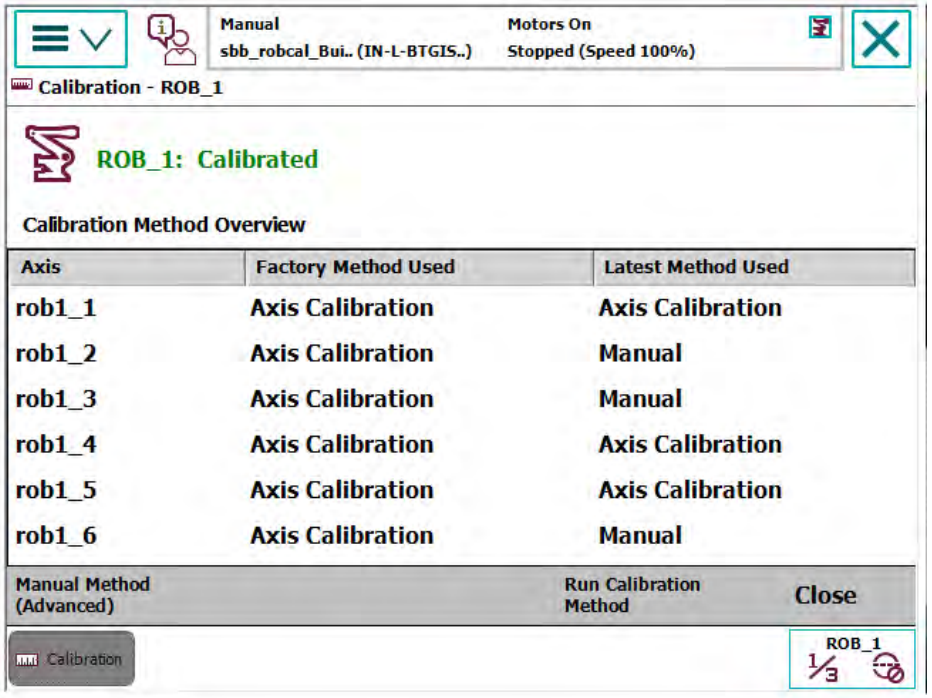
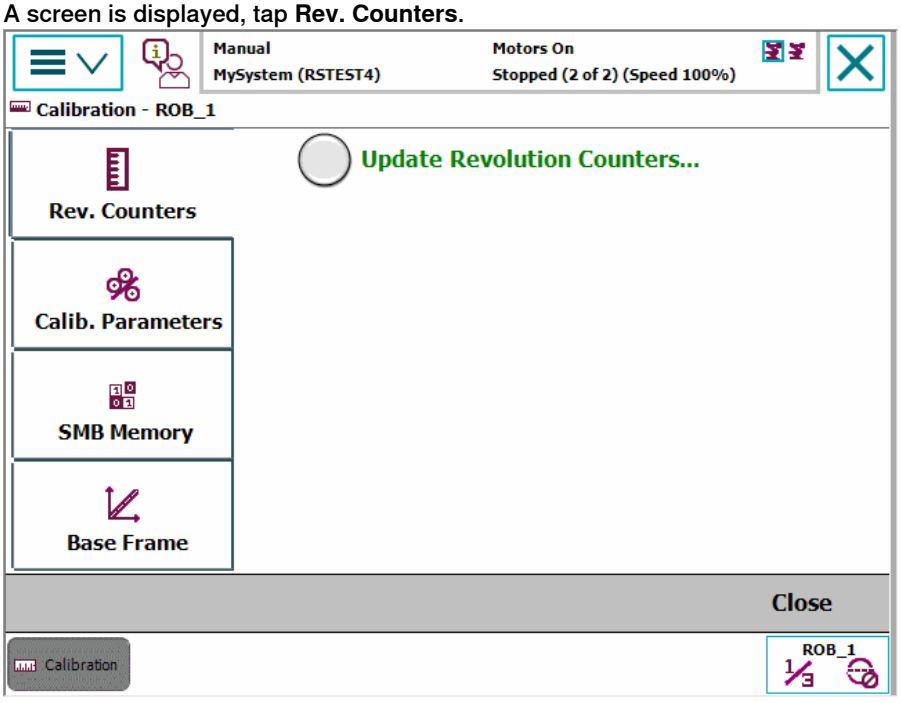
	Action
3	**This step is valid for RobotWare 6.02 and later.** Calibration method used at factory for each axis is shown, as well as calibration method used during last field calibration. Tap **Manual Method (Advanced)**.  xx1500000944
4	A screen is displayed, tap **Rev. Counters**.  en0400000771

