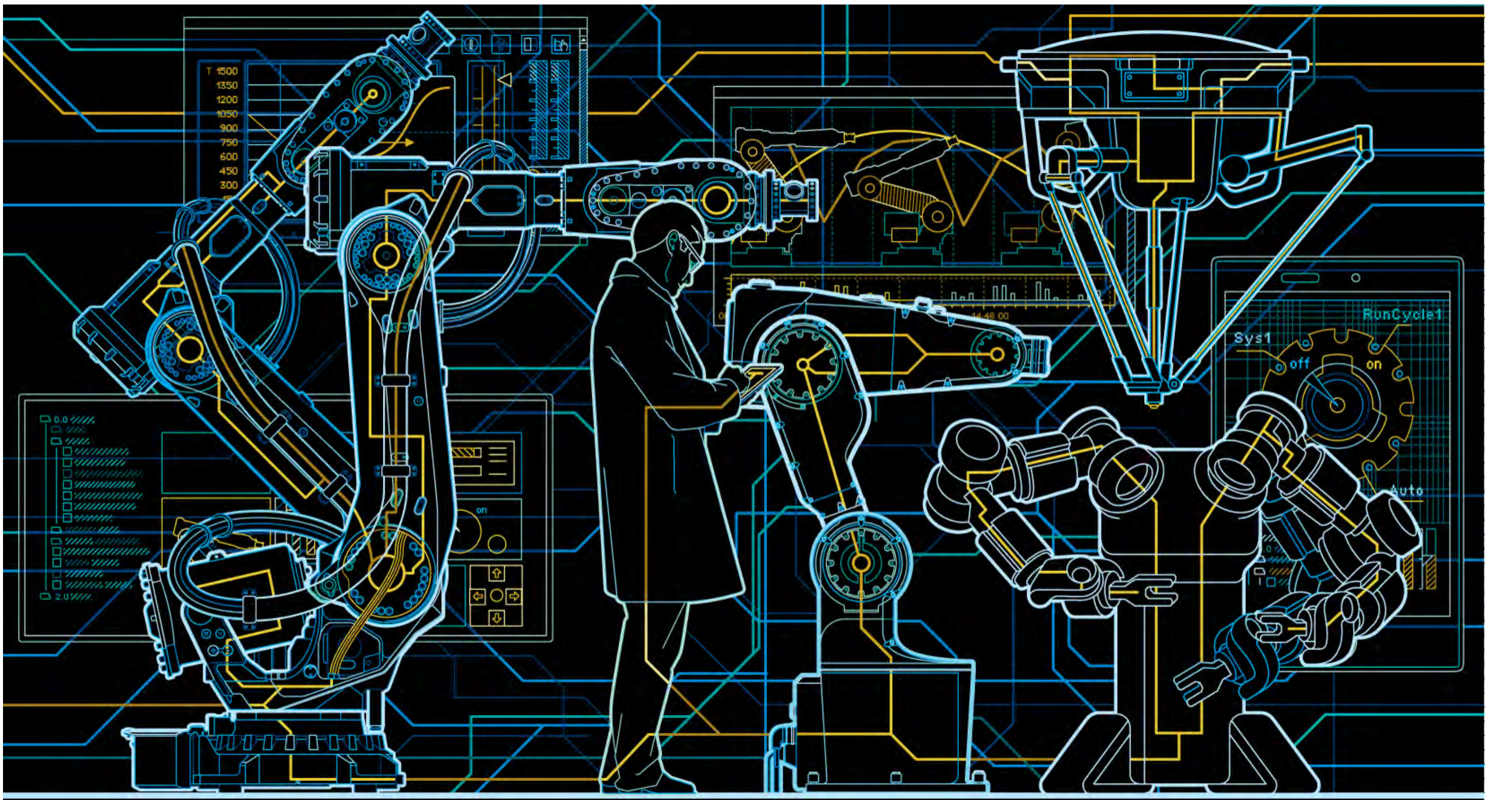

Product manual
IRB 6620

Power and productivity
for a better world™

ABB

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Product manual

IRB 6620 - 150/2.2

IRC5

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Revision: R

ABB AB

Robotics Products

Se-721 68 Västerås

Sweden

Table of contents

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Overview of this manual

About this manual

This manual contains instructions for:

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

Usage

This manual should be used during:

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

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel

Prerequisites

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

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

Organization of chapters

The manual is organized in the following chapters:

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

Continues on next page

Chapter	Contents
Spare parts and exploded views	Complete spare part list and complete list of robot components, shown in the exploded views.
Circuit diagrams	Reference to the circuit diagram for the robot.

References

Reference	Document ID
Product specification - IRB 6620	*3HAC025861-001*
Product manual, spare parts - IRB 6620	*3HAC049109-001*
Circuit diagram - IRB 6620 / IRB 6620LX	*3HAC025090-001*
Operating manual - General safety information [i]	*3HAC031045-001*
Product manual - IRC5 IRC5 with main computer DSQC 639.	*3HAC021313-001*
Product manual - IRC5 IRC5 with main computer DSQC1000.	*3HAC047136-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - Calibration Pendulum	*3HAC16578-1*
Operating manual - Service Information System	*3HAC050944-001*
Application manual - Additional axes and stand alone controller	*3HAC051016-001*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*
Technical reference manual - System parameters	*3HAC050948-001*
Application manual - CalibWare Field 5.0	*3HAC030421-001*

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

Revisions

Revision	Description
-	First edition
A	Changes made in: • Prerequisites in section Overview • Oil change in section Maintenance
B	Changes made in: • Oil change Shell Tivela S 150 is changed to Kyodo Yushi TMO 150. • New sections added "Robot transportation precautions" and "Securing the robot". • Foundry Plus option added.

Continues on next page

Revision	Description
C	This revision includes the following additions and/or changes: • Section *What is an emergency stop?* added to chapter Safety‘ • Section *Maintenance schedule* in chapter Maintenance: Intervals for inspection activities and oilchanges have been revised • Section *Maintenance schedule* in chapter Maintenance: Overhaul of robot is new • Section *Maintenance schedule* in chapter Maintenance: The information about Service Information System (SIS) has been updated • Section *Maintenance schedule* in chapter Maintenance: Intervals for replacement of battery pack changed • Section *Expected lifetime* in chapter Maintenance: The lifetime of certain parts has been revised • Section *Cleaning of robot* updated
D	This revision includes the following additions and/or changes: • Section *Lifting and turning tool* added to the *Installation* chapter. • Section *Foundry Plus,Cable guard* added to chapter *Installation*. • Updated spare part numbers in lists for cable harness and wrist.
E	This revision includes the following additions and/or changes: • Added oil levels for tilted robots, see *Inspecting the oil level in axis-1 gearbox on page 132*, and *Inspecting the oil level in axis-2 gearbox on page 134*. • Corrected item number reference in part list, see *Spare parts - Upper arm* in *Product manual, spare parts - IRB 6620*. • Circuit diagrams are not included in this document but delivered as separate files. See *Circuit diagram on page 361*. • List of standards updated, see *Applicable safety standards on page 347*. The chapter *Safety* updated with: • Updated safety signal graphics for the levels *Danger* and *Warning*, see *Safety signals in the manual on page 42*. • New safety labels on the manipulators, see *Safety symbols on product labels on page 44*. • Revised terminology: *robot* replaced with *manipulator*.
F	This revision includes the following updates: • Maximum deviation changed, see *Securing the base plate on page 94*. • Updated instructions for replacing motor axis 6 on Foundry Plus robots.
G	This revision includes following additions and/or changes: • Removed information about lubricating attachment screws, section *Inspecting the additional mechanical stops on page 153*.

Continues on next page

Revision	Description
H	This revision includes the following updates: • A new block, about general illustrations, added in section *How to read the product manual on page 16*. • Robot designations are adjusted in sub-headings in section *Robot transportation precautions on page 60*. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 350*. • Added *WARNING - Safety risks during handling of batteries on page 55*. • The maximum allowed deviation in levelity of the base plate is changed, see *Securing the base plate on page 94*. • Added information about how to check oil level and change oil in the axis-1 gearbox of a suspended robot, see *Inspecting the oil level in axis-1 gearbox on page 132* and *Changing oil, axis-1 gearbox on page 163*. • Reference to Hilti standard added to the foundation recommendation for the base plate and class designation for foundation is changed to european standard C25/C30 (previously Swedish standard K25/K30), see *Securing the base plate on page 94*. • 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 161*. • Added section *Inspection of air hoses (Foundry Prime) on page 160*.
J	This revision includes the following updates: • Corrected location of label for lifting, see *Inspecting the information labels on page 149*. • Spare part number for wrist (standard) was wrong. Has been corrected. • A new SMB unit and battery is introduced, with longer battery lifetime.
K	This revision includes the following updates: • New instruction for inspection of oil level. • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 346*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 6620*.
L	This revision includes the following updates: • The maximum allowed deviation in levelness of the base plate and foundation is changed, see *Securing the base plate on page 94*. • Changed dimension of cable holder carrier screw, see *Replacement of cable harness, upper end on page 202*. • Added tightening torque for R1.SMB and 7th axis connector, ses *Replacement of cable harness, lower end (axes 1-2) on page 195*. • Minor corrections.
M	This revision includes the following updates: • Splitted fork lift accessory instruction in two sections. • Improvements Foundry Plus (retrofit sets) added throughout the manual. New wrist cover and improved sealing on arm house cover, and more. • Minor corrections.
N	This revision includes the following updates: • Minor corrections.

Continues on next page

Revision	Description
P	This revision includes the following updates: • Minor corrections. • Description about the revolution indicator. • Changed filling oil plug to inspection oil plug in inspection of level axis 3. • Information updated and added in the calibration chapter.
Q	This revision includes the following updates: • New standard calibration method is introduced (Axis Calibration). See *Calibration on page 315*.
R	Published in release R16.2. The following updates are done in this revision: • Drawing of base plate is not available for purchase, faulty information removed in *Securing the base plate on page 94*. • Corrections due to updates in SAP terminology.

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

1.2 General safety information

1.2.1 Introduction to general safety information

Definitions

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

Sections

The general safety information is divided into the following sections.

Contents	Examples of content
General information	• safety, service • limitation of liability • related information
Safety risks lists dangers relevant when working with the product. The dangers are split into different categories.	• safety risks during installation or service • risks associated with live electrical parts
Safety actions describes actions which may be taken to remedy or avoid dangers.	• fire extinguishing • safe use of the teach pendant or jogging device
Safety stops describes different types of stops.	• stopping functions • description of emergency stop • description of safety stop

1.2.2 Safety in the robot system

Validity and responsibility

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

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

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

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

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

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

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

Connection of external safety devices

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

Limitation of liability

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

Related information

Type of information	Detailed in document	Section
Installation of safety devices	*Product manual for the robot*	Installation and commissioning
Changing operating modes	*Operating manual - IRC5 with FlexPendant* *Operator's Manual - IRC5P*	Operating modes

Continues on next page

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!

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 91*.

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

Increased injury

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

1.2.4.4 Brake testing

When to test

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

How to test

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

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

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

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

Note

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

1.2.4.6 Safe use of the jogging device

Three-position enabling device

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

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

Note

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

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

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

Hold-to-run function

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

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

1.2.4.7 Work inside the working range of the robot

WARNING

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

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

  The position *Manual mode with full speed (100%)* may only be used by trained personnel who are aware of the risks that this entails. *Manual mode with full speed (100%)* is not available in USA or Canada.
- Pay attention to the rotating axes of the robot. Keep away from axes to not get entangled with hair or clothing. Also, be aware of any danger that may be caused by rotating tools or other devices mounted on the robot or inside the cell.
- Test the motor brake on each axis, according to the section *Brake testing on page 33*.
- To prevent anyone else from taking control of the robot, always put a safety lock on the cell door and bring the three-position enabling device with you when entering the working space.

WARNING

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

1.2.4.8 Signal lamp (optional)

Description

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

Function

The lamp is active in MOTORS ON mode.

Further information

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

1.2.5 Safety stops

1.2.5.1 What is an emergency stop?

Definition of emergency stop

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

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

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

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

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

Note

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

Note

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

Note

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

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

Classification of stops

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

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

Continues on next page

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

Emergency stop buttons

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

1.2.5.2 What is a safety stop or protective stop?

Definition of safety stops

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

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

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

The default setting is a category 1 stop.

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

Note

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

Note

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

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

Classification of stops

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

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

Continues on next page

Type of safety stops

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

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

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

Note

Use normal program stop for all other types of stop.

1.3 Safety signals and symbols

1.3.1 Safety signals in the manual

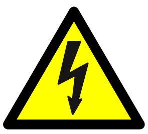
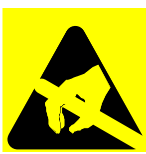
Introduction to safety signals

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

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

Danger levels

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

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

Continues on next page

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

1.3.2 Safety symbols on product labels

Introduction to labels

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

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

Note

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

Types of labels

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

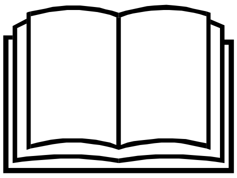
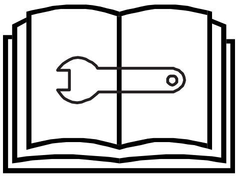
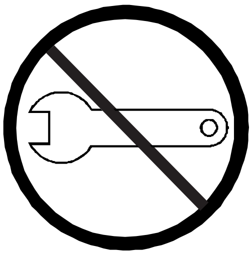
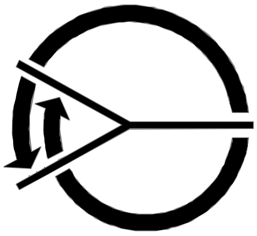
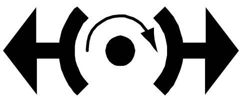
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 44*.

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

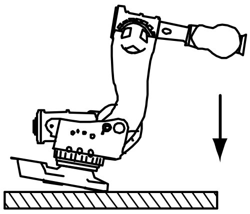
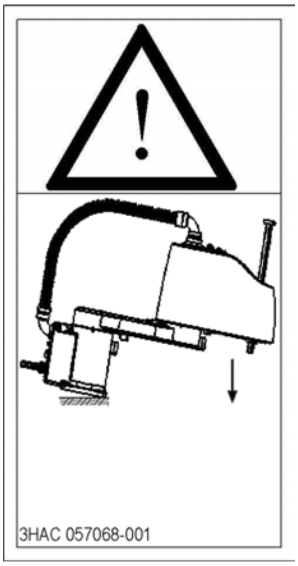
Symbols on safety labels

Symbol	Description
 xx0900000812	**Warning!** Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, etc.
 xx0900000811	**Caution!** Warns that an accident may occur if the instructions are not followed that can result in injury and/or damage to the product. It also applies to warnings of risks that include burns, eye injury, skin injury, hearing damage, crushing or slipping, tripping, impact, fall from height, etc. Furthermore, it applies to warnings that include function requirements when fitting and removing equipment where there is a risk of damaging the product or causing a breakdown.
 xx0900000839	**Prohibition** Used in combinations with other symbols.

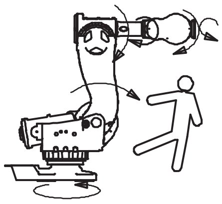
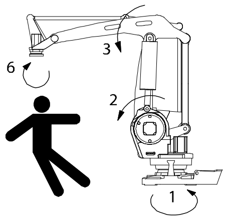
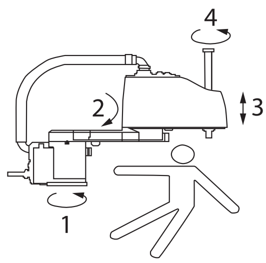
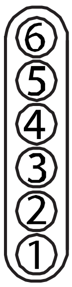
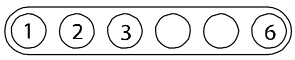
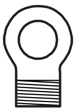
Continues on next page

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

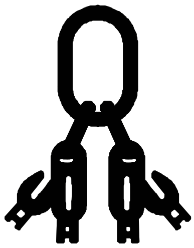
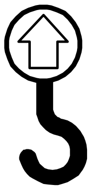
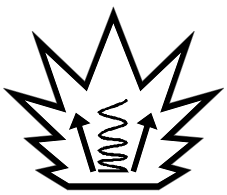
Continues on next page

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.

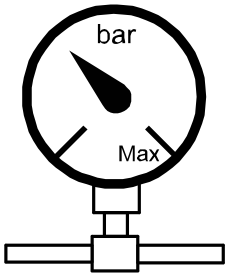
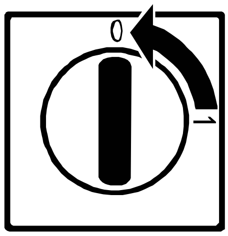
Continues on next page

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 WARNING - The brake release buttons may be jammed after service work

Description

The brake release unit has push-buttons for the brake release of each axis motor. When service work is performed inside the SMB recess that includes removal and refitting of the brake release unit, the brake release buttons may be jammed after refitting.

DANGER

If the power is turned on while a brake release button is jammed in depressed position, the affected motor brake is released! This may cause serious personal injuries and damage to the robot.

Elimination

To eliminate the danger after service work has been performed inside the SMB recess, follow the procedure below.

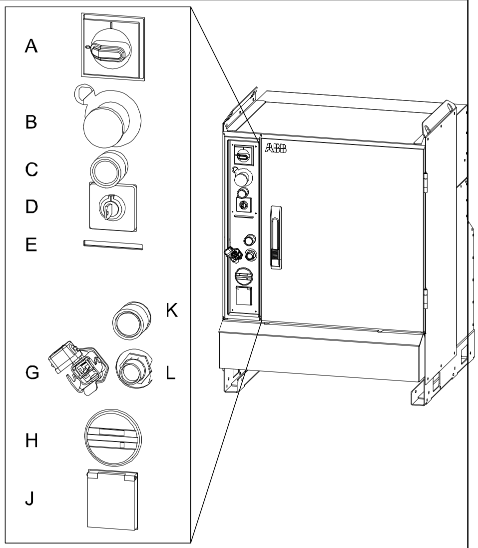
	Action
1	Make sure the power is turned off.
2	Remove the push-button guard, if necessary.
3	Verify that the push-buttons of the brake release unit are working by pressing them down, one by one. Make sure none of the buttons are jammed in the tube.
4	If a button gets jammed in the depressed position, the alignment of the brake release unit must be adjusted so that the buttons can move freely in their tubes!

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

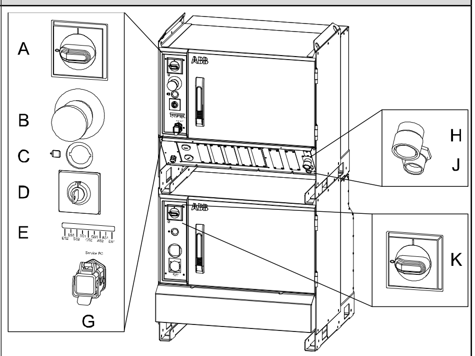
Description

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, Single Cabinet Controller

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

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

1.4.5 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.

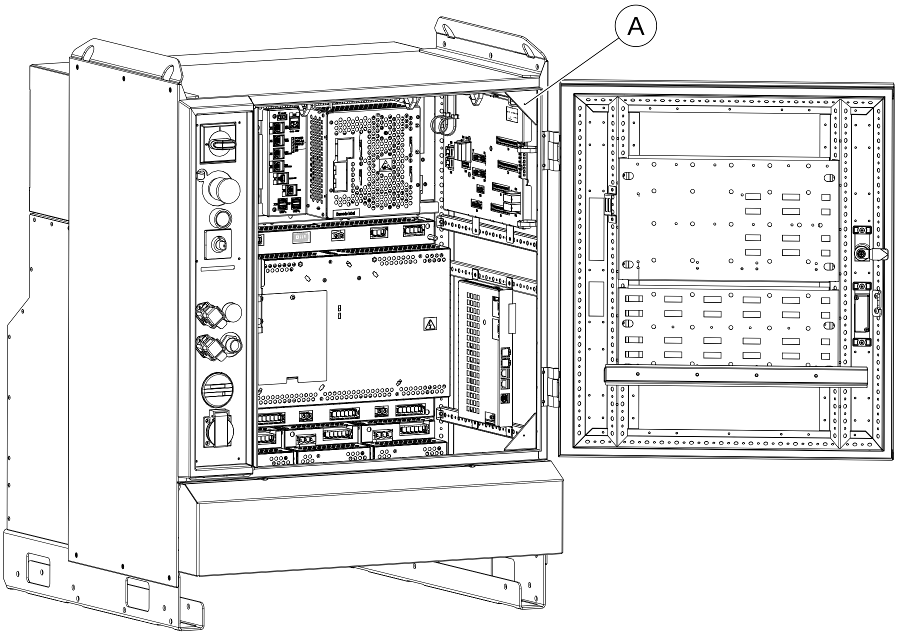
Elimination

	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

1.4.6 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 69*.
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.	

1.4.7 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 6620 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 6620, 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 6620 is connected to power, always make sure that the robot is connected to *protective earth* before starting any installation work!

For more information see:

- *Product manual - IRC5*

2.2 Robot transportation precautions

General

This section describes ABB approved transportation precautions for ABB robots.

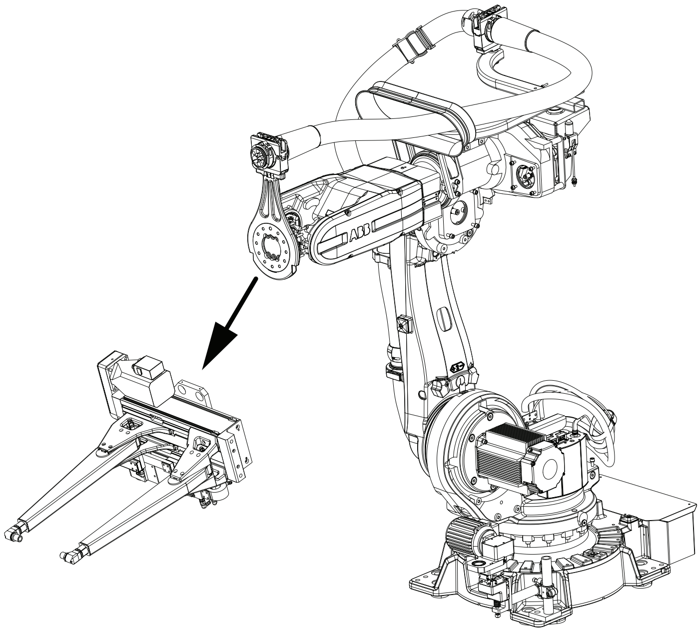
CAUTION

All transportation in or outside the plant, must be carried out according to the method described in this section.

Transportation in any other way can seriously damage the robot. If the robot is incorrectly transported and the instructions are not followed, the robot is not covered by the warranty and ABB will not accept any compensation claim.

Method 1 - recommended method

Transportation according to method 1 is strongly recommended by ABB.



xx0800000030

Always follow these instructions when transporting an ABB robot according to method 1:

- Always remove the tool before transportation of the robot.
- Always place the robot in the ABB recommended transport position, described in section *Risk of tipping/stability on page 77*.
- Always read and follow the instructions in section *Pre-installation procedure on page 69*

Method 2 - transportation with a tool mounted to the robot

Transportation according to method 2 is approved by ABB, only if use of method 1 is not possible.

Continues on next page

Always follow these instructions when transporting an ABB robot according to method 2:

- Always read and follow the instructions in section *Securing the robot with a transport support on page 66*
- Always place the robot in the ABB recommended transport position for robot with tool, described in sub section *Transport position with a transport support on page 63*.
- Always use the recommended transport support described in sub section *Recommended transport support on page 64*.

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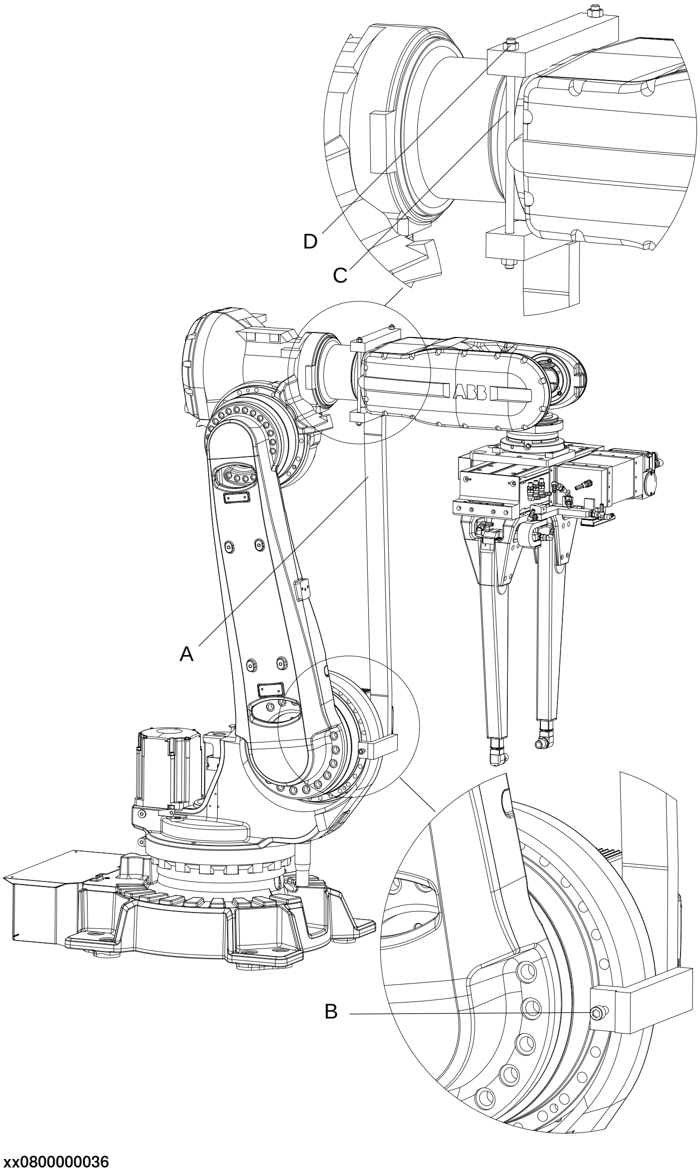
IRB 6620



xx0800000036

A	Transport Support
B	Hexagon socket head cap screw M10x50
C	Threaded bar M10x280
D	Nut M10

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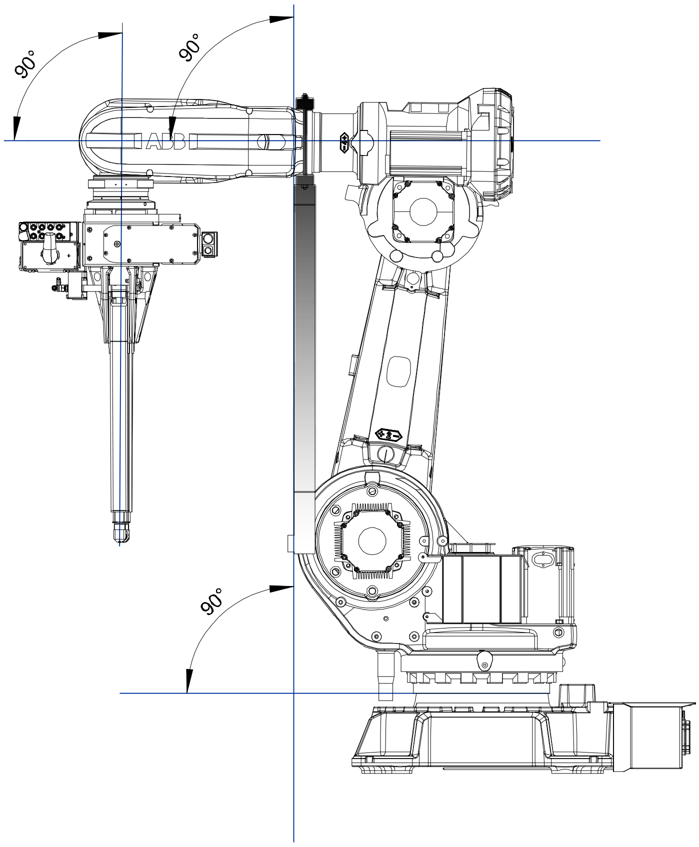
Transport position with a transport support

All transportation of the robot with tool must follow these instructions.

IRB 6620



xx0800000041

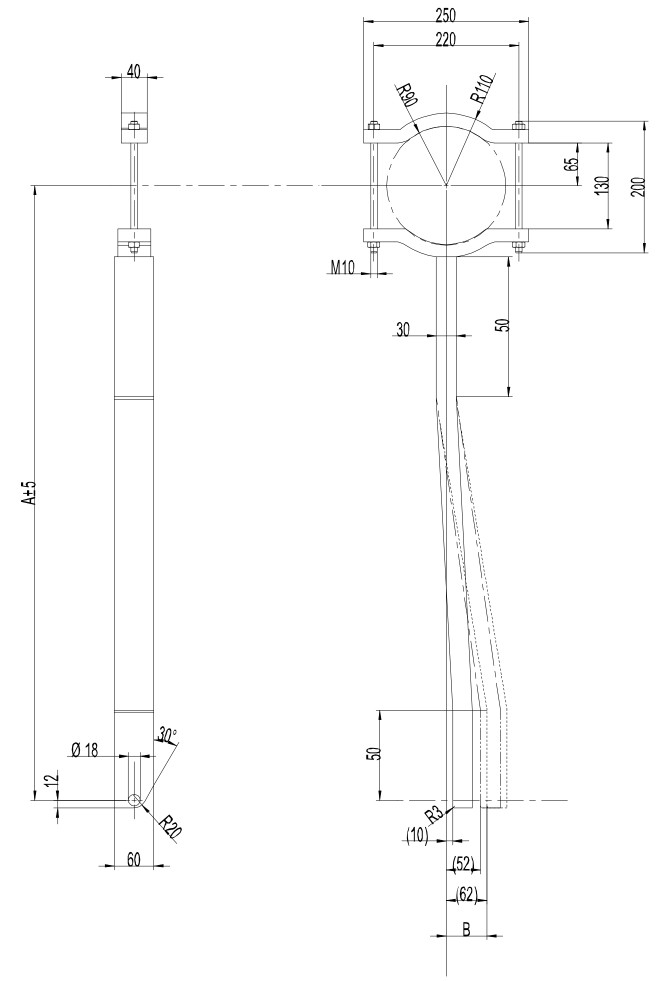
Continues on next page

Recommended transport support

Always use the recommended transport support when transporting a robot with tool.

IRB 6620

	Armlength																	
	IRB6600 IRB6650	2,55	2,75	2,8	3,0	3,0	3,2	IRB6640	2,55	2,75	2,8	3,2	IRB7600	2,3	2,55	2,8	3,05	3,5
	Lower arm L	1075	1280	1075	1075	1280		Lower arm L	1075	1280	1075	1280						
A		900	1130	700	570	995	830		940	1160	785	860			890	730	730	600
B		62	62	62	62	62	62		10	10	10	10		52	52	52	52	52



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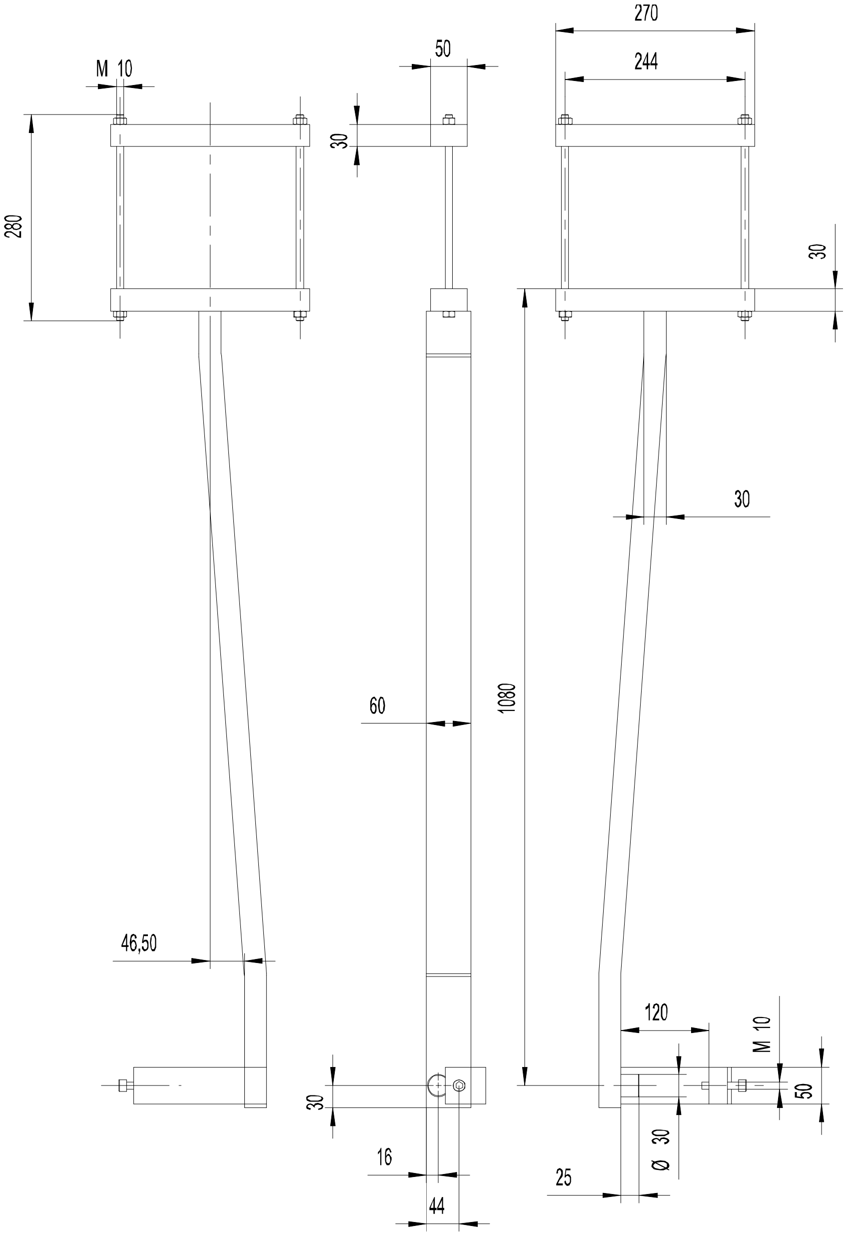
Continues on next page

IRB 6620



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2.3 Securing the robot with a transport support

General

This section describes how to fit the transport support to the robot in order to secure the robot for transportation. The transport support is required if the robot must be transported with mounted tools.

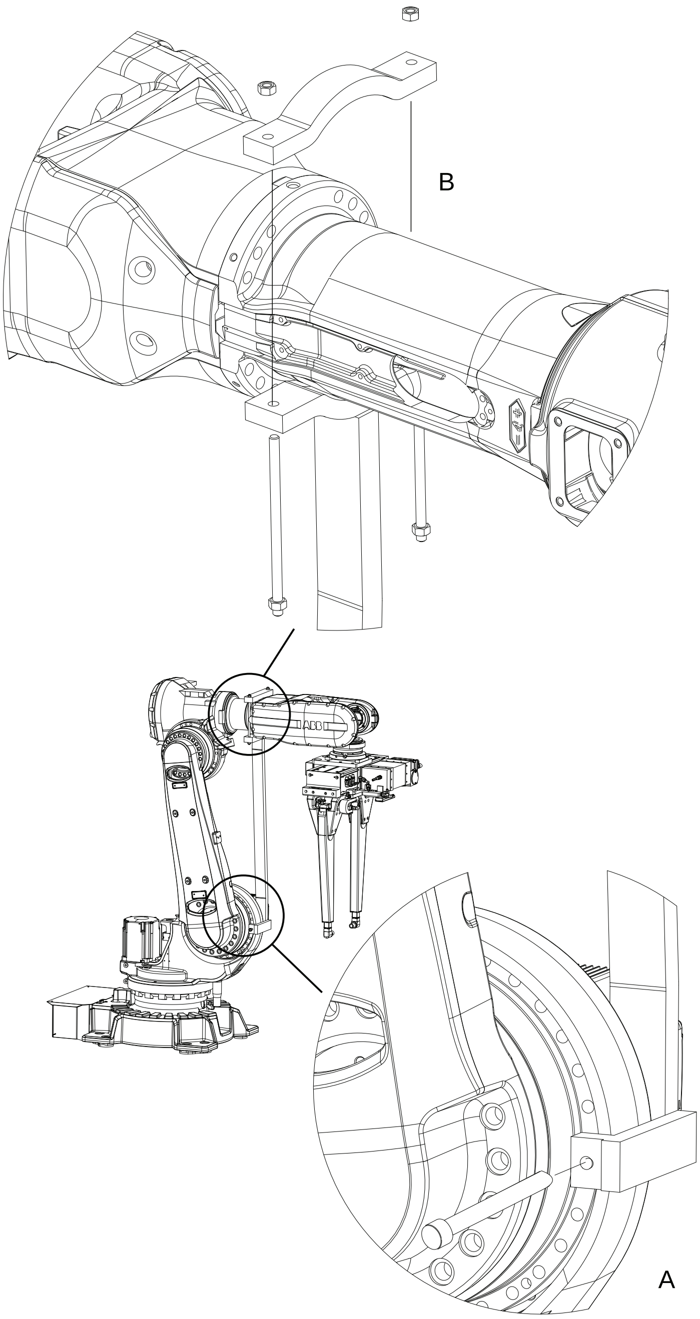
DANGER

Releasing the brakes is a hazardous action that may cause injury and damage property. It must be done with great care and only when absolutely necessary.

Continues on next page

Fitting the transport support

Illustration for fitting the transport support



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Fitting the transport support

	Action	Note
1	Fit the transport support's lower end to the robot using the recommended screw joint, (A) in figure.	Do not tighten the screw. See attachment point for the specific robot in the section *Transport position with a transport support on page 63*.

Continues on next page

	Action	Note
2	Jog the robot into a position as near above as possible to the recommended transport position for the specific robot, as specified in section *Transport position with a transport support on page 63*.	**CAUTION** Do not try to jog the robot to the exact position (max distance 1mm).
3	Use the brake release for axis 3 to reach the final resting position on the transport support, see the section *Manually releasing the brakes on page 91*.	See attachment point for the specific robot in the section *Transport position with a transport support on page 63*
4	Tighten all the attachment screws, (A) and (B), in the figure with the brake release for axis 3 still activated starting with the lower attachment screw.	**CAUTION** Do not attempt to tighten any attachment screws without first releasing the brakes. This can seriously damage the robot.
5	Use the brake release for axis 5 and 6 to reach the final resting position for the tool, see the section *Manually releasing the brakes on page 91*	

2.4 Unpacking

2.4.1 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 70*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 71*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 72*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 70* • *Protection classes, robot on page 72* • *Requirements, foundation on page 71*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 77*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 78*
11	Install required equipment, if any. • *Installation of signal lamp (option) on page 117*

Continues on next page

Weight, robot

The table shows the weight of the robot.

The weight does not include the weight of the DressPack.

Robot model	Weight
IRB 6620	900 kg

Note

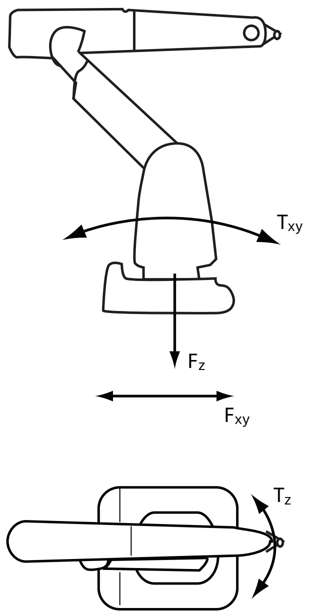
The weight does not include tools and other equipment fitted on the robot!

The weight does not include the weight of the DressPack.

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	± 7.3 kN	± 15.5 kN
Force z	11.0 ±2.0 kN	11.0 ±3.7 kN
Torque xy	± 18.0 kNm	± 37.2 kNm
Torque z	± 4.4 kNm	± 10.4 kNm

Suspended

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 7.3 kN	± 15.5 kN
Force z	- 11.0 ±2.0 kN	- 11.0 ±3.7 kN
Torque xy	± 18.0 kNm	± 37.2 kNm
Torque z	± 4.4 kNm	± 10.4 kNm

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	0.3 mm	Flat foundations give better repeatability of the resolver calibration compared to original settings on delivery from ABB. The value for levelness aims at the circumstance of the anchoring points in the robot base. In order to compensate for an uneven surface, the robot can be recalibrated during installation. If resolver/encoder calibration is changed this will influence the absolute accuracy.
Maximum tilt	15°	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	22 Hz	

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)

Continues on next page

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

Parameter	Value
Minimum ambient temperature	+5° C
Maximum ambient temperature	+50° C
Maximum ambient humidity	Max. 95% at constant temperature

Protection classes, robot

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

Protection type	Protection class
Manipulator, protection type Standard	IP 54 [i]
Manipulator, protection type Foundry Plus	IP 67

i The upper arm, including the wrist, has protection class IP 67.

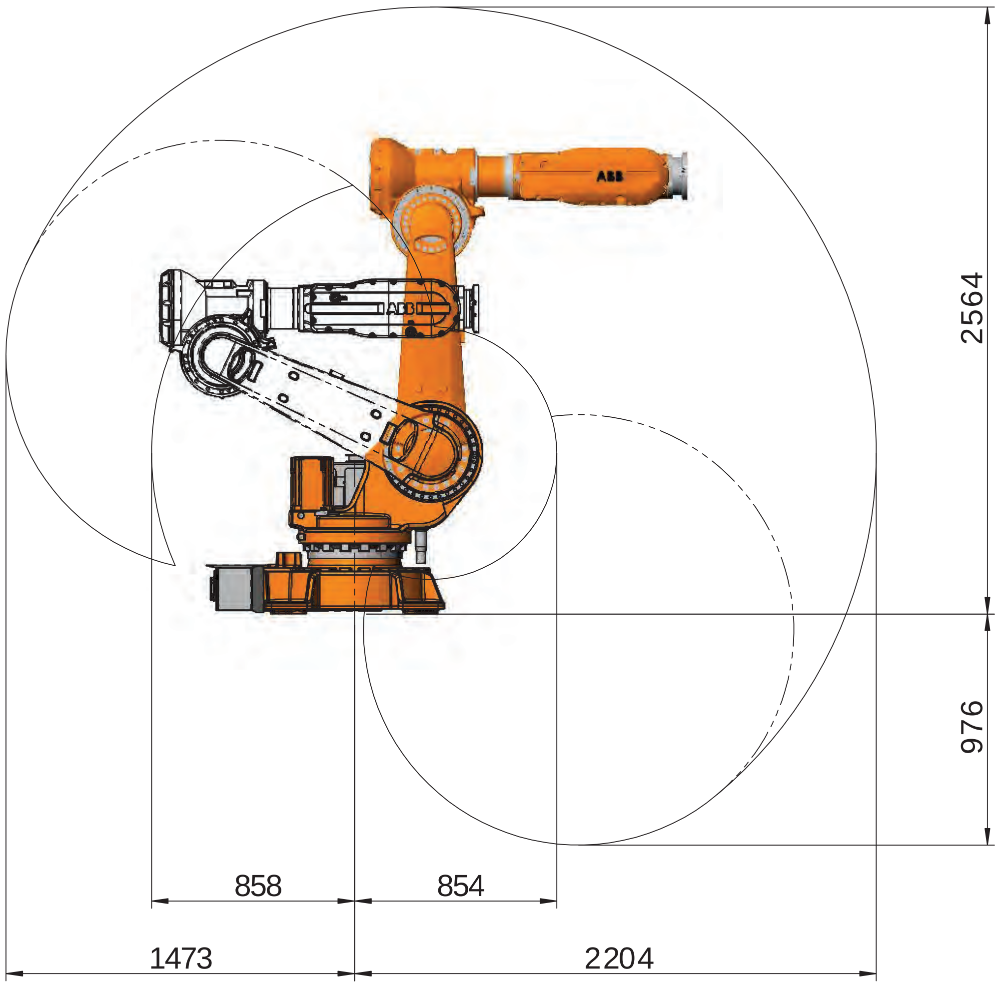
2.4.2 Working range and type of motion

Working range

The following figures show the working ranges of the robot model mounted in different ways. The extreme positions of the robot arm are specified at the wrist center (dimensions in mm).

Floor mounted

The illustration below shows the unrestricted working range when the robot is floor mounted:



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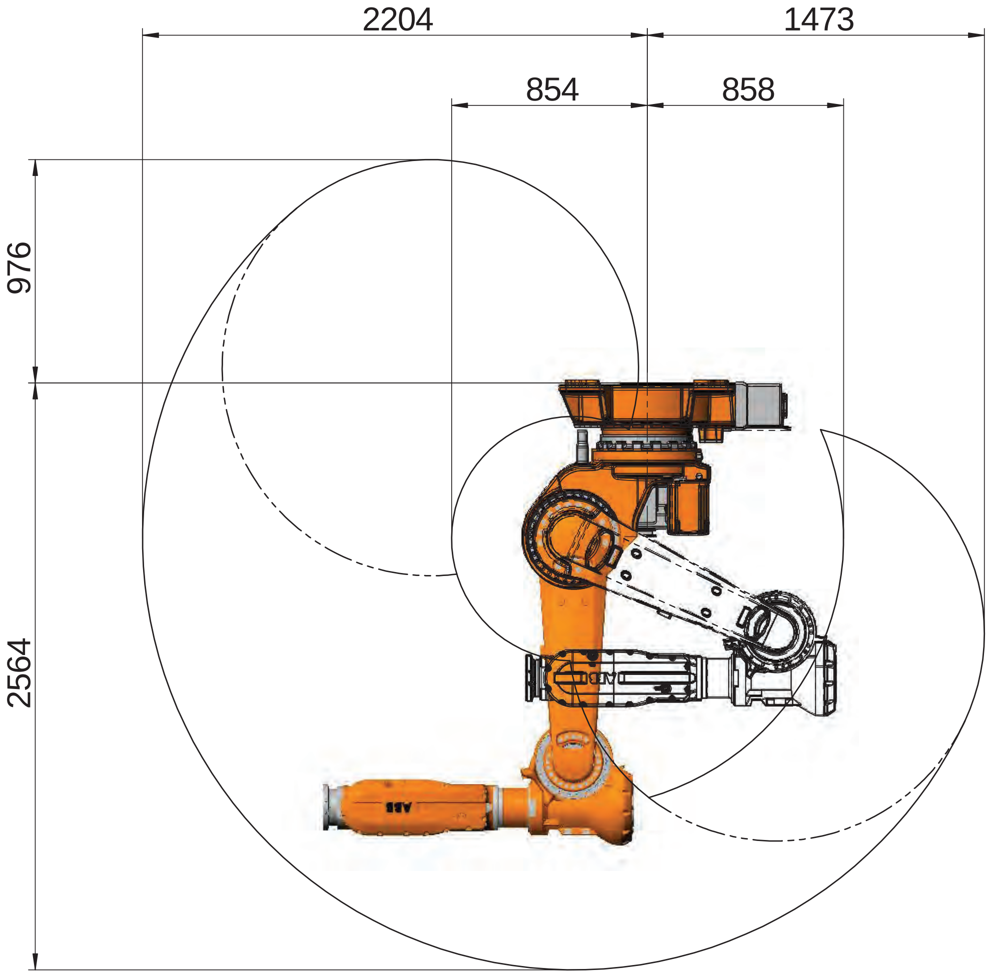
Suspended mounted

The illustration below shows the unrestricted working range when the robot is mounted suspended:



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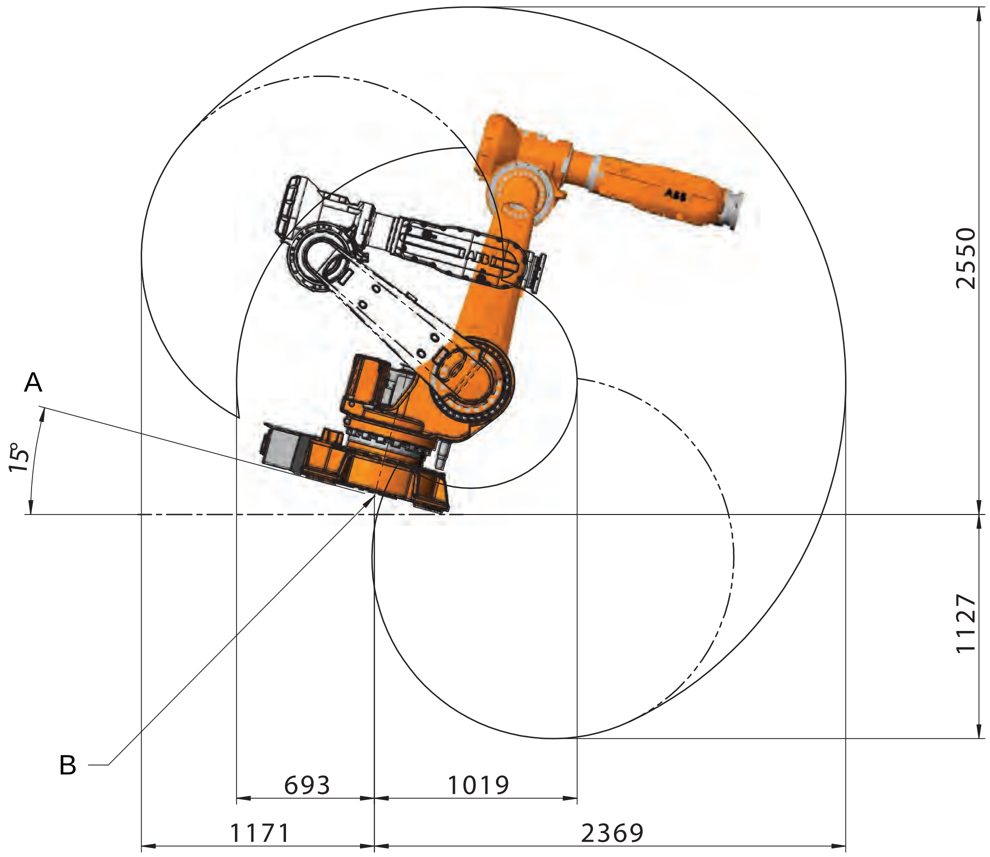
Floor mounted in 15° angle

The illustration below shows the unrestricted working range when the robot is floor mounted in 15° angle:



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A	**Note**! Maximum tilt angle is 15°
B	Intersection between base and axis 1 center

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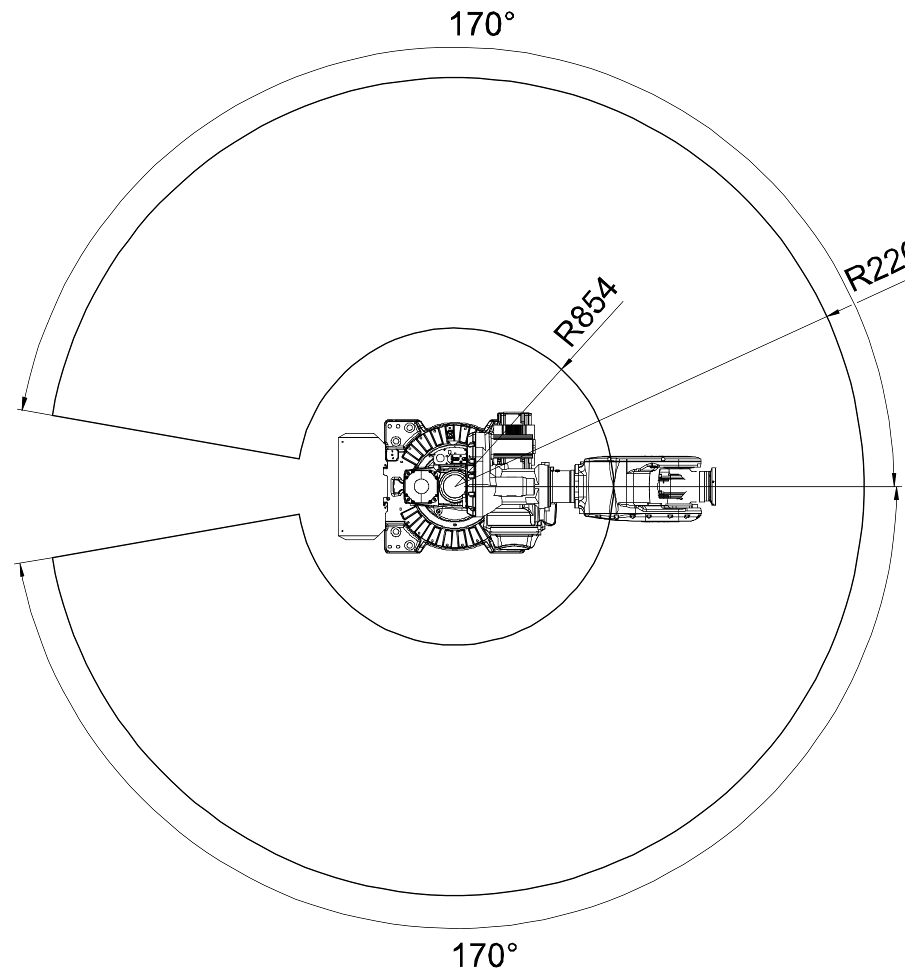
Turning radius - floor mounted

The turning radius for the robot when floor mounted, is shown in the figure below.



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Type of motion

Axis	Type of motion	Range of movement	Note
1	Rotation motion	+ 170° to - 170°	
2	Arm motion	+ 140° to - 65°	
3	Arm motion	+ 70° to - 115°	Limitations with dresspack
4	Wrist motion	+ 300° to - 300°	
5	Bend motion	+ 130° to - 130°	Limitations with dresspack
6	Turn motion	+ 300° to - 300° default	Max. ±96 revolutions [1]

[1] The default working range can be extended by changing parameter values in the software. Option*Advanced Motion* is required.

