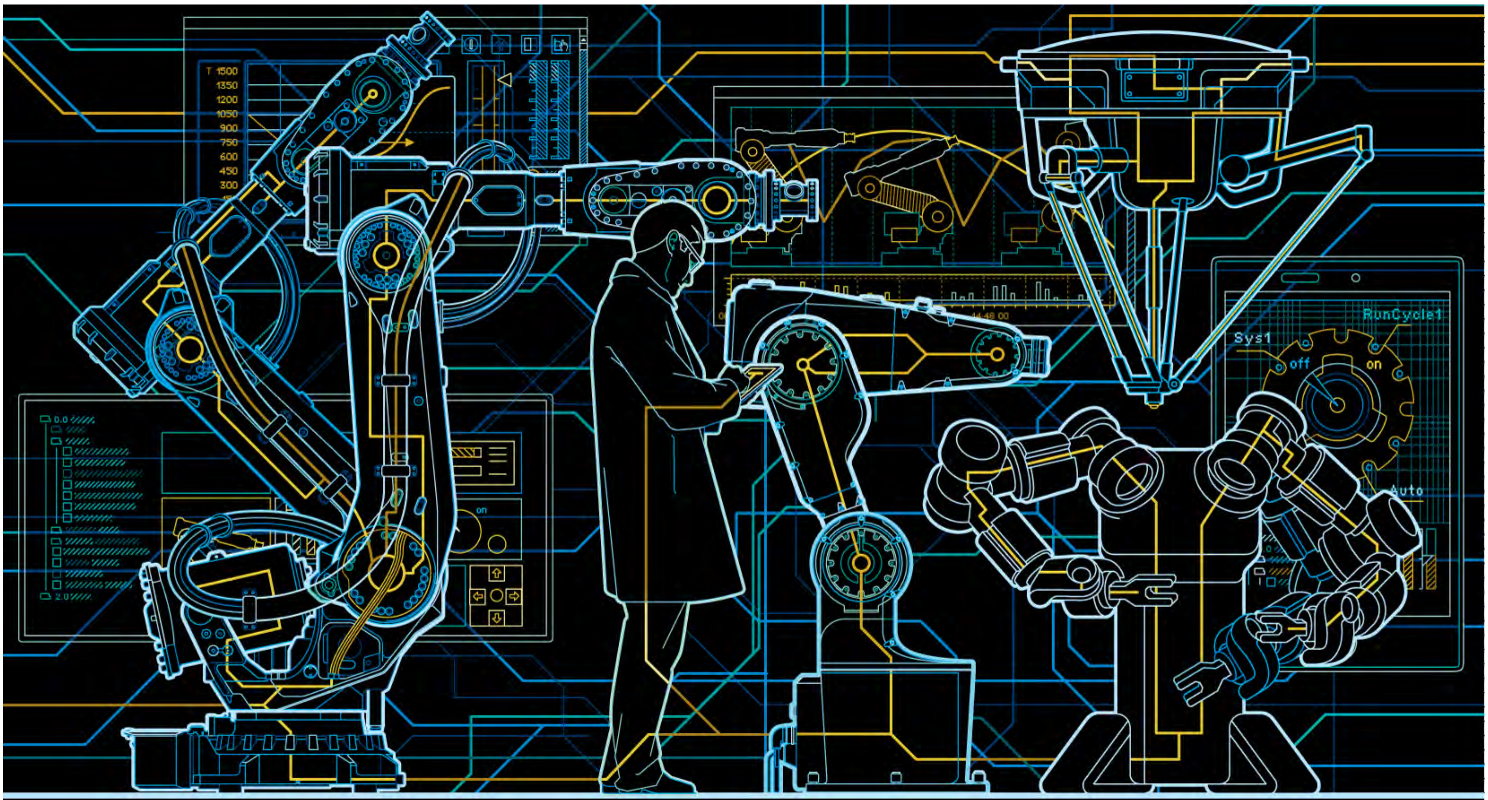

Product manual
IRB 4400

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

Product manual

IRB 4400/60
IRB 4400/L10

M2000, IRC5

Document ID: 3HAC022032-001

Revision: N

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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.

The manual also contains reference information for all procedures detailed in the manual.

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
Installation and commissioning	Information about installation of the robot.
Maintenance	Information about maintenance work, including maintenance schedules.
Repair	Information about repair work.
Calibration information	Procedures that does not require specific calibration equipment. General information about calibration.
Decommissioning	Environmental information about the robot and its components.
Reference information	Useful information when performing installation, maintenance or repair work (lists of necessary tools, reference documents, safety standards)
Part list	Complete list of robot parts, shown in the partlist

Continues on next page

Chapter	Contents
Exploded views	Detailed illustrations of the robot with reference numbers to the part list.
Circuit diagram	Reference to the circuit diagram for the robot.

References

Document name	Document ID	Note
Product specification - IRB 4400	*3HAC9117-1*	
Product manual, spare parts - IRB 4400	*3HAC049107-001*	
Circuit diagram - IRB 4400/4450S	*3HAC9821-1*	
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*	
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*	M2004
Operating manual - Calibration Pendulum	*3HAC16578-1*	
Application manual - CalibWare Field 5.0	*3HAC030421-001*	
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*	
Operating manual - Service Information System	*3HAC050944-001*	
Application manual - Additional axes and stand alone controller	*3HAC051016-001*	M2004

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

Revisions

Revision	Description
-	First edition. Replaces previous manuals: • Installation and Commissioning 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 Safety, service replaced with chapter Safety. Chapter Calibration replaced with chapter Calibration information. Removed chapter Calibration, M2004. Section Document references is completed with article numbers for calibration manuals.
B	Yaskawa motors been added.
C	Robot model IRB 4450S added.
D	Foundry Prime (Water jet application) added.

Continues on next page

Revision	Description
E	The protection type Clean Room is added. Changes made in: • Prerequisites in section Overview • Oil change in section Maintenance
F	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 • Maintenance/Cleaning of robot
G	Missing spare part in chapter Spare parts, section Upper arm, axes 4-6, added: • Item 29, Gear axis 6
H	This revision includes the following updates: • Inspection of surface treatment added to maintenance schedule (Foundry Prime) • Circuit diagrams are not included in this document but delivered as separate files. See *Circuit diagram on page 303*. • List of applicable safety standards updated. • Decommissioning chapter added. The chapter Safety updated with: • Updated safety signal graphics for the levels Danger and Warning. Safety signals in the manual: • New safety labels on the manipulator. • Revised terminology: robot replaced with manipulator.
J	This revision includes the following updates: • All information about IRB 4400-45, IRB 4400-L10, IRB 4400-L30, IRB 4400-S and IRB 4450S is removed from the manual. • A new block, about general illustrations, added in section *How to read the product manual on page 16*. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 293*. • Added *WARNING - Safety risks during handling of batteries on page 55*. • 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 124*. • A new SMB unit and battery is introduced, with longer battery lifetime.
K	This revision includes the following updates: • The SMB unit backup battery of type NiCad, is no longer available as a spare part. Therefor removed from this manual. • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 287*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 4400*. • The variant IRB 4400/L10 is added.
L	This revision includes the following updates: • Minor corrections.
M	This revision includes the following updates: • Turning disc fixture is removed from special tools for Levelmeter calibration. • Information about mounting guard plate at push button unit for brake release added.

Continues on next page

Revision	Description
N	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.

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

Application manuals

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

An application manual generally contains information about:

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

Operating manuals

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

The group of manuals includes (among others):

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

How to read the product manual

Reading the procedures

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

References to figures

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

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

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

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

References to required equipment

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

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

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

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

Safety information

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

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

Illustrations

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

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

1 Safety

1.1 Introduction to safety information

Overview

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

- General safety aspects, important to attend to before performing any service work on the robot. These are applicable for all service work and are found in *General safety information on page 18*.
- Safety signals and symbols shown in the manual and on the robot, warning for different types of dangers, are found in *Safety signals and symbols on page 41*.
- 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 49*.

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

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

- 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!

Balancing device

Safety risk	Description
Dangerous balancing device!	**WARNING** *Do not*, under any circumstances, deal with the balancing device in any other way than that described in the product documentation! For example, attempting to open the balancing device is potentially lethal!

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 73*.

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.

1.2.5 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

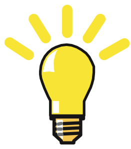
The table below defines the captions specifying the danger levels used throughout this manual.

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

1.3.1 Safety signals in the manual

Continued

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.

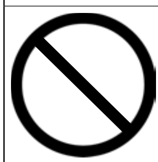
Types of labels

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.

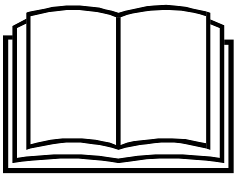
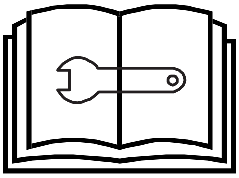
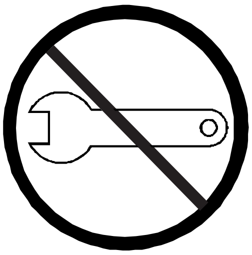
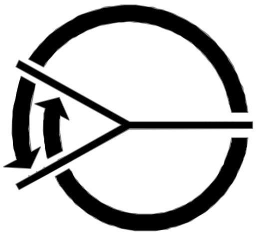
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 43*.

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

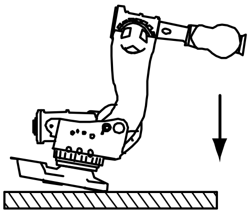
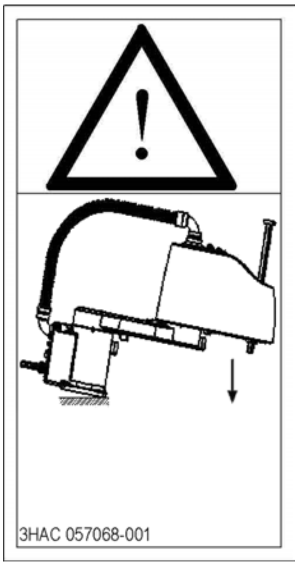
Symbols on safety labels

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.

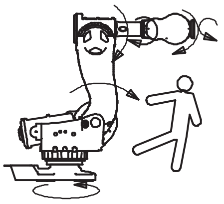
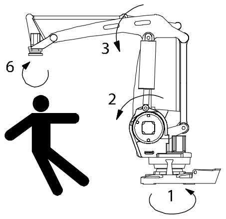
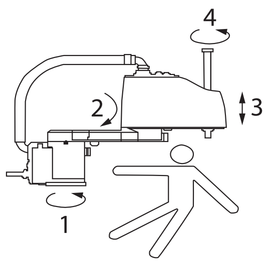
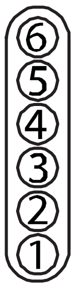
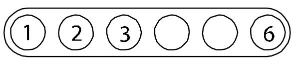
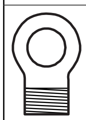
Continues on next page

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.

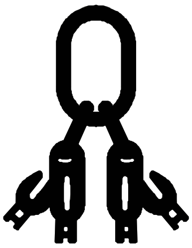
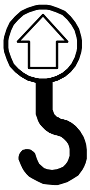
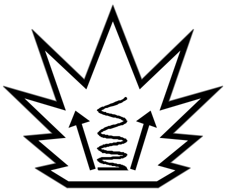
Continues on next page

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.

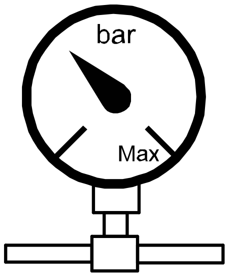
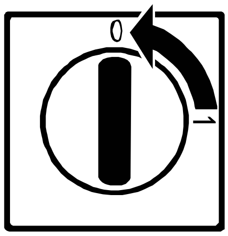
Continues on next page

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

Continues on next page

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

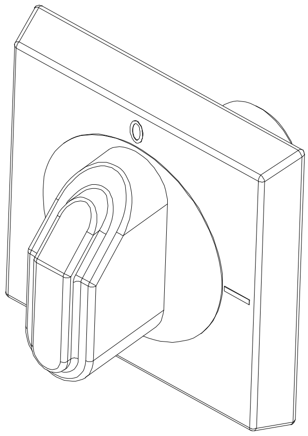
When programming the movements of the robot, always identify potential collision risks before the first test run.

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

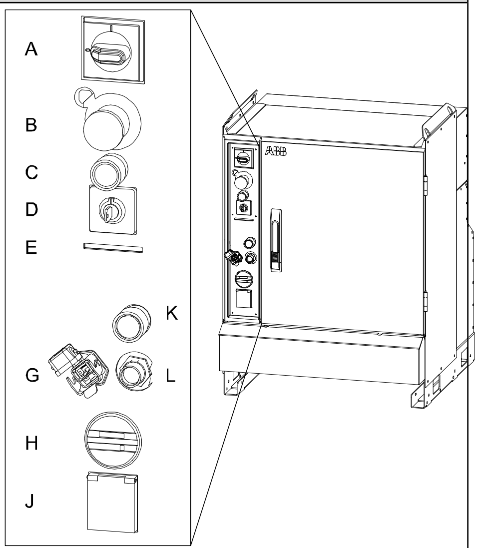
Description

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

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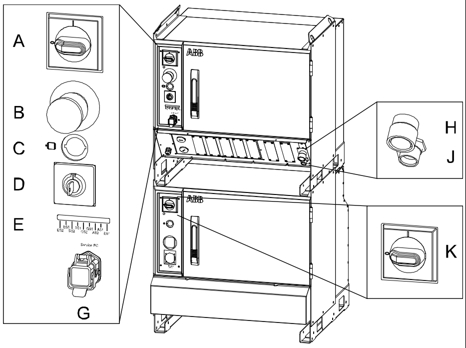
Elimination, Dual Cabinet Controller

	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.

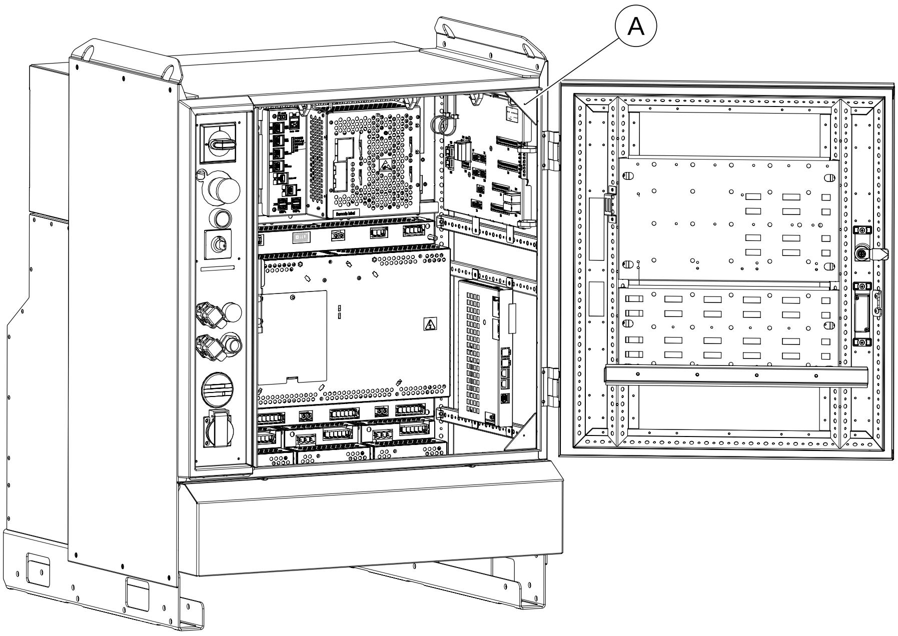
Elimination

	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

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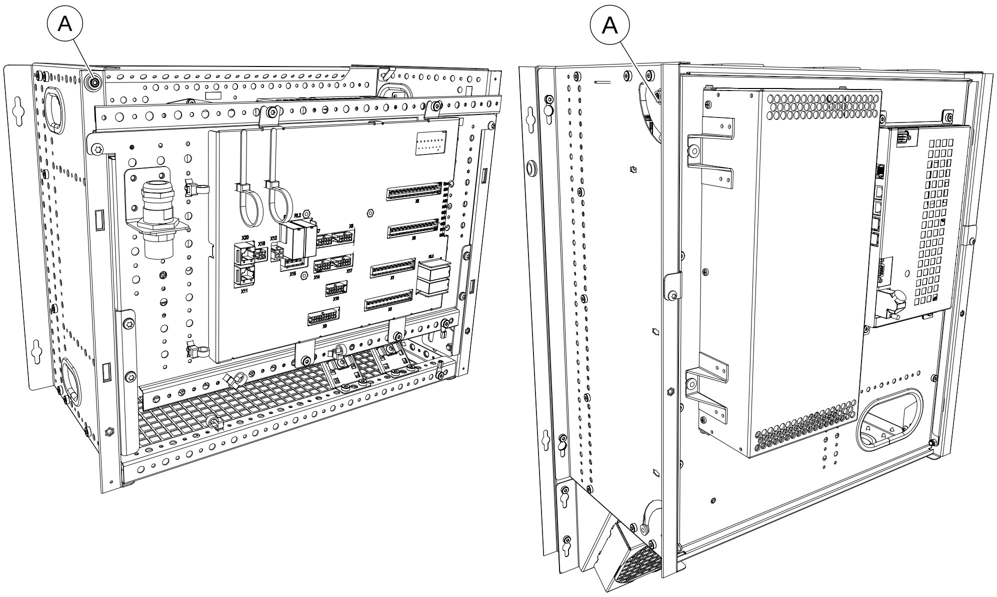
Panel Mounted Controller



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 63*.
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

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.	

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2 Installation and commissioning

2.1 Introduction

General

This chapter contains assembly instructions and information for installing the IRB 4400 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 4400, 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 4400 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 Installation and operational requirements for Foundry Prime robots

Introduction

Robots with protection type Foundry Prime are specially designed to work in harsh environments. To ensure that the protection offers the best reliability, special measures are required during installation and operation. It is required that the environmental and application conditions are fulfilled and that the special maintenance activities and intervals for the Foundry Prime protected robot are followed.

Fluids in the vicinity of the robot

If fluids that can cause rust formation, for example, water etc., are used in the vicinity of the robot it is required to add rust inhibator to the fluid or take other measures to prevent rust on unpainted joints or other unprotected surfaces of the robot.

Activity to lubricate gearboxes cavities and gears

Run each axis on high speed at least once per hour. This activity will lubricate the gearbox cavities and gears, which reduces the risk for corrosion due to condensation in the gearboxes.

Pressurized components

The motors, the balancing device, and the serial measurement board cavity must be pressurized on Foundry Prime robots during operation and shut down. The overpressure can be dropped when atmospheric humidity has reached the same level as the surrounding environment.

At the installation of the Foundry Prime robot a pressure sensor and pressure relief valve (not included) must be installed in the air supply system to monitor the supply of air pressure in order to secure a correct pressure. See *Pressurizing equipment on page 61* for equipment specifications.

The overpressure must be kept at 0.2 - 0.3 ± 0.0 bar during 24 hours independent of Motors On/Off mode, start-up, and shut down periods.

WARNING

If the air pressure exceeds the specified, it could result in a brake failure in the motors and cause the robot arms to fall down, leading to personal injury or physical damage.

WARNING

If the pressurized air contains oil, it could result in a brake failure in the motors and cause the robot arms to fall down, leading to personal injury or physical damage.

Continues on next page

Note

To secure the supply of air pressure, use a pressure sensor.

Air quality for pressurizing of robot

The air must be dry and clean, such as instrument air. The following table describes the air specifications.

Parameter	Value
Dew point	<+2°C at 6 bar
Solid particle size	<5 microns
Oil content	<1 ppm (1 mg/m^3)
Air flow	>200 L/min

Pressurizing equipment

ABB recommends a safety valve set at 0.4 bar, pressure sensor set at 0.2-0.3 bar or regulator set for maximum 0.3 bar to be attached on the pressure side of the air system.

Example of products:

Equipment	Description
Pressure sensor	Festo SDE1-series
Pressure regulator	Festo LRP-series

Precautionary measures

Note

It is strictly forbidden to expose any part of the robot to direct high pressure water jet! The sealing joints between the moving parts on the wrist must not be exposed to high pressure water.

Rebounding high pressure water jet must be avoided. ABB recommends using a tool design with integrated covers that protect the wrist from direct or indirect high pressure water jet.

Note

Make sure that the special Foundry Prime painting of the robot is not broken during testing, installation, or repair work. Use the touch up kit available for Foundry Prime (article number 3HAC035355-001) to repair any damages in the paint.

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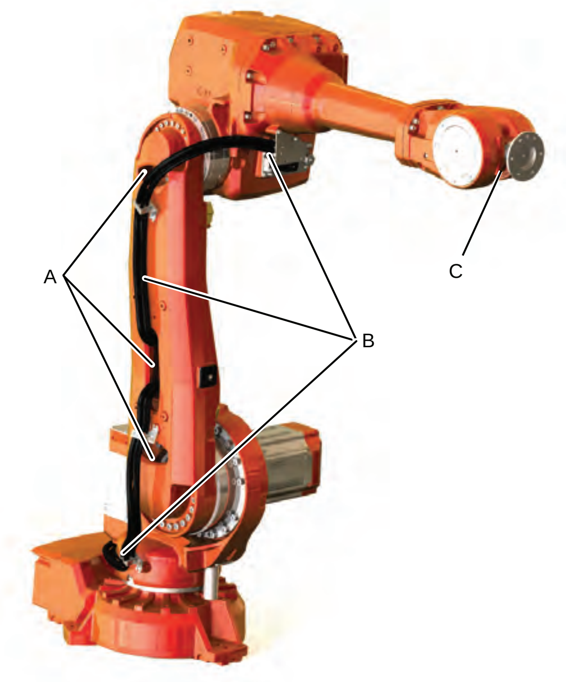
Sensitive points IRB 4400

Illustration shows points that are particularly sensitive to water spray.



xx0800000462

A	Inside lower arm
B	Cable package
C	Wrist

Shut-down periods

During shut-down periods the cleaning cell must be ventilated out (aired out). This reduces the risk that moister is sucked into gearboxes during cooling down. It gives the robot the possibility to dry as the rust inhibation effect normally gets reduced after some time.

Ventilate and air out the cell during and after shut-downs:

- The cell must be ventilated during shut-down until the atmosheric humidity in the cell has reached the same level as the surrounding environment.
- Will avoid that humid air is trapped into gearboxes or other cavities due to raised vacuum when cooling down.
- Will give the robot a chance to dry as most rust preventive components in washing detergents have a decaying effect, i.e. the rust preventive effect is reduced after a time. Please refer to the Product Specification of the washing detergent in question for decaying effect. Washing detergent or water without rust inhibator can give an accelarated corrosion on some robot components.
- **The overpressure must be kept at 0.2 - 0.3 ± 0.0 bar during 24 hours independent of Motors On/Off mode, start-up and shut down periods.**

2.3 Unpacking

2.3.1 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 64*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 65*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 65*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 64* • *Protection classes, robot on page 66* • *Requirements, foundation on page 65*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 95*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 70*
11	Install required equipment, if any.

Continues on next page

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 4400	1300 kg

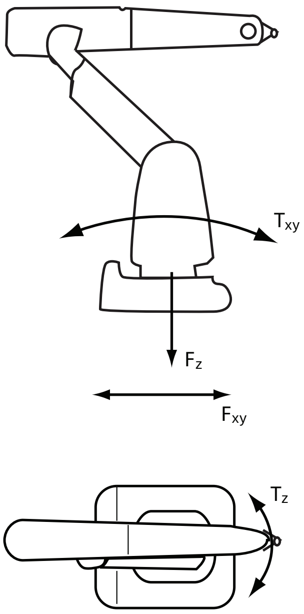
Note

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.



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

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

Note

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

Continues on next page

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 7500 N	± 9000 N
Force z	+9500 ± 2000 N	+9500 ± 3000 N
Torque xy	± 14000 Nm	± 16000 Nm
Torque z	± 2000 Nm	± 4000 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	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	-	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	-	

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

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

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

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

Continues on next page

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	IP54
Manipulator, protection type Foundry Prime	IP67, steam washable

2.3.2 Working range

Introduction to robot motion

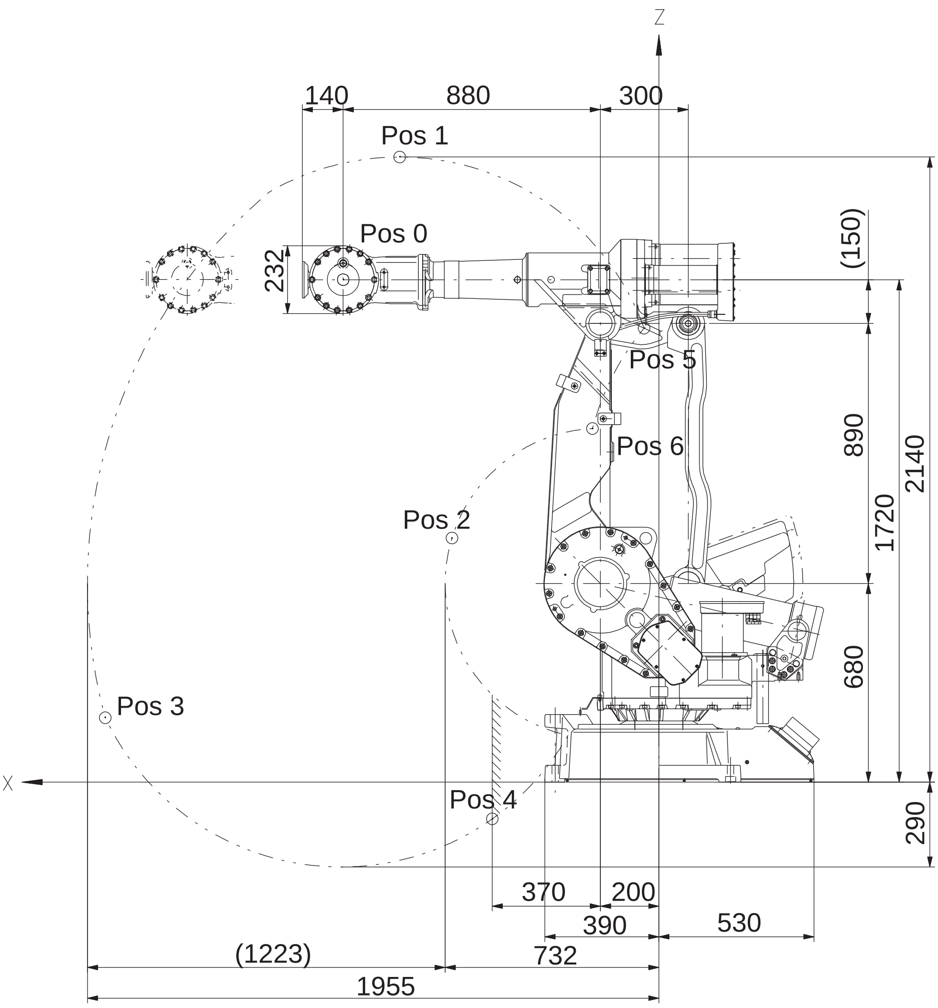
Axis	Type of motion	Range of movement
1	Rotation motion	+ 165° to - 165°
2	Arm motion	+ 95° to - 70°
3	Arm motion	+ 65° to - 60°
4	Rotation motion	+ 200° to - 200°
5	Bend motion	+ 120° to - 120°
6	Turn motion	+ 400° to - 400° + 200 [i] rev.[ii] to - 200 rev. Max.[iii]

i + 183 rev to - 183 rev valid for IRB 4400/L10

ii rev. = Revolutions

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

IRB 4400/60



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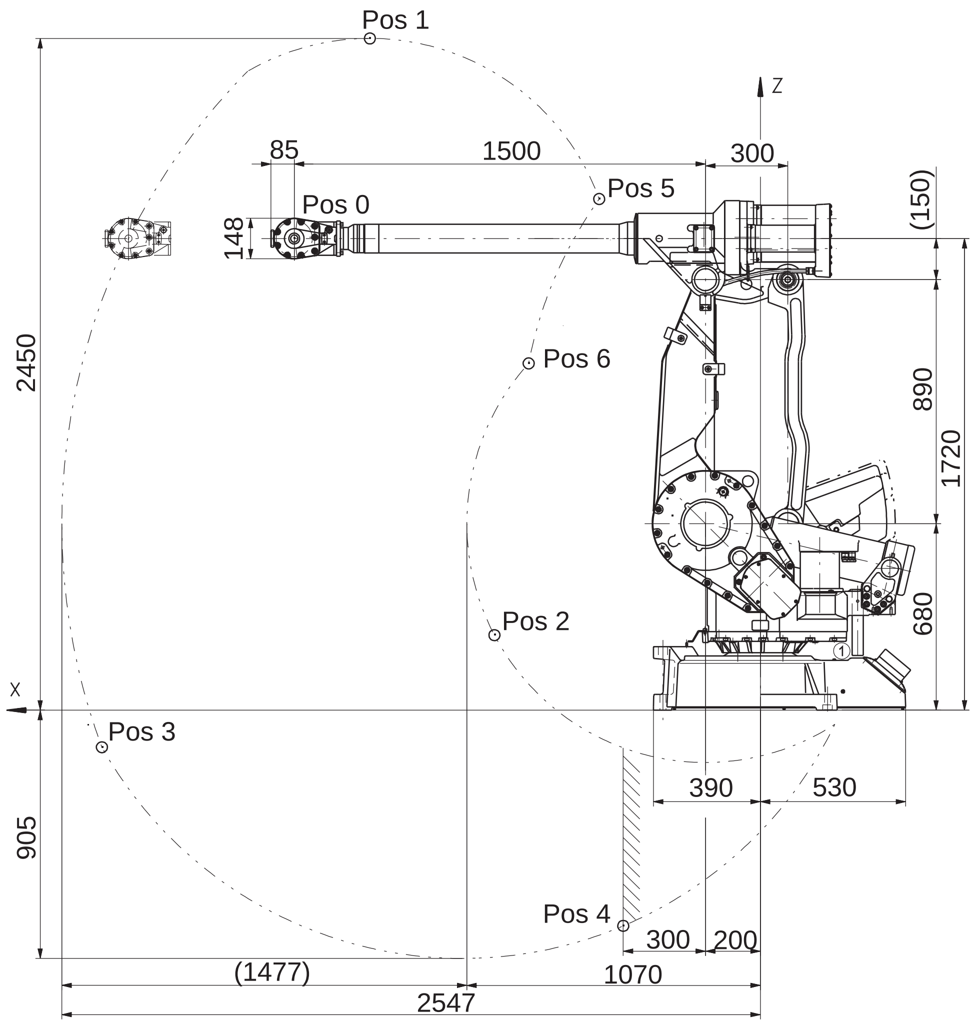
Positions at wrist center (mm) and angle (degrees):

Position no (see figure above)	Position (mm) X	Position (mm) Z	Angle (degrees) Axis 2	Angle (degrees) Axis 3
0	1080	1720	0	0
1	887	2140	0	-30
2	708	836	0	65
3	1894	221	95	-60
4	570	-126	95	40
5	51	1554	-70	40
6	227	1210	-70	65

IRB 4400/L10



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Positions at wrist center (mm) and angle (degrees):

Position no (see figure above)	Position (mm) X	Position (mm) Z	Angle (degrees) Axis 2	Angle (degrees) Axis 3
0	1700	1720	0	0

Continues on next page

Position no (see figure above)	Position (mm) X	Position (mm) Z	Angle (degrees) Axis 2	Angle (degrees) Axis 3
1	1424	2450	0	-30
2	970	274	0	65
3	2401	-135	95	-60
4	500	-786	95	24
5	588	1864	-70	40
6	845	1265	-70	65

2.4 On-site installation

2.4.1 Lifting robot with roundslings

General

Lift the robot using lifting straps and a traverse crane according to this section.

Required equipment

Equipment	Art. no.	Note
Crane		Lifting capacity: 2100kg (max. load at 90°)
Round slings, 2 m		Lifting capacity/sling: 1100kg 2 pcs for IRB 4400
Lifting lugs		Type: OBK 7-8

CAUTION

The IRB 4400 robot weighs 1300 kg.

All lifting accessories used must be sized accordingly!

WARNING

Personnel must not, under any circumstances, be present under the suspended load!

CAUTION

Failure to attach the straps correctly can cause the suspended load to tilt suddenly and cause both personal injury and severe damage to the load.

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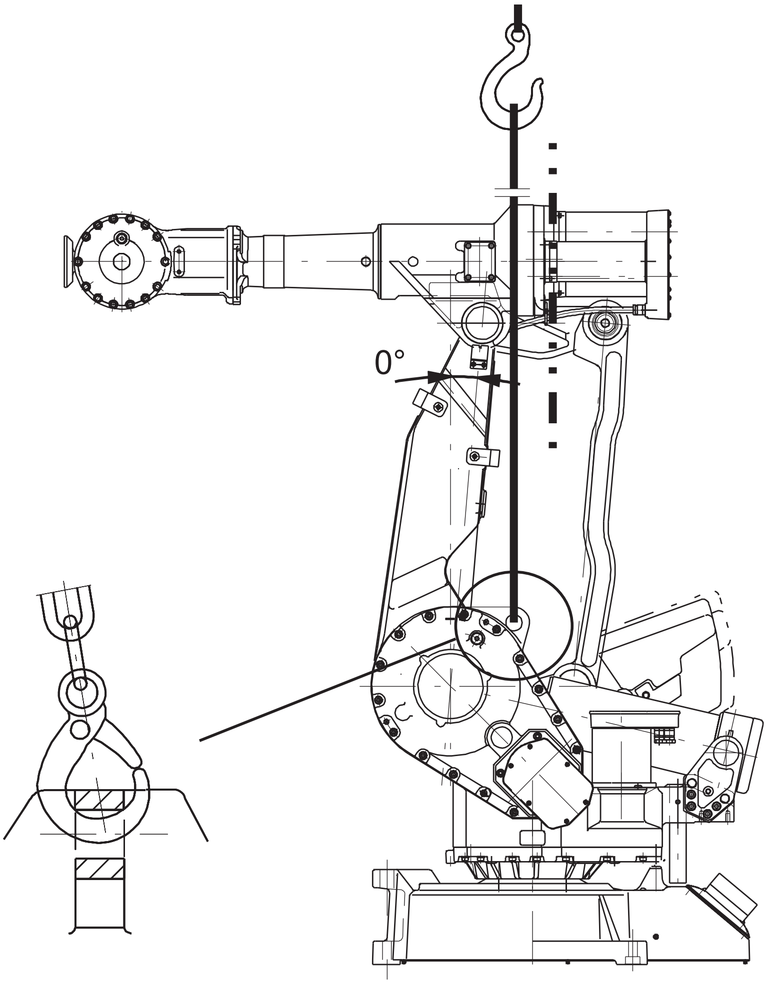
Lifting, robot version, IRB 4400

The lifting equipment is attached to the robot as shown in the figure below.



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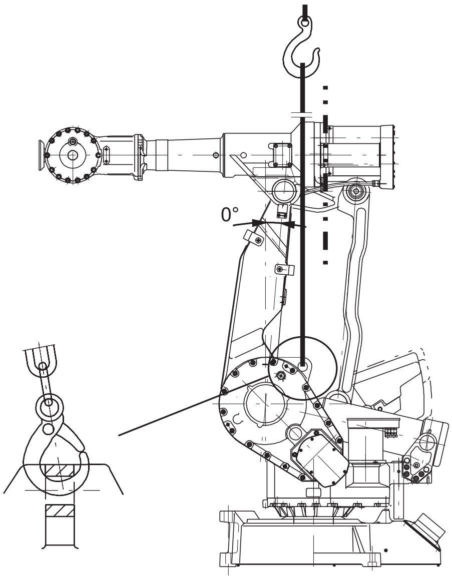
Lifting instruction, IRB 4400

The procedure below details how to lift the complete robot.

	Action	Information
1	Release the brakes manually, to make it possible to alter the positions of the arms.	Detailed in section *Manually releasing the brakes on page 73*.
2	Move the robot to the calibration position.	

Continues on next page

	Action	Information
3	Move the lower arm backwards to get balance, according to angle specified to the right.	 xx0300000245
4	Attach the *round slings* to the special eye bolts on the gearbox unit for axes 2 and 3 using *lifting lugs*.	Shown in the figure *Lifting, robot version, IRB 4400 on page 71*. The roundsling and lifting lug dimensions must comply with the applicable standards specified in *Required equipment on page 70*.
5	Lift the robot to its installation site. Make sure the slings do not rub against any sharp edges!	

2.4.2 Manually releasing the brakes

General

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

This can be done in one of three ways:

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

DANGER

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

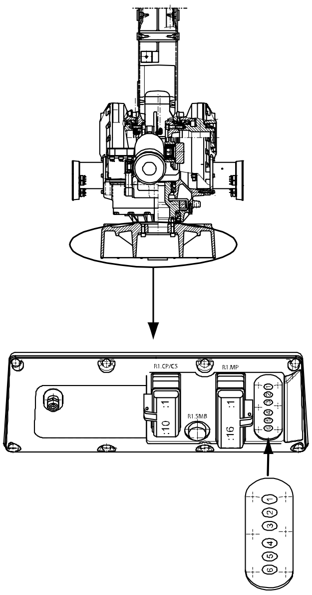
DANGER

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

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

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

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

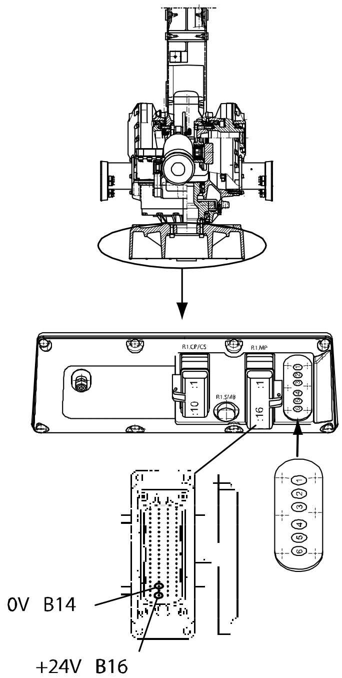
	Action	Note
1	The internal brake release unit is located at the base of the robot.	 xx0300000198
2	The brake release unit is equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes.	

Continues on next page

	Action	Note
3	Release the holding brake on a particular axis by pressing the corresponding button on the push-button unit and keeping it depressed.	
4	The brake will function again as soon as the button is released.	

