ROBOTICS

Product manual

IRB 1600/1660

Trace back information:
Workspace 24A version a16
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Product manual

IRB 1600 - 5/1.2 type A
IRB 1600 - 5/1.45 type A
IRB 1600 - 6/1.2 type A
IRB 1600 - 6/1.45 type A
IRB 1600 - 7/1.2 type A
IRB 1600 - 7/1.45 type A
IRB 1600 - 8/1.2 type A
IRB 1600 - 8/1.45 type A
IRB 1600 - 10/1.2 type A
IRB 1600 - 10/1.45 type A
IRB 1600ID - 4/1.5
IRB 1600ID - 4/1.5 type A
IRB 1660ID - 6/1.55
IRB 1660ID - 4/1.55

IRC5

Document ID: 3HAC026660-001

Revision: AK

Original instructions.

Table of contents

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Overview of this manual

About this manual

This manual contains instructions for:

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

Usage

This manual should be used during:

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

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

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

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

Product manual scope

The manual covers covers all variants and designs of the IRB 1600/1660ID. Some variants and designs may have been removed from the business offer and are no longer available for purchase.

Organization of chapters

The manual is organized in the following chapters:

Chapter	Contents
Safety, service	Safety information that must be read through before performing any installation or service work on robot. Contains general safety aspects as well as more specific information on how to avoid personal injuries and damage to the product.
Installation and commissioning	Required information about lifting and installation of the robot.
Maintenance	Step-by-step procedures that describe how to perform maintenance of the robot. Based on a maintenance schedule that may be used to plan periodical maintenance.
Repair	Step-by-step procedures that describe how to perform repair activities of the robot. Based on available spare parts.

Continues on next page

Chapter	Contents
Calibration	Calibration procedures and general information about calibration.
Decommissioning	Environmental information about the robot and its components.
Reference information	Useful information when performing installation, maintenance or repair work. Includes lists of necessary tools, additional documents, safety standards, etc.
Spare parts and exploded views	Complete spare part list and complete list of robot components, shown in exploded views.
Circuit diagram	Reference to the circuit diagram for the robot.

References

General

Document name	Document ID
Product manual, spare parts - IRB 1600/1660	*3HAC049104-001*
Safety manual for robot - Manipulator and IRC5 or OmniCore controller [i]	*3HAC031045-001*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*
Instructions lifting accessory 3HAC024483-001	3HAC028664-002

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

IRC5 robots

Document name	Document ID
Product specification - IRB 1600/1660	*3HAC023604-001*
Circuit diagram - IRB 1600/1660 (with IRC5)	*3HAC021351-003*
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. See also *Type A of IRB 1600 on page 373*.
A	AW equipped upper arm 1600ID, IRB 1600-6/1.2, IRB 1600-6/1.45, IRB 1600-8/1.2 and IRB 1600-8/1.45 added.
B	*Clean Room* added. Changes made in: • *Prerequisites* in section *Overview* • *Oil change* in section *Maintenance*

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Revision	Description
C	Content updated in section: • *Making robot ready for operation, Clean Room / Additional installation procedure*.
D	Content updated in chapter/section: • Maintenance/Cleaning of robot • Maintenance/Maintenance schedule: Interval for replacement of battery pack changed • Section *What is an emergency stop?* added to chapter Safety.
E	Content updated in chapter/section: • Maintenance/Oil in gearboxes: Amount of oil in gearboxes axes 1 and 2.
F	Content updated in sections: • New graphics for equipment load areas, see *Fitting equipment on the robot (robot dimensions) on page 74*. • Instruction moved from chapter *Repair* to *Installation*, see *Installation of the wire feeder shelf for 1600ID/1660ID on page 93*. • Spare part list, updated regarding *Foundry Plus Cable guard*. • *Cleaning the IRB 1600/1660ID on page 142* in chapter Maintenance updated. • Sealing compound updated in *Cut the paint or surface on the robot before replacing parts on page 153*. • Decommissioning chapter added. Updates in the chapter *Safety*: • Updated safety signal graphics for the levels *Danger* and *Warning*, see *Safety signals in the manual on page 23*. • New safety labels on the manipulators, see *Safety symbols on manipulator labels on page 25*. • Revised terminology: *robot* replaced with *manipulator*.
G	Content updated in sections: • Added reference to lifting accessory, see *Lifting and turning a suspended mounted robot on page 60*.
H	Content updated in sections: • Added note about not inserting guide pin too far into the tool flange, section *Fitting equipment on the robot (robot dimensions) on page 74*. • Updated spare part numbers, in sections: Base, frame, upper arm, upper arm 1600ID and options. • New and updated safety symbols, see *Safety symbols on manipulator labels on page 25*.

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Revision	Description
J	This revision includes the following updates: • A new block, about general illustrations, added in section *How to read the product manual on page 19*. • Resolver connection added, connection for resolver signals axis 7 located on the base see section *Customer connectors on the robot on page 109* • Added an illustration that shows the directions of the robot stress forces and changed the value for the force in the Z plane, see *Loads on foundation, robot on page 46*. • Improvements made in the instruction for replacing the complete ID upper arm, see *Replacing the complete upper arm, IRB 1600ID/1660ID on page 182*. • Gearboxes and motor pinions from SAMP are added to the spare part lists together with a table that shows compability between the motors and gearboxes, see *Spare parts -Compatible gearboxes and motors*. The spare part numbers are also removed from the Required equipment lists in the repair instructions for motors and gearboxes, and instead replaced with links to the Spare parts chapter. • The option *Foundry Plus Cable Guard* is removed. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 381*. • Corrected value for working range of wall mounted robots, added working range for IRB 1600ID and updated a figure, see *Working range on page 49*. • Spare part numbers for axis-4, axis-5 and axis-6 motors for IRB 1600ID are corrected. • Added information about batteries.
K	This revision includes the following updates: • Added range and capacity to the denomination of IRB 1600ID. • Added information about IRB 1600ID type A, on first inside page and as a new section *Type A of IRB 1600ID on page 374*. • Spare part numbers for SAMP motors and upper arms are corrected, see *Spare parts - Compatible gearboxes and motors*. • Added variants IRB 1600 - 10/1.2 and IRB 1600 - 10/1.45 to the manual. • Updated loads on the foundation, see *Loads on foundation, robot on page 46*. • Corrected the appearance of figures in section *Working range on page 49*. • Changed maximum tilt from 60º to 55º, see *Requirements, foundation on page 47*. • 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 130*. • Added information about importance to install the robot with correct X direction in the base coordinate system, see *Installation of additional mechanical stops on axis 1 on page 96* and *Setting the system parameters for a suspended or tilted robot on page 67*. • A new SMB unit and battery is introduced, with longer battery lifetime. • Added mounting holes on the lower arm, see *Fitting equipment on the robot (robot dimensions) on page 74*.

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Revision	Description
L	This revision includes the following updates: • Spare numbers in general, updated/corrected. • Spare number for Motor axis 3 (Rexnord) changed. • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 372*. • Base connections, illustration updated with new views. • Updated tightening torque for the oil plug on axis 5-6 for IRB 1600ID, see *Changing the oil in axis 5-6 gearbox, IRB 1600ID/1660ID on page 134*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 1600/1660*. • Note about the placement of connectors in ID-upper arm added in Repair instructions. See *Replacement of motor, axis 5, IRB 1600ID on page 289* and *Replacing the wrist unit, IRB 1600ID on page 200*. • Note about handling the wrist during replacement added. See *Replacing the wrist unit, IRB 1600ID on page 200*.
M	This revision includes the following updates: • Changed article number for signal lamp, see *Installation of signal lamp for 1600 with IRC5 (option) on page 88*. • Added detailed view of the orientation of axis-5 motor, see Replacement of axis-5 motor. • Minor corrections.
N	This revision includes the following updates: • Added instructions for measuring the play in the ID wrist, see *Measuring the play 1600ID/1660ID, axis 5 on page 229*, and *Measuring the play 1600ID/1660ID, axis 6 on page 232*. • Minor corrections.
P	This revision includes the following updates: • Added a new variant IRB 1600ID - 6/1.55. • Updated the loads on foundation, see *Loads on foundation, robot on page 46*. • Added maintenance activities for the grease oil in IRB 1600 axes 1 to 4.
Q	This revision includes the following updates: • Rename the new variant IRB 1600ID - 6/1.55 to IRB 1660ID - 6/1.55. • Updated figure that shows cable bracket and cable tie of axis-2 motor cable on the frame, see *Replacement of motor, axis 2 on page 258*.
R	Published in release R16.2. The following updates are done in this revision: • Added a new variant IRB 1660ID - 4/1.55. • Wall mounting available to IRB 1660ID - X/1.55.
S	Published in release R17.1. The following updates are made in this revision: • Updated the robot weight, see *Weight, robot on page 45*. • New standard calibration method is introduced (Axis Calibration). See *Calibration on page 333*. • Information about grounding point is added, see *Robot cabling and connection points on page 112*.

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Revision	Description
T	Published in release R17.2. The following updates are made in this revision: • Information about coupled axes in *Updating revolution counters on IRC5 robots on page 342*. • Caution about removing metal residues added in sections about SMB boards. • Information added into calibration procedure regarding installation of calibration tool on turning disc, see *Overview of the calibration procedure on the FlexPendant on page 355*. • Information about minimum resonance frequency added. • Bending radius for static floor cables added. • Updated list of applicable standards. • Article number for the Calibration tool box, Axis Calibration is changed. • Section *Start of robot in cold environments on page 119* added. • Updated information regarding replacement of brake release board. • Updated information regarding lifting tool, upper arm, in section *Special tools on page 386*. • Updated information regarding disconnecting and reconnecting battery cable to serial measurement board.
U	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 349*. • Added sections in *General procedures on page 146*. • Safety restructured. • Updated spare part number brake release unit (was DSQC574, is DSQC1054) • Tool flange figure is updated. • Note added to calibration chapter to emphasize the requirement of equally dressed robot when using previously created reference calibration values. • Information about myABB Business Portal added. • Added Nickel in environmental information.
V	Published in release R18.2. The following updates are done in this revision: • Updated information of holes for mounting of extra equipment for IRB 1600, see *Holes for mounting of extra equipment for IRB 1600 on page 79*. • Added section for inspection of labels in maintenance chapter. • Updated information regarding o-ring replacement for axis-1 and axis-2 motors.
W	Published in release R18.2. The following updates are done in this revision: • Updated reference.
X	Published in release 19B. The following updates are made in this revision: • New touch up color Graphite White available. See *Cut the paint or surface on the robot before replacing parts on page 153*. • New article numbers for manipulator cables in section *Robot cabling and connection points on page 112*. • Vertical dimensions of IRB 1660ID-X/1.55 added. See *Fitting equipment on the robot (robot dimensions) on page 74*.

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Revision	Description
Y	Published in release 19C. The following updates are made in this revision: • Note added about the need to calibrate if the robot is other than floor mounted. See *When to calibrate on page 337*. • Figure of grounding point updated.
Z	Published in release 19D. The following updates are made in this revision: • Updated the tightening torque to secure motor axis 6 with flexible coupling. • Removed the spare part position switch, axis 1. • Added step of refitting oil plug during replacement of axis-1 and -2 gearboxes.
AA	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 149*. • Clarified text about position of robot and added table with dependencies between axes during Axis Calibration. • Updated the parts included in axis-1 and -2 gearbox. • Article number of Calibration tool box, Axis Calibration is changed from 3HAC062326-001 to 3HAC074119-001. • Replaced article number and name of grease, previously 3HAB3537-1. • Added information about Wrist Optimization in calibration chapter.
AB	Published in release 20C. The following updates are made in this revision: • Updated description about mounting holes of extra equipment for IRB 1600.
AC	Published in release 20D. The following updates are made in this revision: • Removed information about axis-5 gearbox oil change (IRB 1600/1660ID). • Added information about refilling oil in the axis-5 gear after replacing the axis-5 motor (IRB 1600/1660ID). • Added tightening torque and inspection step for axis-5 gear oil plug, after refilling oil during axis-5 motor replacement (IRB 1600/1660ID).
AD	Published in release 21A. The following updates are made in this revision: • Added information about robot versions, A and B, according to which the robot power cable is ordered. See *Robot cables on page 112* and *Version A and version B of IRB 1600/1660ID on page 375*. • Added procedures of measuring play of axis 5 and axis 6 for IRB 1600. See *Measuring the play 1600, axis 5 and axis 6 on page 227*. • Note regarding maximum leakage current for attached equipment. See *Customer connections on the robot on page 116*.
AE	Published in release 21C. The following updates are done in this revision: • Text regarding fastener quality is updated, see *Fastener quality on page 87*. • Info about option 561-1 included.
AF	Published in release 21D. The following updates are done in this revision: • Updated description about axis calibration method and how to calibrate suspended and wall-mounted robots. • Removed information for option 561-1, as it is not available for IRB 1600/1660ID.

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Revision	Description
AG	Published in release 22A. The following updates are done in this revision: • Measurement in illustration *Dimensions IRB 1660ID-X/1.55* is changed. • Updated information about Gleitmo treated screws, see *Screw joints on page 381*.
AH	Published in release 22B. The following updates are done in this revision: • Updated protection class for *IRB 1660ID-X/1.55*.
AJ	Published in release 22D. The following updates are made in this revision: • Changed the spare part number of *V-ring (sealing ring)* from 3HAB3732-21 to 3HAB3773-11.
AK	Published in release 24A. The following updates are done in this revision: • Added axis positions for most stable transport position. • Updated the robot weight of IRB 1660ID, see *Weight, robot on page 45*. • Updated tightening torque for the oil plug on axis 5-6 for IRB 1600ID/IRB 1660ID. • Updated article numbers of signal cables.

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.

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- 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 21*.

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.

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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

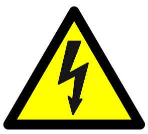
Introduction to safety signals

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.

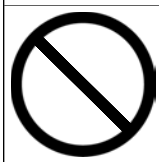
Types of symbols

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 25*.

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.

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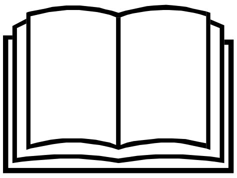
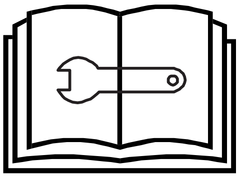
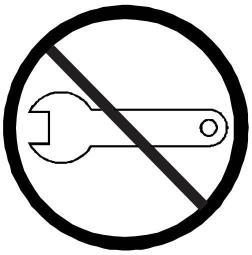
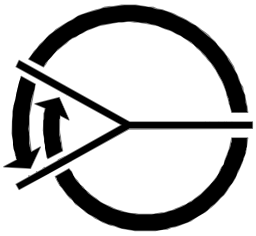
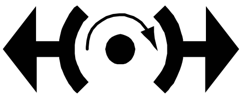
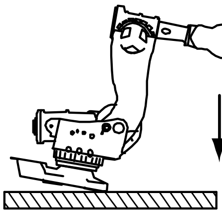
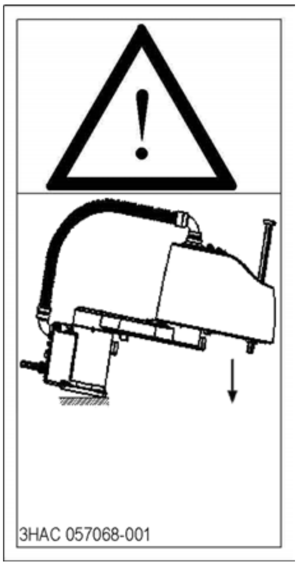
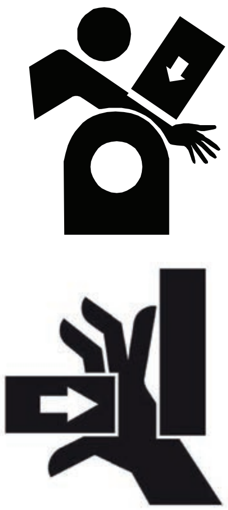
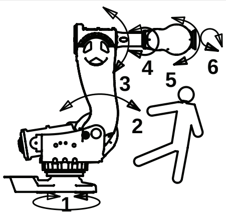
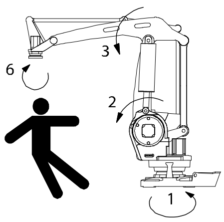
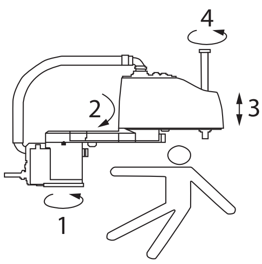
Symbol	Description
 xx0900000813	**See user documentation** Read user documentation for details. Which manual to read is defined by the symbol: • No text: *Product manual*. • EPS: *Application manual - Electronic Position Switches*.
 xx0900000816	**Before disassembly, see product manual**
 xx0900000815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

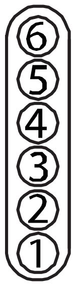
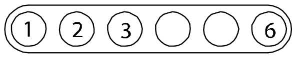
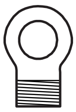
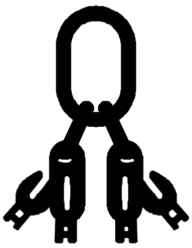
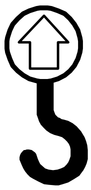
Continues on next page

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.

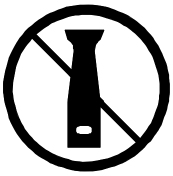
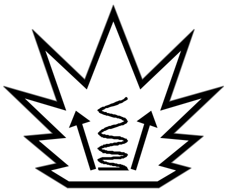
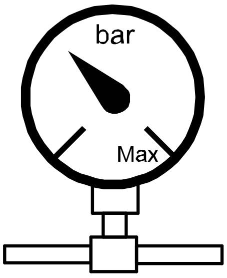
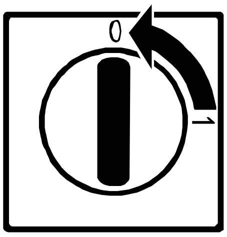
Continues on next page

Symbol	Description
 xx0900000818  xx1300001087	**Heat** Risk of heat that can cause burns. (Both signs are used)
 xx0900000819  xx1000001141  xx1500002616	**Moving robot** The robot can move unexpectedly.

Continues on next page

Symbol	Description
 xx0900000820  xx1000001140	**Brake release buttons**
 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**

Continues on next page

Symbol	Description
 xx1000001144	**No mechanical stop**
 xx0900000825	**Stored energy** Warns that this part contains stored energy. Used in combination with *Do not disassemble* symbol.
 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 - IRC5*
- *Product manual - IRC5 Compact*
- *Product manual - IRC5 Panel Mounted Controller*

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 370* 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 lubricant to spray from the opening.	Open the plug carefully and keep away from the opening. Do not overfill the gearbox when filling.
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 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 48*.

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 61*.

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.

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 369*.

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 1600/1660ID 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 45*.

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 21* before performing any installation work.

Note

Always connect the IRB 1600/1660ID 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 - IRC5*
- *Product manual - IRC5 Compact*
- *Product manual - IRC5 Panel Mounted Controller*

2.2 Unpacking

2.2.1 Pre-installation procedure

Introduction

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

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 45*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 48*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 48*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 46* • *Protection classes, robot on page 48* • *Requirements, foundation on page 47*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 55*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 58*
11	Install required equipment, if any. • *Installation of signal lamp for 1600 with IRC5 (option) on page 88*

2.2.2 Technical data

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 1600/1660ID	IRB 1600/IRB 1600ID: 250 kg IRB 1660ID: 257 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°	
Wall mounted	90°	
Suspended	18°	
Tilted	0-55°	Contact ABB for further information about acceptable loads.

Note

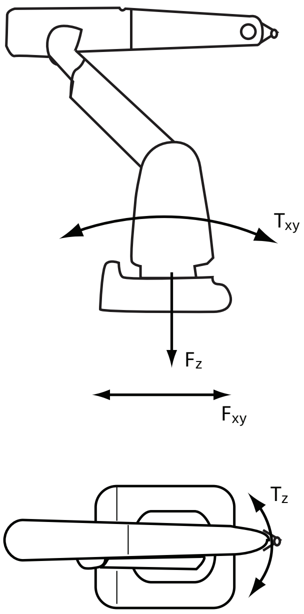
The actual mounting angle must always be configured in the system parameters, otherwise the performance and lifetime is affected. See *Setting the system parameters for a suspended or tilted robot on page 67*.

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	± 1850 N	± 3900 N
Force z	2700 ± 1150 N	2700 ± 2200 N
Torque xy	± 1750 Nm	± 4000 Nm
Torque z	± 855 Nm	± 1500 Nm

Continues on next page

Wall mounted

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 3900 N	± 5300 N
Force z	± 1400 N	± 2800 N
Torque xy	± 2310 Nm	± 3850 Nm
Torque z	± 855 Nm	± 1550 Nm

Suspended

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	± 1850 N	± 3900 N
Force z	- 2700 ± 1150 N	- 2700 ± 2200 N
Torque xy	± 1750 Nm	± 4000 Nm
Torque z	± 855 Nm	± 1500 Nm

Requirements, foundation

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

Requirement	Value	Note
Flatness of foundation surface	0.5 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	25 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.

Continues on next page

Storage conditions, robot

The table shows the allowed storage conditions for the robot:

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

Note

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

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

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

Protection classes, robot

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

Protection type	Protection class [i]
Manipulator, protection type Standard	IRB 1600: IP54 IRB 1600ID: IP40 IRB 1660ID: IP67 (Axis 4: IP40)
Manipulator, protection type Foundry Plus	IP 67
Manipulator, protection type Clean Room	IP 54
Manipulator, protection type Wash	IP 67

i According to IEC 60529.

2.2.3 Working range

Range of movement - IRB 1600

Axis	Type of motion	Range of movement 1.2 m reach	Range of movement 1.45 m reach
1	Rotation motion	+180° to -180° [i]	+180° to -180° [i]
2	Arm motion	+110° to -63° +136° to -63° (with axis 1 limited to ±100°)	+120° to -90° +150° to -90° (with axis 1 limited to ±95°)
3	Arm motion	+55° to -235°	+65° to -245°
4	Rotation motion	+200° to -200° default +190 rev. [ii] to -190 rev. maximum [iii]	+200° to -200° default +190 rev. [ii] to -190 rev. maximum [iii]
5	Bend motion	+115° to -115°	+115° to -115°
6	Turn motion	+400° to -400° default +288 rev. [ii] to -288 rev. maximum [iii]	+400° to -400° default +288 rev. [ii] to -288 rev. maximum [iii]

i The working range of axis 1 has the following limitations for wall mounted robots:
- IRB 1600-6/x: ± 20°
- IRB 1600-10/x: ± 60°

If the robot is tilted, the following combinations of tilt angles and axis 1 working ranges are allowed:
- IRB 1600-6/x: axis 1 ± 45° with tilt angles up to 30°
- IRB 1600-10/x: axis 1 ± 180° with tilt angles up to 55°

ii rev. = Revolutions

iii The default working range for axis 4 and axis 6 can be extended by changing parameter values in the software.
Option 610-1 “Independent axis” can be used for resetting the revolution counter after the axis has been rotated (no need for “rewinding” the axis).

Range of movement - IRB 1600ID

Axis	Type of motion	Range of movement 1.5 m reach
1	Rotation motion	+180° to -180° [i]
2	Arm motion	+150° to -90°
3	Arm motion	+79° to -238°
4	Rotation motion	+155° to -155°
5	Bend motion	+135° to -90°
6	Turn motion	+200° to -200° +288 rev. [ii] to -288 rev. maximum [iii]

i If the robot is tilted, the working range with tilt angles is:
- ± 40° with tilt angles up to 30°

ii rev. = Revolutions

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

Range of movement - IRB 1660ID

Axis	Type of motion	Range of movement 1.55 m reach
1	Rotation motion	+180° to -180° [i]

Continues on next page

Axis	Type of motion	Range of movement 1.55 m reach
2	Arm motion	+150° to -90°
3	Arm motion	+79° to -238°
4	Rotation motion	+175° to -175°
5	Bend motion	+120° to -120°
6	Turn motion	+400° to -400° +191 rev. [ii] to -191 rev. maximum [iii]

i The working range of axis 1 has the following limitations for wall mounted robots:

- IRB 1660ID-X/1.55: ±45°

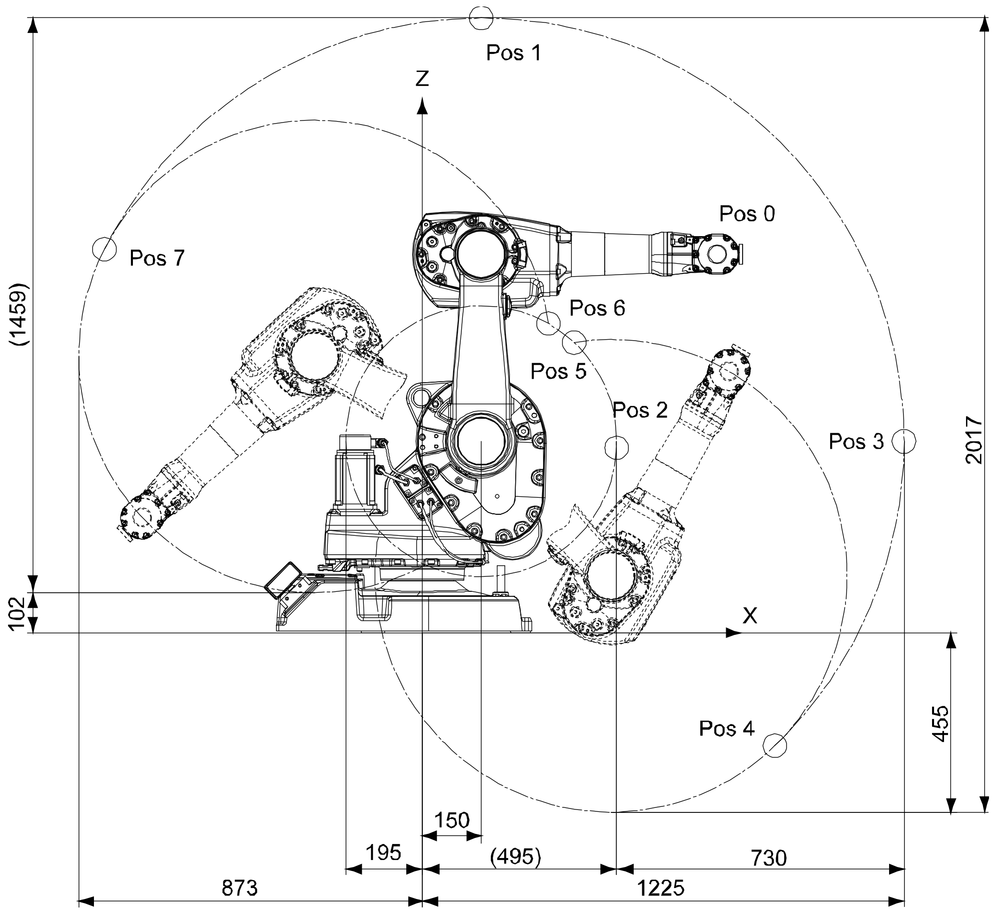
If the robot is tilted, the working range with tilt angles is:

- ± 180° with tilt angles up to 45°

ii rev. = Revolutions

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

Positions at wrist center 1.2 m reach



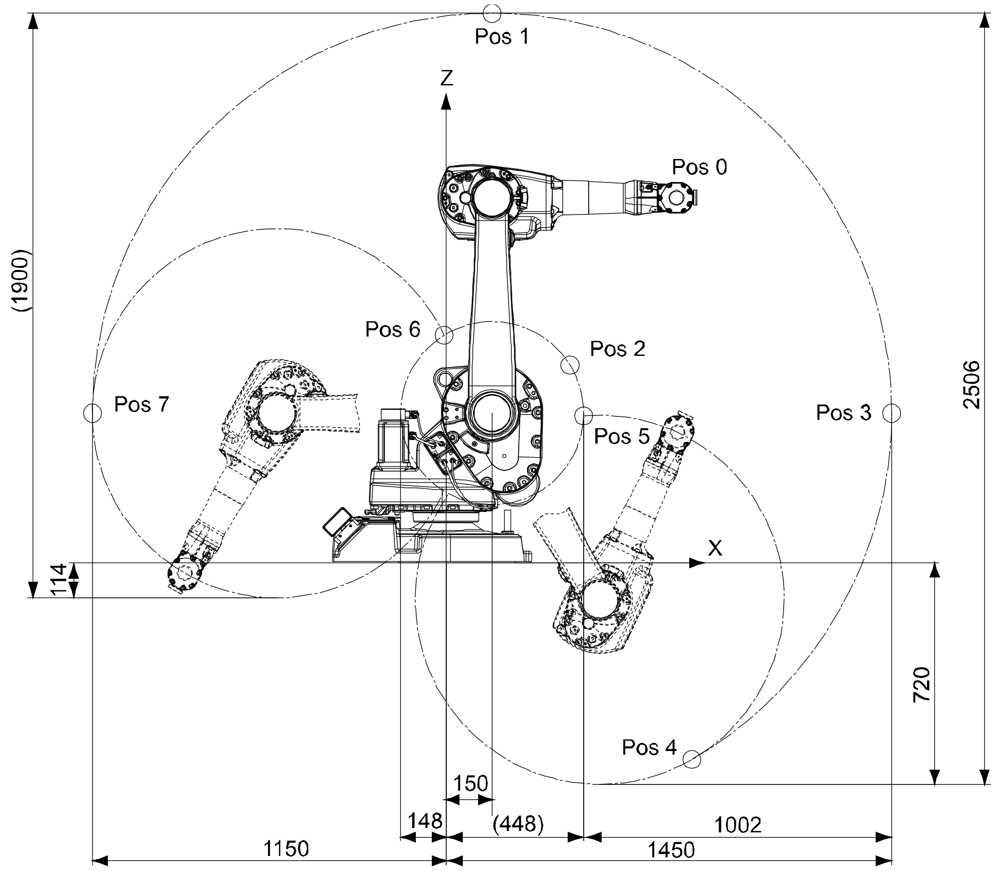
xx1000000914

Position	X (mm)	Z (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
0	750	962	0	0
1	150	1562	0	-90

Continues on next page

Position	X (mm)	Z (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
2	494	470	0	+55
3	1225	487	+90	-90
4	897	-287	+136	-90
5	386	737	+136	-235
6	321	786	-63	+55
7	-808	975	-63	-90

Positions at wrist center 1.45 m reach



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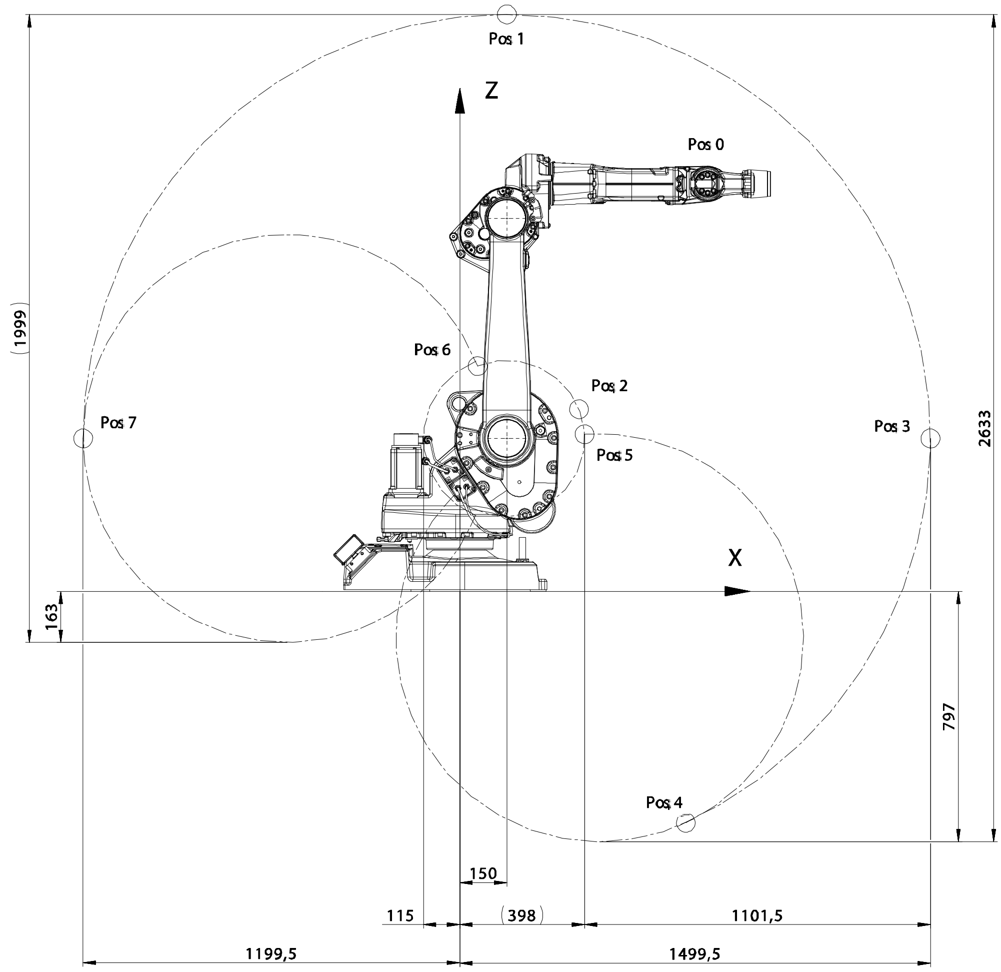
Position	X (mm)	Z (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
0	750	1187	0	0
1	150	1787	0	-90
2	404	643	0	+65
3	1450	487	+90	-90
4	800	-639	+150	-90
5	448	478	+150	-245
6	-6	740	-90	+65

Continues on next page

Position	X (mm)	Z (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
7	-1150	487	-90	-90

Positions at wrist center IRB 1600ID

IRB 1600ID-4/1.5



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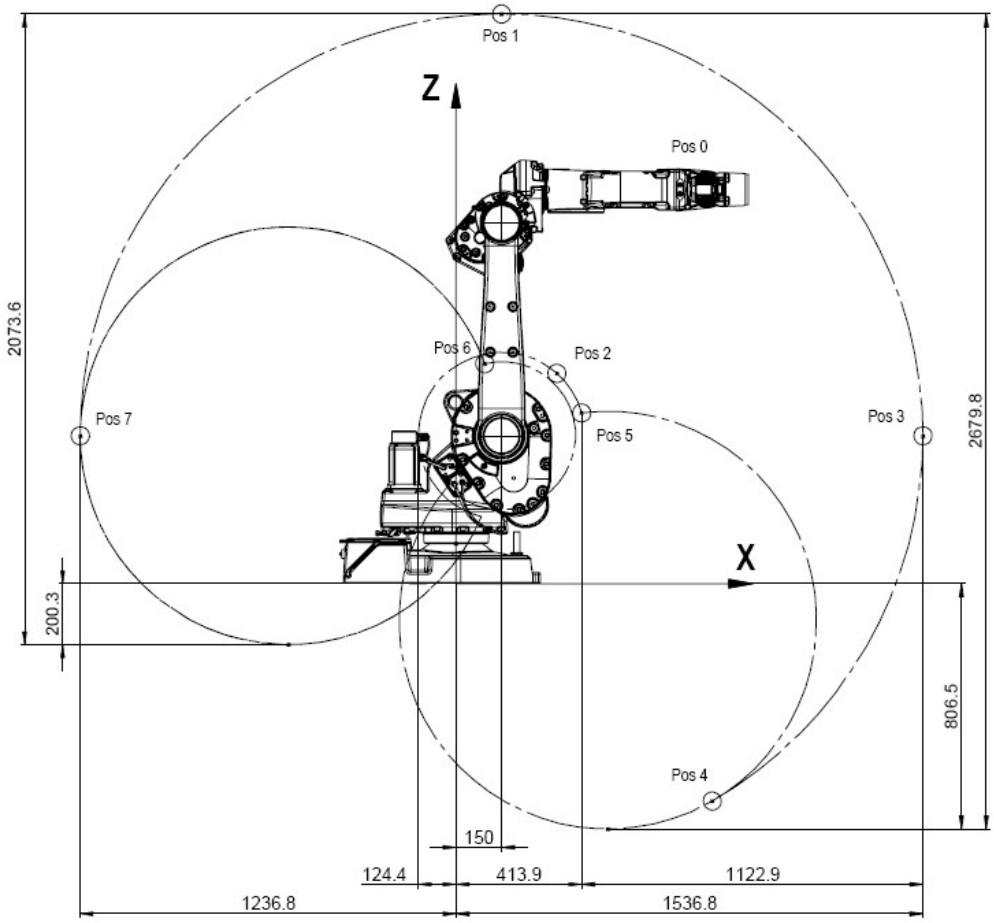
Position	X (mm)	Z (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
0	790	1297	0	0
1	150	1836	0	-80
2	380	579	0	+79
3	1500	487	+90	-80
4	721	-737	+150	-80
5	398	500	+150	-238
6	58	717	-90	+79
7	-1200	487	-90	-80

Continues on next page

Positions at wrist center IRB 1660ID

IRB 1660ID-X/1.55



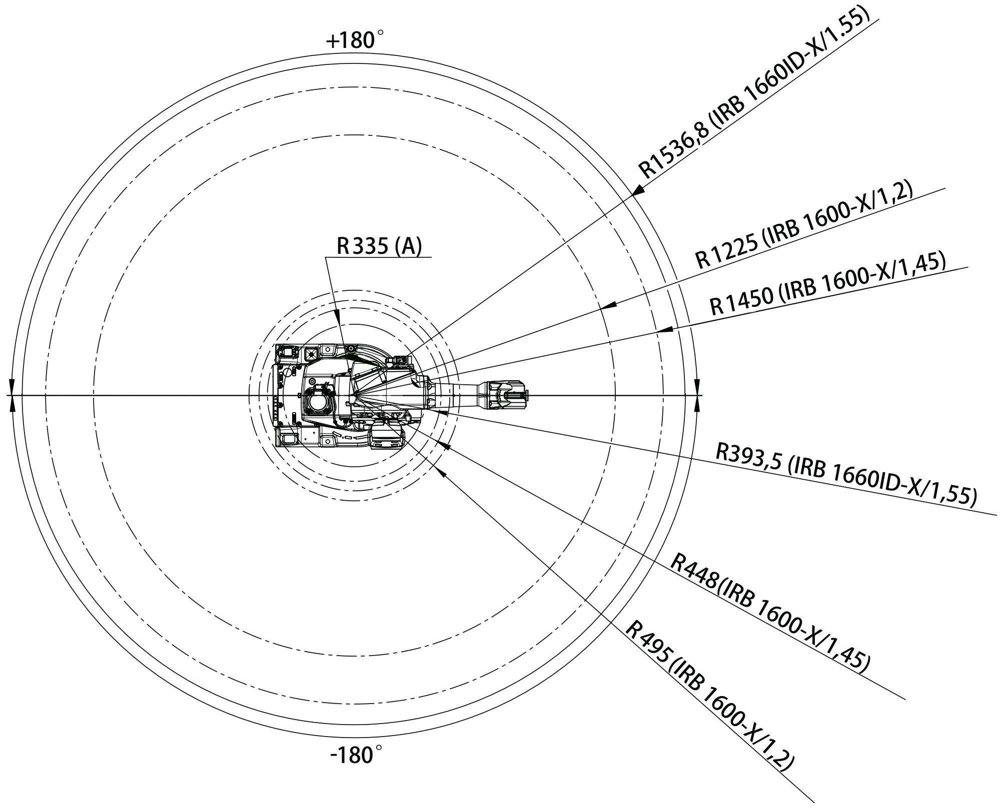
xx1500001246

Position	X (mm)	Z (mm)	Axis 2 angle (degrees)	Axis 3 angle (degrees)
0	828	1,296.5	0	0
1	150	1,873.3	0	-81
2	332.2	691.7	0	+79
3	1,536.8	486.5	+90	-81
4	843.4	-714.5	+150	-81
5	413.9	561.7	+150	-238
6	94.6	723.7	-90	+79
7	-1,236.8	486.5	-90	-81

Continues on next page

Turning radius

The turning radius for the robot is shown in the figure below. Notice the differences depending on the length of the lower arm.



xx1500002817

(A)	Minimum turning radius axis 1 (all models)

2.2.4 Risk of tipping/stability

Risk of tipping

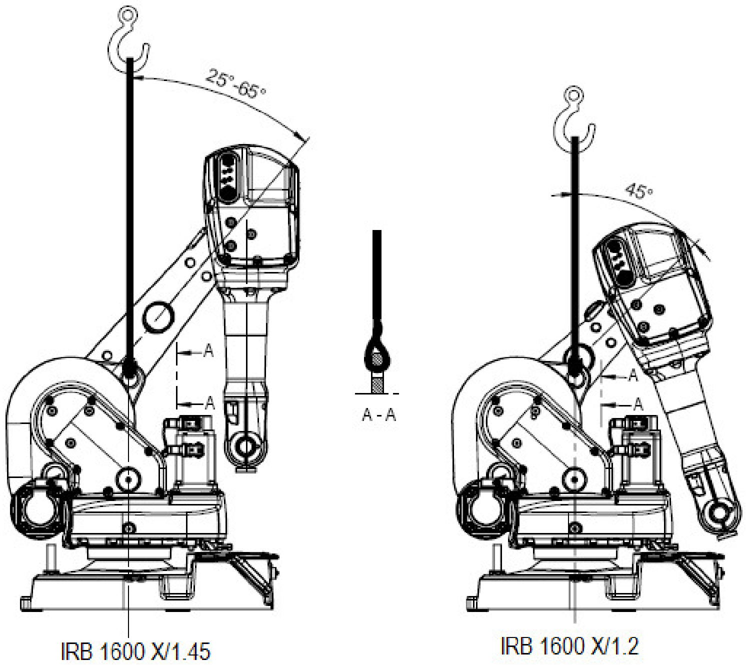
If the robot is not fastened to the foundation while moving the arm, the robot is not stable in the whole working area. Moving the arm will displace the center of gravity, which may cause the robot to tip over.

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.



xx1500001247

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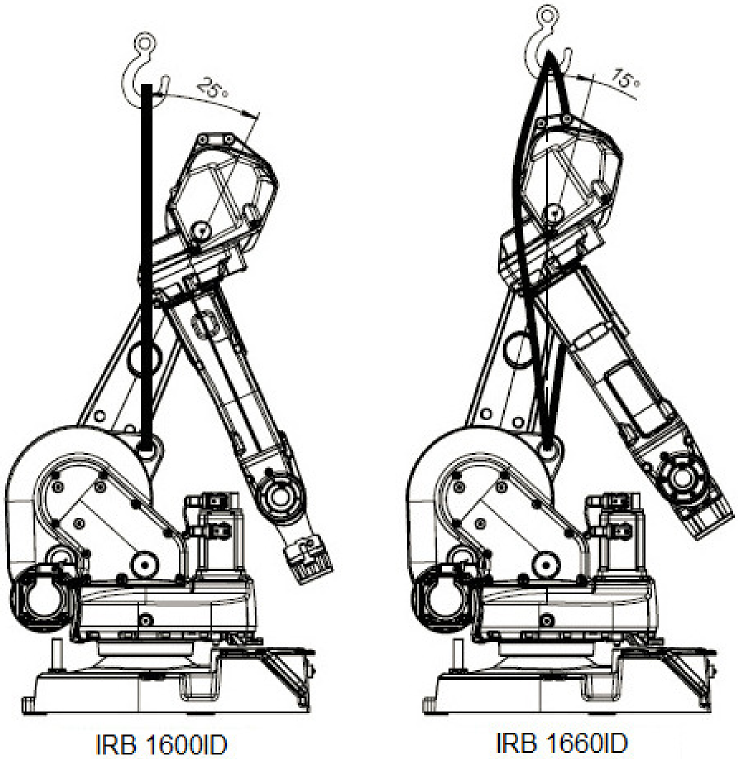


xx1500001248

Axis number	Angle of axis
Axis 1	0°
Axis 2	IRB 1600-*X*/1.2: -45° IRB 1600-*X*/1.45: -40° IRB 1600ID-*X*/1.55: -15°
Axis 3	IRB 1600-*X*/1.2: -205° IRB 1600-*X*/1.45: -230° IRB 1600ID-*X*/1.55: -220°
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.

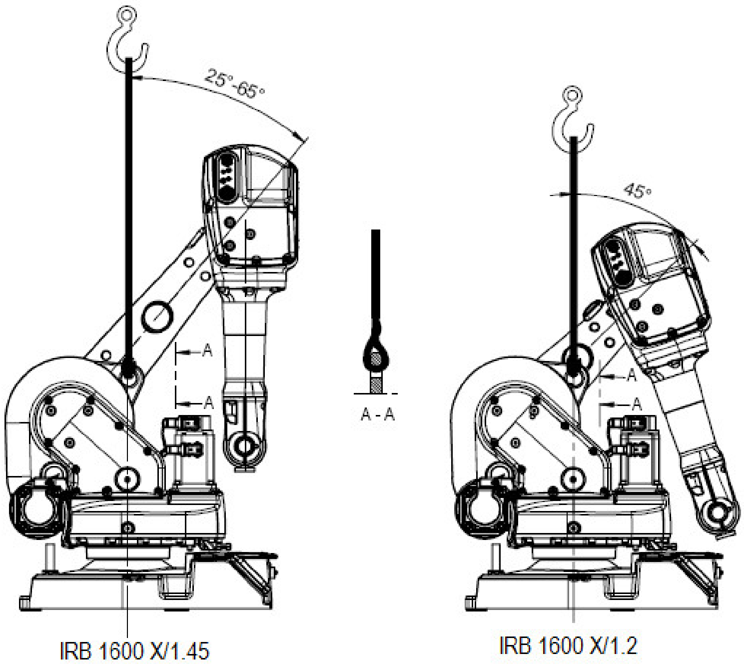
  The mat must be grounded through a current-limiting resistor.
- Use a dissipative table mat.

  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 roundslings

Attaching the roundslings



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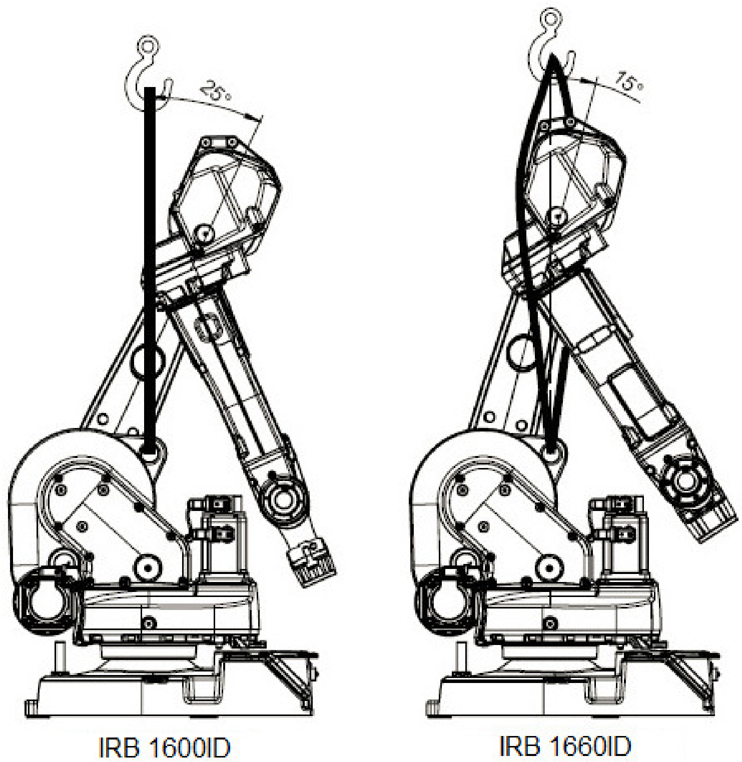

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Required equipment

Equipment	Art. no.	Note
Overhead crane	-	Lifting capacity: 500 kg.
Roundsling	-	Length: 2 m. Lifting capacity: 500 kg.

Lifting the robot with roundslings

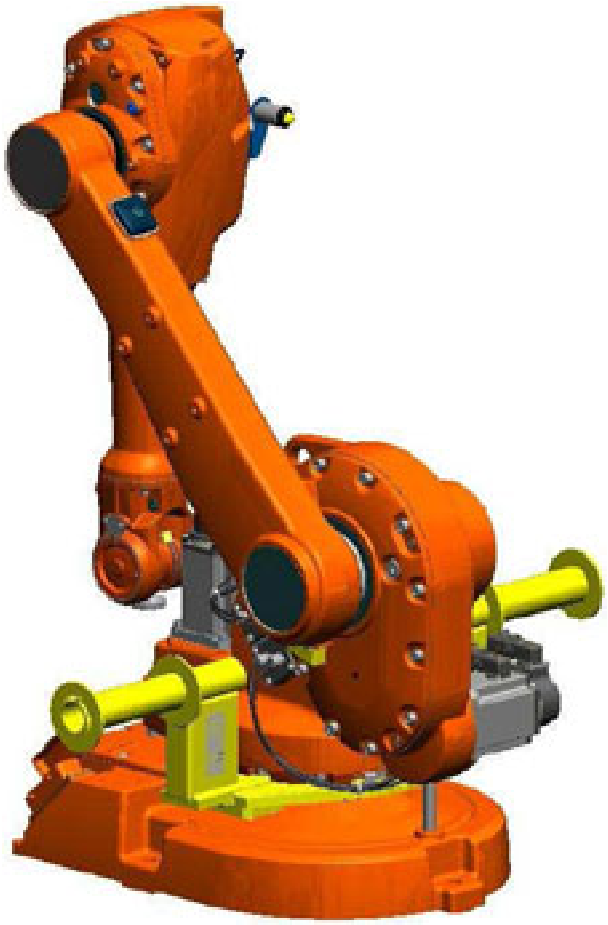
Use this procedure to lift the robot with roundslings.

	Action	Note
1	Move the robot to an appropriate lifting position.	See *Risk of tipping/stability on page 55*.
2	Secure the *roundsling* safely at the lifting lug in the frame and at the overhead crane.	Make sure the roundsling has free space and does not wear against any part of the robot. Capacity for the roundsling is specified in *Required equipment on page 59*. See attachment in *Attaching the roundslings on page 58*.
3	**CAUTION** The robot weighs IRB 1600/IRB 1600ID: 250 kg IRB 1660ID: 257 kg All lifting accessories used must be sized accordingly!	
4	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	
5	Raise the overhead crane to lift the robot.	

2.3.2 Lifting and turning a suspended mounted robot

Introduction

How to lift and turn the robot into a suspended position using turning accessory 3HAC037108-001 is described in the lifting instruction (article number 3HAC028664-002) delivered with the turning accessory. Contact ABB for more information.



xx1000000320

2.3.3 Manually releasing the brakes

General

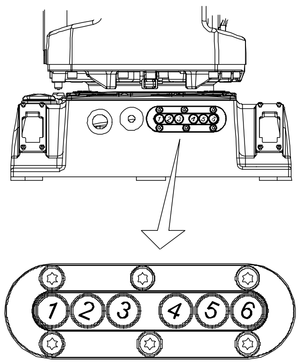
The section below details how to release the holding brakes of each axis' motor.

This may be done in one of three ways:

- using the brake release unit when the robot is connected to the controller.
- using the brake release unit when the robot is disconnected from the controller, but connected to an external power supply at the connector R1.MP.
- using an external voltage supply directly on the motor connector.

Using the brake release unit when the robot is connected to the controller

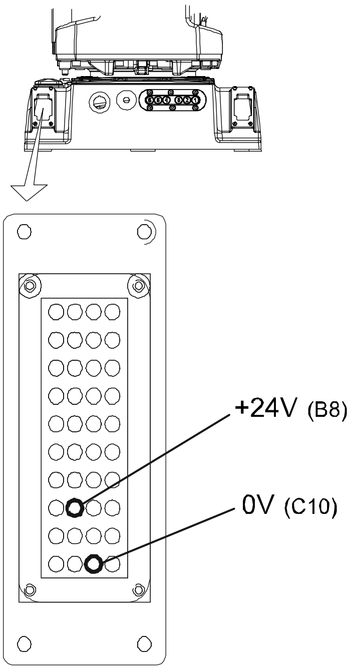
Use this procedure to release the holding brakes with the internal brake release unit.

	Action	Note
1	The internal brake release unit is located at the base of the robot and equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes.	 xx0400001255
2	**DANGER** When releasing the holding brakes, the robot axes may move very quickly and sometimes in unexpected ways! Make sure no personnel is near or beneath the robot arm!	
3	Release the holding brake on a particular robot axis by pressing the corresponding button on the internal brake release panel and keeping it depressed. The brake will function again as soon as the button is released.	

Continues on next page

Using the brake release unit with an external power supply

This section details how to release the holding brakes with the internal brake release unit using an external voltage supply. This is done if the robot is not connected to the controller.

	Action	Note
1	 **DANGER** Incorrect connections, such as supplying power to the wrong pin, may cause all brakes to be released simultaneously!	Also, be careful not to interchange the 24V and 0V pins. If they are mixed up, damage can be caused to a resistor diode and to the system board.
2	Connect an external power supply to connector R1.MP.	 xx0400001302 Supply: • 0V on pin C10 • 24V on pin B8
3	Push the brake release button to release the holding brakes, according to the previous procedure.	

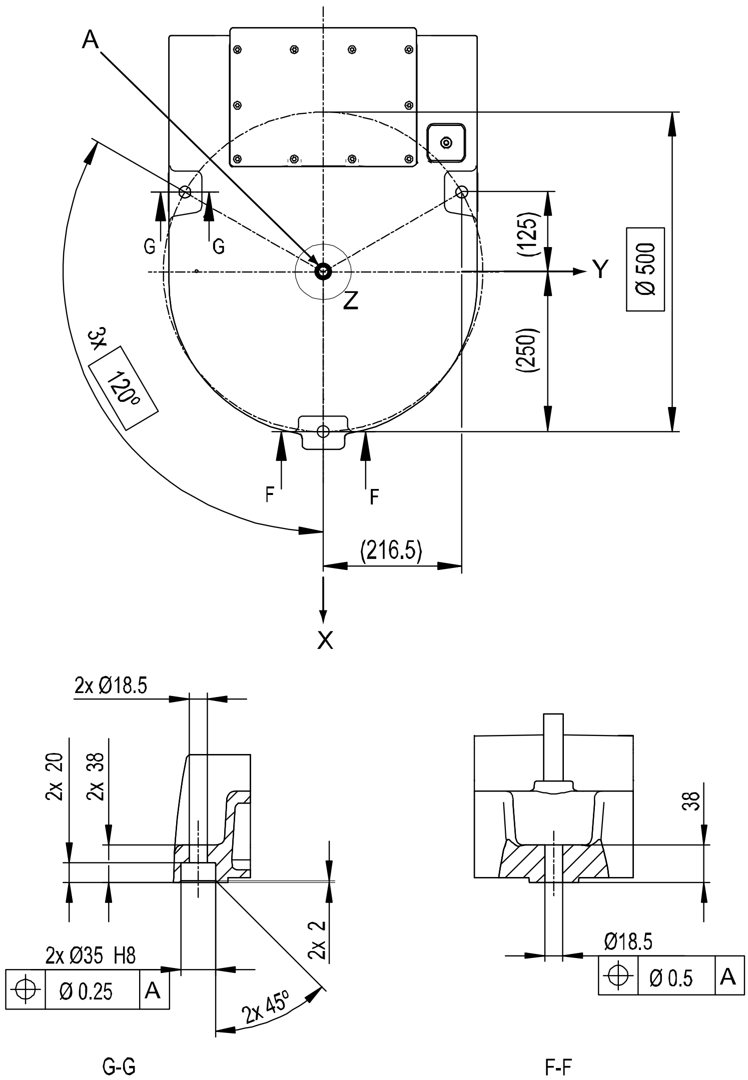
2.3.4 Orienting and securing the robot

General

This section details how to orient and secure the robot at a horizontal level at the installation site.

Hole configuration, base

The figure shows the hole pattern and dimensions of the robot base.



xx0400001300

A	Center of axis 1

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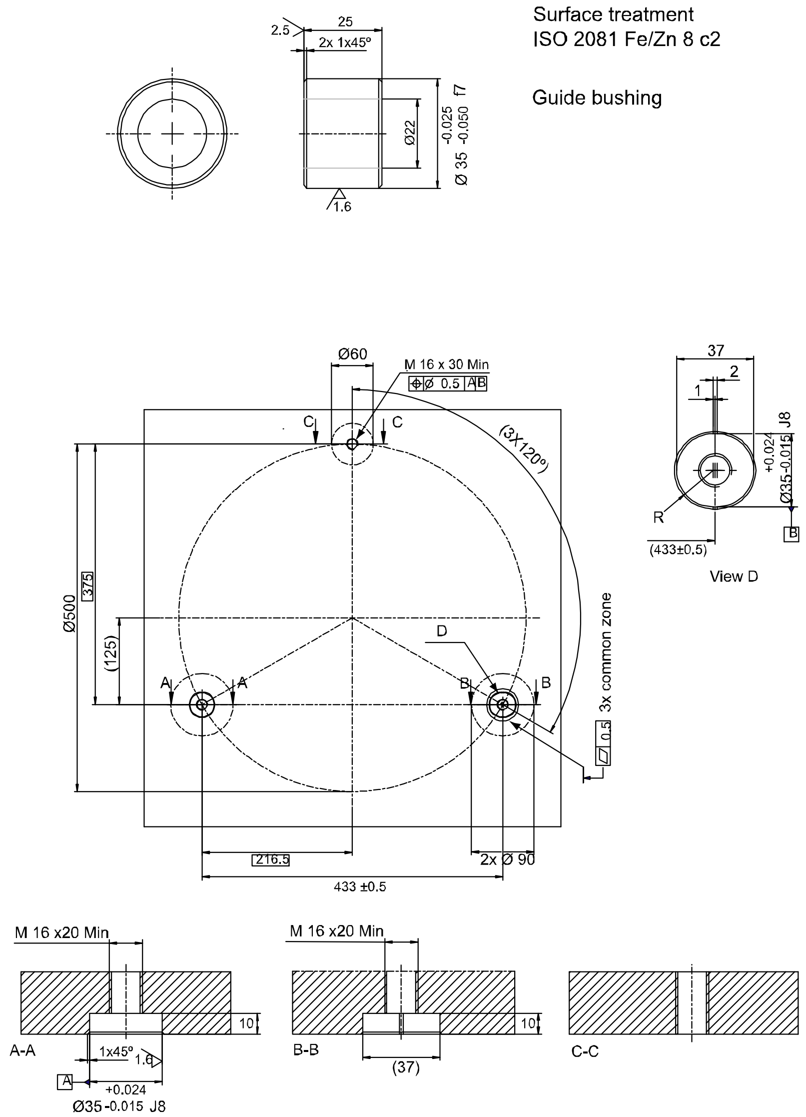
Dimension, mounting surface and guiding sleeve

The figure shows the dimension of the mounting surface and guiding sleeves, if used.



xx0400001306

Attachment bolts, specification

Attachment bolts	3 pcs M16 x 60 (installation directly on foundation of steel), M16 x 70/80 (installation on foundation or base plate, using guiding sleeves)
Washers	30 x 17 x 3
Quality	8.8 (wall or angle mounted robot: Quality 12.9)
Tightening torque	200 Nm

Guiding sleeves

Use a pair of guiding sleeves to make the robot installation easier.

Continues on next page

The guiding sleeves are absolutely needed if the robot is wall or angle mounted, or if the robot is calibrated with AbsAcc.

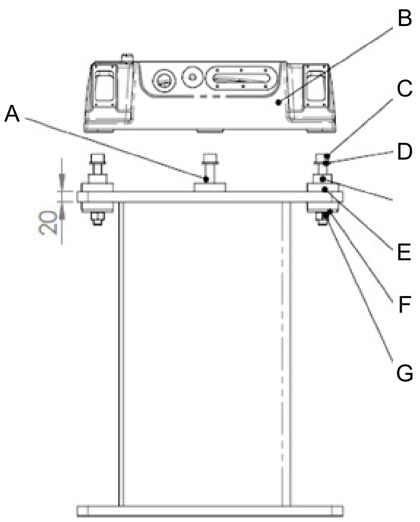
Orienting and securing the robot to installation site

	Action	Note
1	Make sure the installation site for the robot conforms to the specifications in section *Pre-installation procedure on page 44*.	
2	Prepare the installation site with attachment holes. If the robot is calibrated with AbsAcc, it must be installed using guiding sleeves.	Hole configuration of the base is shown in the figure *Hole configuration, base on page 63*. Dimension of mounting surface and the guiding sleeves are shown in the figure *Dimension, mounting surface and guiding sleeve on page 64*.
3	Lift the robot to the installation site.	Detailed in section *Lifting robot with roundslings on page 58*.
4	Guide the robot gently using two of the attachment bolts while lowering it into its mounting position.	
5	Fit and tighten the *bolts and washers* in the base attachment holes.	Specified in section *Attachment bolts, specification on page 64*.

Isolating AW manipulator

CAUTION

If the manipulator is used for arc welding and is mounted on a pedestal, make sure that the manipulator is isolated from the pedestal with isolators.



A	Attachment point, front (no guide sleeve)
B	Manipulator base
C	Screw M16x120

Continues on next page

D	Plain washer
E	Guide sleeve
F	Isolator
G	Nut M16

2.3.5 Setting the system parameters for a suspended or tilted robot

General

The robot is configured for mounting parallel to the floor, without tilting, on delivery. If the robot is mounted in any other angle than 0°, then the system parameters that describe the mounting angle (how the robot is oriented relative to the gravity) must be re-defined.

Note

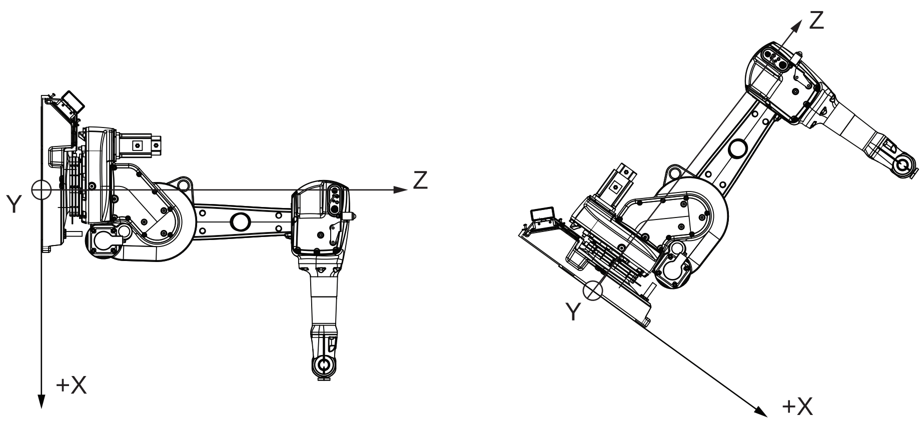
With inverted installation, make sure that the gantry or corresponding structure is rigid enough to prevent unacceptable vibrations and deflections, so that optimum performance can be achieved.

Note

The mounting positions are described in *Mounting positions on page 45*, and the requirements on the foundation are described in *Requirements, foundation on page 47*.

The x-direction in the base coordinate system

If the robot is wall mounted or mounted in a tilted position, it is important that the x-direction of the robot base coordinate system points downwards, as shown in the following figure.



xx1200001354

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System parameters

Note

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

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

Gravity Beta

If the robot is mounted upside down or on a wall (rotated around the y-axis), then the robot base frame and the system parameter *Gravity Beta* must be redefined. *Gravity Beta* should then be π (+3.141593) if the robot is mounted upside down (suspended), or ±π/2 (±1.570796) if mounted on a wall.

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

Gravity Alpha

If the robot is mounted on a wall (rotated around the x-axis), then the robot base frame and the system parameter *Gravity Alpha* must be redefined. The value of *Gravity Alpha* should then be ±π/2 (±1.570796).

