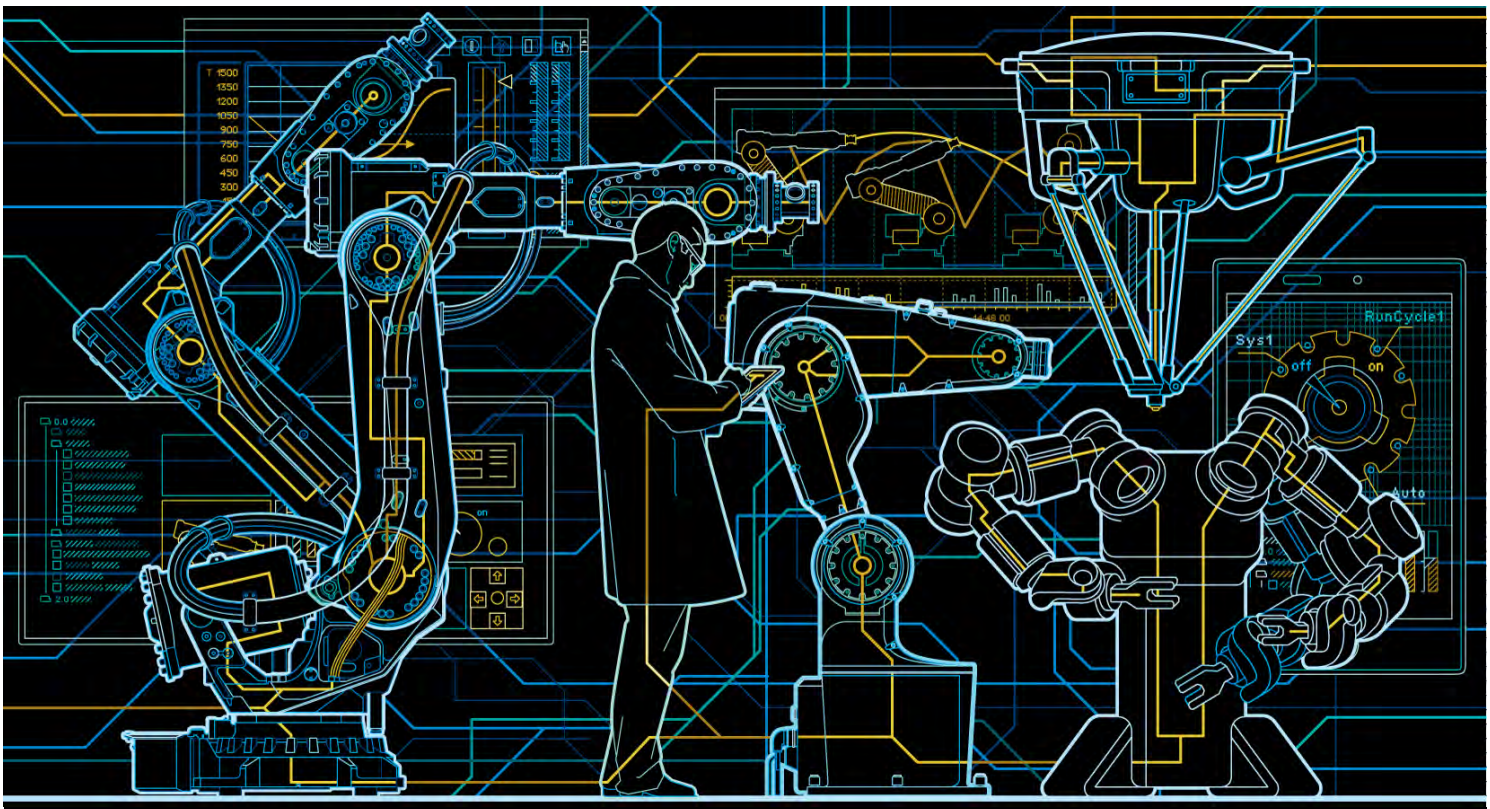

Product manual
IRB 2400

Power and productivity
for a better world™

Trace back information:
Workspace R16-2 version a5
Checked in 2016-09-08
Skribenta version 4.6.318

Product manual

IRB 2400/L
IRB 2400/10
IRB 2400/16

M2000, M2000A, IRC5

Document ID: 3HAC022031-001

Revision: M

The information in this manual is subject to change without notice and should not be construed as a commitment by ABB. ABB assumes no responsibility for any errors that may appear in this manual.

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.

Additional copies of this manual may be obtained from ABB.

The original language for this publication is English. Any other languages that are supplied have been translated from English.

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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.

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, service	Safety information that must be read through before performing any installation or service work on robot. Contains general safety aspects as well as more specific information about how to avoid personal injuries and damage to the product.
Installation and commissioning	Required information about lifting and installation of the robot.
Maintenance	Step-by-step procedures that describe how to perform maintenance of the robot. Based on a maintenance schedule that may be used in the work of planning periodical maintenance.
Repair	Step-by-step procedures that describe how to perform repair activities of the robot. Based on available spare parts.
Calibration information	Procedures that does not require specific calibration equipment.
Decommissioning	Environmental information about the robot and its components.
Reference information	Useful information when performing installation, maintenance or repair work (lists of necessary tools, reference documents, safety standards).

Continues on next page

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Chapter	Contents
Part list	Complete list of robot parts, shown in the exploded views or foldouts.
Exploded views / Foldouts	Detailed illustrations of the robot with reference numbers to the part list.
Circuit diagram	References to the circuit diagram for the robot.

References

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

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

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

Additional document references

Document name	Document ID
Application manual - CalibWare Field 5.0	*3HAC030421-001*

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Revisions

Revision	Description
-	First edition. Replaces previous manuals: • Installation and Commssioning Manual • Maintenance Manual • Repair Manual, part 1 • Repair Manual, part 2. Changes made in the material from the previous manuals: • Model M2004 implemented.
A	• Chapter“ Calibration” replaced with chapter “Calibration information”. • Safety chapter rewritten. • Section Document references is completed with article numbers for calibration manuals.
B	• Sections are restructured into Replacement procedures, instead of removal/refitting procedures. • Procedure for refitting the motor of axis 1 is completed. • Correction made in *Protection classes, robot on page 63*. • Various corrections due to technical revisions etc.
C	Changes made in: • Prerequisites in section Overview • Oil change in section Maintenance
D	Content updated in chapter/section: • Section *What is an emergency stop?* added to chapter Safety. • *Maintenance/Maintenance schedule*: Interval for replacement of battery pack changed.
E	Content updated in chapter/section: • Decommissioning chapter added. • Sealing compound updated in *Replacing parts on the robot on page 127*. • Circuit diagrams are not included in this document but delivered as separate files. See *Circuit diagram on page 235*. • List of standards updated, see *Applicable safety standards on page 222*. • Corrected spare part number for upper arm, see *Spare parts - upper arm, IRB 2400/10/16*. Updates in the chapter *Safety*: • Updated safety signal graphics for the levels *Danger* and *Warning*, see *Safety signals in the manual on page 42*. • New safety labels on the manipulators, see *Safety symbols on product labels on page 44*. • Revised terminology: *robot* replaced with *manipulator*.
F	Content updated in chapter/section: • Corrected spare part number for gasket in *Spare parts - upper arm, IRB 2400/L*.

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Revision	Description
G	This revision includes the following updates: • A new block, about general illustrations, added in section *How to read the product manual on page 13*. • Added *Setting the system parameters for a suspended or tilted robot on page 77*. • Corrections and changes in spare parts lists: - Item 27, 29, 34, 35, 39, 51, 57, 58 and 59 are corrected in *Spare parts - Upper arm*. The exploded view for the upper arm spare parts is updated so that item 44 (bearing for the upper and lower tie rod) is now shown, item 45 is moved and 61 is deleted, see *Spare part view 7*. - Item 16, 32, 35, 48, 56 and 134 are corrected and item 63 is removed in *Spare parts - Lower arm*. The exploded view for the lower arm spare parts is updated so that the sealings are shown for the upper and lower tie rod, see *Spare part view 1*. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 225*. • Added *WARNING - Safety risks during handling of batteries on page 56*. • Added *Risk of tipping/stability on page 67*. • Added *Service Information System, M2000 on page 112* (information only valid for M2000 systems). • Touch-up paint added to *Replacing parts on the robot on page 127*. • Added *Installation of signal lamp (option) on page 76*.
H	This revision includes the following updates: • All data about type of lubrication in gearboxes is moved from the manual to a separate lubrication manual, see *Type and amount of oil in gearboxes on page 102*. • A new SMB unit and battery is introduced, with longer battery lifetime.
J	This revision includes the following updates: • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 220*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 2400*.
K	This revision includes the following updates: • Minor corrections.
L	This revision includes the following updates: • Turning disc fixture is removed from special tools for Levelmeter calibration. • Guard plate is added to instruction "Replacement of brake release unit". See *Replacement, brake release board on page 165* • Robot base hole configuration updated. • Oil change instructions for IRB2400L/5 kg added.
M	Published in release R16.2. The following updates are done in this revision: • Corrections due to updates in SAP terminology. • Location of labels figure added.

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.

Product documentation, M2000/M2000A

General

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

Product manuals

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

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

Software manuals

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

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

Controller hardware option manual

Each hardware option for the controller is supplied with its own documentation. Each document set contains the types of information specified below:

- Installation information
- Repair information
- Maintenance information

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

Product documentation, IRC5

Categories for user documentation from ABB Robotics

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

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

Product manuals

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

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

Technical reference manuals

The technical reference manuals describe reference information for robotics products.

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

Continues on next page

Continued

Application manuals

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

An application manual generally contains information about:

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

Operating manuals

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

The group of manuals includes (among others):

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

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 42*.
- Specific safety information, pointed out in the procedures. How to avoid and eliminate the danger is either described directly in the procedure, or in specific instructions in the section *Safety related instructions on page 50*.

1.2 General safety information

1.2.1 Introduction to general safety information

Definitions

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

Sections

The general safety information is divided into the following sections.

Contents	Examples of content
General information	• safety, service • limitation of liability • related information
Safety risks 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 describes actions which may be taken to remedy or avoid dangers.	• fire extinguishing • safe use of the teach pendant or jogging device
Safety stops describes different types of stops.	• stopping functions • description of emergency stop • description of safety stop

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* *Operator's Manual - IRC5P*	Operating modes

Continues on next page

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

1.2.3 Safety risks

1.2.3.1 Safety risks during installation and service work on robots

Overview

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

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

General risks during installation and service

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

Spare parts and special equipment

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

Personal protective equipment

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

Nation/region specific regulations

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

Non-voltage related risks

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

Continues on next page

1.2.3.1 Safety risks during installation and service work on robots
Continued

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

To be observed by the supplier of the complete system

When integrating the robot with external devices and machines:

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

Complete robot

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

Continues on next page

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!

1.2.3.2 CAUTION - Hot parts may cause burns!

Description

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

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

Elimination

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

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

1.2.3.3 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.

1.2.3.4 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.

1.2.3.5 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.

1.2.3.6 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

Voltage related risks, robot

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

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

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

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

1.2.4 Safety actions

1.2.4.1 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.

1.2.4.2 Fire extinguishing

Note

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

1.2.4.3 Emergency release of the robot arm

Description

In an emergency situation, the brakes on the robot axes can be released manually by pushing the brake release buttons.

How to release the brakes is detailed in the section:

- *Manually releasing the brakes on page 69*.

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!

1.2.4.4 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.

1.2.4.5 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".

1.2.4.6 Safe use of the jogging device

Three-position enabling device

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

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

Note

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

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

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

Hold-to-run function

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

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

1.2.4.7 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 33*.
- To prevent anyone else from taking control of the robot, always put a safety lock on the cell door and bring the three-position enabling device with you when entering the working space.

WARNING

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

1.2.4.8 Signal lamp (optional)

Description

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

Function

The lamp is active in MOTORS ON mode.

Further information

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

1.2.5 Safety stops

1.2.5.1 What is an emergency stop?

Definition of emergency stop

An emergency stop is a state that takes precedence over all other robot controls, causes all controlled hazards to stop, removes drive power from the robot actuators, remains active until it is reset, and can only be reset by manual action.

An emergency stop state means that all power is disconnected from the robot except for the manual brake release circuits. You must perform a recovery procedure, that is, resetting the emergency stop button and pressing the Motors On button, to return to normal operation.

The robot system can be configured so that the emergency stop results in either:

- A category 0 stop, immediately stopping the robot actions by disconnecting power from the motors.
- A category 1 stop, stopping the robot actions with power available to the motors so that the robot path can be maintained. When completed, power is disconnected from the motors.

The default setting is a category 0 stop. However, category 1 stops are preferred since they minimize unnecessary wear on the robot and the actions needed to return the system back to production. Consult your plant or cell documentation to see how your robot system is configured.

Note

The emergency stop function may only be used for the purpose and under the conditions for which it is intended.

Note

The emergency stop function is intended for immediately stopping equipment in the event of an emergency.

Note

Emergency stop should not be used for normal program stops as this causes extra, unnecessary wear on the robot.

For how to perform normal program stops, see section *Stopping programs* in *Operating manual - IRC5 with FlexPendant*.

Classification of stops

The safety standards that regulate automation and robot equipment define categories in which each type of stop applies:

If the stop is...	... then it is classified as...
category 0 (zero)	uncontrolled

Continues on next page

If the stop is...	... then it is classified as...
category 1	controlled

Emergency stop buttons

In a robot system there are several emergency stop buttons that can be operated in order to achieve an emergency stop. There are emergency stop buttons available on the FlexPendant and on the controller cabinet. There can also be other types of emergency stops on your robot. Consult your plant or cell documentation to see how your robot system is configured.

1.2.5.2 What is a safety stop or protective stop?

Definition of safety stops

A safety stop is a state that stops all robot motion and removes power to the robot drive actuators. There is no recovery procedure. You need only to restore motor power to recover from a safety stop. Safety stop is also called protective stop.

The robot system can be configured so that the safety stop results in either:

- A category 0 stop, immediately stopping the manipulator actions by disconnecting power from the motors.
- A category 1 stop, stopping the manipulator actions with power available to the motors so that the manipulator path can be maintained. When completed, power is disconnected from the motors.

The default setting is a category 1 stop.

Category 1 stops are preferred since they minimize unnecessary wear on the manipulator and the actions needed to return the system back to production. Consult your plant or cell documentation to see how your robot system is configured.

Note

The safety stop function may only be used for the purpose and under the conditions for which it is intended.

Note

Safety stop should not be used for normal program stops as this causes extra, unnecessary wear on the manipulator.

For how to perform normal program stops, see section *Stopping programs* in *Operating manual - IRC5 with FlexPendant*.

Classification of stops

The safety standards that regulate automation and robot equipment define categories in which each type of stop applies:

If the stop is...	... then it is classified as...
category 0 (zero)	uncontrolled
category 1	controlled

Continues on next page

Type of safety stops

Safety stops are activated through special signal inputs to the controller, see *Product manual - IRC5*.

The inputs are intended for safety devices such as cell doors, light curtains, or light beams.

Safety stop:	Description:
Automatic mode stop (AS)	Disconnects drive power in automatic mode. In manual mode this input is inactive.
General stop (GS)	Disconnects drive power in all operating modes.
Superior stop (SS)	Disconnects drive power in all operating modes. Intended for external equipment.

Note

Use normal program stop for all other types of stop.

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

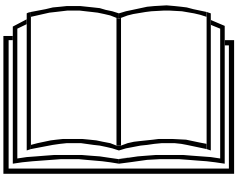
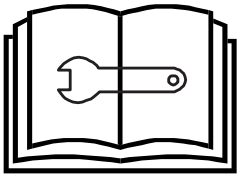
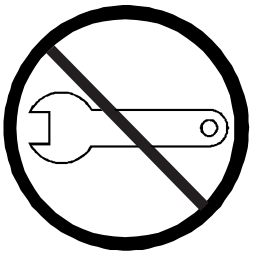
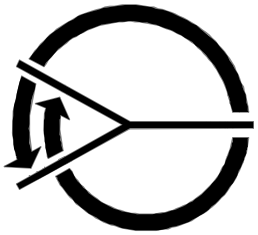
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 44*.

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

Symbols on safety labels

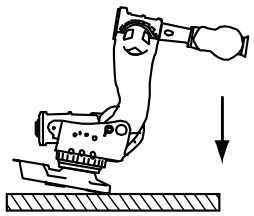
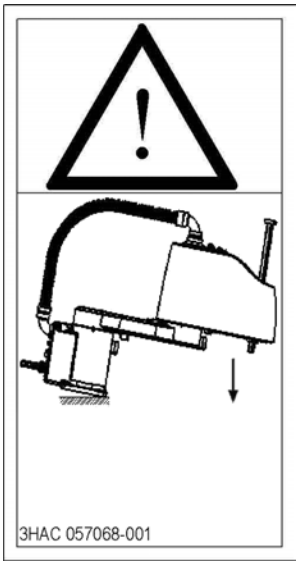
Symbol	Description
 xx0900000812	**Warning!** Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical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

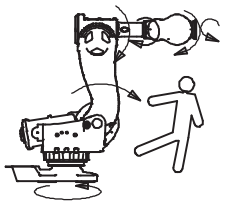
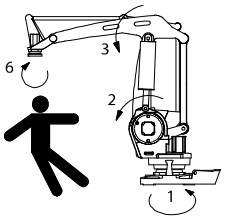
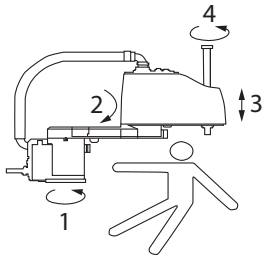
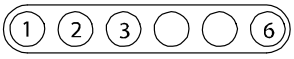
Symbol	Description
 xx0900000813	**See user documentation** Read user documentation for details. Which manual to read is defined by the symbol: • No text: *Product manual*. • EPS: *Application manual - Electronic Position Switches*.
 xx0900000816	**Before disassemble, see product manual**
 xx0900000815	**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

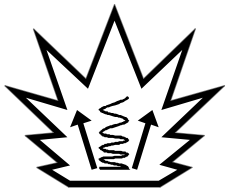
Symbol	Description
 xx0900000810  xx1500002402	**Tip risk when loosening bolts** The robot can tip over if the bolts are not securely fastened.
 xx0900000817	**Crush** Risk of crush injuries.
 xx0900000818	**Heat** Risk of heat that can cause burns.

Continues on next page

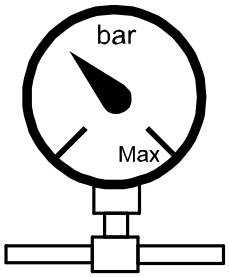
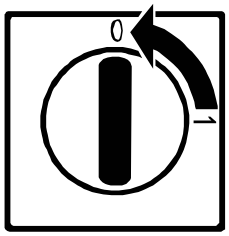
Symbol	Description
 xx0900000819  xx1000001141  xx1500002616	**Moving robot** The robot can move unexpectedly.
 xx0900000820  xx1000001140	**Brake release buttons**
 xx0900000821	**Lifting bolt**

Continues on next page

1.3.2 Safety symbols on product labels
Continued

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

Continues on next page

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

1.4 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.

	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 the fixture and work piece are well secured, if applicable.
4	Install all safety equipment properly.
5	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.
6	Pay special attention to the function of the part that previously was serviced.

Collision risks

CAUTION

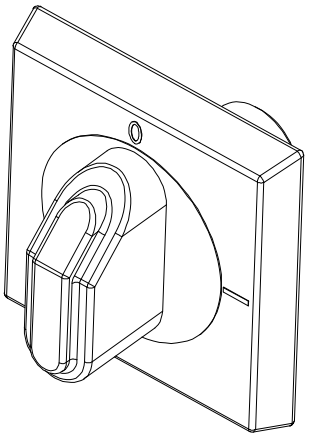
When programming the movements of the robot, always identify potential collision risks before the first test run.

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

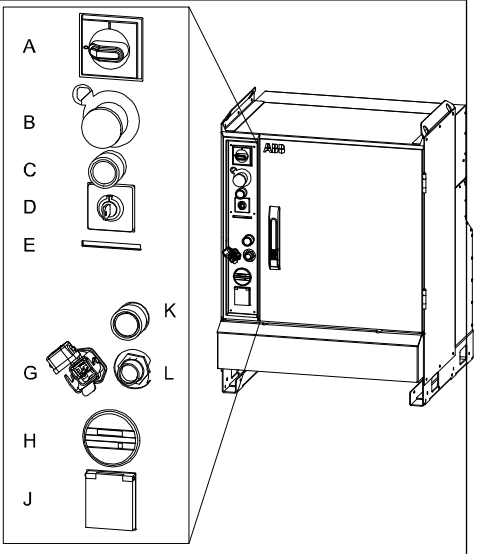
Description

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, Panel Mounted Controller

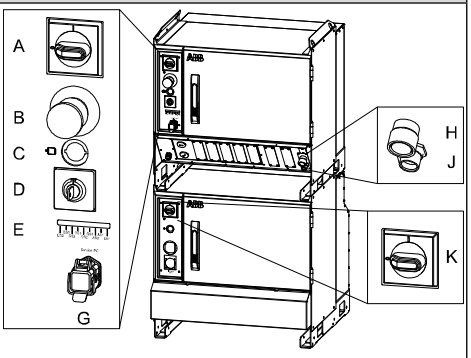
	Action	Note/illustration
1	Switch off the main switch for the controller.	 xx0600003255

Elimination, Single Cabinet Controller

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

Continues on next page

Elimination, 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

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.

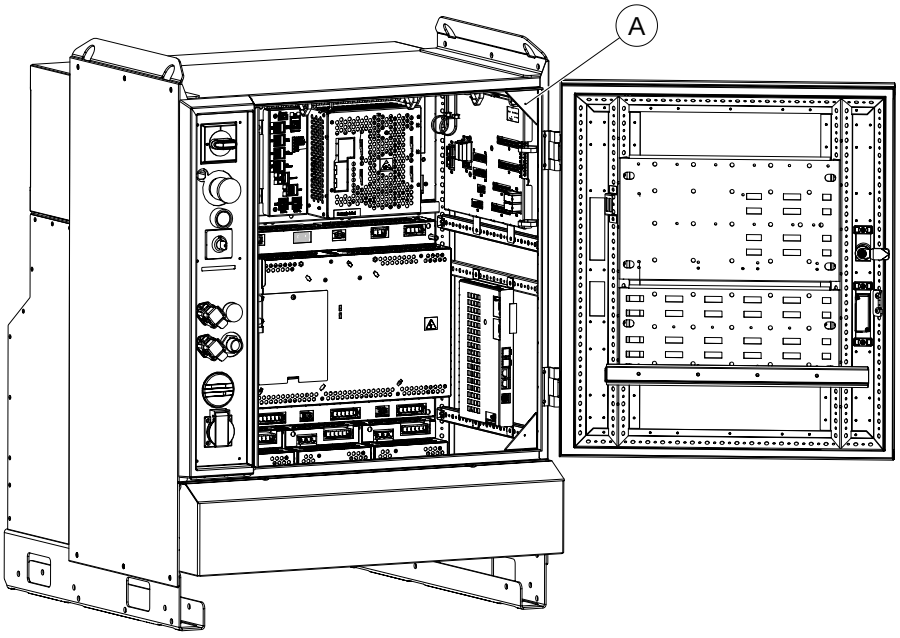
Elimination

	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

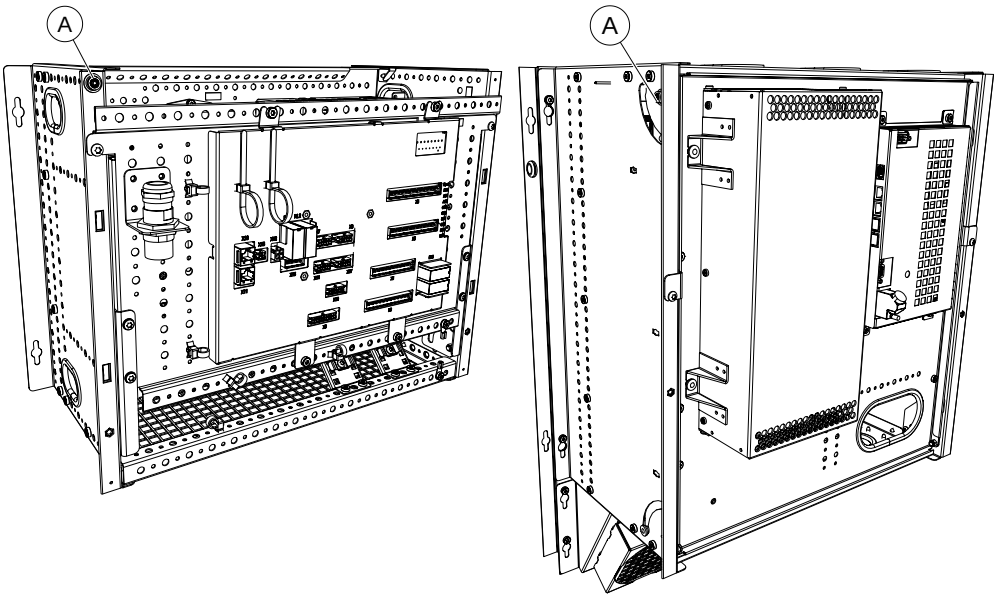


xx1300000856

A	Wrist strap button

Continues on next page

Panel Mounted Controller



xx1300001960

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 60*.
2	Use safety glasses when handling the batteries.	
3	In the event of leakage, wear gloves and chemical apron.	
4	In the event of fire, use self-contained breathing apparatus.	

1.4.6 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.
 xx0100000002 **Do not mix types of oil**	Mixing types of oil may cause severe damage to the gearbox.	When filling gearbox oil, do not mix different types of oil unless specified in the instructions. Always use the type of oil specified by the manufacturer!
 xx0100000098 **Heat up the oil**	Warm oil drains quicker than cold oil.	When changing gearbox oil, first run the robot for a time to heat up the oil.
 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 2400 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 2400, 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 2400 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*
- *Product manual - IRC5 Panel Mounted Controller*

2.2 Unpacking

2.2.1 Pre-installation procedure

Introduction

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

Checking the pre-requisites for installation

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

Installation personnel working with an ABB robot 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.

	Action
1	Make a visual inspection of the packaging and make sure that nothing is damaged.
2	Remove the packaging.
3	Check for any visible transport damage. **Note** Stop unpacking and contact ABB if transport damages are found.
4	Clean the unit with a lint-free cloth, if necessary.
5	Make sure that the lifting accessory used is suitable to handle the weight of the robot as specified in: *Weight, robot on page 61*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 62*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 63*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 61* • *Protection classes, robot on page 63* • *Requirements, foundation on page 62*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 67*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 68*
11	Install required equipment, if any. • *Installation of signal lamp (option) on page 76*

Continues on next page

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 2400	380 kg

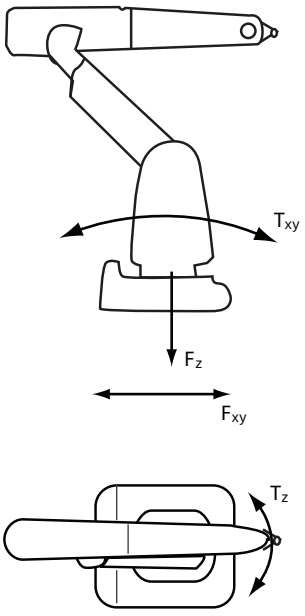
Note

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 and suspended 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!

Continues on next page

2.2.1 Pre-installation procedure
Continued

Floor mounted

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

Suspended

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

Requirements, foundation

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

Requirement	Value	Note
Maximum deviation from levelness	0,5 mm	Flat foundations give better repeatability of the resolver calibration compared to original settings on delivery from ABB. The value for levelness aims at the circumstance of the anchoring points in the robot base. In order to compensate for an uneven surface, the robot can be recalibrated during installation. If resolver/encoder calibration is changed this will influence the absolute accuracy.
Maximum tilt	5°	The limit for the maximum payload on the robot is reduced if the robot is tilted from 0°. Contact ABB for further information about acceptable loads.
Minimum resonance frequency	30 Hz	

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	Max. 95% at constant temperature

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

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

Protection classes, robot

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

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

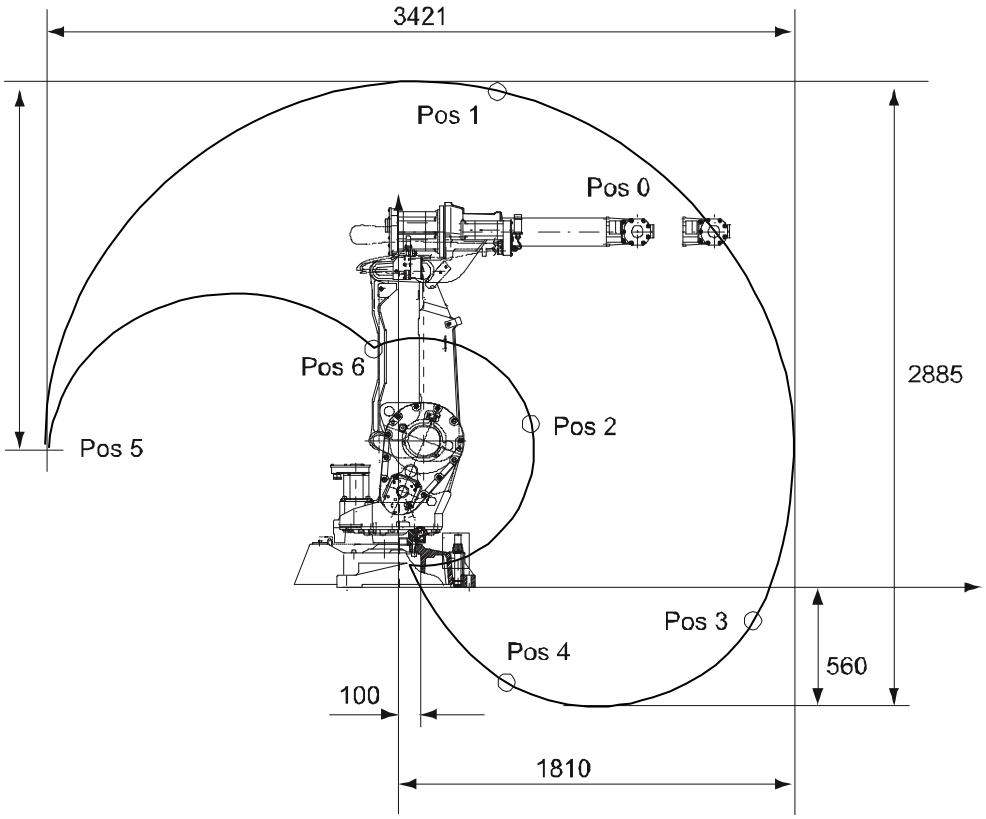
2.2.2 Working range

Working range

This section specifies the working areas of the robot models.

IRB 2400/L

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



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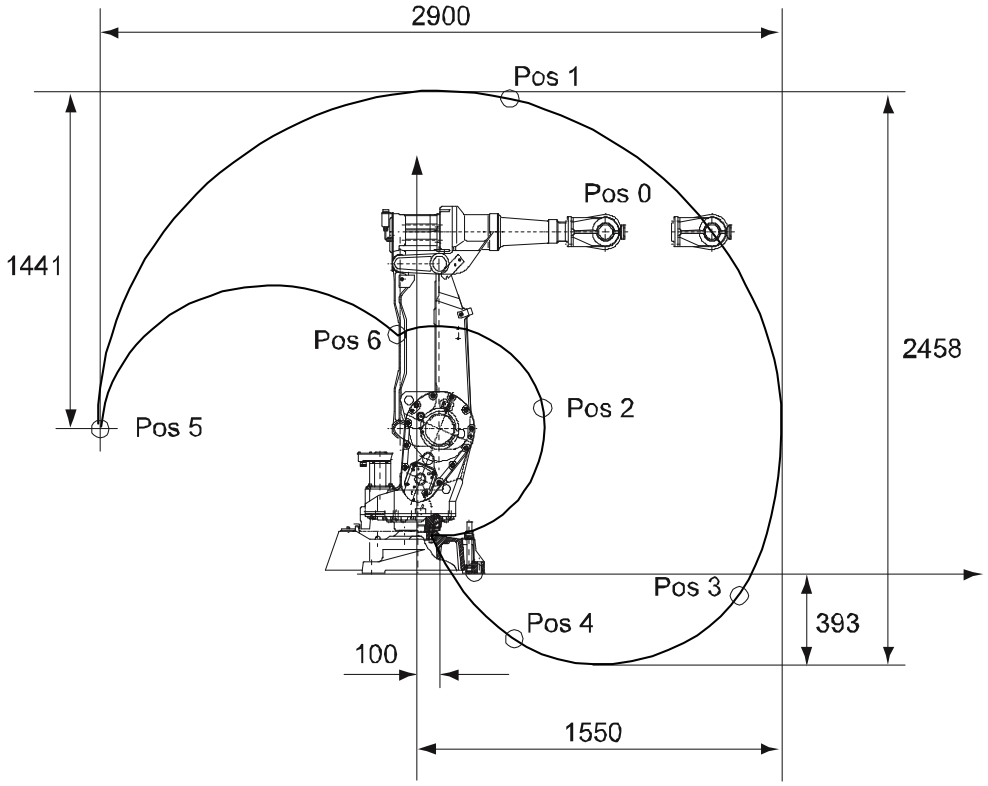
Pos.	X	Z	Angle axis 2	Angle axis 3
0	970	1620	0	0
1	404	2298	0	-60
2	602	745	0	65
3	1577	-246	110	-60
4	400	-403	110	24.5
5	-1611	623	-100	-60
6	-115	1088	-100	65

Continues on next page

IRB 2400/10, /16

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



xx0200000160

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

Positions in the working range

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

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

Continues on next page

2.2.2 Working range
Continued

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

2.2.3 Risk of tipping/stability

Risk of tipping

If the robot is not fastened to the foundation and standing still, the robot is not stable in the whole working area. Moving the arms 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!