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

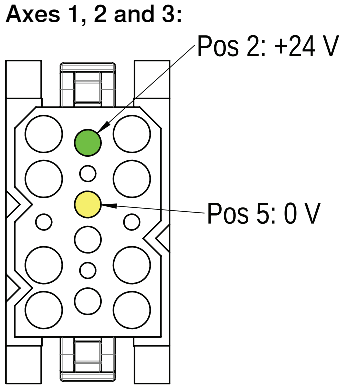
This procedure details how to release the holding brakes with the push-buttons, when the robot is **not** connected to the controller.

	Action	Note
1	Connect an external 24VDC power supply to the connector R1.MP on the robot base, as shown in the figure to the right. **Note!** Be careful not to interchange the 24V and 0V pins. If they are mixed up, damage can be caused to the brake release unit and the intergrated quenching circuits.  xx0200000022 DANGER! **Incorrect connections can cause all brakes to be released simultaneously!**	 xx0300000200 Connect to connector R1.MP: • 0V: pin B14 or B15 • +24V: pin B16
2	Release the holding brake on a particular axis by pressing the corresponding button on the push-button unit and keeping it depressed.	The brake release unit is equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes. See the previous figure.
3	The brake will function again as soon as the button is released.	

Continues on next page

Using an external voltage supply directly on the respective brake

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

	Action	Note
1	Every axis has a holding brake built into the axis motor. This holding brake may be released by connecting 24VDC power supply directly to one of the connectors in the motor. **DANGER** When power is connected directly to the brake cable, the brake will be released immediately when the power is switched on. This may cause some unexpected robot movements!	Make the connection to the current motor according to the Circuit Diagram. See chapter *Circuit diagram on page 303*.
2	Connect an external 24 VDC power supply to the motor, according to the figures. **Note** Be careful not to interchange the 24V and 0V pins! If they are mixed up, damage can be caused to the intergrated quenching circuits. **WARNING** **Incorrect connections can cause all brakes to be released simultaneously!**	Axes 1, 2 and 3:  xx1400001984

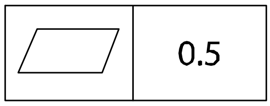
2.4.3 Orienting and securing the robot

General

This section details how to orient and secure the robot to the base plate after fitting it to the foundation.

Securing parts/facts

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

Securing parts/fact	Dimension/art. no.	Amount/Note
Securing screws, oiled	M20	3 pcs
Washers	Thickness: 3 mm Outer diameter: 36 mm Inner diameter: 21 mm	3 pcs
Guide sleeves	21510024-169	2 pcs Added to the rear bolt holes, to allow the same robot to be re-mounted without program adjustments.
Tightening torque	350 - 400 Nm	Oiled screws
Level surface requirements	 xx0300000251	

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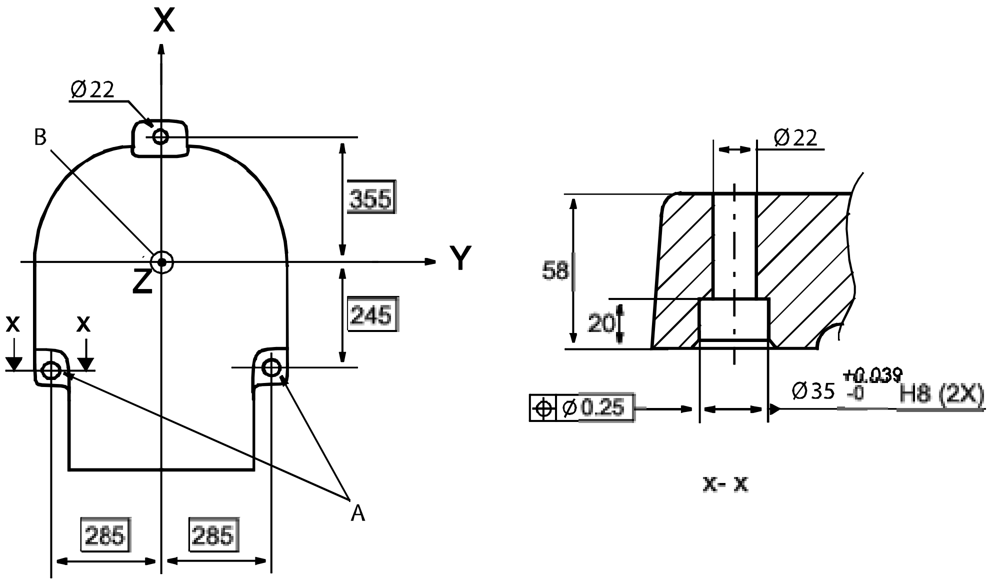
Hole configuration and dimensions

The illustration below shows the hole configuration and hole dimensions of the robot base, seen from below.

The cut x-x shows the dimension of the rear bolt holes, where the guide sleeves may be used.



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A	Rear bolt holes
B	Center line, axis 1

Orienting and securing the robot

The procedure below details how to orient and secure the robot to the base plate after fitting the plate to the foundation.

	Action	Info/Illustration
1	**WARNING** When the robot is put down, before attachment to the floor is done, the risk of tipping is big, if not properly secured.	
2	**CAUTION** The IRB 4400 robot weighs 1300 kg. All lifting accessories used must be sized accordingly!	
3	Lift the robot.	Detailed in section *Lifting robot with roundslings on page 70*.
4	Move the robot to the vicinity of the installation site.	

Continues on next page

	Action	Info/Illustration
5	Fit two *guide sleeves* to the *rear bolt holes* in the base.	Art. no. is specified in *Securing parts/facts on page 76*. Shown in the figure *Hole configuration and dimensions on page 77*.
6	Guide the robot gently using M20 screws while lowering it into its mounting position.	
7	Fit the *securing screws and washers* in the base attachment holes.	Specified in *Securing parts/facts on page 76*. Attachment holes shown in the figure *Hole configuration and dimensions on page 77*.
8	When bolting a mounting plate or frame to a concrete floor, follow the general instructions for expansion-shell bolts. The screw joint must be able to withstand the stress loads defined in section *Loads on foundation, robot on page 64*.	

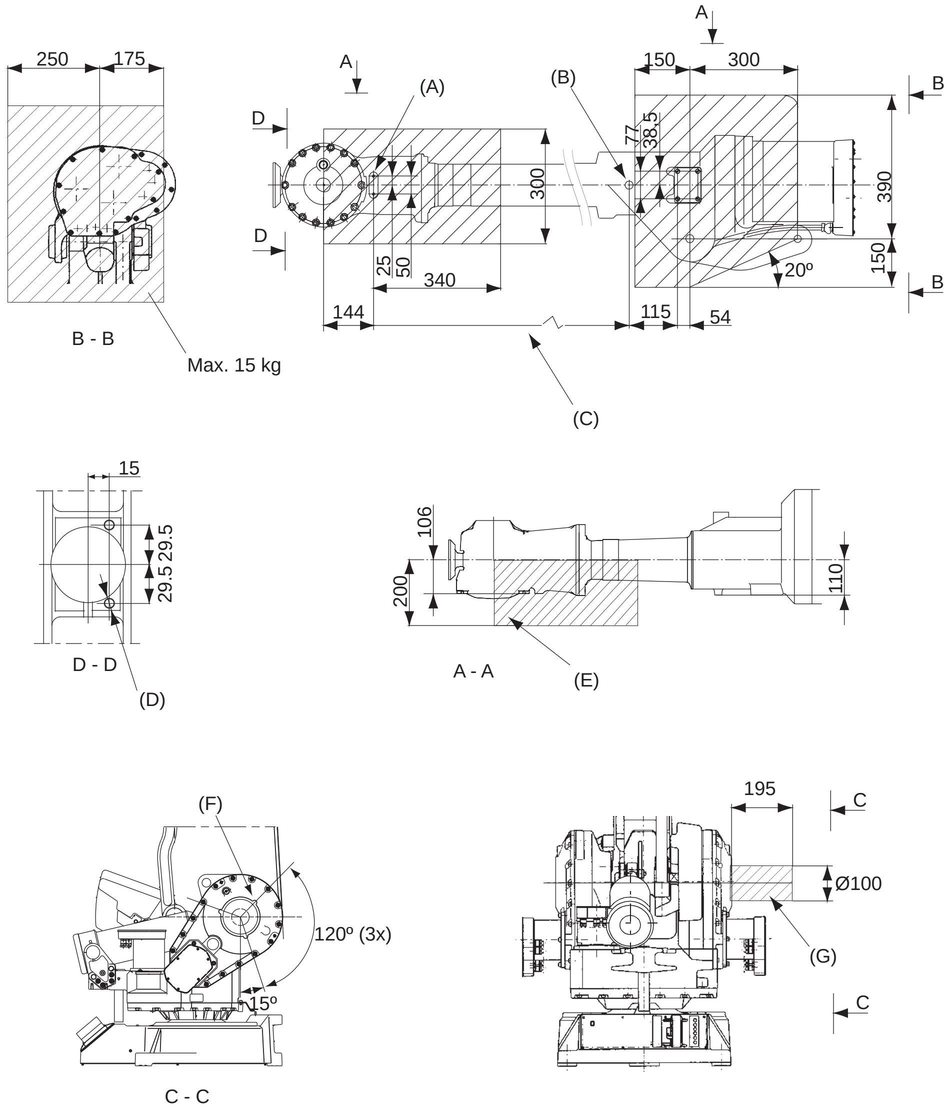
2.4.4 Fitting equipment on the robot

2.4.4.1 Mounting equipment

Upper arm and base

The robot is supplied with tapped holes on the upper arm and on the base for mounting extra equipment.

IRB 4400/60



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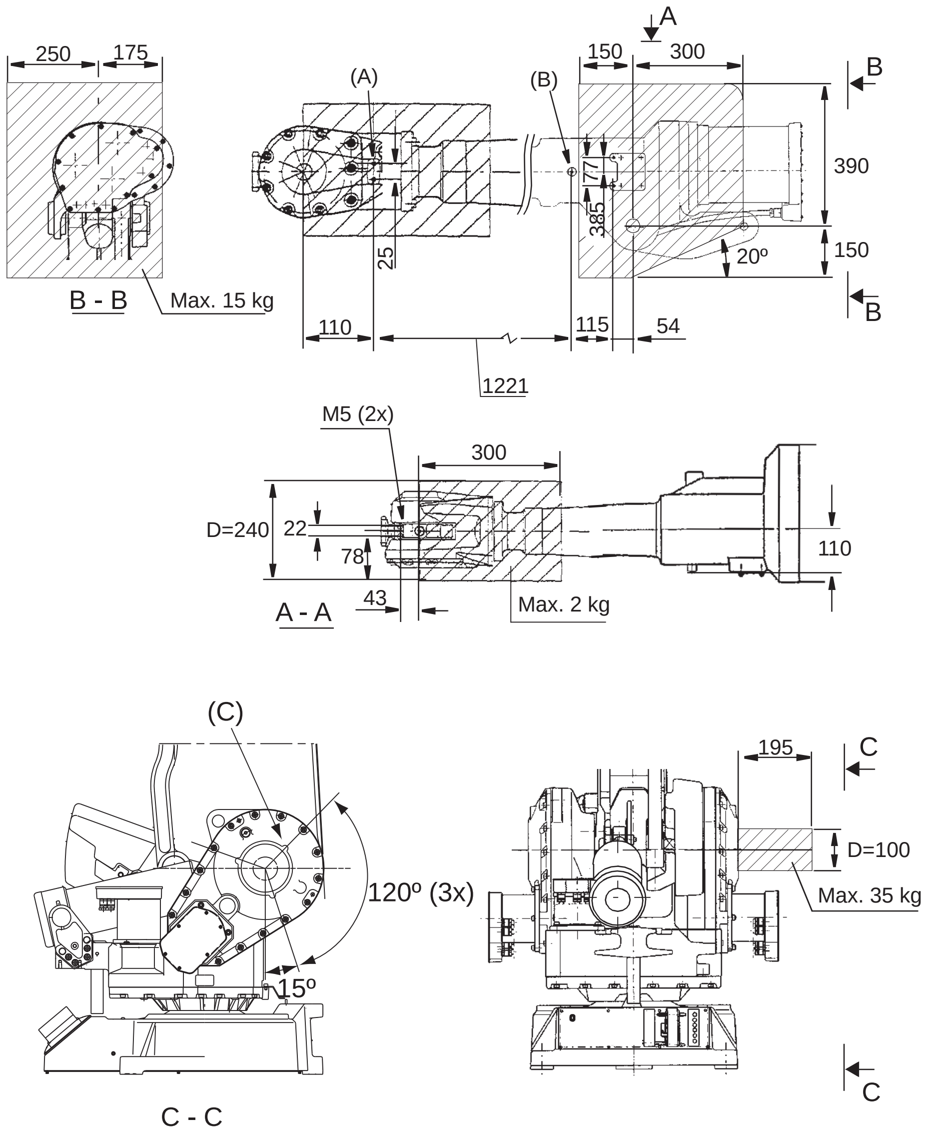
Pos	Description
A	M8 (x2) Used if option 218-6 is chosen, depth of thread 9 mm
B	M8 (x3) Depth of thread 14 mm
C	571 mm

Continues on next page

Pos	Description
D	M6 (2x) tapped depth 12 mm
E	Max. 5 kg at max handling weight
F	M8 (x3) R= 92 mm, depth 16 mm (if option 34-1 is chosen these holes are occupied)
G	Max. 35 kg

IRB 4400/L10



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Pos	Description
A	M8 (x2), depth of thread 9 mm
B	M8 (x3) Depth of thread 14 mm
C	M8 (x3) R= 92 mm, depth of thread 16 mm (If option 34-1 is chosen these holes are occupied)

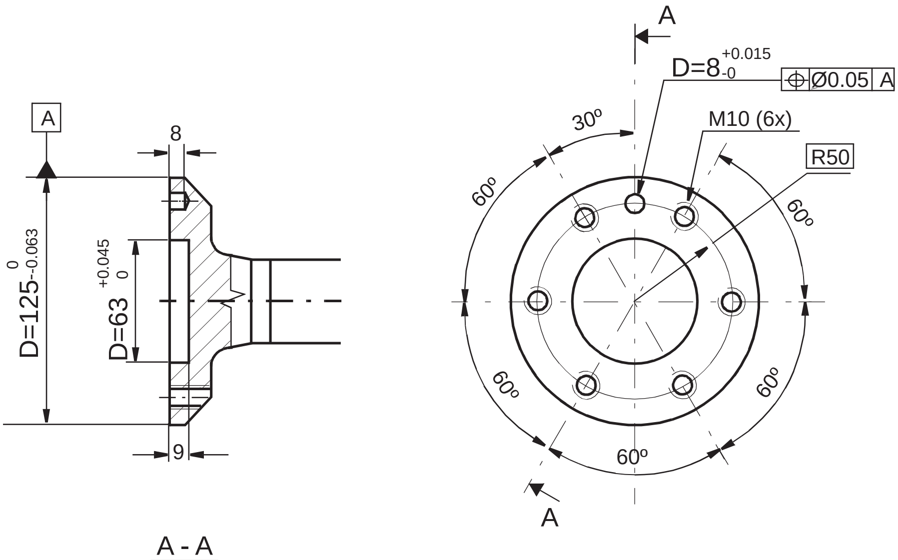
Continues on next page

Note

Maximum loads must never be exceeded!

Tool flange

IRB 4400/60



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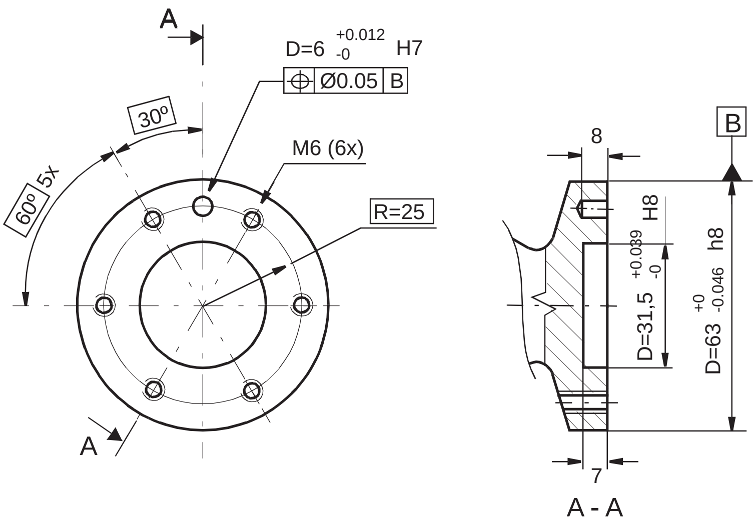
IRB 4400/L10



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For fastening of gripper tool flange to Robot tool flange every one of the screw holes for 6 screws, quality class 12.9 shall be used. Min. 10 mm used thread length.

2.4.5 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.

2.4.6 Installation of signal lamp (option)

Signal lamp

See the assembly instruction delivered with the signal lamp.

2.5 Restricting the working range

2.5.1 Axes with restricted working range

General

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

The working range of the following axes may be restricted:

- Axis 1, hardware (mechanical stop) and software (signal from adjustable position switch)
- Axis 2, hardware (mechanical stop)
- Axis 3, software (signal from 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.

2.5.2 Mechanically restricting the working range of axis 1

Mechanically restricting the working range

The working range of axis 1 can be restricted mechanically by fitting additional mechanical stops to the base, as detailed in this section.

Required equipment

Equipment, etc.	Art. no.	Note
Mechanical stop, axis 1	3HAB3833-1	Includes 2 additional stop lugs, 8 attachment screws, 8 plain washers and a label
Attachment screw	9ADA183-71	4 pcs/lug, included in 3HAB3833-1 M12x60
Washer	9ADA312-9	4 pcs/lug, included in 3HAB3833-1 13x24x2.5
Standard toolkit	3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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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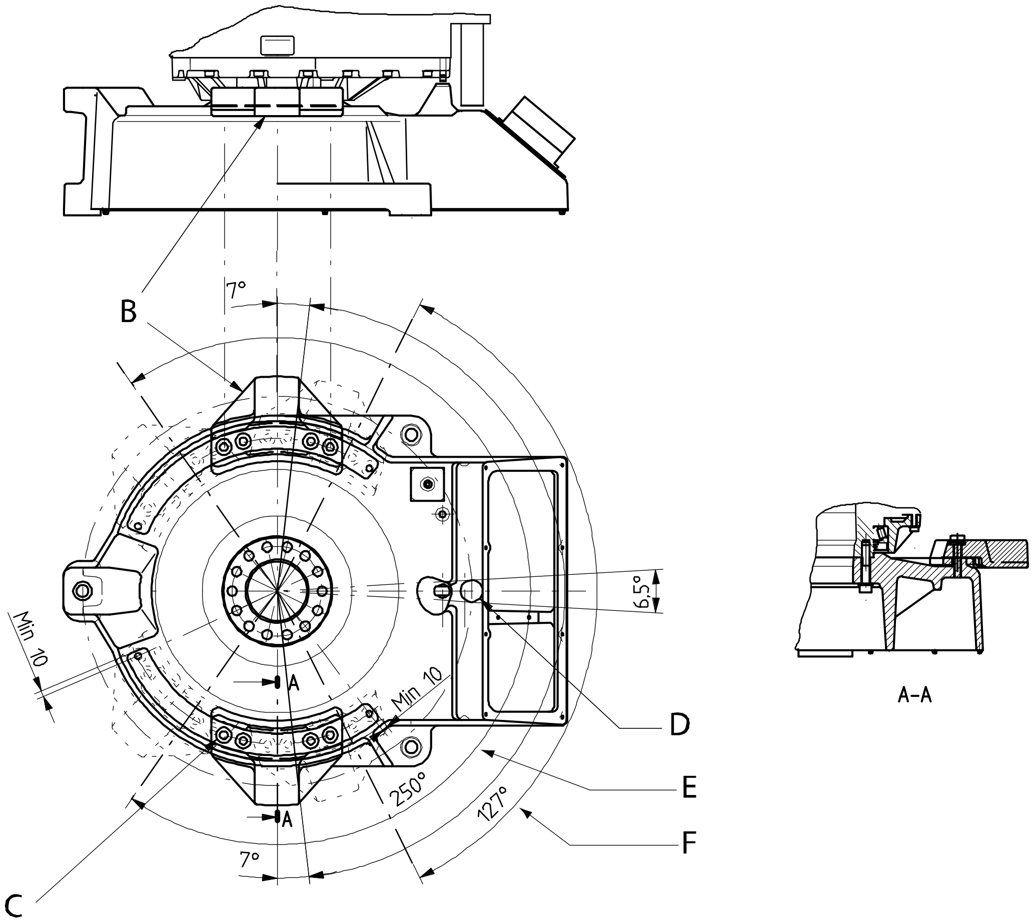
Additional stops

The additional stops are fitted as shown in the figure.



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B	Mechanical stop lugs
C	Attachment screw and washer
D	Max. working range with stop lugs (250°)
E	Stop pin
F	Min. working range with stop lugs (127°)

Fitting, mechanical stop axis 1

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

Mounting instructions are also supplied with the kit.

	Action	Note
1	Determine the position of the stop lugs and mark the hole positions on the base.	See the figure *Additional stops on page 86* for guidance.
2	Drill Ø10.2 mm to a maximum depth of 45 mm and tap with M12 thread. Min. thread depth 35 mm.	

Continues on next page

	Action	Note
3	Fit the stop lugs firmly with *attachment screws and washers* according to the figure *Additional stops on page 86*.	Specified in *Required equipment on page 85*. M12x60, tightening torque: 82 Nm, oil lubrication.

2.5.3 Mechanically restricting the working range of axis 2

Mechanically restricting the working range

The working range of axis 2 can be restricted mechanically by fitting additional mechanical stops (spacers and dampers) to the lower arm and gearbox unit axis 1-3, as detailed in this section. Note that the system parameter configuration must also be adjusted (*Upper joint bound* and *Lower joint bound* for the type *Arm* in the topic *Motion*).

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Mechanical stop, axis 2	3HAC4225-1		Includes spacers, dampers, attachment screws and nuts.
Spacer (damper)	3HAB9185-1		
Spacer	3HAC3962-1		
Standard toolkit		3HAC17594-1	Content is defined in section *Contents, standard toolkit on page 297*.
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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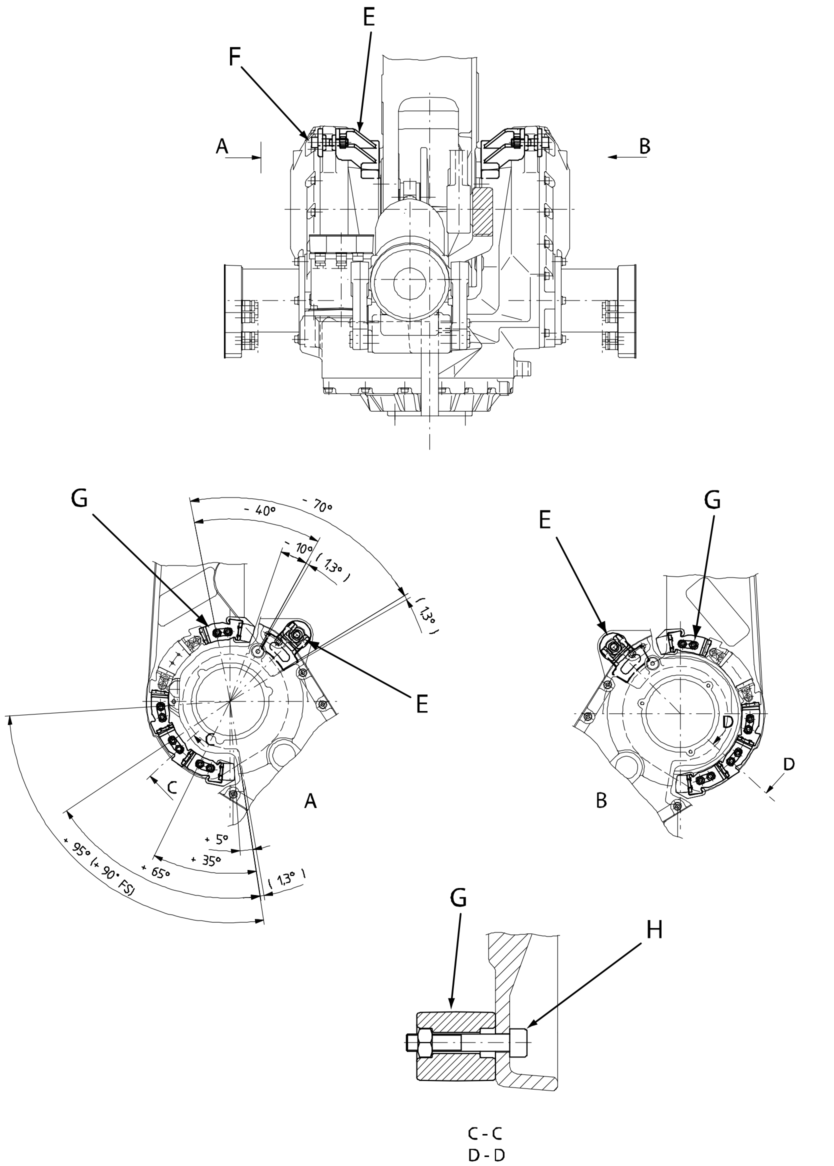
Additional stops

The additional mechanical stops (spacers and dampers) are fitted to the lower arm and the gearbox unit, as shown in the figure below.



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A	View A of the lower arm
B	View B of the lower arm
C	Cut of the mech stop attachment
D	Spacer
E	Attachment screw, spacer (+nut)
F	Damper
G	Attachment screw, damper (+nut)

Continues on next page

Working range

The working range of axis 2 can be restricted according to the table below.

Working range	Damper, qty	Spacer, qty
+95° / -70°	-	-
+95° / -40°	-	2
+95° / -10°	2	2
+65° / -70°	2	-
+65° / -40°	2	2
+65° / -10°	4	2
+35° / -70°	4	-
+35° / -40°	4	2
+35° / -10°	6	2
+5° / -70°	6	-
+5° / -40°	6	2
+5° / -10°	8	2

- Each damper is fitted with: 2 attachment screws and 2 hexagon nuts.
- Each spacer is fitted with: 1 attachment screw and 1 hexagon nut.

Fitting, mechancial stop axis 2

The procedure below details how to fit the additional mechanical stop to the lower arm and the gearbox unit.

Mounting instructions are also supplied with the kit.

	Action	Info/Illustration
1	Determine the working range restriction.	See *Working range on page 90*.
2	Fit both the *spacers* to either side of the gearbox unit, with the *attachment screws and nuts, spacer.*	Shown in the figure *Additional stops on page 89*. Art. no. is specified in *Required equipment on page 88*. Attachment screw: 1 pc/spacer, M16x70. Tightening torque: 156 Nm.
3	Fit the *dampers* to both sides of the lower arm with the *attachment screws and nuts, damper.*	Shown in the figure *Additional stops on page 89*. Art. no. is specified in *Required equipment on page 88*. Attachment screws: 2 pcs/damper, M10x60. Tightening torque: 49 Nm.

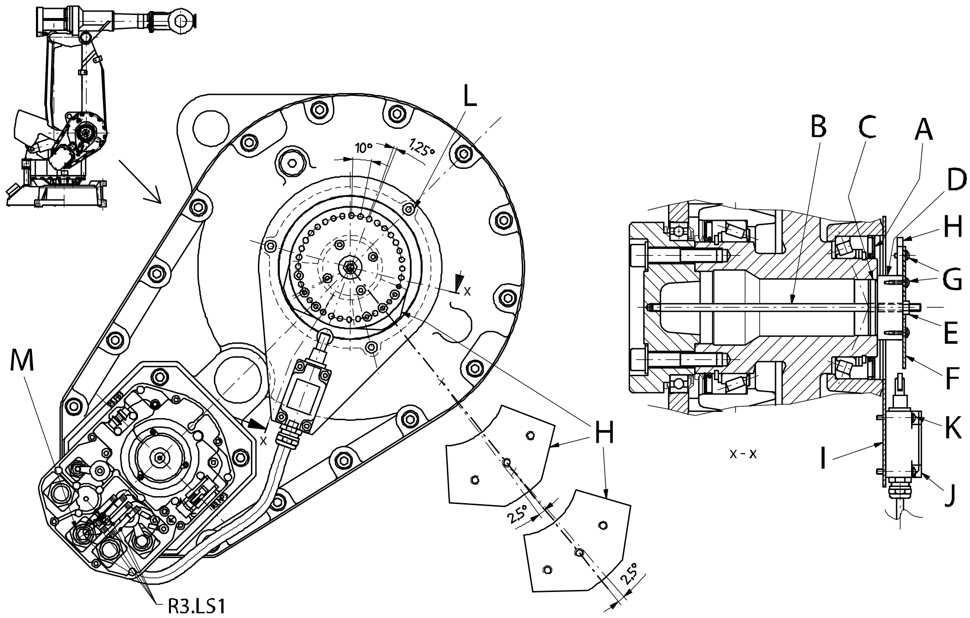
2.5.4 Electrically restricting the working range of axis 3

Electrically restricting the working range

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

Electrical stop

All the separate parts of the electrical stop are fitted to axis 3 as shown in the figure below.



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A	Sealing with dust lip (3HAB 3701-14)
B	Stud (2122 2012-867)
C	All screws are locked with locking liquid
D	Tap (3HAB 3798-1)
E	Hexagon nut (9ADA 267-7)
F	Disc (3HAB 3799-1)
G	Screw (9ADA 618-44)
H	Cam (3HAB 3800-1)
I	Bracket (3HAB 8400-1)
J	Limit switch complete (3HAB 8312-1)
K	Screw (9ADA 629-50)
L	Attachment screw (9ADA 183-35)
M	Retaining ring (9ABA 135-18), reducing coupling (2686 015-3), washer (2152 398-3)

Continues on next page

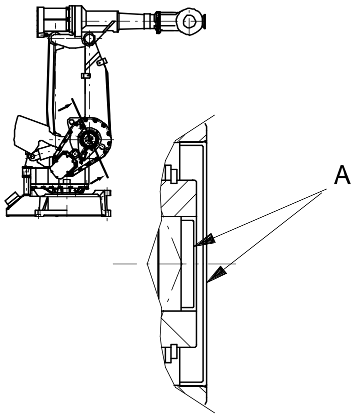
Required equipment

Equipment, etc.	Art. no.	Note
Electrical stop, axis 3	3HAB3795-1	Includes all spare parts shown in the figure *Electrical stop on page 91*.
Locking liquid		Loctite 243
Standard toolkit	3HAC17594-1	Content is defined in section *Contents, standard toolkit on page 297*.
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 diagrams		See chapter *Circuit diagram on page 303*.

Fitting, electrical stop axis 3

The procedure below details how to fit the electrical stop to axis 3.

Mounting instructions are also supplied with the kit.

	Action	Info/Illustration
1	Remove the covers (A) from axis 3.	 xx0300000263
2	All screws are locked with *locking liquid*, when fitted.	Specified in *Required equipment on page 92*.
3	Fit the electrical stop according to the figure *Electrical stop on page 91*.	
4	Adjust the software working range limitations (system parameter configuration) to correspond to the mechanical limitations.	The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.

2.5.5 Unlimited working range

Resetting the work area for an axis

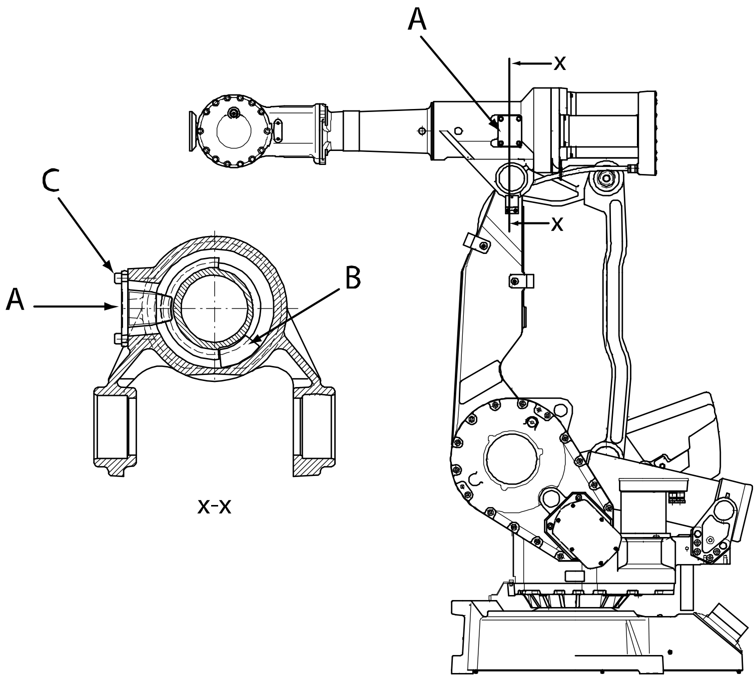
The function *Resetting the work area for an axis*, included in *Advanced Motions 3.0*, can also be used for axis 4. To enable this function, the mechanical stop on axis 4 should be removed. Follow the procedure below to dismantle the mechanical stop.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.

Location of mechanical stop, axis 4

The mechanical stop of axis 4 is located as shown in the figure below.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000176

A	Mechanical stop axis 4
B	Damper axis 4
C	Attachment screws, mechanical stop

Continues on next page

Removal of mechanical stop, axis 4

The procedure below details how to remove the mechanical stop of axis 4, to enable the function *Resetting the work area for an axis*.

WARNING

When the damper is removed from axis 4, the axis does not have a mechanical stop! If the robot is provided with cabling on the upper arm, the cabling can be damaged when the function *Resetting the work area for an axis* is used, or if the robot is jogged uncalibrated.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Loosen the *attachment screws, mech stop* and remove the *mechanical stop, axis 4*.	Shown in the figure *Location of mechanical stop, axis 4 on page 93*.
3	Slowly rotate axis 4 until the damper is visible through the hole.	
4	Remove the damper.	
5	Refit the mechanical stop to the axis 4 with its attachment screws.	4 pcs, M8x16. Tightening torque: 24 Nm.

2.5.6 Risk of tipping/stability

Risk of tipping

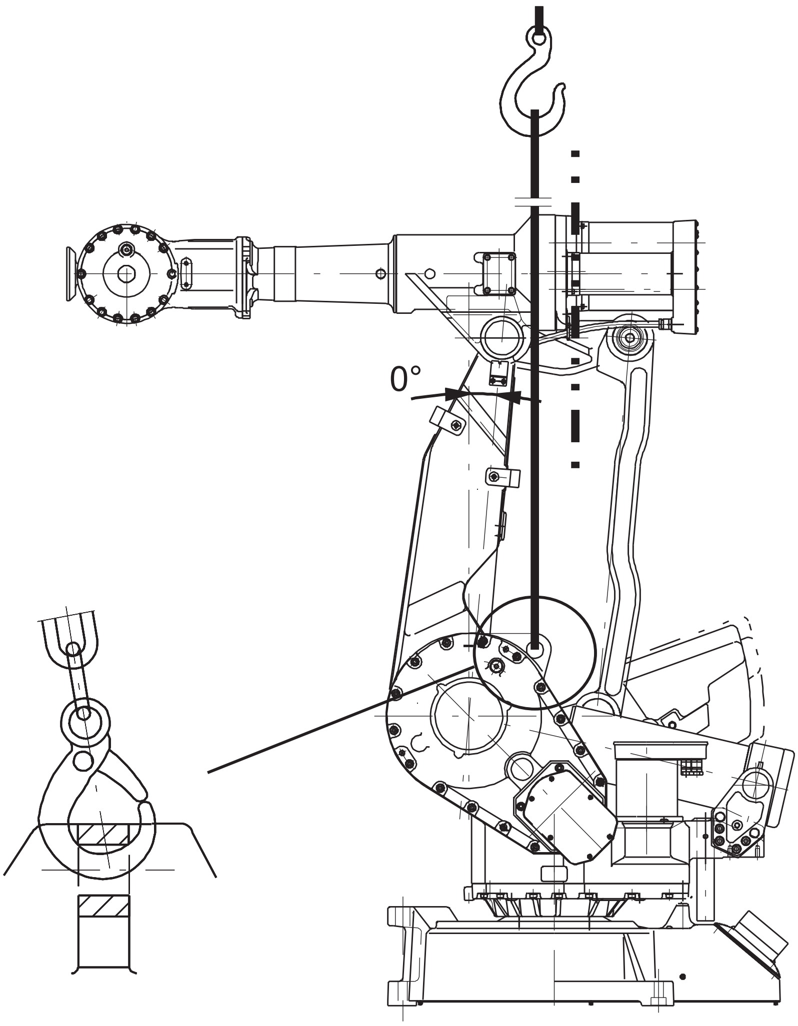
If the robot is not fastened to the foundation and standing still, the robot is not stable in the whole working area. Moving the arms will displace the center of gravity, which may cause the robot to tip over.

The shipping position is the most stable position.

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

Shipping and transport position

This figure shows the robot in its shipping position, which also is a recommended transport position.



xx0300000245

WARNING

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

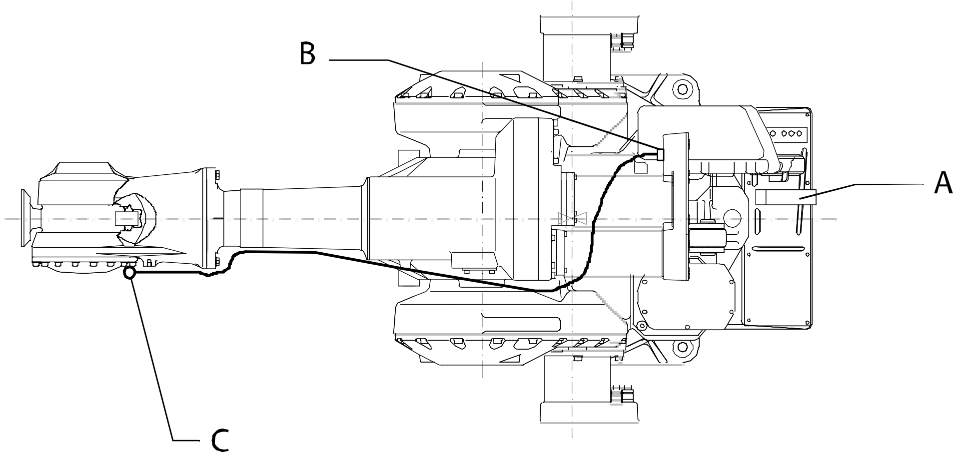
2.6 Electrical connections

2.6.1 Customer connection on robot

Location of customer connection

For the connection of extra equipment to the robot, cables and air hose are integrated into the robot´s cabling, and there is one FCI UT071823SH44N and one FCI UT071412SH44N connector on the rear part of the upper arm.