2.4.3 Risk of tipping/stability

Risk of tipping

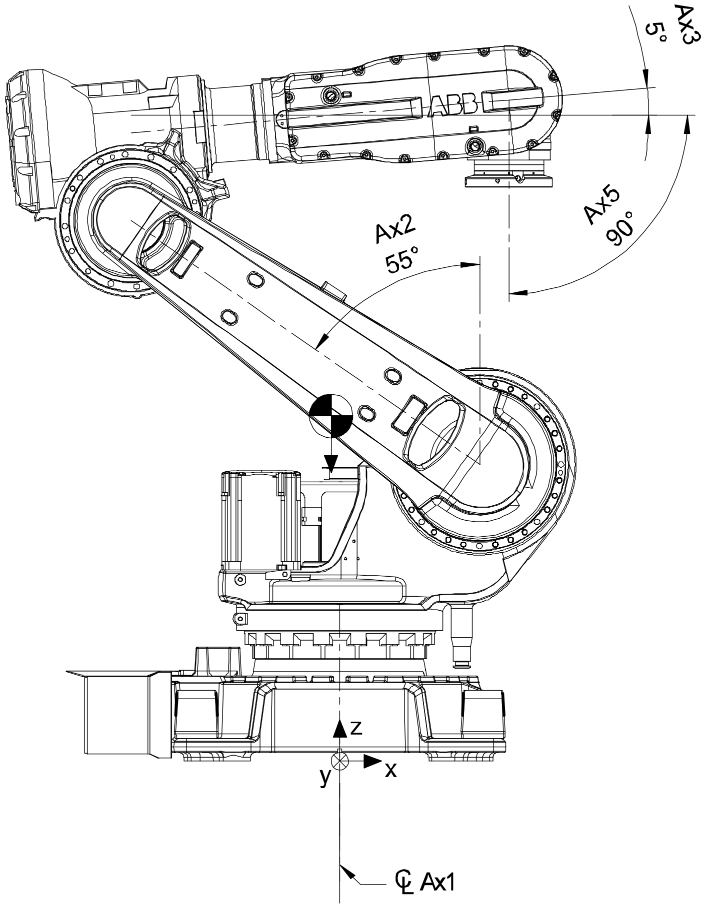
If the robot is not fastened to the foundation and standing still, the robot is not stable in the whole working area. Moving the arms will displace the center of gravity, which may cause the robot to tip over.

The shipping position is the most stable position.

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

Shipping and transport position

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



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WARNING

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

2.5 On-site installation

2.5.1 Lifting the robot with fork lift accessory

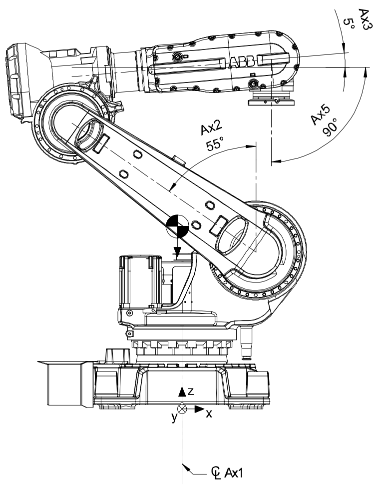
2.5.1.1 Fitting the fork lift accessory

Required equipment

The following equipment is required when lifting a robot with the fork lift accessory:

Equipment	Art. no.	Note
Fork lift pocket set	3HAC025040-003	The fork lift accessory set contains: • fork lift pocket 3HAC025528-001, with CE-Marking fitted (4 pcs) • attachment screws M20x60 Steel 8.8-A3F (8 pcs) • Drawing Fork lift accessory set • manual *Directions for use - Fork lift accessory for IRB 6620, 6640, 460*
Fork lift truck	-	The operator must be fully trained and authorized to operate a fork lift truck.

Preparations before fitting the fork lift pockets

	Action	Note
1	Remove any tools fitted on the axis-6 turning disk. **Note** No tool is permitted to be fitted on the robot when lifting the robot with the fork lift accessory!	DressPack, if used, can stay fitted as long as the tool fitted on the turning disk is removed.
2	Jog the robot to its shipping position. See figures for the different IRB models. **Note** The figures shows the shipping position of an *undressed* robot. If the robot is dressed, this must be taken into consideration when the robot is being lifted.	 xx0600002935

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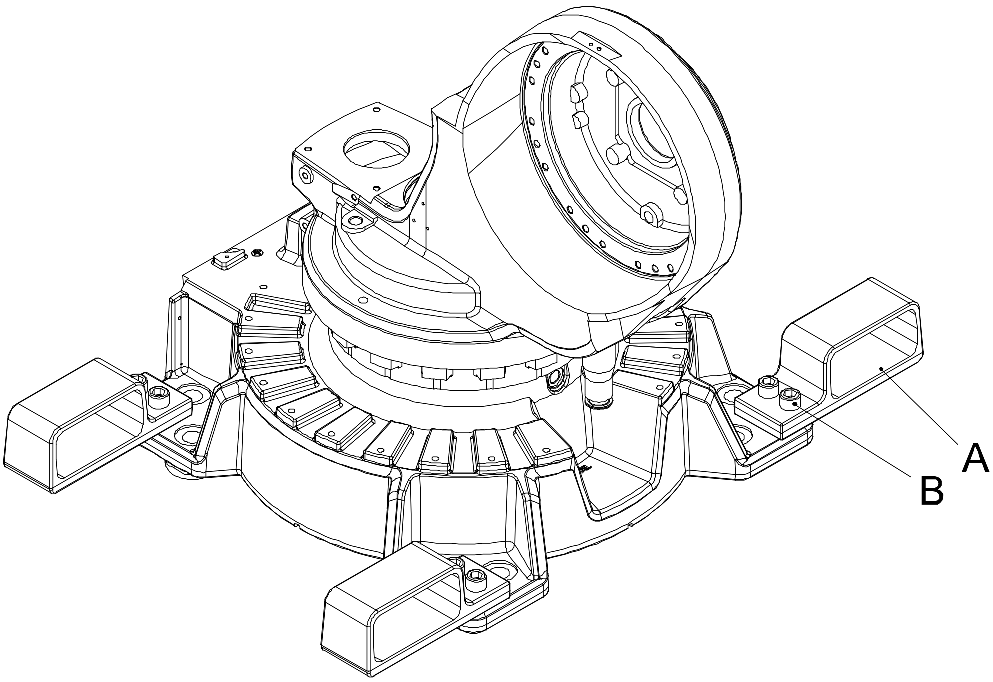
	Action	Note
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

Attachment points on the robot

The fork lift accessory is fitted on the robot as shown in the figure.



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A	Fork lift pocket
B	Attachment screw M20x60 quality 8.8 (2 pcs x4)

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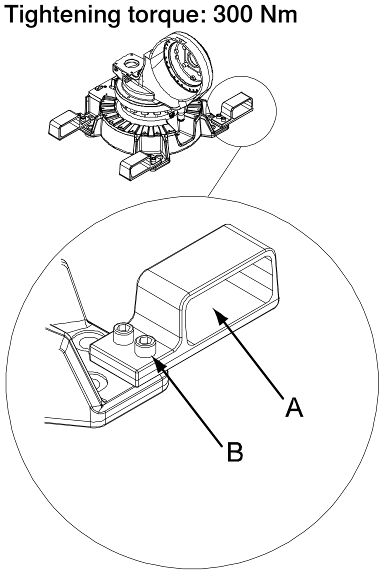
Fitting the fork lift accessory set

	Action	Note
1	Fit the four fork lift pockets on the base of the robot with its attachment screws. **Note** Before fitting any attachment screws, make sure they are not damaged in any way. Replace damaged screws.	Tightening torque: 300 Nm  xx0600002930 A Fork lift pocket (4 pcs) B Attachment screw M20x60 quality 8.8 (2 pcs x4)
2	Verify that all four fork lift pockets are properly secured before lifting.	

2.5.1.2 Lifting the robot with fork lift truck

General

The robot may be moved using a fork lift truck, provided that a complete fork lift accessory set, aimed for the robot, is used.

This section describes how to lift the robot with a fork lift truck.

Required equipment

Equipment	Art. no.	Note
Fork lift accessory	3HAC025040-003	
Fork lift truck		

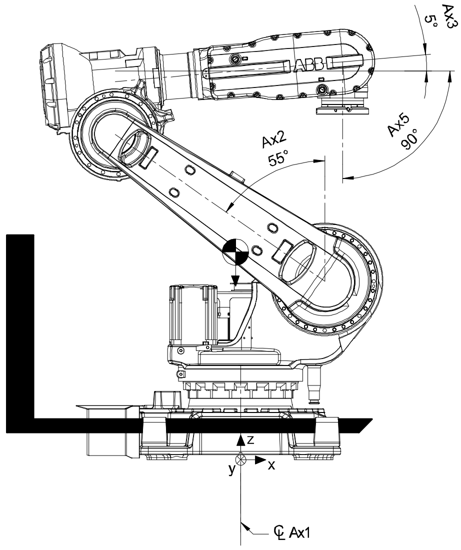
Lifting the robot with fork lift truck

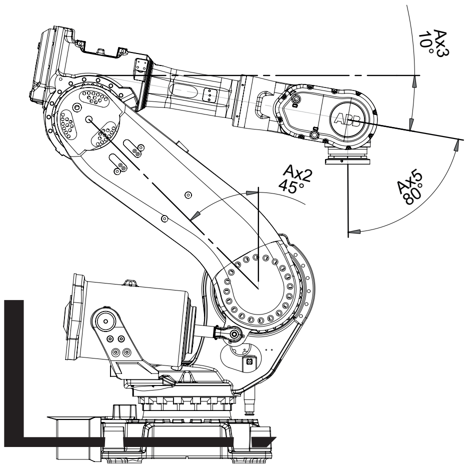
	Action	Note
1	Make sure that the robot is in shipping position!	**Note** No load is permitted on the robot!
2	**DANGER** Make sure that all supplies for electrical power, hydraulic pressure, and air pressure are turned off.	
3	Verify that all four fork lift pockets are properly secured before lifting.	

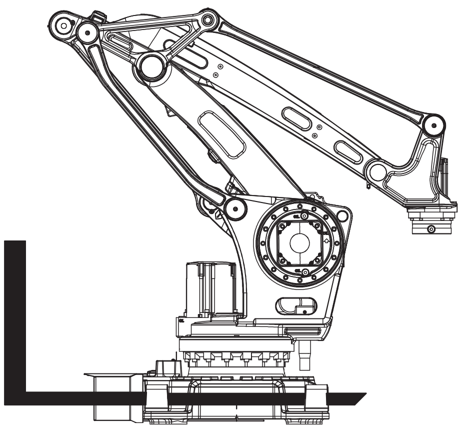
Continues on next page

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>4</td><td>Insert fork lift forks into the pockets.

CAUTION

Lifting the robot with fork lift shall only be done with all four fork lift pockets fitted! If lifting with fewer than four fork lift pockets fitted, there is a risk of accidents!</td><td>IRB 6620


xx0600002911
IRB 6640


xx0600003401
IRB 460

xx1000001159</td></tr>
</table>

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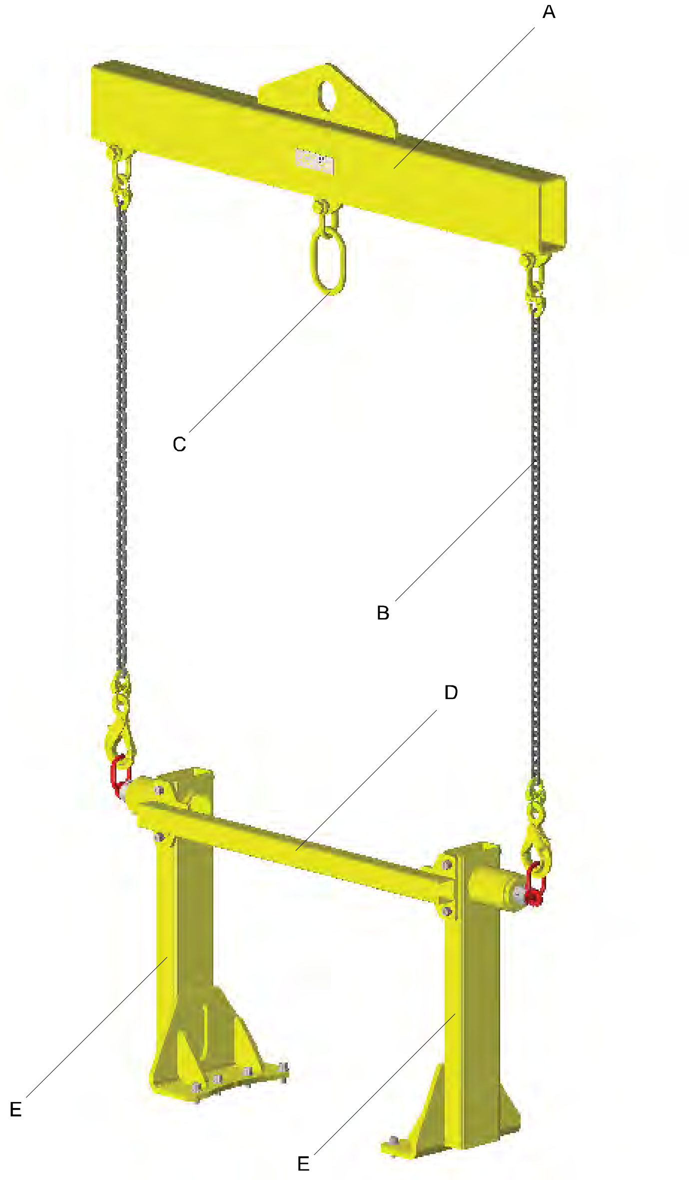
	Action	Note
5	Remove the attachment bolts securing the robot to the foundation.	
6	**CAUTION** The IRB 6620 robot weighs 900 kg. All lifting accessories used must be sized accordingly!	
7	Carefully lift the robot. **WARNING** Personnel must not, under any circumstances, be present under the suspended load!	
8	Move the robot slowly to its new position.	**Note** Move the robot with low speed!
9	Secure the robot to the foundation **DANGER** Do not power the robot up until it is secured properly to the foundation.	
10	Remove the fork lift accessories.	

2.5.2 Lifting and turning tool

The lifting and turning tool

The lifting and turning tool 3HAC025792-001is used for lifting and turning of the IRB 6620.



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A	Upper lifting beam
B	Chains
C	Lifting eye
D	Lower lifting beam
E	Lifting hold (Left and Right)

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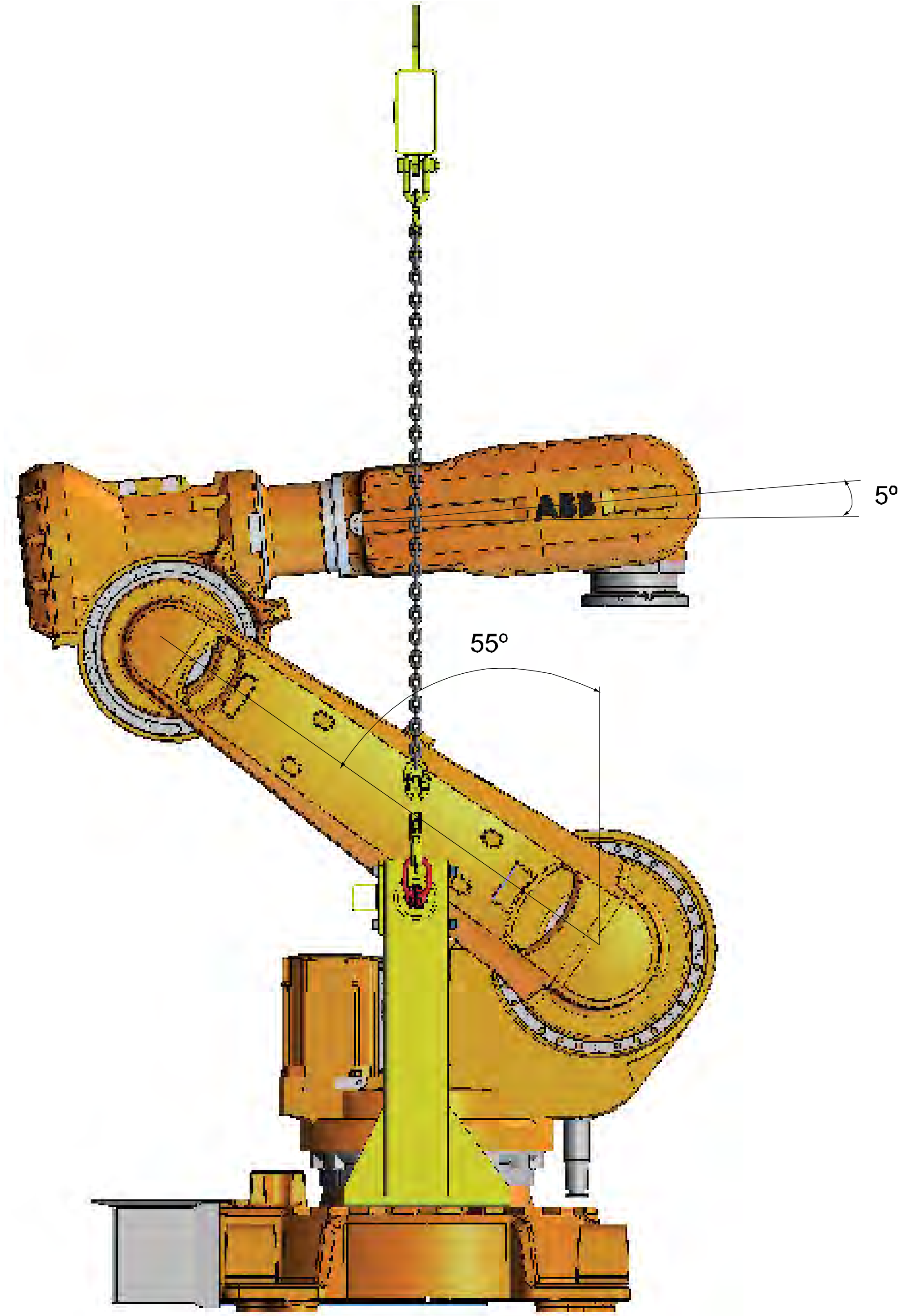
Lifting position



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	Action	Note
1	Jog the robot axis to a position suitable for lifting	Lifting position according to figure.

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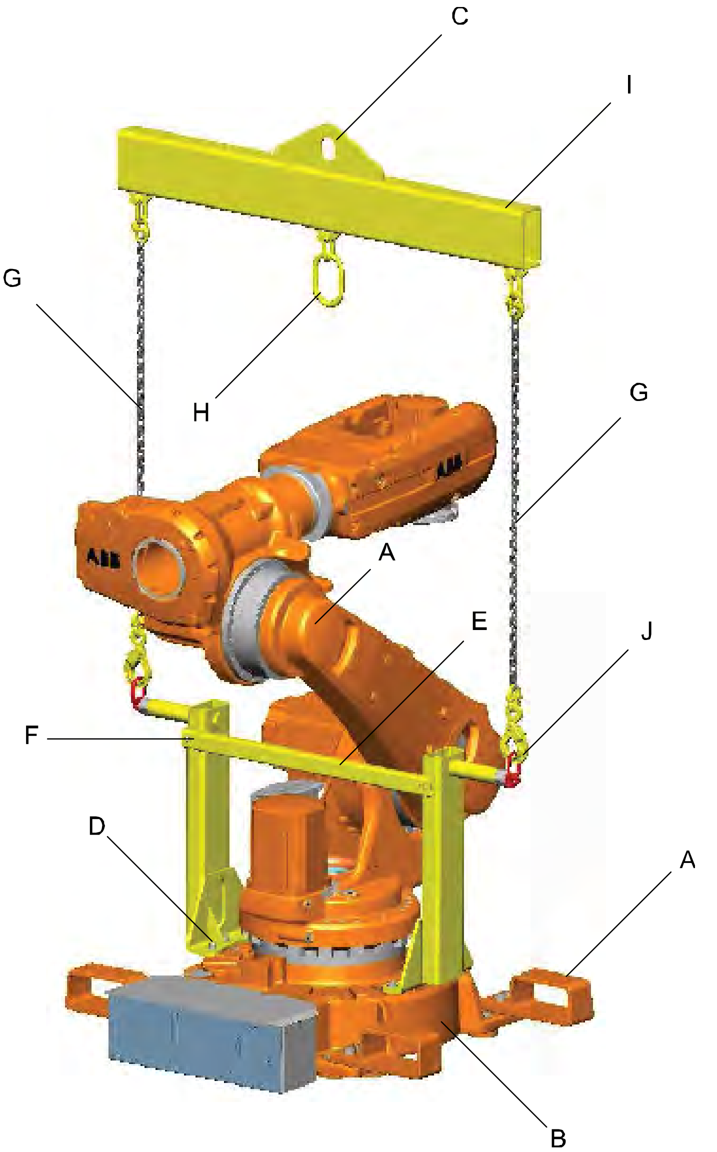
Turning procedure

Fitting the lifting and turning tool

The figure shows the lifting and turning tool fitted to the robot.



xx0900000327

A	Lifting accessories for forks
B	Robot base
C	Lifting eye upper beam
D	Attachment bolts in robot base
E	Distribution beam
F	Attachment bolts for distribution beam
G	Lifting chains
H	Chain block lifting eye
I	Upper beam

Continues on next page

J	Lifting hooks

Turning the robot

	Action	Information
1	**DANGER** Turn off all electrical power, hydraulic and pneumatic pressure supplies to the robot! Also read the safety sections: • *Safety risks related to pneumatic/hydraulic systems on page 26* • *Lifting and turning tool on page 84* • *Safety risks during installation and service work on robots on page 21*	
2	Fit the four lifting accessories for forks on the robot base	Tightening torque 300Nm
3	Fit the lifting tool 3HAC025792-001 to the robot base using the eight attachment screws	Tightening torque 90Nm
4	Lift the upper beam using a overhead crane	
5	Attach the upper beam to the lower beam using the lifting chains.	
6	Lift slowly until the chains are tensioned. Make sure that no cabling is damaged while lifting.	
7	Attach the chain block to the upper beam lifting eye.	**Note** Use a suitable chain block for minimum lifting weight 500 kg and with chain length minimum 3 m.

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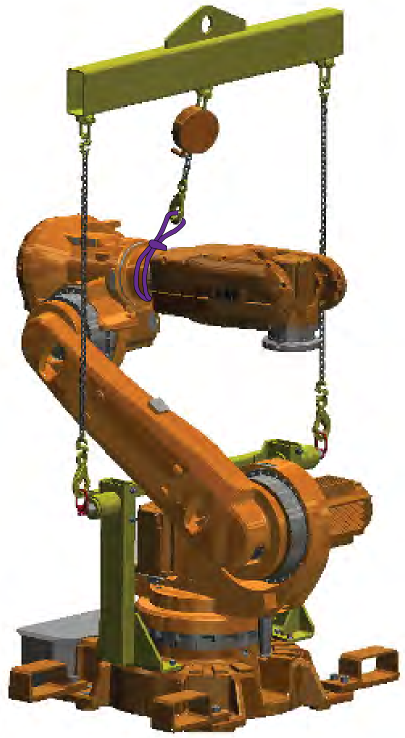
	Action	Information
8	Use lifting slings to secure the robot shown in figure.	 xx0900000332
9	Lift slowly until the load moves. Lift until the distance between the floor and robot is at least 350 mm.	
10	Turn the robot using the chain block.	
11	If the robot is to be moved to the installation location, use a forklift.	

2.5.3 Lifting robot with roundslings

General

The robot can be lifted with roundslings according to this section.

Sling specification

Sling type	Qty	Lifting capacity	Length / Note
Roundsling, robot	4 pcs	1 000 kg	2.5 m
Roundsling, upper arm	2 pcs	1 000 kg	**Note!** Do not stretch! 2 m Secures against rotation.
Roundsling, upper arm	1 pc	1 000 kg	2 m **Note!** Do not stretch! Secures against rotation.

Lifting with roundslings

	Action	Note
1	Position robot in a secure transport position.	
2	Attach *lifting eye bolts* in the rear M20 holes.	Shown in figure *Attachment points on page 90*.
3	Attach roundslings to robot according to figure *Attachment points on page 90*.	
4	**Note** Make sure that the roundslings do not lie against sensitive parts, for example harness and customer equipment!	
5	When attaching the **roundsling A** on the upper arm, put it in a U-shape through the hole in the wrist.	Shown in the figure *Attachment points on page 90*.
6	When attaching the **roundsling B** on the upper arm, put it in a sling around the gearbox axis 4 and on the inside of motor axis 4.	Shown in the figure *Attachment points on page 90*.
7	When attaching the *roundsling C* , *note* that it shall be routed on the inside of the cable harness of motor axis 2, in order not to damage the harness!	Shown in the figure *Attachment points on page 90*.
8	**CAUTION** The IRB 6620 robot weighs 900 kg. All lifting accessories used must be sized accordingly!	

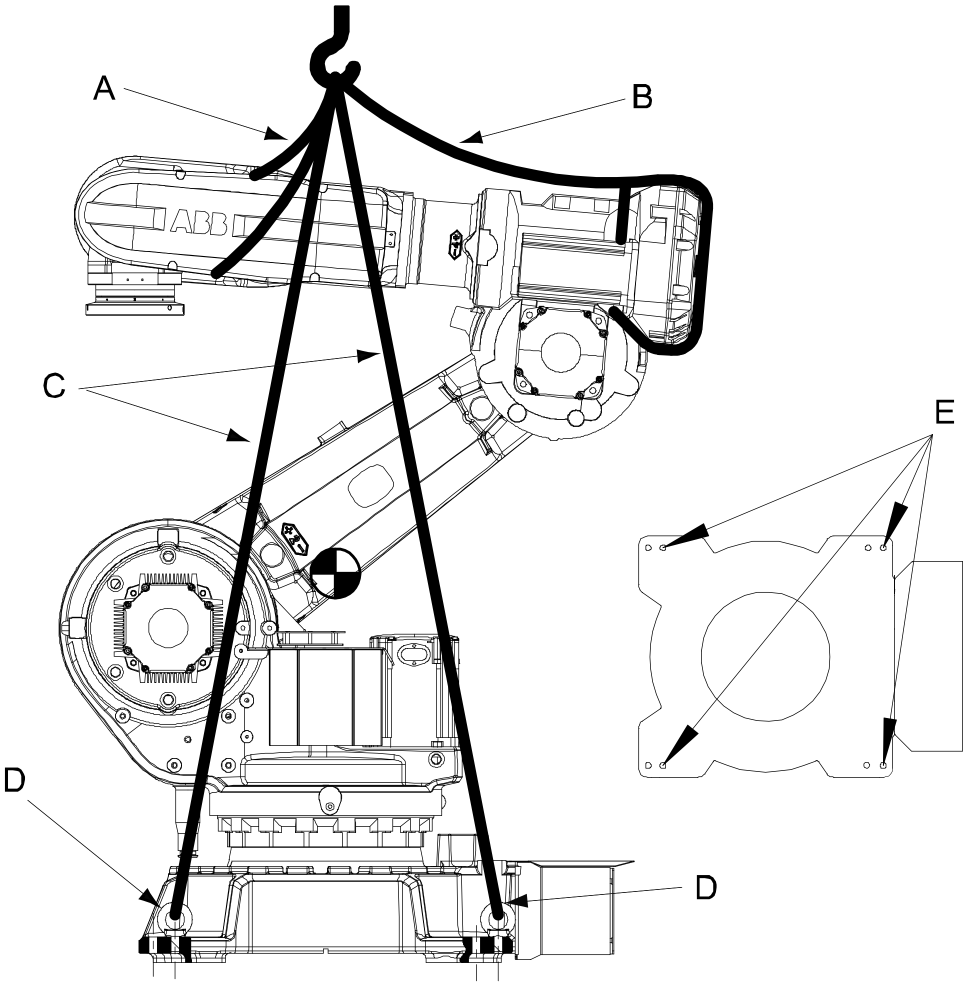
Continues on next page

	Action	Note
9	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	

Attachment points

This figure shows how to attach the roundslings to the robot.

The illustration is similar with the label attached to the robot's lower arm.



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A	Roundsling upper arm, 2.5 m.
B	Roundsling upper arm, 2 m.
C	Roundsling robot, 2.5 m (4 pcs).
D	Lifting eye, M20 (4 pcs)
E	Holes for lifting eyes in the robotbase. (Rear holes)

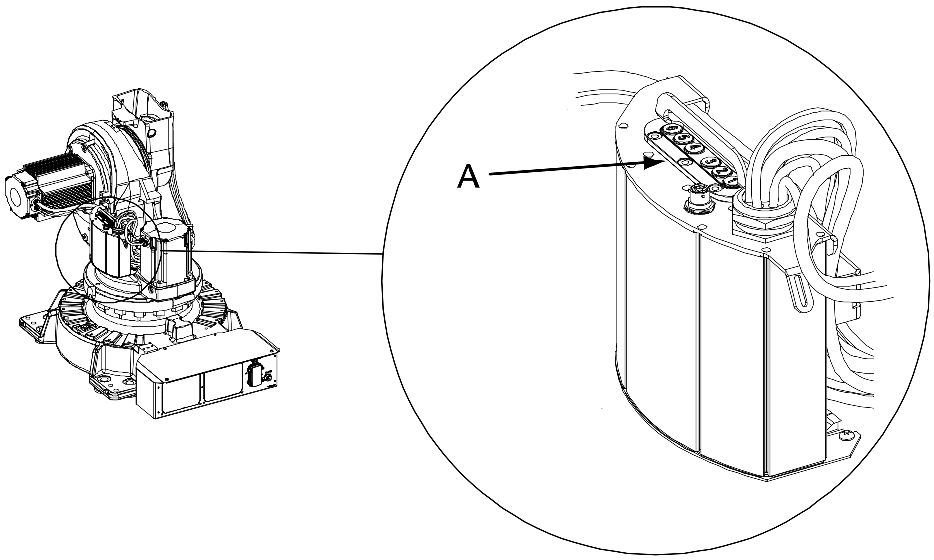
2.5.4 Manually releasing the brakes

Introduction to manually releasing the brakes

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

Location of brake release unit

The internal brake release unit is located as shown in the figure.



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Releasing the brakes

This procedure details how to release the holding brakes when the robot is equipped with an internal brake release unit.

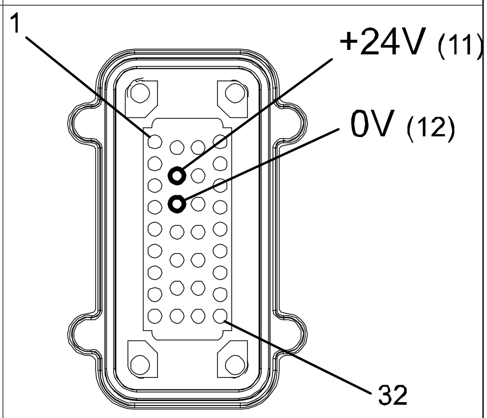
	Action	Note
1	The internal brake release unit is equipped with buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes. If the robot is not connected to the controller, power must be supplied to the connector R1.MP according to the section *Supplying power to connector R1.MP on page 92*.	Buttons are shown in figure *Location of brake release unit on page 91*.
2	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways. Make sure no personnel is near or beneath the robot arm.	

Continues on next page

	Action	Note
3	Release the holding brake on a particular robot axis by pressing the corresponding button on the internal brake release unit. The brake will function again as soon as the button is released.	

Supplying power to connector R1.MP

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

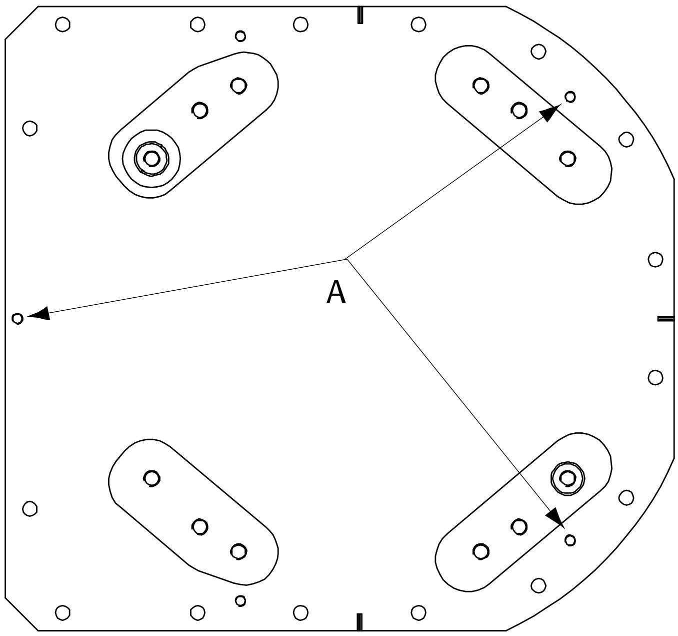
	Action	Note
1	**DANGER** Incorrect connections, such as supplying power to the wrong pin, may cause all brakes to be released simultaneously!	
2	Supply 0V on pin 12 and 24V on pin 11.	 xx0600002937

2.5.5 Lifting the base plate

Required equipment

Equipment	Article number	Note
Lifting eye, M16	3HAC14457-4	3 pcs
Lifting slings		Length: approx. 2 m

Hole configuration



xx0200000096

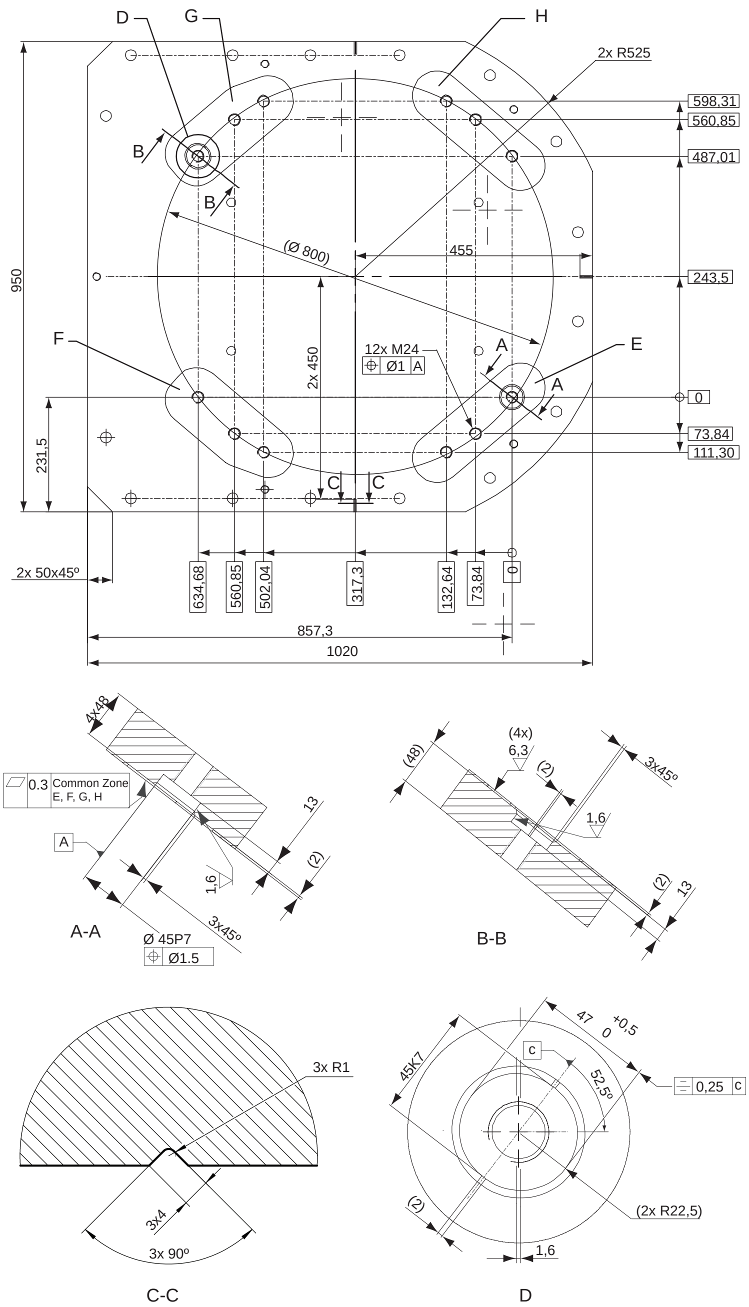
A	Attachment holes for lifting eyes (x3)

Lifting, base plate

	Action	Note
1	**CAUTION** The base plate weighs 353 kg. All lifting accessories used must be sized accordingly.	
2	Fit lifting eyes in specified holes.	Shown in figure *Hole configuration on page 93*.
3	Fit lifting slings to the eyes and to the lifting accessory. **CAUTION** Lift and move the base plate very slowly. If the base plate starts to swing it is a risk for injuries or damage.	

2.5.6 Securing the base plate

Base plate, dimensions



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E, F, G, H	Common tolerance zone (accuracy all over the base plate from one contact surface to the other)

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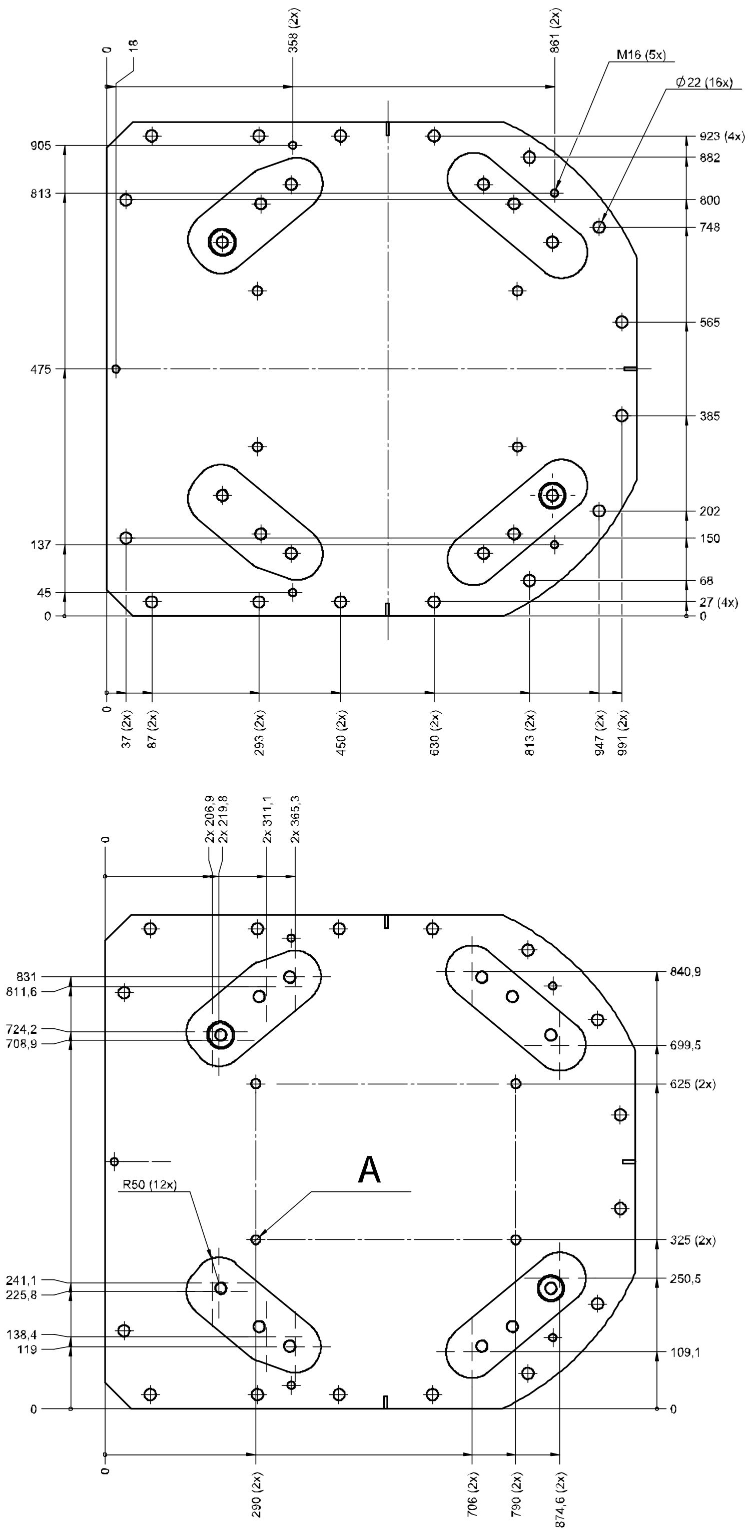

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A	Four holes for alternative clamping, 4x Ø18

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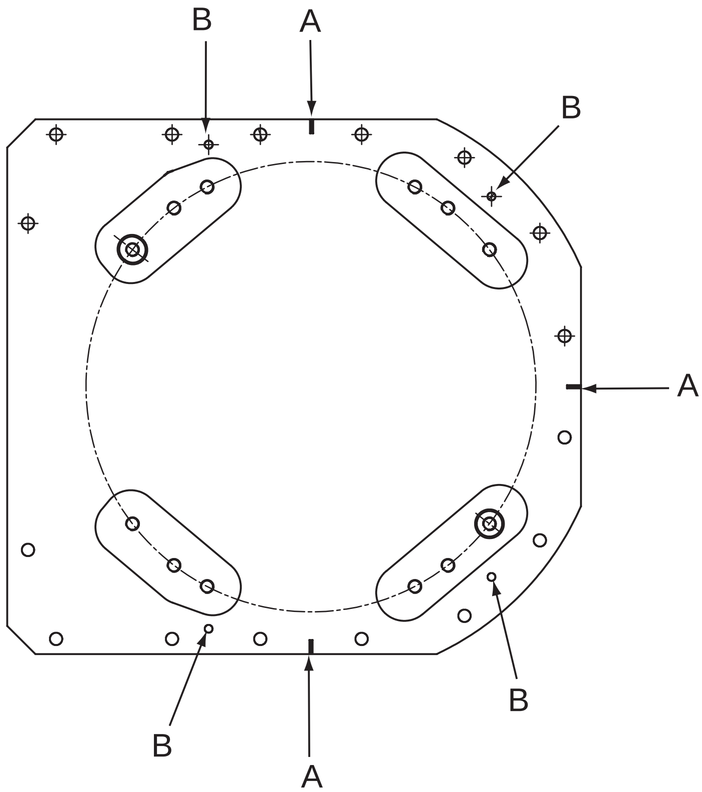
Base plate, orienting grooves and leveling bolts

The illustration below shows the orienting grooves and attachment holes for leveling bolts in the base plate.



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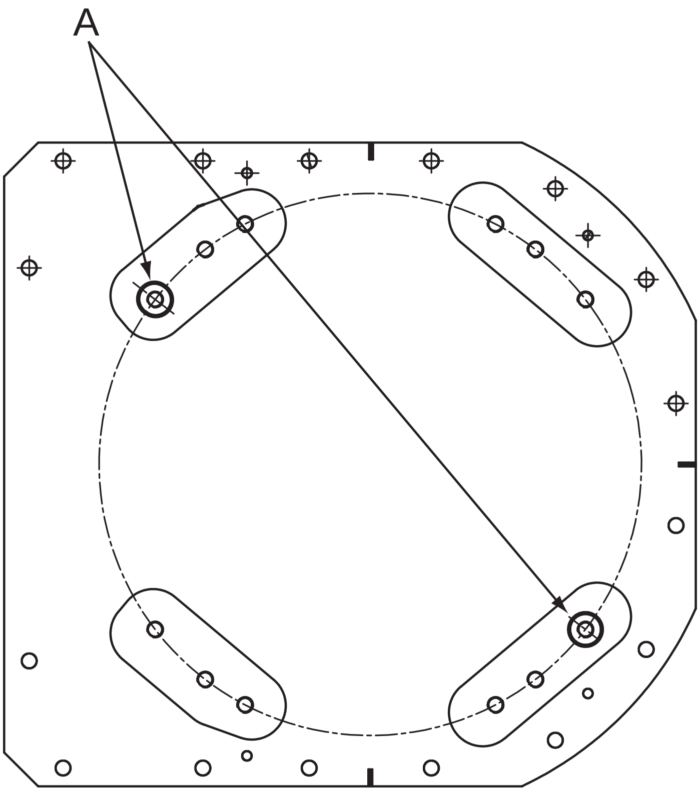
A	Orienting grooves (3 pcs)
B	Levelling bolts, attachment holes (4 pcs)

Continues on next page

Base plate, guide sleeve holes

The illustration below shows the orienting grooves and guide sleeve holes in the base plate.



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A	Guide sleeve holes (2 pcs)

Required equipment

Equipment	Article number	Note
Base plate	3HAC12937-9	Includes • guide sleeves, 3HAC12937-3 • levelling screws, 9ADA120-79 • attachment screws and washers for securing the robot to the base plate.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
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

Recommendations, quality

The table specifies any recommendations made by ABB:

Variable	Recommendation
Recommended bolt quality and dimension	Hilti HDA-P, M20 x 250/50 (maximum thickness of base plate = 50 mm) Hilti HDA-P, M20 x 250/100 (maximum thickness of base plate = 100 mm)
Recommended foundation quality 1	Steel fibre reinforced concrete foundation, 30 kg/m3, class C30 [i]
Recommended foundation quality 2	Sturdy concrete foundation, double reinforced by ø10 mm steel bars, distance 140 mm, class C25 [i]

i See recommended depth of drill hole, minimum base material thickness etc. in standards from the bolt supplier. When choosing bolts from Hilti, see standard AFTM2011.

Base plate

This section details how to secure the base plate to the foundation.

	Action	Note
1	Make sure the foundation is levelled.	
2	**CAUTION** The base plate weighs 353 kg! All lifting equipment used must be sized accordingly!	
3	Position base plate in relation to the robot work location using the grooves in the base plate.	Shown in figure *Base plate, orienting grooves and leveling bolts on page 96*.
4	Lift the base plate to its mounting position.	Detailed in section *Lifting the base plate on page 93*.
5	Use the base plate as a template and drill attachment holes as required by the selected bolt dimension.	Attachment holes: 16 pcs. If possible, observe the recommendations specified in section *Recommendations, quality on page 98*. ABB does not assume any responsibility for other foundation qualities, due to great variations in the foundation properties.
6	Fit the base plate and use the levelling bolts to level the base plate.	Shown in figure *Base plate, orienting grooves and leveling bolts on page 96*.
7	If required, fit strips of sheet metal underneath the base plate to fill any gaps.	
8	Secure the base plate to the foundation with screws and sleeves.	
9	Recheck the four contact surfaces on the base plate to make sure the base plate is levelled and flat. If it is not, use pieces of sheet metal or similar to bring the base plate to a levelled position.	Maximum allowed deviation all over the base plate, from one contact surface to the other: 0.3 mm.

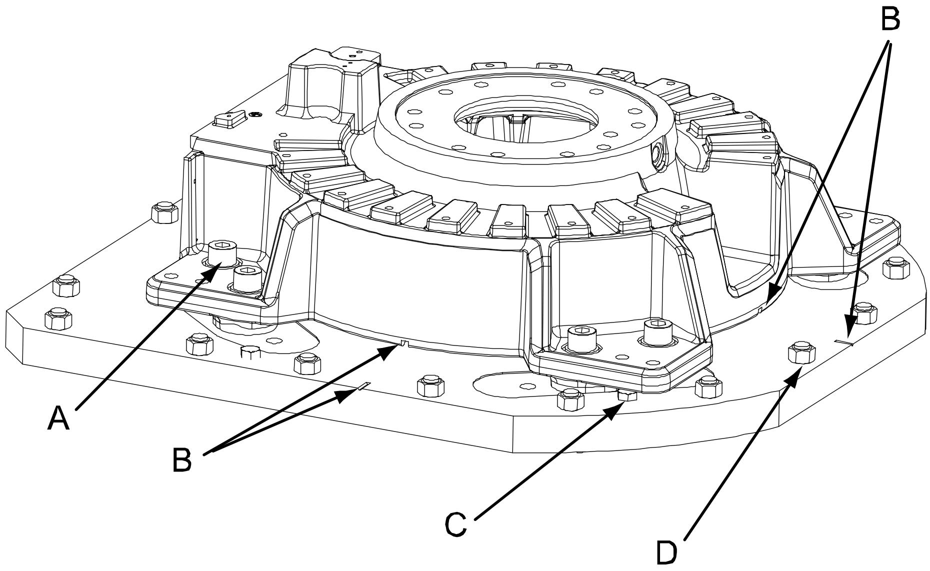
2.5.7 Orienting and securing the robot

General

This section details how to orient and secure the robot to the base plate in order to run the robot safely.

Illustration, robot fitted to base plate

This illustration shows the robot base fitted to the base plate.



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A	Robot attachment bolts and washers, 8 pcs (M24 x 100)
B	Orienting grooves in the robot base and in the base plate
C	Levelling screws. **Note!** Remove before the robot base is fitted!
D	Base plate attachment screws

Attachment screws

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

Suitable screws, lightly lubricated:	M24 x 100
Quality:	Quality 8.8
Suitable washer:	Thickness: 4 mm Outer diameter: 44 mm Inner diameter: 25 mm
Tightening torque:	725 Nm

Continues on next page

Securing the robot

Use this procedure to secure robot to base plate after fitting plate to the foundation.

	Action	Note
1	Lift the robot.	See section *Lifting robot with round-slings on page 89*.
2	Move robot to the vicinity of its installation location.	
3	Fit two guide sleeves to the *guide sleeve holes* in the base plate.	Shown in figure *Base plate, guide sleeve holes on page 97*. **Note** One of the guide sleeve holes is elongated!
4	Guide the robot gently using two M24 screws while lowering it into its mounting position.	Make sure the robot base is correctly fitted onto the guide sleeves!
5	Fit the *bolts and washers* in the base attachment holes.	Specified in *Attachment screws on page 99*. Shown in figure *Illustration, robot fitted to base plate on page 99*. **Note** Lightly lubricate screws before assembly!
6	Tighten bolts in a criss-cross pattern to ensure that the base is not distorted.	

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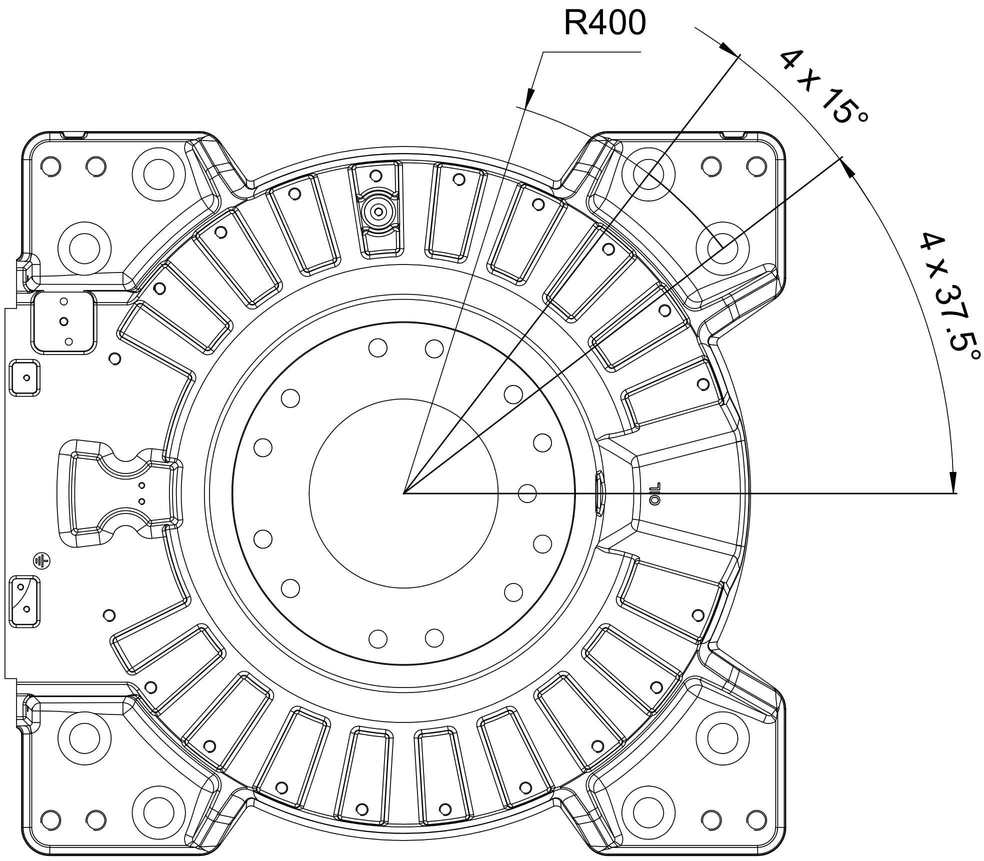
Hole configuration, base

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



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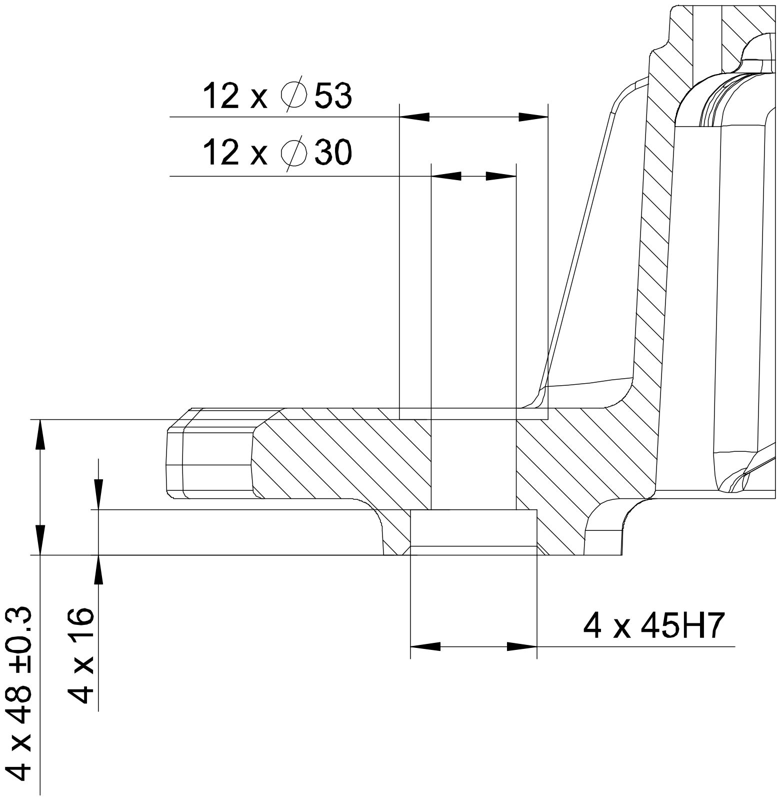
Cross section, guide sleeve hole

This illustration shows the cross section of the guide sleeve holes.



