ROBOTICS

Product manual

IRB 4600

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Product manual

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IRB 4600 - 45/2.05
IRB 4600 - 40/2.55
IRB 4600 - 20/2.50

IRC5, OmniCore

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Original instructions.

Table of contents

Overview of this manual ... 9
Product documentation ... 18
How to read the product manual ... 20

1 Safety 21

1.1 Safety information ... 21
1.1.1 Limitation of liability ... 21
1.1.2 Requirements on personnel ... 22
1.2 Safety signals and symbols ... 23
1.2.1 Safety signals in the manual ... 23
1.2.2 Safety symbols on manipulator labels ... 25
1.3 Robot stopping functions ... 31
1.4 Safety during installation and commissioning ... 32
1.5 Safety during operation ... 35
1.6 Safety during maintenance and repair ... 36
1.6.1 Safety during maintenance and repair ... 36
1.6.2 Emergency release of the robot axes ... 39
1.6.3 Brake testing ... 40
1.7 Safety during troubleshooting ... 41
1.8 Safety during decommissioning ... 42

2 Installation and commissioning 43

2.1 Introduction to installation and commissioning ... 43
2.2 Unpacking ... 44
2.2.1 Pre-installation procedure ... 44
2.2.2 Working range and type of motion ... 48
2.2.3 Risk of tipping/stability ... 52
2.2.4 The unit is sensitive to ESD ... 53
2.3 On-site installation ... 54
2.3.1 Lifting robot with roundslings ... 54
2.3.2 Lifting and turning a suspended mounted robot ... 57
2.3.3 Manually releasing the brakes ... 58
2.3.4 Orienting and securing the robot ... 61
2.3.5 Setting the system parameters for a suspended or tilted robot ... 65
2.3.6 Fitting equipment on robot ... 69
2.3.7 Loads fitted to the robot, stopping time and braking distances ... 76
2.3.8 Installation of signal lamp (option) ... 77
2.4 Restricting the working range ... 78
2.4.1 Axes with restricted working range ... 78
2.4.2 Mechanically restricting the working range of axis 1 ... 79
2.5 Installing options ... 82
2.5.1 Installation of cooling fan for motors (option) ... 82
2.5.2 Installation of Foundry Plus Cable guard (option no. 908-1) ... 89
2.5.3 Installing an expansion container ... 90
2.6 Robot in hot environments ... 95
2.6.1 Start of robot in hot environments ... 95
2.7 Robot in cold environments ... 96
2.7.1 Start of robot in cold environments ... 96
2.8 Electrical connections ... 97
2.8.1 Robot cabling and connection points ... 97
2.8.2 Customer connection on robot ... 100
2.9 Test run after installation, maintenance, or repair ... 106

3 Maintenance 107

3.1 Introduction ... 107

3.2 Maintenance schedule 108
3.2.1 Specification of maintenance intervals 108
3.2.2 Maintenance schedule 109
3.2.3 Expected component life 111
3.3 Inspection activities 112
3.3.1 Inspecting oil level, axis 1 gearbox 112
3.3.2 Inspecting the oil level, axis 2 gearbox 119
3.3.3 Inspecting the oil level, axis 3 gearbox 121
3.3.4 Inspecting the oil level, axis 4 gearbox 124
3.3.5 Inspecting oil level, gearbox axes 5 - 6 126
3.3.6 Inspecting the cable harness 130
3.3.7 Inspecting information labels 132
3.3.8 Inspecting the mechanical stop pin, axis 1 135
3.3.9 Inspecting additional mechanical stops 138
3.3.10 Inspecting dampers 140
3.3.11 Inspecting the pressure relief valve 142
3.3.12 Inspecting Signal lamp (option) 144
3.4 Replacement activities 146
3.4.1 Type of lubrication in gearboxes 146
3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots 148
3.4.3 Changing the oil, axis-1 gearbox on suspended robots 153
3.4.4 Changing the oil, axis-2 gearbox 159
3.4.5 Changing the oil, axis-3 gearbox 163
3.4.6 Changing the oil, axis-4 gearbox 169
3.4.7 Changing oil, axes-5 and -6 gearboxes 173
3.4.8 Replacing SMB battery 179
3.5 Cleaning activities 184
3.5.1 Cleaning the IRB 4600 184

4 Repair 187

4.1 Introduction 187
4.2 General procedures 188
4.2.1 Performing a leak-down test 188
4.2.2 Mounting instructions for bearings 189
4.2.3 Mounting instructions for sealings 191
4.2.4 Cut the paint or surface on the robot before replacing parts 194
4.2.5 The brake release buttons may be jammed after service work 195
4.3 Complete robot 196
4.3.1 Removing the complete cable harness 196
4.3.2 Refitting the complete cable harness 209
4.3.3 Replacing SMB unit 225
4.3.4 Replacing the brake release board 231
4.3.5 Replacing the base 236
4.4 Upper arm 247
4.4.1 Replacing the complete upper arm 247
4.4.2 Replacing complete tubular shaft unit 257
4.4.3 Replacing wrist unit 263
4.4.4 Measuring the play, axis 5 271
4.4.5 Measuring the play, axis 6 274
4.5 Lower arm 277
4.5.1 Replacing the lower arm 277
4.6 Frame and base 284
4.6.1 Replacing stop pin axis 1 284
4.7 Motors 287
4.7.1 Removing motors 287
4.7.2 Refitting motors 295
4.7.3 Adjusting the play of axis 4, 5 and 6 motors 305
4.8 Gearboxes 306
4.8.1 Replacing gearbox axis 1 306

4.8.2 Replacing gearbox axis 2 ... 317
4.8.3 Replacing gearbox axis 3 ... 326

5 Calibration **335**

5.1 Introduction to calibration ... 335
5.1.1 Introduction and calibration terminology ... 335
5.1.2 Calibration methods ... 336
5.1.3 When to calibrate ... 339
5.2 Synchronization marks and axis movement directions ... 340
5.2.1 Synchronization marks and synchronization position for axes ... 340
5.2.2 Calibration movement directions for all axes ... 343
5.3 Updating revolution counters ... 344
5.3.1 Updating revolution counters on IRC5 robots ... 344
5.3.2 Updating revolution counters on OmniCore robots ... 348
5.4 Calibrating with Axis Calibration method ... 350
5.4.1 Description of Axis Calibration ... 350
5.4.2 Calibration tools for Axis Calibration ... 353
5.4.3 Installation locations for the calibration tools ... 355
5.4.4 Axis Calibration - Running the calibration procedure ... 358
5.4.5 Reference calibration ... 363
5.5 Calibrating with Calibration Pendulum method ... 365
5.6 Calibrating with Wrist Optimization method ... 366
5.7 Verifying the calibration ... 368
5.8 Checking the synchronization position ... 369

6 Decommissioning **371**

6.1 Introduction to decommissioning ... 371
6.2 Environmental information ... 372
6.3 Scrapping of robot ... 374

7 Robot description **375**

7.1 Manipulator types and variants ... 375
7.2 Type C of IRB 4600 ... 376
7.3 Type D of IRB 4600 ... 377

8 Reference information **379**

8.1 Introduction ... 379
8.2 Applicable standards ... 380
8.3 Unit conversion ... 381
8.4 Screw joints ... 382
8.5 Weight specifications ... 385
8.6 Standard tools ... 386
8.7 Special tools ... 387
8.8 Lifting accessories and lifting instructions ... 390

9 Spare part lists **391**

9.1 Spare part lists and illustrations ... 391

10 Circuit diagram **393**

10.1 Circuit diagrams ... 393

Index **395**

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Overview of this manual

About this manual

This manual contains instructions for:

- mechanical and electrical installation of the IRB 4600
- maintenance of the IRB 4600
- mechanical and electrical repair of the IRB 4600

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

- *Standard*
- *Foundry Plus*

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

Product manual scope

The manual covers all variants and designs of the IRB 4600. Some variants and designs may have been removed from the business offer and are no longer available for purchase.

Usage

This manual should be used during:

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

Note

It is the responsibility of the integrator to conduct a risk assessment of the final application.

It is the responsibility of the integrator to provide safety and user guides for the robot system.

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel.

Prerequisites

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

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

Continues on next page

References

Reference	Document ID
Product manual, spare parts - IRB 4600	*3HAC049108-001*
Product manual - IRB 4600 Foundry Prime	*3HAC040585-001*
Circuit diagram - IRB 4600	*3HAC029038-003*
Technical reference manual - Lubrication in gearboxes	*3HAC042927-001*
Safety manual for robot - Manipulator and IRC5 or OmniCore controller [i]	*3HAC031045-001*
Product specification - IRB 4600 For OmniCore robots	*3HAC080366-001*
Product specification - IRB 4600 For IRC5 robots	*3HAC032885-001*
Product manual - OmniCore V250XT For OmniCore robots	*3HAC073447-001*
Product manual - IRC5 For IRC5 robots, with main computer DSQC 639.	*3HAC021313-001*
Product manual - IRC5 For IRC5 robots, with main computer DSQC1000.	*3HAC047136-001*
Operating manual - Emergency safety information	*3HAC027098-001*
Operating manual - OmniCore	*3HAC065036-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - Calibration Pendulum	*3HAC16578-1*
Operating manual - Service Information System (IRC5) or *Operating manual - OmniCore* For IRC5 robots	*3HAC050944-001* (IRC5) or *Operating manual - OmniCore*
Technical reference manual - System parameters For OmniCore robots	*3HAC065041-001*
Technical reference manual - System parameters For IRC5 robots	*3HAC050948-001*
Application manual - Additional axes and stand alone controller (IRC5) For IRC5 robots	*3HAC051016-001* (IRC5)
Application manual - Electronic Position Switches For IRC5 robots	*3HAC050996-001*
Application manual - CalibWare Field For IRC5 robots	*3HAC030421-001*

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

Revisions

Revision	Description
-	First edition

Continues on next page

Revision	Description
A	The following updates have been made in this revision: • Added more information about working in the safeguarded space. • Added more information about hazards with oil. • Information about the quality and used threadlength for attachment screws on mounting flange, added in *Installation chapter* section *Fitting equipment on wrist and mounting flange on page 73*. • The text in the introduction to chapters *Installation*, *Maintenance* and *Repair* has been updated concerning the robot being connected to earth when power connected. • Levelmeter calibration added in sections *Brief description of calibration methods on page 337* and *Calibration equipment, Levelmeter (alternative method) on page 387*. • Section *Upper arm (2.05/2.50/2.55)* in Spare parts updated with Type A spare parts. • Section *Lifting and turning a suspended mounted robot on page 57* added in Installation chapter. • Section *Installation of Foundry Plus Cable guard (option no. 908-1) on page 89* added in Installation chapter. • New **DANGER!** added in section *Manually releasing the brakes on page 58*. • Restricting working range with software added in section *Mechanically restricting the working range of axis 1 on page 79*. • The sections describing *Replacing motors* axes 1 through 6 has been updated. Two new sections *Removing motors on page 287* and *Refitting motors on page 295* replaces the older ones.
B	The following updates have been made in this revision: • Missing text "*type A*" for armhousing 3HAC034549-005 added in chapter *Spare parts* section *Upper arm (2.05/2.50/2.55)*. • Wrist Foundry added in chapter *Spare parts*, section *Wrist unit (20 kg and 45/60kg*. • Motors in wrist as rebuilding parts added in section *Rebuilding parts* in *Spare parts IRB 4600*. • How to adjust the play on motors axes 4-6 and on wrist added in sections *Replacing motors, axes 4, 5 and 6* and *Replacing wrist unit on page 263*. • Correction of required oil level, see *Inspecting oil level, axis 1 gearbox on page 112*. In chapter *Safety* : • Updated safety signal graphics for 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 teminology: *robot* replaced with *manipulator*.

Continues on next page

Revision	Description
C	The following updates have been made in this revision: • Added *Installing an expansion container on page 90*. • A figure showing IRB 2600 removed in section *Orienting and securing the robot on page 61*. • Section *Installation of Foundry Plus Cable guard (option no. 908-1) on page 89* added. • Updated the section *Start of robot in cold environments on page 96*. • Interval for inspection of signal lamp added in section *Maintenance schedule on page 109*. • New design of frame added in sections *Inspecting oil level, axis 1 gearbox on page 112* and *Changing the oil, axis-1 gearbox on floor mounted robots on page 148*. • Figure showing required oil level added in section *Inspecting oil level, axis 1 gearbox on page 112*. • Inspection of oil level on suspended robot updated in section *Inspecting oil level, axis 1 gearbox on page 112*.
D	The following updates have been made in this revision: • Added information about the bracket on the mechanical stop pin axis 1 has been updated in section *Mechanically restricting the working range of axis 1 on page 79*, *Inspecting the mechanical stop pin, axis 1 on page 135* and *Replacing stop pin axis 1 on page 284* • All information about Foundry Prime is removed from the manual. This manual now only contains information for a Standard IRB 4600. The instructions for a IRB 4600 Foundry prime can be found in a separate manual. For art. No. See *References on page 10*.

Continues on next page

Revision	Description
E	The following updates have been made in this revision: • A new block, about general illustrations, added in section *How to read the product manual on page 20*. • Figure and describing text edited for the stress forces. Also, the actual values of the stress forces are updated. See *Loads on foundation, robot on page 45*. • The difference in weight between the different robot variants is minor, therefor the weight specification for the robot is simplified. See *Weight, robot on page 44*. • Removed Foundry from table with protection classes. See *Protection classes, robot on page 47*. • Additional information about software adjustments when suspending robot, new section *Setting the system parameters for a suspended or tilted robot on page 65*. • Note about fan cabling added in the cable list. See *Robot cabling and connection points on page 97*. • Note about ambient temperature deleted from the maintenance schedule. See *Maintenance schedule on page 109*. • Changed information about the robot position when removing motor. See *Removing motors on page 287*. • Additional instructions for how to adjust the play of axes 4, 5 and 6 motors. See *Adjusting the play of axis 4, 5 and 6 motors on page 305*. • Added step about removing/refitting axis 1 motor when replacing the axis 1 gearbox. Also added information about guide pins. See *Replacing gearbox axis 1 on page 306*. Also minor additions concerning the mating of gearbox and motor, in all such instructions. • New section about calibration movement directions for axes is added, see *Calibration movement directions for all axes on page 343*. • New section about how to perform a rough calibration of each robot axis is added, see *Updating revolution counters on IRC5 robots on page 344*. • New section about how to check the calibration position is added, see *Checking the synchronization position on page 369*. • Spare part number for tubular shaft unit is corrected, see *Spare parts - Upper arm*. • Additional information about lifting accessories and how to attach them to the upper arm of the robot, see *Attaching the lifting accessories to the upper arm on page 252*. • Additional information in the procedure for replacing the base with improved lifting instruction etc., see *Replacing the base on page 236*. • Changed type of oil in axes 1, 3 and 4 gearboxes. See *Type of lubrication in gearboxes on page 146*.

Continues on next page

Revision	Description
F	The following updates have been made in this revision: • Corrected measurement that belong to figure xx0300000187, when fitting tools for measuring the play of axis 5, see *Measuring the play, axis 5 on page 271*. • Deleted the spare part number for harnesses in *Spare parts - lower arm* and instead inserted a reference to the *Electrical connections*. • Corrected the spare part numbers for cable harnesses, see *Electrical connections*. • Added information about releasing the motor brakes in order to set the weight of different axes onto lifting accessories, see *Replacing the complete upper arm on page 247*, *Replacing gearbox axis 3 on page 326* and *Replacing gearbox axis 2 on page 317*. • Changed the instruction for how to replace the axes 2 and 3 gearboxes without having to remove the cable harness, see *Replacing gearbox axis 3 on page 326* and *Replacing gearbox axis 2 on page 317*. • Added safety information about preventing roundslings from sliding when lifting the upper arm tube, see *Replacing complete tubular shaft unit on page 257*. • Added information about removing painting, if any, from assembly surfaces when replacing gearboxes and motors. • Added tip to speed up the draining of axis 4 gearbox, see *Changing the oil, axis-4 gearbox on page 169*. • Added information about o-ring and made other minor approvements to the instruction for replacing wrist unit, see *Replacing wrist unit on page 263*. • Added information about disconnecting the battery cable when removing the cable harness, see *Removing the complete cable harness on page 196*. • Added a funnel to equipment list, see *Changing the oil, axis-3 gearbox on page 163*. • Added Profibus to the section about connections to extra equipment, see *Customer connection on robot on page 100*. • Some general tightening torques have been changed/added, see updated values in *Screw joints on page 382*. • The method of changing the axis-1 gearbox oil in suspended robots is improved, see the new section *Changing the oil, axis-1 gearbox on suspended robots on page 153*. • Added spare part number for type B gearbox (axis 3), see *Spare parts, upper arm*. • Added information about batteries.
G	The following updates have been made in this revision: • Cable harness for Profibus is added to the spare part list, see *Electrical connections*. • Article number for guide sleeves is added. • Information about the type and amount of oil has been removed from the manual and can now be found in the *Technical reference manual - Lubrication in gearboxes*, see *References on page 10*. • Type C is added throughout the manual. • Valid for other designs than type C: Information about oil plug sealing washer on the axis-1 and axis-2 gearbox is changed. The spare part number is added. • A new SMB unit and battery is introduced, with longer battery lifetime.

Continues on next page

Revision	Description
H	The following updates have been made in this revision: • Spare part numbers are corrected for the lower arm, see *Lower arm type C* and *Rebuilding parts*, and for motors, see *Motors type C* in *Product manual, spare parts - IRB 4600*. • Several more spare part numbers are corrected throughout the spare part chapter. • Section describing inspection of oil level in axis-1 gearbox for suspended robots is clarified, see *Inspecting oil level, axis 1 gearbox on page 112*.
J	The following updates have been made in this revision: • New article number for working range limit, axis 1 (Type C), is added in spare parts. • New article number for turning tool (Type C) is added in spare parts. • Spare parts for electrical connections, cable harness, is updated. • Instructions on how to fill oil in suspended robot is corrected, and article number for oil change equipment is added to special tools. • Amount of oil in axis-3 gearbox (Type C) is changed. • Added information about risks when scrapping a decommissioned robot, see *Scrapping of robot on page 374*. • *Spare parts and exploded views* are not included in this document but delivered as a separate document. See *Product manual, spare parts - IRB 4600*.
K	The following updates have been made in this revision: • Illustration changes in *Dimension, mounting surface and guide bushing on page 62*. • Term "Guide sleeves" changed to "Guide bushings", see *Dimension, mounting surface and guide bushing on page 62*. • A new **WARNING**! is added in the section about motor replacement, informing not to mix different motor types. • Minor corrections.
L	The following updates have been made in this revision: • Added values for restricted working range if the robot is equipped with a gearbox Type C, see *Mechanically restricting the working range of axis 1 on page 79*. • Information about removing the mech stop bracket added in section *Axes with restricted working range on page 78*.
M	The following updates have been made in this revision: • Turning disk fixture is removed from special tools for Levelmeter calibration. • Oil levels adjusted. • Information about grounding and bonding point added, see *Robot cabling and connection points on page 97*.
N	Published in release R16.2. The following updates are done in this revision: • Corrections due to updates in terminology. • New dimensional drawing of the turning disk added to *Fitting equipment on wrist and mounting flange on page 73*. • New standard calibration method is introduced (Axis Calibration). See *Calibration on page 335*. • Information about grounding point added. See *Robot cabling and connection points on page 97*.
P	Published in release R17.1. The following updates are done in this revision: • Changed the tightening torque of the oil plug located on axis-1 gearbox.

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Revision	Description
Q	Published in release R17.2. The following updates are done in this revision: • Information about coupled axes in *Updating revolution counters on IRC5 robots on page 344*. • 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 358*. • 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. • Updated the section *Start of robot in cold environments on page 96*. • Updated information regarding replacement of brake release board. • Updated information regarding disconnecting and reconnecting battery cable to serial measurement board. • Definition of reference calibration clarified.
R	Published in release R18.1. The following updates are done in this revision: • Information added about fatigue to Axis Calibration tool, see *Calibration tools for Axis Calibration on page 353*. • Added sections in *General procedures on page 188*. • Updated figure of axis-6 synchronization mark. • Safety restructured. • Added information about harness customer ethernet connection. • New spare part numbers for Brake release board. • 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. • Information about measuring the play in axis 5 and 6 updated. • Added Nickel in Environmental information.
S	Published in release R18.2. The following updates are done in this revision: • Updates related to mechanical stop pin. • Changed the method for replacing the axis-1 gearbox and the base.
T	Published in release R18.2. The following updates are done in this revision: • Updated references.
U	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 194*. • New article numbers for manipulator cables in section *Robot cabling and connection points on page 97*. • Levelmeter 2000 kit (6369901-347) no longer available. • Added spare parts for wrist and sealing for IRB 4600 -20/2.50. See *Replacing wrist unit on page 263*. • • Added a note regarding usage of an angled ethernet connection, see *Customer connection on robot on page 100*.
V	Published in release 19D. 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 339*.

Continues on next page

Revision	Description
W	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 191*. • Clarified text about position of robot and added table with dependencies between axes during Axis Calibration. • 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.
X	Published in release 20C. The following updates are made in this revision: • Added note about differences in type of oil pre-filled in axis-4 gear compared to recommended oil for field maintenance. • Updated section about customer connections in regard to Ethernet etc. See *Customer connection on robot on page 100*.
Y	Published in release 21A. The following updates are made in this revision: • Note regarding maximum leakage current for attached equipment. See *Customer connection on robot on page 100*. • Description for new Type D with alternative motor added to *Type D of IRB 4600 on page 377*. • "Type C" is now "Type C and Type D" through out the complete manual.
Z	Published in release 21B. The following updates are made in this revision: • New cable bracket. See *Location of axis-3, axis-4, axis-5 and axis-6 motors on page 288*. • Information regarding documentation of Installation of Foundry Plus Cable guard (option no. 908-1) is changed since DVDs are removed. See *Installation of Foundry Plus Cable guard (option no. 908-1) on page 89*. • Text regarding fastener quality is updated, see *Fastener quality on page 75*.
AA	Published in release 21D. The following updates are made in this revision: • Added information for the OmniCore robot controller.
AB	Published in release 22B. The following updates are done in this revision: • Updated information about Gleitmo treated screws, see *Screw joints on page 382*. • Updated manipulator weight. • Corrected manipulator variant designations in section *Installing an expansion container on page 90*.

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

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

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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.

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.
- 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. 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

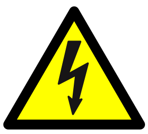
Introduction to safety signals

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.

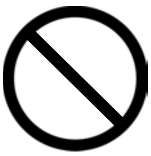
Types of symbols

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.

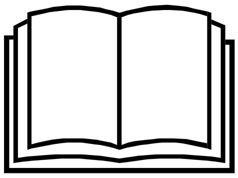
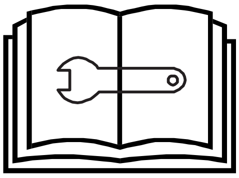
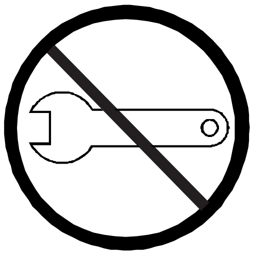
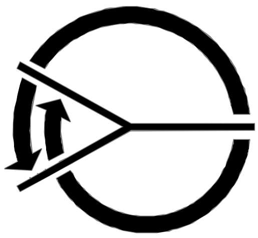
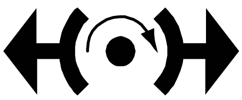
The safety labels are language independent, they only use graphics. See *Symbols on safety labels on page 25*.

The information labels can contain information in text.

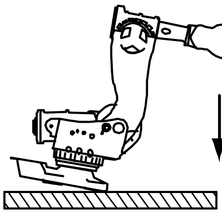
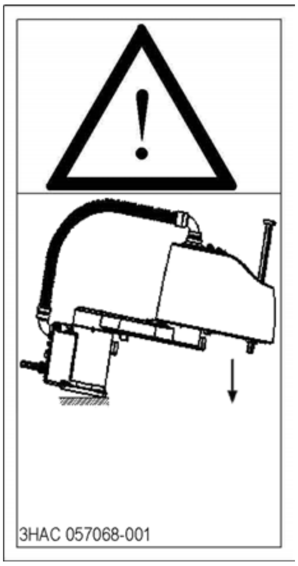
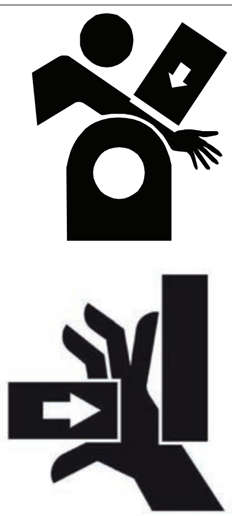
Symbols on safety labels

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.

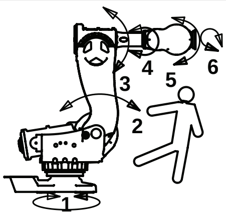
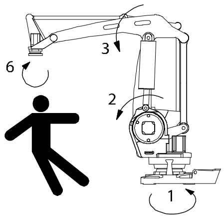
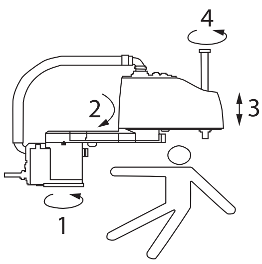
Continues on next page

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

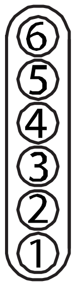
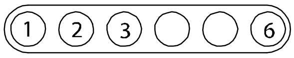
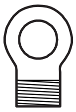
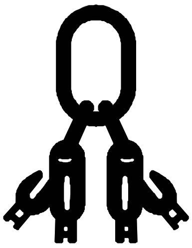
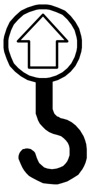
Continues on next page

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

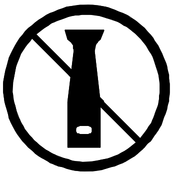
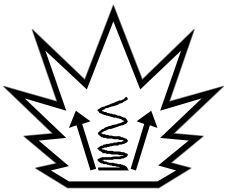
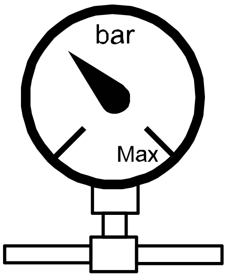
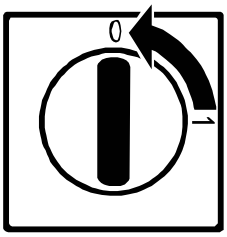
Continues on next page

Symbol	Description
 xx0900000818  xx1300001087	**Heat** Risk of heat that can cause burns. (Both signs are used)
 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	**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 - OmniCore V250XT*
- *Product manual - IRC5*
- *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 372* 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

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.

Pressure relief valves

The pressure relief valve prevents too much air pressure being built up inside the robot. The air pressure must not exceed the rated limit for the manipulator, or there is a risk of personal injury and mechanical damage.

Continues on next page

Pressure relief valves must be kept clean.

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 loose screws, turnings, or other unexpected parts remaining after work on the robot has been performed.

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.
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.
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.

Continues on next page

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 47*.

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 58*.

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

Increased injury

Before releasing the brakes, make sure that the weight of the manipulator does not result in additional hazards, for example, even more severe injuries on a trapped person.

DANGER

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

Make sure no personnel is near or beneath the robot.

1.6.3 Brake testing

When to test

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

How to test

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

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

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

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

1.7 Safety during troubleshooting

General

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

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

DANGER

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

CAUTION

Risk of hot surfaces that can cause burns.

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

WARNING

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

A robot may perform unexpected limited movement.

WARNING

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

Related information

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

1.8 Safety during decommissioning

General

See section *Decommissioning on page 371*.

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 4600 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.

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 4600 and the robot to protective earth and residual current device (RCD) before connecting to power and starting any installation work.

For more information see:

- *Product manual - OmniCore V250XT*
- *Product manual - IRC5*
- *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 44*
6	If the robot is not installed directly, it must be stored as described in: *Storage conditions, robot on page 47*
7	Make sure that the expected operating environment of the robot conforms to the specifications as described in: *Operating conditions, robot on page 47*
8	Before taking the robot to its installation site, make sure that the site conforms to: • *Loads on foundation, robot on page 45* • *Protection classes, robot on page 47* • *Requirements, foundation on page 46*
9	Before moving the robot, please observe the stability of the robot: *Risk of tipping/stability on page 52*
10	When these prerequisites are met, the robot can be taken to its installation site as described in section: *On-site installation on page 54*
11	Install required equipment, if any. • *Installation of signal lamp (option) on page 77*

Weight, robot

The table shows the weight of the robot.

Robot model	Weight
IRB 4600	465 kg

Continues on next page

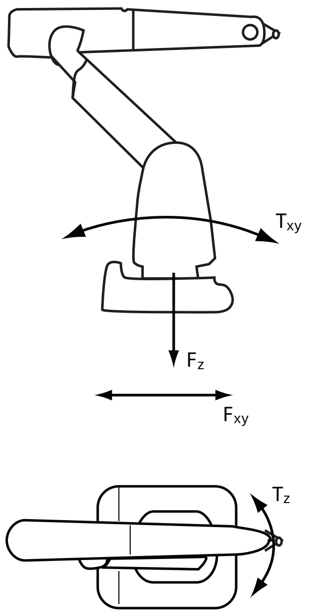
Note

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

Loads on foundation, robot

The illustration shows the directions of the robots stress forces.

The directions are valid for all floor mounted, 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	±3940 N	±7790 N

Continues on next page

Force	Endurance load (in operation)	Max. load (emergency stop)
Force z	4350 ±2460 N	4350 ±6360 N
Torque xy	±6850 Nm	±14090 Nm
Torque z	±1610 Nm	±2960 Nm

Suspended

Force	Endurance load (in operation)	Max. load (emergency stop)
Force xy	±3940N	±7790 N
Force z	-4350 ±2460N	-4350 ±6360 N
Torque xy	±6850 Nm	±14090 Nm
Torque z	±1610 Nm	±2960 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.
Maximum tilt	15°	The limit for the maximum payload on the robot is reduced if the robot is tilted from 0°. Contact ABB for further information about acceptable loads.
Minimum resonance frequency	22 Hz **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)

Operating conditions, robot

The table shows the allowed operating conditions for the robot:

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

Protection classes, robot

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

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

2.2.2 Working range and type of motion

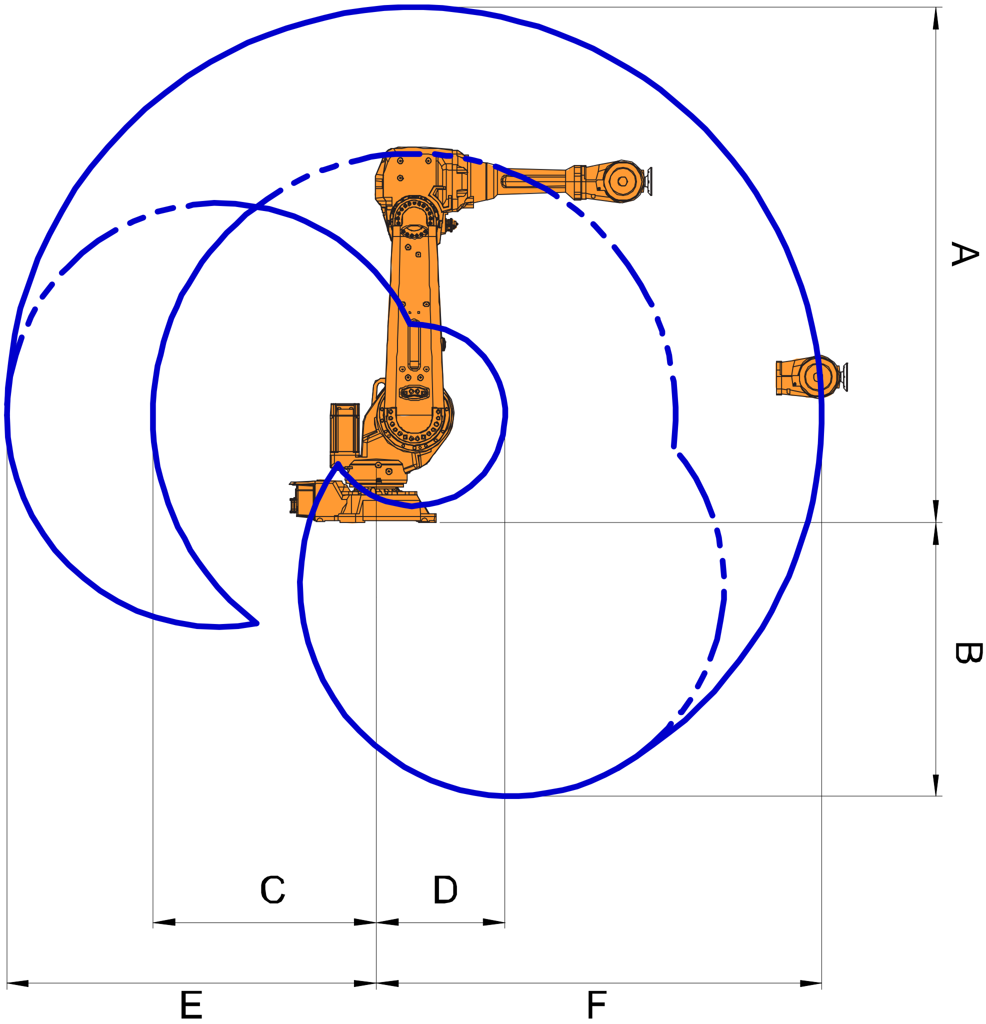
Working range

The figures show the working ranges of the robot variants mounted in different ways.

The extreme positions of the robot arm are specified at the wrist center (dimensions in mm).

Working range, floor mounted

The illustration shows the unrestricted working range for a floor mounted robot.



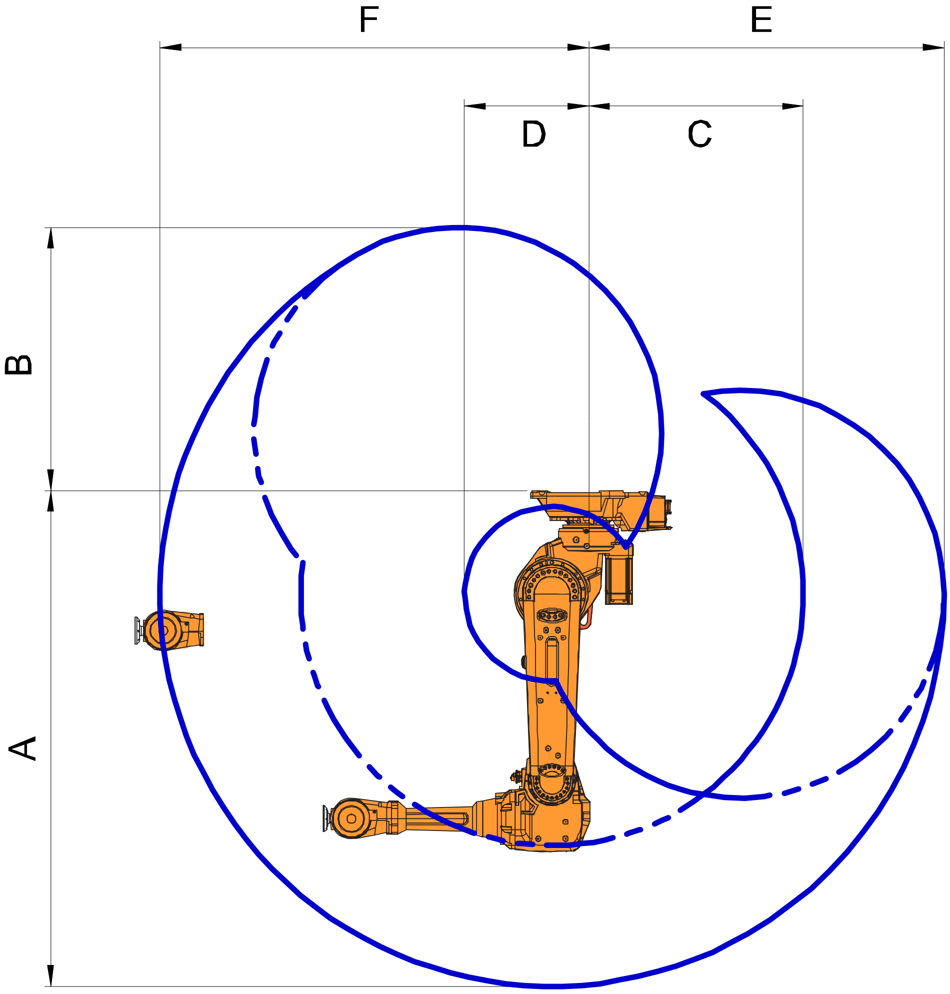
xx0800000267

Variant	Pos. A	Pos. B	Pos. C	Pos. D	Pos. E	Pos. F
IRB 4600 - 60/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 45/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 40/2.55	2872 mm	1735 mm	1393 mm	680 mm	2202 mm	2552 mm
IRB 4600 - 20/2.50	2833 mm	1696 mm	1361 mm	665 mm	2163 mm	2513 mm

Continues on next page

Working range, suspended mounted

The illustration shows the unrestricted working range for a suspended mounted robot.



xx0900000055

Variant	Pos. A	Pos. B	Pos. C	Pos. D	Pos. E	Pos. F
IRB 4600 - 60/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 45/2.05	2371 mm	1260 mm	1028 mm	593 mm	1701 mm	2051 mm
IRB 4600 - 40/2.55	2872 mm	1735 mm	1393 mm	680 mm	2202 mm	2552 mm
IRB 4600 - 20/2.50	2833 mm	1696 mm	1361 mm	665 mm	2163 mm	2513 mm

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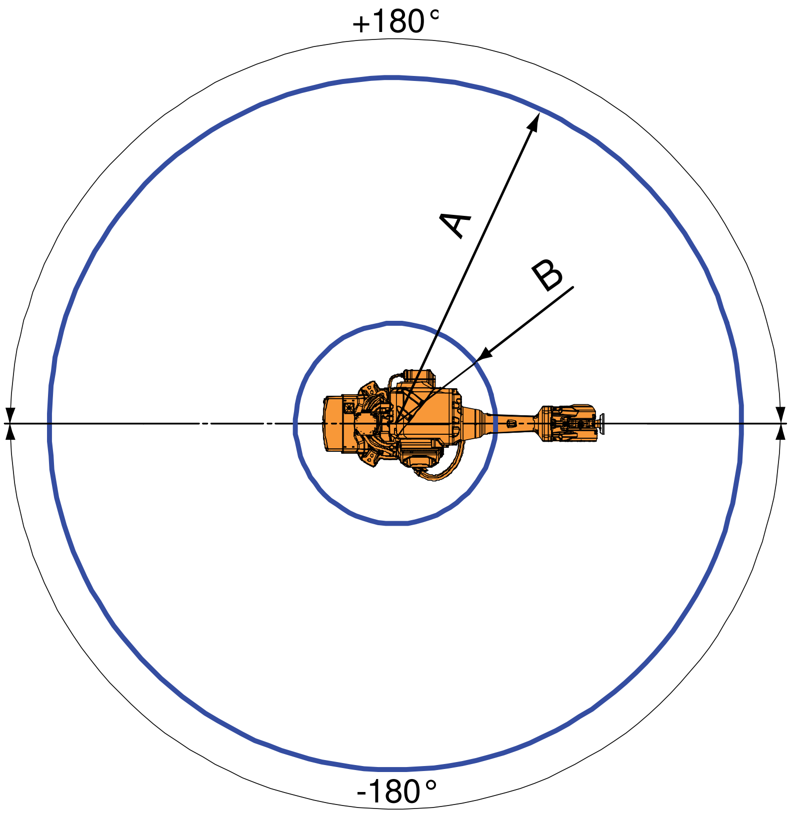
Turning radius

The turning radius of the robot that is floor or suspended mounted is shown in the figure.



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Variant	Pos. A	Pos. B
IRB 4600 - 60/2.05	R2051	R593
IRB 4600 - 45/2.05	R2051	R593
IRB 4600 - 40/2.55	R2552	R680
IRB 4600 - 20/2.50	R2513	R665

Robot motion, IRB 4600-60/2.05, -45/2.05, -40/2.55

The table specifies the types and ranges of motion in every axes.

Location of motion	Type of motion	Range of movement
Axis 1	Rotation motion	±180°
Axis 2	Arm motion	+150° / -90°
Axis 3	Arm motion	+75° / -180°
Axis 4	Wrist motion	±400°
Axis 5	Bend motion	+120° / -125°
Axis 6	Turn motion	±400°

Continues on next page

Robot motion, IRB 4600-20/2.50

The table specifies the types and ranges of motion in every axes.

Location of motion	Type of motion	Range of movement
Axis 1	Rotation motion	±180°
Axis 2	Arm motion	+150° / -90°
Axis 3	Arm motion	+75° / -180°
Axis 4	Wrist motion	±400°
Axis 5	Bend motion	±120°
Axis 6	Turn motion	±400°

2.2.3 Risk of tipping/stability

Risk of tipping

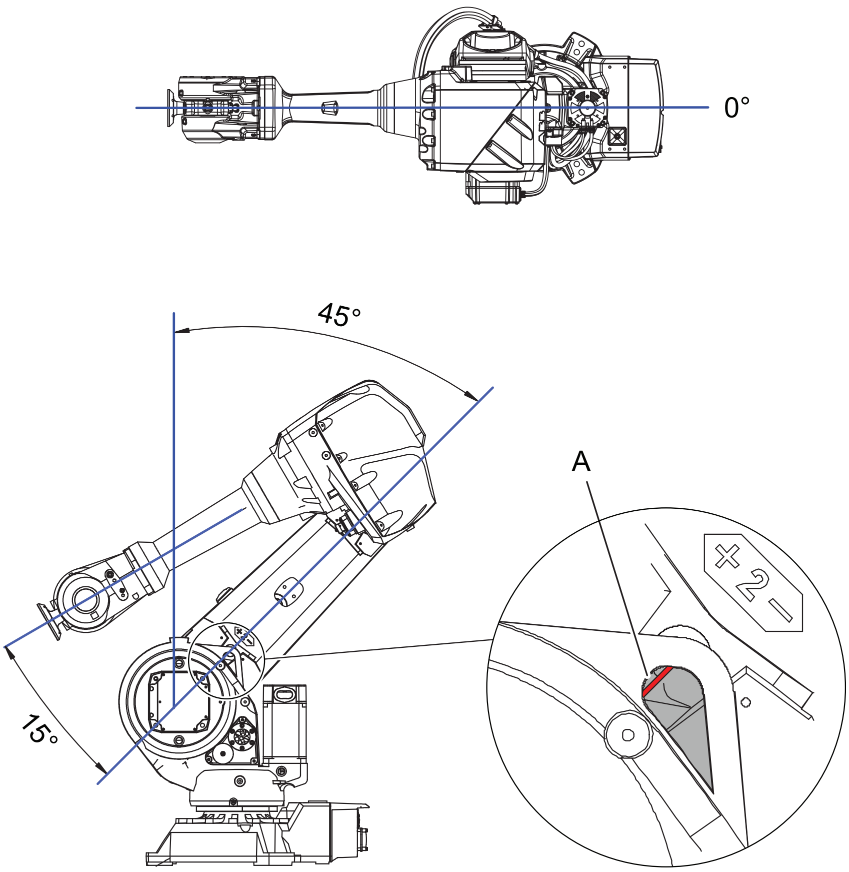
Do not change the robot position before securing it to the foundation.

The shipping position is the most stable position.

Shipping and transportation position

This figure shows the robot in its shipping position and transportation position.

The position of the calibration mark (A) in the figure is approximate and is used as aiming aid.



xx0800000263

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

2.2.4 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

Introduction

When lifting the robot use roundslings and an overhead crane.

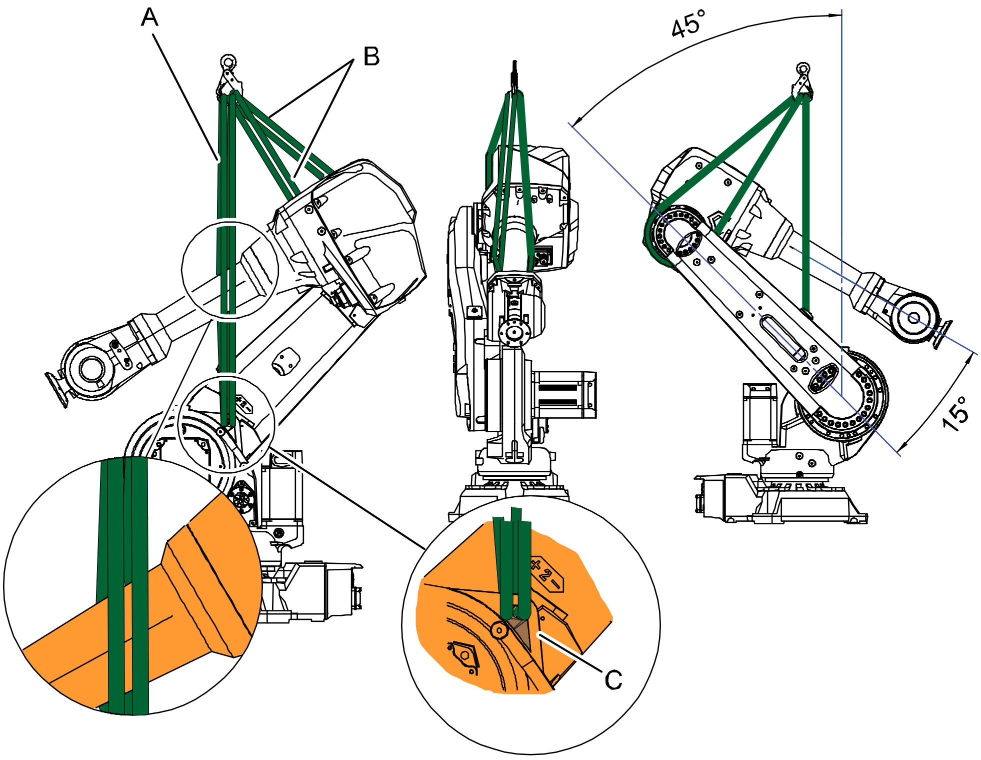
How to lift *suspended mounted robot* is described in the lifting instruction delivered with the turning tool art. no. 3HAC034766-001. See *Lifting and turning a suspended mounted robot on page 57*.

Required equipment

Equipment	Note
Overhead crane	Lifting capacity 1 000 kg (Max load at 90°)
Roundslings (2 pcs)	• Lifting capacity/roundsling: 1 000 kg • Length: 2 m

Lifting

Attach the roundslings as shown in the figure.



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A	Roundsling put folded in U-shape through the lifting lug
B	Roundsling put folded in U-shape around gearbox axis 3
C	Lifting lug

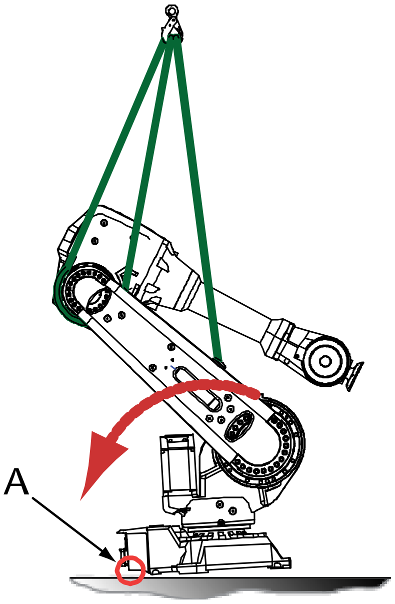
Continues on next page

Lifting instructions

Use this procedure to lift the robot in a safe way.

	Action	Note
1	**CAUTION** The IRB 4600 robot weighs 465 kg. All lifting accessories used must be sized accordingly!	
2	**CAUTION** Attempting to lift the robot in any other position than that recommended may result in the robot tipping over and causing severe damage or injury!	
3	**WARNING** Personnel must not, under any circumstances, be present under the suspended load!	
4	Move the robot to its most stable position.	Detailed in section: • *Risk of tipping/stability on page 52*
5	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
6	Attach *roundsling A* to the lifting lug on the frame, and put folded in a U-shape on either side of the upper arm.	See the figure in: • *Lifting on page 54*
7	Attach *roundsling B* at axis 3 gearbox by running it folded in a U-shape around the gearbox.	See the figure in: • *Lifting on page 54*
8	Make sure the roundslings do not rub against any sharp edges.	

Continues on next page

	Action	Note
9	When the robot is lifted the roundslings will adjust themselves. **CAUTION** When lifting, the robot will tilt slightly backwards! Be careful not to damage the *connection box* at the base of the robot!	 xx0800000291 • A: Area where the connection box can be damaged while lifting.
10	Lift the robot with an overhead crane.	Lifting capacity: • See *Required equipment on page 54*

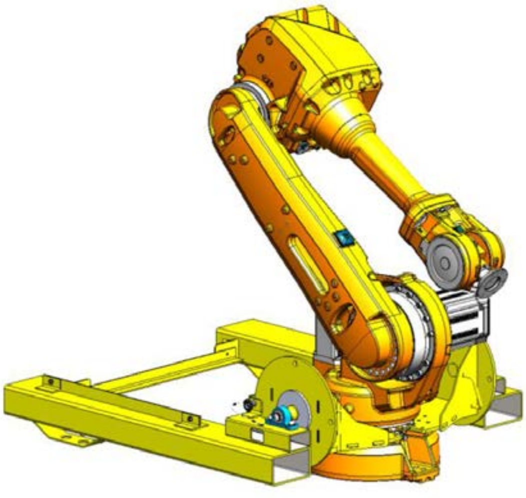
2.3.2 Lifting and turning a suspended mounted robot

Introduction

How to lift and turn the robot to a suspended position using the turning accessory is described in the lifting instruction delivered with the turning accessory. Article numbers for the accessory and the instruction is specified in *Special tools on page 387*. Any additional equipment required is specified in the instruction for the lifting accessory. Contact ABB for more information.

How to lift and turn the robot into position for **tilted** position: Contact ABB for more information.

Illustration



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2.3.3 Manually releasing the brakes

General

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

This can be done in one of three ways:

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

DANGER

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

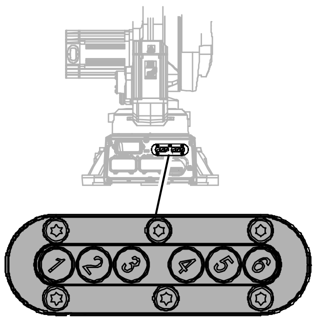
DANGER

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

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

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

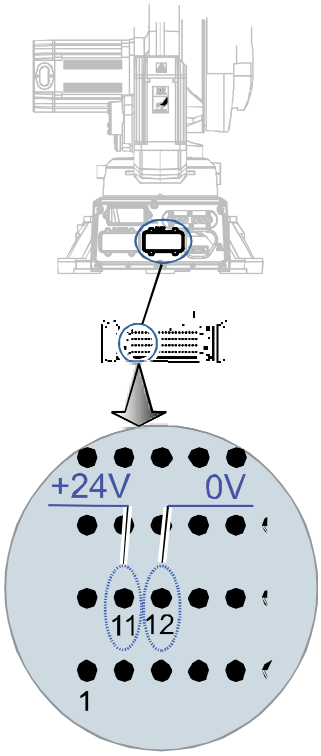
This procedure details how to release the holding brakes with push-buttons, when the robot is connected to the controller.

	Action	Note
1	The internal brake release unit is located at the base of the robot.	 xx0800000272
2	The brake release unit is equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes.	
3	Release the holding brake on a particular axis by pressing the corresponding button on the push-button unit and keeping it depressed.	
4	The brake will function again as soon as the button is released.	

Continues on next page

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

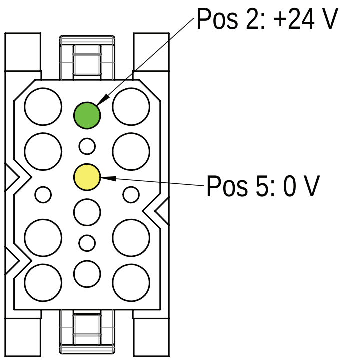
This procedure details how to release the holding brakes with the push-buttons, when the robot is **not** connected to the controller.

	Action	Note
1	Connect an external 24VDC power supply to the connector R1.MP on the robot base. **Note** Be careful not to interchange the 24V and 0V pins! If they are mixed up, damage can be caused to the brake release unit and the system board! **WARNING** **Incorrect connections can cause all brakes to be released simultaneously!**	 xx0800000269 Connect to connector R1.MP: • 0V to pin 12 • +24V to pin 11
2	Release the holding brake on a particular axis by pressing the corresponding button on the push-button unit and keeping it depressed.	The brake release unit is equipped with six buttons for controlling the axes brakes. The buttons are numbered according to the numbers of the axes. See the previous figure.
3	The brake will function again as soon as the button is released.	

Continues on next page

Using an external voltage supply directly on the respective brake

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

	Action	Note
1	Every axis has a holding brake built into the axis motor. This holding brake may be released by connecting 24VDC power supply directly to one of the connectors in the motor. **DANGER** When power is connected directly to the brake cable, the brake will be released immediately when the power is switched on. This may cause some unexpected robot movements!	Make the connection to the current motor according to the Circuit Diagram. See chapter *Circuit diagram on page 393*.
2	Connect an external 24 VDC power supply to the motor, according to the figures. **Note** Be careful not to interchange the 24V and 0V pins! If they are mixed up, damage can be caused to the intergrated quenching circuits. **WARNING** **Incorrect connections can cause all brakes to be released simultaneously!**	**Axes 1, 2 and 3:**  xx1400001984

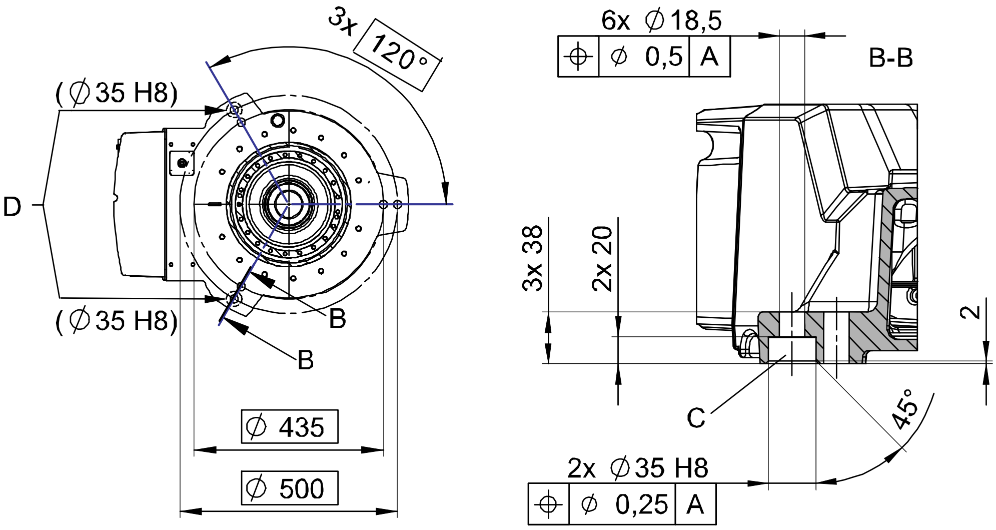
2.3.4 Orienting and securing the robot

Introduction

This section describes how to orient and secure the robot to the foundation or base plate in order to run the robot safely. The requirements made on the foundation are shown in sections *Loads on foundation, robot on page 45* and *Requirements, foundation on page 46*.

Hole configuration, base

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



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C	Hole for guide bushing
D	Rear bolt holes

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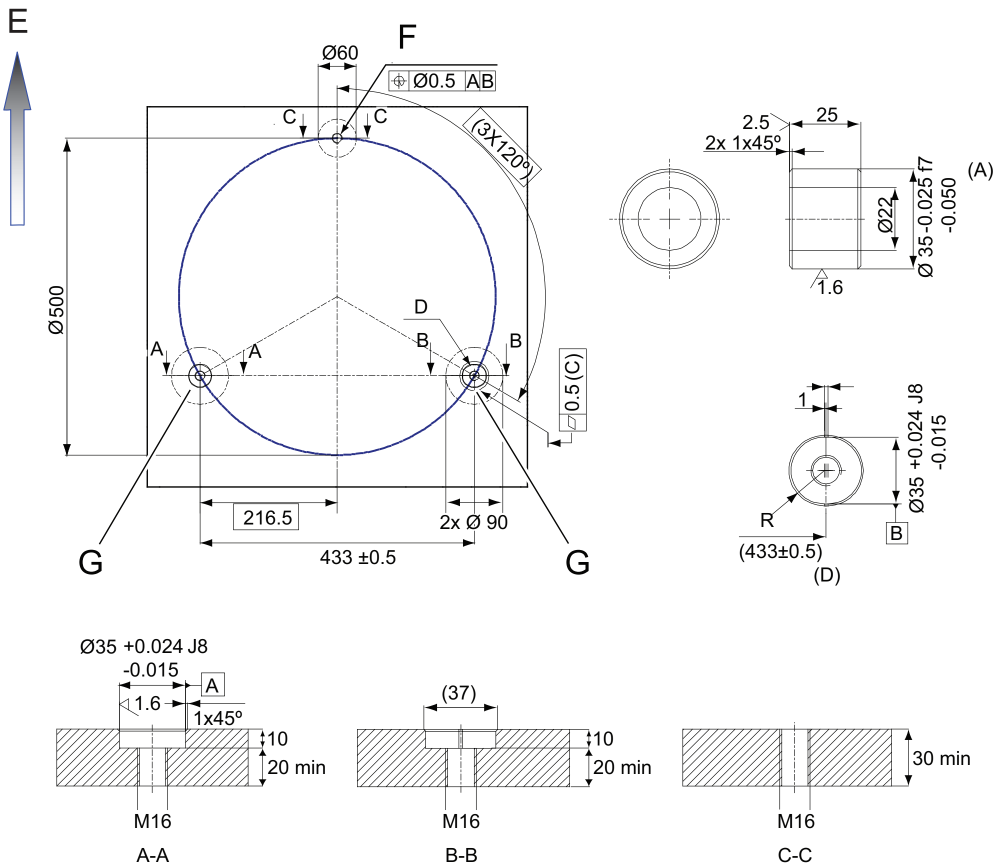
Dimension, mounting surface and guide bushing

The figure shows the dimension of the mounting surface and guide bushings.



xx1700001492

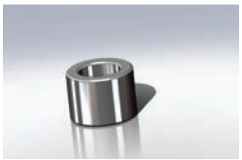
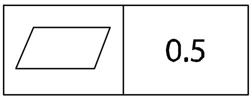
(C)	3x common zone
E	Position of the front of the robot
F	M16 (3 pcs)
G	Guide bushings (2 pcs)

Specification, attachment screws

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

Securing parts/Facts	Dimension	Note
Securing screws, oiled	M16 x 60 (installation directly on foundation) M16 x 70/80 (installation on foundation or base plate, using guide bushings) Quality 8.8	6 pcs 200 Nm
Washers	17 x 30 x 3	6 pcs

Continues on next page

Securing parts/Facts	Dimension	Note
Guide bushings		Article number: 21510024-169, 2 pcs. Added to the rear bolt holes, to allow the same robot to be re-mounted without program adjustments.  xx1200000885
Level surface requirements	 xx0300000251	

Orienting and securing the robot

Use this procedure to orient and secure the robot.

	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.	Hole configuration of the base is shown in the figure in: • *Hole configuration, base on page 61*
3	**CAUTION** The IRB 4600 robot weighs 465 kg. All lifting accessories used must be sized accordingly!	
4	**CAUTION** When the robot is put down after being lifted or transported, there is a risk of it tipping, if not properly secured.	
5	Lift the robot to its installation site.	How to lift the robot is described in section: • *Lifting robot with roundslings on page 54*
6	Fit two *guide bushings* to the *rear bolts* in the base.	
7	Guide the robot gently, using the attachment screws while lowering it into its mounting position.	Make sure the robot base is correctly fitted onto the guide sleeves.

Continues on next page

	Action	Note
8	Fit the *securing screws* and *washers* in the attachment holes of the base.	
9	Tighten the bolts in a criss-cross pattern to ensure that the base is not distorted.	

Securing robot on a mounting plate

When bolting a mounting plate or frame to a concrete floor, follow the general instructions for expansion-shell bolts.

Screw joints must be able to withstand the stress loads defined in section *Loads on foundation, robot on page 45*.

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. The method for mounting the robot in a suspended (upside down) or tilted position is basically the same as for floor mounting, but the system parameters that describe the mounting angle (how the robot is oriented relative to the gravity) must be re-defined.

Note

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

Note

The allowed mounting positions are described in the product specification for the robot. The requirements on the foundation are described in *Requirements, foundation on page 46*.

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 tilted (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).

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

Continues on next page

Gravity Alpha

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

Note

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

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

Note

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

Gamma Rotation

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

Mounting angles and values

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

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

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

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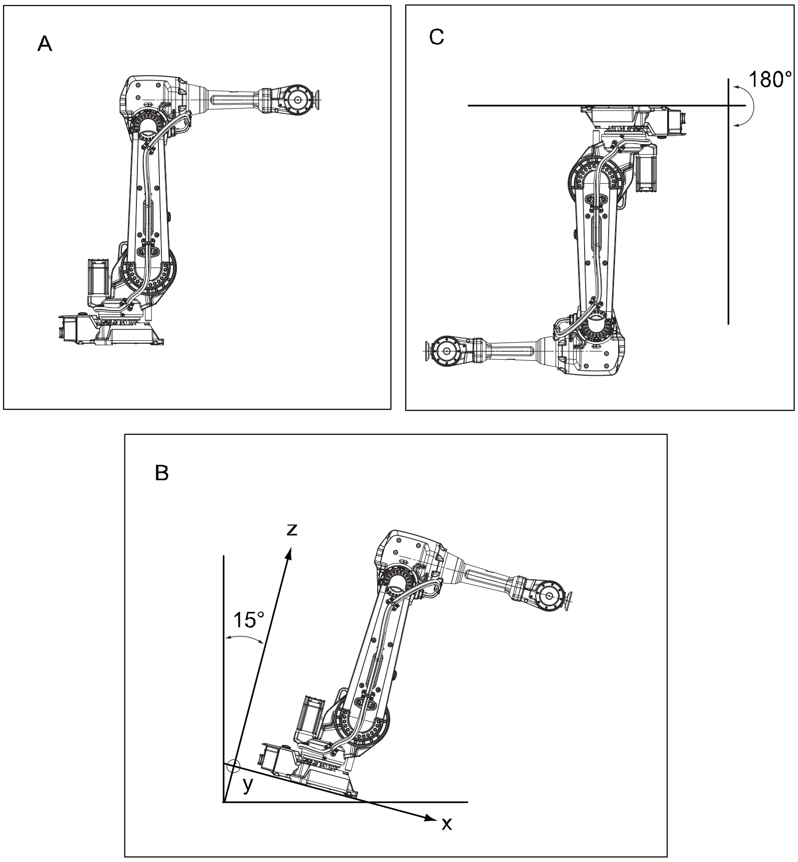
Examples of mounting angles tilted around the Y axis (*Gravity Beta*)



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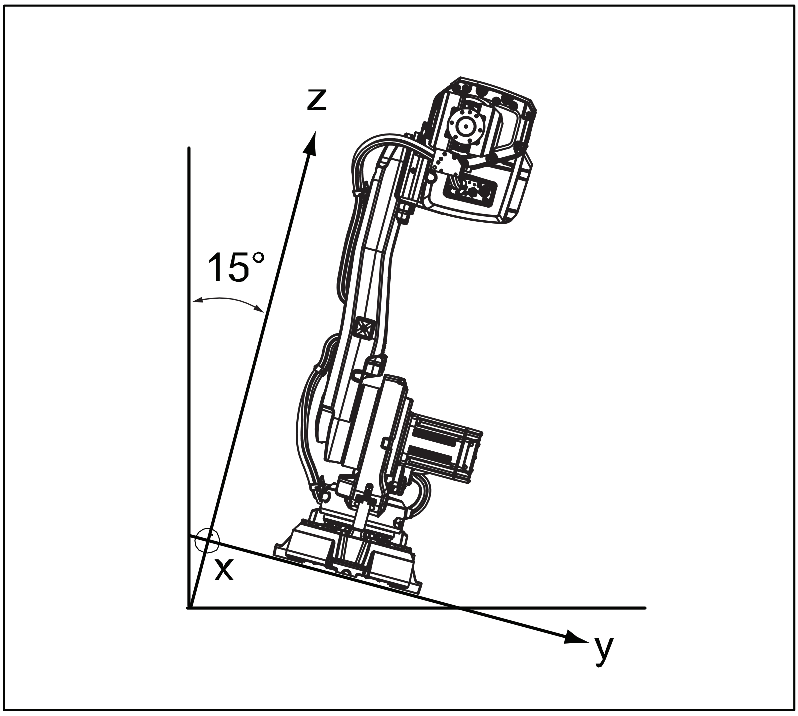
A	Floor mounted
B	Tilted mounting, mounting angle 15°.
C	Suspended mounting, mounting angle 180°.