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

Note

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

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

Note

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

Gamma Rotation

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

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Mounting angles and values

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

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

Example of position	Mounting angle (A°)	Gravity Beta
Floor mounted	0°	0.000000 (Default)
Tilted mounting	30º	0.523599
Wall mounting	90°	1.570796
Suspended mounting	180°	3.141593

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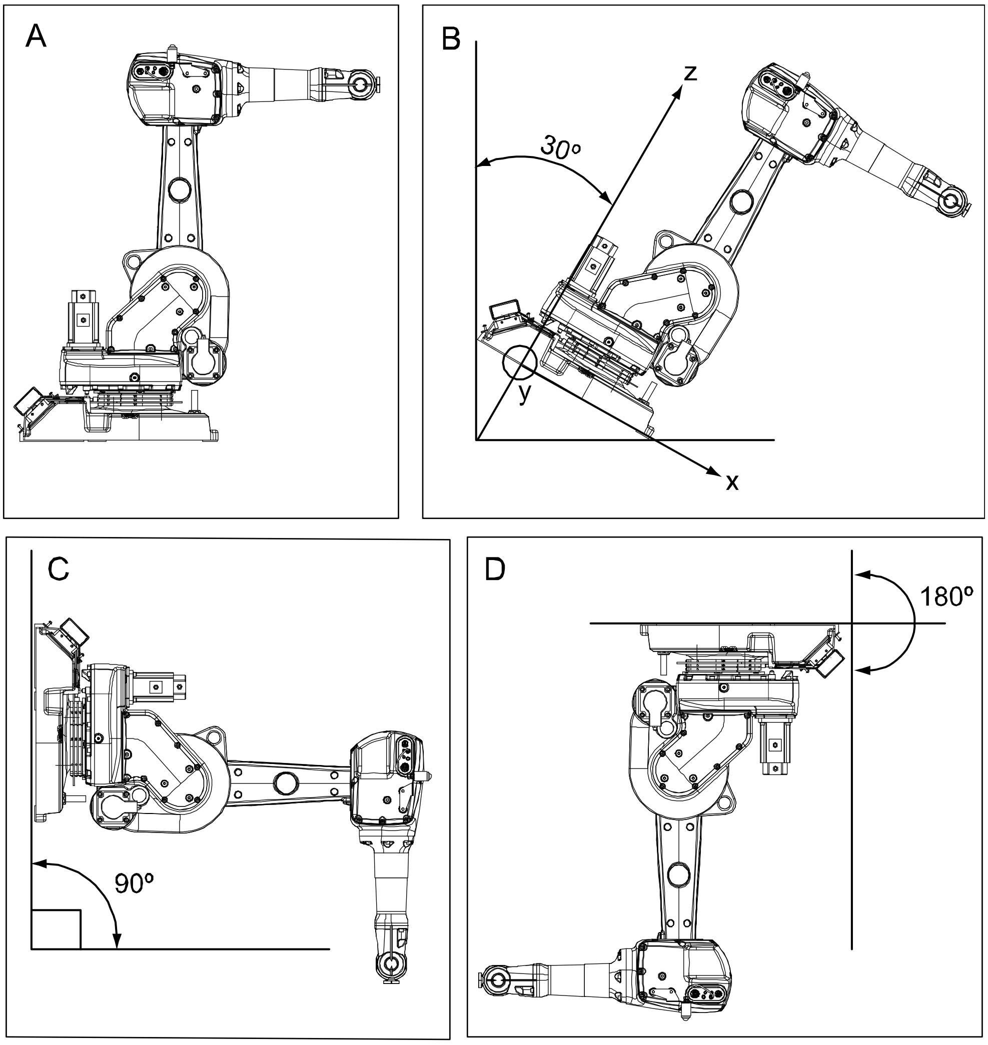
Examples of mounting angles tilted around the Y axis (*Gravity Beta*)



xx0600002779

A	Floor mounted
B	Tilted mounting, mounting angle 30º
C	Wall mounted, mounting angle 90º
D	Suspended mounting, mounting angle 180º

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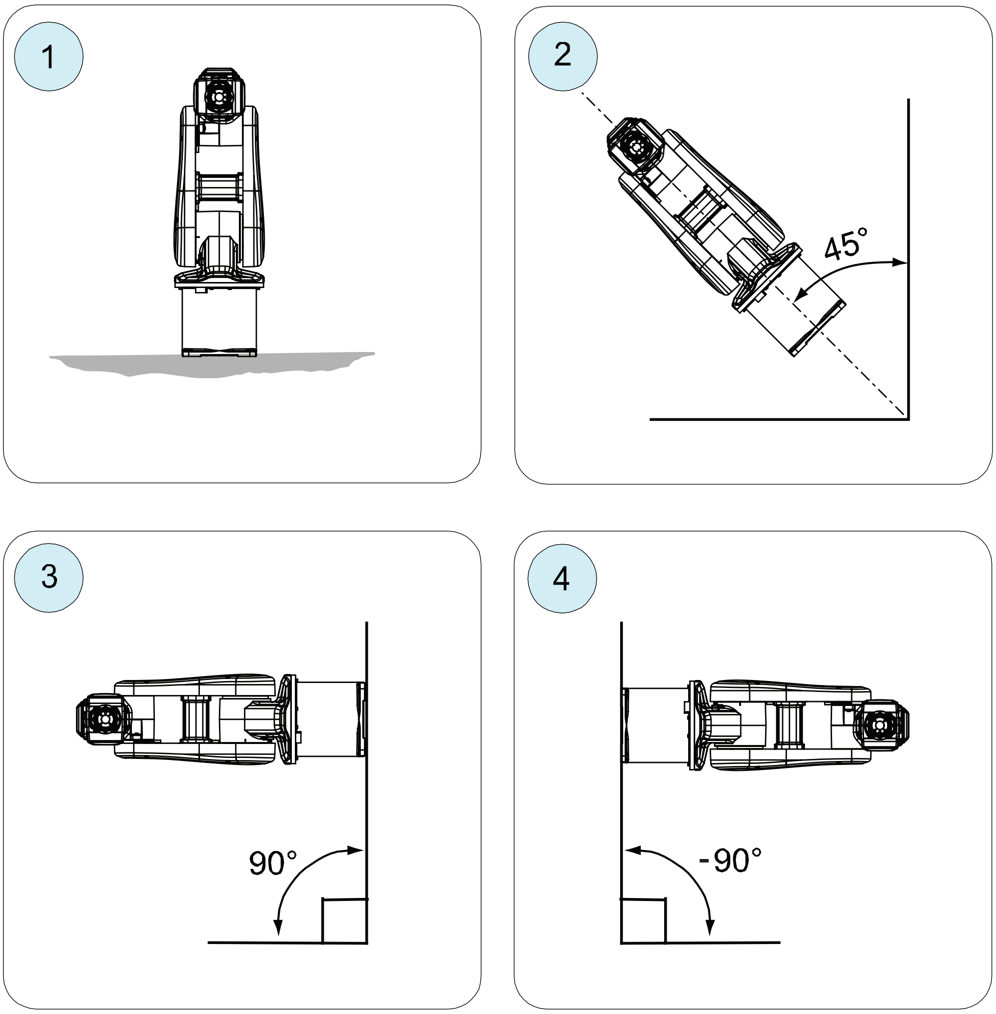
Examples of mounting angles tilted around the X axis (*Gravity Alpha*)

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



xx1500000532

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

Note

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

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Limitations in working area

If tilting a floor mounted robot or mounting the robot on a wall, the working range of axis 1 is limited. These limitations are specified in the table *Working range on page 49*.

Defining the parameter in RobotWare

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

How to calculate a new value is detailed in *Mounting angles and values on page 69*.

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

The system parameters are configured in RobotStudio or on the FlexPendant.

2.3.6 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*

Stopping time and braking distances

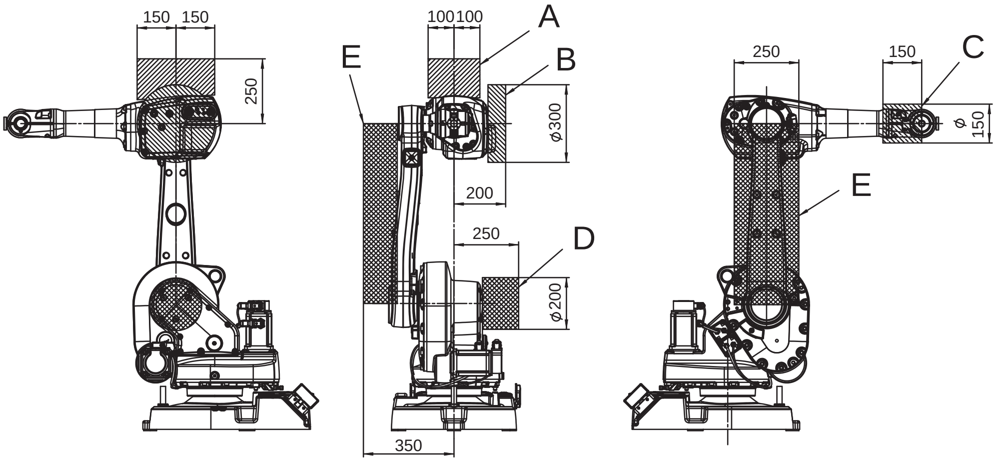
The performance of the motor brake depends on if there are any loads attached to the robot. For more information, see product specification listed in *References on page 10*.

2.3.7 Fitting equipment on the robot (robot dimensions)

Load areas

Extra loads can be mounted on the wrist, the upper arm housing, and on the frame. Load areas and permitted loads are shown in graphic below. The center of gravity of the extra load shall be within the marked load areas.

IRB 1600 - 5 kg and 7 kg



xx1000000154

Robot	Maximum load in load area					
	A	B	C	D	E	A+B+E
IRB 1600-5/X	15 kg	5 kg	0.5 kg	15 kg	15 kg	15 kg
IRB 1600-7/X	5 kg	5 kg	0.5 kg	15 kg	5 kg	5 kg

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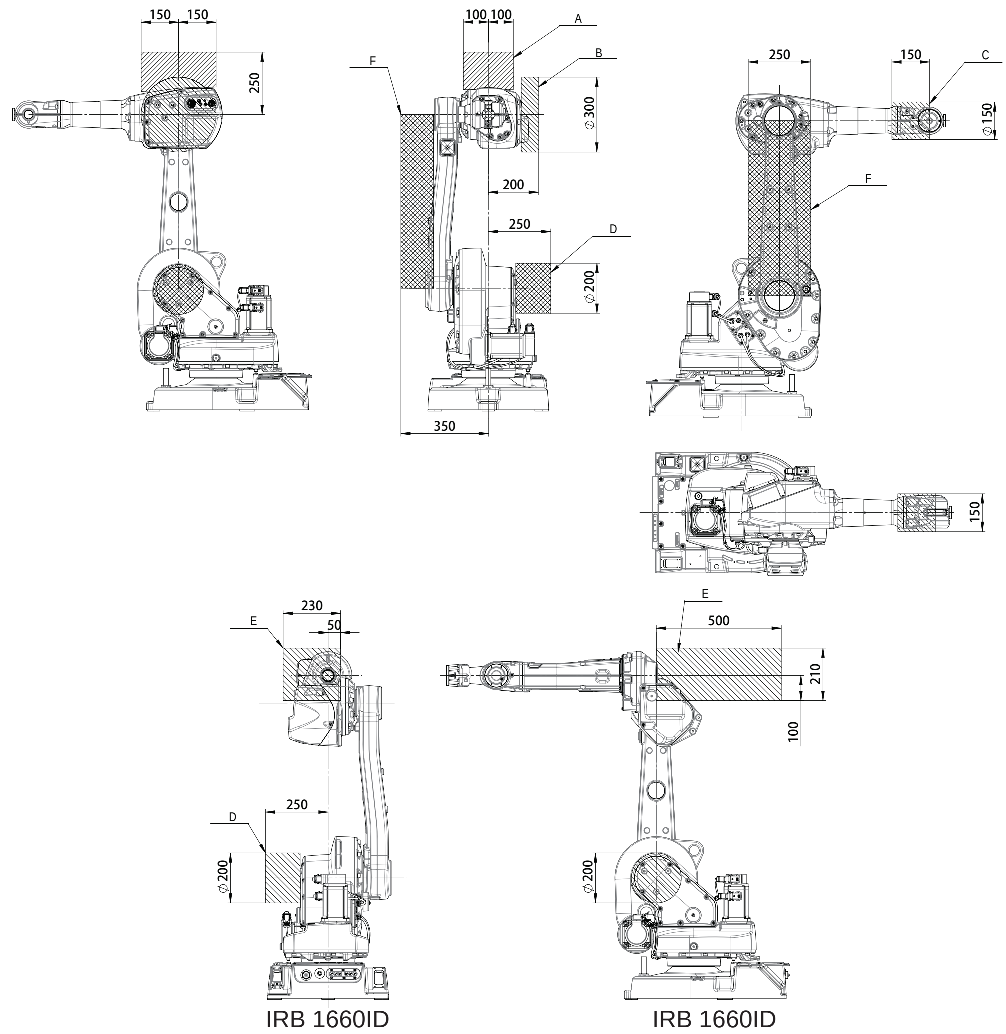
IRB 1600 - 6 kg, 8 kg, 10 kg, 1600ID, and 1660ID



xx1500000249

Robot	Maximum load in load area							
	A	B	C	D	E	F	A+B+F	E+F
IRB 1600-6/X	15 kg	5 kg	0.5 kg	15 kg	-	15 kg	15 kg	-
IRB 1600-8/X	5 kg	5 kg	0.5 kg	15 kg	-	5 kg	5 kg	-
IRB 1600-10/X	5 kg	5 kg	0.5 kg	15 kg	-	5 kg	5 kg	-
IRB 1600ID-4/1.5	-	-	-	15 kg	15 kg	15 kg	-	15 kg
IRB 1660ID-6/1.55	-	-	-	15 kg	10 kg	15 kg	-	15 kg
IRB 1660ID-4/1.55	-	-	-	15 kg	12 kg	15 kg	-	15 kg

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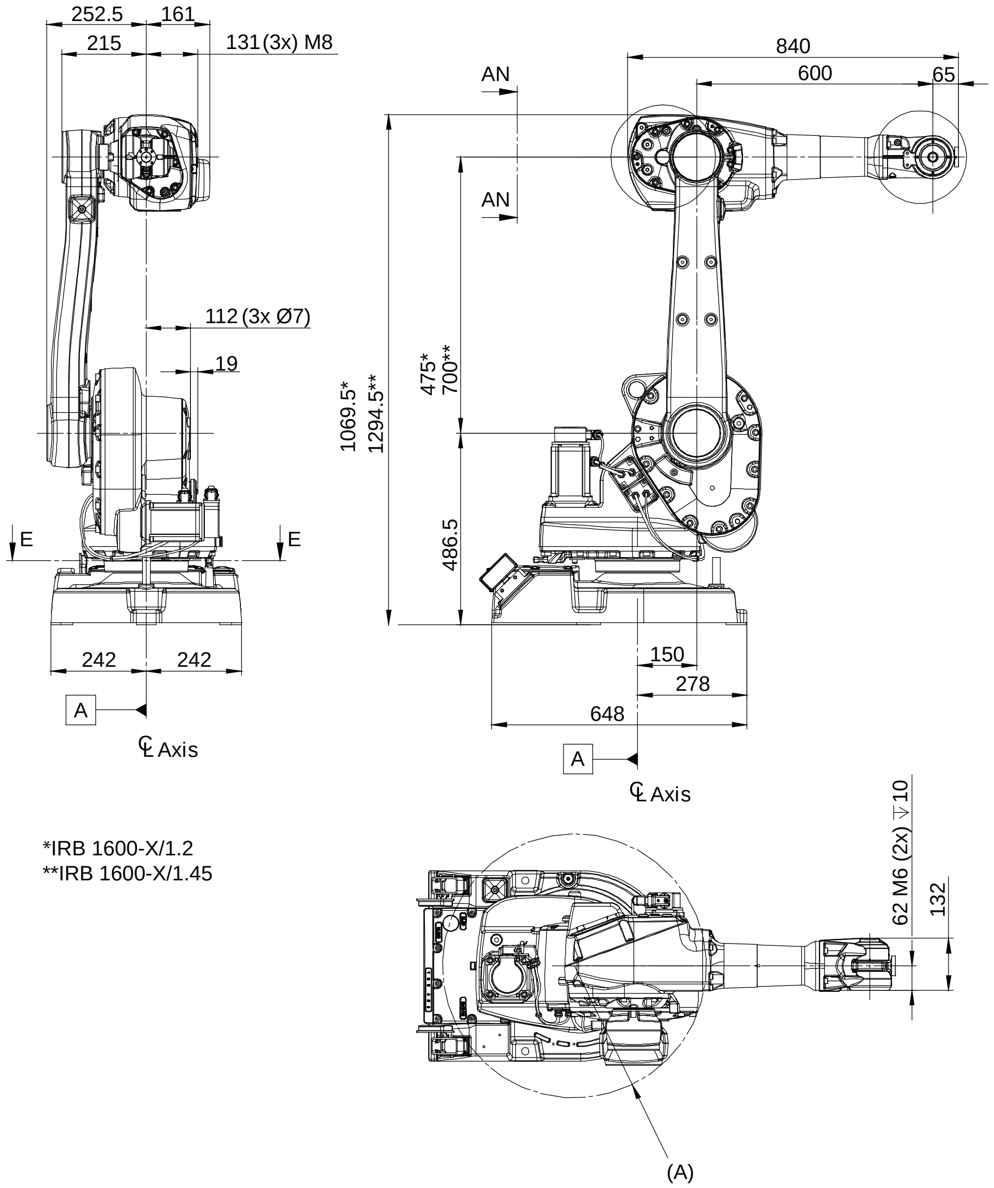
Dimensions IRB 1600-X/1.2 (1.45)



xx1000000972

A	R335 Minimum turning radius

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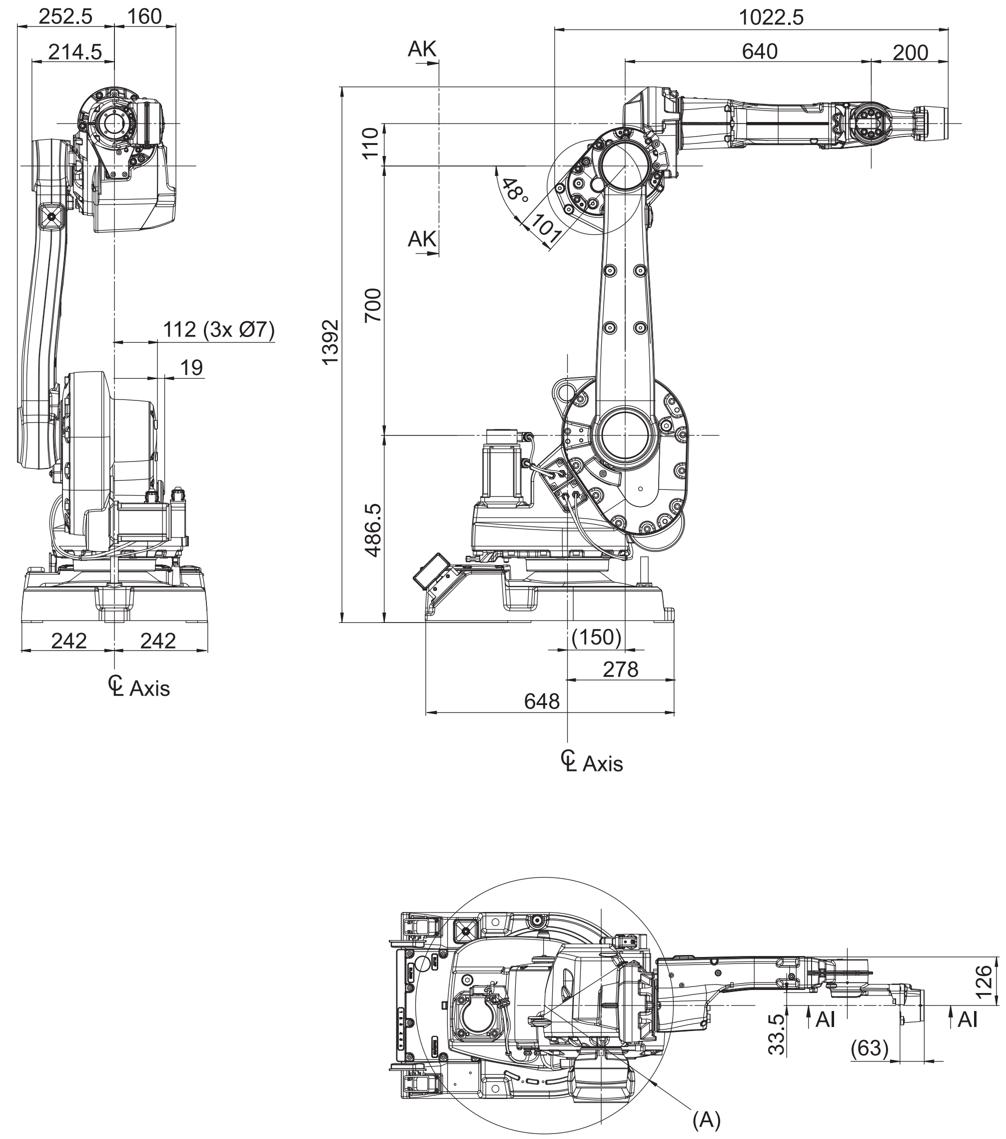
Dimensions IRB 1600ID

IRB 1600ID-4/1.5



xx1000000893

A	R335 Minimum turning radius

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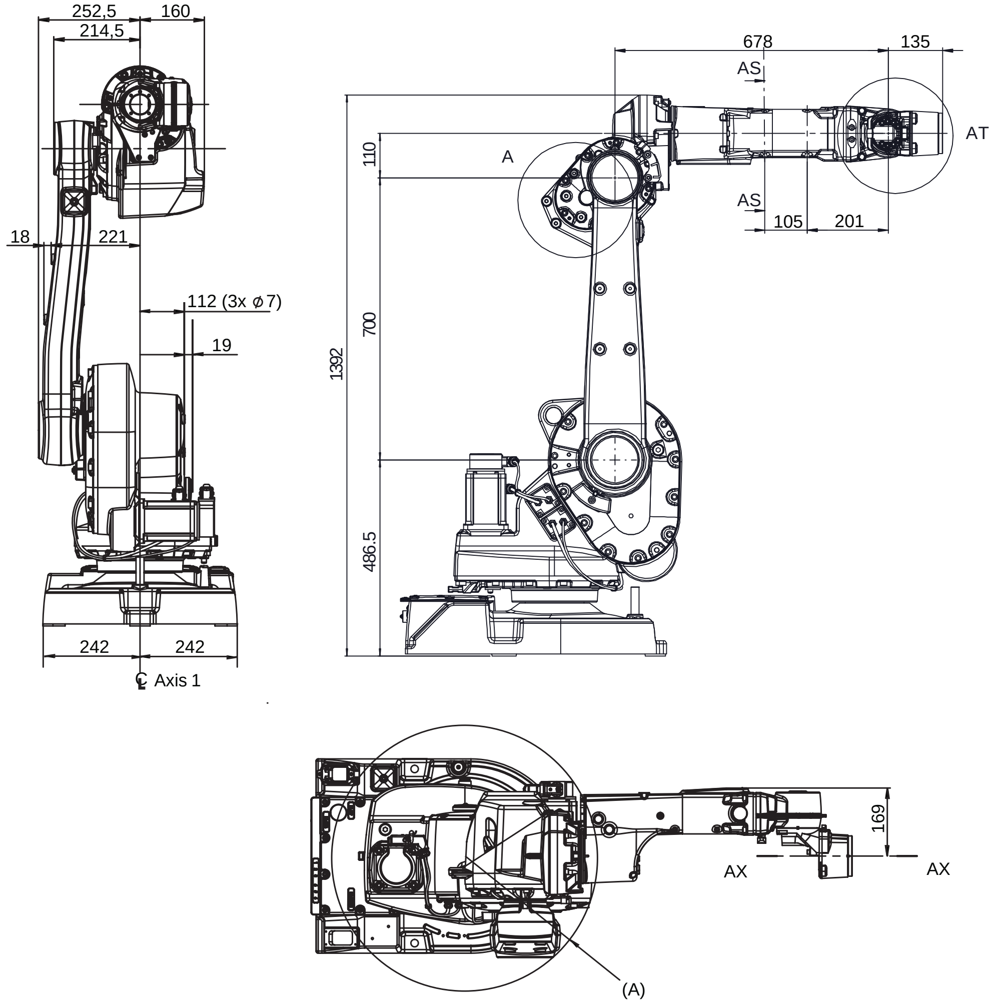
Dimensions IRB 1660ID

IRB 1660ID-X/1.55



xx1500001250

A	R335 Minimum turning radius

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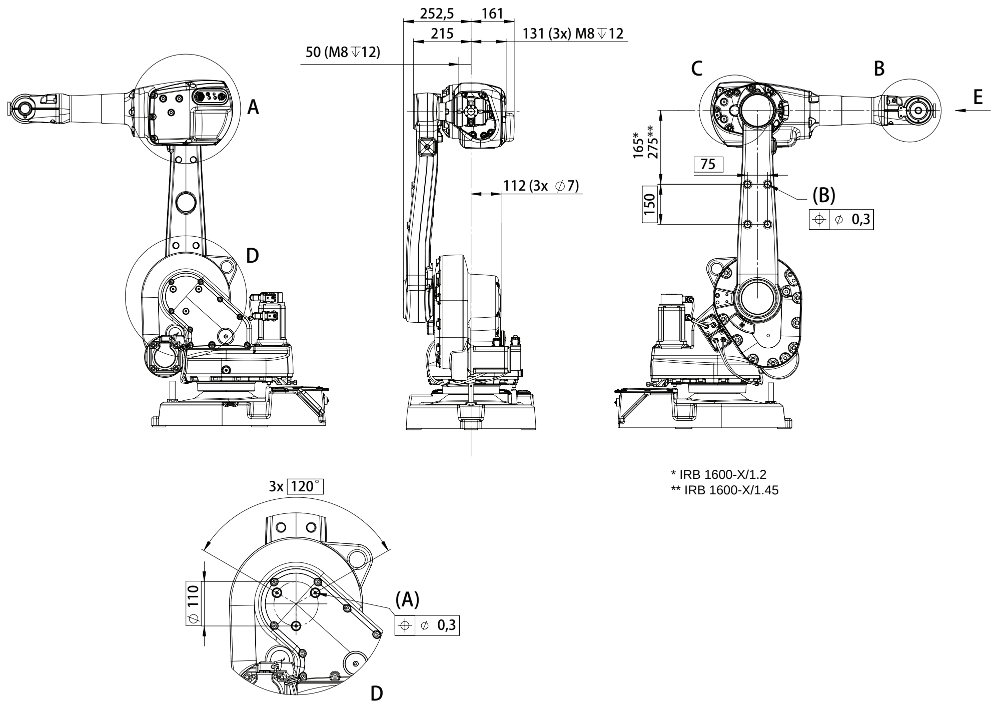
Holes for mounting of extra equipment for IRB 1600

The robot has holes for mounting extra equipment.



xx1500003258

A	3xΦ7 maximum depth 27. Reserved as a guide hole for enlarging the base hole to install the threaded sleeve (if needed). An M8 threaded sleeve with a max. depth of 20 mm is recommended.
B	4xM8 depth 12, mounting holes for equipment

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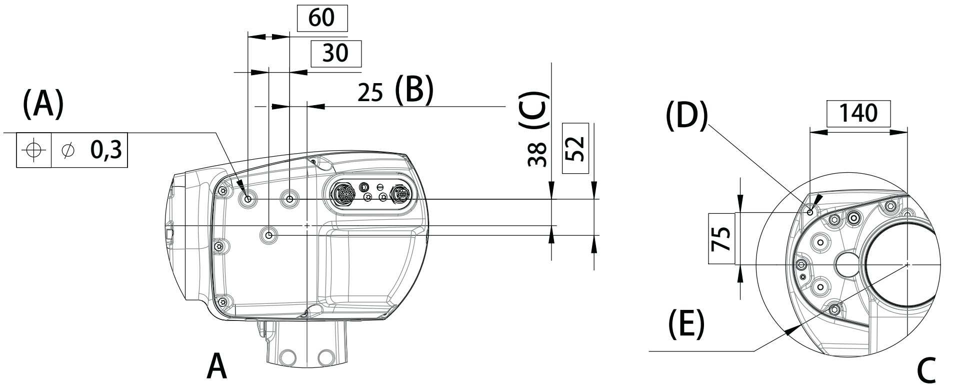


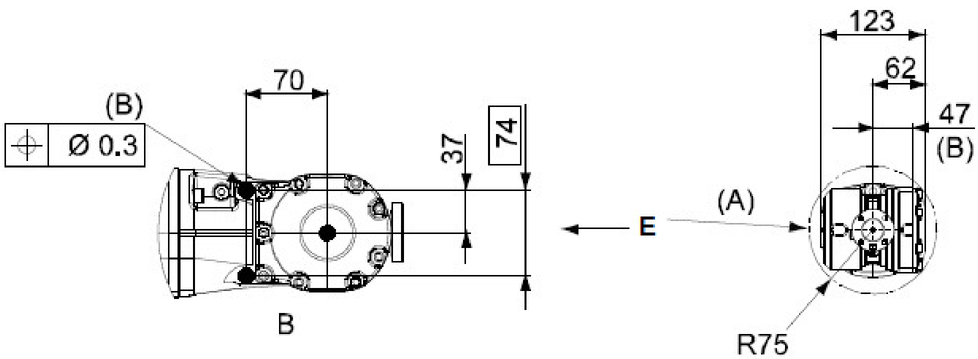
xx1500003262

A	3xM8 depth 12, mounting holes for equipment
B	From center line axis 3
C	From center line axis 4
D	3xM8 depth 16, mounting holes for equipment
E	R175, Axis 3 turning radius

Note

Note! When mounting heavier equipment, for example wire feeders in holes (A), the bracket must be supported in the opposite holes (D).

Design until June 2006



xx1500003259

A	View from E
B	2xM5 depth 7.5, mounting holes for equipment

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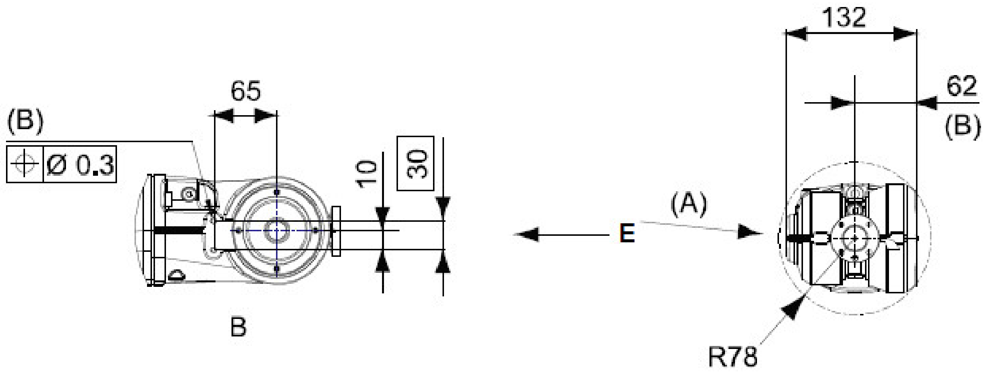
Design after June 2006, type A



xx1500003260

A	View from E
B	2xM6 depth 10, mounting holes for equipment

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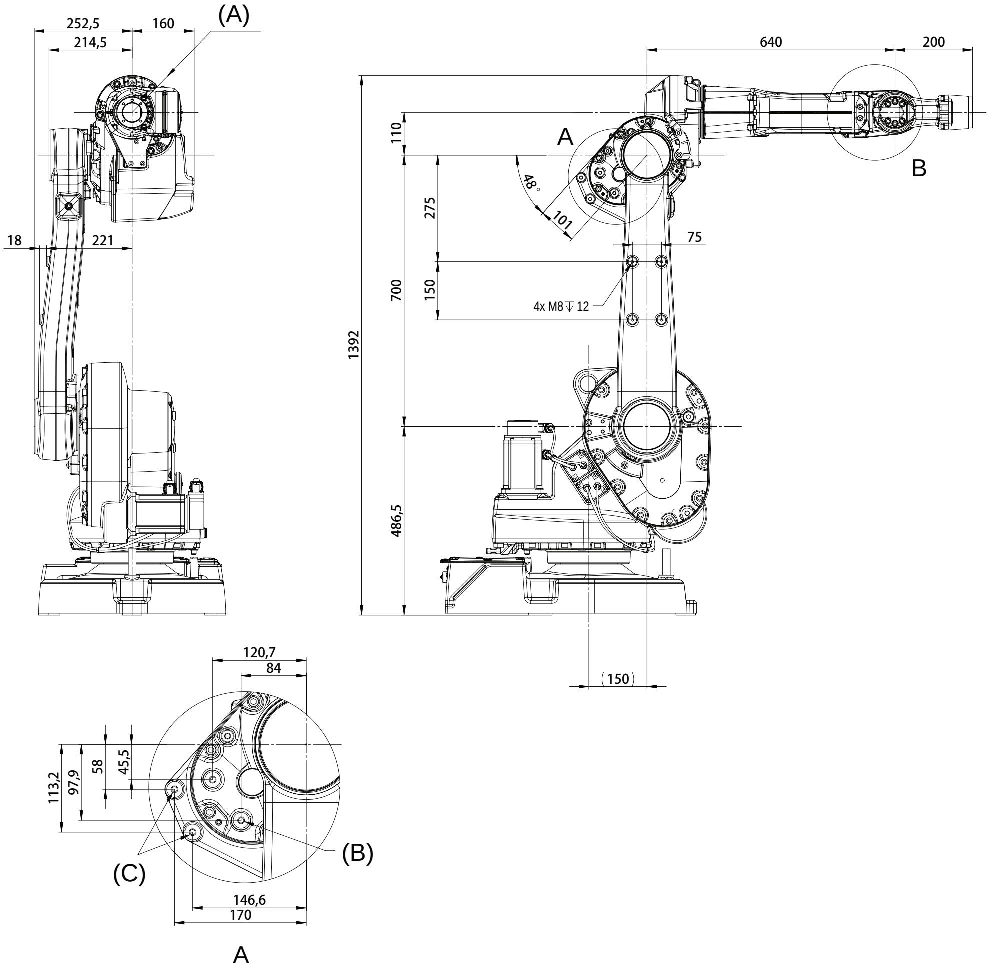
Holes for mounting of extra equipment for IRB 1600ID

IRB 1600ID-4/1.5



xx1000000911

A	R130, smallest circumscribed radius of axis 4
B	2xM8 depth 16, mounting holes for equipment
C	2xM8, mounting holes for equipment

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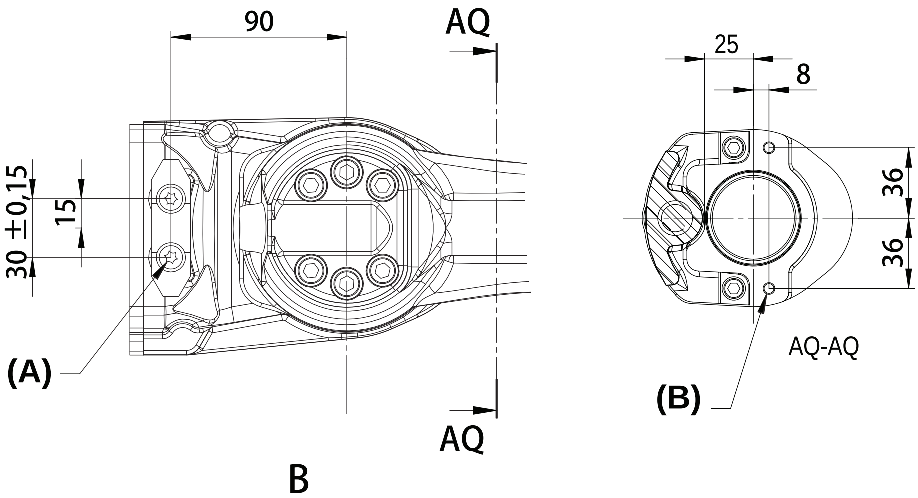

xx1500003261

A	2xM6 depth 12, mounting holes for equipment
B	2xM6 depth 12, mounting holes for equipment

Note

Lower arms among IRB 1600, IRB 1600ID, and IRB 1660ID are the same. For holes on the lower arm, see *Holes for mounting of extra equipment for IRB 1600 on page 79*.

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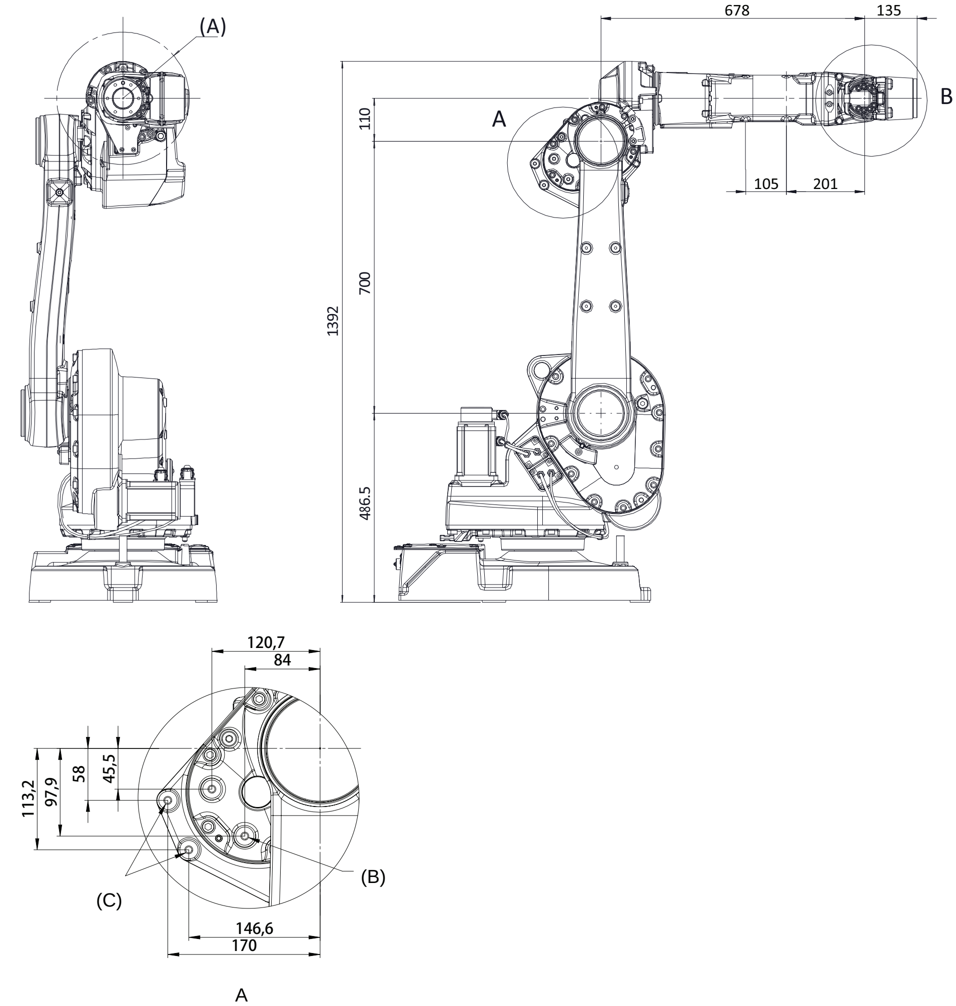
Holes for mounting of extra equipment for IRB 1660ID

IRB 1660ID-X/1.55



xx1500001253

A	R170.4, smallest circumscribed radius of axis 4
B	2xM8 depth 16, mounting holes for equipment
C	2xM8, mounting holes for equipment

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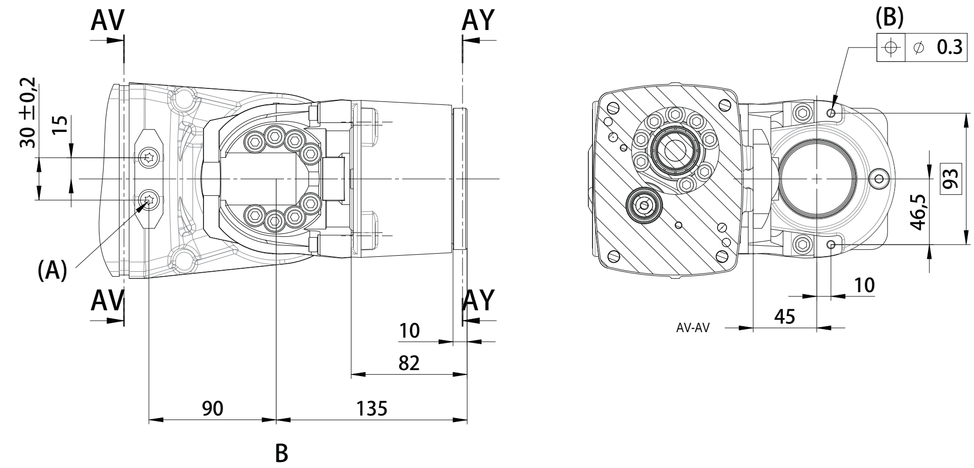


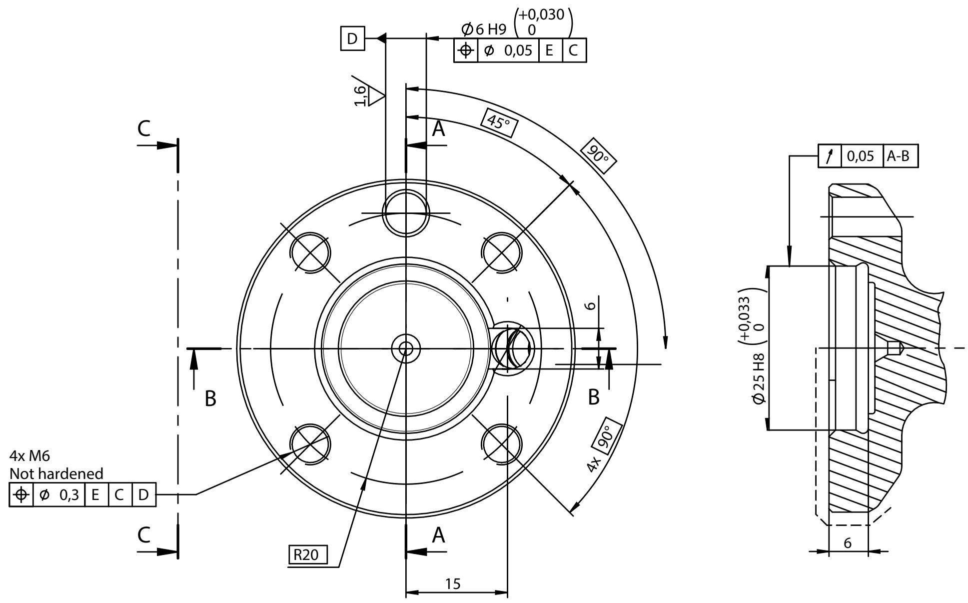
xx1500001251

A	2xM6 depth 12, mounting holes for equipment
B	2xM6 depth 18, mounting holes for equipment

Note

Lower arms among IRB 1600, IRB 1600ID, and IRB 1660ID are the same. For holes on the lower arm, see *Holes for mounting of extra equipment for IRB 1600 on page 79*.

Robot tool flange



xx1000000912

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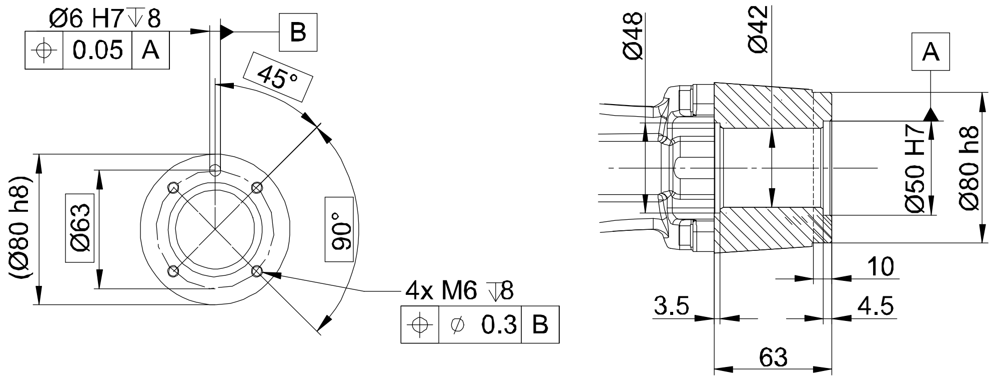
Note

The tool flange dimensions are the same over time, but a hole for the Axis calibration method is added. This hole is not perpendicular to the surface so it is easily noticed.

Robot tool flange for IRB 1600ID

IRB 1600ID-4/1.5



xx1000000913

Note

Make sure that the guide pin is not inserted more than max. 9.5mm in the tool flange.

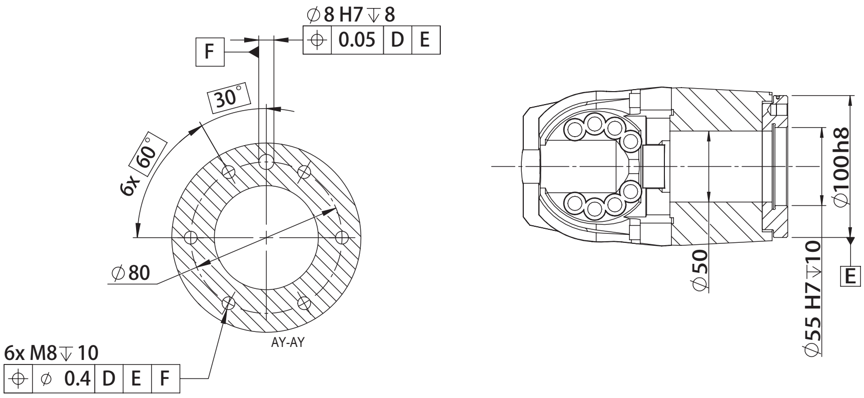
Before mounting the tool, insert the screw and measure the length of the screw sticking out, behind the tool. The length must not exceed 9.5 mm. Otherwise there is a risk that the screw can damage the sealing behind the tool flange.

The length, 9.5mm, refers to the total length of the screw, not just the thread length.

Continues on next page

Robot tool flange for IRB 1660ID

IRB 1660ID-X/1.55



xx1500001254

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.

2.3.8 Installation of signal lamp for 1600 with IRC5 (option)

General

A signal lamp with an yellow fixed light can be mounted on the robot, as a safety device. The signal lamp is required on an UL/UR approved robot.

The lamp is active in MOTORS ON mode.

Note

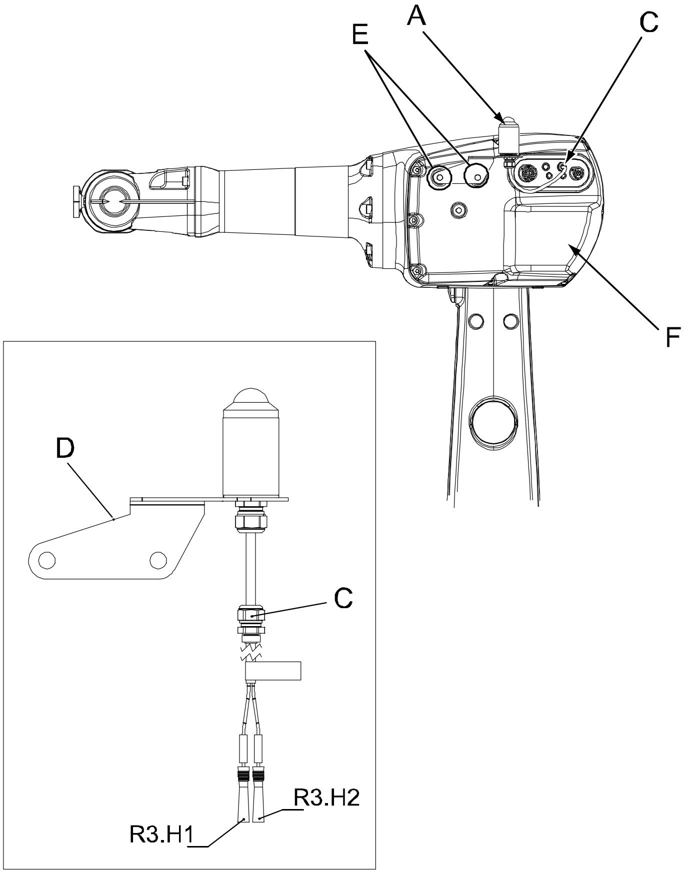
Do not use the signal lamp option in a Clean Room environment.

Different signal lamps on IRB 1600 and IRB 1600ID

This instruction details how to install the signal lamp on IRB 1600. If installing the lamp on an IRB 1600ID or an IRB 1660ID robot, see *Installation of signal lamp for 1600ID/1660ID with IRC5 (option) on page 91*.

Location of signal lamp

The signal lamp is fitted to the upper arm housing of the robot, as shown in the figure below.



xx0400001265

A	Signal lamp
C	Cable gland

Continues on next page

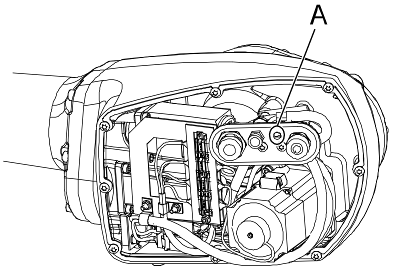
D	Cable bracket
E	Attachment holes for the signal lamp
F	Cover, upper arm housing

Required equipment

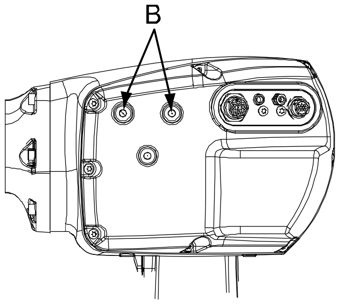
Equipment	Art. no.	Note
Signal lamp	3HAC050417-001	ABB Orange
	3HAC050418-001	Graphite White
Gasket, customer connections	3HAC022050-001	Replace if damaged.
Gasket, upper arm cover	3HAC022049-001	Replace if damaged.

Installation, signal lamp

The procedure below details how to install the signal lamp to the robot.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Remove the *cover from the upper arm housing* to get access to the connectors inside the housing.	Shown in the figure *Location of signal lamp on page 88*.
3	Remove the protection plug (A) from the insertion hole in the contact panel. Run the cables of the lamp through the hole in the contact panel. Secure the cable gland in the hole.	 xx0400001264 • A: Plug with o-ring, M10
4	Connect the lamp connectors, R3.H1 and R3.H2 and place the cables safely inside the housing.	
5	Take out the lamp unit through the hole in the *upper arm housing cover* and refit the cover. Make sure the gaskets are not damaged.	Shown in the figure *Location of signal lamp on page 88*.

Continues on next page

	Action	Note/Illustration
6	Fit the *cable bracket* of the signal lamp to the two mounting holes in the upper arm housing (B).	Shown in the figure *Location of signal lamp on page 88*.  xx0400001263 • B: Mounting holes, M8 x 12
7	The signal lamp is now ready for use and is lit in MOTORS ON mode.	

2.3.9 Installation of signal lamp for 1600ID/1660ID with IRC5 (option)

General

A signal lamp with an yellow fixed light can be mounted on the robot, as a safety device. The signal lamp is reqired on an UL/UR approved robot.

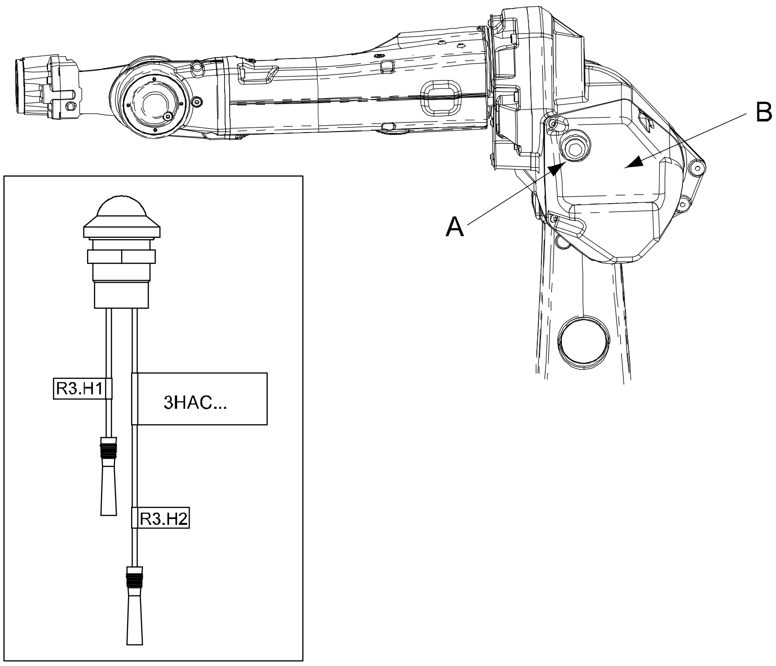
The lamp is active in MOTORS ON mode.

Note

Do not use the signal lamp option in a Clean Room environment.

Location of signal lamp

The signal lamp is fitted to the upper arm housing of the robot, as shown in the figure below



xx0700000100

A	Signal lamp
B	Cover, upper arm housing

Required equipment

Equipment	Art. no.	Note
Signal lamp	3HAC9258-1	
Drill	-	Diameter 22.5 mm

Continues on next page

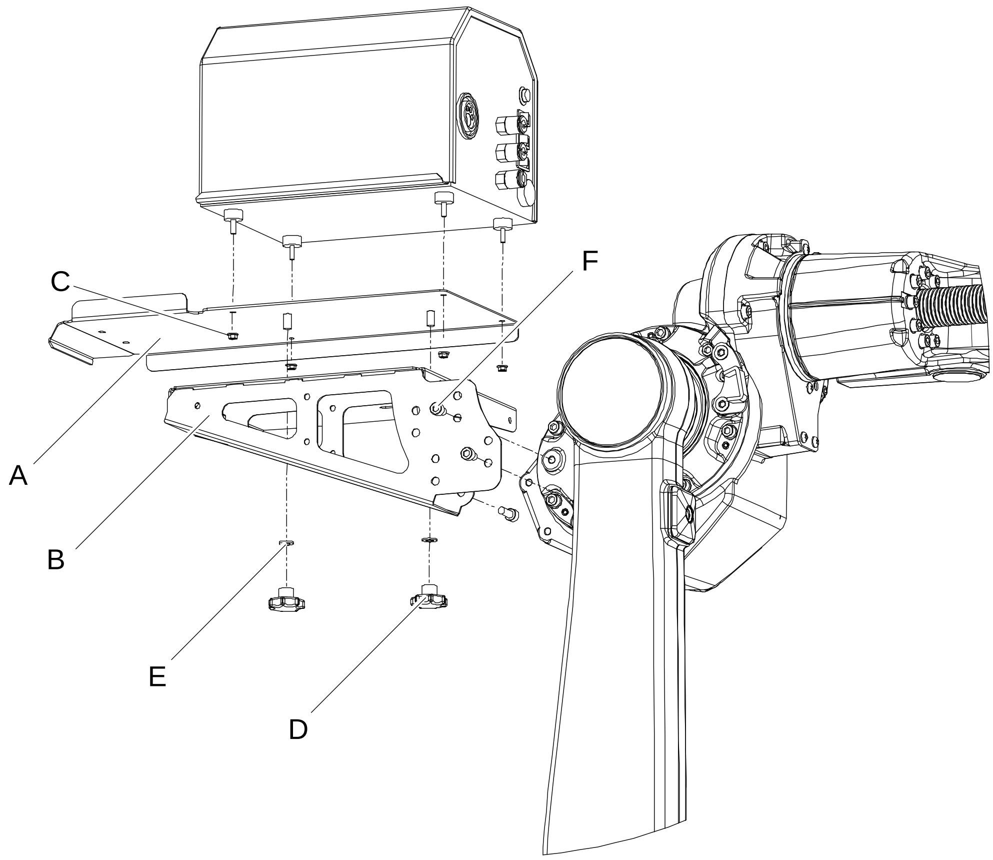
Equipment	Art. no.	Note
Standard toolkit	-	The contents of the toolkit is defined in section, *Standard tools on page 385*

Installation, signal lamp

	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	Remove the *cover from the upper arm housing*.	Shown in the figure *Location of signal lamp on page 91*.
3	On the cover there is a mark where the lamp is to be installed. Find the mark and drill a hole with a diameter of 22.5mm.	
4	Fit the lamp and tighten the nut.	
5	In the upper arm housing find the two cables marked R3.H1 and R3.H2 and connect them with the lamp	
6	Refit the cover on the upper arm housing.	
7	The signal lamp is now ready for use and is lit in MOTORS ON mode.	

2.3.10 Installation of the wire feeder shelf for 1600ID/1660ID

Location of shelf, wire feeder



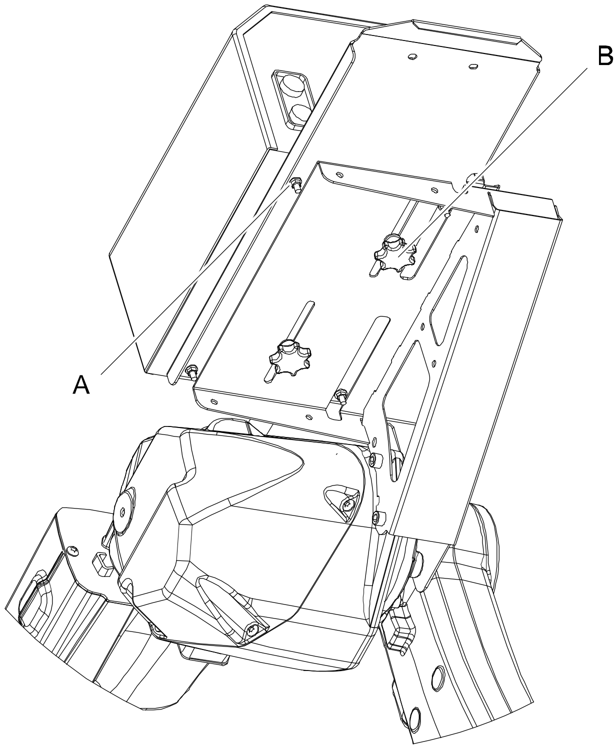
xx0700000311

A	Bracket ESAB wire feeder
B	Shelf, wire feeder
C	Hexagon nut with flange M5
D	Knob
E	Plain washer (8.4x16x1.6)
F	Hex socket head cap screw (M8x12)

Fitting the wire feeder shelf

	Action	Note
1	Fit the Shelf, wire feeder (B) using the four (4) Hex socket head cap screw (F).	Shown in figure *Location of shelf, wire feeder on page 93*

Continues on next page

	Action	Note
2	Fit the bracket on the wire feeder using the four (4) Hexagon nut with flange (A).	 xx0700000312 A Hexagon nut with flange M5 B Knob
3	Fit the wire feeder with the mounted bracket on the Shelf, wire feeder and mount the two knobs.	

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

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 Installation of additional mechanical stops on axis 1

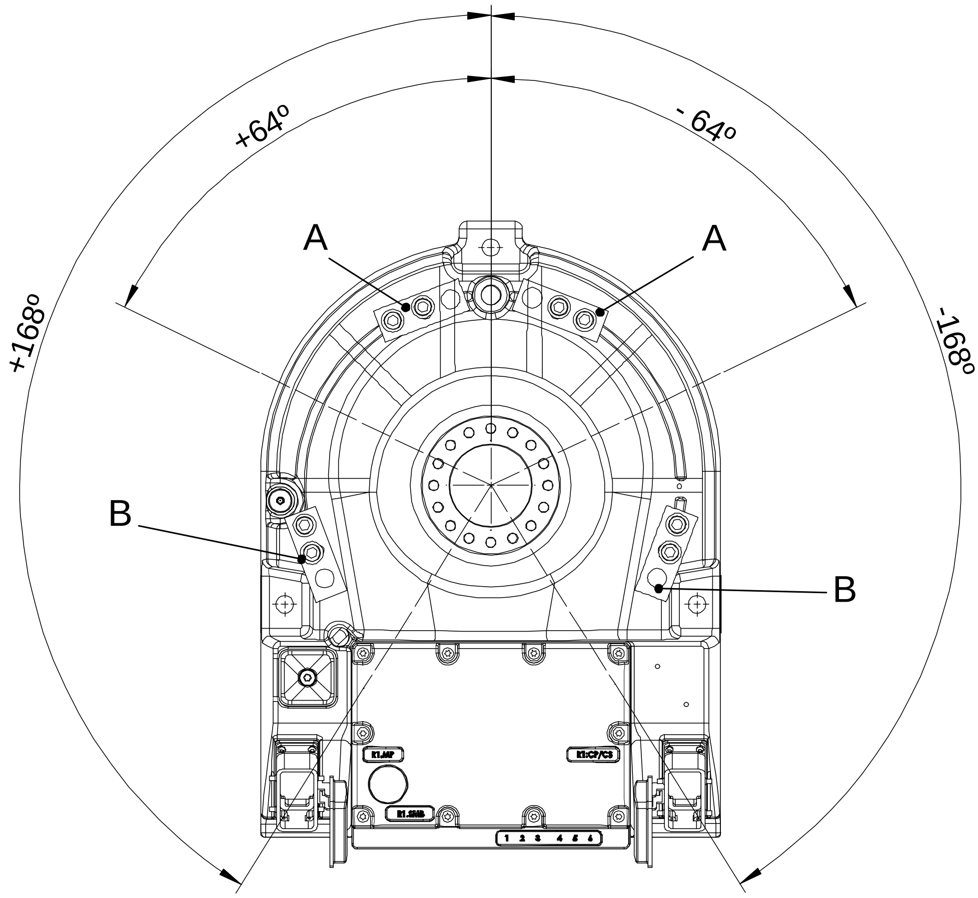
General

This section details how to install additional mechanical stops on axis 1 in order to restrict the working range of the axis.

Restrictions in working range

The working range of axis 1 can be restricted by fitting one or two additional mechanical stops on the casted groove at the base.

The figure below shows both the minimum and maximum working range of the robot, when restricted by the additional mechanical stops. The working range can be restricted freely within the shown scope, depending on where the mechanical stop is installed along the casted groove.



xx0400001286

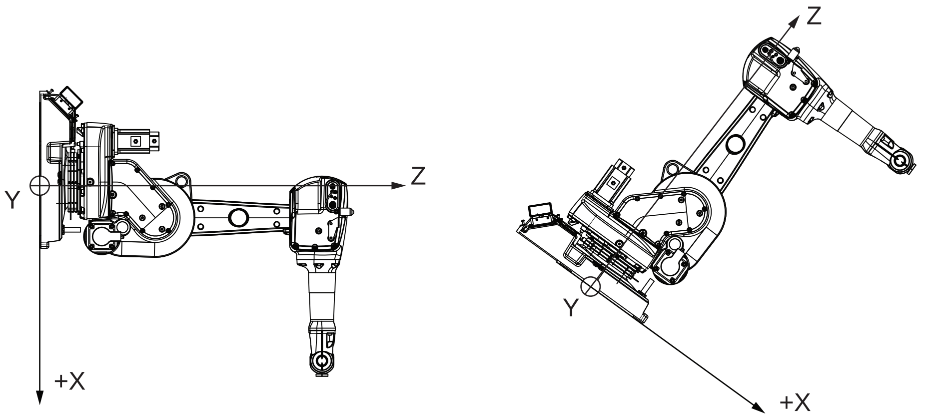
A	Mounting position of two additional stops for maximum working area (±168º)
B	Mounting position of two additional stops for minimum working area (±64º)

Continues on next page

Keep X direction downwards (tilted or wall mounted robot)

CAUTION

If the robot is wall mounted or mounted in a tilted position, it is important that the X direction of the base coordinate system points downwards, as shown in the figure below.

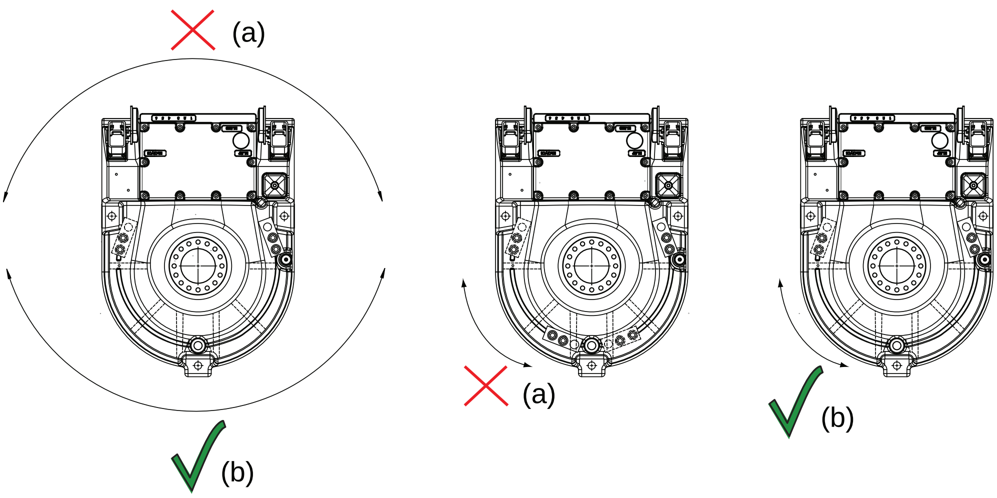


xx1200001354

Negative directions in axis 1 have extra gravity force (tilted or wall mounted robots)

If the robot is wall mounted or mounted in a tilted position, the additional mechanical stop pin restricts the robot when the axis 1 moves in a positive direction, for example from 0º and upwards to 90º (b).

The stop pin does not manage the extra gravity force that comes from when axis 1 moves in a negative direction, for example from 180º downwards to 90º (a).



xx1300000180

(a)	The additional stop pin does not manage the extra gravity force in this restricted working area (for tilted or wall mounted robots).
(b)	The additional stop pin manages to restrict this working area (for tilted or wall mounted robots).