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2.5.8 Setting the system parameters for a suspended or tilted robot

General

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

Note

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

Note

The allowed mounting positions are described in the product specification for the robot. The requirements on the foundation are described in *Requirements, foundation on page 71*.

System parameters

Note

The mounting angle must be configured correctly in the system parameters so that the robot system can control the movements in the best possible way. An incorrect definition of the mounting angle will result in:

- Overloading the mechanical structure.
- Lower path performance and path accuracy.
- Some functions will not work properly, for example *Load Identification* and *Collision detection*.

Gamma Rotation

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

Gravity Beta

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

The *Gravity Beta* is a positive rotation direction around the y-axis in the base coordinate system. The value is set in radians.

Continues on next page

Gravity Alpha

If the robot is mounted on a wall (rotated around the x-axis), then the robot base frame and the system parameter *Gravity Alpha* must be redefined. The value of *Gravity Alpha* should then be ±π/2 (±3.141593/2).

The *Gravity Alpha* is a positive rotation direction around the x-axis in the base coordinate system. The value is set in radians.

Note

The system parameter *Gravity Alpha* is not supported for all robot types. It is not supported for IRB 140, IRB 1410, IRB 1600ID, IRB 2400, IRB 4400, IRB 6400R, IRB 6400 (except for IRB 6400 200/2.5 and IRB 6400 200/2.8), IRB 6600, IRB 6650, IRB 6650S and IRB 7600 (except for IRB 7600 325/3.1).

If the robot does not support *Gravity Alpha*, then use *Gravity Beta* along with the recalibration of axis 1 to define the rotation of the robot around the x-axis.

Note

The parameter is supported for all robots on track when the system parameter *7 axes high performance motion* is set, see *Technical reference manual - System parameters*.

Gamma Rotation

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

Mounting angles and values

The parameter *Gravity Beta* (or *Gravity Alpha*) specifies the mounting angle of the robot in radians. It is calculated in the following way.

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

Example of position	Mounting angle (A°)	Gravity Beta
Floor mounted	0°	0.000000 (Default)
Tilted mounting	15°	0.261799
Suspended mounting	180°	3.141593

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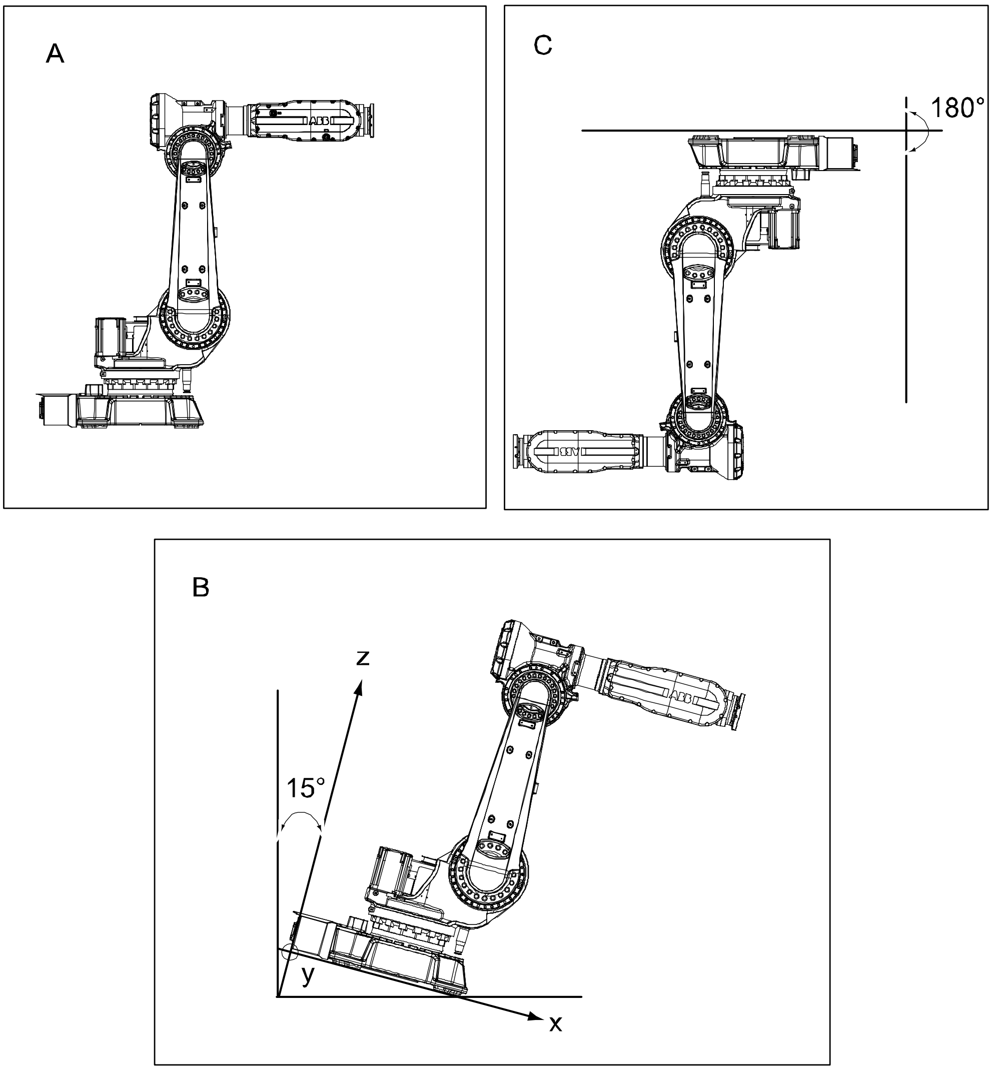
Examples of mounting angles tilted around the Y axis (*Gravity Beta*)



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A	Floor mounted
B	Tilted mounting, mounting angle 15°.
C	Suspended mounting, mounting angle 180°.

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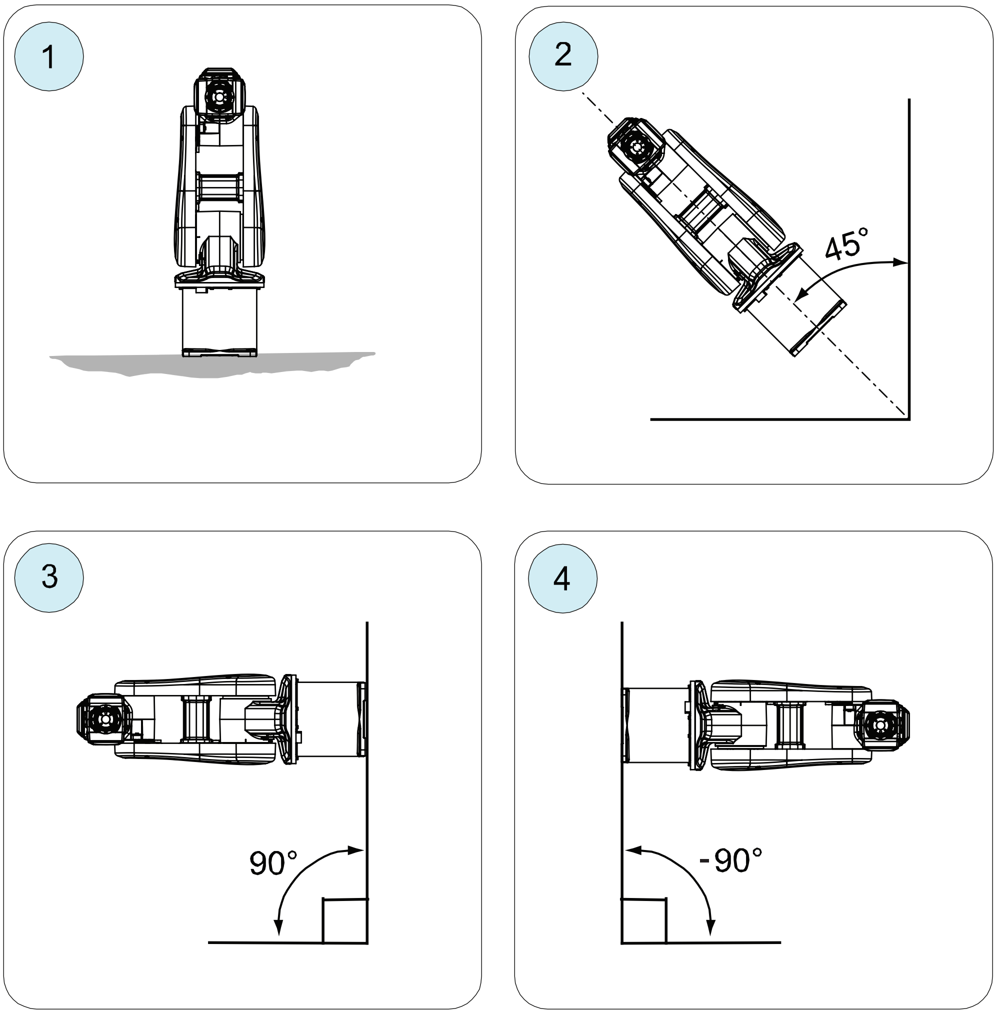
Examples of mounting angles tilted around the X axis (*Gravity Alpha*)

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



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

Note

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

Continues on next page

Defining the parameter in the IRC5 software

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

How to calculate a new value is detailed in *Mounting angles and values on page 104*.

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

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

2.5.9 Fitting equipment on robot

General

The robot features mounting holes for additional equipment.

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

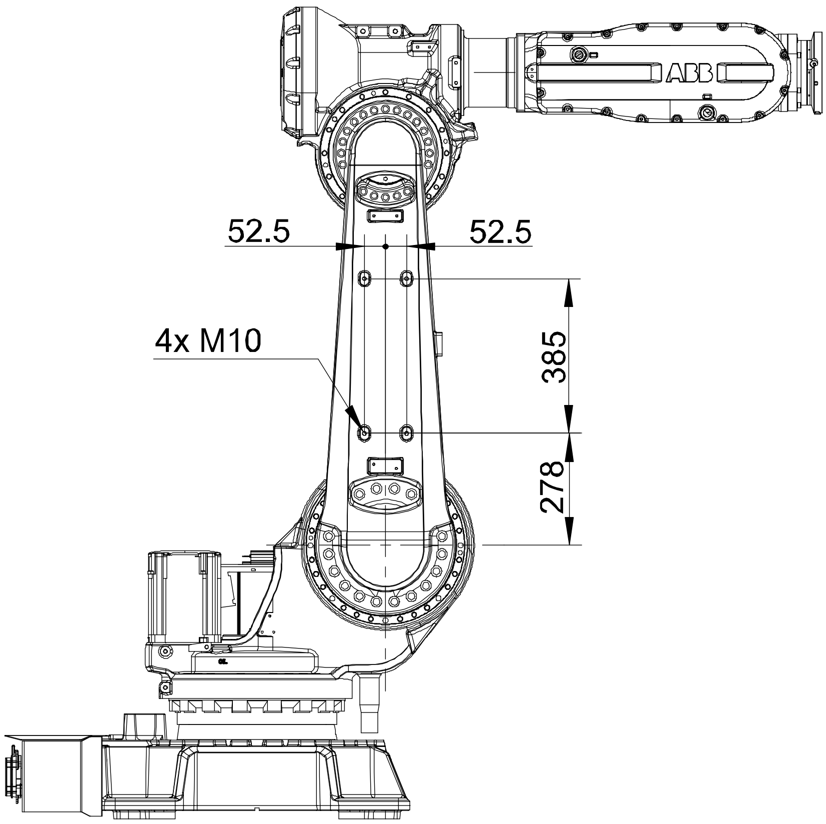
Note

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

Illustration, fitting of extra equipment on lower arm

The illustrations below shows the mounting holes available for fitting extra equipment on the lower arm.

Make sure not to damage the robot cabling on the lower arm when fitting extra equipment. Always use appropriate attachment screws!



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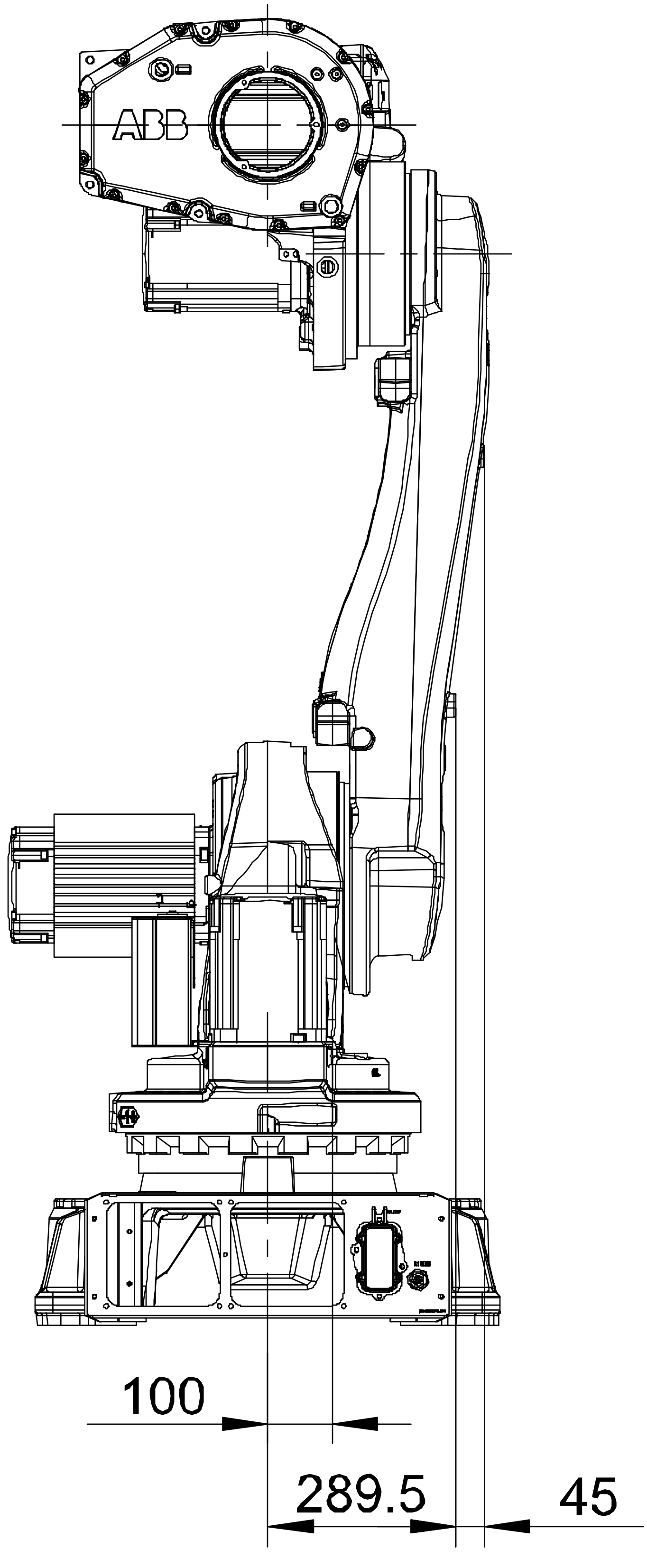

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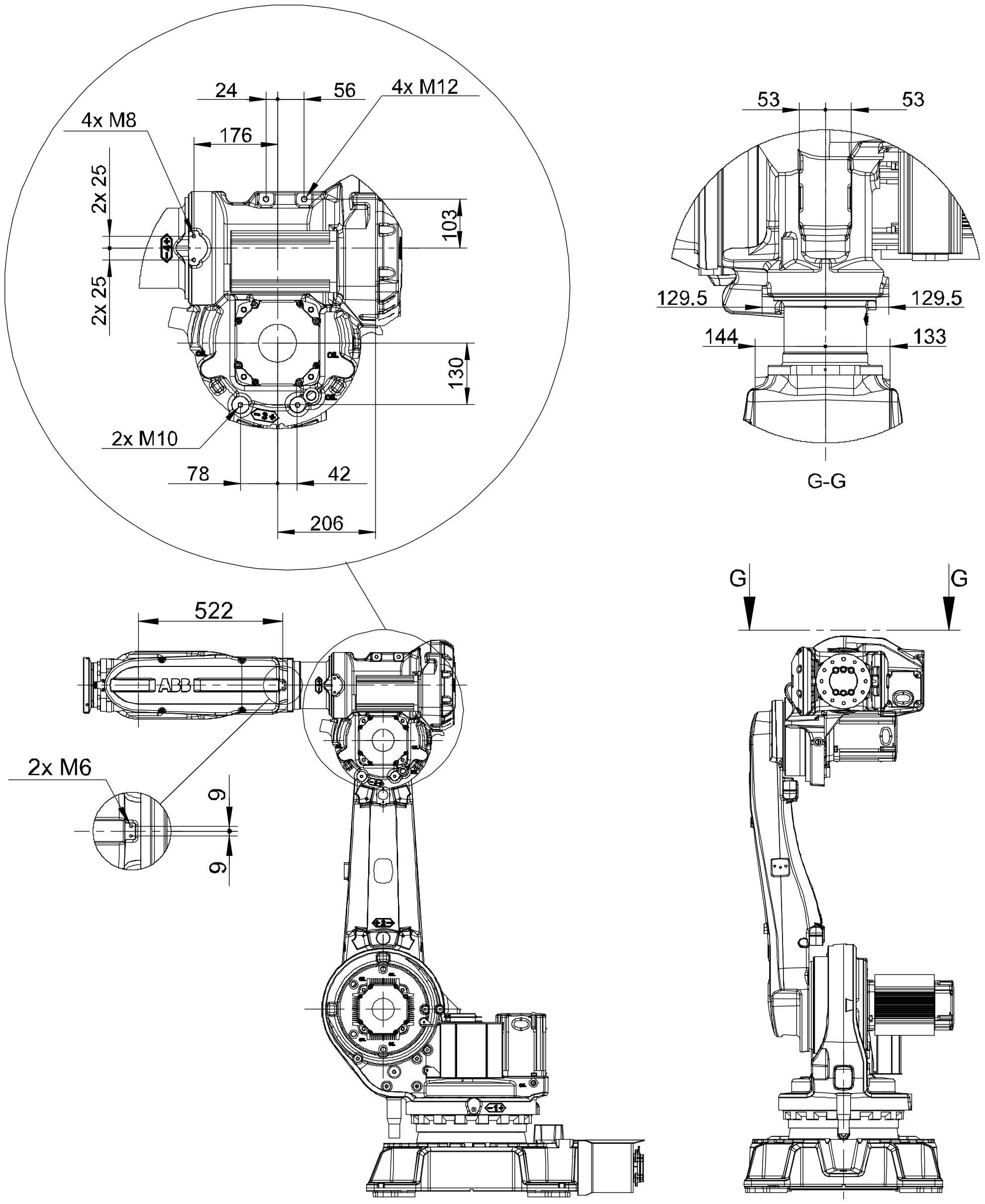
Illustration, fitting of extra equipment on upper arm

The illustrations below shows the mounting holes available for fitting extra equipment on the upper arm.



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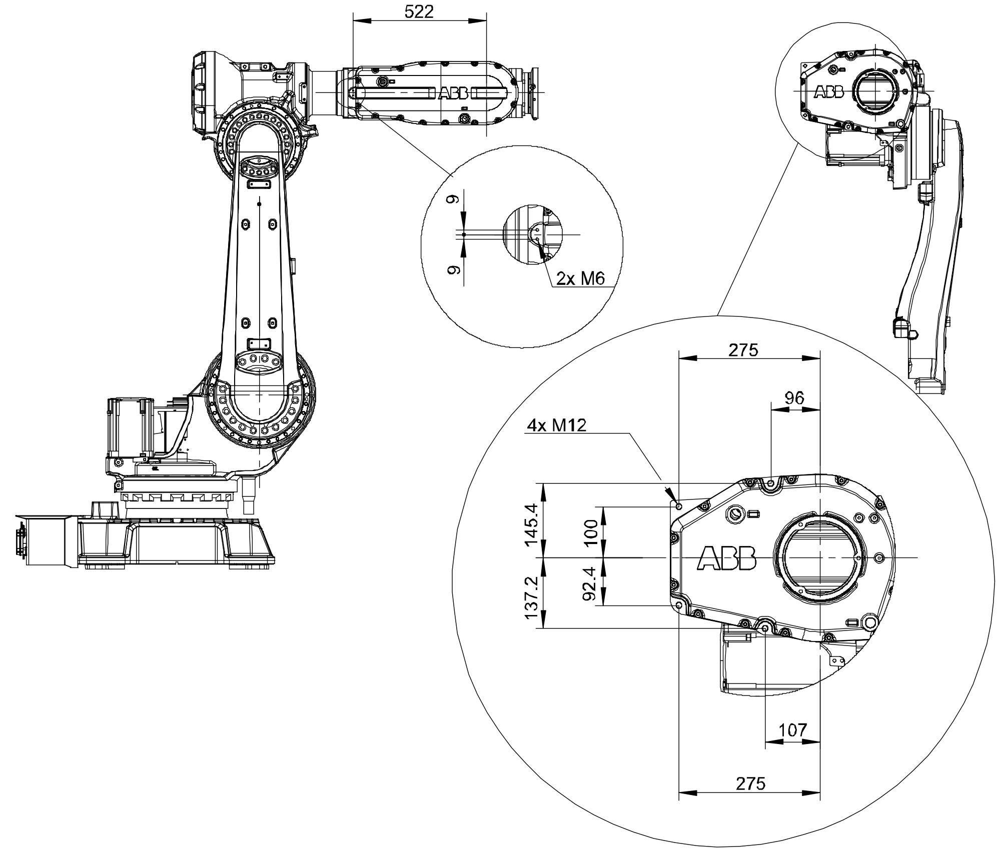

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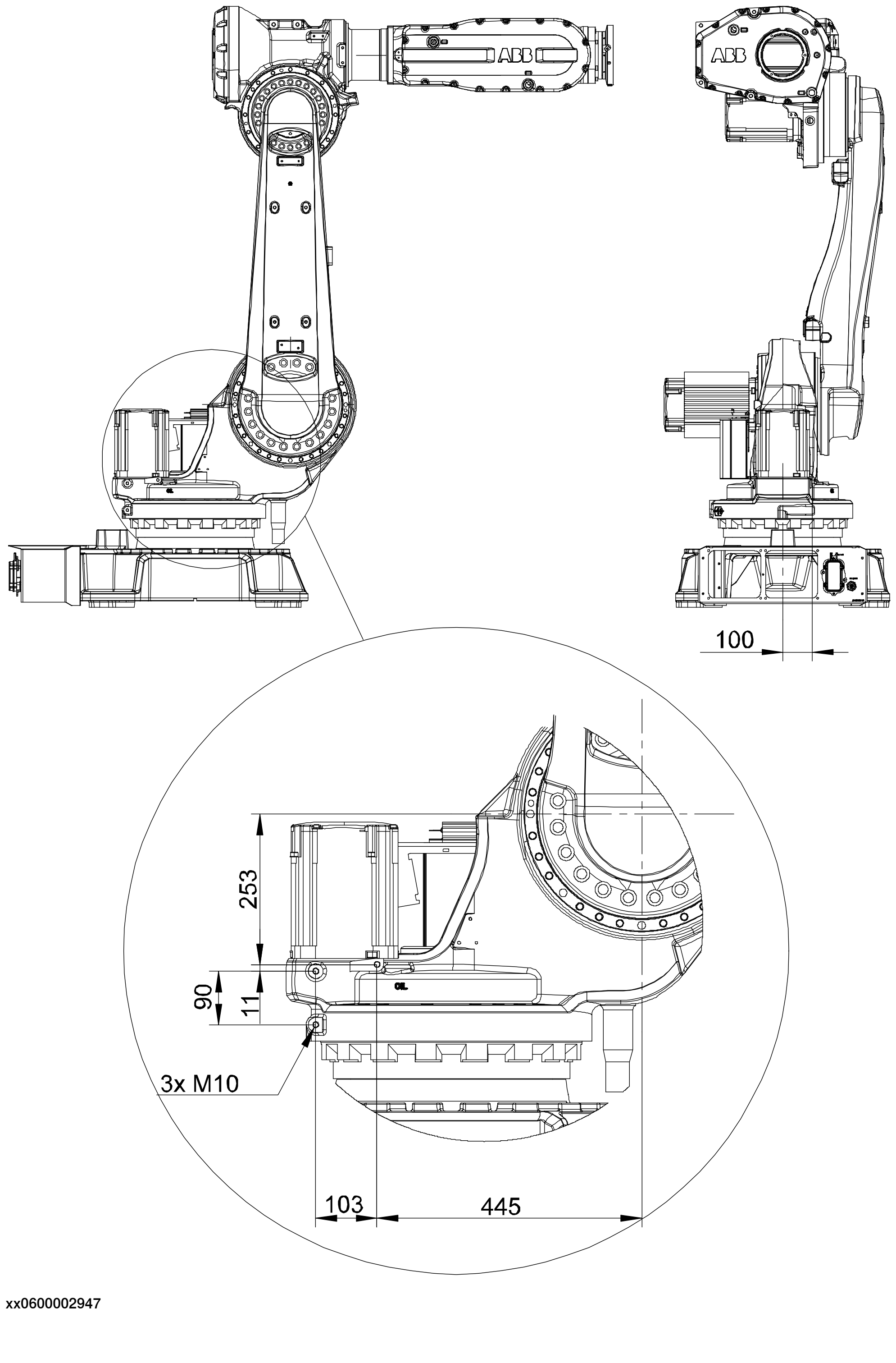
Illustration, fitting of extra equipment on frame

The mounting holes available for fitting extra equipment on the frame are shown below.



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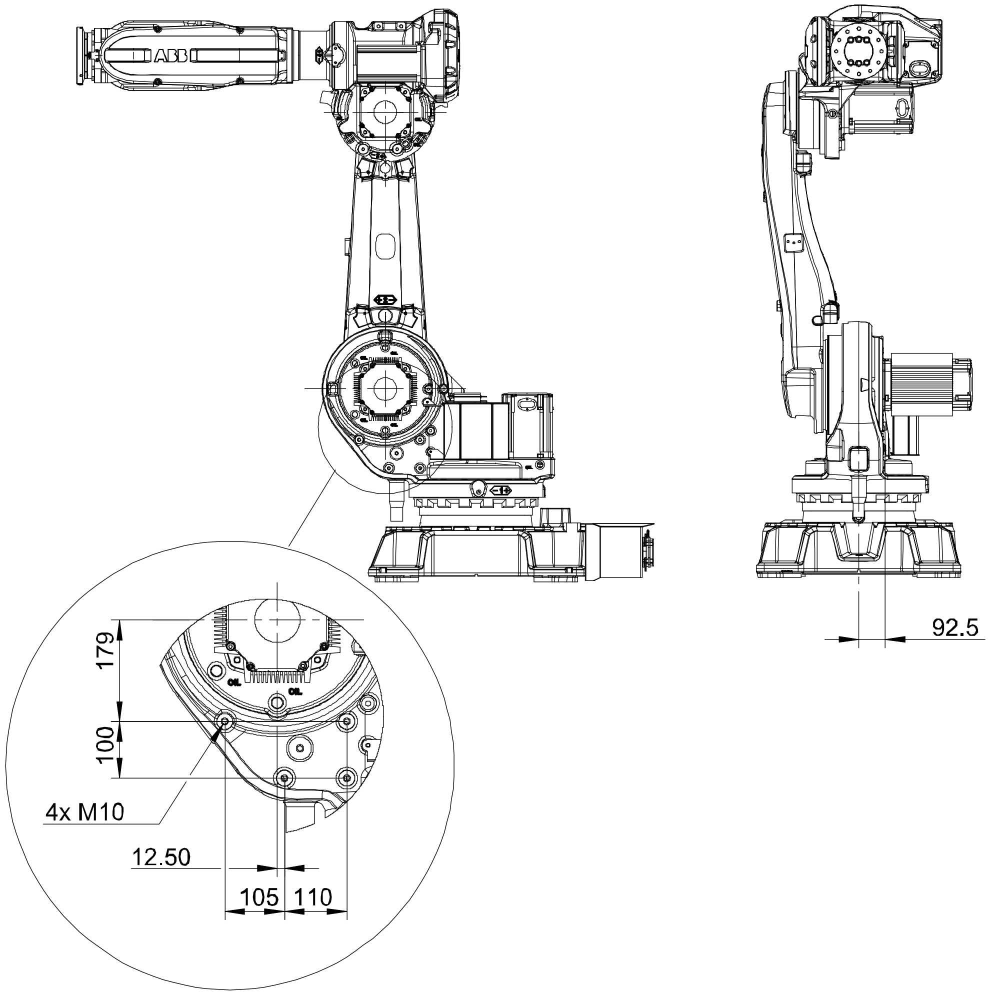

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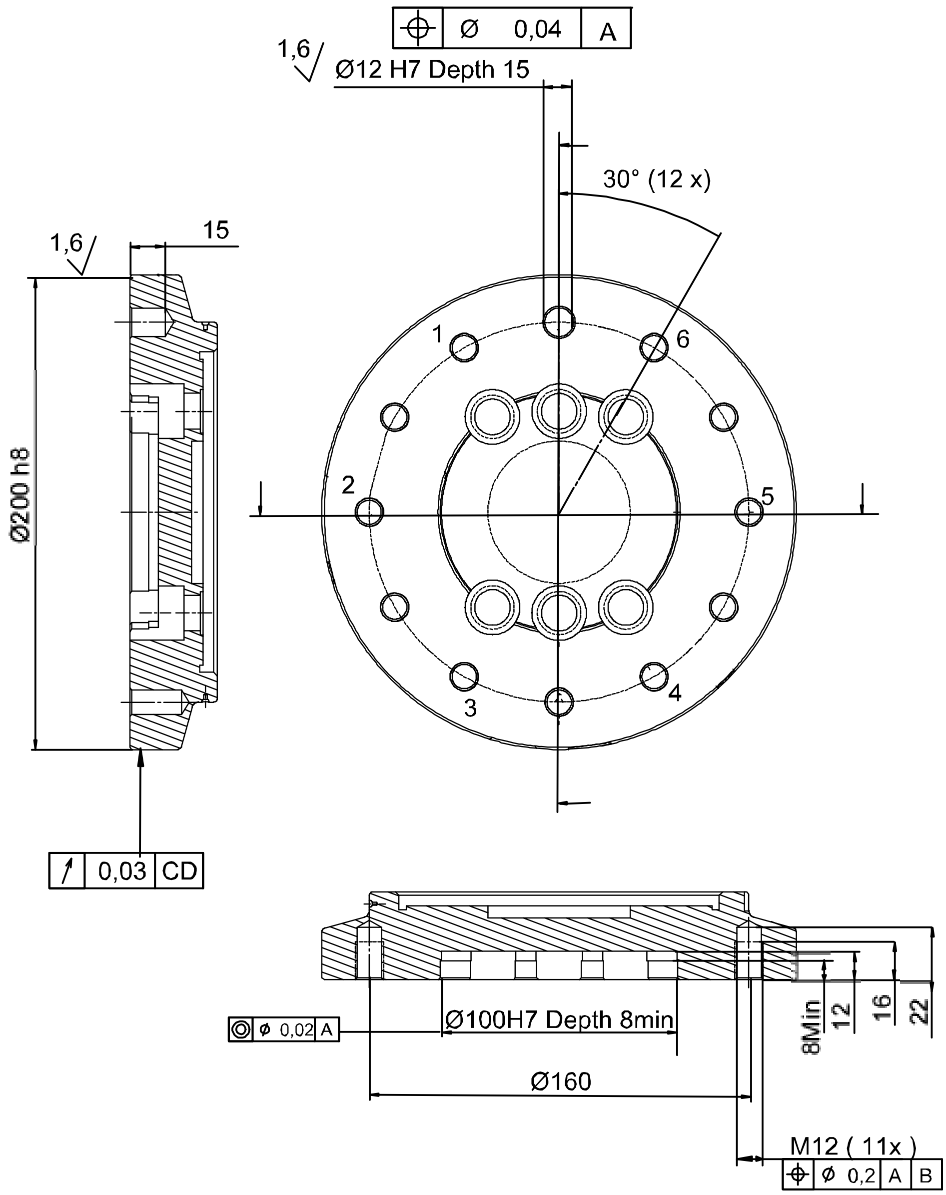
Illustration, fitting on turning disc

The illustration below shows the mounting holes available for fitting equipment on the turning disc.



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-	Turning disk for robot version IRB6620 - 150/2.2. Use every other of the bolt holes for six attachment bolts, as numbered in the figure.
-	Turning disk type 1

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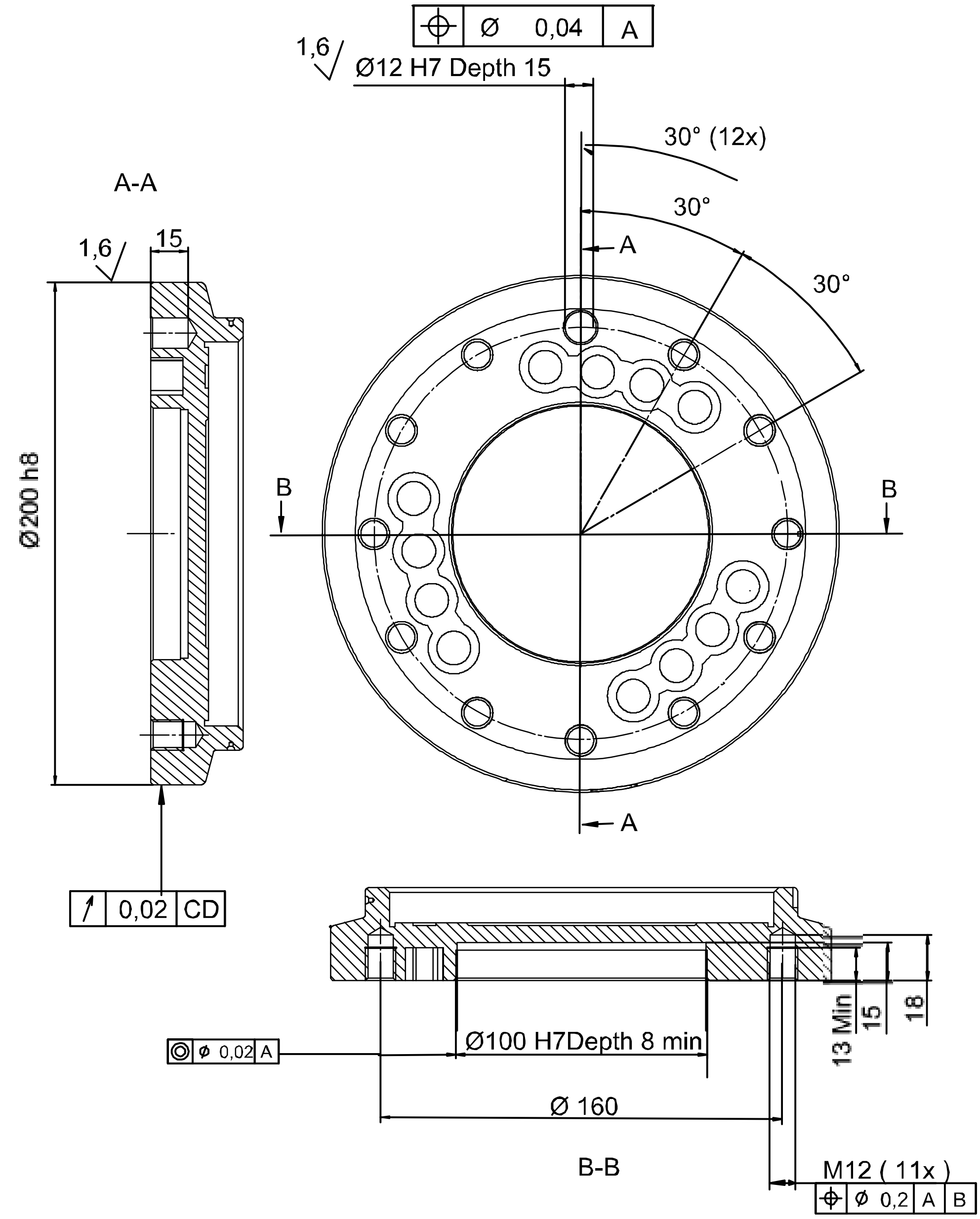

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-	Turning disk (type 2) for robot version IRB 6620 Foundry Plus.

Fastener quality

When fitting tools on the turning disk (see the figures above), only use screws with quality 12.9.

Standard screws with quality 8.8 may be used when fitting other equipment to the mounting holes.

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

General

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

CAUTION

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

References

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

- *Operating manual - IRC5 with FlexPendant*

Stopping time and braking distances

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

2.5.11 Installation of signal lamp (option)

Signal lamp

See the assembly instruction delivered with the signal lamp.

2.6 Restricting the working range

2.6.1 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.
- Axis 3, hardware (mechanical stop) and software.

As a standard configuration, axis 1 is allowed to move ±170°.

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.

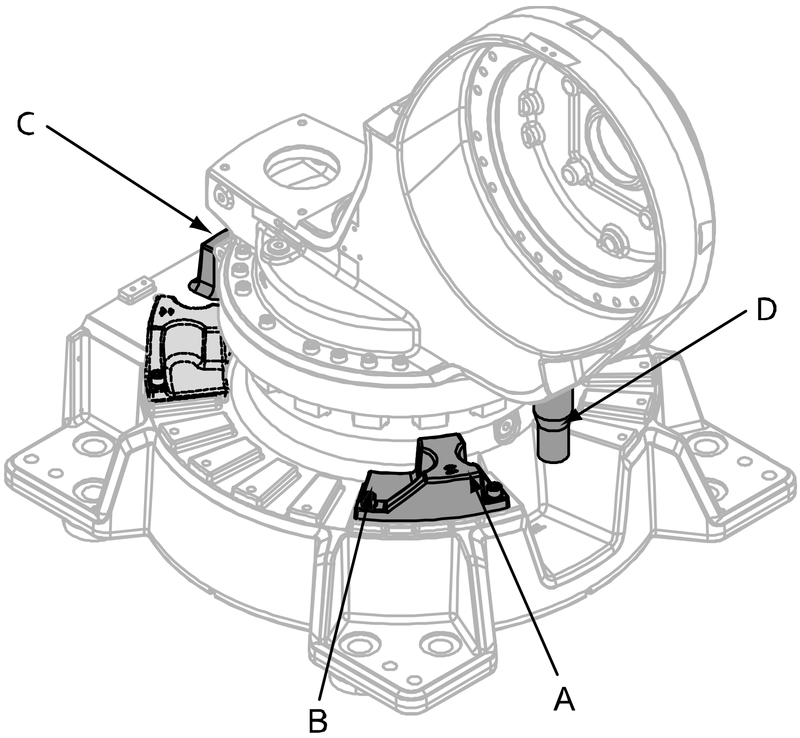
2.6.2 Mechanically restricting the working range of axis 1

General

The working range of axis 1 is limited by fixed mechanical stops and adjustment of the system parameter configuration. The working range can be reduced by adding additional mechanical stops giving 7.5 or 15 graduation, between 22.5° and 135° in both directions.

Mechanical stops, axis 1

The illustration shows the mounting position of the stop pin and one of the additional mechanical stops available for axis 1.



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A	Movable mechanical stop
B	Attachment screw plus washer, M12 x 40 quality 12.9 (2 pcs)
C	Fixed mechanical stop
D	Mechanical stop pin axis 1

Continues on next page

Required equipment

Equipment, etc.	Article number	Note
Movable mechanical stop set, axis 1 (+15°/-7.5°)	3HAC025204-003	Includes: • one stop (+15°/ -7.5°), 3HAC025366-001 • one stop (+7.5°/ -15°), 3HAC025367-001 • attachment screws and washers • document for movable mech.stop, 3HAC025204-002
Movable mechanical stop set, axis 1 (+7.5°/-15°)	3HAC025204-003	Includes: • two stops (+15°/ -7.5°), 3HAC025366-001 • two stops (+7.5°/ -15°), 3HAC025367-001 • attachment screws and washers • document for movable mech.stop, 3HAC025408-001
Standard toolkit	-	
Technical reference manual - System parameters	-	Article number is specified in section *References on page 10*.

Installation, mechanical stops axis 1

Use this procedure to fit the additional mechanical stops to axis 1 of the robot. An assembly drawing is also enclosed with the product.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Fit the additional mechanical stop to the frame according to the figure *Mechanical stops, axis 1 on page 119*.	Tightening torque: 120 Nm.
3	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*.

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	Action	Note
4	**WARNING** If the mechanical stop pin is deformed after a hard collision, it must be replaced! Deformed *movable stops* and/or *additional stops* as well as deformed *attachment screws* must also be replaced after a hard collision.	

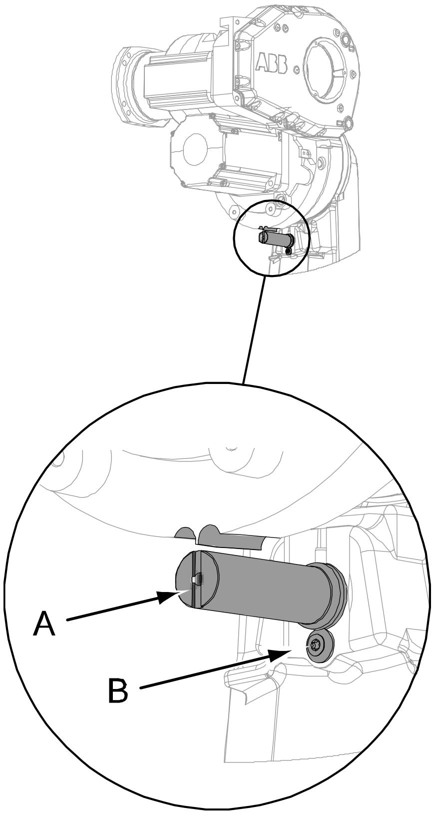
2.6.3 Mechanically restricting the working range of axis 3

General

The working range of axis 3 is limited by a fixed mechanical stop. This stop limits the backwards movement of the upper arm to -90°, which secures the robot arm from tipping over.

Mechanical stops, axis 3

The illustration shows the mounting position of the mechanical stops on axis 3.



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A	Mechanical stop pin, axis 3
B	Attachment screw and washer

Required equipment

Equipment, etc.	Art. no.	Note
Mechanical stop set, axis 3	3HAC025290-003	Includes: • one mechanical stop pin, 3HAC025092-001. • attachment screw and washer. • document for Mech stop pin, 3HAC025409-001.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.

Continues on next page

Equipment, etc.	Art. no.	Note
Technical reference manual - System parameters	-	Art. no. is specified in section *References on page 10*.

Installation, mechanical stops axis 3

Use the procedure to fit the mechanical stops for axis 3 to the robot. An assembly drawing is also enclosed with the product.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Fit and tighten the mechanical stop, axis 3, on to the lower arm.	Tightening torque: 115 Nm. Shown in the figure *Mechanical stops, axis 3 on page 122*
3	**Note** The software working range limitations (system parameters) must be redefined to correspond to the changes in the mechanical limitations of the working range (+70°/ -90°).	The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.
4	**WARNING** If the *mechanical stop pin* is deformed after a hard collision, it must be replaced! Deformed *movable stops* and/or *additional stops* as well as deformed *attachment screws* must also be replaced after a hard collision.	

2.7 Foundry Plus Cable guard (option)

2.7.1 Installation of Foundry Plus Cable guard (option no. 908-1)

Introduction

How to install the Foundry Plus Cable guard is described in the instruction delivered with the cable guard.

Separate instructions for IRB 140, 4600, 1600, 6620, 6640, 6650S, 6660 and 7600 are available in English, German, French, Spanish and Italian and can be found on the DVD delivered with the Cable guard, article number 3HAC035933-001.

2.8 Electrical connections

2.8.1 Robot cabling and connection points

Introduction

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

Main cable categories

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

Cable category	Description
Robot cables	Handles power supply to and control of the robot's motors as well as feedback from the serial measurement board. Specified in the table *Robot cables on page 125*.
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. The customer cables also handle databus communication. See the product manual for the controller, see document number in *References on page 10*.
External axes cables (option)	Handles power supply to and control of the external axes' motors as well as feedback from the servo system. See the *Application manual - Additional axes and stand alone controller (M2004)*, see document number in *References on page 10*.

Robot cables

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

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

Robot cable, power

Cable	Art. no.
Robot cable, power: 7 m	3HAC026787-001
Robot cable, power: 15 m	3HAC026787-002
Robot cable, power: 22 m	3HAC026787-003
Robot cable, power: 30 m	3HAC026787-004

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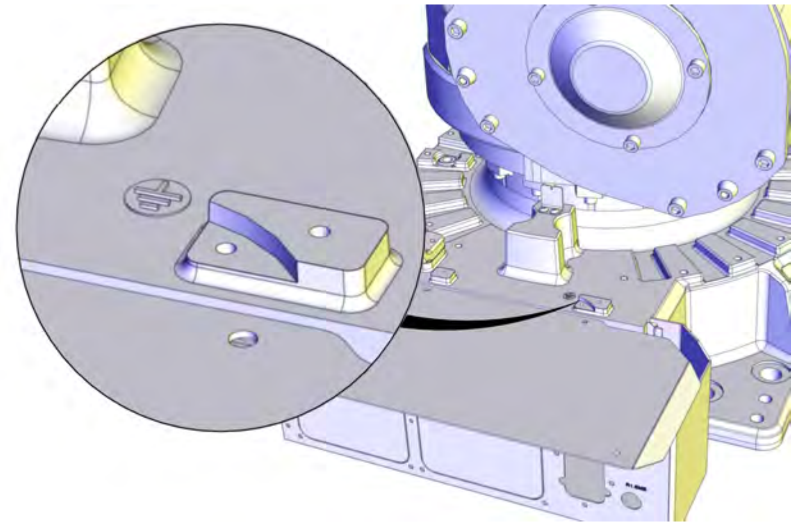
Robot cable, signals

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

Grounding and bonding point on manipulator

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



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3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 6620.

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 6620 is connected to power, always make sure that the IRB 6620 is connected to protective earth before starting any maintenance work!

For more information see:

- *Product manual - IRC5*

3.2 Maintenance schedule and expected component life

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 6620:

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

3.2.2 Maintenance schedule

General

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

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

The inspection intervals *do not* specify the life of each component. Values for these are specified in the section *Expected component life on page 131*

Instructions for how to perform the different maintenance activities are found in sections:

- *Inspection activities on page 132*
- *Replacement/changing activities on page 161*
- *Cleaning activities on page 185*

Activities and intervals, standard equipment

The following table specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval
Cleaning	Robot	*Cleaning the IRB 6620 on page 185*
Inspection	Oil level in axis-1 gearbox	Every 12 months.
Inspection	Oil level in axis-2 gearbox	Every 12 months.
Inspection	Oil level in axis-3 gearbox	Every 12 months.
Inspection	Oil level in axis-4 gearbox	Every 12 months.
Inspection	Oil level in axis-5 gearbox	Every 12 months.
Inspection	Oil level in axis-6 gearbox	Every 12 months.
Inspection	Robot harness	Every 12 months[i].
Inspection	Information labels	Every 12 months.
Inspection	Dampers	Every 12 months.
Inspection	Mechanical stop	Every 12 months.
Change	Oil in axis-1 gearbox	First change when DTC [ii] reads: • 6,000 hours Second change when DTC[ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Change	Oil in axis-2 gearbox	First change when DTC [ii] reads: • 6,000 hours Second change when DTC[ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.

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Maintenance activity	Equipment	Interval
Change	Oil in axis-3 gearbox	First change when DTC [ii] reads: • 6,000 hours Second change when DTC [ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Change	Oil in axis-4 gearbox	Every 24,000 hours.
Change	Oil in axis-5 gearbox	Every 24,000 hours.
Change	Oil in axis-6 gear	First change when DTC [ii] reads: • 6,000 hours Second change when DTC [ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Overhaul	Robot	Every: • 40,000 hours .
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [iii]
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [iv]

i Replace when damage or cracks is detected or life limit is approaching that specified in section *Expected component life on page 131*.

ii DTC = Duty Time Counter. Shows the operational time of the robot.

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

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

Activities and intervals, optional equipment

The following table specifies the required maintenance activities and intervals for common optional equipment. The maintenance of other external equipment for the robot is detailed in separate documents.

Maintenance activity	Equipment	Interval	Note
Inspection	Signal lamp	Every: 12 months	
Inspection	Mechanical stop axis 1 and 3	Every: 12 months	

3.2.3 Expected component life

General

The expected life of a specific component of the robot can vary greatly depending on how hard it is run.

Expected component life - protection type Standard

Component	Expected life	Note
Cable harness Normal usage [i]	40,000 hours [ii]	Not including: • Possible SpotPack harnesses • Optional upper arm harnesses
Cable harness Extreme usage [iii]	20,000 hours [ii]	Not including: • Possible SpotPack harnesses • Optional upper arm harnesses
Gearboxes [iv]	40,000 hours	

i Examples of "normal usage" in regard to movement: most material handling applications and limited use of bending backwards mode of axis 3.

ii Severe chemical or thermal environments, or similar environments, can result in shortened life expectancy.

iii Examples of "extreme usage" in regard to movement: press tending, very severe palletizing applications, major use of axis 1 movement and major use of bending backwards of axis 3.

iv Depending on application, the lifetime can vary. The Service Information System (SIS) that is integrated in the robot software can be used as guidance when planning gearbox service for the individual robot. This applies to gearboxes on axes 1, 2, 3 and 6. The lifetime of gearbox axes 4 and 5 is not calculated by SIS (See the *Operating manual - Service Information System*). In some applications, such as Foundry or Washing, the robot can be exposed to chemicals, high temperature or humidity, which can have an effect on the lifetime of the gearboxes. Contact the local *ABB Robotics Service team* for more information.

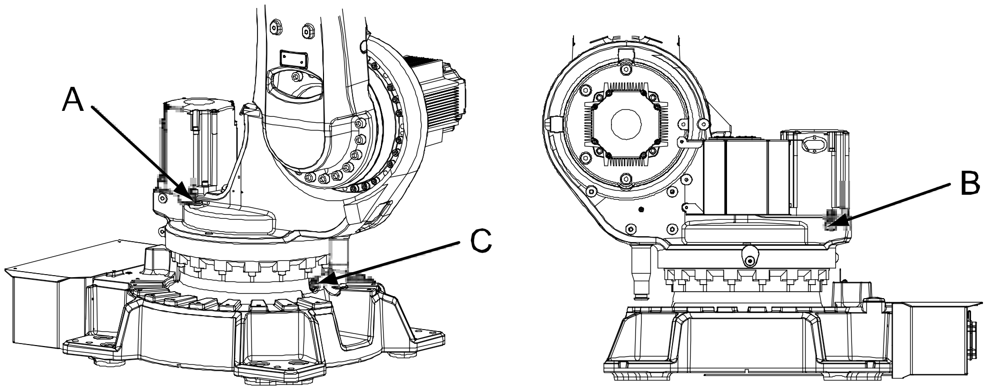
The SIS for an IRC5 system is described in the *Operating manual - Service Information System*.

3.3 Inspection activities

3.3.1 Inspecting the oil level in axis-1 gearbox

Location of gearbox

The axis-1 gearbox is located between the frame and base. See oil plugs in the following figure.



xx0600002958

A	Oil plug, filling
B	Oil plug, inspection
C	Oil plug, draining

Required equipment

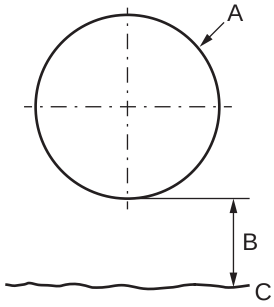
Equipment	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	**Note** Do not mix with other oils!
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting the oil level in axis-1 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	

Continues on next page

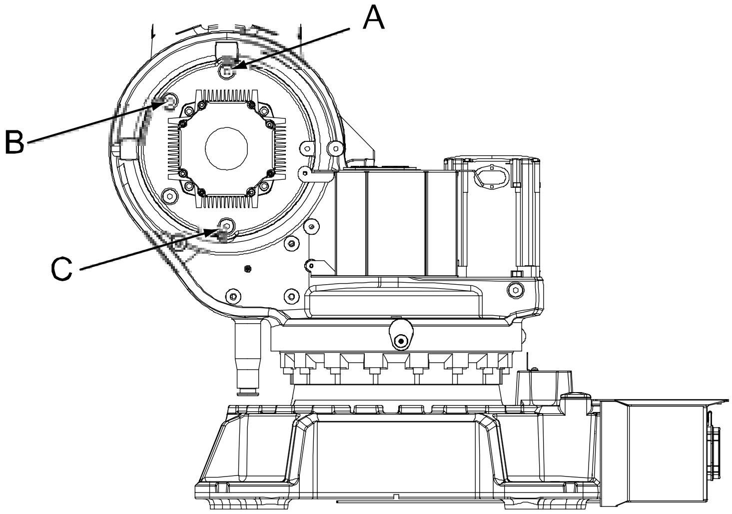
	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
4	Open the *oil plug, inspection*.	Shown in figure *Location of gearbox on page 132*.
5	Measure the oil level. Required oil level: max. 5 mm below the oil plug hole. Required oil level for tilted robots: 15-20 mm below the oil plug hole.	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
6	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type of lubrication in gearboxes on page 161*. Further information about how to fill with oil is found in section *Changing oil, axis-1 gearbox on page 163*.
7	Refit the oil plug.	Tightening torque:24 Nm

3.3.2 Inspecting the oil level in axis-2 gearbox

Location of gearbox on floor mounted robot

The axis-2 gearbox is located in the lower arm rotational center, underneath the motor attachment.

The following figure shows the robot mounted on the floor.