Continues on next page

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



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-	Tilted mounting, mounting angle 15°.

Note

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

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 66*.

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 Fitting equipment on robot

Introduction

The robot features mounting holes for additional equipment.

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

Note

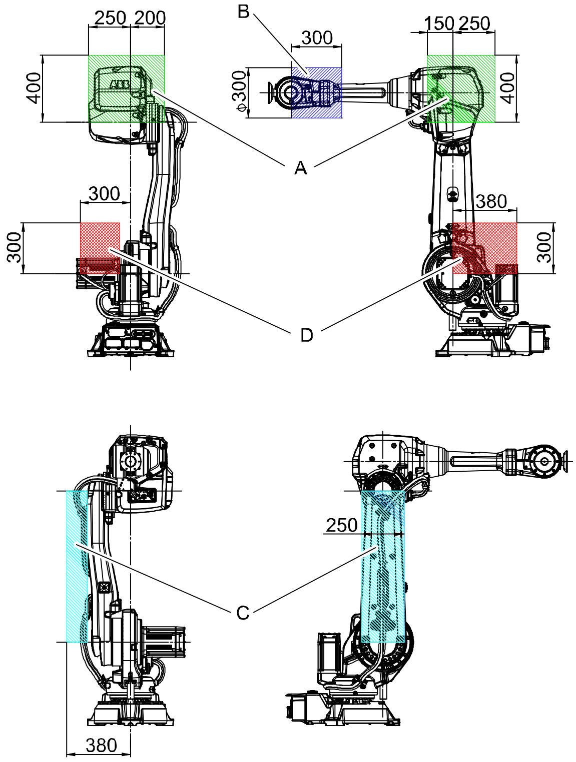
All equipment and cables used on the robot, must be designed and fitted not to damage the robot and/or its parts.

Note

Never drill a hole in the robot without first consulting ABB!

Fitting equipment on robot - Load areas

The shaded area indicates the permitted positions (center of gravity) for any extra equipment fitted in the holes intended for this purpose.



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Variant	Max load A	Max load B	Max load C	Max load A+C	Max load D
IRB 4600-60/2.05	15 kg	5 kg [i]	15 kg	15 kg	35 kg
IRB 4600-45/2.05	15 kg	5 kg [ii]	15 kg	15 kg	35 kg

Continues on next page

Variant	Max load A	Max load B	Max load C	Max load A+C	Max load D
IRB 4600-40/2.55	15 kg	5 kg [iii]	15 kg	15 kg	35 kg
IRB 4600-20/2.50	10 kg	1 kg	10 kg	10 kg	35 kg

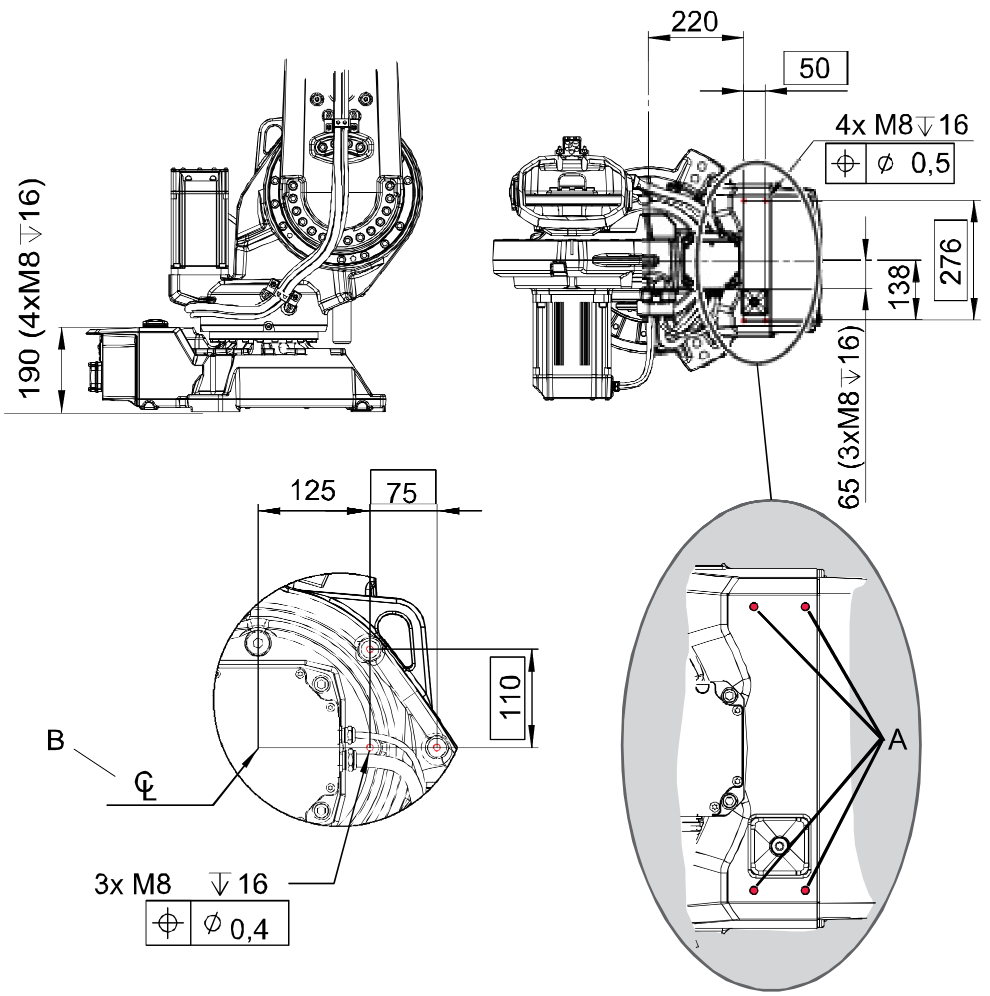
i Payload + B = Max 60 kg
ii Payload + B = Max 45 kg
iii Payload + B = Max 40 kg

Note

Maximum loads must never be exceeded!

Fitting equipment on base and frame

The illustrations show the fitting holes available for fitting extra equipment on the base and frame of the robot.



xx0800000276

A	Attachment holes on base
B	Center axis 2

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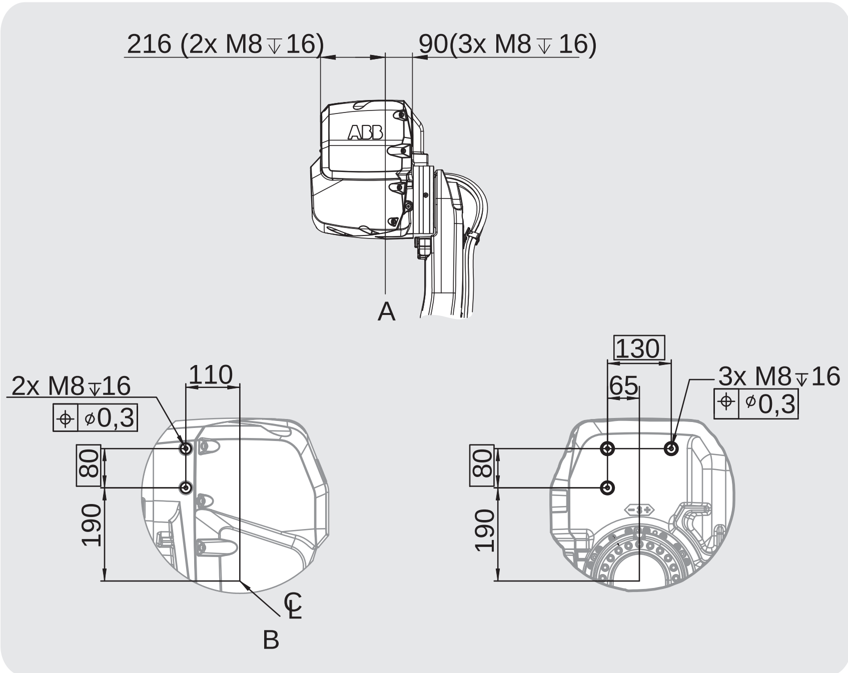
Fitting equipment on lower and upper arm

The illustrations show the fitting holes available for fitting extra equipment on the lower and upper arm of the robot.



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A	Center axis 4
B	Center axis 3

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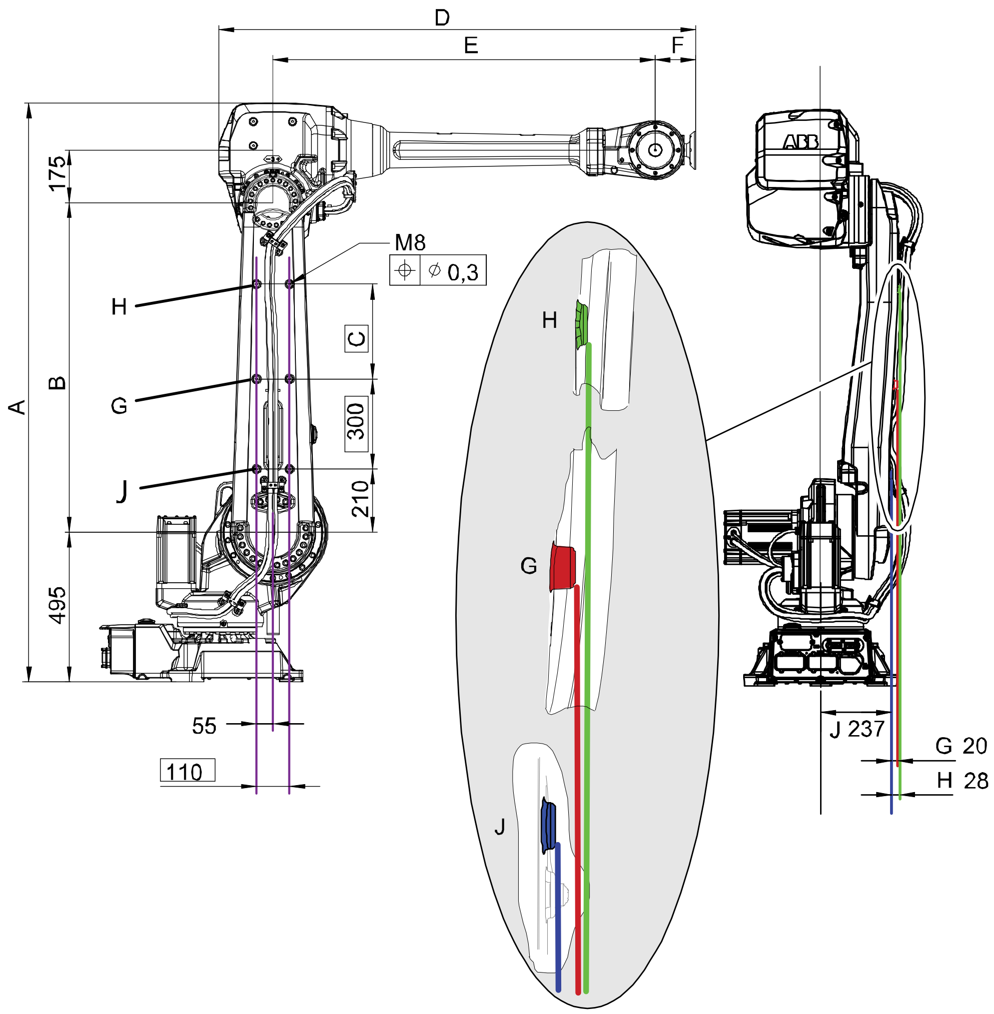

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Variant	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	J (mm)
60/2.05	1727	900	See note i	1276	960	135	20	See note i	237
45/2.05	1727	900	See note i	1276	960	135	20	See note i	237
40/2.55	1922	1095	315	1586	1270	135	20	28	237
20/2.50	1922	1095	315	1496.5	1230.5	85	20	28	237

i Position H and measurement C is only applicable to IRB 4600 - 40/2.55 and IRB 4600 - 20/2.50.
Position H and measurement C is only applicable to IRB 4600 - 40/2.55 and IRB 4600 - 20/2.50.

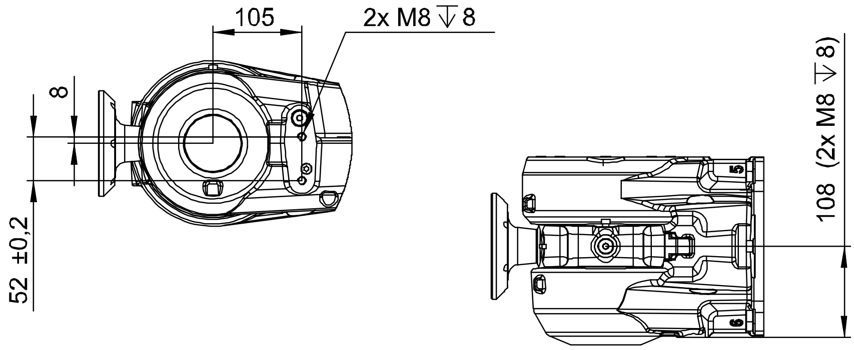
Variant	Attachment screws
60/2.05	4x M8, through
45/2.05	4x M8, through
40/2.55	6x M8, through
20/2.50	6x M8, through

Continues on next page

Fitting equipment on wrist and mounting flange

Extra equipment on wrist, robot versions IRB 4600 -60/2.05, -45/2.05 and -40/2.55

The illustration shows the fitting holes available for fitting extra equipment on the wrist of the robot.



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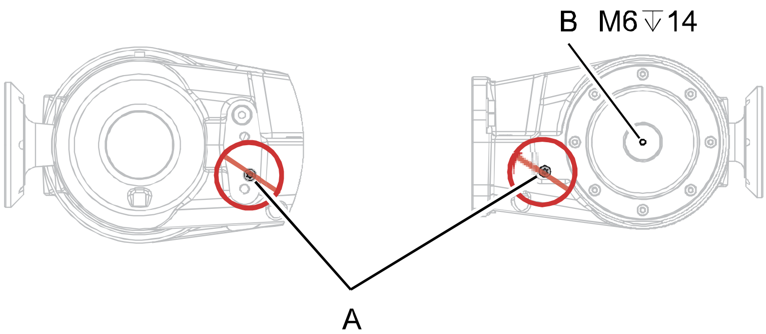
> **Note**
>
> Do not remove screws indicated in the illustration below!



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A	Screws not to be removed! Do not use these holes for fitting equipment on the wrist!
B	Screw hole intended for swivel fitting.

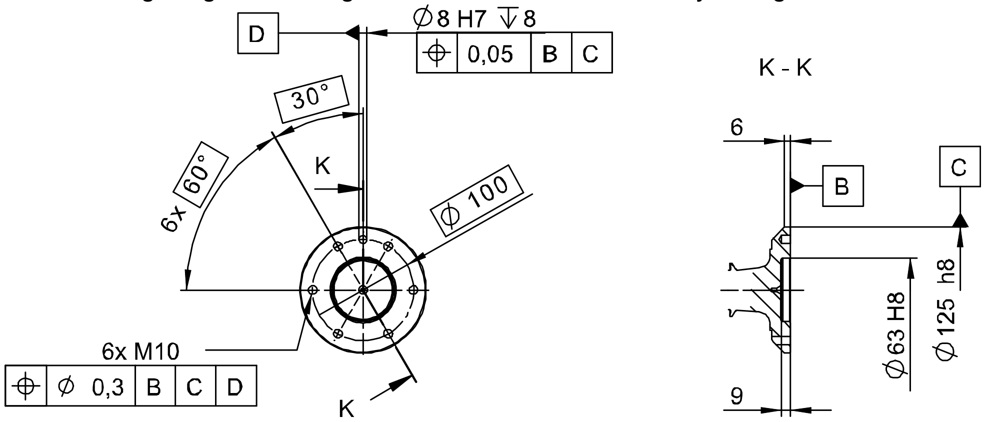
Continues on next page

Extra equipment on mounting flange, robot versions IRB 4600 -60/2.05, -45/2.05 and -40/2.55

The illustration shows the mechanical interface for the mounting flange.

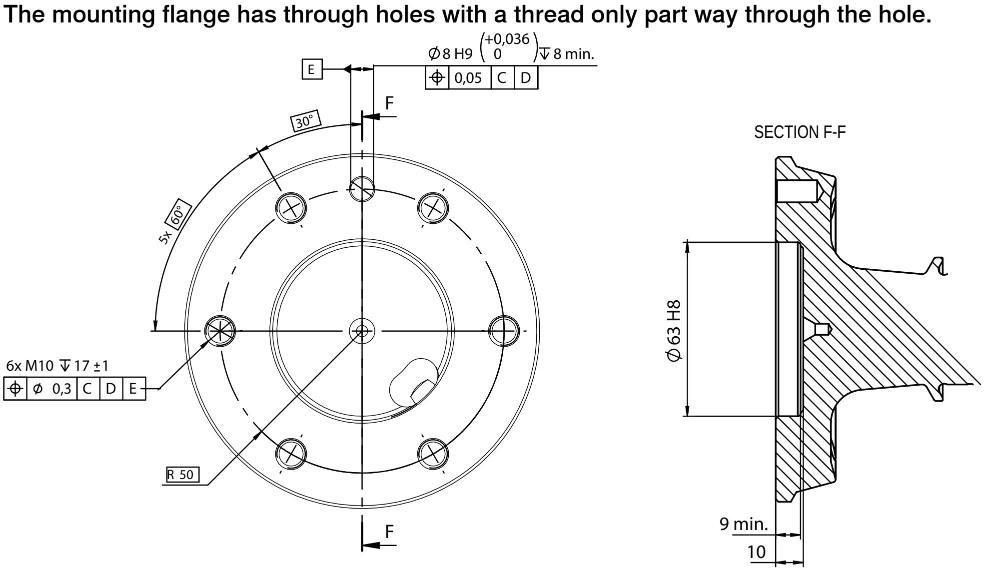
There are two versions of the mounting flange, differences are shown in the figures.

The mounting flange has through holes with a thread all the way through.



xx0800000282

The mounting flange has through holes with a thread only part way through the hole.



xx1600000626

Note

Use attachment screws M10, quality 12.9 and 15 mm *used* thread length.

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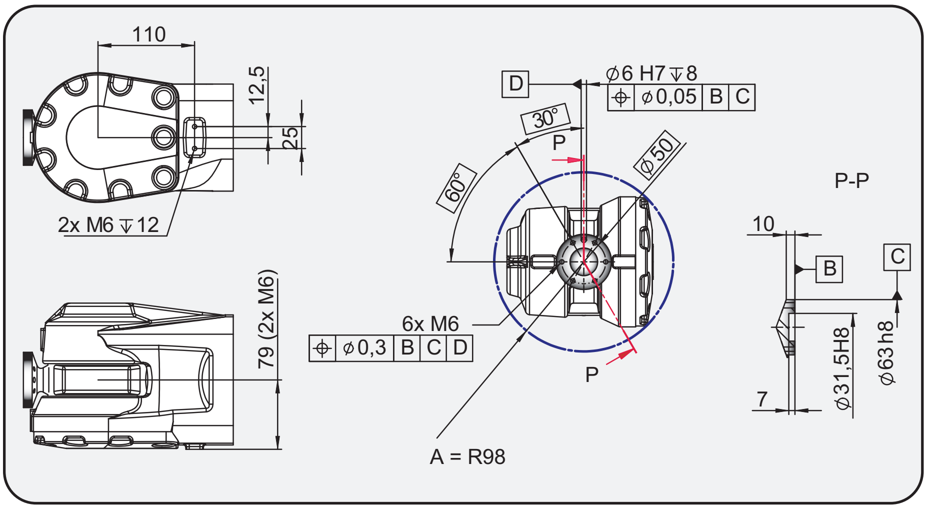
Extra equipment on wrist and mounting flange, robot version IRB 4600 -20/2.50

The illustration shows the fitting holes available for fitting extra equipment on the wrist of the robot version IRB 4600 -20/2.50.

The illustration also shows the mechanical interface for the mounting flange of the robot version IRB 4600 -20/2.50.



xx0800000278

A	Smallest circumscribed radius axis 4

Note

Use attachment screws M6, quality 12.9 and 10 mm *used* thread length.

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.

2.3.7 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 for the robot.

2.3.8 Installation of signal lamp (option)

Signal lamp

See the assembly instruction delivered with the signal lamp.

2.4 Restricting the working range

2.4.1 Axes with restricted working range

General

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

The working range of the following axes may be restricted:

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

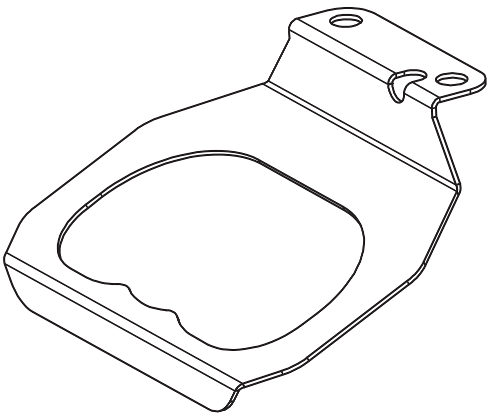
This section describes how to install hardware that restricts the working range.

Note

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

WARNING

Remove the mechanical stop bracket if the robots full working range is from one mechanical stop to another mechanical stop. Otherwise the mechanical stop pin will be worn out.



xx1500000253

2.4.2 Mechanically restricting the working range of axis 1

Mechanically restricting the working range

The information in this section is valid both for the floor and the suspended mounted robot.

The working range of axis 1 is limited by fixed mechanical stops. The working range can be reduced further by adding movable mechanical stops.

The mechanical turning range can be limited in steps of 22.5° from the synchronization position, between values defined in the table. The values differ depending on which design of the gearbox (and base) the robot is equipped with.

Design of gearbox	Limitation in mechanical turning range, calculated from synchronization position
Type C and Type D	±126° to ±13.5° in steps of 22.5°
other design than Type C and Type D	±129° to ±16.5° in steps of 22.5°

Note

The software working range limitations must be adjusted to correspond to the changes in the mechanical limitations of the working range. The system parameters that must be changed (*Upper joint bound* and *Lower joint bound*) are described in *Technical reference manual - System parameters*.

Required equipment

Equipment, etc.	Art. no.	Note
Mechanical stop, axis 1	See *Spare part lists on page 391*.	Includes two additional stop lugs, attachment screws, washers and instruction
Attachment screw	See *Spare part lists on page 391*.	2 pcs/stop lug Hex socket head cap screw M12x40, quality 8.8-A3F
Washer	See *Spare part lists on page 391*.	2 pcs/lug 13x24x2.5
Standard toolkit		Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

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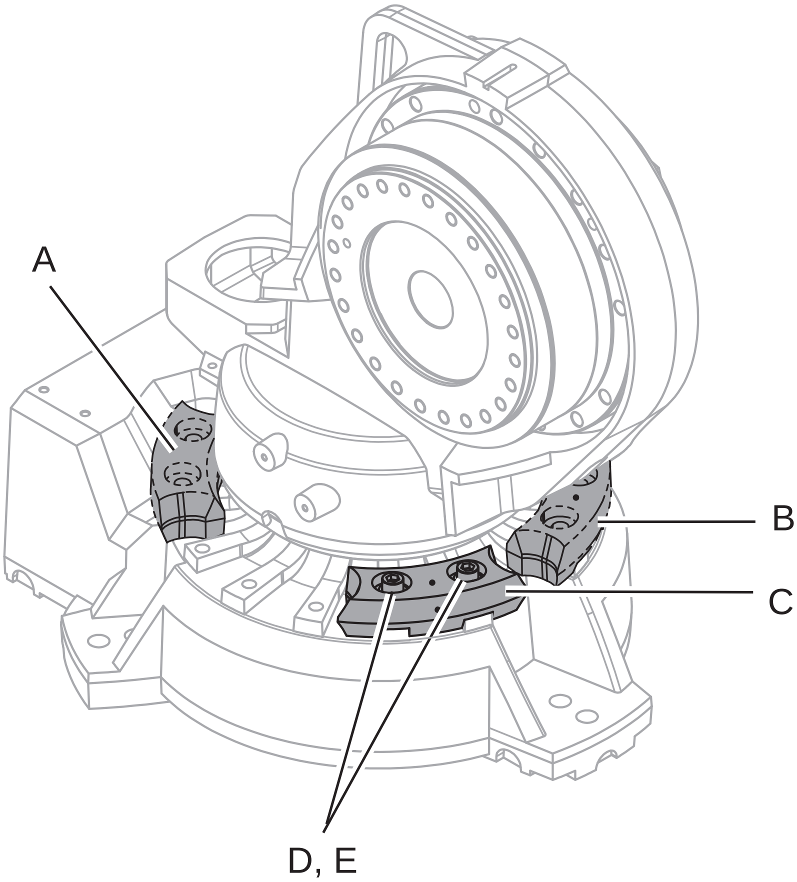
Additional stops

The additional stops are fitted as shown in the figure.



xx0800000273

A	Movable mechanical stop. Limited to: • -126° (Type C and Type D) • -129° (other design than Type C and Type D)
B	Movable mechanical stop. Limited to: • +13.5° (Type C and Type D) • +16.5° (other design than Type C and Type D)
C	Movable mechanical stop. Limited to: • -13.5° (Type C and Type D) • -16.5° (other design than Type C and Type D)
D	Attachment screws
E	Washers

Fitting, mechanical stop axis 1

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

Mounting instructions are also supplied with the kit.

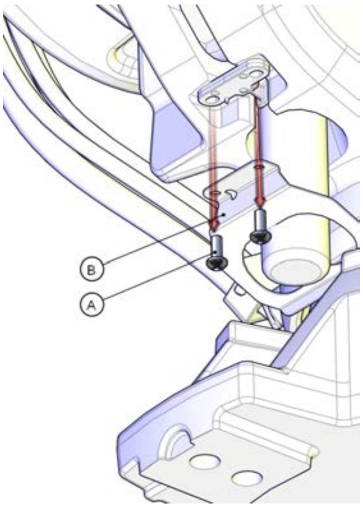
	Action	Note
1	Determine the position of the stop lugs.	See the figure *Additional stops on page 80* for guidance.

Continues on next page

	Action	Note
2	Fit the stop lugs firmly with *attachment screws and washers* according to the figure *Additional stops on page 80*.	Specified in *Required equipment on page 79*. Tightening torque: 82 Nm

Preparing the robot for working range ±180º

This procedure describes how to prepare the robot for working range ±180º.

	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 two screws holding the mechanical stop and the bracket.	 xx1100000091 A Attachment screw B Bracket, stop axis 1
3	Remove the bracket.	
4	Refit the attachment screws.	

2.5 Installing options

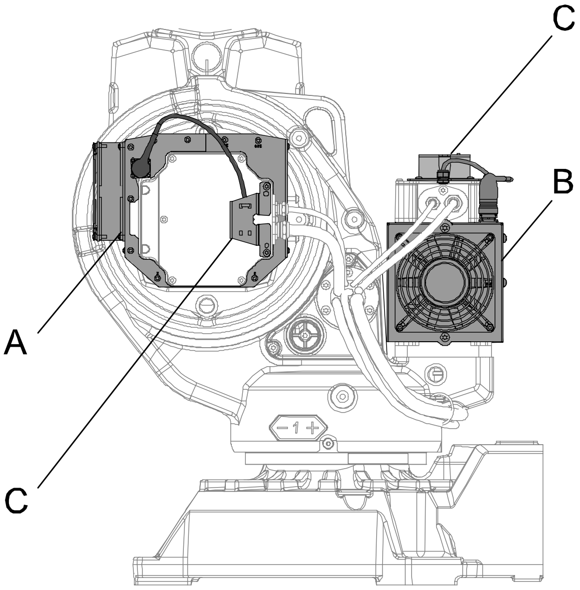
2.5.1 Installation of cooling fan for motors (option)

General

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

Location of cooling fans

The fans are installed on the motors, axes 1 or 2, as shown in the figure below.



xx0900000135

A	Fan, motor axis 2
B	Fan, motor axis 1
C	Protection cover

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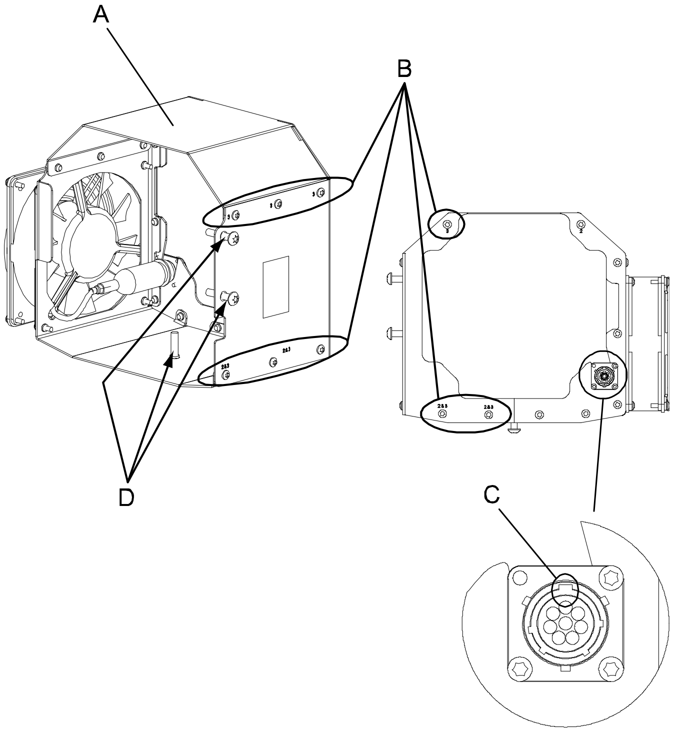
Cooling fan

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



xx0500002158

A	Fanbox (motor axis 2)
B	Attachment screws, fanbox plates (9 pcs)
C	Groove in the connector
D	Tightening screws, fanbox (3 pcs)

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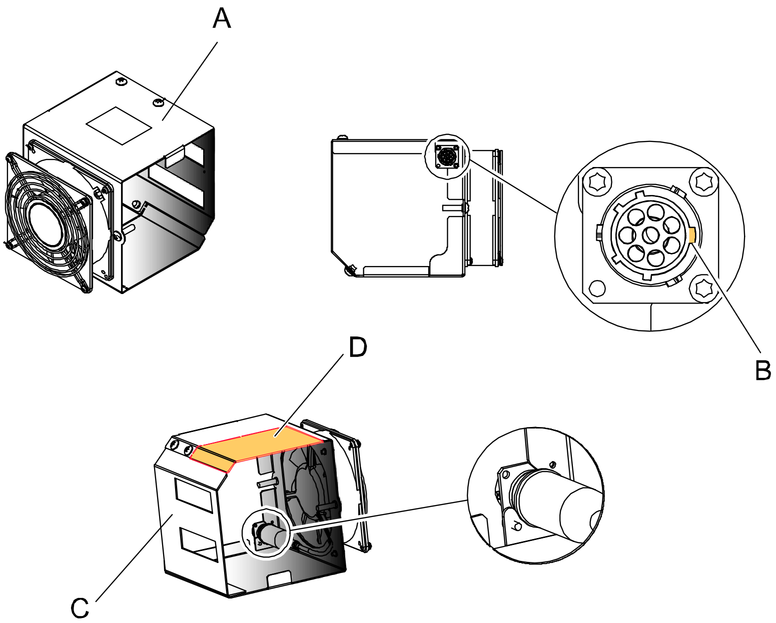


xx0900000137

A	Fanbox (motor axis 1)
B	Groove in the connector
C	Back plate
D	Part of the fanbox that can be removed, if needed.

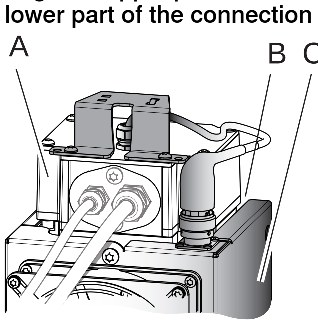
Required equipment

Equipment	Article number	Note
Cooling fan axis 1, set	-	For Spare part no. see chapter *Spare parts,* section: • *Spare part lists on page 391*
Cooling fan axis 2, set	-	For Spare part no. see chapter *Spare parts,* section: • *Spare part lists on page 391*
Locking liquid	-	Loctite 243. Used for the three tightening screws.
Standard toolkit	-	Content is defined in section *Standard tools on page 386*.
Circuit diagram	-	See chapter *Circuit diagram on page 393*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Continues on next page

Installation, fan on motor axis 1

Use this procedure to install the cooling fan on motor axis 1.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Remove the back plate of the fanbox.	See the figure in: • *Cooling fan on page 83*
3	Place the fanbox around motor axis 1.	See the figure in: • *Cooling fan on page 83*
4	Refit the back plate of the fanbox.	
5	**Tip** If there is a lack of space between motor and robot, it is possible to remove part of the fanbox.	See the figure in: • *Cooling fan on page 83*
6	Push the fanbox in line with the connection box.	Align the upper part of the fan with the lower part of the connection box.  xx1000000124 Parts: • A: Connection box • B: Position where the fan shall be aligned with connection box • C: Fan
7	Fit the fanbox with two attachment screws M6x25.	

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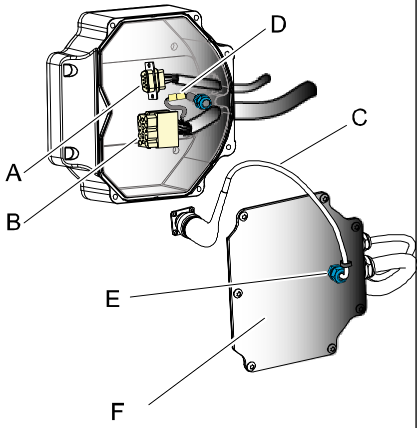
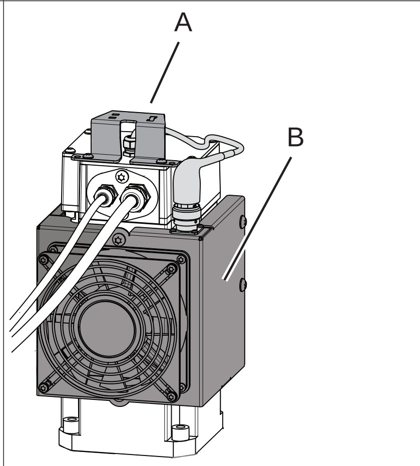
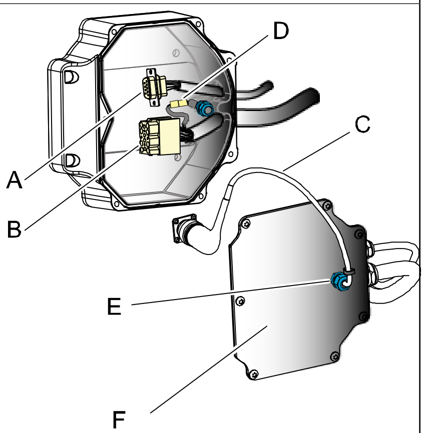
	Action	Note
8	Connect the fan connector to motor and fan.	 xx0900000405 Parts: • A: Connector, signal • B: Connector, power • C: Fan cable • D: Connector, fan • E: Cable gland • F: Motor cover, with fan cable
9	After fitting the motor cover, fit the **protection cover** using two attachment screws for the motor cover.	 xx0900000406 Parts: • A: Protection cover • B: Fan
10	Secure the fan cable to the protection cover with a cable strap.	

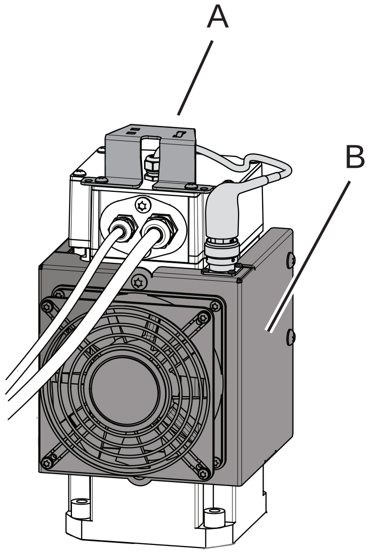
Continues on next page

Installation, fan on motor axis 2

Use this procedure to install the cooling fan on motor axis 2.

	Action	Note
1	**DANGER** Turn off all: • electric power supply to the robot • hydraulic pressure supply to the robot • air pressure supply to the robot Before entering the robot working area.	
2	Remove the back plate of the fanbox.	See the figure in: • *Cooling fan on page 83*
3	Place the fanbox around motor axis 1.	
4	Refit the back plate of the fanbox.	See the figure in: • *Cooling fan on page 83*
5	Fit the fanbox with two attachment screws M6x30.	
6	Connect the fan connector to motor and fan.	 xx0900000405 Parts: • A: Connector, signal • B: Connector, power • C: Fan cable • D: Connector, fan • E: Cable gland • F: Motor cover, with fan cable

Continues on next page

	Action	Note
7	After fitting the motor cover, fit the *protection cover* using two attachment screws for the motor cover.	 xx0900000406 Parts: • A: Protection cover • B: Fan

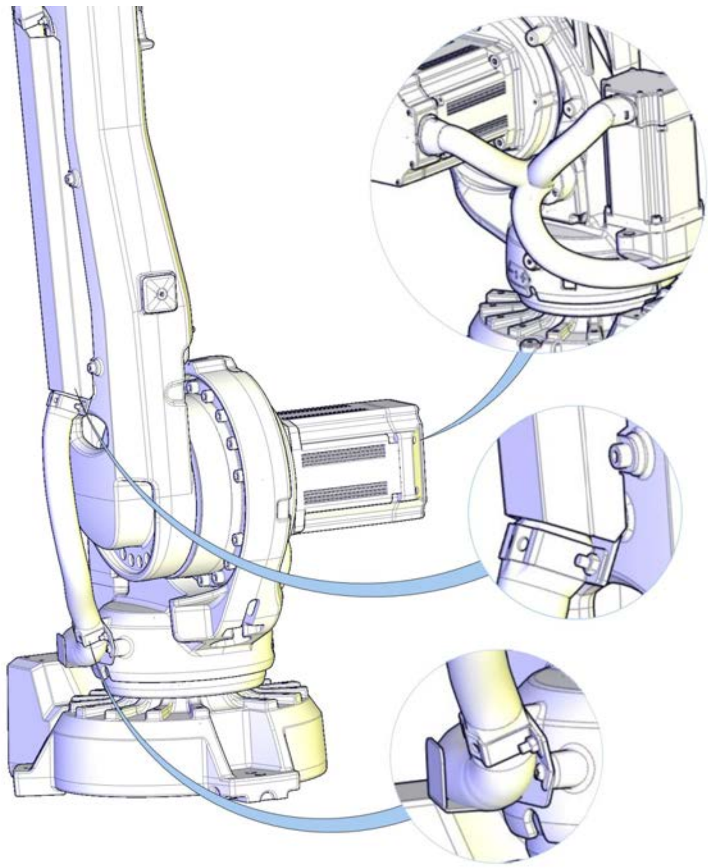
Adjustments in RobotWare

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

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

Introduction

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



xx1100000097

2.5.3 Installing an expansion container

Validity of this section

This section is only valid for other design than Type C and Type D.

Introduction to the expansion container

The expansion container is needed on suspended robots (other design than Type C and Type D) to make sure that the amount of oil in gearbox axis 1 covers all important parts. Robots ordered as suspended robots (Option 224-2) have the expansion container installed on delivery.

Note

Manipulators delivered for floor mounting must have the option 224-2 added before changing mounting position to inverted.

Type C and Type D are not valid for inverted mounting.

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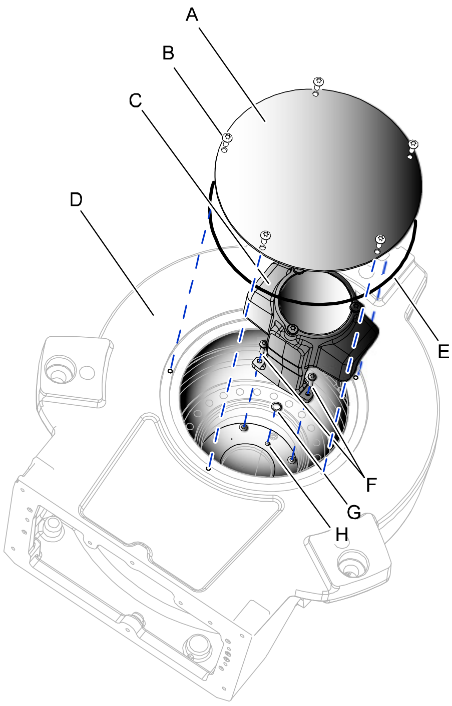
Expansion container



xx1000000318

A	Cover
B	Attachment screw M6x16, quality 8.8-A2F (5 pcs)
C	Oil expansion container with cover
D	Base
E	O-ring D220x5
F	Attachment screw M5x20, quality 8.8-A2F and washer (2+2 pcs)
G	O-ring D1=9.5 D2=1.6
H	Oil plug (to be removed)

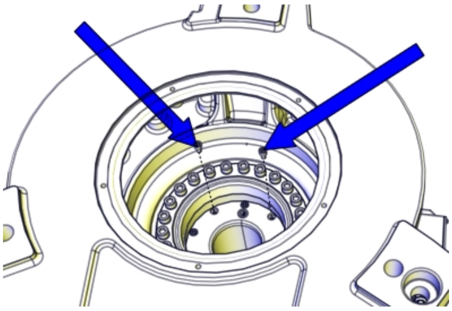
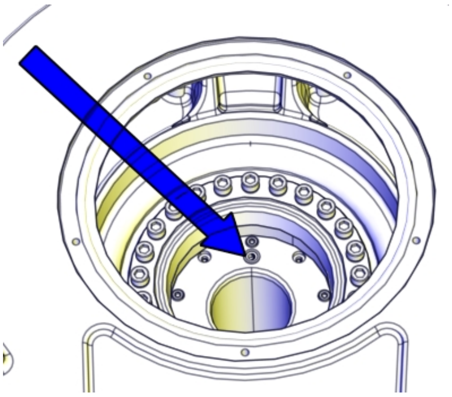
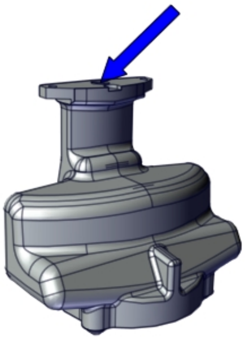
Required equipment

Equipment	Note
Expansion container	Kit including oil.
Lifting accessory	3HAC034766-001
Lifting instruction	Included with the lifting accessory.
Grease	-
Locking liquid	3HAB7116-1 Loctite 243
O-ring for base cover	Replace if damaged.

Continues on next page

Installing an expansion container

Use this procedure to install the expansion container.

	Action	Information
1	Lift the robot using the lifting accessory and place it in suspended position with the base free for installation work.	See *Lifting and turning a suspended mounted robot on page 57*.
2	Remove the *cover* and the *o-ring* from the *base*.	
3	Remove two existing *attachment screws* as shown in the figure.	 xx1500001958 The screws must be replaced with longer screws.
4	Remove the *oil plug* from the base.	 xx1900001818
5	Fit a *plastic plug* in the expansion container drain hole.	 xx1500001956
6	Fill the expansion container with oil.	Oil volume: 0.4 l

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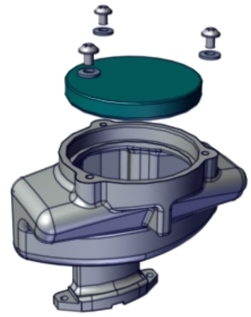
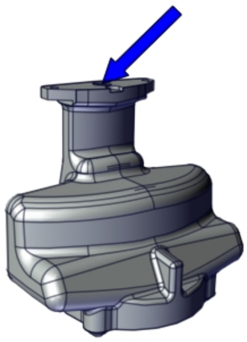
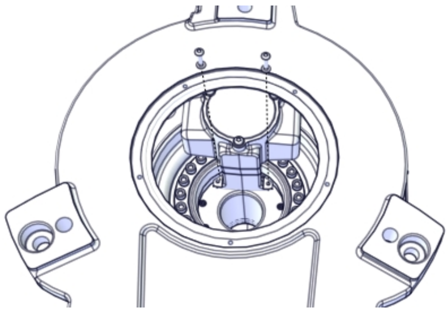
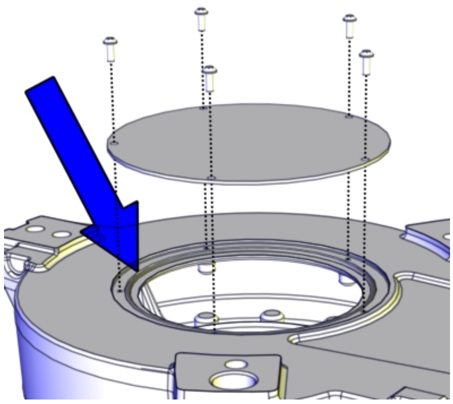
	Action	Information
7	Apply locking liquid to the three screw holes in the expansion container. Knock in the *VK-cover* with a rubber mallet. Secure with three screws and washers.	Locking liquid: 3HAB7116-1 (Loctite 243). Screws: M6x8 (3 pcs).  xx1500001957
8	Remove the *plastic plug*.	 xx1500001956
9	Apply some grease on the small *o-ring* and place it in the recess on the expansion container.	
10	Place the *expansion container* in the base and place it so the drain holes match. **Tip** Turn and install the container quickly to avoid oil spill.	 xx1500001959 Tightening torque 6 Nm.
11	Secure the expansion container with the *attachment screws* and *washers*. Wipe off any oil residuals before continuing.	
12	Check the *o-ring* used on the cover. Replace it if damaged.	 xx1900001819
13	Refit the *cover* on the base with its *attachment screws*.	

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	Action	Information
14	Turn the robot so it is not suspended.	
15	Turn the robot to suspended position.	
16	Inspect the oil level.	See procedure for suspended robot, *Inspecting oil level, axis 1 gearbox on page 112*.

2.6 Robot in hot environments

2.6.1 Start of robot in hot environments

Introduction

This procedure describes how to start the robot in a hot environment. This procedure must be performed the first time the robot is started in a hot environment or if it has not been used for some time in a hot environment.

There is a possibility that some overpressure has been built up in the system. This overpressure must be released before starting up the robot.

Releasing overpressure in gearboxes

Use this procedure before the start of the robot in a hot environment to release potential overpressure being built up in gearboxes.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**CAUTION** Components may be hot.	
3	**Note** Before opening the oil plug, make certain that the oil plug is above the oil level. Place the robot accordingly.	
4	Open oil plug filling *very carefully*! **Note** Open the oil plug just enough for the overpressure to be released.	**Tip** Hold a cloth or some paper over the oil plug while opening it to prevent surplus oil causing burns or other injuries.
5	Let the overpressure leave the gearbox.	
6	Refit the oil plug.	
7	Continue releasing the overpressure on all gearboxes.	

2.7 Robot in cold environments

2.7.1 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.

2.8 Electrical connections

2.8.1 Robot cabling and connection points

Introduction

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

CAUTION

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

CAUTION

Verify that the robot 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 97*.
Fan cables (option)	Handles supply to and feedback from any cooling fan on the robot. Specified in the table *Fan cables (option) on page 99*.
Customer cables (option)	Handles communication with equipment fitted on the robot by the customer, low voltage signals and high voltage power supply + protective ground. The customer cables also handle databus communication. See the product manual for the controller, see document number in *References on page 10*.
External axes cables (option)	Handles power supply to and control of the external axes' motors as well as feedback from the servo system. See *Application manual - Additional axes and stand alone controller (IRC5)*, document number in *References on page 10*.

Robot cables

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

Cable sub-category	Description	Connection point, cabinet	Connection point, robot
Robot cable, power	Transfers drive power from the drive units in the control cabinet to the robot motors.	XS1 (IRC5 controllers) X1 (OmniCore controllers)	R1.MP

Continues on next page

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

Robot cable, power

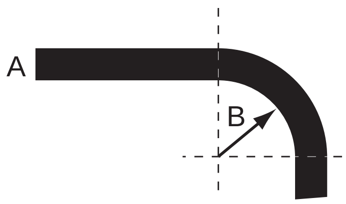
Cable	Art. no.
Robot cable, power: 7 m	3HAC026787-001
Robot cable, power: 15 m	3HAC026787-002
Robot cable, power: 22 m	3HAC026787-003
Robot cable, power: 30 m	3HAC026787-004

Robot cable, signals

Cable	Art. no.
Robot cable signal, shielded: 7 m	3HAC068917-001
Robot cable signal, shielded: 15 m	3HAC068918-001
Robot cable signal, shielded: 22 m	3HAC068919-001
Robot cable signal, shielded: 30 m	3HAC068920-001

Bending radius for static floor cables

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



xx1600002016

A	Diameter
B	Diameter x10

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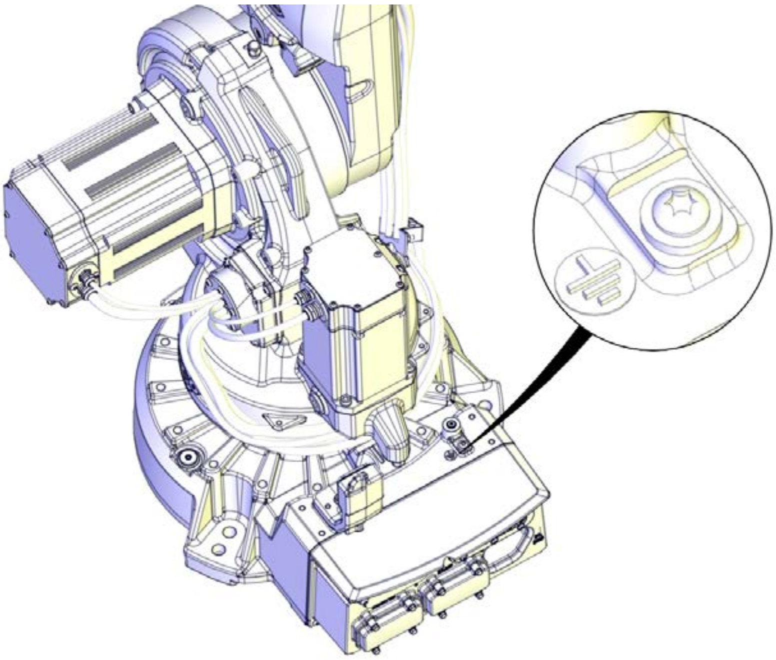
Grounding and bonding point on manipulator

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



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Fan cables (option)

These cables are *not* included in the standard delivery, but are included in the delivery if the fan option is ordered. The cables are completely pre-manufactured and ready to plug in.

Cabling to be installed on the robot is specified in section *Installation of cooling fan for motors (option) on page 82*.

2.8.2 Customer connection on robot

Location of customer connection

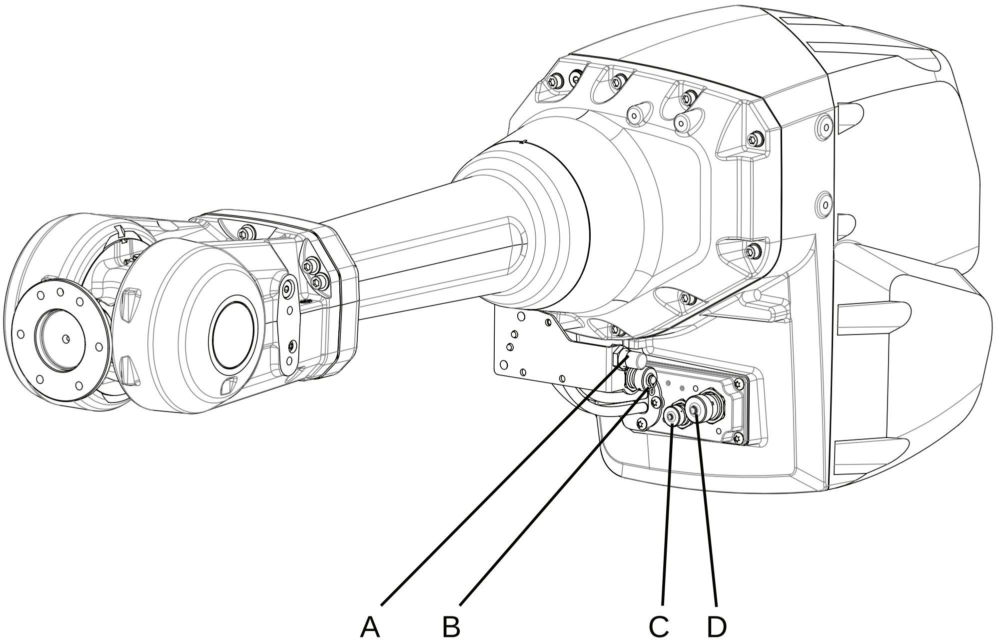
For the connection of extra equipment to the robot, cables and air hose are integrated into the robot´s cabling, and there can be two UTOW71210SH06 and one UTOW71626SH06 connector on the front part of the upper arm.

Note

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

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

Customer connections on upper arm



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A	R2.PROC1 Air M16x1.5 (24° cone sealing)
B	R2.ETHERNET[i]
C	R2.CP or R2.CBUS
D	R2.CS or R2.CP/CS

i Use a straight ethernet connector. Using an angled connector causes a collision risk with R2.CP, R2.CBUS or R2.CP/CS.

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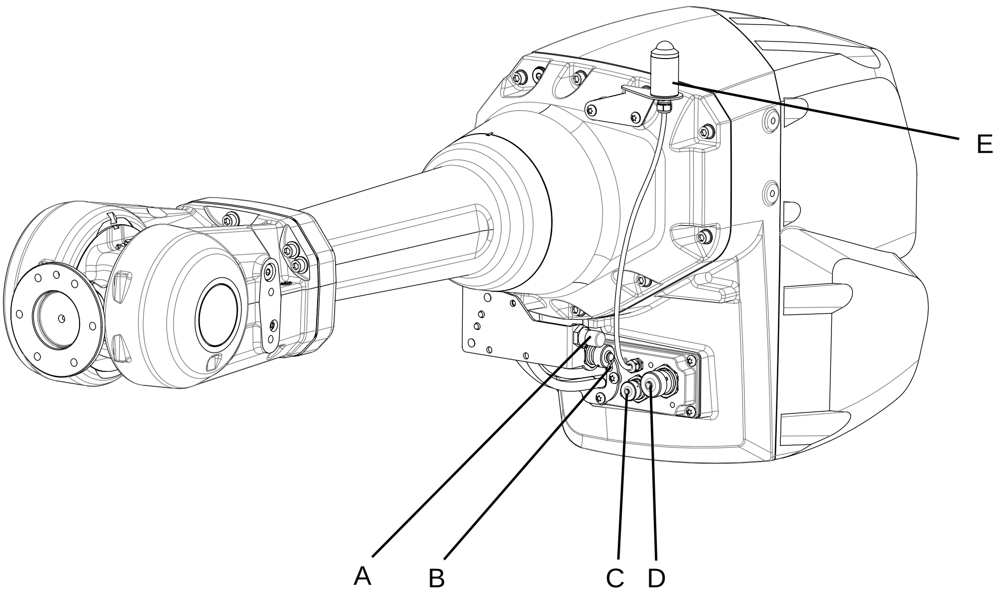
Customer connections on upper arm with signal lamp

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



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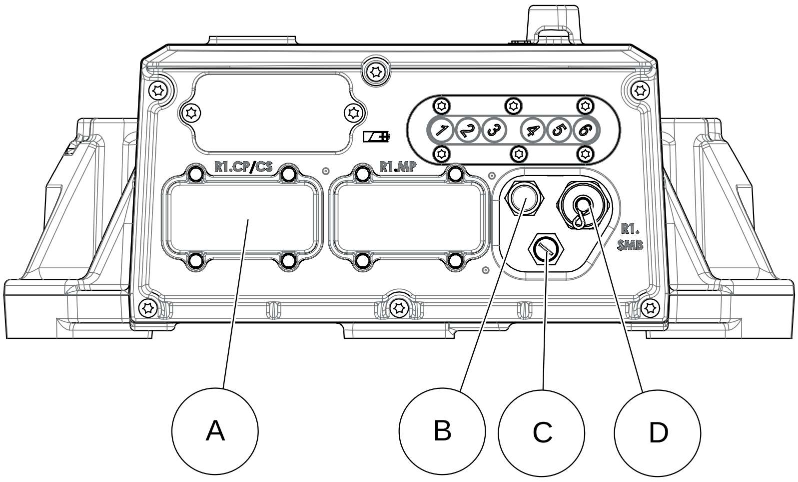
A	R2.PROC1 Air M16x1.5 (24° cone sealing)
B	R2.ETHERNET[i]
C	R2.CP or R2.CBUS
D	R2.CS or R2.CP/CS
E	Signal lamp
-	R3.H1 +, R3.H2 - (inside the arm house, not shown in figure)

[i] Use a straight ethernet connector. Using an angled connector causes a collision risk with R2.CP, R2.CBUS, R2.CS or R2.CP/CS.

Continues on next page

Customer connections base



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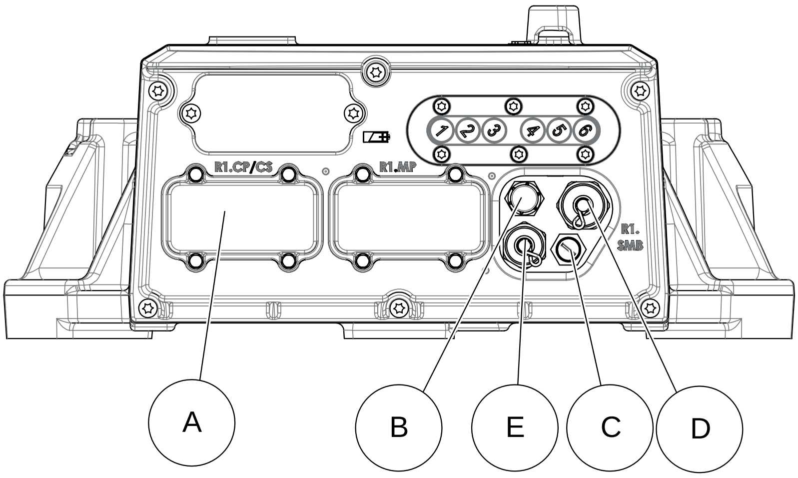
A	R1.CP/CS
B	R1.PROC1 (Air M16x1.5)
C	R1.ETHERNET
D	R1.SMB

Customer connections base with 7th axis



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A	R1.CP/CS
B	R1.PROC1 (Air M16x1.5)
C	R1.ETHERNET
D	R1.SMB
E	R2.FB7

Continues on next page

Extra equipment connections

Connections to the:

- air hose (3/8") is located on the front part of the upper arm and at the base. Max. 8 bar. Inner diameter of the air hose: 9.5 mm.

Number of signals, customer connections option Parallel&Air (803-1):

- 23 (50V, 0.5A)
- 9 (300V, 2A). 8 are double crimped in R1.CP/CS and 1 is only accessible in the robot base.
- 1 protective ground

Number of signals, customer connections option Ethernet, Parallel&Air (803-2) and DeviceNet, Parallel&Air (803-3):

- 8 (50V, 0.5A)
- 3 (300V, 2A)
- 2 DeviceNet
- 4 EtherNet
- 1 protective ground

Number of signals, customer connections option Profibus, Parallel&Air (803-4):

- 8 (50V, 0.5A)
- 2 (300V, 2A)
- 2 Profibus
- 1 protective ground

Connection sets

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

Connection set	Connector	Art. no.	Content
PROC1 on base	R1.CP/CS	3HAC16667-1	• Sockets for cable area of 0.14-2.5 mm² • Hood foundry • Hinged frame, hood • Multicontact-module, female
Connector set on base	R1.ETHER-NET	3HAC033181-001	• Hose coupling • M12 connector, male
R2.CP/R2.CS	R2.CP/R2.CS	3HAC025396-001	• Pins for cable area 0.21 - 0.93 mm² • Bottle shaped shrinking hose • Angle shaped shrinking hose • Hose coupling
Connector set upper arm	R2.ETHER-NET	3HAC070439-001	• Pins for cable area 0.21 - 0.93 mm² • Bottle shaped shrinking hose • Angle shaped shrinking hose

Continues on next page

Power supply connections on the robot

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CPA	XP6.1	R2.CP.A	R1.CP/CS.d1
CPB	XP6.2	R2.CP.B	R1.CP/CS.d6
CPC	XP6.3	R2.CP.C	R1.CP/CS.d3
CPD	XP6.4	R2.CP.D	R1.CP/CS.d4
CPE	XP6.1	R2.CP.E	R1.CP/CS.d1
CPF	XP6.2	R2.CP.F	R1.CP/CS.d6
CPG		R2.CP.G (Earth)	
CPH	-	R2.CP.H	R1.CP/CS.d7
CPJ	XP6.3	R2.CP.J	R1.CP/CS.d3
CPK	XP6.4	R2.CP.K	R1.CP/CS.d4

Signal connection on the robot

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CSA	XP5.1.1	R2.CS.A	R1.CP/CS.b1
CSB	XP5.1.2	R2.CS.B	R1.CP/CS.b2
CSC	XP5.2.1	R2.CS.C	R1.CP/CS.b3
CSD	XP5.2.2	R2.CS.D	R1.CP/CS.b4
CSE	XP5.2.3	R2.CS.E	R1.CP/CS.b5
CSF	XP5.2.4	R2.CS.F	R1.CP/CS.b6
CSG	XP5.1.9	R2.CS.G	R1.CP/CS.b7
CSH	XP5.1.10	R2.CS.H	R1.CP/CS.b8
CSJ	XP5.1.11	R2.CS.J	R1.CP/CS.b9
CSK	XP5.1.12	R2.CS.K	R1.CP/CS.b10
CSL	XP5.1.3	R2.CS.L	R1.CP/CS.b11
CSM	XP5.1.4	R2.CS.M	R1.CP/CS.b12
CSN	XP5.1.5	R2.CS.N	R1.CP/CS.b13
CSP	XP5.1.6	R2.CS.P	R1.CP/CS.b14
CSR	XP5.3.1	R2.CS.R	R1.CP/CS.b15
CSS	XP5.3.2	R2.CS.S	R1.CP/CS.b16
CST	XP5.3.3	R2.CS.T	R1.CP/CS.b18
CSU	XP5.3.4	R2.CS.U	R1.CP/CS.b19
CSV	XP5.3.5	R2.CS.V	R1.CP/CS.b20
CSW	XP5.3.6	R2.CS.W	R1.CP/CS.b21
CSX	XP5.2.9	R2.CS.X	R1.CP/CS.b22

Continues on next page

Signal name	Customer Terminal Controller	Customer Contact on Upper arm, R2	Customer Contact on robot base (cable between robot and controller not supplied)
CSY	XP5.2.10	R2.CS.Y	R1.CP/CS.b23
CSZ	XP5.2.11	R2.CS.Z	R1.CP/CS.b24

2.9 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.

Mechanical stops will not always stop the movements of the robot completely.