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



xx0300000270

A	R1.CP, R1.CS, Air R1/4"
B	R2.CP, R2.CS, Air R1/4"
C	R3.CP, R3.CS, Air R1/4"

Extra equipment connections

Connections to the:

- air hose (R1/4") is located on the rear part of the upper arm and at the base. Max. 8 bar. Inner hose diameter: 8 mm.
- signal cabling (option) is located on the front of the upper arm.

Number of signals: 23 (50V, 250mA), 10 (250V, 2A), one protective ground.

Connection sets

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

Connection set	Connector	Art. no.	Content
R1.CP/CS (protection Standard)	R1.CP/CS	3HAC12275-1	• socket for area of 0.14 - 0.5 mm^2 • compression gland for cables, diameter 2 x 12 mm • key pin

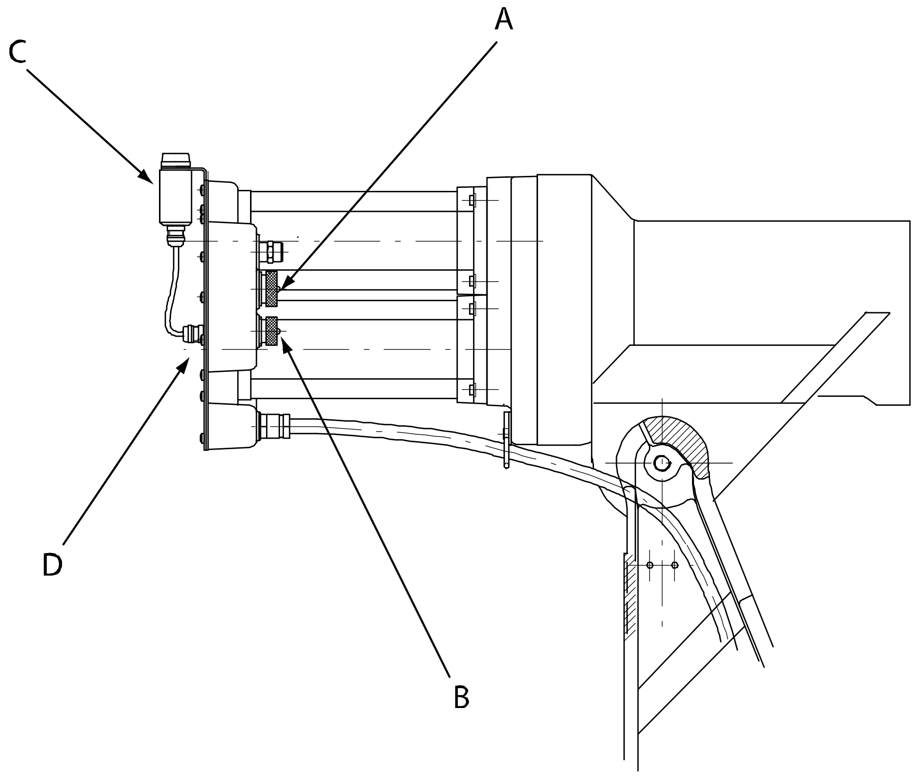
Continues on next page

Connection set	Connector	Art. no.	Content
R1.CP/CS F (protection Foundry Prime)	R1.CP/CS	3HAC12276-1	• socket for area of 0.14 - 0.5 mm^2 • compression gland for cables, diameters 10 mm and 12 mm • key pin
R2.CS/R3.CS	R2.CS/R3.CS	3HAC12327-1	• pins for cable area of 0.13 - 0.25 mm^2 • reduction hose, bottled-shaped • reduction hose, angled
R2.CP/R3.CP	R2.CP/R3.CP	3HAC12326-1	• pins for cable area of 0.13 - 0.25 mm^2 • reduction hose, bottled-shaped • reduction hose, angled

2.6.2 Customer connections on upper arm

Customer connections on upper arm

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



xx0300000269

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

Power supply connections on upper arm

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CPA	XT6.1	R2.CP.A	RI.CP/CS.A1
CPB	XT6.2	R2.CP.B	RI.CP/CS.B1
CPC	XT6.3	R2.CP.C	RI.CP/CS.C1
CPD	XT6.4	R2.CP.D	RI.CP/CS.D1
CPE	XT6.5	R2.CP.E	RI.CP/CS.A2
CPF	XT6.6	R2.CP.F	RI.CP/CS.B2
		R2.CP.G (Earth)	RI.CP/CSP Earth

Continues on next page

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
	XT6.H	R2.CP.H (Key pin)	
CPJ	XT6.7	R2.CP.J	RI.CP/CS.C2
CPK	XT6.8	R2.CP.K	RI.CP/CS.D2
CPL	XT6.9	R2.CP.L	RI.CP/CS.A3
CPM	XT6.10	R2.CP.M	RI.CP/CS.B3

Signal connections on upper arm

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CSA	XT5.1	R2.CS.A	R1.CS/CP.B5
CSB	XT5.2	R2.CS.B	R1.CS/CP.C5
CSC	XT5.3	R2.CS.C	R1.CS/CP.D5
CSD	XT5.4	R2.CS.D	R1.CS/CP.A6
CSE	XT5.5	R2.CS.E	R1.CS/CP.B6
CSF	XT5.6	R2.CS.F	R1.CS/CP.C6
CSG	XT5.7	R2.CS.G	R1.CS/CP.D6
CSH	XT5.8	R2.CS.H	R1.CS/CP.A7
CSJ	XT5.9	R2.CS.J	R1.CS/CP.B7
CSK	XT5.10	R2.CS.K	R1.CS/CP.C7
CSL	XT5.11	R2.CS.L	R1.CS/CP.D7
CSM	XT5.12	R2.CS.M	R1.CS/CP.A8
CSN	XT5.13	R2.CS.N	R1.CS/CP.B8
CSP	XT5.14	R2.CS.P	R1.CS/CP.C8
CSR	XT5.15	R2.CS.R	R1.CS/CP.D8
CSS	XT5.16	R2.CS.S	R1.CS/CP.A9
CST	XT5.17	R2.CS.T	R1.CS/CP.B9
CSU	XT5.18	R2.CS.U	R1.CS/CP.C9
CSV	XT5.19	R2.CS.V	R1.CS/CP.D9
CSW	XT5.20	R2.CS.W	R1.CS/CP.A10
CSX	XT5.21	R2.CS.X	R1.CS/CP.B10

2.7 Additional installation, Foundry Prime

2.7.1 Installation of IRB 4400 in a water jet application

General

Robots delivered with the Foundry Prime protection are specially designed to work in water jet cleaning cells with 100% humidity and alkaline detergent. To ensure that the protection offers the best reliability, some measures are needed during installation of the robot according to the procedures below.

Note

For best reliability, it is also of highest importance that the special maintenance instructions for the Foundry Prime robot are followed and documented.

Commissioning

- Never switch off the overpressure in motors and serial measurement compartment during cooling down of robot after it has been switched off.
- When turning off an cleaning cell we recommend that the humid air inside a cell is ventilated out, to avoid that the humid air is sucked into e.g. gearboxes due to the raised vacuum when cooled down.

Environmental conditions

Humidity	100%
Washing detergent with pH	<9.0
Washing detergent must contain rust inhibitor and be approved by ABB.	
Cleaning bath temperature	<60°C, used in a typical waterjet cleaning application at suitable speed.

Air specification for pressurizing of robot

The air must be dry and clean, such as instrument air. Following table details the air specification.

Dew point	<+2°C at 6 bar
Solid particle size	<5 microns
Oil content	<1 ppm (1 mg/m3)
Pressure to robot	0.2 - 0.3 bar

WARNING

If the pressurized air contains oil, it could result in a brake failure in the motors and cause the robot arms to fall down, leding to personal injure or physical damage.

Continues on next page

WARNING

If the air pressure exceeds the specified, it could result in a brake failure in the motors and cause the robot arms to fall down, leding to personal injure or physical damage.

Note

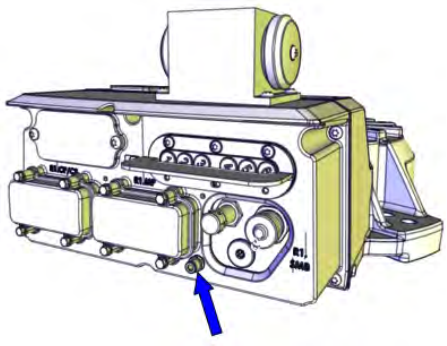
To secure sufficient air pressure, it is recommended to use a pressure sensor.

Pressurize the motors and serial measurement board cavity

The robots are prepared with hoses to the motors and the serial measurement board cavity to enable pressurizing of them.

WARNING

The robot must be pressurized also when it is switch off, to avoid that the humid environmental air is sucked into the motors when cooling down.

	Action	Note/Illustration
1	Connect a compressed air hose to air connector on robot base, see illustration.	 xx1500002398 Dimension: G1/8, d=6mm
2	Protect the screws on the Harting connectors on the robot base from corrosion with Mercasol.	Do this when the controller cables are connected.
3	Pressurize the robot.	See *Air specification for pressurizing of robot on page 100* for correct pressure.
4	Inspect the air system.	See *Inspection of air hoses (Foundry Prime) on page 116*.

Protecting from high pressure water

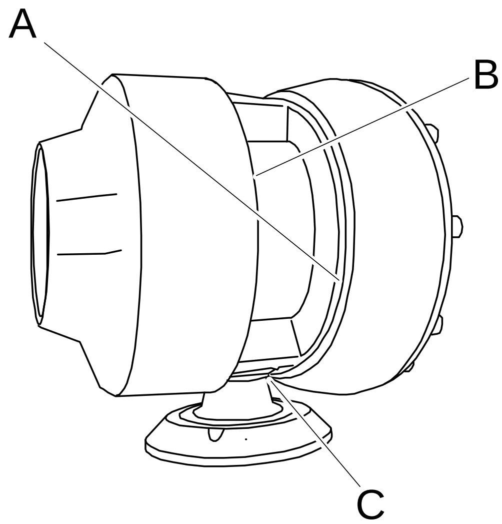
WARNING

No part of the robot are allowed to be exposed to direct high pressure jet of water. The sealings between the moving parts on the wrist must not be exposed to direct or rebounding high-pressure jet of water.

Continues on next page

Protecting the wrist joints

The sealings between the moving parts on the wrist must not be exposed to direct high-pressure water. We recommend that the gripper include a shield that prevents direct water flush on the sealing surfaces of the wrist. The sealings are pointed out in the illustration below.

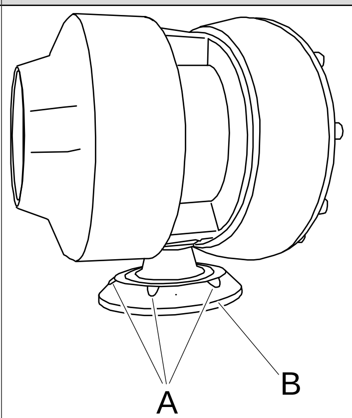


xx0600003108

A	Axis 5, bearing support side
B	Axis 5, bearing gear side
C	Axis 6, mounting flange - gear house

Protecting the wrist flange from corrosion

The mounting surface on the wrist flange is protected with grease. The joint between the wrist flange and the tool and the screw holes on the wrist flange must be protected.

	Action	Note/Illustration
1	After mounting the tool, clean the following surfaces from grease: • the visible surface (not painted) • the rear end of the screw holes and end of screws.	 xx0600003109 A screw holes and screws B unpainted surface
2	Protect these surfaces with Mercasol.	

Continues on next page

	Action	Note/Illustration
3	Before running the robot in a water jet cleaning cell: • perform a inspection of the pressure in motors and SMB cavity.	*Inspection of air hoses (Foundry Prime) on page 116*

2.7.2 Commissioning (Foundry Prime)

General

The following should be taken in consideration when running a robot in a water jet application cell:

CAUTION

Never switch off the overpressure in motors and serial measurement compartment during cooling down of robot after it has been switched off.

Note

To reduce the risk for corrosion due to condensation in gearboxes, it is required that the robot is running with high speed on each axes at least on one occasion each hour. This is to lubricate the gearbox cavities.

Note

When turning off a cleaning cell we recommend that the humid air is ventilated out from the cell, to avoid that the humid air is sucked into gearboxes for example, due to the raised vacuum when cooled down.

3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 4400.

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 4400 is connected to power, always make sure that the IRB 4400 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 Introduction for Foundry Prime robots

Introduction

The Foundry Prime robots are designed for installation and operation in very hard environments. Misuse of the robots, as well as poor installation, cleaning, maintenance, and repair can be harmful for the functioning of the robot.

To eliminate these risks appropriate equipment and procedures are required when installing, cleaning, maintaining, and repairing ABB Foundry Prime robots.

An extended maintenance program including service activities and schedule is required.

Cleaning and maintenance of robots with Foundry Prime protection shall be performed by trained personnel.

Specific maintenance activities and intervals for Foundry Prime

The Foundry Prime robots have specific maintenance activities and intervals compared to standard robots:

- More comprehensive
- More frequent
- Sample activities for check of lubrication
- Conditional - for example, water content in gearbox control/decide replacement intervals

Preventive measures every 6 months secure the uptime of the robot:

- Inspection of oil level in gearboxes
- Surface treatment
- Cable harness
- Balancing device

Activity to lubricate gearboxes cavities and gears

Run each axis on high speed at least one occasion per hour. This activity will lubricate the gearbox cavities and gears, which reduce the risk for corrosion due to condensation in gearboxes.

Non-predictable situations

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

> **Note**
>
> Repair damages on painted surfaces as soon as possible. Use the touch-up kit 3HAC035355-001 for Foundry Prime protection.

Warranty claims

Warranty claims for defect products due to misuse or failure to fulfil operational and maintenance requirements will not be approved.

3.3 Maintenance schedule

3.3.1 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 4400:

- 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 137*. The SIS used in M2004 is further described in the *Operating manual - Service Information System*.

3.3.2 Maintenance schedule

General

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

Unexpected situations that arise prompt inspection of the robot. Any damage must be attended to immediately!

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

Activities and intervals (protection Standard)

The table below specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval	Detailed in section
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [i]	*Replacing the SMB battery on page 118*
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [ii]	*Replacing the SMB battery on page 118*
Replacement	Signal cabling, upper arm (option 042)	12,000 hrs	*Replacement of signal cabling, upper arm (option 042) on page 185*
Inspection	Mechanical stop, axis 1	Regularly [iii]	*Inspection of mechanical stop, axis 1 on page 114*
Change	Oil, gearbox axis 4	12,000 hrs [iv]	*Oil change, gearbox axis 4 on page 128*
Change	Oil, gearbox axes 5 and 6	12,000 hrs iv	*Oil change, gearbox axis 5 and 6 (all robot versions) on page 131*

i 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.

ii 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.

iii Must be replaced if bent!

iv The gearboxes are lubricated for life, which corresponds to 40,000 hours of operation if the robot is operating with an ambient temperature of less than 40° C. If the temperature is higher, the oil must be changed!

Continues on next page

Activities and intervals (protection Foundry Prime)

Robots working with water jet cleaning and that have the special tightness for this application require special maintenance for proper function. The maintenance must be done according to the maintenance schedule in the Product Manual and the following additional maintenance.

Maintenance activity	Equipment	Interval	Detailed in section
Inspection Replacement	Cable harness	6 months If required [i]	*Replacement of cable harness, axes 1-3 on page 153* or *Replacement of cable harness, axes 4-6 on page 158*
Inspection	Mechanical stop, axis 1	Regularly [ii]	*Inspection of mechanical stop, axis 1 on page 114*
Inspection	Air hoses	6 months	*Inspection of air hoses (Foundry Prime) on page 116*
Inspection	Wrist rust protection	6 mths	*Protecting the wrist flange from corrosion on page 102*
Inspection	Surface treatment	6 months [iii]	*Inspection of surface treatment (Foundry Prime) on page 117*
Inspection	Balancing device	6 months	
Changing	Gear oil axes 1-6	6,000 hrs [iv]	*Changing and inspecting oil on page 124*
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [v]	*Replacing the SMB battery on page 118*
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [vi]	*Replacing the SMB battery on page 118*

i Parts that need to be changed according to the maintenance schedule are not covered by warranty.

ii Must be replaced if bent!

iii Damage to painted surfaces must be repaired as soon as possible to avoid corrosion.

iv The gearboxes are lubricated for life, which corresponds to 40,000 hours of operation if the robot is operating with an ambient temperature of less than 40° C. If the temperature is higher, the oil must be changed!

v 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.

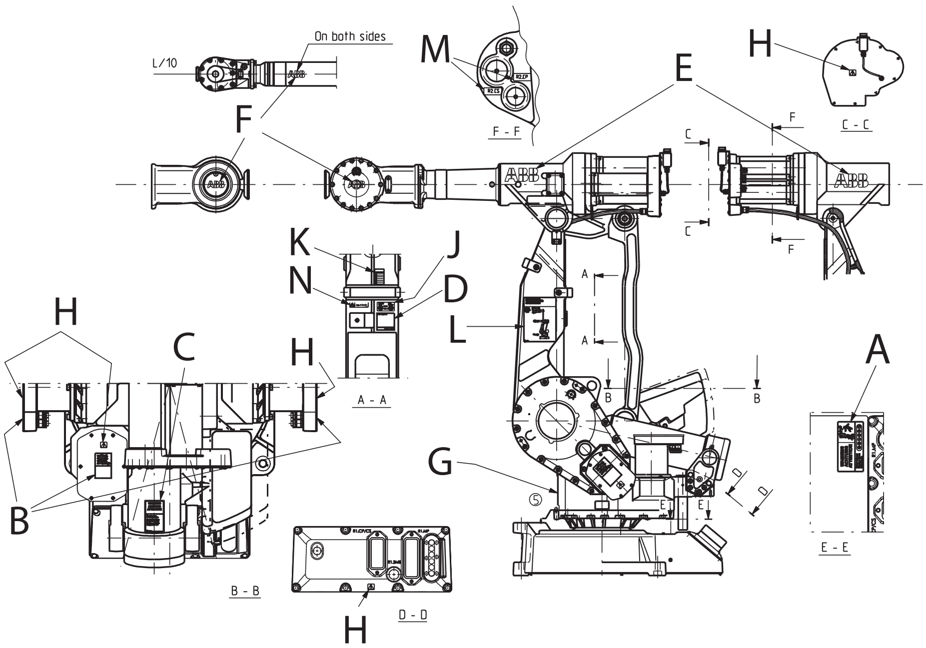
vi The battery low alert (38213 **Battery charge low**) is displayed when remaining backup capacity (robot powered off) is less than 2 months. The typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can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

3.4 Inspection activities

3.4.1 Inspecting information labels

Location of information labels

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



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xx1600001280

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

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 301*.	Labels are sold separately.

Inspecting labels

Use this procedure to inspect the labels on the robot.

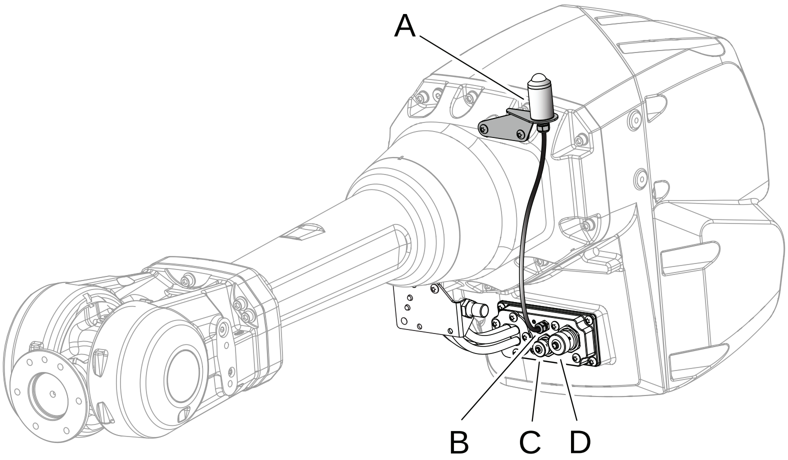
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply to the robot, before entering the robot working area.	
2	Check all labels.	See the figure in *Location of information labels on page 110*.
3	Replace any missing or damaged labels.	

3.4.2 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 297*.
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.

Additional equipment - Foundry Prime

Equipment	Art. no.	Note
Rust preventive	3HAC034903-001	Mercasol
Sikaflex 521FC	3HAC026759-001	
Loctite 574	12340011-116	
Brush		
Foundry Prime touch up kit	3HAC035355-001	

Continues on next page

Inspecting signal lamp

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

Note

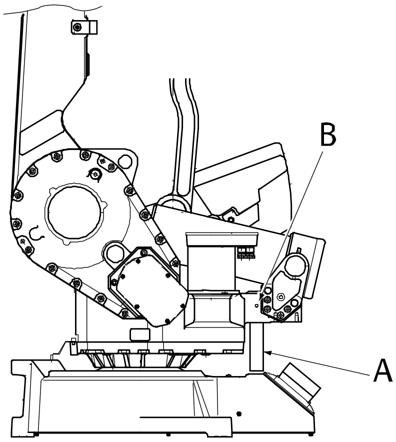
If the signal lamp is damaged, it shall be replaced!

	Action	Note
1	Check that the signal lamp is lit when motors are put in operation ("MOTORS ON").	
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 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 150*.	

3.4.3 Inspection of mechanical stop, axis 1

Location of mechanical stop

The mechanical stop on axis 1 is located on the frame as shown in the figure.



xx0300000182

A	Mechanical stop pin, axis 1
B	Set screw

Required equipment

Equipment, etc.	Spare part no.	Note
Mechanical stop, axis 1	3HAB3647-1	
Standard toolkit		Content is defined in section *Contents, standard toolkit on page 297*.
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.

Inspection

The procedure below details how to inspect the mechanical stop on axis 1

WARNING

If the mechanical stop has been deformed after a hard collision, it must be replaced!

Continues on next page

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Check regularly that the stop pin is not bent or damaged in any other way.	
3	**Note** If the mechanical stop pin has been deformed or damaged, it must be replaced by a new one!	Removal/refitting of the mechanical stop is detailed in section *Fitting, mechanical stop axis 1 on page 86*.
4	Also check that the stop pin is properly attached.	

3.4.4 Inspection of air hoses (Foundry Prime)

General

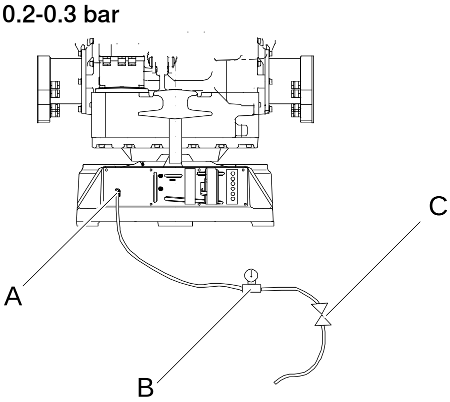
The air hoses on Foundry Prime robots must be inspected for leakage every six months.

Required equipment

Equipment, etc.	Art. no.
Leak detection spray	-
Pressure gauge	-
Cut off valve	-

Procedure

For this test it is recommended that the air supply to the robot has a pressure gauge and a cut-off valve connected.

	Action	Note
1	Apply compressed air to the air connector on robot base, and raise the pressure with the knob until the correct value is shown on the pressure gauge.	Recommended pressure: 0.2-0.3 bar  xx0600003341 • A: Air Connection • B: Pressure gauge • C: Cut off valve
2	Close the cut off valve.	It should take at least 5 seconds for the pressure to reach 0 bar.
3	The time is < 5 seconds: • If the answer is **YES**: Localize the leakage by following the procedures below. • If the answer is **NO**: The system is OK. Remove the leak testing equipment.	
4	Pressurize by opening the cut off valve.	
5	Spray suspected leak areas with *leak detection spray*. Bubbles indicate a leak.	
6	When the leak is localized: correct the leak.	

3.4.5 Inspection of surface treatment (Foundry Prime)

Introduction to inspection of surface treatment

Damage to painted surfaces must be repaired as soon as possible to avoid corrosion. All painted surfaces on the robot must be inspected.

Required equipment

Equipment, etc.	Note
Touch up paint Foundry Prime 2, grey	See Touch up paint for Foundry Prime robots in partlist*Spare Part lists on page 301*.

Additional equipment - Foundry Prime

Equipment	Article number	Note
Rust preventive	3HAC034903-001	Mercasol
Sikaflex 521FC	3HAC026759-001	
Loctite 574	12340011-116	
Brush		
Foundry Prime touch up kit	3HAC035355-001	

Inspection and repair of surface treatment

Use this procedure to inspect the surface treatment on Foundry Prime robots.

	Action	Information
1	Inspect all painted surfaces for damages.	
2	Repair damages as described in the instruction included in the spare part kit.	

3.5 General maintenance activities

3.5.1 Replacing the SMB battery

Note

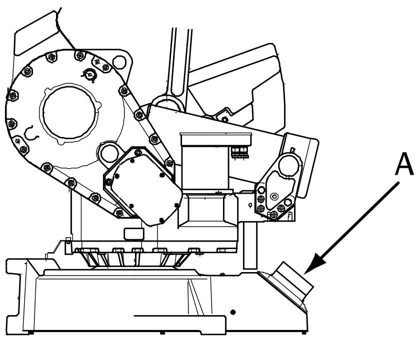
The battery low alert (38213 **Battery charge low**) is displayed when the battery needs to be replaced. The recommendation to avoid an unsynchronized robot is to keep the power to the controller turned on until the battery is to be replaced.

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.

Location of battery pack

The battery pack is fit to the serial measurement unit, located inside the base. To access the unit and battery pack, the rear cover plate shown in the figure below must be removed.



xx0300000106

A	Rear cover plate

Required equipment

Note

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

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

Continues on next page

Equipment, etc.	Note
Battery pack	For spare part number, see *Spare Parts - Serial measurement unit*.
Standard toolkit	The contents are defined in section *Contents, standard toolkit on page 297*.
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, battery pack

The procedure below details how to replace the battery pack in the serial measurement unit.

Step	Action	Info/Illustration
1	 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 53*	
2	Set the robot to the MOTORS OFF operating mode. This way the robot does not need to be calibrated after the battery change.	
3	Remove the *rear cover plate* from the base.	Shown in the figure *Location of battery pack on page 118*.
4	Loosen the battery terminals from the serial measuring board and cut the clasps that keep the battery pack in place.	
5	Remove the old battery pack.	
6	Fit a new *battery pack* with two clasps and connect the terminals to the serial measuring board.	

3.5.2 Cleaning the IRB 4400

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 4400 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 4400.

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 110*.
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!

Never!

- Never point the water jet at connectors, joints, sealings, or gaskets!
- Never use compressed air to clean the robot!

Continues on next page

- 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 Prime	Yes	Yes. With cleaning detergent approved by ABB, spirit or isopropyl alcohol. See *Approved cleaners and detergents on page 122*.	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. If cleaning detergents are used they must be approved by ABB for Foundry Prime robots. See *Approved cleaners and detergents on page 122*.

i Perform according to section *Cleaning with water and steam on page 121*.

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
- 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]

1 See *Cleaning methods on page 121* for exceptions.

2 See *Cleaning methods on page 121* for exceptions.

Continues on next page

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

Additional cleaning instructions for Foundry Prime robots

Washing detergents

- Only washing detergents approved by ABB shall be used.
- The washing detergent must be cleansed continuously.
- The washing detergent must contain rust inhibitor.
- The detergent pH value and concentration must be checked regularly.
- Maximum allowed pH of the washing detergent is 9.0, if not stated otherwise.
- The user must follow the recommendations regarding detergent concentration and pH value.
- No other additive than water is guaranteed without prior testing or agreement with ABB. Other additives than water may have a harmful effect on the life of the robot and its components.
- Recommendations given by the detergent manufacturer for the specific detergent in question must be followed.

Note

If the pH value or the detergent concentration is varying from its original specification, it can become very corrosive.

Approved cleaners and detergents

All cleaners and detergents must be approved by ABB before use. Contact ABB Robotics Sales Support to get the latest released list of approved cleaners and detergents.

Temperature of cleaning bath

- Maximum temperature <60ºC.

  Ambient temperature must not be higher than +45° C.

Note

Make sure that the special Foundry Prime painting of the robot is not broken during testing, installation, or repair work. Use the touch up kit available for Foundry Prime (article number 3HAC035355-001) to repair any damages in the paint.

Washing without detergent

If the washing is performed without detergent, the water must contain rust inhibator.

Continues on next page

Cables

Movable cables need to be able to move freely:

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

3.6 Changing and inspecting oil

3.6.1 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 Foundy Prime robots before doing any repair work, see *Replacing parts on the robot on page 150*.

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.

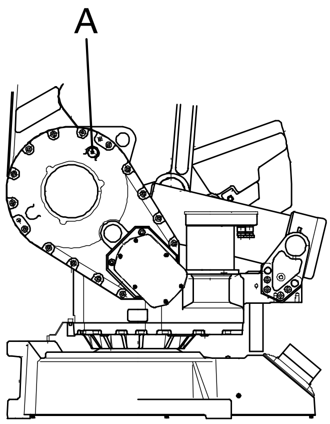
Equipment

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	

3.6.2 Inspection of oil levels

Location of oil plugs, axes 2 and 3

The oil plug, filling for the gearbox unit, axes 2 and 3, is located as shown in the figure below. The figure shows the location of the axis-2-side and is the same on the opposite side.

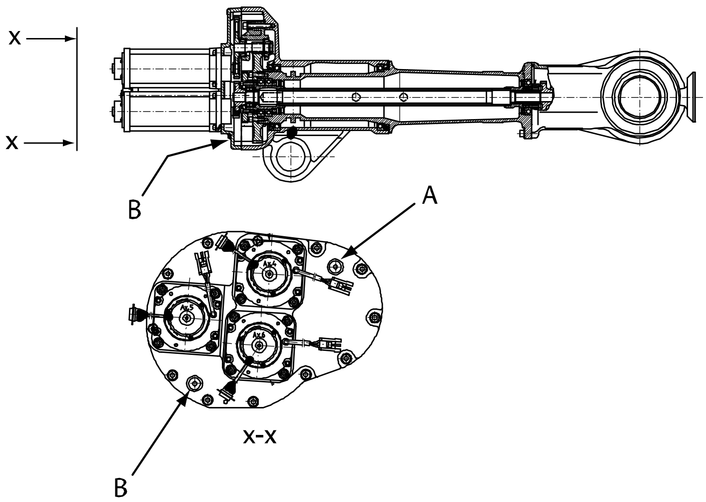


xx0300000331

A	Oil plug, filling

Location of oil plugs, axis 4

The axis 4 gearbox has one oil plug for draining and one oil plug for filling, located as shown in the figure below.



xx0300000220

A	Upper oil plug, filling
B	Lower oil plug, draining

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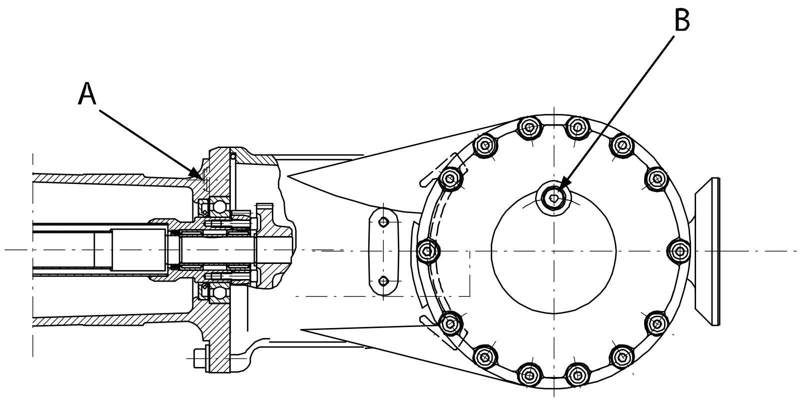
Location of oil plugs, axes 5 and 6 (all robot versions)

The wrist unit has two oil plugs for draining and one oil plug for filling, located as shown in the figure below.



xx0300000223

A	Oil plug, draining (2 pcs, the other oil plug not shown in figure)
B	Oil plug, filling (also used for draining)

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Standard toolkit		3HAC17594-1	Content is defined in section *Contents, standard toolkit on page 297*.
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.

Inspection, oil level axis 2-3

The procedure below details how to inspect the oil level of the gearbox unit, axes 2-3.

	Action	Note/Illustration
1	Remove the *oil plug, filling*.	Shown in the figure *Location of oil plugs, axes 2 and 3 on page 125*.
2	Measure the oil level from the oil plug hole. Required oil level: 225 mm ± 25 mm.	The oil must cover at least half of the lower arm bearing!
3	Fill or drain, if necessary.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*.
4	Clean and refit the oil plug.	

Continues on next page

Inspection, oil level axis 4

The procedure below details how to inspect the oil level of the gearbox, axis 4.

WARNING

Changing and draining gearbox oil may require handling hot oil of up to 90 °C! Make sure that protective gear like goggles and gloves are always worn during this activity.

Also, be aware of possible pressure build up in gearbox! When opening the oil plug, there may be pressure present in the gearbox, causing oil to spray from the opening!

WARNING

When filling gearbox oil, do not mix different types of oil as this may cause severe damage to the gearbox! Always use the type of oil specified by the manufacturer!

If the oils are mixed, the gearbox must be thoroughly rinsed! Contact ABB for further instructions!

	Action	Info/Illustration
1	Move the upper arm to a horizontal position (calibration position).	
2	Remove the *upper oil plug, filling*.	Shown in the figure *Location of oil plugs, axis 4 on page 125*.
3	Required oil level: 4 mm to the edge of the oil plug hole.	
4	Fill with *lubricating oil*, if necessary.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*.
5	Refit the oil plug.	

Inspection, oil level axis 5 and 6 (all robot versions)

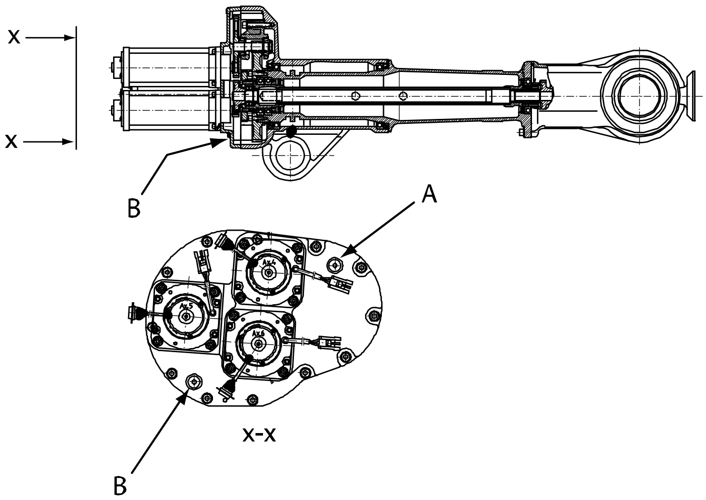
The procedure below details how to inspect the oil level of wrist unit, axis 5 and 6 for all robot versions.

	Action	Note/Illustration
1	Move the robot to the calibration position.	
2	Remove one of the *oil plugs, draining* at the rear of the wrist.	Shown in the figure *Location of oil plugs, axes 5 and 6 (all robot versions) on page 126*.
3	Required oil level: on level with the edge of the oil plug hole.	
4	Fill with *lubricating oil*, if necessary	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*.
5	Refit the oil plug.	

3.6.3 Oil change, gearbox axis 4

Location of oil plugs

The axis 4 gearbox has one oil plug for draining and one oil plug for filling, located as shown in the figure below.



xx0300000220

A	Upper oil plug, filling
B	Lower oil plug, draining

Required equipment

Equipment, etc.	Art. no.	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 124*.
Standard toolkit	3HAC17594-1	Content is defined in section *Contents, standard toolkit on page 297*.
Oil collecting vessel		The capacity of the vessel must be sufficient to take the complete amount of oil.
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.

Draining

The procedure below details how to drain the oil from the gearbox, axis 4.

Tip

When changing gearbox oil, first run the robot for a time to heat up the oil. Warm oil drains quicker than cold oil.

Continues on next page

WARNING

Changing and draining gearbox oil may require handling hot oil of up to 90 °C! Make sure that protective gear like goggles and gloves are always worn during this activity.

Also, be aware of possible pressure build up in gearbox! When opening the oil plug, there may be pressure present in the gearbox, causing oil to spray from the opening!

	Action	Info/Illustration
1	Move the arms backward and the upper arm to a nearly vertical position.	
2	Remove the *lower oil plug, draining* and drain the oil into an oil collecting vessel.	Shown in the figure *Location of oil plugs on page 128*. Capacity of the oil collecting vessel is specified in *Required equipment on page 128*.
3	Clean and refit the oil plug.	

Filling

The procedure below details how to refill the oil to the gearbox, axis 4.

Note

The specified amount of oil is based on the total volume of the gearbox. When changing the oil, the amount of refilled oil may differ from the specified amount, depending on how much oil has previously been drained from the gearbox.

WARNING

When filling gearbox oil, do not mix different types of oil as this may cause severe damage to the gearbox! Always use the type of oil specified by the manufacturer!

If the oils are mixed, the gearbox must be thoroughly rinsed! Contact ABB for further instructions!

WARNING

When filling gearbox oil, do not overfill, since this could lead to internal over-pressure inside the gearbox which in turn may:

- - damage seals and gaskets
- - completely press out seals and gaskets
- - prevent the manipulator from moving freely

	Action	Note/Illustration
1	Move the upper arm to a vertical position (rear end upwards).	

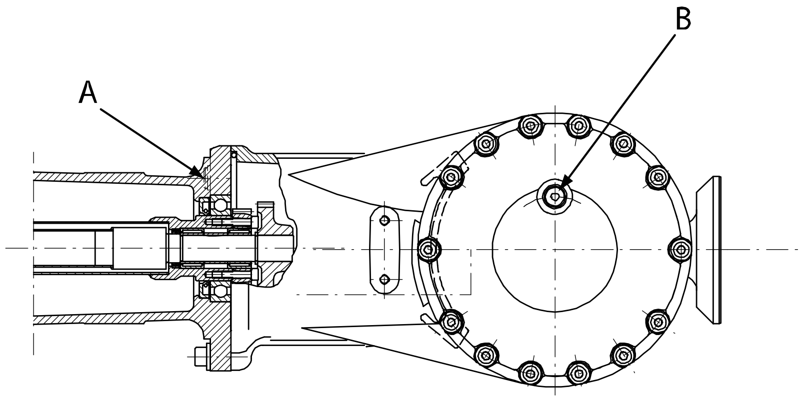
Continues on next page

	Action	Note/Illustration
2	Remove the *upper oil plug, filling*.	Shown in the figure *Location of oil plugs on page 128*.
3	Fill the gearbox with *lubricating oil*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*. Correct oil level is specified in section *Inspection of oil levels on page 125*.
4	Clean and refit the oil plug.	

