ROBOTICS

Product manual

IRB 6660

Trace back information:
Workspace 24C version a5
Checked in 2024-09-17
Skribenta version 5.5.019

Product manual

IRB 6660 - 100/3.3
IRB 6660 - 130/3.1
IRB 6660 - 205/1.9

IRC5, OmniCore

Document ID: 3HAC028197-001

Revision: AE

Original instructions.

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Overview of this manual

About this manual

This manual contains instructions for:

- mechanical and electrical installation of the IRB 6660
- maintenance of the IRB 6660
- mechanical and electrical repair of the IRB 6660

The robot described in this manual has the following protection types:

- *Standard*
- *Foundry Plus*

This manual describes the manipulator using either the IRC5 or the OmniCore controller.

Product manual scope

The manual covers all variants and designs of the IRB 6660. Some variants and designs may have been removed from the business offer and are no longer available for purchase.

Usage

This manual should be used during:

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

> **Note**
>
> It is the responsibility of the integrator to conduct a risk assessment of the final application.
>
> It is the responsibility of the integrator to provide safety and user guides for the robot system.

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

A maintenance/repair/installation craftsman working with an ABB robot must:

- be trained by ABB and have the required knowledge of mechanical and electrical installation/repair/maintenance work.
- be trained to respond to emergencies or abnormal situations.

Continues on next page

References

General references

Reference	Document ID
Product manual, spare parts - IRB 6660	*3HAC049112-001*
Circuit diagram - DressPack 6660	*3HAC029940-001*
Circuit diagram - IRB 6660	*Circuit diagram - IRB 6660*
Operating manual - Calibration Pendulum	*3HAC16578-1*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*

OmniCore robots

Document name	Document ID
Product specification - IRB 6660	*3HAC087212-001*
Product manual - OmniCore V250XT Type B	*3HAC087112-001*
Product manual - OmniCore V400XT	*3HAC081697-001*
Operating manual - OmniCore	*3HAC065036-001*
Technical reference manual - System parameters	*3HAC065041-001*
Application manual - Additional axes	*3HAC082287-001*

IRC5 robots

Document name	Document ID
Product specification - IRB 6660	*Document.ID-1*
Product manual - IRC5 IRC5 with main computer DSQC1000 or later.	*3HAC047136-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - Calibration Pendulum	*3HAC16578-1*
Operating manual - Service Information System	*3HAC050944-001*
Technical reference manual - System parameters	*3HAC050948-001*
Application manual - Additional axes and standalone controller	*3HAC051016-001*
Application manual - CalibWare Field	*3HAC030421-001*

Revisions

Revision	Description
-	First edition
A	This revision includes the following additions and/or changes: • Robot version IRB 6660 - 205/1.9 added which includes new *upper arm* and new *lower arm*, as well as *Chip protection*. • Process cable package added. • Option *Base spacers* no longer available for this robot model. Section is removed from the manual. • *Prerequisites* in section Overview changed. • Oil change intervals for Shell Tivela S 150 is changed. • New product name *Mobilgear 600 XP 320* (old name Mobile Gearlube X 320). Art. no. remains the same.

Continues on next page

Revision	Description
	• Procedure for *Process cable package 1-3 MH* added.
B	This revision includes the following additions and/or changes: • The product name RobotStudio Online is changed to RobotStudio. • Section "*WARNING! - Mixed oils may cause severe damage to gearboxes*" in chapter Safety, has been integrated in section "*Type of oil in gearboxes*" in Maintenance chapter. • The oil Shell Tivela S150 has been replaced by Kyodo Yushi TMO150. • Section *Type of oil in gearboxes* in chapter *Maintenance* has been updated according to changes made in oil types. • Section *What is an emergency stop?* added to chapter *Safety*. • Section *Maintenance schedule* in chapter Maintenance: Intervals for inspection activities and oilchanges have been revised. • Section *Maintenance schedule* in chapter Maintenance: Overhaul of robot is new. • Section *Maintenance schedule* in chapter Maintenance: The information about Service Information System (SIS) has been updated. • Section *Maintenance schedule* in chapter Maintenance: Intervals for replacement of battery pack changed • Section *Expected lifetime* in chapter Maintenance: The lifetime of certain parts has been revised. • Section *Cleaning of robot* updated.
C	This revision include the following addition: • New **WARNING!** added in chapter *Safety* section *Work inside the robot´s working range*. • New **WARNING!** added in *Safety chapter* section *WARNING! - Safety risks during work with gearbox oil*. • The text in the introductions to chapters *Installation*, *Maintenance* and *Repair* has been updated concerning the robot being connected to earth when power connected. • Section *Expected component life* in chapter *Maintenance* : The lifetime of certain parts has been updated. • Section *Foundry Plus,Cable guard* added to chapter *Installation*.
D	This revision includes the following additions and/or changes: • The lifetime of certain parts has been updated, see *Expected component life on page 111*. • Circuit diagrams are not included in this document but delivered as separate files. See *General references on page 10*. • List of standards updated, see *Applicable standards on page 384*. The chapter *Safety* updated with: • Updated safety signal graphics for the levels *Danger* and *Warning*, see *Safety signals in the manual on page 21*. • New safety labels on the manipulators, see *Safety symbols on manipulator labels on page 23*. • Revised terminology: *robot* replaced with *manipulator*.
E	This revision includes the following updates: • Maximum deviation changed, see *Securing the base plate on page 71*.
F	This revision includes following additions and/or changes: • Removed information about lubricating attachment screws, section *Inspecting the additional mechanical stops on page 136*. • Changed tightening torque of fork lift adapters, from 60 Nm to 270 Nm, see section *Lifting robot with fork lift on page 56*. • Information about restricting and extending the working range of axis 1 is now separated, see *Mechanically restricting the working range of axis 1 on page 98* and the new section *Extended working range, axis*

Continues on next page

Revision	Description
	1 (option) on page 95. Also added signal about option 561-1 in section *Inspecting the axis-1 mechanical stop pin on page 134*.
G	This revision includes the following updates: • Added section *Extended working range, axis 1 (option) on page 95*. • A new block, about general illustrations, added in section *How to read the product manual on page 18*. • Added instructions for securing parallel arm and lower arm to each other before removing the lower arm, see *Replacing the complete lower arm on page 244*. • Added guide sleeves to hold the axes 2/3 sealing in place when refitting the lower arm, see *Replacing the complete lower arm on page 244*. • Made minor corrections and improvements in the complete instruction for how to replace the lower arm system, see *Replacing the complete lower arm on page 244*. • Made minor corrections and improvements in the complete instruction for how to replace the parallel arm, see *Replacement of parallel arm on page 252*. • Made minor corrections and improvements in the complete instruction for how to replace the axis 1 gearbox, see *Replacing the axis 1 gearbox on page 312*. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 386*. • Added information about batteries. • The maximum allowed deviation in levelity of the base plate is changed, see *Securing the base plate on page 71*. • Reference to Hilti standard added to the foundation recommendation for the base plate and class designation for foundation is changed to european standard C25/C30 (previously Swedish standard K25/K30), see *Securing the base plate on page 71*. • Corrections and improvements are made in the instruction for how to replace the axis-2 and axis-3 gearbox, see *Replacing the gearbox, axes 2- 3 on page 324*. • All data about type of lubrication in gearboxes is moved from the manual to a separate lubrication manual, see *Type and amount of oil in gearboxes on page 142*. • Corrected the article number for the o-ring in axis-6 gearbox, see *Replacement of gearbox, axis 6 on page 336*.
H	This revision includes the following updates: • New variant IRB 6660 - 100/3.3 is added. • Added turning radius and wrist center positions to the working range information, see *Working range and type of motion on page 47*. • New spare part number for the cable harness for robot variant IRB 6660 - 130/3.1, see *Spare parts - cable harness*. • Added complete axis 4 and upper arm extenders to the spare part list, and removed upper arm and cooling elements as spare parts, see *Spare parts - upper arm*. • Corrected the method of inspecting oil level in the axis-6 gearbox, see *Inspecting the oil level in axis-6 gearbox on page 121*. • Added o-rings to required equipment lists in *Replacing motor, axis 1 on page 275* and *Replacing motors, axes 2 and 3 on page 282*. • Corrected the position numbers of axis-3 motor and its attachments, see *Spare parts - frame to lower arm*. • A new SMB unit and battery is introduced, with longer battery lifetime.
J	This revision includes the following updates: • Instruction for inspection of oil level updated. • Added cabling to cooling fan for axis-1 and axis-2 motors.

Continues on next page

Revision	Description
	• Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 378*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 6660*
K	This revision includes the following updates: • The maximum allowed deviation in levelness of the base plate and foundation is changed, see *Securing the base plate on page 71*. • Changed dimension of cable holder carrier screw, see *Replacement of cable harness, upper end on page 194*. • Information about option Foundry Plus implemented in chapter Repair. • Added tightening torque for R1.SMB and 7th axis connector, ses *Replacement of cable harness, lower end (axes 1-3) on page 179*. • Minor corrections.
L	This revision includes the following updates: • Illustrations of SMB battery RMU improved.
M	This revision includes the following updates: • New standard calibration method is introduced (Axis Calibration). See *Calibration on page 341*.
N	Published in release R16.2. The following updates are made in this revision: • Drawing of base plate is not available for purchase, faulty information removed in *Securing the base plate on page 71*. • Corrections due to updates in terminology. • Information about grounding point added. See *Robot cabling and connection points on page 100*.
P	Published in release R17.2. The following updates are made in this revision: • Caution about removing metal residues added in sections about SMB boards. • Information about minimum resonance frequency added. • Bending radius of static floor cables added. • Updated list of applicable standards. • Added text regarding overhaul in section specification of maintenance intervals. • Section *Start of robot in cold environments on page 104* added. • Updated information regarding replacement of brake release board. • Updated information regarding disconnecting and reconnecting battery cable to serial measurement board. • Updated information regarding replacing the balancing device.
Q	Published in release R18.1. The following updates are made in this revision: • Information added about fatigue to Axis Calibration tool, see *Calibration tools for Axis Calibration on page 358*. • Added sections in General procedures. • Safety restructured. • Updated spare parts number brake release board (is DSQC1050, was DSQC563) • Note added to calibration chapter to emphasize the requirement of equally dressed robot when using previously created reference calibration values. • Moved position of customer cabling plate at robot base to new location, see *Replacement of process cable package 1 - 3 MH on page 187*. • Information about myABB Business Portal added. • Changed direction of installed cooling fan on axis-2 motor and removed a faulty image showing the design of the cooling fan. Also added detailed images to installation procedure for the fan.

Continues on next page

Revision	Description
R	Published in release R18.2. The following updates are made in this revision: • Removed doubled information.
S	Published in release R18.2. The following updates are made in this revision: • Updated references.
T	Published in release 19B. The following updates are made in this revision: • Updated figure *View of the assembly of the upper arm components*, in section *Replacement of upper arm on page 225*. Spacer ring added on axis-3 side.
U	Published in release 19D. The following updates are made in this revision: • Added press tool for installation of support rings in the upper arm housing, see *Replacement of upper arm on page 225*.
V	Published in release 20B. The following updates are made in this revision: • Clarified and added information in mounting instructions for rotating sealings, see *Mounting instructions for sealings on page 173*. • Clarified text about position of robot axes during Axis Calibration. • Added information about Wrist Optimization in calibration chapter. • Replaced article number and name of grease, previously 3HAB3537-1.
W	Published in release 20C. The following updates are made in this revision: • Removed lifting tool for axis-2 and axis-3 gearbox from the special tools list (lifting method was changed in previous revision).
X	Published in release 20D. The following updates are made in this revision: • Updated figures and added information regarding functional ground and Ethernet, see *Replacement of process cable package 1 - 3 MH on page 187*
Y	Published in release 21A. The following updates are made in this revision: • New number and instruction for press tool, parallel arm, see *Required equipment on page 252*. • Number for Lubrication tool number changed, see *Required equipment on page 164*.
Z	Published in release 21B. The following updates are made in this revision: • Information regarding documentation of Installation of Foundry Plus Cable guard (option no. 908-1) is changed since DVDs are removed. See *Installation of Foundry Plus Cable guard (option) on page 92*. • Text regarding fastener quality is updated, see *Fastener quality on page 82*.
AA	Published in release 21C. The following updates are made in this revision: • Info about option Extended working range included, see *Extended working range, axis 1 (option) on page 95*.
AB	Published in release 22C. The following updates are done in this revision: • Updated information about Gleitmo treated screws, see *Screw joints on page 386*. • Corrected article number for lubrication tool intended for lubrication of balancing device bearings and piston rod. Incorrect number 3HAC5222-1 is replaced with correct number 3HAC5222-2.
AC	Published in release 23D. The following updates are done in this revision: • Added information for the OmniCore robot controller.
AD	Published in release 24B. The following updates are done in this revision: • Updated the lubrication for bearings to Tribol GR 100-2 PD. • Added information for cooling fan on OmniCore robots.

Continues on next page

Revision	Description
AE	Published in release 24C. The following updates are done in this revision: • Updated the axis angle data for axis 3 in section *Risk of tipping/stability on page 51*. • Updated the shaft screw torque for axes 2 and 3 to 800 Nm, was 400 Nm, see *Refitting, upper arm on page 233*. • Changed locking liquid Loctite 243 to Loctite 2400.

Product documentation

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.

Tip

All documents can be found via myABB Business Portal, *www.abb.com/myABB*.

Product manuals

Manipulators, controllers, DressPack, 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.
- Troubleshooting.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

Technical reference manuals

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

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, software).
- How to install included or required hardware.
- How to use the application.

Continues on next page

- Examples of how to use the application.

Operating manuals

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

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 19*.

Illustrations

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

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

1 Safety

1.1 Safety information

1.1.1 Limitation of liability

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.

The information does not cover how to design, install and operate a robot system, nor does it cover all peripheral equipment that can influence the safety of the robot system.

In particular, liability cannot be accepted if injury or damage has been caused for any of the following reasons:

- Use of the robot in other ways than intended.
- Incorrect operation or maintenance.
- Operation of the robot when the safety devices are defective, not in their intended location or in any other way not working.
- When instructions for operation and maintenance are not followed as intended.
- Non-authorized design modifications of the robot.
- Repairs on the robot and its spare parts carried out by in-experienced or non-qualified personnel.
- Foreign objects.
- Force majeure.

Spare parts and equipment

ABB supplies original spare parts and equipment which have been tested and approved for their intended use. The installation and/or use of non-original spare parts and equipment can negatively affect the safety, function, performance, and structural properties of the robot. ABB is not liable for damages caused by the use of non-original spare parts and equipment.

1.1.2 Requirements on personnel

General

Only personnel with appropriate training are allowed to install, maintain, service, repair, and use the robot. This includes electrical, mechanical, hydraulics, pneumatics, and other hazards identified in the risk assessment.

Persons who are under the influence of alcohol, drugs or any other intoxicating substances are not allowed to install, maintain, service, repair, or use the robot.

The plant liable must make sure that the personnel is trained on the robot, and on responding to emergency or abnormal situations.

Personal protective equipment

Use personal protective equipment, as stated in the instructions.

1.2 Safety signals and symbols

1.2.1 Safety signals in the manual

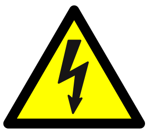
Introduction to safety signals

This section specifies all safety signals used in the user manuals. Each signal consists of:

- A caption specifying the hazard level (DANGER, WARNING, or CAUTION) and the type of hazard.
- Instruction about how to reduce the hazard to an acceptable level.
- A brief description of remaining hazards, if not adequately reduced.

Hazard levels

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

Symbol	Designation	Significance
	DANGER	Signal word used to indicate an imminently hazardous situation which, if not avoided, will result in serious injury.
	WARNING	Signal word used to indicate a potentially hazardous situation which, if not avoided, could result in serious injury.
	ELECTRICAL SHOCK	Signal word used to indicate a potentially hazardous situation related to electrical hazards which, if not avoided, could result in serious injury.
	CAUTION	Signal word used to indicate a potentially hazardous situation which, if not avoided, could result in slight injury.
	ELECTROSTATIC DISCHARGE (ESD)	Signal word used to indicate a potentially hazardous situation which, if not avoided, could result in severe damage to the product.
	NOTE	Signal word used to indicate important facts and conditions.

Continues on next page

Symbol	Designation	Significance
	TIP	Signal word used to indicate where to find additional information or how to do an operation in an easier way.

1.2.2 Safety symbols on manipulator labels

Introduction to symbols

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

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 symbols on the labels on the product must be observed. Additional symbols added by the integrator must also be observed.

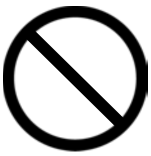
Types of symbols

Both the manipulator and the controller are marked with symbols, containing important information about the product. This is important for all personnel handling the robot, for example during installation, service, or operation.

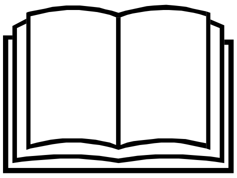
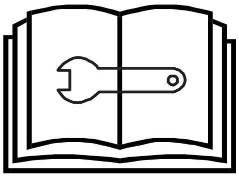
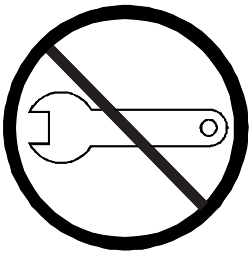
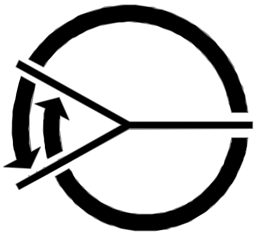
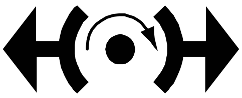
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 23*.

The information labels can contain information in text.

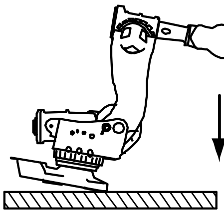
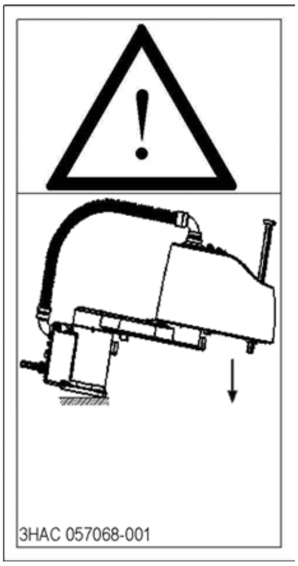
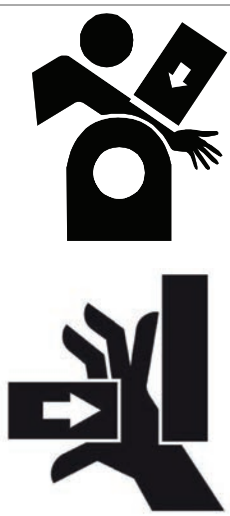
Symbols on safety labels

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.

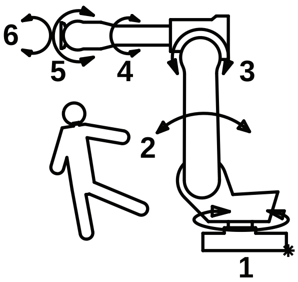
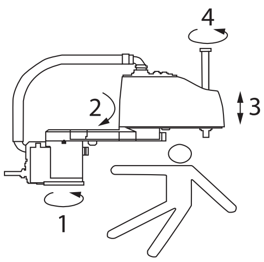
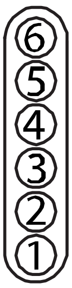
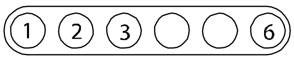
Continues on next page

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 disassembly, see product manual**
 xx0900000815	**Do not disassemble** Disassembling this part can cause injury.
 xx0900000814	**Extended rotation** This axis has extended rotation (working area) compared to standard.
 xx0900000808	**Brake release** Pressing this button will release the brakes. This means that the robot arm can fall down.

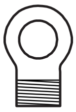
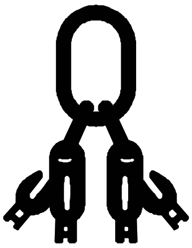
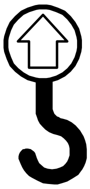
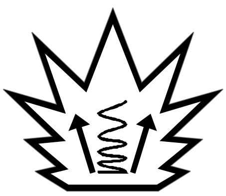
Continues on next page

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

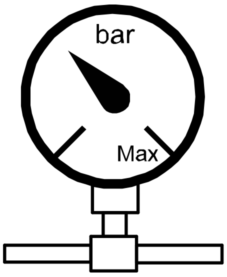
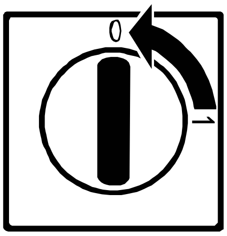
Continues on next page

Symbol	Description
 xx0900000818  xx1300001087	**Heat** Risk of heat that can cause burns. (Both signs are used)
 xx2400000736  xx1500002616	**Moving robot** The robot can move unexpectedly.
 xx0900000820  xx1000001140	**Brake release buttons**

Continues on next page

Symbol	Description
 xx0900000821	**Lifting bolt**
 xx1000001242	**Adjustable 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.

1.3 Robot stopping functions

Protective stop and emergency stop

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

For more information see:

- *Product manual - OmniCore V250XT Type B*
- *Product manual - OmniCore V400XT*
- *Product manual - IRC5*

1.4 Safety during installation and commissioning

National or regional regulations

The integrator of the robot system is responsible for the safety of the robot system.

The integrator is responsible that the robot system is designed and installed in accordance with the safety requirements set forth in the applicable national and regional standards and regulations.

The integrator of the robot system is required to perform a risk assessment.

Layout

The robot integrated to a robot system shall be designed to allow safe access to all spaces during installation, operation, maintenance, and repair.

If robot movement can be initiated from an external control panel then an emergency stop must also be available.

If the manipulator is delivered with mechanical stops, these can be used for reducing the working space.

A perimeter safeguarding, for example a fence, shall be dimensioned to withstand the following:

- The force of the manipulator.
- The force of the load handled by the robot if dropped or released at maximum speed.
- The maximum possible impact caused by a breaking or malfunctioning rotating tool or other device fitted to the robot.

The maximum TCP speed and the maximum velocity of the robot axes are detailed in the section *Robot motion* in the product specification for the respective manipulator.

Consider exposure to hazards, such as slipping, tripping, and falling.

Hazards due to the working position and posture for a person working with or near the robot shall be considered.

Hazards due to noise emission from the robot needs to be considered.

Consider hazards from other equipment in the robot system, for example, that guards remain active until identified hazards are reduced to an acceptable level.

Allergenic material

See *Environmental information on page 376* for specification of allergenic materials in the product, if any.

Securing the robot to the foundation

The robot must be properly fixed to its foundation/support, as described in the respective product manual.

When the robot is installed at a height, hanging, or other than mounted directly on the floor, there will be additional hazards.

Continues on next page

Using lifting accessories and other external equipment

Ensure that all equipment used during installation, service and all handling of the robot are in correct condition for the intended use.

Electrical safety

Incoming mains must be installed to fulfill national regulations.

The power supply wiring to the robot must be sufficiently fused and if necessary, it must be possible to disconnect it manually from the mains power.

The power to the robot must be turned off with the main switch and the mains power disconnected when performing work inside the controller cabinet. Lock and tag shall be considered.

Harnesses between controller and manipulator shall be fixed and protected to avoid tripping and wear.

Wherever possible, power on/off or rebooting the robot controller shall be performed with all persons outside the safeguarded space.

> **Note**
>
> Use a CARBON DIOXIDE (CO_2) extinguisher in the event of a fire in the robot.

Safety devices

The integrator is responsible for that the safety devices necessary to protect people working with the robot system are designed and installed correctly.

When integrating the robot with external devices to a robot system:

- The integrator of the robot system must ensure that emergency stop functions are interlocked in accordance with applicable standards.
- The integrator of the robot system must ensure that safety functions are interlocked in accordance with applicable standards.

Other hazards

A robot may perform unexpected limited movement.

> **WARNING**
>
> Manipulator movements can cause serious injuries on users and may damage equipment.

The risk assessment should also consider other hazards arising from the application, such as, but not limited to:

- Water
- Compressed air
- Hydraulics

End-effector hazards require particular attention for applications which involve close human collaboration with the robot.

Continues on next page

Pneumatic or hydraulic related hazards

> **Note**
>
> The pressure in the complete pneumatic or hydraulic systems must be released before service and maintenance.
>
> All components in the robot system that remain pressurized after switching off the power to the robot must be marked with clearly visible drain facilities and a warning sign that indicates the hazard of stored energy.

Loss of pressure in the robot system may cause parts or objects 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.

All pipes, hoses, and connections have to be inspected regularly for leaks and damage. Damage must be repaired immediately.

Verify the safety functions

Before the robot system is put into operation, verify that the safety functions are working as intended and that any remaining hazards identified in the risk assessment are mitigated to an acceptable level.

1.5 Safety during operation

Automatic operation

Verify the application in the operating mode manual reduced speed, before changing mode to automatic and initiating automatic operation.

Unexpected movement of robot arm

WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.

WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

1.6 Safety during maintenance and repair

1.6.1 Safety during maintenance and repair

General

Corrective maintenance must only be carried out by personnel trained on the robot.

Maintenance or repair must be done with all electrical, pneumatic, and hydraulic power switched off, that is, no remaining hazards.

Hazards due to stored mechanical energy in the manipulator for the purpose of counterbalancing axes must be considered before maintenance or repair.

Never use the robot as a ladder, which means, do not climb on the controller, manipulator, including motors, or other parts. There are hazards of slipping and falling. The robot might be damaged.

Make sure that there are no tools, loose screws, turnings, or other unexpected parts remaining after maintenance or repair work.

When the work is completed, verify that the safety functions are working as intended.

Hot surfaces

Surfaces can be hot after running the robot, and touching these may result in burns. Allow the surfaces to cool down before maintenance or repair.

Allergic reaction

Warning	Description	Elimination/Action
Allergic reaction	When working with lubricants there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.

Gearbox lubricants (oil or grease)

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

Note

Take special care when handling hot lubricants.

Warning	Description	Elimination/Action
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.

Continues on next page

Warning	Description	Elimination/Action
Allergic reaction	When working with lubricants there is a risk of an allergic reaction.	Make sure that protective gear like goggles and gloves are always worn.
Possible pressure build-up in gearbox	When opening the oil or grease plug, there may be pressure present in the gearbox, causing hot lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling. Put oil absorbent cloth, bags or paper at appropriate locations to catch any oil residues. Use appropriate protective gear such as heat-resistant gloves, goggles/protective visor, or a body suit if necessary.
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.
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 for the product.
Oil residues	Oil residues might be present in a drained gearbox and spilled when separating a motor and gearbox during repair.	Make sure that protective gear like goggles/protective visor, gloves and arm protection are always worn during this activity. Put oil absorbent cloth, bags or paper at appropriate locations to catch any oil residues.
Heat up the oil	Warm oil drains quicker than cold oil.	Run the robot before changing the gearbox oil, if possible.
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.

Continues on next page

Warning	Description	Elimination/Action
Contaminated oil in gearboxes	For lifetime reasons always drain as much oil as possible from the gearbox. The magnetic oil plugs will gather residual metal chips.	

Hazards related to batteries

Under rated conditions, the electrode materials and liquid electrolyte in the batteries are sealed and not exposed to the outside.

There is a hazard in case of abuse (mechanical, thermal, electrical) which leads to the activation of safety valves and/or the rupture of the battery container. As a result under certain circumstances, electrolyte leakage, electrode materials reaction with moisture/water or battery vent/explosion/fire may follow.

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 *Operating conditions, robot on page 46*.

See safety instructions for the batteries in *Material/product safety data sheet - Battery pack* (*3HAC043118-001*).

Unexpected movement of robot arm

> **WARNING**
>
> Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.

> **WARNING**
>
> Manipulator movements can cause serious injuries on users and may damage equipment.

Related information

See also the safety information related to installation and operation.

1.6.2 Emergency release of the robot axes

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 described in the section:

- *Manually releasing the brakes on page 68*.

The robot 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 manipulator does not result in additional hazards, for example, even more severe injuries on a trapped person.

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.

1.6.3 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 axis to a position where the combined weight of the manipulator 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 manipulator does not change position as the motors are switched off, then the brake function is adequate.

> **Note**
>
> It is recommended to run the service routine *BrakeCheck* as part of the regular maintenance, see the operating manual for the robot controller.
>
> For robots with the option SafeMove, the *Cyclic Brake Check* routine is recommended. See the manual for SafeMove in *References on page 10*.

1.7 Safety during troubleshooting

General

When troubleshooting requires work with power switched on, special considerations must be taken:

- Safety circuits might be muted or disconnected.
- Electrical parts must be considered as *live*.
- The manipulator can move unexpectedly at any time.

DANGER

Troubleshooting on the controller while powered on must be performed by personnel trained by ABB or by ABB field engineers.

CAUTION

Risk of hot surfaces that can cause burns.

A risk assessment must be done to address both robot and robot system specific hazards.

WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.

WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

Related information

See also the safety information related to installation, operation, maintenance, and repair.

1.8 Safety during decommissioning

General

See section *Decommissioning on page 375*.

If the robot is decommissioned for storage, take extra precaution to reset safety devices to delivery status.

Unexpected movement of robot arm

WARNING

Hazards due to the use of brake release devices and/or gravity beneath the manipulator shall be considered.

A robot may perform unexpected limited movement.

WARNING

Manipulator movements can cause serious injuries on users and may damage equipment.

2 Installation and commissioning

2.1 Introduction to installation and commissioning

General

This chapter contains assembly instructions and information for installing the IRB 6660 at the working site.

See also the product manual for the robot controller.

The installation must be done by qualified installation personnel in accordance with the safety requirements set forth in the applicable national and regional standards and regulations.

The technical data is detailed in section *Technical data on page 43*.

Safety information

Before any installation work is commenced, all safety information must be 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 19* before performing any installation work.

Note

Always connect the IRB 6660 and the robot to protective earth and residual current device (RCD) before connecting to power and starting any installation work.

For more information see:

- *Product manual - OmniCore V250XT Type B*
- *Product manual - OmniCore V400XT*
- *Product manual - IRC5*

2.2 Unpacking

2.2.1 Pre-installation procedure

Introduction

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

Prerequisites for installation personnel

Installation personnel working with an ABB product must:

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

Checking the pre-requisites for installation

	Action
1	Make a visual inspection of the packaging and make sure that nothing is damaged.
2	Remove the packaging.
3	Check for any visible transport damage. **Note** Stop unpacking and contact ABB if transport damages are found.
4	Clean the unit with a lint-free cloth, if necessary.
5	Make sure that the lifting accessory used (if required) is suitable to handle the weight of the robot as specified in: *Weight, robot on page 43*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 45*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 46*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 44* • *Protection classes, robot on page 46* • *Requirements, foundation on page 45*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 51*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 54*
11	Install required equipment, if any. • *Safety lamp (option for IRC5) on page 94*

2.2.2 Technical data

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 6660	1950 kg

Note

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

Mounting positions

The table shows valid mounting options for the manipulator.

Mounting option	Installation angle	Note
Floor mounted	0° [i]	

[i] A tilt of up to 5° does not affect the payload or reach, but it can have a negative impact on performance and lifetime. The actual value must be set in the system parameters.

Note

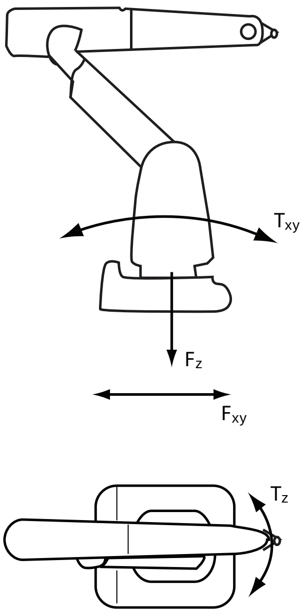
The actual mounting angle must always be configured in the system parameters, otherwise the performance and lifetime is affected.

Continues on next page

Loads on foundation, robot

The illustration shows the directions of the robots stress forces.

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



xx1100000521

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

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

Note

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

WARNING

The robot installation is restricted to the mounting options given in following load table(s).

Floor mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 7.6 kN (IRB 6660 - 100/3.3) ± 8.5 kN (IRB 6660 - 130/3.1) ± 7.9 kN (IRB 6660 - 205/1.9)	± 12.8 kN (IRB 6660 - 100/3.3) ± 16.1 kN (IRB 6660 - 130/3.1) ± 14.9 kN (IRB 6660 - 205/1.9)

Continues on next page

Force	Endurance load (in operation)	Max. load (emergency stop)
Force z	18.5 ± 3.7 kN (IRB 6660 - 100/3.3) 18.8 ± 8.4 kN (IRB 6660 - 130/3.1) 18.0 ± 4.4 kN (IRB 6660 - 205/1.9)	18.5 ± 7.4 kN (IRB 6660 - 100/3.3) 18.8 ±12.8 kN (IRB 6660 - 130/3.1) 18.0 ±7.7 kN (IRB 6660 - 205/1.9)
Torque xy	± 24.4 kNm (IRB 6660 - 100/3.3) ± 25.6 kNm (IRB 6660 - 130/3.1) ± 19.6 kNm (IRB 6660 - 205/1.9)	± 33.4 kNm (IRB 6660 - 100/3.3) ± 37.2 kNm (IRB 6660 - 130/3.1) ± 32.4 kNm (IRB 6660 - 205/1.9)
Torque z	± 7.6 kNm (IRB 6660 - 100/3.3) ± 10.3 kNm (IRB 6660 - 130/3.1) ± 7.1 kNm (IRB 6660 - 205/1.9)	± 14.5 kNm (IRB 6660 - 100/3.3) ± 19.3 kNm (IRB 6660 - 130/3.1) ± 14.7 kNm (IRB 6660 - 205/1.9)

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	0.3 mm	Flat foundations give better repeatability of the resolver calibration compared to original settings on delivery from ABB. The value for levelness aims at the circumstance of the anchoring points in the robot base. In order to compensate for an uneven surface, the robot can be recalibrated during installation. If resolver/encoder calibration is changed this will influence the absolute accuracy.
Minimum resonance frequency	22 Hz **Note** It may affect the manipulator lifetime to have a lower resonance frequency than recommended.	The value is recommended for optimal performance. Due to foundation stiffness, consider robot mass including equipment. [i] For information about compensating for foundation flexibility, see the application manual of the controller software, section *Motion Process Mode*.

i The minimum resonance frequency given should be interpreted as the frequency of the robot mass/inertia, robot assumed stiff, when a foundation translational/torsional elasticity is added, i.e., the stiffness of the pedestal where the robot is mounted. The minimum resonance frequency should not be interpreted as the resonance frequency of the building, floor etc. For example, if the equivalent mass of the floor is very high, it will not affect robot movement, even if the frequency is well below the stated frequency. The robot should be mounted as rigid as possibly to the floor.

Disturbances from other machinery will affect the robot and the tool accuracy. The robot has resonance frequencies in the region 10 – 20 Hz and disturbances in this region will be amplified, although somewhat damped by the servo control. This might be a problem, depending on the requirements from the applications. If this is a problem, the robot needs to be isolated from the environment.

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

Parameter	Value
Minimum ambient temperature	-25° C
Maximum ambient temperature	+55° C
Maximum ambient temperature (less than 24 hrs)	+70° C

Continues on next page

Parameter	Value
Maximum ambient humidity	95% at constant temperature (gaseous only)

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

Parameter	Value
Minimum ambient temperature	+5° C
Maximum ambient temperature	+50° C [i]
Maximum ambient humidity	95% at constant temperature

i In a high speed presstending application, max ambient temperature is +40° C.

Protection classes, robot

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

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

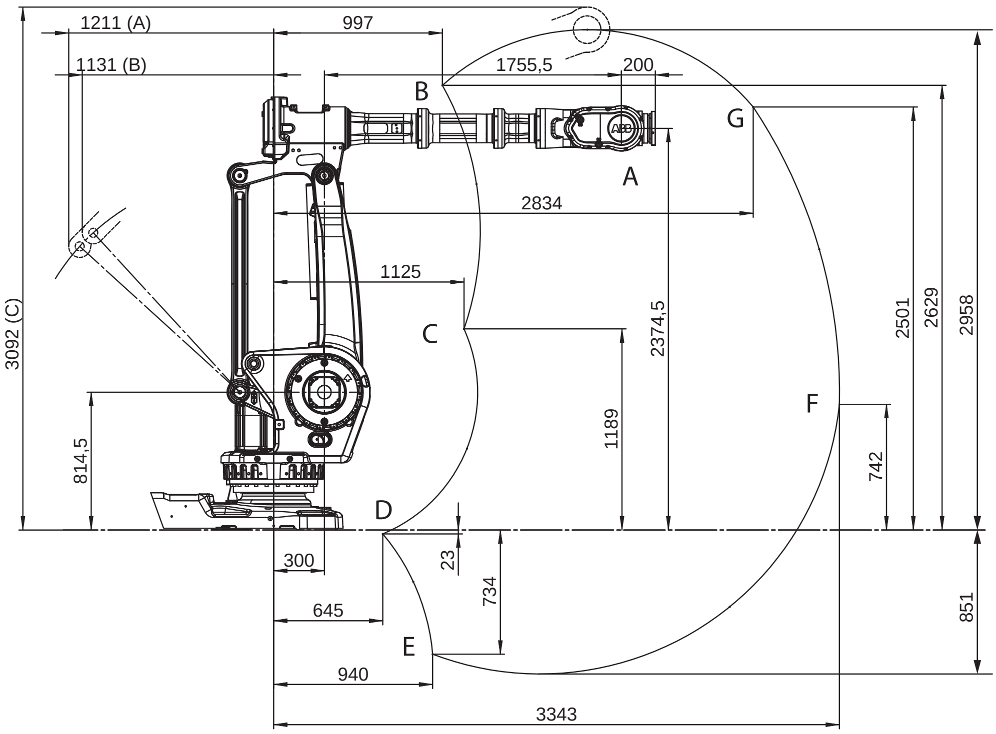
i According to IEC 60529.

2.2.3 Working range and type of motion

Working range

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

IRB 6660 - 100/3.3



xx1200000979

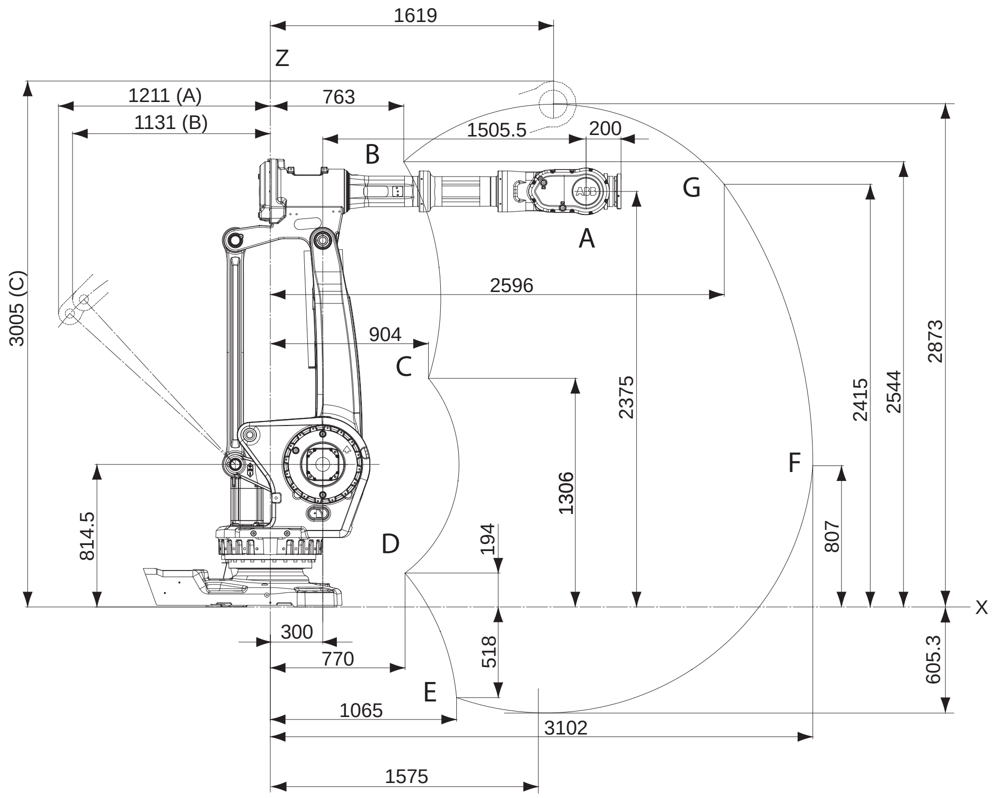
(A)	Mechanical stop
(B)	Max. working range
(C)	Max. working range

Positions at wrist center

Position number, see figure above	X position (mm)	Z position (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
A	2055.5	2374,5	0	0
B	997	2629	-42	-20
C	1125	1189	-42	28
D	645	-23	50	120
E	940	-734	85	120
F	3343	742	85	15
G	2834	2501	50	-20

Continues on next page

IRB 6660 - 130/3.1



xx1000000662

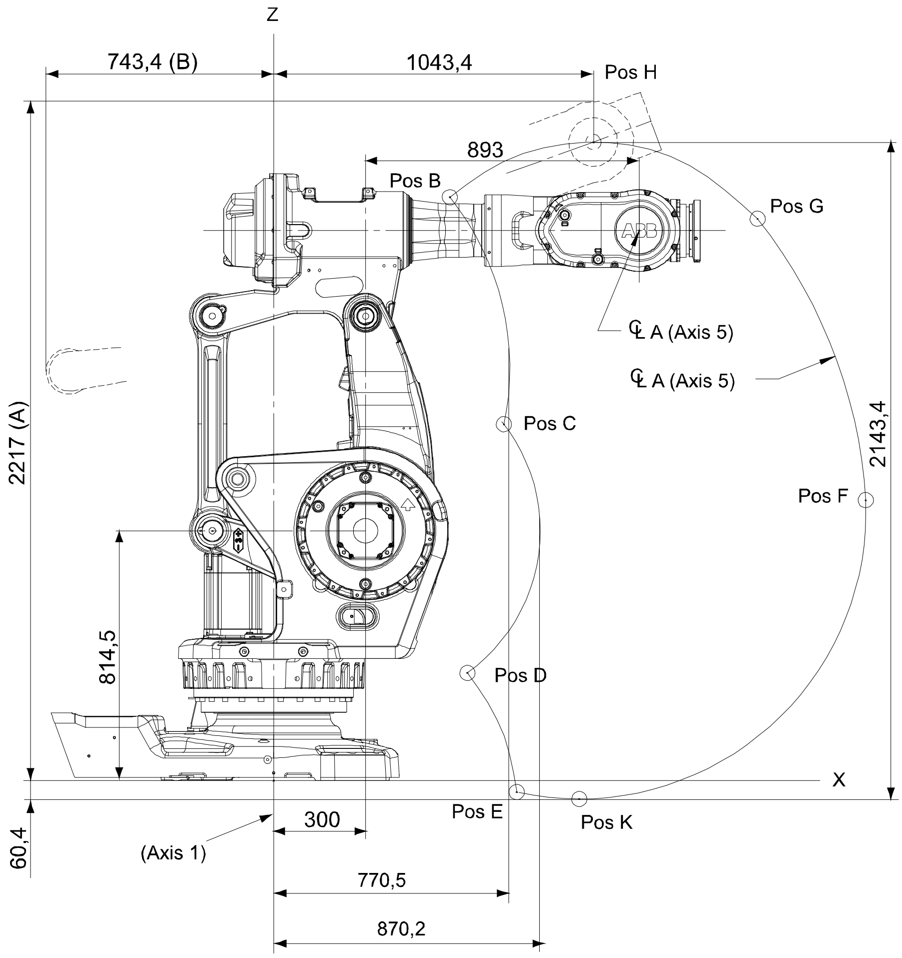
(A)	Max. working range
(B)	Mechanical stop
(C)	Max. working range

Positions at wrist center

Position number, see figure above	X position (mm)	Z position (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
A	1805.5	2374.5	0	0
B	763	2544	-42	-20
C	904	1306	-42	28
D	770	194	50	120
E	1065	-518	85	120
F	3102	807	85	15
G	2596	2415	50	-20

Continues on next page

IRB 6660 - 205/1.9



xx1000000663

(A)	Max. working range
(B)	Max. working range

Positions at wrist center

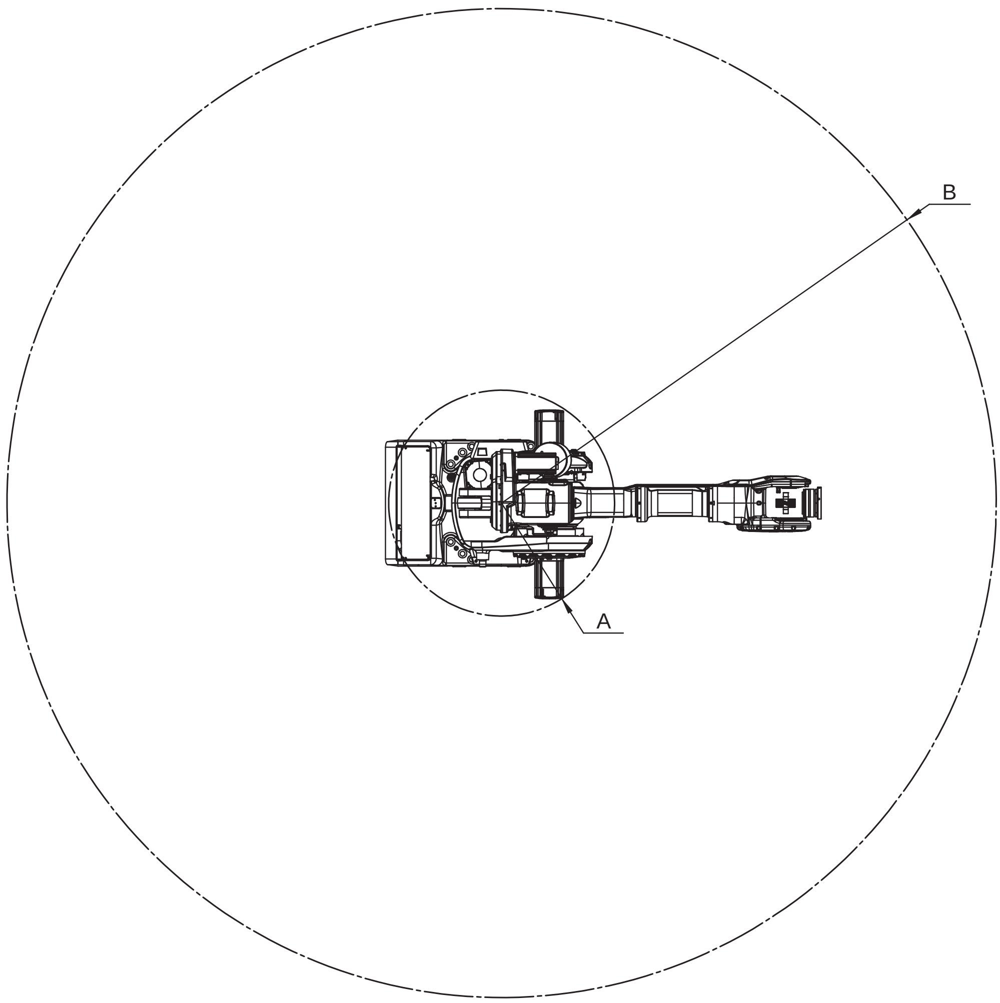
Position number, see figure above	X position (mm)	Z position (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
A	1193	1794.5	0	0
B	575	1903.2	-42	-20
C	751.5	1162.7	-42	28
D	632.2	351.1	50	120
E	793.3	-37.9	85	120
F	1932.4	914.8	85	15
G	1579.6	1833	50	-20
H	1043.4	2083.2	0	-20
K	997.3	-60.4	85	107.4

Continues on next page

Type of motion

Axis	Type of motion	Range of movement	Note
1	Rotation motion	+180° to -180°	
2	Arm motion	+85° to -42°	
3	Arm motion	+120° to -20°	
2-3	Arm motion	+20° to +160°	
4	Wrist motion	+300° to -300°	
5	Bend motion	+120° to -120°	
6	Turn motion	+300° to -300°	

Turning radius



xx1200000980

Robot variant	Radius A (axis-3 motor)	Radius B
IRB 6660 - 100/3.3	710 mm	3343 mm
IRB 6660 - 130/3.1	710 mm	3102 mm
IRB 6660 - 205/1.9	710 mm	1932 mm

2.2.4 Risk of tipping/stability

Risk of tipping

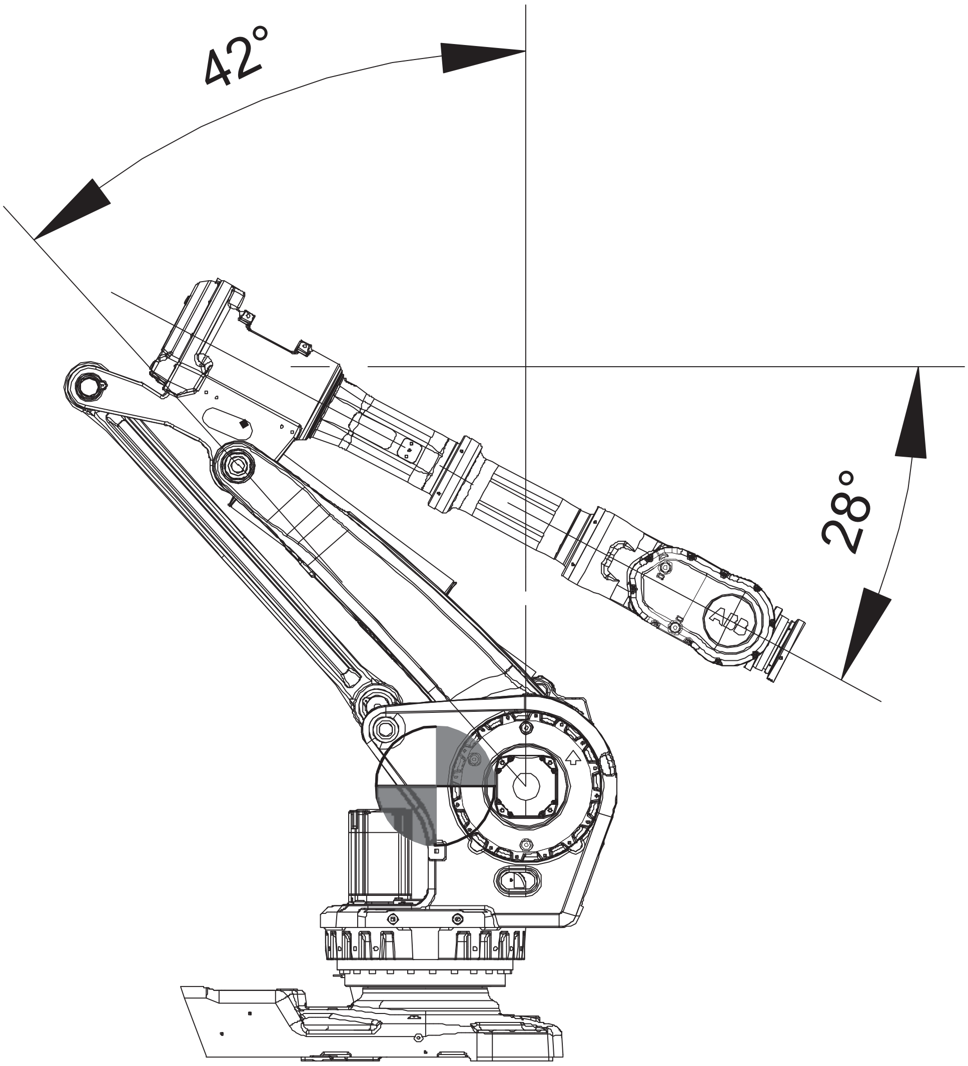
If the robot is not fastened to the foundation while moving the arm, the robot is not stable in the whole working area. Moving the arm will displace the center of gravity, which may cause the robot to tip over.

The transportation position is the most stable position.

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

Transportation position

This figure shows the robot in its transportation position.



xx0700000001

Axis number	Angle of axis
Axis 1	0°
Axis 2	-42°
Axis 3	+28°

Continues on next page

Axis number	Angle of axis
Axis 4	0°
Axis 5	0°
Axis 6	0°

Note

The robot might be positioned in a different position at delivery, due to actual configurations and options (for example DressPack).

WARNING

The robot will be mechanically unstable if not properly secured to the foundation.

2.2.5 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.

Safe handling

Use one of the following alternatives:

- Use a wrist strap.

  Wrist straps must be tested frequently to ensure that they are not damaged and are operating correctly.
- Use an ESD protective floor mat.

  The mat must be grounded through a current-limiting resistor.
- Use a dissipative table mat.

  The mat should provide a controlled discharge of static voltages and must be grounded.

2.3 On-site installation

2.3.1 Lifting robot with fork lift

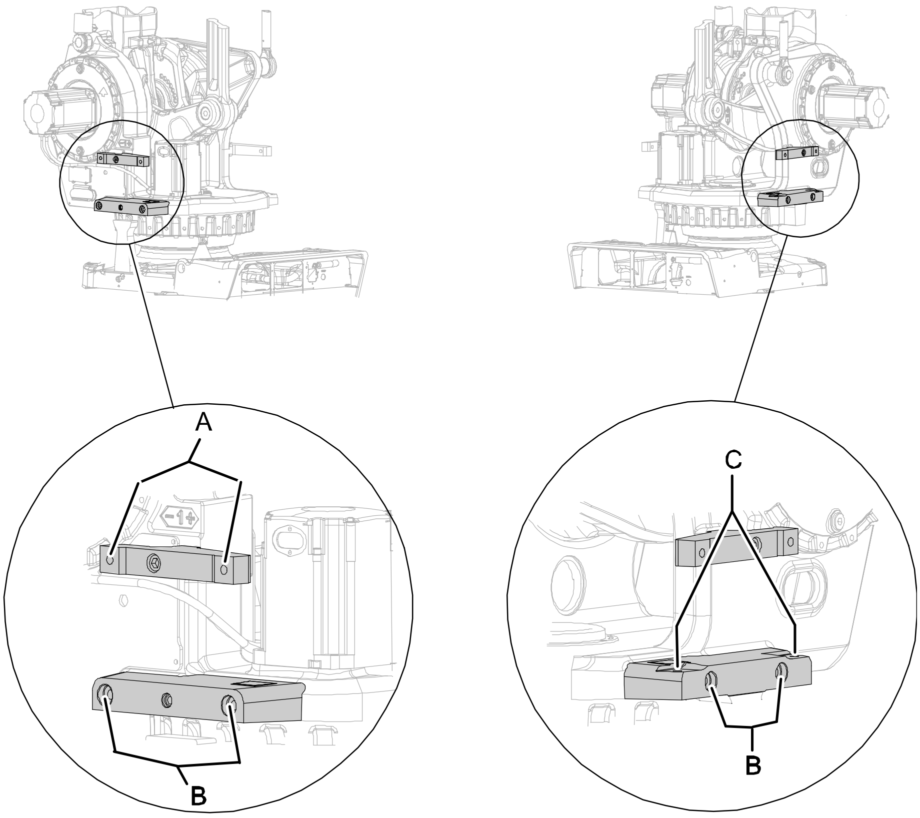
General

The robot may be moved using a fork lift, provided that available special aids are used.

This section describes how to attach the fork lift equipment to the robot.

Attachment points on robot

The attachment points for the fork lift equipment are shown in this figure.



xx0500002276

A	Attachment points on adapter and horizontal attachment screws
B	Attachment points, horizontal attachment screws
C	Attachment points, vertical attachment screws

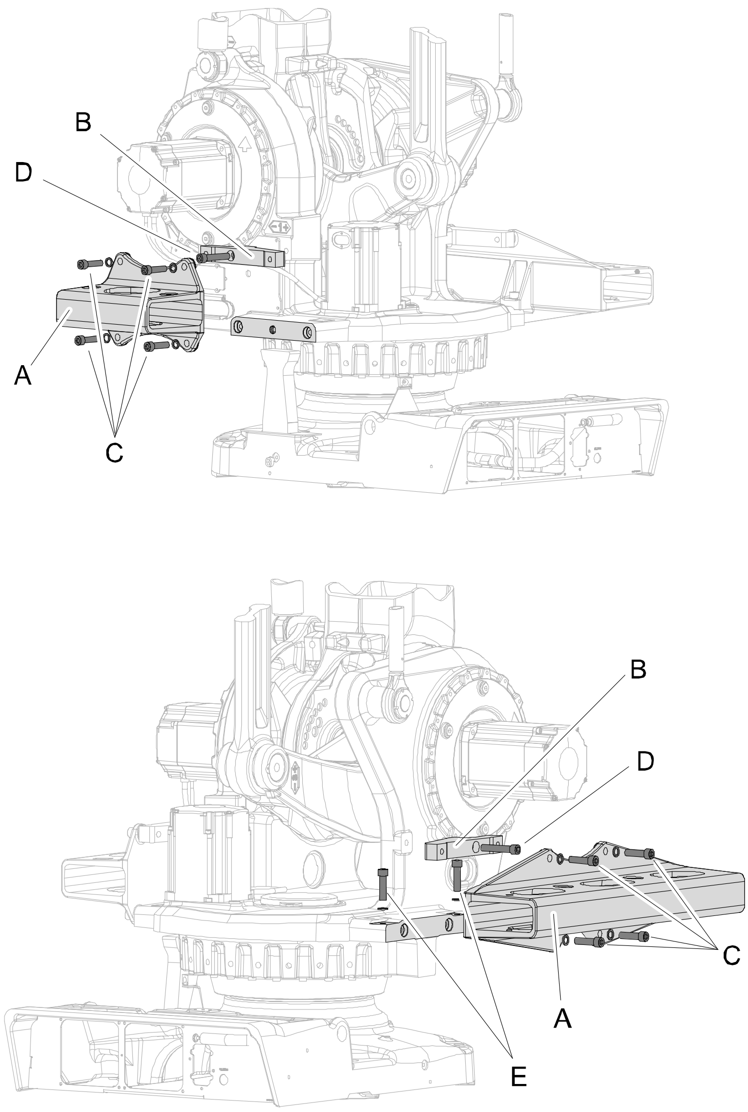
Required equipment

Equipment, etc.	Art. no.	Note
Fork lift set, incl. all required hardware	3HAC023044-001	See figure *Fork lift set, 3HAC023044-001 on page 55*.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

Fork lift set, 3HAC023044-001

The fork lift set 3HAC023044-001, is fitted to the robot as shown in the figure below.



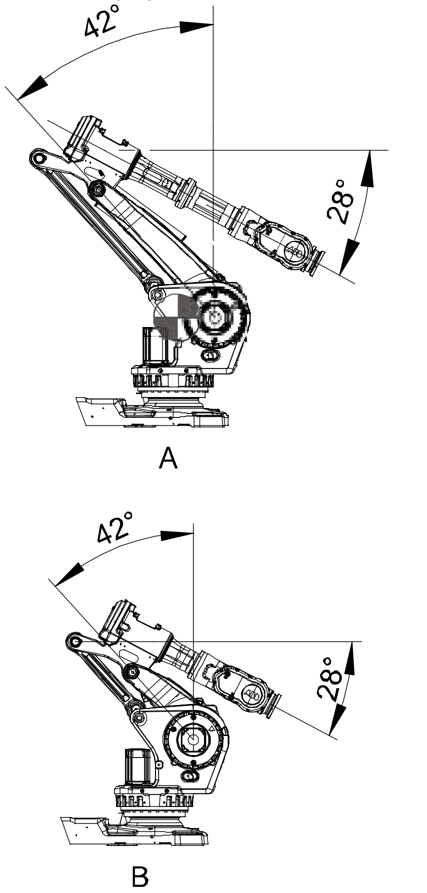
xx0500002277

A	Fork lift pocket (2 pcs, one long and one short)
B	Adapter (2 pcs)
C	Horizontal attachment screws (4 pcs / fork lift pocket)
D	Attachment screw for adapter (1 pc / adapter)
E	Vertical attachment screws (2 pcs)

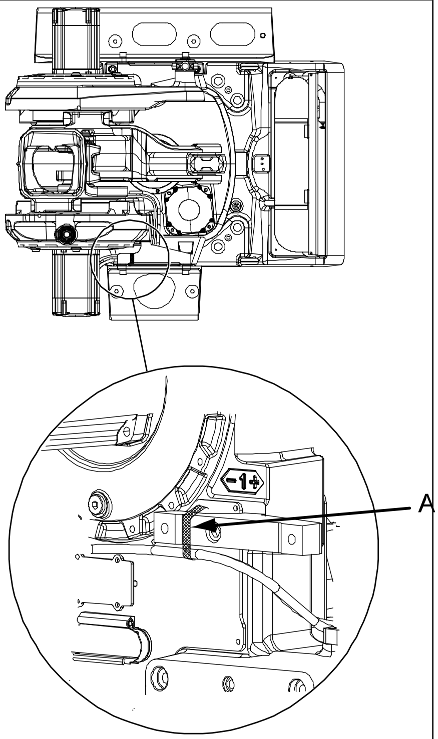
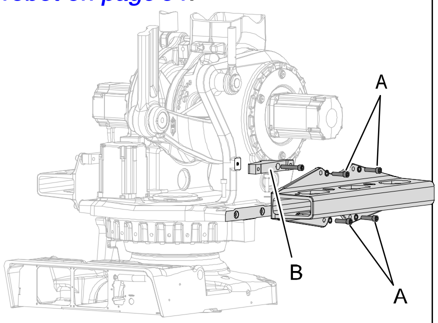
Continues on next page

Lifting robot with fork lift

This section details how to secure the fork lift set to the robot in order to lift and move the robot using the fork lift ONLY!

	Action	Note
1	If a cooling fan for the axis 1 motor is used, it must be removed in order to use the fork lift device!	
2	Position the robot as shown in the figure to the right!	Release the brakes if required as detailed in section *Manually releasing the brakes on page 68*.  xx0700000517 • A: IRB 6660 - 100/3.3, IRB 6660 - 130/3.1 • B: IRB 6660 - 205/1.9
3	Fit the two adapters to the robot and secure.	Attachment points are shown in figure *Attachment points on robot on page 54*. Attachment screws, 2 pcs, M16 x 90. Tightening torque: 270 Nm.

Continues on next page

	Action	Note
4	Strap up axis 2 motor cable on the adapter.	 xx0500002278 • A: Strap, velcro
5	**CAUTION** The fork lift pocket weighs 60 kg!	
6	Secure the longer *fork lift pocket* to the adapter and frame with four of the horizontal *attachment screws* and *washers*. **Note** The screws, which are attached horizontally and vertically, are identical. However, they are tightened with different torque!	Always use original screws (or replacements of equivalent quality: M16, quality 12.9)! Attachment points on the robot are shown in figure *Attachment points on robot on page 54*.  xx0500002279 A Horizontal attachment screws, 4 pcs, M16 x 60. Tightening torque: 60 Nm. B Adapter

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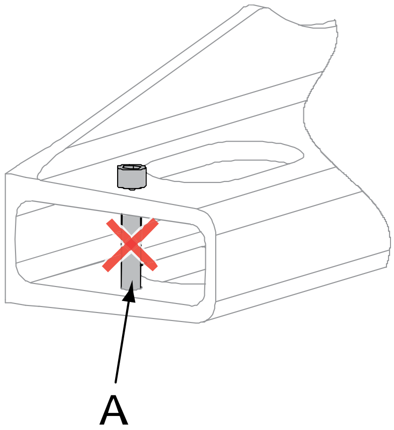
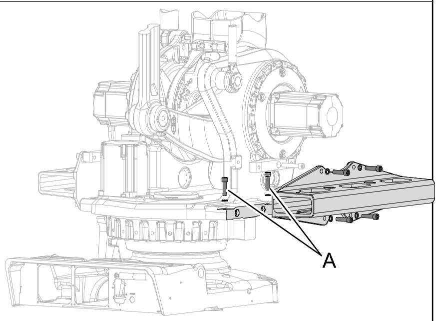
	Action	Note
7	Make sure the securing screw is removed from the fork lift pocket! It is only used for robot model IRB 6650S.	 xx0700000655 A Securing screw
8	Secure fork lift pocket to robot with two *vertical attachment screws* and washers. **Note** Vertically and the horizontally attached screws are identical, but tightened with different torques!	 xx0500002284 A Vertical attachment screws, 2 pcs, M16x60. Tightening torque: 270 Nm. Always use original screws (or replacements of equivalent quality: M16, quality 12.9)! Attachment points on robot are shown in figure *Attachment points on robot on page 54*.
9	**CAUTION** The fork lift pocket weighs 22 kg!	
10	Secure the shorter fork lift pocket on the other side of the robot with the four remaining *horizontal attachment screws*.	4 pcs, M16x60. Tightening torque: 60 Nm. Always use original screws (or replacements of equivalent quality: M16, quality 12.9)! Attachment points on robot are shown in figure *Attachment points on robot on page 54*.
11	Double-check that pockets are properly secured to the robot! Insert fork lift forks into the pockets.	

Continues on next page

	Action	Note
12	**CAUTION** The IRB 6660 robot weighs 1950 kg. All lifting accessories used must be sized accordingly!	**Note** If the robot is equipped with *fork lift pockets* an extra weight of 90 kg must be added to the robot weight!
13	Carefully lift the robot and move it to its installation site.	
14	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	
15	Refit the cooling fan to the motor, if any.	