3 Maintenance

3.1 Introduction

Structure of this chapter

This chapter describes all the maintenance activities recommended for the IRB 4600.

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 4600 is connected to power, always make sure that the IRB 4600 is connected to protective earth and a residual current device (RCD) before starting any maintenance work.

For more information see:

- *Product manual - OmniCore V250XT*
- *Product manual - IRC5*
- *Product manual - IRC5 Panel Mounted Controller*
- *Robot cabling and connection points on page 97*.

3.2 Maintenance schedule

3.2.1 Specification of maintenance intervals

Introduction

The intervals are specified in different ways depending on the type of maintenance activity to be carried out and the working conditions of the IRB 4600:

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

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

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

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

Overhaul

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

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

Contact your local ABB Customer Service to get more information.

3.2.2 Maintenance schedule

General

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

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

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

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

- *Inspection activities on page 112*
- *Replacement activities on page 146*
- *Cleaning activities on page 184*

Activities and intervals, standard equipment

The following table specifies the required maintenance activities and intervals.

Maintenance activity	Equipment	Interval
Cleaning	Robot	*Cleaning the IRB 4600 on page 184*
Inspection	Oil level in axis-1 gearbox	Every 12 months.
Inspection	Oil level in axis-2 gearbox	Every 12 months.
Inspection	Oil level in axis-3 gearbox	Every 12 months.
Inspection	Oil level in axis-4 gearbox	Every 12 months.
Inspection	Oil level in axis-5-6 gearbox	Every 12 months.
Inspection	Robot harness	Every 12 months[i].
Inspection	Information labels	Every 12 months.
Inspection	Dampers	Every 12 months.
Inspection	Pressure relief valve	Every 12 months[ii].
Inspection	Mechanical stop	Every 12 months.
Change	Oil in axis-1 gearbox	First change when DTC [iii] reads: • 6,000 hours Second change when DTC[iii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Change	Oil in axis-2 gearbox	First change when DTC [iii] reads: • 6,000 hours Second change when DTC[iii] reads: • 24,000 hours Following changes: • Every 24,000 hours.

Continues on next page

Maintenance activity	Equipment	Interval
Change	Oil in axis-3 gearbox	First change when DTC [iii] reads: • 6,000 hours Second change when DTC [iii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Change	Oil in axis-4 gearbox	No change needed.
Change	Oil in axis-5-6 gearbox	First change when DTC [iii] reads: • 6,000 hours Second change when DTC [iii] reads: • 24,000 hours Following changes: • Every 24,000 hours.
Overhaul	Robot	Every: • 40,000 hours .
Replacement	Battery pack, measurement system of type RMU101 or RMU102 (3-pole battery contact)	36 months or battery low alert [iv]
Replacement	Battery pack, measurement system with 2-pole battery contact, e.g. DSQC633A	Battery low alert [v]

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

ii Check more often if the environment is very contaminated.

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

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

See the replacement instruction for more details.

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

Activities and intervals, optional equipment

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

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

3.2.3 Expected component life

General

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

Expected component life - protection type Standard

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

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

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

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

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

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

3.3 Inspection activities

3.3.1 Inspecting oil level, axis 1 gearbox

Mounting position of the robot

If the robot is floor mounted, follow the procedures in *Inspecting the gearbox oil level in a floor mounted robot on page 113*.

If the robot is suspended, follow the procedures in *Inspecting the gearbox oil level in a suspended robot (Other design than Type C and Type D) on page 116*.

Note

If the suspended robot is design **Type C and Type D**, the oil level can not be inspected while the robot is hanging upside down. To make sure that the correct amount of oil is refilled after some repair work, make a note of how much oil was drained and make sure to refill with the same amount. If in doubt, the suspended robot must be dismantled from its suspended position, secured in a floor mounted position, and then the oil level can be inspected according to *Inspecting the gearbox oil level in a floor mounted robot on page 113*.

The method described in this section of inspecting the oil level in a suspended robot is only valid for **Other design than Type C and Type D.**

Read more about design **Type C and Type D** in section *Type C of IRB 4600 on page 376* and *Type D of IRB 4600 on page 377*.

Required equipment

Equipment	Note
Only valid for Other design than Type C and Type D: Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 146*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

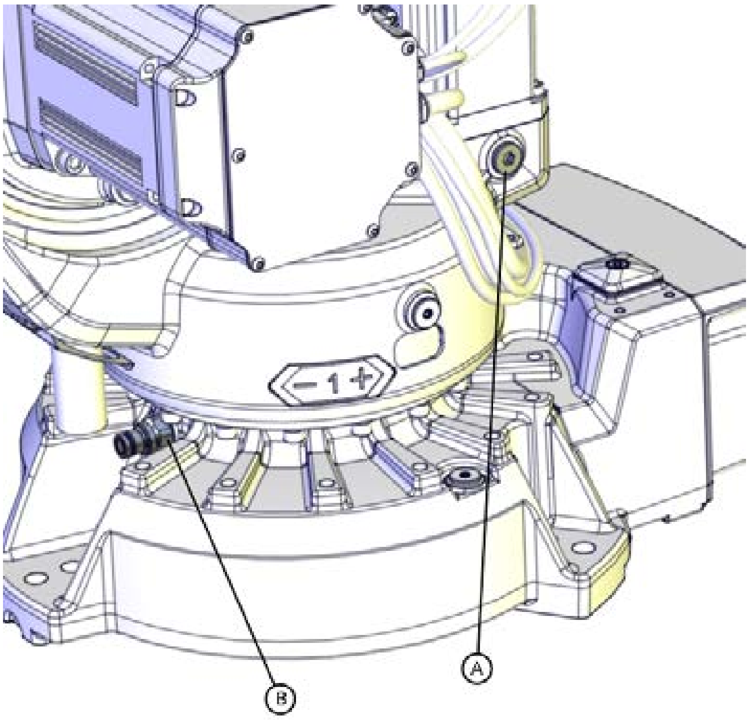
Continues on next page

Inspecting the gearbox oil level in a floor mounted robot

Location of oil plugs (floor mounted)

The axis 1 gearbox is located between the frame and base of the robot. The oil plug for inspection is shown in the figure.

Type C and Type D



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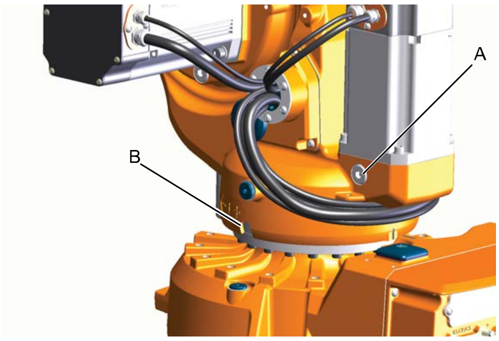
A	Oil plug, filling and inspection
B	Oil plug, draining

Other design (1) than Type C and Type D



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A	Oil plug, inspection
B	Oil plug, gearbox

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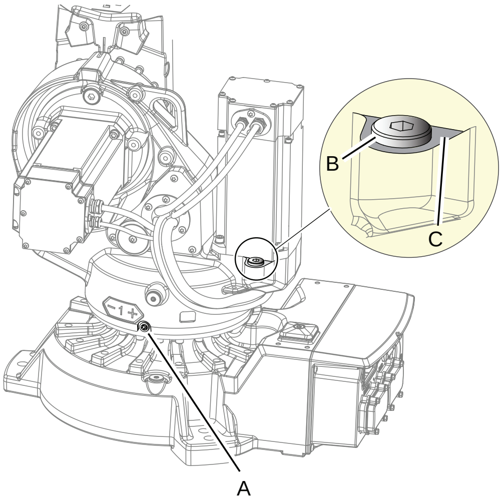
Other design (2) than Type C and Type D



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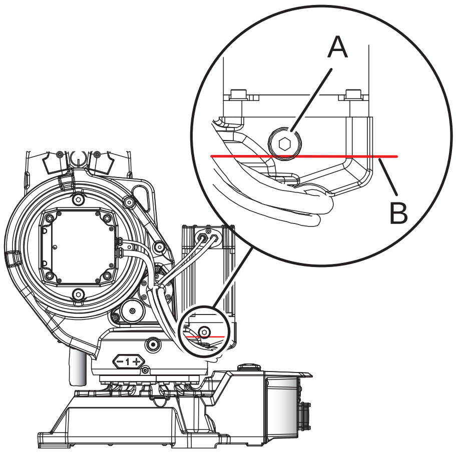
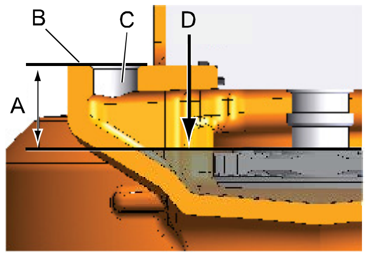
A	Oil plug draining, on gearbox
B	Oil plug filling, on surface for motor flange
C	Surface for motor flange

Inspecting oil level, axis-1 gearbox (floor mounted)

Use this procedure to inspect the oil level in the axis-1 gearbox, when the robot is floor mounted.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
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 can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Open the *oil plug, inspection*.	See *Location of oil plugs (floor mounted) on page 113*.

Continues on next page

	Action	Note
5	**Note** Valid for **Type C and Type D** and **Other design (1)** than **Type C and Type D** Measure the oil level by looking into the hole of the oil plug inspection. Required oil level: • 0 -5 mm, up to the lower edge of the oil plug hole of the oil plug inspection.	 xx1200000859 Parts: A Oil plug inspection B Approximate oil level
6	**Note** **Valid for Other design (2) than Type C and Type D:** Measure the oil level at the oil plug hole. Required oil level: • 35 ± 3 mm below the surface for the motor flange. The oil level shall only just start to be observed when looking through the oil filling hole. See figure!	 xx1000000824 Parts: • A: 35 ± 3 mm • B: Surface for motor flange • C: Filling hole • D: Oil level
7	Add oil if required.	How to fill oil is described in section: • *Changing the oil, axis-1 gearbox on floor mounted robots on page 148*
8	Refit the oil plug, inspection.	Tightening torque: • 24 Nm

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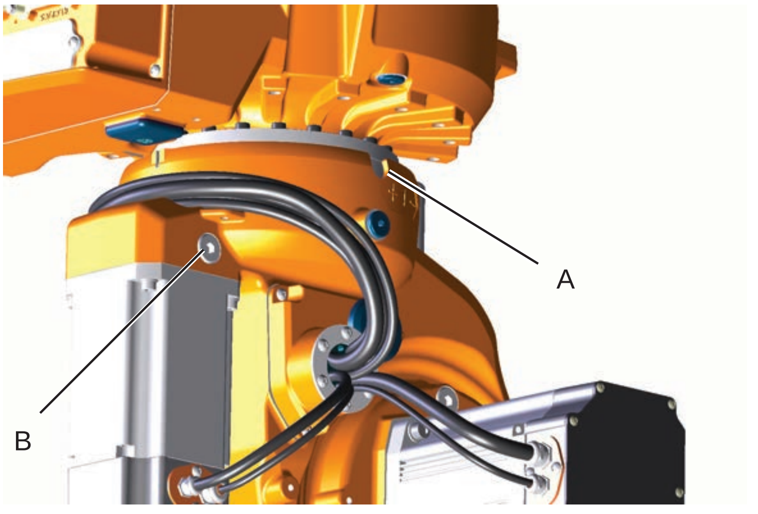
Inspecting the gearbox oil level in a suspended robot (Other design than Type C and Type D)

Location of oil plugs (suspended)

Other design (1) than Type C and Type D



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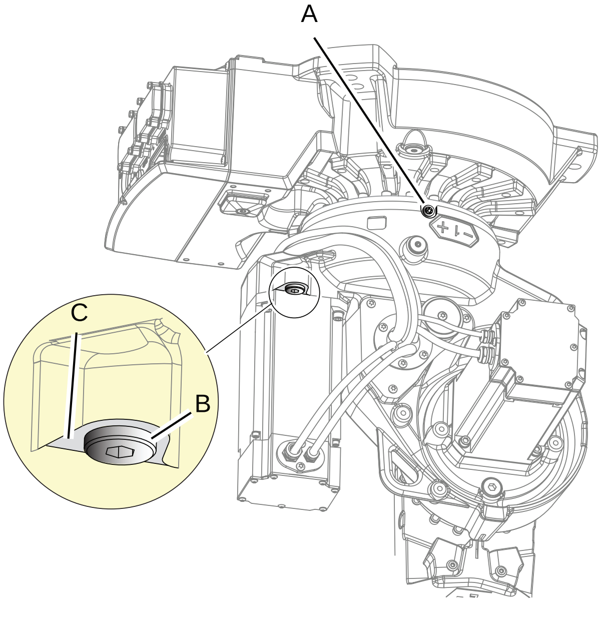
A	Oil plug, filling
B	Oil plug, draining

Other design (2) than Type C and Type D



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A	Filling oil plug, on gearbox
B	Draining oil plug, on surface for motor flange
C	Surface for motor flange

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Inspecting oil level, axis-1 gearbox (suspended robot)

Use this procedure to inspect the oil level in the axis-1 gearbox, when the robot is suspended.

This procedure is only valid for **Other design than Type C and Type D**.

Note

If the suspended robot is design **Type C and Type D**, the oil level can not be inspected while the robot is hanging upside down. To make sure that the correct amount of oil is refilled after some repair work, make a note of how much oil was drained and make sure to refill with the same amount. If in doubt, the suspended robot must be dismantled from its suspended position, secured in a floor mounted position, and then the oil level can be inspected according to *Inspecting the gearbox oil level in a floor mounted robot on page 113*.

Note

If the suspended robot is **Other design than Type C and Type D**, and the axis-1 gearbox is filled with an amount of oil suited for an inverted position, the oil level can only be inspected in the inverted position! If the robot was taken down to stand on the floor, the oil level would be above the oil plug hole, which would result in oil leakage if the plug would be opened while robot stands on the floor!

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
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 can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Open the *oil plug inspection* on the axis 1 gearbox.	See the figure in: • *Location of oil plugs (floor mounted) on page 113*

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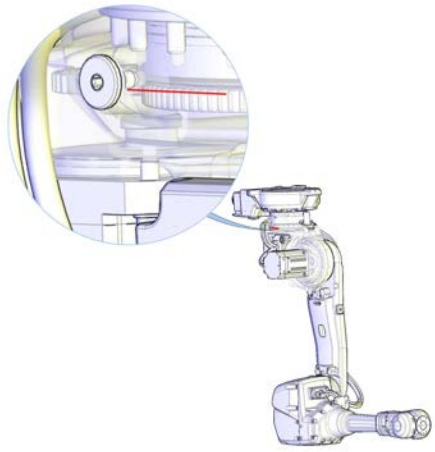
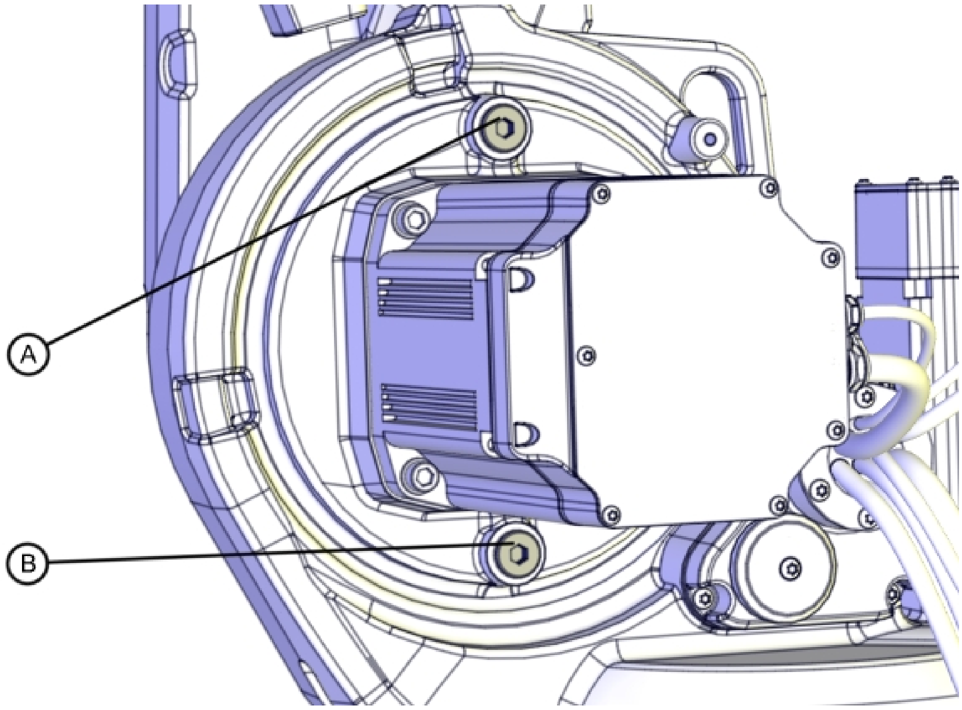
	Action	Note
5	Required oil level: • up to the lower edge of the oil plug hole. **Note** The oil plugs on gearbox axis 1 are now on top.	 xx1100000008
6	Add oil if required.	How to fill oil is described in section: • *Changing the oil, axis-1 gearbox on floor mounted robots on page 148*
7	Refit the oil plug. **Note** **Only valid for Other design than Type C and Type D**: Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 3-8 Nm

3.3.2 Inspecting the oil level, axis 2 gearbox

Location of axis 2 gearbox

The axis 2 gearbox is located in the lower arm rotational center, underneath the motor attachment. The oil plugs are shown in the figure.



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A	Oil plug, filling
B	Oil plug, draining (Quick connect fitting)

Required equipment

Equipment	Note
Only valid for Other design than Type C and Type D: Oil plug sealing washer, gearbox	3HAC029646-001
Lubrication oil	See section *Type of lubrication in gearboxes on page 146*.
Oil plug (Quick connect fitting)	For article number see *Spare part lists on page 391*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Continues on next page

Inspecting oil level, axis 2 gearbox

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

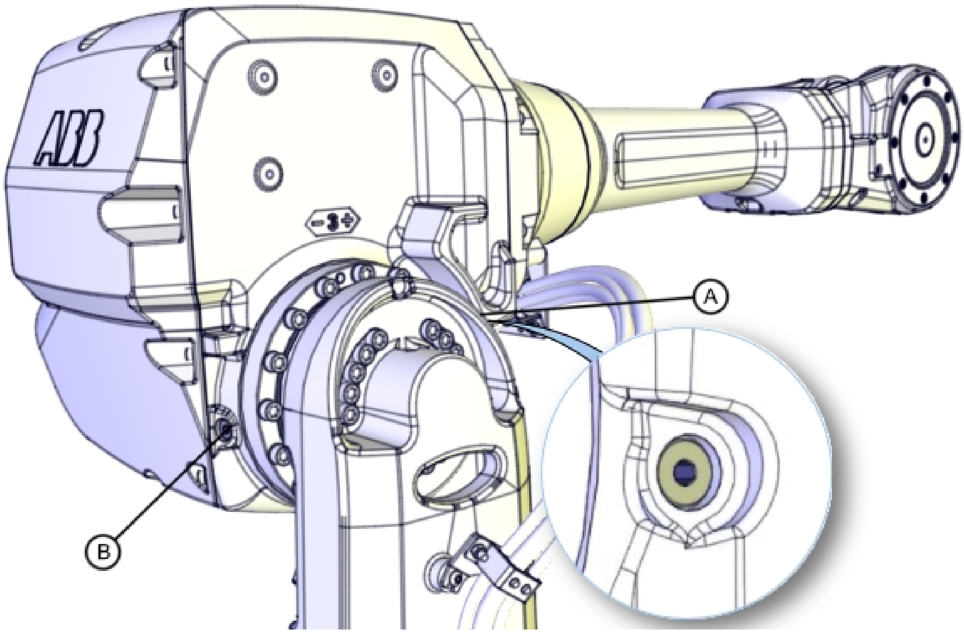
	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Open the *oil plug, inspection* (location depends on how the robot is mounted). **Note** Always open the oil plug on top, depending how the robot is mounted.	See the figure in: • *Location of axis 2 gearbox on page 119*
5	Measure the oil level at the oil plug hole. Required oil level: • 42 mm ± 5 mm below the lower edge of the oil plug hole.	
6	Add oil if required.	How to fill oil is described in section • *Changing the oil, axis-2 gearbox on page 159*
7	Refit the oil plug. **Note** **Only valid for Other design than Type C and Type D:** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 24 Nm

3.3.3 Inspecting the oil level, axis 3 gearbox

Location of axis 3 gearbox

The axis 3 gearbox is located in the upper arm rotational center, underneath the motor attachment. The oil plug for inspection is shown in the figure.

Type C and Type D



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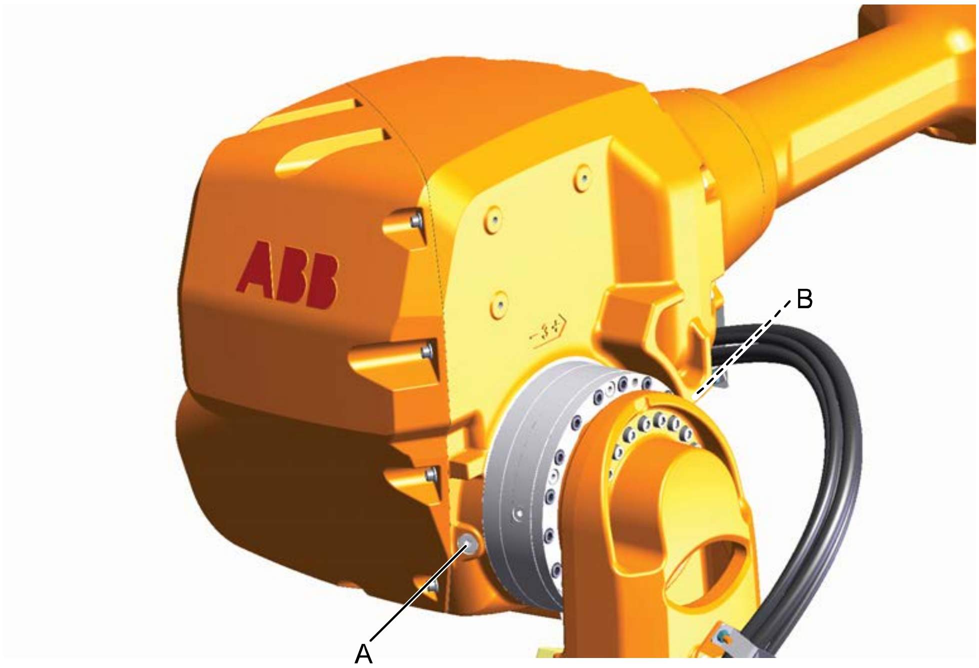
A	Oil plug, armhouse (Not visible in this figure. See enlarged figure!)
B	Oil plug, armhouse

Continues on next page

Other design than Type C and Type D



xx0800000306

A	Oil plug, armhouse
B	Oil plug, gearbox (not visible in this figure)

Required equipment

Equipment	Note
Lubrication oil	See section *Type of lubrication in gearboxes on page 146*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Inspecting the oil level, axis 3 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
2	Move the robot to where the upper arm is placed in a +30° position.	

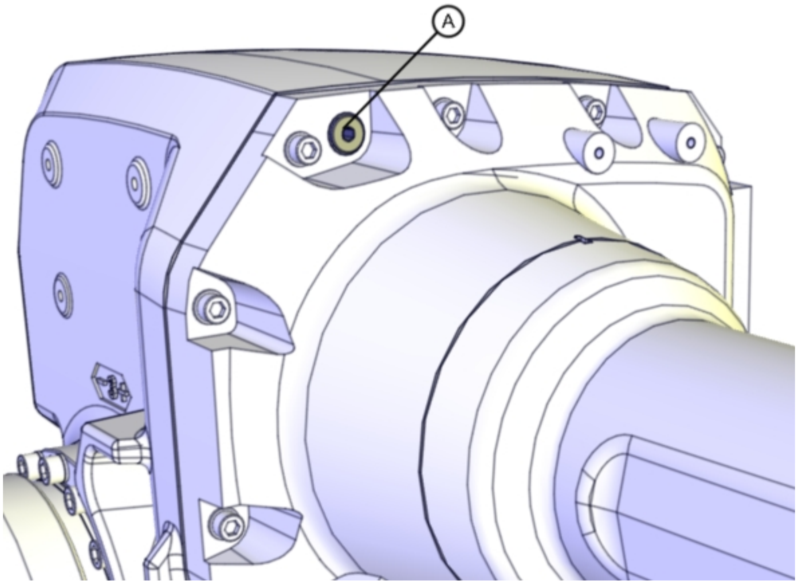
Continues on next page

	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	**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.	
5	**Type C and Type D:** Open the *oil plug, armhouse* (pos. B). **Other design than Type C and Type D:** Open the *oil plug, armhouse*.	See the figure in: • *Location of axis 3 gearbox on page 121*
6	Measure the oil level at the oil plug hole. Required oil level: • oil in the gearbox shall be just below the edge of the oil plug hole.	
7	Add oil if required.	How to fill oil is described in section: • *Changing the oil, axis-3 gearbox on page 163*
8	Refit the oil plug.	Tightening torque: • **Other design than Type C and Type D**, in armhouse: 10 Nm **Other design than Type C and Type D**, in gearbox: 3 Nm **Type C and Type D**, both plugs: 10 Nm

3.3.4 Inspecting the oil level, axis 4 gearbox

Location of axis 4 gearbox

The axis 4 gearbox is located in the upper armhouse. The oil plug is shown in the figure.



xx0800000307

A	Oil plug, for filling and draining

Required equipment

Equipment	Note
Lubrication oil	See section *Type of lubrication in gearboxes on page 146*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Inspecting the oil level, axis 4 gearbox

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

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
2	Move the robot to where the upper arm points straight up and the oil plug hole is on top of the axis 4 gearbox.	

Continues on next page

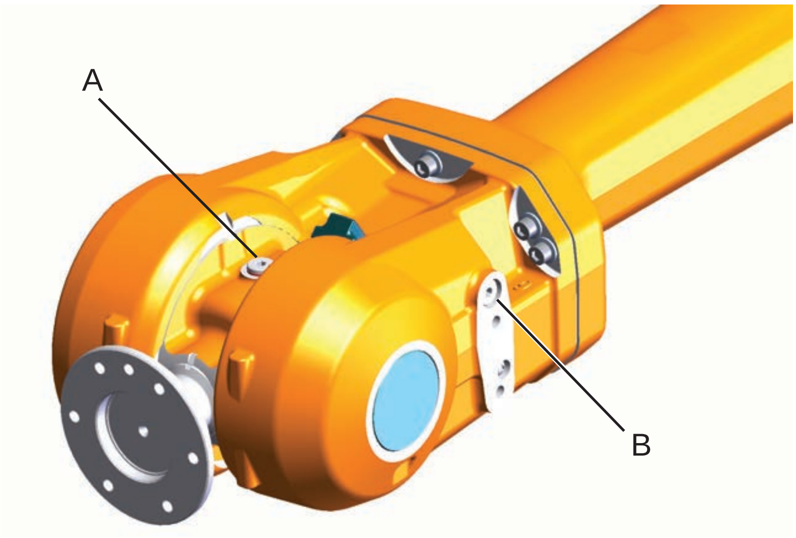
	Action	Note
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
5	Open the *oil plug*.	See the figure in: • *Location of axis 4 gearbox on page 124*
6	Measure the oil level at the oil plug hole. Required oil level: • 35 ± 5 mm below the oil plug flange.	
7	Add oil if required.	How to fill oil is described in section: • *Changing the oil, axis-4 gearbox on page 169*
8	Refit the oil plug, filling.	Tightening torque: • 10 Nm

3.3.5 Inspecting oil level, gearbox axes 5 - 6

Location of gearbox, axes 5-6

The gearbox axes 5-6 is located in the wrist unit. The oil plug is shown in the figure.

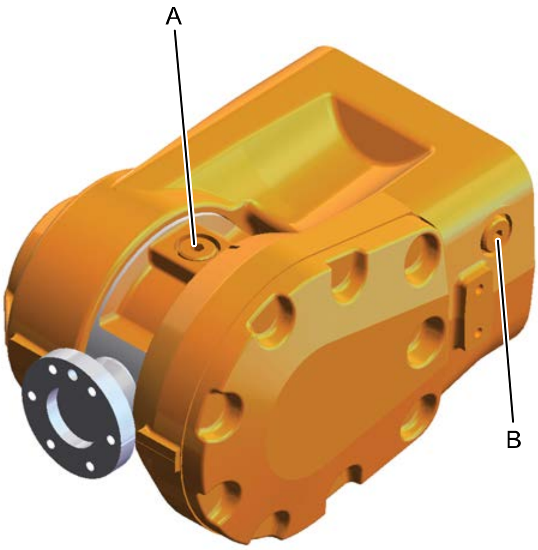
The figure shows IRB 4600 -60/2.05, -45/2.05, -40/2.55 with wrist 60 kg



xx0800000308

A	Oil plug, tilthouse
B	Oil plug, wrist (also used as air inlet when draining from oil plug A)

The figure shows IRB 4600 -20/2.50 with wrist 12/20 kg



xx0900000139

A	Oil plug, tilthouse
B	Oil plug, wrist (also used as air inlet when draining from oil plug A)

Continues on next page

Required equipment

Equipment	Note
Lubrication oil	See section *Type of lubrication in gearboxes on page 146*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Inspecting oil level, gearbox axes 5-6 - wrist 60 kg

Use this procedure to inspect the oil level in gearbox axes 5-6.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
2	Move the robot to where the upper arm is placed in its calibration 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	**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.	
5	Open the *oil plug, wrist*.	See the figure in: • *Location of gearbox, axes 5-6 on page 126*
6	Required oil level: • 3 ±3 mm below the edge of the oil plug hole.	**Note** Open the *oil plug, tilthouse* when inspecting. This will level up oil in axes 5 and 6. See the figure in: • *Inspecting oil level, gearbox axes 5 - 6 on page 126*

Continues on next page

	Action	Note
7	Add *oil* if required.	How to fill oil is decribed in section: • *Changing oil, axes-5 and -6 gearboxes on page 173*
8	Refit the oil plugs.	Tightening torque: • 10 Nm

Inspecting oil level, gearbox axes 5-6 alternative method - wrist 60 kg

Use this procedure to inspect the oil level in gearbox axes 5-6 as an alternative method.

	Action	Note
1	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
2	Move the robot to where the upper arm is placed in its calibration position.	
3	Move the upper arm (axis 3) to a horizontal position, then rotate (axis 4) +90°.	This will put the *oil plug, wrist* on top. See the figure in: • *Location of gearbox, axes 5-6 on page 126* **Note** In this position it is **not** possible to open the *oil plug, tilthouse*, in order to level up oil in axes 5 and 6!
4	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
5	**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.	
6	Open the *oil plug, wrist*.	See the figure in: • *Location of gearbox, axes 5-6 on page 126*
7	Required oil level: • 63 ±3 mm below the edge of the oil plug hole.	

Continues on next page

	Action	Note
8	Add oil if required.	How to fill oil is described in section: • *Changing oil, axes-5 and -6 gearboxes on page 173*
9	Refit *oil plug, wrist*.	Tightening torque: • 10 Nm

Inspecting oil level, gearbox axes 5-6 - wrist 12/20 kg

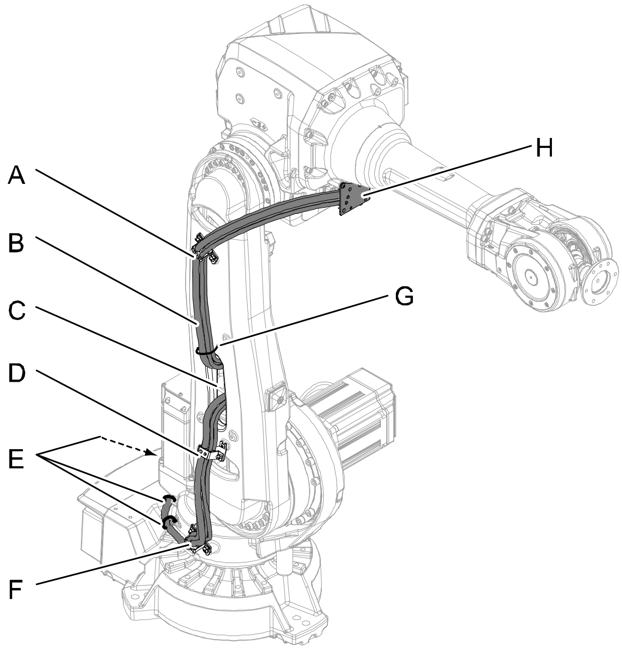
Use this procedure to fill oil in the gearbox.

	Action	Note
1	Move the robot to a position where the upper arm is close to horizontal and axis 4 in the calibration position.	
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**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.	
4	Remove the *oil plug, wrist*.	See the figure in: • *Location of gearbox, axes 5-6 on page 126*
5	Required oil level: • 3 ± 3 mm from the lower edge of the oil plug in the wrist house. Open the oil plug in the tilthouse to allow the oil level between axis 5 and 6 to level.	
6	If necessary, refill oil.	How to fill oil is described in section: • *Changing oil, axes-5 and -6 gearboxes on page 173*
7	Refit the oil plug.	Tightening torque: • 10 Nm

3.3.6 Inspecting the cable harness

Location of cable harness

The figure shows the location of the cable harness.



xx0900000012

A	Bracket, lower arm
B	Cable harness
C	Hole in lower arm
D	Bracket, lower arm
E	Cable straps steel (One not visible here)
F	Bracket, frame
G	Cable strap plastic, lower arm
H	Bracket, armhouse

Required equipment

Equipment	Note
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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 393*.

Continues on next page

Inspecting the cable harness

Use this procedure to inspect the cable harness. The inspection points are shown in the figure *Location of cable harness on page 130*

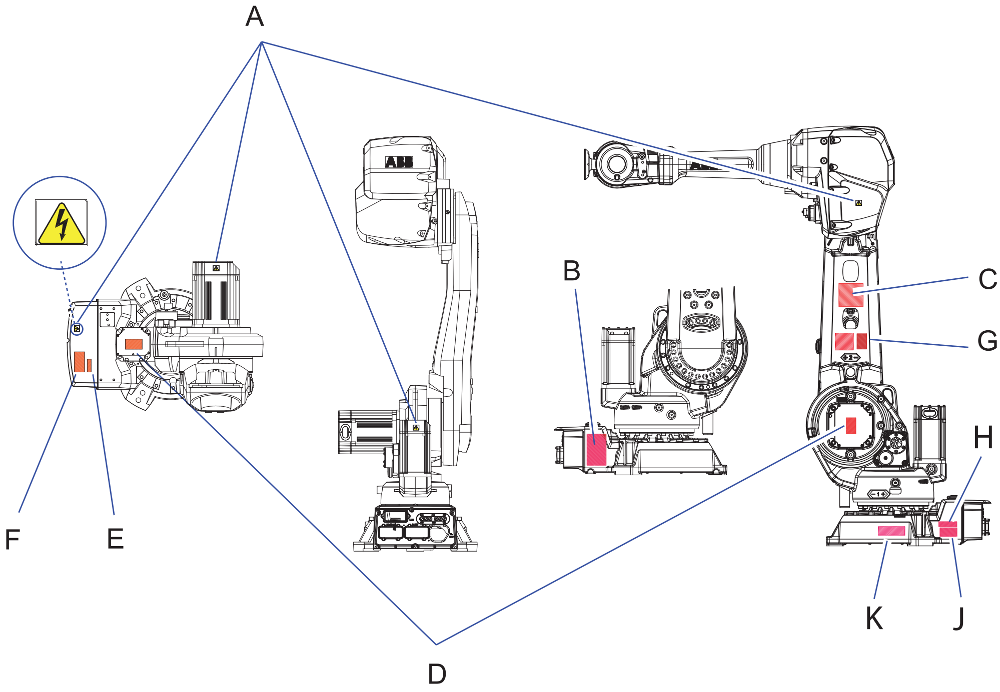
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Make an overall visual inspection of the cable harness in order to detect wear or damage.	
3	Check the *connectors at the base*.	
4	Check the *connectors at the armhouse*.	
5	Check all *brackets* and *straps* are properly attached to the robot.	
6	Replace the cable harness if wear, cracks or damage is detected.	How to replace the cable harness is described in *Repair on page 187*.

3.3.7 Inspecting information labels

Location of information labels

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

Type C and Type D

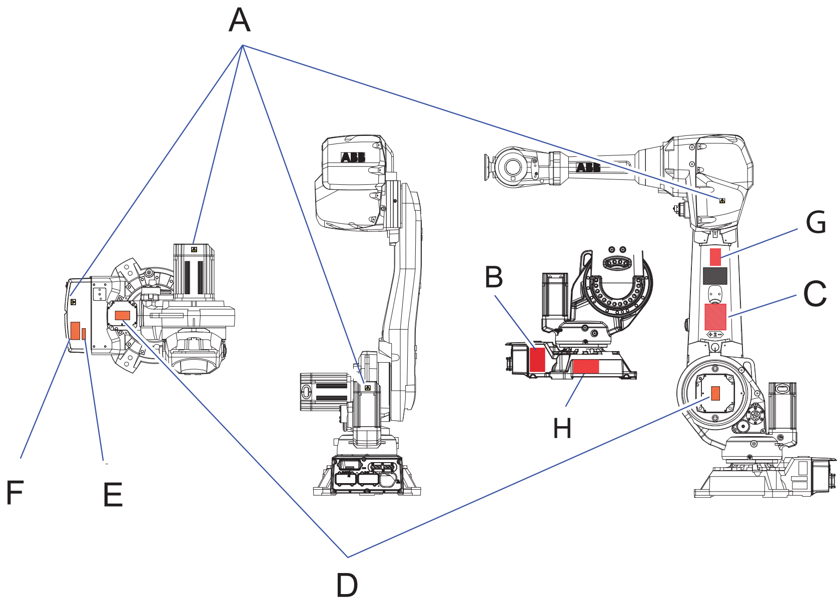


xx1200000519

A	Warning - Symbol of flash
B	Warning - Risk of tipping
C	Label - Lifting instruction
D	Warning - High temperature
E	Label - Max. air pressure
F	Warning - Brake release unit
G	Label - Calibration
H	AbsAcc Information Sign
J	UL-Label
K	Oil quality

Continues on next page

Other design than Type C and Type D



xx1000000197

A	Warning - Symbol of flash (4 pcs)
B	Warning - Risk of tipping
C	Label - Lifting instruction
D	Warning - "High temperature" (2 pcs)
E	Label - Max. air pressure
F	Warning - Brake release unit
G	Label - Calibration
H	Label - Suspended robot

Required equipment

Equipment	Spare part number	Note
Labels	See *Spare part lists on page 391*.	

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.	

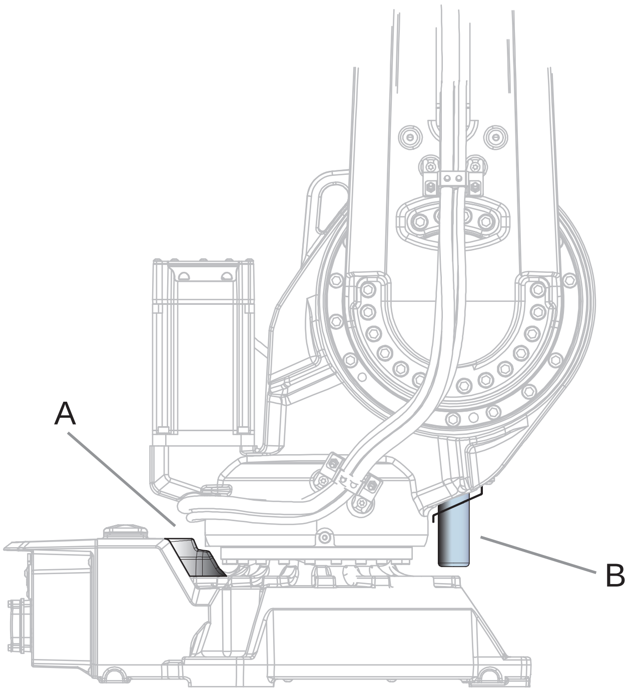
Continues on next page

	Action	Note
2	Check all labels.	See the figure in *Location of information labels on page 132*.
3	Replace any missing or damaged labels.	

3.3.8 Inspecting the mechanical stop pin, axis 1

Location of mechanical stop pin, axis 1

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



xx0800000298

A	Fixed stop
B	Mechanical stop pin, axis 1

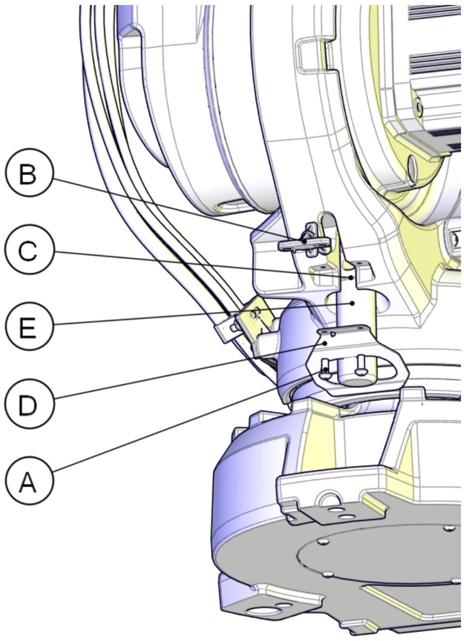
Required equipment

Equipment	Article number	Note
Mechanical stop pin axis 1	See *Spare part lists on page 391*.	
Standard toolkit		Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

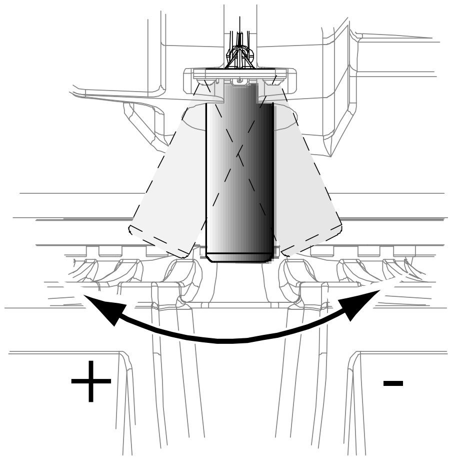
Continues on next page

Inspection of mechanical stop pin, axis 1

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

<table>
<tr><th></th><th>Action</th><th>Note</th></tr>
<tr><td>1</td><td>DANGER
Turn off all:
electric power supply
hydraulic pressure supply
air pressure supply
to the robot, before entering the robot working area.</td><td></td></tr>
<tr><td>2</td><td>Regularly check that the mechanical stop pin is not bent or damaged in any other way.</td><td>See the figure in:
Location of mechanical stop pin, axis 1 on page 135</td></tr>
<tr><td>3</td><td>Note
If the mechanical stop pin has been deformed or damaged, all of its mounting parts have to be replaced.

xx0800000045
Parts:
A Attachment screws
B Bracket
C O-ring (2 pcs) - Not used if bracket (D) is installed.
D Bracket
E Stop pin</td><td>How to replace the stop pin is described in section Replacing stop pin axis 1 on page 284.</td></tr>
<tr><td>4</td><td>Check that the mechanical stop pin is properly attached.</td><td></td></tr>
</table>

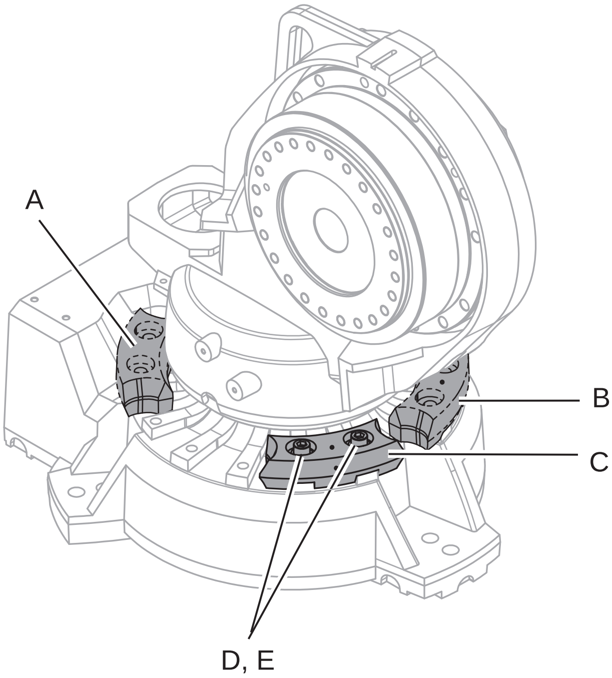
Continues on next page

	Action	Note
5	Check that the *mechanical stop pin* can move freely in both directions and the *bracket* works as it is supposed to.	 xx1000000222

3.3.9 Inspecting additional mechanical stops

Location of additional mechanical stops

The figure shows the location of the additional stops.



xx0800000273

A	Movable mechanical stop. Limited to: • -126° (Type C and Type D) • -129° (other design than Type C and Type D)
B	Movable mechanical stop. Limited to: • +13.5° (Type C and Type D) • +16.5° (other design than Type C and Type D)
C	Movable mechanical stop. Limited to: • -13.5° (Type C and Type D) • -16.5° (other design than Type C and Type D)
D	Attachment screws
E	Washers

Required equipment

Equipment etc.	Note
Mechanical stop set, axis 1	Includes: • Stop • Attachment screws plus washers • Document for movable mechanical stop For spare part number see *Spare part lists on page 391*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Continues on next page

Equipment etc.	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Inspecting additional mechanical stops

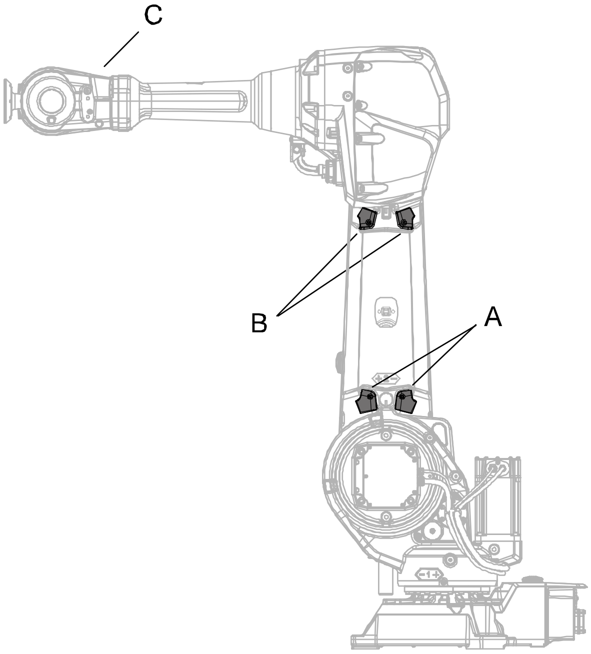
Use this procedure to inspect the additional mechanical stops on axis 1.

	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.	
2	Check the *additional mechanical stops* on axis 1 for damage.	See the figure in: • *Location of additional mechanical stops on page 138*
3	Make sure the stops are properly attached.	Tightening torque: • 82 Nm
4	If any damage on stops or attachment screws etc. is detected, the *mechanical stops* must be replaced!	Attachment screws: • M12x40, quality 8.8-A3F • 2 pcs/stop lug

3.3.10 Inspecting dampers

Location of dampers

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



xx0800000297

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

Required equipment

Equipment	Spare part no.	Note
Damper	See *Spare part lists on page 391*.	
Standard toolkit	-	Content is defined in section *Standard tools on page 386*.

Inspecting dampers

Use this procedure 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.	

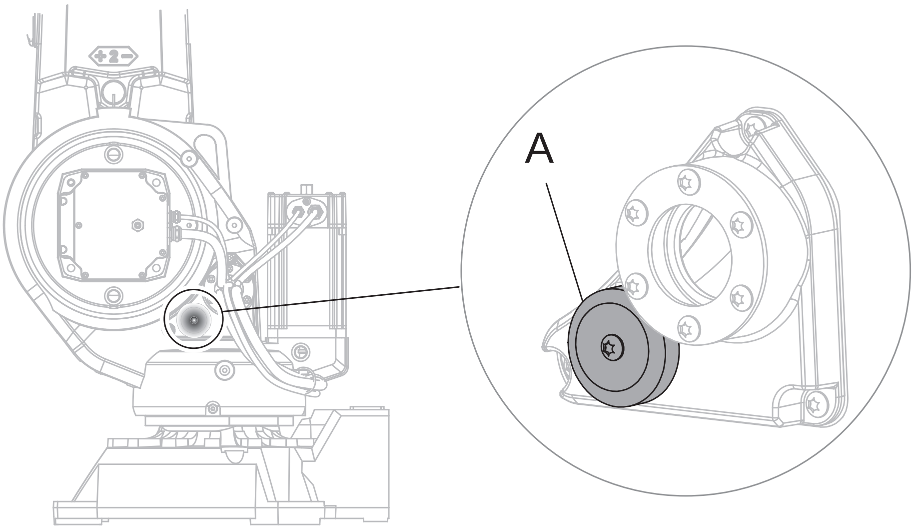
Continues on next page

	Action	Note
2	Check all *dampers* for damage or cracks.	See the figure in: • *Location of dampers on page 140*
3	Check all dampers for existing impressions larger than 2-3 mm.	
4	Check attachment screws for deformation.	
5	If any damage is detected the damper must be replaced.	

3.3.11 Inspecting the pressure relief valve

Location of the pressure relief valve

The figure shows the location of the pressure relief valve.



xx0900000131

A	Pressure relief valve

Required equipment

Equipment	Note
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Inspecting pressure relief valve

Use this procedure to inspect the pressure relief valve.

	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	**DANGER** It is important to keep the pressure relief valve open and clean. If the air pressure is stopped up, too much pressure can be built up which can be hazardous.	

Continues on next page

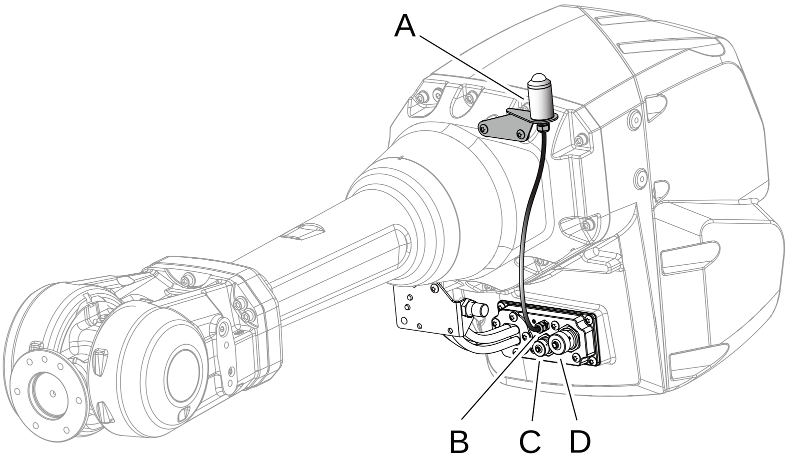
	Action	Note
3	Check if the pressure relief valve is contaminated or covered with litter.	
4	Clean if necessary. **Note** Use a cloth or a brush.	

3.3.12 Inspecting Signal lamp (option)

Location of signal lamp

Signal lamp is an option.

Located as shown in the figure.



xx0800000290

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

Required equipment

Equipment	Note
Signal lamp	For spare parts no. see Spare parts - *Spare parts options* in *Product manual, spare parts - IRB 2600*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Inspecting signal lamp

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

Note

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

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

Continues on next page

	Action	Note
2	If the signal lamp is not lit, continue tracing the fault with the steps below.	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Check whether the signal lamp is broken. If so, replace.	
5	Check the cable connections.	
6	Measure the voltage in connectors, motor axis 3.	24V
7	Check the cabling. If a fault is detected, replace.	
8	Seal and paint the joints that have been opened. Also repair possible damages of the special Foundry Prime paint coat of the robot. See *Cut the paint or surface on the robot before replacing parts on page 194*.	

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.

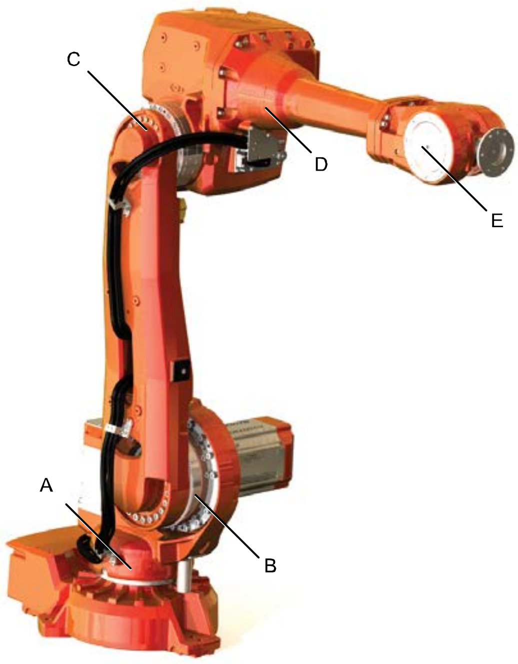
Note

The type of oil pre-filled in axis-4 gear differs from the type of oil recommended for field maintenance, due to differences in factory and customer sites prerequisites. The two types of oil are fully equal and compatible.

Use the type of oil specified in *Technical reference manual - Lubrication in gearboxes*, even though it differs from the oil specified in WebConfig.

Location of gearboxes

The figure shows the location of the gearboxes.



xx0800000311

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A	Axis-1 gearbox
B	Axis-2 gearbox
C	Axis-3 gearbox
D	Axis-4 gearbox
E	Axis-5 and -6 gearbox

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	**Type C and Type D**: Used on the axes-1 and -2 gearboxes. **Other design than Type C and Type D**: Used on the axis-2 gearbox.
Not valid for type C and Type D: Expansion container, gearbox axis 1	Used when the robot is fitted in a suspended position. (valid for other design than Type C and Type D)

3.4.2 Changing the oil, axis-1 gearbox on floor mounted robots

General

This section describes how to change the axis-1 gearbox oil in a floor mounted robot.

Note

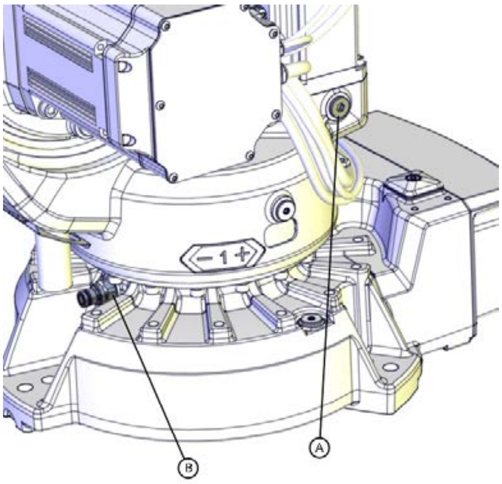
The method of changing oil on the axis-1 gearbox is different on **Type C and Type D** compared to **Other design than Type C and Type D**.

Both methods are described in this section.

Location of oil plugs

The oil plugs in axis 1 gearbox are located according to the following figures.

Type C and Type D



xx1200000632

A	Oil plug, filling and inspection
B	Oil plug, draining (Also used for filling if an oil dispenser is used.)

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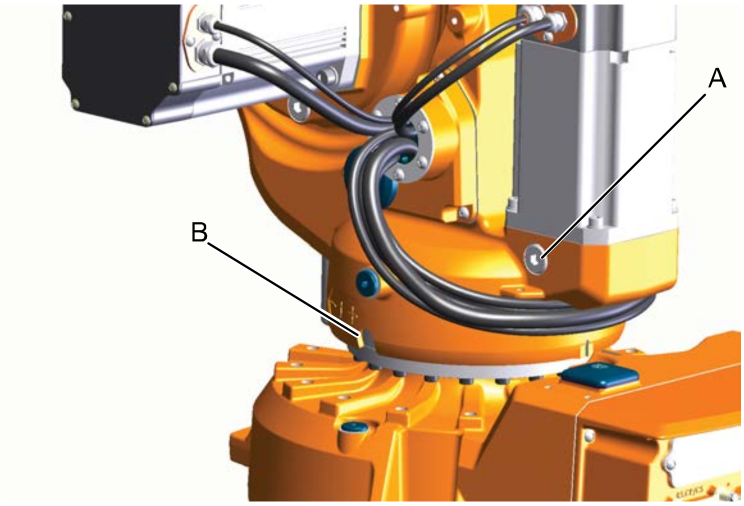
Other design than Type C and Type D

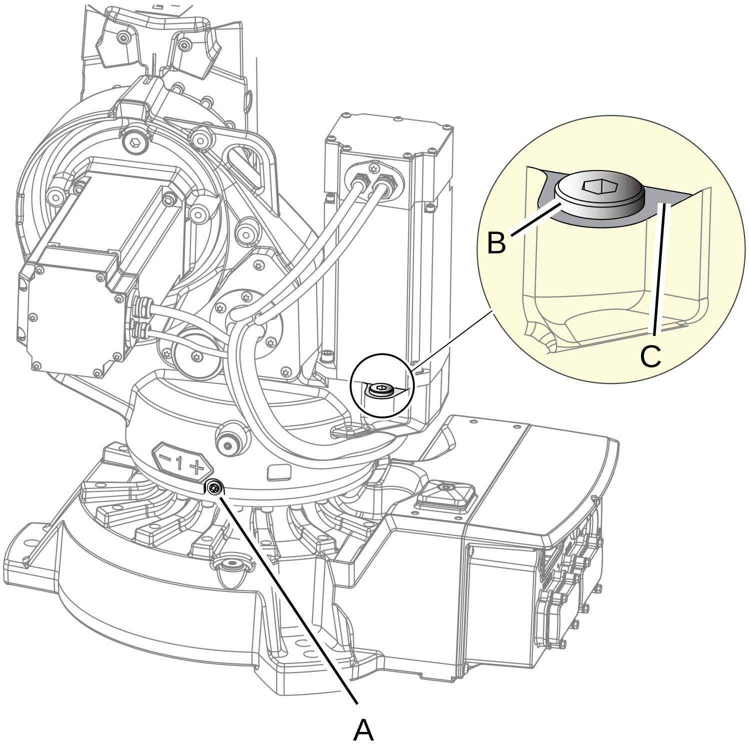
Type A



xx0800000304

A	Oil plug, filling
B	Oil plug, draining

Type B



xx1000000669

A	Oil plug, draining
B	Oil plug, filling
C	Surface for motor flange

Continues on next page

Required equipment

Equipment	Note
Only valid for Other design than Type C and Type D: Oil plug sealing washer, gearbox	3HAC029646-001
Lubricating oil	See section *Type of lubrication in gearboxes on page 146*
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Oil dispenser	One example of oil dispenser can be found in section: • *Type of lubrication in gearboxes on page 146*
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Draining, axis-1 gearbox

Use this procedure to drain the gearbox of oil.

> **Tip**
>
> In order to save time, a pneumatic oil dispenser can be used to suck out the oil from the gearbox. Follow the instructions below!

	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	**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
4	Put an *oil collecting vessel* as close as possible to the draining hole placed in: • **Type C and Type D**: the base. • **Other design than Type C and Type D**: the gearbox.	For the capacity of vessel, see section: • *Type of lubrication in gearboxes on page 146*
5	**Only valid for Other design than Type C and Type D**: Replace *oil plug draining* quickly with a nipple (M10x1.5) where a draining hose is fitted.	See the figure in: • *Location of oil plugs on page 148* **Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
6	Connect the *oil dispenser*.	One example can be found in section: • *Type of lubrication in gearboxes on page 146*
7	Open the *oil plug filling*. **WARNING** If the oil plug filling is not open when the oil dispenser is working, there is a risk of damaging vital parts in the gearbox!	See the figure in: • *Location of oil plugs on page 148*
8	Using a low air pressure, start sucking the oil out from the gearbox with the oil ejector equipment.	
9	**Only valid if an oil dispenser is not used**: If an oil dispenser is not used, open the oil plug draining and drain oil into an oil collecting vessel.	**Note** Time consuming activity!
10	**WARNING** Used oil is hazardous material and must be disposed of in a safe way. See section *Decommissioning on page 371* for more information.	
11	**Note** There will be some oil left in the gearbox after draining.	
12	Refit the *oil plug draining*. **Note** **Only valid for Other design than Type C and Type D**: Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	See the figure in: • *Location of oil plugs on page 148* Tightening torque: • **Other design than Type C and Type D**: 3-8 Nm **Type C and Type D**: 24 Nm

Continues on next page

Filling oil, axis-1 gearbox

Use this procedure to fill the gearbox with oil.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
3	**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.	
4	Open the *oil plug, filling*.	See the figure in; • *Location of oil plugs on page 148*
5	Refill the gearbox with *lubrication oil*. **Note** The exact amount of oil to be filled depends on the amount previously being drained.	The type and amount of oil in the gearbox is detailed in section: • *Type of lubrication in gearboxes on page 146*
6	Inspect the oil level.	How to inspect the oil level is described in section: • *Inspecting oil level, axis 1 gearbox on page 112*
7	Refit the *oil plug*. **Note** **Only valid for Other design than Type C and Type D:** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 24 Nm

3.4.3 Changing the oil, axis-1 gearbox on suspended robots

General

This section describes how to change the axis-1 gearbox oil in a suspended robot.

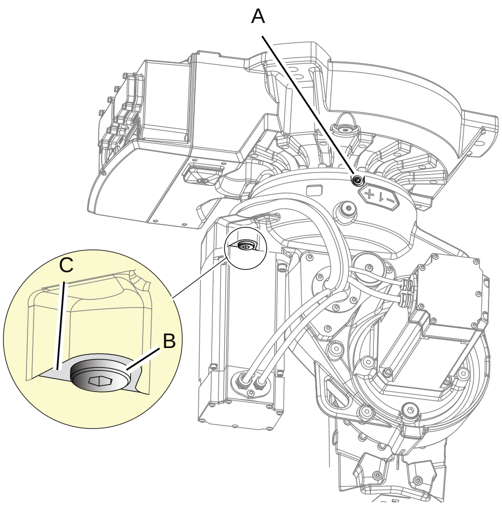
> **Note**
>
> The method of changing oil on the axis-1 gearbox is different on **Type C and Type D** compared to **Other design than Type C and Type D**.

> **Note**
>
> **Only valid for Type C and Type D!**
>
> If the robot has design Type C or Type D, the basic method for changing oil in a suspended robot is to fill the same amount of oil that has been drained.
>
> Measure the amount of oil drained and record the result. The same amount will be added later.

Location of oil plugs

The oil plugs in axis 1 gearbox are located according to the following figures

Type C and Type D

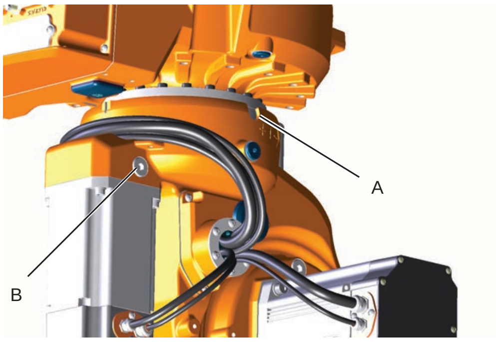


xx1000001436

A	Oil plug for filling and venting
B	Oil plug for draining
C	Motor flange

Continues on next page

Other design than Type C and Type D



xx1200000883

- A Oil plug, venting
- B Oil plug, draining and filling

Required equipment

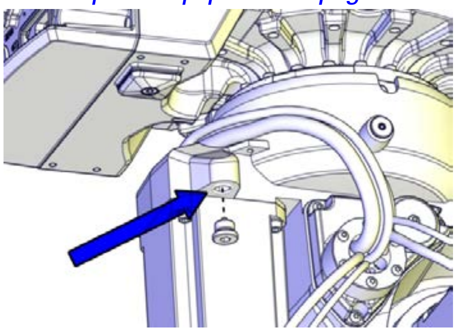
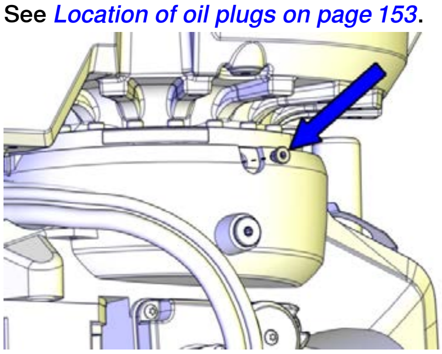
Equipment	Note
Only valid for Other design than Type C and Type D: Oil plug sealing washer, gearbox	3HAC029646-001
Lubricating oil	See section *Type of lubrication in gearboxes on page 146*
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Oil dispenser	One example of oil dispenser can be found in section: • *Type of lubrication in gearboxes on page 146*
Oil change equipment	
Hose	Used with the oil dispenser
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Draining, axis-1 gearbox

Use this procedure to drain the gearbox of oil.