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5.3 Updating revolution counters
Continued

	Action
5	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.
6	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**.
7	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.
8	**CAUTION** If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See *Checking the synchronization position on page 249*.

5.4 Calibrating with Axis Calibration method

5.4.1 Description of Axis Calibration

Instructions for Axis Calibration procedure given on the FlexPendant

The actual instructions of how to perform the calibration procedure and what to do at each step is given on the FlexPendant. You will be guided through the calibration procedure, step by step.

This manual contains a brief description of the method, additional information to the information given on the FlexPendant, article number for the tools and images of where to fit the calibration tools on the robot.

Overview of the Axis Calibration procedure

The Axis Calibration procedure applies to all axes, and is performed on one axis at the time. The robot axes are both manually and automatically moved into position, as instructed on the FlexPendant.

A fixed calibration pin/bushing is installed on each robot axis at delivery.

The Axis Calibration procedure described roughly:

- The calibration tool/element is prepared by the operator. Any protection needs to be removed prior to starting calibration.
- During the calibration procedure, RobotWare moves the robot axis chosen for calibration so that the calibration tools get into contact. RobotWare records values of the axis position and repeats the coming-in-contact procedure several times to get an exact value of the axis position.

  WARNING

  Risk of pinching! The contact force for large robots can be up to 150 kg. Keep a safe distance to the robot.

- The axis position is stored in RobotWare with an active choice from the operator.

Routines in the calibration procedure

The following routines are available in the Axis Calibration procedure, given at the beginning of the procedure on the FlexPendant.

Fine calibration routine

Choose this routine to calibrate the robot when there are no tools, process cabling or equipment fitted to the robot.

Update revolution counters

Choose this routine to make a rough calibration of each manipulator axis by updating the revolution counter for each axis, using the FlexPendant.

Validation

In the mentioned routines, it is also possible to validate the calibration data.

Continues on next page

5.4.1 Description of Axis Calibration
Continued

Position of robot axes

The axis chosen for calibration is automatically run by the calibration program to its calibration position during the calibration procedure.

In order for the axis to be able to be moved to calibration position, or in order for getting proper access to the calibration bushing, other axes might need to be jogged to positions different from 0 degrees. Information about which axes are allowed to be jogged will be given on the FlexPendant. These axes are marked with **Unrestricted** in the FlexPendant window.

How to calibrate a suspended or wall mounted robot

The IRB 120 is calibrated floor standing in factory, prior to shipping.

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

5.4.2 Axis Calibration - Running the calibration procedure

Required tools

The calibration tools used for Axis Calibration are designed to meet requirements for calibration performance and durability.

WARNING

Calibrating the robot with Axis Calibration requires special calibration tools from ABB. Using other pins in the calibration holes may cause severe damage to the robot and/or personnel.

Equipment, etc.	Article number	Note
Calibration tool set	3HAC037305-001	Includes: • Calibration tool axes 5 and 6 • Attachment screws M5x12 quality Steel 8.8-A2F (4 pcs) • Guide pin

Required consumables

Consumable	Article number	Note
Clean cloth	-	

Spare parts

Spare part	Article number	Note
N/A		

Overview of the calibration procedure on the FlexPendant

The actual instructions of how to perform the calibration procedure and what to do at each step is given on the FlexPendant. You will be guided through the calibration procedure, step by step.

Use the following list to learn about the calibration procedure before running the RobotWare program on the FlexPendant. It gives you a brief overview of the calibration procedure sequence.

After the calibration method has been called for on the FlexPendant, the following sequence will be run.

