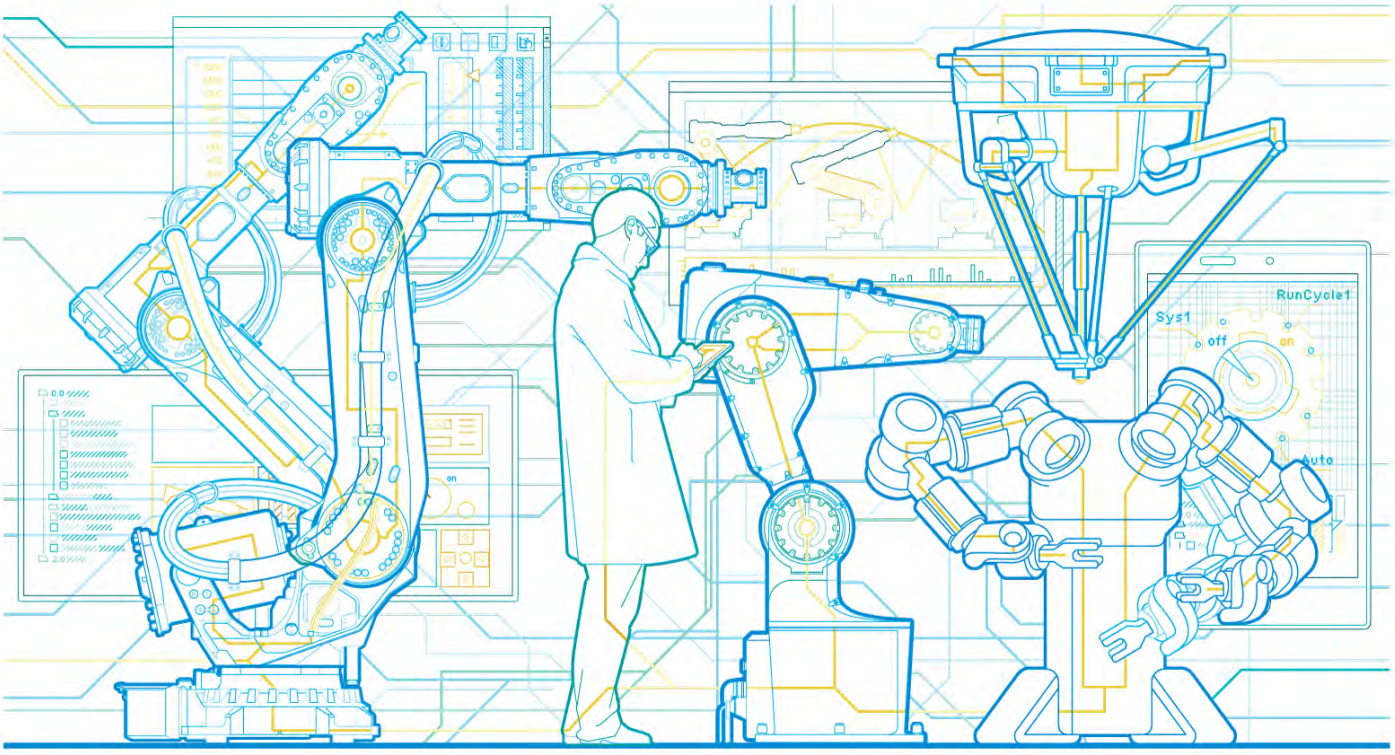

Product manual
IRB 1410

Trace back information:
Workspace R17-1 version a7
Checked in 2017-03-22
Skribenta version 5.1.011

Product manual

IRB 1410

IRC5

Document ID: 3HAC026320-001

Revision: J

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

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

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

Keep for future reference.

Additional copies of this manual may be obtained from ABB.

Original instructions.

ABB AB, Robotics
Robotics and Motion
Se-721 68 Västerås
Sweden

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Overview of this manual

About this manual

This manual contains instructions for

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

Usage

This manual should be used during

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

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

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

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

Organization of chapters

The manual is organized in the following chapters:

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

Continues on next page

Continued

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

References

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

Document name	Document ID	Note
Product specification - IRB 2400	*3HAC042195-001*	M2004
Product manual, spare parts - IRB 1410	*3HAC049103-001*	
Operating manual - General safety information [i]	*3HAC031045-001*	M2004
Circuit diagram - IRB 1410	*3HAC2800-3*	
Product manual - IRC5 IRC5 with main computer DSQC 639.	*3HAC021313-001*	M2004
Product manual - IRC5 IRC5 with main computer DSQC1000.	*3HAC047136-001*	M2004
Product manual - S4Cplus M2000	*3HAC021333-001*	M2000
Product manual - S4Cplus M2000A	*3HAC022419-001*	M2000A
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*	M2004
User's guide - S4Cplus (BaseWare OS 4.0)	*3HAC7793-1*	M2000/M2000A
Operating manual - Service Information System	*3HAC050944-001*	M2004
Operating manual - Calibration Pendulum	*3HAC16578-1*	
Operating manual - Levelmeter Calibration	*3HAC022907-001*	M2000/M2000A
Technical reference manual - Lubrication in gear-boxes	*3HAC042927-001*	
Technical reference manual - System parameters	*3HAC050948-001*	M2004
Application manual - Additional axes and stand alone controller	*3HAC051016-001*	M2004
Application manual - External axes	*3HAC9299-1*	M2000
Operating manual - RobotStudio	*3HAC032104-001*	M2004

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

Additional document references

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

Continues on next page

Revisions

Revision	Description
F	This revision includes the following updates: • The manual is partly restructured. • Released with R14.1. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 1410*
G	This revision includes the following updates: • Minor corrections.
H	This revision includes the following updates: • Turning disk fixture is removed from special tools for Levelmeter calibration. • Information regarding SMB and battery is changed. • Information regarding axes-5 and -6 greasing is changed.
J	This revision includes the following updates: • Minor corrections. • The dimension of hole configuration is corrected.

How to read the product manual

Reading the procedures

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

References to figures

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

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

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

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

References to required equipment

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

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

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

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

Safety information

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

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

Illustrations

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

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

Product documentation, M2000/M2000A

General

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

Product manuals

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

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

Software manuals

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

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

Controller hardware option manual

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

- Installation information
- Repair information
- Maintenance information

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

Product documentation, IRC5

Categories for user documentation from ABB Robotics

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

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

Product manuals

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

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

Technical reference manuals

The technical reference manuals describe reference information for robotics products.

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

Continues on next page

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*

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1 Safety

1.1 Introduction to safety information

Overview

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

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

1.2 General safety information

1.2.1 Introduction to general safety information

Definitions

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

Sections

The general safety information is divided into the following sections.

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

1.2.2 Safety in the manipulator system

Validity and responsibility

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

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

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

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

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

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

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

Connection of external safety devices

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

Limitation of liability

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

Related information

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

Continues on next page

1.2.2 Safety in the manipulator system
Continued

Type of information	Detailed in document	Section
Restricting the working space	*Product manual for the robot*	Installation and commissioning

1.2.3 Protective stop and emergency stop

Overview

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

1.2.4 Safety risks

1.2.4.1 Safety risks during installation and service work on 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

1.2.4.1 Safety risks during installation and service work on robots
Continued

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

Cabling

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

Gearboxes and motors

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

1.2.4.2 CAUTION - Hot parts may cause burns!

Description

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

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

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.	

1.2.4.3 Safety risks related to tools/work pieces

Safe handling

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

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

Safe design

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

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

CAUTION

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

1.2.4.4 Safety risks related to pneumatic/hydraulic systems

General

Special safety regulations apply to pneumatic and hydraulic systems.

Note

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

Residual energy

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

Safe design

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

1.2.4.5 Safety risks during operational disturbances

General

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

Qualified personnel

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

Extraordinary risks

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

1.2.4.6 Risks associated with live electric parts

Voltage related risks, general

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

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

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

All work must be performed:

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

Voltage related risks, IRC5 controller

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

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

Continues on next page

1.2.4.6 Risks associated with live electric parts
Continued

Voltage related risks, robot

A danger of 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.

1.2.5 Safety actions

1.2.5.1 Safety fence dimensions

General

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

Dimensioning

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

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

1.2.5.2 Fire extinguishing

Note

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

1.2.5.3 Emergency release of the robot arm

Description

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

How to release the brakes is detailed in the section:

- *Manually releasing the brakes on page 63*.

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

Increased injury

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

DANGER

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

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

1.2.5.4 Brake testing

When to test

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

How to test

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

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

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

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

Note

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

1.2.5.6 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*.

1.2.5.7 Work inside the working range of the robot

WARNING

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

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

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

WARNING

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

1.3 Safety signals and symbols

1.3.1 Safety signals in the manual

Introduction to safety signals

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

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

Danger levels

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

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

Continues on next page

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

1.3.2 Safety symbols on product labels

Introduction to labels

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

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

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

Types of labels

Both the 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.

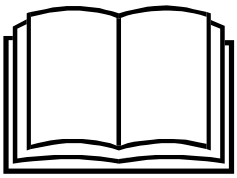
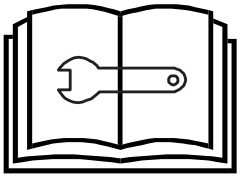
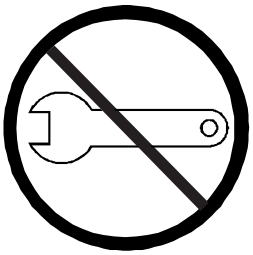
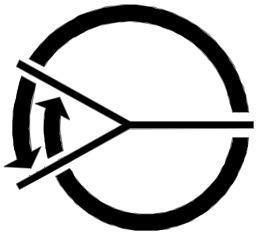
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 40*.

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

Symbols on safety labels

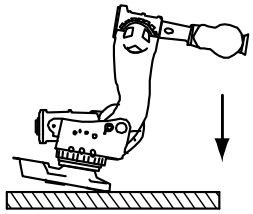
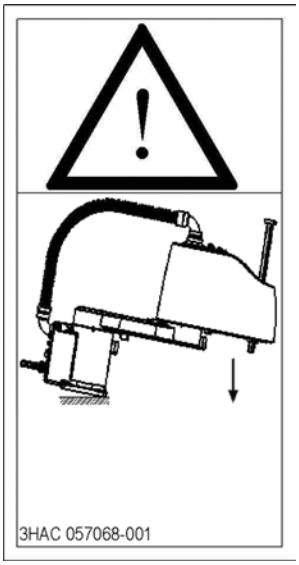
Symbol	Description
 xx0900000812	**Warning!** Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical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

Continues on next page

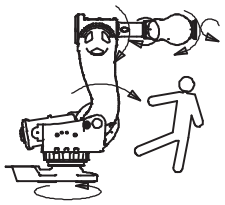
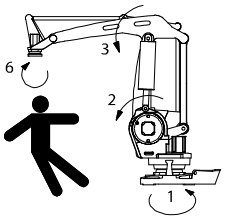
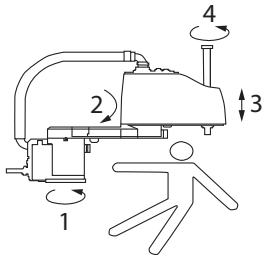
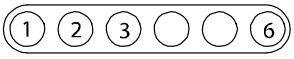
Symbol	Description
 xx0900000813	**See user documentation** Read user documentation for details. Which manual to read is defined by the symbol: • No text: *Product manual*. • EPS: *Application manual - Electronic Position Switches*.
 xx0900000816	**Before disassemble, see product manual**
 xx0900000815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

Continues on next page

1.3.2 Safety symbols on product labels
Continued

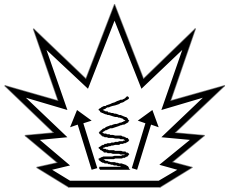
Symbol	Description
 xx0900000810  xx1500002402	**Tip risk when loosening bolts** The robot can tip over if the bolts are not securely fastened.
  xx0900000817	**Crush** Risk of crush injuries.
 xx0900000818	**Heat** Risk of heat that can cause burns.

Continues on next page

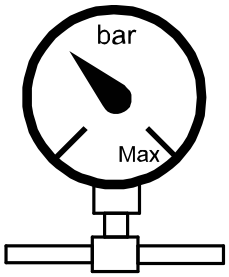
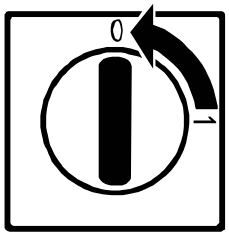
Symbol	Description
 xx0900000819  xx1000001141  xx1500002616	**Moving robot** The robot can move unexpectedly.
 xx0900000820  xx1000001140	**Brake release buttons**
 xx0900000821	**Lifting bolt**

Continues on next page

1.3.2 Safety symbols on product labels
Continued

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

Continues on next page

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

1.4 Safety related instructions

1.4.1 DANGER - Moving robots are potentially lethal!

Description

Any moving robot is a potentially lethal machine.