> **Tip**
>
> In order to save time, a pneumatic oil dispenser can be used to suck the oil out from the gearbox.

Continues on next page

	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	**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.	
4	Connect the *oil dispenser* to the *oil plug for draining*.	See *Required equipment on page 154*.  xx1800001271
5	Put the end of the hose in an *oil collecting vessel*.	The capacity of the vessel must be sufficient to take the complete amount of oil.
6	Open the end plug of the hose.	
7	Open the *oil plug, venting*.	See *Location of oil plugs on page 153*.  xx1800001272

Continues on next page

	Action	Note
8	Using a low air pressure, start sucking the oil out from the gearbox with the oil change equipment.	
9	**WARNING** Used oil is hazardous material and must be disposed of in a safe way. See section *Decommissioning on page 371* for more information.	
10	Let the oil drain until the gearbox is empty. **Note** There will be some oil left in the gearbox after draining. Measure the volume of the drained oil in the vessel.	**Tip** Make a note how much oil was drained. The same amount shall later be refilled.
11	Remove the hose and clean it.	

Filling oil, axis-1 gearbox

Use this procedure to fill the gearbox with oil.

Note

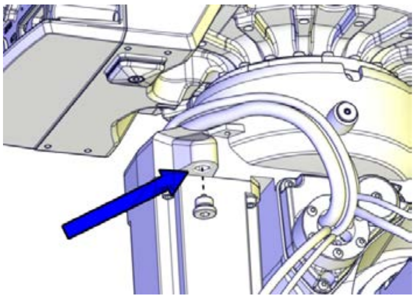
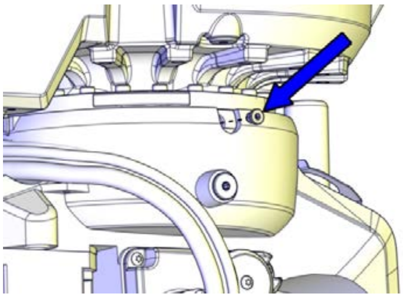
Only valid for Type C and Type D!

The basic method to change oil in a suspended robot of this type, when still mounted in a suspended position, is to fill the same amount of oil that was drained.

The only way to inspect the oil level after some repair work, is to make a note how much oil was drained and to refill with the same amount. If in doubt, the suspended robot must be dismantled from its inverted position and the oil being inspected with the robot in a floor mounted position.

	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*.	

Continues on next page

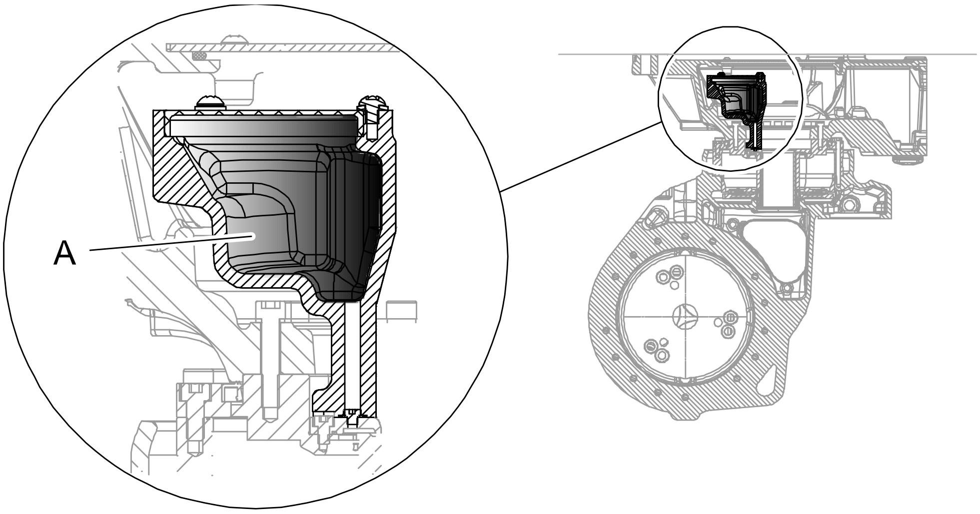
	Action	Note
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Verify that the hose of the oil change equipment is clean and then fit the quick connection to the *oil plug for filling*.	 xx1800001271
5	Open the oil *plug for venting*.	 xx1800001272
6	Prepare oil change equipment with the same amount of *lubrication oil* that was drained. **Note** The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 146*.
7	Inspect the oil level.	How to inspect the oil level is described in section: • *Inspecting oil level, axis 1 gearbox on page 112*
8	Disconnect the oil change equipment and put on the protective hood on the oil plug.	
9	Refit the *oil plug for venting*. **Note** **Only valid for Other design than Type C and Type D:** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • **Other design than Type C and Type D**: 3-8 Nm **Type C and Type D**: 24 Nm

Continues on next page

Expansion container axis-1 gearbox, suspended mounted robots

> **Note**
>
> **Not valid for Type C and Type D!**
>
> Expansion container is not needed on **Type C and Type D.**

When the robot is fitted in a suspended mounted position, an expansion container for oil must be fitted on gearbox axis 1.



xx0900000129

A	Expansion container

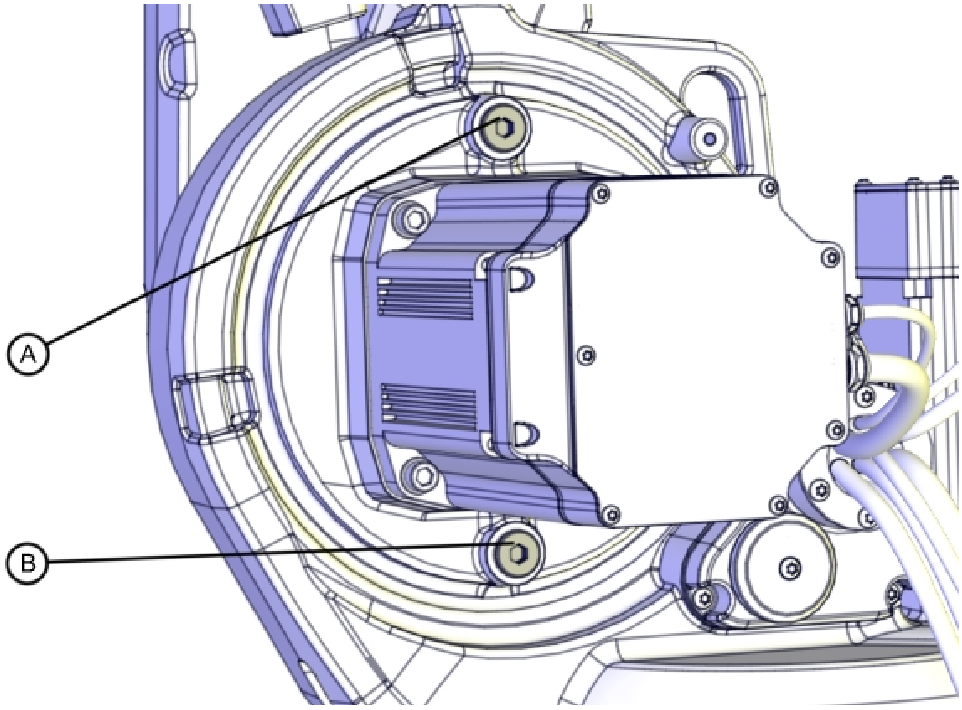
> **Note**
>
> The expansion container is installed on delivery on the robot if ordered as option suspended/inverted mounted. If a floor mounted robot shall be fitted in a suspended mounted position, an expansion container must be installed. See *Installing an expansion container on page 90*.

3.4.4 Changing the oil, axis-2 gearbox

Location of oil plugs

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

Oil plugs are shown in the figure.



xx0800000305

A	Oil plug, filling (draining when suspended mounted)
B	Oil plug, draining (filling when suspended mounted) (Quick connect fitting)

Required equipment

Equipment	Note
Only valid for Other design than Type C and Type D: Oil plug sealing washer, gearbox	3HAC029646-001
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 146*.
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Nipple (TEMA IF 3820 S06)	To be fitted on a hose, and then used for draining connected to the *quick connect fitting*. See *Location of oil plugs on page 159*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Continues on next page

Draining, axis-2 gearbox

Use this procedure to drain the gearbox of oil.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
3	**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.	
4	Either • connect a nipple to the *quick connect fitting* in the hole for draining or • remove the *quick connect fitting*.	See the figure in: • *Location of oil plugs on page 159*
5	Open the *oil plug, filling*.	See the figure in: • *Location of oil plugs on page 159* **Note** Drainage will be quicker if the oil plug, filling is removed.
6	Drain the gearbox oil using an *oil collecting vessel*.	**Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
7	**WARNING** Used oil is hazardous material and must be disposed of in a safe way. See section *Decommissioning on page 371* for more information.	

Continues on next page

	Action	Note
8	**Note** There will be some oil left in the gearbox after draining.	
9	Refit *oil plug*. **Note** **Only valid for Other design than Type C and Type D:** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 24 Nm

Filling oil, axis-2 gearbox

Use this procedure to fill the gearbox with oil.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
3	**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.	
4	Open *oil plug, filling*.	See the figure in: • *Location of oil plugs on page 159*
5	Refill the gearbox with *lubrication oil*. **Note** The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 146*.

Continues on next page

	Action	Note
6	Inspect the oil level.	How to inspect the oil level is described in section: • *Inspecting the oil level, axis 2 gearbox on page 119*
7	Refit *oil plug*. **Note** **Only valid for Other design than Type C and Type D:** Before refitting the oil plug in the gearbox, always replace the oil plug sealing washer with a new one. If not there is a risk of leakage.	Tightening torque: • 24 Nm

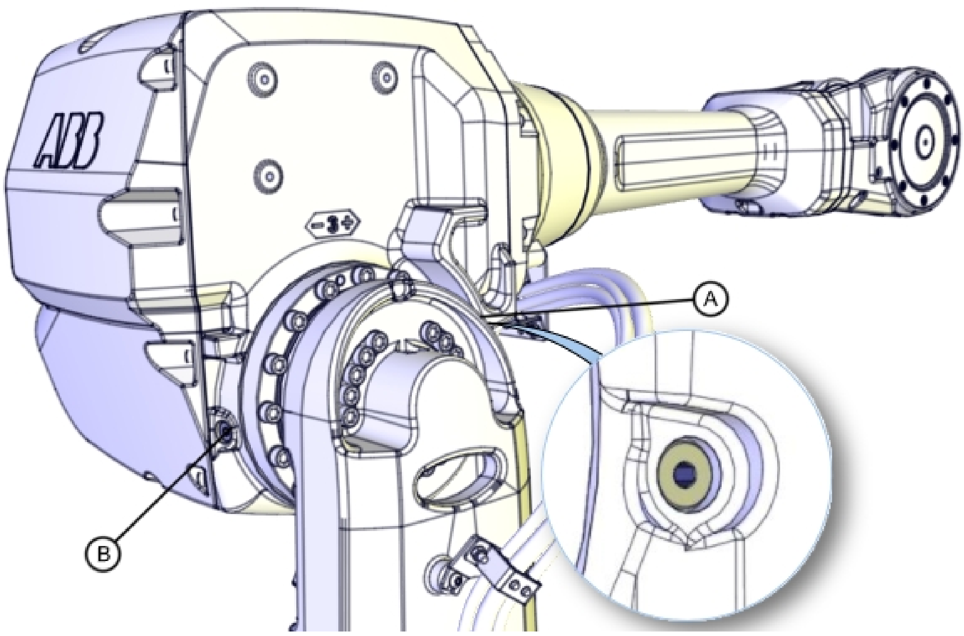
3.4.5 Changing the oil, axis-3 gearbox

Location of oil plugs

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

Oil plugs are shown in the figure.

Type C and Type D



xx1200000633

A	Oil plug, armhouse (not visible in this figure)
B	Oil plug, armhouse

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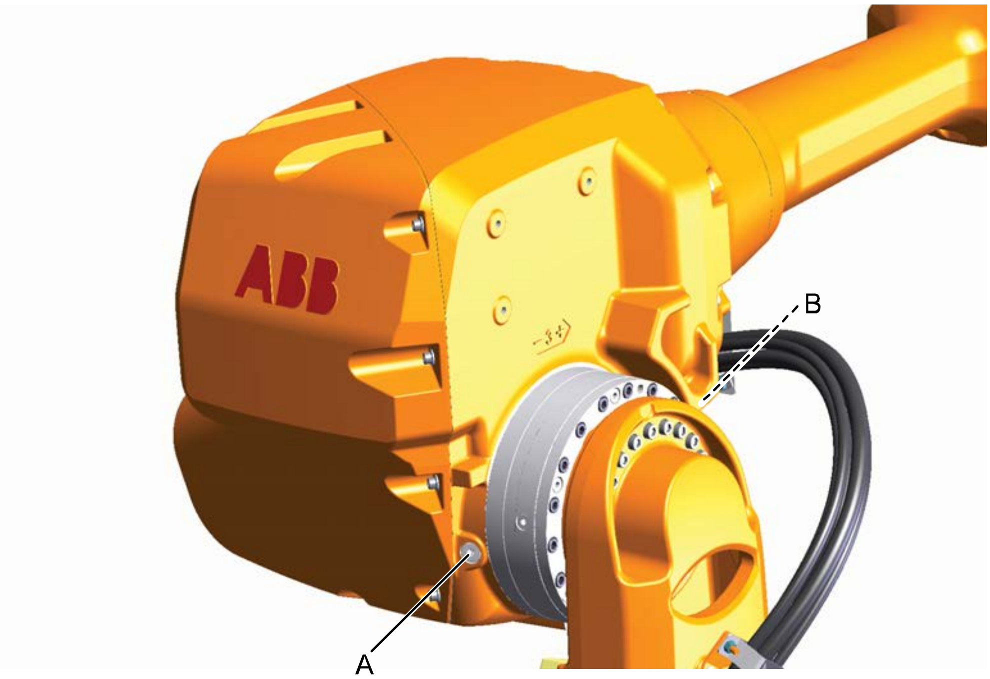
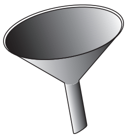
Other design than Type C and Type D



xx0800000306

A	Oil plug, armhouse
B	Oil plug, gearbox (not visible in this figure)

Required equipment

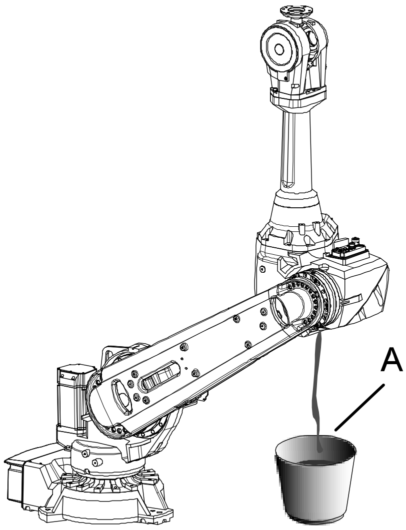
Equipment	Note
Lubricating oil	Information about the oil is found in *Technical reference manual - Lubrication in gearboxes*. See *Type and amount of oil in gearboxes on page 146*.
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Oil dispenser	One example of oil dispenser can be found in section: • *Type of lubrication in gearboxes on page 146*
Funnel	 xx1200000862
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Continues on next page

Draining, axis-3 gearbox

Use this procedure to drain the gearbox of oil.

There is an alternative method to drain the gearbox. See *Draining - alternative method on page 166*.

	Action	Note
1	Move the robot to an upright position as shown in the figure.	 xx0800000327 • A: Oil collecting vessel
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
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.	
5	Open the *oil plug, armhouse*	See the figure in: • *Location of oil plugs on page 163*
6	**Type C and Type D**: Open the other oil plug in the *armhouse* and use it as a ventilation hole. **Other design than Type C and Type D**: Open the *oil plug, gearbox* and use it as a ventilation hole.	See the figure in: • *Location of oil plugs on page 163*

Continues on next page

	Action	Note
7	Drain the gearbox oil using an *oil collecting vessel*.	**Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
8	**WARNING** Used oil is hazardous material and must be disposed of in a proper way. See section *Decommissioning* for more information.	
9	Refit oil plugs.	Tightening torque: **Other design than Type C and Type D**, in armhouse: 10 Nm **Other design than Type C and Type D**, in gearbox: 3 Nm **Type C and Type D**, both plugs: 10 Nm

Draining - alternative method

Use this procedure to drain the oil from the gearbox, as an alternative method.

If this method is used, oil must be sucked out of the gearbox using an oil dispenser.

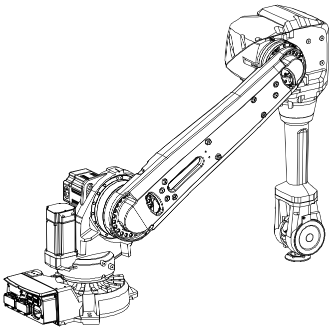
	Action	Note
1	Move the upper arm of the robot to a position where the *oil plug, gearbox* is pointing at the floor.	See the figure in: • *Location of oil plugs on page 163*
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**CAUTION** The gearbox can contain an *excess of pressure* that can be hazardous. Open the oil plug carefully in order to let out the excess pressure.	
4	Use an *oil dispenser* fitted to the *oil plug, gearbox* to drain the oil.	An example of oil dispenser is detailed in section: • *Type of lubrication in gearboxes on page 146* See the figure in: • *Location of oil plugs on page 163*
5	Replace the *oil plug, gearbox* with a nipple where a draining hose is fitted.	See the figure in: • *Location of oil plugs on page 163*

Continues on next page

	Action	Note
6	Connect the *oil dispenser*.	One example can be found in section: • *Type of lubrication in gearboxes on page 146*
7	Open the *oil plug, armhouse* now pointing upwards and use it as a ventilation hole.	See the figure in: • *Location of oil plugs on page 163* **WARNING** The oil plug, gearbox must be open when the oil dispenser equipment is used! Otherwise sealings and other parts will be damaged.
8	Start sucking the oil out from the gearbox with the oil ejector equipment.	For capacity of the vessel see section: • *Type of lubrication in gearboxes on page 146*
9	**WARNING** Used oil is hazardous material and must be disposed of in a proper way. See section *Decommissioning* for more information.	
10	**Note** There will be some oil left in the gearbox after draining!	
11	Refit the *oilplugs*.	See the figure in: • *Location of oil plugs on page 163* Tightening torque: **Other design than Type C and Type D**, in armhouse: 10 Nm **Other design than Type C and Type D**, in gearbox: 3 Nm **Type C and Type D**, both plugs: 10 Nm

Filling oil, axis-3 gearbox

Use this procedure to fill the gearbox with oil.

	Action	Note
1	Move the upper arm to a position where the wrist is pointing towards the floor as shown in the figure.	 xx0800000329

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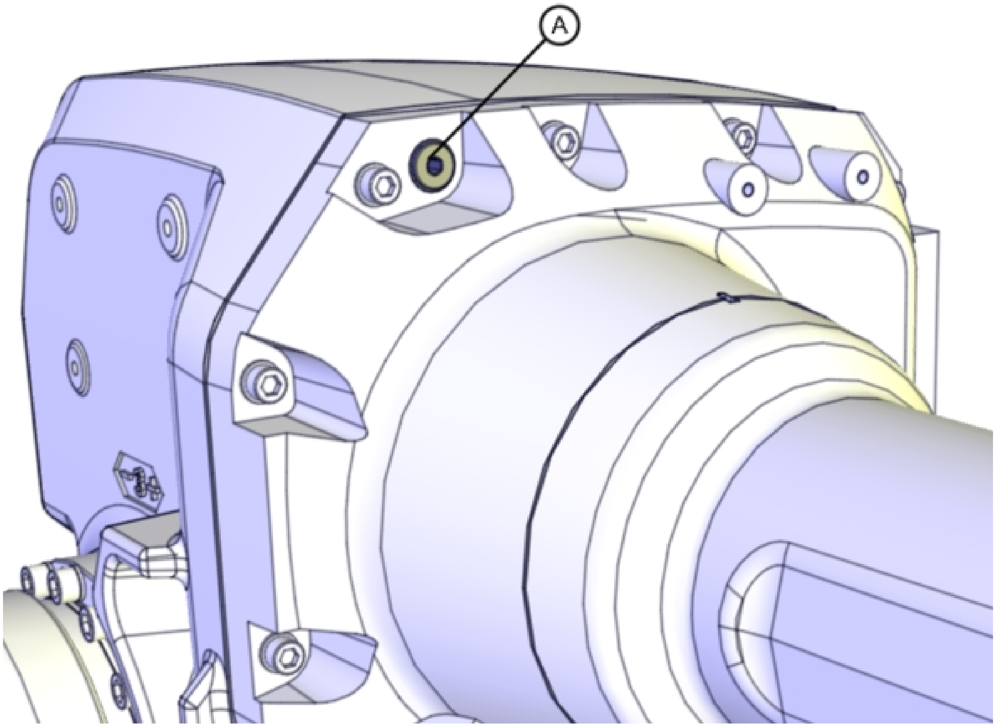
	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
4	**CAUTION** 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.	
5	Open the *oil plug, armhouse*.	See the figure in: • *Location of oil plugs on page 163*
6	Refill the gearbox with *lubricating oil*. **Tip** Use a funnel. **Note** The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 146*.
7	Inspect the *oil level*.	How to inspect oil is described in section: • *Inspecting the oil level, axis 3 gearbox on page 121*
8	Refit the *oil plug*.	Tightening torque: **Other design than Type C and Type D**, in armhouse: 10 Nm **Other design than Type C and Type D**, in gearbox: 3 Nm **Type C and Type D**, both plugs: 10 Nm

3.4.6 Changing the oil, axis-4 gearbox

Location of oil plugs

The axis-4 gearbox is located in the front of the upper armhouse.

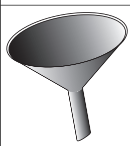
The oil plug is shown in the figure.



xx0800000307

A	Oil plug, for filling and draining

Required equipment

Equipment	Note
Lubricating oil	Where to find information of the *type of oil*, *article number* and the *amount* in the gearbox, see section *Type of lubrication in gearboxes on page 146*
Oil collecting vessel	The capacity of the vessel must be sufficient to take the complete amount of oil.
Plastic hose	Used for venting the gearbox during draining. A suitable hose would be a hose normally used for compressed air. Length: minimum 300 mm. Diameter: 5 mm.
Funnel	 xx1200000862

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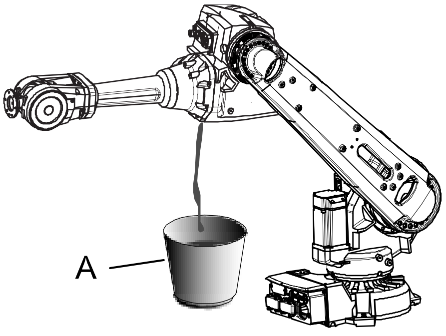
Equipment	Note
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Draining oil

Use this procedure to drain oil from the gearbox.

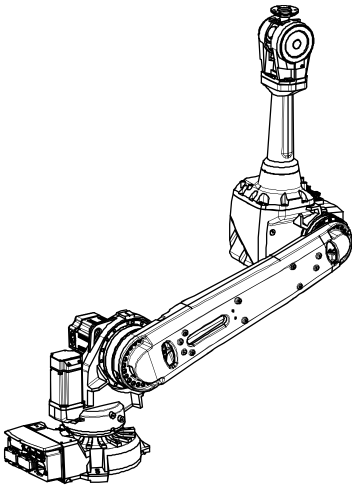
	Action	Note
1	Move the robot to the position shown in the figure.	 xx0800000328 • A: Oil collecting vessel
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
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.	
5	Open *oil plug, draining*.	See the figure in: • *Location of oil plugs on page 169*

Continues on next page

	Action	Note
6	Drain the gearbox oil using an *oil collecting vessel*. **Tip** Insert a compressed air hose approximately 100 mm into the gearbox, to vent the gearbox. This speeds up the draining significantly.	**Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
7	**WARNING** Used oil is hazardous material and must be disposed of in a safe way. See section *Decommissioning on page 371* for more information.	
8	Refit the oil plug.	Tightening torque: 10 Nm.

Filling oil

Use this procedure to fill oil in the gearbox.

	Action	Note
1	Move the upper arm to the position shown in the figure.	 xx0800000330
2	**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
3	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
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.	
5	Open the *oil plug, filling*.	See the figure in: • *Location of oil plugs on page 169*
6	Refill the gearbox with *lubricating oil*. **Tip** Use a funnel. **Note** The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 146*.
7	Refit the *oil plug*.	Tightening torque: 10 Nm.

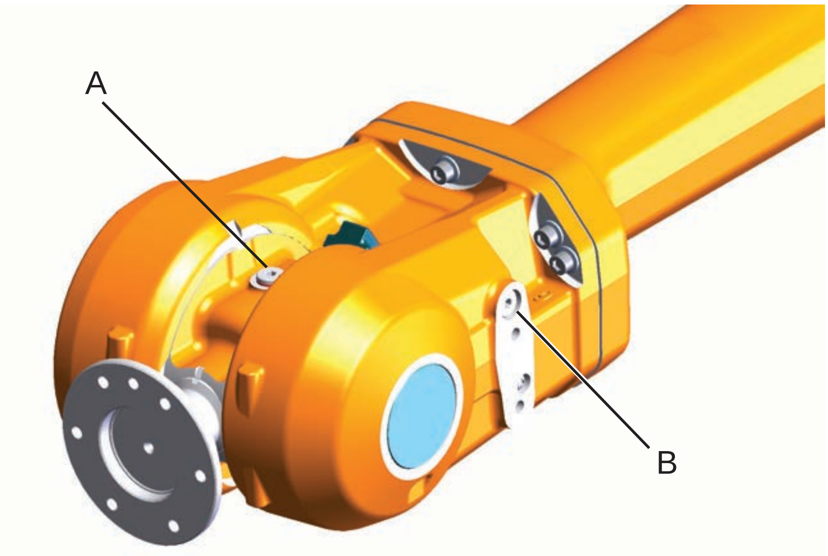
3.4.7 Changing oil, axes-5 and -6 gearboxes

Location of oil plugs

The axes-5 and -6 gearboxes are located in the wrist unit.

The oil plug is shown in the figure.

The figure shows wrist variant 60 kg



xx0800000308

A	Oil plug, tilthouse
B	Oil plug, wrist unit (also used as air inlet when draining from oil plug A)

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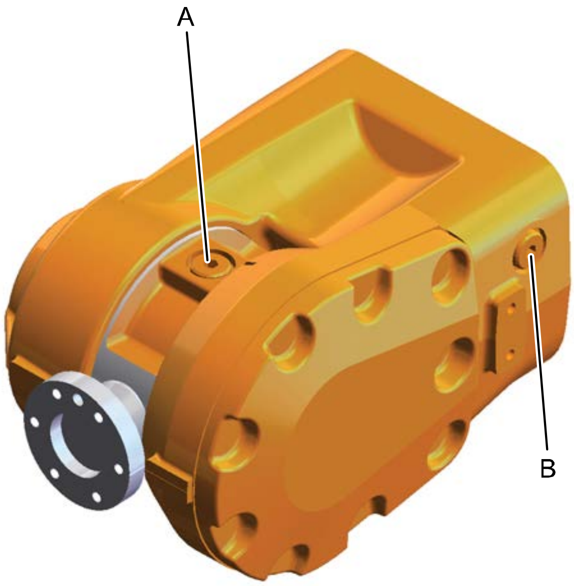
The figure shows wrist variant 12/20 kg



xx0900000139

A	Oil plug, tilthouse
B	Oil plug, wrist (also used as air inlet when draining from oil plug A)

Note

The gearboxes for axes-5 and -6 are the same.

Required equipment

Equipment	Note
Lubrication oil	Where to find information of the *type of oil*, *article number* and the *amount* in the gearbox, see section: *Type of lubrication in gearboxes on page 146*
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 386*.

Draining axes-5 and -6 gearbox - wrist 60 kg

Use this procedure to drain oil from the gearbox.

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.

	Action	Note
1	Move the *upper arm* to a position where it points downwards.	

Continues on next page

	Action	Note
2	Move axis 5 to a position where the *oil plug, tilthouse* points downwards.	The turning disk shall be in a horisontal 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	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
5	Put an *oil collecting vessel* under the wrist in order to collect drained oil.	The capacity of the vessel must be sufficient to take the complete amount of oil.
6	Open the *oil plug, tilthouse*.	See the figure in: • *Location of oil plugs on page 173*
7	Open the oil plug, wrist (air inlet). This is done for the ventilation of the gearbox and to fascilitate draining.	See the figure in: • *Location of oil plugs on page 173*
8	Drain the gearbox.	**Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.
9	**WARNING** Used oil is hazardous material and must be disposed of in a safe way. See section *Decommissioning on page 371* for more information.	

Draining axes-5 and -6 gearbox - wrist 12/20 kg

Use this procedure to drain oil from the gearbox.

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.

	Action	Note
1	Move the upper arm to a horizontal position.	

Continues on next page

	Action	Note
2	Turn axis-4 to the calibration position.	See the figure in *Location of oil plugs on page 173*.
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
5	Remove the *oil plugs* in the wrist.	See the figure in *Location of oil plugs on page 173*.
6	Turn axis-4 through so that the oil plug on the side of the wrist points downwards.	
7	Then turn axis-4 another 90°.	
8	Let the remaining oil run out through the oil plug hole, tilthouse.	

Filling oil axes-5 and -6 gearbox - wrist 60 kg

Use this procedure to fill oil in the gearbox.

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.

	Action	Note
1	Move the upper arm to a position where the *oil plug, wrist* points upwards.	See the figure in: • *Location of oil plugs on page 173*
2	Move axis-5 to a position where the *oil plug, tilthouse* points upwards.	See the figure in: • *Location of oil plugs on page 173*
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	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
5	Open *oil plug, wrist*.	See the figure in: • *Location of oil plugs on page 173*
6	Open *oil plug, tilthouse*.	See the figure in: • *Location of oil plugs on page 173*
7	Refill oil using *oil plug, wrist*. **Note** There will be some oil left in the gearbox after draining.	There will be oil left in the gearbox after draining. Therefore the amount of oil filled will be less than the total amount. When filling oil in a wrist (60 kg) begin by only filling 1.500 ml. Check oil level. If needed add more oil.
8	Refill the gearbox with *lubrication oil*. **Note** The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 146*.
9	Inspect the *oil level*.	How to inspect the oil level is described in section: • *Inspecting oil level, gearbox axes 5 - 6 on page 126*
10	Refit both oil plugs.	Tightening torque: • 10 Nm

Filling oil axes-5 and -6 gearbox - wrist 12/20 kg

Use this procedure to fill oil in the gearbox.

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.

	Action	Note
1	Run the upper arm to a horizontal position.	
2	Turn axis-4 to the calibration position.	
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	**WARNING** Handling gearbox oil involves several safety risks, see *Gearbox lubricants (oil or grease) on page 36*.	
5	Open the *oil plug, tilthouse*.	See in figure: • *Location of oil plugs on page 173*
6	Refill the gearbox with *lubrication oil*. **Note** The amount of oil to be filled depends on the amount previously being drained.	Where to find type of oil and total amount is detailed in *Type and amount of oil in gearboxes on page 146*.
7	Inspect the oil level.	How to inspect the oil level is described in section: • *Inspecting oil level, gearbox axes 5 - 6 on page 126*
8	**Note** If the robot is fitted in a suspended position, the wrist should be turned 180°.	
9	Refit the oil plugs.	Tightening torque: • 10 Nm

3.4.8 Replacing SMB battery

Note

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

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

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

WARNING

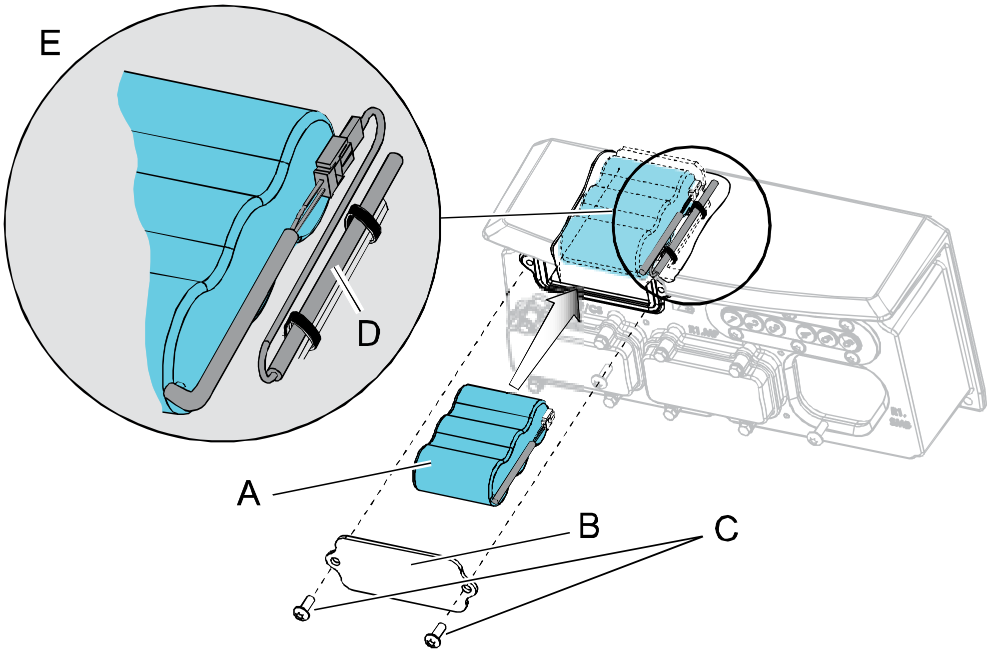
See *Hazards related to batteries on page 37*.

Continues on next page

Location of SMB battery

The SMB battery is located at the base of the robot, as shown in the figure.

DSQC 633A

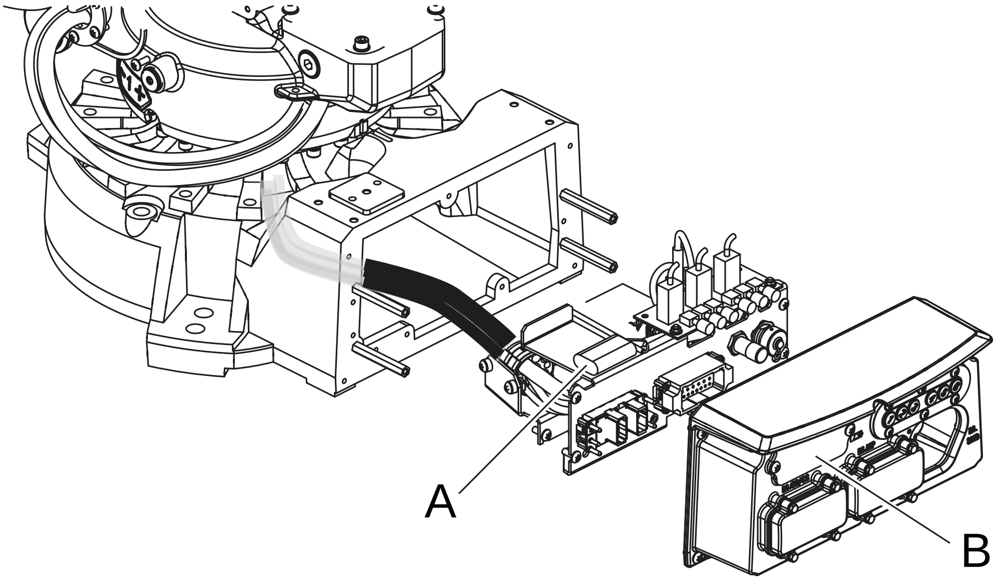


xx0800000322

A	SMB battery (2-pole battery contact)
B	Battery cover
C	Attachment screws
D	SMB battery cable
E	How to arrange the battery cable

Continues on next page

RMU 101



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A	SMB battery (3-pole battery contact)
B	Battery cover

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	Note
SMB battery pack	Battery includes protection circuits. Replace it only with given spare part no. or an ABB approved equivalent. See *Spare part lists on page 391*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Circuit diagram	See chapter *Circuit diagram on page 393*.

Removing SMB battery

Use this procedure to remove the SMB battery.

	Action	Note
1	Move the robot to its calibration position.	This is done in order to facilitate the updating of the revolution counter.

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	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *The unit is sensitive to ESD on page 53*	
4	Remove the *SMB battery cover*. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	See the figure in *Location of SMB battery on page 180*.
5	Pull out the *SMB battery*.	See the figure in *Location of SMB battery on page 180*.
6	Disconnect the *battery cable* and remove the battery.	See the figure in *Location of SMB battery on page 180*.
7	How to dispose of the used SMB battery, see chapter *Decommissioning on page 371*.	

Refitting SMB battery

Use this procedure to refit the SMB battery.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit please read the safety information in the section *The unit is sensitive to ESD on page 53*	
3	Reconnect the *battery cable* to the *SMB battery*.	See the figure in *Location of SMB battery on page 180*.

Continues on next page

	Action	Note
4	Put the battery unit into its recess while arranging the SMB cables as shown in the figure.	See the figure in *Location of SMB battery on page 180*.
5	Secure the *SMB cover* with its *attachment screws*.	See the figure in *Location of SMB battery on page 180*.
6	Update the revolution counter.	Detailed in *Updating revolution counters on IRC5 robots on page 344*.
7	**DANGER** Make sure all safety requirements are met when performing the first test run.	

3.5 Cleaning activities

3.5.1 Cleaning the IRB 4600

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 4600 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 4600.

Note

Always verify the protection type of the robot before cleaning.

Oil spills

Oil spills from gearboxes

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

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

Special cleaning considerations

This section specifies some special considerations when cleaning the robot.

- Always use cleaning equipment as specified. Any other cleaning equipment may shorten the life of the robot.
- Always check that all protective covers are fitted to the robot before cleaning.
- Never point the water jet at connectors, joints, sealings, or gaskets.
- Do not use compressed air to clean the robot.
- Never use solvents that are not approved by ABB to clean the robot.
- Do not spray from a distance closer than 0.4 m.
- Do not remove any covers or other protective devices before cleaning the robot.

Continues on next page

Cleaning methods

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

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

i Perform according to section *Cleaning with water and steam on page 185*.

Cleaning with water and steam

Instructions for rinsing with water

ABB robots with protection types *Standard*, *Foundry Plus*, *Wash*, or *Foundry Prime* can be cleaned by rinsing with water (water cleaner).[1]

The following list defines the prerequisites:

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

I Typical tap water pressure and flow

Instructions for steam or high pressure water cleaning

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

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.

1 See *Cleaning methods on page 185* for exceptions.

2 See *Cleaning methods on page 185* for exceptions.

Continues on next page

- Clean the cables if they have a crusty surface, for example from dry release agents.

Cooling fans

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

4 Repair

4.1 Introduction

Structure of this chapter

This chapter describes repair activities for the IRB 4600. 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 4600, 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 4600 is connected to power, always make sure that the IRB 4600 is connected to protective earth and a residual current device (RCD) before starting any repair work.
>
> For more information see:
>
> - *Product manual - OmniCore V250XT*
> - *Product manual - IRC5*
> - *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.

Required equipment

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

Performing a leak-down test

	Action	Note
1	Finish the refitting procedure of the motor or gear in question.	
2	Remove the 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

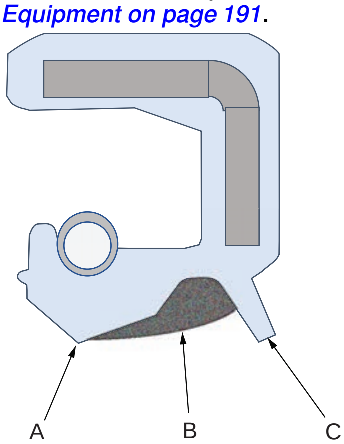
Rotating sealings

The procedure below describes 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.
- 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.

	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 191*.  xx2000000071 A Main lip B Grease C Dust lip

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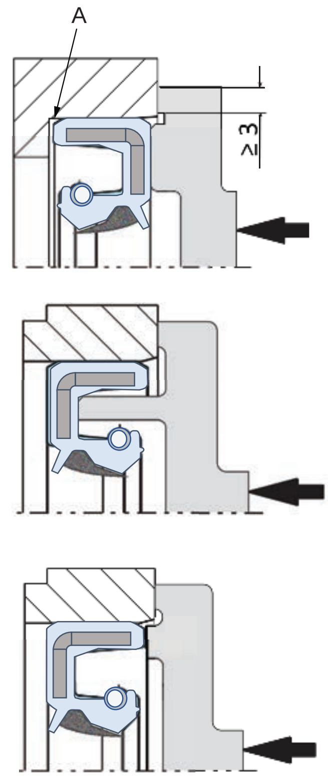
	Action	Note
4	Mount the sealing correctly with a mounting tool. Never hammer directly on the sealing as this may result in leakage.	 xx2000000072 A Gap

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, preferably with a brush.
4	Tighten the screws evenly when fastening the flange joint.

O-rings

The following procedure describes how to fit o-rings.

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

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

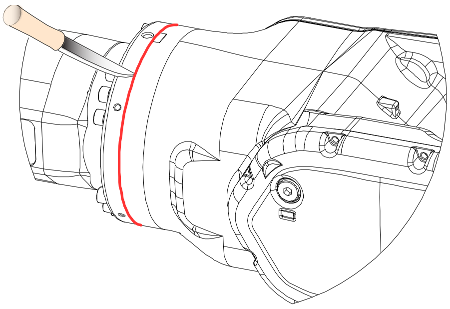
General

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

Required equipment

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

Removing

	Action	Description
1	Cut the paint with a knife in the joint between the part that will be removed and the structure, to avoid that the paint cracks.	 xx0900000121
2	Carefully grind the paint edge that is left on the structure to a smooth surface.	

4.2.5 The brake release buttons may be jammed after service work

Description

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

DANGER

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

Elimination

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

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

4.3 Complete robot

4.3.1 Removing the complete cable harness

Introduction

This procedure describes how to remove the complete cable harness.

How to refit the cable harness is described in section *Refitting the complete cable harness on page 209*.

The removal procedure is presented in the order the work is recommended to be performed. Therefore the order is different in the two procedures removal and refitting of the cable harness. Cross references will make it easy to find what is needed to know as the work continues.

The section *Removing the complete cable harness* consists of the following parts presented in the order the work is recommended to be performed:

- Removal in the *base* *Removing cable harness in base on page 199*
- Removal in the *frame* *Removing cable harness in frame on page 205*
- Removal in *lower arm* and *armhouse* *Removing cable harness in lower arm and armhouse on page 206*.

How to replace the SMB unit, brake release unit and motors can be found in:

- SMB unit *Removing the SMB unit on page 226*
- Brake release unit *Removing the brake release board on page 232*
- Motors *Removing motors on page 287*

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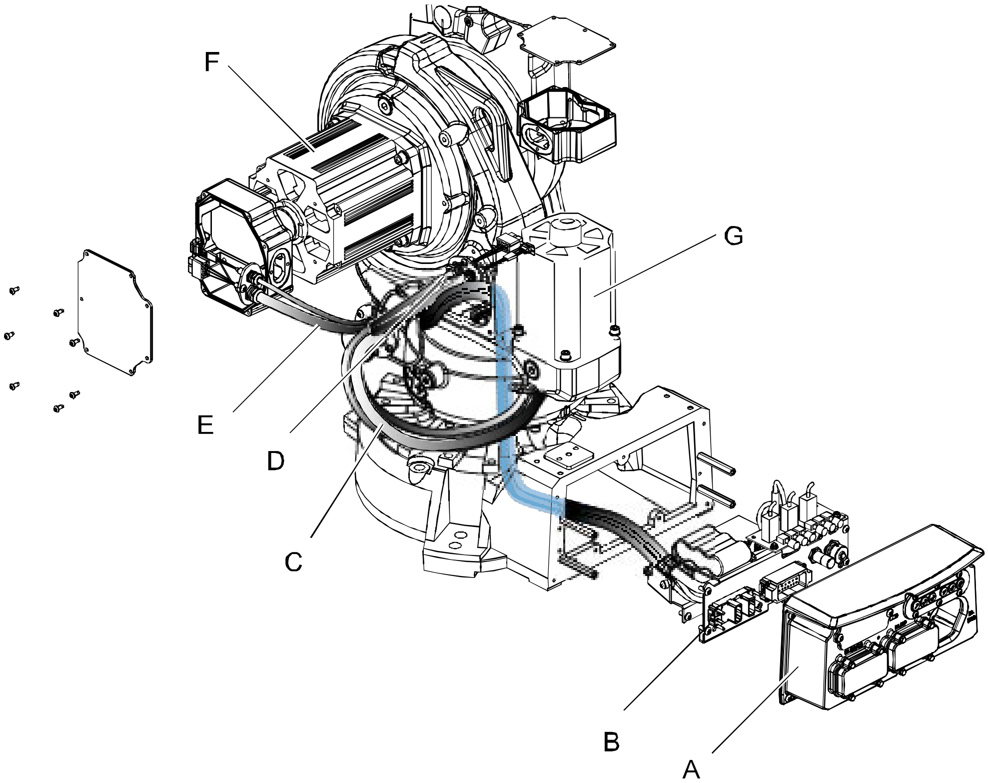
Location of the cable harness

The location of the cable harness in the base, frame and lower arm is shown in the figures.

Cable harness, base and frame.



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A	Cover base
B	Bracket
C	Cable harness
D	Axis-1 motor cable
E	Axis-2 motor cable
F	Axis-2 motor
G	Axis-1 motor

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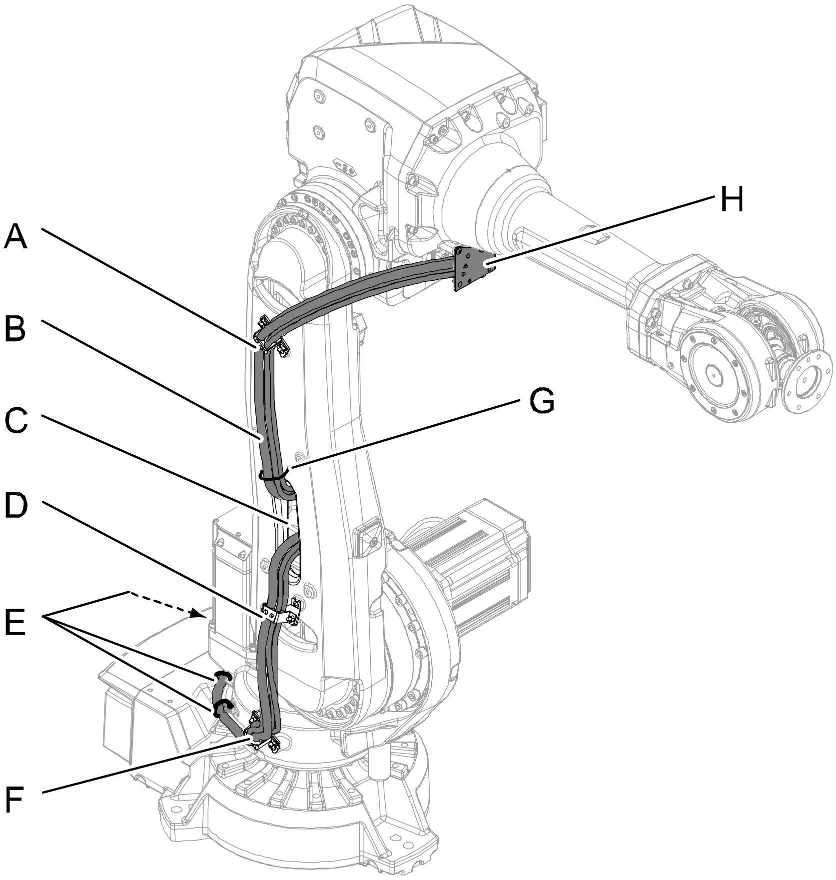
Cable harness, lower arm.



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A	Bracket, lower arm
B	Cable harness
C	Hole in lower arm
D	Bracket, lower arm
E	Cable straps, one not visible here (steel)
F	Bracket, frame
G	Cable strap, lower arm (plastic)
H	Bracket, armhouse

Required equipment

Equipment	Note
Deep well hexagon socket	Width 30 mm
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Continues on next page

Deciding calibration routine

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

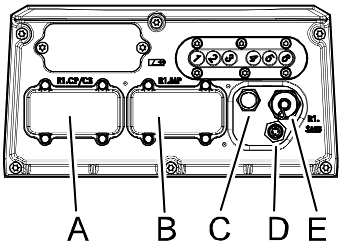
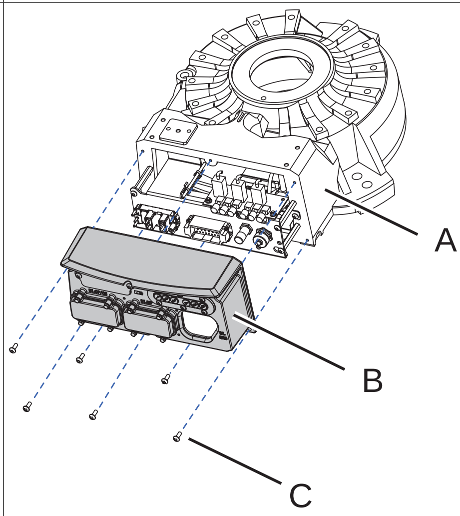
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing cable harness in base

Use this procedure to remove the cable harness in the base.

	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.	

Continues on next page

	Action	Note
3	Disconnect the following connectors on the *base cover*: • R1.CP/CS • R1.MP • R1.ETHERNET (if used) **Tip** Do not remove the *R1.SMB-connector* and *air hose connector* at this stage. It will be easier to remove these two when the cover base has been removed.	 xx0900000014 Parts: • A: R1.CP/CS • B: R1.MP • C: Air hose connector • D: Position of R1.ETHERNET (if used) • E: R1.SMB
4	Remove the *cover base*.	 xx0800000456 A Base B Cover base C Attachment screws
5	Disconnect connectors on the brake release unit: • X8 • X9 • X10	

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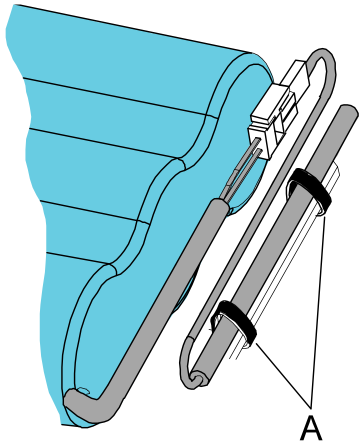
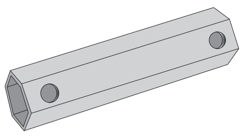
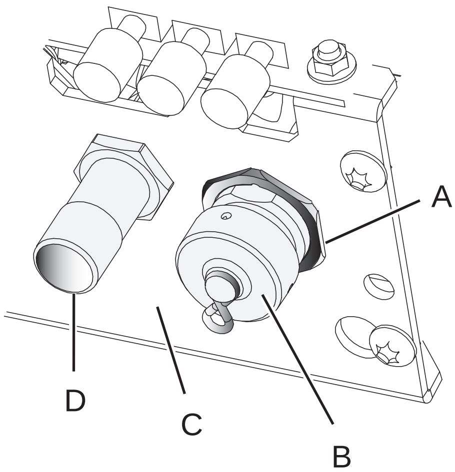
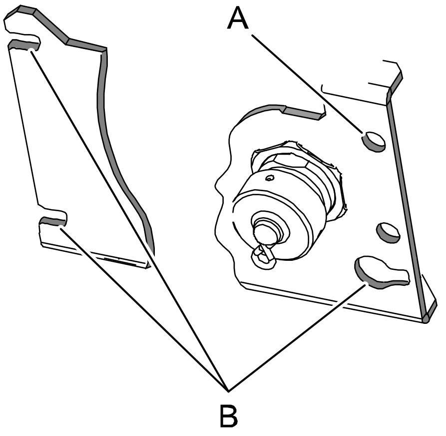
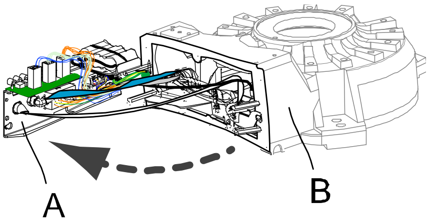
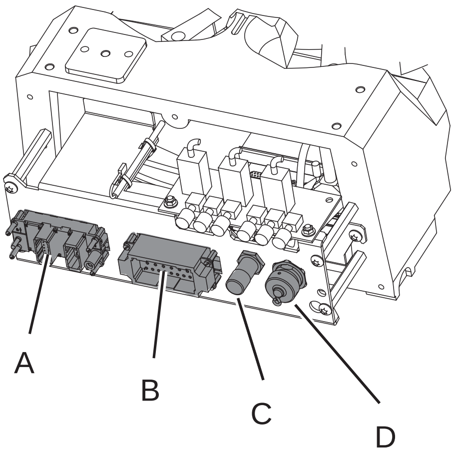
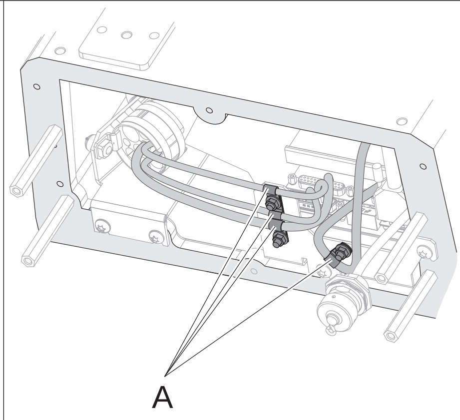
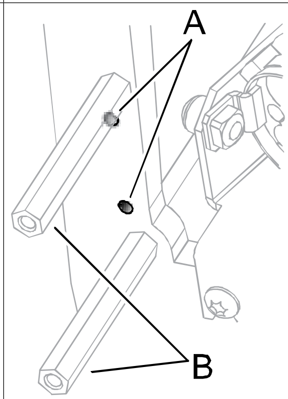
	Action	Note
6	Cut the *cable straps* securing the battery cable.	 xx0900000099 Parts: • A: Cable straps (2 pcs)
7	Disconnect the battery cable.	
8	Unscrew the thin nut securing the R1.SMB connector on the outside of the bracket. **Tip** Use a deep well hexagon socket, width 30 mm (like the ones used for spark plugs, or similar).  xx1200000888	 xx1200000889 A Thin nut, width 30 mm B R1.SMB C Bracket D Air connector
9	Unscrew the nut for the air connection on the inside of the bracket.	

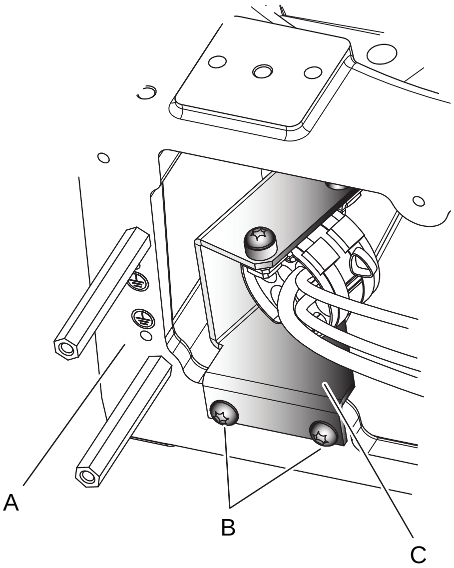
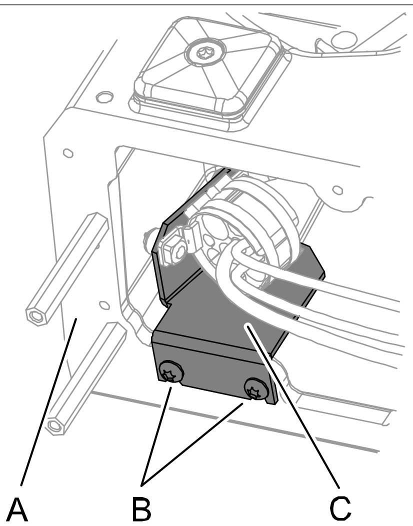
Continues on next page

	Action	Note
10	Remove the screw that secures the bracket and unscrew the three other screws a little just enough to be able to slide the bracket sideways.	 xx0900000100 Parts: • A: Screw to be removed • B: Screws to be unscrewed (3 pcs)
11	Remove the *bracket* by sliding it off the remaining three attachment screws and put it at a 90° angle from the base. Putting the bracket at a 90° angle facilitates the disconnecting of cables from the bracket. **Note** Use caution when performing this procedure in order not to damage cables or other components!	 xx0900000013 Parts: • A: Bracket at a 90° angle • B: Base
12	Remove connectors and air hose connector completely from the *bracket*: • R1.CP/CS • R1.MP • R1.SMB • Air hose connector • R1.ETHERNET (if used)	 xx1200000890 A R1.CP/CS B R1.MP C Air hose connector D R1.SMB
13	Remove the *SMB unit* from its attachment screws. Leave the screws in the base.	How to remove the *SMB unit* is described in section: • *Removing the SMB unit on page 226*

Continues on next page

	Action	Note
14	Disconnect connectors on the SMB unit: • R1.SMB1-2 • R1.SMB2-6 • R2.SMB	
15	Disconnect the *screen connections* of: • R1.SMB1-2 • R1.SMB2-6	 xx0900000035 Parts: • A: Screen connection (4 pcs)
16	Disconnect the *earth cables*.	 xx0900000015 Parts: • A: Earth • B: Distance screws

Continues on next page

	Action	Note
17	**Valid for Type C and Type D.** Remove the *bracket* securing the cable package inside the base on the left side, by following these steps: • Unscrew the attachment screws just enough to be able to remove the bracket. • Lift the bracket off the screws.	 xx1200000860 Parts: • A: Base • B: Attachment screws • C: Bracket
18	**Valid for Other design than Type C and Type D.** Remove the *bracket* securing the cable package inside the base on the left side, by following these steps: • Unscrew the attachment screws just enough to be able to remove the bracket. • Lift the bracket off the screws.	 xx0900000018 Parts: • A: Base • B: Attachment screws • C: Bracket
19	Continue removal of the cable package from the frame.	How to remove the cable package from the frame is described in section • *Removing cable harness in frame on page 205*

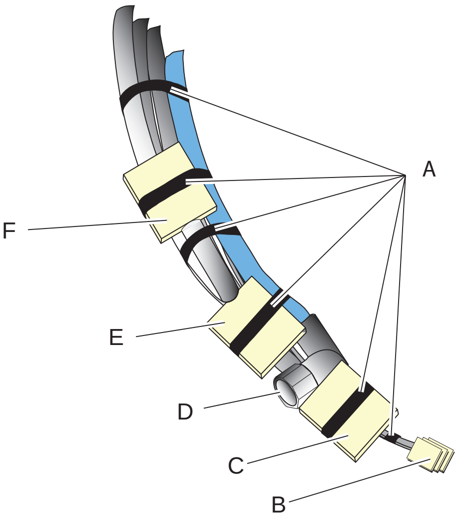
Continues on next page

Removing cable harness in frame

Use this procedure to remove the cable harness in the frame.

Tip

Before starting this procedure, first remove the cable harness in the base. See *Removing the complete cable harness on page 196*.

	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	Disconnect the *motor cables* on the axis-1 and axis-2 motors.	How to remove the motor cables is described in section: • *Removing motors on page 287*
3	Remove the *bracket* securing the cable package to the frame.	See the figure in: • *Location of the cable harness on page 197*
4	Cut the *cable straps* securing the cable harness to the frame and lower arm.	See the figure in: • *Location of the cable harness on page 197*
5	Prepare the end of the cable package in the base with tape as shown in the figure. **Tip** In order to protect the connectors from getting residual grease on the cable harness, put some plastic over them prior to pushing it through the hole in the frame.	 xx1200000886 A Tape B Connectors to SMB unit and Brake release unit C R1.CP/CS D Air hose E R1.MP F R1.SMB (Connector bent and taped upwards)

Continues on next page

	Action	Note
6	Pull out the cable package through the hole in the frame. **Note** Use caution when performing this procedure in order not to damage cables or other components!	
7	Continue the removal of the cable package from the lower arm and armhouse.	How to remove the cable package from the lower arm and armhouse is described in section: • *Removing cable harness in lower arm and armhouse on page 206*

Removing cable harness in lower arm and armhouse

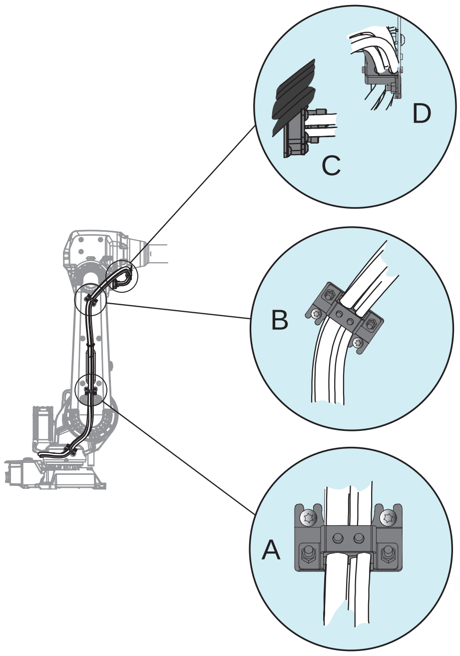
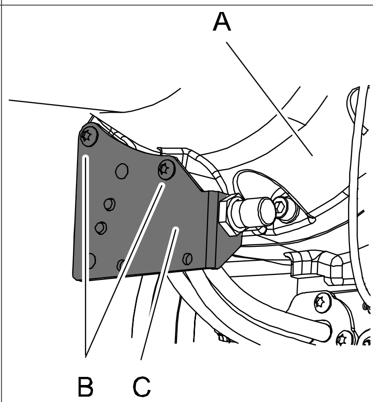
Use this procedure to remove the cable harness in the lower arm and armhouse.

Tip

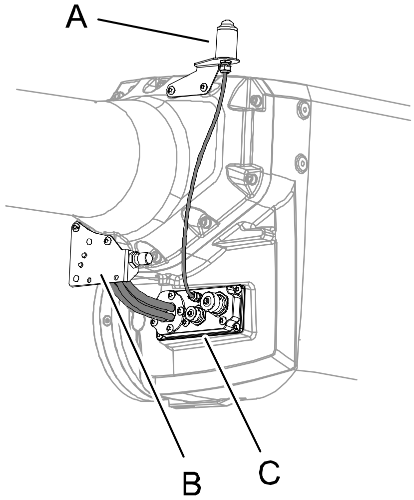
Before starting this procedure, first remove the cable harness in the base *Removing the complete cable harness on page 196* and frame *Removing the complete cable harness on page 196*.