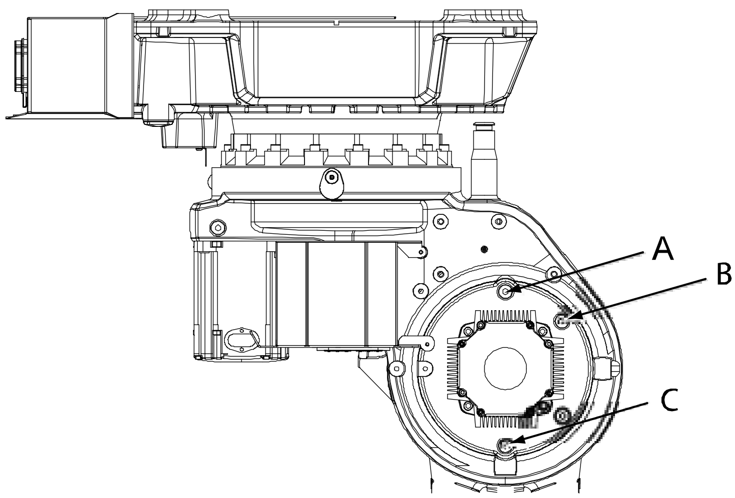
xx0600002959

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

Location of gearbox on suspended mounted robot

The following figure shows suspended mounted robot.

The gearbox, axis 2, is located in the lower arm rotational center, underneath the motor attachment.



xx0600002960

Continues on next page

A	Oil plug, filling
B	Oil plug, inspection
C	Oil plug, draining

Required equipment

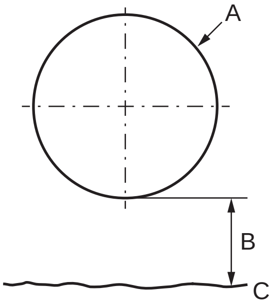
Equipment, etc.,	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	**Note!** Do not mix with other oils!
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting the oil level in axis-2 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
4	Open the *oil plug, filling and inspection*.	Shown in the figure *Location of gearbox on floor mounted robot on page 134*.

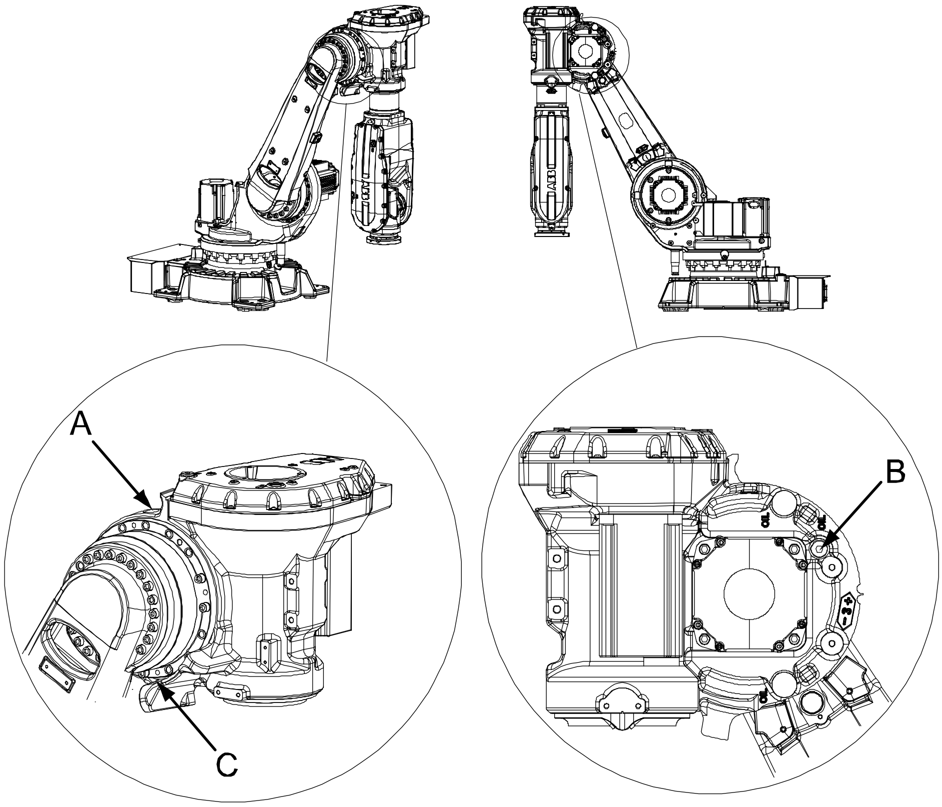
Continues on next page

	Action	Note
5	Measure the oil level. Required oil level: max. 5 mm below the inspection oil plug hole. Required oil level for tilted robots: 40-45 mm below the oil plug filling hole. Note! Not the oil plug inspection hole.	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
6	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*. Filling of oil is detailed further in the section *Filling, oil on page 167*.
7	Refit the oil plug.	Tightening torque: 24 Nm.

3.3.3 Inspecting the oil level in axis-3 gearbox

Location of gearbox

The axis 3 gearbox is located in the upper arm rotational center as shown in the figure.



xx0600002961

A	Oil plug, filling
B	Oil plug, inspection
C	Oil plug, draining

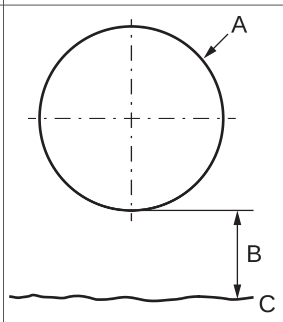
Required equipment

Equipment, etc.	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	**Note!** Do not mix with other oils!
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
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

Inspecting the oil level in axis-3 gearbox

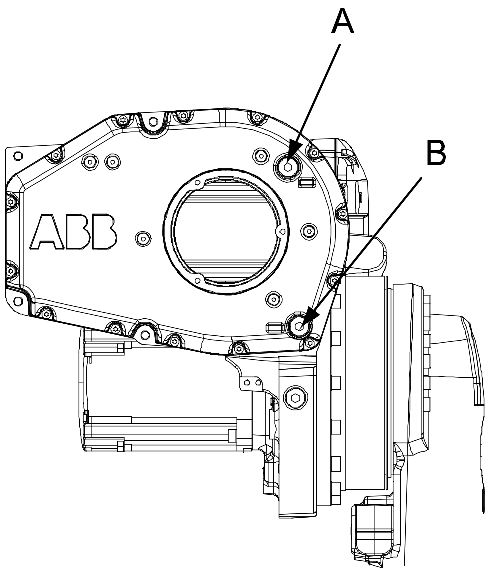
Use this procedure to inspect the oil level in the axis-3 gearbox.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
2	Move the robot to a position according to the illustration in *Location of gearbox on page 137*.	Detailed in the section *Synchronization marks and synchronization position for axes on page 320*.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
5	Open the *oil plug, inspection*.	Shown in the figure *Location of gearbox on page 137*.
6	Measure the oil level. Required oil level: max. 5 mm below the inspection oil plug hole.	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
7	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*. Further information about how to fill the oil may be found in the section *Filling, oil on page 171*.
8	Refit the oil plug.	Tightening torque:24 Nm

3.3.4 Inspecting the oil level in axis-4 gearbox

Location of gearbox

The axis-4 gearbox is located in the rear part of the upper arm as shown in the figure.



xx0600002962

A	Oil plug, filling and inspection
B	Oil plug, draining

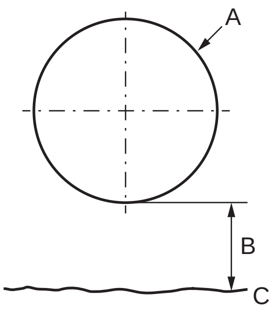
Required equipment

Equipment, etc.	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
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

Inspecting the oil level in axis-4 gearbox

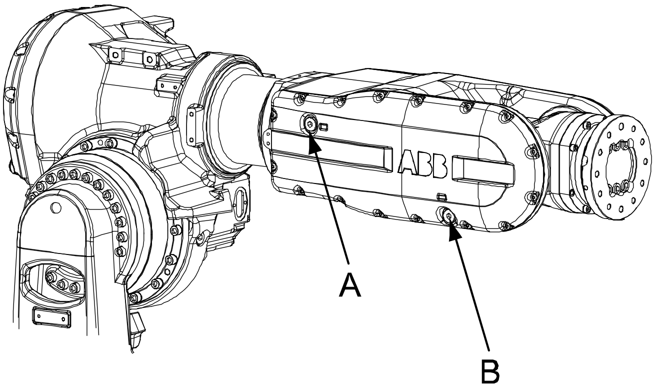
Use this procedure to inspect the oil level in the axis-4 gearbox.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
2	Move the robot to the calibration position.	This is detailed in section *Synchronization marks and synchronization position for axes on page 320*.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
5	Open the *oil plug, filling and inspection*.	Shown in the figure *Location of gearbox on page 139*.
6	Measure the oil level. Required oil level: 0-10 mm	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
7	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*. Further information about how to fill the oil may be found in the section *Filling, oil on page 173*.
8	Refit the oil plug.	Tightening torque:24 Nm

3.3.5 Inspecting the oil level in axis-5 gearbox

Location of gearbox

The axis-5 gearbox is located in the wrist unit as shown in the figure.



xx0600002963

A	Oil plug, filling and inspection
B	Oil plug, draining

Required equipment

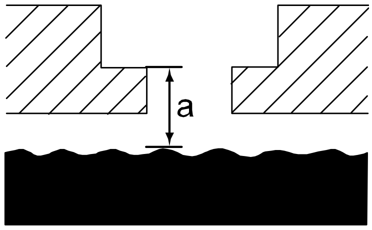
Equipment etc.	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting the oil level in axis-5 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
2	Move the robot upper arm to a horizontal position.	
3	Turn the wrist unit in a way that both oil plugs are facing upwards.	

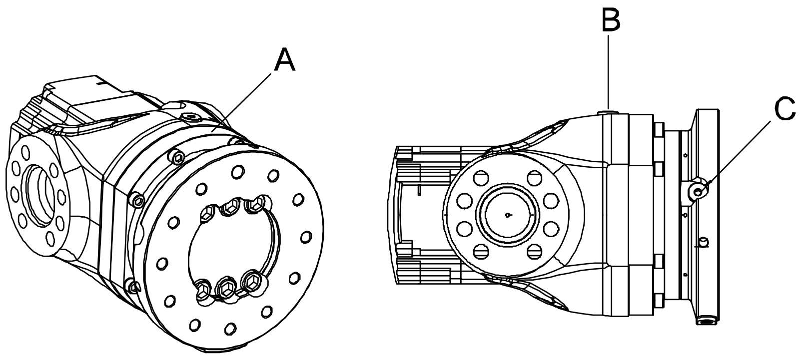
Continues on next page

	Action	Note
4	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
5	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
6	Open the *oil plug, filling and inspection*.	Shown in the figure *Location of gearbox on page 141*.
7	Measure the oil level. Required oil level to the upper edge of the filling and inspection oil plug hole (a): 10 mm	 xx0500002222
8	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*. Further information about how to fill the oil may be found in the section *Filling, oil, axis 5 on page 176*.
9	Refit the oil plug.	Tightening torque:24 Nm

3.3.6 Inspecting the oil level in axis-6 gearbox

Location of gearbox

The axis-6 gearbox is located in the wrist unit as shown in this figure.



xx0600002964

	Type 1
A	Axis-6 gearbox
B	Oil plug, filling and inspection
C	Oil plug, draining

Required equipment

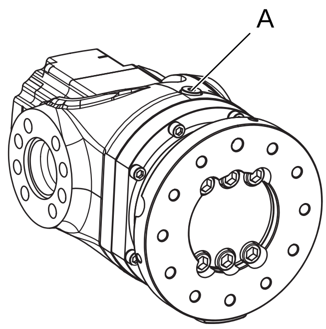
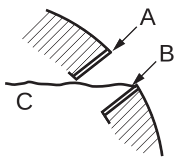
Equipment	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting the oil level in axis-6 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
2	Move axes 3 and 5 to a horizontal position, and make sure that the *oil plug, filling and inspection* is facing upwards.	

Continues on next page

	Action	Note
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
5	Open the *oil plug, filling and inspection*.	 xx1300000244
6	Turn axis 6 so that the *oil plug, draining* faces upwards.	
7	Open the *oil plug, draining*.	This is a precaution to avoid vacuum effects by allowing air to enter at the top of the gearbox. **Note** If equipment that covers the *oil plug, draining* is fitted on the robot so that the oil plug cannot be opened, then this step can be skipped.
8	Slowly turn axis 4, while adjusting axis 6 so that the oil plug, draining always faces upwards. Turn axis 4 until the axis-4 angle reads -45° to -55°.	
9	Inspect the oil level in the hole for the *oil plug, filling and inspection*. The oil should reach all the way up to the external edge of the thread for the *oil plug, filling and inspection*. **Note** If the *oil plug, draining* is not opened, then use a clean, narrow object, for example an oil stick or a cable tie, to gently poke the oil surface. This will avoid surface tension from stopping air to enter into the gearbox.	 xx1400002786 A Oil plug hole B Required oil level C Gearbox oil

Continues on next page

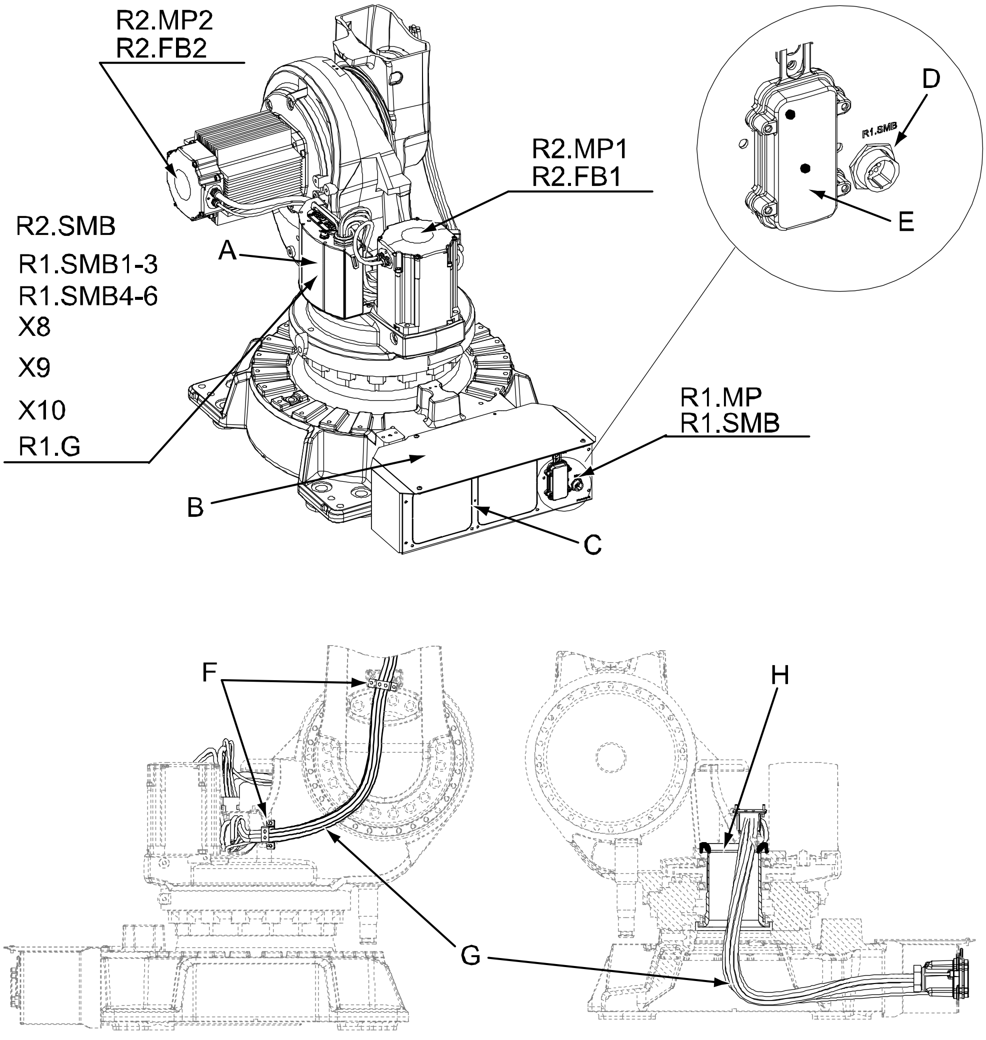
	Action	Note
10	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*. Further information about how to fill the oil may be found in the section .
11	Refit the oil plugs.	Tightening torque: 24 Nm.
12	**WARNING** Do not mix oil types! If wrong oil is refilled, the gearbox must be rinsed as detailed in *Technical reference manual - Lubrication in gearboxes*.	

3.3.7 Inspecting, cable harness

Location of cable harness, axes 1-6

The axes-1-6 cable harness is shown below.

The figure shows the lower routing of the cable harness.

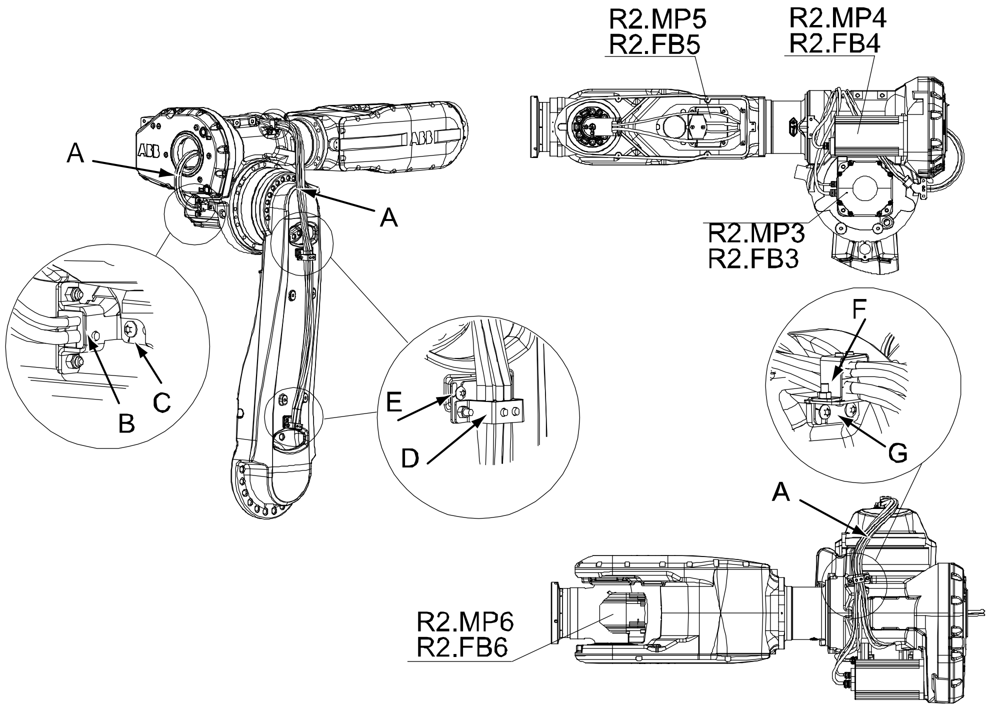


xx0600002970

A	SMB/BU box
B	Top cover, connection box
C	Connection plate, base
D	Connector R1.SMB
E	Connector R1.MP
F	Metal clamps
G	Cable harness
H	Cable guide (cut away view)

Continues on next page

The figure shows the upper routing of the cable harness.



xx0600003078

A	Cable harness
B	Metal clamp, at gearbox axis 3
C	Attachment screws, metal clamp at gearbox axis 3, M6x16 quality 8.8 (2 pcs)
D	Metal clamp, lower arm (2 pcs)
E	Attachment screws, metal clamp lower arm, M6x16 quality 8.8 (2+2 pcs)
F	Metal clamp, armhouse
G	Attachment screws, metal clamp armhouse, M6x16 quality 8.8 (2 pcs)

Required equipment

Visual inspection, no tools are needed.

Inspecting cable harness, axes 1-6

Use this procedure to inspect cable harness of axes 1-6.

	Action	Note
1	 **DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

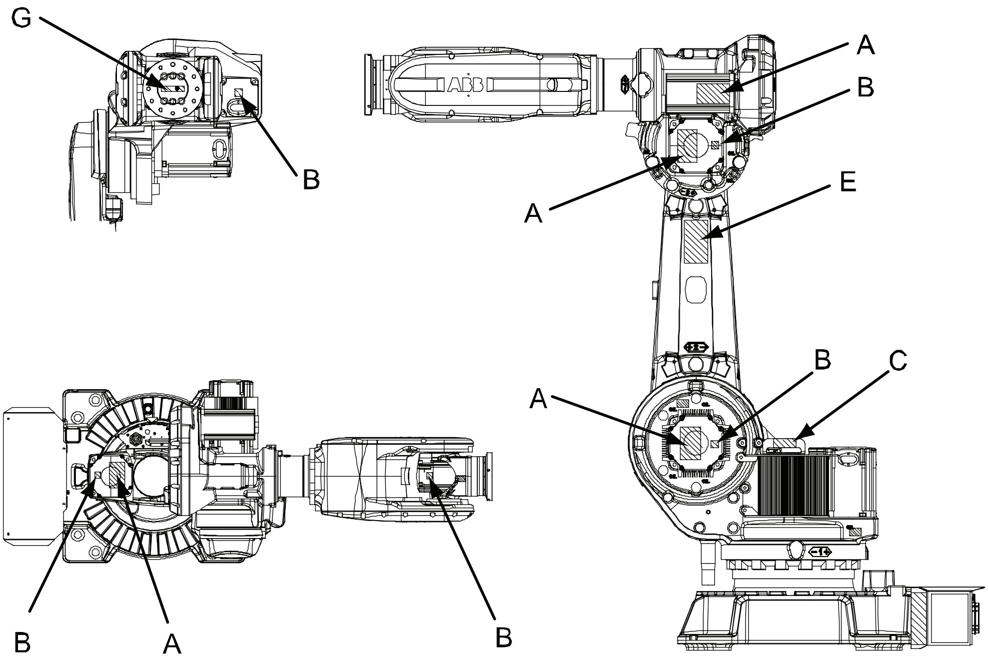
Continues on next page

	Action	Note
2	Make an overall inspection of the cable harness in order to detect wear and damage.	
3	Check the *connectors at the base*.	Shown in figure *Location of cable harness, axes 1-6 on page 146*
4	Check the cables.	Shown in figure *Location of cable harness, axes 1-6 on page 146*
5	Check the *metal clamps* on the robot.	Shown in figure *Location of cable harness, axes 1-6 on page 146*
6	Replace the cable harness if wear or damage is detected!	Detailed in section: *Replacement of cable harness, lower end (axes 1-2) on page 195* *Replacement of cable harness, upper end on page 202*

3.3.8 Inspecting the information labels

Location of labels

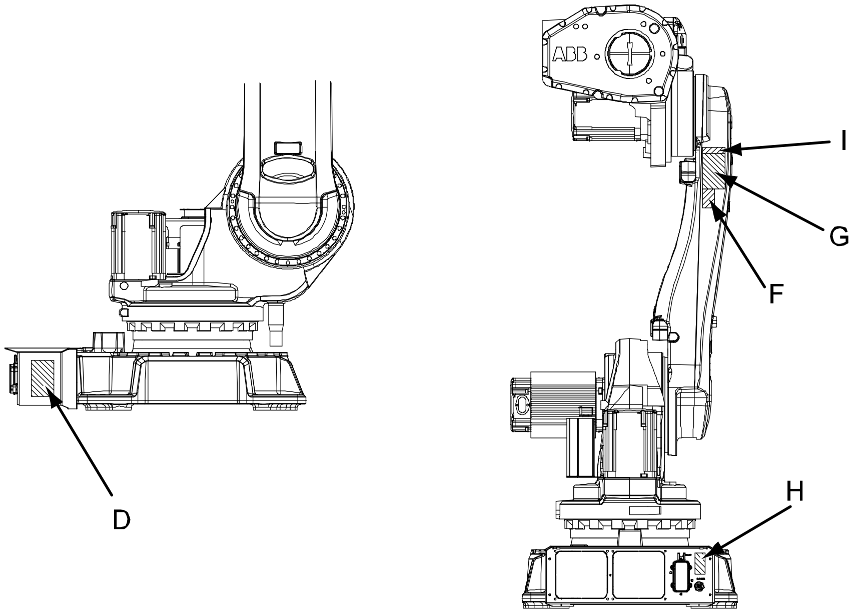
These figures show the location of the information labels to be inspected. The symbols are described in section *Safety symbols on product labels on page 44*.



xx0600002980

A	Warning label concerning high temperature (4 pcs)
B	Warning sign, symbol of a flash (located on motor cover) (5 pcs)
C	Warning label concerning brake release
E	Instruction label concerning lifting
G	Serial no. from rating label

Continues on next page



xx0600002981

D	Warning label concerning risk of tipping
F	Label for calibration
G	Serial no. from rating label
H	UL-label
I	AbsAcc information sign

Required tools and equipment

Visual inspection, no tools are required.

Inspecting, labels

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Inspect the labels, located as shown in the figures.	
3	Replace any missing or damaged labels.	Article numbers for the labels and plate set is specified in *Spare part lists on page 359*.

3.3.9 Inspecting the axis-1 mechanical stop pin

WARNING

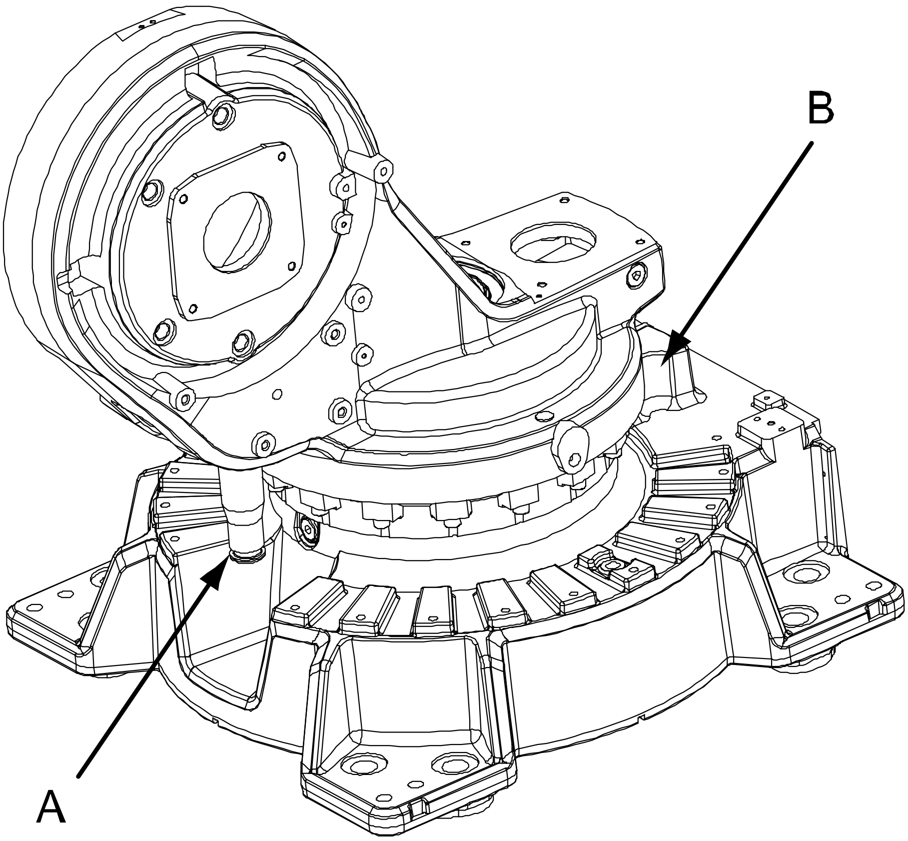
Mechanical stop pin can not be fitted onto robot if option 810-1 *Electronic Position Switch* is used.

WARNING

Mechanical stop pin can not be fitted onto robot if option 561-1 *Extended work range axis 1* is used.

Location of mechanical stop pin

The axis-1 mechanical stop is located at the base as shown in the figure.



xx0600002972

A	Mechanical stop pin, axis 1
B	Fixed mechanical stop

Required equipment

Visual inspection, no tools are required.

Continues on next page

Inspecting, mechanical stop pin

Use this procedure to inspect the axis-1 mechanical stop pin.

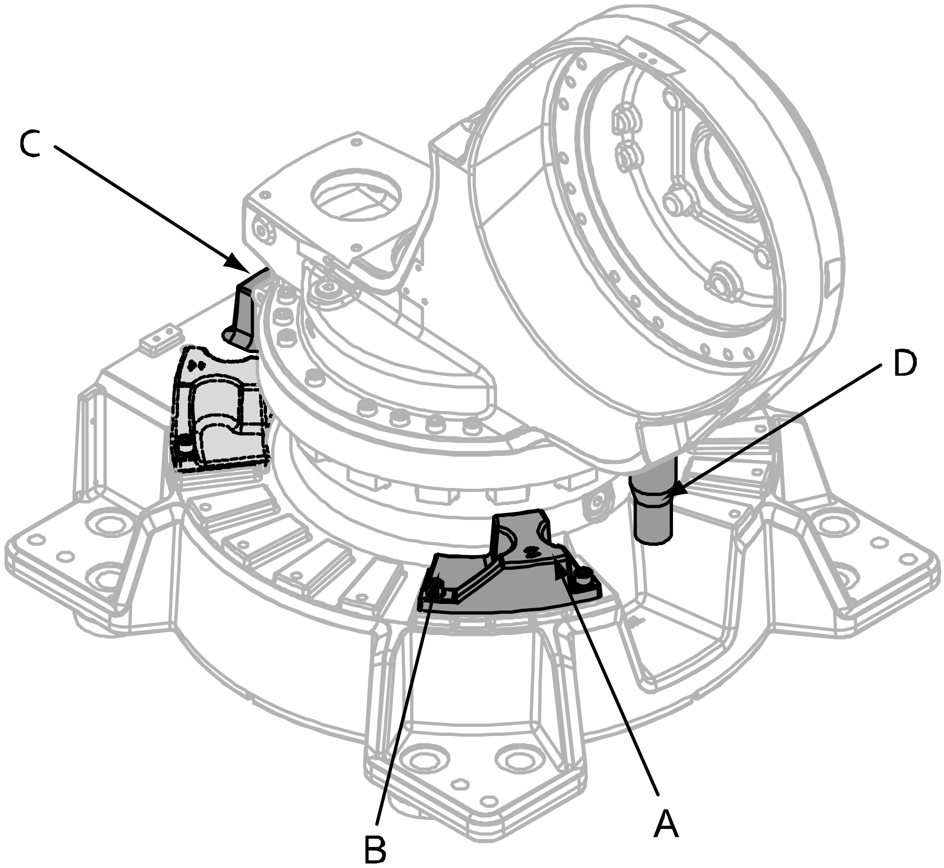
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Inspect the axis-1 mechanical stop pin. If the mechanical stop pin is bent or damaged, it must be replaced! **Note** The expected life of gearboxes can be reduced as a result of collisions with the mechanical stop.	Shown in figure *Location of mechanical stop pin on page 151*.

3.3.10 Inspecting the additional mechanical stops

Location of mechanical stops

The figure shows the location of the additional mechanical stops on axes 1 and 3.

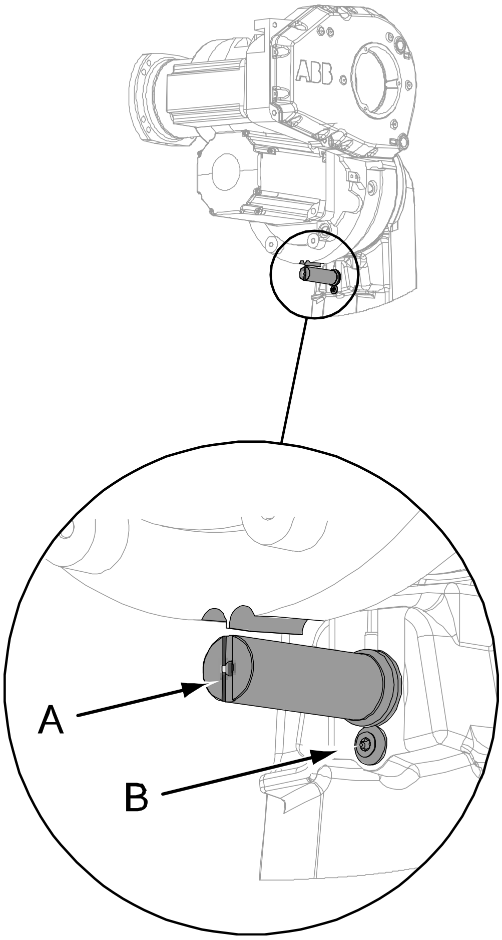
Additional mechanical stops are not provided for axis 2.



xx0600002938

A	Additional stop, axis 1
B	Attachment screws and washers (2 pcs)
C	Fixed stop
D	Mechanical stop pin, axis 1

Continues on next page



xx0600002973

A	Mechanical stop pin, axis 3
B	Attachment screw and washer

Required equipment

Equipment etc.	Article number	Note
Mechanical stop set, axis 1	3HAC025204-003	Includes: • Stop +15°/-7.5° • Stop +7.5°/-15° • Attachment screws plus washers • Document for movable mechanical stop
Mechanical stop set, axis 3	3HAC025290-003	Includes: • Mechanical stop pin • Attachment screw and washer • Document for mechanical stop pin
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.

Continues on next page

Inspecting, mechanical stops

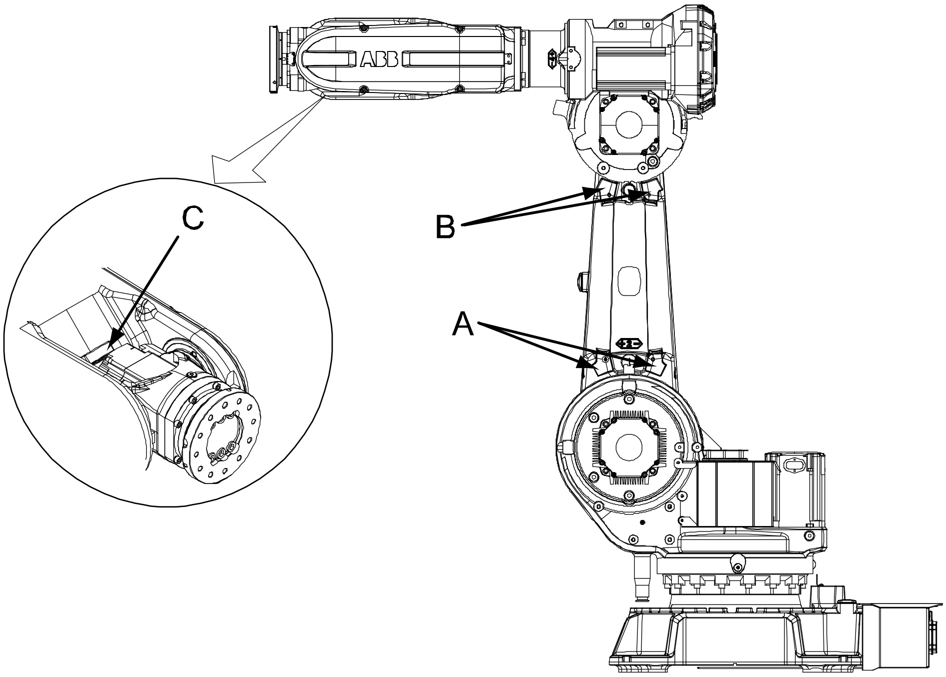
Use this procedure to inspect the additional mechanical stops.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Make sure no additional stops are damaged.	Shown in figure *Location of mechanical stops on page 153*.
3	Make sure the stops are properly attached. Correct tightening torque, additional mechanical stops: • Axis 1 = 120 Nm • Axes 2 and 3 = 115 Nm	
4	If any damage is detected, the mechanical stops must be replaced! Correct attachment screws: • Axis 1: M12 x 40, quality 12.9. • Axis 3: M6 x 16	Article number is specified in *Required equipment on page 154*.

3.3.11 Inspecting the damper on axes 2-5

Location of dampers

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



xx0600002976

A	Damper axis 2
B	Damper axis 3
C	Damper axis 5

Required equipment

A damper must be replaced if damaged!

Equipment	Spare part/ art. no.	Note
Damper axes 2-3	3HAC12320-1	
Damper axis 5	3HAC024541-001	
Standard toolkit	3HAC15571-1	Content is defined in section *Standard tools on page 354*.

Continues on next page

Inspection, dampers

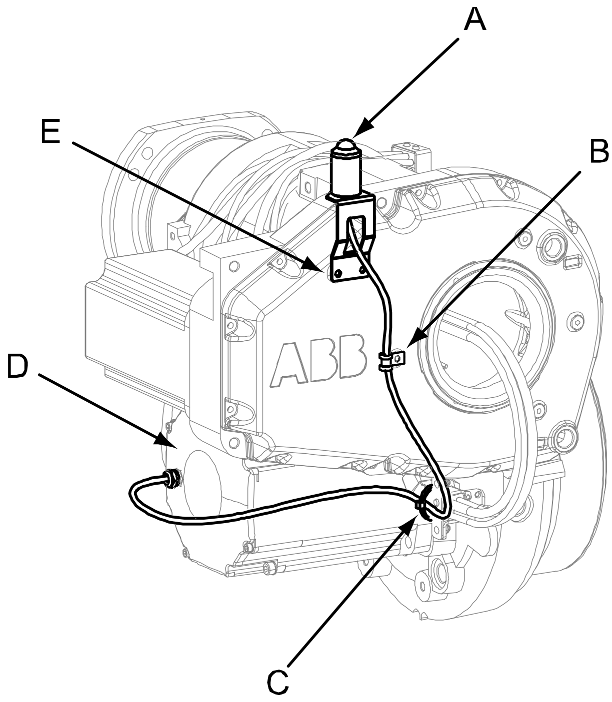
The procedure below details how to inspect the dampers, axes 2-5.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Check all *dampers* for damage, and for cracks or existing impressions larger than 1 mm.	Shown in the figure *Location of dampers on page 156*.
3	Check attachment screws for deformation.	
4	If any damage is detected, the damper must be replaced with a new one!	Art. no. is specified in *Required equipment on page 156*.

3.3.12 Inspecting, signal lamp

Location of signal lamp

The signal lamp is located as shown in this figure.



xx0600003071

A	UL signal lamp
B	Clamp
C	Cable strap, outdoor
D	Motor, axis 3
E	Attachment screw, M6x8 quality 8-A2F(2 pcs)

Required equipment

Equipment, etc.	Art. no.	Note
Signal lamp	3HAC10830-1	To be replaced in case of detected damage.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
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

Inspecting, signal lamp

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

	Action	Note
1	Check that signal lamp is lit when motors are put in operation ("MOTORS ON").	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	If the lamp is not lit, trace the fault by: • Checking whether the *signal lamp* is broken. If so, replace it. • Checking cable connections. • Measuring the voltage in connectors motor axis 3 (=24V). • Checking the cabling. Replace cabling if a fault is detected.	Art. no. is specified in *Required equipment on page 158*.

3.3.13 Inspection of air hoses (Foundry Prime)

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
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 Replacement/changing activities

3.4.1 Type of lubrication in gearboxes

Introduction

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

Type and amount of oil in gearboxes

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

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

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

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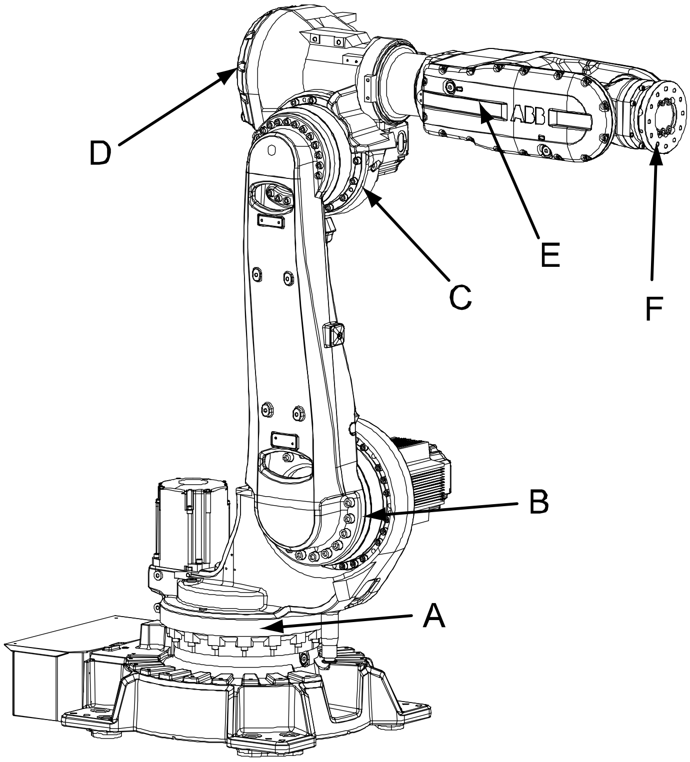
Location of gearboxes

The figure shows the location of the gearboxes.



xx0600002977

A	Gearbox, axis 1
B	Gearbox, axis 2
C	Gearbox, axis 3
D	Gearbox, axis 4
E	Gearbox, axis 5
F	Gearbox, axis 6

Equipment

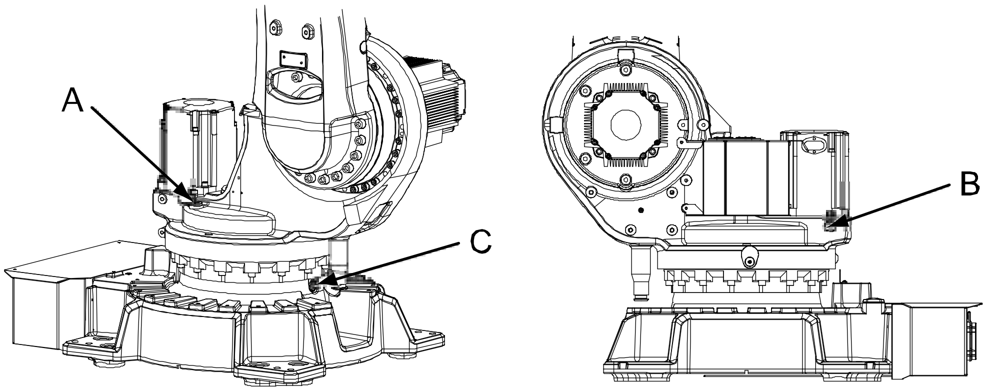
Equipment	Note
Oil dispenser	Includes pump with outlet pipe. Use the suggested dispenser or a similar one: • Orion OriCan art. no. 22590 (pneumatic)
Nipple for quick connect fitting, with o-ring	

3.4.2 Changing oil, axis-1 gearbox

Location of oil plugs

The axis-1 gearbox is located between the frame and base. See oil plugs in the following figure.

falseThe oil is drained through a hose, which is located at the rear of the robot base.



xx0600002958

A	Oil plug, filling
B	Oil plug, inspection
C	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	See *Type and amount of oil in gearboxes on page 161*.	**Note** Do not mix with other oils!
Oil collecting vessel	-		Capacity: 8,000 ml.
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 355*.
Standard toolkit	-		Content is defined in section *Standard tools on page 354*.

Continues on next page

Draining oil, axis-1 gearbox

Use this procedure to drain the oil in gearbox axis 1.

When using oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 163*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	If the robot is suspended: lift down the robot from its inverted position and secure it on the floor.	
4	Collect drained oil in an oil vessel.	Vessel capacity is specified in *Required equipment on page 163*.
5	Remove *oil plug, filling* in order to drain oil quicker!	Shown in figure *Location of oil plugs on page 163*.
6	Open the oil plug for draining and drain the oil into a vessel. **CAUTION** Drain as much oil as possible. See *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	**Note** Draining is time-consuming. Elapsed time depends on the temperature of the oil.
7	Refit the *oil plug, draining*.	

Continues on next page

Filling oil, axis-1 gearbox

Use this procedure to fill gearbox axis 1 with oil.

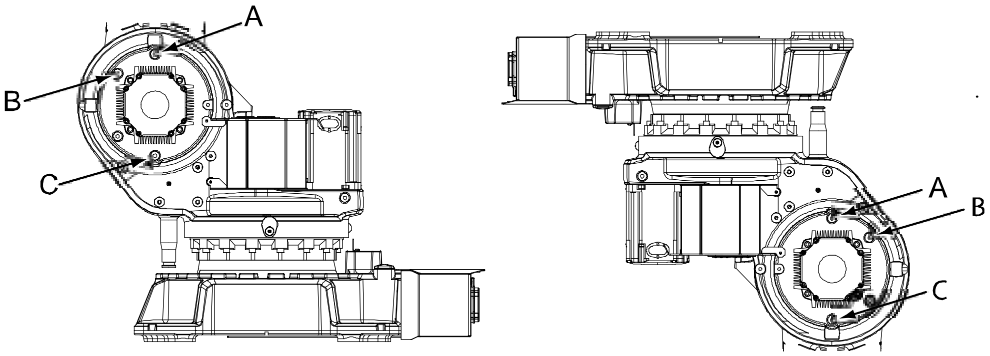
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	Open the *oil plug, filling.*	Shown in figure *Location of oil plugs on page 163*.
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-1 gearbox on page 132*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*.
5	**Note** Do not mix Kyodo Yushi TMO 150 with other oil types!	
6	Refit the oil plug, filling.	Tightening torque: 24 Nm.

3.4.3 Changing oil, axis-2 gearbox

Location of oil plugs

The axis-2 gearbox is located in the lower arm rotational center, underneath the motor attachment.

The figure shows both floor and suspended mounted robot. **Note** that the holes are used differently depending on how the robot is mounted!



xx0600002983

A	Oil plug, filling
B	Oil plug, inspection
C	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	See *Type and amount of oil in gearboxes on page 161*.	**Note!** Do not mix with other oil types!
Oil collecting vessel	-		Capacity: 5,000 ml.
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 355*.
Standard toolkit	-		Content is defined in section *Standard tools on page 354*.

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Draining, oil

The procedure below details how to drain the oil in gearbox axis 2.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 166*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	Remove the *oil plug, draining,* and drain the gearbox oil using a hose with nipple and an oil collecting vessel. **CAUTION** Drain as much oil as possible. See *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	Shown in the figure *Location of oil plugs on page 166*. Vessel capacity is specified in *Required equipment on page 166*. **Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
4	Refit the oil plug.	Tightening torque: 24 Nm.

Filling, oil

Use this procedure to fill oil into the axis-2 gearbox.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 166*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	

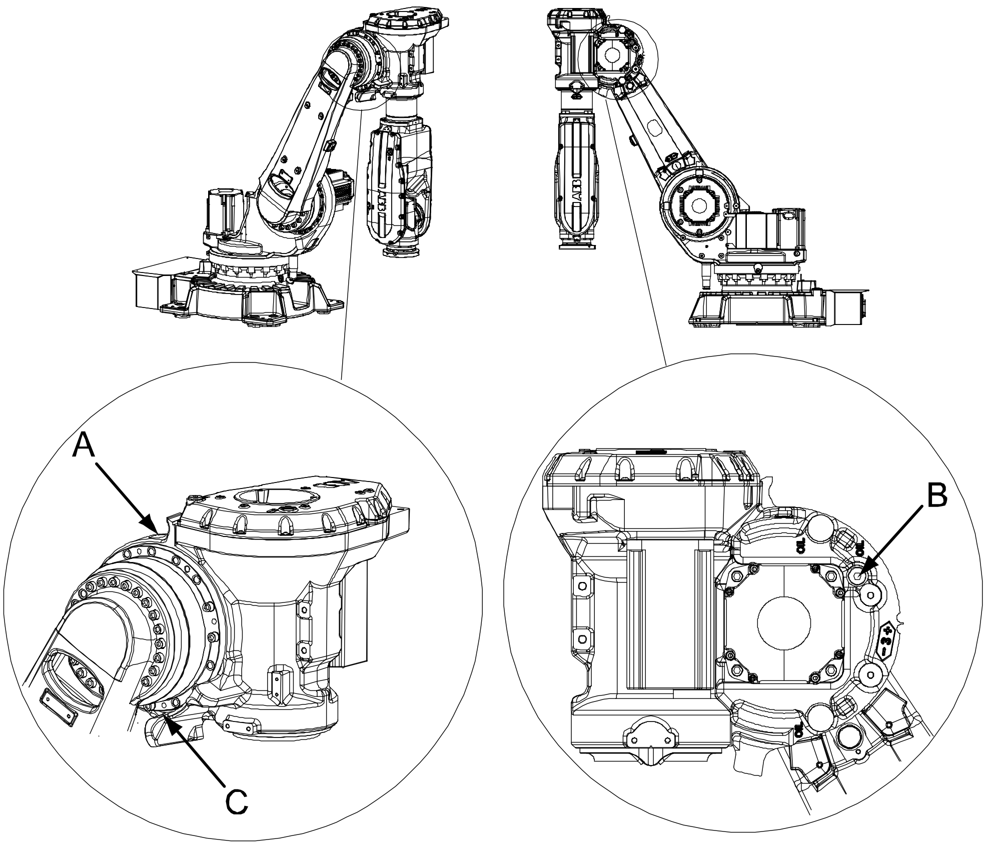
Continues on next page

	Action	Note
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	Remove the *oil plug for filling* and the *oil plug for inspection*.	Shown in the figure *Location of oil plugs on page 166*.
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-2 gearbox on page 134*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*.
5	**Note** Don´t mix Kyodo Yushi TMO 150 with other oil types!	
6	Refit the oil plug.	Tightening torque: 24 Nm.

3.4.4 Changing oil, axis-3 gearbox

Location of gearbox

The axis-3 gearbox is located in the upper arm rotational center as shown in the following figure.



xx0600002961

A	Oil plug, filling
B	Oil plug, inspection
C	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	See *Type and amount of oil in gear-boxes on page 161*.	**Note!** Do not mix with other oil types!
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 355*.
Oil collecting vessel	-		Capacity: 3,000 ml.
Standard toolkit	-		Content is defined in section *Standard tools on page 354*.

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Draining, oil

The procedure below details how to drain oil from the gearbox, axis 3.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 169*.

	Action	Note
1	Move the upper arm of the robot to the position where the wrist is pointing towards the floor.	This is done in order to drain all oil from the gearbox axis 3.
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
4	Remove the *oil plug, filling*.	
5	Remove the *oil plug, draining,* and drain the gearbox oil using a hose with nipple and an oil collecting vessel. **CAUTION** Drain as much oil as possible. See *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	Shown in the figure *Location of gearbox on page 169*. Vessel capacity is specified in *Required equipment on page 169*. **Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
6	Refit the oil plug.	Tightening torque: 24 Nm.

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Filling, oil

The procedure below details how to fill oil into the gearbox, axis 3.

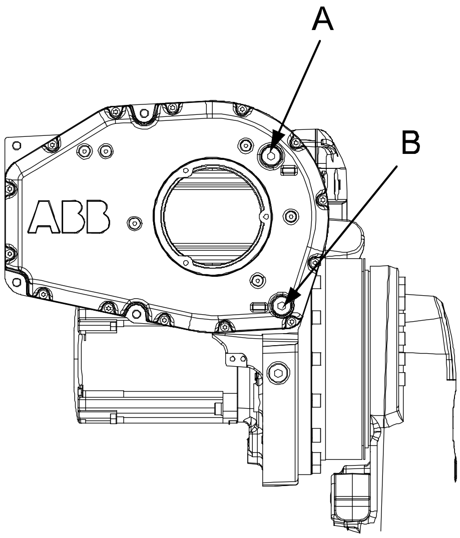
When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 169*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	Remove the *oil plug, filling.*	Shown in the figure *Location of gearbox on page 169*.
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-3 gearbox on page 137*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*.
5	**Note** Do not mix Kyodo Yushi TMO 150 with other oil types!	
6	Refit the oil plug.	Tightening torque: 24 Nm.

3.4.5 Changing oil, axis-4 gearbox

Location of gearbox

The axis 4 gearbox is located in the rearmost part of the upper arm as shown in the figure below.



xx0600002962

A	Oil plug, filling / inspection
B	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	See *Type and amount of oil in gear-boxes on page 161*.	
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 355*.
Oil collecting vessel	-		Capacity: 6,000 ml.
Standard toolkit	-		Content is defined in section *Standard tools on page 354*.

Draining, oil

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 172*.

	Action	Note
1	Run the upper arm -45° from the calibration position.	

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
4	Remove the *oil plug, filling*.	
5	Drain the oil from the gearbox into a vessel by opening the *oil plug, draining.*	Shown in the figure *Location of gearbox on page 172*. Vessel capacity is specified in *Required equipment on page 172*.
6	Run the upper arm back to its calibration position (horizontal position).	This is detailed in section *Synchronization marks and synchronization position for axes on page 320*.
7	Refit the oil plug, draining.	Tightening torque: 24 Nm.

Filling, oil

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 172*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	

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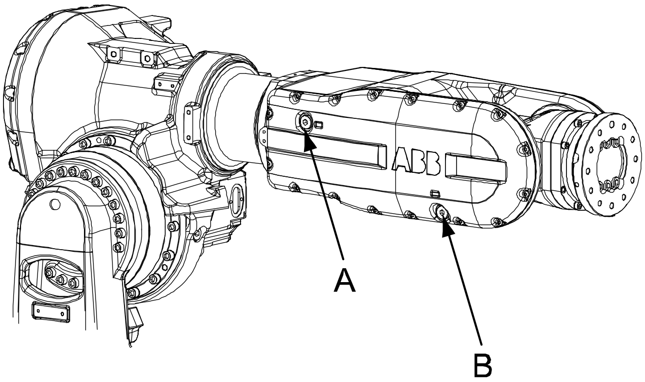
	Action	Note
3	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-4 gearbox on page 139*.	Shown in the figure *Location of gearbox on page 172*. Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*.
4	Refit the oil plug, filling.	Tightening torque: 24 Nm.

3.4.6 Changing oil, axis-5 gearbox

Location of gearbox

The axis 5 gearbox is located in the wrist unit as shown in the figure below.



xx0600002963

A	Oil plug, filling/inspection
B	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	See *Type and amount of oil in gearboxes on page 161*.	
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 355*.
Oil collecting vessel	-		Capacity: 4,000 ml.
Standard toolkit	-		Content is defined in section *Standard tools on page 354*.

Draining, oil, axis 5

The procedure below details how to change the oil in gearbox, axis 5.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 175*.

	Action	Note
1	Move the robot to its calibration position.	This puts the oil plug draing in the right position.