WARNING

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

2.3 On-site installation

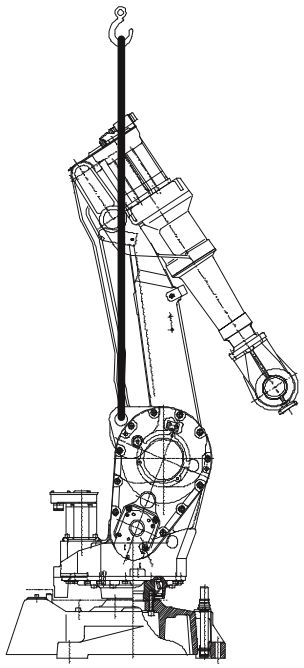
2.3.1 Lifting robot with lifting slings

Required equipment

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

Illustration, attachment of lifting slings

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



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Lifting of robot

	Action	Note
1	Move the robot to the lifting position shown in the figure above.	If necessary, release the brakes as detailed in section *Manually releasing the brakes on page 69*.
2	Attach the straps to the special eye bolts on the gearboxes for axes 2 and 3.	
3	Lift the robot carefully.	

2.3.2 Manually releasing the brakes

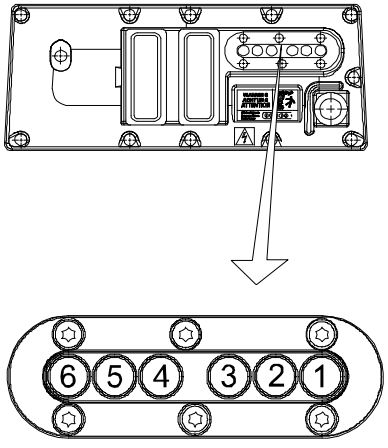
General

The holding brakes of each axis' motor are of an electromechanical type and are released when voltage is applied. This section details how to release the brakes, using the internal brake release unit, in order to enable the axes to move manually.

The brake of each motor can also be released by connecting an external voltage supply directly on the motor connector, see the circuit diagram or the repair procedures for each motor (section *Motors on page 171*).

Releasing the brakes using the brake release unit

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

	Action	Note/Illustration
1	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways! Make sure no personnel is near or beneath the robot arm!	
2	If the robot is not connected to the controller, power must be supplied to the connector R1.MP.	Detailed in section *Supplying power to connector R1.MP on page 70*.
3	The internal brake release unit is located at the base of the robot and equipped with buttons for controlling the holding brakes for each axis separately. The buttons are numbered according to the numbers of the axes. To release the brake on a particular robot axis, push the corresponding button on the internal brake release panel and keep it depressed. The brake will function again as soon as the button is released.	 xx0600002697

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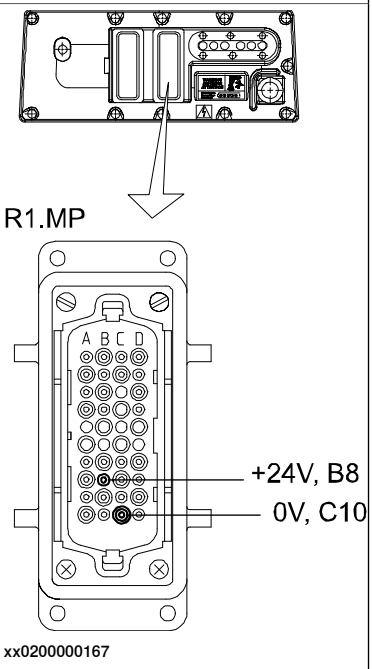
2.3.2 Manually releasing the brakes
Continued

Supplying power to connector R1.MP

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

	Action	Note/Illustration
1	**CAUTION** Be careful not to interchange the 24 VDC and 0V pins! If they are mixed up, damage can be caused to a resistor diode and to the system board.	
2	Connect an external power supply to connector R1.MP, at the robot base. Supply: • +24 V on pin B8 • 0 V on pin C10	 xx0200000167
3	Release the brakes with the brake release unit as detailed in the previous procedure.	

2.3.3 Orienting and securing the robot

General

This section details how to orient and secure the robot to the foundation in order to safely run the robot. The requirements for the foundations are shown in *Requirements, foundation on page 62*.

For suspended mounting, see *Setting the system parameters for a suspended or tilted robot on page 77*.

Bolting requirements

When bolting a base plate or the base to a concrete floor, follow the general instructions for expansion-shell bolts. The screw joint must be able to withstand the stress loads defined in section *Pre-installation procedure on page 60*.

Note

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

Attachment screws

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

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

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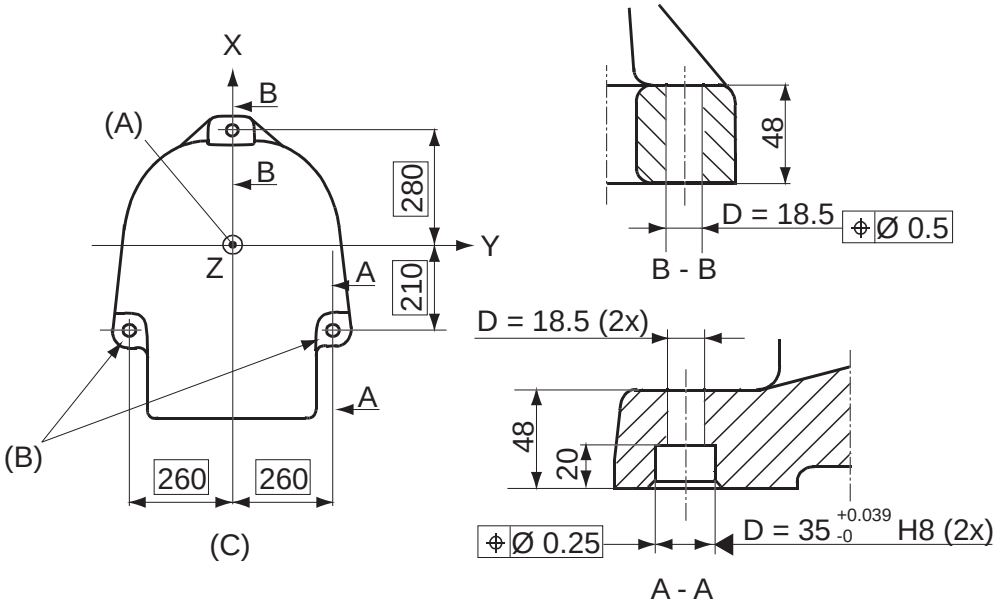
2.3.3 Orienting and securing the robot
Continued

Hole configuration

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



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Guide sleeves

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

Equipment	Art. no.
Guide sleeves	2151 0024-169

2.3.4 Mounting the robot in suspended position

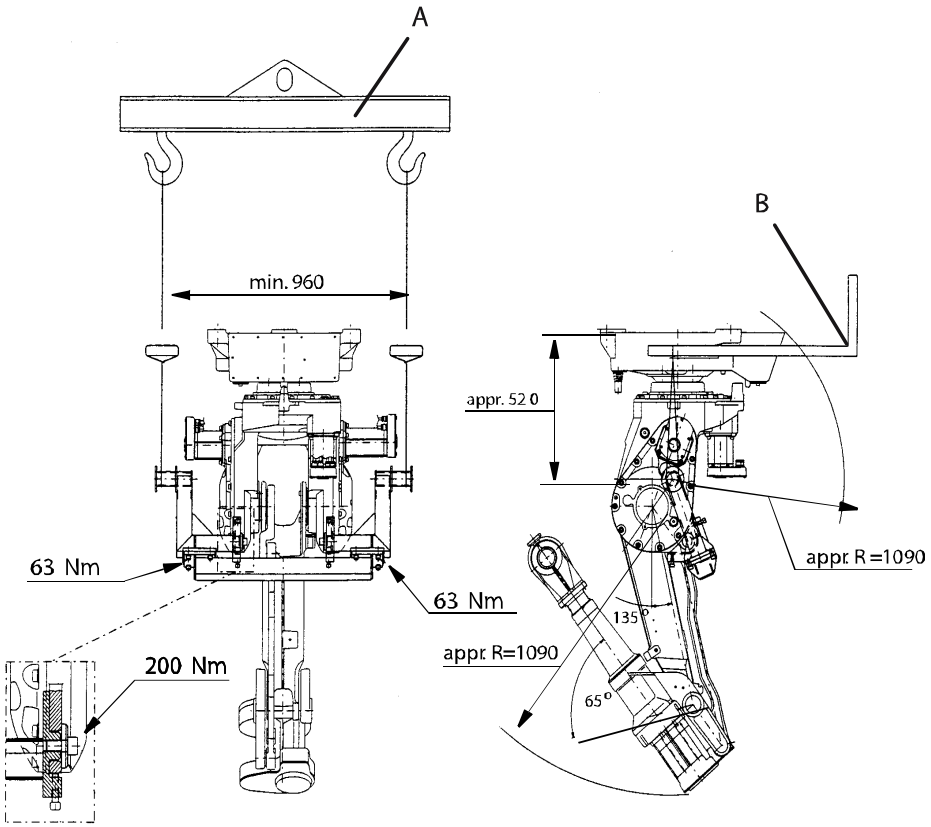
General

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

How to change the system parameters is detailed in *Setting the system parameters for a suspended or tilted robot on page 77*.

Turning the robot

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



xx0200000212

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

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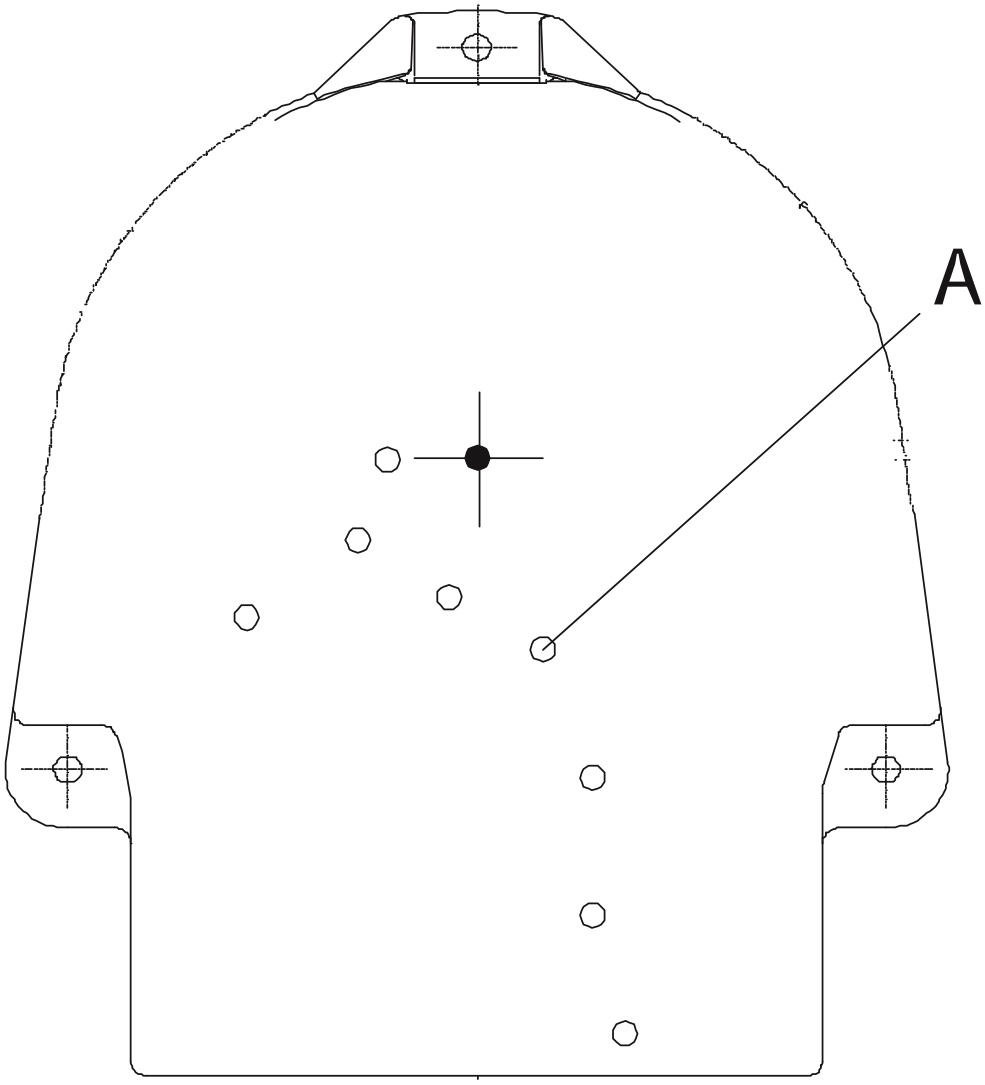
2.3.4 Mounting the robot in suspended position
Continued

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



xx0200000215

A	Plastic plugs (x8)

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

General

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

CAUTION

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

References

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

- *User's guide - S4Cplus (BaseWare OS 4.0)*
- *Operating manual - IRC5 with FlexPendant*

Stopping time and braking distances

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

2.3.6 Installation of signal lamp (option)

Signal lamp

See the assembly instruction delivered with the signal lamp.

2.3.7 Setting the system parameters for a suspended or tilted robot

General

The robot is configured for mounting parallel to the floor, without tilting, on delivery. The method for mounting the robot in a suspended (upside down) or tilted position is basically the same as for floor mounting, but the system parameters that describe the mounting angle (how the robot is oriented relative to the gravity) must be 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 62*.

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*.

Gamma Rotation

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

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.

Continues on next page

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

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).

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.

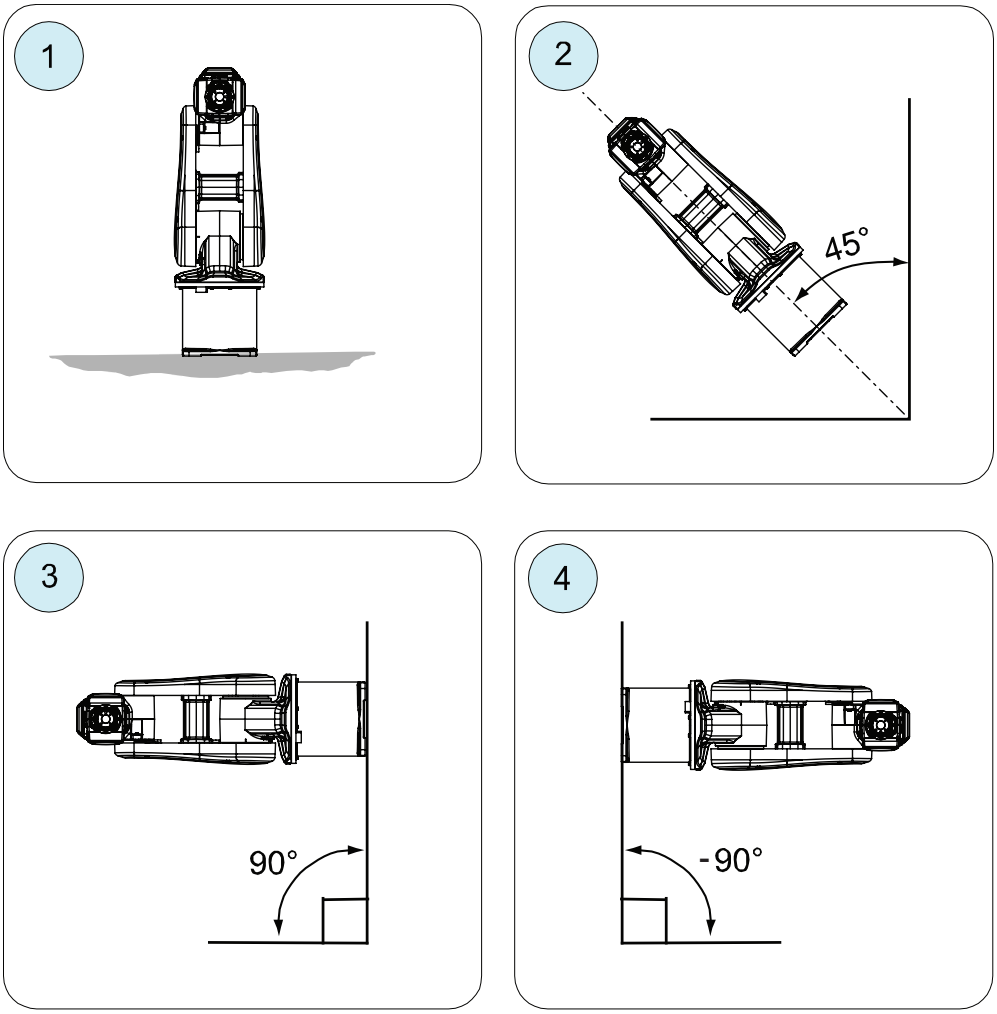
`Gravity Beta = A° x 3.141593/180 = B radians`, where `A` is the mounting angle in degrees and `B` is the mounting angle in radians.

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

Continues on next page

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

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



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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*.

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

Defining the parameter in the software, M2000/M2000A

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

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

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 78*.

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.

2.4 Restricting the working range

2.4.1 Axes with restricted working range

General

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

The working range of the following axes may be restricted:

- Axis 1, hardware (mechanical stop and position switch)
- Axis 2, hardware (mechanical stop).
- Axis 3, hardware (limit switch)

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

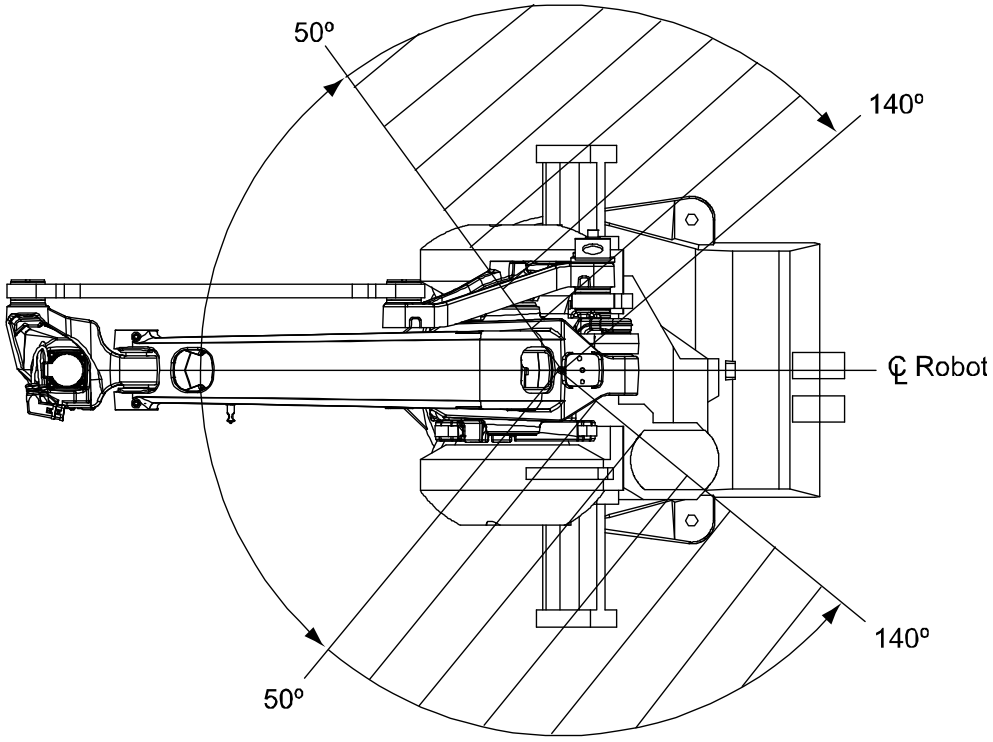
Note

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

2.4.2 Mechanically restricting the working range of axis 1

Restrictions in the working range

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



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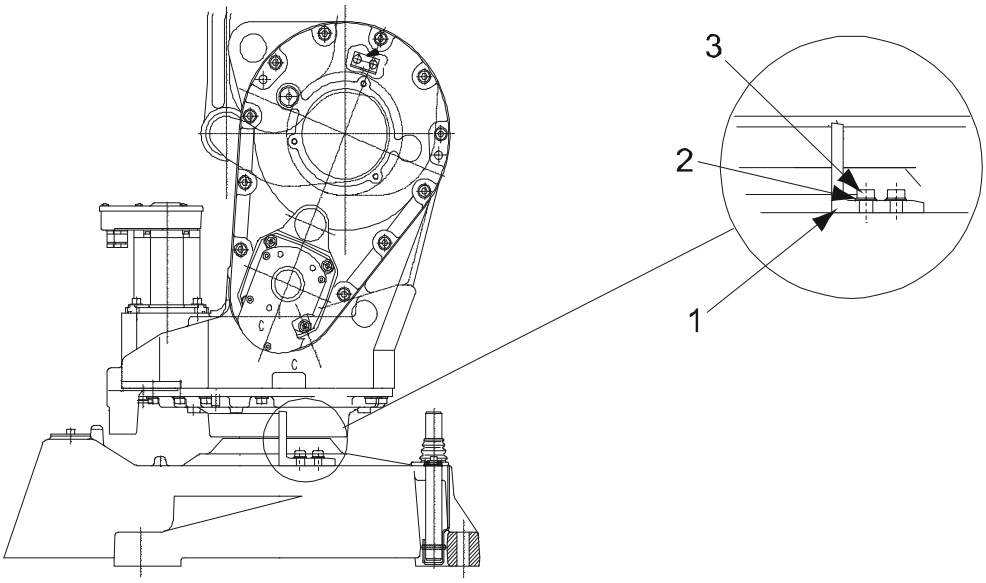
Location of the mechanical stop, axis 1

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

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



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

Required equipment

Equipment	Art. no.	Note
Mechanical stop unit, axis 1	3HAB7298-1	Includes: • removable stop (2 pcs) • plain washers (4 pcs) • hex socket head cap screw (4 pcs, M12x30) • drill template (1 pc)
User's guide - S4Cplus (BaseWare OS 4.0) (RobotWare 4.0) *Technical reference manual - System parameters*	-	Art. no. is specified in *References on page 10*.

Fitting, mechanical stop axis 1

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

	Action	Note
1	Decide where to fit the extra mechanical stops, according to the figure *Location of where to drill holes for extra stops on page 85*.	
2	Make a copy of the drill template, enclosed with the mechanical stop.	The template is also shown in the figure *Drill template on page 87* in scale 1:1.

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2.4.2 Mechanically restricting the working range of axis 1

Continued

	Action	Note
3	Use the template to mark the center of the two holes on each stop.	Place the template edge edge with the robot base, as shown in the figure *Location of where to drill holes for extra stops on page 85*.
4	Drill the holes through, Ø 10.2. Cut threads, M12.	
5	Fit the stops to the robot base, but without tightening the screws.	**Note!** The stops must be mounted in correct direction, as shown in the figure *Location of where to drill holes for extra stops on page 85*.
6	Turn axis 1 manually and check the working range between the stops.	If necessary; correct the angle of impact.
7	Tighten the screws.	
8	Adjust the software working range limitations (system parameter configuration) to correspond to the mechanical limitations.	How to define the range of movement in RobotWare 4.0 is detailed in *User's guide - S4Cplus (BaseWare OS 4.0), chapter System Parameters - topic Manipulator*. The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.
9	**WARNING** If the *mechanical stop pin* is deformed after a hard collision, it must be replaced! Deformed *movable stops* and/or *additional stops* as well as deformed *attachment screws* must also be replaced after a hard collision.	

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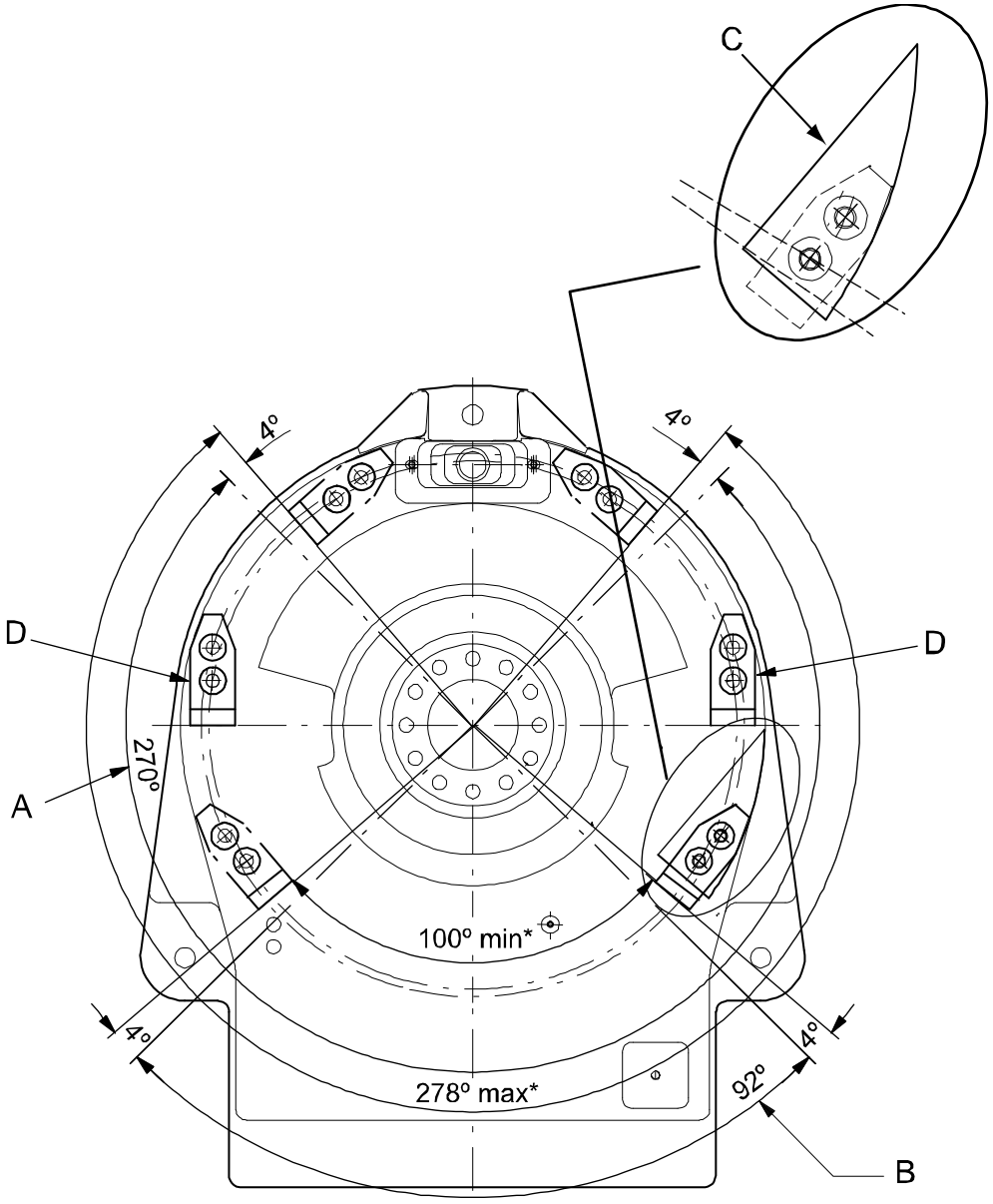
Location of where to drill holes for extra stops

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



xx0200000206

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

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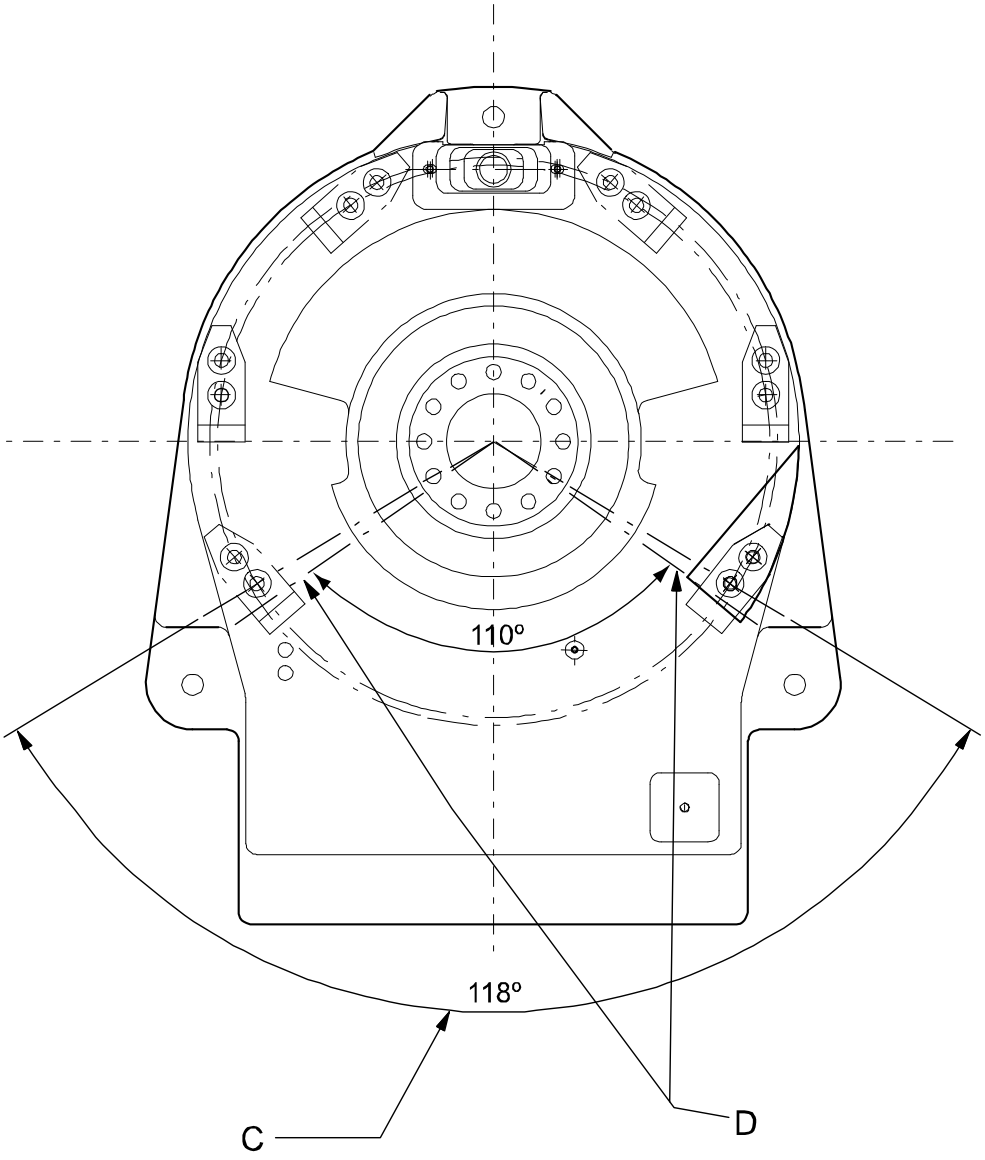
2.4.2 Mechanically restricting the working range of axis 1
Continued