3.6.4 Oil change, gearbox axis 5 and 6 (all robot versions)

Location of oil plugs

The wrist unit has two oil plugs for draining and one oil plug for filling, located as shown in the figure below.



xx0300000223

A	Oil plug, draining (2 pcs, the other oil plug not shown in figure)
B	Oil plug, filling (also used for draining)

Required equipment

Equipment, etc.	Art. no.	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 124*.
Standard toolkit	3HAC17594-1	Content is defined in section *Contents, standard toolkit on page 297*.
Oil collecting vessel		The capacity of the vessel must be sufficient to take the complete amount of oil.
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.

Draining oil

The procedure below details how to drain the oil from the wrist unit (axis 5 and 6).

Tip

When changing gearbox oil, first run the robot for a time to heat up the oil. Warm oil drains quicker than cold oil.

Continues on next page

WARNING

Changing and draining gearbox oil may require handling hot oil of up to 90 °C! Make sure that protective gear like goggles and gloves are always worn during this activity.

Also, be aware of possible pressure build up in gearbox! When opening the oil plug, there may be pressure present in the gearbox, causing oil to spray from the opening!

	Action	Info/Illustration
1	Move the upper arm to a horizontal position and turn axis 4 to the calibration position.	
2	Turn axis 4, 135°.	
3	Remove the lower *oil plug, draining* at the rear of the wrist.	Shown in the figure *Location of oil plugs on page 131*. Capacity of oil collecting vessel is specified in *Required equipment on page 131*.
4	Remove the other oil plug, draining.	
5	Move axis 3 up -15° and let the oil run out for a couple of minutes.	
6	Turn axis 4 so that the *oil plug, filling* is facing downwards.	Shown in the figure *Location of oil plugs on page 131*.
7	Remove the *oil plug, axis 5* to drain the oil.	
8	Move axis 3 down to 0°.	
9	Move axis 4 backwards and forwards a couple of times to drain all the oil.	
10	Clean and refit the both *oil plugs, draining*.	

Filling oil

The procedure below details how to fill oil to the wrist unit (axis 5 and 6).

Note

The specified amount of oil is based on the total volume of the gearbox. When changing the oil, the amount of refilled oil may differ from the specified amount, depending on how much oil has previously been drained from the gearbox.

WARNING

When filling gearbox oil, do not mix different types of oil as this may cause severe damage to the gearbox! Always use the type of oil specified by the manufacturer!

If the oils are mixed, the gearbox must be thoroughly rinsed! Contact ABB for further instructions!

Continues on next page

WARNING

When filling gearbox oil, do not overfill, since this could lead to internal over-pressure inside the gearbox which in turn may:

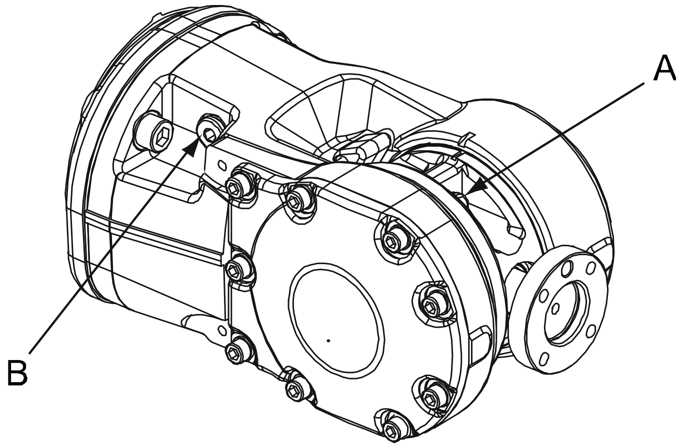
- - damage seals and gaskets
- - completely press out seals and gaskets
- - prevent the manipulator from moving freely

	Action	Note/Illustration
1	Move the upper arm to a horizontal position and turn axis 4 to calibration position.	
2	Turn axis 4 so that the *oil plug, filling* is facing upwards.	Shown in the figure *Location of oil plugs on page 131*.
3	Fill the wrist with *lubricating oil* through the oil plug hole, filling. Fill in intervals so that the oil runs into the wrist.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*. Correct oil level is specified in section *Inspection of oil levels on page 125*.
4	Clean and refit the oil plug, filling.	

3.6.5 Oil change, gearbox axis 5 and 6 (IRB 4400/L10 only)

Location of oil plugs

The wrist unit has one oil plug for draining the oil and one oil plug for filling, located as shown in the figure below. The oil plug for filling is also used as an air inlet when draining the oil.



xx0300000118

A	Oil plug, draining
B	Oil plug, filling (also used as air inlet when draining)

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Lubricating oil		3HAC0860-1	Optimol Optigear BM 100 Volume: 800 ml
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Oil collecting vessel			Capacity: 1000 ml
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.

Draining oil

The procedure below details how to drain the oil from the wrist unit (axis 5 and 6), robot version IRB 4400/L10.

> **Tip**
>
> When changing gearbox oil, first run the robot for a time to heat up the oil. Warm oil drains quicker than cold oil.

Continues on next page

WARNING

Changing and draining gearbox oil may require handling hot oil of up to 90 °C! Make sure that protective gear like goggles and gloves are always worn during this activity.

Also, be aware of possible pressure build up in gearbox! When opening the oil plug, there may be pressure present in the gearbox, causing oil to spray from the opening!

Step	Action	Info/Illustration
1	Move the upper arm to a horizontal position and turn axis 4 to the calibration position.	
2	Remove the *oil plug, draining* in the wrist.	Shown in the figure *Location of oil plugs on page 134*.
3	Turn axis 4 to a position where the *oil plug, draining* is faced downwards and drain the oil into an *oil collecting vessel*. Also remove the *oil plug, filling*, in order to use it as an air inlet.	Shown in the figure *Location of oil plugs on page 134*. Capacity of vessel is specified in *Required equipment on page 134*.
4	Turn axis 4 another 90° to allow the remaining oil to be drained.	
5	Clean and refit the oil plug, draining.	

Filling oil

The procedure below details how to fill oil to the wrist unit (axis 5 and 6), robot version IRB 4400/L10.

Note

The specified amount of oil is based on the total volume of the gearbox. When changing the oil, the amount of refilled oil may differ from the specified amount, depending on how much oil has previously been drained from the gearbox.

WARNING

When filling gearbox oil, do not mix different types of oil as this may cause severe damage to the gearbox! Always use the type of oil specified by the manufacturer!

If the oils are mixed, the gearbox must be thoroughly rinsed! Contact ABB for further instructions!

WARNING

When filling gearbox oil, do not overfill, since this could lead to internal over-pressure inside the gearbox which in turn may:

- - damage seals and gaskets
- - completely press out seals and gaskets
- - prevent the manipulator from moving freely

Continues on next page

Step	Action	Note/Illustration
1	Move the upper arm to a horizontal position and turn axis 4 to the calibration position.	
2	Fill the wrist with *lubricating oil* through the oil plug hole, filling.	Art. no. and amount are specified in *Required equipment on page 134*. Correct oil level is specified in section *Inspection, oil level axis 5 and 6 (all robot versions) on page 127*.
3	Clean and refit the oil plug, filling.	

3.7 Service Information System, M2000

3.7.1 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 138*.
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 141*.
3	Enter these parameters in the system.	How to do this is detailed in *Setting the SIS parameters on page 142*.
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 138*.
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 143*.
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 144*.

3.7.2 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 142*. 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 143*.

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 142*.
Remaining time	Remaining time to next scheduled service date.

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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 143*.

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 142*.
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 143*.

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 144*!

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.

3.7.3 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

3.7.4 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 141*.

3.7.5 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 142*. Proceed with the required service as detailed in chapter *Repair on page 145* or chapter *Maintenance on page 105* 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 142*.
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 142*. Proceed with the required service as detailed in chapter *Repair on page 145* or chapter *Maintenance on page 105* 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 142*.
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 145* or chapter *Maintenance on page 105* 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 142*.

3.7.6 Exporting the SIS data

General

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

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

Definitions

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

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

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes all repair activities recommended for the IRB 4400 and any external unit.

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

The procedures are gathered in sections, divided according to the component location on the IRB 4400.

Required equipment

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

The details of equipment are also available in different lists in the chapter *Reference information on page 289*.

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 4400 is connected to power, always make sure that the IRB 4400 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 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

Continues on next page

grease when mounted, as excessive grease will be pressed out from the bearing when the robot is started.

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

Grease the different types of bearings as following description:

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

4.2.2 Mounting instructions for 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 148*.
4	Mount the seal correctly with a mounting tool. Never hammer directly on the seal as this may result in leakage.	

Continues on next page

Flange seals and static seals

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

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

O-rings

The following procedure describes how to fit o-rings.

	Action	Note
1	Ensure that the correct o-ring size is used.	
2	Check the o-ring for surface defects, burrs, shape accuracy, and so on.	Defective o-rings may not be used.
3	Check the o-ring grooves. The grooves must be geometrically correct and should be free of pores and contamination.	Defective o-rings may not be used.
4	Lubricate the o-ring with grease.	
5	Tighten the screws evenly while assembling.	

4.2.3 Replacing parts on the robot

General

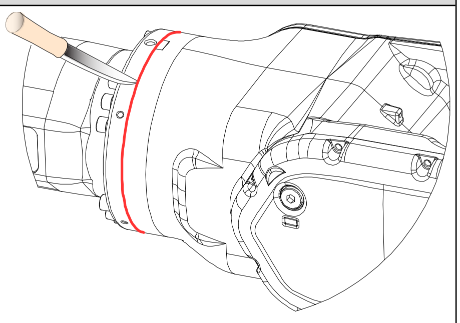
Follow the procedures in this section whenever breaking the surface paint of the robot during replacement of parts.

When replacing parts on a robot with protection type Foundry Prime, it is important to make sure that after the replacement, no surface without paint is exposed to the aggressive working environment.

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		
Rust preventive		Mercasol
Brush		
Touch up paint Foundry Prime 2, Grey	3HAC035355-001	The grey touch up paint is used on all Foundry Prime robots, regardless of the original color of the robot.
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.	

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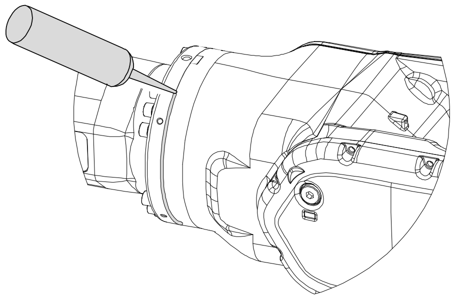
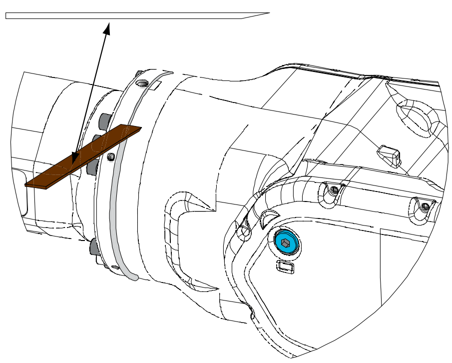
	Action	Description
3	Seal all refitted joints with Sikaflex 521FC.	 xx0900000122
4	Use the tooling pin to even out the surface of the Sikaflex seal.	 xx0900000125
5	Wait 15 minutes.	Sikaflex 521FC skin dry time (15 minutes).
6	Use Touch up paint Foundry Prime 2, grey to paint the joint. **Note** Always read the instruction in the product data sheet in the paint repair kit for Foundry Prime.	3HAC035355-001
7	Apply Mercasol on all screw heads and set screws after tightening.	

4.2.4 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.	

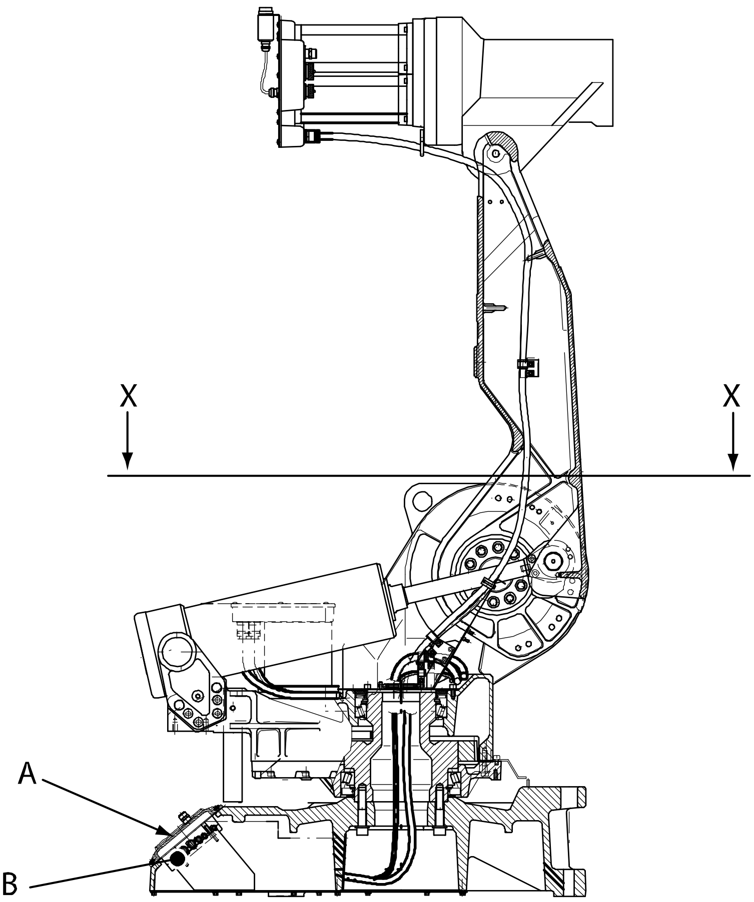
4.3 Complete robot

4.3.1 Replacement of cable harness, axes 1-3

Location of cable harness, axes 1-3

The cable harness of axes 1-3 is located throughout the axis 1 of the robot as shown in the figure below. Also see the following figure for the view X-X.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000111

A	Rear cover plate
B	Connectors at the base. Connectors at the rear cover plate: R1.MP, R1.SMB, R1.CP/CS, R2.MP4-6. Brake release connectors: R2.BU, R2.BU1-3, R2.BU4-6. Connectors at serial measurement unit: R2.SMB, R2.FB1-3, R2.FB4-6.

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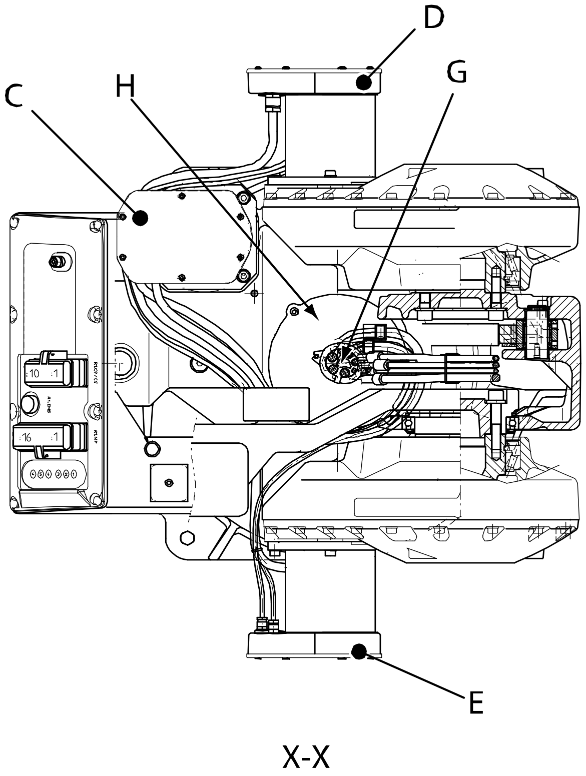
Location of cable harness, view X-X

The cable guides in the middle of axis 1 are located as shown in the figure below.



xx0300000110

C	Connection box, motor 1. Connectors at motor 1: R3.MP1, R3.FB1.
D	Connection box, motor 2. Connectors at motor 2: R3.MP2, R3.FB2.
E	Connection box, motor 3. Connectors at motor 3: R3.MP3, R3.FB3.
G	Cable guides in the middle of axis 1
H	Protection plate

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable harness, axes 1-3	See *Product manual, spare parts - IRB 4400*.		IRB 4400 (all models)
Gasket	3HAC4432-1		Between the motor and the connection box, axes 1, 2 and 3. Replace if damaged.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, cabling axes 1-3

The procedure below details how to remove the cable harness from the axes 1-3.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the *rear cover plate*.	Shown in the figure *Location of cable harness, axes 1-3 on page 153*.
3	Remove the serial measurement unit.	Removal detailed in section *Removal, serial measurement unit on page 216*.
4	Loosen the connectors *R1.MP1, R2.FB1-3, R2.BU, R2.BU1-3*. Also loosen the earth connections.	Shown in the figure *Location of cable harness, axes 1-3 on page 153*.
5	Cut all the ties around bundle.	
6	Remove the cable bracket inside the base.	
7	Remove the *cable guides* and the *protection plate* in the middle of axis 1.	Shown in the figure *Location of cable harness, view X-X on page 154*.
8	Remove the covers from the connections boxes for the motors in axes 1-2-3.	
9	Loosen all the connectors to the motors of axes 1-2-3.	Shown in the figure *Location of cable harness, view X-X on page 154*.
10	Remove the connection boxes from the motors 1-2-3.	
11	Feed the cabling up through the middle of axis 1 and remove the complete cabling. **Tip!** Gather the loose cabling and connectors into a package with tape in order to protect the connectors and make the cabling easier to handle.	

Continues on next page

Refitting, cabling axes 1-3

The procedure below details how to refit the cable harness to axes 1-3.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Feed the *cable harness, axes 1-3* through the protection plate and down through the middle of axis 1. **Tip** Gather the loose cabling and connectors into a package with tape in order to protect the connectors and make the cabling easier to handle.	Part no. is specified in *Required equipment on page 154*
3	Refit the connection boxes to the motors 1-2-3. Replace the *gaskets* if they are damaged.	Part no. is specified in *Required equipment on page 154*
4	Reconnect the *connectors* in the motors 1-2-3.	Shown in the figure *Location of cable harness, view X-X on page 154*
5	Refit the *cable guide* and the *protection plate* in the middle of axis 1.	Shown in the figure *Location of cable harness, view X-X on page 154*
6	Secure the cabling with straps, according to foldout 3.	See chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.
7	Refit the cable bracket inside the base.	
8	Reposition the cabling inside the base according to foldout 4.	See chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.
9	Reconnect all connectors at the base.	
10	Refit the serial measurement unit.	This is detailed in section *Refitting, serial measurement unit on page 217*.
11	Refit the rear cover plate.	Shown in the figure *Location of cable harness, axes 1-3 on page 153*
12	Refit the covers of the connection boxes.	
13	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.

Continues on next page

	Action	Info/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 50*.	

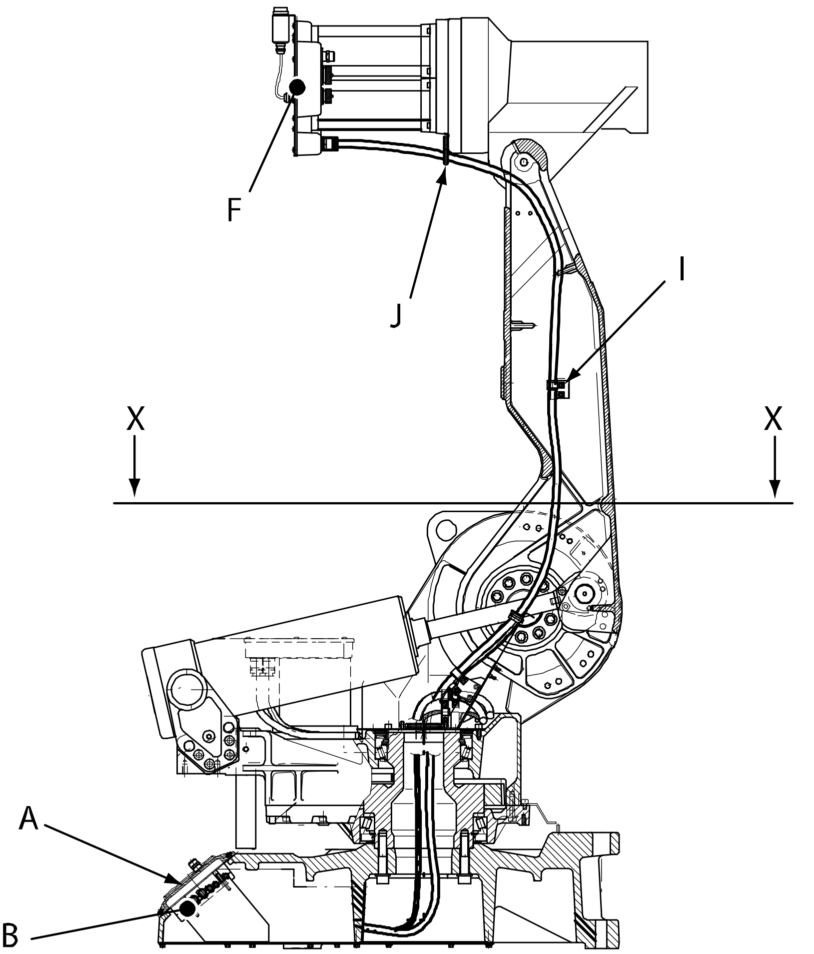
4.3.2 Replacement of cable harness, axes 4-6

Location of cable harness, axes 4-6

The cable harness of axes 4-6 is located throughout the robot as shown in the figure below.

Also see the following figure for the view X-X.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000112

A	Rear cover plate
B	Connectors at the base. Connectors at the rear cover plate: R1.MP, R1.SMB, R1.CP/CS (customer connection), R2.MP4-6. Brake release connectors: R2.BU, R2.BU1-3, R2.BU4-6. Connectors at serial measurement unit: R2.SMB, R2.FB1-3, R2.FB4-6.
F	Connection box, motor 4, 5 and 6. Connectors to the motors at upper arm: R3.MP4, R3.MP5, R3.MP6, R3.FB4, R3.FB5, R3.FB6. Customer connections: R2.CP, R2.CS.
I	Cable bracket inside the lower arm
J	Cable bracket at the upper arm

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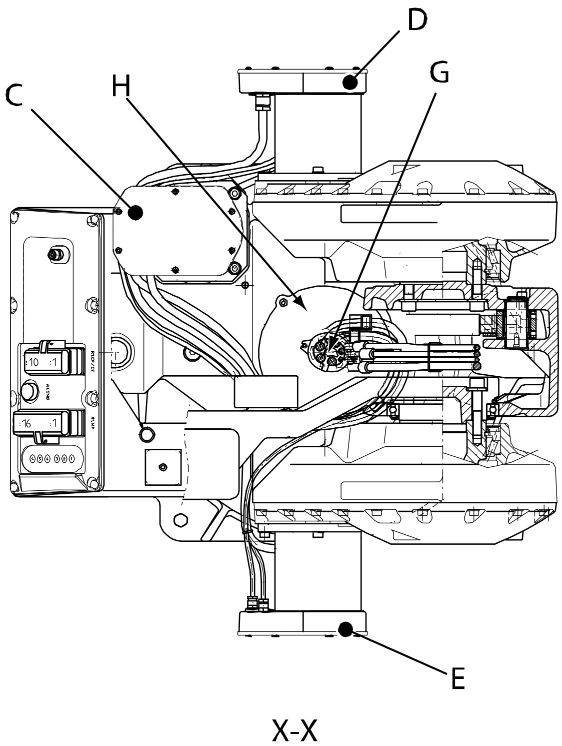
Location of cable harness, view X-X

The cable guides in the middle of axis 1 are located as shown in the figure below.



xx0300000110

C	Connection box, motor 1. Connectors at motor 1: R3.MP1, R3.FB1.
D	Connection box, motor 2. Connectors at motor 2: R3.MP2, R3.FB2.
E	Connection box, motor 3. Connectors at motor 3: R3.MP3, R3.FB3.
G	Cable guides in the middle of axis 1
H	Protection plate

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable harness, axes 4-6	See *Product manual, spare parts - IRB 4400*.		IRB 4400 (all models)
Gasket	3HAB3676-1		3 pcs Between the motor and the connection box. Replace if damaged.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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

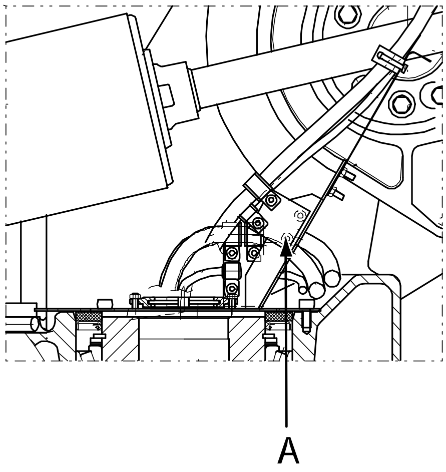
Equipment, etc.	Spare part no.	Art. no.	Note
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			Calibration is detailed in a separate calibration manual enclosed with the calibration tools. Art. no. is specified in section *on page ?* in part 2 of the Product manual.

Removal, cabling axes 4-6

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the cover ot the connection box for motors 4-5-6.	
3	Remove the rear cover plate.	Shown in the figure *Location of cable harness, axes 4-6 on page 158*
4	Remove the serial measurement unit.	Detailed in section *Removal, serial measurement unit on page 216*
5	Loosen the connectors R2.MP4-6, R2.FB4-6, R2.BU4-6, R1.CP/CS. Also loosen the earth connections.	Shown in the figure *Location of cable harness, axes 4-6 on page 158*
6	Cut all the straps around the bundle.	
7	Remove the cable bracket inside the base.	
8	Remove the cable guides and the protection plate in the midle of axis 1.	Shown in the figure*Location of cable harness, view X-X on page 159*

Continues on next page

	Action	Info/Illustration
9	Loosen the cable brackets (A) between gearboxes 2 and 3 and cut the strap around them.	 xx0300000113
10	Feed the cabling and the air hose, if any, up through axis 1.  **Tip** Gather the loose cabling and connectors into a package with tape in order to protect the connectors and make the cabling easier to handle.	
11	Loosen the cable bracket inside the lower arm and undo the two screws.	Shown in the figure *Location of cable harness, axes 4-6 on page 158*
12	Loosen the cable bracket at the upper arm.	Shown in the figure *Location of cable harness, axes 4-6 on page 158*
13	Loosen all the connectors to the motors at the upper arm and customer connections, if any.	Shown in the figure *Location of cable harness, axes 4-6 on page 158*
14	Remove the connection box together with the cabling.	

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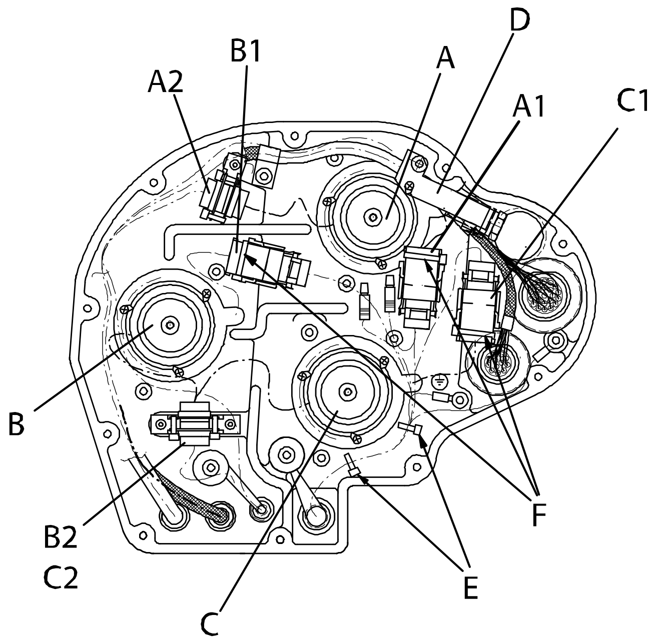
Connection box, upper arm

The figure below shows the location of the motors, connectors and cabling in the upper arm connection box.



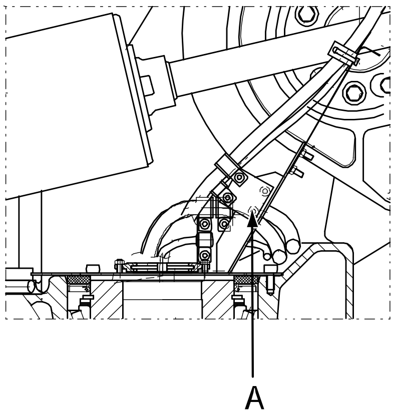
xx0300000116

A	Axis 4 motor
A1	Connector R3.MP4
A2	Connector R3.FB4
B	Axis 5 motor
B1	Connector R3.MP5
B2	Connector R3.FB5
C	Axis 6 motor
C1	Connector R3.MP6
C2	Connector R3.FB6
D	Protection plate
E	Cable strap, indoor
F	cable strap, outdoor

Continues on next page

Refitting, cabling axes 4-6

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Check the position of the three *gaskets*, located between the motors and the connection box. Replace them if damaged.	Part no. is specified in *Required equipment on page 159*.
3	Refit the connection box. Make sure the gaskets are seated properly!	
4	Reconnect all the connectors and reposition the cabling inside the connection box using straps.	Connectors and correct positioning are shown in the figure *Connection box, upper arm on page 162*.
5	Refit the *protection plate* in the connection box.	Shown in the figure *Connection box, upper arm on page 162*.
6	Run the cabling through the lower arm.	
7	Refit the *cable bracket at the upper arm.*	Shown in the figure *Location of cable harness, axes 4-6 on page 158*.
8	Refit the *cable bracket inside the lower arm.*	Shown in the figure *Location of cable harness, axes 4-6 on page 158*.
9	Feed the cabling through the *protection plate* and down through the axis 1.	Shown in the figure *Location of cable harness, view X-X on page 159*.
10	Refit the cable brackets (A) between the gearboxes of axes 2 and 3 and strap the cabling.	 xx0300000113
11	Refit the cable bracket inside the base.	
12	Put straps around the bundle and position the cabling at the base according to foldout 4.	See chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.
13	Reconnect all the connectors at the base.	

Continues on next page

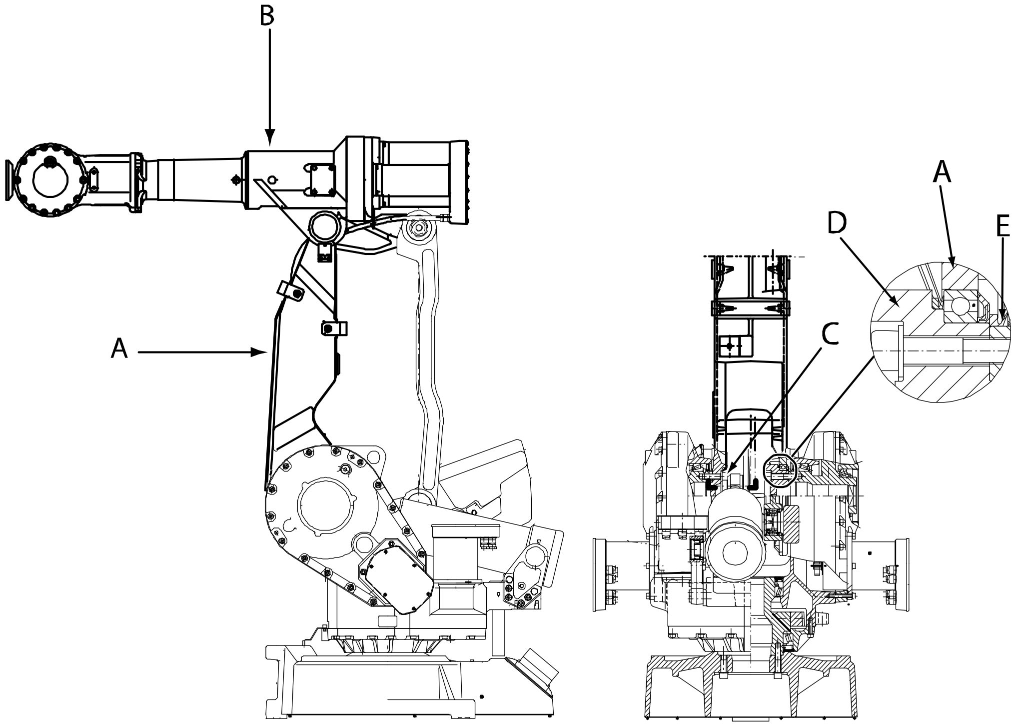
	Action	Info/Illustration
14	Refit the serial measurement unit.	Detailed in *Refitting, serial measurement unit on page 217*.
15	Refit the *rear cover plate.*	Shown in the figure *Location of cable harness, axes 4-6 on page 158*.
16	Refit the cover of the connection box in the upper arm.	
17	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
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 50*.	

4.3.3 Replacement of complete arm system

Location of complete arm system

The complete arm system includes the lower arm and the complete upper arm, as shown in the figure below.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000143

A	Lower arm
B	Upper arm
C	Attachment screws and friction washers, lower arm
D	Parallel arm
E	V-ring between lower arm and gearbox axis 3

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
V-ring	3HAB3773-11		2 pcs. On both sides of the lower arm, in the frame.
Grease		3HAB3537-1	Used to grease sealings and bearings.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.

Continues on next page

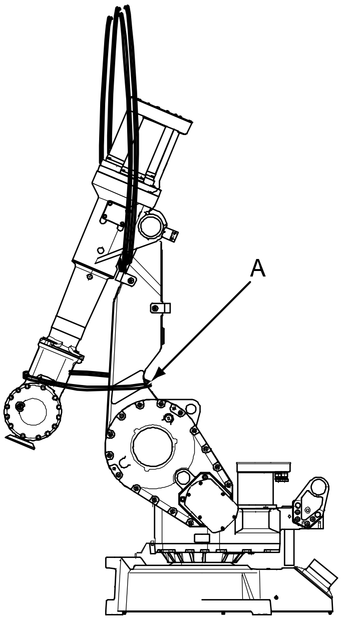
Equipment, etc.	Spare part no.	Art. no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, complete arm system

The procedure below details how to remove the complete arm system from the robot.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The robot arm system weighs 245 kg. All lifting accessories used must be sized accordingly!	
3	Remove the tie rod.	Detailed in section *Replacement of tie rod on page 199*.
4	Remove the cabling down to axis 1.	Detailed in section *Replacement of complete arm system on page 165*.

Continues on next page

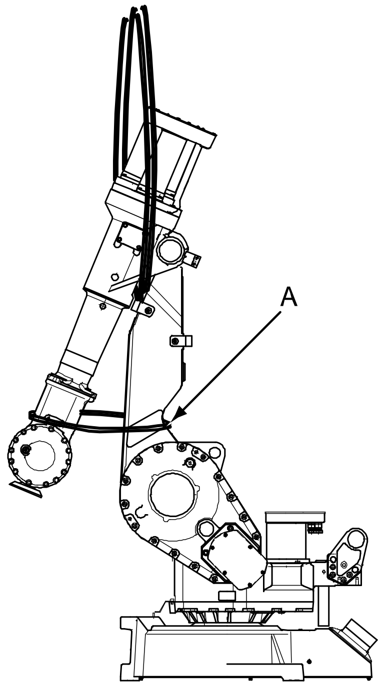
	Action	Info/Illustration
5	Move the upper arm into a resting position against the lower arm. Lock the upper arm in this position with securing slings around the lower and upper arm (A), as shown in the figure to the right. **Note!** If the arms are not properly secured, the upper arm may move during the lift and cause a drop of the complete arm system.	 xx0300000142 **Note!** The figure shows the IRB 4400.
6	Unload the weight of the arm system with lifting slings and a crane.	
7	Remove the balancing device.	Detailed in section *Removal, balancing device on page 208*.
8	Remove the parallel arm.	Detailed in section *Replacement of parallel arm / Replacement of bearing on page 203*.
9	Remove the *attachment screws and friction washers, lower arm*.	Shown in the figure *Location of complete arm system on page 165*.
10	Lift away the complete arm system. Make sure the upper and lower arm are properly secured to each other during the lift.	

Refitting, complete arm system

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

	Action	Info/Illustration
1	 **DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	

Continues on next page

	Action	Info/Illustration
2	**CAUTION** The robot arm system weighs 245 kg. All lifting accessories used must be sized accordingly!	
3	Check and grease both of the *V-rings* in the frame. Replace if damaged.	Part no. is specified in *Required equipment on page 165*
4	Lift the arm system into mounting position. Make sure the arms are properly secured to each other (A), as shown in the figure to the right.	 xx0300000142
5	Secure the arm system to the gearbox axis 2 with the *attachment screws and friction washers.* Make sure both V-rings are seated properly!	10 pcs, M16x55. Tightening torque: 260 Nm. Shown in the figure *Location of complete arm system on page 165*
6	Grease the bearing seating of the parallel arm in the lower arm, to prevent clicking during operation.	
7	Refit the parallel arm.	Detailed in section *Refitting, parallel arm/bearing on page 205*
8	Refit the balancing device.	Detailed in section *Refitting of balancing device on page 212*
9	Move the upper arm to a horizontal position.	
10	Refit the tie rod.	Detailed in section *Refitting, tie rod on page 201*
11	Refit the cabling to the upper arm.	Detailed in section *Refitting, cabling axes 4-6 on page 163*

Continues on next page

	Action	Info/Illustration
12	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
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 50*.	