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
4	Remove the *oil plug, filling*.	
5	Drain the oil from the gearbox by opening the *oil plug, draining.*	Shown in the figure *Location of gearbox on page 175*. Vessel capacity is specified in *Required equipment on page 175*.
6	Refit the oil plug, draining.	Tightening torque: 24 Nm.

Filling, oil, axis 5

The procedure below details how to change the oil in gearbox, axis 5.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 175*.

	Action	Note
1	Run axis 4 to a position where the oil plug, filling, is facing upwards.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	

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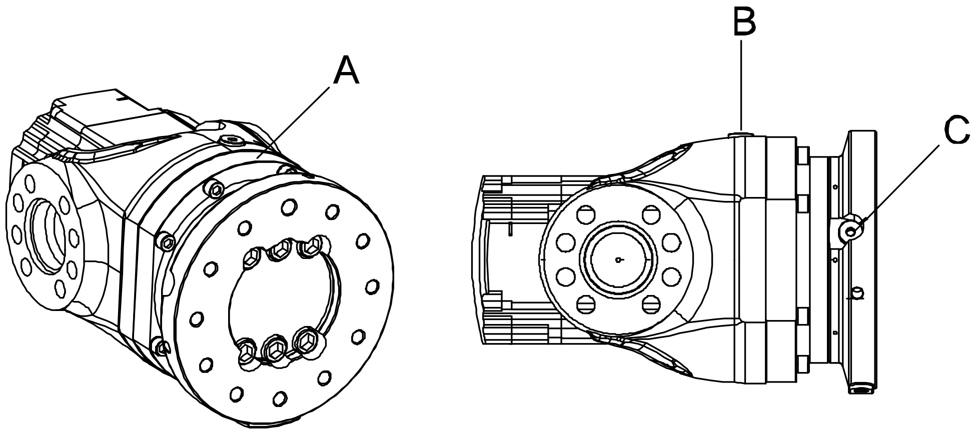
	Action	Note
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-5 gearbox on page 141*.	Shown in the figure *Location of gearbox on page 175*. Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*.
5	Refit the oil plug, filling.	Tightening torque: 24 Nm.

3.4.7 Changing oil, axis-6 gearbox

Location of gearbox

The axis 6 gearbox is located in the center of the wrist unit as shown in the figure below.

The figure shows gearbox axis 6 for IRB 6620 Foundry Plus.



xx0600002964

A	Gearbox axis 6
B	Oil plug, filling
C	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 161*.	See *Type and amount of oil in gearboxes on page 161*.	**Note** Do not mix with other oils!
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 355*.
Oil collecting vessel	-		Vessel capacity: 500 ml
Standard toolkit	-		Content is defined in section *Standard tools on page 354*.

Draining, oil, axis 6

The procedure below details how to drain oil from the gearbox, axis 6.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 178*.

	Action	Note
1	Run the robot to a position where the *oil plug, filling* of axis 6 gearbox is facing downwards.	Shown in the figure *Location of gearbox on page 178*.

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
4	Drain the oil from the gearbox into a vessel by removing the oil plug.	Vessel capacity is specified in *Required equipment on page 178*.
5	Refit the *oil plug, filling*.	Tightening torque: 24 Nm.

Filling, oil, axis 6

The procedure below details how to fill oil into the gearbox, axis 6.

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 178*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks. Before proceeding, please read the safety information in the section *WARNING - Safety risks during work with gearbox lubricants (oil or grease) on page 56*.	
3	Remove the *oil plug, filling.*	Shown in the figure *Location of gearbox on page 178*.
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-6 gearbox on page 143*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 161*.

Continues on next page

	Action	Note
5	**Note** Do not mix Kyodo Yushi TMO 150 with other oil types!	Detailed in the section *Type of lubrication in gearboxes on page 161*.
6	Refit the oil plug.	Tightening torque: 24 Nm.
	Inspect the oil level.	Detailed in the section *Inspecting the oil level in axis-6 gearbox on page 143*.

3.4.8 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.

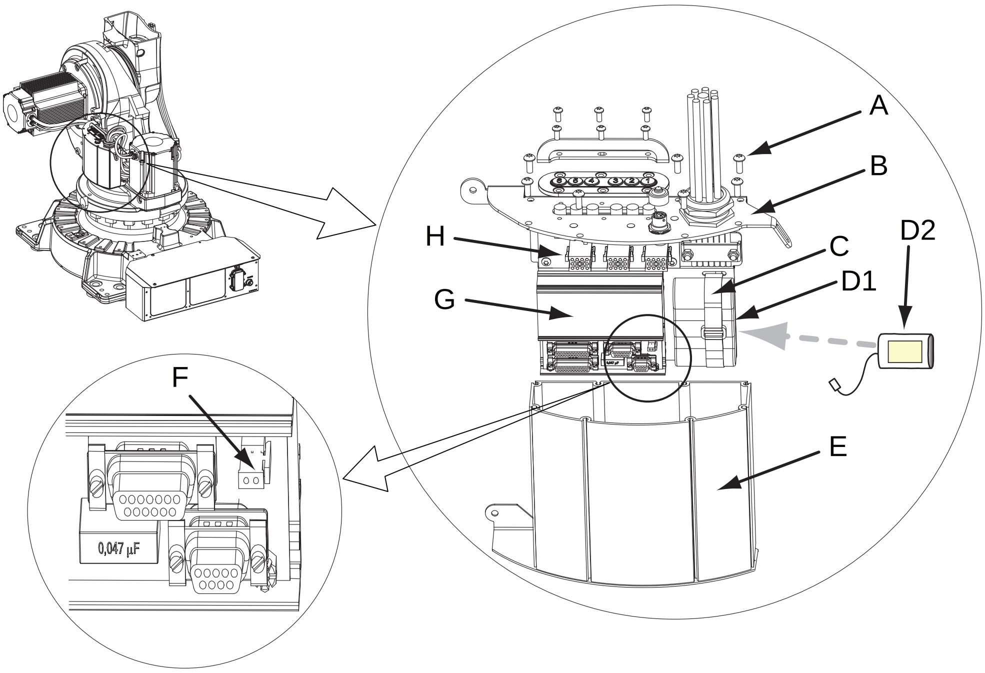
For an SMB board with 2-pole battery contact, the typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended for longer production breaks with a battery shutdown service routine. See *Operating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

WARNING

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

Location of SMB battery

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



xx0600002982

A	Attachment screws
B	SMB/BU unit (complete)

Continues on next page

C	Velcro strap
D1	Battery pack (2-pole battery contact)
D2	Battery pack (3-pole battery contact)
E	SMB/BU box
F	Connection point, battery cable
G	SMB (Serial measurement board)
H	BU unit (Brake release unit)

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!

Equipment, etc.	Spare part no.	Note
Battery pack	For spare part no. see: • *Spare part lists on page 359*	Battery includes protection circuits. Only replace with a specified spare part or an ABB-approved equivalent.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
Circuit diagram	-	See chapter *Circuit diagram on page 361*.

Removing, battery

Use this procedure to remove the SMB battery.

	Action	Note
1	Move the robot to its calibration position.	This is done in order to facilitate updating of the revolution counter.
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

Continues on next page

	Action	Note
3	 xx0200000023 **WARNING** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *WARNING - The unit is sensitive to ESD! on page 54*	
4	Remove SMB/BU box by unscrewing the attachment screws.	
5	Lift the *SMB/BU unit* out of its box and disconnect the battery cable.	
6	Remove the velcro strap that holds the battery.	
7	Remove the *SMB battery.* Battery includes protection circuits. Only replace with a specified spare part or with an ABB- approved equivalent.	Shown in figure *Location of SMB battery on page 181*.

Refitting, battery

Use this procedure to refit the SMB battery.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	 xx0200000023 **WARNING** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *WARNING - The unit is sensitive to ESD! on page 54*	
3	Reconnect the battery cable to the SMB battery pack and secure it with the *velcro strap*.	Art. no. is specified in *Required equipment on page 182*. Shown in figure *Location of SMB battery on page 181*.
4	Put the *SMB/BU unit* back into the box and secure it with its *attachment screws*.	Shown in figure *Location of SMB battery on page 181*.

Continues on next page

	Action	Note
5	Update the revolution counter.	Detailed in chapter Calibration - section *Updating revolution counters on page 323*.
6	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

3.5 Cleaning activities

3.5.1 Cleaning the IRB 6620

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 6620 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 6620.

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 132*.
2. Write down the oil level.
3. Inspect the oil level again after, for example, 6 months.
4. If the oil level is decreased then replace the gearbox.

Oil spills discolors painted surfaces

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

Note

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

Dos and don'ts!

This section specifies some special considerations when cleaning the robot.

Always!

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

Continues on next page

Never!

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

Cleaning methods

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

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

i Perform according to section *Cleaning with water and steam on page 186*.

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 186* for exceptions.

2 See *Cleaning methods on page 186* 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

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.

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes all repair activities recommended for the IRB 6620 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 6620.

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 347*.

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 6620 is connected to power, always make sure that the IRB 6620 is connected to earth before starting any repair work.

For more information see:

- *Product manual - IRC5*

4.2 General procedures

4.2.1 Performing a leak-down test

When to perform a leak-down test

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

Required equipment

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

Performing a leak-down test

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

4.2.2 Mounting instructions for bearings

General

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

Equipment

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

Assembly of all bearings

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

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

Assembly of tapered bearings

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

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

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

Greasing of bearings

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

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

Continues on next page

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

Grease the different types of bearings as following description:

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

4.2.3 Mounting instructions for seals

General

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

Equipment

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

Rotating seals

The procedure below describes how to fit rotating seals.

CAUTION

Please observe the following before commencing any assembly of seals:

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

	Action	Note
1	Check the seal to ensure that: • The seal is of the correct type (provided with cutting edge). • There is no damage to the sealing edge (feel with a fingernail).	
2	Inspect the sealing surface before mounting. If scratches or damage are found, the seal must be replaced since it may result in future leakage.	
3	Lubricate the seal with grease just before fitting. (Not too early - there is a risk of dirt and foreign particles adhering to the seal.) Fill 2/3 of the space between the dust tongue and sealing lip with grease. The rubber coated external diameter must also be greased, unless otherwise specified.	Article number is specified in *Equipment on page 193*.
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.	

4.3 Complete robot

4.3.1 Replacement of cable harness, lower end (axes 1-2)

General

The cable harness 1-6 is undivided.

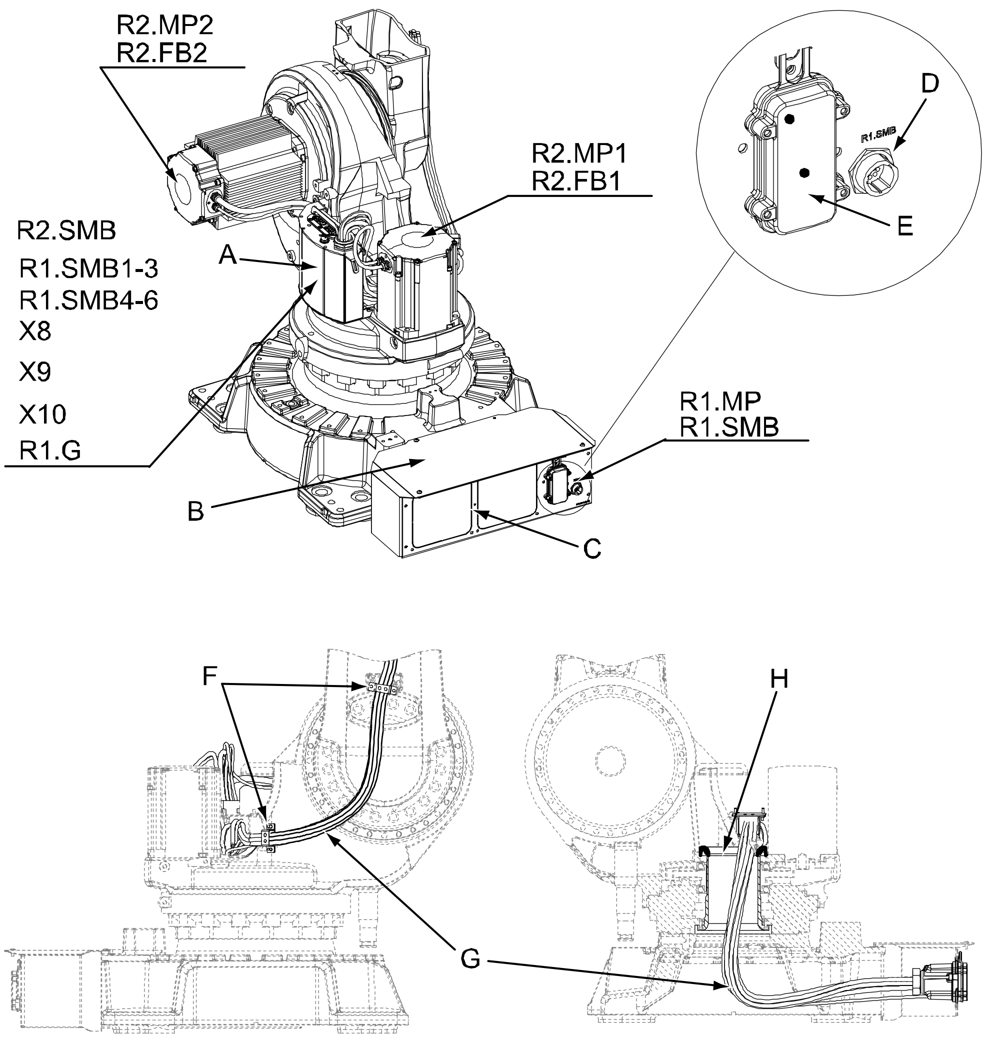
Replacement of the cable harness is detailed in two steps - lower end and upper end.

The procedure below details replacement of the lower end of the cable harness.

The procedure for replacing the upper end is detailed in the section *Replacement of cable harness, upper end on page 202*.

Location of cable harness, axes 1-2

The cable harness for axes 1-2 is run throughout the base and frame as shown in the figure below.



xx0600002970

A	SMB/BU unit

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B	Top cover, connection box
C	Connection plate, base
D	Connector R1.SMB
E	Connector R1.MP
F	Metal clamps
G	Cable harness
H	Cable guide (cut away view)

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Cable harness	See *Spare part lists on page 359*.		
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
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 361*.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.

Continues on next page

	Action	Note
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal

The procedure below details how to remove the cable harness, axes 1-2.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	In order to facilitate refitting of the cable harness, run the robot to the specified positions: • Axis 1: 0° • Axis 2: 0° • Axis 3: 0° • Axis 4: 0° • Axis 5: +90° • Axis 6: no significance	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove the *top cover, connection box* from the robot by removing its attachment screws.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.

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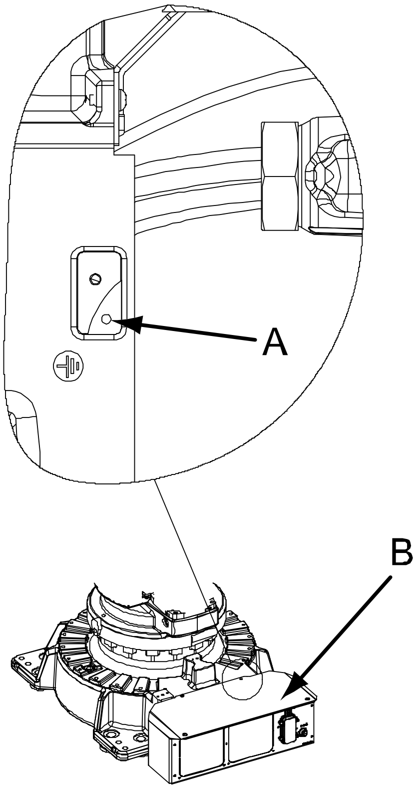
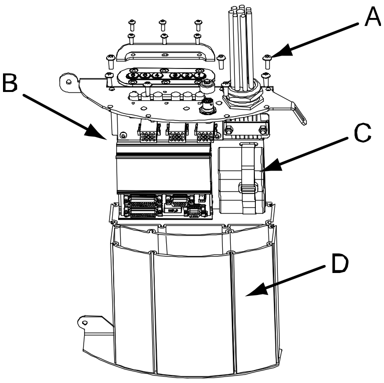
	Action	Note
5	Disconnect the earth cable.	 xx0600003028 • A: Earth (placed beneath the top cover) • B: Top cover, connection box
6	Disconnect connectors *R1.MP* and *R1.SMB* on the *connection plate, base*.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.
7	Disconnect all connectors at motors 1 *R2.MP1, R2.FB1* and 2 *R2.MP2, R2.FB2*.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.
8	Remove the *metal clamps* on the frame, securing the cable harness.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.

Continues on next page

	Action	Note
9	Remove the *attachment screws* holding the *SMB/BU unit* in its *box*. The cable between the battery and the SMB/BU unit may stay connected in order to avoid an update of the revolution counter. If the battery cable is disconnected, an update of the revolution counter is necessary!	 xx0600003026 • A: Attachment screws, M5x12 quality 8.8 (7 pcs) • B: SMB/BU unit • C: Battery unit • D: Box
10	Carefully lift the *SMB/BU unit* out of its *box*, while at the same time lifting the cables of the harness.	
11	Pull the *cable harness* and its *connectors* carefully up through the *cable guide* in the center of the frame.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.
12	Continue removal of the cable harness, axes 3-6.	Detailed in the section *Replacement of cable harness, upper end on page 202*.

Refitting

The procedure below details how to refit the cable harness axes 1-2.

	Action	Note
1	Push the *cable harness* axes 1-2 carefully down through the *cable guide* in the center of the frame.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.
2	Reconnect the connectors *R1.MP* and *R1.SMB* at the *connection plate, base*.	Tightening torque for R1.SMB: 10 Nm. Shown in the figure *Location of cable harness, axes 1-2 on page 195*.

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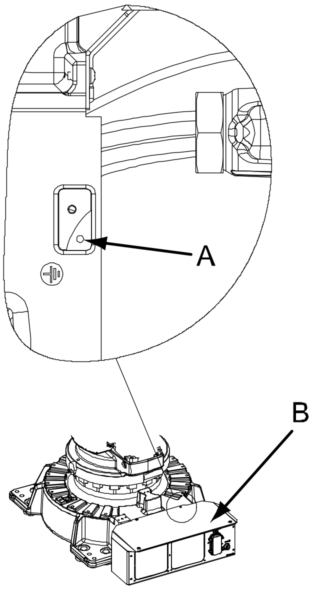
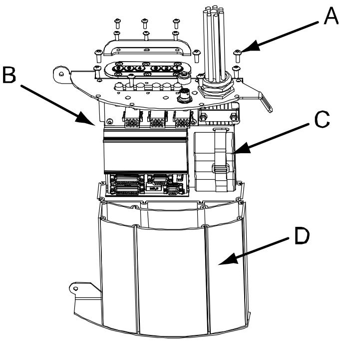
	Action	Note
3	Reconnect the earth cable.	 xx0600003028 • A: Earth (placed beneath the top cover) • B: Top cover, connection box
4	Put the *SMB/BU unit* carefully back into its *box* and refit its *attachment screws*.	 xx0600003026 • A : Attachment screws, M5x12 quality 8.8 (7 pcs) • B : SMB/BU unit • C : Battery unit • D : Box
5	Reconnect all connectors at motors 1 *R2.MP1, R2,FB1* and 2 *R2.MP2, R2.FB2*.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.
6	Refit the *metal clamps* on the frame, securing the cable harness.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.
7	Refit the *top cover, connection box*.	Shown in the figure *Location of cable harness, axes 1-2 on page 195*.

Continues on next page

	Action	Note
8	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
9	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.3.2 Replacement of cable harness, upper end

Introduction

The cable harness 1-6 is undivided.

Replacing the cable harness is described in two steps:

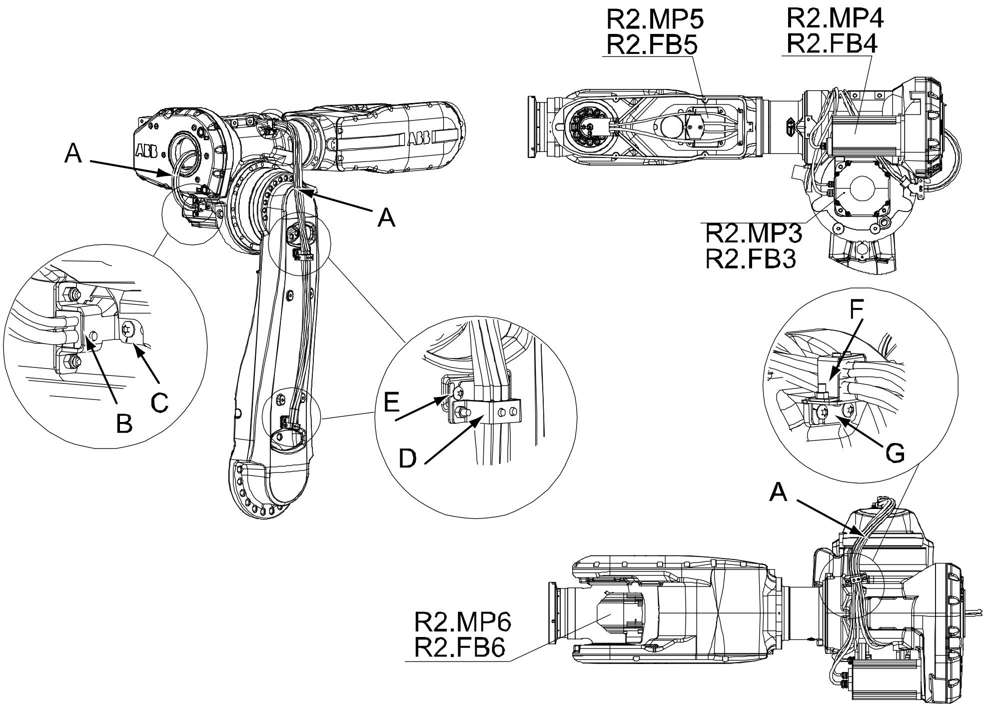
- lower end (axes 1-2)
- upper end (axes 3-6)

This procedure details how to replace the upper end.

For description of how to replace the lower end, see *Replacement of cable harness, lower end (axes 1-2) on page 195*.

Location of cable harness

The cable harness for the axes 3 to 6 runs throughout the lower and upper arm as shown in the figure below:



xx0600003078

A	Cable harness
B	Metal clamp, at gearbox axis 3
C	Attachment screws, metal clamp at gearbox axis 3, M6x16 quality 8.8 (2 pcs)
D	Metal clamp, lower arm (2 pcs)
E	Attachment screws, metal clamp lower arm, M6x16 quality 8.8 (2+2 pcs)
F	Metal clamp, armhouse
G	Attachment screws, metal clamp armhouse, M6x16 quality 8.8 (2 pcs)

Continues on next page

Required equipment

Equipment, etc.	Note
Cable harness axes 1-6	See *Spare part lists on page 359*.
Gasket	Motors axes 1-5 See *Spare part lists on page 359*.
Gasket	Motor axis 6. Recommended to be changed for Foundry Plus. See *Spare part lists on page 359*.
Retrofit set Foundry Plus, wrist	See *Spare part lists on page 359*.
Retrofit set Foundry Plus, upper arm axis 4	See *Spare part lists on page 359*.
Standard toolkit	Content is defined in section *Standard tools on page 354*.
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 361*.

Deciding calibration routine

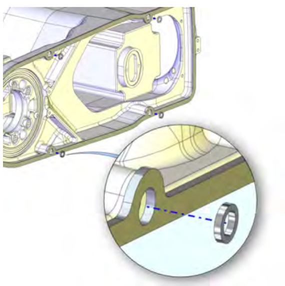
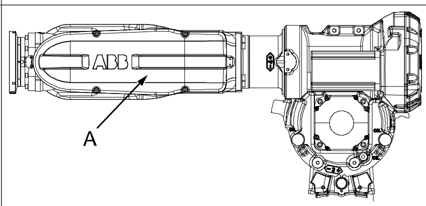
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Continues on next page

Removal

The procedure below details how to remove the cable harness.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	In order to facilitate refitting of the cable harness, run the robot to the specified positions: • Axis 1: 0° • Axis 2: 0° • Axis 3: 0° • Axis 4: 0° • Axis 5: +90° • Axis 6: no significance	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Before starting the removal of cable harness axes 3-6, first remove cable harness axes 1-2.	Detailed in the section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
5	Remove the *cover, wrist unit* in order to reach the cable harness at axes 5 and 6. **Note** *Foundry Plus* Make sure not to lose the washers placed in the holes of the foundry gasket.  xx1400002580	 xx0600003024 • A : Cover, wrist unit

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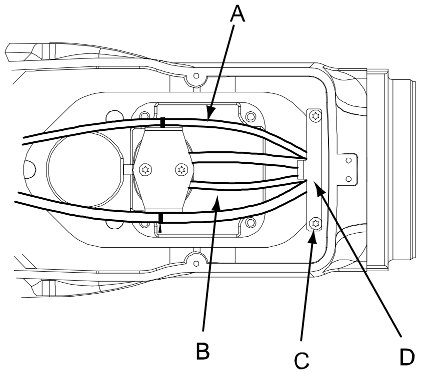
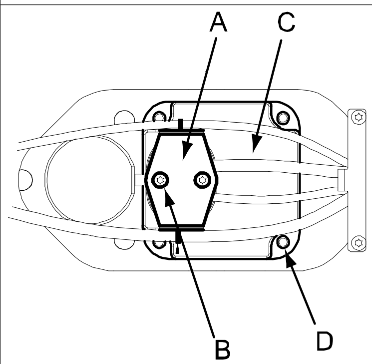
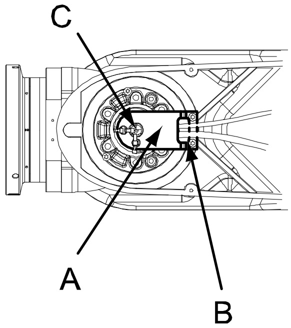
	Action	Note
6	Remove the *metal clamp* securing the *cable harness* at axis 5 by removing its *attachment screws*.	 xx0600003030 • A : Cable harness • B : Motor, axis 5 • C : Attachment screw, M6x16 8.8 (2 pcs) • D : Metal clamp
7	Remove the *cover* at motor axis 5 by removing its *attachment screws.* Also remove the *cover motor, axis 5* by removing its attachment screws and disconnect the motor cables *R2.MP5* and *R2.FB5*.	 xx0600003032 • A : Cover • B : Attachment screw M6X30 8.8 (2 pcs) • C : Cover motor, axis 5 • D : Attachment screws motor
8	Remove the *cable holder* in the wrist unit by unscrewing the three *attachment screws*. Two of the attachment screws (M6x16) are visibly located at the rear of the cable holder. The third screw (M4x12) is located at the bottom of the cable holder, securing the carrier.	 xx0600003034 • A : Cable holder • B : Attachment screws M6x16, 8.8 (2 pcs) • C : Attachment screw M4x12, 8-A2F (securing the carrier)

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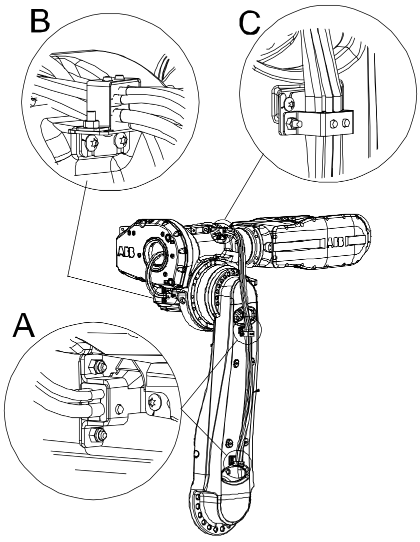
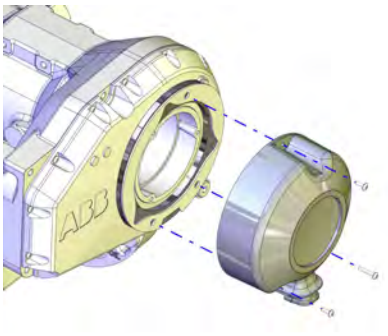
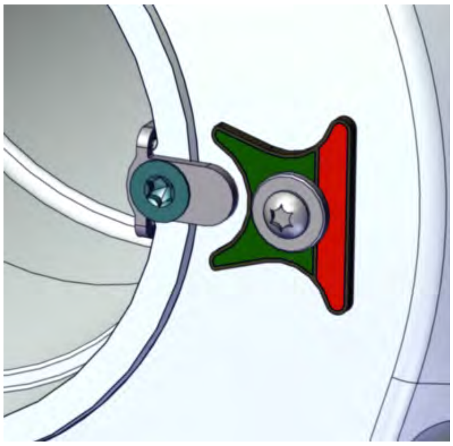
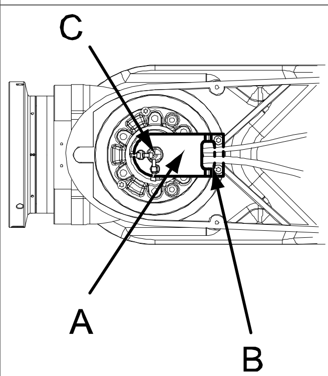
	Action	Note
9	Remove the back cover motor, axis 6 by removing its attachment screws.	
10	Pull out the cabling *R2.MP6* and *R2.FB6* from motor axis 6 .	Shown in the figure *Location of cable harness on page 202*
11	Disconnect all connectors at motor axis 6 *R2.MP6* and *R2.FB6*.	Shown in the figure *Location of cable harness on page 202*
12	Remove the cover of motor axes 3 and 4 by removing its attachment screws.	
13	Disconnect all connectors at motor axes 3 *R2.MP3, R2.FB3* and 4 *R2.MP4, R2.FB.4*.	Shown in the figure *Location of cable harness on page 202*
14	Remove the *metal clamps*, two on the lower arm, one on gearbox axis 3 and one on the armhouse.	 xx0600003083 • A : Metal clamp, lower arm (2 pcs) • B : Metal clamp, gearbox axis 3 • C : Metal clamp, armhouse
15	*Foundry Plus* Remove the Foundry Plus arm house cover.	 xx1400002582
16	Use caution and pull out the cable harness of the upper arm.	
17	Tie the connectors into a bundle, to avoid damaging them during further removal.	

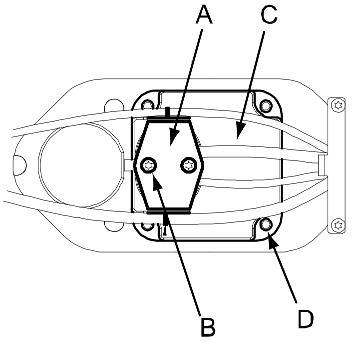
Continues on next page

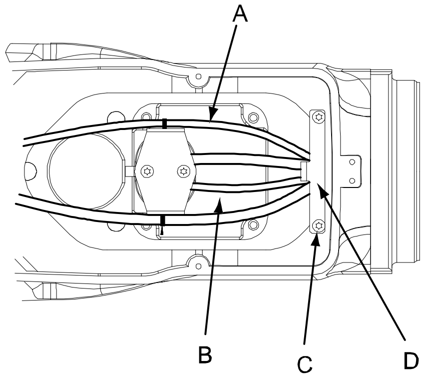
Refitting

The procedure below details how to refit the cable harness.

	Action	Note
1	Begin by refitting the cable harness lower end (axes 1-2).	Detailed in the section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
2	Insert the cable harness gently from the rear into the upper arm.	Arrange the cable harness as shown in the figure *Location of cable harness on page 202*
3	Place the cabling to motor axis 6 correctly on the upper arm and pull the connectors carefully through the hole on top of the wrist unit to motor, axis 6.	Shown in the figure *Location of cable harness on page 202* We recommend changing the *gasket* on the cover for Foundry Plus robots.
4	Reconnect all connectors at motor axes 3 *(R2.MP3, R2.FB3)* and 4 *(R2.MP4, R2.FB4)*.	
5	Refit covers motor axes 3 and 4. Make sure to turn the revolution indicator with the green side towards axis 4 center.	 xx1500002404
6	Refit the cable holder wrist unit with the three attachment screws. Two of the attachment screws (M6x16) are visibly located at the rear of the cable holder. The third screw (M4x10) is located at the bottom of the cable holder, securing the carrier.	 xx0600003034 • A : Cable holder • B : Attachment screws M6x16, quality 8.8 (2 pcs) • C . Attachment screws M4x10, quality 8-A2F (securing the carrier)
7	Reconnect the motor cables axis 6 *R2.MP6* and *R2.FB6*.	Shown in the figure *Location of cable harness on page 202*
8	Refit cover motor, axis 6.	

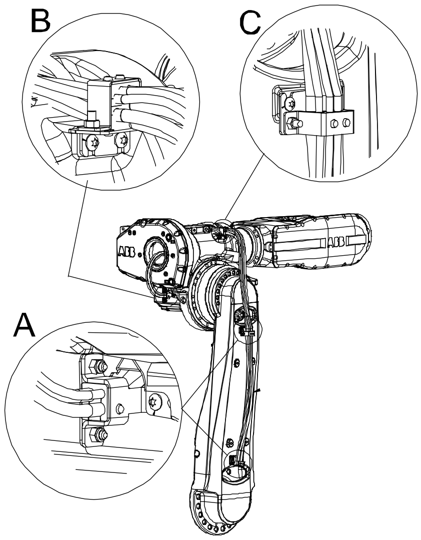
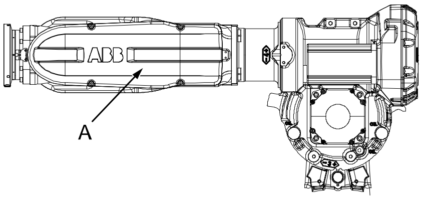
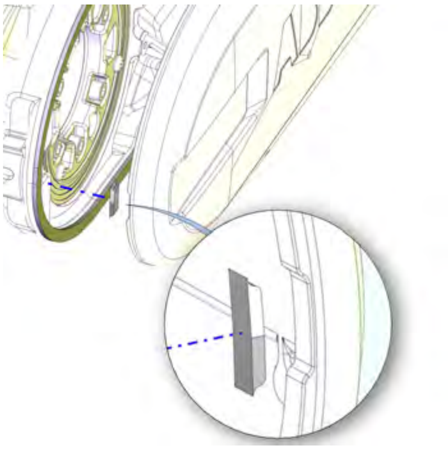
Continues on next page

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>9</td><td>Reconnect the motor cables axis 5 R2.MP5 and R2.FB5.</td><td>Shown in the figure Location of cable harness on page 202</td></tr>
<tr><td>10</td><td>Refit the cover motor, axis 5 (C) and cover (A).</td><td>

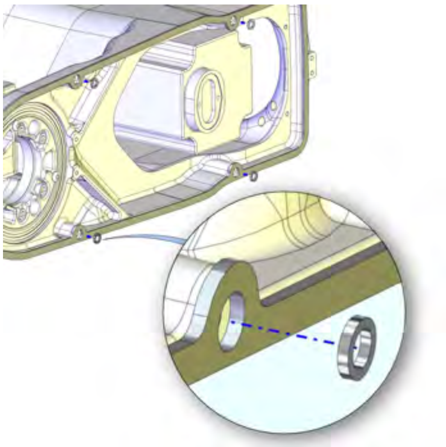
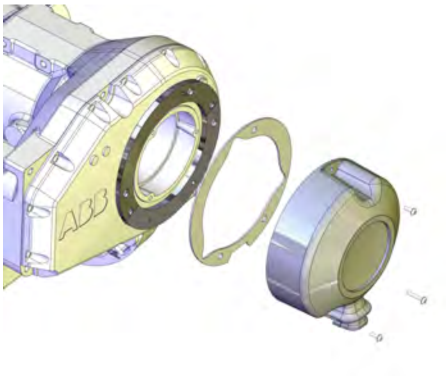
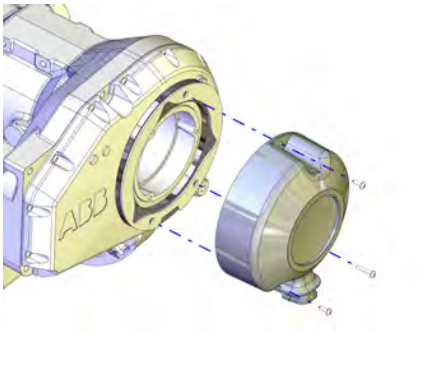
xx0600003032
• A : Cover
• B : Attachment screws M6x30, 8.8 (2 pcs)
• C : Cover motor, axis 5
• D : Attachment screws</td></tr>
<tr><td>11</td><td>Refit the metal clamp securing the cable harness at axis 5.</td><td>

xx0600003030
• A : Cable harness
• B : Motor, axis 5
• C : Attachment screws M6x16, 8.8 (2 pcs)
• D : Metal clamp</td></tr>
</table>

Continues on next page

	Action	Note
12	Refit the four *metal clamps*, two on the lower arm, one on gearbox axis 3 and one on the armhouse.	 xx0600003083 • A : Metal clamp, lower arm (2 pcs) • B : Metal clamp, gearbox axis 3 • C : Metal clamp, armhouse
13	*Standard* Fit the wrist cover.	 xx0600003024 • A : Cover, wrist unit
14	*Foundry Plus* Make sure the wrist cover gasket and the small gasket fitted in the recess of the wrist cover are undamaged. Replace if damaged.	 xx1400002579

Continues on next page

	Action	Note
15	*Foundry Plus* Make sure the washers are fitted in the gasket holes.	 xx1400002580
16	*Foundry Plus* Fit the wrist cover, Foundry Plus. Make sure the gasket stays undamaged after fitting. Replace if damaged.	
17	*Foundry Plus* Make sure the gasket on the adapter ring is undamaged. Replace if damaged.	 xx1400002581
18	*Foundry Plus* Fit the Foundry Plus cover on the adapter ring.	 xx1400002582
19	Make sure the gasket on the adapter ring is undamaged. Replace if damaged.	

Continues on next page

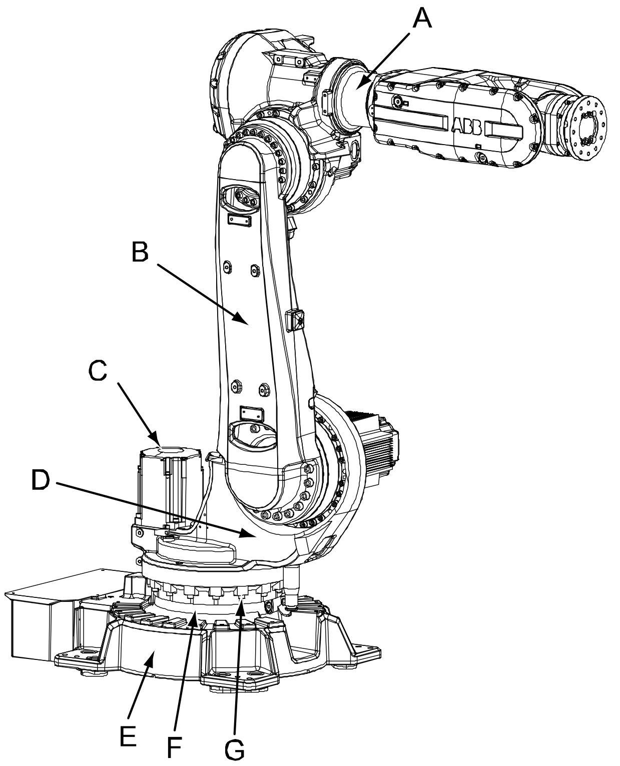
	Action	Note
20	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
21	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.3.3 Replacement of complete arm system

Location of arm system

The complete arm system is defined as the complete robot except for the base, motor and axis-1 gearbox axis 1. This is shown in the figure below.

A more detailed view of the component and its position may be found in *Spare part lists on page 359*.



xx0600003035

A	Upper arm
B	Lower arm
C	Motor, axis 1
D	Frame
E	Base
F	Gearbox, axis 1
G	Attachment screws base M12x80, quality 12.9 Gleitmo (16 pcs)

Required equipment

Equipment, etc.	Art. no.	Note
Lifting accessory, robot	3HAC026597-001	Instruction 3HAC026600-002 is en-closed!

Continues on next page

Equipment, etc.	Art. no.	Note
Guide pins M12 x 130	3HAC022637-001	Used to guide the complete arm system when lifting it. Always use the guide pins in pairs! In order to make the refitting easier, it is recommended to use two guide pins of different lengths.
Roundsling 1,5 m		Lifting capacity 1,000 kg
Roundslings	-	
Hoisting block	-	Used to adjust the length of the lifting chain.
Lifting chain	-	Used together with the hoisting block.
Isopropanol	-	Used for cleaning mounting surfaces.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
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.

Deciding calibration routine

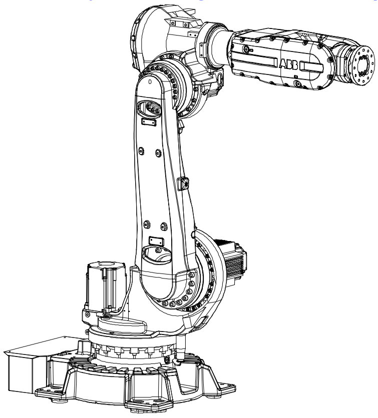
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

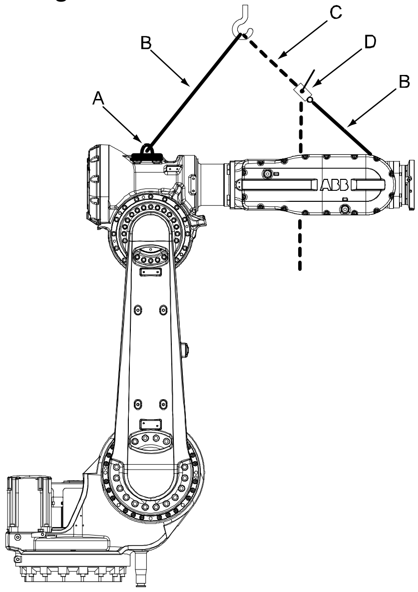
Continues on next page

Removal, arm system

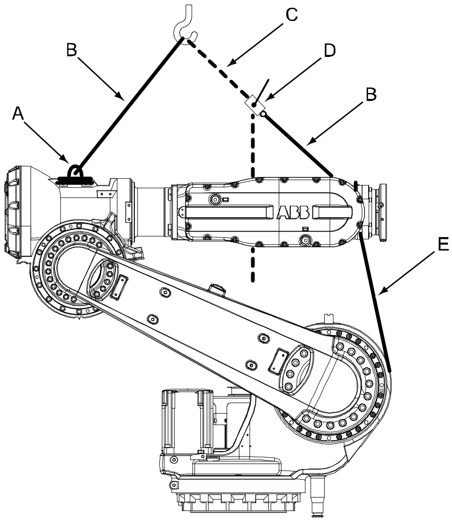
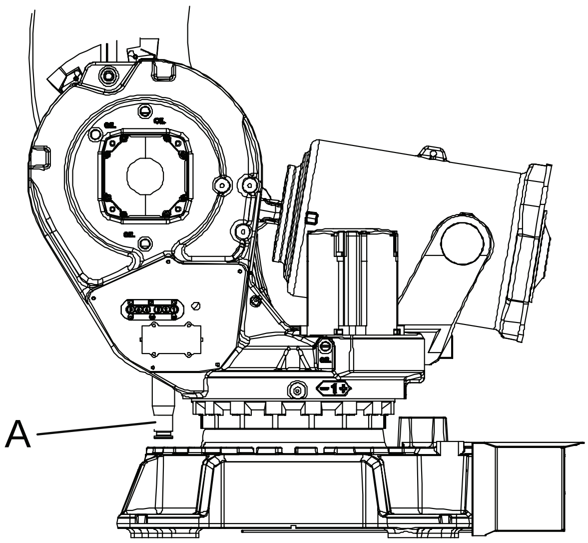
Use this procedure to lift and remove the complete arm system.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Run the robot to the position shown in the figure to the right.	Release the brakes if necessary, as detailed in section *Manually releasing the brakes on page 91*.  xx0600003125
3	Run the overhead crane to a position above the robot.	

Continues on next page

	Action	Note
4	Fit the *lifting accessory* and adjust it as detailed in the enclosed *instructions*. Also fit a *hoisting block* to the front, used to adjust the balance of the arm system in order to lift it completely level. **Note** There is an **alternate method** of lifting the complete armsystem described below.	Art. no. is specified in *Required equipment on page 212*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting accessory! **Read the instructions before lifting!**  xx0600003101 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block
5	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
6	Drain the oil from gearbox axis 1.	Detailed in section *Changing oil, axis-1 gearbox on page 163*.
7	Disconnect the cabling in the rear of the robot base and remove the cable support plate inside the base.	
8	Pull the disconnected cabling up through the center of the axis-1 gearbox.	How to replace the cabling is detailed in *Replacement of cable harness, lower end (axes 1-2) on page 195*.
9	Remove the motor, axis 1.	Detailed in section *Replacement of motor, axis 1 on page 252*.

Continues on next page

	Action	Note
10	*Alternate method* of lifting: Fit the *lifting accessory* and a *roundsling* on the upper arm **and** a *roundsling* with a hoisting block, to the wrist unit. Also fit a separate *roundsling* between the wrist and the frame in order to eliminate any load through the brake on motor axis 3. The hoisting block is used to balance the upper arm. See the **lifting instructions.** **Note** The brake on axis 3 shall be released during the lift, until the roundsling between the wrist and the frame tranfers the load of the frame. See figure to the right!	Art. no. is specified in *Required equipment on page 212*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting accessory! **Follow the instructions before lifting!** Releasing the brakes is detailed in section *Manually releasing the brakes on page 91*.  xx0600003100 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block • E : Roundsling (used to transfer the load of the frame)
11	Remove the mechanical stop pin from the frame.	 xx1200000668 A Mechanical stop pin

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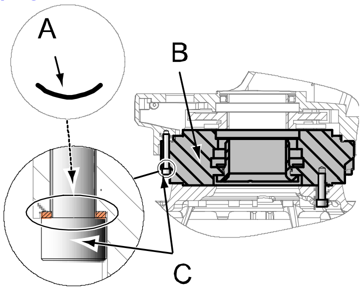
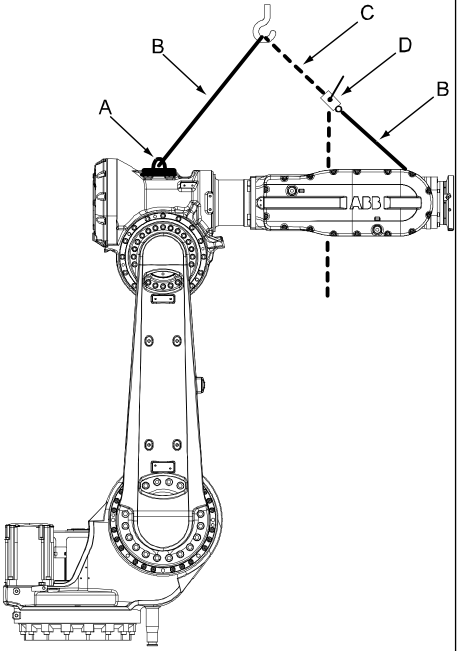
	Action	Note
12	Unfasten the arm system from the base by unscrewing its 16 *attachment screws.*	Shown in the figure *Location of arm system on page 212*.  xx0600003070 Parts: • A: Serrated lock washer • B: Gearbox axis 1 • C: Attachment screws M12x80
13	Fit two *guide pins* in two opposite screw holes.	Art. no. is specified in section *Required equipment on page 212*.
14	 **CAUTION** The complete arm system weighs 590 kg! All lifting equipment used must be sized accordingly!	
15	Lift the arm system carefully and secure it in a safe area. Always move the robot at very low speeds, making sure it does not tip. Continue lifting even if the arm system turns out to be unbalanced despite earlier adjustments! The risk of damaging the interfaces is bigger if the load is lowered unbalanced!	Make sure all hooks and attachments stay in the correct position while lifting the arm system and that the lifting accessory does not wear against sharp edges.

Refitting, arm system

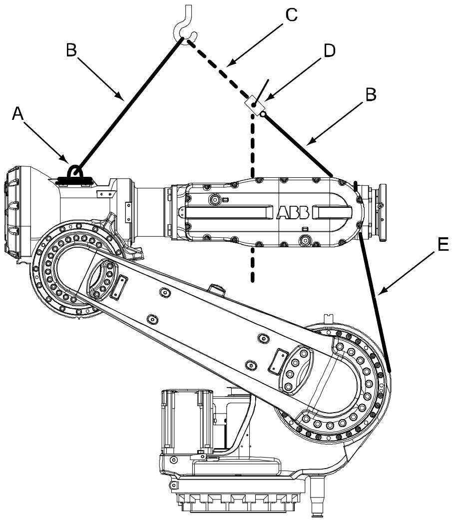
The procedure describes how to lift and refit the complete arm system.

	Action	Note
1	 **DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	

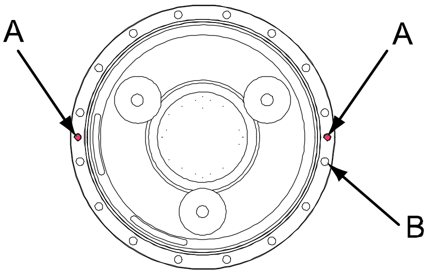
Continues on next page

	Action	Note
2	Fit the lifting accessory as detailed in the figure to the right. Also fit a *hoisting block* to the front. (Used to adjust the balance of the arm system in order to lift it completely level!) **Note** There is an **alternate method** of lifting the complete armsystem described below!	Art. no. is specified in *Required equipment on page 212*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting accessory! **Follow the instructions before lifting!** Releasing the brakes are detailed in section *Manually releasing the brakes on page 91*.  xx0600003101 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block

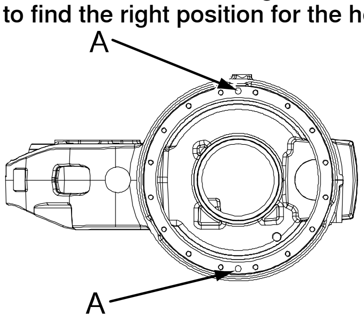
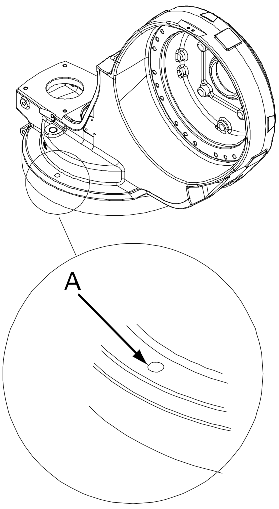
Continues on next page

	Action	Note
3	*Alternate method* of lifting: Fit the *lifting device* and a *roundsling* on the upper arm **and** a *roundsling* with a hoisting block, to the wrist unit. Also fit a separate *roundsling* between the wrist and the frame in order to eliminate any load through the brake on motor axis 3. The hoisting block is used to balance the upper arm. See the **lifting instructions**. **Note** The brake on axis 3 shall be released during the lift, until the roundsling between the wrist and the frame transfers the load of the frame. See figure to the right!	Art. no. is specified in *Required equipment on page 212*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting device! **Follow the instructions before lifting!** Releasing the brakes is detailed in section *Manually releasing the brakes on page 91*.  xx0600003100 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block • E : Roundsling (used to transfer the load of the frame)
4	**CAUTION** The complete arm system weighs 590 kg! All lifting equipment used must be sized accordingly!	
5	Lift the complete arm system and move it at very low speed, making sure it does not tip! Make sure the lift is done completely level. Adjust the length of the chains as detailed in enclosed instruction or with a hoisting block.	
6	Clean the mounting surfaces with isopropanol.	

Continues on next page

	Action	Note
7	Fit two *guide pins* in the holes in the axis-1 gearbox, as shown in the figure to the right. If using guide pins of different lengths, fit the pin with maximal length of 130 mm on the right side of the gearbox (seen from behind). **Note** Lubricate the guide pins for easier fitting of the arm system.	Dimension is specified in *Required equipment on page 212*.  xx0600003095 The figure below shows the gearbox, axis 1. A Attachment holes for guide pins, M12 in gearbox axis 1. B Hole for attachment screw.
8	Lubricate the outer surface of the gearbox for easier mating of the gearbox and arm system.	

Continues on next page

	Action	Note
9	Look through the empty mounting hole of motor 1 to assist in aligning the assembly during refitting of the arm system. Lower the arm system with guidance from the guide pins previously fitted to the axis-1 gearbox axis 1. Fit the guide pins in the corresponding holes in the frame as shown in the figure to the right. **Note** The refitting must be made completely level! Make sure the lifting accessory is adjusted prior to refitting of arm system.	This is a complex task to be performed with utmost care in order to avoid injury or damage! Use a crank to turn the gearbox in order to find the right position for the holes.  xx0600003094 • A : Holes in frame for guide pins, shown from below.  xx0600003093 • A : Holes in frame for guide pins, shown from above.
10	Remove the guide pins and secure the arm system to the base with its 16 *attachment screws and washers.*	Shown in the figure *Location of arm system on page 212*. M12 x 80, 12.9 quality gleitmo. Tightening torque: 105 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 350* before fitting.
11	Refit the *axis-1 motor*.	
12	Perform a *leak-down test* of the axis-1 gearbox.	Detailed in section *Performing a leak-down test on page 190*.
13	Refit the *cabling* in the base.	Detailed in section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
14	Refill the gearbox with lubricating oil.	Detailed in section *Changing oil, axis-1 gearbox on page 163*.

Continues on next page

	Action	Note
15	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
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 51*.	