Hidden stiffening ribs and forbidden drilling sector



xx0600002647

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

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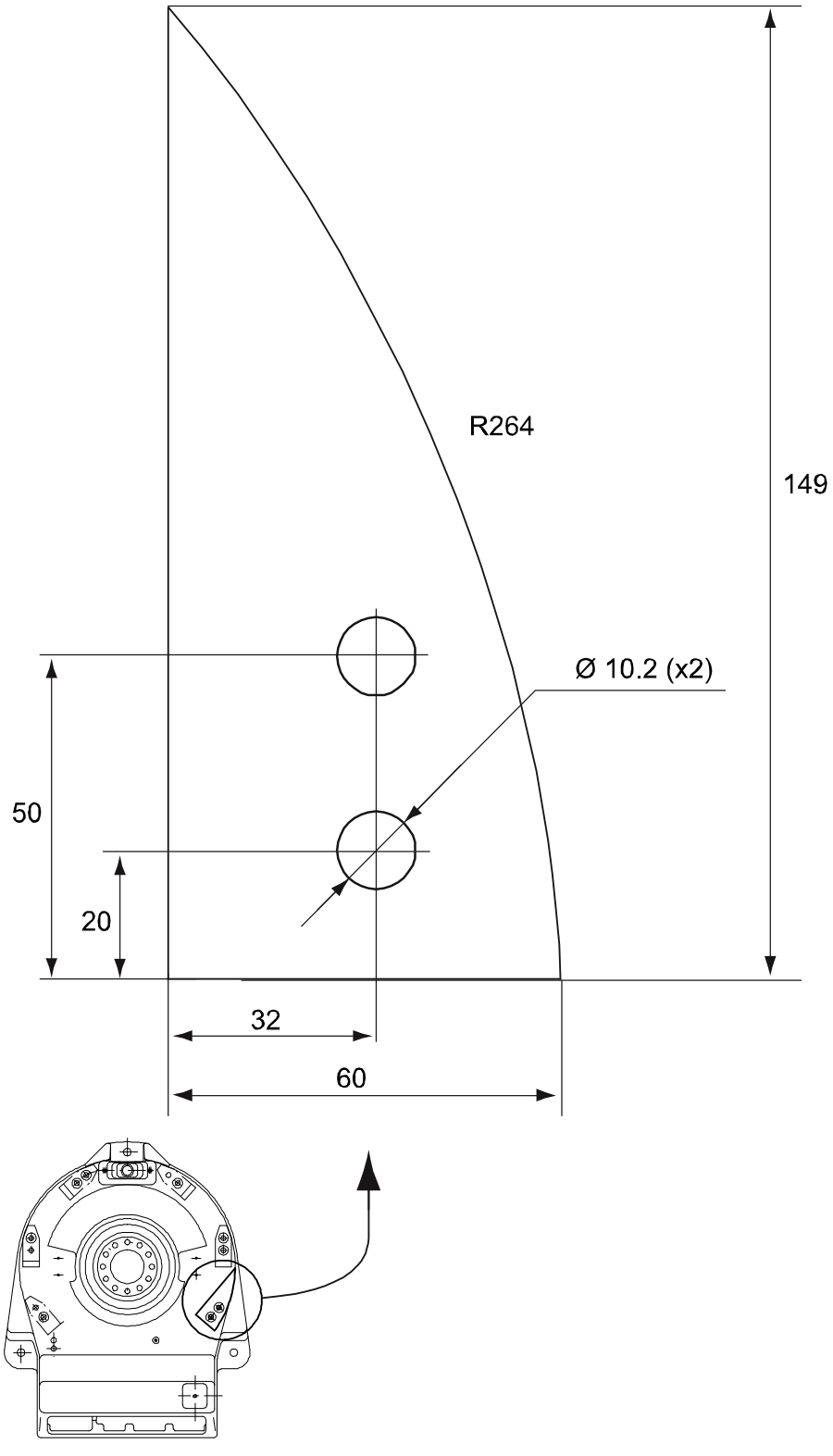
Drill template



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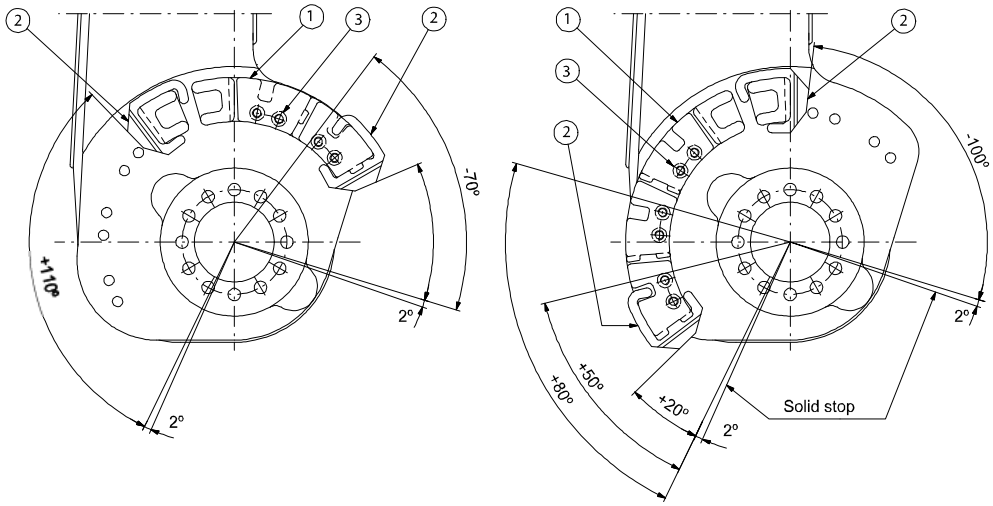
2.4.3 Mechanically restricting the working range of axis 2

General

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

Restrictions in working range

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



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

Required equipment

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

Continues on next page

Equipment	Art. no.	Note
User's guide - S4Cplus (BaseWare OS 4.0) (RobotWare 4.0) *Technical reference manual - System parameters*	-	Art. no. is specified in section *References on page 10*.
Standard toolkit	-	The content is defined in the section *Standard tools on page 229*.

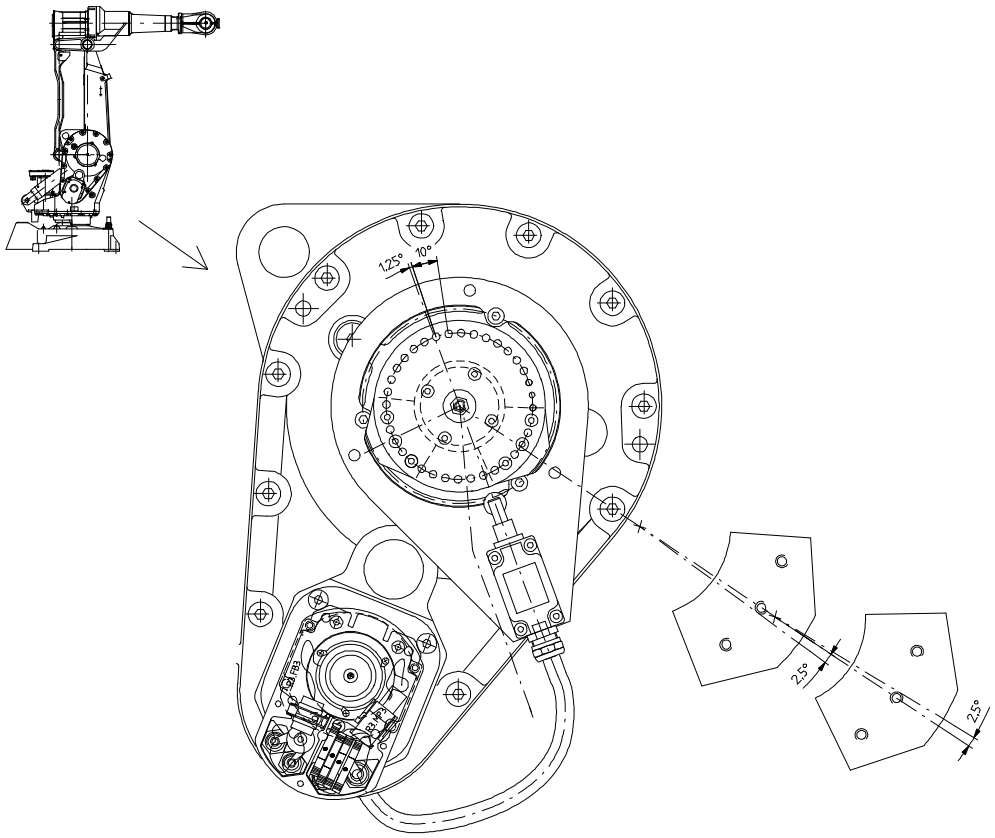
2.4.4 Installation of limit switch, axis 3

General

The working range of axis 3 can be limited by fitting an electrical switch on the gearbox axis 3, which senses the position via a cam. The system parameter configuration must also be updated.

Mounting of eletrical stop

Following illustration shows how to fit the electrical stop.



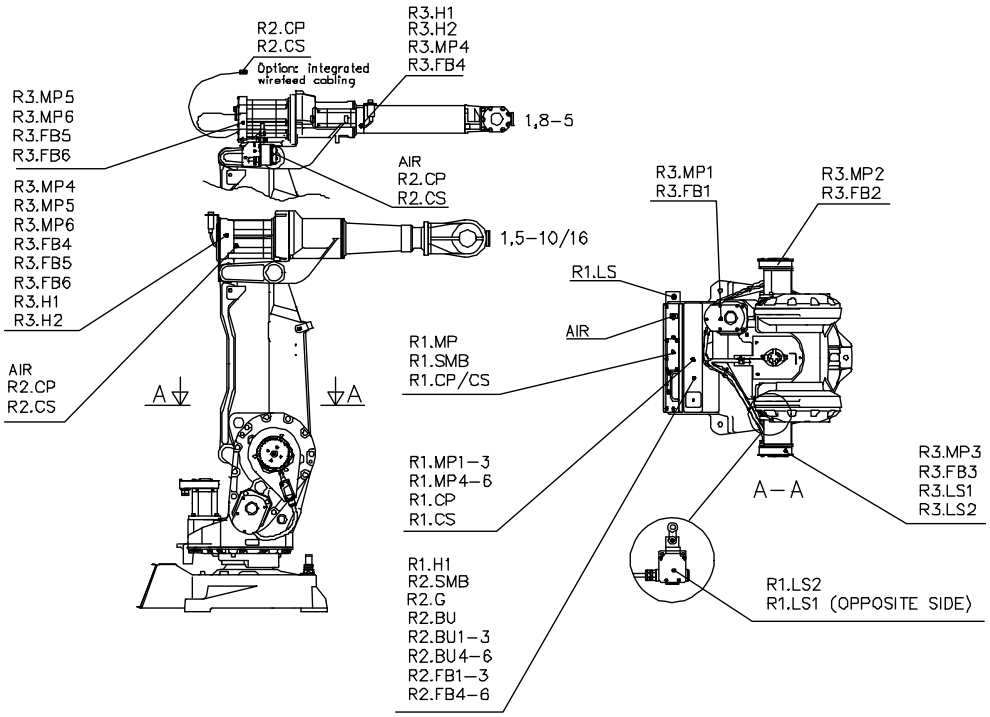
xx0200000211

2.5 Electrical connections

2.5.1 Connectors on robot

Connectors on the robot

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



xx0500002043

2.5.2 Robot cabling and connection points

Introduction

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

Main cable categories

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

Cable category	Description
Robot cables	Handles power supply to and control of the robot's motors as well as feedback from the serial measurement board. Specified in the table *Robot cables on page 92*.
Position switch cables (option)	Handles supply to and feedback from any position switches on the robot. Specified in the table *Position switch cables, robot base to controller (option) on page 93*.
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. See the product manual for the controller 1).
External axes cables (option)	Handles power supply to and control of the external axes' motors as well as feedback from the servo system. See the *Application manual - Additional axes and stand alone controller (M2004)*or *Application manual - External axes (M2000)* 1).

1)	Art. no. is specified in section *References on page 10*.

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

Robot cables

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

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

Robot cable, power

Cable	Art. no.
Robot cable, power: 7 m	3HAC9038-1
Robot cable, power: 15 m	3HAC9038-2
Robot cable, power: 22 m	3HAC9038-3
Robot cable, power: 30 m	3HAC9038-4

Continues on next page

Robot cable, signals

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

Position switch cables, robot base to controller (option)

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

Cabling between robot base and controller

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

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3 Maintenance

3.1 Introduction

Structure of this chapter

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

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

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

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

Safety information

Observe all safety information before conducting any service work!

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

Note

If the IRB 2400 is connected to power, always make sure that the IRB 2400 is connected to protective earth before starting any maintenance work!

For more information see:

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

3.2 Maintenance schedule

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 2400:

- Calendar time: specified in months regardless of whether the system is running or not.
- Operating time: specified in operating hours. More frequent running means more frequent maintenance activities.
- SIS: specified by the robot's SIS (Service Information System). A typical value is given for a typical work cycle, but the value will differ depending on how hard each part is run. The SIS used in M2000 and M2000A is further described in the section *Service Information System, M2000 on page 112*. The SIS used in M2004 is further described in the *Operating manual - Service Information System*.

3.2.2 Maintenance schedule

General

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

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

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

Activities and intervals, standard equipment

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

Maintenance activity	Interval	Note	Detailed in section:
Oil change in gearboxes, axes 1,2, 3 and 4.	40000 h	Lubricated for life. Maintenance free units.	
Oil change in wrist unit	After first 4000 h, then every 60 month [i] 12000 h [ii]		*Oil change, gearbox axes 5-6 (wrist unit) on page 103*.
Replacement of battery pack, SMB unit	Battery low alert [iii]	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	*Replacement of SMB battery on page 107*.
Replacement of battery pack, SMB unit	36 months or battery low alert [iv]	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	*Replacement of SMB battery on page 107*.
Inspection of all signal cabling in lower and upper arm	36 months	Replace if damaged.	
Replacement of mechanical stop axis 1	60 months	Replace if bent.	*Fitting, mechanical stop axis 1 on page 83*.

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

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

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

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

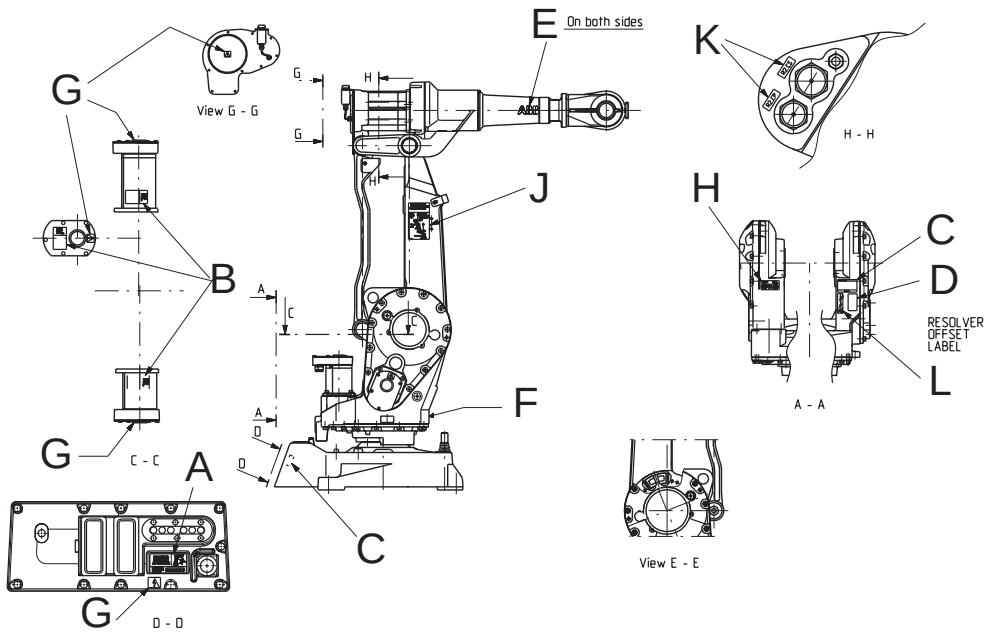
See the replacement instruction for more details.

3.3 Inspection activities

3.3.1 Inspecting information labels

Location of information labels

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



xx1600001279

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

Continues on next page

Required equipment

Equipment	Spare part number	Note
Labels	For spare part number of a specific label see *Spare part lists on page 233*.	Labels are sold separately.

Inspecting labels

Use this procedure to inspect the labels on the robot.

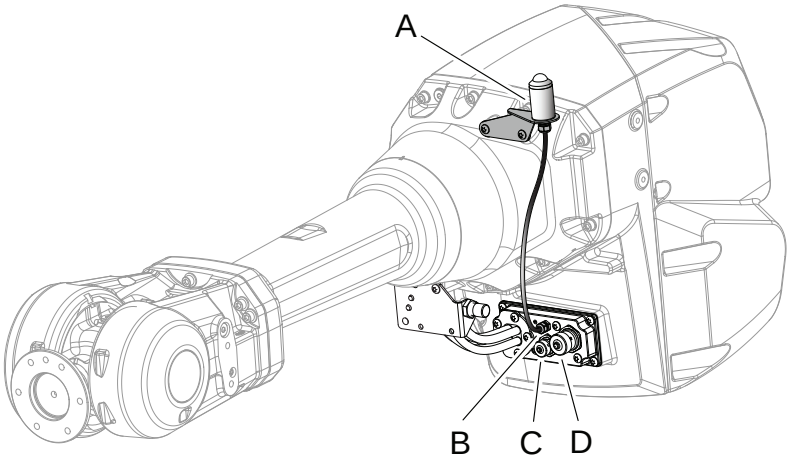
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Check all labels.	See the figure in *Location of information labels on page 98*.
3	Replace any missing or damaged labels.	

3.3.2 Inspecting Signal lamp (option)

Location of signal lamp

Signal lamp is an option.

Located as shown in the figure.



xx0800000290

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

Required equipment

Equipment	Note
Signal lamp	For spare parts no. see Spare parts - *Spare parts options* in *Product manual, spare parts - IRB 2600*.
Standard toolkit	Content is defined in section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Inspecting signal lamp

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

Note

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

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

Continues on next page

	Action	Note
2	If the signal lamp is not lit, continue tracing the fault with the steps below.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Check whether the signal lamp is broken. If so, replace.	
5	Check the cable connections.	
6	Measure the voltage in connectors, motor axis 3.	24V
7	Check the cabling. If a fault is detected, replace.	
8	Clean Room and Foundry Prime robots: seal and paint the joints that have been opened. Also repair possible damages of the special Foundry Prime paint coat of the robot. See *Replacing parts on the robot on page 127*. **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

3.4 Changing activities

3.4.1 Type of lubrication in gearboxes

Introduction

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

> **CAUTION**
>
> Always read the specific instructions for Clean Room robots before doing any repair work, see *Replacing parts on the robot on page 127*.

Type and amount of oil in gearboxes

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

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

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

Location of gearboxes

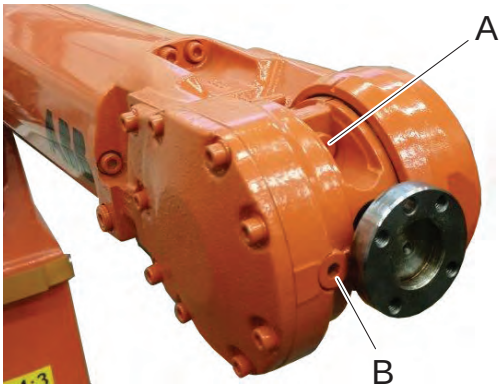
The figure shows the location of the gearboxes.

Equipment

Equipment	Note
Oil dispenser	Includes pump with outlet pipe. Use the suggested dispenser or a similar one: • Orion OriCan art. no. 22590 (pneumatic)
Nipple for quick connect fitting, with o-ring	

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

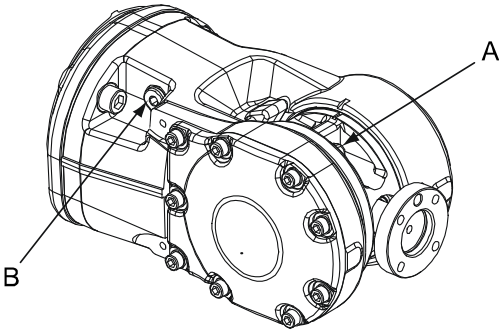
Location of oil plugs, axes 5-6 (IRB 2400L/5)



xx1600000097

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

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



xx0300000118

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

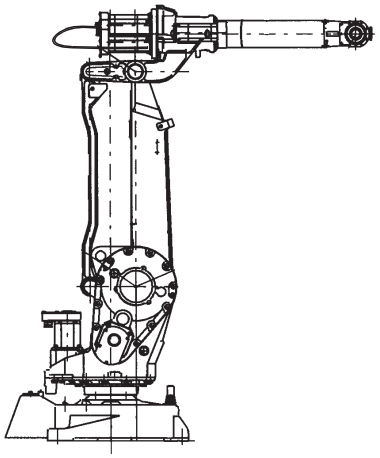
Required equipment

Equipment	Note
Lubricating oil	Information about the oil is found in *Technical reference manual - Lubrication in gearboxes*. See *Type and amount of oil in gearboxes on page 102*.
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Standard toolkit	The content is defined in the section *Standard tools on page 229*.

Continues on next page

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

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

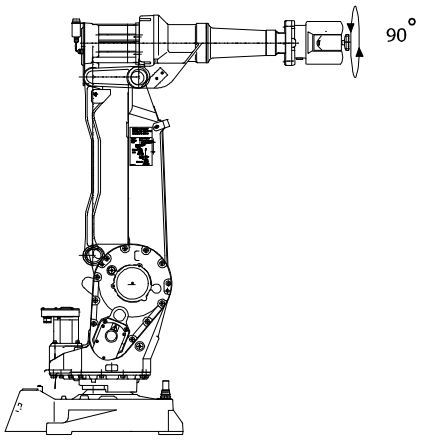
	Action	Note/Illustration
1	**DANGER** The robot must have power during the oil change. Place a sign that clearly indicates that service work is ongoing.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 57*.	
3	Run the upper arm to a horizontal position and turn axis 4 to the calibration position.	 xx1600000098
4	Turn axis 4 through 180° so that the oil plug (A) on the tilt housing is pointing downwards.	
5	Remove oil plugs A and B	Shown in the figure *Location of oil plugs, axes 5-6 (IRB 2400L/5) on page 103*.
6	Turn axis 5 -30° if necessary to drain all oil.	

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

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

	Action	Note/Illustration
1	**DANGER** The robot must have power during the oil change. Place a sign that clearly indicates that service work is ongoing.	

Continues on next page

	Action	Note/Illustration
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 57*.	
3	Run the upper arm to a horizontal position and turn axis 4 to the calibration position.	
4	Remove the *oil plugs* in the wrist.	Shown in the figure *Location of oil plugs, axes 5-6 (IRB 2400/10/16) on page 103*.
5	Turn axis 4 through 90° so that the oil plug on the side of the wrist is pointing downwards.	 xx0300000121
6	Then turn axis 4 another 90°.	
7	Let the remaining oil run out through the hole on the tilt housing.	

Refilling, gearbox axes 5-6

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

	Action	Note
1	Run the upper arm to a horizontal position and turn axis 4 to the calibration position.	
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 57*.	

Continues on next page

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

	Action	Note
4	**Valid for IRB 2400L/5 kg** Fill oil in the plug hole (A) located on the tilt housing (axis 5) until the oil reaches up to oil plug (B) in the front of the wrist.	
5	**Valid for IRB 2400/10/16 kg** Fill oil in the plug hole (A) located on the tilt housing (axis 5) until the oil reaches up to the hole located on the side of the wrist.	
6	**Note** If the robot is mounted in suspension, the wrist should be turned 180°.	
7	Refit the oil plugs to the wrist.	

3.4.3 Replacement of SMB battery

Note

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

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

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

WARNING

See instructions for batteries, *WARNING - Safety risks during handling of batteries on page 56*.

Location of SMB battery unit

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

A	SMB connection
B	SMB battery RMU
C	SMB battery connector

Required equipment

Note

There are two variants of SMB units and batteries. One with 2-pole battery contact and one with 3-pole battery contact. The battery with the 3-pole contact has a longer lifetime.

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

Equipment	Spare part no.	Note
Battery unit (2-pole battery contact)	3HAC16831-1	Lithium battery. This battery requires that the serial measurement unit 3HAC17396-1 is installed.
Battery unit (3-pole battery contact)	3HAC044075-001	RMU Lithium battery. Can only be used with SMB unit 3HAC046277-001 containing SMB board 3HAC044168-001.

Continues on next page

3.4.3 Replacement of SMB battery
Continued

Equipment	Spare part no.	Note
Gasket, cover	3HAC3200-1	Always replace with a new one!
Standard toolkit		The content is defined in the section *Standard tools on page 229*.
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.

Replacement, SMB battery

The procedure below details how to replace the SMB battery.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	 xx0200000023 **WARNING** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *WARNING - The unit is sensitive to ESD! on page 54*	
3	Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).	
4	Remove the battery terminals from the serial measuring board and cut the clasp that keeps the battery unit in place.	
5	Fit the new **battery** and connect the terminals to the serial measuring board.	Shown in the figure *Location of SMB battery unit on page 107*.
6	Refit the cover to the robot base, together with a new *gasket*.	Always replace a removed gasket with a new! Spare part no. is specified in *Required equipment on page 107*.
7	Update the revolution counters!	Detailed in the section *Updating revolution counters on page 212*.

3.5 Cleaning activities

3.5.1 Cleaning the IRB 2400

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 2400 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 2400.

Note

Always verify the protection type of the robot before cleaning.

Oil spills

Oil spills from gearboxes

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

1. Inspect that the oil level in the suspected gearbox is according to the recommendations, see *Inspection activities on page 98*.
2. Write down the oil level.
3. Inspect the oil level again after, for example, 6 months.
4. If the oil level is decreased then replace the gearbox.

Oil spills discolors painted surfaces

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

Note

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

Dos and don'ts!

This section specifies some special considerations when cleaning the robot.

Always!

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

Continues on next page

Never!

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

Cleaning methods

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

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

i Perform according to section *Cleaning with water and steam on page 110*.
ii Perform according to section *Cleaning with water and steam on page 110*.

Cleaning with water and steam

Instructions for rinsing with water

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

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 700 kN/m^2 (7 bar) I
- Fan jet nozzle should be used, min. 45° spread

1 See *Cleaning methods on page 110* for exceptions.

Continues on next page

- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum flow: 20 liters/min[I]

[I] Typical tap water pressure and flow

Instructions for steam or high pressure water cleaning

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

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 2,500 kN/m^2 (25 bar)
- Fan jet nozzle should be used, min. 45° spread
- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum water temperature: 80° C

Cables

Movable cables need to be able to move freely:

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

[2] See *Cleaning methods on page 110* for exceptions.

3.6 Service Information System, M2000

3.6.1 Using the SIS system

General

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

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

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

Basic procedure

	Action	Reference
1	Determine which of the system functions you require.	These are described in *Description of Service Information System (SIS) on page 113*.
2	Define what values are adequate and suitable for your application in your production environment.	Recommendations on how to define these are given in *SIS system parameters on page 116*.
3	Enter these parameters in the system.	How to do this is detailed in *Setting the SIS parameters on page 117*.
4	Run the robot in normal operation.	
5	Reset the counter if a repair is made, or if a counter for any other reason is restarted.	The TPU displays for resetting any SIS value are shown in *Description of Service Information System (SIS) on page 113*.
6	When a time limit, set in the parameters, is exceeded, a message may be read on the Tech Pendant Unit (TPU).	How to access this is detailed in *Reading the SIS output logs on page 118*.
7	If the log containing the message is to be available from an external PC, or if the SIS parameters are to be entered from an external PC, a set of software tools are available to build such an application.	These are described in *Exporting the SIS data on page 119*.

3.6.2 Description of Service Information System (SIS)

General

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

Maintenance is scheduled by setting the system parameters of the type SIS Parameters, see section *Setting the SIS parameters on page 117*. All system parameters are described in *User´s Guide - System Parameters*.

Supervised functions

The following counters are available:

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

Counters are reset when maintenance has been performed.

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

Calendar time

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

When the calendar time limit for maintenance is reached, a message is displayed on the TPU. How to access this is detailed in section *Reading the SIS output logs on page 118*.

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

Prev service	Date when the counter was reset last time, i.e. after the last service.
Elapsed time	Elapsed time since the counter was reset the last time.
Next service	Date when next scheduled service is planned. This date is calculated using system parameters, as detailed in section *Setting the SIS parameters on page 117*.
Remaining time	Remaining time to next scheduled service date.

Continues on next page

3.6.2 Description of Service Information System (SIS)
Continued

Operation time

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

When the operation time limit for maintenance is reached, a message is displayed on the TPU. How to access this is detailed in section *Reading the SIS output logs on page 118*.

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

Service interval	The specified service interval until another service will be required. This parameter was entered manually as detailed in section *Setting the SIS parameters on page 117*.
Elapsed time	Operation time since the service interval was set the last time.
Remaining time	Remaining operation time until the time set in service interval has expired.

Gearbox

Based on measurements, torque and RPM, for example, the system calculates an expected service interval for each gearbox. When service is due, a message will be shown on the TPU. How to access this is detailed in section *Reading the SIS output logs on page 118*.

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

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

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

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

Reset values

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

When resetting, the counter variables are reset. The variables are described in section *Exporting the SIS data on page 119*!

Service interval exceeded

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

Continues on next page

No data available

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

3.6.3 SIS system parameters

General

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

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

Operation time limit (service level)

The number of operation hours selected as service interval.

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

Operation time warning

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

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

Calendar time limit (service level)

The number of calendar years selected as service interval.

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

Calendar time warning

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

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

Gearbox warning

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

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

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

3.6.4 Setting the SIS parameters

General

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

Procedure M2000

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

	Action	Note
1	Open "System parameters" using the TPU.	Detailed in the User's Guide.
2	Go to "System parameters/Manipulator/types 2".	
3	Select "0 SIS parameters" and press "Enter".	
4	Select the required system The parameter list is displayed.	
5	Select the required parameters by stepping up and down through the parameter list.	Available parameters are described in section *SIS system parameters on page 116*.

3.6.5 Reading the SIS output logs

General

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

Access to logs

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

Available messages

The following messages may be shown:

Available in:	SIS message in the log:	Meaning:
Calendar time	Service Message Service is due! X calendar days since last service.	The manually set calendar time limit has expired. How to set the limit is detailed in section *Setting the SIS parameters on page 117*. Proceed with the required service as detailed in chapter *Repair on page 121* or chapter *Maintenance on page 95* depending on which type of service.
Calendar time	Service Message X calendar days to next service.	X number of calendar days remain until the manually set calendar time limit expires. How to set the value determining when the message is to be shown, is detailed in section *Setting the SIS parameters on page 117*.
Operation time	Service Message Service is due! X production hours since last service.	The manually set operation time limit has expired. How to set the limit is detailed in section *Setting the SIS parameters on page 117*. Proceed with the required service as detailed in chapter *Repair on page 121* or chapter *Maintenance on page 95* depending on which type of service.
Operation time	Service Message X production hours to next service.	X number of operation hours remain until the manually set operation time limit expires. How to set the value determining when the message is to be shown, is detailed in section *Setting the SIS parameters on page 117*.
Gearbox time	Service Message Gearbox x requires service!	The automatically calculated gearbox time limit has expired. Proceed with the required service as detailed in chapter *Repair on page 121* or chapter *Maintenance on page 95* depending on which type of service.
Gearbox time	Service Message X% of the service interval has expired for gearbox x!	X percent of gearbox hours remain until the automatically calculated gearbox time limit expires. How to set the value determining when the message is to be shown, is detailed in section *Setting the SIS parameters on page 117*.

3.6.6 Exporting the SIS data

General

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

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

Definitions

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

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

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4 Repair

4.1 Introduction

Structure of this chapter

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

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

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

Required equipment

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

The details of equipments are also available in different lists in the chapter *References on page 10*.

Safety information

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

Note

If the IRB 2400 is connected to power, always make sure that the IRB 2400 is connected to *earth* before starting any repair work.

For more information see:

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

4.2 General procedures

4.2.1 Performing a leak-down test

When to perform a leak-down test

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

Required equipment

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

Performing a leak-down test

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

4.2.2 Mounting instructions for bearings

General

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

Equipment

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

Assembly of all bearings

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

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

Assembly of tapered bearings

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

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

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

Greasing of bearings

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

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

Continues on next page

4.2.2 Mounting instructions for bearings
Continued

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

Grease the different types of bearings as following description:

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

4.2.3 Mounting instructions for seals

General

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

Equipment

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

Rotating seals

The procedure below describes how to fit rotating seals.

CAUTION

Please observe the following before commencing any assembly of seals:

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

	Action	Note
1	Check the seal to ensure that: • 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 125*.
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

4.2.3 Mounting instructions for seals
Continued

Flange seals and static seals

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

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

O-rings

The following procedure describes how to fit o-rings.

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

4.2.4 Replacing parts on the robot

General

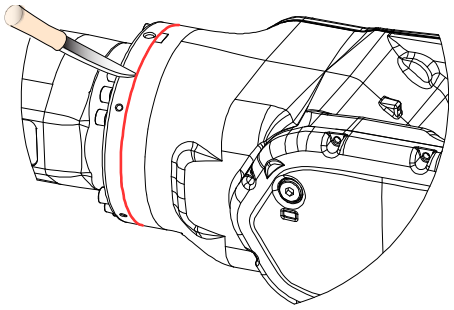
Follow the procedures in this section whenever breaking the surface paint of the robot during replacement of parts.