1. Choose calibration routine. The routines are described in *Routines in the calibration procedure on page 235*.
2. Choose which axis/axes to calibrate.
3. The robot moves to synchronization position.
4. Validate the synchronization marks.
5. The robot moves to preparation position.
6. Remove the protective cover from the fixed pin and the protection plug from the bushing, if any, and install the calibration tool.

   Axes 1, 2 and 3 are fitted with dampers that need to be removed.

Continues on next page

7 The robot performs a measurement sequence by rotating the axis back and forth.
8 Remove the calibration tool and reinstall the protective cover on the fixed pin and the protection plug in the bushing, if any.

   Refit the dampers on axes 1, 2 and 3.
9 Choose whether to save the calibration data or not.

Calibration of the robot is not finished until the calibration data is saved, as last step of the calibration procedure.

Preparation prior to calibration

The calibration procedure is described in the FlexPendant while conducting it.

	Action	Note
1	**DANGER** While conducting the calibration, the robot needs to be connected to power. Make sure that the robots working area is empty, as the robot can make unpredictable movements.	
2	**CAUTION** For robots with protection type Clean Room: Always cut the paint with a knife and grind the paint edge when disassembling parts of the robot! See *Replacing parts on the robot on page 118*	
3	Wipe the calibration tool clean. **Note** The calibration method is exact. Dust, dirt or color flakes will affect the calibration value.	Use a clean cloth.

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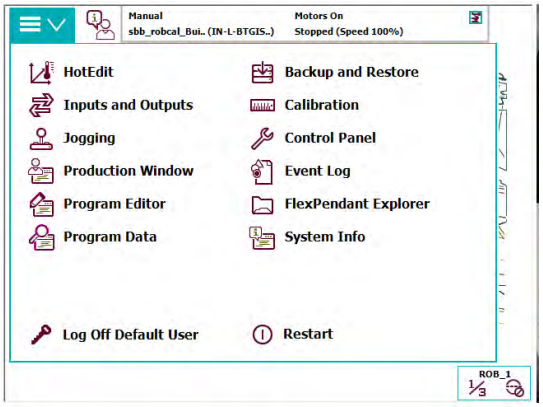
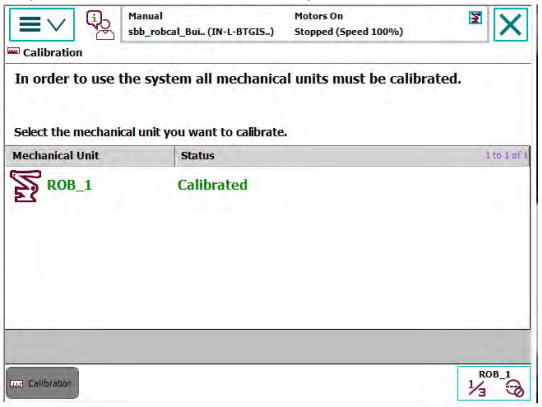
Starting the calibration procedure

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

	Action	Note
1	On the **ABB** menu, tap **Calibration**.  xx1500000942	
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943	

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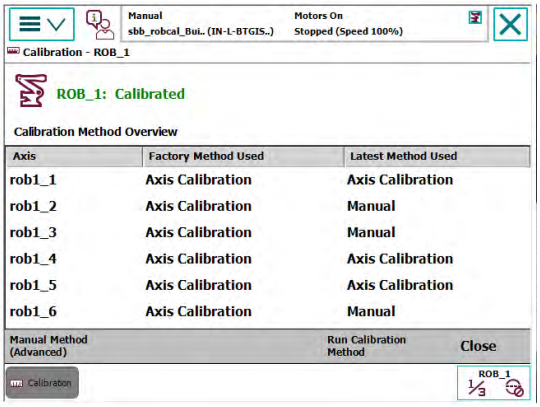
5.4.2 Axis Calibration - Running the calibration procedure
Continued

	Action	Note
3	Calibration method used at factory for each axis is shown, as well as calibration method used for the robot during last field calibration. Tap **Run Calibration Method**. The software will automatically call for the procedure for the valid calibration method.  xx1500000944	The FlexPendant will give all information needed to proceed with Axis Calibration.
4	Follow the instructions given on the FlexPendant.	A brief overview of the sequence that will be run on the FlexPendant is given in *Overview of the calibration procedure on the FlexPendant on page 237*.