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

Elimination

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

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

Description

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

Elimination

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

DANGER

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

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

Collision risks

CAUTION

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

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

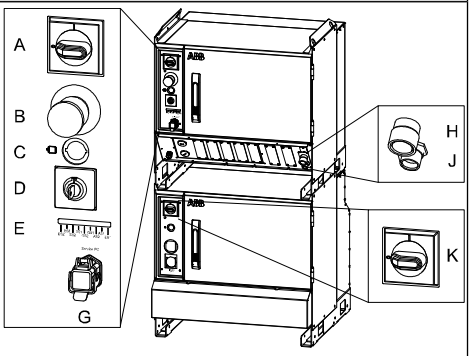
Description

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

Elimination, IRC5 Single Cabinet Controller

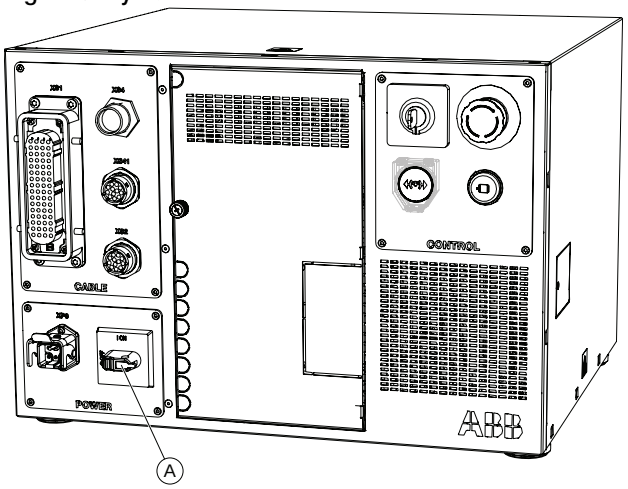
	Action	Note/illustration
1		

Elimination, IRC5 Dual Cabinet Controller

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

Continues on next page

Elimination, IRC5 Compact Controller

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

1.4.4 WARNING - The unit is sensitive to ESD!

Description

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

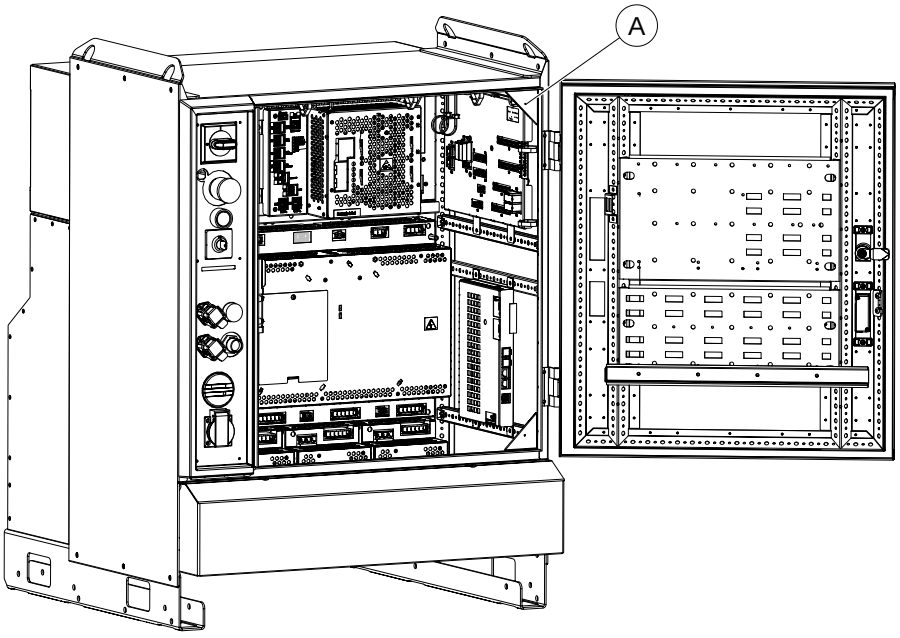
Elimination

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

Location of wrist strap button

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

IRC5

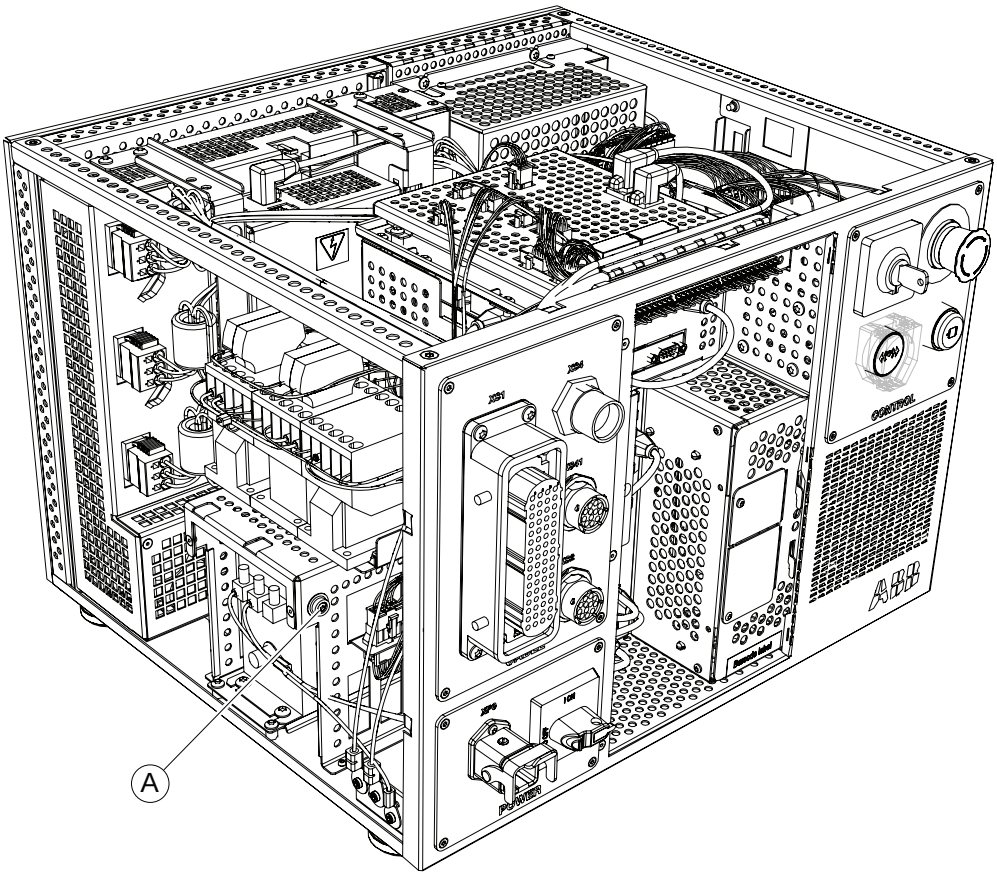


xx1300000856

A	Wrist strap button

Continues on next page

IRC5 Compact Controller



xx1400001622

A	Wrist strap button

1.4.5 WARNING - Safety risks during handling of batteries

Description

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

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

Note

Appropriate disposal regulations must be observed.

Elimination

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

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

Description

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

Note

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

Note

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

Note

Appropriate disposal regulations must be observed.

Note

Take special care when handling hot lubricants.

Warnings and elimination

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

Continues on next page

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

Warning	Description	Elimination/Action
 xx0100000002 **Do not overfill**	Overfilling of gearbox lubricant can lead to internal over-pressure inside the gearbox which in turn may: • damage seals and gaskets • completely press out seals and gaskets • prevent the robot from moving freely.	Make sure not to overfill the gearbox when filling it with oil or grease! After filling, verify that the level is correct.
 xx0100000002 **Do not mix types of oil**	Mixing types of oil may cause severe damage to the gearbox.	When filling gearbox oil, do not mix different types of oil unless specified in the instructions. Always use the type of oil specified by the manufacturer!
 xx0100000098 **Heat up the oil**	Warm oil drains quicker than cold oil.	When changing gearbox oil, first run the robot for a time to heat up the oil.
 xx0100000004 **Specified amount depends on drained volume**	The specified amount of oil or grease is based on the total volume of the gearbox. When changing the lubricant, the amount refilled may differ from the specified amount, depending on how much has previously been drained from the gearbox.	After filling, verify that the level is correct.
 xx0100000003 **Contaminated oil in gear boxes**	When draining the oil make sure that as much oil as possible is drained from the gearbox. The reason for this is to drain as much oil sludge and metal chips as possible from the gearbox. The magnetic oil plugs will take care of any remaining metal chips.	

2 Installation and commissioning

2.1 Introduction

General

This chapter contains assembly instructions and information for installing the IRB 1410 at the working site.

More detailed technical data can be found in the *Product specification* for the IRB 1410, 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 1410 is connected to power, always make sure that the robot is connected to *protective earth* before starting any installation work!

For more information see:

- *Product manual - IRC5*

2.2 Unpacking

2.2.1 Pre-installation procedure

Introduction

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

Prerequisites for installation personnel

Installation personnel working with an ABB product must:

- be trained by ABB and have the required knowledge of mechanical and electrical installation/maintenance/repair work
- conform to all national and local codes.

Checking the pre-requisites for installation

	Action
1	Make a visual inspection of the packaging and make sure that nothing is damaged.
2	Remove the packaging.
3	Check for any visible transport damage. **Note** Stop unpacking and contact ABB if transport damages are found.
4	Clean the unit with a lint-free cloth, if necessary.
5	Make sure that the lifting accessory used is suitable to handle the weight of the robot as specified in: *Weight, robot on page 56*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 57*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 58*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 57* • *Protection classes, robot on page 58* • *Requirements, foundation on page 57*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 60*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 62*
11	Install required equipment, if any.

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 1410	225 kg

Continues on next page

Note

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

Loads on foundation, robot

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

Note

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

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	±1500 N	±2000 N
Force z	2800 ±500 N	2800 ±700 N
Torque xy	±1800 Nm	±2000 Nm
Torque z	±400 Nm	±500 Nm

Requirements, foundation

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

Requirement	Value	Note
Flatness of foundation surface	0.5	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	55°	
Minimum resonance frequency	25 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

2.2.1 Pre-installation procedure
Continued

Note

If the manipulator should not be used immediately, all unpainted / unprotected surfaces must be treated with a rust inhibitor, type Vaseline or similar.

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

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

Protection classes, robot

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

Protection type	Protection class
Manipulator, protection type Standard	IP 54

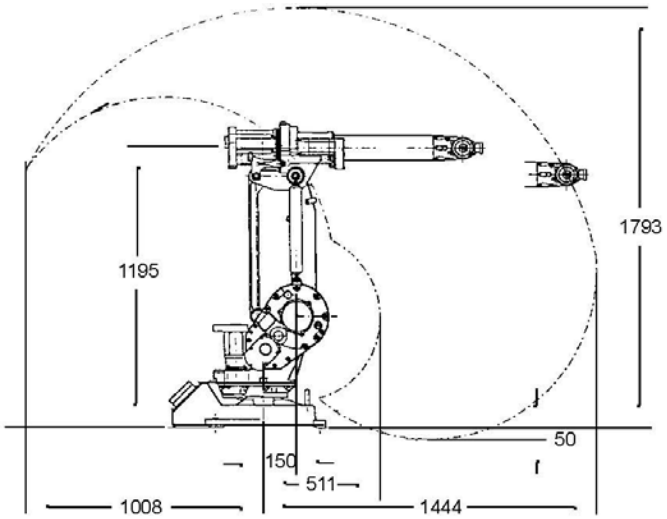
2.2.2 Amount of space required

General

The amount of working space required to operate the manipulator is illustrated in the figures below. The working range for axis 1 is +/- 170°.

CAUTION

There are no software or mechanical limits for the working space under the base of the manipulator.



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2.2.3 Risk of tipping/stability

Risk of tipping

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

The shipping position is the most stable position.

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

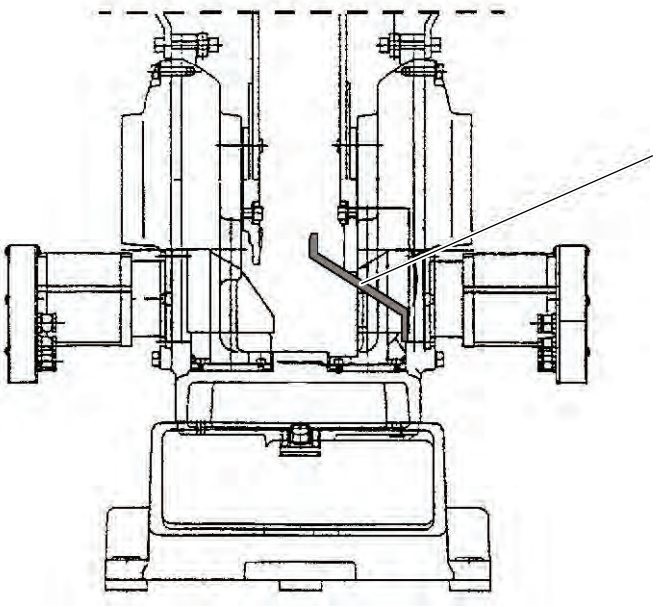
WARNING

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

2.2.4 Transport locking device

Manipulator

At delivery, axis 2 (= lower arm) is equipped with a transport locking device, see figure.



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2.3 On-site installation

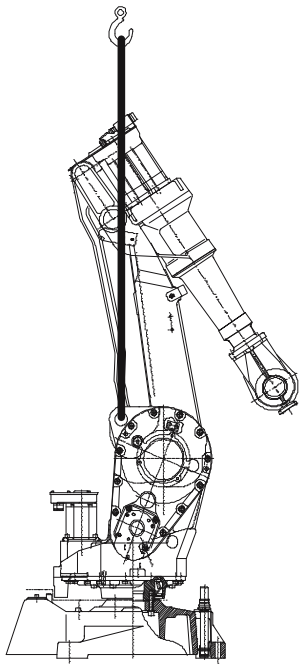
2.3.1 Lifting robot with lifting slings

Required equipment

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

Illustration, attachment of lifting slings

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



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Lifting of robot

	Action	Note
1	Move the robot to the lifting position shown in the figure above.	If necessary, release the brakes as detailed in section *Manually releasing the brakes on page 63*.
2	Attach the straps to the special eye bolts on the gearboxes for axes 2 and 3.	
3	Lift the robot carefully.	

2.3.2 Manually releasing the brakes

General

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

The brake of each motor can also be released by connecting an external voltage supply directly on the motor connector, see the circuit diagram.