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

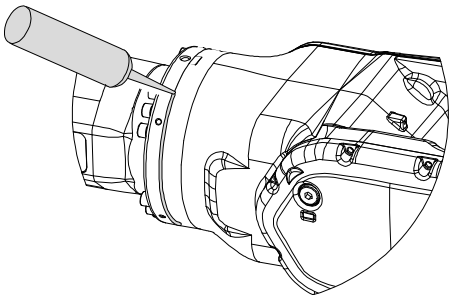
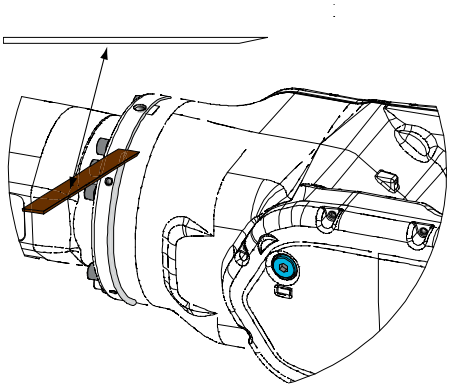
	Action	Description
1	Cut the paint with a knife in the joint between the part that will be removed and the structure, to avoid that the paint cracks.	 xx0900000121
2	Carefully grind the paint edge that is left on the structure to a smooth surface.	

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

4.2.4 Replacing parts on the robot
Continued

	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.

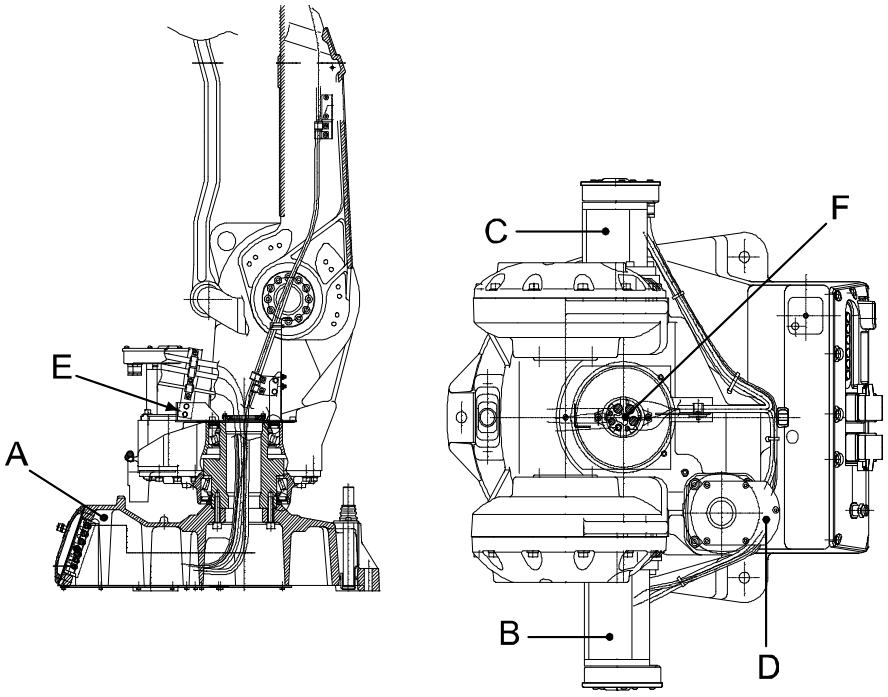
4.3 Complete robot

4.3.1 Replacement of cable unit, axes 1-3

Location of cabling

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

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



xx0500002541

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

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable unit axes 1-3, Standard	3HAC4791-1		Includes: • cabling • covers, motor 1-3 • attachment screws • gaskets, motor axes 1-3

Continues on next page

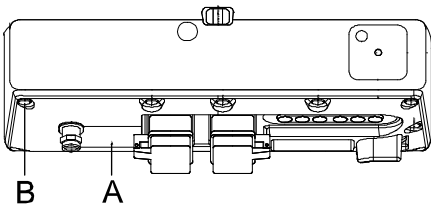
4.3.1 Replacement of cable unit, axes 1-3

Continued

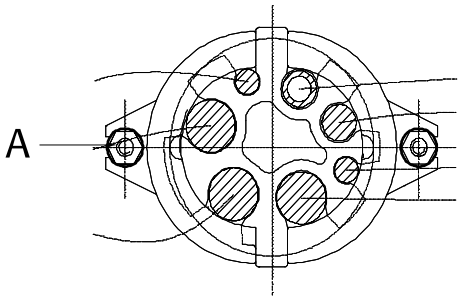
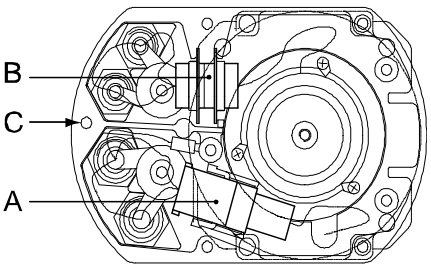
Equipment, etc.	Spare part no.	Art. no.	Note
Sealing	3HAC4113-1		Sealing in the base for the cables. Always use a new sealing.
Gasket, cover	3HAC3200-1		
Cable straps, outdoor		2166 2055-3	
Flange sealing		12340011-116	Loctite 574
Circuit diagram			See the chapter *Circuit diagram on page 235*.
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Removal, cable unit, axes 1-3

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

	Action	Note/Illustration
1	In order to facilitate refitting of the cable harness, move the robot to the specified position: • Axis 1: 0° • Axis 2: 0° • Axis 3: 0° • Axis 4: 0° • Axis 5: +90° • Axis 6: no significance	Axes 2 and 3 may be tilted slightly to improve access.
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).	 xx0200000399
4	Disconnect the connectors R1.MP1-3 and R2.BU1-3 inside the base.	
5	Disconnect all the earth cables on the R1.M1-3 cable from the back of the cover.	

Continues on next page

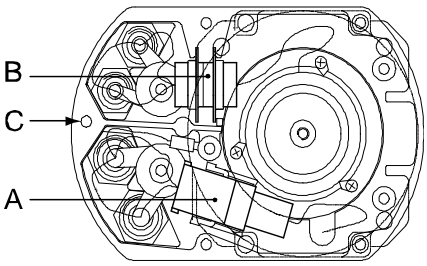
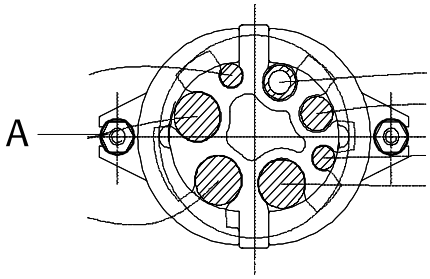
	Action	Note/Illustration
6	Loosen the nuts and remove the SMB unit carefully from the bracket. The cable between the battery and the SMB unit may stay connected, in order to avoid recalibration of the robot. Be careful not to let the weight of the SMB unit strain the cable! In order to remove the SMB unit completely, the connector R2.G must be disconnected! This causes a necessary recalibration of the robot!	
7	Disconnect the connector R2.FB 1-3 from the connection R2.SMB1-4 on the SMB unit.	
8	Unscrew the four screws securing the cable gland.	This releases the cable harness from the frame.
9	Remove the cable guide in the middle of the frame by removing the attachment screws of the holder (A). Remove the cables from the guide.	 xx0200000404 **Note!** Different robot versions are fitted with different versions of the holder. Make sure the correct one is used to avoid cable failure.
10	Remove the upper bracket securing the cables to the arm house by unscrewing its two attachment screws.	**Note!** Do not remove or loosen any of the cable brackets from the new harness, the angle of the brackets is factory optimized.
11	Remove the cover of the motors 1-3.	
12	Disconnect all the connectors at the motors of axes 1, 2 and 3.	 xx0200000401 R3.MP1-3 R3.FB1-3 Connection box
13	Remove the three screws of the connection box for the motors of axes 1, 2 and 3.	
14	Gently pull the cable harness out.	

Continues on next page

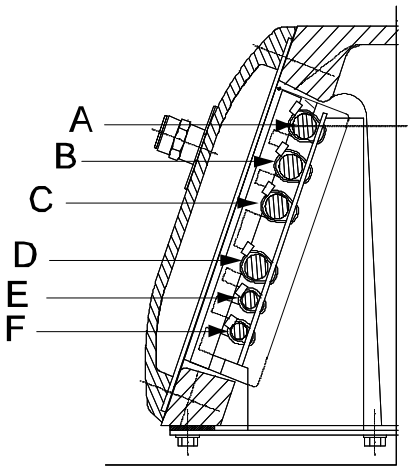
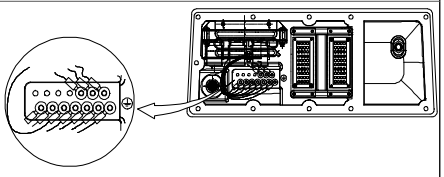
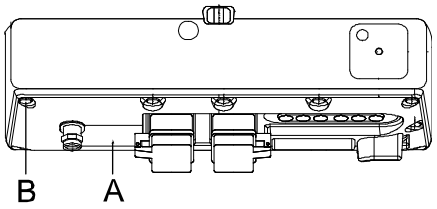
4.3.1 Replacement of cable unit, axes 1-3
Continued

Refitting, cable unit, axes 1-3

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Gently pull down the cable harness through the center hole of axis 1.	
3	Fit a new *gasket* and fit the connection box on motor 1, 2 and 3, using the three attachment screws.	The gasket is included in the spare part of the cable unit, spare part no. is specified in *Required equipment on page 129*.
4	Reconnect all the connectors at motors 1, 2 and 3.	 xx0200000401 R3.MP1-3 R3.FB1-3 Connection box
5	Refit the cover of the motors, axes 1, 2 and 3, with the five attachment screws.	
6	Refit the upper bracket securing the cables to the arm house, using the two attachment screws.	
7	Fit the cable guide to the harness and secure the holder to the frame with its two attachment screws (A).	 xx0200000404 **Note!** Different robot versions are fitted with different versions of the holder. Make sure the correct one is used to avoid cable failure.

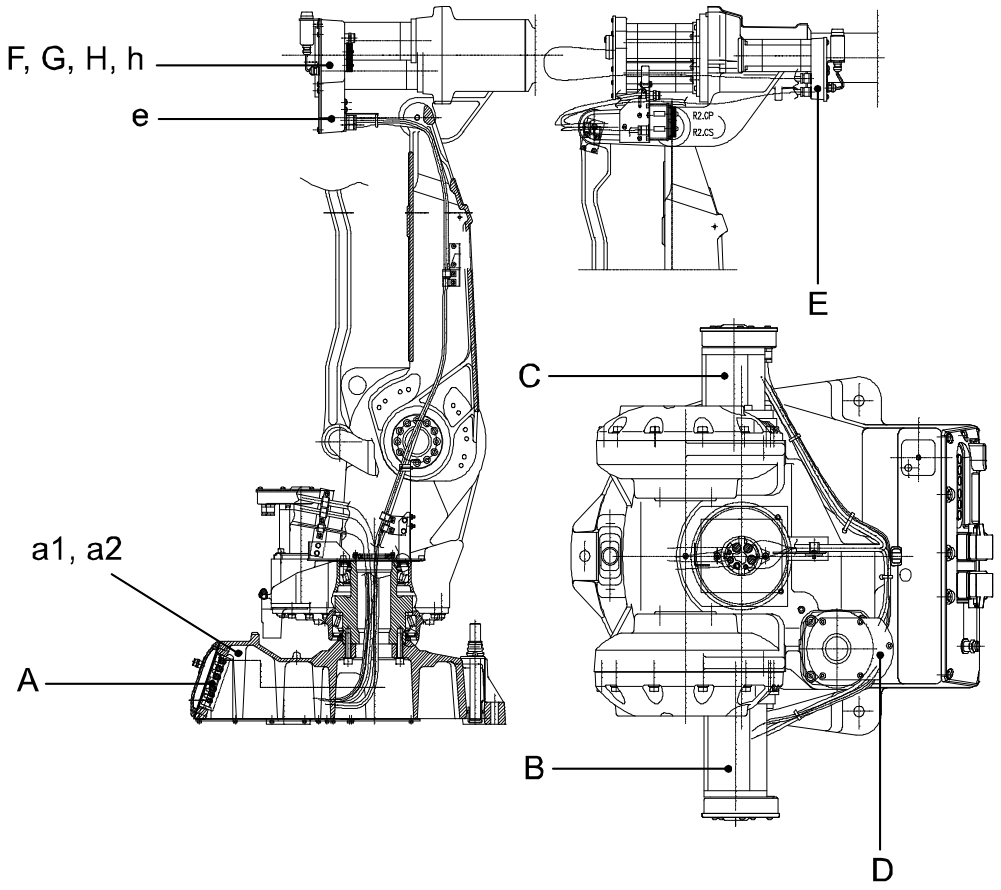
Continues on next page

	Action	Note/Illustration
8	Secure the cabling inside the base. Insert the cables in the sealing: Power cable Power cable Power cable Customer cable Signal cable Signal cable **Note!** Make sure that each cable is fitted in the same position as the old one, otherwise the conduit entry will not be watertight. Use six *cable straps*. **Note!** Always use a new *sealing*, combined with a *flange sealing* (Loctite 574).	 xx0200000402 Art. numbers are specified in *Required equipment on page 129*.
9	Connect the connectors R2.FB 1-3 to the connection R2.SMB1-4 on the SMB unit.	
10	Refit the SMB unit to the bracket with the nuts. Be careful not to let the weight of the SMB-unit strain the cable!.	**Note!** The cable between the battery and the SMB-unit may stay connected, in order to avoid recalibration of the robot.
11	Connect all the earth cables on the R1.M1-3 cable to the back of the cover.	 xx0200000403
12	Connect the connectors R1.MP1-3 and R2.BU1-3 inside the base.	
13	Refit the rear cover plate (A) on the robot with its attachment screws (B), together with a new *gasket*.	 xx0200000399 Spare part no. is specified in *Required equipment on page 129*.
14	If the battery has been disconnected from the SMB unit, the revolution counters must be updated!	Detailed in the section *Updating revolution counters on page 212*.
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 51*.	

4.3.2 Replacement of cable harness, axes 4-6

Location of cable harness

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



xx0200000396

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

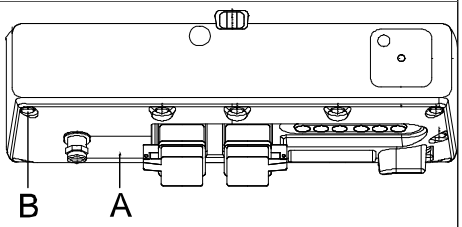
Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable unit axes 4-6 Standard	3HAC 9330-1		IRB 2400/L
Cable unit axes 4-6 Standard	3HAC9328-1		IRB 2400 /10, /16
Cable unit, axes 4-6 Opt 043	3HAC 8520-1		IRB 2400/L Option 043
Gasket, motor axes 4-6	3HAC4429-1		
Sealing	3HAB 5922-1		
Flange sealing		12340011-116	Loctite 574
Cable straps, outdoor		21662055-1	L=208mm
Circuit diagram			See the chapter *Circuit diagram on page 235*.
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Removal, cable harness, axes 4-6

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	In order to facilitate refitting of the cable harness, run the robot to the specified position: • Axis 1: 0 ° • Axis 2: 0 ° • Axis 3: 0 ° • Axis 4: 0 ° • Axis 5: +90 ° • Axis 6: no significance	Axes 2 and 3 may be tilted slightly to improve access.
3	Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).	 xx0200000399

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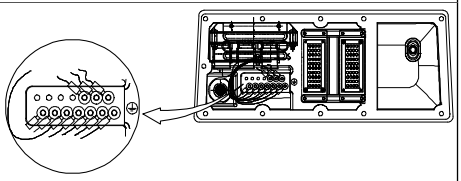
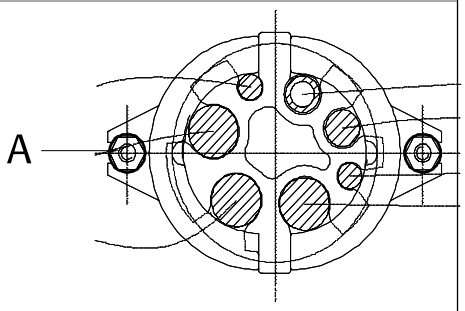
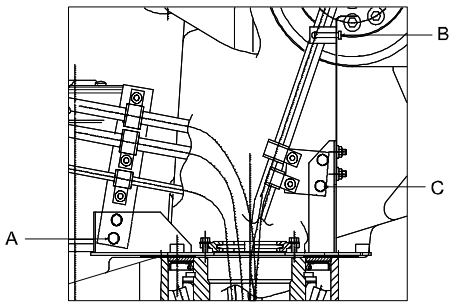
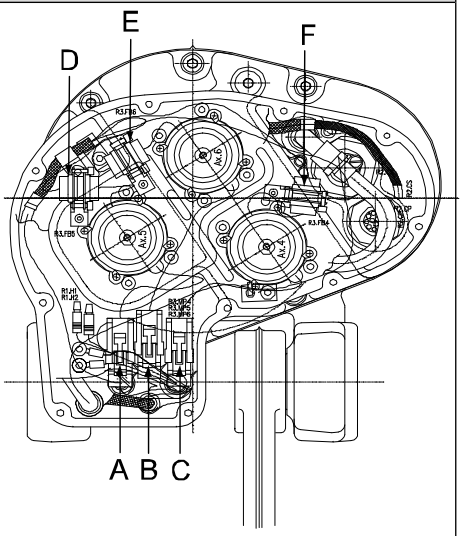
4.3.2 Replacement of cable harness, axes 4-6

Continued

	Action	Note/Illustration
4	Disconnect connectors R1.MP4-6 and R2.BU4-6.	
5	Disconnect all the earth cables on the R1.M4-6 cable from the back of the cover.	 xx0200000403
6	Loosen the nuts holding the SMB-unit slightly, then remove it carefully from the bracket. The cable between the battery and the SMB-unit may stay connected, in order to avoid recalibration of the robot. Be careful not to let the weight of the SMB-unit strain the cable! In order to remove the SMB-unit completely, the connector R2.G must be disconnected! This causes a necessary recalibration of the robot!	
7	Disconnect connector R2.FB 4-6 from the connection R2.SMB4-6 on the SMB-unit.	
8	Unscrew the four screws securing the cable gland.	This releases the cable harness from the frame.
9	Remove the adapter plate from the harness by removing its two attachment screws (A).	 xx0200000404 Note! Different robot versions are fitted with different plate versions. Make sure the correct one is used to avoid cable failure.
10	Remove the upper bracket securing the cables to the arm house by unscrewing its two attachment screws (C). Cut the strip clamp (B).	 xx0200000405
11	Remove the back cover of the motors 4-6, fitted with torx screw.	

Continues on next page

	Action	Note/Illustration
12	Disconnect all connectors at motor 4, 5 and motor 6, R3.MP4-6 and R3.FB4-6: A - R3.MP5 B - R3.MP6 C - R3.MP4 D - R3.FB5 E - R3.FB6 F - R3.FB4	 xx0200000406
13	Remove all screws holding the motor case on motor 4-6.	
14	Gently pull the cable harness out.	

Refitting, cable harness, axes 4-6

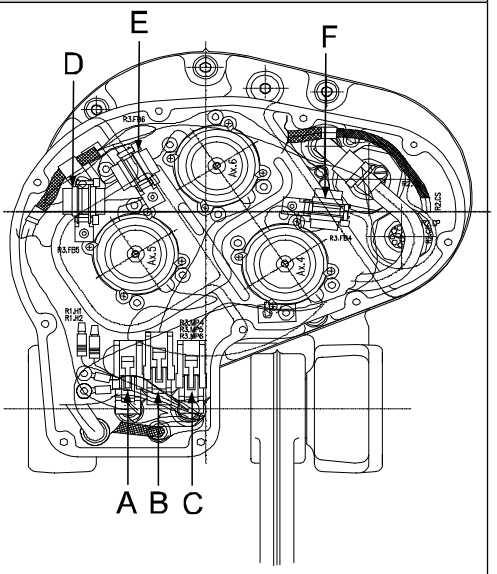
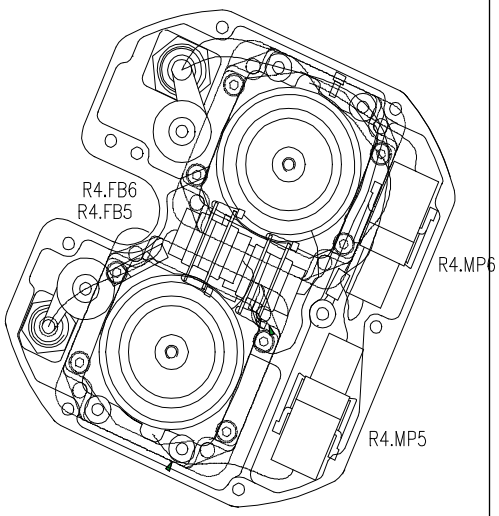
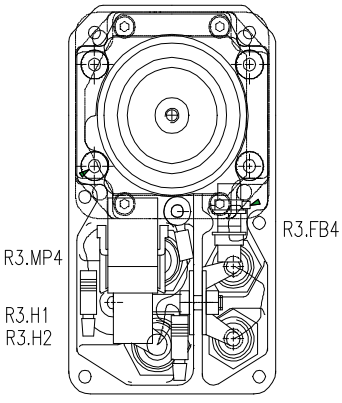
The procedure below details how to refit the cable harness, axes 4-6.

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	In order to facilitate refitting of the cable harness, run the robot to the specified position: • Axis 1: 0 ° • Axis 2: 0 ° • Axis 3: 0 ° • Axis 4: 0 ° • Axis 5: +90 ° • Axis 6: no significance	Axes 2 and 3 may be tilted slightly to improve access.
3	Gently pull down the cable harness through the center of the lower arm and through the hole of axis 1.	
4	Fit a new gasket and fit the motor case on motor 4-6 using the nine torx screws .	Note! Always use a new gasket! Art. no. is specified in *Required equipment on page 135*.

Continues on next page

4.3.2 Replacement of cable harness, axes 4-6

Continued

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

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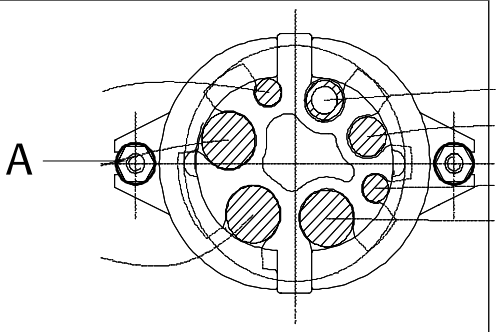
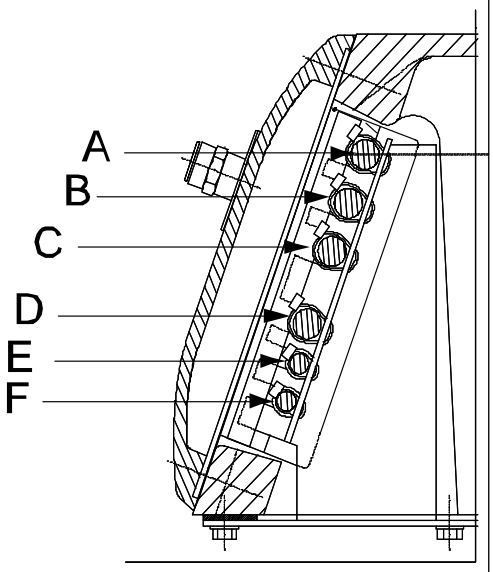
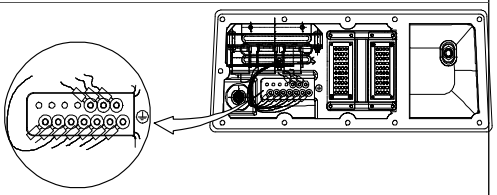
	Action	Note/Illustration
7	Fit the upper bracket securing the cables to the arm house, using the two attachment screws.	
8	Fit the adapter plate to the harness by using its two attachment screws (A).	 xx0200000404 Note! Different robot versions are fitted with different plate versions. Make sure the correct one is used to avoid cable failure.
9	Fit all the screws securing the cable gland. This attaches the cable harness to the frame. Cables • A - Power • B - Power • C - Power • D - Customer • E - Signal • F - Signal Note! Make sure that each cable is fitted at the same position as the old ones, otherwise the conduit entry will not be watertight. Note! Always use a new *sealing* and combine it with a *flange sealing* (Loctite 574).	 xx0200000402 Art. no:s.are specified in *Required equipment on page 135*.
10	Connect connectors R2.FB 4-6 to the connection R2.SMB4-6 on the SMB-unit.	
11	Fit the SMB-unit to the bracket with the nuts, be careful not to let the weight of the SMB-unit strain the battery cable!.	Note! The cable between the battery and the SMB-unit may stay connected, in order to avoid recalibration of the robot.
12	Run all the earth cables on the R1.M4-6 cable to the back of the cover.	 xx0200000403
13	Connect connectors R1.MP4-6 and R2.BU4-6.	

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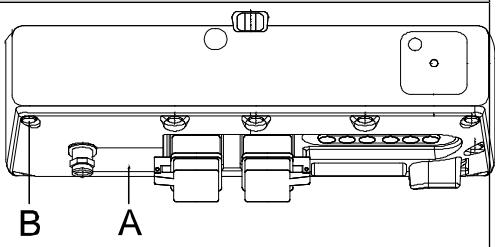
4.3.2 Replacement of cable harness, axes 4-6

Continued

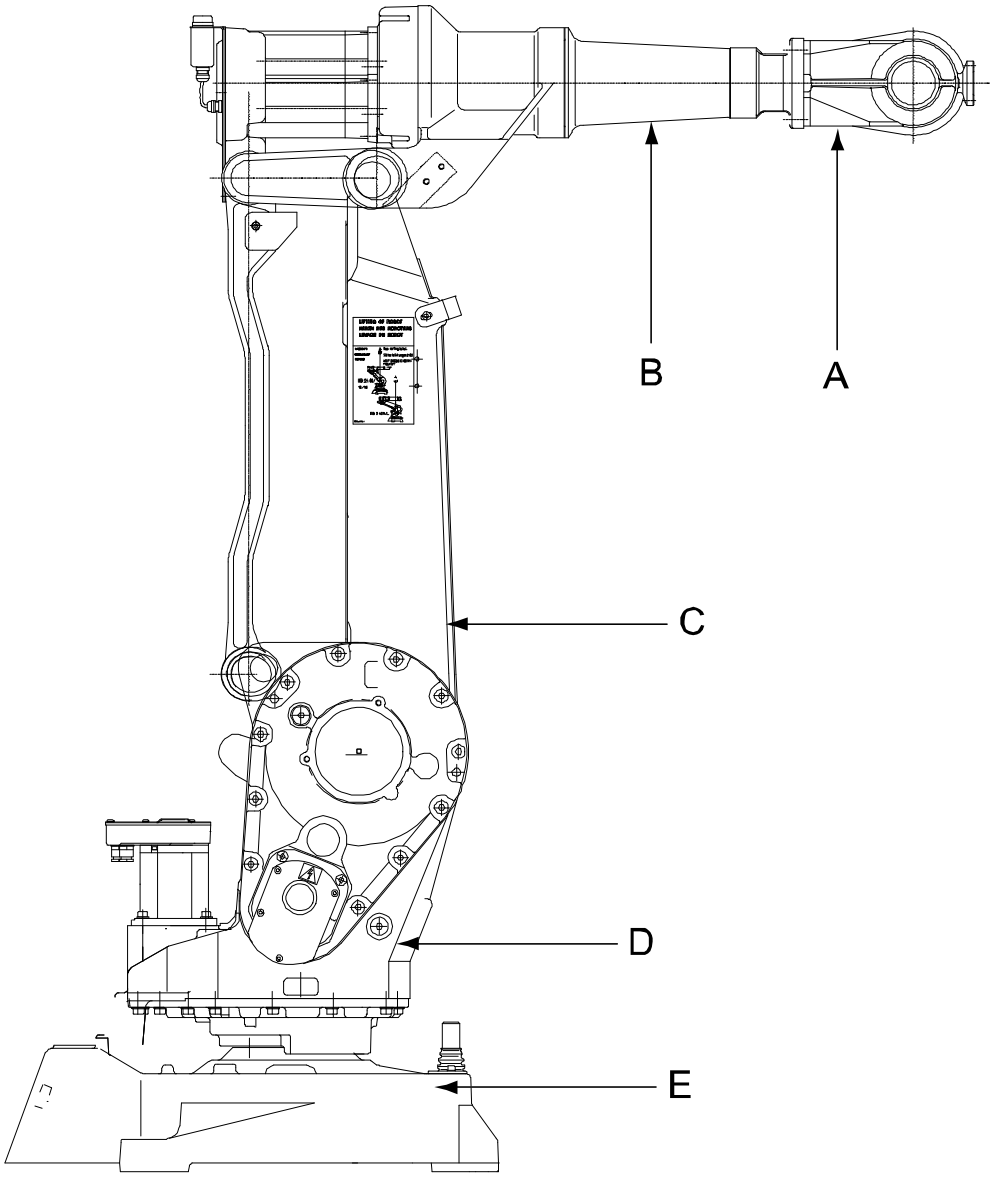
	Action	Note/Illustration
14	Refit the rear cover plate (A) on the robot with its attachment screws (B).	 xx0200000399
15	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.4 Upper arm

4.4.1 Replacement of wrist IRB 2400/10/16

Location of wrist

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



xx0300000103

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

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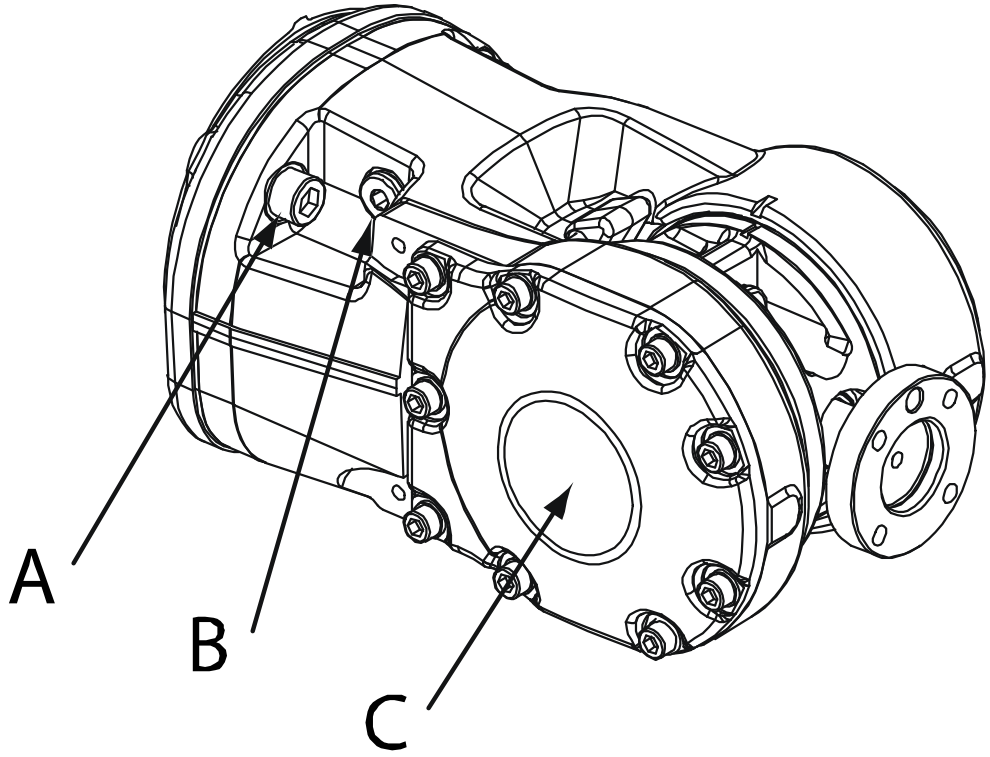
4.4.1 Replacement of wrist IRB 2400/10/16
Continued

Wrist unit



xx0300000104

A	Attachment screws and washers
B	Oil plug
C	Wrist

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Wrist, Standard	3HAB9398-1		ABB Orange
	3HAC050646-001		Graphite White
O-ring		3HAB3772-12	Replace if damaged.
Grease		3HAB3537-1	Shell Alvania WR2
Guide pins		-	M8, length = 70 mm
Measuring tool		3HAB7887-1	
Power supply		-	24 VDC, 1.5 A. For releasing the brakes.
Standard toolkit		-	The content is defined in the section *Standard tools on page 229*.
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

Removal, wrist unit

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

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

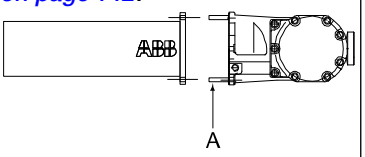
ABB recommends its customers to carry out only the following servicing and repair work on the wrist.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the *oil plug* on the wrist and drain it from all the oil.	Shown in the figure *Wrist unit on page 142*.
3	Undo the *attachment screws* and remove the wrist.	Shown in the figure *Wrist unit on page 142*.