Restarting an interrupted calibration procedure

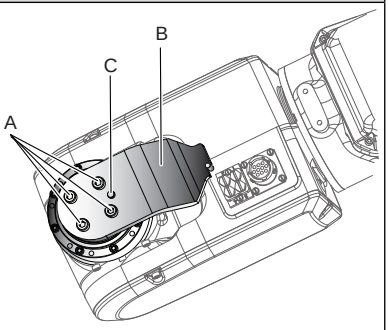
If the Axis Calibration procedure is interrupted before the calibration is finished, the RobotWare program needs to be started again. Use this procedure to take required action.

Situation	Action
The three-position enabling device on the FlexPendant has been released during robot movement.	Press and hold the three-position enabling device and press **Play**.
The RobotWare program is terminated with **PP to Main**.	Remove the calibration tool, if it is installed, and restart the calibration procedure from the beginning. See *Starting the calibration procedure on page 239*. If the calibration tool is in contact the robot axis needs to be jogged in order to release the calibration tool. Jogging the axis in wrong direction will cause the calibration tool to break. Directions of axis movement is shown in *Calibration movement directions for all axes on page 230*

After calibration

	Action	Note
1	Check that all dampers are refitted on axes 1, 2 and 3.	

Continues on next page

	Action	Note
2	Remove the tool on axis 6.	 xx1000000005 Parts: A Attachment screws (4 pcs) B Calibration tool C Guide pin

5.5 Calibrating with manual calibration method

Introduction

This section describes how to calibrate the robot manually and how to use the calibration pins when calibrating.

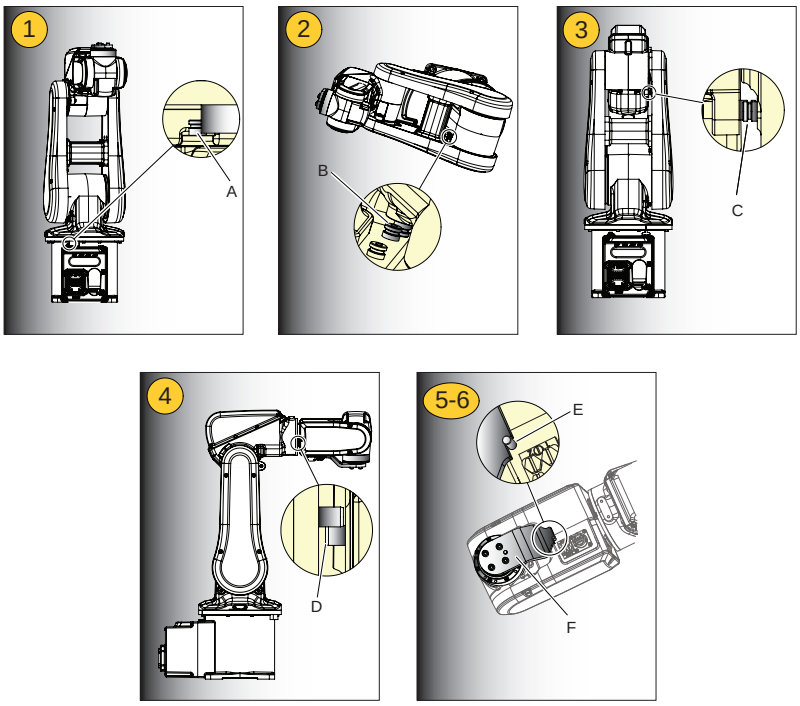
Note

Calibration can be done in the following ways:

- axis 1, 2 and 3 at the same time using the FlexPendant
- axis 4, 5 and 6 at the same time using the FlexPendant
- each axis separately.