2.3.2 Lifting robot with roundslings

General

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

Sling specification

Sling type	Qty	Lifting capacity	Length / Note
Roundsling, robot	3 pcs	3 000 kg	2 m

Lifting with roundslings

	Action	Note
1	Position robot in a secure transport position.	
2	Attach roundslings to robot according to figure *Attachment points on page 60*.	
3	**Note** Make sure that the roundslings do not lie against sensitive parts, for example harness and customer equipment!	
4	When attaching the **roundsling A** on the upper arm, put it in a U-shape through the hole in the wrist.	Shown in the figure *Attachment points on page 60*.
5	**CAUTION** The IRB 6660 robot weighs 1950 kg. All lifting accessories used must be sized accordingly!	**Note** If the robot is equipped with *fork lift pockets* an extra weight of 90 kg must be added to the robot weight!
6	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	

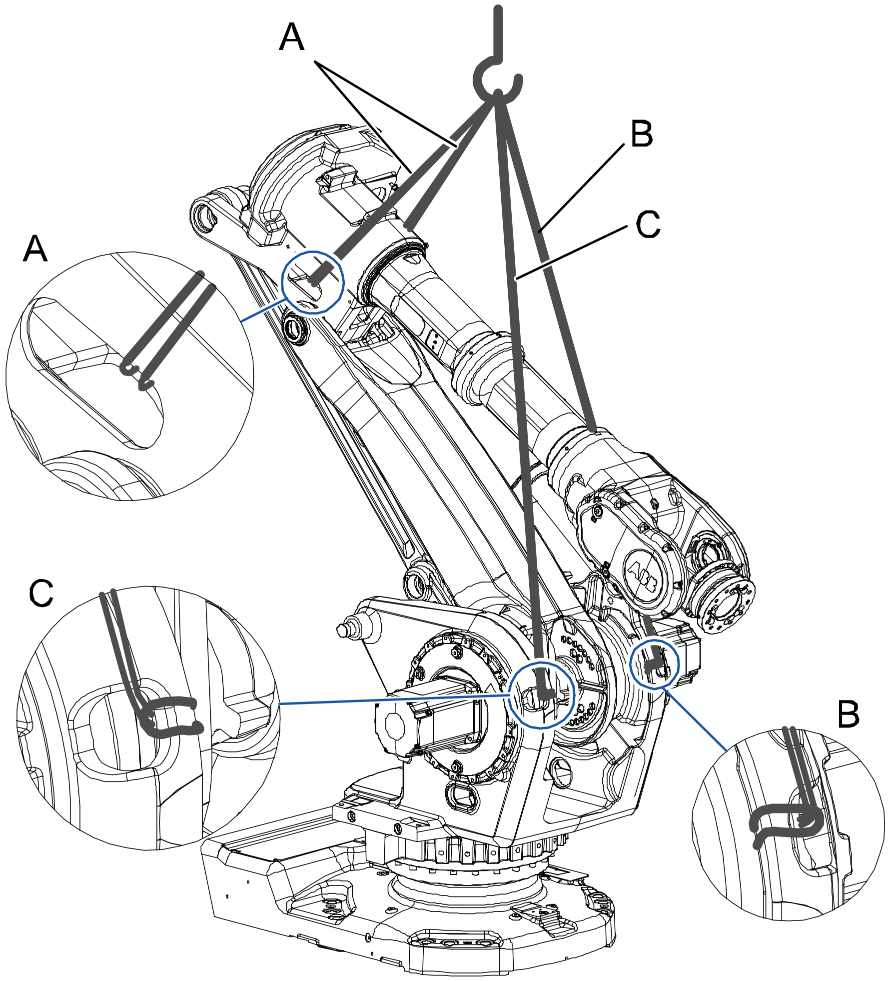
Attachment points

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

Continues on next page

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

IRB 6660 - 130/3.1, IRB 6660 - 100/3.3

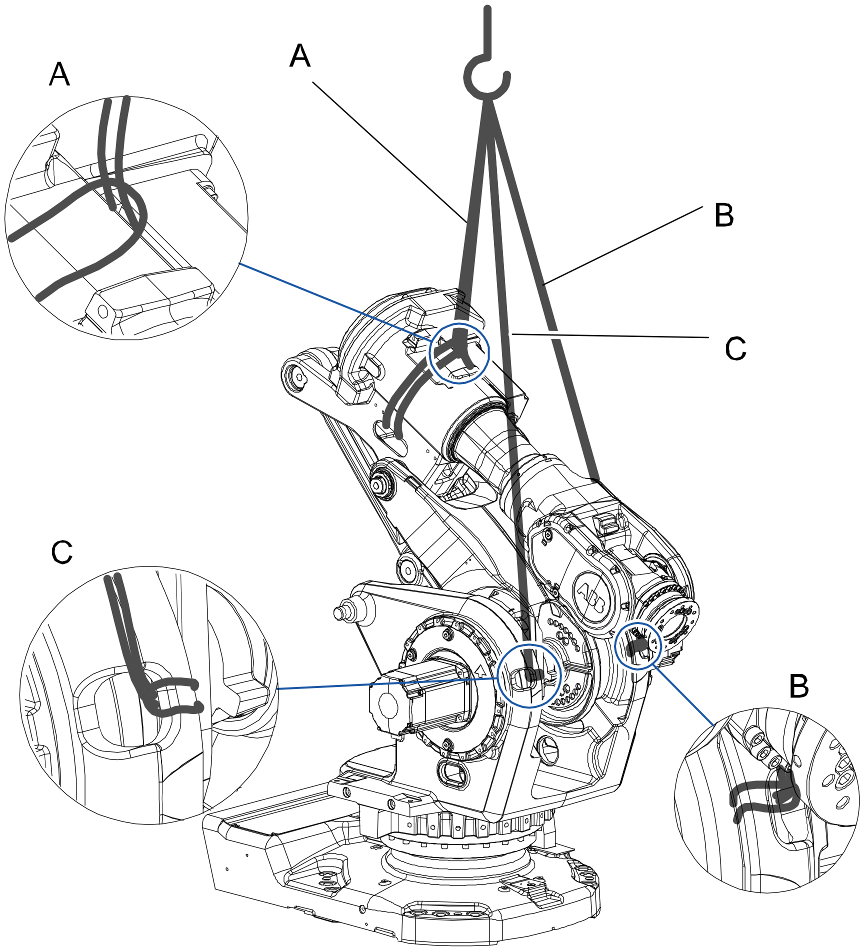


xx0700000002

A	Roundsling 2 m
B	Roundsling 2 m
C	Roundsling 2 m

Continues on next page

IRB 6660 - 205/1.9



xx0700000426

A	Roundsling 2 m
B	Roundsling 2 m
C	Roundsling 2 m

2.3.3 Lifting robot with lifting accessory (recommended lifting method)

General

This section contains a general overview of how to lift the complete robot using special lifting accessory.

Illustration, lifting accessory

The following figure shows the principle for how to use and lift the entire robot with lifting accessory. For a more detailed instruction, see the user instructions enclosed with the accessory.

Note

The user manual may be out of date. The latest revision is available for download via myABB Business Portal, *www.abb.com/myABB*.

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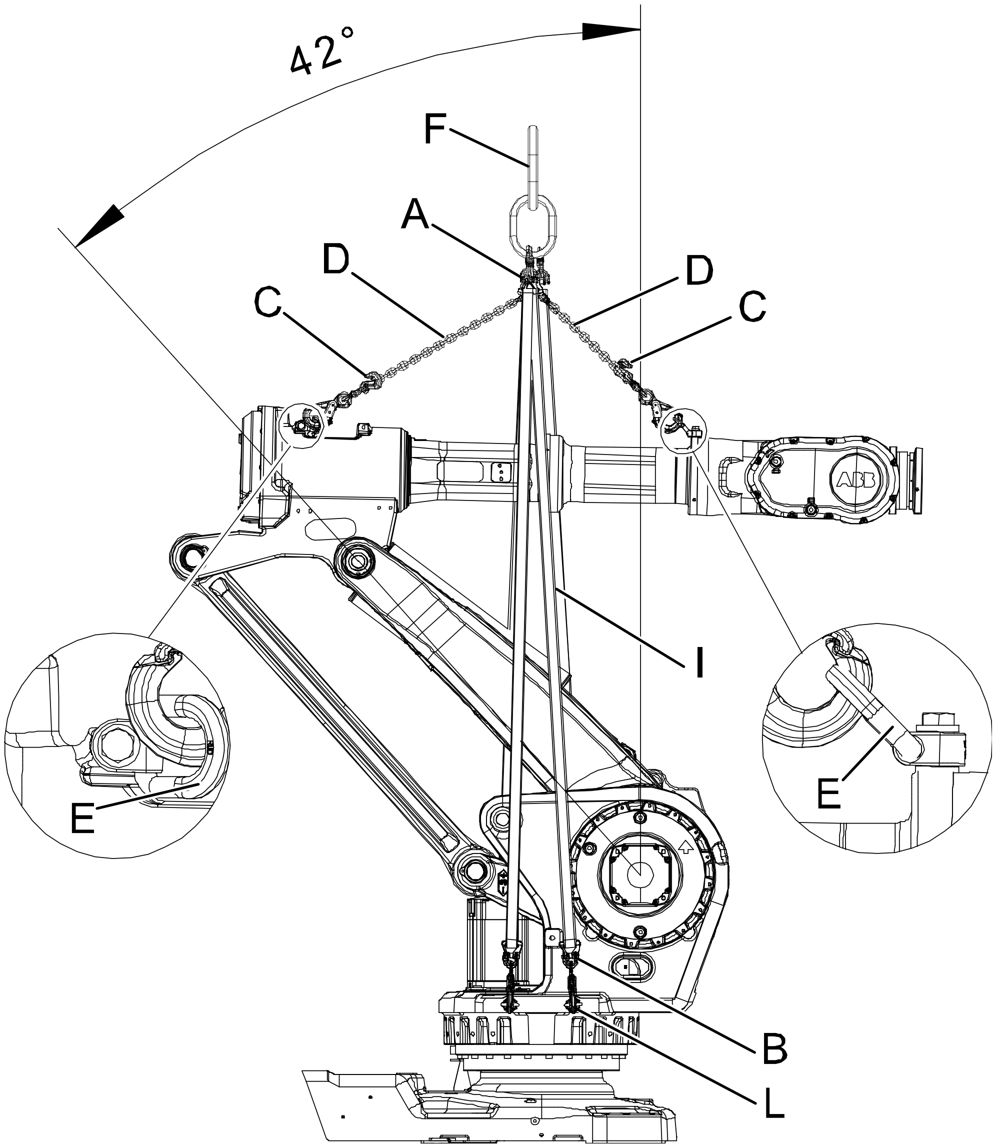
IRB 6660 - 130/3.1, IRB 6660 - 100/3.3



xx0700000004

A	Load hook
B	Swivelling lifting eyes, 4 pcs
C	Shortening hook
D	Chain
E	Lifting eye, M12
F	Eye for lifting accessory
I	Lifting slings, 4 pcs
L	Hook

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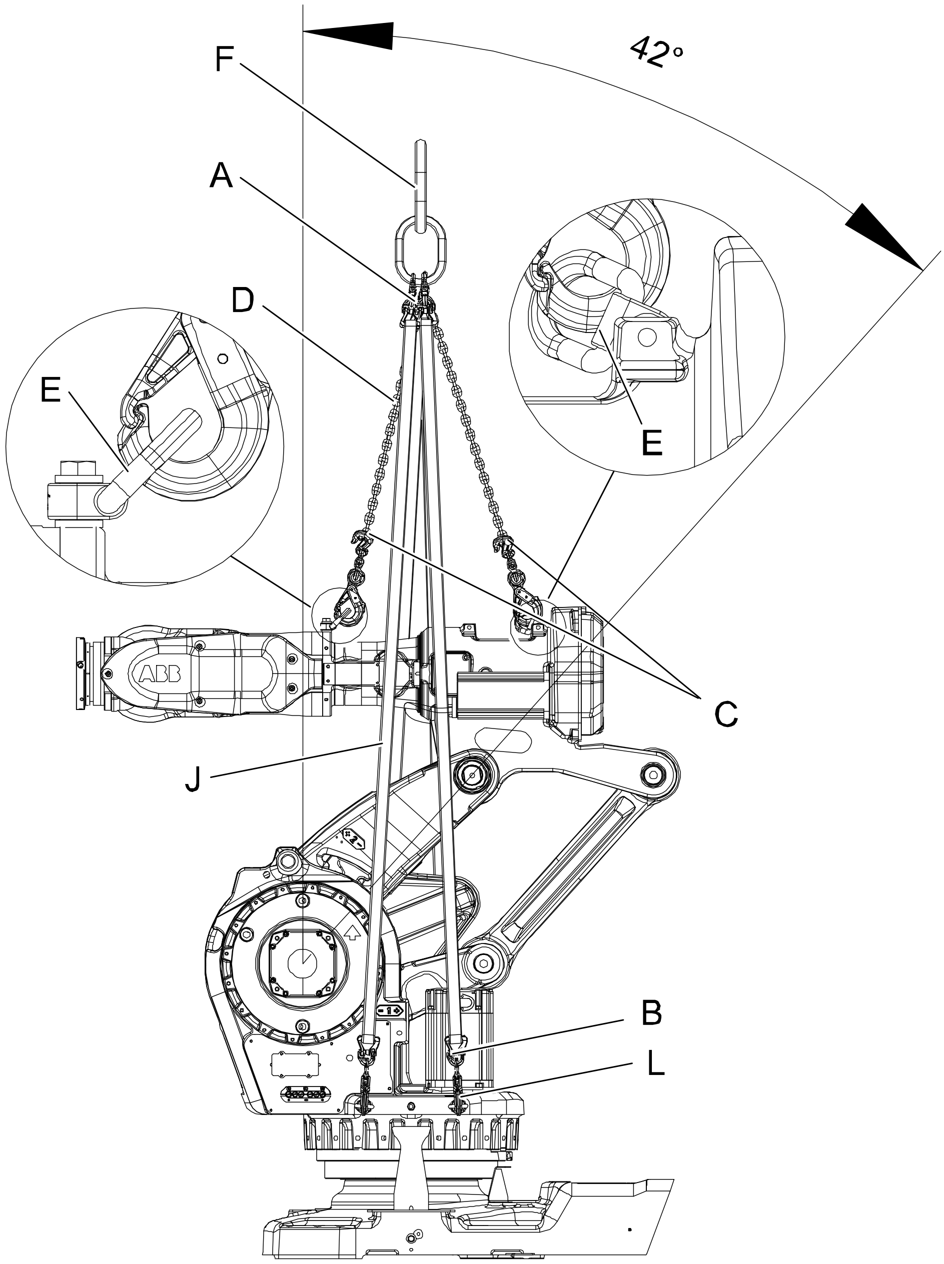
IRB 6660 - 205/1.9



xx0700000427

A	Load hook
B	Swivelling lifting eyes, 4 pcs
C	Shortening hook
D	Chain
E	Lifting eye, M12
F	Eye for lifting accessory
J	Lifting slings, 4 pcs
L	Hook

Continues on next page

Required equipment

Equipment	Article number	Note
Lifting accessory, robot	3HAC15607-1	Includes user instructions 3HAC15971-2

Slings attached directly onto robot

This section details how to lift and move the robot using lifting slings when these are attached directly onto the robot.

Note

Please refer to the enclosed user instruction for instruction how to place the manipulator in an correct position. Attempting to lift a manipulator in any other position may result in the robot tipping over, causing severe damage or injury!

	Action	Note
1	Run the overhead crane to a position above the robot.	
2	Position the robot as detailed in enclosed instruction!	Article number is specified in *Required equipment on page 66*. Release the brakes, if required, as detailed in section *Manually releasing the brakes on page 68*.
3	**Note** If the robot is equipped with forklift pockets, it is necessary to remove these in order to reach the lower holes in the frame. These are used to attach the *hooks* of the lifting slings.	Shown in the figure *Illustration, lifting accessory on page 63*.
4	Fit the *lifting accessory* to the robot as described in the enclosed instruction! Go to the user instructions enclosed with the lifting accessory. **DANGER** Handling the tool incorrectly will cause serious injury. Read and follow enclosed user instructions for the tool.	Article number is specified in *Required equipment on page 66*.
5	**CAUTION** The IRB 6660 robot weighs 1950 kg. All lifting accessories used must be sized accordingly!	**Note** If the robot is equipped with *fork lift pockets* an extra weight of 90 kg must be added to the robot weight!
6	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	

Continues on next page

	Action	Note
7	Raise overhead crane to lift the robot.	Make sure all hooks and attachments maintain their correct positions while lifting the robot! Always move the robot at very low speeds, making sure it does not tip.

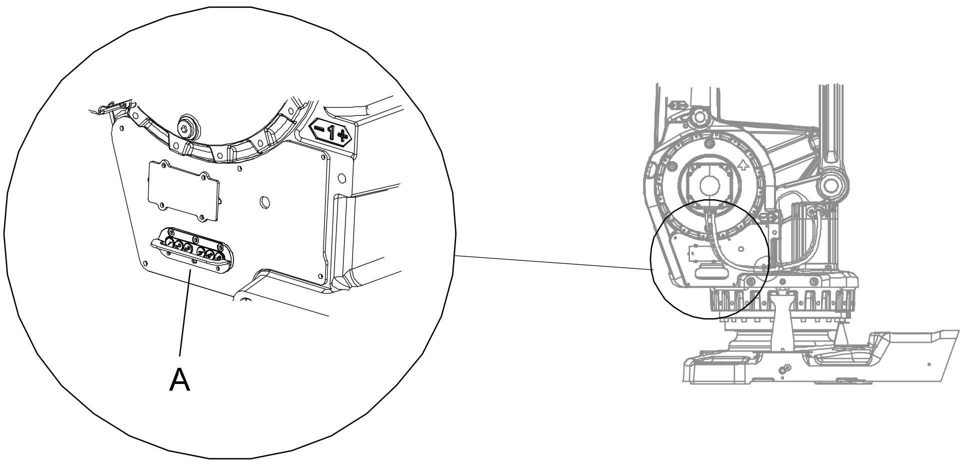
2.3.4 Manually releasing the brakes

Introduction to manually releasing the brakes

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

Location of brake release unit

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



xx0700000005

Releasing the brakes

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

	Action	Note
1	The internal brake release unit is equipped with buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes. If the robot is not connected to the controller, power must be supplied to the connector R1.MP according to the section *Supplying power to connector R1.MP on page 69*.	Buttons are shown in figure *Location of brake release unit on page 68*.
2	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways. Make sure no personnel is near or beneath the robot.	
3	Release the holding brake on a particular robot axis by pressing the corresponding button on the internal brake release unit. The brake will function again as soon as the button is released.	

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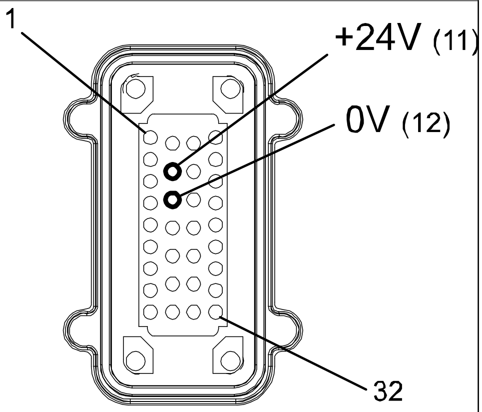
Supplying power to connector R1.MP

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

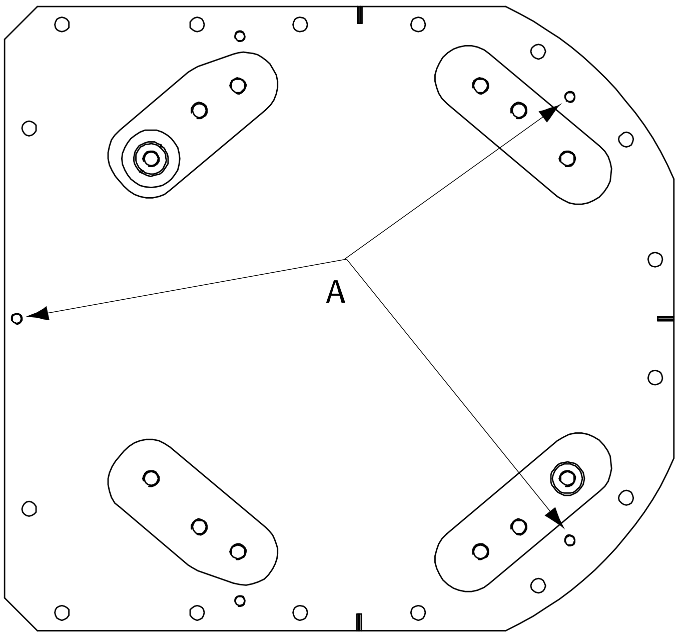
	Action	Note
1	**DANGER** Incorrect connections, such as supplying power to the wrong pin, may cause all brakes to be released simultaneously!	
2	Supply 0V on pin 12 and 24V on pin 11.	 xx0600002937

2.3.5 Lifting the base plate

Required equipment

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

Hole configuration



xx0200000096

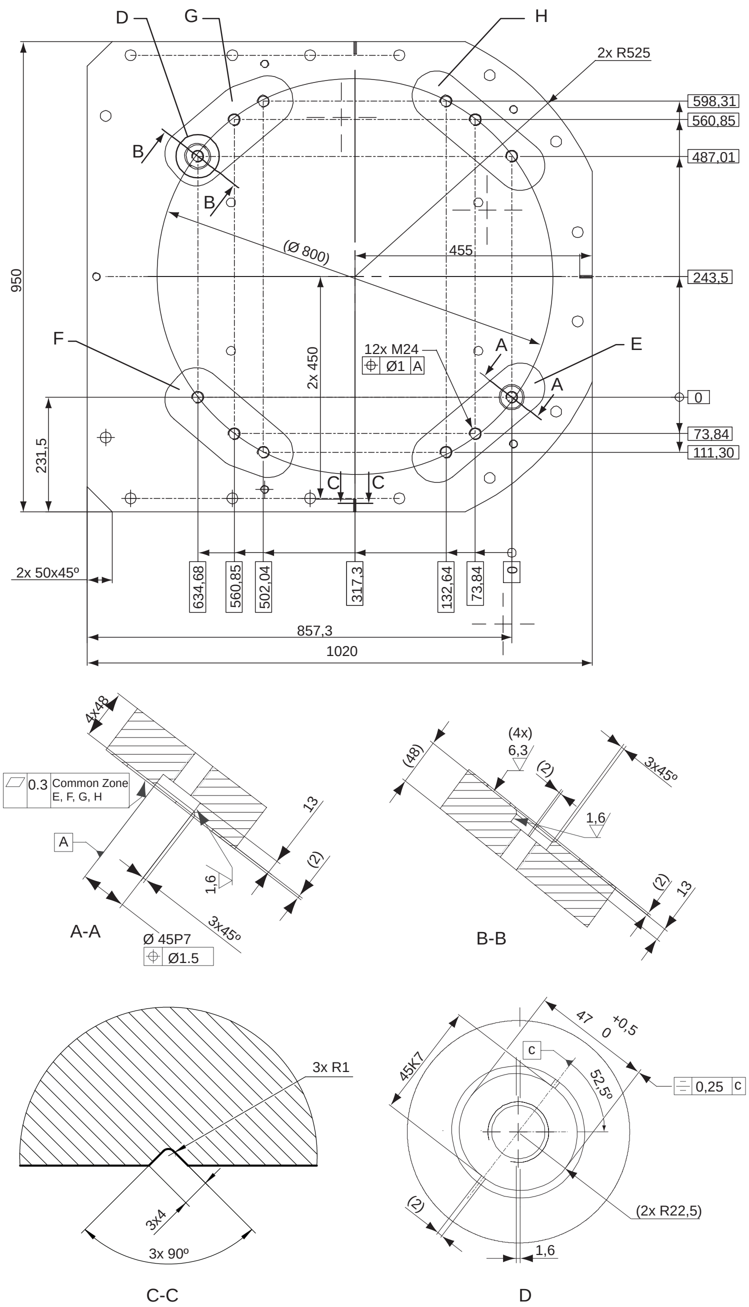
A	Attachment holes for lifting eyes (x3)

Lifting, base plate

	Action	Note
1	**CAUTION** The base plate weighs 353 kg. All lifting accessories used must be sized accordingly.	
2	Fit lifting eyes in specified holes.	Shown in figure *Hole configuration on page 70*.
3	Fit lifting slings to the eyes and to the lifting accessory. **CAUTION** Lift and move the base plate very slowly. If the base plate starts to swing it is a risk for injuries or damage.	

2.3.6 Securing the base plate

Base plate, dimensions



xx1000001053

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

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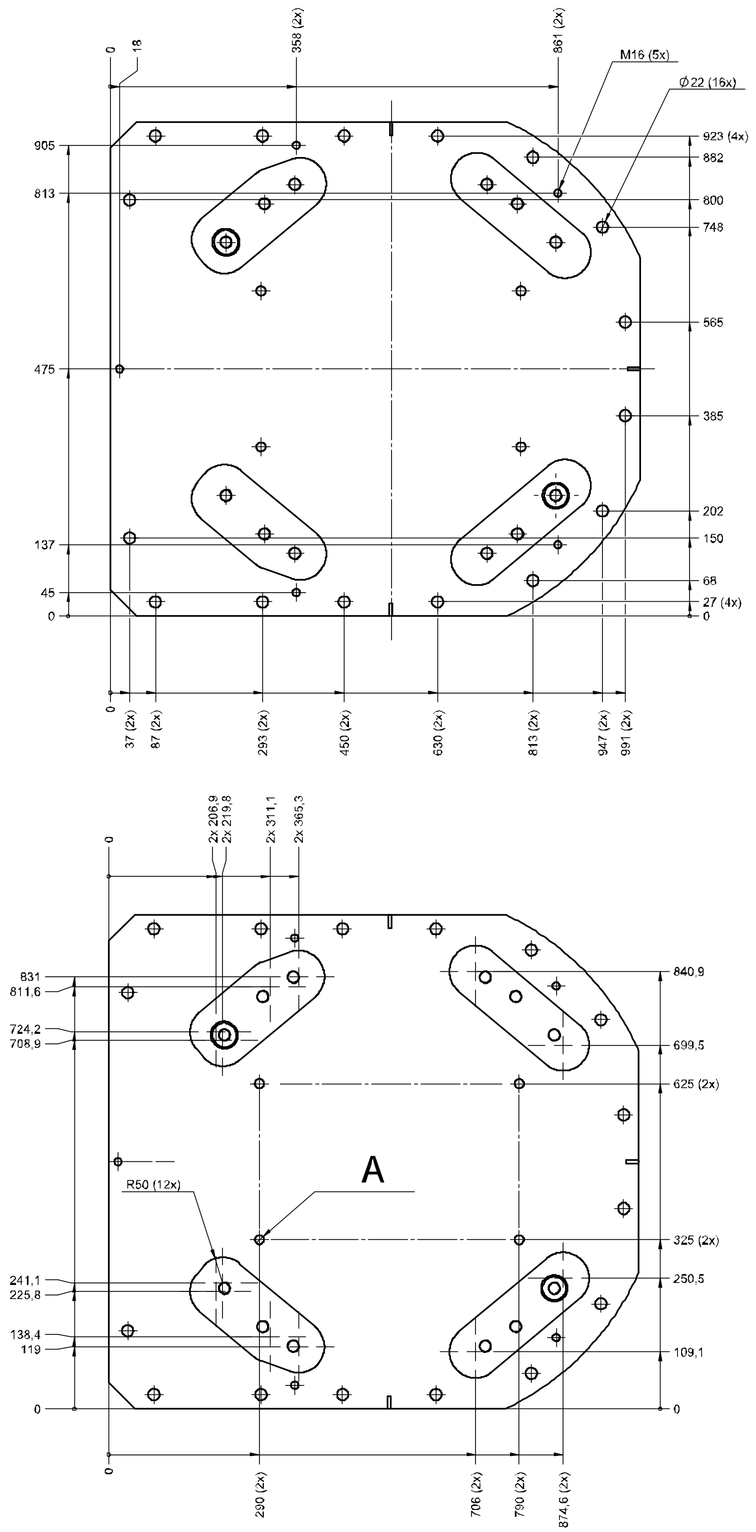
2.3.6 Securing the base plate

Continued



xx0400000715

A	Four holes for alternative clamping, 4x Ø18

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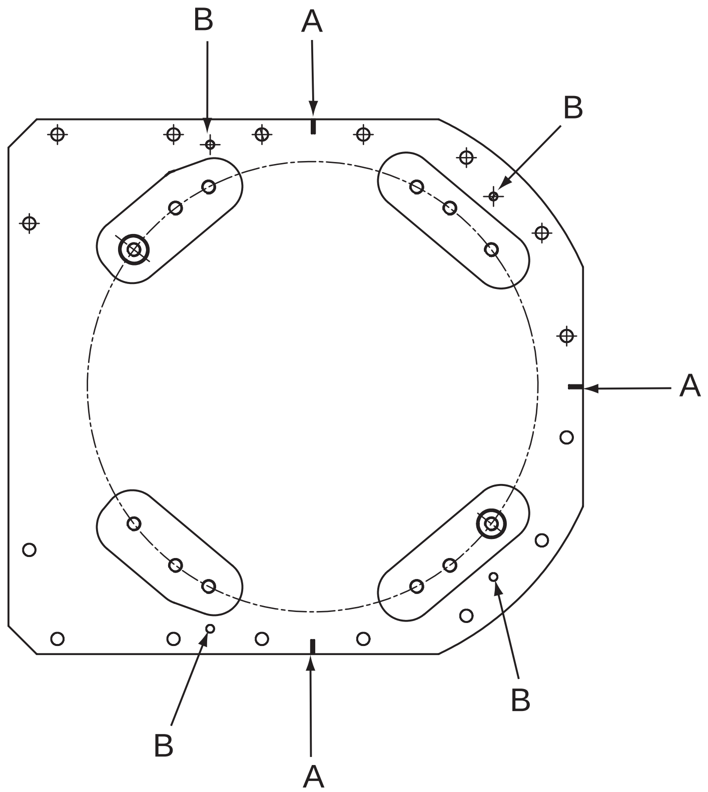
Base plate, orienting grooves and leveling bolts

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



xx1500000312

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

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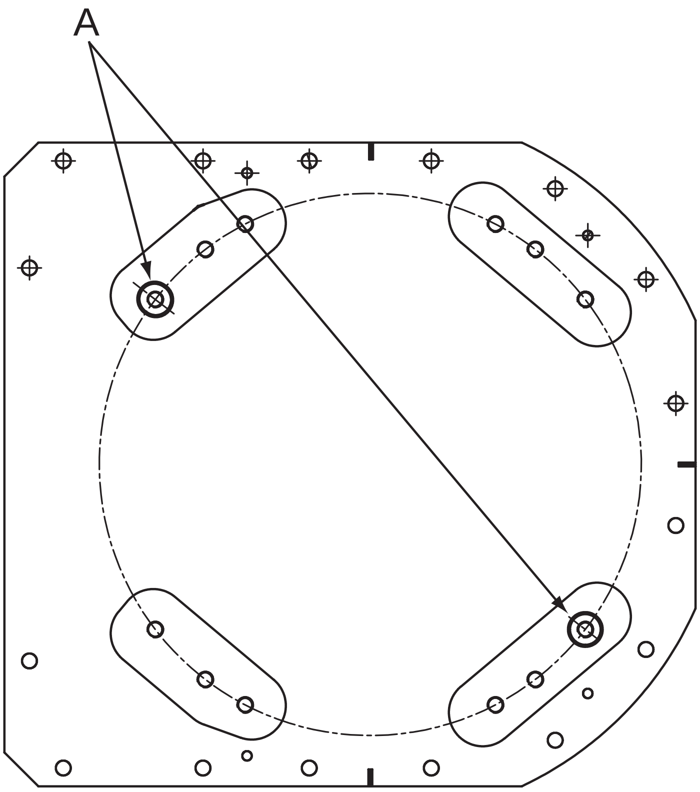
Base plate, guide sleeve holes

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



xx0300000045

A	Guide sleeve holes (2 pcs)

Required equipment

Equipment	Article number	Note
Base plate	3HAC12937-7	Includes • guide sleeves, 3HAC12937-3 • levelling screws, 9ADA120-79 • attachment screws and washers for securing the robot to the base plate.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
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.

Base plate

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

	Action	Note
1	Make sure the foundation is levelled.	

Continues on next page

	Action	Note
2	**CAUTION** The base plate weighs 353 kg! All lifting equipment used must be sized accordingly!	
3	Position base plate in relation to the robot work location using the grooves in the base plate.	Shown in figure *Base plate, orienting grooves and leveling bolts on page 73*.
4	Lift the base plate to its mounting position.	Detailed in section *Lifting the base plate on page 70*.
5	Use the base plate as a template and drill attachment holes as required by the selected bolt dimension.	Attachment holes: 16 pcs.
6	Fit the base plate and use the levelling bolts to level the base plate.	Shown in figure *Base plate, orienting grooves and leveling bolts on page 73*.
7	If required, fit strips of sheet metal underneath the base plate to fill any gaps.	
8	Secure the base plate to the foundation with screws and sleeves.	
9	Recheck the four contact surfaces on the base plate to make sure the base plate is levelled and flat. If it is not, use pieces of sheet metal or similar to bring the base plate to a levelled position.	Maximum allowed deviation all over the base plate, from one contact surface to the other: 0.3 mm.

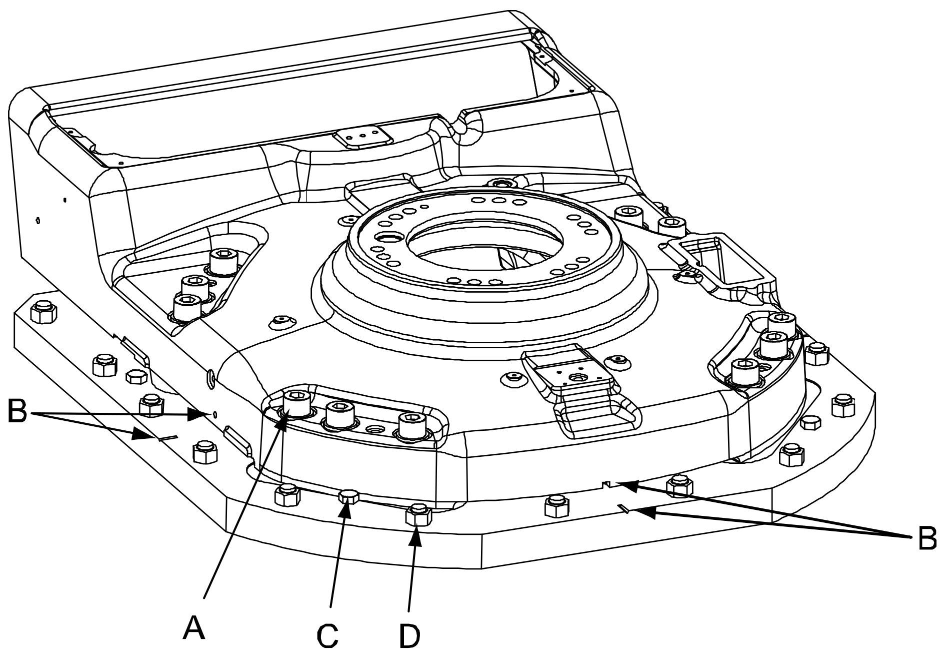
2.3.7 Orienting and securing the robot

General

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

Illustration, robot fitted to base plate

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



xx0100000107

A	Robot attachment bolts and washers, 12 pcs (M24 x 140)
B	Orienting grooves in the robot base and in the base plate
C	Levelling screws
D	Base plate attachment screws

Attachment screws

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

Suitable screws, lightly lubricated:	M24 x 140
Quality:	Quality 8.8
Suitable washer:	Thickness: 4 mm Outer diameter: 44 mm Inner diameter: 25 mm
Tightening torque:	725 Nm

Continues on next page

Securing the robot

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

	Action	Note
1	Lift the robot.	See section *Lifting robot with lifting accessory (recommended lifting method) on page 63*. See section *Lifting robot with roundslings on page 60*.
2	Move robot to the vicinity of its installation location.	
3	Fit two guide sleeves to the *guide sleeve holes* in the base plate.	Shown in figure *Base plate, guide sleeve holes on page 74*. **Note** One of the guide sleeve holes is elongated!
4	Guide the robot gently using two M24 screws while lowering it into its mounting position.	Make sure the robot base is correctly fitted onto the guide sleeves!
5	Fit the *bolts and washers* in the base attachment holes.	Specified in *Attachment screws on page 76*. Shown in figure *Illustration, robot fitted to base plate on page 76*. **Note** Lightly lubricate screws before assembly!
6	Tighten bolts in a criss-cross pattern to ensure that the base is not distorted.	

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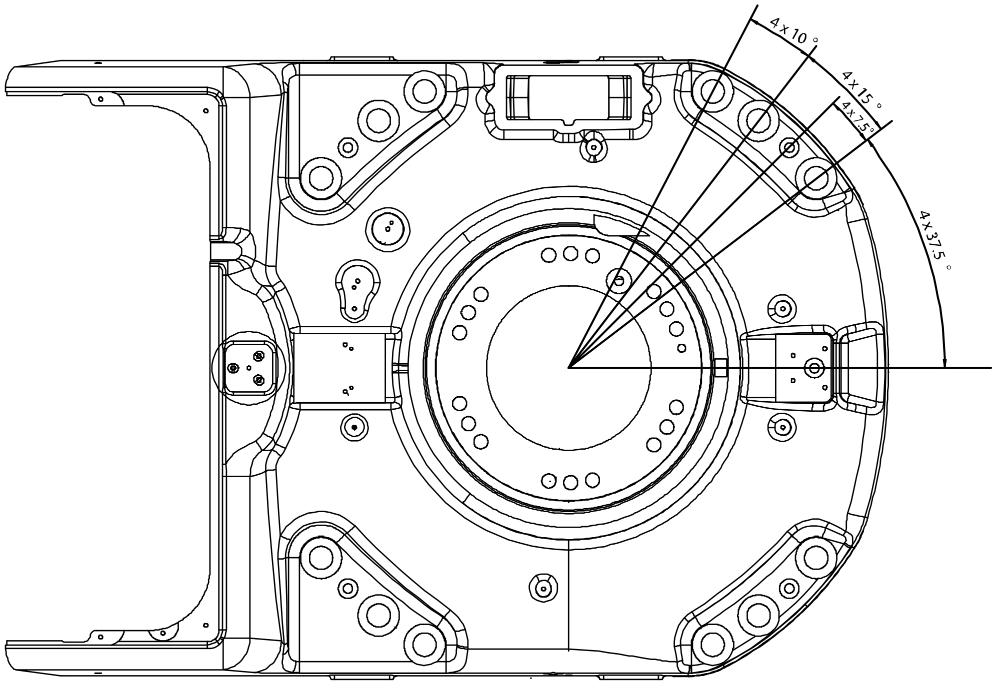
Hole configuration, base

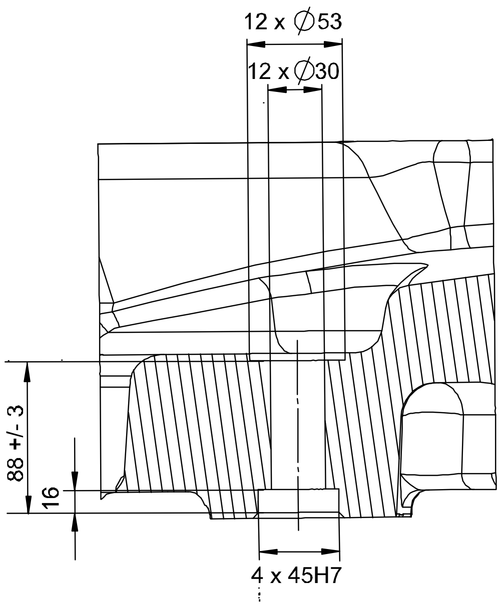
This illustration shows the hole configuration used when securing the robot.



xx0300000046

Cross section, guide sleeve hole

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



xx0100000109

2.3.8 Fitting equipment on robot

General

The robot features mounting holes for additional equipment.

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

Note

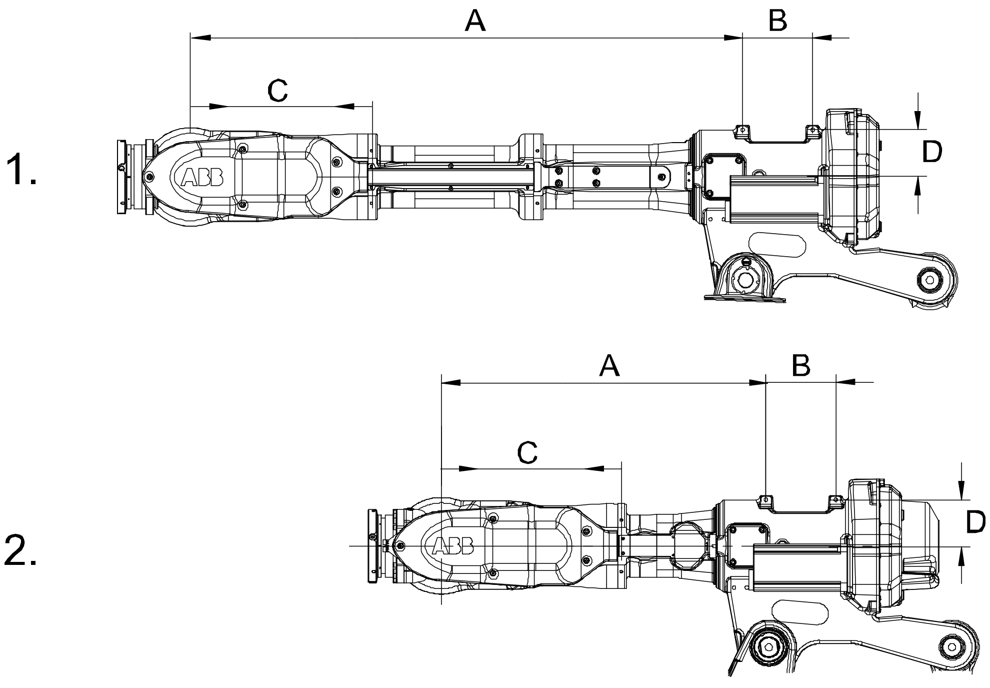
All equipment and cables used on the robot, must be designed and fitted not to damage the robot and/or its parts.

Note

No extra equipment may be fitted on the lower arm of the robot.

Illustration, fitting of extra equipment on upper arm

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



xx0700000015

Number	Robot variant	A	B	C	D
1	IRB 6660 - 100/3.3	1747.5 mm	190 mm	490 mm	128 mm
	IRB 6660 - 130/3.1	1497.5 mm	190 mm	490 mm	128 mm
2	IRB 6660 - 205/1.9	885 mm	190 mm	490 mm	128 mm

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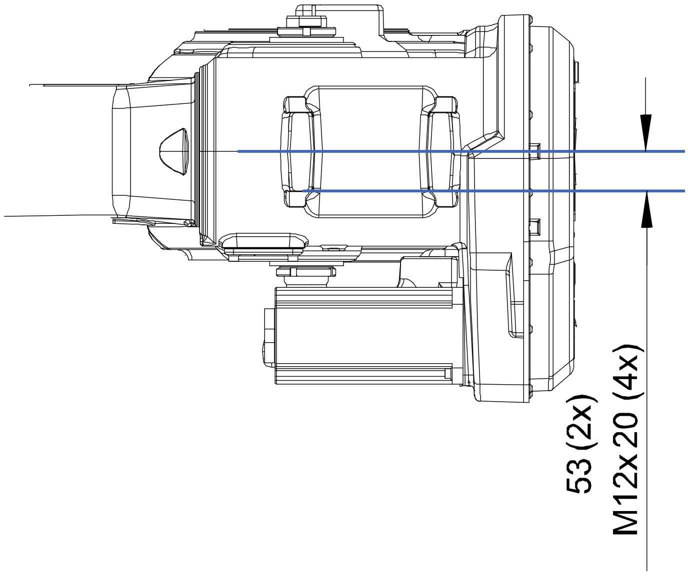

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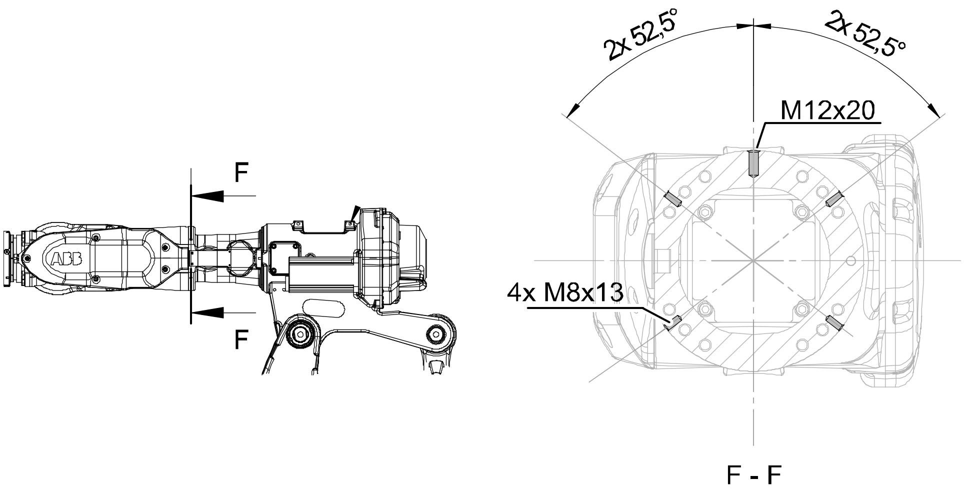

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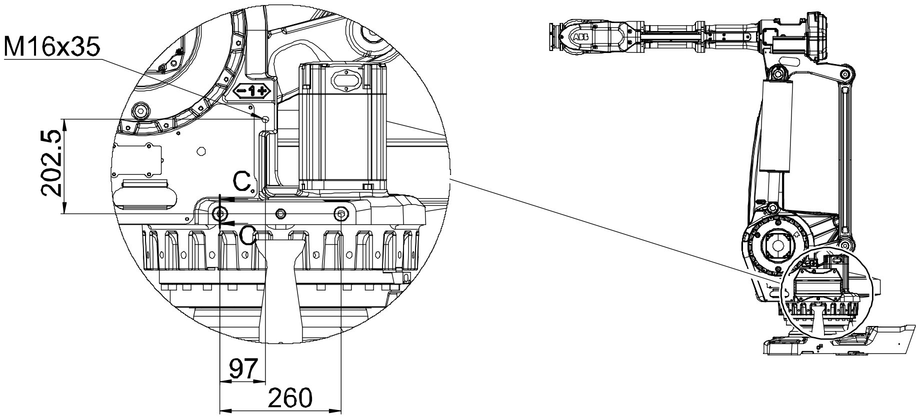
Illustration, fitting of extra equipment on frame

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

Illustrations show robot variant IRB 6660 - 130/3.1 but all shown measurements are the same on all variants.



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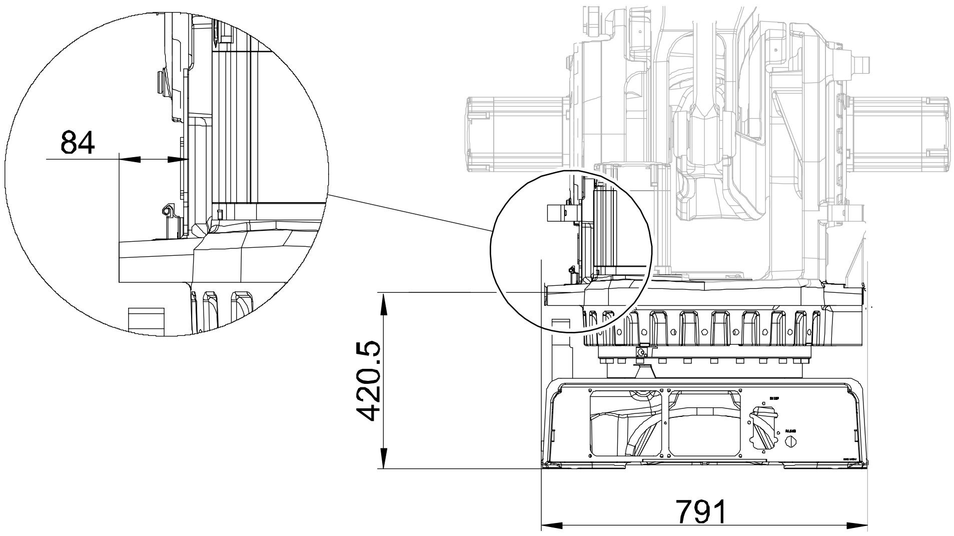

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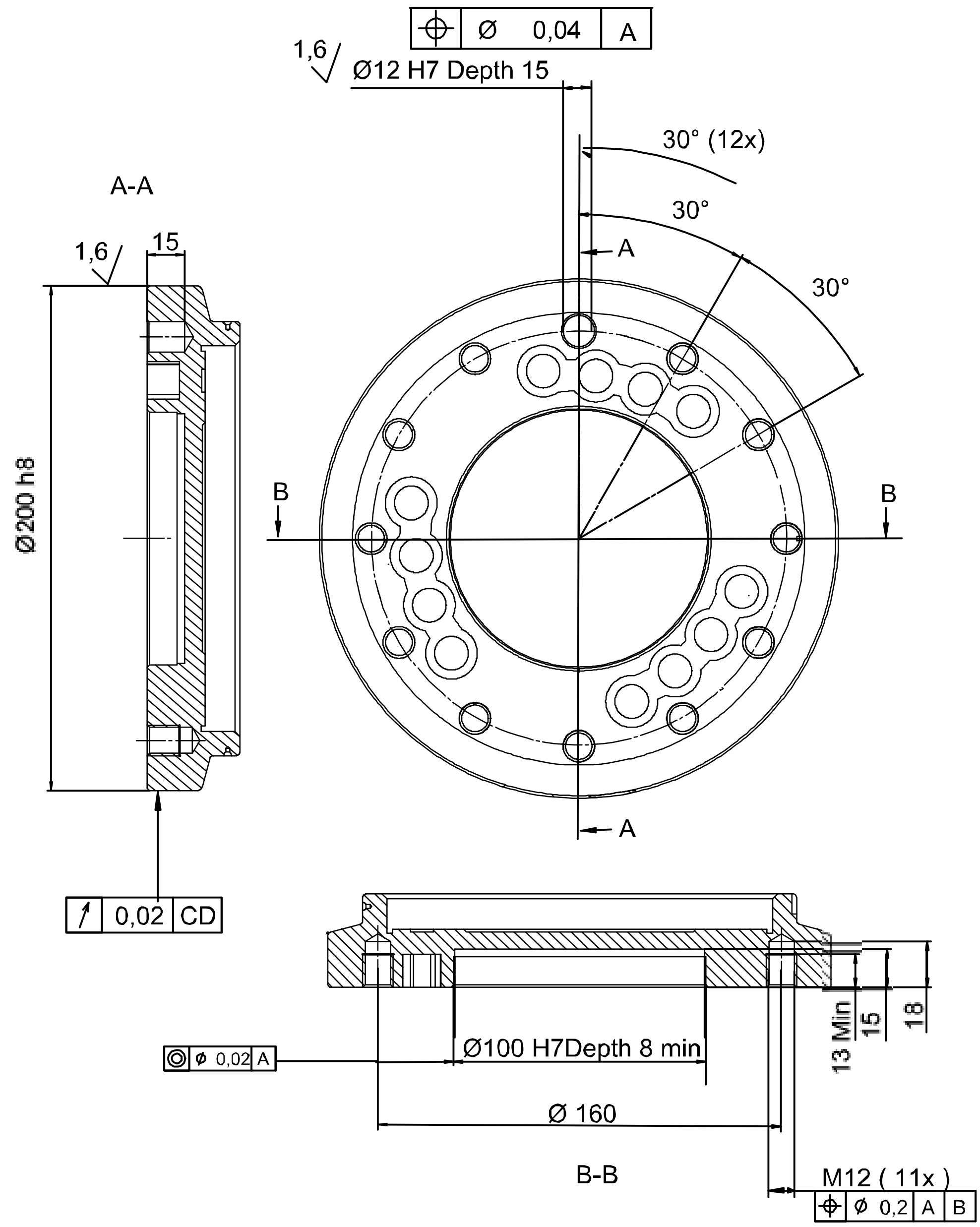
Illustration, fitting on turning disc

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



xx0200000197

-	Turning disk (type 2) for all robot versions.

Fastener quality

When fitting tools on the tool flange, only use screws with quality 12.9. For other equipment use suitable screws and tightening torque for your application.

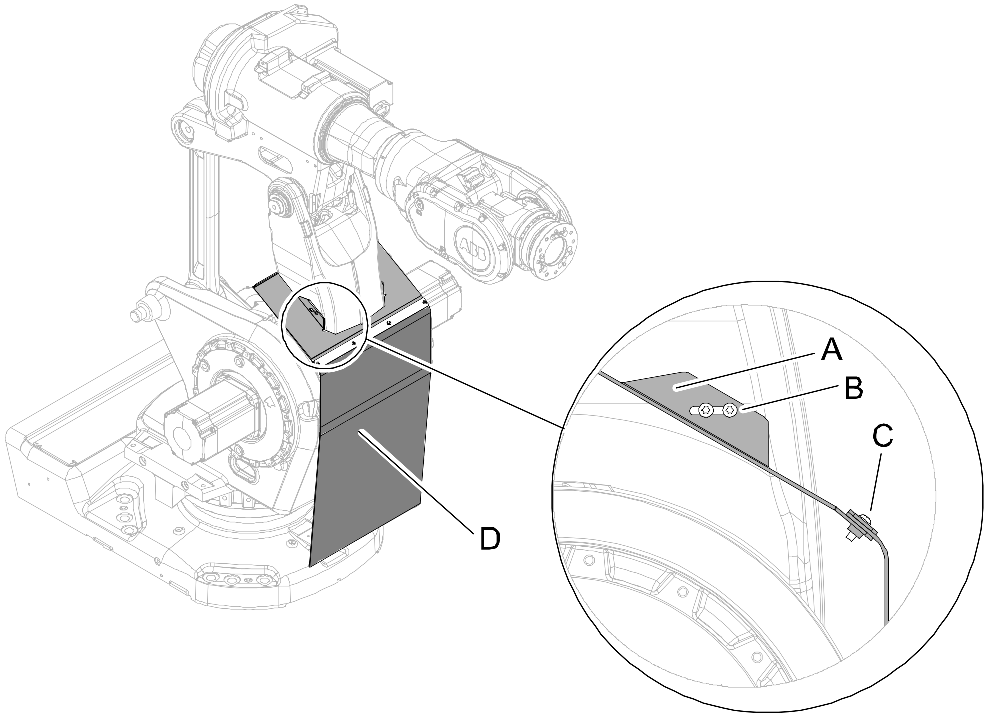
2.3.9 Installation of chip protection - IRB 6660 - 205/1.9

Note

This section is only applicable to the robot variant IRB 6660 - 205/1.9.

Location of chip protection

The chip protection is installed on the lower arm as shown in the figure below.



xx0700000630

A	Bracket
B	Attachment screws M6x16 quality 8.8-A2F (2 pcs per side)
C	Attachment screws M6x16 quality 8.8-A2F (4 pcs)
D	Protection

Required equipment

Equipment	Art. no.	Note
Chip protection	3HAC030124-001	
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243) For locking screws.
Standard toolkit		Content is defined in section *Standard tools on page 390*.

Continues on next page

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

Installation, chip protection

The procedure below details how to install the chip protection on the lower arm of the robot.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Place the chip protection around the lower arm.	As shown in the figure *Location of chip protection on page 83*.
3	Fit the *bracket* on the chip protection with its attachment screws - two screws on each side of the lower arm. Lock screws with *locking liquid*.	Art. no. is detailed in *Required equipment on page 83*.
4	Let the protection hang down in front of the lower arm and base of the robot.	As shown in the figure *Location of chip protection on page 83*.

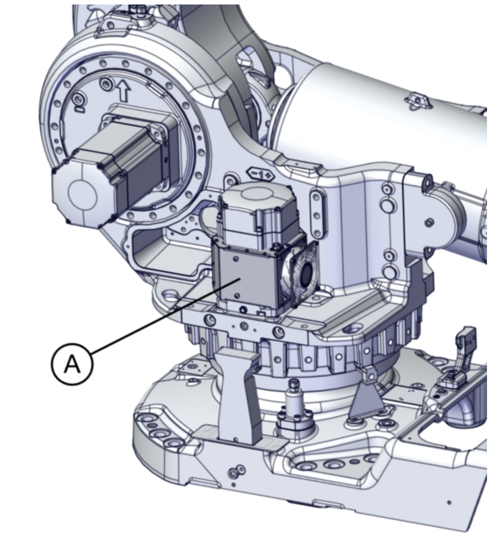
2.3.10 Installation of cooling fan for motors (option)

General

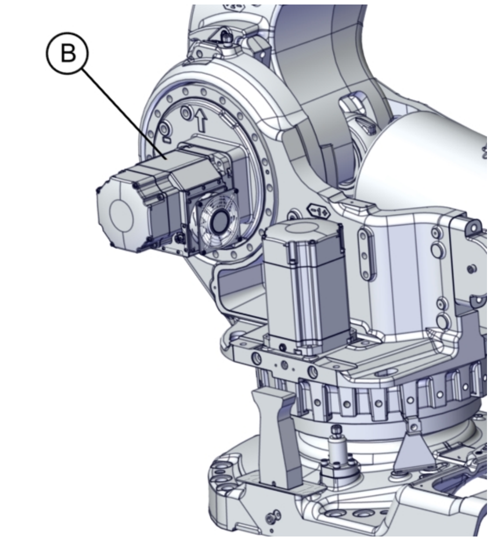
A cooling fan can be installed on motor axis 1 and/or axis 2.

Location of cooling fans

The fan can be installed on motor axis 1 and/or axis 2, as shown in the figure below. The figure shows IRB 7600 but the principle fitting is the same.



xx1800000169



xx1800000170

A	Cooling fan, axis 1
B	Cooling fan, axis 2

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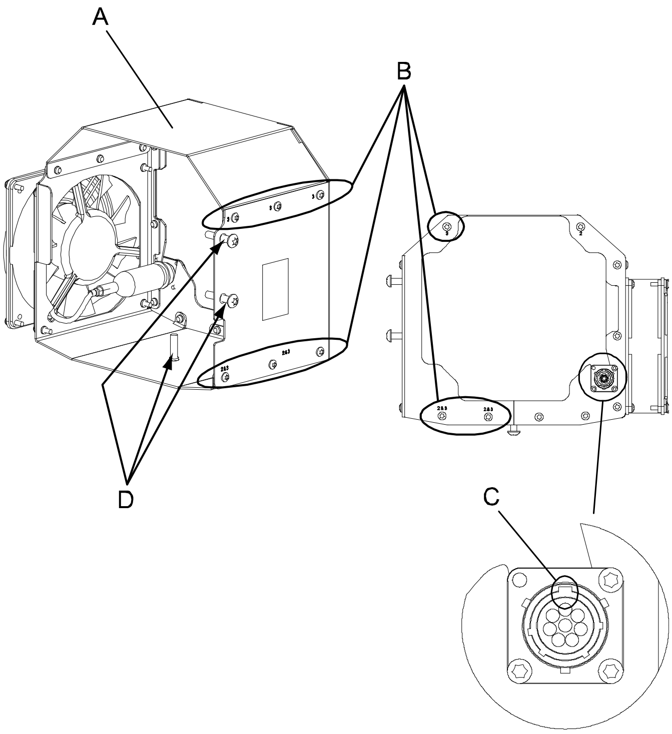
Cooling fan

The details of the cooling fan are shown in the figure below.



xx0500002158

A	Fanbox
B	Attachment screws, fanbox plates (9 pcs)
C	Groove in the connector
D	Tightening screws, fanbox (3 pcs)

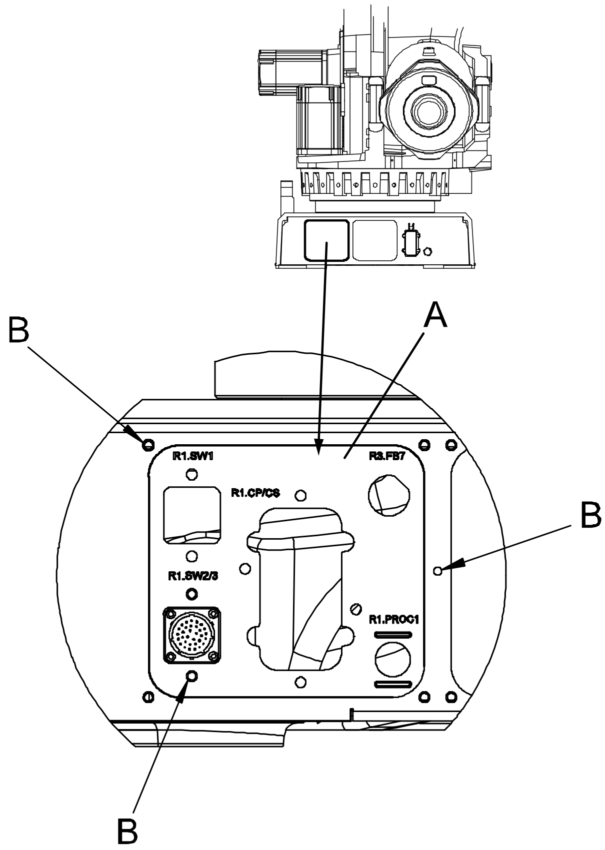
Required equipment

Equipment	Article number	Note
Cooling fan	3HAC15374-1	
Cabling, cooling fan, axes 1 and 2	3HAC046362-001	Choose this cabling if equipping the robot with cooling fans on both axis 1 and 2.
Plate for customer connections	3HAC025778-001	An additional connection plate must be fitted to the robot base, if not already installed. The plate is shown in the figure *Plate for customer connections, at base on page 87*.
Additional cabling to the controller	-	Specified in section *Fan cables (option) on page 102*.
Material set fan axes 1 and 2	3HAC023999-001	The set includes: • fan axes 1 & 2 cable harness • plate, customer • attachment screws and nuts.
Cable harness inside controller	3HAC025488-001	

Continues on next page

Equipment	Article number	Note
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243) Used for the three tightening screws.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Circuit diagram	3HAC025744-001	See chapter *General references on page 10*.
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.

Plate for customer connections, at base



xx0500002301

A	Plate for customer connections
B	Attachment screws, 3 pcs, M6x16 quality 8.8-A2F

Continues on next page

Installation, fan

The procedure below details how to install the cooling fan on motors, axes 1 or 2
.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Prepare the fanbox for installation: • disassemble the two parts of the box by removing the nine *attachment screws* • loosen the three *tightening screws*, to avoid damaging the surfaces of the motor when fitting the fanbox • turn the connector to the correct position; axis 1: groove pointing inwards, as shown in the figure *Cooling fan on page 86*.	Shown in the figure *Cooling fan on page 86*.
3	Temporarily lift the motor cabling out of the way of the current motor to make room for the fanbox.	
4	Fit the parts of the fanbox to the motor and reassemble with the nine *attachment screws*.	
5	Lift the box (axis 1) so that it does not rest directly on the robot and secure the box with the three tightening screws, using locking liquid. Tighten them properly so that the box is firmly attached to the motor.	
6	Install the cabling and make adjustments in RobotWare, as described in the following procedures.	

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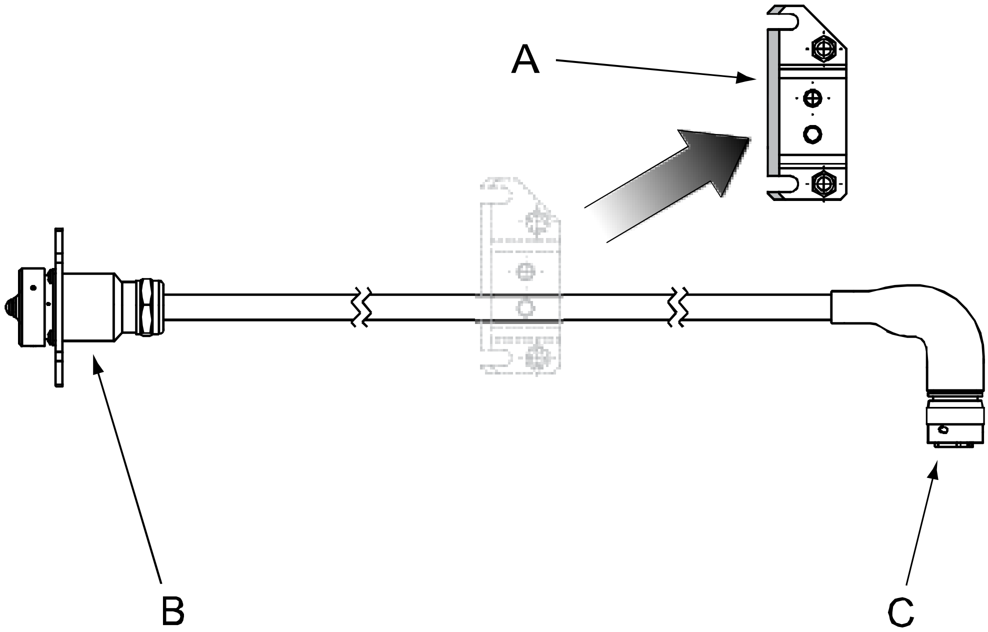
Separate cabling for axis 1 or 2

The figure below shows the cabling used for the fan on axis 1 or 2.



xx0700000669

A	Cable bracket (to be removed)
B	Connector R1.SW2/3, connected to the robot base
C	Connector R3.FAN2, connected to the fan of axis 1 or 2.

Installation, separate fan cabling axis 1 or 2

The procedure below details how to install the separate cabling for the cooling fan of axis 1 or 2.

	Action	Note
1	Move the robot to its calibration position.	This is detailed in section *Synchronization marks and synchronization position for axes on page 346*.
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	

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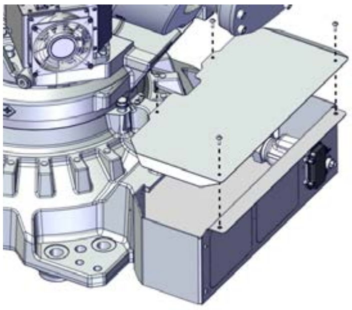
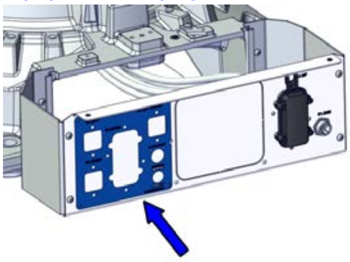
	Action	Note
3	Remove the rear cover plate from the robot base.	 xx1800000161
4	Remove the cable bracket (A)	Shown in the figure *Separate cabling for axis 1 or 2 on page 89*
5	Fit the *plate for customer connections*, if not already fitted, to the connection plate of the robot base.	Art. no. is specified in *Required equipment on page 86*.  xx1800000162
6	Run the cabling up through the base and frame.	
7	Run the cable underneath the robot cabling and out through the side of the frame, at motor, axis 1 or 2. Strap the fan cable to the cable of the motor axis 1 or 2, close to the motor. **Note** The fan cable must not be strapped to the motor cable along the part of the cable that is twisted when the robot is in operation.	
8	Connect the connector R3.FAN2 to the fan of axis 1.	
9	Connect the connector R1.SW2/3 to the base of the robot. Make sure that the cabling, run through the frame and base, is not twisted and runs freely from the robot cabling.	
10	Refit the rear cover plate to the robot base.	
11	Install additional cabling to and inside the controller. Also make adjustments in RobotWare, as described in the following procedure.	Cable is specified in section *Robot cabling and connection points on page 100*.

Continues on next page

Adjustments in RobotWare

	Action	Note
1	Modify the settings in RobotWare to include the cooling fans.	RobotWare 5: modify the option information in **System Builder** (RobotStudio). Read more about modifying the system in *Operating manual - RobotStudio*. RobotWare 6: modify the option information using the**Installation Manager** function (RobotStudio). Read more about modifying the system in *Operating manual - RobotStudio*.

2.3.11 Installation of Foundry Plus Cable guard (option)

Introduction

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

Separate instructions for IRB 2600, 4600, 6620, 6640, 6650S, 6660 and 7600 are available in English, German, French, Spanish, and Italian and can be found for registered users on myABB Business Portal (*www.abb.com/myabb*) and delivered with the Cable guard, article number 3HAC035933-001.

2.3.12 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 be defined in the software.

- *Operating manual - IRC5 with FlexPendant*
- *Operating manual - OmniCore*

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 listed in *References on page 10*.

2.3.13 Safety lamp (option for IRC5)

Description

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

Installation

See the assembly instruction delivered with the signal lamp.

Function

The lamp is active in MOTORS ON mode.

Further information

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

2.3.14 Extended working range, axis 1 (option)

Overview

The working range of axis 1 can be extended on a floor-mounted robot, from the default range limited by mechanical stops. The working range can be extended to ±220°.

CAUTION

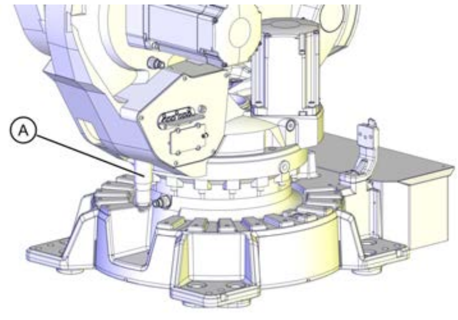
The option *Extended work range* enables an extension of the working range for axis 1, through a software configuration. With this option installed, the working range can exceed the range limited by the mechanical stop on axis 1. The working range shall be limited through the option SafeMove.

A risk analysis must be done to ensure that no risks remain when using option *Extended work range*, to limit the working range, and before removing the mechanical stops.