Refitting, wrist unit

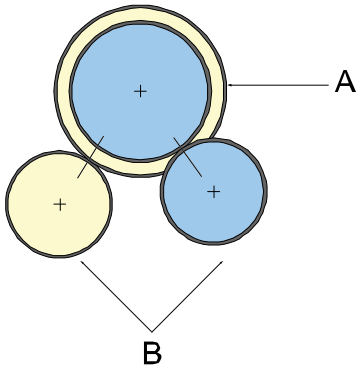
The wrist, which includes axes 5 and 6, is a complete unit comprising drive units and gearboxes. It is a replacement unit of complex design and should not normally be serviced on-site. Instead it should be sent to ABB for service.

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Clean the surface of the tubular shaft.	
3	Lubricate the *o-ring* with *grease* to be sure that it does not get displaced, and fit it in its position on the upper arm tubular.	Art. no. is specified in *Required equipment on page 142*.
4	Fit the two *guide pins* (A) diagonally on the wrist. Carefully push the wrist against the tubular. When the gears are meeting each other, they may need to be rotated to mesh properly.	Specified in *Required equipment on page 142*.  xx0200000424
5	Fix the wrist with two screws and two washers. Remove the M8 guide pins and fit the other two screws and washers.	

Continues on next page

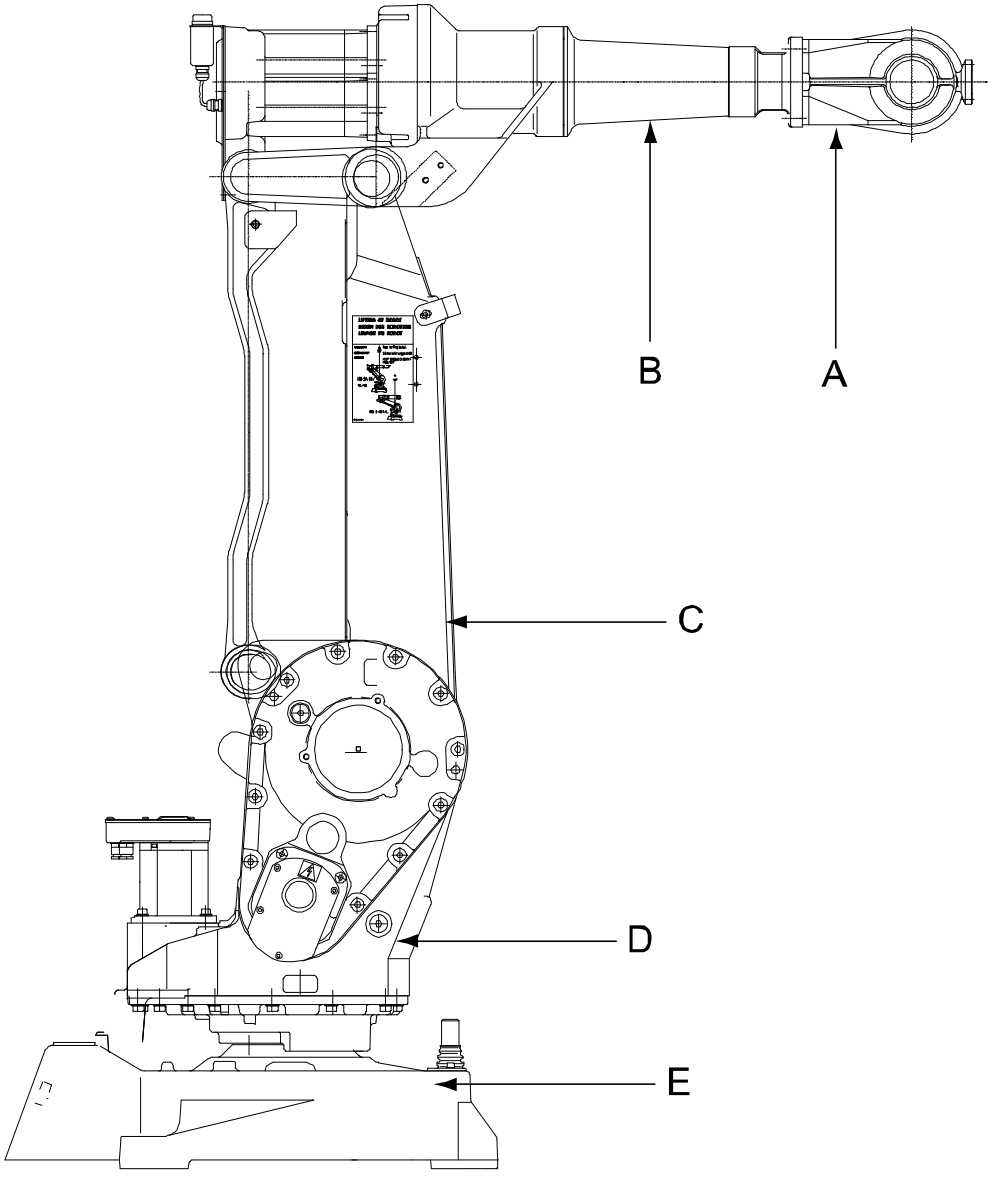
4.4.1 Replacement of wrist IRB 2400/10/16
Continued

	Action	Note/Illustration
6	In order to release the brakes, connect the 24 VDC power supply to the motor. **Note!** Release the brakes of the two motors, but one at a time!	Connect to motor axis 5, connector R3.MP5: • + :pin 7 • -: pin 8 Connect to motor axis 6, connector R3.MP6: • + : pin 7 • -: pin 8
7	Fit the *measuring tool* at the rear of the motor.	Art. no. is specified in *Required equipment on page 142*.
8	Push the wrist, as shown in the figure to the right, to locate the smallest play in the same way as for adjustment of play when changing motors for axes 5 and 6, detailed in section *Replacement of motors, axes 4-6, IRB 2400/10/16 on page 193*.	 xx0200000425 A Gears on drive shaft unit, axis 5-6 B Gears on the wrist
9	Tighten the attachment screws and washers.	Tightening torque: 17 Nm.
10	Check the play by moving axes 5 and 6 by hand.	
11	Refill the wrist unit with oil.	This is detailed in section *Oil change, gearbox axes 5-6 (wrist unit) on page 103*.
12	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.4.2 Replacement of wrist IRB 2400L

Location of wrist

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



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

Continues on next page

4.4.2 Replacement of wrist IRB 2400L
Continued

Required equipment

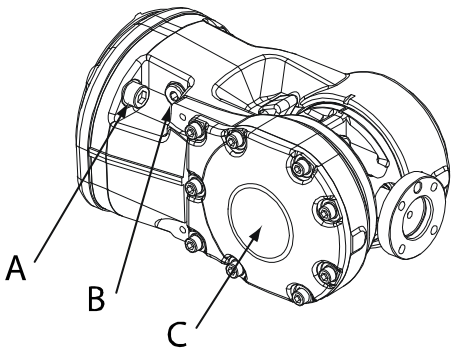
Equipment, etc.	Spare part no.	Note
Wrist, 5 kg	3HAC10814-1	Standard and Foundry.
Locking liquid	-	Loctite 574
Standard toolkit	-	The content is defined in the section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Removal, wrist unit

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

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

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the oil plug from the wrist and drain it from all the oil.	 xx0300000104 A Screw B Oil plug (air inlet) C Wrist unit
3	Undo the screws and remove the wrist.	

Continues on next page

Refitting, wrist unit

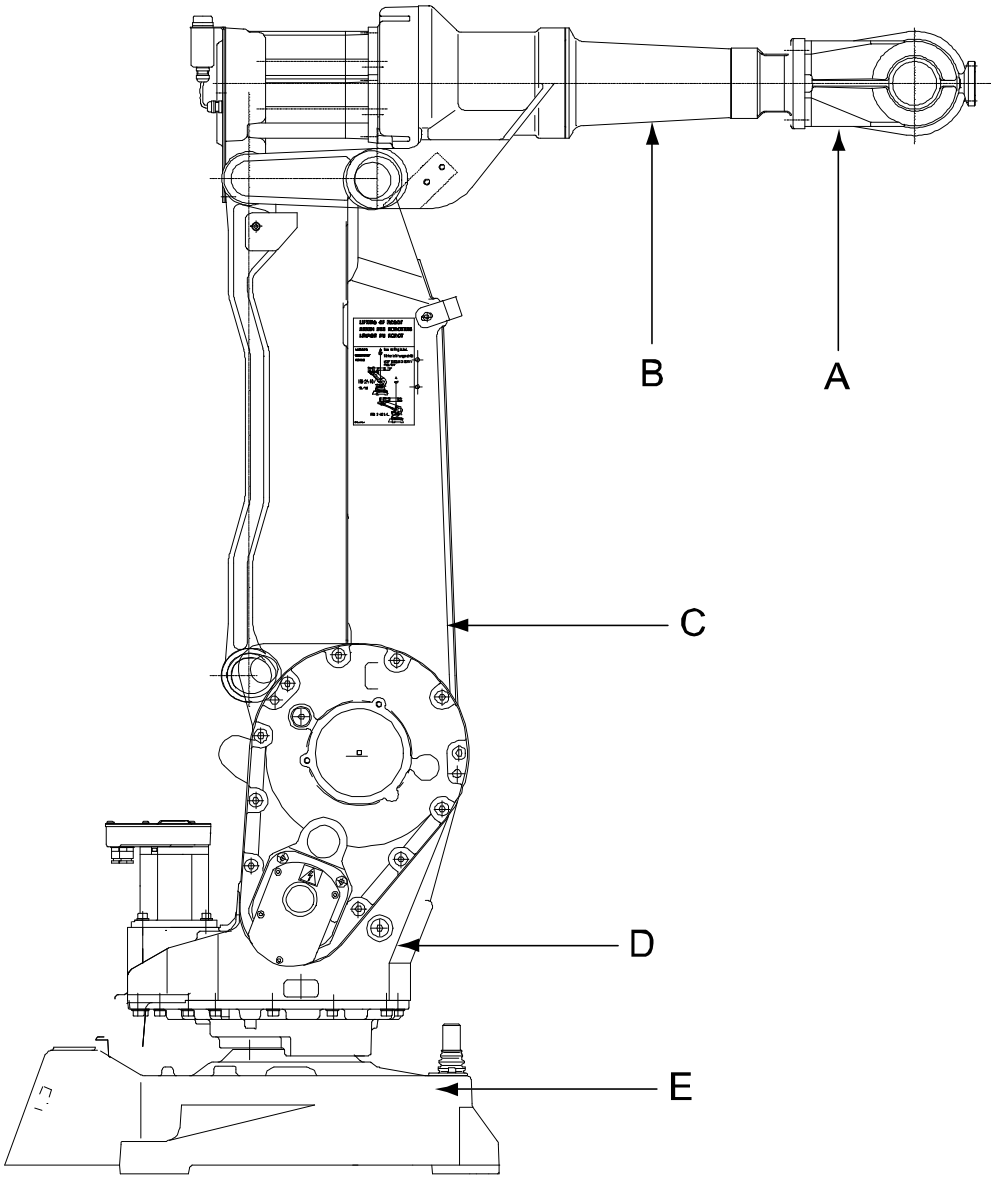
The procedure below details how to refit the wrist unit to the robot.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Clean the surface of the tubular shaft.	
3	Apply Loctite 574 all around.	
4	Fit the wrist, tighten the attachment screws.	Tightening torque: 8.3 Nm +10%.
5	Screw the clamping sleeves together using screws to a torque of 5.7 Nm.	
6	Refit the plugs.	
7	Refit the cover at the motor side of axis 5-6.	
8	Calibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
9	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.4.3 Replacement of complete upper arm

Location of upper arm

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



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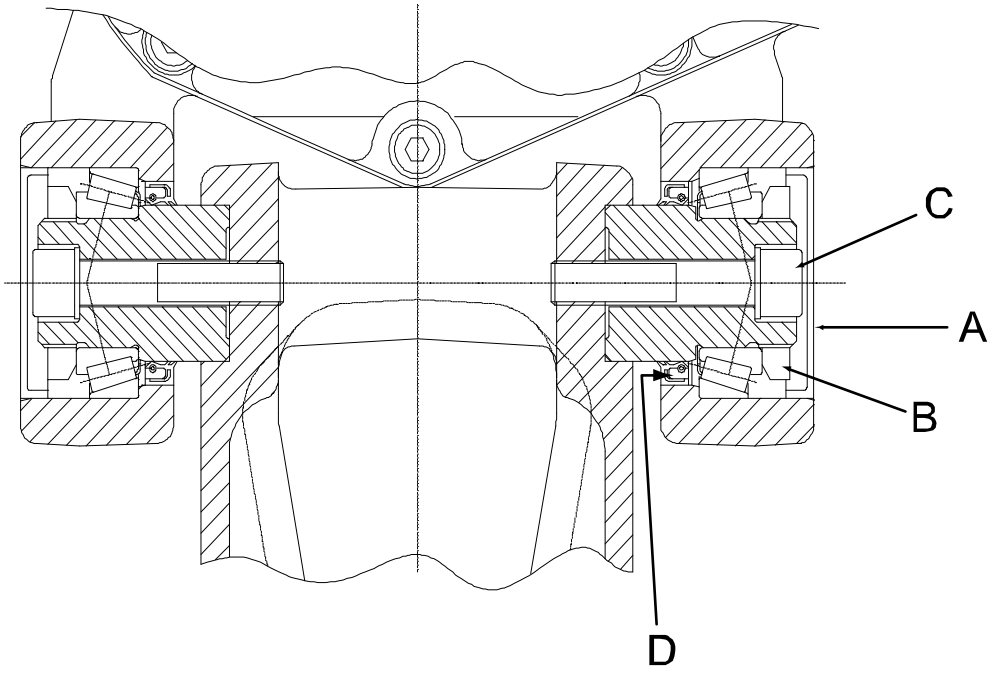
A	Wrist axis 5-6
B	Upper arm axis 3-4
C	Lower arm axis 2
D	Frame axis 1
E	Base

Continues on next page

Required equipment

Equipment	Art. no.	Note
Lifting device, upper arm	-	
Dismounting tool, shaft ends	3HAB9009-1	Used for removing the shafts from the upper arm.
Mounting tool, bearing	3HAB6464-1	
Lifting tool (chain)	-	To be used together with lifting eye, M12 and lifting device, upper arm.
Standard toolkit	-	The content is defined in the section *Standard tools on page 229*.
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.

Upper arm attachment



xx0200000436

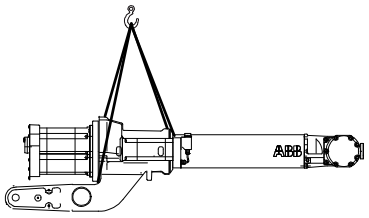
A	Cover
B	KM nuts
C	Attachment screw
D	Sealing (insert a strap under the sealing to let the air go out when fitting the cover)

Continues on next page

4.4.3 Replacement of complete upper arm
Continued

Removal, upper arm

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the tie rod.	Detailed in section *Replacement of tie rod on page 156*.
3	Loosen the connectors of the motors of axes 4, 5 and 6.	Detailed in section *Replacement of motors, axes 4-6, IRB 2400L on page 186*.
4	Disconnect the connection box from the motors.	
5	Remove the covers (Left + Right).	Shown in the figure *Upper arm attachment on page 149*.
6	Undo the KM nuts (Left + Right).	Shown in the figure *Upper arm attachment on page 149*.
7	Remove the attachment screws (Left + Right).	Shown in the figure *Upper arm attachment on page 149*.
8	Fit the lifting device to the upper arm, and lift enough for the strap to stretch *without lifting the robot*.	 xx0200000435 Lifting without lifting tool!
9	Pull out the shaft, using the *dismounting tool for shaft ends*. Mark the shafts (left, right).	Art. no. is specified in *Required equipment on page 149*.

Refitting, upper arm

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Fit sealings in the upper arm.	
3	Fit the inner ring of the bearings on shafts, using the *mounting tool for bearings*.	Art. no. is specified in *Required equipment on page 149*.
4	Raise the upper arm into the mounting position.	
5	Fit shaft spindles (both sides).	

Continues on next page

	Action	Note
6	Insert the *screws* and tighten.	Tightening torque: 90 Nm. Shown in the figure *Upper arm attachment on page 149*.
7	*The following procedure must be performed within 10 minutes, before the Loctite starts to harden.* • Apply Loctite 243 on the KM-nuts. • Fit and tighten the *KM-nut* on the left side first (robot seen from behind) so that the bearing comes against the collar. • Unscrew the KM-nut and then retighten with a torque of 35 Nm. • Tighten the KM-nut on the right side, move the upper arm up and down at the same time, until there is no play. • Unscrew the nut again. • Tighten the KM-nut with a torque of 35 Nm. • Push in a strap under the *sealing* to let the air go out and then fit the *covers*.	Shown in the figure *Upper arm attachment on page 149*.
8	Fit the calibration plate for axis 3.	
9	Reconnect the connection boxes and the cabling.	
10	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
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 51*.	

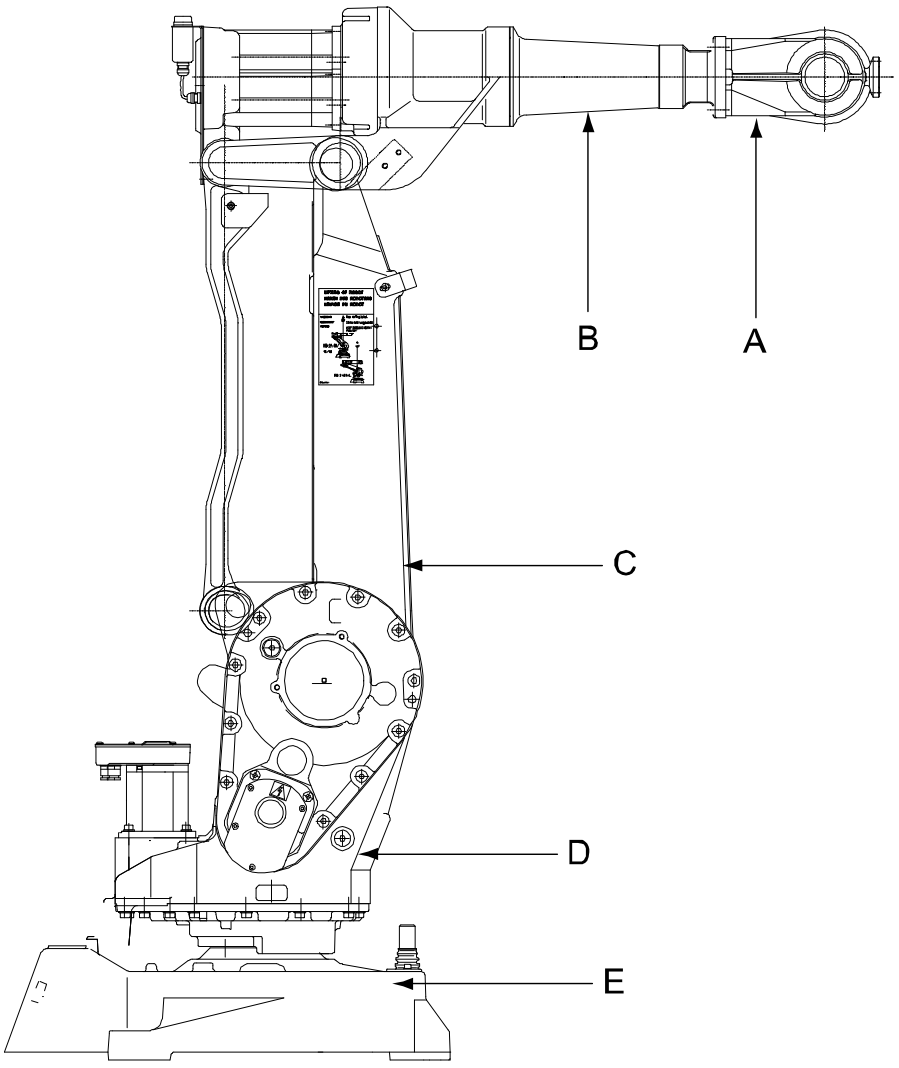
4.5 Lower arm

4.5.1 Replacement of complete lower arm

Location of lower arm

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0200000409

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

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Lower arm	3HAC4796-1		2400/10, /16
Lower arm	3HAC4797-1		2400L
Sealing ring (V-ring)	3HAB3732-13		Replace if damaged.
Bearing grease		3HAB3537-1	Used to lubricate the sealing ring.
Hoisting equipment		-	
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Removal, lower arm

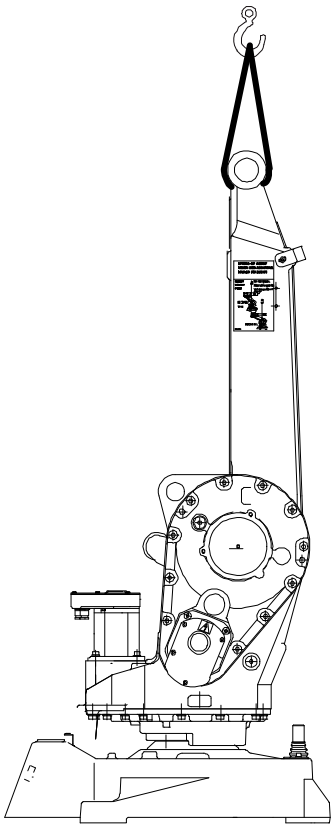
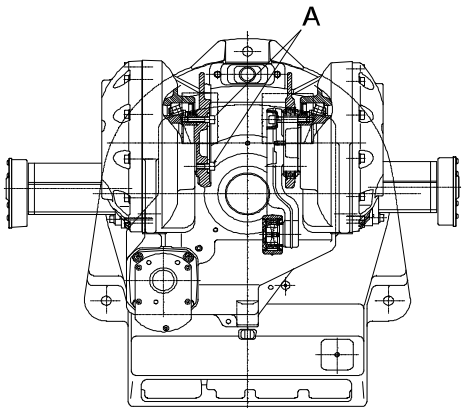
The procedure below details how to remove the complete lower arm.

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the upper arm.	Detailed in section *Removal, upper arm on page 150*.
3	**CAUTION** The robot lower arm weighs 27 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	

Continues on next page

4.5.1 Replacement of complete lower arm

Continued

	Action	Note/Illustration
4	Fit the lifting equipment to the lower arm to secure its weight.	 xx0200000439
5	Remove the tie rod.	Detailed in section *Removal, tie rod on page 158*.
6	Remove the parallel arm.	Detailed in section *Removal, parallel arm on page 168*.
7	Pull down the cabling from inside the lower arm and remove any cable attachments.	
8	Remove the *attachment screws* and the *spring tension plate*.	 xx0200000440 Attachment screws
9	Remove the lower arm.	

Continues on next page

Refitting, lower arm

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

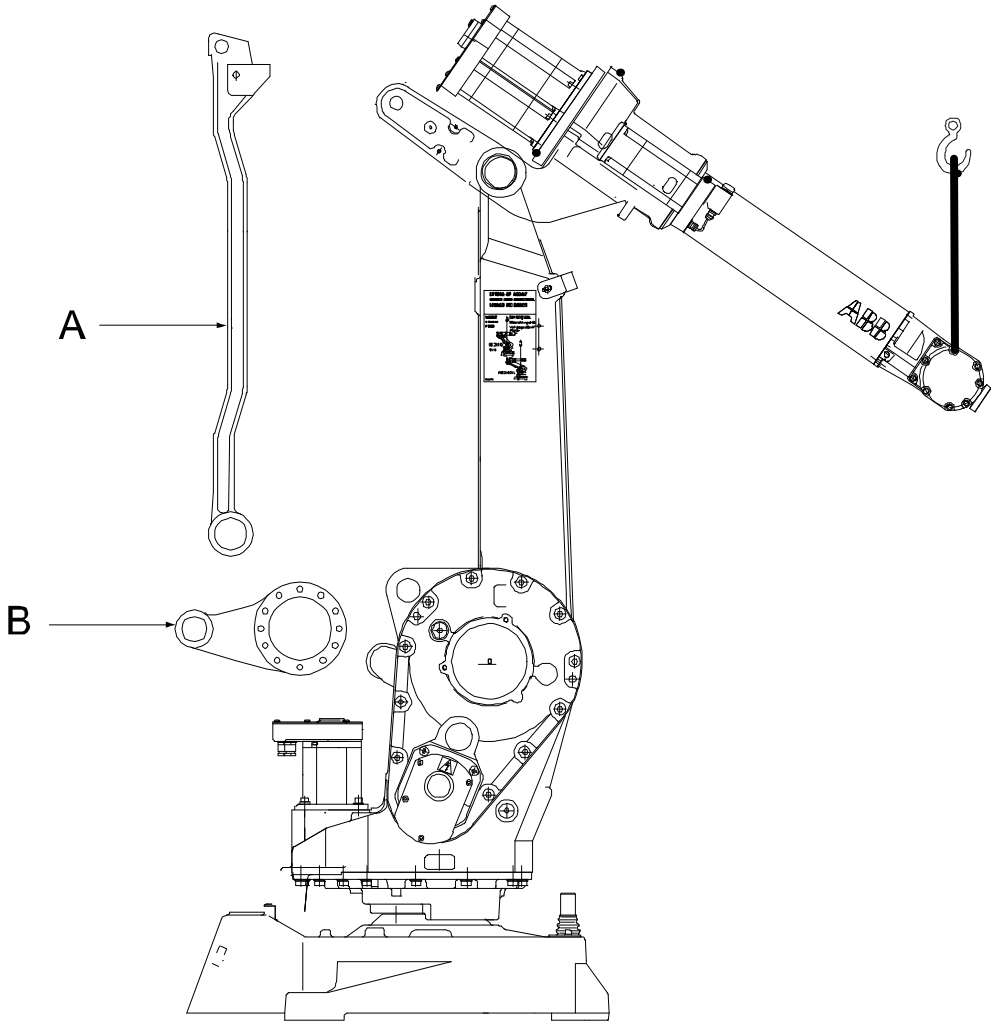
	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Move the damper and calibration marking to the new lower arm.	
3	Make sure that the *sealing ring* is fitted properly to the gearbox, undamaged and properly lubricated with *grease*. If damaged, replace with a new one.	Spare part no. is specified in *Required equipment on page 153*. Shown in the figure *Location of lower arm on page 152*.
4	**CAUTION** The robot lower arm weighs 27 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	
5	Lift the lower arm into position.	
6	Fit the *spring tension plate* to the lower arm and secure the arm to the gearbox with the 12 *attachment screws*.	12 pcs; M10 x 40. Tightening torque: 72 Nm.
7	Refit the parallel arm.	Detailed in section *Refitting, parallel arm on page 169*.
8	Refit the tie rod.	Detailed in section *Refitting, tie rod on page 158*.
9	Refit the upper arm.	Detailed in section *Refitting, upper arm on page 150*.
10	Refit the cabling.	Detailed in section *Refitting, cable harness, axes 4-6 on page 137*.
11	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.5.2 Replacement of tie rod

Location of tie rod

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

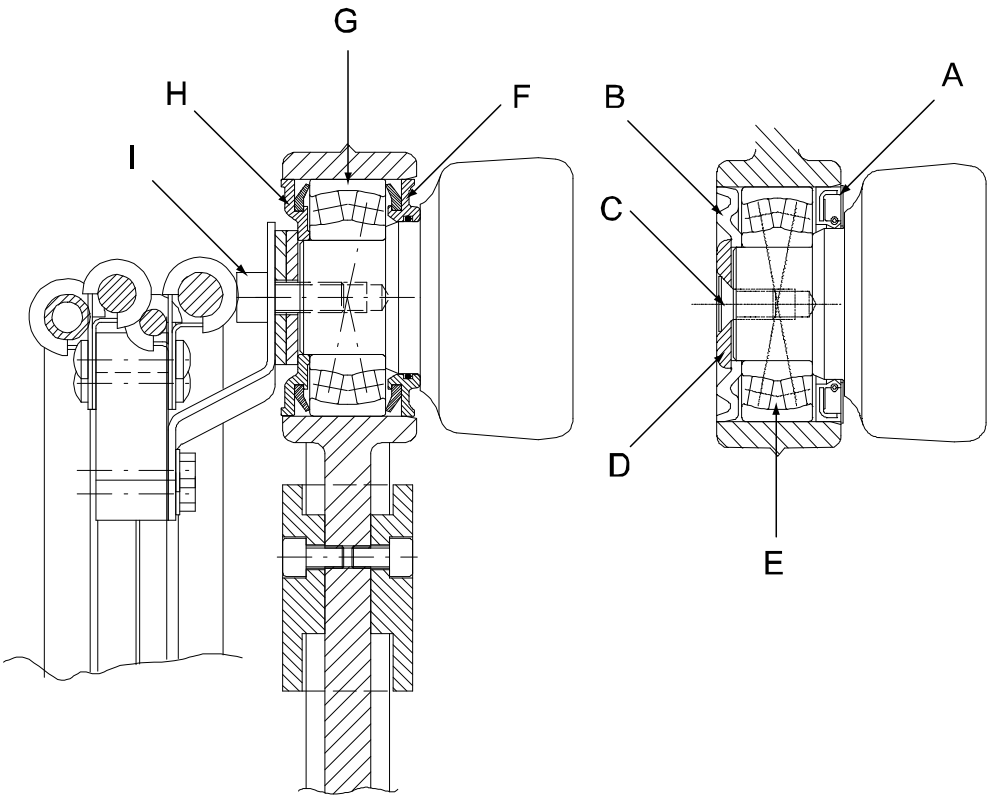
A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0200000444

A	Tie rod
B	Parallel arm

Continues on next page



xx0200000443

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

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Locking liquid		3HAB7116-1	Loctite 243
Grease		3HAB3537-1	
Press tool, parallel bar bearing		3HAB6324-1	
Mounting tool, parallel bar		3HAB6331-1	Used to fit the tie rod.
Standard toolkit		-	The content is defined in the section *Standard tools on page 229*.

Continues on next page

4.5.2 Replacement of tie rod
Continued

Equipment, etc.	Spare part no.	Art. no.	Note
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Removal, tie rod

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** The robot upper arm weighs 23 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	
3	Use a crane to secure the weight of the upper arm.	Shown in the figure *Location of tie rod on page 156*.
4	Remove the *attachment screw* from the upper and lower end.	Shown in the figure *Location of tie rod on page 156*.
5	Remove the *locking washer* from both ends.	Shown in the figure *Location of tie rod on page 156*.
6	Insert a screw in the center of each end, to be used as support.	M8
7	Use a puller to pull out the tie rod.	
8	Remove the bearings and seals.	Shown in the figure *Location of tie rod on page 156*.

Refitting, tie rod

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Make sure the weight of the upper arm is properly secured.	Use a crane!

Continues on next page

	Action	Note
3	Fit the new *spherical roller bearings* to the tie rod using the *press tool, parallel bar bearing*. Lubricate the bearings with bearing grease.	Shown in the figure *Location of tie rod on page 156*. Art. no. is specified in *Required equipment on page 157*.
4	Fit new *bearing sealings* to the shaft ends and lubricate the shaft ends with grease.	Shown in the figure *Location of tie rod on page 156*. Spare part no. is specified in *Required equipment on page 157*.
5	Refit the tie rod, using the *mounting tool, parallel bar*. **Note** Press by hand!	Art. no. is specified in *Required equipment on page 157*.
6	Fit new bearing sealings to the bearings.	
7	Refit the back up ring.	Shown in the figure *Location of tie rod on page 156*.
8	Refit the locking washer.	Shown in the figure *Location of tie rod on page 156*.
9	Refit the *attachment screw* at both ends of the bar, using *locking liquid*.	M8 x 16. Loctite 243 Shown in the figure *Location of tie rod on page 156*.
10	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
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 51*.	