Location of calibration pins

The figure shows the position of the calibration pins on axes 1 - 6.



xx0900000627

1	Calibration, axis 1. (Rotate axis 1 -170.2°)
A	Calibration pins, axis 1
2	Calibration, axis 2. (Rotate axis 2 -115.1°)
B	Calibration pins, axis 2
3	Calibration, axis 3. (Rotate axis 3 75.8°)
C	Calibration pins, axis 3
4	Calibration, axis 4. (Rotate axis 4 -174.7°)
D	Calibration pins, axis 4
5-6	Calibration, axis 5-6. (Rotate axis 5 -90° and axis 6 90°)

Continues on next page

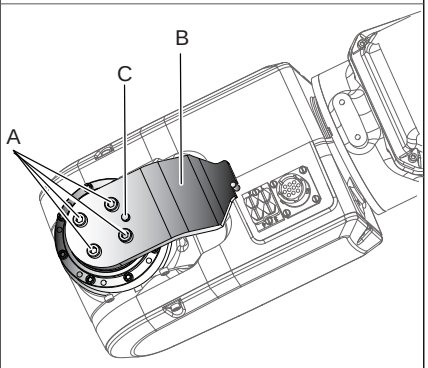
E	Calibration pin, axis 5-6
F	Calibration tool, axis 5-6

Required equipment

Equipment	Note
Standard toolkit	The content is defined in the section *Standard toolkit on page 260*.
Calibration tool set	3HAC037305-001 Includes: • Calibration tool axes 5 and 6 • Attachment screws M5x12 quality Steel 8.8-A2F (4 pcs) • Guide pin

Calibration using the FlexPendant

This procedure describes how to calibrate the robot using the FlexPendant.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove all dampers from the *calibration pins*.	See the figure in: • *Location of calibration pins on page 242*
3	Fit the *calibration tool* on axis 6.	 xx1000000005 Parts: • A: Attachment screws (4 pcs) • B: Calibration tool • C: Guide pin
4	Release the brakes.	How to release the brakes see section: • *Manually releasing the brakes on page 66*
5	Rotate axes 4, 5 and 6 manually until the two calibration pins of each axis are in contact with each other.	See the figure in: • *Location of calibration pins on page 242*
6	Choose **fine calibration** from **Calib menu**.	
7	Choose **Calibrate** on the FlexPendant.	

Continues on next page

	Action	Note
8	Choose **axes 4, 5 and 6** on the FlexPendant and **Calibrate**.	
9	After calibration is done, use the FlexPendant to jog each axis to zero degree.	
10	Rotate axes 1, 2 and 3 manually until the two calibration pins of each axis are in contact with each other.	See the figure in: • *Location of calibration pins on page 242*
11	Choose **fine calibration** from **Calib menu**.	
12	Choose **axes 1, 2 and 3** on the FlexPendant and **Calibrate**.	
13	The *synchronisation marks* on each axis shall now be matched.	See section • *Synchronization marks and synchronization position for axes on page 228*
14	Choose *Update Revolution counters* from the *Calib menu*.	
15	Choose *Axis 1 to 6* on the FlexPendant and **update the revoultion counters**.	

Calibration of axis 1 separately

Use this procedure when calibrating axis 1 separately.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the dampers from the *calibration pins*.	See the figure in: • *Location of calibration pins on page 242*
3	Release the brakes.	See section • *Manually releasing the brakes on page 66*
4	Rotate axis 1 manually until the two *calibration pins* are in contact with each other.	See figure in: • *Location of calibration pins on page 242*
5	Choose fine calibration from Calib menu.	
6	Choose Calibrate on the the FlexPendant.	
7	Choose axis 1 on the FlexPendant and Calibrate.	
8	After calibration is done use the FlexPendant to jog each axis to zero degree.	
9	The *synchronisation marks* on axis 1 shall now be matched.	See section • *Synchronization marks and synchronization position for axes on page 228*
10	Choose *Update Revolution counters* from the *Calib menu*.	

Continues on next page

	Action	Information
11	Choose *Axis 1* on the FlexPendant and **update the revoultion counters**.	