Releasing the brakes using the brake release unit

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

	Action	Note/Illustration
1	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways! Make sure no personnel is near or beneath the robot arm!	
2	If the robot is not connected to the controller, power must be supplied to the connector R1.MP.	Detailed in section *Supplying power to connector R1.MP on page 63*.
3	The internal brake release unit is located at the base of the robot and equipped with buttons for controlling the holding brakes for each axis separately. The buttons are numbered according to the numbers of the axes. To release the brake on a particular robot axis, push the corresponding button on the internal brake release panel and keep it depressed. The brake will function again as soon as the button is released.	

Supplying power to connector R1.MP

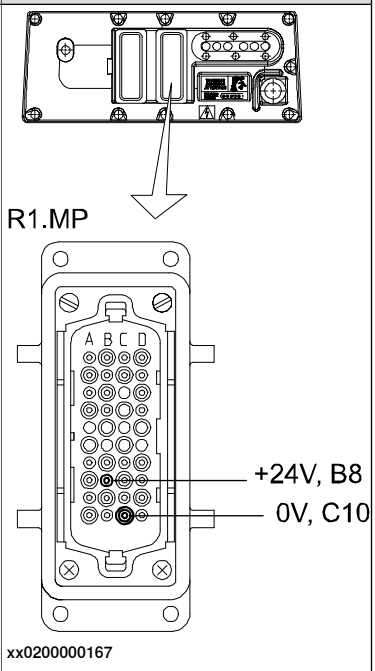
If the robot is not connected to the controller, power must be supplied to connector R1.MP in the robot base in order to enable the brake release unit on the robot.

	Action	Note/Illustration
1	**CAUTION** Be careful not to interchange the 24 VDC and 0V pins! If they are mixed up, damage can be caused to a resistor diode and to the system board.	

Continues on next page

2.3.2 Manually releasing the brakes

Continued

	Action	Note/Illustration
2	Connect an external power supply to connector R1.MP, at the robot base. Supply: • +24 V on pin B8 • 0 V on pin C10	
3	Release the brakes with the brake release unit as detailed in the previous procedure.	

2.3.3 Orienting and securing the robot

General

This section details how to orient and secure the robot to the foundation in order to safely run the robot. The requirements for the foundations are shown in *Requirements, foundation on page 57*.

Bolting requirements

When bolting a base plate or the base to a concrete floor, follow the general instructions for expansion-shell bolts. The screw joint must be able to withstand the stress loads defined in section *Pre-installation procedure on page 56*.

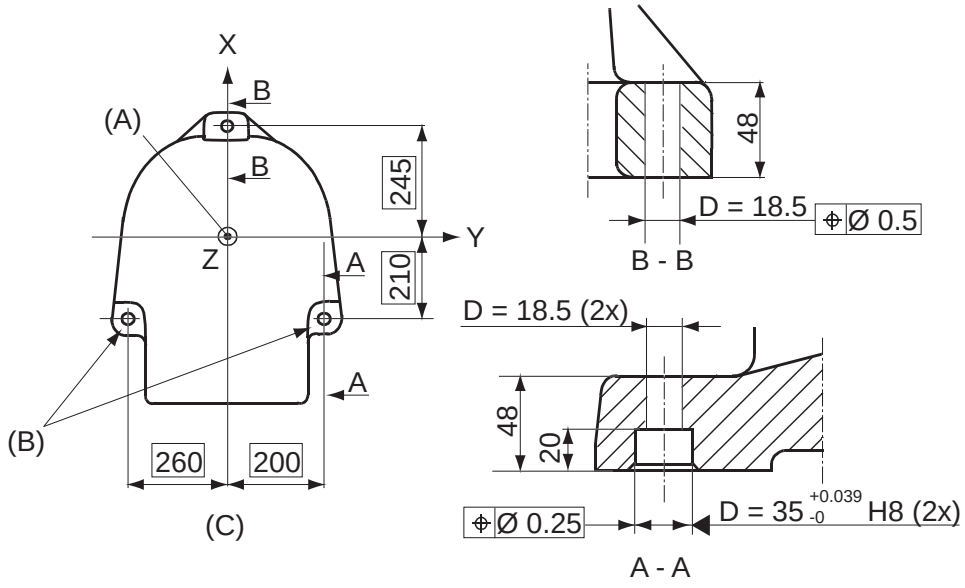
Attachment screws

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

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

Hole configuration

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



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2.3.3 Orienting and securing the robot
Continued

Guide sleeves

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

Equipment	Art. no.
Guide sleeves	2151 0024-169

2.3.4 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.

2.3.5 Installation of signal lamp (option)

Signal lamp

See the assembly instruction delivered with the signal lamp.

2.4 Restricting the working range

General

When installing the manipulator, make sure that it can move freely within its entire working range. If there is a risk that it may collide with other objects, its working range should be limited, both mechanically and in the system parameter configuration (software). Installation of an optional extra stop for the main axes 1, 2 and 3 is described below.

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

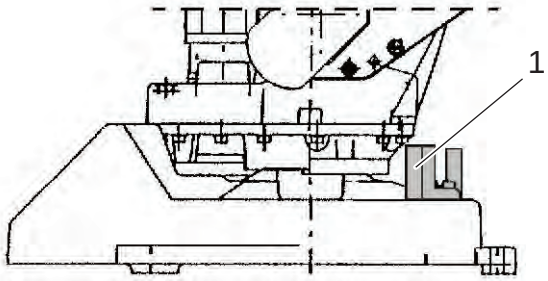
Axis 1

The range of rotation for axis 1 can be limited mechanically by fitting extra stop lugs to the base, see figure.

Instructions for necessary machining and mounting are supplied with the kit.

CAUTION

The original stop lug must never be removed.



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1	Extra stop lug for axis 1

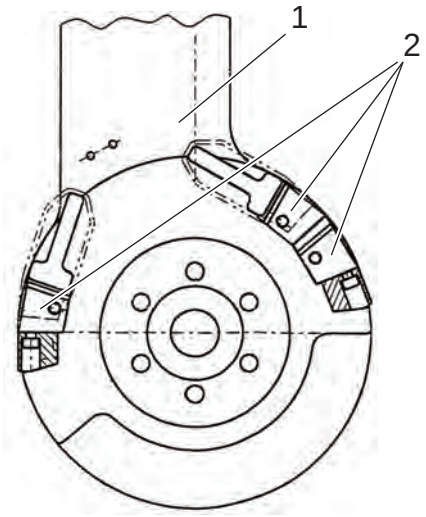
Continues on next page

2.4 Restricting the working range
Continued

Axis 2

The working range of axis 2 can be limited mechanically by fitting extra stop lugs to the lower arm (see Figure 12). The lugs limit the arm movements in intervals of 20°. (20° = 1 lug, 40° = 2 lugs, etc.)

Instructions for doing this are supplied with the kit.



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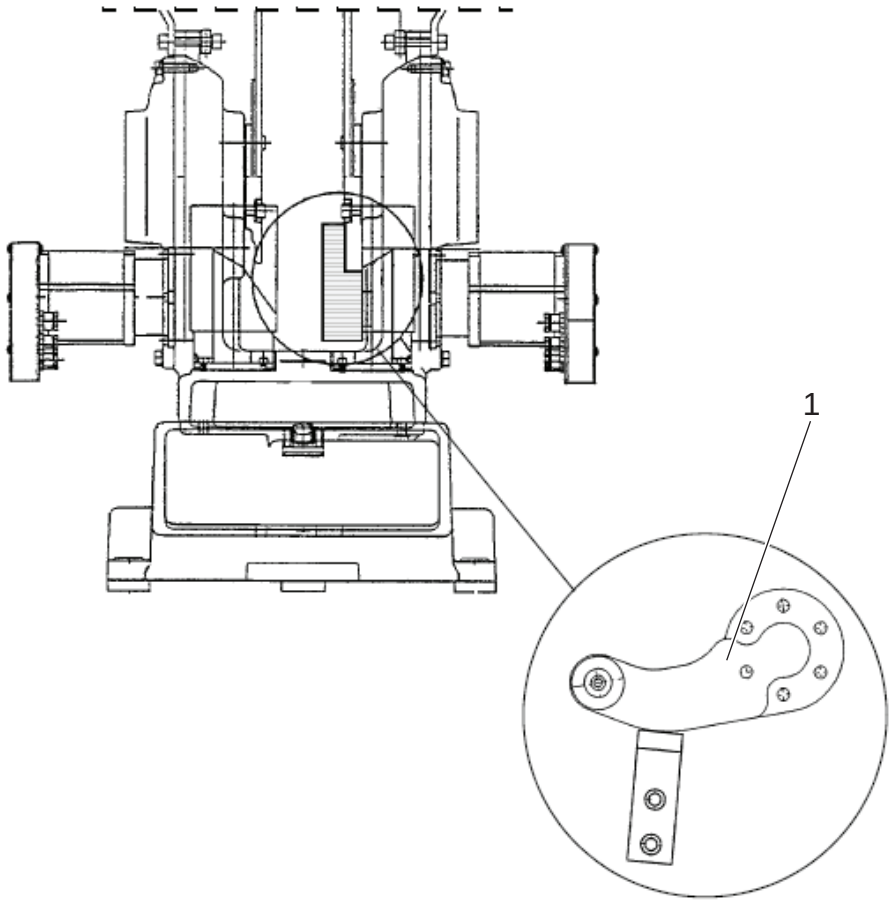
1	Lower arm
2	Extra stop lug for axis 2

Continues on next page

Axis 3

The working range of axis 3 can be limited mechanically by fitting a stop lug under the parallel arm (see Figure 13). Axis 3 is limited upwards to 0 or -10 degrees above the horizontal plane.

Instructions for doing this are supplied with the kit.



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1	Extra Stop Lug for limiting Axis 3

2.5 Electrical connections

2.5.1 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 72*.
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. See the product manual for the controller, 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

Art. no.	Cable
3HAC2492-1	Robot cable, power:L= 7 m
3HAC2529-1	Robot cable, power: L=15 m
3HAC2539-1	Robot cable, power: L=22 m
3HAC2564-1	Robot cable, power: L=30 m

Robot cable, signals

Art. no.	Description
3HAC2493-1	Control cable signal L=7m
3HAC2530-1	Control cable signal L=15m
3HAC2540-1	Control cable signal L=22m
3HAC2566-1	Control cable signal L=30m

Continues on next page

Robot cable, signals

Cable	Art. no.
Robot cable signal, shielded: 7 m	
Robot cable signal, shielded: 15 m	
Robot cable signal, shielded: 22 m	
Robot cable signal, shielded: 30 m	

2.5.2 Customer connections

2.5.2.1 Air supply and signals for extra equipment to upper arm

Option 041

Hose for compressed air is integrated into the manipulator. There is an inlet at the base and an outlet on the upper arm housing. Connections: R1/4” in the upper arm housing and at the base. Max. 8 bar. Inner hose diameter: 6.5 mm.

For connection of extra equipment on the manipulator, there are cables integrated into the manipulator’s cabling.

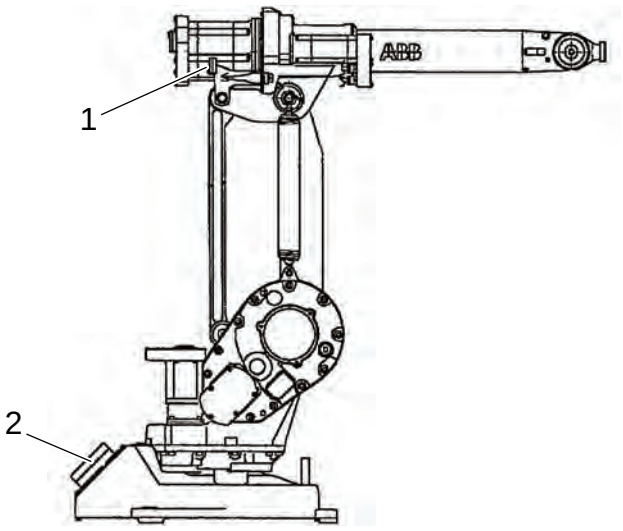
Signals	
Number of signals	12 signals, 49V, 500 mA
Connector on upper arm	FCI 12-pin UT001412SHT
Connector on robot base	FCI 12-pin UT001412PHT

Option 042

Control cabling to arc welding wire-feeder is integrated into the manipulator’s cabling.

Control signals	
Number of signals:	16 signals, 49V, 500 mA
Connector on robot base: FCI 23-pin UT001823SHT	FCI 23-pin UTG61823PN
Connector on upper arm housing:	FCI 23-pin UT001823SHT

Power signals	
Number of signals:	12 signals, 300V, 4A
Connector on upper arm housing:	FCI 12-pin socket UTG61412SN
Connector on robot base:	FCI 12-pin UT001412PHT



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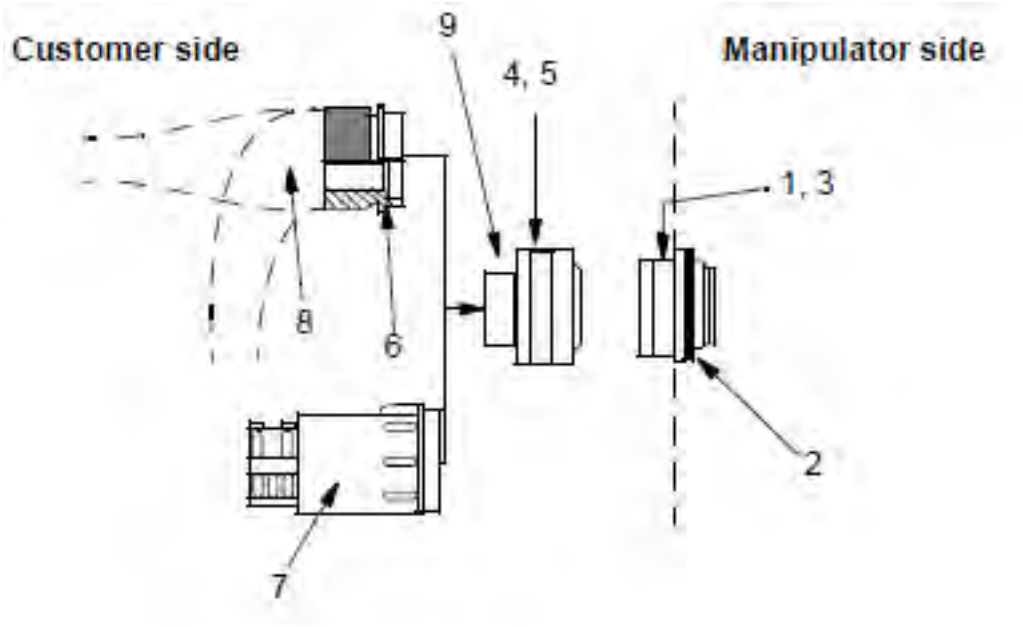
1	R2.CS Air (only option 041) R2.CP (only option 042)
2	R1.CS Air (only option 041) R2.CP (only option 042)

To connect power and signal conductors to the manipulator base and to the upper arm connectors, the following parts are recommended:

- ABB's recommended contact set, for connector R2.CS, has Art. No. 3HAC 12583-1
- ABB's recommended contact set, for connector R1.CS, has Art. No. 3HAC 12493-1.