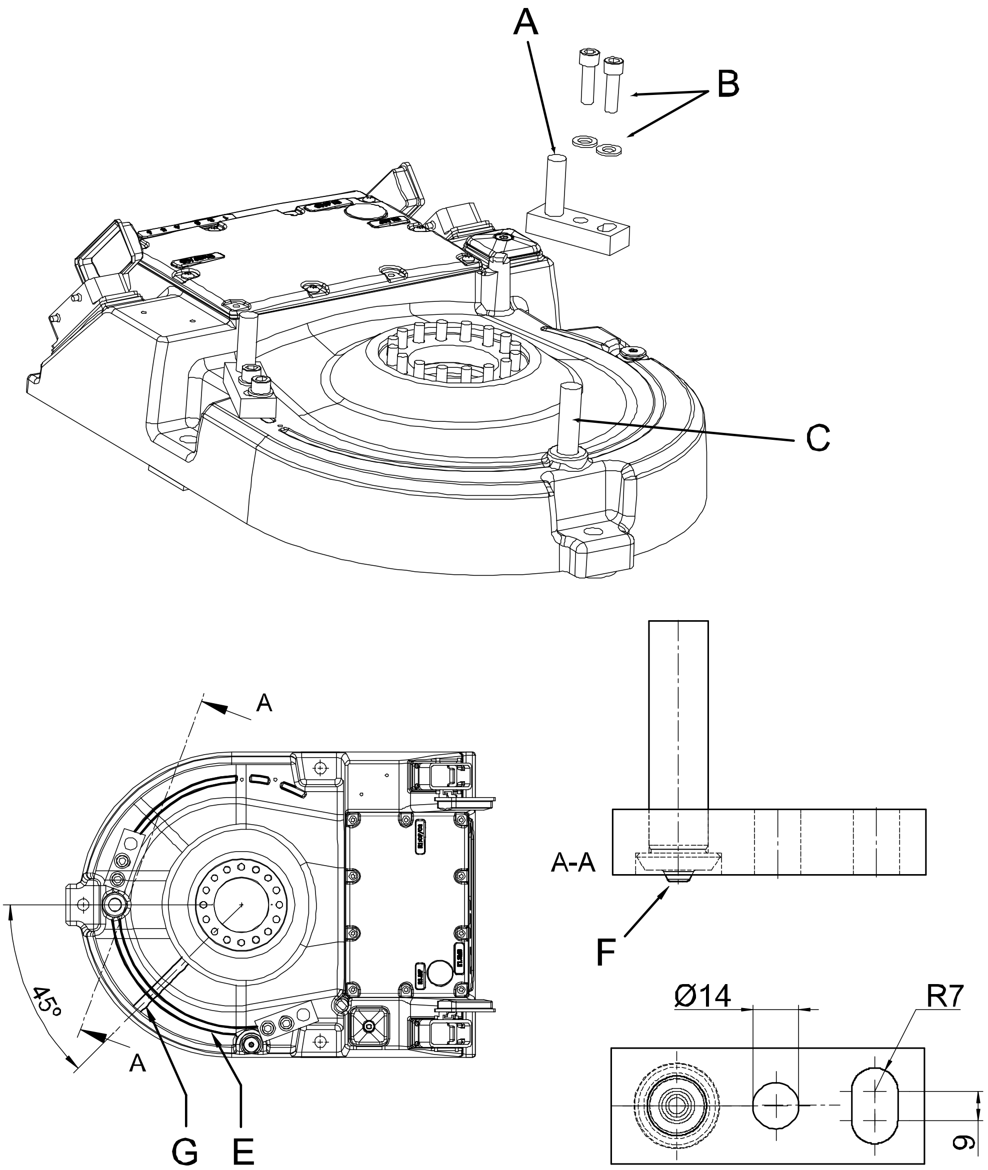
Continues on next page

Required equipment

Equipment	Art. no.	Note
Working range limit axis 1	3HAC026119-001	Includes mechanical stops (2 pcs), attachment bolts and washers.
Technical reference manual - System parameters	-	Art. no. is specified in section *References on page 10*.

Illustration, mechanical stop, axis 1

The additional mechanical stop of axis 1 is fitted to the base of the robot, as shown in the figure below.



xx0400001287

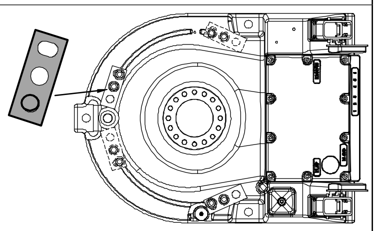
A	Mechanical stop, axis 1 (additional)
B	Attachment bolts and washers, mechanical stop

Continues on next page

C	Stop pin (standard)
E	Casted groove
F	Guiding pin
G	Hidden stiffening ribs

Installation of mechanical stop, axis 1

The procedure below details how to install the mechanical stop to axis 1.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Place the stop at the base, with the *guiding pin* in the casted groove. Turn the stop until the holes align with the groove. The stop can be mounted in either direction, resulting in differences in the working range.	 xx0400001288 Also see the figure *Illustration, mechanical stop, axis 1 on page 98*.
3	Drill two holes in the casted groove, with guidance from the circular and the elliptical hole. Drill the holes through 10.2 mm. If drilling in a stiffening rib, drill depth must be min. 30 mm.	
4	Cut the threads M12. If cutting in a stiffening rib, thread depth must be min. 23 mm.	
5	Fit the stop to the base without tightening the bolts.	
6	Turn axis 1 manually and check the working area between the stops.	How to release the holding brake of the axis motor is detailed in section *Manually releasing the brakes on page 61*.
7	Tighten the bolts.	2 pcs/stop: M12 x 40, tightening torque: 85 Nm.
8	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*.

Continues on next page

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

2.4.3 Installation of additional mechanical stop on axis 2

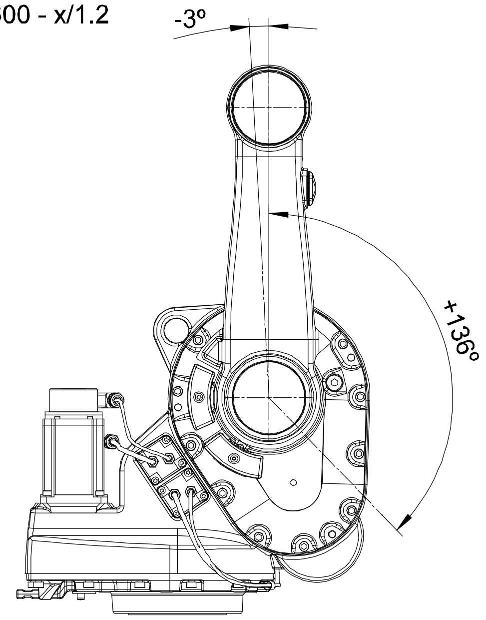
General

This section details how to install an additional mechanical stop on axis 2 in order to restrict the working range of the axis.

Restrictions in working range

The working range of axis 2 can be restricted by fitting an additional mechanical stop at the frame. The working range can only be restricted backwards, as shown in the figures below. Notice the different working ranges for the different models!

IRB 1600 - x/1.2



xx0400001289

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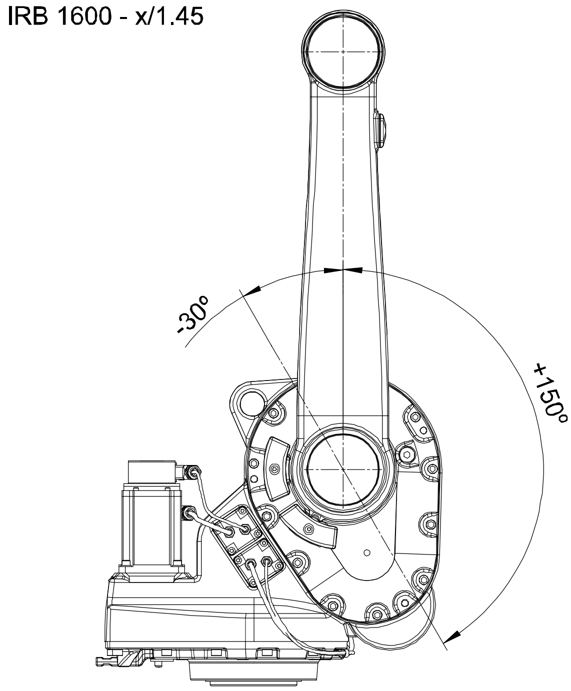
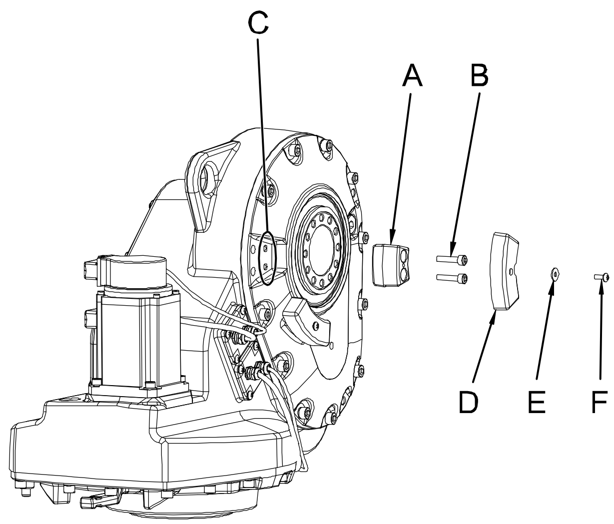


xx0400001290

Illustration, mechanical stop, axis 2

The additional mechanical stop for axis 2 is fitted together with a damper to the frame, as shown in the figure below.



xx0400001291

A	Mechanical stop, axis 2
B	Attachment bolts, mechanical stop (2 pcs)
C	Attachment holes, mechanical stop
D	Damper, axis 2
E	Washer
F	Attachment screw, damper

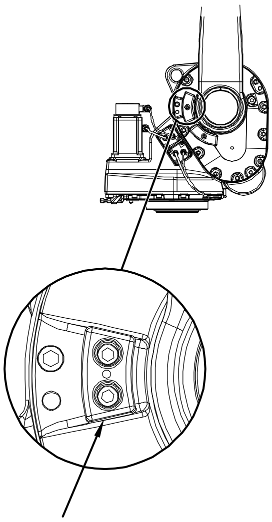
Continues on next page

Required equipment

Equipment	Art. no.	Note
Working range limit axis 2	3HAC026120-001	Includes mechanical stop, damper and attachment bolts.
Technical reference manual - System parameters	-	Art. no. is specified in section *References on page 10*.

Installation of mechanical stop, axis 2

The procedure below details how to install the mechanical stop to axis 2.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Fit the mechanical stop to the frame, without tightening the bolts.	Attachment holes are shown in the figure *Illustration, mechanical stop, axis 2 on page 102*.
3	Make sure that the stop is in contact with the lower boss on the gearbox, as the arrow shows in the figure to the right.	 xx0400001292 **Note!** It is important that the mechanical stop is fitted in contact with the lower boss on the gearbox!
4	Tighten the attachment bolts.	2 pcs; M8 x 35, tightening torque: 25 Nm.
5	Fit the *damper* to the mechanical stop, with its attachment screw and washer. Tighten the screw.	Shown in the figure *Illustration, mechanical stop, axis 2 on page 102*.
6	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*.

Continues on next page

	Action	Note/Illustration
7	**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.	

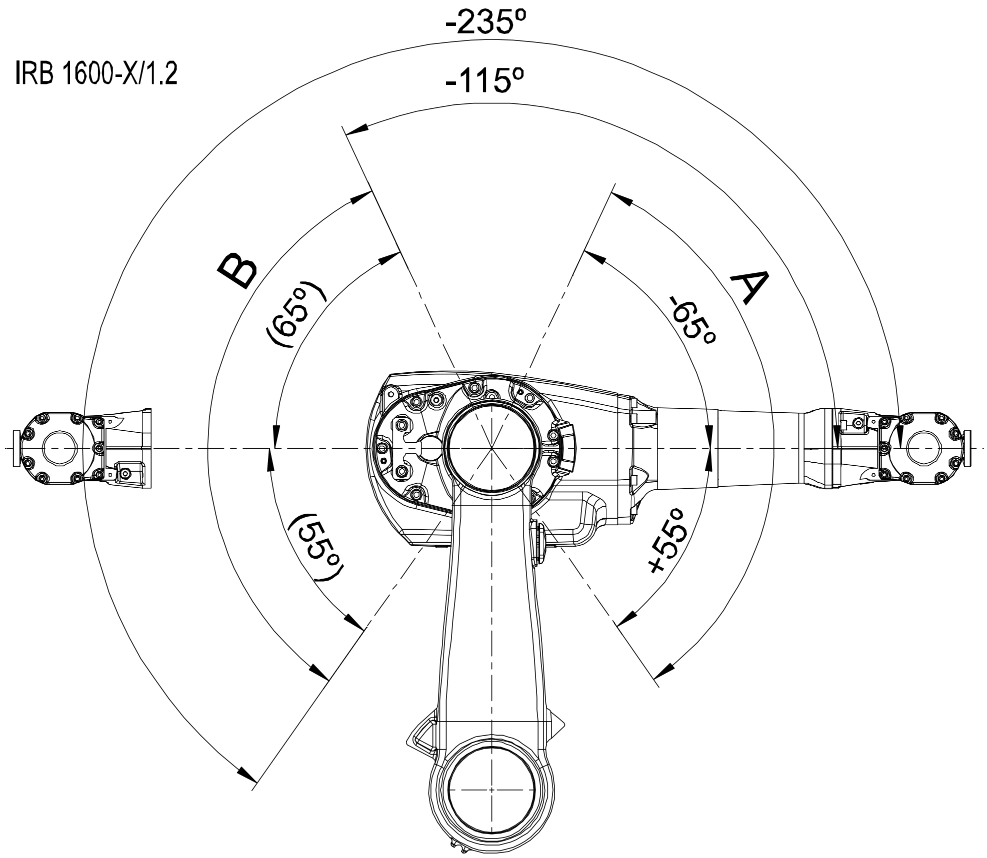
2.4.4 Installation of additional mechanical stops on axis 3

General

This section details how to install an additional mechanical stop on axis 3 in order to restrict the working range of the axis.

Restrictions in working range

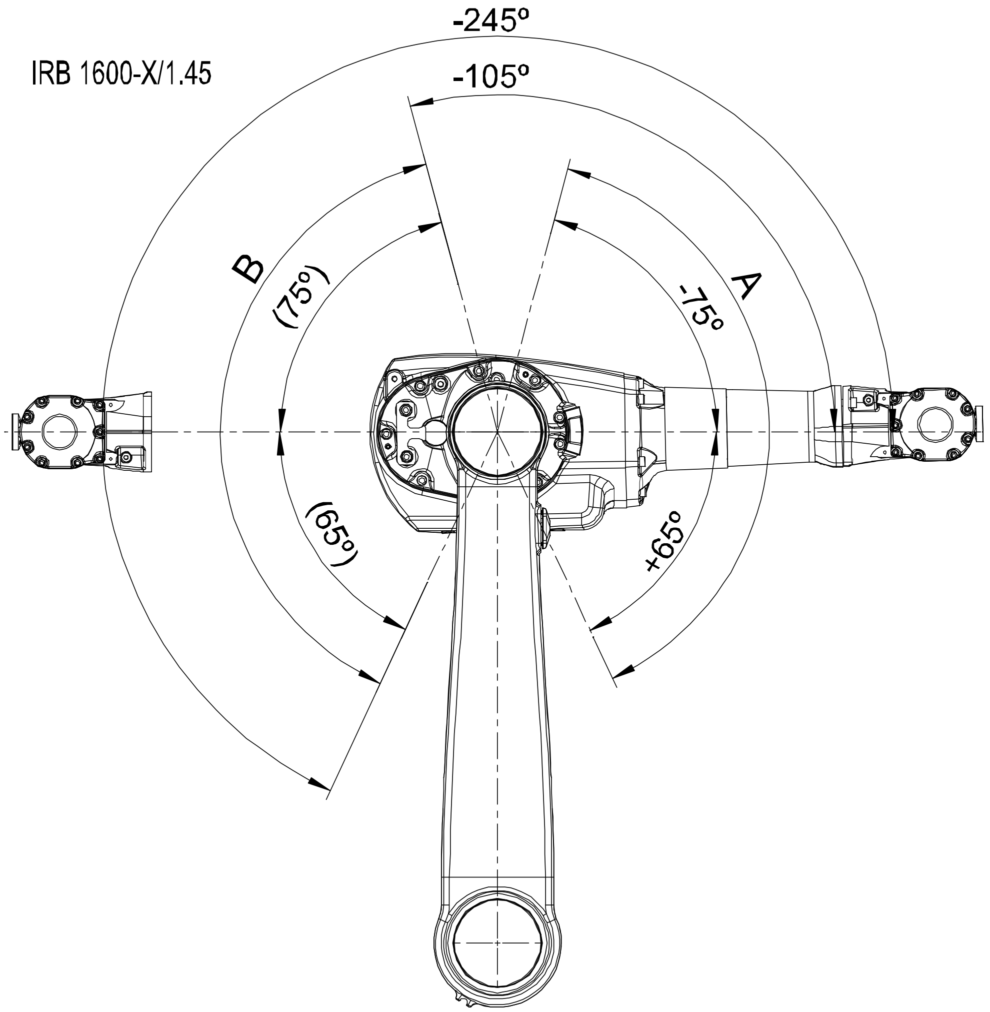
The working range of axis 3 can be restricted into two different working areas, as shown in the two figures below. Notice the differences between the different models.



xx0400001283

-	Robot models IRB 1600 - x/1.2
A	Working range A
B	Working range B

Continues on next page



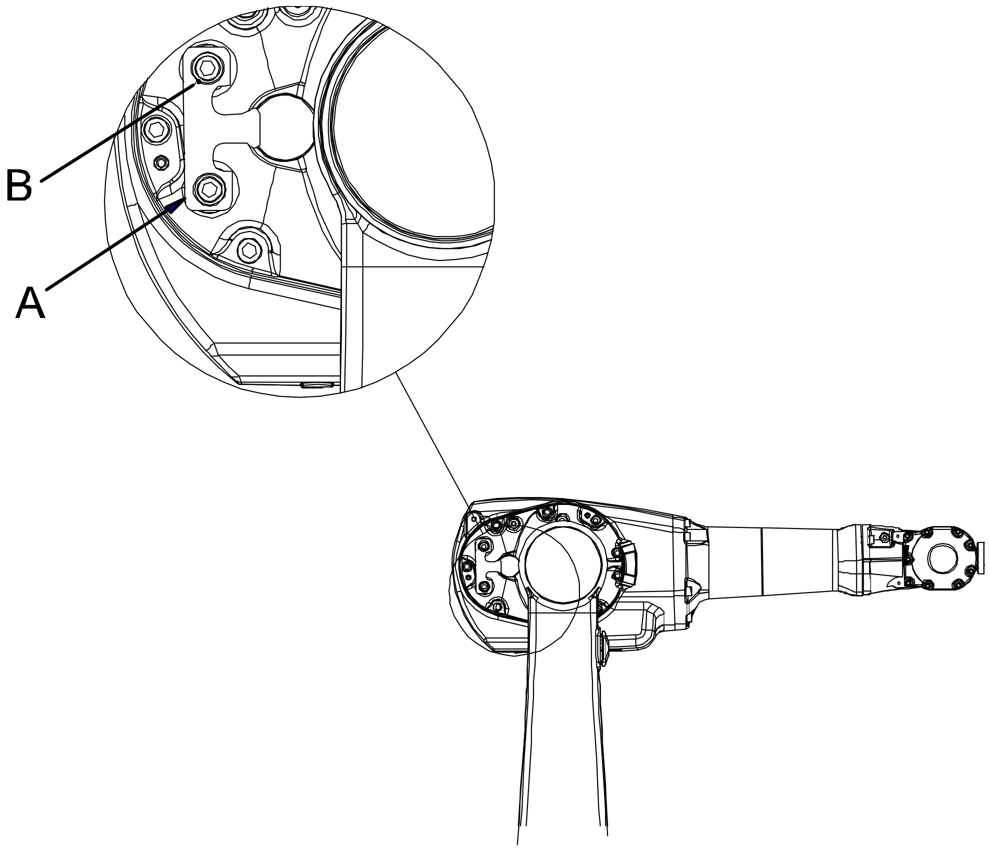
xx0400001284

-	Robot models IRB 1600 - x/1.45
A	Working range A
B	Working range B

Continues on next page

Illustration, mechanical stop, axis 3

The mechanical stop is installed at the upper arm housing, as shown in the figure below.



xx0400001285

A	Mechanical stop, axis 3
B	Attachment screws and washers (2 pcs)

Required equipment

Equipment	Art. no.	Note
Working range limit axis 3	3HAC026121-001	Includes mechanical stop, attachment screws and washers.
Technical reference manual - System parameters	-	Art. no. is specified in *References on page 10*.

Continues on next page

Installation of mechanical stop, axis 3

The procedure below details how to install the mechanical stop to axis 3.

	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	Fit the mechanical stop to the two mounting holes at the upper arm housing, with the two attachment screws and washers. Tighten the screws.	See *Illustration, mechanical stop, axis 3 on page 107*. 2 pcs: M8 x 25, tightening torque: 25 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 Customer connectors on the robot

General

Customer connections are options, the cables for them are integrated in the robot and the connectors are placed on the upper arm housing.

The customer connections are:

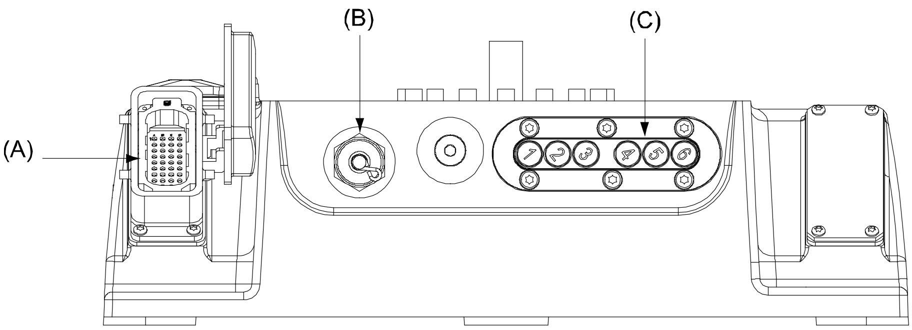
- The standard connections for signals, power and air.
- The integrated wire feed cabling for signals and power.
- The 7-axis connection.

Note

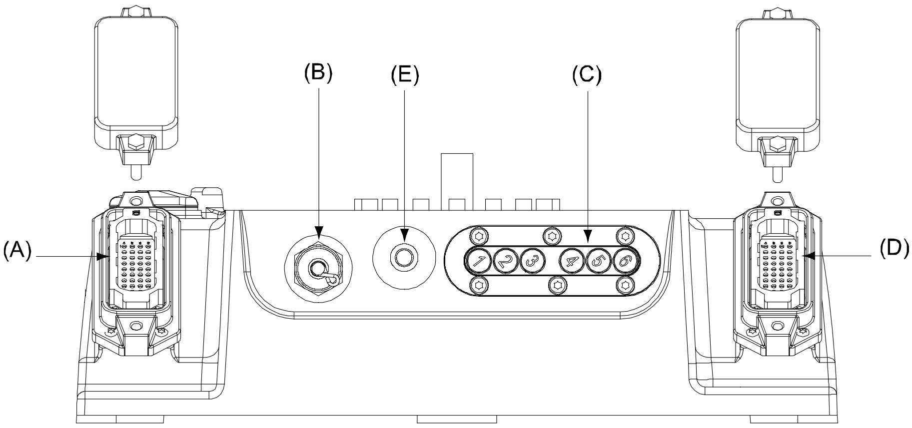
No customer/application connections are available for IRB 1660ID.

Connections at robot base

The graphics below show the customer connections on the robot base. For description of all connection types see *Connection table on page 110*.



xx1000000918



xx1000000919

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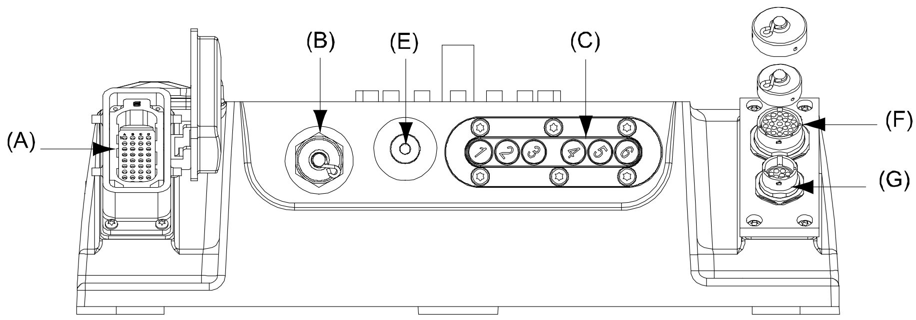
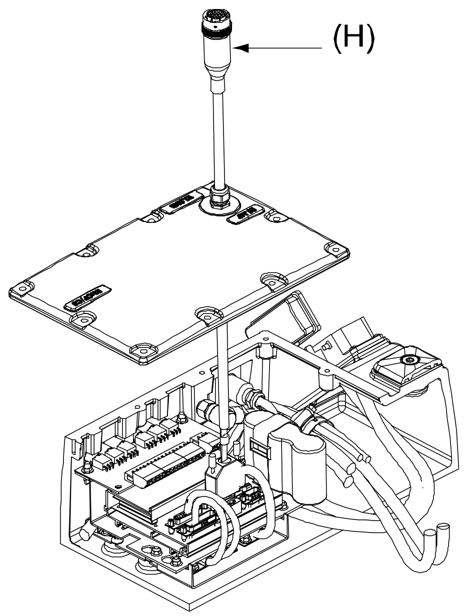


xx1000000920



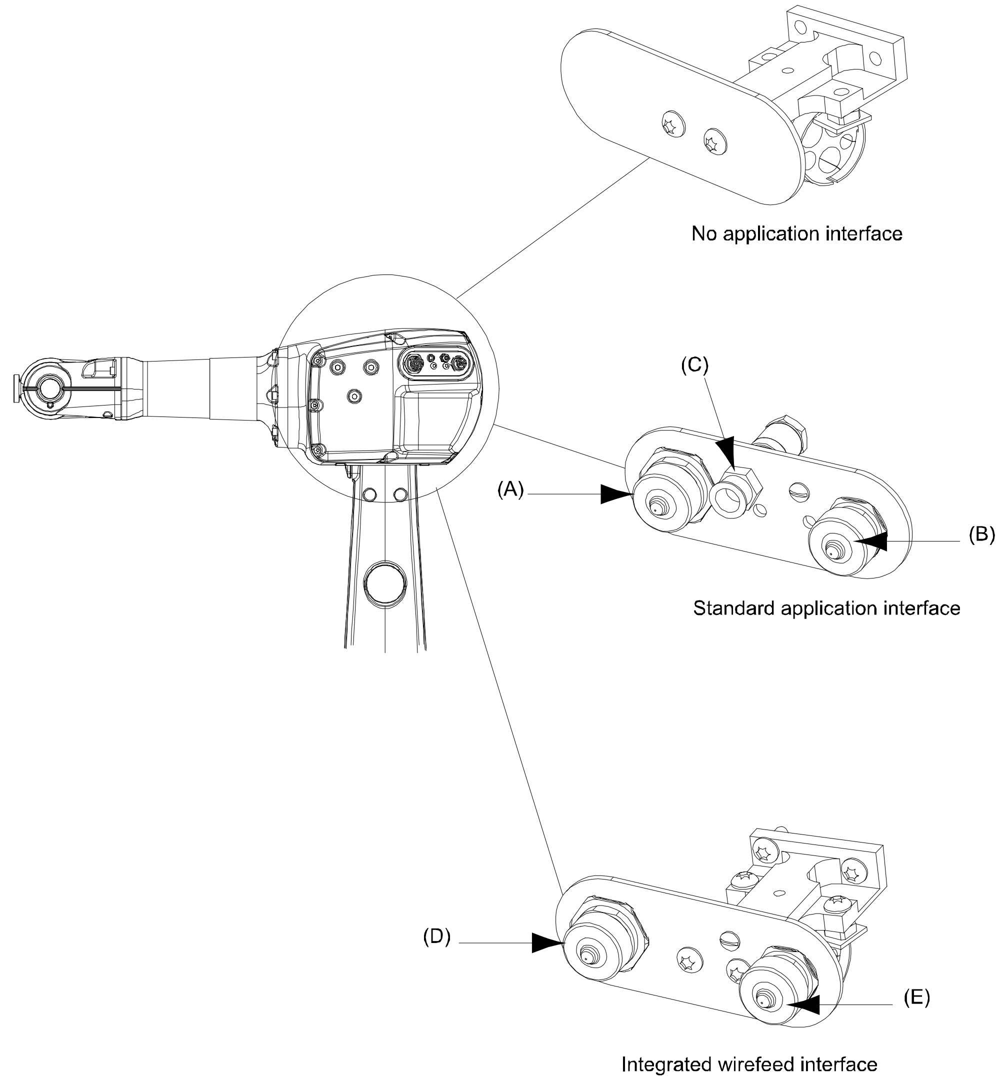
xx1000000921

Connection table

Pos	Connection type	Description
A	R1.MP	Motor power
B	R1.SMB	Serial measurement board signal
C	-	Robot axes brake release buttons
D	R.1 CP/CS	Standard customer power and customer signal
E	R.1Air	Standard air
F	R1.CS	Customer signal for integrated wirefeed interface
G	R1.CP	Customer power for integrated wirefeed interface
H	R1.FB7	Axis 7 connection, 1.5 m cable

Continues on next page

Connections on upper arm



xx1000000922

Pos	Connection type	Description
A	R2.CP	Standard customer power
B	R2.CS	Standard customer signal
C	R2.Air	Standard air
D	R2.CP	Customer power for integrated wirefeed interface
E	R2.CS	Customer signal for integrated wirefeed interface

2.5.2 Robot cabling and connection points

Introduction

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

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 112*.
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. See the product manual for the controller, see document number in *References on page 10*. Also specified in the table *Customer cables (option) on page 114*.
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*, document number in *References on page 10*.

Robot cables

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

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

Continues on next page

Robot cable, power, for robots with standard protection, type A

The following table lists the power cables for connecting IRC5 controller.

Cable (standard in version A)[i]	Art. no.
Robot cable, power: 7 m	3HAC2492-1
Robot cable, power: 15 m	3HAC2529-1
Robot cable, power: 22 m	3HAC2539-1
Robot cable, power: 30 m	3HAC2564-1

i IRB 1600/1660ID in standard protection has two versions, A and B. For details about the robot version, see *Version A and version B of IRB 1600/1660ID on page 375*.

Robot cable, power, for robots with standard protection type B, and with foundry and wash protection

The following table lists the power cables for connecting IRC5 controller

Cable (standard in version B, foundry and wash)[i]	Art. no.
Robot cable, power: 7 m	3HAC9038-1
Robot cable, power: 15 m	3HAC9038-2
Robot cable, power: 22 m	3HAC9038-3
Robot cable, power: 30 m	3HAC9038-4

i IRB 1600/1660ID in standard protection has two versions, A and B. For details about the robot version, see *Version A and version B of IRB 1600/1660ID on page 375*.

Robot cable, signals

The following table lists the power cables for connecting IRC5 controller

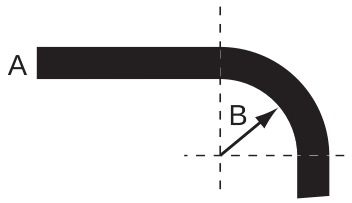
Cable	Art. no.
Robot cable signal, shielded: 7 m	3HAC2493-1
Robot cable signal, shielded: 15 m	3HAC2530-1
Robot cable signal, shielded: 22 m	3HAC2540-1
Robot cable signal, shielded: 30 m	3HAC2566-1

Tip

In case duplicate CP/CS harnesses are included on delivery, one can be saved as a spare part.

Bending radius for static floor cables

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



xx1600002016

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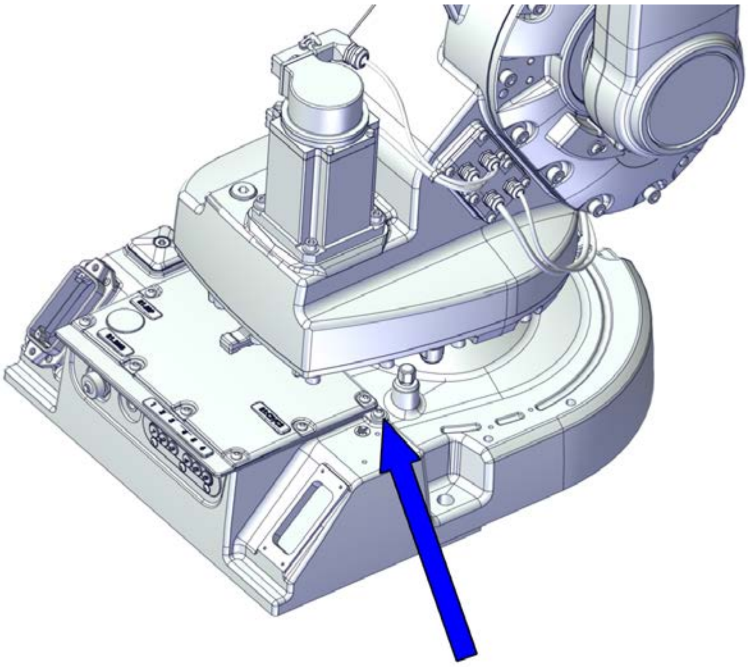
A	Diameter
B	Diameter x10

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.



xx1700000097

Customer cables (option)

The customer cables specified below are connected between robot and controller.

The customer cables are ordered according to current protection class of the robot.

Customer cables for robots with standard protection (IRC5)

Cable (standard)	Art. no.	Connection point, robot
Customer cable, power-signal, 7 m	3HAC3353-1	R1.CP/CS
Customer cable, power-signal, 15 m	3HAC3354-1	R1.CP/CS
Customer cable, power-signal, 22 m	3HAC3355-1	R1.CP/CS
Customer cable, power-signal, 30 m	3HAC3356-1	R1.CP/CS

Customer cables for robots with foundry and wash protection (IRC5)

Cable (Foundry, Wash)	Art. no.	Connection point, robot
Customer cable, power-signal, 7 m	3HAC8183-1	R1.CP/CS
Customer cable, power-signal, 15 m	3HAC8183-2	R1.CP/CS

Continues on next page

Cable (Foundry, Wash)	Art. no.	Connection point, robot
Customer cable, power-signal, 22 m	3HAC8183-3	R1.CP/CS
Customer cable, power-signal, 30 m	3HAC8183-4	R1.CP/CS

2.5.3 Customer connections on the robot

General

For connection of equipment on the robot, there are cables integrated into the robot cabling. This section specifies recommendations for the customer connections.

The air and electrical connectors are shown in the figure *Customer connectors on the robot on page 109*.

Note

The maximum leakage current for attached equipment must not exceed 10mA.

Air connection

Connection	Dimension
Air inlet (at the base)	
Air outlet (at the upper arm housing)	1/4"

The integrated air hose is sized as specified in the table below.

Inner diameter	Max. pressure
8 mm	0.8 MPa / 115 psi

Customer connectors R2.CS and R2.CP

The customer connectors R2.CS and R2.CP can be used with either:

- a connector set from ABB for standard connection
- specified connector components from Souriau, or
- connectors that meet Military standard MIL-C-26482 series 1.

These connectors are further detailed in following sections.

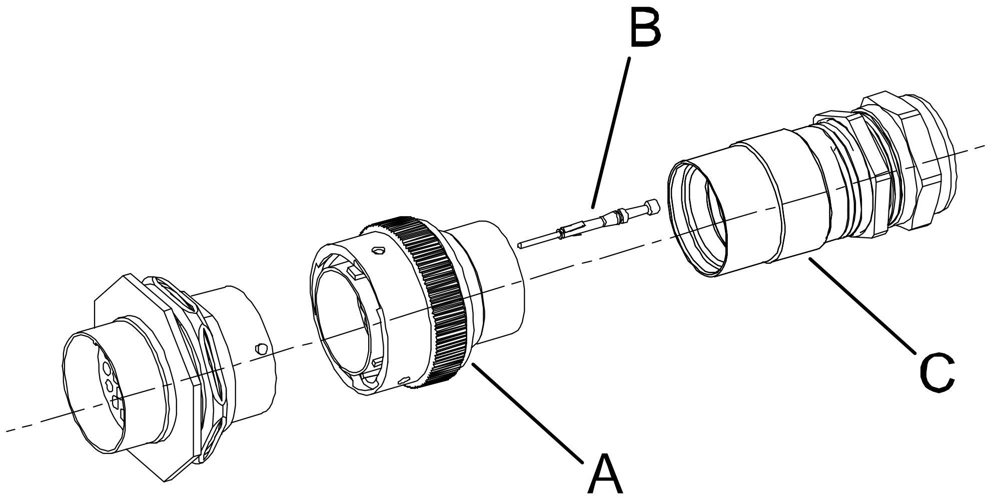
Connector set from ABB for standard connection

Equipment	ABB art. no.	Note
Connection set R2.CP/R2.CS	3HAC025396-001	Only for standard connection.

Continues on next page

Specified connector components from Souriau

The components specified below are from connector manufacturer Souriau and can be used for connection to R2.CS and R2.CP.



xx0400001339

A	Pin connector
B	Pin
C	Backshell

Recommended pin connectors

Pin connector	Souriau art. no.
Pin connector, standard connection, CS (Customer Signal)	UT0W6 1626 P-H
Pin connector, standard connection, CP (Customer Power)	UT0W6 1210 P-H
Pin connector, integrated wirefeeder cabling, CS	UT0W6 1626 P-H
Pin connector, Integrated wirefeeder cabling, CP	UT06 1412 P-H04

Recommended pins (turned)

Turned pins for cable area...	Pin diameter	Souriau art. no.
0.21 - 0.93 mm^2 (standard connection, CP/CS and integrated wirefeeder cabling, CS)	1 mm	RM18W3K
0.13 - 0.25 mm^2 (integrated wirefeeder cabling, CP)	1.6 mm	RM24M9K
0.25 - 0.5 mm^2 (integrated wirefeeder cabling, CP)	1.6 mm	RM20M12K
0.5 - 1.5 mm^2 (integrated wirefeeder cabling, CP)	1.6 mm	RM16M23K

Recommended backshell

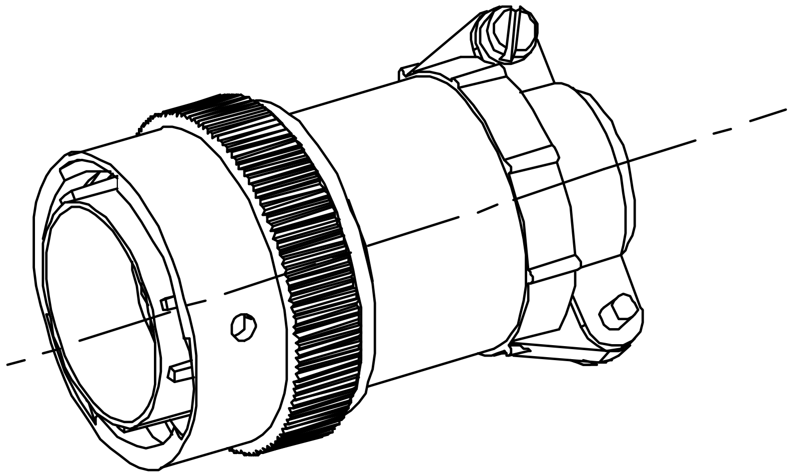
Backshell	Souriau art. no.
Backshell, standard connection, CS	UT0 16JC
Backshell, standard connection, CP	UT0 12JC
Backshell, integrated wirefeeder cabling, CS	UT0 16JC
Backshell, integrated wirefeeder cabling, CP	UT0 14JC

Continues on next page

Connectors that meet Military standard

The connectors specified below meet Millitary standard MIL-C-26482 series 1 and can be used for connection to R2.CS and R2.CP (only for standard customer connection).

The figure below shows a complete connector, including pin connector and backshell.



xx0400001340

Connector for crimping

The complete pin connectors for crimping include pin connector and backshell.

Connector for crimping	Military standard MIL-C-26482
Complete pin connector, CS	MS3126*1626S
Complete pin connector, CP	MS3126*1210S
Turned pin 0.2 - 0.5 mm^2	M39029/31-240
Turned pin 0.5 - 1.5 mm^2	M29029/31-228

Connector for soldering

The complete pin connectors for soldering include pin connector, backshell and pins.

Connector for soldering	Military standard MIL-C-26482
Complete pin connector, CS	MS3116*1626S
Complete pin connector, CP	MS3116*1210S

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.

3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 1600/1660ID.

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

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

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

Safety information

Observe all safety information before conducting any service work.

There are general safety aspects that must be read through, as well as more specific safety information that describes the danger and safety risks when performing the procedures. Read the chapter *Safety on page 21* before performing any service 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 1600/1660ID is connected to power, always make sure that the IRB 1600/1660ID is connected to protective earth and a residual current device (RCD) before starting any maintenance work.

For more information see:

- *Product manual - IRC5*
- *Product manual - IRC5 Compact*
- *Product manual - IRC5 Panel Mounted Controller*
- *Robot cabling and connection points on page 112*.

3.2 Maintenance schedule and expected component life

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 1600/1660ID:

- 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*.

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

3.2.2 Maintenance schedule

General

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

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

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

Maintenance schedule

The table below specifies the required maintenance activities and intervals:

Maintenance activity	Equipment	Interval	Detailed in section
Maintenance free	Gearbox oil, axes 1 to 4 IRB 1600	40,000 hrs	
Inspection	Information labels	12 months	Replace any damaged, missing or unreadable labels. *Inspecting information labels on page 128*
Changing	Gearbox oil, axes 5 and 6 IRB 1600	20,000 hrs	*Changing the oil in axes 5 and 6 gearboxes on page 131*.
Changing	Gearbox oil, axes 5-6 IRB 1600ID-4/1.5	20,000 hrs	*Changing the oil in axis 5-6 gearbox, IRB 1600ID/1660ID on page 134*
Changing	Gearbox oil, axes 5-6 IRB 1660ID-X/1.55	20,000 hrs	*Changing the oil in axis 5-6 gearbox, IRB 1600ID/1660ID on page 134*
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [i]	*Replacing the battery pack on page 137*
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [ii]	*Replacing the battery pack on page 137*.
Cleaning	Complete robot	Regular [iii]	*Cleaning the IRB 1600/1660ID on page 142*

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

See the replacement instruction for more details.

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

iii A regular interval implies that the activity is to be performed regularly, but the actual interval may not be specified by the robot manufacturer. The interval depends on the operation cycle of the robot, its working environment and movement pattern. Generally, the more contaminated environment, the closer the intervals. The more demanding movement pattern (sharper bending cable harness), the closer the intervals.

3.2.3 Expected component life

General

The life of any component depends on how hard it is run, and it can vary greatly.

Expected component life

Component	Expected life	Note
Robot cable harness IRB 1600	2,000,000 cycles	See note [i]
Robot cable harness IRB 1600ID-4/1.5	2,000,000 cycles	See note [i]
Robot cable harness IRB 1660ID-X/1.55	2,000,000 cycles	See note [i]
Cabling for position switch	2,000,000 cycles	See note [i]
Gearbox	40,000 hrs	

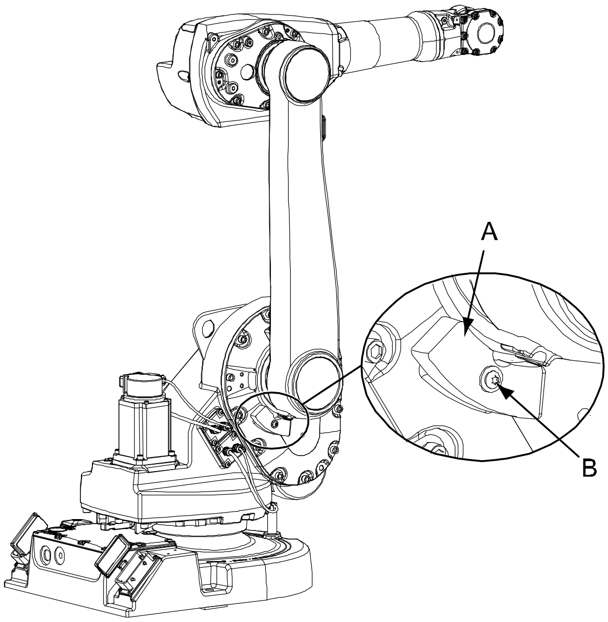
i The expected life can also be affected by grouping harnesses/cables other than standard options. The life expectancy is based on a test cycle that for every axis goes from the calibration position to minimum angle, to maximum angle and back to the calibration position. Deviations from this test cycle will result in differences in expected life!

3.3 Inspection activities

3.3.1 Inspection, damper axes 2, 3 and 5

Location of dampers

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



xx0400001217

A	Damper, axis 2
B	Attachment screw

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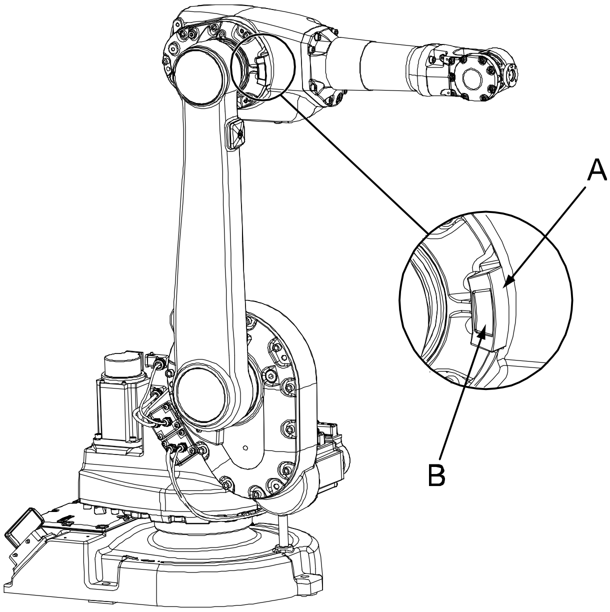
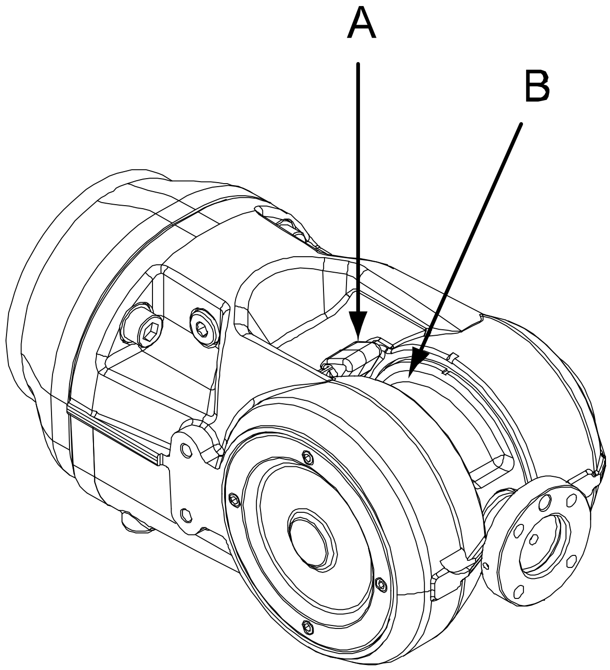


xx0400001215

A	Damper, axis 3
B	Cast tab



xx0600002806

A	Damper, axis 5
B	Recess

Continues on next page

Required equipment

Equipment	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Inspection, dampers

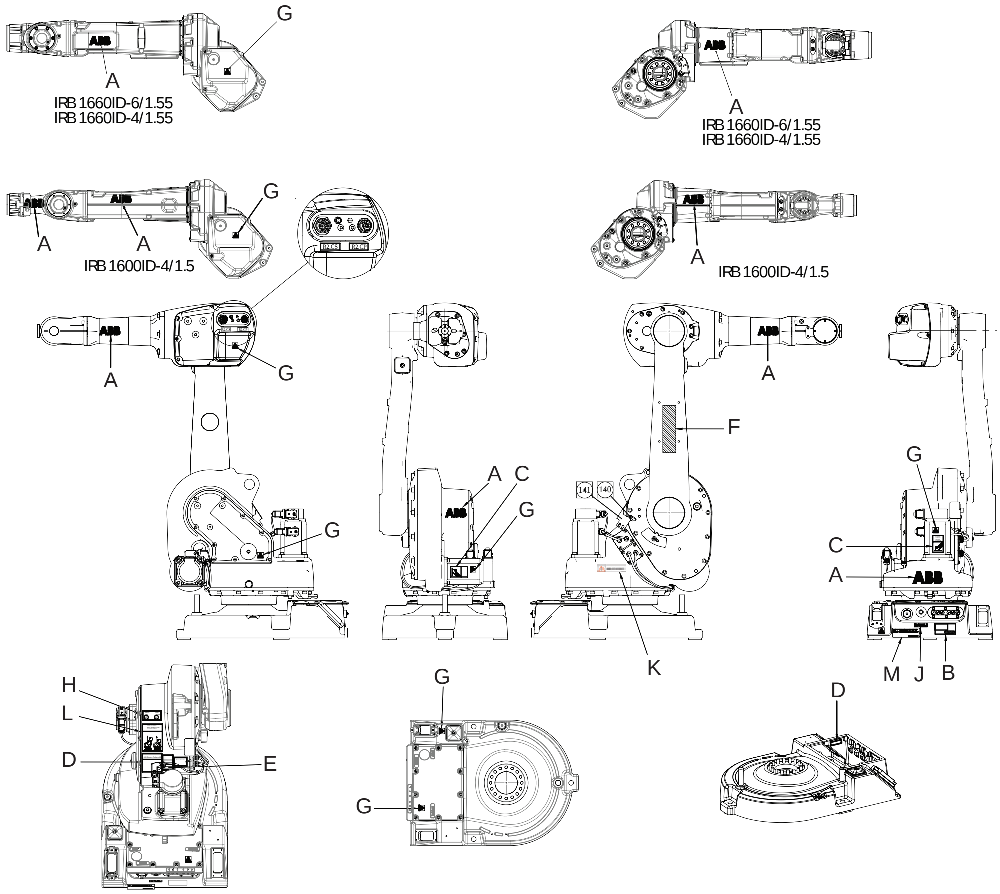
The procedure below details how to inspect the dampers.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Check all *dampers* for damage, such as cracks or existing impressions that are larger than 1 mm.	Shown in the figure *Location of dampers on page 125*.
3	Check attachment screws for deformation.	
4	If any damage is detected, the damper must be replaced with a new one!	Replacement is detailed in sections: • *Replacing the damper, axis 2 on page 214* • *Replacing the damper, axis 3 on page 216* • *Replacement of damper, axis 5 on page 220*.

3.3.2 Inspecting information labels

Location of information labels

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



xx1800001187

A	ABB logotype
B	Warning label - Brake release
C	Warning label - heat (2 pcs)
D	Rating label
E	Calibration label
F	Foundry Plus or CleanRoom logotype, if applicable.
G	Warning label - Electricity (symbol of flash) (6 pcs)
H	UL label
J	Label - Max. air pressure
K	Information sign - AbsAcc
L	Lifting instruction label
M	Oil label

Continues on next page

Required equipment

Equipment	Spare part number	Note
Labels	See *Spare part lists on page 389*.	

Inspecting labels

Use this procedure to inspect the labels on the robot.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Check all labels.	See the figure in *Location of information labels on page 128*.
3	Replace any missing or damaged labels.	

3.4 Replacement 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.

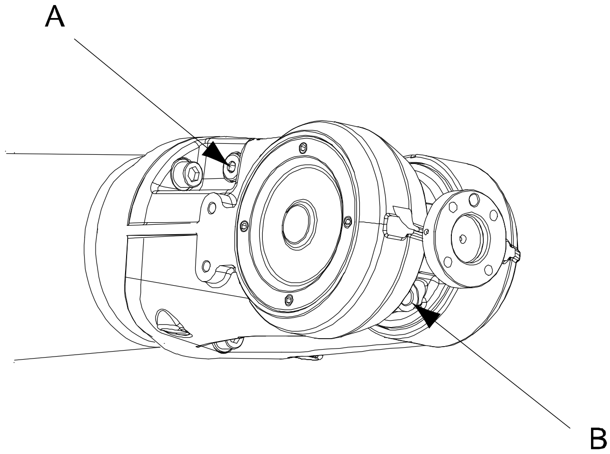
Equipment

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 the oil in axes 5 and 6 gearboxes

Location of oil plugs

The gearboxes for axes 5 and 6 are located in the wrist unit as shown in the figure below.



xx0600002846

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

Required equipment

Equipment, etc.	Note
Lubricating oil	Information about the oil is found in *Technical reference manual - Lubrication in gearboxes*. See *Type and amount of oil in gearboxes on page 130*.
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Standard toolkit	Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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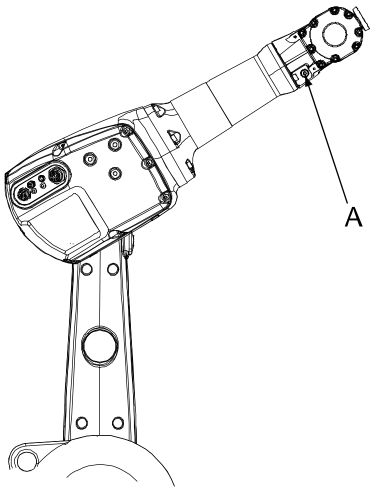
Draining, wrist unit

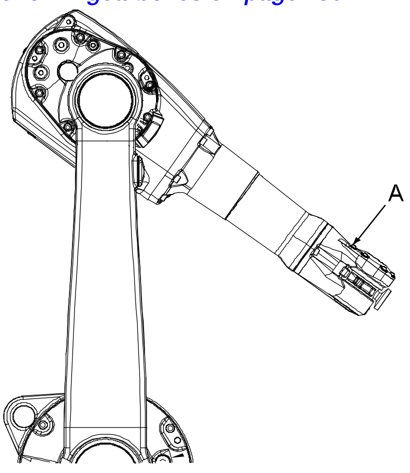
The procedure below details how to drain oil from the gearboxes in the wrist unit.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
3	Position the robot as shown in the figure to the right: • upper arm: upwards for a standing robot • axis 4: 180º, to a position where the oil plug (A), faces downwards. **Note!** The total amount of oil will not be drained. There will remain approximately 50 ml in the wrist unit.	The capacity of the vessel must be sufficient to take the complete amount of oil.  xx0500001434 A Oil plug, draining and filling The position for an *inverted robot* is the opposite!
4	Remove the both *oil plugs*. Both oil plugs must be removed in order to drain the wrist unit properly.	Shown in the figure *Location of oil plugs on page 131*.
5	Refit the oil plug, vent hole.	

Continues on next page

Filling oil, wrist unit

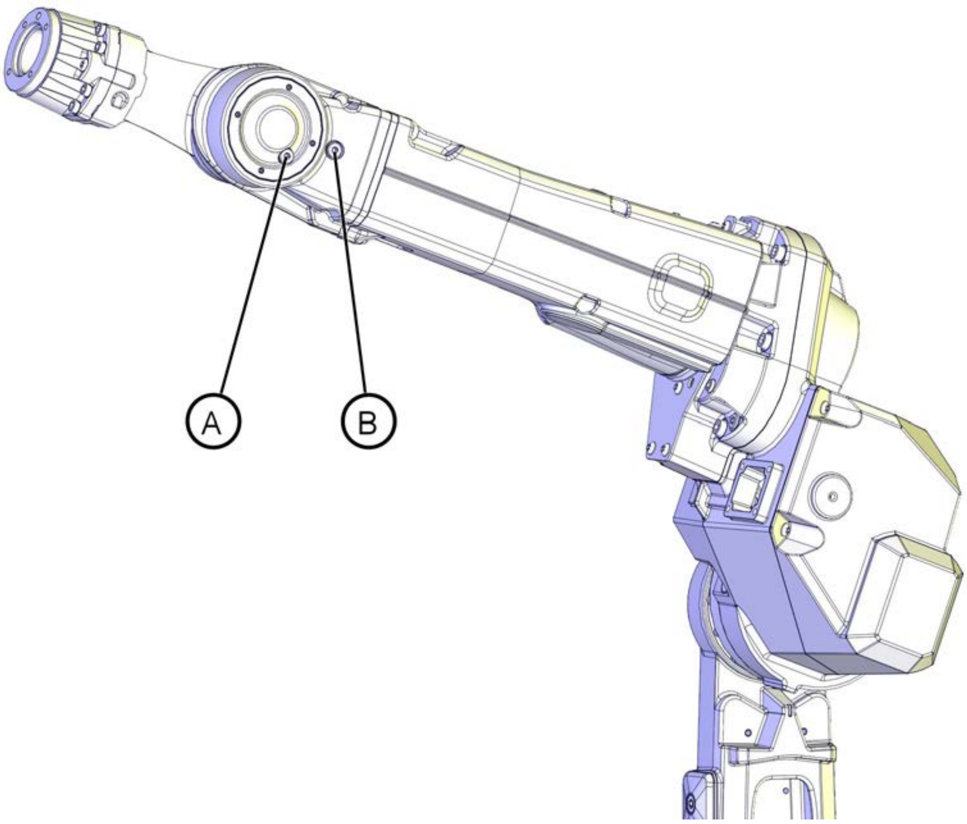
The procedure below details how to fill oil in the gearboxes in the wrist unit.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
3	Remove the *oil plug, draining and filling.*	Shown in the figure *Location of oil plugs on page 131*!
4	Position the robot as shown in the figure to the right: • upper arm: downwards for a standing robot • axis 4: 90º, to a position where the oil plug (A), faces upwards. Fill oil in the wrist unit through the oil plug.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 130*.  xx0500001435 • A: Oil plug, draining and filling The position for an *inverted robot* is the opposite.
5	Refit the oil plug.	

3.4.3 Changing the oil in axis 5-6 gearbox, IRB 1600ID/1660ID

Location of oil plugs, axis 5-6 gearbox

The oil plugs for the axis 5-6 gearbox are located in the wrist unit as shown in the figure below.



xx1100000343

A	Oil plug, draining and filling
B	Ventilation plug

Required equipment

Equipment	Note
Lubricating oil	Information about the oil is found in *Technical reference manual - Lubrication in gearboxes*. See *Type and amount of oil in gearboxes on page 130*.
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Standard toolkit	Content is defined in section *Standard tools on page 385*.
Other tools and procedures may be required.	See references to these procedures in the step-by-step instructions below.

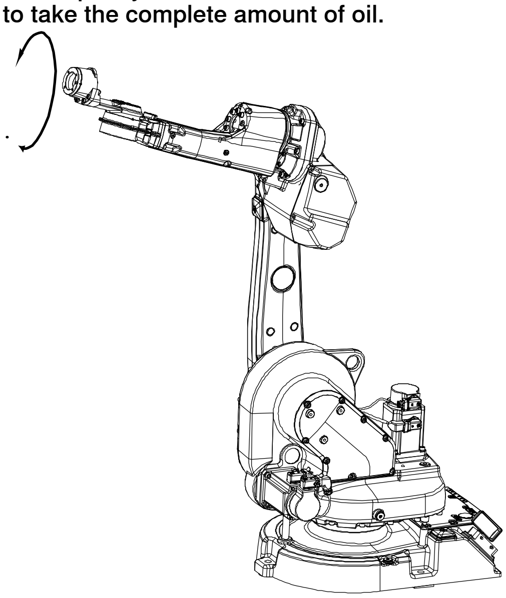
Continues on next page

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Draining, axis 5-6 gearbox

Use this procedure to drain the axis 5-6 gearbox.

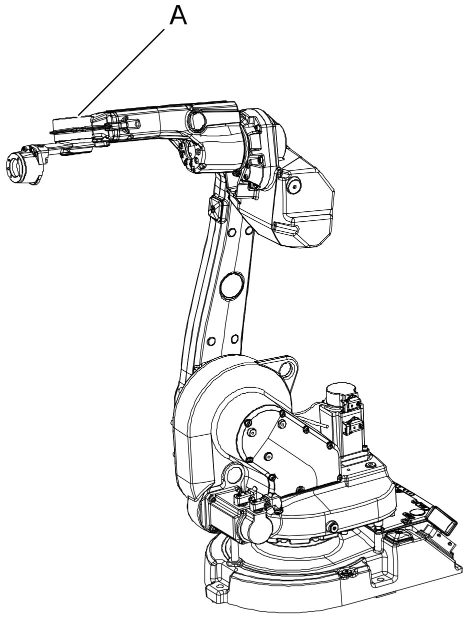
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
3	Position the robot as shown in the figure to the right: • upper arm: upwards for a standing robot. • axis 4: - 90º, to a position where the oil plug (A) is faced downwards. **Note** The total amount of oil will not be drained. There will remain approximately 20 ml in the wrist unit.	The capacity of the vessel must be sufficient to take the complete amount of oil.  xx0700000033
4	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	

Continues on next page

	Action	Note
5	Remove the oil plug (A) and the ventilation plug (B).	Shown in figure *Location of oil plugs, axis 5-6 gearbox on page 134*.
6	Drain the wrist of oil.	The quantity of the oil: • 1660ID: About 240 ml • 1600ID: About 100 ml
7	Refit the oil plugs.	Tightening torque: 3.8 Nm.

Filling oil, axis 5-6 gearbox

Use this procedure to fill the axis 5-6 gearbox with oil.

	Action	Note
1	Position the robot as shown in the figure to the right: • axis 4: + 90º, to a position where the oil plug (A) is faced upwards.	 xx0700000034 A Oil plugs
2	Fill new oil in the wrist. Check the oil level to make sure the filled amount of oil is correct.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 130*.
3	Refit the oil plug and the ventilation plug.	Tightening torque: 3.8 Nm.

3.4.4 Replacing the battery pack

Note

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

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

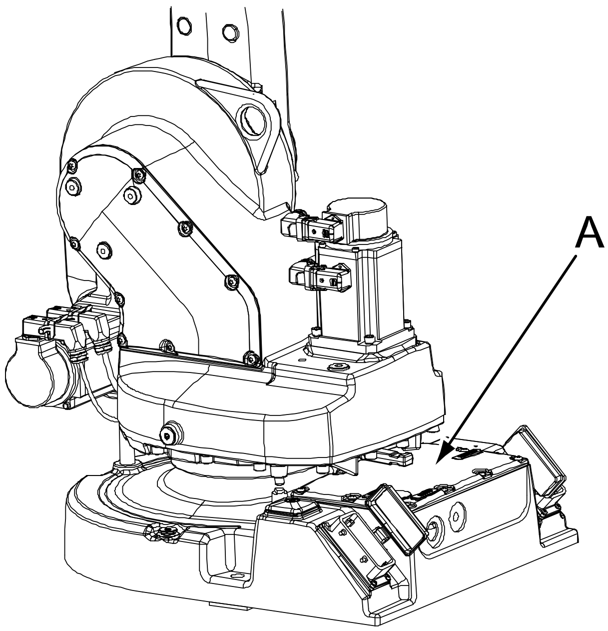
For an SMB board with 2-pole battery contact, the typical lifetime of a new battery is 36 months if the robot is powered off 2 days/week or 18 months if the robot is powered off 16 h/day. The lifetime can be extended for longer production breaks with a battery shutdown service routine. See the operating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

WARNING

See *Hazards related to batteries on page 38*.

Location of battery pack

The battery pack for the measurement system is located inside the base of the robot, as shown in the figure below.



xx0500001390

A	Base cover, including gasket. Battery pack is located beneath the cover.

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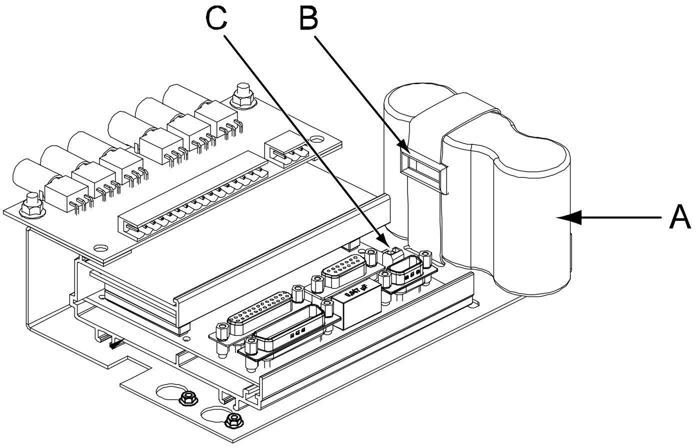
Battery pack on serial measurement unit

The battery pack is attached to the serial measurement unit as shown in the figure below.

DSQC 633A

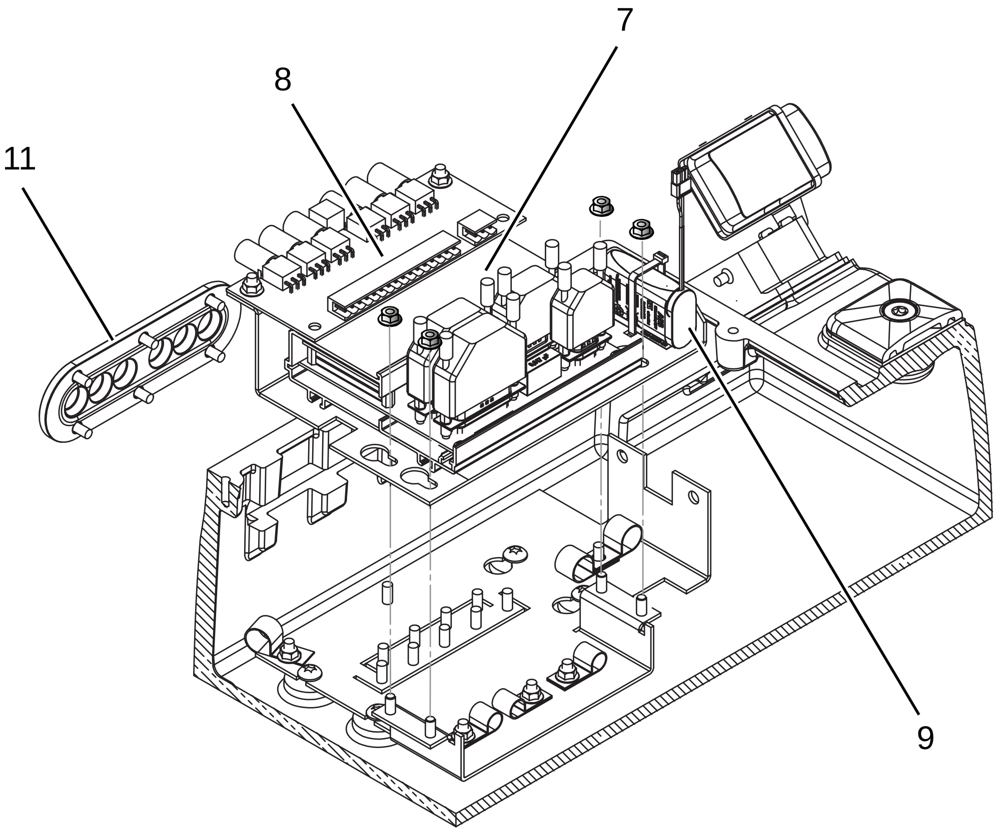


xx0500001393

A	Battery pack battery (2-pole battery contact)
B	Velcro strap
C	Connector X3

Continues on next page

RMU 101



xx1300000332

7	Serial measurement board RMU 101
8	BU unit
9	Battery pack (3-pole battery contact)
10	Push button guard

Required equipment

Note

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

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

Equipment	Spare part no.	Note
Serial measurement board	See *Spare part lists on page 389*.	
Battery pack	See *Spare part lists on page 389*.	
Gasket, base cover	3HAC 022047-001	Replace if damaged.