Calibration of axis 2 separately

Use this procedure when calibrating axis 2 separately.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the dampers from the *calibration pins*.	See the figure in: • *Location of calibration pins on page 242*
3	Release the brakes.	See section • *Manually releasing the brakes on page 66*
4	Rotate axis 2 manually until the two *calibration pins* are in contact with each other.	See figure 2 in: • *Location of calibration pins on page 242*
5	Choose fine calibration from Calib menu.	
6	Choose Calibrate on the the FlexPendant.	
7	After calibration is done use the FlexPendant to jog each axis to zero degree.	
8	The *synchronisation marks* on axis 2 shall now be matched	See section • *Synchronization marks and synchronization position for axes on page 228*
9	Choose *Update Revolution counters* from the *Calib menu*.	
10	Choose *Axis 2* on the FlexPendant and **update the revoultion counters**.	

Calibration of axis 3 separately

Use this procedure when calibrating axis 3 separately.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the dampers from the *calibration pins*.	See the figure in: • *Location of calibration pins on page 242*
3	Release the brakes.	See section • *Manually releasing the brakes on page 66*

Continues on next page

	Action	Information
4	Rotate axis 3 manually until the two *calibration pins* are in contact with each other.	See figure 3 in: • *Location of calibration pins on page 242*
5	Choose fine calibration from Calib menu.	
6	Choose Calibrate on the the FlexPendant.	
7	After calibration is done use the FlexPendant to jog each axis to zero degree.	
8	The *synchronisation marks* on axis 3 shall now be matched.	See section • *Synchronization marks and synchronization position for axes on page 228*
9	Choose *Update Revolution counters* from the *Calib menu*.	
10	Choose *Axis 3* on the FlexPendant and **update the revoultion counters**.	

Calibration of axis 4 separately

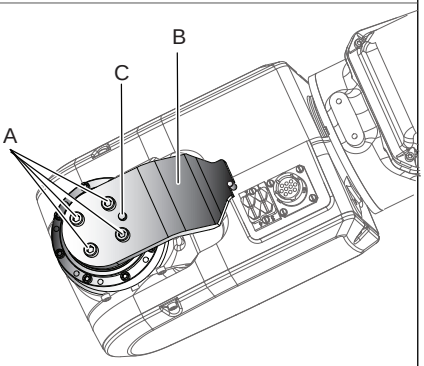
Use this procedure when calibrating axis 4 separately.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Release the brakes.	See section • *Manually releasing the brakes on page 66*
3	Rotate axis 4 manually until the two *calibration pins* are in contact with each other.	See the figure 4 in: • *Location of calibration pins on page 242*
4	Choose fine calibration from Calib menu.	
5	Choose Calibrate on the the FlexPendant.	
6	After calibration is done use the FlexPendant to jog each axis to zero degree	
7	The *synchronisation marks* on axis 4 shall now be matched.	See section • *Synchronization marks and synchronization position for axes on page 228*
8	Choose *Update Revolution counters* from the *Calib menu*.	
9	Choose *Axis 4* on the FlexPendant and **update the revoultion counters**.	

Continues on next page

Calibration of axes 5 and 6 using the calibration tool

Use this procedure when calibrating axes 5 and 6 separately.

	Action	Information
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Fit the *calibration tool* on the wrist with its *attachment screws*.	 xx1000000005 Parts: • A: Attachment screws (4 pcs) • B: Calibration tool • C: Guide pin
3	Release the brakes.	See section • *Manually releasing the brakes on page 66*
4	Rotate axes 5 and 6 manually until the *calibration pin* on the wrist and the *fork* of the tool are in contact with each other.	See figure 5-6 in: • *Location of calibration pins on page 242*
5	Choose fine calibration from Calib menu.	
6	Choose Calibrate on the the FlexPendant.	
7	After calibration is done use the FlexPendant to jog each axis to zero degree.	
8	The *synchronisation marks* on axes 5 and 6 shall now be matched.	See section • *Synchronization marks and synchronization position for axes on page 228*
9	Choose *Update Revolution counters* from the *Calib menu*.	
10	Choose *Axis 5 to 6* on the FlexPendant and **update the revoultion counters**.	