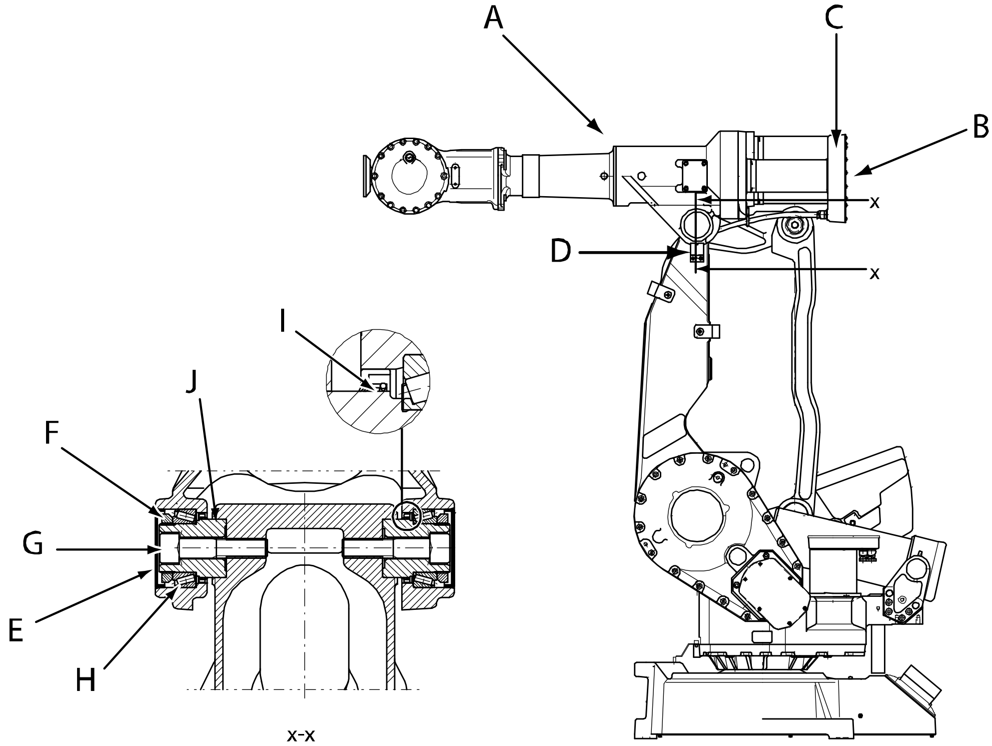
4.4 Upper arm

4.4.1 Replacement of complete upper arm

Location of upper arm

The complete upper arm includes the wrist unit and is located as shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000129

A	Upper arm
B	Connectors of motors, axes 4, 5 and 6
C	Connection box, upper arm
D	Calibration plate, axis 3
E	VK cover
F	KM nut
G	Screw
H	Bearing
I	Sealing ring
J	Shaft end

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Upper arm, without wrist and motors	3HAC17542-1		Foundry (also used for Standard) Color: ABB Orange.
	3HAC050860-001		Foundry (also used for Standard) Color: Graphite White
Sealing ring	3HAC7877-1		
Taper roller bearing	3HAA2103-13		
VK cover	3HAC12165-1		
Shaft end	3HAC4744-1		
Grease		3HAB3537-1	Used to grease the bearing.
Locking liquid			Loctite 243
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Dismounting tool		3HAC0163-1	Used to pull out the shaft.
Mounting tool		3HAB1463-1	Used to fit the inner ring of the bearing. Contains two separate parts.
De-air tool		3HAC8704-1	Used to evacuate air when refitting VK-cover, if the cover has no grooves for venting.
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.
Calibration Pendulum Instruction			Art. no. is specified in section *Calibration on page 269*.

Removal, upper arm

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	

Continues on next page

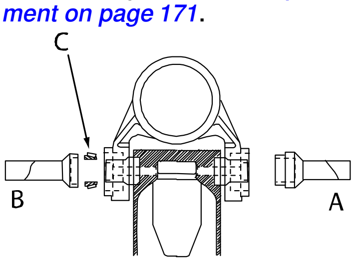
	Action	Info/Illustration
2	**CAUTION** The robot upper arm weighs 180 kg. All lifting accessories used must be sized accordingly!	
3	Move the upper arm to a horizontal position.	
4	Secure the weight of the upper arm with the lifting slings and a crane.	
5	Remove the tie rod.	Detailed in section *Removal, tie rod on page 200*
6	Loosen the connectors of motors, axes 4, 5 and 6.	Shown in the figure *Location of upper arm on page 170*
7	Remove the connection box, upper arm from the motors.	Shown in the figure *Location of upper arm on page 170*
8	Remove the calibration plate, axis 3.	Shown in the figure *Location of upper arm on page 170*
9	Remove the VK covers on both sides of the upper arm. Be careful with the bearing beneath the cover! Make a hole in the outer edge of the cover and bend it away.	Shown in the figure *Location of upper arm on page 170*
10	Undo the KM nuts.	Shown in the figure *Location of upper arm on page 170*
11	Remove the screws.	Shown in the figure *Location of upper arm on page 170*
12	Pull out the shaft with the dismounting tool. Mark the shafts (left and right)!	Art.no. is specified in *Required equipment on page 171*
13	Remove the sealings and bearings, if damaged.	Shown in the figure *Location of upper arm on page 170*
14	Remove the upper arm from the manipulator.	

Refitting, upper arm

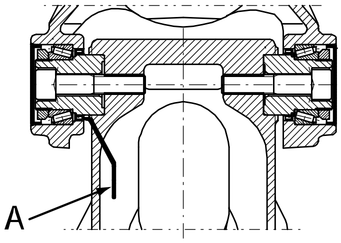
The procedure below details how to refit the complete upper arm to the robot.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	

Continues on next page

	Action	Info/Illustration
2	**CAUTION** The robot upper arm weighs 180 kg. All lifting accessories used must be sized accordingly!	
3	Fit the *sealings* and the outer ring of the *bearings* in the upper arm, if removed. The bearing must be completely filled with grease.	Shown in the figure *Location of upper arm on page 170*. Part no. is specified in *Required equipment on page 171*.
4	Lower the upper arm into mounting position.	
5	Refit both *shaft ends.*	Shown in the figure *Location of upper arm on page 170*. Part no. is specified in *Required equipment on page 171*.
6	Insert both *screws.*	Shown in the figure *Location of upper arm on page 170*. 2 pcs, tightening torque: 470 Nm.
7	If the bearing is removed, the inner ring of the bearing is fitted as follows: • Fit the holding-on tool (part A of the *mounting tool*) on the right side of the upper arm (seen from behind). • Fit the inner ring (C) of the bearing on the left side of the upper arm, using the press tool (part B of the mounting tool). • Remove the holding-on tool and fit the inner ring also on that side.	Art. no. is specified in *Required equipment on page 171*.  xx0300000130 • A: Holding-on tool • B: Press tool • C: Inner ring
8	Apply *locking liquid* on the threads of the *KM nut.*	Locking liquid specified in *Required equipment on page 171* Shown in the figure *Required equipment on page 171*.
9	Tighten the KM nut... • on the **left side**, with torque 95 Nm in order to center the upper arm • on the **right side** first with 105 Nm. Then unscrew the KM nut and re-tighten it with torque 95 Nm. **Note!** This procedure must be performed within 10 minutes, before the Loctite begins to harden.	

Continues on next page

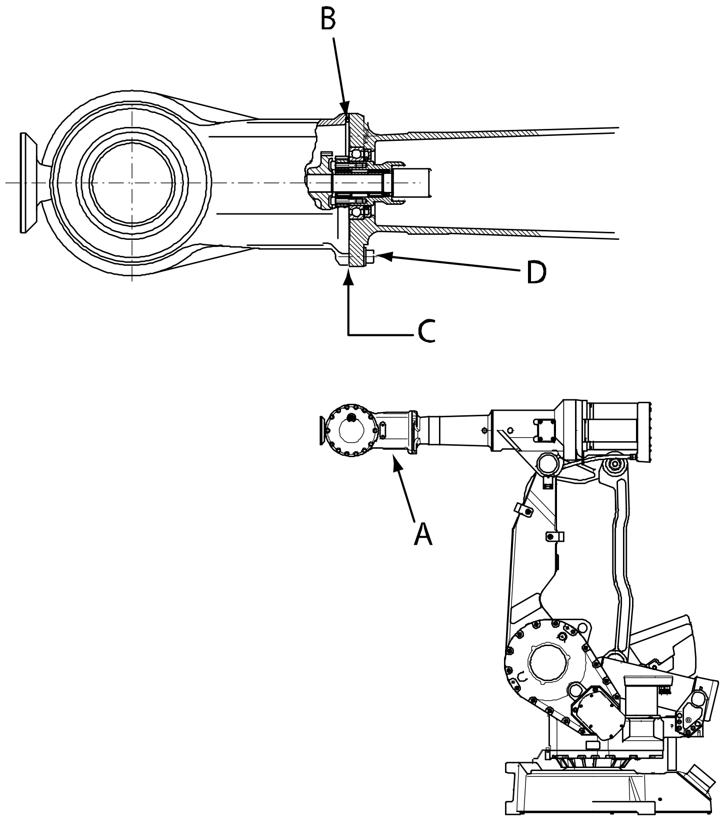
	Action	Info/Illustration
10	Fit new *VK covers.* **Note!** If the covers have no grooves for venting, the air must be evacuated by using the *de-air tool (A)*. Also use a clamp as an aid in positioning the covers tilted, to avoid overpressure.	Part no. is specified in *Required equipment on page 171*. Shown in the figure *Location of upper arm on page 170*.  xx0300000134 • A: De-air tool, used if the VK-cover has no grooves for venting.
11	Refit the tie rod.	Detailed in section *Replacement of complete upper arm on page 170*.
12	Refit the *calibration plate, axis 3.*	Shown in the figure *Location of upper arm on page 170*.
13	Refit the *connection box.*	Shown in the figure *Location of upper arm on page 170*.
14	Reconnect the *connectors to motors, axes 4, 5 and 6.*	Shown in the figure *Location of upper arm on page 170*.
15	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
16	**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 50*.	

4.4.2 Replacement of wrist unit

Location of wrist unit

The wrist unit is located in the upper arm as shown in the figure below. (The illustration shows the IRB 4400.) Removal/refitting procedures differs depending on robot version.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000150

A	Wrist unit
B	O-ring
C	Sealing surface between wrist unit and upper arm tube
D	Attachment screws and washers

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Wrist unit (IRB 4400)	3HAB8271-1		
Wrist unit (IRB 4400/L10)	3HAB9398-1		ABB Orange
	3HAC050646-001		Graphite White

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
O-ring (IRB 4400)	21522012-541		
Grease		3HAB3537-1	Used to lubricate the o-ring groove.
Flange sealing		12340011-116	Loctite 574
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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.
Calibration Pendulum Instruction			Art. no. is specified in section *Calibration on page 269* .

Removal of wrist unit

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

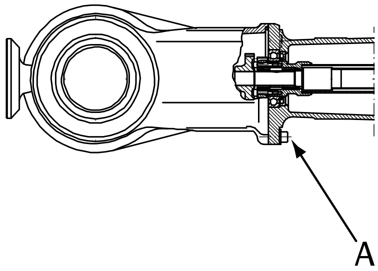
Note

This component includes a complete unit comprising motors 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.

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The robot wrist unit weighs 48 kg. All lifting accessories used must be sized accordingly!	
3	Drain the oil from the wrist unit.	Draining is detailed in sections *Oil change, gearbox axis 5 and 6 (all robot versions) on page 131*

Continues on next page

	Action	Info/Illustration
4	Remove the attachment screws and washers (A).	 xx0300000148 Wrist unit on robot version IRB 4400.
5	Remove the wrist unit from the upper arm.	

Refitting, wrist unit IRB 4400

The procedure below details how to refit the wrist unit to robot versions IRB 4400/60 and Foundry Prime.

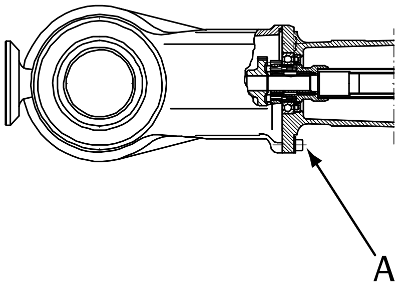
Note

This component includes a complete unit comprising motors 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 carry out **only** the following servicing/repair work on this unit.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area. **CAUTION** The robot wrist unit weighs 48 kg. All lifting accessories used must be sized accordingly!	
2	Lubricate the o-ring groove in order to position the *o-ring*. Fit the o-ring to the wrist.	Part no. is specified in *Required equipment on page 175*. Shown in the figure *Location of wrist unit on page 175*.
3	Apply *flange sealing* to the surface of the wrist that will seal against the upper arm tube.	Specified in *Required equipment on page 175*. Sealing surface shown in the figure *Location of wrist unit on page 175*.

Continues on next page

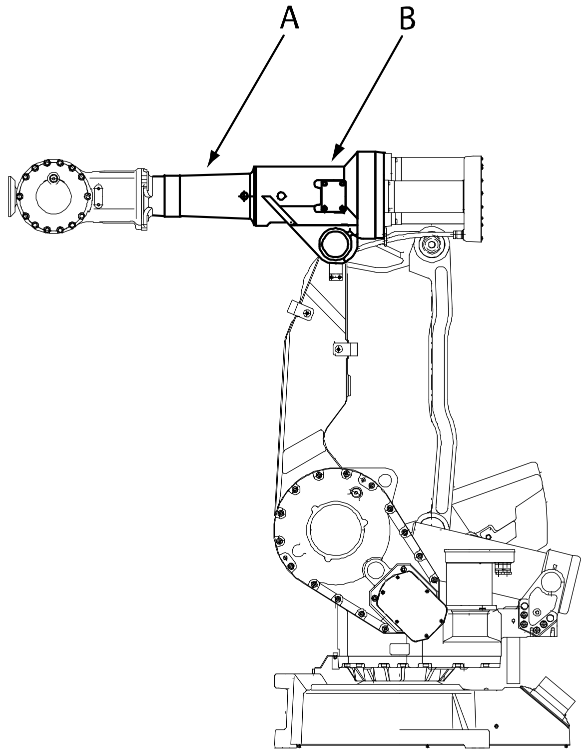
	Action	Info/Illustration
4	Refit the wrist with attachment screws and washers (A).	 xx0300000148 • A: 8 pcs, M10x35. Tightening torque: 41 Nm.
5	Fill the wrist unit with oil.	Detailed in section *Oil change, gearbox axis 5 and 6 (all robot versions) on page 131*.
6	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
7	**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 50*.	

4.4.3 Replacement of arm house unit, axis 4

Location of arm house unit

The arm house unit includes the axis 4 housing and the upper arm tube. It is located as shown in the figure below.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000183

A	Upper arm tube
B	Axis 4 housing

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Upper arm without wrist and motors	3HAC17542-1		Foundry, also used for Standard. Color: ABB Orange.
	3HAC050860-001		Foundry, also used for Standard. Color: Graphite White
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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

Equipment, etc.	Spare part no.	Art. no.	Note
Calibration Pendulum Instruction			Art. no. is specified in section *Calibration on page 269*.

Replacement, arm house unit

The procedure below details how to replace the arm house unit.

CAUTION

The complete arm house unit weighs 152 kg! All lifting equipment used must be dimensioned accordingly!

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the wrist unit.	Detailed in section *Replacement of arm house unit, axis 4 on page 179*.
3	Remove the motors for axes 4, 5 and 6.	Detailed in section *Removal of motor, axes 4, 5 and 6 on page 241*.
4	Remove the arm house unit.	Detailed in section *Replacement of arm house unit, axis 4 on page 179*.
5	Fit the new *arm house unit*.	Part no. is specified in *Required equipment on page 179*.
6	Refit the wrist unit.	Detailed in section *Replacement of wrist unit on page 175*.
7	Refit the motors for axes 4, 5 and 6.	Detailed in sections • *Refitting of motor, axis 4 on page 243* • *Refitting of motor, axis 5 on page 246* • *Refitting of motor, axis 6 on page 250*
8	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.

Continues on next page

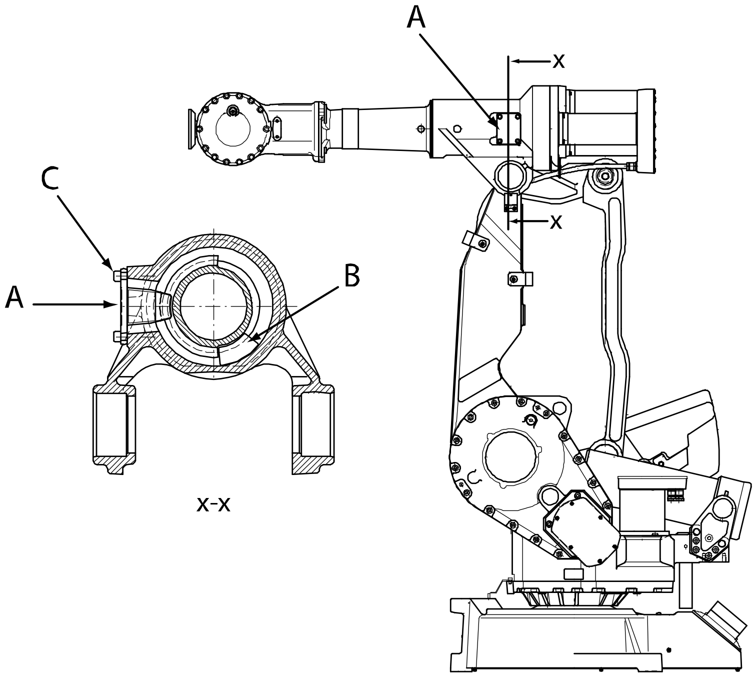
	Action	Info/Illustration
9	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 50*.	

4.4.4 Replacement of mechanical stop, axis 4

Location of mechanical stop

The mechanical stop of axis 4 is located in the upper arm as shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000176

A	Mechanical stop axis 4
B	Damper axis 4
C	Attachment screws, mechanical stop

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Mechanical stop, axis 4	3HAB8856-1		
Damper	3HAB3760-1		
Flange sealing		12340011-116	Loctite 574
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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

WARNING

If the mechanical stop has been deformed after a hard collision, it must be replaced!

WARNING

When the damper is removed from axis 4, the axis does not have a mechanical stop! If the robot is provided with cabling on the upper arm, the cabling can be damaged when the function *Resetting the work area for an axis* is used, or if the robot is jogged uncalibrated.

Removal, mechanical stop

The procedure below details how to remove the axis 4 mechanical stop from the robot.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the *mechanical stop* by removing its *attachment screws.*	Shown in the figure *Location of mechanical stop on page 182*.
3	Rotate axis 4 so that the *damper* is visible. Remove the damper.	Shown in the figure *Location of mechanical stop on page 182*.

Refitting, mechanical stop

The procedure below details how to refit the axis 4 mechanical stop to the robot.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	

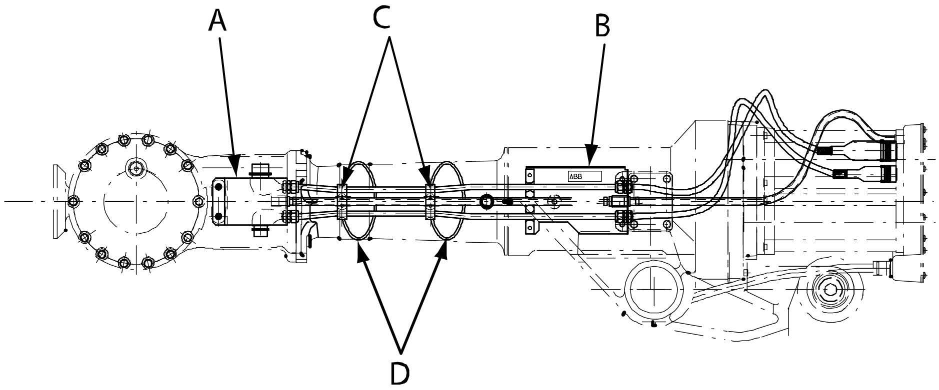
Continues on next page

	Action	Note/Illustration
2	Fit the *damper* to the axis 4.	Shown in the figure *Location of mechanical stop on page 182*. Part no. is specified in *Required equipment on page 182*.
3	Apply *flange sealing* to the stop.	Art. no. is specified in *Required equipment on page 182*.
4	Fit the *mechanical stop* to the axis 4 with its *attachment screws.*	Shown in the figure *Location of mechanical stop on page 182*. Part no. is specified in *Required equipment on page 182*. 4 pcs, M8x16. Tightening torque: 24 Nm.

4.4.5 Replacement of signal cabling, upper arm (option 042)

Location of signal cabling, upper arm

The signal cabling (option 042) runs along the upper arm as shown in the figure below.



xx0300000192

A	Wrist bracket
B	Upper arm bracket
C	Front and rear cable holders
D	Plastic hose

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Customer connection axis 4	3HAC8820-1		Includes signal/power cabling, necessary brackets, holders etc.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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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Removal, signal cabling upper arm

The procedure below details how to remove the signal cabling from the upper arm.

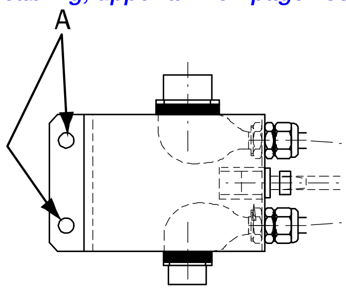
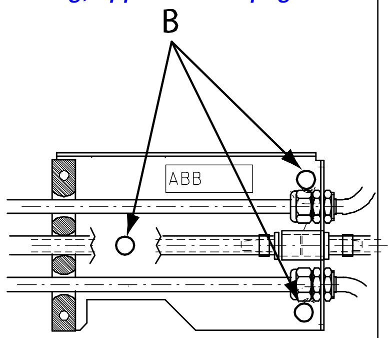
	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the *wrist bracket* and the *upper arm bracket* from the upper arm.	Shown in the figure *Location of signal cabling, upper arm on page 185*.
3	Remove the *front and rear cable holders* from the tube shaft.	Shown in the figure *Location of signal cabling, upper arm on page 185*.
4	Disconnect the connectors at the rear of the upper arm.	

Refitting, signal cabling upper arm

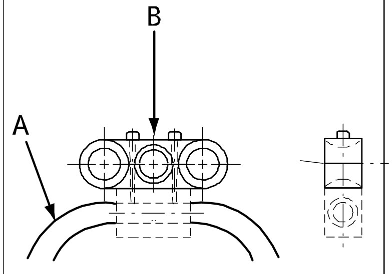
The procedure below details how to refit the signal cabling to the upper arm.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Fit transparent protection tape to the narrow part of the tube shaft. Remove dirt and grease from the surface first!	
3	Move axis 4 to its calibration position (0°).	

Continues on next page

	Action	Note/Illustration
4	Refit the *wrist bracket* to the upper arm.	Location of the bracket is shown in the figure *Location of signal cabling, upper arm on page 185*.  xx0300000193 • A: 2 pcs, M8x12.
5	Refit the *upper arm bracket* to the upper arm.	Location of the bracket is shown in the figure *Location of signal cabling, upper arm on page 185*.  xx0300000194 • B: 3pcs, M8x12.
6	Slowly rotate axis 4 clockwise to its stop position. Constantly check that the cables are not fully extended! **Note!** If the cables gets fully extended, stop the rotation and let out more cable from the rear cable holder. This is done by loosening the grey holders and pushing ot the cables by hand.	
7	Complete the rotation. **Note!** Do not tighten the rear cable holder, leave it open!	

Continues on next page

	Action	Note/Illustration
8	First fit the *front cable holder* around the tube shaft. Run the black *plastic hose* through the foot of the holder. Fit the *rear cable holder* around the tube shaft in the same way.	 xx0300000197 • A: Plastic hose • B: Cable holder Also see the figure *Location of signal cabling, upper arm on page 185*.
9	Move axis 4 from one extreme limit to the other and back again.  xx0100000003 **Caution!** Check the cables during movement: • the cables must not be fully extended! • the cables and air hose must not touch any moving parts of the arm! • the fixing rings must always slide smoothly with no excessive pulling!	
10	Adjust the length of the cables by pushing and pulling the cables through the inner holders, which are still loose. **Note!** When axis 4 is moving, no stretching of the cables should be felt.	
11	Tighten the holders by hand. Do not use tools.	
12	Reconnect the connectors at the rear end of the upper arm.	
13	Connect the air hose.	
14	Secure the cables and air hose together with cable straps above the motors.	
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 50*.	

4.4.6 Measuring the play, axis 5

General

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

Required equipment

Equipment, etc.	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 297*.
Measuring tool, play	3HAB1611-6	
Measuring tool, play (IRB 4400/L10)	3HAB6337-1	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Additional equipment - Foundry Prime

Equipment	Art. no.	Note
Rust preventive	3HAC034903-001	Mercasol
Sikaflex 521FC	3HAC026759-001	
Loctite 574	12340011-116	
Brush		
Foundry Prime touch up kit	3HAC035355-001	

Measurement, axis 5

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

Note

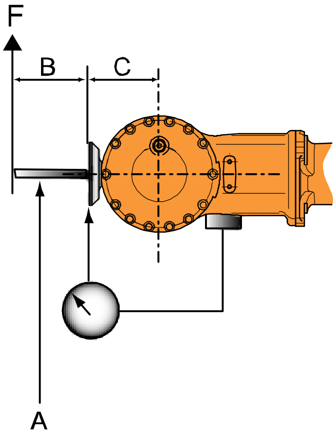
The measuring tool and measuring values differ depending on robot version!

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Move the robot to calibration position and turn the axis 4 90°.	

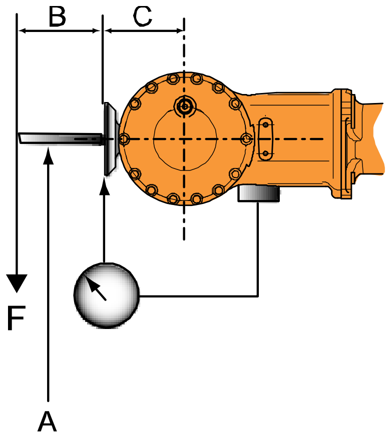
Continues on next page

4.4.6 Measuring the play, axis 5

Continued

	Action	Information
3	Fit the *measuring tool, play* to the turning disk.	Art. no. is specified in *Required equipment on page 189*.
4	Apply load F in one direction, as shown in the figure to the right. **Note** Different load and distances for the different robot versions, as specified to the right!	 xx0300000186 **Values for robot version IRB 4400** • A: Measuring tool, play • B: 100 mm • C: 140 mm • F: 200 N **Values for robot version IRB 4400/L10:** • A: Measuring tool, play • B: 140 mm • C: 85 mm • F: 40 N
5	Remove the load and set the dial indicator to zero.	

Continues on next page

	Action	Information
6	Apply load F in the opposite direction, as shown in the figure to the right.	 xx0300000187 **Values for robot version IRB 4400:** • A: Measuring tool, play • B: 100 mm • C: 140 mm • F: 200 N **Values for robot version IRB 4400/L10:** • A: Measuring tool, play • B: 140 mm • C: 85 mm • F: 40 N
7	Remove the load and measure the play by reading the dial indicator.	The maximum play allowed at the given distance from the center of axis 5 is, for robot version • IRB 4400: 0.20 mm • IRB 4400/L10: 0.08 mm

4.4.7 Measuring the play, axis 6

General

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

Required equipment

Equipment	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 297*.
Measuring tool, play	3HAB1611-6	
Measuring tool, play (IRB 4400/L10)	3HAB6337-1	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Additional equipment - Foundry Prime

Equipment	Art. no.	Note
Rust preventive	3HAC034903-001	Mercasol
Sikaflex 521FC	3HAC026759-001	
Loctite 574	12340011-116	
Brush		
Foundry Prime touch up kit	3HAC035355-001	

Measurement, axis 6

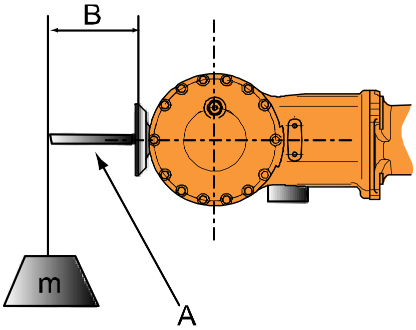
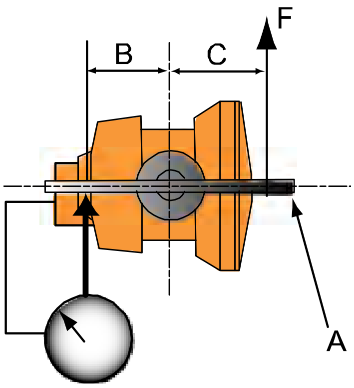
The procedure below details how to measure the play in axis 6.

Note

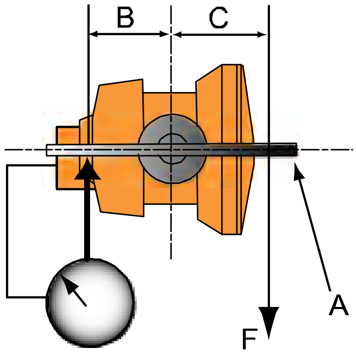
The measuring tool and measuring values differ depending on robot version!

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Fit the *measuring tool, play* to the turning disk.	Art. no. is specified in *Required equipment on page 192*.

Continues on next page

	Action	Information
3	Attach a weight (m) at a distance (B) from the wrist flange, in order to avoid the effects of play on axis 5. **Note** Different weight and distance for the different robot versions, as specified to the right!	 xx0300000188 **Values for robot versions IRB 4400:** • A: Measuring tool, play • B: 100 mm • m: 20 kg **Values for robot version IRB 4400/L10:** • A: Measuring tool, play • B: 140 mm • m: 10 kg
4	Apply load F in one direction. **Note** Different load and distances for the different robot versions, as specified to the right!	 xx0300000189 **Values for robot version IRB 4400:** • A: Measuring tool, play • B: 100 mm • C: 100 mm • F: 100 N **Values for robot version IRB 4400/L10:** • A: Measuring tool, play • B: 100 mm • C: 150 mm • F: 40 N
5	Remove the load and set the dial indicator to zero.	

Continues on next page

	Action	Information
6	Apply load F in the opposite direction, as shown in the figure to the right.	 xx0300000190 **Values for robot version IRB 4400:** • A: Measuring tool, play • B: 100 mm • C: 100 mm • F: 100 N **Values for robot version IRB 4400/L10:** • A: Measuring tool, play • B: 100 mm • C: 150 mm • F: 40 N
7	Remove the load and measure the play by reading the dial indicator.	The maximum play allowed at the given distance (B) from the center of axis 6 is, for robot version: • IRB 4400: 0.15 mm • IRB 4400/L10: 0.2 mm

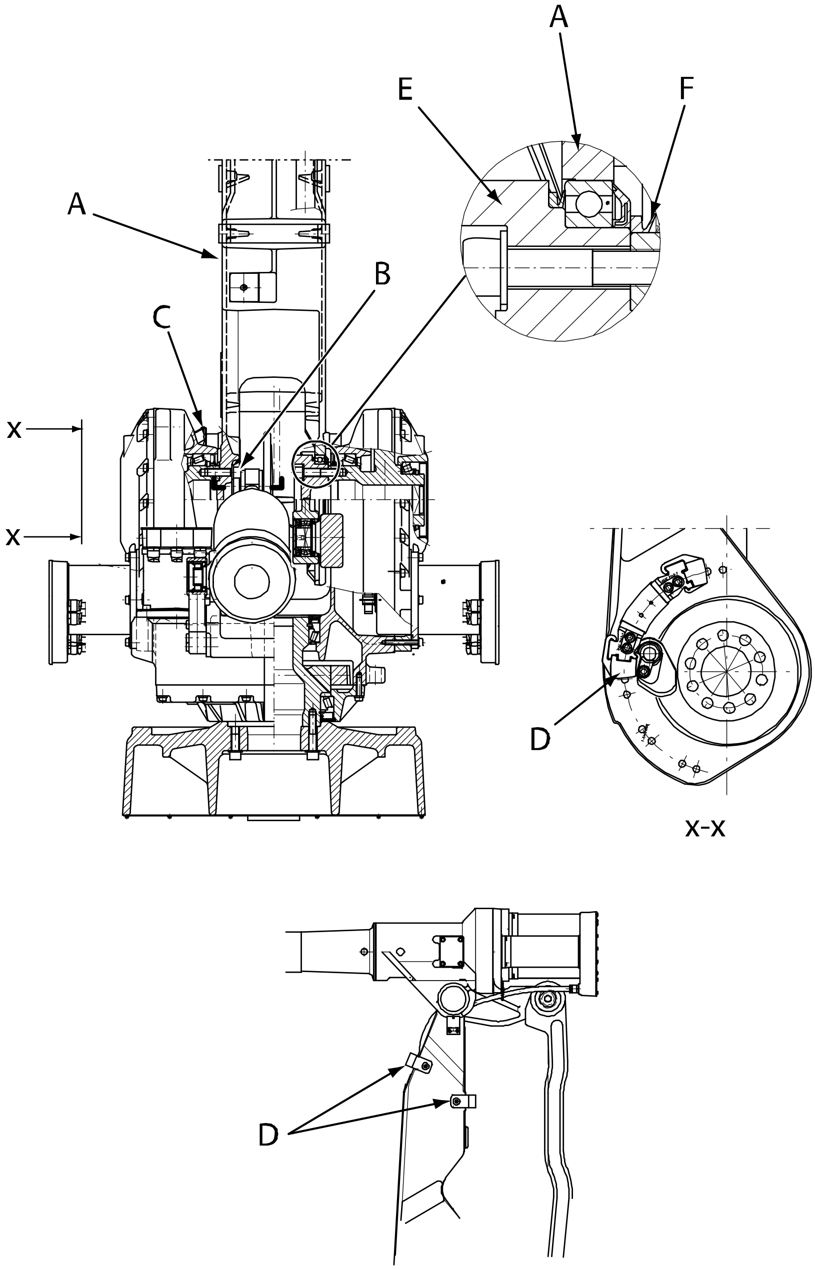
4.5 Lower arm

4.5.1 Replacement of lower arm

Location of lower arm

The lower arm is located as shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000141

A	Lower arm

Continues on next page

B	Attachment screws and friction washers, lower arm
C	Calibration plate, axis 2
D	Damper
E	Parallel arm
F	V-ring between lower arm and gearbox axis 3

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Lower arm (IRB 4400)	3HAC5955-1		
V-ring	3HAB3773-11		2 pcs On both sides of the lower arm, in the frame.
Grease		3HAB3537-1	Used to grease sealings and bearings.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, lower arm

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The robot lower arm weighs 65 kg. All lifting accessories used must be sized accordingly!	
3	Remove the cabling down to axis 1.	Detailed in section *Replacement of lower arm on page 195*.

Continues on next page

	Action	Info/Illustration
4	Remove the complete upper arm.	Detailed in section *Replacement of lower arm on page 195*.
5	Attach a crane to the lower arm and unload the weight.	
6	Remove the balancing device.	Detailed in section *Removal, balancing device on page 208*.
7	Remove the parallel arm.	Detailed in section *Replacement of parallel arm / Replacement of bearing on page 203*.
8	Remove the *attachment screws and friction washers, lower arm*.	Shown in the figure *Location of lower arm on page 195*.
9	Remove the lower arm from the manipulator.	

Refitting, lower arm

The procedure below deatails how to refit the lower arm to the robot.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The robot lower arm weighs 65 kg. All lifting accessories used must be sized accordingly!	
3	Move the damper and the calibration plate from the old to the new *lower arm*.	Part no. is specified in *Required equipment on page 196*
4	Check and grease both V-rings in the frame. Replace if damaged.	Part no. is specified in *Required equipment on page 196*
5	Lift the lower arm and lower it into mounting position. Make sure both V-rings stay seated properly!	
6	Refit the lower arm to the gearbox axis 2 with attachment screws and friction washers, lower arm.	10 pcs. M16x55. Tightening torque: 260 Nm. Shown in the figure *Location of lower arm on page 195*
7	Grease the bearing seating of the parallel arm in the lower arm, to prevent clicking during operation.	
8	Refit the parallel arm.	Detailed in section *Refitting, parallel arm/bearing on page 205*

Continues on next page

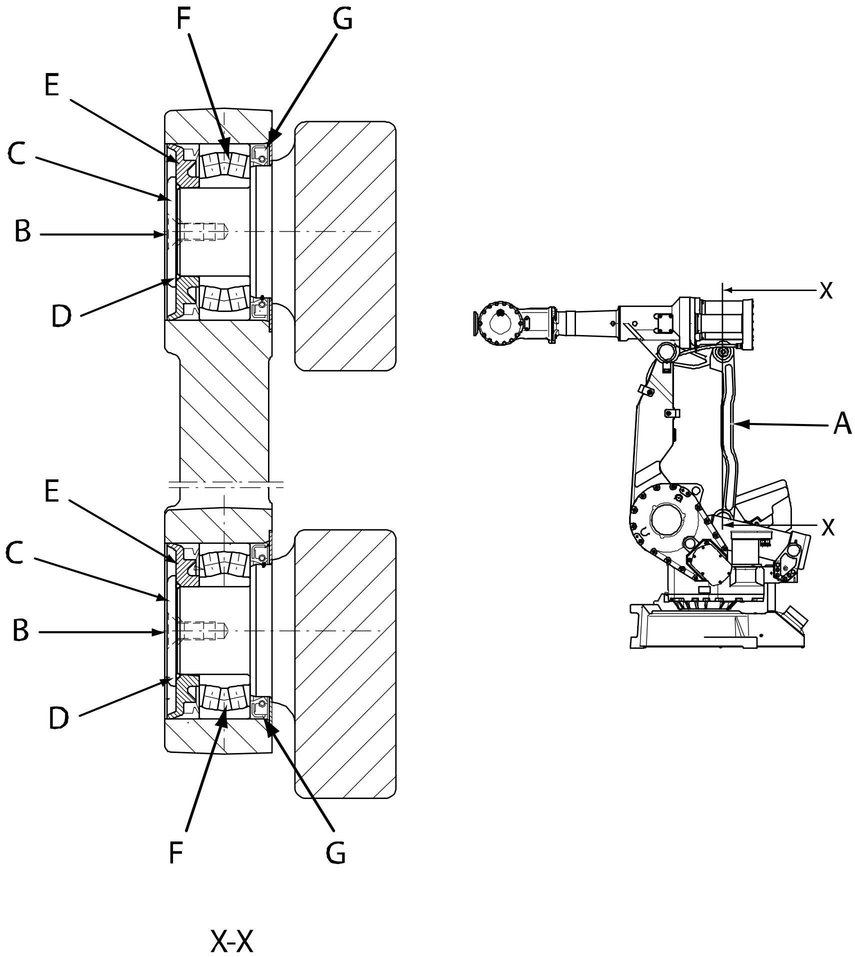
	Action	Info/Illustration
9	Refit the balancing device.	Detailed in section *Refitting of balancing device on page 212*
10	Refit the upper arm.	Detailed in section *Refitting, upper arm on page 172*
11	Refit the cabling.	Detailed in section *Refitting, cabling axes 4-6 on page 163*
12	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
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 50*.	