4.6 Frame and base

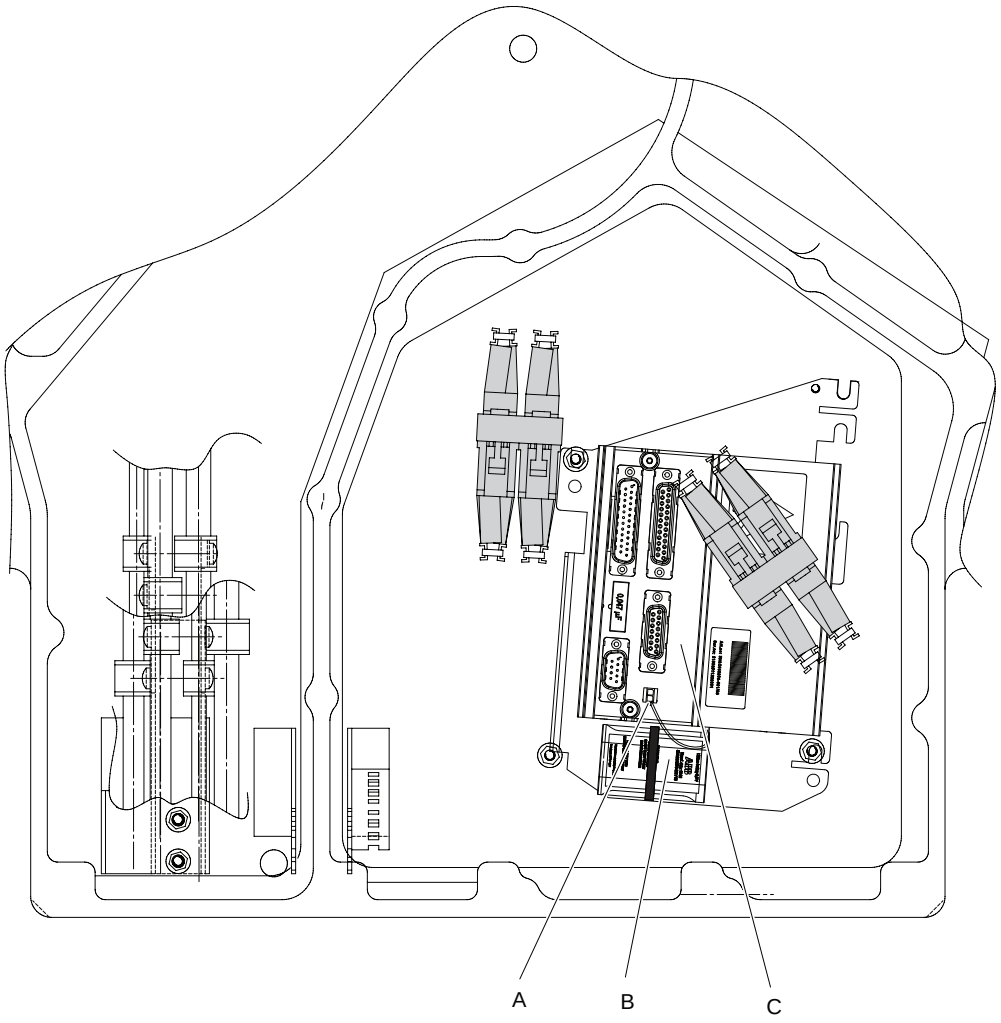
4.6.1 Replacement of SMB unit

Location of SMB unit

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.

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



xx1300000289

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

Continues on next page

Required equipment

Note

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

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

Equipment	Spare part no.	Art. no.	Note
Gasket, base cover		3HAB 5537-1	Must always be replaced!
Serial measurement unit	3HAC17396-1		Contains serial measurement board 3HAC031851-001 and battery pack 3HAC16831-1.
Serial measurement unit	3HAC046277-001		Contains serial measurement board 3HAC044168-001 and battery pack 3HAC44075-001.
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Circuit diagram		-	See the chapter *Circuit diagram on page 235*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

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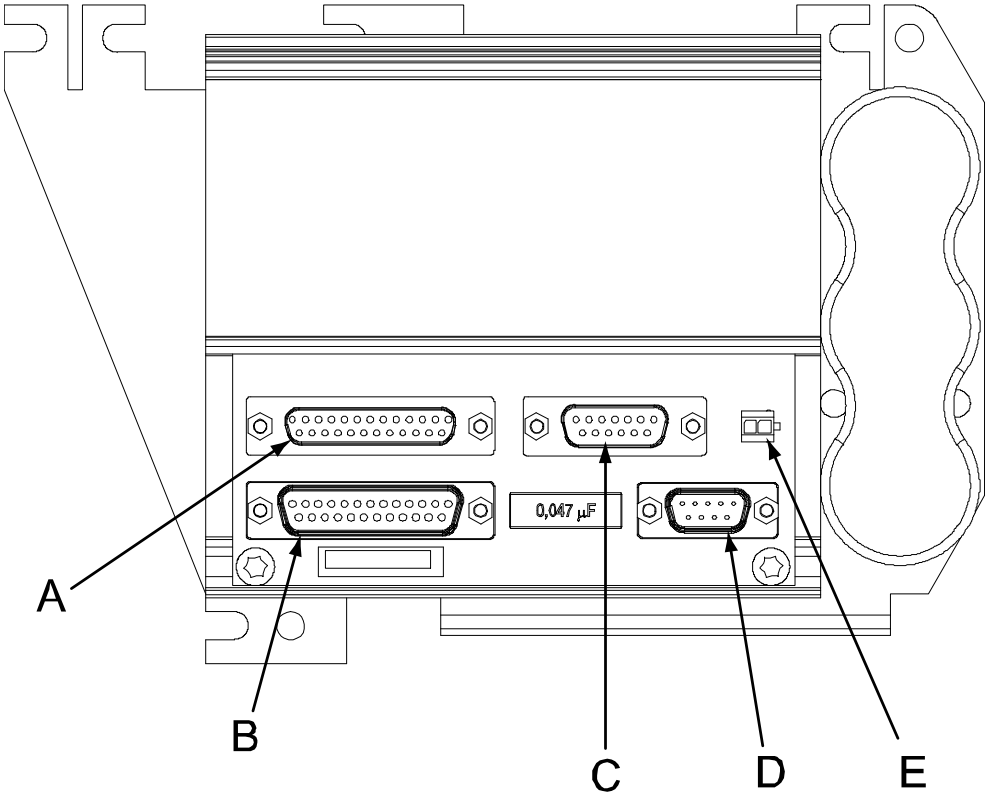
4.6.1 Replacement of SMB unit
Continued

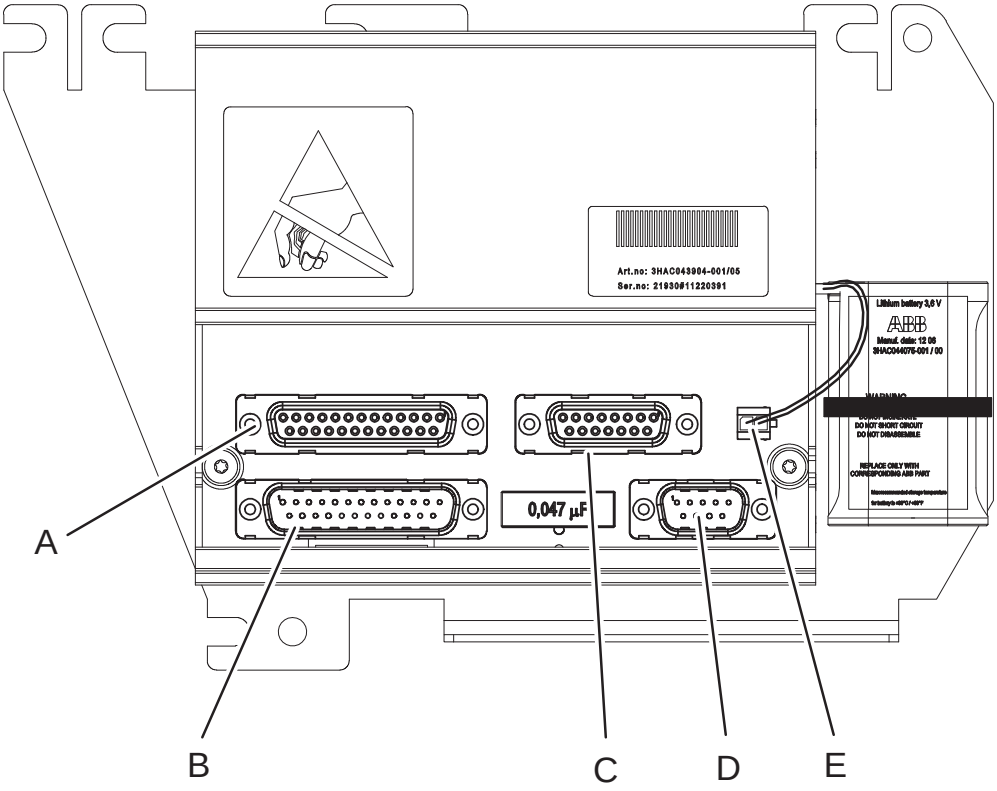
SMB unit, layout



xx0600002645

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

Continues on next page

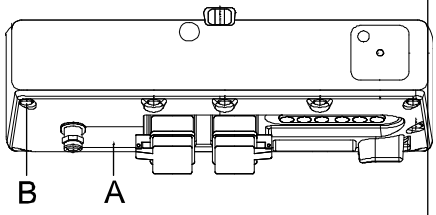


xx1300000310

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

Replacement, SMB unit

The procedure below details how to replace the SMB unit.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the rear cover plate (A) from the base by unscrewing the attachment screws (B).	 xx0200000399
3	Remove the SMB battery.	Detailed in section *Replacement, SMB battery on page 108*.

Continues on next page

4.6.1 Replacement of SMB unit

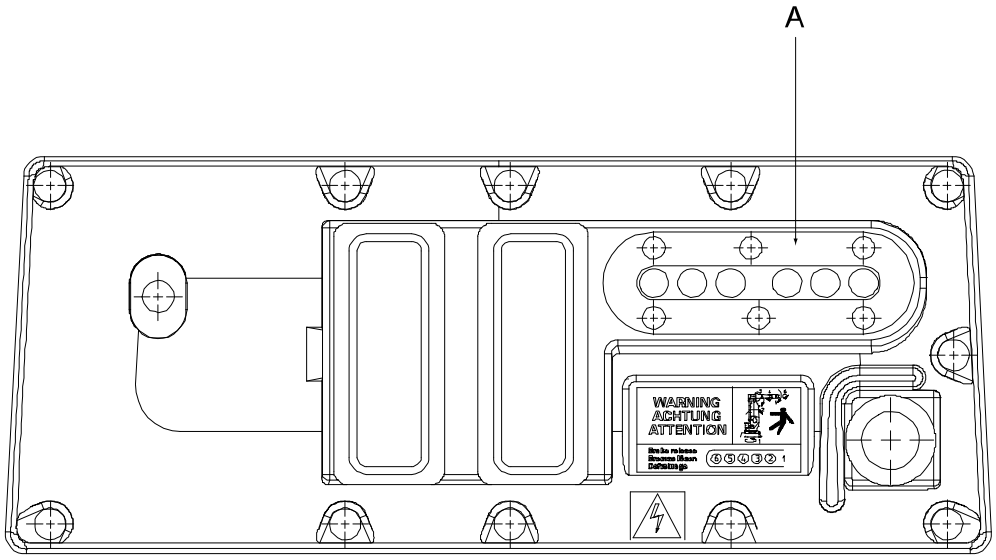
Continued

	Action	Note
4	Remove the SMB cover by unscrewing its attachment screws. Pull the battery cable through the hole in the SMB cover.	
5	Remove the two locknuts and washers from the *pins* securing the board.	
6	Gently disconnect the connectors from the SMB unit when pulling the board out. Also disconnect the battery cable from the SMB unit.	All connectors are shown in the figure *SMB unit, layout on page 162*.
7	Gently connect the connectors to the new SMB unit and push the board in.	All connectors are shown in the figure *SMB unit, layout on page 162*.
8	Refit the SMB cover using the attachment lock nuts. Pull the battery cable through the hole in the SMB cover.	
9	Reassemble the two locknuts and washers to the pins securing the board.	
10	Refit the SMB battery.	
11	Fit a new *gasket* to the cover and refit the cover with the attachment screws.	Always replace a removed gasket with a new! Art. no. is specified in *Required equipment on page 161*.
12	Update the revolution counters!	Detailed in the section *Updating revolution counters on page 212*.

4.6.2 Replacement of brake release unit

Location of brake release unit

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



xx0200000463

A	Brake release unit with buttons

Required equipment

Equipment, etc.	Spare part no.	Note
DSQC 563 Brake release board	3HAC16035-1	
Standard toolkit	-	The content is defined in the section *Standard tools on page 229*.
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.

Replacement, brake release board

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

	Action
1	**DANGER** If the robot normally works in an inverted position, it must be removed from this position and placed on the floor before the work detailed in this procedure may be carried out!

Continues on next page

4.6.2 Replacement of brake release unit

Continued

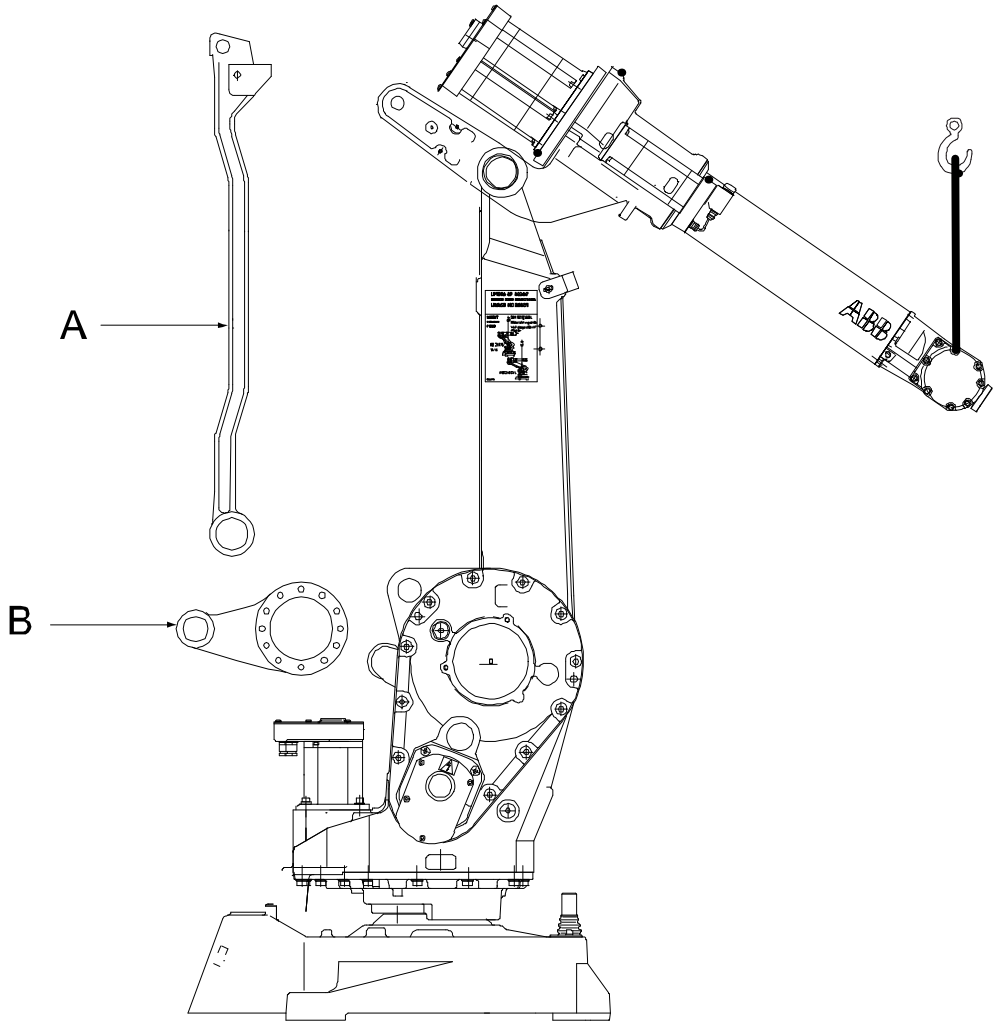
	Action
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!
3	Remove the cover at the rear of the base.
4	Unscrew the six attachment screws of the brake release board on the outside of the base. **Note** The guard plate will be dismantled when the screws for brake release board are unscrewed.
5	Disconnect the cable from the brake release board and remove it from the base.
6	Reconnect the cable to the new brake release board and fit it to the base.
7	Secure the board with its six attachment screws on the outside of the base. **Note** Make sure that the guard plate is mounted when the screws for brake release board are reassembled.
8	Refit the cover to the rear of the base.
9	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.

4.6.3 Replacement of parallel arm

Location of parallel arm

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0200000444

A	Tie rod
B	Parallel arm

Required equipment

Equipment	Spare part no.	Art. no.	Note
Groove ball bearing	3HAB3643-12		
Sealing ring	3HAB5515-1		
Bearing grease		3HAB3537-1	

Continues on next page

4.6.3 Replacement of parallel arm
Continued

Equipment	Spare part no.	Art. no.	Note
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Removal, parallel arm

The procedure below details how to remove the parallel arm.

	Action	Note
1	 **DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the tie rod.	Detailed in section *Removal, tie rod on page 158*.
3	Remove the parallel arm by removing its eight attachment screws and washers.	

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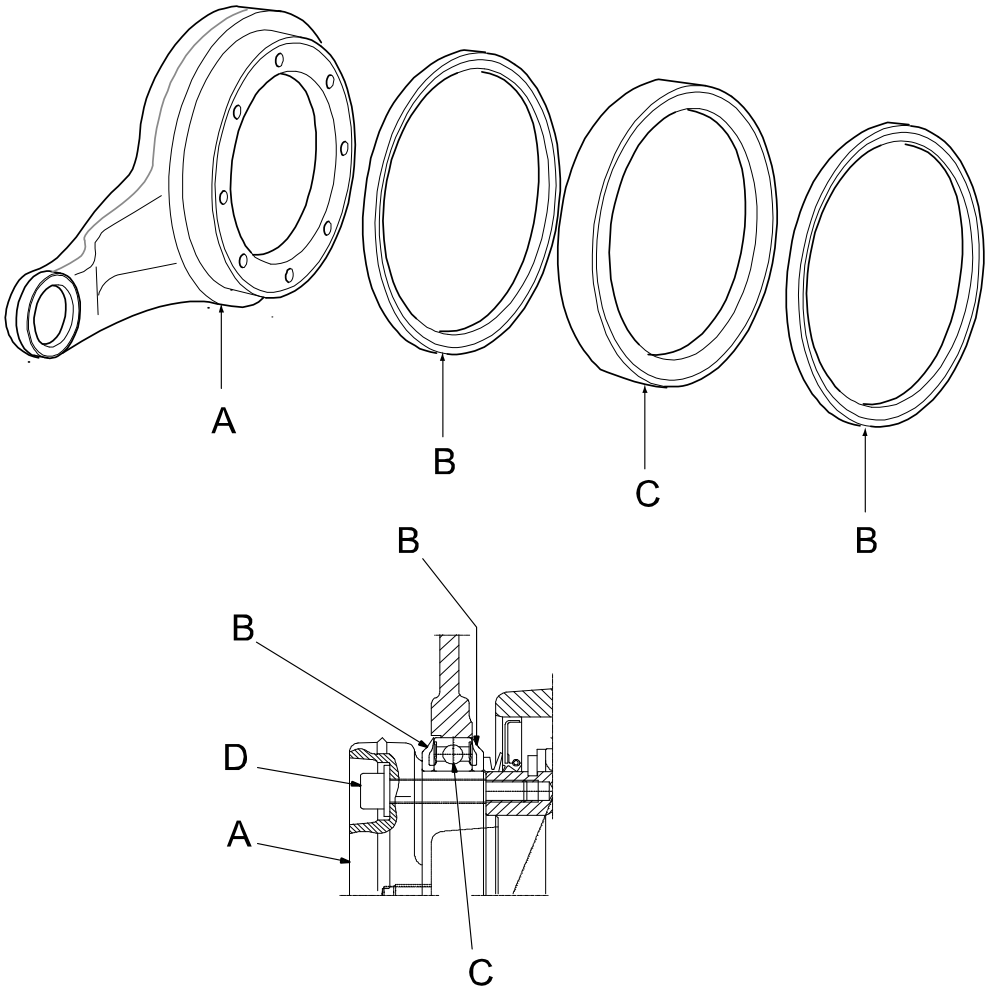
Assembly, parallel arm

The figure below shows the assembly of the parallel arm.



xx0200000450

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

Refitting, parallel arm

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Fit one of the two *V-rings* to the parallel arm.	Shown in the figure *Assembly, parallel arm on page 169*.

Continues on next page

4.6.3 Replacement of parallel arm

Continued

	Action	Note
3	Heat up the new bearing to 170º and fit it to the parallel arm.	
4	Fit the second V-ring to the parallel arm.	
5	Fit the complete parallel arm to the robot with the eight attachment screws and washers.	8 pcs; M10x60. Tightening torque: 72 Nm.
6	Refit the tie rod.	Detailed in section *Refitting, tie rod on page 158*.
7	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
8	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

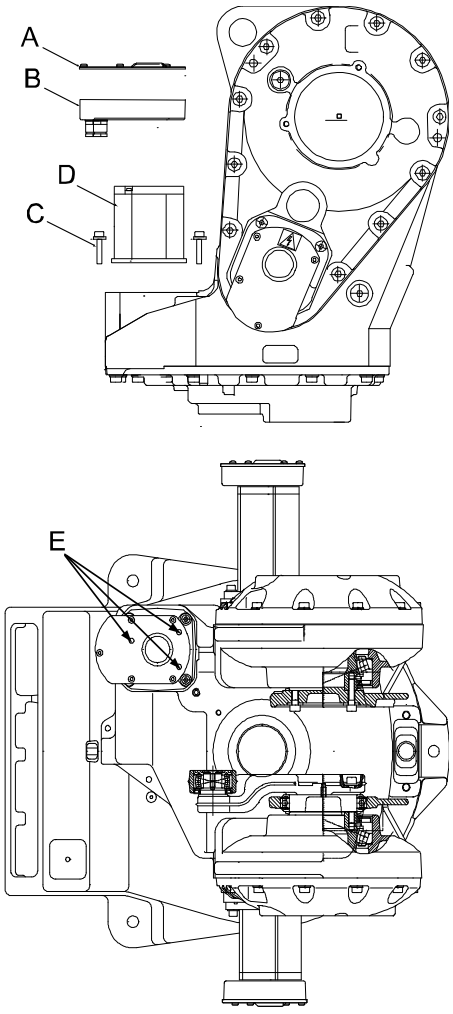
4.7 Motors

4.7.1 Replacement of motor, axis 1

Location of motor, axis 1

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0200000465

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

Continues on next page

4.7.1 Replacement of motor, axis 1
Continued

Required equipment

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

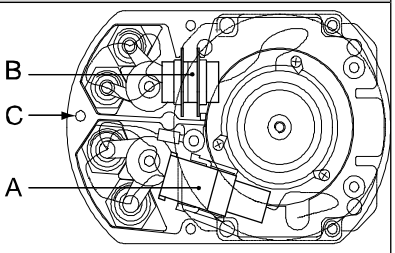
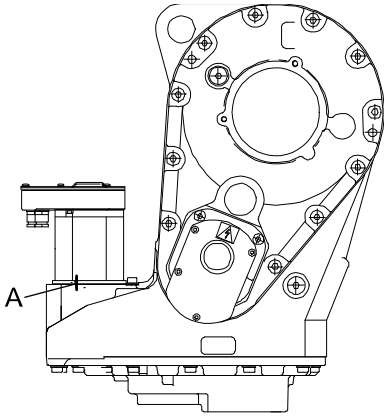
Equipment	Spare part no.	Art. no.	Note
Motor axis 1	3HAC4789-1		IRB 2400 /L, /10, /16 (Elmo)
	3HAC14271-1		IRB 2400 /Wall mounted (Elmo)
	3HAC021346-001		Color: ABB Orange IRB 2400 /L, /10, /16 (Yaskawa)
	3HAC021346-003		Color: Graphite White IRB 2400 /L, /10, /16 (Yaskawa)
	3HAC021961-001		IRB 2400 /Wall mounted (Yaskawa)
O-ring		3HAB 3772-1	Always fit a new one!
Gasket		3HAB 3676-1	
Measuring tool, motor		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section *Special tools on page 230*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See the chapter *Circuit diagram on page 235*.

Removal, motor axis 1

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the *cover* of the connection box.	Shown in the figure *Location of motor, axis 1 on page 171*

Continues on next page

	Action	Note/Illustration
3	Disconnect the connectors R3.MP1 and R3.FB1.	 xx0200000401 • A: R3.MP1 • B: R3.FB1 • C: Connection box
4	Remove the *connection box* by unscrewing its three attachment screws and plain washers.	Shown in the figure *Location of motor, axis 1 on page 171*.
5	Use a marker pen to mark the position of the motor (A), if the same motor is to be refitted.	 xx0600002646
6	Unscrew the four *attachment screws and washers* of the motor.	Shown in the figure *Location of motor, axis 1 on page 171*.
7	Gently lift the motor straight up, making sure not to damage the motor pinion.	

Refitting, motor axis 1

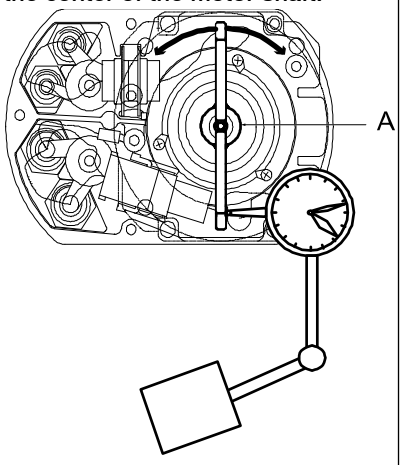
The procedure below details how to refit the motor, axis 1.

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor is unscratched.	
3	Fit the new *o-ring*.	Always fit a new one, see art. no. in *Required equipment on page 172*.

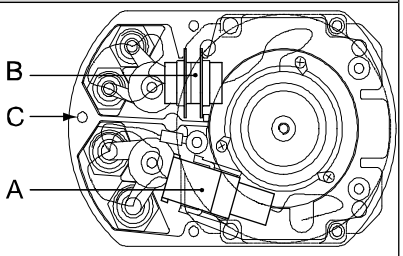
Continues on next page

4.7.1 Replacement of motor, axis 1

Continued

	Action	Note/Illustration
4	Fit the motor by gently lowering it straight down.	Note the position of the motor! Use the mark , made on the motor base before removal. See also orientation of the holes on top of the motor, shown in the figure *Location of motor, axis 1 on page 171*.
5	Tighten the four *attachment screws and washers*.	4 pcs. TIghtening torque: 2 Nm.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect power supply to connector R3.MP1: • + : pin 7 • -: pin 8
7	Fit the *measuring tool* to the rear of the motor.	Art. no. is specified in *Required equipment on page 172*. Shown in the figure below.
8	Rotate the motor shaft several turns, using the measuring tool. There must always be some backlash, meaning that the shaft should go easy to rotate!	
9	Place the tip of a dial indicator against the scribed mark on the measuring tool.	The tip of the dial indicator must measure on a 50 mm radius from the center of the motor shaft.  xx0200000473 Measuring tool
10	Set the gear play to 0.02 mm, which corresponds to a reading on the dial indicator of 0.13 mm.	
11	Pull gently in one direction. Note the reading. (The gear must not turn.)	
12	Then gently knock on the tool in the other direction and note the reading. The difference in reading = gear play. The gear play should be 0.02 mm which corresponds to a reading on the dial indicator of 0.13 mm.	
13	Tighten the motor attachment screws.	4 pcs. Tightening torque: 23 Nm.
14	Refit the *connection box* with the three attachment screws and plain washers. Make sure the gasket is fitted properly!	Shown in the figure *Location of motor, axis 1 on page 171*.

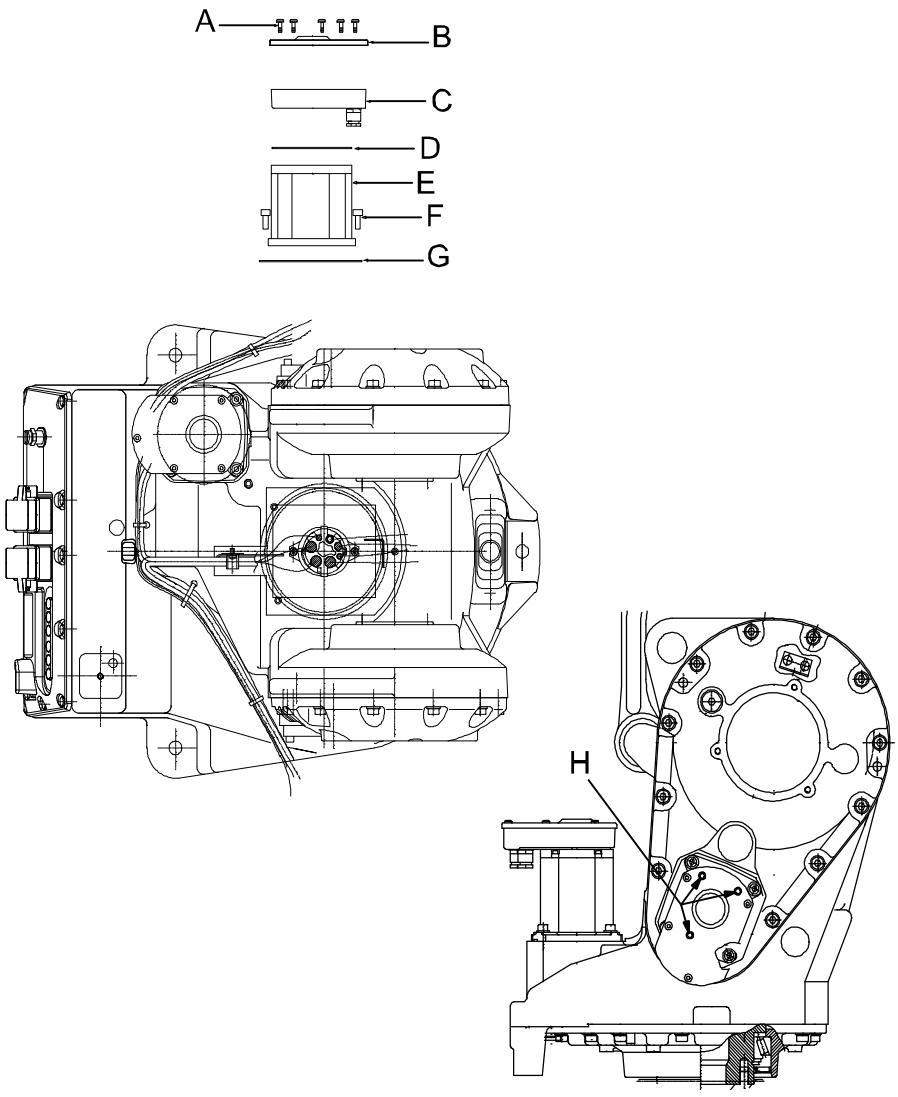
Continues on next page

	Action	Note/Illustration
15	Reconnect the connectors R3.MP1 and R3.FB1.	 xx0200000401 • A: R3.MP1 • B: R3.FB1 • C: Connection box
16	Refit the *cover* of the connection box.	Shown in the figure *Location of motor, axis 1 on page 171*.
17	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
18	**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 51*.	

4.7.2 Replacement of motor, axis 2

Location of motor, axis 2

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



xx0200000470

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

Continues on next page

Required equipment

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

Equipment, etc.	Spare part no.	Art. no.	Note
Motor, axis 2	3HAC4790-1		(Elmo)
Motor, axis 2	3HAC021350-001		Color: ABB Orange (Yaskawa)
	3HAC021350-003		Color: Graphite White (Yaskawa)
O-ring		3HAB3772-1	Always fit a new one!
Gasket		3HAB3676-1	
Measuring tool, motor		3HAB7887-1	
Power supply			24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See the chapter *Circuit diagram on page 235*.

Removal, motor axis 2

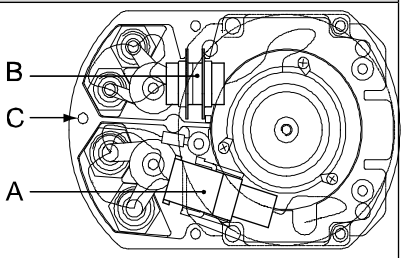
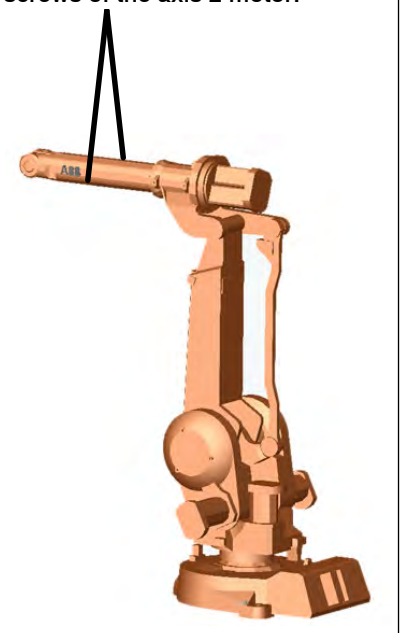
The procedure below details how to remove the motor, axis 2.

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the *cover* of the connection box.	Shown in the figure *Location of motor, axis 2 on page 176*.