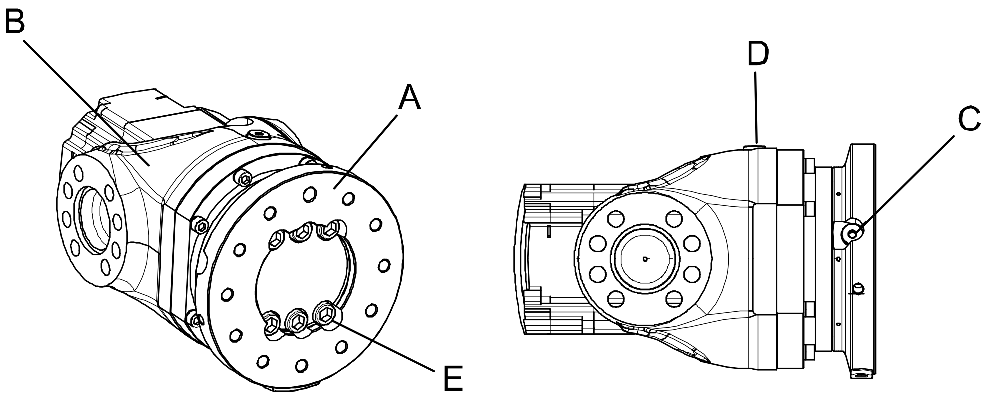
4.4 Upper and lower arm

4.4.1 Replacing the turning disk

Location of turning disk

The turning disk is located in the front of the wrist housing as shown in the figure below.

The figure shows the turning disk on an IRB 6620 Foundry Plus/IRB 6620LX.



xx0600003082

A	Turning disk
B	Wrist unit
C	Oil plug, draining
D	Oil plug, filling
E	Attachment screws, turning disk (6 pcs)

Required equipment

Equipment, etc.	Art. no.	Note
Turning disk	For spare part no. see: *Spare part lists on page 359*.	O-rings are not included!
O-ring Wrist, type 1	3HAB3772-65 (1pc) 21520431-20 (6 pcs)	Must be replaced when replacing the turning disk!
O-ring Wrist, type 2	3HAB3772-64 (1 pc) 3HAB3772-61 (12 pcs)	For IRB 6620 Foundry Plus. Must be replaced when replacing the turning disk!
Grease	3HAB3537-1	Used to lubricate the o-rings.
Flange sealant	3HAC034903-001	Loctite 574
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

Removing, turning disk

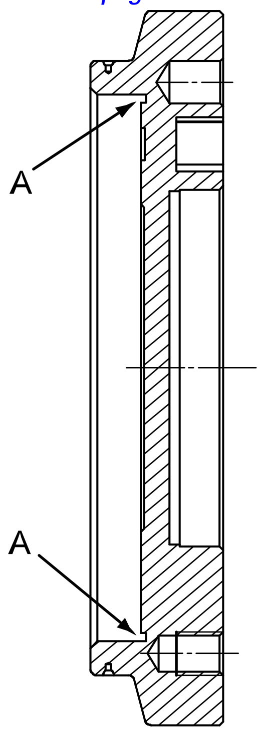
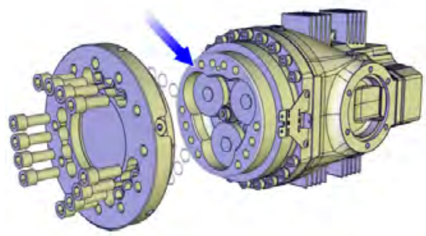
Use this procedure to remove the turning disk.

	Action	Note
1	Run the robot to a position where the *oil plug, draining* of axis 6 gearbox faces downwards.	Shown in the figure *Location of turning disk on page 223*.
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove any equipment fitted to the turning disk.	
4	Drain the axis 6 gearbox.	See section • *Changing oil, axis-6 gearbox on page 178*
5	Remove the *attachment screws* that secure the turning disk.	Shown in the figure *Location of turning disk on page 223*.
6	Remove the *turning disk*.	
7	*Foundry Plus:* Remove old flange sealant residues and other contamination from the contact surfaces.	

Continues on next page

Refitting, turning disk

Use this procedure to refit the turning disk.

	Action	Note
1	Lubricate the *o-ring* of the turning disk with *grease* and fit it to the turning disk. Also fit the six o-rings, when refitting the attachment screws.	Art. no. is specified in *Required equipment on page 223*.  xx0200000218 • A: Sealing surface, o-ring
2	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400000995
3	Secure the turning disk with its *attachment screws*.	6 pcs M14 x 25, 12.9 quality. Tightening torque: 175 Nm Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 350* before fitting.
4	Perform a *leak-down test* of the gearbox axis 6.	Detailed in the section *Performing a leak-down test on page 190*.
5	Refill the axis 6 gearbox with oil.	See section • *Changing oil, axis-6 gearbox on page 178*
6	Refit any equipment removed during disassembly to the turning disk.	

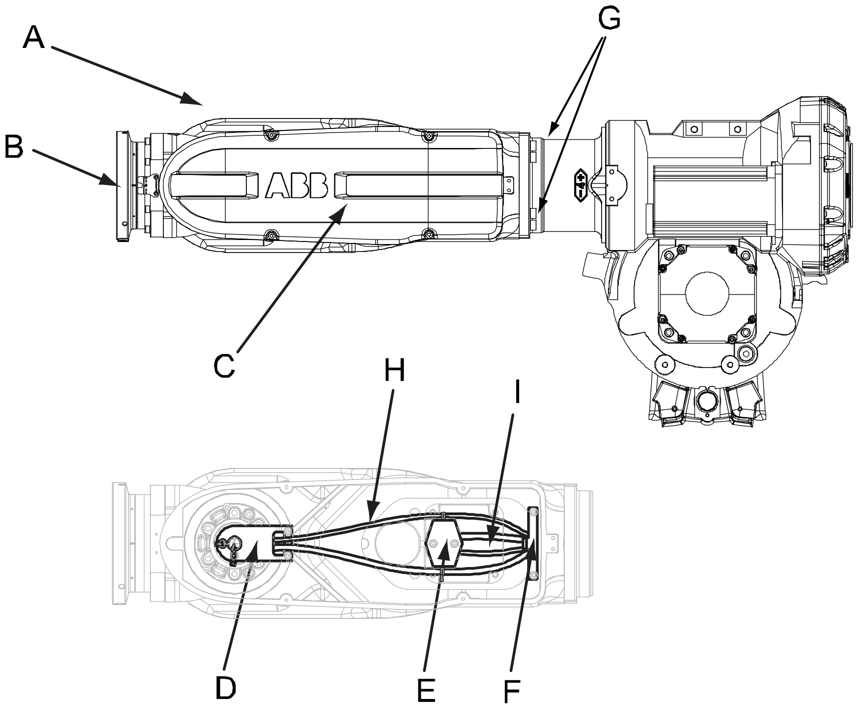
Continues on next page

	Action	Note
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 51*.	

4.4.2 Replacement of wrist unit

Location of wrist unit

The wrist unit is located in the foremost part of the upper arm as shown in the figure below.



xx0600003055

A	Wrist unit
B	Turning disk
C	Cover, wrist unit
D	Cable holder
E	Cover, cable gland
F	Metal clamp
G	Wrist unit, attachment screws
H	Cable harness, axis 6
I	Cable harness, axis 5

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Wrist unit	See *Spare part lists on page 359*.		
Wrist unit, insulated	See *Spare part lists on page 359*.		
Retrofit set Foundry Plus, wrist	See *Spare part lists on page 359*.		

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Retrofit set Foundry Plus, upper arm axis 4	See *Spare part lists on page 359*.		
Roundsling		-	
Grease		3HAB 3537-1	Used to lubricate o-rings.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
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.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

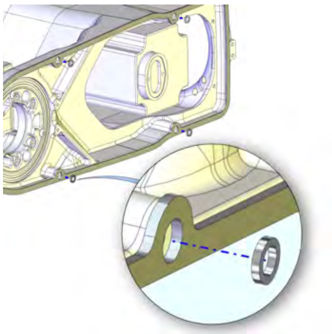
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal

The procedure below details how to remove the wrist unit.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to a suitable position for removal of the wrist unit.	

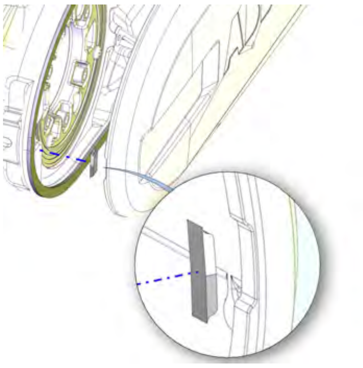
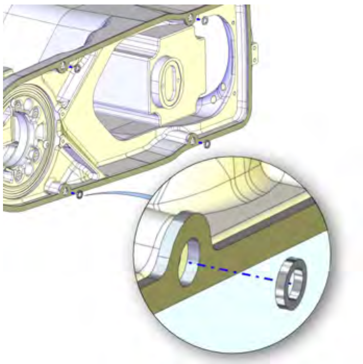
Continues on next page

	Action	Note
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove all equipment fitted to the *wrist unit*.	Shown in the figure in *Location of wrist unit on page 227*.
5	Remove the *cover, wrist unit* in order to reach the cable harness. **Note** *Foundry Plus* Make sure not to lose the washers placed in the holes of the Foundry Plus gasket.  xx1400002580	Shown in the figure *Location of wrist unit on page 227*.
6	Remove the cable harness, axes 5 and 6.	Detailed in section *Replacement of cable harness, upper end on page 202*.
7	**CAUTION** The complete wrist unit weighs 96 kg! All lifting equipment used must be sized accordingly!	
8	Secure the wrist unit with a roundsling in an overhead crane.	
9	Unscrew the eight *attachment screws* securing the wrist unit.	Shown in the figure *Location of wrist unit on page 227*.
10	Remove the wrist unit from the upper arm by moving it a little back and forth until it is lose.	**Note!** Do not damage the cylindrical pin in the process.

Refitting

	Action	Note
1	Secure the wrist unit with a roundsling in an overhead crane and lift it to its mounting position.	

Continues on next page

	Action	Note
2	**CAUTION** The complete wrist unit weighs 96 kg! All lifting equipment used must be sized accordingly!	
3	Put some *grease* on the surface of the fit.	
4	Check the cylindrical pin.	If the pin is damaged replace it.
5	Fit the wrist with its 8 attachment screws and washers.	M12x50 12.9 gleitmo (8 pcs) Tightening torque: 120 Nm
6	Refit the cable harness, axes 5 and 6.	Detailed in the section *Replacement of cable harness, upper end on page 202*.
7	*Standard* Fit the wrist cover.	Shown in the figure *Location of wrist unit on page 227*.
8	*Foundry Plus* Make sure the wrist cover gasket and the small gasket fitted in the recess of the wrist cover are undamaged. Replace if damaged.	 xx1400002579
9	*Foundry Plus* Make sure the washers are fitted in the gasket holes. Refit the wrist cover, Foundry Plus.	 xx1400002580
10	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.

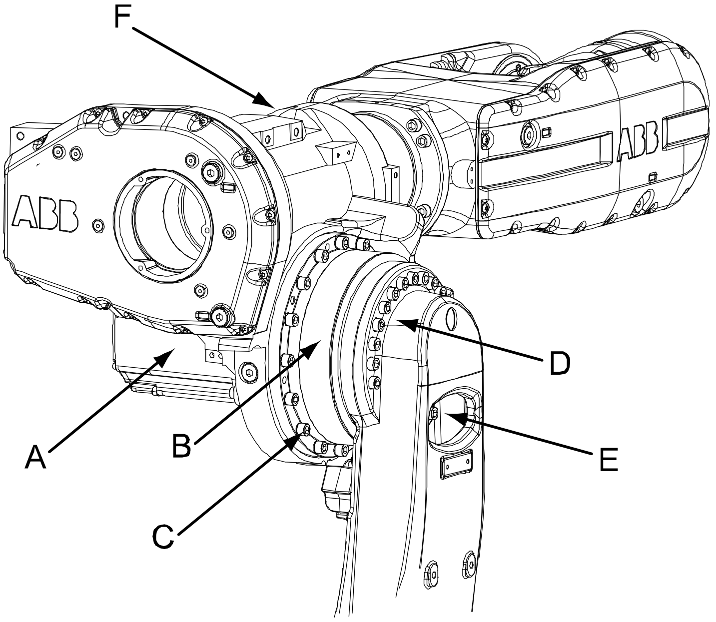
Continues on next page

	Action	Note
11	Refit any equipment previously removed from the wrist unit.	
12	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.4.3 Replacement of the upper arm

Location of the upper arm

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



xx0600003057

A	Motor, axis 3
B	Gearbox, axis 3
C	Attachment screws, M12x50 quality 12.9 Gleitmo (20 pcs)
D	Attachment screws, M16x50 quality 12.9 Gleitmo (16 pcs)
E	Hole in the lower arm
F	Upper arm

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Upper arm (Axes 3-4)	See *Spare part lists on page 359*.		
O-ring			Replace only if damaged.
Lifting tool		3HAC026597-001	Instruction 3HAC026600-002 is enclosed.
Lifting chain		-	
Roundsling		-	
Guiding pins			Always use in pairs.
Hoisting block		-	
Grease		3HAB3537-1	Used to lubricate o-rings.

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
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.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

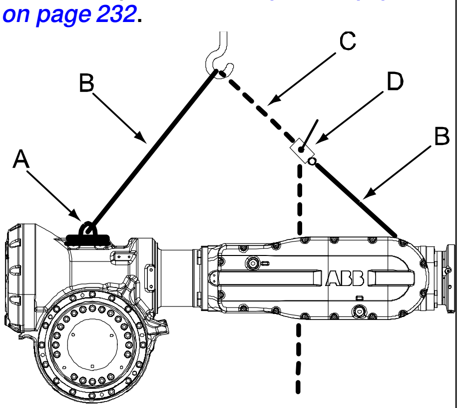
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal

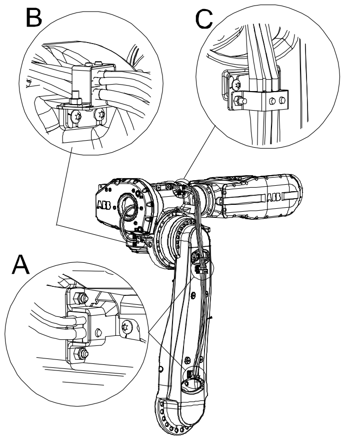
The procedure below details how to remove the upper arm.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Drain the oil from gearbox axis 3.	Detailed in the section *Changing oil, axis-3 gearbox on page 169*.
4	Raise the upper arm to a position where it is parallel to the floor by releasing the brake of the axis 3 motor. In order to release the brake of the axis 3 motor, connect the 24 VDC power supply. **Note!** When releasing the brake, the position of the upper arm can change suddenly! Perform the procedure carefully!	Connect to connector R2.MP3: • + : pin 2 • -: pin 5
5	**CAUTION** The complete upper arm (incl. gearbox axis 3) weighs 282 kg without any additional equipment fitted! Use a suitable lifting device to avoid injury to personnel!	
6	Fit the *lifting tool* on the upper arm as detailed in the enclosed instructions. Also fit a *hoisting block* to the front which is used to adjust the balance of the upper arm in order to lift it completely level.	Art. no. is specified in *Required equipment on page 232*.  xx0600003102 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block
7	Remove the cable harness, axes 3-6.	Detailed in the section *Replacement of cable harness, upper end on page 202*.

Continues on next page

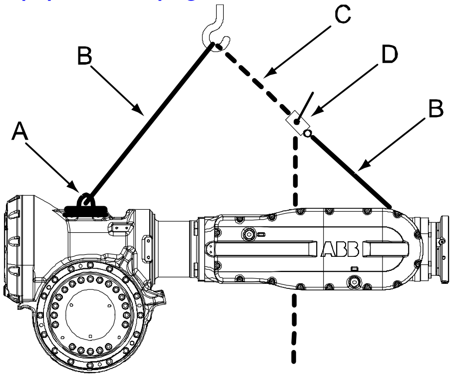
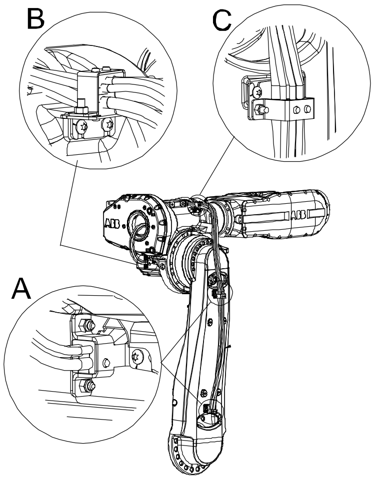
	Action	Note
8	Remove the three metal clamps securing the cable harness on the lower arm and armhouse.	 xx0600003083 • A: Metal clamp, lower arm (2 pcs) • B: Metal clamp, gearbox axis 3 • C: Metal clamp, armhouse
9	Remove motor, axis 3.	Detailed in the section *Replacement of motor, axis 3 on page 263*.
10	Remove the attachment screws securing the upper arm to the gearbox axis 3. **Note!** Do not forget to remove the four screws inside the hole in the lower arm.	Shown in the figure *Location of the upper arm on page 232*.
11	Remove the complete upper arm and put it on the floor. Let the upper arm lean on its side.	

Refitting

The procedure below details how to refit the upper arm.

	Action	Note
1	Make sure the o-ring is fitted to the gearbox. Lightly lubricate the o-ring with grease.	
2	**CAUTION** The complete upper arm (incl. gearbox axis 3) weighs 282 kg without any additional equipment fitted! Use a suitable lifting device to avoid injury to personnel!	

Continues on next page

	Action	Note
3	Fit the *lifting tool* on the upper arm as detailed in the enclosed instructions and lift it to its mounting position. Also fit a *hoisting block* to the front which is used to adjust the balance of the upper arm in order to lift it completely level.	Art. number is specified in *Required equipment on page 232*.  xx0600003102 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block
4	Fit the guiding pins in gearbox axis 3.	
5	Refit the attachment screws securing the upper arm to the gearbox. **Note**! Do not forget the four screws inside the hole in the upper arm.	Shown in the figure *Location of the upper arm on page 232*.
6	Remove the guiding pins.	
7	Refit motor, axis 3.	Detailed in the section *Replacement of motor, axis 3 on page 263*.
8	Refit the metal clamps securing the cable harness on the lower arm and armhouse.	 xx0600003083 • A: Metal clamp, lower arm (2 pcs) • B: Metal clamp, gearbox axis 3 • C: Metal clamp, armhouse
9	Perform a leak-down test of the axis-3 gearbox.	Detailed in section *Performing a leak-down test on page 190*.
10	Refit the cable harness, axes 3-6.	Detailed in section *Replacement of cable harness, upper end on page 202*.

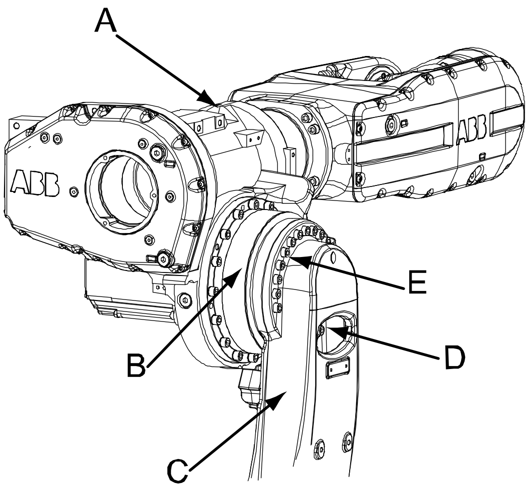
Continues on next page

	Action	Note
11	Fill gearbox, axis 3 with oil.	Detailed in section *Changing oil, axis-3 gearbox on page 169*.
12	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.4.4 Replacement of lower arm

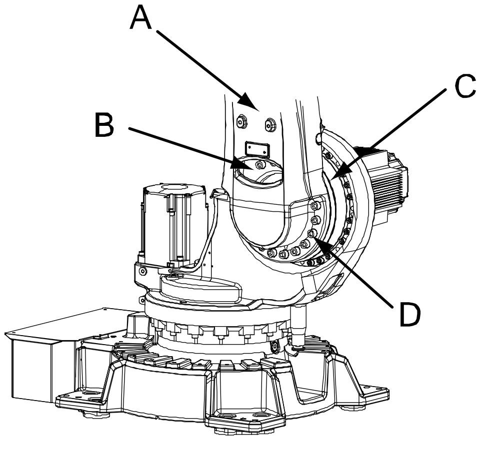
Location of lower arm

The location of the lower arm is shown in the figure below.



xx0600003058

A	Upper arm
B	Gearbox, axis 3
C	Lower arm
D	Hole in lower arm
E	Attachment screws, M16x50 quality 12.9 Gleitmo (16 pcs)



xx0600003059

A	Lower arm
B	Hole in lower arm
C	Gearbox, axis 2
D	Attachment screws, M16x50 quality 12.9 Gleitmo (16 pcs)

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art no.	Note
Lower arm	See *Spare part lists on page 359*.		
Grease		3HAB3537-1	Used to lubricate o-rings.
Lifting tool		3HAC026597-001	Instruction 3HAC026600-002 is enclosed.
Lifting chain		-	
Hoisting block		-	
Roundslings		-	
Guiding pins			Always use in pairs.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
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.

Deciding calibration routine

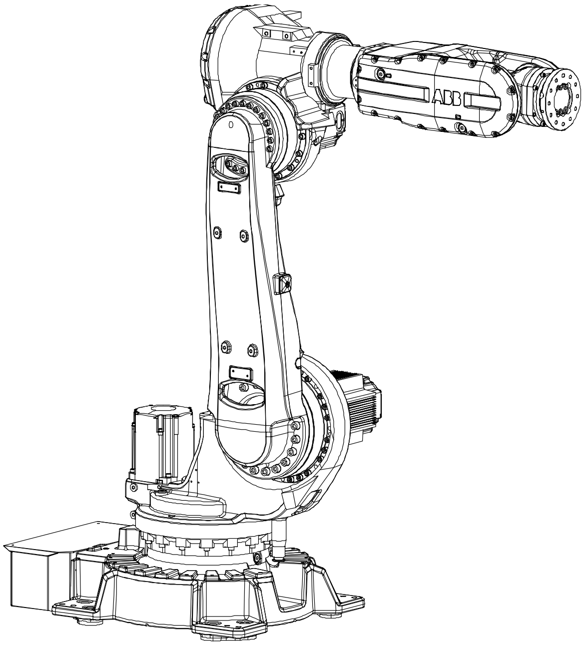
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Continues on next page

Removal

The procedure below details how to remove the lower arm.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to the position shown in the figure to the right.	 xx0600003125
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove the cable harness axes 3-6.	Detailed in the section *Replacement of cable harness, upper end on page 202*.
5	Let the cable harness hang loose, without it getting damaged in the proceeded removal procedure.	
6	Remove the upper arm.	Detailed in the section *Replacement of the upper arm on page 232*.
7	Secure the lower arm with a roundsling in an overhead crane.	

Continues on next page

	Action	Note
8	**CAUTION** The lower arm weighs 75 kg (gearboxes axes 2-3 excluded)!	
9	Remove the attachment screws and washers securing the lower arm to gearbox axis 2.	Shown in the figure *Location of lower arm on page 238*.
10	Remove the lower arm.	

Refitting

The procedure below details how to refit the lower arm.

	Action	Note
1	Secure the lower arm with a roundsling and lift it to its mounting position.	
2	**CAUTION** The lower arm weighs 75 kg (gearboxes axes 2-3 excluded)!	
3	Make sure the o-ring is fitted to the gearbox. Lightly lubricate the o-ring with grease.	
4	Fit guiding pins in two of the holes in gearbox axis 2.	
5	Lift the lower arm on to the guiding pins.	
6	Refit the attachment screws and washers securing the lower arm to gearbox axis 2.	Shown in the figure *Location of lower arm on page 238*. M16x50, quality 12.9 gleitmo (16 pcs). Tightening torque: 300 Nm.
7	Remove the guiding pins.	
8	Secure the upper arm with a roundsling and lift it to its mounting position.	
9	Refit the upper arm.	Detailed in the section *Replacement of the upper arm on page 232*.
10	Refit the cable harness axes 3-6.	Detailed in the section *Replacement of cable harness, upper end on page 202*.
11	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.

Continues on next page

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

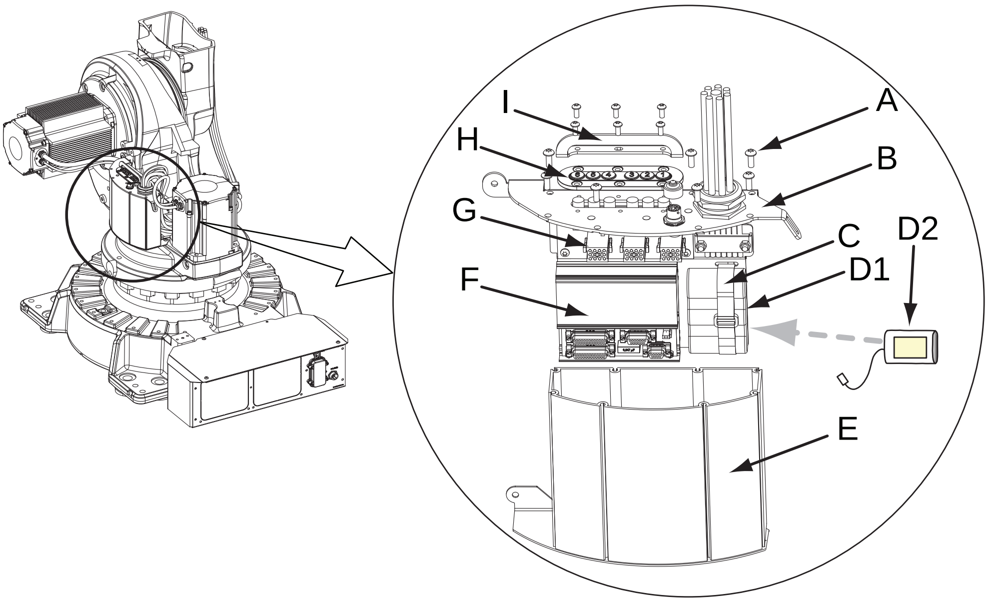
4.5 Frame and base

4.5.1 Replacement of SMB unit

Location of SMB unit

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

The SMB unit and the BU unit are both located inside the SMB/BU box.



xx0600003052

A	Attachment screws (4 pcs)
B	SMB/BU unit
C	Velcro strap
D1	Battery pack (2-pole battery contact)
D2	Battery pack (3-pole battery contact)
E	SMB/BU box
F	Serial measurement unit (SMB), DSQC 633A
F	Serial measurement unit (SMB), RMU 101
G	Brakerelease unit (BU), DSQC 563
H	Push button guard
I	Cover, push button guard
J	Gasket (Foundry Plus)

Continues on next page

Required equipment

Note

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

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

Equipment, etc.	Spare part no.	Art. no.	Note
Serial measurement unit (SMB)		*Spare part lists on page 359*.	
Standard toolkit		-	Content is defined in section *Special tools on page 355*.
Circuit diagram			See chapter *Circuit diagram on page 361*.

Removal, SMB unit

The procedure below details how to remove the SMB unit.

	Action	Note
1	Move the robot to the calibration position.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	 xx0200000023 **WARNING!** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *WARNING - The unit is sensitive to ESD! on page 54*	
4	Unscrew the attachment screws of the SMB/BU unit and carefully lift it out of its box.	Shown in the figure *Location of SMB unit on page 243*.

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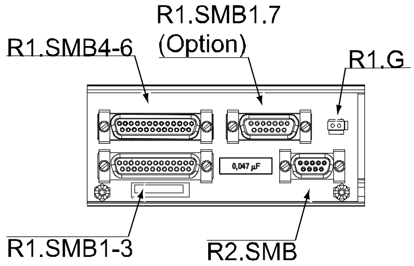
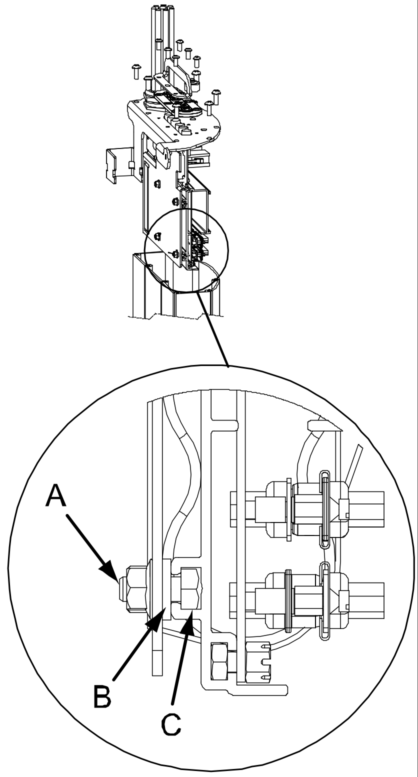
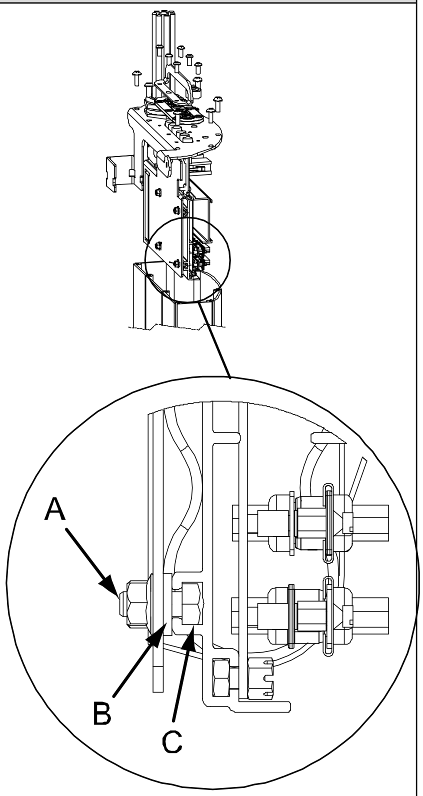
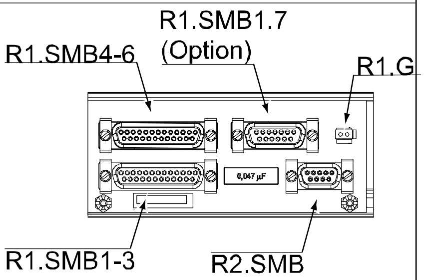
	Action	Note
5	Carefully disconnect the connectors from the SMB unit.	Connectors R1.SMB1-3, R1.SMB4-6 and R2.SMB  xx0600003054
6	Disconnect the battery cable from the SMB unit.	Connector R1.G
7	Unscrew the hexagon nuts securing the SMB unit just enough to pull the SMB unit out.	 xx0600003053 • A: Hexagon nut, M5 • B: Tooth lock washer, 6.4 fzb • C: Hexagon screw, M5x12 quality 8.8
8	Pull the SMB unit out carefully.	

Continues on next page

Refitting, SMB unit

The procedure below details how to refit the SMB unit.

	Action	Note
1	Push the SMB unit into its tracks and secure it with its hexagon nuts.	 xx0600003053 • A : Hexagon nut, M5 • B : Tooth lock washer, 6.4 fzb • C : Hexagon screw, M5x12 quality 8.8
2	Reconnect the connectors to the SMB unit. If cabling is used for 7th axis (option), refit the connector R2.FB7 to the SMB cover and tighten with 6 Nm.	 xx0600003054
3	Reconnect the battery cable.	Connector R1.G
4	Put the SMB/BU unit back into its box and refit the attachment screws.	Shown in the figure *Location of SMB unit on page 243*.
5	Update the revolution counters!	Detailed in section *Updating revolution counters on page 323*.

Continues on next page

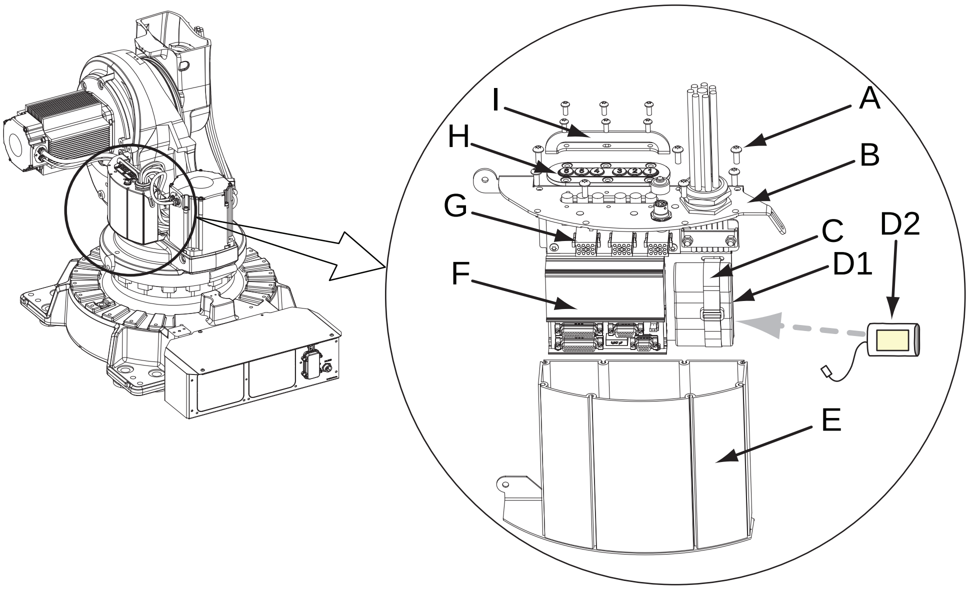
	Action	Note
6	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.5.2 Replacing the brake release board

Location of brake release board

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

The SMB unit and the BU unit are both located inside the SMB/BU box.



xx0600003052

A	Attachment screws (4 pcs)
B	SMB/BU unit
C	Velcro strap
D	Battery pack
E	SMB/BU box
F	Serial measurement unit (SMB), DSQC 633
G	Brakerelease unit (BU), DSQC 563
H	Push button guard
I	Cover, push button guard
J	Gasket (Foundry Plus)

Required equipment

Equipment, etc.	Art. no.	Note
Brake release board with buttons	For spare part no. see: • *Spare part lists on page 359*	
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.

Continues on next page

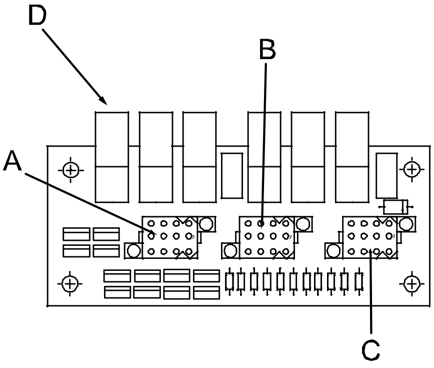
Equipment, etc.	Art. no.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Removing, brake release board

Use this procedure to remove the brake release board.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *WARNING - The unit is sensitive to ESD! on page 54*	
3	Remove the *cover for the push button guard*.	
4	Remove the *push button guard* from the SMB cover.	Shown in the figure *Location of brake release board on page 248*. The guard must be removed to ensure a correct refitting of the brake release board.
5	Unscrew the attachment screws of the SMB/BU unit and carefully lift the unit out of its box. Let the battery stay connected, to avoid the need of synchronization of the robot!	Shown in the figure *Location of brake release board on page 248*.

Continues on next page

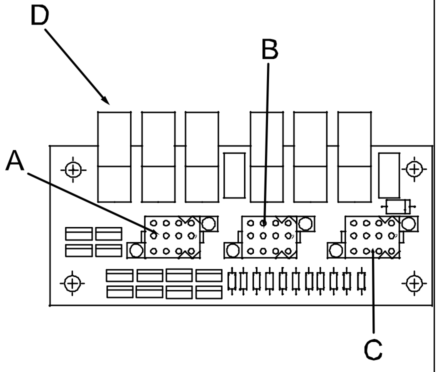
	Action	Note
6	Disconnect the connectors X8, X9 and X10 from the *brake release board.*	 xx0200000129 • A: Connector X8 • B: Connector X9 • C: Connector X10 • D: Push buttons Location of the brake release unit is shown in the figure *Location of brake release board on page 248*.
7	Remove the brake release board from the bracket by removing the four attachment screws.	

Refitting, brake release board

Use this procedure to refit the brake release board.

	Action	Note
1	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *WARNING - The unit is sensitive to ESD! on page 54*	
2	Fasten the *brake release board* on the bracket with the attachment screws. Make sure the board is positioned as straight as possible on the bracket! The push buttons can otherwise get jammed when the SMB cover is refitted.	Shown in the figure *Location of brake release board on page 248*. Art. no. is specified in *Required equipment on page 248*.

Continues on next page

	Action	Note
3	Connect the connectors X8, X9 and X10 to the brake release board.	 xx0200000129 • A: Connector X8 • B: Connector X9 • C: Connector X10 • D: Push buttons
4	Put the SMB/BU unit carefully back into its box and refit its attachment screws. The push button guard must not be mounted on the cover before the check described in following warning is made!	Shown in the figure *Location of brake release board on page 248*.
5	**WARNING** Before continuing any service work, please observe the safety information in section *WARNING - The brake release buttons may be jammed after service work on page 52*!	
6	Refit the *push button guard* to the SMB cover.	Shown in the figure *Location of brake release board on page 248*.
7	Refit the *cover, push button guard*.	
8	If the battery has been disconnected the revolution counter must be updated.	Detailed in the Calibration chapter - section *Updating revolution counters on page 323*.
9	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

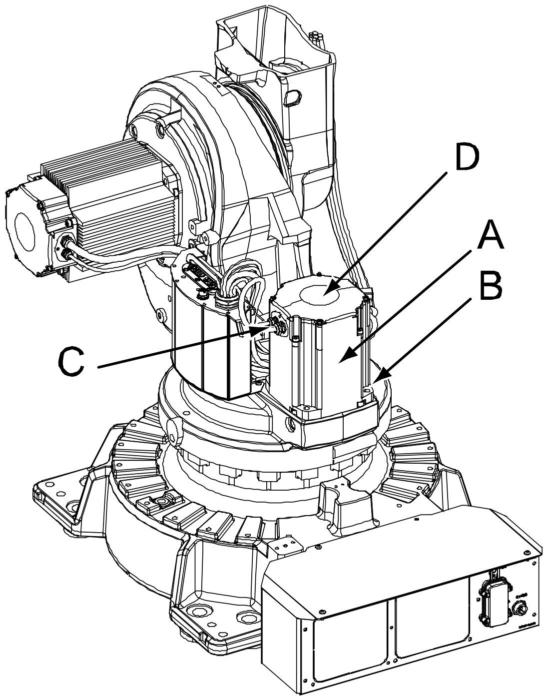
4.6 Motors

4.6.1 Replacement of motor, axis 1

> **Note**
>
> This procedure requires calibration of the robot.
>
> The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.
>
> Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.

Location of motor

The motor axis 1 is located as shown in the figure below.



xx0600003037

A	Motor, axis 1
B	Motor attachment screws and washers
C	Cable gland
D	Cover

Continues on next page

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor including pinion	See *Spare part lists on page 359*.		Includes • motor • pinion • o-ring 21522012-430.
O-ring	21522012-430		Must be replaced when reassemling the motor.
Mobilux EP 2	-	-	Used to lubricate the motor clutch.
Grease		3HAB3537-1	Used to lubricate the o-ring.
Removal tool, motor M12x		3HAC14973-1	Always use the removal tools in pairs!
Lifting tool, motor ax 1, 4, 5		3HAC14459-1	
Power supply		-	24 VDC, max. 1,5 A For releasing the brakes.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
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 361*.

Continues on next page

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

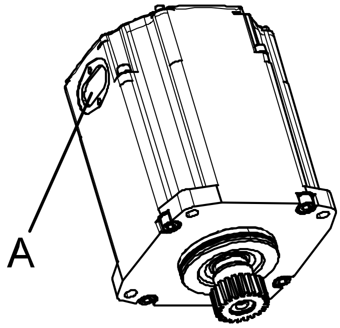
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, motor axis 1

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Remove the cover for connector access on top of the motor by unscrewing its four attachment screws.	Shown in the figure *Location of motor on page 252*.

Continues on next page

	Action	Note
4	Remove the cable gland cover at the cable exit by unscrewing its two attachment screws. **Note** Make sure the gasket is not damaged!	 xx0200000199 • A: Cable gland cover
5	Disconnect all connectors beneath the motor cover.	
6	Apply *lifting tool, motor axis 1, 4, 5* to the motor.	Art. no. is specified in *Required equipment on page 253*.
7	In order to release the brakes, connect the 24 VDC power supply.	Connect to connector R2.MP1 • +: pin 2 • -: pin 5
8	Remove the motor by unscrewing its four *attachment screws* and plain washers.	Shown in the figure *Location of motor on page 252*.
9	**CAUTION** The motor weighs 25 kg! All lifting equipment used must be sized accordingly!	
10	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	
11	Remove the motor by gently lifting it straight up.	

Refitting, motor axis 1

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the o-ring with *grease*.	Art no. is specified in *Required equipment on page 253*.
3	**CAUTION** The motor weighs 25 kg! All lifting equipment used must be sized accordingly!	

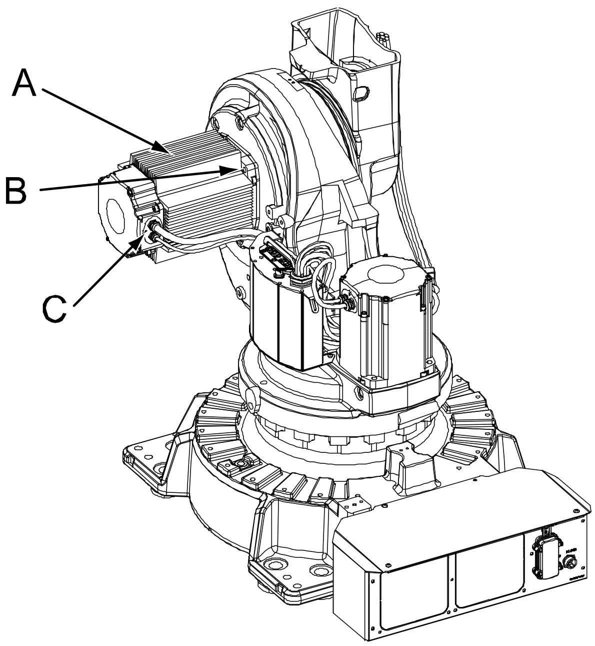
Continues on next page

	Action	Note
4	Apply the *lifting tool, motor axis 1, 4, 5* to the motor.	Art no. is specified in *Required equipment on page 253*.
5	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP1 • +: pin 2 • -: pin 5
6	Fit the motor, making sure the motor pinion is properly mated to gearbox of axis 1.	Make sure the motor is turned the correct way, that is connection of motorcable as shown in the figure *Location of motor on page 252*. Make sure the motor pinion does not get damaged!
7	Fit the clutch on the pinion on the motor.	
8	Secure the motor with its four attachment screws and plain washers.	M10 x 40, tightening torque: 50 Nm.
9	Disconnect the brake release voltage.	
10	Reconnect all connectors beneath the motor cover.	
11	Refit the cable gland cover at the cable exit with its two attachment screws.	Make sure the cover is tightly sealed!
12	Refit the motor cover with its four attachment screws.	Make sure the cover is tightly sealed!
13	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
14	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.6.2 Replacement of motor axis 2

Location of motor

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



xx0600003040

A	Motor, axis 2
B	Motor attachment holes (4 pcs)
C	Cable gland

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor including pinion	See *Spare part lists on page 359*.		Includes • motor • pinion • o-ring 2152 2012-430
O-ring	21522012-430		Must be replaced when reassembling motor!
Grease		3HAB3537-1	For lubricating the o-ring.
Removal tool, motor M12x		3HAC14973-1	Always use the removal tools in pairs!
Guide pins M10 x 150		3HAC15521-2	For guiding the motor. Guides are to be used in pairs!
Lifting tool, motor ax 2,3		3HAC026061-001	
Extension bar, 300 mm for bits 1/2"		3HAC12342-1	

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Power supply		-	24 VDC, 1.5 A For releasing the brakes.
Rotation tool		3HAC17105-1	Used to rotate the motor pinion when mating it to the gear when brakes are released with 24VDC power supply.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
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 361*.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	

Continues on next page

	Action	Note
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, motor

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Secure the robot from collapsing once the motor axis 2 is removed, by following the procedure detailed below: • Move the lower arm as far back as possible. • *Release the brakes* on motor axis 2 which will enable the lower arm to rest on its mechanical stop . • The motor axis 2 can now be replaced without securing the robot in an overhead crane.	Releasing brakes are detailed in section *Manually releasing the brakes on page 91*.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Drain the oil from gearbox, axis 2.	Detailed in the section *Changing oil, axis-2 gearbox on page 166*.
5	Remove the cover on top of the motor by unscrewing its four attachment screws.	

Continues on next page

	Action	Note
6	Remove the *cable gland cover* at the cable exit by unscrewing its two attachment screws.	Shown in the figure *Location of motor on page 257*. Make sure the gasket is not damaged!
7	Disconnect all connectors beneath the motor cover.	
8	**DANGER** Secure the weight of the lower arm properly before releasing the brakes of motor, axis 2! When releasing the holding brakes of the motor, the lower arm will be movable and may fall down!	Use the lock screw to lock the lower arm, as detailed above!
9	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP2 • +: pin 2 • -: pin 5
10	Remove the motor by unscrewing its four attachment screws and plain washers.	
11	Fit the two *guide pins* in two of the *motor attachment holes.*	Art. no. is specified in *Required equipment on page 257*. Shown in the figure *Location of motor on page 257*.
12	If required, press the motor out of position by fitting the *removal tool, motor* to the remaining *motor attachment holes.*	Art. no. is specified in *Required equipment on page 257*. Shown in the figure *Location of motor on page 257*. Always use the removal tools in pairs!
13	Remove the removal tools and fit the *lifting tool, motor axis 2, 3, 4* to the motor.	Art. no. is specified in *Required equipment on page 257*.
14	**CAUTION** The motor weighs 38 kg! All lifting equipment used must be sized accordingly!	
15	Lift the motor to get the pinion away from the gear.	Make sure the motor pinion does not get damaged!
16	Remove the motor by gently lifting it straight out and place it on a secure surface. Disconnect the brake release voltage.	

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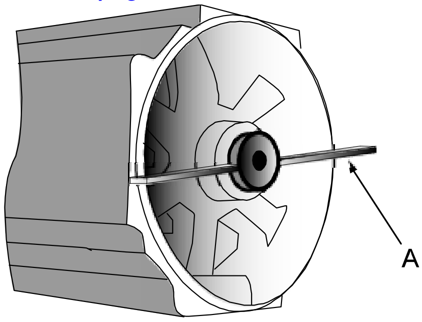
Refitting, motor

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the o-ring with *grease.*	Art. no. is specified in *Required equipment on page 257*.
3	In order to release the brake, remove the cover on top of the motor and connect the 24 VDC power supply.	Connect to connector R2.MP2 • +: pin 2 • -: pin 5
4	Fit the *lifting tool, motor axis 2, 3, 4* to the motor.	Art. no. is specified in *Required equipment on page 257*.
5	Fit the two *guide pins* in the two lower *motor attachment holes.*	Art. no. is specified in *Required equipment on page 257*. Shown in the figure *Location of motor on page 257*.
6	**CAUTION** The motor weighs 38 kg! All lifting equipment used must be sized accordingly!	
7	Lift the motor and guide it onto the guide pins, as close to the correct position as possible without pushing the motor pinion into the gear. Make sure that the motor is turned the right direction, that is the cables facing as shown in the figure *Location of motor on page 257*.	
8	Remove the lifting tool and allow the motor to rest on the guide pins.	

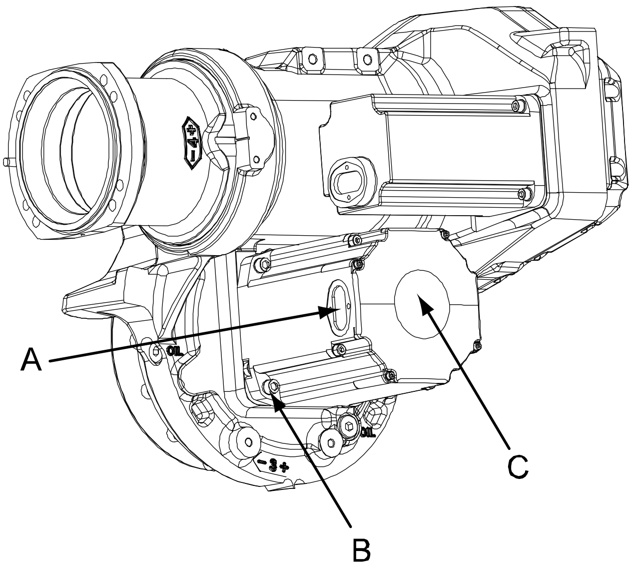
Continues on next page

	Action	Note
9	Use the *rotation tool* in order to rotate the motor pinion when mating it to the gear (see the figure to the right). Fit the motor, making sure the motor pinion is properly mated to the gear of gearbox axis 2 and that it does not get damaged.	Art. no. is specified in *Required equipment on page 257*.  xx0200000165 The rotation tool is used beneath the motor cover, directly on the motor shaft as shown in the figure above. • A: Rotation tool
10	Remove the guide pins.	
11	Secure the motor with four attachment screws and plain washers.	M10 x 40, tightening torque: 50 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 350* before fitting.
12	Disconnect the brake release voltage.	
13	Reconnect all connectors beneath the motor cover.	Connect in accordance with markings on connectors.
14	Refit the *cable gland cover* at the cable exit with its two attachment screws.	Shown in the figure *Location of motor on page 257*.
15	Refit the cover on top of the motor with its four attachment screws.	Make sure the cover is tightly sealed!
16	Perform a leak down test.	Detailed in *Performing a leak-down test on page 190*.
17	Refill the gearbox with oil.	Detailed in the section *Changing oil, axis-2 gearbox on page 166*.
18	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
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 51*.	

4.6.3 Replacement of motor, axis 3

Location of motor

The motor axis 3 is located on the left hand side of the robot as shown in the figure below.



xx0600003051

A	Cable gland cover, motor axis 3
B	Motor attachment holes (4 pcs)
C	Motor, axis 3

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor, axis 3	See *Spare part lists on page 359*.		Includes: • motor • pinion • o-ring 21522012-430
O-ring	21522012-430		Must be replaced when reassembling motor!
Grease		3HAB3537-1	For lubricating the o-ring.
Bolts M16x60 (for mechanical stop axis 3)		3HAB3409-86	
Guide pins M10 x 100		3HAC15521-1	For guiding the motor.
Guide pins M10 x 150		3HAC15521-2	For guiding the motor.
Rotation tool		3HAC17105-1	Used to rotate the motor pinion when mating it to the gear when brakes are released with 24 VDC power supply.

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Equipment, etc.	Spare part no.	Art. no.	Note
Power supply		-	24 VDC, max. 1.5 A For releasing the brakes.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
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		3HAC025090-001	See chapter *Circuit diagram on page 361*.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

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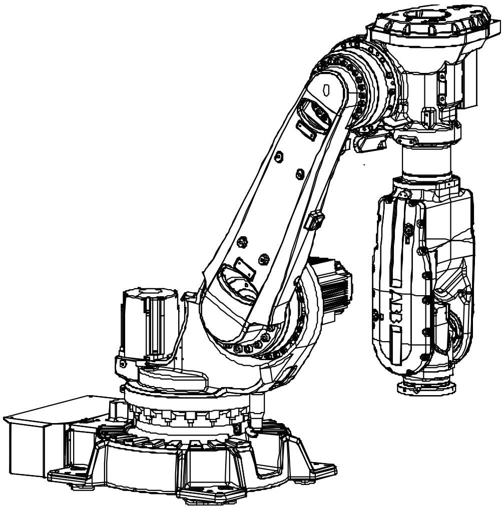
Removal, motor

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to the position shown in the figure. This is done in order to drain all oil from the gearbox axis 3.	 xx0600003041
3	Drain the oil from gearbox axis 3.	Detailed in the section *Changing oil, axis-3 gearbox on page 169*.
4	Secure the robot from collapsing once the motor axis 3 is removed, by following the procedure detailed below: • Move the lower arm as far back as possible. • *Release the brakes* on motor axis 2 and let the lower arm rest on its mechanical stop. • Also *release the brakes* on motor axis 3 and let the upper arm rest on its mechanical stop. • The lower and upper arms now rests on their respective mechanical stops. The motor axis 3 can now be replaced without securing the armsystem in an overhead crane.	Detailed in the section *Manually releasing the brakes on page 91*.

Continues on next page

	Action	Note
5	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
6	Remove any equipment hindering access to motor axis 3.	
7	Remove the cover on top of the motor by unscrewing its four attachment screws.	
8	Remove the *cable gland cover* at the cable exit by unscrewing its two securing screws.	Shown in the figure *Location of motor on page 263*. Make sure the gasket is not damaged!
9	Disconnect all connectors beneath the motor cover.	
10	Unscrew the motors four *attachment screws and plain washers* .	Shown in the figure *Location of motor on page 263*.
11	Fit the two *guide pins* in two of the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 263*.
12	Press the motor out of position by fitting *removal tool, motor* to the remaining motor attachment screw holes.	Art. no. is specified in *Required equipment on page 263*. Always use the removal tools in pairs!
13	Apply the *lifting tool, motor axis 2 ,3, 4* to the motor.	Art. no. is specified in *Required equipment on page 263*.
14	**CAUTION** The motor weighs 25 kg! All lifting equipment used must be sized accordingly!	
15	Lift the motor to get the pinion away from the gear.	
16	Remove the motor by gently lifting it straight out and disconnect the brake release voltage.	Make sure the motor pinion is not damaged!