4.5.2 Replacement of tie rod

Location of tie rod

The tie rod is located as shown in the figure below. (Figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000117

A	Tie rod
B	Attachment screw
C	Washer
D	O-ring
E	Sealing, outside
F	Spherical roller bearing
G	Sealing, inside

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Washer	3HAB3704-1		Replace if damaged.

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
O-ring	3HAB3772-23		
Sealing, outside	3HAC3297-1		
Spherical roller bearing	3HAA2167-11		
Sealing, inside	3HAC3990-11		
Grease		3HAB3537-1	Used to lubricate the shaft on the robot where the tie rod is to be refitted.
Locking liquid			Loctite 243
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Puller tool			2 pcs Used to pull out the tie rod alternately at the upper and lower end if the tie rod.
Press tool		3HAB1598-1	Used to press in the spherical roller bearing.
Press tool, p-arm		3HAB1529-1	2 pcs. Used to press on the tie rod alternately at the upper and lower end of the tie rod.
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.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, tie rod

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Lock the upper arm in a horizontal position with help of a crane or similar.	
3	Remove the two *attachment screws*.	Shown in the figure *Location of tie rod on page 199*.
4	Remove the two *washers, o-rings and sealings, outside* from the tie rod.	Shown in the figure *Location of tie rod on page 199*.

Continues on next page

	Action	Info/Illustration
5	Insert a screw in each center, to be used as a support.	
6	Use two puller tools to pull out the tie rod, one at the upper and lower end. Pull alternately at the upper end and at the lower end with the puller tools!	
7	Remove the bearings if they are to be replaced.	The part no. for new bearings is specified in section *Replacement of tie rod on page 199*.

Refitting, tie rod

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	If the bearings are to be replaced, fit new *spherical roller bearings* and new *sealings, inside* to the tie rod. Use the *press tool*.	Part/Art. no. is specified in *Required equipment on page 199*
3	Lift the tie rod to its mounting site. Make sure the tie rod is refitted with the correct end up!	
4	Grease the shaft on the robot and refit the tie rod on to the robot using two *press tolls for p-arm*. Press alternately at the upper and lower end with the press tools!	Art. no. is specified in *Required equipment on page 199*
5	Fit the *sealings, outside* to the tie rod.	Part no. is specified in *Required equipment on page 199*
6	Fit the *o-rings* to the tie rod.	Part no. is specified in *Required equipment on page 199*
7	Refit the *washers and attachment screws* using *locking liquid*.	Shown in the figure *Location of tie rod on page 199* Locking liquid is specified in *Required equipment on page 199*
8	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.

Continues on next page

	Action	Info/Illustration
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 50*.	

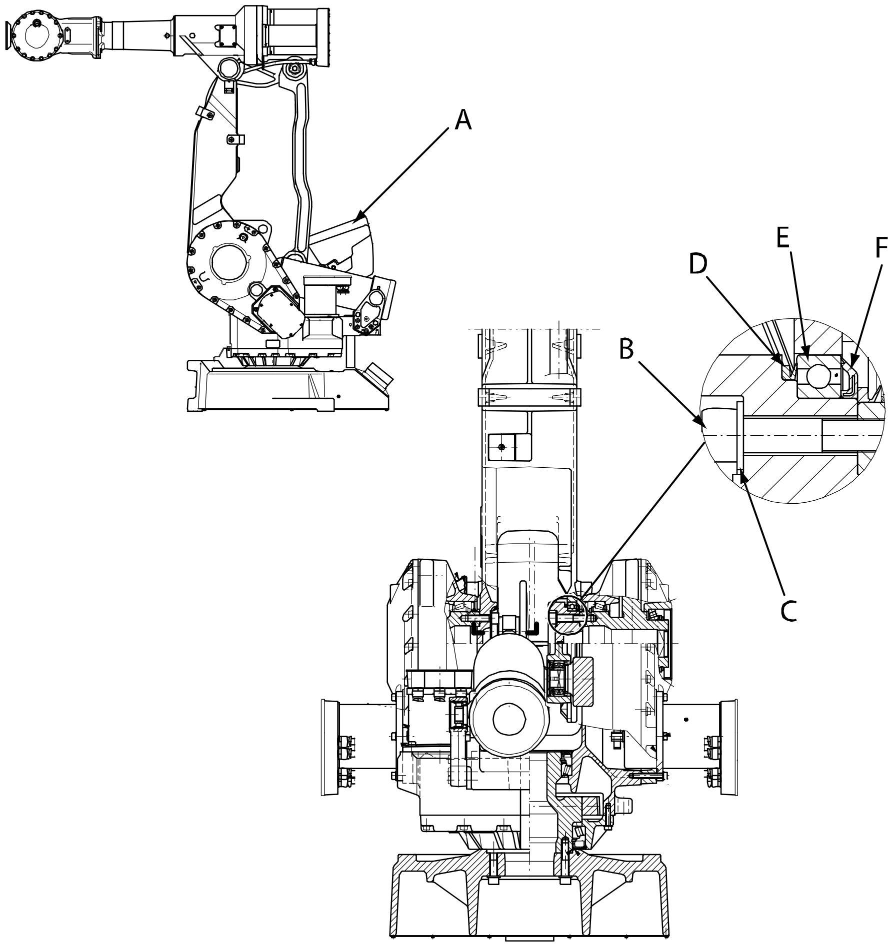
4.5.3 Replacement of parallel arm / Replacement of bearing

Location of parallel arm

The parallel arm is located on the robot, as shown in the figure below. (The figure shows the IRB 4400.)

The bearing of the parallel arm is shown in the enlarged view.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000128

A	Parallel arm
B	Attachment screw
C	Washer
D	V-ring on parallel arm
E	Bearing
F	Sealing

Continues on next page

Required equipment

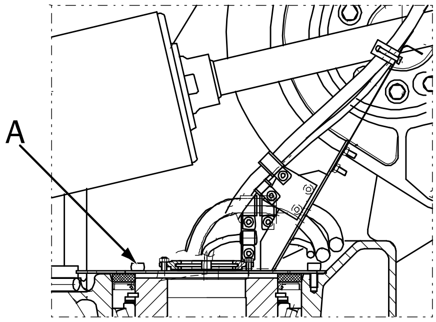
Equipment, etc.	Spare part no.	Art. no.	Note
V-ring sealing	3HAB3732-11		
Groove ball bearing	3HAC10905-1		
Sealing ring	3HAB3749-1		
Grease		3HAB3537-1	Used to lubricate the bearings and sealings.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Lifting tool		3HAB1412-1	Used to lift the parallel arm.
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.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, parallel arm/bearing

The procedure below details how to remove the parallel arm from the robot during repair work. It also details how to remove the bearing from the parallel arm in order to replace it.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The parallel arm system weighs 118 kg. All lifting accessories used must be sized accordingly!	
3	Remove the tie rod.	Detailed in *Replacement of tie rod on page 199*.
4	Fit the *lifting tool* to the parallel arm. Unload the arm with a crane.	Art. no. is specified in *Required equipment on page 204*.

Continues on next page

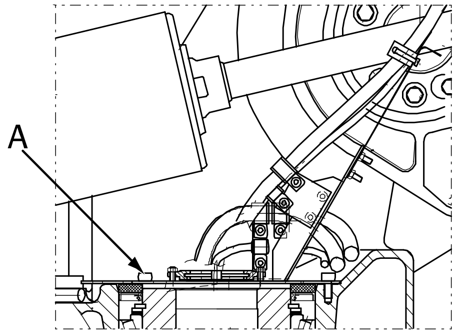
	Action	Info/Illustration
5	Loosen the attachment screws (A) so that the cabling can be moved slightly.	 xx0300000127
6	Remove the 10 attachment screws and the washer that holds the parallel arm to gearbox axis 3.	
7	Lift away the parallel arm from the robot.	
8	If they are to be replaced, remove the bearing and sealings from the parallel arm.	

Refitting, parallel arm/bearing

The procedure below details how to refit the parallel arm on to the robot during repair work. It also details how to fit a new bearing to the parallel arm as replacement.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The parallel arm system weighs 118 kg. All lifting accessories used must be sized accordingly!	
3	Fit the new **V-ring** to the parallel arm.	Part no. is specified in *Required equipment on page 204*
4	**If the bearing is to be changed:** • Heat the new **groove ball bearing** to 170°C. • Fit the bearing to the parallel arm. **If the old bearing is kept:** • Grease the bearing.	Part no. is specified in *Required equipment on page 204*

Continues on next page

	Action	Info/Illustration
5	Fit the *sealing ring* to the bearing.	Part no. is specified in *Required equipment on page 204*
6	Refit the washer and the 10 attachment screws that hold the parallel arm to the gearbox unit.	10 pcs. M16x80, 12.9 quality UNBRAKO. Tightening torque: 260. Reused screws may be used, providing they are lubricated as detailed in section **Screw Joints** in the Product manual, reference information, before fitting.
7	Move the upper arm to a horizontal position with a crane (if not already positioned horizontal) and refit the tie rod.	Detailed in section *Refitting, tie rod on page 201*
8	Reposition the cabling and tighten the cable attachment screws.	 xx0300000127
9	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
10	**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 50*.	

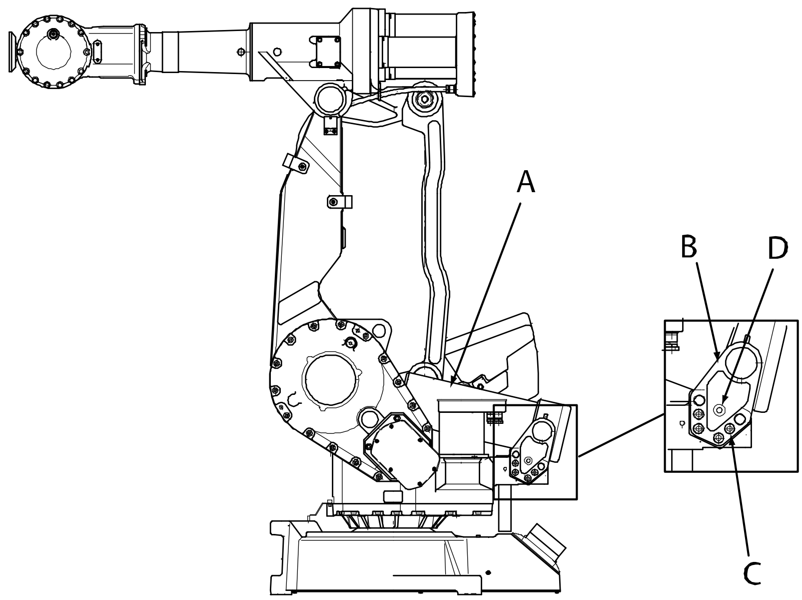
4.6 Frame and base

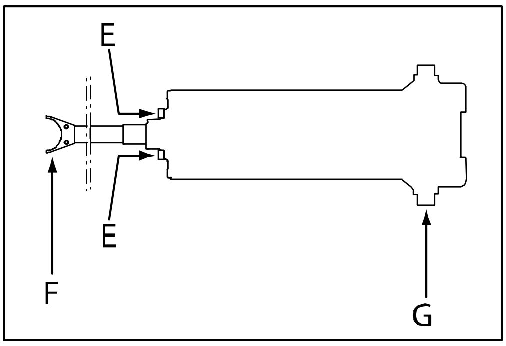
4.6.1 Replacement of balancing device

Location of balancing device

The balancing device is located as shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.





xx0300000100

A	Balancing device
B	Bracket
C	Attachment screws, bracket (M12x50)
D	Press out hole
E	Front screws
F	Fork
G	End part of shaft

Continues on next page

Required equipment

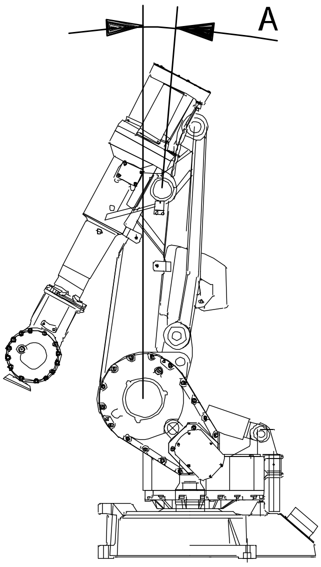
Equipment, etc.	Spare part no.	Art. no.	Note
Balancing device IRB 4400	See *Product manual, spare parts - IRB 4400*.		Includes balancing device 3HAC3702-1 Includes cylindrical roller bearing 3HAC4334-2 Includes front screws 3HAC6456-1
Sealing ring with dust lip	See *Product manual, spare parts - IRB 4400*.		
Grease		3HAC3537-1	Used to lubricate: • the bearings at the balancing device brackets (min. 500 ml. in each bearing) • the sealing at the balancing device brackets • the bearing at the balancing device fork
Nipple			Used to lubricate the bearing at hte balancing device fork. The lubrication hole is dimensioned M10.
Standard toolkit		3HAC17594-1	The contents are defined in section *Standard tools on page 297*.
Securing front screws			M10x40H H= threaded to the head. Used to unload the balancing device before removal.
Press tool, bearing		3HAC5465-1	Used to fit the cylindrical roller bearings and the sealings into the brackets.
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, balancing device

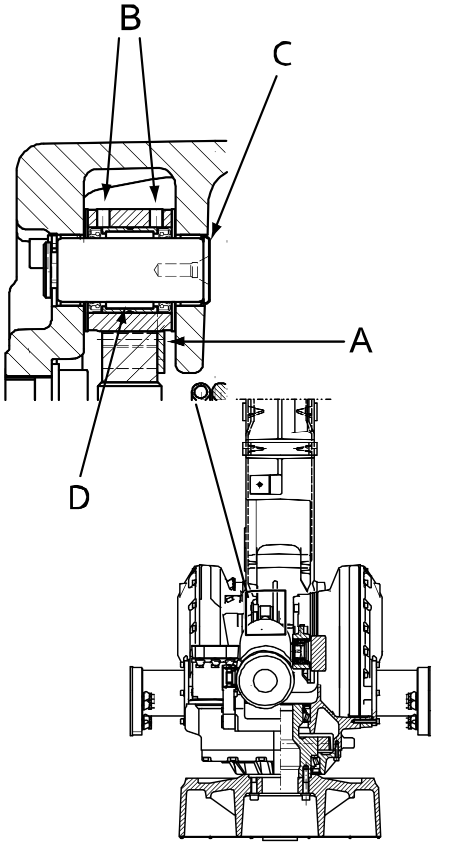
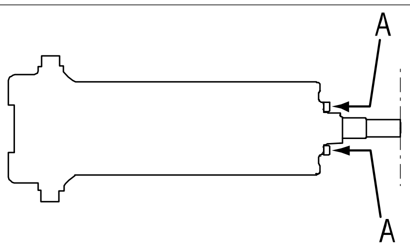
The procedure below details how to remove the balancing device.

	Action	Info/Illustration
1	**WARNING** *Do not* under any circumstances, deal with the balancing device in any other way than that detailed in the product documentation! For example, attempting to open the balancing device is potentially lethal!	

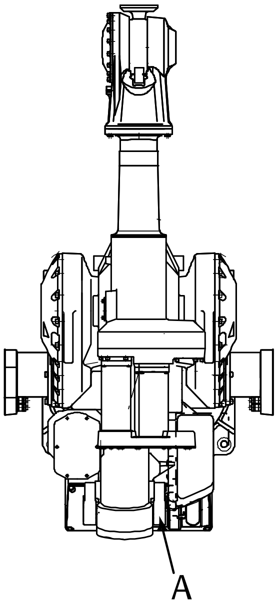
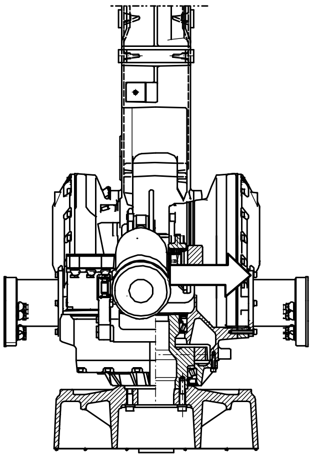
Continues on next page

	Action	Info/Illustration
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
3	**CAUTION** The balancing device weighs 50 kg. All lifting accessories used must be sized accordingly!	
4	Move the manipulator to the calibration position, as shown in the figure to the right.	 xx0300000088 • A: Approximately 2º

Continues on next page

	Action	Info/Illustration
5	Remove the two securing screws (A), located at the *fork* of the balancing device. Also remove the plate (C) which secures that the bushing (D) is held in position.	 xx0300000089 The fork is shown in the figure *Location of balancing device on page 207*.
6	Unload the balancing device by replacing the two front screws (A) with two *securing front screws*. Unload the device level by fastening the securing screws parallel with each other.	 xx0300000095 Dimension specified in *Required equipment on page 208*!
7	Check that the piston is unloaded by moving it manually.	

Continues on next page

	Action	Info/Illustration
8	Remove the four *attachment screws, bracket* from the bracket at the right side of the balancing device (A), seen from above.	Shown in the figure *Location of balancing device on page 207*!  xx0300000098
9	Remove the bracket from the frame by pressing it out using a M10x30 screw in the *press out hole*.	Shown in the figure *Location of balancing device on page 207*!
10	Remove the balancing device by pushing it to the side. *Note!* The balancing device weighs 50 kg!	 xx0300000099
11	If the balancing device is to be replaced with a new device, the bracket on the right side must be removed and fitted to the new device.	

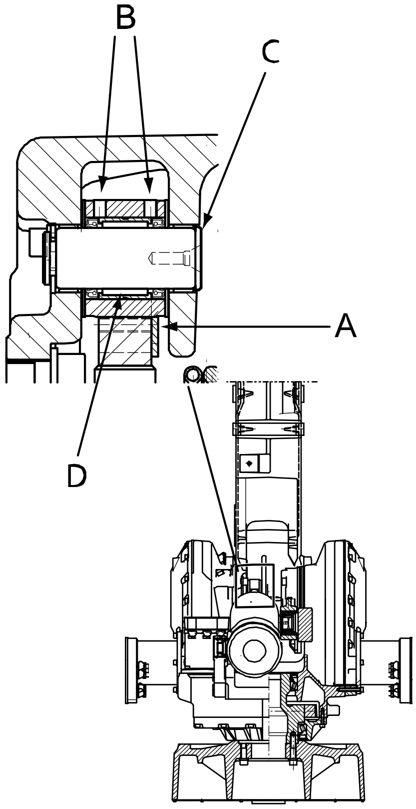
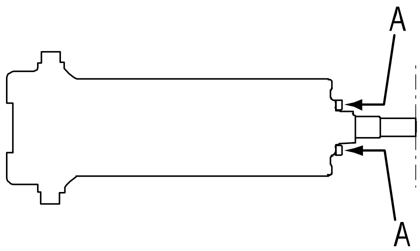
Continues on next page

Refitting of balancing device

The procedure below details how to refit the balancing device.

	Action	Info/Illustration
1	**WARNING** *Do not* under any circumstances, deal with the balancing device in any other way than that detailed in the product documentation! For example, attempting to open the balancing device is potentially lethal!	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
3	**CAUTION** The balancing device weighs 50 kg. All lifting accessories used must be sized accordingly!	
4	Fit the cylindrical roller bearings and sealings to the balancing device and brackets if • the **balancing device** is a new spare part • the old bearings/sealings are damaged.	The procedure is detailed in *Fitting of cylindrical roller bearing on page 214* Part no. is specified in *Required equipment on page 208*
5	Lift the balancing device to its mounting position.	If the balancing device is a new spare part, it must be unloaded as described in *Removal, balancing device on page 208*
6	Fit the balancing device to the left *bracket* and put the fork into correct position.	Shown in the figure *Location of balancing device on page 207*
7	Refit the right bracket with *attachment screws, bracket* .	4 pcs: M12x50, tightening torque: 82 Nm Shown in the figure *Location of balancing device on page 207*
8	Refit the original protection screws in the *press out holes* in both the brackets.	2 pcs. MC6S M10x12 8.8 fzb. Shown in the figure *Location of balancing device on page 207*

Continues on next page

	Action	Info/Illustration
9	Lubricate the bearing at the fork: • Remove the two stop screws (B). • Fill with grease through one of the lubrication holes, until excessive grease is forced out through the second hole. Use a nipple! • Refit the two stop screws. • Refit the plate with one screw M8x16 (C). This plate secures the bushing (D) is held in its position.	 xx0300000089 A: Securing screws (2 pcs) B: Stop screws, M10 x 40 (2 pcs) C: Plate and screw M8 x 16 (1 pc) D: Bushing
10	Before restoring the balancing device, check that: • the fork is in position • the fork does not cover the lubrication holes of the shaft!	The fork is shown in the figure *Location of balancing device on page 207*
11	Restore the balancing device by removing the replacement front screws (A) and refitting the original protection front screws.	 xx0300000095 2 pcs: MC6S M10x12 8.8 fzb
12	Refit the fork to the shaft in the lower arm, by refitting the two securing screws (A) at the fork of the balancing device. Make sure that the fork does *not* cover the lubrication holes of the shaft!	Shown in the figure above in *Refitting of balancing device on page 212*

Continues on next page

	Action	Info/Illustration
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 50*.	

Fitting of cylindrical roller bearing

The procedure below details how to fit the cylindrical roller bearings onto the balancing device shaft and into the frame brackets.

	Action	Info/Illustration
1	Fit the inner ring of the bearing onto both *end parts of the balancing devices shaft*.	Shown in the figure *Location of balancing device on page 207*
2	Fit the outer ring of the bearing into both brackets with a *press toll, bearing*.	Art. no. is specified in *Required equipment on page 208*
3	Fit the *sealing ring with dust lip* with the same, but turned, *press tool, bearing*.	Part no. is specified in *Required equipment on page 208*
4	Lubricate the bearing and the sealing with *grease*.	Art. no. and amount specified in *Required equipment on page 208*
5	**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 50*.	

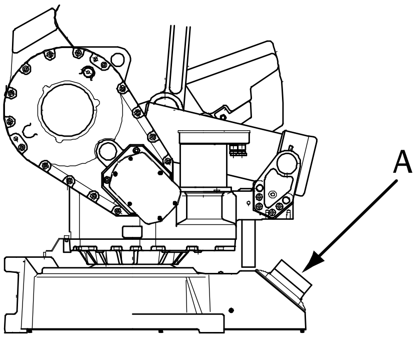
4.6.2 Replacement of serial measurement unit

WARNING

See instructions for batteries, *WARNING - Safety risks during handling of batteries on page 55*.

Location of serial measurement unit

The serial measurement unit is located inside the base of the robot, behind the rear cover, as shown in the figure below.



xx0300000106

A	Rear cover plate

Different versions, serial measurement unit

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!

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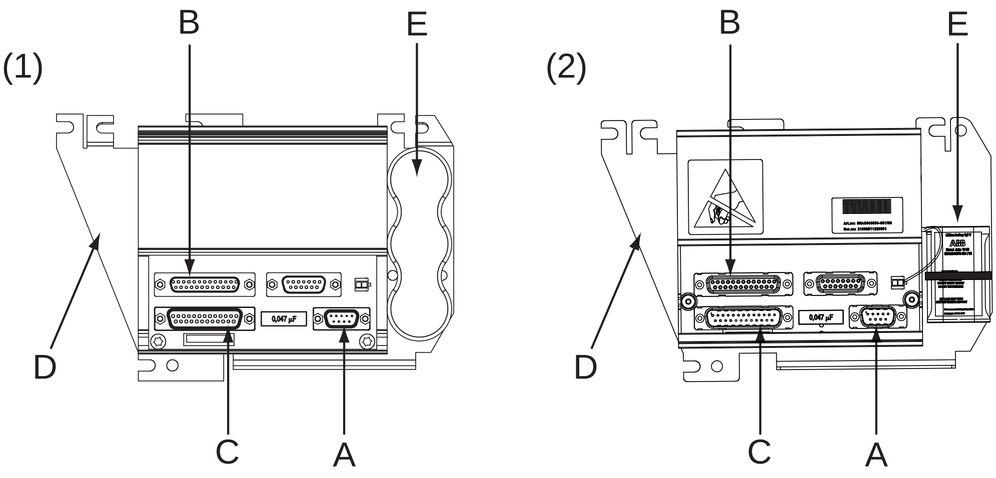


xx1300000355

1 and 2	Different versions of serial measurement unit
(2)	New version of serial measurement unit (RMU 101)
A	R2.SMB
B	R2.FB4-6
C	R2.FB1-3
D	Fastening plate
E	Battery pack

Required equipment

Equipment, etc.	Note
Serial measurement unit	See *Product manual, spare parts - IRB 4400*.
Fastening plate	See *Product manual, spare parts - IRB 4400*.
Standard toolkit	Content is defined in section *Standard tools on page 297*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Circuit diagram	See chapter *Circuit diagram on page 303*.

Removal, serial measurement unit

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

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	

Continues on next page

	Action	Note/Illustration
2	**ELECTROSTATIC DISCHARGE (ESD)** 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 53*	
3	Remove the *rear cover plate* from the base.	Shown in the figure *Location of serial measurement unit on page 215*.
4	Cut all the straps.	
5	Unscrew the nuts that attaches the serial measurement unit inside the base.	
6	Remove the serial measurement unit.	
7	Remove the connectors from the board.	The connectors are shown in the figure *Different versions, serial measurement unit on page 215*.

Refitting, serial measurement unit

The procedure below details how to refit the complete serial measurement unit.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** 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 53*	
3	Refit the connectors to the *serial measurement unit*.	Art. no. is specified in *Required equipment on page 216*. The connectors are shown in the figure *Different versions, serial measurement unit on page 215*.
4	Refit the serial measurement unit inside the base using nuts.	
5	Strap the cables.	
6	Refit the *rear cover plate* on the base.	Shown in the figure *Location of serial measurement unit on page 215*.

Continues on next page

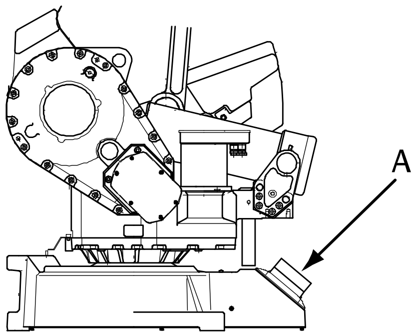
	Action	Note/Illustration
7	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.

4.6.3 Replacement of the brake release board

Location of the brake release board

The brake release board is located in the base of the robot, as shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.

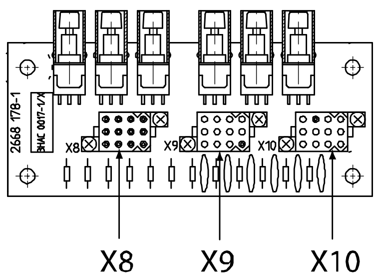


xx0300000106

A	Rear cover plate

Connectors on the brake release board

The connectors X8, X9 and X10 are placed on the brake release board as shown in the figure below.



xx0300000201

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
DSQC 563 Brake release board	See *Product manual, spare parts - IRB 4400*.		
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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

Equipment, etc.	Spare part no.	Art. no.	Note
Calibration Pendulum Instruction			Art. no. is specified in section *on page ?* in part 2 of the Product manual.

Removal, brake release board

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

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** 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 53*	
3	Secure the robot by moving... • the lower arm to one of its end positions • the upper arm to its end position.	
4	Remove the *rear cover plate.*	Shown in the figure *Location of the brake release board on page 219*.
5	Remove the connectors *X8, X9 and X10* from the brake release board.	Shown in the figure *Connectors on the brake release board on page 219*.
6	Remove the brake release board by removing its attachment screws. **Note** The guard plate will be dismantled when the screws for brake release board are unscrewed.	

Continues on next page

Refitting of brake release board

The procedure below details how to refit the brake release board to the robot.

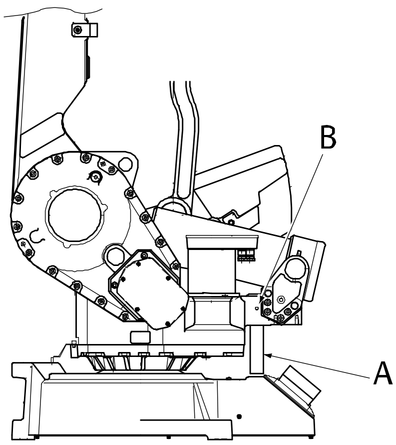
	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *WARNING - The unit is sensitive to ESD! on page 53*	
3	Refit the new *brake release board* with its attachment screws. **Note** Make sure that the guard plate is mounted when the screws for brake release unit are reassembled.	
4	Refit the connectors *X8, X9 and X10* to the brake release board.	Shown in the figure *Connectors on the brake release board on page 219*.
5	Refit the *rear cover plate* to the base of the robot.	Shown in the figure *Location of the brake release board on page 219*.
6	Recalibrate the robot!	Calibration is detailed in section *Calibration on page 269*.
7	**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 50*.	

4.6.4 Replacement of mechanical stop pin, axis 1

Location of mechanical stop pin

The mechanical stop pin on axis 1 is located on the frame as shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000182

A	Mechanical stop pin, axis 1
B	Set screw

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Mechanical stop, axis 1	3HAB3647-1		
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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, mechanical stop pin

The procedure below details how to replace the mechanical stop pin on axis 1.

WARNING

If the mechanical stop has been deformed after a hard collision, it must be replaced!

Continues on next page

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the *set screw*.	Shown in the figure in *Location of mechanical stop pin on page 222*.
3	Remove the old *mechanical stop pin*.	Shown in the figure in *Location of mechanical stop pin on page 222*.
4	Refit the new *mechanical stop* with the set screw.	Part no. is specified in *Required equipment on page 222*. M10x12

4.7 Motors

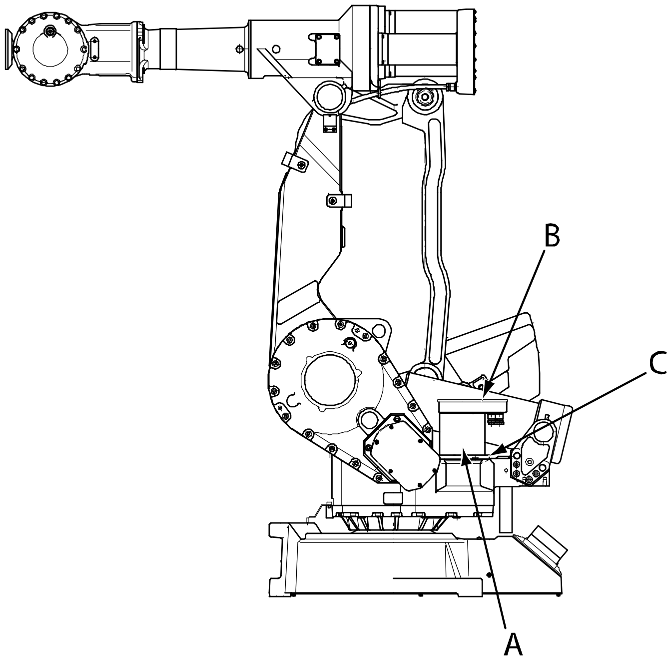
4.7.1 Replacement of motor, axis 1

Location of motor

The motor, axis 1, is located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and the drive gear constitute one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000154

A	Motor, axis 1
B	Connection box with cover
C	Attachment screws and washers

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 1 (IRB 4400)	3HAC5952-1		Elmo Includes motor pinion.
	3HAC021724-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021724-003		Color: Graphite White Yaskawa Includes pinion
O-ring, motor	21520431-11		

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Flange sealing		12340011-116	Loctite 574
Gasket	3HAC4432-1		Between the motor and the connection box. Replace if damaged!
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Power supply			24 VDC, 1.5 A Used in order to release the brakes.
Measuring tool		3HAB7887-1 or 3HAB1408-1	Choose one of the tools.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, motor axis 1

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

DANGER

If a shelf-mounted robot version is **not** flat mounted, the manipulator can contain a living force!

Removing the motor from axis 1 may result in movement of the axis, because the brake is released.

To avoid this, move the robot into normal calibration position or move axis 1 to get the lowest location of the center of gravity for the upper arm.

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	

Continues on next page

	Action	Information
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3	Remove the *cover of the connection box*.	Shown in the figure *Location of motor on page 224*.
4	Disconnect all the connectors in the motor.	
5	Remove the *connection box*.	Shown in the figure *Location of motor on page 224*.
6	Remove the *attachment screws and washers* of the motor. **Note** Check the position of the motor label before removing the motor! The motor must be mounted back at the same position!	Shown in the figure *Location of motor on page 224*.
7	Remove the motor.	

Refitting, motor axis 1

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3	**Note** The motor units from Elmo and Yaskawa are not compatible!	
4	Check that the assembly surfaces are clean from paint, lubricant etc. Make sure that the motor and the gearbox are not damaged or scratched.	

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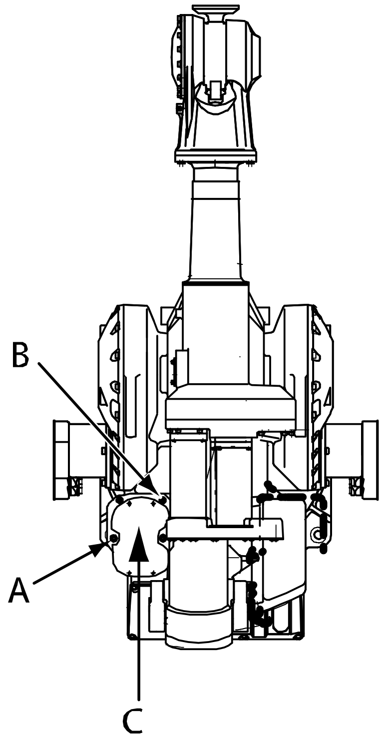
	Action	Information
5	Fit the **o-ring** to the new motor unit.	Part no. is specified in *Required equipment on page 224*
6	Release the brake of the motor by connecting the 24 VDC power supply.	Connect to connector R3.MP1 • +24V: pin 7 • 0V: pin 8.
7	Apply *flange sealing* to the motor flange.	Art. no. is specified in *Required equipment on page 224*
8	Place the new motor in the gearbox. Do not damage the pinion and the gear-wheel! Note the position of the motor! The motor label should be mounted in the same position as it had before removal.	
9	Fit the upper and lower screws (A, B) and tighten until there is no space between the motor flange and the gearbox. There should be a big backlash between the motor pinion and the gear.	 xx0300000155 A: Lower screw B: Upper screw C: Pushing direction
10	**Note** Adjust the motor before continuing the refitting procedure!	Adjustment detailed in section *Adjustment of motors, axes 1-3 on page 239*
11	Fit the other two attachment screws and washers.	Total 4 pcs. M10x30. Tightening torque: 60 Nm.
12	Check the oil level. Fill with oil if necessary	Detailed in section *Inspection of oil levels on page 125*
13	Refit the connection box. Replace the gaskets if they are damaged!	Part no. is specified in *Required equipment on page 224*

Continues on next page

	Action	Information
14	Reconnect all the connectors.	
15	Refit the cover of the connection box.	
16	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
17	**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 50*.	

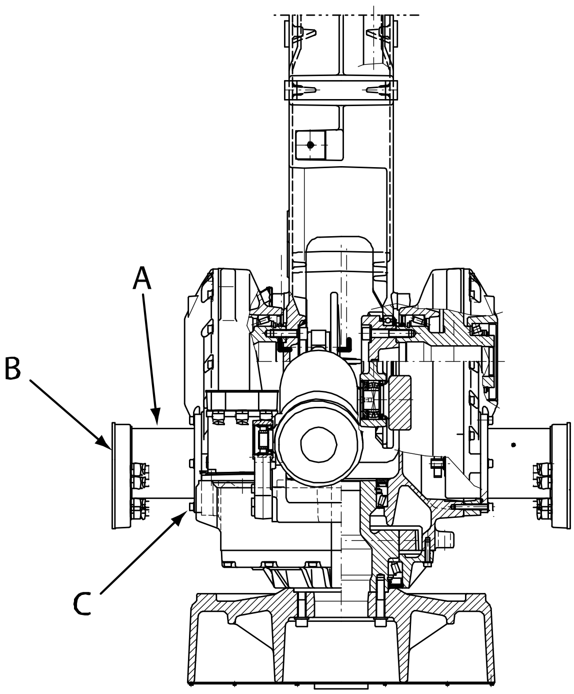
4.7.2 Replacement of motor, axis 2

Location of motor

The motor, axis 2, is located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and the drive gear constitute one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



xx0300000159

A	Motor, axis 2
B	Connection box
C	Attachment screws and washers

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 2 (IRB 4400)	3HAC5954-1		Elmo Includes pinion
	3HAC021725-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021725-003		Color: Graphite White Yaskawa Includes pinion
O-ring	21520431-11		
Flange sealing		12340011-11	Loctite 574

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Power supply			24 VDC, 1,5 A Used in order to release the brakes.
Measuring tool		3HAB7887-1 3HAB1408-1	Choose one of the two tools.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, motor axis 2

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	xx0200000022 Secure the arm system before removing the motor! The brake is located in the motor and is therefore released when the motor is removed.	
3	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
4	Remove the cover of the connection box.	
5	Disconnect all the connectors in the motor.	
6	Remove the *connection box.*	Shown in the figure *Location of motor on page 229*.

Continues on next page

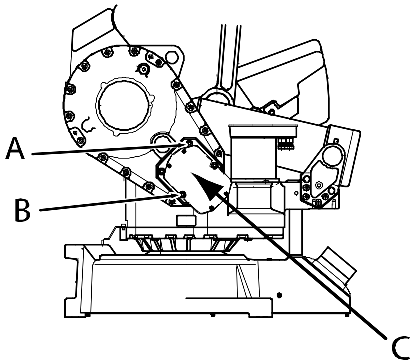
	Action	Information
7	**Note** Check the position of the motor label before removing it. The motor must be mounted in the same position.	
8	Remove the *attachment screws and washers* of the motor. **Note** Oil will start to run out when removing the motor!	Shown in the figure *Location of motor on page 229*.
9	Remove the motor.	