	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	Cut the *cable strap* on the lower arm.	See the figure in: • *Location of the cable harness on page 197* (Cable harness, lower arm)

Continues on next page

	Action	Note
3	Remove the *brackets* on the lower arm.	 xx0900000020 Parts: • A: Bracket, lower arm • B: Bracket, lower arm • C: Bracket, armhouse • D: Cable bracket
4	Remove the *bracket* on the armhouse.	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws • C: Bracket, armhouse

Continues on next page

	Action	Note
5	Remove the *cable cover* on the armhouse.	 xx0800000338 Parts: • A: Signal lamp • B: Bracket • C: Cable cover, armhouse
6	Remove signal lamp if used.	
7	Continue the removal of the cable package by disconnecting the motor cables of the axis-3, axis-4, axis-5 and axis-6 motors.	How to remove the *motor cables* from the *axis-3, axis-4, axis-5 and axis-6 motors* see section: • *Removing motors on page 287*

4.3.2 Refitting the complete cable harness

Introduction

This procedure describes how to refit the complete cable harness.

How to remove the cable harness is described in *Removing the complete cable harness on page 196*.

The refitting procedure is presented in the order the work is recommended to be performed.

Therefore the order is different in the two procedures removal and refitting of the cable harness. Cross references will make it easy to find what is needed to know as the work continues.

The section *Refitting the complete cable harness* consists of the following parts presented in the order the work is recommended to be performed:

- Refitting in the frame *Refitting the cable harness in the frame on page 212*
- Refitting in the base *Refitting the cable harness in the base on page 215*
- Refitting in the lower arm and armhouse *Refitting the cable harness in the lower arm and armhouse on page 221*.

How to refit the SMB unit, brake release unit and motors can be found in:

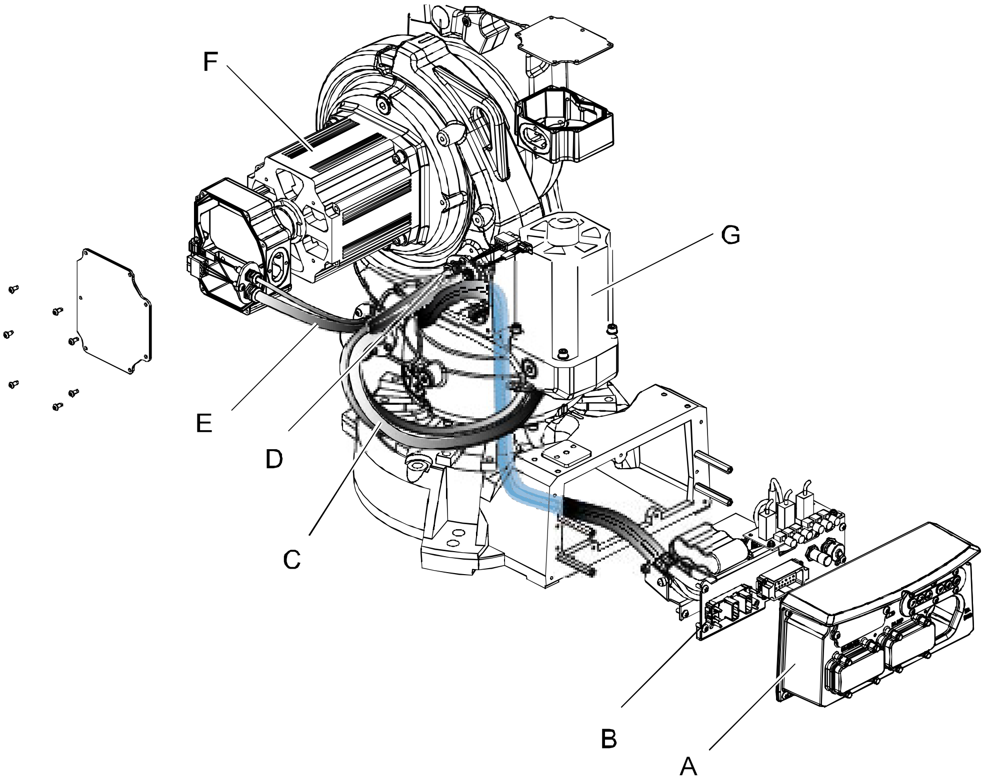
- SMB unit *Refitting the SMB unit on page 229*
- Brake release unit *Refitting the brake release board on page 233*
- Motors *Refitting motors on page 295*

Continues on next page

Location of the cable harness

The location of the cable harness in the base, frame and lower arm is shown in the figures.

Cable harness, base and frame.

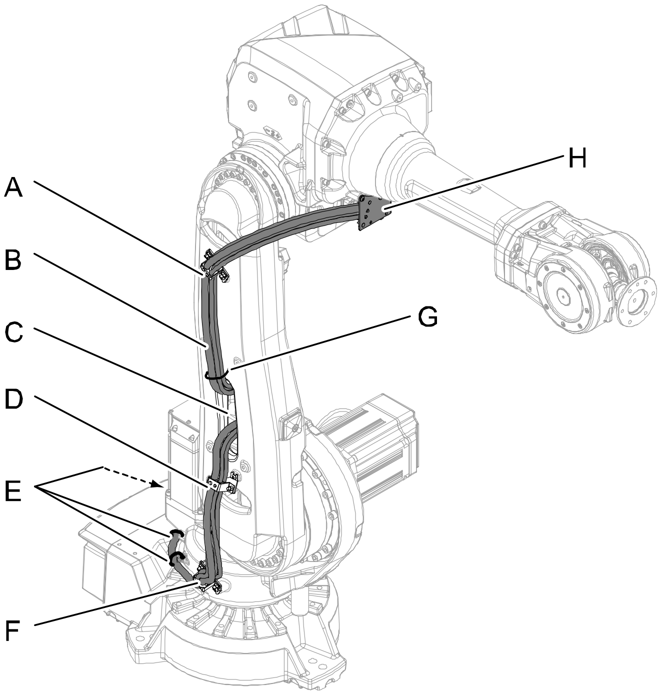


xx0900000009

A	Cover base
B	Bracket
C	Cable harness
D	Axis-1 motor cable
E	Axis-2 motor cable
F	Axis-2 motor
G	Axis-1 motor

Continues on next page

Cable harness, lower arm.



xx0900000012

A	Bracket, lower arm
B	Cable harness
C	Hole in lower arm
D	Bracket, lower arm
E	Cable straps, one not visible here (steel)
F	Bracket, frame
G	Cable strap, lower arm (plastic)
H	Bracket, armhouse

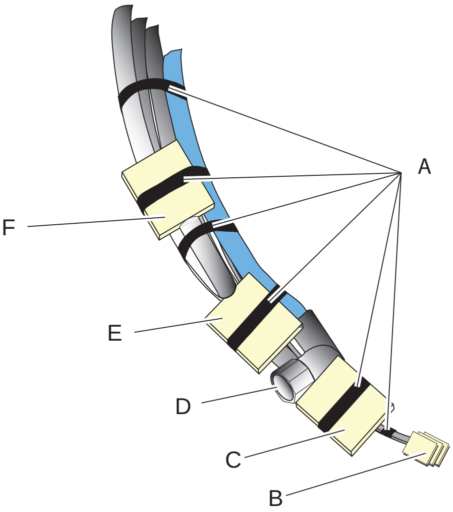
Required equipment

Equipment	Note
Deep well hexagon socket	Width 30 mm
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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.
Cable grease	3HAC042536-001 (Shell Gadus S2)

Continues on next page

Refitting the cable harness in the frame

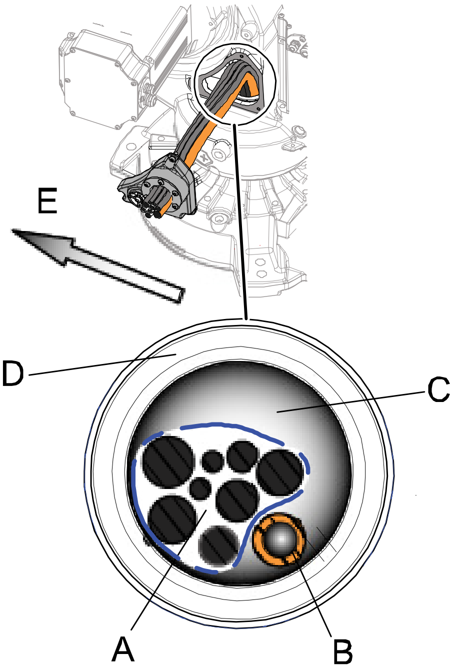
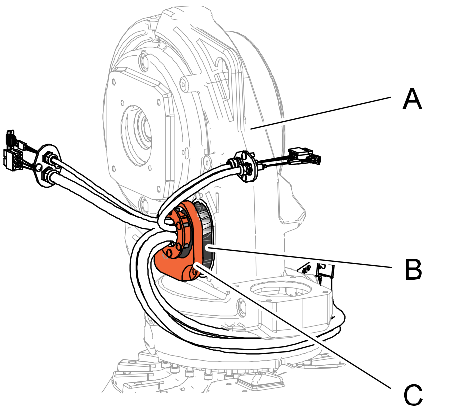
Use this procedure to refit the cable harness in the frame.

	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	Apply **cable grease** on these surfaces: • cable guide inside the hole • the part of the cable harness that runs through the cable guide.	Cable grease is specified in: • *Required equipment on page 211*
3	**Note** Two alternative methods to insert the cable package in frame and base are presented below. Chose one of the methods.	
4	*Use this procedure when replacing the old cable harness:* **Method 1, step 1:** Prepare the end of the cable package in the base with tape as shown in the figure. **Tip** In order to protect the connectors from getting residual grease on the cable harness, put some plastic over them prior to pushing it through the hole in the frame.	 xx1200000886 A Tape B Connectors to SMB unit and Brake release unit C R1.CP/CS D Air hose E R1.MP F R1.SMB (Connector bent and taped upwards)

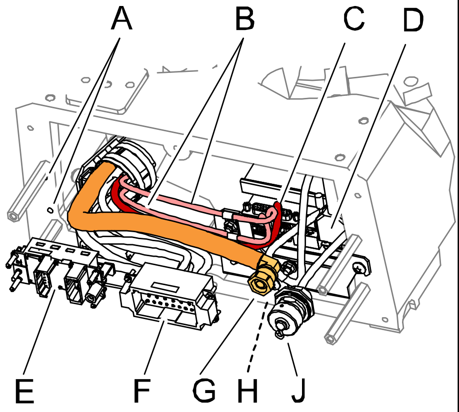
Continues on next page

	Action	Note
5	*Use this procedure when replacing the old cable harness:* **Method 1, step 2:** Push the cable package carefully in through the base and up through the hole in the frame. **Note** Use caution when performing this procedure in order not to damage cables or other components!	
6	*Use this procedure when replacing the old cable harness:* **Method 2:** Push the cable harness carefully into the **hole in the frame** and out of the hole in the base. Perform the procedure in the following order: • R1.MP • R1.CP/CS • R1.SMB1-2 and R1.SMB3-6 • Air hose. **Note** Use caution when performing this procedure in order not to damage cables or other components! **Tip** In order to protect the connectors from getting residual grease on the cable harness, put some plastic over them prior to pushing it through the hole in the frame.	
7	*Use this procedure when fitting a new cable harness:* Without removing the plastic around cables and hose, push the cable harness through the hole in the frame. **Note** Use caution when performing this procedure in order not to damage cables or other components!	**Note** Check that cables and air hose are placed as shown in the figure above.

Continues on next page

	Action	Note
8	**Note** It is vital that the position of the air hose is correct, as shown in the figure!	 xx0900000096 Parts: • A: Cables • B: Air hose • C: Hole in frame • D: Cable guide • E: Position of the front of the robot
9	Secure the *cover* to the frame with its attachment screws.	 xx0900000016 Parts: • A: Frame • B: Hole in frame • C: Cover
10	Connect the axis-1 and axis-2 **motor cables**.	How to refit the motor cables is described in section: • *Refitting motors on page 295*

Continues on next page

	Action	Note
11	Sort out the different cables the way they later will be fit on the bracket in the base.	 xx0900000017 Connections: • A: Earth cables • B: R1.SMB1-2 • C: R1.SMB3-6 • D: R2.SMB • E: R1.CP/CS • F: R1.MP • G: Air hose • H: Position of R1.ETHERNET (if used) • J: R1.SMB
12	Continue the refitting of the cable harness in the base.	How to refit the cable harness in the base is described in section: • *Refitting the cable harness in the base on page 215*

Refitting the cable harness in the base

Use this procedure to refit the cable harness in the base.

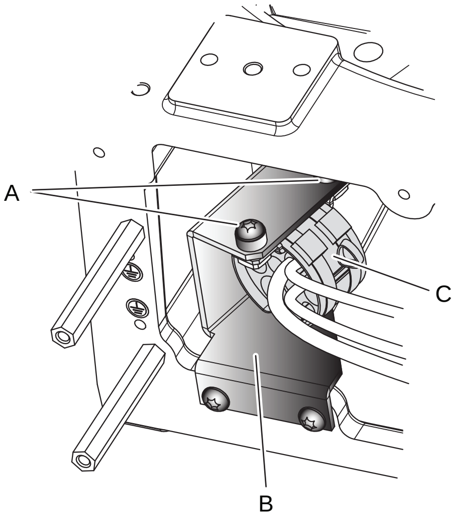
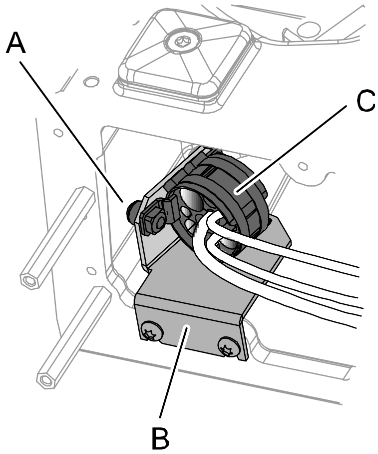
Tip

Before starting this procedure, first refit the cable harness in the *frame*. See:

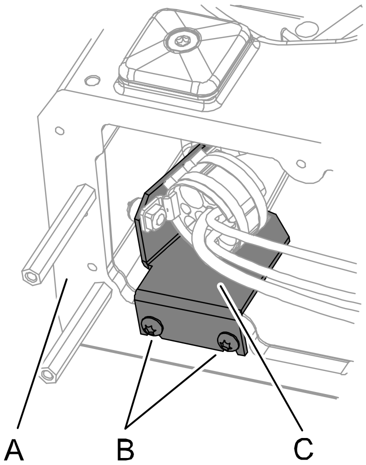
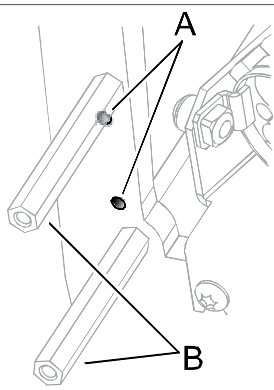
- *Refitting the complete cable harness on page 209*

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

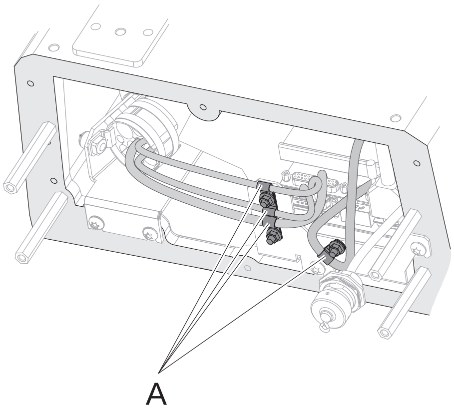
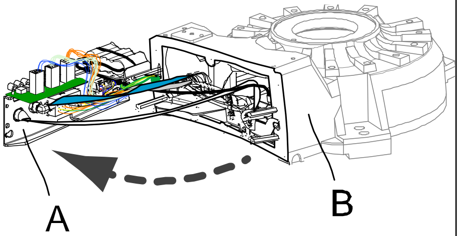
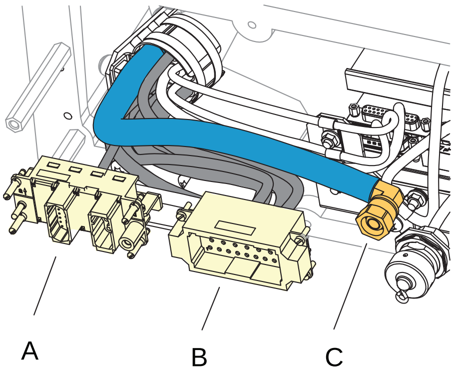
Continues on next page

	Action	Note
2	**Valid for Type C and Type D.** Attach the *cable harness* to the bracket.	 xx1200000861 Parts: • A: Attachment screw and nut • B: Bracket • C: Cable harness
3	**Valid for other design than Type C and Type D**. Attach the *cable harness* to the bracket.	 xx0900000098 Parts: • A: Attachment screw and nut • B: Bracket • C: Cable harness

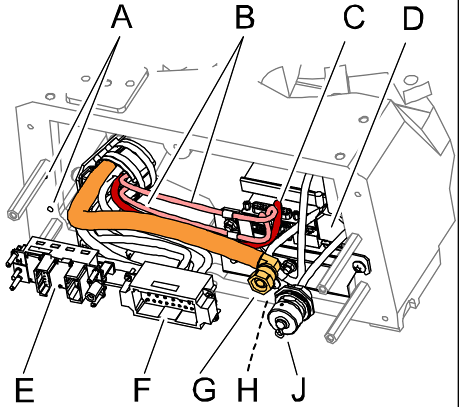
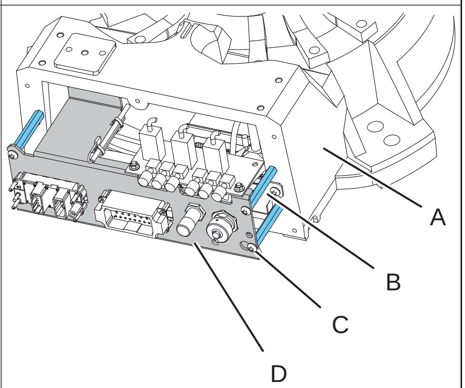
Continues on next page

	Action	Note
4	Secure the *bracket* on its *attachment screws* in the base. **Tip** Perform this in the following order: • Put the *attachment screws* in the holes but do not tighten them yet (if they have been removed earlier). • Place the *bracket* on the attachment screws. • Secure the bracket with its attachment screws.	The figure shows **Other design than Type C and Type D.** The principle of securing the bracket on **Type C and Type D** is the same.  xx0900000018 Parts: • A: Base • B: Attachment screws (2 pcs) • C: Bracket
5	Refit the *earth cables*.	 xx0900000015 Parts: • A: Earth • B: Distance screws
6	Connect the contacts on the SMB unit: • R1.SMB1-2 • R1.SMB3-6 • R2.SMB	
7	Refit the SMB unit.	How to refit the SMB unit is described in section: • *Refitting the SMB unit on page 229*

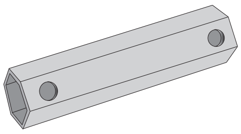
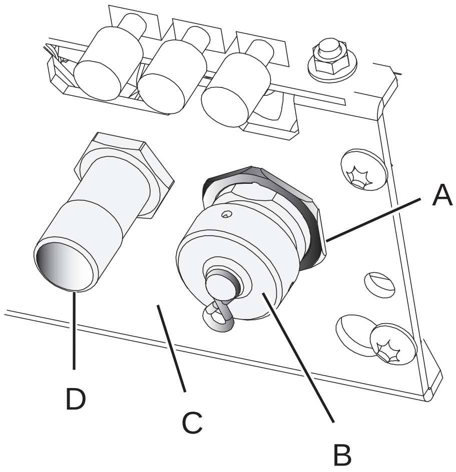
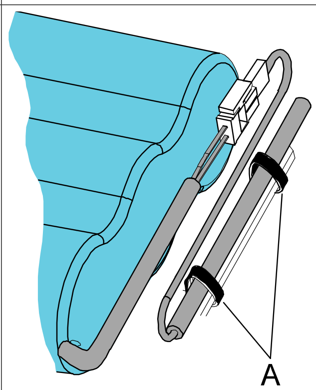
Continues on next page

	Action	Note
8	Refit the cables with the *screen connections*.	 xx0900000035 Parts: • A: Screen connections (4 pcs)
9	**Tip** When refitting connectors on the *bracket*, put it at a 90° angle.	 xx0900000013 Parts: • A: Bracket • B: Base
10	Before refitting the connectors on the bracket, arrange cables and connectors as shown in the figure.	 xx1200000857 A R1.CP/CS B R1.MP C Air hose

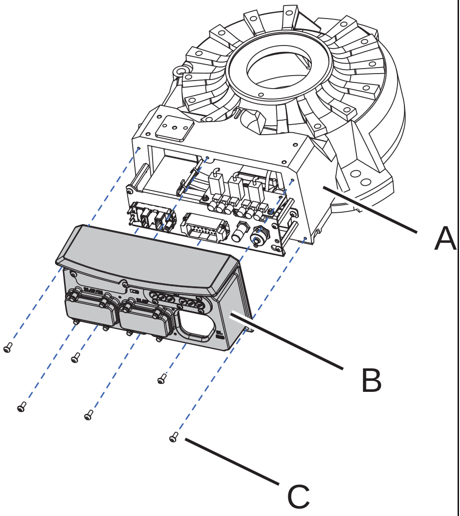
Continues on next page

	Action	Note
11	Refit the *connectors* and *air hose* on the bracket: • R1.CP/CS • R1.ETHERNET (if used) • R1.MP **Tip** Do not refit the *R1.SMB-connector* and *air hose* at this stage. It will be easier to refit these two when the bracket has been fitted to the distance screws.	 xx0900000017 Connectors: • A: Earth cables • B: R1.SMB1-2 • C: R1.SMB3-6 • D: R2.SMB • E: R1.CP/CS • F: R1.MP • G: Air hose • H: Position of R1.ETHERNET (if used) • J: R1.SMB
12	Secure the bracket on the distance screws.	 xx1200000887 A Base B Distance screw C Attachment screw D Bracket
13	Reconnect connectors on the brake release unit: • X8 • X9 • X10	

Continues on next page

	Action	Note
14	Refit the *R1.SMB-connector* on the bracket. **Tip** Use a deep well hexagon socket, width 30 mm (like the ones used for spark plugs, or similar).  xx1200000888	 xx1200000889 A Thin nut, width 30 mm B R1.SMB C Bracket D Air connector
15	Refit the *air hose connector* on the bracket. **Note** Check that there is no leakage from the air hose.	
16	Reconnect the battery cable.	
17	Secure the battery cable with *cable straps*.	 xx0900000099 Parts: • A: Cable straps (2 pcs)

Continues on next page

	Action	Note
18	Use caution when pushing the *base cover* into position while at the same time checking that no cables are damaged.	 xx0800000456 Parts: • A: Base • B: Base cover • C: Attachment screws (6 pcs)
19	Secure the *base cover* with its attachment screws.	
20	Refit the *bracket* on the frame.	See the figure in: • *Location of the cable harness on page 210*
21	Refit the *cable straps* securing the cable harness to the frame.	See the figure in: • *Location of the cable harness on page 210*
22	Continue the refitting of the cable package on lower arm and armhouse.	How to refit the cable harness on the *lower arm and armhouse* is described in section: • *Refitting the cable harness in the lower arm and armhouse on page 221*

Refitting the cable harness in the lower arm and armhouse

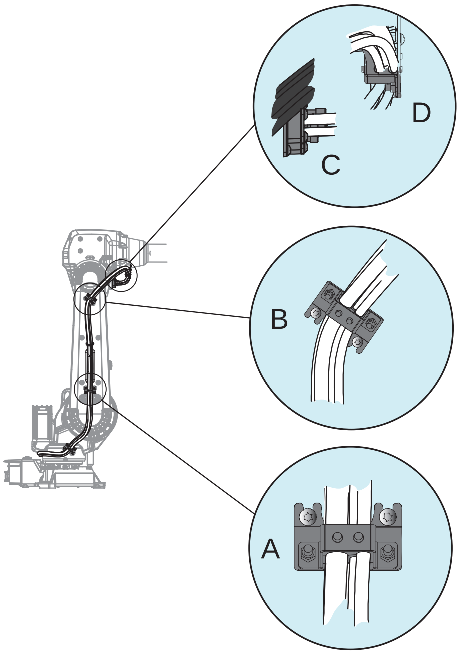
Use this procedure to refit the cable harness in the *lower arm* and *armhouse*.

Tip

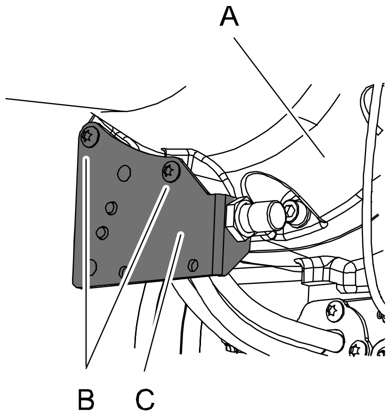
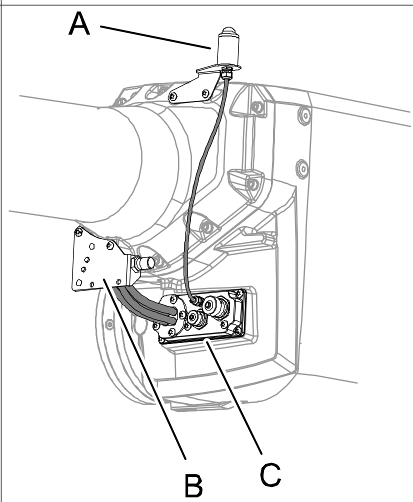
Before starting this procedure, first refit the cable harness in the *frame* and *base*. See:

- *Refitting the complete cable harness on page 209*
- *Refitting the complete cable harness on page 209*

Continues on next page

	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	Secure the *brackets* on the lower arm.	 xx0900000020 Parts: • A: Bracket, lower arm • B: Bracket, lower arm • C: Bracket, armhouse • D: Cable bracket
3	Refit the *cable straps* securing the cable harness to the lower arm.	See the figure in: • *Location of the cable harness on page 210* (Cable harness, lower arm)
4	Push the cable harness carefully into the armhouse.	

Continues on next page

	Action	Note
5	Secure the *bracket, armhouse* with its attachment screws.	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws • C: Bracket, armhouse
6	Secure the *bracket* to the armhouse with its attachment screws.	 xx0800000338 Parts: • A: Signal lamp • B: Bracket, armhouse • C: Cable bracket
7	Reconnect the axis-3, axis-4, axis-5 and axis-6 *motor cables*.	How to connect the axis-3, axis-4, axis-5 and axis-6 motor cables, see: • *Refitting motors on page 295*
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 350*. General calibration information is included in section *Calibration on page 335*.

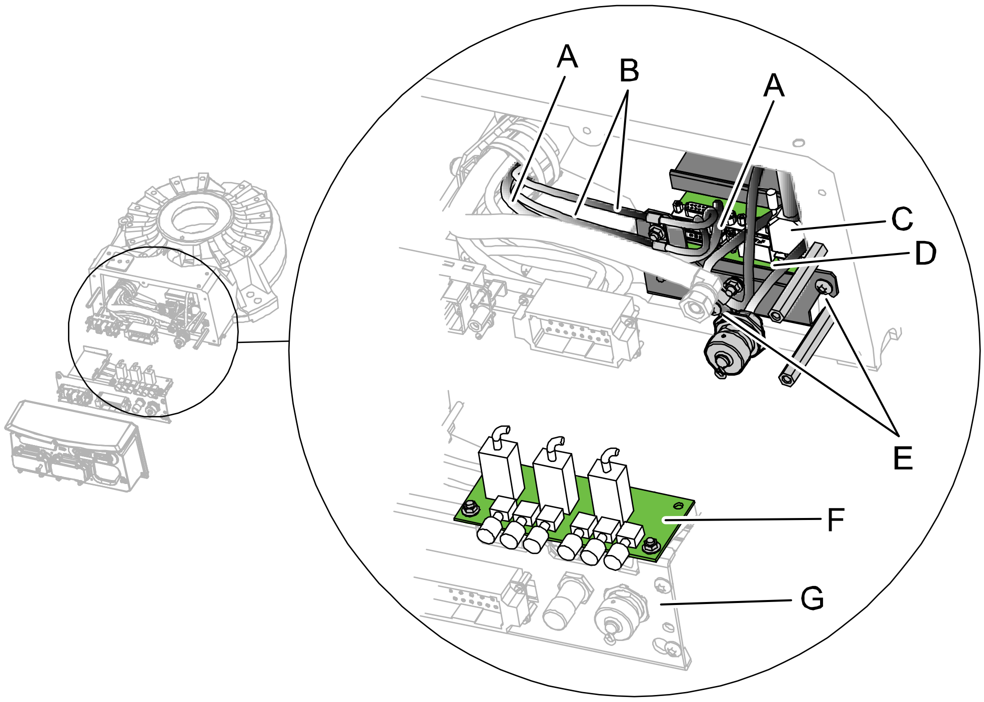
Continues on next page

	Action	Note
9	**WARNING** The cover on the armhouse must be fitted when the robot is running. It is a vital part for the stability of the robot.	
10	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.3.3 Replacing SMB unit

Location of SMB unit

The SMB unit (SMB = Serial measurement board) is located in the base below the brake release unit, as shown in the figure.



xx0800000466

A	R1.SMB3-6
B	R1.SMB1-2
C	R2.SMB
D	SMB unit
E	Attachment screws M6x16 quality 8.8-A2F (2 pcs)
F	Brake release unit
G	Bracket

Required equipment

Note

There are different variants of SMB units and batteries. The variant with the 3-pole battery contact (RMU) 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	Note
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Continues on next page

Equipment	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.
SMB unit	For spare part no. see chapter Spare parts, section: • *Spare part lists 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.

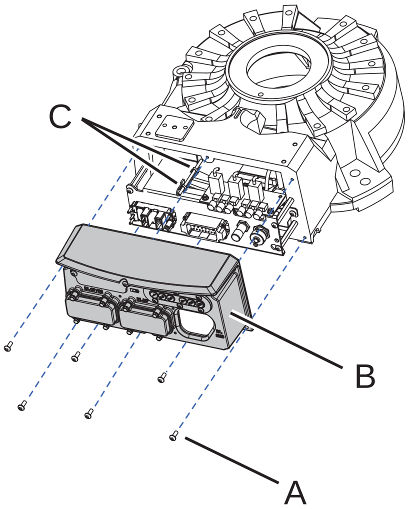
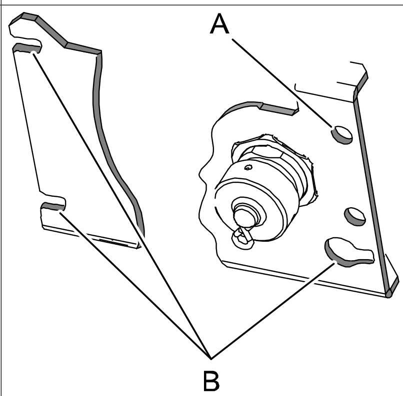
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is 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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing the SMB unit

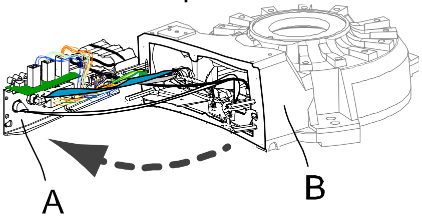
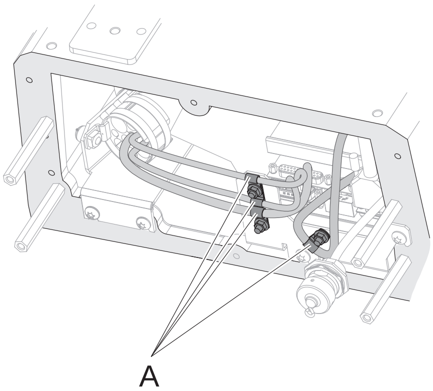
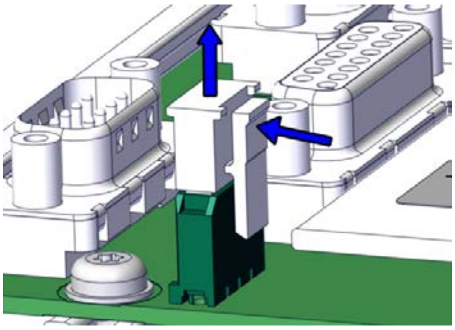
Use this procedure to remove the SMB unit.

	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.	

Continues on next page

	Action	Note
3	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.	 xx0900000103 Parts: A Attachment screws (6 pcs) B Base cover C Cable straps, securing the battery cable (2 pcs)
4	Cut the *cable straps* securing the battery cable.	
5	Remove the screw that secures the bracket and unscrew the three other screws a little just enough to be able to slide the bracket sideways. **Note** It is not needed to remove these three screws.	 xx0900000100 Parts: A Screw to be removed B Screws to be unscrewed a little (3 pcs)

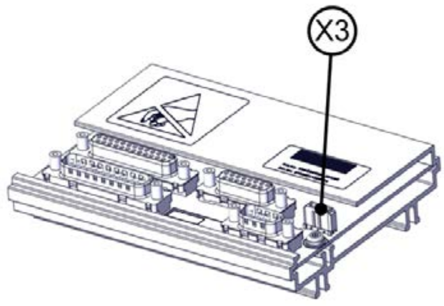
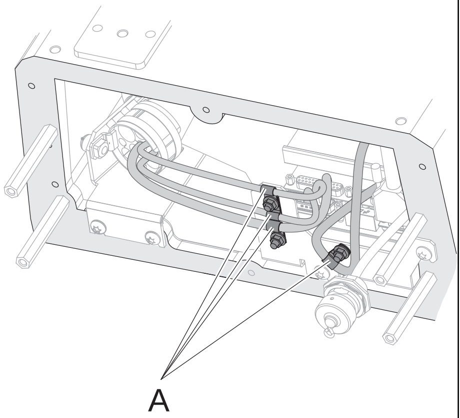
Continues on next page

	Action	Note
6	Remove the *bracket* by sliding it off the remaining three attachment screws and put it at a 90° angle from the base. Putting the bracket at a 90° angle facilitates the disconnecting of cables from the bracket. **Note** Use caution when performing this procedure order not to damage cables or other components!	Cable harness can stay connected to all connectors except to the SMB unit.  xx0900000013 Parts: A Bracket at a 90° angle B Base
7	Disconnect cable clamps.	 xx0900000035 Parts: A Cable clamps
8	Unscrew the *attachment screws* securing the SMB unit just enough to be able to remove the SMB unit.	See the figure in: • *Location of SMB unit on page 225*
9	Remove the SMB unit.	
10	Disconnect the battery cable by pressing down the upper lip of the R1.G connector to release the lock while pulling the connector upwards.	 xx1700000993
11	Disconnect the remaining connectors on the SMB unit: • R1.SMB1-2 • R1.SMB3-6 • R2.SMB	See the figure in: • *Location of SMB unit on page 225*

Continues on next page

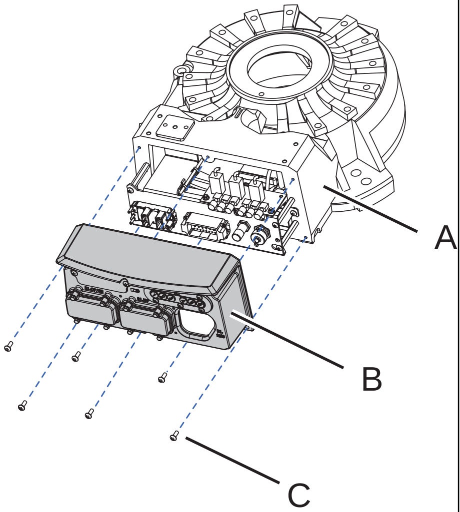
Refitting the SMB unit

Use this procedure to refit the SMB unit.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Reconnect contacts on the SMB unit: • R1.SMB1-2 • R1.SMB3-6 • R2.SMB • Battery cable R1.G (X3) Make sure the lock snaps into place during refitting.	 xx1700000994
3	Place the SMB unit on its *attachment screws*.	See the figure in: • *Location of SMB unit on page 225*
4	Secure the SMB unit with its attachment screws.	
5	Refit the *cable clamps*.	 xx0900000035 Parts: A Cable clamps
6	Put back the cable harness in the base and refit the bracket on the distance screws. **Note** Use caution when performing this procedure order not to damage cables or other components!	See the figure in: • *Location of SMB unit on page 225*

Continues on next page

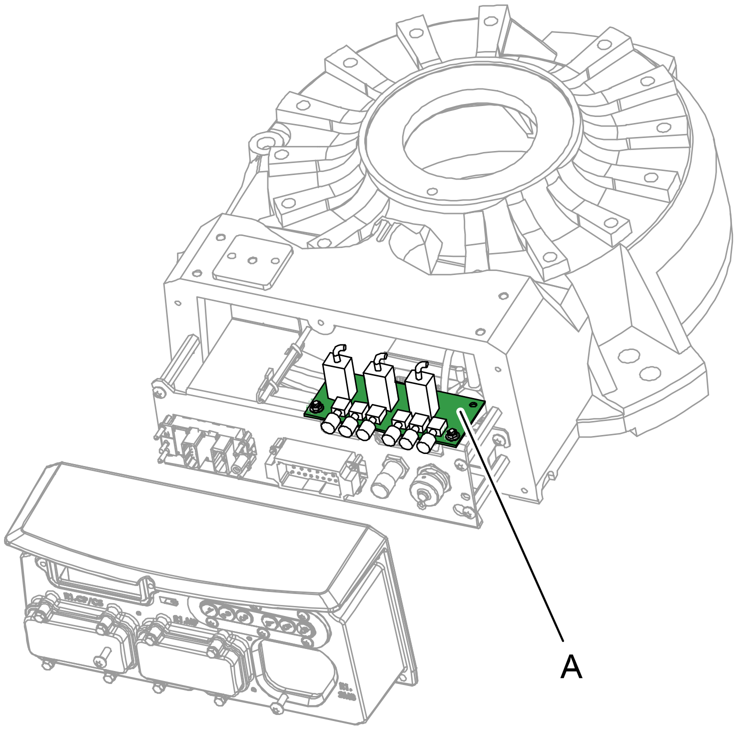
4.3.3 Replacing SMB unit
Continued

	Action	Note
7	Secure the battery cable with cable straps.	
8	Use caution when pushing the *base cover* into position while at the same time checking that no cables are damaged.	 xx0800000456 Parts: A Attachment screws (6 pcs) B Base cover C Base
9	Secure the *base cover* with the attachment screws.	
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 350*. General calibration information is included in section *Calibration on page 335*.
11	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.3.4 Replacing the brake release board

Location of brake release board

The brake release board is located as shown in the figure.

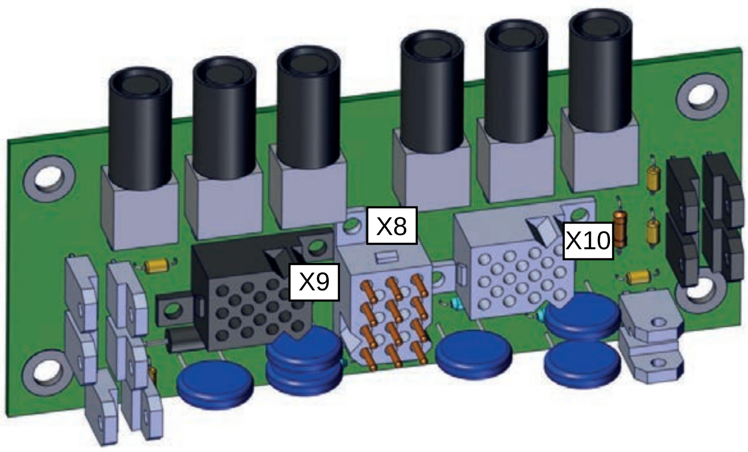


xx0900000101

A	Brake release board

Connectors on push-button board

The connectors X8, X9 and X10 are placed on the push-button board as shown in the figure below.



xx1700000978

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Required equipment

Equipment		Note
Brake release board	3HAC065020-001 [i] 3HAC062021-001 [ii]	DSQC1050 DSQC1052
Standard toolkit		Content is defined in section *Standard tools on page 386*.
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.

i Valid for robots that are equipped with motors of Type A and Type B (see *Product manual, spare parts - IRB 4600*).
Includes brake release board and harness.

ii Valid for robots that are equipped with motors of Type B (see *Product manual, spare parts - IRB 4600*).
Includes brake release board and harness.

Removing the brake release board

Use this procedure to remove the brake release board.

	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *The unit is sensitive to ESD on page 53*.	
3	Remove the *push button guard* from the SMB cover.	The guard must be removed to ensure a correct refitting of the brake release board.

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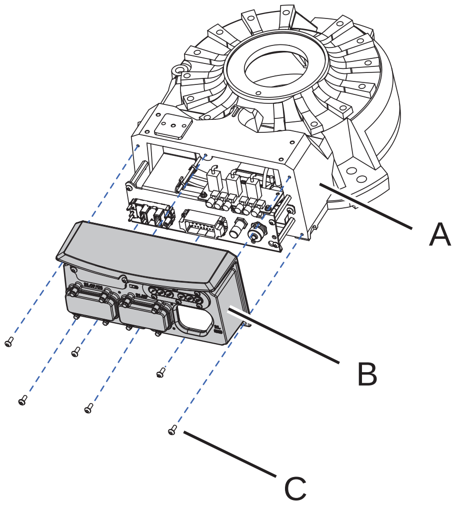
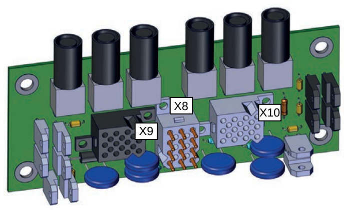
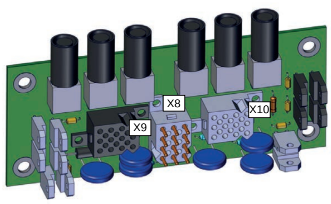
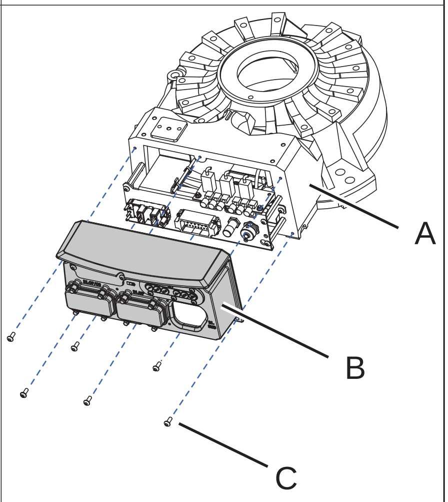
	Action	Note
4	Remove the *base cover*. **CAUTION** Clean cover from metal residues before opening. Metal residues can cause shortage on the boards which can result in hazardous failures.	 xx0800000456 Parts: A Base B Base cover C Attachment screws M6x16 quality 8.8-A2F (6 pcs)
5	Take a picture or make notes of how the robot cabling is positioned in regard to the brake release board.	
6	Disconnect *connectors X8, X9* and *X10* from the brake release board.	 xx1700000978
7	Remove the *nuts* securing the brake release board.	
8	Remove the brake release board.	

Refitting the brake release board

Use this procedure to refit the brake release board.

	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	**ELECTROSTATIC DISCHARGE (ESD)** The unit is sensitive to ESD. Before handling the unit read the safety information in section *The unit is sensitive to ESD on page 53*.	
3	Secure the brake release board to the *bracket* with its *nuts with flange*.	Maximum tightening torque: 5 Nm. See the figure in: • *Location of brake release board on page 231*
4	Reconnect *connectors X8*, *X9* and *X10* to the brake release board. Be careful not to damage the sockets or pins. Make sure the connector and its locking arms are snapped down properly.	 xx1700000978
5	Verify that the robot cabling is positioned correctly, according to previously taken picture/notes. **WARNING** Screened cables must not get in contact with the brake release board after installation. Eliminate all risks of contact between screened cables and the brake release board.	
6	Use caution when pushing the *base cover* into position while at the same time checking that no cables are damaged.	 xx0800000456 Parts: A Base B Base cover C Attachment screws M6x16 quality 8.8-A2F (6 pcs)
7	Secure the *base cover* with its *attachment screws*.	

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	Action	Note
8	**WARNING** Before continuing any service work, follow the safety procedure in section *The brake release buttons may be jammed after service work on page 195*!	
9	Refit the *push button guard* to the SMB cover.	
10	Press the push buttons 1 to 6, one at a time, to make sure that the buttons are moving freely and do not stay in any locked position.	
11	**DANGER** Make sure all safety requirements are met when performing the first test run.	

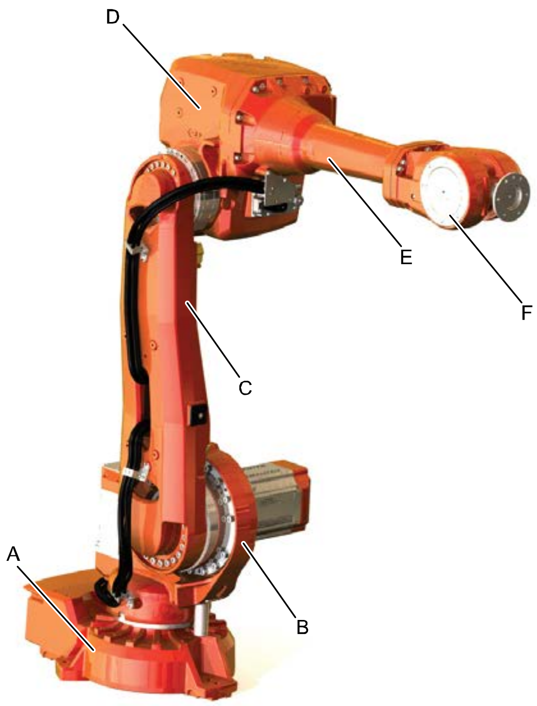
4.3.5 Replacing the base

Location of base and complete arm system

The complete arm system is defined as:

- complete upper arm (includes: wrist unit, tubular shaft unit and armhouse)
- lower arm
- frame
- axis-1 gearbox

The location of the base and the complete arm system is shown in the figure.



xx0800000345

A	Base
B	Frame
C	Lower arm
D	Arm house (part of complete upper arm)
E	Tubular shaft unit (part of complete upper arm)
F	Wrist unit (part of complete upper arm)

Required equipment

Equipment	Article number	Note
Roundslings	-	Length: 2 m (2 pcs), 1.5 m (1 pcs) Lifting capacity: 1,000 kg.
Support legs	3HAC15535-1	3 pcs
Guide pin, M8x150	3HAC15520-2	Always use guide pins in pairs.

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Equipment	Article number	Note
Lifting eye	-	M8 3 pcs
Standard toolkit		Content is defined in section *Standard tools on page 386*.
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.
Cleaning agent	-	Loctite 7063 For cleaning.
Flange sealant	-	Loctite 574 For sealing.

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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing the base

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

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

Continues on next page

	Action	Note
2	Jog the robot to: • Axis 1: 0° • Axis 2: 0° • Axis 3: -10° • Axis 4: 0° • Axis 5: 0° • Axis 6: 0°	
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safe-guarded space.	
4	Drain the axis-1 gearbox. **Note** Draining is time-consuming. Elapsed time varies depending on the temperature of the oil.	How to drain oil is detailed in section • *Changing the oil, axis-1 gearbox on floor mounted robots on page 148*
5	Remove the *cable harness* in the base, the frame and the lower arm of the robot. **Tip** Wrap up the cabling against the frame to keep it undamaged during the remaining work.	How to remove the cable harness in base and frame is detailed in sections: • *Removing cable harness in base on page 199* • *Removing cable harness in frame on page 205* • *Removing cable harness in lower arm and armhouse on page 206*

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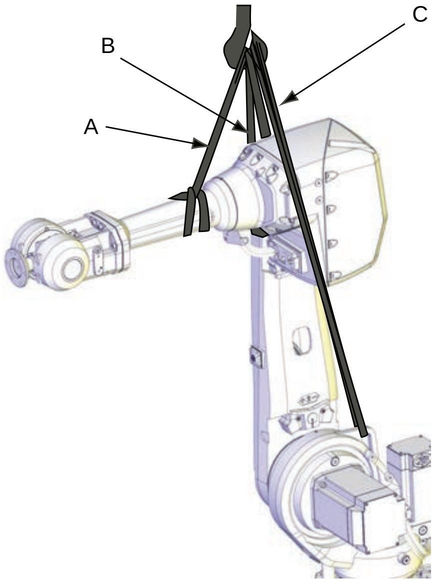
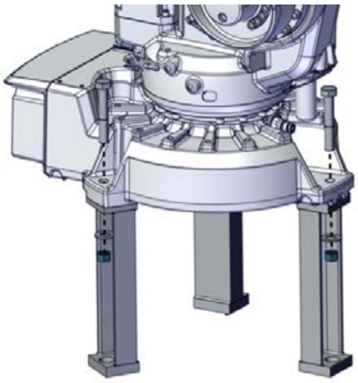
	Action	Note
6	Secure the robot with *roundslings* in an overhead crane. Stretch the roundslings so that the robot weight is secured when removing foundation bolts in next step.	Dimensions are specified in *Required equipment on page 236*.  xx1100000582 A Roundsling 1.5 m B Roundsling 2 m C Roundsling 2 m
7	**CAUTION** The IRB 4600 robot weighs 465 kg. All lifting accessories used must be sized accordingly!	
8	Remove the bolts that secure the robot to the foundation.	
9	Lift the robot and fit three support legs to the robot base, using bolts, washers and nuts. **DANGER** Working underneath the manipulator without safely securing the support legs between the robot base and the foundation will result in serious or fatal injury. Make sure the robot is stable and safely secured to the foundation via the support legs, before working underneath the robot. Keep the lifting accessories stretched for extra safety precautions.	 xx1800000874

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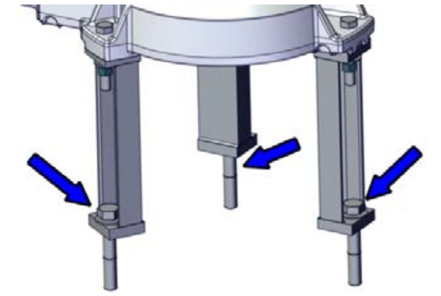
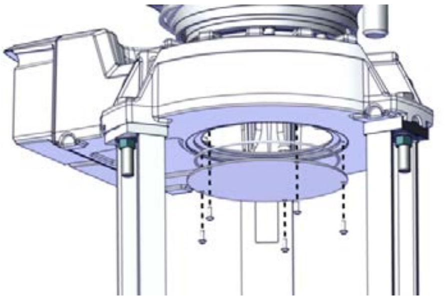
	Action	Note
10	Lower the robot and secure the support legs to the foundation, using bolts and washers.	 xx1800000875
11	Remove the *cover plate* at the bottom of the base.	 xx1800000879

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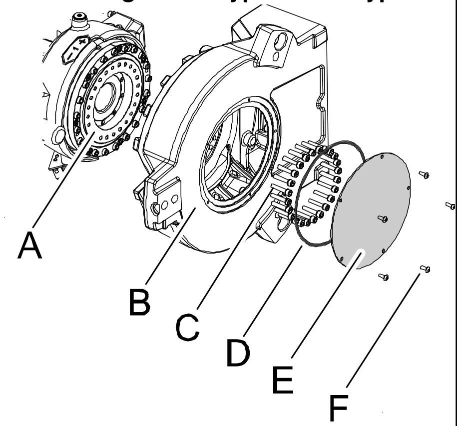
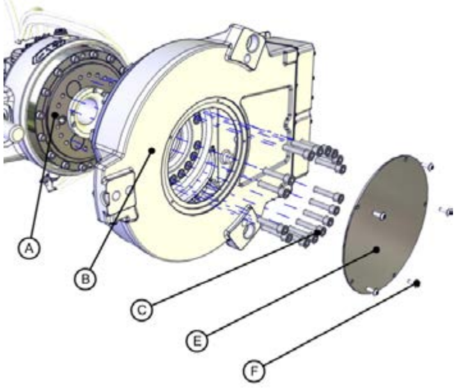
	Action	Note
12	Remove the base attachment screws and washers.	**Other design than Type C and Type D**:  xx0800000357 **Type C and Type D**:  xx1200000634 Parts: • A: Gearbox axis 1 • B: Base • C: **Other design than Type C and Type D:** Attachment screws M8x40 quality Steel 12.9 Gleitmo and washers (24+24 pcs) • C: **Type C and Type D**: Attachment screws M12x50 quality Steel 12.9 Gleitmo and washers (24+24 pcs) • D: O-ring (Not visible behind cover plate in figure of **Type C and Type D**) • E: Cover plate • F: Attachment screws M6x16 quality 8.8-A2F (5 pcs)

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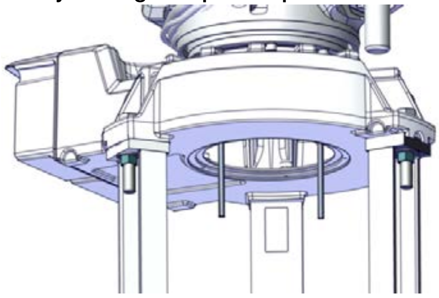
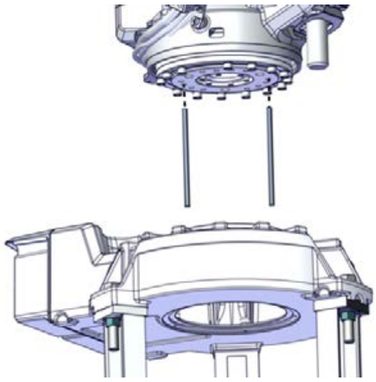
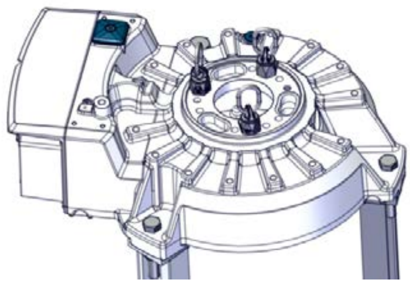
	Action	Note
13	Fit two guide pins in opposite holes in the axis-1 gearbox.	Guide pin, M8x150: 3HAC15520-2 Always use guide pins in pairs.  xx1800000883
14	**CAUTION** The arm system and axis-1 gearbox weighs 380 kg together. All lifting accessories must be sized accordingly.	
15	Lift away the robot arm system. Remove the guide pins, if the arm system is about to be laid down on the floor. See *Illustration of robot put down on its side on page 309*.	 xx1800000884
16	**CAUTION** The weight of the base is 49 kg All lifting accessories used must be sized accordingly.	
17	Fit three lifting eyes to the base and secure with roundslings in an overhead crane or similar.	Lifting eye: M8  xx1800000931

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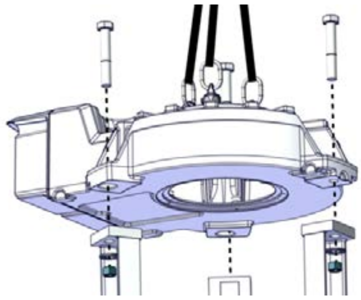
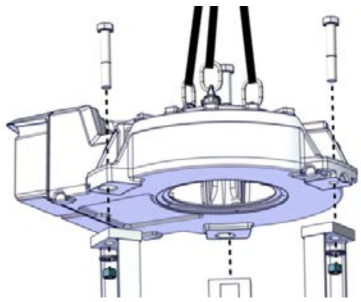
	Action	Note
18	Remove the support legs attachments screws and remove the base from the support legs.	 xx1800000885

Refitting the base

Use this procedure to refit the complete arm system to the base.

	Action	Note
1	**CAUTION** The weight of the base is 49 kg All lifting accessories used must be sized accordingly.	
2	Fit three lifting eyes to the base and secure with roundslings in an overhead crane or similar.	Lifting eye: M8
3	Fit the new base to the support legs and secure with the attachment screws.	 xx1800000885
4	Remove residues of old Loctite and other contaminations from surfaces before applying new Loctite 574.	**Tip** Use Loctite 7063 (or similar) for cleaning.

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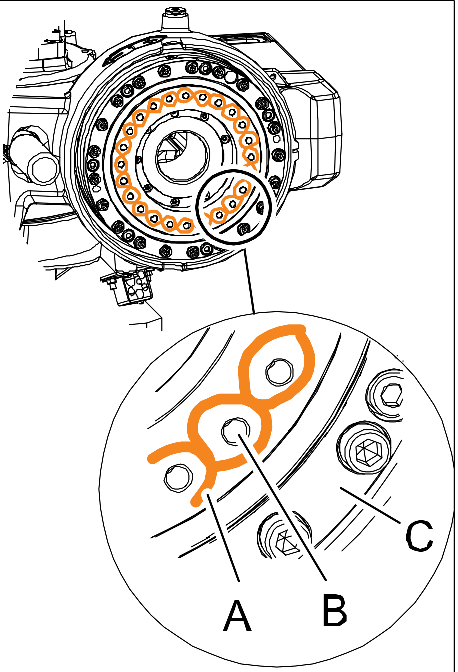
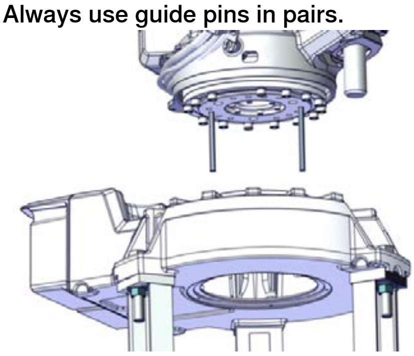
	Action	Note
5	Apply *Loctite 574* around the *screw holes* on the axis-1 gearbox as shown in the figure.	 xx0800000353 Parts A Loctite 574 B Screw hole in axis-1 gearbox C Axis-1 gearbox
6	**CAUTION** The arm system and axis-1 gearbox weighs 380 kg together. All lifting accessories must be sized accordingly.	
7	Lift the arm system to the mounting site.	
8	Fit two guide pins in opposite holes in the axis-1 gearbox.	Guide pin, M8x150: 3HAC15520-2 Always use guide pins in pairs.  xx1800000932

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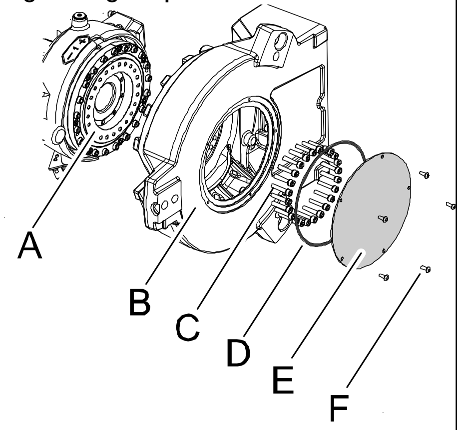
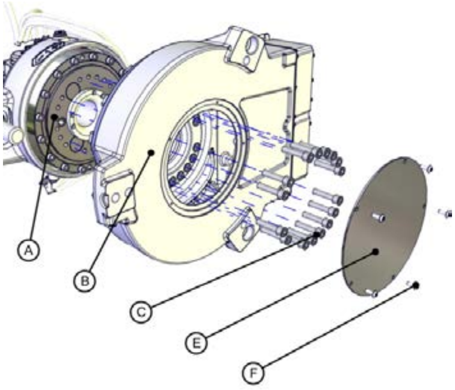
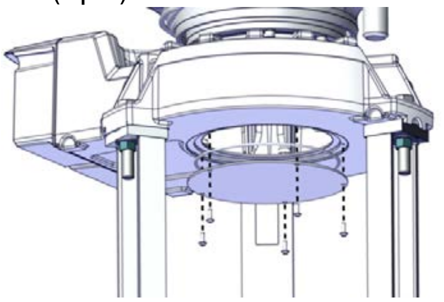
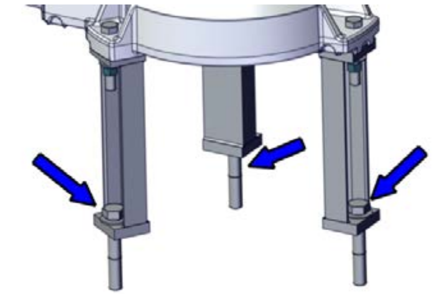
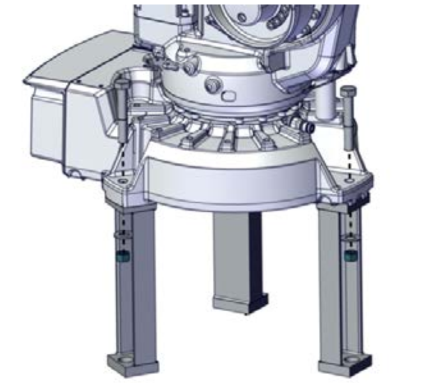
	Action	Note
9	Refit the base with its *attachment screws* and *washers*. **Note** The attachment screws on **Type C and Type D** are different from the ones on **Other design than Type C and Type D**!	**Other design than Type C and Type D**: Tightening torque: 35 Nm.  xx0800000357 **Type C and Type D**: Tightening torque: 110 Nm.  xx1200000634 Parts: • A: Gearbox axis 1 • B: Base • C: **Other design than Type C and Type D:** Attachment screws M8x40 quality Steel 12.9 Gleitmo and washers (24+24 pcs) • C: **Type C and Type D**: Attachment screws M12x50 quality Steel 12.9 Gleitmo and washers (24+24 pcs) • D: O-ring (Not visible behind cover plate in figure of **Type C and Type D**) • E: Cover plate • F: Attachment screws M6x16 quality 8.8-A2F (5 pcs)
10	Apply some grease to the *o-ring* and refit the o-ring between the cover and base.	

Continues on next page

	Action	Note
11	Refit the *cover plate* at the bottom of the base with its attachment screws.	Attachment screws: M6x16 quality 8.8-A2F (5 pcs)  xx1800000879
12	Remove the screws that secure the support legs to the foundation. **DANGER** Stretch the roundslings to make sure that the robot weight is secured.	 xx1800000875
13	Lift the complete robot and remove the support legs from the base.	 xx1800000874
14	Lower the robot and secure it to the foundation.	See *Orienting and securing the robot on page 61*.
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 350*. General calibration information is included in section *Calibration on page 335*.
16	**DANGER** Make sure all safety requirements are met when performing the first test run.	