For information about the option SafeMove, see *Application manual - Functional safety and SafeMove2* (IRC5) or *Application manual - Functional safety and SafeMove* (OmniCore).

If the mechanical stop is removed, then the manipulator should have a marking for this, for example, a label. If the robot is delivered with the option *Extended work range*, then such a label is included on delivery.

Extending the working range

	Action	Note/Illustration
1	Configure the safety setup and verify it by test.	
2	Hold the mechanical stop pin in a firm grip, and remove it by unscrewing the attachment screw.	 xx2100001702
3	In RobotWare, redefine the working range limitations in the system parameters, topic *Motion*. The *Arm* parameters *Upper Joint Bound* and *Lower Joint Bound* can be changed to the values corresponding to the actual installation.	With the option *Extended working range*, the maximum value for the system parameters *Upper Joint Bound* and *Lower Joint Bound* is 3.84 respectively -3.84. The values are in radians, that is 3.84 radians = 220 degrees.

Related information

The system parameters are described in detail in the reference manual, see *References on page 10*.

Continues on next page

For more information about SafeMove, see *Application manual - Functional safety and SafeMove2* (IRC5) or *Application manual - Functional safety and SafeMove* (OmniCore).

2.4 Restricting the working range

2.4.1 Axes with restricted working range

General

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

The working range of the following axes may be restricted:

- Axis 1, hardware (mechanical stop) and software.
- Axis 2, software.
- Axis 3, software.

As standard configuration, axis 1 is allowed to move ± 180º.

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

Note

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

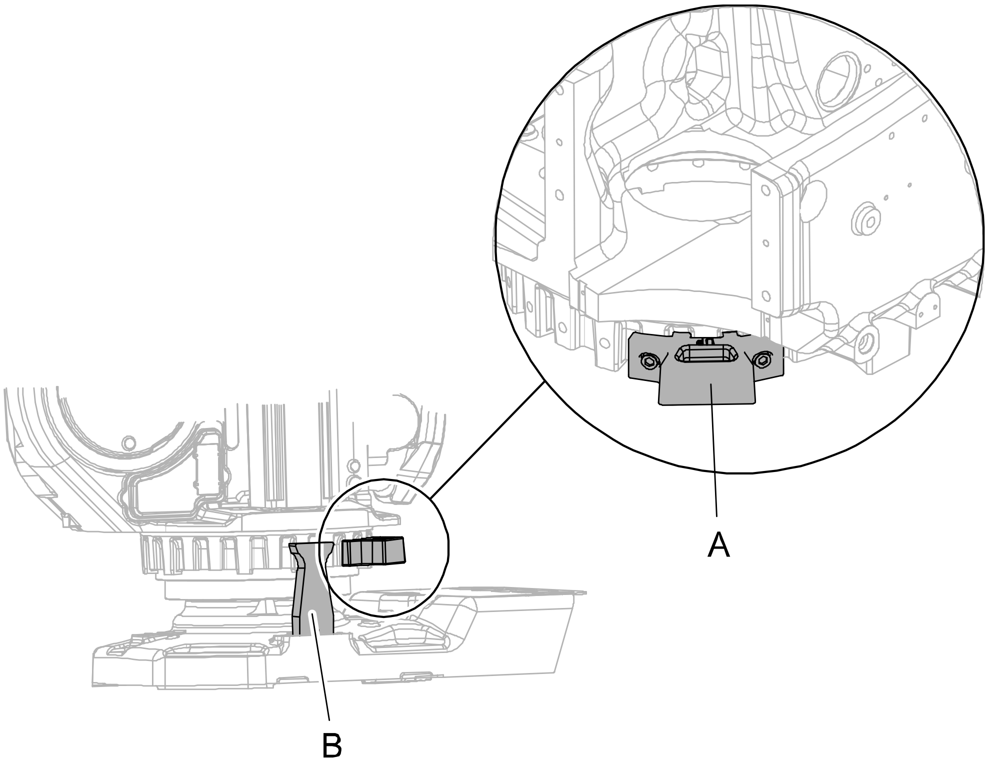
2.4.2 Mechanically restricting the working range of axis 1

General

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

Mechanical stops, axis 1

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



xx0300000049

A	Additional mechanical stop
B	Stop pin

Required equipment

Equipment, etc.	Article number	Note
Mechanical stop for axis 1, 7.5°	3HAC11076-1	Includes attachment screws and an assembly drawing.
Mechanical stop for axis 1, 15°	3HAC11076-2	Includes attachment screws and an assembly drawing.
Standard toolkit	-	
Technical reference manual - System parameters	-	Article number is specified in section *References on page 10*.

Continues on next page

Installation, mechanical stops axis 1

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Fit the additional mechanical stop to the frame according to the figure *Mechanical stops, axis 1 on page 98*.	Tightening torque: 120 Nm.
3	Adjust the software working range limitations (system parameter configuration) to correspond to the mechanical limitations.	The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.
4	**WARNING** If the mechanical stop pin is deformed after a hard collision, it must be replaced! Deformed *movable stops* and/or *additional stops* as well as deformed *attachment screws* must also be replaced after a hard collision.	

2.5 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.

CAUTION

Connect the male and female connectors perfectly aligned horizontally to avoid any kind of tilt or skew.

CAUTION

Verify that the serial number is according to the number(s) in the *Declaration of Incorporation* (DoI).

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 100*.
Fan cables (option)	Handles supply to and feedback from any cooling fan on the robot. Specified in the table *Fan cables (option) on page 102*.
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. The customer cables also handle databus communication. See the product manual for the controller, see document number in *References on page 10*.
External axes cables (option)	Handles power supply to and control of the external axes' motors as well as feedback from the servo system. See *Application manual - Additional axes and standalone controller (IRC5) or Application manual - Additional axes (OmniCore)*, 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 (IRC5 controllers) X1 (OmniCore controllers)	R1.MP

Continues on next page

Cable sub-category	Description	Connection point, cabinet	Connection point, robot
Robot cable, signals	Transfers resolver data from and power supply to the serial measurement board.	XS2 (IRC5 controllers) X2 (OmniCore controllers)	R1.SMB

Robot cable, power

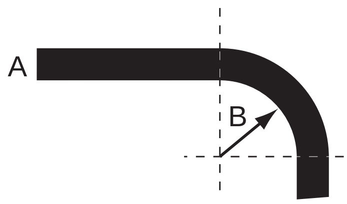
Cable	Art. no.
Robot cable, power: 7 m	3HAC026787-001
Robot cable, power: 15 m	3HAC026787-002
Robot cable, power: 22 m	3HAC026787-003
Robot cable, power: 30 m	3HAC026787-004

Robot cable, signals

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

Bending radius for static floor cables

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



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A	Diameter
B	Diameter x10

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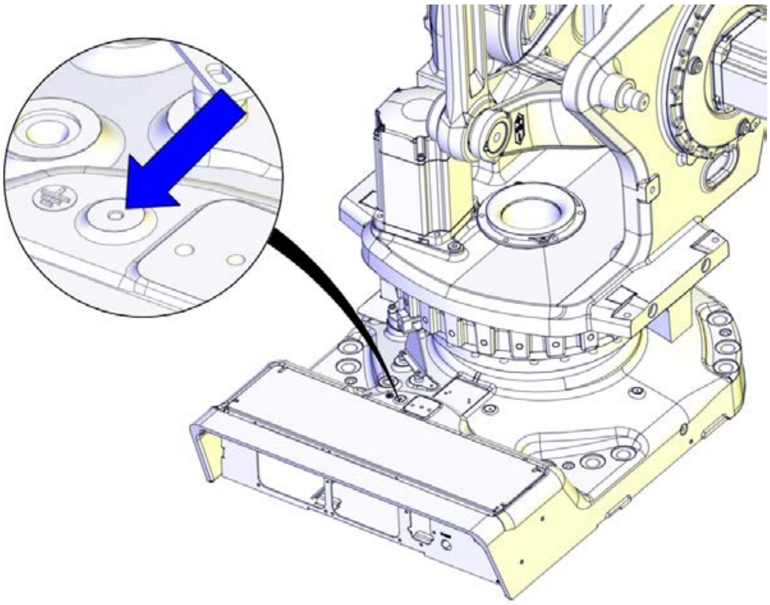
Grounding and bonding point on manipulator

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



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Fan cables (option)

These cables are only included in the delivery if the fan option is ordered. The cables are completely pre-manufactured and ready to plug in.

Cabling to be installed on the robot is specified in section *Installation of cooling fan for motors (option) on page 85*.

Cabling between robot base and control cabinet, cooling fans

The following cables are used when the robot is equipped with cooling fans. The cabling for the cooling fans run from the robot base to the controller cabinet, and connecting inside with a distribution cable. For instructions on how to connect the distribution cable inside the controller, see the product manual for the robot controller.

Fans can also be ordered without cables.

If cooling fans are added to an existing installation, use the cabling specified below.

Cable	Art. no.	Connection point
Harness - cooling, 7 m	3HAC022723-001	Distributing cable: R1.FAN.SW2/3 Inside cabinet: A43.X10 and A43.X11 (IRC5) Inside cabinet: A43.X10/A43.X11 - A2.X23 (OmniCore)

Continues on next page

Cable	Art. no.	Connection point
Harness - cooling, 15 m	3HAC022723-004	Distributing cable: R1.FAN.SW2/3 Inside cabinet: A43.X10 and A43.X11 (IRC5) Inside cabinet: A43.X10/A43.X11 - A2.X23 (OmniCore)
Harness - cooling, 22 m	3HAC022723-005	Distributing cable: R1.FAN.SW2/3 Inside cabinet: A43.X10 and A43.X11 (IRC5) Inside cabinet: A43.X10/A43.X11 - A2.X23 (OmniCore)
Harness - cooling, 30 m	3HAC022723-006	Distributing cable: R1.FAN.SW2/3 Inside cabinet: A43.X10 and A43.X11 (IRC5) Inside cabinet: A43.X10/A43.X11 - A2.X23 (OmniCore)

2.6 Start of robot in cold environments

Introduction

This section describes how to start the robot in a cold environment if it is not starting the normal way.

Problems with starting the robot

Event message from Motion Supervision

Use this procedure if an event message indicates a problem with Motion supervision at start-up. More information about Motion Supervision is found in *Technical reference manual - System parameters*.

	Action	Note
1	Turn off Motion Supervision.	
2	Start the robot.	
3	When the robot has reached normal working temperature, the Motion Supervision can be turned on again.	

Robot stopping with other event message

Use this procedure if the robot is not starting.

	Action	Note
1	Start the robot with its normal program but with reduced speed.	The speed can be regulated with the RAPID instruction `VelSet`.

Adjusting the speed and acceleration during warm-up

Depending on how cold the environment is and what program is being used, the speed might need to be ramped up until reached maximum. The table shows examples of how to adjust the speed:

Work cycles	`AccSet`	Speed/velocity
3 Work cycles	20, 20	v100 (100 mm/s)
5 Work cycles	40, 40	v400 (400 mm/s)
5 Work cycles	60, 60	v600 (600 mm/s)
5 Work cycles	100, 100	v1000 (1000 mm/s)
More than 5 Work cycles	100, 100	Max.

If the program consists of large wrist movements, it is possible that the reorientation velocity, which is always high in predefined velocities, needs to be included in the ramping up.

2.7 Test run after installation, maintenance, or repair

Safe handling

Use the following procedure after installation, maintenance, or repair, before initiating motion.

DANGER

Initiating motion without fulfilling the following aspects, may increase the risk for injury or cause damage to the robot.

	Action
1	Remove all tools and foreign objects from the robot and its working area.
2	Verify that the robot is properly secured to its position by all screws, before it is powered up.
3	Verify that any safety equipment installed to secure the position or restrict the robot motion during service activity is removed.
4	Verify that the fixture and work piece are well secured, if applicable.
5	Verify that all safety equipment is installed, as designed for the application.
6	Verify that no personnel are inside the safeguarded space.
7	If maintenance or repair has been done, verify the function of the part that was maintained.
8	Verify the application in the operating mode manual reduced speed.

Collision risks

CAUTION

When programming the movements of the robot, always identify potential collision risks before initiating motion.

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3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 6660.

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 maintenance 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 19* before performing any maintenance work.

The maintenance must be done by qualified personnel in accordance with the safety requirements set forth in the applicable national and regional standards and regulations.

Note

If the IRB 6660 is connected to power, always make sure that the IRB 6660 is connected to protective earth and a residual current device (RCD) before starting any maintenance work.

For more information see:

- *Product manual - OmniCore V250XT Type B*
- *Product manual - OmniCore V400XT*
- *Product manual - IRC5*
- *Robot cabling and connection points on page 100*.

3.2 Maintenance schedule and component life

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 6660:

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

  The SIS used in M2004 is further described in the *Operating manual - Service Information System* (IRC5) or *Operating manual - OmniCore*.

  The SIS used in OmniCore is further described in the *Operating manual - OmniCore*.

Robots with the functionality *Service Information System* activated can show active counters in the device browser in RobotStudio, or on the FlexPendant.

Overhaul

Depending on application and operational environment a complete overhaul may be necessary in average around 40000 hours.

ABB Connected Services and its Assessment tools can help you to identify the real stress level of your robot, and define the optimal ABB support to maintain your robot working.

Contact your local ABB Customer Service to get more information.

3.2.2 Maintenance schedule

General

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

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

The inspection intervals *do not* specify the life of each component. Values for these are specified in the section *Expected component life on page 111*

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

- *Inspection activities on page 112*
- *Replacement/changing activities on page 142*
- *Cleaning activities on page 166*

Activities and intervals, standard equipment

The following table specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval
Cleaning	Robot	*Cleaning the IRB 6660 on page 166*
Inspection	Oil level in axis-1 gearbox	Every 12 months.
Inspection	Oil level in axis-2 gearbox	Every 12 months.
Inspection	Oil level in axis-3 gearbox	Every 12 months.
Inspection	Oil level in axis-4 gearbox	Every 12 months.
Inspection	Oil level in axis-5 gearbox	Every 12 months.
Inspection	Oil level in axis-6 gearbox	Every 12 months.
Inspection	Balancing device	Every 6 months.
Inspection	Robot harness	Every 12 months[i].
Inspection	Information labels	Every 12 months.
Inspection	Dampers	Every 12 months.
Inspection	Mechanical stop	Every 12 months.
Change	Oil in axis-1 gearbox	First change when DTC [ii] reads: • 6,000 hours Second change when DTC[ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Change	Oil in axis-2 gearbox	First change when DTC [ii] reads: • 6,000 hours Second change when DTC[ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.

Continues on next page

Maintenance activity	Equipment	Interval
Change	Oil in axis-3 gearbox	First change when DTC[ii] reads: • 6,000 hours Second change when DTC[ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Change	Oil in axis-4 gearbox	Every 24,000 hours.
Change	Oil in axis-5 gearbox	Every 24,000 hours.
Change	Oil in axis-6 gear	First change when DTC[ii] reads: • 6,000 hours Second change when DTC[ii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Overhaul	Robot	Every: • 40,000 hours [iii].
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [iv]
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [v]
Lubrication	Balancing device bearings	Every 12,000 hours [vi]

i Replace when damage or cracks is detected or life limit is approaching that specified in section *Expected component life on page 111*.

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

iii If the robot is run in presstending applications, typically 36 months.

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

See the replacement instruction for more details.

v 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 the operating manual for the robot controller for instructions.

vi Always lubricate the front eye bearing after refitting the shaft of the balancing device.

Activities and intervals, optional equipment

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

Maintenance activity	Equipment	Interval	Note
Inspection	Signal lamp	Every: 12 months	
Inspection	Additional mechanical stop axis 1	Every: 12 months	
Inspection	Motor fan	Every 12 months	Inspect the fan for contamination that could hinder the air supply. Clean if necessary.

3.2.3 Expected component life

General

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

Expected component life - protection type Standard

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

i Examples of "normal usage" in regard to movement: most material handling applications.

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

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

iv The given life for the balancing device is based on a test cycle of 4,000,000 cycles that starts from the initial position and goes to maximum extension, and back. Deviations from this cycle will result in differences in expected life!

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

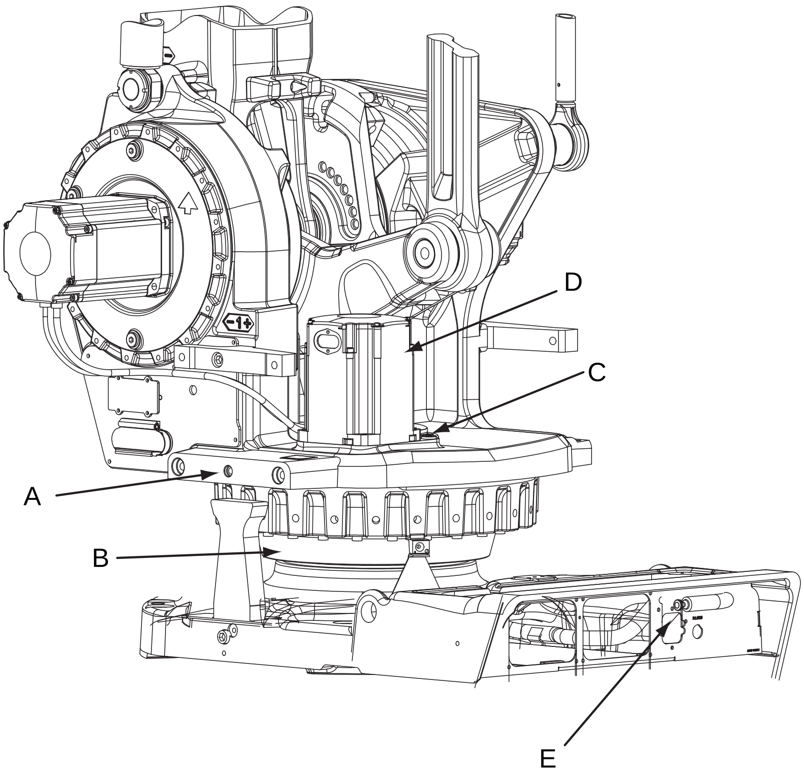
The SIS for an IRC5 system is described in the *Operating manual - Service Information System*.

3.3 Inspection activities

3.3.1 Inspecting the oil level in axis-1 gearbox

Location of gearbox

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



xx0500002479

A	Oil plug, inspection
B	Gearbox, axis 1
C	Oil plug filling
D	Motor, axis 1
E	Drain hose (Behind cover)

Required equipment

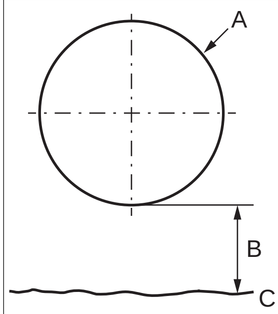
Equipment	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	**Note** Do not mix with other oils!
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

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

Inspecting the oil level in axis-1 gearbox

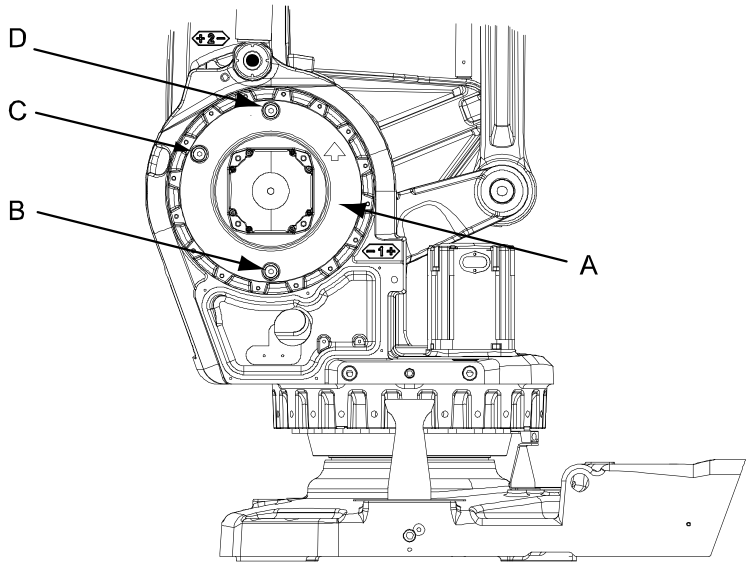
Use this procedure to inspect the oil level in the axis-1 gearbox.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
3	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
4	Open the *oil plug, inspection*.	Shown in figure *Location of gearbox on page 112*.
5	Measure the oil level. Required oil level: max. 10 mm below the oil plug hole.	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
6	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type of lubrication in gearboxes on page 142*. Further information about how to fill with oil is found in section *Changing oil, axis-1 gearbox on page 144*.
7	Refit the oil plug.	Tightening torque:24 Nm

3.3.2 Inspecting, oil level gearbox axes 2 - 3

Location of gearbox, axes 2-3

The gearboxes axes 2-3 are located in the lower arm rotational center, underneath the motor attachment.



xx0500002482

A	Gearbox, axis 2
B	Oil plug, draining
C	Oil plug, filling
D	Ventilation hole, gearbox axis 2

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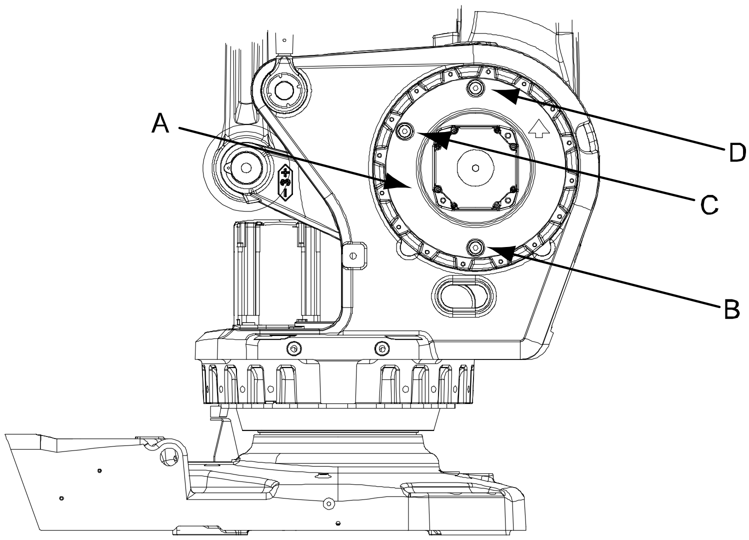


xx0500002483

A	Gearbox, axis 3
B	Oil plug, draining
C	Oil plug, filling
D	Ventilation hole, gearbox axis 3

Required equipment

Equipment etc.	Art.no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	**Note** Do not mix with other oils!
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below		These procedures include references to the tools required.

Inspecting, oil level gearbox 2 - 3

Use this procedure to inspect the oil level in gearbox axes 2 - 3.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	

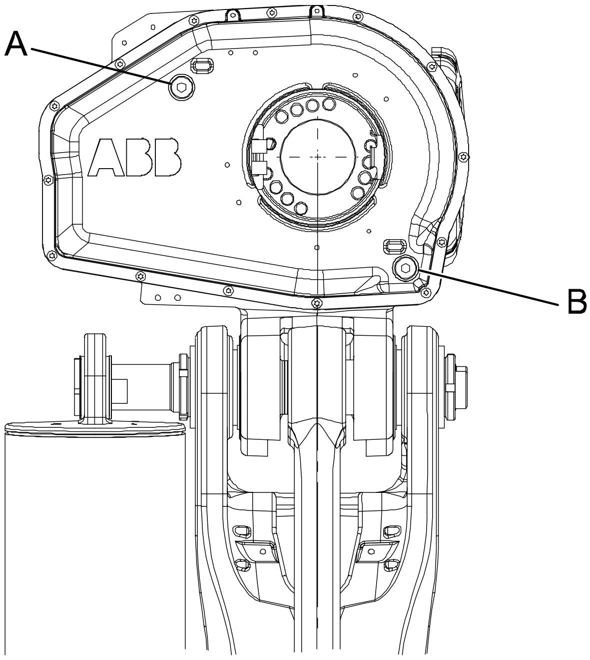
Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
3	Open *oil plug, filling*	See *Location of gearbox, axes 2-3 on page 114*.
4	Measure oil level at the oil plug, filling. Required oil level: max. 5 mm below oil plug hole.	
5	Add *oil* if required.	Art.no. is specified in *Required equipment on page 115*. Filling of oil is detailed further in section *Changing oil, gearbox axes 2 and 3 on page 147*.
6	Refit oil plug, filling.	Tightening torque: 24 Nm.

3.3.3 Inspecting the oil level in axis-4 gearbox

Location of gearbox

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



xx0700000018

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

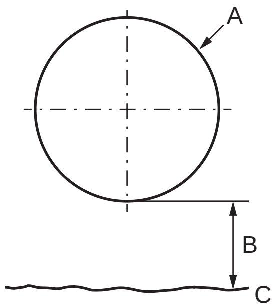
Required equipment

Equipment, etc.	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

Inspecting the oil level in axis-4 gearbox

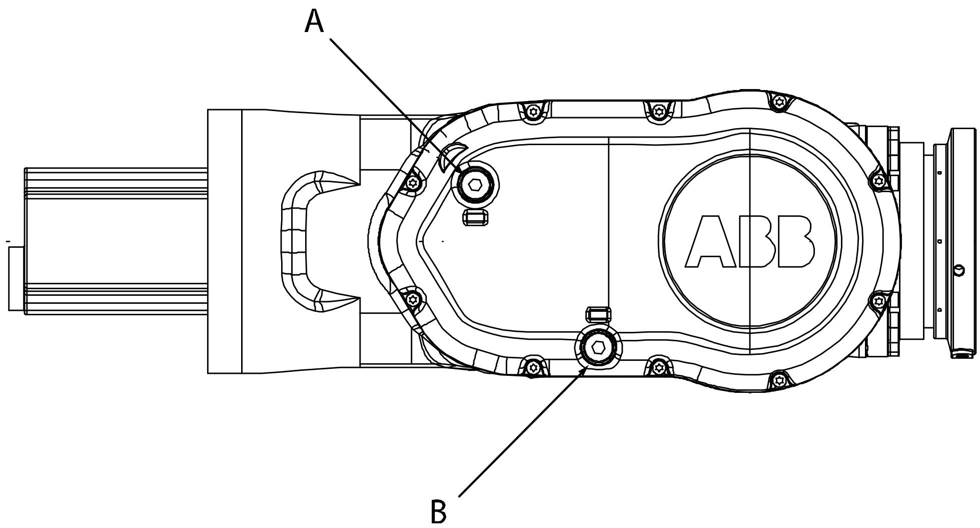
Use this procedure to inspect the oil level in the axis-4 gearbox.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
2	Move the robot to the calibration position.	This is detailed in section *Synchronization marks and synchronization position for axes on page 346*.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
5	Open the *oil plug, filling and inspection*.	Shown in the figure *Location of gearbox on page 117*.
6	Measure the oil level. Required oil level: 0-10 mm	 xx1400002785 A Oil plug hole B Required oil level C Gearbox oil
7	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*. Further information about how to fill the oil may be found in the section *Filling, oil on page 152*.
8	Refit the oil plug.	Tightening torque:24 Nm

3.3.4 Inspecting the oil level in axis-5 gearbox

Location of gearbox

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



xx0200000232

-	The figure above shows the wrist unit of IRB 6600 and IRB 6650
A	Oil plug, filling and inspection
B	Oil plug, draining

Required equipment

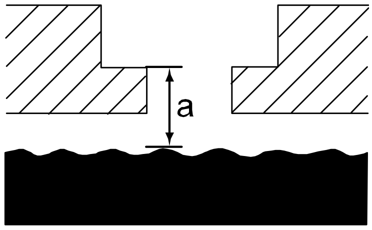
Equipment etc.	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting the oil level in axis-5 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
2	Move the robot upper arm to a horizontal position.	

Continues on next page

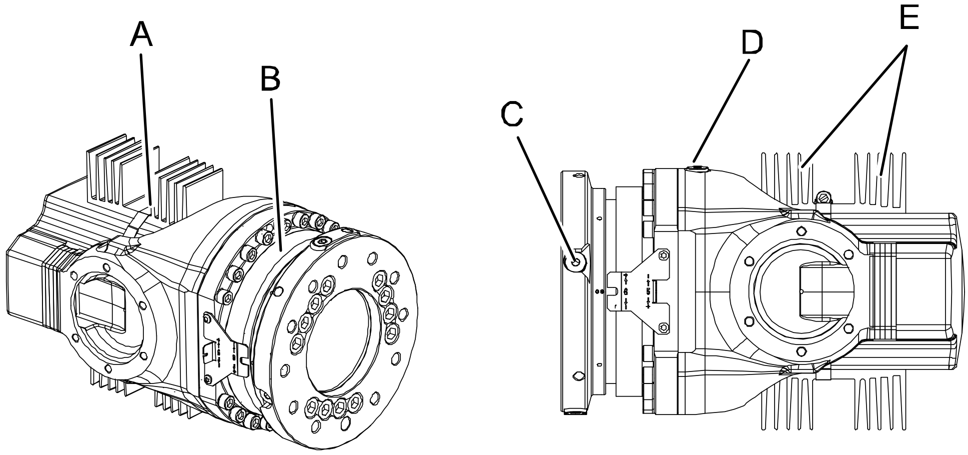
	Action	Note
3	Turn the wrist unit in a way that both oil plugs are facing upwards.	
4	 **DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
5	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
6	Open the *oil plug, filling and inspection*.	Shown in the figure *Location of gearbox on page 119*.
7	Measure the oil level. Required oil level to the upper edge of the filling and inspection oil plug hole (a): 30 mm	 xx0500002222
8	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*. Further information about how to fill the oil may be found in the section *Filling, oil, axis 5 on page 155*.
9	Refit the oil plug.	Tightening torque:24 Nm

3.3.5 Inspecting the oil level in axis-6 gearbox

Location of gearbox

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

The figure shows the gearbox for robot variant IRB 6660 - 100/3.3 and IRB 6660 - 130/3.1. The axis-6 motor on variant IRB 6660 - 205/1.9 has no cooling elements.



xx0700000161

A	Strap (securing cooling elements)
B	Axis-6 gearbox
C	Oil plug, draining
D	Oil plug, filling
E	Cooling element (IRB 6660 - 100/3.3 and IRB 6660 - 130/3.1)

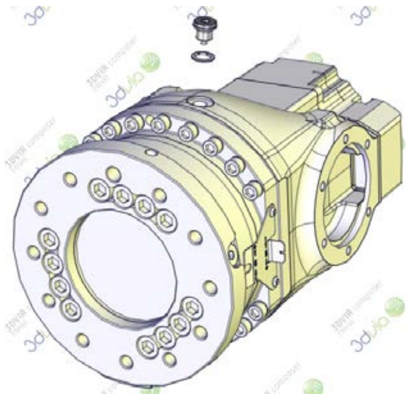
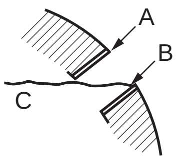
Required equipment

Equipment	Art. no.	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

Inspecting the oil level in axis-6 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
2	Move axes 3 and 5 to a horizontal position, and make sure that the *oil plug, filling and inspection* is facing upwards.	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Make sure that the oil temperature is +25°C ±10°C.	This is a precaution to reduce the temperature dependency of the measurement.
5	Remove the *oil plug, filling and inspection*.	 xx1300002447
6	Slowly turn axis 4 until the axis-4 angle reads +72.5° to +77.5°.	
7	Inspect the oil level in the hole for the *oil plug, filling and inspection*. The oil should reach all the way up to the external edge of the thread for the *oil plug, filling and inspection*. **Note** If needed, use a clean, narrow object, for example an oil stick or a cable tie, to gently poke the oil surface. This will avoid surface tension from stopping air to enter into the gearbox.	 xx1400002786 A Oil plug hole B Required oil level C Gearbox oil

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	Action	Note
8	Adjust the oil level, if required.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*. Further information about how to fill the oil may be found in the section *Filling, oil, axis 6 on page 157*.
9	Refit the oil plug.	Tightening torque: 24 Nm.
10	**WARNING** Do not mix oil types! If wrong oil is refilled, the gearbox must be rinsed as detailed in *Technical reference manual - Lubrication in gearboxes*.	

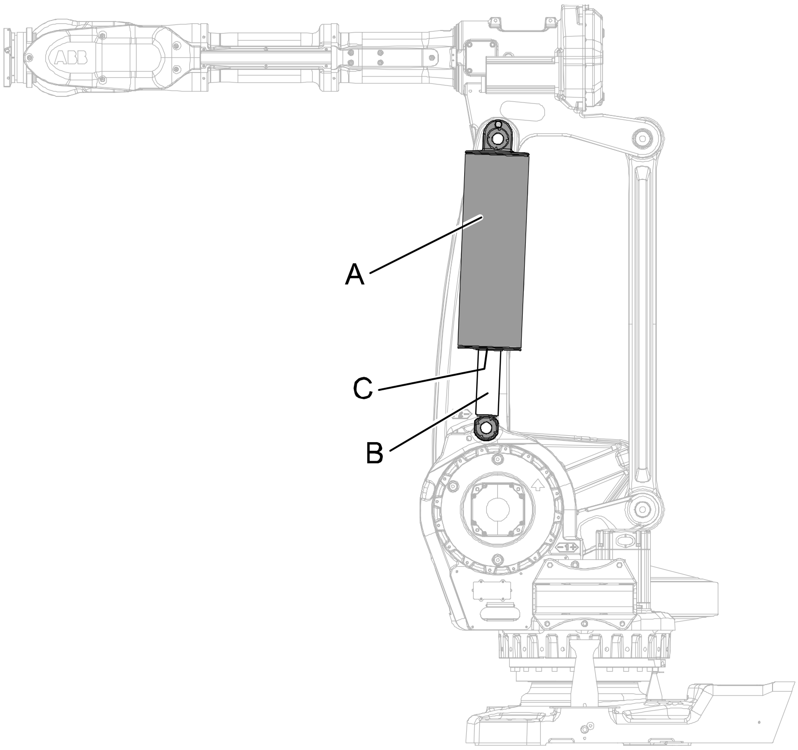
3.3.6 Inspecting, balancing device bearings and piston rod guide ring

Note

This section is not applicable to robot variant IRB 6660-205/1.9.

Location of balancing device

The figure shows the location of the balancing device.



xx0700000019

A	Balancing device
B	Piston rod
C	Guide ring (not visible in this figure)

Required equipment

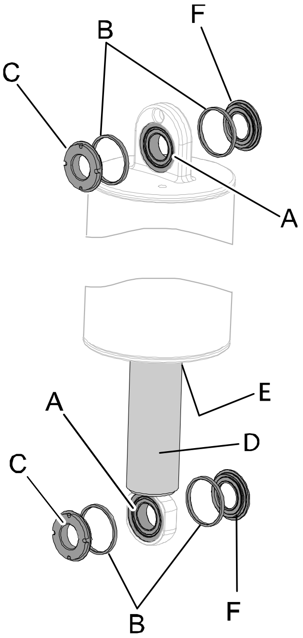
Equipment	Art.no	Note
Grease	3HAC9408-1	Tribol GR 100-2 PD
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243)
Auxiliary shaft, upper	3HAC5276-1	
Auxiliary shaft, lower	3HAC5275-1	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

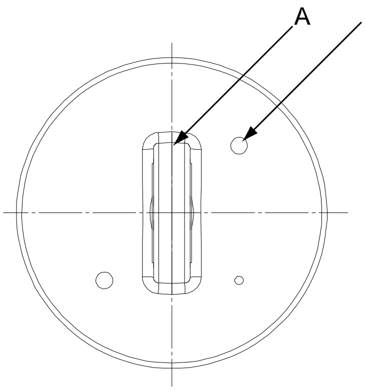
Equipment	Art.no	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting, bearings

Use this procedure to inspect the bearings, balancing device.

	Action	Note
1	Move axis 2 to calibration position.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Remove locknuts (KM10), sealing rings and support washers.	 xx0500002496 A Ear (adjustable needle bearing located inside) B Support washer C Lock nut KM10 (with sealing ring) D Piston rod E Guide ring (not visible in this view) F Inner ring
4	Fit the *auxiliary shafts* on upper and lower axes of balancing device. The shafts should be tightened to their bottom position.	Art. no. is specified in *Required equipment on page 124*.

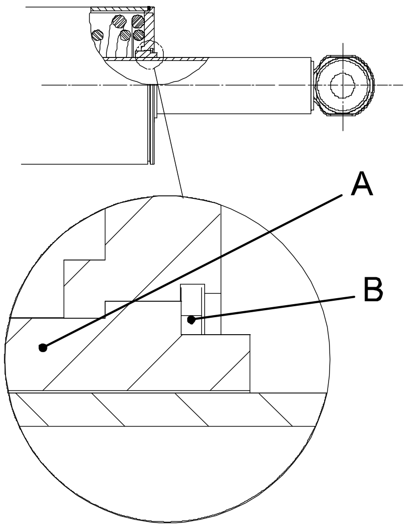
Continues on next page

	Action	Note
5	Remove the protection hood from the M12 hole on top of the balancing device.	 xx0600002687 A Attachment (seen from above) B Protection hood
6	Unload the bearings using a M12x50 screw, in the hole for the protective hood, at the cylinder top.	
7	Pull out the cylinder a little, in order to be able to inspect the *inner rings* without removing the balancing cylinder.	Shown in previous figure in this procedure.
8	Wipe the inner rings clean and check that there are no pressure marks or other similar deformations.	**Note** It is quite normal for the bearing races to have a darker color than the surrounding material.
9	Inspect the *bearings*, *support washers* and *sealing rings*.	Shown in previous figure.
10	If any of the parts looks abnormal, replace.	Detailed in section *Replacing the balancing device on page 267*.
11	Lubricate the shafts, if needed.	
12	Push the cylinder back in.	Make sure that the inner support washers and sealing rings get in the correct position.
13	Remove the auxiliary shafts.	
14	Remove the M12x50 screw. Put back the protection hood in the hole.	**Note** Don´t forget to remove the screw! If the screw isn´t removed it may damage the balancing device, when the robot starts operating.
15	Apply *locking liquid* on the lock nuts (KM10) and refit them.	Tightening torque on the lock nuts: • 120 Nm

Continues on next page

Inspecting, piston rod guide ring

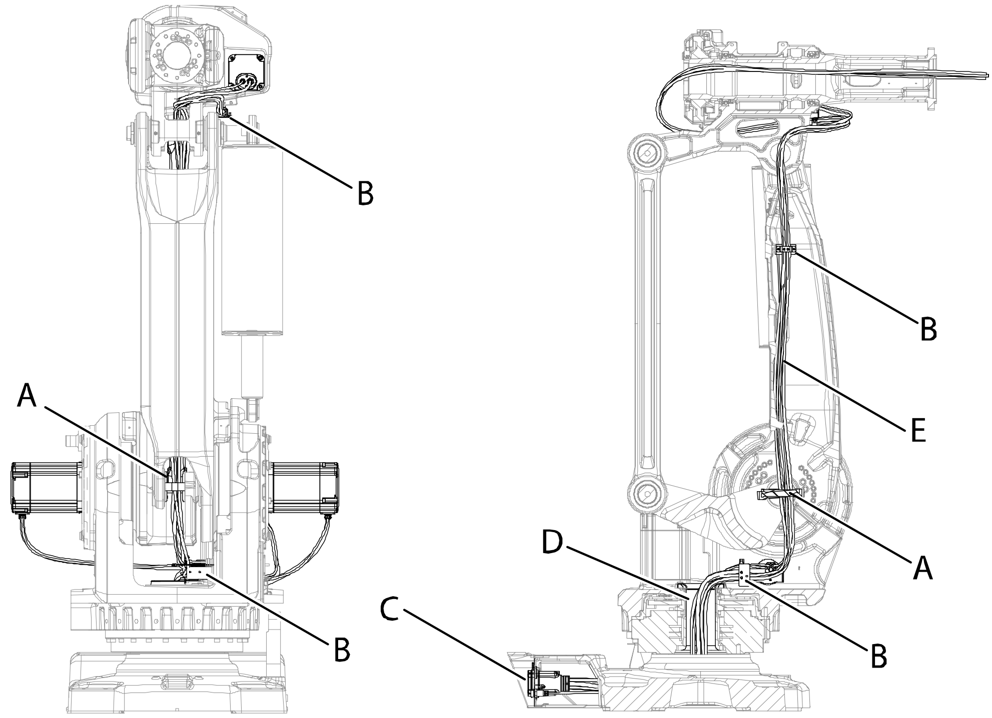
Use this procedure to inspect the piston rod guide ring for wear.

	Action	Note
1	Move axis 2 to a position where the balancing device is in a horizontal position.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Check the guide ring for wear. Replace if necessary.	 xx0600002689 A Guide ring B Circlip
4	**Note** If there is a risk of metallic contact between the piston rod and the end cover, the guide ring must be replaced!	

3.3.7 Inspection, cable harness

Location of cable harness

The robot cable harness, axes 1-6 is located as shown in the figures below:



xx0700000022

A	Cable guide, axis 2
B	Metal clamp (4 pcs)
C	Connectors at base
D	Cable guide
E	Cable harness

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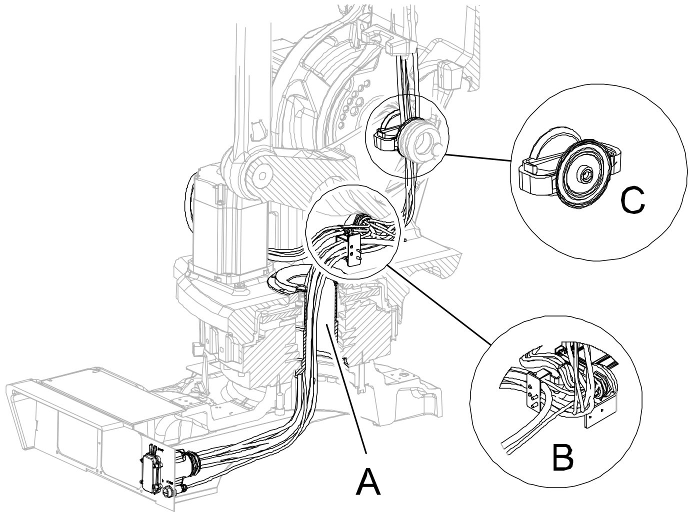

xx0700000631

A	Cable guide, axis 1
B	Cable gland, SMB unit
C	Cable guide, axis 2

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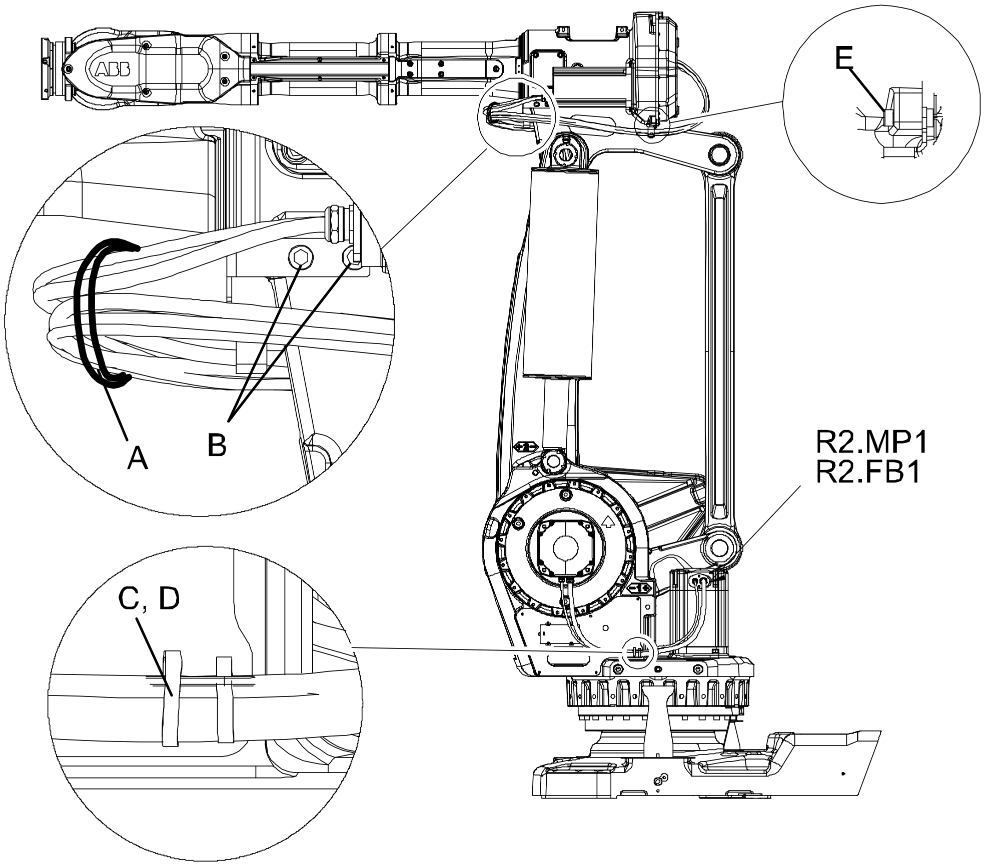


xx0700000021

A	Cable strap, outdoor
B	Attachment screw, M10x16 quality 8.8 (2 pcs)
C	Cable strap, outdoor
D	Cable fixing bracket
E	Attachment screw, metal clamp M6x25 quality steel 12.9 Gleitmo

Required equipment

Equipment, etc.	Art. no.	Note
Cable harness	For spare part number, see *Spare part lists on page 395*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See chapter *General references on page 10*.

Continues on next page

Inspection, cable harness

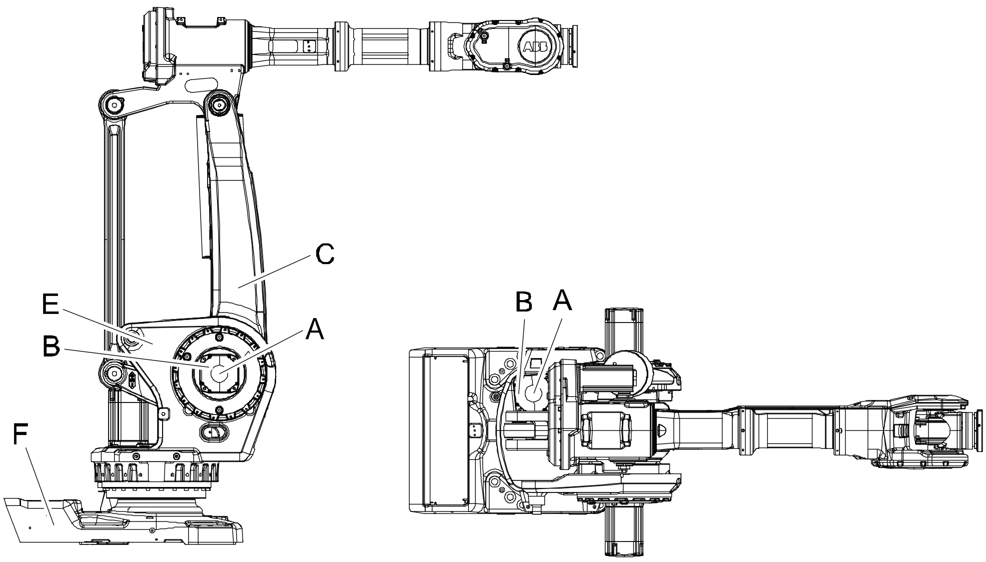
The procedure below details how to inspect the cable harness axes 1-6.

	Action	Note
1	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
2	Make an overall visual inspection of the cable harness in order to detect wear and damage.	
3	Check the connectors at the base.	Shown in the figure *Location of cable harness on page 128*.
4	Check the metal clamps at the rear of the upper arm and in the upper arm tube.	Shown in the figure *Location of cable harness on page 128*.
5	Check that the velcro straps and the mounting plate are properly attached to the frame.	
6	Check the cabling leading into the lower arm. Make sure it is attached by the straps and not damaged.	
7	Replace the cable harness if wear, cracks or damage is detected.	Detailed in sections *Replacement of cable harness, lower end (axes 1-3) on page 179* and *Replacement of cable harness, upper end on page 194*.

3.3.8 Inspecting the information labels

Location of labels

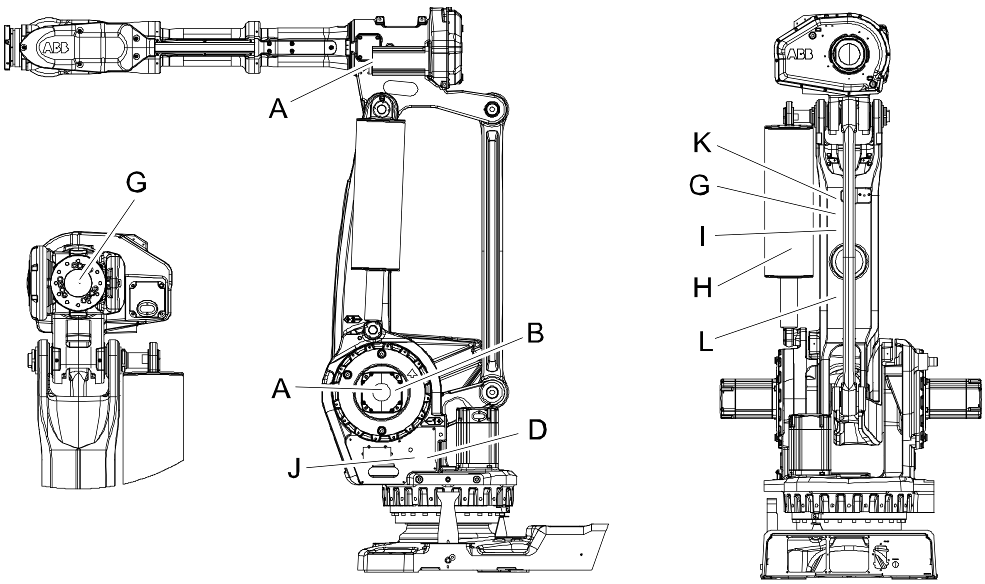
These figures show the location of the information labels to be inspected. The symbols are described in section *Safety symbols on manipulator labels on page 23*.



xx0700000047

A	Warning label concerning high temperature (2 pcs)
B	Warning label, symbol of flash (located on motor cover) (2 pcs)
C	Instruction label
E	Instruction label concerning lifting the robot
F	Warning label concerning risk of tipping
-	Information labels at gearboxes and at robot base, specifying which oil is used in gearboxes.

Continues on next page



xx0700000048

A	Warning label concerning high temperature (2 pcs)
B	Warning label, symbol of a flash (located on motor cover) (1 pcs)
D	Warning label concerning brake release
G	Serial no. from rating label
H	Warning label concerning stored energy
I	Label calibration
J	Warning label concerning shutting off power
K	Abs-Acc information sign
L	Danger label concerning clamping risk

Required tools and equipment

Visual inspection, no tools are required.

Inspecting, labels

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	Inspect the labels, located as shown in the figures.	
3	Replace any missing or damaged labels.	Article numbers for the labels and plate set is specified in *Spare part lists on page 395*.

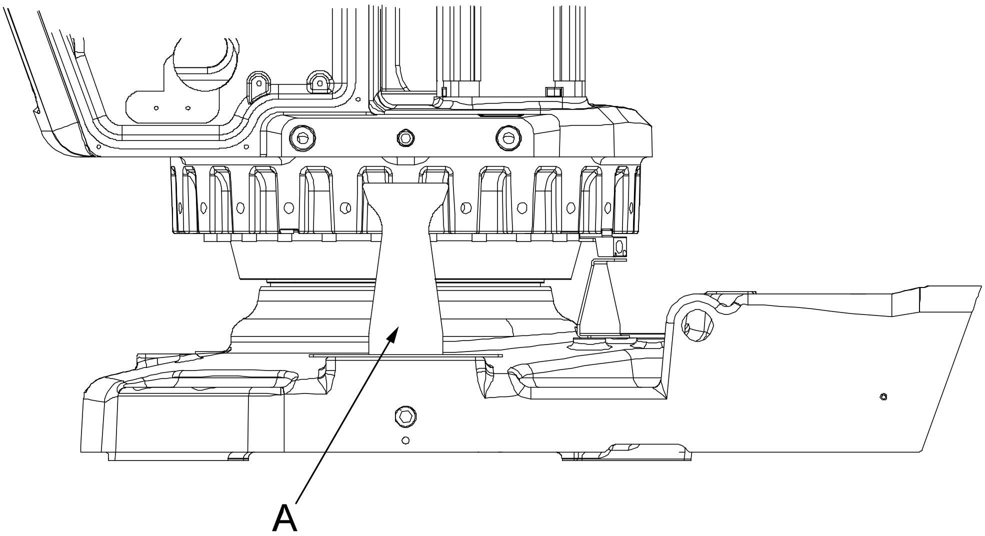
3.3.9 Inspecting the axis-1 mechanical stop pin

WARNING

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

Location of mechanical stop pin

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



xx0200000151

A	Mechanical stop pin

Required equipment

Visual inspection, no tools are required.

Inspecting, mechanical stop pin

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

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

Continues on next page

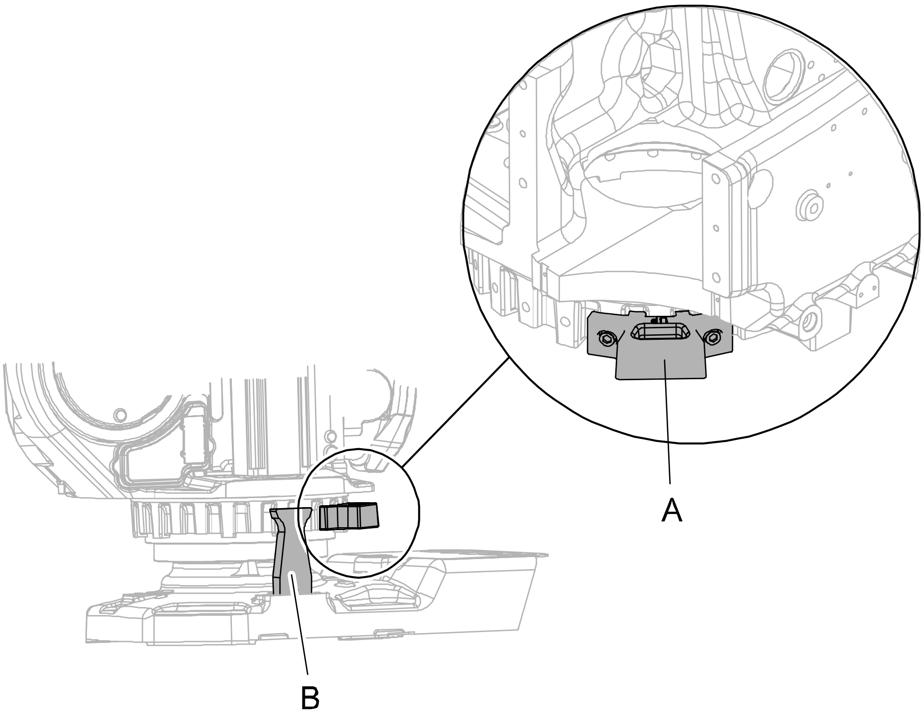
	Action	Note
2	Inspect the axis-1 mechanical stop pin. If the mechanical stop pin is bent or damaged, it must be replaced. **Note** The expected life of gearboxes can be reduced after collision with the mechanical stop.	
3	Make sure the mechanical stop pin can move in both directions.	

3.3.10 Inspecting the additional mechanical stops

Location of mechanical stops

This figure shows the location of the additional mechanical stop on axis 1.

Additional mechanical stops are not provided for axis 2 and 3.



xx0300000049

A	Additional mechanical stop
B	Stop pin

Required equipment

Equipment etc.	Article number	Note
Mechanical stop axis 1	3HAC11076-1	Limits the robot working range by 7.5°.
Mechanical stop axis 1	3HAC11076-2	Limits the robot working range by 15°.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

Inspecting, mechanical stops

Use this procedure to inspect the additional mechanical stops.

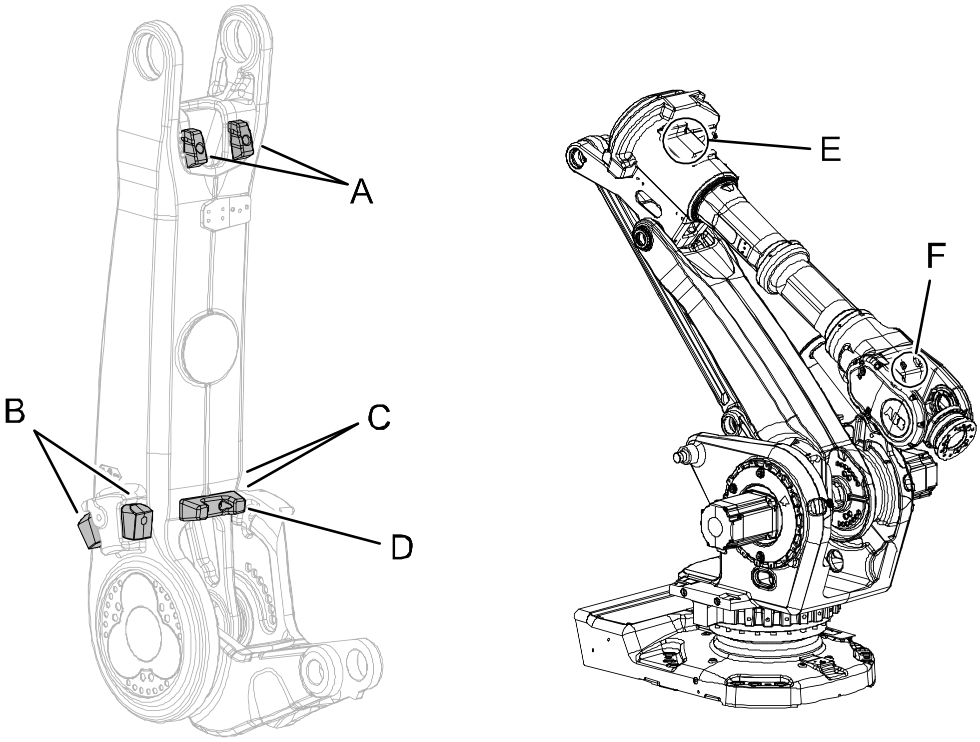
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Make sure no additional stops are damaged.	Shown in figure *Location of mechanical stops on page 136*.
3	Make sure the stops are properly attached. Correct tightening torque, additional mechanical stops: • Axis 1 = 120 Nm.	
4	If any damage is detected, the mechanical stops must be replaced. Correct attachment screws: • Axis 1: M16 x 35, quality 12.9.	Article number is specified in *Required equipment on page 136*.

3.3.11 Inspecting the damper on axes 2-5

Location of dampers

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

The figure shows the robot variant IRB 6660 - 130/3.1. Dampers and the position of the dampers are the same on all variants.



xx0700000024

A	Damper (2 pcs)
B	Damper, axis 2 (2 pcs)
C	Damper, axis 3 (2 pcs). Not visible in this view.
D	Damper (1 pcs)
E	Damper, axis 4 (1 pcs), inside armhouse
F	Damper, axis 5 (2 pcs)

Required equipment

A damper must be replaced if damaged!

Equipment	Spare part/ art. no.	Note
Damper axis 2	3HAC12991-1	
Damper	3HAC022338-001	
Damper	3HAC022339-001	
Standard toolkit	3HAC15571-1	Content is defined in section *Standard tools on page 390*.

Continues on next page

Inspection, dampers

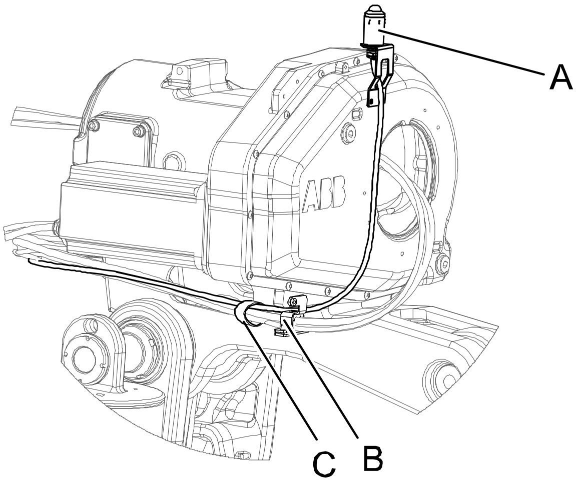
The procedure below details how to inspect the dampers, axes 2-5.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	Check all *dampers* for damage, and for cracks or existing impressions larger than 1 mm. To inspect the damper axis 4, remove the two covers on top of the upper arm!	Shown in the figure *Location of dampers on page 138*.
3	Check attachment screws for deformation.	
4	If any damage is detected, the damper must be replaced with a new one!	Art. no. is specified in *Required equipment on page 138*.

3.3.12 Inspecting, signal lamp (option)

Location of signal lamp

The signal lamp is located as shown in figure below. Note that the position can differ depending on how the customer harness for axis 4-6 is mounted. See assembly drawing on the current harness for alternative positioning.



xx0700000056

A	Signal lamp
B	Metal clamp
C	Cable strap, outdoor

Required equipment

Equipment, etc.	Art. no.	Note
Signal lamp	3HAC028196-001	To be replaced in case of detected damage.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Inspecting, signal lamp

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

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

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	If the lamp is not lit, trace the fault by: • Checking whether the *signal lamp* is broken. If so, replace it. • Checking cable connections. • Measuring the voltage in connectors motor axis 3 (=24V). • Checking the cabling. Replace cabling if a fault is detected.	Art. no. is specified in *Required equipment on page 140*.

3.4 Replacement/changing activities

3.4.1 Type of lubrication in gearboxes

Introduction

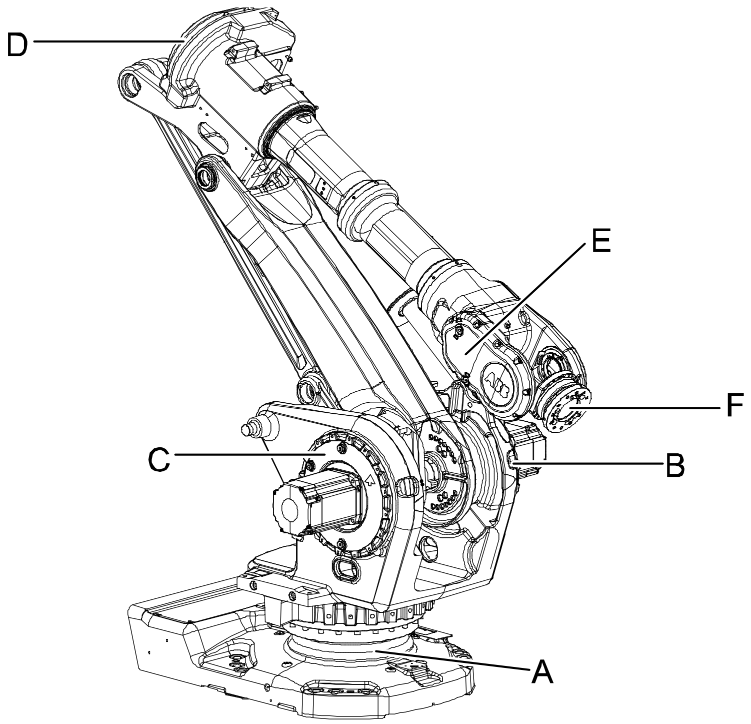
This section describes where to find information about the type of lubrication, article number and the amount of lubrication in the specific gearbox. It also describes the equipment needed when working with lubrication.

Type and amount of oil in gearboxes

Information about the type of lubrication, article number as well as the amount in the specific gearbox can be found in *Technical reference manual - Lubrication in gearboxes* available for registered users on myABB Business Portal, www.abb.com/myABB.

Location of gearboxes

The figure shows the location of the gearboxes.



xx0700000026

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

Continues on next page

Equipment

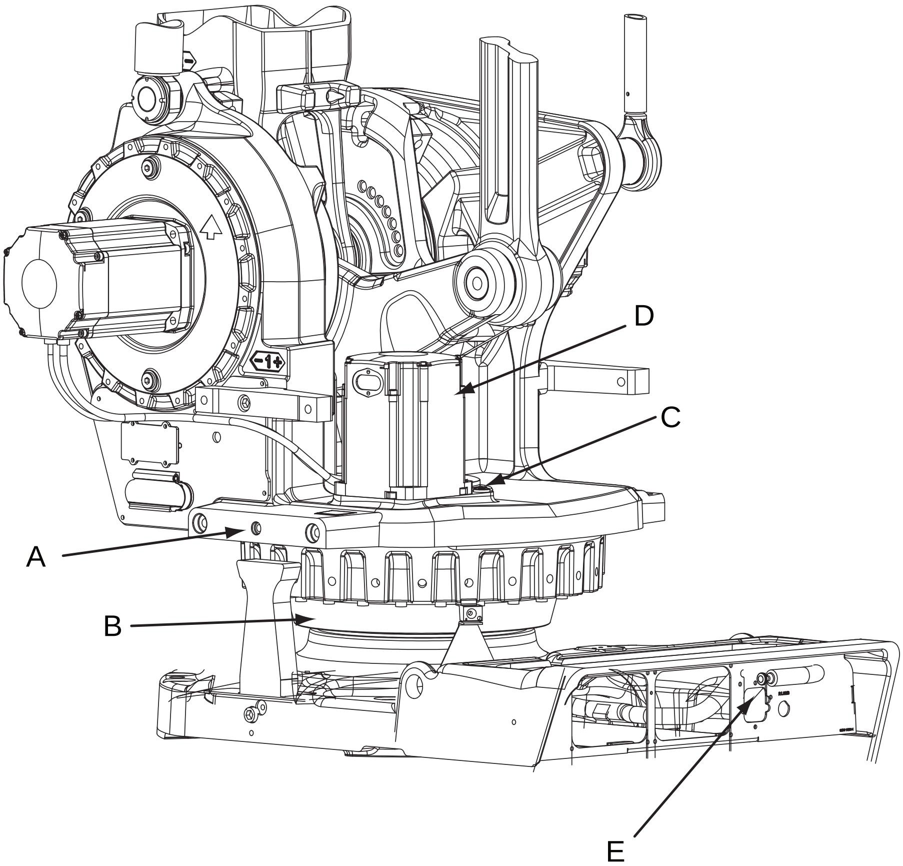
Equipment	Note
Oil dispenser	Includes pump with outlet pipe. Use the suggested dispenser or a similar one: • Orion OriCan article number 22590 (pneumatic)
Nipple for quick connect fitting, with o-ring	

3.4.2 Changing oil, axis-1 gearbox

Location of oil plugs

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

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



xx0500002479

A	Oil plug, inspection
B	Gearbox axis 1
C	Oil plug, filling
D	Motor, axis 1
E	Drain hose

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	See *Type and amount of oil in gear- boxes on page 142*.	**Note** Do not mix with other oils!
Oil collecting vessel	-		Capacity: 8,000 ml.

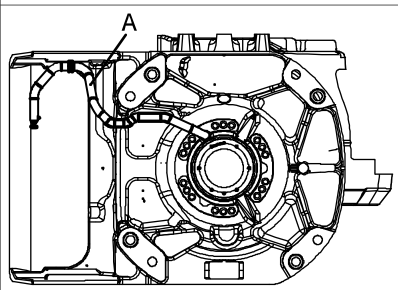
Continues on next page

Equipment, etc.	Art. no.	Amount	Note
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 391*.
Standard toolkit	-		Content is defined in section *Standard tools on page 390*.

Draining oil, axis-1 gearbox

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

When using oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 144*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
3	Remove rear cover on the base by unscrewing its attachment screws.	
4	Pull out the draining hose from the rear of the base.	 xx0200000237 The hose is located beneath the base, seen from below. A Oil draining hose
5	Place an oil vessel close to hose end.	Vessel capacity is specified in *Required equipment on page 144*.
6	Remove *oil plug, filling* in order to drain oil quicker!	Shown in figure *Location of oil plugs on page 144*.