Continues on next page

Equipment	Spare part no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
Circuit diagram	-	See chapter *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Replacement, battery pack

The procedure below details how to replace the battery pack.

	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	Remove the *base cover* from the robot 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. **CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	See *Location of battery pack on page 137*.
3	Disconnect the battery from the serial measurement unit.	
4	**Valid for battery pack with 2-pole battery contact:** Open the velcro strap and remove the battery pack.	
5	**Valid for battery pack with 3-pole battery contact.** Cut the cable strap and remove the battery pack.	
6	Fit the new *battery pack* and connect it to the serial measurement unit (X3).	See *Battery pack on serial measurement unit on page 138*.

Continues on next page

	Action	Note
7	**Valid for battery pack with 2-pole battery contact:** Close the velcro strap around the battery pack.	
8	**Valid for battery pack with 3-pole battery contact.** Secure the battery with a cable strap.	
9	Check the base cover *gasket*, replace if damaged.	Spare part no. is specified in *Required equipment on page 139*.
10	Refit the *base cover* to the robot.	See *Location of battery pack on page 137*.
11	Update the revolution counters.	Detailed in section *Updating revolution counters on page 342*..

3.5 Cleaning activities

3.5.1 Cleaning the IRB 1600/1660ID

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 1600/1660ID 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 1600/1660ID.

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 125*.
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.

Note

Rinsing with water is not allowed for a robot with integrated dressing (ID variants).

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

i Perform according to section *Cleaning with water and steam on page 144*.

ii Perform according to section *Cleaning with water and steam on page 144*.

Wiping with cloth

Additional cleaning instructions for Clean Room robots

ABB robots with protection types *Clean Room* are designed to be cleaned at a low cleaning frequency, before entering the cleanroom environment, after robot commissioning or during cleanroom maintenance.

Wipe-down cleaning method is recommended. Robot surfaces shall be wiped with clean and low particle emission cleanroom cloth which is soaked in 70% ethanol
.

Use the following procedure to clean Clean Room robots:

1. Before cleaning, use the lint free cloth to remove dirt, debris or any other contaminant from the to-be cleaned surfaces.
   - Make sure no visible residues left.

Continues on next page

- Never apply hard forces on or rub against the robot surfaces to remove dirt or debris; otherwise, protective paint layers may be damaged.

2 Wet a clean cloth with the cleaning detergent and then wipe the robot painting surfaces.
- Make sure no cleaning agents are sprayed onto robot surfaces or into the robot structure.
- Wipe from the surface center to edge and always in the same direction.

3 Wait a few minutes for detergent volatilization.
- Make sure no residue of cleaning agents left on the robot surfaces after wipe down cleaning.

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

Cables

Movable cables need to be able to move freely:

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

1 See *Cleaning methods on page 143* for exceptions.

2 See *Cleaning methods on page 143* for exceptions.

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes repair activities for the IRB 1600/1660ID. 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 1600/1660ID, 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 21* before commencing any service work.

Note

If the IRB 1600/1660ID is connected to power, always make sure that the IRB 1600/1660ID is connected to protective earth and a residual current device (RCD) before starting any repair work.

For more information see:

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

4.2 General procedures

4.2.1 Performing a leak-down test

When to perform a leak-down test

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

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
Grease	3HAC042536-001	Shell Gadus S2 Used to grease the bearings, if not specified otherwise.

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.

Continues on next page

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

- The bearings must not be completely filled with grease. However, if space is available beside the bearing fitting, the bearing may be totally filled with grease when mounted, as excessive grease will be pressed out from the bearing when the robot is started.
- 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
Grease	3HAC042536-001	Shell Gadus S2

Rotating sealings

The following procedures describe how to fit rotating sealings.

CAUTION

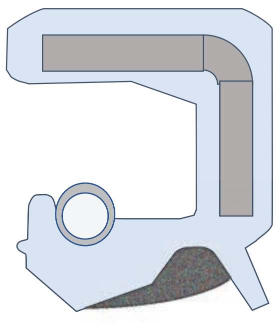
Please observe the following before commencing any assembly of sealings:

- 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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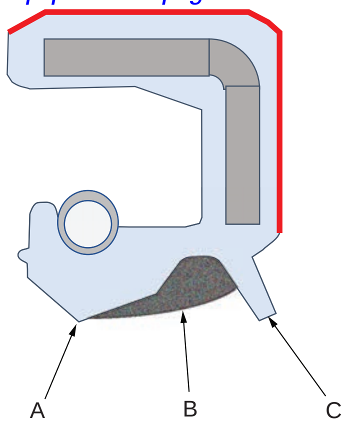
	Action	Note
1	Check the sealing to ensure that: • The sealing is of the correct type. • There is no damage on the main lip.	
2	Inspect the shaft surface before mounting. If scratches or damage are found, the shaft must be replaced since it may result in future leakage. Do not try to grind or polish the 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 149*.  xx2000000071 A Main lip B Grease C Dust lip **Note** Ensure that no grease is applied to the red marked surface.

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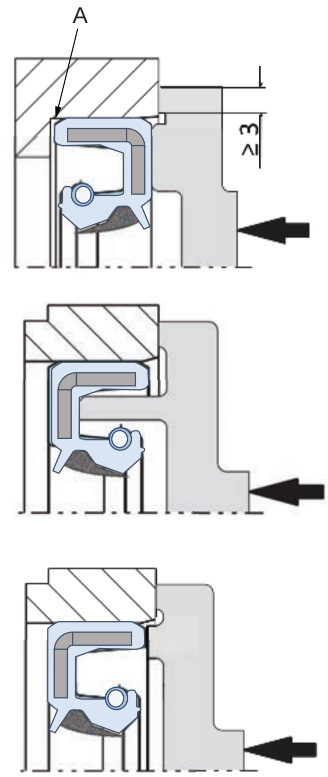
	Action	Note
4	Mount the sealing correctly with a mounting tool. Never hammer directly on the sealing as this may result in leakage.	 xx2000000072 A Gap
5	Make sure that no grease is left on the robot surface.	

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.	
7	Make sure that no grease is left on the robot surface.	

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.

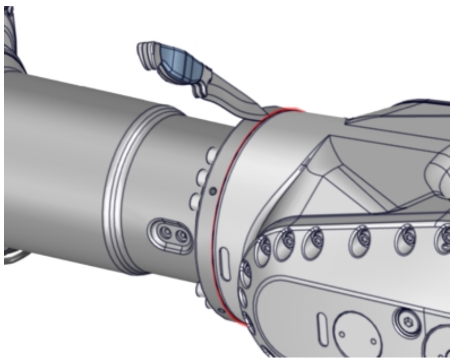
For robots with protection type Clean Room

When replacing parts on the robot, it is important to make sure that after the replacement, no particles will be emitted from the joint between the structure and the new part, and that the easy cleaned surface is retained.

Required equipment

Equipment	Spare parts	Note
Sealing compound	3HAC026759-001	Sikaflex 521 FC. Color white.
Tooling pin		Width 6-9 mm, made of wood.
Cleaning agent		Ethanol
Knife		
Lint free cloth		
Touch up paint Clean Room/Hygienic	3HAC036639-001	White
Touch up paint Standard/Foundry Plus	3HAC067974-001	Graphite White
Touch up paint Standard/Foundry Plus	3HAC037052-001	ABB Orange

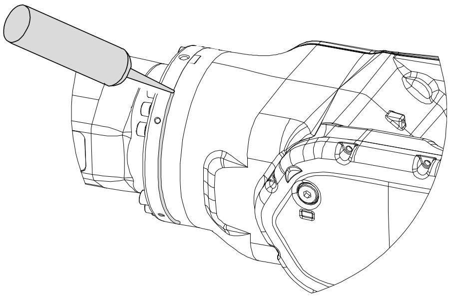
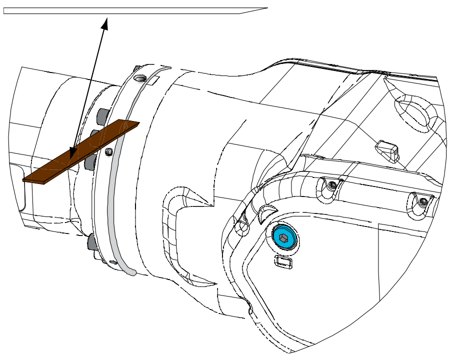
Removing

	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.	

Refitting

	Action	Description
1	Before the parts are refitted, clean the joint so that it is free from oil and grease.	Use ethanol on a lint free cloth.

Continues on next page

	Action	Description
2	Place the tooling pin in hot water.	
3	Seal all refitted joints with sealing compound.	 xx0900000122
4	Use the tooling pin to even out the surface of the sealing compound.	 xx0900000125
5	**For robots with protection type Clean Room** Wait 10 minutes.	**For robots with protection type Clean Room** Sikaflex 521FC skin dry time (10 minutes).
6	Use Touch up paint Clean Room/Hygienic, white to paint any damaged surfaces. **Note** Always read the instruction in the product data sheet in the paint repair kit for Clean Room/Hygienic.	3HAC036639-001

Note

After all repair work, wipe the robot free from particles with spirit on a lint free cloth.

4.2.5 The brake release buttons may be jammed after service work

Description

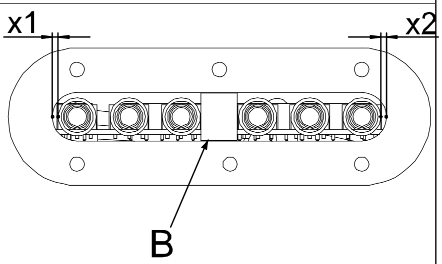
The brake release unit has push-buttons for the brake release of each axis motor. When service work is performed inside the SMB recess that includes removal and refitting of the brake release unit, the brake release buttons may be jammed after refitting.

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	Note
1	Make sure the power is turned off.	
2	Refit the push button guard, if removed.	
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 by the push button guard.	
4	If a button gets jammed in the depressed position, the alignment of the push button unit must be adjusted so that the buttons can move freely. Remove the push button guard and: • Make sure the centering piece (B) is properly fitted to the unit. (The piece aligns the unit vertically.) • Adjust the unit sideways so that the measurements x1 and x2 in the figure to the right do not differ more than 1 mm from each other.	xx0600002777 Article number for the centering piece is specified in *Required equipment on page 248*.
5	Refit the push button guard and check the buttons again by pressing them down, one by one.	

4.3 Complete manipulator

4.3.1 Replacing the cable harness, IRB 1600

Location of cable harness

The cable harness is run through the robot from the base to the upper arm housing. The location of the harness is shown in several figures, next to the procedures, later on in this section.

Views of the cable harness may also be found in the chapter *Spare part lists on page 389*.

Required equipment

Equipment	Spare part no.	Note
Cable harness IRB 1600/1.45	3HAC 021827-001	No application interface.
Cable harness IRB 1600/1.45, Customer connections	3HAC 021828-001	
Cable harness IRB 1600/1.45, Wire feeder	3HAC 021830-001	
Cable harness IRB 1600/1.2, Customer connections	3HAC 021828-003	
Gasket, upper arm cover	3HAC022049-001	Replace if damaged.
Gasket, customer connections	3HAC022050-001	Replace if damaged.
Gasket, base cover	3HAC 022047-001	Replace if damaged.
Gasket, gearbox axis 1-2	3HAC022048-001	Replace if damaged.
VK-cover	3HAA 2166-23	Upper and lower covers. 2 pcs
VK-cover	3HAA 2166-21	Middle cover.
Cable ties		
Centering piece	3HAC025815-001	Fitted to the push button unit in order to align it correctly. Replace if damaged.
Standard toolkit		Content is defined in section *Standard tools on page 385*.
Circuit diagram		See chapter *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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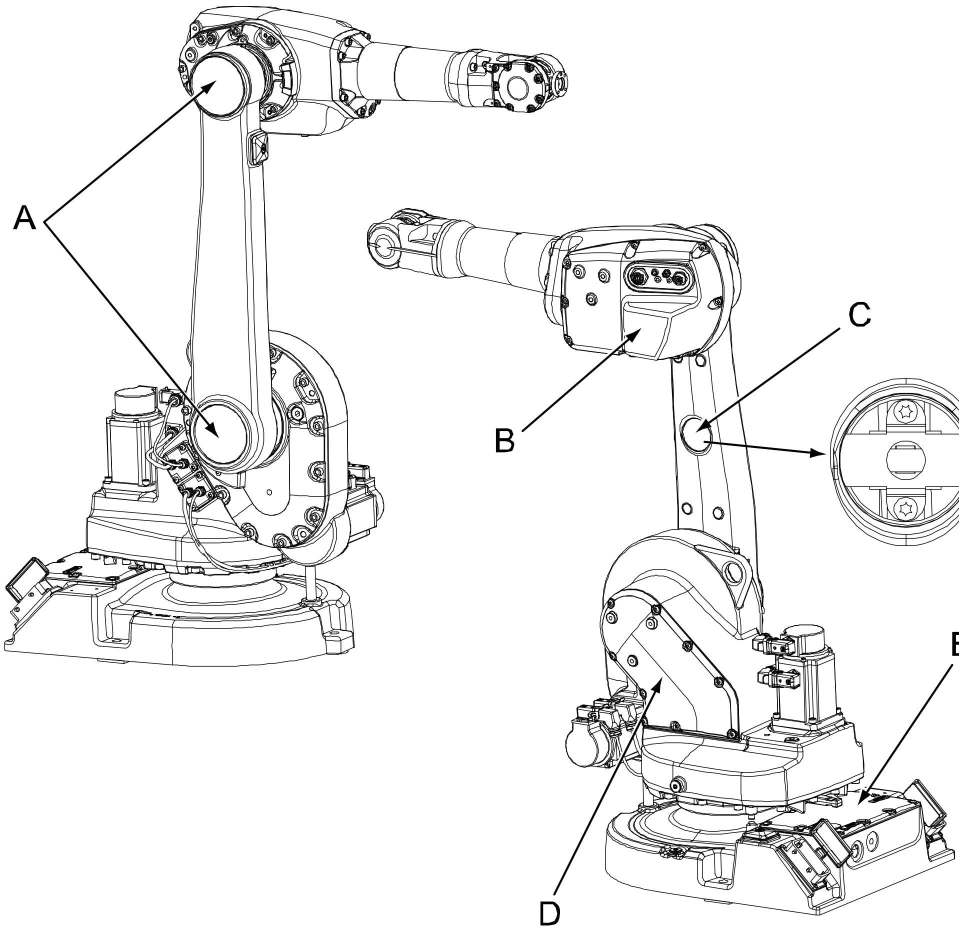
Illustration, covers to remove

The figure below shows all the covers that must be removed from the robot in order to get access to the cable harness and all the brackets.



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A	Upper and lower VK-cover
B	Arm housing cover, with gaskets
C	VK-cover (also shown with the cover removed)
D	Cover, frame, with gasket
E	Base cover, with gasket

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.

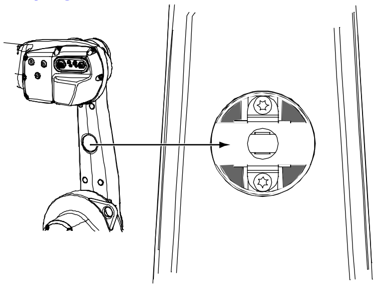
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is 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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, cable harness

The procedure below details how to remove the complete cable harness from the robot.

	Action	Note/Illustration
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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

Continues on next page

	Action	Note/Illustration
3	Remove all the covers: • Remove the covers of the upper arm housing, frame and base. • Push out the upper and lower VK-cover from the inside. • Remove the middle VK-cover from the lower arm. **Caution!** Be careful not to damage the cabling and cable bracket inside the lower arm when removing the middle VK-cover! The figure to the right shows the space underneath the cover. The gray areas are safe for insertion of a tool that may be inserted with a maximum depth of 20 mm!	All the covers are shown in the figure *Illustration, covers to remove on page 157*.  xx0400001247
4	The cable bracket inside the lower arm is attached to the cable harness. Move the bracket to the new cabling.	
5	Disconnect all the connectors inside the upper arm housing.	Shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
6	Remove all cable ties, clamps and brackets inside the upper arm housing.	Attachment points inside the upper arm housing are shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
7	Disconnect all the connectors inside the frame.	Shown in the figure *Illustration, cabling inside frame on page 162*.
8	Remove the fastening plate, all cable ties and brackets from inside the frame. Remove the cable clamp unit from the fastening plate.	Attachment points inside the frame are shown in the figure *Illustration, cabling inside frame on page 162*.
9	Disconnect all the connectors at the base and remove the *SMB unit* from the base. **Note!** Do not lose the centering piece fitted to the push button unit!	Shown in the figure *Illustration, cabling inside base on page 163*.
10	Remove all cable ties and brackets at the base.	Shown in the figure *Illustration, cabling inside base on page 163*.
11	Pull out the cabling from the upper arm housing and pull it down through the lower arm.	
12	Continue pulling down the cable harness through the frame and pull it out at the rear of the base.	

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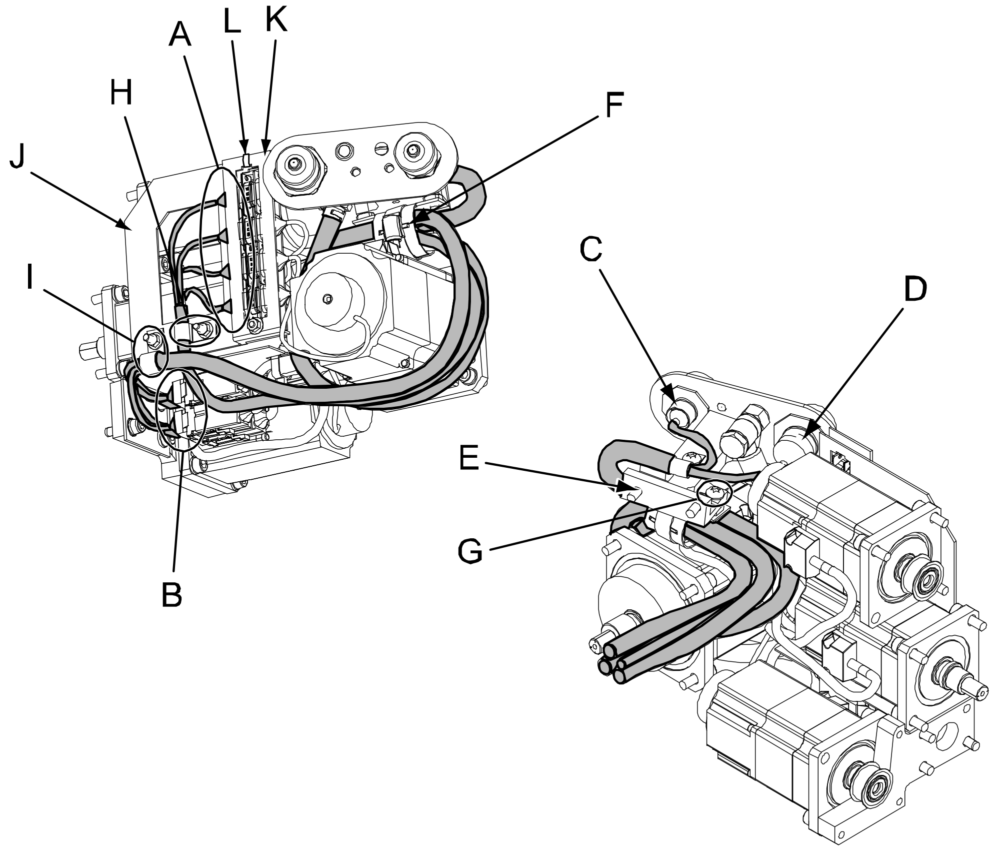
Illustration, cabling inside upper arm housing

The figure below shows how the cabling is run inside the upper arm housing.



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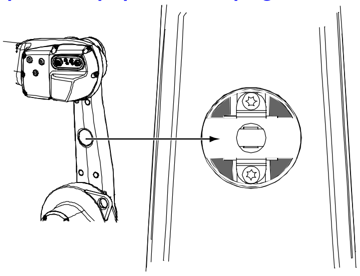
A	Signal cabling; connectors for motors on axes 3, 4, 5 and 6: R3.FB3, R3.FB4, R3.FB5 and R3.FB6
B	Power cabling; connectors for motors on axes 3, 4, 5 and 6: R3.MP3, R3.MP4, R3.MP5 and R3.MP6
C	Optional connector: R2.CP
D	Optional connector: R2.CS
E	Distance console with contact panel
F	Cable clamp unit
G	Attachment screws, cable clamp unit (2 pcs, only one shown)
H	Clamp, signal cabling
I	Clamp, motor cabling
J	Connector plate
K	Connector holder
L	Cable tie, connector holder

Continues on next page

Refitting, cable harness in upper arm housing and lower arm

The procedure below details how to refit the cabling inside the upper arm housing. The cable layout is shown in the figure *Illustration, cabling inside upper arm housing on page 160*.

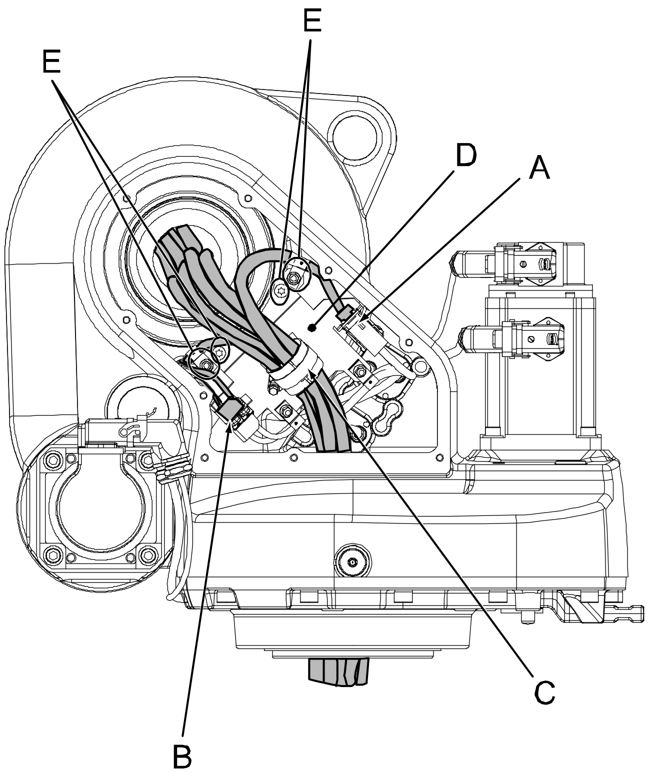
	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Insert the cabling to axes 3, 4, 5 and 6 up through the lower arm and into the upper arm housing.	
3	Place the cable bracket correctly inside the lower arm and secure it by refitting the *VK-cover*.	Spare part no. is specified in *Required equipment on page 156*.  xx0400001247 Cable bracket is attached to the cabling with 2 screws, M6x8.
4	Fasten the cabling inside the upper arm housing by fitting the *cable clamp unit* to the *distance console* with two *attachment screws*.	Shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
5	Fit the motor and signal cabling to the *connector plate* with *clamps*.	Hexagon nut: M5. 1 pc for each clamp.
6	Reconnect the signal cable connectors and slide them into the *connector holder*. Notice that one of the cable ties in the connector holder plate must be removed in order to insert the cables into the holder. Refit it when the connectors are inserted.	Shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
7	Reconnect the motor cable connectors.	
8	Reconnect optional connectors, if any, at the contact panel.	
9	Place the cabling correctly inside the housing and secure it with cable ties.	The cable layout is shown in the figure *Illustration, cabling inside upper arm housing on page 160*.

Continues on next page

	Action	Note/Illustration
10	Refit the *arm housing cover* with eight attachment screws. Check the two *gaskets* and replace, if damaged.	8 pcs, M6. Shown in the figure *Illustration, covers to remove on page 157*. Spare part no. is specified in *Required equipment on page 156*.
11	Fit new *VK-covers* to the lower arm.	Spare part no. is specified in *Required equipment on page 156*.
12	Continue refitting the cable harness according to procedure *Refitting, cable harness in frame and base on page 164*.	

Illustration, cabling inside frame

The figure below shows how the cabling is run inside the frame.



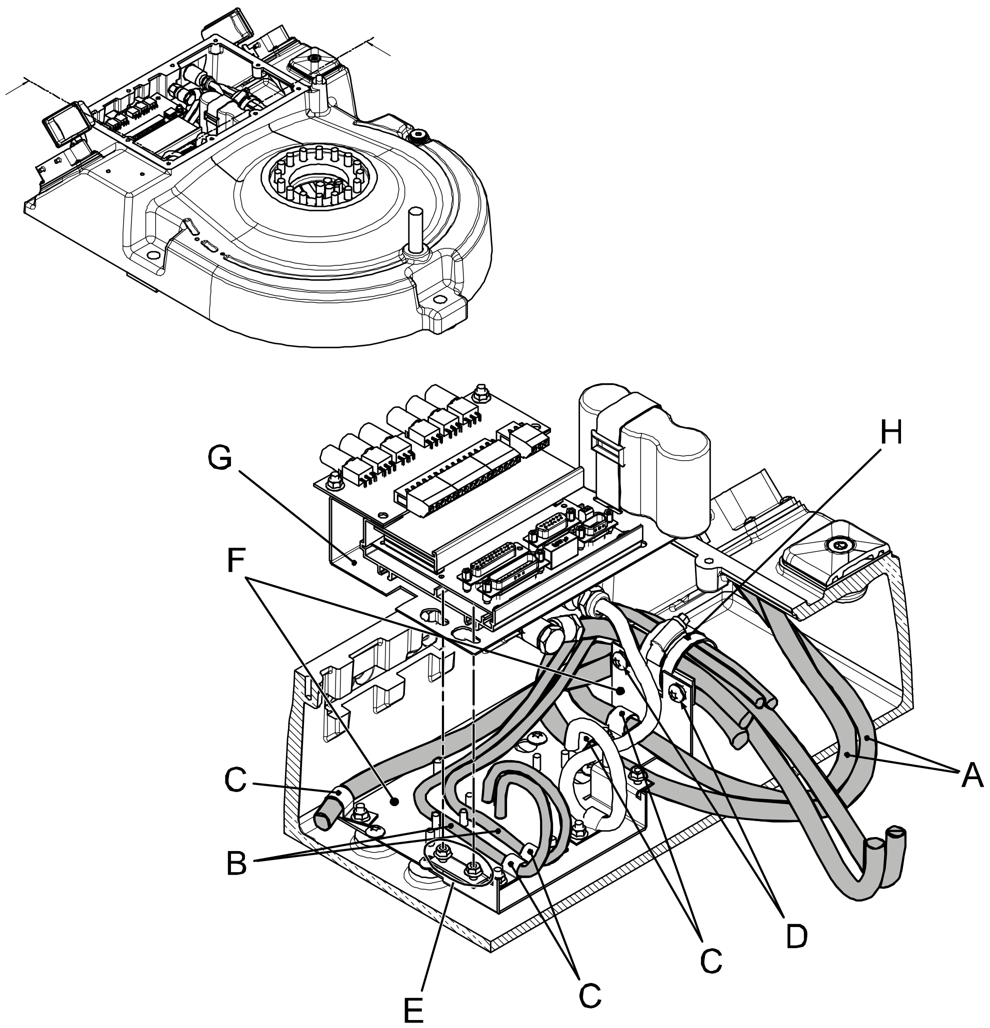
xx0400001249

A	Power cabling; connectors for motors on axes 1 and 2: R3.MP1 and R3.MP2
B	Signal cabling; connectors for motors on axes 1 and 2: R3.FB1 and R3.FB2
C	Cable clamp unit (attachment screws behind the fastening plate)
D	Fastening plate
E	Attachment screws and nuts

Continues on next page

Illustration, cabling inside base

The figure below shows how the cabling is run inside the base. Optional cabling is also shown in the figure, but not further specified.



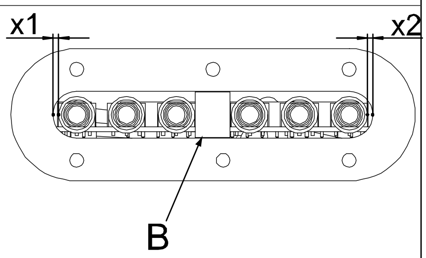
xx0500001388

A	Power cabling
B	Signal cabling
C	Clamp with hexagon nut
D	Attachment screws, cable clamp unit
E	Hexagon nut, SMB plate
F	Fastening plate
G	SMB unit
H	Cable clamp unit

Continues on next page

Refitting, cable harness in frame and base

The procedure below details how to refit the cabling inside the frame and the base. The cable layout is shown in the figures *Illustration, cabling inside frame on page 162* and *Illustration, cabling inside base on page 163*.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Run the cables from the lower arm into the frame.	
3	Fit the *cable clamp unit* to the *fastening plate* with two attachment screws, but do not secure the plate to the frame yet.	Shown in the figure *Illustration, cabling inside frame on page 162*.
4	Run the cabling down to the base. Pull it out at the rear of the base.	
5	Connect all the connectors inside the frame and secure all plates and cable brackets inside the frame with *attachment screws and nuts*.	Shown in the figure *Illustration, cabling inside frame on page 162*.
6	In the base, secure the cabling to the bottom *fastening plate*: • fit the *cable clamp unit* with two *attachment screws* (M6). • fit the separate cables with *clamps and hexagon nuts*.	Shown in the figure *Illustration, cabling inside base on page 163*.
7	Refit the *SMB unit* to the fastening plate with hexagon nuts.	Shown in the figure *Illustration, cabling inside base on page 163*.
8	Refit the centering piece (B) to the push button unit in order to align it vertically. Also make sure that the unit is correctly aligned sideways: the measurements x1 and x2 in the figure to the right should not differ more than 1 mm from each other!	 xx0600002777 Art. no. for the centering piece is specified in *Required equipment on page 156*.
9	Refit the push button guard to the robot base.	
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 155*!	

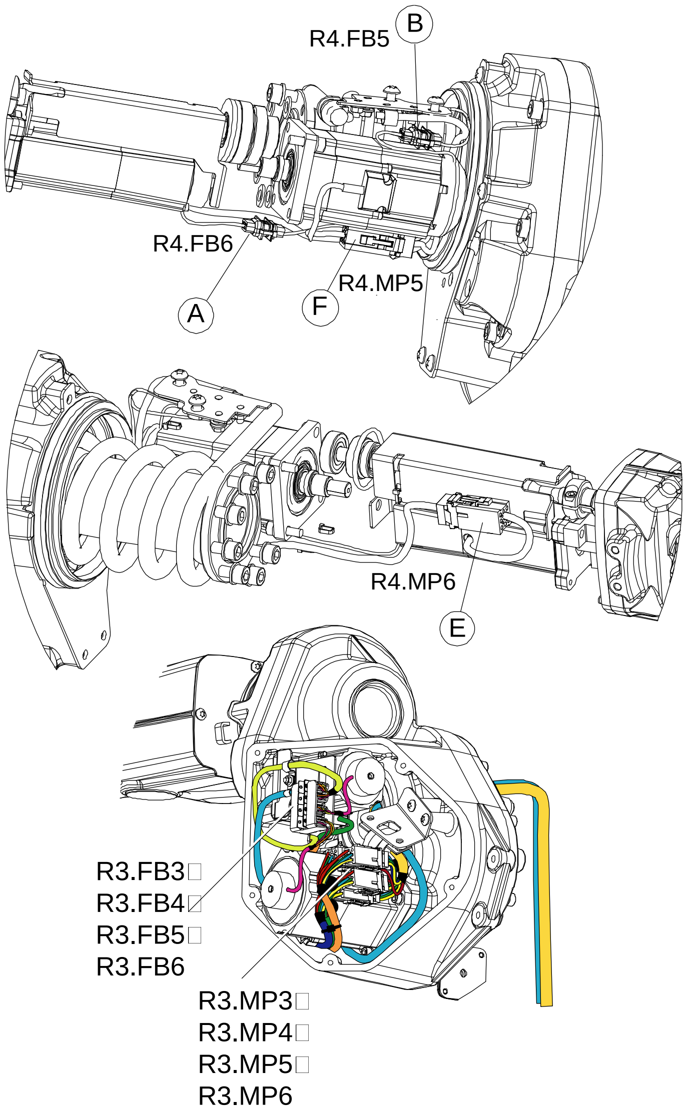
Continues on next page

	Action	Note
11	Connect the: • signal cable connectors to the SMB unit • power cable connector to the housing in the base • optional cabling, if any • ground cable.	Shown in the figure *Illustration, cabling inside base on page 163*.
12	Refit the *covers* to the frame and to the base. Replace the *gaskets*, if damaged.	Shown in the figure *Illustration, covers to remove on page 157*. Spare part no. is specified in *Required equipment on page 156*.
13	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.

4.3.2 Replacing the cable harness, 1600ID/1660ID

Location of the harness

The location of the harness is shown in several figures, next to the procedures, later on in this section.



xx0700000038

A	R4.FB6
B	R4.FB5
E	R4.MP6
F	R4.MP5

Required equipment

Equipment	Spare part no.	Note
Standard toolkit		*Standard tools on page 385*

Continues on next page

Equipment	Spare part no.	Note
Circuit diagram		
Cable ties		
VK- cover	3HAA 2166-23	Upper and lower covers. 2 pcs
Cable harness axis 5-6	3HAC027523-002	IRB 1600ID-4/1.5
	3HAC055651-001	IRB 1660ID-X/1.55

CAUTION

Be careful when handling the wrist. Always hold on the casting, do not hold on the wrist cover. This can damage the sealing which will cause oil leakage.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Deciding calibration routine

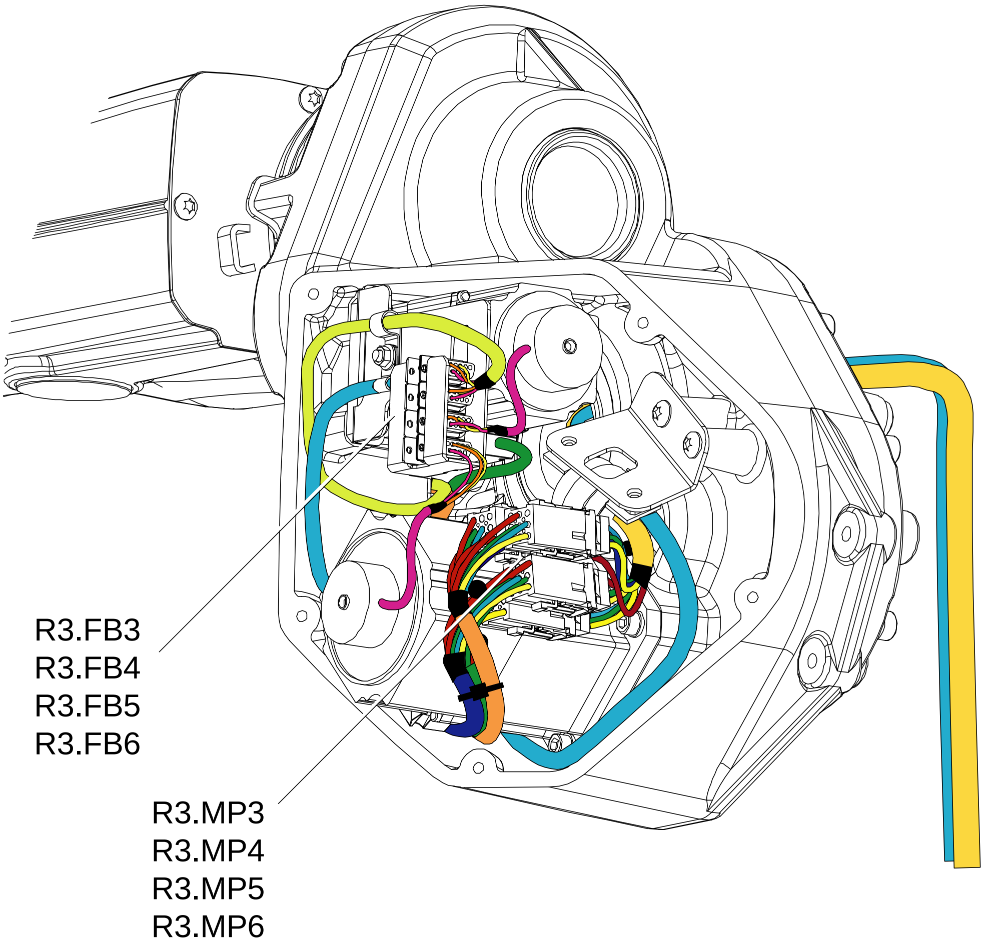
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	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 347*.
	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, cable harness lower arm and upper arm back

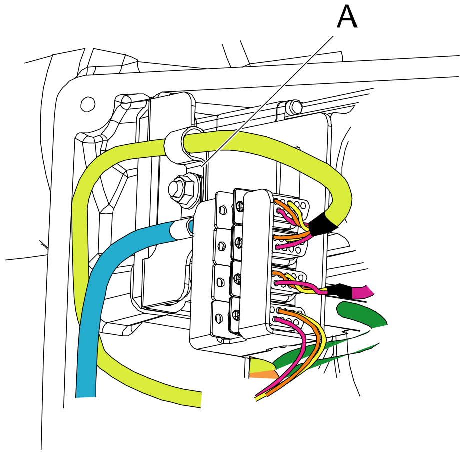
The procedure below describes removal of the complete cable harness in upper arm back.



xx0700000105

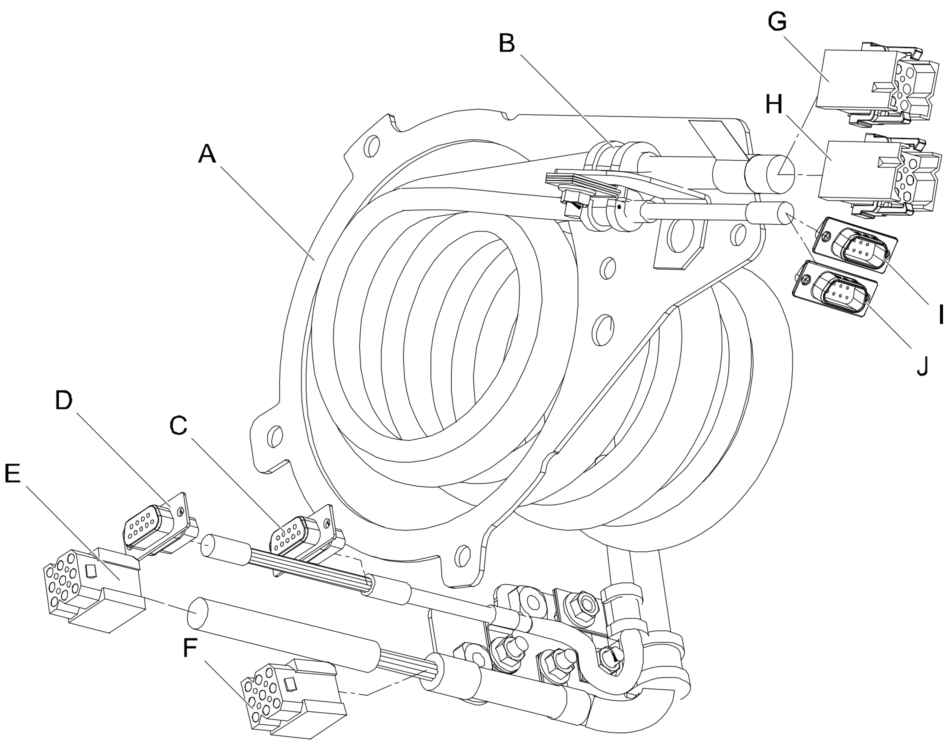
	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the cover to the upper arm.	

Continues on next page

	Action	Note
4	Remove the hexagon nut with flange (A) holding the two (2) clamps.	 xx0700000106 A Hexagon nut with flange
5	Disconnect R3.FB3 - R3.FB6.	
6	Disconnect R3.MP3 - R3.MP6.	
7	Remove the cable harness from the lower arm.	Follow instructions in section *Replacing the cable harness, IRB 1600 on page 156*.

Removal, cable harness upper arm tube

The procedure below describes removal of the complete cable harness in upper arm tube.



xx0700000099

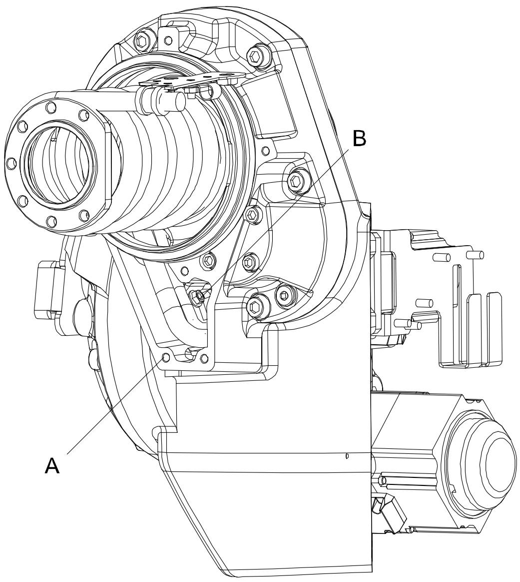
A	Cover plate

Continues on next page

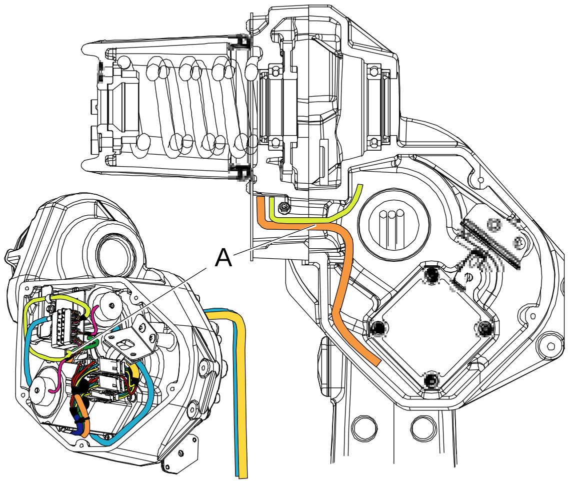
4.3.2 Replacing the cable harness, 1600ID/1660ID

Continued

B	Clamp
C	R4.FB5
D	R4.FB6
E	R4.MP6
F	R4.MP5
G	R3.MP5
H	R3.MP6
I	R3.FB5
J	R3.FB6

	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	Remove the upper arm tube.	Described in section: • IRB 1600ID: *Replacement of motor, axis 5, IRB 1600ID on page 289* • IRB 1660ID: *Replacement of motor, axis 5, IRB 1660ID on page 297*
3	Remove all the Torx pan head screw (A) holding the cover.	 xx0700000113 A Torx pan head screw M6x12 B Hexagon nut with flange M5

Continues on next page

	Action	Note
4	Remove the cover plate.	 **Tip** The spare part cable harness 3HAC027523-002 includes a galvanized coverplate without paint. If a painted cover is prefered, use the old cover plate.
5	Remove the cable pulling it out through the passage (A).	 xx0700000114

Refitting, cable harness

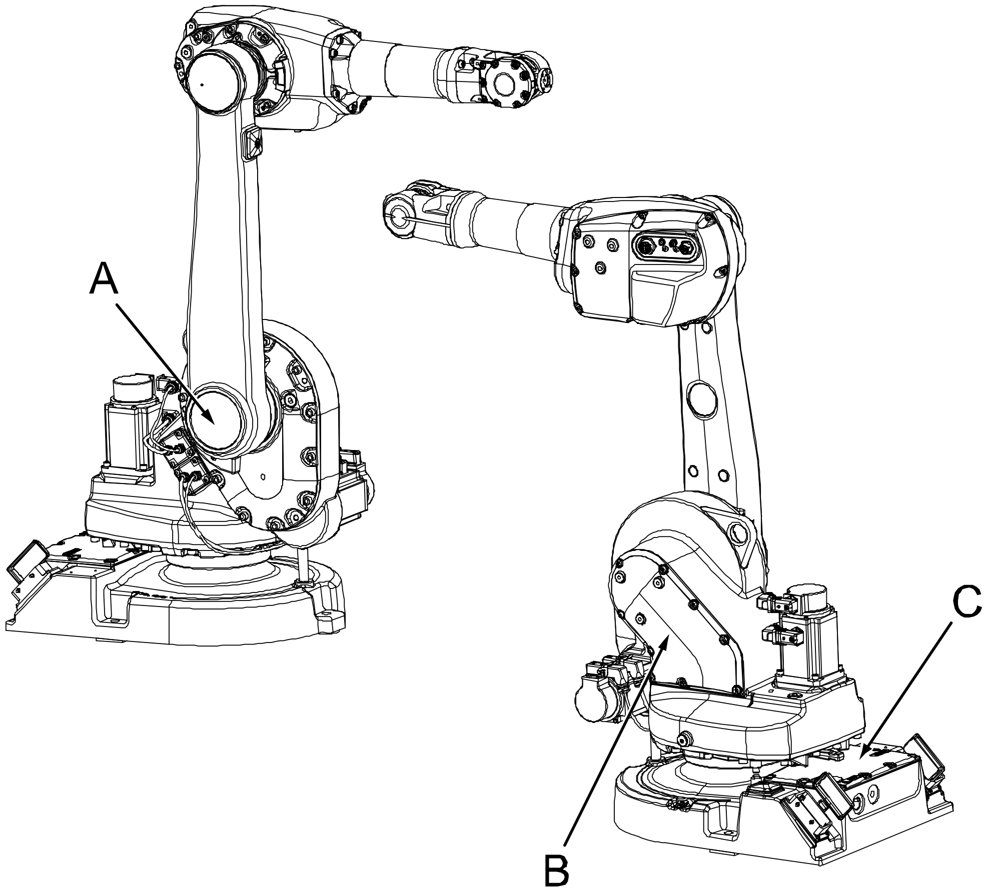
The procedure below describes refitting of the complete cable harness.

	Action	Note
1	Refit the cable harness.	Described in section *Refitting, cable harness in upper arm housing and lower arm on page 161*
2	Refit the upper arm tube.	Described in section *Refitting, motor axis 5 on page 294*.
3	Refit the connections in the upper arm.	Shown in figure *Location of the harness on page 166*.
4	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 346*. General calibration information is included in section *Calibration on page 333*.

4.3.3 Replacement of complete arm system

Location of complete arm system

The complete arm system includes complete upper and lower arms.



xx0500001443

A	VK-cover (attachment screws underneath cover)
B	Cover, frame
C	Cover, base

Required equipment

Equipment	Art. no.	Note
Lifting slings	-	
VK-cover	3HAA 2166-23	
Sealing ring (V-ring)	3HAB3732-13	Replace if damaged.
Isopropanol	-	Used to clean the mating surfaces.
Locking liquid	-	Loctite 574
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.

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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing the complete arm system

Use this procedure to remove the complete arm system from the robot.

	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 calibration position.	

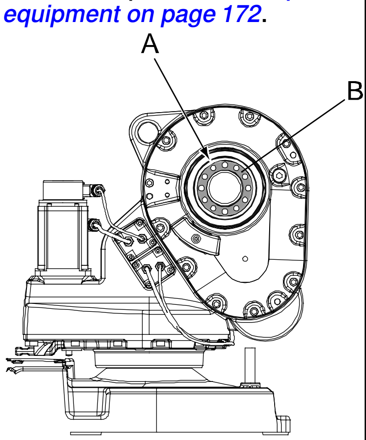
Continues on next page

	Action	Note
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove the covers from the base and the frame.	
5	Release the cable harness from below upwards to the lower arm by: • disconnecting all the connectors inside the base and the frame. • removing all cable ties and brackets inside the base and the frame.	The cable layouts inside the base and the frame are shown in the figures: • *Illustration, cabling inside base on page 163*. • *Illustration, cabling inside frame on page 162*.
6	Push out the *VK-cover* from inside of the frame.	Shown in the figure *Location of complete arm system on page 172*.
7	**CAUTION** The complete arm system weighs 55 kg. All lifting accessories used must be sized accordingly!	
8	Fit lifting slings to the upper arm to unload the weight of the complete arm system.	
9	Unscrew the 12 attachment screws and remove the one washer. Be careful when pulling the cabling through base, frame and lower arm. Use tape to bunch the connectors and protect them.	
10	Gently pull out the cabling from the frame and base while lifting away the complete arm system.	
11	Secure the cable harness to the arm system in a way that it is not damaged in the continued process.	
12	Check the *sealing ring*. Replace if damaged.	

Continues on next page

Refitting, complete arm system

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

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Clean the mating surfaces on both the lower arm and on the frame with isopropanol. Also clean the area where the sealing ring is fitted, if it has been removed.	
3	Fit the *sealing ring* properly to the frame. Replace it if damaged.	Art. no. is specified in *Required equipment on page 172*.  xx0400001245 • A: Sealing ring • B: Mating surface
4	Lubricate the attachment holes at the mating surface on the frame with Loctite 574.	
5	**CAUTION** The complete arm system weighs 55 kg. All lifting accessories used must be sized accordingly!	
6	Fit the lifting slings to the complete arm system and lift it into position while inserting the cabling into the frame.	
7	Fit the lower arm against the frame, fit the one washer and secure with the 12 attachment screws.	12 pcs; M10 x 40, tightening torque: 70 Nm.
8	Refit the cabling inside the frame and the base.	Detailed in section *Refitting, cable harness in frame and base on page 164*.
9	Fit a new *VK-cover* to the lower arm.	Art. no. is specified in *Required equipment on page 172*.

Continues on next page

	Action	Note/Illustration
10	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.4 Upper and lower arm

4.4.1 Replacing the complete upper arm, IRB 1600

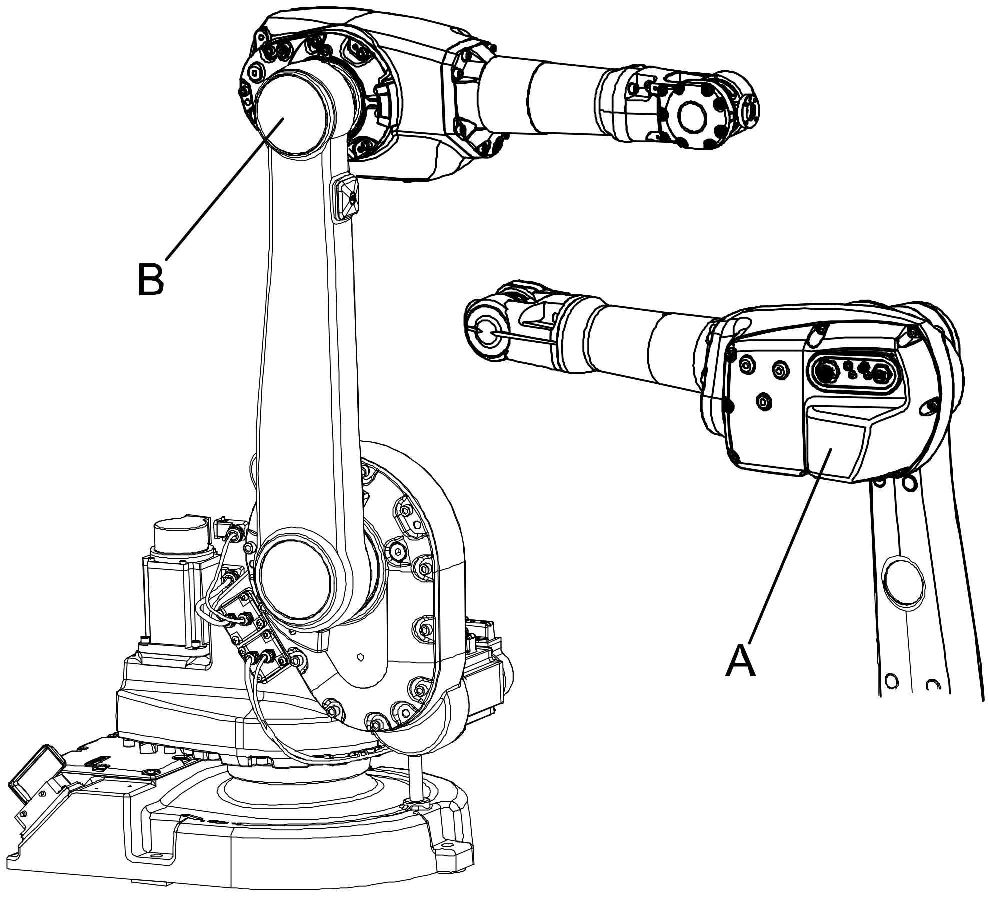
General

The complete upper arm is considered a spare part, including wrist, gearboxes and motors.

Location of upper arm

The figure below shows the location of the upper arm on the robot and some of the upper arm components.

A more detailed view of the upper arm may be found in the spare part view, see *Spare parts - Upper arm, exploded view*.



xx0400001218

A	Arm housing cover, including gaskets for the cover and the contact panel
B	VK cover. Upper arm attachment screws inside

Continues on next page

Required equipment

Equipment	Spare part no.	Art. no.	Note
Upper arm	For spare part number, see: • *Spare part lists on page 389*.		Includes the wrist unit. All gearboxes are filled with oil at delivery. **Note**! This upper arm spare is interchangeable with upper arm spare with art. no. 3HAC 023630-001. But this change of upper arm requires software 5.07.01.
VK-cover	3HAA 2166-23		
Sealing ring (V-ring)	3HAB3732-19		Replace if damaged.
Gasket, upper arm cover	3HAC022049-001		Replace if damaged.
Gasket, customer connections	3HAC022050-001		Replace if damaged.
Grease		3HAB 3537-1	To lubricate the sealing ring (V-ring).
Locking liquid		-	Loctite 574
Lifting slings		-	
Standard toolkit			Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Deciding calibration routine

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

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

Continues on next page

	Action	Note
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, complete upper arm

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

	Action	Note/Illustration
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the upper arm to a horizontal position.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove the *arm housing cover* from the upper arm.	Shown in the figure *Location of upper arm on page 177*.
5	Disconnect all connectors inside the arm housing and loosen the cabling from straps and brackets.	The cabling and all connectors inside the upper arm housing are shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
6	Remove the *VK-cover* from the lower arm by pushing it out from the inside. Pull out the cabling from the arm housing.	Shown in the figure *Location of upper arm on page 177*.
7	Secure the weight of the arm with lifting slings.	
8	**CAUTION** The complete upper arm weighs 55 kg without any additional equipment fitted! All lifting accessories used must be sized accordingly!	

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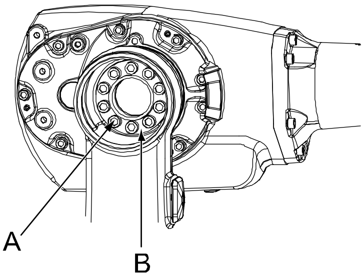
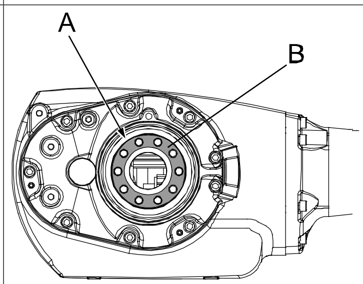
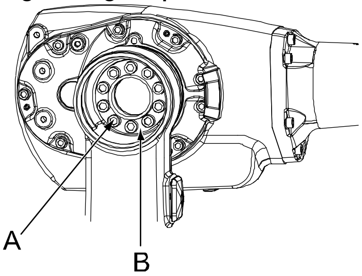
	Action	Note/Illustration
9	Remove the 10 attachment screws (A) and the single washer (B).	 xx0400001219
10	Remove the upper arm, lift it away and place it securely.	

Refitting, complete upper arm

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

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Wipe the contact surfaces clean on both the upper and lower arm.	
3	**CAUTION** The complete upper arm weighs 55 kg without any additional equipment fitted! All lifting accessories used must be sized accordingly!	
4	Attach lifting slings to the upper arm and lift it.	
5	Lubricate the *sealing ring* (A) with *grease* and fit it to the upper arm. Replace the sealing ring, if damaged.	 xx0400001220 • A: Sealing ring, spare part no. is specified in *Required equipment on page 178*. • B: Contact surface.

Continues on next page

	Action	Note/Illustration
6	Lubricate the the contact surface, upper arm, with Loctite 574.	
7	Lift the upper arm to mounting position, fit the washer (B) and secure the upper arm with the 10 attachment screws (A).	10 pcs: M10 x 40. Tightening torque: 70 Nm.  xx0400001219
8	Run the cabling through the lower arm and into the arm housing.	
9	Connect all the connectors in the arm housing and secure the cabling with brackets and straps.	Refitting of the cabling in the upper arm housing is further detailed in section *Refitting, cable harness in upper arm housing and lower arm on page 161*.
10	Refit the *arm housing cover* to the upper arm. Check the two *gaskets* in the cover and replace them, if damaged.	Shown in the figure *Location of upper arm on page 177*. Spare part no. is specified in section *Required equipment on page 178*.
11	Refit a new *VK-cover* to the lower arm.	Shown in the figure *Location of upper arm on page 177*. Spare part no. is specified in section *Required equipment on page 178*.
12	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

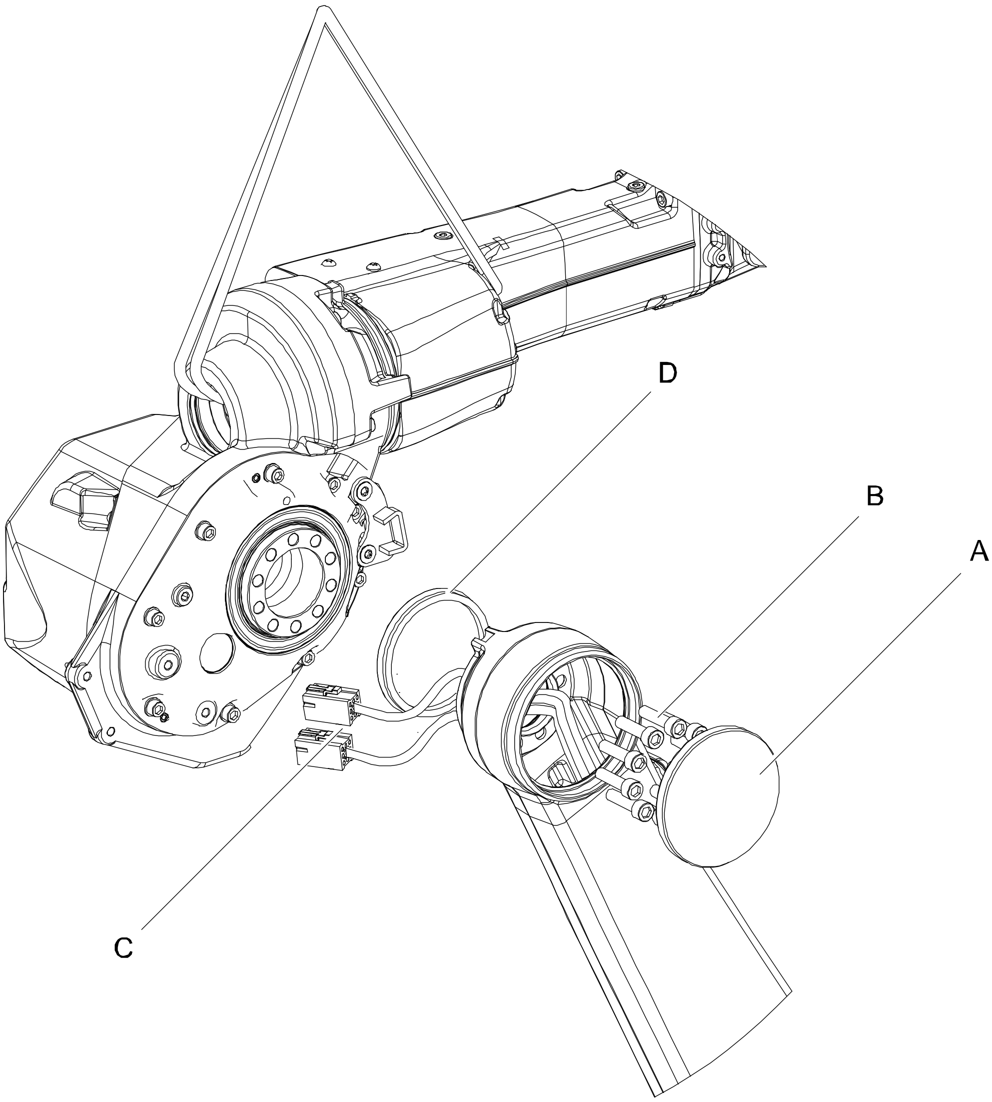
4.4.2 Replacing the complete upper arm, IRB 1600ID/1660ID

Note

Recalibration of robot axis 3-6 is required after replacement of upper arm.

Location of the complete upper arm

The complete upper arm is considered a spare part, including wrist, gearboxes and motors. The figure below shows the location of the upper arm and connection to the lower arm.



xx0700000045

A	VK -Cover
B	Socket head cap screw M10x40
C	Cable harness
D	V-ring

Continues on next page

Required equipment

Equipment	Art. no.	Note
Upper arm, spare	For spare part number, see: • *Spare part lists on page 389*.	Includes the wrist unit. All gearboxes are filled with oil at delivery.
VK-cover	3HAA2166-23	
Gasket, customer connections	3HAC 022050-001	Replace if damaged
Torx pan head screw	3HAC080811-001	M6 x 12 (glue)
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Deciding calibration routine

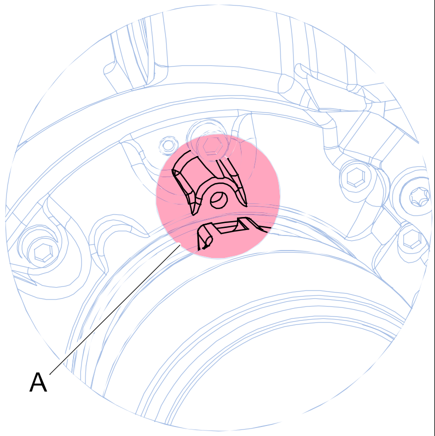
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	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 347*.
	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

Removing the complete upper arm

Use this procedure to remove the complete upper arm.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Put the robot in synchronization position for Axis 3.	 xx0700000075 A Synchronization mark Axis 3
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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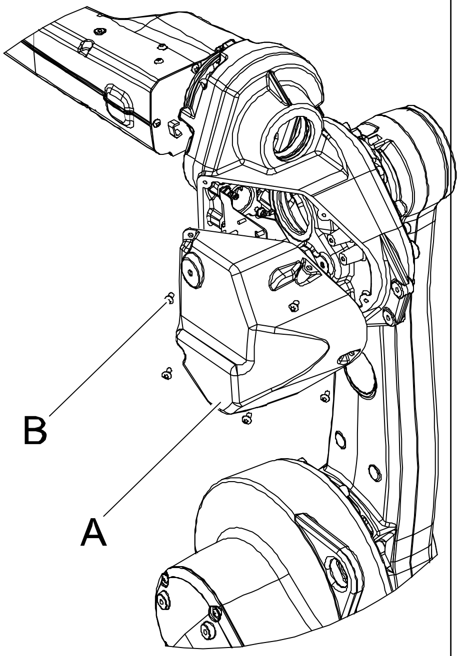
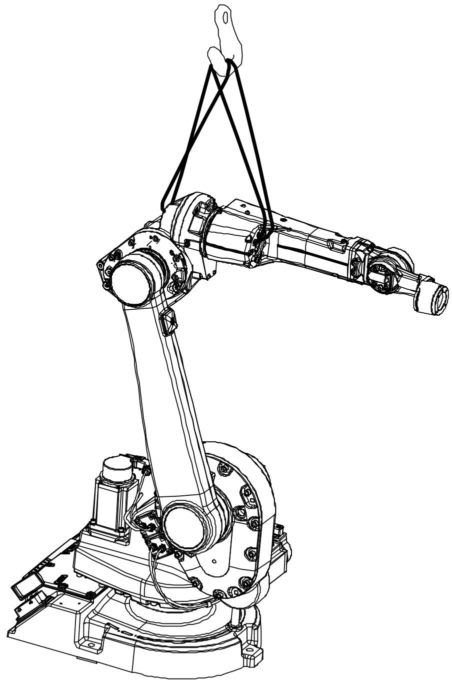
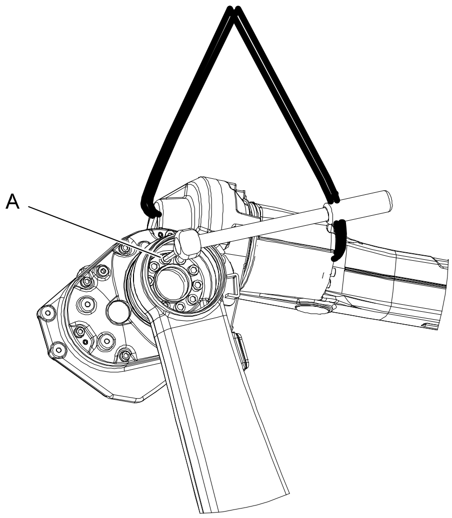
	Action	Note
4	Remove the *cover arm housing*.	 xx0700000077 A Cover Arm Housing B Torx pan head screw
5	Disconnect all connectors inside the arm-house and loosen the cabling from straps and brackets.	Described in section *Replacing the cable harness, IRB 1600 on page 156*
6	**CAUTION** The robot upper arm weighs 39 kg. All lifting accessories used must be sized accordingly!	