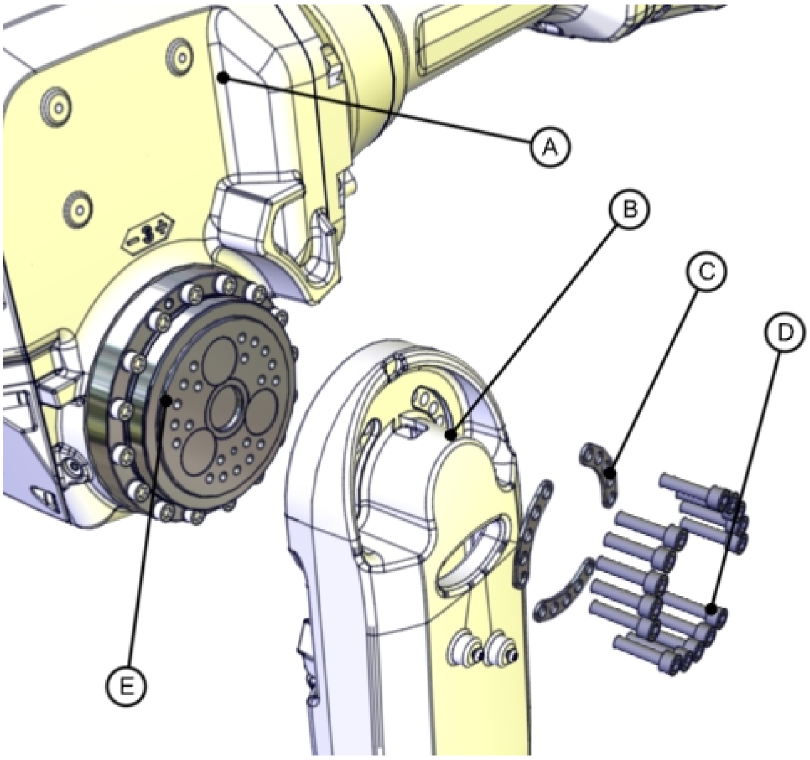
4.4 Upper arm

4.4.1 Replacing the complete upper arm

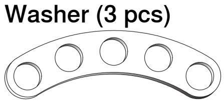
Location of the complete upper arm

Type C and Type D

The upper complete arm is located as shown in the figure.



xx1200000635

A	Upper arm
B	Lower arm
C	Washer (3 pcs)  xx1200000520
D	Attachment screws M10x40 quality steel 12.9 Gleitmo (15 pcs)
E	Axis-3 gearbox

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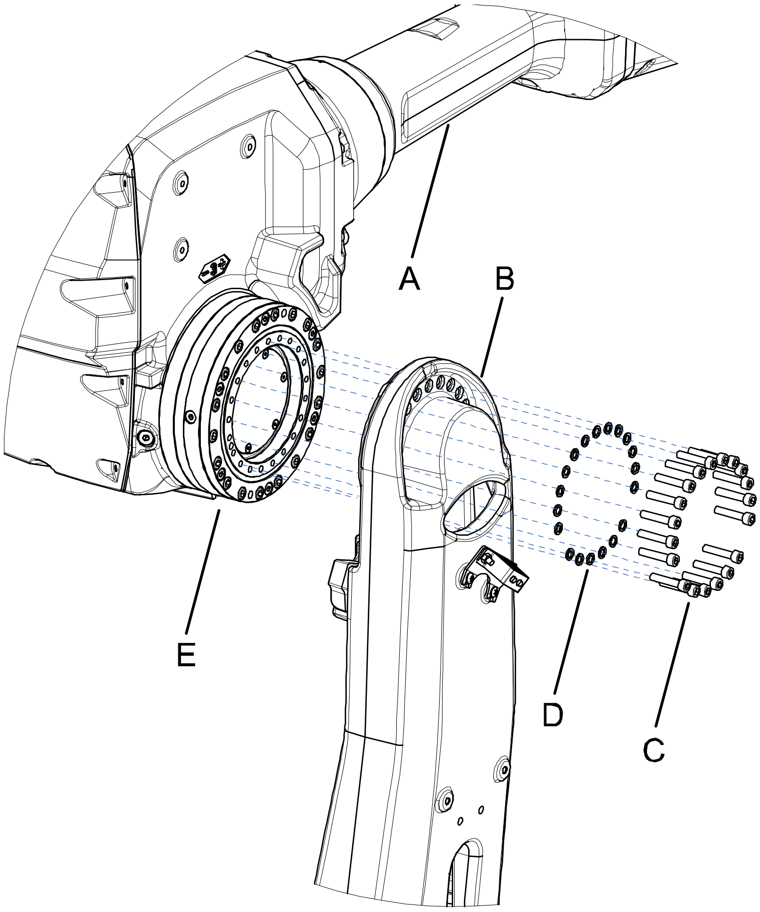
Other design than Type C and Type D

The complete upper arm is located as shown in the figure.



xx0800000337

A	Upper arm
B	Lower arm
C	Attachment screws M8x40 quality steel 12.9 Gleitmo (19 pcs)
D	Washers quality steel 8.4x13x1.5 (19 pcs)
E	Axis-2 gearbox

Required equipment

Equipment	Note
Armhouse	For spare parts no. see Spare parts - *Upper arm (2.05/2.50/2.55)* in *Product manual, spare parts - IRB 2600*.
Tubular shaft unit	For spare parts no. see Spare parts - *Upper arm (2.05/2.50/2.55)* in *Product manual, spare parts - IRB 2600*.

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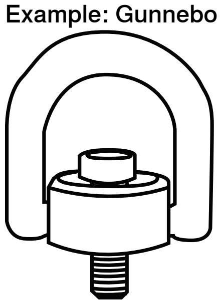
Equipment	Note
Rotating lifting point	2 pcs. Dimension: M8. Example: Gunnebo RLP GrabiQ M8-10.  xx1100000564
Washer	Required if the screw in the rotating lifting point bottoms. Inner diameter: 12 mm. Outer diameter: min. 23 mm. Thickness: enough to prevent the screw in the rotating lifting point to bottom.
Roundslings	3 pcs. Length: 1.5 m. Lifting capacity: 500 kg.
Screws	2 pcs. Used to prevent the roundsling at the wrist from sliding. Dimension: • M6. Length: 70 mm. Quality: 8.8. (IRB 4600 - 20/2.5) • M8. Length: 70 mm. Quality: 8.8. (IRB 4600 - 60/2.05, - 45/2.05, - 40/2.55)
Guide pins	**Type C and Type D:** M10 (2 pcs) **Other design than Type C and Type D:** M8 (2 pcs)
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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.	

Continues on next page

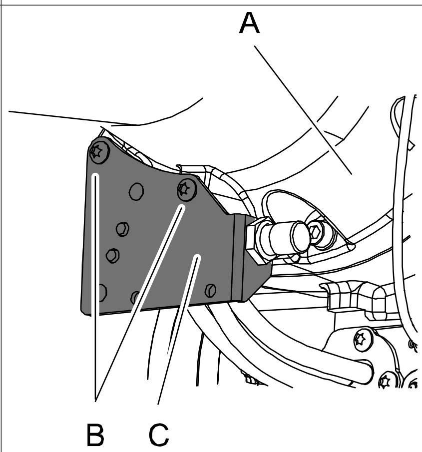
	Action	Note
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference 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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing the complete upper arm

Use this procedure to remove the complete upper arm. This procedure can be done without draining the axis 3 gearbox.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Run the robot to the position shown in the figure. The robot must be floor mounted and the upper arm must be horizontally positioned.	 xx0800000336
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	**CAUTION** The weight of the complete upper arm (including the wrist) is 140 kg All lifting accessories used must be sized accordingly.	

Continues on next page

	Action	Note
5	Attach the lifting accessories to the upper arm.	See *Attaching the lifting accessories to the upper arm on page 252*.
6	Unload the weight of the upper arm by stretching the roundslings. **Tip** Turn on the power temporarily and release the brakes of axis 3 to rest the weight onto the roundslings.	
7	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
8	Disconnect all *motor cables* from motors axes 3, 4, 5 and 6.	How to disconnect cables from motors is detailed in sections: • *Removing motors on page 287*
9	Remove the *bracket* fitted on the tubular shaft unit.	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws M6x16 quality 8.8-A2F (2 pcs) • C: Bracket
10	Remove the *signal lamp*, if used.	

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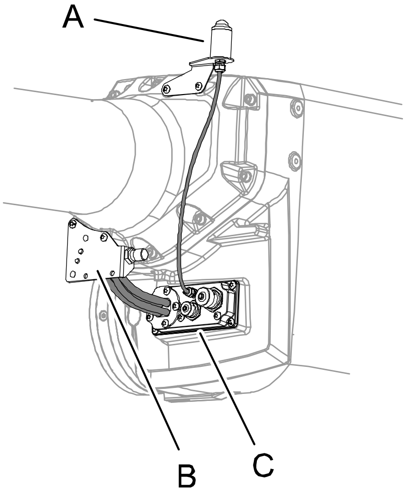
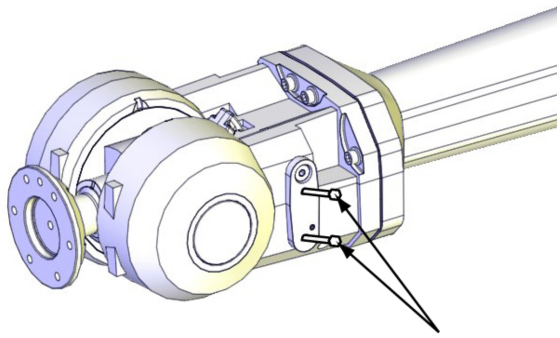
	Action	Note
11	Remove the *cable bracket* on the armhouse.	 xx0800000338 Parts: • A: Signal lamp • B: Bracket • C: Cable bracket
12	Using caution, pull the cable package out of the hole where the cable bracket was fitted.	
13	Remove the *attachment screws* securing the upper arm to the lower arm.	See the figure in: • *Location of the complete upper arm on page 247* **Note** Do not remove the attachment screws securing the gearbox axis 3 to the armhouse!
14	Remove the complete upper arm.	

Attaching the lifting accessories to the upper arm

Attaching the lifting accessories

	Action	Note
1	Fit two *screws* in the wrist unit. The purpose of these screws is to prevent the roundsling from sliding.	Dimension is specified in *Required equipment on page 248*.  xx1100000568

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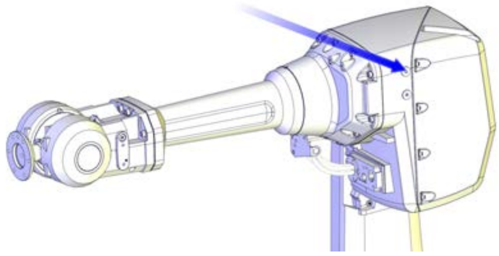
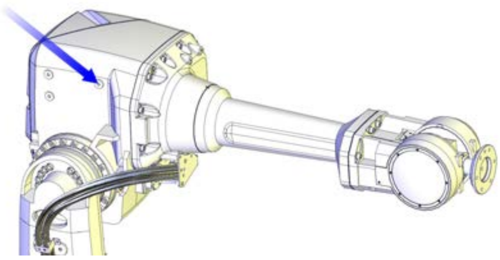
	Action	Note
2	Fit two *rotating lifting points* to the attachment holes in the arm house, see the figure. Secure the lifting point tightly against the arm house, but at the same time making sure that the screw does not bottom. Use an extra *washer* if the screw does bottom. Tightening torque: 30 Nm.	Dimension is specified in *Required equipment on page 248*.  xx1100000565  xx1100000566
3	Run a *roundsling* through each rotating lifting point and fasten both ends at the lifting hook.	Dimension is specified in *Required equipment on page 248*. See figure *Attaching the roundslings to the upper arm on page 254*.
4	Make a loop of the third *roundsling*, running it around the wrist unit. Run the roundsling on both sides of the screws and fasten the free end of the roundsling to the lifting hook.	Dimension is specified in *Required equipment on page 248*. See figure *Attaching the roundslings to the upper arm on page 254*.

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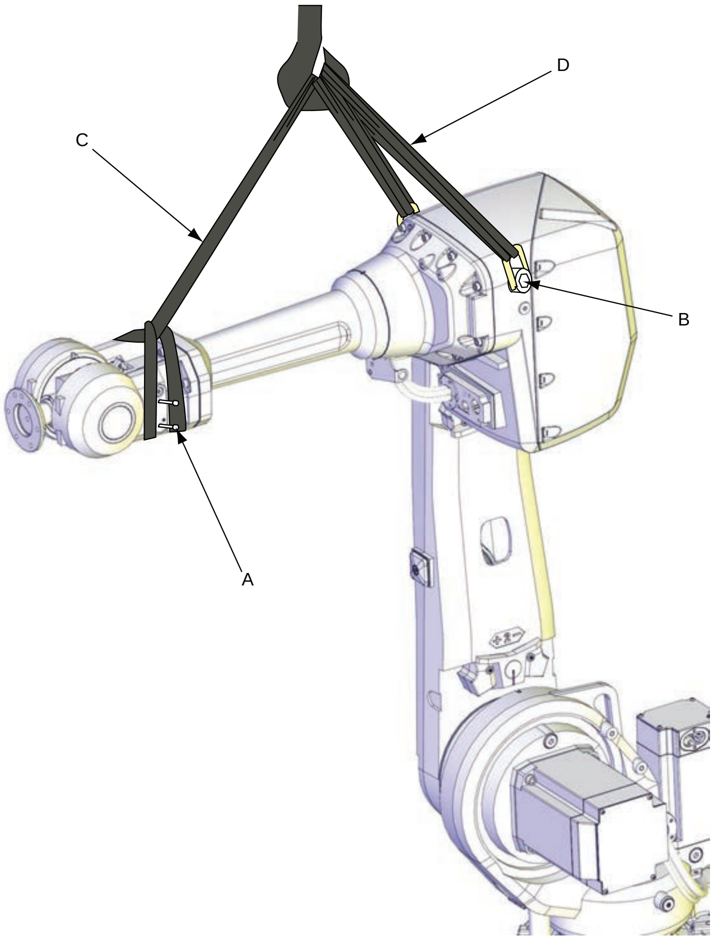
Attaching the roundslings to the upper arm



xx1100000567

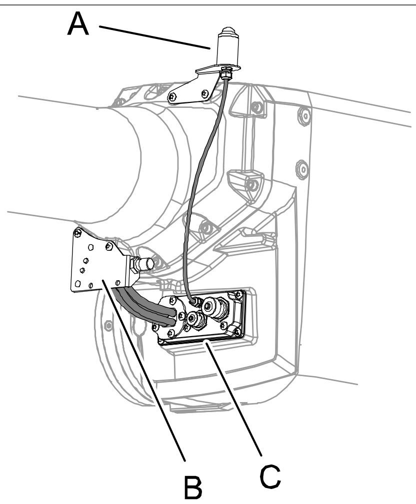
A	Screws to prevent the roundsling from sliding, 2 pcs
B	Rotating lifting point, 2 pcs
C	Roundsling around wrist unit Length: 1.5 m.
D	Roundsling attached to arm house, 2 pcs Length: 1.5 m.

Refitting the complete upper arm

Use this procedure to refit the complete upper arm.

	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	**CAUTION** The weight of the complete upper arm (including the wrist) is 140 kg All lifting accessories used must be sized accordingly.	
3	Clean all assembly surfaces.	
4	Attach the lifting accessories to the upper arm.	See *Attaching the lifting accessories to the upper arm on page 252*.
5	Fit *guide pins* to the upper arm.	Specified in *Required equipment on page 248*.
6	Lift the upper arm to the robot using an overhead crane.	
7	Release the brakes of the axis 3 motor.	
8	Refit the upper arm to the lower arm with its *attachment screws*. **Note** Use new attachment screws! It may be necessary to turn the gear by rotating the motor pinion with a *rotation tool, motor* beneath the motor cover.	See the figure in: • *Location of the complete upper arm on page 247* Tightening torque **Other design than Type C and Type D:** • 35 Nm Tightening torque and angle **Type C and Type D:** • 50 Nm and 90° angle
9	Using caution, push the cable package through the hole where the cable bracket will be fitted.	 xx0800000338 Parts: • A: Signal lamp • B: Bracket • C: Cable bracket
10	Refit the *cable bracket* with its attachment screws.	
11	Reconnect all *motor cables*.	How to connect motor cables is detailed in sections: • *Refitting motors on page 295*

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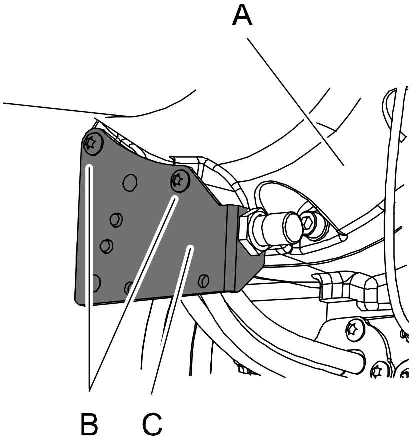
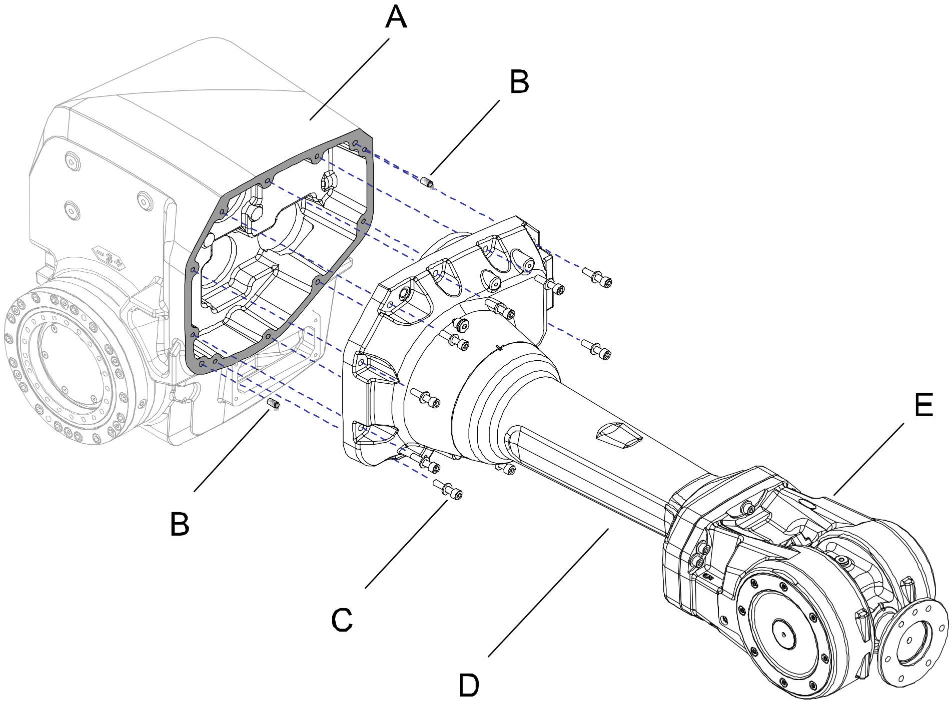
	Action	Note
12	Refit the *bracket* on the *tubular shaft unit*.	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws M6x16 quality 8.8-A2F (2 pcs) • C: Bracket
13	Refit the *signal lamp*, if used.	
14	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 350*. General calibration information is included in section *Calibration on page 335*.
15	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.4.2 Replacing complete tubular shaft unit

Location of tubular shaft unit

The tubular shaft unit is located as shown in the figure.



xx0800000334

A	Armhouse
B	Parallel pin, hardened 8x16 m6 (2 pcs)
C	Attachment screws M8x35 quality 8.8-A2F and washers (10 + 10 pcs)
D	Tubular shaft unit
E	Wrist unit

Required equipment

Equipment	Note
Tubular shaft unit	For spare parts no. see Spare parts - *Upper arm (2.05/2.50/2.55)* in *Product manual, spare parts - IRB 2600*.
Guide pins	2 pcs. Dimension: M8.
Cleaning agent	Isopropanol
Sealing liquid	Loctite 574
Standard toolkit	Content is defined in section *Standard tools on page 386*.
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Continues on next page

Deciding calibration routine

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

	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing complete tubular shaft unit

Use this procedure to remove the complete tubular shaft unit.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Drain *oil* from gearbox axis 4.	How to drain the oil from the gearbox is described in section: • *Changing the oil, axis-4 gearbox on page 169*
3	Move the robot to the position shown in the figure.	 xx0800000336

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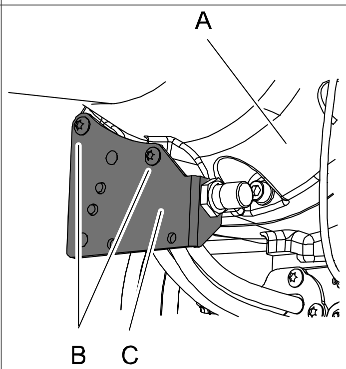
	Action	Note
4	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
5	Remove the *bracket* securing the cable package to the tubular shaft unit by removing its attachment screws.	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws M6x16 quality 8.8-A2F (2 pcs) • C: Bracket
6	Place the cable package in a way that it will not be damaged in the continued removal procedure.	
7	Remove motors axes 4, 5 and 6.	How to remove motors is described in section: • *Removing motors on page 287*
8	**Tip** If only the tubular shaft unit shall be replaced, it is a good idea to remove the *wrist unit* at this stage.	How to remove the wrist unit is detailed in section: • *Removal of wrist unit on page 265*
9	**CAUTION** The robot arm tube weighs 65 kg. All lifting accessories used must be sized accordingly.	

Continues on next page

	Action	Note
10	Secure the *tubular shaft unit* with round-slings in an overhead crane. **CAUTION** Prevent the slings from sliding! For example a small plate can be fitted to the lower attachment hole for the cable bracket (removed in a previous step). The plate should be fitted so it points down-wards and functions as a mechanical stop for the roundsling. At the other end of the tubular shaft unit, a shackle can be fitted if the wrist unit is re-moved.	
11	Remove the *attachment screws* that secure the tubular shaft unit.	See the figure in: • *Location of tubular shaft unit on page 257*
12	Remove the *tubular shaft unit* using caution. The tubular shaft unit is fitted with Loctite. **CAUTION** Do not damage the gears when removing the tubular shaft unit. **CAUTION** Remaining oil will drain out from the gear-box cavity when the tubular shaft is lifted out.	**Note** There are two parallel pins guiding the tubular shaft unit into its place. See figure in *Replacing complete tubular shaft unit on page 257*.

Refitting complete tubular shaft unit

Use this procedure to refit the tubular shaft 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 residues of old Loctite and other contaminations from the assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	

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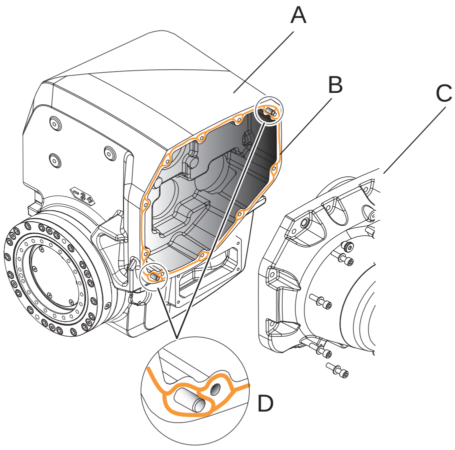
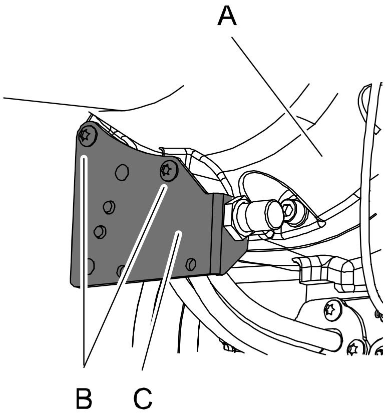
	Action	Note
3	Apply sealing liquid (Loctite 574) on the surface between the tubular shaft unit and the armhouse. Make sure to apply the sealing liquid in circles around each of the attachment holes.	 xx0800000457 Parts: A Armhouse B Surface where Loctite 574 shall be applied C Tubular shaft unit D Cylindrical pin (2 pcs)
4	**CAUTION** The robot arm tube weighs 65 kg. All lifting accessories used must be sized accordingly!	
5	Secure the tubular shaft unit with a roundsling in an overhead crane. **CAUTION** Prevent the slings from sliding! For example a small plate can be fitted to the lower attachment hole for the cable bracket (removed in a previous step). The plate should be fitted so it points downwards and functions as a mechanical stop for the roundsling. At the other end of the tubular shaft unit, a shackle can be fitted if the wrist unit is removed.	
6	Fit *guide pins* in the upper arm house.	Specified in *Required equipment on page 257*.
7	Refit the tubular shaft unit, using caution. **CAUTION** Do not damage the gears when refitting the tubular shaft unit.	**Note** There are two parallel pins guiding the tubular shaft unit into its place.

Continues on next page

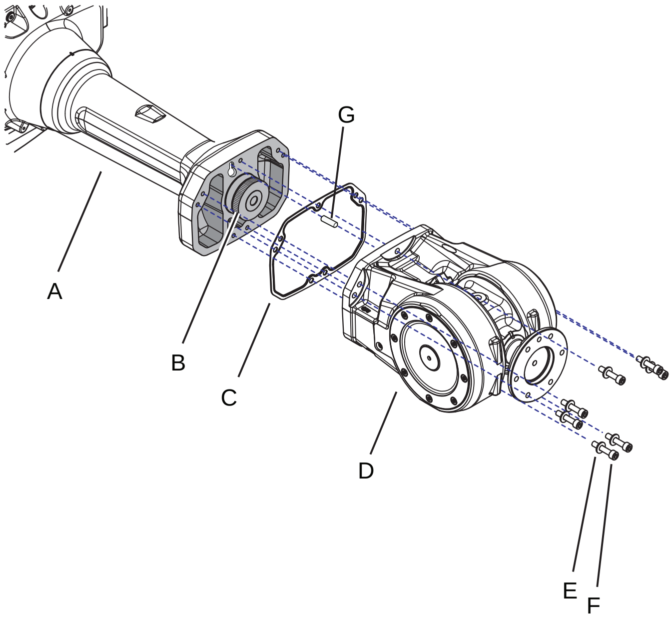
	Action	Note
8	Secure the tubular shaft unit with its *attachment screws*.	See the figure in: • *Location of tubular shaft unit on page 257* Tightening torque: 22 Nm
9	Refit *motors axes 4, 5 and 6*.	How to refit motors is described in section: • *Refitting motors on page 295*
10	Perform a leak-down test.	See *Performing a leak-down test on page 188*.
11	Refit the *bracket* securing the cable package to the tubular shaft unit, with its *attachment screws*.	 xx0800000335 Parts: • A: Tubular shaft unit • B: Attachment screws M6x16 quality 8.8-A2F (2 pcs) • C: Bracket
12	If the *wrist unit* has been removed from the tubular shaft unit, refit it now.	How to refit the wrist unit is detailed in section: • *Refitting of wrist unit on page 266*
13	Refill gearbox axis 4 with oil.	How to refill oil in gearbox is described in section: • *Changing the oil, axis-4 gearbox on page 169*
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 350*. General calibration information is included in section *Calibration on page 335*.
15	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.4.3 Replacing wrist unit

Location of wrist unit

The wrist unit is located in the upper arm as shown in the figures.

IRB 4600 -60/2.05, -45/2.05, -40/2.55



xx0800000333

A	Upper arm
B	Gear
C	O-ring/sealing plate
D	Wrist unit
E	Spring washer, conical 8.4x18x2, quality steel-mZn12c (7 pcs)
F	Attachment screw M8x40, quality steel 12.9 Gleitmo (7 pcs)
G	Guide pin (only available for robots that are calibrated with Axis Calibration)

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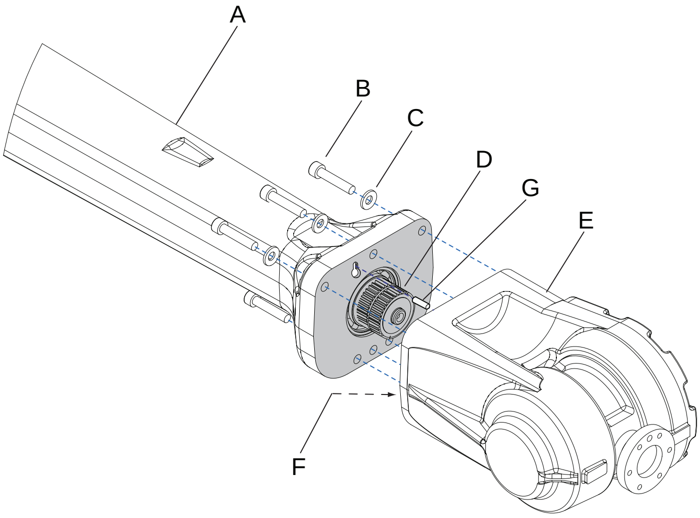
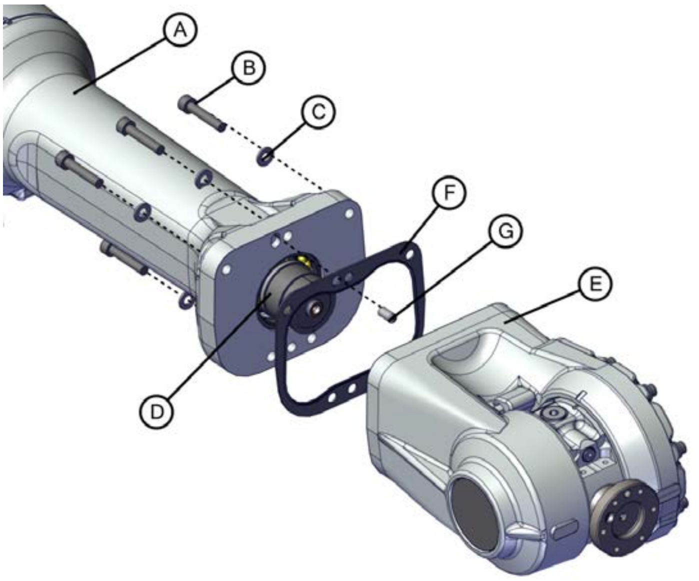
There are two versions of the wrist, one with an o-ring and one with a sealing. Make sure to order the correct spare parts.

IRB 4600 -20/2.50



xx0800000341



xx1800003343

A	Upper arm
B	Attachment screw M8x40, quality steel 12.9 Gleitmo (5 pcs)
C	Spring washer, conical 8.4x18x2, quality steel-mZn12c (5 pcs)
D	Gears
E	Wrist unit
F	O-ring (Placed on the wrist, not visible) Sealing (lower image)
G	Guide pin (only available for robots that are calibrated with Axis Calibration)

Continues on next page

Required equipment

Equipment	Note
Wrist unit	For spare parts no. see Spare parts - *Upper arm (2.05/2.50/2.55)* in *Product manual, spare parts - IRB 2600*.
O-ring	For spare parts no. see Spare parts - *Upper arm (2.05/2.50/2.55)* in *Product manual, spare parts - IRB 2600*.
Sealing	
Measuring tool	For adjusting the play.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removal of wrist unit

Use this procedure to remove the 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

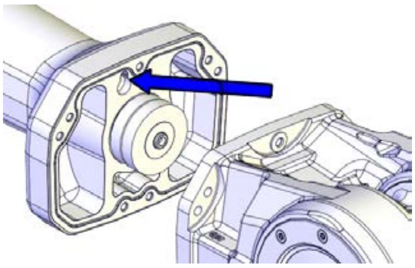
	Action	Note
2	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
3	Drain *oil* from gearbox axes 5-6.	How to drain the oil from gearbox axes 5-6 is described in section: • *Changing oil, axes-5 and -6 gearboxes on page 173*
4	**CAUTION** The robot wrist unit weighs 25 kg (IRB 4600 - 60/2.05, - 45/2.05, -40/2.55) and 15 kg (IRB 4600 - 20/2.50). All lifting accessories used must be sized accordingly!	
5	Secure the wrist unit with a roundsling in an overhead crane or similar.	
6	Remove the *attachment screws* and carefully remove the wrist unit. **CAUTION** Do not damage the gears.	See the figure in: • *Location of wrist unit on page 263*

Refitting of wrist unit

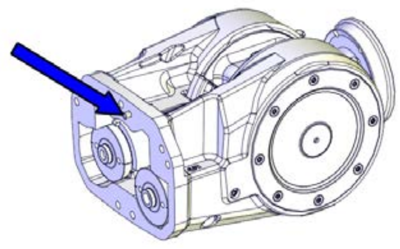
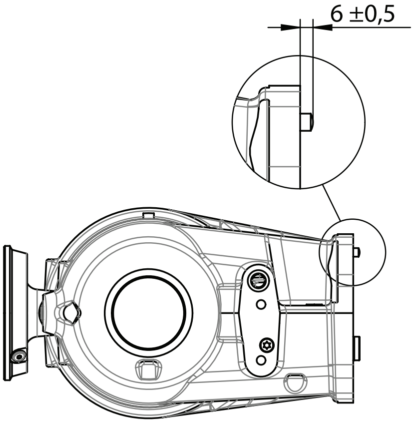
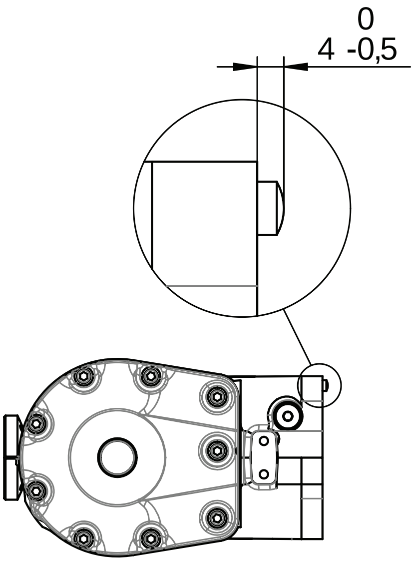
Use this procedure to refit the wrist unit.

	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.	

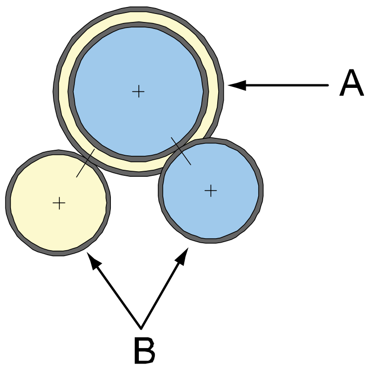
Continues on next page

	Action	Note
2	Check if there is a parallel pin hole in the upper arm tube. The hole is available on robots that are calibrated with the Axis Calibration method.	 xx1600000690

Continues on next page

	Action	Note
3	If there is a hole, fit the parallel pin into the corresponding hole in the wrist (enclosed with the new wrist spare part). **Note** If the parallel pin is not installed on a robot calibrated with Axis Calibration, the calibration result will be affected negatively.	 xx1600000689 Verify that the parallel pin sticks out from the wrist according to the measurement given below. IRB 4600 -60/2.05, -45/2.05, -40/2.55  xx1600000702 IRB 4600 -20/2.50  xx1600000703
4	Clean all assembly surfaces. Remove any painting from the assembly surfaces with a knife.	

Continues on next page

	Action	Note
5	**Not applicable to variant IRB 4600-20/2.50.** Fit the **o-ring sealing plate.**	See the figure in: • *Location of wrist unit on page 263*
6	Check the o-ring or sealing. Replace if damaged.	See the figure in: • *Location of wrist unit on page 263*
7	Prepare the refitting of the wrist by inserting the attachment screws and washers in the upper arm tube.	
8	**CAUTION** The robot wrist unit weighs 25 kg (IRB 4600 - 60/2.05, - 45/2.05, -40/2.55) and 15 kg (IRB 4600 - 20/2.50). All lifting accessories used must be sized accordingly.	
9	Carefully put the *wrist unit* in its place on the *upper arm*. **CAUTION** Do not damage the gears. **CAUTION** Make sure that the o-ring stays in place on the wrist unit.	
10	Adjust the play of the wrist by following these steps: • Fit the *measuring tool* at the rear of the motor. • Push the wrist as shown in the figure to locate the smallest play in the same way as for adjustment of motors for axes 4, 5 and 6. See *Refitting motors on page 295*.	 xx1000000223 Parts: • A: Gears on drive shaft unit, axes 5-6 • B: Gears on the wrist
11	Secure the wrist unit with its *attachment screws* and *washers*.	See the figure in • *Location of wrist unit on page 263* Tightening torque: 35 Nm.

Continues on next page

	Action	Note
12	*Measure the play* by moving axes 5 and 6 with the measuring tool.	How to measure the play is described in sections: • *Measuring the play, axis 5 on page 271* • *Measuring the play, axis 6 on page 274*
13	Perform a leak-down test.	See *Performing a leak-down test on page 188*.
14	Refill *oil* in gearbox axes 5-6.	How to fill oil in gearbox axes 5-6 is described in section: • *Changing oil, axes-5 and -6 gearboxes on page 173*
15	Re-calibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 350*. General calibration information is included in section *Calibration on page 335*.
16	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.4.4 Measuring the play, axis 5

General

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

Required equipment

Equipment, etc.	Article number	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 386*.
Measuring tool, play (IRB 4600 -60/2.05, -45/2.05, -40/2.55)	3HAB1611-6	
Measuring tool, play (IRB 4600 -20/2.50)	3HAB6337-1	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Measurement, axis 5

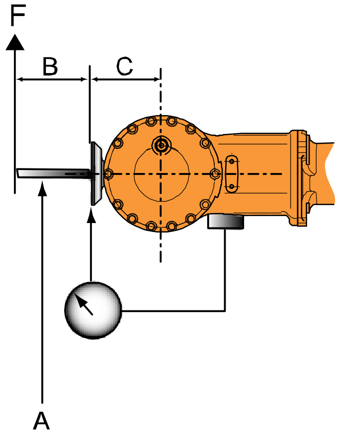
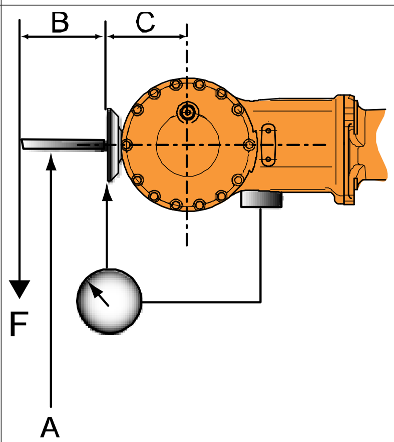
The procedure below details how to measure the play of axis 5.

Note

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

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Move the robot to calibration position and turn the axis 4 90°.	
3	Fit the *measuring tool, play* to the turning disc.	Article number is specified in *Required equipment on page 271*.

Continues on next page

	Action	Information
4	Apply load F in one direction, as shown in the figure to the right. **Note** Different load and distances for the different robot versions, as specified to the right!	 xx0300000186 **Values for IRB 4600 - 60/2.05, -45/2.05, -40/2.55:** • A: Measuring tool, play • B: 207.5 mm • C: 135 mm • F: 90N **Values for IRB 4600 -20/2.50:** • A: Measuring tool, play • B: 140 mm • C: 85 mm • F: 40N
5	Remove the load and set the dial indicator to zero.	
6	Apply load F in the opposite direction, as shown in the figure to the right.	 xx0300000187 **Values for IRB 4600 -60/2.05, -45/2.05, -40/2.55:** • A: Measuring tool, play • B: 207.5 mm • C: 135 mm • F: 90N **Values for IRB 4600 -20/2.50:** • A: Measuring tool, play • B: 140 mm • C: 85 mm • F: 40N

Continues on next page

	Action	Information
7	Remove the load and measure the play by reading the dial indicator.	The maximum play allowed at the given distance from the center of axis 5 is, for robot version: • IRB 4600 -60/2.05, -45/2.05, -40/2.55: **0.10 mm** • IRB 4600 -20/2.50: **0.08 mm**

4.4.5 Measuring the play, axis 6

General

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

Required equipment

Equipment	Article number	Note
Standard toolkit	-	Content is defined in section *Standard tools on page 386*.
Measuring tool, play (IRB 4600 -60/2.05, -45/2.05, -40/2.55)	3HAB1611-6	
Measuring tool, play (IRB 4600 -20/2.50)	3HAB6337-1	
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.		These procedures include references to the tools required.

Measurement, axis 6

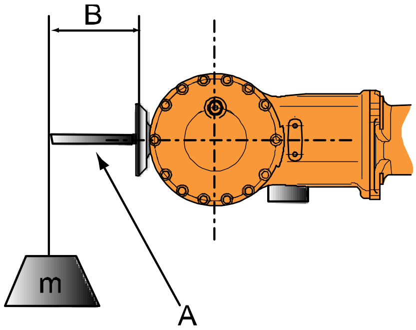
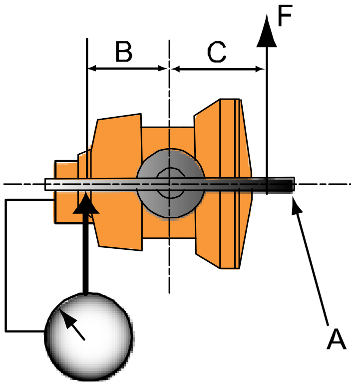
The procedure below details how to measure the play in axis 6.

Note

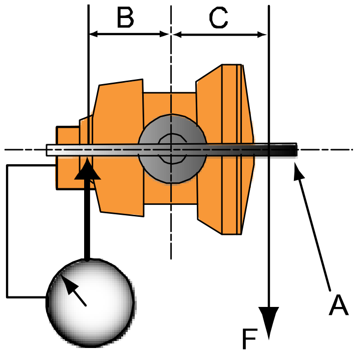
The measuring tool and measuring values differ depending on robot version.

	Action	Information
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Fit the *measuring tool, play* to the turning disc.	Article number is specified in *Required equipment on page 274*.

Continues on next page

	Action	Information
3	Attach a weight (m) at a distance (B) from the wrist flange, in order to avoid the effects of play on axis 5. **Note** Different weight and distance for the different robot versions, as specified to the right.	 xx0300000188 **Values for robot versions IRB 4600 -60/2.05, -45/2.05, -40/2.55:** • A: Measuring tool, play • B: 207.5 mm • m: 20 kg **Values for robot version IRB 4600 -20/2.50:** • A: Measuring tool, play • B: 140 mm • m: 10 kg
4	Apply load F in one direction. **Note** Different load and distances for the different robot versions, as specified to the right.	 xx0300000189 **Values for robot versions IRB 4600 -60/2.05, -45/2.05, -40/2.55:** • A: Measuring tool, play • B: 100 mm • C: 100 mm • F: 50N **Values for robot version IRB 4600 -20/2.50:** • A: Measuring tool, play • B: 100 mm • C: 150 mm • F: 40N
5	Remove the load and set the dial indicator to zero.	

Continues on next page

	Action	Information
6	Apply load F in the opposite direction, as shown in the figure to the right.	 xx0300000190 **Values for robot versions IRB 4600 -60/2.05, -45/2.05, -40/2.55:** • A: Measuring tool, play • B: 100 mm • C: 100 mm • F: 50N **Values for robot version IRB 4600 -20/2.50:** • A: Measuring tool, play • B: 100 mm • C: 150 mm • F: 40N
7	Remove the load and measure the play by reading the dial indicator.	The maximum play allowed at the given distance (B) from the center of axis 6 is, for robot version: • IRB 4600 -60/2.05, -45/2.05, -40/2.55: **0.16 mm** • Values for IRB 4600 -20/2.55: **0.19 mm**

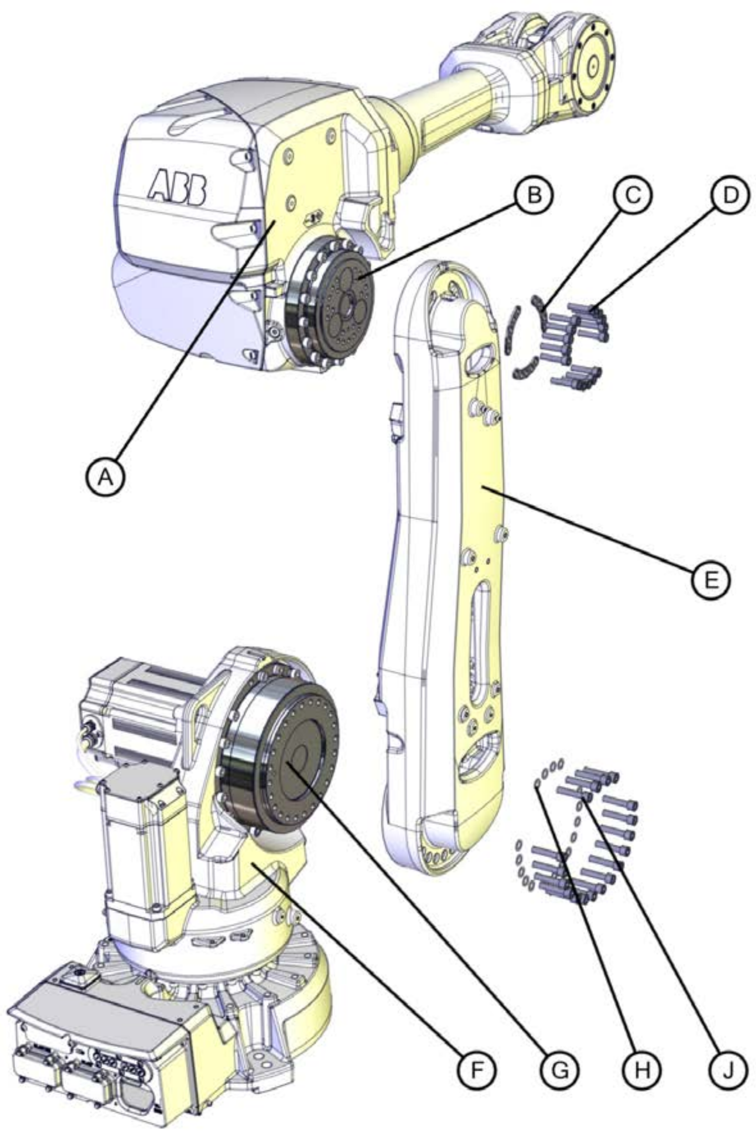
4.5 Lower arm

4.5.1 Replacing the lower arm

Location of lower arm

Type C and Type D

The lower arm is located as shown in the figure.



xx1200000636

A	Upper arm
B	Axis-3 gearbox

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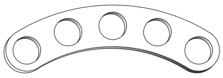
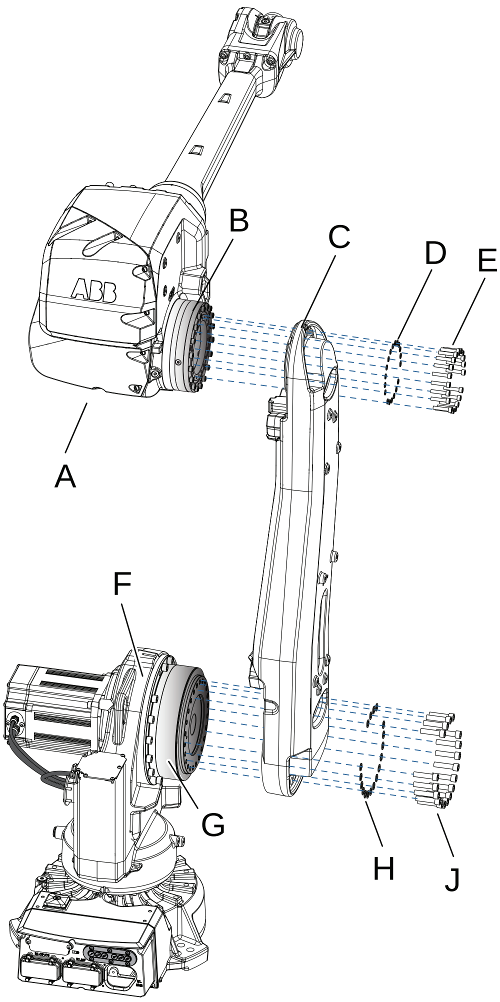
C	Washer with five holes (3 pcs)  xx1200000520
D	Attachment screws M10x40 quality Steel 12.9 Gleitmo (15 pcs)
E	Lower arm
F	Frame
G	Axis-2 gearbox
H	Washer (18 pcs)
J	Attachment screws M12x50 quality Steel 12.9 Gleitmo (18 pcs)

Other design than Type C and Type D

The lower arm is located as shown in the figure.



xx0800000360

A	Upper arm
B	Axis-3 gearbox
C	Lower arm

Continues on next page

D	Washer (19 pcs)
E	Attachment screws M8x40 quality Steel 12.9 Gleitmo (19 pcs)
F	Frame
G	Axis-2 gearbox
H	Washer (18 pcs)
J	Attachment screws M12x50 quality Steel 12.9 Gleitmo (18 pcs)

Required equipment

Equipment	Note
Lower arm	For spare parts no. see Spare parts - *Lower arm and motors* in *Product manual, spare parts - IRB 2600*.
Lifting eye	Type C and Type D M10 Other design than Type C and Type D M8
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

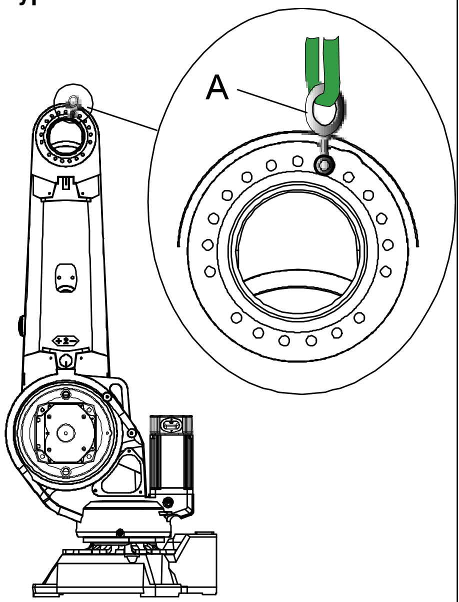
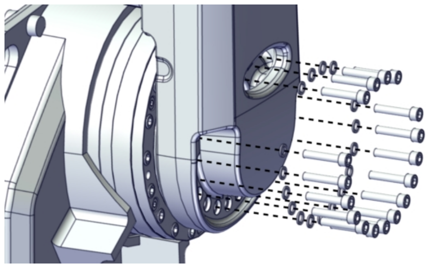
Continues on next page

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	Move the robot to the position shown in the figure.	 xx0800000336
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 *cable package* from all axes except in the base.	How to remove the cable package in frame, lower arm and armhouse is described in sections: • *Removing cable harness in frame on page 205* • *Removing cable harness in lower arm and armhouse on page 206*
5	Secure the upper arm with a roundsling in an overhead crane.	
6	Remove the *complete upper arm* and put it on a loading pallet.	How to remove the complete upper arm is described in section: • *Removing the complete upper arm on page 250*
7	 **CAUTION** The robot lower arm weighs 65 kg. All lifting accessories used must be sized accordingly!	

Continues on next page

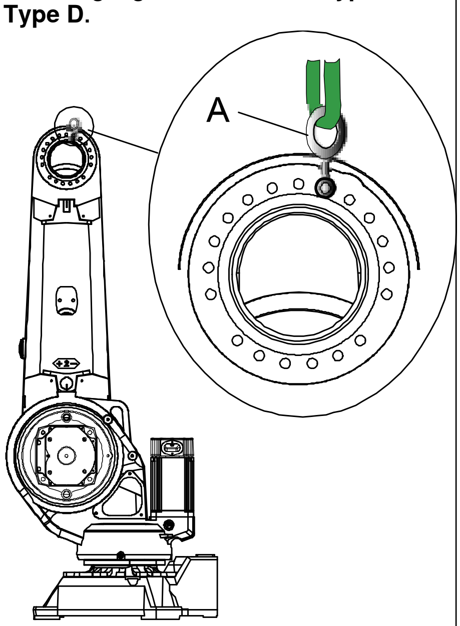
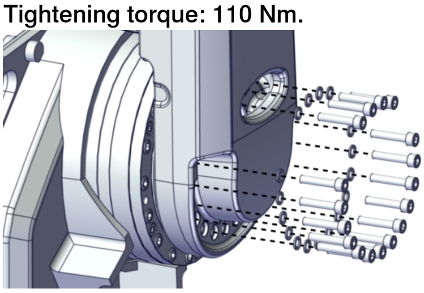
	Action	Note
8	Fit a *lifting lug* in one of the upper holes in the lower arm, for the attachment screws.	The figure shows **other design than Type C and Type D**, but the principle of fitting the lifting lug is the same on **Type C and Type D**.  xx0800000379 Parts: • A: Lifting lug
9	Remove the *attachment screws and washers* that secure the lower arm to the axis-2 gearbox.	 xx1800000935
10	Remove the lower arm.	

Refitting the lower arm

Use this procedure to refit the lower arm.

	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	**CAUTION** The robot lower arm weighs 65 kg. All lifting accessories used must be sized accordingly!	
3	Fit a *lifting lug* in one of the upper holes in the lower arm, for the attachment screws.	The figure shows **other design than Type C and Type D**, but the principle of fitting the lifting lug is the same on **Type C and Type D**.  xx0800000379 Parts: • A: Lifting lug
4	Secure the lower arm with a roundsling in an overhead crane and lift it to the robot.	
5	Refit the *attachment screws and washers* to secure the lower arm to the axis-2 gear-box.	Attachment screws: M12x50 quality steel Gleitmo 12.9 (18 pcs) Tightening torque: 110 Nm.  xx1800000935
6	Secure the complete upper arm with round-slings in an overhead crane and lift it to the robot.	
7	Refit the *complete upper arm*.	How to refit the complete upper arm is described in section: • *Refitting the complete upper arm on page 254*

Continues on next page

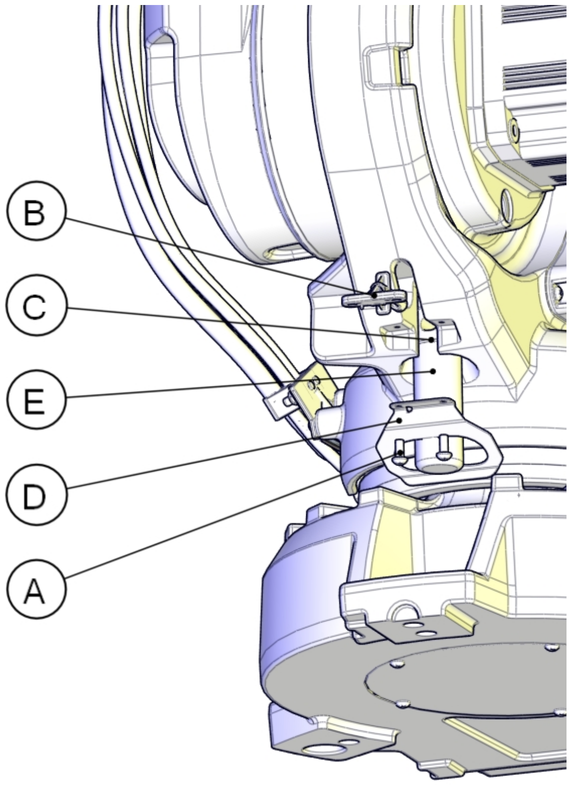
	Action	Note
8	Refit the *cable package*.	How to refit the cable package in frame, lower arm and armhouse is described in sections: • *Refitting the cable harness in the frame on page 212* • *Refitting the cable harness in the lower arm and armhouse on page 221*
9	Recalibrate the robot.	Pendulum Calibration is described in *Operating manual - Calibration Pendulum*, enclosed with the calibration tools. Axis Calibration is described in *Calibrating with Axis Calibration method on page 350*. General calibration information is included in section *Calibration on page 335*.
10	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.6 Frame and base

4.6.1 Replacing stop pin axis 1

Location of stop pin axis 1

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



xx0800000045

A	Attachment screws M6x16 quality 8.8-A2F (2 pcs)
B	Bracket
C	O-ring (2 pcs) - Not used if bracket (D) is installed.
D	Bracket
E	Stop pin

Required equipment

Equipment	Note
Stop pin	For spare parts number, see Spare parts - *Frame and base* in *Product manual, spare parts - IRB 2600*.
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Continues on next page

Equipment	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Removing the stop pin, axis 1

Use this procedure to remove the stop pin axis 1.

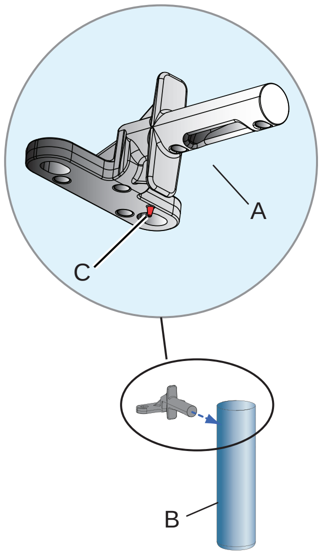
	Action	Note
1	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
2	Remove the *attachment screws* securing the *bracket* and *stop pin*.	See the figure in • *Location of stop pin axis 1 on page 284*
3	Remove the *bracket* and *stop pin*.	See the figure in • *Location of stop pin axis 1 on page 284*

Refitting the stop pin, axis 1

Use this procedure to refit the stop pin 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.	
2	Fit the two *o-rings* on the stop pin. **Note** The o-rings are not used when bracket (D) is installed.	See the figure in • *Location of stop pin axis 1 on page 284*

Continues on next page

	Action	Note
3	Fit the *stop pin* on the *bracket*. **Note** The small spike on the bracket shall be pointing downwards for correct fitting of the stop pin.	 xx0800000453 Parts: • A: Bracket • B: Stop pin • C: Small spike
4	Secure the stop pin together with bracket (D) on the frame with its *attachment screws*. Use Locking liquid	3HAB7116-1 (Loctite 243). Tightening torque: 10 Nm See the figure in • *Location of stop pin axis 1 on page 284*
5	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.7 Motors

4.7.1 Removing motors

Introduction

This procedure describes how to remove motors on all axes of the robot.

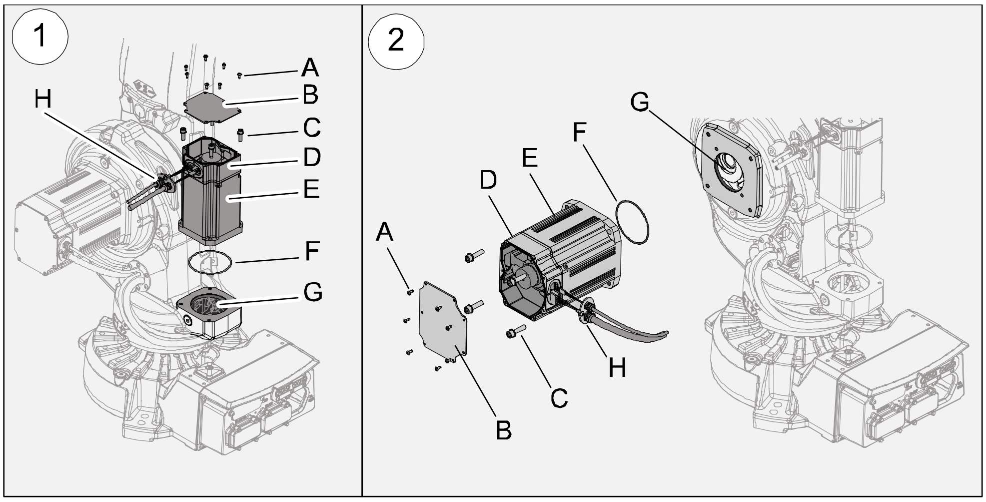
Location of axis-1 and axis-2 motors

The axis-1 and axis-2 motors are located as shown in the figure.

Motors:

(1) = Axis-1 motor

(2) = Axis-2 motor



xx0900000302

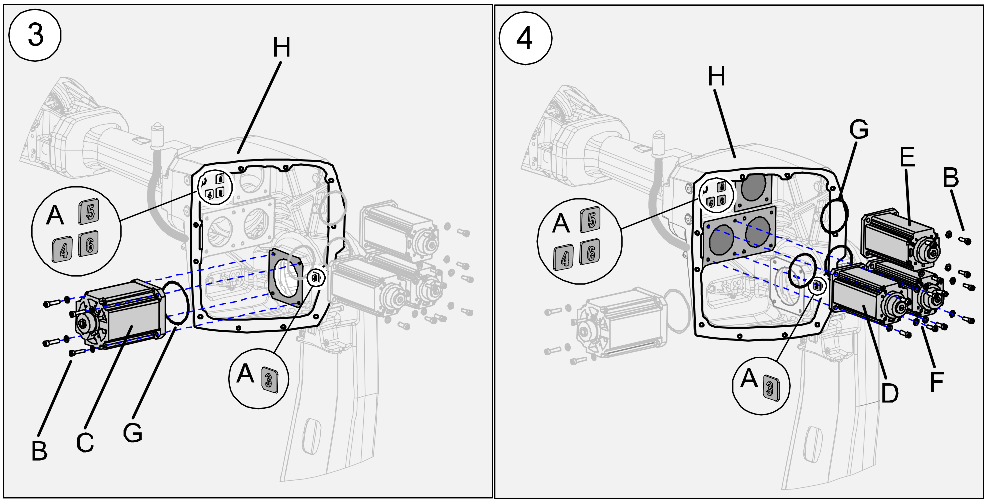
A	Attachment screws M5x16, quality Steel 8-A2F (7 pcs)
B	Motor cover
C	Attachment screws, axis-1 motor (4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
C	Attachment screws, axis-2 motor (4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
D	Connection box
E	Axis-1 motor
E	Axis-2 motor
F	O-ring
G	Hole
H	Cable gland cover

Continues on next page

Location of axis-3, axis-4, axis-5 and axis-6 motors

The axis-3, axis-4, axis-5 and axis-6 motors are located as shown in the figures.

Motors: (3) = Axis-3 motor. (4) = Axis-4, axis-5 and axis-6 motors.



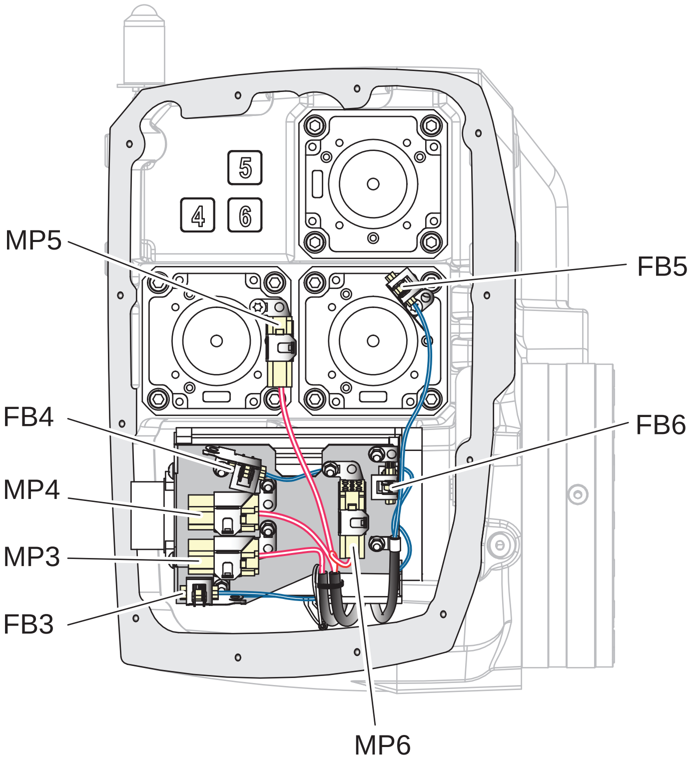
xx0900000303

A	Markings inside armhouse, identifying the position of each motor
B	Attachment screws, axis-3 motor (4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
B	Attachment screws, axis-4, axis-5 and axis-6 motors (3x4 pcs) + washers. *Tightening torques and attachment screws on page 299*
C	Axis-3 motor
D	Axis-4 motor
E	Axis-5 motor
F	Axis-6 motor
G	O-ring (axis-4, axis-5 and axis-6)
H	Armhouse

Continues on next page

Connectors, axis-3 and axis-4 motors

The figure shows the connectors of motors axes 3-6.



xx0900000410

Required equipment

Equipment	Note
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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.

Weights

The motors for the different axes weighs according to the table:

Motor	Weight in kg
Axis-1 motor	13 kg
Axis-2 motor	25 kg
Axis-3 motor	13 kg
Axis-4 motor	8 kg
Axis-5 motor	8 kg
Axis-6 motor	8 kg

Continues on next page

CAUTION

All lifting equipment must be sized accordingly!

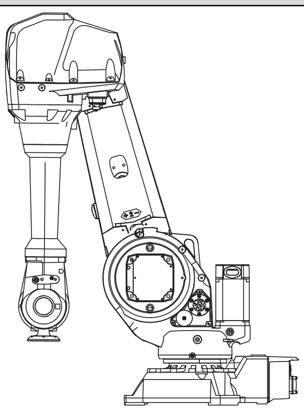
Deciding calibration routine

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.

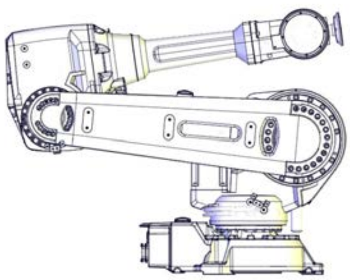
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is 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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Position of robot

Use this procedure to place the robot in the position recommended in order to facilitate replacement of motors.

	Action	Information
	Axis-1, axis-4, axis-5 and axis-6 motor • Move the robot to a position where the wrist is pointing to the floor, as shown in the figure. This will make it possible to remove the motors without draining the oil from the gearbox.	 xx0800000388

Continues on next page

	Action	Information
	Axis-2 motor • Move the robot to a position where the lower arm rests firmly on the damper of axes 2 and 3. Release the brake of axis 2 to be sure that the lower arm rests in the end position.	 xx1100000548
	Axis-3 motor • Move axis-2 to 0° and axis-3 to maximal +. Release the brake of axis-3 to be sure that the upper arm is completely vertical and rests against the damper of axis-2 and axis-3.	