Refitting, motor axis 2

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3	**Note** The motor units from Elmo and Yaskawa are not compatible!	
4	Check that the assembly surfaces are clean from paint, lubricant etc. Make sure that the motor and the gearbox are not damaged or scratched.	
5	Mount the o-ring to the new motor unit.	Part no. is specified in *Required equipment on page 229*
6	Release the brake of the motor by connecting the 24 VDC power supply.	Connect to connector R3.MP2 • +24V: pin 7 • 0V: pin 8
7	Apply flange sealing to the motor flange.	Art. no. is specified in *Required equipment on page 229*

Continues on next page

	Action	Information
8	Place the new motor in the gearbox. Do not damage the pinion or the gear wheel! **Note** Check the position of the motor! The motor label should be mounted in the same position as it had before the removal.	
9	Fit the upper and lower screws (A, B) and tighten until there is no space between the motor flange and the gearbox. There should be a big backlash between the motor pinion and the gear.	 xx0300000160 A: Upper screw B: Lower screw C: Pushing direction
10	**Note** Adjust the motor before continuing the refitting procedure!	Adjustment is detailed in section *Adjustment of motors, axes 1-3 on page 239*
11	Fit the other two *attachment screws and washers.*	Shown in the figure *Location of motor on page 229* 2 pcs: M10x70 2 pcs: M10x30 Tightening torque: 60 Nm
12	Refill with oil.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*.
13	Refit the connection box.	Shown in the figure *Location of motor on page 229*
14	Reconnect the connectors.	
15	Refit the cover of the connection box.	
16	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.

Continues on next page

	Action	Information
17	**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 50*.	

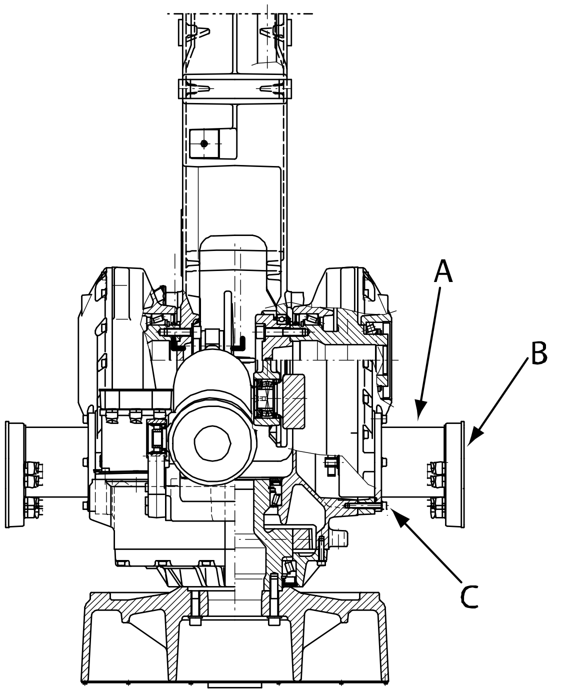
4.7.3 Replacement of motor, axis 3

Location of motor

The motor, axis 3, is located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and the drive gear constitute one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



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A	Motor, axis 3
B	Connection box
C	Attachment screws and washers, motor

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 3 (IRB 4400)	3HAC5954-1		Elmo Includes pinion
	3HAC021725-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021725-003		Color: Graphite White Yaskawa Includes pinion
O-ring	21520431-11		
Flange sealing		12340011-116	Loctite 574

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Power supply			24 VDC, 1.5 A To be used for releasing the brakes.
Measuring tool		3HAB7887-1 3HAB1408-1	Choose one of the two tools.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			General calibration information is included in section *Calibration on page 269*.

Removal, motor axis 3

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**DANGER** Secure the upper arm system before removing the motor from axis 3! The brake is located in the motor and is therefore released when the motor is removed.	
3	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
4	Remove the cover from the connection box.	
5	Disconnect all the connectors in the motor.	
6	Remove the *connection box* from the motor.	Shown in the figure *Location of motor on page 234*.

Continues on next page

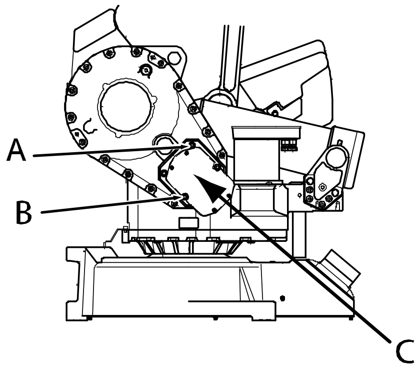
	Action	Information
7	**Note** Check the position of the motor label before removing it! The motor must be mounted in the same position.	
8	Remove the *attachment screws and washers, motor.* **Note** Oil will start to run out when removing the motor!	Shown in the figure *Location of motor on page 234*.
9	Remove the motor.	

Refitting motor axis 3

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3	**Note** The motor units from ELMO and YASKAWA are not compatible!	
4	Check that the assembly surfaces are clean from paint, lubricant etc. Make sure that the motor and the gearbox are not damaged or scratched.	
5	Fit the *o-ring* to the new *motor unit.*	Part no. is specified in *Required equipment on page 234*
6	Release the brake of the motor by connecting the 24 VDC power supply.	Connect to connectorR3.MP3 • +24V: pin 7 • 0V: pin 8
7	Apply *flange sealing* to the motor flange.	Art. no. is specified in *Required equipment on page 234*

Continues on next page

	Action	Information
8	Place the new motor in the gearbox. Do not damage the pinion and the gear wheel!	**Note** Check the position of the motor! The motor label should be mounted in the same position as it had before the removal.
9	Fit the upper and lower screws (A, B) and tighten until there is no space between the motor flange and the gearbox. There should be a big backlash between the motor pinion and the gear.	 xx0300000160 Motor axis 2, is shown in the figure! A: Upper screw B: Lower screw C: Pushing direction
10	**Note** Adjust the motor before continuing the refitting procedure!	Adjustment is detailed in section *Adjustment of motors, axes 1-3 on page 239*
11	Fit the other two *attachment screws and washers, motor.*	Shown in figure *Location of motor on page 234* M10x70 M10x30 Tightening torque: 60 Nm
12	Refill with oil.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 124*.
13	Refit the *connection box.*	Shown in the figure *Location of motor on page 234*
14	Reconnect the connectors.	
15	Refit the cover of the connection box.	
16	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.

Continues on next page

	Action	Information
17	**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 50*.	

4.7.4 Adjustment of motors, axes 1-3

General

This section details how to adjust the motors during refitting. It applies to the motors in axes 1, 2 and 3 and is a complement to the refitting instructions found in sections

- *Replacement of motor, axis 1 on page 224*
- *Replacement of motor, axis 2 on page 229*
- *Replacement of motor, axis 3 on page 234*.

Required equipment

Equipment, etc.	Art. no.	Note
Standard toolkit	3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Measuring tool	Either 3HAB7887-1 or 3HAB1408-1	Choose one of the tools. They are all compatible with the motor.
Power supply		24 VDC, 1.5 A For releasing the brakes.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *Circuit diagram on page 303*.

Adjustment

The procedure below details how to adjust the motors during refitting.

	Action	Information
1	Lock the motor brake before mounting the adjustment tool.	
2	Fit the *measuring tool* to the motor axis.	Art. no. is specified in *Required equipment on page 239*.
3	Release the brake of the current motor by connecting the 24VDC supply.	Axis 1 motor: connect to connector R3.MP1 • +24V: pin 7 • 0V: pin 8. Axis 2 motor: connect to connector R3.MP2 • +24V: pin 7 • 0V: pin 8. Axis 3 motor: connect to connector R3.MP3 • +24V: pin 7 • 0V: pin 8.

Continues on next page

	Action	Information
4	Rotate the motor shaft with the measuring tool. Measure the torque in both directions with a spring balance. A normal torque is 0.6-0.8 Nm (=6-8 N on radius 100 mm). Torques higher than 0.8 Nm are not allowed, as they will reduce the lifetime of the motor and gear.	
5	Loosen the lower and upper screws until the motor can be moved sideways by hand.	**Note** The brake must be released in the motor.
6	Push the motor with one hand against the gear and tighten the two screws with the other hand.	
7	Measure the torque with the motor shaft in different positions. The torque should be max. 0.1 Nm (on radius 50 mm) more than measured before. If the torque is more, • slightly loosen the screws a little and carefully knock the motor in the opposite direction • then measure the torque again. Check that the backlash is very limited, by moving the tool back and forward in small movements. When turning the motor shaft, a tick-tack sound can be heard from the brake disc [1)]. This should not be mixed up with the backlash. The difficult part is to find the motor position where the torque just starts to increase.	[1)] The brake disc is mounted on the motor shaft with a type of splined coupling. Between the splines there is a narrow backlash. **Note** There should always be a backlash, but it should be as minimal as possible.
8	Remove the measuring tool.	
9	Disconnect the brake release voltage.	
10	Continue refitting the motor.	*Refitting, motor axis 1 on page 226* *Refitting, motor axis 2 on page 231* *Refitting motor axis 3 on page 236*

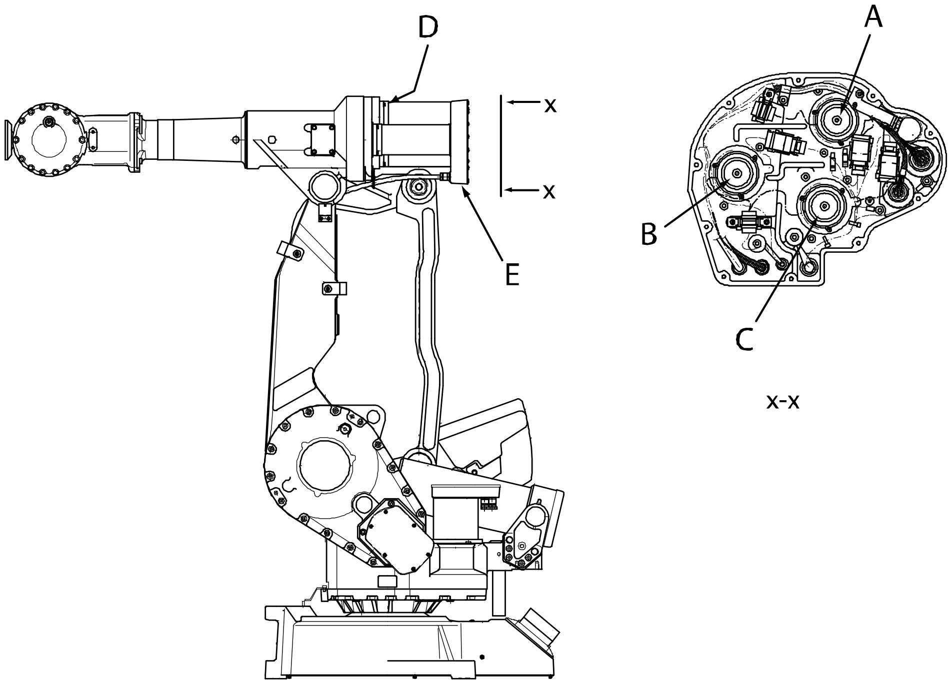
4.7.5 Removal of motor, axes 4, 5 and 6

Location of motors

The motors, axes 4, 5 and 6, are located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and the drive gear of each axis constitute one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



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A	Motor unit, axis 4
B	Motor unit, axis 5
C	Motor unit, axis 6
D	Attachment screws and washers, motor
E	Connection box

Required equipment

Equipment, etc.	Art. no.	Note
Standard toolkit	3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *Circuit diagram on page 303*.

Continues on next page

Removal, motor axes 4, 5 and 6

The procedure below details how to remove the motors of axes 4, 5 and 6.

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**DANGER** Secure the arm system before removing any motor! The brake is located in the motor and is therefore released when the motor is removed!	
3	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
4	Drain the oil from the gearbox.	Draining is detailed in sections: • *Oil change, gearbox axis 4 on page 128*. • *Oil change, gearbox axis 5 and 6 (all robot versions) on page 131*
5	Remove the cover of the connection box.	
6	Disconnect all the connectors in the connection box.	
7	Remove the *connection box.*	Shown in the figure *Location of motors on page 241*.
8	**Note** Check the position of the motor before removing it. The motor must be mounted back at the same position.	
9	Remove the *attachment screws and washers, motor.*	Shown in the figure *Location of motors on page 241*.
10	Remove the motor.	

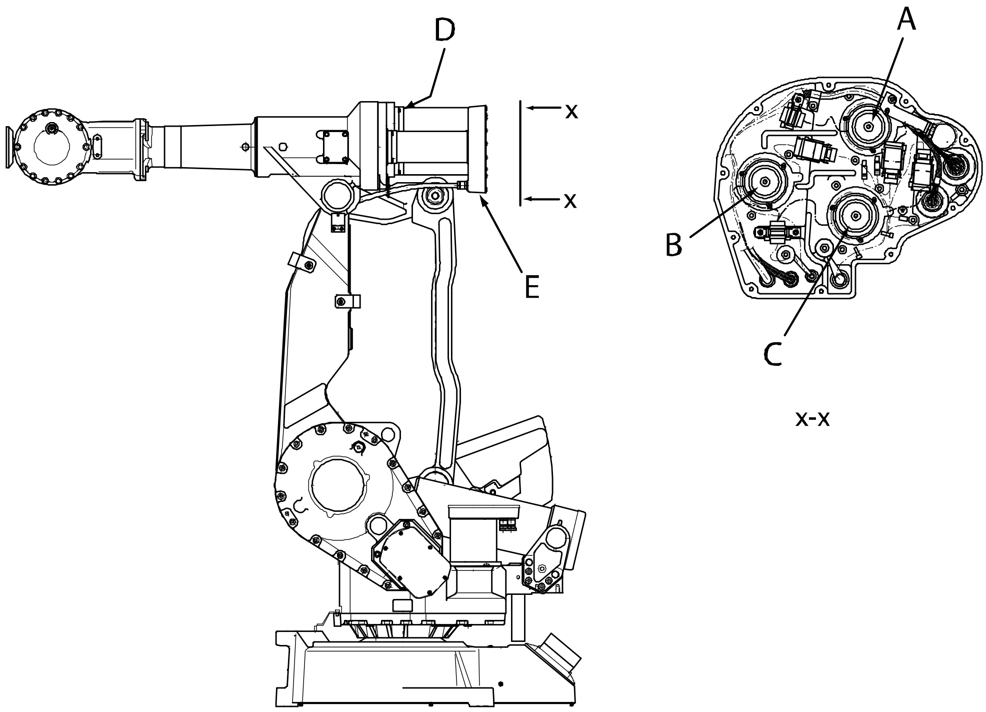
4.7.6 Refitting of motor, axis 4

Location of motor

The motors, axes 4, 5 and 6, are located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and the drive gear of each axis constitute one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



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A	Motor unit, axis 4
B	Motor unit, axis 5
C	Motor unit axis 6
D	Attachment screws and washers, motor
E	Connection box

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 4 (IRB 4400)	3HAC10603-1		Elmo Includes pinion.
	3HAC021726-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021726-003		Color: Graphite White Yaskawa Includes pinion

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 4 (IRB 4400/L10)	3HAC021962-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021962-002		Color: Graphite White Yaskawa Includes pinion
O-ring	21522012-426		
Gasket	3HAB3676-1		3 pcs Between the motors and the connection box. Replace if damaged.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Measuring tool		3HAB1409-1	
Power supply			24VDC, 1.5A Used to release the brake of the motor.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			Art. no. is specified in section *Calibration on page 269* manual.

Refitting, motor axis 4

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	

Continues on next page

	Action	Information
3	**Note** The motor unit from ELMO and YASKAWA are **not** compatible!	
4	Check that the assembly surfaces are clean from paint, lubricant etc. Make sure that the motor and the gearbox are not damaged or scratched.	
5	Fit the *o-ring* to the new *motor unit.*	Part no. is specified in *Required equipment on page 243*.
6	Fit the *measuring tool* to the rear of the motor.	Art. no. is specified in *Required equipment on page 243*.
7	Release the brake of the motor by connecting the 24 VDC power supply.	Connect to connector R3.MP4 • +24V: pin 7 • 0V: pin 8.
8	Place the new motor unit in the gearbox. Do not damage the pinion or the gear wheel.	
9	Find the position with the least play by turning the motor shaft 10 revolutions, noting changes in play as you turn the motor.	
10	Push the motor in a radial direction so that the play is minimal within one motor revolution without the gear "chewing".	
11	Refit the motor with its *attachment screws and washers, motor.*	Shown in the figure *Location of motor on page 243*. 4 pcs, M6x25. Tightening torque: 15 Nm.
12	Refill with oil, if drained.	Detailed in section *Oil change, gearbox axis 4 on page 128*.
13	Check the position of the three *gaskets,* located between the motors and the connection box. Replace them if damaged.	Part no. is specified in *Required equipment on page 243*.
14	Refit the *connection box.* Make sure the gaskets are seated properly!	Shown in the figure *Location of motor on page 243*.
15	Reconnect all the connectors.	
16	Refit the cover to the connection box.	
17	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
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 50*.	

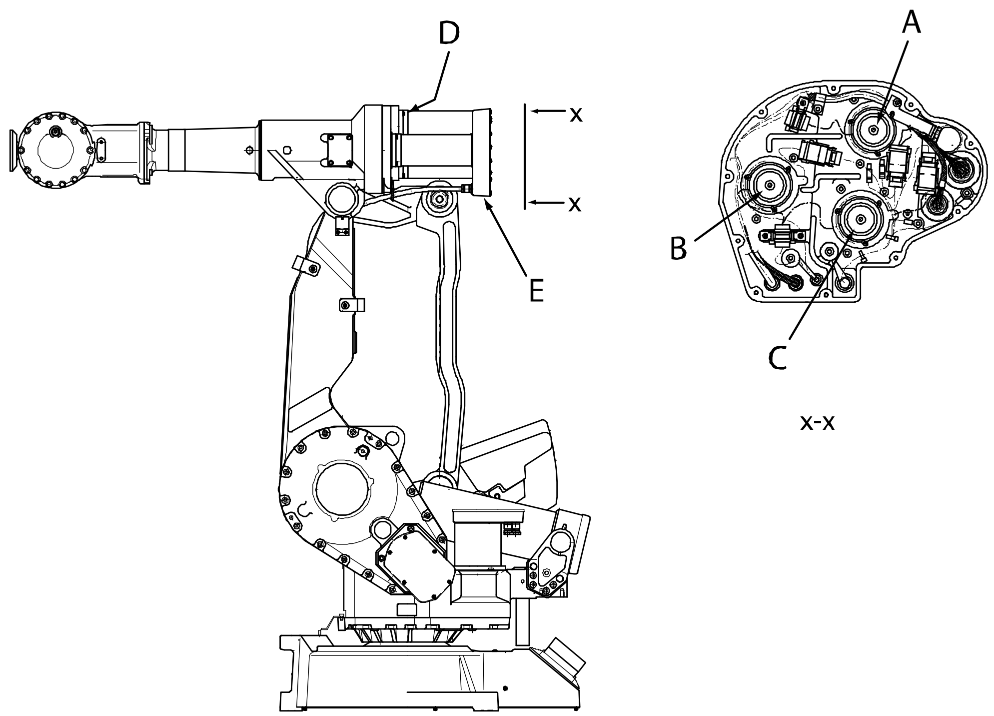
4.7.7 Refitting of motor, axis 5

Location of motor

The motors, axes 4, 5 and 6 are located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and drive gear of each axis constitutes one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



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A	Motor unit, axis 4
B	Motor unit, axis 5
C	Motor unit, axis 6
D	Attachment screws and washers, motor
E	Connection box

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 5 (IRB 4400)	3HAC10603-1		Elmo Includes pinion.
	3HAC021726-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021726-003		Color: Graphite White Yaskawa Includes pinion
Motor unit, axis 5 (IRB 4400/L10)	3HAC021962-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021962-002		Color: Graphite White Yaskawa Includes pinion
O-ring	21522012-426		
Gasket	3HAB3676-1		3 pcs Between the motor and the connection box. Replace if damaged.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Measuring tool		3HAB1409-1	
Power supply			24VDC, 1.5A 2 pcs, used to release the brakes in the motors for axes 4 and 5.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			Art. no. is specified in section *Calibration on page 269*.

Continues on next page

Refitting, motor axis 5

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3	**Note** The motor units from ELMO and YASKAWA are not compatible!	
4	Check that the assembly surfaces are clean from paint, lubricant etc. Make sure that the motor and the gearbox are not damaged or scratched.	
5	Fit the *o-ring* into the new motor.	Part no. is specified in *Required equipment on page 247*.
6	Fit the *measuring tool* to the rear of the motor.	Art. no. is specified in *Required equipment on page 247*.
7	Release the brakes in the motors for axes 4 and 5, by connecting the 24 VDC power supply.	Connect to connector R3.MP4/MP5 • +24V: pin 7 • 0V: pin 8.
8	Place the new motor unit in the gearbox. Do not damage the pinion or the gear wheel.	
9	Find the position of least play by turning the outgoing shaft for axis 4 in intervals of 90°, one revolution in all, to locate the area where the play for the motor axis 5 is the smallest.	
10	Turn the motor for axis 5 one full revolution at a time, five revolutions in all. Find the smallest play within this range.	
11	Push the motor in a radial direction so that the play is minimal within one motor revolution without the gear "chewing".	
12	Refit the motor with its *attachment screws and washers, motor.*	Shown in the figure *Location of motor on page 246*. 4 pcs, M6x25. Tightening torque: 15 Nm.

Continues on next page

	Action	Information
13	Refill with oil, if drained.	Detailed in section: • *Oil change, gearbox axis 5 and 6 (all robot versions) on page 131*.
14	Check the position of the three *gaskets*, located between the motors and the connection box. Replace them if damaged.	Part no. is specified in *Required equipment on page 247*.
15	Refit the *connection box.* Make sure the gaskets are seated properly!	Shown in the figure *Location of motor on page 246*.
16	Reconnect all the connectors.	
17	Refit the cover on the connection box.	
18	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
19	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 50*.	

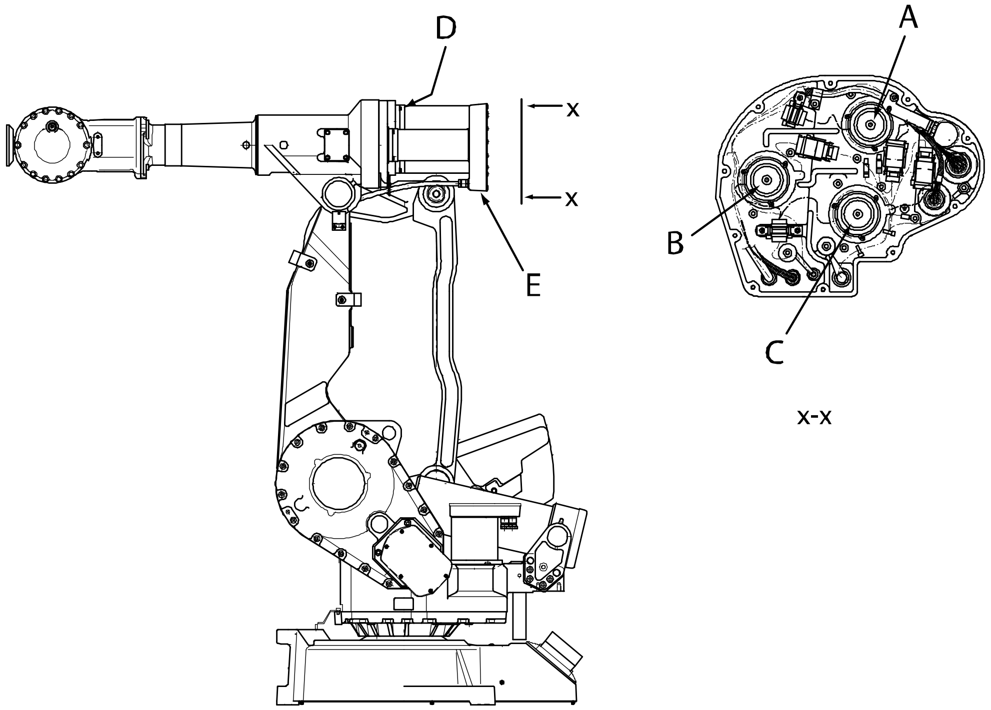
4.7.8 Refitting of motor, axis 6

Location of motor

The motors, axes 4, 5 and 6, are located as shown in the figure below. (The figure shows the IRB 4400.)

The motor and the drive gear of each axis constitute one unit.

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



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A	Motor unit, axis 4
B	Motor unit, axis 5
C	Motor unit, axis 6
D	Attachment screws and washers, motor
E	Connection box

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 6 (IRB 4400)	3HAC10604-1		Elmo Includes pinion.
Motor unit, axis 6 (IRB 4400)	3HAC021728-001		Yaskawa Includes pinion

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Equipment, etc.	Spare part no.	Art. no.	Note
Motor unit, axis 6 (IRB 4400/L10)	3HAC021962-001		Color: ABB Orange Yaskawa Includes pinion
	3HAC021962-002		Color: Graphite White Yaskawa Includes pinion
O-ring	21522012-426		
Gasket	3HAB3676-1		3 pcs Between the motors and the connection box. Replace if damaged.
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
Measuring tool		3HAB1409-1	
Power supply			24VDC, 1.5A 3 pcs, used to release the brakes in the motors for axes 4, 5 and 6.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 303*.
Calibration Pendulum Instruction			Art. no. is specified in section *Calibration on page 269*.

Refitting, motor axis 6

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	

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	Action	Information
3	**Note** The motor units from ELMO and YASKAWA are not compatible!	
4	Check that the assembly surfaces are clean from paint, lubricant etc. Make sure that the motor and the gearbox are not damaged or scratched.	
5	Fit the *o-ring* to the new *motor unit*.	Part no. is specified in *Required equipment on page 250*.
6	Fit the *measuring tool* at the rear of the motor.	Art. no. is specified in *Required equipment on page 250*.
7	Release the brakes in the motors for axes 4, 5 and 6, by connecting the 24 VDC power supply.	Connect to connector R3.MP4/MP5/MP6 • +24V: pin 7 • 0V: pin 8.
8	Place the new motor unit in the gearbox. Do not damage the pinion or the gear wheel!	
9	Find the position of least play by turning the outgoing shaft for axis 4 in intervals of 90°, one revolution in all, to locate the area where the play for the axis 6 motor is the smallest.	
10	Turn the motor for axis 5 one full revolution at a time, five revolutions in all. Find the least play for axis 6 within this range.	
11	Turn the motor for axis 6 one full revolutipon at a time, three turns in all. Find the least play for axis 6 within this range.	
12	Push the motor in a radial direction so that the play is minimal within one motor revolution without the gear "chewing".	
13	Refit the motor with its *attachment screws and washers, motor.*	Shown in the figure *Location of motor on page 250*. 4 pcs, M6 x 25. Tightening torque: 15 Nm.
14	Refill with oil, if drained.	Detailed in section • *Oil change, gearbox axis 5 and 6 (all robot versions) on page 131*.
15	Check the position of the three *gaskets*, located between the motors and the connection box. Replace them if damaged.	Part no. is specified in *Required equipment on page 250*.
16	Refit the *connection box*. Make sure the gaskets are seated properly!	Shown in the figure *Location of motor on page 250*.
17	Reconnect all the connectors.	
18	Refit the cover on the connection box.	

Continues on next page

	Action	Information
19	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
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 50*.	

4.8 Gearboxes

4.8.1 Replacement of gearbox unit, axes 1-2-3

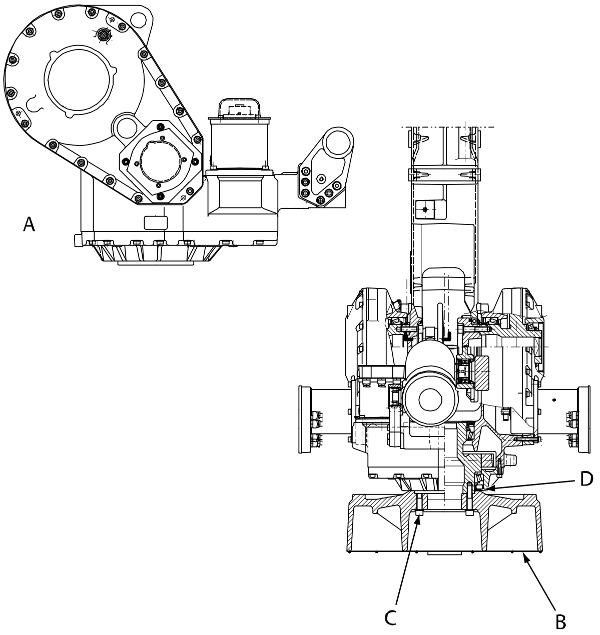
General

The gearboxes of axes 1-2-3 are handled as one complete unit. Except for the gearboxes, the spare part also includes motor units and lubricating oil for the axes 1, 2 and 3.

Location of gearbox unit

The gearbox unit, axes 1-2-3, is shown in the figure below. (The figure shows the IRB 4400.)

A more detailed view of the component and its position may be found in chapter *Exploded views*, in *Product manual, spare parts - IRB 4400*.



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A	Gearbox unit axes 1-3, spare part
B	Bottom plate
C	Attachment screws and washers, gearbox unit
D	Sealing

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Gearbox unit, axes 1-3 (IRB 4400)	3HAC5948-1		Does not include motors and lubricating oil.
Sealing	3HAC5479-2		Replace if damaged!
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.

Continues on next page

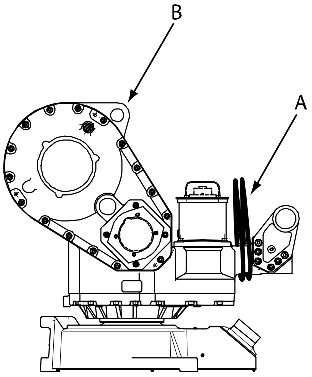
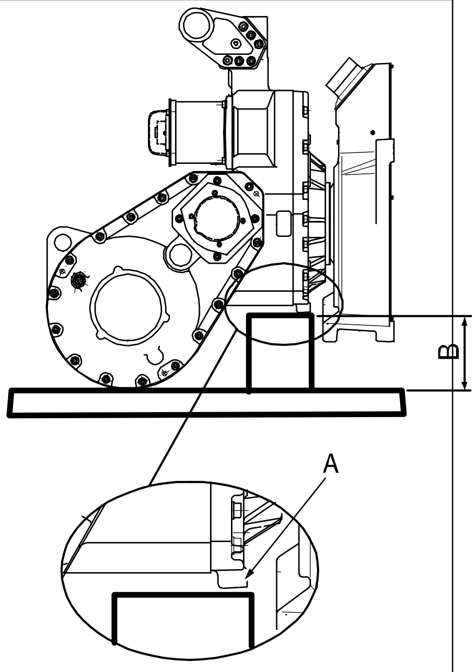
Equipment, etc.	Spare part no.	Art. no.	Note
Lifting slings with hoisting block			Lifting capacity: 500 kg.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Calibration Pendulum instruction			General calibration information is included in section *Calibration on page 269*.

Removal, gearbox unit

The procedure below details how to remove the gearbox unit, axis 1-2-3, including the motors, from the robot.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The robot arm system weighs 245 kg. All lifting accessories used must be sized accordingly!	
3	**CAUTION** The robot base weighs 130 kg. All lifting accessories used must be sized accordingly!	
4	Remove the cable harness and serial measuring board.	Detailed in sections *Replacement of cable harness, axes 1-3 on page 153*, and *Replacement of serial measurement unit on page 215*.
5	Remove the tie rod.	Detailed in section *Replacement of tie rod on page 199*.
6	Remove the parallel arm.	Detailed in section *Replacement of parallel arm / Replacement of bearing on page 203*.
7	Remove the complete arm system.	Detailed in section *Replacement of complete arm system on page 165*.
8	Unfasten the robot from the foundation.	

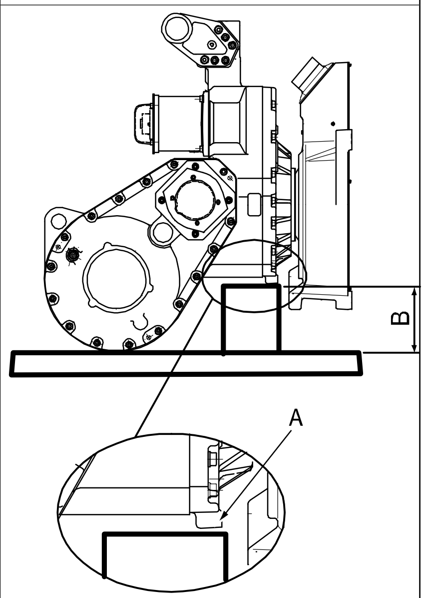
Continues on next page

	Action	Info/Illustration
9	Fit and secure straps (A) around the rear part of the gearbox unit, as shown in the figure to the right. Attach the straps to lifting slings with a hoisting block. Fit and secure hooks to the lifting lugs (B). Use the same crane for both attachment points.	This figure shows the IRB 4400.  xx0300000172
10	Lift the gearbox unit together with the base and use the hoisting block to tip the complete assembly forward 90°.	
11	Place the assembly on a level surface and support it at position A, according to the figure on the right.  **CAUTION** Make sure the unit is stable and rests securily before removing the lifting equipment.	 xx0300000173 • B: Approximately 200 mm (IRB 4400 all models)
12	Remove the *bottom plate* from the base.	Shown in the figure *Refitting, complete arm system on page 167*.
13	Move the lifting straps to the base and unload its weight.	
14	Remove the *attachment screws and washers, gearbox unit.*	Shown in the figure *Refitting, cabling axes 1-3 on page 156*.
15	Remove the base from the gearbox unit.	
16	Remove the sealing from the gearbox unit.	

Continues on next page

Refitting, gearbox unit

The procedure below details how to refit the gearbox unit, including motors, to the robot.

Step	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	**CAUTION** The robot base weighs 130 kg. All lifting accessories used must be sized accordingly!	
3	**CAUTION** The robot arm system weighs 245 kg. All lifting accessories used must be sized accordingly!	
4	Place the new *gearbox unit* on a level surface and support it at position A, according to the figure on the right. Make sure the unit is stable and rests securily on the surface, including the weight of the base that is to be refitted.	xx0300000173 Part no. is specified in *Required equipment on page 254* B: Approximately 200mm (IRB 4400 models)

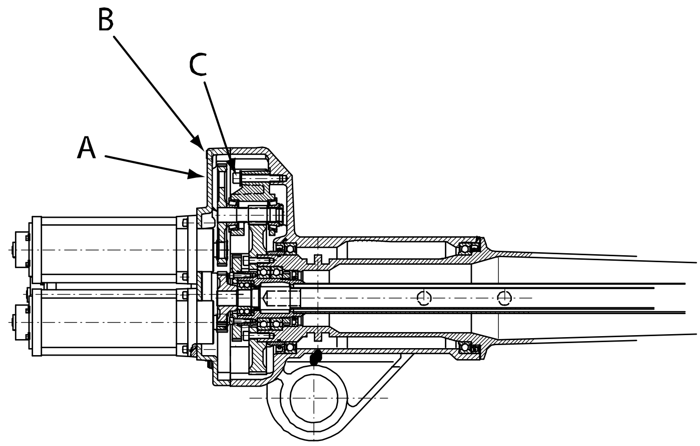
Continues on next page

Step	Action	Info/Illustration
5	Refit the *sealing* to the gearbox unit. Replace it if damaged.	Shown in figure *Location of gearbox unit on page 254* Part no. is specified in *Required equipment on page 254*
6	Raise the base and fit it to the gearbox unit. Align the hole pattern of the base to the gearboxes. Turn the gear if necessary by the motor pinion, axis 1.	
7	Refit the base with the *attachment screws and washers, gearbox unit.*	Shown in figure *Location of gearbox unit on page 254* Attachment: 14 pcs, M16x80-12.9 UNBRAKO. Tightening torque: 260 Nm. Reused screws may be used, providing they are lubricated as detailed in Screw joints in the Product manual, reference information before fitting.
8	Refit the *bottom plate* with its attachment screws.	Shown in the figure *Location of gearbox unit on page 254*
9	Strap the gearbox unit as in the removal instruction	See section *Removal, gearbox unit on page 255*
10	Lift the gearbox unit together with the base and use the hoisting block to tip the complete assembly backward by 90°, into normal mounting position.	
11	Refit the robot to the foundation.	
12	Refit the complete arm system.	Detailed in section *Replacement of complete arm system on page 165*
13	Refit the parallel arm.	Detailed in section *Refitting, parallel arm/bearing on page 205*
14	Refit the tie rod.	Detailed in section *Refitting, tie rod on page 201*
15	Refit the cable harness and serial measuring board.	Detailed in sections *Refitting, cabling axes 1-3 on page 156*
16	Recalibrate the robot!	Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 269*.
17	**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 50*.	

4.8.2 Adjusting play on axis 4, intermediate gear

Illustration, adjusting play

In order to adjust the play on axis 4, the gear must be accessible. The figure below shows the parts in the upper arm housing that must be removed/unlocked.



xx0300000191

A	Cover
B	Attachment screws, cover
C	Screws, 3 pcs

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Flange sealing		12340011-116	Loctite 574
Standard toolkit		3HAC17594-1	Content is defined in section *Standard tools on page 297*.
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

Adjusting play, axis 4

The procedure below details how to adjust the play for the intermediate gear of axis 4.

	Action	Info/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply (do not turn off for Foundry Prime robots!) to the robot, before entering the robot working area.	
2	Remove the motors for axes 4, 5 and 6.	Detailed in section *Removal of motor, axes 4, 5 and 6 on page 241*.
3	Remove the *cover*.	Shown in the figure *Illustration, adjusting play on page 259*.
4	Unlock the three *screws*.	Shown in the figure *Illustration, adjusting play on page 259*.
5	Rotate axis 4 to find the highest position of the gear on the upper arm tubular.	
6	Tighten the three screws again.	3 pcs, tightening torque: 69 Nm.
7	Apply *flange sealing* to the cover and refit it with its *attachment screws and washers*.	Art. no. is specified in *Required equipment on page 259*. 10 pcs: M8x40. Tightening torque: 24 Nm.

4.9 Additional repair routines for Foundry Prime

4.9.1 Repair routines

Overview

Robots working with water jet cleaning have special tightness for water jet cleaning application and require special repair routines to maintain the tightness level. The repair must be done according to the repair chapter with the additions described in the following procedures.