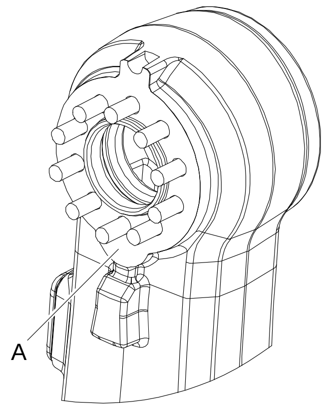
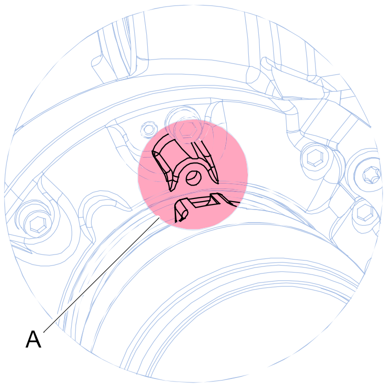
Continues on next page

	Action	Note
7	Secure the weight of the upper arm with a roundsling. Apply the roundsling through the hole in the upper arm. See figure!	 xx0700000060
8	Knock out the VK-cover from the motor side.	
9	Remove the 10 attachment screws (A) and the single washer, use standard tools.	 xx0700000057 A Socket head cap screw M10x40
10	Carefully lift away the upper arm and put it somewhere safe.	

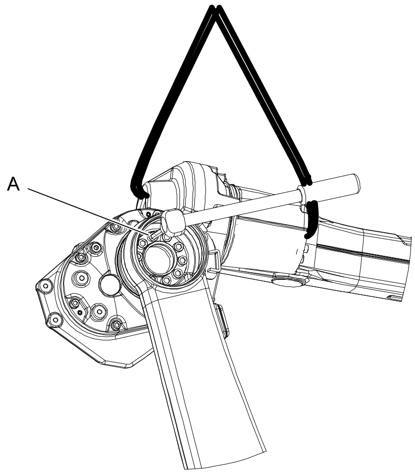
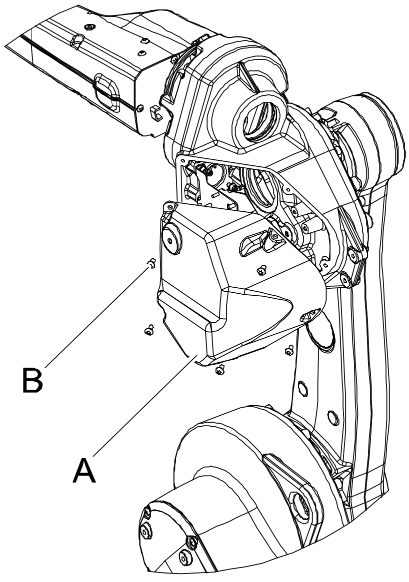
Continues on next page

Refitting the complete upper arm

Use this procedure to refit the complete upper arm.

	Action	Note
1	 **CAUTION** The robot upper arm weighs 39 kg. All lifting accessories used must be sized accordingly!	
2	Attach a roundsling to the upper arm and lift it.	
3	Clean the contact surface.	 xx0700000076 A Contact surface.
4	Carefully refit the upper arm to the lower arm, making sure that the new upper arm is mounted in the synchronization position.	 xx0700000075 A Synchronization mark Axis 3

Continues on next page

	Action	Note
5	Refit the 10 attachment screws (A) and the single washer, use standard tools. Tightening torque: 70 Nm.	 xx0700000057 A Socket head cap screw M10x40
6	Run the cabling through the lower arm and into the arm housing.	
7	Connect all the connectors in the armhouse and secure the cabling with brackets and straps.	
8	Refit the cover arm housing to the upper arm *Standard tools on page 385*.	 xx0700000077 A Cover Arm Housing B Torx pan head screw
9	Refit a new *VK-cover* to the lower arm. replace it, if damaged.	Spare part no. is specified in *Required equipment on page 183*.

Continues on next page

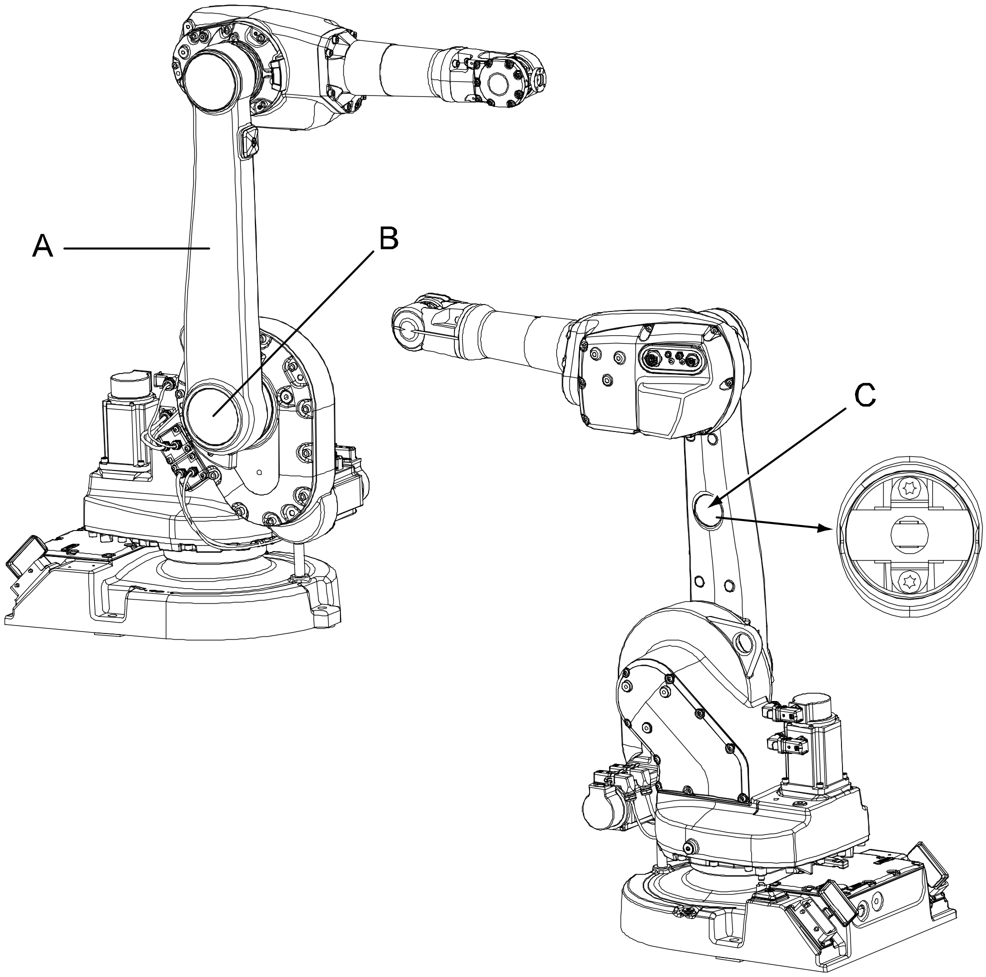
	Action	Note
10	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.4.3 Replacing the complete lower arm

Location of lower arm

The lower arm is located on the robot as shown in the figure.

A more detailed view of the lower arm may be found in the spare part view, *Spare parts - Lower arm, exploded view*.



xx0400001246

A	Lower arm
B	VK-cover
C	VK-cover, middle

Required equipment

Equipment	Art. no.	Note
Lower arm	See *Spare part lists on page 389*.	
VK-cover	3HAA2166-23	
VK-cover	3HAA2166-21	In the middle of the lower arm.

Continues on next page

Equipment	Art. no.	Note
Sealing ring (V-ring)	3HAB3732-13	Replace if damaged.
Isopropanol	-	Used to clean the mating surfaces.
Locking liquid	-	Loctite 574
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Deciding calibration routine

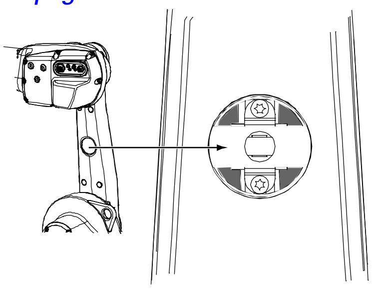
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	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 347*.
	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

Removing the lower arm

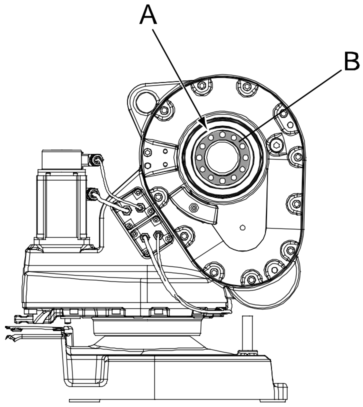
Use this procedure to remove the lower arm.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**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 upper arm.	See section *Replacing the complete upper arm, IRB 1600ID/1660ID on page 182*.
4	Remove the *VK-covers*. **CAUTION** Be careful not to damage the cabling and cable bracket inside the lower arm when removing the middle VK-cover! The figure to the right shows the space underneath the cover. The gray areas are safe for insertion of a tool that may be inserted with a maximum depth of 20 mm!	Shown in the figure *Location of lower arm on page 190*.  xx0400001247
5	Pull down the cabling through the lower arm and pull it out.	
6	**CAUTION** The robot lower arm weighs 20 kg. All lifting accessories used must be sized accordingly!	
7	Fit the lifting device to the lower arm to secure the weight of the arm.	
8	Unscrew the 12 attachment screws and remove the single washer.	
9	Gently pull out the cabling while lifting away the lower arm. Be careful with the connectors, they are sensitive to damage!	
10	Check the *sealing ring*. Replace it if damaged.	Spare part no. is specified in *Required equipment on page 190*.

Continues on next page

Refitting the lower arm

Use this procedure to refit the complete lower arm.

	Action	Note
1	Clean the mating surfaces on both the lower arm and on the frame with isopropanol. Also clean the area where the sealing ring is fitted.	
2	Fit the *sealing ring* properly to the frame. Replace it if damaged.	Spare part no. is specified in *Required equipment on page 190*.  xx0400001245 • A: Sealing ring • B: Mating surface
3	Lubricate the mating surface on the frame with Loctite 574.	
4	**CAUTION** The robot lower arm weighs 20 kg. All lifting accessories used must be sized accordingly!	
5	Fit the lifting device to the lower arm and lift it into position.	
6	Insert the cabling into the lower arm.	
7	Fit the lower arm against the frame, fit the washer and secure with the 12 attachment screws.	12 pcs; M10 x 40, tightening torque: 70 Nm.
8	Push the cabling up through the lower arm and place the cable bracket inside the lower arm correctly.	
9	Fit new *VK-covers* to the lower arm. Make sure that the cable bracket inside the lower arm is secured beneath the middle VK-cover.	Spare part no. is specified in *Required equipment on page 190*.
10	Refit the upper arm.	See section *Replacing the complete upper arm, IRB 1600ID/1660ID on page 182*.

Continues on next page

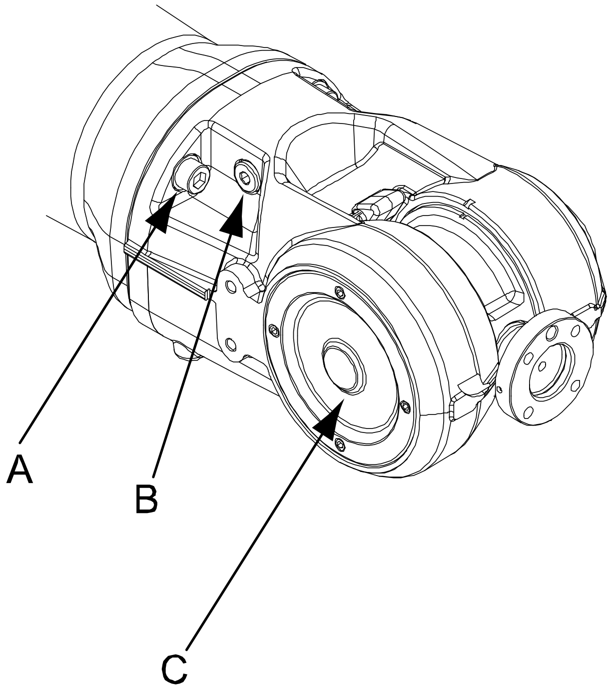
	Action	Note
11	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.4.4 Replacing the wrist unit, IRB 1600

Location of wrist unit

The wrist unit is located in the frontmost part of the upper arm.

A more detailed view of the upper arm, including the wrist unit, is found in the spare part view, see *Spare parts - Upper arm, exploded view*.



xx0600002847

A	Attachment screws, wrist unit (3 pcs)
B	Oil plug (only one shown)
C	Wrist unit

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Wrist Standard/Foundry	3HAC027003-001		Standard and Foundry versions. O-ring sealing plate not included! **Note**! The wrist, standard/Foundry is **not** interchangeable with art. no. 3HAC 10475-1!
O-ring sealing plate	3HAC025420-001		Must be replaced. **Note**! The o-ring sealing plate is **not** interchangeable with art.no. 3HAC 7191-1!
Grease		3HAC 3537-1	For lubricating the o-ring sealing plate.
Standard toolkit			Content is defined in section *Standard tools on page 385*.

Continues on next page

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

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	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.	

Continues on next page

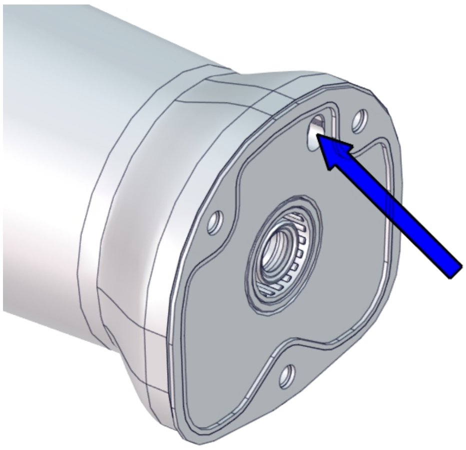
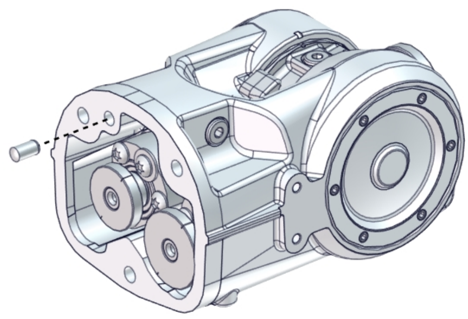
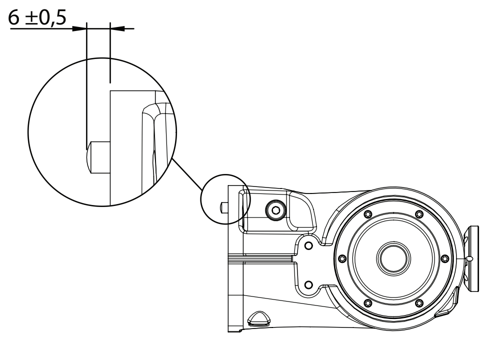
	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	
4	Drain the oil from the wrist unit.	Detailed in section *Changing the oil in axes 5 and 6 gearboxes on page 131*.
5	Remove the wrist unit by unscrewing its three attachment screws.	Shown in the figure in section *Location of wrist unit on page 195*.

Refitting, wrist unit

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153*	
2	Move the robot to a position where the upper arm is vertical.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	

Continues on next page

	Action	Note
4	With the new spare part wrist there is a parallel pin enclosed. The parallel pin must be installed on the wrist if the robot is calibrated with the Axis Calibration method. If the calibration method is unknown, look at the tubular shaft interface. If it has an elongated hole, install the parallel pin into the wrist, according to the next step.	 xx1700000117
5	If the robot is calibrated with Axis Calibration. fit the parallel pin into the corresponding hole in the wrist. **Note** If the parallel pin is not installed on a robot calibrated with Axis Calibration, the calibration result will be affected negatively.	 xx1700000118 Verify that the parallel pin sticks out from the wrist according to the measurement given below.  xx1700000119
6	Lightly lubricate the o-ring sealingplate with *grease*.	Art. no. is specified in section *Required equipment on page 195*.
7	In order to release the brake, connect the 24 VDC power supply to motors:	Connect to connector R3.MP5 or 6: • +: pin 7 • -: pin 8
8	Fit the *o-ring sealingplate* to the upper arm. Fit the *wrist unit* to the upper arm with the three attachment screws, while making sure that the gears mate properly.	Use a new o-ring! Spare part no. is specified in *Required equipment on page 195*. 3 pcs, M8 x 25, tightening torque: 28 Nm.

Continues on next page

	Action	Note
9	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 146*.
10	Refill the wrist unit with oil.	Detailed in section *Changing the oil in axes 5 and 6 gearboxes on page 131*.
11	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
12	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

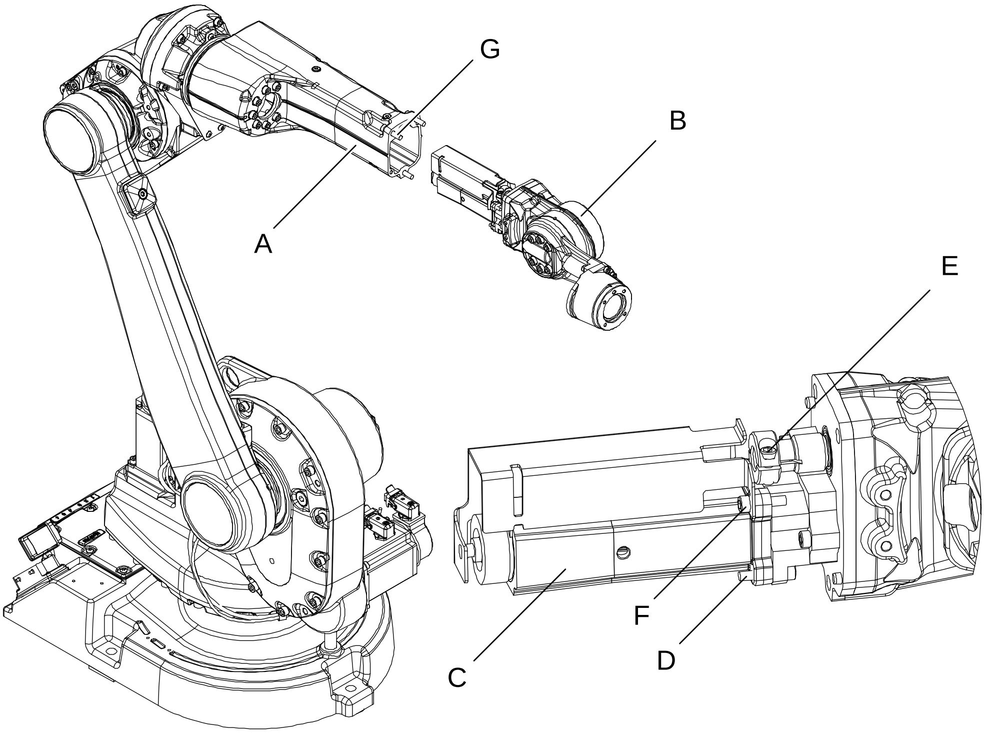
4.4.5 Replacing the wrist unit, IRB 1600ID

Note

After replacement of motors/motor or gearbox in a manipulator, recalibration is required.

Location of wrist unit

The wrist unit is located in the frontmost part of the upper arm.



xx0700000025

A	Upper arm
B	Wrist
C	Motor axis 6
D	Hexagon socket head screw M5x25
E	Hexagon socket head screw M5X16 (10.9) (Short head)
F	Hexagon socket head screw M5x25
G	Hexagon socket head screw M8x35

Required equipment

Equipment	Art. No.	Note
Wrist, ID	See *Spare part lists on page 389*.	
O-ring		

Continues on next page

Equipment	Art. No.	Note
Grease	3HAC3537-1	For lubricating the o-ring sealing plate.
Arm	3HAC9037-1	For adjusting the gear play, motor/pinion.
Loctite 242	1269-0014-410	
Standard toolkit		Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Deciding calibration routine

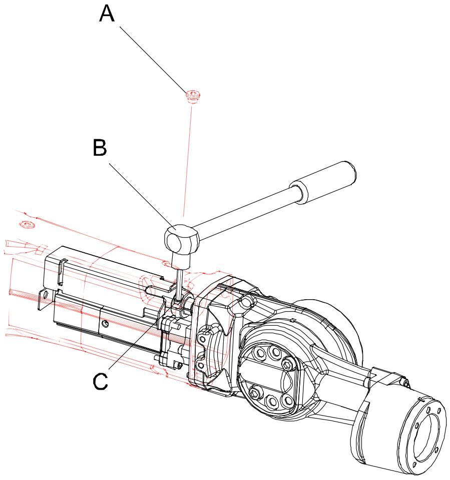
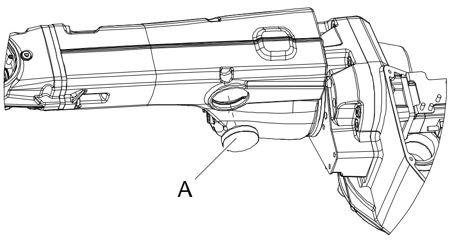
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	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 347*.
	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

Removing the wrist unit

Use this procedure 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	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove all extra equipment fitted on upper arm and wrist.	Shown in *Remove AW Gun on page 223*
4	The plug (A) in figure covering the screw (C). Remove the plug using standard tools (B). Remove the screw for looking of motor axis 5, (C) in figure *Location of wrist unit on page 200*.	 xx0700000092 A Plug B Standard tool, *Standard tools on page 385* C Hexagon socket head screw M5X16 (Short head)
5	Remove the VK-Cover.	 xx0700000054 A VK-Cover
6	Gently pull the cables out through the hole for the VK- cover in the armtube.	

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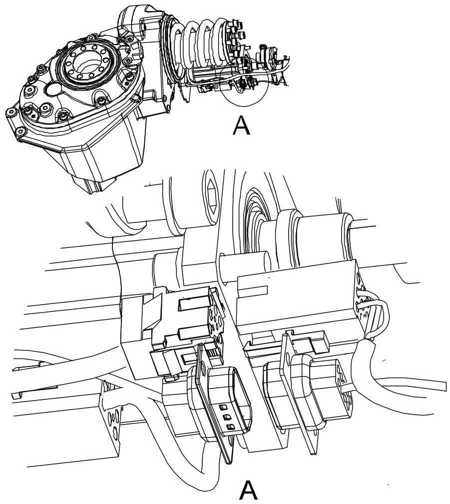
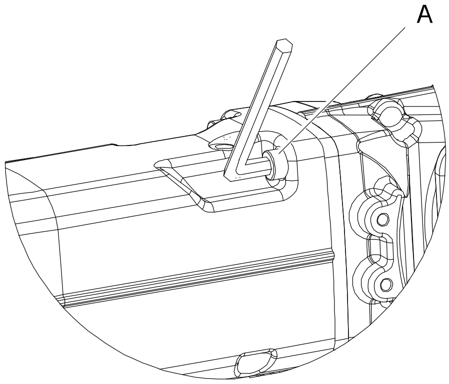
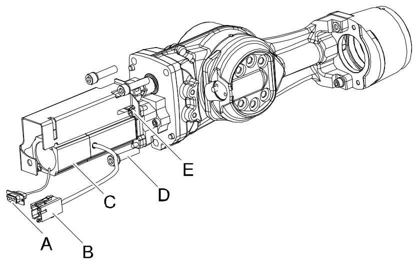
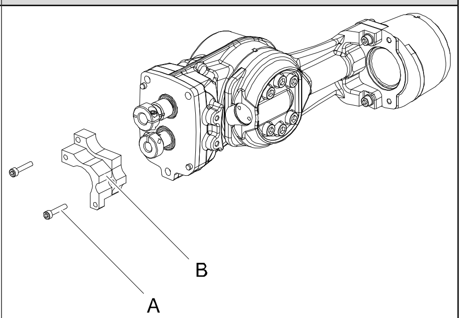
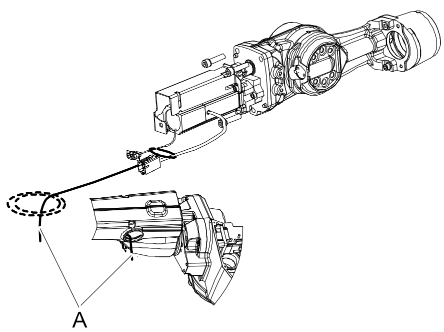
	Action	Note
7	Disconnect the connectors R4.FB6 and R4.MP6 to motor axis 6, through the hole for the VK cover.	 xx0700000053 • A: Connectors R4.FB6 & R4.MP6
8	Remove the attachment screws securing the wrist.	 xx0700000052 • A: Hex socket head cap screw M8x35 quality 8.8-A2F (3 pcs)
9	Remove the wrist with motor 6 from the upper arm tube and put it on a work bench or similar. **CAUTION** Be careful when handling the wrist. Always hold on the casting, do not hold on the wrist cover. This can damage the sealing which will cause oil leakage.	

Continues on next page

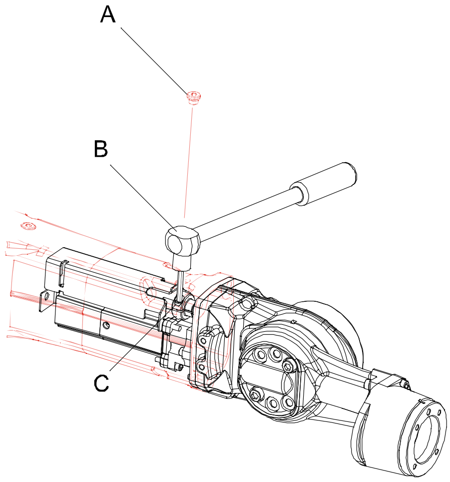
	Action	Note
10	Remove the three screws, hexagon socket head screw M5x25 (E) securing the motor axis 6 and remove the motor (C).	 xx0700000091 A: Contact R4.FB6 B: Contact R4.MP6 C: Motor axis 6 D: Hexagon socket head screw M8x35 F: Hexagon socket head screw M5x25

Refitting the wrist unit

Use this procedure to refit the complete wrist unit.

	Action	Note
1	**Note** Remove the console from the old motor and scrap it. The new console shall be fitted to the axis-6 motor. See .	 xx0700000353 A Hex socket head cap screw M5x25 B Motor Console
2	Apply a string or similar to the cable harness and run it out through the hole for the VK cover.	
3	Carefully fit the wrist (with motor axis 6 fitted) to the upper arm tube, using the string to pull the cable harness back through the hole for the VK cover.	 xx0700000093 A: String

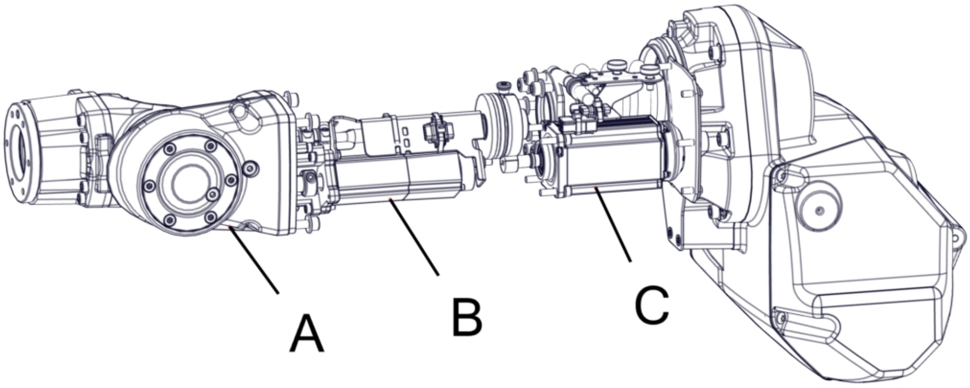
Continues on next page

	Action	Note
4	Use standard tools to refit the three hexagon socket head screw (M8x35).	Shown as (H) in figure *Location of wrist unit on page 200*. **Tightening torque 24 Nm**
5	Reconnect connectors R4.FB6 and R4.MP6, through the hole for the VK cover.	**Note** When reconnecting the connectors R4.FB6 and R4.MP6, make sure to push the connectors towards the wrist as far away from the axis 5-6 cable spiral as possible, to avoid grease to accumulate on the resolver connector.
6	Tighten the hexagon socket head screw M5X16 (Short head).	Shown as (E) in figure *Location of wrist unit on page 200*. **Tightening torque 6 Nm**
7	Refit the VK cover.	
8	Tightening the plug (A). **Tightening torque 6 Nm**	 xx0700000092
9	Refit the AW equipment in the upper arm.	Shown in *Refitting the wrist unit on page 204*
10	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.4.6 Replacing the wrist unit, IRB1660ID

Location of wrist unit

The wrist unit is located in the frontmost part of the upper arm, as shown in the figure.



xx1500002930

A	Wrist
B	Motor axis 6
C	Motor axis 5

Required equipment

Equipment	Art. no.	Note
Motor, axis 6	For spare part number, see: • *Spare part lists on page 389*.	
Wrist unit, ID	For spare part number, see: • *Spare part lists on page 389*	
VK-cover	3HAA2166-18	Always replace with a new when removed.
Locking liquid	-	Loctite 574
Standard toolkit		Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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.

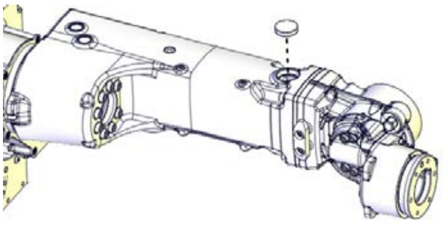
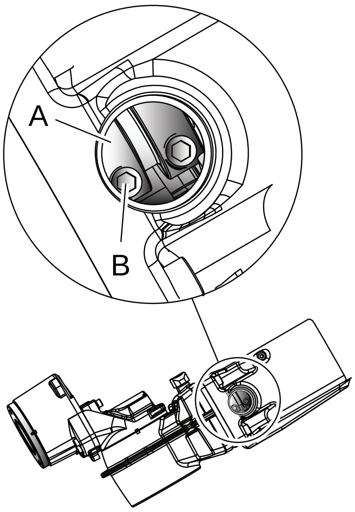
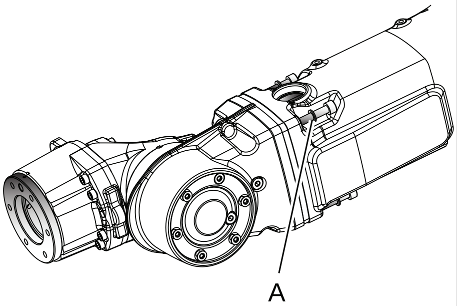
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is 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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing wrist unit

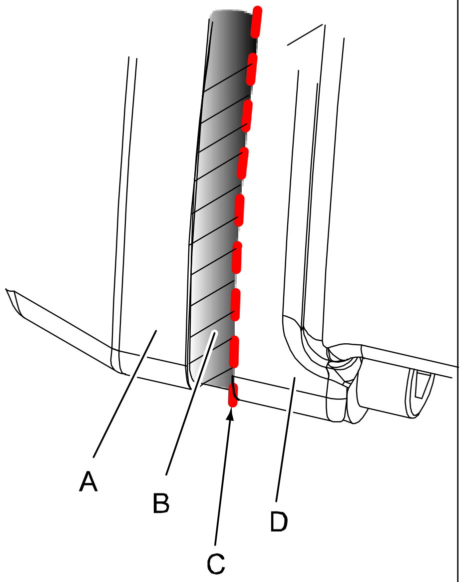
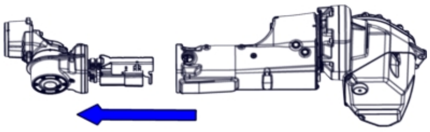
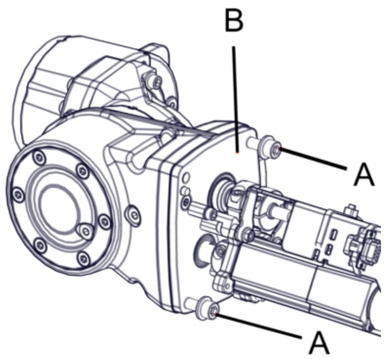
Use this procedure to remove the wrist unit.

	Action	Information
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the upper arm to synchronization position.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove all extra equipment fitted on the upper arm.	

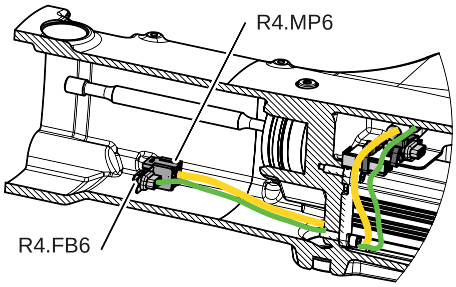
Continues on next page

	Action	Information
5	Remove the VK-cover.	 xx1000000873
6	Open the flexible coupling securing motor axis 5, on the side facing the wrist.	 xx1000000874 • A: Coupling • B: Attachment screw
7	Remove the attachment screws securing the wrist.	 xx1000000875 • A: Attachment screws (4 pcs)

Continues on next page

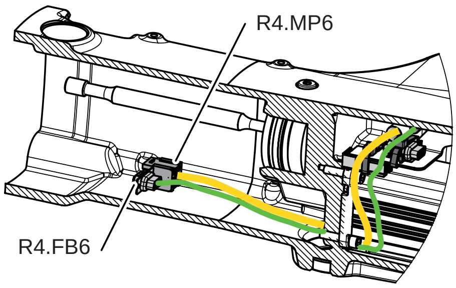
	Action	Information
8	Separate the wrist and upper arm tube at the marked division point (along the dotted line in the figure). **Note** There is oil inside the wrist. The cover is only secured with Loctite 574. If opened in the wrong place, oil will spill out.	 xx1000000933 • A: Wrist • B: Cover (Secured with Loctite 574 to the wrist) • C: Division point • D: Upper arm tube
9	Pull carefully out the wrist a little to reach the motor cables to motor axis 6. **Note** The wrist is fitted on cylindrical pins.	 xx1500001259
10	Fit two short screws in the holes for the attachment screws to temporarily secure the cover.	 xx1500003257 • A: Short screws (2 pcs) • B: Cover

Continues on next page

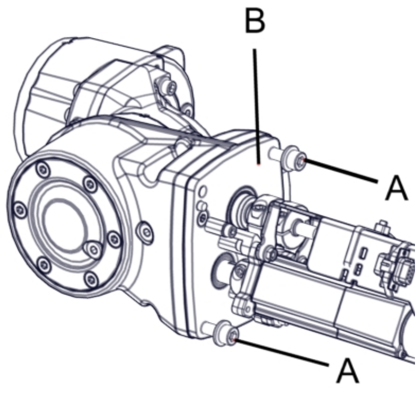
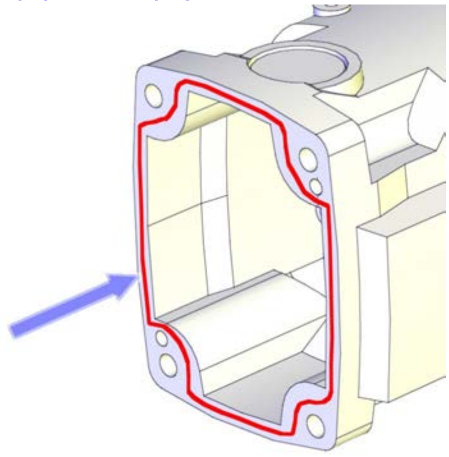
	Action	Information
11	Disconnect the cables R4.MP6 and R4.FB6 to motor axis 6.	 xx1400002575
12	Put the wrist with motor axis 6 on a work bench.	
13	Remove motor axis 6 from the wrist.	For details, see *Replacement of motor, axis 6, IRB 1660ID on page 315*.

Refitting wrist unit

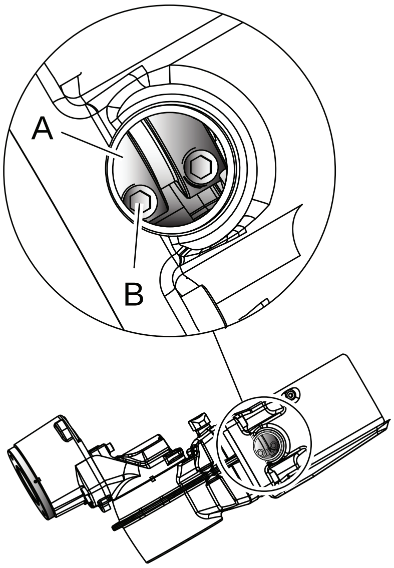
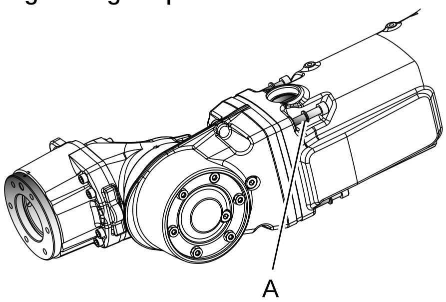
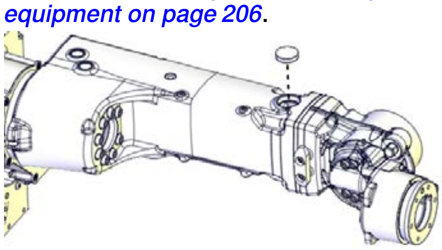
Use this procedure to refit the wrist unit.

	Action	Information
1	Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	
2	Refit motor axis 6 to the wrist.	For details, see *Replacement of motor, axis 6, IRB 1660ID on page 315*.
3	Place the wrist with motor axis 6 fitted a little into the upper arm tube.	
4	Reconnect the cables R4.MP6 and R4.FB6 to motor axis 6.	 xx1400002575

Continues on next page

	Action	Information
5	Remove the two short screws used to temporarily secure the cover.	 xx1500003257 • A: Short screws (2 pcs) • B: Cover
6	Apply locking liquid to the assembly surface on the upper arm tube.	The locking liquid is specified in *Required equipment on page 206*.  xx1200000063

Continues on next page

	Action	Information
7	Push the wrist with motor axis 6 into its position onto the cylindrical pins. **Tip** Look through the hole for the VK-cover when fitting the axis into the flexible coupling of motor axis 5.	 xx1000000874 • A: Flexible coupling axis 5 • B: Attachment screw
8	Secure the wrist with its attachment screws and washers.	Tightening torque: 35 Nm  xx1000000875 • A: Attachment screws (4 pcs)
9	Secure the flexible coupling axis 5 with its attachment screw.	Tightening torque: 14 Nm
10	Fit a new VK-cover.	Article number is specified in *Required equipment on page 206*.  xx1000000873

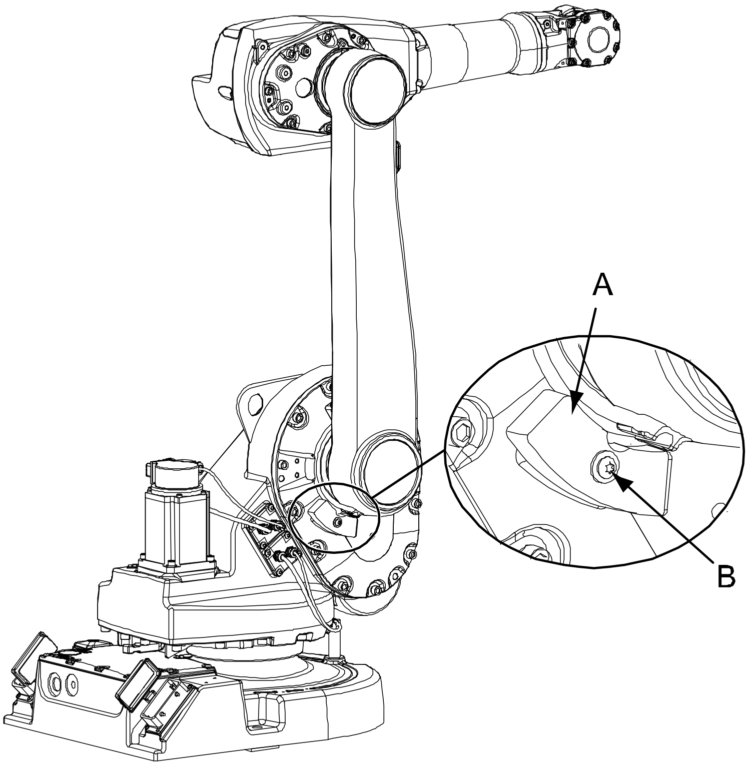
Continues on next page

	Action	Information
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 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.4.7 Replacing the damper, axis 2

Location of damper, axis 2

The damper, axis 2, is located as shown in the figure.



xx0400001217

A	Damper, axis 2
B	Attachment screw and washer

Required equipment

Equipment, etc.	Art. no.	Note
Damper, axis 2	3HAC022013-001	
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Continues on next page

Removing the damper

Use this procedure to remove the damper.

	Action	Note
1	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	
2	Run the robot to a position where it is best to enable access to the attachment screw of the damper.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove the damper by unscrewing the attachment screw and washer.	

Refitting the damper

Use this procedure to refit the damper.

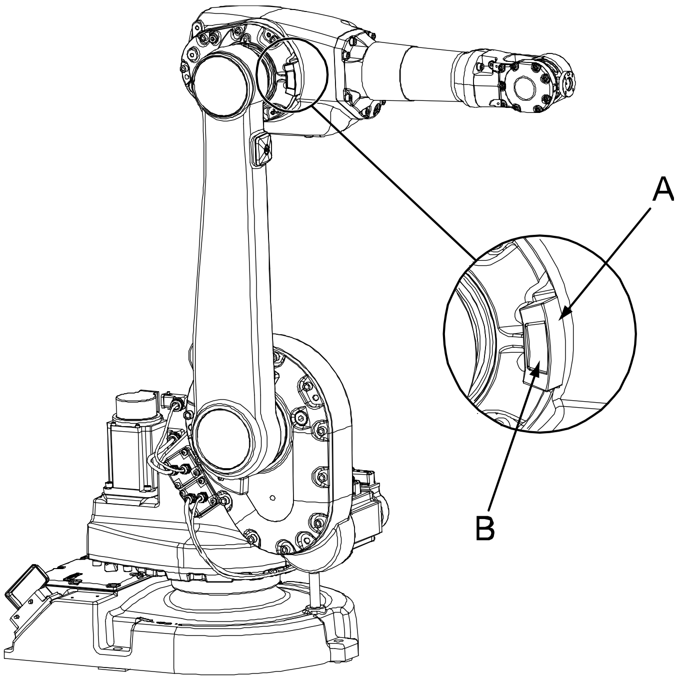
	Action	Note
1	Run the robot to a position where it is best to enable access to the attachment screw of the damper.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Secure the damper with the attachment screw and washer.	1 pc: M6 x 16.
4	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

4.4.8 Replacing the damper, axis 3

Location of damper, axis 3

The damper axis 3, is located as shown in the figure.

A more detailed view of the damper and its position may be found in the spare part view, see *Spare parts - Upper arm, exploded view*.



xx0400001215

A	Damper, axis 3
B	Cast tab

Required equipment

Equipment, etc.	Art. no.	Note
Damper, axis 3	3HAC022260-001	
Standard toolkit		Content is defined in section *Standard tools on page 385*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Removing the damper axis 3

Use this procedure to remove the damper.

	Action	Note
1	Run the robot to a position where it is best to enable access to the access 3 damper.	Shown in the figure *Location of damper, axis 3 on page 216*.

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 damper by gently prying it from the cast tab.	

Refitting the damper axis 3

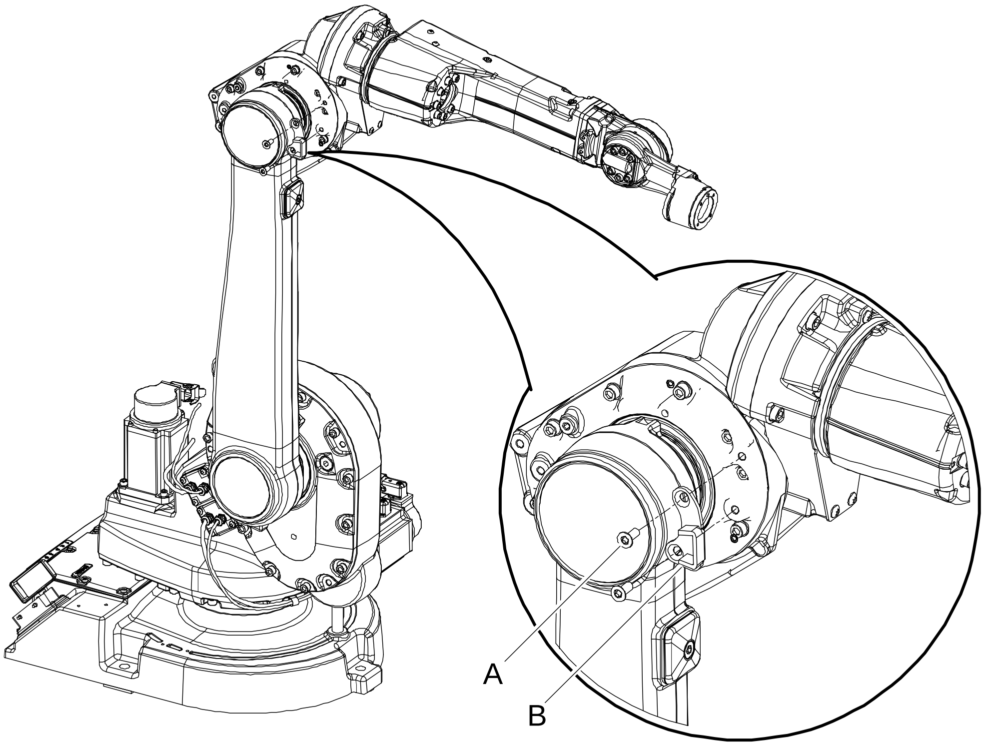
Use this procedure to refit the damper.

	Action	Note
1	Run the robot to a position where it is best to enable access to the location where the axis 3 damper is fitted.	Shown in the figure *Location of damper, axis 3 on page 216*.
2	⚠ **DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Refit the damper by gently pressing it onto the cast tab on the upper arm.	
4	⚠ **DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

4.4.9 Replacing the mechanical stop axis 3, IRB 1600ID/1660ID

Location of the mechanical stop axis 3

The mechanical stop axis 3 is located as shown in the figure.



xx0700000043

A	Torx counters. head screw
B	Mechanical damper

Required equipment

Equipment	Art. no.	Note
Mechanical stop	See *Spare part lists on page 389*.	
Standard tools		Content is defined in section *Standard tools on page 385*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Continues on next page

Removing the mechanical stop axis 3

Use this procedure to remove the mechanical stop.

	Action	Note
1	Run the robot to a position that enables access to the mechanical stop.	
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 mechanical stop.	

Refitting the mechanical stop axis 3

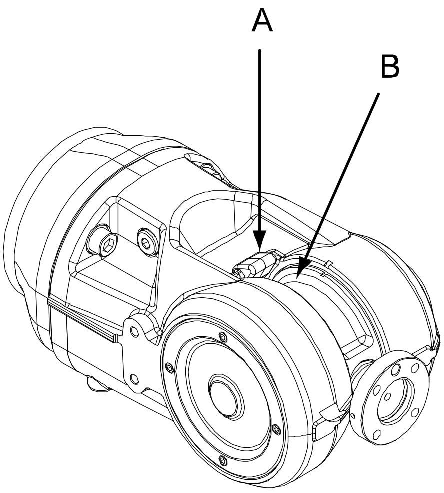
Use this procedure to refit the mechanical stop.

	Action	Note
1	Refit the mechanical stop with its attachment screws.	
2	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

4.4.10 Replacement of damper, axis 5

Location of damper, axis 5

The damper, axis 5, is located as shown in the figure below!



xx0600002806

A	Damper, axis 5
B	Recess

Required equipment

Equipment, etc.	Spare part no.	Note
Damper, axis 5	3HAB 8964-1	
Standard toolkit		Content is defined in section *Standard tools on page 385*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Removal, damper axis 5

The procedure below details how to remove the damper, axis 5.

	Action	Note
1	Run the robot to a position that enables the end of the *damper* to be pushed into the *recess* in the wrist unit.	Shown in the figure *Location of damper, axis 5 on page 220*.

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	Unhook the end of the damper, and push it into the recess.	
4	Manually move the wrist (robot axis 5) away from the damper to pull it out.	

Refitting, damper axis 5

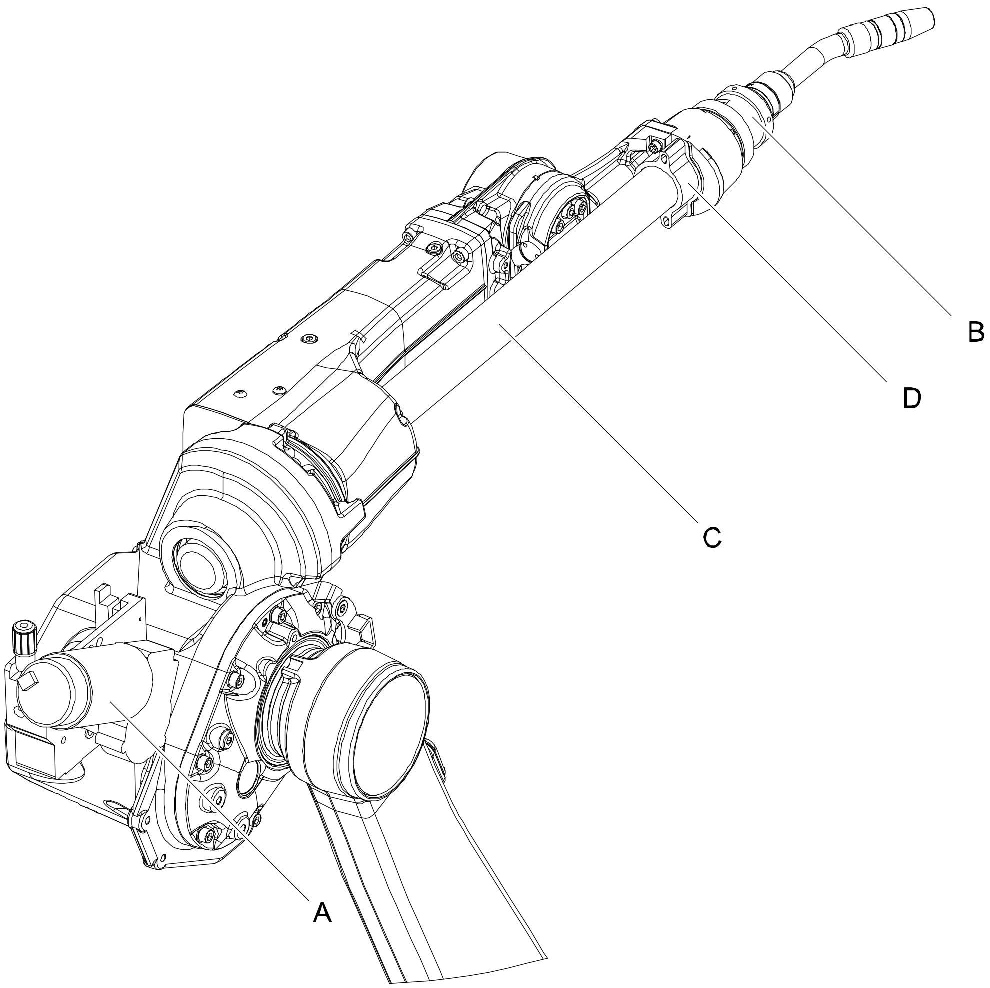
The procedure below details how to refit the damper, axis 5.

	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	Push the end of the damper into the gap between the wrist unit and upper arm.	Make sure the damper is turned the correct way!
3	Manually move the wrist (robot axis 5) in order to pull the damper into position.	
4	Fold out the damper hooks to secure it in position.	
5	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

4.4.11 Remove upper arm AW Gun

Location of AW Gun

The location of the AW equipment.



xx0700000153

A	Wire feeder (customer option)
B	Weld gun (BINZEL)
C	Welding cable (BINZEL)
D	Brace (BINZEL)

Required equipment

Equipment	Art. no.	Note
Standard tools	-	*Standard tools on page 385*.

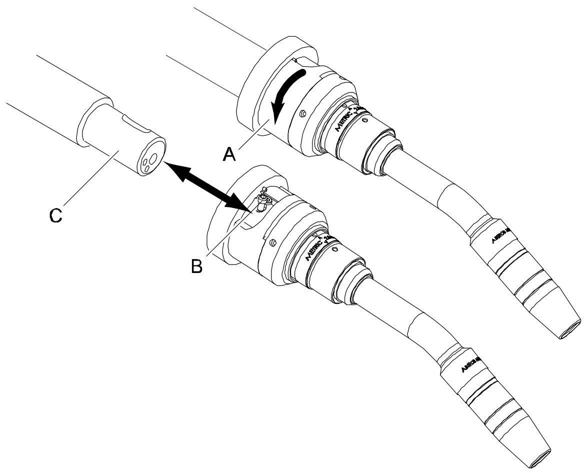
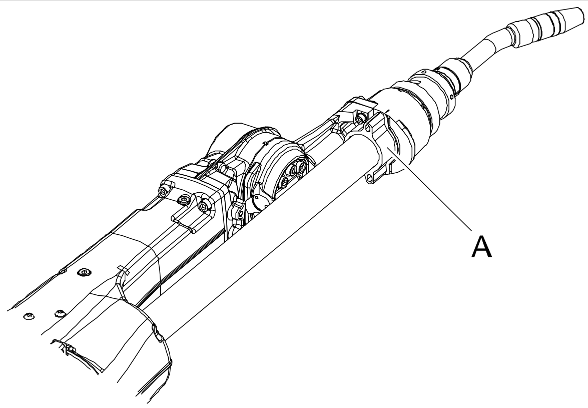
CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

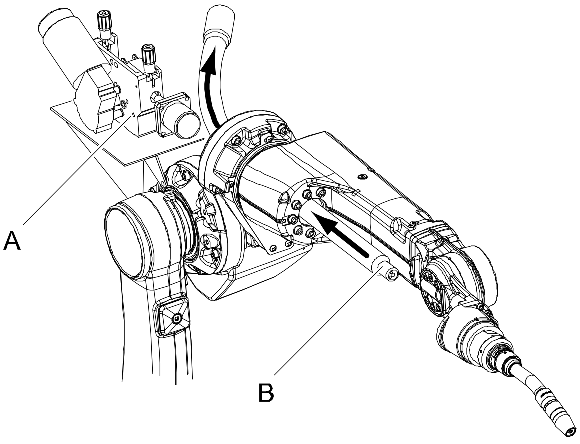
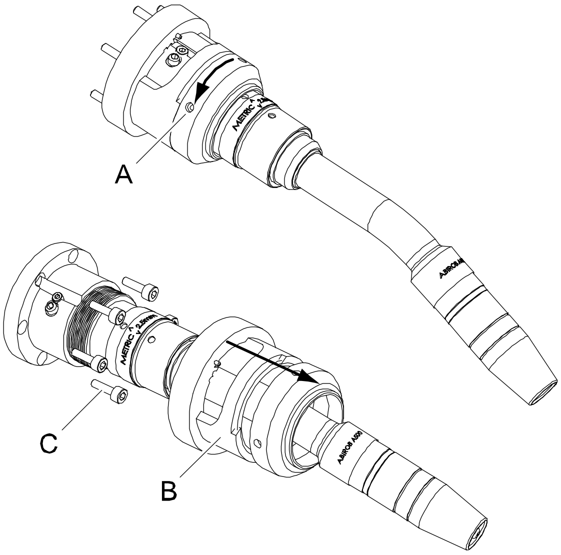
Continues on next page

Remove AW Gun

The section below shows how to remove the AW. equipment from the upper arm of an IRB 1600 ID.

	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	Remove the welding cable (C) from the weld gun by twisting the locking sleeve (A) counter clockwise. Loosen the locking screw (B) and pull out the welding cable.	 xx0700000151 A Locking sleeve B Locking screw C Welding cable
3	Remove the two screws holding the brace.	 xx0700000273 A BINZEL Brace

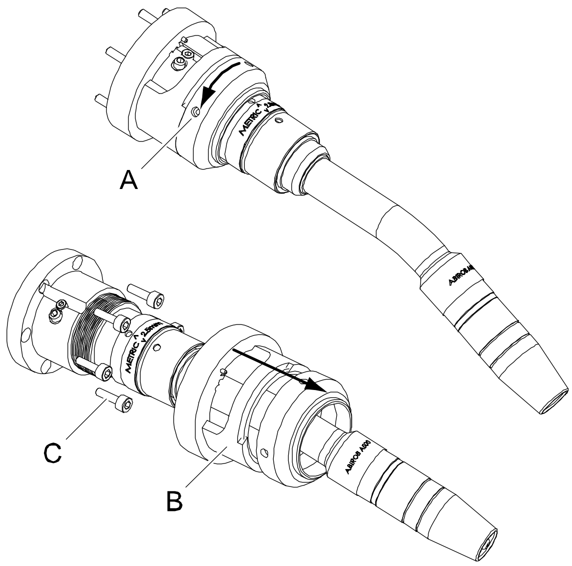
Continues on next page

	Action	Note
4	Remove the welding cable from the wire feeder and pull it out.	 xx0700000142 A Wire feeder B Welding cable
5	The locking ring (A) has a thread, loosen it counter clockwise and remove it. Remove the locking sleeve (B). Remove all 6x M5 screw (C).	 xx0700000150 A Locking ring B Locking sleeve C Screw M5

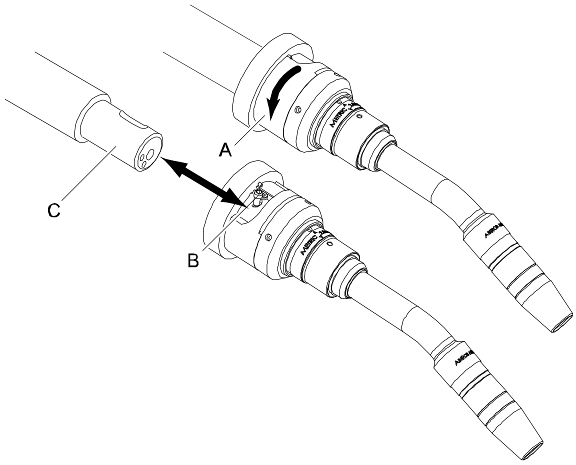
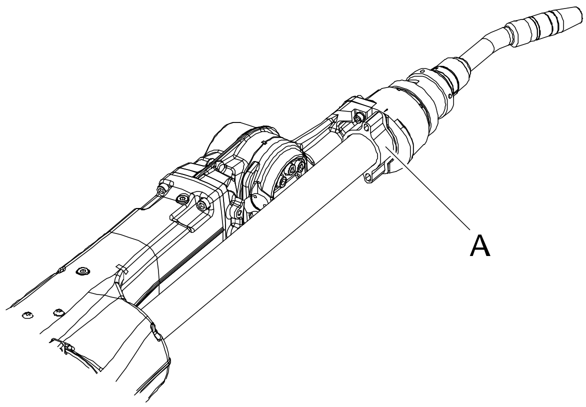
Continues on next page

Refit AW Gun

The section below shows how to refit the AW. equipment to the upper arm of a IRB 1600 ID.

	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	Refit the welding gun using the 6X Socket head cap screw M5 (C). Refit the locking sleeve (B). Lock the sleeve using the locking ring (A).	 xx0700000150 A Locking ring B Locking sleeve C Screw M5

Continues on next page

	Action	Note
3	Refit the welding cable (C). Lock the cable using the screw (B).	 xx0700000151 A Locking sleeve B Locking screw C Welding cable
4	Refit the brace (A).	 xx0700000273

4.4.12 Measuring the play 1600, axis 5 and axis 6

General

This section is only valid for IRB 1600.

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

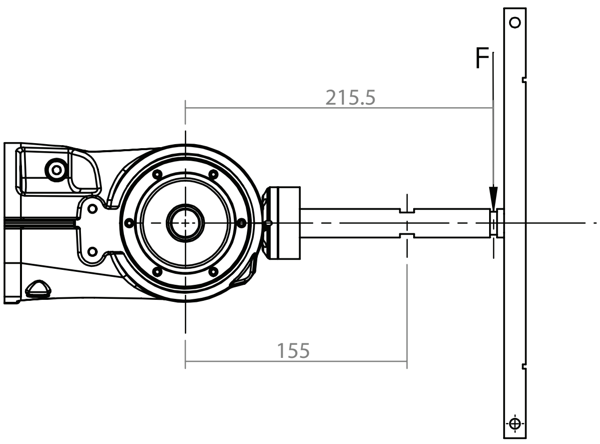
Axis 5

User the following procedure to measure the play of axis 5.

1. Turn axis 4 90°.
2. Load axis 5 with the force of 30 N in one direction, unload to 3 N and start measure the play a1.
3. Load axis 5 with the force of 40 N in another direction, unload to 3 N and start measure the play a2.

   The axis play will be C1=|a1|+|a2|.
4. Change the position of axis 5 by 90°.
5. Repeat previous steps to measure and obtain values C2 and C3.

   Axis 5 play is the maximum one among C1, C2 and C3. It is acceptable is the value is less than 0.18 mm.



xx2100000110

Axis 6

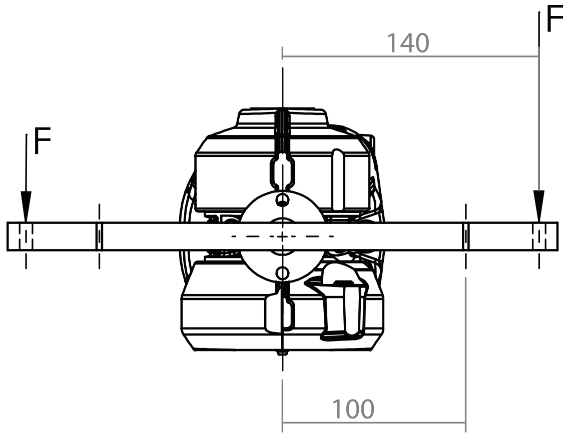
User the following procedure to measure the play of axis 6.

1. Load axis 6 with the force of 40 N downwards, unload to 3 N and start measure the play a1.
2. Load axis 6 with the force of 30 N downwards at the other end, unload to 3 N and start measure the play a2.

   The axis play will be C1=|a1|+|a2|.
3. Change the position of axis 6 by 180°.
4. Repeat previous steps to measure and obtain values C2 and C3.

Continues on next page

Axis 5 play is the maximum one among C1, C2 and C3. It is acceptable is the value is less than 0.3 mm.



xx2100000111

4.4.13 Measuring the play 1600ID/1660ID, axis 5

General

This section is only valid for IRB 1600ID/1660ID.

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

Required equipment

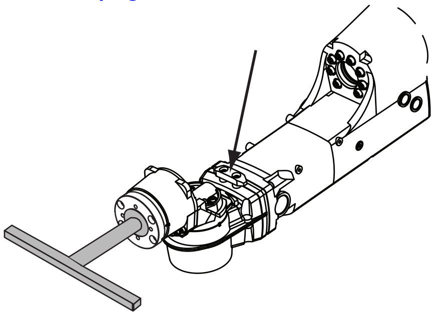
Equipment, etc.	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
Turning disk adapter	3HAC027717-020	
Measuring tool	3HAB9238-1	For measuring play.
Measuring bracket	3HAC032976-001	
Dial indicator with a magnetic foot	-	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Measurement, axis 5

Use this procedure to measure the play of axis 5.

	Action	Information
1	Move the robot to calibration position. Turn axis 4 to +90°.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Fit the *turning disk adapter* to the turning disk.	Art. no. is specified in *Required equipment on page 229*.
4	Fit the *measuring tool* to the turning disk adapter.	Art. no. is specified in *Required equipment on page 229*.