Draining gearbox

Use this procedure to drain gearboxes, if needed.

Note

Draining of gearbox is only needed when removing the axes 2 and 3 motors.

	Action	Note
1	Axis-1 motor: • Draining of gearbox is not needed.	-
2	Axis-2 motor: • The gearbox has to be drained before removing the motor.	How to drain the gearbox is described in section: • *Changing the oil, axis-2 gearbox on page 159*
3	Axis-3 motor: • The gearbox has to be drained before removing the motor.	How to drain the gearbox is described in section: • *Changing the oil, axis-3 gearbox on page 163*
4	Axis-4, axis-5 and axis-6 motors: • Draining of gearbox oil is not needed if robot is positioned as recommended.	-

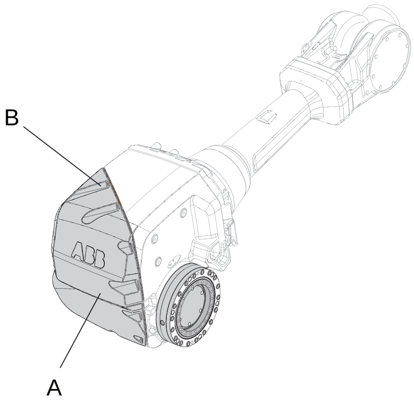
Removing motors

Use this procedure to remove the axis-1, axis-2, axis-3, axis-4, axis-5 and axis-6 motors.

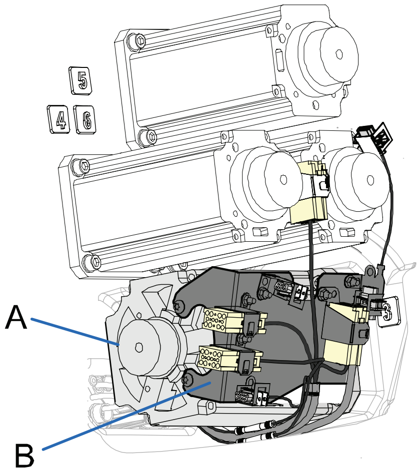
Note

The procedure contains information how to remove motors on all axes of the robot. Some steps are only applicable to a certain motor. Follow the steps carefully in order not to miss vital information!

Continues on next page

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to the recommended position for the motor that shall be removed.	Also see • *Position of robot on page 290*
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Check if the gearbox needs to be drained.	Also see • *Draining gearbox on page 291*
5	**Only applicable to axis-3, axis-4, axis-5 and axis-6 motors!** Remove the cover in the back of the arm house. **WARNING** The robot must never be run without the cover in the armhouse fitted! It is a vital supporting part of the robot.	 xx0800000389 Parts: • A: Cover • B: Attachment screws (10 pcs) + washers.
6	**Only applicable to motors on axes 1 and 2 with fan fitted!** Remove the fan before starting the removal!	How to remove the fan is detailed in section: • *Installation of cooling fan for motors (option) on page 82*
7	**Only applicable to axis-1 and axis-2 motors!** Remove the motor cover.	See the figure in: • *Location of axis-1 and axis-2 motors on page 287*
8	**Only applicable to axis-1 and axis-2 motors!** Remove the cable gland cover.	See the figure in: • *Location of axis-1 and axis-2 motors on page 287*
9	**Only applicable to axis-1 and axis-2 motors!** Remove the connection box. **Note** Only needed if the motor shall be replaced with a new one.	See the figure in: • *Location of axis-1 and axis-2 motors on page 287*

Continues on next page

	Action	Note
10	Disconnect the *motor cables*.	**Note** When removing the axis-3 motor, the cables of the axis-4, axis-5 and axis-6 motors must be disconnected too. This must be done in order to be able to remove the bracket on top of the axis-3 motor.
11	**Only applicable to axis-3 motor!** Remove the *bracket* from the axis-3 motor.	 xx0800000390 Parts: • A: Axis-3 motor • B: Bracket
12	In order to release the brakes of the motor to be removed, connect the 24 VDC power supply to the motor connector. **Tip** **For axis-2 and axis-3 motors:** release the motor brake until the arm firmly rests on the damper for each axis respectively. See positions in *Position of robot on page 290*.	Connectors: • Axis-1 motor: R2.MP1 • Axis-2 motor: R2.MP2 • Axis-3 motor: R2.MP3 • Axis-4 motor: R2.MP4 • Axis-5 motor: R2.MP5 • Axis-6 motor: R2.MP6 Connect to pins: • + : pin 2 • -: pin 5 **CAUTION** The connections for the motor brakes (24 VDC connection) are phase dependent. If the connection on the pins is switched, it can cause severe damage to vital parts.
13	**Note** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	

Continues on next page

	Action	Note
14	Remove the attachment screws securing the motor. If needed use a 300 mm extension for bits 1/2" (Motor axis 1).	See the figure in: • *Location of axis-1 and axis-2 motors on page 287*
15	If required, press the motor out of position by fitting two screws in the threaded holes in the motor flange.	**Note** Always use removal tools in pairs diagonal to each other.
16	Remove the motor!	**CAUTION** Lift the motor gently in order not to damage pinion or gears.
17	**Only applicable to motor axis 1!** Cover the hole if replacement of motor axis 1 is not immediate, in order to avoid contamination.	See the figure in: • *Location of axis-1 and axis-2 motors on page 287*
18	**Only applicable to motors axes 4, 5 and 6!** Check that the o-ring also is removed. It might stay in the armhouse when the motor is removed.	See the figure in: • *Location of axis-1 and axis-2 motors on page 287*

4.7.2 Refitting motors

Introduction

This procedure describes how to refit motors on all axes of the robot.

WARNING

When a motor is replaced, make sure to use the correct type of new motor. Motors of different types may not be compatible. See the *Spare parts manual* on myABB business portal (*www.abb.com/myABB*).

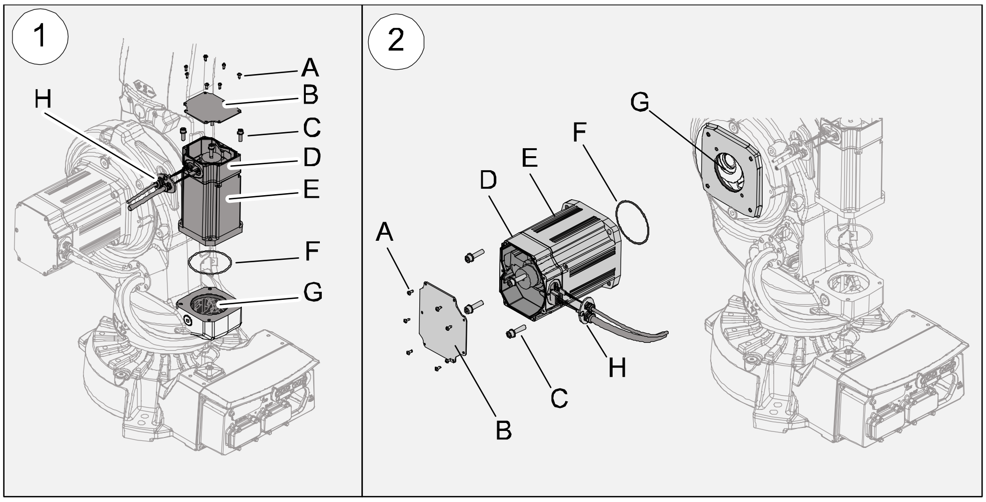
Location of axis-1 and axis-2 motors

The axis-1 and axis-2 motors are located as shown in the figure.

Motors:

(1) = Axis-1 motor

(2) = Axis-2 motor



xx0900000302

A	Attachment screws M5x16, quality Steel 8-A2F (7 pcs)
B	Motor cover
C	**Axis-1 motor:** Attachment screws(4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
C	**Axis-2 motor:** Attachment screw (4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
D	Connection box
E	Axis-1 motor
E	Axis-2 motor
F	O-ring
G	Hole
H	Cable gland cover

Continues on next page

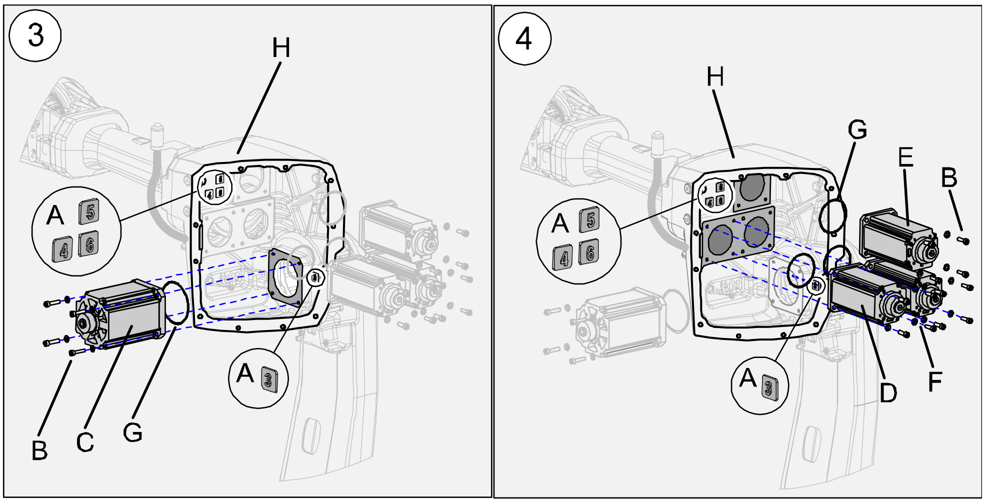
Location of axis-3, axis-4, axis-5 and axis-6 motors

The axis-3, axis-4, axis-5 and axis-6 motors are located as shown in the figures.

Motors:

(3) = Axis-3 motor

(4) = Axis-4, axis-5 and axis-6 motors



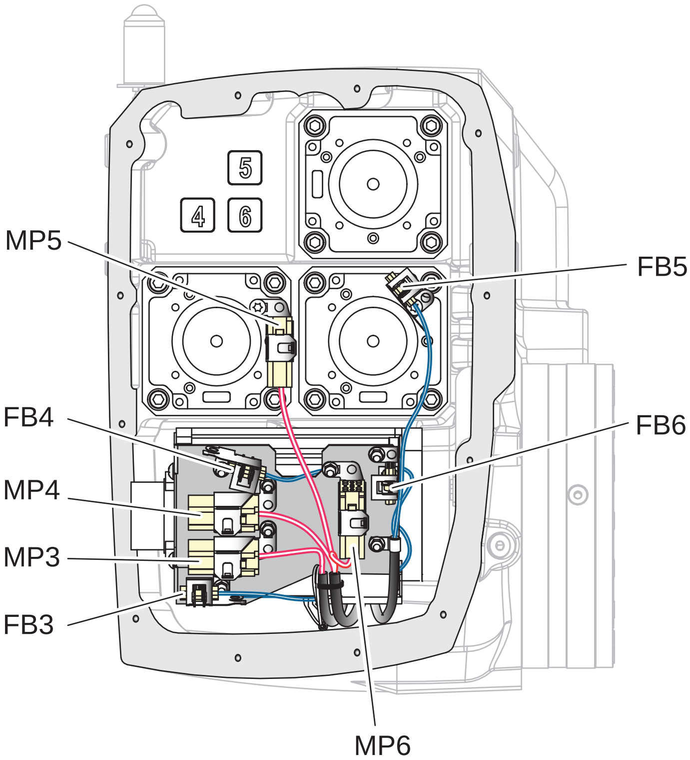
xx0900000303

A	Markings inside armhouse, identifying the position of each motor
B	Attachment screws, axis-3 motor, (4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
B	Attachment screws, axis-4, axis-5 and axis-6 motors, (3x4 pcs) + washers. See *Tightening torques and attachment screws on page 299*
C	Axis-3 motor
D	Axis-4 motor
E	Axis-5 motor
F	Axis-6 motor
G	O-ring (axis-4, axis-5 and axis-6)
H	Armhouse

Continues on next page

Connectors, axis-3 and axis-4 motors

The figure shows the connectors of the axis-3 and axis-4 motors.



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Required equipment

Equipment	Note
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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.
Lifting tool, axis-2	For art. no. see *Reference information*.
Lifting tool, axis-3	For art. no. see *Reference information*.
Motors	For spare part no. see *Spare part lists on page 391*.

Weights

The motors for the different axes weighs according to the table:

Motor	Weight in kg
Axis-1 motor	13 kg
Axis-2 motor	25 kg
Axis-3 motor	13 kg
Axis-4 motor	8 kg
Axis-5 motor	8 kg

Continues on next page

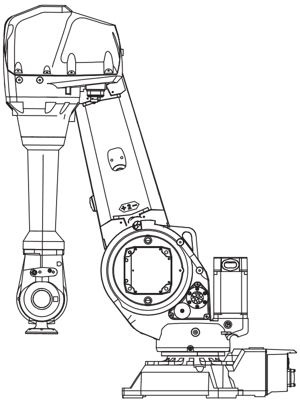
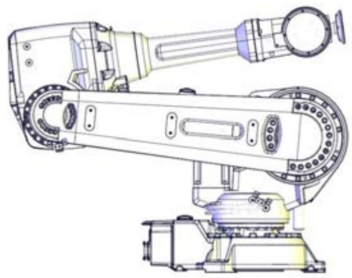
Motor	Weight in kg
Axis-6 motor	8 kg

CAUTION

All lifting equipment must be sized accordingly!

Position of robot

Use this procedure to place the robot in the position recommended in order to facilitate replacement of motors.

	Action	Information
	Axis-1, axis-4, axis-5 and axis-6 motors • Move the robot to a position where the wrist is pointing to the floor, as shown in the figure. This will make it possible to remove the motors without draining the oil from the gearbox.	 xx0800000388
	Axis-2 motor • Move the robot to a position where the lower arm rests firmly on the axis-3 damper. Release the axis-2 brake to be sure that the lower arm rests in the end position.	 xx1100000548
	Axis-3 motor • Move axis-2 to 0° and axis-3 to maximal +. Release the axis-3 brake to be sure that the upper arm is completely vertical and rests against the damper.	

Filling oil in gearbox

Use this procedure to fill oil in gearbox, if needed.

Note

Filling oil in the gearbox is only needed when refitting motors axes 2 and 3.

Continues on next page

	Action	Note
1	Axis-1 motor: • Filling gearbox oil not needed.	-
2	Axis-2 motor: • Refill oil in gearbox after refitting.	How to fill oil in gearbox is described in section: • *Changing the oil, axis-2 gearbox on page 159*
3	Axis-3 motor: • Refill oil in gearbox after refitting.	How to fill oil in gearbox is described in section: • *Changing the oil, axis-3 gearbox on page 163*
4	Axis-4, axis-5 and axis-6 motors: • Filling gearbox oil not needed.	-

Tightening torques and attachment screws

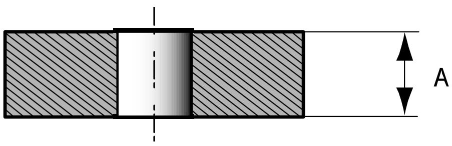
The table shows the tightening torques for all motors.

Motor	Attachment screw	Quality	Tightening torque
Motor, axis 1	M8x25	8.8-A2F	22 Nm
Motor, axis 2	*Screwlengths depending on flange thickness on page 299*	8.8-A2F	35 Nm
Motor, axis 3	*Screwlengths depending on flange thickness on page 299*	8.8-A2F	22 Nm
Motor, axis 4	M8x25	8.8-A2F	22 Nm
Motor, axis 5	M8x25	8.8-A2F	22 Nm
Motor, axis 6	M8x25	8.8-A2F	22 Nm

Screwlengths depending on flange thickness

Screwlengths can vary depending on when the robot is delivered. The different screwlengths depends on the different flange thickness of motors. Make sure to use the correct screwlength! See table:

Motor axis 2		Motor axis 3	
Flange thickness	Attachment screws	Flange thickness	Attachment screws
18.5 mm	M10x40	15 mm	M8x35
16 mm	M10x35	13 mm	M8x30



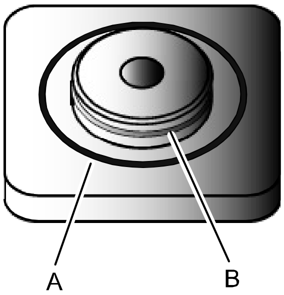
xx0900000443

A	Flange thickness

Continues on next page

Preparations before the refitting of motors

Use this procedure to make necessary preparations before refitting motors.

	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	Grind the paint on the surface carefully to get a smoth surface.	
3	Clean the surface from contamination such as oil and dirt. Remove any painting from the assembly surfaces, with a knife.	
4	Make sure that the motor and the pinion are not damaged or scratched.	
5	Apply *Loctite 574* on the o-ring.	
6	Make sure the *o-ring* on the flange of the motor is seated properly.	xx0900000082 Parts: • A: Correct position of o-ring • B: Incorrect position of o-ring ! Replace with a new o-ring if damaged!

Continues on next page

	Action	Note
7	In order to release the brakes, connect the 24 VDC power supply.	Connectors: • Motor axis 1: R2.MP1 • Motor axis 2: R2.MP2 • Motor axis 3: R2.MP3 • Motor axis 4: R2.MP4 • Motor axis 5: R2.MP5 • Motor axis 6: R2.MP6 Connect to pins: • + : pin 2 • -: pin 5 **CAUTION** The connections for the motor brakes (24 VDC connection) are phase dependent. If the connection on the pins is switched, it can cause severe damage to vital parts.

Note

A fan is recommended to be used to avoid overheating of motor and gear in applications with intensive motion (high average torque and/or short wait time) of axes 1 and 2. IP54 is valid for cooling fan.

A fan is also recommended to be used if the environmental temperature is high.

How to install a fan is described in section *Installation of cooling fan for motors (option) on page 82*.

Refitting motors

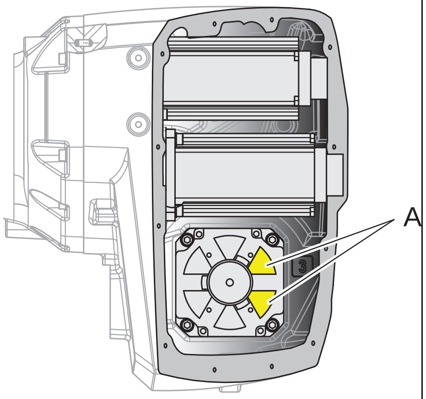
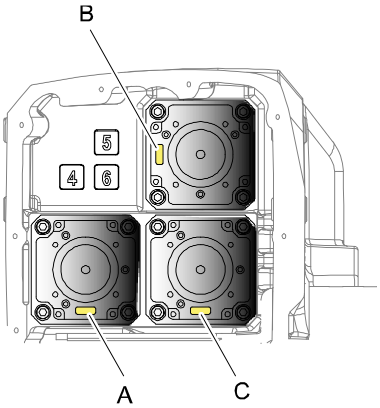
Use this procedure to refit motors axes 1, 2, 3, 4, 5 and 6.

Note

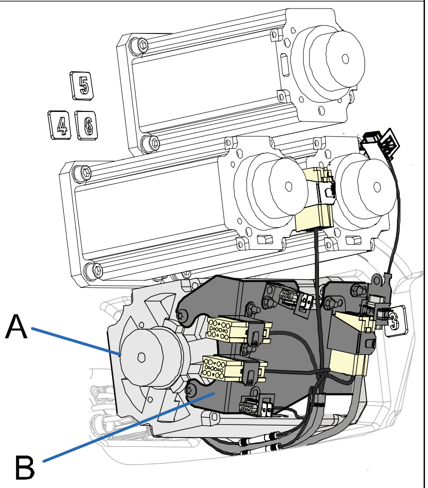
The procedure contains information how to refit motors on all axes of the robot. Some steps are only applicable to a certain motor. Follow the steps carefully in order not to miss vital information!

	Action	Information
1	**Note** Before starting the refitting of the motor, first make the necessary preparations!	Also see • *Preparations before the refitting of motors on page 300*
2	**Note** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
3	Place the motor carefully in the gearbox.	

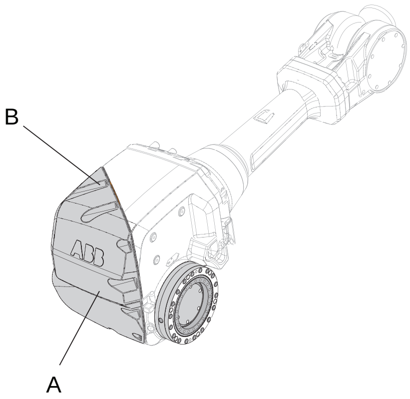
Continues on next page

	Action	Information
4	Fit the motor, making sure the motor pinion is properly mated to the gear in the gearbox.	Make sure that: • the motor is turned the correct way • the pinion or gear of the motor does not get damaged!
5	**Applicable to motor axis 3!** Make sure that the wire exit holes of motor axis 3 are in the correct position. See illustration!	 xx0900000300 Parts: • A: Wire exit holes, motor axis 3
6	**Applicable to motors axes 4, 5 and 6!** Make sure that the wire exit hole of the motor is in the correct position.	 xx0900000062 Parts: • A: Wire exit hole, motor axis 4 • B: Wire exit hole, motor axis 5 • C: Wire exit hole, motor axis 6
7	**Only applicable to motors axes 4, 5 and 6!** Fit the attachment screws for the motor and fasten them sligthly. The motor must be able to move parallel to the gear during the adjustment of the play.	
8	**Only applicable to motors axes 4, 5 and 6!** Adjust the play of the motor.	See *Adjusting the play of axis 4, 5 and 6 motors on page 305*.
9	Secure the motor with its **attachment screws** and **washers**. **Note** Apply the correct tightening torque!	Tightening torque and attachment screws are specified in the table: • *Tightening torques and attachment screws on page 299*
10	Disconnect the brake release voltage.	

Continues on next page

	Action	Information
11	**Only applicable to motors axes 1 and 2!** Refit the connection box (if it has been removed). **Note** Make sure that the o-ring is in place!	See the figure in: • *Location of axis-1 and axis-2 motors on page 295*
12	**Applicable to motor axis 3!** Refit the bracket on motor axis 3.	 xx0800000390 Parts: • A: Motor axis 3 • B: Bracket
13	Reconnect the motor cables.	
14	**Applicable to motor axes 1 and 2!** Refit the *cable gland* and **motor covers**. Make sure that the *o-ring* is in place!	See the figure in: • *Location of axis-1 and axis-2 motors on page 295* **Note** Make sure that the cover is tightly sealed!
15	**Applicable to motors axis 2!** Refill gearbox oil.	How to fill oil in the gearbox is described in sections: • *Changing the oil, axis-2 gearbox on page 159* • *Changing the oil, axis-3 gearbox on page 163*
16	**Applicable to motors axes 3, 4, 5 and 6!** Make sure that the gasket on the cover on the armhouse is intact.	If the gasket is damaged, it need to be replaced.

Continues on next page

	Action	Information
17	**Applicable to motors axes 3, 4, 5 and 6!** Refit the cover in the back of the armhouse with its attachment screws and washers. **WARNING** The cover on the armhouse must be fitted when the robot is running. It is a vital part for the stability of the robot.	Make sure that the cover is tightly sealed.  xx0800000389 Parts: • A: Cover • B: Attachment screws M6x25, quality 8.8-A2F (10 pcs) Tightening torque: • 14 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 350*. General calibration information is included in section *Calibration on page 335*.
19	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.7.3 Adjusting the play of axis 4, 5 and 6 motors

Required equipment

Equipment	Note
Measuring tool	For adjusting the play.
Standard toolkit	Content is defined in section *Standard tools on page 386*.
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.

Adjusting the play of axis 4, 5 and 6 motors

	Action	Note
1	Fit the measuring tool at the rear of the motor.	
2	Adjust the play on the motor by starting with a big play and then gradually finding the smallest play. Use swift movements in order to avoid noticing the magnetic field which causes the gears to stick together. Follow the instructions for current motor: **Motor axis 4:** 1 Turn the motor shaft six turns and find the smallest play within this range. **Axis 5 motor:** 1 Turn the outgoing shaft for axis 4 in intervals of 90° for one full turn and find the smallest play for the axis 5 motor within this range. 2 Turn the axis 5 motor one full turn at a time for a total of five turns and find the smallest play within this range. **Axis 6 motor:** 1 Turn the outgoing shaft for axis 4 in intervals of 90° for one full turn and find the smallest play for the axis 6 motor within this area. 2 Turn the axis 5 motor one full turn at a time for a total of five turns and find the smallest play for axis 6 within this range. 3 Turn the axis 6 motor one full turn at a time for a total of three turns and find the smallest play for axis 6 within this range.	
3	Push or tap the motor in radial direction so that the play becomes minimal within one motor turn, without the gear "chewing".	

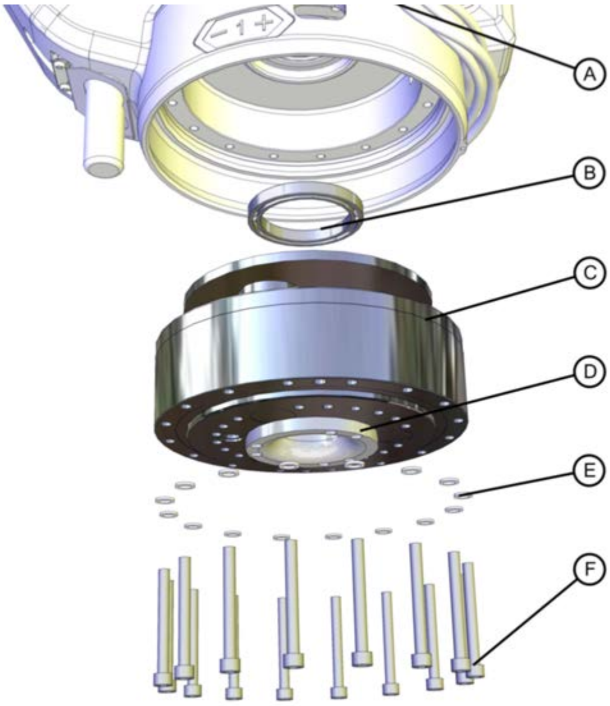
4.8 Gearboxes

4.8.1 Replacing gearbox axis 1

Location of gearbox

The gearbox is located as shown in the figure. The exploded view only shows the principle of the assembly. The actual replacing is recommended to be done with the robot resting on its side.

Type C and Type D

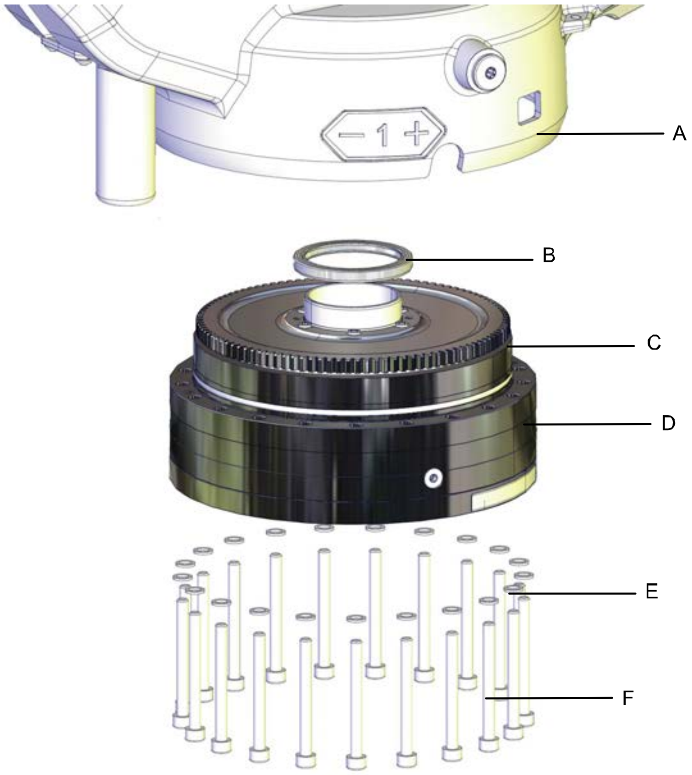


xx1200000637

A	Frame
B	Radial sealing
C	Axis-1 gearbox with O-ring
D	Harness pipe
E	Washer (16 pcs)
F	Attachment screws M10x100 quality Steel 12.9 Gleitmo (16 pcs)

Continues on next page

Other design than Type C and Type D



xx0800000400

A	Frame
B	Radial sealing
C	O-ring
D	Axis-1 gearbox
E	Washer (21 pcs)
F	Attachment screws M8x80 quality Steel 12.9 Gleitmo (21 pcs)

Required equipment

Equipment	Note
Gearbox	See *Spare part lists on page 391*.
Guide pins	**Type C and Type D**: Guide pin, M10x150: 3HAC15521-2/ **Other design than Type C and Type D**: Guide pin, M8x150: 3HAC15520-2 Used to guide the gearbox during removal/refitting. Always use guide pins in pairs.
Guide for reduction gear	3HACxxx Used to guide axis-1 gear and frame during refitting.
Standard toolkit	Content is defined in section *Standard tools on page 386*.

Continues on next page

Equipment	Note
Other tools and procedures may be required. See references to these procedures in the step-by-step instructions below.	These procedures include references to the tools required.

Deciding calibration routine

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

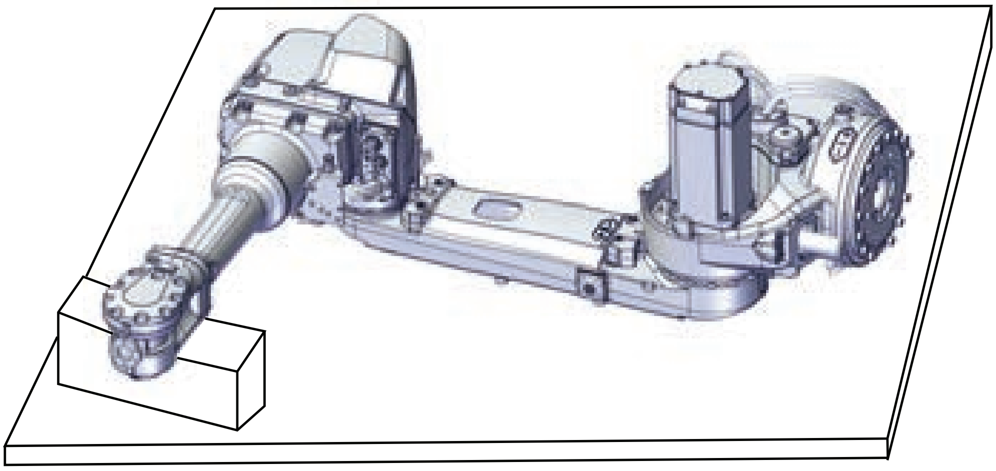
	Action	Note
1	Decide which calibration routine to use for calibrating the robot. • Reference calibration. External cable packages (DressPack) and tools can stay fitted on the robot. • Fine calibration. All external cable packages (DressPack) and tools must be removed from the robot.	
	If the robot is to be calibrated with reference calibration: Find previous reference values for the axis or create new reference values. These values are to be used after the repair procedure is completed, for calibration of the robot. If no previous reference values exist, and no new reference values can be created, then reference calibration is not possible.	Follow the instructions given in the reference calibration routine on the FlexPendant to create reference values. Creating new values requires possibility to move the robot. Read more about reference calibration for Axis Calibration in *Reference calibration routine on page 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Continues on next page

Illustration of robot put down on its side

The robot is put down on its side for a safe removal of the axis-1 gearbox. Prepare an area on the floor with cardboard, plastic foam or similar and prepare higher support for the wrist.

Make sure the cabling brackets on the lower arm are unfastened and moved out of the way so that the cabling is not getting squeezed.



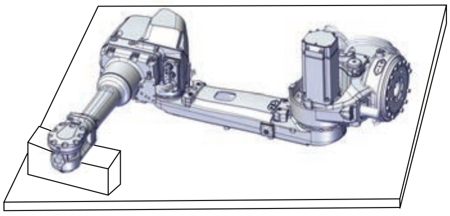
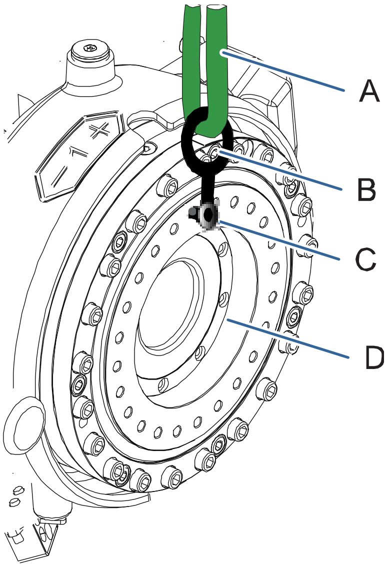
xx1800000593

Removing gearbox axis 1

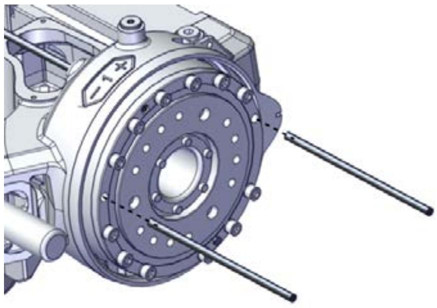
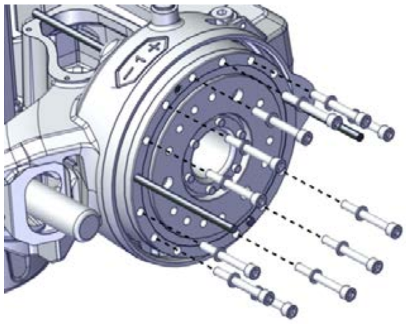
Use this procedure to remove the gearbox.

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Drain the oil from the gearbox.	How to drain the oil from the gearbox is described in section: • *Changing the oil, axis-1 gearbox on floor mounted robots on page 148*
3	Jog the robot to: • Axis 1: 0° • Axis 2: 0° • Axis 3: -10° • Axis 4: 0° • Axis 5: 0° • Axis 6: 0°	
4	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the safeguarded space.	

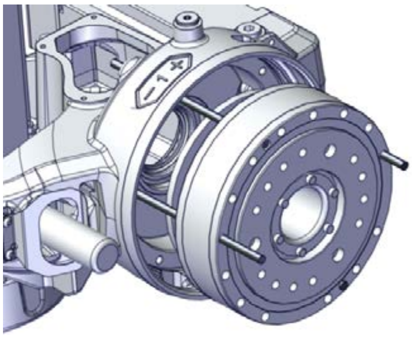
Continues on next page

	Action	Note
5	Remove the axis-1 motor.	See *Removing motors on page 287*.
6	Remove the complete arm system from the base and lay down the robot on its side.	See *Removing the base on page 237*.  xx1800000593
7	Fit a lifting lug in the uppermost hole for the base attachment screws.	 xx0800000440 A Roundsling B Lifting lug C Uppermost base attachment hole D Axis-1 gearbox
8	**CAUTION** The gearbox weighs 27 kg. All lifting accessories used must be sized accordingly!	
9	Secure the gearbox in an overhead crane or similar.	
10	Remove the *attachment screws* securing the gearbox.	See the figure in: • *Location of gearbox on page 306*

Continues on next page

	Action	Note
11	Remove two gearbox attachment screws opposite to each other and fit two guide pins into the holes.	 xx1800000789 **Type C and Type D**: Guide pin, M10x150: 3HAC15521-2/ **Other design than Type C and Type D**: Guide pin, M8x150: 3HAC15520-2 Always use guide pins in pairs!
12	Remove the remaining attachment screws and washers.	 xx1800000790
13	**Note** Whenever parting/mating motor and gear-box, the gears may be damaged if excessive force is used!	
14	**Note** There will be some excess oil running out of the gearbox when it is removed. Use some absorbent material to catch the oil.	

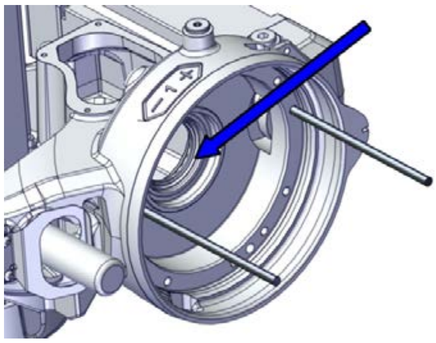
Continues on next page

	Action	Note
15	Slide the gearbox out onto the guide pins and lift it away. If necessary use removal tools to remove the gearbox.	**Note** Always use removal tools in pairs diagonal to each other.  xx1800000791

Refitting gearbox axis 1

Use these procedures to refit the gearbox.

Refitting the gearbox to the frame

	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 the radial sealing in the frame. Replace if damaged.	 xx1800000794

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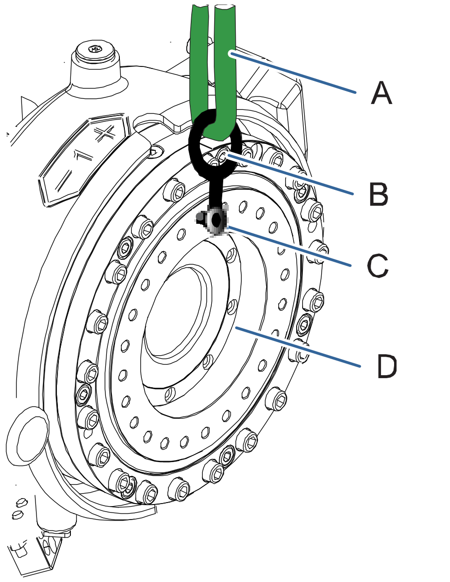
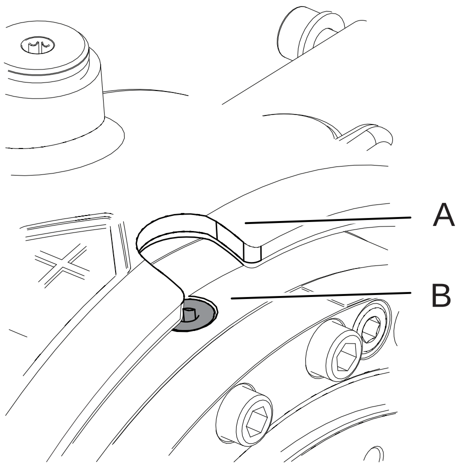
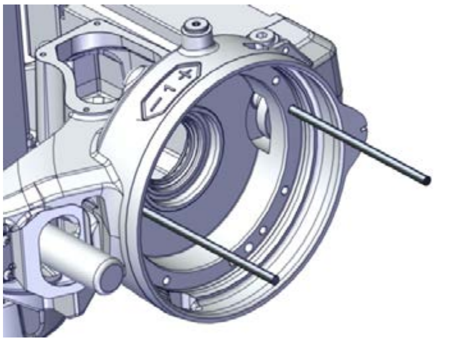
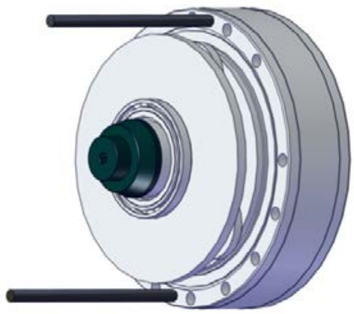
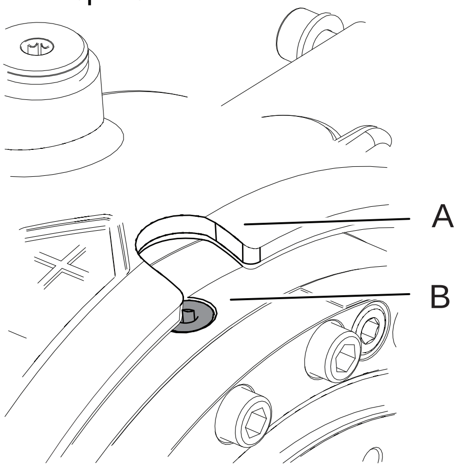
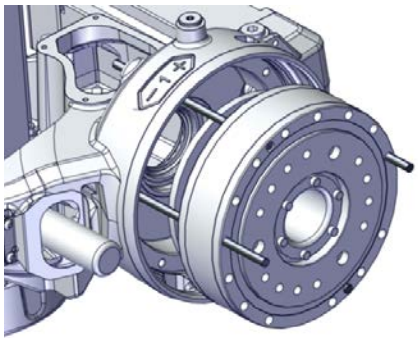
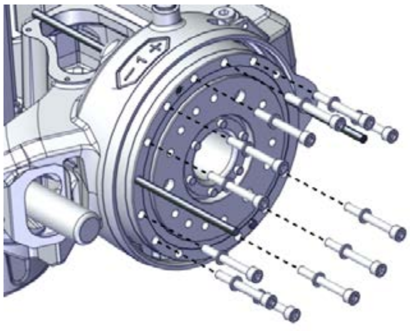
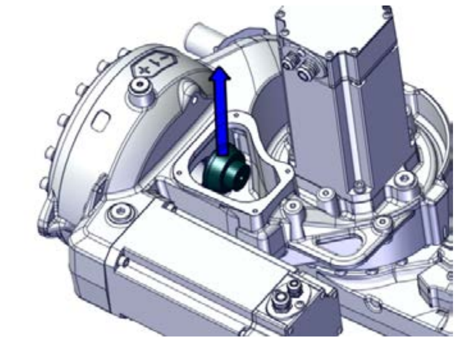
	Action	Note
3	Fit a lifting lug in the uppermost hole for the base attachment screws.	 xx0800000440 A Roundsling B Lifting lug C Uppermost base attachment hole D Axis-1 gearbox
4	**Only valid for Other design than Type C and Type D:** **Note** Check, when fitting the lifting lug, that **both** *oil plugs* will be placed in the correct position after the gearbox is fitted as shown in the figure. The oil plugs shall be placed in the *openings* in the frame.	 xx0800000441 A Opening for oil plug in frame B Oil plug
5	Apply grease on the *o-ring*.	See the figure in: • *Location of gearbox on page 306* Replace o-ring if damaged.
6	Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	

Continues on next page

	Action	Note
7	Fit two guide pins to the frame.	 xx1800000793 **Type C and Type D**: Guide pin, M10x150: 3HAC15521-2/ **Other design than Type C and Type D**: Guide pin, M8x150: 3HAC15520-2 Always use guide pins in pairs!
8	Fit the guide for the gear on top of the protection tube. It protects the radial sealing from being damaged during refitting.	Guide for reduction gear: 3HACxxx.  xx1800000795
9	**CAUTION** The gearbox weighs 27 kg. All lifting accessories used must be sized accordingly!	

Continues on next page

	Action	Note
10	Lift the gearbox onto the guide pins and slide it into position, using caution. Check that the radial sealing in the frame tube does not get damaged. **Only valid for Other design than Type C and Type D**: Double check that the oil plugs are in the correct position.  xx0800000441 A Opening for oil plug in frame B Oil plug	 xx1800000791
11	Secure the gearbox with its attachment screws and washers.	
12	Remove the guide pins from the frame and secure the remaining two screws.	 xx1800000790 • **Other design than Type C and Type D**: 35 Nm • **Type C and Type D**: 68 Nm
13	Remove the guide from the protection tube.	 xx1800000796

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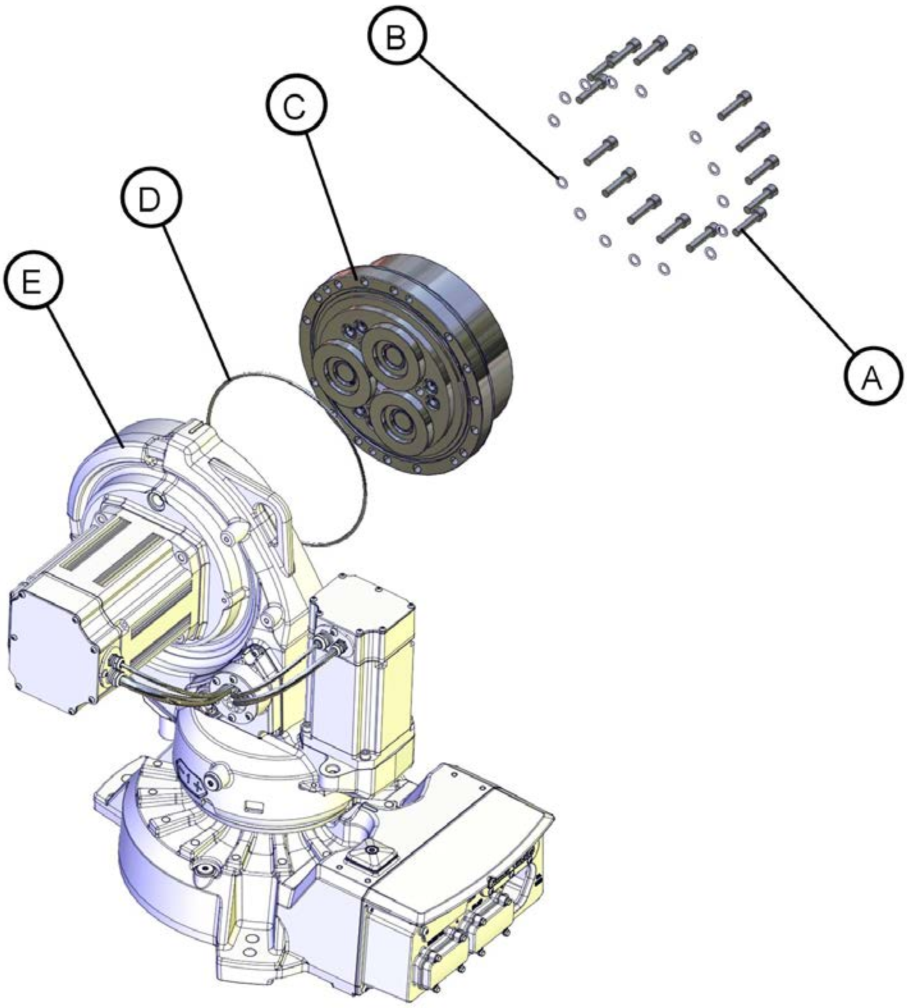
Refitting the arm system to the base

	Action	Note
1	Refit the complete arm system to the base.	See *Refitting the base on page 243*.
2	Refit the axis-1 motor.	See *Refitting motors on page 295*.
3	Refit the cable harness in the base, the frame and the lower arm.	Also see • *Refitting the cable harness in the base on page 215* • *Refitting the cable harness in the frame on page 212* • *Refitting the cable harness in the lower arm and armhouse on page 221* .
4	Refill oil in the gearbox.	See *Changing the oil, axis-1 gearbox on floor mounted robots on page 148*.
5	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 350*. General calibration information is included in section *Calibration on page 335*.
6	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.8.2 Replacing gearbox axis 2

Location of gearbox axis 2

The gearbox is located as shown in the figure.



xx0800000438

A	Attachment screws M12x50 quality Steel 12.9 Gleitmo (15 pcs)
B	Washers (15 pcs)
C	Gearbox axis 2
D	O-ring
E	Frame

Required equipment

Equipment	Article number	Note
Gearbox	See *Spare part lists on page 391*.	
Rotation tool	3HAB7887-1	

Continues on next page

Equipment	Article number	Note
Lifting accessories	-	Roundslings.
Guide pin, M12x150	3HAC13056-2	Always use guide pins in pairs.
Standard toolkit		Content is defined in section *Standard tools on page 386*.
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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

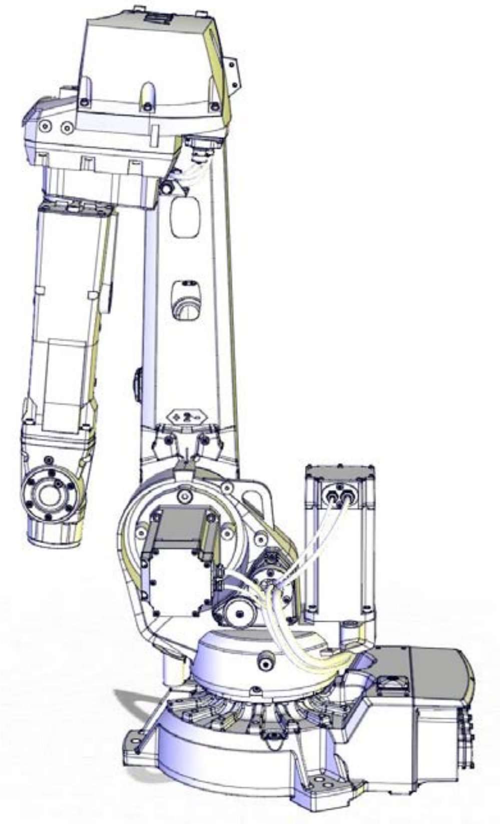
Removing gearbox axis 2

Use this procedure to remove the gearbox.

WARNING

The procedure details how to replace the gearbox without removing the cable harness, only by loosening it. This means that the upper and lower arm will be separated from the frame but still be connected to the frame through the cabling. Be careful not to damage the cables!

Continues on next page

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Move the robot to the position shown in the figure. Upper arm should rest on the axis-3 damper.	The figure shows IRB 2600 but the position of the robot is correct.  xx1200000068
3	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
4	Drain the gearbox.	How to drain the gearbox is described in section: • *Changing the oil, axis-2 gearbox on page 159*

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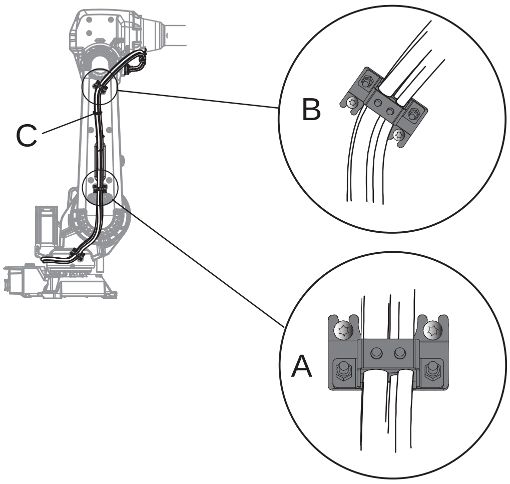
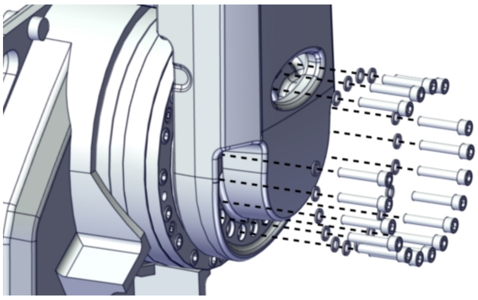
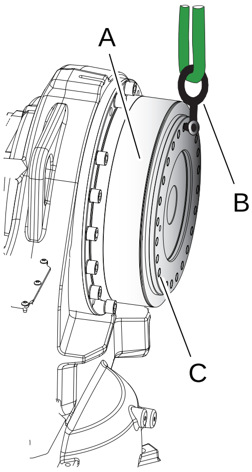
	Action	Note
5	Loosen the cabling from the lower arm by removing two cable brackets and a cable strap.	 xx1100000946 A Cable bracket B Cable bracket C Cable strap
6	**CAUTION** The weight of the complete upper and lower arm together is 205 kg All lifting accessories used must be sized accordingly.	
7	Attach a roundsling around the upper arm house.	
8	Unload the weight of the lower and upper arm package by stretching the roundslings with the overhead crane. Turn on the power temporarily and release the brakes of axis 2 to rest the weight onto the roundslings.	
9	**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
10	Remove the *attachment screws and washers* that secure the lower arm to the axis-2 gearbox.	 xx1800000935
11	Remove the lower and upper arm package from the frame. **WARNING** The cable harness is still installed on the robot! Make sure not to damage the cables or the cable brackets on the robot.	
12	**CAUTION** The gearbox weighs 51 kg All lifting accessories used must be sized accordingly!	
13	Fit a *lifting lug* in the uppermost hole for the attachment screws that secure the lower arm to the gearbox.	 xx0800000445 Parts: • A: Gearbox axis 2 • B: Lifting lug • C: Holes for attachment screws that secure the lower arm to the axis-2 gearbox
14	Secure the gearbox with a roundsling in an overhead crane or similar.	
15	Remove the *attachment screws and washers* that secure the gearbox to the frame.	See the figure in: • *Location of gearbox axis 2 on page 317*

Continues on next page

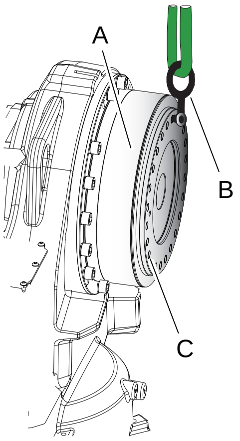
	Action	Note
16	Fit guide pins to help guiding the gearbox out from the frame.	Guide pin, M12x150: 3HAC13056-2 Always use guide pins in pairs.
17	If necessary, use removal tools to remove the gearbox.	**Note** Always use removal tools in pairs diagonal to each other.
18	Remove the gearbox. **CAUTION** Use caution in order not to damage gearbox or pinion!	

Refitting gearbox axis 2

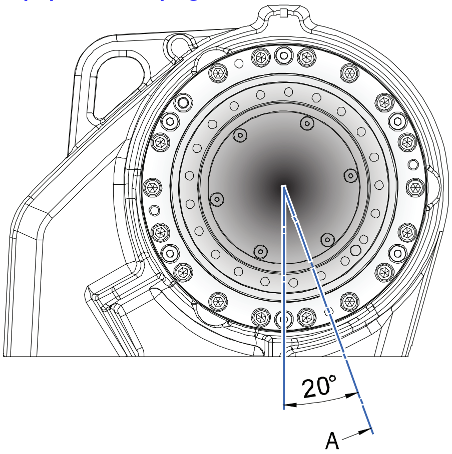
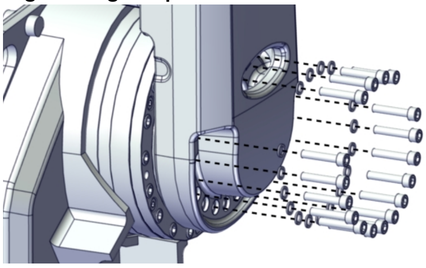
Use this procedure to refit the gearbox.

	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	**CAUTION** The gearbox weighs 51 kg All lifting accessories used must be sized accordingly!	

Continues on next page

	Action	Note
3	Fit a **lifting lug** in the uppermost hole for the attachment screws securing the lower arm to the gearbox.	 xx0800000445 Parts: • A: Gearbox axis 2 • B: Lifting lug • C: Holes for attachment screws securing the lower arm to gearbox axis 2.
4	Clean all assembly surfaces. Remove any painting from the assembly surfaces, with a knife.	
5	Apply some grease on the o-ring before fitting. **Valid for Type C and Type D:** Replace if damaged.	O-ring, nitrile rubber: 3HAB3772-120. See the figure in: • *Location of gearbox axis 2 on page 317*
6	Fit two guide pins in opposite holes in the frame.	Guide pin, M12x150: 3HAC13056-2 Always use guide pins in pairs.
7	Secure the gearbox with a roundsling in an overhead crane or similar.	
8	Release the brakes of the axis 2 motor.	

Continues on next page

	Action	Note
9	Lift the gearbox onto the guide pins and slide it into position while rotating the motor pinion to find the mating position. Use a *rotation tool*. **Note** The position of the oil plug shall be according to the illustration.	Article number is specified in *Required equipment on page 317*.  xx1000000307 Parts: • A: Position of oil plug on gearbox
10	Secure the gearbox with its *attachment screws* and *washers*.	See screw dimension in the figure in: • *Location of gearbox axis 2 on page 317* Tightening torque: 110 Nm
11	Perform a leak-down test.	See *Performing a leak-down test on page 188*.
12	Fit the guide pins to the gearbox.	
13	**CAUTION** The weight of the complete upper and lower arm together is 205 kg All lifting accessories used must be sized accordingly.	
14	Lift the upper and lower arms into mounting position and guide them in place with the guide pins. It might be necessary to rotate the motor pinion with the rotating tool to find the mating position.	
15	Refit the *attachment screws and washers* to secure the lower arm to the axis-2 gearbox.	Attachment screws: M12x50 quality steel Gleitmo 12.9 (18 pcs) Tightening torque: 110 Nm.  xx1800000935

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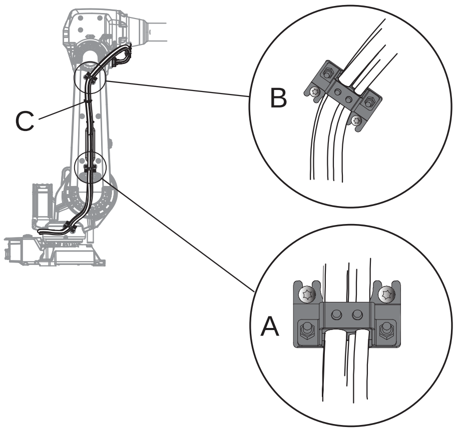
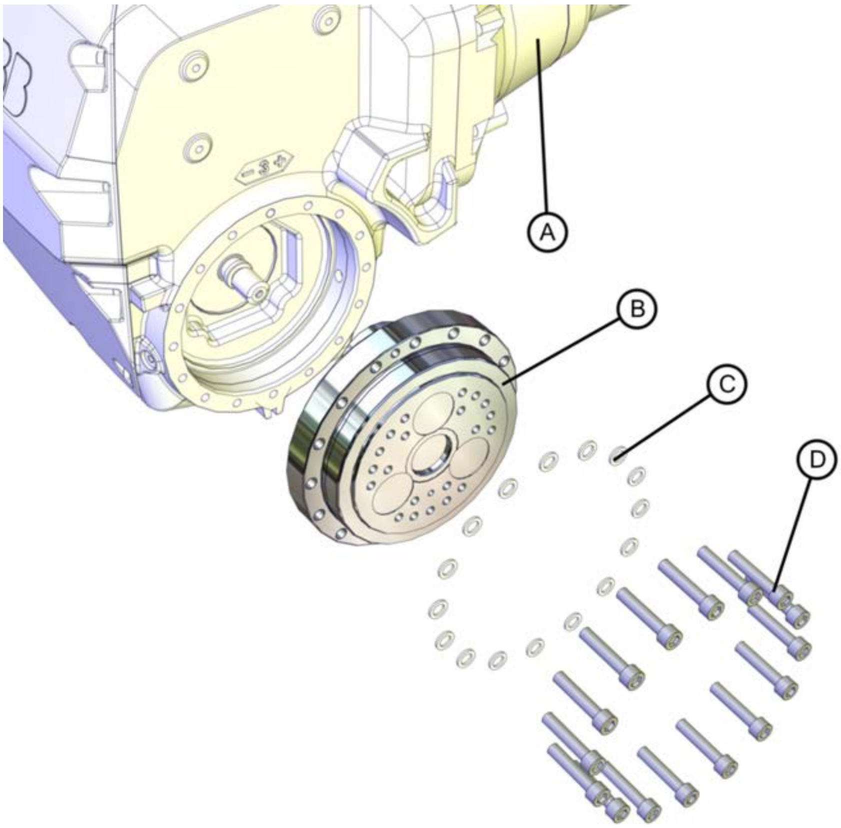
	Action	Note
16	Refit the cable brackets and cable strap to the lower arm.	 xx1100000946 A Cable bracket B Cable bracket C Cable strap
17	Refill the gearbox with *lubrication oil*.	How to fill the gearbox with oil is described in section: • *Changing the oil, axis-2 gearbox on page 159*
18	Recalibrate 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 350*. General calibration information is included in section *Calibration on page 335*.
19	**DANGER** Make sure all safety requirements are met when performing the first test run.	

4.8.3 Replacing gearbox axis 3

Location of gearbox axis 3

The gearbox is located as shown in the figure.

Type C and Type D



xx1200000638

A	Upper arm
B	Axis-3 gearbox
C	Washers (16 pcs)
D	Attachment screws M10x50 quality Steel 12.9 Gleitmo (16 pcs)

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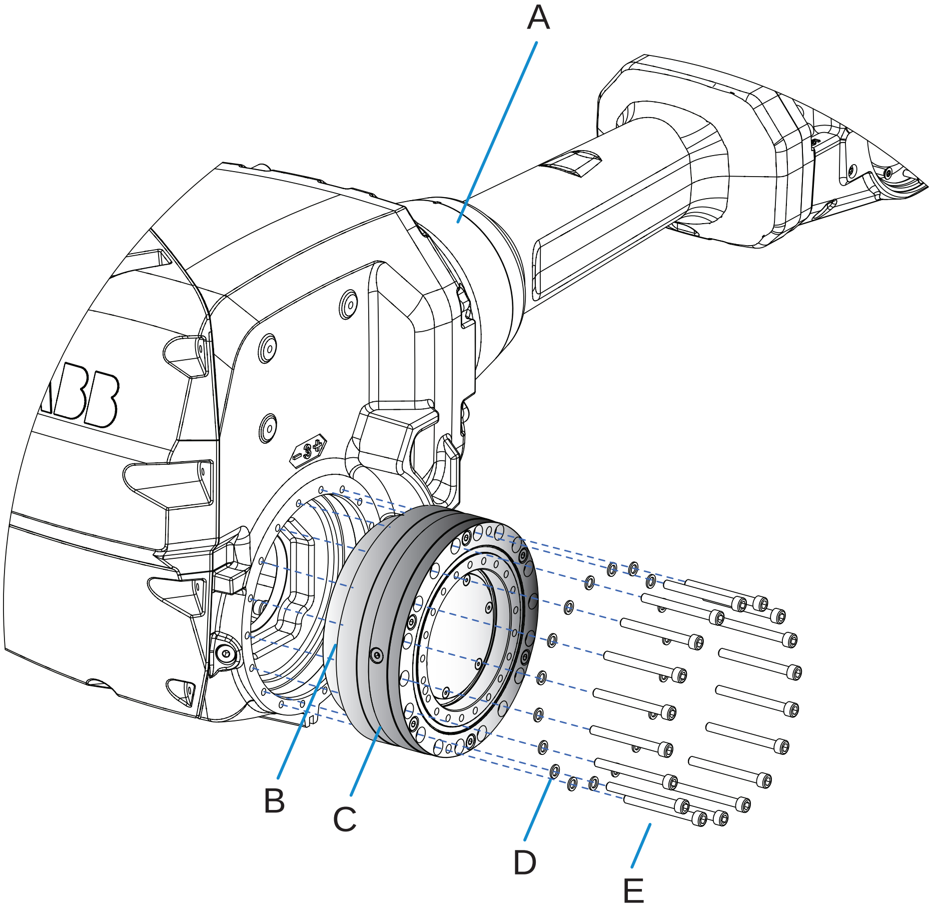
Other design than Type C and Type D



xx0800000398

A	Upper arm
B	O-ring
C	Axis-3 gearbox
D	Washers (18 pcs)
E	Attachment screws M8x80 quality Steel 12.9 Gleitmo (18 pcs)

Required equipment

Equipment	Art. no.	Note
Gearbox		See *Spare part lists on page 391*.
Guide pins		**Type C and Type D**: M10 (2 pcs) **Other design than Type C and Type D**: M8 (2 pcs) Used to guide the gearbox and the upper arm during removal/refitting.
Rotation tool	3HAB7887-1	
Standard toolkit		Content is defined in section *Standard tools on page 386*.

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.

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 351*. Read more about reference calibration for Pendulum Calibration in *Operating manual - Calibration Pendulum*.
	If the robot is to be calibrated with fine calibration: Remove all external cable packages (DressPack) and tools from the robot.	

Removing gearbox axis 3

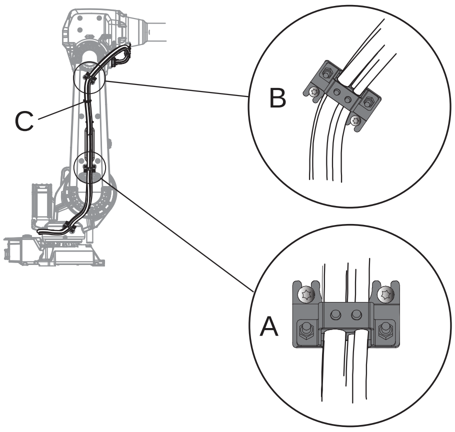
Use this procedure to remove the gearbox.