Continues on next page

4.7.2 Replacement of motor, axis 2

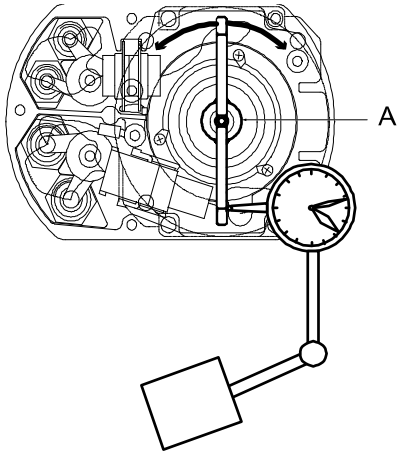
Continued

	Action	Note/Illustration
3	Disconnect the motor connectors R3.MP2 and R3.FB2.	 xx0200000401 • A: R3.MP2 • B: R3.FB2 • C: Connection box
4	Remove the connection box by unscrewing its three attachment screws and plain washers.	
5	Use a marker pen to mark out the position of the motor, if the same motor is to be refitted.	
6	**DANGER** Secure the weight of the lower arm properly before releasing the brakes of motor, axis 2! When releasing the holding brakes of the motor, the lower arm will be movable and may fall down!	Secure the robot arms before unscrewing any of the attachment screws of the axis 2 motor.  xx0700000660
7	**WARNING** Oil will be running out of the motor attachment hole when removing the motor! It may also be hot! Take any necessary measures to collect the oil.	
8	Unscrew the four *attachment screws and washers* of the motor.	Shown in the figure *Location of motor, axis 2 on page 176*.
9	Remove the motor by gently lifting it straight out.	

Continues on next page

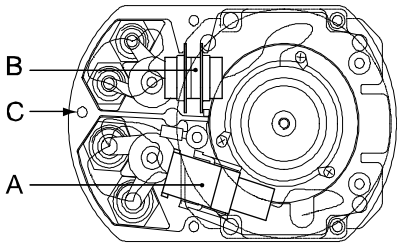
Refitting, motor axis 2

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor is unscratched.	
3	Fit the *o-ring*.	Always fit a new one, see art. no. in *Required equipment on page 177*.
4	Fit the motor by gently lifting it straight on.	Note the position of the motor! Use the mark on the motor base, made before removing the motor. Also see the orientation holes on the motor cover, shown in the figure *Location of motor, axis 2 on page 176*.
5	Fit the four attachment screws and tighten them slightly. Make the adjustments described below before tightening the screws properly.	4 pcs. Tightening torque: 2 Nm.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP2: • +: pin 7 • -: pin 8
7	Fit the *measuring tool* to the rear of the motor.	See the figure below. Art. no. is specified in *Required equipment on page 177*.
8	Rotate the motor shaft several turns, using the measuring tool. There must always be some backlash, meaning that the shaft should go easy to rotate!	
9	Place the tip of a dial indicator against the scribed mark on the measuring tool.	The tip of the dial indicator must measure on a 50 mm radius from the center of the motor shaft.  xx0200000473 A Measuring tool
10	Set the gear play to 0.02 mm, which corresponds to a reading on the dial indicator of 0.13 mm.	

Continues on next page

4.7.2 Replacement of motor, axis 2
Continued

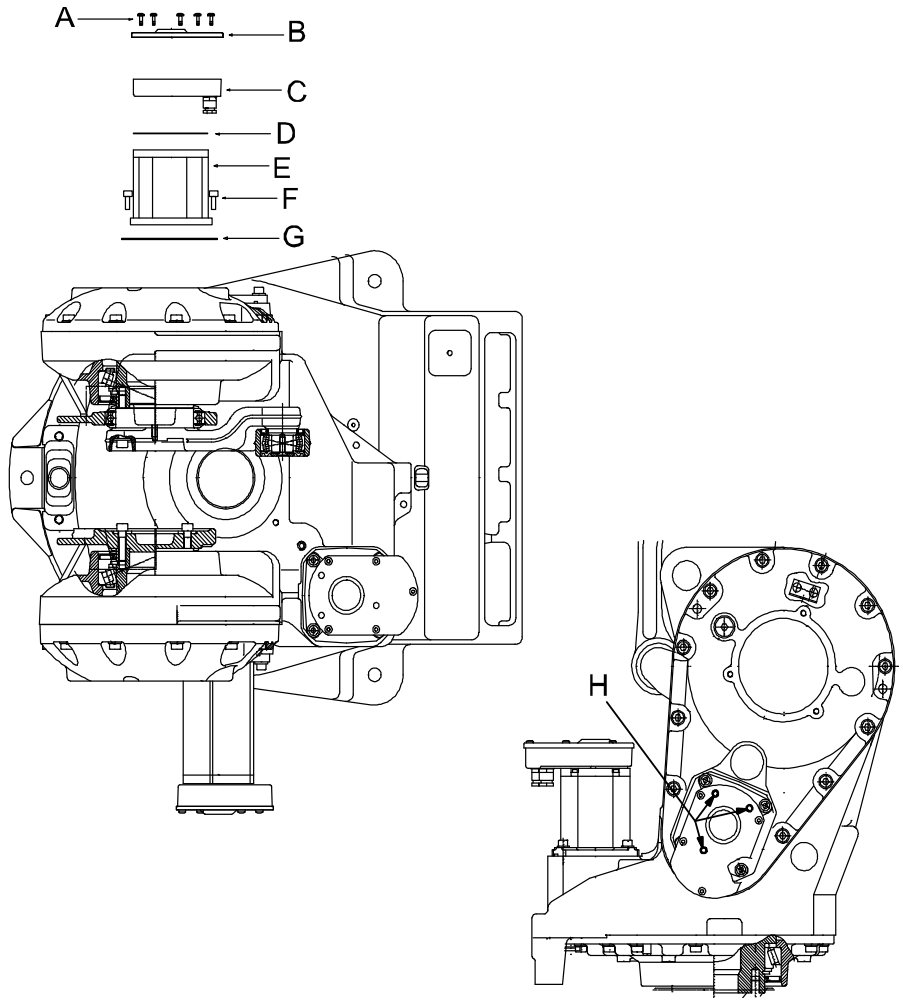
	Action	Note/Illustration
11	Pull gently in one direction. Note the reading. (The gear must not turn.)	See the figure above.
12	Then gently knock on the tool in the other direction and note the reading. The difference in reading = gear play. The gear play should be 0.02 mm which corresponds to a reading on the dial indicator of 0.13 mm.	See the figure above.
13	Tighten the four attachment screws.	4 pcs. Tightening torque: 23 Nm.
14	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 122*.
15	Fill the gearbox with oil.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 102*.
16	Refit the *connection box* and secure with the three attachment screws and plain washers. Make sure that the gasket is fitted properly!	Shown in the figure *Location of motor, axis 2 on page 176*.
17	Reconnect connectors R3.MP2 and R3.FB2.	 xx0200000401 • A: R3.MP2 • B: R3.FB2 • C: Connection box
18	Refit the *cover* of the connection box.	Shown in the figure *Location of motor, axis 2 on page 176*.
19	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
20	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.7.3 Replacement of motor, axis 3

Location of motor, axis 3

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0200000471

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

Continues on next page

4.7.3 Replacement of motor, axis 3
Continued

Required equipment

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

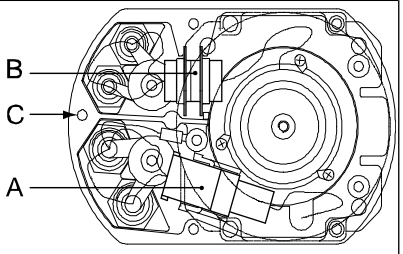
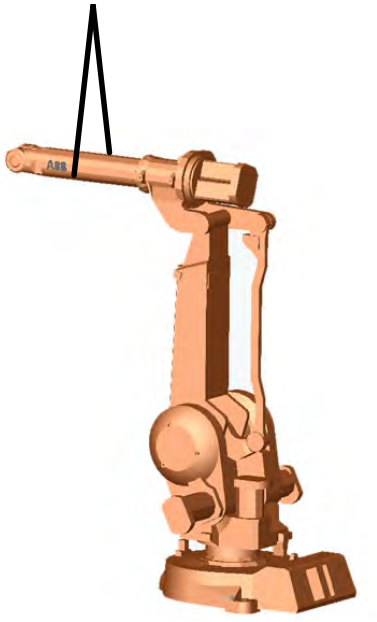
Equipment	Spare part no.	Art. no.	Note
Motor axis 3	3HAC4789-1		(Elmo)
	3HAC021346-001		Color: ABB Orange (Yaskawa)
	3HAC021346-003		Color: Graphite White (Yaskawa)
Gasket		3HAB3676-1	
O-ring		3HAB3772-1	Always fit a new one.
Measuring tool, motor		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit		-	The content is defined in the section *Standard tools on page 229*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram		-	See the chapter *Circuit diagram on page 235*.

Removal, motor axis 3

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the *cover* of the connection box.	Shown in the figure *Location of motor, axis 3 on page 181*.

Continues on next page

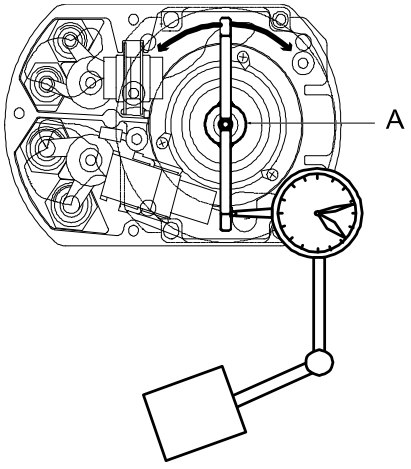
	Action	Note/Illustration
3	Disconnect the motor connectors R3.MP3 and R3.FB3.	 xx0200000401 • A: R3.MP3 • B: R3.FB3 • C: Connection box
4	Remove the *connection box* by unscrewing its three attachment screws and plain washers.	Shown in the figure *Location of motor, axis 3 on page 181*.
5	Use a marker pen to mark out the position of the motor, if the same motor is to be refitted.	
6	**DANGER** Secure the weight of the upper arm properly before releasing the brakes of motor, axis 3. When releasing the holding brakes of the motor, the upper arm will be movable and may fall down!	Secure the upper arm before loosening any of the screws on the motor!  xx0700000660
7	**WARNING** Oil will be running out of the motor attachment hole when removing the motor! It may also be hot! Take any necessary measures to collect the oil.	
8	Unscrew the four *attachment screws* and plain washers of the motor.	Shown in the figure *Location of motor, axis 3 on page 181*.
9	Remove the motor by gently lifting it straight out.	

Continues on next page

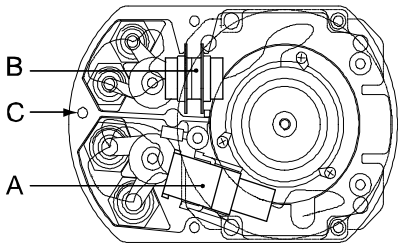
4.7.3 Replacement of motor, axis 3
Continued

Refitting, motor axis 3

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor is unscratched.	
3	Fit a new *o-ring* to the motor.	Always mount a new one, see art. no. in section *Required equipment on page 182*.
4	Fit the motor, by gently lifting it straight on.	Note the position of the motor! Use the mark on the motor base, made before removal. Also see the orientation holes on the motor cover, shown in the figure *Location of motor, axis 3 on page 181*.
5	Tighten the four screws lightly.	Tightening torque: 2 Nm.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP3: • +: pin 7 • -: pin 8
7	Fit the *measuring tool* to the rear of the motor.	See the figure below. Art. no. is specified in *Required equipment on page 182*.
8	Rotate the motor shaft several turns, using the measuring tool. There must always be some backlash, meaning that the shaft should go easy to rotate!	See the figure below.
9	Place the tip of a dial indicator against the scribed mark on the measuring tool.	The tip of the dial indicator must measure on a 50 mm radius from the center of the motor shaft.  xx0200000473 A Measuring tool
10	Set the gear play to 0.02 mm, which corresponds to a reading on the dial indicator of 0.13 mm.	

Continues on next page

	Action	Note/Illustration
11	Pull gently in one direction. Note the reading. (*The gear must not turn.*)	See the figure above.
12	Then gently knock on the tool in the other direction and note the reading. The difference in reading = gear play. The gear play should be 0.02 mm which corresponds to a reading on the dial indicator of 0.13 mm.	See the figure above.
13	Tighten the four motor attachment screws.	4 pcs. Tightening torque: 23 Nm.
14	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 122*.
15	Refill the gearbox with oil.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 102*.
16	Refit the *connection box* with the three attachment screws and plain washers. Make sure that the gasket is fitted properly!	Shown in the figure *Location of motor, axis 3 on page 181*.
17	Reconnect the motor connectors R3.MP3 and R3.FB3.	 xx0200000401 • A: R3.MP3 • B: R3.FB3 • C: Connection box
18	Refit the *cover* of the connection box.	Shown in the figure *Location of motor, axis 3 on page 181*.
19	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
20	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

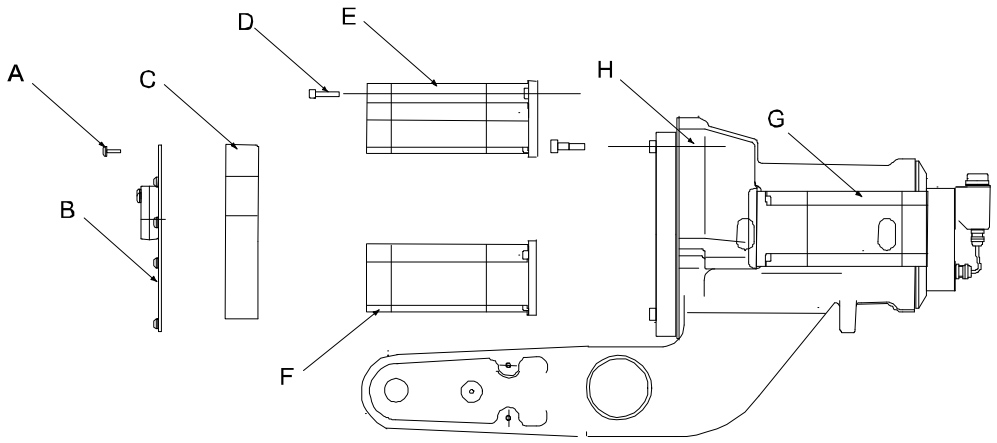
4.7.4 Replacement of motors, axes 4-6, IRB 2400L

Location of motors axes 4-6

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

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0200000476

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

Required equipment

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

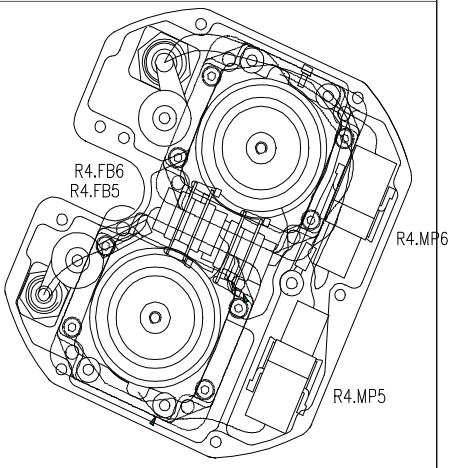
Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit axis 4	3HAC11864-1		(Elmo)
Motor unit axis 4	3HAC021740-001		(Yaskawa)
Motor unit axes 5-6	3HAC11865-1		(Elmo)
Motor unit axes 5-6	3HAC021741-001		(Yaskawa)
O-ring	21522011-414		
Locking liquid		3HAB7116-1	Loctite 243
Bearing grease		3HAB3537-1	

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Lubricating oil		11712016-604	30 ml For the gearbox of axis 4.
Measuring tool		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See the chapter *Circuit diagram on page 235*.

Removal, motor axes 5-6

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the cover of the connection box.	Shown in the figure *Location of motors axes 4-6 on page 186*.
3	Loosen connectors R3.MP5-6 and R3.FB5-6.	 xx0300000063
4	Remove the connection box by unscrewing its three attachment screws and plain washers.	
5	Use a marker pen to mark out the position of the motors, if same motors are to be refitted.	Shown in the figure *Location of motors axes 4-6 on page 186*.
6	Unscrew the attachment screws and plain washers of the motors.	

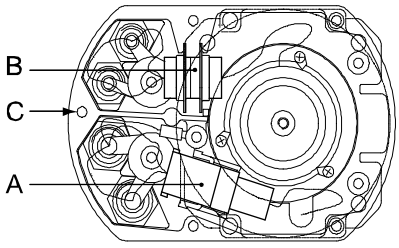
Continues on next page

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

	Action	Note/Illustration
7	Remove the motors by gently lifting them straight out (horizontal movement).	Shown in the figure *Location of motors axes 4-6 on page 186*.

Removal, motor axis 4

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

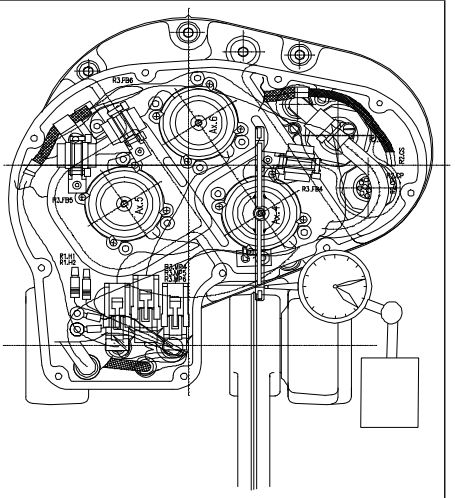
	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Drain the oil from the axis 4 gearbox.	
3	Remove the cover of the connection box.	 xx0200000401 • A: R3.MP4 • B: R3.FB4 • C: Connection box
4	Disconnect the connectors R3.MP4 and R3.FB4.	
5	Remove the connection box by unscrewing its three attachment screws and plain washers.	
6	Use a marker pen to mark out the position of the motor.	
7	Remove the motor by unscrewing its attachment screws and plain washers.	
8	Remove the motor by gently lifting it straight out (horizontal movement).	

Refitting, motor axis 4

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

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

Continues on next page

	Action	Note/Illustration
4	Lubricate the gear with *bearing grease*.	Art. no. is specified in *Required equipment on page 186*.
5	Fit the *measuring tool* at the rear of the motor.	 xx0300000005
6	The motor's fixing screws shall be fastened, but do not tighten them, to ensure that the motor will be able to move parallel to the gear when the adjustment is done	
7	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4: • + : pin 7 • -: pin 8
8	Start with a play in all positions and then locate the smallest play by turning the motor shaft six turns and thereby finding the area with the smallest play within this range. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
9	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". **Do not use force!**	
10	Tighten the motor attachment screws and secure them with locking fluid.	4.1 Nm Loctite 243
11	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 122*.
12	Refill the axis 4 gearbox with *lubricating oil*.	Art. no. and amount is specified in *Required equipment on page 186*.
13	Reconnect the cabling.	Detailed in section *Refitting, cable harness, axes 4-6 on page 137*.
14	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.

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

	Action	Note/Illustration
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 51*.	

Refitting, motor axis 5

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched.	
3	Fit a new *o-ring* on the motor.	Spare part no. is specified in *Required equipment on page 186*.
4	Fit the *measuring tool* at the rear of the motor.	Look at the figure in the procedure *Refitting, motor axis 4 on page 188*. Art. no. is specified in *Required equipment on page 186*.
5	The motor's fixing screws shall be fastened, but do not tighten them, to ensure that the motor will be able to move parallel to the gear when the adjustment is done.	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connector to connector R3.MP5: • + : pin 7 • -: pin 8
7	Locate the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, one full turn, and thereby finding the area where the play for motor 5 becomes smallest. Turn the motor for axis 5 one full turn at a time for a total of five turns. Find where the smallest play is within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". **Do not use force!**	
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Described in *Refitting, cable harness, axes 4-6 on page 137*.

Continues on next page

	Action	Note
11	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

Refitting, motor axis 6

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched	
3	Fit an new *o-ring* on the motor.	Spare part no. is specified in *Required equipment on page 186*.
4	Fit the *measuring tool* at the rear of the motor.	Look at the figure in the procedure *Refitting, motor axis 4 on page 188*. Art. no. is specified in *Required equipment on page 186*.
5	The motor's fixing screws shall be fastened, but do not tighten them, to esure that the motor will be able to move parallel to the gear when the adjustment is done	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP6: • + : pin 7 • -: pin 8
7	Find the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, totally one whole turn, and thereby finding the area where the play for motor 6 becomes smallest. Turn the motor for axis 5 one full turn at the time, totally five turns. Find the smallest play for axis 6 within this area. Turn the motor for axis 6 one full turn at a time for a time for a total of three turns. Find the smallest play for axis 6 within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together	

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

Continued

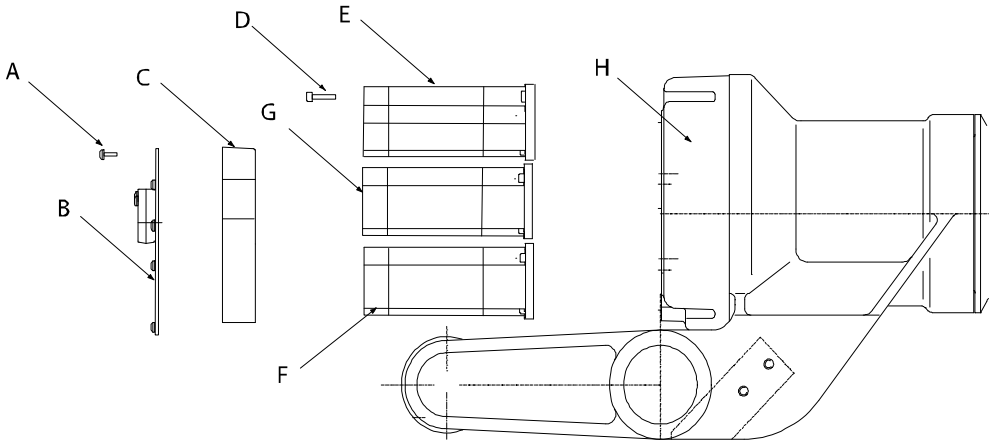
	Action	Note
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear “chewing”. **Do not use force!**	
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Described in *Refitting, cable harness, axes 4-6 on page 137*.
11	Recalibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

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

Location of motors axis 4-6

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.



xx0300000108

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

Required equipment

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

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

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

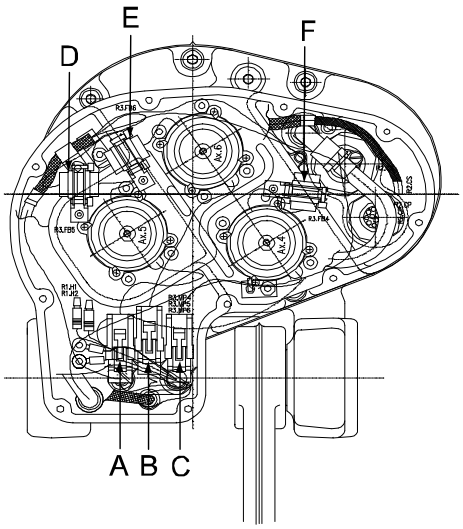
Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit axis 6	3HAC10602-2		(Elmo)
	3HAC021731-001		Color: ABB Orange (Yaskawa)
	3HAC021731-003		Color: Graphite White (Yaskawa)
O-ring	3HAB3772-12		One piece for each motor.
Locking liquid		3HAB 7116-1	Loctite 243
Bearing grease		3HAB 3537-1	
Lubricating oil		3HAC 0860-1	1,500 ml Optimol BM 100 For the gearbox of axis 4.
Measuring tool		3HAB7887-1	
Power supply		-	24 VDC, max. 1.5 A. For releasing the brakes.
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

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

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Drain the oil from the axis 4 gearbox.	
3	Remove the cover of the connection box.	Shown in the figure *Location of motors axis 4-6 on page 193*.

Continues on next page

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

Refitting, motor axis 4

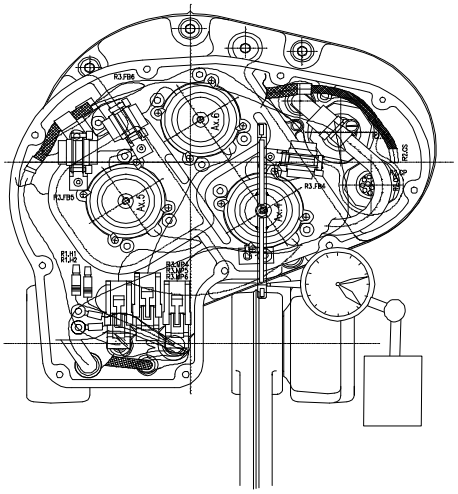
The procedure below details how to refit the motor, axis 4.

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched.	
3	Fit a new *o-ring* on the motor.	Spare part no. is specified in *Required equipment on page 193*.
4	Lubricate the gear with bearing grease.	Art. no. is specified in *Required equipment on page 193*.

Continues on next page

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

Continued

	Action	Note/Illustration
5	Fit the *measuring tool* at the rear of the motor.	 xx0300000005 Art. no. is specified in *Required equipment on page 193*.
6	The motor's fixing screws shall be fastened, but do not tighten them, to be sure that the motor will be able to move parallel to the gear when the adjustment is done	
7	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4: • + : pin 7 • -: pin 8
8	Start with a play in all positions and then find the smallest play by turning the motor shaft six turns and thereby finding the area with the smallest play within this range. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
9	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". **Do not use force!**	
10	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
11	Refill the gearbox with oil.	Art. no. and amount is specified in *Required equipment on page 193*.
12	Reconnect the cabling.	Described in *Refitting, cable harness, axes 4-6 on page 137*.
13	Recalibrate the robot. (When all service work is done, i.e. the other motors are also refitted.)	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.

Continues on next page

	Action	Note/Illustration
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 51*.	

Refitting, motor axis 5

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unscratched.	
3	Fit a new *o-ring* on the motor.	Spare part no. is specified in *Required equipment on page 193*.
4	Fit the *measuring tool* at the rear of the motor.	See how to fit the tool in the figure in the procedure *Refitting, motor axis 4 on page 195*. Art. no. is specified in *Required equipment on page 193*.
5	The motor's fixing screws shall be fastened, but do not tighten them, to be sure that the motor will be able to move parallel to the gear when the adjustment is done	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP5: • + : pin 7 • -: pin 8
7	Find the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, one full turn, and thereby finding the area where the play for motor 5 becomes smallest. Turn the motor for axis 5 one full turn at a time for a total of five turns. Find where the smallest play is within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together.	
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing". **Do not use force!**	
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Detailed in section *Refitting, cable harness, axes 4-6 on page 137*.

Continues on next page

	Action	Note
11	Recalibrate the robot. (When all service work is done, i.e. the other motors are also refitted.)	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

Refitting, motor axis 6

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Check that the assembly surfaces are clean and the motor unstructured.	
3	Fit a new *o-ring* on the motor.	Spare part no. is specified in *Required equipment on page 193*.
4	Fit the *measuring tool* at the rear of the motor.	See how to fit the tool in the figure in the procedure *Refitting, motor axis 4 on page 195*. Art. no. is specified in *Required equipment on page 193*.
5	The motor's fixing screws shall be fastened, but do not tighten them, to be sure that the motor will be able to move parallel to the gear when the adjustment is done	
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP6: • + : pin 7 • -: pin 8
7	Find the smallest play by turning the outgoing shaft for axis 4 in intervals of 90°, one full turn, and thereby finding the area where the play for motor 6 becomes smallest. Turn the motor for axis 5 one full turn at the time, totally five turns. Find the smallest play for axis 6 within this area. Turn the motor for axis 6 one full turn at a for a total of three turns. Find the smallest play for axis 6 within this area. Use swift movements to avoid noticing the magnetic field, which makes the gears stick together	

Continues on next page

	Action	Note
8	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear “chewing”. **Do not use force!**	
9	Tighten the motor attachment screws and secure them with locking fluid.	Tightening torque: 4.1 Nm. Loctite 243
10	Reconnect the cabling.	Detailed in section *Refitting, cable harness, axes 4-6 on page 137*.
11	Recalibrate the robot. (When all service work is done, i.e. the other motors are also refitted.)	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.8 Gearboxes

4.8.1 Replacement of gearbox, axis 1-3

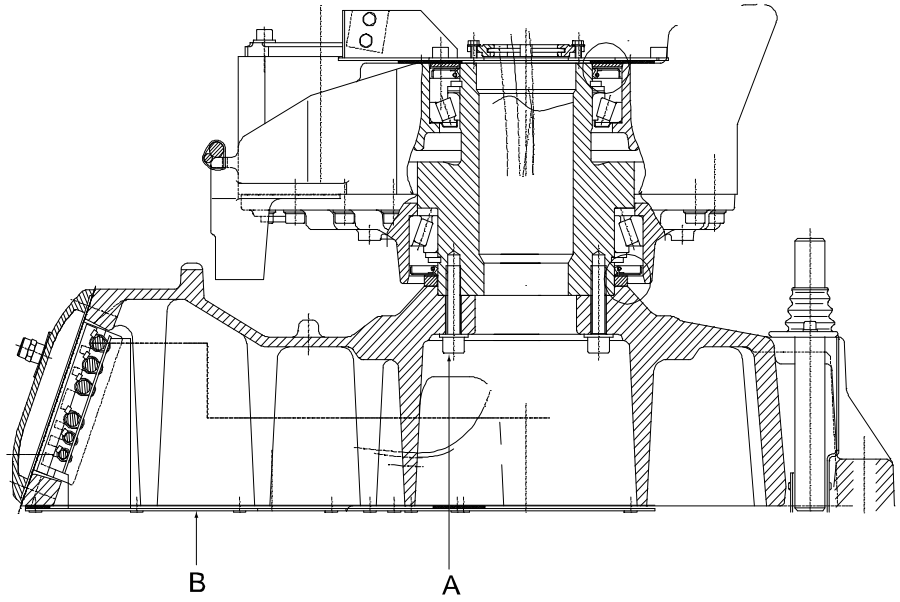
Location of gearbox, axis 1-3

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

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

A more detailed view of the component and its position may be found in chapter *Spare part lists on page 233*.

Note! The gearbox is not normally serviced or adjusted.



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A	Attachment screws, gearbox unit
B	Bottom plate

Required equipment

Equipment	Spare part no.	Art. no.	Note
Gearbox, axes 1-3	3HAC025711-001		
Standard toolkit	-		The content is defined in the section *Standard tools on page 229*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

Continues on next page

Removal, gearbox axis 1-3

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the cable unit, axes 1-3.	Detailed in section *Removal, cable unit, axes 1-3 on page 130*.
3	Remove the complete lower arm.	Detailed in section *Removal, lower arm on page 153*.
4	Remove the motor, axis 1.	Detailed in section *Removal, motor axis 1 on page 172*.
5	Remove the motor, axis 2.	Detailed in section *Removal, motor axis 2 on page 177*.
6	Remove the motor, axis 3.	Detailed in section *Removal, motor axis 3 on page 182*.
7	**CAUTION** The complete gearbox unit weighs 200 kg without the base. All lifting accessories used must be sized accordingly!	
8	Place the remaining parts of the robot upside-down on a table or similar surface and remove the bottom plate.	
9	Undo the 12 attachment screws.	
10	Lift away the base from the gearbox unit.	

Refitting, gearbox axis 1-3

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

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	**CAUTION** The complete gearbox unit weighs 200 kg without the base. All lifting accessories used must be sized accordingly!	
3	Place the gearbox unit upside-down on a table or similar surface.	