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Refitting, motor

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate it with *grease*.	Art no. is specified in *Required equipment on page 263*.
3	Fit the *lifting tool, motor axis 2, 3, 4* to the motor.	Art no. is specified in *Required equipment on page 263*.
4	Fit the two *guide pins* in the two lower *motor attachment holes.*	Art no. is specified in *Required equipment on page 263*. Shown in the figure *Location of motor on page 263*
5	**CAUTION** The motor weighs 25 kg! All lifting equipment used must be sized accordingly!	
6	Lift the motor and guide it onto the guide pins, as close to the correct position as possible without pushing the motor pinion into the gear.	
7	Remove the lifting tool and allow the motor to stay on the guide pins.	
8	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP3 • +: pin 2 • -: pin 5

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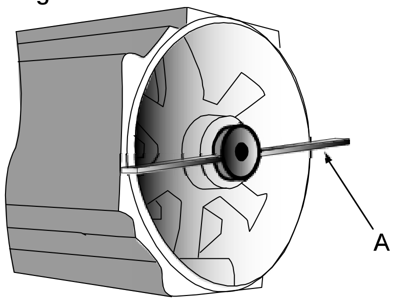
	Action	Note
9	Use the *rotation tool* in order to rotate the motor pinion when mating it to the gear! Fit the motor, making sure the motor pinion is properly mated to the gear of gearbox, axis 3.	Art no. is specified in *Required equipment on page 263*. Make sure the motor pinion does not get damaged! Make sure the motor is turned the right direction, that is the cables facing forwards.  xx0200000165 The rotation tool is used beneath the motor cover, directly on the motor shaft as shown in figure above. • A: Rotation tool.
10	Remove the guide pins.	
11	Secure the motor with four attachment screws and plain washers.	4 pcs: M10 x 40, tightening torque: 50 Nm.
12	Disconnect the brake release voltage.	
13	Reconnect all connectors beneath the motor cover.	Connect in accordance with markings on connectors.
14	Refit the *cable gland cover* at the cable exit with its two attachment screws.	Make sure the cover is tightly sealed! Shown in the figure *Location of motor on page 263*.
15	Refit the cover on top of the motor with its four attachment screws.	Make sure the cover is tightly sealed!
16	Remove the equipment used to unload the upper arm.	
17	Perform a leak-down test.	Detailed in the section *Performing a leak-down test on page 190*.
18	Refill the gearbox with oil.	Detailed in the section *Changing oil, axis-3 gearbox on page 169*.
19	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.

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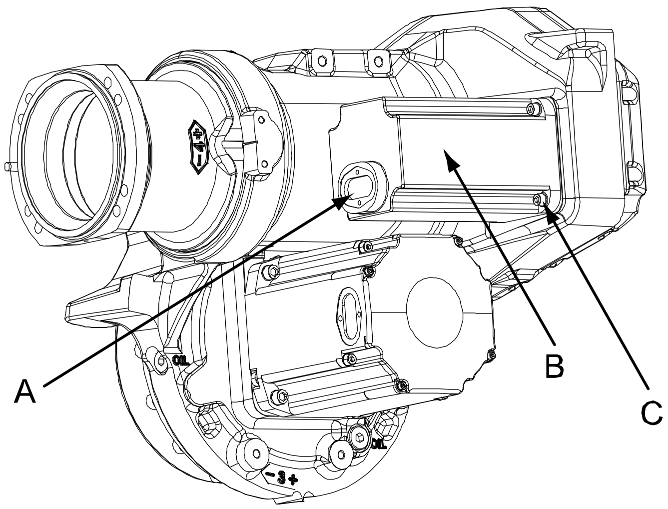
	Action	Note
20	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.6.4 Replacement of motor, axis 4

Location of motor

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



xx0600003050

A	Cable gland cover, motor axis 4
B	Motor, axis 4
C	Motor attachment holes (4 pcs)

Required equipment

Equipment, etc.	Art. no.	Note
Motor including pinion	See spare part number in *Spare part lists on page 359*.	Includes: • motor • pinion • o-ring 21522012-430
O-ring	21522012-430	Must be replaced when reassembling motor!
Grease	3HAB3537-1	Used to lubricate the o-ring.
Loctite 574, Flange sealant	12340011-116	Option Foundry Plus
Guide pins M8 x 100	3HAC15520-1	For guiding the motor.
Guide pins M8 x 150	3HAC15520-2	For guiding the motor.
Rotation tool	3HAC17105-1	Used to rotate the motor pinion when mating it to the gear when brakes are released with 24 VDC power supply.
Power supply	-	24 VDC, max. 1,5 A For releasing the brakes.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.

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Equipment, etc.	Art. no.	Note
Calibration Pendulum toolkit	3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
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	3HAC024090-001	See chapter *Circuit diagram on page 361*.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, motor axis 4

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

Continues on next page

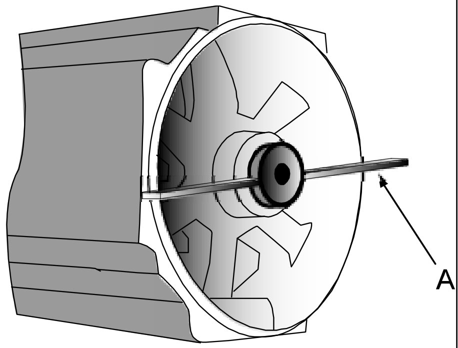
	Action	Note
2	Move the robot to a position where the upper arm is pointed straight up. This position enables the motor to be replaced without draining the gear oil, which in turn saves time. Any other position of the upper arm requires a draining of oil from the gearbox for axis 4.	Draining of oil is described in section *Draining, oil on page 172*.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove the *cable gland cover* at the cable exit of the motor by unscrewing its two attachment screws.	Shown in the figure *Location of motor on page 270*. Make sure the gasket is not damaged!
5	Remove the cover on top of the motor by unscrewing its four attachment screws.	
6	Disconnect all connectors beneath the motor cover.	
7	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP4 • +: pin 2 • -: pin 5
8	Unscrew the motors four *attachment screws and plain washers.*	Shown in the figure *Location of motor on page 270*.
9	Fit the two *guide pins* in two of the motor attachment screw holes.	
10	If required, press the motor out of position by fitting *removal tool, motor* to the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 270*. Always use the removal tools in pairs!
11	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	
12	Remove the motor by gently lifting it straight out.	Make sure the motor pinion is not damaged!

Refitting, motor axis 4

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	

Continues on next page

	Action	Note
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the o-ring with *grease.*	Art. no. is specified in *Required equipment on page 270*.
3	In order to release the brakes, connect the 24 VDC power supply.	Connect to connector R2.MP4: • +: pin 2 • -: pin 5
4	Fit the two *guide pins* in two of the *motor attachment holes.*	Art. no. is specified in *Required equipment on page 270*. Shown in the figure *Location of motor on page 270*.
5	Fit the motor with guidance of the pins, making sure the motor pinion is properly mated to the gear of gearbox 4.	Make sure the motor pinion does not get damaged!
6	Use the *rotation tool* in order to rotate the motor pinion when mating it to the gear! Fit the motor, making sure the motor pinion is properly mated to the gear, axis 4.	Art. no. is specified in *Required equipment on page 270*. Make sure the motor pinion does not get damaged! Make sure the motor is turned the right direction, that is the cables facing forwards.  xx0200000165 The rotation tool is used beneath the motor cover, directly on the motor shaft as shown in figure above. • A: Rotation tool.
7	Remove the guide pins.	
8	Secure the motor with four attachment screws and plain washers.	4 pcs: M8 x 25, tightening torque: 24 Nm.
9	Disconnect the brake release voltage.	
10	Reconnect all connectors beneath the motor cover.	
11	Refit the cover on top of the motor with its four attachment screws.	Make sure the cover is tightly sealed!
12	Refit the *cable gland cover* at the cable exit with its two attachment screws.	Shown in the figure *Location of motor on page 270*.
13	Perform a leak-down test if the gearbox has been drained.	Detailed in the section *Performing a leak-down test on page 190*.
14	Refill the gearbox with oil if drained.	

Continues on next page

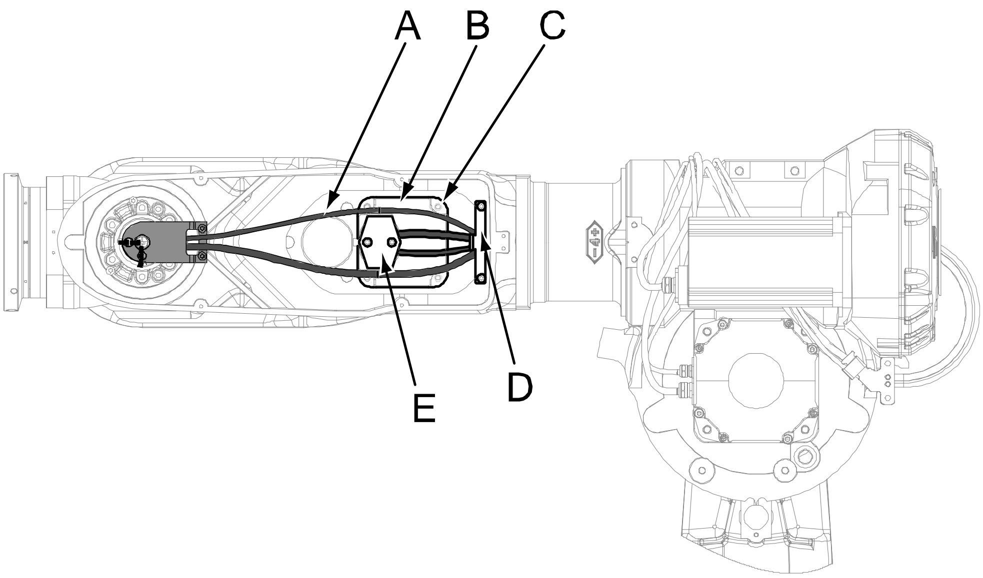
	Action	Note
15	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
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 51*.	

4.6.5 Replacement of motor, axis 5 , IRB 6620/6620LX

Location of motor

The motor axis 5 is located inside the upper arm tube, but attached to the wrist unit, as shown in the figure below.

A more detailed view of the component and its position may be found in *Spare part lists on page 359*.



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A	Cable harness
B	Motor, axis 5
C	Attachment screws (4 pcs)
D	Metal clamp
E	Cover, cable gland

Required equipment

Equipment, etc.	Art. no.	Note
Motor	For spare part number, see *Spare part lists on page 359*.	
Retrofit set Foundry Plus, wrist	For spare part number, see *Spare part lists on page 359*.	
Retrofit set Foundry Plus, upper arm axis 4	For spare part number, see *Spare part lists on page 359*.	
O-ring	21522012-430	Must be replaced when reassembling motor!
Grease	3HAB3537-1	For lubricating the o-ring.
Loctite 574, Flange sealant	12340011-116	Option Foundry Plus

Continues on next page

Equipment, etc.	Art. no.	Note
Removal tool, motor M10x	3HAC14972-1	Always use the removal tools in pairs!
Extension bar 300 mm for bits 1/2"	3HAC12342-1	
Guide pins M8 x 100	3HAC15520-1	For guiding the motor.
Guide pins M8 x 150	3HAC15520-2	For guiding the motor.
Power supply	-	24 VDC, 1.5 A For releasing the brakes.
Standard toolkit	-	Content is defined in section *Standard tools on page 354*.
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 361*.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

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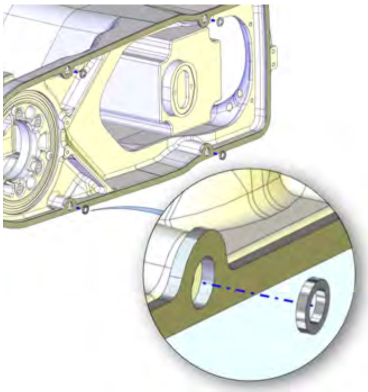
Removal, motor, axis 5

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to a position where the upper arm is parallel to the floor and the side of the wrist unit, where motor axis 5 is placed, is facing up.	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove the cover on the wrist unit by removing its attachment screws. **Note** Make sure not to lose the washers placed in the holes of the foundry gasket.	 xx1400002580
5	Remove the *metal clamp* securing the cable harness.	Shown in the figure in section *Location of motor on page 275*.
6	Remove the *cable gland cover* at the cable exit by unscrewing its two attachment screws.	Shown in the figure in section *Location of motor on page 275*.
7	Remove the cover on top of the motor by unscrewing its four attachment screws.	
8	Disconnect all connectors beneath the motor cover and remove the cable of the axis-5 motor.	
9	Pull the *cable harness* out of the upper arm a little, far enough to make room for removal of the motor.	Shown in the figure in the section *Location of motor on page 275*.
10	In order to release the brake, connect the 24 VDC power supply.	Connect to: - connector R2.MP5 (in the motor): • + : pin 2 • -: pin 5
11	Remove the motor by unscrewing its four attachment screws and plain washers.	
12	Fit the two *guide pins* in two of the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 275*.

Continues on next page

	Action	Note
13	If required, press the motor out of position by fitting *removal tool, motor, M10* to the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 275*. Always use the removal tools in pairs and diagonally!
14	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	Make sure the motor pinion is not damaged!
15	Remove the motor by gently lifting it straight out.	Keep track of the shims between the motor flange and the wrist housing.

Refitting, motor, axis 5

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the *o-ring* with *grease.*	Art. no. is specified in *Required equipment on page 275*.
3	In order to release the brake, connect the 24 VDC power supply.	Connect to: - connector R2.MP5 (in the motor): • + : pin 2 • -: pin 5
4	Fit the two *guide pins* in two of the motor attachment holes.	Art. no. is specified in *Required equipment on page 275*.
5	Fit the motor, with guidance from the pins, making sure the motor pinion is properly mated to the gear of axis 5.	Make sure the motor pinion does not get damaged!
6	Secure the motor with four attachment screws and plain washers.	4 pcs: M8 x 25; tightening torque: 24 Nm.
7	Disconnect the brake release voltage.	
8	Refit the cable of the axis-5 motor and reconnect all connectors beneath the motor cover.	
9	Refit the cover on top of the motor with its four attachment screws.	
10	Refit the cable gland cover at the cable exit with its two attachment screws.	Make sure the cover is tightly sealed!
11	Refit the *metal clamp* securing the cable harness.	Shown in the figure in the section *Location of motor on page 275*.
12	Perform a leak-down test.	Detailed in the section *Performing a leak-down test on page 190*.
13	*Standard* Refit the cover of the wrist unit with its attachment screws.	

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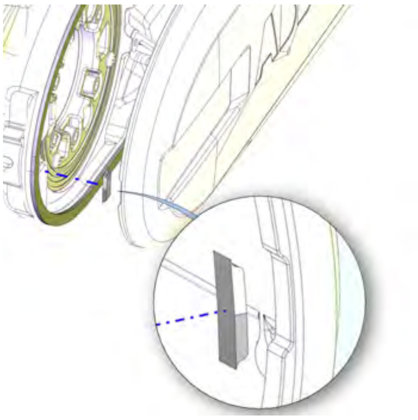
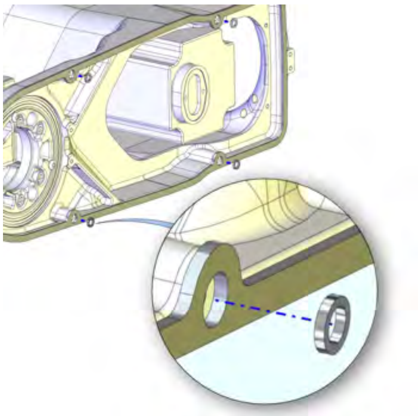
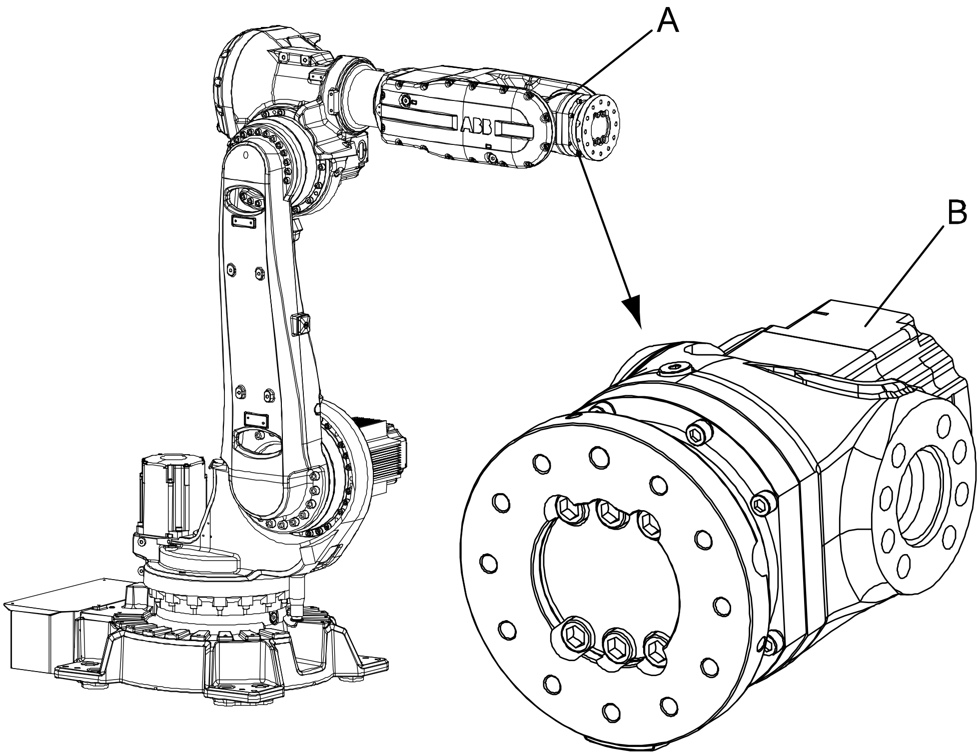
	Action	Note
14	*Foundry Plus* Make sure that the gasket is undamaged. Also the small gasket fitted in the cover recess. Replace if damaged.	 xx1400002579
15	*Foundry Plus* Make sure the washers are fitted in the gasket holes. Refit the *cover, wrist unit* Foundry Plus.	 xx1400002580
16	Refill the gear with oil.	Detailed in the section *Changing oil, axis-5 gearbox on page 175*.
17	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
18	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.6.6 Replacement of motor, axis 6

Location of motor

The motor axis 6 is located in the center of the wrist unit as shown in the figure below.



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A	Wrist unit
B	Motor, axis 6

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor including pinion Motor including pinion (Foundry Plus)	See spare part number in *Spare part lists on page 359*.		Includes: • motor • pinion • o-ring 21522012-430
Motor including pinion (insulated)	See spare part number in *Spare part lists on page 359*.		Includes: • motor • pinion • o-ring 21522012-430
O-ring	21522012-430		Must be replaced when reassembling motor!
Gasket	3HAC12877-1		Protection Standard. Must be replaced when replacing motor

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
Gasket	3HAC033206-001		Protection Foundry Plus Must be replaced when replacing motor
Gasket, cover	3HAC033489-001		Must be replaced when opening cover.
Removal tool, motor M10x		3HAC14972-1	Always use the removal tools in pairs!
Extension bar 300 mm for bits 1/2"		3HAC12342-1	
Guide pins M8 x 100		3HAC15520-1	For guiding the motor.
Guide pins M8 x 150		3HAC15520-2	For guiding the motor.
Power supply		-	24 VDC, 1.5 A For releasing the brakes.
Grease		3HAB3537-1	For lubricating the o-ring.
Loctite 574, Flange sealant		12340011-116	Option Foundry Plus
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
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 361*.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	

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	Action	Note
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, motor

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

Note

Robots with protection type Foundry Plus or Foundry Prime require special repair routines to maintain the tightness level, in addition to the procedure below, described in *Replacement of the motor axis 6 (Foundry Plus) on page 285*.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to a position where the motor in axis 6 is pointed straight up. This position enables the motor to be replaced without draining the gear oil, which in turn saves time.	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove the rear motor cover by unscrewing the five attachment screws.	
5	Disconnect all connectors beneath the cover.	
6	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R3.MP6 • +: pin 2 • -: pin 5

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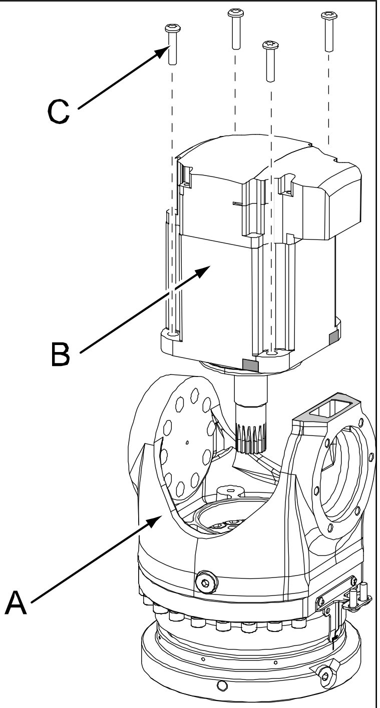
	Action	Note
7	Remove the motor by unscrewing its four attachment screws and plain washers.	 xx0600003038 • A: Tilthouse • B: Motor, axis 6 • C: Attachment screws (4 pcs)
8	If required, press the motor out of position by fitting *removal tool, motor* to the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 280*. Always use the removal tools in pairs!
9	Lift the motor carefully to get the pinion away from the gear and disconnect the brake release voltage.	Make sure the motor pinion is not damaged!
10	Remove the motor by gently lifting it straight out.	

Refitting, motor

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

Note

Robots with protection type Foundry Plus or Foundry Prime require special repair routines to maintain the tightness level, in addition to the procedure below, described in *Replacement of the motor axis 6 (Foundry Plus) on page 285*.

	Action	Note
1	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the o-ring with *grease.*	Art. no. is specified in *Required equipment on page 280*.
2	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R3.MP6 • +: pin 2 • -: pin 5

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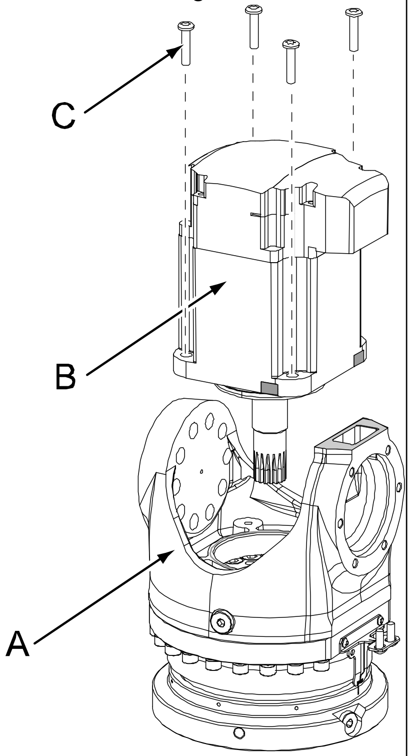
	Action	Note
3	Fit the two *guide pins* in two of the motor attachment holes.	Art. no. is specified in *Required equipment on page 280*.
4	Fit the motor, with guidance from the pins, making sure the motor pinion is properly mated to the gear of gearbox, axis 6.	Make sure the pinion on the motor shaft is not damaged!  xx0600003038 • A: Tilthouse • B: Motor, axis 6 • C: Attachment screws
5	Remove the guide pins.	
6	Secure the motor with its four attachment screws and plain washers.	4 pcs: M8 x 25, tightening torque: 24 Nm.
7	Disconnect the brake release voltage.	
8	Reconnect all connectors beneath the motor cover.	
9	Refit the cover on top of the motor with its five attachment screws.	Make sure the cover is tightly sealed!
10	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.

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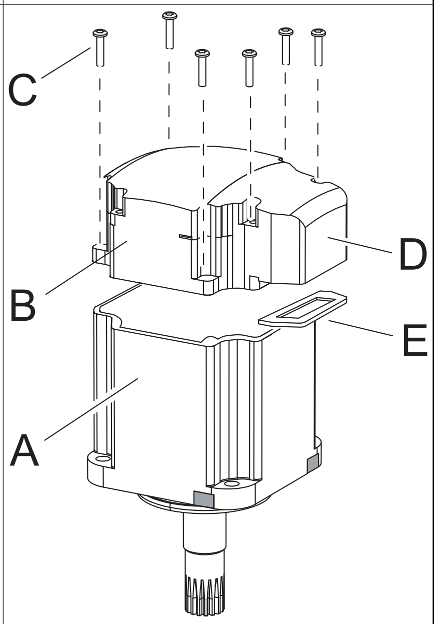
	Action	Note
11	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

Replacement of the motor axis 6 (Foundry Plus)

Robots with protection type Foundry Plus require special repair routines to maintain the tightness level.

The repair must be done according to the previous repair procedure with the following additions.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Remove the rear motor cover by unscrewing the five attachment screws.	 xx1500002524 • A: Motor unit • B: Connection box • C: Attachment screw (5 pcs) • D: Rear motor cover • E: Gasket
3	Continue to remove the motor unit, according to step 6 and forwards in *Removal, motor on page 282*.	

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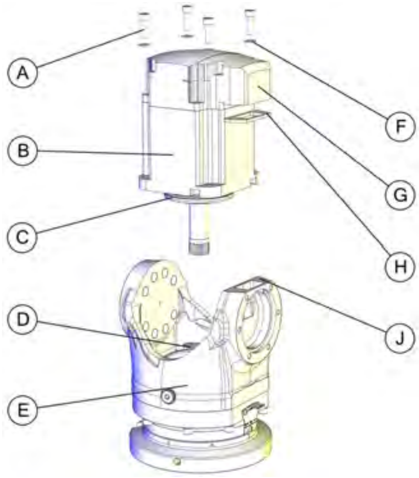
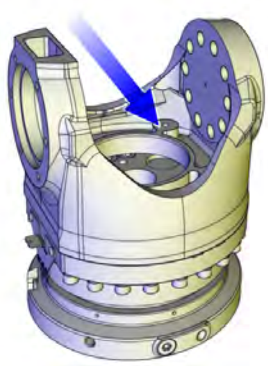
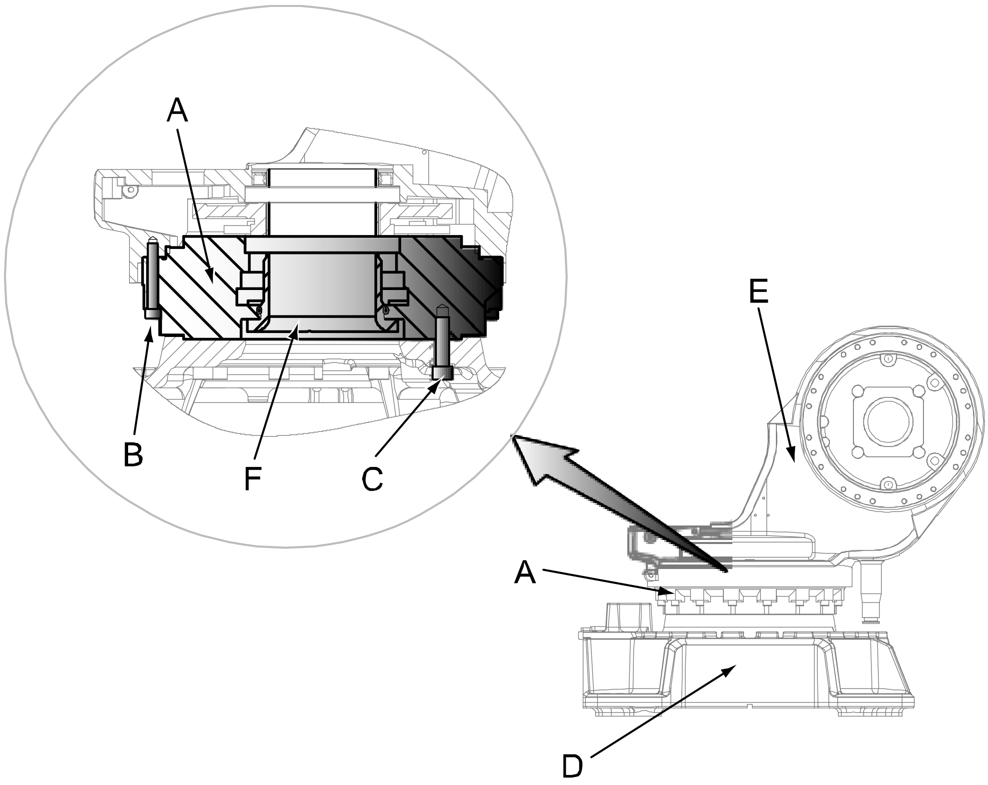
	Action	Note
4	**Note** Keep the old *rear motor cover* with the air nipple.	
5	Remove the protection strip on the *gasket* and mount it on the *motor*.	 xx1500002425 • A: Attachment screw (4pcs) Mercasol 3106 • B: Motor unit • C: O-ring • D: Sikaflex in screw recesses • E: Tilt house • F: Washer • G: Rear motor cover • H: Sealing • J: Loctite 574
6	Apply Mercasol 3106 on the *motor end cover*.	
7	Apply Loctite 574 flange sealant on the contact surface.	 xx1400000992
8	Apply grease on the *o-ring* on the *motor*.	
9	Continue to refit the new motor according to section, *Refitting, motor on page 283*.	

4.7 Gearboxes

4.7.1 Replacement gearbox axis 1

Location of gearbox axis 1



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A	Gearbox, axis 1 RV 320C-191.35
B	Attachment screw, M12x80 quality 12.9 gleitmo (16 pcs)
C	Attachment screw, M16x60 quality 12.9 gleitmo (12 pcs)
D	Base
E	Frame
F	Protection pipe axis 1
G	O-ring

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Gearbox, axis 1	See *Spare part lists on page 359*.		Includes: • gearbox • o-ring
O-ring	3HAB3772-93		Replace only when damaged. 380.6x3.53
O-ring (3 pcs)	3HAB3772-97		23x3.6

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Equipment, etc.	Spare part no.	Art. no.	Note
Support, base and gear axis 1		3HAC15535-1	Consists of 4 pcs.
Guide pins (M16x300)		3HAC13120-5	Always use guiding pins in pairs.
Guide pins (M16x250)		3HAC13120-4	Always use guiding pins in pairs
Lifting tool		3HAC026597-001	Instruction 3HAC026600-002 is enclosed.
Lifting tool		3HAC15556-1	Used to lift gearbox axis 1 and frame.
Lifting eye (2 pcs)		3HAC025333-005	Used together with lifting tool 3HAC15556-1.
Grease		3HAB3537-1	For lubricating o-rings.
Standard tools		-	Content is defined in section *Standard tools on page 354*.
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.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

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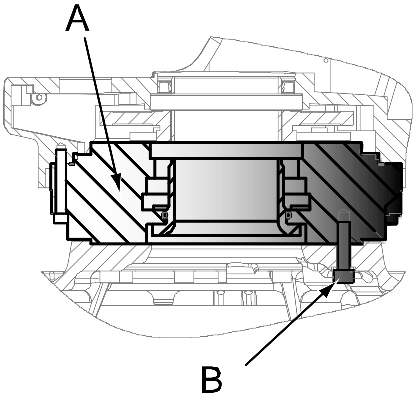
Removal

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Remove motor, axis 1.	Detailed in section *Replacement of motor, axis 1 on page 252*.
4	Remove the cable harness, axes 1-2. Secure the cable harness to the robot in a safe way, that it will not be damaged in the continued removal procedure.	Detailed in section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
5	Run an overhead crane to a position above the robot.	
6	**CAUTION** The complete arm system weighs 590 kg! All lifting equipment used must be sized accordingly!	
7	Lift the robot (without the base) and put it safely on its side on the floor.	
8	Remove the robot´s attachments screws in order to unfasten the base from the foundation.	Detailed in section *Orienting and securing the robot on page 99*.
9	Fit two *lifting eyes* on each side of the gearbox and secure it with a roundsling.	Art. no. is specified in *Required equipment on page 287*.
10	Attach the *lifting tool* to the gearbox.	Art. no. is specified in *Required equipment on page 287*.
11	**CAUTION** The complete gearbox unit and base weighs 241 kg together! (Base: 133 kg, gearbox unit: 108 kg.) All lifting equipment used must be sized accordingly!	
12	Lift the robot base with gearbox axis 1, to allow fitting the *support, base and gear axis 1* on each side of the base.	Art. no. is specified in *Required equipment on page 287*.

Continues on next page

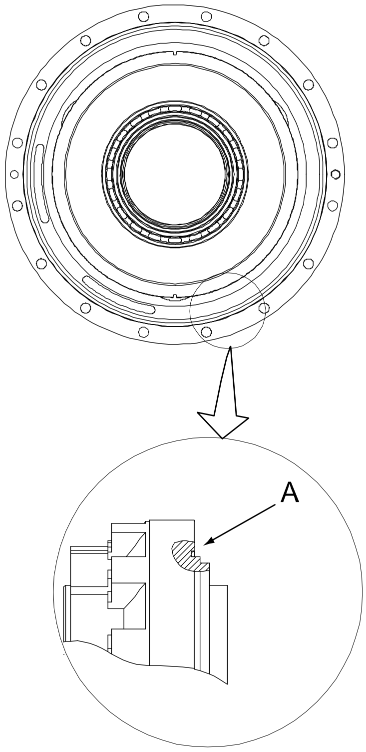
	Action	Note
13	Fit the support, base and gear axis 1. Make sure the base remains in a stable position before performing any work underneath the base!	
14	Unscrew the 12 attachment screws and washers securing the gearbox to the base.	 xx0600003069 • A: Gearbox, axis 1 • B: Attachment screw, M16x60
15	**CAUTION** The gearbox weighs 108 kg! All lifting equipment used must be sized accordingly!	
16	Remove the gearbox.	

Refitting

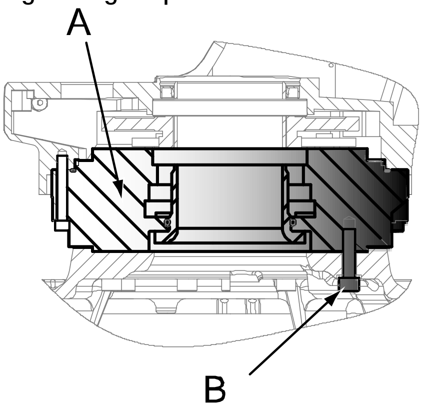
The procedure below details how to remove the gearbox axis 1.

	Action	Note
1	If the base not already is resting on the *support base and gear, axis 1*, this should be done first.	Mounting of the *support base and gear, axis 1* is detailed in section *Removal on page 289*.

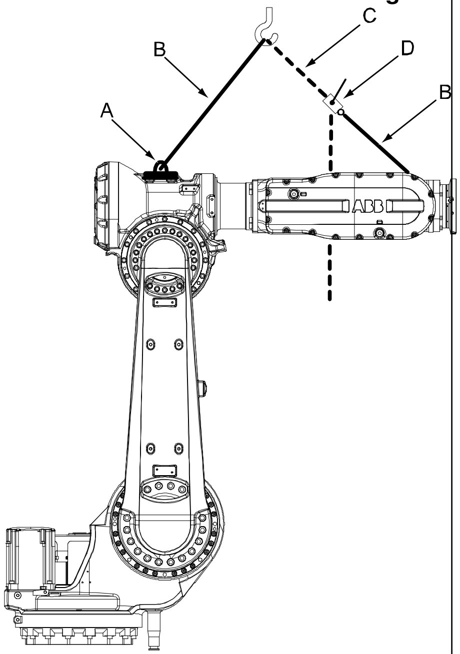
Continues on next page

	Action	Note
2	Make sure the *o-ring* is fitted to the gearbox as shown in the figure to the right. Lightly lubricate the o-ring with grease.	Art. no. is specified in *Required equipment on page 287*.  xx0600003126 • A : O-ring (Gearbox shown from the side)
3	Fit the three o-rings (23x3.6).	Use some grease to attach them.
4	Refit the *protection pipe axis 1* in the center of gearbox 1 with its attachment screws.	Shown in the figure *Location of gearbox axis 1 on page 287*.
5	Fit two *lifting eyes* on each side of the gearbox and secure it with a roundsling.	Art. no. is specified in *Required equipment on page 287*.
6	Fit two guide pins in two of the attachment holes, parallel to each other.	
7	**CAUTION** The gearbox weighs 108 kg! All lifting equipment used must be sized accordingly!	
8	Lift the gearbox on to the guide pins and lower it carefully to its mounting position.	

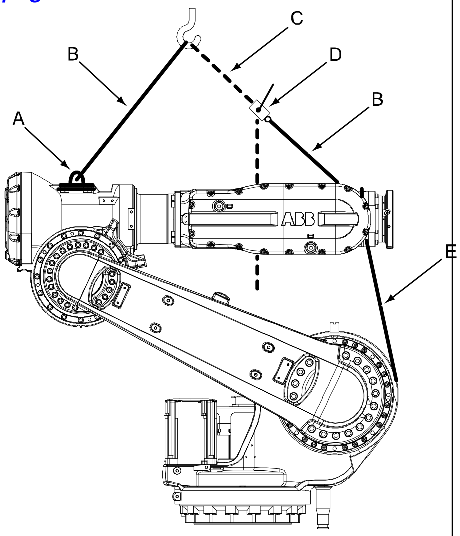
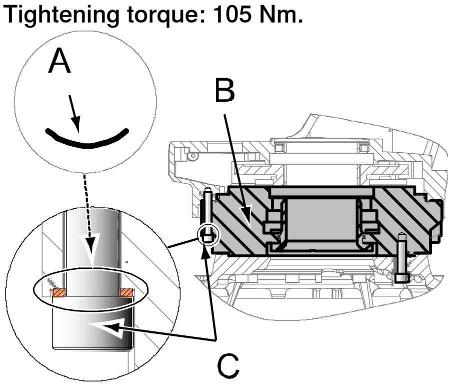
Continues on next page

	Action	Note
9	Refit the gearbox to the base with its attachment screws and washers.	Shown in the figure *Location of gearbox axis 1 on page 287*. M16x60 quality 12.9 (12 pcs) Tightening torque: 300 Nm.  xx0600003069 • A: Gearbox, axis 1 • B: Attachment screw, M16x60
10	**CAUTION** The complete gearbox unit and base weighs 241 kg together! (Base: 133 kg, gearbox unit: 108 kg.) All lifting equipment used must be sized accordingly!	
11	Lift the robot base and gearbox 1 to allow removing the support, base and gear.	
12	Secure the base to the mounting site.	Detailed in section *Orienting and securing the robot on page 99*.
13	**CAUTION** The complete arm system weighs 590 kg! All lifting equipment used must be sized accordingly!	

Continues on next page

	Action	Note
14	Fit the *lifting tool* and adjust as detailed in the enclosed instructions. Also fit a hoisting block to the front, used to adjust the balance of the armsystem in order to lift it completely level. **Note** There is an **alternate method** of lifting the complete armsystem, described below.	Art. no. is specified in *Required equipment on page 287*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting tool. **Read the instructions before lifting!**  xx0600003101 • A : Lifting tool • B : Roundsling • C : Lifting sling • D : Hoisting block

Continues on next page

	Action	Note
15	**Alternate method** of lifting: Fit the **lifting tool** and a roundsling on the upper arm and a roundsling with a hoisting block, to the wrist unit. Also fit a separate roundsling between the wrist and the frame in order to eliminate any load through the brake on motor axis 3. The hoisting block is used to balance the upper arm. **Note** The brake on axis 3 shall be released during the lift, until the roundsling between the wrist and the frame transfers the load of the frame!	Art. no. is specified in *Required equipment on page 287*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting tool. *Read the instructions before lifting!* Releasing the brakes is detailed in section *Manually releasing the brakes on page 91*.  xx0600003100 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block • E : Roundsling (used to transfer the load of the frame)
16	Refit the robot to the base with its attachment screws and serrated lock washers. **Note** The orientation of the serrated lock washer must be fitted as is shown in the figure to the right!	Shown in the figure *Location of gearbox axis 1 on page 287*. M12x80 quality 12.9 (16 pcs) Tightening torque: 105 Nm.  xx0600003070 • A: Serrated lock washer • B: Gearbox, axis 1 • C: Attachment screw, M12x80

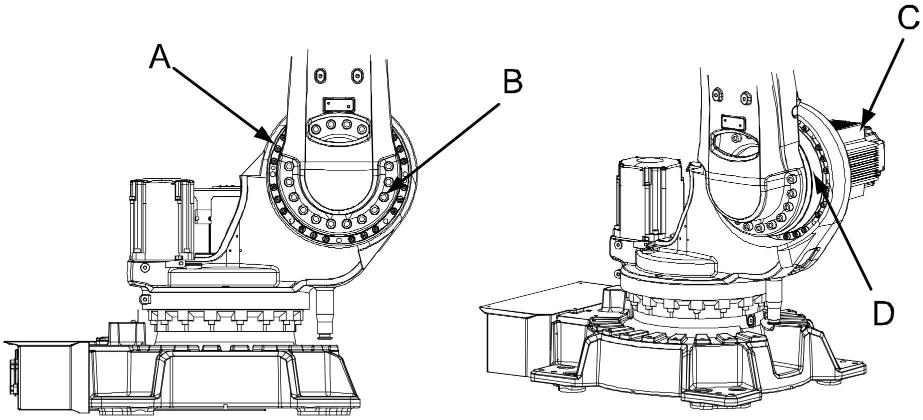
Continues on next page

	Action	Note
17	Refit the cable harness, axes 1-2.	Detailed in section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
18	Refit motor, axis 1.	Detailed in section *Replacement of motor, axis 1 on page 252*.
19	Fill oil in gearbox axis 1.	Detailed in section *Changing oil, axis-1 gearbox on page 163*.
20	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
21	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

4.7.2 Replacement gearbox axis 2

Location of gearbox axis 2

The gearbox axis 2 is located in the lower arm rotational center.



xx0600003056

A	Attachment screws, M12x60 quality 12.9 Gleitmo (24 pcs)
B	Attachment screws, M16x50 quality 12.9 Gleitmo (16 pcs)
C	Motor, axis 2
D	Gearbox, axis 2

Required equipment

Equipment, etc	Spare part no.	Art. no.	Note
Gearbox, axis 2	See Spare parts		Includes: • gearbox • o-ring
O-ring (339.3x5.7)	3HAB3772-91		
Grease		3HAB3537-1	For lubricating o-rings.
Lifting tool		3HAC026597-001	Instruction 3HAC026600-002 is enclosed.
Lifting tool		3HAC025214-001	For lifting gearbox
Roundsling		-	
Guide pins (M12x250)		3HAC13056-4	Always use in pairs.
Guide pins (M12x200)		3HAC13056-3	Always use in pairs.
Crank		3HAC020999-001	Used to turn the gear in correct position.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.

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.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

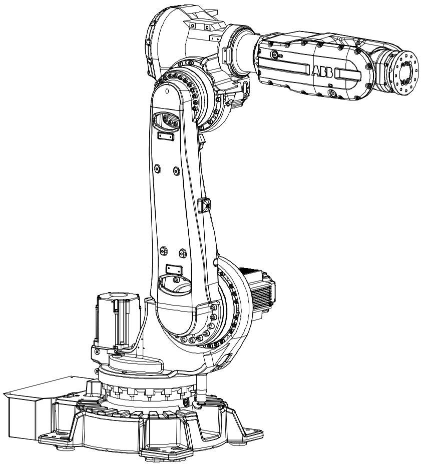
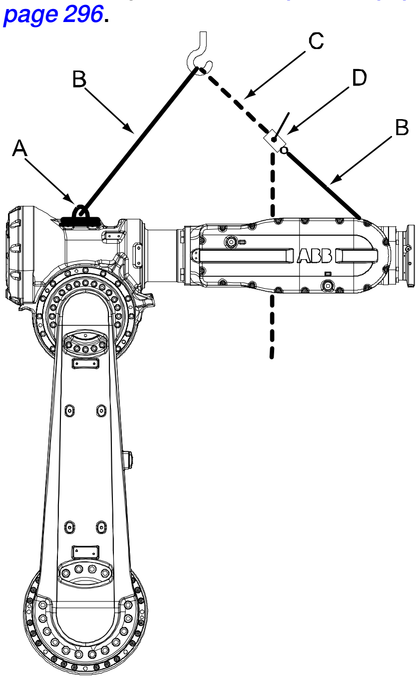
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal

The procedure below details how to remove gearbox axis 2.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

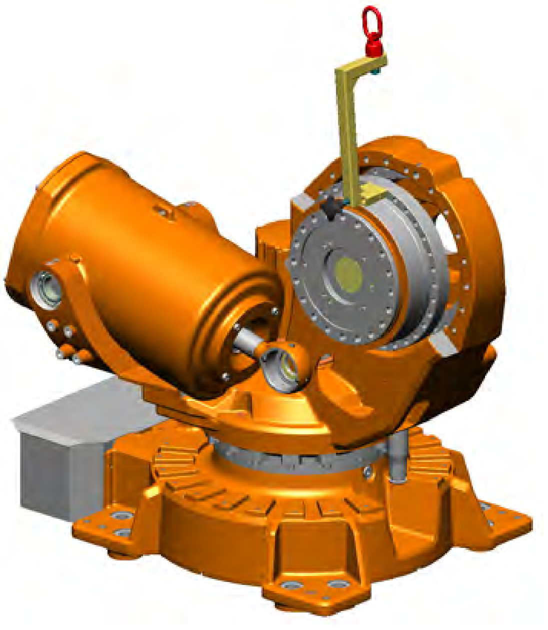
Continues on next page

	Action	Note
2	Jog the robot to the position shown in the figure to the right.	 xx0600003125
3	**CAUTION** The upper and lower arms (incl. gearboxes axes 2 and 3) weighs 455 kg. All lifting equipment used must be sized accordingly!	
4	Fit the *lifting tool* on the upper arm and secure the robot in an overhead crane.	Art. no. is specified in *Required equipment on page 296*.  xx0600003099 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block
5	Drain the oil from gearbox axis 2.	Detailed in the section *Changing oil, axis-2 gearbox on page 166*.

Continues on next page

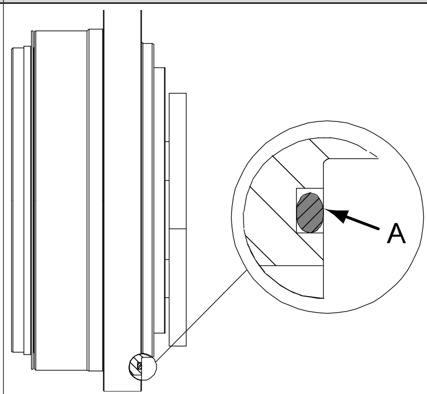
	Action	Note
6	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
7	Remove the cable harness, axes 1-3.	Detailed in the section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
8	Let the removed part of the cable harness hang loose and take care not to damage it during the removal process.	
9	Remove the attachment screws M16x50 (16 pcs) that secure the lower arm to gearbox axis 2.	Shown in the figure *Location of gearbox axis 2 on page 296*.
10	Remove the upper and lower arms and put them down on the floor.	
11	Remove motor axis 2.	Detailed in the section *Replacement of motor axis 2 on page 257*.
12	Remove two attachment screws (M12x60) parallel to each other.	
13	Fit two guide pins in the holes, parallel to each other.	
14	**CAUTION** The gearbox weighs 98 kg! All lifting equipment used must be sized accordingly!	

Continues on next page

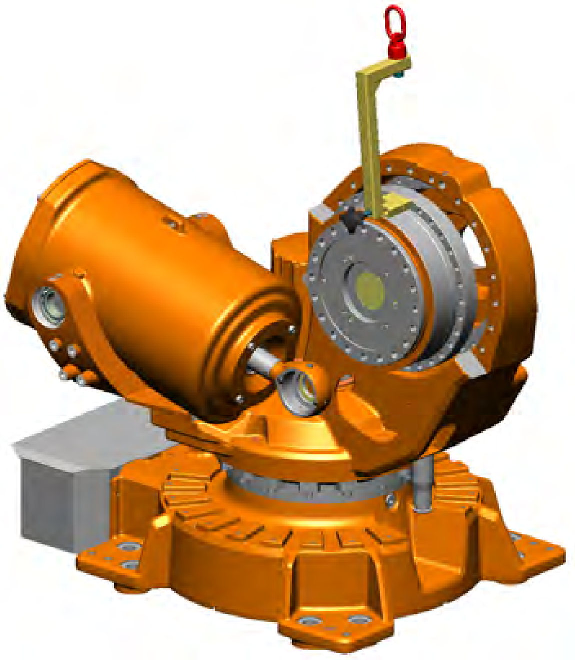
	Action	Note
15	Fit the *lifting tool* for lifting the gearbox in the uppermost hole and secure it with a roundsling.	Art. no. is specified in *Required equipment on page 296*.  xx0900000114 The figure shows IRB6640.
16	Remove the attachment screws M12x60 (24 pcs) securing the gearbox to the frame.	Shown in the figure *Location of gearbox axis 2 on page 296*.
17	Remove the gearbox and put it in a place where it will not/cannot be damaged.	
18	Wipe away residual oil and paint.	

Refitting

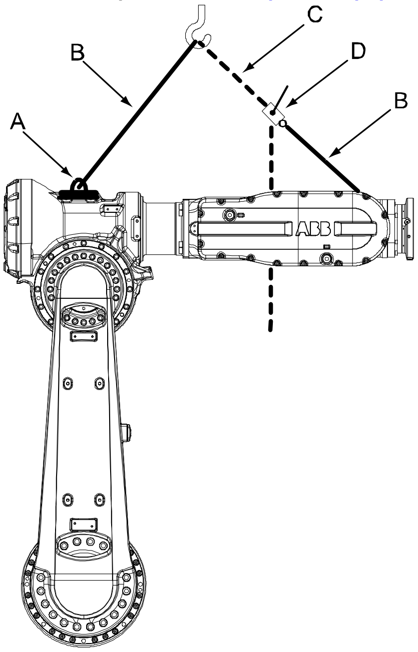
The procedure below details how to refit gearbox axis 2.

	Action	Note
1	Make sure the o-ring is fitted to the gearbox. Lightly lubricate it with grease.	 xx0600003128 • A : O-ring 3HAB3772-91

Continues on next page

	Action	Note
2	**CAUTION** The gearbox weighs 98 kg! All lifting equipment used must be sized accordingly!	
3	Fit the *lifting tool* for lifting the gearbox in the uppermost hole of the gearbox and secure it with a roundsling.	Art. no. is specified in *Required equipment on page 296*.  xx0900000114 The figure shows IRB6640.
4	Fit two guide pins in two of the attachment holes, parallel to each other.	
5	Lift the gearbox on to the guide pins and push it in mounting position.	
6	Refit the gearbox with its attachment screws.	M12x60 (24 pcs) Tightening torque: 120 Nm.
7	**CAUTION** The upper and lower arms (incl. gearboxes axes 2 and 3) weighs 455 kg. All lifting equipment used must be sized accordingly!	

Continues on next page

	Action	Note
8	Fit the *lifting tool* on the upper arm and secure the robot in an overhead crane and lift it carefully up to its mounting position.	Art. no. is specified in *Required equipment on page 296*.  xx0600003099 • A : Lifting tool • B : Roundsling • C : Lifting chain • D : Hoisting block
9	Use a crank in the gearbox in order to find the holes for the attachment screws.	
10	Refit the lower arm to the gearbox axis 2 with its attachment screws.	M16x50 (16 pcs) Tightening torque: 300 Nm.
11	Refit motor axis 2.	Detailed in the section *Replacement of motor axis 2 on page 257*.
12	Refit the cable harness, axes 1-3.	Detailed in the section *Replacement of cable harness, lower end (axes 1-2) on page 195*.
13	Fill the gearbox axis 2 with oil.	Detailed in the section *Changing oil, axis-2 gearbox on page 166*.
14	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.

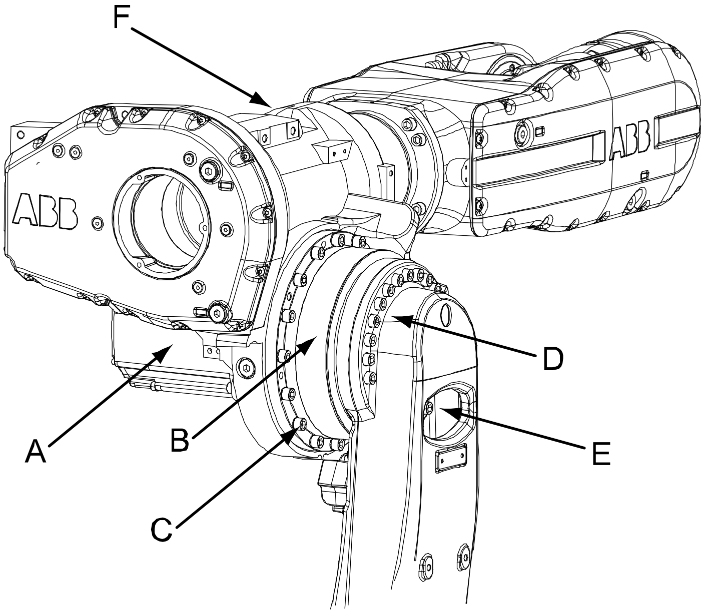
Continues on next page

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

4.7.3 Replacement of gearbox axis 3

Location of gearbox axis 3

The gearbox axis 3 is located in the upper arm rotational center.



xx0600003057

A	Motor, axis 3
B	Gearbox, axis 3
C	Attachment screws, M12x50 quality 12.9 gleitmo (20 pcs)
D	Attachment screws, M16x50 quality 12.9 gleitmo (16 pcs)
E	Hole in lower arm

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Gearbox, axis 3	See *Spare part lists on page 359*.		Includes: • gearbox • o-ring
O-ring		3HAB3772-92	Replace only if damaged.
Grease		3HAB3537-1	Used to lubricate the o-ring.
Lifting tool		3HAC026597-001	Instructions 3HAC 026600-002 is enclosed.
Lifting tool		3HAC025214-001	For lifting gearbox.
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.

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.

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

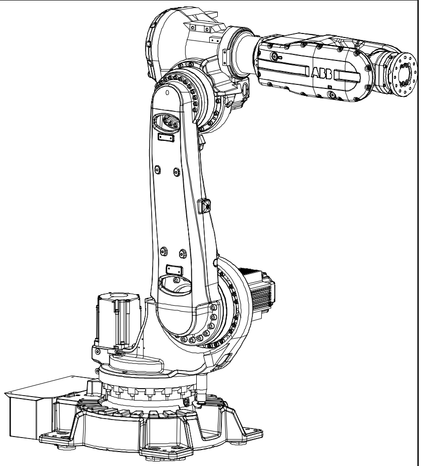
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal

The procedure below details how to remove gearbox axis 3.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

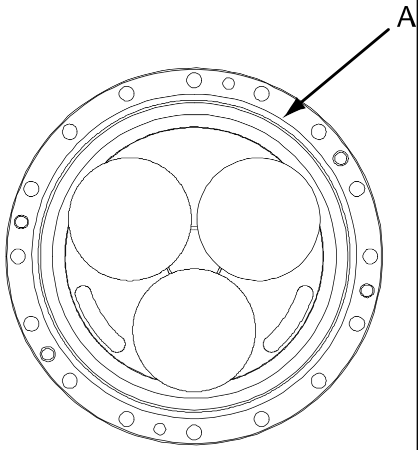
Continues on next page

	Action	Note
2	Move the robot to the position shown in the figure to the right.	 xx0600003125
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Drain the oil from gearbox axis 3.	Detailed in the section *Changing oil, axis-3 gearbox on page 169*.
5	Remove the upper arm.	Detailed in the section *Replacement of the upper arm on page 232*.
6	While the upper arm is resting on its side on the floor, fit the *lifting tool* in the uppermost hole of the gearbox.	Art. no. is specified in *Required equipment on page 304*.
7	**CAUTION** The gearbox weighs 51 kg! All lifting equipment used must be sized accordingly!	
8	Secure the gearbox with a roundsling in an overhead crane.	
9	Remove the *attachment screws* securing the gearbox to the upper arm.	Shown in the figure *Location of gearbox axis 3 on page 304*.
10	Remove the gearbox and put it in a safe place.	