Continues on next page

	Action	Information
5	Fit the *measuring bracket* to the wrist. Use the holes that are pointed out in the figure.	Art. no. is specified in *Required equipment on page 229*.  xx1100000688
6	Fit the magnetic foot of the *dial indicator* on the measuring bracket.	
7	Place the tip of the dial indicator on the milled surface of the measuring tool shaft, as shown in the figure.	 xx1500000313
8	Verify that axis 5 is put in calibration position.	
9	Set the dial indicator to zero.	
10	Apply load F with a dynamometer, as shown in the figure. • IRB 1600ID-4/1.5: F = 40N • IRB 1660ID-X/1.55: F = 30N Remove the load and make a note of the value from the dynamometer, as value *a1*.	 xx1500000314

Continues on next page

	Action	Information
11	Apply the same load in the opposite direction (180°), as shown in the figure. Remove the load and make a note of the value from the dynamometer, as value *a2*.	 xx1500000315
12	Calculate the play in the axis as *a1* + *a2*. The values of *a1* and *a2* are absolute values.	The maximum play allowed is: • IRB 1600ID-4/1.5: 0.34 mm • IRB 1660ID-X/1.55: 0.25 mm
13	Turn on power.	
14	Turn axis 5 to +90°.	
15	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
16	Repeat *step 10* to *step 12*.	
17	Turn on power.	
18	Turn axis 5 to -90°.	
19	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
20	Repeat *step 10* to *step 12*.	

4.4.14 Measuring the play 1600ID/1660ID, axis 6

General

This section is only valid for IRB 1600ID/1660ID.

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

Required equipment

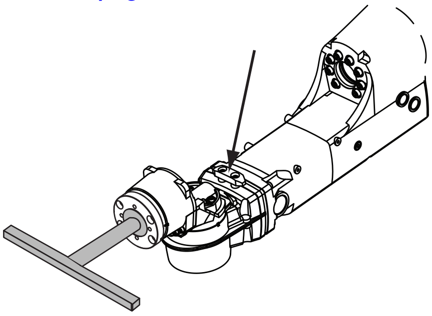
Equipment, etc.	Art. no.	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
Turning disk adapter	3HAC027717-020	
Measuring tool	3HAB9238-1	For measuring play.
Measuring bracket	3HAC032976-001	
Dial indicator with magnetic foot	-	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Measurement, axis 6

Use this procedure to measure the play of axis 6.

	Action	Information
1	Move the robot to calibration position. Turn axis 4 to +90°.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Fit the *turning disk adapter* to the turning disk.	Art. no. is specified in *Required equipment on page 232*.
4	Fit the *measuring tool* to the turning disk adapter.	Art. no. is specified in *Required equipment on page 232*.

Continues on next page

	Action	Information
5	Fit the *measuring bracket* to the wrist. Use the holes that are pointed out in the figure.	Art. no. is specified in *Required equipment on page 232*.  xx1100000688
6	Fit the magnetic foot of the *dial indicator* on the measuring bracket.	
7	Place the tip of the dial indicator on the marking, as shown in the figure.	 xx1500000316
8	Verify that axis 6 is put in calibration position.	
9	Set the dial indicator to zero.	
10	Apply load F=40N with a dynamometer on the opposite side of the dial indicator, as shown in the figure. Remove the load and make a note of the value from the dynamometer, as value *b1*.	 xx1500000317

Continues on next page

	Action	Information
11	Apply load F=40N downwards on another side, as shown in the figure. Remove the load and make a note of the value from the dynamometer, as value *b2*.	 xx1500000318
12	Calculate the play in the axis as *b1* + *b2*. The values of *b1* and *b2* are absolute values.	The maximum play allowed is: • IRB 1600ID-4/1.5: 0.25 mm • IRB 1660ID-X/1.55: 0.20 mm
13	Turn on power.	
14	Turn axis 6 to +180°.	
15	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
16	Repeat *step 10* to *step 12*.	

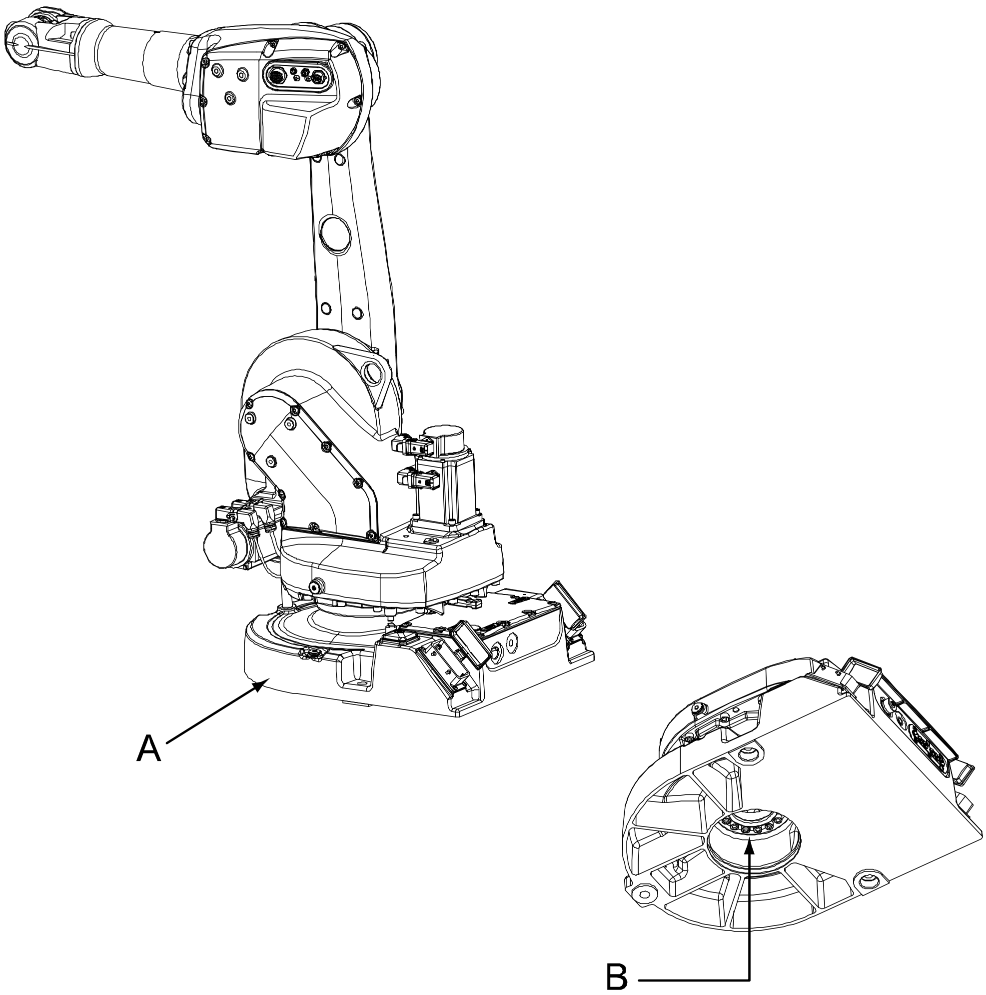
4.5 Frame and base

4.5.1 Replacement of base

Location of base

The base is located at the bottom of the robot as shown in the figure below.

A more detailed view of the base may be found in the spare part view, see *Spare parts - Base, exploded view*.



xx0500001453

A	Base
B	Attachment screws and washer, base-gearbox unit (VK-cover removed)

Required equipment

Equipment	Spare part no.	Art. no.	Note
Base, spare	For spare part number, see: • *Spare part lists on page 389*.		

Continues on next page

Equipment	Spare part no.	Art. no.	Note
V-ring (sealing ring)	3HAB3773-11		Replace if damaged.
VK-cover	3HAA2166-26		
Lifting slings		-	
Locking liquid			Loctite 574 For sealing the base to the gearbox 1-2.
Grease		3HAC042536-001	For lubricating the V-ring.
Isopropanol			For cleaning the mating surfaces.
Standard toolkit		-	Content is defined in section *Standard tools on page 385*.
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 347*.
	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

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Removal, base

The procedure below details how to remove the base from the robot.

	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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	
4	Remove the cabling inside the base and pull it up to the gearbox unit.	The cable layout in the base is shown in the figure *Illustration, cabling inside base on page 163*.
5	Remove the serial measurement unit.	Detailed in section *Removing the serial measurement unit on page 243*.
6	Unfasten the base from the installation site by removing the attachment bolts from the foundation.	
7	**CAUTION** The robot weighs . IRB 1600/IRB 1600ID: 250 kg IRB 1660ID: 257 kg All lifting accessories used must be sized accordingly!	
8	Fit the *lifting slings* to the robot, lift it and place it with the side of the lower arm downwards on a work bench. Be careful not to damage the motor connectors!	Art. no. is specified in *Required equipment on page 235*.

Continues on next page

	Action	Note
9	Remove the VK-cover from the base. **Tip!** Push out the cover from inside or drill a hole in the cover through which a tool can be inserted in order to bend out the cover.	
10	**CAUTION** The robot base weighs 81 kg. All lifting accessories used must be sized accordingly!	
11	Secure the weight of the base and remove the *gearbox/base attachment screws and washer*.	Shown in the figure *Location of base on page 235*.
12	Separate the base from the gearbox unit.	

Refitting, base

The procedure below details how to refit the base to the robot.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153*	
3	Place the robot with the side of the lower arm downwards on a workbench. Be careful not to damage the motor connectors.	
4	Clean the mating surfaces between the base and the gearbox unit with isopropanol.	
5	Check the *V-ring* on the gearbox unit. Lubricate with grease if needed. Replace it if damaged!	Spare part no. is specified in *Required equipment on page 235*.
6	Lubricate the mating surface on the base with Loctite 574.	
7	**CAUTION** The robot base weighs 81 kg. All lifting accessories used must be sized accordingly!	
8	Lift the base to mounting position.	

Continues on next page

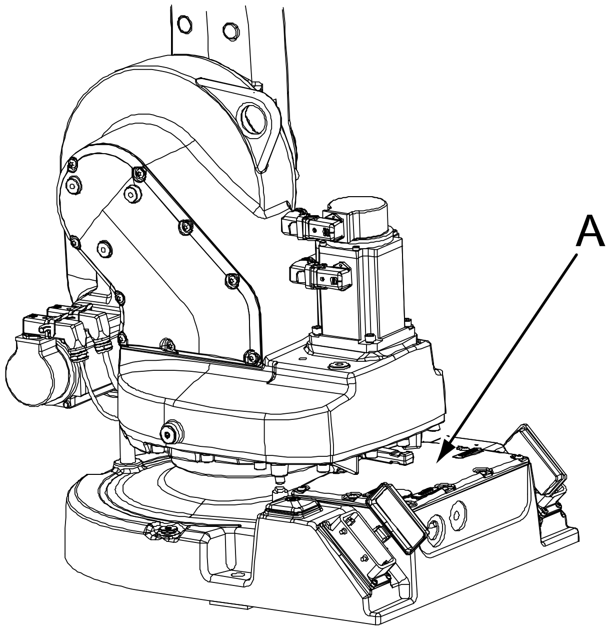
	Action	Note
9	Secure the base to the gearbox unit with the *gearbox/base attachment screws and washer.*	Shown in the figure *Location of base on page 235*. 16 pcs, M10 x 40, tightening torque: 70 Nm.
10	Refit a new *VK-cover* to the base.	Spare part no. is specified in *Required equipment on page 235*.
11	**CAUTION** The robot weighs . IRB 1600/IRB 1600ID: 250 kg IRB 1660ID: 257 kg All lifting accessories used must be sized accordingly!	
12	Turn the robot to stand upright.	
13	Secure the base to the foundation.	Attachment bolts and tightening torque are specified in section *Attachment bolts, specification on page 64*.
14	Pull down the cabling and refit it inside the base.	The cable layout inside the base is shown in the figure *Illustration, cabling inside base on page 163*.
15	Refit the serial measurement unit.	Detailed in section *Refitting the serial measurement unit on page 245*.
16	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
17	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.5.2 Replacing the serial measurement unit

Location of serial measurement unit

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

A more detailed view of the base may be found in the spare part view, see *Spare parts - Base, exploded view*.



xx0500001390

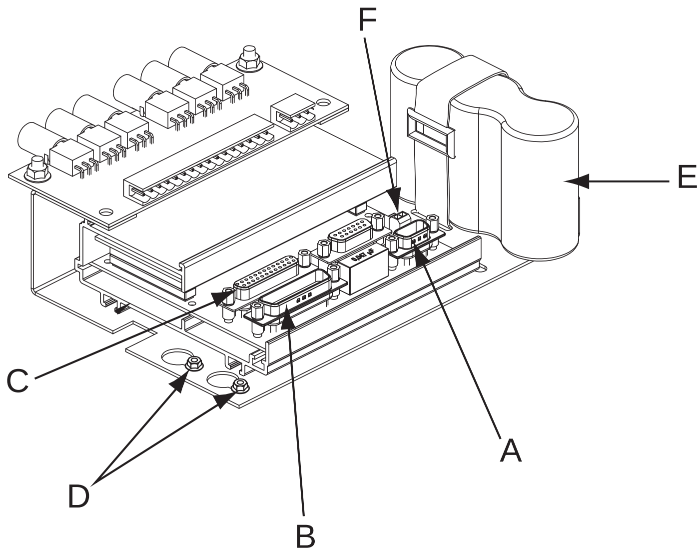
A	Base cover, including gasket. Serial measurement unit is located beneath the cover.

Continues on next page

Serial measurement unit layout

The complete spare part of the serial measurement unit is shown in the figure.

DSQC 633A

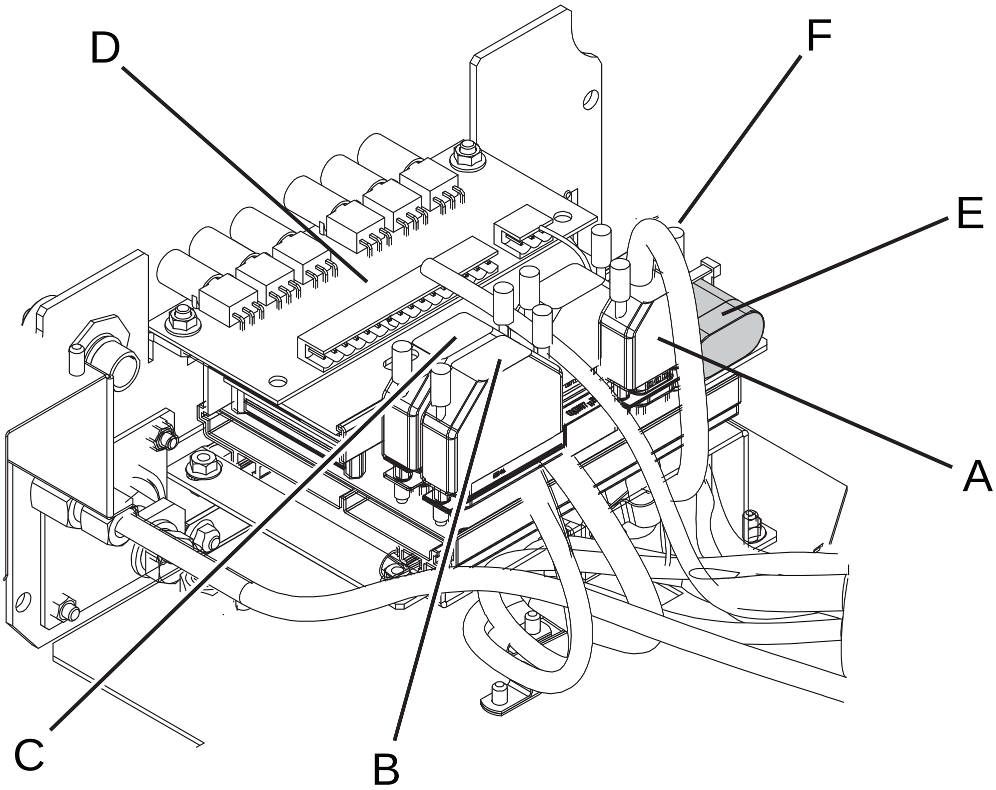


xx0500001391

A	Connector SMB
B	Connector SMB1-4
C	Connector SMB 3-6
D	Hexagon nuts (totally 4 pcs)
D	Hexagon nuts (totally 2 pcs). Only the outer nuts are used.
E	Battery pack (2-pole battery contact)
F	Battery cable connector

Continues on next page

RMU 101



xx1300000331

A	Connector SMB
B	Connector SMB1-4
C	Connector SMB 3-6
D	BU unit
E	Battery pack (3-pole battery contact)
F	Battery cable connector

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	Art. no.	Note
Serial measurement unit	See *Spare part lists on page 389*.	
Battery pack	See *Spare part lists on page 389*.	

Continues on next page

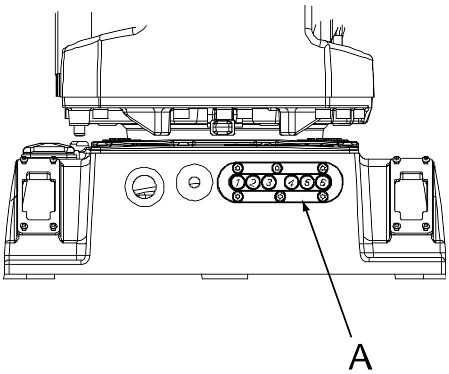
Equipment	Art. no.	Note
Gasket, base cover	See *Spare part lists on page 389*.	
Centering piece	3HAC025815-001	Fitted to the push button unit in order to align it correctly. Replace if damaged.
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
Circuit diagram	-	See chapter *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Removing the serial measurement unit

Use this procedure remove the serial measurement 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	Remove the push button guard from the base.	The push button guard must be removed to ensure a correct refitting of the push buttons.  xx0600002744 A Push button guard

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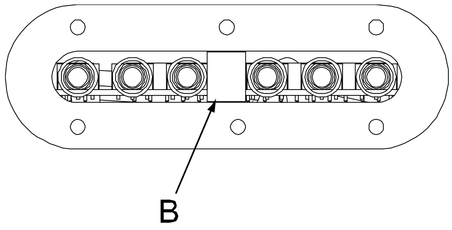
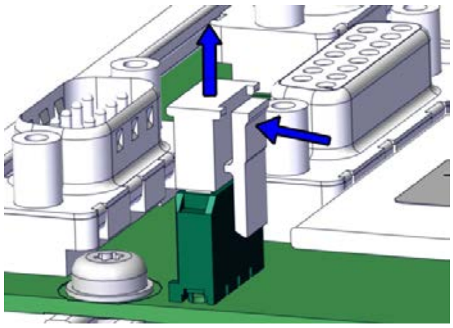
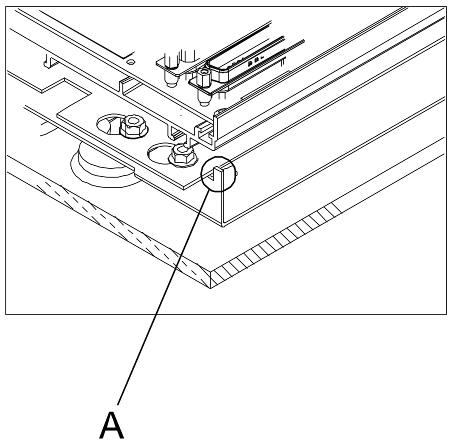
	Action	Note
3	Remove the centering piece from the push button unit.	 xx0600002776 • B: Centering piece
4	Remove the *base cover*. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	Shown in the figure *Location of serial measurement unit on page 240*.
5	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
6	Disconnect all remaining connectors to the serial measurement unit and push button units.	
7	Unscrew the *hexagon nuts* on the serial measurement unit a little and slide the SMB unit out. Do not remove the nuts!	Shown in the figure *Serial measurement unit layout on page 241*.
8	Lift and pull the serial measurement unit backwards, over the lip (A), and lift it away.	 xx0500001455

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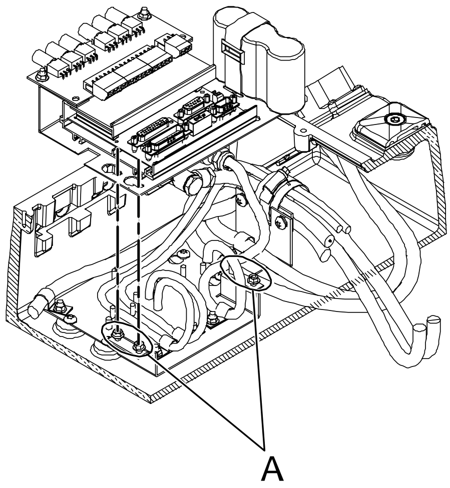
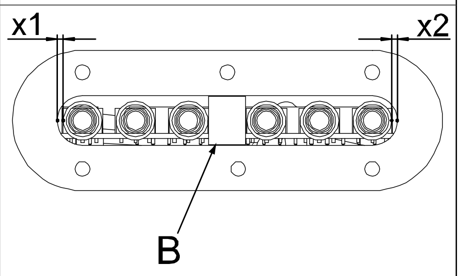
Refitting the serial measurement unit

Use this procedure refit the serial measurement unit.

	Action	Note
1	Fit the serial measurement unit on to the four pins.	 xx0500001392 A Pins
2	Slide the unit into position, within the lips, and secure with the four hexagon nuts.	Make sure the unit is positioned as straight as possible! The push buttons can otherwise get jammed.
3	Reconnect all the *connectors*. Make sure the lock on the battery cable connector R2.G snaps into place during refitting.	Shown in the figure *Serial measurement unit layout on page 241*.
4	Refit the centering piece (B) to the push button unit in order to align it vertically. Also make sure that the unit is correctly aligned sideways: the measurements x1 and x2 in the figure to the right should not differ more than 1 mm from each other!	 xx0600002777 Art. no. for the centering piece is specified in *Required equipment on page 242*.
5	Check the *gasket* of the base cover. Replace it if damaged.	Spare part no. is specified in *Required equipment on page 242*.
6	Refit the *base cover*.	Shown in the figure *Location of serial measurement unit on page 240*.
7	**WARNING** Before continuing any service work, follow the safety procedure in section *The brake release buttons may be jammed after service work on page 155*!	
8	Refit the push button guard to the robot base.	

Continues on next page

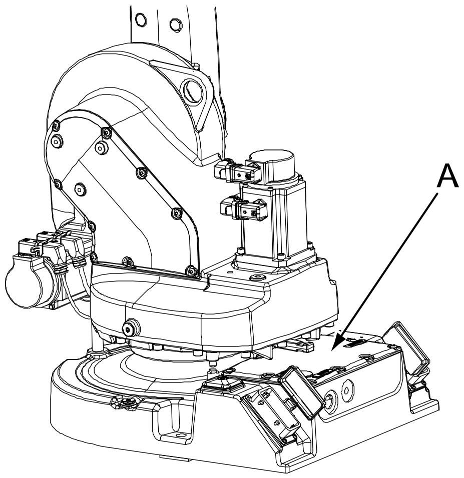
	Action	Note
9	Press the push buttons 1 to 6, one at a time, to make sure that the buttons are moving freely and do not stay in any locked position.	
10	Update the revolution counters!	Detailed in section *Updating revolution counters on page 342*..

4.5.3 Replacing the push button unit

Location of push button unit

The push button unit for brake release is located inside the base of the robot.

A more detailed view of the component and its location is shown in the spare part view, see *Spare parts - Base, exploded view*..

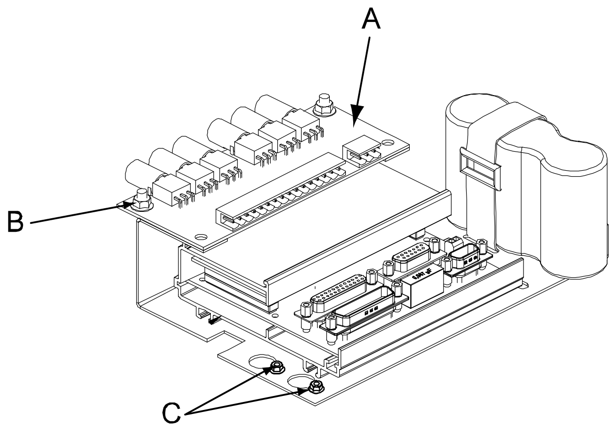


xx0500001390

A	Base cover, including gasket. Push button unit is located beneath the cover.

Push button unit on serial measurement unit

The push button unit is attached to the serial measurement unit as shown in the figure.



xx0500001394

A	Push button unit
B	Hexagon nuts (2 pcs)
C	Hexagon nuts, SMB unit (4 pcs). Only the outer ones are used.

Continues on next page

Required equipment

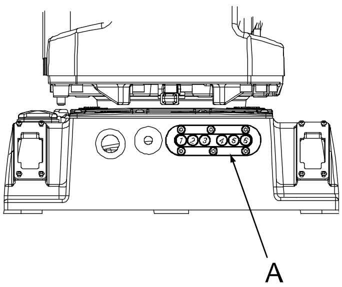
Equipment	Article number	Note
DSQC1054 Push button/Brake release unit	3HAC064944-001	
Gasket, base cover	3HAC022047-001	
Centering piece	3HAC025815-001	Fitted to the push button unit in order to align it correctly. Replace if damaged.
Standard toolkit		Content is defined in section *Standard tools on page 385*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Removing the push button unit

Use this procedure to remove the push button 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 57*.	
3	Remove the push button guard from the base.	The push button guard must be removed to ensure a correct refitting of the push button unit.  xx0600002744 A Push button guard

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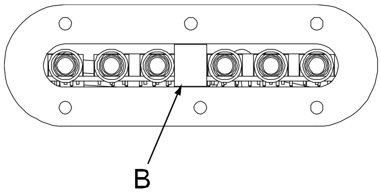
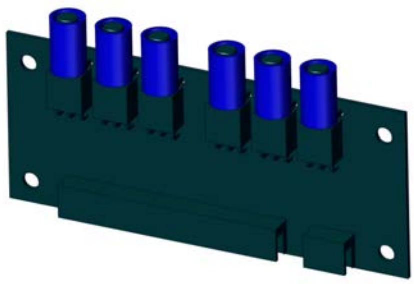
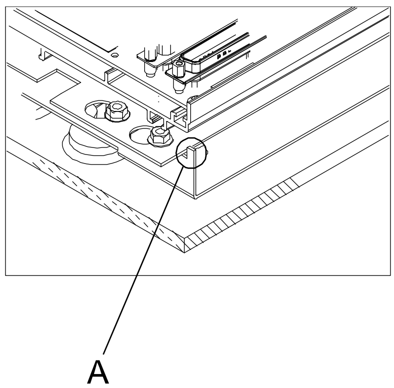
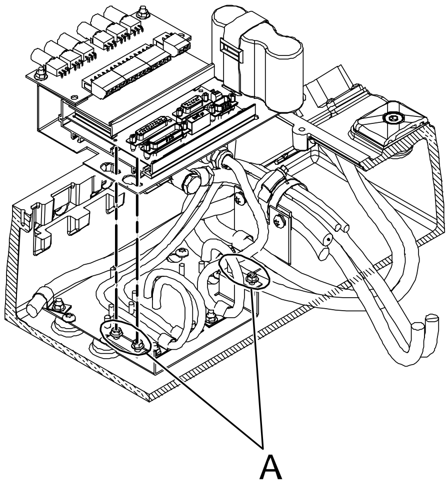
	Action	Note
4	Remove the centering piece from the push button unit.	 xx0600002776 • B: Centering piece
5	Remove the *base cover* from the robot. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	Shown in the figure *Location of push button unit on page 247*.
6	Take a picture or make notes of how the robot cabling is positioned in regard to the push button unit.	
7	Disconnect the connectors from the *brake release board.*	 xx1800000171
8	Unscrew the four *hexagon nuts on the SMB unit* enough to enable lifting the unit. Do not remove the nuts.	Shown in the figure *Push button unit on serial measurement unit on page 247*.
9	Lift and pull the serial measurement unit backwards, over the lip (A), and lift it away.	 xx0500001455
10	Remove the two *hexagon nuts* from the push button unit.	Shown in the figure *Push button unit on serial measurement unit on page 247*.
11	Remove the push button unit by lifting it up.	

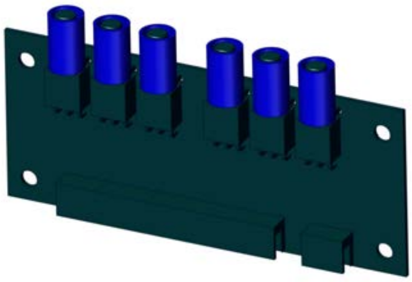
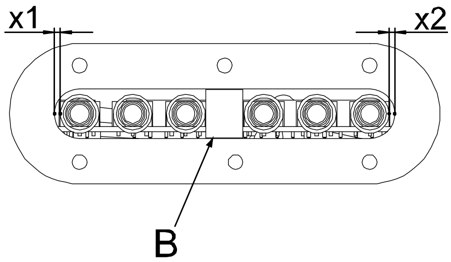
Continues on next page

Refitting the push button unit

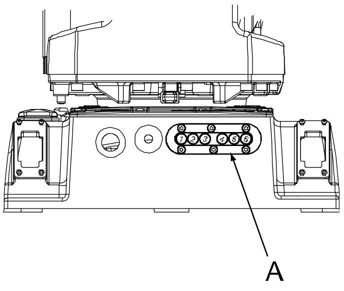
Use this procedure to refit the push button unit.

	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 57*.	
3	Fit the new *push button unit* to the serial measurement unit.	Maximum tightening torque: 5 Nm. Spare part no. is specified in *Required equipment on page 248*. Shown in the figure *Push button unit on serial measurement unit on page 247*.
4	Fit the serial measurement unit on to the four pins.	 xx0500001392 A Pins
5	Slide the unit into position, within the lips, and secure with the four hexagon nuts.	Make sure the unit is positioned as straight as possible! The push buttons can otherwise get jammed.

Continues on next page

	Action	Note
6	Reconnect all the connectors to the board. Be careful not to damage the sockets or pins. Make sure the connector and its locking arms are snapped down properly.	 xx1800000171
7	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.	
8	Check the *gasket* of the base cover. Replace it if damaged.	Spare part no. is specified in *Required equipment on page 248*.
9	Refit the base cover.	Shown in the figure *Location of push button unit on page 247*.
10	Refit the centering piece (B) to the push button unit in order to align it vertically. Also make sure that the unit is correctly aligned sideways: the measurements x1 and x2 in the figure to the right should not differ more than 1 mm from each other!	 xx0600002777
11	**WARNING** Before continuing any service work, follow the safety procedure in section *The brake release buttons may be jammed after service work on page 155*!	

Continues on next page

	Action	Note
12	Refit the push button guard to the robot base.	 xx0600002744 A Push button guard
13	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 any locked position.	
14	Update the revolution counters!	Detailed in section *Updating revolution counters on page 342*..
15	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

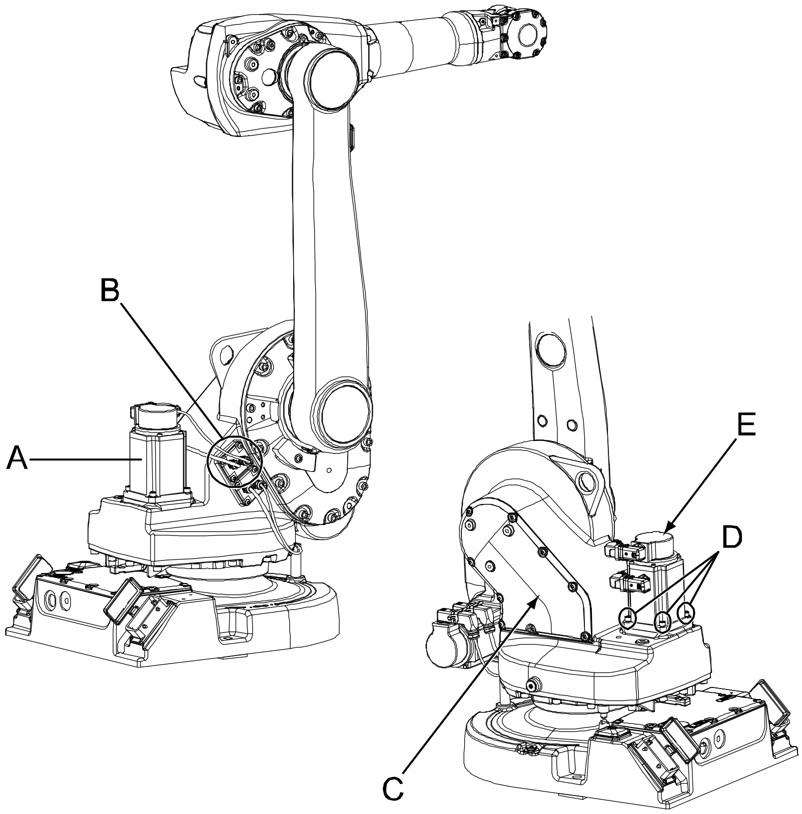
4.6 Motors

4.6.1 Replacement of motor, axis 1

Location of motor

The axis 1 motor is located on the frame, as shown in the figure.

A more detailed view of the motor and its position may be found in the spare part view, see *Spare parts - Frame, exploded view*.



xx0400001256

A	Motor, axis 1
B	Connector plate for motor cabling
C	Cover, frame
D	Attachment screws, motor (4 pcs)
E	Motor cover

Required equipment

Equipment	Art. no.	Note
Standard, Rot. ac motor incl. pinion	For spare part number, see: • *Spare part lists on page 389*	Cable harness, motor axes 1-2 must be ordered separately.

Continues on next page

Equipment	Art. no.	Note
Cable harness, motor axes 1-2	For spare part number, see: • *Spare part lists on page 389*	
O-ring	21522012-428	O-ring, motor. Replace if damaged.
Gasket, gearbox axis 1-2	For spare part number, see: • *Spare part lists on page 389*	Replace if damaged.
Power supply	-	24 VDC, max 1.5 A For releasing the brakes.
Isopropanol	-	Used to clean mating surfaces.
Locking liquid	-	Loctite 574
Rotation tool, motor	3HAC022266-003	
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
Circuit diagram	-	See *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.

Continues on next page

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

Removing the motor axis 1

Use this procedure to remove the motor, axis 1.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the *cover, frame*.	Shown in the figure *Location of motor on page 253*.
4	Disconnect the connectors for the motor.	
5	Loosen the *connector plate* from the frame.	
6	Pull out the motor cabling carefully.	
7	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP1: • +: pin 7 • -: pin 8
8	Unscrew the *attachment screws* securing the motor.	Shown in the figure *Location of motor on page 253*.
9	Remove the motor by gently lifting it straight up, making sure the motor pinion is not damaged against the gear.	
10	Disconnect the brake release voltage from the motor connector.	

Refitting the motor axis 1

Use this procedure to refit the motor, axis 1.

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

Continues on next page

	Action	Note
2	**Note** It is important that the gearbox and the mating motor pinion are provided by the same sub-supplier, make sure to order the correct spare part! To determine the correct spare part, see *Compatible gearboxes and motors* in *Product manual, spare parts - IRB 1600/1660*.	
3	Clean the mating surfaces.	
4	Replace the *o-ring* if damaged. 1 Apply enough Loctite 574 to the motor groove. 2 Refit the o-ring. Make sure the *o-ring* on the circumference of the motor is seated properly.	Spare part number is specified in *Required equipment on page 253*.
5	Remove the *motor cover* from top of the motor.	Shown in the figure *Location of motor on page 253*.
6	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP1: • +: pin 7 • -: pin 8
7	Fit the *rotation tool* to the end of the motor shaft.	Article number is specified in *Required equipment on page 253*.
8	Fit the motor, making sure the motor pinion is properly mated to the gear of gearbox, axis 1. Use the *rotation tool* to rotate the motor pinion, when mating it to the gear.	
9	Secure the motor with four attachment screws and washers, but do not tighten yet.	4 pcs, M8 x 25.
10	Adjust the motor in relation to the gear in the gearbox: • use the rotation tool to wiggle the motor shaft back and forth to feel the play. Tap with a plastic mallet. • position the motor pinion at at least two other positions by turning axis 1 manually and check the gear play again.	There should be a barely noticable gear play.
11	Tighten the motor attachment screws.	Tightening torque: 35 Nm.
12	Disconnect the brake release voltage.	
13	Refit the *motor cover* to top of the motor.	Shown in the figure *Location of motor on page 253*.
14	Insert the motor cabling through the frame and secure the *connector plate* with attachment screws.	4 pcs.
15	Connect all the connectors.	The cable layout is shown in the figure *Illustration, cabling inside frame on page 162*.
16	Refit the cover, frame. Replace the *gasket*, if damaged.	

Continues on next page

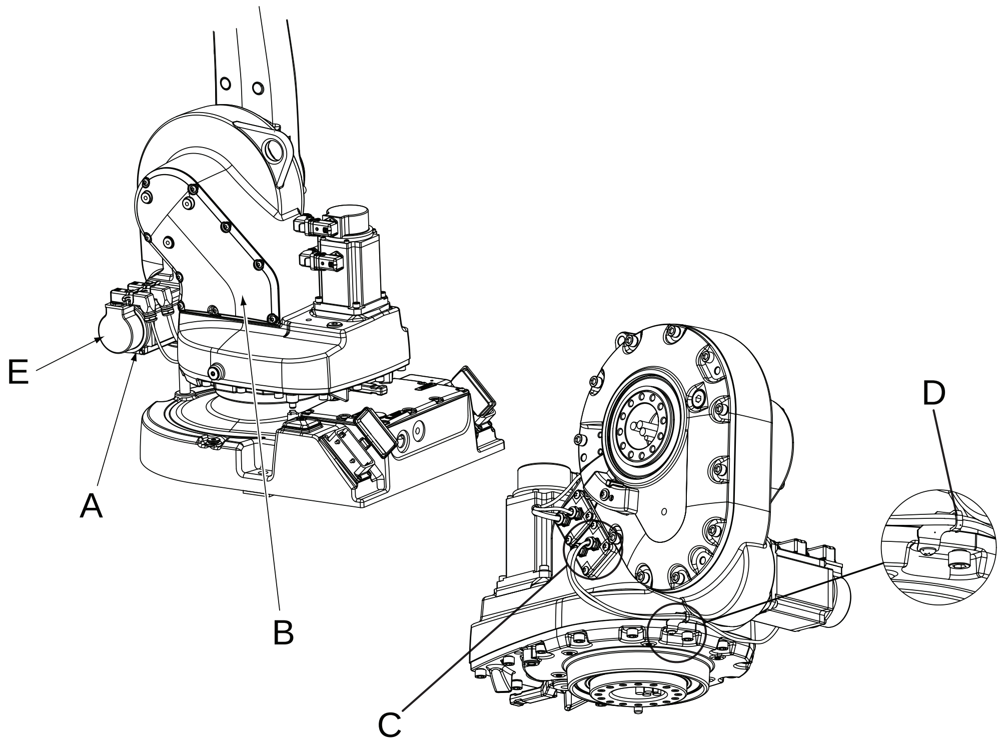
	Action	Note
17	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.6.2 Replacement of motor, axis 2

Location of motor axis 2

The motor axis 2 is located on the front of the robot as shown in the figure.

A more detailed view of the motor and its position may be found in the spare part view, see *Spare parts - Frame, exploded view*.



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A	Motor, axis 2
B	Cover, frame
C	Connector plate for motor cabling
D	Bracket and cable tie
E	Motor cover

Required equipment

Equipment, etc.	Art. no.	Note
Rot. ac motor with pinion	For spare part number, see: • *Spare part lists on page 389*	
Cable harness, motor axes 1-2	For spare part number, see: • *Spare part lists on page 389*	

Continues on next page

Equipment, etc.	Art. no.	Note
O-ring	21522012-428	Must be replaced when replacing motor.
Gasket, gearbox axis 1-2	For spare part number, see: • *Spare part lists on page 389*	Replace if damaged.
Locking liquid		Loctite 574
Isopropanol	-	For cleaning mating surfaces.
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
Rotation tool, motor	3HAC022266-003	For adjusting the gear play, motor/pinion
Power supply	-	24 VDC, 1.5 A. For releasing the brakes.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	-	See chapter *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.

Continues on next page

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

Removal, motor axis 2

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

	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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	
4	Remove the *cover, frame*.	Shown in the figure *Location of motor axis 2 on page 258*.
5	Disconnect the motor connectors inside the frame.	Connectors: • R3.MP2 • R3.FB2
6	Cut any cable ties and remove any brackets or clamps securing the cables.	
7	Remove the *connector plate* by removing its attachment screws, and pull the cables out from the frame.	Shown in the figure *Location of motor axis 2 on page 258*.
8	**DANGER** Secure the weight of the lower arm properly before releasing the brakes of motor, axis 2! When releasing the holding brakes of the motor, the lower arm will be movable and may fall down!	
9	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP2 • +: pin 7 • -: pin 8

Continues on next page

	Action	Note
10	**WARNING** Oil will be running out of the motor attachment hole when removing the motor! It may also be hot! Take any necessary measures to collect the oil.	
11	Remove the motor by unscrewing its four *attachment screws* and plain washers.	Shown in the figure *Location of motor axis 2 on page 258*.
12	Remove the motor by gently pulling it out, making sure the motor pinion does not get damaged while moving it away from the gear.	
13	Disconnect the brake release voltage.	
14	Remove any remaining oil from the gearbox by siphoning it off.	

Refitting, motor axis 2

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

	Action	Note
1	**Note** It is important that the gearbox and the mating motor pinion are provided by the same sub-supplier, make sure to order the correct spare part! To determine the correct spare part, see *Compatible gearboxes and motors* in *Product manual, spare parts - IRB 1600/1660*.	
2	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153*	
3	Make sure the mating surfaces on the motor and the gearbox are clean and free from burrs. If necessary, clean the surfaces with isopropanol.	
4	Replace the *o-ring* if damaged. 1 Apply enough Loctite 574 to the motor groove. 2 Refit the *o-ring*. Make sure the *o-ring* on the circumference of the motor is seated properly.	Art. no. is specified in section *Required equipment on page 258*.
5	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP2: • +: pin 7 • -: pin 8
6	Remove the *motor cover* from top of the motor.	Shown in the figure *Location of motor axis 2 on page 258*.
7	Fit the *rotation tool* to the end of the motor shaft.	Art. no. is specified in section *Required equipment on page 258*.
8	Fit the motor, making sure the motor pinion is properly mated to gearbox 2. Use the rotation tool to rotate the motor pinion, when mating it to the gear.	Make sure the motor is turned the right way, i.e. connections upwards. Make sure the motor pinion does not get damaged!

Continues on next page

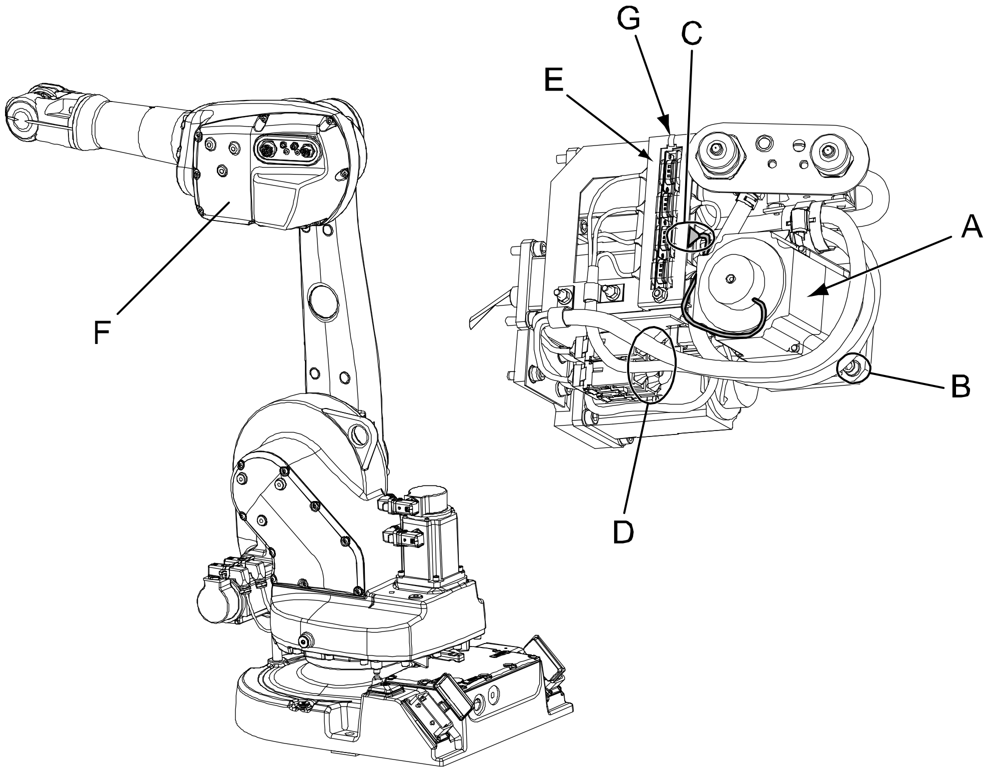
	Action	Note
9	Secure the motor with four attachment screws and plain washers, but do not tighten yet.	4 pcs, M8 x 25. Tightening torque: approx 2 Nm.
10	Adjust the motor in relation to the gear in the gearbox. Use the rotation tool to wiggle the motor shaft back and forth to feel the play. Tap with a plastic mallet.	There should be a barely noticable gear play.
11	Refit the motor cover to the top of the motor. Be careful not to damage the cables!	
12	Tighten the motor attachment screws.	Tightening torque: 35 Nm
13	Disconnect the brake release voltage.	
14	Refit the *connector plate* with its attachment screws.	Shown in the figure *Location of motor axis 2 on page 258*.
15	Reconnect the motor connectors inside the frame.	Cable layout is shown in the figure *Illustration, cabling inside frame on page 162*.
16	Refit all cable ties, and the *bracket* underneath the frame.	Shown in the figure *Location of motor axis 2 on page 258*.
17	Refit the *cover, frame*. Replace the gasket, if damaged.	Shown in the figure *Location of motor axis 2 on page 258*. Art. no. for the gasket is specified in section *Required equipment on page 258*.
18	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 146*.
19	Refill the gearbox with oil.	See, *Technical reference manual - Lubrication in gearboxes*.
20	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
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 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.6.3 Replacement of motor, axis 3, IRB 1600

Location of motor

The motor of axis 3 is located inside the upper arm housing, as shown in the figure below.

A more detailed view of the motor and its position may be found in the spare part view, *Spare parts - Upper arm, exploded view*.



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A	Motor, axis 3
B	Attachment screws and washers of the motor (4 pcs)
C	Signal connector R3.FB3
D	Power connector R3.MP3
E	Connector holder
F	Upper arm housing cover
G	Cable tie

Required equipment

Equipment	Art. no.	Note
Rot. ac motor incl pinion	For spare part number, see: • *Spare part lists on page 389*	
O-ring	21522012-426	Replace if damaged.

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Equipment	Art. no.	Note
Gasket, upper arm cover	3HAC022049-001	Replace if damaged.
Gasket, customer connections	3HAC022050-001	Replace if damaged.
Isopropanol	-	Used for cleaning the mating surfaces.
Grease	3HAC042536-001	Used for lubricating the o-ring.
Rotation tool, motor	3HAC022266-003	For adjusting the gear play.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram		See chapter *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	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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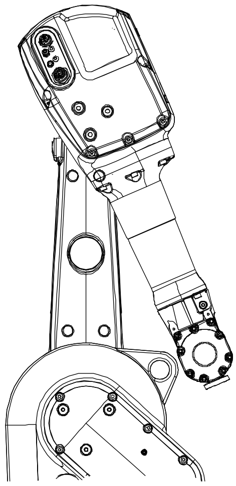
Removal, motor axis 3

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

	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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove any additional mechanical stops from axis 3.	
4	Move: • axis 2 to calibration position • upper arm backwards against the mechanical stop. This position enables removal of the motor without draining of the gearbox, axis 3.	 xx0500001447
5	Remove the *upper arm housing cover*.	Shown in the figure *Location of motor on page 263*.
6	Disconnect the motor connectors R3.MP3 and R3.FB3.	Shown in the figure *Location of motor on page 263*.
7	 **DANGER** Secure the weight of the upper arm properly before releasing the brakes of motor, axis 3. When releasing the holding brakes of the motor, the upper arm will be movable and may fall down!	
8	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP3: • +: pin 7 • -: pin 8
9	Remove the motor, axis 3, by unscrewing its attachment screws and washers. Lift the motor gently straight out, making sure the motor pinion is not damaged.	
10	Disconnect the brake release voltage.	

Continues on next page

Refitting, motor axis 3

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

	Action	Note
1	**Note** It is important that the gearbox and the mating motor pinion are provided by the same sub-supplier, make sure to order the correct spare part! To determine the correct spare part, see *Compatible gearboxes and motors* in *Product manual, spare parts - IRB 1600/1660*.	
2	Clean the mating surfaces inside the upper arm housing and on the motor with isopropanol.	
3	Make sure the *o-ring* on the circumference of the motor is seated properly. Ligthly lubricate it with grease.	Replace the o-ring if damaged. Art .no. is specified in section *Required equipment on page 263*.
4	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP3: • +: pin 7 • -: pin 8
5	Fit the motor to the upper arm housing, making sure the motor pinion is properly mated to the gear of axis 3.	
6	Fit the *attachment screws and washers* but do not tighten them yet.	4 pcs, M6 x 20. Shown in the figure *Location of motor on page 263*.
7	Fit the *rotation tool* to the end of the motor shaft.	Art. no. is specified in *Required equipment on page 263*.
8	Adjust the motor in relation to the gear. Use the rotation tool to wiggle the motor shaft back and forth to feel the play.	There should be a barely noticable gear play.
9	Tighten the motor attachment screws.	Tightening torque: 10 Nm.
10	Disconnect the brake release voltage.	
11	Reconnect the motor connectors, run and secure the cabling correctly inside the upper arm housing.	Cable layout is shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
12	Refit the *cover, upper arm housing*. Check both the *gaskets* and replace, if damaged.	Shown in the figure *Location of motor on page 263*. Art. no. is specified in section *Required equipment on page 263*.
13	Refit any additional mechanical stops.	Detailed in section *Installation of additional mechanical stops on axis 3 on page 105*.

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	Action	Note
14	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
15	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

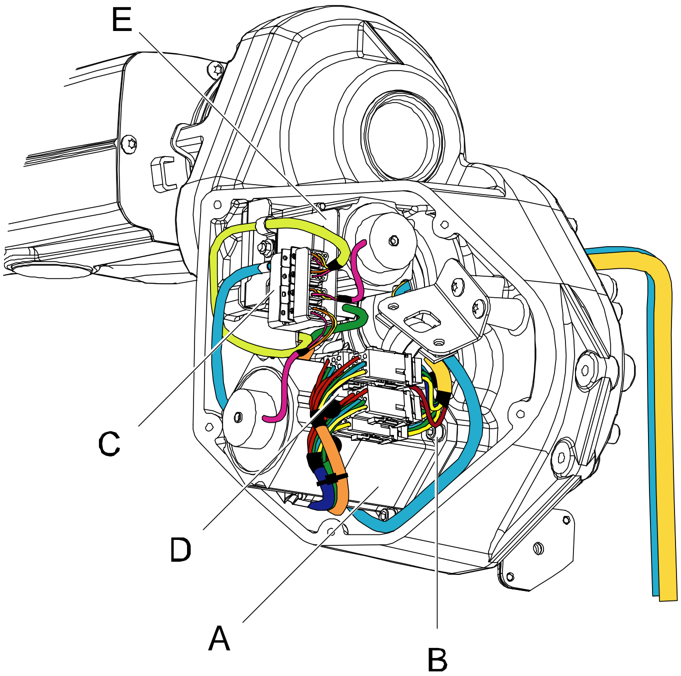
4.6.4 Replacement of motor, axis 3, 1600ID/1660ID

Note

After replacement of motors/motor in a manipulator, recalibration is required.

Location of motor

The motor of axis 3 is located inside the upper arm housing, as shown in the figure below.



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A	Motor, axis 3
B	Attachment screws and washers of the motor (4 pcs)
C	Signal connector R3.FB3
D	Power connector R3.MP3
E	Connector holder

Required equipment

Equipment	Art.no.	Note
Rot. ac motor incl pinion	For spare part number, see: • *Spare part lists on page 389*.	
O-ring	3HAB3772-100	
Isopropanol		Used for cleaning the mating surfaces.
Grease		

Continues on next page

Equipment	Art.no.	Note
Standard tools		*Standard tools on page 385*
Circuit diagram		
Pendulum Calibration tool		

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Deciding calibration routine

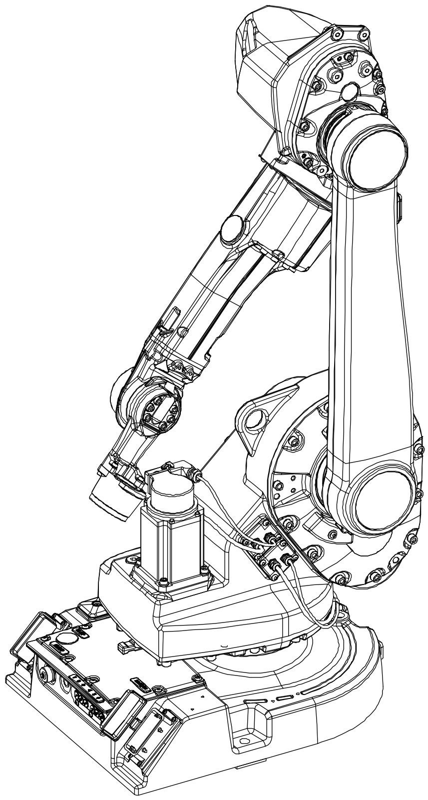
Decide which calibration routine to be used, based on the information in the table. Depending on which routine is chosen, action might be required prior to beginning the repair work of the robot, see the table.

	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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

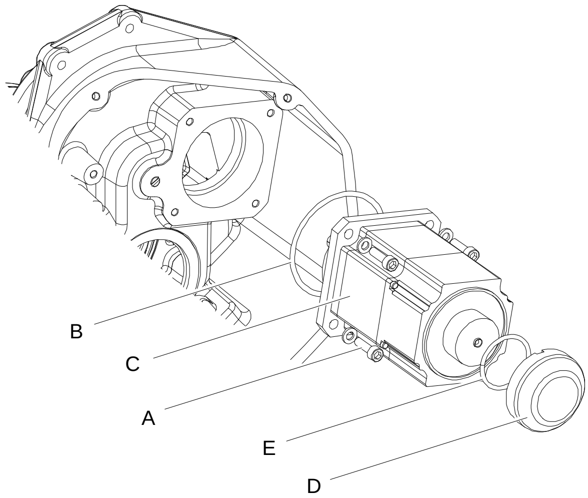
Removal, motor axis 3

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

Continues on next page

	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP3: • +: pin 7 • -: pin 8
4	Remove any additional mechanical stops from axis 3.	
5	Move: • axis 2 to calibration position • upper arm backwards against the mechanical stop This position enables removal of the motor without draining oil of the gearbox, axis 3.	 xx0700000010
6	Remove the *upper arm housing cover*.	Shown in the figure *Location of motor on page 268*
7	Disconnect the motor connectors R3.MP3 and R3.FB3.	Shown in the figure *Location of motor on page 268*

Continues on next page

	Action	Note
8	**DANGER** Secure the weight of the upper arm properly before releasing the brakes of motor, axis 3. When releasing the holding brakes of the motor, the upper arm will be movable and fall down!	
9	**DANGER** The motor has a high temperature after running which can occur burns.	
10	Remove the motor, axis 3, by unscrewing its attachment screws and washers. Lift the motor gently straight out, making sure the motor pinion is not damaged.	 xx0700000050 A Hex socket head cap screw B O-ring C Motor axis 3 D Resolver cover E O-ring
11	Remove the resolver cover for refitting on the new motor.	
12	Disconnect the brake release voltage.	

Continues on next page

Refitting, motor axis 3

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

	Action	Note
1	**Note** It is important that the gearbox and the mating motor pinion are provided by the same sub-supplier, make sure to order the correct spare part! To determine the correct spare part, see *Compatible gearboxes and motors* in *Product manual, spare parts - IRB 1600/1660*.	
2	Clean the mating surfaces inside the upper arm housing and on the motor with Isopropanol.	
3	Make sure the *o-ring* on the circumference of the motor is seated properly. Lubricate it with grease.	Replace the o-ring if damaged. Part number is specified in section *Required equipment on page 263*.
4	Fit the new motor to the upper arm housing, making sure the motor pinion is properly mated to the gear of axis 3.	
5	Fit the *attachment screws and washers* but do not tighten them yet.	4 pcs, M6 x 20. Shown in the figure *Location of motor on page 268*.
6	Fit the *rotation tool* to the end of the motor shaft.	Part number is specified in *Required equipment on page 263*.
7	Adjust the motor in relation to the gear. Use the rotation tool to wiggle the motor shaft back and forth to feel the play.	There should be a barely noticeable gear play.
8	Tighten the motor attachment screws.	**Tightening torque: 10 Nm.**
9	Refit the resolver cover on the new motor.	
10	Reconnect the motor connectors, run and secure the cabling correctly inside the upper arm housing.	Cable layout is shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
11	Refit the *cover, upper arm housing*.	Shown in the figure *Location of motor on page 268*. Art. no. is specified in section *Required equipment on page 263*.
12	Refit any additional mechanical stops.	Detailed in section *Installation of additional mechanical stops on axis 3 on page 105*.
13	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.

Continues on next page

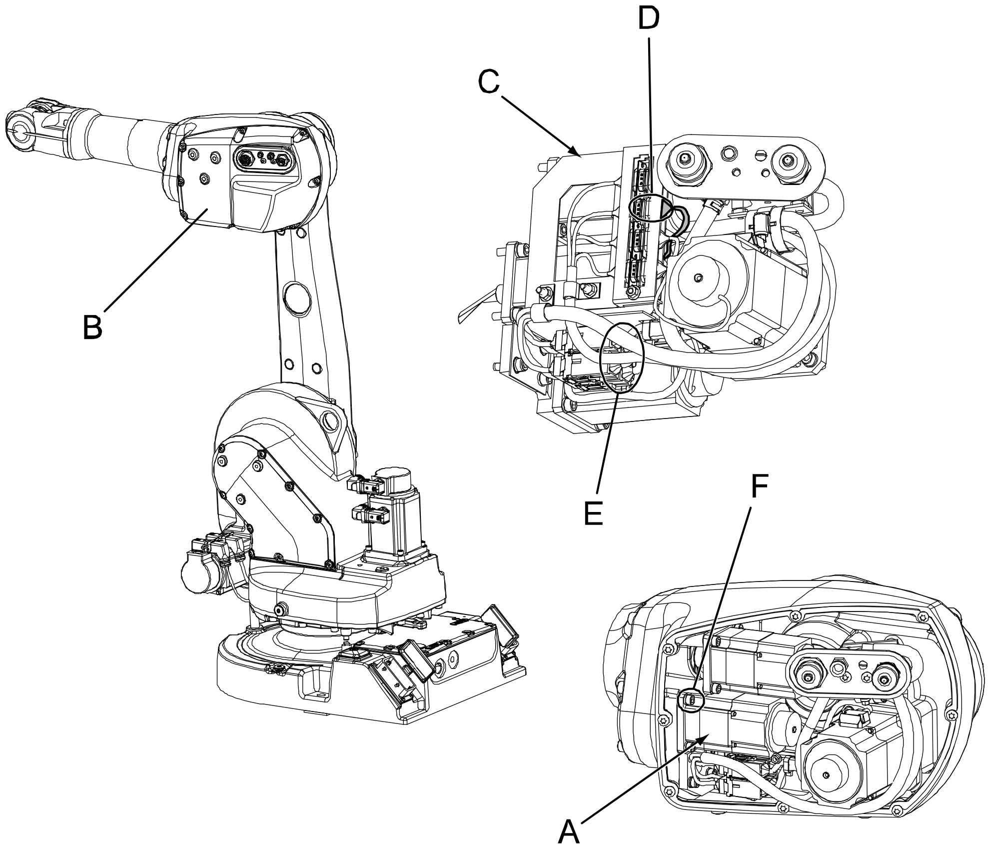
	Action	Note
14	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

4.6.5 Replacement of motor, axis 4, IRB 1600

Location of motor

The axis 4 motor is located inside the upper arm housing, as shown in the figure below.

A more detailed view of the component and its position may be found in the spare part view, *Spare parts - Upper arm, exploded view*.



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A	Motor, axis 4
B	Cover, upper arm housing
C	Connector plate
D	Signal connector, R3.FB4
E	Power connector, R3.MP4
F	Attachment screw and washer, motor (4 pcs)

Required equipment

Equipment, etc.	Spare part no.	Art. no.	Note
Rot. ac motor with pinion	For spare part number, see: • *Spare part lists on page 389*		

Continues on next page

Equipment, etc.	Spare part no.	Art. no.	Note
O-ring		3HAB3772-81	Replace if damaged.
Gasket, upper arm cover	3HAC022049-001		Replace if damaged.
Gasket, customer connections	3HAC022050-001		Replace if damaged.
Grease		3HAC042536-001	Used for lubricating the o-ring.
Standard toolkit			Content is defined in section *Standard tools on page 385*.
Power supply		-	24 VDC, max. 1,5 A. For releasing the brakes.
Rotation tool, motor		3HAC022266-003	For adjusting the gear play.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 391*.

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 347*.
	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

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	
4	Manually move the robot to a position where the upper arm points straight down.	This will enable the motor 4 to be removed without draining the oil in the gearbox.
5	Remove the cover from the upper arm housing.	
6	Remove the *connector plate* to get access to the axis 4 motor.	Shown in the figure *Location of motor on page 274*.
7	Disconnect the connectors R3.MP4 and R3.FB4 from the axis 4 motor.	
8	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4 • +: pin 7 • -: pin 8
9	Remove the *motor, axis 4* by unscrewing the motor *attachment screws*.	Shown in the figure *Location of motor on page 274*.
10	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	
11	Remove the motor by gently lifting it out.	Make sure the motor pinion is not damaged!

Continues on next page

Refitting, motor axis 4

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

	Action	Note
1	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153*	
2	Clean the mating surfaces on the *motor* and the gearbox.	Shown in the figure *Location of motor on page 274*.
3	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 section *Required equipment on page 274*.
4	In order to release the brakes, connect the 24 VDC power supply to the motor.	Connect to connector R3.MP4 • +: pin 7 • -: pin 8
5	Fit the motor with the *attachment screws* and washers. Until the motor shaft is adjusted to the gear, as described in following steps, only tighten the screws lightly.	Shown in the figure *Location of motor on page 274*. Tightening torque: approx. 2 Nm. 4 pcs, M6 x 20.
6	Fit the *rotational tool* to the end of the motor shaft.	Art. no. is specified in section *Required equipment on page 274*.
7	Adjust the motor in relation to the gear in the gearbox. Use the arm tool to wiggle the motor shaft back and forth to feel the play.	There should be a barely noticable gear play.
8	Tighten the motor *attachment screws*.	Shown in the figure *Location of motor on page 274*. Tightening torque: 10 Nm.
9	Reconnect the motor connectors R3.MP4 and R3.FB4.	
10	Refit the *connector plate*.	Shown in the figure *Location of motor on page 274*.
11	Make sure all the cabling is placed correctly inside the upper arm housing.	Cable layout is shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
12	Refit the cover to the upper arm housing. Check both the *gaskets* and replace, if damaged.	Art. no. is specified in *Required equipment on page 274*.
13	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 146*.
14	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	

Continues on next page

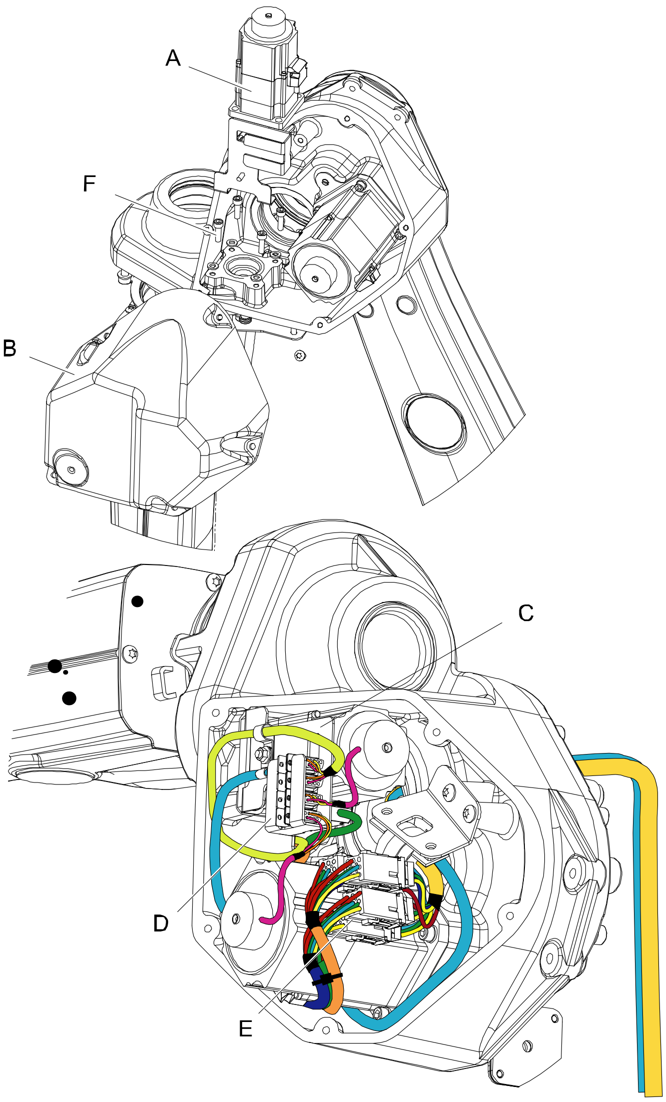
	Action	Note
15	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.6.6 Replacement of motor, axis 4, 1600ID/1660ID

Note

After replacement of motors/motor in a manipulator, recalibration is required.