The complete contact set (option), which corresponds to item 4, 5, 6, 7, 8 and 9 according to Figure 17. contains:

- Pins for cable area 0.13 - 0.25 mm2
- Shrinking hose, bottled shaped
- Shrinking hose, angled



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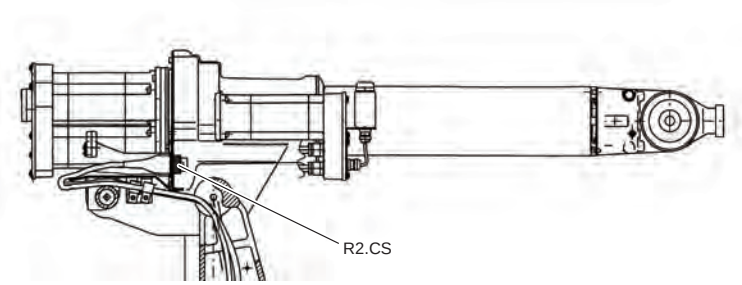
2.5.2.2 Connection of extra equipment to the manipulator

Technical data for customer connections.

Signals	
Conductor resistance	< 3 ohm, 0.154 mm2
Max. voltage	50 V AC/DC
Max. current	250 mA

Connections on upper arm



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Signal	Terminal (Controller)	Contact on Upper Arm, R2	Contact on Manipulator Base (Cable not supplied)
CSA	XT5.1	R2.CS.A	R1.CS.A
CSB	XT5.2	R2.CS.B	R1.CS.B
CSC	XT5.3	R2.CS.C	R1.CS.C
CSD	XT5.4	R2.CS.D	R1.CS.D
CSE	XT5.5	R2.CS.E	R1.CS.E
CSF	XT5.6	R2.CS.F	R1.CS.F
CSG	XT5.7	R2.CS.G	R1.CS.G
CSH	XT5.8	R2.CS.H	R1.CS.H
CSJ	XT5.9	R2.CS.J	R1.CS.J
CSK	XT5.10	R2.CS.K	R1.CS.K
CSL	XT5.11	R2.CS.L	R1.CS.L
CSM	XT5.12	R2.CS.M	R1.CS.M

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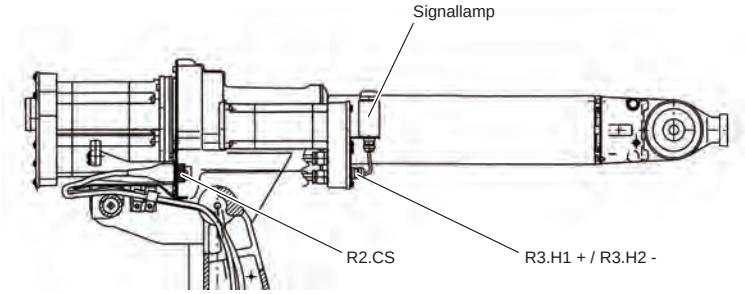
Connection of signal lamp on upper arm (option)



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3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 1410.

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 1410 is connected to power, always make sure that the IRB 1410 is connected to protective earth before starting any maintenance work!

For more information see:

- *Product manual - IRC5*

3.2 Maintenance schedule

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 1410:

- 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.

3.2.2 Maintenance schedule

General

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

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

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

Activities and intervals, standard equipment

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

Maintenance activity	Interval	Note	Detailed in section:
Oil change in gearboxes, axes 1,2, 3 and 4.	40000 h	Lubricated for life. Maintenance free units.	
Replacement of battery pack, SMB unit	Battery low alert [i]	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	*Replacement of SMB battery on page 84*.
Replacement of battery pack, SMB unit	36 months or battery low alert [ii]	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	*Replacement of SMB battery on page 84*.
Inspection of all signal cabling in lower and upper arm	36 months	Replace if damaged.	
Replacement of mechanical stop axis 1	60 months	Replace if bent.	
Lubrication of spring brackets	Every 2000 hours or 6 months		
Lubrication of gears, axis 5-6	Every 4000 hours or 1 year		

[i] 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.

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

See the replacement instruction for more details.

3.3 Changing activities

3.3.1 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

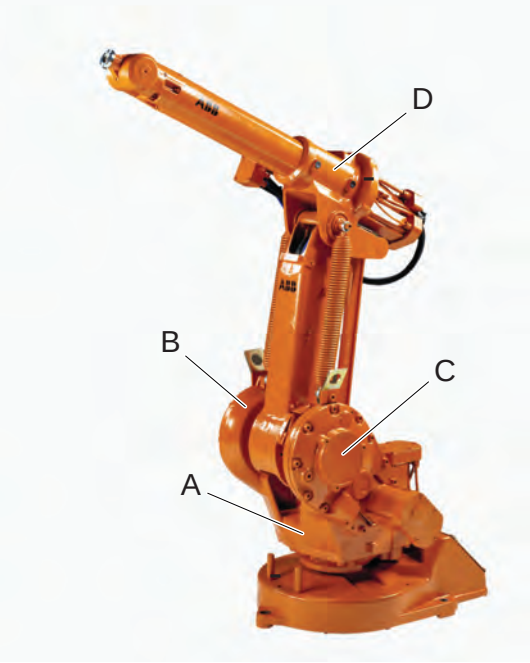
Information about the *type of lubrication*, *article number* as well as the *amount* in the specific gearbox can be found in *Technical reference manual - Lubrication in gearboxes* on the Documentation DVD (released twice a year). The revision of the manual published on the Documentation DVD, will contain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

Location of gearboxes

The figure shows the location of the gearboxes.



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

Equipment

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

3.3.2 Replacement of SMB battery

Note

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

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

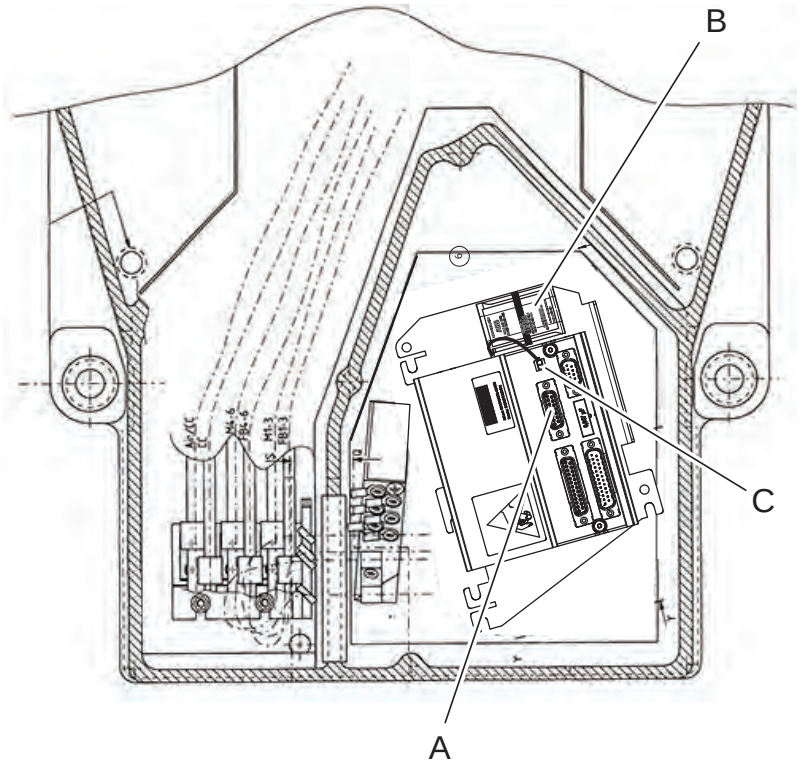
For an SMB board with 2-pole battery contact, the typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended for longer production breaks with a battery shutdown service routine. See *Operating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

WARNING

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

Location of SMB battery unit

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



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A	SMB connection

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B	SMB battery RMU
C	SMB battery connector

Required equipment

Note

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

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

Equipment	Spare part no.	Note
Battery unit (2-pole battery contact)	3HAC16831-1	Lithium battery. This battery requires that the serial measurement unit 3HAC17396-1 is installed.
Battery unit (3-pole battery contact)	3HAC044075-001	RMU Lithium battery. Can only be used with SMB unit 3HAC046277-001 containing SMB board 3HAC044168-001.
Gasket, cover	3HAC3200-1	Always replace with a new one!
Standard toolkit		The content is defined in the section *Standard tools on page 151*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Replacement, SMB battery

The procedure below details how to replace the SMB battery.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	 xx0200000023 **WARNING** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *WARNING - The unit is sensitive to ESD! on page 50*	

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3.3.2 Replacement of SMB battery

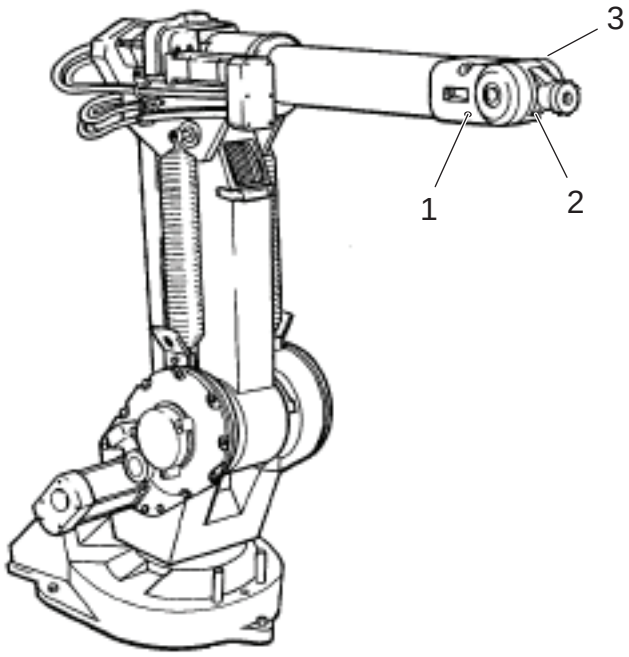
Continued

	Action	Note
3	Remove the rear cover plate (A) on the robot by unscrewing its attachment screws (B).	
4	Remove the battery terminals from the serial measuring board and cut the clasp that keeps the battery unit in place.	
5	Fit the new **battery** and connect the terminals to the serial measuring board.	Shown in the figure *Location of SMB battery unit on page 84*.
6	Refit the cover to the robot base, together with a new *gasket*.	Always replace a removed gasket with a new! Spare part no. is specified in *Required equipment on page 85*.
7	Update the revolution counters!	Detailed in the section *Updating revolution counters on page 136*.

3.4 Lubrication activities

Greasing axes-5 and -6

Grease is pressed through the 3 nipples.



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1	Nipple, axis 5
2	Nipple, axis 6
3	Nipple, axis 5

Grease is Energrease LS-EP2 S or equivalent.

Lubricating spring brackets

There are four lubrication places, located over and under the two balancing springs.

3.5 Cleaning activities

3.5.1 Cleaning the IRB 1410

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 1410 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 1410.

Note

Always verify the protection type of the robot before cleaning.

Dos and don'ts!

This section specifies some special considerations when cleaning the robot.

Always!

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

Never!

- Never 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!

Continues on next page

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

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

Cables

Movable cables need to be able to move freely:

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

1 See *Cleaning methods on page 89* for exceptions.

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4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes all repair activities recommended for the IRB 1410 and any external unit.

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

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

Required equipment

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

The details of equipment are also available in different lists in the chapter *Reference information on page 143*.

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 1410 is connected to power, always make sure that the IRB 1410 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.
Grease	Shell GADUS S2 V220AC 2, or similar	

Assembly of all bearings

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

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

Assembly of tapered bearings

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

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

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

Greasing of bearings

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

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

Continues on next page

4.2.2 Mounting instructions for bearings
Continued

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

Grease the different types of bearings as following description:

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

4.2.3 Mounting instructions for seals

General

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

Equipment

Equipment, etc.	Article number	Note
Grease	Shell GADUS S2 V220AC 2, or similar	

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 95*.
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

4.2.3 Mounting instructions for seals
Continued

Flange seals and static seals

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

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

O-rings

The following procedure describes how to fit o-rings.

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

4.2.4 Checking for play in gearboxes and wrist

Checking for play

When checking for play in gearboxes the brakes must be disengaged. When trying to move an arm manually when the brakes are engaged, some play can be felt.

The play that can be felt is between the brake disk and the motor shaft, not in the gearbox itself. This is because the rotating brake disk is connected to the motor shaft by splines. This is why the brakes must be disengaged before testing for play in the gearboxes and wrist. The brakes are disengaged by pressing the enable button on the FlexPendant.