Continues on next page

	Action	Note
7	Open the hose end and drain the oil into a vessel. **CAUTION** Drain as much oil as possible.	**Note** Draining is time-consuming. Elapsed time depends on the temperature of the oil.
8	Close the oil drain hose, and put it back inside the base.	
9	Refit rear cover by securing it with its attachment screws.	

Filling oil, axis-1 gearbox

Use this procedure to fill gearbox axis 1 with oil.

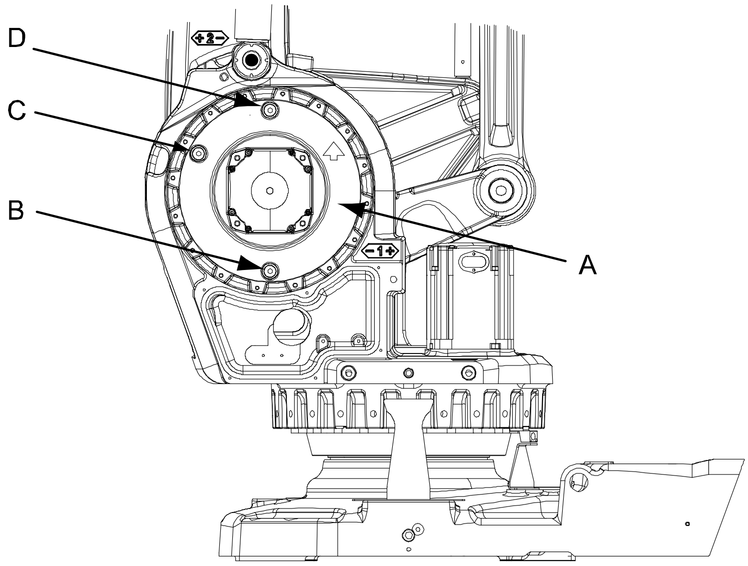
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
3	Open the *oil plug, filling.*	Shown in figure *Location of oil plugs on page 144*.
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-1 gearbox on page 112*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*.
5	**Note** Do not mix Kyodo Yushi TMO 150 with other oil types!	
6	Refit the oil plug, filling.	Tightening torque: 24 Nm.

3.4.3 Changing oil, gearbox axes 2 and 3

Location of oil plugs

Gearboxes, axes 2 and 3, are located in lower arm rotational center, underneath motor attachment.

The figure shows the position of gearbox, axis 2.

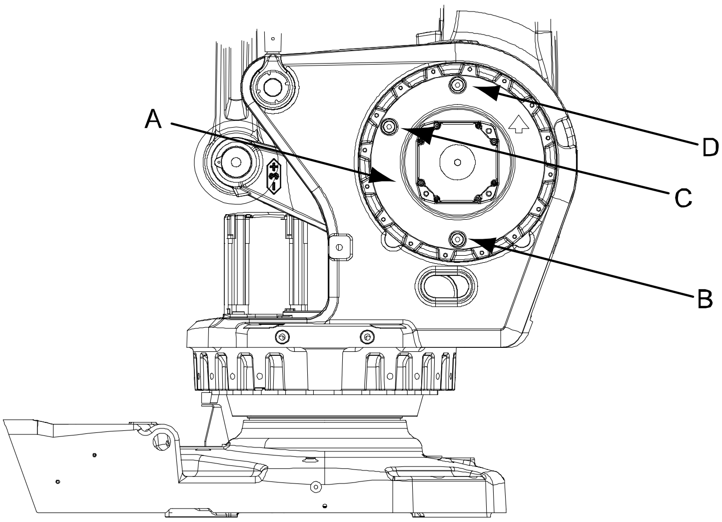


xx0500002482

A	Gearbox axis 2
B	Oil plug, draining
C	Oil plug, filling
D	Ventilation hole plug, gearbox axis 2

Continues on next page

The figure shows position of gearbox, axis 3.



xx0500002483

A	Gearbox, axis 3
B	Oil plug, draining
C	Oil plug, filling
D	Ventilation hole plug, gearbox axis 3

Required equipment

Equipment etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	See *Type and amount of oil in gearboxes on page 142*.	**Note** Do not mix with other oils!
Oil collecting vessel			Capacity: 6,000 ml
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 391*.
Standard toolkit	-		Content is defined in section *Standard tools on page 390*.

Continues on next page

Draining, axes 2 and 3

Use this procedure to drain oil in gearbox axes 2 and 3.

When using oil change equipment, follow the instructions enclosed with kit.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
3	Remove the *ventilation hole plug*.	Shown in *Location of oil plugs on page 147*.
4	Remove the *oil plug, draining*, and drain gearbox using a hose with a nipple and an oil collecting vessel.	Shown in *Location of oil plugs on page 147*. Vessel capacity is specified in *Required equipment on page 148*. Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
5	Refit the oil plug, draining.	Tightening torque: 24 Nm.

Filling, axes 2 and 3

Use this procedure to fill gearboxes of axes 2 and 3 with oil.

When using oil change equipment, follow the instructions enclosed with kit.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	

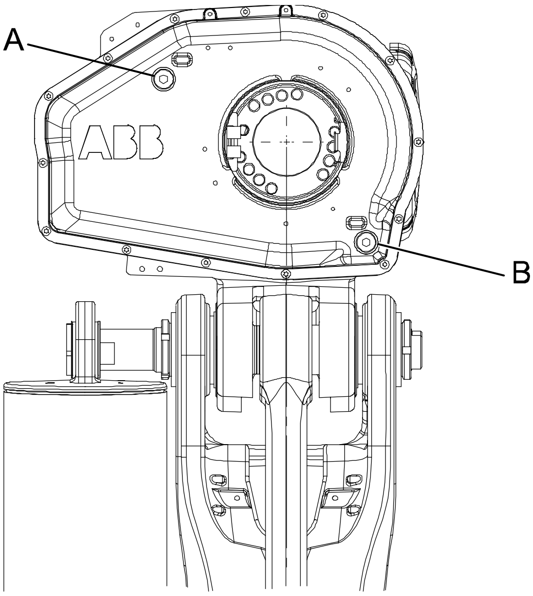
Continues on next page

	Action	Note
3	Remove the *oil plug, filling*. (*Ventilation hole plug* should also be removed.)	Shown in *Location of oil plugs on page 147*. Tightening torque: 24 Nm.
4	**Note** Don´t mix Kyodo Yushi TMO 150 with other oil types!	
5	Refill gearbox with *lubricating oil*. The *amount of oil* to be filled depends on the amount that was previously drained.	Art.no. and total amount are specified in *Required equipment on page 148*.
6	Refit *oil plug,filling* and *ventilation hole plug*.	Shown in *Location of oil plugs on page 147*. Tightening torque: 24 Nm.

3.4.4 Changing oil, axis-4 gearbox

Location of gearbox

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



xx0700000018

A	Oil plug, filling
B	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	See *Type and amount of oil in gear-boxes on page 142*.	
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 391*.
Oil collecting vessel	-		Capacity: 9,000 ml.
Standard toolkit	-		Content is defined in section *Standard tools on page 390*.

Continues on next page

Draining, oil

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 151*.

	Action	Note
1	Run the upper arm -45° from the calibration position.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
4	Remove the *oil plug, filling*.	
5	Drain the oil from the gearbox into a vessel by opening the *oil plug, draining.*	Shown in the figure *Location of gearbox on page 151*. Vessel capacity is specified in *Required equipment on page 151*.
6	Run the upper arm back to its calibration position (horizontal position).	This is detailed in section *Synchronization marks and synchronization position for axes on page 346*.
7	Refit the oil plug, draining.	Tightening torque: 24 Nm.

Filling, oil

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 151*.

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

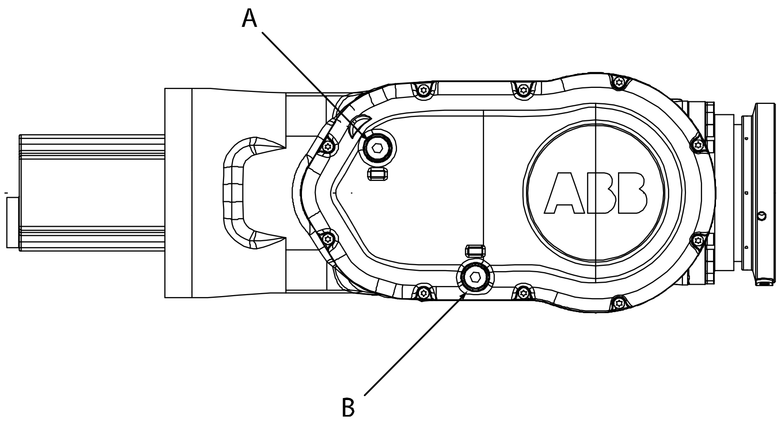
Continues on next page

	Action	Note
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
3	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-4 gearbox on page 117*.	Shown in the figure *Location of gearbox on page 151*. Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*.
4	Refit the oil plug, filling.	Tightening torque: 24 Nm.

3.4.5 Changing oil, axis-5 gearbox

Location of gearbox

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



xx0200000232

-	Wrist unit of IRB 6600 and IRB 6650
A	Oil plug, filling
B	Oil plug, draining

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	See *Type and amount of oil in gearboxes on page 142*.	
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 391*.
Oil collecting vessel	-		Capacity: 7,000 ml.
Standard toolkit	-		Content is defined in section *Standard tools on page 390*.

Draining, oil, axis 5

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 154*.

	Action	Note
1	Run axis 4 to a position where the oil plug for draining is facing downwards.	

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
4	Remove the *oil plug, filling*.	
5	Drain the oil from the gearbox by opening the *oil plug, draining.*	Shown in the figure *Location of gearbox on page 154*. Vessel capacity is specified in *Required equipment on page 154*.
6	Refit the oil plug, draining.	Tightening torque: 24 Nm.

Filling, oil, axis 5

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 154*.

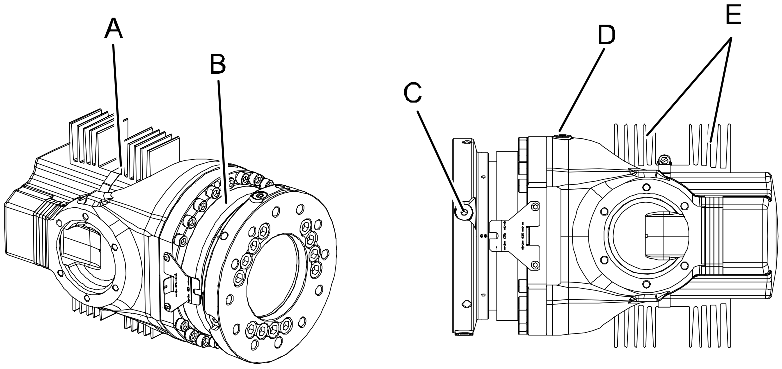
	Action	Note
1	Run axis 4 to a position where the oil plug, filling, is facing upwards.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-5 gearbox on page 119*.	Shown in the figure *Location of gearbox on page 154*. Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*.
5	Refit the oil plug, filling.	Tightening torque: 24 Nm.

3.4.6 Changing oil, axis-6 gearbox

Location of gearbox

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

The figure shows the axis-6 gearbox for robot variant IRB 6660 - 100/3.3 and IRB 6660 - 130/3.1, and includes cooling elements on motor. There are no cooling elements on the axis-6 motor on robot variant IRB 6660 - 205/1.9.



xx0700000161

A	Strap
B	Gearbox, axis 6
C	Oil plug, draining
D	Oil plug, filling
E	Cooling elements (IRB 6660 - 100/3.3, IRB 6660 - 130/3.1)

Required equipment

Equipment, etc.	Art. no.	Amount	Note
Lubricating oil	See *Type and amount of oil in gearboxes on page 142*.	See *Type and amount of oil in gearboxes on page 142*.	**Note** Do not mix with other oils!
Oil exchange equipment	3HAC021745-001		Content is defined in section *Special tools on page 391*.
Oil collecting vessel	-		Vessel capacity: 500 ml
Standard toolkit	-		Content is defined in section *Standard tools on page 390*.

Continues on next page

Draining, oil, axis 6

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 156*.

	Action	Note
1	Run the robot to a position where the *oil plug, filling* of axis 6 gearbox is facing downwards.	Shown in the figure *Location of gearbox on page 156*.
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
4	Drain the oil from the gearbox into a vessel by removing the oil plug.	Vessel capacity is specified in *Required equipment on page 156*.
	Measure the amount of oil drained.	The amount of oil to be refilled depends on the amount previously drained.
5	Refit the *oil plug, draining*.	Tightening torque: 24 Nm.

Filling, oil, axis 6

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

When using the oil exchange equipment, follow the instructions enclosed with the kit. Art. no. for the kit is specified in *Required equipment on page 156*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 34*.	
3	Remove the *oil plug, filling.*	Shown in the figure *Location of gearbox on page 156*.

Continues on next page

	Action	Note
4	Refill the gearbox with clean *lubricating oil.* The correct oil level is detailed in section *Inspecting the oil level in axis-6 gearbox on page 121*.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 142*.
5	Refit the oil plug.	Tightening torque: 24 Nm.
	Inspect the oil level.	Detailed in the section *Inspecting the oil level in axis-6 gearbox on page 121*.

3.4.7 Replacing the SMB battery

Note

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

For a 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 a SMB board with 2-pole battery contact (DSQC), 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 the operating manual for the robot controller for instructions.

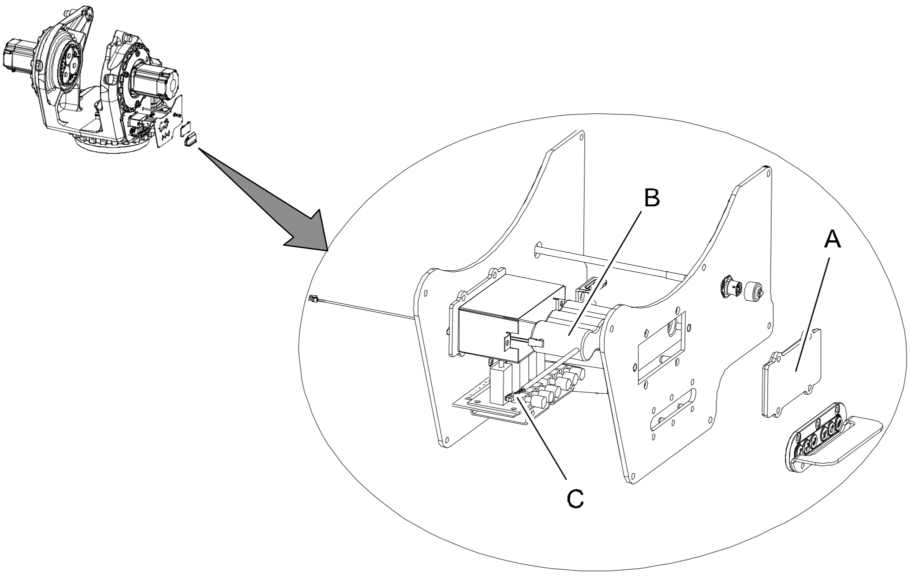
WARNING

See *Hazards related to batteries on page 36*.

Location of SMB battery

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

Battery pack with a 2-pole battery contact (DSQC)

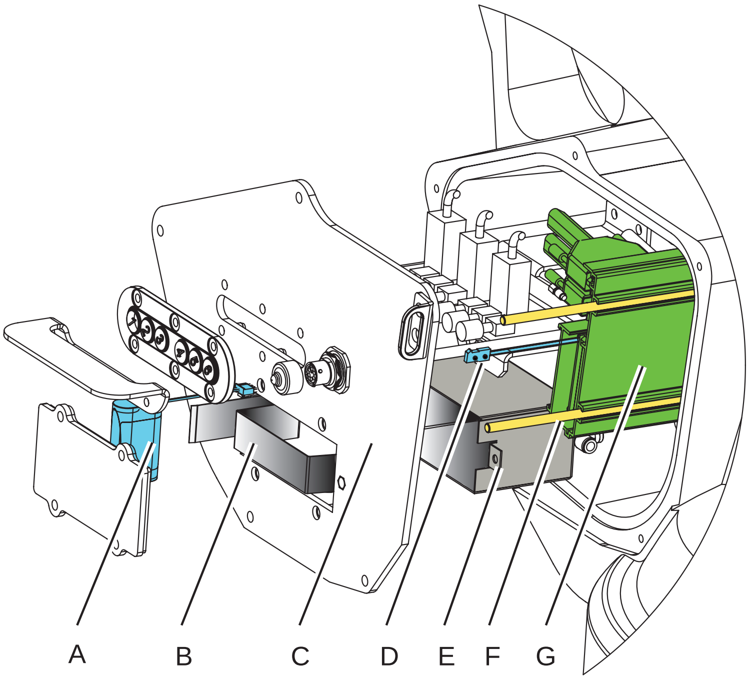


xx0700000029

A	SMB battery cover
B	SMB battery pack with 2-pole battery contact.
C	Battery cable

Continues on next page

Battery pack with a 3-pole battery contact (RMU)



xx1400002574

A	Battery pack RMU
B	Holder for battery
C	SMB cover
D	Battery cable
E	Battry holder
F	Guide pin (2 pcs)
G	SMB unit

Required equipment

Note

There are two variants of SMB units and batteries. One with 2-pole battery contact (DSQC) and one with 3-pole battery contact (RMU). 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 exchange battery contacts!

Equipment, etc.	Spare part no.	Note
Battery unit	For spare part no. see: • *Spare part lists on page 395*	Battery includes protection circuits. Only replace with a specified spare part or an ABB-approved equivalent.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

Equipment, etc.	Spare part no.	Note
Circuit diagram	-	See chapter *General references on page 10*.

Removing, battery

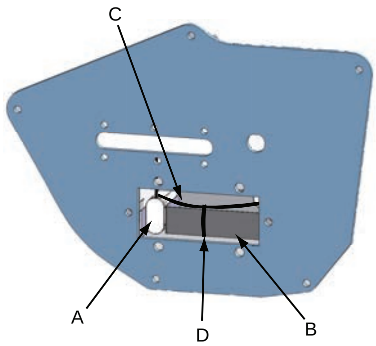
Use this procedure to remove the SMB battery.

	Action	Note
1	Move the robot to its calibration position.	This is done in order to facilitate updating of the revolution counter.
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
3	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *The unit is sensitive to ESD on page 53*	
4	Remove the *SMB battery cover* by unscrewing the attachment screws. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	Shown in figure *Location of SMB battery on page 159*.
5	Pull out the battery and disconnect the *battery cable*.	Shown in figure *Location of SMB battery on page 159*.
6	Remove the *SMB battery.* Battery includes protection circuits. Only replace with a specified spare part or with an ABB- approved equivalent.	Shown in figure *Location of SMB battery on page 159*.

Continues on next page

Refitting, battery

Use this procedure to refit the SMB battery.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *The unit is sensitive to ESD on page 53*	
3	Reconnect the *battery cable* and install the battery pack into the SMB/battery recess. **Note** RMU batteries are installed together with a battery holder to be properly secured inside the recess. See figure. Strap the battery cable to the holder.	Art. no. is specified in *Required equipment on page 160*. Shown in figure *Location of SMB battery on page 159*.  xx1300000307 A Battery pack RMU B Battery holder C Battery cable D Strap
4	Secure the *SMB battery cover* with its attachment screws.	Shown in figure *Location of SMB battery on page 159*.
5	Update the revolution counters.	Detailed in chapter Calibration - section *Updating revolution counters on IRC5 robots on page 349*.
6	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

3.5 Lubrication activities

3.5.1 Lubricating balancing device bearings and piston rod

Note

This section is not applicable to the robot variant IRB 6660-205/1.9

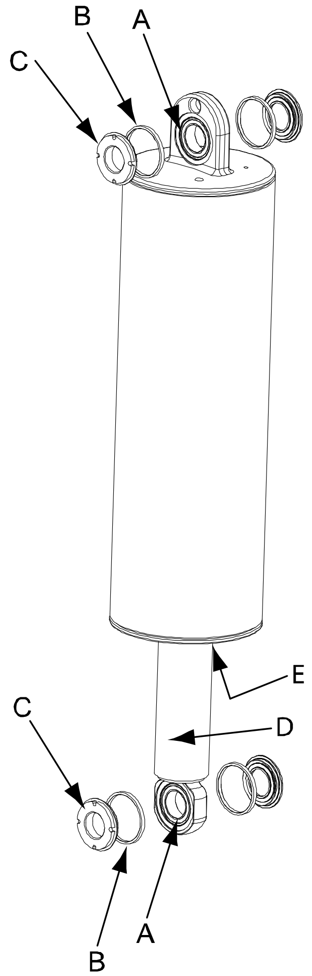
Overview

This procedure details how to lubricate bearings and piston rod of the balancing device.

Location of bearing and piston rod

This figure shows the location of bearings and piston rod.

Note! Balancing device must be fitted on robot when lubricating bearings.



xx0500002489

A	Ear (bearing located inside)
B	Support washer

Continues on next page

C	Lock nut
D	Piston rod
E	Guide ring (not visible in this view)

Required equipment

Equipment	Art.no.	Note
Lubrication tool	3HAC5222-2	
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD
Cleaning agent	-	Isopropanol
Piston rod grease	-	Choose any of following equivalents: • Shell: SRS Grease 4000 • Preem: Novatex Heavy EP 2 • Castrol: Entrepenadfett • Statoil: Uniway 2X2N
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243)
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
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.

Lubricating, bearings

Use this procedure to lubricate the balancing device bearings.

	Action	Note
1	Move axis 2 to calibration position.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Remove locknut.	Be careful not to loose the support washer in the process.
4	Fit the lubricating tool. It should be tightened to the bottom, by hand only.	
5	Grease through nipple on the lubricating tool.	
6	Continue filling grease until clean grease exudes behind the inner sealing ring. Repeat this procedure at the other bearing!	
7	Remove lubricating tool and clean threads on shaft ends free from grease.	Also clean from old grease on the inner side!
8	Apply some grease on the support washers.	

Continues on next page

	Action	Note
9	Apply locking liquid on the lock nuts (KM10). **Note** Do not apply locking liquid on the shafts!	Tightening torque on lock nuts: • 120 Nm
10	Check play between support washer and bearings at both bearings.	Minimum play: • 0.1 mm

Lubricating, piston rod

Use this procedure to lubricate the balancing device piston rod.

	Action	Note
1	Move axis 2 to a position where the balancing device is in horizontal position and the piston rod extended as much as possible.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Clean piston rod with isopropanol before applying new grease.	
4	Apply new grease.	Type of grease is specified in *Required equipment on page 164*.

3.6 Cleaning activities

3.6.1 Cleaning the IRB 6660

DANGER

Turn off all:

- electric power supply
- hydraulic pressure supply
- air pressure supply

to the robot, before entering the safeguarded space.

General

To secure high uptime it is important that the IRB 6660 is cleaned regularly. The frequency of cleaning depends on the environment in which the product works.

Different cleaning methods are allowed depending on the type of protection of the IRB 6660.

Note

Always verify the protection type of the robot before cleaning.

Oil spills

Oil spills from gearboxes

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

1. Inspect that the oil level in the suspected gearbox is according to the recommendations, see *Inspection activities on page 112*.
2. Write down the oil level.
3. Inspect the oil level again after, for example, 6 months.
4. If the oil level is decreased then replace the gearbox.

Special cleaning considerations

This section specifies some special considerations when cleaning the robot.

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

Continues on next page

Cleaning methods

The following table defines what cleaning methods are allowed depending on the protection type.

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

i Perform according to section *Cleaning with water and steam on page 167*.

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), provided that the robot is not equipped with the option of motor cooling fans.[1]

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 700 kN/m^2 (7 bar) [I]
- Fan jet nozzle should be used, min. 45° spread
- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum flow: 20 liters/min[I]

I Typical tap water pressure and flow

Instructions for steam or high pressure water cleaning

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

The following list defines the prerequisites:

- Maximum water pressure at the nozzle: 2500 kN/m^2 (25 bar)
- Fan jet nozzle should be used, min. 45° spread
- Minimum distance from nozzle to encapsulation: 0.4 meters
- Maximum water temperature: 80° C

1 See *Cleaning methods on page 167* for exceptions.

2 See *Cleaning methods on page 167* for exceptions.

Continues on next page

Cables

Movable cables need to be able to move freely:

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

Cooling fans

Inspect the air supply inlet of the the motor cooling fans. Clean to remove any contamination that could hinder the air supply.

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes repair activities for the IRB 6660. Each procedure contains 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.

Report replaced units

Note

When replacing a part on the IRB 6660, report to your local ABB the serial number, the article number, and the revision of both the replaced unit and the replacement unit.

This is particularly important for safety equipment to maintain the safety integrity of the installation.

Safety information

Make sure to read through the chapter *Safety on page 19* before commencing any service work.

Note

If the IRB 6660 is connected to power, always make sure that the IRB 6660 is connected to protective earth and a residual current device (RCD) before starting any repair work.

For more information see:

- *Product manual - OmniCore V250XT Type B*
- *Product manual - OmniCore V400XT*
- *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.

The gearbox must be drained of oil before performing the 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, but **do not** refill the gearbox with oil before performing the leak-down test.	
2	Remove the upper 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
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD

Assembly of all bearings

Attend to 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

Note

This instruction is not valid for solid oil bearings.

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

- The bearings must not be completely filled with grease. However, if space is available beside the bearing fitting, the bearing may be totally filled with

Continues on next page

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

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

Grease the different types of bearings as following description:

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

4.2.3 Mounting instructions for sealings

General

This section describes how to mount different types of sealings.

Equipment

Consumable	Article number	Note
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD

Rotating sealings

The following procedures describe how to fit rotating sealings.

CAUTION

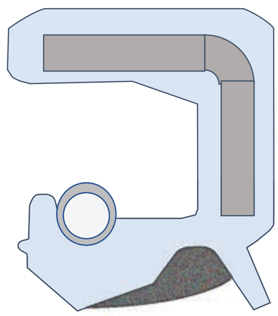
Please observe the following before commencing any assembly of sealings:

- Protect the sealing during transport and mounting, especially the main lip on radial sealings.
- Keep the sealing in its original wrappings or protect it well before actual mounting.
- The fitting of sealings and gears must be carried out on clean workbenches.
- Use a protective sleeve for the main lip during mounting, when sliding over threads, keyways or other sharp edges.
- Do not lubricate a static side of a sealing with grease, since this may result in movement of the sealing during operation.

  The only exception for lubrication of static sides of a sealing, is to use P-80 rubber lubrication gel against certain aluminium surfaces. If usage of P-80 is relevant, it is stated in the repair procedures.

Radial sealings

A radial sealing consists of a flexible rubber lip bonded to a rigid metal case. Only one side of the sealing is static with a metal insert.



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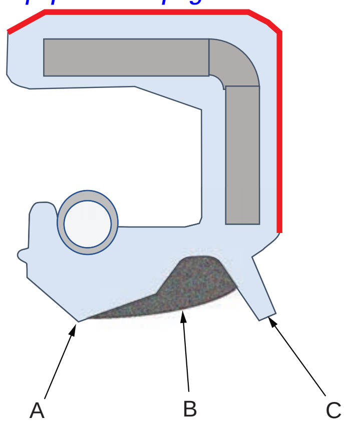
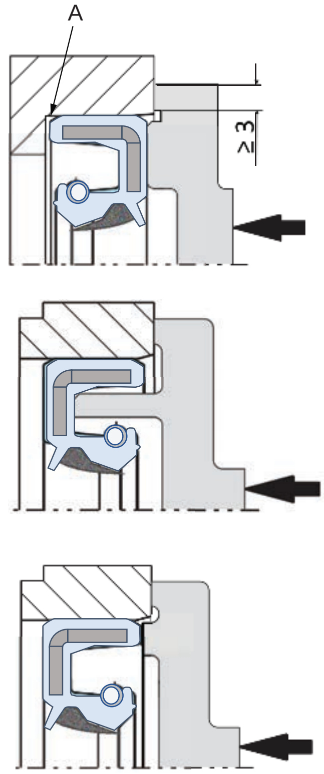
	Action	Note
1	Check the sealing to ensure that: • The sealing is of the correct type. • There is no damage on the main lip.	
2	Inspect the shaft surface before mounting. If scratches or damage are found, the shaft must be replaced since it may result in future leakage. Do not try to grind or polish the shaft surface to get rid of the defect.	
3	Lubricate the sealing with grease just before fitting. (Not too early - there is a risk of dirt and foreign particles adhering to the sealing.) Fill 2/3 of the space between the dust lip and the main lip with grease. If the sealing is without dust lip, just lubricate the main lip with a thin layer of grease.	Article number is specified in *Equipment on page 173*.  xx2000000071 A Main lip B Grease C Dust lip **Note** Ensure that no grease is applied to the red marked surface.

Continues on next page

	Action	Note
4	Mount the sealing correctly with a mounting tool. Never hammer directly on the sealing as this may result in leakage.	 xx2000000072 A Gap

Flange sealings and static sealings

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

	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.
4	Tighten the screws evenly when fastening the flange joint.

O-rings

The following procedure describes how to fit o-rings.

	Action	Note
1	Ensure that the correct o-ring size is used.	
2	Check the o-ring for surface defects, burrs, shape accuracy, or deformation.	Defective o-rings, including damaged or deformed o-rings, may not be used.

Continues on next page

	Action	Note
3	Check the o-ring grooves and mating surfaces. They should be free of pores, contamination and obvious scratches/damage.	
4	Lubricate the o-ring with grease.	
5	Tighten the screws evenly while assembling.	
6	Check that the o-ring is not squashed outside the o-ring groove.	

4.2.4 Cut the paint or surface on the robot before replacing parts

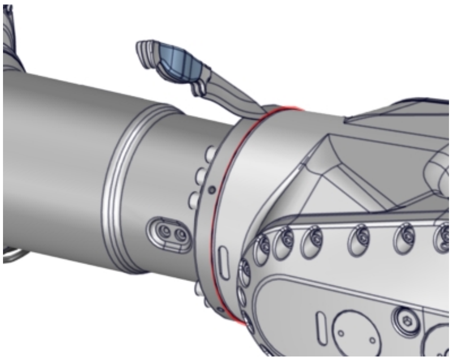
General

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

Required equipment

Equipment	Spare parts	Note
Cleaning agent		Ethanol
Knife		
Lint free cloth		
Touch up paint Standard/Foundry Plus	3HAC067974-001	Graphite White
Touch up paint Standard/Foundry Plus	3HAC037052-001	ABB Orange

Removing

	Action	Description
1	Cut the paint with a knife in the joint between the part that will be removed and the structure, to avoid that the paint cracks.	 xx2300000950
2	Carefully grind the paint edge that is left on the structure to a smooth surface.	

4.2.5 The brake release buttons may be jammed after service work

Description

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

DANGER

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

Elimination

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

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

4.3 Complete robot

4.3.1 Replacement of cable harness, lower end (axes 1-3)

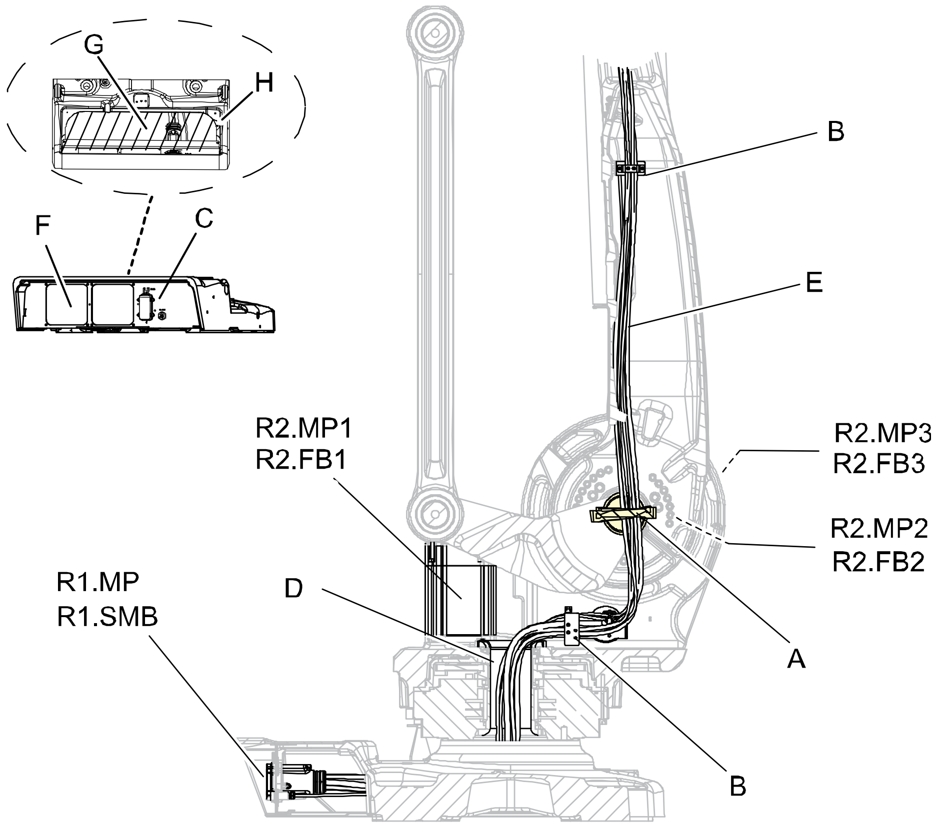
Overview

The cable harness 1-6 is undivided.

Replacement of the cable harness is detailed in two steps - lower end (axes 1-3) and upper end (axes 4-6). The procedure below details replacement of lower end of the cable harness. The procedure for replacing the upper end is detailed in section *Replacement of cable harness, upper end on page 194*.

Location of cable harness - lower end (axes 1-3)

The cable harness, lower end (axes 1-3) is located throughout the base, frame and lower arm as shown in the figure below.



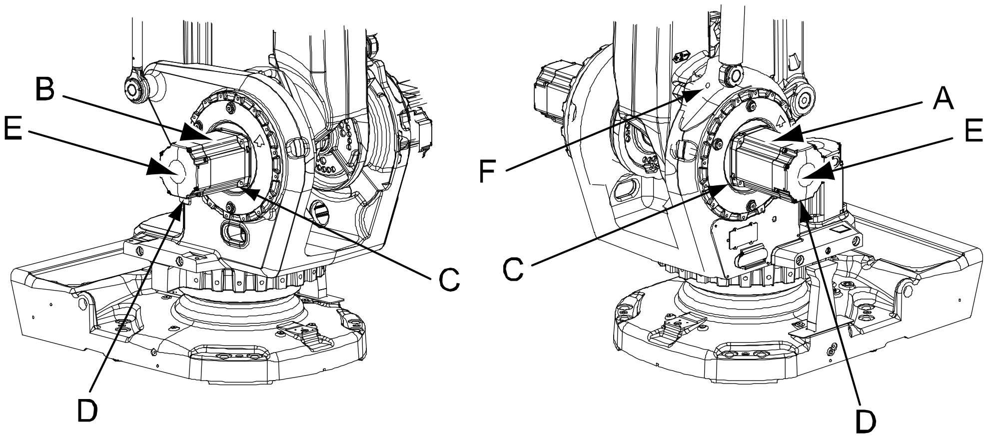
xx0700000070

A	Cable guide, axis 2
B	Metal clamp
C	Connector at base
D	Cable guide, axis 1
E	Cable harness, axes 1-6
F	Cover plate
G	Rear cover plate

Continues on next page

H	Attachment point for earth lug

The motors axes 2-3 are located on either side of the robot as shown in the figure below.



xx0600002599

A	Motor, axis 2
B	Motor, axis 3
C	Motor attachment screws and washers
D	Cable gland cover (located on the lower side of the motor)
E	Motor cover

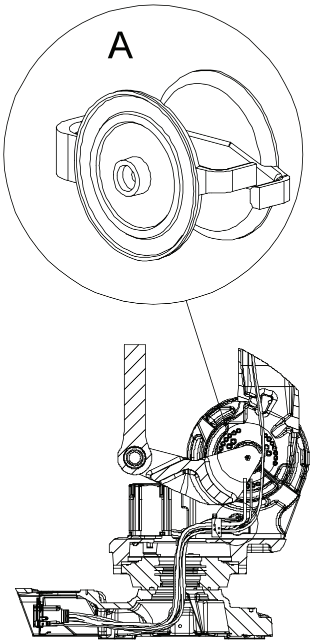
Required equipment

Equipment, etc.	Spare part no.	Art.no.	Note
Cable harness axes 1-6		For spare part number, see *Spare part lists on page 395*.	
Gasket		3HAC3537-1	Motor axes 1-5
Standard toolkit		-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram		3HAC025744-001	See chapter *General references on page 10*.

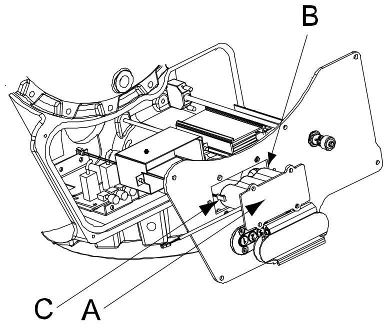
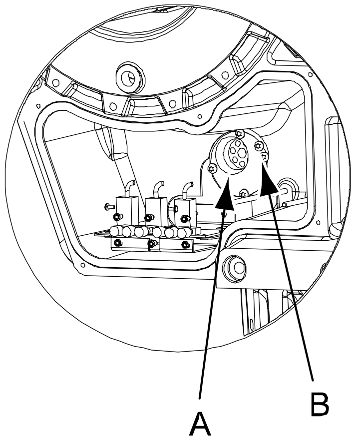
Continues on next page

Removal, cable harness - lower end (axes 1-3)

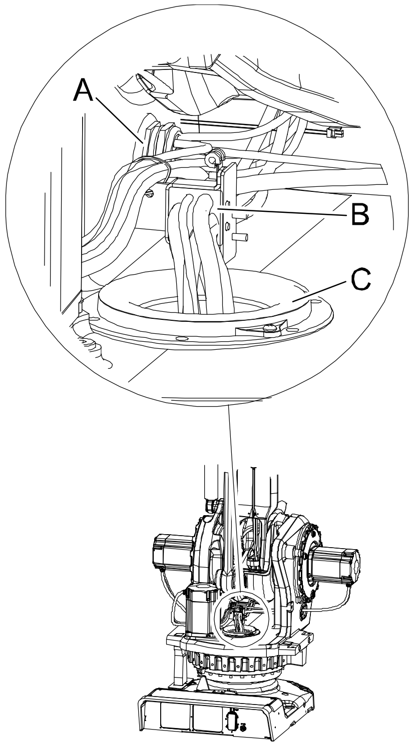
The procedure below details how to remove the cable harness, lower end (axes 1-3).

	Action	Note
1	Move the robot to the calibration position.	This is done in order to facilitate updating of the revolution counter.
2	 **DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the *rear cover plate* on the robot by removing its attachment screws.	Shown in *Location of cable harness - lower end (axes 1-3) on page 179*.
4	Disconnect the *earth cable*.	Shown in *Location of cable harness - lower end (axes 1-3) on page 179*.
5	Disconnect connectors *R1.MP* and *R1.SMB*.	Shown in *Location of cable harness - lower end (axes 1-3) on page 179*.
6	Remove the cable guide axis 2.	 xx0600002698 • A: Cable guide ax 2
7	Unscrew the screws in the *metal clamps* holding the cable harness in the frame and lower arm.	Shown in *Location of cable harness - lower end (axes 1-3) on page 179*
8	Remove the motor cover, axis 1, 2, 3 by removing its attachment screws, in order to reach the connectors.	
9	Disconnect all connectors at motor 1, 2 and 3.	

Continues on next page

	Action	Note
10	Open the SMB cover carefully. The cable (C) between the battery and the SMB unit may stay connected, in order to avoid an update of the revolution counter. Be careful not to let the weight of the cover strain the cable! In order to remove the cover completely, the connector R1.G must be disconnected! This causes a necessary updating of the revolution counter!	 xx0600002700 • A: SMB battery cover • B: SMB battery pack • C: Battery cable
11	Disconnect connectors R2.SMB, R1.SMB1-3, R1.SMB4-6 from the SMB unit. Disconnect X8, X9 and X10 from the brake release unit.	
12	Remove the cable gland, SMB by removing its four attachment screws from inside the SMB recess. Perform this removal with care, in order not to damage any of the components inside the SMB recess.	 xx0600002701 • A: Cable gland, SMB • B: Attachment screws (4 pcs)

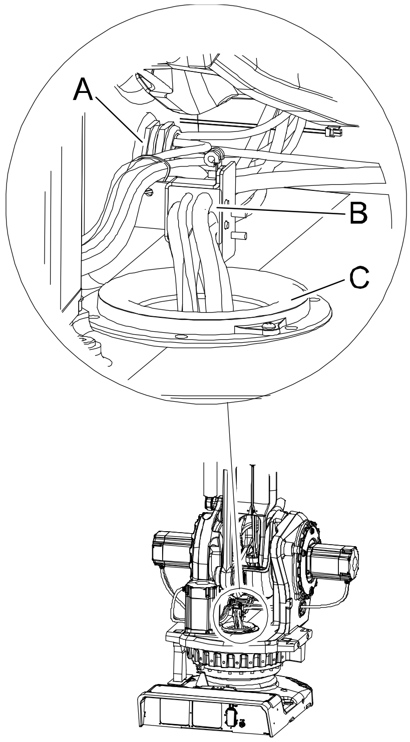
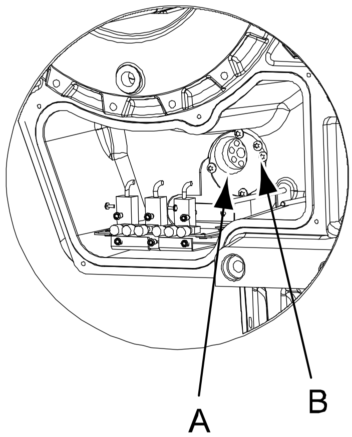
Continues on next page

	Action	Note
13	Gently pull the cable harness out of base through the cable guide, axis 1 and the frame.	 xx0700000154 • A: Cable gland, SMB • B: Metal clamp, frame • C: Cable guide, axis 1
14	Continue removal of the cable harness in the upper arm.	Detailed in *Replacement of cable harness, upper end on page 194*.

Continues on next page

Refitting, cable harness - lower end (axes 1-3)

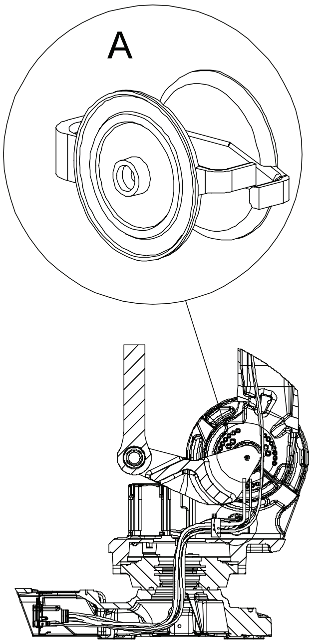
The procedure below details how to refit the cable harness, lower end (axes 1-3).

	Action	Note
1	Pull the cable and connectors down through the cable guide axis 1 in the center of the frame.	Make sure the cables are not twisted with each other or with eventual customer harness!  xx0700000154 • A: Cable gland, SMB • B: Metal clamp, frame • C: Cable guide, axis 1
2	Pull out the cables and connectors to the SMB unit through the frame and refit the cable gland with its four attachment screws from inside the SMB recess. Perform this refitting with care, in order not to damage any of the components inside the SMB recess.	 xx0600002701 • A: Cable gland, SMB • B: Attachment screws, (4 pcs)

Continues on next page

	Action	Note
3	Reconnect connectors *R1.MP* and *R1.SMB* at the robot base.	Tightening torque for R1.SMB: 10 Nm. Attachment points are shown in the figure *Location of cable harness - lower end (axes 1-3) on page 179*.
4	Reconnect the *earth cable*.	Attachment point is shown in the figure *Location of cable harness - lower end (axes 1-3) on page 179*
5	Refit the *rear cover plate* on the robot with its attachment screws.	Shown in the figure *Location of cable harness - lower end (axes 1-3) on page 179*
6	Reconnect all connectors at motor 1, 2 and 3.	
7	Refit the motor cover, axis 1, 2, 3. Make sure the cabling is placed correctly when refitting the cover and does not get jammed.	
8	Reconnect connectors R2.SMB, R1.SMB1-3, R1.SMB4-6 to the SMB unit. Reconnect X8, X9 and X10 to the brake release unit. Reconnect R1.G if it has been disconnected.	
9	Secure the SMB cover with its attachment screws. If cabling is used for 7th axis (option), refit the connector R2.FB7 to the SMB cover and tighten with 6 Nm.	
10	**WARNING** Before continuing any service work, please observe the safety information in section *The brake release buttons may be jammed after service work on page 178*!	

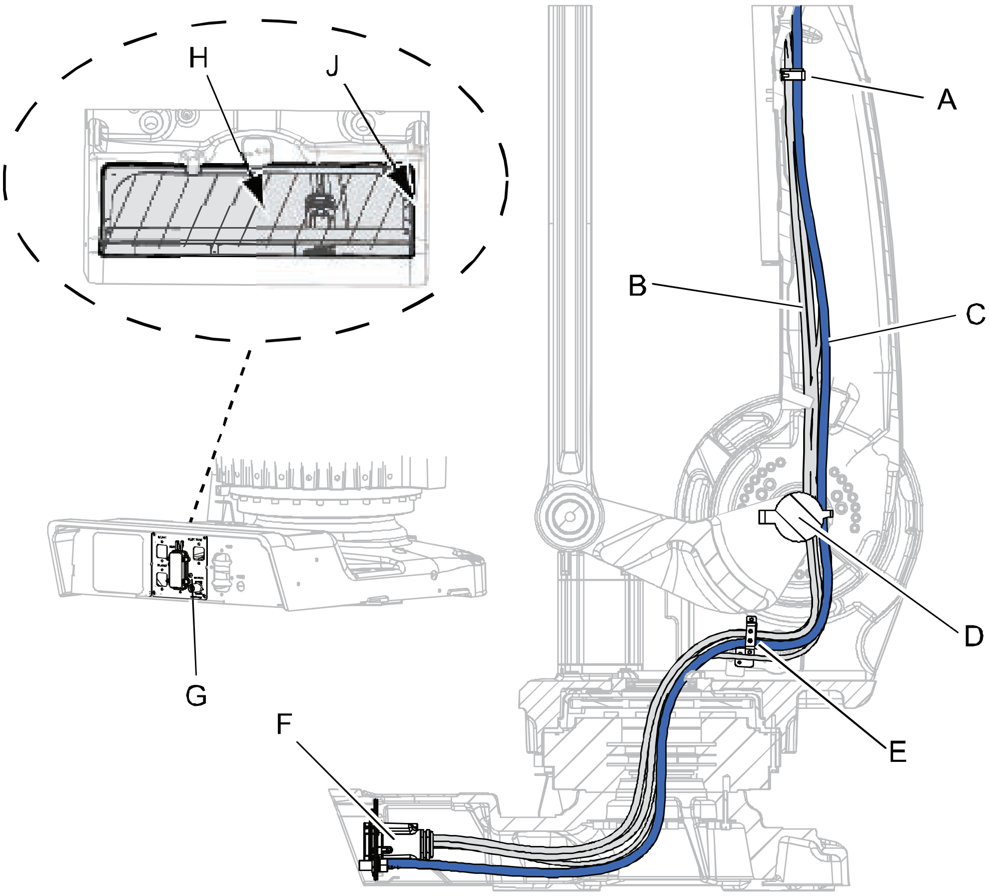
Continues on next page

	Action	Note
11	Refit the cable guide, axis 2.	xx0600002698 • A: Cable guide axis 2
12	Pull the cable harness through the lower arm.	
13	Refit the *metal clamps* holding the cable harness in the frame and lower arm with its attachment screws.	Shown in the figure *Location of cable harness - lower end (axes 1-3) on page 179*.
14	Continue refitting of the cable harness in the upper arm.	Detailed in section *Replacement of cable harness, upper end on page 194*.
15	Update the revolution counters.	Detailed in section *Updating revolution counters on IRC5 robots on page 349*.
16	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.3.2 Replacement of process cable package 1 - 3 MH

Location of process cable package axes 1 - 3 MH

The process cable package for axes 1 - 3 MH is located throughout the base, frame and lower arm as shown in the figure below.



xx0700000657

A	Metal clamp (inside lower arm)
B	Process cable package, cables
C	Process cable package, hose
D	Cable guide
E	Metal clamp
F	Connectors at base
G	Customer plate
H	Rear cover plate
J	Earth

Continues on next page

Required equipment

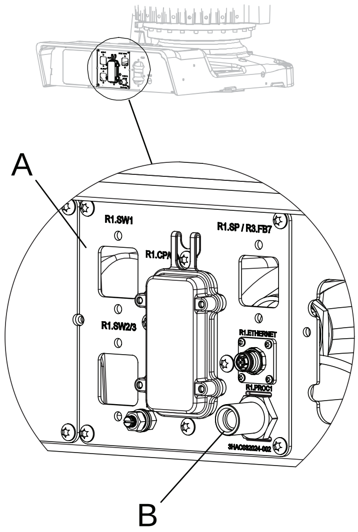
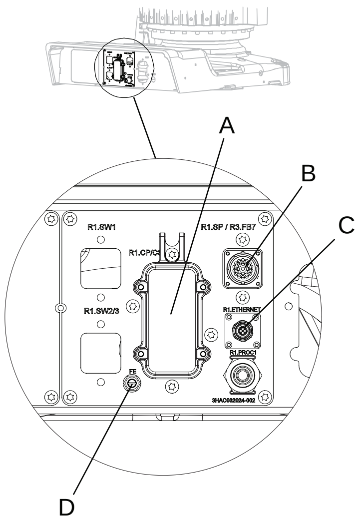
Equipment	Art. no	Note
Process cable package 1 - 3 MH	For spare part number, see *Spare part lists on page 395*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	-	These procedures include references to the tools required.
Circuit diagram	-	See *General references on page 10*.

Removal

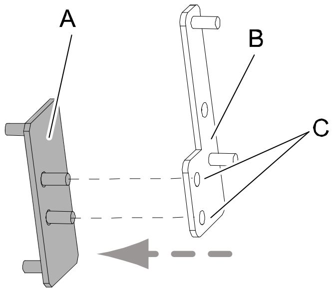
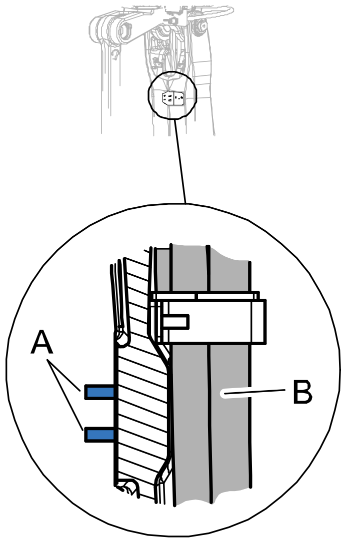
The procedure below details how to remove the process cable package 1 - 3 MH.

	Action	Note
1	Move the robot to the calibration position.	
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	**CAUTION** The cable package is sensitive to mechanical damage. They must be handled with care, especially the connectors, in order to avoid damaging them.	
4	Remove the rear *cover plate* at the back of the robot base in order to reach the connectors at the base.	Shown in the figure *Location of process cable package axes 1 - 3 MH on page 187*.

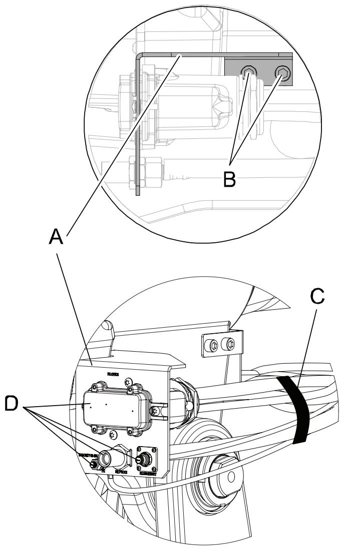
Continues on next page

	Action	Note
5	Disconnect the *hose* from the customer plate.	 xx0700000643 Parts: • A: Customer plate • B: Hose connector R1.PROC1
6	Disconnect the *cable connectors* from the customer plate.	 xx0700000645 Parts: A Connector R1.CP/CS B Connector R1.SP/R3.FP7 C Connector R1.ETHERNET D Screw connection, functional ground (FE)

Continues on next page

	Action	Note
7	Remove the prev. torque nuts securing the metal clamp of the process cable package, to the metal clamp of the robot cable package, at the SMB recess.	 xx0700000646 Parts: • A: Metal clamp bracket, robot cable package • B: Metal clamp bracket, process cable package • C: Position for prev. torque nuts
8	Pull the lower end of the process cable package out through the centrum hole in gearbox axis 1.	Order of removal: 1 Hose 2 Cables
9	Remove the prev. torque nuts securing the process cable package on the inside of the lower arm.	 xx0700000649 Parts: • A: Position for prev. torque nuts • B: Process cable package

Continues on next page

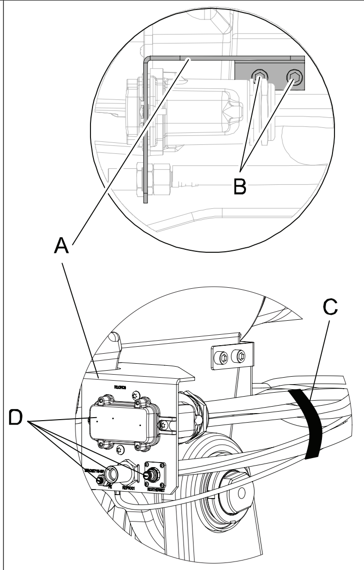
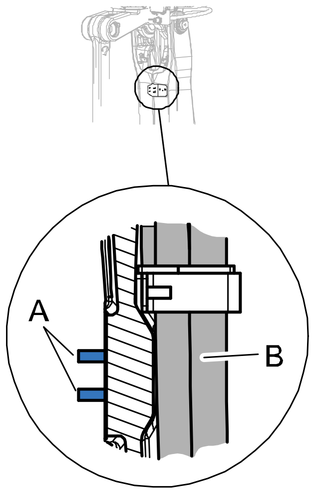
	Action	Note
10	Disconnect all connectors on the attachment plate.	 xx0700000648 Parts: • A: Attachment plate • B: Attachment screws M10x16 quality 8.8-A3F (2 pcs) • C; Strap, velcro • D: Connectors
11	Pull the process cable package gently out off the lower arm.	**Note** Perform this carefully in order not to damage the cable harness of the robot.

Refitting

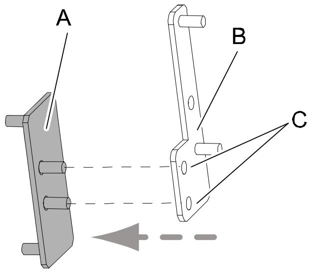
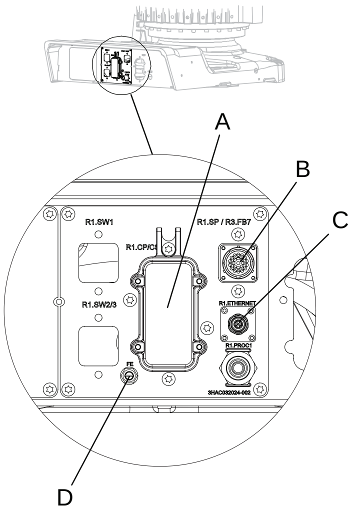
The procedure below details how to refit the process cable package 1 - 3 MH.

	Action	Note
1	Push the process cable package gently down through the lower arm.	Make sure that the cables are not twisted with each other. **Note** Perform this carefully in order not to damage the cable harness of the robot.

Continues on next page

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>2</td><td>Connect all connectors at the attachment plate.</td><td>xx0700000648
Parts:
A: Attachment plate
B: Attachment screws M10x16 quality 8.8-A3F (2 pcs)
C: Strap, velcro
D: Connectors</td></tr>
<tr><td>3</td><td>Refit the prev. torque nuts securing the process cable package on the inside of the lower arm.</td><td>xx0700000649
Parts:
A: Position for prev. torque nuts
B: Process cable package</td></tr>
<tr><td>4</td><td>Push the process cable package gently down through the cable guide in the centrum hole in gearbox axis 1.</td><td>Order of refitting:
Cables
Hose</td></tr>
</table>

Continues on next page

	Action	Note
5	Secure the metal clamp of the process cable package, with the prev. torque nuts on the metal clamp of the robot cable package, close to the SMB recess.	 xx0700000646 Parts: • A: Metal clamp bracket, robot cable package • B: Metal clamp bracket, process cable package • C: Position for prev. torque nuts
6	Connect all connectors at the customer plate.	 xx0700000645 Parts: A Connector R1.CP/CS B Connector R1.SP/R3.FP7 C Connector R1.ETHERNET D Screw connection, functional ground (FE)
7	Refit the rear cover plate.	Shown in the figure *Location of process cable package axes 1 - 3 MH on page 187*.
8	Update the revolution counter.	
9	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.3.3 Replacement of cable harness, upper end

Introduction

The cable harness 1-6 is undivided.

Replacing the cable harness is described in two steps:

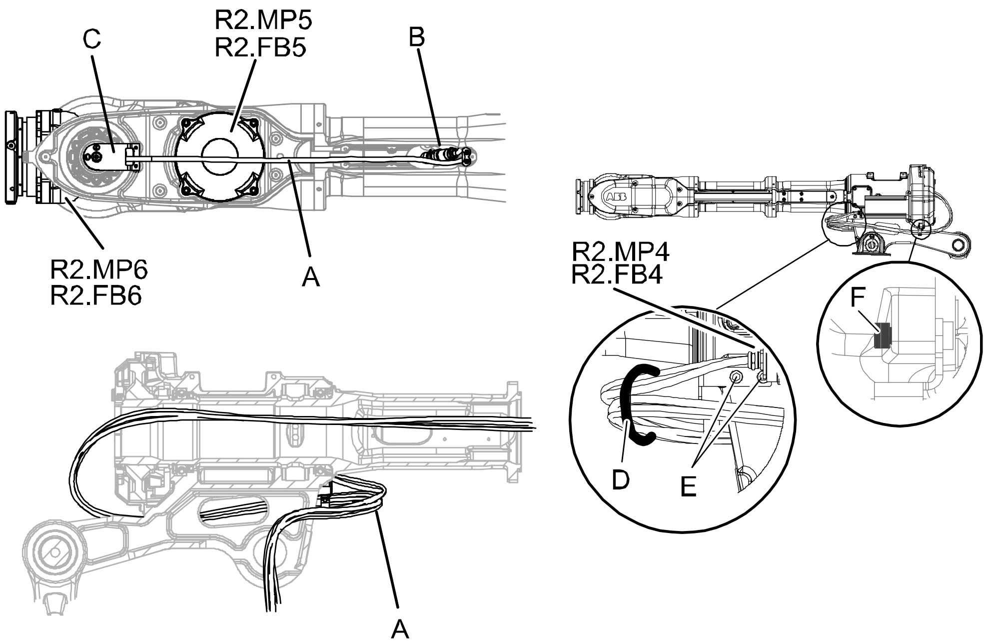
- lower end (axes 1-3)
- upper end (axes 4-6)

This procedure details how to replace the upper end.

For description of how to replace the lower end, see *Replacement of cable harness, lower end (axes 1-3) on page 179*.

Location of cable harness

The cable harness for the axes 4 to 6 runs throughout the upper arm and wrist unit as shown in the figure below:



xx0700000071

A	Cable harness, axes 1-6
B	Cable bracket, upper arm tube
C	Cable bracket, wrist unit
D	Cable starps, outdoor
E	Attachment screws (cable attachment armhouse), M10x16 quality 8.8 (2 pcs)
F	Attachment screw (cable attachment rear), M6x25 quality 12.9 Gleitmo

Required equipment

Equipment, etc.	Note
Cable harness axes 1-6	See *Spare part lists on page 395*.

Continues on next page

Equipment, etc.	Note
Gasket	Motors axes 1-5 See *Spare part lists on page 395*.
Gasket	Motor axis 6. Recommended to be changed for Foundry Plus. See *Spare part lists on page 395*.
Retrofit set Foundry Plus, wrist	See *Spare part lists on page 395*.
Retrofit set Foundry Plus, upper arm axis 4	See *Spare part lists on page 395*.
Standard toolkit	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.
Circuit diagram	See chapter *General references on page 10*.

Deciding calibration routine

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

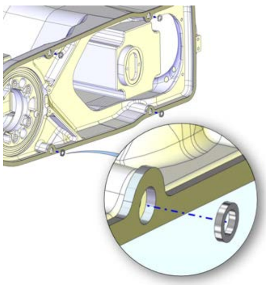
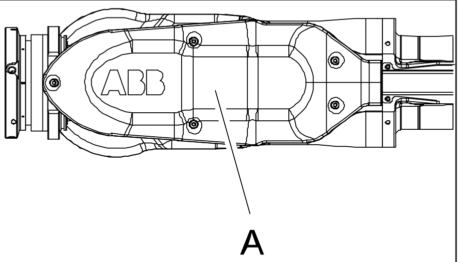
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal

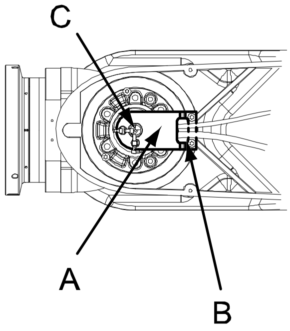
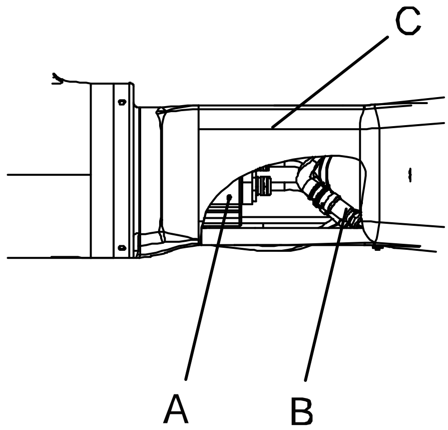
The procedure below details how to remove the cable harness.

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

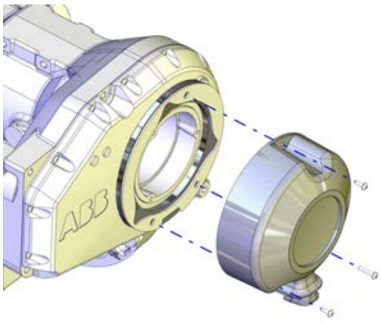
Continues on next page

	Action	Note
2	In order to facilitate refitting of the cable harness, run the robot to the specified positions: • Axis 1: 0° • Axis 2: 0° • Axis 3: 0° • Axis 4: 0° • Axis 5: +90° • Axis 6: no significance	**Note** Axis 5 must be oriented in the correct position (+90°) to allow the cover of motor axis 6 to open.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Before starting the removal of the axes-4-6 cable harness, first remove the cable harness of axes 1-3.	Detailed in the section *Replacement of cable harness, lower end (axes 1-3) on page 179*.
5	Remove the *cover, wrist unit* in order to reach the cable harness at axes 5 and 6. **Note** *Foundry Plus* Make sure not to lose the washers placed in the holes of the foundry gasket.  xx1400002580	 xx0700000140 • A : Cover, wrist unit

Continues on next page

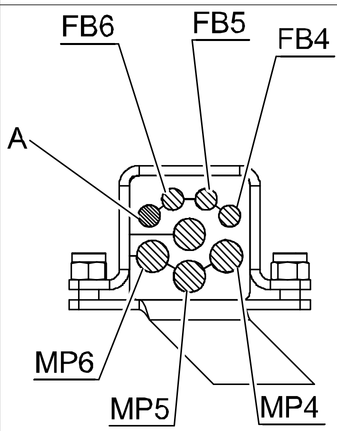
	Action	Note
6	Remove the *cable holder* in the wrist unit by unscrewing the three *attachment screws*. Two of the attachment screws (M6x16) are visibly located at the rear of the cable holder. The third screw (M4x12) is located at the bottom of the cable holder, securing the carrier.	 xx0600003034 • A : Cable holder • B : Attachment screws M6x16, 8.8 (2 pcs) • C : Attachment screw M4x12, 8-A2F (securing the carrier)
7	Remove the back cover motor, axis 6 by removing its attachment screws.	
8	Pull out the cabling *R2.MP6* and *R2.FB6* from motor axis 6 .	Shown in the figure *Location of cable harness on page 194*
9	Disconnect all connectors at motor axis 6 *R2.MP6* and *R2.FB6*.	Shown in the figure *Location of cable harness on page 194*
10	Loosen the *cable bracket in the upper arm tube* by undoing its two attachment screws on top of the tube.	
11	Disconnect the two *connectors (R2.FB5 and R2.MP5)* inside the tube.	 xx0700000072 Parts: • A: Motor axis 5 with connectors R4.FB5 and R4.MP5 • B: Connectors R2.FB5 and R2.MP5 • C: Upper arm tube
12	Remove eventual cable straps from the harness.	
13	Remove the cover motor axis 4 by removing its attachment screws.	
14	Disconnect all connectors at motor axis 4 *(R2.MP4, R2.FB4).*	Shown in the figure *Location of cable harness on page 194*

Continues on next page

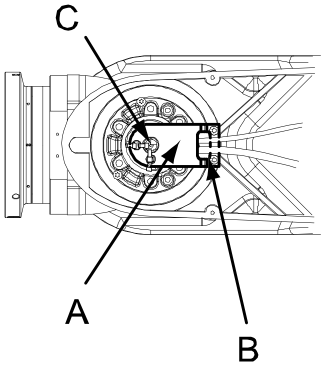
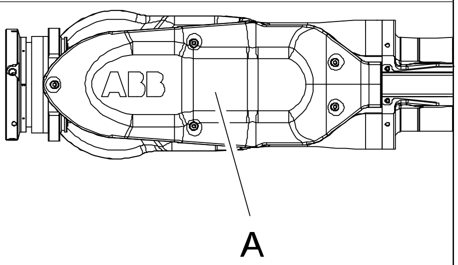
	Action	Note
15	Remove the *metal clamps*, on the armhouse.	
16	*Foundry Plus* Remove the Foundry Plus arm house cover.	 xx1400002582
17	Use caution and pull out the cable harness of the upper arm.	
18	Tie the connectors into a bundle, to avoid damaging them during further removal.	

Refitting

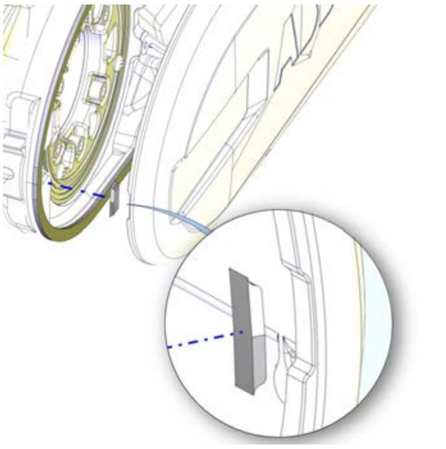
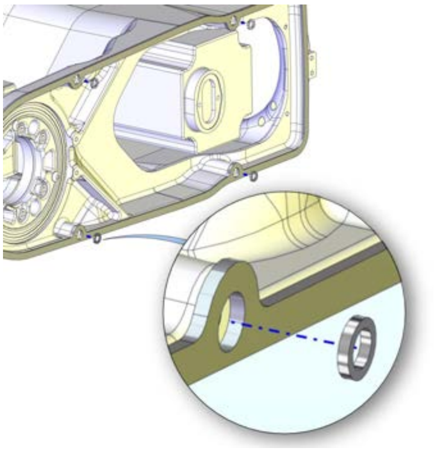
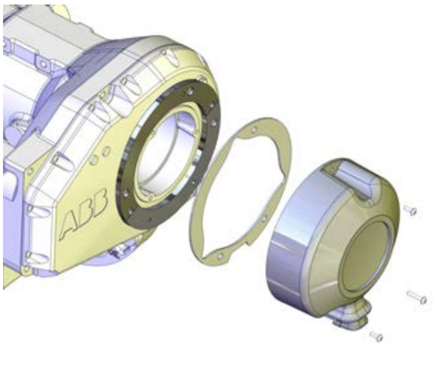
The procedure below details how to refit the cable harness.