Location of motor



xx0700000017

A	Motor, axis 4
B	Cover, upper arm housing
C	Connector plate
D	Signal connector, R3.FB4
E	Power connector, R3.MP4
F	Attachment screw and washer, motor (4 pcs)

Continues on next page

Required equipment

Equipment, etc.	Art. no.	Note
Rot. ac motor incl pinion	For spare part number, see: • *Spare part lists on page 389*	
O-ring	3HAB3772-81	
Standard toolkit		The contents are defined in section *Standard tools on page 385*.
Power supply	-	24 VDC, max. 1,5 A. For releasing the brakes.
Rotation tool, motor		For adjusting the gear play.
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 *Circuit diagram on page 391*.
Pendulum Calibration tool		See *Special tools on page 386*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.

Continues on next page

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

Removal, motor axis 4

	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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the cover from the upper arm housing.	
4	Remove the *connector plate* to get access to the axis 4 motor.	Shown in the figure *Location of motor on page 279*.
5	Disconnect the connectors R3.MP4 and R3.FB4 from the axis 4 motor.	
6	**DANGER** The motor has a high temperature after running which can occur burns.	
7	Remove the *motor, axis 4* by unscrewing the motor *attachment screws*.	Shown in the figure *Location of motor on page 279*.
8	Lift the motor to get the pinion away from the gear and disconnect the brake release voltage.	
9	Remove the motor by gently lifting it out.	Make sure the motor pinion is not damaged!

Refitting, motor axis 4

	Action	Note
1	Clean the mating surfaces on the *motor* and the gearbox.	Shown in the figure *Location of motor on page 279*.
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 section.
3	Fit the motor with the *attachment screws* and washers. Until the motor shaft is adjusted to the gear, as described in following steps, only tighten the screws lightly.	Shown in the figure *Location of motor on page 279*. **Tightening torque: approx. 2 Nm.** 4 pcs, M6 x 20.

Continues on next page

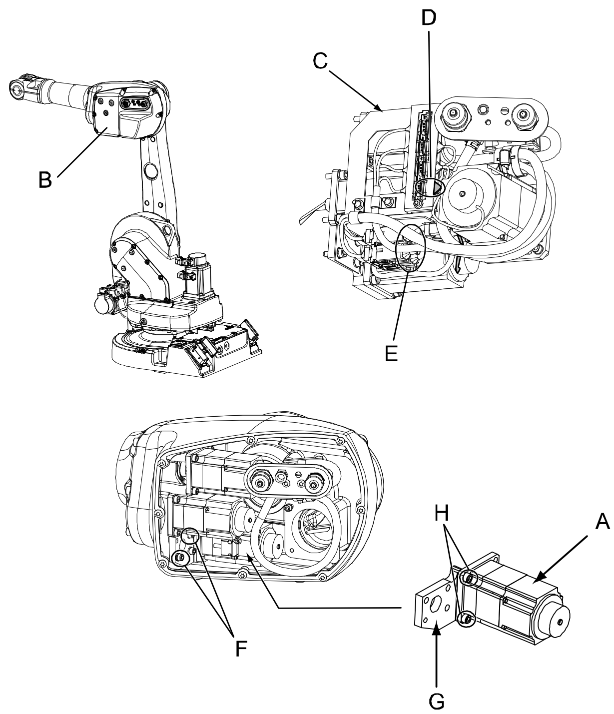
	Action	Note
4	Tighten the motor *attachment screws*.	Shown in the figure *Location of motor on page 279*. **Tightening torque: 10 Nm.**
5	Reconnect the motor connectors R3.MP4 and R3.FB4.	
6	Refit the *connector plate*.	Shown in the figure *Location of motor on page 279*.
7	Refit the cover to the upper arm housing.	
8	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.

4.6.7 Replacement of motor and timing belt, axis 5, IRB 1600

Location of motor

The motor and timing belt of axis 5 is located inside the upper arm housing, as shown in the figure below.

A more detailed view of the motor and its position may be found in the spare part view, *Spare parts - Upper arm, exploded view*.



xx0400001279

A	Motor, axis 5
B	Cover, upper arm housing
C	Connector plate
D	Signal cable, motor 5: R3.FB5
E	Power cable, motor 5: R3.MP5
F	Attachment screws and washers, motor bracket (2 pcs)
G	Motor bracket
H	Attachment screws and washers, motor (3 pcs)

Required equipment

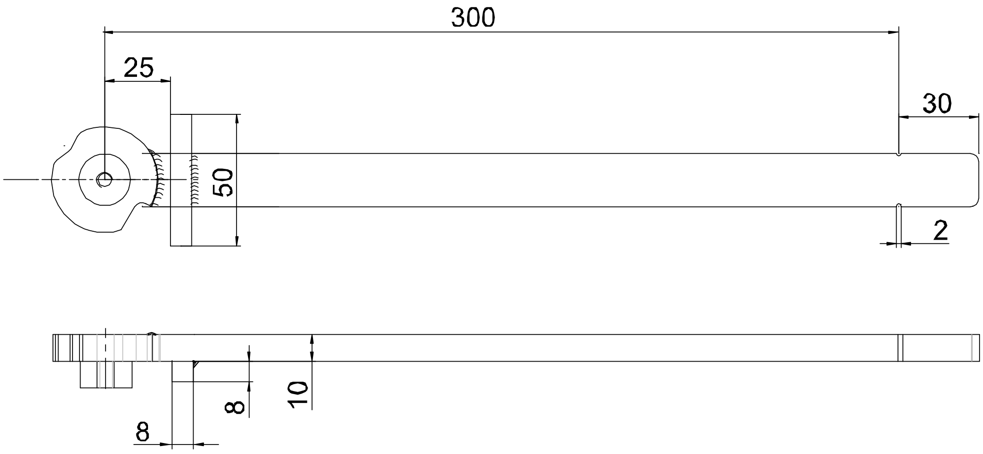
Equipment	Spare part no.	Art. no.	Note
Rot. ac motor incl pinion	3HAC021800-003		
Timing belt	3HAC021304-001		
Gasket, upper arm cover	3HAC022049-001		Replace if damaged.
Gasket, customer connections	3HAC022050-001		Replace if damaged.

Continues on next page

Equipment	Spare part no.	Art. no.	Note
Belt tightener		3HAC024044-001	
Dynamometer		-	Capacity: 100N
Standard toolkit			Content is defined in section *Standard tools on page 385*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 391*.

Belt tightener, 3HAC 024044-001

The belt tightener is a special tool that is used when adjusting the tension of the timing belt of axis 5. The length of the tool is important, since the tool is pulled with a given force.



xx0500001457

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal, motor axis 5 and timing belt

The procedure below details how to remove the motor and the timing belt of 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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the axis 4 motor.	Detailed in section *Removal, motor axis 4 on page 276*.
4	Remove the motor and timing belt of axis 6.	Detailed in section *Removal, motor and timing belt, axis 6 on page 309*.
5	Disconnect the axis 5 motor connectors: R3.MP5 and R3.FB5.	

Continues on next page

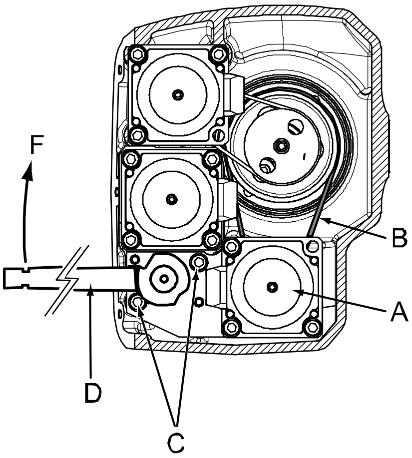
	Action	Note
6	Move aside all cabling that is hindering access to the axis 5 motor.	
7	Remove the *motor bracket*, including the motor, by unscrewing the two *attachment screws and washers*.	Shown in the figure *Location of motor on page 283*.
8	Remove the timing belt of axis 5.	
9	Remove the motor bracket from the motor.	

Refitting, motor and timing belt axis 5

The procedure below details how to refit the motor and timing belt of axis 5.

	Action	Note/Illustration
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Clean the mating surfaces on the motor and in the upper arm housing.	
3	Fit the new motor to the motor bracket, previously removed from the old motor.	3 pcs, M6 x 20.

Continues on next page

	Action	Note/Illustration
4	Follow the steps below when fitting the motor: • Place the timing belt (B) round the motor pinion and place the belt round the axis 5 as fitting the motor in the upper arm housing. • Fasten the motor bracket with two attachment screws (C), but do not tighten the screws yet. Use correct attachment holes, shown in the figure to the right! • Adjust the belt tension by pulling the motor bracket, using the *belt tightener* and *dynamometer*, as shown in the figure to the right. • Tighten the two attachment screws of the bracket (C) with a torque of 10 Nm.	Art. no. is specified in *Required equipment on page 283*.  xx0400001280 A Motor axis 5 B Timing belt, axis 5 C Attachment screws and washers, motor bracket, 2 pcs, M6 x 20 D Belt tightener, the dimensions are shown in the figure *Belt tightener, 3HAC 024044-001 on page 284*. F (Force): 24 N.
5	Refit the motor and timing belt of axis 6.	Detailed in section *Refitting, motor and timing belt, axis 6 on page 309*.
6	Refit the motor of axis 4.	Detailed in section *Refitting, motor axis 4 on page 277*.
7	Reconnect all connectors and place the cabling correctly inside the upper arm housing.	Cable layout shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
8	Refit the cover to the upper arm housing. Check both the *gaskets* and replace, if damaged.	Art.no. is specified in *Required equipment on page 283*.
9	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.

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	Action	Note/Illustration
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 120*.	

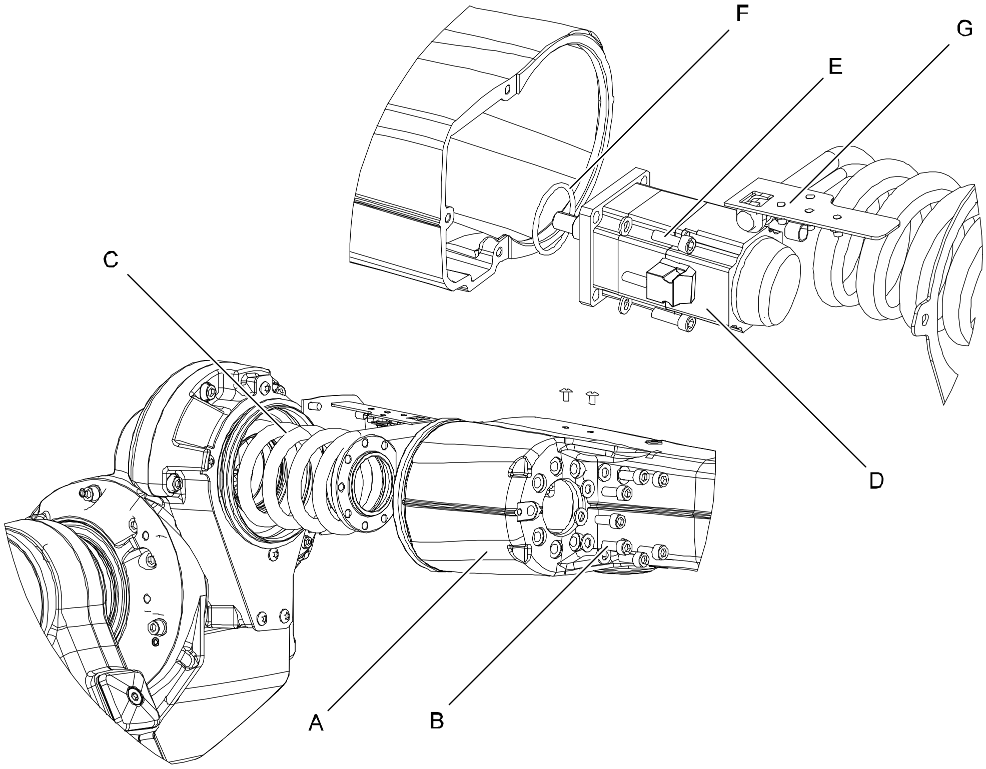
4.6.8 Replacement of motor, axis 5, IRB 1600ID

Note

After replacement of motors/motor in a manipulator, recalibration is required.

Location of motor, axis 5

The motor of axes 5 is located inside the upper arm as shown in the figure below.



xx0700000020

A	Arm Tube
B	Hex socket head cap screw M8X20
C	Cable harness IRB1600ID
D	Rotational ac motor Axis 5
E	Hex. socket head cap screw M6X20
F	O-ring
G	Cable harness bracket

Required equipment

Equipment, etc.	Art. no.	Note
Rot. ac motor with pinion	For spare part number, see: • *Spare part lists on page 389*	
VK cover	3HAA2166-19	

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Equipment, etc.	Art. no.	Note
Standard toolkit	-	The contents are defined in section *Standard tools on page 385*, in part 2 of the Product manual.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.
Circuit diagram	3HAC6816-3	See chapter *Circuit diagram on page 391*.
O-ring	3HAB3772-81	Nitrite
Cable grease		
Isopropanol		

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	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.

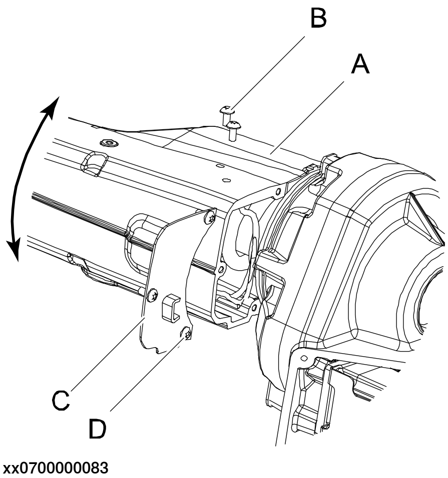
WARNING

Please observe the following before commencing any repair work on the manipulator:

- Motors and gears are HOT after running the robot! Touching the motors and gears may result in burns!
- Turn off all electric power, hydraulic and pneumatic pressure supplies to the robot!
- Take any necessary measures to ensure that the manipulator does not collapse as parts are removed, e.g. secure the lower arm with fixtures if removing motor, axis 2.

Note

Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Remove the cover (C) on the back of the upper arm tube (A). Rotate the upper arm to access all the screws (D). Remove the screws (B) holding the cable harness. **CAUTION** After removal of the cover (mec stop), do not rotate axis 4 do to risk of cable harness damage.	 xx0700000083 A Arm Tube B Torx pan head screw M6X12 C Cover D Torx pan head screw M6X12

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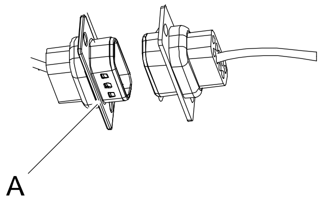
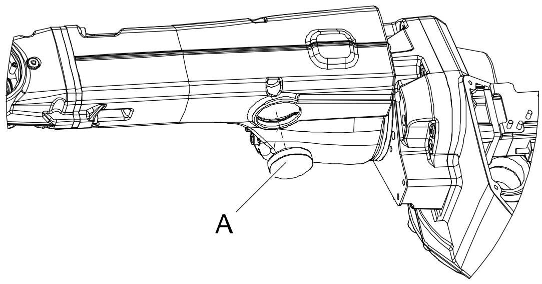
	Action	Note
3	 **DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove the AW equipment from the upper arm.	Shown in section *Remove AW Gun on page 223*
5	Disconnect connectors R4.FB5 and R4.MP5, from the back.	 xx0700000080 A R4.FB5
6	Remove the VK- Cover to access the cable connections inside the arm.	 xx0700000054 A VK-Cover
7	Gently pull the cables out of the upper arm.	

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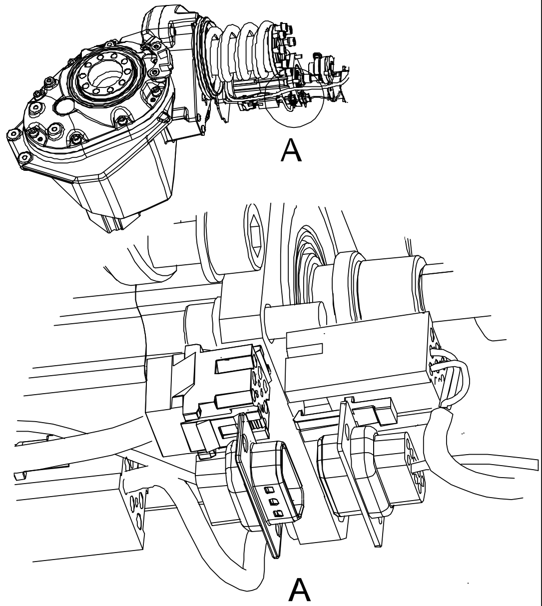
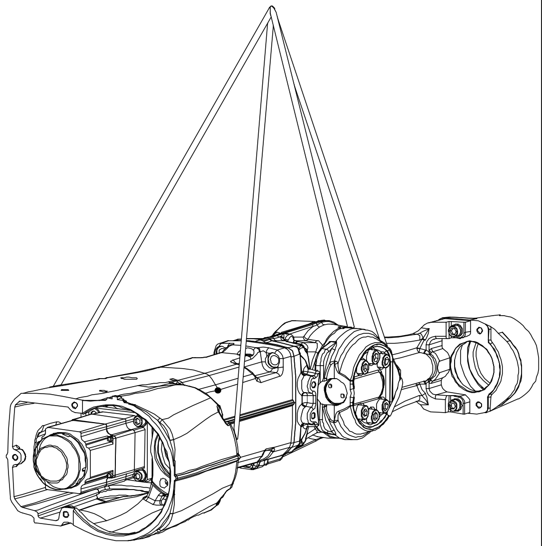
	Action	Note
8	Disconnect through the hole connection R4.FB6 and R4.MP6.	 xx0700000053
9	**CAUTION** The upper arm tube weighs 12.3 kg without any additional equipment fitted. All lifting accessories used must be sized accordingly!	
10	Secure the weight of the arm with lifting slings.	 xx0700000088
11	Remove the seven (7) Hexagon socket head cap screw M8X20, holding the upper arm.	Position (B) in figure *Location of motor, axis 5 on page 289*.
12	Remove the upper arm.	

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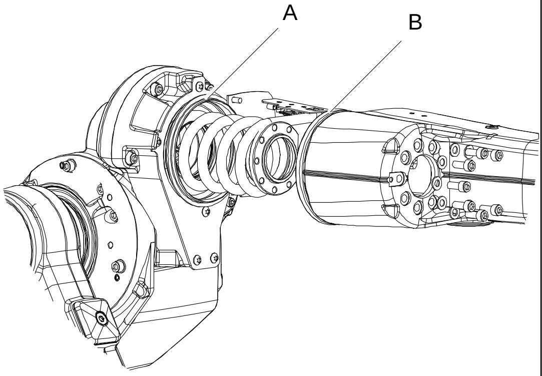
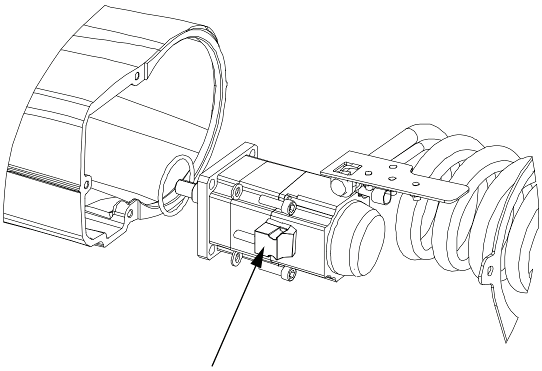
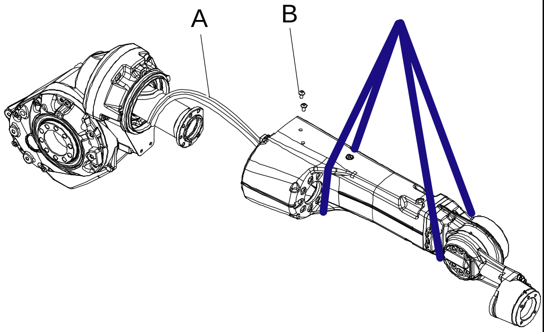
	Action	Note
13	Remove the V-ring (A) and the support ring (B).	 xx0700000248 A V-ring B Support ring
14	Remove the four (4) Hexagon socket head cap screw M6X20 holding motor 5.	Position (E), (D) in figure *Location of motor, axis 5 on page 289*
15	Remove the O-ring and change it if necessary.	Position (F) in figure *Location of motor, axis 5 on page 289*.
16	Remove the resolver cover for reuse.	

Refitting, motor axis 5

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

	Action	Note
1	Clean the mating surfaces inside the upper arm housing and on the motor with Isopropanol.	
2	Make sure the o-ring on the circumference of the motor is seated properly. Lubricate it with grease.	Replace the o-ring if damaged. Part number is specified in section *Required equipment on page 289*.
3	Position the motor into the upper arm housing with the motor connector pointing towards the side, as shown in the figure. Make sure the motor pinion is properly mated to the gear.	 xx1400001567
4	Fit the attachment screws and washers but do not tighten them yet.	4 pcs, M6 x 20. Shown in the figure *Location of motor, axis 5 on page 289*.
5	Fit the rotation tool to the end of motor shaft.	Part number is specified in *Required equipment on page 289*

Continues on next page

	Action	Note
6	Adjust the motor in relation to the gear. Use the rotation tool to wiggle the motor shaft back and forth to feel the play.	There should be a barely noticeable gear play.
7	Tighten the motors attachment scews.	**Tightening torque: 10Nm**
8	Refit the V-ring and support ring.	
9	Refit the cable harness bracket (G) in figure *Location of motor, axis 5 on page 289*, inside the upper arm tube, use the two torx pan head screw M6X12 (B). Wind the cable harness (A), in a spiral with four free turns around the axis as in figure *Location of motor, axis 5 on page 289* Grease the cable harness with **cable grease.**	 xx0700000089 A Cable harness B Torx pan head screw M6X12
10	Refitt the upper arm using the 7 Hex socket head cap screw M8X20.	Shown in figure *Location of motor, axis 5 on page 289*. **Tightening torque: 24 Nm**
11	Reconnect connections R4.FB6, and R4.MP6 through the VK-hole. Make sure all the cabling is placed correctly inside the upper arm housing.	
12	Reconnect connection R4.FB5 and R4.MP5 from the back.	**Note** When reconnecting the connection R4.FB5, make sure to place the connectors as far away from the axis 5-6 cable spiral as possible, to avoid grease to accumulate on the resolver connector.
13	**DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	
14	Refit the cover (mec stop) on the back of the upper arm tube. Rotate the upper arm to access all tree screws. **CAUTION** Before refitting of the cover (mec stop), do not over rotate axis 4 do to risk of cable harness damage.	

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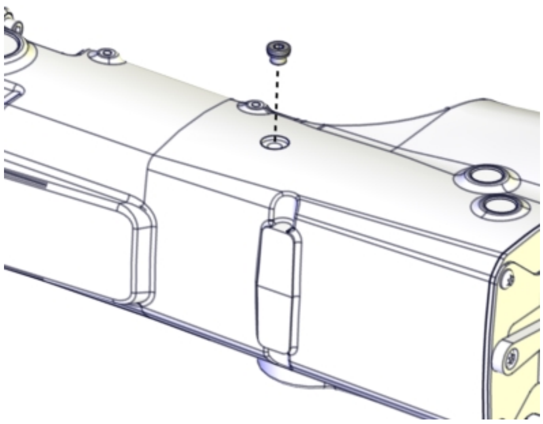
	Action	Note
15	Remove the oil plug, and refill the axis-5 gear with *lubricating oil*.	 xx2000002311 Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 130*.
16	Inspect the oil plug regarding thickness and condition of the sealing. Replace the complete oil plug if the sealing thickness is less than 1.5 mm or if the sealing is damaged. **CAUTION** Risk of damage to internal components of the axis-5 gear. Tighten the oil plug with correct torque and make sure the sealing thickness is minimum 1.5 mm.	Oil plug with sealing: 3HAC048968-001.
17	Refit the oil plug with sealing.	Tightening torque: 3.8 Nm.
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 346*. General calibration information is included in section *Calibration on page 333*.

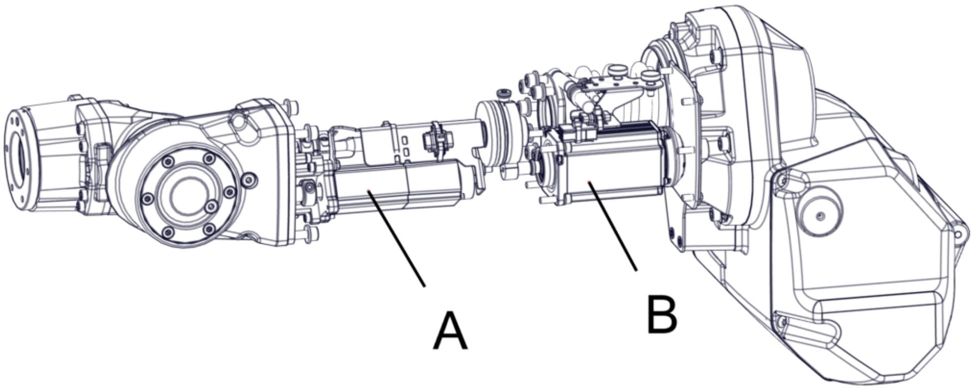
4.6.9 Replacement of motor, axis 5, IRB 1660ID

Note

After replacement of motors/motor in a manipulator, recalibration is required.

Location of motor axis 5

Motor axis 5 is located inside the upper arm tube as shown in the figure.



xx1500001258

A	Motor axis 6
B	Motor axis 5

Required equipment

Equipment	Art. no.	Note
Sikaflex 521FC	3HAC026759-001	
VK-cover	3HAA2166-17	Always replace with a new when removed.
Standard toolkit	-	Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Continues on next page

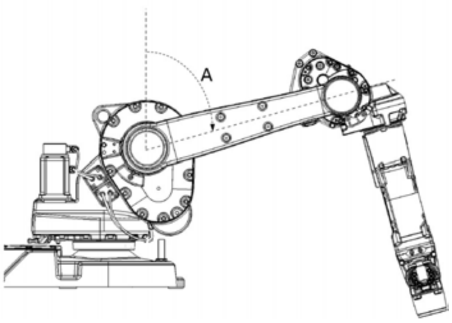
Deciding calibration routine

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.

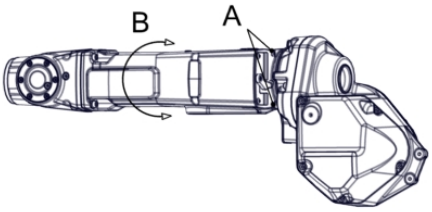
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is 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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing motor axis 5

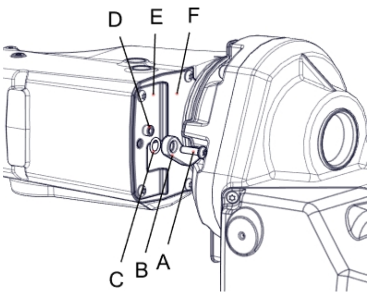
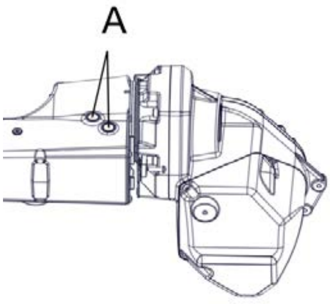
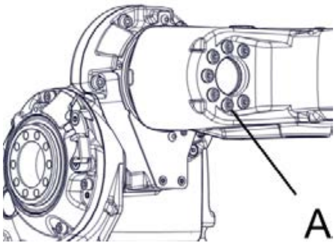
Use this procedure to remove motor axis 5.

	Action	Information
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the lower arm to the position shown in the figure.	xx1500003066 • A: 75° approximately
3	Move the upper arm to a horizontal position.	

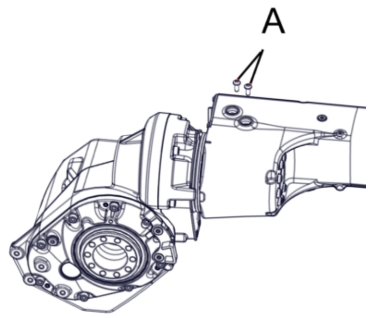
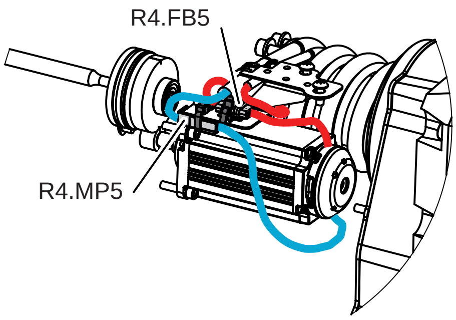
Continues on next page

	Action	Information
4	Rotate the upper arm to access the two inner attachment screws securing the cover and remove them.	 xx1500001260 • A: Inner attachment screws (2 pcs) • B: Directions of rotation
5	Move the upper arm to sync. position.	For the synchronization positions, see *Synchronization marks and synchronization position for axes on page 338*.
6	**DANGER** Before entering the robot working area, turn off all: • Electric power supply to the robot • Hydraulic pressure supply to the robot • Air pressure supply to the robot	
7	Remove all extra equipment fitted on the upper arm and wrist.	
8	Remove the wrist and disconnect those cables to motor axis 6.	How to remove the wrist see the section: • *Replacing the wrist unit, IRB1660ID on page 206*
9	**Note** Make a note of the position of axis 4 before continuing the removal process. It is important to refit the mechanical stop and cable harness spiral, with axis 4 in the same position as it was before the removal. If axis 4 has been moved, it must be returned to the position it was when the mechanical stop was removed. This is due to risk of damage to the cable harness.	

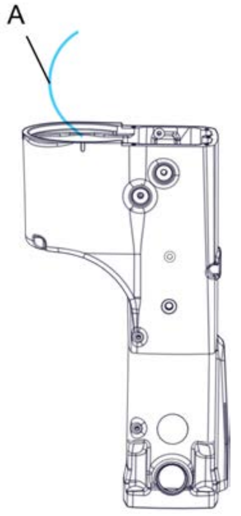
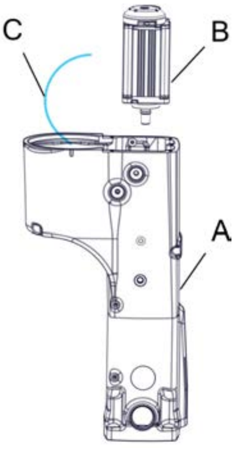
Continues on next page

	Action	Information
10	Remove the mechanical stop. **Note** Do not loose the o-ring and distance ring in the removal process!	 xx1500001266 • A: Attachment screws (5 pcs) • B: Mechanical stop • C: O-ring • D: Distance ring • E: Bracket • F: Cover
11	Remove the bracket.	See figure above.
12	Remove the cover.	See figure above.
13	Remove the two VK-covers, covering the attachment screws securing the cable harness to the upper arm tube.	 xx1500001265 • A: VK-covers (2 pcs)
14	Remove the attachment screws (7 pcs) securing the tube of the armhouse. **Note** The screws are secured with locking liquid Loctite 243.	 xx1500001262 • A: Attachment screws (7 pcs)

Continues on next page

	Action	Information
15	Remove the attachment screws securing the cable harness bracket to the upper arm tube.	 xx1500001267 • A: Attachment screws (2 pcs)
16	Pull carefully out the upper arm tube a little. Not more than it is possible to reach the connectors for motor axis 5. **CAUTION** Be careful not to damage the cable harness in the process. The space is cramp.	
17	Disconnect connectors R4.MP5 and R4.FB5 to motor axis 5.	 xx1400002576
18	Remove the upper arm tube with the cable harness to motor axis 6. **CAUTION** Be careful not to damage the cable harness to motor axis 6 in the process.	

Continues on next page

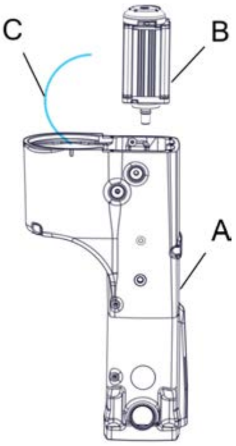
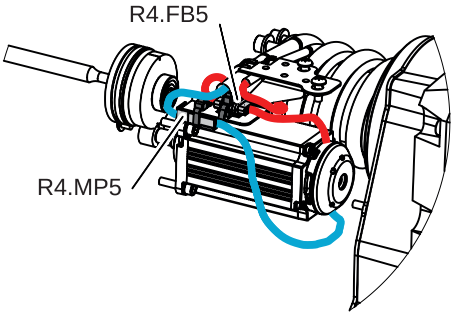
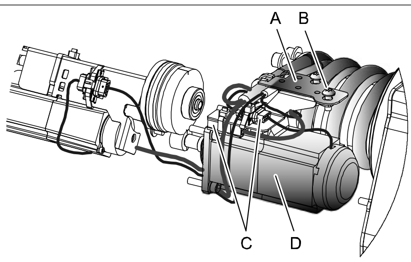
	Action	Information
19	Secure the upper arm tube with motor axis 5 pointing upwards. This is to avoid draining the oil when motor axis 5 is removed.	 xx1500001263 • A: Cable harness to motor axis 6
20	Remove motor axis 5 by unscrewing its attachment screws.	 xx1500001264 • A: Upper arm tube • B: Motor axis 5 • C: Cable harness to motor axis 6

Refitting motor axis 5

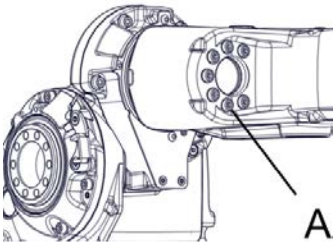
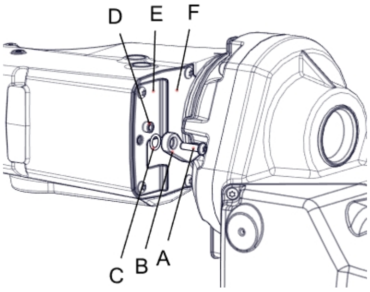
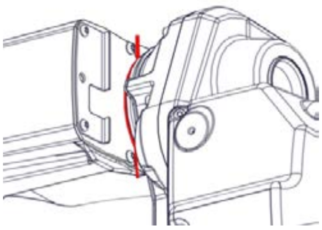
Use this procedure to refit motor axis 5.

	Action	Information
1	Place motor axis 5 in the upper arm tube.	

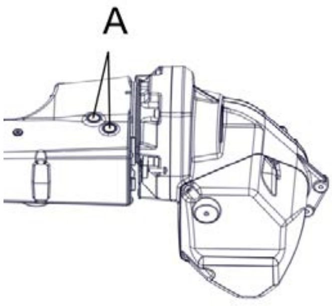
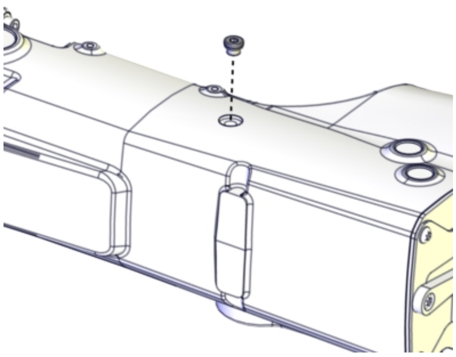
Continues on next page

	Action	Information
2	Tighten the attachment screws just enough to still be able to move the motor.	 xx1500001264 • A: Upper arm tube • B: Motor axis 5 • C: Cable harness to motor axis 6
3	Adjust the play by finding the smallest play.	
4	Secure the motor with its attachment screws.	Tightening torque: 10 Nm
5	Lift the upper arm tube to the robot.	
6	Connect connectors R4.MP5 and R4.FB5 to motor axis 5.	 xx1400002576
7	Secure the cable harness with its attachment screws to the upper arm tube.	 xx1000000998 A Bracket B Attachment screws (2 pcs) C Connectors motor axis 5 D Motor axis 5
8	Examine the spiral of the cable harness to make sure it is fitted correctly.	See section • *Replacing the cable harness, 1600ID/1660ID on page 166*

Continues on next page

	Action	Information
9	Secure the upper arm tube with attachment screws. Use locking liquid Loctite 243.	Tightening torque: 26 Nm  xx1500001262 A Attachment screws (7 pcs)
10	Refit the cover with two inner attachment screws.	 xx1500001266 • A: Attachment screws (5 pcs) • B: Mechanical stop • C: O-ring • D: Distance ring • E: Bracket • F: Cover
11	Refit the bracket with the remaining attachment screws.	See figure above.
12	Apply Sikaflex 521FC on the surface along the red curve in the figure.	 xx1500001269
13	Refit the mechanical stop.	

Continues on next page

	Action	Information
14	Fit two new VK-covers.	Article number is specified in *Required equipment on page 297*.  xx1500001265 A VK-covers (2 pcs)
15	Connect the cable to motor axis 6.	
16	Refit the wrist.	See section • *Replacing the wrist unit, IRB1660ID on page 206*
17	Remove the oil plug, and refill the axis-5 gear with *lubricating oil*.	 xx2000002311 Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 130*.
18	Inspect the oil plug regarding thickness and condition of the sealing. Replace the complete oil plug if the sealing thickness is less than 1.5 mm or if the sealing is damaged. **CAUTION** Risk of damage to internal components of the axis-5 gear. Tighten the oil plug with correct torque and make sure the sealing thickness is minimum 1.5 mm.	Oil plug with sealing: 3HAC048968-001.
19	Refit the oil plug with sealing.	Tightening torque: 3.8 Nm.

Continues on next page

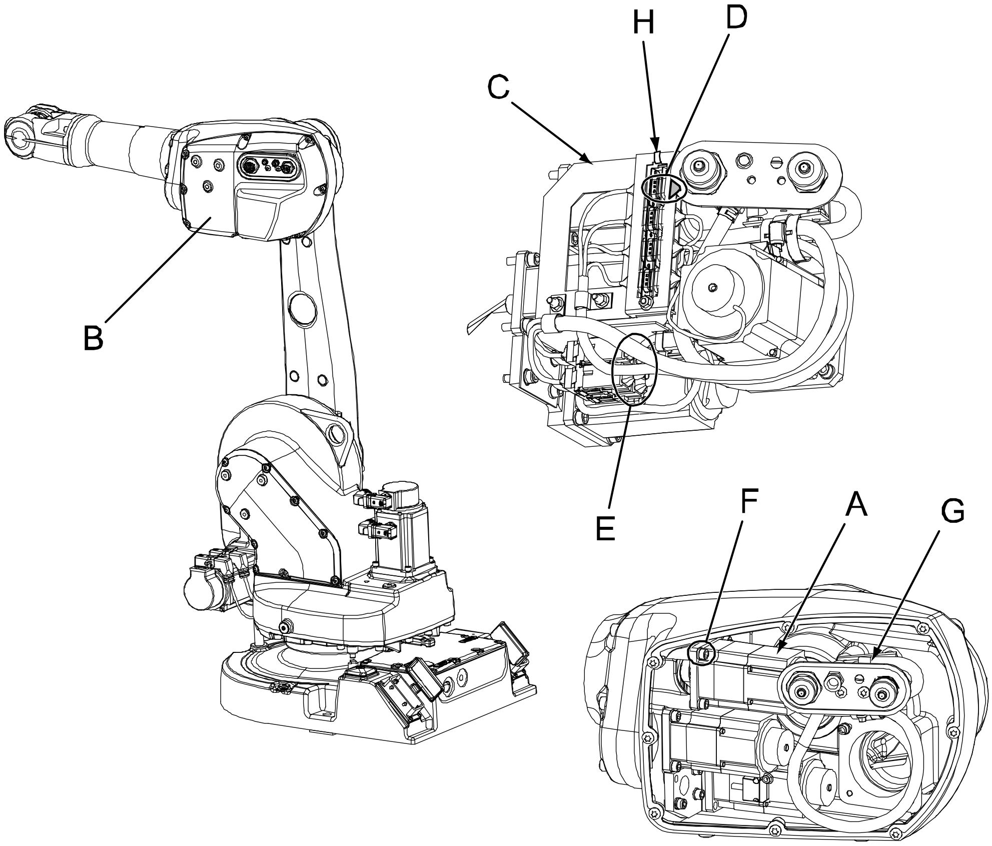
	Action	Information
20	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.6.10 Replacement of motor and timing belt, axis 6, IRB 1600

Location of motor

The motor and timing belt of axis 6 are located inside the upper arm housing, as shown in the figure below.

A more detailed view of the motor and its position may be found in the spare part view, *Spare parts - Upper arm, exploded view*.



xx0400001281

A	Motor, axis 6
B	Cover, upper arm housing
C	Connector plate
D	Signal cable, axis 6 motor: R3.FB6
E	Power cable, axis 6 motor: R3.MP6
F	Attachment screws and washers, motor (3 pcs)
G	Distance console with cable bracket and contact panel
H	Cable tie

Required equipment

Equipment	Spare part no.	Art. no.	Note
Rot. ac motor incl pinion	3HAC021800-003		

Continues on next page

Equipment	Spare part no.	Art. no.	Note
Timing belt	3HAC6779-1		
Gasket, upper arm cover	3HAC022049-001		Replace if damaged.
Gasket, customer connections	3HAC022050-001		Replace if damaged.
Hook		3HAC024045-001	
Dynamometer		-	Capacity: 100N
Standard toolkit			Content is defined in section *Standard tools on page 385*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.			These procedures include references to the tools required.
Circuit diagram			See chapter *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	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, motor and timing belt, axis 6

The procedure below details how to remove the motor and timing belt of axis 6.

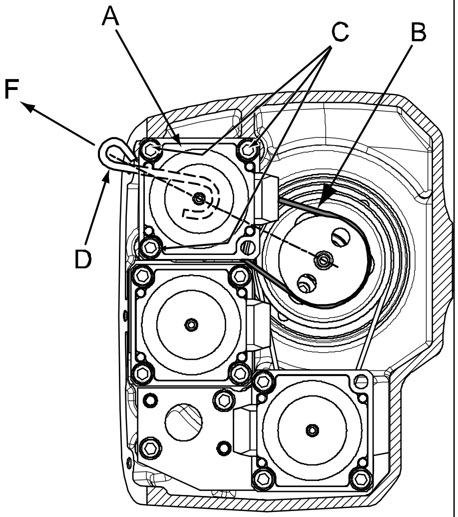
	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Remove the cover from the upper arm housing.	
4	Remove the *connector plate*.	Shown in the figure *Location of motor on page 307*.
5	Remove the complete *distance console* with cable brackets and contact panel.	Shown in the figure *Location of motor on page 307*.
6	Disconnect the motor cables for the axis 6 motor; R3.MP6 and R3.FB6.	
7	Remove the axis 6 motor by unscrewing its three attachment screws and washers.	
8	Remove the timing belt.	

Refitting, motor and timing belt, axis 6

The procedure below details how to refit the motor and timing belt of axis 6.

	Action	Note
1	Clean the mating surfaces on the motor and in the upper arm housing.	

Continues on next page

	Action	Note
2	Follow the steps below when fitting the motor: • Place the timing belt (B) round the motor pinion and place the belt round the axis 6 as fitting the motor in the upper arm housing. • Secure the motor with its tree attachment screws and washers (C), but do not tighten them yet. • Attach the *hook* round the motor pinion (underneath the motor) and adjust the belt tension with a force of 80 N, using a *dynamometer*. Shown in the figure to the right. • Tighten the motor attachment screws with a torque of 10 Nm.	 xx0400001282 A Motor, axis 6 B Timing belt, axis 6 C Attachment screws and washers, motor, 3 pcs, M6 x 20 D Hook (motor pinion: Ø24.07 mm) F (Force): 80 N.
3	Refit the complete *distance console*.	Shown in the figure *Location of motor on page 307*.
4	Refit the *connector plate*. Refit the *cable tie*.	Shown in the figure *Location of motor on page 307*.
5	Reconnect the motor cables: R3.MP6 and R3.FB6.	
6	Place all the cabling correctly inside the upper arm housing.	Cable layout is shown in the figure *Illustration, cabling inside upper arm housing on page 160*.
7	Refit the cover to the upper arm housing. Check both the *gaskets* and replace, if damaged.	Art. no. is specified in *Required equipment on page 307*.
8	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

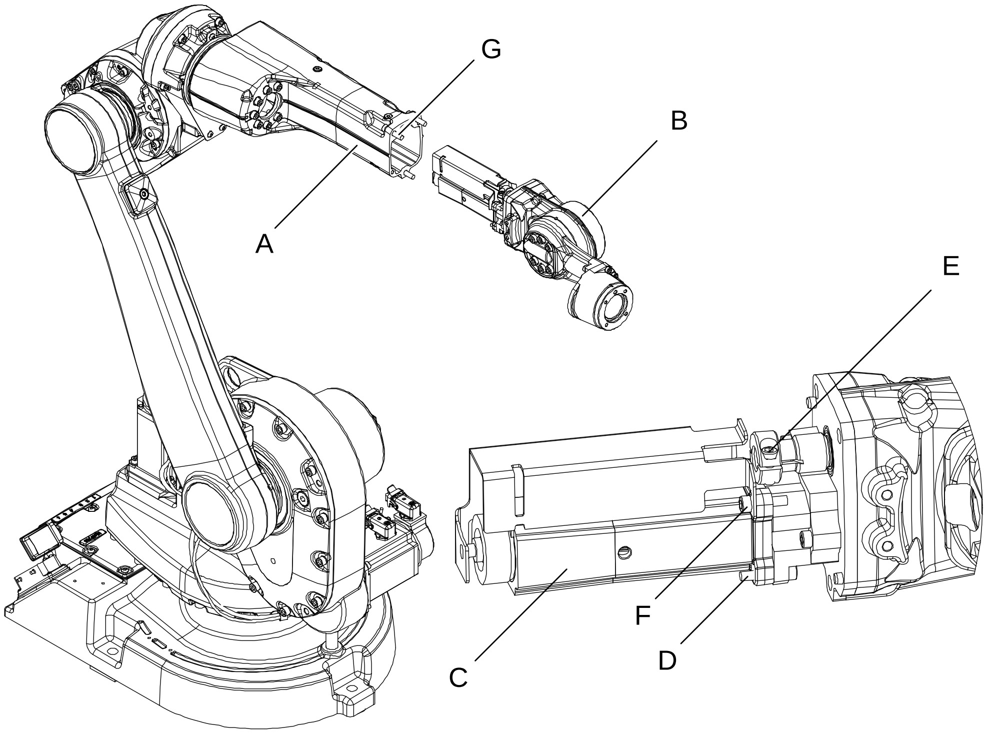
4.6.11 Replacement of motor, axis 6, IRB 1600ID

Note

After replacement of motors/motor in a manipulator, recalibration is required.

Location of motor

The motor of axis 6 is located inside the upper arm housing, as shown in the figure below.



xx0700000025

A	Upper arm
B	Wrist
C	Motor, axis 6
D	Hexagon socket head screw M5x25
E	Hexagon socket head screw M5x16 10.9 (Short head)
F	Hexagon socket head screw M5x25
G	Hexagon socket head screw M8x35

Required equipment

Equipment	Art. no.	Note
Rot. ac motor incl pinion	For spare part number, see: • Spare part lists on page 389	

Continues on next page

Equipment	Art. no.	Note
Standard toolkit	-	*Standard tools on page 385*
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 *Circuit diagram on page 391*.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal of motor axis 6

	Action	Note
1	Move the upper arm to the synchronization position.	
2	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	

Continues on next page

	Action	Note
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove all extra equipment fitted on the upper arm and wrist.	See *Remove AW Gun on page 223*
5	Remove the wrist. **CAUTION** Be careful when handling the wrist. Always hold on the casting, do not hold on the wrist cover. This can damage the sealing which will cause oil leakage.	See *Removing the wrist unit on page 202*
6	Put the wrist on a work bench or similar.	
7	Remove the cable protection by removing the nuts that holds it.	
8	Open the flexible coupling of the axis-6 motor.	
9	Remove the attachment screws that holds the console and the axis-6 motor.	
10	Remove the motor.	

Refitting of motor axis 6

	Action	Note
1	Remove the old console from the removed axis-6 motor, and scrap it.	
2	Remove the new console from the new spare part wrist.	
3	Fit the new console to the axis-6 motor.	Tightening torque: 6 Nm
4	Fit motor with the new console fitted to the new wrist.	Use Loctite 243 on the attachment screws.
5	Tighten the attachment screws just enough to still be able to move motor and console.	
6	Use caution and rotate the coupling manually. This will help the coupling and motor shaft to be aligned.	
7	Tighten the attachment screws that holds the console to the wrist.	Tightening torque: 6 Nm
8	Check wrist motion by rotating the coupling manually. The motion shall be smoth and even. If not unscrew the attachment screws that holds motor and console, and redo the process.	
9	Tighten the lock screw on the coupling.	Tightening torque: 6 Nm
10	Fit the cable protection cover.	Tightening torque: 6 Nm

Continues on next page

	Action	Note
11	Secure the cables to the attachment point with a cable strap.	
12	Refit the wrist.	
13	Recalibrate the robot!	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

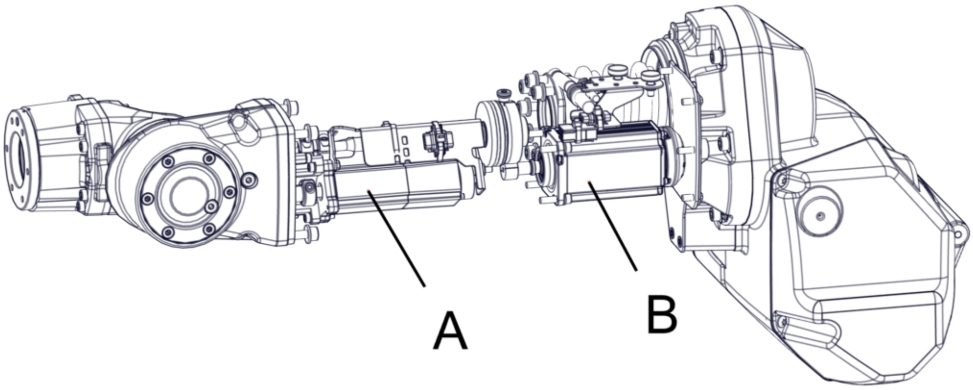
4.6.12 Replacement of motor, axis 6, IRB 1660ID

Note

After replacement of motors/motor in a manipulator, recalibration is required.

Location of motor axis 6

Motor axis 6 is located inside the upper arm tube, as shown in the figure.



xx1500001258

A	Motor axis 6
B	Motor axis 5

Required equipment

Equipment	Art. no.	Note
Motor, axis 6	For spare part number, see: • *Spare part lists on page 389*	
Wrist unit, ID	For spare part number, see: • *Spare part lists on page 389*	
VK-cover	3HAA2166-18	Always replace with a new when removed.
Locking liquid	-	Loctite 574
Standard toolkit		Content is defined in section *Standard tools on page 385*.
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.

CAUTION

Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

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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.

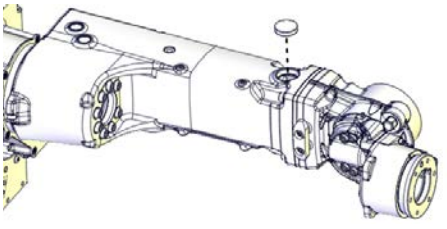
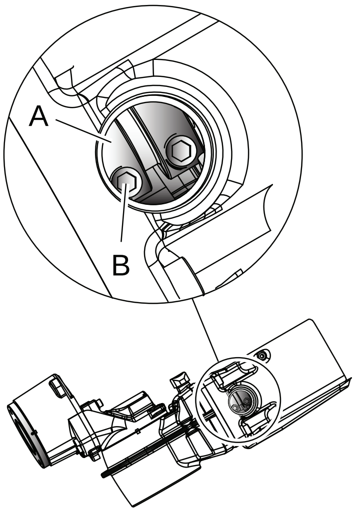
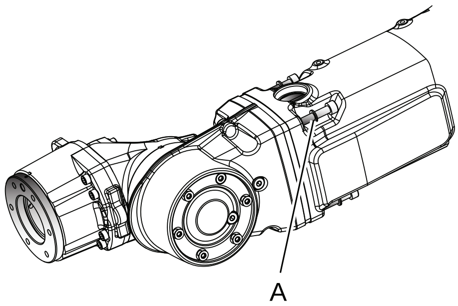
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is 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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing axis-6 motor and wrist unit

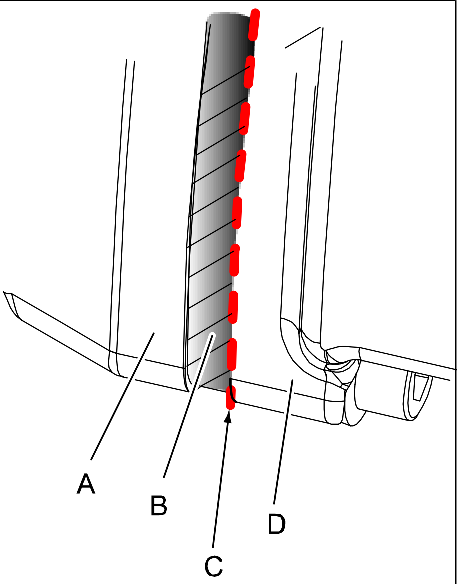
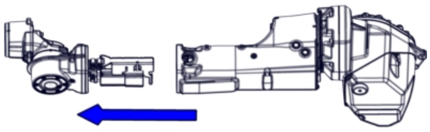
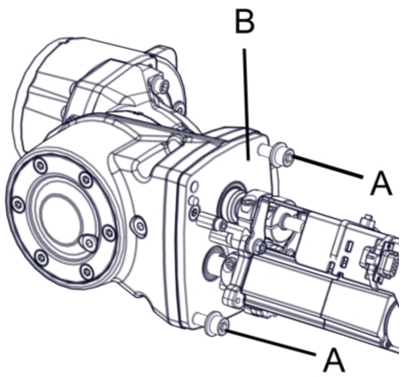
Use this procedure to remove the axis-6 motor and the wrist unit.

	Action	Information
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the upper arm to synchronization position.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Remove all extra equipment fitted on the upper arm.	

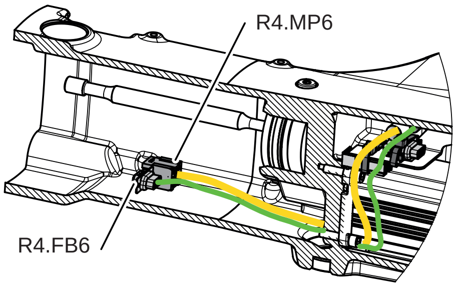
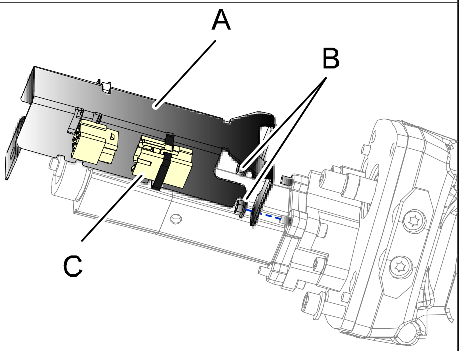
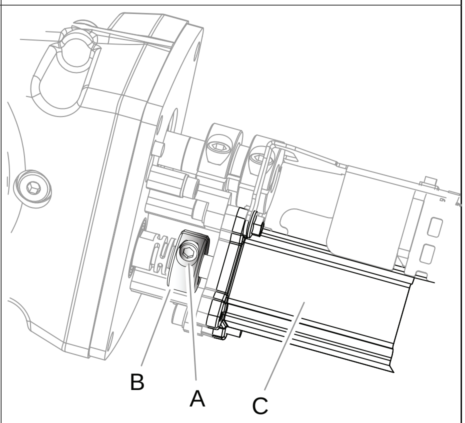
Continues on next page

	Action	Information
5	Remove the VK-cover.	 xx1000000873
6	Open the flexible coupling securing motor axis 5, on the side facing the wrist.	 xx1000000874 • A: Coupling • B: Attachment screw
7	Remove the attachment screws securing the wrist.	 xx1000000875 • A: Attachment screws (4 pcs)

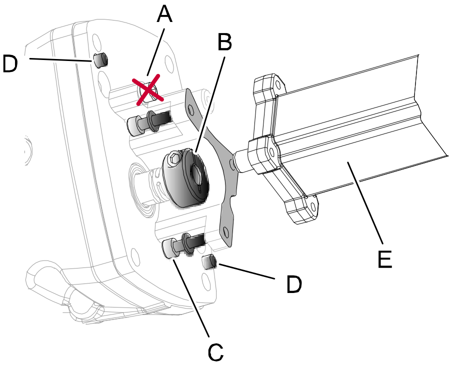
Continues on next page

	Action	Information
8	Separate wrist and upper arm tube at the marked division point (along the dotted line in the figure). **Note** There is oil inside the wrist. The cover is only secured with Loctite 574. If opened in the wrong place oil will spill out.	 xx1000000933 • A: Wrist • B: Cover (Secured with Loctite 574 to the wrist) • C: Division point • D: Upper arm tube
9	Pull carefully out the wrist a little to reach the motor cables to motor axis 6. **Note** The wrist is fitted on cylindrical pins.	 xx1500001259
10	Fit two short screws to the holes for the attachment screws to temporarily secure the cover.	 xx1500003257 • A: Short screws (2 pcs) • B: Cover

Continues on next page

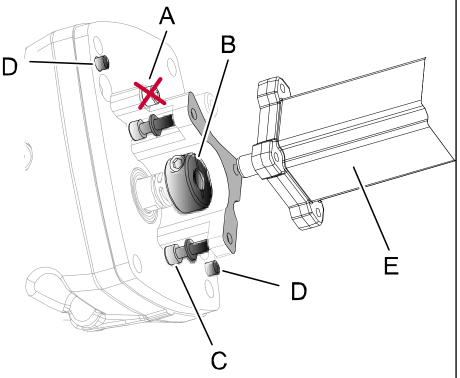
	Action	Information
11	Disconnect the cables R4.MP6 and R4.FB6 to motor axis 6.	 xx1400002575
12	Put the wrist with motor axis 6 on a work bench.	
13	**Note** Do not move the gears in the wrist when the motor is removed! When refitting the motor the gears in the wrist shall be in the same position as they were before the removal.	
14	Remove the cable protection by removing the nuts securing it.	 xx1000000931 • A: Cable protection • B: Nuts (2 pcs) • C: Connector motor axis 6
15	Open the flexible coupling securing motor axis 6.	 xx1000000930 • A: Attachment screw, coupling • B: Flexible coupling • C: Motor, axis 6

Continues on next page

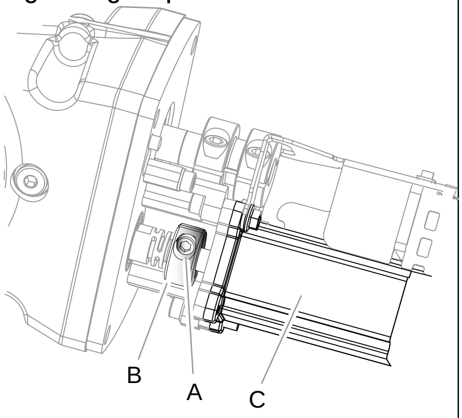
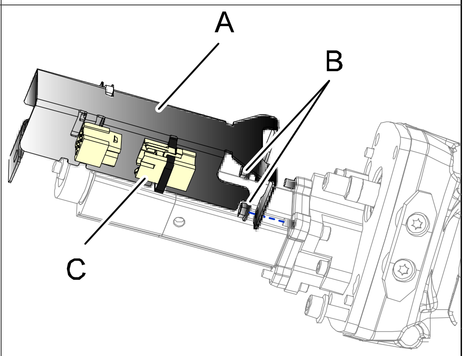
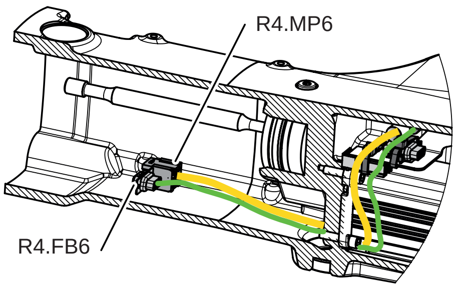
	Action	Information
16	Remove the attachment screws securing motor axis 6 and remove the motor. **Note** Do not remove the attachment screws securing the motor bracket.	 xx1000000929 • A: Attachment screws, bracket • B: Flexible coupling • C: Attachment screws, motor (3 pcs) • D: Cylindrical pins (2 pcs) • E: Motor axis 6

Refitting axis-6 motor and wrist unit

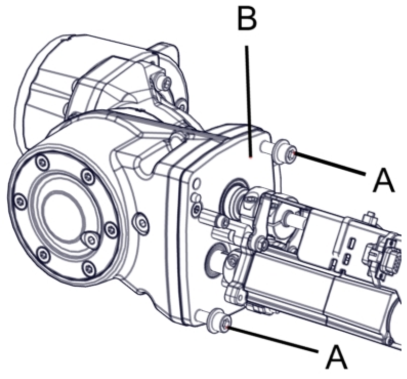
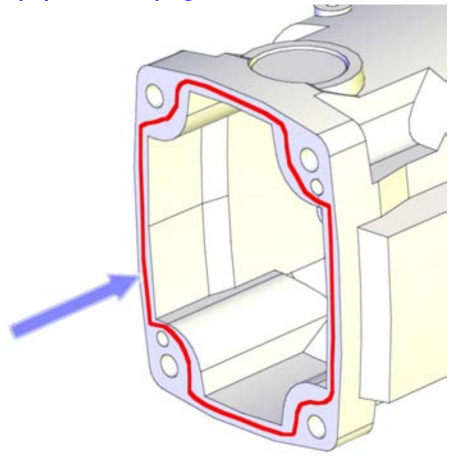
Use this procedure to refit the axis-6 motor and the wrist unit.

	Action	Information
1	Place the motor axis 6 into the flexible coupling axis 6.	 xx1000000929 • A: Attachment screws, bracket • B: Flexible coupling • C: Attachment screws, motor (3 pcs) • D: Cylindrical pins (2 pcs) • E: Motor axis 6
2	Secure the motor with its attachment screws.	Tightening torque: 6 Nm

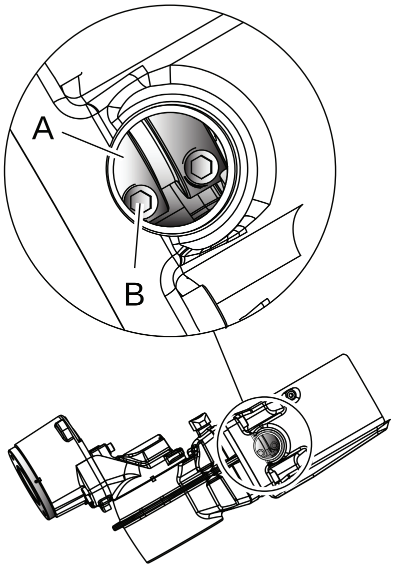
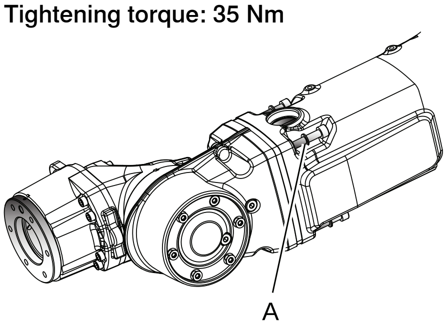
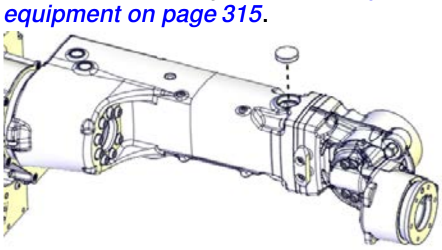
Continues on next page

	Action	Information
3	Secure motor axis 6 with the flexible coupling with its attachment screw.	Tightening torque: 6 Nm  xx1000000930 • A: Attachment screw, coupling • B: Flexible coupling • C: Motor axis 6
4	Fit the cable protection with its nuts.	 xx1000000931 • A: Cable protection • B: Nuts (2 pcs) • C: Connector motor axis 6
5	Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	
6	Place the wrist with motor axis 6 fitted a little into the upper arm tube.	
7	Reconnect the cables R4.MP6 and R4.FB6 to motor axis 6.	 xx1400002575

Continues on next page

	Action	Information
8	Remove the two short screws used to temporarily secure the cover.	 xx1500003257 • A: Short screws (2 pcs) • B: Cover
9	Apply locking liquid to the assembly surface on the upper arm tube.	The locking liquid is specified in *Required equipment on page 315*.  xx1200000063

Continues on next page

	Action	Information
10	Push the wrist and motor axis 6 into its position onto the cylindrical pins. **Tip** Look through the hole for the VK-cover when fitting the axis into the flexible coupling of motor axis 5.	 xx1000000874 • A: Flexible coupling axis 5 • B: Attachment screw
11	Secure the wrist with its attachment screws and washers.	Tightening torque: 35 Nm  xx1000000875 • A: Attachment screws (4 pcs)
12	Secure the flexible coupling axis 5 with its attachment screw.	Tightening torque: 14 Nm
13	Fit a new VK-cover.	Article number is specified in *Required equipment on page 315*.  xx1000000873

Continues on next page

	Action	Information
14	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 346*. General calibration information is included in section *Calibration on page 333*.
15	 **DANGER** Make sure all safety requirements are met when performing the first test run. See *Test run after installation, maintenance, or repair on page 120*.	