Note

The play in the brake disk does not affect the robot motion or accuracy.

4.3 Axis 1

4.3.1 Replacing the axis-1 motor

General

See foldouts 1 and 5 in chapter, Foldout.

The motor and the drive gear constitute one unit.

Removing

	Action	Note
1	Remove the cover of the motor.	
2	Loosen connectors R4.MP1 and R4.FB1.	
3	Remove the connection box by unscrewing.	See foldout/pos. <5/160>
	Note Note the position of the motor.	
4	Loosen the motor by unscrewing.	See foldout/pos. <1/10>

Refitting

	Action	Note
1	Check that the assembly surfaces are clean and the motor unscratched.	
2	Release the brake, apply 24V DC to terminals 7 and 8 in the 4.MP1 connector.	
3	Install the motor according to previously done markings, tighten screws.	See foldout/pos. <1/10>
4	Adjust the motor in relation to the gear in the gearbox.	
5	Screw the 3HAB 1201-1 crank tool into the end of the motor shaft.	
6	Make sure there is very small play by turning axis 1 at least 45o.	
7	Tighten screws using a torque of 8.3 Nm ±10%.	See foldout/pos. <1/10>
8	Connect the cabling.	
9	Calibrate the robot as specified.	Described in section: *Calibration information on page 131*

4.3.2 Replacing the axis-1 gearbox

General

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

The gearbox is not normally serviced or adjusted. See foldout 1 in chapter, Foldout.

Note

If the gearbox on any of the axes 1, 2 or 3 is replaced, the whole unit must be replaced.

Removing

	Action	Note
1	Remove the motors on axes 1, 2 and 3.	Described in section: *Replacing the axis-1 motor on page 98*, *Replacing the axis-2 motor on page 103* and *Replacing the axis-3 motor on page 109*.
2	Remove the cabling and serial measurement board.	Described in section: *Replacing the serial measurement board on page 122*
3	Remove the tie rod.	Described in section: *Replacing the tie rod on page 112*
4	Remove the parallel arm.	Described in section: *Replacing the parallel arm on page 111*
5	Remove the balancing springs.	Described in section: *Replacing the balancing springs on page 108*
6	Remove the upper arm.	Described in section: *Replacing the complete upper arm on page 113*
7	Remove the lower arm.	Described in section: *Replacing the lower arm on page 106*
8	Place the remaining parts of the manipulator upside-down on a table or similar surface, and remove the bottom plate.	See Figure 22, and foldout/pos. <1/5>.

Refitting

	Action	Note
1	Place a new gear unit on the table.	
2	Raise the base.	
3	Screw in the screws together with their washers.	See foldout/pos. <1/4> and <1/3>. Tighten using a torque of 68 Nm ±10%.
4	Refit the bottom plate using screws.	See foldout/pos. <1/5> and <1/7>
5	Turn the foot.	
6	Refit the lower arm.	Described in section: *Replacing the lower arm on page 106*

Continues on next page

4.3.2 Replacing the axis-1 gearbox
Continued

	Action	Note
7	Refit the parallel arm.	Described in section: *Replacing the parallel arm on page 111*
8	Refit the upper arm.	Described in section: *Replacing the complete upper arm on page 113*
9	Refit the cabling.	Described in section: *Replacing the axis-1, -2, and -3 cabling on page 123*
10	Refit the tie rod.	Described in section: *Replacing the tie rod on page 112*
11	Refit the balancingd springs.	Described in section: *Replacing the balancing springs on page 108*
12	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.3.3 Replacing the position indicator (Optional)

General

See foldouts 3 and 4 in chapter, Foldout.

Removing

	Action	Note
1	Remove the flange plate.	See foldout/pos. <4/138>
2	Loosen the connector R1.LS.	
3	Removing the two limit switches.	See foldout/pos. <3/174>
4	Loosen the cables from the switches.	
5	Remove the cabling through the base.	

Refitting

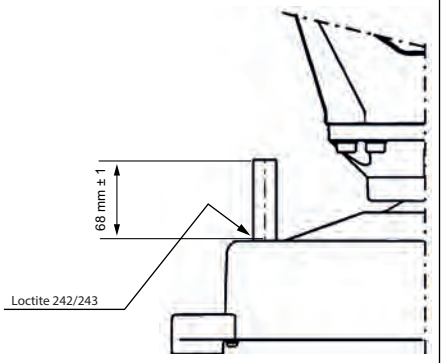
	Action	Note
1	Route the new cabling through the base.	
2	Connect the cables to the switches.	
3	Assemble the two limit switches.	See foldout/pos. <3/174>
4	Connect connector R1.LS.	
5	Assemble the flange plate.	See foldout/pos. <4/138>

4.3.4 Replacing the mechanical stop

General

If the stop pins are bent, they must be replaced. See foldout 1 in chapter, Foldout.

Replacement

	Action	Note
1	Remove the old stop pin.	
2	Fit the new pin according to the illustration.	

4.4 Axis 2

4.4.1 Replacing the axis-2 motor

General

See foldouts 1 and 5 in chapter, Foldout.

The motor and the drive gear constitute one unit.

Removing

WARNING

Lock the arm system before dismantling the motor; the brake is located in the motor.

	Action	Note
1	Remove the cover of the motor.	
2	Loosen connectors R3.MP2 and R3.FB2.	
3	Remove the connection box by unscrewing the screws.	See foldout/pos. <5/160>
4	Note the position of the motor before removing it.	
	Note The oil will start to run out when loosen the motor.	
5	Loosen the motor by unscrewing the motor screws.	See foldout/pos. <1/10>

Refitting

	Action	Note
1	Check that the assembly surfaces are clean and the motor unscratched.	
2	Release the brake, apply 24 V DC to terminals 7 and 8 on the R3.MP2 connector.	
3	Install the motor according to previously done markings, tighten screws.	See foldout/pos. <1/10> Torque, approximately 2 Nm.
4	Adjust the motor in relation to the drive in the gearbox.	
5	Screw the 3HAB 1201-1 crank tool into the end of the motor shaft.	
6	Make sure there is no play.	
7	Tighten screws.	See foldout/pos. <1/10> Torque 8.3 Nm ±10%
8	Fill with oil.	Described in section: *Type of lubrication in gearboxes on page 82*
9	Connect the cabling.	

Continues on next page

4.4.1 Replacing the axis-2 motor

Continued

	Action	Note
10	Calibrate the robot.	Described in section: Calibration

4.4.2 Replacing the axis-2 gearbox

General

Axis 2 gearbox is of a conventional type, manufactured with a high degree of precision and, together with the gearbox for axes 1 and 3, forms a complete unit. See foldout 1 in chapter, Foldout.

The gearbox is not normally serviced or adjusted.

Note

If the gearbox of any of the axes 1, 2 or 3 needs to be changed, the whole unit must be changed.

Replace

How to replace the gearbox is described in section *Replacing the axis-1 gearbox on page 99*

4.4.3 Replacing the lower arm

General

See foldouts 1 in chapter, Foldout.

Removing

	Action	Note
1	Remove the balancing springs.	Described in section: *Replacing the balancing springs on page 108*
2	Remove the cabling down to axis 1.	Described in section: *Replacing the axis-1, -2, and -3 cabling on page 123*
3	Remove the upper arm.	Described in section: *Replacing the complete upper arm on page 113*
4	Attach a hoist with lifting slings to the lower arm.	
5	Remove the parallel arm.	Described in section: *Replacing the parallel arm on page 111*
6	Loosen screws.	See foldout/pos. <1/13>
7	Remove the lower arm.	

Refitting

	Action	Note
1	Transfer the damping element and calibration marking to the new lower arm.	
2	Lift the lower arm into position.	
3	Fix the lower arm to gear 2 using screws <1/13> and tighten them to a torque of 68 Nm ±10%.	
	WARNING To prevent clicking during operation of the robot, grease the bearing seating of the parallel arm in the lower arm.	
4	Refit the parallel arm.	Described in section: *Replacing the parallel arm on page 111*
5	Refit the upper arm.	Described in section: *Replacing the complete upper arm on page 113*
6	Refit the balancing springs.	Described in section: *Replacing the balancing springs on page 108*
7	Refit the cabling.	Described in section: *Replacing the axis-1, -2, and -3 cabling on page 123*
8	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.4.4 Replacing the bearings in the upper arm

General

See foldouts 1 and 2 in chapter, Foldout.

Removing

	Action	Note
1	Loosen the upper bracket of the tie rod.	Described in section: *Replacing the tie rod on page 112*
2	Unscrew screws which hold the parallel arm to gear 3.	See foldout/pos. <1/13>
3	Remove the bearings from the parallel arm.	

Refitting

	Action	Note
1	Fit new bearings to the parallel arm.	
2	Replace the parallel arm using screws and tighten.	See foldout/pos. <1/13>. Torque of 68 Nm ±10%.
3	Attach the upper bracket of the tie rod as specified in.	Described in section: *Replacing the tie rod on page 112*
4	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.4.5 Replacing the balancing springs

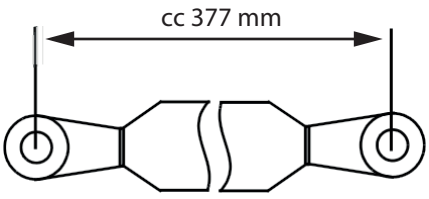
General

See foldout 1, in chapter, Foldout.

Removing

	Action	Note
1	Place the lower arm in a vertical position.	
2	Loosen the locking nut.	See foldout/pos. <1/76>
3	Release the spring using tool 3HAB 1214-6 and undo the screw at the same time.	See foldout/pos. <1/13>
	WARNING If the tool 3HAB 1214-6 is not available, but there are two persons, then the spring can be released manually.	
4	Unscrew the screw in the upper bracket of the spring.	See foldout/pos. <2/65>
5	Remove the springs.	

Refitting

	Action	Note
1	Before installing new springs, make sure that the distance between the attachment points is correct, see illustration.	 xx1300002637
2	Lock the link heads using Loctite 601.	
3	Lubricate the link heads with grease.	
4	Attach the springs to the top bracket using screws and tighten.	See foldout/pos. <2/65> Torque of 68 Nm ±10%.
5	Pull the springs down using tool 3HAB1214-6 and attach screws, together with lifting lug and washer.	
6	Attach the locking nut <1/76>.	

4.5 Axis 3

4.5.1 Replacing the axis-3 motor

General

See foldouts 1 and 5 in chapter, Foldout.

The motor and the drive gear constitute one unit.

Removing

	Action	Note
1	Remove the cover of the motor.	
2	Loosen connectors R5.MP3 and R5.FB3.	
3	Remove the connection box by unscrewing.	See foldout/pos. <5/160>
4	Note the position of the motor before removing it.	
	Note The oil will start to run out when loosing the motor.	
5	Loosen the motor by unscrewing the motor screws.	See foldout/pos. <1/10>

Refitting

	Action	Note
1	Check that the assembly surfaces are clean and the motor unscratched.	
2	Release the brake, apply 24V DC to terminals 7 and 8 in the 4.MP1 connector.	
3	Install the motor according to previously done markings, tighten screws.	See foldout/pos. <1/10> Torque, approximately 2 Nm
4	Adjust the motor in relation to the gear in the gearbox.	
5	Screw the 3HAB 1201-1 crank tool into the end of the motor shaft.	
6	Make sure there is no play.	
7	Tighten screws.	See foldout/pos. <1/10> Torque of 8.3 Nm ±10%.
8	Fill with oil	Described in section: *Type of lubrication in gearboxes on page 82*
9	Connect the cabling.	
10	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.5.2 Replacing the axis-3 gearbox

General

Axis 3's gearbox is of a conventional type, manufactured with a high degree of precision and, together with the gearbox for axes 1 and 2, forms a complete unit. See foldout 1 in chapter, Foldout.

The gearbox is not normally serviced or adjusted.

Note

If the gearbox of any of the axes 1, 2 or 3 needs to be changed, the whole unit must be changed.

Replace

How to replace the gearbox is described in section *Replacing the axis-1 gearbox on page 99*

4.5.3 Replacing the parallel arm

General

See foldout1 in chapter, Foldout.

Removing

	Action	Note
1	Loosen the upper bracket of the tie rod.	Described in section: *Replacing the tie rod on page 112*
2	Unscrew screws which fix the parallel arm to gear 3.	
3	Remove the bearings from the parallel arm.	See foldout/pos. <1/13>

Refitting

	Action	Note
1	Fit the bearings on the parallel arm.	
2	Replace the parallel arm using screws and tighten.	See foldout/pos. <1/13> Torque, 68 Nm ±10%.
3	Attach the upper bracket of the tie rod.	Described in section: *Replacing the tie rod on page 112*
4	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.5.4 Replacing the tie rod

General

See foldout 2 in chapter, Foldout.

Removing

	Action	Note
1	Lock the upper arm in a horizontal position with the help of a hoist and lifting slings.	
2	Unscrew screw.	See foldout/pos. <2/74>
3	Undo the two screws for fixing the cabling bracket of the upper arm housing.	
4	Fold back the cabling bracket.	
5	Screw the screw back into the shaft.	See foldout/pos. <2/74> and <2/71>
6	Carefully knock the shaft out.	
7	Remove housing.	See foldout/pos. <2/72>
8	Unscrew on the lower bracket.	See foldout/pos. <2/70>
9	Carefully tap the rod off the shaft.	

Refitting

	Action	Note
1	Fit bearings on the parallel arm.	
2	Make sure you replace the rod the correct way up.	
3	Install grommets: (3 x) and (1 x).	
	Note The grommet is bevelled and must be inserted the right way up in the lower bearing.	
4	Place the lower bearing of the tie rod on the parallel arm.	
5	Screw in the screw and its washer. Lock using Loctite 242 or 243.	
6	Replace shaft. **Note** Do not forget the sleeve <72>.	See foldout/pos. <1/71>
7	Mount washer <73> and tighten the shaft using a temporary screw, M8x35.	
8	Replace this screw by screw <74> and mount the cable bearer <163>.	
9	Lock using Loctite 242 or 243.	