	Action	Note
1	Begin by refitting the cable harness lower end (axes 1-3).	Detailed in the section *Replacement of cable harness, lower end (axes 1-3) on page 179*.
2	Insert the cable harness gently from the rear into the upper arm.	Arrange the cable harness as shown in the figure *Location of cable harness on page 194*
3	Refit the cable gland securing the cables to the armhouse. Make sure not to twist the harness.	 xx0700000041
4	Connect the two connectors inside the upper arm tube, *(R2.MP5 and R2.FB5)* and secure the *cable bracket* with its two attachment screws to the tube.	

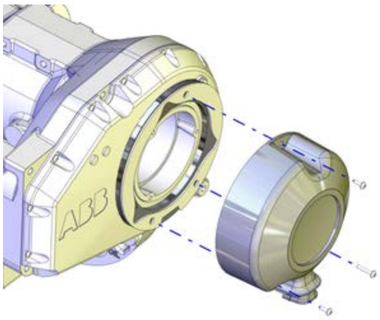
Continues on next page

	Action	Note
5	Place the cabling to motor axis 6 correctly on the upper arm and pull the connectors carefully through the hole on top of the wrist unit to motor, axis 6.	Shown in the figure *Location of cable harness on page 194* We recommend changing the *gasket* on the cover for Foundry Plus robots.
6	Reconnect all connectors at motor axis 4 *(R2.MP4,R2.FB4)*.	
7	Refit cover motor axis 4.	
8	Refit the cable holder wrist unit with the three attachment screws. Two of the attachment screws (M6x16) are visibly located at the rear of the cable holder. The third screw (M4x10) is located at the bottom of the cable holder, securing the carrier.	 xx0600003034 • A : Cable holder • B : Attachment screws M6x16, quality 8.8 (2 pcs) • C . Attachment screws M4x10, quality 8-A2F (securing the carrier)
9	Reconnect the motor cables axis 6 *R2.MP6* and *R2.FB6*.	Shown in the figure *Location of cable harness on page 194*
10	Refit cover motor, axis 6.	
11	Refit the *metal clamps*, on the armhouse.	
12	*Standard* Fit the wrist cover.	 xx0700000140 • A : Cover, wrist unit

Continues on next page

	Action	Note
13	*Foundry Plus* Make sure the wrist cover gasket and the small gasket fitted in the recess of the wrist cover are undamaged. Replace if damaged.	 xx1400002579
14	*Foundry Plus* Make sure the washers are fitted in the gasket holes.	 xx1400002580
15	*Foundry Plus* Fit the wrist cover, Foundry Plus. Make sure the gasket stays undamaged after fitting. Replace if damaged.	
16	*Foundry Plus* Make sure the gasket on the adapter ring is undamaged. Replace if damaged.	 xx1400002581

Continues on next page

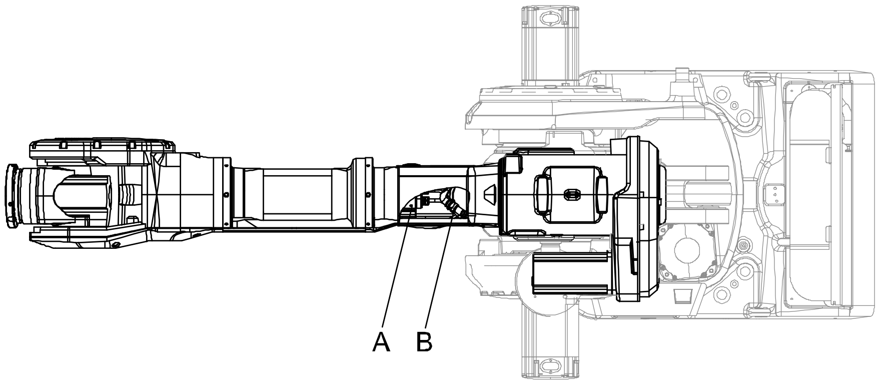
	Action	Note
17	*Foundry Plus* Fit the Foundry Plus cover on the adapter ring.	 xx1400002582
18	If the connection between the SMB battery and the SMB unit has been broken, the revolution counters must be updated.	Detailed in the section *Updating revolution counters on IRC5 robots on page 349*.
19	Make sure the gasket on the adapter ring is undamaged. Replace if damaged.	
20	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
21	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.3.4 Replacement of cabling, axis 5 motor

Location of cabling

The separate cables for the axis 5 motor are located inside the upper arm tube, as shown in the figure below.

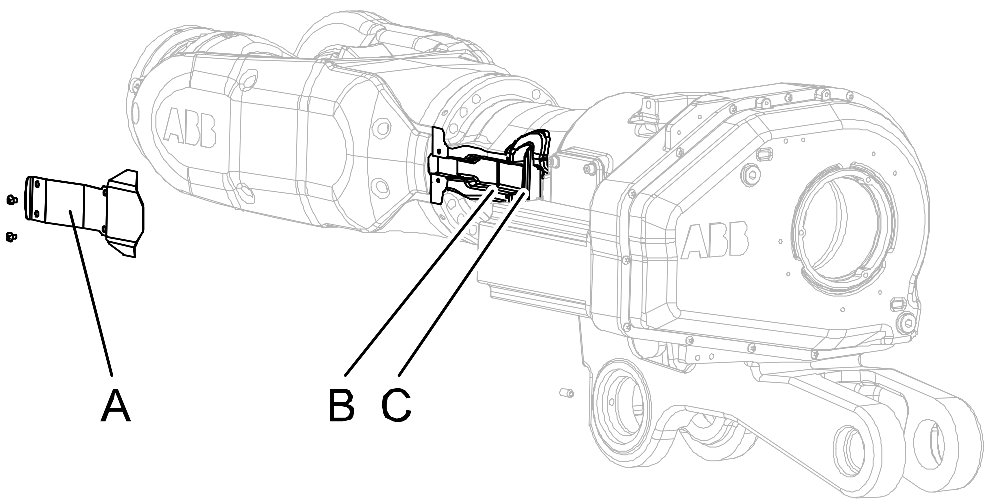
IRB 6660 - 100/3.3, IRB 6660 - 130/3.1



xx0700000055

A	Motor axis 5 with connectors R4.FB5 and R4.MP5
B	Connectors R3.FB5 and R3.MP5

IRB 6660 - 205/1.9



xx0700000632

A	Cable cover
B	Motor axis 5 with connectors R4.FB5 and R4.MP5
C	Connectors R3.FB5 and R3.MP5

Required equipment

Equipment	Spare part no.	Note
Cable harness axis 5	See *Spare part lists on page 395*.	

Continues on next page

Equipment	Spare part no.	Note
Circuit diagram	3HAC025744-001	
Standard toolkit		Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Removal, cabling axis 5 motor

The procedure below details how to remove the cabling from the axis 5 motor.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Remove the complete wrist unit.	Detailed in section: • *Removal, wrist unit on page 221*.
3	Remove the cover of motor, axis 5.	
4	Disconnect all connectors at motor, axis 5.	
5	Remove the cable gland cover at the cable exit by unscrewing its two attachment screws.	
6	Remove the cable, axis 5.	

Refitting, cabling axis 5 motor

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Reconnect all connectors at motor, axis 5.	
3	Refit the cable gland cover at the cable exit with its two attachment screws.	
4	Refit the cover of motor, axis 5.	
5	Refit the complete wrist unit.	Detailed in section: • *Refitting, wrist unit on page 223*.

Continues on next page

	Action	Note
6	Re-calibrate the robot.	This is done if a new wrist has been fitted. Calibration is detailed in a separate calibration manual enclosed with the calibration tools. General calibration information is included in section *Calibration on page 341*.
7	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

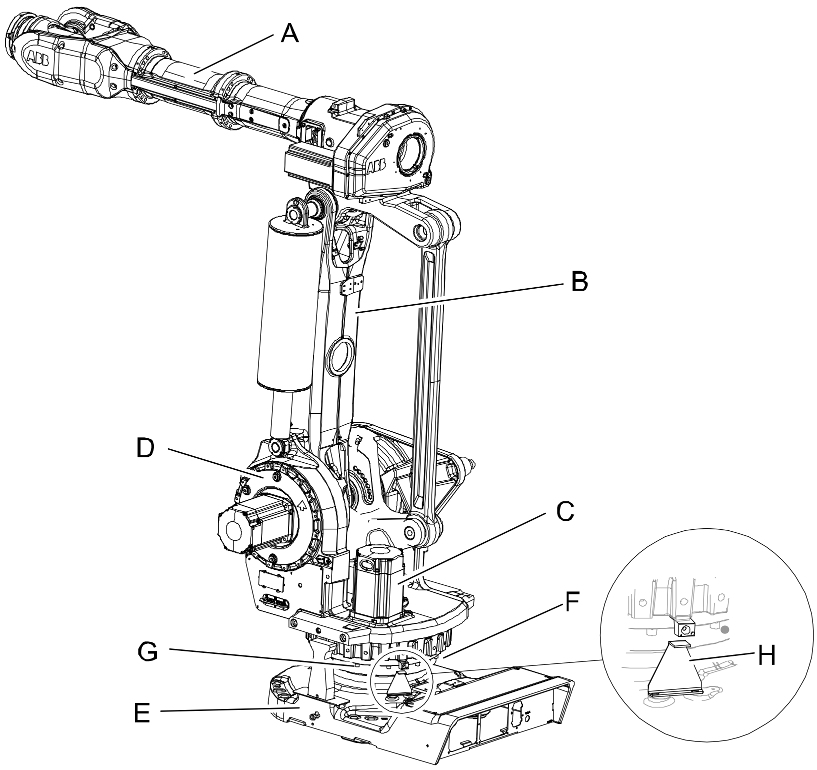
4.3.5 Replacement of complete arm system

Location of arm system

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

A more detailed view of the component and its position may be found in *Spare part lists on page 395*.

IRB 6660 - 100/3.3, IRB 6660 - 130/3.1



xx0700000073

A	Upper arm
B	Lower arm
C	Motor, axis 1
D	Frame
E	Base
F	Gearbox, axis 1
G	Attachment screws base M12x70, quality 12.9 Gleitmo (24 pcs)
H	Calibration plate axis 1

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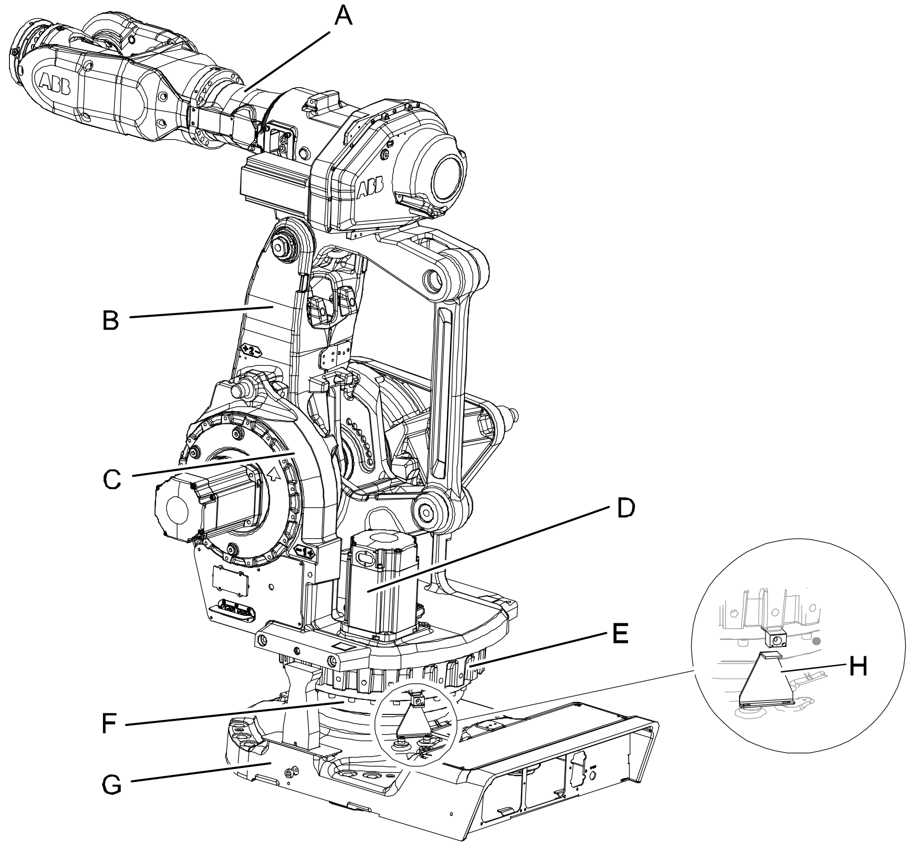
IRB 6660 - 205/1.9



xx0700000633

A	Upper arm
B	Lower arm
C	Frame
D	Motor, axis 1
E	Gearbox, axis 1
F	Attachment screws base M12x70, quality 12.9 Gleitmo (24 pcs)
G	Base
H	Calibration plate axis 1

Required equipment

Equipment, etc.	Art. no.	Note
Lifting accessory, robot	3HAC15607-1	Instruction 3HAC15971-2 is enclosed!
Guide pins M12 x 130	3HAC022637-001	Used to guide the complete arm system when lifting it. Always use the guide pins in pairs! In order to make the refitting easier, it is recommended to use two guide pins of different lengths. Notice that longer guide pins than 140 mm will not be possible to remove from the frame because lack of space after refitting!

Continues on next page

Equipment, etc.	Art. no.	Note
Roundsling 1,5 m		Lifting capacity 1,000 kg
Isopropanol	-	Used for cleaning mounting surfaces.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

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

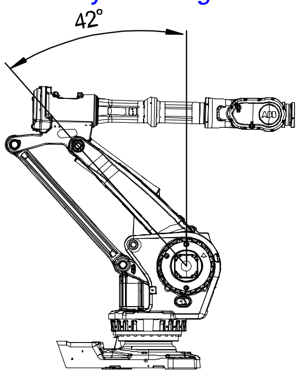
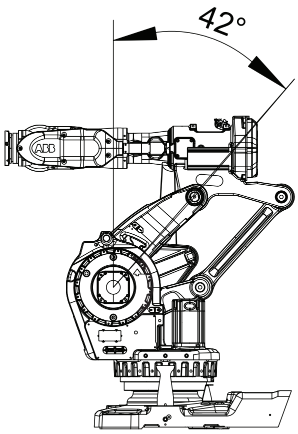
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, arm system

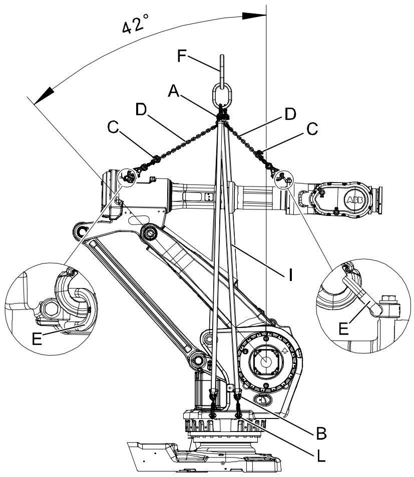
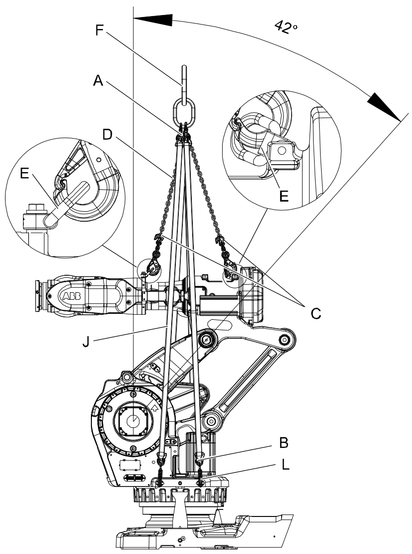
Use this procedure to lift and remove the complete arm system.

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

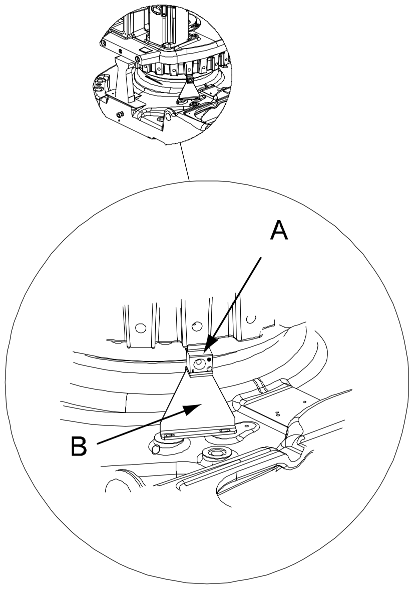
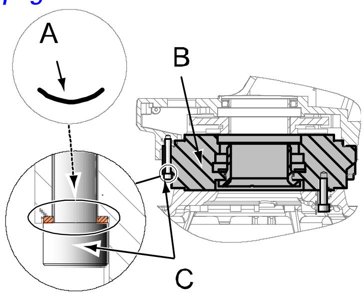
Continues on next page

	Action	Note
2	Run the robot to the position shown in the figure to the right.	Release the brakes if necessary, as detailed in section *Manually releasing the brakes on page 68*.  xx0700000137  xx0700000518
3	Run the overhead crane to a position above the robot.	
4	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
5	Drain the oil from gearbox axis 1.	Detailed in section *Changing oil, axis-1 gearbox on page 144*.
6	Disconnect the cabling in the rear of the robot base and remove the cable support plate inside the base.	
7	Pull the disconnected cabling up through the center of the axis-1 gearbox.	How to replace the cabling is detailed in *Replacement of cable harness, lower end (axes 1-3) on page 179*.

Continues on next page

	Action	Note
8	Remove the motor, axis 1.	Detailed in section *Replacing motor, axis 1 on page 275*.
9	Fit the *lifting accessory* and adjust it as detailed in the enclosed **instructions**.	Art. no. is specified in *Required equipment on page 206*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting accessory! *Follow the instructions before lifting!* IRB 6660 - 130/3.1, IRB 6660 - 100/3.3  xx0700000004 IRB 6660 - 205/1.9  xx0700000427 A: Load hook B: Swiveling lifting eyes (4 pcs) C: Shortening hook D: Chain E: Lifting eye M12 F: Eye of lifting accessory I: Lifting slings (4 pcs) L: Hook

Continues on next page

	Action	Note
10	Remove the *block for calibration* and *calibration plate axis 1* from the bottom of the frame.	 xx0600002734 • A: Block for calibration • B: Calibration plate axis 1
11	Unfasten the arm system from the base by unscrewing its 24 *attachment screws.*	Shown in the figure *Location of arm system on page 205*.  xx0600003070 Parts: • A: Serrated lock washer • B: Gearbox axis 1 • C: Attachment screws M12x80
12	Fit two *guide pins* in two opposite screw holes.	Art. no. is specified in section *Required equipment on page 206*.
13	**CAUTION** The complete arm system weighs 1330 - 1520 kg! All lifting equipment used must be sized accordingly!	

Continues on next page

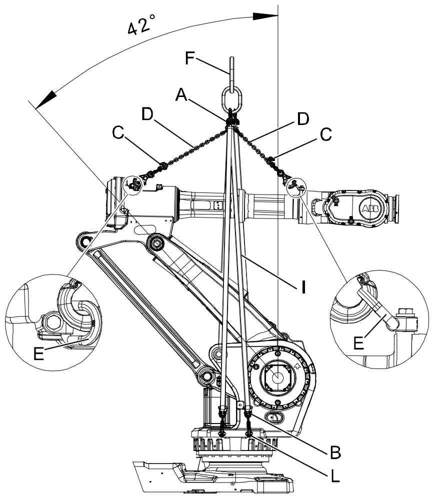
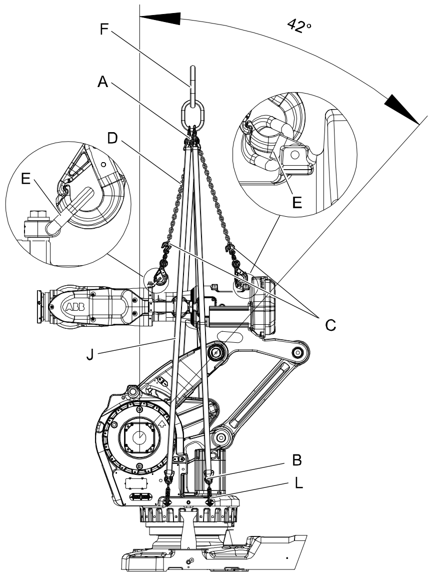
	Action	Note
14	Lift the arm system carefully and secure it in a safe area. Always move the robot at very low speeds, making sure it does not tip. Continue lifting even if the arm system turns out to be unbalanced despite earlier adjustments! The risk of damaging the interfaces is bigger if the load is lowered unbalanced!	Make sure all hooks and attachments stay in the correct position while lifting the arm system and that the lifting accessory does not wear against sharp edges.

Refitting, arm system

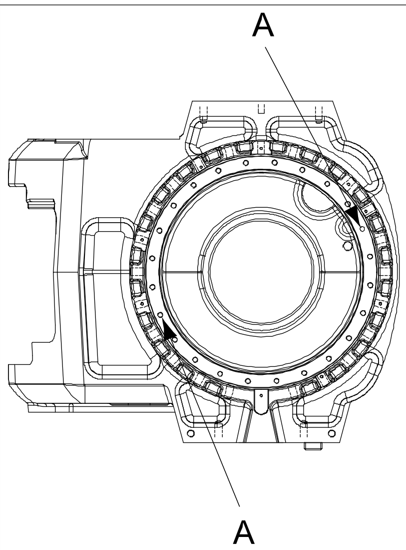
The procedure describes how to lift and refit the complete arm system.

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

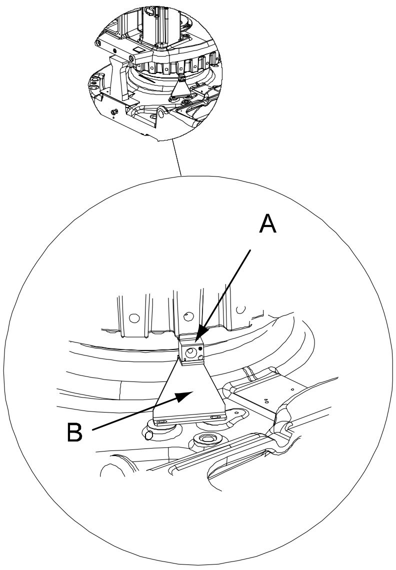
Continues on next page

	Action	Note
2	Fit the *lifting accessory* as detailed in enclosed instruction.	Art. no. is specified in *Required equipment on page 206*. Make sure the lift is done completely level! How to adjust the lift is described in the enclosed instruction to the lifting accessory! *Follow the instructions before lifting!* IRB 6660 - 130/3.1, IRB 6660 - 100/3.3  xx0700000004 IRB 6660 - 205/3.1  xx0700000427 • A: Load hook • B: Swiveling lifting eyes (4 pcs) • C: Shortening hook • D: Chain • E: Lifting eye M12 • F: Eye of lifting accessory • I: Lifting slings • L: Hook

Continues on next page

	Action	Note
3	**CAUTION** The complete arm system weighs 1330 - 1520 kg! All lifting equipment used must be sized accordingly!	
4	Lift the complete arm system and move it at very low speed, making sure it does not tip! Make sure the lift is done completely level. Adjust the length of the chains as detailed in enclosed instruction .	Make sure all the hooks and attachments stay in the correct position while lifting the robot!
5	Clean the mounting surfaces with isopropanol.	
6	Fit the two **guide pins** to the frame attachment holes, as shown in the figure to the right.	 xx0600002632 The figure above shows the frame, view from below. • A: Attachment holes for the guide pins, M12
7	Lubricate the outer surface of the gearbox for easier mating of the gearbox and arm system.	
8	Look through the empty mounting hole of motor 1 to assist in aligning the assembly during refitting of the arm system. Lower the arm system with guidance from the guide pins previously fitted to the frame. **Note** The refitting must be made completely level! Make sure the lifting accessory is adjusted prior to refitting of arm system.	This is a complex task to be performed with utmost care in order to avoid injury or damage!
9	Refit 22 of the 24 attachment screws before the arm system is completely lowered.	

Continues on next page

	Action	Note
10	Remove the guide pins and secure the arm system to the base with its 24 *attachment screws and washers.*	Shown in the figure *Location of arm system on page 205*. M12 x 70, tightening torque: 115 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 386* before fitting.
11	Refit the *block for calibration* at the bottom of the frame. Also refit the *axis 1 calibration plate*.	 xx0600002734 • A: Block for calibration • B: Calibration plate axis 1
12	Refit the *axis-1 motor*.	Detailed in section *Replacing motor, axis 1 on page 275*.
13	Perform a *leak-down test* of the axis-1 gearbox.	Detailed in section *Performing a leak-down test on page 170*.
14	Refit the *cabling* in the base.	Detailed in section *Replacement of cable harness, lower end (axes 1-3) on page 179*.
15	Refill the gearbox with lubricating oil.	Detailed in section *Changing oil, axis-1 gearbox on page 144*.
16	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
17	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

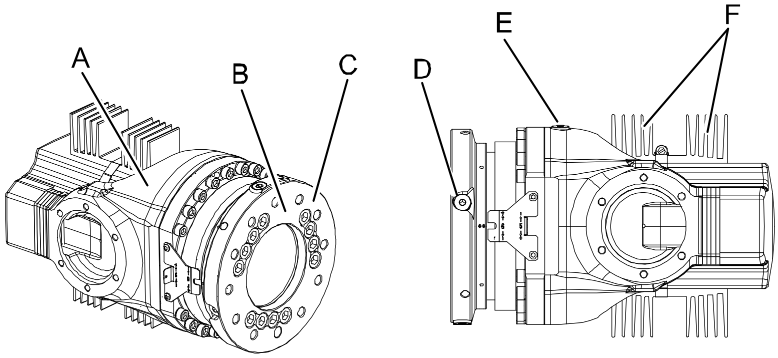
4.4 Upper and lower arms

4.4.1 Replacing the turning disk

Location of turning disk

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

The figure shows the axis-6 gearbox for robot variant IRB 6660 - 100/3.3 and IRB 6660 - 130/3.1, and includes cooling elements on motor. There are no cooling elements on the axis-6 motor on robot variant IRB 6660 - 250/1.9.



xx0700000163

A	Wrist unit
B	Turning disk
C	Attachment screws, turning disk (12 pcs)
D	Oil plug, draining
E	Oil plug, filling
F	Cooling elements (IRB 6660 - 100/3.3, IRB 6660 - 130/3.1)

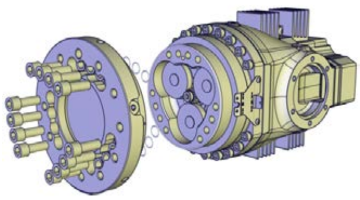
Required equipment

Equipment, etc.	Art. no.	Note
Turning disk	For spare part no. see: *Spare part lists on page 395*.	
O-ring Wrist, type 2	3HAB3772-64 (1 pc) 3HAB3772-61 (12 pcs)	Must be replaced when replacing the turning disk!
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD Used to lubricate the o-rings.
Flange sealant	-	Loctite 574
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

Removing, turning disk

Use this procedure to remove the turning disk.

	Action	Note
1	Run the robot to a position where the *oil plug, draining* of axis 6 gearbox faces downwards.	Shown in the figure *Location of turning disk on page 215*.
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove any equipment fitted to the turning disk.	
4	Drain the axis 6 gearbox.	See section • *Changing oil, axis-6 gearbox on page 156*
5	Remove the *attachment screws* that secure the turning disk.	 xx1400000994 Shown in the figure *Location of turning disk on page 215*.
6	Remove the *turning disk*.	
7	*Foundry Plus:* Remove old flange sealant residues and other contamination from the contact surfaces.	

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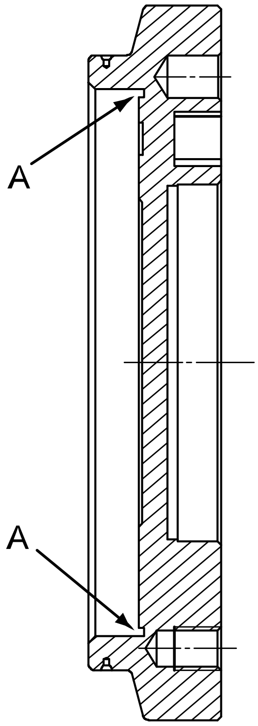
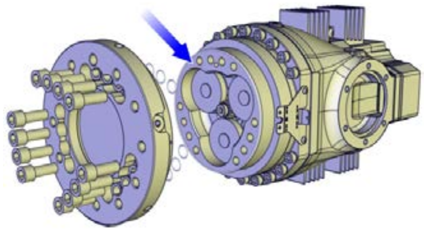
Refitting, turning disk

Use this procedure to refit the turning disk.

	Action	Note
1	Lubricate the *o-ring* of the turning disk with *grease* and fit it to the turning disk. Also fit the 12 o-rings, when refitting the attachment screws.	Art. no. is specified in *Required equipment on page 215*.  xx0200000218 • A: Sealing surface, o-ring
2	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400000995

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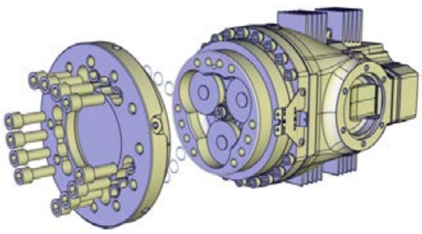
	Action	Note
3	Secure the turning disk with its *attachment screws*.	12 pcs, M12 x 30, 12.9 quality Gleitmo. **Tightening torque: 100 Nm.**  xx1400000994 Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 386* before fitting.
4	Perform a *leak-down test* of the gearbox axis 6.	Detailed in the section *Performing a leak-down test on page 170*.
5	Refill the axis 6 gearbox with oil.	See section • *Changing oil, axis-6 gearbox on page 156*
6	Refit any equipment removed during disassembly to the turning disk.	
7	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

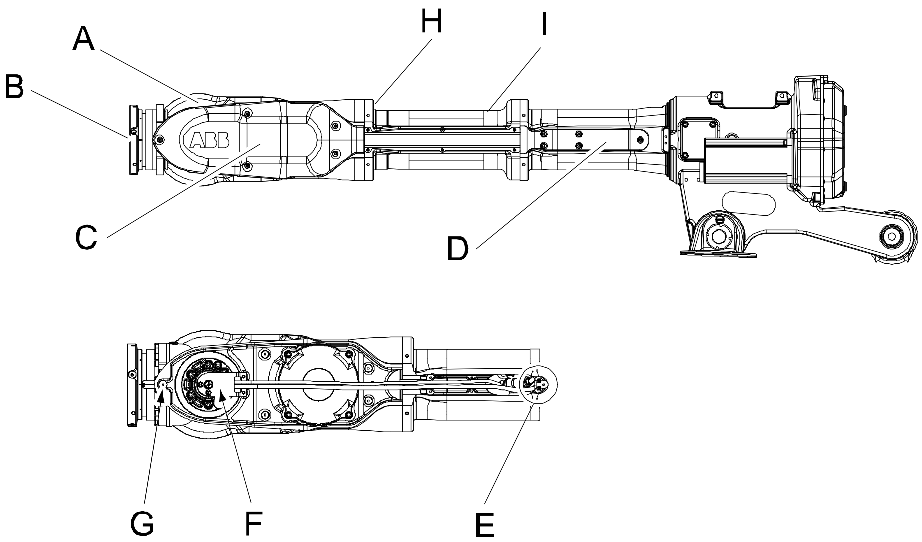
4.4.2 Replacement of complete wrist unit

Location of wrist unit

The wrist unit is located on the upper arm as shown in the figure below.

A more detailed view of the component and its position may be found in *Spare part lists on page 395*.

IRB 6660 - 100/3.3, IRB 6660 - 130/3.1

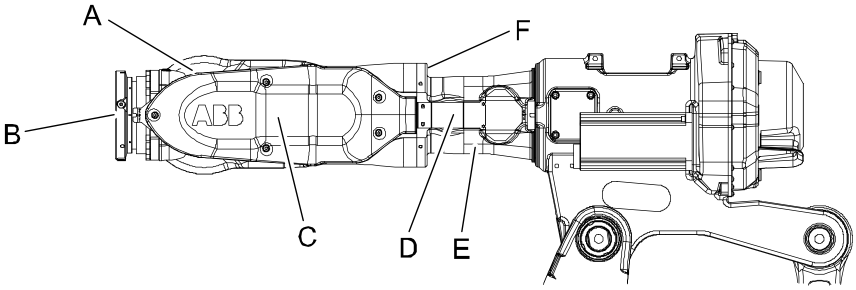


xx0700000069

A	Wrist unit
B	Turning disk
C	Cover, wrist unit
D	Cover, upper arm tube
E	Connectors, upper arm tube, with cable bracket (R3.FB5, R3.MP5)
F	Cable bracket
G	Attachment point for lifting tool, wrist unit
H	Attachment screws and washers, wrist unit
I	Upper arm tube

Continues on next page

IRB 6660 - 205/1.9



xx0700000635

A	Wrist unit
B	Turning disk
C	Cover, wrist unit
D	Cover, upper arm tube
E	Upper arm tube
F	Attachment screws and washers, wrist unit

Required equipment

Equipment etc.	Art. no.	Note
Wrist unit	For spare part number, see *Spare part lists on page 395*.	
Cover for wrist unit	For spare part number, see *Spare part lists on page 395*.	
Guide pins M12 x 200	3HAC13056-3	Always use guide pins in pairs!
Lifting accessory, wrist unit	3HAC13605-1	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *General references on page 10*.

Continues on next page

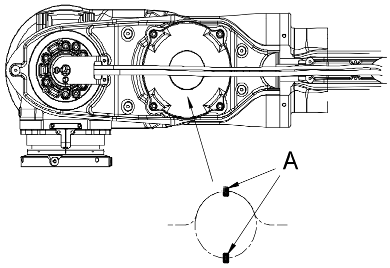
Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, wrist unit

The procedure below details how to remove the complete wrist unit.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Remove all equipment fitted to the turning disk.	
3	Turn axis 4 to a position where the *cover, upper arm tube and wrist unit,* faces upwards. Turn axis 5 to +90°.	 xx0200000185

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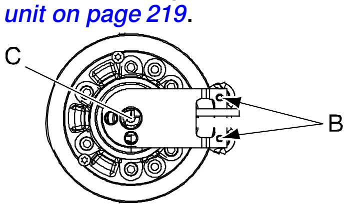
	Action	Note
4	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
5	Remove the *cover, wrist unit*.	Shown in the figure *Location of wrist unit on page 219*.
6	Remove the *cover, upper arm tube.*	Shown in the figure *Location of wrist unit on page 219*.
7	Remove the cover of motor, axis 6 and disconnect all connectors beneath.	
8	Loosen the *cable bracket, wrist unit* on top of the wrist by undoing the three attachment screws. Two of the *attachment screws* are visibly located at the rear of the bracket and the third located at the bottom of the cable bracket, in the center.	Shown in the figure *Location of wrist unit on page 219*.  xx0200000254 • B: Attachment screws, rear of cable bracket (2 pcs) • C: Attachment screw, bottom of cable bracket
9	Pick out the cabling from motor, axis 6 and place it safely on the tube.	
10	Fit the *lifting accessory* to the wrist unit.	Art. no. is specified in *Required equipment on page 220*.
11	**CAUTION** The complete wrist unit weighs 130 kg! All lifting equipment used must be sized accordingly!	
12	Slightly raise the wrist unit to unload the screw joint, facilitating removing the attachment screws.	
13	Remove the *wrist unit attachment screws and washers*.	Shown in the figure *Location of wrist unit on page 219*.
14	Pull the wrist unit out, lift it away and place it on a secure surface.	
15	Disconnect the *motor axis 5* by disconnecting the two connectors in the upper arm tube (R3.FB5, R3.MP5).	Shown in the figure *Location of wrist unit on page 219*.

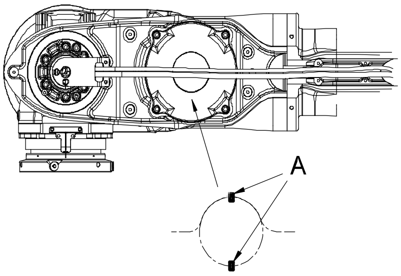
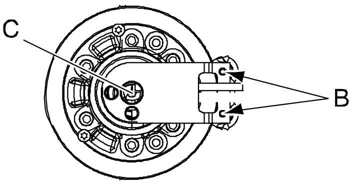
Continues on next page

Refitting, wrist unit

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Fit two *guide pins, M12* in the upper arm tube, in two of the holes for the *wrist unit attachment screws.*	Art. no. is specified in *Required equipment on page 220*. Shown in the figure *Location of wrist unit on page 219*.
3	Fit the *lifting tool* to the wrist unit.	Art. no. is specified *Location of wrist unit on page 219*.
4	**CAUTION** The complete wrist unit weighs 130 kg! All lifting equipment used must be sized accordingly!	
5	Lift the wrist unit and guide it to the upper arm tube with help of the guide pins. Make sure the cabling from motor, axis 5 is safely run into the arm tube and does not get jammed.	
6	Reconnect the motor axis 5 by connecting the two *connectors inside the upper arm tube* (R3.FB5, R3.MP5) and secure the cable bracket with the two attachment screws to the tube.	Shown in the figure *Location of wrist unit on page 219*.
7	Secure the wrist unit with 10 of the 12 *attachment screws* and *washers*.	Shown in the figure *Location of wrist unit on page 219*. 12 pcs: M12 x 50, 12.9 quality Gleitmo. Tightening torque: 115 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 386* before fitting.
8	Remove the guide pins and secure the two remaining attachment screws as detailed above.	
9	Remove the lifting tool from the wrist unit.	
10	**Note** Axis 5 must be oriented in the correct position (+90º) to allow the motor 6 cover to open!	

Continues on next page

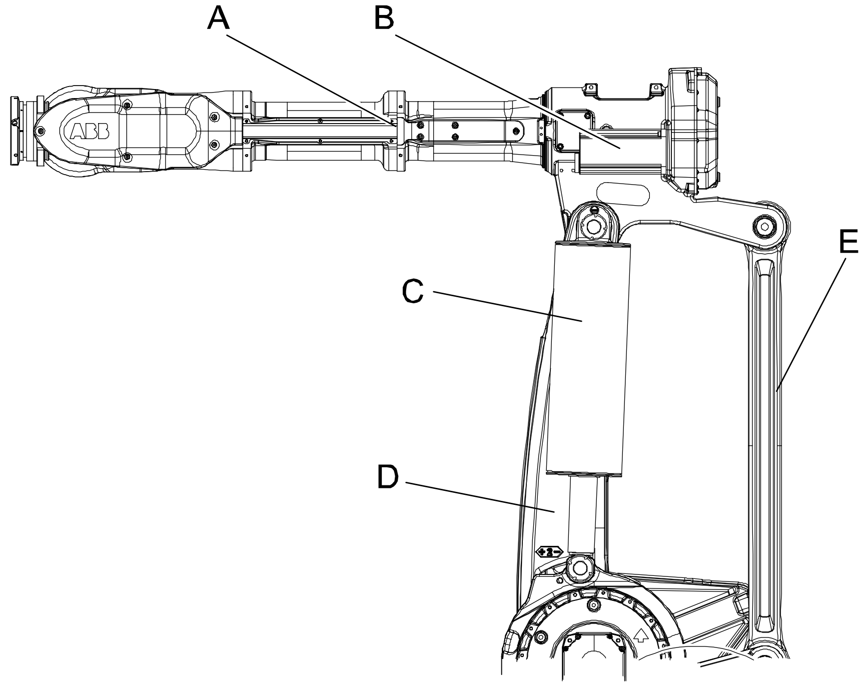
	Action	Note
11	Place the cabling to motor axis 6 correctly on the upper arm and gently pull the connectors through the hole on top of wrist unit to motor, axis 6. In case of excess of cable length: • put the excess cable in a loop in the area shown in the figure and secure with with *cable straps*. Cables are longer in order to fit different upper arm lengths.	 xx0200000185 Parts: • A: Cable straps
12	Fasten the *cable bracket* at top of the wrist unit with three *attachment screws*. Two of them are visible at the *rear attachment point* and the third is located on the *bottom* of the cable bracket, in the center.	Shown in the figure *Location of wrist unit on page 219*.  xx0200000254 • B: Attachment screws, rear attachment point of cable bracket (2 pcs) • C: Attachment screw, bottom of cable bracket
13	Reconnect the connectors to the axis-6 motor and refit the motor cover.	
14	Refit the *cover, upper arm tube.*	Shown in the figure *Location of wrist unit on page 219*.
15	Refit the *cover, wrist unit.*	Shown in the figure *Location of wrist unit on page 219*. Tightening torque: 14 Nm±10%. Screw 3HAB3409-25 (with Loctite), Washer 3HAC062379-001.
16	Re-calibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
17	Refit any equipment previously removed from the turning disk.	
18	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.4.3 Replacement of upper arm

Location of upper arm

The upper arm is located as shown below.

IRB 6660 - 100/3.3, IRB 6660 - 130/3.1



xx0700000059

A	Upper arm
B	Motor, axis 4
C	Balancing device
D	Lower arm
E	Parallel rod

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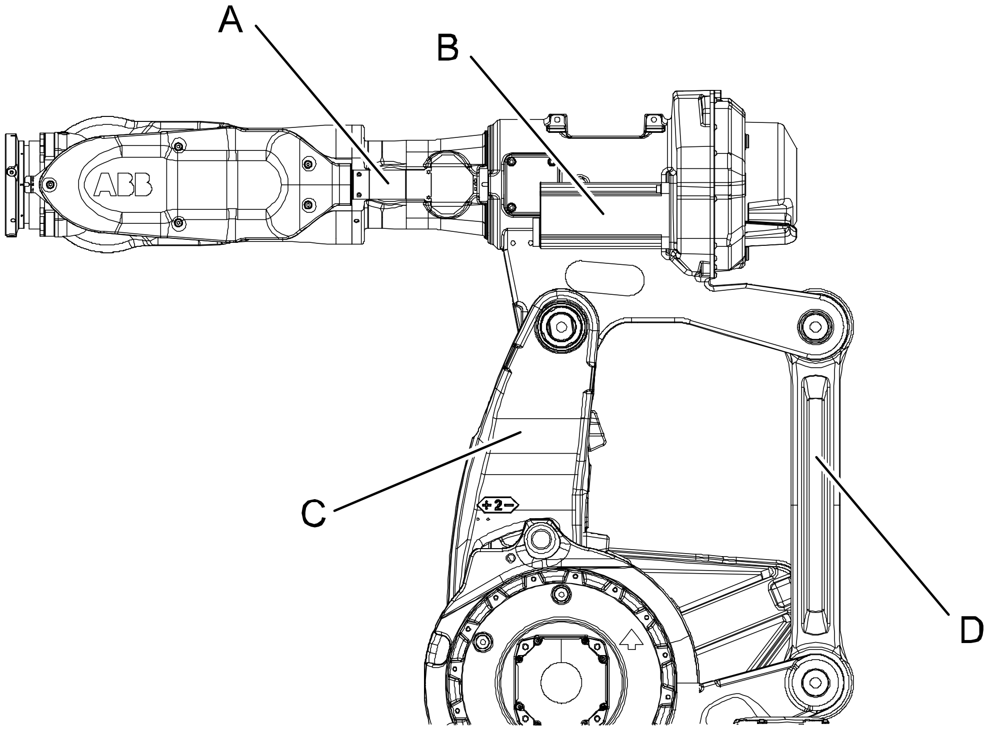
IRB 6660 - 205/1.9



xx0700000636

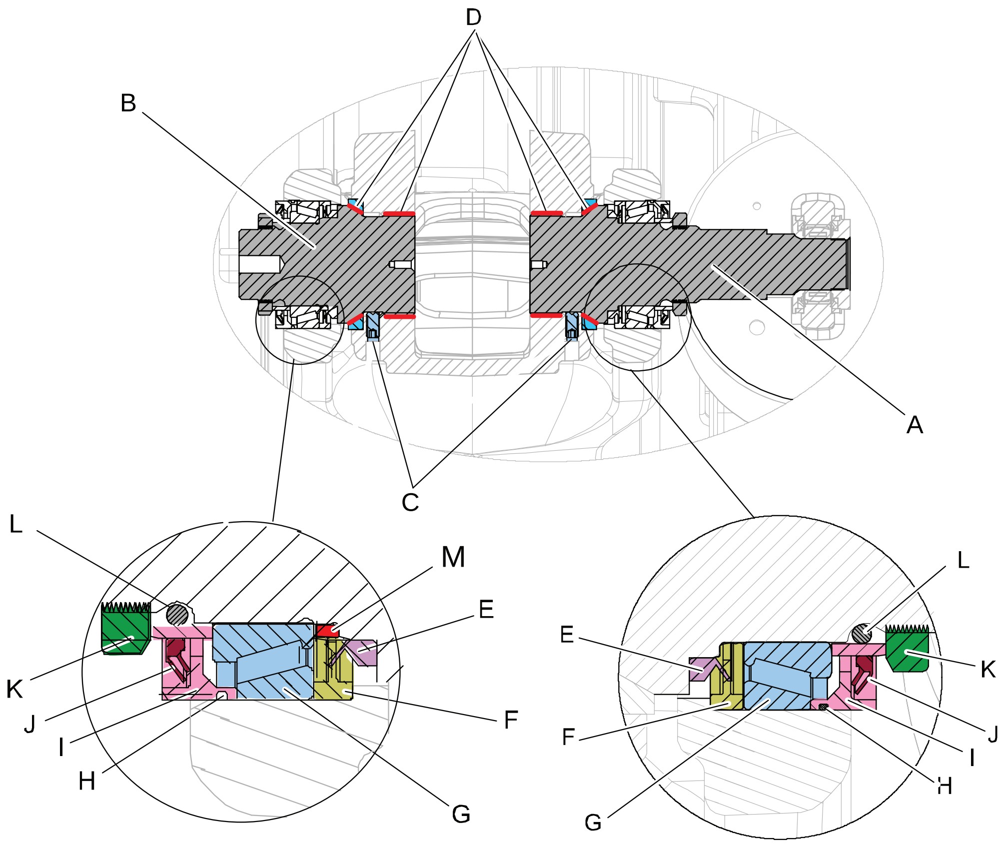
A	Upper arm
B	Upper arm
C	Lower arm
D	Parallel rod

Continues on next page

View of the assembly of the upper arm components

Shown below is a cut away view of how the upper arm is fitted to the lower arm (seen from above). The letters are being referred to in the following step by step procedures.

IRB 6660 - 100/3.3, IRB 6660 - 130/3.1



xx0700000058

A	Shaft, axis 2
B	Shaft, axis 3
C	Set screw, cup point M10 x 20 quality 45H-A3F
D	Lubricant paste (Molycote 1000)
E	Sealing ring (V-ring)
F	Sealing ring
G	Taper roller bearing
H	O-ring
I	Sealing ring
J	Sealing assembly
K	Lock nut (KM12)
L	O-ring (Di = 54.2 mm, t = 5.7 mm)
M	Spacer ring

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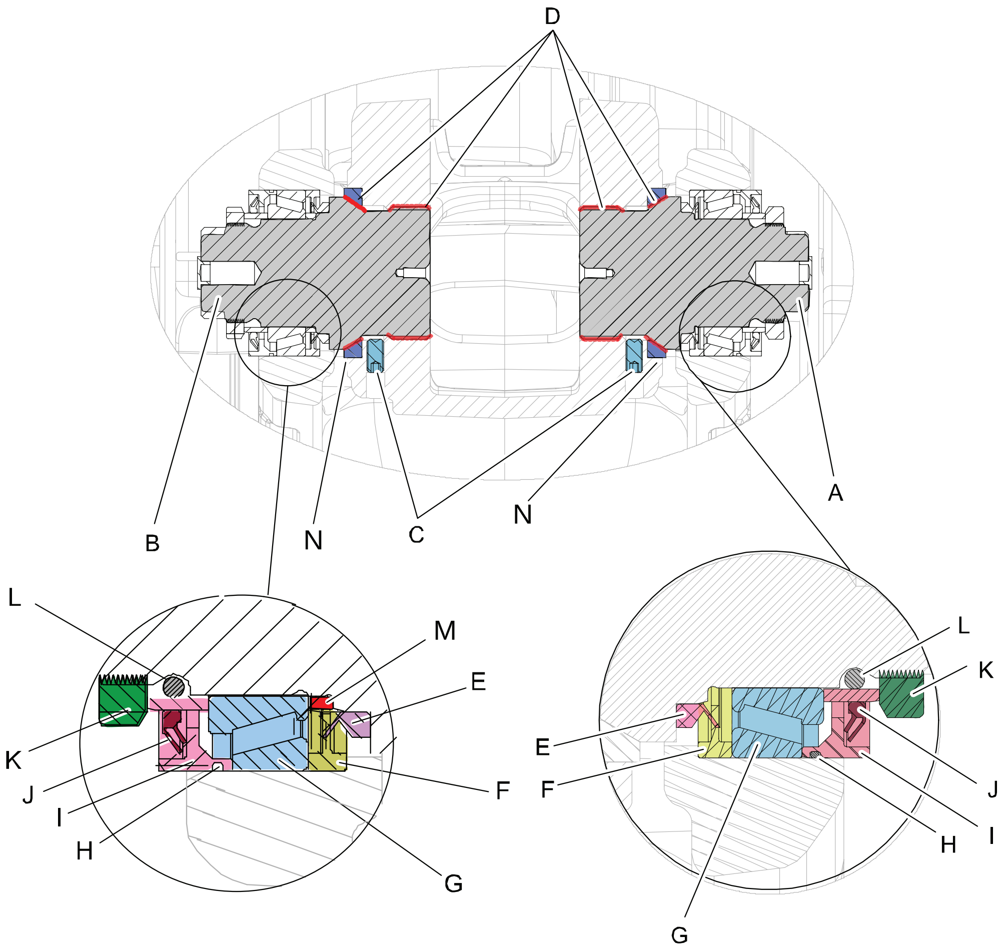
IRB 6660 - 205/1.9



xx0700000637

A	Shaft, axis 2
B	Shaft, axis 3
C	Set screw, cup point M10x20 quality 45H-A3F
D	Surfaces where to apply lubricant paste (Molycote 1000)
E	Sealing ring (V-ring)
F	Sealing ring
G	Taper roller bearing
H	O-ring
I	Sealing ring
J	Sealing assembly (including support ring)
K	Lock nut (KM12)
L	O-ring (Di = 54.2 mm, t = 5.7 mm)
M	Spacer ring

Continues on next page

Required equipment

Equipment, etc.	Art.no.	Note
Upper arm, axis 4	For spare part number, see *Spare part lists on page 395*.	
Support ring	For spare part number, see *Spare part lists on page 395*.	2 pcs Install on a new upper arm.
Grease filling tool	-	
Rust preventive	3HAC034903-001	Mercasol 3110 Waxcoat
Press tool, support ring	3HAC072616-001	Used to press in the support rings in the upper arm housing.
KM12 socket	3HAC023739-001	
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243)
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See chapter *General references on page 10*.

Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.

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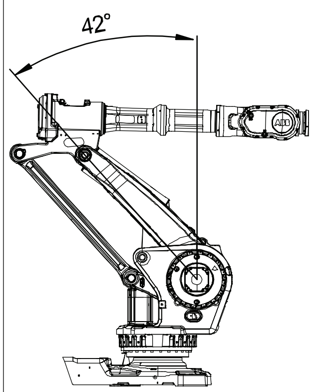
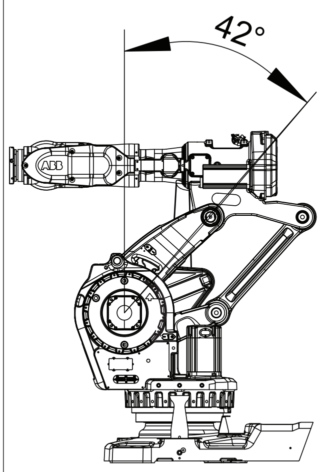
	Action	Note
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, upper arm

The procedure below details how to remove the upper arm.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Remove all equipment fitted to the turning disk.	
3	Move the upper arm to a horizontal position. Rotate axis 4 so that the attachment hole for lifting eye is facing upwards.	IRB 6660 - 130/3.1, IRB 6660 - 100/3.3  xx0700000137 IRB 6660 - 205/1.9  xx0700000518

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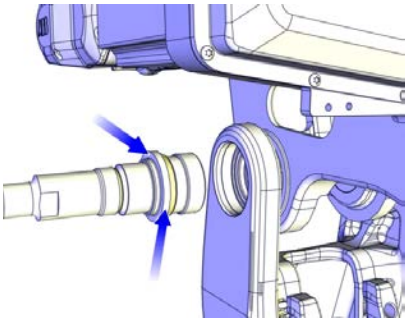
	Action	Note
4	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
5	Secure the *upper arm* with lifting slings in an overhead crane.	
6	Drain the oil from axis 4.	Detailed in section *Changing oil, axis-4 gearbox on page 151*.
7	Remove the *cable harness* in the upper arm.	Detailed in section *Replacement of cable harness, upper end on page 194*
8	**CAUTION** The complete upper arm weighs 380 kg without any additional equipment fitted! Use a suitable lifting accessory to avoid injury to personnel!	
9	Raise the lifting equipment to take the weight of the upper arm.	
10	**(Not applicable to robot variant IRB 6660 - 205/1.9!)** Remove the *balancing device*.	Detailed in section *Replacing the balancing device on page 267*
11	Remove the *parallel rod.*	Detailed in section *Replacing the parallel rod on page 238*
12	Remove the shaft, axis 3 (B): 1 Remove the *lock nut* (K). 2 Remove the *set screw* (C) holding the *shaft*. 3 Remove the shaft.	Shown in the figure *View of the assembly of the upper arm components on page 227*. Perform the removal with care. Threads can otherwise be damaged! Art.no. is specified in *Required equipment on page 229*
13	Then remove the *shaft, axis 2* (A) in the same order: 1 Remove the *lock nut* (K) 2 Remove the *set screw* (C) holding the shaft 3 Remove the *shaft axis 2*.	Shown in the figure *View of the assembly of the upper arm components on page 227*.
14	Put the *shafts* in a clean and safe place.	
15	Remove the *upper arm*.	

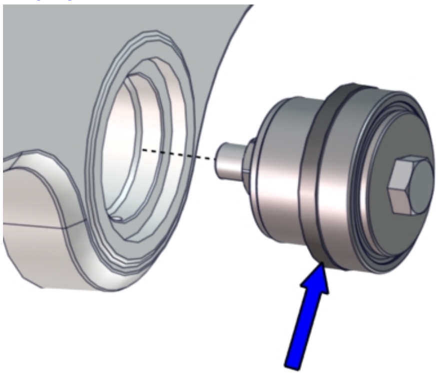
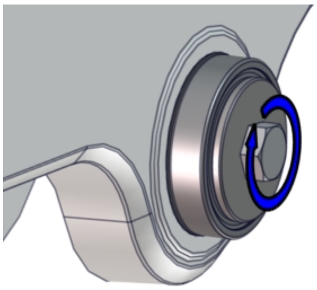
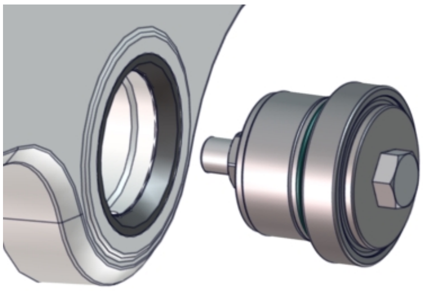
Continues on next page

Preparations before refitting, upper arm

The procedure below details the preparations which must be done before refitting the upper arm.

	Action	Note
1	Prepare the shafts: • Put the *shafts* (A & B) on a workbench and fit the *sealing rings* (E). • Lubricate the sealing rings with grease. • Fit the *spacer ring* (M) to the axis-3 *shaft* (B). • Apply some grease on the *shafts*. **Note** Don´t apply grease on the threads and cones of the shafts! • Apply *lubricant paste* (D) on the threads and cones of the *shafts*. Molycote 1000. • *Foundry Plus:* Apply rust preventive on the surfaces on the shaft, according to illustration. **Note** Apply rust preventive to the shafts on both sides of the robot.  xx1400001124	Shown in the figure *View of the assembly of the upper arm components on page 227*.
2	Prepare the bearings: Fill the *bearings* (G) with bearing grease. Use grease filling tool.	Art. no. is specified *Required equipment on page 229* Shown in the figure *View of the assembly of the upper arm components on page 227*.

Continues on next page

	Action	Note
3	Install two support rings to the upper arm: 1. Fit a support ring to the press tool and lubricate with grease for easier assembly. 2. Press in the support ring to the upper arm housing by screwing on the press tool assembly. Tighten with 120 Nm. 3. Remove the press tool. The support ring is now fitted to the upper arm housing. 4. Repeat the procedure on the other side. **CAUTION** If the support ring is mounted askew, there is a risk of play between the shaft and the upper arm. Make sure the support rings are aligned correctly (level) inside the upper arm housing.	Art. no. is specified *Required equipment on page 229*  xx1900001713  xx1900001714  xx1900001205

Refitting, upper arm

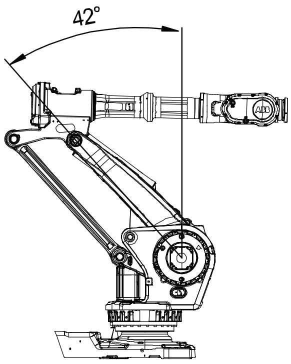
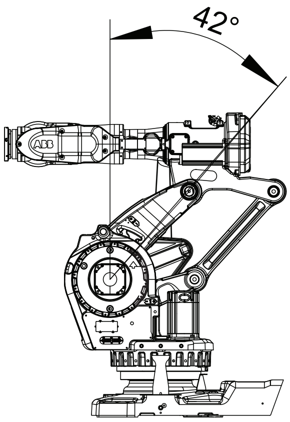
The procedure below details how to refit the upper arm.

Note

Refit the axis 3 side first!

	Action	Note
1	Secure the *upper arm* with lifting slings in an overhead crane.	

Continues on next page

	Action	Note
2	**CAUTION** The complete upper arm weighs 380 kg without any additional equipment fitted! Use a suitable lifting accessory to avoid injury to personnel!	
3	Lift the *upper arm* with an overhead crane and move it to its mounting position. Make sure that the *upper arm* is placed in a horizontal position.	IRB 6660 - 130/3.1, IRB 6660 - 100/3.3  xx0700000137 IRB 6660 - 205/1.9  xx0700000518
4	**Refit the axis-3 shaft:** 1 Carefully refit the *shaft, axis 3* (B) by hand only. Do not use force since the threads can be damaged if fitting is not done in the correct way. 2 Secure the shaft. Tightening torque: 800 Nm. 3 Refit the *sealing ring* (F) on the *shaft*.	Shown in the figure *View of the assembly of the upper arm components on page 227*. Art. no. is specified *Required equipment on page 229* Loctite 2400 (or equivalent Loctite 243)

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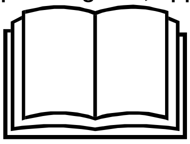
	Action	Note
5	Refit the *bearing* (G) on the *shaft* with the pressing tool, upper arm.  xx0900000813 Go to the user instructions enclosed with the press tool. **DANGER** Handling the tool incorrectly will cause serious injury. Read and follow enclosed user instructions for the tool.	Art. no. is specified in *Required equipment on page 229*.
6	Fit an *o-ring* (H) on the *sealing ring* (I) and fit it on the *shaft*. **Note** The o-ring shall be faced against the *bearing*.	
7	Fit the *o-ring* (L) on the *sealing assembly* (J) and refit the *sealing assembly* on the *shaft*.	
8	Apply locking liquid on the *lock nut* (K) and refit it using a *KM12 socket*. Tightening torque 90 Nm.	Loctite 2400 (or equivalent Loctite 243)
9	**Refit the axis-2 shaft:** 1 Carefully refit the *shaft, axis 2* (A) by hand only. Do not use force since the threads can be damaged if fitting is not done in the correct way. 2 Secure the shaft. Tightening torque: 800 Nm. 3 Refit the *sealing ring* (F) on the *shaft*.	Shown in the figure *View of the assembly of the upper arm components on page 227*. Art. no. is specified *Required equipment on page 229* Loctite 2400 (or equivalent Loctite 243)

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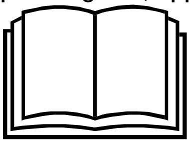
	Action	Note
10	Refit the *bearing* (G) on the *shaft* with the pressing tool, upper arm.  xx0900000813 Go to the user instructions enclosed with the press tool. **DANGER** Handling the tool incorrectly will cause serious injury. Read and follow enclosed user instructions for the tool.	Art. no. is specified in *Required equipment on page 229*.
11	Fit an *o-ring* (H) on the *sealing ring* (I) and fit it on the *shaft*. **Note** The o-ring shall be faced against the *bearing*.	
12	Fit the *o-ring* (L) on the *sealing assembly* (J) and refit the *sealing assembly* on the *shaft*.	
13	Apply locking liquid on the *lock nut* (K) and refit it using a *KM12 socket*: a Fit the *lock nut* with a tightening torque of 300 Nm. b Unscrew the *lock nut*. c	Loctite 2400 (or equivalent Loctite 243)
14	Fit the *lock nut* once again. This time with a tightening torque of 90 Nm.	
15	Apply locking liquid in the holes for the *set screws* (C) and fit the screws.	Shown in the figure *View of the assembly of the upper arm components on page 227* Loctite 2400 (or equivalent Loctite 243) Tightening torque: 35 Nm.
16	Wipe residual grease from the *shafts*.	
17	Refit the **parallel rod.**	Detailed in section *Replacing the parallel rod on page 238*
18	Refit the *cable harness, upper end*.	Detailed in section *Replacement of cable harness, upper end on page 194*
19	**(Not applicable to the robot variant IRB 6660 - 205/1.9!)** Refit the *balancing device*.	Detailed in section *Replacing the balancing device on page 267*

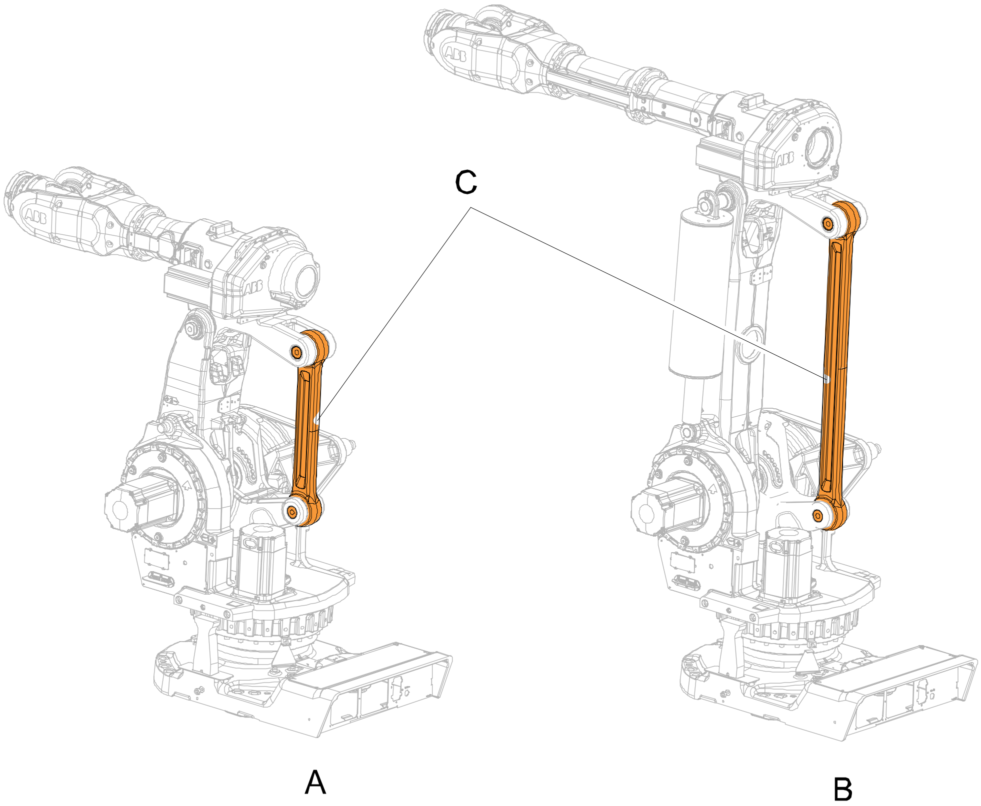
Continues on next page

	Action	Note
20	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
21	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.4.4 Replacing the parallel rod

Location of parallel rod

The parallel rod is located as shown in the figure.



xx0700000064

A	Robot variant IRB 6660 - 205/1.9
B	Robot variant IRB 6660 - 130/3.1, IRB 6660 - 100/3.3
C	Parallel rod

Required equipment

Equipment, etc.	Art.no.	Note
Parallel rod	For spare part no. see: • *Spare part lists on page 395*.	
Mounting/Demounting tool	3HAC5021-1	
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243)
Rust preventive	3HAC034903-001	Mercasol 3110 Waxcoat
Protection plug	3HAC4836-2	F21 28x22, 4x12x9
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

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

Removing, parallel rod

Use this procedure to remove the parallel rod. The procedure is the same in both ends of the parallel rod.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**CAUTION** Secure the upper arm with a roundsling in an overhead crane or similar, in order to avoid accidents.	
3	*Foundry Plus:* Remove the protection plugs	

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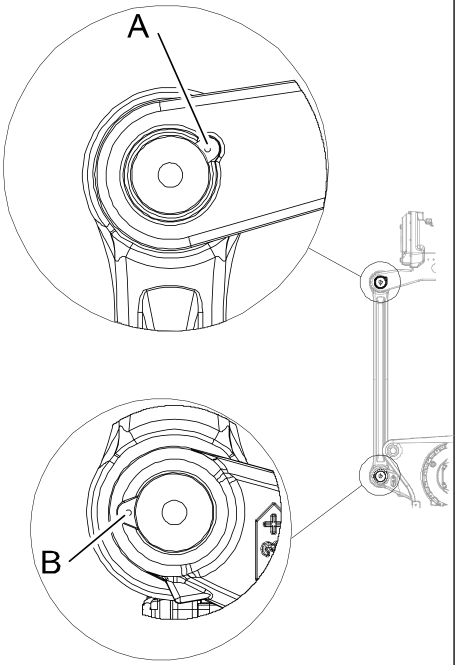
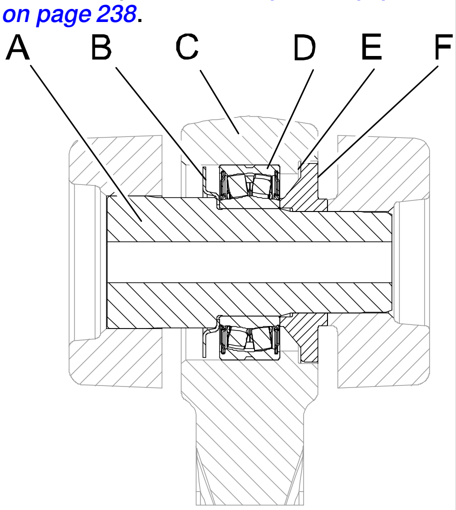
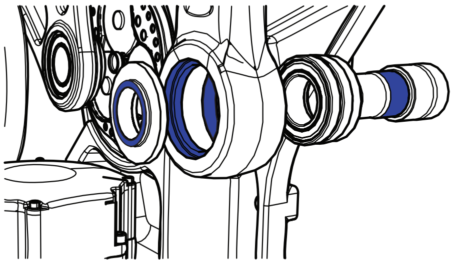
	Action	Note
4	Remove the upper *lock screw* and *washer*, that secure the parallel rod in position.	 xx0700000066 Parts: • A: Lock screw M6x16, (upper) • B: Lock screw M6x16, (lower)
5	Remove the upper *shaft* (A) and *cover washer* (B), using the *fitting/removing tool*.	Art. no. is specified in *Required equipment on page 238*.  xx0700000065 Parts: A Shaft B Cover washer C Parallel rod D Sealed spherical bearing E Bearing grease F Thrust washer
6	Remove the *thrust washer* (F).	See figure above!