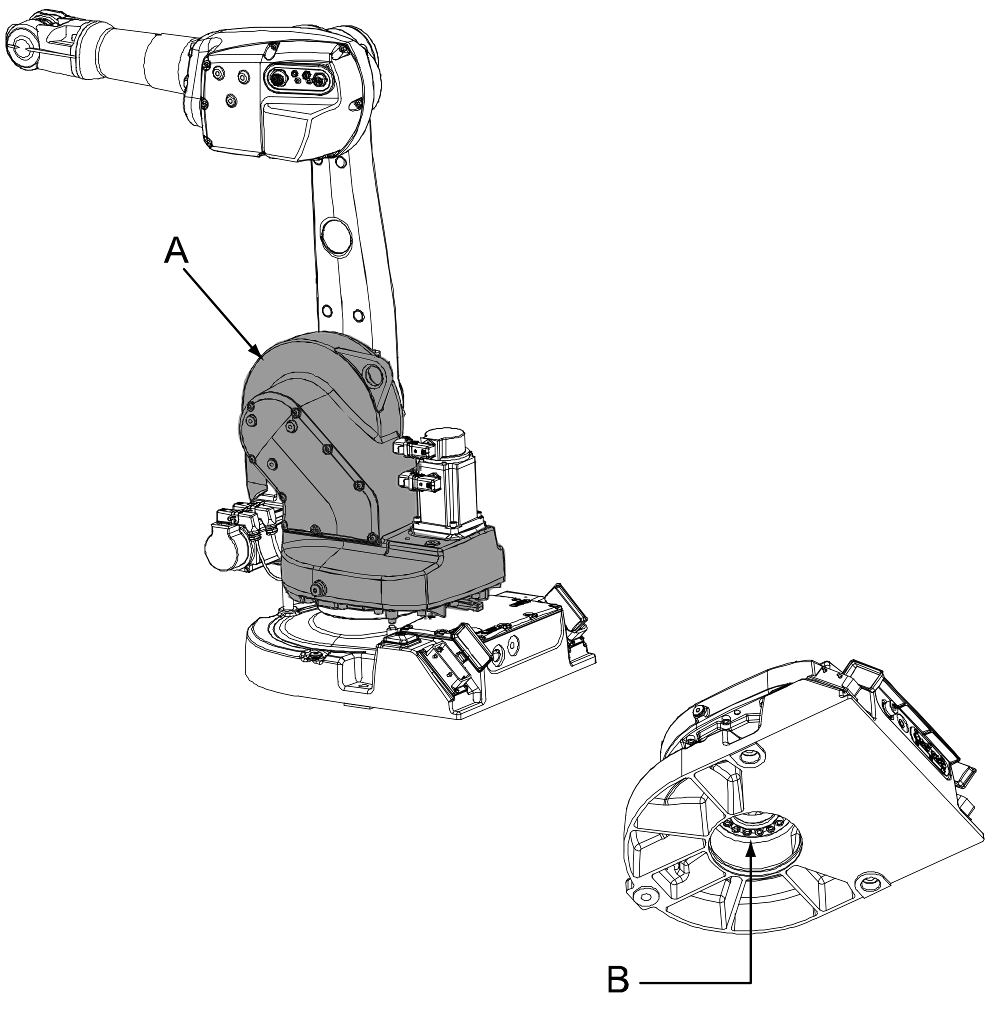
4.7 Gearboxes

4.7.1 Replacement of gearbox, axes 1-2

Location of gearbox unit, axes 1-2

The gearboxes of axes 1 and 2 are located as shown in the figure below. Note that both gearboxes, 1 and 2, are a single unit!

A more detailed view of the gearbox and its position may be found in the spare part view, *Spare parts - Frame, exploded view*.



xx0500001400

A	Gearbox unit, axes 1-2
B	Attachment screws and washer, base-gearbox unit (VK-cover is removed)

Continues on next page

Required equipment

Equipment	Art. no.	Note
Gearbox, axis 1 and 2	For spare part number, see: • *Spare part lists on page 389*.	Includes: • gearbox • V-ring (sealing ring) • stop arm
VK-cover	3HAA2166-26	
Isopropanol	-	For cleaning the mating surfaces before fitting.
Grease	3HAC042536-001	For lubricating the V-ring.
Locking liquid	-	Loctite 574
Lifting slings	-	
Standard toolkit		Content is defined in section *Standard tools on page 385*.
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 347*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

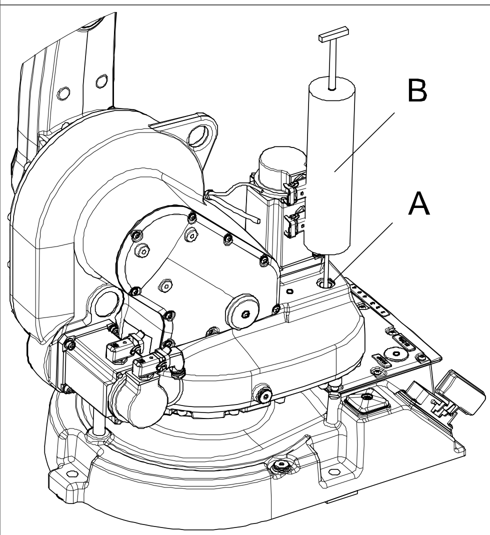
Continues on next page

CAUTION

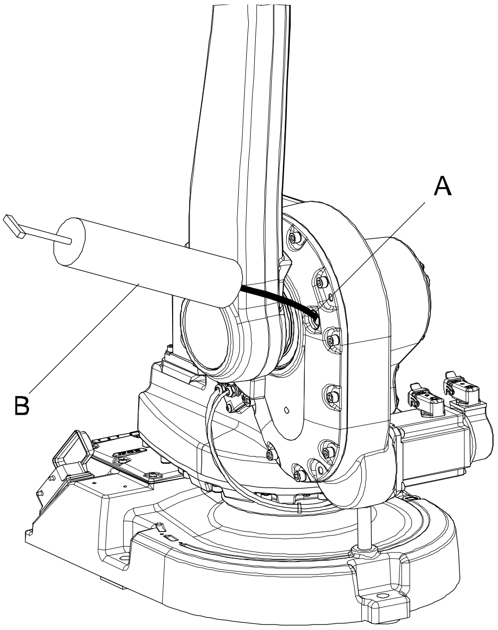
Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.

Removal, gearbox unit axes 1-2

The procedure below details how to remove the complete gearbox unit, axes 1-2.

	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 • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** Always cut the paint with a knife and grind the paint edge when disassembling parts. See *Cut the paint or surface on the robot before replacing parts on page 153*.	
4	Remove the oil plug and drain all oil from gearbox axis 1 using a drain pump.	 xx0800000260 A Oil plug B Drain pump

Continues on next page

	Action	Note
5	Remove the oil plug and drain all oil from gearbox axis 2 using a drain pump.	 xx0800000261 A Oil plug B Drain pump
6	Remove the motor, axis 2.	Detailed in section *Replacement of motor, axis 2 on page 258*.
7	Remove the motor, axis 1.	Detailed in section *Removing the motor axis 1 on page 255*.
8	Remove the complete arm system.	Detailed in section *Removing the complete arm system on page 173*.
9	Unfasten the base from the installation site by removing the attachment bolts from the foundation.	
10	**CAUTION** The gearbox unit weighs 120 kg. The base weighs 81 kg. All lifting accessories used must be sized accordingly!	
11	Fit the lifting slings to the base/gearbox unit and place it with the lower arm side downwards, on top of a suitable workbench.	
12	Remove the VK-cover from the bottom of the robot base. **Tip!** When the cabling is removed, it may be easier to drill a hole through the cover or to try and push it out from the inside.	
13	Secure the weight of the base with lifting slings.	

Continues on next page

	Action	Note
14	Remove the *gearbox/base attachment screws and washer*.	Shown in the figure *Location of gearbox unit, axes 1-2 on page 325*.
15	Separate the base from the gearbox unit.	

Refitting, gearbox unit axes 1-2

The procedure below details how to refit the complete gearbox unit, axes 1-2.

	Action	Note
1	**Note** It is important that the gearbox and the mating motor pinion are provided by the same sub-supplier, make sure to order the correct spare part! To determine the correct spare part, see *Compatible gearboxes and motors* in *Product manual, spare parts - IRB 1600/1660*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox unit weighs 120 kg. All lifting accessories used must be sized accordingly!	
4	Clean the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153*	
5	Place the gearbox unit with the lower arm side downwards on a suitable workbench.	
6	Clean the mating surfaces of the base and of the gearbox unit with isopropanol.	
7	Lubricate the V-ring with *grease* and fit it to the gearbox unit.	Art. no. is specified in *Required equipment on page 326*.
8	Fit a small amount of Loctite 574 on the mating surface in the gearbox unit.	
9	Fit the base to the gearbox unit and secure it with the *attachment screws* and the washer.	Shown in the figure *Location of gearbox unit, axes 1-2 on page 325*. 16 pcs, M10 x 40, tightening torque: 70 Nm.

Continues on next page

	Action	Note
10	Fit a new *VK-cover* to the base of the robot.	Shown in the figure *Location of gearbox unit, axes 1-2 on page 325*. Spare part no. is specified in *Required equipment on page 326*.
11	**CAUTION** The gearbox unit weighs 120 kg. The base weighs 81 kg. All lifting accessories used must be sized accordingly!	
12	Fit the *lifting slings* to the base/gearbox unit, turn it right side up and move it to the installation site.	
13	Secure the base to the foundation.	Attachment bolts and the tightening torque are specified in section *Attachment bolts, specification on page 64*.
14	Refit the complete arm system.	Detailed in section *Refitting, complete arm system on page 175*.
15	Refit the motors, axes 1 and 2.	Detailed in sections: • *Refitting the motor axis 1 on page 255* • *Refitting, motor axis 2 on page 261*.
16	Perform a leak-down test.	Detailed in section *Performing a leak-down test on page 146*.
17	Fill the two gearboxes with oil.	See, *Technical reference manual - Lubrication in gearboxes*.
18	Refit the oil plugs, axes 1 and 2.	Tightening torque: 24 Nm
19	Seal and paint the joints that have been opened. See *Cut the paint or surface on the robot before replacing parts on page 153* **Note** After all repair work, wipe the robot free from particles with spirit on a lint free cloth.	
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 346*. General calibration information is included in section *Calibration on page 333*.
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 120*.	

4.7.2 Service work on gearboxes, axes 3, 4, 5 and 6

Gearboxes, replacement

The gearboxes of axes 3, 4, 5 and 6 are intended to run without requiring any repairs or maintenance work. This implies that they must under *no circumstances* be opened or serviced.

If the gearboxes require replacement:

- axes 3 and 4: the complete upper arm is to be replaced. This procedure is detailed in section *Replacing the complete upper arm, IRB 1600 on page 177*.
- axes 5 and 6: the complete wrist unit is to be replaced. This procedure is detailed in section *Replacing the wrist unit, IRB 1600 on page 195*.

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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 346*.

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). 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
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, 5 and 6.	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.

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Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of some ABB robots.

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 1600/1660ID. 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 346*.

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.

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.

References

Article numbers for the calibration tools are listed in the section *Special tools on page 386*.

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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 342*. 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.

Robot is not floor mounted

The original calibration data delivered with the robot is generated when the robot is floor mounted. If the robot is not floor mounted, then the robot accuracy could be affected. The robot needs to be calibrated after it is mounted.

5.2 Synchronization marks and axis movement directions

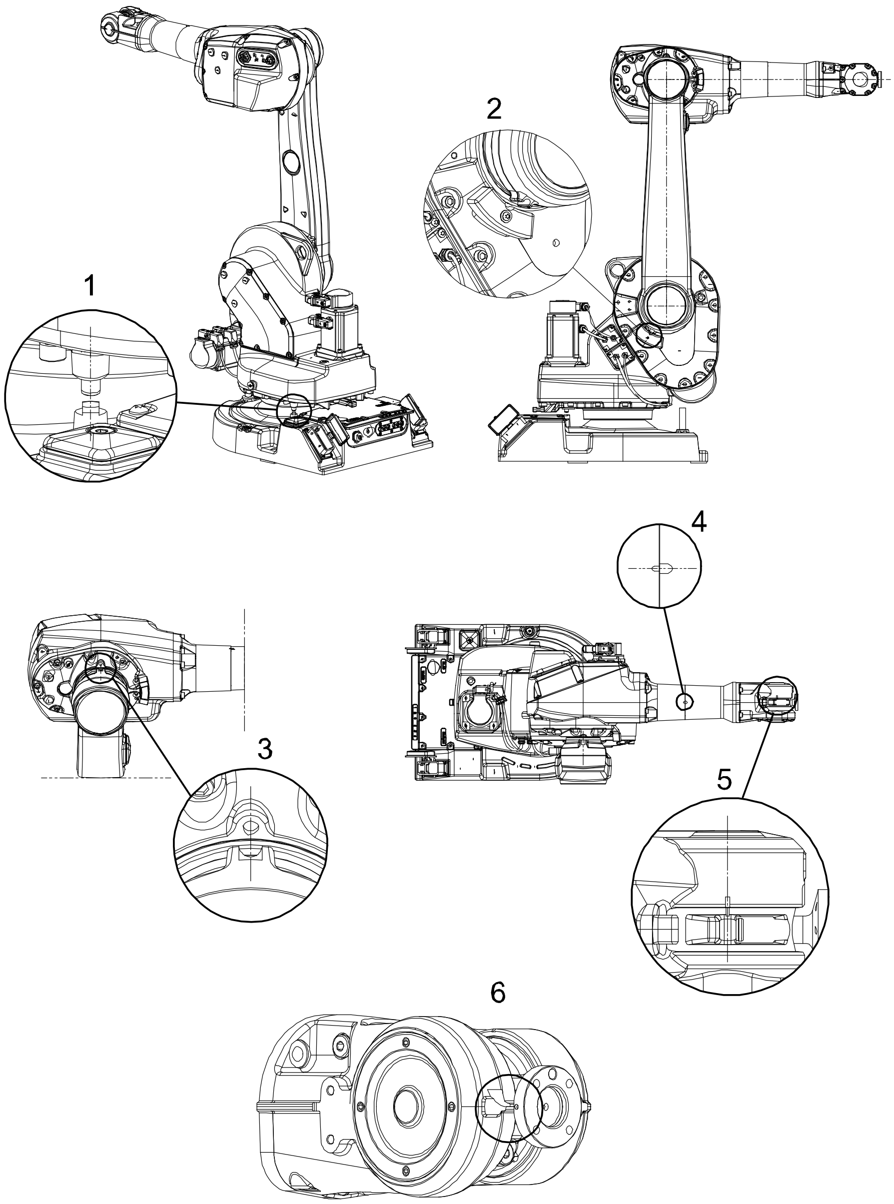
5.2.1 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 1600/IRB 1660ID

IRB 1600



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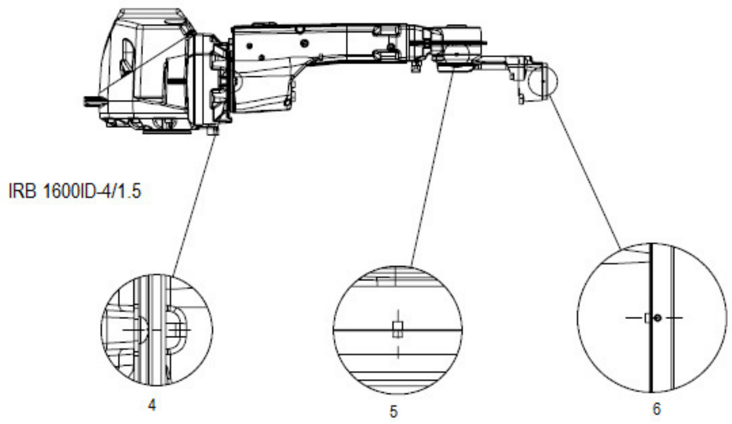
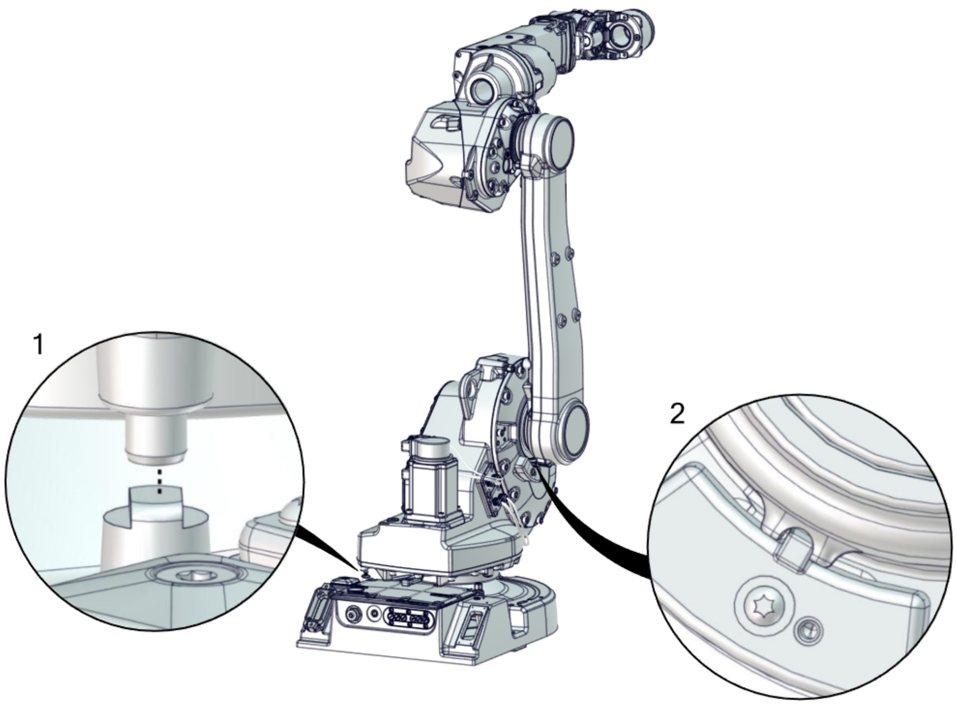
IRB 1600ID

The illustration shows the synchronization marks of axes 4, 5 and 6 for IRB 1600ID. Refer to illustration valid for IRB 1600 for axes 1, 2 and 3.



xx1500001256

IRB 1660ID



xx1700000115

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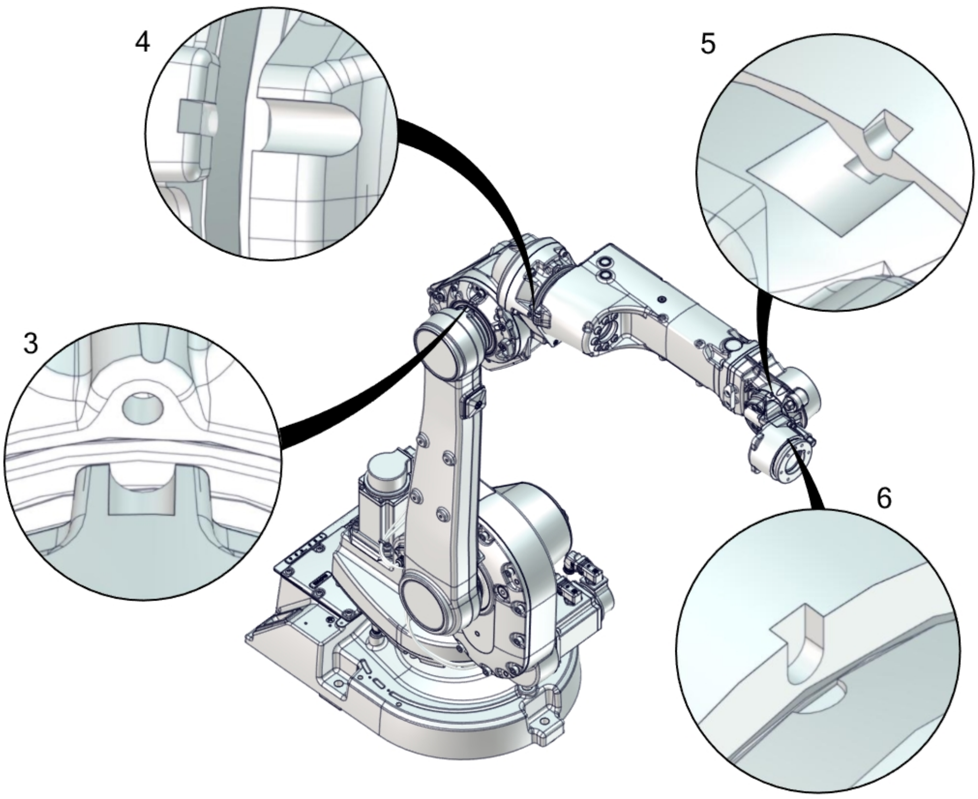


xx1700000116

5.2.2 Calibration movement directions for all axes

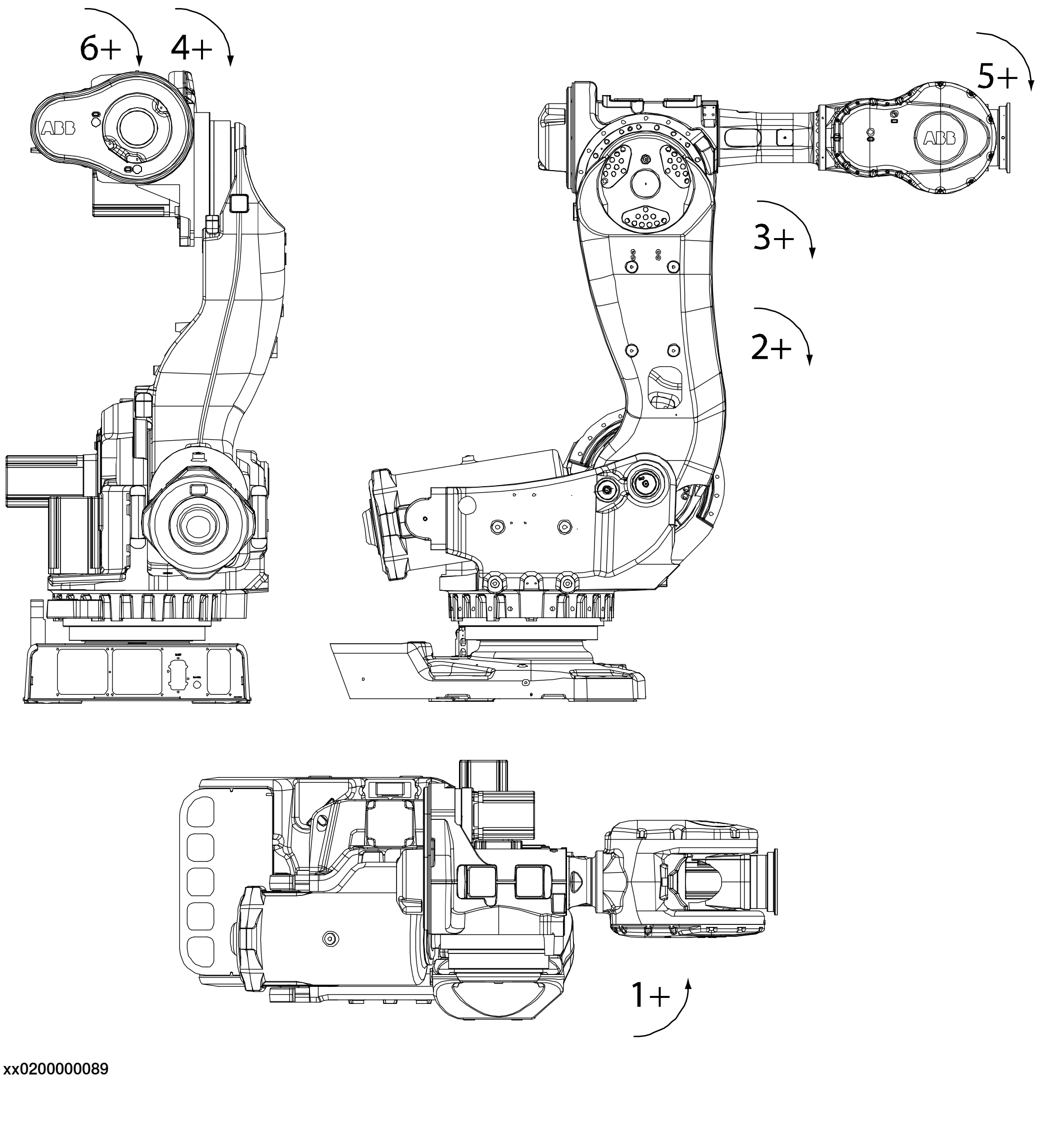
Overview

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.

Coupled axes

When updating the revolution counters for a coupled axis, also the axis it is coupled to needs to be at its synchronization position for the update to be correct; i.e. axis 4 needs to be in synchronization position when updating axis 5 and 6.

With reversed coupled joints, the relationship is the opposite, i.e. axis 4 needs to be in synchronization position to update axis 3.

Coupled axes	IRB 1410	IRB 1510	IRB 1520	IRB 1600	IRB 1600ID	IRB 1660ID	IRB 910 SC	IRB 2400	IRB 2600	IRB 2600ID	IRB 4400	IRB 4450S	IRB 4600
Axis 4, 5, 6				x				x	x		x	x	x
Axis 5, 6	x	x	x		x	x				x			
Axis 4, 3							x						

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 338*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 343*.

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.

Continues on next page

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:

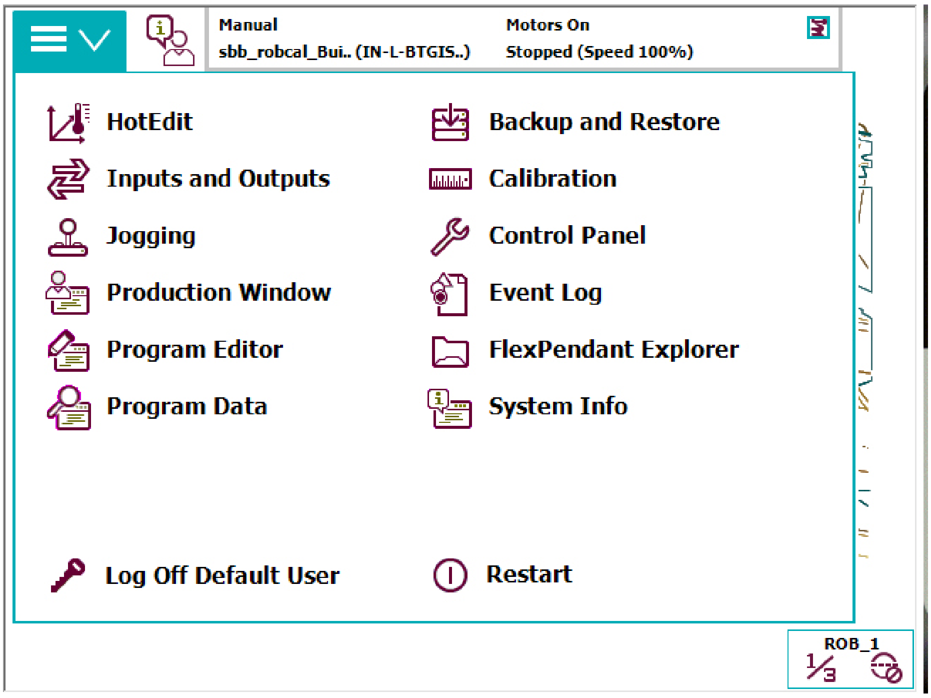
Manipulator variant	Axis 4	Axis 6
IRB 1600	No	Yes
IRB 1600ID, IRB 1660ID	No	No

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

Step 2 - Updating the revolution counter with the FlexPendant

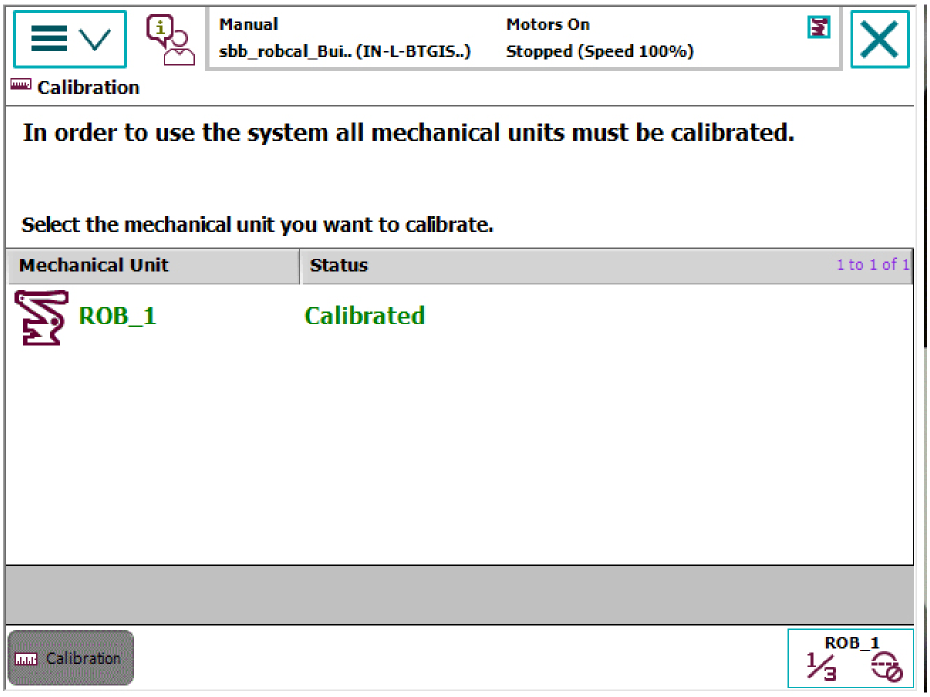
Use this procedure to update the revolution counter with the FlexPendant (IRC5).

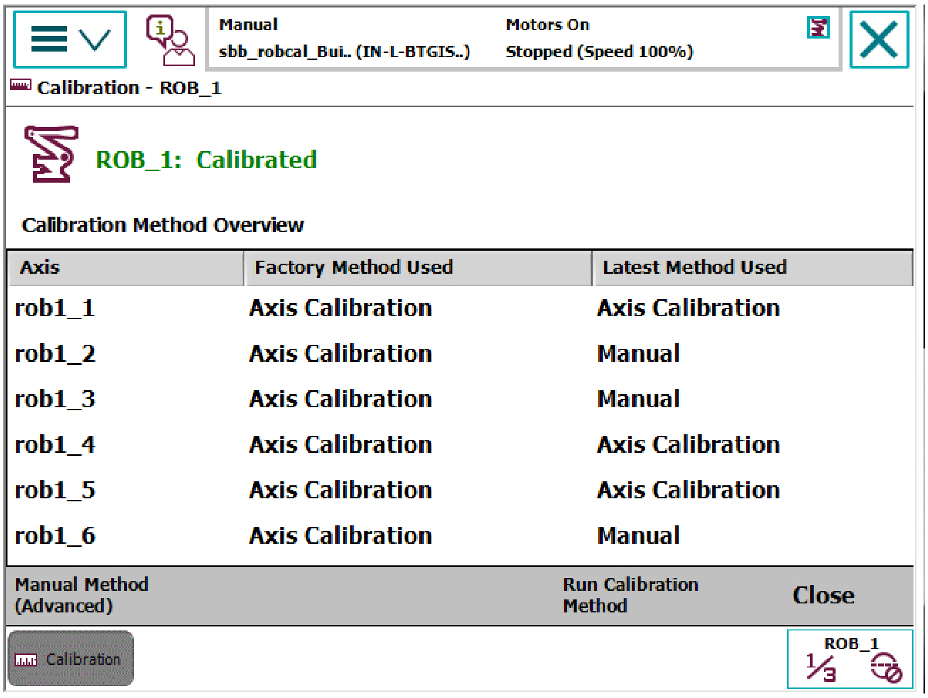
<table>
<tr><th></th><th>Action</th></tr>
<tr><td>1</td><td>On the ABB menu, tap Calibration.



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

Continues on next page

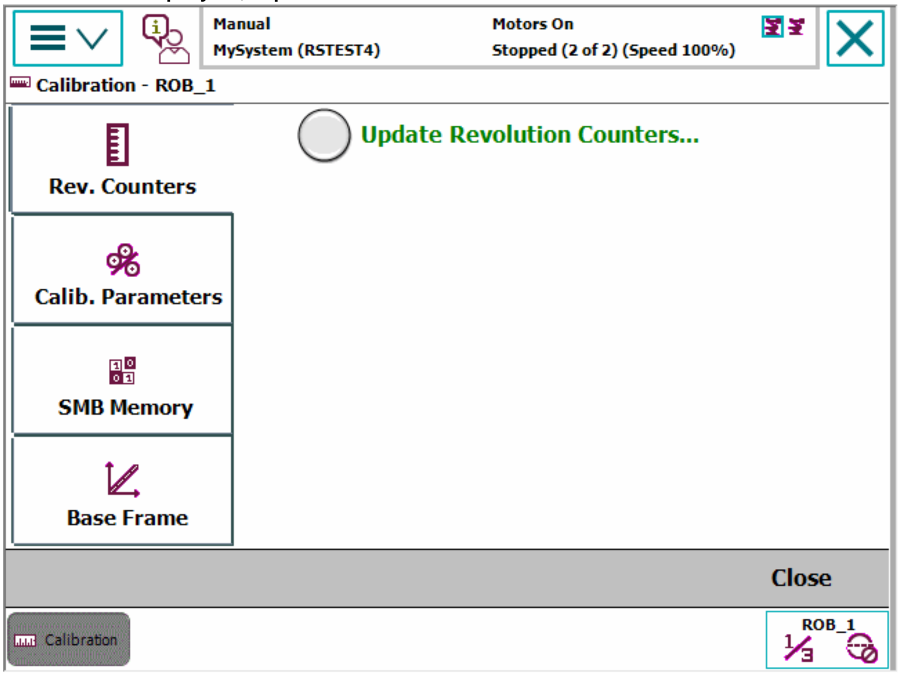
<table>
<tr><th></th><th>Action</th></tr>
<tr><td>2</td><td>All mechanical units connected to the system are shown with their calibration status.
Tap the mechanical unit in question.


xx1500000943</td></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).


xx1500000944</td></tr>
</table>

Continues on next page

<table>
<tr><th></th><th>Action</th></tr>
<tr><td>4</td><td>A screen is displayed, tap Rev. Counters.



en0400000771</td></tr>
<tr><td>5</td><td>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.</td></tr>
<tr><td>6</td><td>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.</td></tr>
<tr><td>7</td><td>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.</td></tr>
<tr><td>8</td><td>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 367.</td></tr>
</table>

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.

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

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.

Continues on next page

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. 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	*	*	*	-	0[i] / *[ii]	0[i] / *[ii]
Axis 5	*	*	*	*	-	0
Axis 6	*	*	*	*	*	-

i Valid for IRB 1600.
ii Valid for IRB 1660ID.

-	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.

How to calibrate a suspended or wall mounted robot

The IRB 1600/1660ID is fine calibrated floor standing in factory, prior to shipping.

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

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

5.4.2 Calibration tools for Axis Calibration

Calibration tool set

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

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	3HAC074119-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot. Contains a removal tool for removing special protection plugs on the turning disc.

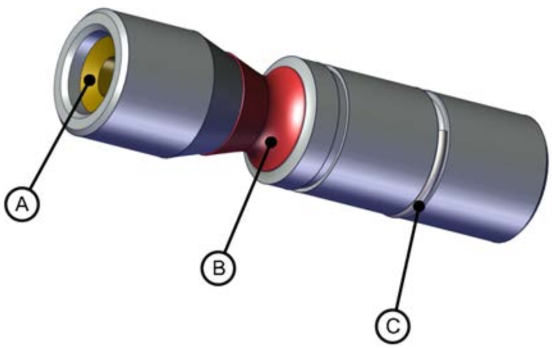
Examining the calibration tool

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

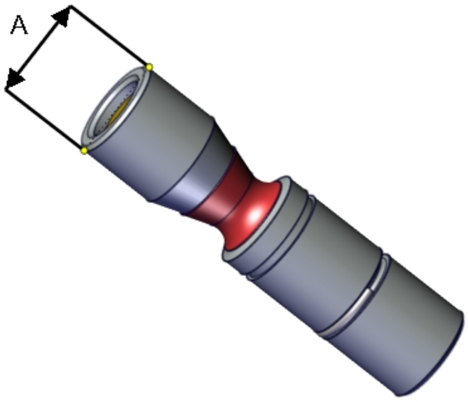
A	Tube insert
B	Plastic protection
C	Steel spring ring

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

5.4.3 Installation locations for the calibration tools

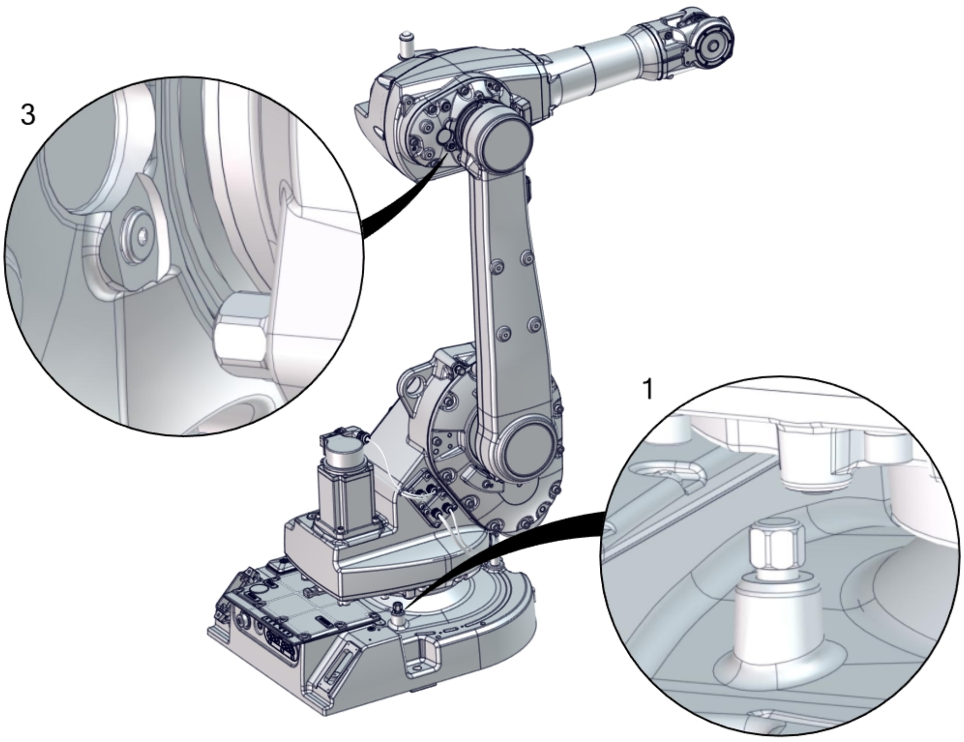
Location of fixed calibration items

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.

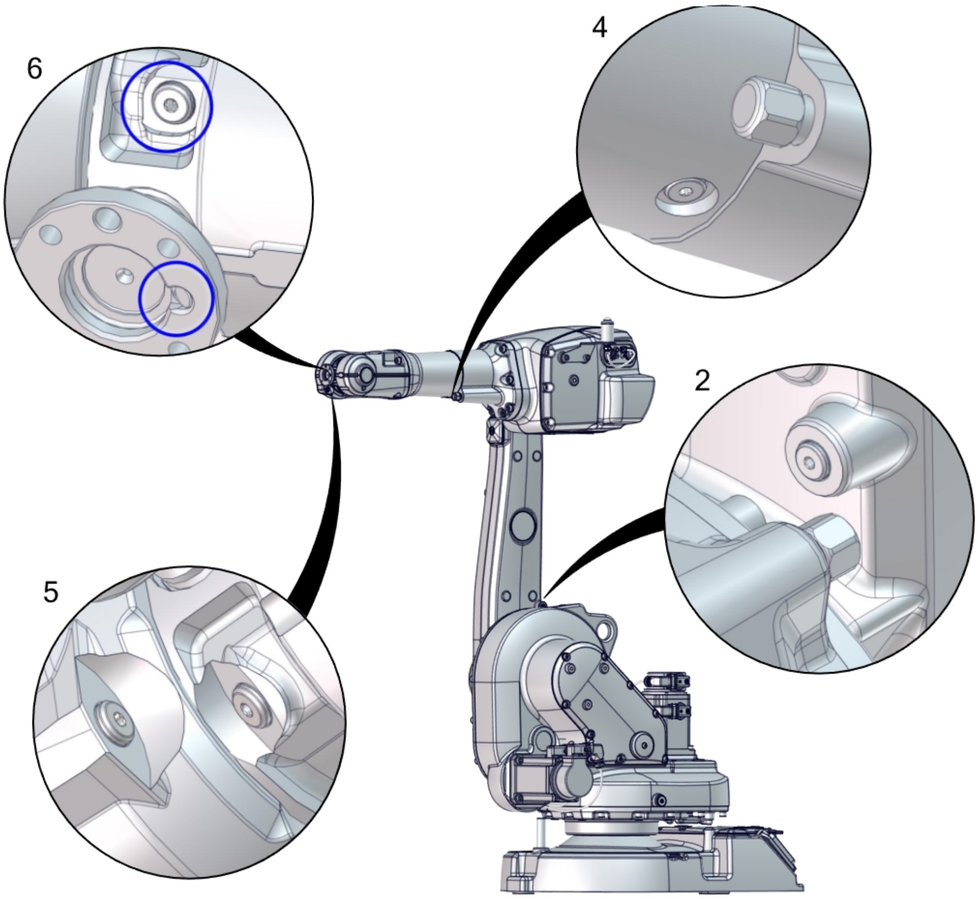
If there is not enough space on an axis to install a fixed calibration pin, the axis is equipped with two bushings instead, for installation of two calibration tools when calibration is carried out. This is shown in the figure.

IRB 1600



xx1700000113

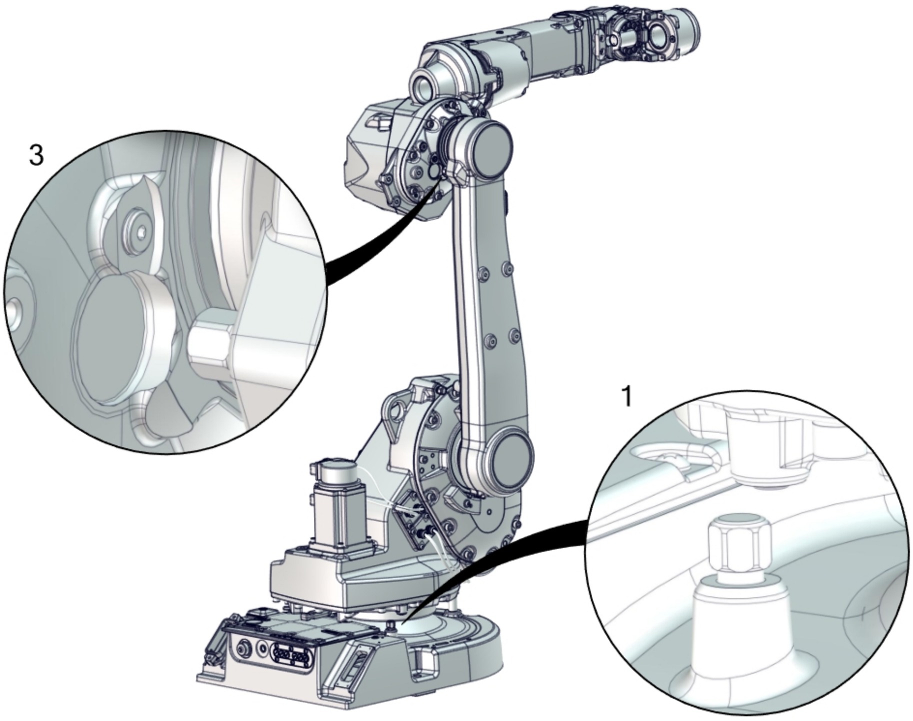
Continues on next page



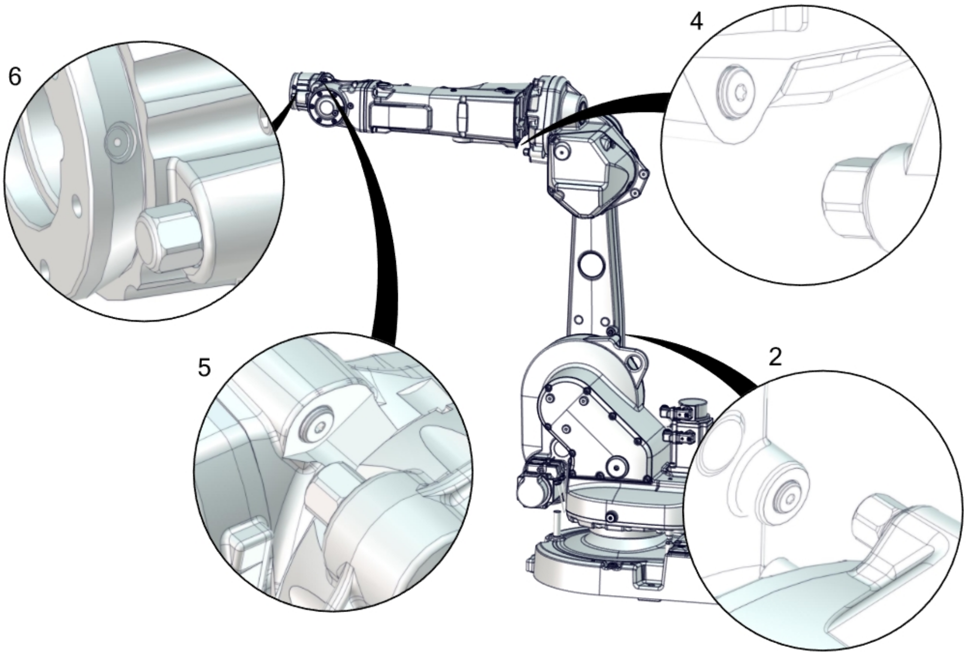
xx1700000114

Continues on next page

IRB 1660ID



xx1700000111



xx1700000112

Continues on next page

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	3HAC059487-001	Contains replacement calibration pin covers and protective plugs for the bushing.
Protective plug on turning disc	3HAC057676-001 (IRB 1660ID) 3HAC061134-001 (IRB 1600)	Replace if damaged or missing.

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	3HAC074119-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot. Contains a removal tool for removing special protection plugs on the turning disc.

Required consumables

Consumable	Article number	Note
Clean cloth	-	

Spare parts

Spare part	Article number	Note
Protection cover and plug set	3HAC059487-001	Contains replacement calibration pin covers and protective plugs for the bushing.
Protective plug on turning disc	3HAC057676-001 (IRB 1660ID) 3HAC061134-001 (IRB 1600)	Replace if damaged or missing.

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 347*.
2. Choose which axis/axes to calibrate.
3. The robot moves to synchronization position.

Continues on next page

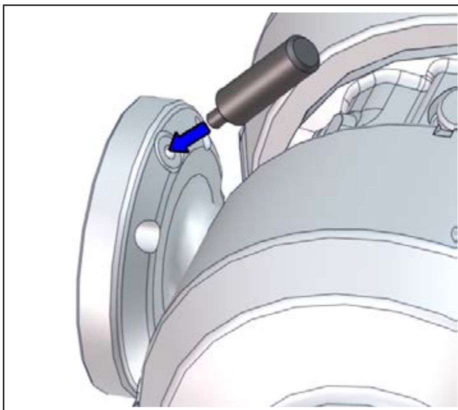
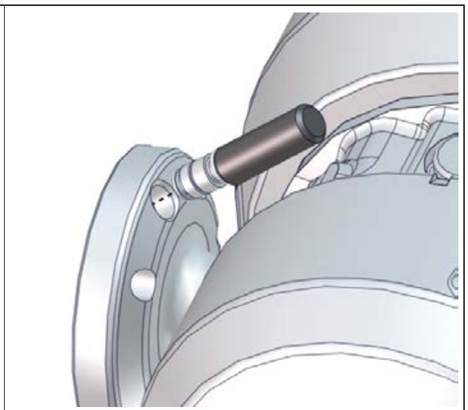
4 Validate the synchronization marks.

5 The robot moves to preparation position.

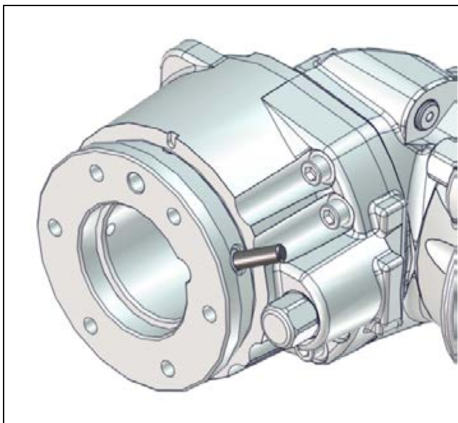
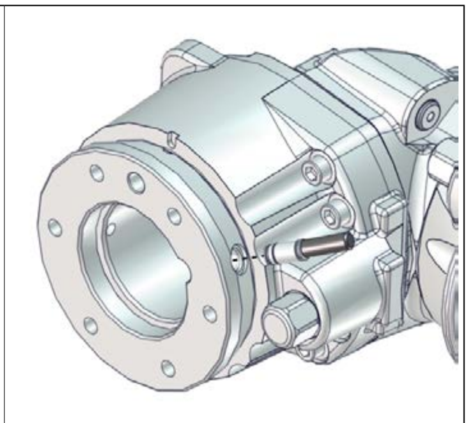
6 Remove the protective cover from the fixed pin and the protection plug from the bushing, if any, and install the calibration tool.

Use the removal tool included in the calibration tool box to remove the special protection plug(s) on the turning disc.

IRB 1600

 xx1700000407	 xx1700000408

IRB 1660ID

 xx1700000410	 xx1700000411

When calibrating axis 6, push in the calibration tool into the turning disc until the snap ring engages, no further.

On IRB 1600, this makes the calibration tool to stick out on the other side of the turning disc. Any equipment fitted to the turning disc must therefor either be removed or designed with a cavity, giving space to the calibration tool to stick out.

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.

Refit the protection plug(s) to the turning disc, push until the steel spring ring snaps into place.

Continues on next page

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, 5 or 6 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 364*.

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.	
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.
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	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 355*.

Continues on next page

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 341*

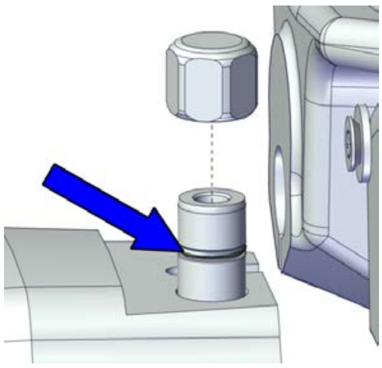
Axis Calibration with SafeMove option

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.

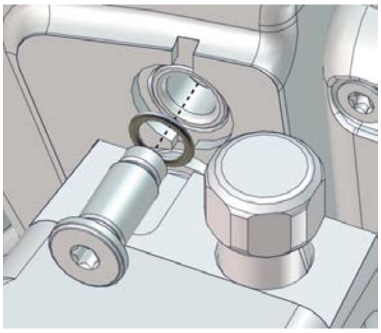
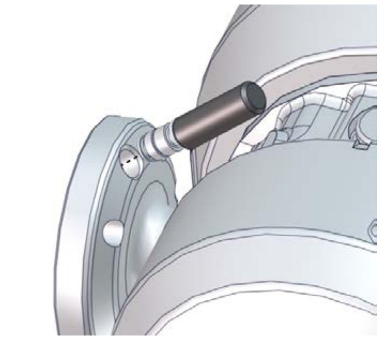
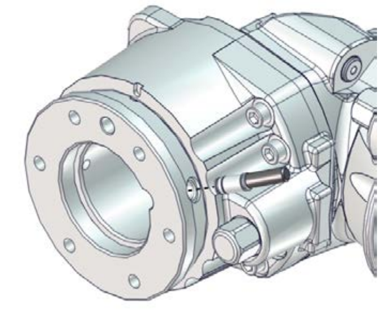
However, SafeMove may generate other warning messages anytime during the Axis Calibration routine. When a warning message is displayed, tap **Acknowledge** to confirm the unsynchronized state and continue Axis Calibration procedure.

> **CAUTION**
>
> SafeMove must be synchronized after the calibration is completed.

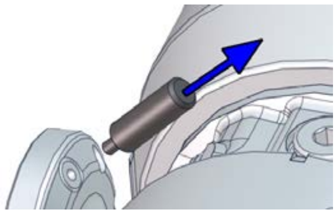
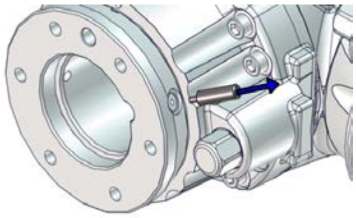
After calibration

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>1</td><td>Check the o-ring on the fixed calibration pin.
Replace if damaged or missing.</td><td rowspan="2">
xx1600002102
Protection cover and plug set: 3HAC059487-001.</td></tr>
<tr><td>2</td><td>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.</td></tr>
</table>

Continues on next page

	Action	Note
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: 3HAC059487-001.
4	Refit the special protection plug to the turning disc using the tool included in the calibration tool box.	IRB 1600  xx1700000408 IRB 1660ID  xx1700000411

Continues on next page

	Action	Note
5	Remove the tool from the protection plug.	IRB 1600  xx1700000901 IRB 1660ID  xx1700000902
6	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 364*.

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.
12. (For system containing SafeMove or EPS) 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 361*).

Example "Adjust axis 4":

1. Create a backup.

Continues on next page

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, 6. 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.

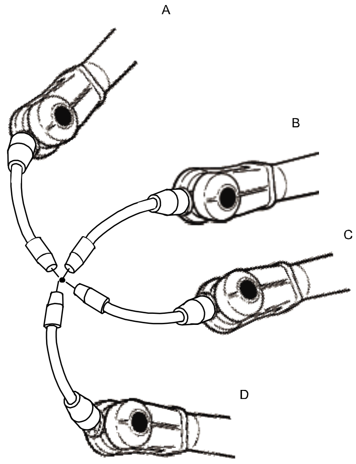
a Jog the robot to an appropriate position, A, for the first approach point.

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 367*.
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 338*.
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.

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 338* and *Updating revolution counters on page 342*.

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 338* and *Updating revolution counters on page 342*.

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 370*.

Transportation

Prepare the robot or parts before transport, this to avoid hazards.

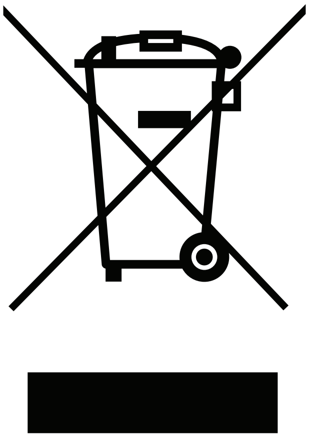
6.2 Environmental information

Introduction

ABB robots contain components in different materials. During decommissioning, all materials should 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.

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, upper arm
Batteries, Lithium	Serial measurement board
Cast iron/nodular iron	Base, lower arm
Copper	Cables, motors
Neodymium	Brakes, motors
Nickel	Turning disc (foundry)
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.

7 Robot description

7.1 Type A of IRB 1600

Type A - new upper arm and wrist

Type A of IRB 1600 have a new upper arm, complete and a new wrist unit. As a result of this, the following parts differ from earlier versions:

- Upper arm, complete
- Wrist unit
- O-ring sealingplate

How to know which type the robot is?

The identification plate on the cabinet and the lower arm of the robot tells if the robot has a new upper arm and wrist or not.

Those robots with a new upper arm and wrist are named IRB 1600, type A.

Those robots which are not equipped with a new upper arm and wrist are simply named IRB 1600 (no type specified).

Which parts are interchangeable and which are not?

The following parts **are interchangeable**.

- The upper arm, complete with spare part no. 3HAC026567-001 **is interchangeable** with spare part no. 3HAC023630-001. **Note**! Software version 5.07.01 is needed!

The following parts are **not** interchangeable:

- The wrist unit with spare part no. 3HAC026569-001 is **not** interchangeable with spare part no. 3HAC10475-1.
- The o-ring sealingplate with spare part no. 3HAC025420-001 is **not** interchangeable with spare part no. 3HAC 7191-1.

Other changes in this product manual, compared to product manual IRB 1600, 3HAC023637-001

The content in this product manual is the same as in the product manual with art. no. 3HAC023637-001, except for the new upper arm complete and the new wrist unit for type A. In order to distinguish IRB 1600 type A from earlier versions, a new art. no. has been created.

There has been a few other changes in the manual, not related to the IRB 1600 type A. These changes are described below:

- The cable harness for motors axes 1-2 has got a new spare part no. The motors axes 1-2 (3HAC023557-001) and the cable harness, motors axes 1-2 (3HAC023754-001) now have two separate spare part no:s.
- Some cable harnesses have been replaced.

For details, see *Base, spare part list* and *Frame, spare part list*, in *Product manual, spare parts - IRB 1600/1660*.

7.2 Type A of IRB 1600ID

Type A - changes in the ISO data

IRB 1600ID robots delivered as from R 11.2/RW 5.14.02, have designation Type A due to new basic tuning and a different MOC.cfg structure.

Upgrade from IRB 1600ID to IRB 1600ID type A

To upgrade an existing installation with the IRB 1600ID to the IRB 1600ID Type A version, with improved performance, a new drive module key with Type A version of the robot is needed. The new key then has to be used instead of the old by modifying the existing system in System Builder in RobotStudio. Please contact Robotics After Sales for more information and purchase of a new key.

After the upgrade the existing programs may require a touch-up of positions.

Further information

Technote 110912 includes more detailed information. Contact Robotics After Sales.

7.3 Version A and version B of IRB 1600/1660ID

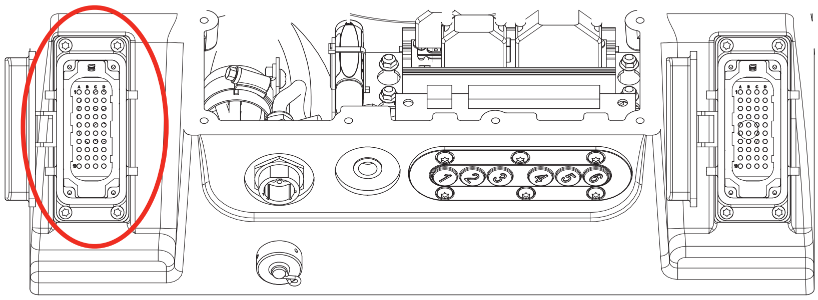
Version A and version B

Version A and version B are only available for IRB 1600/1600ID in standard protection. Robot power cables must be ordered according to the robot version.

How to know which version the robot is?

The power connector on the robot base tells which version the robot is.

The following figure illustrates the power connector (circled) on the base of robots in version A.



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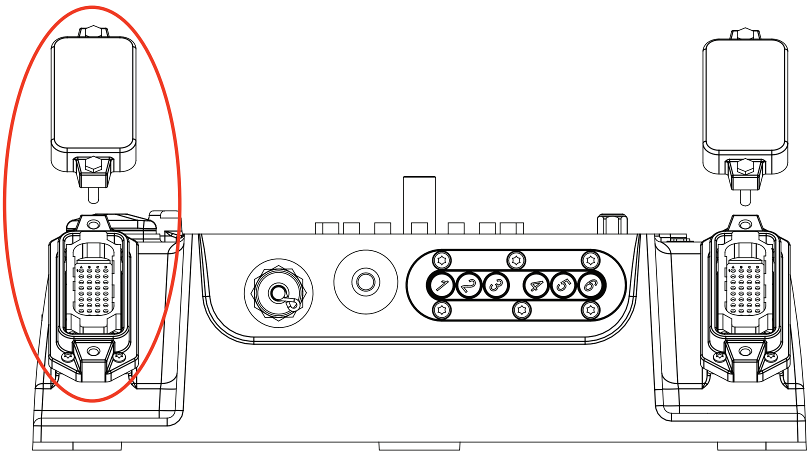
The following figure illustrates the power connector (circled) on the base of robots in version B.



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8 Reference information

8.1 Introduction

General

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

8.2 Applicable standards

Note

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

General

The product is designed in accordance 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 deviations from ISO 10218-1:2011, these are listed in the declaration of incorporation which is part of the product delivery.

Normative standards as referred to from ISO 10218-1

Standard	Description
ISO 9283:1998	Manipulating industrial robots - Performance criteria and related test methods
ISO 10218-2	Robots and robotic devices - Safety requirements for industrial robots - Part 2: Robot systems and integration
ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
ISO 13849-1:2006	Safety of machinery - Safety related parts of control systems - Part 1: General principles for design
ISO 13850	Safety of machinery - Emergency stop - Principles for design
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements

Deviations from ISO 10218-1:2011 for IRC5 with MultiMove

A deviation exists towards ISO 10218-1:2011, paragraph *5.9 Control of simultaneous motion*, for the option MultiMove. See the application manual for MultiMove.

Region specific standards and regulations

Standard	Description
ANSI/RIA R15.06	Safety requirements for industrial robots and robot systems
ANSI/UL 1740	Safety standard for robots and robotic equipment
CAN/CSA Z 434-03	Industrial robots and robot Systems - General safety requirements

Other standards used in design

Standard	Description
ISO 9787:2013	Robots and robotic devices -- Coordinate systems and motion nomenclatures
IEC 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments

Continues on next page

Standard	Description
IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
ISO 13732-1:2006	Ergonomics of the thermal environment - Part 1
IEC 60974-1:2012[i]	Arc welding equipment - Part 1: Welding power sources
IEC 60974-10:2014[i]	Arc welding equipment - Part 10: EMC requirements
ISO 14644-1:2015[ii]	Classification of air cleanliness
IEC 60529:1989 + A2:2013	Degrees of protection provided by enclosures (IP code)

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

8.3 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	

8.4 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

8.5 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.	

8.6 Standard tools

General

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

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

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

Contents, standard toolkit

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

8.7 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 385*, and of special tools, listed directly in the instructions and also gathered in this section.

Measuring tools, play

The tools listed for measuring the play are used after service work on axes 5 and 6.

Description	Robot variant	Art. no.
Measuring tool, play	IRB 1600ID/1660ID	3HAB9238-1
Turning disk adapter	IRB 1600ID/1660ID	3HAC027717-020
Measuring bracket	IRB 1600ID/1660ID	3HAC032976-001

Special tools

The following table specifies all the tools, not considered standard, used when performing service activities on the robot. The special tools are also listed directly in the instructions.

Description	Art. no.	Note
Rotation tool, motor	3HAC022266-003	Used to adjust the gear play on all motors.
Dynamometer	-	Capacity: 100N
Hook	3HAC024045-001	Used to tighten the timing belt of axis 6, together with the dynamometer.
Belt tightener	3HAC024044-001	Used to tighten the timing belt of axis 5, together with the dynamometer.
Lifting tool, gearbox	3HAC023364-001	
Lifting tool, upper arm	3HAC062980-001	

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.

Continues on next page

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	3HAC074119-001	Delivered as a set of calibration tools. Required if Axis Calibration is the valid calibration method for the robot. Contains a removal tool for removing special protection plugs on the turning disc.

8.8 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.

9 Spare part lists

9.1 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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10 Circuit diagram

10.1 Circuit diagrams

Overview

The circuit diagrams are not included in this manual, but are available for registered users on myABB Business Portal, www.abb.com/myABB.

See the article numbers in the tables below.

Controllers

Product	Article numbers for circuit diagrams
Circuit diagram - IRC5	*3HAC024480-011*
Circuit diagram - IRC5 Compact	*3HAC049406-003*
Circuit diagram - IRC5 Panel Mounted Controller	*3HAC026871-020*

Manipulators

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 120	*3HAC031408-003*
Circuit diagram - IRB 140 type C	*3HAC6816-3*
Circuit diagram - IRB 260	*3HAC025611-001*
Circuit diagram - IRB 360	*3HAC028647-009*
Circuit diagram - IRB 390	*3HAC060545-009*
Circuit diagram - IRB 460	*3HAC036446-005*
Circuit diagram - IRB 660	*3HAC025691-001*
Circuit diagram - IRB 760	*3HAC025691-001*
Circuit diagram - IRB 1200	*3HAC046307-003*
Circuit diagram - IRB 1410	*3HAC2800-3*
Circuit diagram - IRB 1600/1660 (with IRC5)	*3HAC021351-003*
Circuit diagram - IRB 1510	*3HAC087368-003*
Circuit diagram - IRB 1520	*3HAC039498-007*
Circuit diagram - IRB 2400	*3HAC6670-3*
Circuit diagram - IRB 2600	*3HAC029570-007*
Circuit diagram - IRB 4400/4450S	*3HAC9821-1*
Circuit diagram - IRB 4600	*3HAC029038-003*
Circuit diagram - IRB 6620	*3HAC025090-001*
Circuit diagram - IRB 6620 / IRB 6620LX	*3HAC025090-001*
Circuit diagram - IRB 6640	*3HAC025744-001*
Circuit diagram - IRB 6650S	*3HAC13347-1* *3HAC025744-001*

Continues on next page

Product	Article numbers for circuit diagrams
Circuit diagram - IRB 6660	*3HAC025744-001* *3HAC029940-001*
Circuit diagram - IRB 6700 / IRB 6790	*3HAC043446-005*
Circuit diagram - IRB 7600	*3HAC13347-1* *3HAC025744-001*
Circuit diagram - IRB 14000	*3HAC050778-003*
Circuit diagram - IRB 910SC	*3HAC056159-002*

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