4.5.5 Replacing the complete upper arm

General

See foldout 2 in chapter, Foldout.

Required equipment

Equipment	Art no.	Note
Measuring instrument	3HAB 1205-1	
Withdrawing tool for shaft spindles	3HAB 1259-1	

Removing

WARNING

Attach a hoist with lifting slings to the upper arm.

	Action	Note
1	Unscrew the upper bracket of the tie rod as specified in.	Described in section: *Replacing the tie rod on page 112*
2	Loosen the connectors of the motors of axes 4, 5 and 6.	
3	Disconnect the connection box from the motors.	
4	Detach the balancing springs.	Described in section: *Replacing the balancing springs on page 108*
5	Undo the KM nuts.	See foldout/pos. <2/64>
6	Remove washers and shims on the same side as axis 3.	See foldout/pos. <2/61, 2/62> and <2/63>.
7	Attach the withdrawing tool 3HAB 1259-1 to the shaft spindle, and pull off.	See foldout/pos. <2/59>.
8	Repeat the step 6, 7 and 8 on axis 2 side.	

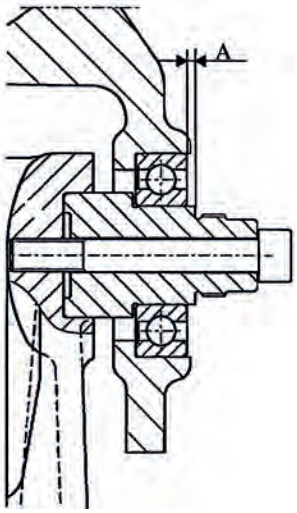
Refitting

	Action	Note
1	Raise the upper arm into assembly position.	
2	Install shaft spindles (both sides), use two temporary screws M10x90.	See foldout/pos. <2/59>
3	Insert bearings (both sides) using tool 3HAB1200-1 and screws.	See foldout/pos. <2/60> and <2/65>.
4	Detach the tool and tighten the screws once more, only to prevent rotation of the axis when the KM nut is tightened.	Tool no.3HAB 1259-1
	Note Assemble the same side as axis 2 first.	

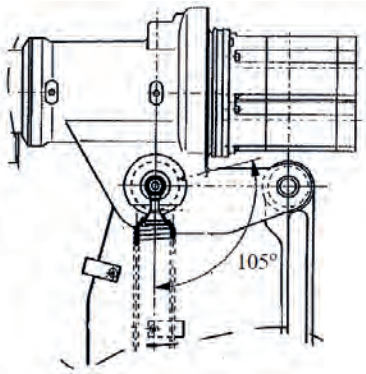
Continues on next page

4.5.5 Replacing the complete upper arm

Continued

	Action	Note
5	Mount two washers and calibration washer.	See foldout/pos. <2/63> and <2/50>
6	Tighten using the KM nut.	See foldout/pos. <2/64>
7	Attach the measuring instrument 3HAB 1205-1 to the shaft spindle on axis 3.	
	Note If measuring instrument is not available, you can use a micrometer thickness gauge.	
8	Hold the tool against the shoulder of the shaft spindle and measure the dimension “A”. See illustration.	 xx1300002642
9	(If you are not using the measuring instrument, tighten using the KM nut and, before measuring with the micrometer thickness gauge, then undo it again.)	
10	Make a note of the dimension “A”. Fit one washer and shims , and using the micrometer, measure the thickness so that the total thickness is 0.10 - 0.20 mm more than the noted dimension “A”. This will result in a preloading of the bearing of 0.10 - 0.20 mm.	See foldout/pos. <2/63>, <2/61> and <2/62>
11	Fit the shims and washer and tighten the KM nut.	See foldout/pos. <2/64>
12	Replace the upper attachment of the tie rod as specified in.	Described in section: *Replacing the tie rod on page 112*
13	Replace the balancing springs.	Described in section: *Replacing the balancing springs on page 108*
14	Reconnect the connection boxes and the cabling.	
15	Calibrate the robot.	Described in section: Calibration
16	Undo the KM-nut on the axis 2 side, just to be able to adjust the calibration washer.	See foldout/pos. <2/50>

Continues on next page

	Action	Note
17	If the old arm house is mounted: • Adjust the calibration washer according to the punch mark. If the arm house is new: • Adjust the washer according to illustration and make new punch marks for axes 3 and 4.	 xx1300002643

4.6 Axis 4

4.6.1 Replacing the axis-4 motor

General

See foldouts 5 and 8 in chapter, Foldout.

The motor and the drive gear constitute one unit.

Position the arm system in such a way that the motor of axis 4 points upwards.

Removing

	Action	Note
1	Remove the cover of the motor.	
2	Loosen connectors R3.MP4 and R3.FB4.	
3	Remove the connection box by unscrewing the screw.	See foldout/pos. <5/160>
	Note Note the position of the motor before removing it.	
4	Loosen the motor by unscrewing the screw.	See foldout/pos. <8/23>

Refitting

	Action	Note
1	Check that the assembly surfaces are clean and the motor unscratched.	
2	Put O-ring on the motor.	See foldout/pos. <8/21>
3	Release the brake, and apply 24 V DC to terminals 7 and 8 on the R3.MP4 connector.	
4	Install the motor according to previously done markings, tighten screws.	See foldout/pos. <8/23> Torque, approximately 2 Nm
5	Adjust the position of the motor in relation to the drive in the gearbox.	
6	Screw the crank tool into the end of the motor shaft.	Tool no. 3HAB 1201-1
7	Make sure there is a small clearance.	
8	Unscrew one screw at a time, apply Loctite 242 or 243 and tighten.	Torque, 4.1 Nm ±10%.
9	Reconnect the cabling.	
10	Calibrate the robot.	Described in section: Calibration

4.6.2 Replacing the intermediate gear including sealing

General

See foldout 8 in chapter, Foldout.

Removing

	Action	Note
1	Remove the wrist.	Described in section: *Replacing the wrist on page 126*
2	Remove the drive mechanism.	Described in section: *Replacing the wrist on page 126*
3	Remove the motor of axis 4.	Described in section: *Replacing the axis-4 motor on page 116*
4	Remove the cover.	See foldout/pos. <8/25>.
5	Undo screws fixing the large drive gear and dismantle it.	See foldout/pos. <8/18> and <8/17>.
6	**Note** Put the shims in a safe place.	
7	Undo screws.	See foldout/pos. <8/12>.
8	Push the intermediate gear out of the arm housing.	

Refitting

	Action	Note
1	Grease the seating of the arm housing to provide radial sealing.	
2	Push the gear unit down into the arm housing.	
3	Screw in screws together with their washers and pull the gear down.	See foldout/pos. <8/12> and <8/13>
4	Mount the drive gear <17> using screws <18> and tighten to a torque of 8.3 Nm ±10%.	
	Note Do not forget to insert shims under the drive gear.	See foldout/pos. <8/14, 8/15 and 8/16>
5	Tighten the screws.	See foldout/pos. <8/12>. Torque, approximately 5 Nm.
6	Bend the pinion towards the large drive gear, and then rotate it around the tubular shaft a couple of times so that the clearance in the gears can adjust itself in relation to the highest point of the large drive gear.	
7	Then tighten the screws.	See foldout/pos. <8/12>. Torque, 20 Nm ±10%.

Continues on next page

4.6.2 Replacing the intermediate gear including sealing

Continued

	Action	Note
8	Check the clearance in relation to the tightening torque.	
9	Replace the cover using screws. Use a drop of Loctite 242 or 243.	See foldout/pos. <8/25> and <8/26>.
10	Position the manipulator so that the tubular shaft points upwards.	
11	Fill oil into axis-4 gear.	Described in section: *Type of lubrication in gearboxes on page 82*
12	Install the axis-4 motor.	Described in section: *Replacing the axis-4 motor on page 116*
13	Install drive mechanism.	See foldout/pos. <8/28>. Described in section: *Replacing the wrist on page 126*
14	Replace the wrist in accordance with.	Described in section: *Replacing the wrist on page 126*
15	Calibrate the robot as specified in .	Described in section: *Calibration information on page 131*

4.6.3 Replacing the drive gear on the tubular shaft

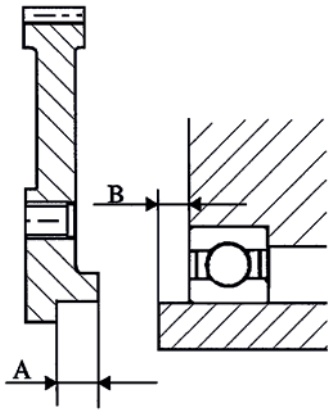
General

See foldout 8 in chapter, Foldout.

Removing

	Action	Note
1	Remove the wrist.	Described in section: xx
2	Remove the drive mechanism in accordance with.	Described in section: xx
3	Remove the axis-4 motor as specified in.	Described in section: *Replacing the axis-4 motor on page 116*
4	Remove the cover.	See foldout/pos. <8/25>.
5	Unscrew screws that hold the intermediate gear in place.	See foldout/pos. <8/12>.
6	Unscrew screws that hold the large drive gear and then dismantle it.	See foldout/pos. <8/18> and <8/17>.
7		
	Note Put the shims from under the drive gear in a safe place.	

Refitting

	Action	Note
1	Shim between drive gear and the rear bearing.	See foldout/pos. <8/17> and <8/3>.  xx1300002638 Shim thickness = B - A + 0.05 mm, see Figure 27.
2	Install the drive gear using screws	See foldout/pos. <8/18> (screws). Torque, 8.3 Nm ±10%.
3	**Note** Do not forget the shims.	

Continues on next page

4.6.3 Replacing the drive gear on the tubular shaft
Continued

	Action	Note
4	Screw the screw and 2 washers into the drive gear. Lock using Loctite 242 or 243.	See foldout/pos. <8/19> and <8/20>.
5	Mount the intermediate gear.	Described in section: *Replacing the intermediate gear including sealing on page 117*
6	Lubricate the drive gear with grease (30 g).	
7	Install the axis-4 motor.	Described in section: *Replacing the axis-4 motor on page 116*
8	Replace the cover using screws. Lock using a drop of Loctite 242 or 243.	See foldout/pos. <8/25> and <8/26>.
9	Mount the drive mechanism.	Described in section: *Replacing the complete axis-5 and axis-6 drive mechanism on page 127*
10	Mount the wrist.	Described in section: *Replacing the wrist on page 126*
11	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.6.4 Dismantling the tubular shaft and changing bearings

General

See foldout 8 in chapter, Foldout.

Removing

	Action	Note
1	Remove the drive gear.	Described in section: *Replacing the drive gear on the tubular shaft on page 119*
2	Push out the tubular shaft.	

Refitting

	Action	Note
1	Fit a new bearing on the tubular shaft using the tool.	See foldout/pos. <8/3> Tool no. 6896 134-V.
2	Push the tube into the housing of the upper arm.	
3	Insert the rear bearing using the tool.	See foldout/pos. <8/3> Tool no. 6896 134-JB
4	Mount the drive gear.	Described in section: *Replacing the drive gear on the tubular shaft on page 119*
5	Calibrate the robot.	Described in section: *Calibration information on page 131*

4.7 Cabling and serial measurement board

4.7.1 Replacing the serial measurement board

General

See foldout 4 in chapter, Foldout.

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!

Removing

	Action	Note
1	Remove flange plate.	See foldout/pos. <4/138>.
2	Cut tie around bundle.	See foldout/pos. <4/144>.
3	Unscrew the serial measuring board using screws.	See foldout/pos. <4/135> and <4/7>.
4	Remove the board and loosen the connectors	

Refitting

	Action	Note
1	Fit the new serial measurement board.	
2	Reconnect connectors.	
3	Fit new cable ties around the bundle.	
4	Refit the flange plate.	

4.7.2 Replacing the axis-1, -2, and -3 cabling

General

See foldouts 3 and 4 in chapter, Foldout.

Removing

	Action	Note
1	Remove the cover of the motors.	
2	Remove the flange plate.	See foldout/pos. <4/138>
3	Loosen connectors R1.MP, R2.FB1-3.	
4	Cut tie around bundle and detach the cable brackets.	
5	Detach the cable guides and undo screws.	See foldout/pos. <3/104 and 105> (cable guides). See foldout/pos. <3/149> (screw).
6	Loosen the connectors in the motors.	
7	Disconnect the connection boxes in the motors.	
8	Feed the cabling up through the middle of axis 1.	

Refitting

	Action	Note
1	Feed the new cabling down through the middle of axis 1.	
2	Connect the connection boxes in the motors.	
3	Reconnect the connectors in the motors.	
4	Attach the cable guides and fasten screws.	
5	Fit new cables tie around bundle and attach the cable brackets.	
6	Reconnect connectors R1.MP, R2.FB1-3.	
7	Refit the flange plate.	
8	Refit the cover of the motors.	

4.7.3 Replacing the axis-4, -5, and -6 cabling

General

See foldouts 2, 3 and 4 in chapter, Foldout.

Removing

	Action	Note
1	Remove the cover of the motors.	
2	Remove the flange plate.	See foldout/pos. <4/138>.
3	Loosen connectors R2.MP4-6 and R2.FB4-6, including customer connector R1.CS (if there is one) and the air hose.	
4	Detach the cable guides.	See foldout/pos. <3/104, 105>.
5	Loosen the cable brackets between gears 2 and 3 and cut the tie around them.	See foldout/pos. <3/149>.
6	Feed the cabling and air hose up through axis 1.	
7	Loosen the cable bracket on the lower arm and undo screws.	See foldout/pos. <3/147>.
8	Undo screw which fixes the shaft of the tie rod.	See foldout/pos. <2/74>.
9	Disconnect the connection boxes in the motors.	
10	Loosen the remaining cable brackets and remove the cabling.	