Continues on next page

	Action	Note
7	**CAUTION** The parallel rod weighs 45 kg. All lifting accessories used must be sized accordingly!	
8	Move the *parallel rod* backwards from its upper connection point and let it rest against the frame and base.	See figure above and *Location of parallel rod on page 238*!
9	Secure the parallel rod with a roundsling in an overhead crane or similar.	
10	Remove the lower end of the parallel rod in the same way as the upper end: 1 Remove the lower *lock screw* and washer. 2 Remove the lower *shaft* (A)and *cover washer* (B). 3 Remove the *thrust washer* (F).	See figure above!
11	Remove the parallel rod from the robot.	
12	Replace the *bearings* (D), if necessary.	See figure above!

Refitting, parallel rod

Use this procedure to refit the parallel rod. The procedure is the same in both ends of the parallel rod.

	Action	Note
1	Start by refitting the lower end.	
2	Verify that the bearings are in correct position in the parallel rod.	
3	**CAUTION** The parallel rod weighs 45 kg. All lifting accessories used must be sized accordingly!	
4	Lift the parallel rod to the mounting position of the lower end, and let it rest on the the frame and base.	
5	*Foundry Plus:* Apply rust preventive on the highlighted areas. **Note** Rust preventive should be applied in both ends of the parallel rod.	 xx1400001126

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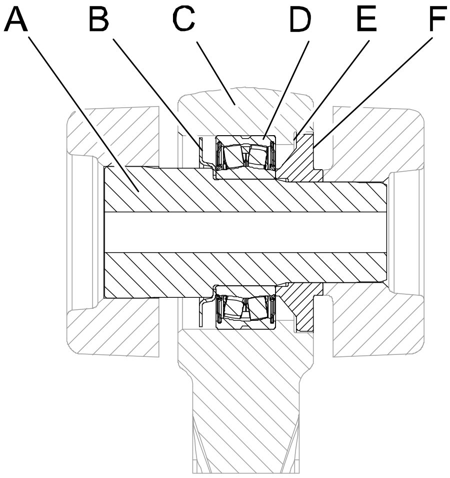
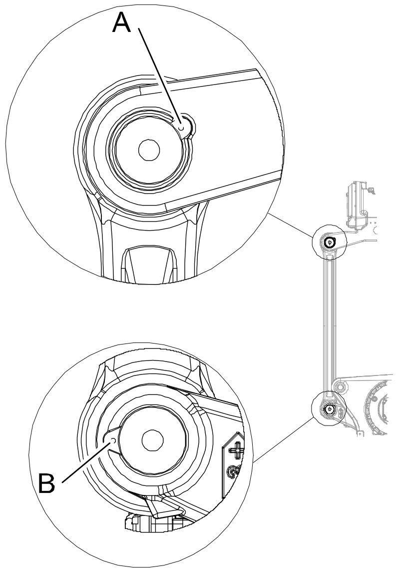
	Action	Note
6	Put the *thrust washer* (F) on the axis 2 side of the *parallel rod* (C).	 xx0700000065 Parts: A Shaft B Cover washer C Parallel rod D Sealed spherical bearing E Bearing grease F Thrust washer
7	Put the *cover washer* (B) on the axis 3 side of the parallel rod.	See figure above!
8	Refit the *shaft* (A) by pressing it through the parallel bar with the *fitting/removing tool*.	Art. no. is specified in *Required equipment on page 238*. See figure above!
9	Apply *locking liquid* in the hole of the lock screw.	Loctite 2400 (or equivalent Loctite 243)
10	Refit the *lock screw* and plain washer.	 xx0700000066 Parts: • A: Lock screw M6x16, (upper) • B: Lock screw M6x16 (lower)

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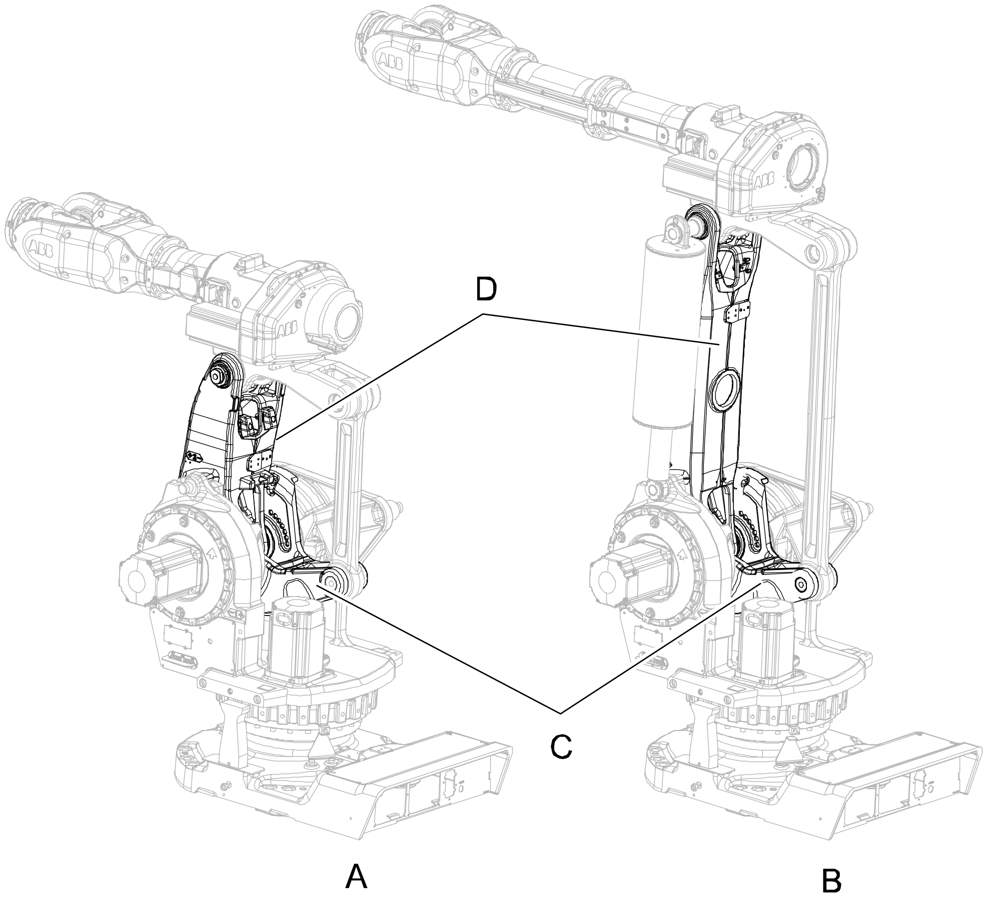
	Action	Note
11	Lift the parallel rod up into position for fitting the upper end.	
12	Refit the upper end of the parallel rod in the same way as the lower end.	
13	*Foundry Plus:* Refit the protection plugs.	
14	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.4.5 Replacing the complete lower arm

Location of lower arm

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



xx0700000067

A	Lower arm
B	Parallel arm

Required equipment

Equipment, etc.	Art.no.	Note
Lower arm	For spare part no. see: • *Spare part lists on page 395*.	
Sealing, axes 2/3		Always change the sealing.
Guide sleeves	3HAC14446-1	Used to keep the axes 2/3 sealing in place during refitting of lower arm.
Crank	3HAC023132-001	
Lock screw	-	M16x90
Lifting tool, lower arm complete	3HAC8446-1	

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Equipment, etc.	Art.no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *General references on page 10*.

Deciding calibration routine

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

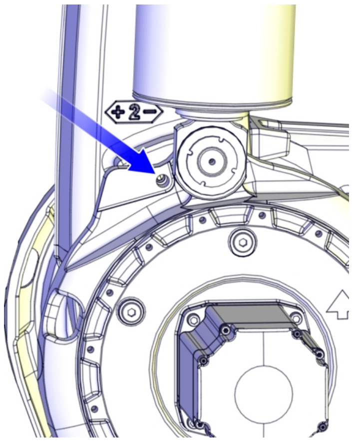
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, lower arm

The procedure below details how to remove the lower arm.

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

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Secure the lower arm with a *lock screw* in the hole as shown in the figure to the right. **CAUTION** Tighten by hand!	 xx1000001101
4	**(Not applicable to robot variant IRB 6660 - 205/1.9 !)** Remove the balancing device.	See *Replacing the balancing device on page 267*
5	Remove the parallel rod.	Also see
6	Remove the cable harness in the upper and lower arm. Secure the cable harness in a way that it is protected from oil spill and damage.	Also see
7	Remove the complete upper arm.	See *Replacement of upper arm on page 225*.
8	Remove the axes 2 and 3 motors.	See *Replacing motors, axes 2 and 3 on page 282*.
9	Remove the axes 2 and 3 gearboxes.	Also see
10	**CAUTION** The robot lower arm weighs 160 kg (IRB 6660 - 100/3.3, IRB 6660 - 130/3.1) / 110 kg (IRB 6660 - 205/1.9). All lifting accessories used must be sized accordingly!	
11	Secure the complete lower arm system (including the parallel arm) with a *lifting tool, lower arm complete* in an overhead crane or similar.	Specified in *Required equipment on page 244*.

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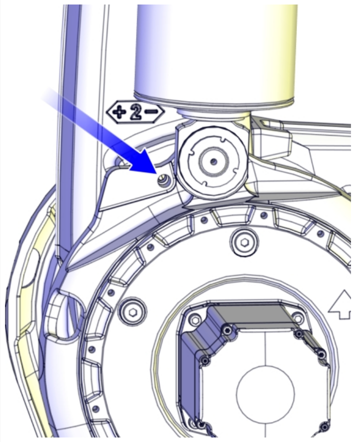
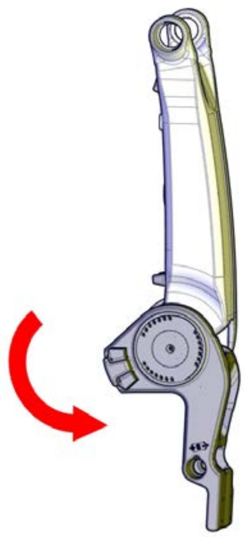
	Action	Note
12	Remove the *lock screw* that secures the lower arm system.	 xx1000001101
13	Remove all M12 and M16 screws that hold the lower arm, on both sides. **Note** The axis 3 side has no M16 screws!	
14	**DANGER** Secure the parallel arm to the lower arm before lifting the lower arm system. If not secured, the parallel arm can fall down and cause a serious accident!	 xx1000001359
15	**CAUTION** The parallel arm system weighs 92 kg. All lifting accessories used must be sized accordingly!	

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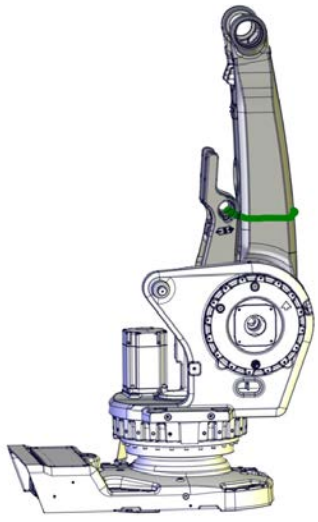
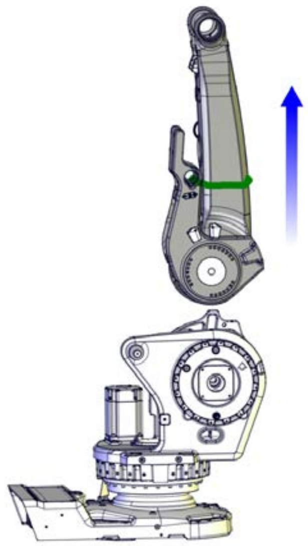
	Action	Note
16	Move the parallel arm and secure it to the lower arm as shown in the figure, to prevent it from falling down.	 xx1000001357
17	The space between the gearboxes is cramp. Push therefor the lower and parallel arm together with help of an iron bar or similar before removing them.	**Note** If the parts are not pushed together, it will be difficult to remove the complete lower arm.
18	**CAUTION** The robot lower arm weighs 160 kg (IRB 6660 - 100/3.3, IRB 6660 - 130/3.1) / 110 kg (IRB 6660 - 205/1.9). All lifting accessories used must be sized accordingly!	
19	Remove the complete lower arm (including the parallel arm).	 xx1000001358

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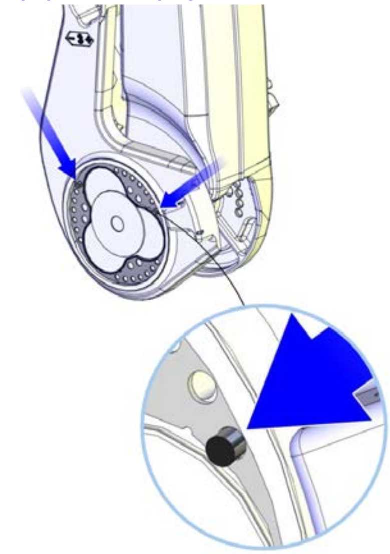
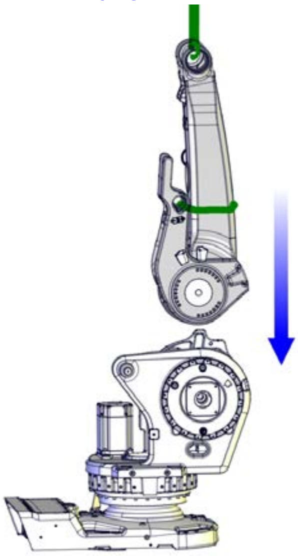
	Action	Note
20	How to replace the parallel arm is detailed in section *Replacement of parallel arm on page 252*.	

Refitting, lower arm

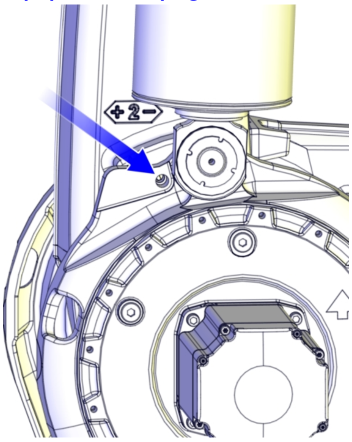
Use this procedure to refit the lower arm system.

	Action	Note
1	Fit the parallel arm to the lower arm.	See *Replacement of parallel arm on page 252*.
2	**CAUTION** The robot lower arm weighs 160 kg (IRB 6660 - 100/3.3, IRB 6660 - 130/3.1) / 110 kg (IRB 6660 - 205/1.9). All lifting accessories used must be sized accordingly!	
3	Fit a *lifting tool, lower arm complete*, to the lower arm system and lift it up. **DANGER** Secure the parallel arm to the lower arm before lifting the lower arm system. If not secured, the parallel arm can fall down and cause a serious accident!	Specified in *Required equipment on page 244*.
4	Fit two *guide sleeves* for the axes 2/3 sealings to the lower arm and put the sealings on them. See figure.	Art. no. is specified in *Required equipment on page 244*.  xx1000001368

Continues on next page

	Action	Note
5	Put the lower arm in its mounting position. If the hole pattern needs to be adjusted, use a *crank* to move the gears in order to find the correct hole pattern.	Art. no. is specified in *Required equipment on page 244*.  xx1000001370
6	**Note** Refit the axis 2 side first!	
7	Verify that the sealings are still in place.	
8	Refit all screws (both M12 and M16) and washers, that are possible to fit at this stage, on the axis 2 side.	Tightening torque M16: 300 Nm Tightening torque M12: 120 Nm
9	Push the parallel arm against the axis 3 side with the help of an iron bar or similar.	
10	Refit all screws and washers, that are possible to fit, on the axis 3 side. **Note** The axis 3 side has no M16 screws!	Tightening torque M12: 120 Nm
11	Remove the guide sleeves and secure two screws more.	
12	Change the position of the lower arm in order to reach the remaining attachment holes, and fit the remaining screws.	

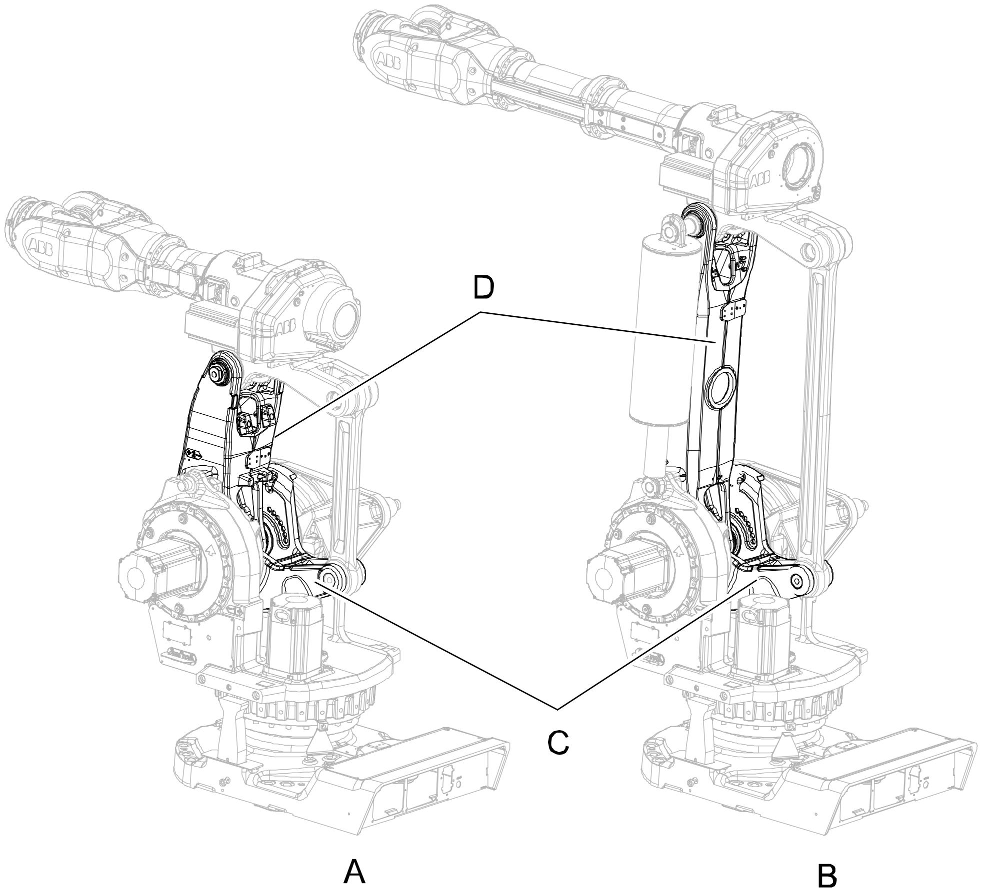
Continues on next page

	Action	Note
13	Secure the lower arm by fitting a *lock screw*. **CAUTION** Tighten by hand!	Dimension is specified in *Required equipment on page 244*.  xx1000001101
14	Refit the axes 2 and 3 gearboxes.	See *Replacing the gearbox, axes 2-3 on page 324*.
15	Refit the axes 2 and 3 motors.	See *Replacing motors, axes 2 and 3 on page 282*.
16	Refit the complete upper arm.	See *Replacement of upper arm on page 225*.
17	Refit the cable harness.	Also see
18	Refit the parallel rod.	See *Replacing the parallel rod on page 238*
19	**(Not applicable to robot variant IRB 6660 - 205/1.9 !)** Refit the balancing device.	Also see
20	Remove the lock screw.	
21	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
22	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.4.6 Replacement of parallel arm

Location of parallel arm

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



xx0700000067

A	Robot variant IRB 6660 - 205/1.9
B	Robot variant IRB 6660 - 130/3.1, IRB 6660 - 100/3.3
C	Parallel arm
D	Lower arm

Required equipment

Equipment, etc.	Art.no.	Note
Parallel arm	For spare part no. see: • *Spare part lists on page 395*.	
VK cover	3HAA2166-23	D=120 mm, T=12 mm
VK cover	3HAA2166-18	D=35 mm, T=8 mm
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD
Rust preventive	3HAC034903-001	Mercasol 3110 Waxcoat

Continues on next page

Equipment, etc.	Art.no.	Note
Press equipment	3HAC076749-001	For replacing the bearings on parallel arm. User instructions are enclosed with the tool.
Lifting accessory, parallel arm	3HAC023098-001	
Lifting accessory, lower arm complete	3HAC8446-1	
Level	-	
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

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

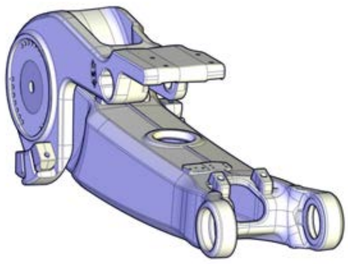
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, parallel arm

Use this procedure to remove the parallel arm.

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

Continues on next page

	Action	Note
2	 **DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the complete lower arm.	See *Replacing the complete lower arm on page 244*.
4	Put the complete lower arm on a workbench as shown in the figure.  **Tip** Removal of the parallel arm is best performed on a workbench.	 xx1000001024
5	Remove the two VK covers.	 xx1000001371

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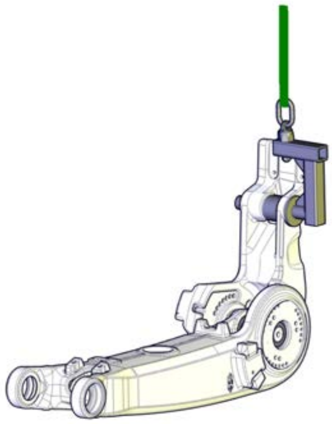
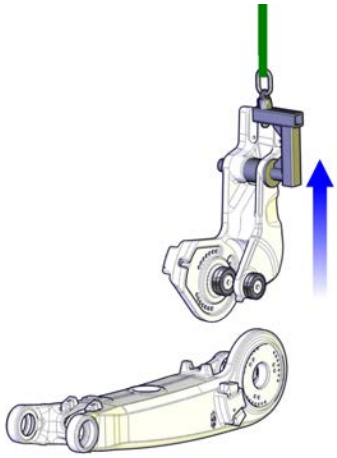
	Action	Note
6	Fit the *lifting accessory, parallel arm* on the parallel arm. Lift the parallel arm to the position shown in the figure.	Art. no. is specified in *Required equipment on page 252*.  xx1000001375
7	Disassemble the parallel arm from the lower arm by using the *pressing tool, lower arm*.	Art. no. is specified in *Required equipment on page 252*.
8	**CAUTION** The parallel arm system weighs 92 kg. All lifting accessories used must be sized accordingly!	
9	Remove the parallel arm.	 xx1000001018

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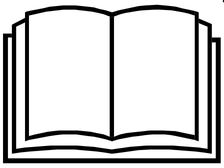
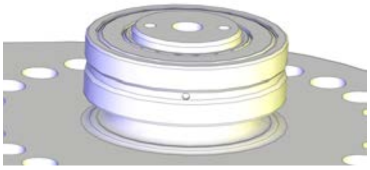
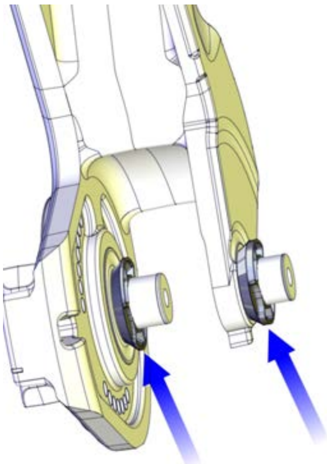
	Action	Note
10	If needed, replace bearings, using the *press equipment, parallel arm*, according to user instructions enclosed with the equipment.  xx0900000813 Go to the user instructions enclosed with the press tool. **DANGER** Handling the tool incorrectly will cause serious injury. Read and follow enclosed user instructions for the tool.	 xx1100000218

Refitting, parallel arm

Use this procedure to refit the parallel arm.

	Action	Note
1	Refitting of the parallel arm is best performed on a workbench.	
2	Check that the assembly and the condition of the *bearing* is good.	
3	Apply some *grease* on the shafts on the parallel arm.	Specified in *Required equipment on page 252*
4	Refit a *spacing sleeve* on each shaft.	 xx1000001376

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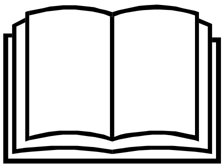
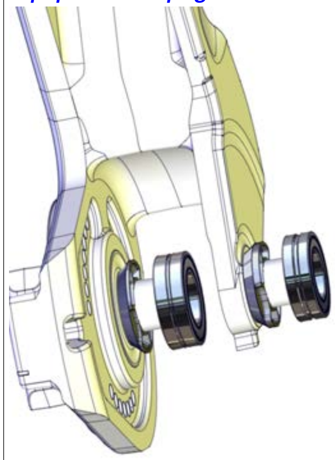
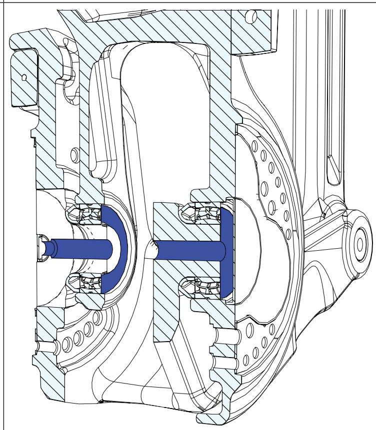
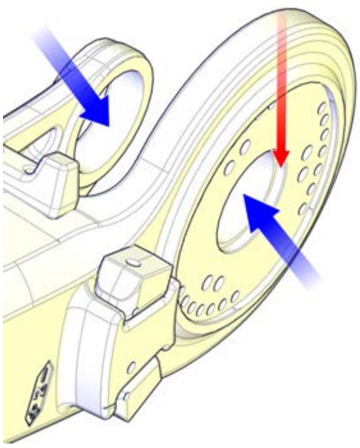
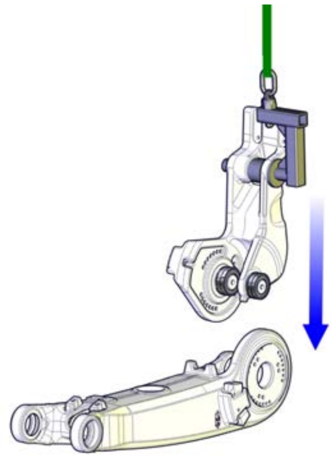
	Action	Note
5	Refit a bearing on each shaft with *pressing tool, lower arm*.  xx0900000813 Go to the user instructions enclosed with the press tool.  **DANGER** Handling the tool incorrectly will cause serious injury. Read and follow enclosed user instructions for the tool.	Art. no. is specified in *Required equipment on page 252*  xx1000001377
6	*Foundry Plus:* Apply rust preventive on the highlighted areas.	 xx1400001127
7	Refit the protection washer on the inner shaft.	
8	Refit the lock ring on the inner shaft.	
9	 **CAUTION** The parallel arm system weighs 92 kg. All lifting accessories used must be sized accordingly!	
10	Fit the *lifting accessory, parallel arm*.	Art. no. is specified in *Required equipment on page 252*.
11	Lift the parallel arm onto the workbench where the lower arm is placed.	Art. no. is specified in *Required equipment on page 252*
12	Adjust the lower arm in a way that both holes are parallel. Use a *level*.	

Continues on next page

	Action	Note
13	Apply some *grease* in the holes in the lower arm (thick blue arrows). **Note** Do not put grease on the surfaces for the VK covers (thin red arrow)!	 xx1000001380
14	Lift the parallel arm, lower it and put it in mounting position with the lower arm.	 xx1000001379
15	Carefully press the parallel arm onto the lower arm using the *pressing tool, lower arm*.	Art. no. is specified in *Required equipment on page 252*.
16	Fit the big and small VK cover.	
17	Refit the complete lower arm.	Detailed in section *Replacing the complete lower arm on page 244*.
18	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.

Continues on next page

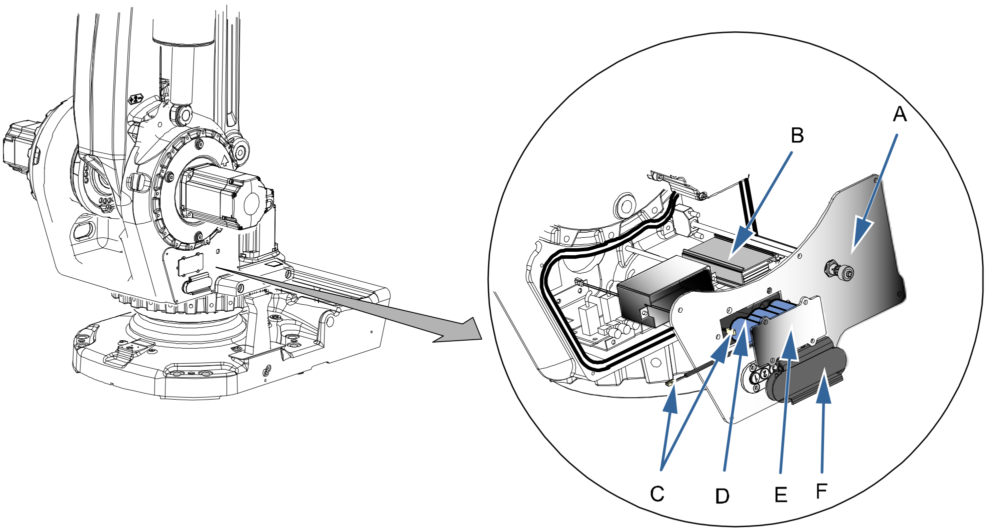
	Action	Note
19	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.5 Frame and base

4.5.1 Replacing the SMB unit

Location of SMB unit

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



xx0600002621

A	SMB cover
B	SMB unit
C	Battery cable
D	SMB battery
E	SMB battery, cover

Required equipment

Note

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

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

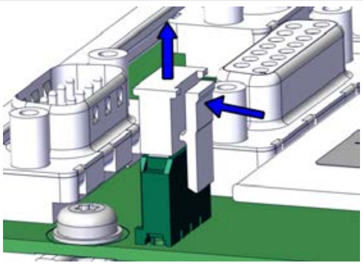
Equipment, etc.	Article number	Note
SMB unit	For spare part number, see: *Spare part lists on page 395*.	
Battery pack	For spare part number, see: *Spare part lists on page 395*.	

Continues on next page

Equipment, etc.	Article number	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Circuit diagram	-	See chapter *General references on page 10*.

Removing, SMB unit

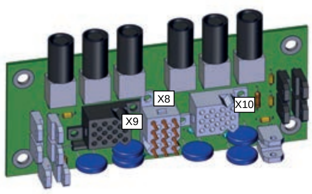
Use this procedure to remove the SMB unit.

	Action	Note
1	Move the robot to the calibration position.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *The unit is sensitive to ESD on page 53*.	
4	Remove the SMB cover by unscrewing its attachment screws. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	Shown in the figure *Location of SMB unit on page 260*.
5	Use caution and remove the connectors X8, X9 and X10 from the brake release board, if need of more space.	
6	Remove the nuts and washers from the guide pins that secure the board.	Shown in the figure *Location of SMB unit on page 260*.
7	Use caution and disconnect the connectors from the SMB unit when pulling the board out.	Connectors R1.SMB1-3, R1.SMB4-6 and R2.SMB
8	Disconnect the battery cable by pressing down the upper lip of the R2.G connector to release the lock while pulling the connector upwards.	 xx1700000993

Continues on next page

Refitting, SMB unit

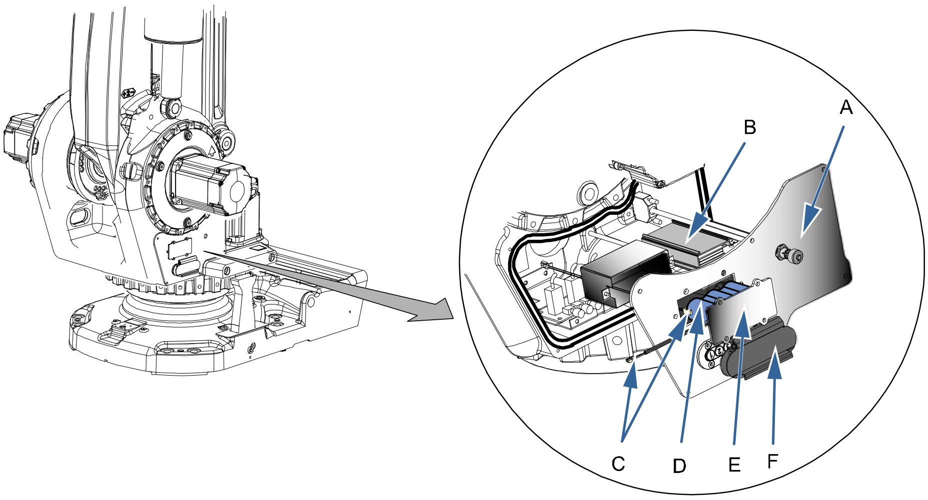
Use this procedure to refit the SMB unit.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *The unit is sensitive to ESD on page 53*.	
3	Connect the *battery cable* to the SMB unit. Make sure the lock on the battery cable connector R2.G snaps into place during refitting.	Shown in the figure *Location of SMB unit on page 260*.
4	Connect all connectors to the SMB board: R1.SMB1-3, R1.SMB4-6 and R2.SMB	Art. no. is specified in *Required equipment on page 260*. Shown in the figure *Location of SMB unit on page 260*.
5	Fit the *SMB unit* onto the *guide pins*.	
6	Secure the SMB unit to the pins with the nuts and washers.	
7	If disconnected, reconnect the connectors X8, X9 and X10 to the brake release board. Be careful not to damage the sockets or pins. Make sure the connector and its locking arms are snapped down properly.	 xx1700000978
8	Secure the *SMB cover* with its attachment screws. If cabling is used for 7th axis (option), refit the 7th axis connector to the SMB cover and tighten with 6 Nm.	Shown in the figure *Location of SMB unit on page 260*.
9	Update the revolution counters.	See *Updating revolution counters on IRC5 robots on page 349*.
10	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.5.2 Replacing the brake release board

Location of brake release board

The brake release unit is located together with the SMB unit on the left hand side of the frame, right next to the gearbox, axis 2, as shown in figure below.



xx0600002621

A	SMB cover
B	SMB unit
C	Battery cable
D	SMB battery
E	SMB battery, cover

Required equipment

Equipment, etc.	Article number	Note
Brake release board	3HAC065020-001	DSQC1050
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

Removing, brake release board

Use this procedure to remove the brake release board.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *The unit is sensitive to ESD on page 53*.	
3	Remove the cover for the push button guard.	
4	Remove the push button guard from the SMB cover.	Shown in the figure *Location of brake release board on page 263*. The guard must be removed to ensure a correct refitting of the brake release board.
5	Open the SMB cover by unscrewing the attachment screws. Let the battery stay connected, to avoid the need of synchronization of the robot! **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	Shown in the figure *Location of brake release board on page 263*.
6	Take a picture or make notes of how the robot cabling is positioned in regard to the brake release board.	
7	Remove the complete brake release board (including brake release board and bracket) from the SMB recess, by removing its two attachment screws.	

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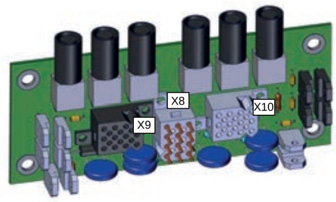
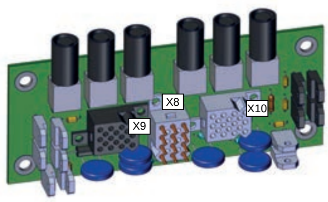
	Action	Note
8	Disconnect the connectors X8, X9 and X10 from the brake release board.	 xx1700000978 Location of the brake release unit is shown in the figure *Location of brake release board on page 263*.
9	Remove the brake release board from the bracket by removing the four attachment screws.	

Refitting, brake release board

Use this procedure to refit the brake release board.

	Action	Note
1	 **ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *The unit is sensitive to ESD on page 53*.	
2	Connect the connectors X8, X9 and X10 to the brake release board. Be careful not to damage the sockets or pins. Make sure the connector and its locking arms are snapped down properly.	 xx1700000978
3	Fasten the *brake release board* on the bracket with the attachment screws. Make sure the board is positioned as straight as possible on the bracket! The push buttons can otherwise get jammed when the SMB cover is refitted.	Maximum tightening torque: 5 Nm. Shown in the figure *Location of brake release board on page 263*. Art. no. is specified in *Required equipment on page 263*.
4	Refit the complete brake release board (including brake release board and bracket) to the SMB recess with the two attachment screws.	
5	Verify that the robot cabling is positioned correctly, according to previously taken picture/notes.  **WARNING** Screened cables must not get in contact with the brake release board after installation. Eliminate all risks of contact between screened cables and the brake release board.	

Continues on next page

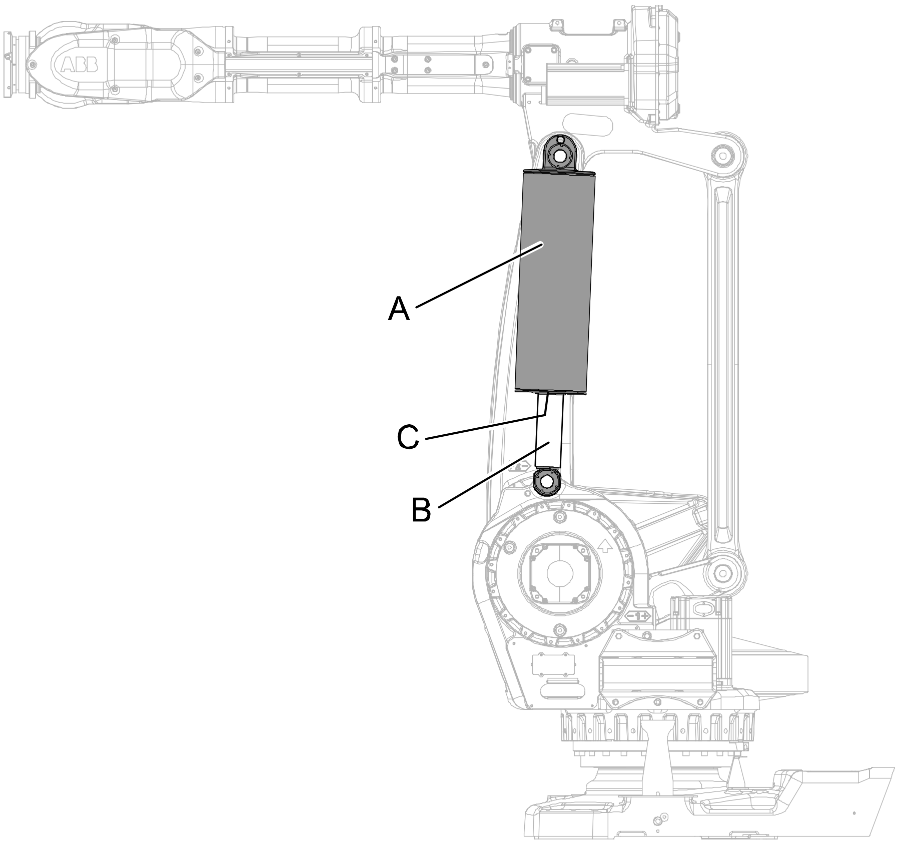
	Action	Note
6	Refit the *SMB cover* with its attachment screws.	Shown in the figure *Location of brake release board on page 263*.
7	**WARNING** Before continuing any service work, follow the safety procedure in *The brake release buttons may be jammed after service work on page 178*.	
8	Refit the *push button guard* to the SMB cover.	Shown in the figure *Location of brake release board on page 263*.
9	Refit the *cover, push button guard*.	
10	Press the push buttons 1 to 6, one at a time, to make sure that the buttons are moving freely and do not stay in a locked position.	
11	If the battery has been disconnected the revolution counter must be updated.	Detailed in the Calibration chapter - section *Updating revolution counters on IRC5 robots on page 349*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.5.3 Replacing the balancing device

> **Note**
>
> This section is only applicable to robot variant IRB 6660 - 100/3.3, IRB 6660 - 130/3.1.

Location, balancing device

The balancing device is located as shown in the figure.



xx0700000019

A	Balancing device
B	Piston rod
C	Guide ring (not visible in this figure)

Required equipment

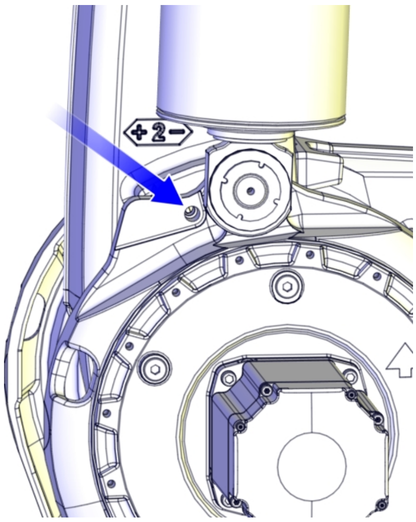
Equipment, etc.	Art.no.	Note
Balancing device	For spare part number, see *Spare part lists on page 395*.	
Auxiliary shaft	3HAC5281-1	For fitting the inner rings of the bearings
Auxiliary shaft, long	3HAC5275-1	

Continues on next page

Equipment, etc.	Art.no.	Note
Auxiliary shaft, short	3HAC5276-1	
Lock screw	-	M16 x 90 For securing the lower arm.
Screw		2 pcs, M12 x 50 For neutralizing the spring force of the balancing cylinder.
Lubrication tool	3HAC5222-2	
Lifting accessories	-	
Locking liquid	-	Loctite 2400 (or equivalent Loctite 243)
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Ball bearing puller	-	

Removing, balancing device

Use this procedure to remove the balancing device.

	Action	Note
1	Move the robot to a position close enough to its calibration position, to allow the lock screw to be inserted into the hole for the lock screw.	The balancing device must be placed in a 90° angle from the floor, in order the be lifted in the most secure way. See the figure in *Location, balancing device on page 267*.
2	Lock the lower arm by inserting the *lock screw* into the *hole*. **CAUTION** Tighten by hand!	 xx1000001101
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

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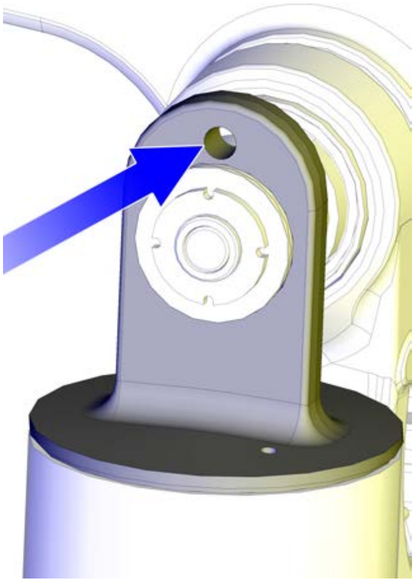
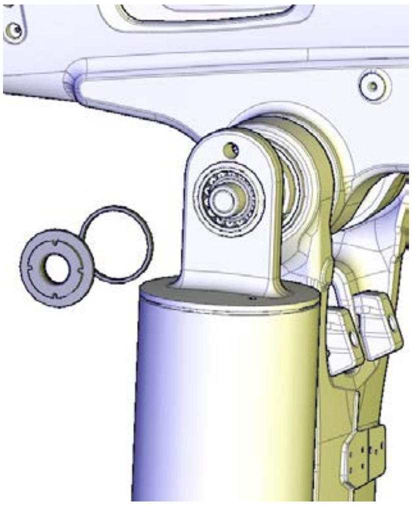
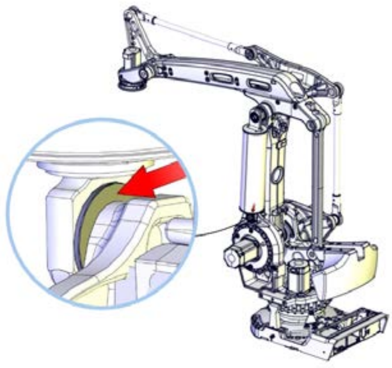
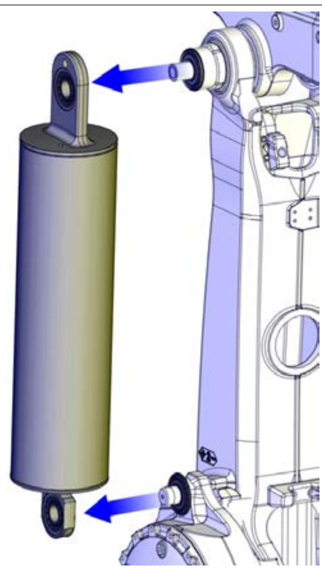
	Action	Note
4	Remove the *protection hood* in the upper end of the balancing device.	
5	Insert two *screws, M12x50* in the holes to neutralize the spring force. Screw in the screws until they have proper contact with the cylinder inside. The length of the cylinder is now locked and the balancing device is unloaded. It should now be possible to easily rotate the balancing device.	
6	Attach a *lifting accessories* to the balancing device. Use the *hole* in the lifting ear.	 xx1000001112
7	Remove the upper and lower *lock nuts* and *support washers* (2+2 pcs). **Note** Make sure that the shaft between the upper and lower arm does not rotate when unscrewing the lock nuts! The lock nut is locked with locking liquid.	 xx1000001113
8	Fit the *auxiliary shafts* on the upper and lower pivot shaft. Fit the short auxiliary shaft on the upper shaft and the longer on the lower shaft.	Art.no. is specified in *Required equipment on page 267*
9	Stretch the *roundsling*.	

Continues on next page

	Action	Note
10	Apply a *ball bearing puller* behind the lower ear of the balancing device. **Note** The ball bearing puller must be applied around the *spacer ring*. See figure!	The figure show IRB 760, but the principle is the same.  xx1000001115
11	**CAUTION** The balancing device weighs 70 kg. All lifting accessories used must be sized accordingly!	
12	With the help of the ball bearing puller carefully remove the *balancing device* from its upper and lower attachments.	 xx1000001114
13	Remove the balancing device and put it in a safe place.	
14	Remove the inner rings of the bearings.	

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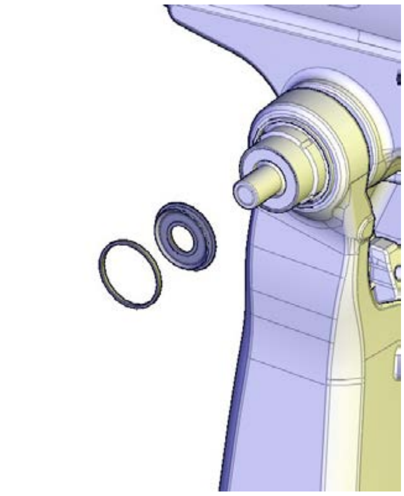
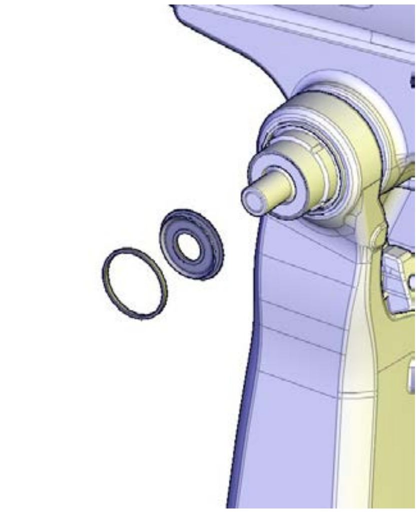
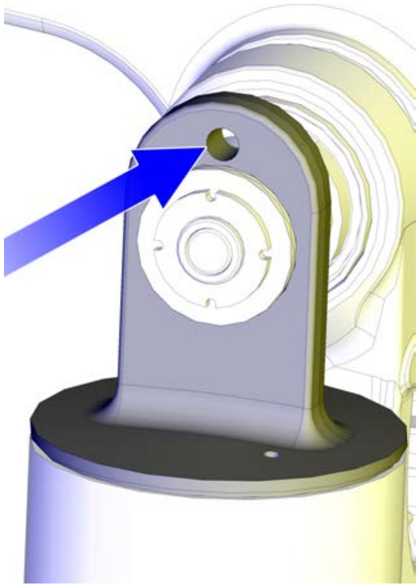
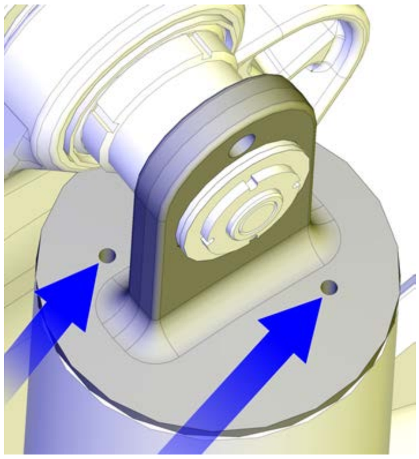
	Action	Note
15	Remove upper and lower *spacer rings* and *support washers* (2+2 pcs).	 xx1000001116
16	Remove residual grease.	

Refitting, balancing device

use this procedure to refit the balancing device.

	Action	Note
1	Check the bearings. Replace if needed.	
2	Refit the inner *sealing rings* and *support washers* in both ends.	 xx1000001116
3	Refit the inner ring of the bearings on the upper and lower pivot shaft with the auxiliary shaft.	
4	Fit the auxiliary shafts on the upper and lower shafts. Fit the short auxiliary shaft on the upper shaft and the longer on the lower shaft.	Art.no. is specified in section *Required equipment on page 267*

Continues on next page

	Action	Note
5	**CAUTION** The balancing device weighs 70 kg. All lifting accessories used must be sized accordingly!	
6	Attach lifting accessory to the balancing device and lift it on to the auxiliary shafts.	 xx1000001112
7	Adjust the length between the upper and lower bearings by means of the M12 screws, used to neutralize the spring force. This length should preferably be 0.5 mm too short than 0.1 mm too long. If the distance is too long the bearings may be damaged when erecting the balancing device.	 xx1000001111

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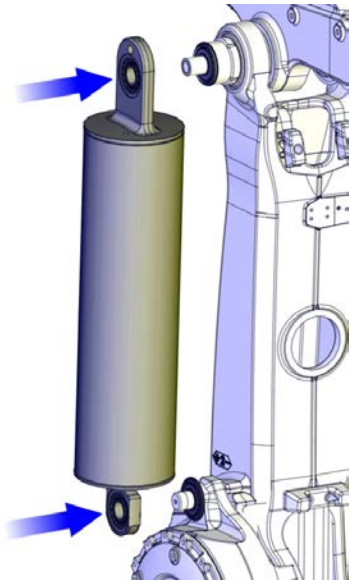
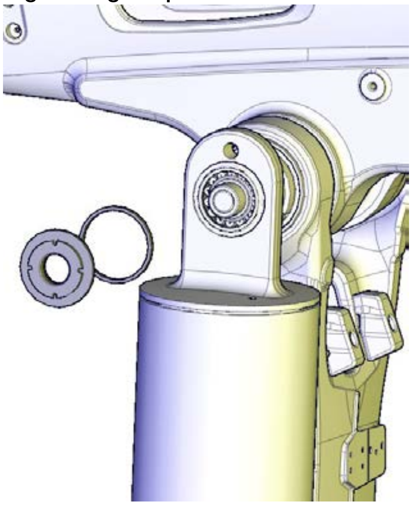
	Action	Note
8	Carefully refit the balancing device on the upper and lower shafts.	 xx1000001271
9	Fit the *lubricating tool*. The tool should be tightened to the bottom position by hand power only.	Art. no. is specified in section *Required equipment on page 267*.
10	Fill the bearings with grease through the nipple. Continue until grease excudes behind the inner sealing.	
11	Remove the lubricating tool and wipe off protruding grease.	
12	Remove the auxiliary shafts.	
13	Apply *locking liquid* on the threads of the lock nuts.	Specified in section *Required equipment on page 267*.
14	Refit the lock nuts and support washers.	Tightening torque: 120 Nm  xx1000001113
15	Check play (min. 0.1 mm) between support washers and bearing seat at both bearings.	

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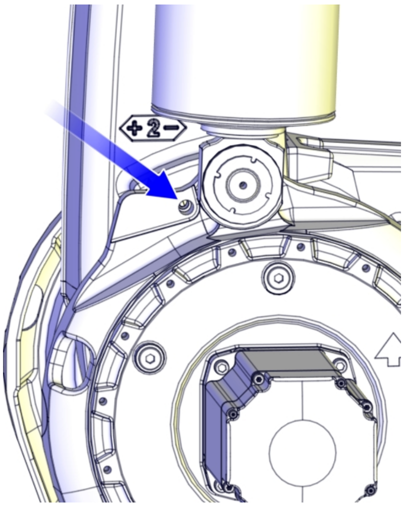
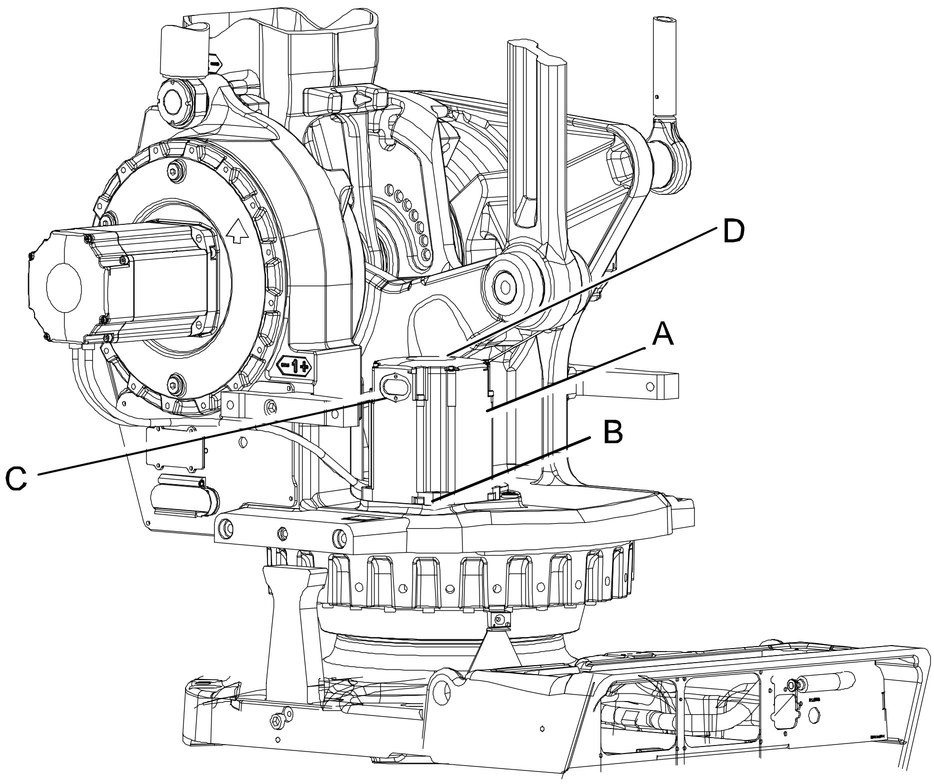
	Action	Note
16	Remove the M12x50 screws from the balancing device to restore the springforce.	
17	Remove the *lock screw*.	 xx1000001101
18	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.6 Motors

4.6.1 Replacing motor, axis 1

Location of motor axis 1

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



xx0600002598

A	Motor axis 1
B	Motor attachment screws and washers
C	Cable gland cover (located on the left hand side of the motor)
D	Motor cover

Required equipment

Equipment, etc	Art.no.	Note
Motor axis 1	See spare part number in *Spare part lists on page 395*.	Includes: • motor • pinion • o-ring (Old o-ring must be replaced when replacing the motor)
O-ring	21522012-430	Replace if damaged.
Grease	3HAC9408-1	Tribol GR 100-2 PD Used to lubricate the o-ring

Continues on next page

Equipment, etc	Art.no.	Note
Loctite 574, Flange sealant	12340011-116	Option Foundry Plus
Power supply	-	24 VDC, max. 1,5 A For releasing the brakes.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *General references on page 10*.

Deciding calibration routine

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

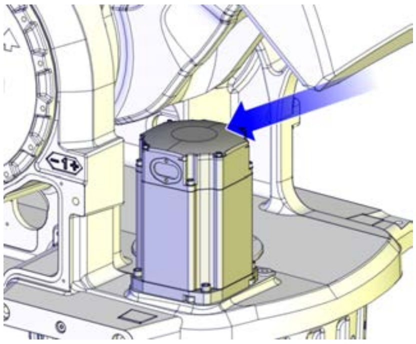
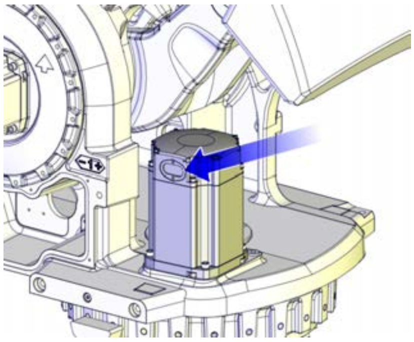
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing motor axis 1

Use this procedure to remove the axis-1 motor.

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

Continues on next page

	Action	Note
2	**DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
3	Remove the *motor cover* in order to get access to the connectors on top of the motor.	 xx1000001092 Part: Motor cover
4	Remove the *cable gland cover* at the motor cable exit. **Note** Make sure the gasket is undamaged! Replace if damaged.	 xx1000001094 Part: Position of Cable gland cover
5	Disconnect all connectors beneath the motor cover.	
6	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP1 • + : pin 2 • -: pin 5

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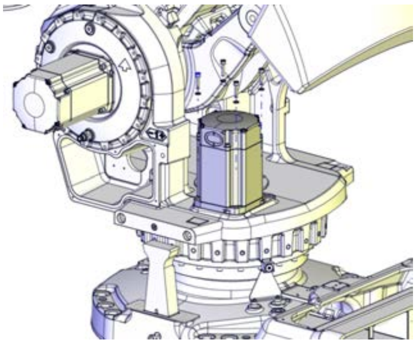
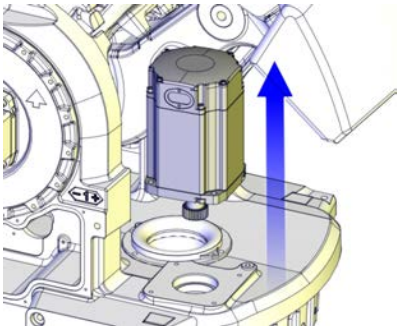
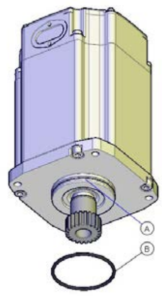
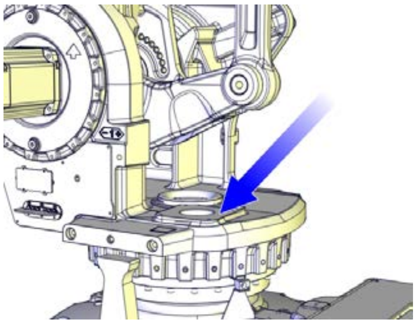
	Action	Note
7	Remove the *attachment screws* of the motor.	 xx1000001090 Parts: Motor axis 1 Attachment screw (4 pcs) Washer (4 pcs) Pinion
8	If required, press the motor out of position by fitting two screws in the holes on the motor for pressing out the motor.	Always use removal screws and tools in pairs!
9	**CAUTION** The motor weighs 29 kg! All lifting equipment used must be sized accordingly!	
10	Remove the motor by carefully lifting it straight up to get the pinion away from gear. **CAUTION** Be careful not to damage the pinion in the process!	 xx1000001021
11	Disconnect the brake release voltage.	
12	Check the pinion. If there is any damage, the pinion must be replaced.	
13	*Foundry Plus:* Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces on both motor and gearbox.	

Continues on next page

Refitting motor axis 1

This procedure describes how to refit motor axis 1.

	Action	Note
1	Make sure the *o-ring* on the *circumference* of the motor is seated properly. Lightly lubricate the o-ring with *grease*.	 xx1000001096 Parts: Circumference of motor O-ring **Note** The o-ring must be replaced when replacing the motor.
2	**CAUTION** The motor weighs 29 kg! All lifting equipment used must be sized accordingly!	
3	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP1 • + : pin 2 • -: pin 5
4	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400000986

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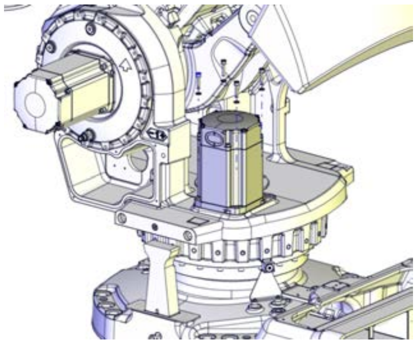
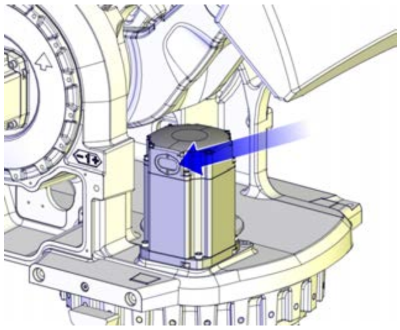
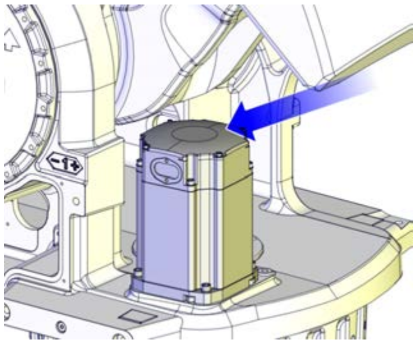
4.6.1 Replacing motor, axis 1

Continued

	Action	Note
5	Gently lower the motor into the gear, making sure the pinion is properly mated to the gearbox of axis 1. **Note** Make sure the motor is turned the right way. See figure. **Note** Make sure the motor pinion does not get damaged!	 xx1000001090 Parts: Motor axis 1 Attachment screw (4 pcs) Washer (4 pcs) Pinion
6	Secure the motor with its four *attachment screws* and plain *washers*.	M10 x 40 Shown in the figure *Location of motor axis 1 on page 275*. Tightening torque: • 50 Nm
7	Disconnect the brake release voltage.	
8	Reconnect all connectors beneath the motor cover.	
9	Refit the *cable gland cover* at the cable exit with its attachment screws. **Note** Make sure the cover is tightly sealed! Replace gasket if damaged.	 xx1000001094 Part: Position of Cable gland cover
10	Refit the *motor cover* with its attachment screws. **Note** Make sure the cover is tightly sealed!	 xx1000001092 Part: Motor cover

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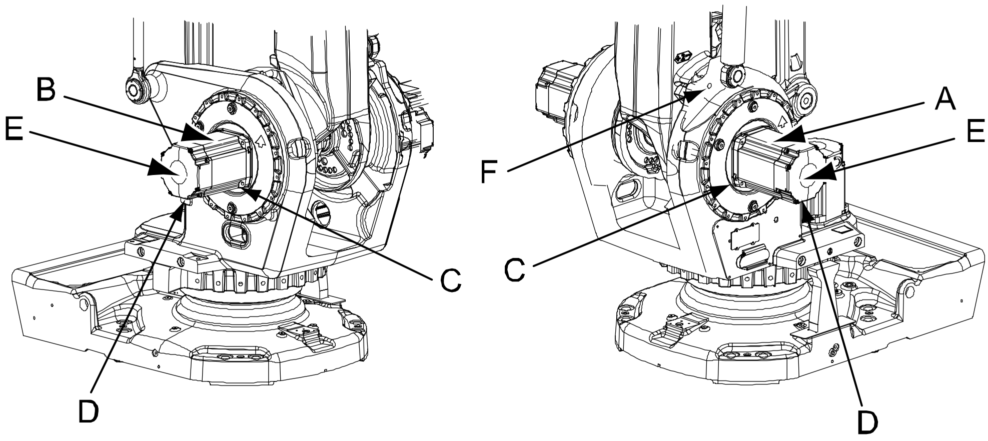
	Action	Note
11	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.6.2 Replacing motors, axes 2 and 3

Location of motors, axes 2 and 3

The motors axes 2 and 3 are located on either side of the robot as shown in the figure.

The procedure is the same for both motors.



xx0600002599

A	Motor, axis 2
B	Motor, axis 3
C	Motor attachment screws and washers
D	Cable gland cover (located on the lower side of the motor)
E	Motor cover
F	Hole for lock screw

Required equipment

Equipment, etc.	Art. no.	Note
Motor axes 2-3	See spare part number in *Spare part lists on page 395*.	Includes • motor • pinion • o-ring (the o-ring must be replaced when the motor is replaced)
O-ring, motor	21522012-430	Replace if damaged.
Grease	3HAC9408-1	Tribol GR 100-2 PD For lubricating the o-ring.
Loctite 574, Flange sealant	12340011-116	Option Foundry Plus
Guide pins	3HAC13120-2	M10x150 For guiding the motor. Guide pins are to be used in pairs!
Lifting tool, motor axes 2-3	3HAC14586-1	
Lock screw		M16x90 For securing the lower arm.

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Equipment, etc.	Art. no.	Note
Power supply	-	24 VDC, 1.5 A For releasing the brakes.
Rotation tool		Used to rotate the motor pinion when mating it to the gear, when brakes are released with 24 VDC power supply.
Standard toolkit		Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	3HAC025744-001	See chapter *General references on page 10*.

Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing motors axes 2 and 3

Use this procedure to remove motors axes 2 and 3.