Continues on next page

4.8.1 Replacement of gearbox, axis 1-3

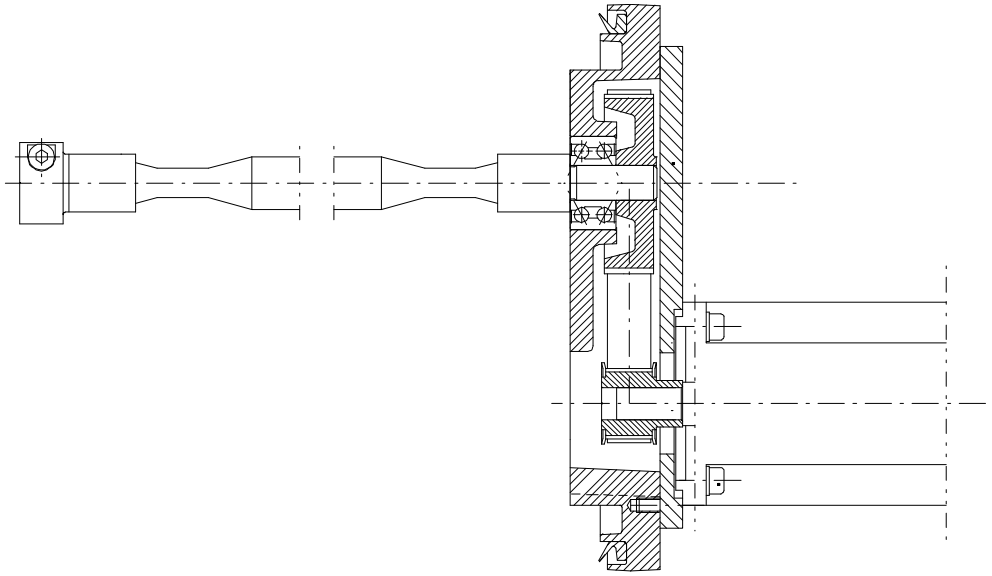
Continued

	Action	Note
4	Fit the base to the gearbox unit and secure with the 12 screws and washers.	12 pcs; M12x50. Tightening torque: 54 Nm.
5	Refit the bottom plate to the base.	
6	Turn the base and gearbox unit around and secure to the installation site.	This is detailed in section *Orienting and securing the robot on page 71*.
7	Refit the motor, axis 1.	Detailed in section *Refitting, motor axis 1 on page 173*.
8	Refit the motor, axis 2.	Detailed in section *Refitting, motor axis 2 on page 179*.
9	Refit the motor, axis 3.	Detailed in section *Refitting, motor axis 3 on page 184*.
10	Refit the complete lower arm.	Detailed in section *Refitting, lower arm on page 155*.
11	Refit the cable unit, axes 1-3.	Detailed in section *Refitting, gearbox axis 1-3 on page 201*.
12	Calibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.8.2 Replacement of drive shaft unit, IRB 2400L

Location, drive shaft unit

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



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Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Drive shaft unit, axes 5-6	3HAC11804-1		
Gear belt	3HAA2393-1		2 pcs
Adjustment tool		3HAA7601-50	
Lifting device, robot		-	
Standard toolkit			The content is defined in the section *Standard tools on page 229*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.

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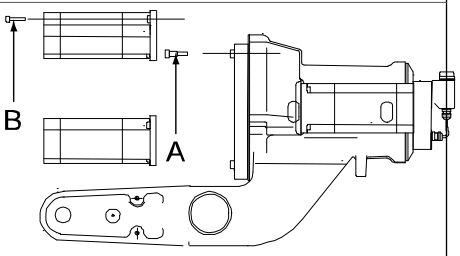
4.8.2 Replacement of drive shaft unit, IRB 2400L
Continued

Removal, drive shaft unit

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

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

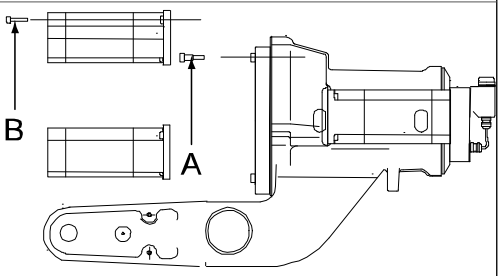
	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Remove the wrist.	Detailed in section *Removal, wrist unit on page 146*.
3	Loosen the connection box and disconnect the connectors on the motors of axes 5 and 6. Mark the motor number on the motors, to simplify the reconnecting.	Detailed in section *Replacement of motors, axes 4-6, IRB 2400L on page 186*.
4	Undo the screws.	 xx0300000021 • A: Screws • B: Motor screws
5	Squeeze the drive shafts together at the tip of the tubular shaft, so they can pass through the tube.	
6	Pull out the complete drive mechanism of axes 5 and 6.	
7	Undo the screws and nuts, holding the motors and remove both motors.	Detailed in section *Replacement of motors, axes 4-6, IRB 2400L on page 186*.
8	Undo the screws and remove the motor plate.	
9	Remove the gear belts.	

Continues on next page

Refitting, drive shaft unit

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

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

	Action	Note/Illustration
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Install the belts.	
3	Fit the plate using screws and washers.	**Note!** Do not forget the nuts on the motors!
4	Fit the motors.	
5	Push the motors sideways to tighten the belts, using the tool. Place the round post of the *adjustment tool* into the motor pulley and let the cam press to the outer diameter of the large pulley.	Art. no. is specified in *Required equipment on page 203*. Tighten screws B (shown in the illustration below) to 4.1 Nm.
6	Rotate the drive shafts. Check the tension on the belt.	
7	Install the drive mechanism in the tubular shaft.	Do not forget the rubber damper.
8	Tighten screws.	 xx0300000021 • A: 8.3 Nm
9	Install the cabling and fit the cover to the motors axes 5 and 6.	Detailed in *Replacement of motors, axes 4-6, IRB 2400L on page 186*.
10	Refit the wrist.	Detailed in section *Refitting, wrist unit on page 147*.
11	Calibrate the robot.	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in the section *Calibration information on page 207*.

Continues on next page

4.8.2 Replacement of drive shaft unit, IRB 2400L
Continued

	Action	Note/Illustration
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

5 Calibration information

5.1 When to calibrate

When to calibrate

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

The resolver values are changed

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

If the robot has *absolute accuracy* calibration, it is also recommended, but not always necessary to calibrate for new absolute accuracy.

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

The revolution counter memory is lost

If the revolution counter memory is lost, the counters must be updated. See *Updating revolution counters on page 212*. This will occur when:

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

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

The robot is rebuilt

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

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

5.2 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.	Calibration Pendulum Levelmeter calibration (alternative method)
Absolute accuracy calibration (optional)	Based on standard calibration, and besides positioning the robot at synchronization position, the Absolute accuracy calibration also compensates for: • Mechanical tolerances in the robot structure • Deflection due to load Absolute accuracy calibration focuses on positioning accuracy in the Cartesian coordinate system for the robot. Absolute accuracy calibration data is found on the SMB (serial measurement board) in the robot. For robots with RobotWare 5.05 or older, the absolute accuracy calibration data is delivered in a file, absacc.cfg, supplied with the robot at delivery. The file replaces the calib.cfg file and identifies motor positions as well as absolute accuracy compensation parameters. A robot calibrated with absolute accuracy has a sticker next to the identification plate of the robot. To regain 100% absolute accuracy performance, the robot must be recalibrated for absolute accuracy!  xx0400001197	CalibWare

Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of all ABB robots (except IRB 6400R, IRB 640, IRB 1400H, and IRB 4400S).

Continues on next page

Two different routines are available for the Calibration Pendulum method:

- Calibration Pendulum II
- Reference calibration

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

Levelmeter calibration - alternative method

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

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

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

CalibWare - Absolute Accuracy calibration

To achieve a good positioning in the Cartesian coordinate system, Absolute Accuracy calibration is used as a TCP calibration. The CalibWare tool guides through the calibration process and calculates new compensation parameters. This is further detailed in the *Application manual - CalibWare Field 5.0*.

If a service operation is done to a robot with the option Absolute Accuracy, a new absolute accuracy calibration is required in order to establish full performance. For most cases after motor and transmission replacements that do not include taking apart the robot structure, standard calibration is sufficient. Standard calibration also supports wrist exchange.

References

Article numbers for the calibration tools are listed in the section *Special tools on page 230*.

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

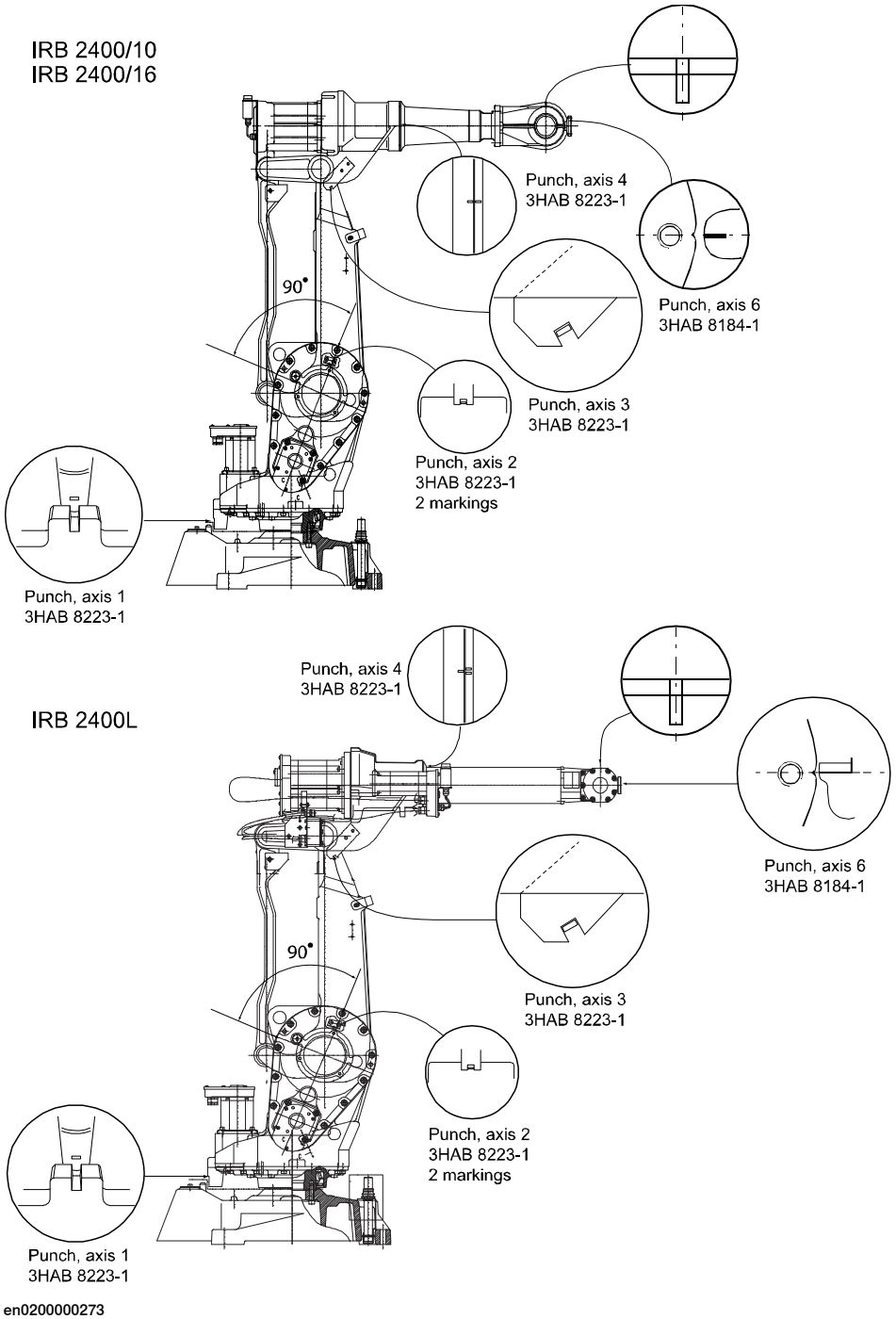
5.3 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 2400

The illustration below shows the calibration marks on all axes of the robot.



5.4 Calibration movement directions for all axes

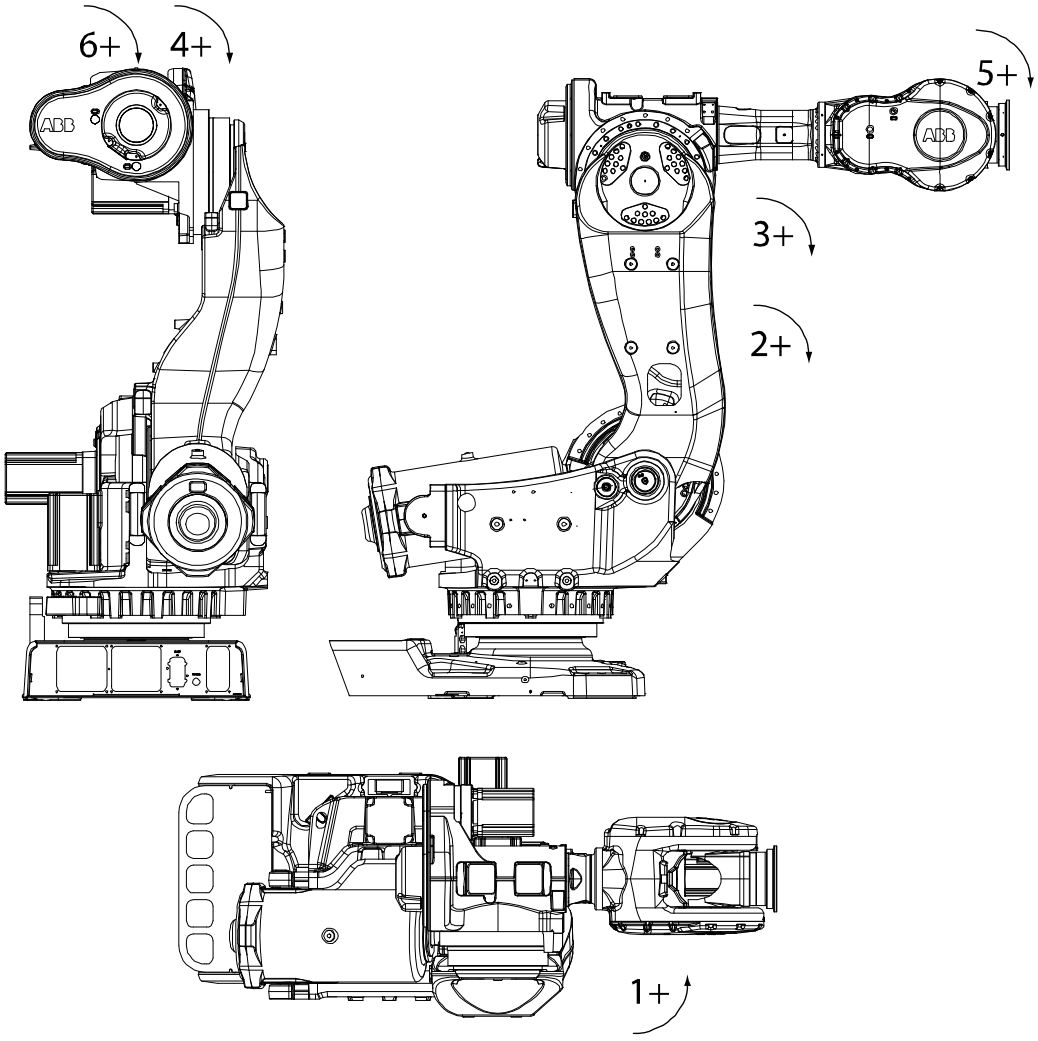
Overview

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

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

Manual movement directions, 6 axes

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



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5.5 Updating revolution counters

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. IRB 140, 1400, 2400, 4400, 6600ID/6650ID, 6640ID: Axes 5 and 6 must be positioned together!	See *Synchronization marks and synchronization position for axes on page 210*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the TPU on page 213* (BaseWare 4.0). *Step 2 - Updating the revolution counter with the FlexPendant on page 214*.

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:

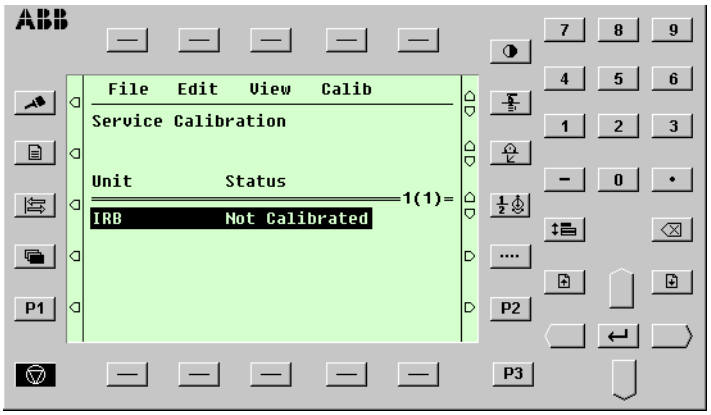
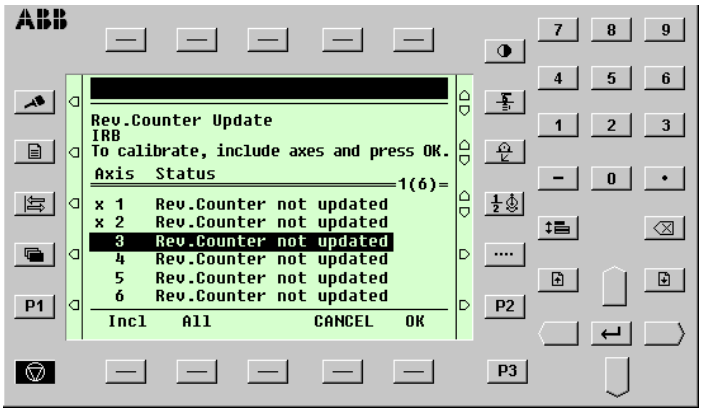
Manipulator variant	Axis 4	Axis 6
IRB 2400	No	No

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

Continues on next page

Step 2 - Updating the revolution counter with the TPU

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

	Action	Note
1	Press the button **Miscellaneous** then **ENTER** to select the service window.  xx0100000194	
2	Select **Calibration** from the **View** menu. The **Calibration window** appears. If there is more than one unit connected to the manipulator, they will be listed in the window.  xx0100000201	
3	Select the desired unit and choose **Rev Counter Update** from the **Calib** menu. The **Revolution Counter Update** window appears.  xx0100000202	
4	Select the desired axis and press **Incl** to include it (it will be marked with an x) or press **All** to select all axes.	
5	Press **OK** when all axes that are to be updated are marked with an x. **CANCEL** returns to the **Calibration** window.	
6	Press **OK** again to confirm and start the update. **CANCEL** returns to the **Revolution Counter Update** window.	

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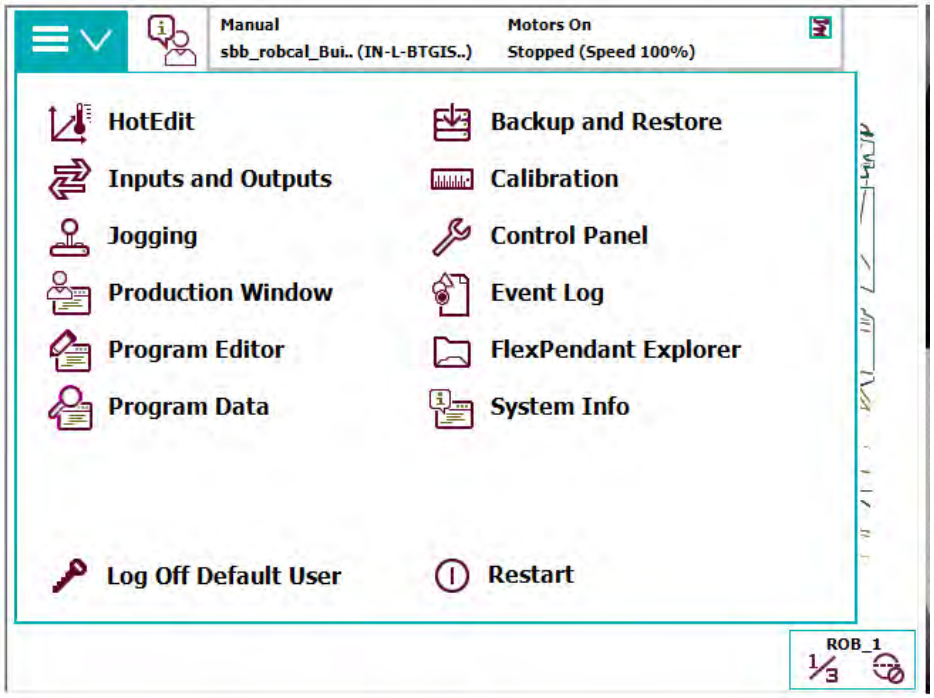
	Action	Note
7	At this point, it is *recommended* that the revolution counter values are saved to a diskette.	Not required.
8	**CAUTION** If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. How to perform the check is detailed in section *Checking the synchronization position on page 217*.	

Step 2 - Updating the revolution counter with the FlexPendant

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

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

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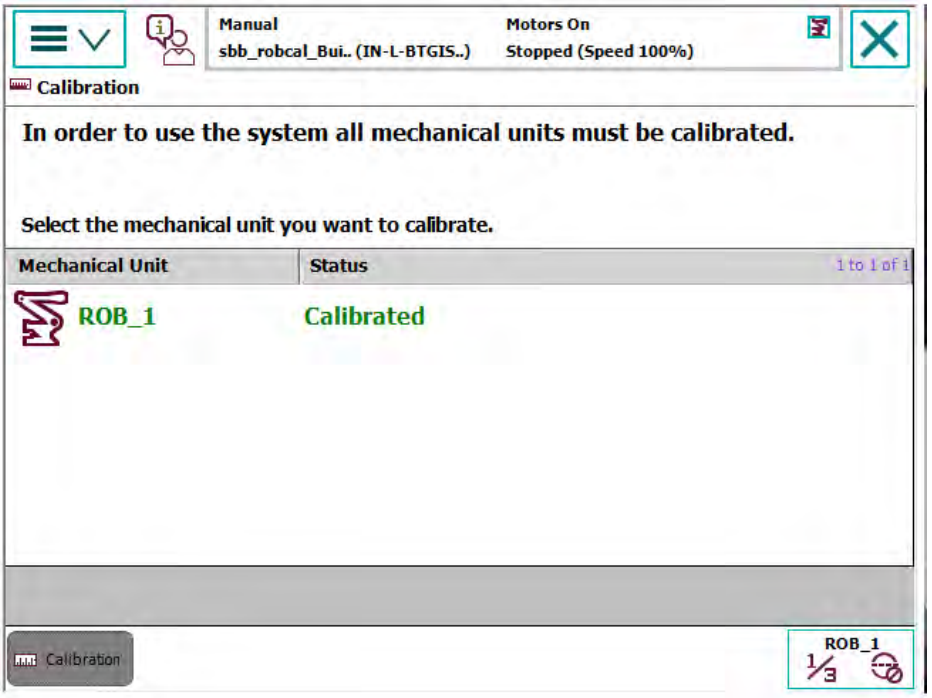
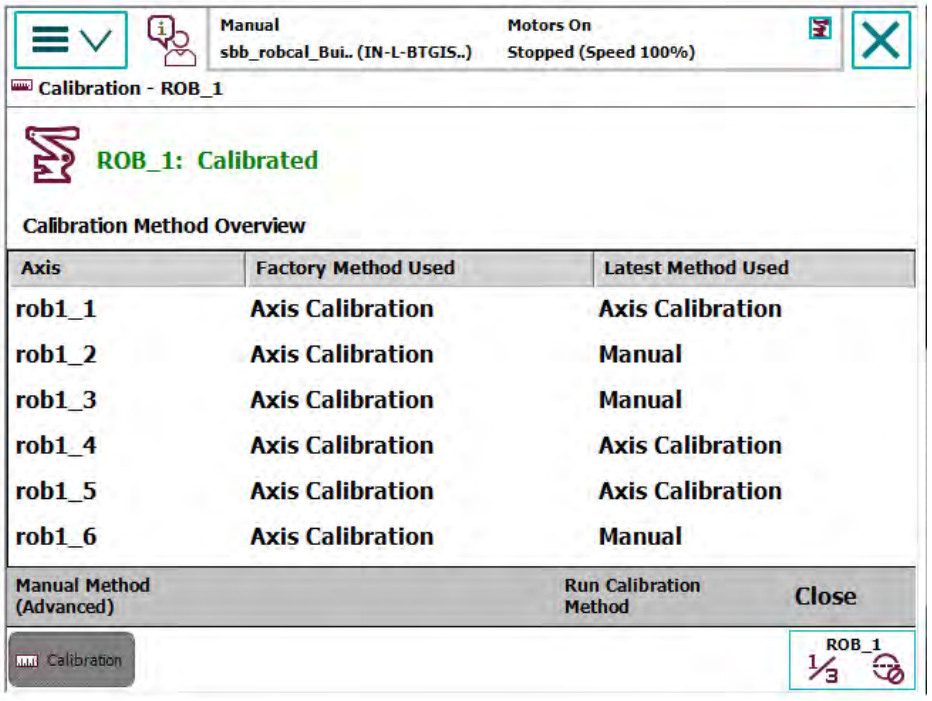
	Action
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943
3	**This step is valid for RobotWare 6.02 and later.** Calibration method used at factory for each axis is shown, as well as calibration method used during last field calibration. Tap **Manual Method (Advanced)**.  xx1500000944

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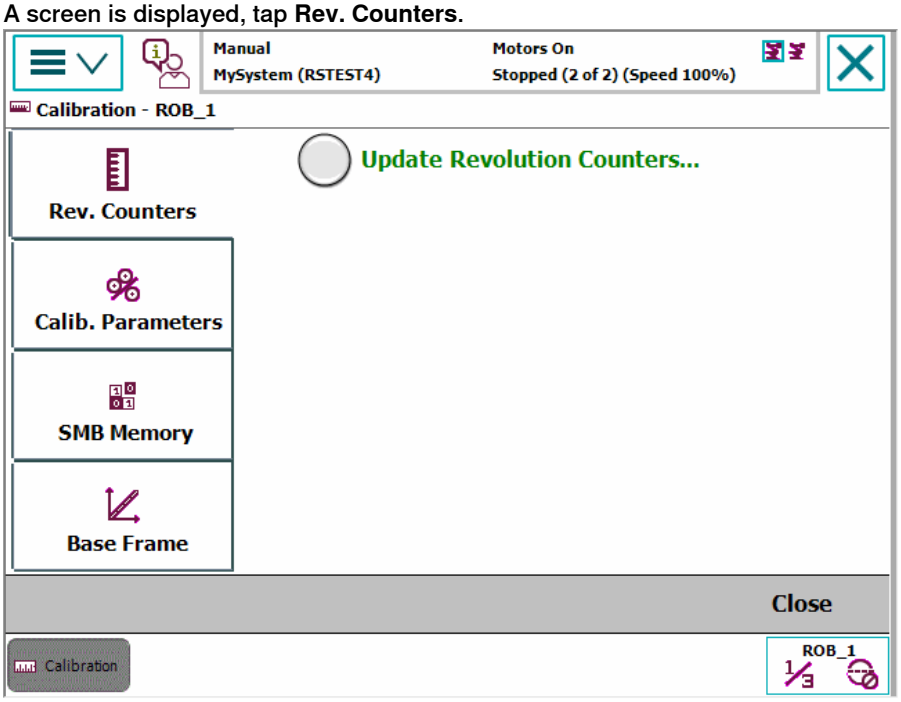
5.5 Updating revolution counters
Continued

	Action
4	A screen is displayed, tap **Rev. Counters**.  en0400000771
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 217*.

5.6 Checking the synchronization position

Introduction

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

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

Using a MoveAbsJ instruction on the TPU, S4Cplus

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

	Action	Note
1	Create the following program: `MoveAbsJ [[0,0,0,0,0,0], [9E9, 9E9,9E9,9E9,9E9,9E9]] \NoEOffs, v1000, z50, Tool0`	
2	Run the program in manual mode.	
3	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See *Synchronization marks and synchronization position for axes on page 210* and *Updating revolution counters on page 212*.

Using a MoveAbsJ instruction

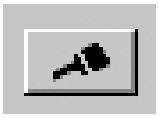
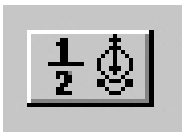
Use this procedure to create a program that runs all the robot axes to their synchronization position.

	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 210* and *Updating revolution counters on page 212*.

Continues on next page

Using the jogging window on the TPU, S4Cplus

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

	Action	Illustration/Note
1	Open the **Jogging** window.	 xx0100000195
2	Select running axes-by-axes.	 xx0100000196
3	Manually run the robot axes to a position where the axis position value read on the TPU, is equal to zero.	
4	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See *Synchronization marks and synchronization position for axes on page 210* and *Updating revolution counters on page 212*.

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 210* and *Updating revolution counters on page 212*.

6 Decommissioning

6.1 Environmental information

Hazardous material

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

Dispose components properly to prevent health or environmental hazards.

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

Oil and grease

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

Also note that:

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

6.2 Scrapping of robot

Important when scrapping the robot

DANGER

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

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

7 Reference information

7.1 Introduction

General

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

7.2 Applicable safety standards

Standards, EN ISO

The robot system is designed in accordance with the requirements of:

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

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

European standards

Standard	Description
EN 614-1	Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles
EN 574	Safety of machinery - Two-hand control devices - Functional aspects - Principles for design
EN 953	Safety of machinery - General requirements for the design and construction of fixed and movable guards

Other standards

Standard	Description
ANSI/RIA R15.06	Safety requirements for industrial robots and robot systems
ANSI/UL 1740 (option 429-1)	Safety standard for robots and robotic equipment

Continues on next page

Standard	Description
CAN/CSA Z 434-03 (option 429-1)	Industrial robots and robot Systems - General safety requirements

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 2400.

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

UNBRAKO screws

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

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

Gleitmo treated screws

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

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

Screws lubricated in other ways

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

In such cases, proceed as follows:

1 Apply lubricant to the screw thread.
2 Apply lubricant between the plain washer and screw head.
3 Screw dimensions of M8 or larger must be tightened with a torque wrench. Screw dimensions of M6 or smaller may be tightened without a torque wrench *if* this is done by trained and qualified personnel.

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

Tightening torque

Before tightening any screw, note the following:

- Determine whether a **standard** tightening torque or **special** torque is to be applied. The **standard torques** are specified in the following tables. Any **special torques** are specified in the repair, maintenance or installation procedure descriptions. **Any special torque specified overrides the standard torque!**
- Use the *correct tightening torque* for each type of screw joint.
- Only use *correctly calibrated* torque keys.

Continues on next page

7.4 Screw joints
Continued

- Always *tighten the joint by hand,* and never use pneumatic tools.
- Use the *correct tightening technique*, that is *do not* jerk. Tighten the screw in a slow, flowing motion.
- Maximum allowed total deviation from the specified value is **10%**!

Oil-lubricated screws with slotted or cross-recess head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *slotted or cross-recess head screws.* Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Oil-lubricated screws with allen head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *allen head screws.* Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Dimension	Tightening torque (Nm) Class 8.8, oil-lubricated	Tightening torque (Nm) Class 10.9, oil-lubricated	Tightening torque (Nm) Class 12.9, oil-lubricated
M5	6	-	-
M6	10	-	-
M8	24	34	40
M10	47	67	80
M12	82	115	140
M16	200	290	340
M20	400	560	670
M24	680	960	1150

Lubricated screws (Molycote, Gleitmo or equivalent) with allen head screws

The following table specifies the recommended standard tightening torque for *screws lubricated with Molycote 1000, Gleitmo 603 or equivalent* with *allen head screws.* Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Dimension	Tightening torque (Nm) Class 10.9, lubricated [i]	Tightening torque (Nm) Class 12.9, lubricated [i]
M8	28	35
M10	55	70
M12	96	120
M16	235	280
M20	460	550
M24	790	950

[i] Lubricated with Molycote 1000, Gleitmo 603 or equivalent

Continues on next page

Water and air connectors

The following table specifies the recommended standard tightening torque for *water and air connectors* when *one* or *both* connectors are made of *brass*. Any special torque specified in the repair, maintenance or installation procedure overrides the standard torque!

Dimension	Tightening torque Nm - Nominal	Tightening torque Nm - Min.	Tightening torque Nm - Max.
1/8	12	8	15
1/4	15	10	20
3/8	20	15	25
1/2	40	30	50
3/4	70	55	90

7.5 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 380 kg. All lifting accessories used must be sized accordingly!	

7.6 Standard tools

General

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

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

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

Contents, standard toolkit

Qty	Tool
1	Ring-open-end spanner 8-19 mm
1	Socket head cap 2.5-17 mm
1	Torx socket no: 20-60
1	Torque wrench 10-100 Nm
1	Small screwdriver
1	Plastic mallet
1	Ratchet head for torque wrench 1/2"
1	KM socket (KM10) (6369901-480)
1	Socket head cap no: 5, socket 1/2" bit L 20 mm
1	Socket head cap no: 6, socket 1/2" bit L 20 mm
1	Socket head cap no: 8, socket 1/2" bit L 20 mm
1	Small cutting plier
1	T-handle with ball head

7.7 Special tools

General

All service instructions contain lists of tools required to perform the specified activity. The required tools are a sum of standard tools, defined in the section *Standard tools on page 229*, and of special tools, listed directly in the instructions and also gathered in this section.

Special tools

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

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

Calibration equipment, Levelmeter (alternative method)

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

Description	Art. no.	Note
Angle bracket	68080011-LP	
Calibration bracket	3HAC13908-9	
Calibration tool ax1	3HAC13908-4	
Levelmeter 2000 kit	6369901-347	Includes one sensor.
Measuring pin	3HAC13908-5	
Sensor fixture	68080011-GM	
Sensor plate	3HAC0392-1	
Sync. adapter	3HAC13908-1	
Turn disk fixture	3HAC68080011-GU	

Calibration equipment, Calibration Pendulum

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

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

7.8 Lifting equipment and lifting instructions

General

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

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

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

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8 Spare part lists

8.1 Spare part lists and illustrations

Location

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

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9 Circuit diagram

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*

Continues on next page

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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