Continues on next page

Refitting

The procedure below details how to refit gearbox axis 3.

	Action	Note
1	Make sure the o-ring is fitted to the gearbox. Lightly lubricate the o-ring with grease.	 xx0600003127 • A : O-ring 3HAB 3772-92
2	**CAUTION** The gearbox weighs 51 kg! All lifting equipment used must be sized accordingly!	
3	Fit a *lifting tool* in the uppermost hole of the gearbox and secure it with a roundsling.	Art. no. is specified in *Required equipment on page 304*.
4	Fit two guide pins in two of the attachment holes, parallel to each other.	
5	Lift the gearbox on to the guide pins and push it to its mounting position.	
6	Refit the gearbox, while the upper arm is resting on its side on the floor.	
7	Refit the *upper arm*.	Detailed in the section *Replacement of the upper arm on page 232*.
8	Fill the *gearbox axis 3* with oil.	Detailed in the section *Changing oil, axis-3 gearbox on page 169*.
9	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.

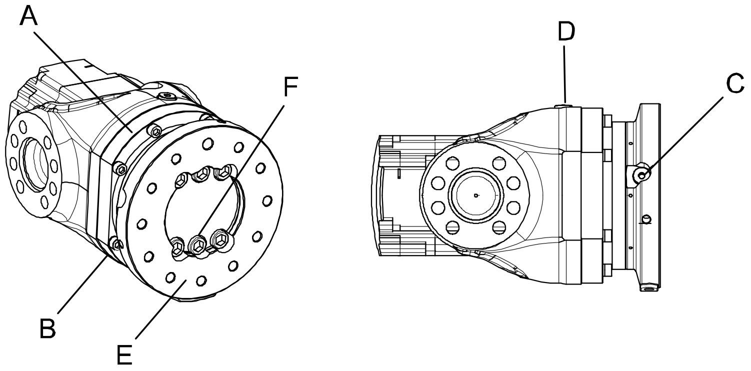
Continues on next page

	Action	Note
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 51*.	

4.7.4 Replacement of gearbox, axis 6

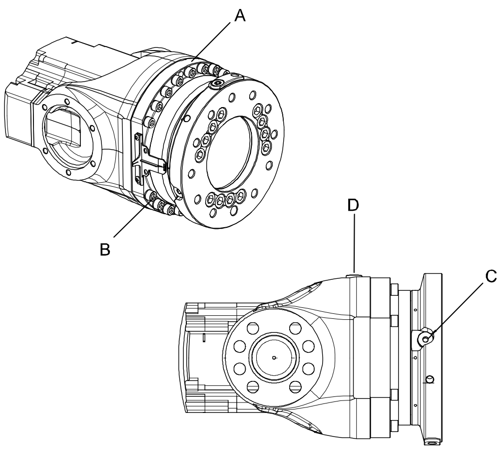
Location of gearbox

The axis 6 gearbox is located in the center of the wrist unit as shown in the figure below.



xx0600003085

A	Gearbox, axis 6 (IRB 6620)
B	Attachment screws, gearbox
C	Oil plug, draining
D	Oil plug, filling
E	Turning disk
F	Attachment screws, turning disk



xx0200000219

A	Gearbox, axis 6 (IRB 6620 Foundry Plus)
B	Attachment screws and washers
C	Oil plug, draining
D	Oil plug, filling

Continues on next page

Required equipment

Equipment, etc.		Art. no.	Note
Gearbox		For spare part number, see *Spare part lists on page 359*.	Includes o-ring.
O-ring		3HAB3772-58	Must be replaced when reassembling gearbox!
O-ring		3HAB3772-57	For type 2 of the gearbox. 164.7x3.53 Must be replaced when reassembling gearbox.
O-ring		3HAB3772-64	For type 2 of the gearbox. 150.0x2.0 Must be replaced when reassembling gearbox.
O-ring		3HAB3772-61	For type 2 of the gearbox. 12 pcs, 13.1x1.6 Must be replaced when reassembling gearbox.
Grease		3HAB3537-1	For lubricating the o-ring.
Flange sealant		12340011-116	Loctite 574
Standard toolkit		-	Content is defined in section *Standard tools on page 354*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
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

Deciding calibration routine

Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

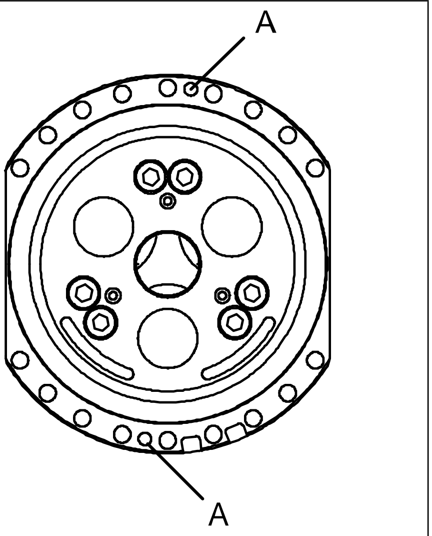
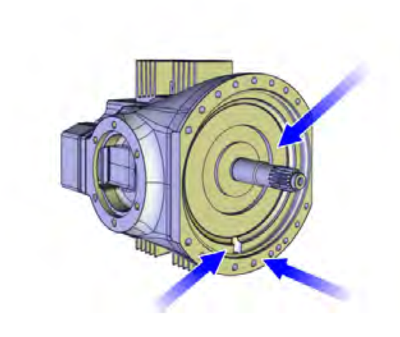
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 330*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, gearbox

The procedure below details how to remove gearbox, axis 6.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Drain the oil from gearbox, axis 6.	Detailed in the section *Changing oil, axis-6 gearbox on page 178*.
4	Remove the *turning disk*.	Detailed in the section *Removing, turning disk on page 224*.
5	Remove the gearbox by unscrewing its 8 attachment screws.	Shown in the figure *Location of gearbox on page 309*.

Continues on next page

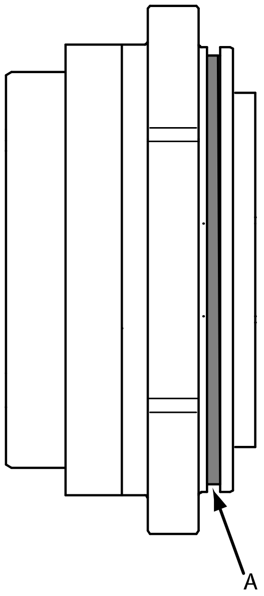
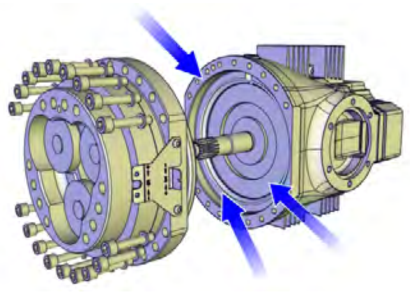
	Action	Note
6	If required, apply M8 screws to the holes shown in the figure beside to press the gearbox out.	 xx0200000220 • A: M8 holes for pressing out the gearbox
	Foundry Plus: Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces.	 xx1400001123
7	Remove the gearbox axis 6 by lifting it out carefully.	Be careful not to damage the motor pinion!

Refitting, gearbox

The procedure below details how to refit gearbox, axis 6.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	

Continues on next page

	Action	Note
2	Make sure the *o-ring* is fitted to the rear of the gearbox. Lubricate the o-ring with *grease.*	Art. no. is specified in *Required equipment on page 310*.  xx0200000221 • A: O-ring, gearbox axis 6
3	Release the holding brake of motor axis 6.	Detailed in the section *Manually releasing the brakes on page 91*.
4	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400001122
5	Insert the *gearbox, axis 6* into the wrist unit.	Art. no. is specified in *Required equipment on page 310*. Shown in the figure *Location of gearbox on page 309*. Make sure the gears of the gearbox mate with the gears of the motor!
6	Secure the gearbox with the *attachment screws and washers.*	Shown in the figure *Location of gearbox on page 309*. 8 pcs or 18 pcs (depending on wrist version): M8 x 40, 12.9 quality Gleitmo, Tightening torque: 30 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 350* before fitting.
7	Refit the *turning disk*.	Detailed in the section *Refitting, turning disk on page 225*.

Continues on next page

	Action	Note
8	Perform a *leak-down test*.	Detailed in the section *Performing a leak-down test on page 190*.
9	Refill the gearbox with oil.	Detailed in the section *Changing oil, axis-6 gearbox on page 178*.
10	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 329*. General calibration information is included in section *Calibration on page 315*.
11	**DANGER** Make sure all safety requirements are met when performing the first test run. These are further detailed in the section *DANGER - First test run may cause injury or damage! on page 51*.	

5 Calibration

5.1 Introduction to calibration

5.1.1 Introduction and calibration terminology

Calibration information

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

Detailed instructions of how to perform Axis Calibration are given on the FlexPendant during the calibration procedure. To prepare calibration with Axis Calibration method, see *Calibrating with Axis Calibration method on page 329*.

Detailed instructions of how to perform Pendulum Calibration are given in the documentation enclosed with the calibration tools.

Calibration terminology

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

5.1.2 Calibration methods

Overview

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

Types of calibration

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

[i] The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.

Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.

If no data is found related to standard calibration, Calibration Pendulum is used as default.

Continues on next page

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).

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.

Axis Calibration method

Axis Calibration is a standard calibration method for calibration of IRB 6620 and is the most accurate method for the standard calibration. It is the recommended method in order to achieve proper performance.

The following routines are available for the Axis Calibration method:

- Fine calibration
- Update revolution counters
- Reference calibration

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

An introduction to the calibration method is given in this manual, see *Calibrating with Axis Calibration method on page 329*.

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

Levelmeter calibration - alternative method

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

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

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

CalibWare - Absolute Accuracy calibration

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.

Continues on next page

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 355*.

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.

5.1.3 When to calibrate

When to calibrate

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

The resolver values are changed

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

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 323*. 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 Synchronization marks and axis movement directions

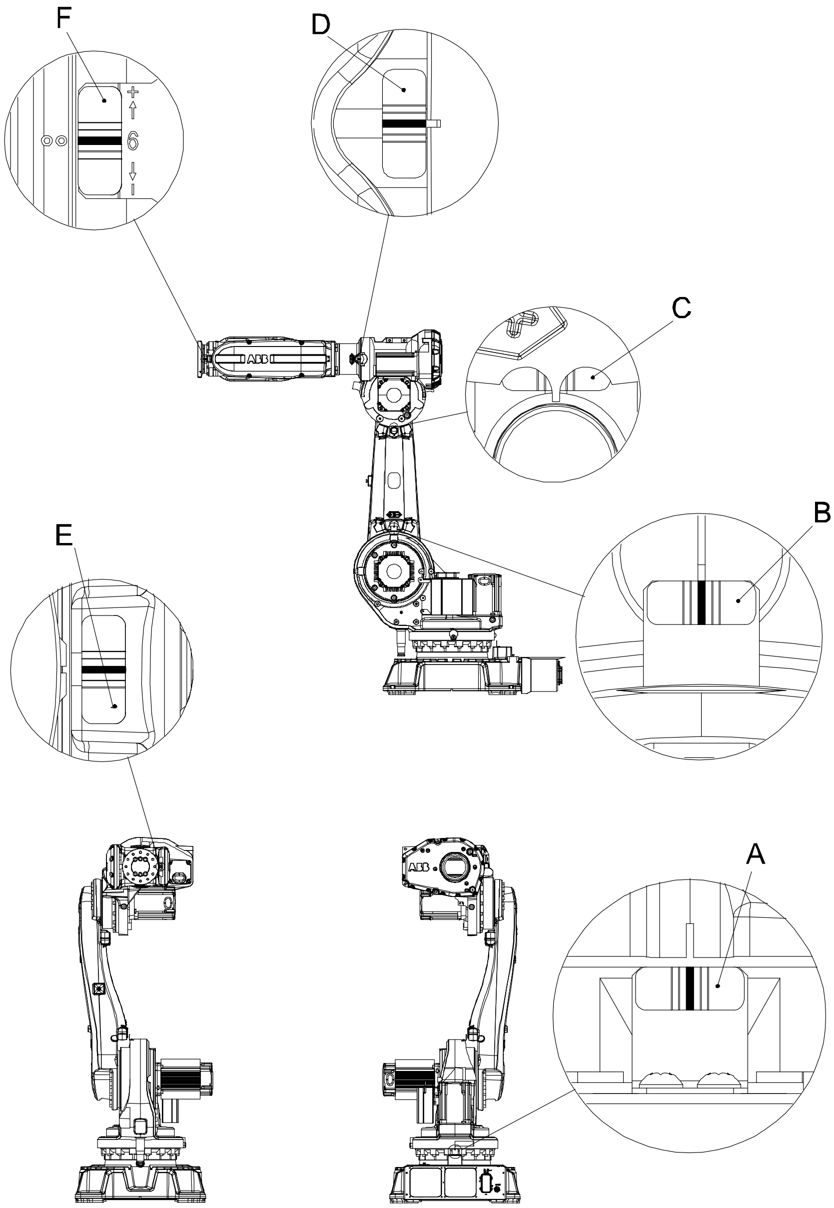
5.2.1 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 6620

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



xx0600003096

A	Synchronization mark, axis 1

Continues on next page

B	Synchronization mark, axis 2
C	Synchronization mark, axis 3
D	Synchronization mark, axis 4
E	Synchronization mark, axis 5
F	Synchronization mark, axis 6

5.2.2 Calibration movement directions for all axes

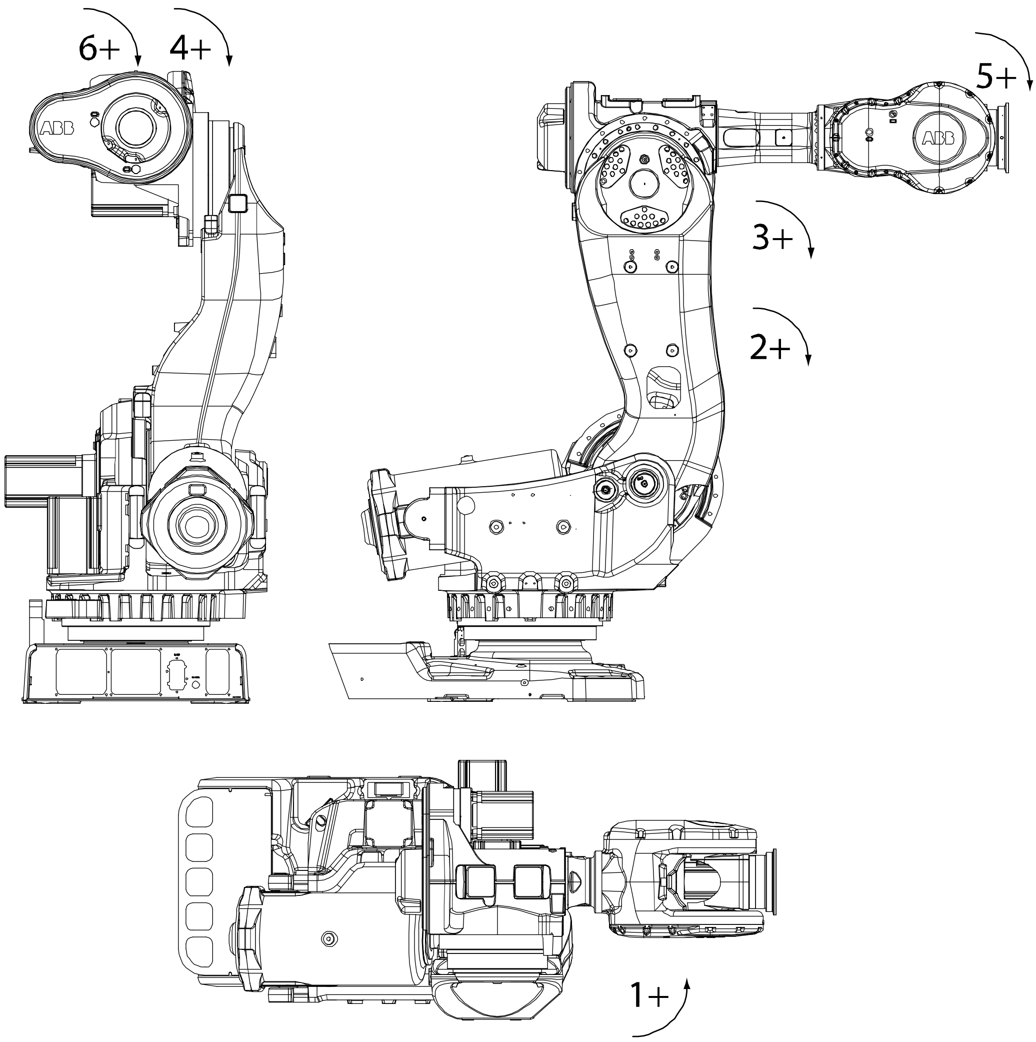
Overview

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

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

Manual movement directions, 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

5.3 Updating revolution counters

Introduction

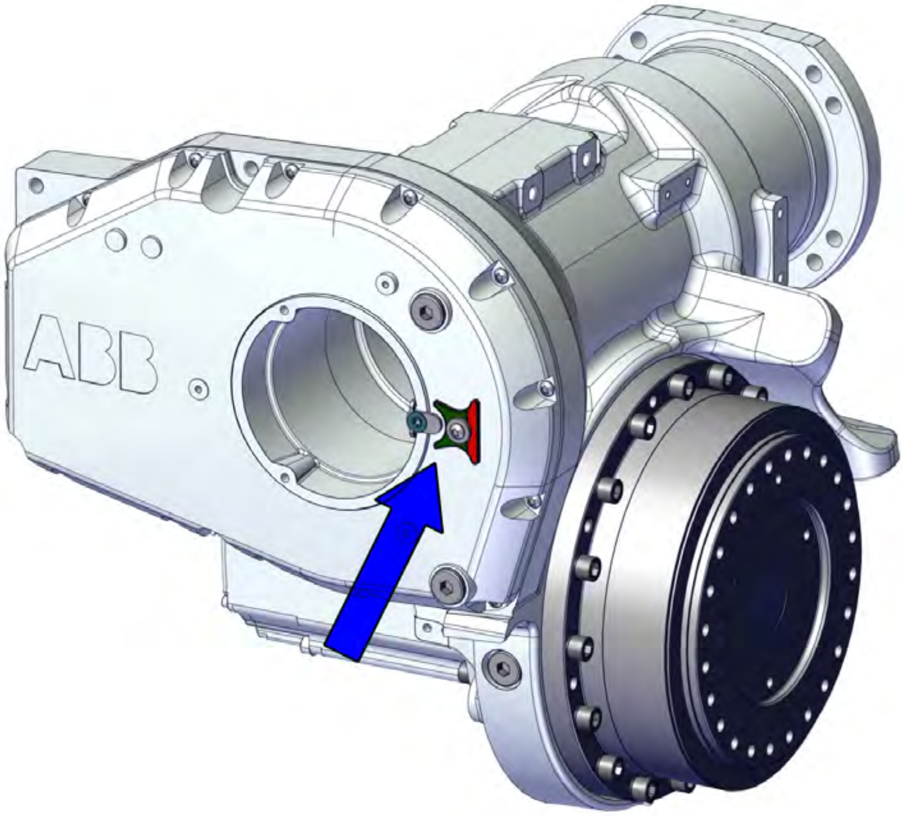
This section describes how to do a rough calibration of each manipulator axis by updating the revolution counter for each axis, using the FlexPendant.

Revolution indicator

The IRB 6620/IRB 6620 LX (not Foundry version) is equipped with a revolution indicator on axis 4.

Location

The revolution indicator is located as shown in figure.



xx1500002405

Function

Before doing an update of the revolution counter, the revolution indicator must be checked.

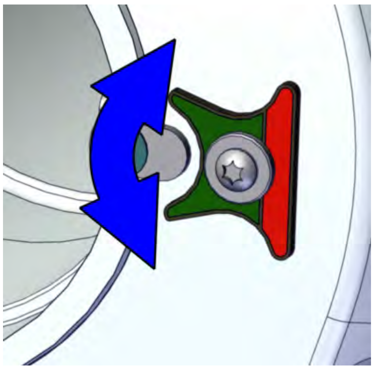
The green side of the indicator shall point towards axis centre.

The indicatior shows if axis 4 is turned correctly or has been rotated more than ±360°. If the indicator has been turned, the robot has to be jogged manually in the

Continues on next page

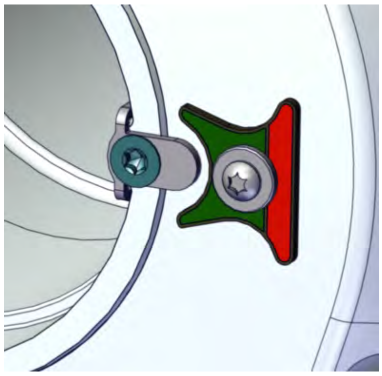
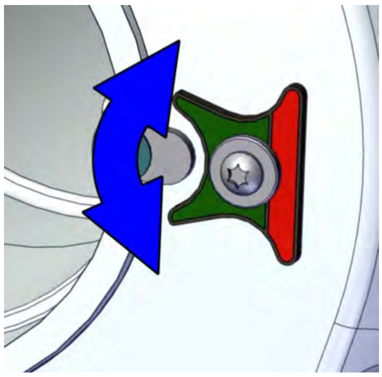
opposite direction to reach the correct position before aligning synchronization marks. If not there is a risk of twisting the cabling.

- When turning axis 4, the indicator will move accordingly, up or down.



xx1500002449

Check indicator before synchonization

	Action	Note
1	Make sure that the green side of the indicator is turned towards the axis 4 center.	 xx1500002404
2	**If not:** Jog the robot manually in the opposite direction to reach the correct position.	 xx1500002449

Continues on next page

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>3</td><td>If the indicator moves towards red when jogging, switch to the opposite direction to reach green side.

CAUTION

If axis 4 is turned too much, the red side of the indicator will turn towards axis 4 and the cabling may be damaged. Jog the robot in the opposite direction.

xx1500002450</td><td></td></tr>
<tr><td>4</td><td>If the red side of the indicator points towards axis 4 centre, make a check that the motor cabling and motor connectors are not damaged. Replace if damaged.</td><td></td></tr>
</table>

Step 1 - Manually running the manipulator to the synchronization position

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

	Action	Note
1	Select axis-by-axis motion mode.	
2	Jog the manipulator to align the synchronization marks.	See *Synchronization marks and synchronization position for axes on page 320*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 326*.

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

Continues on next page

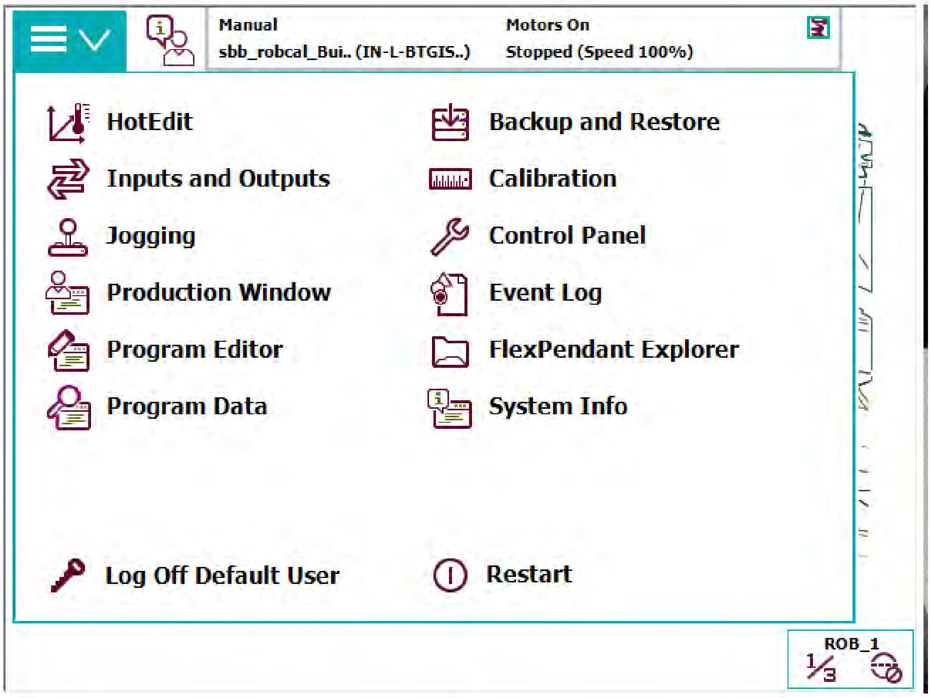
position will be lost due to non-integer gear ratio. This affects the following manipulators:

Manipulator variant	Axis 4	Axis 6
IRB 6620	Yes	No

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

Step 2 - Updating the revolution counter with the FlexPendant

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

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

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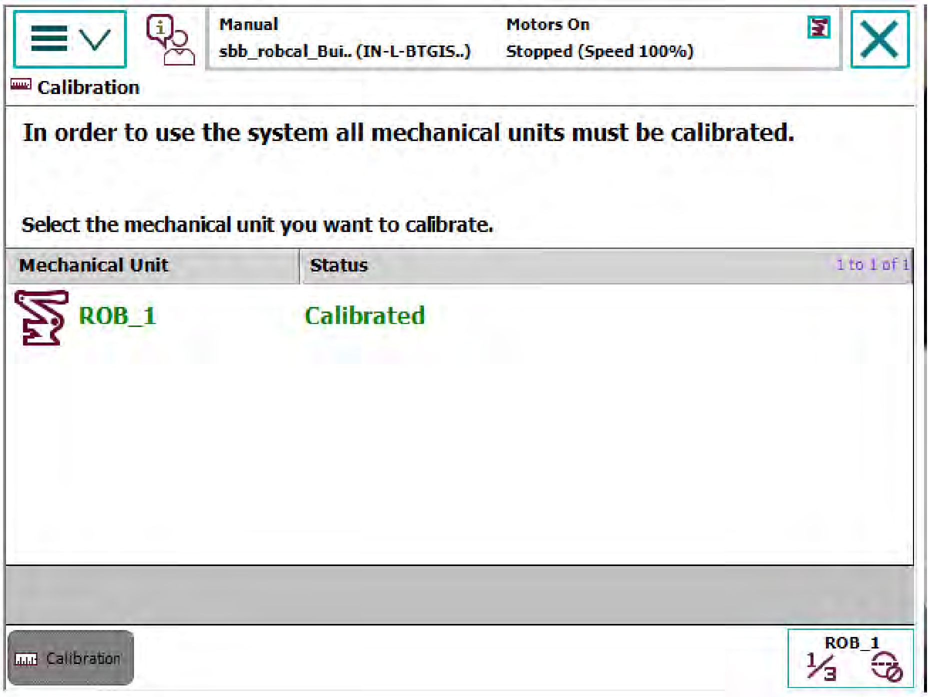
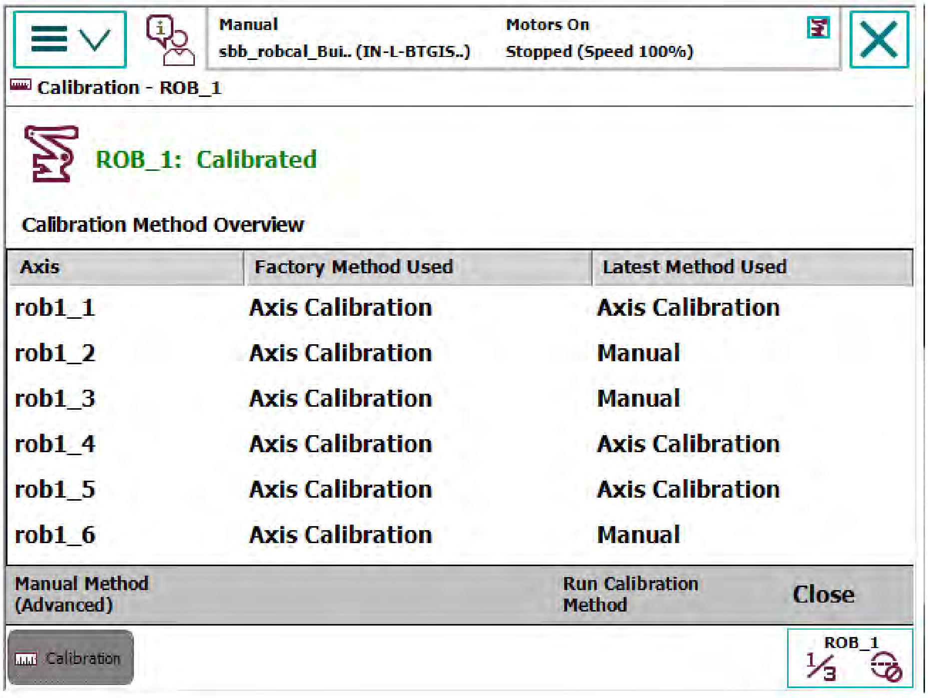
	Action
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.



xx1500000943

	Action
3	**This step is valid for RobotWare 6.02 and later.** Calibration method used at factory for each axis is shown, as well as calibration method used during last field calibration. Tap **Manual Method (Advanced)**.



xx1500000944

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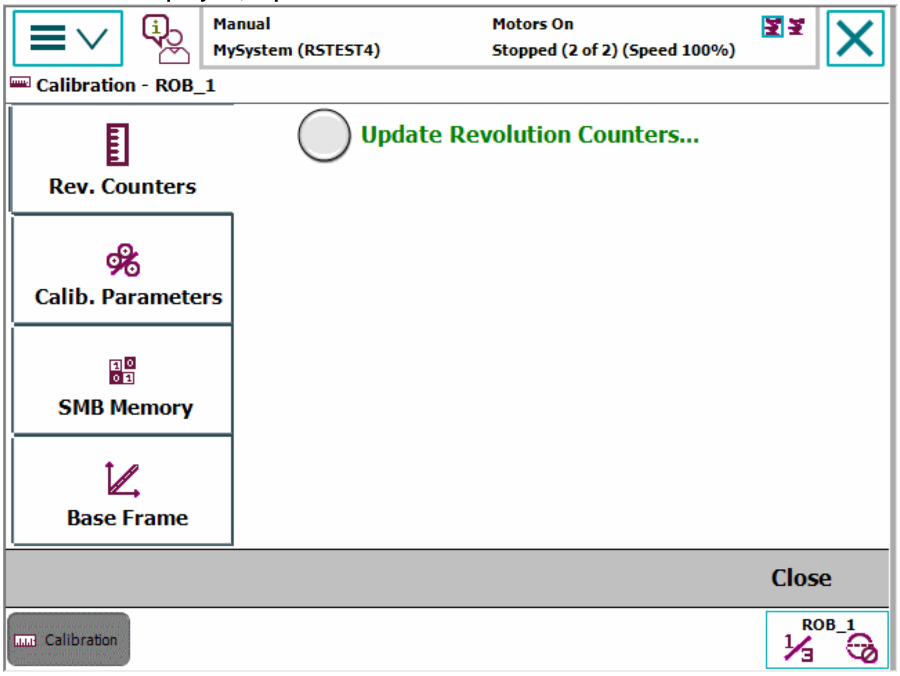
	Action
4	A screen is displayed, tap **Rev. Counters**.  en0400000771
5	Tap **Update Revolution Counters...**. A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: • Tap **Yes** to update the revolution counters. • Tap **No** to cancel updating 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 343*.

5.4 Calibrating with Axis Calibration method

5.4.1 Description of Axis Calibration

Instructions for Axis Calibration procedure given on the FlexPendant

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

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

Overview of the Axis Calibration procedure

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

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

The Axis Calibration procedure described roughly:

- A removable calibration tool is inserted by the operator into a calibration bushing on the axis chosen for calibration, according to instructions on the FlexPendant.

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

> **WARNING**
>
> The calibration tool must be fully inserted into the calibration bushing, until the steel spring ring snaps into place.

- During the calibration procedure, RobotWare moves the robot axis chosen for calibration so that the calibration tools get into contact. RobotWare records values of the axis position and repeats the coming-in-contact procedure several times to get an exact value of the axis position.

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

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

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Routines in the calibration procedure

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

Fine calibration routine

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

Reference calibration routine

Choose this routine to create reference values and to calibrate the robot when the robot is dressed with tools, process cabling or other equipment.

Also choose this routine if the robot is wall mounted or suspended.

If calibrating the robot with reference calibration there must be reference values created before repair is made to the robot, if values are not already available. Creating new values requires possibility to move the robot. The reference values contain positions of all axes, torque of axes and technical data about the tool installed. The reference value is unique for the current setup of the robot and will be named according to tool name, date etc.

Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values.

When reference calibration is performed, the robot is restored to the status given by the reference values.

Update revolution counters

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

Validation

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

Position of robot axes

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

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

How to calibrate a suspended or wall mounted robot

The IRB 6620 is calibrated floor standing in factory, prior to shipping.

To calibrate a suspended or wall mounted robot, reference calibration must be used. Reference values for a suspended or a wall mounted robot must be created with the robot mounted at its working position, not standing on a floor.

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

5.4.2 Calibration tools for Axis Calibration

Calibration tool set

The calibration tools used for Axis Calibration are designed to meet requirements for calibration performance, durability and safety in case of accidental damage.

WARNING

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

Equipment, etc.	Article number	Note
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

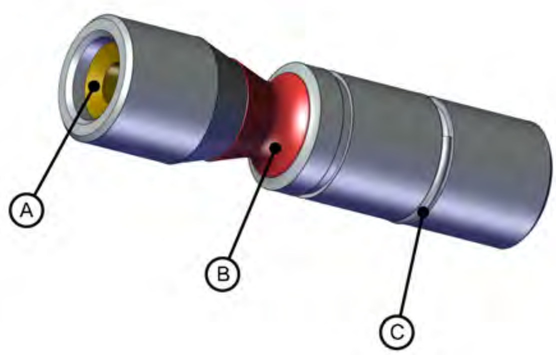
Examining the calibration tool

Check prior to usage

Before using the calibration tool, make sure that the tube insert, the plastic protection and the steel spring ring are present.

WARNING

If any part is missing or damaged, the tool must be replaced immediately.



xx1500001914

A	Tube insert
B	Plastic protection
C	Steel spring ring

Periodic check of the calibration tool

If including the calibration tool in a local periodic check system, the following measures should be checked.

- Outer diameter within Ø12g4 mm, Ø8g4 mm or Ø6g5 mm (depending on calibration tool size).

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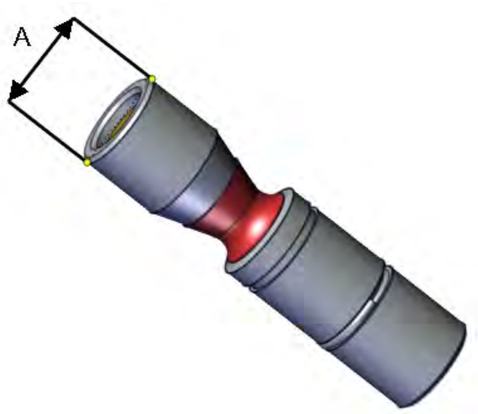
- Straightness within 0.005 mm.



xx1500000951

A	Outer diameter

Identifying the calibrating tools

It is possible to make the pins identifiable with, for example, an RFID chip. The procedure of how to install an RFID chip is described below.

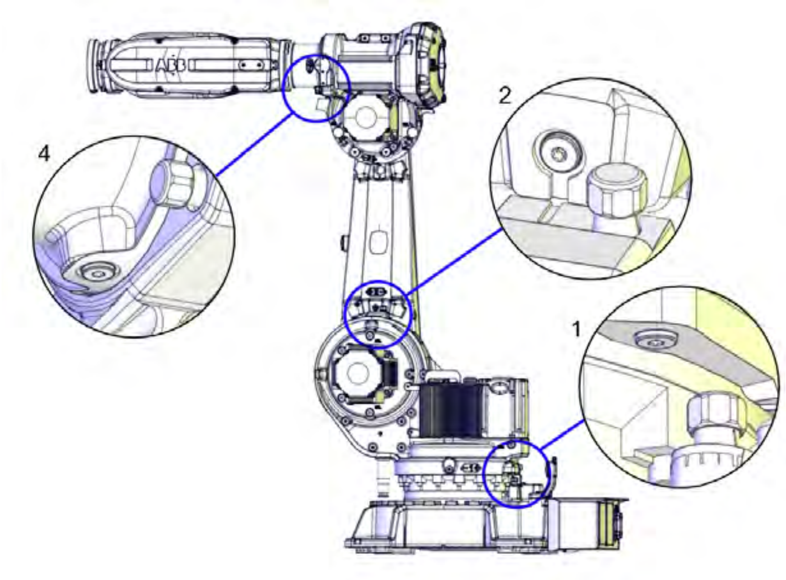
> **Note**
>
> The pin identifier is NOT delivered from ABB, it is a customized solution.

	Action	Note
1	It is possible to use any RFID solution, with the correct dimensions. ABB has verifed function on some suppliers fulfilling the requirements of NFC compatible devices (13.56 Mhz) according to ISO 14443 or ISO 15693. **Note** The maximum dimensions on the RFID chip must not exceed Ø7.9 mm x 8.0 mm, Ø5.9 mm x 8.0 mm or Ø3.9 mm x 8.0 mm (depending on calibration tool size).	
2	There is a cavity on one end of the calibration tool in which the RFID chip can be installed. Install the RFID chip according to supplier instructions. Install the chip in flush with the tool end.	

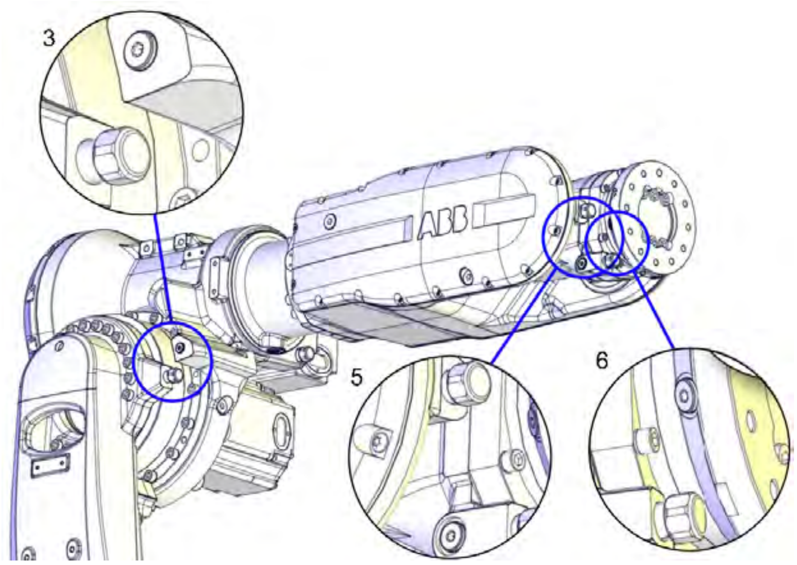
5.4.3 Location of calibration items

Location of calibration items

A fixed calibration pin and a bushing for the movable calibration tool are located on each axis as follows.



xx1600000001



xx1600000011

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Spare parts

When calibration is not being performed, a protective cover and an o-ring should always be installed on the fixed calibration pin as well as a protective plug in the bushing. Replace damaged parts with new, if needed.

Spare part	Article number	Note
Protection cover and plug set	3HAC056806-001	Contains replacement calibration pin covers and protective plugs for the bushing.

5.4.4 Axis Calibration - Running the calibration procedure

Required tools

The calibration tools used for Axis Calibration are designed to meet requirements for calibration performance, durability and safety in case of accidental damage.

WARNING

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

Equipment, etc.	Article number	Note
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

Required consumables

Consumable	Article number	Note
Clean cloth	-	

Spare parts

Spare part	Article number	Note
Protection cover and plug set	3HAC056806-001	Contains replacement calibration pin covers and protective plugs for the bushing.

Overview of the calibration procedure on the FlexPendant

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

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

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

1. Choose calibration routine. The routines are described in *Routines in the calibration procedure on page 330*.
2. Choose which axis/axes to calibrate.
3. The robot moves to synchronization position.
4. Validate the synchronization marks.
5. The robot moves to preparation position.
6. Remove the protective cover from the fixed pin and the protection plug from the bushing, if any, and install the calibration tool.

Continues on next page

7 The robot performs a measurement sequence by rotating the axis back and forth.

8 Remove the calibration tool and reinstall the protective cover on the fixed pin and the protection plug in the bushing, if any.

9 The robot moves to verify that the calibration tool is removed.

10 Choose whether to save the calibration data or not.

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

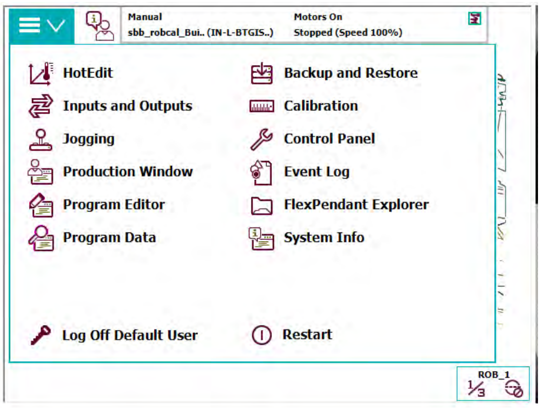
Preparation prior to calibration

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

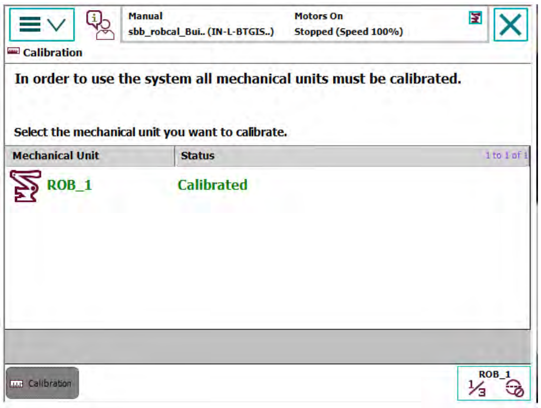
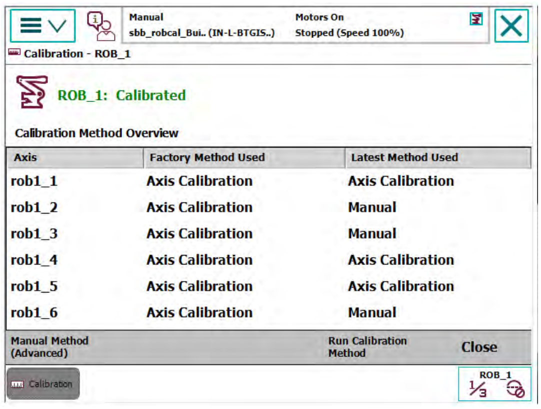
	Action	Note
1	**DANGER** While conducting the calibration, the robot needs to be connected to power. Make sure that the robots working area is empty, as the robot can make unpredicted movements.	
2	Wipe the calibration tool clean. **Note** The calibration method is exact. Dust, dirt or color flakes will affect the calibration value.	Use a clean cloth.

Starting the calibration procedure

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

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

Continues on next page

	Action	Note
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943	
3	Calibration method used at factory for each axis is shown, as well as calibration method used for the robot during last field calibration. Tap **Run Calibration Method**. The software will automatically call for the procedure for the valid calibration method.  xx1500000944	The FlexPendant will give all information needed to proceed with Axis Calibration.
4	Follow the instructions given on the FlexPendant.	A brief overview of the sequence that will be run on the FlexPendant is given in *Overview of the calibration procedure on the FlexPendant on page 335*.

Restarting an interrupted calibration procedure

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

Situation	Action
The three-position enabling device on the FlexPendant has been released during robot movement.	Press and hold the three-position enabling device and press **Play**.

Continues on next page

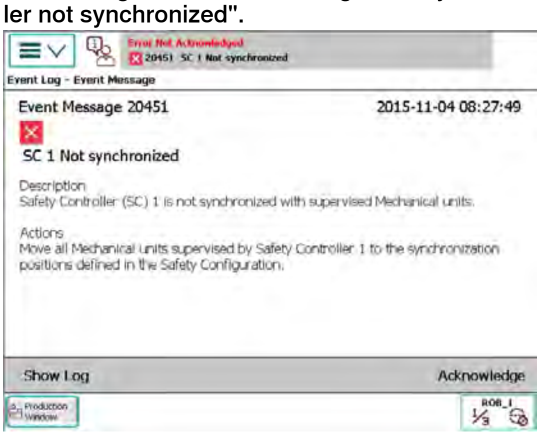
Situation	Action
The RobotWare program is terminated with **PP to Main**.	Remove the calibration tool, if it is installed, and restart the calibration procedure from the beginning. See *Starting the calibration procedure on page 336*. If the calibration tool is in contact the robot axis needs to be jogged in order to release the calibration tool. Jogging the axis in wrong direction will cause the calibration tool to break. Directions of axis movement is shown in *Calibration movement directions for all axes on page 322*

Axis Calibration with SafeMove option

To be able to run Axis Calibration SafeMove needs to be unsynchronized. The Axis Calibration routine recognizes if the robot is equipped with SafeMove and will force SafeMove to unsynchronize automatically.

However, SafeMove may generate other warning messages anytime during the Axis Calibration routine.

Safety controller not synchronized - SafeMove message

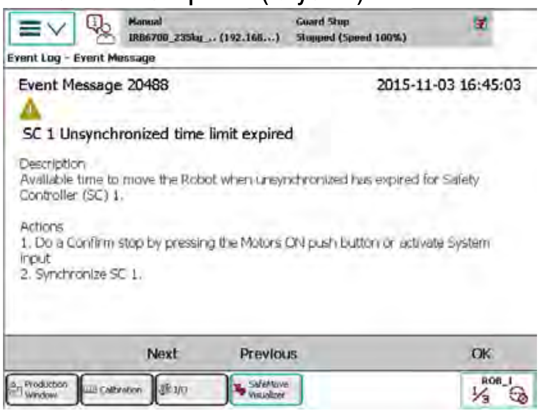
	Action	Note
1	SafeMove generates the message "Safety controller not synchronized".  xx1500002480	
2	Confirm unsynchronized state by pressing **Acknowledge** to continue Axis Calibration procedure.	
3	Restart Axis Calibration procedure by pressing **Play**.	

Continues on next page

Unsynchronized speed exceeded - SafeMove message while saving robot data

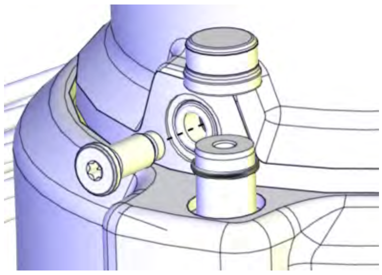
	Action	Note
1	SafeMove generates the message "Unsynchronized speed exceeded" while saving robot data.  xx1500002481	
2	Press **Acknowledge** to continue Axis Calibration procedure.	
3	Restart Axis Calibration procedure by pressing **Play**.	

Unsynchronized time limit expired - SafeMove message anytime during Axis Calibration routine

	Action	Note
1	SafeMove generates the message "Unsynchronized time limit expired" (anytime).  xx1500002482	
2	Press **OK** to continue Axis Calibration procedure.	
3	Restart Axis Calibration procedure by pressing **Play**.	

Continues on next page

After calibration

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>1</td><td>Check the o-ring on the fixed calibration pin.
Replace if damaged or missing.</td><td rowspan="2">
xx1500000952
Protection cover and plug set: 3HAC056806-001.</td></tr>
<tr><td>2</td><td>Reinstall the protective cover on the fixed calibration pin and the protective plug on the bushing on each axis, directly after the axis is calibrated.
Replace the cover/plug with new spare part, if missing or damaged.</td></tr>
</table>

5.5 Calibrating with Calibration Pendulum method

Where to find information for Calibration Pendulum

Detailed instructions of how to perform Pendulum Calibration are given in the documentation enclosed with the calibration tools.

5.6 Verifying the calibration

Introduction

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

Verifying the calibration

Use this procedure to verify the calibration result.

	Action	Note
1	Run the calibration home position program twice. Do not change the position of the robot axes after running the program!	See *Checking the synchronization position on page 343*.
2	Adjust the *synchronization marks* when the calibration is done, if necessary.	This is detailed in section *Synchronization marks and synchronization position for axes on page 320*.
3	Write down the values on a new label and stick it on top of the calibration label. The label is located on the lower arm.	
4	Remove any calibration equipment from the robot.	

5.7 Checking the synchronization position

Introduction

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

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

Using a `MoveAbsJ` instruction

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

	Action	Note
1	On ABB menu tap **Program editor**.	
2	Create a new program.	
3	Use **MoveAbsJ** in the **Motion&Proc** menu.	

4	Create the following program:
	`MoveAbsJ [[0,0,0,0,0,0],`
	`[9E9,9E9,9E9,9E9,9E9,9E9]]`
	`\NoEOffs, v1000, fine, tool0`	

5	Run the program in manual mode.	
6	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See *Synchronization marks and synchronization position for axes on page 320* and *Updating revolution counters on page 323*.

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 320* and *Updating revolution counters on page 323*.

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6 Decommissioning

6.1 Environmental information

Hazardous material

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

Dispose components properly to prevent health or environmental hazards.

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

Oil and grease

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

Also note that:

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

6.2 Scrapping of robot

Important when scrapping the robot

DANGER

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

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

7 Reference information

7.1 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

Continues on next page

Standard	Description
ANSI/UL 1740 (option 429-1)	Safety standard for robots and robotic equipment
CAN/CSA Z 434-03 (option 429-1)	Industrial robots and robot Systems - General safety requirements

7.2 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	

7.3 Screw joints

General

This section describes how to tighten the various types of screw joints on the IRB 6620.

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

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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

7.4 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 900 kg. All lifting accessories used must be sized accordingly!	

7.5 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	Rem.
1	Ring-open-end spanner 8-19 mm	
1	Socket head cap 5-17 mm	
1	Torx socket no: 20-60	
1	Box spanner set	
1	Torque wrench 10-100 Nm	
1	Torque wrench 75-400 Nm	
1	Ratchet head for torque wrench 1/2	
2	Hexagon-headed screw M10x100	
1	Hex bit socket head cap no. 14 socket 40 mm L=100 mm	
1	Hex bit socket head cap no. 14 socket 40 mm L=20 mm	To be shortened to 12 mm
1	Hex bit socket head cap no. 6 socket 40 mm L=145 mm	
1	Hex bit socket head cap no. 6 socket 40mm bit L=220 mm	

7.6 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 354*, and of special tools, listed directly in the instructions and also gathered in this section.

Calibration equipment, Calibration Pendulum

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

The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.

Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.

If no data is found related to standard calibration, Calibration Pendulum is used as default.

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

Calibration equipment, Axis Calibration

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

The robot is calibrated by either Calibration Pendulum or Axis Calibration at factory. Always use the same calibration method as used at the factory.

Information about valid calibration method is found on the calibration label or in the calibration menu on the FlexPendant.

If no data is found related to standard calibration, Calibration Pendulum is used as default.

Description	Art. no.	Note
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

Basic tools

The following table specifies the tools in the basic toolkit that are used for the current robot model. This toolkit is necessary primarily when removing and refitting the motors.

The tools are also listed directly in the instructions.

Description	Qty	Art. no.
Extension 300mm for bits 1/2"	1	3HAC12342-1
Guide pins M8 x 100	2	3HAC15520-1
Guide pins M8 x 150	2	3HAC15520-2

Continues on next page

Description	Qty	Art. no.
Guide pins M10 x 100	2	3HAC15521-1
Guide pins M10 x 150	2	3HAC15521-2
Lifting tool, motor ax 1	1	3HAC14459-1
Lifting tool, motor ax 2, 3	1	3HAC026061-001
Removal tool, motor M10x	2	3HAC14972-1 Fits motors, axes 6.
Removal tool, motor M12x		Fits motors axes 1, 2 and 3.
Rotation tool	1	3HAC17105-1
Standard toolkit (content described in section *Standard tools on page 354*)	1	-

Lifting tool

The following table specifies the lifting tools required during several of the service procedures. The tools may be ordered separately and are also specified directly in concerned instructions in the product manual.

Description	Qty	Art. no.
Lifting tool		3HAC026597-001
Hoisting block		
Lifting chain (used together with the hoisting block)		
Support, base and gear axis 1		3HAC15535-1
Lifting tool, gearbox axis 1		3HAC15556-1
Lifting eye (used together with lifting tool 3HAC 15556-1)		3HAC025333-005
Lifting tool, gearbox		3HAC025214-001
Guide pins, M12x130		3HAC022637-001
Guide pins, M16x		
Lifting eye, M16		3HAC14457-1
Lifting eye, M20		
Crank		

7.7 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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Contact us

ABB AB
Discrete Automation and Motion
Robotics
S-721 68 VÄSTERÅS, Sweden
Telephone +46 (0) 21 344 400

ABB AS, Robotics
Discrete Automation and Motion
Nordlysvegen 7, N-4340 BRYNE, Norway
Box 265, N-4349 BRYNE, Norway
Telephone: +47 51489000

ABB Engineering (Shanghai) Ltd.
No. 4528 Kangxin Highway
PuDong District
SHANGHAI 201319, China
Telephone: +86 21 6105 6666

www.abb.com/robotics

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