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

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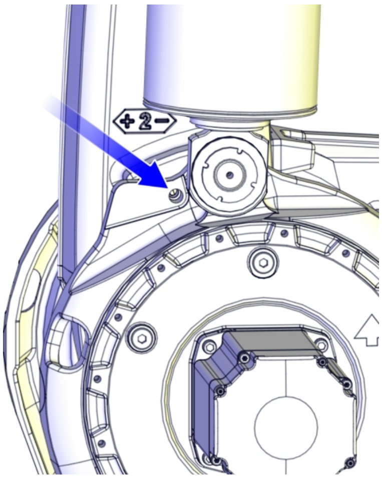
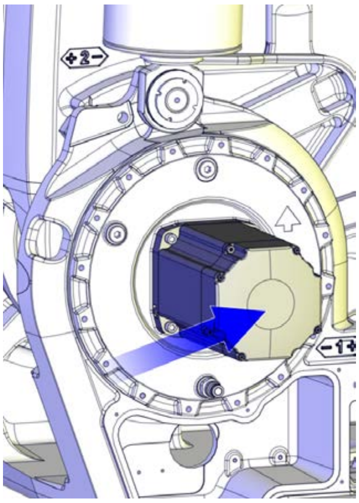
	Action	Note
2	Run the robot to a position close enough to its calibration position, to allow the lock screw to be inserted into the *hole for lock screw*.	 xx1000001101
3	Lock the *lower arm* by inserting the *lock screw* into the hole of the frame. This is done in order to secure axis 2 from collapsing when gearbox axis 2 is being removed.	See figure above.
4	⚠ **DANGER** Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!	
5	Secure the *upper arm* with roundslings in an overhead crane. This is done in order to secure axis 3 from collapsing when gearbox axis 3 is being removed.	
6	Drain the oil from *gearbox*.	See section • *Draining, axes 2 and 3 on page 149*
7	Remove the *motor cover*.	 xx1000001102

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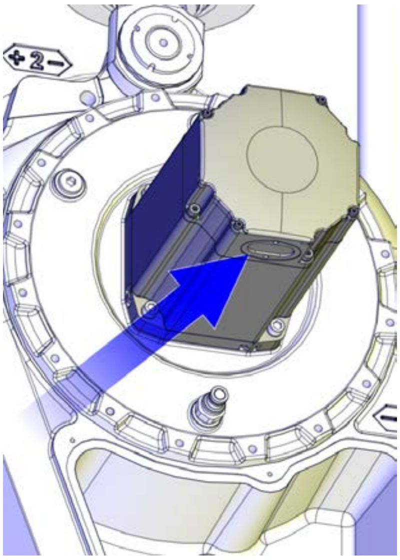
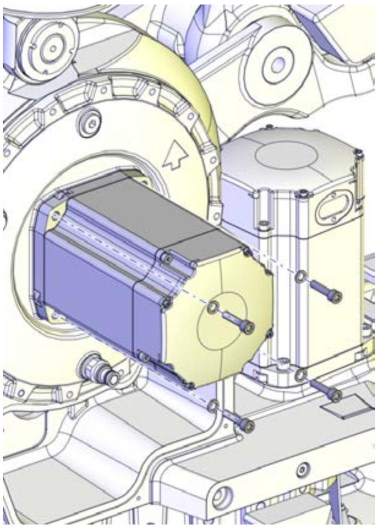
	Action	Note
8	Remove the *cable gland cover* at the cable exit . **Note** Make sure the gasket is not damaged! Replace if damaged.	 xx1000001103
9	Disconnect all connectors beneath the motor cover.	
10	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP2 • + : pin 2 • -: pin 5
11	Unscrew *attachment screws* and *washers* of the motor.	 xx1000001104

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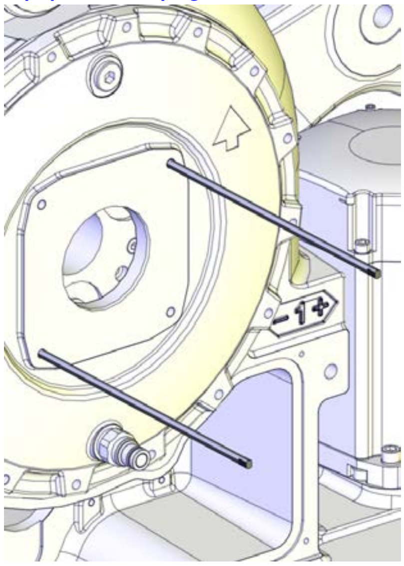
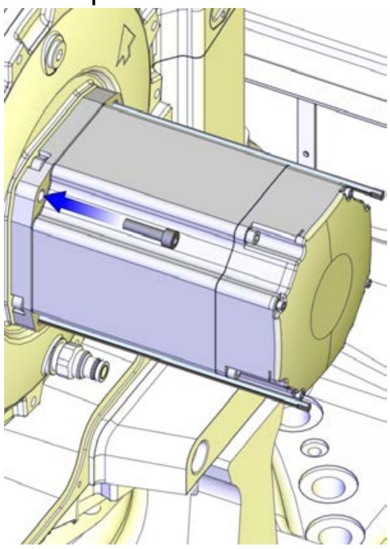
	Action	Note
12	Fit two *guide pins* in two of the motors attachment holes.	Art. no. is specified in *Required equipment on page 282*.  xx1000001131
13	If required, press the motor out of position by fitting two *screws* in the remaining attachment holes of the motor, diagonal to each other.	Always use the removal screws and tools in pairs!  xx1000001184
14	Remove the two screws and fit the *lifting tool, motor axes 2-3* to the motor.	Art. no. is specified in *Required equipment on page 282*.
15	**CAUTION** The motor weighs 32 kg! All lifting equipment used must be sized accordingly!	

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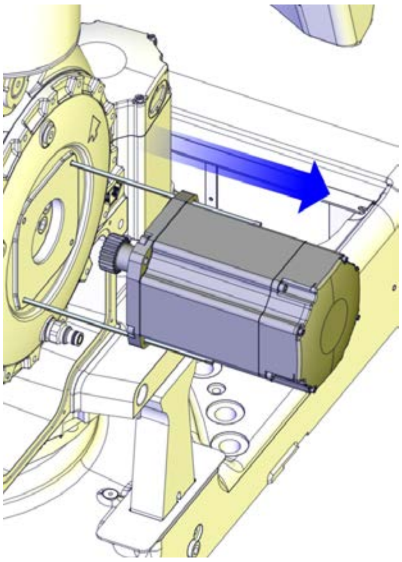
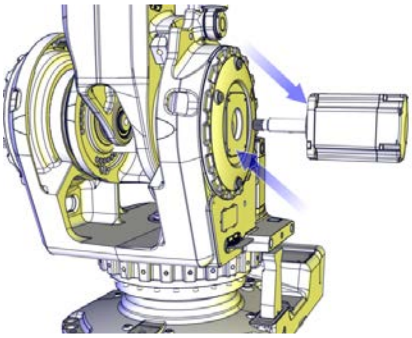
	Action	Note
16	Pull out the *motor* to get the pinion away from the gear. Make sure the pinion does not get damaged!	 xx1000001105
17	Remove the motor by gently lifting it straight out and place it on a secure surface.	
18	Disconnect the brake release voltage!	
19	Check the pinion. If there is any damage, the motor pinion must be replaced.	
20	*Foundry Plus:* Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces on both motor and gearbox.	 xx1400000988

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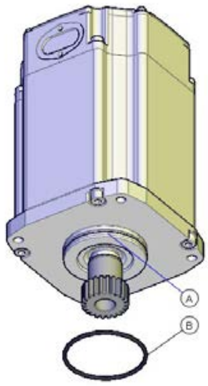
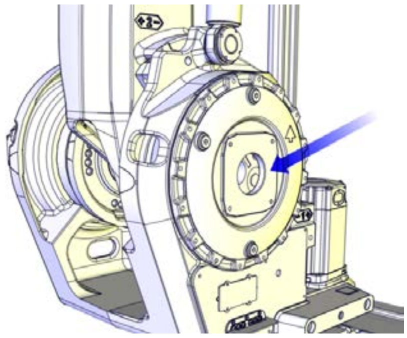
Refitting, motor

Use this procedure to refit the motors for axes 2 and 3.

	Action	Note
1	Make sure the *o-ring* on the *circumference* of the motor is seated properly. Lightly lubricate the o-ring with grease.	 xx1000001096 Parts: A Circumference B O-ring
2	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP1 • + : pin 2 • -: pin 5
3	Fit the *lifting tool, motor axes 2-3* to the motor.	Art. no. is specified in *Required equipment on page 282*.
4	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400000987

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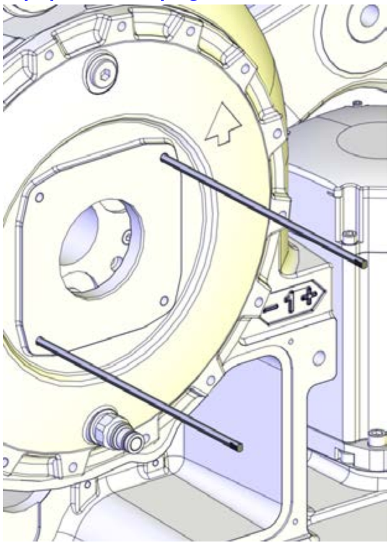
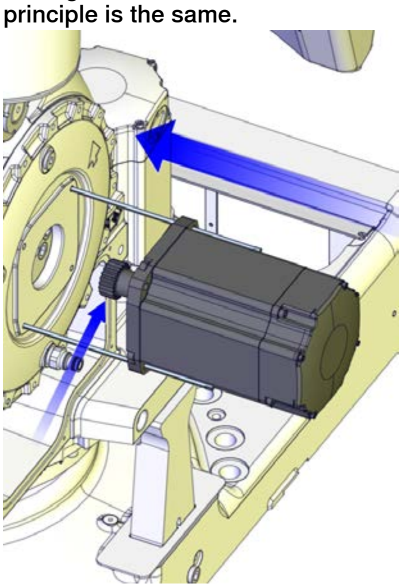
	Action	Note
5	Fit the two *guide pins* in the two lower motor attachment holes.	Art. no. is specified in *Required equipment on page 282*.  xx1000001131
6	**CAUTION** The motor weighs 32 kg! All lifting equipment used must be sized accordingly!	
7	Lift the *motor* and guide it on to the *guide pins*, as close to the correct position as possible without pushing the motor *pinion* into the gear. **Note** Make sure the motor is turned the right way, that is connections for the cables facing downwards.	The figure shows IRB 760 but the principle is the same.  xx1000001185
8	Remove the lifting tool and allow the motor to rest on the guide pins.	

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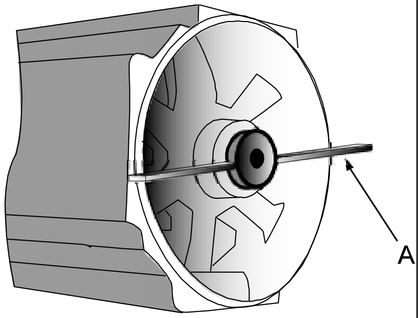
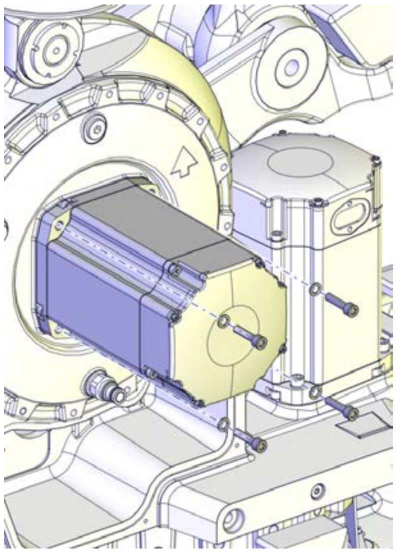
	Action	Note
9	Use the *rotation tool* in order to rotate the motor pinion when mating it to the gear (see figure). Fit the motor, making sure the motor pinion is properly mated to the gear of gearbox axis 2-3 and that it doesn´t get damaged. **Note** The rotation tool is used beneath the motor cover, directly on the motor shaft as shown in figure above.	 xx0200000165 Part: A Rotation tool
10	Remove the guide pins.	
11	Secure the motor with its *attachment screws* and *plain washers*.	 xx1000001104 M10 x 40 (4 pcs) Tightening torque: 50 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 386* before fitting.
12	Disconnect the brake release voltage.	
13	Reconnect all connectors beneath the motor cover.	Connect in accordance with markings on connectors.
14	Refit the *cable gland cover* at the cable exit with its two attachment screws. **Note** Use a new gasket!	

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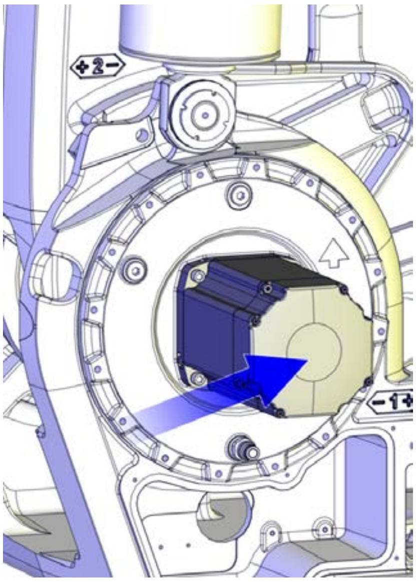
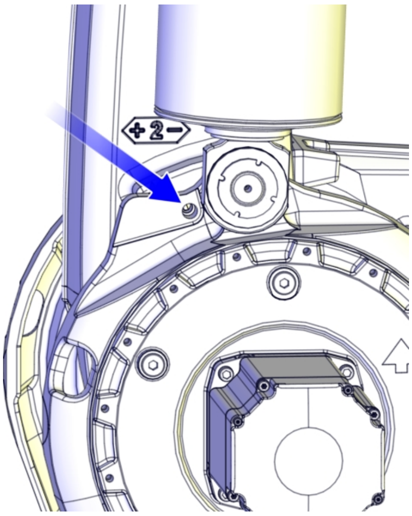
	Action	Note
15	Refit the *motor cover* with its attachment screws and washers. **Note** Make sure the cover is tightly sealed!	 xx1000001102
16	Remove the *lock screw* from the *hole for lock screw*.	 xx1000001101
17	Perform a leak-down test of the axis 2 (or 3) gearbox.	
18	Refill the gearbox with oil.	Detailed in *Filling, axes 2 and 3 on page 149*.
19	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.

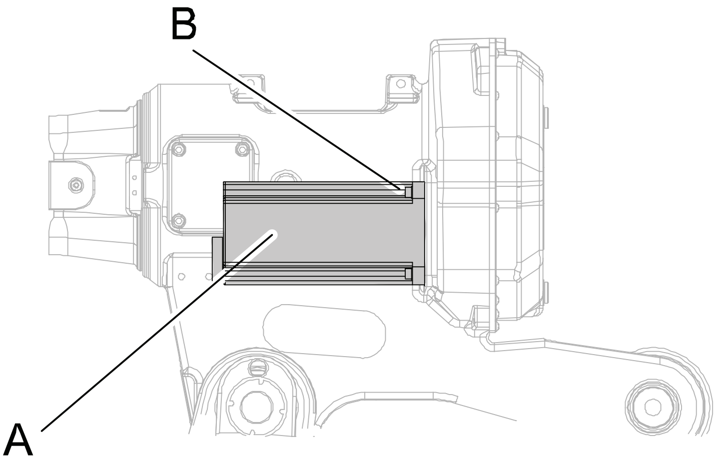
Continues on next page

	Action	Note
20	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.6.3 Replacement of motor, axis 4

Location of motor

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



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A	Motor, axis 4
B	Attachment screws M8X25 quality 8.8 (4 pcs)

Required equipment

Equipment, etc.	Art. no.	Note
Motor including pinion	See spare part number in *Spare part lists on page 395*.	Includes: • motor • pinion • o-ring 21522012-430
O-ring	21522012-430	Must be replaced when reassembling motor!
Lifting tool, motor ax 1, 4, 5	3HAC14459-1	
Grease	3HAC9408-1	Tribol GR 100-2 PD Used to lubricate the o-ring.
Loctite 574, Flange sealant	12340011-116	Option Foundry Plus
Removal tool. motor M10x	3HAC14972-1	Always use the removal tools in pairs!
Guide pins M8 x 100	3HAC15520-1	For guiding the motor.
Guide pins M8 x 150	3HAC15520-2	For guiding the motor.
Rotation tool	3HAC17105-1	Used to rotate the motor pinion when mating it to the gear when brakes are released with 24 VDC power supply.
Power supply	-	24 VDC, max. 1,5 A For releasing the brakes.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.

Continues on next page

Equipment, etc.	Art. no.	Note
Calibration Pendulum toolkit	3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	3HAC025744-001	See chapter *General references on page 10*.

Deciding calibration routine

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

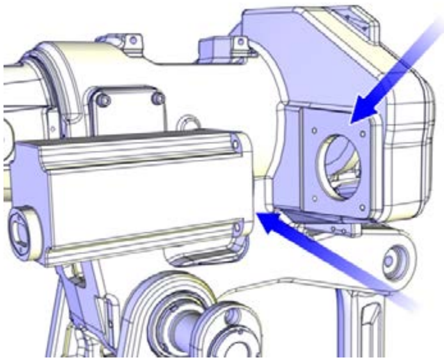
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, motor axis 4

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

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

Continues on next page

	Action	Note
2	Move the robot to a position where the upper arm is pointed straight up. This position enables the motor to be replaced without draining the gear oil, which in turn saves time. Any other position of the upper arm requires a draining of oil from the gearbox for axis 4.	Draining of oil is described in section *Draining, oil on page 152*.
3	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
4	Remove the *cable gland cover* at the cable exit of the motor by unscrewing its two attachment screws.	Shown in the figure *Location of motor on page 293*. Make sure the gasket is not damaged!
5	Remove the cover on top of the motor by unscrewing its four attachment screws.	
6	Disconnect all connectors beneath the motor cover.	
7	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R2.MP4 • +: pin 2 • -: pin 5
8	Unscrew the motors four *attachment screws and plain washers.*	Shown in the figure *Location of motor on page 293*.
9	Fit the two *guide pins* in two of the motor attachment screw holes.	
10	If required, press the motor out of position by fitting *removal tool, motor* to the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 293*. Always use the removal tools in pairs!
11	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	
12	Remove the motor by gently lifting it straight out.	Make sure the motor pinion is not damaged!
13	*Foundry Plus:* Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces on both motor and gearbox.	 xx1400000989

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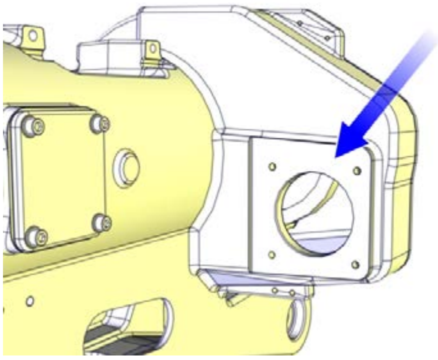
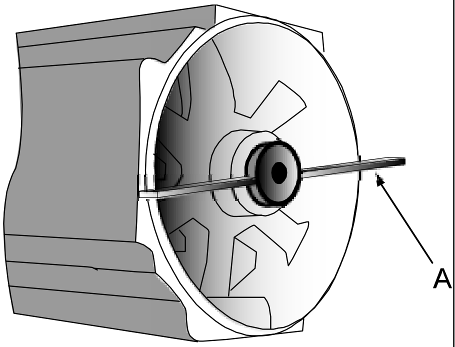
Refitting, motor axis 4

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the o-ring with *grease.*	Art. no. is specified in *Required equipment on page 293*.
3	In order to release the brakes, connect the 24 VDC power supply.	Connect to connector R2.MP4: • +: pin 2 • -: pin 5
4	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400000990
5	Fit the two *guide pins* in two of the *motor attachment holes.*	Art. no. is specified in *Required equipment on page 293*. Shown in the figure *Location of motor on page 293*.
6	Fit the motor with guidance of the pins, making sure the motor pinion is properly mated to the gear of gearbox 4.	Make sure the motor pinion does not get damaged!

Continues on next page

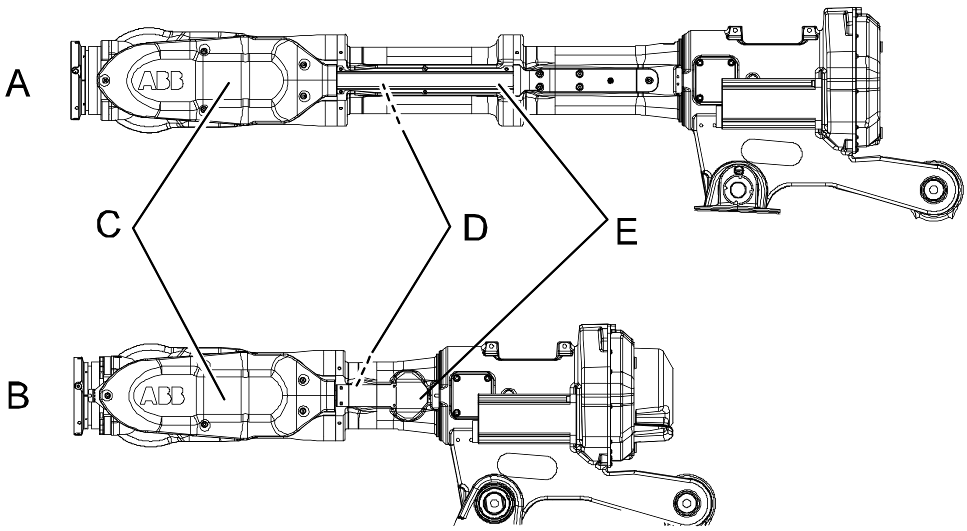
	Action	Note
7	Use the *rotation tool* in order to rotate the motor pinion when mating it to the gear! Fit the motor, making sure the motor pinion is properly mated to the gear, axis 4.	Art. no. is specified in *Required equipment on page 293*. Make sure the motor pinion does not get damaged! Make sure the motor is turned the right direction, that is the cables facing forwards.  xx0200000165 The rotation tool is used beneath the motor cover, directly on the motor shaft as shown in figure above. • A: Rotation tool.
8	Remove the guide pins.	
9	Secure the motor with four attachment screws and plain washers.	4 pcs: M8 x 25, tightening torque: 24 Nm.
10	Disconnect the brake release voltage.	
11	Reconnect all connectors beneath the motor cover.	
12	Refit the cover on top of the motor with its four attachment screws.	Make sure the cover is tightly sealed!
13	Refit the *cable gland cover* at the cable exit with its two attachment screws.	Shown in the figure *Location of motor on page 293*.
14	Perform a leak-down test if the gearbox has been drained.	Detailed in the section *Performing a leak-down test on page 170*.
15	Refill the gearbox with oil if drained.	
16	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
17	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.6.4 Replacement of motor, axis 5

Location of motor

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

A more detailed view of the component and its position may be found in *Spare part lists on page 395*.



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A	Robot variant IRB 6660 - 100/3.3, IRB 6660 - 130/3.1
B	Robot variant IRB 6660 - 205/1.9
C	Wrist unit
D	Motor, axis 5 (Inside upper arm tube)
E	Upper arm tube

Required equipment

Equipment, etc.	Art. no.	Note
Motor	For spare part number, see *Spare part lists on page 395*.	
Set of shim, motor	3HAC7941-28	Used to obtain the correct distance between motor flange and outer surface of motor pinion.
O-ring	21522012-430	Must be replaced when reassembling motor!
Grease	3HAC9408-1	Tribol GR 100-2 PD For lubricating the o-ring.
Loctite 574, Flange sealant	12340011-116	Option Foundry Plus
Isopropanol	11771012-208	For cleaning motor pinion and motor pinion hole.

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Equipment, etc.	Art. no.	Note
Mineral oil	CS 320	For lubrication of pinion shaft and pinion hole.
Removal tool, motor M10x	3HAC14972-1	Always use the removal tools in pairs!
Measuring tool	6896134-GN	
Guide pins M8 x 100	3HAC15520-1	For guiding the motor.
Guide pins M8 x 150	3HAC15520-2	For guiding the motor.
Power supply	-	24 VDC, 1.5 A For releasing the brakes.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See chapter *General references on page 10*.

Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

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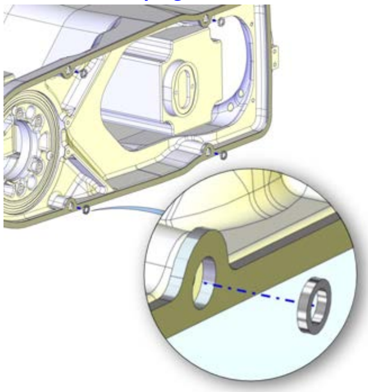
Removal, motor, axis 5

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

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Drain the oil from gearbox axis 5.	Detailed in the section *Changing oil, axis-5 gearbox on page 154*.
4	Remove the wrist unit.	Detailed in the section *Removal, wrist unit on page 221*.  xx1400002580
5	Place the wrist unit safely on a workbench, in a fixture or similar.	
6	Remove the cover on top of the motor by unscrewing its four attachment screws.	
7	Remove the cable gland cover at the cable exit by unscrewing its two attachment screws.	
8	Disconnect all connectors beneath the motor cover and remove the cable of the axis-5 motor.	
9	In order to release the brake, connect the 24 VDC power supply.	Connect to either: - connector R4.MP5 (in the motor): • + : pin 2 • -: pin 5 - connector R3.MP5 (on the separate cable, if not removed): • +: pin C • -: pin D
10	Remove the motor by unscrewing its four attachment screws and plain washers.	

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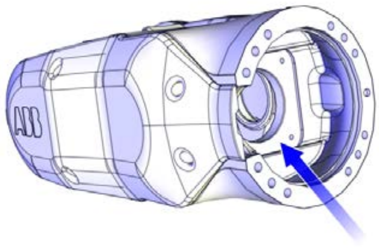
	Action	Note
11	Fit the two *guide pins* in two of the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 298*.
12	If required, press the motor out of position by fitting *removal tool, motor, M10* to the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 298*. Always use the removal tools in pairs and diagonally!
13	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	Make sure the motor pinion is not damaged!
14	Remove the motor by gently lifting it straight out.	Keep track of the shims between the motor flange and the wrist housing.
15	*Foundry Plus:* Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces on both motor and gearbox.	 xx1400000991

Refitting, motor, axis 5

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the *o-ring* with *grease.*	Art. no. is specified in *Required equipment on page 298*.
3	In order to release the brake, connect the 24 VDC power supply.	Connect to either: - connector R4.MP5 (in the motor): • +: pin 2 • -: pin 5 - connector R3.MP5 (on the separate cable, if not removed): • +: pin C • -: pin D

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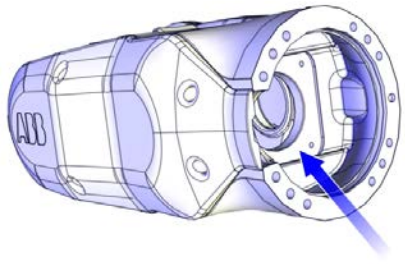
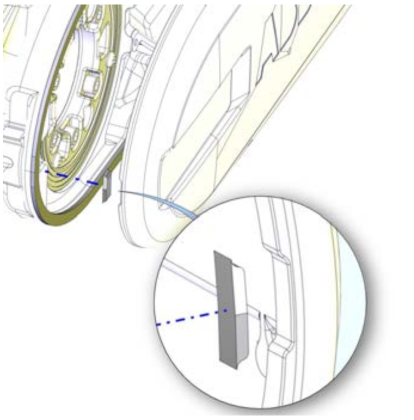
	Action	Note
4	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400000991
5	Fit the two *guide pins* in two of the motor attachment holes.	Art. no. is specified in *Required equipment on page 298*.
6	Fit the motor, with guidance from the pins, making sure the motor pinion is properly mated to the gear of axis 5.	Make sure the motor pinion does not get damaged!
7	Secure the motor with four attachment screws and plain washers.	4 pcs: M8 x 25; tightening torque: 24 Nm.
8	Disconnect the brake release voltage.	
9	Refit the cable of the axis-5 motor and reconnect all connectors beneath the motor cover.	
10	Refit the cable gland cover at the cable exit with its two attachment screws.	
11	Refit the cover on top of the motor with its four attachment screws.	Make sure the cover is tightly sealed!
12	Perform a leak-down test.	Detailed in the section *Performing a leak-down test on page 170*.
13	Refit the wrist unit.	
14	*Foundry Plus* Make sure that the gasket is undamaged. Also the small gasket fitted in the cover recess. Replace if damaged.	 xx1400002579

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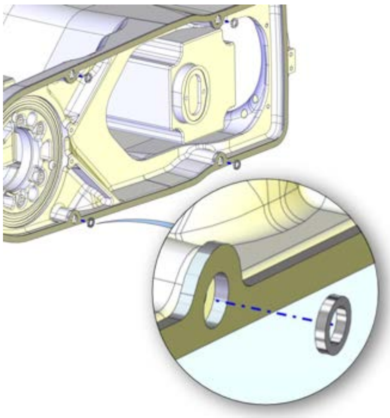
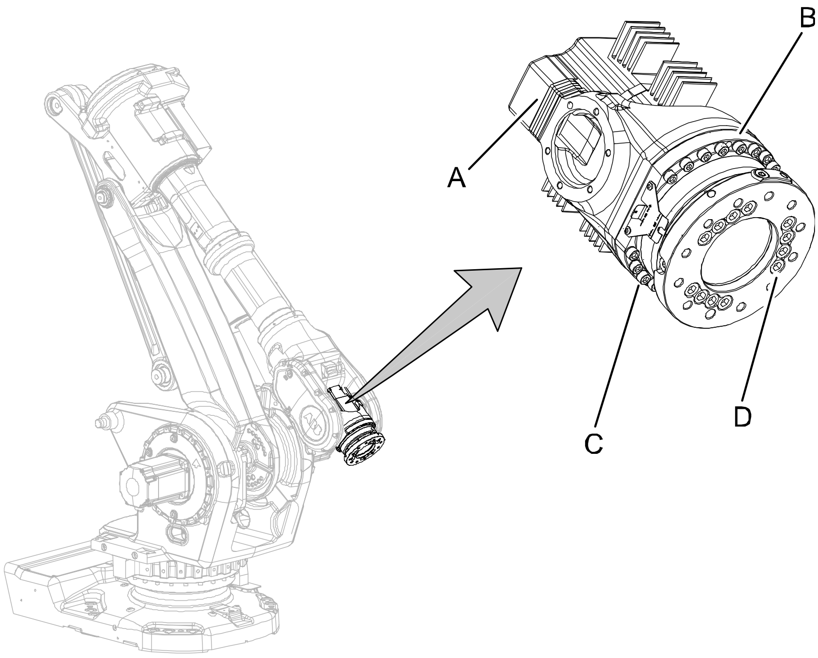
	Action	Note
15	*Foundry Plus* Make sure the washers are fitted in the gasket holes. Refit the *cover, wrist unit* Foundry Plus.	 xx1400002580
16	Refill the gear with oil.	Detailed in the section *Changing oil, axis-5 gearbox on page 154*.
17	Re-calibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
18	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.6.5 Replacement of motor, axis 6

Location of motor

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



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A	Axis-6 motor. Figure shows a motor with cooling elements. (There are no cooling elements on the motor on variant IRB 6660 - 205/1.9.)
B	Axis-6 gearbox
C	Attachment screws and washers gearbox (18 pcs)
D	Attachment screws, turning disk (12 pcs)

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Motor, axis 6	See spare part number in *Spare part lists on page 395*.		Includes: • motor • pinion • o-ring
O-ring	21522012-430		Must be replaced when reassembling motor!
Gasket	3HAC048560-001		Must be replaced when replacing motor
Gasket, cover	3HAC033489-001		Must be replaced when opening cover.
Removal tool, motor M10x		3HAC14972-1	Always use the removal tools in pairs!
Guide pins M8 x 100		3HAC15520-1	For guiding the motor.

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Equipment, etc.	Spare part no.	Art. no.	Note
Guide pins M8 x 150		3HAC15520-2	For guiding the motor.
Power supply		-	24 VDC, 1.5 A For releasing the brakes.
Grease		3HAC9408-1	Tribol GR 100-2 PD For lubricating the o-ring.
Loctite 574, Flange sealant		12340011-116	Option Foundry Plus
Standard toolkit		-	Content is defined in section *Standard tools on page 390*.
Calibration Pendulum toolkit		3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration		3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram		3HAC025744-001	See chapter *General references on page 10*.

Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.

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

Removal, motor

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

> **Note**
>
> Robots with protection type Foundry Plus or Foundry Prime require special repair routines to maintain the tightness level, in addition to the procedure below, described in *Replacement of the motor axis 6 (Foundry Plus) on page 309*.

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

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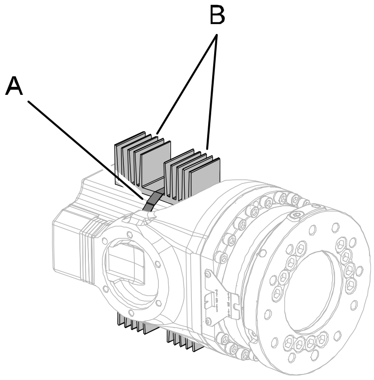
	Action	Note
7	**(Not applicable to robot variant IRB 6660 - 205/1.9 !)** If needed, loosen the strap securing the cooling elements in order to reach the attachment screws securing motor axis 6.	 xx0700000164 • A: Strap • B: Cooling element.
8	Remove the motor by unscrewing its four attachment screws and plain washers.	
9	If required, press the motor out of position by fitting *removal tool, motor* to the motor attachment screw holes.	Art. no. is specified in *Required equipment on page 304*. Always use the removal tools in pairs!
10	Lift the motor carefully to get the pinion away from the gear and disconnect the brake release voltage.	Make sure the motor pinion is not damaged!
11	Remove the motor by gently lifting it straight out.	

Refitting, motor

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

Note

Robots with protection type Foundry Plus or Foundry Prime require special repair routines to maintain the tightness level, in addition to the procedure below, described in *Replacement of the motor axis 6 (Foundry Plus) on page 309*.

	Action	Note
1	Make sure the *o-ring* on the circumference of the motor is seated properly. Lightly lubricate the o-ring with *grease.*	Art. no. is specified in *Required equipment on page 304*.
2	In order to release the brake, connect the 24 VDC power supply.	Connect to connector R3.MP6 • +: pin 2 • -: pin 5
3	Fit the two *guide pins* in two of the motor attachment holes.	Art. no. is specified in *Required equipment on page 304*.
4	Fit the motor, with guidance from the pins, making sure the motor pinion is properly mated to the gear of gearbox, axis 6.	Make sure the pinion on the motor shaft is not damaged!
5	Remove the guide pins.	
6	Secure the motor with its four attachment screws and plain washers.	4 pcs: M8 x 25, tightening torque: 24 Nm.

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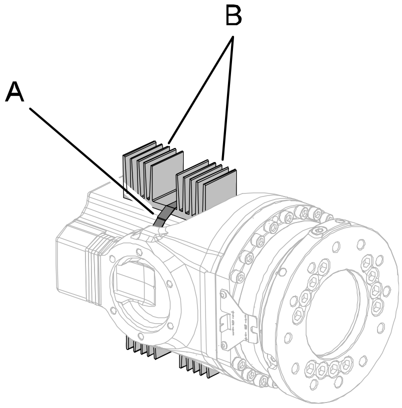
	Action	Note
7	**(Not applicable to robot variant IRB 6660 - 205/1.9!)** Refit the strap securing the cooling elements.	 xx0700000164 • A: Strap • B: Cooling elements
8	Disconnect the brake release voltage.	
9	Reconnect all connectors beneath the motor cover.	
10	Refit the cover on top of the motor with its five attachment screws.	Make sure the cover is tightly sealed!
11	Re-calibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
12	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

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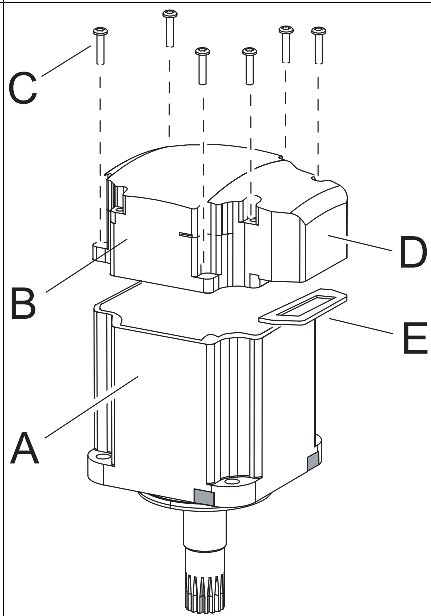
Replacement of the motor axis 6 (Foundry Plus)

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

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

	Action	Note
1	 **DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Remove the rear motor cover by unscrewing the five attachment screws.	 xx1500002524 • A: Motor unit • B: Connection box • C: Attachment screw (5 pcs) • D: Rear motor cover • E: Gasket
3	Continue to remove the motor unit, according to step 6 and forwards in *Removal, motor on page 306*.	
4	 **Note** Keep the old *rear motor cover* with the air nipple.	

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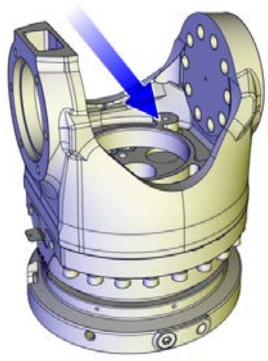
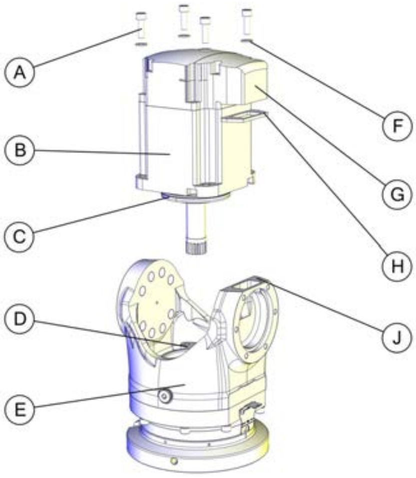
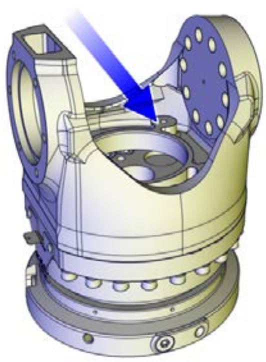
	Action	Note
5	Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces on both motor and gearbox.	 xx1400000992
6	Remove the protection strip on the *gasket* and mount it on the *motor*.	 xx1500002425 • A: Attachment screw (4pcs) Mercasol 3106 • B: Motor unit • C: O-ring • D: Sikaflex in screw recesses • E: Tilt house • F: Washer • G: Rear motor cover • H: Sealing • J: Loctite 574
7	Apply Mercasol 3106 on the *motor end cover*.	

Continues on next page

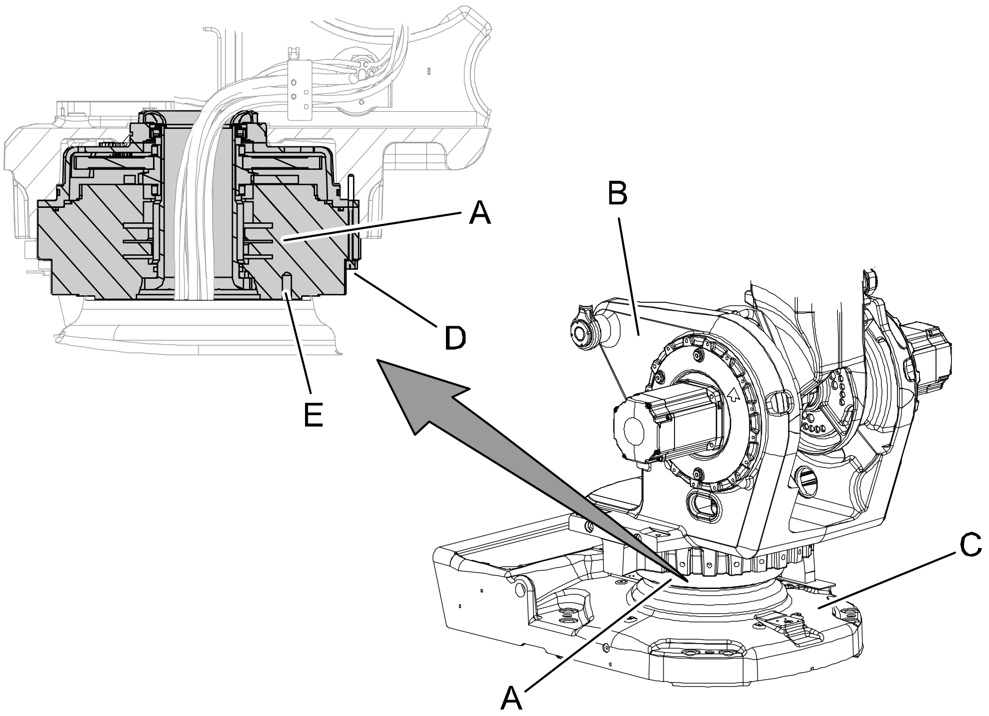
	Action	Note
8	Apply Loctite 574 flange sealant on the contact surface.	 xx1400000992
9	Apply grease on the *o-ring* on the *motor*.	
10	Continue to refit the new motor according to section, *Refitting, motor on page 307*.	

4.7 Gearboxes

4.7.1 Replacing the axis 1 gearbox

Location of gearbox

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



xx0700000074

A	Gearbox, axis 1
B	Frame
C	Base
D	Attachment screws gearbox axis 1, M12x70 quality 12.9 UNBRAKO (24 pcs)
E	Attachment screws gearbox axis 1, M16x90 quality 12.9 UNBRAKO (18 pcs)

Required equipment

Equipment, etc.	Art. no.	Note
Gearbox	For spare part no. see: • *Spare part lists on page 395*.	Includes: • gearbox • all o-rings and sealing rings
O-ring	3HAB3772-54	Replace if damaged!
O-ring	3HAB3772-55	Replace if damaged!
Sealing ring	3HAC11581-4	Replace if damaged!
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD Used to lubricate the o-rings.
Support, base and gear 1	3HAC15535-1	

Continues on next page

Equipment, etc.	Art. no.	Note
Lifting accessory, base	3HAC15560-1	
Lifting accessory (chain)	3HAC15556-1	
Guide pins		2 pcs, M16x150. Used for guiding the gearbox into place in the base. Always use guide pins in pairs!
Calibration Pendulum toolkit	3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

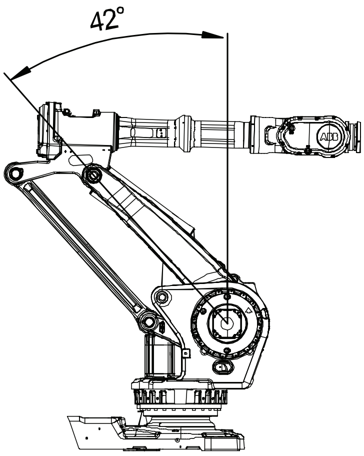
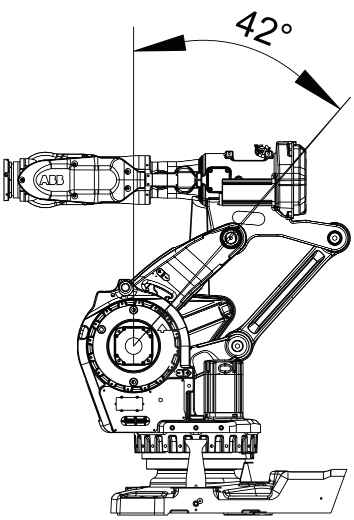
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

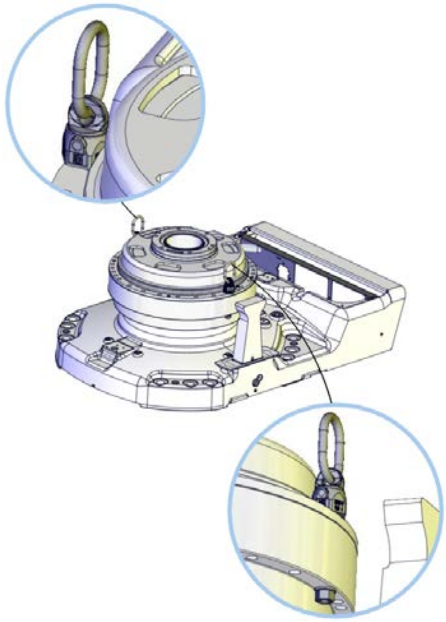
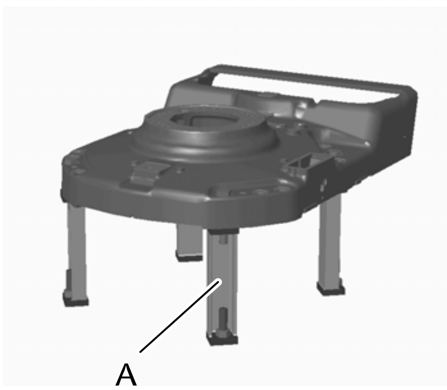
Continues on next page

Removal, gearbox axis 1

Use this procedure to remove gearbox, axis 1.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to its most stable position, shown in the figure to the right.	IRB 6660 - 130/3.1, IRB 6660 - 100/3.3  xx0700000137 IRB 6660 - 205/1.9  xx0700000518
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Drain the axis 1 gearbox.	See *Changing oil, axis-1 gearbox on page 144*.

Continues on next page

	Action	Note
5	Remove the complete arm system.	Detailed in section *Removal, arm system on page 207*.
6	Unfasten the robot base from the foundation by removing the base attachment screws.	
7	Attach the *lifting accessory, base and gear 1* and the *lifting tool (chain)* to the gearbox and base.	 xx1000001395 Specified in *Required equipment on page 312*.
8	**CAUTION** The base and axis 1 gearbox weighs 310 kg + 200 kg. All lifting accessories used must be sized accordingly!	
9	Lift the robot base including the axis 1 gearbox to allow the *base and gear 1 support* be fitted on each sides of the base.	Art. no. is specified in *Required equipment on page 312*.
10	Secure the support to the base and to the foundation. Make sure the base remains in a stable position before performing any work underneath the base!	 xx1000000364 A Support base (4 pcs)

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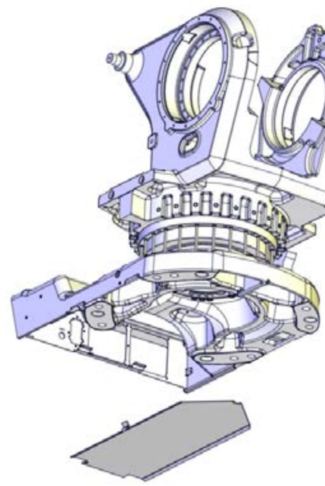
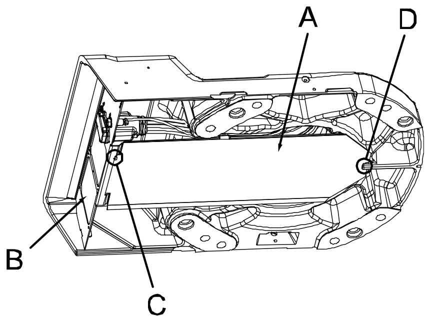
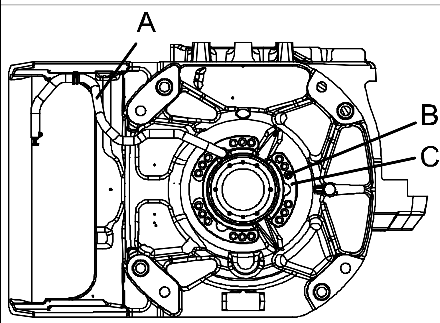
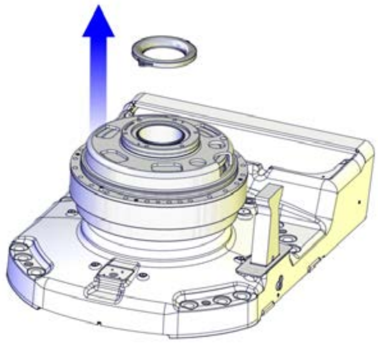
	Action	Note
11	Remove the bottom plate from underneath the base in order to get access to the attachment screws. It may be necessary to also remove the rear connector plate.	 xx1000001385  xx0300000612 A Bottom plate B Rear connector plate C Attachment screw D Groove
12	Unscrew the attachment screws and remove the washers.	 xx0200000227 A view from below: • A: Oil drain hose • B: Attachment screws, gearbox axis 1, 18 pcs • C: Washers, 3 pcs

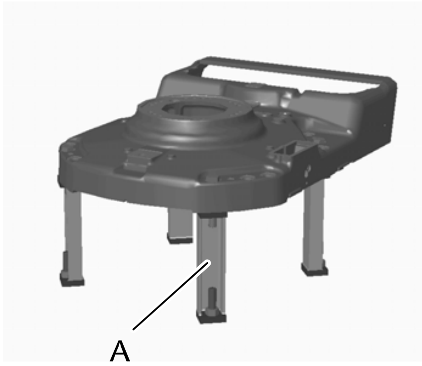
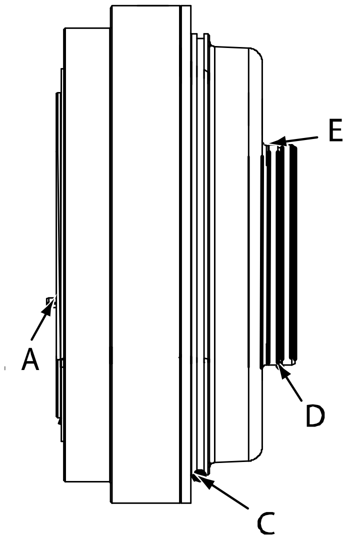
Continues on next page

	Action	Note
13	Remove the cable guide in the center of gearbox 1 by unscrewing its attachment screws.	 xx1000001387
14	**CAUTION** The gearbox weighs 200 kg. All lifting accessories used must be sized accordingly!	
15	Lift the gearbox away with the already mounted lifting tools.	
16	Turn the gearbox, and remove the protection pipe by unscrewing two attachment screws. **Note** Move the protective pipe over to the new gearbox.	 xx1400000786

Continues on next page

Refitting, gearbox axis 1

Use this procedure to refit gearbox, axis 1.

	Action	Note
1	Fit the *support, base and gear 1* to the base.	Mounting of the support, base and gear 1 is detailed in section *Removal, gearbox axis 1 on page 314*.  xx1000000364 A Support base (4 pcs)
2	Make sure the two *o-rings* on the circumference of the gearbox are seated properly in their respective groove. Lubricate them with *grease*.	Art no. is specified in *Required equipment on page 312*.  xx0200000055 • A: Guide pin • C: O-ring 3HAB 3772-54 • D: O-ring 3HAB 3772-55 • E: Sealing ring 3HAC 11581-4

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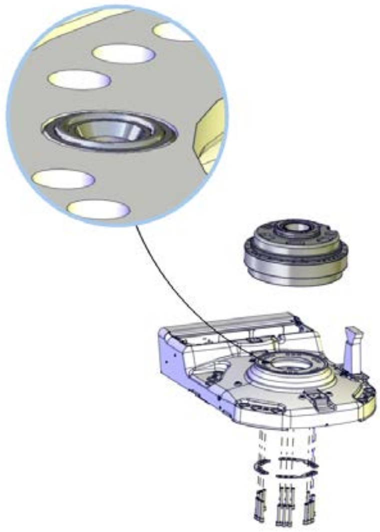
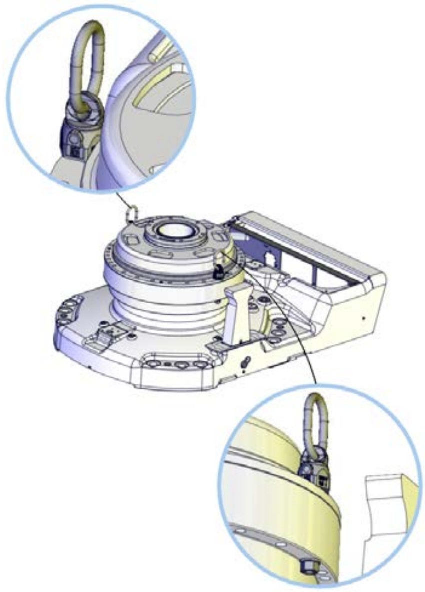
	Action	Note
3	Make sure the small o-ring around the oil hole is fitted properly!	 xx1000001392
4	Attach the *lifting accessory, base and gear 1* and the *lifting tool (chain)* to the gearbox.	Specified in *Required equipment on page 312*.  xx1000001395
5	Fit two *guide pins* in two of the attachment holes in the gearbox, parallel to each other.	Specified in *Required equipment on page 312*.
6	**CAUTION** The gearbox weighs 200 kg. All lifting accessories used must be sized accordingly!	

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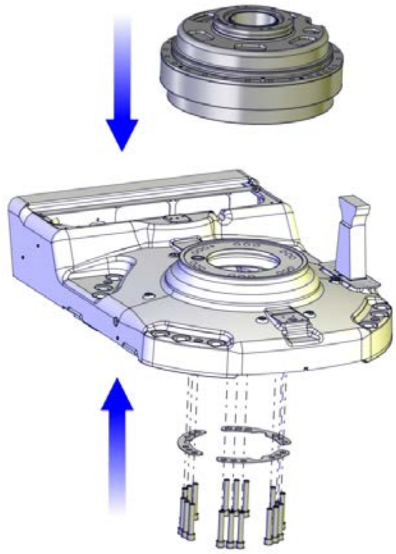
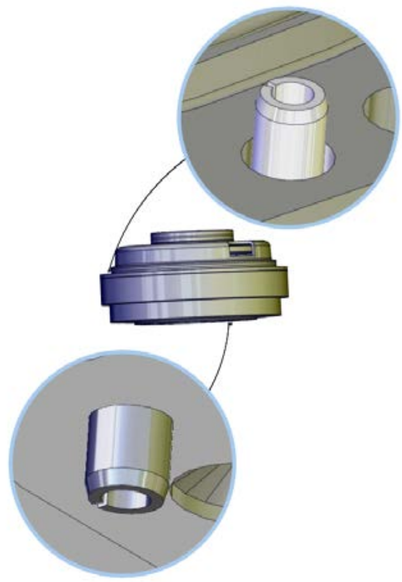
	Action	Note
7	Lift the gearbox. Make sure the guide pin in the bottom face of the gearbox is properly aligned with the base.	 xx1000001389  xx1000001391
8	Lift gearbox axis 1 onto the guide pins and lower it carefully to its mounting position.	Always use guide pins in pairs!

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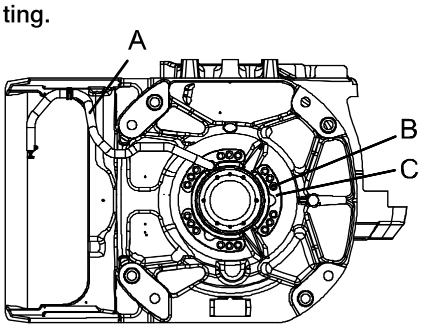
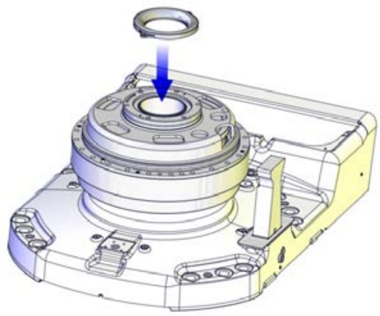
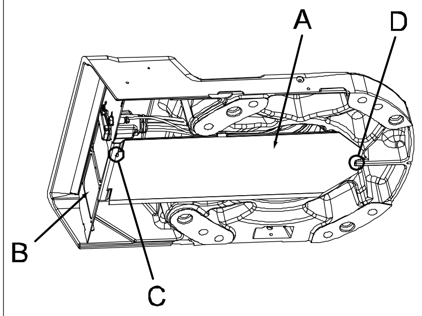
	Action	Note
9	Secure the gearbox with its *attachment screws* and washers.	18 pcs, M16 x 90, 12.9 quality UNBRAKO. Tightening torque: 300 Nm Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 386* before fitting.  xx0200000227 A view from below: • A: Oil drain hose • B: Attachment screws, gearbox axis 1, 18 pcs • C: Washers, 3 pcs
10	Refit the cable guide in the center of gearbox 1 with its attachment screws.	 xx1000001393

Continues on next page

	Action	Note
11	Refit the bottom plate underneath the robot base by pushing it into the groove and fitting the attachment screw. If removed, also refit the rear connector plate. **Note** Direct the bends on the bottom plate downwards!	1 screw: M6 x 8.  xx0300000612 • A: Bottom plate • B: Rear connector plate • C: Attachment screw • D: Groove
12	**CAUTION** The base and axis 1 gearbox weighs 310 kg + 200 kg. All lifting accessories used must be sized accordingly!	
13	Lift the robot base and gearbox 1 and remove the base and gear support.	
14	Secure the base to the mounting site.	See *Orienting and securing the robot on page 76*.
15	Refit the complete arm system. **CAUTION** This is a complex task to be performed with utmost care in order to avoid injury or damage!	Detailed in section *Refitting, arm system on page 211*.
16	Perform a leak-down test.	See section *Performing a leak-down test on page 170*.
17	Refill the gearbox with oil.	See *Changing oil, axis-1 gearbox on page 144*.
18	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.

Continues on next page

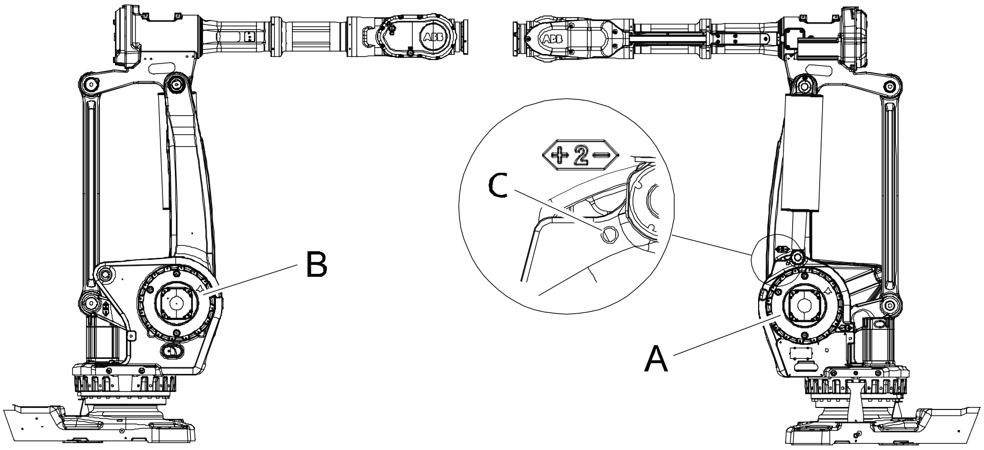
	Action	Note
19	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.7.2 Replacing the gearbox, axes 2- 3

Location of gearbox, axes 2-3

The axis-2 and axis-3 gearboxes are located on either side of the frame as shown in the figure.

The figure shows robot variant IRB 6660 - 130/3.1. The location of the gearboxes is the same on all variants.



xx0700000063

A	Gearbox, axis 2
B	Gearbox, axis 3
C	Hole for lockscrew

Required equipment

Equipment, etc.	Art.no	Note
Gearbox, axes 2-3	For spare part no. see: • *Spare part lists on page 395*.	
Sealing axes 2-3	3HAC022379-001	Always replace.
O-ring	3HAB3772-127	Replace if damaged.
Lock screw M16x55	-	Use to lock the lower arm.
Screw M12x50	-	2 pcs. Use to unload the balancing device.
Screw M12x100	-	2 pcs, must have full thread. Use to press the gearbox free from the frame.
Guide pins M12	-	Use guide pins in pairs.
Lifting accessory	-	Roundsling and a rotating lifting point. Lifting capacity: 100 kg. Used to lift the gearbox.
Guide sleeves	3HAC14628-1/2	Use to keep the sealing in place.

Continues on next page

Equipment, etc.	Art.no	Note
Grease		Use to lubricate surfaces on the gearbox for easier assembly.
Bearing grease	3HAC9408-1	Tribol GR 100-2 PD Option Foundry Plus
Rust preventive	3HAC034903-001	Mercasol 3110 Waxcoat
Standard toolkit		Content is defined in section *Standard tools on page 390*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

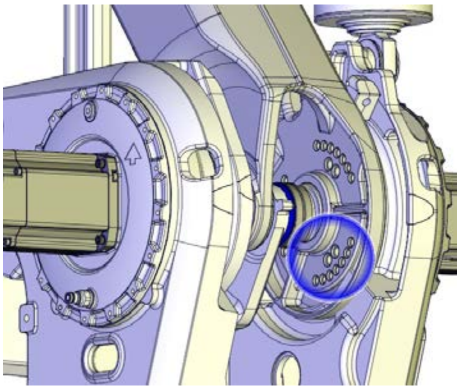
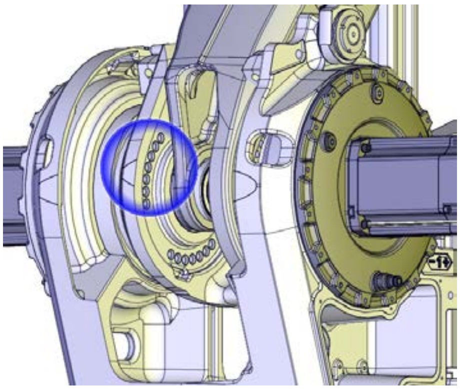
Removal, axis-2 / axis-3 gearbox

Use this procedure to remove the axis-2 or axis-3 gearbox.

Note

Do not replace both gearboxes at the same time, unless the complete arm system is already removed!

Continues on next page

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**When removing axis 2 gearbox:** Run the axis 2 to -42° and all other axes to 0° (calibration position). **When removing axis 3 gearbox:** Run the axis 2 to -40°, axis 3 to +15° and all other axes to 0°.	
3	**When removing axis 2 gearbox:** Remove all screws in the lower screw area on the inside of the lower arm (7 pcs M12, 2 pcs M16). See figure. **When removing axis 3 gearbox:** Remove all screws in the upper front screw area and three screws in the upper back area.	**Axis 2:**  xx1100000623 **Axis 3:**  xx1100000624
4	Run axis 2 to 0°.	

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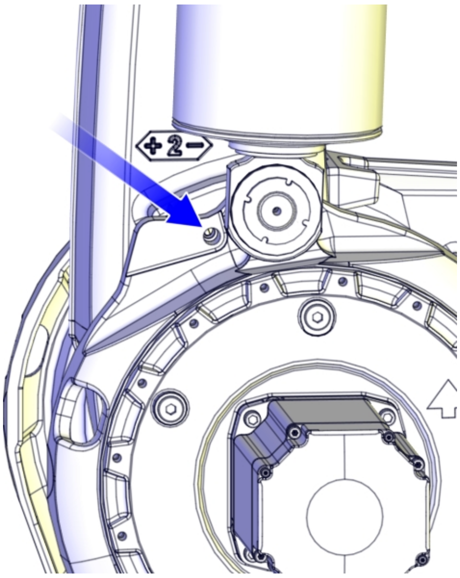
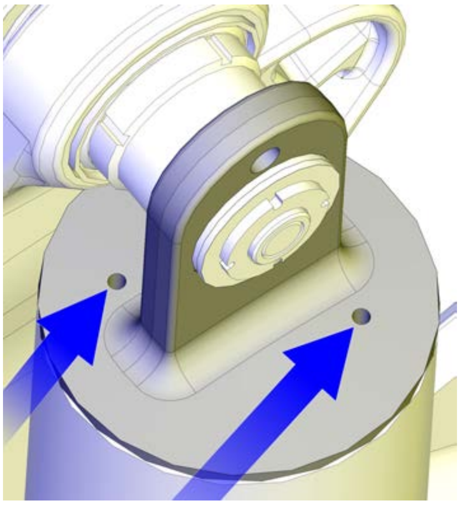
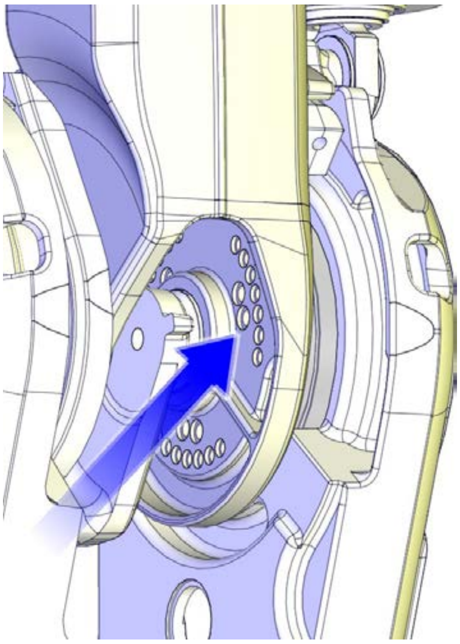
	Action	Note
5	Fit the *lock screw* in the lower arm to secure axis 2. **CAUTION** Tighten by hand!	 xx1000001101
6	Secure the weight of the upper arm with roundslings in an overhead crane.	
7	Raise the lifting equipment to take the weight of the upper arm.	
8	Release the brakes of axis 2 to rest the weight of the axis against the lock screw.	
9	Release the brakes of axis 3 to rest the weight of the axis by the roundslings and overhead crane.	
10	Remove the two plastic screws in the upper end of the balancing device. **Note** Keep the plastic screws. They will be refitted later.	 xx1000001111

Continues on next page

	Action	Note
11	Insert two *screws, M12x50* in the holes to neutralize the spring force. Screw in the screws until they have proper contact with the cylinder inside. The length of the cylinder is now locked and the balancing device is unloaded. It should now be possible to easily rotate the balancing device.	See the previous figure!
12	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
13	Drain the gearbox.	Detailed in section *Draining, axes 2 and 3 on page 149*. **Note** Time-consuming activity!
14	Remove the motor cables of axis-2 or axis-3 motor, depending on which gearbox is being removed. Protect the cables from getting damaged and from oil spill.	
15	Remove one gearbox at a time!	
16	Remove the axis-2 or axis-3 motor, depending on which gearbox is being removed.	Detailed in section *Replacing motors, axes 2 and 3 on page 282*
17	Remove all remaining *attachment screws* that secure the gearbox to the lower arm system. Axis 2: M16 and M12. Axis 3: M12.	 xx1000001405

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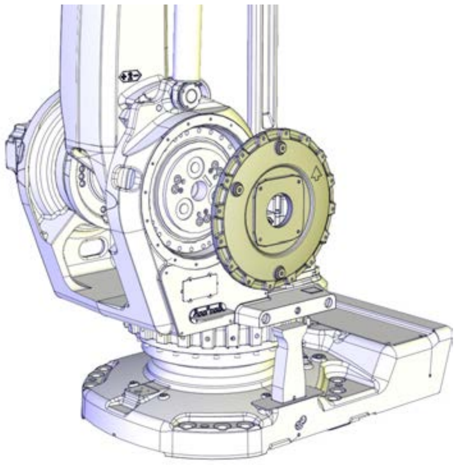
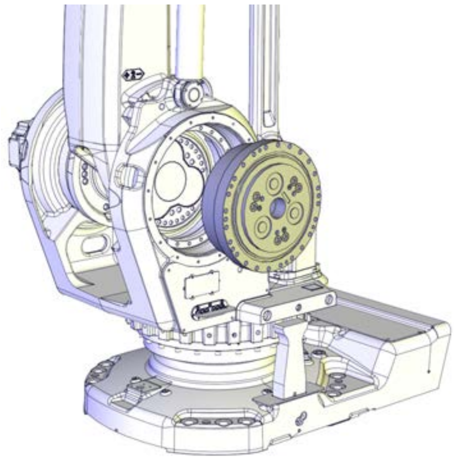
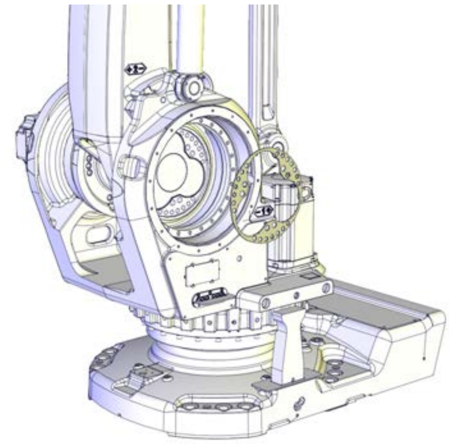
	Action	Note
18	Remove the gearbox cover by removing its attachment screws.	 xx1200000628
19	Remove two opposite screws of the attachment screws that hold the gearbox and replace them with two guide pins.	**Note** Always use guide pins in pairs!
20	Remove the remaining attachment screws.	
21	Fit the *lifting accessory* to the gearbox.	Art. no. is specified in *Required equipment on page 324*.
22	**CAUTION** The gearbox weighs 69 kg. All lifting accessories used must be sized accordingly!	
23	If required, apply two *screws, M12x100* to the holes in the gearbox, in order to press it free. (The screws need to have a full thread.)	
24	**CAUTION** When the gearbox comes free from the frame and comes off the guide pins it will tilt and there is a risk of damage to the gearbox surfaces! Be aware of this and remove the gearbox carefully!	