WARNING

The procedure details how to replace the gearbox without removing the cable harness. This means that the upper and lower arm will be separated but still be connected to eachother through the cabling. Be careful not to damage the cables!

	Action	Note
1	Decide which calibration routine to use, and take actions accordingly prior to beginning the repair procedure.	
2	Drain the gearbox.	How to drain the gearbox is described in section: • *Changing the oil, axis-3 gearbox on page 163*

Continues on next page

	Action	Note
3	Move the robot to the position shown in the figure.	 xx0800000336
4	**DANGER** Turn off all: • electric power supply • hydraulic pressure supply • air pressure supply to the robot, before entering the robot working area.	
5	Unscrew the attachment screws securing the cable harness to the lower arm by the the two cable brackets and a cable strap.	 xx1100000946 A Cable bracket B Cable bracket C Cable strap
6	Loosen the cabling from the lower arm by unhooking the two cable brackets. **CAUTION** The cable harness is still mounted in other parts of the robot. Make sure not to damage the cable harness or any cable brackets in the continued removal.	
7	Attach the lifting accessories to the upper arm.	See *Attaching the lifting accessories to the upper arm on page 252*
8	Connect the 24 VDC power supply to the axis-3 motor and release the brakes.	

Continues on next page

	Action	Note
9	Releasing the brakes of the axis-3 motor unloads the weight of the upper arm by stretching the roundslings.	
10	Remove the *attachment screws* that secure the upper arm to the lower arm. **Note** Do not remove the attachment screws securing the gearbox axis 3 to the armhouse!	See the figure in: • *Location of the complete upper arm on page 247*
11	**CAUTION** The robot upper arm weighs 140 kg. All lifting accessories used must be sized accordingly!	
12	Remove the upper arm from the lower arm and leave it hanging in the air. **CAUTION** When the upper arm no longer is attached to the robot, the armhouse has a tendency to drop down a little. In order to prevent this is to rise the front end of the upper arm a little before removing the attachment screws securing the upper arm.	**WARNING** The cable harness is still installed on the robot! Make sure not to damage the cable harness or the cable brackets on the robot.
13	**CAUTION** The gearbox weighs 23 kg. All lifting accessories used must be sized accordingly!	
14	Remove two attachment screws diagonally located and insert guide pins.	Always use guide pins in pairs!
15	Remove the remaining *attachment screws* that secures the gearbox.	See the figure in: • *Location of gearbox axis 3 on page 326*
16	**Note** There will be some surplus oil in the gearbox. Place some absorbant cloth or similar under the gearbox.	
17	Slide the gearbox carefully out onto the guide pins and lift it away. If necessary, use a pair of screws to push out the gearbox. **CAUTION** Remaining oil will drain out from the gearbox cavity when the gearbox is lifted out.	**Note** Always use removal tools in pairs diagonal to each other.

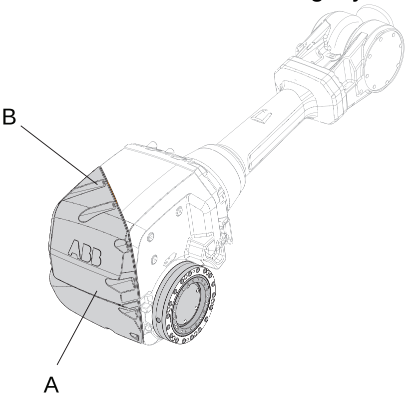
Continues on next page

Refitting the gearbox axis 3

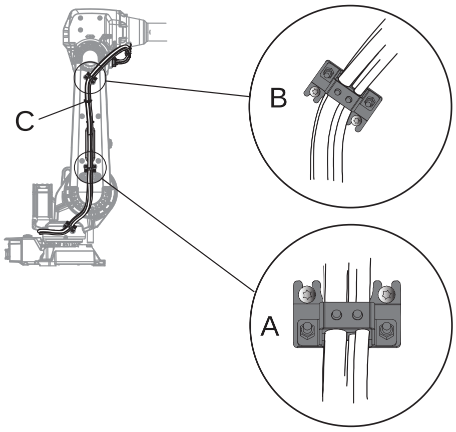
Use this procedure to refit the gearbox.

	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	**CAUTION** The gearbox weighs 23 kg. All lifting accessories used must be sized accordingly!	
3	Clean all assembly surfaces. Remove any painting or other contamination from the assembly surfaces, with a knife.	
4	Apply some grease on the o-ring before fitting it to the gearbox.	See the figure in: • *Location of gearbox axis 3 on page 326*
5	Fit two guide pins in two opposite screw holes in the upper arm.	Always use guide pins in pairs!
6	Remove the arm house cover.	
7	Attach the rotation tool on the axis-3 motor.	
8	Release the brakes of the axis 3 motor.	
9	Lift the gearbox onto the guide pins.	
10	**Note** Whenever parting/mating motor and gearbox, the gears may be damaged if excessive force is used!	
11	Slide the gearbox into position while rotating the motor pinion to find the mating position. Use a *rotation tool*. **Tip** Two persons are required for this step since the upper arm is hanging freely in the air. One person needs to hold the upper arm still while the other fits the gearbox into the upper arm.	Article number for the rotation tool is specified in *Required equipment on page 327*.
12	Rotate the motor pinion and slide the gearbox into position.	

Continues on next page

	Action	Note
13	Secure the gearbox with its *attachment screws* and *washers*.	See the figure in: • *Location of gearbox axis 3 on page 326* Tightening torque: 35 Nm.
14	Remove the guide pins and replace them with the remaining attachment screws.	
15	Perform a leak-down test.	See *Performing a leak-down test on page 188*.
16	Fit *guide pins* in the upper arm.	Specified in *Required equipment on page 327*.
17	Move the upper arm to its mounting position. (With the brakes of the axis 3 motor still released.)	
18	Refit the upper arm to the lower arm with its *attachment screws*.	See the figure in: • *Location of the complete upper arm on page 247* Tightening torque: • **Type C and Type D**: 50 Nm and 90° angle • **Other design than Type C and Type D**: 35 Nm
19	Remove the guide pins and replace with the remaining attachment screws.	
20	Remove the 24 VDC power supply.	
21	Refit the upper armhouse cover with its attachment screws and washers. **WARNING** The cover on the armhouse must be fitted when the robot is running. It is a vital part for the stability of the robot.	Tightening torque: 14 Nm. Make sure that the cover is tightly sealed.  xx0800000389 Parts: • A: Cover • B: Attachment screws M6x25, quality 8.8-A2F (10 pcs)

Continues on next page

	Action	Note
22	Refit the two cable brackets and a cable strap to the lower arm.	 xx1100000946 A Cable bracket B Cable bracket C Cable strap
23	Refill the gearbox with *lubrication oil*.	How to fill the gearbox with oil is described in section: • *Changing the oil, axis-3 gearbox on page 163*
24	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 350*. General calibration information is included in section *Calibration on page 335*.
25	**DANGER** Make sure all safety requirements are met when performing the first test run.	

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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 350*.

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. For robots with RobotWare 5.04 or older, the calibration data is delivered in a file, calib.cfg, supplied with the robot at delivery. The file identifies the correct resolver/motor position corresponding to the robot home position.	Axis Calibration or Calibration Pendulum [i]
Absolute accuracy calibration (optional)	Based on standard calibration, and besides positioning the robot at synchronization position, the Absolute accuracy calibration also compensates for: • Mechanical tolerances in the robot structure • Deflection due to load Absolute accuracy calibration focuses on positioning accuracy in the Cartesian coordinate system for the robot. Absolute accuracy calibration data is found on the SMB (serial measurement board) in the robot. For robots with RobotWare 5.05 or older, the absolute accuracy calibration data is delivered in a file, absacc.cfg, supplied with the robot at delivery. The file replaces the calib.cfg file and identifies motor positions as well as absolute accuracy compensation parameters. A robot calibrated with Absolute accuracy has a sticker next to the identification plate of the robot. A robot calibrated with Absolute accuracy has the option information printed on its name plate. 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

Continues on next page

Type of calibration	Description	Calibration method
Optimization	Optimization of TCP reorientation performance. The purpose is to improve reorientation accuracy for continuous processes like welding and gluing. Wrist optimization will update standard calibration data for axes 4, 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.

Brief description of calibration methods

Calibration Pendulum method

Calibration Pendulum is a standard calibration method for calibration of many of ABB robots (except IRB 6400R, IRB 640, IRB 1400H, and IRB 4400S). This calibration method is not used on OmniCore 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 4600. 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 350*.

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 following routines are available for the Wrist Optimization method:

- Wrist Optimization

Continues on next page

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.

CalibWare - Absolute Accuracy calibration

The CalibWare tool guides through the calibration process and calculates new compensation parameters. This is further detailed in the *Application manual - CalibWare Field*.

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

The Absolute Accuracy option varies according to the robot mounting position. This is printed on the robot name plate for each robot. The robot must be in the correct mounting position when it is recalibrated for absolute accuracy.

References

Article numbers for the calibration tools are listed in the section *Special tools on page 387*.

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 344*. 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

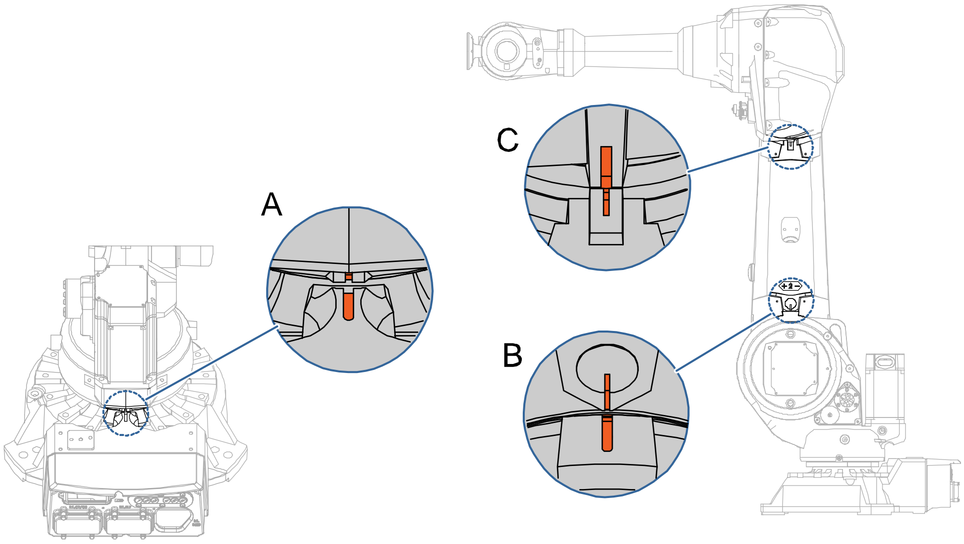
5.2.1 Synchronization marks and synchronization position for axes

Introduction

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

Synchronization marks, IRB 4600

IRB 4600-60/2.05, -45/2.05, -40/2.55, -20/2.50

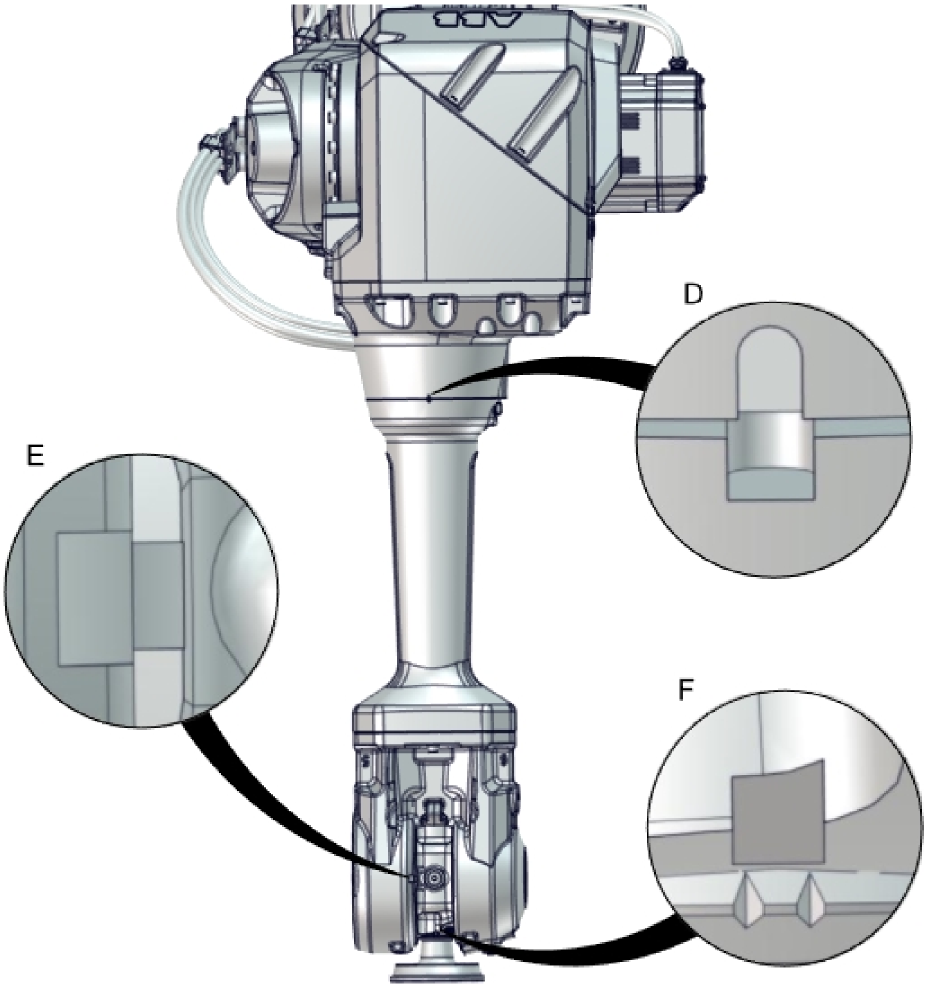


xx0800000312

A	Synchronization mark, axis 1
B	Synchronization mark, axis 2
C	Synchronization mark, axis 3

Continues on next page

IRB 4600 - 60/2.05, -45/2.05, 40/2.55

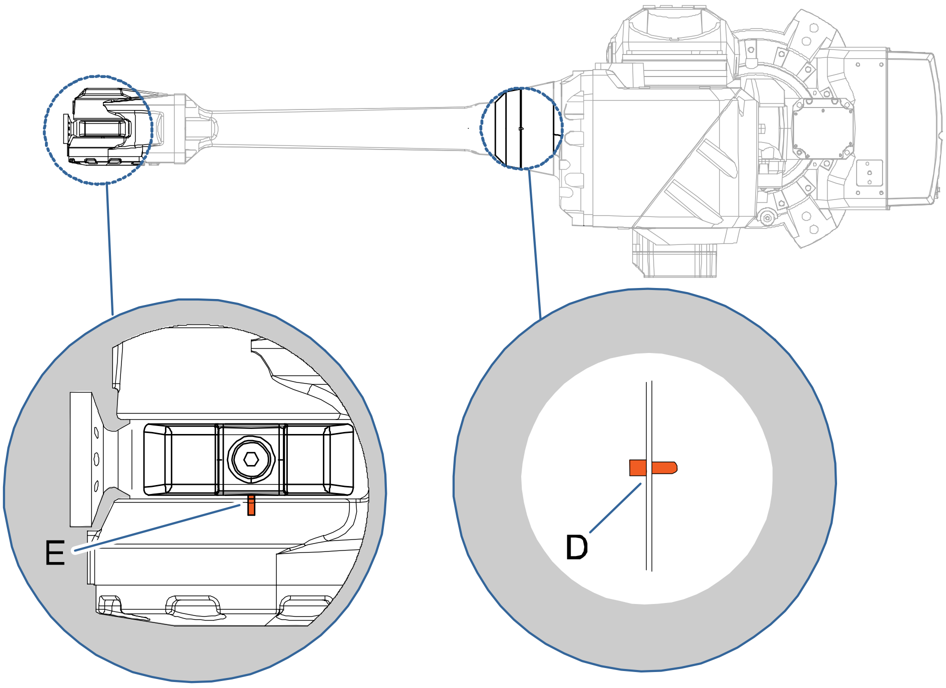


xx1700001814

D	Synchronization mark, axis 4
E	Synchronization mark, axis 5
F	Synchronization mark, axis 6 The two tips of the arrows should be inside the corresponding groove on the tilt housing when in synchronization position.

Continues on next page

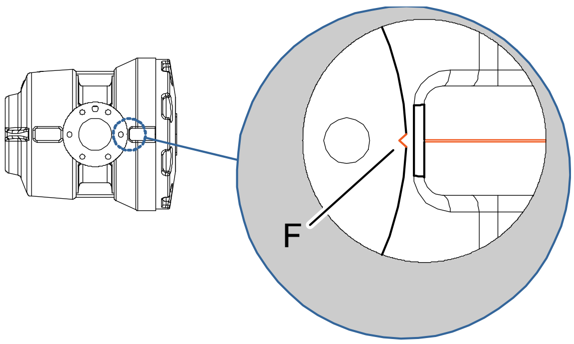
IRB 4600 -20/2.50



xx0800000320

D	Synchronization mark, axis 4
E	Synchronization mark, axis 5

IRB 4600 -20/2.50



xx0800000321

F	Synchronization mark, axis 6

5.2.2 Calibration movement directions for all axes

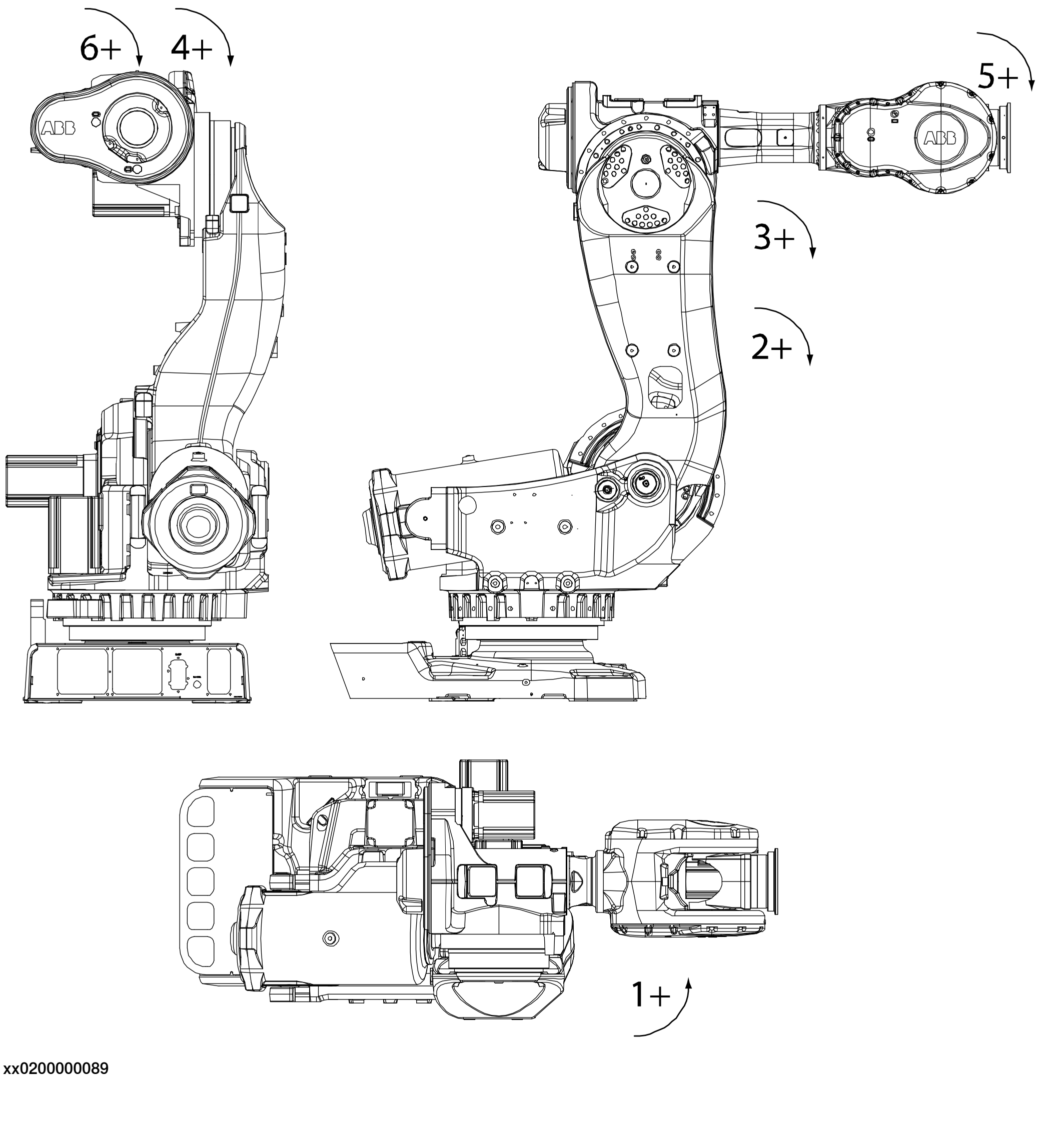
Overview

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

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

Manual movement directions, 6 axes

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



xx0200000089

5.3 Updating revolution counters

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 140	IRB 1410	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	x
Axis 5, 6		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 340*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 345*.

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.

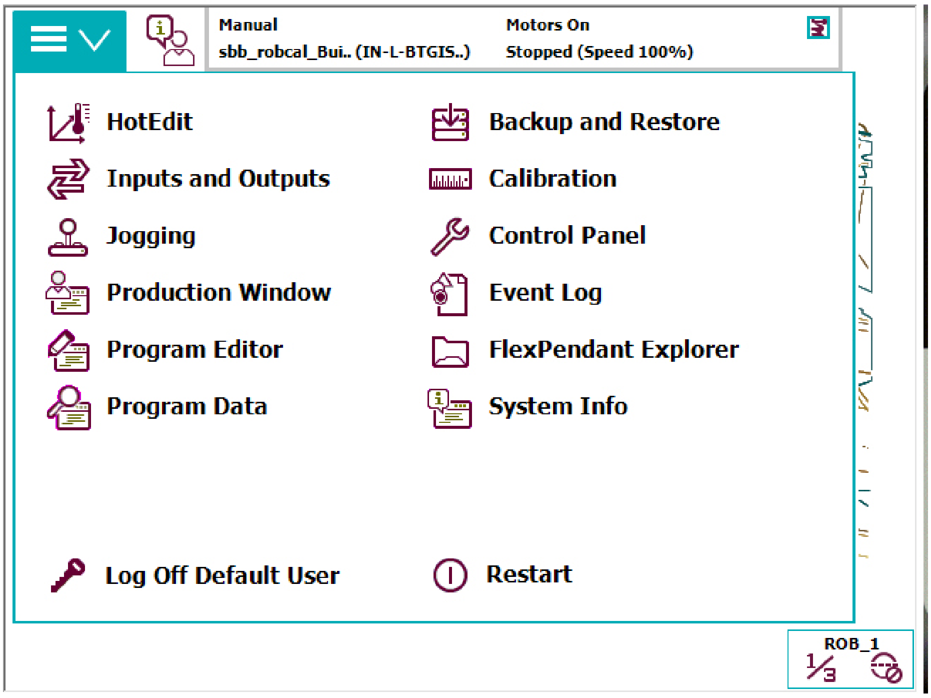
If one of the following mentioned axes are rotated one or more turns from its calibration position before updating the revolution counter, the correct calibration position will be lost due to non-integer gear ratio. This affects the following manipulators:

Manipulator variant	Axis 4	Axis 6
IRB 4600	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).

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

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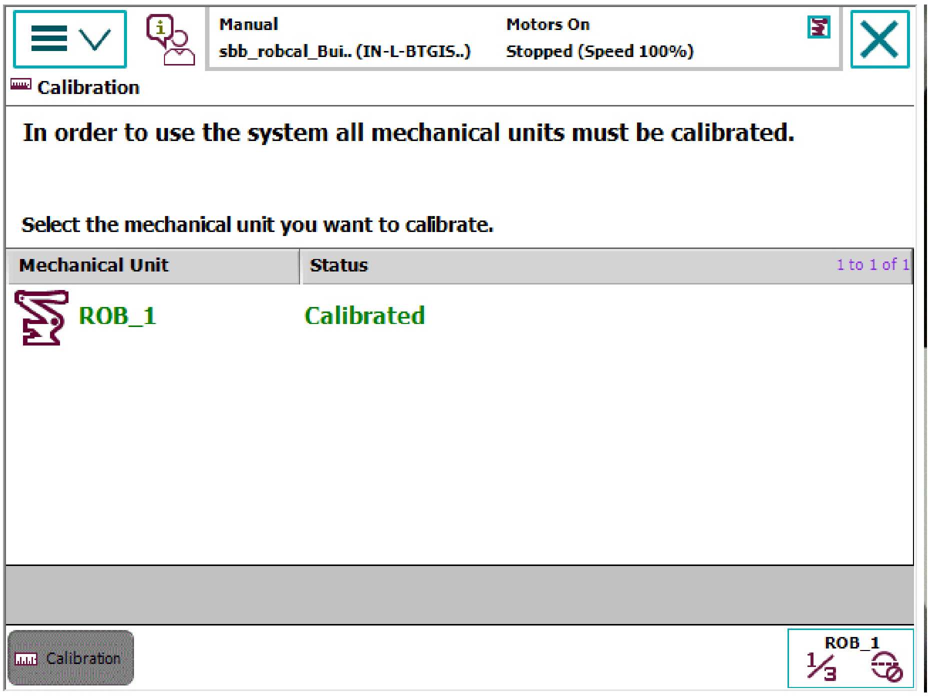
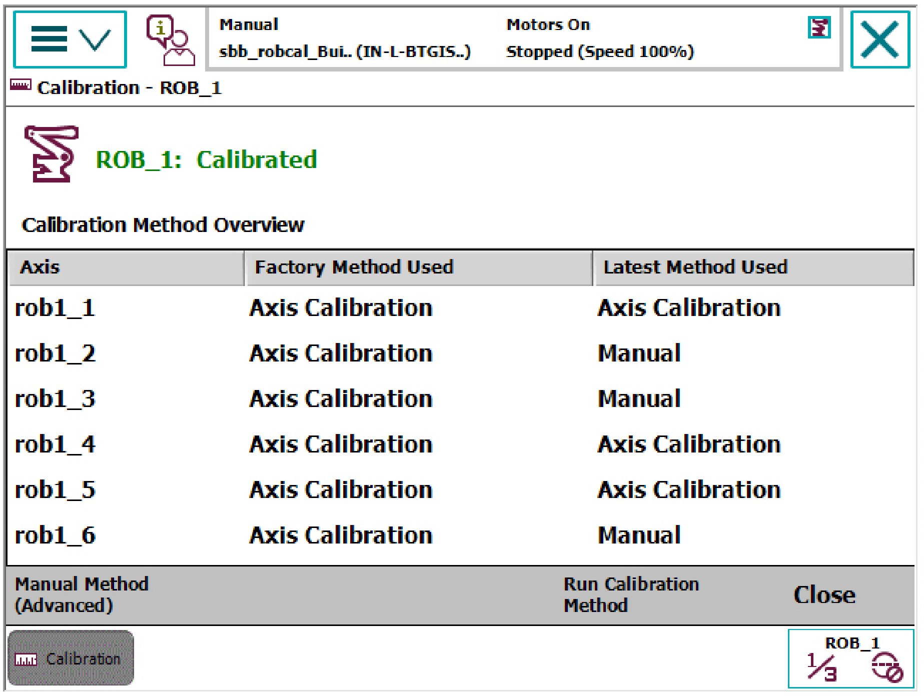
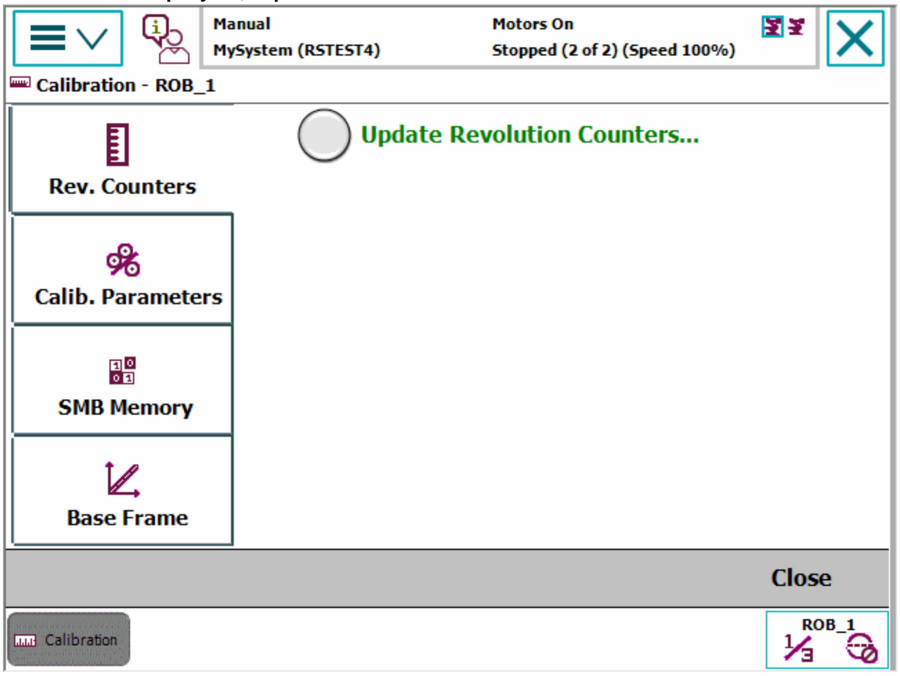
	Action
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question.  xx1500000943
3	**This step is valid for RobotWare 6.02 and later.** Calibration method used at factory for each axis is shown, as well as calibration method used during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

Continues on next page

	Action
4	A screen is displayed, tap **Rev. Counters**.  en0400000771
5	Tap **Update Revolution Counters...**. A dialog box is displayed, warning that updating the revolution counters may change programmed robot positions: • Tap **Yes** to update the revolution counters. • Tap **No** to cancel updating the revolution counters. Tapping **Yes** displays the axis selection window.
6	Select the axis to have its revolution counter updated by: • Ticking in the box to the left • Tapping **Select all** to update all axes. Then tap **Update**.
7	A dialog box is displayed, warning that the updating operation cannot be undone: • Tap **Update** to proceed with updating the revolution counters. • Tap **Cancel** to cancel updating the revolution counters. Tapping **Update** updates the selected revolution counters and removes the tick from the list of axes.
8	**CAUTION** If a revolution counter is incorrectly updated, it will cause incorrect manipulator positioning, which in turn may cause damage or injury! Check the synchronization position very carefully after each update. See *Checking the synchronization position on page 369*.

5.3.2 Updating revolution counters on OmniCore robots

Introduction

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

Step 1 - Manually running the manipulator to the synchronization position

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

	Action	Note
1	Select axis-by-axis motion mode.	
2	Jog the manipulator to align the synchronization marks.	See *Synchronization marks and synchronization position for axes on page 340*.
3	When all axes are positioned, update the revolution counter.	*Step 2 - Updating the revolution counter with the FlexPendant on page 348*.

Step 2 - Updating the revolution counter with the FlexPendant

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

	Action
1	On the start screen, tap **Calibrate**.
2	Select **Calibration** from the menu. The **Mechanical Units** page displays a list of available mechanical units. **Note** This step is required only if you are not already in the **Mechanical Unit** page when you open **Calibrate**. **Note** The **Mechanical Unit** page is displayed only if there are more than one mechanical unit available. Otherwise, the calibration summary page for the available mechanical unit is displayed.
3	Select the mechanical unit for which revolution counter need to be updated.
4	The calibration summary page for the selected mechanical unit is displayed. Calibration method used at factory for each axis is shown, as well as calibration method used during last field calibration.
5	Tap **Calibration Methods** on the right pane. The calibration options are displayed.
6	Tap **Revolution Counters**.
7	In the **Selection** column select the axes for which revolution counters need to be updated.
8	Tap **Update**. 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** and a confirmation window is displayed.

Continues on next page

	Action
9	Tap **OK**. The revolution counter for the selected axes is updated.
10	**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 369*.

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 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.

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

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

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

Update revolution counters

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

Validation

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

Position of robot axes

The robot axes should be positioned close to 0 degrees before commencing the calibration program. The axis chosen for calibration is then automatically run by the calibration program to its exact calibration position during the calibration procedure.

It is possible to position some of the other axes in positions different from 0 degrees. Information about which axes are allowed to be jogged is given on the FlexPendant.

Continues on next page

These axes are marked with **Unrestricted** in the FlexPendant window. Also the following table shows the dependencies between the axes.

Requirements for axis positioning during calibration

	Axis to calibrate					
Required position of axis	**Axis 1**	**Axis 2**	**Axis 3**	**Axis 4**	**Axis 5**	**Axis 6**
Axis 1	-	*	*	*	*	*
Axis 2	0	-	0	*	*	*
Axis 3	0	0	-	*	*	*
Axis 4	*	*	*	-	0	0
Axis 5	*	*	*	*	-	0
Axis 6	*	*	*	*	*	-

-	Axis to be calibrated
*	Unrestricted. Axis is allowed to be jogged to other position than 0 degrees.
0	Axis must be put in position 0 degrees.

System containing SafeMove

SafeMove will lose its synchronization to the controller if a new calibration is done. New calibration values have to be downloaded to SafeMove, and a new SafeMove calibration has to be done. Make sure that the user rights admit to change the safety settings and to synchronize SafeMove.

For robots with EPS, the same applies as for SafeMove.

How to calibrate a suspended robot

The IRB 4600 is fine calibrated floor standing in factory, prior to shipping.

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

To calibrate a suspended robot with the fine calibration routine, the robot must first be taken down and then be 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 disk.

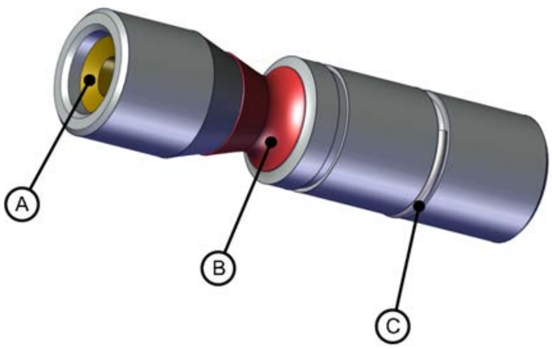
Examining the calibration tool

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

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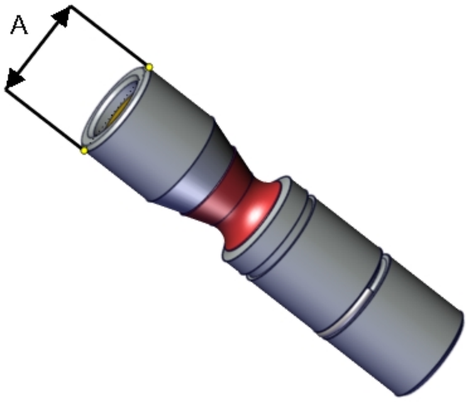
Periodic check of the calibration tool

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

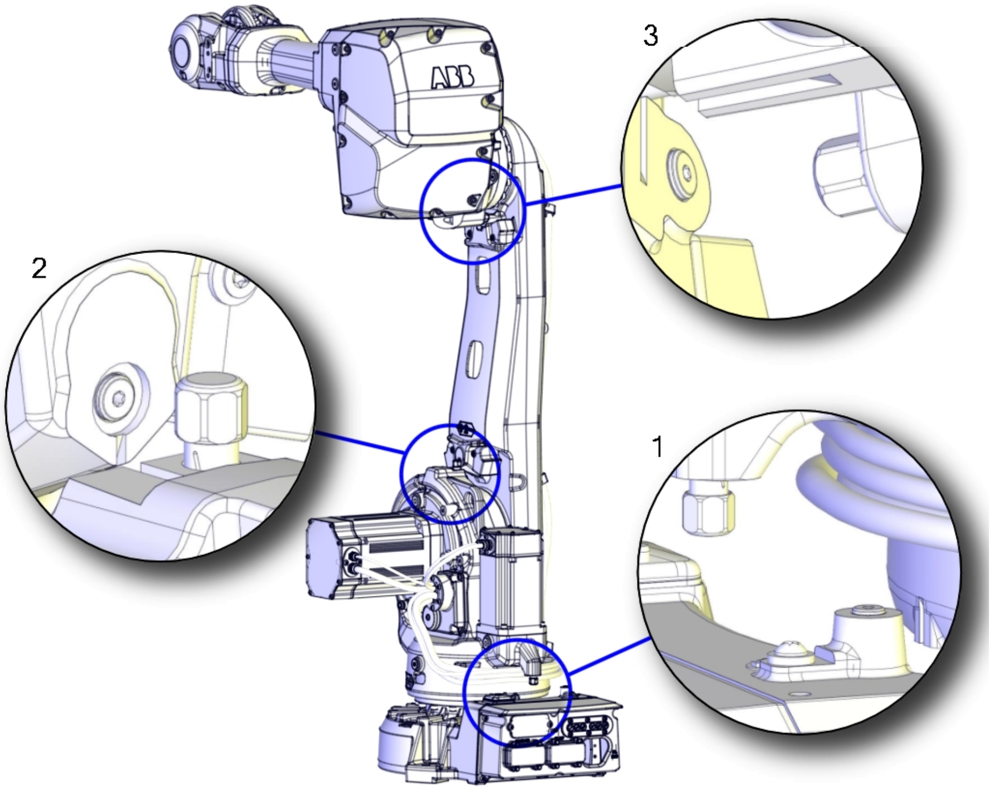
5.4.3 Installation locations for the calibration tools

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.



xx1600000641

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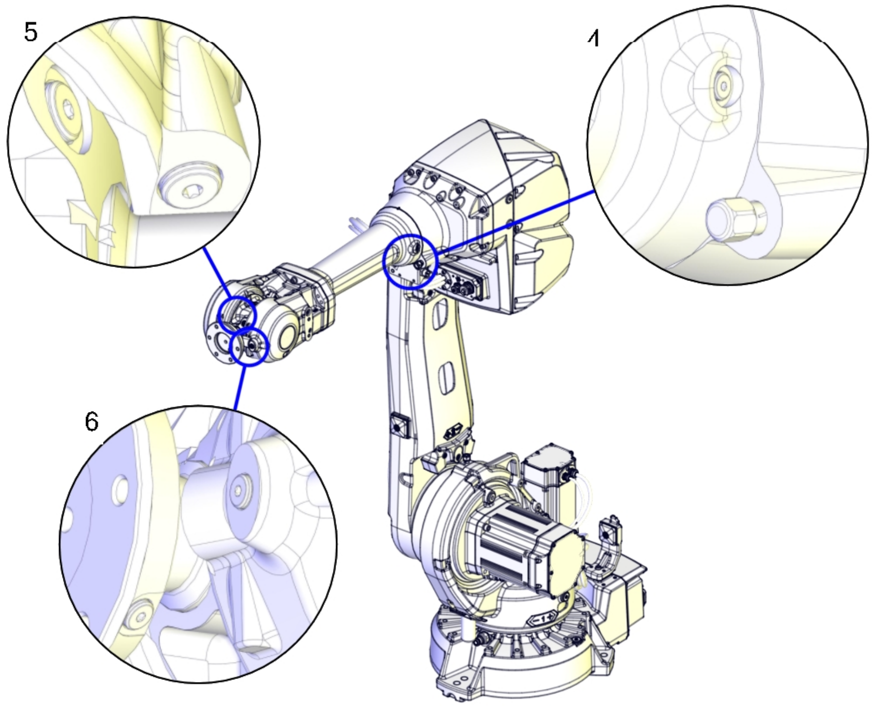
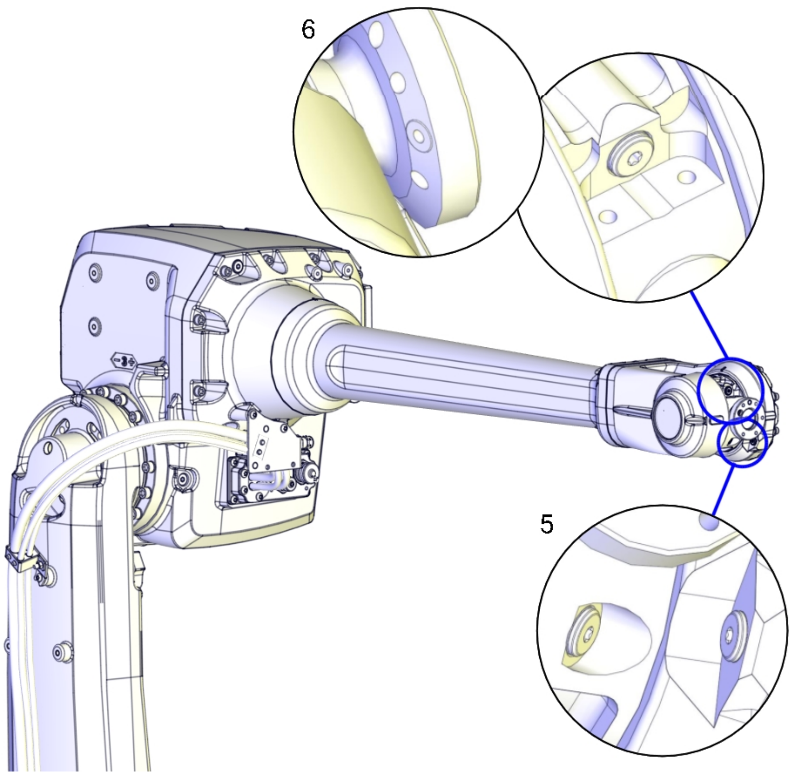


xx1600000642

IRB 4600 - 20/2.50



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Spare parts

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

Spare part	Article number	Note
Protection cover and plug set	3HAC059487-001 (protection type Standard)	Contains replacement calibration pin covers and protective plugs for the bushing.
Protective plug on turning disc	3HAC057511-001	Only on IRB 4600 - 20/2.50. 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 disk.

Required consumables

Consumable	Article number	Note
Clean cloth	-	

Spare parts

Spare part	Article number	Note
Protection cover and plug set	3HAC059487-001 (protection type Standard)	Contains replacement calibration pin covers and protective plugs for the bushing.
Protective plug on turning disc	3HAC057511-001	Only on IRB 4600 - 20/2.50. 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.

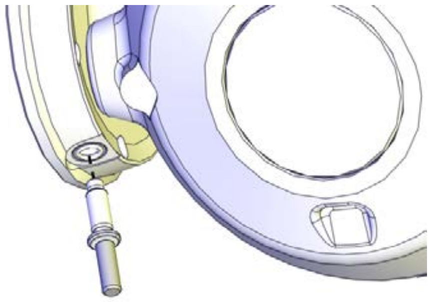
1. Choose calibration routine. The routines are described in *Routines in the calibration procedure on page 351*.
2. Choose which axis/axes to calibrate.
3. The robot moves to synchronization position.
4. Validate the synchronization marks.

Continues on next page

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 4600 - 20/2.50:

   xx1700000905

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

Continues on next page

	Action	Note
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 366*.

Starting the calibration procedure

Use this procedure to start the Axis Calibration routine on the FlexPendant.

	Action	Note
1	Tap the calibration icon and enter the calibration main page.	
2	All mechanical units connected to the system are shown with their calibration status. Tap the mechanical unit in question. **Note** For RobotWare 7, the mechanical unit page is displayed only if there is more than one mechanical unit available.	
3	The calibration method used at ABB factory for each axis is shown, as well as calibration method used for the robot during last field calibration.	The FlexPendant will give all information needed to proceed with Axis Calibration.
4	**Valid for RobotWare 6** Tap **Call Calibration Method**. The software will automatically call for the procedure for the valid calibration method. If not, tap **Call Routine** and then tap **Axis calibration**.	
5	**Valid for RobotWare 7** Tap **Calibration Methods** on the right pane and then tap **Calibration**. The software will automatically call for the procedure for the valid calibration method.	
6	Follow the instructions given on the FlexPendant.	A brief overview of the sequence that will be run on the FlexPendant is given in *Overview of the calibration procedure on the FlexPendant on page 358*.

Restarting an interrupted calibration procedure

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

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

Continues on next page

Situation	Action
The RobotWare program is terminated with **PP to Main**.	Remove the calibration tool, if it is installed, and restart the calibration procedure from the beginning. See *Starting the calibration procedure*. 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 343*

Axis Calibration with SafeMove option

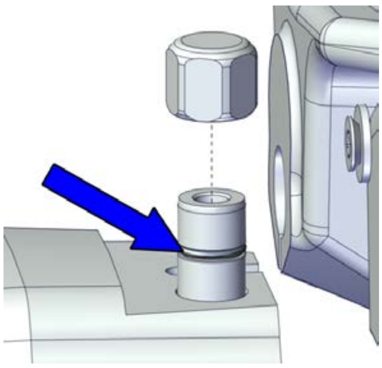
To be able to run Axis Calibration, SafeMove needs to be unsynchronized. The Axis Calibration routine recognizes if the robot is equipped with SafeMove and will force SafeMove to unsynchronize automatically.

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.

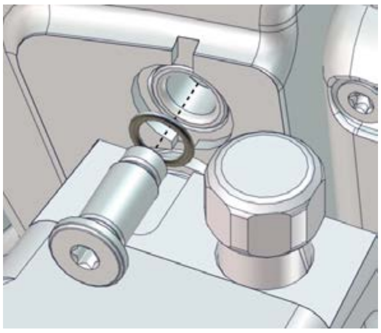
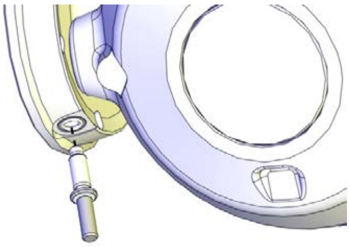
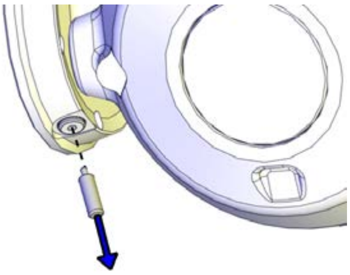
CAUTION

SafeMove must be synchronized after the calibration is completed.

After calibration

	Action	Note
1	Check the o-ring on the fixed calibration pin. Replace if damaged or missing.	 xx1600002102 Protection cover and plug set: . 3HAC059487-001 (protection type Standard)
2	Reinstall the protective cover on the fixed calibration pin on each axis, directly after the axis has been calibrated. Replace the cover with new spare part, if missing or damaged.	

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 (protection type Standard)
4	Refit the special protection plug to the turning disc using the tool included in the calibration tool box.	IRB 4600 - 20/2.50  xx1700000905
5	Remove the tool from the protection plug.	IRB 4600 - 20/2.50  xx1700000906
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 366*.

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 silver label (on the lower arm or the base).
3. Jog the manipulator so that all axes are in zero position (ex use `MoveAbsJ` instruction). Check that all axis scales are aligned with calibration marks.
4. If the scales differ from calibration marks it might depend on wrong turns of the revolution counters. Make a marker line on the corresponding axis to be able to validate the result of the calibration. If more than one motor revolutions are wrong, the calibration will fail.
5. Use a verification position. This is especially recommended if all axes were not aligned with the synchronization marks (step 3). Reuse an existing position that is suitable and accurate so it can be used to validate the repair. Use a position where a deviation in axis calibration gives a big deviation in positioning. Note! Check the position after each repair in one axis.
6. Use Reference calibration to save reference values for all axes that is to be replaced. Make sure that the values are saved in RobotStudio or FTP program. The files are located in "Active system folder name/HOME/RefCalibFiles".
7. Perform the repair.
8. Make sure that the tooling and process equipment are the same as when creating the reference. Use Reference calibration to update the system with new calibration offset value for the repaired axis.
9. Check the position against the verification position (step 5).
10. Proceed with the repair of the next axis, if necessary, and repeat (step 8-9) for every axis.
11. (For system containing SafeMove or EPS) Download new calibration values to SafeMove. Use Visual SafeMove in RobotStudio.(For system containing SafeMove) Download new calibration values to SafeMove. Use Visual SafeMove in RobotStudio.
12. (For system containing SafeMove or EPS) Synchronize SafeMove to activate SafeMove.(For system containing SafeMove) Synchronize SafeMove to activate SafeMove.
13. Perform test run.
14. Update the label for resolver values with new 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 363*).

Continues on next page

Example "Adjust axis 4":

1. Create a backup.
2. Run the manipulator to the verification position. (The manipulator position is now deviating from the verification position.)
3. Read and note current axis 4 value in degrees (example: 96.3 degrees).
4. Manually jog, only axis 4, so that the manipulator is correctly positioned to the verification position.
5. Read and note current axis 4 value in degrees (example: 94.2 degrees).
6. Move the manipulator to its calibration position.
7. Calculate the angle difference (ie 96.3-94.2=2.1 degrees).
8. Manually jog axis 4 the calculated angle difference (-2.1). NOTE! The direction +/- shall be the same direction as the direction used when axis 4 was manually jogged to coincide with the verification process. In the example -2.1 degrees.
9. Make a new manual fine calibration of axis 4 with axis in -2.1 degrees position.
10. Check again against the verification position.
11. Repeat the manual tuning if needed.
12. Create a new reference if the intention is to use the reference in the future.

5.5 Calibrating with Calibration Pendulum method

Where to find information for Calibration Pendulum

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

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.

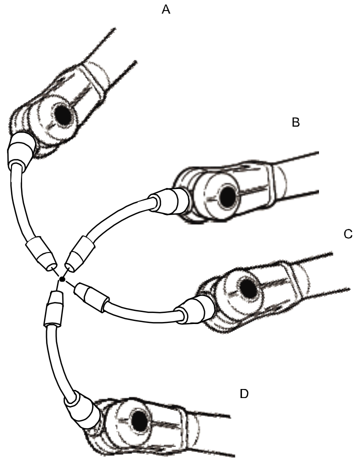
   a. Jog the robot to an appropriate position, A, for the first approach point.

      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.



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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 369*.
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 340*.
3	Write down the values on a new label and stick it on top of the calibration label. The label is located on the lower arm.	

5.8 Checking the synchronization position

Introduction

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

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

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 340* and *Updating revolution counters on page 344*.

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 340* and *Updating revolution counters on page 344*.

Continues on next page

Using a `MoveAbsJ` instruction

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

	Action	Note
1	Tap **Code**.	
2	Create a new program.	
3	Use **MoveAbsJ** in the **Add Instruction** menu.	

4	Create the following program:
	`MoveAbsJ [[0,0,0,0,0,0],`
	`[9E9,9E9,9E9,9E9,9E9,9E9]]`
	`\NoEOffs, v1000, fine, tool0`	

5	Run the program in manual mode.	
6	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See *Synchronization marks and synchronization position for axes on page 340* and *Updating revolution counters on page 344*.

Using the jogging window

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

	Action	Note
1	Tap **Jog**.	
2	From the **Mechanical unit** list select a mechanical unit.	
3	From the **Motion mode** section, select an axis-set that need to be jogged. For example, to jog axis 2, select the axis set **Axis 1-3**.	
4	Follow the screen instruction on joystick movements to understand the direction of the axis that you want to move and move the joystick.	
5	Manually run the robots axes to a position where the axis position value read on the FlexPendant, is equal to zero.	
6	Check that the synchronization marks for the axes align correctly. If they do not, update the revolution counters.	See *Synchronization marks and synchronization position for axes on page 340* and *Updating revolution counters on page 344*.

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.

General

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

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

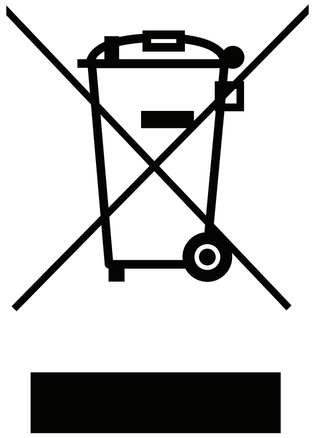
6.2 Environmental information

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
Batteries, Lithium	Serial measurement board
Cast iron/nodular iron	Base, lower arm, upper 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 Manipulator types and variants

Overview

IRB 4600 variant	First manipulator revision (Type A)	Second manipulator revision (Type B)	Third manipulator revision (Type C)	Fourth manipulator revision (Type D)
IRB 4600-60/2.05, IRB 4600-45/2.05, IRB 4600-40/2.55 (Standard, Foundry Plus 2)	Axis 3 new gearbox	Axis 3 new gearbox	Axis 1 and 3 new gearboxes	
IRB 4600-20/2.50 (Standard, Foundry Plus 2)	Axis 3 new gearbox	Axis 3 new gearbox	Axis 1 and 3 new gearboxes	Axis 4, 5, and 6 new motors

7.2 Type C of IRB 4600

Type C - alternative gearboxes

Type C of IRB 4600 have an alternative supplier of the axis-1 and axis-3 gearboxes.

How to know which of the types is described, in the manual

Throughout the manual the alternative gearboxes are described as "Type C". Other types of gearboxes are called "Other design than Type C". The manual describes all the types of gearboxes.

Interchangeable parts

Type C gearboxes are not interchangeable with other designs of the axis-1 and axis-3 gearboxes.

Notable changes connected to the Type C gearboxes

- Dimension and number of attachments screws are different.
- Washers between the lower arm and axis-3 gearbox, are different.
- Tightening torques are different.
- Tightening torque with angle 90 degrees added when the lower arm is secured to the axis-3 gearbox.
- The frame and base are redesigned to fit the axis-1 gearbox and are not compatible with other designs of the gearbox. This affects the installation of additional mechanical stops on axis 1 and the values of possible restricted working range.

7.3 Type D of IRB 4600

Type D - alternative motor

Type D of IRB 4600 uses a *Type C of IRB 4600 on page 376* with an alternative motor, and is only valid for the 20 kg/2.50 m variant.

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

General

The product is compliant with ISO 10218-1:2011, *Robots for industrial environments - Safety requirements - Part 1 Robots*, and applicable parts in the normative references, as referred to from ISO 10218-1:2011. In case of deviation from ISO 10218-1:2011, these are listed in the declaration of incorporation. The declaration of incorporation is part of the delivery.

Robot standards

Standard	Description
ISO 9283	Manipulating industrial robots – Performance criteria and related test methods
ISO 9787	Robots and robotic devices – Coordinate systems and motion nomenclatures
ISO 9946	Manipulating industrial robots – Presentation of characteristics

Other standards used in design

Standard	Description
IEC 60204	Safety of machinery - Electrical equipment of machines - Part 1: General requirements, normative reference from ISO 10218-1
IEC 61000-6-2	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity standard for industrial environments
IEC 61000-6-4	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments
ISO 13849-1:2006	Safety of machinery - Safety related parts of control systems - Part 1: General principles for design, normative reference from ISO 10218-1

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
EN ISO 10218-1	Robots and robotic devices — Safety requirements for industrial robots — Part 1: Robots

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%**!

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.

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

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]
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 386*, 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 4600 - 60/2.05, -45/2.05, -40/2.55	3HAB1611-6
Measuring tool, play	IRB 4600 - 20/2.50	3HAB6337-1

Special tools

The following table specifies the special tools required during several of the service procedures. The tools may be ordered separately and are also specified directly in concerned instructions in the product manual.

Description	Qty	Art. no.
Guide pins, removal/refitting of axis 1 gearbox	2 pcs	-
Guide pins, removal/refitting of axis 3 gearbox	2 pcs	-

Oil change equipment

The following table specifies the oil change equipment. The tool is specified directly in concerned instructions in the product manual.

Description	Included parts	Art. no.
Oil change equipment	• vacuum pump with regulator, hose and coupling • couplings and adapters • pump (manual) with hose and coupling • graduated measuring glass • oil gun • user instructions.	3HAC021745-001

Calibration equipment, Levelmeter (alternative method)

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

Description	Art. no.	Note
Angle bracket	68080011-LP	
Calibration bracket	3HAC13908-9	

Continues on next page

Description	Art. no.	Note
Calibration tool ax1	3HAC13908-4	
Measuring pin	3HAC13908-5	
Sensor fixture	68080011-GM	
Sensor plate	3HAC0392-1	
Sync. adapter	3HAC13908-1	

Calibration equipment, Calibration Pendulum

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

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

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

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

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

Calibration equipment, Axis Calibration

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

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

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

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

Description	Art. no.	Note
Calibration tool box, Axis Calibration	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 disk.

Turning tool for suspended mounting

The following table specifies the lifting tool required when fitting the robot in a suspended position.

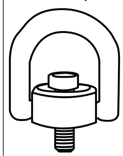
Description	Art. no.	Note
Turning tool (includes lifting instruction)	3HAC034766-001	Valid for other designs than Type B, C and Type D.

Continues on next page

Description	Art. no.	Note
Turning tool (includes lifting instruction 3HAC051688-001)	3HAC048502-001	Valid for Types B, D and Type D.

Lifting accessories

This table specifies the lifting accessories required during several of the service procedures. The lifting accessories can be ordered separately and are also specified directly in concerned instructions.

Description	Qty	Article no.	Note
Lifting accessory, axis 2			
Lifting accessory, axis 3			
Rotating lifting point	2 pcs	-	For lifting of upper arm. Dimension: M8. Example: Gunnebo RLP GrabiQ M8-10.  xx1100000564

Special tools

This table specifies the special tools required during several of the service procedures. The tools are specified directly in concerned instructions.

Description	Qty	Article no.
Guide for reduction gear	1	3HACxxx Used to guide axis-1 gear and frame during refitting.

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 - OmniCore V250XT	*3HAC074000-008*
Circuit diagram - IRC5	*3HAC024480-011*
Circuit diagram - IRC5 Panel Mounted Controller	*3HAC026871-020*
Circuit diagram - Euromap 67, design 14	*3HAC024120-005*
Circuit diagram - Spot welding cabinet	*3HAC057185-001*

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 460	*3HAC036446-005*
Circuit diagram - IRB 660	*3HAC025691-001*
Circuit diagram - IRB 760	*3HAC025691-001*
Circuit diagram - IRB 1200	*3HAC046307-003*
Circuit diagram - IRB 1410	*3HAC2800-3*
Circuit diagram - IRB 1600/1660	*3HAC021351-003*
Circuit diagram - IRB 1520	*3HAC039498-007*
Circuit diagram - IRB 2400	*3HAC6670-3*
Circuit diagram - IRB 2600	*3HAC029570-007*
Circuit diagram - IRB 4400/4450S	*3HAC9821-1*
Circuit diagram - IRB 4600	*3HAC029038-003*
Circuit diagram - IRB 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*

Index

A

Absolute Accuracy, calibration, 338
allergenic material, 32
aluminum
    disposal, 372
ambient humidity
    operation, 47
    storage, 47
ambient temperature
    operation, 47
    storage, 47
assembly instructions, 43
assessment of hazards and risks, 32
Axis Calibration, 350
    calibration tool
        article number, 353, 358
        examining, 353
        installation position, 355
    overview of method, 350
    procedure on FlexPendant, 358, 366
    protective cover and protection plug, 355, 358

B

batteries
    disposal, 372
battery pack
    replacing, interval, 110
brakes
    testing function, 40

C

cabinet lock, 33
cabling, robot, 97
cabling between robot and controller, 97
calibrating
    robot, 350
    roughly, 344, 348
calibrating robot, 350, 365–366
calibration
    Absolute Accuracy type, 336
    rough, 344, 348
    standard type, 336
    verification, 368
    when to calibrate, 339
calibration, Absolute Accuracy, 338
calibration manuals, 338
calibration marks, 340
Calibration Pendulum
    overview of method, 365
calibration position
    jogging to, 369–370
    scales, 340
calibration scales, 340
CalibWare, 336
carbon dioxide extinguisher, 33
cast iron
    disposal, 372
cleaning, 184
climbing on robot, 36
Cold environments, 96
connecting the robot and controller, cabling, 97
copper
    disposal, 372

D

direction of axes, 343

E

environmental information, 372
ESD
    damage elimination, 53
    sensitive equipment, 53
expansion container
    installing, 90
expected life, 111

F

fire extinguishing, 33
FlexPendant
    jogging to calibration position, 369–370
    MoveAbsJ instruction, 369–370
    updating revolution counters, 345, 348
foundation
    requirements, 46

G

gearboxes
    location of, 146
Gravity Alpha, 66
Gravity Beta, 65
grease, 36
    disposal, 372

H

hanging
    installed hanging, 32
hazard levels, 23
hazardous material, 372
height
    installed at a height, 32
hot surfaces, 36
HRA, 32
humidity
    operation, 47
    storage, 47

I

instructions for assembly, 43
integrator responsibility, 32
intervals for maintenance, 109

L

labels
    robot, 25
leak-down test, 188
lifting
    accessory, 57
lifting accessory, 385
limitation of liability, 21
Lithium
    disposal, 372
loads on foundation, 45
lock and tag, 33
lubricants, 36
lubrication
    amount in gearboxes, 146
    type of lubrication, 146

M

magnesium
    disposal, 372

maintenance schedule, 109
MoveAbsJ instruction, 369–370

N
national regulations, 32
negative directions, axes, 343
neodymium
  disposal, 372
nodular iron
  disposal, 372

O
oil, 36
  amount in gearboxes, 146
  disposal, 372
  type of oil, 146
oil change
  axis 1, floor mounted robots, 148
  axis 1, suspended robots, 153
  axis 2, 159
  axis 3, 163
  axis 4, 169
  axis 5, 173
  axis 6, 173
operating conditions, 47
options
  expansion container, 90
original spare parts, 21

P
pedestal
  installed on pedestal, 32
personnel
  requirements, 22
plastic
  disposal, 372
positive directions, axes, 343
PPE, 22
product standards, 380
protection classes, 47
protection type, 47
protective equipment, 22
protective wear, 22

R
recycling, 372
regional regulations, 32
release brakes, 39
replacements, report, 187
report replacements, 187
requirements on foundation, 46
responsibility and validity, 21
revolution counters
  storing on FlexPendant, 345, 348
  updating, 344, 348
risk of burns, 36
risk of tipping, 52
robot
  labels, 25
  protection class, 47
  protection types, 47
  symbols, 25
rubber
  disposal, 372

S
safety
  brake testing, 40
  ESD, 53
  fire extinguishing, 33
  release robot axes, 39
  signals, 23
  signals in manual, 23
  symbols, 23
  symbols on robot, 25
  test run, 106
safety devices, 33
safety hazard
  hydraulic system, 34
  pneumatic system, 34
safety signals
  in manual, 23
safety standards, 380
scales on robot, 340
schedule for maintenance, 109
screw joints, 382
signals
  safety, 23
special tools, 387
speed
  adjusting, 96
stability, 52
standards, 380
  ANSI, 380
  CAN, 380
start of robot in cold environments, 96
steel
  disposal, 372
storage conditions, 47
suspended mounting, 65
symbols
  safety, 23
synchronization position, 344, 348
sync marks, 340
system integrator requirements, 32
system parameter
  Gravity Alpha, 66
  Gravity Beta, 65

T
temperatures
  operation, 47
  storage, 47
testing
  brakes, 40
tilted mounting, 65
tools
  Axis Calibration, 388
  calibration equipment, Levelmeter, 387
  Calibration Pendulum, 388
  for service, 387
torques on foundation, 45
troubleshooting
  oil spills, 184
  safety, 41
turning
  accessory, 57

U
upcycling, 372
updating revolution counters, 344, 348
users
  requirements, 22

V
validity and responsibility, 21
velocity
adjusting, 96
verifying calibration, 368

W
weight, 44
base, 242–243
robot, 55, 63, 239, 259, 261, 266, 269, 280, 282, 310, 314, 321–322, 330–331
upper and lower arm, 320, 324
upper arm, complete, 250, 255
Wrist Optimization
overview of method, 366

Z
zero position
checking, 369

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