5.6 Verifying the calibration

Introduction

Always verify the results after calibrating *any* robot axis to verify that all calibration positions are correct.

Verifying the calibration

Use this procedure to verify the calibration result.

	Action	Note
1	Run the calibration home position program twice. Do not change the position of the robot axes after running the program!	See *Checking the synchronization position on page 249*.
2	Adjust the *synchronization marks* when the calibration is done, if necessary.	This is detailed in section *Synchronization marks and synchronization position for axes on page 228*.
3	Write down the values on a new label and stick it on top of the calibration label. xx	
4	Remove any calibration equipment from the robot.	

5.7 Checking the synchronization position

Introduction

Check the synchronization position of the robot before beginning any programming of the robot system. This may be done:

- Using a `MoveAbsJ` instruction with argument zero on all axes.
- Using the **Jogging** window on the FlexPendant.

Using a `MoveAbsJ` instruction

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

	Action	Note
1	On ABB menu tap **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 228* and *Updating revolution counters on page 231*.

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 228* and *Updating revolution counters on page 231*.

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6 Decommissioning

6.1 Introduction

Introduction

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

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

General

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

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

6.2 Environmental information

Hazardous material

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

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

Material	Example application
Batteries, NiCad or Lithium	Encoder Interface Board
Copper	Cables, motors
Cast iron/nodular iron	Upper arm
Steel	Gears, screws, shafts, brackets, and so on.
Neodymium	Brakes, motors
Plastic/rubber	Cables, connectors, drive belts, covers, and so on.
Oil, grease	Gearboxes
Aluminium	Structure

Oil and grease

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

Also note that:

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

6.3 Scrapping of robot

Important when scrapping the robot

DANGER

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

- Always remove all batteries from the robot. If a battery is exposed to heat, for example from a blow torch, it will explode.
- Always remove all oil/grease in gearboxes. If exposed to heat, for example from a blow torch, the oil/grease will catch fire.
- When motors are removed from the robot, the robot will collapse if it is not properly supported before the motor is removed.

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7 Reference information

7.1 Introduction

General

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

7.2 Applicable standards

Note

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

Standards, EN ISO

The product is designed in accordance with the requirements of:

Standard	Description
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 13849-1:2015	Safety of machinery, safety related parts of control systems - Part 1: General principles for design
EN ISO 13850:2015	Safety of machinery - Emergency stop - Principles for design
EN ISO 10218-1:2011	Robots for industrial environments - Safety requirements -Part 1 Robot
ISO 9787:2013	Robots and robotic devices -- Coordinate systems and motion nomenclatures
ISO 9283:1998	Manipulating industrial robots, performance criteria, and related test methods
EN ISO 14644-1:2015 [i]	Classification of air cleanliness
EN ISO 13732-1:2008	Ergonomics of the thermal environment - Part 1
EN 61000-6-4:2007 + A1:2011 IEC 61000-6-4:2006 + A1:2010 (option 129-1)	EMC, Generic emission
EN 61000-6-2:2005 IEC 61000-6-2:2005	EMC, Generic immunity
EN IEC 60974-1:2012 [ii]	Arc welding equipment - Part 1: Welding power sources
EN IEC 60974-10:2014 [ii]	Arc welding equipment - Part 10: EMC requirements
EN IEC 60204-1:2006	Safety of machinery - Electrical equipment of machines - Part 1 General requirements
IEC 60529:1989 + A2:2013	Degrees of protection provided by enclosures (IP code)

i Only robots with protection Clean Room.
ii Only valid for arc welding robots. Replaces EN IEC 61000-6-4 for arc welding robots.

European standards

Standard	Description
EN 614-1:2006 + A1:2009	Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles
EN 574:1996 + A1:2008	Safety of machinery - Two-hand control devices - Functional aspects - Principles for design

7.3 Unit conversion

Converter table

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

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

7.4 Screw joints

General

This section describes how to tighten the various types of screw joints on the IRB 120.

The instructions and torque values are valid for screw joints comprised of metallic materials and do *not* apply to soft or brittle materials.