Continues on next page

	Action	Note
25	Remove the gearbox axis 2-3 using an overhead crane or similar, with guidance from the fitted guide pins.	 xx1200000629
26	Remove the sealing from the lower arm and clean it. **Note** The sealing can hang onto the gearbox, sticking to the oil.	 xx1200000630

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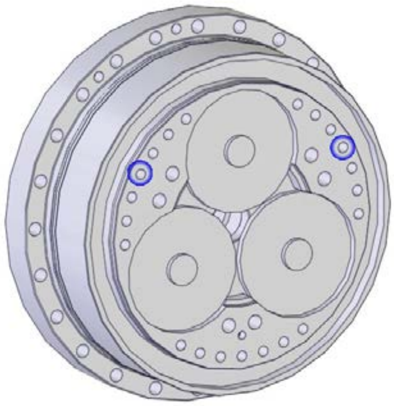
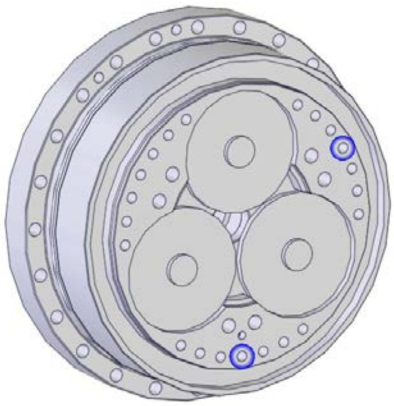
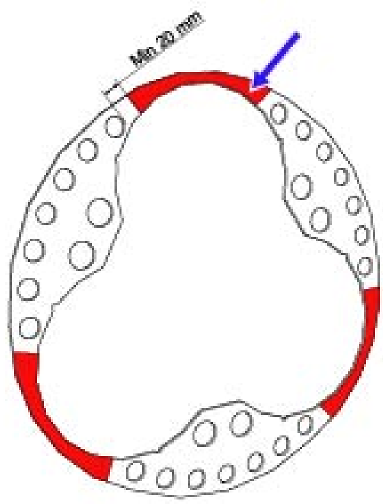
Refitting, axis-2 / axis-3 gearbox

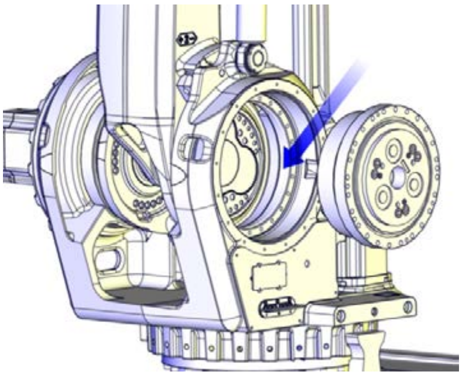
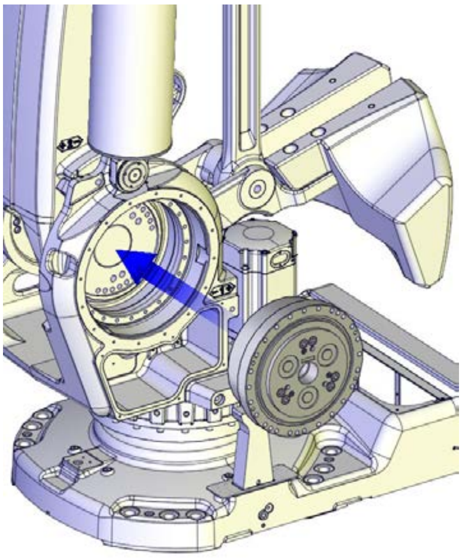
Use this procedure to refit the axes-2 or axis-3 gearbox.

	Action	Note
1	Make sure that the o-ring is fitted to the gearbox. Lightly lubricate it with *grease*.	 xx1000001404 Specified in *Required equipment on page 324*.
2	Fit two *guide pins* in the frame. Use two of the attachment holes for the screws that hold the gearbox.	
3	**CAUTION** The gearbox weighs 69 kg! All lifting equipment used must be sized accordingly!	
4	Fit the *lifting accessory* to the gearbox and lift it with an overhead crane.	Specified in *Required equipment on page 324*.

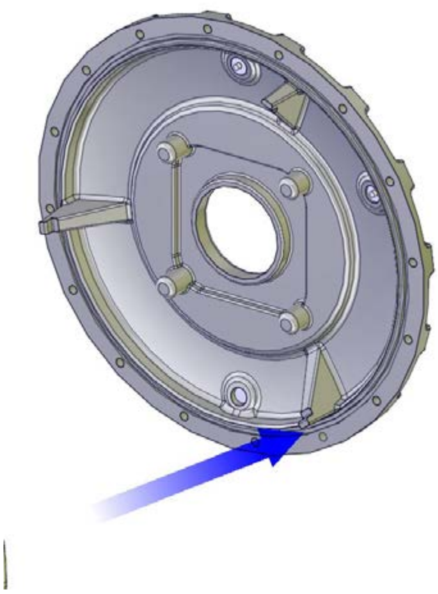
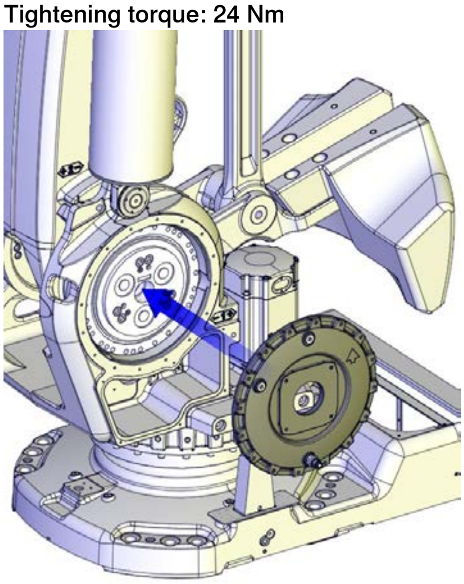
Continues on next page

	Action	Note
5	Fit a new *sealing* to the gearbox and secure it to the gearbox by using two *guide sleeves*. **When refitting axis 2 gearbox:**Insert the guide sleeves in the two middle holes of the upper screw areas. **When refitting axis 3 gearbox:** Insert one guide sleeve in the middle screw hole in the upper back area and one guide sleeve in the middle screw hole in the the lower area.	Art. no. is specified in *Required equipment on page 324*. **Axis 2:**  xx1100000621 **Axis 3:**  xx1100000622
6	*Foundry Plus:* Apply bearing grease on the highlighted areas on both sides of the sealing. **Note** Do not apply grease closer than 20 mm from the edge of the holes in the sealing.	 xx1400000993

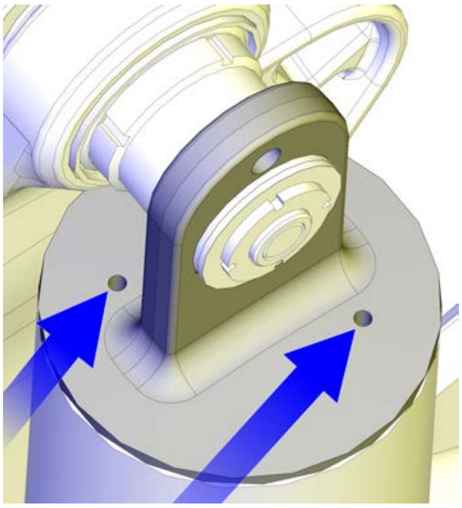
Continues on next page

	Action	Note
	Foundry Plus: Apply rust preventive on the highlighted area.	 xx1400001132
7	Lubricate necessary surfaces of the gearbox with *grease* in order to make it easier to insert the gearbox into the frame.	Specified in *Required equipment on page 324*.
8	Put the gearbox onto the guide pins and slide it carefully into place in the frame. **Note** Check that the sealing is in place during the procedure.	 xx1000001406
9	Use a crank to move the gears in order to find the holes for the attachment screws.	
10	Secure the gearbox to the lower arm with the *attachment screws* and *washers* in two of the screw areas (the third is not reachable at this point). Do not remove the guide sleeves yet.	**Axis 2** M12x60 quality 12.9 Gleitmo (6+6 pcs) • Tightening torque: 120 Nm. M16x90 quality 12.9 Gleitmo (2+2 pcs) • Tightening torque: 300 Nm. **Axis 3** M12x60 quality 12.9 Gleitmo • Tightening torque: 120 Nm.
11	Remove the two guide sleeves and replace them with the two remaining M12 screws.	M12x60 quality 12.9 Gleitmo (1+1 pc) • Tightening torque: 120 Nm.
12	Secure the gearbox to the frame.	M12, quality 8.8-A2F Tightening torque: 120 Nm.

Continues on next page

	Action	Note
13	Clean the gearbox of residual grease.	
14	Apply locking liquid in the attachment holes for the gearbox cover.	Loctite 2400 (or equivalent Loctite 243)
15	Fit the *o-ring* in the cover.	 xx1000001407
16	Refit the cover with its attachment screws and washers. **Note** Fit the cover so that the arrow on the cover points upwards!	M8x35 quality 8.8-A2F (12 pcs) Tightening torque: 24 Nm  xx1000001408
17	Refit the *motors axes 2-3*.	See *Replacing motors, axes 2 and 3 on page 282*
18	Perform a leakdown test.	See *Performing a leak-down test on page 170*.

Continues on next page

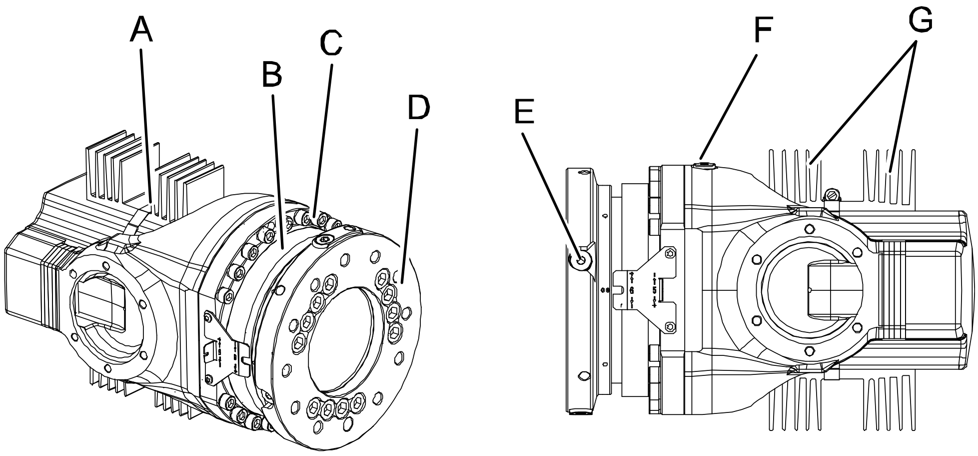
	Action	Note
19	Refill the gearbox axes 2-3 with oil.	See *Filling, axes 2 and 3 on page 149*
20	Remove the screws that unload the balancing device and put back the plastic screws.	 xx1000001111
21	Remove the lock screw from the lower arm.	
22	Run the axes 2 and 3 to a position where the remaining screws in the lower arm can be fitted.	**Axis 2** M12x60 quality 12.9 Gleitmo (6 pcs) • Tightening torque: 120 Nm. M16x90 quality 12.9 Gleitmo (2 pcs) • Tightening torque: 300 Nm. **Axis 3** M12x60 quality 12.9 Gleitmo • Tightening torque: 120 Nm.
23	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
24	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

4.7.3 Replacement of gearbox, axis 6

Location of gearbox

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

The figure shows the motor for robot variant IRB 6660 - 130/3.1 (with cooling elements).



xx0700000165

A	Strap
B	Gearbox, axis 6
C	Attachment screws and washers, gearbox (18 pcs)
D	Attachment screws and washers, turning disk (12 pcs)
E	Oil plug, draining
F	Oil plug, filling
G	Cooling elements

Required equipment

Equipment, etc.	Article number	Note
Gearbox	For spare part number, see *Spare part lists on page 395*.	Includes o-ring
Washers	3HAA1001-172	Not included in gearbox! Replace when damaged.
O-ring	3HAB3772-57	164.7x3.53 Must be replaced when reassembling gearbox.
O-ring	3HAB3772-64	150.0x2.0 Must be replaced when reassembling gearbox.
O-ring	3HAB3772-61	12 pcs, 13.1x1.6 Must be replaced when reassembling gearbox.

Continues on next page

Equipment, etc.	Article number	Note
Grease	3HAC9408-1	Tribol GR 100-2 PD For lubricating the o-ring.
Flange sealant	-	Loctite 574
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Calibration Pendulum toolkit	3HAC15716-1	Complete kit that also includes operating manual. Required if Calibration Pendulum is the valid calibration method for the robot.
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Deciding calibration routine

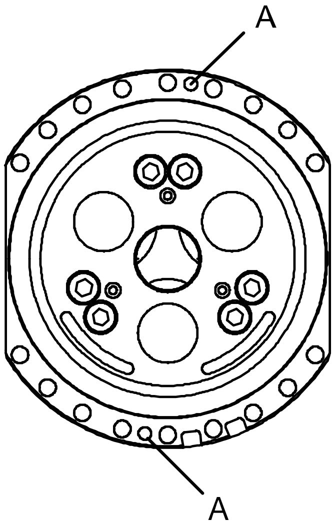
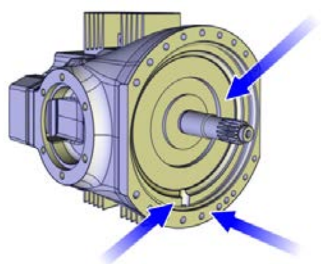
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 356*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Continues on next page

Removal, gearbox

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

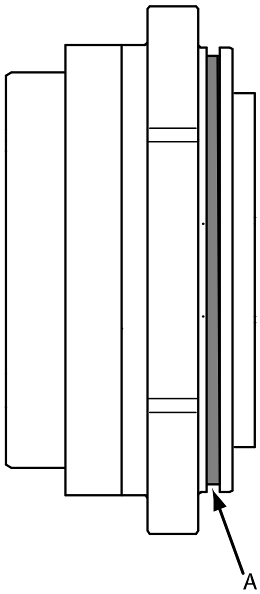
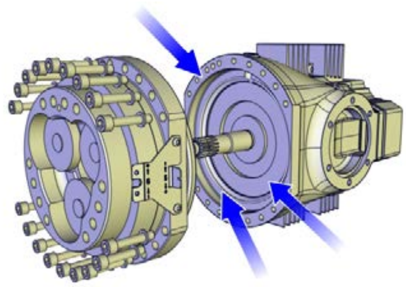
	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
3	Drain the oil from gearbox, axis 6.	Detailed in the section *Changing oil, axis-6 gearbox on page 156*.
4	Remove the *turning disc*.	Detailed in the section *Removing, turning disk on page 216*.
5	Remove the gearbox by unscrewing its *attachment screws*.	Shown in the figure *Location of gearbox on page 336*.
6	If required, apply M8 screws to the holes shown in the figure beside to press the gearbox out.	 xx0200000220 • A: M8 holes for pressing out the gearbox
	Foundry Plus: Remove old Loctite 574 flange sealant residues and other contamination from the contact surfaces.	 xx1400001123

Continues on next page

	Action	Note
7	Remove the gearbox axis 6 by lifting it out carefully.	Be careful not to damage the motor pinion!

Refitting, gearbox

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

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Make sure the *o-ring* is fitted to the rear of the gearbox. Lubricate the o-ring with *grease.*	Article number is specified in *Required equipment on page 336*.  xx0200000221 • A: O-ring, gearbox axis 6
3	Release the holding brake of motor axis 6.	Detailed in the section *Manually releasing the brakes on page 68*.
4	*Foundry Plus:* Apply Loctite 574 flange sealant on the contact surface.	 xx1400001122

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	Action	Note
5	Insert the *gearbox, axis 6* into the wrist unit.	Article number is specified in *Required equipment on page 336*. Shown in the figure *Location of gearbox on page 336*. Make sure the gears of the gearbox mate with the gears of the motor!
6	Secure the gearbox with the *attachment screws and washers.*	Shown in the figure *Location of gearbox on page 336*. 8 pcs or 18 pcs (depending on wrist version): M8 x 40, 12.9 quality Gleitmo, Tightening torque: 30 Nm. Reused screws may be used, providing they are lubricated as detailed in section *Screw joints on page 386* before fitting.
7	Refit the *turning disc*.	Detailed in the section *Refitting, turning disk on page 217*.
8	Perform a *leak-down test*.	Detailed in the section *Performing a leak-down test on page 170*.
9	Refill the gearbox with oil.	Detailed in the section *Changing oil, axis-6 gearbox on page 156*.
10	Re-calibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 355*. General calibration information is included in section *Calibration on page 341*.
11	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 105*.	

5 Calibration

5.1 Introduction to calibration

5.1.1 Introduction and calibration terminology

Calibration information

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

Detailed instructions of how to perform Axis Calibration are given on the FlexPendant during the calibration procedure. To prepare calibration with Axis Calibration method, see *Calibrating with Axis Calibration method on page 355*.

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

Calibration terminology

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

5.1.2 Calibration methods

Overview

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

Types of calibration

Type of calibration	Description	Calibration method
Standard calibration	The calibrated robot is positioned at calibration position. Standard calibration data is found on the SMB (serial measurement board) or EIB in the robot.	Axis Calibration or Calibration Pendulum [i]
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 serial measurement board (SMB) or other robot memory. For IRC5 robots, 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 (IRC5). A robot calibrated with Absolute accuracy has the option information printed on its name plate (OmniCore). To regain 100% Absolute accuracy performance, the robot must be recalibrated for absolute accuracy after repair or maintenance that affects the mechanical structure.  xx0400001197	CalibWare

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Type of calibration	Description	Calibration method
Optimization	Optimization of TCP reorientation performance. The purpose is to improve reorientation accuracy for continuous processes like welding and gluing. Wrist optimization will update standard calibration data for axes 4 and 5. **Note** For advanced users, it is also possible to use the do the wrist optimization using the RAPID instruction `WristOpt`, see *Technical reference manual - RAPID Instructions, Functions and Data types*. This instruction is only available for OmniCore robots.	Wrist Optimization

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

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

If no data is found related to standard calibration, contact the local ABB Service.

Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of some ABB robots. On OmniCore, this calibration method is only used on IRB 1510, IRB 1520, IRB 2400, and IRB 4400.

Two different routines are available for the Calibration Pendulum method:

- Calibration Pendulum II
- Reference calibration

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

Axis Calibration method

Axis Calibration is a standard calibration method for calibration of IRB 6660. It is the recommended method in order to achieve proper performance.

The following routines are available for the Axis Calibration method:

- Fine calibration
- Update revolution counters
- Reference calibration

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

An introduction to the calibration method is given in this manual, see *Calibrating with Axis Calibration method on page 355*.

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

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Wrist Optimization method

Wrist Optimization is a method for improving reorientation accuracy for continuous processes like welding and gluing and is a complement to the standard calibration method.

The actual instructions of how to perform the wrist optimization procedure is given on the FlexPendant.

CalibWare - Absolute Accuracy calibration

The CalibWare tool guides through the calibration process and calculates new compensation parameters. This is further detailed in the *Application manual - CalibWare Field*.

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 replacements that do not include taking apart the robot structure, standard calibration is sufficient.

The Absolute Accuracy option varies according to the robot mounting position. This is printed on the robot name plate for each robot. The robot must be in the correct mounting position when it is recalibrated for absolute accuracy.

References

Article numbers for the calibration tools are listed in the section *Special tools on page 391*.

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

5.1.3 When to calibrate

When to calibrate

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

The resolver values are changed

If resolver values are changed, the robot must be re-calibrated 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 349*. 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 reachability of a robot is changed, it needs to be re-calibrated for new resolver values.

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

5.2 Synchronization marks and axis movement directions

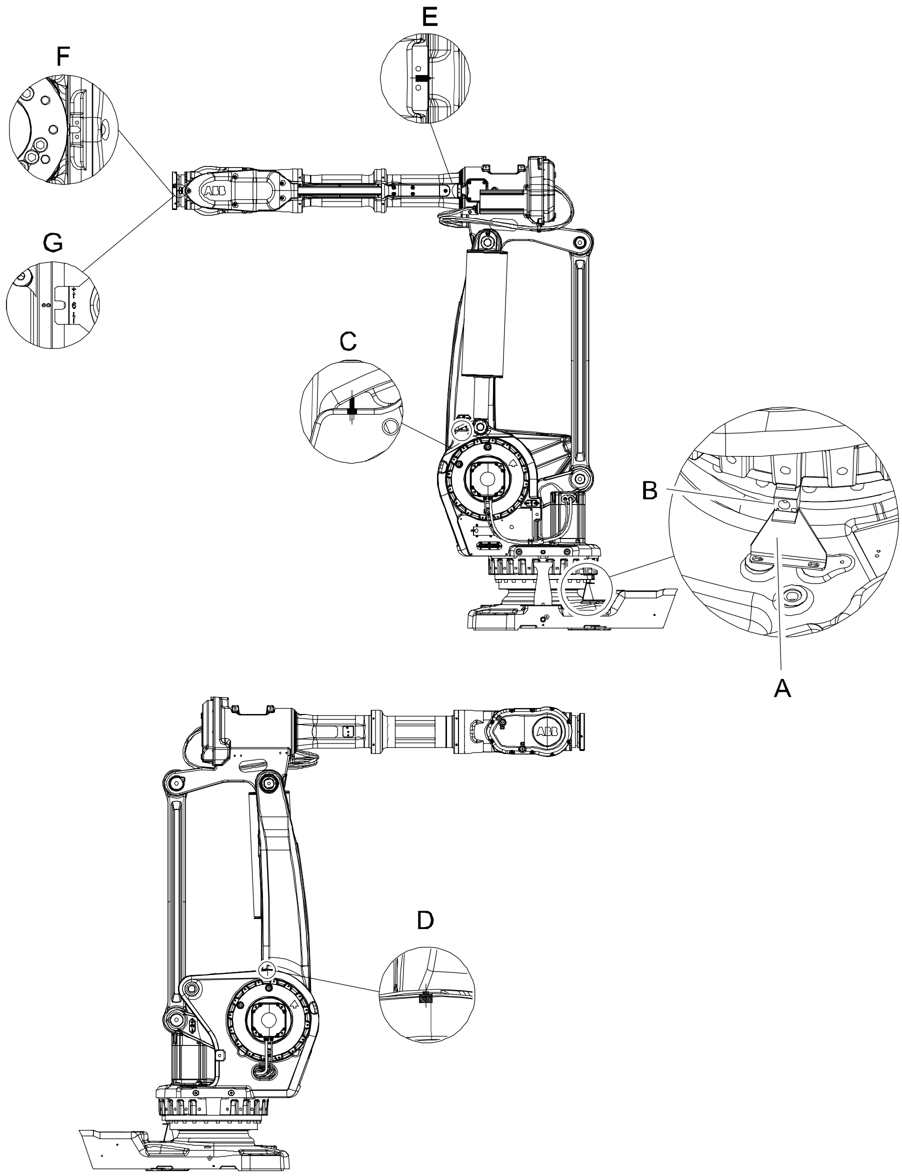
5.2.1 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 6660

The figure shows robot variant IRB 6660 - 130/3.1 but the position of the marks are the same on all IRB 6660 robot variants.



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A	Synchronization plate, axis 1
B	Synchronization tab on robot

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

5.2.2 Calibration movement directions for all axes

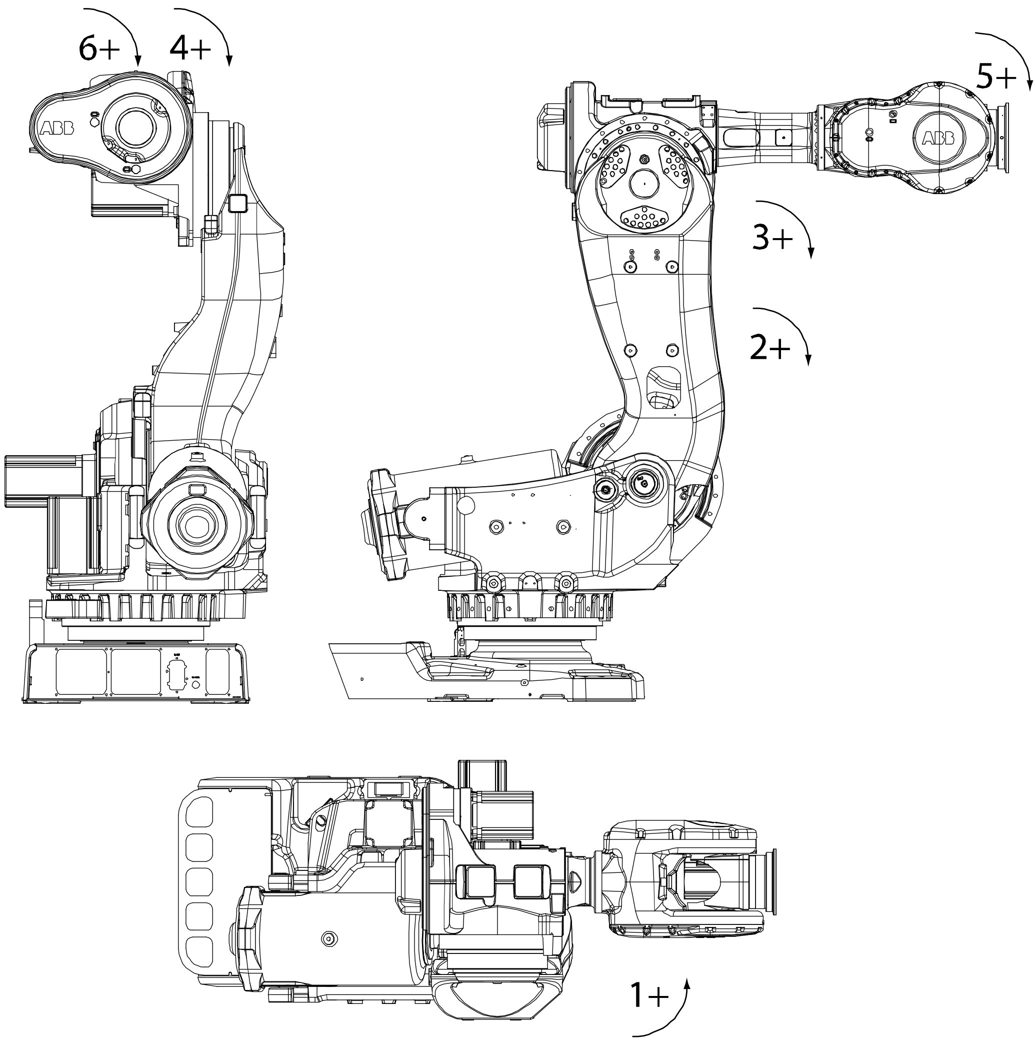
Overview

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

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

Manual movement directions, 6 axes

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



xx0200000089

5.3 Updating revolution counters

5.3.1 Updating revolution counters on IRC5 robots

Introduction

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

Step 1 - Manually running the manipulator to the synchronization position

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

	Action	Note
1	Select axis-by-axis motion mode.	
2	Jog the manipulator to align the synchronization marks.	See *Synchronization marks and synchronization position for axes on page 346*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 350*.

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 6660	Yes	Yes

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

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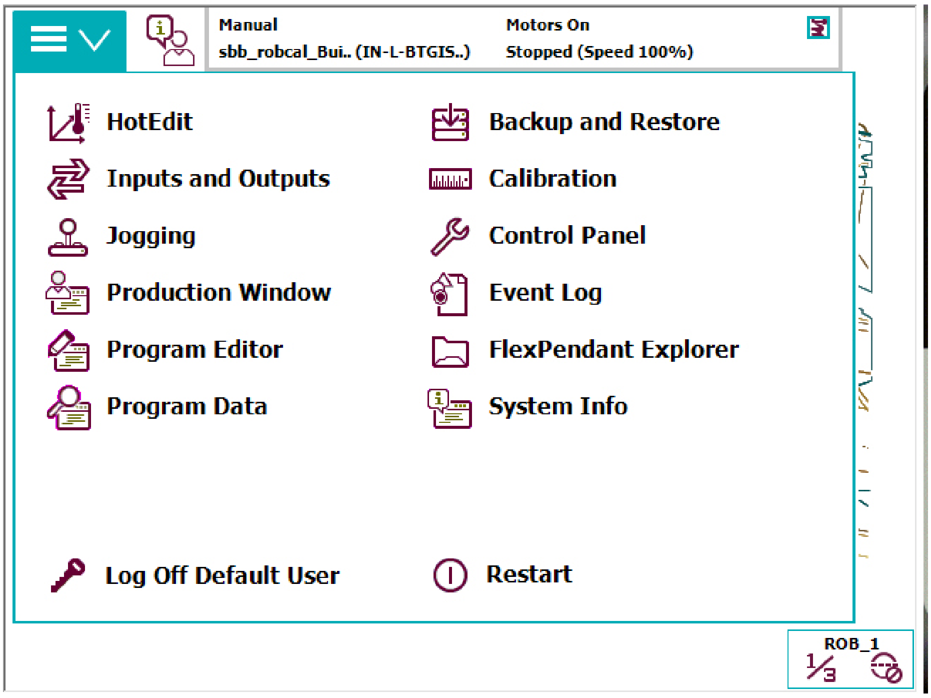
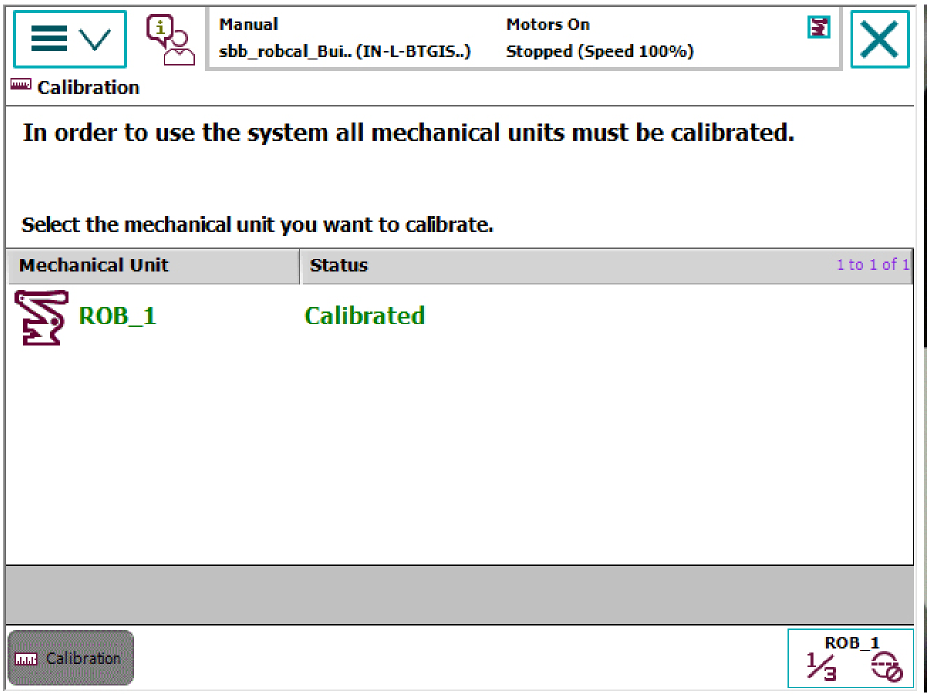
Step 2 - Updating the revolution counter with the FlexPendant

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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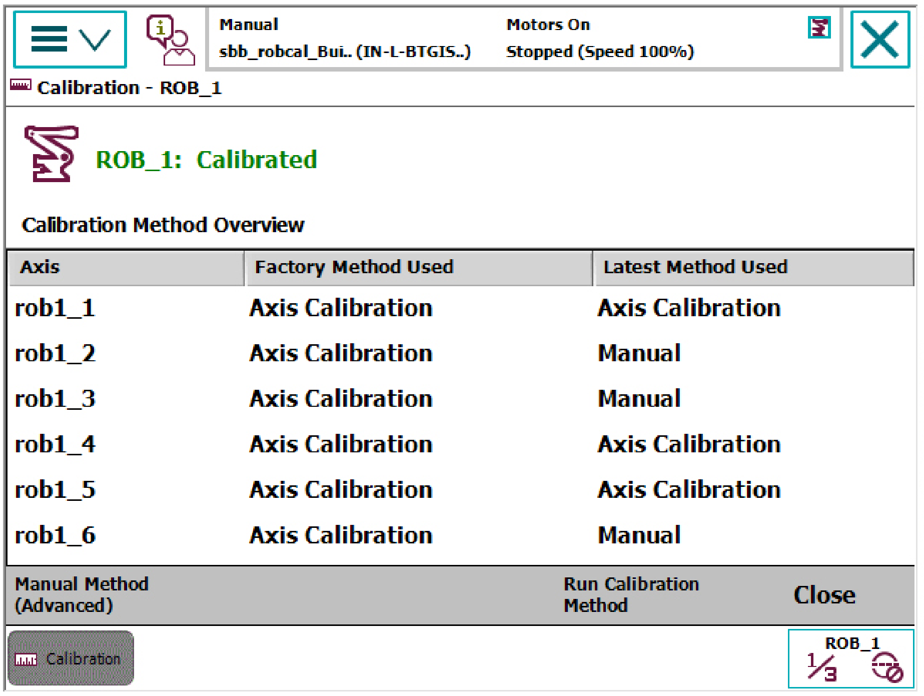
<table>
<tr><th></th><th>Action</th></tr>
<tr><td>3</td><td>

This step is valid for RobotWare 6.02 and later.

Calibration method used at factory for each axis is shown, as well as calibration method used during last field calibration.

Tap **Manual Method (Advanced)**.



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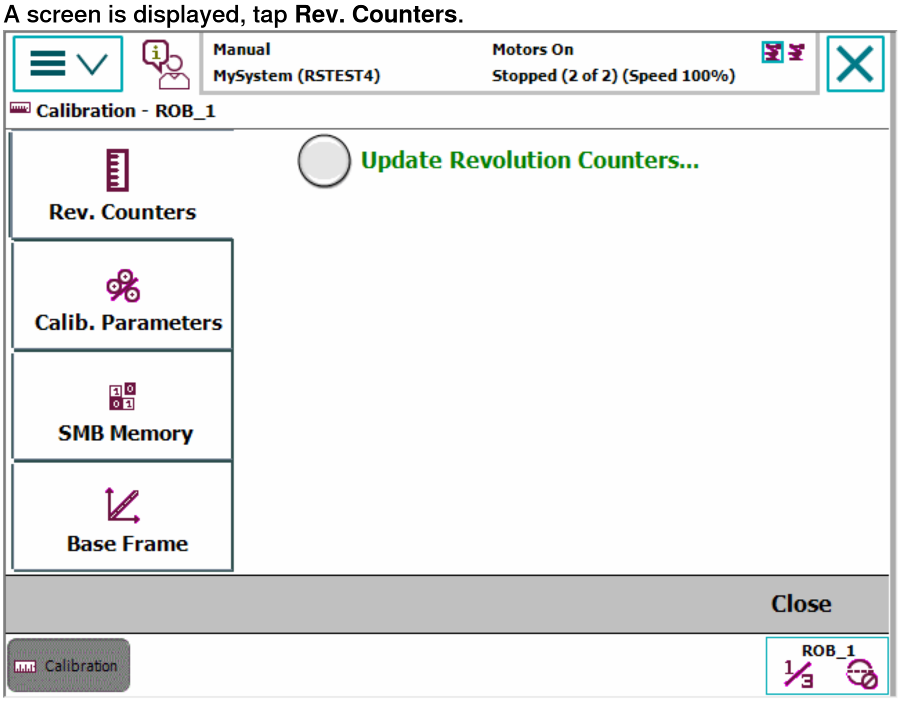
</td></tr>
<tr><td>4</td><td>

A screen is displayed, tap **Rev. Counters**.



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

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	Action
5	Tap **Update Revolution Counters...**. A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: • Tap **Yes** to update the revolution counters. • Tap **No** to cancel updating the revolution counters. Tapping **Yes** displays the axis selection window.
6	Select the axis to have its revolution counter updated by: • Ticking in the box to the left • Tapping **Select all** to update all axes. Then tap **Update**.
7	A dialog box is displayed, warning that the updating operation cannot be undone: • Tap **Update** to proceed with updating the revolution counters. • Tap **Cancel** to cancel updating the revolution counters. Tapping **Update** updates the selected revolution counters and removes the tick from the list of axes.
8	**CAUTION** If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See *Checking the synchronization position on page 371*.

5.3.2 Updating revolution counters on OmniCore robots

Introduction

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

Step 1 - Manually running the manipulator to the synchronization position

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

	Action	Note
1	Select axis-by-axis motion mode.	
2	Jog the manipulator to align the synchronization marks.	See *Synchronization marks and synchronization position for axes on page 346*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 353*.

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 6660	Yes	Yes

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

Step 2 - Updating the revolution counter with the FlexPendant

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

	Action
1	On the start screen, tap **Calibrate**. The calibration summary page for the mechanical unit is displayed.
2	In the **Calibration Methods** menu, select **Revolution Counters**.

Continues on next page

	Action
3	In the **Selection** column select the axes for which revolution counters need to be updated.
4	Tap **Update**. A dialog box is displayed warning that the updating operation cannot be undone.
5	Tap **OK** to update the revolution counter.
6	**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 371*.

5.4 Calibrating with Axis Calibration method

5.4.1 Description of Axis Calibration

Instructions for Axis Calibration procedure given on the FlexPendant

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

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

Overview of the Axis Calibration procedure

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

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

The Axis Calibration procedure described roughly:

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

   WARNING

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

   WARNING

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

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

   WARNING

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

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

Continues on next page

Routines in the calibration procedure

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

Fine calibration routine

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

Reference calibration routine

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

Note

When calibrating the robot with the reference calibration routine, the robot must be dressed with the same tools, process cabling and any other equipment as when the reference values were created.

Note

When using reference calibration with some tools, typically large or flexible tools, oscillations in the robot can cause issues leading to failure of the calibration.

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

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

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

Update revolution counters

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

Validation

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

Position of robot axes

The robot axes should be positioned close to 0 degrees before commencing the calibration program. The axis chosen for calibration is then automatically run by the calibration program to its exact calibration position during the calibration procedure.

It is possible to position some of the other axes in positions different from 0 degrees. Information about which axes are allowed to be jogged is given on the FlexPendant.

Continues on next page

These axes are marked with **Unrestricted** in the FlexPendant window. Also the following table shows the dependencies between the axes.

Requirements for axis positioning during calibration

	Axis to calibrate					
Required position of axis	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**	**Axis 5**	**Axis 6**
Axis 1	-	*	*	*	*	*
Axis 2	0	-	0	*	*	*
Axis 3	0	0	-	*	*	*
Axis 4	*	*	*	-	*	*
Axis 5	*	*	*	*	-	*
Axis 6	*	*	*	*	*	-

-	Axis to be calibrated
*	Unrestricted. Axis is allowed to be jogged to other position than 0 degrees.
0	Axis must be put in position 0 degrees.

System containing SafeMove

SafeMove will lose its synchronization to the controller if a new calibration is done. New calibration values have to be downloaded to SafeMove, and a new SafeMove calibration has to be done. Make sure that the user rights admit to change the safety settings and to synchronize SafeMove.

For robots with EPS, the same applies as for SafeMove.

5.4.2 Calibration tools for Axis Calibration

Calibration tool set

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

The calibration tool will eventually break from fatigue after longer period of use and then needs to be replaced. There is no risk for bad calibrations as long as the calibration tool is in one piece.

WARNING

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

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

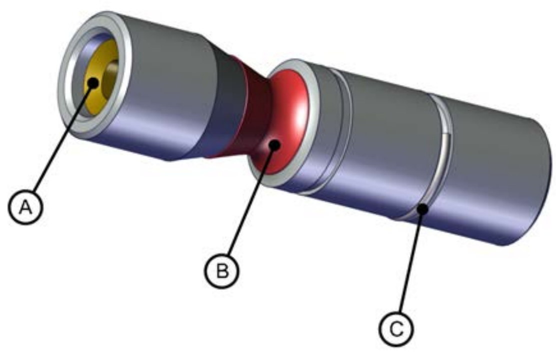
Examining the calibration tool

Check prior to usage

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

WARNING

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



xx1500001914

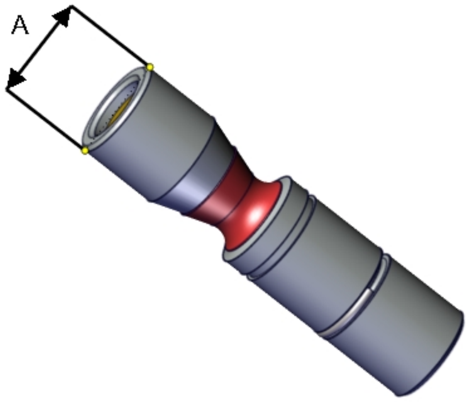
A	Tube insert
B	Plastic protection
C	Steel spring ring

Continues on next page

Periodic check of the calibration tool

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

- Outer diameter within Ø12g4 mm, Ø8g4 mm or Ø6g5 mm (depending on calibration tool size).
- Straightness within 0.005 mm.



xx1500000951

A	Outer diameter

Identifying the calibrating tools

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

Note

The tool identifier is NOT delivered from ABB, it is a customized solution.

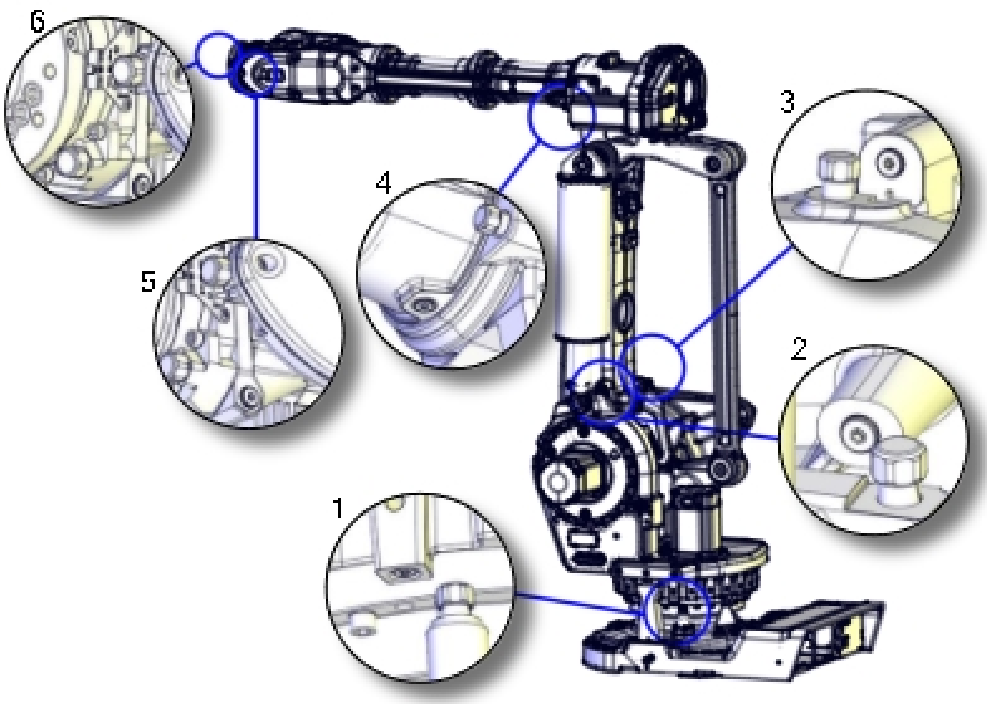
	Action	Note
1	It is possible to use any RFID solution, with the correct dimensions. ABB has verifed function on some suppliers fulfilling the requirements of NFC compatible devices (13.56 Mhz) according to ISO 14443 or ISO 15693. **Note** The maximum dimensions on the RFID chip must not exceed Ø7.9 mm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

5.4.3 Installation locations for the calibration tools

Location of fixed calibration items

This section shows how the robot is equipped with items for installation of calibration tools for Axis Calibration (fixed calibration pins and/or bushings). Installed calibration tools are not shown.

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



xx1500003256

The fixed calibration pin for axis 1 is installed on a removable tower. The tower will need to be removed if electronic position switches are fitted to the robot. Keep the tower in a safe location for future recalibration needs and mark it with robot serial number to ensure that the correct one is refitted.

Spare parts

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

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

5.4.4 Axis Calibration - Running the calibration procedure

Required tools

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

WARNING

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

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

Required consumables

Consumable	Article number	Note
Clean cloth	-	

Spare parts

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

Overview of the calibration procedure on the FlexPendant

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

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

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

1. Choose calibration routine. The routines are described in *Routines in the calibration procedure on page 356*.
2. Choose which axis/axes to calibrate.
3. The robot moves to synchronization position.
4. Validate the synchronization marks.
5. The robot moves to preparation position.
6. Remove the protective cover from the fixed pin and the protection plug from the bushing, if any, and install the calibration tool.

Continues on next page

7. The robot performs a measurement sequence by rotating the axis back and forth.
8. Remove the calibration tool and reinstall the protective cover on the fixed pin and the protection plug in the bushing, if any.
9. The robot moves to verify that the calibration tool is removed.
10. Choose whether to save the calibration data or not.

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

Preparation prior to calibration

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

	Action	Note
1	**DANGER** While conducting the calibration, the robot needs to be connected to power. Make sure that the robot's working area is empty, as the robot can make unpredictable movements.	
2	Wipe the calibration tool clean. **Note** The calibration method is exact. Dust, dirt or color flakes will affect the calibration value.	Use a clean cloth.
3	Check if the standard calibration data for axes 4 or 5 are updated with wrist optimization. This is shown in the calibration overview/summary window on the FlexPendant.	If the data is optimized, the calibration routine **Wrist Optimization** must be re-run after standard calibration. See *Calibrating with Wrist Optimization method on page 368*.

Starting the calibration procedure

Use this procedure to start the Axis Calibration routine on the FlexPendant.

	Action	Note
1	Tap the calibration icon and enter the calibration main page.	
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question. **Note** For RobotWare 7, the mechanical unit page is displayed only if there is more than one mechanical unit available.	
3	The calibration method used at ABB factory for each axis is shown, as well as calibration method used for the robot during last field calibration.	The FlexPendant will give all information needed to proceed with Axis Calibration.

Continues on next page

	Action	Note
4	**Valid for RobotWare 6** Tap **Call Calibration Method.** The software will automatically call for the procedure for the valid calibration method. If not, tap **Call Routine** and then tap **Axis calibration**.	
5	**Valid for RobotWare 7** Tap **Calibration Methods** on the right pane and then tap **Calibration**. The software will automatically call for the procedure for the valid calibration method.	
6	Follow the instructions given on the FlexPendant.	A brief overview of the sequence that will be run on the FlexPendant is given in *Overview of the calibration procedure on the FlexPendant on page 361*.

Restarting an interrupted calibration procedure

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

Situation	Action
The three-position enabling device on the FlexPendant has been released during robot movement.	Press and hold the three-position enabling device and press **Play**.
The RobotWare program is terminated with **PP to Main**.	Remove the calibration tool, if it is installed, and restart the calibration procedure from the beginning. See *Starting the calibration procedure*. If the calibration tool is in contact the robot axis needs to be jogged in order to release the calibration tool. Jogging the axis in wrong direction will cause the calibration tool to break. Directions of axis movement is shown in *Calibration movement directions for all axes on page 348*

Axis Calibration with SafeMove option

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

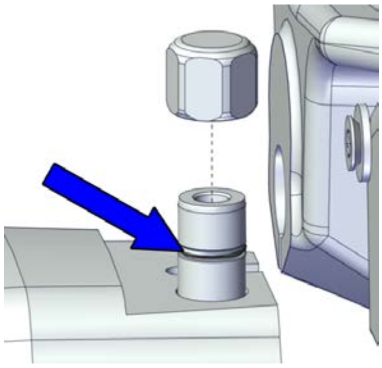
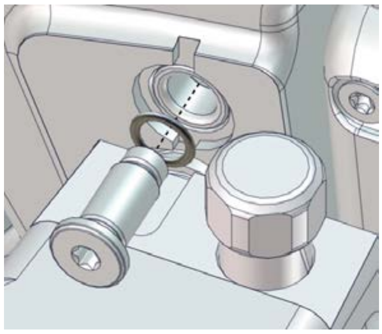
However, SafeMove may generate other warning messages anytime during the Axis Calibration routine. When a warning message is displayed, tap **Acknowledge** to confirm the unsynchronized state and continue Axis Calibration procedure.

CAUTION

SafeMove must be synchronized after the calibration is completed.

Continues on next page

After calibration

	Action	Note
1	Check the o-ring on the fixed calibration pin. Replace if damaged or missing.	 xx1600002102 Protection cover and plug set: 3HAC056806-001.
2	Reinstall the protective cover on the fixed calibration pin on each axis, directly after the axis has been calibrated. Replace the cover with new spare part, if missing or damaged.	
3	Reinstall the protective plug and sealing in the bushing on each axis, directly after the axis has been calibrated. Ensure that the sealing is not damaged. Replace the plug and the sealing with new spare part, if missing or damaged.	 xx1500000952 Protection cover and plug set: 3HAC056806-001.
4	If the standard calibration data for axes 4, 5 or 6 should be updated with wrist optimization, run the calibration routine **Wrist Optimization**.	See *Calibrating with Wrist Optimization method on page 368*.

5.4.5 Reference calibration

Brief introduction to Reference Calibration

Reference calibration is a faster method compared to Fine calibration, as it refers to a previously made calibration.

1. Create a backup of the current robot system.
2. Check that the active calibration offset values corresponds to the values on the calibration label (located on the lower arm or the base).
3. Jog the manipulator so that all axes are in zero position (ex use `MoveAbsJ` instruction). Check that all axis scales are aligned with calibration marks.
4. If the scales differ from calibration marks it might depend on wrong turns of the revolution counters. Make a marker line on the corresponding axis to be able to validate the result of the calibration. If more than one motor revolutions are wrong, the calibration will fail.
5. Use a verification position. This is especially recommended if all axes were not aligned with the synchronization marks (step 3). Reuse an existing position that is suitable and accurate so it can be used to validate the repair. Use a position where a deviation in axis calibration gives a big deviation in positioning. Note! Check the position after each repair in one axis.
6. Use Reference calibration to save reference values for all axes that is to be replaced. Make sure that the values are saved in RobotStudio or FTP program. The files are located in "Active system folder name/HOME/RefCalibFiles".
7. Perform the repair.
8. Make sure that the tooling and process equipment are the same as when creating the reference. Use Reference calibration to update the system with new calibration offset value for the repaired axis.
9. Check the position against the verification position (step 5).
10. Proceed with the repair of the next axis, if necessary, and repeat (step 8-9) for every axis.
11. (For system containing SafeMove or EPS) Download new calibration values to SafeMove. Use Visual SafeMove in RobotStudio.(For system containing SafeMove) Download new calibration values to SafeMove. Use Visual SafeMove in RobotStudio.
12. (For system containing SafeMove or EPS) Synchronize SafeMove to activate SafeMove.(For system containing SafeMove) Synchronize SafeMove to activate SafeMove.
13. Perform test run.
14. Update the calibration label with new resolver values (calibration values).

Manual tuning of calibration offset

Manual tuning of calibration offset is normally not needed, but can be useful in some situations. The requirement to do manual tuning is that there is a known accurate position, that worked accurately before the repair (step 5, see *Brief introduction to Reference Calibration on page 365*).

Continues on next page

Example "Adjust axis 4":

1. Create a backup.
2. Run the manipulator to the verification position. (The manipulator position is now deviating from the verification position.)
3. Read and note current axis 4 value in degrees (example: 96.3 degrees).
4. Manually jog, only axis 4, so that the manipulator is correctly positioned to the verification position.
5. Read and note current axis 4 value in degrees (example: 94.2 degrees).
6. Move the manipulator to its calibration position.
7. Calculate the angle difference (ie 96.3-94.2=2.1 degrees).
8. Manually jog axis 4 the calculated angle difference (-2.1). NOTE! The direction +/- shall be the same direction as the direction used when axis 4 was manually jogged to coincide with the verification process. In the example -2.1 degrees.
9. Make a new manual fine calibration of axis 4 with axis in -2.1 degrees position.
10. Check again against the verification position.
11. Repeat the manual tuning if needed.
12. Create a new reference if the intention is to use the reference in the future.

5.5 Calibrating with Calibration Pendulum method

Where to find information for Calibration Pendulum

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.

5.6 Calibrating with Wrist Optimization method

When to run Wrist Optimization

Wrist Optimization routine is run to improve TCP reorientation performance.

Calibrating the robot with standard calibration method overwrites the optimized positions of axes 4, 5. Re-run the **Wrist Optimization** routine after standard calibration to re-achieve the optimized positions of the wrist axes.

Overview of the calibration procedure on the FlexPendant

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

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

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

1. Choose calibration routine Wrist Optimization.
2. Modify targets for 4-point tool frame definition, in Wrist Optimization routine.

   > **Tip**
   >
   > Select positions with large reorientations around the TCP. For best results, make sure that axis 4 and 5 have large movements.

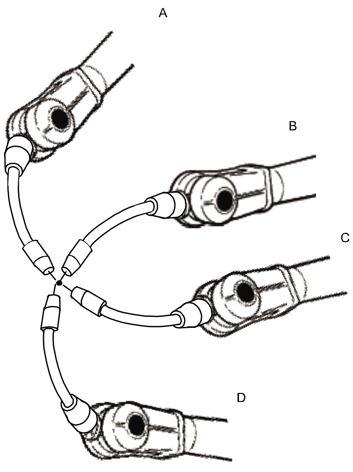
   a. Jog the robot to an appropriate position, A, for the first approach point.

      Use small increments to accurately position the tool tip as close to the reference point as possible.

   b. Tap **Modify Position** to define the point.

   c. Repeat for each approach point to be defined, positions B, C, and D.

      Jog away from the fixed world point to achieve the best result. Just changing the tool orientation will not give as good a result.



en0400000906

3. Improved calibration data to the wrist axes is identified and presented.
4. Optimized positions for the wrist axes are presented.

Continues on next page

5. The robot moves to the optimized positions for the wrist axes and automatically overwrites previous calibration data.

   WARNING

   Robot moves automatically when pressing **Calibrate**.

6. Wrist optimization is finished.
7. Redefine / verify TCP for all tools.

5.7 Verifying the calibration

Introduction

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

Verifying the calibration

Use this procedure to verify the calibration result.

	Action	Note
1	Run the calibration home position program twice. Do not change the position of the robot axes after running the program!	See *Checking the synchronization position on page 371*.
2	Adjust the *synchronization marks* when the calibration is done, if necessary.	This is detailed in section *Synchronization marks and synchronization position for axes on page 346*.
3	Write down the values on a new label and stick it on top of the calibration label. xx	

5.8 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 the **Jog** window on the FlexPendant.

Continues on next page

5.8.1 Checking the synchronization position on IRC5 robots

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 346* and *Updating revolution counters on page 349*.

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 346* and *Updating revolution counters on page 349*.

5.8.2 Checking the synchronization position on OmniCore robots

Using a `MoveAbsJ` instruction

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

	Action	Note
1	Tap **Code**.	
2	Create a new program.	
3	Use **MoveAbsJ** in the **Add Instruction** 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 346* and *Updating revolution counters on page 349*.

Using the jogging window

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

	Action	Note
1	Tap **Jog**.	
2	From the **Mechanical unit** list select a mechanical unit.	
3	From the **Motion mode** section, select an axis-set that need to be jogged. For example, to jog axis 2, select the axis set **Axis 1-3**.	
4	Follow the screen instruction on joystick movements to understand the direction of the axis that you want to move and move the joystick.	
5	Manually run the robots axes to a position where the axis position value read on the FlexPendant, is equal to zero.	
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 346* and *Updating revolution counters on page 349*.

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6 Decommissioning

6.1 Introduction to decommissioning

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.

Note

The decommissioning process shall be preceded by a risk assessment.

Disposal of materials used in the robot

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.

See also *Environmental information on page 376*.

Transportation

Prepare the robot or parts before transport, this to avoid hazards.

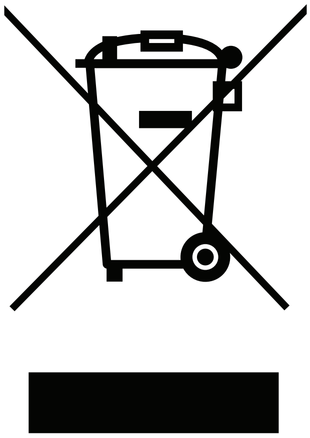
6.2 Environmental information

Introduction

ABB robots contain components in different materials. During decommissioning, all materials shall be dismantled, recycled, or reused responsibly, according to the relevant laws and industrial standards. Robots or parts that can be reused or upcycled helps to reduce the usage of natural resources.

Disposal symbol

The following symbol indicates that the product must not be disposed of as common garbage. Handle each product according to local regulations for the respective content (see table below).



xx1800000058

Materials used in the product

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

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

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

Continues on next page

Oil and grease

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

Also note that:

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

6.3 Scrapping of robot

Note

The decommissioning process shall be preceded by a risk assessment.

Important when scrapping the robot

DANGER

The risk assessment should consider hazards arising in the decommissioning, such as, but not limited to:

- Always remove all batteries. If a battery is exposed to heat, for example from a blow torch, it will explode.
- Always remove all oil/grease in gearboxes. If exposed to heat, for example from a blow torch, the oil/grease will catch fire.
- When motors are removed from the robot, the robot will collapse if it is not properly supported before the motor is removed.
- A used robot does not have the same performance as on delivery. Springs, brakes, bearings, and other parts might be worn or broken.

6.4 Decommissioning of balancing device

Note

This section is not applicable to robot variant IRB 6660 - 205/1.9.

General

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

The device must be dismantled by a decommissioning company.

Required equipment

Equipment	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 390*.
Protective clothing that also covers face and hands	-	Must protect against spatter of sparks and flames.
Cutting torch with a long shaft	-	For opening housing and cutting coils. The long shaft is a safety requirement.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

DANGER

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

Action on field, decommissioning

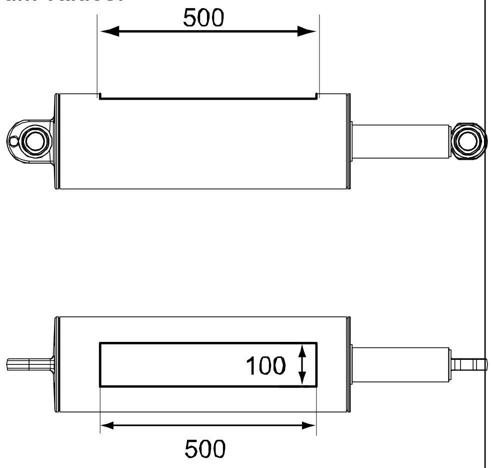
The procedure below details the actions to perform on field, when the balancing device is to be decommissioned.

	Action	Note
1	Remove the balancing device from the robot.	Detailed in section *Replacing the balancing device on page 267*.
2	Send the device to a decommissioning company.	Make sure the decommissioning company is well informed about the stored energy built up by high tensioned compression springs and that the device contains some grease. The following procedure contains useful information about decommissioning.

Continues on next page

Decommissioning at decommissioning company, balancing device

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

	Action	Note
1	**DANGER** There is stored energy built up by high tensioned compression springs inside the balancing device! When a coil is cut the released tension creates a spatter of sparks and flames. The working area must be free of flammable materials. Position the balancing device so that the spatter will be directed away from personnel.	
2	Clamp the device at the working location. Place the device at ground level so that the hole and spring coils are cut from a more safe distance.	
3	**DANGER** The hole must be cut as specified in the figure. Pieces can be ejected from the cylinder at high speed if the hole is cut larger than specified!	
4	Cut a hole in the housing as shown in the figure.	Use a cutting torch with a long shaft. The measurements shown below are maximum values!  xx0700000155

Continues on next page

	Action	Note
5	**DANGER** There is stored energy built up by high tensioned compression springs inside the balancing device! When a coil is cut the released tension creates a spatter of sparks and flames. The working area must be free of flammable materials. Position the balancing device so that the spatter will be directed away from personnel.	
6	Cut the coils of the springs inside the housing as specified below: • Outer spring: cut at least five coils! • Middle spring: cut at least four coils! • Inner spring: cut at least four coils!	Use a cutting torch with a long shaft.
7	Double-check the number of coils cut and make sure all the tension in the springs are removed.	

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7 Reference information

7.1 Introduction

General

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

7.2 Applicable standards

General

The product is compliant with ISO 10218-1:2011, *Robots for industrial environments - Safety requirements - Part 1 Robots*, and applicable parts in the normative references, as referred to from ISO 10218-1:2011. In case of deviation from ISO 10218-1:2011, these are listed in the declaration of incorporation. The declaration of incorporation is part of the delivery.

Robot standards

Standard	Description
ISO 9283	Manipulating industrial robots – Performance criteria and related test methods
ISO 9787	Robots and robotic devices – Coordinate systems and motion nomenclatures
ISO 9946	Manipulating industrial robots – Presentation of characteristics

Other standards used in design

Standard	Description
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements, normative reference from ISO 10218-1
IEC 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments
IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
ISO 13849-1:2006	Safety of machinery - Safety related parts of control systems - Part 1: General principles for design, normative reference from ISO 10218-1
UL 1740 (option) CSA Z434 (option)	Standards For Safety - Robots and Robotic Equipment Industrial robots and robot Systems - General safety requirements Valid for USA and Canada.

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 ABB robots.

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. It is recommended by ABB for M6-M20 screw joints. 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.

Generally, screws are lubricated with *Gleitmo 603* mixed with *Geomet 500* or *Geomet 702* in proportion 1:3. *Geomet* thickness varies according to screw dimensions, refer to the following.

Dimension	Lubricant	Geomet thickness
M6-M20 (any length except M20x60)	*Gleitmo 603 + Geomet 500*	3-5 µm
M6-M20 (any length except M20x60)	*Gleitmo 603 + Geomet 720*	3-5 µm
M20x60	*Gleitmo 603 + Geomet 500*	8-12 µm
M20x60	*Gleitmo 603 + Geomet 720*	6-10 µm

Screws lubricated in other ways

Screws lubricated with Molykote 1000 or Molykote P1900 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.

Continues on next page

Lubricant	Article number
Molykote 1000 (molybdenum disulphide grease)	3HAC042472-001
Molykote P1900 (molybdenum disulphide grease)	3HAC070875-001

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.
- 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%**!

Tightening torque for 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.*

Note

A special torque specified in the repair, maintenance or installation procedure overrides the standard torque.

Tightening torque for oil-lubricated screws with allen head screws

The following table specifies the recommended standard tightening torque for *oil-lubricated screws* with *allen head screws.*

Note

A 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

Continues on next page

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
M24	680	960	1150

Tightening torque for lubricated screws (Molykote, 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.*

Note

A 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]
M5		8
M6		14
M8	28	35
M10	55	70
M12	96	120
M16	235	300
M20	460	550
M24	790	950

i Lubricated with Molycote 1000, Gleitmo 603 or equivalent

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 arm weighs 25 kg. All lifting accessories used must be sized accordingly.	

7.6 Standard tools

General

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

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

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

Contents, standard toolkit

Qty	Tool	Rem.
1	Ring-open-end spanner 8-19 mm	
1	Socket head cap 5-17 mm	
1	Torx socket no: 20-60	
1	Box spanner set	
1	Torque wrench 10-100 Nm	
1	Torque wrench 75-400 Nm	
1	Ratchet head for torque wrench 1/2	
2	Hexagon-headed screw M10x100	
1	Hex bit socket head cap no. 14 socket 40 mm L=100 mm	
1	Hex bit socket head cap no. 14 socket 40 mm L=20 mm	To be shortened to 12 mm
1	Hex bit socket head cap no. 6 socket 40 mm L=145 mm	
1	Hex bit socket head cap no. 6 socket 40mm bit L=220 mm	

7.7 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 390*, and of special tools, listed directly in the instructions and also gathered in this section.

Calibration equipment, Calibration Pendulum

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

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

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

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

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

Calibration equipment, Axis Calibration

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

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

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

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

Description	Art. no.	Note
Calibration tool box, Axis Calibration	3HAC055412-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot.

Continues on next page

Oil exchange equipment

The following table specifies the recommended equipment for oil exchange.

Description	Art. no.	Note
Oil exchange equipment	3HAC021745-001	Includes: • Vacuum pump with regulator, hose and coupling • Couplings and adapters • Pump (manual) with hose and coupling • Graduated measuring glass • Oil gun • User instructions.

Basic tools

The following table specifies the tools in the basic toolkit that are used for the current robot model. This toolkit is necessary primarily when removing and refitting the motors.

The tools are also listed directly in the instructions.

Description	Qty	Art. no.
Extension 300mm for bits 1/2"	1	3HAC12342-1
Guide pins M8 x 100	2	3HAC15520-1
Guide pins M8 x 150	2	3HAC15520-2
Guide pins M10 x 100	2	3HAC15521-1
Guide pins M10 x 150	2	3HAC15521-2
Lifting tool, motor ax 1	1	3HAC14459-1
Lifting tool, motor ax 2, 3	1	3HAC15534-1
Removal tool, motor M10x	2	3HAC14972-1 Fits motors, axes 6.
Removal tool, motor M12x		Fits motors axes 1, 2 and 3.
Rotation tool	1	3HAC17105-1
	1	3HAC12342-1
Standard toolkit (content described in section *Standard tools on page 390*)	1	-

Lifting tools

The following table specifies the lifting tools required during several of the service procedures. The tools may be ordered separately and are also specified directly in concerned instructions.

Description	Qty	Article no.
Hoisting block	1	
Lifting chain (used together with the hoisting block)	1	
Support, base and gearbox axis 1	1	3HAC15535-1
Lifting tool, gearbox axis 1	1	3HAC15556-1

Continues on next page

Description	Qty	Article no.
Lifting eye (used together with lifting tool 3HAC15556-1)		3HAC025333-005
Lifting tool, motor	1	3HAC14586-1
Lifting tool, frame	1	3HAC023308-001
Lifting tool. complete robot	1	3HAC15607-1 (User instruction 3HAC15971-1)
Lifting tool, parallel arm	1	3HAC023098-001
Lifting tool, wrist unit	1	3HAC13605-1
Lifting tool, base	1	3HAC14868-1
Standard toolkit (content described in section *Standard tools on page 390*)	1	-

Special tools

The following table specifies the special tools required during several of the service procedures. The tools may be ordered separately and are also specified directly in concerned instructions.

Description	Qty	Article no.
KM7 socket		6369901-438
KM8 socket		Standard
KM10 socket		Standard
Pinion crank		3HAC023132-001
Press tool, support ring		3HAC072616-001
Pressing, lower arm/balancing weight		3HAC076749-001
Pressing, upper arm		3HAC083570-001
Pressing, tie rod		3HAC5021-1
Auxiliary shaft, long		3HAC5275-1
Auxiliary shaft, short		3HAC5276-1
Support shaft/bearing race		3HAC5281-1
Tool for lubrication		3HAC5222-2
Adapter for shaft axis 3		3HAC071308-001
Guide sleeves		3HAC14446-1

7.8 Lifting accessories and lifting instructions

General

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

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

The instructions delivered with the lifting accessories should be stored for later reference.

8 Spare part lists

8.1 Spare part lists and illustrations

Location

Spare parts and exploded views are not included in the manual but delivered as a separate document for registered users on myABB Business Portal, www.abb.com/myABB.

Tip

All documents can be found via myABB Business Portal, www.abb.com/myABB.

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3HAC028197-001, Rev AE, en