Refitting

	Action	Note
1	Refit in reverse order.	

4.8 The wrist, axis 5, and axis 6

4.8.1 Introduction

General

The wrist, which includes axes 5 and 6, is a complete unit, comprising drive units and gears. It is of such a complex design that it is not normally serviced on-site, but should be sent to ABB to be serviced.

4.8.2 Replacing the wrist

Removing

	Action	Note
1	Remove the 2 plastic plugs on the rear of the wrist.	
2	Release the brake in axes 5 and 6.	
3	Rotate axes 5 and 6 so that you can see screws in the clamping sleeve through the hole.	See foldout/pos. <9/15>
4	Disconnect the clamping sleeve.	
5	Undo screws and remove the wrist.	See foldout/pos. <1/53>

Refitting

	Action	Note
1	Mount the wrist, tighten screws.	See foldout/pos. <1/53> Torque, 8.3 Nm ±10%.
	Note The grease nipple on the tilt house should point towards the base.	
2	Screw the clamping sleeves together using screws.	See foldout/pos. <9/15>.
3	Replace the plastic plugs.	
4	Calibrate the robot.	Described in section: Calibration.

4.8.3 Replacing the complete axis-5 and axis-6 drive mechanism

General

See foldouts 8 and 9 in chapter, Foldout.

Removing

	Action	Note
1	Dismantle the wrist.	Described in section: *Replacing the wrist on page 126*
2	Loosen the connectors on the motors of axes-5 and -6.	
3	Undo screws.	See foldout/pos. <8/29>
4	Squeeze the drive shafts together at the tip of the tubular shaft, in order that they can pass through the tube.	See foldout/pos. <9/1>
5	Pull out the complete axes-5 and -6 drive mechanism.	

Refitting

	Action	Note
1	Install the drive mechanism in the tubular shaft.	
2	Tighten screws.	See foldout/pos. <8/29> Torque, 8.3 Nm ±10%
3	Insert the cabling.	
4	Mount the wrist.	Described in section: *Replacing the wrist on page 126*

4.8.4 Changing the axis-5 and axis-6 motor or driving belt

General

See foldout 9 in chapter, Foldout.

Removing

	Action	Note
1	Dismantle the wrist.	Described in section: *Replacing the wrist on page 126*
2	Dismantle the drive mechanism.	Described in section: *Replacing the complete axis-5 and axis-6 drive mechanism on page 127*
3	Undo screws and remove the motor.	See foldout/pos. <9/9>
4	If the driving belt is to be changed, both motors must be removed.	
5	Undo screws and remove plate.	See foldout/pos. <9/9> and <9/7>.

Refitting

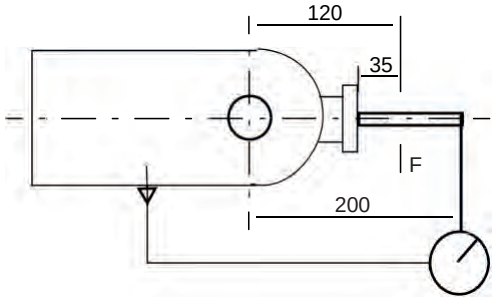
	Action	Note
1	Install the driving belts.	
2	Mount the plate using screws.	See foldout/pos. <9/7> and <9/9>
	Note Do not forget the nuts of the motors.	
3	Install the motors.	
4	Push the motors in sideways to tension the belts using the tool, and tighten screws.	See foldout/pos. <9/9> Tool no. 3HAA 7601-050 Torque, 4.1 Nm.
5	Rotate the drive shafts. Check the tension on the belt.	
6	Install the drive mechanism.	Described in section: *Replacing the complete axis-5 and axis-6 drive mechanism on page 127*
7	Mount the wrist.	Described in section: *Replacing the wrist on page 126*
8	Calibrate the robot.	Described in section: Calibration

4.8.5 Measuring the play in axis-5 and axis-6

Axis-5

Axis 4 shall be turned 90o. The maximum accepted play in axis 5 is 4.7 arc. minutes when loading axis 5 with a moment of 4.8 Nm in one direction, unloading to 0.24 Nm and start measuring the play, loading in the other direction with 4.8 Nm unloading to 0.24 Nm and reading the play. This correspond to play of 0.27 mm on a radius of 200 mm when the load is F=40

N and 2 N on radius 120 mm. See illustration.



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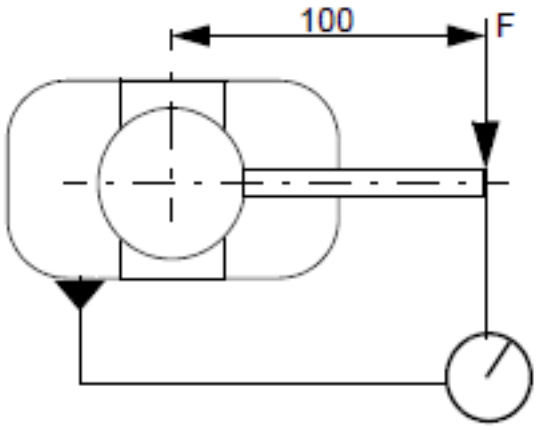
Axis-6

The maximum accepted play in axis 6 is 12.8 arc.minutes when loading axis 6 with a moment of 4.2 Nm in one direction, unloading to 0.2 Nm and start measuring the play, loading in the other direction with 4.2 Nm unloading to 0.2 Nm and reading the play.

This correspond to a play of 0.37 mm on a radius of 100 mm when the load is F=42 N and 2 N. See illustration.



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4.9 Motor units

4.9.1 Introduction

General

Each axis (6 axes) of the manipulator has its own motor unit, and is regarded as one complete

unit, comprising:

- A synchronous motor
- A brake (built into the motor)
- A feedback device.

Description

The power and signal cables are run to the respective motor from the cable connector points on the manipulator. The cables are connected to the motor units by connectors.

The drive shaft of the electric motor forms a part of the gearbox of the manipulator axis. A brake, operated electromagnetically, is mounted on the rear end of the motor shaft and a pinion is mounted on its drive end. The brake releases when power is supplied to the electromagnets.

The commutation value of the motors is: 1.570800.

Note

There is a feedback device mounted on each motor unit. The device is installed by the supplier of the motor and should never be removed from the motor. The motor need never be commutated.

5 Calibration information

5.1 When to calibrate

When to calibrate

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

The resolver values are changed

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

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

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

The revolution counter memory is lost

If the revolution counter memory is lost, the counters must be updated. See *Updating revolution counters on page 136*. This will occur when:

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

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

The robot is rebuilt

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

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

5.2 Calibration methods

Overview

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

Types of calibration

Type of calibration	Description	Calibration method
Standard calibration	The calibrated robot is positioned at calibration position. Standard calibration data is found on the SMB (serial measurement board) or EIB in the robot. For robots with RobotWare 5.04 or older, the calibration data is delivered in a file, calib.cfg, supplied with the robot at delivery. The file identifies the correct resolver/motor position corresponding to the robot home position.	Calibration Pendulum Levelmeter calibration (alternative method)
Absolute accuracy calibration (optional)	Based on standard calibration, and besides positioning the robot at synchronization position, the Absolute accuracy calibration also compensates for: • Mechanical tolerances in the robot structure • Deflection due to load Absolute accuracy calibration focuses on positioning accuracy in the Cartesian coordinate system for the robot. Absolute accuracy calibration data is found on the SMB (serial measurement board) in the robot. For robots with RobotWare 5.05 or older, the absolute accuracy calibration data is delivered in a file, absacc.cfg, supplied with the robot at delivery. The file replaces the calib.cfg file and identifies motor positions as well as absolute accuracy compensation parameters. A robot calibrated with absolute accuracy has a sticker next to the identification plate of the robot. To regain 100% absolute accuracy performance, the robot must be recalibrated for absolute accuracy!  xx0400001197	CalibWare

Brief description of calibration methods

Calibration Pendulum method

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

Continues on next page

Two different routines are available for the Calibration Pendulum method:

- Calibration Pendulum II
- Reference calibration

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

Levelmeter calibration - alternative method

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

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

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

CalibWare - Absolute Accuracy calibration

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

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

References

Article numbers for the calibration tools are listed in the section *Special tools on page 152*.

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

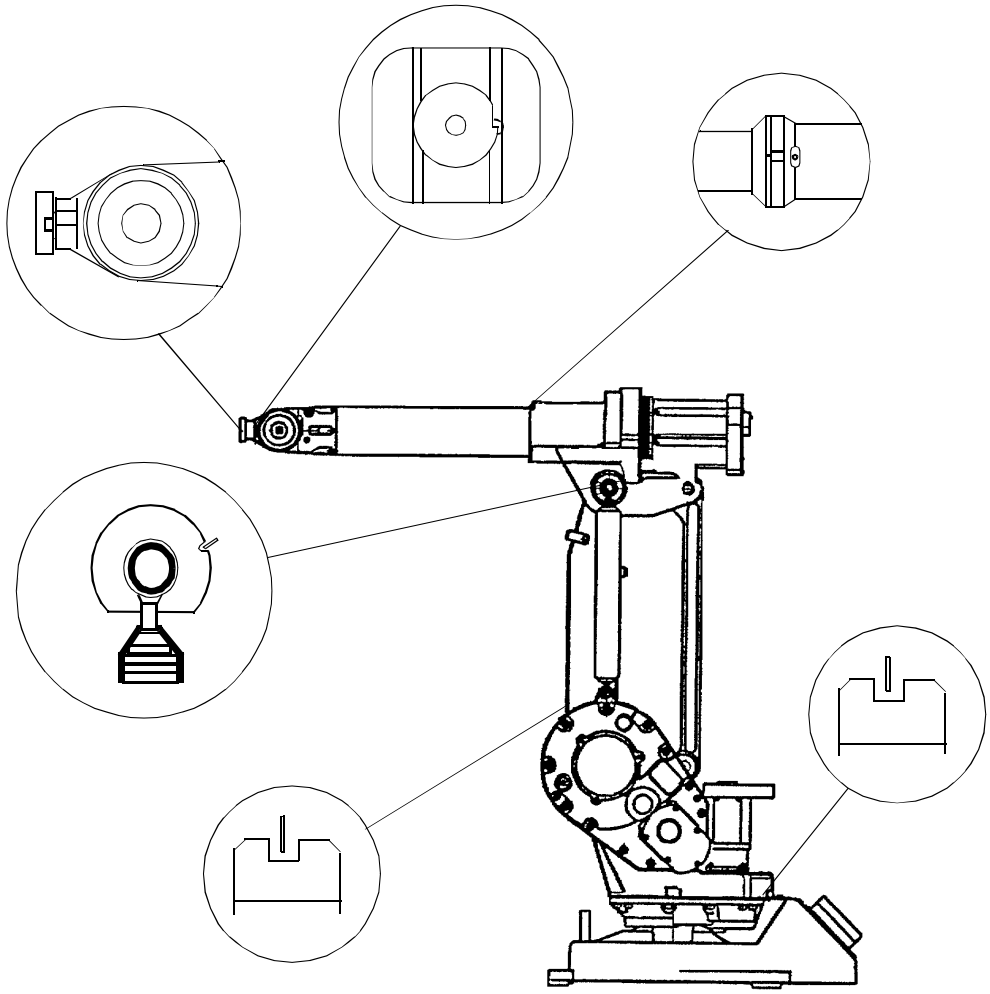
5.3 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 1410

The illustration below shows the calibration scale positions on IRB 1410.



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5.4 Calibration movement directions for all axes

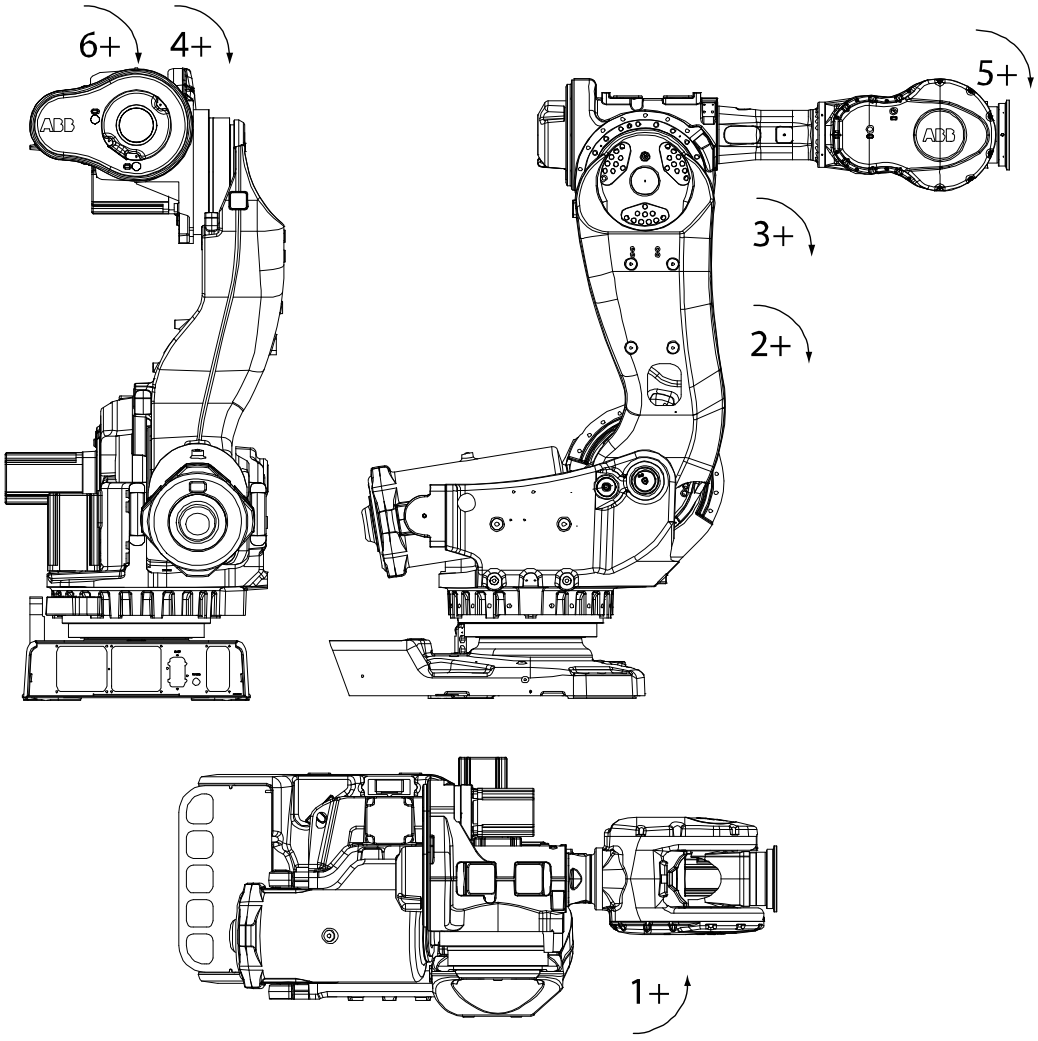
Overview

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

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

Manual movement directions, 6 axes

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



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5.5 Updating revolution counters

Introduction

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

Step 1 - Manually running the manipulator to the synchronization position

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

	Action	Note
1	Select axis-by-axis motion mode.	
2	Jog the manipulator to align the synchronization marks. IRB 140, 1400, 2400, 4400, 6600ID/6650ID, 6640ID: Axes 5 and 6 must be positioned together!	See *Synchronization marks and synchronization position for axes on page 134*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 137*.