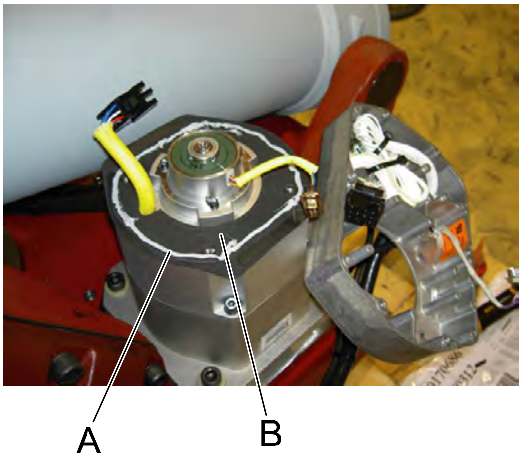
Required equipment

Follow the instruction in the Repair chapter, with the following additional measure.

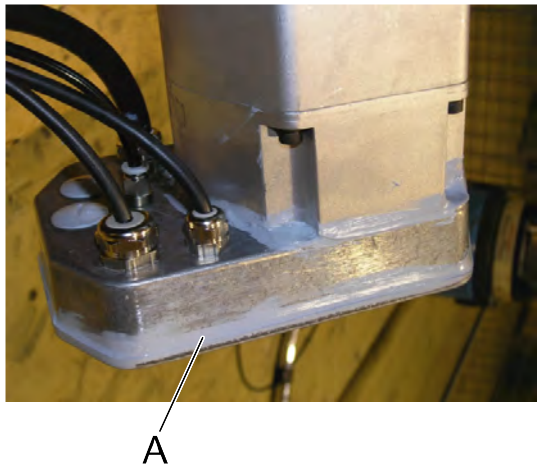
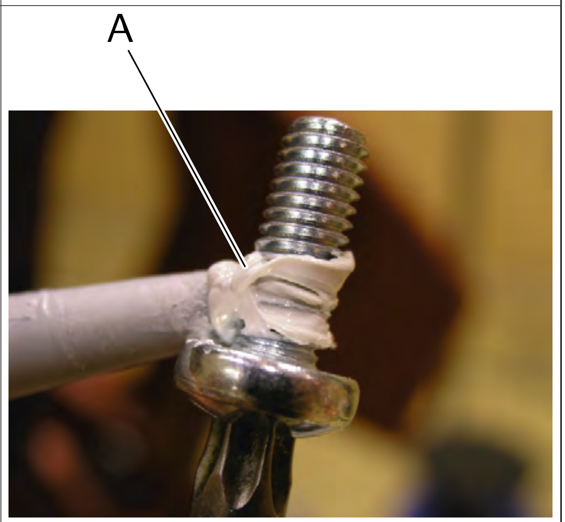
Equipment	Article number
Cable strap	21662055-3
Sikaflex 521FC	3HAC026759-001
Drill diameter 8.8 mm	

Replacement of motor axes 1-3

The following procedure details how to replace motors axes 1-3.

	Action	Note
1	Apply Sikaflex 521FC on both sides of the gasket between motor and cable box before assembling the cable box.	 xx0600003111 • A: Sikaflex • B: Gasket
2	Cut the projecting part of the gasket with a knife.	

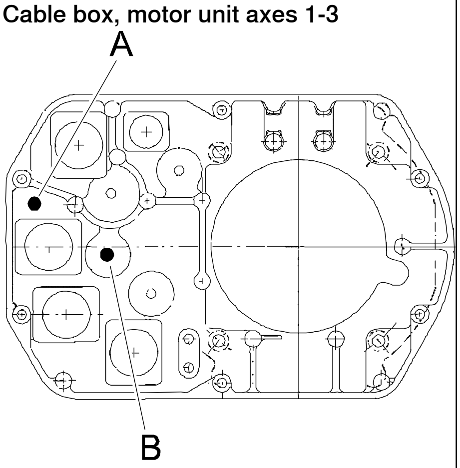
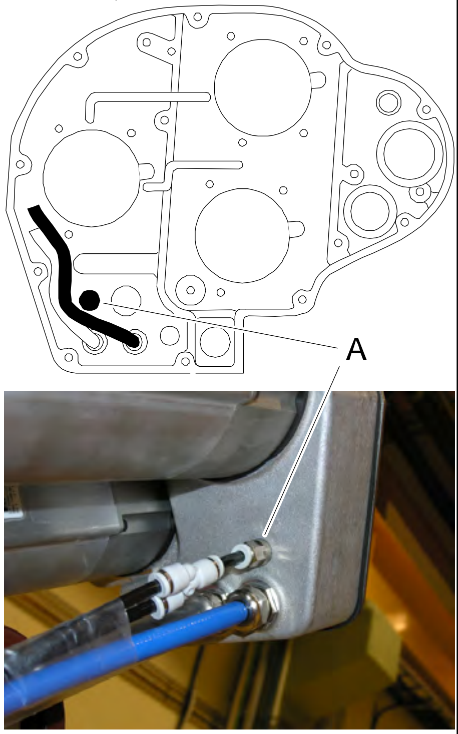
Continues on next page

	Action	Note
3	Apply Sikaflex 521FC outside the gasket and the cover plate around the motor.	 xx0600003112 • A: Sikaflex
4	Apply Sikaflex 521FC underneath the cover attachment screw heads.	 xx0600003113 • A: Sikaflex

Continues on next page

Replacement of cable harness to motor axes 1-3 and 4-6

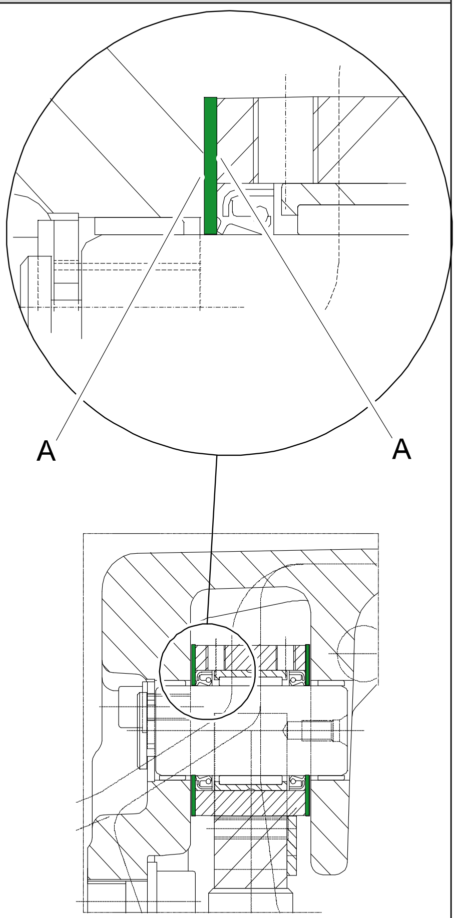
The following procedure details how to replace motor cabling axes 1-3 and 4-6.

	Action	Note
1	Drill and tap holes in the cable boxes for the air fittings before assembling a new cable harness. Drill diameter: 8.8mm Thread: 1/8" pipe thread	Cable box, motor unit axes 1-3  xx0600003114 • A: Air connection on motor cable box axis 1. • B: Air connection on motor cable box axis 2 and 3 (not used earth connection. Cable box, motor unit axes 4-6  Additional r • A: Air connection on motor cable box axis 4-6

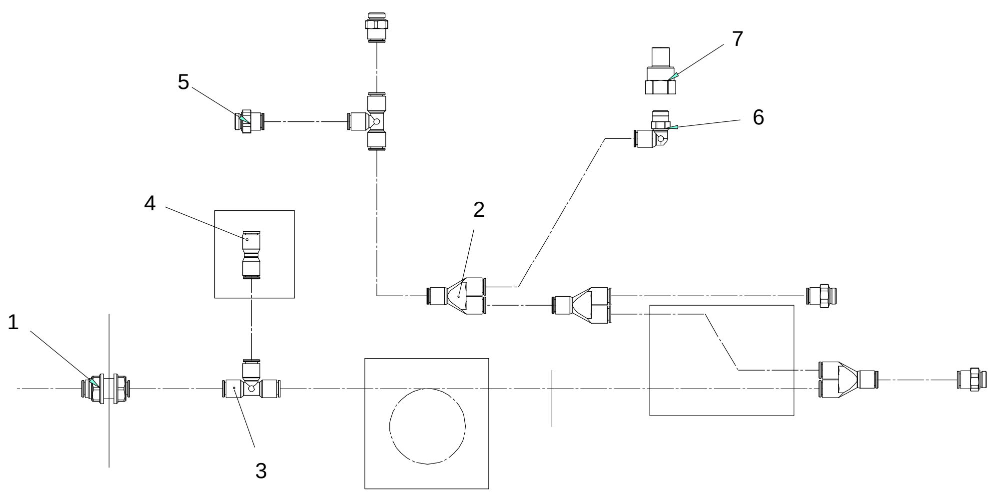
Continues on next page

Replacement of balancing device

The following procedure details how to replace the balancing device.

	Action	Note
1	Before refitting the balancing device in the robot, apply Mercasol on both side of the ear and both side of the washers.	 xx0600003123 • A: Mercasol

Replacement of air hose (Required equipment)



xx0600003342

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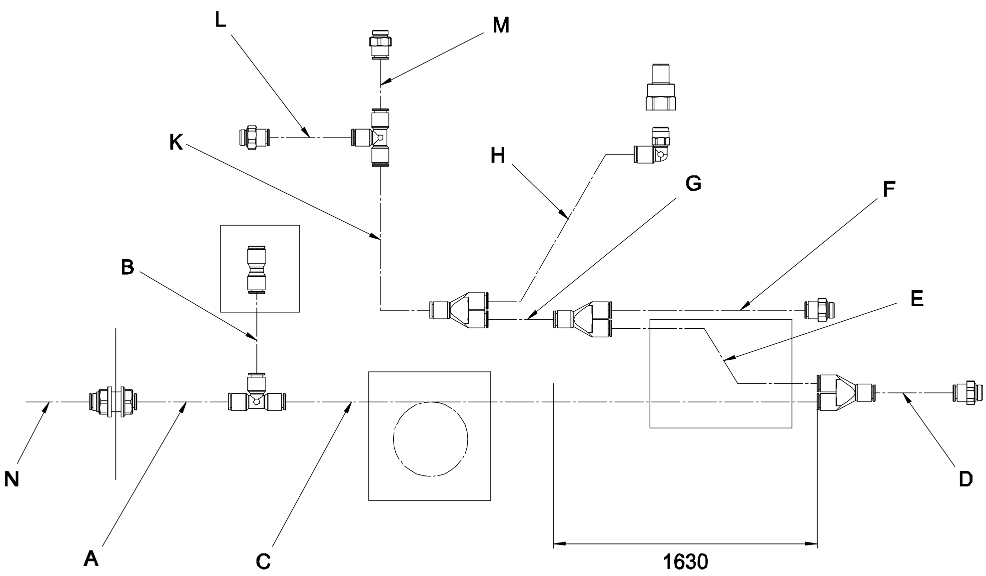
Equipment	Article number	
Elbow fitting	3HAC026511-001/ 1	Pos 6 in figure above
Rubber clamp	3HAC026523-001	
T-plug connector	3HAC026515-001/ 2	Pos 3 in figure above
Y-plug connector	3HAC026514-001/ 3	Pos 2 in figure above
Bulkhead plug connector	3HAC026513-001/ 1	Pos 1 in figure above
Air hose	3HAC026526-001	According to table: Pneumatic house Length 7500 mm
Straight plug connector	3HAC026516-001/ 1	Pos 4 in figure above
Straight fitting	3HAC026507-001/ 4	Pos 5 in figure above
Adapter	3HAC027569-001/ 1	Pos 7 in figure above



xx0600003343

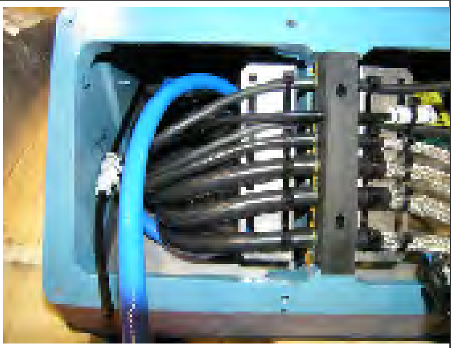
Pneumatic house	Article number 3HAC026526-001	Note
A	140 mm	From the Bulkhead plug in the front plate to the T-plug connector for the SMB box, se step 1 and 2 in *Replacement of air hose on page 266*
B	270 mm	From the T-plug connector to the stright plug connector in the SMB box.
C	3050 mm	From the T-plug connector through the base and up to the Y-plug connector at the motors of axis 4,5,6, se step 3-5 in *Replacement of air hose on page 266*.
D	40 mm	From the Y-plug connector at axis 4,5,6 motors to the straight fitting in the motor cover axis 4,5,6.
E	1750 mm	From the Y-plug connector at axis 4,5,6 motors to the the Y-plug connector at for the motors of axis 3, se step 6 in *Replacement of air hose on page 266*.
F	425 mm	From the Y-plug connector at axis 3 motors to the straight fitting in the motor cover axis 3.

Continues on next page

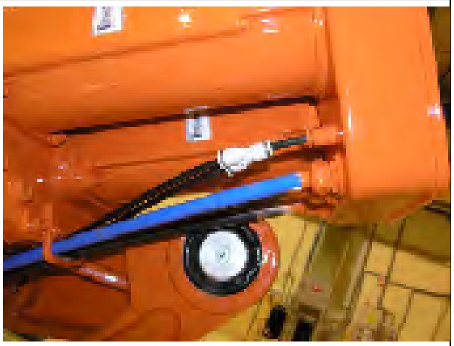
Pneumatic house	Article number 3HAC026526-001	Note
G	80 mm	From the Y-plug connector at axis 3 to the Y-plug connector for the balancing cylinder.
H	460 mm	From the Y-plug connector for the balancing cylinder to the elbow fitting in the bak of the balancing cylinder, se step 7 in *Replacement of air hose on page 266*.
K	220 mm	From the Y-plug connector for the balancing cylinder to the T-plug connector for axis 1 and axis 2.
L	140 mm	From the T-plug connector to the straight fitting in the motor cover axis 1.
M	365 mm	From the T-plug connector to the straight fitting in the motor cover axis 2.
N	150 mm	To the Bulkhead plug in the front plate.

Replacement of air hose

The following procedure details how to replace the air hose.

	Action	Note
1	The air is let in via the cover of the rear side of the foot where a bulkhead plug for Ø6mm plastic hose is mounted. A plastic hose is drawn from the bulkhead plug to a T-plug connector and led to the SMB compartment.	 Additional r
2	The hose is drawn through a drilled hole in the rubber sealing and firmly tightened with a straight fitting.	 Additional r

Continues on next page

	Action	Note
3	In the base an extra ring of the hose is made so that full movement for axis 1 is guaranteed.	 Additional r
4	The plastic hose is drawn from the T-plug connector up through axis 1. A hole is drilled in the cable guide axis 1 for the air hose. A bulkhead is mounted in the hole to prevent wear on the hose. The hose must be able to run free in the bulkhead.	 Additional r
5	The hose continue through the lower arm and is connected to a Y-plug connector at the upper arm housing.	 xx0600003120

Continues on next page

	Action	Note
6	The hose is led back down the lower arm to motors axis 1-3 from the Y-plug connector. The air is distributed via a Y-plug connector and a T-plug connector to the cable boxes	 xx0600003121  xx0600003122
7	From the Y-plug connector for the balancing cylinder to the elbow plug in the back of the balancing cylinder.	 xx0600003344

5 Calibration

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 275*. 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 298*.

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.

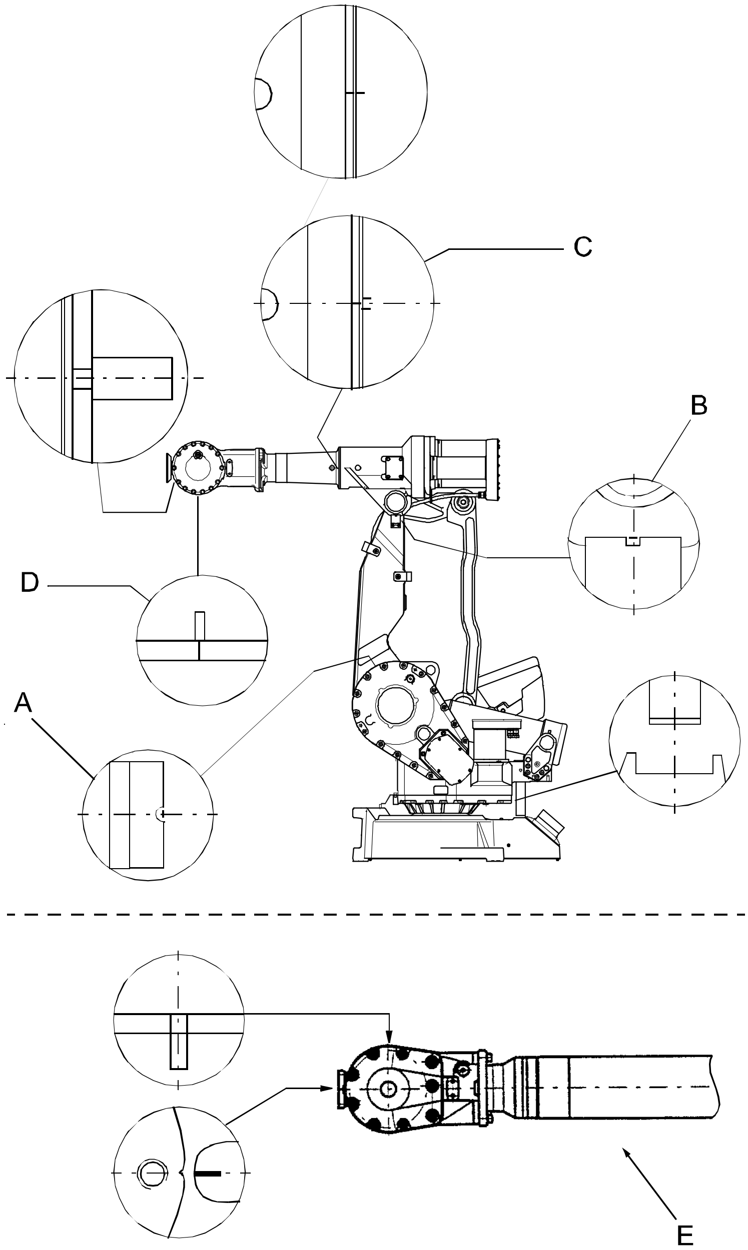
5.3 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 4400

The illustration shows the calibration scale positions on IRB 4400. The calibration marks for axes 2, 3, 4 and 5 are marked using punch mark tools.



xx0300000209

A	Punch, axis 2, 3HAB 1521-1
B	Punch, axis 3, 3HAB 1522-1

Continues on next page

C	Punch, axis 4, 3HAB 1523-1 (there are two different versions of the marks, as shown in the figure)
D	Punch, axis 5, 3HAB 1524-1

5.4 Calibration movement directions for all axes

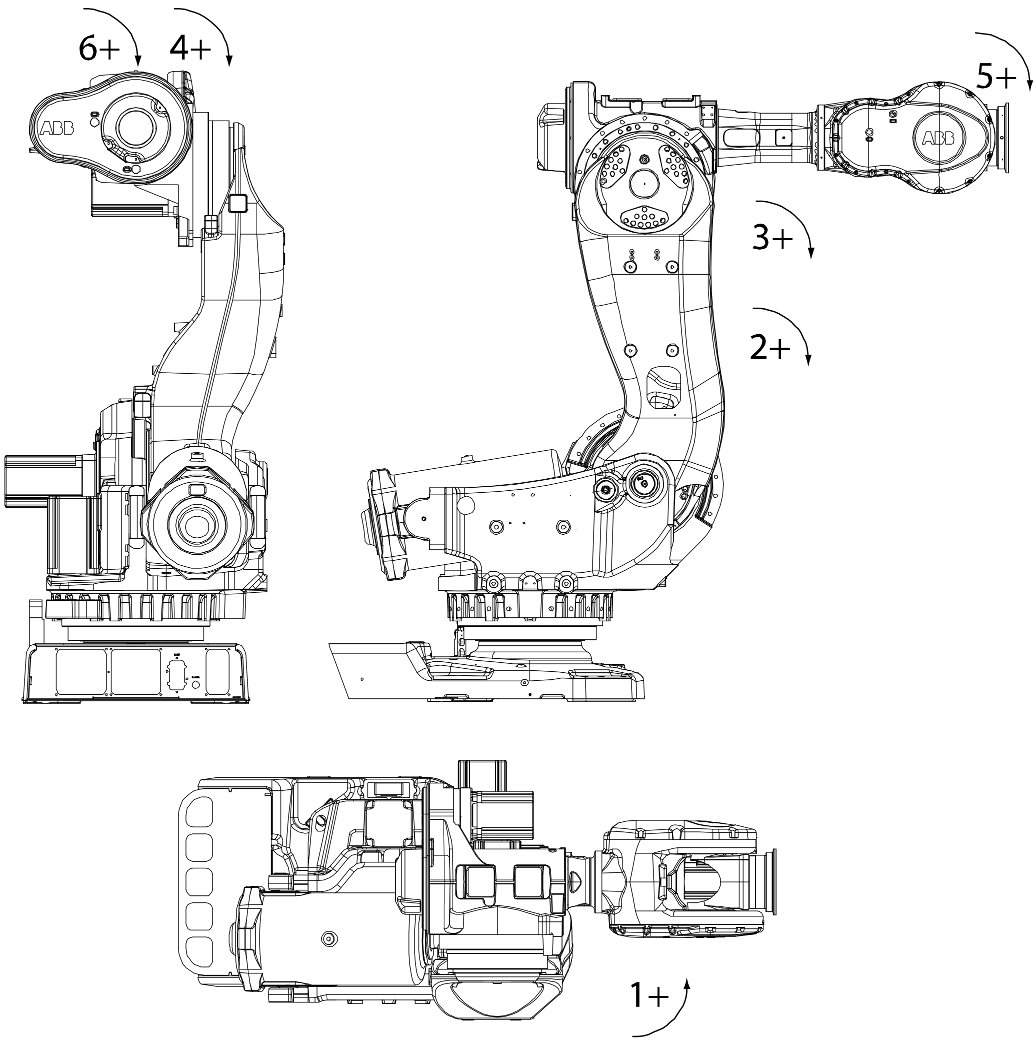
Overview

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!



xx0200000089

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 272*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the TPU on page 276* (BaseWare 4.0). *Step 2 - Updating the revolution counter with the FlexPendant on page 277*.

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:

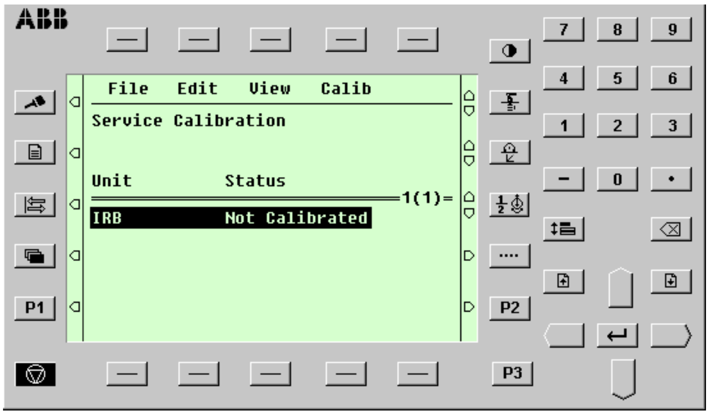
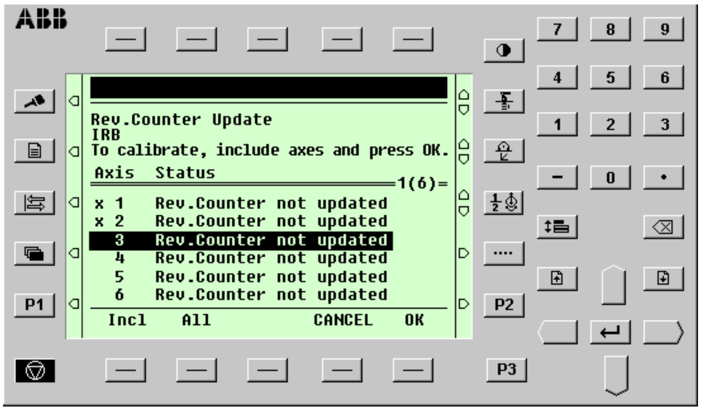
Manipulator variant	Axis 4	Axis 6
IRB 4400	No	No

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.	

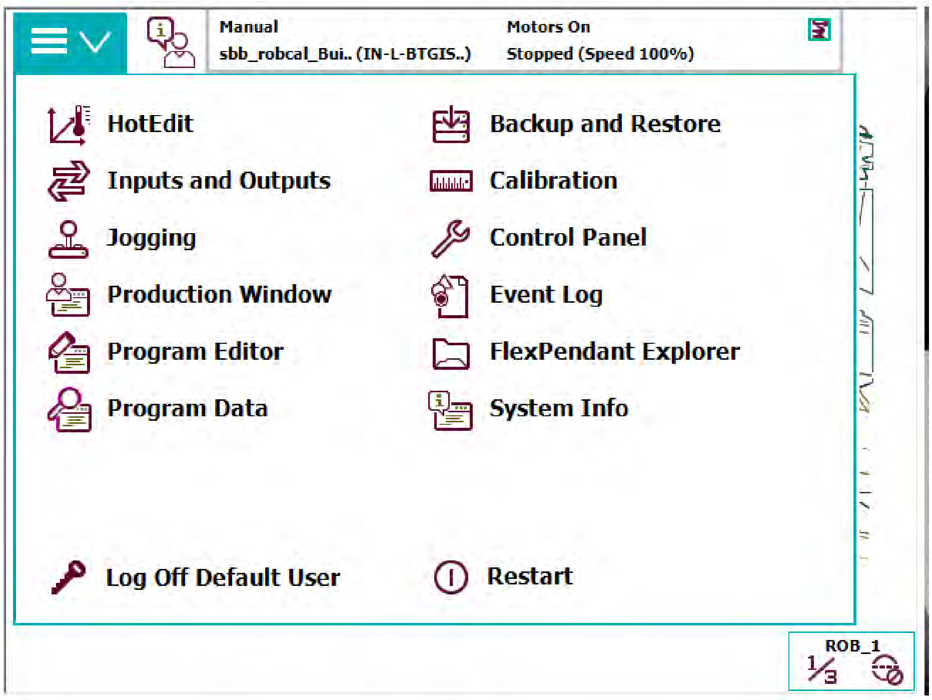
Continues on next page

	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 280*.	

Step 2 - Updating the revolution counter with the FlexPendant

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

<table>
<tr><th></th><th>Action</th></tr>
<tr><td>1</td><td>On the ABB menu, tap Calibration.



xx1500000942</td></tr>
</table>

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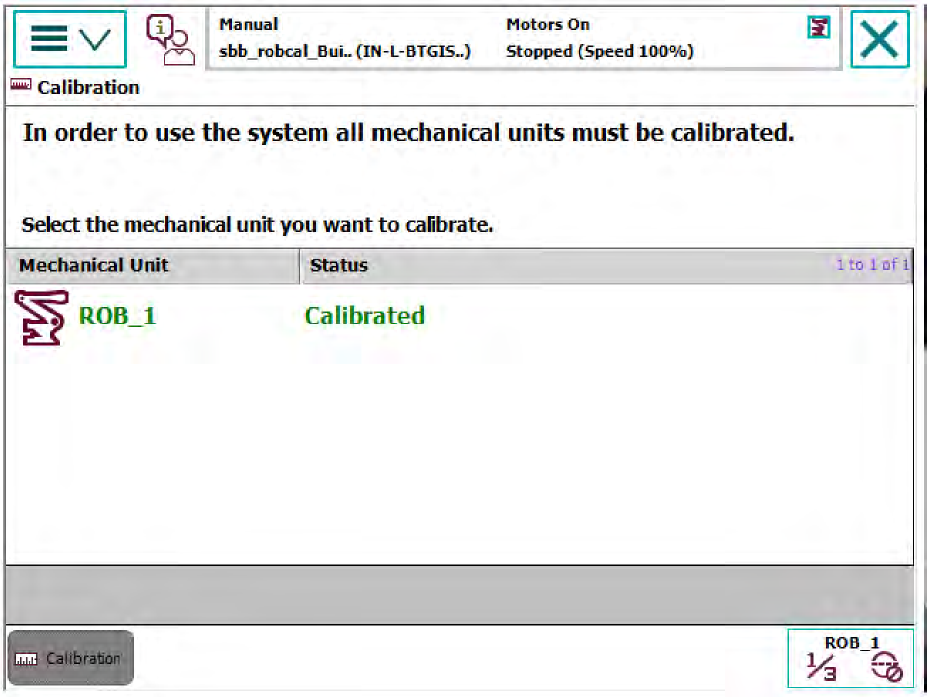
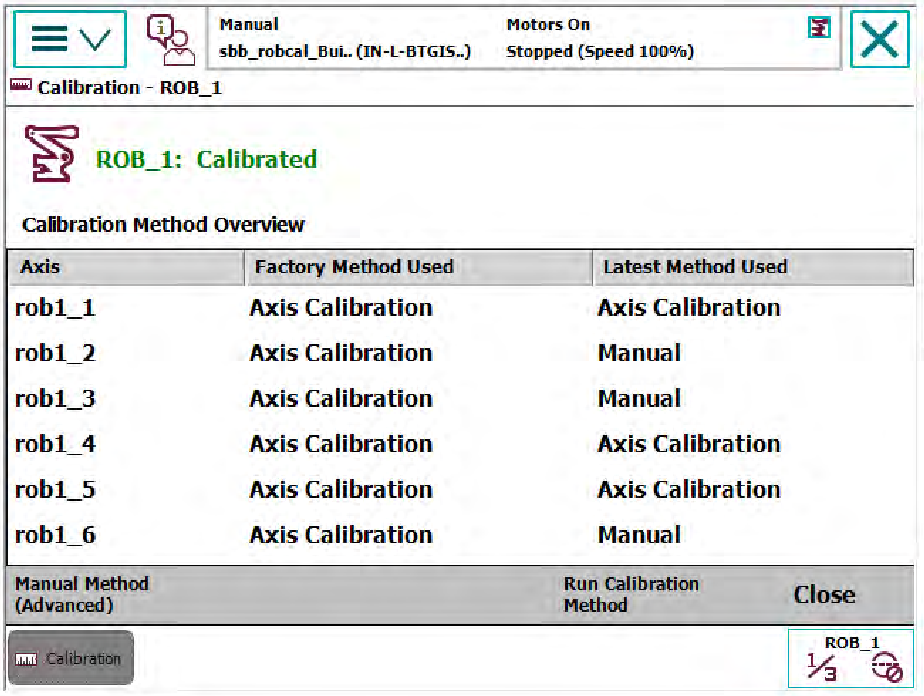
	Action
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943
3	**This step is valid for RobotWare 6.02 and later.** Calibration method used at factory for each axis is shown, as well as calibration method used during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

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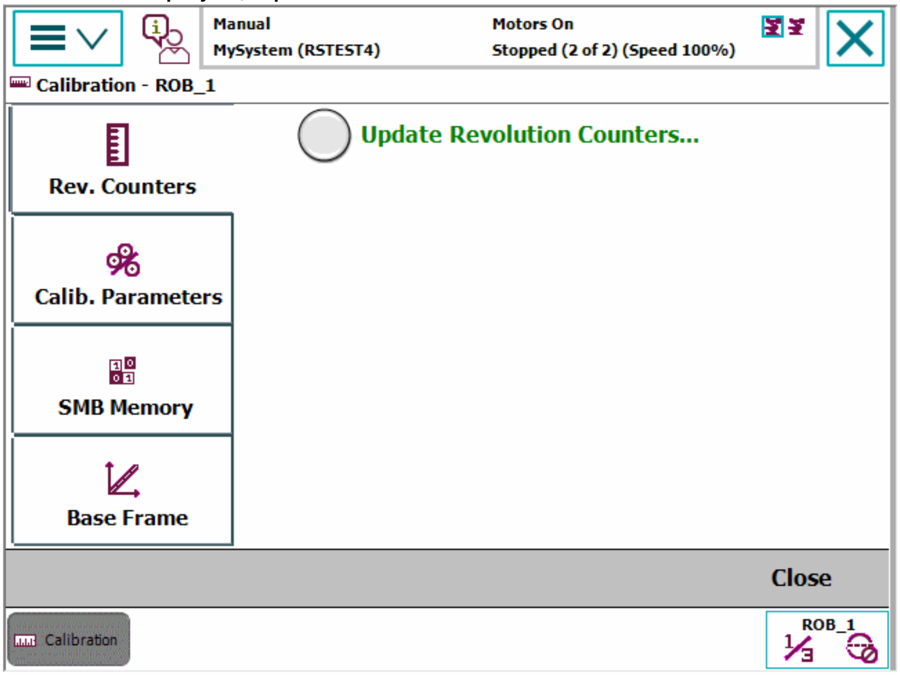
	Action
4	A screen is displayed, tap **Rev. Counters**.  en0400000771
5	Tap **Update Revolution Counters...**. A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: • Tap **Yes** to update the revolution counters. • Tap **No** to cancel updating 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 280*.

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 272* and *Updating revolution counters on page 275*.

Using a `MoveAbsJ` instruction

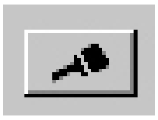
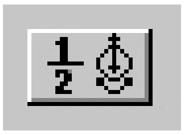
Use this procedure to create a program that runs all the robot axes to their synchronization position.

	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 272* and *Updating revolution counters on page 275*.

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 272* and *Updating revolution counters on page 275*.

Using the jogging window

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

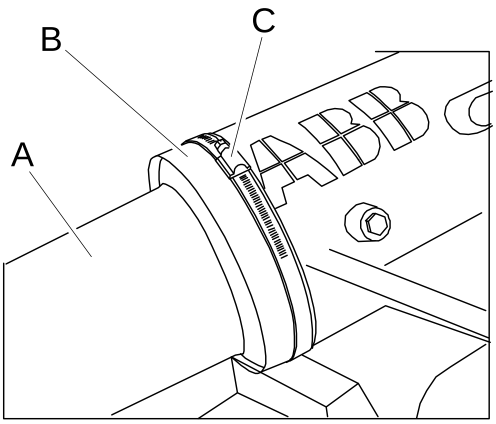
	Action	Note
1	On the **ABB** menu, tap **Jogging**.	
2	Tap **Motion mode** to select group of axes to jog.	
3	Tap to select the axis to jog, axis 1, 2, or 3.	
4	Manually run the robots axes to a position where the axis position value read on the FlexPendant, is equal to zero.	
5	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See *Synchronization marks and synchronization position for axes on page 272* and *Updating revolution counters on page 275*.

5.7 Additional calibration instruction, IRB 4400

Instruction

Before updating the revolution counters (coarse calibration) on IRB 4400, the stainless steel metal ring on axis 4 need to be removed.

Illustration



xx0600003124

A	Upper arm
B	Stainless steel ring
C	Hose clamp

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 Decommissioning of balancing device

General

There is much energy stored in the balancing device. Therefore a special procedure is required to disassemble it. The coil springs inside the balancing device exert a potentially lethal force unless disassembled properly.

The device must be disassembled by a decommissioning company.

Required equipment

Equipment	Article number	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 297*.
Protective clothing that also covers face and hands	-	Must protect against spatter of sparks and flames.
Cutting torch with a long shaft	-	For opening housing and cutting coils. The long shaft is a safety requirement.
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.

DANGER

Do not, under any circumstances, deal with the balancing device in any other way than that detailed in the product documentation! For example, attempting to open the balancing device is potentially lethal!

Action on field, decommissioning

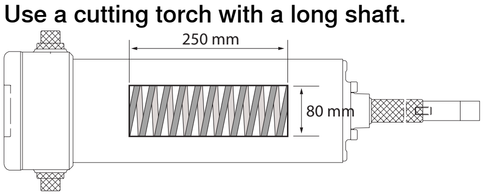
The procedure below details the actions to perform on field, when the balancing device is to be decommissioned.

	Action	Note
1	Remove the balancing device from the robot.	Detailed in section *Replacement of balancing device on page 207*.
2	Send the device to a decommissioning company.	Make sure the decommissioning company is well informed about the stored energy built up by high tensioned compression springs and that the device contains some grease. The following procedure contains useful information about decommissioning.

Continues on next page

Decommissioning at decommissioning company, balancing device

The instruction below details how to decommission the balancing device. Contact ABB Robotics for further consultation.

	Action	Note
1	**DANGER** There is stored energy built up by high tensioned compression springs inside the balancing device! When a coil is cut the released tension creates a spatter of sparks and flames. The working area must be free of flammable materials. Position the balancing device so that the spatter will be directed away from personnel.	
2	Clamp the device at the working location. Place the device at ground level so that the hole and spring coils are cut from a safe distance and somewhat from above.	
3	**DANGER** The hole must be cut as specified in the figure. Pieces of the spring can be thrown out from the cylinder at high speed if the hole is cut larger than specified!	
4	Cut a hole in the housing as shown in the figure.	Use a cutting torch with a long shaft.  xx0700000730
5	**DANGER** There is stored energy built up by high tensioned compression springs inside the balancing device! When a coil is cut the released tension creates a spatter of sparks and flames. The working area must be free of flammable materials. Position the balancing device so that the spatter will be directed away from personnel.	
6	• Outer spring: cut at least five coils! • Middle spring: cut at least four coils! • Inner spring: cut at least four coils!	Use a cutting torch with a long shaft.

Continues on next page

	Action	Note
7	Double-check the number of coils cut and make sure all the tension in the springs is removed. Double-check the number of coils cut and make sure all the tension in the springs is removed.	

6.3 Scrapping of robot

Important when scrapping the robot

DANGER

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

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

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7 Reference information

7.1 Introduction

General

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

7.2 Applicable 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 4400.

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

- 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 1300 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	Allen key 5-17 mm
1	Socket with ratchet
1	Box spanner set
1	Screwdriver
1	Torx socket no:20, 25, 30
1	Extension bar 100 mm
2	Puller bar
1	KM nut (KM10, KM17)
1	Lifting hoist
1	Cutting pliers
1	Torque wrench 10-470 Nm

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

Calibration equipment, Levelmeter (alternative method)

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

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

Calibration equipment, Calibration Pendulum

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

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

7.8 Lifting accessories and lifting instructions

General

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

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

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

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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

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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