UNBRAKO screws

UNBRAKO is a special type of screw recommended by ABB for certain screw joints. It features special surface treatment (Gleitmo as described below) and is extremely resistant to fatigue.

Whenever used, this is specified in the instructions, and in such cases, *no other type of replacement screw* is allowed. Using other types of screws will void any warranty and may potentially cause serious damage or injury.

Gleitmo treated screws

Gleitmo is a special surface treatment to reduce the friction when tightening the screw joint. Screws treated with Gleitmo may be reused 3-4 times before the coating disappears. After this the screw must be discarded and replaced with a new one.

When handling screws treated with Gleitmo, protective gloves of **nitrile rubber** type should be used.

Screws lubricated in other ways

Screws lubricated with Molycote 1000 should *only* be used when specified in the repair, maintenance or installation procedure descriptions.

In such cases, proceed as follows:

1 Apply lubricant to the screw thread.
2 Apply lubricant between the plain washer and screw head.
3 Tighten to the torque as described in the procedures.

Lubricant	Article number
Molycote 1000 (molybdenum disulphide grease)	11712016-618

7.5 Weight specifications

Definition

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

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

Example

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

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

7.6 Standard toolkit

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	Socket head cap 2.5-17 mm
1	Torque wrench 0.5-10 Nm
1	Small screwdriver
1	Plastic mallet
1	Ratchet head for torque wrench 1/2
1	Socket head cap no. 2.5, socket 1/2" bit L 110 mm
1	Small cutting plier
1	T-handle with ball head

7.7 Special tools

General

All service instructions contain lists of tools required to perform the specified activity. The required tools are a sum of standard tools, defined in the section *Standard toolkit on page 260*, and of special tools, listed directly in the instructions and also gathered in this section.

Calibration tool set

The following table specifies the calibration equipment needed when calibrating axes 5 and 6 of the robot.

Equipment, etc.	Article number	Note
Calibration tool set	3HAC037305-001	Includes: • Calibration tool axes 5 and 6 • Attachment screws M5x12 quality Steel 8.8-A2F (4 pcs) • Guide pin

Lifting tool set

The following table specifies the lifting tool set needed when lifting the complete robot.

Description	Art. no.	Note
Lifting tool set	3HAC037304-001	Includes: • Bracket • Attachment screws (wrist) M5x12 quality steel 8.8-A2F (2 pcs) • Spring washers, conical (wrist) 5.3x11x1.2 quality Steel-mZn12c (2 pcs) • Attachment screws DIN912 (swing housing) M4x8 quality Steel 8.8-ELZN (2 pcs) • Conical spring washers 4 mm (swing housing) 4.3x9x1.3 quality Steel-MZn12C (2 pcs)

7.8 Lifting equipment and lifting instructions

General

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

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

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

8 Spare parts

8.1 Spare part lists and illustrations

Location

Spare parts and exploded views are not included in the manual but delivered as a separate document on the documentation DVD.

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9 Circuit diagrams

9.1 Circuit diagrams

Overview

The circuit diagrams are not included in this manual, but delivered as separate documents on the documentation DVD. See the article numbers in the tables below.

Controllers

Product	Article numbers for circuit diagrams
Circuit diagram - IRC5	*3HAC024480-011*
Circuit diagram - IRC5 Compact	*3HAC049406-003*
Circuit diagram - IRC5 Panel Mounted Controller	*3HAC026871-020*
Circuit diagram - Euromap	*3HAC024120-004*
Circuit diagram - Spot welding cabinet	*3HAC057185-001*

Robots

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 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 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 6400RF	*3HAC8935-1*
Circuit diagram - IRB 6600 type A	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6600 type B	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6620	*3HAC025090-001*

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9.1 Circuit diagrams
Continued

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 6620 / IRB 6620LX	*3HAC025090-001*
Circuit diagram - IRB 6640	*3HAC025744-001*
Circuit diagram - IRB 6650S	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6660	*3HAC025744-001* *3HAC029940-001*
Circuit diagram - IRB 6700	*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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