Correct calibration position of axis 4 and 6

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

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

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

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

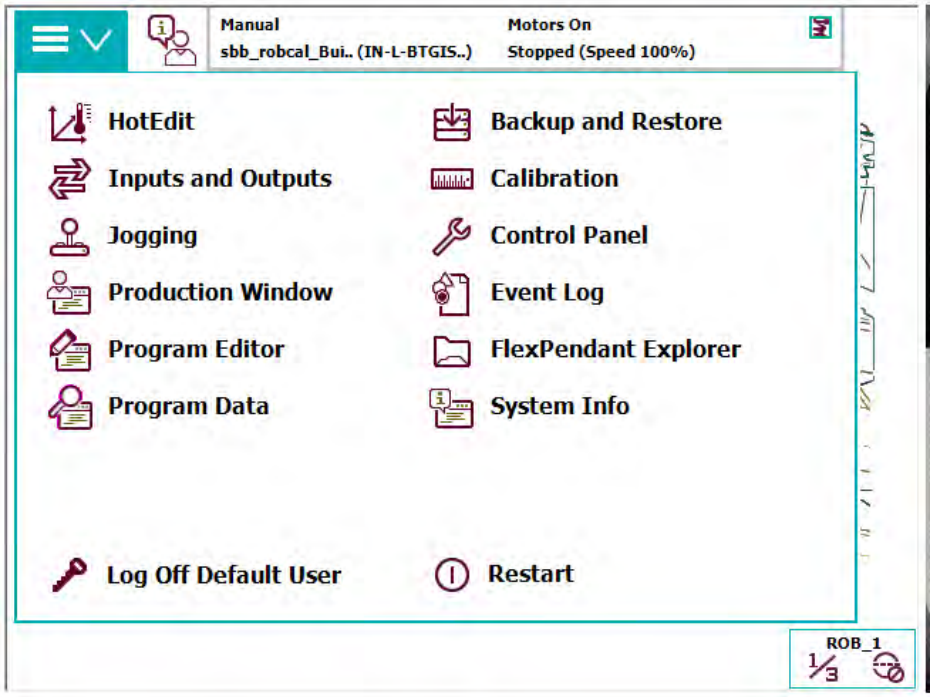
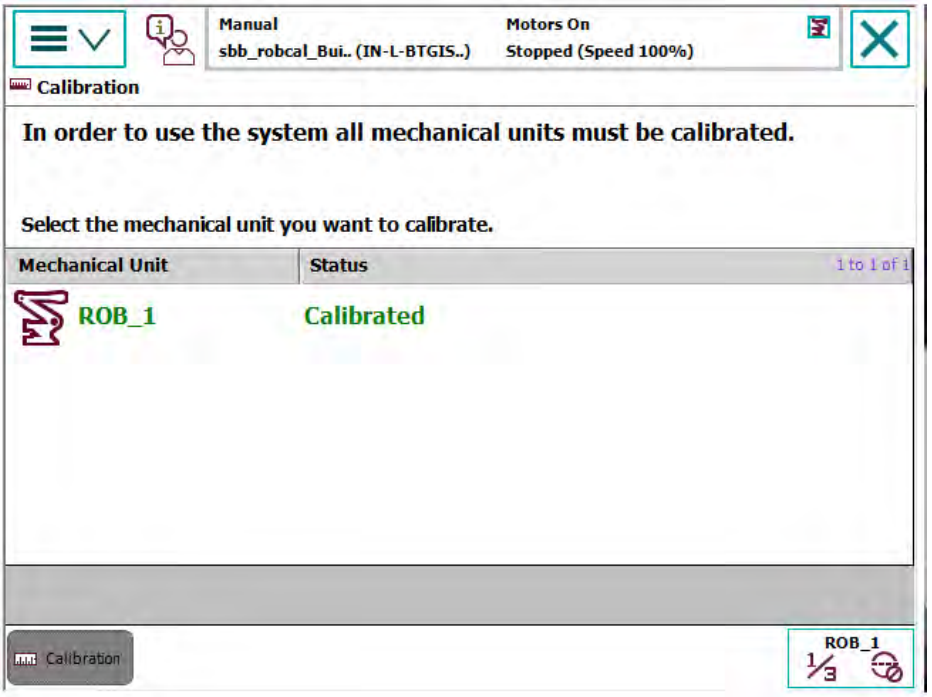
Manipulator variant	Axis 4	Axis 6
IRB 1410	No	No

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

Continues on next page

Step 2 - Updating the revolution counter with the FlexPendant

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

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

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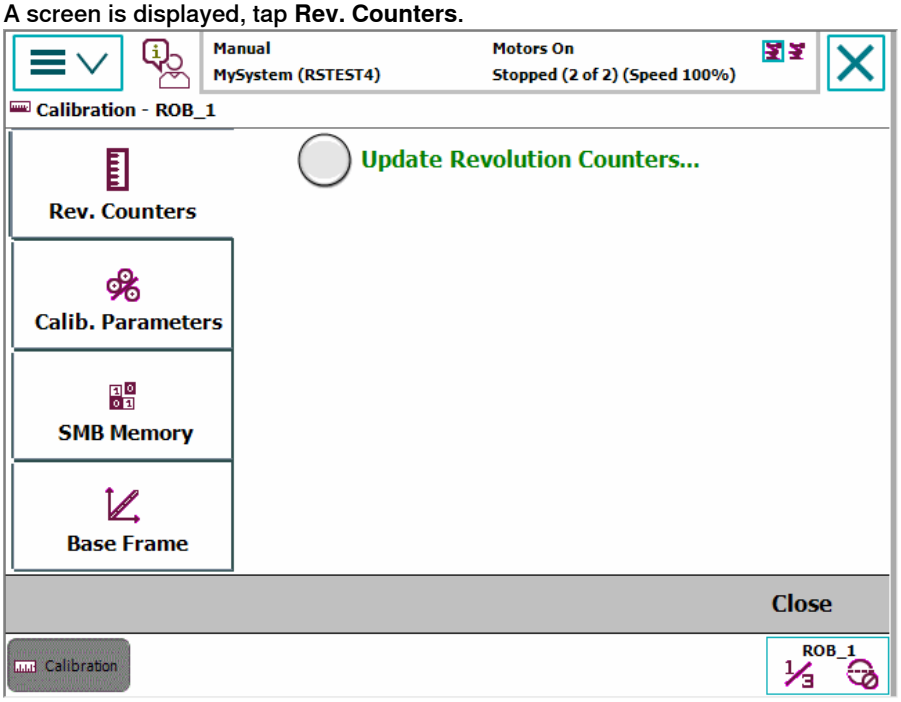
5.5 Updating revolution counters
Continued

	Action
3	A screen is displayed, tap **Rev. Counters**.  en0400000771
4	Tap **Update Revolution Counters...**. A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: • Tap **Yes** to update the revolution counters. • Tap **No** to cancel updating the revolution counters. Tapping **Yes** displays the axis selection window.
5	Select the axis to have its revolution counter updated by: • Ticking in the box to the left • Tapping **Select all** to update all axes. Then tap **Update**.
6	A dialog box is displayed, warning that the updating operation cannot be undone: • Tap **Update** to proceed with updating the revolution counters. • Tap **Cancel** to cancel updating the revolution counters. Tapping **Update** updates the selected revolution counters and removes the tick from the list of axes.
7	**CAUTION** If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See *Checking the synchronization position on page 139*.

5.6 Checking the synchronization position

Introduction

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

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

Using a `MoveAbsJ` instruction

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 134* and *Updating revolution counters on page 136*.

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 134* and *Updating revolution counters on page 136*.

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6 Decommissioning

6.1 Introduction

Introduction

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

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

General

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

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

6.2 Environmental information

Hazardous material

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

Dispose components properly 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, sync. 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.

7 Reference information

7.1 Introduction

General

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

7.2 Applicable standards

Note

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

Standards, EN ISO

The product is designed in accordance with the requirements of:

Standard	Description
EN ISO 12100	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

Continues on next page

Other standards

Standard	Description
ANSI/RIA R15.06	Safety requirements for industrial robots and robot systems
ANSI/UL 1740	Safety standard for robots and robotic equipment
CAN/CSA Z 434-14	Industrial robots and robot Systems - General safety requirements

7.3 Unit conversion

Converter table

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

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

7.4 Screw joints

General

This section describes how to tighten the various types of screw joints on the IRB 1410.

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

UNBRAKO screws

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

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

Gleitmo treated screws

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

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

Screws lubricated in other ways

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

In such cases, proceed as follows:

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

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

Tightening torque

Before tightening any screw, note the following:

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

Continues on next page

7.4 Screw joints
Continued

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

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

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

Oil-lubricated screws with allen head screws

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

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

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

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

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

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

Continues on next page

Water and air connectors

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

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

7.5 Weight specifications

Definition

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

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

Example

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

	Action	Note
	CAUTION The robot weighs 225 kg. All lifting accessories used must be sized accordingly!	

7.6 Standard tools

General

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

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

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

7.7 Special tools

General

All service instructions contain lists of tools required to perform the specified activity. The required tools are a sum of standard tools, defined in the section *Standard tools on page 151*, and of special tools, listed directly in the instructions and also gathered in this section.

Calibration equipment, Levelmeter (alternative method)

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

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

Calibration equipment, Calibration Pendulum

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

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

7.8 Lifting equipment and lifting instructions

General

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

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

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

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8 Spare part list

8.1 Spare part lists and illustrations

Location

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

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9 Circuit diagram

9.1 Circuit diagrams

Overview

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

Controllers

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

Robots

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 120	*3HAC031408-003*
Circuit diagram - IRB 140 type C	*3HAC6816-3*
Circuit diagram - IRB 260	*3HAC025611-001*
Circuit diagram - IRB 360	*3HAC028647-009*
Circuit diagram - IRB 460	*3HAC036446-005*
Circuit diagram - IRB 660	*3HAC025691-001*
Circuit diagram - IRB 760	*3HAC025691-001*
Circuit diagram - IRB 1200	*3HAC046307-003*
Circuit diagram - IRB 1410	*3HAC2800-3*
Circuit diagram - IRB 1600/1660	*3HAC021351-003*
Circuit diagram - IRB 1520	*3HAC039498-007*
Circuit diagram - IRB 2400	*3HAC6670-3*
Circuit diagram - IRB 2600	*3HAC029570-007*
Circuit diagram - IRB 4400/4450S	*3HAC9821-1*
Circuit diagram - IRB 4600	*3HAC029038-003*
Circuit diagram - IRB 6400RF	*3HAC8935-1*
Circuit diagram - IRB 6600 type A	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6600 type B	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6620	*3HAC025090-001*

Continues on next page

9.1 Circuit diagrams
Continued

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 6620 / IRB 6620LX	*3HAC025090-001*
Circuit diagram - IRB 6640	*3HAC025744-001*
Circuit diagram - IRB 6650S	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 6660	*3HAC025744-001* *3HAC029940-001*
Circuit diagram - IRB 6700	*3HAC043446-005*
Circuit diagram - IRB 7600	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 14000	*3HAC050778-003*
Circuit diagram - IRB 910SC	*3HAC056159-002*

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Contact us

ABB AB, Robotics
Robotics and Motion
S-721 68 VÄSTERÅS, Sweden
Telephone +46 (0) 21 344 400

ABB AS, Robotics
Robotics and Motion
Nordlysvegen 7, N-4340 BRYNE, Norway
Box 265, N-4349 BRYNE, Norway
Telephone: +47 22 87 2000

ABB Engineering (Shanghai) Ltd.
Robotics and Motion
No. 4528 Kangxin Highway
PuDong District
SHANGHAI 201319, China
Telephone: +86 21 6105 6666

ABB Inc.
Robotics and Motion
1250 Brown Road
Auburn Hills, MI 48326
USA
Telephone: +1 248 391 9000

www.abb.com/robotics

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